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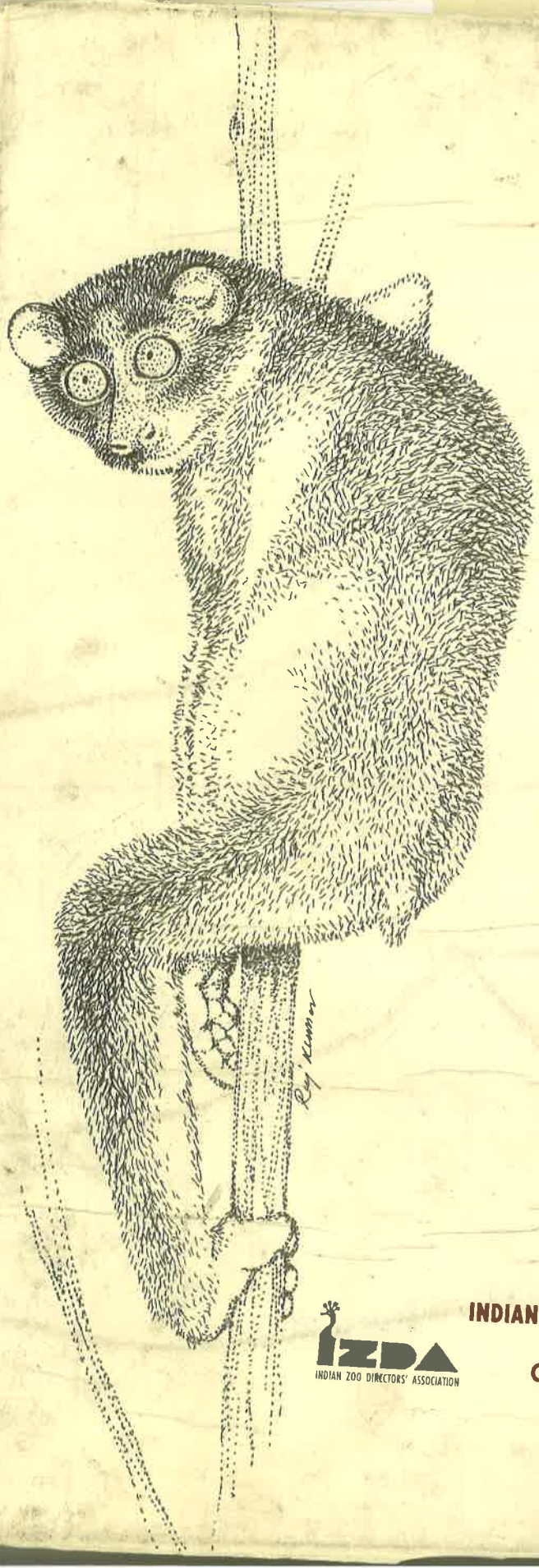
VOL - II



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VOL - II
(ANIMAL BIOLOGY AND CONSERVATION)

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A COMPENDIUM OF PUBLICATIONS FROM INDIAN ZOOS

VOL - II

(ANIMAL BIOLOGY AND CONSERVATION)

Compilers

S.K. PATNAIK
L.N. ACHARJYO

INDIAN ZOO DIRECTORS' ASSOCIATION
&
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1998

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VOL - II

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PREFACE

Zoo movement in India is more than a century old. Different Zoos have done pioneering works in the field of up-keep and management of indigenous and exotic animals in captivity. It was not only confined to these works, but they have also published their works in different books, journals, magazines, reports, etc. The earliest such known work is that of Ram Brahma Sanyal of Alipore Zoological Garden, Calcutta in 1892. This is recognised all-over the world as one of the earliest reference books on zoo animal management. This has recently been reprinted by the Central Zoo Authority in 1995. Similarly, many other papers on wildlife diseases, biology, nutrition, management, education and awareness, etc. have been published by the Indian authors from time to time in national and international publications. But they were not available for ready reference to the zoo workers for their day to day work and for further research. A necessity of putting all these articles together was felt by the Indian Zoo Directors' Association. The Cenral Zoo Authority also agreed to support such a venture for the benefit of the Indian zoo community. We are thankful to different authors, institutions, publishers, etc., who have readily responded for copying of articles for publication in this compendium. The first volume is being entirely devoted to health and disease management. The second volume is devoted to animal biology and conservation. Subsequent volumes are planned on different subjects like further papers on diseases, animal biology, conservation, etc. which will depend on the response of the contributors and publishers. We are thankful to the Central Zoo Authority and its Member Secretary, Sri S.C. Sharma for actively supporting this venture. We are also thankful to all authors and editors of journals for including their papers in the compendium for the benefit of the Indian Zoo Community. It is our earnest hope that these publications will be useful for zoo personnels for their day to day management.

COMPILERS

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BIRDS

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A COMPENDIUM OF PUBLICATIONS FROM INDIAN ZOOS
VOL-II (ANIMAL BIOLOGY AND CONSERVATION), 1998

MAMMALS

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Genetic variation in Asiatic lions and Indian tigers

Previous reports have suggested that Asiatic lions and tigers are highly inbred and exhibit very low levels of genetic variation. Our analyses on these species have shown much higher degrees of polymorphism than reported. Randomly amplified polymorphic DNA (RAPD) analysis of 38 Asiatic lions, which exist as a single population in the Gir Forest Sanctuary in India, shows an average heterozygosity of 25.82% with four primers. Sperm motility studies by our colleagues corroborate this data. In Indian tigers, microsatellite analysis of five CA repeat loci and multilocus fingerprinting using Bkm 2(8) probe on a population of 22 individuals revealed a heterozygosity of 22.65%. Microsatellite analysis at loci Fca 77 and Fca 126 revealed polymorphism amongst the Asiatic × African lion hybrids, which has enabled us to use these as markers to discriminate the pure Asiatic lions from the hybrids. A similar analysis was used to identify hybrids of Indian and Siberian tigers through polymerase chain reaction (PCR) amplification of hair samples. To ascertain the variation which existed before the population bottleneck at the turn of the present century, microsatellite analysis was performed on 50- to 125-year-old skin samples from museum specimens. Our results show similar levels of genetic variability as in the present population (21.01%). This suggests that low genetic variability may be the characteristic feature of these species and not the result of intensive inbreeding. DNA fingerprinting studies of Asiatic lions and tigers have helped in identifying individuals with high genetic variability which can be used for conservation breeding programs.

1 Introduction

The habitat of the Asiatic lion (*Panthera leo persica*) ranged across southwestern Asia, extending from Syria to Northern India, as recently as 200 years ago [1]. The subspecies became extinct in Syria, Iraq, Iran, Afghanistan and Pakistan in the latter part of the 19th century. At present, Asiatic lions exist as a single relict population isolated since the 1880s [1] in the Gir Forest Sanctuary and the surrounding forest in the Gujarat state in western India. Large-scale hunting had reduced the population to less than twenty at the turn of the present century. Conservation efforts have brought this number up to 350. O'Brien *et al.* [2–4] reported a total absence of variation at each of 46 allozyme loci in 28 individuals of Asiatic lions of Gir Forest in contrast to several African lion (*Panthera leo leo*) populations which showed moderate levels of allozyme variation at the same loci. Lack of genetic variation in the Asiatic lion was correlated with a high incidence of morphologically abnormal spermatozoa and low levels of circulating testosterone, a critical hormone for spermatogenesis [4]. Based on these observations, the prediction was made [2–4] that the Asiatic lion is a severely endangered species that has suffered a population bottleneck or a series of bottlenecks followed by inbreeding in their recent history. The Indian tiger (*Panthera tigris tigris*), is another critically endangered felid. The population of this animal has dwindled from 40 000 individuals at the beginning of this century to the present figure of approximately 3500. Poaching for bones and hair, which have purported medicinal properties, and habitat shrinkage have been the major causes for the drastic reduction in number. Furthermore, the lions and tigers presently kept in various Indian zoos are suspected to be hybrids between Asiatic and African lions, and Indian and Siberian tigers.

The present study was, therefore, undertaken (i) to examine the extent of inbreeding in the Asiatic lion and Indian tiger population, (ii) to identify pure Asiatic lion from the hybrid between Asiatic and African lion, and pure Indian tiger from the hybrid between Indian tiger and Siberian tiger, and (iii) to identify the lions and tigers showing extensive genetic variation for selective breeding for their proper genetic management. To answer the above questions we have used random amplified polymorphic DNA (RAPD) and microsatellite analyses. For RAPD, short arbitrary oligonucleotides were used as primers in a PCR reaction to generate a DNA pattern. The advantages of this technique are that no prior sequence information of the genomes under investigations is required, it covers the genome more extensively than other techniques, and minute amounts of DNA are sufficient to carry out the analysis. RAPD, therefore, has been used to study many animal and plant genomes [5–7]. Microsatellites, due to their abundance in the genome and high mutation rates, prove useful in addressing questions in dynamics of populations. They have been used in conservation biology to assess the levels of genetic diversity and plan future strategies as in the case of the bottlenecked wombat and endangered Ethiopian wolf [8, 9]. We have also used banded krait minor satellite DNA (Bkm)-derived 2(8) multilocus DNA finger-

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Nonstandard abbreviations: Bkm, banded krait minor satellite DNA; OTU, operational taxonomic unit; RAPD, randomly amplified polymorphic DNA

Keywords: Genetic variation / Randomly amplified polymorphic DNA / Microsatellites / Lions / Tigers / Conservation

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Table 1. Collection of blood samples of lions, tigers and tiger skin and hair samples from various zoos in India

Zoo	Animals	Number of animals (males + females)	International Stud Book No.
Chandigarh	Hybrid lion (Asiatic × African)	20 (12 + 8)	
	Indian tiger	2 (1 + 1)	
Calcutta	Hybrid lion (Asiatic × African)	10 (6 + 4)	
	Indian tiger	10 (7 + 3)	
	Tigon (male Indian tiger and female hybrid lion)	1 (0 + 1)	
	Litigon (male hybrid lion and female tigon)	2 (1 + 1)	
Bhubaneshwar	Hybrid lion (Asiatic × African)	18 (13 + 5)	
	Asiatic lion	2 (0 + 2)	304, 1017
	Indian tiger	43 (26 + 17)	
Guwahati	Hybrid lion (Asiatic × African)	2 (1 + 1)	
	Indian tiger	6 (4 + 2)	
Sakkarbaug Gir Forest	Asiatic lion	41 (18 + 23)	299, 312, 321, 323, 1201, 1224, 1225, 1236, 1237, 1243, 1256, 1258, 1272, 1274
	Indian tiger	5 (3 + 2)	
Hyderabad	Hybrid lion (Asiatic × African)	13 (7+ 6)	
	Indian tiger	5 (2 + 3)	
Darjeeling	Siberian tiger	5 (2+3)	

Total No. of hybrid lions (Asiatic × African) = 63
Total No. of Asiatic lions = 33
Total No. of Indian tigers = 71
Total No. of Siberian tigers = 5
Total No. of tigon = 1
Total No. of litigons = 2

Skin samples from National Museum, Calcutta (50–125 years old) of Indian tiger = 15.
Hair samples of hybrid between Siberian and Indian tiger = 2

printing to detect minisatellite variations. In order to probe into the genetic history of lions and tigers, microsatellite analysis on five CA repeat loci was carried out using skin samples from museum specimens (some of them 125 years old).

2 Materials and methods

2.1 Samples

Blood samples of the Asiatic lion (*Panthera leo persica*), Indian tigers (*Panthera tigris tigris*), hybrids between Asiatic lion and African lion (*Panthera leo leo*) and Siberian tigers (*Panthera tigris altaica*) from various zoos in India were collected from the femoral vein by immobilizing the animals in squeeze cages or by anesthetizing them (Table 1).

2.2 DNA Isolation and multilocus fingerprinting

Genomic DNA prepared from blood [10] was digested with *Hinf*1 and electrophoresed in a 0.9% agarose gel. Southern blotting and filter hybridization with Bkm 2(8) probe were done as described [11, 12].

2.3 Bkm 2(8) probe

The 2(8) probe is a Bkm-positive subclone of the *Drosophila* clone CS314 [13], subcloned in M13mp9, containing a 545 base pair insert consisting of 66 copies of GATA repeat, a highly conserved component of Bkm interspersed with a variable number of dinucleotide repeats of CA in several locations.

2.4 ^{32}P-labelling of probes

The ^{32}P-labeled single-stranded probe (specific activity of 0.7–3.0 × 10^8 cpm/μg) was prepared by using M13 universal primer [14], and [α-^{32}P]dATP (specific activity 3000 Ci/mmol; Jonaki, BARC, India).

2.5 RAPD analysis

The RAPD analysis was performed with 30 primers obtained from Operon Technologies (Alameda, CA, USA). The primers used for the detailed analysis were OPJ 13, OPAV 16, OPC 04, and OPC 02. PCR was performed with 50 ng of genomic DNA, 5 pmoles of the primer, 200 μM each of dATP, dGTP, dCTP, dTTP, 2 mM $MgCl_2$, and 0.5 U *Taq* polymerase. The reaction conditions were 94°C for 1 min, 37°C for 1 min, 72°C for 2 min, for 45 cycles, followed by a 7 min extension at 72°C. The PCR products were analyzed on a 1.4% agarose gel and the bands visualized by ethidium bromide staining under UV. Band sharing index and heterozygosity were calculated according to Yuhuki and O'Brien [15]. The heterozygosity was calculated as the average of the number of fragments differing in each pairwise combination divided by the total number of fragments.

2.6 Microsatellite analysis

The following CA repeat loci were analyzed [16].

Fca 35: 5′ CTTGCCTCTGAAAAATGTAAAATG 3′
5′ AAACGTAGGTGGGGTTAGTGG 3′
Fca 43: 5′ GAGCCACCCCTAGCACATATACC 3′
5′ AGACGGGATTGCATGAAAAG 3′
Fca 77: 5′ GGCACCTATAACTACCAGTGTGA 3′
5′ ATCTCTGGGGAAATAAATTTTGG 3′
Fca 90: 5′ ATCAAAAGTCTTGAAGAGCATGG 3′
5′ TGTTAGCTCATGTTCATGTGTCC 3′
Fca 126: 5′ GCCCCTGATACCCTGAATG 3′
5′ CTATCCTTGCTGGCTGAAGG 3′

One of the primers for each locus was 5′ end-labeled with gamma [γ-^{32}P]ATP (specific activity 3000 Ci/mmol; Jonaki). Reactions were performed with 50 ng of genomic DNA, 5 pmoles of each primer (one of them radioactively labeled), 200 μM each of dATP, dCTP, dGTP, dTTP, and 0.5 U *Taq* polymerase. The reaction conditions were 94°C for 30 s, 55°C for 15 s, 72°C for 15 s, 30 cycles, followed by a 7 min extension at 72°C. The PCR products were electrophoresed in an 8% denaturing polyacrylamide gel and exposed overnight to X-ray film (Kodak X-omat film) or visualized with Phosphor Imager (Molecular Dynamics, CA, USA) using ImageQuant software.

2.7 Skin and hair samples

Skin with hair (0.1 g) was incubated overnight at 55°C in a 5% Chelex (Bio-Rad) solution. The sample was then kept at 100°C for 8 min and subsequently spun at 12000 rpm for 10 min. The supernatant was treated with Geneclean Bio 101 kit and DNA was eluted from glass milk at 55°C. The DNA was then used for subsequent PCR reactions for microsatellite analysis.

2.8 Multivariate map-like graphical representation

The raw data obtained from fingerprinting using Bkm 2(8) and RAPD analyses were transformed into distance matrices according to Nei [17] which were then used to derive the relatedness among individuals (operational taxonomic units or OTUs). A new multivariate approach was used to obtain graphical relative positions of OTUs with respect to the computed genetic distances (Chandrika B.-Rao and K. C. Majumdar, submitted for publication).

3 Results

3.1 DNA fingerprinting

Multilocus fingerprinting with Bkm 2(8) probe was performed on 31 Asiatic lions using several restriction enzymes (*Hinf*I, *Taq*I, *Bst*NI, *Hae*III, *Mbo*I). No polymorphism was detected in the populations studied. However, in 22 tigers, Bkm 2(8) probe in combination with *Hinf*I restriction enzyme revealed polymorphism (Fig. 1). Per individual, 25–27 bands were scored in the 1–8 kbp molecular weight range. The majority of polymorphic bands were found in the 2–6 kbp region. An average heterozygosity of 28% was observed (Table 2).

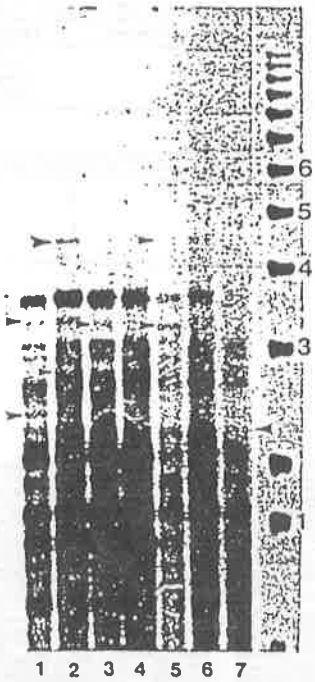

*Figure 1. Hinf*I DNA profiles of 7 Indian tigers (lanes 2–7) from Bhubaneshwar zoo developed after hybridization with Bkm 2(8) probe showing polymorphism. Molecular weight marker lane represents 1 kbp ladder.

3.2 RAPD analysis

RAPD patterns were assessed in Asiatic lions and Indian tigers using 30 random primers. Four of these produced polymorphic pattern in Asiatic lions and were used for population studies (Figs. 2, 3). A total of 38 individuals were analyzed and an average heterozygosity of 25.82% was observed. The heterozygosities ranged from 16.71% to 34.39% for individual primers (Table 3). The primers which showed polymorphism in lions did not reveal any polymorphism in tigers.

3.3 Microsatellite analysis

Microsatellite analysis was carried out on five CA repeat loci which are polymorphic in the felids. Asiatic lions, however, did not show any variation at all at the five microsatellite loci analyzed. Analysis of locus Fca 77 (Fig. 4) and locus Fca 126 (Fig. 5) showed differences between the Asiatic lions and hybrid lions. While Asiatic lions were monomorphic and homozygous at these loci, the hybrid lions were polymorphic and not all alleles matched those found in Asiatic lions (Fig. 4, 5). These alleles are probably due to the contribution of African lion to their genome. Analysis at these loci was also able to confirm that two Asiatic lions in the Bhubaneshwar zoo were indeed pure Asiatic lions.

Table 2. Analysis of DNA profiles of Indian tigers developed with Bkm 2(8) probe

Population	Number of animals	Fragment size	% Heterozygosity
White skin color	7	2.0–8.8 kbp	20.0
Normal skin color	7	2.0–8.3 kbp	28.8
Heterozygous for skin color	8	2.0–5.5 kbp	23.0

Table 3. RAPD analysis of Asiatic lions

Primer	Number of animals	Average number of fragments scored/individual	% Heterozygosity
OPAV 16	38	8	30.54
OPD 05	38	7	16.71
OPC 04	39	8	34.39
OPJ 13	35	6	21.67

Average % heterozygosity = 25.82%

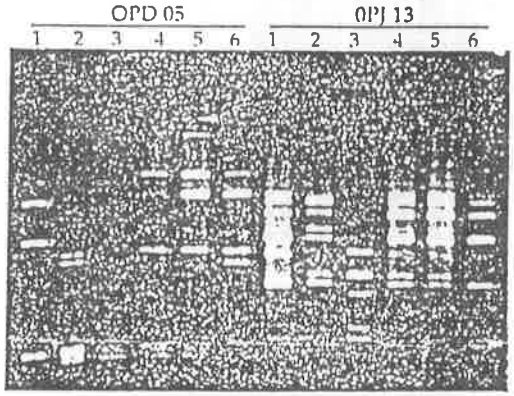

Figure 2. RAPD pattern using primers OPD 05 and OPJ 13 showing polymorphism in Asiatic lions from Sakkarbaug zoo.

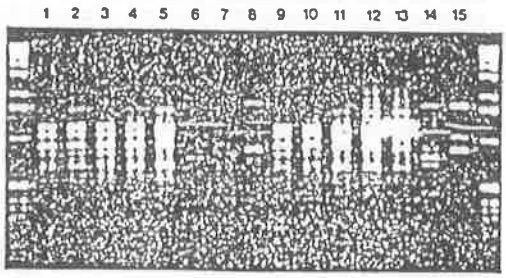

Figure 3. RAPD pattern using primer OPAV 16 showing moderate levels of genetic variability in the Asiatic lion population of Sakkarbaug zoo.

Microsatellite analyses of 30 Indian tigers revealed an average heterozygosity of 22.65% at three of the five loci (Fig. 6). Two of the loci were monomorphic, as in the case of Asiatic lions (Table 4). Microsatellite analysis of 15 skin samples of tigers, ranging in age from 50 to 125 years, was performed (Fig. 7). The average heterozygosity observed was 21.01% and the difference between the present and the past populations was not statistically significant (Table 5). Only those loci which were polymorphic in the present population showed polymorphism in individuals 50–125 years ago. The loci found to be monomorphic in the present population were found to be monomorphic in the ancient population as well. The levels of genetic variability revealed are much higher than reported. The Siberian tigers showed an average heterozygosity of 29.66% in the loci tested. Hair samples of two suspected Indian and Siberian tiger hybrids were tested to confirm hybridization. The analysis of locus Fca 126 and Fca 35 revealed that both animals had alleles contributed by each of the species (Fig. 8).

3.4 Graphical representation

The multivariate graphical representation of the fingerprinting and RAPD data revealed the clustering pattern of the genetic variability in the population. In the representation of the Asiatic lion population (Fig. 9), points D, E, I, and J, which lie outside the cluster, represent the animals having high amounts of genetic variation. The cluster represents the animals having low genetic variability. Three distinct clusters are observed in the representation of the tiger population (Fig. 10). Each cluster represents animals having a particular skin color. The representation thus enables us to identify heterozygotes for skin color by their position on the graph.

4 Discussion

As natural habitats disappear, many species are reduced to small populations as a direct or indirect consequence of human actions. Large outcrossing populations that suddenly decline to a few individuals show reduced viability and fecundity, known as inbreeding depression [18, 19]. Although harmful effects of inbreeding on individuals may diminish as deleterious recessive genes are removed from the population by selection [20, 21], the population as a whole loses the evolutionary flexibility conferred by genetic diversity [22]. Inbreeding and loss of genetic variation decreases the ability of wild populations to adapt to extreme climatic changes and make them vulnerable to new diseases, parasites, pollutants, competitors, and food supplies [23–25]. The importance of disease outbreaks on selecting genetically resistant survivors was first emphasized by Haldane [26]. Infec-

Figure 4. Fca 77 microsatellite analysis of pure Asiatic lions and hybrid lions from various Indian zoos. Last two lanes representing lions from Bhubaneshwar zoo show similar pattern as that of pure Asiatic lions, which are different from the hybrids, thus confirming their purity. Lane numbers indicate particular animals from each zoo. Similar numbered animals are identical in both Figs. 4 and 5. HYB. Z, Hyderabad Zoo; BH. Z, Bhubaneshwar Zoo; CAL. Z, Calcutta Zoo; CHD. Z, Chandigarh Zoo. Pure Asiatic lions were from Sakkarbaug Zoo.

Figure 5. Fca 126 microsatellite analyasis of pure Asiatic and hybrid lions from various Indian zoos. Two lions from Hyderabad zoo (HYB. Z, lanes 1, 2) which were considered pure Asiatic lions, showed alleles different from those of Asiatic lions but similar to those of the hybrids from other zoos. Similar numbered animals are identical in both Figs. 4 and 5. Key to the zoos is the same as in Fig. 4.

Figure 6. Allelic variability in the Indian tigers at CA repeat locus Fca 126. The presence of stutter bands is usual in dinucleotide microsatellites.

tious diseases, like any ecological factor, are now considered to be one of the important factors in determining the selective pressure on the genomes of surviving species [27, 28].

Molecular studies on the African cheetah showed that it possessed extremely low levels of genetic variation [15, 16, 29–31]. O'Brien *et al.* [31] suggested that in a highly inbred population there is a higher rate of juvenile mortality and species susceptibility to pathogens leading to extinction. The above evidence indicating that lack of genetic variation is the cause of the cheetah's plight was seriously contradicted [32] and the necessity of carrying out detailed ecological studies to identify the factors responsible was suggested.

O'Brien *et al.* [2, 33] conducted a genetic survey of 46 electrophoretic allozyme systems resolved from blood of 28 Asiatic lions wild-caught or captive-bred, maintained at the Sakkarbaug Zoo in India but originally derived from the Gir Forest. They found no variation at any of the 46 loci tested. In contrast, they observed moderate levels of allozyme variation at the same loci in several African lions (*Panthera leo leo*). They observed that, like the cheetah (71%), the Asiatic lions show a high incidence of morphologically abnormal spermatozoa (79%) compared to free-ranging African lions (25–61%) and other species such as bull or dog (20–30%), which is nearly always associated with infertility in these species [2]. They speculated that the lack of genetic variation in genes affecting sperm development could be the cause for such high levels of spermatozoal abnormalities [2]. O'Brien *et al.* [2] have stated: "The Gir lion population may thus represent another example of a severely endangered species that has suffered a population bottleneck or series of bottlenecks followed by inbreeding in their recent history".

In contrast to the bove observations, our present study of 38 Asiatic lions using RAPD analysis with four primers showed an average heterozygosity of 26% (ranging from 15% to 35% for individual primers). Only two of the lions analyzed by O'Brien's group were analyzed in our study. DNA fingerprinting using Bkm-derived 2(8) multilocus probe, which gives extensive variation in most of the eukaryotes, including human and crocodile [10, 11, 34] and microsatellite analysis of five CA repeat loci, however, failed to reveal any variation at all. This suggests that perhaps the sequences which are hypervariable are different in different species and therefore, based on a limited study, one needs to be cautious before deriving conclusions of far reaching importance.

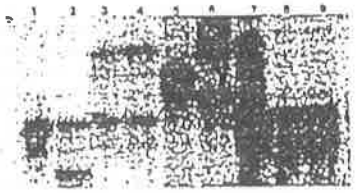

Figure 7. Allelic variability at CA repeat locus Fca 43 in the present population of Indian tigers (lanes 1–4) and 50- to 125-year-old skin samples from museum specimens (lanes 5–9).

Table 4. Microsatellite analysis of Asiatic lions, Indian tigers and Siberian tigers

Locus	Asiatic lions		Indian tigers		Siberian tigers	
	Number of alleles	% Heterozygosity	Number of alleles	% Heterozygosity	Number of alleles	% Heterozygosity
Fca 35	1	0.0	1	0.0	1	0.0
Fca 43	1	0.0	5	22.41	5	31.45
Fca 77	1	0.0	1	0.0	1	0.0
Fca 90	1	0.0	3	23.3	3	27.87
Fca 126	1	0.0	3	29.24	–	–

Table 5. Microsatellite analysis of Indian tigers

Locus	Number of alleles	Blood (live animals)		Skin (museum specimens, 50–125 years old)	
		Number of animals	% Heterozygosity	Number of animals	% Heterozygosity
Fca 35	1	23	0.0	15	0.0
Fca 43	5	23	22.41	15	24.68
Fca 77	1	23	0.0	15	0.0
Fca 90	3	23	23.3	15	18.57
Fca 126	3	23	29.24	15	19.79

Figure 8. Identification of hybrids between Indian tigers and Siberian tigers using microsatellites. Hair samples (lanes 5, 6) from two suspected hybrids and blood samples from pure tigers were analyzed at locus Fca 126. The upper band (shown by asterix) matches with that of Indian tigers (lanes 1–4) while the lower band (shown by asterix) matches with that of Siberian tigers (lanes 7–9).

Microsatellite analysis of the hybrids between Asiatic lion and African lion showed the presence of alleles which are absent in the Asiatic lions studied and may, therefore, serve as a marker for distinguishing hybrids from pure Asiatic lions. Sperm morphology and motility studies of a large number of Asiatic lions from Gir forest carried out by our colleague in CCMB (Dr. S. Shivaji, personal communication) using computer-aided motility analysis did not reveal a high level of sperm abnormalities, similar to that reported by O'Brien *et al.* [2]. This discrepancy may be attributed to many factors such as small sample size, seasonality, age, sexual activity of the animals and the procedure of serial electroejaculation itself [2].

The mutation rates of various genetic loci, coding, minisatellite, microsatellite, *etc.*, vary considerably within and amongst themselves. Reconstitution of genetic variation in a population reduced to homozygosity by a population bottleneck depends upon the mutation rates of the loci examined and the generation time of the species. The wide range in heterozygosity levels observed in the various loci and within the RAPD loci suggests a wide range in their rates of mutations. Toward the end of the last ice age, some 10000 years ago, nearly 75% of all the mammals in North America and Europe became extinct. The northern elephant seal, the moose, the polar bear and the Yellowstone elk [35–37] have been reported to have diminished levels of genetic variation. The low levels of genetic variation seems to be a characteristic feature of these and many other species. The lack of significant difference in the amount of genetic variability was observed in the past (125 years ago) and present populations as ascertained by analysis of skin and blood samples. These observations suggest that the species went through an ancient population bottleneck and the low level of genetic variability observed is a characteristic of these species.

Small populations tend to lose genetic variation by genetic drift more rapidly than large populations because of random sampling of a small number of alleles at each generation. An immediate effect of depletion of genetic variability is increased homozygosity. Though the impact of increased homozygosity is still widely debated, it often leads to lower viability, that is, increased susceptibility to diseases and fecundity (inbreeding depression). It becomes imperative that conservation programs for small populations must devise methods to minimize,

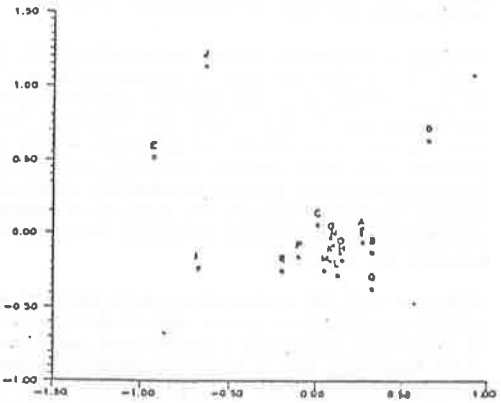

Figure 9. Multivariate map-like representation of the Asiatic lion population in the Sakkarbaug zoo based on RAPD analysis. Outlying points D (wild caught), E (Stud No. 1237), I (Stud No. 1256), J (wild caught) represent the animals showing greater genetic variation. *X* and *Y* axes are arbitrarily scaled.

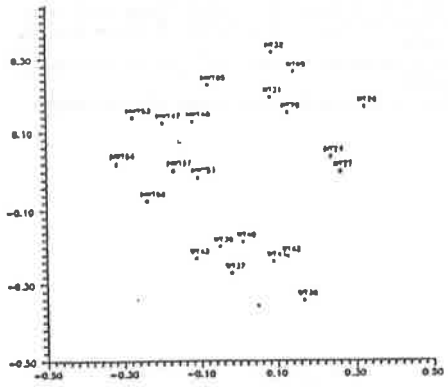

Figure 10. Multivariate map-like representation o... ...ndian tigers in Bhubaneshwar zoo based on Bkm 2(8) fingerprinting. The representation depicts the clustering of white tigers (WT), heterozygote for white skin (HWT), and normal skin color (wild) tigers (NT). The *X* and *Y* axes are arbitrarily scaled.

halt, or even reverse the decline in genetic variability that occurs. The powerful technique of molecular genetics has the ability to reveal a population's past history, present status and future prognosis for survival. Cluster analysis of the RAPD data showed that while most of the Asiatic lions cluster together, some individuals exist as outgroups. These individuals exhibit variation from the population. These can be used for conservation breeding program to increase the genetic variability of the population.

Our finding that the hair samples from two tigers from the wild population in Uttar Pradesh, India are probably those of hybrids between Indian and Siberian tigers, is very disturbing. DNA profiling of all the tigers in that population must be carried out at the earliest opportunity to identify and segregate the hybrids in order to preserve the genetic identity of the Indian tiger. Genetic markers are the indices of genomic variation and not the object genes for natural selection and adaptation. Human, mammalian, and model species genome projects are beginning to identify genes of would-be candidates for selective adaptation. When DNA probes for population analysis of such genes become available, the effect of lack of genetic variation on the viability of the species will become clearer. Until then, we have to be content with the indirect correlation. In this tudy, the use of RAPD and microsatellite analysis have revealed a much higher level of genetic variability in Asiatic lions and tigers than previous studies using conventional methods. A cautious approach should be taken when discussing implications of studies on population genetic variation as the low levels of variation detected could be due to the limitations of the experimental technique used.

We express our sincere thanks to the directors and other staff of Delhi, Sakkarbaug, Hyderabad, Bhubaneshwar, Calcutta, Guwahati, Chandigarh, Lucknow, Mysore and Darjeeling Zoos for their whole-hearted support in immobilizing the animals and for collecting the blood samples. Without their active cooperation, the present study would not have been possible. Financial support by a grant from the Central Zoo Authority to Dr. Lalji Singh is gratefully acknowledged. Our thanks go to Mr. S. C. Sharma, Member Secretary, Central Zoo Authority, Ministry of Environment, Govt. of India for providing all possible support for the present work. We are also thankful to Dr. K. Thangaraj, Scientist, CCMB for help during the study.

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5 References

[1] Joslin, P., *J. Bombay Nat. Hist. Soc.* 1984, *81*, 648–664.
[2] O'Brien, S. J., Joslin, P., Smith, G. L., III, Wolfe, R., Schaffer, N., Heath, E., Ott-Joslin, J., Rawal, P. P., Bhattacharjee, K. K., Martenson, J. S., *Zoo. Biol.* 1987, *6*, 99–116.
[3] O'Brien, S. J., Martenson, J. S., Packer, C., Herbst, L., DeVos, V., Joslin, P., Ott-Joslin, J., Wildt, D. E., Bush, M., *Natl. Geog. Res.* 1987, *3*, 114–124.
[4] Wildt, D. E., Bush, M., Goodrowe, K. L., Packer, C., Pusey, A. E., Brown, J. L., Joslin, P., O'Brien, S. J., *Nature* 1987, *329*, 328–331.
[5] Hadrys, H., Balick, M., Schierwater, B., *Mol. Ecol.* 1992, *1*, 55–63.
[6] Dawson, I. K., Chalmers, K. J., Waugh, R., Powell, W., *Mol. Ecol.* 1993, *2*, 151–159.
[7] Bardakci, F., Skibinski, D., *Heredity* 1994, *73*, 117–123.
[8] Gottelli, D., Sillero-Zubiri, C., Appelbaum, G. D., Roy, M. S., Girman, D. J., Garcia-Moreno, J., Ostrander, E. A., Wayne, R. K., *Mol. Ecol.* 1994, *3*, 301–312.
[9] Taylor, A. C., Sherwin, W. B., Wayne, R. K., *Mol. Ecol.* 1994, *3*, 277–290.
[10] Lang, J. W., Aggarwal, R. K., Majumdar, K. C., Singh, L., *Mol. Gen. Genet.* 1993, *238*, 49–58.
[11] Aggarwal, R. K., Majumdar, K. C., Lang, J. W., Singh, L., *Proc. Natl. Acad. Sci. USA* 1994, *91*, 10601–10605.
[12] Aggarwal, R. K., Lang, J. W., Singh, L., *Genet. Anal. Tech. Appl.* 1993, *9*, 54–57.
[13] Singh, L., Philips, C., Jones, K. W., *Cell* 1984, *36*, 111–120.
[14] Hu, N., Messing, J., *Gene* 1982, *17*, 271–277.
[15] Yuhki, N., O'Brien, S. J., *Proc. Natl. Acad. Sci. USA* 1990, *87*, 836–840.
[16] Menotti-Raymond, M. A., O'Brien, S. J., *J. Hered.* 1995, *86*, 319–322.
[17] Nei, M., *Molecular Evolutionary Genetics*, Columbia University Press, New York 1987.
[18] Falconer, D. S., *Introduction to Quantitative Genetics*, Longman, New York 1981.
[19] Ralls, K., Ballou, J., in: Schonewald-Cox, C. M., Chambers, S. M., MacBryde, B., Thomas, L. (Eds.), *Genetics and Conservation*, Benjamin/Cummings, Menlo Park, CA 1983, pp. 104–184.
[20] Lynch, C. B., *Evolution* 1977, *31*, 526–537.
[21] Templeton, A. R., Read, B., in: Schonewald-Cox, C. M., Chambers, S. M., MacBryde, B., Thomas, L. (Eds.), *Genetics and Conservation*, Benjamin/Cummings, Menlo Park, CA 1983, pp. 241–261.
[22] Selander, R. K., in: Schonewald-Cox, C. M., Chambers, S. M., MacBryde, B., Thomas, L. (Eds.), *Genetics and Conservation*, Benjamin/Cummings, Menlo Park, CA, 1983, pp. 201–215.
[23] Frankham, R., *Conserv. Biol.* 1995, *9*, 792–799.
[24] Heschel, M. S., Paige, K. N., *Conserv. Biol.* 1995, *9*, 126–133.
[25] Pray, L. A., Schwartz, J. M., Goodnight, C. J., Stevens, L., *Conserv. Biol.* 1994, *8*, 562–568.
[26] Haldane, J. B. S., *La Ricerca Sci. Suppl.* 1949, *19*, 2–11.
[27] Anderson, R. M., May, R. M., *Infectious Diseases of Humans: Dynamics and Control*, Oxford University Press, New York 1992, 757 pp.
[28] O'Brien, S. J., Evermann, J. F., *Trends. Ecol.* 1988, *3*, 254–259.
[29] O'Brien, S. J., Wildt, D. E., Goldman, D., Merril, C., Bush, M., *Science* 1983, *221*, 459–462.
[30] O'Brien, S. J., Wildt, D. E., Bush, M., Coro, T. M., FitzGibbon, C., Aggundy, I., Leaky, R. E., *Proc. Natl. Acad. Sci. USA* 1987, *84*, 508–511.

[31] O'Brien, S. J., Roelke, M. E., Marker, L., Newman, A., Winkler, C. A., Meltzer, D., Colly, L., Evermann, J. F., *Science* 1985, *227*, 1428–1434.
[32] Caro, T. M., Laurenson, M. K., *Science* 1994, *263*, 485–486.
[33] Wildt, D., Pukazhenthi, B., Brown, J., Monfort, S., Howard, J., Roth, T., *Reprod. Fertil. Dev.* 1995, *7*, 811–824.
[34] Singh, L., *Curr. Sci.* 1991, *60*, 581–585.
[35] O'Brien, S. J., Goldman, D., Knight, J., Moore, H. D., Wildt, D. E., Bush, M., Montali, R. J., Kleiman, D., *Science* 1984, *223*, 1127–1129.
[36] Mikko, S., Andersson, L., *Proc. Natl. Acad. Sci. USA* 1995, *92*, 4259–4263.
[37] Bonnell, M. L., Selander, R. K., *Science* 1974, *184*, 908–909.

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Observations on the breeding habits of the Indian smooth otter *Lutrogale perspicillata* in captivity

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The Indian smooth otters *Lutrogale perspicillata* at Delhi Zoo have been kept in a large open enclosure since 1964. The area measures 534 m² and is fronted by a dry moat 2·5 m wide and 1·5 m deep. In the centre lies a 93 m² L-shaped pool, 1 m deep, containing a small, 5 × 2 m, island. The strip of ground between the pool and the dry moat is filled with earth and sand where the otters can dig their own dens. The enclosure is also planted with trees and shrubs to provide natural surroundings. At the back, smaller enclosures are provided where the otters can be taken in case of illness or injury. The pool is drained and refilled with unfiltered river water at least once a week.

DIET

Otters are voracious feeders. Their diet in the wild consists of fish, frogs, turtles and aquatic invertebrates (*3*). The daily allowance per otter is 1 kg of dead fish, ranging from 22 to 30 cm long. The animals are fed twice daily: 500 g fish each in the morning and evening. Occasionally they are also given live fish.

REPRODUCTION

Although *Lutrogale* has been kept in a number of zoos, to our knowledge it has bred successfully only at Delhi, Jaipur and Twycross Zoos. At the present time we have 11 Smooth otters – 2/4 adults and five cubs born here in October 1970. The breeding success achieved to date is summarised in Table 1.

All the matings took place in August, in the water, and were preceded by prolonged, playful bouts between partners. Copulation took place several times daily. All the ♀♀ were mated by the same ♂ and the births all occurred in October. The ♀♀ were seen digging dens in the enclosure during August and September, and each ♀ gave birth in a separate den which she had excavated herself. The first indication we had of birth was the squeaking of cubs heard on the following morning. It was observed that the ♀ did not come out for food for one or two days before parturition, and that, after birth, she did not allow the ♂ or other ♀♀ to enter her den. The ♂ was vigorously chased away and there were also occasional fights. In one instance, one ♀ was severely bitten by another which had littered and the injured animal had to be removed to another enclosure.

The average gestation period for four litters, calculated from the last observed mating to the date of parturition, was 61 days. This compares well with the gestation period of the Eurasian otter *Lutra lutra* (*1; 3*) and with Yadav's (*4*) record of 63 days for *Lutrogale*. Two of the three ♀♀ born in 1968 were seen mating during August 1970 when they were 22 months old, and both had cubs in October when exactly two years old.

♀♀	LAST OBSERVED MATING	AGE AT FIRST MATING	DATE OF PARTURITION	GESTATION (days)	SIZE OF LITTER	WEANED AFTER (days)
Moti	14 Aug. 1968	7 years	14 Oct. 1968	61	5	–
Vimla	10 Aug. 1968	4 years	9 Oct. 1968	60	3	131
Radha	6 Aug. 1970	22 months	7 Oct. 1970	62	3	129
Soniya	7 Aug. 1970	22 months	8 Oct. 1970	62	2	130

Table 1. Breeding records of Indian smooth otters *Lutrogale perspicillata* at Delhi Zoo.

This accords with the observations of Liers (2) regarding Canadian otters *Lutra canadensis*.

The ♀, 'Moti', which bred only at seven years, was about six months old when she was obtained in 1962, but she remained alone and without a mate until early in 1962 when five more otters, also about six months old, arrived. Of these, three failed to survive, but the remaining pair (♂ 'Ram' and ♀ 'Vimla') settled down well. They mated for the first time in August 1968, and subsequently Ram also mated with Moti, in the same month. Both ♀♀ had cubs in October 1968.

PARENTAL CARE AND WEANING

Almost all the young born in the zoo were successfully reared by the parents. The only exception was Moti's litter in 1968, when she was injured by another ♀ and had to be removed to another enclosure. The cubs, born blind, were normal in all respects. But the mother did not care for them at all and as a result none survived. All other ♀♀ gave birth in the dens they had dug and cared well for the young. The exact parturition process could not be observed owing to the ♀♀'s aggressive behaviour.

'Radha' and 'Soniya' gave birth on consecutive days (7 and 8 October 1970) in two separate dens. The cubs of both litters appeared with their mothers for the first time at 1800 hours on 5 November. The cautious mothers did not allow them to wander on their own in the enclosure, nor to go near the water. They were always kept within reach of the den and after about an hour taken inside again. Later, such excursions became daily events and all five cubs, always followed by their mothers, often ventured near the water. But the ♀♀ did not permit them to enter the water until 31 December and the cubs took their first prolonged swim on 3 January 1971. During this time the ♂ seemed interested in the young and occasionally went near them; the ♀♀ kept close watch during his approach but were not aggressive. Later on he was accepted by both cubs and mothers as a member of the group and the whole family moved together.

The cubs were first seen chewing fish on 1 December and gradually began eating it. Both 1970 litters were completely weaned at Days 129 and 130 respectively and regularly started eating fish given to adults. A very interesting ♂ behaviour pattern was observed at feeding time. The cubs were allowed to eat first, followed by the ♀♀, while the ♂ would wait, or even give away the fish thrown to him to the cubs or the ♀ nearest him. On several occasions he was seen to take fish to the cubs or to the ♀ and he would eat only after the rest had finished.

REFERENCES

1. COCKS, A. H. (1881): Notes on the breeding of the otter. *Proc. zool. Soc. Lond.* 1881: 249–250.
2. LIERS, E. E. (1951): Notes on the River otter (*Lutra canadensis*). *J. Mammal.* 32 (1): 1–9.
3. WALKER, E. P. (1964): *Mammals of the world.* 2: Baltimore: Johns Hopkins Press.
4. YADAV, R. N. (1967): Breeding the Smooth-coated Indian otter *Lutra perspicillata* at Jaipur Zoo. *Int. Zoo Yb.* 7: 130–131.

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The Manipur brow-antlered deer

Cervus eldii eldii:

its status and breeding in captivity

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The results of the aerial survey of the remaining natural habitat of the Manipur brow-antlered deer *Cervus eldii eldii* conducted by Ranjit Singh (1975) indicated that there were no more than 14 individuals, five ♂♂, six ♀♀ and three fawns, still living in the wild; this makes it one of the most threatened animals in the world.

This subspecies of the Brow-antlered deer was always confined to the valley of Manipur in India; there are two other races, *C. e. thamin* and *C. e. siamensis*, with a small and scattered distribution in parts of South-east Asia. For many years the Manipur deer had been zealously protected by the former rulers of Manipur State, but from the turn of the century they had been hunted relentlessly and their decline has been compounded by ruthless poaching. By 1951 the subspecies was already regarded as extinct, but it was later rediscovered in the Keibul Lamjao region at the south-eastern corner of the Logtak Lake. Although this 35 km² area of swamp was in 1954 declared a sanctuary, the persistence of hunting and poaching and of habitat destruction due to agricultural activities by 1960 had already reduced the deer population to about 100 (Gee, 1960); in 1972 this had further dwindled to only 50 (Ranjit Singh, 1975). The water-filled depressions of the Keibul Lamjao contain large 'islands' of floating decaying vegetation (known locally as *phumdi*) supporting grasses and sedges, on which for much of the year the deer are dependent. However, human disturbance within and on the peripheries of the sanctuary – cattle grazing, illegal cultivation, grass and tree cutting and fishing – have effectively reduced the habitat available to the deer to some 14·4 km² (Ranjit Singh, 1975). With the existing small population there is little hope of saving this deer in its natural habitat and unless urgent steps for its propagation are taken it will soon become extinct.

CAPTIVE HERDS

With its survival in the wild in doubt, the breeding and conservation of the Manipur deer in zoos is of paramount importance. Fortunately, the species breeds well in captivity. There are two viable herds, with different gene pools, in Delhi and Calcutta zoos and both have been breeding successfully for several years. These herds at present number 6.7 and 6.8 respectively.

The Delhi herd stems from a pair received in 1962 as a gift from the then Manipur State. Between 1963–1976 there have been 36 (16.20) births recorded. Encouraged by this success, it was decided to establish more breeding units in the country at proven zoos. Accordingly, young and healthy pairs were distributed from the Delhi herd on a sale or barter basis to the zoos at Ahmedabad, Kanpur, Lucknow, Hyderabad and Mysore. In a surprisingly short time the deer had adjusted to their new surroundings and at Ahmedabad, Hyderabad and Mysore have raised young. The present captive population of Manipur deer in India (as of 1 January 1977) numbers 49 (19.30), located in seven collections: Ahmedabad 1.5; Calcutta 6.8; Delhi 6.7; Hyderabad 1.3; Kanpur 1.1; Lucknow 1.1; Mysore 3.5.

The size of enclosure does not seem to be an important factor in their maintenance. At Delhi Zoo the deer are kept in an outdoor enclosure about 0·6 ha in area. It is bounded on two sides by a 2·0 m high fence, while a water-filled moat, 2·0 m deep, forms an effective barrier between animals and zoo visitors on the remaining perimeter. At Calcutta and Ahmedabad the herds are kept in medium-sized enclosures; both have fine breeding records.

Dietary requirements are not elaborate. The daily ration for a single adult deer at Delhi is 1 kg concentrates and 5 kg green fodder. In addition, the animals also have free access to green grass

growing in the enclosure. The concentrate formula was developed as a feed for all hoofed stock at the zoo and is constituted as follows:

	%
Wheat bran	22
Horse gram (whole pulses)	12
Maize (whole)	13
Barley (crushed)	16
Oats (compressed)	8
Oil cake	26
Turmeric powder	1
Salt	1
Mineral mixture	1

REPRODUCTION

Like other deer species, the Manipur deer is seasonally monoestrous. At Delhi Zoo stags shed their antlers in late June, the rutting season is between March–April, and the peak birth season occurs during October–November. Out of 36 recorded births, 85·5% took place at that time (Fig. 1). There was no instance of twins.

The gestation period varies between 236–244 days, with a mean (calculated from five births) of 240·4 days. The mean birth weight of three ♂♂ and five ♀♀ young is 6·0 and 4·4 kg respectively (Sankhala & Desai, 1971). Fawns are weaned at the age of three months. Females become sexually mature at two to three years while ♂♂ attain maturity about a year later.

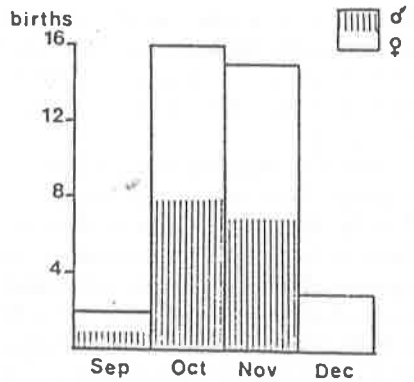

Fig. 1. Seasonal distribution of births of the Manipur brow-antlered deer *Cervus eldii eldii* between 1963–1976 at Delhi Zoo.

Adult ♂♂ will sometimes become highly aggressive towards ♀♀, and on two occasions at Delhi a ♂ in pursuit of a ♀ during rut fatally injured her. For this reason it is advisable that truculent individuals such as these should, during the rutting season, be segregated from the rest of the herd. Between 1963–1976, accidents, injuries acquired in fighting, infant deaths and old age at Delhi Zoo were responsible for the deaths of five ♂♂ and five ♀♀, a mortality rate of 27·7%.

CONCLUSION

The results of the captive breeding programme are so far encouraging. Given the limited number of breeding groups in the country and the present rate of reproduction, however, any attempt to reintroduce the Manipur deer into the wild is at present neither practicable nor would it be conducive to the overall welfare of the subspecies. Reintroduction must depend on the prior development of a proper management plan, in conjunction with a parallel programme for the rehabilitation of the natural habitat so that it is able to support the deer population.

It is proposed, as a preliminary step, that a small breeding nucleus (three ♂♂, seven ♀♀) made up of captive-bred animals from the two different blood lines be established in a properly fenced enclosure close to the Keibul Lamjao sanctuary. The fact that an earlier group of two pairs from Delhi Zoo, established along similar lines at the end of 1974 (Sankhala, 1977), is survived by only one of the original ♂♂ and a ♂ offspring suggests with what care such plans must be laid.

REFERENCES

GEE, E. P. (1960): Report on the status of the brow-antlered deer of Manipur. *J. Bombay nat. Hist. Soc.* 57: 597–617.

RANJIT SINGH, M. K. (1975): Keibul Lamjao sanctuary and the brow-antlered deer – 1972 with notes on a visit in 1975. *J. Bombay nat. Hist. Soc.* 72: 243–255.

SANKHALA, K. S. (1977): Captive breeding, re-introduction and nature protection: the Indian experience. *Int. Zoo Yb.* 17: 98–101.

SANKHALA, K. S. & DESAI, J. H. (1971): Reproductive behaviour of brow-antlered deer. *J. Bombay nat. Hist. Soc.* 67: 561–565.

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Growth and development of a hand-reared kinkajou *Potos flavus* at Delhi Zoo

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INTRODUCTION

On 12 February 1965, two young kinkajous *Potos flavus* were obtained for the Delhi Zoo from the United States. A small wooden box, lined with rice straw, kept in the enclosure at a height of about 1 m (3 ft), serves as night quarters for the animals. Their daily diet consists of fresh vegetables, fruits, bread, milk and one egg.

They bred for the first time in 1967 and the female gave birth on 23 August 1967. Un-

fortunately, the youngster did not survive. On 15 March 1970, the kinkajous were observed mating and the female subsequently gave birth to another youngster during the night of 16/17 July. At about 0730 hours on the morning of 17 July the baby was seen lying on the floor of the enclosure. It was observed that the mother did not show any interest in it, nevertheless we attempted to coax her. Even after repeated attempts, she did not go near it and we therefore removed it from the enclosure for hand-rearing.

DIET

Feeding by plastic eye dropper was attempted immediately after its removal from the enclosure, the formula consisting of one part Glaxo baby food to two parts water. It was found that the young was not able to suck milk easily from the eye dropper, and cotton wick dipped in milk was tried. This was successful but was replaced after seven days, as it could by then take milk easily through the eye dropper.

AGE (days)	WEIGHT (g)	BODY LENGTH (including tail) (mm)	TAIL LENGTH (mm)
0	150	261	137
5	145	302	139
10	168	330	140
15	205	342	144
20	220	350	150
25	275	370	158
30	326	400	165
35	405	435	185
40	465	460	200
45	478	495	215
50	516	525	220
55	556	535	245
60	628	550	260
65	658	565	272
70	700	585	285
75	735	590	290
80	760	595	295
85	780	600	300
95	826	610	325
125	1,250	690	345
155	1,400	720	365
185	1,650	760	375
210	1,800	785	390

Table 1. Growth in length and weight of a hand-reared kinkajou *Potos flavus*.

The youngster was fed six times daily at three hourly intervals for the first 15 days, and offered as much as it would take at each time. The first feed was given at 0700 hours and the last at 2200 hours. Thereafter the cub was fed four times daily till it was three months old. The milk formula was supplemented with three drops of Abidec in the first morning feed from day 3. From the age of 30 days, the diet was changed to one part Glaxo baby food powder to one part water.

DEVELOPMENT	AGE (days)
Animal with soft black fur	At birth
Low pitched squeaks	1
Body twitch during sleep	2
Sucking reflex	4
Pawing with forelegs	5
High pitched squeaks	7
Defaecated without stimulation	7
Eyes partially opened	9
Eyes completely opened	10
Prehensile tail reflex	12
Dragged body by forelimbs	14
Walked on all fours	33
Self-feeding	35
Prehensile tail functional	48
Started taking solid food	82
Adult pelage	150

Table 2. Physical development of a hand-reared kinkajou *Potos flavus*.

From day 7 onward the young kinkajou took between 7 and 10 ml milk per feed, but from the age of four weeks its consumption increased to 20–25 ml per feed. From eight weeks, the young was given ripe banana pulp in addition to the milk feed. The quantity of ripe fruits was gradually increased, and the frequency of milk diet was reduced to twice daily, after the youngster was three months of age. Gradually, other food items such as bread, boiled egg and boiled rice were also introduced. The youngster was put on the following diet at the age of five months:

Banana	2
Tomato	50 g
Papaya	100 g
Chiku	100 g
Sweet potato	100 g
Egg (boiled)	1

[Reprint, from *J. Bombay nat. Hist. Soc. 72, No. 2] 1975*

Observations on the reproductive Biology and early postnatal development of the Panther, *Panthera pardus* L., in captivity[1]

J. H. DESAI[2]

(*With three text-figures*)

INTRODUCTION

Among the big cats, the panther is the most widely distributed species over the world (Walker 1964). Like the tiger it has been subjected to an increasing hunting pressure and persecution from the last century. In the recent past it has declined noticeably in peninsular India and is mostly found in certain favourable localities such as sanctuaries and is almost rare in many places where it was common formerly (Krishnan 1972). Considerable information regarding its habits, habitat and hunting technique is available from the records of hunters and naturalists, but little is known of its breeding habits in the wild.

Considering the secretiveness of the panther it is little wonder that such information is notably lacking in literature. However, in view of its importance as one of the major predators, a knowledge of the reproductive biology is essential background information. This study was undertaken to provide information (1) on the reproductive behaviour of the panther; (2) to ascertain the duration of oestrus, breeding season, gestation period and size of litter; and (3) to provide comparative data on the early postnatal development of the panther. This paper is based on data collected at the Delhi Zoological Park from 1958 to 1973 and on comparative records available from various other zoos.

MATERIALS AND METHODS

The Delhi Zoological Park was officially opened to the public on

[1] Accepted June 1973.

[2] Joint Director, Delhi Zoological Park, New Delhi-3.

1st November 1959 but work on the zoo had started in 1955. In 1956 the zoo received four panther cubs as presents from different sources. The Delhi zoo was successful in breeding panthers for the first time in 1960, when a litter of two cubs was born on 29th May. Until May 1973, 63 panther cubs had been born to nine pantheresses.

The panthers at the Delhi Zoological Park are kept in spacious enclosures which provide sufficient room for exercise. Each enclosure has small cells at the back where the panthers are shut in during the night. The floors of the cells are cemented but wooden platforms are provided as warm resting places.

The panthers are fed six days in a week on buffalo calf meat and on Friday of each week no food is given. On average, an adult panther is given 5 kg of fresh raw meat with bones daily, but the quantity is adjusted according to the size, age and general condition of the animal.

For the purpose of this study, data have been drawn from my own observations from 1963 onward, supported by the records maintained at the Delhi Zoological Park in the form of individual animal history cards, daily observation reports and Head Animal Keepers' registers.

The measurements of seven newly born cubs were recorded within twelve hours after their birth. The early postnatal growth of one cub was recorded from the time of birth till the age of four months, when it had weaned completely; and that of other two cubs till the age of two months. All the three cubs were raised by their respective mothers.

Comparative data on early postnatal development of the cubs were derived from Zurich zoo (Weillenmann 1963); New York zoo (Crandall 1964) and Sao Paulo zoo, Brazil (Carvalho 1968).

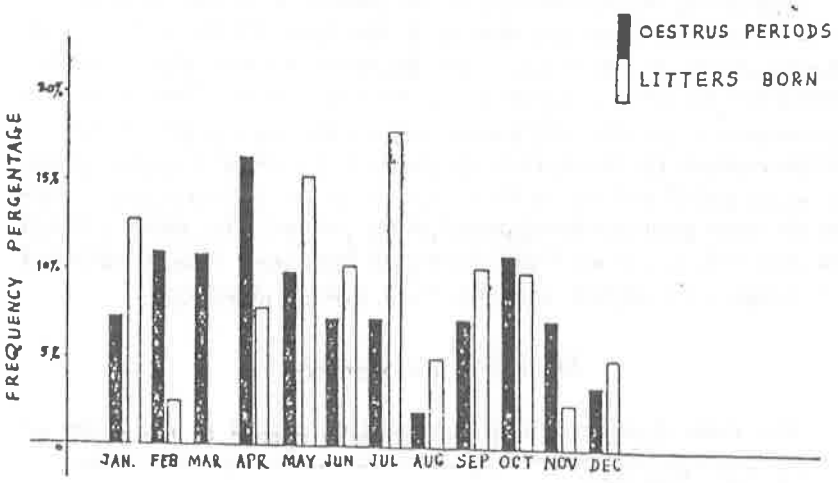

Fig. 1. Frequency distribution of oestrus periods and birth of Panther cubs.

BREEDING SEASON

Panthers breed all the year round (Prater 1971). Between the years 1828 and 1961, panthers had bred during all seasons at Whipsnade and Regent's Park (Jarvis & Morris 1962). It has been stated that in India panther cubs are born between February and March (Blandford 1888-91).

At the Delhi Zoological Park the females come in oestrus during all the months of the year (Fig. 1). From 1958 to 1973, 55 oestrus or heat-periods of nine females have been recorded, during which these females were mated several times by the males and from 1960 to 1972, 63 cubs were born in 39 litters. These data are presented in Table 1.

TABLE 1

BREEDING SEASON OF PANTHER, *Panthera pardus*, IN CAPTIVITY

Months	Number of oestrus or heat-periods	Percentage	No. of litters born	Percentage
January	4	7.3	5 (8)	12.8
February	6	10.9	1 (2)	2.5
March	6	10.9	– –	—
April	9	16.4	3 (5)	7.7
May	5	9.9	6 (9)	15.4
June	4	7.3	4 (4)	10.3
July	4	7.3	7 (12)	17.9
August	1	1.8	2 (3)	5.1
September	4	7.3	4 (7)	10.3
October	6	10.9	4 (7)	10.3
November	4	7.3	1 (3)	2.5
December	2	3.6	2 (3)	5.1
Total	55	100	39 (63)	100

Figures in bracket indicate number of cubs.

DURATION OF OESTRUS

Behaviour such as willingness to be stroked by their keepers, increased rubbing on bars and walls of the cages, repeated rolling over on the back indicate that the female is in oestrus (Sadlier 1966). The duration of oestrus was taken as the total number of days on which the above behaviour of a female was recorded and when she permitted mounting and copulation by the males.

Available data on the oestrus periods of 9 adult pantheresses show a wide range of variation (Table 2).

TABLE 2

BREEDING BIOLOGY OF PANTHER, *Panthera pardus*, AT DELHI ZOOLOGICAL PARK

Specimen	No. of oestrus periods	Range of oestrus (days)	Average oestrus period (days)	Average of last day of oestrus to birth (days) (gestation period)	Average number of cubs/litter
Budhi	9	6 – 12	9	92.2 (5)	1.6 (6)
Tara	7	4 – 10	7.4	94.6 (3)	1.7 (4)
Heer	3	5 – 10	5.0	91.0 (2)	1.7 (4)
Rani	4	7 – 13	7.5	91.0 (3)	1.6 (5)
Vimla	6	6 – 12	8.5	93.6 (3)	1.6 (5)
Ganga	3	8 – 11	10.0	93.0 (2)	1.0 (2)
Kali	7	6 – 12	8.1	—	—
Meenu	9	7 – 12	8.0	93.0 (5)	1.6 (11)
Jamuna	7	8 – 14	10.0	87.5 (2)	1.5 (2)

Figures in brackets indicate number of litters.

SEXUAL MATURITY

Mivart (1881) reports that the domestic cat becomes reproductively mature at the age of one year. The Scottish wild cat breeds first when about 12 months old (Mathews 1941). Sankhala (1967) states that tiger cubs mature at an age between 3½ and 6 years. Young female lions become cyclic at the age of about 3 years, while males appear to require several months longer to achieve sexual maturity (Crandall 1964).

One pantheress (Tara) came into oestrus for the first time at the age of 1 year and 8 months at the Delhi Zoological Park. Another pantheress (Ganga) became cyclic at the age of 2 years 11 months and Heer and Jamuna did so at the age of 3 years 2 months and 3 years 3 months respectively. Two females Meenu and Rani littered for the first time at the age of 2 years 3 months and 2 years 9 months respectively (Table 3). One male Ajay mated for the first time at the age of 2 years.

TABLE 3

OBSERVATIONS ON SEXUAL MATURITY OF PANTHER, *Panthera pardus*, AT DELHI ZOOLOGICAL PARK

Specimen	Date of birth	Date of first oestrus	Age at which observed in oestrus for the first time	Date on which first litter was born	Age at which littered for the first time
Tara	20.8.56	5.4.58	1 – 8	5.8.60	4 – 0
Ganga	15.4.63	5.3.66	2 – 11	15.6.66	3 – 2
Heer	March 56	24.5.59	3 – 2	29.5.60	4 – 2
Jamuna	15.4.63	3.7.66	3 – 3	–	–
Meenu	27.4.58	Records not available		11.7.60	2 – 3
Rani	Oct. 58	Records not available		18.7.61	2 – 9
Budhi	24.5.57	10.3.61	3 – 10	18.6.61	4 – 1

MATING BEHAVIOUR

Properly adjusted and well-mated pairs of panthers breed freely in captivity but attempts to introduce mature specimens to each other are not without risks of injury (Crandall 1964). When any female comes in oestrus at the Delhi Zoological Park, a male is put in the adjoining cage from where the two can see and smell each other. If both show signs of compatibility, it is assumed that they will accept each other and subsequently both are introduced to each other in a large enclosure. They approach each other very cautiously. The muscles of both animals remain taut and they continually growl and snarl at each other. After some time they relax and gradually come closer, till they are face to face. They sniff each other. When mutual confidence is established, the female starts rolling on her back in front of the male and presents herself. She sits with her forelimbs extended fully on the ground, her hind limbs remaining half bent. The male approaches from behind and mounts, and his first insertion takes place within 4 to 8 seconds. Actual coition time varies from 10 to 50 seconds. During coition, the animals emit a variety of guttural sounds. As the climax of the act approaches, the male firmly holds the skin of the female's nape between his incisors and both panthers make a high-pitched sound. As soon as copulation is complete, the male dismounts quickly or is thrown off. Sometimes a short scuffle takes place. After each copulation the female lies flat on the ground for some time. After a short interval, the female again approaches the male, and the whole process is repeated.

During the peak of oestrus copulation takes place 5 to 60 times between 8.00 a.m. and 5.00 p.m. At this time the male and female are both unconcerned about any other activity and show no interest even in the food offered to them.

As stated earlier, bringing male and female together in zoos is not without risk. Sometimes the partners behave aggressively and one of them may be seriously injured or even killed by the other. In June 1967, one of the females Rani was introduced to a male Milu. For some time they behaved very well, but suddenly the male, which was heavier and bigger, caught hold of the female, and a serious fight took place. Rani died of injuries two days later.

GESTATION PERIOD

The gestation period of the panther is given as 90 to 100 days or 98 to 105 days by Kenneth (1953). Asdell (1946) records it as being 92 to 95 days and Pocock (1939) notes a gestation period of 102 days for an African leopard at Whipsnade Park Zoo as being exceptional. Cran-

dall (1964) gives one gestation length for a black leopard as 90 days from the middle of the heat period. Sadlier (1966) notes 100 day gestation period for two litters of the Chinese leopard from the second day of oestrus. The longest gestation period of the species is recorded as 112 days, at Prague zoo (Dobroruka 1968). Prater (1971) gives the gestation period as 13 weeks. It is difficult to compare the above data as in most cases the date of conception is defined differently. For purposes of this study, the duration of gestation is estimated as the period from last day of mating to birth, and the mean period was 91.9 days, the extremes being 84 and 98 (Table 2).

Litter size

Prater (1971) records that two to four cubs are usually produced. Dobroruka (1968) states that over a period of 15 years at Prague zoo, three young have been born on only two occasions. One was born in two instances and two in seven instances. Jobaert (1960) mentions that in the Congo leopards give birth to two or three young. Zuckermann (1953) records one to three young per litter in the Zoological Gardens of London from 1839 to 1937. According to Pushp Kumar (Curator, Nehru Zoological Park, Hyderabad), usually one to two cubs have been born in a litter at the Nehru Zoological Park, three cubs have only been born on two occasions (pers. comm.).

Data on 39 litters at the Delhi Zoological Park indicate that two cubs per litter were born on twenty occasions, one on seventeen occasions and only in two instances were three young born. The average was 1.6 cubs per litter (Table 2).

Postnatal development of the young

The panther cubs born in the New York and Zurich zoo weighed 0.567 kg and 0.430 kg at birth respectively as recorded by Crandall (1964) and Weillenmann (1963).

The weights and measurements of seven cubs at Delhi Zoological Park indicate that a newly born cub weighs approximately 0.500 kg to 1.00 kg and measures 360 mm to 483 mm from tip of nose to tip of tail between pegs (Table 4). All cubs were born with their eyes closed.

TABLE 4

MEASUREMENTS OF CUBS OF *Panthera pardus*, RECORDED WITHIN TWELVE HOURS AFTER BIRTH

Date of birth	Sex	Weight in kg	Total length in mm	Tail length in mm	Ear length in mm	Forefoot in mm
29.1.66	Male	1.000	483	181	25	103
25.6.66	Male	0.750	360	130	—	75
29.9.66	Female	0.575	420	133	15	95
29.9.66	Female	0.600	430	165	15	102
24.4.67	Female	0.500	360	120	11	80
10.6.67	Female	0.600	370	140	15	90
20.6.67	Male	0.950	432	163	24	108
Average		0.710	407.8	147	15.8	93.2

At birth the panther cub is a helpless little creature as its eyes are closed and the movements of the limbs are uncoordinated and rather random. The skin on nose-tip, paws and perineal area is mostly pink. The fur is short, the spots are faintly developed and the whiskers are black in colour. A cub emits a low cry when hungry or uncomfortable.

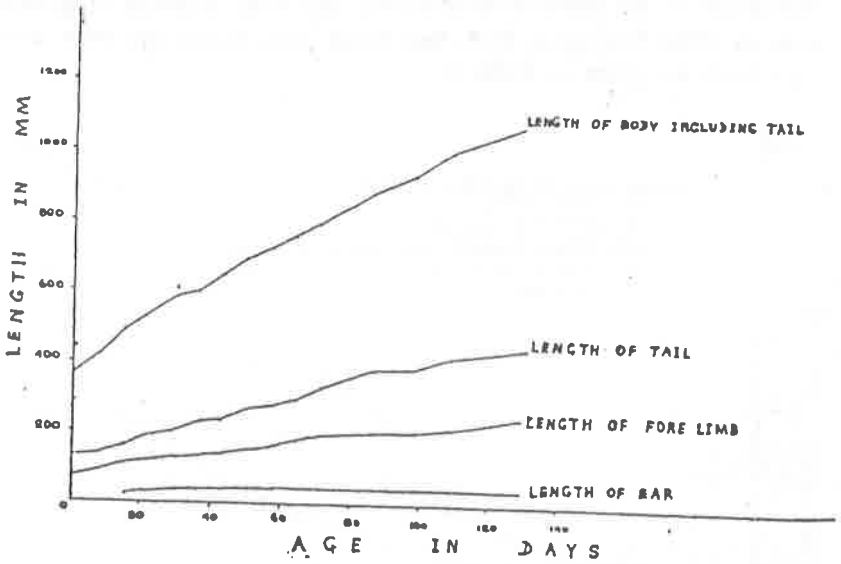

Fig. 2. Growth rate of body parts of cub born at Delhi Zoo (Table 5).

A panther cub born in 15th January 1966 was measured and weighed from birth till the age of 129 days when it was completely weaned and handling was no longer possible. Details of the measurements are given in table 5.

TABLE 5

GROWTH IN WEIGHT AND LENGTH OF PANTHER, *Panthera pardus*, BORN AT DELHI ZOOLOGICAL PARK

Age in days	Weight in kg	Total length in mm	Length of tail in mm	Length of forelimb in mm	Length of ear in mm
0	0.750	360	130	75	—
8	1.000	420	140	90	—
15	1.250	490	160	110	30
21	1.450	530	190	120	35
29	1.550	580	200	130	40
36	1.800	600	230	135	40
43	2.150	640	240	145	43
50	2.400	700	270	155	45
57	2.800	725	280	160	50
64	3.050	760	300	185	50
71	3.250	800	330	200	50
86	4.000	890	390	210	50
98	4.750	940	390	210	50
114	5.600	1010	420	220	50
129	6.250	1080	450	255	50

In Fig. 3, the growth rates of panther cubs hand-reared at Zurich and New York zoos are compared with those of young cubs reared by their mothers at Delhi Zoological Park and Sao Paulo Zoo, Brazil. Further details of the physical development and tooth eruption of panther cubs at Delhi Zoological Park, Sao Paulo Zoo, Brazil and New York Zoo, USA are given in Table 6.

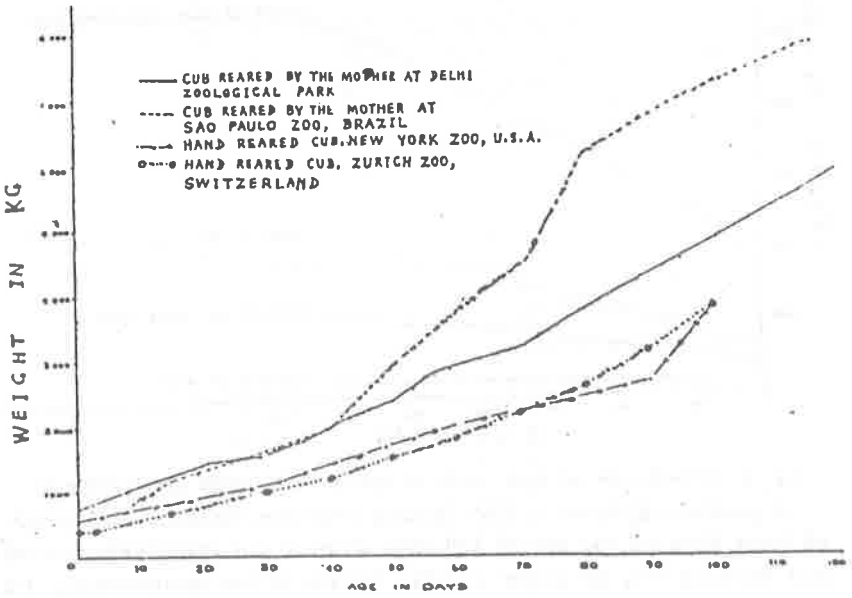

Fig. 3. Growth rate of cubs born at Delhi zoo compared with cubs in other zoos.

TABLE 6

COMPARISON OF PHYSICAL DEVELOPMENT ON PANTHER CUBS BORN AT DELHI ZOOLOGICAL PARK AND OTHER ZOOS

Specimen	Age in days when:					
	eyes open	incisors erupt	1st canine erupts	1st molar erupts	weaned	permanent canine erupts
Born at Sao Paulo Zoo Barzil on 18.7.1966	9	20	—	45	120-125	280
Born at New York Zoo, U.S.A. on 23.2.45	6	—	—	—	—	—
Born at Delhi Zoological Park (India) on 15.6.1966	8	21-29	29	52	114-~~294~~ 129	—
Born at Delhi Zoological Park on 29.9.1966	4	22	30	53	—	—

DISCUSSION AND CONCLUSIONS

Figure 1 shows that the panther breeds throughout the year and cubs are produced during all seasons in captivity. However, there is a peak period of births during the months of January, May and July, while February and November show a low percentage of births. During March not a single cub was born at Delhi Zoological Park between 1958 and 1973. This corresponds to the low breeding activities during December. According to the records of Whipsnade and Regent's Park from 1828 to 1961, the maximum number of births took place during the months of March, August and October while minimum briths took place during January. The records of San Francisco zoo, USA, from 1929 to March 1967, show a high percentage of births during April and May and a low percentage during November, December, February and March (Reuther & Doherty 1968). The breeding records of panthers at Jaipur zoo indicate that from 1954 to 1963 not a single cub was born during the months of February and November (Sankhala & Desai 1969).

The records of San Francisco zoo and Jaipur zoo compare well with those of the Delhi Zoological Park. The variations in peak periods of

birth may be due to the different climatic condition and local conditions

2. All the larger felidae appear polyoestrus in captivity (Eckstein & Zuckermann 1956). Several authors (Asdell 1946; Eckstein & Zuckermann 1956; Sadlier 1966) give seven days as the duration of the oestrus period in lionesses. Sankhala (1967) states that the mating period of the tiger ranges from 3 to 23 days. Sadlier's data (1966) of three female panthers of three different types show mean length of oestrus for the species as 6.7 days

The duration of oestrus varies from 4 to 14 days, according to the data of nine females at Delhi Zoological Park. There is also a wide range of individual variation among the pantberesses as shown in Table 2. It is not known whether age, physical condition, climate and frequency of copulation are responsible for such variations. The mean length of oestrus calculated from 55 oestrus periods of nine females is 8.1 days.

3. There is much individual variation in the age at which panthers attain sexual maturity. It appears that panthers become sexually mature at an age of between 2 and 4 years However, no definite conclusion can be drawn from this small sample.

4. Well-adjusted pairs of panthers breed freely in captivity, but the first meeting involves risks of fatal injury. The mating behaviour of panther is very similar to that of the tiger described by Sankhala (1967). The entire act of copulation lasts from one to three minutes but the actual coition takes only ten to fifty seconds. Mating takes place any time during the day. Panthers may mate five to sixty times in a day.

5. Data on 39 litters born at the Delhi Zoological Park from 1960 indicate a gestation period of 84 to 98 days with an average gestation of 91·9 days. This compares well with the gestation periods given by several authors (Asdell 1946; Kenneth 1953; Crandall 1964 and Prater 1971).

6. The ratio of number of cubs per litter shows that usually one or two cubs are born at a time in captivity. A litter of three cubs is born only occasionally. The average of 39 litters is 1·6 cubs per litter.

7. A newly-born panther weighs on an average 0.710 kg and measures 408 mm (Table 4). Its eyes are closed at birth and open any time from four to nine days later. It has no co-ordination of movements and cannot walk properly or stand upright During the first four weeks it requries extreme care and nursing by the mother Infant mortality occurs mostly during the first four weeks. The incisors are cut at the age of 21 to 29 days and the canines erupt at the age of 30 days. It starts licking and biting solid food when it is 52 days old and the first molar is cut. At the age of about 70 days, it starts taking buffalo calf meat or goat meat in captivity. In the beginning, nursing is frequent but the period of suckling at each feeding is reduced. As the cub grows, the fre

quency of nursing is reduced but the period of suckling at each feeding increases. At the age of 70 days, it suckles only two to three times in a day. It is completely weaned at 114 to 130 days. The growth rate of the cubs reared by their mothers is much better than that of hand-reared cubs. This is evident from the data of cubs reared by their mothers at Delhi Zoological Park and Sao Paulo Zoo, Brazil as compared to the hand-reared cubs of New York and Zurich zoos (Fig. 2).

There is much individual temperamental variation. Some mothers take good care of their cubs, others neglect them and some pantheresses even eat their own cubs Cannibalism although not common is prevalent among panthers even in well-managed zoos and needs further investigation. As a rule all pantheresses are very possessive and protective of their cubs and become very ferocious if they sense any danger to them.

The panther is one of our most magnificent and graceful animals. It is well adapted for survival in highly variable climates and habitats. Its short gestation period and reproductive potential suggest that under normal conditions it can maintain itself However, with large-scale destruction of habitat due to industrialization and agriculture, depletion of its prey and indiscriminate poaching, it has a slender chance of survival in the wild. In order to evolve suitable measures for its protection further scientific study of the species in its natural habitat is desirable.

REFERENCES

ASDELL, S. A. (1946) : Pattern of mammalian reproduction. Ithaca, N. Y. Cornell University Press.

BLANDFORD, W. T. (1888-91) : The Fauna of British India including Ceylon and Burma. Mamalia, London.

CARV. LHO CORY. T. D. (1968.: Comparative growth rates of hand-reared big cats. *Int. Zoo Yb. 8:56-59.*

CRANDALL, L. S. (1964) : Management of Wild Animals in Captivity. London and Chicago. University of Chicago Press. p. 761.

DOBRORUKA, L. J. (1968) : A note on the gestation period and rearing of young in the Leopard at Prague Zoo. *Int. Zoo Yb. 8:65.*

ECKSTEIN, P. & ZUCKERMANN, S. (1956) : The oestrus cycle in Mammalia, Vol. 1 Part I, Marshall's Physiology of Reproduction. Parks A D. (Ed.), London: Longmans Green & Co. p. 688.

JARVIS C. & MORRIS D. M. (1962) : The breeding seasons of mammals in captivity. *Int. Zoo Yb. 3*: 292-301

JOBAERT, A. J. (1960) : Le Leopard. *Zooleo. 56(5,6) :* 223-230.

KENNETH, J. H. (1953) : Gestation periods. Techn. Comn. 5 Edinburgh : Commonwealth Bureau of Animal breeding and genetics.

KRISHNAN, M. (1972) : An ecological Survey of larger mammals of

Peninsuler India. *J. Bombay nat. Hist. Soc.* 69(1) : 26-54.

MATHEWS, L. H. (1941) : Reproduction in the Scottish Wild Cat; *Felis silvestris grampia* Miller. *Proc. Zool. Soc. London 111:59.*

MIVART, ST. G. (1881) : The Cat. London.

POCOCK, R. I. (1939): The Fauna of British India. I. Mammalia. London: Taylor & Francis.

PRATER, S. H. (1971) : The Book of Indian Animals: Bombay nat. Hist. Soc., Bombay. p. 263.

REUTHER, RONALD T. & DOHERTY, JAMES (1968): Birth season of mammals at San Francisco Zoo. *Int. Zoo. Yb. 8:*96-101.

SADLIER, R. M. F. S. (1966): Notes on reproduction in the larger Felidae. ibid *6:*184-187.

SANKHALA, K. S. (1967): Breeding behaviour of the tiger in Rajasthan. ibid 7:133-147.

SANKHALA, K. S. & DESAI, J. H (1969): Reproductive pattern of some Indian mammals. *Cheetal-Jr. Wildlife Soc. India. 12*(1):114-129.

WALKER, E. P. *et al.* (1964): Mammals of the World: Johns Hopkins Press, Baltimore, USA.

WEILLENMANN, P. (1963): Notes on hand-rearing a Leopard, *Panthera pardus. Int. Zoo Yb. 4:* 317-318.

ZUCKERMANN, S. (1953): The breeding season of mammals in Captivity. *Proc. Zool. Soc. London: 122:*827-950.

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MISCELLANEOUS NOTE

6. REPRODUCTIVE BEHAVIOUR OF BROW-ANTLERED DEER

INTRODUCTION

Thamin deer or Browantiered deer, *Cervus eldi eldi* (McClleland), is found only in a small area of Manipur in eastern India. It is estimated that only about one hundred of these deer now exist in nature in Keibul Lamjao Wild Life Sanctuary of Manipur (Gee 1960) It is one of the threatened species of the sub-continent (Talbot 1960).

Published records on breeding pattern of this deer in nature are almost non-existent. The secretive nature of the deer and the fact that the animal lives in floating islands in swamps in nature makes it very difficult to collect information on its breeding behaviour in the wild. It may be mentioned that Browantlered deer have done well in captivity in various parts of the world. Gee (1960) states that several fawns were born at Woburn, Abbey, U.K.; four fawns were born during 1922-25 in the Regents Park Zoological Garden, U.K., nine fawns were born in Vincennes Zoological Garden of Paris and many fawns were born in Alipore Zoological Garden, Calcutta.

According to Asdell (1946), Cervidae are seasonally monestrous. Cheatum & Morton (1942) state that the length of estrous cycle is about 28 days. The same authors conclude that the estrous period lasts a maximum of thirty-six hours and the period, a female will receive a stag, lasts only about a day. Prater (1965) indicates that the stags shed their antlers in mid-August and are clear of velvet by the end of December, the rut develops between March-April and after a gestation period of 239 to 256 days, usually one fawn is born in October. Gee (1960) mentions that the stags shed their antlers in late June, the rutting season is between February and March and the fawns are born in October and November.

The paper presents the results of the study of breeding pattern of the Browantlered deer conducted in Delhi Zoo from 1962 to 1969. It is hoped that the reproductive data will enhance the biological knowledge about the species and help in its preservation.

DISCUSSION AND CONCLUSION

The Delhi Zoological Park received a pair of Browantlered deer in August, 1962 as a present from Manipur State, India. The deer

were kept in an open moated and grassed enclosure of about 1·5 acres. The deer were given one kilogram of concentrates daily and five kilograms of green fodder. In addition, they had an access to the green grass in the enclosure. The stag had complete access to the doe for mating all the year round. The deer were watched regularly. A total of eight fawns were born during 1963 and 1968.

The stags drop their antlers in late June and beginning of new antlers in velvet take place within three to four days (Table 1). The stags are in full velvet during the month of July. The antlers become clear of velvet in late November. The antlers are very handsome and characteristic of the species. In profile, they seem almost circular. The antlers sweep in one continuous graceful curve from the tip of the browtine to the point of the beam. The number of terminal tines varies from two or three to as many as eight or ten (Prater 1965). The antlers at the maximum measure 102 cm. (42 inches) (Gee 1960). In the Delhi Zoological Park, the shed antlers were measured each year and recorded. The number of tines varied from three to five on each antler (Table 1).

TABLE 1

ANTLER SEQUENCE OF BROWANTLERED DEER

S. No.	Date of dropping of antlers	Measurement of antlers	No. of tines	Beginning of velvet	Completion of velvet	Antlers cleared of velvet	Chasing female or mating
1	26-vi-65	91 cm.	3+3	30-vi-65	3-vii-65	23-xi-65	3-iii-65
2	25-vi-66	97 ,,	3+3	28-vi-66	1-vii-66	21-xi-66	2-iii-66
3	28-vi-67	118 ,,	4+4	2-vii-67	3-vii-67	22-xi-67	1-iii-67
4	28-vi-67	96 ,,	3+3	1-vii-68	4-vii-68	23-xi-68	2-iii-67 • 10-iv-68
5	29-vi-68	98 ,,	3+3	2-vii-68	6-vii-68	24-xi-68	
6	26-vi-69	112 ,,	5+5	29-viii-69	1-vii-69		

A peculiar behaviour of the stag which came to the Zoo in 1962 is during rut, it chases the females and even injures them (two females on 1.3.1967 and 2.3.1967).

Due to the secretive nature of the deer, out of eight successful matings that took place during 1963 and 1968, only one mating on 10.4.1968 was actually observed. Four other mating dates were estimated from the behaviour of the dominant male and the females. On two occasions the females were injured by the male during chase and on other two occasions the male was observed chasing the female

[2]

throughout the day and it was ascertained that the mating would take place on that day. The gestation period were calculated from the estimated date of breeding and the date of parturition. The average gestation period was found to be 240·4 days with a minimum of 236 days and a maximum of 244 days.

TABLE 2

BREEDING, FAWNING AND GESTATION PERIOD OF BROWANTLERED DEER IN DELHI ZOOLOGICAL PARK

S. No.	Estimated date of mating	Date of parturition	Gestation period in days	No. of Fawns born	Composition of herd		Remarks.
					M	F	
1	..	18-x-63	..	1	1	2	
2	..	12-xi-64	..	1	1	3	
3	3-iii-65	29-x-65	240	1	1	3	One male died on 2-xii-65 due to injuries.
4	2-iii-66	26-x-66	238	1	2	3	
5	..	27-x-66	..	1	2	4	
6	1-iii-67	23-x-67	236	1	3	4	
7	2-iii-67	1-xi-67	244	1	3	5	
8	10-iv-68 (Actual mating observed)	10-xii-68	244	1	3	5	One female died on 13-i-1968.
	Average		240·4	Present herd composition	2	3.5	One female died on 2-vi-1969.

In all the eight cases, the does dropped single fawn. Eight fawning dates were recorded with the earliest fawn dropping on 18.x.1963 and the latest on 10.xii.1968.

On an average the fawn of the browantlered deer were observed to be slightly larger than those of the Axis deer (*Axis axis*), Sika deer (*Cervus nippon*) and smaller than those of nilgai (*Boselaphus tragocamelus*) (Tables 3 & 4.)

DELHI ZOOLOGICAL PARK,
NEW DELHI,
November 3, 1969.

K. S. SANKHALA
J. H. DESAI

TABLE 3

MEASUREMENT OF FAWNS (IN CM.) AT BIRTH

S. No.	Date of parturition	Sex	Weight in kg.	Lengths				Age of doe at fawning	Remarks
				Total	Forefoot	tail	ear		
1	18-x-63	F	4·65	71·5	35·1	9·1	9·5	3-4 Years	
2	12-x-64	F	4·54	73·7	34·3	9·1	9·5	3½ ,,	Ten cms. growth of antlers observed on 27-iii-1967. For the past two years only pedicels were observed.
3	29-x-65	M	6·00	73·1	38·1	10·8	10·1	4-5 years	
4	26-x-66	M	6·00	75·0	37·0	9·0	10·0	6 years approximately.	
				Weaned 2-xii-1966.				Pedicels of two cms. observed on 18-v-1967.	
5	27-x-66	F	4·85	72·8	35·5	9·2	9·5	3 years	
6	23-x-67	M	6·10	73·0	37·05	9·1	9·5	4-5 ,,	
7	1-ix-67	F	4·90	72·0	36·0	9·0	9·3	3 years	
8	10-xii-68	F	4·60	73·2	33·8	9·2	9·5	3 years	Completely weaned on 14-i-1969.

TABLE 4

COMPARATIVE MEASUREMENT OF FAWNS OF AXIS DEER, SIKA DEER AND NILGAI AT BIRTH

S. No.	Species	Date of birth	Sex	Weight in Kg.	Length in cm.				
					Total	forefoot	Tail	ear	Girth
1	Axis deer	31-i-64	M	3·63	77·0	30·5	17·8	8·3	..
2	,,	7-v-66	M	4·50	74·0	31·0	17·5	8·2	..
3	Sika deer	1-v-66	F	1·5	56·5	26·7	7·0	6·3	..
4	,,	5-v-66	F	3·0	58·5	30·5	7·6	6·3	..
5	Nilgai	7-ii-67	M	6·25	86·0	38·0	21·5	8·75	43·0
6	,,	18-iii-67	F	5·50	82·0	38·0	20·0	9·0	..

* Exotic species with great difference in size of male and female.

REFERENCES

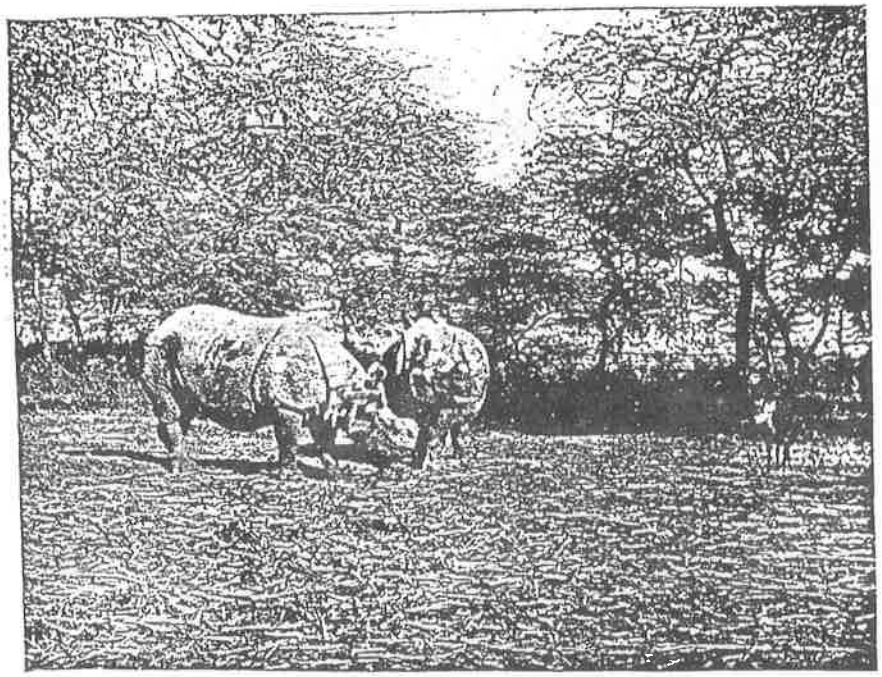
ASDELL, S. A. (1946) : Patterns of mammalian reproduction. Comstock Publishing Company. Ithaca : 314, 338.

CHEATUM, E. L. & GLENT MORTON (1942) : Technique used in determining the period of rut among white-tailed deer of New York State. *Trans. Seventh N. Amer. Wildlife Conf.* 334-342.

GEE, E. P. (1960) : Report on the status of the Browantlered deer of Manipur. *J. Bombay nat. Hist. Soc.* 57 : 597-617.

PRATER, S. H. (1965) : The book of Indian Animals. Bombay Natural History Society, pp. 316.

TALBOT, L. M. (1960) : A look at threatened species. *Oryx* 5 (4 & 5); 147-326.



Above: The Parents.
Below: Rhino Baby and Mother at Delhi Zoological Park.

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MISCELLANEOUS NOTE

4. BREEDING OF THE INDIAN RHINOCEROS (*RHINOCEROS UNICORNIS*) AT DELHI ZOOLOGICAL PARK

(With a plate)

The Great Indian One-horned Rhinoceros (*Rhinoceros unicornis*), like all rhinoceroses, does not breed readily in captivity. Till 1960, only five calves were born in captivity. One reason for few rhino births in captivity might be the violent battles that take place between the sexes which discourages zoo authorities from keeping them together. During the last ten years, however, more Indian rhinos have been bred in captivity. The International Zoo Yearbook, Volume 10, published in 1970 by the Zoological Society of London, lists twelve births of Indian rhinoceros in captivity.

The Delhi Zoological Park obtained 'Mohan' a male Great Indian Rhinoceros in December, 1965. It was three and a half years old when it came to the zoo. Later in March, 1968, a female 'Rongi' of about six years of age was brought to the Zoo from Gauhati, Assam.

The rhino enclosure at the Park is an open air enclosure of about an acre in area. The enclosure has a luxuriant growth of naturally growing trees and undergrowth of *Prosopis juliflora*. In the centre of the enclosure, a wallow has been provided. The enclosure has a few cells and a large enclosed paddock where the animals could be kept separately.

Rongi, arrived at the zoo in the evening of 28th March, 1968, and was kept in the paddock. 'Mohan' was at that time kept in the outer enclosure. It was observed that Mohan was very interested in Rongi but she was very restless for the first few days. Later both used to smell and see each other. It was then decided to introduce her to Mohan. However, it was not without anxiety as it was known that rhinoceros did not readily live together in captivity. In fact, a pair at Whipsnade Zoo had fought and the female was eventually removed to Regent's Park, London. A pair at Chicago, USA, had never became reconciled to each other.

Precautions were therefore taken to avert any possible trouble. In the early morning hours of April 14, 1968, about 20 keepers and attendants stood by with crackers, tin cans and bamboo sticks. The partition door between the paddocks and the main enclosure was

[1]

gradually opened. At 7.00 a.m. Mohan and Rongi met for the first time in the middle of the enclosure. The male was more interested in mounting but the female kept him at a distance. She looked apprehensive, broke off and ran away several times. After about an hour, both settled down, the male went to the mud wallow and the female was seen eating green fodder. Fortunately, there was no fight and the two settled down in course of time.

The female came into oestrus on 4th January, 1969 for the first time but the male remained indifferent and mating did not take place. She again came in oestrus on 22nd September, 1969. This time, the male was continuously seen chasing the female in the enclosure and also in the moat. The female, however, broke off and ran away several times. At about 1.00 p.m. a very fierce fight took place between the two, and both were injured. Later the male was shut in the paddock to avoid one of them being very seriously injured. Two days later the male was released, again with due precautions and there was no fight. On 1 October, 1969, hard blowing and shrill whistling noises were heard from both as they ran about in the enclosure and in through the water in the moat. Several sharp skirmishes also took place between the two but this time one of them was not shut inside. At 2.40 p.m. first mating took place. The whole act lasted for about 30 minutes. In the afternoon another mating was observed. No mating was observed from 2nd October, 1969 onwards and both became quiet. It was hoped that successful mating had taken place, and in the late winter it became apparent that the female was pregnant.

Both the rhinos were, however, kept together in the same enclosure till July, 1970 when Mohan was shut into the paddock. The female was now definitely in calf. Her mammary glands increased in size and became active. She also stopped showing any interest in the male in the adjoining paddock.

On 27th January, 1971, she took her usual food at 11.30 hrs. and retired into the bushes. At about 15.00 hrs. she became very restless and emitted bleating sounds on and off. It was apparent that she was in labour pains. At 16.00 hrs. she went to the far corner of the enclosure, away from the public, and sat in a small wet depression. A watery discharge was seen and she stood up at 16.15 hrs. when birth became imminent. The front legs and head emerged while she was standing and at 16.20 hrs. she exerted a little and the calf was born. She was totally exhausted and sat down and showed little interest in the calf for the first five minutes and then started licking it. The duration of gestation in this case was 484 days as calculated from the day of last mating to the day of birth.

[2]

The baby was pink coloured at birth. At 17.05 hrs. the calf made attempts to stand up but could not succeed. However, by 18.15 hrs. the baby was standing.

The last observation of the mother and calf was made at 19.00 hrs. on 27th January, 1971 and till then she had not nursed the calf. Next day, in the early morning hours, the calf was seen suckling. The vulva of the baby appeared very prominent and it was possible to sex her on the 28th January, 1971. The colour of the skin also appeared to be slightly darker than on previous day. The mother was very protective of the calf and even did not come for feeding during the daytime. She, however, came at about 19.00 hrs. for feeding along with the calf. She first made the calf sit down on the straw padding in the enclosure and then went for feeding. This procedure was followed till the middle of February, 1971. On 20th February, she came out of the bush with the baby in broad day-light at about 13.00 hrs.

On 27th February, evening the calf was seen nibbling green fodder for the first time. She took some fodder leaves in her mouth and attempted to chew and continued to play like this for about 15 minutes. From 17th March, 1971, the calf started to take some green fodder. The calf has now grown considerably stronger and bigger.

DELHI ZOOLOGICAL PARK, C. L. BHATIA
NEW DELHI, J. H. DESAI
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Section C (3)

The Contribution of Delhi Zoo to Conservation

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Zoological Gardens, Menageries or Zoological Parks the world over are one of the biggest drains on wildlife resources. Their staff go out on expeditions, lay their own traps and bring home species to enrich their collections. They buy animals at fabulous prices from organised dealers who in turn depend on local trappers. A new trade has developed. Once money is involved, there remains no limit to exploitation. The trappers are always looking for methods which are less expensive and easier, but which may well be harmful to the animals. They set unattended nets, snares and traps and often reach the scene after the trapped animal is dead. In many cases, the animal's struggle to escape results in loss of a limb, canine or some other part of the body. The animals which reach the base camp undergo another torture. Their every attempt to escape is foiled. With the loss of freedom they lose interest in life. In the atmosphere of tension, they stop eating. Crocodiles, gharials, anteaters and dolphins are specially prone to die of starvation, but even big cats, grown-up elephants and gaurs have been known to hunger-strike to death.

With species such as tiger, clouded leopard, gibbon and monkeys, the young are often caught by killing the mothers accidentally or intentionally. They do not always fall into safe hands and infant mortality is inevitable. Young animals are preferred as they are more easily carried by air or smuggled. Transportation losses are great, particularly in case of deer, antelopes and apes. All the 20 elephants shipped from Mysore last year had to be jettisoned one by one in the Arabian Sea on their way to Europe. Out of four tiger cubs sent by air, only two reached their destination. Two Nilgiri langurs were recently despatched to Delhi. Only one arrived safe. Even a white tiger died on the way to the U.S.A. From the point of capture to arrival at a zoo, all such losses are debited to the zoo's account. This loss of wildlife is substantial (apes 95%, langurs 75%, monkeys 25%, cats 50%, otters 80%, goral, bharal and shrew 99%, and deer 50%): there is no denying that zoos are dangerous agencies in wildlife consumption. This is aggravated when a zoo director is a 'stamp collector' and attempts to possess everything under the sun, without caring for the physical and psychological health of the animals and when the criterion for judging a zoo is the number of animals in the collection rather than display and care. This unsound objective, to possess the maximum number of species and equally to replace losses quickly, has taken a heavy toll of wildlife. Zoo managements have also contributed to further loss by inexperience, neglect and experimentation. Probably, there is no zoo director in the world without some 'blood on his hands'. Losses are increased by public sympathy, over-feeding or feeding unwanted, unhygienic, unauthorized food articles, and partly by the vandalism of visitors who poke animals with sticks or umbrellas, throw stones, break the legs of flamingoes and fatally injure small birds and animals.

But fortunately the concepts of zoo management have changed. Directors hate to be called 'stamp collectors' and refuse to bargain with unauthorized dealers. They prefer zoo-bred to trapped animals. Under the leadership of the Zoo Directors' Union, there is an altogether new dimension in zoo management. Breeding of zoo stocks is given priority to make the zoos self-sufficient and records show that the zoos have played a unique role in successful breeding of rare animals, which in the wild had no chance of survival. Typical examples are Père David's deer, Przewalski's horse, European and American bison, Arabian oryx and Nene goose. Symposia held in London, U.K. in 1964 and in San Diego, U.S.A. in 1966, on the subject of 'Zoos and Conservation', under the auspices of IUCN and the International Union of Directors of Zoological Gardens, respectively, led to such recommendations as the establishment of an international code of rules for zoos and other institutions for breeding rare and endangered species. It was agreed that the zoos of the world should take a responsibility in conserving species and that animal breeding should be an important concern of zoological gardens (Jarvis, 1965).

It is heartening to note that as a result of these deliberations many well established zoos have now taken up the altruistic task of breeding the world's rarities. One hopes that the interest thus promoted by zoological institutions will help people to realise the thrill and pleasure of sharing the planet with a variety of fascinating wild creatures and the importance of conserving its dwindling wild life resources. The idea and concepts of conservation have changed from the purely sentimental to the practical approach of today. Unfortunately this evolution has been so slow in comparison with the rapid destruction of wildlife that the situation has become an emergency, so that the main aim of having rare animals in a zoo must now be to conserve them for future generations, keeping them for long enough to develop a sufficient captive stock of which some can eventually be released back into the wild.

In Delhi, we have today a stock of 28 tigers, probably more than remain in many tiger areas of the country, all from our own breeding stock except for three cubs which were rescued when their mothers were shot. The total world stock of 33 white tigers is similarly the result of the breeding programme of zoological parks of Rewa, Delhi, Calcutta, Washington D.C. and Bristol (Thornton, Young and Sankhala, 1967). Judging from our experience at Delhi, climate plays a less important role than living conditions and nutrition. The Delhi Zoo has been uncommonly successful in breeding, rearing and maintaining such rare animals as the brow-antlered deer *Cervus eldi*, Nilgiri langur *Presbytis johni*, lion-tailed macaque *Macaca silenus*, four-horned antelope *Tetracerus quadricornis* and smooth Indian otter *Lutra perspicillata*, as well as the tigers.

The thamin or brow-antlered deer is a beautiful deer found only in Manipur in India. The species has become very rare in recent years and only 100 deer were estimated to be in existence in the Keibul Lamjao Sanctury in 1959-60 (Gee, 1960). Gee states that the species has bred well in captivity in various parts of the world, but actual records of breeding are few. A pair was presented to the Delhi Zoological Park in 1962 by the Manipur State Administration. They were released in an open moated enclosure of about 1.5 acres. Each deer was given 5 kg of green fodder and one kg of concentrates daily. In addition to this, the deer grazed in the enclosure and were observed to be in good condition. In October 1963, the first fawn was born and thereafter very year the birth of one or two fawns has been recorded. In total, there have been eight births of brow-antlered deer in the Delhi Zoological Park (Table 1).

Similarly, the Delhi Zoo has been successful in breeding the rare four-horned antelope: a pair was received in 1958 and in the last ten years fifteen births have been recorded (Table 1).

TABLE 1

Species	Number of births										
	1959	'60	'61	'62	'63	'64	'65	'66	'67	'68	'69
1. Brow-antlered deer	—	—	—	—	1	1	1	2	2	1	—
2. Four-horned antelope	2	—	—	—	1	—	—	2	1	3	6

Delhi Zoological Park is the only zoo in the world to have bred the Nilgiri langur in captivity. The luxuriant fur and supposed medicinal value of the flesh, blood and organs of this species have caused it to be hunted more than any other monkey. Studies made by the Bombay Natural History Society demonstrate that if the recent forest utilization practices are allowed to continue, both the Nilgiri langur and lion-tailed macaque will be extinct within the decade (Hill, 1960). The lion-tailed macaque has never been common and a recent survey by the Bombay Natural History Society showed that it is now distinctly rare. The Delhi Zoological Park has been successful in breeding both species. A trio of Nilgiri langurs was obtained in 1962 and the first young was born in 1964. One pair of lion-tailed macaque was obtained in 1959 and placed on an island, with trees on it and a moat as a barrier. They soon adapted themselves to their new environment and in 1962, the first young was born and thereafter six births have been recorded, now making a small colony of nine of these monkeys.

Delhi Zoo is also the first to have bred the Smooth Indian otter. Two females gave birth

to five and three young in 1968 and 1969, respectively. They have been kept in large moated enclosures where they burrow and live a natural life. They are given an exclusive diet of live fish.

As already indicated the Zoo is today the main breeding centre for tigers in the world. Since 1962, 65 have been born and at present 28 of them are on display. Many of them have been sent away in exchange or as gifts. In this connection, brief mention may here be made of the contribution made by a number of other zoos in India to the breeding of rare animals. The Sakkarbaug Zoo, Junagarh, has been successful with Indian lion *Panthera leo persica*, having bred 33 lions of pure Indian stock since 1947 and distributed them to various Indian zoos for further propagation (Joslin, 1969). The Mysore Zoological Garden has been uniquely successful in breeding the one-horned Indian rhinoceros, as well as African rhinoceroses and other African animals. The Jaipur Zoo has successfully bred the Indian crocodile for the past 10 years. Alipore Zoological Garden, Calcutta, has been successful with the brow-antlered deer and the lion-tailed monkey.

Success in breeding animals in captivity does not rest entirely on living conditions and nutrition. It is a complicated affair which requires constant observation, patience and common sense. It depends on the time an animal takes to acclimatize and develop confidence. It also depends on the individual behaviour of the animals. There is still too little knowledge about the behaviour, social relationships and diet requirements of many species, all of which need scientific investigation and coordinated research. Every zoo should have a research cell to study the biological and psychological aspects of various animals. Many examples of failure of conservation projects have been due to lack of ecological data on the particular species concerned: in fact, ecology is almost synonymous with conservation or in other words conservation can be interpreted as applied ecology. Since most animals are extremely secretive in their native haunts, a zoo is an ideal place to study their behaviour patterns. Zoos can help to fill in the missing data on feeding, nutrition, reproductive biology, animal behaviour and pathology, and their work can be supplemented by research centres set up in parks and sanctuaries in association with universities. The Delhi Zoological Park is actively engaged in such scientific projects. In collaboration with Delhi University, it has embarked on a research project on the chromosomes of primates. It has also initiated independent research projects on the breeding behaviour of tigers (Sankhala, 1967) and the ecology of painted storks (Desai, 1969).

Most people in India are ignorant of the importance of conservation. They cannot even recognize many of the common animals. They call a lion a tiger and a tiger a cheetah. One of the most important functions of a zoo is therefore to educate the public about wild animals. There are more than 300 zoos in the world and the number of visitors to them every year has been estimated at about one hundred and forty million (Osborn, 1962). If all zoos collaborated in educating the public on the importance of conservation, the aims of mass conservation education could be accomplished in a short period of time. Zoos which cannot play their part in this are not only little more than a drain on the wildlife, but sooner or later will be forced into oblivion by the weight of public opinion.

The Delhi Zoological Park has achieved considerable success in this educational field. With the help of teachers and leaders of organized groups, it arranges guided tours which include a discourse on the conservation, maintenance and ecological aspects of the exhibits. In addition to this, eminent biologists, conservationists and visiting zoo directors from elsewhere in India as well as from abroad are invited to deliver lectures. On the spot wildlife painting competitions are organised annually, children being invited to paint the animals of their choice within a specified time. It has been found that such activities greatly benefit the cause of conservation and help to bring about a realisation that conservation of nature is necessary for the survival of man himself. Various other functions are held every year to promote the cause and television programmes are also organized regularly. Such programmes break down the barriers between education and entertainment, much to the benefit of the general public. Sound and vision have brought a new dimension to the possibility of inculcating an awareness of the crisis facing wild animals.

Recreation of the public is yet another aspect of proper zoo management. A park should be aesthetically attractive for young and old alike. It should have beautiful lawns, colourful gardens, neat pathways and of course an interesting display, so that people can come, relax and enjoy, while assimilating the educational impact of the zoo. Delhi Zoological Park is a good example, with its varied and interesting animals, beautifully maintained

gardens and the magnificent and attractive back-drop of the Old Fort. Another important attraction which has been developed is the mini-bird-sancturary in the lakes. People throng to see and enjoy the birds building their nests, raising their broods, coming in and going out of the Park for food, or training their young to fly. This is an education in itself, as visitors see how, with only little care, protection and food, a bird sancturary can be established amidst a bustling metropolis.

The large enclosures—without bars—of the Delhi Zoo create an atmosphere of freedom, while those provided for the tigers are real Indian jungle with bamboos, Lantana and Zizyphus bushes, reeds, grasses with their ever-changing colours and the moat playing the part of a water-hole. The animals are not exposed to exhibition; they are there but one has to search for them, thus satisfying one's exploratory instincts. The same is true for the lions, as they roam on the sky-line of their wooded enclosure. The elephants have a large area, with a bathing pool, and are unchained. The deer, antelope and rhinoceros enclosures are equally roomy and such species as the zebra and eland can enjoy green grass under their hooves.

In most of the enclosures, attempts are made to simulate the exact natural habitat of the species displayed. Not only the flora but also other fauna associated in nature with the main species on display are included, so that, to take one noteworthy example, with the Indian rhinoceros, barking deer, hog deer, adjutant storks and sarus cranes live in harmony. Along with zebra and ostrich are displayed marabou storks and the white storks. Spotted deer are often found in association with peafowl and sarus crane in nature, so these three species are exhibited in the same enclosure. A similar effort is made with the vegetation, the rhinoceros enclosure being full of tall reeds, sedge and mud holes, while a sample of woodland is maintained for the spotted deer.

A visitor once remarked that he needed binoculars to see animals in the Delhi Zoo. We consider this to be compliment. The animals live as they live in nature. Their petty rivalries and conflicts, family affairs, care for young and other facets of day to day existence are fascinating to watch. But, in addition, they do not have to worry about food, and they get immediate attention if they fall sick or sustain injuries, which could never be possible in the wild. Epidemics, ailments and contagious diseases develop in the wild which take a heavy toll and sometimes even threaten the survival of a species. In a zoo, these hazards can usually be checked and the animals saved by proper treatment. For instance, our white tiger 'Raja' suddenly lost interest in food and within a matter of hours became very sick. He passed blood in the urine and his vitality became very low. The disease was diagnosed as Babesiosis which is usually fatal, but a cure was effected by timely treatment. Two American bisons which developed Pneumonia in the winter of 1968 were saved in the same way and, in the fairly frequent cases of severe injuries to antelope, deer and even lions and tigers which occur during fighting amongst a group, pride or pair, death would often result but for the treatment accorded.

Finally, it is worthy of mention that news of the birth, sickness or romance of animals and birds in the Delhi Zoo often provide our capital city with a much needed change of conversational topic, amusement and relaxation. In short, the breeding of rare or vanishing species, conservation education and the healthy recreation of the people are all positive contributions by zoos to the cause of conserving wildlife. They are the saving grace of a zoo and the consolation of the zoo director in moments of agony due to the 'blood on his hands'.

LITERATURE CITED

DESAI, J. H. 1969. Nesting and Food Ecology of the Painted Stork (*Ibis leucocephalus*) in the Delhi Zoological Park. Accepted for publication, Inter. Zoo Yearb. X.

GEE, E. P. 1960. Report on the Status of Brow-antlered deer of Manipur (India). J. Bomb. Nat. Hist. Soc. 57: 597-617.

HILL, Clide A. 1960. Expedition to India. Zoonoos. XLI No. 7.

JARVIS, Caroline. 1965. Zoos and Conservation Symposium. Inter. Zoo Yearb. V: 97-100.

JOSLIN, Paul. 1969. Conservation of the Indian lion through captive breeding. Report under review. IUCN, IUDZG.

OSBORN, Fairfield. 1962. A new opportunity—Zoos help wildlife. Inter. Zoo Yearb. IV: 65-66.

SANKHALA, K. S. 1967. Breeding behaviour of the tiger in Rajasthan. Inter. Zoo Yearb. 7: 133-147.

THORNTON, I. W. B., K. K. YOUNG and K. S. SANKHALA. 1967. The genetics of the white tigers of Rewa. J. Zool. Lond. (1967) 152, 127-135.

SUMMARY

Zoological parks and zoo gardens have been some of the biggest consumers of wildlife of the world. But the new concept of zoo management of displaying only a few animals and birds in, as far as possible, self-contained eco-units, imparting education to raise conservation consciousness among people, conducting research to discover unknown facts about wild animals for better understanding their physical and psychological needs, and breeding rare and vanishing species for reintroduction in depleted areas, is fast changing the position. Zoos are becoming new reservoirs of wild life and taking a lead in conservation.

The paper describes the contribution of the Delhi Zoological Park, in the field of conservation of wildlife in India.

RÉSUMÉ

Les parcs et jardins zoologiques ont été parmi les plus gros 'consommateurs' d'animaux sauvages du monde. Mais cette situation se transforme rapidement avec les nouvelles conceptions sur l'aménagement des zoos: présentation d'un nombre limité d'animaux et d'oiseaux dans des unités écologiques se suffisant à elles-mêmes autant que possible, diffusion d'un enseignement pour éveiller la conscience du public aux problèmes de la conservation, recherches sur les aspects inconnus de la vie des animaux afin de mieux comprendre leurs besoins physiques et phychologiques et enfin élevage d'espèces rares et en voie d'extinction, en vue de leur réimplantation dans des régions où elles avaient disparu.

L'article décrit le rôle que joue le Parc Zoologique de Delhi dans le domaine de la conservation de la faune indienne.

SECTION C (3): POINTS MADE IN DISCUSSION

Mention has been made in several of the papers of the breeding of rare and endangered species in zoos with the ultimate object of re-introducing them into the wild in their native areas when conditions are favourable. The Arabian oryx operation is a well-known example. But is is also worth noting the interesting case of the blackbuck, which was successfully introduced into Texas in 1930: there it has flourised to such an extent that a project is now afoot to use some of the stock for reintroducing the species into suitable areas of Pakistan where it has become virtually extinct (Gutermuth, U.S.A., Chairman).

In Japan, where the Association of Zoos now has 90 members, a great effort is being made by one or two zoos to save the last remnants of the Japanese Crested Ibis and the Japanese race of the white stork. Eggs have been laid by a captive pair of the latter for two years but have so far failed to hatch. The present plan is that if they lay again, a pair of the European race of the stork, which have nested successfully in the zoo, will be used to incubate them. As one of the Japanese storks was donated by the Pekin Zoo, this project if it succeeds will be a nice example of international collaboration in more ways than one! (Koga, Japan).

The recommendations in Lady Medway's paper for the formation of a Zoos Association in India and for the setting up of a Training school for zoo staff deserve the fullest support. Another suggestion, which has been tried out successfully at the Nehru Zoological Park in Hyderabad, is to incorporate in the educational activities of zoos the setting up of a zoo museum, with particular reference to displays not only of prehistoric species but also of those more recently extinct, so as to encourage interest in preventing further extinctions (P.S. Rao, India).

With reference to the serious losses inflicted on animals in the process of capture, which is largely due to lack of skill and carelessness, two things which could help to improve the situation would be legislation to ensure that only fully qualified dealers, reaching and maintaining specified standards, would be licensed to deal in animals; and secondly, negotiations with all airlines to persuade them to place animals in a different class from normal freight, so that they will never be subjected to mishandling and delays in transit (Leyhausen, Germany).

The problem of using zoo-bred carnivores, such as the tigers mentioned by Mr. Sankhala, would be a particularly difficult one requiring special techniques. Have these ever been worked out or tried? (Harthoorn, Kenya).

No attempt has yet been made to solve this problem, but it does not seem impossible that success could be achieved if a reintroduction could be carried out in stages, only the second generation being expected to adapt itself fully to the wild, rather in the manner of the Eagle Ows referred to in Mr. Wayre's paper (Sankhala, India).

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Genetics of Black Panther (*Panthera pardus*)

By

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The Indian Panther is found all over the country. According to Prater (1965) dark race exists in Nelliampatti Hill in Cochin. According to Walker (1964) black panther is colour phase of the leopard. E.P. Gee (1964) stated that there were reports that black mating with black produced black cubs but black mating with normal coloured (rosette) produced both kinds of cubs in the same litter. Robinson (1970) concluded from the mating data of black and spotted panther that black is inherited as an autosomal recessive. But in Jaguar (*Panthera ounca*) black is dominent to normal colour.

Material and Methods

An adult black male panther, named Bhullu was brought to National Zoological Park from Calcutta Zoo in 1962. Bhullu was introduced to ordinary Pantheress Buddy, a gift received from Smt. Rayzu of Jabalpur.

In 1956, a four month old ordinary pantheress Tara had been presented to the park by Mr. S.S. Joshi. She was introduced to Bhullu. On 15.4.63 Tara gave birth to two ordinary coloured female cubs, named Ganga and Yamuna. When matured, Ganga was introduced to Bhullu and on 24.4.67 a still born cub (ordinary coloured) was born, but Ganga still had trouble and on 28.4.67 a black dead cub was helped out from her. A complete breeding chart of Bhullu with Buddy Tara and Ganga is given in Fig. 1.

At M.C. Zoological Park, Chhatbir (Pb.) a black male Shankar and ordinary female Danger were brought from Gauhati Zoo in 1979. They were allowed to mate, and produced 7 cubs in three litters, out of which two were black. Bhola, an ordinary colour panther, was brought from the forests of Assam and female Papi (ordinary coloured) from Gauhati Zoo. This pair produced 7 cubs in 3 litters, of which one cub was black in each litter. A Geneological chart of panthers of M.C. Zoological Park Chhatbir is given in Fig. 2.

The result of matings of black panthers at N.Z.P. and M.C. Zoological Park, Chhatbir is summarised in Table 1.

Result and Discussions

The result of breeding indicates that the black coat is recessive to normal one, for none of 8 cubs of Buddy x Bhullu, Tara x Bhullu had the black coat. If the normal coat colour

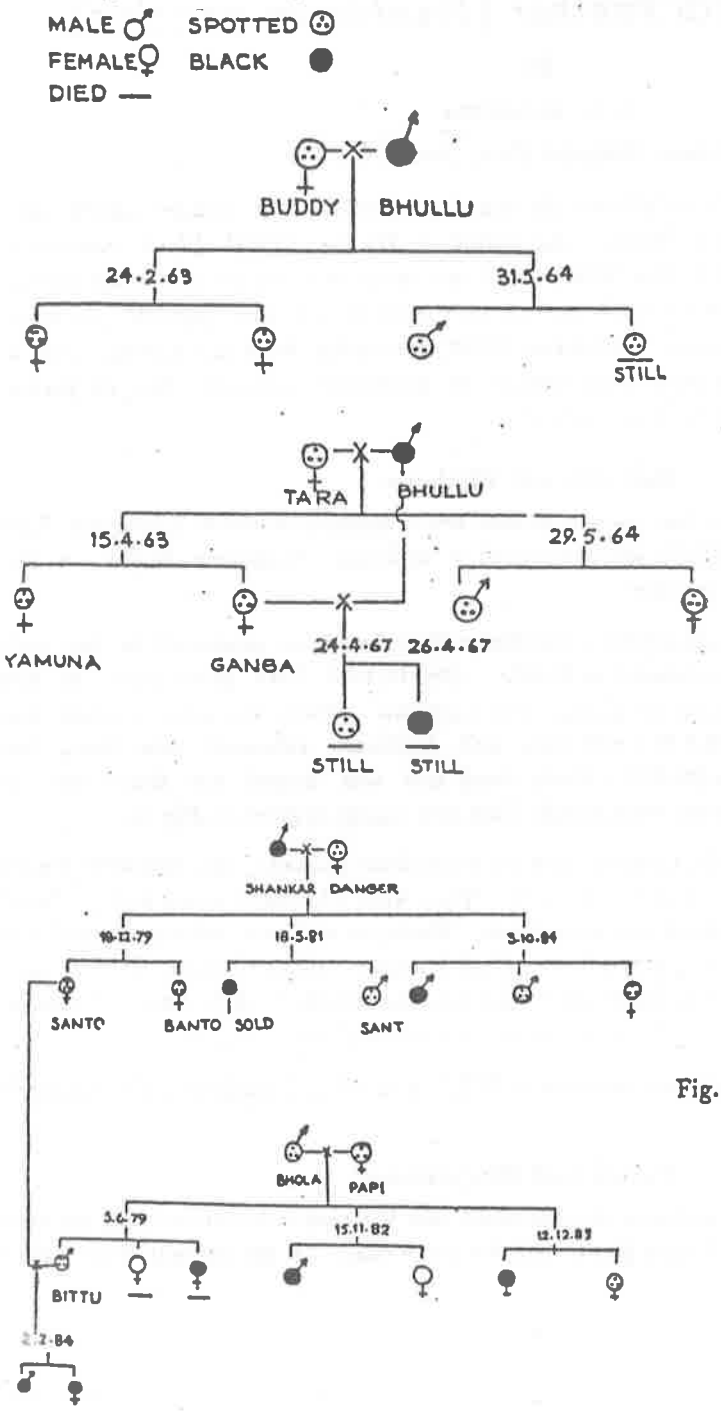

Fig. 1. Geneology of black panthers at National Zoological Park, New Delhi.

Fig. 2. Geneology of black panthers at M.C. Zoological Park, Chhatbir (Pb.)

Table 1

Results of matings of black panthers at N.Z.P. New Delhi and M.C. Zoological Park, Chhatbir

Matings	No. of litters	Spotted cubs	Black cubs	Total
N.Z.P.				
Between ♂ x bb x ♀ BB				
Bhullu x Buddy	2	4	—	4
Bhullu x Tara	2	4	—	4
Between ♂ bb x ♀ Bb				
Bhullu x Ganga	1	1	1	2
M.C.Z.P.				
Between ♂ bb x ♀ Bb				
Shankar x Danger (presumed)	3	5	2	7
Between ♂ Bb x ♀ Bb				
Bhola (presumed) x Papi (presumed)	3		3	7
Bittu x Santo	1	—	2	2

is controlled by a dominant allele B and the black colour by a recessive allele b, the normal coloured leopards are either homozygous (BB) or heterozygous (Bb), the genotypes of Bhullu, Buddy and Tara can, therefore, be written as bb, BB and BB respectively, all their offsprings being heterozygous. Danger is presumed to be heterozygous or else she could not have produced black and normal coloured cubs when she was mated to black panther. Ganga, a known heterozygous, when mated with black Bhullu produced black and spotted cubs at N.Z.P. (Fig. 1 and 2). Further the cross between Bittu and Santo, known heterozygous produced black cubs at M.C. Z.P.

References

Prater, S.H. 1965. The book of Indian animals (Bombay Natural History Society, Bombay).

Walker, E.P. 1964. The Mammals of the world. (Vol. II). Johns Hopkins Press, Baltimore.

Gee, E.P. 1964. The Wildlife of India. Collins, St. James Place, London.

Robinson, R. 1970. Genetica 41 (190).

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OBSERVATIONS ON THE REPRODUCTIVE BEHAVIOUR OF THE TIGER, *PANTHERA TIGRIS TIGRIS* LINN. IN CAPTIVITY[1]

ADHIR KUMAR DAS[2]

(*With a chart*)

INTRODUCTION

In view of the importance of tiger as one of the major endangered species in India a study of its reproductive behaviour is worth noting. This study was undertaken to provide information (i) on the reproductive behaviour of tiger, (ii) to ascertain the duration of oestrus, (iii) breeding season, (iv) gestation period, (v) percentage of pregnancies, (vi) litter size, (vii) sex ratio and (viii) the ratio of white and coloured cubs produced through crossing among coloured hybirds and between coloured hybrids and pure white tigers. This paper is based on data collected at the Calcutta Zoological Garden from 1965 to 1977.

MATERIALS AND METHODS

The Calcutta Zoological Garden has a good record of breeding of tigers in captivity. The first birth of tiger cubs at this Zoo took place in May, 1880 when three cubs were born. Two cubs were born in May, 1886 and two more cubs in April, 1889 (Sanyal 1892). Since then many tiger cubs have been born in this Zoo during the last several decades. Moreover, the acquisition of 3 white tigers (two pure white males from Maharaja of Rewa and one coloured female carrying gene for white, from Delhi Zoological Park) of the same litter in 1963 has improved much of its breeding potential. The tigers at Calcutta Zoo are kept in spacious enclosures and cages having sufficient space for exercise. Each cage or enclosure has a small den at the back where the tiger is shut in at night.

Tigers at Calcutta Zoo are fed six days in a week on beef and on Thursday no food is given. On average an adult tiger is given 12 kg of raw beef with and without bones daily. The ration of beef given to tigers ranges from 7 to 15 kg depending on the age, size, sex and general condition of the animals.

For the purpose of this study, data have been collected from my own observations from 1968 onward, supported by the records maintained at Calcutta Zoo in the form of daily report, birth and mortality registers etc. Mating behaviour of tigers have been recorded by me with assistance from some of my staff.

BREEDING SEASON

The tiger in India breeds all the year round and the cubs are born in any month of the year (Asdell 1946, Crandall 1964, Prater 1964, Schaller 1967, Ewer 1973).

At Calcutta Zoo the tigresses came in oestrus during all the months of the year. From 1965 to 1977, 48 oestruses or heat periods of seven tigresses had been recorded, and the females produced 61 cubs in 22 litters. This data is presented in Table 1.

[1] Accepted May 1978.

[2] Zoological Garden, Alipore, Calcutta-700 027.

TABLE 1
BREEDING SEASON OF TIGER, *Panthera tigris tigris* IN CAPTIVITY

Months	Number of oestrus	Percentage	Number of litters born	Percentage
January	5	10.4	1 (2)	4.5
February	5	10.4	—	—
March	7	14.5	3 (9)	13.6
April	4	8.3	3 (9)	13.6
May	3	6.4	4 (12)	18.1
June	5	10.4	3 (8)	13.6
July	4	8.3	3 (10)	13.6
August	3	6.4	—	—
September	2	4.1	3 (8)	13.6
October	5	10.4	1 (1)	4.5
November	2	4.1	1 (2)	4.5
December	3	6.4	—	—
	48	100	22 (61)	100

The figures in the bracket indicate number of cubs.

tioned behaviours of a tigress were recorded and when she permitted mounting and copulation by the male.

The data of oestrus periods as recorded in 7 tigresses in Calcutta Zoological Garden are shown in Table 2. The minimum interval between two consecutive oestruses was 26 days. Last oestrus phase was observed upto the age of 16 years in a tigress (Malini).

Sexual maturity:

Crandall (1964) reports that a tigress in New York Zoo reached maturity at 3 yrs. 8 months. Sankhala (1967) reports that tiger cubs attain maturity at an age between 3½ and 6 years. In captivity female lions become cyclic at 36 months of age (Crandall 1964). According to Stracey (1968) tigresses start

TABLE 2
BREEDING RECORDS OF TIGER, *Panthera tigris tigris* IN CALCUTTA ZOO

Specimens	Number of oestrus periods	Range of oestrus periods (days)	Average oestrus periods (days)	Average of last day of oestrus to birth (days) Gestation period.	Average number of cubs Litter
Malini	16	4—7	5.1	103	2 (7)
Chandni	14	3—7	5	104	3.2 (7)
Shashi	7	4—6	4.8	103	3.8 (5)
Sona	4	4—7	5.3	—	—
Rupa	3	6—9	7.3	—	—
Bharati	3	6—9	7.2	102	1.5 (2)
Moti	1	5	7	103	2 (5)
	48				

The figures in the bracket indicate number of litter.

Duration of oestrus:

The tigress in oestrus becomes restless and moves about very frequently and sometimes does not feed. Schaller (1967) reports that the tigress in oestrus squirts scent, sniffs, moans and roars in a low voice. The duration of oestrus was calculated on the basis of the total number of days for which the above mentioned behaviours were recorded and when she permitted mounting and copulation by the male.

to breed at the age of about three years. Tigresses in the wild reach sexual maturity at about four years of age, but in the abnormal conditions of captivity copulation has been observed as early as two and a half years (Mountfort 1973). Sexual maturity and birth of 1st litter in the case of six tigresses are shown in Table 3.

TABLE 3

OBSERVATION OF SEXUAL MATURITY OF TIGER, *Panthera tigris tigris*, AT CALCUTTA ZOO

Specimens	Date of birth	Date of first oestrus	Age at onset of oestrus	Date of birth of first litter	Age when first litter born
Malini	18.6.60	25. 2.65	4 yrs. 8 months	12. 6.65	4 yrs. 11 months
Chandni	12.6.65	2. 3.69	3 „ 8 „	14. 7.69	4 „ 1 „
Shashi	8.9.67	21. 7.72	4 „ 10 „	24.11.72	5 „ 2 „
Rupa	25.9.70	12. 3.75	4 „ 5 „	—	— —
Sona	25.9.70	22. 3.74	3 „ 11 „	—	— —
Bharati	10.6.66	10.10.70	3 „ 6 „	24. 1.71	4 „ 10 „

Mating behaviour:

Tigers and tigresses which are kept together, except at night, from very early age, breed freely in captivity but attempts to introduce new specimens to each other are not without risk of injury.

When a tigress comes in oestrus at Calcutta Zoo, a male tiger is put in the adjacent cage from where the two can see each other. At the advent of oestrus the tigress becomes restless, walks and sits frequently. While walking it moans and roars in low voice and squirts scent from its anal gland. She sits repeatedly in front of the wire-netted door of the adjacent cage where the male is confined. She sniffs at different places of the floor and wall and on seeing the male in the adjacent cage she produces a purring sound.

Courtship:

When the door of the adjacent cage is opened, the tigress hurriedly rushes into the adjacent cage and proceeds to the male very cautiously, sniffs the male producing puffing sound. If the male is in mood for mating he responds with a purring noise. If the male is not in a mood for mating a fight may occur and the couple have to be separated. It is seen that after fighting on the first day of oestrus, the male may accept the female the next day. When mutual confidence is established, the female approaches the male, purrs, rolls on her back on the ground in front of the male and pats at him playfully. The male sniffs the genitalia of the female, purrs and squirts scent frequently. He follows the female when she walks with lashing tail and starts playing with her. Mountfort (1973) states that the prelude to mating is accompanied by periods of play and harmless sparring which help to reduce the normal antagonism between sexes.

Copulation:

The tigress sometimes comes very close to the male and rubs her head, body and mouth to the head, body and mouth of the male. She sometimes lies on her belly stretching her forelimbs fully on the ground and her hind limbs remaining half bent. The male approaches from behind the female and arches his back, bringing his penis in contact with the genital region of the female. At this time the female begins to tread by pushing against the floor with her hind legs and when vaginal contact is made she bends her tail sharply to one side exposing her genital region and at the same time she turns her hind end in the direction of the stimulus. The male then holding the scruff of the neck of female by his teeth begins a series of vigorous pelvic thrusts at the female's

urinogenital sinus. Intromission of penis is signalled by a loud copulatory cry from the female and a tremendous roar is produced by the male as he presses his genital region tightly against that of female. Ejaculation occurs during this interval. The actual time of coition varies from 7 to 10 seconds. The female then pulls forward, turns abruptly on the male, hisses and paws him and throws him off her back. Sometimes fighting takes place between the sexes inflicting scratch wounds. There may be unsuccessful attempts at mounting prior to successful mating.

Post copulatory behaviours:

After each copulation the male moves away from the female and walks about in the enclosure or usually lies on the ground. Sometimes he passes stool and urine and in some cases drinks water. The female tigress after copulation rolls on the ground and sometimes goes to the water for bathing. It is seen that the female goes to water at 3 to 5 times a day during her heat period.

After a short interval, the female again approaches the male and the whole process of courtship and copulation is repeated. With repeated copulations, initiative and eagerness of mating are seen more in the female than the male. The tigress proceeds to the male, rubs her head, body with the male and makes purring sound and sits in front of the male in the mating posture inviting him to mount. The entire process of copulation lasts for 1 to 3 minutes.

In Calcutta Zoo tigers are allowed to mate from 7 a.m. to 10-30 a.m. in the morning and again at 2.30 p.m. to 5 p.m. in the afternoon, i.e. for 6 hours per day. The duration of mating period as observed during 48 heat periods was from 3 to 9 days and average heat period was 5—9 days. The range of mating was from 2 to 52 times per day and the averags per day was 22.2 times. The minimum interval between two consecutive matings was 1 minute and maximum was 90 minutes and the average interval was 7.1 minutes. The highest number

TABLE 4

OBSERVATION OF MATINGS OF TIGER, *Panthera tigris tigris* AT CALCUTTA ZOO

Matings between	Number of heat period	Duration of heat period (days)	Average heat period (days)	Range of matings per day (in 6 hrs)	Average matings per day in 6 hours	Average interval between two consecutive matings (in minutes)	Highest number of matings in a single heat period	Lowest number of matings in a single heat period
Malini × Neeladri	16	4—7	5.1	5—52	25.1	7.3	235	66
Chandni × Himadri	12	3—6	4.9	2—45	20.4	4.9	171	20
Chandni × Bhanu	2	4—7	5.5	4—44	23.9	5.3	174	89
Rupa × Barun*	2	7—9	8	3—25	17.1	12.9	152	122
Shashi × Rabi	7	4—6	5	7—49	25.8	6.9	167	27
Rupa × Arun*	1	6	6	12—26	19.5	6.9	117	—
Sona × Bhanu*	4	6—8	6.4	10—48	25.1	7.8	206	126
Bharati × Johny*	3	6—9	7.3	10—47	26	5.6	247	170
Moti × Bhanu	1	5	5	9—35	18.4	6.7	92	—

* Indicates the pair of tigers which lived together except at night.

of matings observed in a single heat period was 235 times and the lowest was 20 times (Table 4).

Gestation period:

The gestation period of tiger is given as 105 to 109 days by Asdell (1946). Crandall (1964) records the gestation period as 100 to 108 days. Stracey (1968) records the gestation period as 15 to 16 weeks. Schaller (1967) reports the gestation period of tiger as 95 to 107 days. Ewer (1973) shows the gestation period of Indian tiger as 95 to 109 days. It is difficult to compare the above data, as in most cases the date of conception is defined differently. Crandall (1964) shows the gestation period of a tigress from the last observed mating as 100 to 108 days.

The duration of gestation period in the present observation has been estimated as the period from last day of mating to birth and the mean period was 103 days and the maximum and minimum were 107 and 101 days respectively.

Percentage of pregnancies:

The tigress does not become pregnant after matings in each heat period. In Calcutta Zoo, 7 tigresses mated with the males in 48 heat periods from 1965 to 1977. Out of 48 mating or heat periods pregnancy occurred in 22 cases and did not occur in 26 cases. The percentage of pregnancy is therefore 45.8% only and non-pregnancy is 54.2%. (Table 5). It was observed that the number of heat periods and percentage of pregnancy were less when both sexes lived together except at night.

TABLE 5

RECORDS OF THE PERCENTAGE OF PREGNANCY AND NON-PREGNANCY OF TIGER, *Panthera tigris tigris*, IN CALCUTTA ZOO

Mating between (specimens)	Number of mating or heat period.	Number of pregnancy	Percentage	Number of non-pregnancy	Percentage
Malini × Neeladri	16	7	43.7	9	56.3
Chandni × Himadri	12	6	50	6	50
Chandni × Bhanu	2	1	50	1	50
Shashi × Rabi	7	5	71.4	2	28.6
Bharati × Johny*	3	2	66.6	1	33.4
Moti × Bhanu	1	1	100	—	—
Rupa × Arun*	1	—	—	1	100
Rupa × Barun*	2	—	—	2	100
Sona × Bhanu*	4	—	—	4	100
	48	22	—	26	—

* Indicates the pair of tigers which lived together except at night.

Litter size:

Asdell (1946) records that the size of the litters varies from one to six but usually two to three cubs are produced. Schaller (1967) shows that the size of the litters varies from 1 to 7. Ewer (1973) reports that range of litter size is from 1 to 4 but 2 to 3 cubs are usually produced. Schaller (1967) shows the average size of 79 litters of tiger cubs born in Zoos as 2.8.

Data of 22 litters of tiger cubs at Calcutta

Zoo indicate that one cub per litter was on three occasions, two on nine occasions, four on eight occasions, three on one occasion and five cubs were born on one occasion. Average number of cubs per litter was 2.6 and the range of cubs per litter was 1 to 5 (Table 6 and Genealogical chart of white tigers).

TABLE 6

LITTER SIZE AND SEX RATIO OF TIGER, *Panthera tigris tigris*, IN CALCUTTA ZOO

Specimens	Litter Size			Sex Ratio	
	Total number of litters	Number of cubs in litter	Average number of cubs in litter	Male	Female
Malini	7	1—4	2.0	8	6
Chandni	7	2—4	3.2	8	15
Shashi	5	2—5	3.8	7	12
Bharati	2	1—2	1.5	1	2
Moti	1	2	2	1	1
	22			25	36

Sex ratio:

Thirty two tiger cubs were born in eleven litters to one tigress from 1948 to 1959 at New York Zoological Park, the divisions of sexes being nineteen males and thirteen females (Crandall 1964). According to Schaller (1967) the sex ratio of 196 tiger cubs at birth in various Zoological Gardens was 100 males and 100 females. Acharjyo and Mohapatra (1977) reported that 18 tiger cubs were born from 1960 to 1975 in Nandan Kanan Biological Park, Orissa of which 6 were males and 12 were females with a sex ratio of 50 : 100.

In Calcutta Zoo five tigresses gave birth to 61 cubs from 1965 to 1977 in 22 litters, the divisions of sexes being 25 males and 36 females. The ratio of male and female cubs was 100 : 144 (Table 6).

Ratio of white and coloured cubs:

In Calcutta Zoo 56 cubs were born out of crossing between pure white tigers with coloured hybrids, among pure whites, among coloured hybrids and between pure white and pure coloured tigers. Fourteen cubs were born

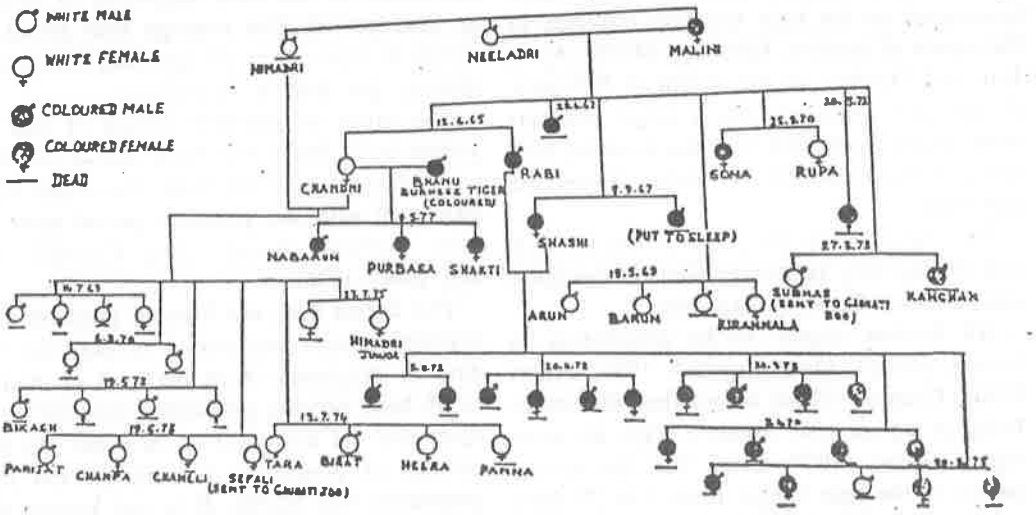

Chart. Genealogy of white tiger *Panthera tigris tigris*, at Calcutta zoo.

to Malini (coloured hybrid female) being crossed with Neeladri (pure white male). The ratio of white and coloured cubs was 7 : 7. Twenty cubs were born to Chandni (pure white female) being crossed with Himadri (pure white male). All cubs were white. But Chandni when crossed with Bhanu (pure coloured Burmese male tiger) produced 3 coloured cubs. Nineteen cubs were born to Shashi (coloured hybrid female) being crossed with Rabi (coloured hybrid male). The ratio of white and coloured cubs was 1 : 18 (Genealogical chart of white tiger).

Discussion and conclusion

Tigers mate throughout the year and cubs are produced during all seasons in captivity although there are peak periods of matings and births. High percentage of mating took place in the month of January, February, March, April, June and October and mating percentage is low in other months of the year. High percentage of birth occurred in March, April, May, June, July and September. These correspond to the high breeding activities in the month of January, February, March, April, June and October. In the month of February, August and December not a single cub was born. These correspond with low breeding activities in the month of November, September and May.

The variations in the peak period of birth and mating may be due to climatic condition and other conditions in captivity.

All Felidae appear to be polyoestrus in tropics (Asdell 1946, Crandall 1964, Prater 1964). Crandall (1964) shows that the receptivity of tigress lasts about 5 days on average. Sankhala (1967) states that the mating period of the tiger ranges from 3 to 23 days. Schaller (1967) reports the average length of receptivity of 14 oestrus periods as 7.1 days. At Calcutta Zoo the duration of 48 oestrus periods of 7 tigresses ranged from 3 to 9 days and the average length of oestrus was 5.9 days. The variations in oestrus periods may be due to age, physical condition and frequency of copulation. Last oestrus phase was observed in a tigress (Malini) upto the age of 16 yrs. This suggests that menopause starts in a tigress after 16 years. It needs further verification.

There is much individual variations in the age at which the tigresses become sexually mature. It appears that tigresses attain sexual maturity at ages between 3½ to 5 years. But no clear conclusion can be drawn from these small examples.

The compatible pair of tigers mate freely in captivity but there is a chance of serious injury in first meeting. It can be seen from the Table 4 that the range of mating period is greater in case of tigresses which live together with the males in captivity. It may be due to the fact that the females are with the males at the vary beginning of oestrus or heat period. The average heat period of tigress in captivity is 5.9 days and the average matings per day is 22.2 times.

The range of gestation period of four tigresses in 22 litters was from 101 to 107 days with an average of 103 days. These data compare well with the gestation period given by other authors (Asdell 1946, Crandall 1964 and Ewer 1973).

The tigress does not become pregnant after matings in each heat period in captivity. The data of pregnancy show that out of matings in 48 heat periods, pregnancy occurred in 22 cases and did not occur in 26 cases. The percentage of pregnancy was 45.8% and non-pregnancy was 54.2%. It is not known whether the age, physical condition, range of mat-

ing period and number of matings in each heat period of a tigress have any role in pregnancy.

Crandall (1964) reported that the average number at birth of tiger cubs at London Zoo in 17 litters was 2.3 per litter. In Calcutta Zoo, the range of tiger cubs per litter was from 1 to 5 with an average of 2.6 cubs per litter. Usually 2 or 4 cubs were born in Calcutta Zoo. It seems probable that condition of health, availability of food, and stress and strain in Zoo condition have some role in litter size of a tigress.

The sex ratio of tiger cubs at birth varies widely. The ratio of male and female cubs born in Calcutta Zoo from 1965 to 1977 was 100: 144.

Genealogical chart of white tigers shows that the ratio of white and coloured cubs produced in a crossing between pure white male with coloured hybrid female is 7 : 7. The pure white female when crossed with pure white male produces all white cubs and pure white female when crossed with pure coloured male produces all coloured cubs. All these data are in conformity with the laws of inheritance. The data of crossing between coloured hybrid female with coloured hybrid male are yet to be observed.

The tigers' adaptibility, wide range in choice of habitat and above all its remarkably short gestation period suggest that under favourable condition it can survive well.

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REFERENCES

ASDELL, S. A. (1946): Patterns of Mammalian Reproduction. Ithaca, New York, Comstock Publishing Co. Inc.

ACHARJYO, L. N. & MOHAPATRA, S. (1977): Sex ratio at birth in some captive wild mammals. *J. Bombay nat. Hist. Soc. 74*: 167-169.

CRANDALL, L. S. (1964): Management of Wild animals in Captivity. London & Chicago, The University of Chicago Press, The University of Toronto Press, Toronto-5, Canada.

EWER, R. F. (1973): The Carnivores. Weidenfeld & Nicolson, London W1.

MOUNTFORT, G. (1973): Tigers. David & Charles (Holdings) Ltd., South Devon House, Newton Abbot, Devon.

PRATER, S. H. (1964): The Book of Indian Animals. Bombay Natural History Society, Bombay.

SANYAL, R. B. (1892): A Hand Book of the Management of Animals in Captivity in Lower Bengal. Bengal Secretariat Press, Calcutta.

SCHALLER, G. B. (1967): The Deer and the Tiger. The University of Chicago Press, Chicago & London. The University of Toronto Press, Toronto-5, Canada.

SANKHALA, K. S. (1967): Breeding behaviour of Tiger in Rajasthan. *Int. Zoo Yb. 7*: 133-147.

STRACEY, P. D. (1968): Tigers. Arthur Barker Limited, 5, Winsley Street, London W1 & Golden Press, New York.

Jour. Beng. nat. Hist. Soc., 2 (1) N. S. pp 92—93, 1983

Longevity record of Indian tiger, *Panthera tigris tigris*, Linn. in captivity

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'Malini', a coloured tigress *(Panthera tigris tigris*, Linn. *)* of White Tiger family of Alipore Zoological Garden died on 18th September, 1980. The cause of death was senility. She was born on 18th June, 1960, at Govindagarh palace of Maharaja of Rewa as a result of cross between 'Mohan', the male white tiger, caught by Maharaja of Rewa and "Radha" a coloured tigress carrying gene for white (Roychoudhury & Sankhala, 1979). 'Malini' was acquired by the Delhi Zoological Park (National Zoological Park) from Maharaja of Rewa and was given to the Alipore Zoological Garden in 1963, on exchange basis. In Alipore Zoo, 'Malini' had been mated with "Neeladri" a white tiger of this Zoo and she produced 14 cubs in 7 litters. Out of 14 cubs, 7 were white and 7 were coloured and their sexes were 8 males and 6 females (Das, 1980).

"Malini" enjoyed a longevity of 20 years 3 months which is the highest longevity of tiger ever recorded in captivity. Crandall (1964) reported that a tigress (Bengal) at Staten Island Zoo, New York, died at the age of 19 years 7 months 23 days. Schaller (1967) reported that maximum longevity of tigers under Zoo conditions is about 20 years, an age which is probably not exceeded in the wild.

References

Crandall, L. S., (1964). *Management of wild animals in captivity*, The University of Chicago Press, Chicago and London, University of Torento Press, Toronto-5, Canada.

Das, A. K., (1980), Observations on the reproductive behaviour of the Tiger, *Panthera tigris tigris*, Linn. In captivity, *J. Bombay nat. Hist. Soc. Vol. 77. No. pp. 253—260.*

Roy Choudhury, A. K. & Sankhala, K. S., (1979), Inbreeding in White Tiger, *Proc. Indian Acad. Sci. Vol. 88B. Part—I No. 5. pp.311—323.*

Schaller, G. B., (1967), *The Deer and the Tiger*, the University of Chicago Press, Chicago & London, The University of Torento Press, Torento-5, Canada.

HYBRIDIZED CAT

TIGON : AN INTERESTING HYBRID CAT

SUBIR KUMAR CHAUDHURI & SWAPAN KUMAR DAS

ALIPORE Zoological Garden of Calcutta has achieved certain remarkable success in breeding quite a few animals, Particular mention may be made about the sanghai or brow-antlered deer (*cervus eldi eldi*) of Manipur which is considered to be one of the rarest deer speci^{e}s of the world. Approximately 50 individuals of this species are reported to exist in Keibul Lamjo National Park of Manipur and another 96 sanghai deer thrive in the enclosures of different Indian zoos as per the census of 1985 (in Majupuria, 1986). It's true that breeding of sanghai satisfies one of the maior involvements of the zoological gardens and parks in conserving rare wild animals and protect them from being listed in the Re d Data Book.

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But the tigon. a hybrid produced from the inter-breeding of a tiger and a lioness is more interesting for the visitors in a zoo. Indeed, a large crowd gathers every-day in front of Burdwan House where two tigon females entertain them. Presently, their attraction is divided. Another hybrid, almost lion-like litigon, adds a new attraction.

Naming

Even a school-student knows that a plant or an animal has a biological name. This Latin name is accepted all over the world. The scientific name of a tiger is *Panthera tigris* and that of a lion is *Panthera leo*. What should be the name of a tigon ? Again why should we call it a tigon and not a liger ?

The confusion should be cleared. Interspecific hybrids cannot be named scientifically. Because when we give a biological name to an organism, its independent biological status is emphasized. A tiger, for example. is not merely distinct from a lion in name but in many other features. These two large cats have many contrasting attributes that appear significant even to a layman.

As a matter of convention. the interspecific hybrids are names by amulgamating the names of two parental species. This practice has been adopted in naming the hybrid as tigon. But why not "liger" ?

There goes the second conventional practice. The name of the male-parent used in the cross is placed before the name of the female parent. In Alipore Zoological Garden hybrids were made by crossing a male tiger with a lioness. Clinging to the convention. the name 'tigon' is chosen.

Tigon—its long history

The first authenticated record of tigons dates

back to the early part of the nineteenth century from a circus which toured Britain. Queen Victoria saw the circus at Windsor Castle, and the latest litter of tigon-cubs produced by the captive tiger and a lioness were shown to her. Carl Hagenbeck of Germany bred many tigers with lions in his lifetime which produced tigons as well as ligers.

Hybridization experiments with tigers and lions in zoo conditions started in thirties'. In 1932, Dresden Zoo was successful in yielding a pair of tigons. Records are also available regarding tigon births in Vincennes Zoological Park, Paris.

In the Alipore Zoological Garden tigon production has been attempted since 1964. The pair used for the purpose of hybridization was a Bengal tiger 'Munna' and a African lioness 'Munni' of about the same age (a little over one year). The tiger was purchased from the local Calcutta market. The lioness was garden born. As expected, Munna did not show a compromising and friendly attitude to Munni at the initial stage but within a few days, they developed a mutual relation and were found to fight each other for any supremacy on rare occasions. Till 1972, that pair produced six litters. The first two pregnancies yielded two premature youngs that might be considered as miscarriages. The next two litters consisted of cubs with various malformations and died immediately after birth. Long eight years of experimentation thus produced no success.

In 1971, Munni conceived again. This fifth conception culminated in the birth of two cubs on the eleventh February, 1972 a still born cub and the other with deformed hind legs. The crippled cub was not fed and attended by Munni. The only maternal instinct that was manifest in that lioness was to protect the cub from any apprehended danger.

In the same year, on the 13th October, 1972, Munni gave the birth of a single female cub. She was named 'Rudrani'. She was exceptionally healthy from her birth and was fortunate in receiving mother's care including breast suck. She is still living and she has been mated with an Indian lion 'Debabrata' to produce litigons. Two years later, on the 8th March, 1974, a solitary female tigon cub was born to the experimental pair. She was named 'Rangini'.

Problems of hybridization

Hybridization in domestic and captive animals is an interesting endeavour to breeders. Certain hybrids such as mules are also important economically. Raising hybrids with zoo animals has two principal aspects; the thrilling experience of hybridization itself, and secondly the hybrids are of special exhibit value. From consideration of public attraction, tigon and liger are much valued.

Tigon is intermediate between its parental species – tigon and lion in many respects. Through examinations of tigon-cubs from new-born stage to the attainment of adulthood revealed their closer resemblance to tiger, at least in morphology. They had a deep fawn pelt like a lion with broken brown stripes like tiger. Shape and colour of ears are, however, more lion-like yet having markings of a tiger. the shape of belly and waist also appear tiger like. The under-side is white like tiger. In temperament, tigons follow their tiger-parent but roar like lion.

Hybrids are, in general, weak and less adaptable. In nature such interspecific mating is prevented by structural, ecological and behavioural barriers. In fact, no authenticated records are available regarding the existence of a cat-hybrid. The chance of interbreeding of tiger and lion is especially very remote since the distribution range of these two large cats are separate and non-overlapping. Moreover, ecological and ethological patterns of these two species are not very identical. Tiger is found nowhere outside Asia while lion is predominantly African, excepting a few pockets in India.

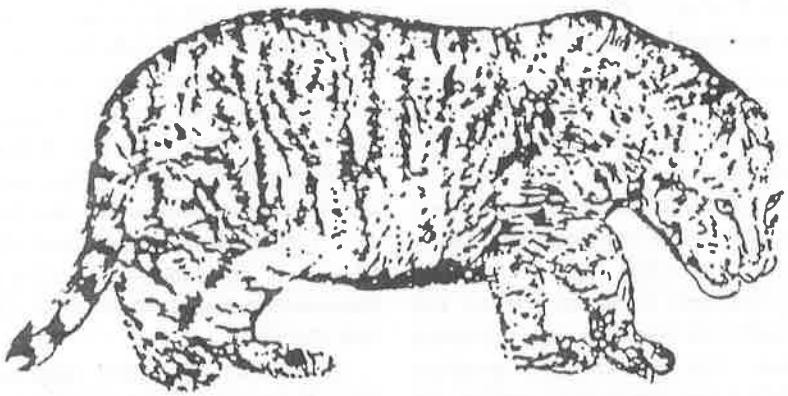
Whether the cat-hybrids are able to thrive in nature is a subject of speculation. No such problem is expected to arise in the maintenance of those hybrids in zoo conditions. Hybrids are generally abandoned just after giving birth by their mother. The second major hazard of such hybridization is the birth of cubs with several physical malformations. Sometimes they are so much handicapped and delicate in internal consti-

tution that it becomes a herculian task to rear them.

One reason appears to be significant and explanatory for such an aberrant maternity. It is found that baby-animals have an odour characteristic for a species. Researches indicate that this olfactory signal may even be specific for a family. Mother recognises her cubs primarily by the chemical nature of the scent which is important to evoke her maternal instinct.

A curious experiment has been conducted by the keepers of the Moscow Zoo. They offered a batch of baby chicks to a female cat who has just given birth of a litter. Kittens were washed with warm water and the washings were sprayed on the baby birds. As a consequence. those chicks smelled like kittens. Although that smell escaped the notice of the zoo keepers, the very smell was reconised and appreciated by the cat-mother. She instantly started lapping chicks and acted like their foster-mother as if she had adopted a batch of feathery orphans.

Since the hereditary make-up of two species of animals essentially different. it is not illogical to think that the chemistry of odorous substance should be different for tiger and lion. Differences in morphology, ecology or behaviours are interpreted in terms of distinctive gene-systems. The question arises what should be the odour of a tigon cub ? Like tiger or like lion ? Considering an admixture of genes of the two species in the hybird, it may be presumed that a tigon would bear an intermediate body odour. This might render some clue towards the development of non-motherly attitude of Munni to her strange offspring.



Genetics of hybridization

As a hybrid, tigon has a gene-system intermediate between that of tiger and lion. Out of the total number of genes it possesses, half is expected to be inherited from tiger and the remainder half from the lion parent. The intermediate quality of a tigon in morphology and behaviour is thus noticeable as the function of the 'mixed' gene-system.

Early in the present century, in 1913, T.H. Morgan established the "gene-theory" accounting the integral relation of the mechanism of heredity to cells the structural units of the body. As the body of common animals are multicellular comprising many million cells. multiplication of cells is

inevitable. When a cell divides, paired thread-like structures, called the chromosomes, are visible under microscopic examinations. Genes are lodged on chromosomes.

Higher animals always have an even number of chromosomes, because two sets of chromosomes are present in each kind of body cells. Of these two sets, one set is paternal and the other is maternal. During reproduction sex-cells or gamates—sperm and eggs are produced in sex organs through special kind of cell division which is reductional. Therefore, chromosome number of a sperm or an egg of an animal will be half the number of chromosomes present in the body-cells. For example in man, total chromosome number is 46 and in a gamate, it is 23.

Fusion of sex-cell (called fertilization) indicates the starting point of embryonic development. The resultant cell or the zygote now restors the full chromosome number comprising two sets a paternal coming from the sperm and a maternal from the egg-cell. The zygotic-cell now multiplies very quickly and increases in size at an enormous pace. It then gradually differentiates into a foetus after anchoring on the wall of uterus in a mammalian mother. The mother at that time manifests symptoms of pregnancy which is culminated at the delivery of a baby in due course. The length of pregnancy, i, e., gestation period is variable in different mammals but it is species-specific.

As a hybrid, tigon is expected to overcome several obstacles characterizing the "biological barriers" preventing interspecific mating. Some of these barriers operate at the initial stage, and an array of others follow during embryogenesis. The important ones may be summarized as follows :

(1) Behavioural barriers accounting for asynchrony in the mating behaviour of tiger and lion, at least in the minor details.

(2) Mechanical barriers preventing successful mating to ensure sperm transfer into the genital tract of the female of a different species.

(3) Zygote-mortality : It is observed in a number of hybridizing experiment but not in cats. Zygotes, although formed, cannot implant itself on the uterine wall and therefore dies instantly.

(4) Deformity and hybrid mortality : Both physical deformity as well as prenatal and perinatal death are recorded in five consecutive litters of Munni.

(5) Hybrid sterility : Available records indicate that male hybrids are invariably sterile. Curiously enough, the female-offspring of such interspecific mating is fertile. This contention could not be verified because both the viable offsprings of Munni were females.

Impairment in the development starting from fertilization is presumed to arise from the incompatibility of the tiger and lion genes. In tigon body-cells, both kinds of chromosomes and genes are present. Since the two gene-systems appear to be completely different and distinctive as indicated by the distinctness of the two big cats, they behaved differently during the process of cell-division. A normal chromosomal behaviour is very essential and obligatory to produce viable gamates. Eclipsed virility of a male hybrid trends to support this idea.

The question remains unanswered—why a female tigon is fertile ? When this female hybrid is mated with either of the parental species, she gives birth of a second generation of hybrids successfully. In Alipore Zoo Garden, 'Rudrani' has given birth of several litters of litigons.

In mammals, the sex-chromosome pair is XX females, and XY in males The Y-chromosome is smaller than the X-chromosome. Also it contains a fewer number of genes in comparison to the X. It is established that the XX-zygote developing into a female-baby is much more strong and viable than XY-zygote. An identical situation is observed in other mammals. Conception in female mule is not absurd although rare, one out of one thousand.

Conclusion

Present day scientists are not in a way to encourage hybridization. Rather they expect more active participation of zoos in conserving the wild

species. The question is raised with all seriousness —what is the fate of these hybrids ? Obviously there is no straightforward answer or argument that can be put in favour of hybridization. But what conclusion we can draw from such hybridizing experiment which has already exhausted the breeding potentialities of such fascinating big cats ? Perhaps. the only logical inference is that tiger and lion represent two true species. The only solution at hand is to find a possibility of breeding tigons with any of the parental species. Precisely, this is done in the Alipore Zoo. Rudrani is mated with the Indian lion. Since ligitons are products of cross between the tigon and a lion, they are expected to have one half tigon genes and one half lion genes. Again, tigon genes comprise one half tiger and one half lion genes. Therefore, in a litigon, the lion's gene-share comes to $\frac{3}{4}$th ($\frac{1}{2}+\frac{1}{4}$). Thus, after a few generations, tiger's contribution may be expected to be overweighed by lion's contribution.

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SNOW LEOPARDS IN INDIAN SUBCONTINENT

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The snow leopard or ounce is one of the rarest cats in the world. Once considered a member of the genus *Panthera*, the animal is now placed in its own single species genus, *Uncia uncia* (Wilson and Reeder 1993). This genetic uniqueness makes the animal very important. Not to speak of common Indian, even the wildlife lovers are not aware of the existence of snow leopard in India. The wildlife biologist in this country mainly concentrate on the tiger, the lion, the elephant, the rhinoceros or other big animals, with whom the man has been interacting since ages.

In the Himalavàs, the animal is found above timberline in dry, rocky, alpine steppe (Jackson and Ahlborn 1984). Locally the animal is known as Ikar, zig, sachak (Tibetan Bhutia), Barhal he (Himachali) Barhel haye (Kumaon), (ZSI 1994, Prater 1988). There is no reliable information on their population. But they are considered rare in every country they are present. Various estimates show that there should be 4500-7500 wild snow leopards distributed in an area of 1,835,000 sq. km throughout the world (Fox 1992). There may even be as few as 1500 individuals (Freeman et al. 1992). At present it is found in and around Tibetan Plateau and Taklimakan desert in the Himalayas, Krarakoram, Hindu Kush, Pamir, Kunlun, Tien Shan, and Altay mountain ranges (Fox 1992).

In India the animal inhabits the Himalayas from Jammu & Kashmir to Arunachal Pradesh between the treeline and snow, but sometimes seen in woodlands. In summer, the animal is found at altitudes between 3000 and 4000 m, and during winter descends to 1500m (Roberts 1977 and Schaller 1977). There may be around 400 animals in Ladakh 100 more in other areas in the country (Freeman et al. 1992).

Diretor, PNHZ Park, Darjeeling.

At present, in India, the animal is found in the following notified conservation areas (Green 1992) :

Name of area	IUCN Management Category	Area (ha)	Year notified
Arunachal Pradesh			
Namdhapa National Park	II	198,524	1983
Himachal Pradesh			
Manali Sanctuary	IV	3,127	1954
Pin Valley National Park	II	80,736	1987
Rupi Bhabha Sanctuary	IV	85,414	1982
Jammu & Kashmir			
Dachigam National Park	II	14,100	1981
Hemis National Park	II	410,000	1981
Kishtwar National Park	II	42,500	1981
Kanji Sanctuary	IV	25,000	1988
Sikkim			
Khangchendzonga National Park	II	84,950	1977
Uttar Pradesh			
Govind National Park	II	47,208	1991
Govind Pashu Vihar Sanctuary	IV	48,104	1954
Kedarnath Sanctuary	IV	97,524	1972
Nanda Devi National Park	I	63,033	1982
Valley of Flowers National Park	II	8,950	1982

The other countries, where the animal is found, have also initiated actions by declaring a number of reserves, The population of the animal seems to be increasing due to these efforts.

THREATS TO SNOW LEOPARDS

The decrease in the wild population of the snow leopard 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.

There is continuous territorial invasion in the snow leopard habitat due to increasing human population and advent of better communication system. The increasing number of domestic live stock in and around their habitat forces the snow leopards to switch over to occasional cattle lifting in harsh winter conditions. Consequently, public attitude towards the snow leopard is not sympathetic. They often consider him a pest. In a particular study

63% of the people strongly and 32% slightly disliked them (Oli 1992). These people would kill any snow leopard, they come across. This killing not only helps them to get rid of their enemy, but also brings them additional revenue from the pelts and bones.

In spite of the fact that most countries are parties to the ban on trade in endangered species, a full-length coat made from 6-10 skins, would cost not less than Rupees two million in international market (Freeman et al. 1992). Even a few hundreds are sufficient to the local poachers.

With the shortage of supply of the tiger bones for medicinal use, the demand of similar species, mainly the leopard and snow leopard have increased.

Tourism is another problem in the habitat. Ladakh was opened to tourism in 1974, and from the few hundred people that arrived that year, the number has risen to over 15,000 in 1988 (Fox and Nurbu 1990). The trekkers would cause increase in the demand of transport, food and firewood. In addition these trekkers would bring with them abiotic substances, which they would not dispose properly.

Due to strategic reason, most of the area in the snow leopard habitat is accessible to the army authorities, most of whom are still not aware of the wildlife laws of the country. They sometimes kill the animal and often capture the cubs for rearing. Due to inaccessibility of the area, such poaching often remains unnoticed. Mostly, these cubs die due to improper care. If they somehow survive, the cost becomes prohibiting when the animals grow. In addition, after their transfer to mainland, these army personnel get scared, when they come to know the consequences to the violation of the rules and regulations. They then, try their best to dispose of the animals. The zoo community, in spite of its conservation objeciives, has not forgotten the commercial aspects. It pounces upon to acquire the animals irrespective of the fact whether suitable facilities are available with them or not. This can be substantiated by the fact that Darjeeling Zoo, the only captive breeding facility in the country, has never received a single wild snow leopard captured in India.

In addition, the result of the study of distribution and transportation of the persistent chemicals in the environment, showed that absorption of persistent chemicals such as DDT and HCH, in lichens, in the Himalayan region are among the highest in the world. India is the possible source for organochlorine insecticides because the highest concentrations of HCHs and DDT were found around New Delhi (Hoi et al. 1992). The presence of these chemicals in feline species in the wild have not been confirmed but their—harmful effects in many of the species cannot be ruled out.

CAPTIVE MANAGEMENT

The history of present day captive management of the snow leopard begins with the procurement of an unsexed specimen by the London Zoo from Bhutan in 1891 (Godman 1891, Sclater 1896). In 1894, the Zoo acquired a male (Flower 1894). By the year 1903, New York, Berlin, Moscow and London had this animal on exhibit (Peel 1903, Anon. 1903). Although the captive breeding was recorded in 1906, 1912 and 1938 yet the first real success was not recorded until Copenhagen born cubs could become the breeder themselves (Wharton et al. 1992).

Now the animals in captivity are over 500 (Blomqvist 1992). Some zoos have done outstanding work in this field. At presnt, the Helsinki Zoo and the Bronx Zoo have recorded 70 and 69 births respectively (Wharton et al. 1992).

In India, first reference to captive management is found in a book, published in the nineteenth century. It is reported that while no snow leopard had ever been obtained for exhibition in Calcutta Zoological Garden, a specimen brought down from Almora for transhipment to Zoological Society's Garden, London died from *heat apoplexy* within a week (Sanyal 1892). First animal, ever housed in any Indian zoo, was a male Moti, acquired by Delhi Zoo in1967. In 1970 another animal, a female, was received by the zoo.

First systematic captive management of this cat in India begins with the gift of a pair of snow leopards—Visna and Kashi to Darjeeling Zoo from Helsinki in the year 1986. The female always gave birth to still born cubs and ultimately died in 1990 during delivery due to rupture of the uterus. In view of breeding failure, a proven breeding pair. Hank and Percia was gifted to Darjeeling Zoo in the year 1989. Within a few month of their arrival, the pair did produce a litter. This was the first ever breeding in the country. One cub died of fecolith within four months while the other survived for more than two years and ultimately died due to shock resulted from the rupture of the urinary bladder. In the meantime, the mother also died of hepatitis. By the end of the year 1991, the zoo did not have any female. In the beginning of 1992, a gift of male and two females was received.

These three animals, Quizil, Quetta and Quila were of the sama litter. Therefore, after attaining maturity, both females were paired with Hank. Visna did not accept any female other than Kashi. In the past, he objected the presence of Percia. Now he refused pairing with Quetta or Quila.

In the year 1993, breeding was recorded for the second time, when Quetta gave birth to three cubs. One of the cubs, totally rejected by the mother, died within minutes of the birth. The other two were looked after by the mother for a month. But one day, when the staff was around, they saw the cub died when the mother accidentally sat over it. The post mortem findings, however, revealed that the worm infestation was the primary factor. There

was no sign of internal haemorrhage. Probably, the ailing cub could not tolerate even the minor thrust and died. The third cub, Rambha a female, has now reached the breeding age.

In 1993 the old male Visna died of senelity.

Later on the other female, Quila, also gave birth, but the cubs could not be saved. The mother did not look after the cubs, who were then removed for hand rearing. The cubs died the next day. After the next mating the female again gave birth. This time she looked after the cubs. One cub died due to unknown reason. The other died after five months due to enteritis.

In 1995 Quetta again gave birth to a triplet. This time she looked after all the three cubs. The cubs grew healthy. But after six months, one of the cubs died due to shock resulted from multiple fracture caused by trauma.

Now, we have in captivity 2:3 adults and 1:1 cubs of snow leopard.

HABIT

The ounce, a noctunral animal, rests by the day, getting up at intervals to make an assessment of the situation. The animal is most active by dawn. In captivity, the animal is forced to take rest during night. He is lathargic during rainy season and becomes most active at the onset of winter. He becomes restless in summer. He pants when it becomes very hot.

Snow leopards mainly prey upon bharal (blue sheep), goral, Himalayan tahr, musk deer, takin, serow, snow cock, ibex, markhor, wild boar, gazelle, rodents, chukor etc. (Dhungel) 1992, Dang 1967. ZSI 1994, IUCN 1972, Anon. 1972, Panwar and Gopal 1984, Fox and Nurbu 1967.

Unlike common leopard, the snow leopard begins its prey from the posterior portion of the body, opening the belly first (Dhungel 1992). The average diet of an adult snow leopard in the wild is 1.5-2.5 Kg meat per day. From a study of food habits in Ladakh it was found that the snow leopard consumed plant material as high as 41% of ist total intake (Chundawat and Rawat 1992). Small animals also form substantial portion of the diet (Zhirjakov 1990).

People say that the Snow leopard saliva is poisonous. Usually wolve, foxes and birds do not touch the remains of the prey killed by the snow leopard (Tserendeleg 1992).

In captivity the North American zoos feed a commercial "feline diet", usually consisting of ground meat (beef of horse), five days per week. This is supplemented with 1.5 kg chicken backs plus large beef khuckles bones for two day per week. In Darjeeling, the animals are fed 3-4 kg mutton for six days per week. This amount includes bones also. The major portion consists of the hind limbs excluding hoofs. Ribs are removed if present. Skin is also provided for roughage. The animals take less food during rains and more food in winter.

No food is supplied on Thursday. The amount varies with the capacity of the animal. Initially they were fed with beef, chiken and mutton simultaneously, when Visna and Kashi refused to accept anything on their arrival in Darjeeling. They were found to prefer chicken followed by mutton. Later on beef was discontinued because it caused indigestion. The chicken was also discontinued because its small bones could cause injury or even death of the animal. Moreover, it was costly also. Chicken has been again started but given only occasionally, especially when the animals are sick.

In the wild, the animals depend on the vegetative matters also. No consideration has been made on this point. Yet the vitamin and mineral supplement should take care of this. Although, it is difficult to make out the nutrient requirements of wild animals in view of insuffi cient data, the Helsinki Zoo's early diet, in their highly successful breeding programme, consisted of vitamins A and D to horsemeat chunks (Wharton 1992). In Darjeeling, all essential vitamines and minerals are provided with a special emphasis to Vit A, Vit D3, and Vit E with calcium supplement. This remains to be seen if the excess of fat soluble vitamins can cause liver problem.

In relating to prophylactic measure in respect of few viral diseases, vaccination are being given on routine basis like feline panleucopaenia and feline infectious rhinotracheatis.

The snow leopard is a territorial animal. It marks the boundaries with its urine. It is however, tolerant to the presence of other snow leopards near waterholes or springs. But they would not like to share the prey at all.

In nature, the breeding season of this cat generally begins in the winter. The gestation period is 90-120 days. Two to five cubs are born between June and July. It is believed that young are aften lost to accidents such as fall from rocks and getting lost from den when other animals kill them in absence of the mother (Tserendeleg 1992).

In the wild, the snow leopard covers a large area because of scarcity of the prey animals. Therefore, the animal must be housed in a big cage. In North America, outdoor cages range in size from about 25 m^2 to 190 m^2 whereas indoor cages are usually smaller, ranging from about 6 m^2 to nearly 50 m^2 (Rosenthal and Joslin 1988, Rieger 1978). The rule is 'bigger the better' In comparison, we have in Darjeeling 250 m^2 outer cage and 5 m^2 indoor cage. The height is 4 m.

The cages are covered with G.I. wire mesh from all sides. The rock work. and logs are provided to enrich the area. The elevated areas are used by the animals for resting while the logs are must for scratching. Initially the enclosure was full of trees, but a large portion of the enclosure was cleared to provide running space to the animal.

The enclosure must be kept clean to maintain hygienic conditions. Darjeeling is a high rainfall area. The indoor cages are dried with fans and kerosine blow lamps. The sound of the lamp sometimes scares a few animals (Bahuguna 1993).

The inside concrete cage floors are covered with wooden planks. At times, it becomes quite hot and the animals retire to the den. In the indoor enclosure fan has also been provided for this purpose. The fan is used for about one month in summer. The fan does not throw direct air on the animal and is more useful to remove the foul smell in the cage.

While the big cages are better from the animal point of view, these create management problem also. At times the animals have to be captured for treatment or otherwise. The animals are tranquilized with the combination of xylazine hydrochloride. and ketamine hydrochlorides Telazol (Telatamine HCL and Zolazepam) has also been found quite effective and safe.

In North America, they make bigger cages for breeding and keep nest boxes which are wooden boxes. In Darjeeling, initially a nest box was made. Kashi used it but she gave birth to stillborn cubs. The size was considered small. Modified nest box did not producce better result. Ultimately the indoor cages were used as breeding dens. With this first succss was obtained.

When birth is expected, these cages are covered with wooden planks from all sides. Only a peeping hele is kept to observe the animal. The cage is kept as dark as possible. To watch the activities in the cage, the staff uses torchlight. The disturbance is reducd to minimum. The adjoining cage is kept empty. Privacy is the most important thing in breeding of the animal.

The snow leopards are very good climbers and leapers, the cages must be covered from all sides and the tops. In Darjeeling one tree stands higher than the enlosure. Wire mesh is tightly secured with angle strips around the tree, so that the animal does not escape out of the enclosure. The mesh is painted with dark green colour to make visibility better and naturalistic. A second layer of mesh is also added to keep the visitors away from the animals. Visitors are not allowed entry inside near the indoor cages. However, in some cases scme important visitors were allowed entry. This has resulted in injuries either due to teasing by the visitors or because the animal wanted to play.

The animals respond to call of the zoo keepers. If in playful mood, the snow leopard returns the call, shakes its tail, sits in pouncing position. He also pushes the ears forward. If he is not in mood, then he will simply return the call and move the tail. But if he is angry, he will pull back ears. The response is more with more aquatinted persons or children. Near the net, he generally allows body touch also.

The Snow Leopard Breeding Centre in Darjeeling, has lots of trees all around. While it gives a natural look to the surroundings, it also casts a lot of shade to the cages. Sunlight is scarce in Darjeeling. Therefore, the animals like to bask in the sun, whenever available. To provide sunshine in the area, a few trees were felled. But this also resulted in an increase in sound pollution.

Although the animal is solitary in nature, the snow leopards in Darjeeling are kept in pairs, separated at the time of feed only. When, introduced the animals are first kept in the indoor enclosures at safe distance, only to allow them visual contact. After a week or so they are brought in the adjoining enclosures, where they can tourch each other if needed. However, in case of fight, they are separated by the staff. If they are observed liking each other. only then they are opened in the same enlosure.

Several institutes with highly successful breeding programmes do not keep the males and females together continuously (Turner 1980, Koivisto et al. 1977, Kitchener et al. 1975). In Darjeeling Zoo, Hank is being paired alternately with Quila and Quetta. But Quizil in paired with Rambha continuously.

Here, the females come to heat 2-3 times a year. The mating com continue for 3-9 days. The response to the food is poor during mating. After a month the females starts taking more rest. The bulge is noticed only after two months. Before this, it is difficult to make out if the female has conceived or not. A pregnant female would not come to estrus. After the second month of pregnancy, she would not allow, even the male to come near her. Rambha did not come to estrus even after four months, though she was not pregant. The amount of rest increases substantially in the third month. Kashi, however, was as playful as ever She was even kept shut in the indoor cage to keep check on her activities. This also did not yield results. In the advanced stage, sometimes, flicker is also noticed.

After the birth takes place, the female licks the cubs thoroughly until they get dried, sometimes for more than an hour. She would, generally not touch the dead cubs. Kashi once licked even her dead cubs also. She would, then, curl her body and tail to wrap the body of the cubs, who are then lost out of sight. At that time it is not possible to notice whether she is feeding the cubs or not.

The female assigns top priority to nursing. She does not bother for food if the cubs feel uncomfortable. Once Quetta did not take food for five days after delivery. Percia used to return back without taking food, to lick and groom, whenever the cubs cried. She opted for food only when the cubs were fast asleep.

After 45-60 days the cubs would join the mother for feed. Percia would give a piece of mutton to her cubs to keep them busy and then finish her meal freely. Quetta allowed her cubs to join for the bite. The present lot Karan and Urvashi could consume big pieces also. However, a small portion of boneless minced meat is also supplied to the cubs, when they start joining the mother for food.

Problems with captive ounces

1. The uniqueness of the animal also creates problems due to lack of expertise. The animal is not housed elsewhere in the Indian sub-continent and the western experience is not applicable in Indian conditions.

2. The snow leopards are infested with Ascarids. In spite of all medication and care, it could not be possible to eradicate the disease.

3. In view of small number of animals, there are chances of in breeding in future. However, efforts are being made to acquire new unrelated animals from abroad.

4. Water crisis is one of the biggest problems in Darjeeling. This at times creates problem in cleaning and disinfecting the enclosures.

5. Animals get the same food daily with same routine. This causes problem in bringing up the animal naturally. In the wild, the animals have to exert to acquire food. This instinct may be lost with generation and may be difficult to recover. Easy food, without a chance to run and jump, gives the animals no chance to get exercise. Muscles of captive snow leopards are, therefore, usually atrophied, mycdynamia is reduced, and signs such as anorexia and dysphoria sometimes occurred in affected snow leopards (Xinchum 1992). However, this problem has never been encountered in Darjeeling.

6. Long-term and chronic effects of noxious stresses such as the hot environment, low elevation, noisc pollution and artificial light can injure the non-specific immunologic functions of captive snow leopards, producing chronic stress diseases (Xinchun 1992).

Conserving snow leopard

The animal is now included in Schedule I of the Wildlife (Protection) Act, 1972 and appendix I of CITES. Out of 98000 sq. km habitat, only 18627 sq. km is covered under National Parks and Sanctuaries in Jammu & Kashmir (8521 sq. km), Himachal Pradesh (3429 sq. km), Uttar Pradesh (3238 sq. km), Sikkim (850 sq. km) and Arunachal Pradesh (2589 sq. km) (Chundawat et al. 1986).

A complete ban on the export of the snow leopard pelt was enforced in 1979. Now only captive bred animals are allowed to be transported that also with the permission of CITES authorities after the approval of Indian Government.

At present there is no concrete information on the status of the animal. Before taking up any conservation measures, it is most essential to collect data, to gather information on population dynamics, and to know about the habit and habitat of the animal.

The local people in and around the habitat are mostly illiterate and not inclined to take up conservation measures. Present methods of awareness only create an inferiority complex which leads to stubbornness against positive measures, A system on the present model of participatory management, will make them feel themselves the owner of the animals. At the same time arrangements be made to uplift their economic conditions, since hungry stomach rccognises no law.

The other method is the use of religious sentiments. If our ancestors could make arrangement to provide protection to some plants and animals for thousands of years, why can't we for few years.

Tourism if properly developed and regulated, is beneficial to conservation. The local people get excited to watch the modern method of living of the tourists. Bad habits are picked fast. Therefore, it is the tourists, who need the education first.

At present 1,835,000 sq. km. area is under the reserves. This consists of non suitable area also. Moreover, in India only Nanda Devi National Park is free from the interference of man and domestic animals. On the other hand the animals are found out of these reserves also. In addition the prime habitats throughout the world are bifurcated by the international boundaries.

This necessitates the need of bringing more and more areas under reserves with international co-operation and relocation of inside settlements.

These days captive management has become an important tool because *ex situ* research leads the way to *in situ* work. There may be objection that in captivity the animals do not behave normally. However, even in the wild the animals will behave abnormally if they feel disturbed by the presence of man. Yet, the inherent behaviour and physiological aspects will remain unchanged in captivity.

In 1986, at a symposium held in India, it was decided to control capture of wild ounces as the captive population size was sufficient. Most of the zoos, housing this captive population, are situated far off from the snow leopard habitat. In India, only Darjeeling Zoo provides an opportunity for such research. Day night observation of the animal behaviour is a unique feature of this zoo.

Conservation is for the benefit of mankind. Therefore, mankind must understand what conservation is before they can benefit from it. Let the world community come forward to save this endangered species from extinction.

Acknowledgement

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References

Anon. 1972. The Snow Leopard in Pakistan. *Animals*. 14 : 256-259.

Anon. 1903. The snow leopard. *Zoological Society Bulletin*. Oct : 109. New York Zoological Society.

Bahuguna, N.C. and Moktan, K. 1993. Some individual differences in the Darjeeling group of captive snow leopards. *Zoos' Print.* Vol. VIII, No. VI, June 1993. pp. 8-10.

Blomqvist, L. 1992. Captive snow leopard report for 1989. *International Zoo News* 236: 5-14.

Chundawat, R. and Rawat, G.S. 1992. Food habits of snow leopard in Ladakh, India. *Proc seventh Intl Snow Leopard Symp*, pp. 127-132.

Chundawat, R., Rodgers, W.; and Panwar, H.S. 1986. Status report on snow leopard in India. *Proc fifth Intl. Snow Leopard Symp.* pp. 207-214.

Crandall, L S. 1964. *Management of wild mammals in captivity.* Chicago. University of Chicago Press.

Dang, H. 1967. The Snow leopard and its prey. *Cheetal* 10: 72-84.

Dhungel, Sanat K. 1992. Conservation of the Snow Leopards in Nepal. *Proc. seventh Intl. Snow Leopard Symp*

Flower, W H. 1894, February 6 1894 Report, *Proceedings of the Zoological Society of London* London. p. 92,

Fox, Joseph Li and Nurbu, Chering, 1990. Hemis. a National park for Snow Leopard in India's Trans-Himalaya. *Int. Ped. Book of Snow Leopards* 6: 71-84.

Fox, Joseph L. 1992. Snow Leopard Conservation in the Wild—A Comprehensive Perspective on a Low Density and Highly Fragmented Population. *Proc. seventh Intl. Snow Leopard Symp.*

Freemen, Helen; Jackson, Rodney; Hillard, Darla; Hunter, Don O. 1992. Project snow leopard : a multinational program spearheaded by the International Snow Leopard Trust. *Proc. seventh Intl. Snow Leopard Symp*, pp 241-245.

Gittleman, John L. (Eds.) 1989. *Carnivore Behaviour, Ecology and Evolution.* Publ. Cornell University Press. 124 Roberts Place, Ithaca, New York.

Godman, D.C. 1891. April 7, 1891 Report. *Proceedings of the Zoological Society of London,* London, p. 212.

Green. M.J.B. 1992. *Nature reserves of the Himalayas and the mountains of Central Asia.* IUCN, Combridge and Oxford University Press, Delhi 458 pp (in press).

Hol, Eric H.; Marden, B. Thomas and Roelke, Melody E. 1992. The Importance of Ecotoxicological Research in Management of the Snow Leopard : Lessons Learned from the Florida Panther. *Proc. seventh Intl Snow Leopard Symp.*, pp. 113-125.

IUCN. 1972. Red Data Book. Vol .I. *Mammala* IUCN. Morges, Switzerland.

Jackson, R. and Ahlborn, G. 1984. A preliminary habitat suitability model for the snow leopard, *Panthera uncia*, in West Nepal *Int. Ped. book of snow leopards* 4: 43-52.

Kitchener, S.L.; Meritt, D.A. and Rosenthal, M. 1975. Observation on the breeding and husbandry of snow leopards, Panthera uncia, at Lincoln Park Zoo, Chicago. *Int. Zoo Yearbook* 15: 212-217.

Koivisto, I; Wahlberg, C. and Muuronen, P. 1977. Breeding the snow leopard, Panthera uncia at Helsinki Zoo, 1967-76. *Int. Zoo Yearbook* 17: 39-44.

Oli, Madan Kumar. 1992. Snow leopards and a local human Population in a Protected Area. A Case Study from the Nepalese Himalayas. *Proc. seventh Intl. Snow Leopard Symp.*, pp 51-64.

Panwar, H.S. and Gopal, R. 1984. *Conservation of Wild Cats in India*. International Cat Symposium, Kanha Tiger Reserve, Madhya Pradesh. 35 pp. (Mimeo).

Peel, C.V.A. 1903. *The Zoological Gardens of Europe*. F.E. Robinson and Co., London.

Prater, S.H. 1988. *The Book of Indian Animals*. Publ. Bombay Natural History Society. Oxford University Press. Bombay. pp 69-70.

Rieger, I. 1978. Some difficulties in breeding ounces, Uncia uncia at Zoological Gardens. *Int. Ped. Book of Snow Leopards* 2: 76-95.

Roberts, T.J. 1977. *The mammals of Pakistan*. Ernest Benn, London.

Rosenthal, M. and Joslin, J. Ott-, eds. 1988. Snow leopard captive management survey, Lincoln Park Zoological Gardens, Chicago,

Sanyal, Ram Brahma. 1892. *A hand-book of the management of the animals in captivity in Lower Bengal*. Bengal Secretariat Press, Calcutta.

Schaller, G.B. 1977. *Mountain monarchs*. Univ. Chicago Press, Chicago.

Sclater, P.L. 1896. List of the Vertebrated Animals in the Gardens of the Zoological Society of London, London, p. 56.

Tserendeleg, Jachin. 1992. On the Protection and Survey of Snow Leopards in Mongolia. *Proc seventh Intl. Snow Leopard Symp*

Turner, L. 1980. Oklahama, City Zoo- Twenty-nine snow leopards. *Int. Ped Book of Snow Leopards* 2: 96-111.

Wharton, Dan and Mainka, Susan A. 1992. Captive Management of the Snow leopards, *Proc. seventh Intl. Snow Leopard Symp.* pp. 135-147.

Wilson, D.E. and Reeder, D.M. 1993. *Mammals Species of the World*. Smithsonian Institution, Washington D.C.

Xinchun, Mu. 1992. Distribution in the wild and the captive raising of snow leopards in Xinjiang, China. *Proc. seventh Intl. Snow Leopard Symp.*, pp 157-165.

Zhirjakov, V.A. 1990. On the ecology of snow leopard in the Zailisky-Alatau (Northern Tien Shan). *Int. Ped. Book of Snow Leopards* 6: 25-30.

ZSI (Zoological Survey of India), 1994. *The Red Data Book of Indian Animals*. Part 1: Vertebrata. Zoological Survey of India, Calcutta.

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Observations on some behavioural aspects of Red Panda *(Ailurus fulgens)* in captivity at the Padmaja Naidu Himalayan Zoological Park, Darjeeling

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Abstract :

Daytime observations on the behavioural pattern of five specimens of Red panda *(Ailurus fulgens)* in captivity were carried out at the Padmaja Naidu Himalayan Zoological Park, Darjeeling, during the months of May and June, 1993. Individual pandas exhibited temparaments distinguishable from one another. The single male specimen showed the highest frequency of scent marking.

Introduction :

Red Panda *(Ailurus fulgens)* has long been recognised as an endangered animal and has been included in the Red Data Book of IUCN and also in the Schedule I of the Wild Life (Protection) Act of India, 1972. Red Panda is known to be occurring in the range starting from the westernmost part of Nepal and extending eastward through Nepal and Sikkim, Arunachal Pradesh, North Burma (Myanmar), Southeastern Tibet, West Yunnan, Sichuan and Shaanxi, China (Yonzon, 1989). Its distribution range also extends into the Singhalila National Park in Darjeeling District and in the

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adjoining areas of the Park at an altitude varying between 7,000 ft. to 12,000 ft. (Maclaren, 1964). Yonzon and Hunter (1991) conducted a population study of Red Panda in the Langtang National Park, Nepal, in the Himalayas. These authors reported that the species is very much a habitat-specialist and prefers a forest with mixed vegetation of bamboo and Jhapra trees. The authors also reported a very low fecundity and high mortality rate for the above-mentioned species. Lubbert *et al* (1993) reviewed the status of Red Panda in captivity over a period of about 9 years (1982—1991) and gave a mean birth : death ratio of 1 : 2. Besides habitat destruction, poaching for fur and flesh as well as for high demand of these animals for the purposes of Zoological gardens etc. pose imminent threat to the survival of this animal. Despite efforts being taken to conserve this threatened animal their number is decreasing steadily (Schaller, 1985).

Perusal of literature reveals that little attention has been paid to the study of the behavioural pattern of this endangered animal both in captivity as well as in the wild, under Indian conditions. The present study was undertaken to gain a better understanding of the behavioural aspects of individual specimens of Red Panda at the Padmaja Naidu Himalayan Zoological Park, Darjeeling. This study is expected to help the formulation of, appropriate conservation strategy.

Material and Methods :

The present report is based on observations made in the Padmaja Naidu Himalayan Zoological Park, Darjeeling. The park houses five Red Pandas, one male and four females. All the specimens were adults and showed typical colouration and it was initially found difficult to distinguish one from the other. However, on careful observations a few physical and behavioural differences at individual level could be discerned. In fact no two specimens were alike in every respect.

For the convenience of study the five specimens were given specific recognition names, *viz.*, specimens A, B, C, D, and E.

Specimens A was a female animal with a bulky body with soft long and thick fur and a bushy tail. The white line of colour at the edges of the external ear continued inwards and the ears looked almost completely white with only a small portion of black in the inner side. This specimen was the healthiest and could be easily recognised.

Specimen B was a male animal. When first observed it was lean and thin and almost all its body and tail fur was found shed off.

Specimens C and D were both female animals and it was initially difficult to distinguish one from the other. Both were of the same size, not as big and bulky as Panda A and their body fur was not as thick as in the case of Panda A. Ears of both these specimens (C, D.) were pointed with a very narrow border of white, lining the edges of the inner portion. Tails of Panda C and D were in the process of moulting at the time of observation. However, Panda C had a characteristically thin, irregular-shaped tail pointed at the tip.

Specimen E was a female and was kept isolated in a cage no. 1 since it was badly injured by one of its companions. The isolated specimen was provided with the required amount of bamboo leaves and its daily meal inside the cage.

The entire study area of Red Panda in the Park was divisible into two portions—Enclosure I and II. Enclosure I comprises the ground covered with grass (Zone A, Fig. 1) and a hillock (Zone B, Fig. 1) with a slope (Zone C, Fig. 1) on the left side. Trees on the ground were *Beilschmiedia* sp., *Castanopsis* sp., *Garuga* sp., *Ficus* sp., *Acer* sp., denoted as T_1, T_2, T_3, T_4, T_5, respectively in Figure 1A. Trees on the hillock were *Castanopsis* sp., *Acer* sp., *Castanopsis* sp., *Beilschmeidia* sp. and are denoted as TH_1, TH_2, TH_3, TH_4, respectively as shown in Figure 1B. Tree on the slope was *Castanopsis* sp. denoted as Ts_1 under which bamboo leaves *(Arundinaria maling, Arundinaria hookeriana, Dendrocalamus hamiuton)* were kept for the Pandas to eat (Fig. 1C). Resting sites on the hillock were R_1, R_2, R_3 (Fig. 1B).

Enclosure II consisted of section D1 (outer face) and section D2 (inner face). Section D1 has the night enclosure with cages (CI, CII, CIII, CIV), varandah and a small playground in front (Fig. 1D). There was a small area (S_1) near cage no. 1 where dry leaves accumulated. The Pandas were not released into section D2 which is used for separating mating pairs during the breeding time and is not shown in the Figure.

The average temperature during the study period was 15°C and relative humidity was 88 ± 2. Observations on the specimens A, B, C & D were carried out for a total period or 364 hours, spending 7 hours per day in the daytime during the months of May and June, 1993, from a spot at an higher elevation inside the study area in the Park. The animals were followed from outside the enclosure when they were moving from one end of the study area to another.

The first few days were spent in identifying the animals depending upon their physical characters like colour, especially of that of face, different patterns in which the fur of the body and tail had been shed.

Secondly, various activities of the identified Pandas were noted down, in a systamatic manner.

The sex of the Pandas were checked by capturing them and examining the external genitalia.

Observation and Discussion :

Panda A was observed usually to roost on the TH_4. Some other resting sites were R_2 on the hillock, S_1 near cage no 1 and the cage varandah showing marked preference for S_1. It rested for an average period of five to six hours during the day time. It had good appetite and was a normal and active animal though not as restless as Panda B. One of the characteristic behaviour of Panda A was that it allowed the Keeper to pat it on its back.

In the beginning of the study one would get the impression that Panda B was suffering from malnutrition. But after seventeen days a marked sprouting of new hair on the tail was observed. With time, a brightly coloured thick fur covered its body and it almost attained the normal bearing of a healthy animal as could be judged from external appearance. The very narrow fringe of white in the inner side of the ears looked larger and pointed. Gradually the fringing white hairs almost completely covered the inner portion of the ears. This transformation of Panda B within 25 to 30 days made it almost indistinguishable from Panda A. However, a few points of difference still remained. The hair on the face of Panda B was of darker shade. Facial hair around its snout was sparse which apparently made the snout look bigger. Hind portion of its body was not as bulging as that of Panda A. Its body was more or less cylindrical.

Panda B preferred resting at the top of the hillock, at the base of tree TH_1 and in the varandah of the cage. It seldom rested. While not resting and foraging, it moved about or entere the cage. In the cage, it paced about in the varandah, climbed the wire net, descended and even teased Panda E across the net. Panda E was heard to make squeaking calls when teased. Panda B had the highest frequency of scent marking

which is done by rubbing anal gland on the ground or on the stones, wooden planks, wooden ledger stumps of trees or on the exposed parts of roots of trees.

Panda B was an active, restless and an inquisitive animal but not dominant. There were many occasions when it had been chased by Panda C and Panda D from its feeding sites and also on chance encounters. Even with Panda A, it maintained a discreet distance. When both were in the same cage, Panda B hurriedly ran in front of Panda A, which seemed to be a submissive gesture.

Panda C and Panda D were initially indistinguishable from one another, except for the shape of the tail. Having followed and studied the animals depending on their tail shape to identify them, it was found that both the specimens C and D had individual preferences and distinct behaviour patterns. Panda C was observed to rest for a substantial period of time (5—6 hours per day). Its preferred resting sites were R_1 and TH_1. Panda C had a habit which made it troublesome and distinct from the others. Every evening at 16 hours the Pandas were provided with their evening meals. When all the three animals—Pandas A, B, and D entered the cage eagerly for their meal, Panda C sat at the base of TH_1. All sorts of efforts had to be made to usher it into the cage. However, once into the cage, it didnot fuss over its food nor was it seen to get involved in a row with any of the other pandas. It entered the inner cage soon after finishing its meal and did not loiter around the verandah as Panda B did after its meal.

Panda D was observed to prefer a wooden plank which served as a ladder to cage No. 1 where Panda E was kept, as its resting site. Another favourite spot was S_1 in section D_1 of Enc. II, which Panda A also, incidentally, preferred. Once when Panda A wanted to occupy the spot, Panda A and Panda D had a row over it (loud coughing, angry calls could be heard). Panda A initially attacked Panda D, but Panda D stood upright and defended itself. No injury was inflicted. Panda A ultimately left the spot and the enclosure after scent-marking a stone in the enclosure. Panda D, while sitting on the wooden plank, in front of the entrance of cage No. 1, occasionally rotated its head in an anti-clockwise direction, lifting its forelimbs alternately. Panda D groomed itself extensively. It spent more time in grooming than the others. It was also observed that all the Pandas showed preference for foraging seeds of *Ficus* sp. from the ground.

The male Panda B appeared to show higher scent-marking frequencies than the female Pandas, confirming the study conducted on scent-marking

in captive Rad Pandas by Conover *et al* (1983). Dewsbury (1975) opines that to gain a comprehensive understanding of species and their behaviour, individual differences and the nature of similarities within species must be dealt with. This study was also mainly directed towards knowing the individual animals.

The results of the present study is expected to provide a basic guideline to assess the individual temperaments of the Pandas and gauge the degree of compatibility between the pairing mates which is an important aspect for successful breeding.

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References :

Conover, G. K. and Gittieman, J. L. (1983). Scent marking in captive red panda *(Ailurus fulgens). Zoo Biol.*, 8 (2) : 193—206.

Dewsbury, A. D. (1975). Animal species : their nature, classification and evolution. In : *Comparative animal behaviour*. McGraw-Hill Book Company, New York : pp. 31.

Lubbert, J., Schaftenaar, W. and Glatson, A. R. (1993). A review of the pathology of the Red Panda *(Ailurus fulgens fulgens)*, in the period 1982—1991. In : *The Red or Lesser Panda Stud-Book*, Number 7 : 10—19, Rotterdam, The Netherlands.

Maclaren, P. I. R. (1964). Notes on mammals of Sikkim and Southern Tibet. *Jr. Beng. Nat. His. Soc.*, XXIV (1).

Schaller, G. B., Jinchu, H., Wenshi, P. and Jing, Z. (1985). *The Giant Pandas of Wolong*. University of Chicago, USA.

Yonzon, P. B. (1989). *Ecology and conservation of the red pandas in the Nepal Himalayas*, PhD dissertation, University of Maine, Orono, USA.

Yonzon, P. B. and Hunter, M. L. Jr. (1991). Conservation of Red Panda *Ailurus fulgens*. *Biological Conservation*, 57 (1991) : 1—11.

Explanation of figures :

Fig. 1. Cross profile of Panda enclosure at P. N. H. Z. Park, showing configuration of land vis-a-vis schematic aerial components.

1 A. Fore-ground plan and location of trees.

1 B. Location of trees on billock shown on topographic cross-section.

1 C. Topographic section showing location of tree and bamboo leaves kept on the slope.

1 D. Plan of night enclosure alongwith cages.

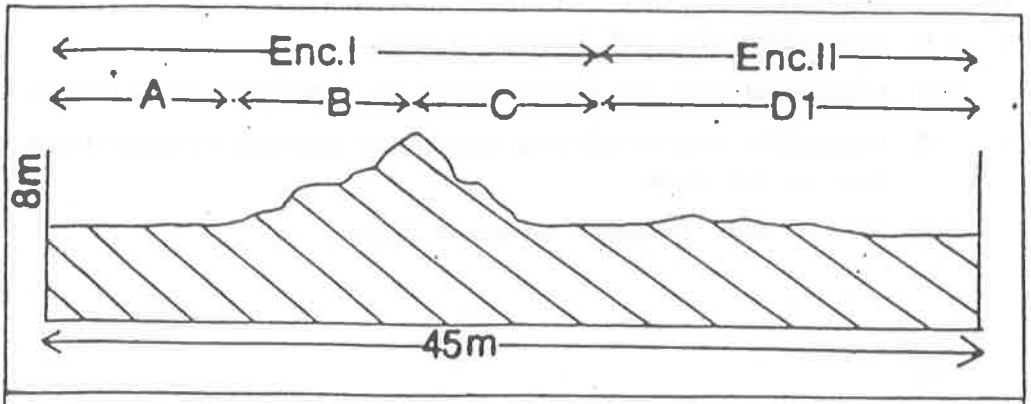
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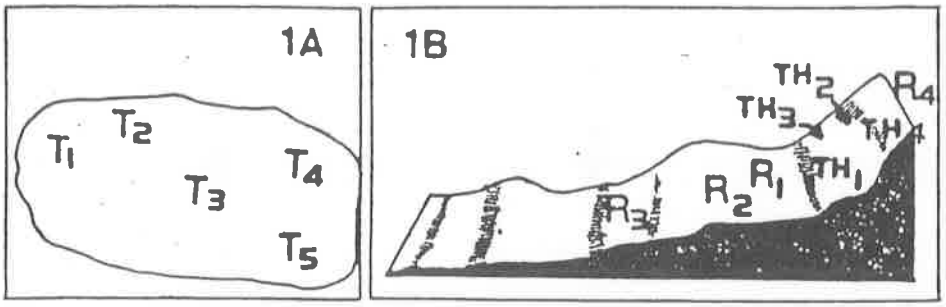
Fig.1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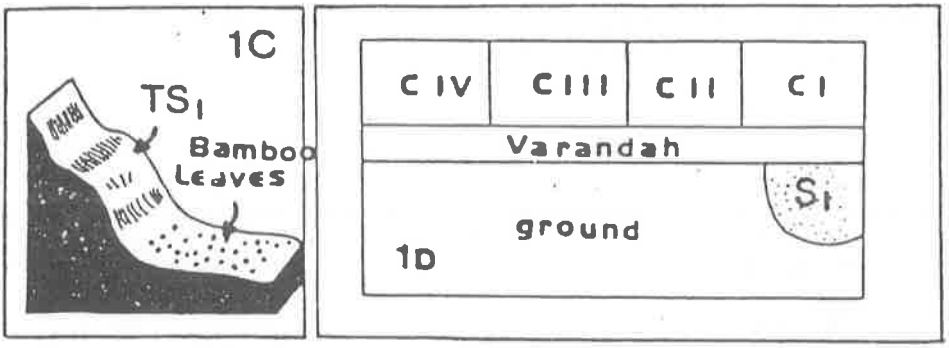
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Varandah
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74

SUCCESSFUL CAPTIVE BREEDING OF STUMPTAILED MACAQUE IN SRI VENKATESWARA ZOOLOGICAL PARK, TIRUPATI (ANDHRA PRADESH)

S.V. KUMAR* AND P.S. RAGHAVAIAH**

Introduction

The Stumptailed Macaque (*Macaca speciosa*) is restricted to Assam hill forests only in India. It is a Schedule-II animal. The tail of Stumptailed Macaque is scarcely 2.5 cm long. The animal is thick set in build, with long and abundant hair and hair is slightly parted in the middle. Shoulder is wavy and middle of the back is parted. Large area of the seat is bare, brilliant red or purple patches are seen on the face, on the genital region and in posterior region. Head and body is dark brown, young individuals are paler in colour.

Habits

The Stumptailed Macaque is more at home on the ground than upon the trees contrary to the other Macaques which are more arboreal in nature. They eat chiefly young leaves, fruits, buds and occasionally small prey. Where opportunity offers, they can leave the forest to raid fields and gardens for maize, sugarcane, rice papayas and mangoes.

Breeding Activities

The sex life of the Stumptailed Macaque seems to have a special social significance, because mating is less restricted to the period of female fertility than in other primates. Mating takes place throughout the year giving a gap of 2 months after delivery and participate even after its conception. After ejaculation, the male is unable to detach himself from the female immediately, much as in canines. This is due to a swelling at the entrance to the vagina. The female will sit "tight" on the male's lap, the male will hold the female for sometime. Both mother and father show affection to the baby, but father does not share his food with baby. But the mother takes much care of the young ones. When it gives a call, the male also will come to rescue the baby. There is a case when the mother didn't leave the dead body of her baby even 5 days after death.

Enclosure for Stumptailed Macaque

The enclosure for Stumptailed Macaque is constructed with an island area of about 275 m^2. This has a top width of 5 m. and a depth of 2.3 m and designed as a wet moat. About 60 cm water level has to be maintained. 60 cm high Parapet wall is constructed above ground. Hedge plants are raised in between the railing and moat wall.

Night house is provided with four cages of 1.2 m x 1.65 m x 1.50 m size each. Night house is camouflaged with rockery. Drainage channel is provided for easy draining of daily cleaning water.

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Fig. 1

One-day old baby Stumptailed Macaque with its mother and father

Fig. 2

Baby Stumptailed Macaque feeling security with its mother and father

Fig. 3

Mischievous baby Stumptailed Macaque playing in the enclosure leaving parents.

Fig. 4

Mother grooming the baby Stumptailed Macaque

Prophylactic Measures

Each animal is provided with bread - 100 g, Vegitables - 75 g, Bananas - 250 g, Vegitable leaf - 50 g, Bengalgram - 100 g and fruits - 210 g in a day. The night house is cleaned daily with Steridor or Aciphor liquid. The moat is disinfected monthly in all the months except twice in a month in rainy season with bleaching powder. Butox is sprayed monthly around the night house and around the moat for pest control. Faecal samples are examined monthly for detection of parasites. Deworming is done once in three months.

Successful Breeding

One male and one female were brought from the Nehru Zoological Park, Hyderabad in the year 1993. They have given birth to a baby on 26.8.93. After nearly one year the baby died under the releasing gate. On 4.8.94 the male macaque lifted the gate and it was holding the gate. At that time the baby was playing near the gate. When the baby was below the gate the male macaque suddenly left the gate. The baby was crushed under the gate.

Second time one more baby was born in 1994. When the baby was one week old, it has tried to cross the cage bars to enter into another cage but only its head has gone to the other side and its boby could not pass through the bars as the gap between the bars is less. The mother pulled the baby from the other side of the cage holding its head instead of pulling back the baby. As a result of this, the baby was squeezed in between the bars and died.

With the experience of these incidents, the following steps were taken to avoid further deaths :

1. Gap between releasing gate and wall above the gate was reduced.
2. Opening of the releasing gate throughout, till the baby crosses juvenile stage.
3. Knitting of chain link mesh to the sides of central cage to prevent the baby crossing the cage bars.
4. Observing the baby and the gate position daily by the Animal Keeper, Animal Watchman and Zoo Sargeant.

Again one baby was born on 20.6.1995. By taking the above steps the baby is growing well and it is in good health. The baby is now becoming dark in colour. The baby has successfully competed one year now in the Sri Venkateswara Zoological Park, Tirupati.

Conclusion

Close supervision of the baby, narrowing the gap between gates and walls, opening of the releasing gate all the time and restricting the movement of the baby through the bars of the night cage made the Stumptailed Macaque baby survive. With these precautions and careful observations, the female Stumptailed Macaque which is pregnant now may deliver another baby Stumptailed Macaque which may successfully grow into an adult taking their family size to 4 from the present family size of 3. The Sri Venkateswara Zoological Park, Tirupati is not enforcing family planning for its animal, the family size of these Stumptailed Macaques may grow into a viable population from the parent stock of one male and one female.

SUMMARY

Breeding activities of Stumptailed Macaque are discussed. The reasons for their mortality and remedial measures and steps taken for their successful captive breeding are also discussed.

श्री वेंकटेश्वर प्राणि उद्यान में ठूँठ पुच्छ कपियों के सफल बन्दी प्रजनन

एस०वी० कुमार व पी०एस० राधवय्या

सारांश

ठूँठ पुच्छ कपियों के प्रजनन गतिविधियों का विवेचन किया गया है । मृत्यु दर कारण तथा प्रतिविधि परिणाम व उनके बन्दी अवस्था में किये गये सफल प्रजनन पदक्षेप का भी विवेचन किया गया है ।

Tactics to Thwart Animals from Fouling Water Bowls

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Abstract

Wild animals may show certain undesirable habits as a result of captivity. Fouling water bowls, reportedly a common trait in some individual lesser felids, is one of them. Information on methods to foil this problem is sparse. This article elaborates on the series of procedures we experimented with in efforts to mitigate this problem successfully in a Leopard cat (*Felis bengalensis*) and a Jackal (*Canis aureus*).

Introduction

Overgrooming, coprophagy, wind-sucking, crib-biting, self-mutilation, tail-chewing and fouling food and/or water bowls are some of the undesirable habits that may occur as a consequence of captivity (Shepherdson, 1988; Worthington, 1993). Fouling of water bowls is a particularly bad habit common in some felids (Mansard, 1989; *Zoo's Print*, 1994). No apparent cause has been attributed to this phenomenon. At the Coimbatore Zoological Park and Conservation Centre, the solitary 0.1 Leopard cat and 0.1 Jackal always defecated in their water bowls. This forced our keepers to frequently change water. Leopard cats are particularly notorious for fouling their water bowls (Mansard, 1989; D. M. Richardson, London Zoo, pers. comm.).

There is little published information available on the methods to mitigate this problem. As far as small cats are concerned, covering their feces may be a natural habit. Since some cats have an inherent need to cover up their feces, providing peat-filled trays is important to localize feces collection and avert fouling water bowls (Law, 1993). Mansard (1989) did mention this fouling problem. He exploited this fouling tendency by providing shallow buckets with about 75mm of water (with sand and ashes added) as latrines. The Leopard cats almost exclusively used these buckets for defecation. Keeping this in mind, we conducted a series of experiments, particularly with the Leopard cat, in an attempt to prevent them from fouling their water bowls. This study was conducted from August through December 1993. This article is to document the sequence of efforts we undertook to revert them to their normal defecation habits.

Procedures Adopted

1. The Case of the Jackal

Our efforts were easily rewarded in the case of the Jackal. The mere shifting of this animal to a new enclosure changed the habit of fouling the bowl. The old enclosure was a cement-floored cage measuring approximately 6ft. x 8 ft. Prior to this move, the animal invariably fouled either the food and/or water bowl. In the new enclosure, which is about 15 times more spacious and includes natural boulders and a den with mud flooring, it always defecated on the floor with no particular preference as to location. During the past five months of our observations, only twice did the Jackal foul the bowl. It happened once because the empty feed trough was kept inside the enclosure for some time. We have already shifted the water bowl to an elevated stand in order to prevent the occurrence of such isolated incidents.

Tactics to Thwart Animals from Fouling Water Bowls, *Continued*

2. The Case of the Leopard Cat

Procedure 1: Providing a second water source -Our earlier attempts were to provide the cat access to clean drinking water. The water bowl was a concrete trough kept on a four-inch high stand and the cat had the habit of getting on top of this bowl to defecate inside it. This made the water unsanitary for drinking. We temporarily solved this problem by providing a second water trough. The cat almost entirely fouled the old one and rarely defecated in the new water dish. This is how Mansard (1989) also exploited the fouling tendency by providing shallow buckets with water as latrines. This procedure solved the problem of providing clean water to the cat. The offensive sight of the second fouled bowl was still a problem.

Procedure 2: Providing a peat-filled trough - As previously mentioned, providing peat-filled trays may localize feces collection (Law, 1993). We decided to replace the water in one of the bowls with sand. We chose the usually-fouled concrete water bowl for this replacement. However, the cat chose to defecate in the new water bowl. Consequently the practice of providing two water troughs continued for some time.

Procedure 3: Withholding water - The cat invariably defecated every day, approximately six to seven defecations per week. We were interested to know the cat's reaction when no water was provided. In the beginning of September, we removed both the water bowls and provided a peat-filled trough instead. We were of the opinion that the cat might continue to use the sand pit if we succeeded at least once in forcing it to use this sand trough. However, the cat seemed to prefer withhold defecation rather than defecate in the sand trough. Finally, on the third day, the cat defecated at the corner of the cage. Since water is an essential element, we could not afford to continue this experiment of withholding water. We noted the site of 20 successive defecations during this month and 35% of these were in the water bowl. The sand trough was used only once.

Procedure 4: Hanging water bowl - Eventually we came up with the idea of providing water in a small (six-inch diameter) plastic bowl that was attached to the sides of the mesh on a basketball-like ring, at a height of about eight inches above the floor. This arrangement ultimately curtailed the habit of the cat fouling its water source. The cat always used a particular corner of the cage for defecation. We took advantage of this preference and provided a sand tray (1' x 2') in that particular corner to localize defecation We observed the cat for a month (October 1993). The sand trough was used only once.

Changes observed when cat was shifted to a new enclosure:

Meanwhile, on 26 September 1993 we shifted the Leopard cat to a new, more naturalistic enclosure which had all the recommended enrichment artifices including a small water pool on the floor of the unit. Though we decided to continue with the practice of providing a hanging water bowl and sand tray in this new enclosure, we were concerned that when released, the cat might foul this new pool. The cat did not disappoint us. We observed the cat fouling the pool for three consecutive days. This forced us to keep the water pool empty for some time.

For more than a month the cat defecated at the corner of the enclosure and not in the special sand tray provided for this purpose. The water pool continued to be empty. Meanwhile, the keeper suggested replacing the sand tray with the sand-filled old concrete bowl that had previously been fouled by the cat whenever it contained water. We were also aware of the fact that "seeding" certain areas with feces can persuade some cats to use those locations for defecation (Barclay & Lewis, 1988). Therefore, we not only kept it exactly at the corner where the cat preferred to defecate, but also buried some of the old feces in the sand to encourage usage. This encouraged the cat to use this sand trough as a latrine site.

For more than two months the water pool was kept empty for fear of the cat fouling it. On 12 December 1993, it rained and the pool was filled with water. To our pleasant surprise, the cat continued to prefer either the sand trough or some site in the enclosure (often a particular location) for defecation. For all those days we had been reluctant to fill the pool with water, but the rain proved our fears groundless.

In December all the defecations were in the sand trough. During the last two months (Jan. & Feb. 1994), 45% (N=55) of the defecations were in the sand trough. The rest were localized in a particular spot, often below a bush/shrub. We never observed the cat making any attempt to bury its feces. We encouraged the cat to use the sand trough by frequently shifting the trough to those sites chosen by the cat for defecation. The cat would use it immediately and for a couple of weeks before changing its preferred defecation site again. We have so far changed the location of the sand trough four times.

Conclusion

The major lesson learned from this exercise is that careful thinking, planning and gradual changes can succeed in getting rid of some of the unpleasant habits of captive animals. In both cases, the water trough had to be raised above ground level to prevent fouling. This could perhaps be the standard procedure for preventing many species of mammals from fouling their water/food bowls.

References

Anonymous, 1994. Report of the Captive Working Group: Global Captive Population Action Plan. *Zoo's Print*, 9(1,2):21-22.

Barclay, E. and Lewis C. 1988. Strategies for exhibit plantings for large felids. *Animal Keepers' Forum*, 15(12): 443-445.

Law, G. 1993. Behavioral enrichment for cats. In *Management guidelines for exotic cats*. Published by the Association of British Wild Animal Keepers. Reproduced by ZOO ZEN, 8(8):31-33.

Mansard, P. 1989. Some environmental considerations for small cats. *International Zoo News*, 36(3)- No. 214: 19-22.

Shepherdson, D. 1988. Environmental enrichment in the zoo. In *Why Zoos?* Universities Federation for Animal Welfare, 8-Hamilton Close, Potters Bar, Herts, EN6 3QD, United Kingdom.

Worthington, M.K. 1`993. Handling and Teaching Zoo Animals. *International Zoo News*, Vol: 40/2, No . 243:14-22.

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MISCELLANEOUS NOTE

1. A NOTE ON THE BIRTH OF A GOLDEN CAT *(FELIS TEMMINCKI)* IN CAPTIVITY

The female of a pair of normal coloured golden cats (*Felis temmincki*) with the Nandankanan Zoo (Orissa) since 29.iii.1967 gave birth to a black coloured female cub on 19.iv.1970. However, the cub died within 48 hours of birth. The dead cub weighed 110 gm. and measured 29 cm. from tip to tip including the 9 cm. long tail. The body coat was thick and black without any pattern.

In the available literature there is no mention of birth weight and size (Crandall 1965; Walker *et al.* 1964; Prater 1965). According to Prater (loc. cit.) the cubs have longer and thicker coat than the adults and lack pattern. According to Walker *et al.* (loc. cit.) melanistic specimens are fairly common. There are several records of birth of this cat in captivity in U.S.A.

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REFERENCES

CRANDALL, LEE S. (1965): The management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London. p. 365.

PRATER, S. H. (1965): The Book of Indian Animals. Bombay Natural History Society and Prince of Wales Museum of Western India, Bombay. pp. 72-73.

WALKER, EARNEST P. *et. al.* (1964): Mammals of the World, Vol. II, The Johns Hopkins Press, Baltimore. p. 1276.

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MISCELLANEOUS NOTE

4. AGE OF SEXUAL MATURITY OF THREE SPECIES OF WILD ANIMALS IN CAPTIVITY

This note is intended to place on record some observations made at Nandankanan Zoo (Orissa) on the age of sexual maturity of the female of three kinds of wild animals.

Sambar (*Cervus unicolor*)

A Sambar doe born at the zoo on 30. viii .1968 gave birth to a fawn for the first time on 27.x.1970 at the age of 2 years, 1 month, 28 days. This was kept along with an adult male throughout this period. Taking the gestation period as about 8 months (Asdell 1964 : PATTERNS OF MAMMALIAN REPRODUCTION, pp. 492-581), the age of sexual maturity of this animal can be said to be not more than 1 year, 5 months, 28 days or say 1 year and 6 months.

The period of maturity recorded for Sambar is two years (Prater 965 : THE BOOK OF INDIAN ANIMALS).

Nilgai (*Boselaphus tragocamelus*)

A female Nilgai born here on 13.iii.1968 gave birth to two young for the first time on 31.xii.1970 at the age of 2 years, 9 months, 19 days. This female had remained with an adult male throughout this period. Taking the gestation period as 8 months and 7 days (Asdell, loc. cit.) the age of sexual maturity of this female can be said to be not more than 2 years, 1 month, 12 days or say 2 years and 1 month.

There is no mention of the age of sexual maturity of Nilgai in the available literature.

African Lion (*Panthera leo*)

A lioness born here on 26.iii.1967 gave birth to a cub on 8.ii.1970 for the first time at the age of 2 years, 10 months, 14 days. This lioness was kept along with an adult lion from 1.viii.1967. Taking the gestation period as about 108 days (Asdell, loc. cit.), the age of sexual maturity of this lioness can be said to be not more than 2 years, 6 months, 28 days or 2 years and 7 months.

The lioness breeds at the age of 3 or 4 years (Asdell, loc. cit.).

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MISCELLANEOUS NOTE

3. BIRTH OF AN INDIAN PANGOLIN (*MANIS CRASSICAUDATA*) IN CAPTIVITY

A pregnant female of the Indian Pangolin (*Manis crassicaudata*) with the Nandankanan Biological Park (Orissa) since 26.x.1971, gave birth to a male young on 17.xi.1971. The new-born young measured 30 cm from tip to tip including a 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 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. The young when handled could not curl up like the adults. It was rejected by the mother on the 4th day, and died the next day.

There is no mention of weight, size and condition of the eyes of the new-born young in the available literature. There are records of birth of this species in India in July (Prater 1971, BOOK OF INDIAN ANIMALS) and in November (Asdell 1964, PATTERNS OF MAMMALIAN REPRODUCTION).

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MISCELLANEOUS NOTE

4. SOME OBSERVATIONS ON DISTRIBUTION OF ZOO BIRTHS AMONG COMMON WILD MAMMALS[1]

Acharjyo (1970) noted birth weight, size, gestation period, litter size, etc., of some common wild mammals maintained at the State Biological Park, Nandankanan (Orissa). In this paper monthwise distribution of zoo births among twelve species of wild mammals observed at the State Biological Park, Nandankanan (Orissa) during the past nine years and five months (from 29.xii.60 to 31.v.70) are reported.

Observations and Discussion

1. Spotted Deer (*Axis axis*)

A total number of 110 births (59 ♂♂, 51 ♀♀) have been recorded here as follows. January, 10; February, 28; March, 22; April, 12; May, 13; June, 1; July, 6; August, 3; September, 2; October, 4; November, 3; and December, 6. From this it appears that there is a definite concentration of births in the months of February and March.

According to Crandall (1964) fawns may be born at any season and the distribution of 225 births at New York Zoological Park was as follows: January, 8; February, 15; March, 30; April, 21; May, 30; June, 25; July, 27; August, 16; September, 18; October, 17; November, 17; and December, 1. Asdell (1964) states that in Ceylon young are born throughout the year but the majority at the beginning; at Woburn most fawns are born between Christmas and Easter and in London Zoo

[1] Abstract submitted to Indian Science Congress, 58th Session held at Bangalore in January, 1971, in the Zoology Section.

[1]

births were evenly distributed throughout the year. Fawns may be seen at any season (Prater 1965). Fawns of all ages and sizes can be found at all times (Walker *et al.* 1964).

2. **Indian Sambar** (*Cervus unicolor niger*)

The 35 births (14 ♂♂, 21 ♀♀) recorded here were distributed almost evenly throughout the year except May as follows : January, 1 ; February, 2 ; March, 1 ; April, 2 ; June, 5 ; July, 2 ; August, 5 ; September, 4 ; October, 5 ; November, 3 ; and December 5.

According to Crandall (loc. cit.) births in captivity may occur at any season and distribution of 41 births of New York Zoological Park were as follows : January, 2 ; March, 1 ; April, 4 ; May, 6 ; June, 5 ; July, 4 ; August, 2 ; September, 5 ; October, 7 ; and November, 5. Asdell (loc. cit.) states that in London Zoo births have been spread throughout the year with a peak at the end of May and at Woburn fawns were dropped at any time of the year. Young are born at the commencement of rains ; in late May or early June (Prater, loc. cit.).

3. **Barking Deer or Muntjac** (*Muntiacus muntjak*)

The birth of 51 fawns (25 ♂♂, 26 ♀♀) were spread almost evenly throughout the year as follows : January, 4 ; February, 5 ; March, 2 ; April, 5 ; May, 5 ; June, 4 ; July, 4 ; August, 4 ; September, 7 ; October, 3 ; November, 4 ; and December, 4.

Crandall (loc. cit.) citing Blanford (1888-91) states that the young are usually born in June or July though some may be produced throughout the year. In London Zoological Gardens 30 births of Indian Muntjac were distributed through every month of the year except January (Zuckerman 1953). Prater (loc. cit.) states that births occur at the beginning of rains. Young are born in July and August in north of India (Asdell, loc. cit.).

4. **Hog Deer** (*Axis porcinus*)

Four premature births recorded here were as follows : March, 1 ; May, 1 ; and October, 2.

According to Crandall (loc. cit.) the 32 births at New York Zoological Park were distributed throughout the year except in August and December. Births all the year have been recorded in London Zoo (Asdell, loc. cit.). Prater (loc. cit.) states that young are dropped in April, May and during the rains. Fawns of all ages and sizes can be seen at all times (Walker *et al.*, loc. cit.).

5. **Black Buck** (*Antilope cervicapra*)

Eleven births recorded in this Park were as follows : January, 2 ; February, 2 ; March, 1 ; May, 3 ; and September, 3.

According to Crandall (loc. cit.) 97 young born at New York Zoological Park were distributed throughout the twelve months of the year with minimum of one young in January and the maximum of 13 young in June. Asdell (loc. cit.) states that in London Zoo births were evenly distributed throughout the year.

6. Nilgai (*Boselaphus tragocamelus*)

Five births recorded in this Zoo were distributed as follows : January, 1 ; February, 2 ; and March, 2.

Crandall (loc. cit.) states that 8 births of New York Zoological Park were scattered from January to November. Sixty-one births at the Zoological Garden, London, occurred in every month, (Zuckerman, loc. cit.). The young are produced at all seasons (Prater, loc. cit.).

7. Indian Wild Boar (*Sus scrofa cristatus*)

Births of 6 litters in this Zoo were scattered from April to October as follows : April, 2 ; May, 3 ; and October, 1.

The majority of young are born shortly before and shortly after the rains in Central India (Prater, loc. cit.).

8. Bonnet Macaque (*Macaca radiata*)

Three births were recorded in the month of June, 1 ; July, 1 ; and August, 1.

Prater (loc. cit.) states that whether there is a marked breeding season is not known.

9. African Lion (*Panthera leo*)

Births of three litters were recorded as follows : February, 1 ; March, 1 ; and June, 1.

In the Gir forest of India, lion cubs are produced between January and February (Prater, loc. cit.). It has no fixed breeding season and is polyestrous (Asdell, loc. cit.). It is polygamous and breeds throughout the year (Walker *et al.*, loc. cit.).

10. Tiger (*Panthera tigris*)

Two litters were born here with one in July and the other in December.

One tigress at the New York Zoological Park produced eleven litters as follows : May, 8 ; June, 1 ; and November, 2 (Crandall, loc. cit.). Asdell (loc. cit.) states that in London Zoo, births have occurred at any time of the year but mostly from June to August. In India majority of young are born between February and May (Prater, loc. cit.).

11. Leopard (*Panthera pardus*)

Five litters born here were scattered as follows : April, 1 ; May, 1 ; June, 2 ; and December, 1.

Crandall (loc. cit.) citing Zuckerman (loc. cit.) reported that the 27 births at the London Zoological Garden during 1839 to 1937 occurred in every month except January. In India most births occur in April and in London Zoo births have been distributed throughout the year (Asdell, loc. cit.). Panther breeds all the year round (Prater, loc. cit.); Walker *et al.*, (loc. cit.).

12. Common Mongoose (*Herpestes edwardsi*)

Two litters were born, one in April and the other in July.

This has no regular season (Asdell, loc. cit.). It breeds all the year round (Prater, loc. cit.).

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REFERENCES

ACHARJYO, L. N. (1970) : Observations on some aspects of reproduction among common wild mammals in captivity. *J. Anim. Health*, 10 : 125-129.

ASDELL, S. A. (1964) : Patterns of Mammalian reproduction. Second edition. Cornell University Press, Ithaca, New York.

CRANDALL, LEE, S. (1964) : The management of wild mammals in captivity. The University of Chicago Press, Chicago and London.

PRATER, S. H. (1965) : The Book of Indian Animals. Bombay Natural History Society and Prince of Wales Museum of Western India, Bombay.

WALKER, ERNEST P. *et al.* (1964) : Mammals of the World, Vol. I & Vol. II, The Johns Hopkins Press, Baltimore.

ZUCKERMAN, S. (1953) : The breeding seasons of mammals in captivity. *Proc. zool. soc.* London, 122 : 827-950.

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MISCELLANEOUS NOTE

2. ON THE FEEDING HABITS OF CRABEATING MONGOOSE (*HERPESTES URVA*) IN CAPTIVITY

A female Crabeating Mongoose (*Herpestes urva*) received at Nandankanan Biological Park (Orissa) on 1-ii-1971 whenever offered hard-shelled snails, usually selects the biggest snail first and carries it in her mouth to a suitable place such as a wall, water or feeding trough. Then with her back to the wall she holds the snail in her forepaws, rises on her hind legs and crashes the shell with force between her hind limbs and on to the hard surface behind her. While smashing the snails, the hind limbs are kept slightly apart and the tail to one side to avoid hitting them. She picks up the partly broken snail, eats the exposed fleshy portions of the snail and the process is repeated till all the fleshy portions are consumed. Thereafter the other snails are taken one after another usually from the biggest to the smallest and processed in the same manner. She deals with the hard-shelled snails in this manner daily but when the fleshy portions of snails removed from the shells or fish are given along with hard-shelled snails, the latter are ignored.

Another male maintained on a diet of fish and snail flesh since 24-i-1965 when given hard-shelled snails along with the female from February, 1971, showed no interest in breaking the snails for the first ten days but used to observe the actions of the female kept in the same enclosure. From the 11th day it started breaking and eating the hard-shelled snails in the same manner as the female.

A second female received on 15-ix-1971 breaks and eats hard-shelled snails. All the mongooses are in excellent health on a diet of fish and snails. They refuse to take fruits, roots and nuts.

Prater (1971) in the BOOK OF INDIAN ANIMALS states that 'it is recorded of an animal kept in captivity that it would take hold of any hard object, such as stone or golf ball, and holding it in its forepaws stand up and crash it to the ground, hurling it with great violence between its hind legs,..... The habit is probably an indication of

[1]

the way in which this mongoose kills and breaks up hard-shelled crabs and molluscs on which it feeds'. Our observations confirm the presumption of Prater (loc. cit.) that this habit of breaking the snails may be the usual feeding habit of this mongoose.

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MISCELLANEOUS NOTE

2. NOTES ON THE BIRTH AND GROWTH OF A SLOW LORIS (*NYCTICEBUS COUCANG*) IN CAPTIVITY

A pregnant Slow Loris (*Nycticebus coucang*) received at the Nandankanan Biological Park (Orissa) on 1.ii.1971 from the forests of Assam, gave birth to a female young on 21.ii.1971. After delivery the mother weighed 1·4 kg.

The new born young weighed 50 gm and measured 14 cm in total length. The eyes were open at birth. The young had a coat of dense fur and numerous long glistening grey hairs were scattered throughout the body and projected far beyond the fur. These long hairs gradually disappeared when the young was about 11 weeks old. The body coat was grey throughout except the hands and limbs which were silvery white. The brown stripe on mid back was very prominent.

A single young is usually born (Prater 1971 ; Walker *et al.* 1964 ; Asdell 1964). Crandall (1965) reported that all births were of single young except the two twin births which were found dead within a day or two. The eyes of a Slow Loris young are open at birth (Crandall, loc. cit.). There is no mention of birth weight and size in the available literature.

Up to the age of seven weeks the young was seen clinging to the mother's abdomen and sucking her teat throughout the day. From the eighth week onwards and up to the age of 10 months, the young was clinging to the mother's abdomen throughout the day, partly keeping her hind quarters on the ground either in between the two limbs of the mother or over the mother's lap. Whenever attempts were made to handle or see the young during the day time, the mother with her baby curled up like a ball and twittered in annoyance. The mother cleaned the baby by licking. After sunset the young was always seen separated from the mother and was either clinging to the chainlink mesh wall or moving about in the house from the very first day. From the third day it was able to produce a feeble noise when handled and this noise immediately attracted the attention of the mother. Up to 8 weeks of age the young one was at times seen clinging to the abdomen of another female kept in the same house. Later the second female did not allow the young to cling to her, probably because of its increased body weight. The young one took bananas for the first time at the age of about one month. The mother was able to crawl along with the baby clinging to her abdomen till the baby was seven months old.

Hill (1937 b) reported that the female Slow Loris may deliberately place her baby on the ground, later picking it up but this behaviour was neither observed by Crandall (loc. cit.) nor in this Park. Crandall

(loc. cit.) reported that a young born in New York Zoological Park was found clinging either to the mother or to the father and he has never seen a mother touch an infant, beyond the usual cleaning treatment with the tongue. The young remains with the mother until it is as large as the mother (Prater, loc. cit.). The young appeared to be dependent upon the mother for at least 9 months or more and a youngster was seen nursing when it was as large as the parent (Crandall, loc. cit.).

The young one reached its maximum weight of 1605 gm at the age of 44 weeks (about 10 months) on 26.xii.1971. Weekly weight growth records were taken at the end of every week and an abstract of the growth records of this animal up to the age of one year is as follows :

Date	Age in weeks	Weight in kg.
21.ii.1971	Birth	0·050
21.iii.1971	4	0·140
18.iv.1971	8	0·295
16.v.1971	12	0·480
13.vi.1971	16	0·718
11.vii.1971	20	0·920
8.viii.1971	24	1·040
5.ix.1971	28	1·222
3.x.1971	32	1·315
31.x.1971	36	1·420
28.xi.1971	40	1·530
26.xii.1971	44	1·605
23.i.1972	48	1·590
20.ii.1972	52	1·588

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REFERENCES

ASDELL, S. A. (1964) : Patterns of Mammalian Reproduction, Cornell University Press, Ithaca, New York, p. 130.

CRANDALL, LEE S. (1965) : The Management of Wild Mammals in Captivity, The University of Chicago Press, Chicago & London, pp. 75-77.

HILL, W. C. OSMAN (1937b) : Cited by Crandall, Lee S. (1965).

PRATER, S. H. (1971) : The Book of Indian Animals, Bombay Natural History Society, Bombay, pp. 43-44.

WALKER, ERNEST P. *et al.* (1964) : Mammals of the World, Vol. I, The Johns Hopkins Press, Baltimore, p. 418.

[Reprint, from *J. Bombay nat. Hist. Soc.* 70 (2) : 375 15-2-1974] 1973

Miscellaneous Note

3. A NOTE ON THE BIRTH OF A MALAYAN GIANT SQUIRREL (*RATUFA BICOLOR*) IN CAPTIVITY

A female Malayan Giant Squirrel (*Ratufa bicolor*), living with a male of the same species since 17 June, 1971 at Nandankanan Biological Park, Orissa gave birth to a female young on 15 July 1972 in one of the wooden boxes kept inside the squirrel cage.

At birth the young weighed 77 gm and measured 29.5 cm including the 12.5 cm long tail. The upper parts of the body coat were black whereas the under parts were light brown. The eyes were closed at birth and opened on the 22nd day (5 Aug. '72). At the age of two weeks the young was fully haired and the brown colour of the underparts gradually turned to white. The mother used to collect leaves and small branches from a plant inside the cage and keep inside the wooden box probably to use as bedding material or to conceal the baby. The mother carried the young by her teeth till the young was 8 weeks old while she jumped from one box to another. The baby was lifted by holding a fold of skin at the back with the teeth, or lifted the young by holding the base of one of the hind limbs. At times the young one used to make the typical giant squirrel call, immediately drawing the attention of the mother. The young was once seen taking banana for the first time at the age of five weeks and was able to come out and get into the wooden box kept at a height of about 90 cm from the ground on a wooden post at the age of eight weeks. It measured 59 cm from nose tip to tip of tail and weighed 445 gm at the age of two months.

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November 28, 1972.

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Miscellaneous Note

6. A NOTE ON AGE OF SEXUAL MATURITY OF TWO SPECIES OF ANTELOPES IN CAPTIVITY

This communication deals with the age of sexual maturity of the female of two species of antelopes observed at Nandankanan Biological Park (Orissa).

1. **Blackbuck** (*Antilope cervicapra*)

A female blackbuck born at the Park on 25.ix.1969 gave birth to a young for the first time on 20.ii.1972 at the age of 2 years, 4 months and 27 days. Another female blackbuck born at the Park on 20.i.1970 gave birth to a young for the first time on 22.ii.1972 at the age of 2 years, 1 month and 3 days. These females were kept along with adult males throughout this period. Taking the gestation period as about 6 months (Asdell, 1964: PATTERNS OF MAMMALIAN REPRODUCTION, pp. 617), the age of sexual maturity of these animals can be said to be not more than 1 year, 10 months and 27 days or 1 year and 11 months and 1 year, 7 months and 3 days or 1 year and 7 months respectively.

There is no mention of age of sexual maturity of this species in the available literature.

2. **Nilgai** (*Boselaphus tragocamelus*)

A female nilgai born here on 13.iii.1968 gave birth to a dead male young for the first time on 1.iv.1971 at the age of 3 years and 20 days. This female had remained with adult males throughout this period. Taking the gestation period as 8 months and 7 days (Asdell, loc. cit.) the age of sexual maturity of this female can be said to be not more than 2 years, 4 months and 13 days or say 2 years and 4 months.

Acharjyo & Misra (1971: *J. Bombay nat. Hist. Soc.* **68** (2): 446) have given the age of sexual maturity of one female nilgai as 2 years and 1 month.

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July 29, 1972.

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MISCELLANEOUS NOTE

2. WEIGHT AND SIZE AT BIRTH OF TWO SPECIES OF WILD MAMMALS IN CAPTIVITY

This note deals with the weight and size at birth of two species of wild mammals observed at Nandankanan Biological Park, Orissa. The weight and measurements were taken within twelve hours of birth.

Jungle Cat (*Felis chaus*)

The four kittens born in one litter on 17.1.1973 weighed from 103 to 126 gm with an average of 111.25 gm and measured from 22 to 24 cm with an average of 22.5 cm from nose tip to tail tip including 6 cm to 7 cm (average 6.5 cm) long tail at birth.

In available literature, there appears to be no report on weight and size of this cat at birth.

Indian Wild Boar (*Sus scrofa cristatus*)

The seven piglets (one out of 4 born in one litter on 10.viii.'72 and 6 born in one litter on 23.ix.1972) weighed from 325 to 665 gm with an average of 557.43 gm and measured from 31.5 to 37 cm with an average of 35 cm from nose tip to tail tip including 4.5 cm to 6 cm (average 5.36 cm) long tail. The shoulder heights were from 14 to 16.5 cm with an average of 15.36 cm. The one young which weighed 325 gm and measured 31.5 cm could not stand without support as it was very weak at birth.

The literature available to us has no report on this subject.

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February 21, 1973.

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MISCELLANEOUS NOTE

3. OCCURRENCE OF FISHING CAT (*FELIS VIVERRINA*) IN ORISSA

A young male of the Fishing Cat (*Felis viverrina*) was caught by some villagers near the village of Balarampur (Keonjhar district, Orissa) on 27-iv-1973 and the animal was received at Nandankanan Biological Park on 27-iv-1973 through the good offices of Sub-Divisional Officer, Anandpur. However, it died soon after its arrival. The animal weighed 3.6 Kg and measured 83 cm from tip to tip including 23 cm long tail. This appears to be the first record of occurrence of this cat in Orissa.

An adult female Fishing Cat received in this Park on 26-vi-1967 through an animal dealer of Calcutta died on 2-iii-1974 after remaining for 6 years, 8 months and 5 days in captivity. The estimated age at the time of death was about 10 years. After death it weighed 6.8 Kg and measured 102 cm including 26 cm long tail. It was fed on a mixed diet of beef and mutton with a chicken once a month and used to take fish whenever offered. It had the peculiar habit of urinating most of the time into the water trough. It was very shy, and kept inside its shelter throughout the day coming out for feeding late in the evening when all the visitors had left and moving about in the enclosure from late evening to early hours of the morning.

Prater (1971)[1] gives the distribution as forests up to 1525 m in the Himalayas and the swamps at the base of the mountains. Parts of Bengal, Uttar Pradesh, and Sind and unknown in the Peninsula of India except in the creeks and backwaters of the Malabar coast between Mangalore and Cape Comorin.

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April 25, 1974.

[1] PRATER, S. H. (1971): The Book of Indian Animals, Bombay Natural History Society, Bombay: 74-75.

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MISCELLANEOUS NOTE

4. A NOTE ON BODY COLOUR AND BREEDING HABITS IN CAPTIVITY OF COMMON PALM CIVET (*PARADOXURUS HERMAPHRODITUS*) OF ORISSA

Prater (1971), has described the normal body colour of the common Palm Civet as 'black or blackish-brown civet with long coarse hair . . . . the new coat, before it is fully grown, generally shows a pattern of longitudinal stripes on the back and spots on the flanks, shoulders and thighs. The limbs are always black or dark brown. Facial markings variable, ...'

Four young common Palm Civets (*Paradoxurus hermaphroditus*) were procured from Simlipal National Park in Mayurbhanj district of Orissa on 8-v-70 at an estimated age of 20 days. Their body colours were:—

(*a*) in two females and one male creamish-white throughout the body coat except the face, head, upper parts of the neck and shoulders from the elbow joints or the middle of the external side of the fore-arms upwards and are large or two small patches at the base of the tail, which were black in colour. The hind limbs and fore-limbs below the elbow joints or middle of the fore-arms were creamish-white. White patches or spots below and above the eyes were present;

(*b*) in the other male the body colour was black except at the tip of the tail of 5 cm length which was creamish-white and white spots below and above the eyes were present.

Breeding:—One of the females described above under (*a*) was allowed to remain with the male, (*b*) at the Nandankanan Biological Park (Orissa) from 6-x-70. Copulation was observed from 30-i-71 to 1-ii-71. On 3-iv-71 the female gave birth to three young (males) (gestation period of 60 days). The colour pattern of the body coat of the young was almost the same as described above under (*a*). The birth weight of the young was from 69 to 102 gm (average of 83 gm) the length from tip to tip was from 28 cm to 30 cm with an average of 29 cm and the tail length was from 11 cm to 13 cm

[1]

with an average of 12·2 cm. The eyes were closed at birth and the young were fully furred. Two of the three young were eaten by the mother within 24 hours of birth. The eyes of living young opened on the 10th day. The young was seen taking banana along with the mother at the age of 6 weeks onwards. The mother carried the young by holding the middle of the body. The young one which weighed 102 gm at birth, weighed 995 gm on 3-vii-71 (3 months).

There is no mention of birth weight and size, gestation period, and age of opening of the eyes of the new born young in the available literature (Prater, loc. cit.; Walker *et al.* 1964; Asdell 1964; Crandall 1965). The litter sizes are given as 3 to 4 (Prater loc. cit.), 3 to 4, sometimes as many as 6 (Asdell loc. cit.) and 2 to 4 (Walker *et al.*, loc. cit.).

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REFERENCES

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction 2nd Edition, Cornell University Press, Ithaca, New York, p. 474.

CRANDALL, LEE S. (1965): The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London. pp. 348-350.

PRATER, S. H. (1971): The Book of Indian Animals. Bombay Natural History Society, pp. 92-93.

WALKER, ERNEST P. *et al.* (1964): Mammals of the World, Vol. II—The John Hopkins Press, Baltimore, p. 1234.

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MISCELLANEOUS NOTE

4. AGE OF SEXUAL MATURITY OF TWO SPECIES OF WILD CARNIVORES IN CAPTIVITY

In this note, an attempt is made to present some information on the age of sexual maturity of two species of wild carnivores observed at Nandankanan Biological Park, Orissa.

Tiger *Panthera tigris* (Linn.)

A female tiger cub with an estimated age of about 7 weeks was received in this Park on 2-xi-1967. She came into heat for the first time on 3-ix-1970 and was allowed to remain with a male tiger born in the Park on 31-vii-1967. Mating was observed during the following periods, 3-ix-1970 to 5-ix-1970; 22-xii-1970 to 25-xii-1970; 2-iv-1971 to 6-iv-1971; 1-vi-1971 to 5-vi-1971; and 23-vii-1971 to 27-vii-1971. A female cub was born on 7-xi-1971. From these facts it can be said that while the first signs of sexual maturity in the female appeared at the age of about 3 years, the male did not reach sexual maturity at least one week before he reached the age of 4 years.

According to Prater (1971) lions and tigers take from 3 to 5 years to become fully adult but males and females are capable of breeding soon after, or even before, they are 3 years old. The first cubbing of a tigress takes place at about the age of four and a tiger is fully grown in about 5 years (Chaturvedi 1970). A female tiger became sexually mature soon after passing the age of 3½ years whereas a male tiger became sexually mature at least 15 days before he reached the age of 4 years (Crandall 1965).

Common Palm Civet or Toddy Cat *Paradoxurus hermaphroditus* (Pallas)

A male common palm civet born in this Park on 3-iv-1971 was allowed to remain with its mother and mating of the young male with the female was first observed from 12-iii-1972 to 14-iii-1972 resulting in the birth of 3 young on 18-v-1972. From these facts the age of sexual maturity of the male common palm civet can be said to be not less than 11 months, 10 days or say 11 months.

The age at which the civets became fully adult is not known (Prater, loc. cit.).

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REFERENCES

CHATURVEDI, M. D. (1970): The Felines. National Book Trust, India, New Delhi, p. 28.

CRANDALL, LEE S. (1965): The Management of Mammals in Captivity. The University of Chicago Press, Chicago and London, p. 387.

PRATER, S. H. (1971): The Book of Indian Animals. Bombay Natural History Society, Bombay pp. 65-93.

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Miscellaneous Note

3. A NOTE ON THE BREEDING HABITS OF FOUR-HORNED ANTELOPE (*TETRACERUS QUADRICORNIS*) IN CAPTIVITY

Specimens of the Fourhorned Antelope or Chowsingha have been received from different parts of Orissa and exhibited at Nandankanan Biological Park, Orissa from time to time. Some notes on the breeding habits of this species observed in this Park are presented here.

So far eleven young have been produced in six births including five twins with an average of 1.83 young per litter. Out of these, 4 were males and 7 were females. The sex ratio of males to females was 1:1.75. The six births were distributed as follows: January, 3; March, 2; and April, 1.

The weight and size at birth of seven young born during 1973 and 1974 were as follows: Weight—from 0.75 to 1.2 kg with an average of 1.04 kg; length from tip to tip—from 42 to 45 cm an average of 43.5 cm and the shoulder height—from 24.5 to 27 cm with an average of 25.2 cm. The one young which weighed 0.75 kg and measured 42 cm at birth died on 13th day.

One female born here on 15-iv-1972 has given birth to a single young for the first time on 12-i-1974 at the age of 1 year, 8 months and 29 days or say 1 year and 9 months. This remained with an adult male throughout this period. Another female received in this Park on 13-v-1971 at an estimated age of about one month gave birth to twin young for the first time on 19-i-1973 at an estimated age of about 1 year and 9 months. This had remained with an adult male from the estimated age of about six months. Taking the gestation period as 8 to 8½ months (Prater 1971) the age of sexual maturity of these two females can be said to be about one year to one year and one month.

One female gave birth thrice during the period from April, 1972 to January, 1974 i.e. 15-iv-1972, 29-iii-1973 and 9-i-1974. So the interparturition interval observed twice in this animal was 347 days and 285 days respectively.

The breeding season is in the hot weather and rains and young are born from October to February (Prater loc. cit.). Asdell (1964) states that in the London Zoo three births had taken place in February and others in May and June and twins were produced in three of the five births. According to Walker *et al.* (1964) mating takes place during the rainy season and the young, one to three in number, are born in January or February.

At birth a fawn of fourhorned antelope weighed 2¼ pounds, measured 15 inches in length and the shoulder height was 10 inches (Shull 1958). The average weight of four young of this species was 1.081 kg, the average length was 46.3 cm and the average shoulder height was 27 cm at birth (Acharjyo & Misra 1972).

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REFERENCES

ACHARJYO, L. N. & MISRA, R. (1972): Cheetal—Journal of Wild Life Preservation Society of India, Vol. *15*, No. 2, pp. 64-67.

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, Second Edition, Cornell University Press, Ithaca, New York, p. 581.

PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay pp. 271-272.

SHIULL, E. M. (1958): Notes on the Fourhorned Antelope *Tetracerus quadricornis* (Blainville). *J. Bombay nat. Hist. Soc.* Vol. *55*, No. 2, pp. 339-340.

WALKER, ERNEST P. (1964): Mammals of the World, Vol. II, The Johns Hopkins Press, Baltimore, p. 1422.

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Miscellaneous Note

4. A NOTE ON INTER-PARTURITION INTERVAL OF SOME CAPTIVE WILD MAMMALS

A sound knowledge of all aspects of reproduction including inter-parturition interval of mammals is necessary for their successful breeding in captivity. It is also necessary for the successful planning of breeding programmes in Zoological Parks. Available literature revealed that there are not many reports on this subject. In this communication an attempt is made to present some information on inter-parturition interval observed among five species of wild mammals at Nandankanan Biological Park, Orissa during the period from 29-xii-1960 to 31-x-1973.

Observations and discussion

African lion (*Panthera leo*)

The details of inter-parturition interval observed in two females of this species are given in Table 1.

Table 1

Name of the lioness.	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	period of separation of the female from the male from the date of last parturition mentioned in col. 3
"Chandrakanti"	26.iii.1967 (1st parturition)	17.vi.1969	2 years, 2 months and 21 days	About 18 weeks
,,	17.vi.1969	9 xi.1970	1 year, 4 months and 22 days	About 6 months
,,	9.xi.1970	3.iv.1971	4 months and 24 days	1 day
,,	3.iv.1971	30.x.1972 (5th parturition)	1 year, 6 months and 26 days	About 5½ months
"Vijayanti"	8.ii.1970 (1st parturition)	19.vii.1970	5 months and 10 days	About 1 month
,,	19.vii.1970	20.x.1971	1 year and 3 months	About 16 weeks
,,	20.x.1971	17.ix.1973 (4th parturition)	1 year, 10 months and 27 days	About 5 months

From this table it can be seen that the inter-parturition interval observed in seven cases among two lionesses varies from 4 months and 24 days to 2 years, 2 months and 21 days with an average of 1 year, 3 months and 23 days. One female gave birth to five litters in a period of 5 years and 8 months whereas another female gave birth to 4 litters in a period of 3 years and 8 months. The minimum intervals of 4 months and 24 days (144 days) and 5 months and 10 days (160 days) were possible as the females lost their cubs and were allowed to remain with

the males within about one day and one month respectively from the date of last parturition.

Young are produced at intervals of at least 18 months to 2 years (Prater 1971). Asdell (1964) states that two litters may be born in a year. Most cats have one or two litters a year, the larger species sometimes breed only every two or three years (Walker *et al.* 1964).

TIGER (*Panthera tigris*)

The details of inter-parturition interval observed in two females of this species are given in Table 2.

TABLE 2

Name of the tigress	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of the female from the male from the date of last parturition mentioned in col. 3
'Sikha'	30.xii.1966 (1st parturition)	31.vii.1967	7 months	About 1 month
"	31.vii.1967	10.iv.1971	3 year, 8 months and 9 days	About 7½ months (The female was kept separately from the male frequently as they fought)
	10.iv.1971	14.xii.1972 (4th parturition)	1 year, 8 months and 3 days	About 9 months
'Rani'	7.xi.1971 (1st parturition)	2.iv.1972	4 months and 25 days	25 days
"	2.iv.1972	22.vi.1973 (3rd parturition)	1 year, 2 months and 19 days	About 9 months

From this it can be seen that the inter-parturition interval observed in five cases among two tigresses varies from 4 months and 25 days to 3 years, 8 months and 9 days with an average of 1 year, 6 months and 5 days. One female could produce 4 litters in about 6 years whereas another could produce 3 litters in 1 year and 8 months. The minimum intervals of 7 months and 4 months and 25 days (164 days) could be possible as the females lost their cubs and were allowed to remain with the males within about 1 month and 25 days respectively from the date of last parturition.

Most cats have one or two litters a year, the larger species sometimes breed only every two or three years (Walker *et al.* loc. cit.). In the wild the interval between two successive cubbings is about three years (Chaturvedi 1970). One tigress of New York Zoological Park produced 11 litters during the period from 1948 to 1959 and that park was in the practice of weaning the tiger cubs when they were between 3½ and 4 months old (Crandall 1965). According to Schaller (1972) in Zoos, where the cubs are usually removed from the mother at birth, one litter

per year is common. At London Zoo a tigress had 8 pregnancies between 1961 and 1964 including 3 births recorded to this female during 1962 (Schaller loc. cit.). Schaller further states that a free living tigress that loses her cubs in some mishap is able to have a new litter within about 5 months.

LEOPARD (*Panthera pardus*)

The details of inter-parturition interval observed in three females of this species are given in Table 3.

TABLE 3

Name of the leopardess	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of the female from the male from the date of last parturition mentioned in col. 3
'Sundari'	9.iv.1967 (1st parturition)	1.xii.1968	1 year, 7 months and 21 days	About 8 months
,,	1.xii.1968	4.vi.1969	6 months and 2 days	4 days
,,	4.vi.1969	31.v.1970	11 months and 26 days	About 14 weeks
,,	31.v.1970	3.viii.1971	1 year, 2 months and 2 days	About 14 weeks
,,	3.viii.1971	20.i.1973 (6th parturition)	1 year, 5 months and 16 days	About 8 months
'Rupa'	12 vi.1969 (1st parturition)	2.xi.1970	1 year, 4 months and 20 days	About 3 months
,,	2.xi.1970	22.iv.1972	1 year, 5 months and 19 days	About 13 weeks
,,	22.iv.1972	2.viii.1973 (4th parturition)	1 year, 3 months and 10 days	About 5 months
'Spotty'	20.i.1971 (1st parturition)	18.vi.1972	1 year, 4 months and 28 days	About 6 months
,,	18.vi.1972	23.vii.1973 (3rd parturition)	1 year, 1 month and 4 days	About 6 months

From this table it can be seen that the inter-parturition interval observed in ten cases among three female leopards varies from 6 months and 2 days to 1 year, 7 months and 21 days with an average of 1 year, 2 months and 27 days. One female produced 6 litters in a period of 5 years and 10 months; a second female produced 4 litters in a period of 4 years, and 2 months whereas a third female produced 3 litters in a period of 2 years and 7 months. The minimum interval of 6 months and 2 days (184 days) was possible as the female was allowed to remain with the male within 5 days from the date of last birth.

A panther produced 3 litters in 3½ years in captivity (Prater loc. cit.). Walker *et al.* (loc. cit.) state that most cats have one or two litters a year, the larger species sometimes breed only every two or three years.

NILGAI (*Boselaphus tragocamelus*)

The details of inter-parturition interval observed in three female nilgais are given in Table 4.

TABLE 4

Particulars of famale Nilgai	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Remarks
Nilgai "A"	5.ii.1966 (1st parturition)	11.ii.1967	370 days	The females remained with the adult males along with there young throughout the period of observation.
"	11.ii.1967	13.iii.1968	395 days	
"	13.iii.1968	16.iii.1969	367 days	
"	16.iii.1969	30 i.1970	319 days	
"	30.i.1970	26.xi.1971	664 days	
"	26.xi.1971	1.ix.1973 (7th parturition)	644 days	
Nilgai "B"	31.xii.1970 (1st parturition)	12.ii.1972 (2nd parturition)	407 days	
Nilgai "C"	1.iv.1971 (1st parturition)	16.ii.1972 (2nd parturition)	320 days	

The inter-parturition interval observed in eight cases among the three females varies from 319 days to 664 days with an average of 436 days. One female produced 7 litters in a period of 7 years and 8 months.

The nilgai breeds immediately after dropping the calves (Asdell loc. cit.).

BLACKBUCK (*Antilope cervicapra*)

The details of inter-parturition interval observed in six cases among three females of this species are given in Table 5.

TABLE 5

Particulars of doe	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Remarks
Blackbuck "A"	20.ii.1972	6.ix.1972	198 days	The does and young remained with adult males throughout the period of observation.
Blackbuck "B"	22 ii.1972	9.ix.1972	199 days	
"	9.ix.1972	25.iii.1973	196 days	
"	25.iii 1973	9.x.1973	197 days	
Blackbuck "C"	25.viii.1972	8 iii.1973	194 days	
"	8.iii.1973	23.ix.1973	198 days	

From this table it can be seen that inter-parturition interval observed in this species varies from 194 days to 199 days with an average of 197 days.

In England the blackbuck breeds twice a year (Asdell loc. cit.). One fawn per year appears to be the rule among blackbuck (Schaller loc. cit.). According to Taibel (1937) one captive doe gave birth to 6 single fawns between June, 1931 and May, 1935 and another to 5 fawns between October, 1933 and February, 1937, less than a year elapsing between some births.

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DIST. CUTTACK

WILD LIFE CONSERVATION OFFICER, R. MISRA
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December 17, 1973.

REFERENCES

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, Second Edition, Cornell University Press, Ithaca, New York, pp. 491-617.

CHATURVEDI, M. D. (1970): The Felines, National Book Trust, India, New Delhi, pp. 27.

CRANDALL, LEE S. (1965): The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London, pp. 359-677.

PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural Historoy Society, Bombay, pp. 65-273.

SCHALLER, GEORGE B. (1972): The Deer and The Tiger. The University of Chicago Press, Chicago and London, pp. 149-233.

TAIBEL, A. (1937): Cited by Schaller, George B. (1972).

WALKER, ERNEST P. *et al.* (1964): Mammals of the World, Volume II. The Johns Hopkins Press, Baltimore, pp. 1268-1457.

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MISCELLANEOUS NOTE

3. A NOTE ON THE BREEDING OF THE INDIAN FOX (*VULPES BENGALENSIS*) IN CAPTIVITY

The mating of a pair of Indian Fox (*Vulpes bengalensis*) was observed twice on 7-ii-75 and once on 8-ii-75 at Nandankanan Biological Park, Orissa. They mated just like domestic dogs and remained tied for several minutes. During copulation either they remained standing or the female moved pulling the tied male along. This female gave birth to four female cubs on 30-iii-75 after an observed gestation period of 50-51 days. The young measured 18.5 cm to 19 cm including the tail length of 5.5 cm to 6 cm and weighed 52 to 65 gm. The eyes of all the four cubs were closed at birth. As the mother rejected the young, all the young died within 24 hours of birth. The female weighed 2.4 kg and the male 2.6 kg on 1-iv-75.

This species mates from November to January and has 4 young, born from February to April (Asdell 1964). According to Prater (1971) the main breeding season is cold weather, cubs usually four in number are born between February and April and the period of gestation is about 51-53 days in the fox.

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REFERENCES

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, Second Edition. Cornell University Press, Ithaca, New York, pp. 440.

PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay, pp. 123-130.

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MISCELLANEOUS NOTE

2. SOME NOTES ON THE BREEDING HABITS AND GROWTH OF THE MALAYAN GIANT SQUIRREL (*RATUFA BICOLOR*) IN CAPTIVITY

Acharjyo & Misra [1973: *J. Bombay nat. Hist. Soc.* *70*(2):375] reported on the birth of a female Malayan Giant Squirrel (*Ratufa bicolor*) young on 15th July 1972 at Nandankanan Biological Park, Orissa.

Further five births were recorded to the female of the same pair of Malayan Giant Squirrels in the same Park as follows: March, 1; April, 2; September, 1; and December, 1. The litter size was always one. There were 3 males and 2 females. The eyes of all the young were closed at birth and the eyes of one young under observation opened on the 27th day.

At birth the young weighed 58 to 89 gm with a mean of 74.5 gm and measured 25.5 to 29.5 cm with a mean of 27.3 cm including tail lengths of 11 to 13 cm with a mean of 12.1 cm. The details of inter-parturition interval observed in this female which was living with her mate throughout the period of observation is given in Table 1.

From this table it can be seen that inter-parturition interval varies from 94 to 407 days mainly depending on the period of survival of the young. This female could give birth to six litters within a period of less than 3 years.

The incisors of the lower jaw of one young born here on 8-iii-1973 appeared in the second week and that of the upper jaw appeared in the fifth week. Whenever required, the mother

TABLE 1

Date of last parturition	Date of subsequent parturition	Inter-parturition interval in days	Remarks
15-vii-1972	8-iii-1973	235	The young of 15-vii-1972 died on 17-ix-1972.
8-iii-1973	20-iv-1974	407	The young of 8-iii-1973 is living till the time of this report.
20-iv-1974	13-ix-1974	145	The young of 20-iv-1974 died on 21-iv-1974.
13-ix-1974	17-xii-1974	94	The young of 13-ix-1974 died on 15-ix-1974.
17-xii-1974	19-iv-1975	122	The young of 17-xii-1974 died on 19-xii-1974.

TABLE 2

Dates	Age in weeks	Weight in Kg.
8-iii-1973	Birth	0.0745
5-iv-1973	4	0.227
3-v-1973	8	0.590
31-v-1973	12	1.010
28-vi-1973	16	1.375
26-vii-1973	20	1.795
23-viii-1973	24	2.032
20-ix-1973	28	2.135
18-x-1973	32	2.200
15-xi-1973	36	2.200
13-xii-1973	40	2.150
10-i-1974	44	2.230
7-ii-1974	48	2.310
7-iii-1974	52	2.370
4-iv-1974	56	2.535
9-v-1974	61	2.730
6-vi-1974	65 (15 months)	2.770
4-vii-1974	69	2.740
8-viii-1974	74	2.750
8-ix-1974	78 (18 months)	2.755

used to lift the baby with the teeth mostly by holding the base of one of the hind limbs. At times just before moving with the baby, the mother used to handle the baby with her fore-limbs, probably to enable her to have a good grip of the baby with the teeth. The mother weighed 2.7 kg and the male 1.83 kg on 29-vii-1973. Other observations are more or less simliar to those observed earlier by Acharjyo & Misra (loc. cit.). The one female young born here on 8-iii-1973 with a weight of 74.5 gm at birth, attained her maximum weight of 2.770 kg at the age of 65 weeks (15 months). Weekly weight growth records were taken at the end of each week and an abstract of the same is given in Table 2.

Once the male was seen carrying the baby born here on 19-iv-1975 and gnawing the left hind limb within a few hours of birth. The mother followed the male attempting to save the baby. However, on our intervention the injured young was dropped by the male. Later the young died from the injuries.

Acharjyo & Misra (loc. cit.) stated that one female young weighed 77 gm, measured 29.5 cm including the 12.5 cm long tail and the eyes of this young opened on the 22nd day. They further stated that at the age of two months the young measured 59 cm in total length and weighed 445 grams. Nothing exact is known of the breeding habits of the giant squirrels (Prater, S. H., 1971: THE BOOK OF INDIAN ANIMALS).

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ACKNOWLEDGEMENTS

We are grateful to Shri S. Jee, I.F.S., Chief Conservator of Forests, Orissa and to Shri S. N. Das, I.F.S., Conservator of Forests, Development Circle, Cuttack for the facilities and to Shri N. Das of Bhubaneswar for the photographs.

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MISCELLANEOUS NOTE

4. NOTES ON A YOUNG HYBRID MACAQUE
(With a photograph)

A female Assamese Macaque (*Macaca assamensis*) living with a group of five Stumptailed Macaques of both sexes and one male Pigtailed Macaque preferred to escape into an adjacent enclosure occupied by one adult male and one young female Bonnet Macaque (*Macaca radiata*) in March 1974 at Nandankanan Biological Park, Orissa. Several attempts were made to separate her from the Bonnet Macaques without success.

A male hybrid macaque young was born to this female Assamese Macaque and the male Bonnet Macaque on 9-iii-1975. The hybrid baby was born completely covered with hair and with its eyes open. In the crown hair of the head, the shape of the ears and the length and shape of the tail it resembled the father. The colour of the body coat resembled that of the mother.

There appears to be no record of such a hybrid in the available literature (Gray, A. P., 1972; MAMMALIAN HYBRIDS Commonwealth Agricultural Bureaux, Farnham Royal, Slough, England).

We are thankful to Shri P. K. Patnaik, Bhubaneswar for the photograph.

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Photo. 1. The Assamese Macaque (*Macaca assamensis*) mother with her six weeks old hybrid baby.

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MISCELLANEOUS NOTE

5. LONGEVITY OF TWO SPECIES OF INDIAN MONGOOSES IN CAPTIVITY

The present report embodies observations on the longevity of two species of Indian mongoose in captivity at Nandankanan Biological Park, Orissa.

SMALL INDIAN MONGOOSE (*Herpestes auropunctatus*). A full-grown adult male of this species received in the Park on 5-ii-1967 died on 27-ix-1975, i.e. after 8 years, 7 months and 23 days in captivity. The estimated age at the time of death was about 9 years and 8 months. This was housed in a small enclosure having a cemented floor space of approximately 3.25 sq. metres and with provisions of a wooden sleeping box and a water trough. It was kept either alone or with common mongooses and maintained very good health on a mixed diet of fish, snail-flesh and banana.

CRABEATING MONGOOSE (*Herpestes urva*). An adult male of this species received in the Park on 24-i-1965 died on 11-i-1975, i.e. after 9 years, 11 months and 19 days. The estimated age at the time of death was about 12 years. It was living in an enclosure having a cemented floor space of approximately 5.25 sq. metres and was provided with a wooden sleeping box and a water trough. It was kept with two females of the same species from 1971 onwards. As already reported by Acharjyo & Misra (1972) it maintained excellent health on a diet of fish and snails.

Prater (1971) states that the smaller species of mongooses like the Small Indian Mongoose live from seven to eight years, whilst the larger forms like the big Stripednecked Mongoose, may have a life span of 13 years and more. The life span of the genus *Herpestes* is given as 7 to 12½ years (Walker *et al.* 1964). Longevity records of these two species are not given by Crandall (1965). According to Blanford (1888-91) fruit is sometimes included in the diet of the Indian Mongoose, but this could not be supported by Crandall (loc. cit.).

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REFERENCES

ACHARJYO, L. N. & MISRA, R. (1972): On the feeding habits of Crabeating Mongoose (*Herpestes urva*) in captivity. *J. Bombay nat. Hist. Soc.* 69(2): 411-412.

BLANFORD, W. T. (1888-91): The Management of Wild Mammals in captivity. By Crandall, Lee S. (1965).

CRANDALL, Lee S. (1965): The Management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London, pp. 352-354.

PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition. Bombay Natural History Society, Bombay, pp. 96-105.

WALKER, ERNEST P. *et al.* (1964): Mammals of the world, Vol. II. The Johns Hopkins Press, Baltimore, pp. 1249-1250.

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MISCELLANEOUS NOTE

2. SOME OBSERVATIONS ON THE BREEDING HABITS AND GROWTH OF JUNGLE CAT (*FELIS CHAUS*) IN CAPTIVITY

The present communication dealing with the breeding habits and growth upto the age of six months of the Jungle Cat (*Felis chaus*) is based on the observations made at Nandankanan Biological Park, Orissa.

So far eight births were recorded in this Park as follows: January, 2; March, 1; April, 2; August, 1; and November, 2. Three kittens per litter were born on five occasions, four on two occasions and five on one occasion with an average of 3.5 kittens per litter. There were eight females and twenty males, the sex ratio of females to males being 1:2.5. The weight and size at birth of 24 kittens born during the period from 12-iv-1973 to 7-xi-1975 were as follows: weight—from 83 to 125 gm with an average of 106.21 gm; length from nose tip to tail tip—from 22 to 26 cm with an average of 23.17 cm including the tail lengths of 5.5 to 6.5 cm with an average of 6.08 cm.

The eyes of the kittens were closed at birth and 11 kittens under observation opened their eyes on 11th day (3 kittens), 12th day (3 kittens), 13th day (2 kittens), 13th and 14th day (2 kittens—one eye on each day) and 15th day (1 kitten). The inter-parturition interval varied from 75 to 272 days mostly depending on the period of survival of the young after birth. One female could give birth to four litters in one year in 1973 as all the kittens were killed by the mother or died within 2 to 16 days after birth.

Weekly growth records of three kittens born in one litter on 7-xi-1975 were maintained upto the age of six months and an abstract of the same is given in the table.

Date	Age in weeks	Weight in Kg.		
		♀.	♂	♂
7-xi-1975	Birth	0.115	0.125	0.107
21-xi-1975	2	0.283	0.281	0.268
5-xii-1975	4	0.445	0.430	0.417
19-xii-1975	6	0.615	0.648	0.645
2-i-1976	8	0.775	0.878	0.840
16-i-1976	10	0.935	1.200	1.180
30-i-1976	12	1.005	1.475	1.450
13-ii-1976	14	1.085	1.685	1.635
27-ii-1976	16	1.185	1.900	1.825
12-iii-1976	18	died on 10-iii-1976	2.160	2.010
26-iii-1976	20	—	2.260	2.085
9-iv-1976	22	—	2.170	2.020
23-iv-1976	24	—	2.330	1.980
7-v-1976	26 (6½ months)	—	2.332	2.030

The mother after giving birth to these three kittens weighed 4.575 kg. The kittens were brown in colour and helpless at birth. The mother used to carry the kittens in the usual manner of cats.

Little definite is known about the breeding habits of this cat (Prater 1971).

Asdell (1964) states that this cat has two litters a year in India, usually 3 to 4 young. He further states that the young are born in May and November in South India.

The eyes of new-born jungle cat kittens were closed at birth and two kittens under observation opened their eyes on the eleventh day (Acharjyo & Misra 1973). The four kittens born in one litter weighed from 103 to 126 gm with an average of 111.25 gm and measured from 22 to 24 cm with an average of 22.5 cm from nose tip to tail tip including 6 cm to 7 cm long tail at birth (Acharjyo & Misra 1974).

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We are grateful to Sri S. Jee, I.F.S. Chief Conservator of Forests, Orissa, Cuttack and to Shri G. M. Das, I.F.S., Chief Wildlife Warden, Orissa, Bhubaneswar for the facilities provided.

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REFERENCES

ACHARJYO, L. N. & MISRA, R. (1973): Cheetal—Journal of Wildlife Preservation Society of India. Vol. *15*(4):49-55.

———— (1974): Weight and size at birth of two species of Wild mammals in captivity. *J. Bombay nat. Hist. Soc.*, *71*(1):137-138.

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, Second Edition, Cornell University Press, Ithaca, New York, pp. 490.

PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay, pp. 75-76.

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MISCELLANEOUS NOTE

9. SEX RATIO AT BIRTH IN SOME CAPTIVE WILD MAMMALS

The determination of accurate sex ratio at birth of wild mammals is only possible from the birth records in captivity. From the available literature, it appears that the information available on this subject is limited. This paper presents the data pertaining to sex ratio at birth of 17 species of wild mammals observed at Nandankanan Biological Park, Orissa during the past 15 years (from 29-12-1960 to 31-12-1975). The details of our observations are given in the table below.

A study of this table reveals that there is a remarkable uneven sex ratio at birth with the females outnumbering the males in five species, Tiger, Golden Cat, Hog-Deer, Indian Sambar and Mouse-Deer; whereas the males outnumber the females in eight species, African Lion, Leopard, Common Palm Civet, Common Mongoose, Nilgai, Spotted Deer, Barking Deer and Blackbuck. The number of observations made on four species, Jackal, Rhesus Macaque, Bonnet Macaque and Slow Loris are inadequate to come to any conclusion. However it is felt that much more observations are necessary to confirm these findings.

Discussion

Thirty-two tiger (*Panthera tigris*) cubs were born in eleven litters to one tigress from 1948 to 1959 at New York Zoological Park, the divisions of sexes being nineteen males and thirteen females (Crandall 1965). According to Schaller (1972) the sex ratio of 196 tiger cubs at birth in various Zoological Gardens was 100 males to 100 females. He further states that on 121 occasions adult tigers were encountered in the wild and of these 102 were females and 19 were males, a ratio of about 5:1.

Schaller (loc. cit.) states there were 10 males and 13 females among 25 newborn spotted deer (*Axis axis*) fawns in the Cal-

Table

Species of Mammals	Total	Males	Females	Sex ratio (No. of males to 100 females)
Tiger (*Panthera tigris*)	18	6	12	50:100
African Lion (*Panthera leo leo*)	21	12	9	133.3:100
Leopard (*Panthera pardus*)	38	22	16	137.5:100
Golden Cat (*Felis temmincki*)	8	3	5	60:100
Jackal (*Canis aureus*)	3	1	2	50:100
Common Palm Civet (*Paradoxurus hermaphroditus*)	30	21	9	233.3:100
Common Mongoose (*Herpestes edwardsi*)	6	5	1	500:100
Rhesus Macaque (*Macaca mulatta*)	3	2	1	200:100
Bonnet Macaque (*Macaca radiata*)	3	1	2	50:100
Slow Loris (*Nycticebus coucang*)	2	1	1	100:100
Spotted Deer (*Axis axis*)	143	73	70	104.3:100
Hog-deer (*Axis porcinus*)	9	3	6	50:100
Indian Sambar (*Cervus unicolor niger*)	73	31	42	73.8:100
Barking Deer (*Muntiacus muntjak*)	62	33	29	113.8:100
Mouse-Deer (*Tragulus meminna*)	6	1	5	20:100
Nilgai (*Boselaphus tragocamelus*)	14	10	4	250:100
Blackbuck (*Antilope cervicapra*)	39	21	18	116.7:100

cutta Zoological Garden, but figures from such a small sample have little relevance. He further states that the disproportion of adult spotted Deer in the wild may be due either to an unequal sex ratio at birth, a higher mortality of male fawns, or both. About Hog-Deer (*Axis porcinus*) Schaller (loc. cit.) states that the sex ratio of adults was about equal or favoured the does only slightly, in contrast to the Spotted Deer which has a disproportionate sex ratio favouring females.

From his study at Kanha National Park, Schaller (loc. cit.) states that Sambar (*Cervus unicolor*) hinds outnumbered the stags by a ratio of about 3:1 and the reason for this great disproportion of the sexes is unknown, but it may be due to selective predation on the males, both as fawns and as adults and perhaps also to an unequal sex ratio at birth.

The ratio of bucks to 100 does among Blackbucks of Kanha National Park on July 1, 1964 was 71:100 whereas in the same Park the sex ratio on June 3, 1965 was 45 bucks: 100 does (Schaller, loc. cit.). He further states that at Sikandra the captive herd showed a higher proportion of bucks (84:100) than the free-living population.

The sex ratio of 36 births of Rhesus Macaque (*Macaca mulatta*) as given by Asdell (1964) was exactly even.

Information on sex ratio of other species mentioned in the table was not available to us from literature.

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We are grateful to Shri S. Jee, I.F.S., Chief Conservator of Forests, Orissa and Shri S. N. Das, I.F.S., Conservator of Forests, Development Circle, Cuttack for providing the facilities for the study.

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REFERENCES

ASDELL, S. A. (1964): Patterns of Mammalian reproduction. (Second Edition), Cornell University Press, Ithaca, New York.

CRANDALL, LEE S. (1965): The Management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London.

SCHALLER, GEORGE B. (1972): The Deer and the Tiger. A study of wildlife in India. The University of Chicago Press, Chicago and London.

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MISCELLANEOUS NOTE

2. BIRTH AND GROWTH OF COMMON PALM CIVET (*PARADOXURUS HERMAPHRODITUS*) IN CAPTIVITY

A pair of Common Palm Civets (*Paradoxurus hermaphroditus*) are housed in an enclosure measuring 4.1 x 3.4 x 1.7 m at the Nandankanan, Biological Park, Orissa. Two wooden sleeping boxes measuring 0.6 x 0.3 x 0.2 m have been provided. They are fed with minced meat, fish, snail flesh, banana, milk and boiled rice.

The female of this pair gave birth to three young (one female and two males) in one litter on 30.4.1975. The young were fully furred and were able to produce a kind of feeble noise when handled within a few hours after birth. Their eyes were closed at birth and opened on the 8th day (male), 10th day (female) and 11th day (male). At birth, the three young weighed 92 to 98 grammes and measured 28.5 to 30.5 cm from tip to tip including tail lengths of 12 to 13 cm. The mother weighed 2.975 kg and the male weighed 3.985 kg on 1.5.1975. Weekly growth records of the three young were maintained upto the age of 11 months and an abstract of the same is given below:

At the age of 11 months the three young apparently looked as large as the present.

Acharjyo & Tripathy (1974) have given the weight at birth of three males as 69 to 102 gm and length from tip to tip as 28 to 30 cm including tail lengths of 11 to 13 cm. They further stated that one young male weighed 995 gm. at the age of 3 months. The young of this species open their eyes in six to ten days (Acharjyo & Misra 1973). The age at which the civets become fully adult is not known (Prater 1971).

Date	Age in weeks	Weight in Kg.		
		Female	Male	Male
30.iv.1975	At birth	0.098	0.092	0.093
14.v.1975	2	0.227	0.244	0.248
28.v.1975	4	0.390	0.417	0.400
11.vi.1975	6	0.475	0.520	0.510
25.vi.1975	8	0.725	0.750	0.725
9.vii.1975	10	0.865	0.880	0.895
23.vii.1975	12	1.008	0.970	1.020
6.viii.1975	14	1.198	1.067	1.187
20.viii.1975	16	1.240	1.120	1.280
3.ix.1975	18	1.225	1.000	1.260
17.ix.1975	20	1.465	1.235	1.545
1.x.1975	22	1.658	1.430	1.592
15.x.1975	24	1.455	1.480	1.587
29.x.1975	26	1.420	1.680	1.560
12.xi.1975	28	1.480	1.805	1.780
26.xi.1975	30	1.652	1.880	1.970
10.xii.1975	32	1.605	1.800	1.940
24.xii.1975	34	1.880	2.010	2.250
7.i.1976	36	2.005	2.200	2.485
21.i.1976	38	2.190	2.280	2.525
4.ii.1976	40	2.555	2.295	2.550
18.ii.1976	42	2.265	2.285	2.540
3.iii.1976	44	2.265	2.305	2.520
17.iii.1976	46	2.280	2.325	2.560
31.iii.1976	48 (11 months)	2.505	2.380	2.585

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REFERENCES

ACHARJYO, L. N. AND MISRA, R. (1973): Cheetal-Journal of Wild Life Preservation Society of India, *15* (4):49-55.

ACHARJYO, L. N. AND TRIPATHY, A. P. (1974): A note on body colour and breeding habits in captivity of Common Palm Civet (*Paradoxurus hermaphroditus*) of Orissa. *J. Bombay nat. Hist. Soc.* *17*(3):601-603.

PRATER, S. H. (1971): The Book of Indian Animals. Bombay Natural History Society, Bombay, p. 88.

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MISCELLANEOUS NOTE

3. A NOTE ON THE BREEDING AND LONGEVITY OF THE INDIAN PANGOLIN (*MANIS CRASSICAUDATA*) IN CAPTIVITY

A pair of adult Indian Pangolins (*Manis crassicaudata*) was acquired for the Nandankanan Biological Park, Orissa. The female arrived on 16th July 1973 and the male arrived on 16th July 1976. They were housed in an enclosure measuring 2.5 × 1.5 × 2 m. high. Attached to the enclosure is a dark sleeping den measuring 0.85 × 0.5 × 0.5 m high. They remain curled up throughout the day in the sleeping den and became active from late evening to early morning. They sometimes climb up a cement tree erected inside the enclosure. They are fed with red tree ants (adults, young and eggs) every evening at the rate of 600 gms per day per adult and occasionally some termites with combs.

A male young was born to the female of this pair on 7-4-1977 early morning but the young was found dead on 8-4-1977. The young measured 33 cm tip to tip including 12 cm long tail and weighed 242 g. The eyes were open and the scales were soft at birth. The mother Pangolin weighed 7.920 Kg and the male weighed 9.250 Kg on 10-4-1977.

The female Pangolin died on 1 December 1977 establishing a longevity of 4 years, 4 months and 16 days in captivity. The details of other five Indian Pangolins which have lived for over 1 year in the Park on a diet of red tree ants and termites are as follows.

Sl. No.	Date of arrival in the Park	Date of death in the Park	Period of survival in the Park
1	31-7-1972	3-12-1974	2 years, 4 months and 4 days.
2	3-11-1973	19-5-1976	2 years, 6 months and 17 days.
3	22-6-1976	26-12-1977	1 year, 6 months and 5 days.
4	16-7-1976	Living on the day of this report	Over 1 year and 8 months.
5	25-9-1976	Living on the day of this report	Over 1 year and 6 months.

There are records of birth of this species in India in July (Prater 1971) and November (Asdell 1964; Acharjyo and Misra 1972). The litter size is usually 1 and occasionally 2 (Asdell, loc. cit.). A new-born young measured 30 cm from tip to tip including 12.5 cm long tail and weighed 235 grams (Acharjyo and Misra, loc. cit.).

A Pangolin lived in captivity for 2 years (Prater, loc. cit.). According to Yadav (1973) Jaipur Zoo has reared Pangolins for a period of over six months. 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 (Crandall 1965). Narayanan (1977) reports that one Pangolin survived for a little more than 2 years in captivity at USPHS—JIPMER Leprosy Research Project, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry.

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REFERENCES

ACHARJYO, L. N. AND MISRA, R. (1972): Birth of an Indian Pangolin (*Manis crassicaudata*) in captivity. *J. Bombay nat. Hist. Soc. 69* (1): 174-175.

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction. Second Edition, Cornell University Press, Ithaca, New York, pp. 182.

CRANDALL, LEE, S.(1965): The Management of Wild Manmals in Captivity. The University of Chicago Press, Chicago and London, pp. 195-199.

NARAYANAN, E. (1977): Pers. Comm.

PRATER, S. H. (1971): The Book of Indian Animals. Third (Revised) Edition, Bombay Natural History Society, Bombay, pp. 301-303.

YADAV, R. N. (1973): Rearing of Indian Pangolin. *Indian Zoo Bulletin*, 1(1): pp. 16.

References

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, Second Edition, Cornell University Press, Ithaca, New York, pp. 425-493.

CRANDALL, LEE S. (1965): The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London, pp. 359-385.

PRATER, S. H. (1971): The Book of Indian Animals, Bombay Natural History Society, Bombay, pp. 63-66.

SADLEIR, R. (1966): Cited by Schaller, G. B. (1972).

SCHALLER, G. B. (1972): The Deer and the Tiger. The University of Chicago Press, Chicago and London, pp. 231.

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3. A NOTE ON THE BREEDING OF THE LEOPARD-CAT (*FELIS BENGALENSIS*) IN CAPTIVITY

The female of a pair of Leopard-Cats (*Felis bengalensis*) has given birth to four litters at Nandankanan Biological Park, Orissa. The litter size was one to two with an average of 1.75 kittens per litter. There were four females and three males. The four births were recorded as follows: February, 1; March, 1; May, 1; and July, 1. At birth the seven kittens weighed 93 to 120 g with an average of 113.14 g and measured 22 to 25 cm with an average of 24.14 cm tip to tip including tail lengths of 6.5 to 7 cm (average 6.86 cm). The inter-parturition intervals recorded thrice (Dates of births: 26.ii.1977, 19.v.1977, 21.iii. 1978 and 4.vii.1978) were 81 days, 305 days and 104 days respectively mostly depending on the period of survival of the young. The mother leopard-cat weighed 2.805 kg and the male weighed 3.605 kg on 8.iii.1977. The mother used to carry the kittens like other cats. The eyes of the new-born kittens were closed at birth and the details of opening of eyes of five kittens under observation are given in the Table 1.

TABLE 1 .

Sl. No.	Sex	Date of birth	Dates of opening of eyes	Age in the days when the eyes of the kittens opened
1	2	3	4	5
1.	Female	19.v.1977	31.v.1977 (Left eye) and 1.vi.1977 (Right eye)	13th (Left eye) and 14th (Right eye)
2.	Female	19.v.1977	26.v.1977 (Right eye) and 27.v.1977 (Left eye)	8th (Right eye) and 9th (Left eye)
3.	Female	21.iii.1978	31.iii.1978 (Left eye) and 1.iv.1978 (Right eye)	11th (Left eye) and 12th (Right eye)
4.	Female	4.vii.1978	11.vii.1978 (Left eye) and 12.vii.1978 (Right eye)	8th (Left eye) and 9th (Right eye)
5.	Male	4.vii.1978	14.vii.1978 (Right eye) and 15.vii.1978 (Left eye)	11th (Right eye) and 12th (Left eye)

TABLE 2

Date	Age in weeks	Weight in kg.
1	2	3
19.v.1977	Birth weight	0.120
26.v.1977	1	0.182
2.vi.1977	2	0.232
9.vi.1977	3	0.294
16.vi.1977	4	0.385
23.vi.1977	5	0.430
30.vi.1977	6	0.570
7.vii.1977	7	0.695
14.vii.1977	8	0.845
21.vii.1977	9	0.945
28.vii.1977	10	1.073
4.viii.1977	11	1.156

The canines of two kittens under observation appeared at the age of four weeks. Weekly growth records of one female kitten born here on 19.5.1977 was maintained upto the age of 11 weeks and the details of the same are given in the Table 2.

Prater (1971) states that the young of this species have been obtained in March and May and 3 to 4 kittens may be born in a litter. In India, this species mates in May and has 3 to 4 young per litter after a gestation period of 56 days (Asdell 1964).

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REFERENCES

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction. Second Edition, Cornell University Press, Ithaca, New York, pp. 490.

PRATER, S. H. (1971): The Book of Indian Animals. Third (Revised) Edition, Bombay Natural History Society, Bombay, pp. 73-74.

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6. LITTER SIZE OF SOME CAPTIVE WILD MAMMALS

This note presents some data on litter size of nineteen species of captive wild mammals observed at Nandankanan Biological Park, Orissa. The details of our observations are given in the Table.

TABLE

Serial No.	Species of mammal	Period of observation	No. of births recorded (Total no. of young born during the period)	Litter size (No. of births)	Average litter size
(1)	(2)	(3)	(4)	(5)	(6)
1.	TIGER (*Panthera tigris*)	1.7.1969 to 31.3.1978	8 (19)	1 (1) 2 (3) 3 (4)	2.38
2.	LION (*Panthera leo*)	1.7.1969 to 31.3.1978	13 (24)	1 (3) 2 (9) 3 (1)	1.85
3.	LEOPARD (*Panthera pardus*)	1.7.1969 to 31.3.1978	22 (54)	1 (2) 2 (12) 3 (6) 4 (1) 6 (1)	2.45
4.	GOLDEN CAT (*Felis temminckii*)	1.4.1972 to 31.3.1978	4 (5)	1 (3) 2 (1)	1.25
5.	JUNGLE CAT (*Felis chaus*)	1.7.1976 to 31.3.1978	2 (8)	3 (1) 5 (1)	4.00
6.	COMMON PALM CIVET (*Paradoxurus hermaphroditus*)	1.4.1964 to 31.3.1978	12 (36)	2 (3) 3 (7) 4 (1) 5 (1)	3.00
7.	COMMON MONGOOSE (*Herpestes edwardsi*)	1.7.1969 to 31.3.1978	1 (2)	2 (1)	2.00
8.	JACKAL (*Canis aureus*)	1.4.1964 to 31.3.1978	1 (3)	3 (1)	3.00
9.	RHESUS MACAQUE (*Macaca mulatta*)	1.7.1969 to 31.3.1978	7 (7)	1 (7)	1.00
10.	BONNET MACAQUE (*Macaca radiata*)	1.7.1969 to 31.3.1978	3 (3)	1 (3)	1.00

11.	INDIAN WILD BOAR (*Sus scrofa cristatus*)	1.4.1969 to 31.3.1978	40 (179)	1 (2) 2 (4) 3 (4) 4 (10) 5 (9) 6 (5) 7 (6)	4.48
12.	SAMBAR (*Cervus unicolor*)	1.7.1969 to 31.3.1978	60 (60)	1 (60)	1.00
13.	SPOTTED DEER (*Axis axis*)	1.7.1969 to 31.3.1978	74 (74)	1 (74)	1.00
14.	HOG DEER (*Axis porcinus*)	1.7.1966 to 31.3.1978	13 (13)	1 (13)	1.00
15.	BARKING DEER (*Muntiacus muntjak*)	1.7.1969 to 31.3.1978	23 (23)	1 (23)	1.00
16.	MOUSE DEER (*Tragulus meminna*)	1.7.1969 to 31.3.1978	6 (6)	1 (6)	1.00
17.	NILGAI (*Boselaphus tragocamelus*)	1.7.1969 to 31.3.1978	7 (8)	1 (6) 2 (1)	1.14
18.	BLACKBUCK (*Antelope cervicapra*)	1.7.1969 to 31.3.1978	64 (64)	1 (64)	1.00
19.	FOURHORNED ANTELOPE (*Tetracerus quadricornis*)	1.4.1974 to 31.3.1978	5 (8)	1 (2) 2 (3)	1.60

The observations of some of the earlier workers on litter size of these nineteen species of wild mammals along with a study of the above table follows.

TIGER: The litter size of eight births of this species in this park was from 1 to 3 with an average of 2.38 cubs.

The size of 79 litters born in zoos was 1 to 5 with an average of about 2.8 (Schaller 1972). The litter size is usually 2 to 3 but as many as 6 may be produced (Prater 1971). The litter size varies from 1 to 7 (Brander 1923).

LION: The litter size of thirteen births was from 1 to 3 with an average of 1.85 cubs.

The average of 64 lion litters in captivity was 2.5 (Cooper 1942). The usual litter size is 2, sometimes 3 and it may contain as many as 5 (Prater loc. cit.). The number of cubs per litter is 1 to 6 with an average of 3.04 and the litter size of one birth in one lioness in Dublin was 7 including three dead ones (Steyn 1951).

LEOPARD: The litter size of 22 births at this Park was from 1 to 6 with an average of 2.45 cubs. The birth of 6 cubs in one litter, observed

in this Park, appears to be the maximum so far recorded.

The usual litter size is 2 to 4 (Prater, loc. cit.). The litter size of 27 births of leopards in the Zoological Gardens of London from 1839 to 1937 was 1 to 3 (Zuckerman 1953). The litter size of 39 births in Delhi Zoological Park was 1 to 3 with an average of 1.6 cubs (Desai 1975). The litter size of four births was 1 to 2 (Acharjyo 1970).

GOLDEN CAT: The litter size of four births of this species was 1 or 2 with an average of 1.25 kittens per litter.

The litter size of one birth is one (Acharjyo 1971), of two births is 1 to 2 (Acharjyo and Misra 1973) and 2 (Prater, loc cit.).

JUNGLE CAT: The litter size of two births was 3 and 5 with an average of 4 kittens per litter.

Acharjyo and Mohapatra (1977) state that the litter size of eight births of this species was from 3 to 5 with an average of 3.5 kittens per litter. Usually 3 to 4 young are born per litter (Asdell 1964).

COMMON PALM CIVET: The litter size of 12 births of this species was from 2 to 5 with an average of 3 young per litter.

The usual litter size is 3 to 4 (Prater, loc cit.) and 3 to 4 but sometimes as many as 6 (Asdell, loc. cit.).

COMMON MONGOOSE: Only one birth with two young per litter was recorded.

The litter size is small, usually 2 to 3 (Prater, loc. cit.). The litter size of two births was 1 and 3 respectively (Acharjyo 1970).

JACKAL: Only one birth with three young per litter was recorded.

The number of young per litter varies from 2 to 6, mode 5, and mean 4 (Asdell, loc. cit.).

RHESUS MACAQUE: The litter size of seven births was always one.

All primates usually produce their young singly but occasionally twins are born (Prater, loc. cit.). Twins in this species are born about once in 90 to 100 births (Asdell, loc. cit.).

BONNET MACAQUE: The litter size of three births was always one.

INDIAN WILD BOAR: The litter size of 40 births was from 1 to 7 with an average of 4.48.

The litter size of this species is 4 to 6 (Prater, loc. cit.). The litter size of five births was from 4 to 7 young (Zuckerman, loc. cit.).

SAMBAR: The litter size of 60 births was always one and never twins.

One to two fawns are usually born per litter (Asdell, loc. cit.). One pair of twins was born in 41 births (Crandall 1965). Always single young was born to the 30 births recorded at Nandankanan Biological Park, Orissa upto 30th June 1969 (Acharjyo 1970). A single fawn per litter is the rule (Schaller 1972).

SPOTTED DEER: Always single young per litter was recorded at all the 74 births.

Usually one young per litter is born (Prater, loc. cit.). Only one pair of twins was noted in 225 births (Crandall, loc. cit.). Twins have been born only once in 80 births in the London Zoo (Asdell, loc. cit.). The litter size of 99 births was always one and never twins (Acharjyo 1970). One to three is usual with twins being common (Brander, loc. cit.). There were no twins in the 25 births at the Calcutta Zoo and 97 births at the Bombay Zoo (Schaller, loc. cit.).

HOG DEER: The litter size of 13 births was always one.

Single young was born to all the 32 births recorded at the New York Zoological Park (Crandall, loc. cit.). Twins have been recorded twice in 55 births in London Zoo (Asdell, loc. cit.).

BARKING DEER: The litter size of 23 births was always one.

The young born per litter is usually one and sometimes two (Prater, loc. cit.). Always single young were born to all the 30 births

recorded in the Zoological Gardens of London (Zuckerman, loc. cit.). Twin birth was recorded once in 47 births (Acharjyo 1970).

MOUSE DEER: The litter size of six births was always one.

The litter size is generally two (Prater, loc. cit.; Asdell, loc. cit.).

NILGAI: The litter size of seven births was 1 or 2 with an average of 1.14 young per litter. Always single young was born to all the eight births recorded at New York Zoological Park (Crandall, loc. cit.). There were two twins in four births (Acharjyo 1970). In about 61 births in the Zoological Garden of London, Zuckerman (loc. cit.) states that on an average twins were born in every alternate birth.

BLACKBUCK: The litter size of 64 births was always one and never twins.

One or two young are produced at a time (Prater, loc. cit.; Asdell, loc. cit.). Always single young and never twins was recorded in 97 births (Crandall, loc. cit.). The litter size of five births was always one (Acharjyo 1970).

FOURHORNED ANTELOPE: The litter size of five births was 1 or 2 with an average of 1.60 young per litter.

The litter size of six births was from 1 to 2 with an average of 1.83 (Acharjyo and Misra 1975). Twins were produced in 3 of the 5 births in the London Zoo (Asdell, loc. cit.).

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REFERENCES

ACHARJYO, L. N. (1970): Observation on some aspects of reproduction among common wild mammals in captivity. *Indian J. Anim. Health*, vol. X (2): 125-129.

———— (1971): A note on the birth of a Golden Cat (*Felis temmincki*) in captivity. *J. Bombay nat. Hist. Soc., 68* (1): 241.

————AND MISRA, R. (1973): Further notes on the breeding of Golden Cat (*Felis temmincki*) in captivity. *Indian Forester, 99* (1): 53-54.

———— ———— (1975): A note on the breeding habits of Fourt-horned antelope (*Tetracerus quadricornis*) in captivity. *J. Bombay nat. His. Soc., 72*(2): 529-530.

———— AND MOHAPATRA, S. (1977): Some observations on the breeding habits and growth of Jungle Cat (*Felis chaus*) in captivity. *J. Bombay nat. Hist. Soc., 74* (1): 158-159.

ASDELL, S. A. (1964): Patterns of mammalian reproduction, Second Edition. Cornell University Press, Ithaca ,New York.

BRANDER, A. (1923): Cited by Schaller, George, B. (1972).

COOPER, J. (1942): Cited by Schaller, George, B. (1972).

CRANDALL, LEE S. (1965): The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London.

DESAI, J. H. (1975): Observations on the Reproductive Biology and early Post-natal Development of the Panther *Panthera pardus* L. in captivity. *J. Bombay nat. Hist. Soc., 72* (2): 293-304.

PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay.

SCHALLER, GEORGE B. (1972): The Deer and the Tiger. The University of Chicago Press, Chicago and London.

STEYN, T. J. (1951): Cited by Crandall, Lee S. (1965).

ZUCKERMAN, S. (1953): Cited by Crandall, Lee S. (1965).

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7. SOME NOTES ON AGE OF SEXUAL MATURITY OF SEVEN SPECIES OF INDIAN WILD MAMMALS IN CAPTIVITY

Perusal of the available literature revealed that there are not many reports on the age of sexual maturity of different Indian Wild mammals. In this note an attempt is made to present some notes on the age of sexual maturity of seven species of Indian Wild mammals observed at Nandankanan Biological Park, Orissa.

Observations and Discussion

TIGER (*Panthera tigris*)

A tigress born in the Park on 14-12-1972 was kept along with a tiger born here on 22-6-1973 from 15-7-1974.

Mating of this pair of tigers was observed for the first time from 6-12-1975 to 7-12-1975 and subsequently during the following periods: 4-1-1976 to 6-1-1976, 1-2-1976 to 4-2-1976, 24-3-1976 to 26-3-1976, 7-5-1976 to 10-5-1976, 26-6-1976 to 30-6-1976, 29-8-1976 to 4-9-1976 and 9-1-1977 to 14-1-1977 resulting in the birth of three cubs on 22-4-1977.

These observations suggest that while the tigress came to her first oestrus at the age of

Table

Sl. No.	Date of birth (Name of the specimen)	Dates of first mating observed (Age at which first oestrus observed)	Date of successful mating with conception	Date of first parturition	Age of sexual maturity (Age at which littered for the first time)
1	2	3	4	5	6
1.	20-1-1973 (LATA)	6-3-1975 (2 years, 1 month and 15 days)	29-3-1975 to 1-4-1975	7-7-1975	2 years, 2 months and 10 days or say 2 years and 2 months (2 years, 5 months and 18 days)
2.	23-7-1973 (SHANTI)	17-10-1975 to 22-10-1975 (2 years, 2 months and 25 days)	29-1-1977 to 2-2-1977	8-5-1977	3 years, 6 months and 7 days or say 3 years and 6 months (3 years, 9 months and 16 days)
3.	2-8-1973 (BASANTI)	26-1-1976 to 29-1-1976 (2 years, 5 months and 25 days)	5-12-1977 to 9-12-1977	14-3-1978	4 years, 4 months and 4 days or say 4 years and 4 months (4 years, 7 months and 13 days)
4.	23-2-1975 (TORU)	Not recorded	Not recorded	11-2-1978	(2 years, 11 months and 20 days)

2 years 11 months and 23 days or say about 3 years, the male reached his sexual maturity at the age of 3 years 6 months and 19 days or say about 3 years and 7 months.

According to Acharjyo and Misra (1975) the first signs of sexual maturity in a tigress appeared at the age of about 3 years but a tiger did not reach his sexual maturity at least one week before he reached the age of 4 years. Chaturvedi (1970) states that the first cubbing of a tigress takes place at about the age of four and a tiger is full grown in about 5 years. A tigress became sexually mature soon after passing the age of 3½ years whereas a tiger became sexually mature at least 15 days before he reached the age of 4 years (Crandall 1965). Prater (1971) states that lions and tigers take from three to five years to became fully adult but males and females are capable of breeding soon after, or even before, they are three years old. Little has been published regarding the age at which tigers reach sexual maturity (Schaller 1972). At the Whipsnade Zoo a female is said to have produced a litter at the age of 2 years (Pocock 1939). Abramov (1962) and Novikov (1962) have given the age of sexual maturity in this species as 4 years. Sankhala (1967) states that the tiger cubs mature at an age between 3½ and 6 years.

LEOPARD OR PANTHER (*Panthera pardus*)

The details of age of sexual maturity observed in four female leopards are given in the Table. They were living with sexually matured males from the age of six to twelve months.

A study of this table reveals that while the first signs of oestrus appeared at the age of about 2 years and 2 months to about 2 years and 6 months, they littered for the first time at the age of about 2 years and 6 months to about 4 years and 7 months. They were capable of reproducing at the age of about 2 years and 2 months to about 4 years and 4 months.

Five female leopards of the Delhi Zoological Park came into oestrus for the first time at the age of 1 year and 8 months to 3 years and 10 months (Desai 1975). He further states that six female leopards littered for the first time at the age of 2 years and 3 months to 4 years and 2 months. Prater (loc. cit.) states that leopards are generally full grown in one and half to three years.

GOLDEN CAT (*Felis temmincki*)

One female golden cat born in the Park on 2-3-1972 littered for the first time in her life on 9-4-1974 at the age of 2 years, 1 month and 8 days or say about 2 years and 1 month. This was living with an adult male throughout this period.

The smaller cats are almost adult when a year old (Prater loc. cit.). Females of most species of *Felis* attain puberty at the age of 12 to 15 months (Walker *et al.* 1964).

JUNGLE CAT (*Felis chaus*)

A male Jungle cat born in the Park on 7-11-1975 was kept along with a full grown adult female of the same species from the age of about six months. The female gave birth to a litter of five kittens on 10-11-1977 when the male was 2 years and 4 days old. Taking the gestation period as above 2 months (Asdell 1964) the age of sexual maturity of the male can be said as 1 year, 10 months and 4 days or say 1 year and 10 months.

The smaller cats are almost adult when a year old (Prater, loc. cit.). Females of most species of *Felis* attain puberty at the age of 12 to 15 moths (Walker *et. al.*, loc. cit.)

COMMON PALM CIVET OR TODDY CAT
(*Paradoxurus hermaproditus*)

One female of this species born in the Park on 30-4-1975 was living with adult males from the age of about four months. Mating of this female with an adult male was observed for the first time from 23-2-1976 to 28-2-1976 resulting in the birth of a litter of three young on 1-5-1976. The observations suggest that the female became sexually mature at the age of 9 months and 24 days or say 10 months. The age at which the civets became fully adult is not known (Prater, loc. cit.). Acharjyo and Misra (1975) have given the age of sexual maturity of one male Common Palm Civet as 11 months.

BLACKBUCK OR INDIAN ANTELOPE
(*Antilope cervicapra*)

One blackbuck doe born on 26-2-1975 has given birth to a female young for the first time on 16-4-1977 at the age of 2 years, 1 month and 22 days. This was living with adult males throughout this period. Taking the gestation period as 6 months (Asdell, loc. cit.) the age of sexual maturity of this female can be said as 1 year 7 months and 22 days or say 1 year and 8 months.

The age of sexual maturity of two females of this species is given as 1 year and 7 months and 1 year and 11 months respectively (Acharjyo and Misra 1973). From his observations of two yearling does of this species Schaller (loc. cit.) states that possibly they did not bear their first young until two and a half to three years old. According to Taibel (1937) the captive does of this species reach sexual maturity at six months of age and one female had her first young at the age of about fourteen months.

CHITAL OF SPOTTED DEER (*Axis axis*)

One female of this species born here on 20-1-1975 gave birth to a dead male fawn for the first time on 27-2-1977 at the age of 2 years 1 month and 8 days. This was living with an adult male throughout the period of observation. Taking the gestation period as 7 to 7½ months (Asdell, loc. cit.) the age of sexual maturity of this female can be said to be about 1 year and 6 months.

Chital reach maturity at the age of two years (Prater, loc. cit.). Many Chital appear to conceive when they are fourteen to seventeen months old (Schaller, loc. cit). He further states that a Chital doe with an estimated age of 23 to 24 months carried full-term foetus when killed by a tiger at Corbett Park. One doe in Hawaii was pregnant when killed at an estimated age of eight to ten months (Nichols 1960).

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REFERENCES

ABRAMOV, V. (1962): Cited by Schaller, George B. (1972).

ACHARJYO, L. N. AND MISRA, R. (1973): A note on age of sexual maturity of two species of antelopes in captivity, *J. Bombay nat. Hist. Soc.* 70 (2): 378.

——— AND ——— (1975): Age of sexual maturity of two species of Wild carnivores in captivity. *J. Bombay nat. Hist. Soc.* 72(1): 196-197.

ASDELL, S. A. (1964): Patterns of mammalian Reproduction. Second Edition, Cornell University Press, Ithaca, New York, pp. 490-617.

CHATURVEDI, M. D. (1970): The Felines. National Book Trust, India, New Delhi, p. 28.

CRANDALL, LEB S. (1965): The management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London, p. 387.

DESAI, J. H. (1975): Observations on the Reproductive Biology and early postnatal Development of the Panther, *Panthera pardus* L., in captivity. *J. Bombay nat. Hist. Soc.* 72(2): 293-304.

NICHOLS, L. (1960): Cited by Schaller, George B. (1972).

NOVIKOV, G. (1962): Cited by Schaller, George B. (1972).

POCOCK, R. (1939): Cited by Schaller, George B. (1972).

PRATER, S. H. (1971): The Book of Indian Animals. Third (Revised) Edition, Bombay Natural History Society, Bombay.

SANKHALA, K. S. (1967): Cited by Desai, J. H. (1975).

SCHALLER, GEORGE B. (1972): The Deer and the Tiger, The University of Chicago Press, Chicago and London.

TAIBEL, A. (1937): Cited by Schaller, George B. (1972).

WALKER, ERNEST P. *et. al* (1964): Mammals of the World, Vol. II. The John Hopkins Press, Baltimore, p. 1274.

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2. SOME NOTES ON THE LONGEVITY OF TWO SPECIES OF INDIAN WILD CATS IN CAPTIVITY

The present communication deals with some notes on the longevity of two species of Indian Wild Cats observed at the Nandankanan Biological Park, Orissa.

Golden Cat : (*Felis temmincki*) : One full grown male of this species received in the Park on 21-7-1966 died on 18-7-1979, after remaining for 12 years, 11 months and 27 days in captivity. The estimated age at the time of death was about 15 years. It was living with one or two female specimens of the same species. It was housed in an enclosure having cemented floor space of approximately 16.5 sq. metres, height 2.80 metres. There was a two chambered cave like retiring den within the enclosure where the golden cats use to stay throughout the day. It was fed with 750 gm of goat meat and 250 gm of beef with bones six days in a week and only 375 gm of goat meat once a week. One live chicken was given once a month in place of its usual diet of goat meat and beef.

According to Crandall (1965) this species of cat has not done well at the New York Zoological Park and none survived for more than 2 years and a golden cat lived for 17 years, 8 months and 25 days at St. Louis Zoological Park. The longevity of this cat in the Zoological Gardens of London is given as 10 years, 9 months and 3 days (Flower 1931).

Clouded Leopard : (*Neofelis nebulosa*) : One full grown adult female clouded leopard received in the Park on 29-4-1966 died on 9-2-1980, after 13 years, 9 months and 12 days in captivity. The estimated age at the time of death was about 15 years. It was kept along with either one male and/or one female specimen of the same species. They were housed in a semi out-door enclosure having an area of approximately 48 sq. metres, height 2.80 metres. There were two spacious retiring cells within the enclosure. The animal maintained very good health on a diet of 1 kg goat meat and 100 gm beef with bones daily for six days in a week and only 500 gm goat meat once a week. One live chicken was given once a month instead of its usual diet of goat meat and beef.

At the New York Zoological Park none of the clouded leopards survived for long, the best record of longevity being 4 years and 8 months. A clouded leopard lived for 10 years, 8 months and 3 days in the San Diego Zoological Garden (Crandall, loc. cit). The longevity of this species in the National Zoological Park is given as 15 years, 10 months and 19 days whereas the longevity of this species in the Philadelphia Zoological Garden is given as 16 years, 11 months and 1 day (Jones 1958).

We would be interested in the longevity records of these two species of wild cats in other Indian Zoological Parks.

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REFERENCES

CRANDALL, LEE S. (1965) : The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London, pp. 359-413.

FLOWER, S. S. (1931) : Cited by Crandall, Lee. S. (1965).

JONES, M. L. (1958); Cited by Crandall, Lee S. (1965).

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6. NOTES ON WEIGHT AND SIZE AT BIRTH OF EIGHT SPECIES OF INDIAN WILD UNGULATES IN CAPTIVITY

The present note embodies some data on the weight and size at birth of eight species of Indian wild ungulates in captivity observed at the Nandankanan Biological Park, Orissa. The weight and size at birth were recorded either immediately after birth or within about twelve hours of birth. The details of our observations are given in the Table.

TABLE

Species of wild ungulates	Peried of observation	No. of specimens under study	Mean weight (Range) in Kg	Mean total length (Range) in cm	Meanshoig ulder he) (Range in cm
1	2	3	4	5	6
Indian Sambar (*Cervus unicolor niger*)	1-7-1972 to 31-7-1980	20	10.270 (7.000-12.300)	99.4 (88.0-107 0)	55.1 (49.0-59.0)
Spotted Deer (*Axis axis*)	1-7-1972 to 31-7-1980	34	2.991 (2.200-4.000)	71.1 (65.0-77.0)	37.7 (33.0-40.0)
Hog Deer (*Axis porcinus*)	1-7-1972 to 31-7-1980	6	2.365 (2.000-2.740)	57.1 (54.0-60.0)	30.0 (27.0-32.0)
Barking Deer (*Muntiacus muntjak*)	1-7-1972 to 31-7-1980	22	1.554 (1.200-2.010)	51.0 (45.0-56.0)	26.6 (24.0-30.0)
Mouse Deer (*Tragulus meminna*)	1-7-1972 to 31-7-1980	4	0.319 (0.288-0.382)	27.9 (26.5-30.5)	14.6 (14.0-16.0)
Black Buck (*Antilope cervicapra*)	1-7-1972 to 31-7-1980	33	3.276 (2.600-4.200)	68.5 (64.0-75.0)	38.4 (36.0-44.0)
Four-horned Antelope (*Tetracerus quadricornis*)	1-4-1974 to 31-7-1980	7	0.942 (0.740-1.065)	43.4 (42.0-46.0)	25.4 (24.0-27.5)
Indian Wild Boar (*Sus scrofa cristatus*)	1-10-1972 to 31-7-1980	7	0.681 (0.630-0.715)	36.4 (34.0-38.0)	16.2 (15.5-17.0)

The observations on weight and size at birth of these eight species of Indian wild ungulates as reported by earlier workers are given as follows.

INDIAN SAMBAR: At birth the weight of seventeen sambar fawns was from 7.600 Kg to 11.000 Kg with an average of 9.653 Kg, the length was from 91 cm to 106 cm with an average of 98.8 cm whereas the shoulder height was from 53 cm to 58 cm with an average of 55.2 cm (Acharjyo and Misra 1972). The average weight of nine sambar fawns at birth was 8.270 Kg, the average length 98 cm and the average shoulder height was 53 cm (Acharjyo 1970).

SPOTED DEER: The weight at birth of twenty-four fawns of this species was from 2.200 Kg to 4.000 Kg with an average of 3.129 Kg, the length was from 65 cm to 79 cm with an average of 72.6 cm and the shoulder height was from 36 cm to 44 cm with an average of 39.7 cm (Acharjyo and Misra 1972). The average weight of 33 fawns was 3.320 Kg, the average length was 71 cm and the average shoulder height was 39 cm at birth (Acharjyo 1970). The weight at birth of two male spotted deer fawns was 3.630 and 4.500 and their total lengths were 77 cm and 74 cm (Sankhala and Desai 1969).

HOG DEER: At birth the average weight of

three premature and dead fawns were 1.333 Kg and their average length was 51.7 cm (Acharjyo and Misra 1972). Sankhala and Desai (1969) stated that the three Hog deer fawns weighed from 1.500 Kg to 3.180 Kg and measured 53.0 cm to 57.8 cm in total length at birth.

BARKING DEER: According to Sankhala and Desai (1969) the two male fawns of this species of Delhi Zoological Park weighed 1.360 Kg and 2.000 Kg and measured 41.3 cm and 52.0 cm in total length at birth. A barking deer fawn weighs about 0.550-0.650 Kg at birth (Walker *et al.* 1964). The birth weight of nine fawns was varying from 0.900 Kg to 2.000 Kg with an average of 1.520 Kg, the length from tip to tip at birth was from 43 cm to 55 cm with an average of 50 cm and the shoulder height was from 25 cm to 30 cm with an average of 27 cm (Acharjyo 1970). Acharjyo and Misra (1972) have given the mean weight of six fawns as 1.250 Kg, the mean length as 49.1 cm and the mean shoulder height as 24.9 cm at birth.

MOUSE DEER: A female fawn of this species weighed 203 grams, measured 27 cm in total length and had a shoulder height of 12.5 cm (Acharjyo and Misra 1972).

BLACK BUCK: One male black buck young at birth weighed 4.770 Kg. and measured 71.2 cm in total length (Sankhala and Desai 1969). According to Acharjyo and Misra (1972) the average weight and size at birth of twelve blackbuck young were as follows: Weight, 3.558 Kg; the length 70.1 cm and the shoulder height 39.8 cm.

FOUR-HORNED ANTELOPE: The weight and size at birth of seven young of this species as reported by Acharjyo and Misra (1975) were as follows: Weight- from 0.75 to 1.2 Kg with an average of 1.04 Kg, length from tip to tip —from 42 to 45 cm with an average of 43.5 cm and the shoulder height—from 24.5 to 27 cm with an average of 25.2 cm. At birth one female young of this species weighed 1.250 Kg and had a total length of 45 cm (Sankhala and Desai 1969). At birth a fawn of this species weighed 2¼ pounds, measured 15 inches in length and the shoulder height was 10 inches (Shull 1958).

INDIAN WILD BOAR: Seven piglets weighed from 325 to 665 gm with an average of 557.43 gm and measured 31.5 to 37 cm with an average of 35 cm and had shoulder heights from 14 to 16.5 cm with an average of 15.36 cm (Acharjyo and Misra 1974).

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REFERENCES

ACHARJYO, L. N. (1970): Observation on some aspects of Reproduction among Common Wild Mammals in Captivity. *Ind. J. Anim. Health*, IX (2): 125-129.

ACHARJYO, L. N. & MISRA, R. (1972): Observations on weight and size at birth of some Wild Mammals in Captivity. *Cheetal-Journal of the Wild Life Preservation Society*, Vol. *15*(2): 64-67.

———— (1974): Weight and size at birth of two species of Wild Mammals in Captivity. *J. Bombay nat. Hist. Soc. 71*(1): 137-138.

———— (1975): A note on the Breeding Habits of Four-Horned Antelope (*Tetracerus quadricornis*) in captivity. *J. Bombay nat. Hist. Soc. 72* (2): 529-530.

SANKHALA, K. S. & DESAI, J. H. (1969): Reproductive pattern of some Indian Mammals. *Cheetal-Journal of the Wild Life Preservation Society of India*, Vol. *12*(1): 114-129.

SHULL, E. M. (1958): Notes on the Four-Horned Antelope (*Tetracerus quadricornis*) (Blainville). *J. Bombay nat. Hist. Soc. 55*(2): 339-340.

WALKER, ERNEST P. *et al.* (1964): Mammals of the world, Vol. II, The Johns Hopkins Press, Baltimore. pp. 1385.

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MISCELLANEOUS NOTES

5. BIRTH OF WHITE TIGER (*PANTHERA TIGRIS*) CUBS TO NORMAL COLOURED TIGERS IN CAPTIVITY

(With a text-figure)

The White Tiger (*Panthera tigris*) is a magnificent snow white animal with ash or light black stripes, pink paw pads and ice-blue eyes. All the white tigers so far available in captivity had their origin from a male White Tiger named 'Mohan' captured from the forests of Rewa (Madhya Pradesh) in May, 1951 at an estimated age of about nine months. The present communication deals with the birth of three White Tiger cubs in one litter at the Nandankanan Biological Park, Orissa to a pair of normal coloured tigers with apparently no known history of having any relation with the White Tiger 'Mohan'.

A normal coloured tigress 'Ganga' whose mating with a normal coloured tiger 'Deepak' was observed from 24-9-79 to 3-10-79 in the Park, gave birth to three White Tiger Cubs (two females and one male) on 8-1-1980. This is the result of a father-daughter mating.

The body colour of the cubs were snow white with light black stripes, pink paw pads and ice-blue eyes. The eyes of the cubs opened on 12th day (one male and one female cubs) and on 11th day (right eye) and 12th day (left eye) in case of the other female cub.

The weight and size of these cubs recorded after about 48 hours on 10-1-1980 were as follows : weight—1.210 Kg (female), 1.240 Kg (female) and 1.385 Kg (male) and measured 50 cm tip to tip including 15 cm long tail (females) and 52 cm tip to tip including 16 cm long tail (male).

The growth rate of these cubs to the age of 3 months were recorded as follows :—

Date	Age	Cub No. I (female)	Cub No. II (female)	Cub No. III (male)
		Kgs.	Kgs.	Kgs.
10.1.1980	48 hours	1.210	1.240	1.380
5.2.1980	4 weeks	3.400	3.800	3.705
12.2.1980	5 weeks	3.800	4.200	4.000
19.2.1980	6 weeks	4.200	4.800	4.200
26.2.1980	7 weeks	4.800	5.200	4.800
4.3.1980	8 weeks	5.200	5.600	5.400
11.3.1980	9 weeks	6.000	6.400	5.800
18.3.1980	10 weeks	6.800	7.200	6.400
25.3.1980	11 weeks	7.600	8.200	7.200
1.4.1980	12 weeks	8.800	9.200	8.200
8.4.1980	13 weeks	9.800	10.400	9.400

The incisors of the cubs appeared in the fifth week and the canines appeared in the seventh week.

Earlier the female of this pair of normal coloured tigers gave birth to two normal coloured tiger cubs on 22-7-1979 but both cubs died within six days as the mother failed to nurse them.

The genealogy of these white tiger cubs is given in the chart (Fig. 1). A study of the genealogical chart reveals that 31 tiger cubs were born in 13 litters out of which only one litter was of white colour, i.e. 7.69% of the litters and 9.67% of the cubs were white. The study of this genealogical chart of white tigers maintained by the Delhi Zoological Park and reported by Saharia (1979) apparently does not

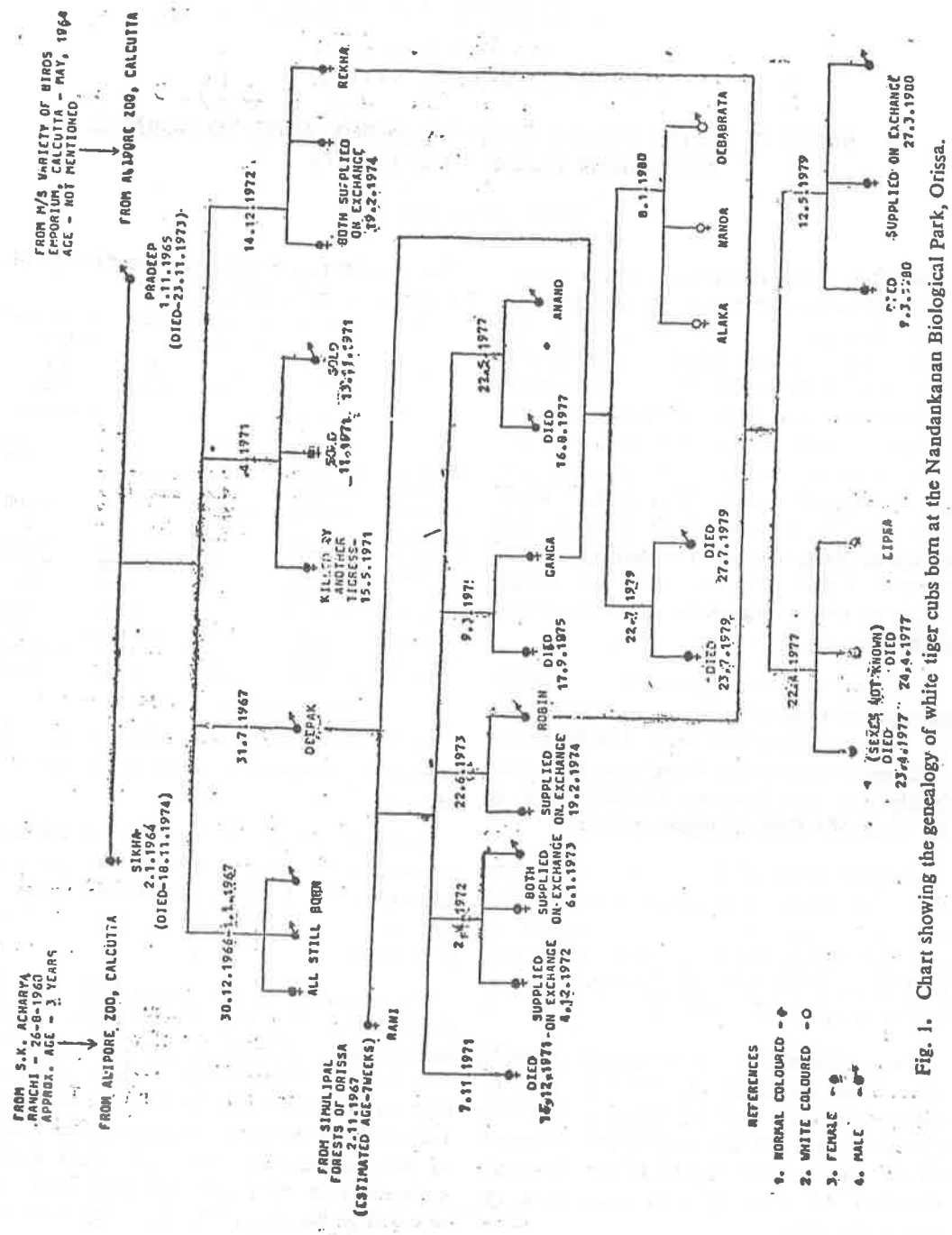

Fig. 1. Chart showing the genealogy of white tiger cubs born at the Nandankanan Biological Park, Orissa.

give an indication of these white tiger cubs having any relation with the white tiger 'Mohan'. The origin of tigers received from Alipore Zoological Gardens, Calcutta beyond the Animal Dealers could not be ascertained. There were reports of white tigers being shot in Orissa (Gee 1964 a). Perusal of the available literature (Gee 1964, a and b, Sankhala 1969, Oswald 1960, Saharia 1979, Robinson 1928, Pant and Dhariyal 1979) did not reveal any information about the birth of all white coloured cubs in one litter to normal coloured parents. The genealogical chart further suggests that the tigers 'Deepak' and 'Ganga' were heterozygous having the recessive gene for white colour.

The pairing of the white tigers born in the Park with the white coloured descendants of the white tiger 'Mohan' can prevent inbreeding and thus may give better chances for the breeding and survival of the white tigers.

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REFERENCES

GEE, E. P. (1964 a): The White Tigers. *Animals*, Vol. 3 (11), pp. 282-286.

——— (1964 b): The Wild Life of India. Collins, London, pp. 69-75.

OSWALD, A. (1960): The White Tigers of Rewa. *Cheetal*, 2 (2): 63-67.

PANT, M. M. AND DHARIYAL, I. D. (1979): White Tiger Breeding—Its economic potentialities. *Cheetal* 21 (1): 3-10.

ROBINSON, F. B. (1928): White Tigers. *J. Bombay nat. Hist. Soc.* 32 (3): 584-585.

SAHARIA, V. B. (1979): Population Dynamics in Captive Tigers. Wild Life News Letter, Vol. 7 (2): 36-40.

SANKHALA, K. S. (1969): The White Tigers. *Cheetal*, 12 (1): 78-81.

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3. FURTHER NOTES ON THE BIRTH AND GROWTH OF THE LEOPARD-CAT (*FELIS BENGALENSIS*) IN CAPTIVITY

Acharjyo and Mishra (1980) reported the birth of four litters to the female of a pair of Leopard-Cats (*Felis bengalensis*) at the Nandankanan Biological Park, Orissa upto December, 1978. The present note is intended to place on record the details of three more litters born to the female of the same pair of Leopard-Cats in the same Park.

The pair of Leopard-Cats were housed in an enclosure having the floor space of approximately 7 square metres, height 2.80 metres. There were two cave like retiring dens one above the other at a height of half a metre from the ground. Each of them was fed with 300 gms of goat meat and 50 gms of beef daily. One live chicken to each was given once a month in place of goat meat and beef.

Out of three litters born during the period from January, 1979 to August, 1980, two were recorded in March and one in June. The size of each of the three litters was always two and interestingly all the six kittens were females. The eyes of all these kittens were closed at birth and the eyes of four kittens under observation opened on 14th day (two kittens), 15th day (one kitten) and 16th day (one kitten). The canines of two kittens under observation erupted on 29th and 30th day respectively. The inter-parturition intervals recorded thrice (Dates of birth: 4.7.1978, 30.3.1979, 9.3.1980 and 30.6.1980) were 267 days, 344 days and 112 days respectively generally depending upon the period of survival of the kittens after birth. Unfortunately the female died in August, 1980. During the period from April, 1976 to August, 1980, she had given birth to seven litters.

The four kittens born on 30-3-1979 and 9-3-1980 weighed 113 to 120 g with a mean of 115.75 g and measured 24 to 26 cm from tip of nose to tip of the tail with a mean of 24.88 cm including tail lengths of 7 cm each at birth.

Growth: Weekly growth records of two (one female and one male) mother-reared kittens born in the Park on 4-7-1978 was maintained upto 37 weeks (about 8½ months) and the details are given in the Table.

Date	Age in weeks	Weight in Kg. Female	Male
4-7-1978	Birth weight	0.118	0.120
18-7-1978	2	0.232	0.243
8-8-1978	5	0.460	0.480
5-9-1878	9	0.845	0.910
3-10-1978	13	1.190	1.280
7-11-1978	18	1.760	1.780
19-12-1978	24	2.200	2.410
30-1-1979	30	2.880	2.900
20-3-1979	37	2.990	3.230

A study of this table reveals that the weight of the kittens were almost doubled at the age of two weeks and quadrupled at the age of five weeks. There is a little over ten fold increase of birth weight at the age of 13 weeks and appeared almost as large as the parents at the age of 37 weeks (8½ months). The table also reveals that the growth rate of the male kitten was comparatively faster than the female kitten.

Both kittens were able to come down from the upper cave like den on 4-8-1978 (32nd day) and started licking minced goat meat along with their mother.

The litter size of three births of this species at West Berlin Zoo was 1, 3 and 2 respectively, there were two females and four males and the births were recorded in April, July and October (Frese 1980). He has further given

the estimated birth weight of four kittens as between 100 to 130 g.

The four births of this species were recorded as follows: February, 1; March, 1; May, 1; and July, 1 and the litter size was one to two with a mean of 1.75 kittens per litter (Acharjyo and Mishra 1980). They have further stated that there were four females and three males; at birth seven kittens weighed 93 to 120 g. (mean 113.14 g.) and measured 22 to 25 cm. (mean 24.14 cm.) tip to tip including tail lengths of 6.5 to 7 cm. and the inter-parturition intervals recorded thrice were 81,305 and 104 days respectively mostly depending on the period of survival of the young.

Prater (1971) states that the young of this species have been obtained in March and May and 3 to 4 kittens may be born in a litter. In India, this species mates in May and has 3 to 4 young per litter after a gestation period of 56 days (Asdell 1964).

Weekly growth record of a female kitten of this species maintained upto the age of 11 weeks and reported by Acharjyo and Mishra (1980) reveals the weight of 1.156 kg. at the age of 11 weeks. A single male kitten born in a litter doubled its birth weight in 11 days, quadrupled in 26 days and by 50th day there was an eight-fold increase in weight whereas the three male kittens born in another litter have doubled their birth weight in 25 days, quadrupled in about 44 days and increased eight fold in 60 days (Frese 1980).

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REFERENCES

ACHARJYO, L. N. AND MISHRA, CH. G. (1980): A note on the Breeding of the Leopard-Cat (*Felis bengalensis*) in captivity. *J. Bombay nat. Hist. Soc.* 77: 127-128.

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction. Second Edition, Cornell University Press, Ithaca, New York. pp. 490.

FRESE, REINHARD (1980): Some notes on Breeding the Leopard Cat *Felis bengalensis* at West Berlin Zoo. International Zoo Year Book, 20: 220-223.

PRATER, S. H. (1971): The Book of Indian Animals. Third (Revised) Edition. Bombay Natural History Society, Bombay, pp. 73-74.

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MISCELLANEOUS NOTES

1. SOME OBSERVATIONS ON ANTLER CYCLE OF HOG-DEER (*AXIS PORCINUS*) IN CAPTIVITY

This communication presents data on antler cycle of Hog-Deer observed at Nandankanan Biological Park, Orissa during the period October, 1970 to March, 1983. The number of Hog-Deer stags' under-observation varied from one to four.

Period of antler casting

During the observation period twenty antler castings (single spike as well as branched) were recorded during a six month period from October to March as follows: October, 2; November, 1; December, 1; January, 9; February, 6; and March, 1. Peak antler casting (85%) was recorded during winter months (November-February).

Both antlers were cast either in one day or within five days. Casting of antlers of both sides was completed on one day in eight instances (40%), on two consecutive days in six instances (30%), within three days in three instances (15%), within four days in two instances (10%) and within five days in one instance (5%).

According to Asdell (1964) the antlers of this species are shed in April in India but in the Philadelphia Zoo there is a record of a February shedding and in the Washington Zoo there is a record of July shedding. The majority of Hog-Deer of Dhikala, Corbett National Park cast their antlers from February to May (Tak and Lamba 1981). Acharjyo (1971) reports three instances of a stag shedding its antlers in December. He further states that both the right and left antlers were always shed the same day.

Period of velvet rubbing

As usual with the other species of Indian deer, the Hog-Deer stags rub off the velvet of antlers soon after their growth is completed. The nineteen observations on velvet rubbing were recorded as follows: February, 3; March, 1; April, 6; May, 4; June, 1; July, 1; November, 1; and December, 2. The majority of stags (63.16%) cleared their velvet during summer months (March-June).

The Hog-Deer stags remove velvet during May-August and hard antlers were retained from August-January at Dhikala, Corbett National park (Tak and Lamba, loc. cit.).

Time taken for antler growth

Observations on the period required from the time of casting of antlers to the time when the stag starts rubbing off the velvet is taken as the span of antler growth. This period observed in twelve instances varies from 3 to 4 months (3 months in 4 occasions, 3½ months in 5 occasions and 4 months in 3 occasions).

Age at first antler casting

Two male Hog-Deer born in the Park in December, 1981 (7.12.1981 and 17.12.1981), started showing knob like pedicels by the end of July, 1982 and rubbed off the velvet in

the second fortnight of December, 1982. Casting of single spike antlers in these two specimens were recorded in the last week of February, 1983. As expected the coronet or burr was absent in single spike antlers.

These observations suggest that the knob like pedicels appear at the age of approximately seven months, rubbing off the velvet starts at the age of about one year and casting of the first set of single spike antlers occurs at the age of about 1 year and 2½ months.

Casting interval

The casting interval observed in seven instances among four specimens varies from 338 to 375 days. The stags cast their antlers annually.

The casting interval reported twice in a stag was 347 and 383 days (Acharjyo, loc. cit.).

Size and weight of cast antlers

Three of the cast single spike antlers measured (weighed) as follows: 6 cm (13.250 gm); 7.5 cm (16.500 gm) and 9 cm (23.200 gm). Maximum length of cast antlers on the outside curve recorded twice was 43 cm each. The maximum weight of two cast antlers of a stag recorded once was 271 gm (right) and 260 gm (left).

The average horns of Indian Hog-Deer measure 30 to 38 cm but the Burmese stags carry antlers upto 61 cm (Prater 1971).

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References

Acharjyo, L. N. (1971): Notes on Time of Shedding of Antlers of Deer in Captivity. *Indian Forester*, 97(3):150-151.

Asdell, S. A. (1964): Patterns of Mammalian Reproduction. Second Edition. Cornell University press, Ithaca, New York, pp. 561.

Prater, S. H. (1971): The Book of Indian Animals. Third (Revised) Edition. Bombay Natural History Society, Bombay. pp. 291-292.

Tak, P. C. & Lamba, B. S. (1981): Some observations on Hog-Deer, *Axis porcinus* (Artiodactyla: Cervidae) at Dhikala, Corbett National Park. *Indian Journal of Forestry*, 4(4):295-305.

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5. A NOTE ON ANTLER CASTING OF BARKING DEER (*MUNTIACUS MUNTJAK*) IN CAPTIVITY

The Barking Deer or Muntjac (*Muntiacus muntjak*) are distributed over the greater part of the Indo-Malayan countries, China, Formosa and Japan (Prater 1971). This note on some aspects of antler casting of barking deer is based on the observations made at the Nandankanan Biological Park, Orissa during the period October, 1970 to March, 1983. The park is within the geographical range of the species. Specimens collected from different parts of Orissa and those born and brought up in the park are included in the study. The number of stags under observation varied from one to seven.

The thirty four antler castings recorded during the observation period were distributed as follows: March, 2; April, 20; and May, 12. Majority of castings (94.12%) were recorded in April and May only. The antlers are cast annually and never retained to the next year.

The fifty one observations on the period of Velvet rubbing were recorded as follows: August, 14; September, 26; October, 9; and November, 2. Majority of observations (78.43%) were recorded in August and September only.

The antlers of both sides were cast either in one day or within four days. Casting of both antlers was observed within one day in twenty instances (58.8%), on eleven instances within two consecutive days (32.3%), on one instance within three days (3%) and on two instances within four days (5.9%).

The period required from the time of casting of antlers to the time when the stags start rubbing off the velvet is taken as the span of antler growth. This period recorded on 12 occasions varied from 4½ to 6½ months (4½ months on three occasions; 5 months on one occasion; 5½ months on seven occasions and 6½ months on one occasion).

The weight and measurements of ten cast antlers are given as follows:

Length in cm	Weight in gm
5.00	7,400
6.50	8,600
7.00	11,500
7.75	12,500
10.00	17,000
10.00	17,700
10.00	20,500
10.50	12,300
11.00	16,900
11.00	25,200

The small antlers were either unbranched or with a short brow-tine as reported by Prater (loc. cit.). The antlers are shed in May and renewed in August but it is doubtful whether this occurs annually (Asdell 1964). Antlers are shed annually in May in southern Asia and they rarely exceed 125 to 152 mm in length (Walker *et al.* 1964). The antlers are cast in May and June and the average Indian antlers measure 5 to 8 cm, and maximum recorded length is 17.8 cm (Prater, loc. cit.). According to Acharjyo (1971) nine antler castings were recorded in April and May and both the antlers were cast either in one or two consecutive days.

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REFERENCES

ACHARJYO, L. N. (1971): Notes on Time of Shedding of Antlers of Deer in captivity. *Indian Forester*, 97(3): 150-151.

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, 2nd Ed. Cornell University Press, Ithaca, New York pp. 559.

PRATER, S. H. (1971): The book of Indian Animals. 3rd (Revised) Ed. Bombay Natural History Society, Bombay. pp. 294-295.

WALKER, E. P. *et al.* (1964): Mammals of the world. Vol. II, The John Hopkins Press, Baltimore, pp. 1385.

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MISCELLANEOUS NOTES

1. ON SOME ASPECTS OF REPRODUCTION AMONG THE TIGERS (*PANTHERA TIGRIS*) OF NANDANKANAN BIOLOGICAL PARK (ORISSA)

The purpose of the present communication is to present data on some aspects of reproduction observed among the captive tigers at the Nandankanan Biological Park, Orissa during the period from January, 1964 to October 1979. The observations of earlier workers have been cited.

Materials and Methods

The Nandankanan Biological Park, Orissa was opened to the public on 29th December, 1960. The first full grown tigress of the Park was received from Alipore Zoological Gardens, Calcutta in January, 1964 and she was paired with a full grown tiger of the same Park in November, 1965. The first birth of tiger cubs in the Park was recorded in December, 1966. So far 28 tiger cubs have been born in the Park to four tigresses in twelve litters.

The tigers in the Park are kept in spacious enclosures, each of which has two adjacent retiring cells. Usually the tigers are kept in pairs and separated about a fortnight before the expected date of parturition till the cubs are about 9 months old.

The tigers are fed six days in a week with beef and on Mondays of each week no food is given. On an average each adult tiger is given 14 Kg of fresh raw beef with bones daily. Vitamin supplements such as Vitablend AD3 (Glaxo) or Becadex Multivitamin tablets (Glaxo) are added to the beef intermittently.

The weight and size of tiger cubs at birth was recorded within about twelve hours after their birth.

Observations and discussion

Sexual Maturity: One tigress born in the Park on 9.3.1975 was allowed to remain with a sexually matured tiger from the age of about 2 years and ten months (from 5.4.1978). Mating of this pair was first observed from 1.10.1978 to 5.10.1978 and subsequently from 15.11.1978 to 23.11.1978, from 27.12.1978 to 5.1.1979, from 13.2.1979 to 18.2.1979 and from 6.4.1979 to 12.4.1979 resulting in the birth of the first litter on 22.7.1979. These observations suggest that the tigress came to her first oestrus at the age of 3 years 6 months and 22 days or say about 3 years and 7 months but gave birth for the first time at the age of 4 years, 4 months and 14 days.

Chaturvedi (1970) states that the first cubbing of a tigress takes place at about the age of four and a tiger is fully grown in about 5 years.

The age of sexual maturity of two tigresses is given as about 3 years and of two tigers is given as about 4 years and about 3 years and 7 months respectively (Acharjyo and Misra 1975, Acharjyo and Mishra 1980). According to Crandall (1965) a female tiger became sexually mature soon after passing the age of 3½ years whereas a male tiger became sexually mature at least 15 days before he reached the age of 4 years. The tiger cubs

mature at an age between 3½ and 6 years (Sankhala 1967). Prater (1971) states that the lions and tigers take from three to five years to become fully adult but males and females are capable of breeding soon after, or even before they are three years old. Little has been published regarding the age at which tigers reach sexual maturity (Schaller 1972). The age of sexual maturity of this species is given as three years (Blanford 1888-91) and as four years (Abramov 1962, Novikov 1962). At the Whipsnade Zoo one tigress is said to have produced a litter at 2 years of age (Pocock 1939).

Mating Season: The mating of the tigers of the Park has been observed in all the months of the year. From April, 1967 to October, 1979; 36 matings were recorded as follows:

Rainy Season (July to October) — 11 (30.56%)

Winter Season (November to February) — 15 (41.67%)

Summer Season (March to June) — 10 (27.77%)

Many tigers in India seem to mate after the rains (Prater, loc. cit.). The tiger breeds all the year (Asdell 1964). According to Schaller (loc. cit.) the peak of sexual activity of tigers at Kanha was from November to about February with some mating probably occurring throughout the year. Sinha (1976) states that majority of mating in tigers of Palamau Tiger Reserve occurs during winter season (mid of October to mid of February) followed by summer (mid February to mid June) and possibly some mating occurs during rains also. Normally tigers mate in November-December or May and June (Singh 1973).

Oestrus period and inter-oestrus interval:

The details of our observations during the period from September, 1977 to October, 1979 is given in Table 1.

TABLE 1

Name of the tigress	Date of last mating observed (Oestrus period) without conception	Date of subsequent mating observed (oestrus period) with or without conception	Inter-oestrus interval in days
1	2	3	4
"Rekha"	28.11.78 to 5.12.78 (8 days)	28.1.79 to 1.2.79 (5 days)	53
"Ganga"	1.10.78 to 5.10.78 (5 days)	15.11.78 to 23.11.78 (9 days)	40
—do—	15.11.78 to 23.11.78 (9 days)	27.12.78 to 5.1.79 (10 days)	33
—do—	27.12.78 to 5.1.79 (10 days)	13.2.79 to 18.2.79 (6 days)	38
—do—	13.2.79 to 18.2.79 (6 days)	6.4.79 to 12.4.79 (7 days)	46
—do—	13.8.79 to 18.8.79 (6 days)	24.9.79 to 3.10.79 (10 days)	36

The Table 1 indicates that the period of mating (Oestrus period) in 9 cases among two tigresses varies from 5 to 10 days with an average of 7.33 days. The inter-oestrus interval observed in 6 cases among two tigresses varies from 33 to 53 days with an average of 41 days.

According to Acharjyo and Mohapatra (1979) the oestrus period observed in 19 cases among two tigresses varies from 2 to 8 days with an average of 5.2 days and inter-oestrus interval observed in 15 cases among two tigresses varies from 28 to 138 days with an average of 65.9 days. The oestrus in one tigress at the Basel Zoo was observed 21 times with an average interval of 51.9 days (range 20-84 days) and in another tigress it was recorded 18 times with an average interval of 54.2 days (range 27-83 days) (Schaller, loc. cit.). Sadleir (1966) states that the interval between the mid-points of 3 consecutive oestrus periods in one tigress varied from 45-55 days and the average length of receptivity during 14 oestrus periods was 7.1 days. The tigress is polyestrous, heat recurring at intervals of about 3 weeks (Crandall, loc cit.).

Gestation period: During the period from September, 1977 to October, 1979 the gestation period observed twice in two tigresses was 100 days and 101 days respectively calculated from the last day of mating to birth.

The gestation period observed on eight occasions among three tigresses of Nandankanan Biological Park from January, 1970 to August, 1977 varied from 98 to 104 days with an average of 101.13 days (Acharjyo and Mohapatra 1978). The gestation period is said to be 15 to 16 weeks (Prater, loc. cit.). Asdell (loc. cit.) states that the gestation period is about 113 days. The gestation period from the last observed mating is given as 100 to 108 days (Crandall, loc. cit.). The gestation period is about 100 days (Chaturvedi, loc. cit.).

Litter size and sex ratio at birth: The litter size of twelve births recorded to four tigresses of the Park during the period from December, 1966 to October, 1979 varied from 1 to 3 cubs with an average of 2.33 cubs per litter. The litter size of two births was one, of four births was two and of six births was three. There were 16 females and 10 males and the sex of the two cubs could not be known as they died and perished in the open-air enclosure. So the sex ratio (No. of males to 100 females) is 62.5 : 100.

The litter size of 79 litters born in Zoos varied from 1 to 5 with an average of 2.8 cubs per litter and the sex ratio of 196 cubs at birth born to these 79 litters was 100 males to 100 females (Schaller, loc cit.). The litter size varies from 1 to 7 (Brander 1923). The litter size is usually 2 to 3 but as many as 6 may be produced (Prater, loc. cit.). One tigress of the New York Zoological Park produced thirty two cubs in 11 litters from 1948 to 1959, the division of sexes being 19 males and 13 females and the litter size was 1 to 4 (Crandall, loc. cit.).

Distribution of births: The twelve births were recorded as follows: March, 1; April, 3; May, 2; June, 1; July, 2; November, 1; and December, 2.

The cubs are born at any time in the London Zoo but most are born from June to August (Asdell, loc cit.). The majority of young are born between February and May in India (Prater, loc. cit.). One tigress produced eleven litters at the New York Zoological Park as follows: May, 8; June, 1; and November, 2; (Crandall, loc. cit.).

Inter-parturition interval: The details of inter-parturition intervals recorded are given in Table 2.

TABLE 2

Specimen	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of the female from the male from the date of last parturition mentioned in col. 2.
Tigress "Rani"	22-6-1973	9-3-1975	1 year 8 months and 14 days.	About 9 months. An abortion and observed after 40 days of conception on 8.11.74.
—do—	9-3-1975	22-5-1977	2 years 2 months and 12 days	About 9 months
Tigress "Rekha"	22-4-1977	12-5-1979	2 years and 19 days	About 17 months

The Table 2 indicates that inter-parturition interval observed on three occasions among two tigresses varies from 1 year 8 months and 14 days to 2 years, 2 months and 12 days with an average of 1 year 11 months and 25 days.

Acharjyo and Misra (1975) state that the inter-parturition interval observed in five cases among two tigresses varies from 4 months and 25 days to 3 years, 8 months and 9 days with an average of 1 year, 6 months and 5 days. Most cats have one or two litters a year, the larger species some times breed only every two or three years (Walker *et al.* 1964). In the wild the intervals between two successive cubbings is about three years (Chaturvedi, loc. cit.). In Zoos where the cubs are usually removed from the mother at birth, one litter per year is common and at London Zoo a tigress had 8 pregnancies between 1961 and 1964 including 3 births to this female in 1962 (Schaller, loc. cit.). He further states that a free living tigress that loses her cubs in some mishap is able to have a new litter within about 5 months.

Weight and size at birth: The weight and measurements of nine new born tiger cubs of the Park born during the period from 1.7.1972 to 31.10.1979 indicates that at birth the weight varies from 1.100 Kg to 1.430 Kg with an average of 1.247 Kg and measures from 50.5 cm to 54.0 cm with an average of 52.05 cm tip to tip including tail lengths of 15 to 17 cm (average 15.67 cm).

The weight of seven tiger cubs at birth varied from 0.920 Kg to 1.450 Kg with an average of 1.202 Kg and the length from tip to tip was 49 cm to 58 cm with an average of 53.4 cm. (Acharjyo and Misra 1972). Tiger cubs at birth weigh under three pounds (Denis 1964). At birth the three tiger cubs of New York Zoological Park measured 20 inches from the tip of the nose to the tip of the tail and their weights were 2 pounds 8 ounces (male), 2 pounds 9 ounces (male) and 2 pounds 11 ounces (female) (Crandall, loc. cit.).

Opening of eyes of cubs: The eyes of five tiger cubs, under observation (born during the period from 1.10.1973 to 31.10.1979) were closed at birth and opened on 7th day (two cubs), 9th day (two cubs) and 12th day (one cub).

According to Chaturvedi (loc. cit.) the tiger cubs open their eyes nine days after birth. The tiger cubs open their eyes in 15 to 16 days (Denis, loc. cit.). Crandall (loc. cit.) reported that the eyes of three tiger cubs were closed at birth and opened on 9th day (female), 11th day (male) and 17th day (male) respectively. The tiger cubs open their eyes in eight to fourteen days (Acharjyo and Misra 1973).

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REFERENCES

ABRAMOV, V. (1962): Cited by Schaller, George-B. (1972).

ACHARJYO, L. N. & MISRA, R. (1972): Observations on weight and size at birth of some wild mammals in captivity. *Cheetal*, Vol. *15*(2): 64-67.

——— (1973): Further notes on opening of eyes of some wild carnivores in captivity. ibid. *15*(4): 49-55.

——— (1975): Age of sexual maturity of two species of wild carnivores in captivity. *J. Bombay nat. Hist. Soc.* 72(1): 196-197.

——— (1975): A note on inter-parturition interval of some captive wild mammals. ibid. *72*(3): 841-845.

——— & MISHRA, CH. G. (1980): Some notes on age of sexual maturity of seven species of Indian Wild mammals in captivity, ibid. *77*(3): 504-507.

ACHARJYO, L. N. & MOHAPATRA, S. (1978): Some observations on periods of receptivity and gestation in two species of Great cats in captivity. *Cheetal*, Vol. *20*(1): 3-8.

——— (1979): Some observations on inter-oestrus interval in captive tigresses [*Panthera tigris* Linnaeus]. *J. Bombay nat. Hist. Soc.* *76*(3): 495-497.

ASDELL, S. A. (1964): Patterns of mammalian reproduction. Second Edition. Cornell University Press, Ithaca, New York. pp. 492-93.

BLANFORD, W. (1889-91): Cited by Schaller, George B. (1972).

BRANDER, A. (1923): Cited by Schaller, George B. (1972).

CHATURVEDI, M. D. (1970): The Felines. National Book Trust, India, New Delhi.

CRANDALL, LEE S. (1965): The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London, pp. 382-389.

DENIS, ARMAND (1964): The Cats of the World. Constable & Co., Ltd., London. pp. 26-62.

NOVIKOV, G. (1962): Cited by Schaller, George B. (1972).

POCOCK, R. (1939): Cited by Schaller, George B. (1972).

PRATER, S. H. (1971): The Book of Indian Animals. Third (Revised) Edition. Bombay Natural History Society, Bombay, pp. 62-66.

SADLEIR, R. (1966): Cited by Schaller, George B. (1972).

*SANKHALA, K. S. (1967): Breeding behaviour of the Tiger in Rajasthan. *Int. Zoo Yb.* *7*: 133-147.

SCHALLER, GEORGE B. (1972): The Deer and the Tiger, The University of Chicago Press, Chicago and London, pp. 231-236.

SINGH, ARJAN (1973): Cited by Sinha, J. P. (1976).

SINHA, J. P. (1976): Mating season in Tiger in Palamau Tiger Reserve. *Cheetal*, Vol. *18*(1&2): 47-55.

WALKER, ERNEST P. *et al.* (1964): Mammals of the World. Volume II, The Johns Hopkins Press. Baltimore, pp. 1268-1279.

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5. OCCURRENCE OF LARGE INDIAN CIVET (*VIVERRA ZIBETHA*) IN ORISSA

(*With a photograph*)

An adult Large Indian Civet (*Viverra zibetha*) was caught by villagers near screw-pine (*Pandanus tectorius*) bushes of the village Banguari (Fulnakhara area in Cuttack District, Orissa) on January 12, 1986 and received at Nandankanan Biological Park in an injured condition (Photo. 1). The animal recovered after treatment. It is housed in an enclosure having a floor space of approximately seven square metres; height 2.80 metres and with two cave-like retiring dens. It is fed with minced meat, milk, boiled rice and fruits like banana and apple. The animal is sluggish during day and becomes active late in the evening when all the visitors had left. This appears to be the first record of occurrence of this Civet in Orissa.

Prater (1971) gives the distribution of Large Indian Civet as Nepal, Sikkim, Bhutan, Upper Bengal and Assam, extending eastwards into Burma., Southern China, Siam and the Malay Peninsula. The distribution of this species is given as Southern China, Nepal, Assam and eastward to the Malay Peninsula (Walker *et al.* 1964). The species has not been reported from Orissa (Das and Agrawal 1973, Behura and Guru 1969).

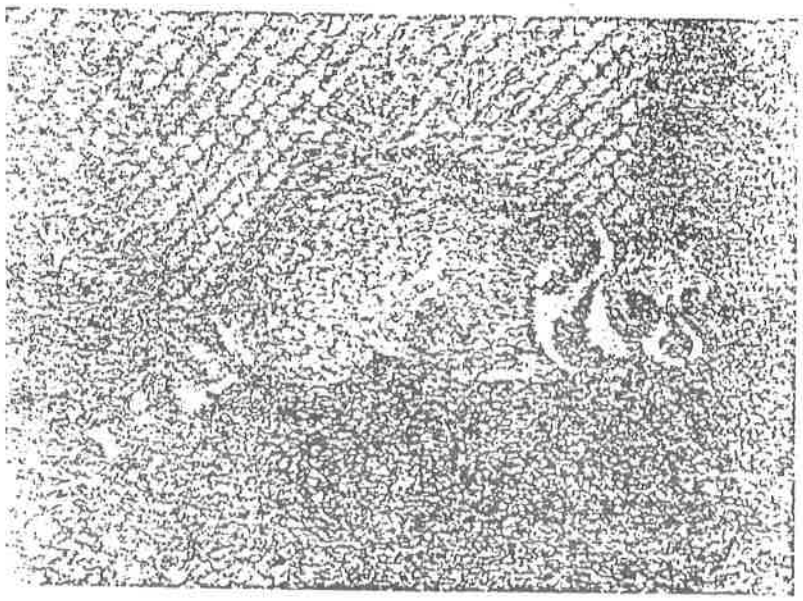

Photo 1. Large Indian Civet (*Viverra zibetha*) in Orissa.

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REFERENCES

BEHURA, B. K. & GURU, G. B. (1969): Wildlife of Orissa. *Prakruti-Utkal University journal-Science*. 6(2): 95-126.

DAS, P. K. & AGRAWAL, V. C. (1973): New Records of Mammals from Orissa. *Science & Culture* 39: 429-430.

PRATER, S. H. (1971): The Book of Indian Animals. Bombay Natural History Society, Bombay, pp. 90-91.

WALKER, ERNEST P. *et al.* (1964): Mammals of the World. Vol. II. The John Hopkins Press, Baltimore.

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3. SOME OBSERVATIONS ON ANTLER CYCLE OF CAPTIVE CHITAL (*CERVUS AXIS*)

INTRODUCTION

The Chital or Spotted deer (*Cervus axis*) is the most common among eight species of Indian deer. It is well known that the Chital casts off antlers periodically. But limited information is available on the different aspects of antler cycle in this species. This communication is an attempt to present additional information on different aspects of antler cycle of Chital observed in captivity.

METHODS

The data on different aspects of antler cycle of Chital based on the day-to-day observations recorded at the Nandankanan Biological Park, Orissa for a continuous period of 12 years and 6 months (1 October, 1970 to 31 March, 1983) were obtained and studied.

The park is within the biogeographical zone of the species under study. Specimens used for this study include those collected from different parts of Orissa and those born and brought up in the park. The number of Chital stags under observation varied from two to 16.

RESULTS AND DISCUSSION

Period of antler casting: During the observation period, 89 antler castings (spike as well as branched) were recorded on a captive population of Chital stags which varied from 3-11 individuals (Table 1). Antler casting occurred during a nine-month period from August to April. All the stags regularly cast their antlers annually and never retained them to the next year. Majority of castings (70 of 89 castings, 79%) occurred during a three-month period from November to January. Ten castings (11%) occurred during a three-month period from February to April and nine castings (10%) were observed during a three-month period from August to October.

TABLE 1

MONTHLY DISTRIBUTION OF CASTING OF ANTLERS AND RUBBING OFF VELVET BY CAPTIVE CHITAL STAGS

Month	Stags casting antlers*	Stags rubbing off velvet**
January	26	2
Febrauary	4	3
March	5	8
April	1	23
May	Nil	31
June	Nil	12
July	Nil	3
August	1	1
September	2	Nil
October	6	Nil
November	20	Nil
December	24	Nil
Total	89	83

* 3-11 stags/year ** 2-16 stags/year

Chital stags in velvet and in hard horn may be seen throughout the year (Krishnan 1975). The time of casting of antlers in this species varies in different localities; in Madhya Pradesh and South India, it is usually in August and September. The new antlers are in velvet till the end of December but stags carrying horns in various stages of development have been seen at all seasons (Prater 1971). Antlers were dropped without regard to season at the New York Zoological Park, so antlers in various stages of development could be seen at any time (Crandall 1965). According to Schaller (1976) most of the stags of Kanha National Park cast their antlers between August and October, though only four stags lost their

antlers between mid-February and mid-June and a few in July. He further stated that in the Calcutta Zoological Garden antlers were cast between September and February which mostly agree with the present findings. Asdell (1964) stated that the antlers are cast at any time in Sri Lanka but in southern Sri Lanka 75% are cast in April and May. At Bandipur National Park, majority of the antlers are cast during the months of September to November (Sharatchandra and Gadgil 1975). The climate, the biogeography and captive management conditions of this park might be responsible for the difference in the season of antler casting in this species from other areas.

Period of velvet rubbing: As usual with the stags of many species of deer, the Chital stags also rub off the velvet from the antlers each year after completion of their growth. During the study period, 83 observations were made on a captive population of 2-16 Chital stags (Table 1). Rubbing off the velvet occurred during an eight-month period from January to August. The majority of stags (74 of 83 clearings, 89%) cleared their velvet during March-June whereas five clearings (6%) were observed during January-February and four clearings (5%) occurred during July-August.

The velvet of antlers are lost at any time in Sri Lanka (Asdell 1964). April to August are the months of loss of velvet at Bandipur National Park (Sharatchandra and Gadgil 1975).

Duration of antler casting: In the 89 cases studied, casting of antlers of both sides was completed in one day in 57 instances (64%), within two consecutive days in 22 instances (25%), within three days in nine instances (10%) and within five days in only one instance (1%). These data indicate that majority of hard antlers (89%) are cast within 1-2 days.

Both the antlers are usually cast on the same day or on consecutive days but only occasionally the second antler is not cast until two or three days after the first one (Schaller 1967). Antlers of both sides are cast in one or two consecutive days (Acharjyo 1971).

Span of antler growth: The period required from the time of casting of hard antlers to the time when the stags start rubbing off the velvet is taken as the span of antler growth. This span, observed in nine cases, varied approximately from $3\frac{1}{2}$ to $5\frac{1}{2}$ months ($3\frac{1}{2}$ months on four occasions, four months on two occasions, $4\frac{1}{2}$ months on one occasion, five months on one occasion and $5\frac{1}{2}$ months on one occasion).

The time required for antlers to grow from the day of casting the old set until most of the velvet has been rubbed off the new one, observed in 11 stags in the Calcutta Zoological Garden varied from $2^2/_3$ to $6^1/_3$ months mostly depending on the length of antlers (Schaller 1967).

Interval between antler castings: The intercasting period observed in eight instances among four stags varied from 322-382 days.

The antlers are dropped at intervals of approximately ten to twelve months (Schaller 1967).

Age at first antler casting: Three male Chital born in the park on 17 December, 1971, 24 January, 1975 and 11 December, 1980 cast their spike antlers for the first time on 29-30 November, 1973, 24 December, 1976 and 4-6 January, 1983 respectively. These observations suggested that spike antlers were cast at an age of approximately one year, 11 months (two specimens) and 2 years, one month (one specimen). The knob-like pedicels became visible at an age of approximately $10\frac{1}{2}$ months (one specimen) and 11 months (two specimens). As expected, the coronet or burr was absent in spike antlers.

At the age of 11 to 12 months, the first set of antlers is visible as two prominent skin-covered bumps or knobs, and at about two

years the spike antlers are cast (Schaller and De 1964).

Size and weight of cast antlers: Eleven cast spike antlers of yearlings varied from 4.0 to 12.5 cm in length (mean $\bar{x}$ 8.18 cm) and 6.850 to 31.600 gm in weight (mean $\bar{x}$ 2.468 gm). Sixteen of the largest 3-pointed cast antlers measured 68.0 to 82.0 cm in length (mean $\bar{x}$ 77.3 cm) and twelve of the largest 3-pointed cast antlers weighed 574 to 840 gm (mean $\bar{x}$ 716.5 gm).

The antlers of yearlings consist of an unbranched spike usually less than seven inches (17.5 cm) long (Schaller and De 1964). The spike horns of Chital measure less than 25 cm in length (Sharatchandra and Gadgil 1975). An 85 cm antler would be good anywhere and 80 cm in south India, although the greatest record is 101 cm (Prater 1971). The longest antler recorded at Calcutta Zoological Garden by Schaller (1967) was 34 inches (85 cm). According to Krishnan (1975) size and formation of antlers differ with locality and are probably dependent mainly on heredity and strain.

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REFERENCES

ACHARJYO, L. N. (1971): Notes on Time of Shedding of Antlers of Deer in captivity. *Indian Forester*, *97*: 150-151.

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction. Second Edition. Cornell University Press, Ithaca, New York.

CRANDALL, L. S. (1965): The Management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London.

KRISHNAN, M. (1975): India's Wildlife in 1959-70. Bombay Natural History Society, Bombay.

PRATER, S. H. (1971): The Book of Indian Animals. 3rd (Revised) Ed. Bombay Natural History Society, Bombay.

SCHALLER, G. B. & DE, R. C. (1964): The Shedding of Antlers by Cheetal Deer. *Cheetal*, *7*: 15-17.

SCHALLER, G. B. (1967): The Deer and the Tiger. The University of Chicago Press, Chicago and London.

SHARATCHANDRA, H. C. & GADGIL, M. (1975): A Year of Bandipur. *J. Bombay nat. Hist. Soc.* *72*: 625-647.

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GENETIC STATUS OF WHITE TIGERS AT NANDANKANAN BIOLOGICAL PARK, ORISSA[1]

A.K. ROYCHOUDHURY[2] AND L.N. ACHARJYO[3]

(With two text-figures)

Using genealogies the inbreeding coefficients of the white tigers at the Calcutta, Delhi and Nandankanan Zoos have been calculated. The white tigers at Nandankanan are less inbred than those at Calcutta and Delhi. Inbreeding does not have much effect on fertility and mortality of the white tigers at Nandankanan. An objective breeding plan for Nandankanan has been given in order to breed white tigers with small values of inbreeding coefficient.

All the white tigers found at the zoos of Calcutta and Delhi in India, Washington D.C. in the U.S.A, and Bristol in England originated from two founder animals, namely Mohan, a white male and Begum, a coloured female. Since these two animals were caught in the forests of Rewa, Madhya Pradesh, India, all their descendants belong to the Rewa lineage. During the last two decades the white tigers of this lineage suffered grevious losses due to the deleterious effects of inbreeding. Matings between close relatives like father–daughter, mother–son, brother–sister etc. practised in the above mentioned zoos resulted in reduced fertility and increased early mortality (Roychoudhury and Sankhala 1979).

There is another lineage of white tigers found at the Nandankanan Biological Park, Orissa (Roychoudhury and Acharjyo 1983). The white tigers born there to a pair of normal coloured tigers have apparently no biological connections with the patriarch of white tigers, Mohan, or with his descendants. As of 20 February 1986, this park had the largest collection of white tigers in India, 8 females and 5 males. It has also 18 normal coloured tigers of which at least one is heterozygous, i.e. carrying a gene for white coat colour. They are all founded by three wild–caught tigers (Pradeep, Sikha and Rani) and one white female (Diana/Subhra) of the Rewa lineage obtained from the Delhi Zoo. Seven white offspring produced by Diana at this Park are the products of a mixture between Rewa and Nandankanan lineages. A number of coloured tigers have been sold or exchanged for animals to three zoological parks and one animal dealer in India. A genealogical chart of the animals is shown in Fig. 1. The dates of births and deaths of the tigers as well as the dates of selling and sending them to different zoological parks are given where available. In this paper we shall discuss the genetic status of the white tigers at Nandankanan.

Degree of inbreeding: At present 19 white descendants of Mohan and Begum are living in India, the USA and England. The inbreeding coefficients of these tigers range from 0.37 to 0.50 with an average of 0.41 ± 0.09 which is slightly higher than the average value (0.39 ± 0.13) of seven white tigers living in Delhi and Calcutta (Table 1). It is therefore clear that all the animals are highly inbred. Among 19 white tigers of the Rewa line, at least four (Neema, Sefali, Barun, and Priya) appear to be infertile. Nothing is known about the reproduction of Seema, Thiana, Akbar II and Nanda. The remaining tigers have produced offspring.

At Nandankanan among 13 white tigers seven are non–inbred, five have an inbreeding coefficient of 0.25 and the one (Diana/Subhra) that had been brought from the Delhi Zoo has an inbreeding value of 0.50. However, the average inbreeding coefficient of all of the white tigers is 0.13 ± 0.05 and it is 0.10 ± 0.04 when Diana is excluded (Table 2). The white tigers at Nandankanan are significantly less inbred than those at the Delhi and Calcutta Zoos.

Genetic contributions of four founders: To preserve the ideal genetic diversity in the tiger population at Nandankanan, all the four founder animals should have equal genetic contributions. From the genealogical chart we can easily calculate the percentage of genes contributed by the founders to each individual. Averaging over all living individuals, the percentages of genetic contributions of four founding animals are determined. It is observed that Pradeep and Sikha have higher genetic

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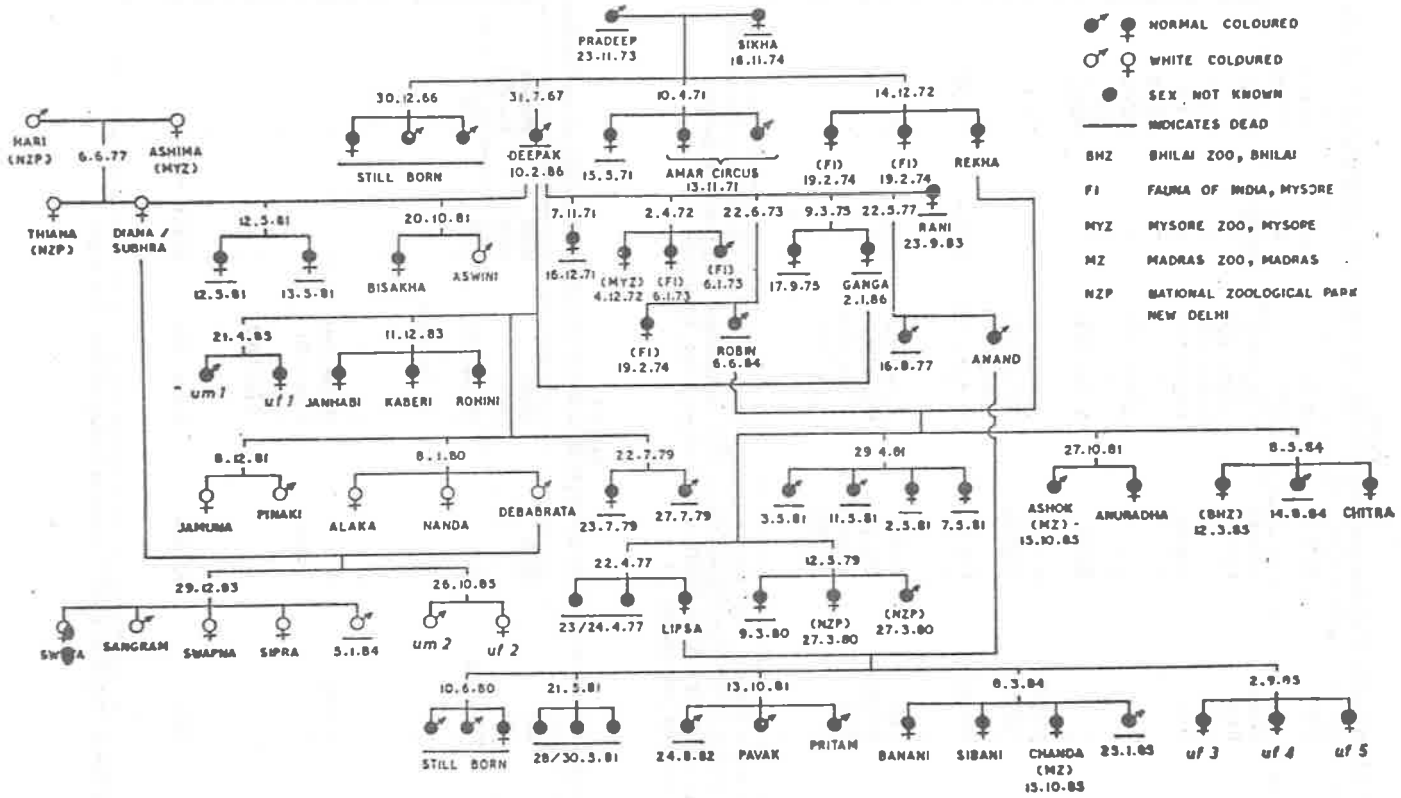

Fig. 1. Geneological chart of tigers at Nandankanan Biological Park

TABLE 1
INBREEDING COEFFICIENTS AND OTHER INFORMATION OF THE LIVING WHITE DESCENDANTS OF MOHAN AND BEGUM

Name	Sex	Sire	Dam	Birth date	Birth place	Present location	Inbreeding coefficient
1. Homa	F	Mohan	Sukeshi	6 Sep 1967	NZPD	NZPD	0.3750
2. Hari	M	Raja	Rani	3 May 1968	"	"	0.3750
3. Ashima	F	"	"	11 Apr 1970	"	MYZ	0.3750
4. Diana/Subhra	F	Hari	Ashima	6 June 1977	"	NBP	0.5000
5. Thiana	F	"	"	"	"	NZPH	0.5000
6. Neema	F	"	"	22 Nov 1977	"	NZPD	0.5000
7. Seema	F	"	"	"	"	KZ	0.5000
8. Vijay	M	"	Homa	6 May 1978	"	NZPD	0.3750
9. Sohrab	M	"	"	"	"	"	0.3750
10. Barun	M	Neeladri	Malini	18 May 1969	CZG	CZG	0.3750
11. Himadri Jr.	F	Himadri	Chandni	28 July 1975	"	"	0.3750
12. Sefali	F	"	"	19 June 1973	"	GZ	0.3750
13. Ranjit	M	Ramana	Kesari	20 June 1974	NZPW	NZPW	0.4062
14. Bharat	M	"	"	"	"	"	0.4062
15. Priya	F	"	"	"	"	"	0.4062
16. Roop	M	Raja	Radha	7 June 1969	NZPD	BZ	0.3750
17. Sumati	F	Champak	Chameli	9 July 1968	BZ	"	0.3750
18. Akbar II	M	Roop	Sumati	16 June.1976	"	"	0.3750
19. Nanda	F	"	Nirmala	7 July 1977	"	"	0.3750
Average							0.406

Abbreviations: BZ: Bristol Zoo, England; CZG: Calcutta Zoological Garden, Calcutta; GZ: Guwahati Zoo, Assam; KZ: Kanpur Zoo, Uttar Pradesh; MYZ: Mysore Zoo, Mysore; NBP: Nandankanan Biological Park, Orissa; NZPD: National Zoological Park, New Delhi; NZPH: Nehru Zoological Park, Hyderabad; NZPW: National Zoological Park, Washington, D.C.

TABLE 2
INBREEDING COEFFCIENTS AND OTHER INFORMATION OF THE LIVING WHITE TIGERS AT NANDANKANAN

Name	Sex	Sire	Dam	Birth date	Birth place	Present location	Inbreeding coefficient
1 Unnamed	M	Debabrata	Diana	26 Oct 1985	NBP	NBP	0
2 "	F	"	"	"	"	"	0
3 Sweta	F	"	"	29. Dec 1983	"	"	0
4 Sangram	M	"	"	"	"	"	0
5 Swapna	F	"	"	"	"	"	0
6 Sipra	F	"	"	"	"	"	0
7 Aswini	M	Deepak	"	20 Oct 1981	"	"	0
8 Jamuna	F	"	Ganga	8 Dec1981	"	"	0.250
9 Pinaki	M	"	"	"	"	"	0.250
10. Alaka	F	"	"	8 Jan 1980	"	"	0.250
11. Nanda	F	"	"	"	"	"	0.250
12. Debabrata	M	"	"	"	"	"	0.250
13 Diana	F	Hari	Ashima	6 June 1977	NZPD	"	0.500
Average							0.134

*NBP: Nandankanan Biological Park, Orissa NZPD: National Zoological Park, New Delhi

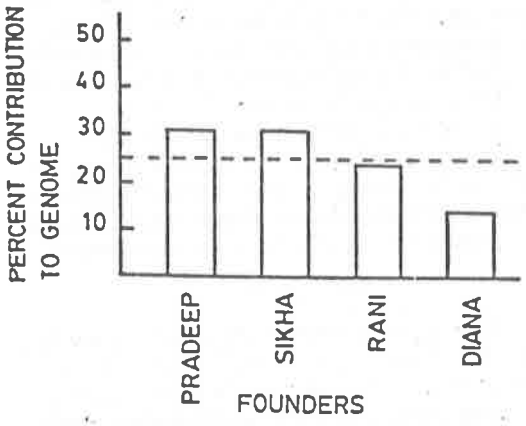

Fig. 2. Genetic constribution of four founders to the tiger population at Nandankanan. The dotted line shows the ideal contribution to the genome, if all founders contribute equally (25%).

contributions than Rani and Diana (Fig. 2). Diana has contributed the least, since she is old and highly inbred.

Inbreeding effects on fertility: The effect of inbreeding on litter size in white tigers of the Rewa lineage at the Delhi and Calcutta Zoos and in white and coloured tigers of the Nandankanan lineage at the Nandankanan Biological Park was examined (Table 3). Cubs with inbreeding coefficients of 0 are classified as non– inbred and those with values greater than 0 as inbred. At the Delhi and Calcutta Zoos, the average litter size of inbred tigresses is less than that of non–inbred ones but the difference is not statistically significant ($p > 0.05$). At Nandankanan, the average litter size is higher in inbred tigresses than in non–inbred ones, but the difference is not statistically significant. Nothing can be said categorically until more data for both inbred and non–inbred births are available.

Inbreeding Effects on Mortality

It has been stated earlier that the matings between close relatives of white tigers at the Delhi, Calcutta, Bristol and Washington Zoos resulted in early mortality. Table 4 shows the number of deaths of offspring for the Rewa and Nandankanan lineages within 30 days after their births for different levels of inbreeding coefficients. It is observed that 10% of

Table 3
LITTER SIZE OF NON–INBRED AND INBRED BIRTHS OF WHITE TIGERS IN REWA LINEAGE (DELHI AND CALCUTTA) AND THOSE OF WHITE AND COLOURED TIGERS AT NANDANKANAN

	Number of cubs in a litter					Mean ± S.D.
	1	2	3	4	5	
Rewa lineage						
Non–inbred births	–	3	5	3	–	3.00 ± 0.23
Inbred births	4	18	6	10	1	2.64 ± 0.17
Nandankanan lineage						
Non–inbred births	2	6	4	–	1	2.39 ± 0.29
Inbred births	–	4	9	2	–	2.87 ± 0.17

Table 4
30 DAY MORTALITY DATA FOR THE OFFSPRING OF TWO LINEAGES OF WHITE TIGERS

Inbreeding coefficient	Rewa lineage		Nandankanan lineage	
	Total No. births	No. of deaths	Total No. births	No. of deaths
0.0	10	1	31	6
0.1250	–	–	15	5
0.1875	–	–	16	6
0.2500	30	8	12	2
0.3750	91	32	–	–
0.4062	4	0	–	–
0.4375	7	5	–	–
0.4687	2	1	–	–
0.5000	22	17	–	–

the non– inbred offspring of Rewa lineage died before they were 30 days old, as compared to 40% of the inbred offspring. The early mortality is increased up to 77% when inbreeding coefficient of the offspring attains 0.5. But at Nandankanan, 19% of the non–inbred offspring died as against 30% in the inbred offspring. In both the lineages, the differences are not statistically significant.

To study the inbreeding effects on mortality of the offspring of the Rewa and Nandankanan lineages, the following standard genetic model is used (Morton *et al.* 1956).

$P = exp\ (-A-BF)$

Where P is the proportion of dead offspring whose inbreeding coefficient is F and, A measures the contribution of non–genetic or environmental causes of death and B the contribution of genetic causes of deaths due to inbreeding. Following Chakraborty and Chakravarti (1977), the estimates of A and B for the Rewa lineage are:

$A = 0.061 \pm 0.077, B = 1.386 \pm 0.282$

Since the standard error of A is larger than its estimate, environment does not seem to have any effect on the mortality of the offspring of the Rewa lineage. But the estimate of B is about five times its standard error, indicating that the inbreeding has a significant role in the early deaths of the offspring.

Using similar type of mortality data for the offspring of the Nandankanan lineage the estimates of A and B are obtained as follows:

$A = 0.241 \pm 0.091, B = 0.589 \pm 0.712$

Unlike the offspring of the Rewa lineage, the effects of inbreeding on early deaths for the offspring of the Nandankanan lineage seem to have a minor role as compared to those of environment.

Breeding Plan

If we know in advance the inbreeding coefficients of the resulting offspring for all possible pairs, an objective breeding plan can be made. A number of workers have calculated the inbreeding coefficients of the resulting offspring for all possible combinations of captive males and females of Sumatran tigers (Ballou and Seidensticker 1982), Indian lions (Smith 1985) and north American white tigers (Murtaugh 1985). We have also calculated the inbreeding coefficients for the offspring of all hypothetical pairings of living tigers at Nandankanan (Table 5).

Table 5
INBREEDING COEFFICIENTS FOR THE OFFSPRING OF LIVING WHITE (CAPITAL LETTERS), HETEROZYGOUS (ITALICS) AND COLOURED TIGERS AT THE NANDANKANAN BIOLOGICAL PARK

Female \ Male	ASWINI	DEBA BRATA	PINAKI	um1	SANGRAM	um 2	Pritam	Pavak	Anand
SUBHRA/ DIANA	0.375	0.	0.	0.	0.375	0.375	0.	0	
ALAKA	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
NANDA	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
JAMUNA	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Janhabi	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Kaberi	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Rohini	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Ufl	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
SWETA	0.281	0.313	0.313	0.313	0.344	0.344	0.177	0.117	0.125
SWAPNA	0.281	0.313	0.313	0.313	0.344	0.344	0.117	0.117	0.125
SIPRA	0.281	0.313	0.313	0.313	0.344	0.344	0.117	0.117	0.125
UF 2	0.281	0.313	0.313	0.313	0.344	0.344	0.117	0.117	0.125
Bisakha	0.313	0.188	0.188	0.188	0.281	0.281	0.125	0.125	0.125
Lipsa	0.125	0.219	0.219	0.219	0.109	0.109	0.375	0.375	0.188
Anuradha	0.125	0.219	0.219	0.219	0.109	0.109	0.375	0.375	0.188
Chitra	0.125	0.219	0.219	0.219	0.109	0.109	0.375	0.375	0.188
Banani	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
Sibani	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
uf 3	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
uf 4	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
uf 5	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344

The inbreeding coefficients of the offspring can be used as guides in the selection of mates for future breeding of white and coloured tigers. Apart from age and health considerations, the mates are to be selected in such a manner that their offspring will have the least inbreeding coefficient. In this respect Lipsa, Anuradha and Chitra may be ideal partners for the white Sangram or the white unnamed male, for their offspring will have an inbreeding coefficient of 0.11. Since Sangram and the unnamed male (UM2) are not mature, they cannot be paired immediately with these three females. In this analysis we have excluded Rekha, the offspring of Sikha, for she has passed her reproductive period.

Of 40 possible pairings between eight white females and five white males, only two pairs produce offspring with inbreeding coefficient of 0, nine pairs produce offspring with inbreeding coefficient of 0.19 and the remaining pairs produce offspring with inbreeding coefficients varying between 0.28 and 0.38. To breed white tigers with an inbreeding value of 0, Diana should be paired with either Debabrata or Pinaki. But she is too old to produce further offspring. Instead of Debabrata, Aswini or Sangram may be the ideal partner for Alaka, Nanda and Jamuna.

Bisakha, born to Subhra and Deepak, is a heterozygous female. If she is mated with any of the mature white males, namely Aswini, Debabrata and Pinaki, white offspring may appear with a chance of 50% per cent. Matings of Bisakha with the last two white tigers will produce offspring with low inbreeding coefficient (0.19). Four coloured females and one coloured male born to Deepak and Ganga in their last two litters are heterozygous with a probability of 0.67. If they are mated with any white tiger, the probability of obtaining a white offspring is 0.33. It is quite unlikely that both Anand and Lipsa are heterozygous. If they were so, they would have produced at least one white cub out of their 16 cubs in five litters. To examine whether any of them is heterozygous, Anand may be paired with Sweta, Swapna or Sipra, and similarly Lipsa with Aswini or Sangram. If Anand or Lipsa produce at least one white offspring, they will be considered heterozygous. In any case the inbreeding coefficient of their offspring will not be higher than 0.12.

Conclusions

To reduce the levels of inbreeding, white tigers should be allowed to outcross with unrelated normal coloured tigers and the offspring thus produced are to be backcrossed with white tigers, preferably of different lineage. If outcrossing and backcrossing are conducted alternately, avoiding common lineage whenever possible, white tigers can be produced with the lowest possible level of inbreeding. This strategy of breeding in white tigers has been advocated earlier by Murtaugh (1985).

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References

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

Chakraborty, R. & Chakravarti, A. (1977): On consanguineous marriages and the genetic load. *Hum. Genet. 36:* 47–54.

Morton, N.E., Crow, J.F. & Muller, H.J. (1956): An estimate of the mutational damage in man from data on consanguineous marriages. *Proc. Natl. Acad. Sci. 42:* 855–863.

Murtaugh, J. (1985): A genetic analysis of the north American population of white tigers with recommendations for future management. National Zoological Park, Washington, D.C., USA, (Unpublished).

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

——— & Acharyo, L.N. (1983): Origin of white tigers at Nandankanan Biological Park, Orissa. *Indian J. Expt. Biol. 21:* 350–352.

Smith, G.L. (1985): International Studbook. Indian Lion, *Panthera leo persica* (Meyer 1926). Knoxville Zoological Park, Tennessee, USA.

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MISCELLANEOUS NOTES

1. ON THE LONGEVITY OF TWO SPECIES OF INDIAN WILD CATS IN CAPTIVITY

Not much information is available on the longevity of different species of Indian cats. In this note we record some data on the longevity of the golden cat *Felis temmincki* and leopard *Panthera pardus* observed at the Nandankanan Biological Park, Orissa.

Golden cat: One female golden cat born in the park on 2 March 1972 died on 13 January 1987 at the age of 14 years, 10 months and 11 days. It was housed along with its parents in an enclosure with a cemented floor space of approximately 16.5 sq. m and height 2.80 m. 750 g of goat meat and 250 g of beef with bones were fed six days a week with only 375 g of goat meat once a week. It was also given one live chicken instead of beef and goat meat once a month.

None of this species survived at the New York Zoological Park for more than 2 years but one, however, lived for 17 years, 8 months and 25 days at St. Louis Zoological Park (Crandall 1965). A golden cat has lived for a maximum period of 5 years at Alipore Zoological Garden, Calcutta (Sanyal 1892). Acharjyo and Mishra (1981) have recorded the death of a male at an estimated age of 15 years.

Leopard: A 15 day old female leopard received in the Park on 20 June 1964 died on 1 July 1987 after remaining for 23 years and 11 days in captivity. During her lifetime she gave birth to 19 cubs in 10 litters.

Another approximately one month old female leopard was received in the park on 14 August 1966. She died on 14 April 1986 after 19 years and 8 months. She also gave birth to 19 cubs in 10 litters during her lifetime.

The leopards of the Park are housed in spacious covered enclosures with suitable vegetation and sandy floors. Each enclosure has a set of cells with cemented floor for protection from extreme weather conditions and for feeding. On an average each animal is fed about 3 kg of fresh raw beef with bones six days a week. They are kept in pairs or in small groups.

A leopard has lived for a maximum period of 14 years at the Alipore Zoological Garden, Calcutta (Sanyal 1892). The best longevity for this species recorded at the New York Zoological Park was 17 years, 1 month and 18 days but another specimen had exceeded that span by October 1963 (Crandall 1965).

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REFERENCES

ACHARJYO, L.N. & MISHRA, CH. G. (1981): Some notes on the longevity of two species of Indian Wild Cats in captivity. *J. Bombay nat. Hist. Soc. 78:* 155-156.

CRANDALL, LEE S. (1965): The Management of Wild Mammals in captivity. The University of Chicago Press, Chicago & London, pp. 359-413.

SANYAL, R.B. (1892): A hand-book of the management of animals in captivity in lower Bengal. Bengal Secretariat Press, Calcutta, pp. 51-56.

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MISCELLANEOUS NOTES

1. SOME OBSERVATIONS ON THE BREEDING AND LONGEVITY OF LION-TAILED MACAQUE (*MACACA SILENUS*) IN CAPTIVITY

A pair of adult lion-tailed macaque (*Macaca silenus*) was received from the National Zoological Park, New Delhi in January, 1982 and displayed in one of the monkey islands surrounded by a water moat of 7 metres width at the Nandankanan Biological Park, Orissa. The land area of the circular island with 12 metres diameter and 2.50 metres deep including the 0.60 metre high parapet on the viewer's side. The shelter house in the centre of the island measures 2.70 x 1.50 x 2.10 metres. The island has natural growth of vegetation. The zoo diet of these macaques consists of a variety of fruits, vegetables, greens, bread, milk and cooked rice. They have also free access to insects in the natural vegetation.

During the period from January 1982 to June 1991, the female of this pair and their two female offsprings gave birth to nine young including two still-births. There was always one young born. Births have taken place in January, 4; March, 2; October, 1 and November, 2. The inter-parturition interval recorded four times in one female (Dates of birth: 4-10-1983, 28-3-1985, 21-1-1987, 3-11-1988 and 16-3-1990) varied from 1 year, 4 months and 13 days to 1 year, 9 months and 24 days with a mean of 1 year, 7 months and 11 days. The two zoo-born females gave birth to their first young at the age of 3 years, 9 months and 29 days and 4 years, 3 months and 16 days respectively. The two still-born male young weighed 417-495 gm (mean 456 gm) and measured 39-42 cm (mean 40.50 cm) from tip of the nose to tip of the tail including 12.50-14.00 cm (mean 13.25 cm) long tails.

One adult female living in the park since January 29, 1966 died on June 16, 1984 after remaining for 18 years, 4 months and 18 days in captivity at an estimated age of 20 years.

Usually all primates produce their young singly and in the wild new born young of this species are seen regularly in September in South India (Prater 1980). There is only one set of twins in 309 births recorded in North American Zoos during 1932-1982 and 305 births for which birth dates are available occur in all the months of the year with minimum of 20 during August to a maximum of 33 in April and December with no evidence of seasonality in reproduction (Lindburg *et al.* 1989). According to Walker *et al.* (1964) all the *Macaca* species usually produce one young but occasionally twins are born. At Delhi Zoological Park 15 births are recorded from March to November with the maximum number of births in April and May (Desai and Malhotra 1976).

The sex ratio at birth was strongly in favour of males (58.5%) which is similar to the present limited findings (Lindburg *et al.* 1989). They further stated that the mean inter-birth interval was 17.3 months for lactating mothers (14.2 months for non-lactating mothers) and the age of sexual maturity for females of this species is given as about 4 years. The birth weight is given as 450 gm (Parker 1990) and 348.8 gm for one specimen (Crandall 1965).

The life span for all species of *Macaca* in general is given as 30 years or more (Walker *et al.* 1964) and for this species as over 20 years (Parker 1990). The maximum longevity recorded for this species is 17 years and 7 months (Jones 1962) and at Rotterdam Zoo one specimen of this species lived for 16 years, 11 months and 16 days (Flower 1931).

March 24, 1994

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References

Crandall, Lee S. (1965): The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London, pp. 110-111.

Desai, J.H. & A.K. Malhotra (1976): A note on the captive status of the Lion-tailed macaque, *Macaca silenus* in India and its Breeding at Delhi Zoo. *Int. Zoo Yb. 16:* 116-117.

Flower, S.S. (1931): Cited by Crandall, Lee S. (1965).

*Jones, M.L. (1962): Mammals in captivity: Primate longevity. *Laboratory Primate News letter, 1:* 3-13.

Lindburg, D.G., A.M. Lyles & N.M. Czekala (1989): Status and Reproductive Potentiality of Lion-tailed macaques in captivity. *Zoo Biology supplement 1:* 5-16.

Parker, S.P. (1990): Grzimek's Encyclopedia of Mammals, Vol. 2. Mcgraw-Hill-Publishing company, New York, St. Lovis, San Francisco, pp. 229-235.

Prater, S.H. (1980): The Book of Indian Animals. Bombay Natural History Society, Bombay, pp. 30-39.

Walker, E.P. *et al.* (1964): Mammals of the World, Volume-I. The Johns Hopkins Press, Baltimore, pp. 448.

*Original not consulted.

JOURNAL, BOMBAY NATURAL HIST. SOCIETY, VOL. 94 (3) : 554-555 (1997)

2. OCCURRENCE OF THE RUSTYSPOTTED CAT (*FELIS RUBIGINOSA*) IN ORISSA

(*With one text-figure*)

Two (one male and one female) rustyspotted kittens (*Felis rubiginosa*) were collected from the road leading to Bhramarbadi village in Daringbadi block (Balliguda Forest Division) in Phulbani dist. on 16th February, 1995 evening, by the Sub-Collector and Sub-Divisional Police Officer of Balliguda Sub-division and received at the Nandankanan Zoological Park, Orissa, on 18th February, 1995 through the good offices of the Divisional Forest Officer, Balliguda.

These were mistakenly identified as leopard cat kittens, with their eyes open and an estimated age of about 3-4 weeks. The kittens were initially kept in a well ventilated wooden box and then shifted to an enclosure with dimensions 1.85 x 1.65 x 2.0 m^3. They were fed with minced goat meat for a few weeks followed by goat meat. Unfortunately the male died on 29th March, 1995. By August 1995, the female kitten had matured and revealed the characteristic size and colour pattern described for the rustyspotted cat by Prater (1971) (Fig. 1). However, she also died on 15th October, 1995. The systematic list of mammals from Orissa reported by Das *et al.* (1993) does not include the rustyspotted cat. This is the first record of the occurrence of this rare species of lesser cat in Orissa.

Reviewing the literature on the occurrence of the rustyspotted cat, Chakraborty (1978) states that this interesting cat is recorded only from certain localities in southern India, Sri Lanka and Seoni in Madhya Pradesh. He further states that one female specimen of the rustyspotted cat was collected from Udhampur (Jammu and Kashmir) on 16th October, 1975 during the faunistic survey.

It occurs in southern India and along the western ghats upto the Dangs in south Gujarat (Prater, 1971; Saharia, 1981; Gee, 1964). Sightings of this lesser cat in Gir Wildlife Sanctuary and National Park, and Shoolpaneshwar Sanctuary in Gujarat have been reported in recent years (Pathak,

Fig. 1. Female rustyspotted cat in Nandankanan Zoological Park

1990; Chavan *et al.* 1991). Tehsin (1994) reported the sightings of this rare cat for the first time near Udaipur (Rajasthan) in July, 1992. This species has also been reported in Panna dist., Madhya Pradesh (Digveerendrasinh, 1995).

The present observation and the observations of other workers on the occurrence of the rustyspotted cat suggest that the species has a much wider range of distribution in India than was believed earlier.

February 8, 1997

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REFERENCES

CHAKRABORTY, S. (1978): The Rustyspotted Cat, *Felis rubiginosa* I. Geoffroy, in Jammu and Kashmir, *J. Bombay nat. Hist. Soc. 75(2)*: 478-479.

CHAVAN, S.A., C.D. PATEL, S.V. PAWAR, N.S. GOGATE & N.P. PANDYA (1991): Sightings of the Rustyspotted Cat, *Felis rubiginosa* Geoffroy in Shoolpaneshwar Sanctuary, Gujarat, *J. Bombay nat. Hist. Soc. 88(1)*: 107-108.

DAS, P.K., J.P. LAL & V.C. AGRAWAL (1993): Mammalia: State Fauna Series-1; Fauna of Orissa, Part 4. Zoological Survey of India, Calcutta, pp 143-180.

DIGVEERENDRASINH (1995): Occurrence of the Rustyspotted Cat (*Felis rubiginosa*) in Madhya Pradesh, *J. Bombay nat. Hist. Soc. 92(3)*: 407-408.

GEE, E.P.(1964): The Wildlife of India, Collins, London, pp 1149.

PATHAK, B.J. (1990): Rustyspotted Cat, *Felis rubiginosa* Geoffroy: A new record for Gir Wildlife Sanctuary and National Park, *J. Bombay nat. Hist. Soc. 87(3)*: 445.

PRATER, S.H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay, pp 74.

SAHARIA, V.B. (1981): Wildlife in India, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi. pp 95.

TEHSIN, R. (1994): Rustyspotted Cat *Felis rubiginosa* Geoffroy sighted near Udaipur. *J. Bombay nat. Hist. Soc. 91(1)*: 136.

[Reprint, from The *Indian Forester, Vol.* 96, No. 9 : 717 September 1970]

IV

Sir,

Sub.:—Notes on a young hybrid langur

A female Nilgiri langur (*Presbytis johni*) which was kept along with a male Common langur (*Presbytis entellus*) from 25.9.67 to 16.7.69 at the Nandankanan Zoo (Orissa), has given birth to one female hybrid young on 18.12.69. However, the mother did not take care of the young and so the young died within 24 hours of birth. The young was black but lighter in colour whereas the pure Nilgiri langur young is jet black (Prater, 1965). The dead young weighed 500 g on 19.12.69 after about 24 hours of birth. In this case the gestation period was not less than 155 days.

Delhi Zoo is the only Zoo in the world, that has successfully bred the Nilgiri langur twice in captivity (Sankhala, 1967). From the available literature, it appears that there is no report of a hybrid young of Nilgiri langur and Common langur in captivity and so this report.

References

1. Prater, S.H. (1965)—The Book of Indian Animals, Bombay Natural History Society and Prince of Wales Museum of Western India, Bombay.

2. Sankhala, K.S. (1967)—The Illustrated Weekly of India, October 1, 1967 p.p. 36-39. The Times of India, Bombay.

Yours faithfully,
Sd. L.N. Acharjyo,
Vety. Asst. Surgeon, Nandankanan
and
Sd. G.S. Padhi,
Wild Life Conservation Officer,
Orissa, Cuttack-1.

Date 24.6.1970

[Reprint, from The *Indian Forester, Vol.* 97, No. 3 : 150-151 March 1971]

NOTES ON TIME OF SHEDDING OF ANTLERS OF DEER IN CAPTIVITY

By

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SUMMARY

Some notes on the time of shedding of antlers of four kinds of deer observed at the Nandankanan Biological Park (Orissa) during the period from April, 1967 to September, 1970 have been reported and the observations of earlier reports have been cited.

It is observed that the Sambars shed their antlers from April to July, the Spotted deer from November to February, the Hog deer (brought from outside the State) in December and the Barking deer in April and May.

Introduction

For the successful management of a Zoological Park it is necessary to know all the normal characters of all the animals Generally various kinds of deer are maintained in almost all the Zoological Parks. The deer shed their antlers periodically. It appears that there are not very many reports on the time of shedding of antlers of deer in captivity from India. Therefore this communication is intended to give a broad aspect on the time of shedding of antlers of four kinds of deer maintained at the zoo wing of the Nandankanan Biological Park (Orissa) and observed during the last 3 years and 6 months (from April, 1967 to September, 1970). The original breeding stocks in sambar, axis deer and muntjacs were obtained from various parts in the State of Orissa. Specimens born and brought up in the zoo are included in the statements. There is no provenance differentiation.

Observations and Discussion

1. Sambar (*Cervus unicolor*)

Altogether fifteen sheddings of antlers were observed during this period.

Shedding was observed regularly every year in all the animals and both the right and left antlers were shed either within a day or in two consecutive days. Two male Sambars born here in August, 1968 have shed their single spike antlers for the first time in June, 1970, i.e., at the age of approximately 1 year and 10 months. Out of fifteen sheddings, fourteen sheddings (93.33%) were observed during the months of April, May and June whereas only one shedding (6.67%) was observed in July.

Lydekker (1924) observed that the antlers are not shed regularly every season but only every 2 or 3 years; in Himalayas they are shed in April whereas in the plains the usual month of shedding is March and they are shed at any time of the year at Woburn. The antlers have been shed from April to September but mostly in May and June in European Zoos (Van Bemmel, 1949-50). Hollister (1920) states that there is a record of shedding of antlers in June in Washington Zoo. Crandall (*loc. cit.*) states that the male Sambars in captivity may shed their antlers at any season. The majority of antlers are shed between the end of March and mid-April in central and southern India (Prater, *loc. cit.*).

2. Spotted Deer or Chital (*Axis axis*)

Twenty sheddings of antlers were observed during this period of observation. Shedding of antlers occurred between November to February with peak shedding in November.

Shedding of antlers was observed always annually and both the right and left antlers were shed in one day or in two consecutive days.

The antlers are shed at any time but mostly in August (Brander, 1923). The antlers are shed at any time in Ceylon but in southern Ceylon 75% are shed in April and May (Phillips, 1927-28). According to Prater (*loc. cit.*) the time of shedding of antlers of this deer varies in different localities; in Madhya Pradesh and south India shedding is usually in August and September but antlers in various stages of development have been seen at all seasons. Antlers were dropped without regard to season and so antlers in various stages of development may be seen at any time (Crandall, *lot. cit.*). The stags shed their antlers in jungle usually in August (Walker *et al.*, *loc. cit.*). The stags in velvet and hard horn may be seen at all seasons (Krishnan, 1969).

3. Muntjac or Barking Deer (*Muntiacus muntjak*)

Nine sheddings of antlers were observed during this period, in April and May each year.

They were shed annually and both the right and left antlers were shed either in one particular day or in two consecutive days.

The antlers of this deer are shed in May (Lydekker, 1898, 1924). The males renew the antlers in August but it is doubtful whether this occurs annually (Banks, 1931). According to Prater (*loc. cit.*) antlers are shed in May and June. In southern Asia, the antlers are shed annually in May (Walker *et al.*, *loc. cit.*).

4. Hog Deer (*Axis porcinus*)

Three sheddings of only one particular stag was observed at every one year interval, always in December only (29.12.1967, 11.12.1968 and 30.12.1969). Both the right and left antlers were always shed in one day.

The antlers of this deer in India are shed in April (Blanford, 1888-91). There is a record of shedding of antlers in February in Philadelphia Zoo (Brown, 1921). In Washington Zoo there is one record of July shedding (Hollister, *loc. cit.*).

Acknowledgement

The author is grateful to Sri R. Misra, I.F.S., Wild Life Conservation Officer, Orissa, Cuttack-1 for going through the manuscript and for permitting to publish the article.

———

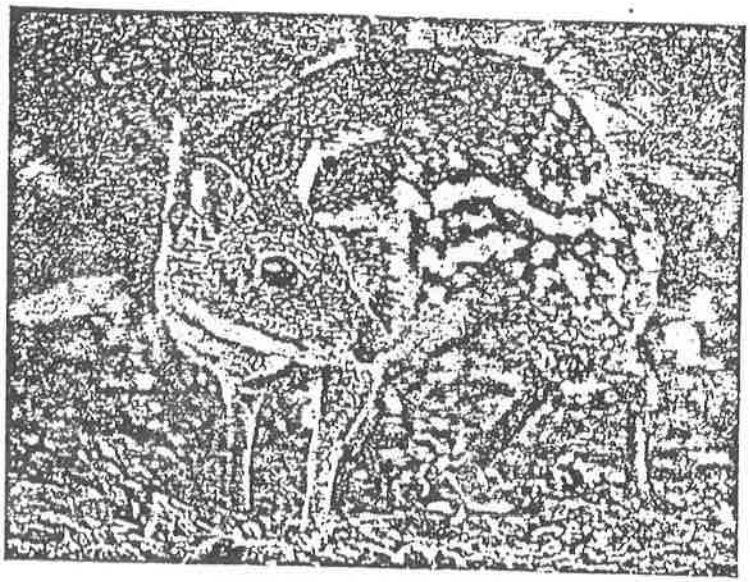
[Reprint, from The *Indian Forester, Vol.* 97, No. 5 : 288-289 May 1971]

II

Sir,

Sub:—**Greatest longevity of Indian Chevrotain or Mouse deer (*Tragulus meminna*) in captivity.**

An adult male Mouse deer (*Tragulus meminna*) which was received at Nandankanan Biological Park (Orissa) on 7.7.1963 died accidentally from heart failure on 4.11.1970 while trying to catch it for transportation. In the Park it had remained in captivity for 7 years, 3 months and 29 days. The estimated age at the time of death is about 10 years. Autopsy revealed very small quantity of fat deposits in the cardiac region. Similar deaths from heart failure while trying to catch or soon after catching for transportation had also been observed among Sambars, Spotted deer and Barking deer in this Park. This animal was taking boiled rice, boiled pulses, milk, brinjal, sweet potatoes, banana, doob (*Cynodon dactylon*) and other edible grasses and it apparently maintained excellent health throughout this period. It was remaining in cages having floor spaces of about 215 square metres, 17 square metres and 55 square metres for periods of about 5½ years, 8 months and 14 months respectively. This was remaining in association with a female Mouse deer, approximately 15 common peafowls and 2 to 8 turkeys for a period of 5½ years; with a female Mouse deer, one white Rabbit and four Guinea pigs for a period of about 8 months and with a female Mouse deer and 3 white Peafowls for a period of about 14 months. No special exercise was given except the usual daily movements inside the cages. From the



Mouse deer (*Tragulus meminna*)

Photo—Miss Nihar Swain.

perusal of the available literature, it seems that this record of 7 years, 3 months and 29 days in captivity for an Indian Chevrotain of this Biological Park is the longest period recorded so far for an Indian Chevrotain in captivity and hence this report.

Jones (1958) says that an Indian Chevrotain has lived in London for a maximum period of 4 years, 8 months, 18 days. Best longevity achieved at the New York Zoological Park for six specimens of *Tragulus* (which might have included *Tragulus meminna* also) was 2 years, 10 months, 18 days (Crandall, 1965). Longevities of Chevrotains are not given by Flower (1931) and Prater (1965). We are interested to know if any other Zoo has achieved either this longevity or more for an Indian Chevrotain.

References

1. Crandall, Lee S. (1965)—The Management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London, P.P. 552-555.
2. Flower, S.S. (1931)—Cited by Crandall Lee S.
3. Jones, Marvin L. (1958)— ————————
4. Prater, S.H. (1965)—The Book of Indian Animals, Bombay Natural History Society and Prince of Wales Museum of Western India, Bombay, P.P. 296-297.

Yours faithfully,
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&
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Dated Dec. 16th 1970

[Reprint, from The *Indian Forester, Vol.* 98, No. 2 : 132-134 February 1972]

A NOTE ON OPENING OF EYES OF SOME GREAT CAT CUBS IN CAPTIVITY

By

L.N. Acharjyo[1] and R. Misra[2]

SUMMARY

This note deals with some observations on the age at which the eyes of three kinds of new born Great Cat cubs opened at the Nandankanan Biological Park (Orissa).

It has been observed that the tiger cubs open their eyes in seven to eleven days, African lion cubs open their eyes in thirteen to fourteen days and the leopard cubs open their eyes in eight to fifteen days. The available data has been cited and discussed.

Introduction

Generally various kinds of cats are exhibited and bred in most of the Zoological Parks. It is reported that all cats are born blind and helpless but some baby lions can also see at birth. There is paucity of information from India on the age at which the eyes of the cat cubs open. Hence this note is intended to place on record some observations on the age at which the eyes of three kinds of new born great cat cubs open. The observations were made at the Nandankanan Biological Park (Orissa) and the period of observation is given in each case.

Observations and Discussion

1. Tiger (*Panthera tigris*)

Both the eyes of all the seven cubs including three still-born cubs born here up to 30-6-1971 were closed at birth and the details of opening of eyes of four cubs are given in Table 1.

Table 1

Details of opening of eyes of tiger cubs

Sl. No.	Sex of the cubs	Date of birth	Date of opening of the eyes	Age in days when the eyes of the cubs opened	Remarks
1	2	3	4	5	6
1	Male	31-7-67	10-8-67	11th Day	
2	Male	10-4-71	20-4-71	11th Day	
3	Female	10-4-71	17-4-71	8th Day	
4	Female	10-4-71	16-4-71	7th Day	

The cubs are usually born blind and helpless (Prater, 1965; Walker *et al.*, 1964). According to Crandall (1965) the eyes of three tiger cubs born at New York Zoological Park were closed at birth and opened on 9th day (female), 11th day (male) and 17th day (male) respectively. Denis (1964) reported that the tiger cubs open their eyes in fifteen to sixteen days.

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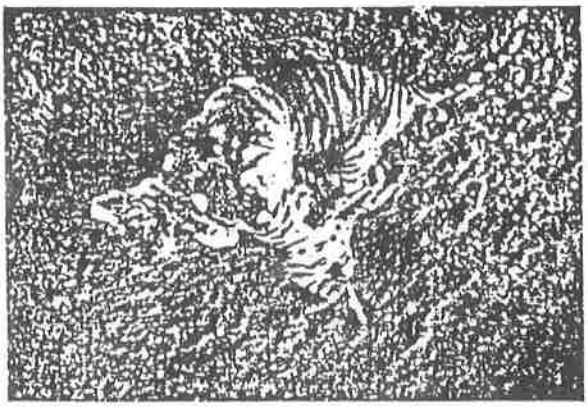

Fig. 1—Tiger (*Panthera tigris*) cubs of about 3 months old engaged in play.

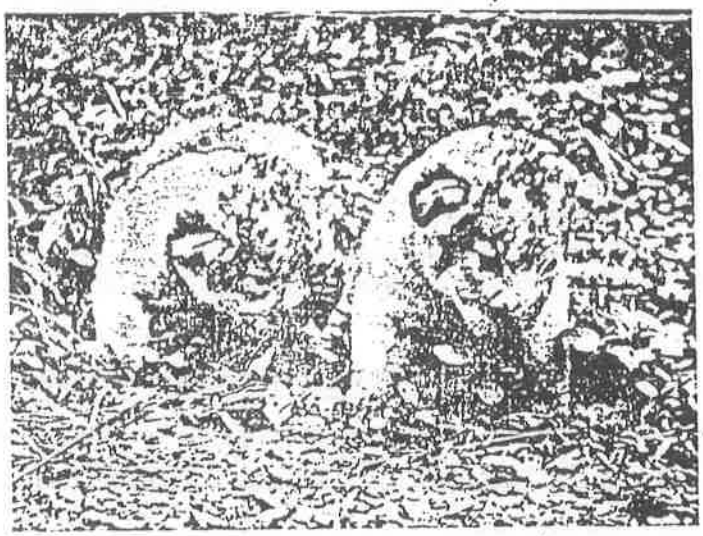

Fig. 2—African Lion (*Panthera leo*) cubs of 3 weeks old with their eyes fully open.

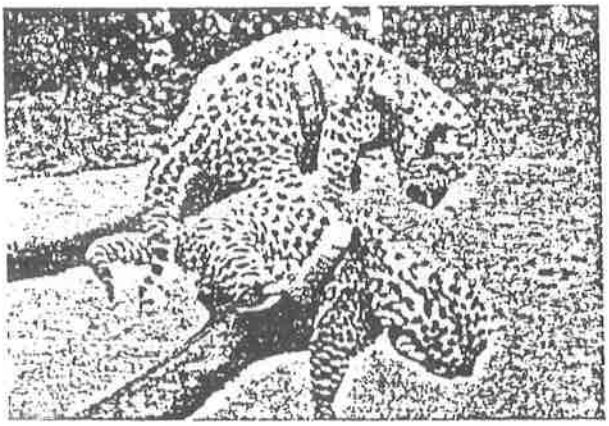

Fig. 3—Leopard (*Panthera pardus*) cubs of 7 days old with their eyes closed.

2. African Lion (*Panthera leo*)

The eyes of all the seven lion cubs born here during the period from 1-7-1969 to 30-6-1971 were closed at birth and the details of opening of the eyes of five cubs only are given in Table 2.

Table 2

Details of opening of eyes of African Lion cubs

Sl. No.	Sex of the cubs	Date of birth	Date of opening of the eyes	Age in days when the eyes of the cubs opened	Remarks
1	2	3	4	5	6
1	Female	8-2-70	21-2-70	14th Day	
2	Male	19-7-70	31-7-70	13th Day	
3	Male	19-7-70	31-7-70	13th Day	
4	Female	3-4-71	16-4-71	14th Day	
5	Female	3-4-71	16-4-71	14th Day	

The cubs are usually born blind (Walker *et al.*, *loc. cit.*). Prater (*loc. cit.*) states that the beasts of prey are usually born blind but some baby lions can see at birth. According to Denis (*loc. cit.*) the lion cubs are born with their eyes open or closed. Some lion cubs have been reported to have been born with their eyes fully open (Lydekker, 1893-96). Crandall (*loc. cit.*) states that the full opening of eyes of lion cubs at birth may happen occasionally but all of the many new born cubs he had seen, had their eyes closed at birth and each of the two female lion cubs born at New York Zoological Park opened one of their eyes on fifth day and the other eye, the next day. Acharjyo (1970) reported that the eyes of four cubs born at Nandankanan Biological Park up to 30-6-1969 were closed at birth and opened on 11th day (2 female cubs) and 13th day (2 male cubs).

3. Leopard or Panther (*Panthera pardus*)

Both the eyes of seven leopard cubs born here during the period from 1-7-1969 to 30-6-1971 were closed at birth and the details of opening of the eyes of these cubs are given in Table 3.

Table 3

Details of opening of eyes of Leopard cubs

Sl. No.	Sex of the cubs	Date of birth	Date of opening of the eyes	Age in days when the eyes of the cubs opened	Remarks
1	2	3	4	5	6
1	Female	31- 5-70	11- 6-70	12th Day	
2	Female	31- 5-70	14- 6-70	15th Day	
3	Male	31- 5-70	14- 6-70	15th Day	
4	Male	2-11-70	9-11-70	8th Day	
5	Male	2-11-70	13-11-70	12th Day	
6	Male	20- 1-71	28- 1-71	9th Day	
7	Female	20- 1-71	27- 1-71	8th Day	

The cubs are usually born blind (Prater, *loc. cit.*; Walker *et al.*, *loc. cit.*). Eyes of a male leopard cub born at New York Zoological Park opened on sixth day (Martini, 1955). Panther cubs are born blind and they generally open their eyes in about three to four weeks (Chaturvedi, 1969). Acharjyo (1970) reported that both the eyes of six leopard cubs born up to 30-6-69 at the Nandankanan Biological Park (Orissa) were closed at. birth and opened on 11th day (2 female cubs), 13th day (2 male cubs) and 15th day (one male cub).

References

1. Acharjyo, L.N. (1970)—Indian Journal of Animal Health: IX (II); 125-129.
2. Chaturvedi, M.D. (1969)—The Panther on the Prowl, National Book Trust, India, New Delhi: p.p. 70.
3. Crandall, lee S. (1965)—The Management of Wild Mammals in captivity, The University of Chicago Press, Chicago and London. p.p. 372-390.
4. Denis, Armand (1964)—Cats of the World, Constable & Co., Ltd:, London WC 2 p.p. 26-62.
5. Lydekker Richard (1893-96)—Cited by Crandall, Lee S. (1965).
6. Martini, Helen (1955)—.....
7. Prater, S.H. (1965)—The Book of Indian Animals 2nd Revised Edition. Bombay Natural History Society and Prince of Wales Museum of Western India, Bombay. p.p. 46-69.
8. Walker, Ernest P. *et al*: (1964)—Mammals of the World, Vol. II, The Johns Hopkins Press, Baltimore. p.p: 1268-1279.

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LETTERS TO THE EDITOR

To,
The Editor,
Indian Forester,
Forest Research Institute & Colleges,
Dehra Dun.

I

Sub.—Effect of amputation of a hind limb on the growth of antlers of deer in captivity.

Sir,

During the course of routine work, some peculiar interesting relation between the amputation of one of the hind limbs and the growth of antlers of a Sambar and a Barking deer has been observed at the Nandankanan Biological Park (Orissa). The details of our findings are recorded below for general information.

Observations

1. Sambar (*Cervus unicolor*)

A male Sambar born here on 17-8-1968 was amputated through the left metatarsal (left hind limb) on 23-2-69 due to unavoidable circumstances. First shedding of single spike antlers of this animal was observed on 9-6-1970 at the age of approximately 1 year and 10 months as already reported by Acharjyo (1971). In this animal the left antler was much longer than the right antler. On shedding the single spike right antler measured 7 cm, whereas the left antler measured 14.5 cm. In the following year of antler formation, the left antler of this animal was again much longer than the right antler (Fig. 1, the photograph was taken on 1-1-1971 when this animal was having fully developed hard horns without velvet). The left long antler measuring 33.5 cm was shed on 24-5-71 and it had a small side branch at the base. The right small antler measuring 10 cm was shed on 26-5-71 and it had no side branch. The same trend of antler formation, i.e., short right antler and long left antler, has again been marked in the third year of antler formation also.

2. Barking Deer (*Muntiacus muntjak*)

A male Barking deer born here on 5-10-1967 was amputated through the right tibia (right hind limb) on 28-12-1967. However it died on 23-10-1969 at the age of 2 years and 19 days. At death it was having its fully developed first hard antlers without velvet. If it would have survived, it would have shed its antlers for the first time in his life in April or May, 1970, i.e., at the age of approximately 2 years, 6 months or 2 years, 7 months; as the antlers of this deer are always shed during April and May only in this Park (Acharjyo, *loc. cit.*).

The length of the two pedicels and the length of two antlers of this deer were of unequal length probably as a result of amputation of the right hind limb. The length of right pedicel was shorter than the left and they measured on the posterior side of the skull as 6 cm and 9.5 cm respectively. But on the other hand the right antler was much longer than the left and they measured on the antero-lateral aspect through the curves as 11 cm and 7 cm

respectively (Fig. 2 A). In the photograph a skull of another normal adult male Barking deer died on 3-9-1970 is also presented for comparison. In this case the pedicels of both sides measured 9.5 cm on the posterior side of the skull and the antlers of both sides on the antero-lateral side through the curves of the skull measured 9 cm only (Fig. 2 B).

Remarks

One common feature found in both these cases was that the antlers of that side which was having an amputated hind limb, was much longer than the other side having a normal hind limb or in other words it can also be said that the antler of the side which was having a normal hind limb, was much shorter than the antler of the other side having an amputated hind limb. On the other hand the length of the pedical of that side which was having an amputated hind limb, was much shorter than the pedicel of the other side having a normal hind limb in case of Barking deer only. This effect on the length of pedicel of Barking deer only may be due to the difference in sites of amputation of hind limbs and also may be due to remarkably long pedicels of Barking deer only. These findings suggest that there may be some relation between the equal growth of pedicels and antlers of both sides of a deer with the balancing of the head and body which is disturbed on amputation of a hind limb. However it is felt that much more observations are necessary to confirm these findings.

Reference

1. Acharjyo, L.N. (1971)—*Ind. Forester*, 97 : pp. 150-151.

Yours faithfully,
L.N. Acharjyo,
Veterinary Asst. Surgeon, Nandankanan Zoo,
P.O. Barang, Distt. Cuttack.
&
R. Misra,
Wild Life Conservation Officer,
Old Secretariate Building, Cuttack-1 (Orissa).

Fig.—1. Photograph of a male Sambar *(Cervus unicolor)* showing the amputated left hind limb through the metatarsal and much longer left antler.

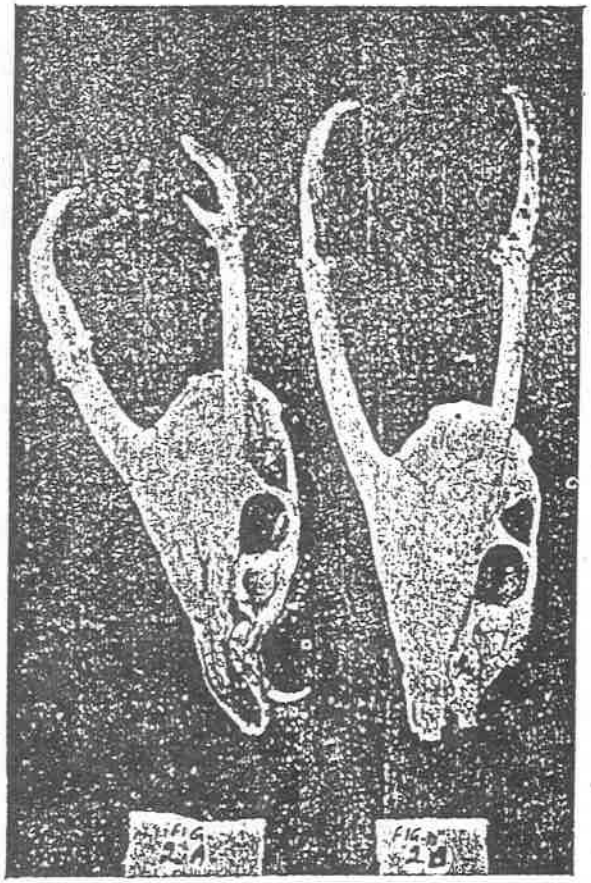

Fig.—2 A. Skull of a male Barking deer *(Muntiacus muntjak)* which was having an amputated right hind limb through the tibia in life, showing unequal length of pedicels and antlers of both sides.

Fig.--2 B. Skull of a normal adult male Barking deer showing equal length of pedicels and antlers of both sides.

[Reprint, from The *Indian Forester, Vol.* 99, No. 1 : 53-54 January 1973]

LETTERS TO THE EDITOR

I

To,

The Editor,
Indian Forester.

Sub: **Further notes on the breeding of golden cat (*Felis temmincki*) in captivity.**

Sri,

Acharjyo (1971) reported the birth of a black coloured female golden cat (*Felis temmincki*) cub on 19-4-1970 at Nandankanan Zoo (Orissa) to the female of a pair of normal coloured golden cats kept there since 29-3-1967.

Further two births to the female of the same pair of golden cats were recorded at Nandankanan Zoo (Orissa) on 23-5-1971 and 2-3-1972. The litter sizes were two and one respectively. Out of these three cubs, two were females and the third a male. Both the eyes of all the three cubs were closed at birth and the eyes of the female cub borned here on 2-3-1972, opened on the 13th day (14-3-1972). The two cubs of 23-5-1971 were black in colour and died within 24 hours of birth as rejected by the mother. The female cub of 2-3-1972 was normal dark brown in colour with white strips on the face and forehead as that of the mother and was reared well by the mother. The cubs were having longer and thicker body coats. The mother was carrying the young by holding a fold of skin at the neck just like any other cat. The male was not causing any disturbance or damage to the cub during rearing, though all these three animals were living together. The cub could lead independent life with the father from the age of 4½ months as unfortunately the mother died suddenly on 19-7-1972.

The interval between two births observed twice were 398 days and 283 days. The birth weight of these three cubs were from 118 grams to 122 grams with an average of 120 grams. The length from tip to tip was from 28.5 cm to 31 cm with an average of 30 cm including 9 cm long tail. The weekly growth records of the female cub born here on 2-3-1972, to the age of 3 months were as follows:

2-3-1972	0.122 kg	20-4-1972	1.050 kg
9-3-1972	0.246 kg	27-4-1972	1.155 kg
16-3-1972	0.337 kg	4-5-1972	1.270 kg
23-3-1972	0.488 kg	11-5-1972	1.330 kg
30-3-1972	0.645 kg	18-5-1972	1.400 kg
6-4-1972	0.770 kg	25-5-1972	1.475 kg
13-4-1972	0.902 kg	1-6-1972	1.552 kg

The litter size of this cat was given by Prater (1971) as two. A female cub which died within 48 hours of birth, weighed 110 grams and measured 29 cm from tip to tip including 9 cm long tail after death (Acharjyo, *loc. cit.*). According to Walker *et al.* (1964) melanistic individuals are fairly common.

There appears to be no other report on successful breeding of golden cat in captivity in India. However we would be interested in any other records of successful breeding of golden cat in captivity in India.

References

1. Acharjyo, L.N. (1971)—J. Bombay nat. Hist. Soc., 68 (1) : 241.
2. Prater, S.H. (1971)—The Book of Indian Animals. Bombay Natural History Society, Bombay, P.P. 72-73.
3. Walker, Ernest P. *et al.* (1964)—Mammals of the World Vol. II. The John Hopkins Press, Baltimore, P.P. 1276.

Yours faithfully,
Sd. L.N. Acharjyo,
Nandankanan Biological Park,
P.O. Barang, District Cuttack.
And
Sd. R. Misra,
Wildlife Conservation Officer, Orissa
Old Secretariate Buildings, Cuttack-1.

[Reprint, from The *Indian Forester, Vol.* 105, No. 10, October, 1979]

LETTER TO THE EDITOR

(I)

To,

The Honorary Editor,
Indian Forester,
New Forest, Dehra Dun.

Sub :—**Age of sexual maturity of Blackbuck or Indian Antelope (*Antilope cervicapra*) in captivity.**

Sir,

A blackbuck doe born on 16-4-1977 at Raj Bhawan Deer Park, Orissa gave birth to a male young for the first time in her life on 20-2-1979 at the age of 1 year, 10 months and 5 days. This doe was living with two adult males of this species since her birth. Taking the gestation period as 6 months (Asdell, 1964) the age of sexual maturity of this doe can be said as 1 year, 4 months and 5 days or say 1 year and 4 months.

Acharjyo & Misra (1973) have given the age of sexual maturity of two blackbuck does as 1 year and 7 months and 1 year and 11 months. The age of sexual maturity of one doe of this species is 1 year and 8 months (Acharjyo & Mishra, *in Press*). Schaller (1972) from his observations of two yearling does of this species states that they do not bear their first young until two and a half to three years old. The captive blackbuck does reach sexual maturity at six months of age and one female had her first young at the age of about fourteen months (Taibel, 1937).

References

1. Acharjyo, L.N. and Misra, R. (1973).—A note on age of sexual maturity of two species of antelopes in captivity, *J. Bombay nat Hist. Soc.* 70 (2) : 378.
2. .....and Mishra, Ch. G. (in Press).—Some notes on age of sexual maturity of seven species of Indian Wild mammals in captivity, *J. Bombay nat. Hist. Soc.* (in Press).
3. Asdell, S A. (1964).—Patterns of Mammaliar Reproduction, Second Edition, Cornell University Press, Ithaca, New York, pp. 617.
4. Schaller, George B (1972) —The Deer and the Tiger, The University of Chicago Press, Chicago and London.
5. Taibel, A. (1937).—Cited by Schaller, George B. (1972).

Your's faithfully,

Sd /- L.N. Acharjyo
Veterinary Assistant Surgeon
Nandankanan Biological Park,
P O Barang, Distt. Cuttack (Orissa)

and

Sd./- Ch. G. Mishra
Wild Life Conservation Officer,
95-Sahid Nagar, Bhubaneswar—751007 (Orissa)

[Reprint, from The *Indian Forester, Vol.* 107, No. 8 : 533-534 August 1981]

(II)

Sub :—Age of sexual Maturity of Tigers (*Panthera tigris*) in Captivity.

Sir,

A tigress named "Lipsa" born at the Nandankanan Biological Park, Orissa on 22.4.1977 was allowed to remain together with a tiger named "Anand" (born in the same Park on 22.5.1977) from 28.12.1978.

Mating of this pair of tigers was observed for the first time from 23.1.1980 to 25.1.1980 and subsequently from 2.3.1980 to 6.3.1980 resulting in the birth of three (2 males and 1 female) still born cubs on 10.6.1980.

These observations suggest that the tigress has shown the signs of her first oestrus at the age of 2 years and 9 months whereas the tiger became sexually mature at the age of 2 years, 9 months and 9 days. The tigress gave birth to her first litter at the age of 3 years, 1 month and 20 days.

Chaturvedi (1970) states that the first cubbing of a tigress takes place at about the age of four and a tiger is fully grown in about 5 years. The first signs of sexual maturity in a tigress appeared at the age of about 3 years but a tiger did not reach his sexual maturity at least one week before he reached the age of 4 years (Acharjyo and Misra, 1975). According to Acharjyo and Mishra (*in Press*) a tigress came to her first oestrus at the age of about 3 years whereas a male tiger was sexually mature at the age of about 3 years and 7 months. The tiger cubs mature at an age between 3½ and 6 years (Sankhala, 1967). Crandall (1965) states that a female tiger became sexually mature soon after passing the age of 3½ years whereas a male tiger became sexually mature at least 15 days before he reached the age of 4 yeers. The lions and tigers take from 3 to 5 years to become fully adult but males and females are capable of breeding soon after, or even before, they are three years old (Prater, 1971). Schaller (1972) states that little has been published regarding the age at which the tigers reach sexual maturity. At the Whipsnade Zoo one female of this species is said to have produced a litter at the age of 2 years (Pocock, 1939). Abramov (1962) and Novikov (1962) have given the age of sexual maturity in this species as 4 years whereas Blanford (1888–91) has given the age of sexual maturity of this species as three years.

References

Abramov, V. (1962). Cited by Schaller, George B. (1972).

Acharjyo, L.N. and Misra, R. (1975). Age of sexual maturity of two species of Wild Carnivores in Captivity, *J. Bombay nat. Hist. Soc.* 72 (1) : 196–197.

Acharjyo, L.N. and Mishra, Ch. G. Some notes on age of sexual maturity of seven species of Indian Wild Mammals in Captivity, *J. Bombay nat. Hist, Soc.* (in press).

Received for publication on 7.5.1981

Blanford, W. (1888–91). Cited by Schaller, Geroge B. (1972).

Chaturvedi, M.D. (1970). The Felines, National Book Trust, India, New Delhi, pp. 28.

Crandall, Lee S. (1965). The Management of Wild Mammals in Captivity, The University of Chicago Press, Chicago and London, pp. 387.

Novikov, G. (1962). Cited by Schaller, George B. (1972).

Pocock, R. (1939). Cited by Schaller, George B. (1972).

Prater, S.H. (1971). The book of Indian Animals, third (Revised) edition, *Bombay Natural History Society, Bombay*, pp. 65.

*Sankhala, K.S. (1967). Breeding Behaviour of the Tiger in Rajasthan, *Int. Zoo Yb.* 7 : 133–147.

Schaller, George B. (1972) The Deer and the Tiger, The University of Chicago Press, Chicago and London, pp. 231–236.

Yours faithfully,

Sd./–L.N. Acharjyo,
Veterinary Asstt. Surgeon,
Nandankanan Biological Park,
P.O. Barang, Distt. Cuttack (Orissa).

and

Sd./–Ch. G. Mishra,
Wild Life Conservation Officer,
Orissa, 95–Sahid Nagar,
Bhubaneswar–751 007 (Orissa).

*Original not consulted.

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(II)

FURTHER NOTES ON THE BIRTH OF HYBRID MACAQUE *MACACA RADIATA* × *MACACA ASSAMENSIS* AT NANDANKANAN BIOLOGICAL PARK, ORISSA

Acharjyo and Misra (1976) reported the birth of one male hybrid macaque of a female Assamese Macaque *(Macaca assamensis)* and a male Bonnet Macaque (*Macaca radiata)* for the first time at Nandankanan Biological Park, Orissa on 9.3.1975. Another female hybrid macaque was born of the same pair of female Assamese Macaque and male Bonnet Macaque on 27.3.1977, after an inter-parturition interval of 2 years and 17 days at the Nandankanan Biological Park.

Like the earlier male hybrid, the colour of the body coat of this female hybrid young also resembled that of the mother whereas the shape of the ears, the length and shape of the tail and crown hair on the head resembled that of the father.

Both the hybrid macaques along with their mother Assamese macaque are doing well. Such a hybrid macaque has not been reported by Gray (1972).

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Wild Life Conservation Officer, Orissa. Ch. G. Misra
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References

Acharjyo, L.N. and R. Misra (1976) : Notes on a Young Hybrid Macaque, *J. Bombay nat. Hist. Soc.* 73 (3) : 521–522.

Gray, A.P. (1972). Mammalian Hybrids, Commonwealth Agricultural Bureaux, Farnham Royal, Slough, England.

LETTER TO THE EDITOR

To
The Honorary Editor,
Indian Forester,
New Forest, Dehra Dun.

Sub :- Age of sexual maturity of Nilgai *(Boselaphus tragocamelus)* in captivity.

Sir,

A female Nilgai (*Boselaphus tragocamelus*) born on 8.5.1979 at Indira Gandhi Zoological Park, Visakhapatnam, Andhra Pradesh was received at the Nandankanan Biological Park, Orissa on 26.4.1981 alongwith another male of the same species. This was said to be living with an adult male Nilgai since her birth. One female young was born in one litter to this female Nilgai for the first time in her life on 27.10.1981 when she was 2 years 5 months and 20 days old. Taking the gestation period as 8 months and 7 days (Asdell, 1964) the age of sexual maturity of this female Nilgai can be said as 1 year 9 months and 13 days or say 1 year and 9 months.

The age of sexual maturity of two female Nilgais of Nandankanan Biological Park are given as 2 years and 1 month (Acharjyo and Mishra, 1971) and 2 years and 4 months (Acharjyo and Mishra, 1973). Age of sexual maturity of this species has not been reported in the available literature (Walker *et. al.*, 1964; Asdell, *loc cit.*, Prater, 1971).

References

Acharjyo, L.N. and R. Mishra (1970). Age of sexual maturity of three species of Wild Animals in Captivity, *J. Bombay Nat. Hist. Soc.* 68 (2) : 446.

Acharjyo, L.N. and R. Mishra (1973). A note on age of sexual maturity of two species of Antelopes in Captivity, *J. Bombay Nat. Hist. Soc.* 70 (2) : 378.

Asdell, S.A. (1964). Patterns Mammalian Reproduction, Sec. Ed., Cornell University Press, Ithaca, New York, 580.

Prater, S.H. (1971). The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay, 272-273.

Walker, Ernest P. *et. al.* (1964). Mammals of the World, Voll. II, The Johns Hopkins Press, Baltimore, 1421.

Yours faithfully,

Sd/- L.N. Acharjyo,
Veterinary Assistant Surgeon,
Nandankanan Biological Park,
P.O. : Barang, Distt : Cuttack (Orissa.)
&
Sd/- Ch. G Mishra,
Wild Life Conservation Officer,
95-Saheed Nagar,
Bhubaneswar (Orissa)

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OBSERVATIONS ON SOME ASPECTS OF REPRODUCTION AMONG THE PANTHERS *(PANTHERA PARDUS)* OF NANDANKANAN BIOLOGICAL PARK, ORISSA

L.N. ACHARJYO* AND S.K. PATNAIK**

Abstract

The present study embodies data on some aspects of reproduction among the panthers observed at the Nandankanan Biological Park, Orissa. The first sings of oestrus in three pantheresses appeared at the age of about 2 years and 5 months to 3 years and 10 months. Matings were observed in all the months of the year. The periods of receptivity and gestation varied from 4 to 10 days (average 7.1 days) and 89 to 99 days (average 95 days) respectively. Eleven pantheresses gave birth to 90 cubs in 42 litters. The litter size was from 1 to 6 with an average of 2.14 cubs per litter. There were 49 males and 41 females. The sex ratio (number) of males to 100 females) was 119.5 : 100. Births have been recorded in all the months of the year. The interparturition interval observed in 21 instances among seven pantheresses varied from 4 months and 16 days to 3 years and 9 months. At birth the cubs weighed 0.410 to 0.693 kg (average 0.555 kg) and measured 39 to 47 cm (average 43.8 cm) tip to tip Eyes of the cubs were closed at birth and opened in 8 to 15 days.

The panther has the greatest range in area of any field and it is found throughout most of Africa and Asia (Walker *et al.*, 1964). The panther is represented in the collection of most of the zoological parks. One of the major aims of the modern zoological park is breeding and propagation of the species in captivity. For successful management and breeding of a species in captivity, considered necessary to have a sound knowledge on different aspects of reproduction. The present study is intended to place on record the data on some aspects of reproduction among the panthers observed at the Nandankanan Biological Park, Orissa during the period from 29-12-1960 to 28-2-1983 and to compare them with the available data of other workers.

Material and Method

The Nandankanan Biological Park was established right inside the lush green forests of Chandaka range in Puri Forest Division (Orissa) on 29-12-1960. Exhibition of panthers in the park began from March 1963. The panthers of the park are housed in covered spacious enclosure provided with suitable vegetation and sandy floor. Each enclosure is having a set of retreating cells with cemented floor for protection from extreme weather conditions and for feeding. The panthers are kept either in pairs or in small groups as per the necessity. Both the normal coloured and black specimens are either kept together or separately. The pantheresses are separated from the panthers about a fortnight before the expected date of parturition till the cubs are about nine months old.

On an average each animal is fed with 3 kg of fresh raw beef with bones six days in a week and no beef is provided on Mondays. But the pregnant and nursing pantheresses are provided with goat meat or poultry meat on Mondays in place of beef. Vitamins and mineral supplements such as VITABLEND AD_3 (Glaxo) or BECADEX multivitamin tablets (Glaxo) and/or VIMGRAN multiple vitamins and minerals tablets (SARABHAI) are added to the beef frequently. The first birth of two panthers cubs was recorded on 9-4-1967. So far 90 cubs were born in 42

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litters to 11 pantheresses which formed the basis of the present studies.

For the purpose of this study day to day data were collected on the appearance of first signs of oestrus, actual mating periods, dates of birth of litters, litter size, sex of new born cubs, inter-parturition interval, dates of opening of eyes and weight and size at birth of new-born panther cubs in the form of individual history register, daily observation reports and our own observation. The pantheresses were kept under observation from the age of one year for the signs of first oestrus. The actual periods of mating was taken as the period of receptivity. The gestation period was calculated from the last day of mating to birth. The interval between two births was taken as inter-parturition interval. The weight and measurements were recorded within about 12 hours of birth. The condition of the eyes of new born cubs were noted daily from the very first day till the opening of eyes.

Observations and Discussion

Sexual maturity : The first signs of oestrus in three pantheresses appeared at the age of about 2 years and 5 months to about 3 years and 10 months whereas they littered for the first time at the age of about 3 years and 4 months to about 7 years and 2 months (Table 1). All these pantheresses were living with saxually matured males from the age of about nine months. These observations also suggest that they were capable of reproducing at the age of about 3 years and 1 month to about 6 year and 11 months.

The first signs of oestrus in three pantheresses appeared at the age of about 2 years and 2 months to about 2 years and 6 months and four pantheresses littered for the first time at the age of about 2 years and 6 months to about 4 years and 7 months (Acharjyo and Mishra, 1980). Five pantheresses of the Delhi Zoological Park came into oestrus for the first time at the age of 1 year and 8 months to 3 years and 10 months whereas six pantheresses littered for the first time at the age of 2 years and 3 months to 4 years and 2 months (Desai, 1975). Prater (1971) states that panthers are generally full grown in one and half to three years.

Mating season : The mating of the panthers of the park has been observed in all the months of the year. During the period from February, 1969 to February, 1983; 179 mating periods were recorded as follows :

Rainy season (July-October) — 57(31.8%)
Winter season
(November-February) — 71(39.7%)
Summer season (March-June) — 51(28.5%)

At the Delhi Zoological Park, the pantheresses came to oestrus during all the months of the year (Desai, *loc. cit.*). Panthers breed all the year round (Prater, *loc. cit.*). According to Jarvis and Morris (1962) panthers at Whipsnade and Regent's Park had bred during all seasons Chaturvedi (1969) states that there seems to be no particular breeding season of the panther, although its "sawing" and caterwauling is more frequently heard during winter and summer.

Periods of receptivity and gestation : The period of receptivity observed in 15 cases among 8 pantheresses of the park during the period from September, 1977 to February, 1983 varies from 4 to 10 days with an average of 7.1 days. The gestation period calculated from the last day of mating to birth varies from 89 to 99 days with an average of 95 days (Table 2).

The periods of receptivity and gestation observed in 19 cases among six pantheresses of of Nandankanan Biological Park, Orissa during the period from January, 1970 to August, 1977 were 4 to 8 days with an average of 5.6 days and 89 to 98 days with an average of 94.74 days respectively (Acharjyo and Mohapatra, 1978). The range of oestrus among nine pantheresses of Delhi Zoological Park are given as 4 to 14 days and the gesta-

Table 1. Observation of sexual maturity of Panther *Panthera pardus* at Nandankanan Biological Park, Orissa.

Specimens	Date of birth	Date of first oestrus (mating observed)	Age at onset of oestrus	Dates of successful mating with conception	Date of birth of first litter	Age when first litter born
Kali	6-9-1978	26-1-1981	2 years 4 months and 21 days	5-10-1981 to 11-10.1981	13-1-1982	3 years 4 months and 8 days
Chandi	14-3-1978	20-1-1982	3 years 10 months and 7 days	25-3-1982 to 31-3-1982	25-6-1982	4 years 3 months and 12 days
Sukanti	26-3-1975	25-6-1978	3 years and 3 months	14-2-1982 to 22-2-1982	25-5-1982	7 years and 2 months

Table 2. Observation on periods of receptivity and gestation among Panthers *Panthera pardus* at Nandankanan Biological Park, Orissa.

Specimens	Dates of mating observed (Period of receptivity)	Date of birth of the litter	Gestation period in days
Sundary	7-9-1977 to 16-9-1977 (10 days)	22-12-1977	97
Sundari	21-6-1979 to 30-6-1979 (10 days)	3-10-1979	95
Rupa	12-11-1981 to 20-11-1981 (9 days)	21-2-1982	93
Spotty	29-12-1977 to 1-1-1978 (4 days)	5-4-1978	94
Basanti	5-12-1977 to 9-12-1977 (5 days)	14-3-1978	95
Basanti	13-11-1981 to 19-11-1981 (7 days)	20-2-1982	93
Shanti	23-3-1978 to 29-3-1978 (7 days)	2-7-1978	95
Shanti	30-12-1981 to 3-1-1982 (5 days)	8-4-1982	95
Kali	5-10-1981 to 11-10-1981 (7 days)	13-1-1982	94
Kali	26-2-1982 to 7-3-1982 (10 days)	4-6-1982	89
Lata	29-3-75 to 1-4-1975 (4 days)	7-7-1975	97
Lata	4-7-1976 to 7-7-1976 (4 days)	13-10-1976	98
Lata	1-2-1978 to 7-2-1978 (7 days)	17-5-1978	99
Lata	19-6-1978 to 27-6-1978 (9 days)	4-10-1978	99
Sukanti	14-2-1982 to 22-2-1982 (9 days)	25-5-1982	92

tion periods are given as 84 to 98 days with an average of 91.9 days (Desai, *loc. cit.*). The mean length oestrus is given as 6.7 days (Sadleir, 1966). The gestation period of this species is about 3 months (Asdell, 1964), 98 to 105 days (Kenneth, 1053), 13 weeks (Prater, *loc. cit.*) and about 90 to 100 days (Chaturvedi, *loc. cit.*). The gestation period of the genus *Panthera* is given as 92 to 113 days (Walker *et al.*, *loc. cit.*). Pocock (1939) reported a gestation period of 102 days for an African leopard at Whipsnade Park Zoo. Crandall (1965) gives the gestation period for a black panther as 90 days from the middle of mating span. Sadleir, (*loc. cit.*) reported 100 days as gestation periods for two litters of Chinese

leopards. The longest gestation period of 112 days was recorded for this species at Prague Zoo (Dobroruka, 1968).

Litter size and sex ratio : The data of 42 litters of panther cubs indicate that one cub per litter was on eight occasions, two on twenty-four occasions, three on eight occasions, four on one occasion and six cubs were born on one occassion. Average number of cubs per litter was 2.4 and the range of cubs per litter was 1 to 6. Eleven Pantheresses gave birth to 90 cubs, the division of sexes being 49 males and 41 females. The sex ratio (number of males to 100 females) was 119.5 : 100 (Table 3).

Table 3. Litter size and sex ratio of panther *Panthera pardus* at Nandankanan Biological Park, Orissa.

Specimens	Litter size			Sex ratio	
	Total No litters of cubs recorded (Total No of cubs)	No of cubs per litter	Average No. of cubs per litter	Male	Female
Sundary	10(19)	1-3	1.9	10	9
Spotty	6(17)	2-4	2.8	8	9
Rupa	9(16)	1-3	1.8	12	4
Lata	5(9)	1-2	1.8	6	3
Basanti	3(5)	1-2	1.7	3	2
Shanti	3(11)	2-6	3.7	6	5
Kali	2(4)	2	2.0	0	4
Kumari	1(2)	2	2.0	2	0
Chandi	1(3)	3	3.0	1	2
Sukanti	1(2)	2	2.0	1	1
Toru	1(2)	2	2.0	0	2
	42(90)	1-6 (Range)	2.14 (Average)	49	41

The usual litter size is 2 to 4 (Prater, *loc. cit.*). The litter size of 39 births at Delhi Zoological Park was 1 to 3 with an average of of 1.6 cubs (Desai, *loc. cit.*). The litter size of 27 births of leopards in Zoological Gardens of London from 1839 to 1937 was 1 to 3 (Zuckerman, 1953).

Distribution of births : Date of litters indicate that the births have been recorded in all the months of the year with minimum of one litter in November and maximum of seven litters in June (Table-4).

Table 4 Monthwise distribution of births of panther cubs, *Panthera pardus* at Nandankanan Biological Park, Orissa.

Months	*No. of litters borns*	*Percentage*
January	3(6)	7.1
February	5(10)	11.9
March	2(4)	4.8
April	5(11)	11.9
May	5(15)	11.9
June	7(16)	16.7
July	3(7)	7.1
August	4(9)	9.5
September	2(3)	4.8
October	3(5)	7.1
November	1(2)	2.4
December	2(2)	4.8
Total	42(90)	100

The figures in the brackets indicate number of cubs.

Panther breeds all the year round (Prater, *loc. cit.*; Walker *et al.*, *loc cit*). Twenty seven births of leopards in Zoological Garden of London were recorded in every month of the year except January (Zuckerman, *loc. cit.*). Three births of black leopards of New York Zoological Park were recorded in February, July and November (Crandall, *loc. cit.*). Thirty nine births of Delhi Zoological Park were recorded in all the months of the year except March with minimum of one litter in February and November and maximum of seven litters in July (Desai, *loc. cit.*).

Inter-parturition interval : The data on inter-parturition interval observed in 21 instances among seven pantheresses during the

Table 5. Inter-parturition interval among Panthers *Panthera pardus* recorded at Nandankanan Biological Park, Orissa.

Specimens	Date of parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of pantheresses from the the panther from the date of last parturition mentioned in column 2
Sundari	20-1-1973	5-6-1974	1 year 4 months and 15 days	About 5 months
Sundari	5-6-1974	13-6-1976	2 years and 7 days	About 8 months
Sundari	13-6-1976	22-12-1977	1 year 6 months and 8 days	About 6 months
Sundari	22-12-1977	3-10-1979	1 year 9 months and 10 days	9 days
Rupa	2-8-1973	26-3-1975	1 year 7 months and 23 days	About 7½ months
Rupa	26-3-1975	6-9-1975	1 year 5 months and 10 days	About 7 months
Rupa	6-9-1976	16-2-1977	5 months and 9 days	4 days
Rupa	16-2-1977	6-9-1978	1 year 6 months and 20 days	About 8 months
Rupa	6-9-1978	21-2-1982	3 year 5 months and 14 days	About 11½ months
Spotty	23-7 1973	23-2-1975	1 year and 7 months	About 8 months
Spotty	23-2-1975	23-5-1976	1 year and 3 months	About 7 months
Spotty	23-5-1976	5-4-1978	1 year 10 months and 12 days	About 6½ months
Lata	7-7-1975	13-10-1976	1 year 3 months and 5 days	About 9 months
Lata	13-10-1976	17-5-1978	1 year 7 months and 3 days	About 6 months
Lata	17-5-1978	4-10-1978	4 months and 16 days	33 days
Lata	4-10-1978	12-4-1979	6 months and 7 days	9 days
Shanti	8-5-1977	2-7-1978	1 year 1 month and 22 days	About 8 months
Shanti	2-7-1978	8-4-1982	3 year 9 months and 5 days	About 13 months
Basanti	14-3-1978	1-8-1979	1 year 4 months and 17 days	About 8½ months
Basanti	1-8-1979	20-2-1982	2 years 6 months and 18 days	About 15 months
Kali	13-1-1982	4-6-1982	4 months and 22 days	3 days

period from November, 1973 and February, 1983 indicate that it varies from 4 months and 16 days to 3 years 9 months and 5 days with an average of 1 year 6 months and 24 days or say 1 year and 7 months (Table-5).

Walker *et al.*, *(loc. cit.)* stated that smaller cats may have more than one litter a year whereas the larger species sometimes bread only every two or three years. A panther produced 3 litter in 3½ years in captivity (Prater, *loc. cit.)*. The inter-parturition interval observed in 10 cases among three female panthers of Nandankanan Biological Park, Orissa from 29-12-1960 to 31-10-1973 was varying from 6 months and 2 days to 1 year 7 months and 21 days with an average of 1 year 2 months and 27 days (Acharjyo and Misra, 1975).

Weight and size at birth : Data on weight and size of 38 panther cubs born from July, 1972 to February, 1983 indicate that at birth panther cubs weight from 0.410 to 0.693 kg with an average of 0.555 kg. They measured 39 to 47 cm with an average of 43.8 cm tip to tip including tail lengths of 13 to 17 cm with an average of 14.9 cm (Table-6).

A single male panther cub of New York Zoological Park was 14 inches in length and weight 20 ounces at birth (Crandall, *loc. cit.*). At birth the weight and size of 14 panther cubs born at the Nandankanan Biological Park between July, 1969 to June, 1972 was from 0.400 to 0.585 kg with an average of 0.518 kg and length was from 42.5 to 49.5 cm with an average of 45 cm including tail lengths of 13.5 to 17 cm (Acharjyo and Misra, 1972a). The

Table 6. Weight and size at birth of Panther cubs, *Panthera pardus* at Nandankanan Biological Park, Orissa.

Date of birth	Sex	Weight in kg	Length tip to tip in cm	Tail length in cm
20-1-1973	Female	0 553	44.0	16.0
20-1-1973	Female	0.497	44.0	15.5
23-7-1973	Female	0.521	39.0	14.5
23-7-1973	Male	0.630	46.0	15.0
23-7-1973	Male	0 693	46.0	15.0
2-8-1973	Male	0.587	43.0	15.0
2-8-1973	Male	0.603	45.0	15.0
2-8-1973	Female	0.550	44 0	15 0
5-6-1974	Male	0.555	42.0	15.0
5-6-1974	Male	0.410	41.0	13.0
23-2-1975	Female	0.603	45.0	15.0
23-2-1975	Female	0 601	45.0	15.5
23-2-1975	Female	0.530	43.5	14 5
23-2-1975	Male	0.600	46 0	16.0
26-3-1975	Male	0 655	45.0	16 0
26-3-1975	Female	0.615	43.0	15.0
13-6-1976	Female	0.498	42.0	14.0
13-6-1976	Male	0 575	44.0	15 0
13-6-1976	Male	0.548	43.0	15.0
6-9-1976	Male	0.450	44.0	13.0
13-10-1976	Male	0 590	47.0	16.0
13-10-1976	Male	0.595	46.0	17.0
16-2-1977	Male	0.605	45.0	15.0
16-2-1977	Male	0.570	45.0	16 0
8-5-1977	Female	0.490	42 0	13.5
8-5-1977	Male	0.475	40.0	13.0
9-5-1977	Female	0.502	42.5	14.5
9-5-1977	Female	0.455	44.0	14.0
9-5-1977	Male	0.515	44 0	15.5
22-12-1977	Female	0.502	43 0	15.0
5-4-1978	Female	0 580	46.0	16 0
5-4-1978	Male	0.585	45.0	15 0
17-5-1978	Male	0.580	45.0	15.0
2-7-1978	Female	0.555	43.0	15.0
2-7-1978	Male	0.560	43.0	14.0
6-9-1878	Male	0 585	44.0	15.5
4-10-1978	Female	0.502	44.0	15.0
3-10-1978	Female	0.555	43.5	15.0
	Average	0.555	43.8	14.9

newly born seven panther cubs of Delhi Zoological Park weighed approximately 0.500 to 1.000 kg with an average of 0.710 kg and measured 364 mm to 483 mm (average 407.8 mm) from tip of the nose to tip of the tail between pegs (Desai, *loc. cit.*).

Opening of eyes of new born panther cubs: All panther cubs under observation had their eyes closed at birth. Data of 33 panther cubs recorded during the period of October, 1973 to February, 1983 indicate that panther cubs open their eyes in 8 to 15 days with an average

Table 7. Opening of eyes of new born panther cubs, *Panthera pardus* at Nandankanan Biological Park, Orissa:

Sex	Date of birth	Date of opening of eyes	Age in days when the eyes of the cubs opened
Male	5-6-1974	15-6-1974	11th day
Male	5-6-1974	16-6-1974	12th day
Male	23-2-1975	4-3-1975	10th day
Female	23-2-1975	4-3-1975	10th day
Female	23-2-1975	4-3-1975	10th day
Female	23-2-1975	5-3-1975	11th day
Female	26-3-1975	3-4-1975	9th day
Male	26-3-1975	2-4-1975	8th day
Male	7-7-1975	16-7-1975	10th day
Female	23-5-1976	3-6-1976	12th day
Female	23-5-1976	2-6-1976	11th day
Male	23-5-1976	2-6-1976	11th day
Female	13-6-1976	23-6-1976	11th day
Male	13-6-1976	21-6-1976	9th day
Male	13-6-1976	21-6-1976	9th day
Male	13-10-1976	24-10-197	12th day
Male	13-10-1976	24-10-1976	12th day
Male	16-2-1977	24-2-1977	9th day
Male	16-2-1977	25-2-1977	10th day
Male	9-5-1977	16-5-1977	8th day
Female	9-5-1977	17-5-1977	9th day
Female	5-4-1978	12-4-1978 (Rt. eye)	8th day (Rt. eye)
		13-4-1978 (Left eye)	9th day (Left eye)
Male	5-4-1978	12-4-1978	8th day
Male	17-5-1978	26-5-1978	10th day
Male	2-7-1978	12-7-1978	11th day
Female	2-7-1978	15-7-1978 (Left eye)	14th day (Left eye)
		16-7-1978 (Rt. eye)	15th day (Rt. eye)
Female	6-9-1978	13-9-1978	8th day
Male	6-9-1978	13-9-1978	8th day
Female	3-10-1979	11-10-1979	9th day
Female	20-2-1982	28-2-1982	9th day
Male	21-2-1982	2-3-1982	10th day
Male	8-4-1982	18-4-1982	11th day
Male	8-4-1982	20-4-1982	13th day

of 10.4 days. Both the eyes open in one or in two consecutive days (Table-7).

The eyes of seven panther cubs opened from 8th to 15th days (Acharjyo and Misra, 1972b). The panther cubs are usually born blind (Prater, *loc. cit.*; Walker *et al*, *loc. cit.*). Eyes of a male panther cub opened on the sixth day (Martini, 1955). Panther cubs are born blind and they generally open their eyes in about three to four weeks (Chaturvedi *loc. cit.*). The eyes of thirteen panther cubs under observation from July, 1971 to September, 1973 at Nandankanan Biological Park opened their eyes in eight to fourteen days (Acharjyo and and Misra, 1973).

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References

Acharjyo, L.N. and Misra, R. (1972a). Observations on weight and size at birth of some wild mammals in captivity, *Cheetal*-Journal of the Wild Life preservation Society of India. 15 (2): 64-67.

Acharjyo, L.N. and Misra, R. (1972b). A not on opening of eyes of some Great cat cubs in captivity. *Indian Forester*, 92 (2) : 132-134.

Acharjyo, L.N. and Misra, R. (1973). Further notes on opening of eyes of some wild carnivores in capativity. *Cheetal*-Journal of the wild Life Preservation Society of Indian. 15 (4) : 49-55.

Acharjyo, L.N. and Misra, R. (1975). A note on inter-parturition interval of some captive wild mammals. *J. Bombay nat. Hist. Soc*, 72 (3). 841-845.

Acharjyo, L.N. and Moha Patra, S. (1978). Some observations on periods of receptivity and gestation in two species of Great cats in captivity *Cheetal*-Journal of the Wildlife Preservation Society of India 20 (1) : 3-8.

Acharjyo, L.N and Mishra, Ch. G. (1980). Some notes on age of sexual maturity of seven species of Indian wild mammals in captivity. *J. Bombay nat. Hist. Soc.*, 77 (3) : 504-507.

Asdell, S.A. (1964) *Patterns of mammalian reproduction*. (2nd Ed.) Cornell University press, Ithaca, New York, pp 491.

Chaturvedi, M.D. (1969). *Panther on the Prowl*. National Book Trust, India, pp 70-75.

Crandall, Lee S. (1965). *The management of wild mammals in captivity*. The University of Chicago Press, Chicago and London, pp. 372-413.

Desai, J.H (1975). Observations on the reproductive biology and early postnatal development of the *Panthera pardus* L. Captivity *J. Bombay nat. Hist.Sco.*, 72 (2) : 293-304.

Dobroruka, L.J. (1968). Cited by Desai, J.H. (1975).

Jarvis, C. and Morris, D.M. (1962). Cited by Desai, J H. (1975).

Kenneth, J.H. (1953). Cited by Desai, J.H. (1975).

Martini H. (1955) Cited by Crandall, Lee S. (1965).

Pocock, R.I. (1939). Cited by Desai, J.H. (1975).

Prater, S.H. (1971). *The Book of Indian Animals*, (3rd Revised ed.), Bombay Natural History Society, Bombay, pp 46-69.

Sadleir, R.M.F.S. (1966). Notes of reproduction in the larger felidae. *Int. Zoo Yb.*, 6 : 184-187.

Walker, E.P. *et al.* (1964). *Mammals of the world*. Vol. II- The Johns Hopkins Press, Baltimore pp 1268-1279.

Zuckerman, S. (1953). Cited by Crandall, Lee S. (1965).

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Observations on Weight and Size at Birth of Some WildMammals in Captivity

By

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In the changing conditions of the world which endanger wildlife, Zoological Parks play an important role in the preservation of vanishing species of wildlife, by breeding them in captivity. It is essential to have a sound knowledge of all aspects of reproduction including the weight and size at birth of wild animals for their successful breeding in captivity. Many of the records on the weight and size at birth of different wild animals are based on captive specimens only. The largest of the living land mammals, the elephant, produces young weighing 175 to 213½ pounds and height from 2 feet 6 inches to 3 feet, at birth (Crandall, 1965), probably the maximum weight and size at birth among land mammals. Similarly the weight of a male Indian rhinoceros calf at birth was given by Lang (1957) as 60.5 Kilograms and that of hippopotamus calves given by Verheyen (1954) as varying from 34 to 40 Kilograms. Acharjyo (1970) reported on weight and size at birth of nine common wild mammals maintained at Nandankanan Biological Park, Orissa as observed by him during the period from 29.12. 1960 to 30.6. 1969. Reports on the weight and size of different wild mammals at birth specially from India are scanty. The present paper is an attempt to place on record further observations on the weight and size at birth of twelve kinds of wild mammals of Nandankanan Biological Park, Orissa; observed during the period from 1.7.1969 to 30.6.1972. The weights and measurements were taken either immediately after or within 12 hours of birth.

Observations and Discussion

1. Tiger (*Panthera tigris*)

The weight at birth of seven cubs, born during the period mentioned above was from 0.920 kg. to 1.450 kg. with an average of 1.202 kg., the length from tip to tip was from 49 cm. to 58 cm. with an average of 53.4 cm. and the length of the tail was from 14 cm. to 17 cm. with an average of 15.6 cm.

At birth, the length[3] from the tip of the nose to the tip of the tail of three tiger cubs born at New York Zoological Park was 20 inches and their weights were 2 pounds 8 ounces (male); 2 pounds 9 ounees (male) and 2 pounds 11 ounces (female) (Crandall, *loc. cit.*). Tiger cubs at birth weight under three pounds (Denis, 1964). One male tiger cub weighed

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2. Wild Life Conservation Officer, Orissa, Cuttack-1.
3. All length measurements are from the tip of the nose to the end of the tail.

1.500 kg. measured 51 cm. in length while the tail measured 15 cm. about 40 hours after birth (Acharjyo, *loc. cit.*).

2. African Lion (*Panthera leo*)

Ten cubs born during the period of observation weighed from 0 900 kg. to 1.200 kg. with an average of 1.055 kg., and messured from 50 cm. to 56 cm. in length with an average of 53 cm. while the tail measured from 14.5 cm. to 17 cm. with an average of 15 7 cm at birth.

Each of the two female cubs at birth measured 21½ inches from the tip of the nose to the tip of the tail and weighed 2 pounds 12 ounces and 3 pounds; another dead male of the same litter weighed 3 pounds 15 ounces (Crandall, *loc. cit.*). The African lion cubs at birth are about one foot long and weigh less than a pound (Denis, *loc, cit.*). Acharjyo (*loc. cit*) has given the averarge weight of four African lion cubs as 1.075 kg., the average length as 53.5 cm. and the average length of the tail as 16 cm. at birth.

3. Leopard (*Panthera paadus*)

The weight at birth and size of fourteen leopard cubs observed during this period was as follows: Weight—from 0.400 kg. to 0.585 kg. with an average of 0.518 kg., the length—from 42.5 cm. to 49 5 cm. with an average of 45 cm. and the tail length—from 13.5 cm. to 17 cm. with an average of 15.1 cm.

A single male cub born in the New York Zoological Park, was at birth 14 inches in length and weighed 20 ounces at birth (Crandall, *loc. cit.*). The average weight of six cubs of Nandankanan Biological Park was 0.517 kg., and the average length 44 cm. whereas the average tail length was 14.5 cm. (Acharjyo, *lcc. cit.*).

4. Common Mongoose (*Herpestes edwardsi*)

Two young, including one dead young born in one litter on an average at birth weighed 35 grams and measured 17.5 cm. including the 5.5. cm. long tail.

One young at birth weighed 35 grams, measured 15 cm. in length including the 4 cm. long tail (Acharjyo, *loc. cit.*).

5 Nilgai or Blue bull (*Boselaphus tragocamelus*)

The weight and size at birth of seven young including two dead young born during this period was as follows: Weight—from 5.200 kg. to 8.300 kg. with an average of 6.543 kg., the length—from 84 cm. to 96 cm with an average of 90.1 cm. and shoulder height—from 52 cm. to 59 cm. with an average of 55.6 cm.

The average weight at birth of three young was 8.070 kg., the average length was 89 cm. and the average shoulder height was 57 cm. (Acharjyo, *loc. cit.*).

6. Black buck (*Antilope cervicapra*)

Twelve black buck young born here during the period of observation weighed at birth from 3.000 kg. to 4.300 kg. with an average of 3.558 kg., measured in length from 65 cm. to 73 cm. with an average of 70.1 cm. and the shoulder height was from 37 cm. to 42 cm. with an average of 39.8 cm.

Acharjyo (*loc. cit.*) reported the average weight of three young as 4.000 kg., the average length as 72 cm. and the average shoulder height as 39 cm. at birth.

7. Four-horned antelope (*Tetracerus quadricornis*)

The four young born in two litters weighed at birth from 1.000 kg. to 1.170 kg. with an average of 1.081 kg., measured 44 cm. to 48 cm. with an average of 46.3 cm. in length and the shoulder height was from 26 cm. to 28 cm. with an average of 27 cm.

Shull (1958) has given the weight of one young as 2¼ pounds, the length as 15 inches and shoulder height as 10 inches, at birth.

8. Sambar (*Cervus unicolor*)

At birth the weight of seventeen sambar fawns born during this period was from 7.600 kg. to 11.000 kg. with an average of 9.653 kg., the length was from 91 cm. to 106 cm. with an average of 98.8 cm. whereas the shoulder height was from 53 cm. to 58 cm. with an average of 55.2 cm.

The average weight of nine fawns at birth was 8.270 kg., the average length 98 cm. and the average shoulder height was 53 cm. (Acharjyo *loc. cit.*).

9. Spotted deer (*Axis axis*)

The weight at birth of tweny-four fawns including three born dead was from 2.200 kg. to 4.000 kg., with an average of 3.129 kg., the length was 65 cm. to 79 cm. with an average of 72.6 cm. and the shoulder height was from 36 cm. to 44 cm. with an average of 39.7 cm.

According to Acharjyo (*loc. cit.*) the average weight of 33 fawns was 3.320 kg., and the average length was 71 cm. and the average shoulder height was 39 cm. at birth.

10. Hog deer (*Axis porcinus*)

The three premature and dead fawns born during this period weighed from 1.100 kg. to 1.500 kg. with an average of 1.333 kg., the length from 48 cm. to 54 cm. with an average of 51.7 cm. Therefore at birth the weight and size of fully developed live fawns are expected to be more than these records.

There is no mention of the weight and size at birth of this species in the available literature.

11. Barking deer (*Muntiacus muntjak*)

At birth the six fawns including one dead fawn weighed from 1.000 kg. to 1.400 kg.

with an average of 1.250 kg., measured from 43 cm. to 53 cm. with an average of 49.1 cm. and the shoulder height was from 22 cm. to 27 cm. with an average of 24.9 cm.

A barking deer fawn weighed from 0.550 kg. to 0.650 kg. at birth (Walker *et. al.*, *loc. cit.*). The average weight and size at birth of nine fawns was given by Acharjyo (*loc. cit.*) as follows: weight, 1.520 kg., the length 50 cm. and the shoulder height, 27 cm.

12. Mouse deer (*Tragulus meminna*)

A female mouse deer fawn born in one litter weighed 203 grams, was 27 cm. in length while the shoulder height was 12.5 cm.

There is no mention of the weight and size at birth of this species in the available literature.

SUMMARY

This paper deals with further observations on birth weight and size of twelve kinds of wild mammals maintained at Nandankanan Biological Park (Orissa) and observed during the period from 1.7.1969 to 30.6.1972. The observations of earlier workers are cited and discussed.

References

1. Acharjyo, L.N. (1970)—Ind. J. Anim. Health, IX (II), P.P. 125-129.
2. Crandall, Lee S. (1965)—The Management of Wild Mammals in Captivity, The University of Chicago Press, Chicago & London. P.P. 348-684.
3. Denis, Armand (1964)—The Cats of the World, Constable & Co., Ltd., London WC2, P.P. 26-62.
4. Lang, E.M. (1957)—Cited by Crandall, Lee S.
5. Prater, S.H. (1971)—The Book of Indian Animals, Bombay Natural History Society, Bombay. P.P. 46-297.
6. Shull, E.M. (1958)—J. Bombay nat. Hist. Soc. Vol. 55, No. 2, P.P. 339-340.
7. Verheyen, Rene (1954)—Cited by Crandall, Lee S.
8. Walker, Ernest P. (1964)—Mammals of the World, Vol. II. The John Hopkins Press; Baltimore, P.P. 1015-1457.

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Further Notes on Opening of Eyes of Some Wild Carnivores in Captivity

By

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It is generally believed that most of the Carnivores are born with their eyes closed and open their eyes several days after birth. Though a number of species of wild carnivores are generally maintained and bred in most of the Zoological Parks, information available on this subject specially from this country is meagre. Earlier Acharjyo (1970), Acharjyo and Tripathy (1971) and Acharjyo and Misra (1972) have reported on the opening of eyes of a few species of new-born wild carnivores of Nandankanan Biological Park, Orissa. In this paper an attempt is made to place on record our further observations on the age at which the eyes of six species of new-born wild carnivores open. The observations were made at the same Nandankanan Biological Park and the period of observations are given in each case. The reports of earlier workers have been cited and discussed.

OBSERVATIONS AND DISCUSSION

1. Tiger (*Panthera tigris*)

Both the eyes of all the nine tiger cubs born in this park during the period from 1.7.1971 to 30.9.1973 were closed at birth and the details of opening of their eyes are given in Table I.

The cats at birth are usually blind and helpless (Prater, 1971; Walker *et al.*; 1964). Chaturvedi (1970) states that the cubs are able to open their eyes nine days after birth. The tiger cubs open their eyes in fifteen to sixteen days (Denis, 1964). Crandall (1965) reported that the eyes of three cubs of New York Zoological Park were closed at birth and opened on 9th day (female), 11th day (male) and 17th day (male) respectively. The tiger cubs are born blind and they open their eyes in seven to eleven days (Acharjyo and Misra, *loc. cit.*).

2. African Lion (*Panthera leo*)

Both the eyes of all the seven African Lion cubs born here during the period from 1-7-1971 to 30-9-1973 were closed at birth and the details of the opening of their eyes are given in Table II.

1. Veterinary Assitant Surgeon, Nandankanan Biological Park, Post: Barang, District: Cuttack.
2. Wild Life Conservation Officer, Orissa, Old Secretariate Building, Cuttack-1.

Table I
Details of opening of eyes of tiger cubs

Sl. No.	Sex of the cubs	Date of birth	Date of opening of the eyes	Age in days when the eyes of the cubs opened	Remarks
1	2	3	4	5	6
1	Female	7-11-1971	14-11-1971	8th day	
2	Female	2-4-1972	13-4-1972	12th day	
3	Female	2-4-1972	15-4-1972	14th day	
4	Male	2-4-19 72	12-4-1972	11th day	
5	Female	14-12-1972	22-12-1972	9th day	
6	Female	14-12-1972	21-12-1972	8th day	
7	Female	14-12-1972	21-12-1972	8th day	
8	Male	22-6-1973	30-6-1973	9th day	
9	Female	22-6-1973	29-6-1973	8th day	

Table II
Details of opening of eyes of African Lion cubs

Sl. No.	Sex of the cubs	Date of birth	Date of opening of the eyes	Age in days when the eyes of the cubs opened	Remarks
1	2	3	4	5	6
1	Female	20-10-1971	28-10-1971	9th day	
2	Male	20-10-1971	28-10-1971	9th day	
3	Male	20-10-1971	28-10-1971	9th day	
4	Male	30-10-1972	14-11-1972	16th day	
5	Female	30-10-1972	11-11-1972	13th day	
6	Male	17-9-1973	25-9-1973	9th day	
7	Male	17-9-1973	26-9-1973	10th day	

The cats at birth are usually blind and helpless (Walker *et al.*; *loc. cit.*). Beasts of prey are usually born blind and helpless but some baby lions can see at birth (Prater, *loc. cit.*). According to Denis (*loc. cit.*) the lion cubs are born with their eyes open or closed. The lion cubs are horn with their eyes fully open (Lydekker, 1893-96). Crandall (*loc. cit.*) states that full opening of eyes of lion cubs at birth may happen occasionally but all of the many new-born lion cubs he had seen, had their eyes closed at birth and each of the two female lion cubs born at New York Zoological Park opened one of their eyes on the fifth day and the other eye on the next day. Acharjyo (*loc. cit.*) reported that both the eyes of all the four African lion cubs were closed at birth and opened on 11th day (2 female cubs) and 13th day (2 male cubs). The African lion cubs are born with their eyes closed and they open their eyes in thirteen to fourteen days (Acharjyo and Misra, *loc. cit.*).

3. Leopard or Panther (*Panthera pardus*)

The eyes of all the fifteen leopard cubs including one still-born cub born here during the period from 1-7-1971 to 30-9-1973 were closed at birth and the details of opening of the eyes of thirteen cubs only are given in Table III (See Page 52).

The cats at birth are usually blind and helpless (Prater, *loc. cit.*; Walker *et al.*, *loc. cit.*). The eyes of a male black leopard cub of New York Zoological Park opened on the sixth day (Martini, 1955). The panther cubs are born blind and they generally open their eyes in about three to four weeks (Chaturvedi, 1969). Acharjyo (*loc. cit.*) reported that both the eyes of all the six cubs born upto 30-6-1969 at Nandankanan Biological Park were closed at birth and opened on 11th day (2 female cubs), 13th day (2 male cubs) and 15th day (1 male cub). According to Acharjyo and Misra (*loc. cit.*) the leopard cubs are blind at birth and they open their eyes in eight to fifteen days.

4. Jungle cat (*Felis chaus*)

The eyes of all the eleven jungle cat kittens born here during the period from 1-7-1971 to 30-9-1973 were closed at birth and the details of opening of eyes of two kittens only are given in Table IV (See Page 53).

The cats at birth are usually blind and helpless (Prater, *loc. cit.*; Walker *et al. loc. cit.*).

5. Common palm civet or Toddy cat (*Paradoxurus hermaphroditus*)

Both the eyes of all the sixteen young born here during the period from 15-4-1971 to 30-9-1973 were closed at birth and the details of opening of eyes of thirteen young only are given in Table V (See Page 53).

Table III

Details of opening of eyes of leapord cubs

Sl. No.	Sex of the cubs	Date of birth	Date of opening of the eyes	Age in days when the eyes of the cubs opened	Remarks
1	2	3	4	5	6
1	Male	3-8-1971	10-8-1971	8th day	
2	Male	3-8-1971	11-8-1971 (Right eye) and 12-8-1971 (left eye)	Right eye on 9th day and left eye on 10th day	
3	Female	22-4-1972	5-5-1972	14th day	
4	Male	18-6-1972	26-6-1972	9th day	
5	Male	18-6-1972	28-6-1972	11th day	
6	Female	20-1-1973	30-1-1973 (Right eye) and 31-1-1973 (left eye)	11th day (Right eye) and 12th day (left eye)	
7	Female	20-1-1973	28-1-1973 (Right eye) and 29-1-1973 (left eye)	9th day (Right eye) and 10th day (left eye)	
8	Female	23-7-1973	3-8-1973	12th day	
9	Male	23-7-1973	31-7-1973 (Right eye) and 1-8-1973 (left eye)	9th day (Right eye) and 10th day (left eye)	
10	Male	23-7-1973	2-8-1973	11th day	
11	Female	2-8-1973	9-8-1973	8th day	Black coloured panther cub
12	Male	2-8-1973	10-8-1973	9th day	Black coloured panther cub
13	Male	2-8-1973	11-8-1973	10th day	

Table IV

Details of opening of eyes of Jungle cat kittens

Sl. No.	Sex of the kittens	Date of birth	Date of opening of the eyes	Age in days when the eyes of the cubs opened	Remarks
1	2	3	4	5	6
1	Female	17-1-1973	27-1-1973	11th day	
2	Male	17-1-1973	27-1-1973	11th day	

Table V

Details of opening of eyes of Common palm civet young

Sl. No.	Sex of the young	Date of birth	Date of opening of the eyes	Age in days when the eyes of the young opened	Remarks
1	2	3	4	5	6
1	Female	24-4-1971	29-4-1971	6th day	
2	Male	24-4-1971	29-4-1971	6th day	
3	Male	7-5-1972	12-5-1972	6th day	
4	Male	7-5-1972	12-5-1972	6th day	
5	Female	7-5-1972	12-5-1972	6th day	
6	Female	7-5-1972	12-5-1972	6th day	
7	Female	18-5-1972	27-5-1972	10th day	
8	Male	8-4-1973	16-4-1973	9th day	
9	Male	8-4-1973	17-4-1973	10th day	
10	Female	4-5-1973	9-5-1973	6th day	
11	Female	4-5-1973	11-5-1973	8th day	
12	Male	4-5-1973	10-5-1973	7th day	
13	Male	4-5-1973	10-5-1973	7th day	

Both the eyes of three young born at Nandankanan Zoo (Orissa) on 3-4-1971 were closed at birth and the eyes of one young opened on the tenth day (Acharjyo and Tripathy, 1971). The viverrids are born blind (Walker *et al.*, *loc. cit.*).

6. Common Mongoose (*Herpestes edwardsi*)

The eyes of two young including one still-born young born here in one litter on 24-5-1971 were closed at birth and the details of opening of eyes of one young is given in Table VI.

Table VI

Details of opening of eyes of Common Mongoose

Sl. No.	Sex of the young	Date of birth	Date of opening of the eyes	Age in days when the eyes of the young opened	Remarks
1	2	3	4	5	6
1	Male	24-5-1971	9-6-1971	17th day	

The eyes of a common mongoose were closed at birth and opened on the 18th day (Acharjyo, *loc. cit.*).

Summary

In this note an attempt is made to present further information on the opening of eyes of six species of Wild carnivores observed at Nandankanan Biological Park, Orissa.

It is observed that the tiger cubs opened their eyes in eight to fourteen days, African lion cubs open their eyes in nine to sixteen days, leopard cubs open their eyes in eight to fourteen days, jungle cat kittens open their eyes in eleven days, common palm civet young open their eyes in six to ten days and the common mongoose open their eyes in seventeen days.

Acknowledgement

The authors are grateful to Shri D.N. Choudhury, I.F.S., Chief Conservator of Forests, Orissa and Shri S.N. Das, I.F.S., Conservator of Forests, Development Circle, Cuttack for the facilities provided.

References

1. Acharjyo, L.N. (1970)—Indian Journal of Animal Health, IX (2); 125–129.
2. .....& Tripathy, A.P. (1971)—A note on body colour and breeding habits in captivity of common palm civet (*Paradoxurus hermaphroditus*) of Orissa. J. Bombay nat. Hist. Soc. (Accepted for publication).
3. .....& Misra, R. (1972)—Indian Forester, 98 (2), PP. 132–134.
4. Chaturvedi, M.D. (1969)—The Panther on the Prowl, National Book Trust, New Delhi, India, PP. 70.
5. .....(1970)—The Felines, National Book Trust, New Delhi, India, PP. 26.
6. Crandall, Lee S. (1965)—The management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London, PP. 348–413.
7. Denis, Armand (1964) —Cats of the World, Constable & Co. Ltd., London WC 2, PP. 26–62.
8. Lydekker, Richard (1893–96)—Cited by Crandall, Lee S. (1965).
9. Martini, Helen (1955)—.....
10. Parter, S.H. (1971)—The Book of Indian Animals, 3rd Revised Edition, Bombay Natural History Society, Bombay, PP. 63–102.
11. Walker, Ernest P. *et al.* (1964)—Mammals of the World, Vol. II, The Jons Hopkins Press, Baltimore, PP. 1224–79.

Cheetal-JOurnal of Wildlife Preservation Society of India, Vol. 16 No. 2, Sept. 1973, P.P. 79

Breeding of Black Panther (*Panthera pardus*) in Captivity

By

L.N. Acharjyo [1] and R. Misra [2]

An adult male Black Panther which was received from Assam State Zoo, Gauhati on 18-10-1972; was mated with two normal coloured female panthers namely "Spotty" and "Rupa" of Nandankanan Biological Park (Orissa). Both these females were caught from the forests of Phulbani district of this State when they were cubs and reared in captivity.

Birth of three normal coloured cubs were recorded on 23-7-1973 to one of the females "Spotty". The second female " Rupa" gave birth to two black panther cubs (1 male and 1 female) and one normal coloured male cub in one litter on 2-8-1973. The spots in the black panther cubs though obscure, were still visible on close observation in good light as in adult black panther. The black panther cubs weighed 587 grams and 550 grams and measured 43 cm. and 44 cm. from tip to tip including 15 cm. long tail at birth. The normal coloured cubs of this litter weighed 603 grams and measured 45 cm. long tail at birth. The mother was jealously guarding all the three cubs. The cubs were seen taking beef alongwith the mother from the seventh week onwards. The growth rate of these three cubs, to the age of 3 months was recorded as follows:—

Date	Black male	Black female	Normal coloured male
1	2	3	4
2-8-73 (birth weight)	0.587 kg.	0.550 kg.	0.603 kg.
9-8-73	0.857 kg.	0.910 kg.	1.065 kg.

(Contd.)

1. Veterinary Assistant Surgeon, Nandankanan Biological Park, P.O. Barang, Dist: Cuttack.
2. Wild Life Conservation Officer, Orissa, Cuttack-1.

1	2	3	4
16-8-73	0.980 kg.	1.223 kg.	1.410 kg.
23-8-73	1.250 kg.	1.500 kg.	1.720 kg.
30-8-73	1.400 kg.	1.700 kg.	1.850 kg.
6-9-73	1.600 kg.	1.800 kg.	2.000 kg.
13-9-73	2.000 kg.	2.000 kg.	2.400 kg.
20-9-73	2.400 kg.	2.300 kg.	2.700 kg.
27-9-73	2.500 kg.	2.400 kg.	2.800 kg.
4-10-73	2.600 kg.	2.700 kg.	3.100 kg.
11-10-73	3.000 kg.	3.200 kg.	3.500 kg.
18-10-73	3.400 kg.	3.700 kg.	4.000 kg.
25-10-73	3.900 kg.	4.100 kg.	4.400 kg.
1-11-73	4.400 kg.	4.600 kg.	4.800 kg.

The black panther cubs were more cunning and bad tempered than the normal coloured cub.

A black panther cub born in one litter to the female of a pair of black panthers of New York Zoological Park measured 14" from tip to tip and weighed 20 ounces at birth (Crandall, 1965). The average weight of fourteen normal coloured panther cubs was 0.518 kg. and the average length from tip to tip was 45 cm. including the average tail length of 15.1 cm. (Acharjyo and Misra, 1972). Pocock (1930) states that black individual are found with some frequency in parts of the Asiatic region but are rare, though not unknown, in Africa. According to Blanford (1888-91) both normally coloured and melanistic examples are said to occur in the same litter in nature. Crandall (*loc. cit.*) states that in his own experience, captive pairs in which both animals were black have produced only black young and no black young have been born to spotted parents. Crandall (*loc. cit.*) further states that late Axel Reventlow once told him that a pair of leopards in the Zoological Gardens of Copenhagen, one spotted, the other black, bred cubs of both colour phases. A photograph of one normal coloured and one black cub

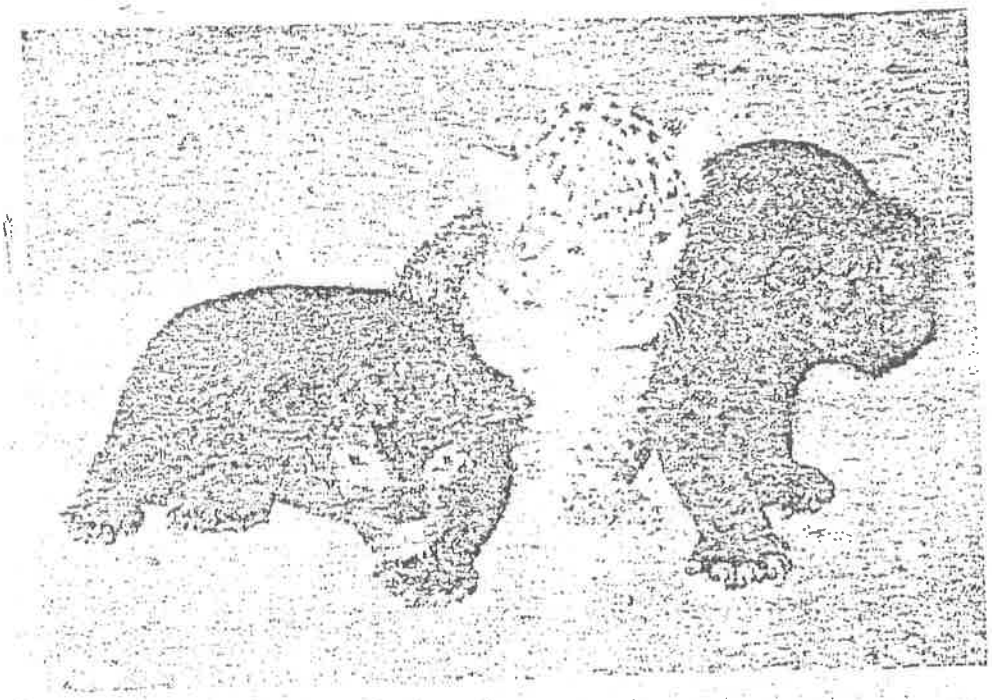
of a normal coloured mother panther (the father may have been black) has appeared in between pages 48-49 of E.P. Gee's (1964) book "The wild life of India".

Acknowledgement

The authors are thankful to Shri N. Das, Bhubaneswar for the Photographs. The authors are grateful to the Chief Conservator of Forests, Orissa and Conservator of Forests, Development Circle, Cuttack for the facilities provided.

References

1. Acharjyo, L.N. and Misra, R. (1972)—Cheetal—Journal of Wild Life Preservation Society of India, Vol.15 No.2, PP. 64–67.
2. Blanford, W.T. (1888-91)—Cited dy Crandall, Lee S. (1965).
3. Crandall, Lee S. (1965)—The Management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London. PP.372-376.
4. Pocock, R.I. (1930)—Cited by Crandall, Lee S. (1965).



Two black and one normal coloured panther cubs born in one litter to a normal coloured mother panther and black panther father on 2-8-1973. (*See Page 7*)

(*Reprinted from CHEETAL, Journal of the Wildlife Preservation Society of India, Vol. 20, No. 1 of September, 1978*)

Some Observations on Periods of Receptivity and Gestation in two Species of Great Cats in Captivity

By

L.N. Acharjyo[1] And S. Mohapatra[2]

It is essential to have a sound knowledge of all aspects of reproduction for the successful planning of breeding programmes in Zoological Parks. Almost all the Zoological Parks maintain some species of great cats and hence a knowledge of their breeding habits including the period of receptivity and gestation is considered necessary for their propagation and well-being. Available literature does not reveal much on this subject about tigers and panthers from India. Therefore some notes on periods of receptivity (period of mating) and gestation of tiger (*Panthera tigris*) and Panther (*Panthera pardus*) observed at the Nandankanan Biological Park, Orissa, during the period from January, 1970 to August, 1977 are presented here and the observations of earlier workers have been cited.

The observed period of mating is taken as the period of receptivity. The duration of gestation is estimated as the period from the last date of mating to birth.

Observations and Discussion

1. TIGER (*Panthera Tigris*)

The details of periods of receptivity and gestation observed in eight cases among three tigresses of the Park are given in the Table-1.

From this table it can be seen that the period of receptivity in tigress varies from 4 to 6 days with an average of 5.9 days and the gestation period varies from 98 to 104 days with an average of 101.13 days

The gestation period of this species is about 113 days (Asbell, 1964). According to Prater (1971) the gestation period is said to be 15 to 16 weeks. The receptivity in tigress continues for about 5 days and the gestation period from last observed mating are given as 100 to 108 days (Crandall, 1965). The gestation period is about 100 days (Chaturvedi, 1970). Sher Jung states that a tigress generally comes to season from February to May and remains in that interesting condition for about ten days and the gestation period is about fourteen weeks. Scott (1964) reports the gestation period of this species as 15 weeks. Acharjyo (1970) has given the gestation period of one tigress observed twice as 104 and 100 days respectively.

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2. Wildlife Conservation Officer, Orissa, 95-Saheed Nagar, Bhubaneswar—751007.

Table I.

Sl. No.	Name of the tigress	Period of mating observed (period of receptivity)	Date on which the litter was born	Gestation Period in days (from last day of mating to birth)
1	2	3	4	5
1.	Tigress "Sikha"	26.12.1970 to 31.12.1970 (6 days)	10.4.1971	100 days
2.	Tigress "Sikha"	2.9.1972 to 5.9.1972 (4 days)	14.12.1972	100 days
3.	Tigress "Rani"	23.7.1971 to 27.7. 1971 (5 days)	7.11.1971	103 days
4.	Tigeress "Rani"	18.12.1971 to 23.12.1971 (6 days)	2.4.1972	101 days
5.	Tigress "Rani"	7.3.1973 to 12.3.1973 6 days)	22.6.1973	102 days
6.	Tigress "Rani"	20.11.1974 to 25.11.1974 (6 days)	9.3.1975	104 days

1	2	3	4	5
7.	Tigress "Rani"	3.2.1977 to 10.2.1977 (8 days)	22.5.1977	101 days
8.	Tigress "Rekha"	9.1.1977 to 14.1.1977 (6 days)	22.4.1977	98 days

2. PANTHER (*Ponthera Pardus*)

The details of period of receptivity and gestation observed in nineteen cases among six Pantheresses of the Park are given in the Table—II.

A study of this table reveals that the period of receptivity in Pantheress varies from 4 to 8 days with an average of 5.6 days. The gestation period varies from 89 days with an average of 94.74 days.

The gestation period of this species is about 3 months (Asdell, *loc. cit;* Scott, *loc. cit.*); 98 to 105 days (Kenneth, 1953); 13 weeks (Prater, *loc. cit.*); and about 90 to 100 days (Chaturvedi, 1969). The gestation period of the genus *Panthera* is given as 92 to 113 days (Walker *et. al.* ; 1964). The range of oestrus among nine adult Pantheresses of Delhi Zoological Park are given as 4 to 14 days and the gestation periods (from last day of mating to birth) are given as 84 to 98 days with a mean of 91.9 days (Desai, 1975). Pocock (1939) reports a gestation period of 102 days for an African leopard at Whipsnade Park Zoo. Crandall, (*loc. cit.*) gives the gestation period for a Black Panther 90 days from the middle of mating span. 112 days is recorded as gestation period at Prague Zoo (Dobroruka, 1968). Sablier (1966) reports the gestation period of 100 days for two litters of the Chinese leopard from the second day of oestrus.

Table II.

Sl. No.	Name of the Pantheress	Period of mating observed (period of receptivity)	Date on which litter was born	Gestation period in days (from last day of mating to birth)
1	2	3	4	5
1.	Pantheress "Sundari"	19.3.1970 to 22.2.1970 (4 days)	31.5.1970	98 days

1	2	3	4	5
2.	Pantheress "Sundari"	24.4.1971 to 28.4.1971 (5 days)	3.8.1971	97 days
3.	Pantheress "Sundari"	14.10.1972 to 20.10.1972 (7 days)	26.1.1973	92 days
4.	Pantheress "Sundari"	23.2.1974 to 2.3.1974 (8 days)	5.6.1974	95 days
5.	Pantheress "Sundari"	7.3.1976 to 13.3.1976 (7 days)	13.6.1976	92 days
6.	Pantheress "Rupa"	26.7.1970 to 31.7.1970 (6 days)	2.11.1970	94 days
7.	Pantheress "Rupa"	20.1.1972 to 24.1.1972 (5 days)	22.4.1972	89 days
8.	Pantheress "Rupa"	13.12.1974 to 20.12.1974 (8 days)	26.3.1975	96 days

1	2	3	4	5
9.	Pantheress "Rupa"	28.5.1976 to 2.6.1976 (6 days)	6.9.1976	96 days
10.	Pantheress "Rupa"	9.11.1976 to 14.11.1976 (6 days)	16.2.1977	94 days
11.	Pantheress "Spotty"	15.10.1970 to 18.10.1970 (4 days)	20.1.1970	94 days
12.	Pantheress "Spotty"	11.3.1972 to 16.3.1972 (6 days)	18.6.1972	94 days)
13.	Pantheress "Spotty"	16.4.1973 to 21.4.1973 (6 days)	23.7.1973	93 days
14.	Pantheress "Spotty"	13.11.1974 to 18.11.1974 (6 days)	23.2.1975	97 days
15.	Pantheress "Spotty"	14.2.1974 to 18 2.1976 (5 days)	23.5.1976	95 days

1	2	3	4	8
16.	Pantheress "Shanti's	29.3.1975 to 1.4.1975 (4 days)	7.7.1975	97 days
17.	Pantheress "Lata"	4.7.1976 to 7.7.1976 (4 days)	13.10.1976	98 days
18.	Pantheress "Shanti"	29.1.1977 to 2.2.1977 (5 days)	8.5.1977 and 9.5.1977	95 days
19.	Pantheress ' Kumari"	24.5.1977 to 28.5.1977 (5 days)	30.8.1977	94 days

Summary

The period of receptivity and gestation in eight cases among three tigresses and in nineteen cases among six pantheresses were observed during the period from January, 1970 to August, 1970 at the Nandankauan Biological Park, Orissa. The observed period of mating is taking as the period of receptivity and the gestation period is estimated as the period from the last day of mating to birth.

The period of receptivity in tigers varies from 4 to 6 days with an average of 5.9 days and the gestation period in this species varies from 98 to 104 days with an avarage of 101.13 days. In pantheress, the period of roceptivity varies from 4 to 8 days with an average of 5.6 days and the gestation period varies from 89 to 98 days with an average of 94.74 days.

Acknowledgement

The authors express their gratitude to Shri S.N. Das I.F.S., Chief Conservator of Forests, Orissa, Cuttack and to Shri G.M. Das, I.F.S., Chief Wild Life Warden, Orissa, Bhubaneswar for the their encouragement.

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Antlers of a Castrated Chital Stag (*Axis Axis*)

By

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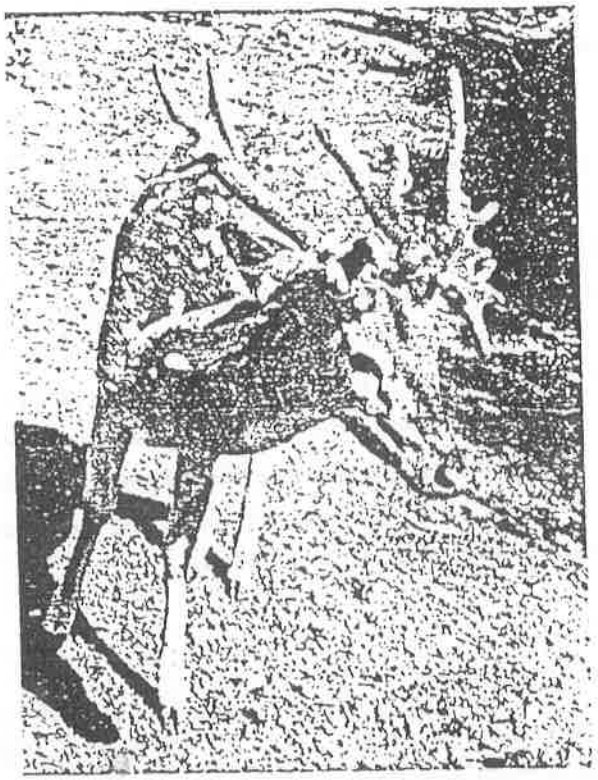
One full grown pet adult chital stag (*Axis axis*) was received at the Nandan Kanan Biological Park, Orissa on 6th February, 1975. It was having antlers with many irregularly projecting branches of different sizes covered with velvet (Fig.). It was impossible to distinguish the main beam from the bez and trez tines of the antlers. The stag was very docile and showed no interest towards a chital doe living with him.

The stag died on 30th May 1976, after remaining one year, three months and 25 days in the park. Throughout this period this stag has neither rubbed off the velvet nor cast his antlers though this species has annual antler cycle. The antlers were not hardened, covered with velvet and was fragile. On post-mortem examination the testicles were absent as castrated before his arrival in the park. This peculiar formation of antlers in the stag can be attributed to castration.

The antlers of a chital stag castrated at the age of 8 years grew in irregular and they remained in velvet (Asdell, 1964).

Reference

Asdell, S.A. (1964) : Patterns of Mammalian Reproduction, Second Edition, Cornell University Press, Ithaca, New York—pp. 560-61.



Antlers of a castrated chital stag (*Axis Axis*) at Nandankanan Biological Park, Orissa.

(See article on Page 74)

Pranikee - Journal of the Zoological Society of Orissa, 2 : 80, 1981

SHORT COMMUNICATION

INCOMPLETE POSTERIOR TWINING IN A GUINEA PIG (*CAVIA PORCELLUS*)

This communication records a case of incomplete posterior twining in a guineapig (*Cavia porcellus*). Out of 354 young guineapigs so far born at the Nandankanan Biological Park, Orissa, one out of two guineapigs born in one litter on June 13, 1972 was born dead. On close examination of the dead young one, it was found to have an extra ill developed hind quarters. The skin was continuous behind the axillary region. The pair of exta hind limbs were much smaller in size and was facing the well developed pair of hind limbs. The pelvic girdle was not, however, developed but there was an extra anal opening. At birth, the dead young weighed 95 gms whereas the living one weighed 74 grams.

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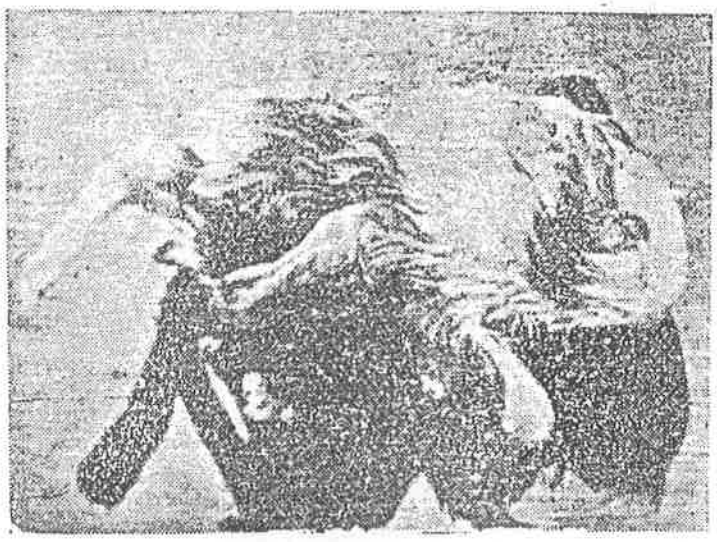

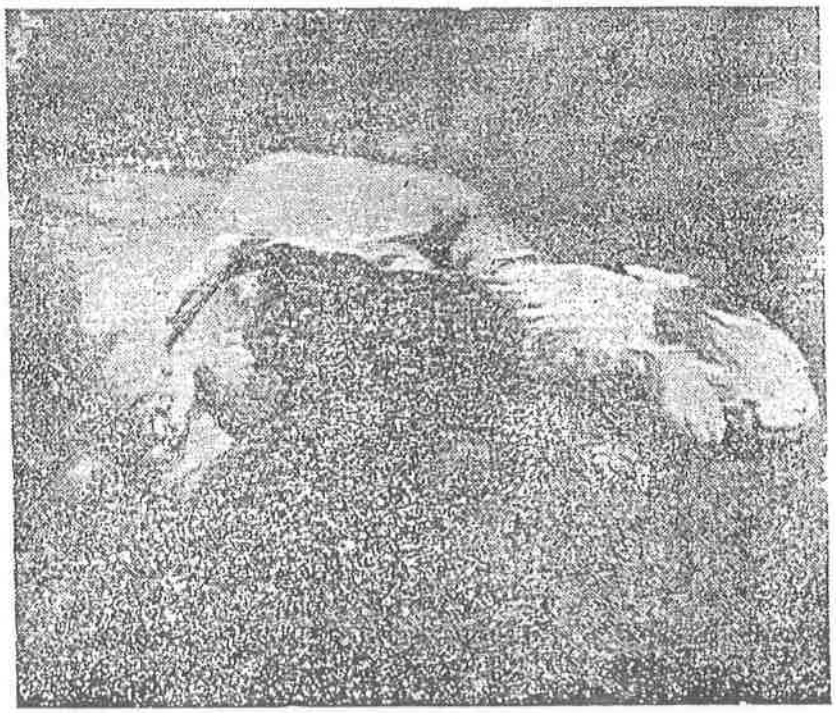

Incomplete posterior twining in a Guineapig (*Cavia porcellus*)

Prnikee, 2 : *60.61 (1981)*

SOME OBSERVATIONS ON MATING BEHAVIOUR OF TIGER (*PANTHERA TIGRIS*) *IN CAPTIVITY*

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The present report embodies some notes on mating behaviour of a compatible pair of tigers (*Panthera tigris*) observed at the Nandankanan Biological park, Orissa during the periods from 13.11-1976 to 20-11-1976 and from 3.2.1977 to 10.2.1977.

The external genitalia of the tigress in oestrus becomes moist and swollen. She frequently marks on the structures of the enclosure i. e., the walls, the fence (Chain link-mesh), the poles and the plants with her marking fluid. The tiger sniffs the places of marking (Fig. 1) followed by grimacing with the nose wrinkled and the tongue protruding out (Fig. 2). At this time droplets of saliva fall down from the hanging tongue. At times the tiger also marks on the places of marking of the tigress The behaviour of sniffing and grimacing are noticed several times during the period of mating.

Mating is always initiated by the tigress in oestrus. She displays a series of signals to intensify the partner's desire to mate. She approaches the resting male and goes on rubbing her face and head on those of the tiger till he gets up. The tigress then moves round the enclosure with the tail raised and the tiger follows her (Fig. 3). During this process the male strikes the hindlimbs of the tigress with his fore-paws. This behaviour may be an indication of readiness of the male for actual mating.

The tigress then sits down in front of the tiger in a crouching position. The male mounts and mating takes place by friction. During mating the hind quarters of the tigress are kept in a somewhat raised position with the tail to one side, probably to facilitate proper contact of the genitals. But the tail of the tiger remains in usual position (Fig. 4).

At the climax of mating the tiger extends his neck, takes a good grip of a fold of skin on the tigress's neck (Fig. 5) and produces a peculiar guttural sound probably corresponding with the act of ejaculation.

At the end of mating, the male jumps off and the female almost turns upside down, both making a peculiar loud noise typical to the end of the mating ceremony. At this stage the male keeps its tail raised probably to maintain balance and his penis remains out for a few seconds (Fig. 6). Each mating lasts for a period of about 8 to 35 seconds (as noticed in 26 observations from 3.2.1977 to 7.2.1977.

The inter-mating period may vary from twenty minutes to several hours. On 7.2.1977, fifteen matings were observed during a period of nine hours (from 8 AM-5 PM).

Mating is more frequent during the mid 2-3 days of the oestrus period and duration of mating is longer during the last two days of the period.

Mating of tigers in this Biological Park have been observed in all the months of the year except October.

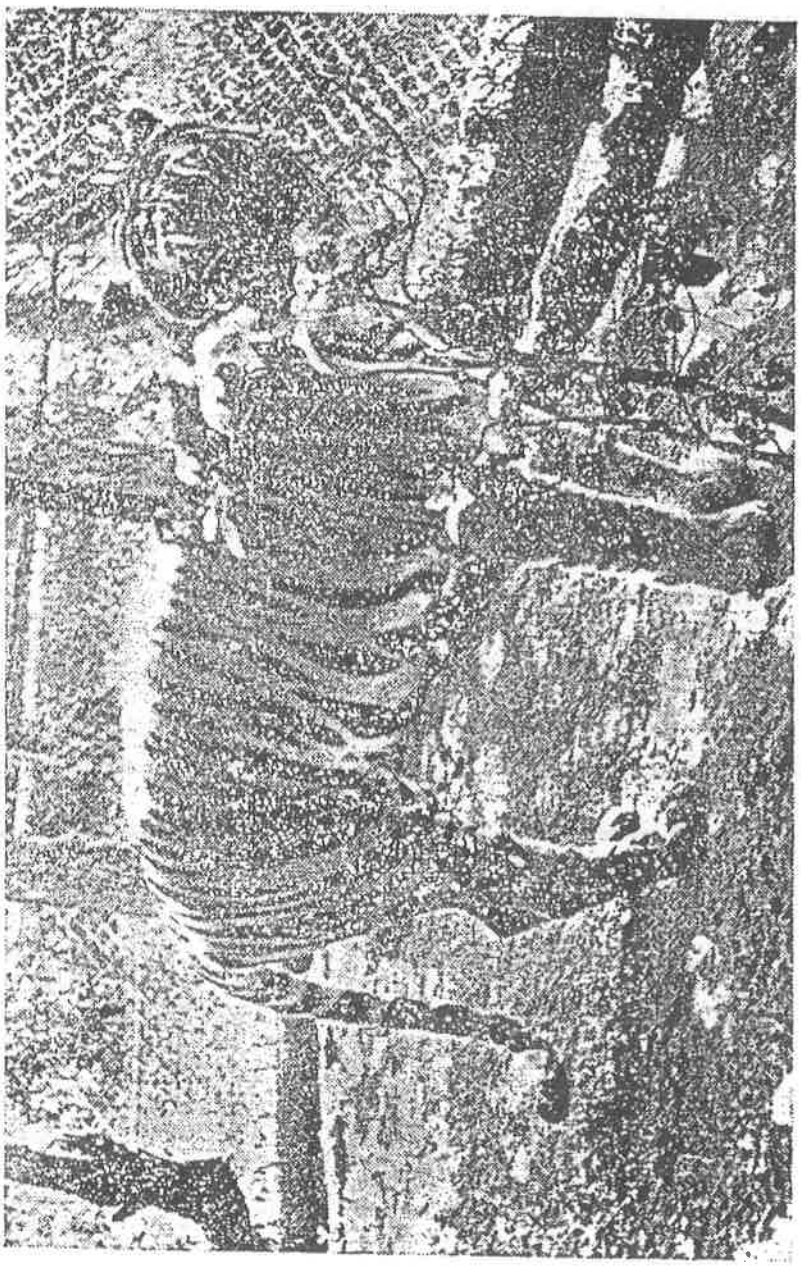

Fig. 1 The tiger sniffs at a plant, previously marked by the tigress in oestrus.
Photo—PRASANT K. PATNAIK

Fig. 2. After sniffing, the tiger grimaces with protruded tongue and wrinkled nose.

Photo—PRASANT K. PATNAIK

Fig. 3. The tiger follows the tigress in oestrus with raised tail, just before mating.

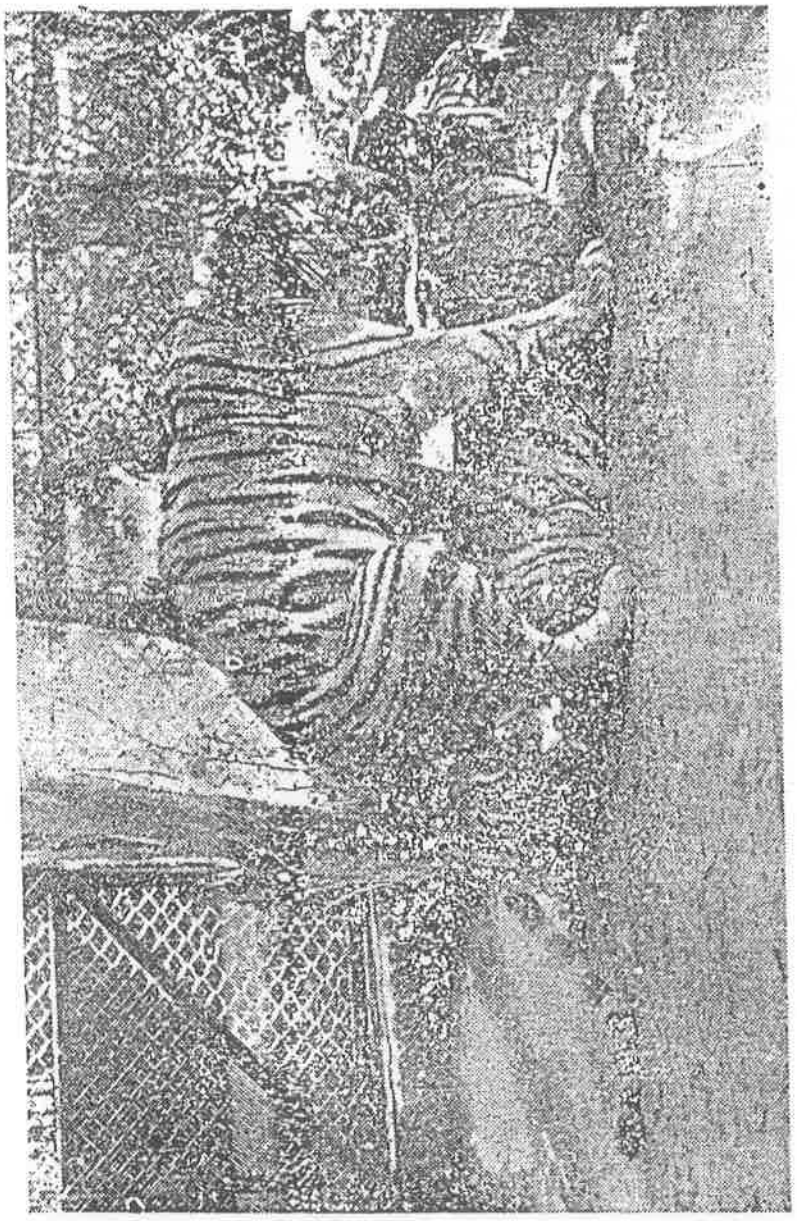

Fig. 4. Mating of tigress in progress. Mark the raised hind quarters and the position of the tail of the tigress.
Photo–PRASANT K. PATNAIK

Fig. 5. Climax of mating. Mark the extended neck condition of the tiger.
Photo—PRASANT K. PATNAIK

Fig. 6. End of mating ceremony. Mark the raised condition of the tail and exposed penis of the tiger.

Photo–PRASANT K. PATNAIK

Pranikee, 6 : (1985) : 86-87

APPEARANCE OF TUSKS IN MALE INDIAN ELEPHANT (ELEPHAS MAXIMUS)

One male baby Indian elephant (*Elephas maximus*) with an estimated age of about four months, was received at the Nandankanan Biological Park, Orissa on 28.4.1967. There was no trace of tusks at the time of receipt. The tusks cut through the gums for the first time on 2.5.1968 (left) and 20.5.1968 (right). In May, 1969 the projecting tusks measured 9 cm (left) and 8 cm (right), respectively. It died on 4.4.1970 at an estimated age of about 3 years and 3 months.

Another male baby elephant with an estimated age of about one month was received in the park on 19.3.1979. No tusks were visible at the time of receipt. The tusks erupted for the first time on 22.10.1980 (left) and 1.12.1980 (right), respectively. On 20.3.1983 each of the exposed portion of the tusks measured 16 cm. On 18.8.1984 the tusks measured 24 cm (left) and 25 cm (right), respectively. By frequent rubbing against wall and trees the tusk tips were sharpened.

These two observations suggest that the tusks in male baby Indian elephant erupt at an estimated age of 16-21 months. At least upto an age of five years and six months the tusks are neither shed nor renewed. In the first two years the tusks grew at the rate of approximately 8 to 9 cm per year and in the subsequent years it grew at the rate of approximately 6 cm per year.

An elephant calf of 4½ feet tall and aged aproximately two years in Corbett National Park had a pair of tusks measuring 6 to 8 inches (Lamba, 1975). Ali (1977) from his field experience is of the opinion that an elephant calf is born with tusks (concealed) that are seldom shed in males and continue to grow throughout its life span. The tusks of the male elephant calf show almost from birth, they are never renewed and the tusks are permanent (Sanderson, 1878). Basing on the informations collected from experienced Forestors, Karens and Burmese; Evans (1910) states that the tusk in male elephant are not shed, though he was told of one or two instances where the milk tusks were shed and renewed.

Sanderson (1960) states that tusks in males of both *Loxodonta* and *Elephas* show at birth and are not replaced. The present observations indicate that tusks are concealed at birth and erupt at an age after the first year but before the completion of the second year.

REFERENCES

ALI, S. M. (1977): Appearance of tusks in elephant *Newsl. Zool. Surv.* India, 3 (2) : 62-64.

EVANS, G. H. (1910): Elephants and their Diseases. *Suptd. Govt. Print. Rangoon*, Burma : 66-67.

LAMBA, B. S. (1975): At what Age Does the Male Indian Elephant Starts Growing Tusks ? Cheetal. J. Wildlife Preservation Society of India, 17 (2) : 46.

SANDERSON, G. P. (1878): Cited by S. M. ALI, 1977

SANDERSON, I. T. (1960): Cited by S. M. ALI, 1977

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SHORT COMMUNICATION

BREEDING OF BLACK PANTHER, *PANTHERA PARDUS* AT NANDANKANAN BIOLOGICAL PARK, ORISSA.

The black panther, *Panthera pardus*, the melanistic variety of normal spotted panther is common in the humid forests of Burma and Assam and in the rain forests of the lower Himalayas and Western Ghats (Prater, 1971). It has been stated that production of melanism is increased when there is combination of high temperature, excessive humidity and reduced light. The spots in the black panther though obscure, were still visible on close observation in good light. Observations in captivity indicate that black specimens are usually bigger in size and appear to be more cunning than their spotted counterparts. Black panthers are rare both in the wild and in captivity. Hence attempts were made to breed them in captivity at Nandankanan Biological Park, Orissa; after procuring one four-year old zoo-born male black panther from Assam State Zoo, Gauhati; in October, 1972.

This male black panther was mated with two normal coloured pantheresses named "Spotty" and "Rupa"-both procured from the forests of Phulbani District, (Orissa); as young specimens and reared in captivity.

As a result of these matings, the pantheress "Spotty" gave birth to tB৭২ cubs in three litters, all with normal spotted coat colour like the mother. But interestingly the pantheress "Rupa" gave birth to eight cubs in four litters, out of which four were black and the rest four normal coloured.

These two breeding experiments suggest that the pantheress "Spotty" was having homo-zygous normal coat colour whereas the pantheress "Rupa" was having heterozygous normal coat colour with a gene for black coat colour. This also indicates that one of the parents of "Rupa" in the wild must have been black.

Unfortunately, the male black panther procured from Gauhati died in December, 1976. Therefore, breeding of black panthers was practised in the park between zoo-born specimens utilising both black and heterozygous normal coloured panthers having a gene for black coat colour. So far 20 black panther cubs were born including one litter of six black panther cubs. The breeding experiments indicated that :

(i) mating of black coloured pantheress with black coloured panther always resulted in the birth of black coloured cubs only.

(ii) mating between heterozygous normal colouredpanther and black panther resulted in the birth of both colour phases—normal colour and black colour.

(iii) mating of homozygous normal coloured pantheress and black panther resulted in the birth of normal coloured cubs only.

Besides, earlier breeding records between homozygous normal coloured pantheress and panther showed the birth of only normal spotted coloured cubs.

Prater (1971) states that both black and normal coloured panther cubs may be produced in the same litter. Crandall (1965) states that captive pairs in which both animals were black have produced only black young and no black young have been born to spotted parents. He further states that late *Axelreventlow* once told him that a pair of leopards in the Zoological Gardens of Copenhagan, one spotted and the other black, bred cubs of both colour phases. Black leopards mating with black invariably produce black cubs but black mating with normal coloured will produce both kinds of cubs (Gee, 1964).

A pair of zoo-born black panthers of this park were supplied to National Zoological park, New Delhi in March 1980 ; and one male black panther was supplied to Vandalur Zoo, Madras in October, 1985. At present there are six black panthers (2 males+4 females), all born in the park. The breeding results thus confirm the earlier occurrence of black panther in the forests of Phulbani district (Orissa). It is hoped that more black panthers can be bred successfully in the park to meet the increasing demands of the Zoological parks of the country.

REFERENCES

CRANDALL, LEE S. (1965) : The management of wild mammals in captivity, The University of Chicago Press, Chicago & London.

GEE, E. P. (1964) : The wildlife of India, Collins, London.

PRATER, S. H. (1971) : The Book of Indian Animals, Bombay Natural History Society, Bombay.

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SHORT COMMUNICATION

A NOTE ON THE LONGEVITY OF THE TIGER (*PANTHERA TIGRIS*) IN CAPTIVITY

A male tiger named "Deepak" which was born at the Nandankanan Biological Park, Orissa on July 31, 1967 died on February 10, 1985 at the age of 18 years, 6 months and 10 days. During his life time, he was paired with three tigresses "Rani", "Ganga" and "Subhra" (two normal coloured and one white) and fathered 26 cubs (20 normal coloured and six white). Latest successful mating of this tiger with the tigress "Ganga" was observed from January 5, 1985 to January 10, 1985 resulting in the birth of two cubs on April 21, 1985 when he was approximately 17 years and 6 months. This is the maximum longevity so far recorded among tigers of this park. He was maintained on a diet of 15 kg of fresh raw beef with bones, six days in a week.

A tiger has lived for the longest period of 14 years at the Alipore Zoological Garden, Calcutta (Sanyal, 1892). Under the zoo conditions the maximum longevity of tigers is 20 years (Schaller; 1967). A Siberian tiger has lived for 19 years in the Zoological Garden (Flower, 1931). According to Crandall (1965) a female Bengal tiger of New York Zoological Park died at the age of 20 years, 7 months and 2 days. Nair (1957) reports the death of a tiger that has lived for 19 years in Zoological Garden of Trichur. The estimated life span of the tiger is about 20 years (Prater, 1971). A tigress named "Radha" born at Govindgarh Palace, Rewa (M. P.) on April 10, 1955 died at National Zoological Park, New Delhi on May 2, 1974 at the age of 19 years and 22 days (Roychoudhury and Sankhala, 1979). The white tigress "Mohini" born at Govindgarh Palace, Rewa on October 30, 1958 died at National Zoological Park, Washington D. C. on April 6, 1979 at the age of 20 years, 5 months and 7 days (Roychoudhury, *Pers. Comm.*). Tigers in captivity have lived for 12 to 19 years (Walker *et. al.* 1964).

REFERENCES

CRANDALL, LEE S. 1965. The Management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London; pp. 735.

FLOWER, S. S. 1931. Cited by Crandall, Lee S. 1965.

NAIR, KESAVAN R. 1957. Cited by Crandall, Lee S. 1965.

PRATER, S. H. 1971. The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay; pp.65-66.

ROYCHOUDHURY, A. K. and K. S. SANKHALA. 1979. Inbreeding in white tigers. Proc. Indian Acad. Sci. Vol. 88B, Part 1; 311-323.

SANYAL, R. B. 1892. A Hand-Book of the Management of Animals in captivity in Lower Bengal. Bengal Secretariat Press, Calcutta; pp. 45-51.

SCHALLER, G. B. 1967. The Dear and the Tiger. The University of Chicago Press, Chicago and London; pp. 221-307.

WALKER, ERNEST P. *et. al.* 1964. Mammals of the World, Volume II. The Johns Hopkings Press, Baltimore; pp. 1279.

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OBSERVATION ON SOME ASPECTS OF REPRODUCTION AMONG COMMON WILD MAMMALS IN CAPTIVITY

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With the advancement of feeding, care, management and disease control of the captive wild life, it is now possible to exhibit them under natural surroundings with better health for more number of years. One of the objects of the modern zoos is breeding and propagation. Therefore, it is necessary to have an idea of the gestation period, number born per litter, birth weight and size, method followed etc. for the successful breeding of the wild life in captivity. In the present communication an attempt is made to present some helpful informations on birth weight and size and some other aspects of reproduction of nine common wild mammals maintained at the State Biological Park, Nandankanan (Orissa) during the past eight years and six months (from 29.12.60 to 30.6.69). Most of the weights and measurements observed here were taken either immediately after birth or within twelve hours of birth. Only in the case of tiger cub, the weight and measurements could be taken after about 40 hours, as it was not possible to separate the cub from the mother earlier.

OBSERVATIONS AND DISCUSSION

I. Lion African (*Panthera leo*)

In this park, there were two records of breeding with two cubs in each litter. The birth weight of 4 cubs was betwween 1.000 kg. to 1.100 kg. with an average of 1.075 kg., the length from tip to tip was 53 cm. to 55 cm. with an average of 53.5 cm. and the length of the tail was from 15 cm. to 17 cm. with an average of 16 cm. The gestation period observed once was 106 days. The interval between two parturitions observed once was 2 years 2 months and 21 days. Both the eyes of all the four cubs were closed at birth. The eyes of two female cubs of the first litter opened on 11th day and that of male cubs of the second litter opened on 13th day.

Asdell (1964) gives the gestation period as about 108 days. The usual number born per litter is 2 to 3. Litter upto 7 has been recorded once in Dublin (Steyn, 1951). The lion is polyestrous and breeds thoughout the year. Crandall (1965) mentioning Lydekker (1893-96) says that the eyes are fully open when the lion cubs are born and this statement has frequently been repeated. At New York Zoological Park, the eyes of two female lion

cubs opened on 5th and 6th day respectively. Each of these cubs measured 21½" from tip to tip and weighed 2 lbs. 12 ozs. and 3 lbs. respectively. Another dead male born along with the same litter weighed 3 lbs. 15 ozs. (Crandall, *loc. cit.*).

II. Tiger (*Panthera tigris*)

There were two births in this zoo, once with three still-born cubs in one litter and again a single cub litter (Acharjyo, 1969). A tigress mated to a tiger on 17.9.1966 delivered her first still-born cub of the litter on 30.12.66 after 104 days. The same tigress mated to the same tiger from 20.4.67 to 22.4.67, delivered a cub on 31.7.67 after 100 days. The interval between two parturitions observed here was 210 days only. The interval between two parturitions could be minimised probably because the tigress was allowed to remain with her mate immediately after she was cured of post-parturient troubles. Only one cub (male) weighed 1.500 kg. and measured 51 cm. from tip to tip and the length of tail was 15 cm. after about 40 hours of birth.

Asdell (*loc. cit.*) gives the gestation period as about 113 days. Crandall (*loc. cit.*) gives the gestation period of New York Zoological Park as 100-108 days and litter size as 1 to 4. It is polyestrous and breeds all the year. The litter size is 2 to 5 (Asdell, *loc. cit.*). A litter of 6 has been recorded in Edinburgh Zoo in 1954 (Schomberg, 1957). According to Walker *et al* (1964), most cats have one or two litters a year and the larger species sometimes breeds only every two or three years. Each of the three cubs born at New York Zoological Park measured 20" from tip to tip and weighed 2 lbs. 9 ozs. (male), 2 lbs. 8 ozs. (male) and 2 lbs. 11 ozs. (female). The eyes of all the three cubs were closed at birth and opened on 11th, 17th and 9th day respectively. Birth weights of 19 male cubs and 18 female cubs of the same zoo varied from 3 lbs. 1 oz. to 3 lbs. 9 ozs. for males and 1 lb. 8 ozs. to 2 lbs. 12 ozs. for females respectively (Crandall, *loc. cit.*).

III. Leopard (*Panthera pardus*)

There were four litters in this park, twice with two cubs and twice with single cub litter. The minimum interval between two parturitions observed here once was 184 days. The gestation period observed twice was 98 days and 111 days respectively. The birth weight of 6 cubs was from 0.450 kg. to 0.600 kg. with an average of 0.517 kg. Only one cub has weighed the minimum weight of 0.450 kg. and it died on the third day. The length from tip to tip was from 42 cm. to 48 cm. with an average of 44 cm. and the length of the tail was from 14 cm. to 15 cm. with an average of 14.5 cm. Both the eyes of all the six cubs were closed at birth. The eyes of the two female cubs opened on 11th day. The eyes of the two male cubs opened on 13th day and that of one male cub opened on 15th day.

The gestation period is about 3 months and in London Zoo the number of young per litter was 1 to 3, usually 1 (Asdell, *loc. cit.*) It breeds throughout the year. At New York Zoological Park a single cub born to a pair of black leopards was weighing 20 ozs. and measured 14" from tip to tip (Crandall, *loc. cit.*). Eyes opened on 6th day (Martini, 1955).

IV. Common Mongoose (*Herpester edwardsi*)

Here there were two records of birth, one with three young and another with one young per litter. The gestation period observed here twice was 49 days and 53 days. The interval between two parturitions observed here once was 105 days. The birth weight of one male young was 35 grams, length from tip to tip was 15 cm. and the tail was 4 cm. The eyes were closed at birth and opened on the 18th day.

Prater (1965) gives the period of gestation as about 60 days. The number born per litter is usually two and it has no regular season (Asdell, *loc. cit.*). There is no mention of birth weight and size in the available literature.

V. Nilgai or Blue Bull (*Boselaphus tragocamelus*)

Out of six fawns born here, there were two single fawn births and two successive twins. The minimum period of interval between two parturitions observed here was 367 days. Birth weight of three young of this park was from 6.700 kg. to 8.800 kg with an average of 8.070 kg. The length from tip to tip was 89 cm. in all the three cases whereas the shoulder height was from 56 cm. to 58 cm. with an average of 57 cm.

The gestation period observed was 8 months 7 days (Asdell, *loc. cit.*). It has no regular breeding season and mates immediately after dropping the young. Always single young was born to all the 8 births recorded at New York Zoological Park (Crandall, *loc. cit*). Crandall mentioning Zuckerman (1953) says "On an average, twins were born in every alternate birth". From the available literature, birth weight and size could not be known.

VI. Black Buck (*Antelope cervicapra*)

Five births with all single young were recorded here. The minimum interval between two parturitions observed here was 209 days. The birth weight of three young was from 3 600 kg. to 4.400 kg. with an average of 4.000 kg. The length from tip to tip was from 70 cm. to 74 cm. with an average of 72 cm. and the shoulder height was from 37 cm. to 42 cm. with an average of 39 cm.

The gestation period is about 6 months and from 1 to 2 young are born at a time and in London Zoo births of single young have been recorded

(Asdell, *loc. cit.*). The chief rutting season is February and March though it breeds in all seasons (Prater, *loc. cit.*). Out of 97 young born at New York Zoological Park, all were single young and never twins (Crandall, *loc. cit.*). There is no mention of birth weight and size in the available literature.

VII. Barking Deer or Muntjac (*Muntiacus muntjak*)

Out of 47 births recorded here, only once twin fawns were born in July, 1964 and the rest all with single fawn. The birth weight of 9 fawns observed in this park was between 0.900 kg. to 2.000 kg. with an average of 1.520 kg. Only one fawn was weighing 0.900 kg. and it died immediately after birth. The length from tip to tip was from 43 cm. to 55 cm. with an average of 50 cm. The shoulder height was from 25 cm. to 30 cm. with an average of 27 cm.

The gestation period is about 180 days and one or occasionally two are born at a time and a young weighs about 550-650 grams at birth (Walker *et al, loc. cit.*). They appear to breed at all seasons but mainly during cold weather (Prater, *loc. cit.*). Crandall (*loc. cit.*) mentioning Zuckerman (*loc. cit.*) says that always single young were born to all the 30 births of Indian muntjak in the Zoological gardens of London.

VIII. Sambar (*Cervus unicolor*)

Always single young were born to all the 30 births recorded in this park. The interval between two parturitions of one of the aged Sambars ovserved here was 368 days. The birth weight of 9 fawns was between 7.200 kg. to 11.700 kg. with an average of 8.270 kg. The length from tip to tip was between 91 cm. to 104 cm. with an average of 98 cm. The shoulder was from 48 cm. to 58 cm. with an average of 53 cm. Only one fawn weighed 7.200 kg. and it died on the second day of birth.

The gestation period is about 8 months and 1 to 2 fawns born at a time (Asdell, *loc. cit.*). Out of 41 fawns (Indian Sambar) born in New York Zoological Park, only one pair of twins was noted (Crandal, *loc. cit.*). There is no mention of birth weight and size in the available literature.

IX. Spotted Deer or Chital (*Axis axis*)

Out of 99 births recorded so far in this zoo, all were born with single young only and never twins. The birth weight of 33 fawns was from 2.300 kg. to 4.100 kg. with an average of 3.3200 kg. Only two fawns weighed 2.300 kg. and both of them died within 36 hours of birth. The length from tip to tip was between 64 cm. to 76 cm. with an average of 71 cm. The shoulder height was between 34 cm. to 43 cm. with an average of 39 cm.

The gestation period is 7 to $7\frac{1}{2}$ months and in London Zoo twins have

been born once in 80 births (Asdell, *loc. cit.*) Out of 225 births at New York Zoological Park, only one pair of twins was noted (Crandall, *loc. cit.*). Walker *et al* (*loc. cit.*) have reported that usually two young but not uncommonly one or three are born in dense cover. In the available literature there is no mention of birth weight and size.

SUMMARY

Some useful informations on reproduction, birth weight and size etc., of nine common captive wild mammals observed during 8 years and 6 months at State Biological Park, Nandankanan (Orissa) has been described and the deviations from the available literature are briefly discussed.

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REFERENCES

Acharjyo, L. N. (1969) — Dystokia in a tigress (*Panthera tigress*). *Ind. Vet. J. 46* : 80-81.

Asdell, S. A. (1964) — Patterns of Mammalian reproduction. 2nd Edition. Cornell University Press, Ithaca, New York.

Crandall, Lee S. (1965) — The management of wild mammals in captivity. The University of Chicago Press, Chicago & London.

David, Reuben (1967) — The Illustrated Weekly of India. October 1, 1967 ; 40-41. The Times of India Press, Bombay-1.

Martini, Helen (1955) — Cited by Crandall, Lee S. (1965).

Prater, S. H. (1965) — The book of Indian Animals. Bombay Natural History Society & Princeof Wales Museum of Western India, Bombay.

Steyn, T. J. (1951) — Cited by Crandall, Lee S. (1965).

Schomberg, Geoffrey (1957)—cited by Crandall, Lee S. (1965)

Walker, Ernest P. ; Warnick, Florence ; Hamlet, Sybil E. ; Lange, Kenneth I. ; Davis, Mary A. ; Uible, Howard E. ; and Wright Patricia F. (1964).—Mammals of the World, Vol. II. The Johns Hopkins Press, Baltimore.

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Reprint : Book - Antler Development in Cervidae - Robert D. Brown, Editor (1983), Caesar Kleberg Wildlife Research Institute, Kingsville, U.S.A.

OBSERVATIONS ON ASPECTS OF ANTLER CASTING IN CAPTIVE SAMBAR DEER

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ABSTRACT

The sambar, the largest of the 8 species of Indian deer, has well developed antlers. Since data on aspects of antler growth and casting in the sambar are scanty, this paper presents data recorded at the Nandankanan Biological Park, Orissa, over a continuous period of 10 years, 7 months (1 October 1970-30 April 1981). Antler casting has been observed during the 6-month period, March-August. However, 60 of 67 observed castings (89.5%) occurred during the 3-month period April-June. All sambar stags under observation cast their antlers annually. The velvet was rubbed off during a continuous 8-month period, August-March. However, the majority of stags, 59 of 79 observations (74.7%), cleared their velvet during September-October. Casting of both left and right antlers was completed in 1-6 days. The majority of stags, however, 58 of 67 observations (86.6%), cast both antlers in 1-3 days. The period between casting of both antlers and the time of clearing of velvet, observed in 33 instances, varied from 4-5½ months. The inter-casting period repeatedly observed in 2 stags (12 observations) varied from 330-378 days. Two young sambar stags cast their single spike hard antlers for the first time at the age of 1 year, 6 months and 1 year, 7 months, respectively. The average length and weight of 12 cast single spike antlers was 18.1 cm and 60.5 grams, respectively. The largest cast antler of an adult stag measured 94 cm along the outer curve and weighted 3.078 kg. KEY WORDS: Antler, Deer, Casting, Sambar.

Eight species of deer occur within the geographical limits of India. With the exception of the musk deer (*Moschus moschiferus*), the stags of the other 7 species carry antlers. The sambar (*Cervus unicolor*) is the largest of all Asiatic deer and attains its best development in India (Krishnan 1975). The sambar, as well as being the largest Indian species of deer, carries the grandest antlers (Prater 1971). Prater (1971) stated that in its first year a sambar stag has simple spikes, in the second year the newly grown antler throws out a branch from near its base, and in the third year a terminal tine is added. The sambar stags cast their antlers periodically, but data on various aspects of growth and casting of antlers are scanty and often fragmentary.

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OBSERVATIONS AND DISCUSSION

The purpose of this paper is to provide additional information on the sambar antler cycle through observations of captive deer. Hence, this paper presents data on some aspects of antler casting in the sambar based on observations recorded at the Nandankanan Biological Park, Orissa, India, for

a continuous period of 10 years, 7 months (1 October 1970-30 April 1981). The sambar were obtained from different parts of Orissa when the park was established in 1960. The park lies within the natural range of this species. Deer born and brought up in the park have been included in this study.

Season of Antler Casting

During the observation period 67 antler castings (single-spiked as well as branched) were recorded on a population varying from 2-12 sambar stags (Table 1). Antler casting occurred during a 6-month period from March-August. All the sambar stags regularly cast their antlers annually, and no stag retained its antlers to the next year. Casting was markedly seasonal; 60 of the 67 castings (89.5%) occurred during a 3-month period from April-June. Four castings (6.0%) were observed in March and 3 castings (4.5%) were observed in July-August.

Acharjyo (1971) stated that 14 of 15 castings (93.3%) of this species occurred from April-June, whereas only 1 casting (6.7%) occurred in July. According to Prater (1971), the majority of sambar stags in central and southern India cast their antlers between the end of March and mid-April. Kishnan (1975), on the basis of observations in Mudumalai Sanctuary of Tamilnadu (south India), stated that there was no defined season for antler casting. Schaller (1967) working at Kanha National Park (Central India) indicated that most castings of this species occurred in late May-June. He further reported 2 castings in April in the Alipore Zoological Gardens, Calcutta.

According to Lydekker (1924), sambar antlers were not cast regularly every season but only every second or third year; in the Himalayas they were cast in April, in the plains in March, and at Woburn the antlers were cast at any time of the year. The antlers of the sambar were cast from April-September but mostly during May-June in European zoos (Van Bemmel 1949-50). Crandall (1965) stated that no sambar in the New York Zoological Park retained its antlers for more than 1 year, but that sambar stags in captivity may shed their antlers at any season. Brander (1923) also stated that the sambar antlers are cast annually.

Period of Velvet Rubbing

As is usual with the stags of many species of deer, the sambar also rub off the velvet from the antlers each year after the completion of their growth. During the study period, 79 observations were made on a captive population of sambar stags, which varied from 2-14 individuals (Table 1).

Rubbing off the velvet occurred from August-March. The majority of stags cleared their velvet during September-October (59 of 79 clearings, 74.7%), whereas 8 clearings (10.1%) occurred in November-December. Interestingly, all 10 clearings (12.7%) observed from January-March were of young stags carrying single-spike antlers; only 2 clearings (2.5%) were observed in August.

Table 1. Monthly distribution of captive sambar stags casting antlers and rubbing off velvet at Nandankanan Biological Park from 1 Oct 1970 to 30 Apr 1981.

Month	Stags casting antlers[1]	Stags rubbing off velvet[2]
Jan		3
Feb		3
Mar	4	4
Apr	22	
May	30	
Jun	8	
Jul	2	
Aug	1	2
Sep		21
Oct		38
Nov		5
Dec		3
Total	67	79

[1]2—12 stags / year
[2]2—14 stags / year

The antlers of sambar stags began growth in May, were in velvet during the rains (July-October) and were cleared of velvet by November (Prater 1971). Thirty-three adult sambar stags observed by Schaller (1967) at Kanha between 19 November-18 May were in hard antlers.

Duration of Antler Casting

In the 67 cases studied, casting of both antlers was completed within 1 day in 30 instances (44.8%), within 2 consecutive days in 18 instances (26.9%), within 3 days in 10 instances (14.9%), within 4 days in 6 instances (8.9%), within 5 days in 2 instances (3.0%), and within 6 days in 1 instance (1.5%). These data indicate that the majority of hard antlers (86.6%) are cast within 1-3 days.

Acharjyo (1971) stated that both antlers were cast in 1 day or on 2 consecutive days. One stag in Alipore Zoological Garden twice lost its antlers on 2 consecutive days (Schaller 1967).

Span of Antler Growth

The interval between antler casting and rubbing off the velvet encompasses the period required for completion of antler growth. This span, observed in 33 cases, varied from approximately 4-5.5 months: 4 months (2 stags), 4.5 months (6), 5 months (21), and 5.5 months (4). Most sambar (63.6%) completed antler growth in 5 months.

Prater (1971) stated that the stags cast their antlers between the end of March and mid-April; the antlers began growth in May and were in velvet during the rains and were cleared of velvet during November. These facts suggest that it takes over 6 months for the full growth of antlers, but the present data indicate that less time is required.

Table 2. Interval between successive antler casting in captive sambar deer in India.

Individual	Date of previous antler casting	Date of subsequent antler casting	Inter-casting period (days)
"A"	30 Apr 1970	27,28 Apr 1971	361—362
"	27,28 Apr 1971	17 Apr 1972	354—355
"	17 Apr 1972	4,5 Apr 1973	351—352
"	4,5 Apr 1973	2 Apr 1974	361—362
"	2 Apr 1974	16 Apr 1975	378
"	16 Apr 1975	26 Apr 1976	375
"	26 Apr 1976	5 May 1977	373
"	5 May 1977	1,2 Apr 1978	330—331
"B"	6 Jun 1970	24,26 May 1971	348—350
"	24,26 May 1971	22 May 1972	361—363
"	22 May 1972	24,25 May 1973	366—367
"	24,25 May 1973	12,14 May 1974	351-354

Interval Between Antler Casting

The inter-casting period of antlers varied from 330-378 days ($\bar{x}$ = 359.4) (Table 2). One stag from Alipore Zoological Garden cast its antlers on 8-9 April 1964 and on 19-20 April 1965 (Schaller 1967), giving an inter-casting period of 375 days.

Age at First Antler Casting

Two sambar males born in the parks on 11 November 1972 and 7 October 1972 cast their antlers for the first time at an age of approximately 1 year, 6 months and 1 year, 7 months respectively. As expected, the coronet or burr

Table 3. Length and weight of cast single-spike antlers in captive sambar deer in India.

No.	Length (cm)	Weight (g)
1	6.5	16.9
2	8.5	15.6
3	9.0	18.1
4	13.0	38.2
5	13.5	40.4
6	15.5	45.3
7	17.0	65.0
8	17.0	78.0
9	17.5	78.5
10	19.5	75.0
11	20.5	48.0
12	24.5	54.2
13	25.0	58.4
14	26.0	92.5
15	27.0	93.0
16	29.5	151.0
$\bar{X}$	18.1	60.5

Table 4. Length and weight of the largest 3-pointed cast antler in captive sambar deer in India.

No.	Date of casting (right or left antler)	Length along the outer curve (cm)	Weight (gm)
1	5 May 1977 (Right)	83.0	1993
2	5 May 1977 (Left)	84.0	1918
3	1 Apr 1978 (Right)	79.5*	1920
4	2 Apr 1978 (Left)	83.0	2060
5	5 May 1978 (Left)	81.0	1713
6	22 Mar 1980 (Right)	76.5	1715
7	23 Mar 1980 (Left)	77.0	1740
8	12 Apr 1980 (Left)	94.0	3078
9	13 Apr 1981 (Left)	81.5	1975
10	13 Apr 1981 (Right)	80.0	2120
11	20 Apr 1981 (Right)	88.0	2890
12	23 Apr 1981 (Left)	93.5	2720

*tip broken

was absent in the single-spike antlers. Two sambar cast their antlers for the first time at the age of approximately 1 year, 10 months (Acharjyo 1971).

Length and Weight of Cast Antlers

The single-spike antlers of yearlings vary from 6.5 to 29.5 cm ($\bar{x}$ 2h 18.1 cm) in length and 15.6-151 g in weight ($\bar{x}$ 2h 60.5 g) (Table 3). The largest antler, measured along the outer curve, was 94 cm and weighed 3.078 kg (Table 4).

According to Schaller (1967) the antlers of sambar yearlings consist of simple spikes up to 25 cm long, and the antlers are generally 50-88 cm long. A record pair of antlers measuring approximately 127 cm long was reported by Ward (1922). Prater (1971) stated that 95 cm is good in North India and 90 cm in South India. Krishnan (1975) gave the length of a mounted sambar shot in a sanctuary in Orissa as 83 cm and the antlers of another mounted sambar head from Bihar as 100 cm long.

LITERATURE CITED

ACHARJYO, L. N. 1971. Notes on time of casting of antlers of deer in captivity. Indian Forester 97. 3:150-151.

BRANDER, A. 1923. Cited by Schaller, George B. 1967. The deer and the tiger. University of Chicago Press, Chicago. pp. 134-137.

CRANDALL, L. S. 1965. The management of wild mammals in captivity. University of Chicago Press, Chicago & London. pp. 569-570.

KRISHNAN, M. 1975. India's wildlife in 1959-70. Bombay Natural Hist. Society, Bombay. pp. 149-155.

LYDEKKER, R. 1924. Cited by S. A. Asdell 1964. Pages 565-566 *in*: Patterns of mammalia reproduction. 2nd Ed. Cornell University Press, Ithaca, New York.

PRATER, S. H. 1971. The book of Indian animals. Third Ed. Bombay Natural History Society, Bombay. pp. 274-291.

SCHALLER, G. B. 1967. The deer and the tiger. University of Chicago Press, Chicago. pp. 134-137.

VAN BEMMEL, A. C. V. 1949. Cited by Asdell, S. A. (1964). Pages 565-566 *in*: Patterns of mammalian reproduction. Cornell University Press, Ithaca, New York.

WARD, R. 1922. Cited by Schaller, George B. 1967. Pages 134-137 *in*: The deer and the tiger. University of Chicago Press, Chicago.

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THE STRUCTURAL PECULIARITIES OF ANTLER BONE IN GENERA *AXIS*, *RUSA* AND *RUCERVUS*[1]

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ABSTRACT

Antler bone in species of the genera *Axis*, *Rusa* and *Rucervus* differs from those of other cervids in 3 ways: (1) A very thick cortex is evidence of long-lasting or very fast rebuilding processes of the osteon. (2) A tubular cavity within a core of spongy bone may be a blood sinus that contains some clotted blood within its maximum 8 mm diameter. In the huge antlers of *Rusa unicolor* and *Axis axis*, the axial channel and other small associated sinuses have walls developed from primary bone. In some seals of the *Rusa* antlers, the sinus stimulates the speculation that such antlers may have remained alive after the velvet shedding despite their surface being exposed to air and consisting of a dead bone cortex. (3) The last peculiarity of antlers of these genera is a concave seal in young specimens and flat seals in primes. Contrary to boreal Cervinae, the yearlings, particularly those of *Rusa unicolor*, have the most concave seal, suggesting a low testosterone level during the hardening period and a fast resorption probably due to a very porous bridge of compact bone between the antler base and pedicle. The evolutionary significance of this phenomenon will be discussed. KEY WORDS: Antler, *Axis*, Deer, *Rucervus*, *Rusa*.

The evolutionary history of *Cervidae* sp. (Bubenik 1983*a*) is still obscure. We do not know for sure whether they evolved independently or from pseudocervicorn genera (like *dicrocerids* or *lagomerycids*) whose perennial appendages became deciduous. No matter which way this occurred, we do not believe that the pressure of winter climate and/or predation on males influenced the change from perennial pseudoantlers to true antlers (Coope 1968; Geist and Bromley 1978). We find supporting evidence in the presence of Eurasiatic perennial, but antlered spikers (Dauerspiesser) in Torton, i.e., between the Middle and Upper Miocene Epochs; these were warm periods characterized by older pseudocervicorn genera (Stehlin 1937; Thenius 1950; Viret 1961; Bubenik 1983*a*).

Living species of the genera *Axis*, *Rucervus*, and *Rusa* have not changed their antler construction since the Pliocene Epoch (Gervais 1859; Zeuner 1959; Azzaroli 1953; Thenius and Hofer 1960). Only true boreal cervids have made very revolutionary progress. The fact that they evolved in and never left the tropical region attests to their evolutionary conservatism, closed behavioral and antlerogenetic program (Bubenik 1983*a*,*b*). They cannot adapt either their antler cycle or their breeding season to climatic changes if transferred to the boreal zone (Lydekker 1898; Mohr 1918; Bedford 1949; Mohr 1968; Whitehead 1972; Ables 1978), and they have an antler bone structure that differs from species we know definitely developed in northern climates.

[1]Ontario Ministry of Natural Resources, Wildlife Research Section, Contribution No. 81-18.

There are enough reasons to regard these genera as archaic and thus worth more intensive study. This was our aim when we built our study on A.B. Bubenik's findings (1966) that tropical cervids have a large axial channel in the spongious core. This paper is a pilot study that may encourage scholars to solve some of the questions that we have raised.

We express our thanks to the donators of the antlers: Nandankanan Biological Park-Barang, Zoological Garden, Calcutta, and the National Zoological Park, Washington, D.C. We are deeply obliged to O. Holzapfel from Wild-Leitz Canada Ltd. for technical help in studying the microstructure of the antlers. Special thanks to G.A. Bubenik, University of Guelph, for his many comments and critical review of the manuscript, Ms. J. Robinson, who did the prints, and Mrs. D. Baggley for her patience in typing the manuscript. We are indebted to the Ontario Ministry of Natural Resources which provided financial support for a great part of this work.

METHODS

We investigated only the transverse antler structure of sambar (*Rusa unicolor*), chital (*Axis axis*), thamin deer (*Rucervus eldi*), and the now extinct Schomburgk's deer (*Rucervus schomburgki*). The specimens were from the Nandankanan Biological Park, Barang-Orissa, India and the National Zoological Park of the Smithsonian Institute, in Washington, D.C.; the only specimen of *R. schomburgki* was bought from a button manufacturer in Prague.

After sections of antler about 5 mm thick were embedded in epoxy resin, each surface was highly polished and photographed in reflected light at 7.1 magnification with a M8 wild zoom stereo microscope with coaxial illumination and fully automatic camera attachment MP 45-51. The cortial thickness measured in the beam's middle portion was expressed as a percentage of beam diameter. The seal profile was classified as either convex, flat, slightly concave (<0.6 mm), moderately concave (<10 mm), very concave (>25 mm), or conically concave (>25 mm). Except for the first antlers where the age was known, the other antlers were only listed as belonging to teen-or prime-age deer.

RESULTS

Seal of Cast Antlers

None of the seals had a convex surface, and they showed either different degrees of concavity or were flat. Those of yearling sambars were moderately to conically concave; in some antlers the entire seal was eroded, and in others a relatively compact seal was preserved (Fig. 1). In the antlers of teenagers, the seals were slightly to moderately concave; in primes they were slightly concave or flat (Fig. 2). In chitals these differences among age classes were not as pronounced. The 4 thamin antlers with flat seals came from prime deer.

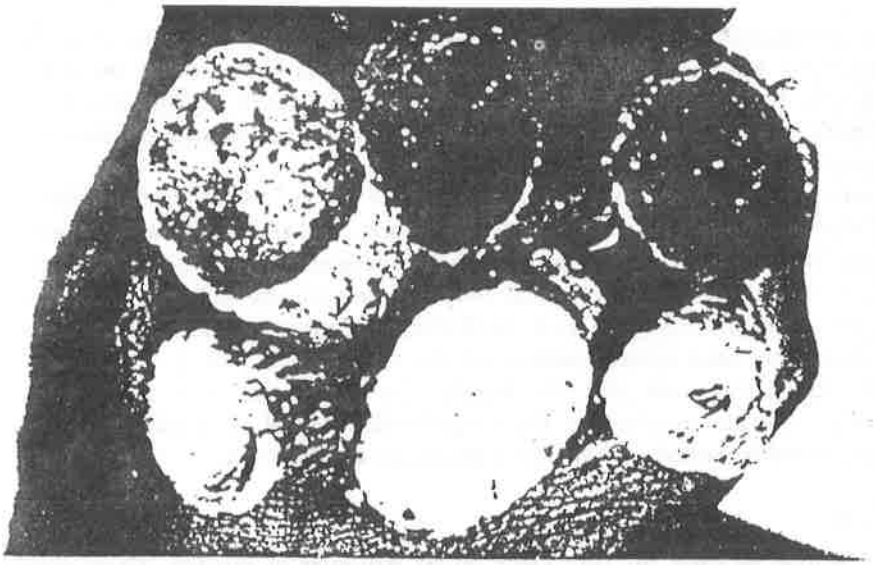

Fig. 1. Antler seals of sambar yearlings.

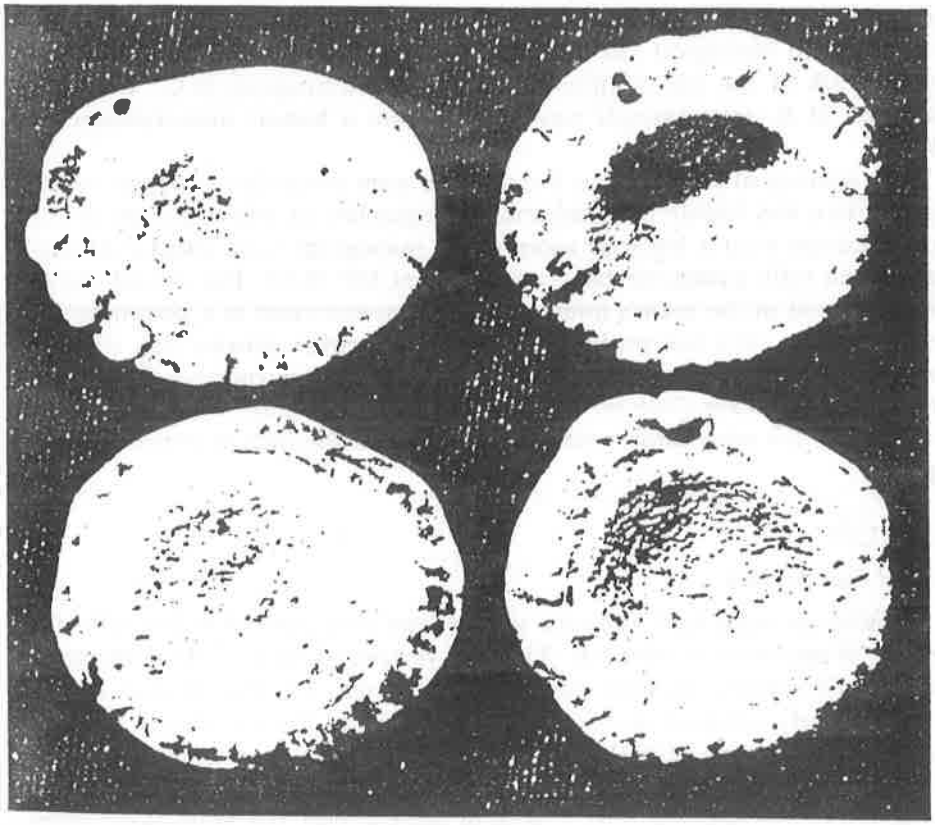

Fig. 2. Antler seals of prime-age sambar.

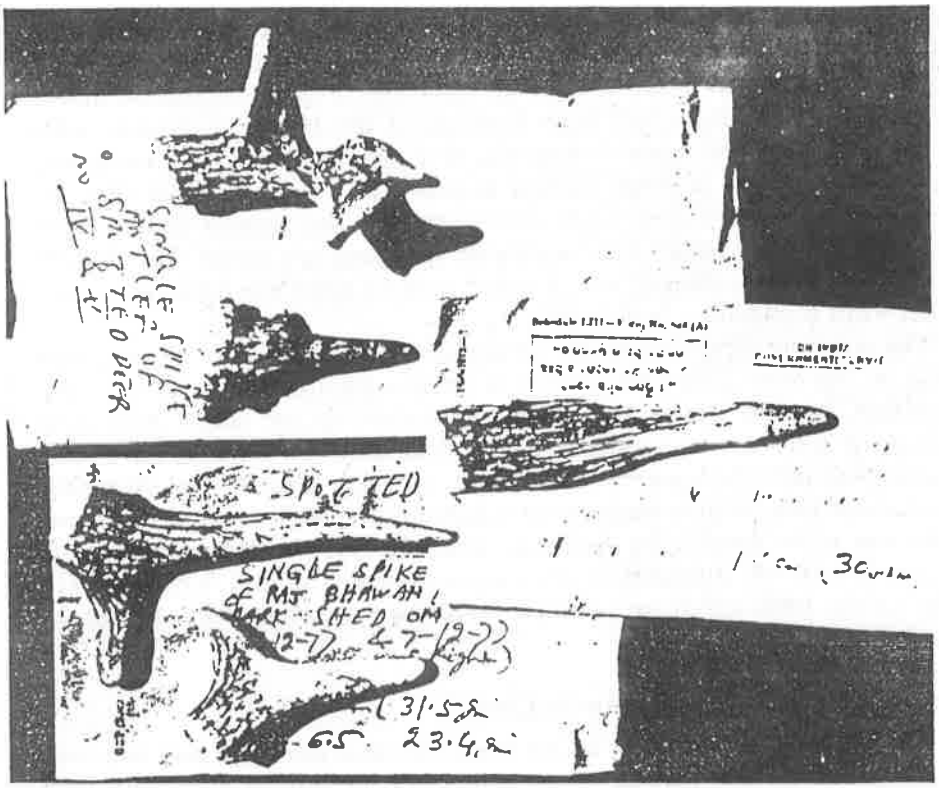

Fig. 3. Primordial antlers of chitals without coronets.

Coronets and Yearling Antlers

The rim around the seal, the coronet, was always only 4-5 mm thick. We never found the superdimensional coronet in sambar that Heck (1956) described. In sambar and chital all primordial antlers were without coronets, as in other cervids (Bubenik 1966). However, some yearling chital antlers exhibited an indication of a brow tine (Fig. 3) that developed from bifurcation of the beam's top, not from an exophyseal protuberance, as in red deer (*Cervus elaphus*) and wapiti (*C. canadensis*) (Bubenik and Munkacevic 1965).

Cortex of the Antlers

In sambar and chital the cortex is very thick and solid. In good antlers of prime sambar, it measured up to 30% of the beam's diameter, in chital up to 20%. In thamin and Schomburgk's deer the cortex was thin and porous, not more than 15% of the diameter.

Microscopic Structure

In sambar the lamellae of the osteons of the cortex were not oriented in any special direction. The osteons indicated intensive rebuilding processes;

the intercellular spaces were filled with tertiary bone (Fig. 4). In chital a layer of Haversian lamellae ran parallel to the surface. The osteons deeper under the surface were oriented in all directions (Fig. 5). In thamin antler from India, the cortex had large luminae of the Haversian system, with many and large Volkmann's channels, and some cavities that we assumed were sinuses. Some of them reached almost to the antler's surface (Fig. 6). This structure contrasted with the cortex of the thamin antler from Washington, D.C. In the only available specimen, the cortex was slightly thicker and more compact; not as much primary bone was deposited in the sinus walls as in Indian thamin (Fig. 7).

The structure of the cortex of Schomburgk's deer appeared very peculiar (Fig. 8). Its outer layers were built of osteons having elongated, very thin lamellae, running almost parallel to the surface. In the deeper zone these elongated osteons were scattered in between spherical ones, so thick and compressed that the bone there appeared ivory-like (Fig. 9). Unfortunately, we did not have another antler with which to compare it to see if this structure was really specific for *Rucervus schomburgki*, nor did we have barasingha antlers (*R. duvaucelli*), the species closest to that of Schomburgki's deer (Mohr 1968) which we assumed would have a cortex similar in microstructure.

Microscopic Structure of the Antler Core

Spongious bone trabeculae in the transition zone to cortex were relatively alike. In sambar and thamin some cavities of bone marrow were filled with dried blood (Fig. 10). Trabeculae became thinner, the cavities wider and closer to the beam's center. Sometimes they were discontinuous (Fig. 11). A large circular or oblique channel with a coarse or smooth wall, sometimes plugged by dried blood clots, was in the core's center (Fig. 12).

In different levels of some antler beams, we followed the development of the axial channel which might also have been a large sinus. The axial channel began its development by rebuilding the most central trabeculae. Those that did not match the spherical shape of the future channel or protruded into the lumen were resorbed and new ones were built so that, finally, a spherical hole was formed (Fig. 13a) During the remodelling process, the sinus walls were coated with primary bone deposited as very thin lamellae, much thicker in the beam (Fig. 13 b,c) than in the tip (Fig. 13d). In the antler of the Washington thamin, the axial channel was not present. Only the core's center was porous with large cavities slightly bigger than in typical boreal cervids, e.g., red deer (Fig. 14). The structural relationships are clearly seen in a close-up of the transverse and longitudinal sections of the tropical and boreal cervids (Fig. 15).

DISCUSSION

The concave seal of the first and consecutive antlers of these tropical cervids is opposite to the development of seals in boreal species. From the very

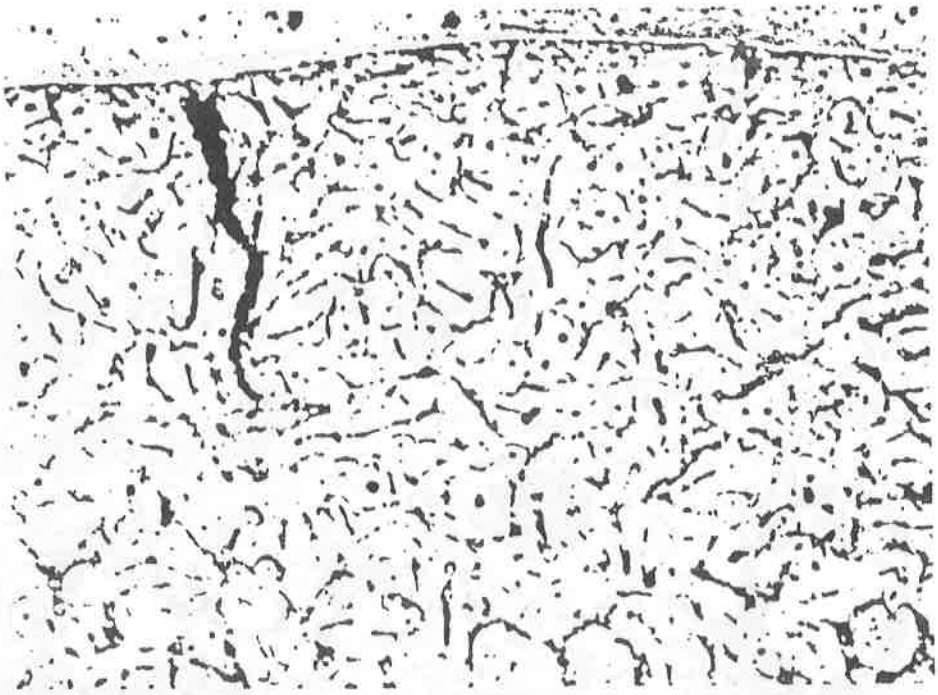

Fig. 4. Osteons from the cortex of sambar antlers.

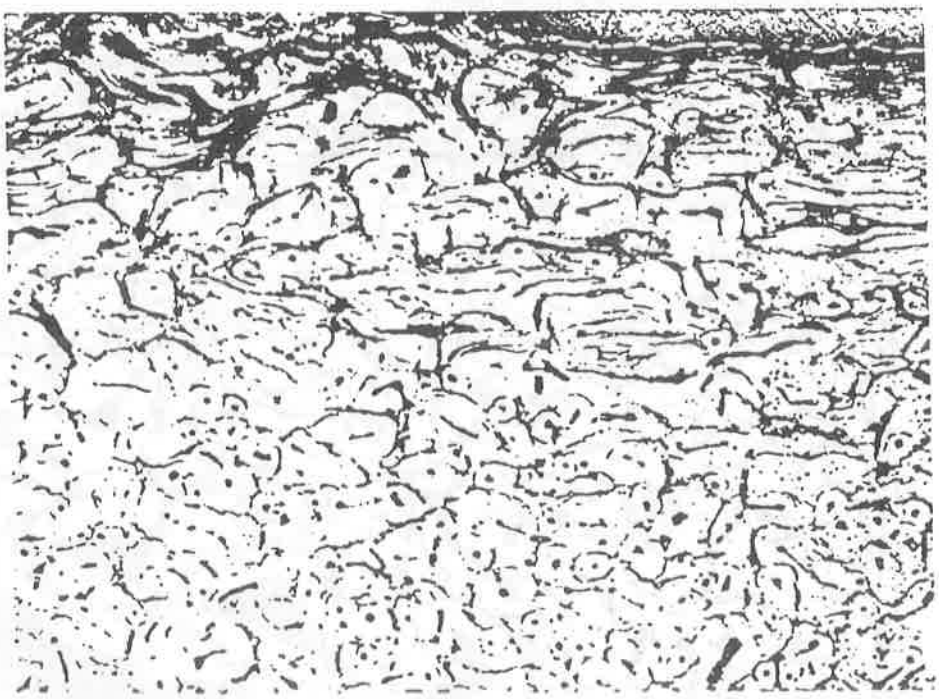

Fig. 5. Osteons from the cortex of chital antlers.

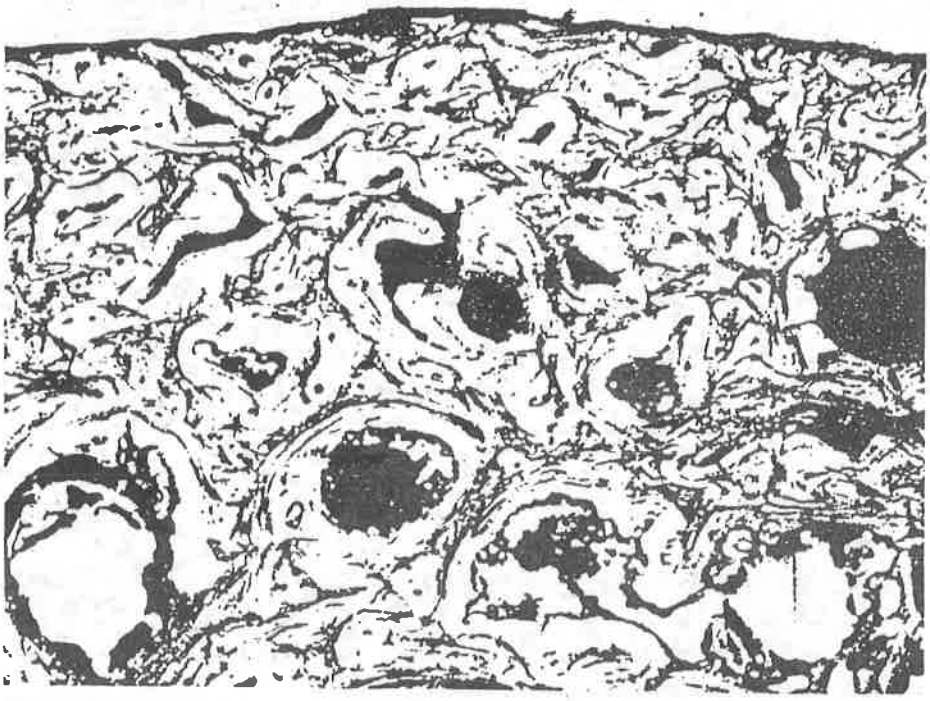

Fig. 6. Osteons from the cortex of Indian thamin.

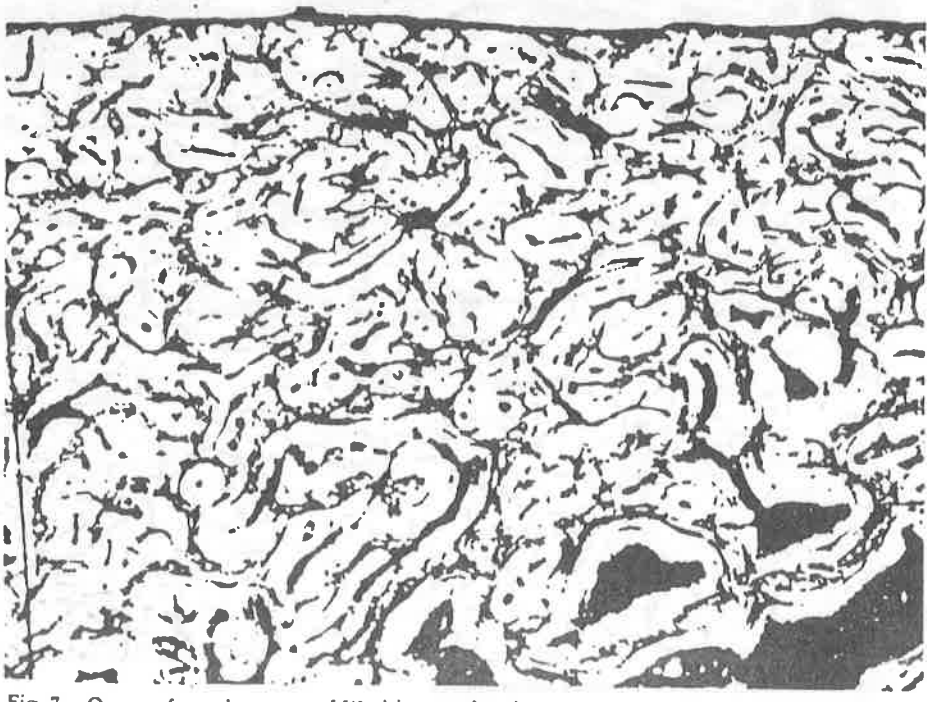

Fig. 7. Osteons from the cortex of Washington thamin.

Fig. 8. Surface osteons from Schomburgk's deer antler.

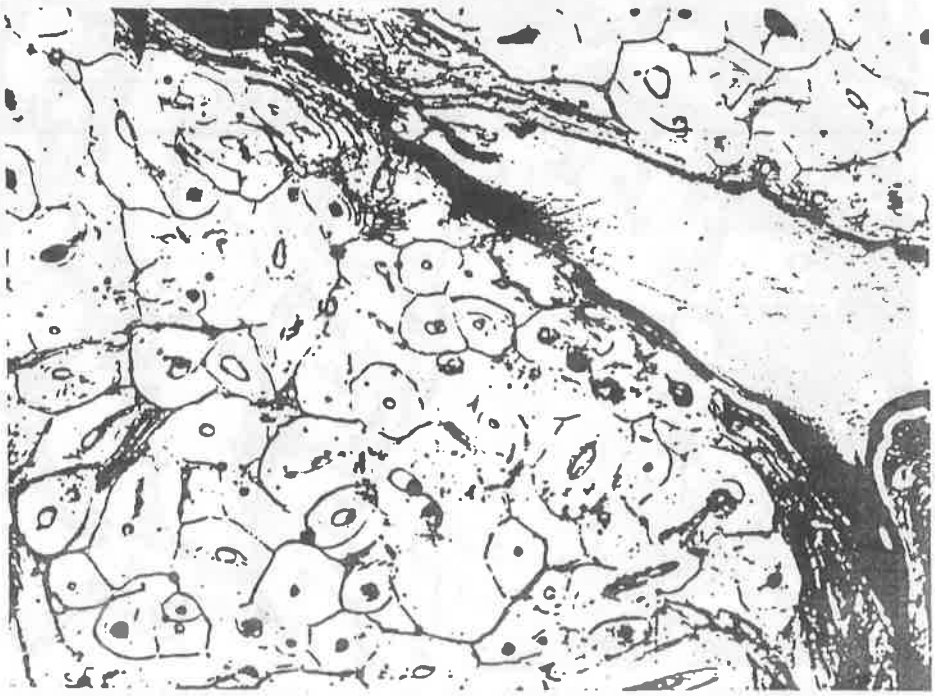

Fig. 9. Osteons in the deeper zone of cortex-Schomburgk's deer.

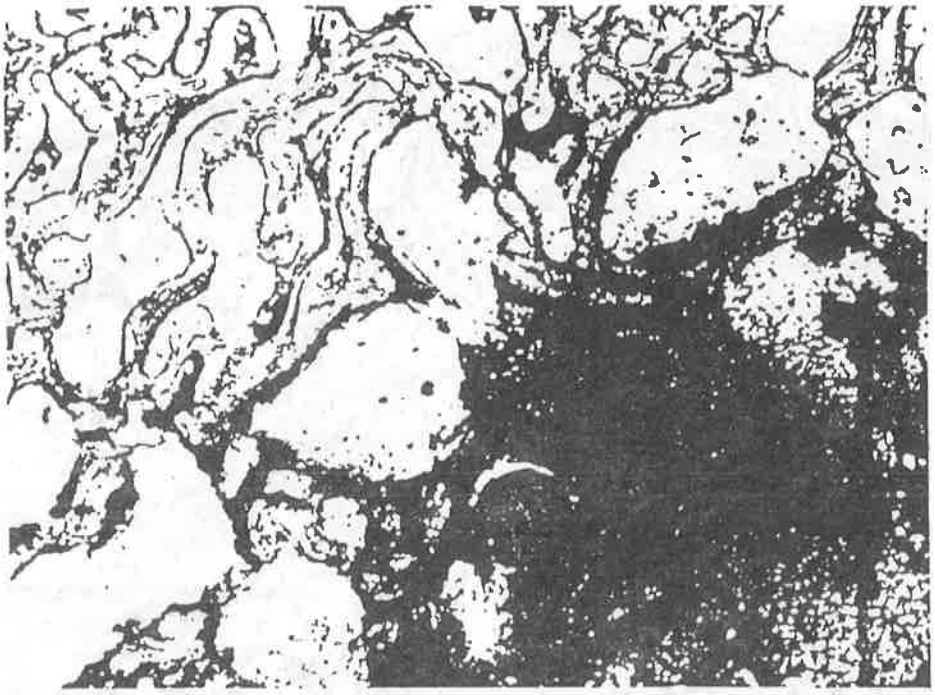

Fig. 10. Zone between cortex and core in sambar antler with clotted blood in some cavities.

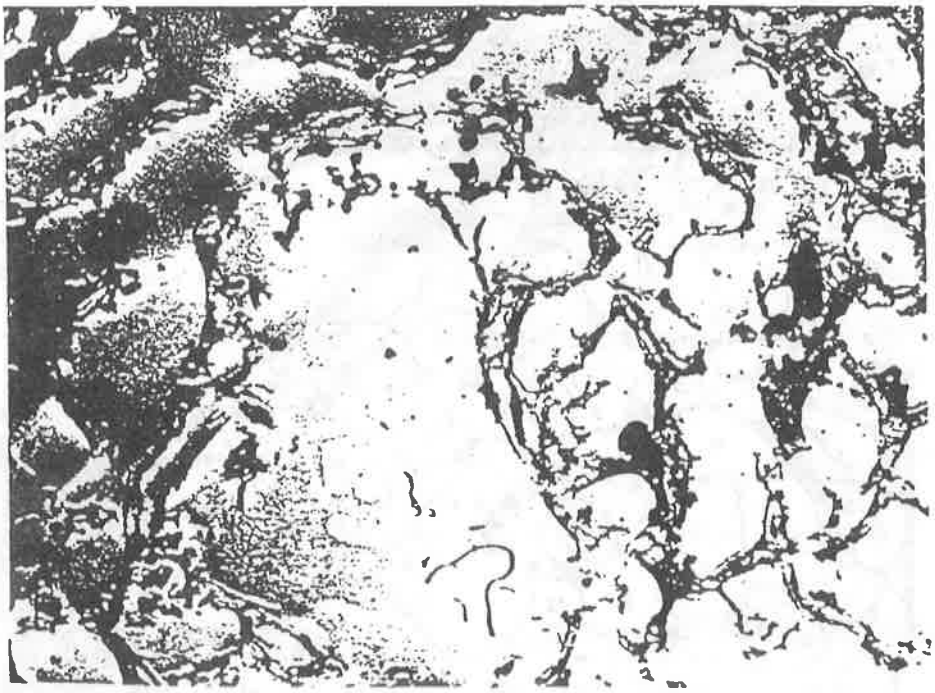

Fig. 11. Middle part of beams in a sambar with very coarse trabeculae to the beginning of the rebuilding process.

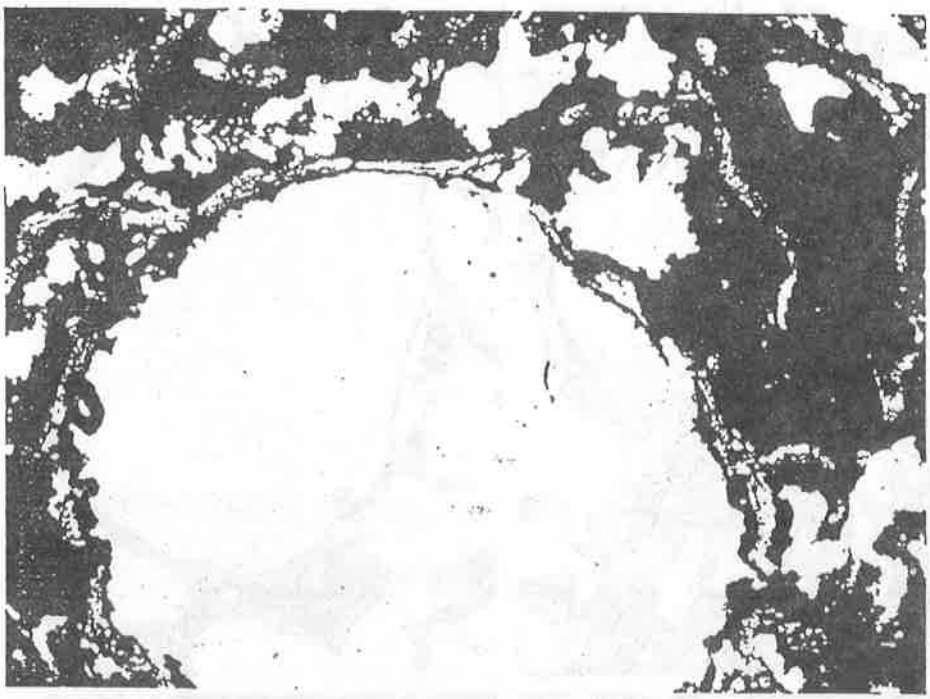

Fig. 12. The axial channel in the beam of sambar antlers.

beginning they have a convex seal until they reach the age where optimum antler growth is attained. Then the seal flattens, and as soon as antlerogenesis begins to decline, the seal becomes concave (Fig. 16) (Bubenik 1966).

Concave seals also occur in hypogonadic white-tailed bucks (Thomas et al. 1964), 1 of which A.B. Bubenik investigated in 1964. Conically concave seals are also known from perukes where casting was initiated by a short-term application of testosterone (Bubenik, G. 1983) or stilbestrol (Bubenik and Tachezy, unpubl. data). As a result, we find that yearlings of tropical cervids may be more or less hypogonadal. In the older deer the testosterone level may not rise as high during the pointed period (Bubenik 1982*c*) as it does in boreal species. Since hypogonadal male antlers or antlers mineralized under low testosterone levels have a low specific gravity, close to 1 (Bubenik, unpubl. data), we were surprised to find the specific gravity of sambar and axis deer to be around 1.8, i.e., much higher than in boreal cervids. These 2 findings obviously contradict each other. However, the logical explanation may be that the testosterone level in tropical cervids does not reach as great an amplitude as in red deer or white-tailed deer (*Odocoileus virginianus*) because the males may be in a reproductive stage independent of the antler cycle.

Under such circumstances the mineralization must progress slowly, and the antler base can remain open from mineralization as long as the testosterone level stays high enough to prevent casting. During this protracted min-

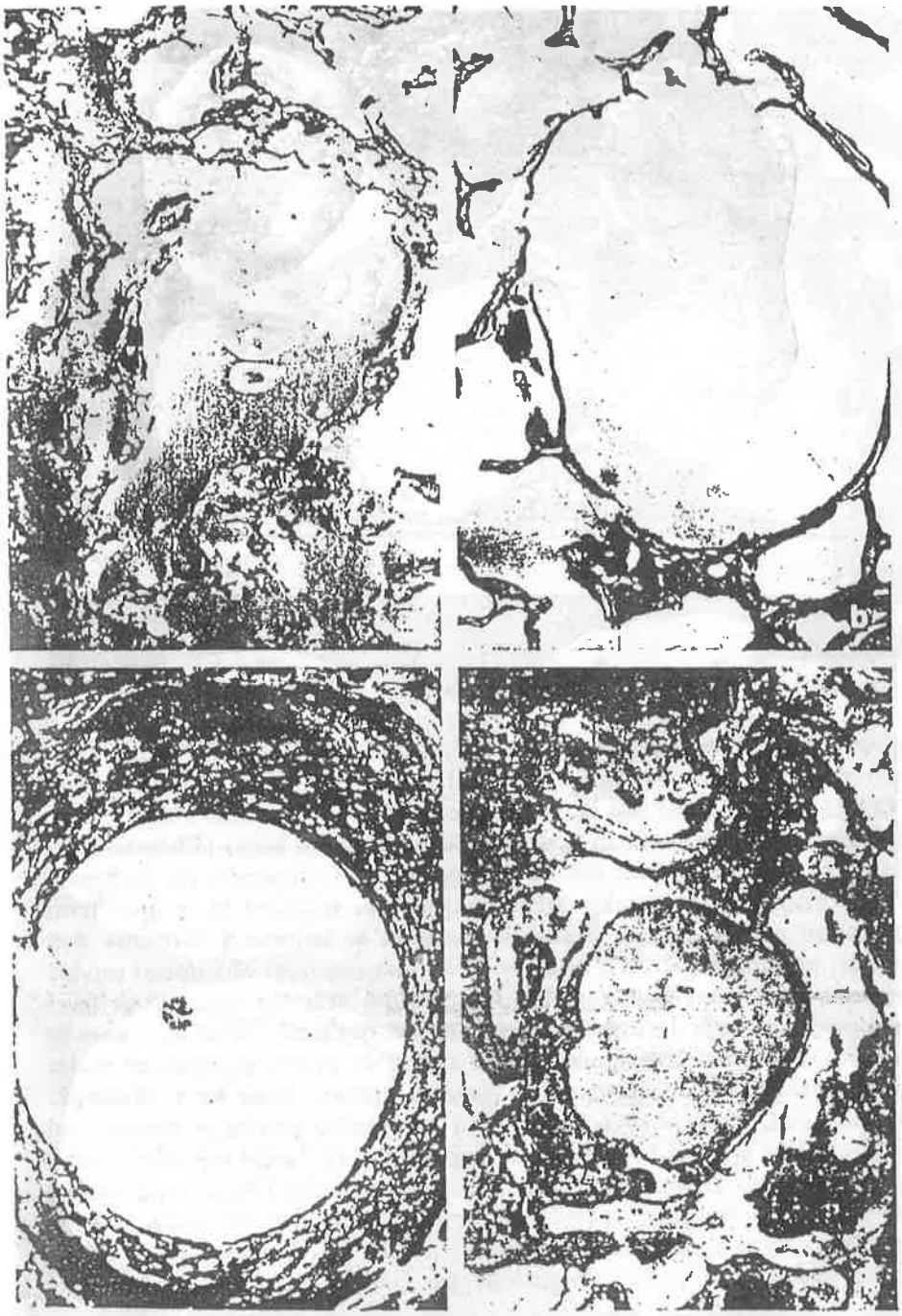

Fig. 13. The building of the axial channel in a sambar beam. a) The removal of protruding trabeculae causes the smoothing of the inner space. b) The axial channel begins to take shape. c) The middle portion of the beam. d) The tip of the beam.

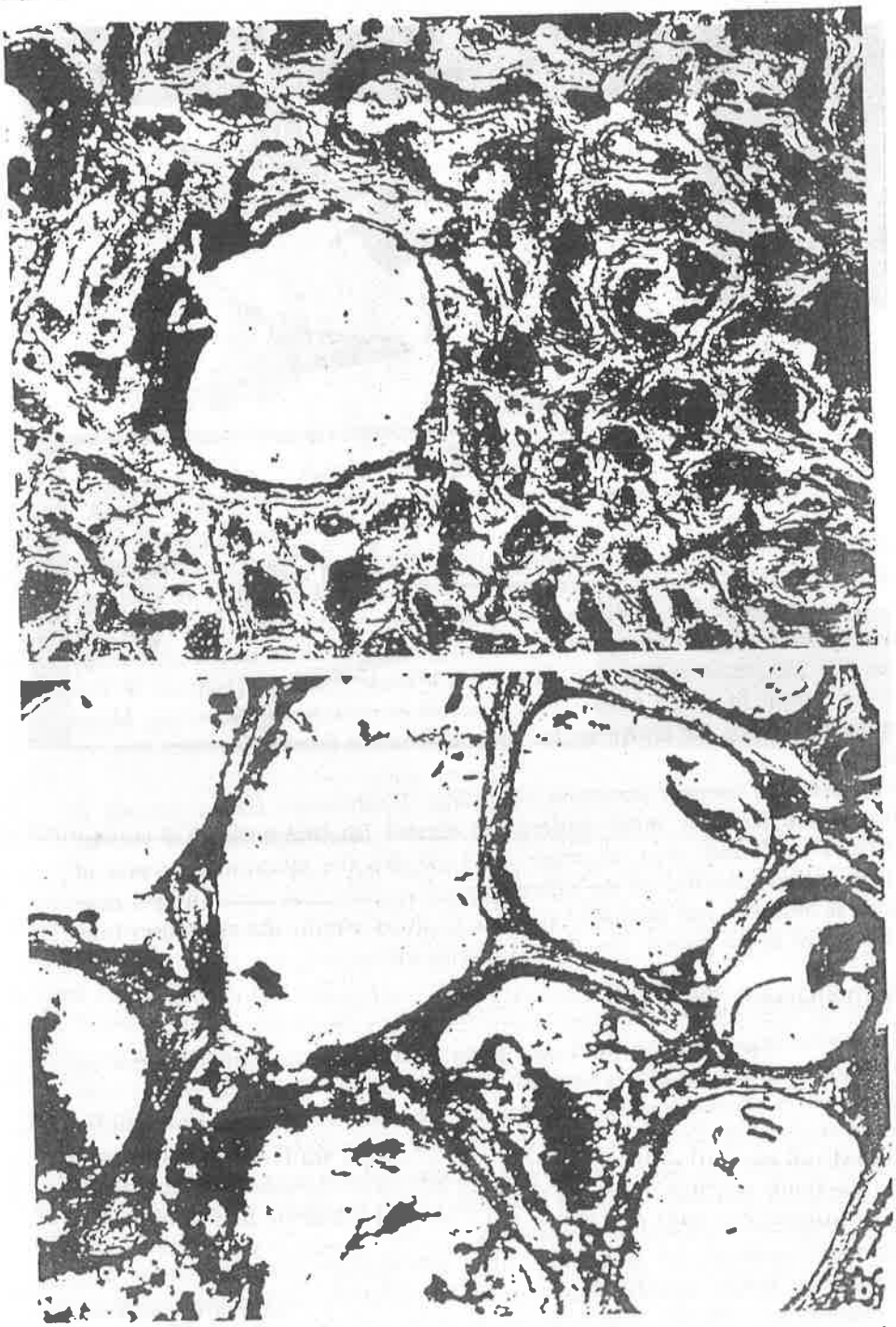

Fig. 14. a) Structure of the antler core in an Indian thamin. b) Structure of the antler core in Washington thamin.

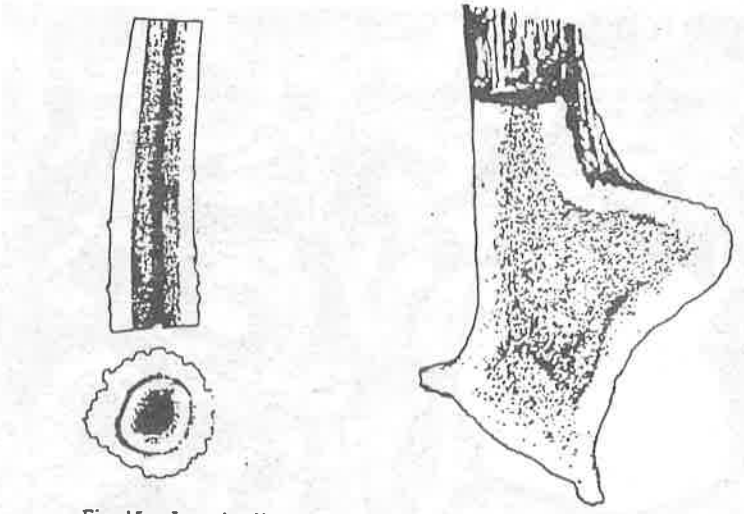

Fig. 15. Longitudinal sections of beams in a sambar and a red deer.

eralization, the blood supply through the pedicle may continue after velvet shedding until it is finally interrupted and the antler tissue dies. In this way the specific gravity can attain a very high value, simply because of the very thick cortex and thin core. Hence, during demineralization of the antler basis, the seal becomes concave. However, a more exact explanation of this process cannot be made without *in vivo* experimentation: recording blood parameters during the entire antler cycle and using labeled isotopes and/or bone stains.

The different cortical structure of Indian Washington (D.C.) thamin is striking, and certainly more antlers are needed for comparison. If similar structures are found, then we must conclude that the rebuilding process of thamin antlers (possibly of the other tropical cervids also) under boreal conditions is different and probably shorter. In other words, the structures may have adapted to the pattern that boreal cervids use.

CONCLUSION

This pilot study has pointed out some differences in microstructure of boreal and tropical cervids. There are the possibilities that their antlers survive the velvet shedding phase for limited time periods and that the amplitudes of testosterone levels in male tropical cervids may be lower than those in boreal species. All data concerning antlers and antlerogenesis in genera *Axis*, *Rucervus*, and *Rusa* indicate that this group is archaic when compared to more progressive, typical boreal species.

We must consider the possibility that the homogenous pattern of the antler core in boreal cervids originated in the axial channel of tropical genera. Accordingly, species that evolved in subtropical regions, such as the white-tailed, roe deer (*Capreolus* sp.), and Mesopotamian deer (*Dama meso-*

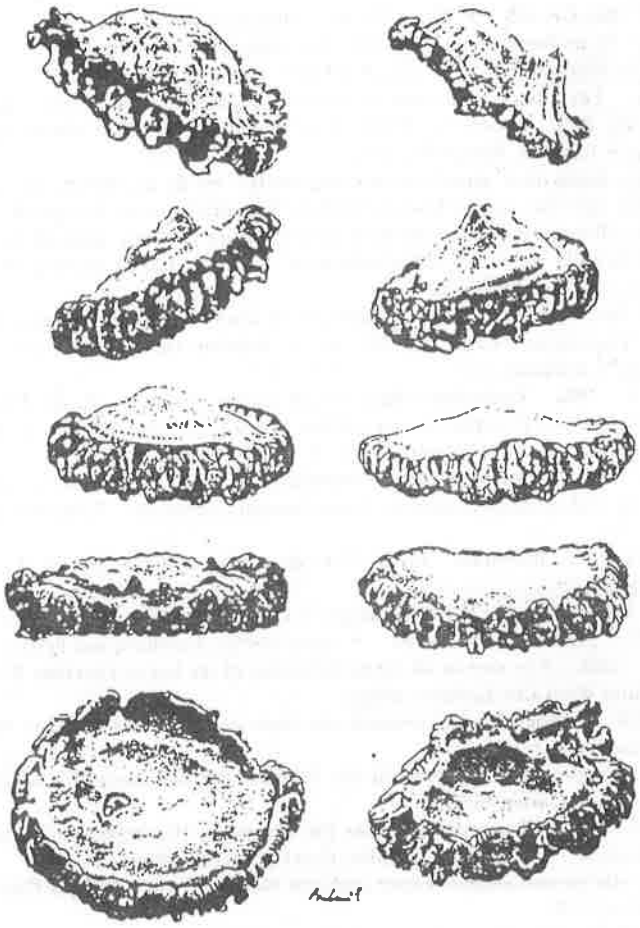

Fig. 16. The changes on the seal surface of red deer antlers as the stag matures from up to prime-age (convex), through the transitional years (flat), to post prime-age (concave).

potamica) (Bubenik 1959), are primitive cervids that occasionally display indications of vestigial axial channels. In Pere David's deer (*Elaphurus davidianus*), a cervid with dichotomous antler construction, a channel is found in each beam (Bubenik 1966, 1973).

LITERATURE CITED

ABLES, E. D. 1978. The axis deer in Texas. Caesar Kleberg Res. Program in Wild. Ecol. and Dept. Wild. & Fish Sci., Texas Agric. Exper. Sta. Texas A&M Univ. College Stat. Texas. 86pp.

AZZAROLI, A. 1953. The deer of Weybourn Crag and Forest Bed of Norfolk. Bull. Brit. Mus. (Nat. History) Geology. 96pp.

BEDFORD, H. 1949. The years of transition. A. Dakers Ltd., London. 340pp.

BUBENIK, A. B. 1959. Der Feingau der Geweihe von Cervus (*Dama*) dama Linne, 1758 und mesopotamicus, Brooke 1875, und ihre Entwicklungsstufe. Saugetierk. Mitt. 7:90-95

———. 1966. Das Geweih. P. Parey Verlag, Hamburg and Berlin. 214 pp.
———. 1973. Hypothesis concerning the morphogenesis in moose antlers. Proc. N. Am. Conf. & Workshop, Quebec City. 9:195-231.
———. 1983*a*. Taxonomy of Pecora in relation to morphology of their cranial appendages. *in*: R. D. Brown, ed. Antler Development in Cervidae. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas.
———. 1983*b*. Behavioral aspects of antlerogenesis. *in*: R. D. Brown, ed. Antler Development in Cervidae. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas.
———. 1983*c*. Proposals for standardized nomenclature for bony appendices in Pecora. *in*: R. D. Brown, ed. Antler Development in Cervidae. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas.
———, AND V. MUNKACEVIC. 1965. Pecularities of antler trophic in red deer in the region of Belje-Yugoslavia. Pages 225-259 *in*: I. Isakovic ed. Trans. VIIth Congr. IUGB. Beograd-Liubliana.
BUBENIK, G. A. 1983. Endocrine regulation of antler cycle. *in*: R. D. Brown, ed. Antler Development in Cervidae, Caesar Kleberg Wildlife Institute, Kingsville, Texas.
COOPE, F. R. 1968. The evolutionary origin of antlers. Deer. 1:215-217.
FLEROV, K. K. 1955. Osnovnye cherty formirovanya mlekopitayushtchich chetwertychnogo perioda v severnom Polusharii, Trudy komisii po isutch. Tchetvert. perioda, 12:121-128.
GEIST, V., AND P. T. BROMLEY. 1978. Why deer shed antlers. Intern. J. Mammal. Biol. 43:223-231.
GERVAILS, P. 1859. Zoologie et Paleontologie Francaise. 2nd Ed. Paris. 544pp.
HECK, L. 1956. Der Rothirsch, 2nd ed. P. Parey Verlag, Hamburg and Berlin. 160pp.
LYDEKKER, R. 1898. The deer of all lands. A history of the family Cervidae living and extinct. Rowland Ward Ltd. London. 329pp.
MOHR, E. 1918. Biologie und Systematik der Sechsender-Hirsche Gattung Rusa. Archiv f. naturgeschicte. 84:105-143.
———. 1968. Keeping and breeding of the Schomburgk-deer *Rucervus Schomburgki* Blyth, 1863. Zool. Garten 36:34-57.
STEHLIN, H. G. 1937. Bemerkungen uber die miocanen Hirschgeneras Stephanocemas und Lagomeryx. Verhandl. d. Naturfor. Gesell. Basel. 47:191-214.
———. 1939. Dicroceros elegans Lartet und sein Geweihwechsel. Eclogae Geologicae Halvetiae. 32:163-179.
THENIUS, E. 1950. Die teriaren Lagomeryciden und Cerviden der Steiremark—Beitre age zur Kenntnis der Saugetierreste des steierischen Tertiars V. Sitzungsberm. Osterr. Akad. d. Wiss. Mathem-Naturwiss. Kl. Abt i. 159:219-254.
———, AND H. HOFER. 1960. Stammesgeschichte der Saugetiere. Springer Verlag Wien. 322pp.
THOMAS, J. W., R. M. ROBINSON, AND R. G. MARBURGER. 1964. Velvet-horn investigation, Part I and II. Texas Fish and Game Magazine. Austin, pp.1-8.
VIRET, J. 1961. Traite de Paleontologie VI/I. Paris.
WHITEHEAD, G. K. 1972. Deer of the world. Constable & Co. Ltd. London. 194pp.
ZEUNER, F. E. 1959. The Pleistocene Period. Its climate, chronology and faunal successions. Hutchinson & Co. Ltd. London. 447pp.

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A note on the mating behaviour of leopard or panther (*Panthera pardus*) at Nandankanan Biological Park, Orissa, India

According to Prater[2] panthers breed all the year round. Acharjyo and Misra[1] stated that the period of receptivity (mating) may continue for 4-7 days. Besides these no other information is available regarding the mating behaviour of panthers. In this note an attempt is made to place on record our observations on the mating behaviour of leopard or panther, *Panthera pardus* at Nandankanan Biological Park, Orissa, India.

A female normal coloured panther, kept along with a male black panther since March 15th 1974, was in estrus from 13th December 1974 to 20th December 1974 (i.e. 8 days). It is mostly the female which initiated the mating. The female just before mating gets up from her rest, makes a peculiar mild growling noise and gives a few sounds. Then it goes to the resting, black male rubs her external genitalia and the body. This process is confirmed till the male gets up from his rest. The male then gets up, looks around and prepares for the mating (Fig. 1) The female in the meantime ·····crouches·····down and goes a changing in her position very near the male restlessly till the male starts mounting. At first both the male and the female raises their tails to facilitate the contact of genitals (Fig. 2).

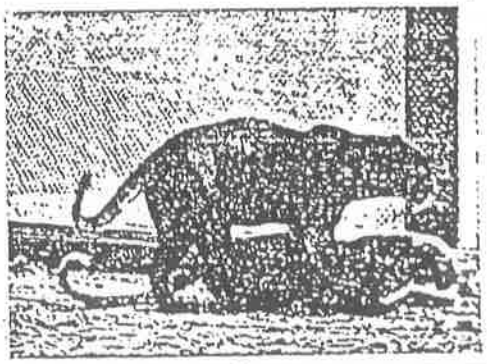

Fig. 1. The black male panther, ready for mating.

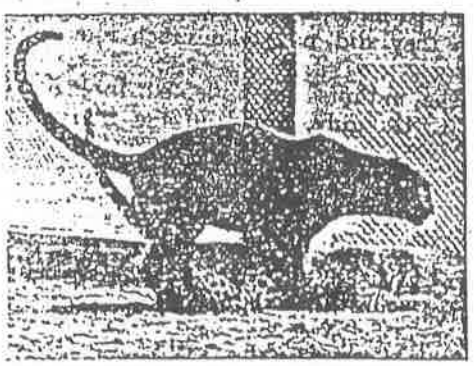

Fig. 2 Both black male and normal female raises their tails to facilitate the contact of genitals.

At the time of actual mating which lasts for 38-58 seconds (six observations), the tail of the female is kept to one side, whereas that of male rests on the ground in usual manner. During mating the male extends his neck, takes a good grip of a fold of skin of the neck of the female till mating takes place by friction. At the climax of mating the male makes a peculiar mild sound which probably corresponds indication of the commencement of the process of ejaculation. At the end, the female turns against him with a roar, and simultaneously the male jumps out of the female. Finally the female turns upside down and relaxes indicating exhaustion (Fig. 3). The male, however,

colour. He transmitted this gene to his son, Deepak who handed over the same to his daughter, Ganga. It was through father—daughter matings that gave birth to white cubs at Nandankanan. A complete genealogy of white tigers at Nandankanan is shown in Figure 2. It does not include the results of matings between Rekha, the daughter of Sikha and Pradeep, and Robin, the son of Rani and Deepak. The dates of births and deaths of tigers and tigresses have been given whenever available.

It is known that the gene for white coat colour is autosomal recessive to the wild type allele for normal yellow colour[1,5,7]. That Deepak is a heterozygous for white gene is evident in result of recent mating. Diana (Subhra) a white tigress of Rewa line was brought from the Delhi Zoo on December 28, 1979. Mated to Deepak she produced two litters comprising four cubs of which one is white and the rest normal coloured. This result indicates that unless Deepak were heterozygous, the white cub would not have been produced.

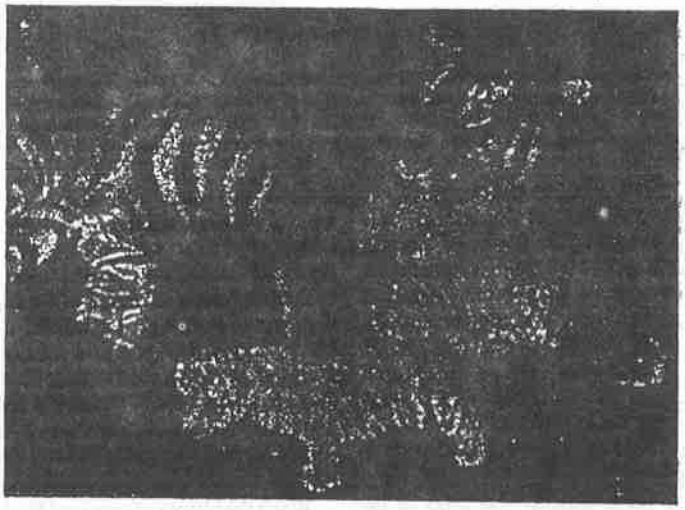

Fig. 1—Ganga with her three white cubs born at Nandankanan

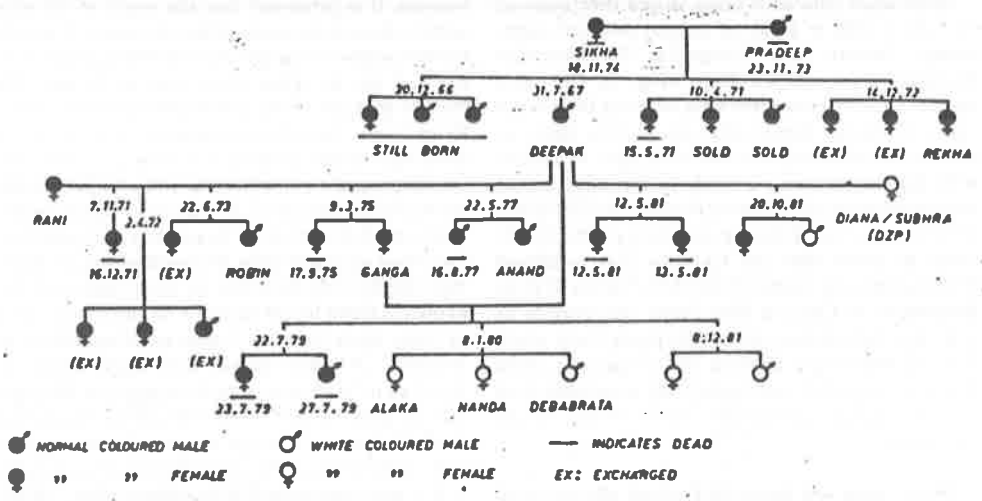

Fig. 2—Genealogy of the white tigers at Nandankanan. DZP-Delhi Zoological Park, Delhi

Since Deepak is heterozygous, he must have received the mutant gene from one of his parents, Sikha and Pradeep. In such a situation either both the parents or one of them contained the mutant gene. It is quite unlikely that both the parents were heterozygous, when mutation frequency in tiger population is supposed to be very low. Furthermore, if they were so, there would have been at least one white cub in the progeny of ten, when probability of occurence of the same is one in four. So, question now stands that either Sikha or Pradeep was heterozygous. Sikha could not be considered heterozygous, for she was caught from a forest of Bihar where availability of normal coloured tigress with a gene for white coat colour is rare. Hence the only possibility left is that Pradeep was heterozygous.

The authors are thankful to Shri Ch. G Mishra, I.F.S., Wildlife Conservation Officer of Orissa for taking keen interest in our study.

References

1 Thornton I W B. *J Zool, Lond.* 185 (1978) 389.

2 Roychoudhury A K. *Probe-India*, 2 (1980) 10.

3 Gee E P. *The wildlife of India* (Collins, St. James's Place, London) 1964.

4 Gee E P. *Animals*, 3 (1964) 282.

5 Sankhala K. *Tiger! The story of the Indian tiger* (Collins, St. James's Place, London) 1978.

6 Robinson F B. *J Bombay Nat Hist Soc*, 32B (1928) 584.

7 Roychoudhury A K & Sankhala K S. *Proc Indian Acad Sci*, 88B (1979) 311.

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Genetics of Coat Colour in the Leopard *Panthera pardus*

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Genealogies of black leopards have been prepared from the results of matings in two zoos in India. An analysis of the genealogical data shows that the coat colour of leopards is controlled by a pair of autosomal alleles, the black being recessive to the normal (spotted) colour.

The black leopard , a melanic variety of the normal spotted one belonging to the species *Panthera pardus* is generally found in the rain forests of the lower Himalayas and the Western Ghats. It also occurs in the humid forests of Assam, Burma and south Malaya[1]. There are reports that black mating with black produce black cubs but black mating with normal coloured (spotted) produce both kinds of cubs in the same litter[2]. Robinson[3] collected data for the matings of black and spotted leopards from 72 zoos and concluded that black is inherited as an autosomal recessive. But in jaguars, melanism is dominant to normal colour[4,5].

We collected the results of matings involving both black and spotted leopards from two zoos in India (Nandankanan Biological Park, Bhubaneswar, Orissa and M.C. Zoological Park, Chhat Bir, Punjab). In the present communication genealogies of leopards in these 2 zoos are presented.

Materials and Methods

A 4 yr-old male leopard, named Bideshi, born to black parents on 12 June 1968 at the Gauhati Zoo in Assam was brought to the Nandankanan Biological Park in 1972. A normal coloured female leopard, named Rupa, was received as one month-old cub on 14 August 1966. She was found in Baliguda Forest Division of Phulbani District of Orissa State. Another normal coloured female cub, named Spotty, was presented to this Park on 23 September 1969, which is reported to have been caught at the age of two months from the same area where Rupa was found. The black leopard, Bideshi was introduced to these normal coloured females, Rupa and Spotty after its arrival from the Gauhati Zoo. A complete genealogy of black leopards at Nandankanan Biological Park is shown in Fig. 1. The births and deaths dates of leopards are indicated where available.

Breeding of leopards at the M.C. Zoological Park was conducted with two pairs. The black male, Shankar, and the spotted female, Danger, of the first pair were brought from the Gauhati Zoo in early 1979. They produced three litters comprising 8 cubs of which 5 were normal coloured and three black. Bola and Papi of the second pair are two normal coloured leopards. Bola was caught from the forests of Assam and donated to the Zoological Park, while Papi was purchased from the Gauhati Zoo. This pair produced two litters comprising four cubs of which one black female and one normal coloured female of the first litter died of feline distemper within six and half months after their births. The genealogy of black leopards at the M.C. Zoological Park is shown in Fig. 2. The results of breeding of leopards at both the Parks are summarised in Table 1.

Results and Discussion

The results indicate that the black coat is recessive to the normal one, for none of the 10 cubs of Bideshi and Spotty had the black coat. If the normal coat colour is controlled by a dominant allele *B* and the black colour by a recessive allele *b*, the normal coloured leopards are either homozygous (*BB*) or heterozygous (*Bb*); the genotypes of Spotty and Bideshi can therefore be written as *BB* and *bb* respectively, all their offspring being heterozygous. If Spotty is homozygote (*BB*), the chance that all the offspring is heterozygous is 1. Alternatively, if she is heterozygote (*Bb*), the probability that she contributes only the dominant gene to each of her ten offspring is $\left(\frac{1}{2}\right)^{10} = \frac{1}{1024}$. Thus the claim that Spotty's genotype is homozygous dominant is overwhelmingly likely as compared to the other alternative. Rupa and Danger are presumed to be heterozygous or else they could not have produced black and normal coloured cubs when they were mated to black leopards (Figs 1 and 2).

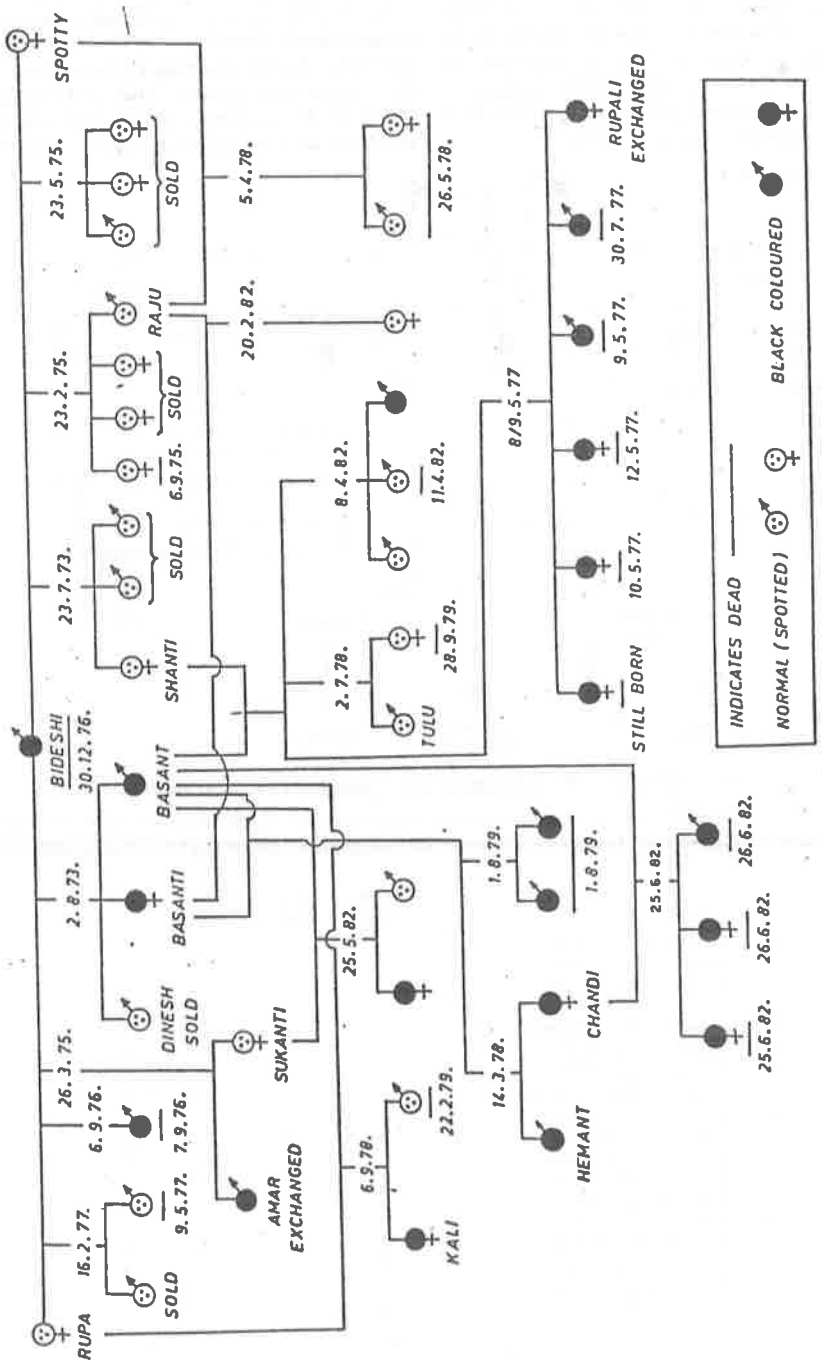

Fig. 1—Genealogy of the black leopards at Nandankanan Biological Park, Bhubaneswar, Orissa

Searle[6] cited the work at the Hanover Zoo where the black colour in leopard was found to be due to a dominant gene. Our investigation shows that not a single normal coloured offspring was born to black parents either at the Nandankanan Biological Park or elsewhere. On the other hand two normal coloured leopards at the M.C. Zoological Park produced a single black cub, indicating that both the parents were normal coloured heterozygous (Fig. 2).

The results of matings between different genotypes of leopards clearly demonstrate that the coat colour is controlled by a pair of autosomal alleles, the black being the recessive to normal. When the heterozygous normal coloured and black leopards were mated to each other, their progeny segregated into normal and black coloured cubs in the ratio of 1:1 as expected (Table 2). The similarity of observed and expected numbers may be considered fortuitous, but the sample

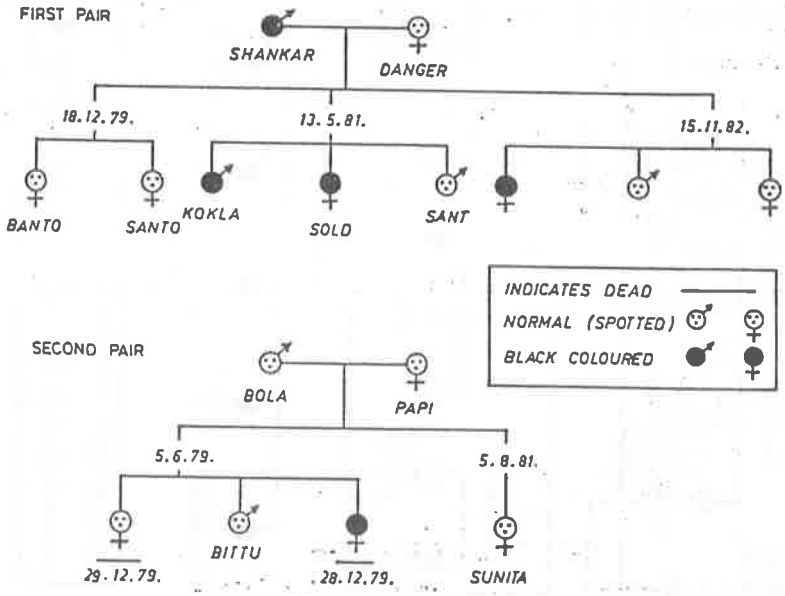

Fig. 2—Genealogy of the black leopards at M.C Zoological Park, Chhat Bir, Punjab

Table 1—Results of Matings between Leopards at Nandankanan Biological Park (NBP) and M.C. Zoological Park (MCZP)

	Matings	No. of litters	Spotted cubs	Black cubs	Total
(a)	Between ♂ *bb* × ♀ *BB*				
	Bideshi × Spotty (NBP)	3	10	—	10
(b)	Between ♂ *Bb* × ♀ *BB*				
	Raju × Spotty (NBP)	1	2	—	2
(c)	Between ♂ *bb* × presumed ♀ *Bb*				
	Bideshi × Rupa (NBP)	4	4	4	8
	Basant × Rupa (NBP)	1	1	1	2
	Shankar × Danger (MCZP)	3	5	3	8
(d)	Between ♂ *bb* × ♀ *Bb*				
	Basant × Shanti (NBP)	3	4	7	11
	Basant × Sukanti (NBP)	1	1	1	2
(e)	Between ♂ *Bb* × ♀ *bb*				
	Raju × Basanti (NBP)	1	1	—	1
(f)	Between ♂ *bb* × ♀ *bb*				
	Basant × Basanti (NBP)	2	—	4	4
	Basant × Chandi (NBP)	1	—	3	3
(g)	Between ♂ *Bb* × ♀ *Bb*				
	Bola × Papi (MCZP)	2	3	1	4

Table 2—Segregation of Spotted and Black Cubs in the Matings of Spotted and Black Leopards

Matings	Ref. (Table 1)	Spotted cubs	Black cubs	Total
♂ *bb* × ♀ *Bb*	(C) + (d)	15	16	31
♂ *Bb* × ♀ *bb*	(e)	1	—	1
All matings		16	16	32
Expected segregation (1:1)		16	16	32

$\chi^2 = 0.000$ d.f. = 1

size is quite large to apply χ^2-test of significance. Besides, the progeny resulting from known matings as shown in Table 1(c), (d) and (e) do not show a significant deviation from the expected segregation and they are in accordance with the hypothesis of a single autosomal gene with the allele 'black' (*b*) being recessive to the allele 'spotted' (*B*). The matings between two heterozygous normal coloured leopards also showed expected segregation of normal and black coloured cubs in the ratio of 3:1 (Table 1) although the number of animals studied was small.

Since submission of this paper, we got the information from M.C. Zoological Park that Bola and Papi, two spotted leopards produced two cubs, one black female and one spotted female on December 12, 1983.

Acknowledgement

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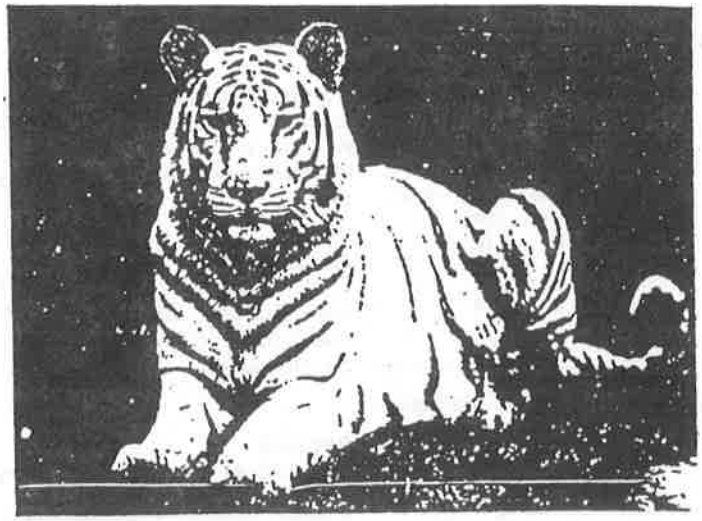
References

1 Prater S H, *The book of Indian animals* (Bombay Natural History Society, Bombay), 1965, 53.
2 Gee E P, *The wildlife of India* (Collins, St James's Place, London), 1964, 70.
3 Robinson R, *Genetica*, 41 (1970) 190.
4 Fisher J, *The field*, London (1940) cited in P Turnbull-Kemp, *The leopard* (The Bailey Bros & Swinfen, London), 1967, 30.
5 Dittrich V L, *Zool Garten (NF)*, 49 (1979) 417.
6 Searle A G, *Comparative genetics of coat colour in mammals* (Logos Press, London), 1967, 148-149.



White tiger of Nandankan Biological Park, Orissa, India. (Photo: Deepak Bhattacharya)

WHITE TIGER IN INDIA – ITS PAST AND PRESENT

by S.K. Patnaik and L.N. Acharjyo

The white tiger *(Panthera tigris)* is a magnificent snow-white carnivore with ash or light black stripes, pink nose and paw pads and icy blue eyes. They are generally bigger in size than normal coloured tigers. The earliest authentic report of a white tiger shooting in India was in 1907, and since then more than 20 white tigers have been shot in the forests of Assam, Orissa, Madhya Pradesh and Bihar (Malhotra, 1981). During a period of 55 years ending in 1964, there were only nine reported cases of white tigers in the forests of Rewa and the last white tiger shot in that area was in 1947 (Gee, 1964). There were about forty white tigers living in the forests of Bihar during the 1930's, but there are none at present and the last record of white tiger shooting was from Bihar in 1958 in Satganwa Forest Range of Hazaribagh (Singh, 1986. These figures suggest that white tigers have always been extremely rare in nature. In recent years there have been no authentic reports of either sightings or shooting of white tigers from any part of India.

The history of white tigers in captivity goes back to May, 1951, when a nine-month-old white tiger cub from a group of four cubs (3 cubs being of normal colour) was captured from the forests of Rewa in Madhya Pradesh by the then Maharaja of Rewa. This white tiger was successfully reared at the summer palace of the Maharaja of Rewa at Govindgarh, and was named "Mohan". Mating of this white with a normal coloured tigress "Begum" captured from the same Rewa forests resulted in the birth of ten normal coloured cubs in three litters during the period from 1953 to 1956. But the mating of a female offspring of the second litter named "Radha" with "Mohan" resulted in the birth of four white cubs (one male and three females) in October, 1958. This was the first birth of white tigers in captivity. Subsequently, white tigers were bred and supplied to some of the Zoological Parks at Delhi, Calcutta, Washington D.C. and Bristol from Govindgarh. All the white tigers so far available in captivity are the descendants of the white tiger "Mohan" and the

coloured tigress "Begum", and so they may be referred to as white tigers of Rewa Origin.

In more recent years a normal coloured tigress named "Ganga" when mated with her father, a normal coloured tiger "Deepak", gave birth to five white tiger cubs in two litters on 8-1-1980 and 8-12-1981 at Nandankanan Biological Park, India. The female of this pair gave birth to ten cubs in four litters, out of which 5 cubs born in the last two litters were of normal colour. A study of the genealogy of these white tigers and the genealogy chart of white tigers of Rewa Origin maintained at the National Zoological Park, New Delhi and reported by Saharia (1979), apparently does not give any indication of these five white cubs having any biological relation with the white tiger "Mohan" or his descendants (Mishra et. al., 1982). These five have formed a separate gene pool of white tigers of 'Nandankanan Origin'.

Further, a white tigress named "Subhra" ('Diana') of Rewa origin procured from the National Zoological Park, New Delhi in December, 1979, when paired with the normal coloured male tiger "Deepak", gave birth to four cubs in two litters on 12-5-81 and 20-10-81. The first litter of two normal coloured cubs were eaten up by the mother within 24 hours of birth. The second litter consisted of one white male and the other a normal coloured female. With the appearance of a new strain of white tigers of Nandankanan origin, it has given new hopes for the survival of white tigers in captivity.

Subsequent successful matings of the white tigress "Subhra" of Rewa Origin with the white tiger "Debabrata" of Nandankanan origin and their offsprings have resulted in the births of a number of white cubs in the park. At present, this park has nineteen white tigers (11 females and 8 males), the maximum number in any Indian Zoological Park is as follows:

- Five (3 females and 2 males) white tigers of Nandankanan origin
- One (female) of Rewa origin
- Seven (4 females and 3 males) white tigers of mixed origin born to white tigress "Subhra" of Rewa origin and normal coloured male "Deepak" or white tiger "Debabrata" of Nandankanan origin.
- Six (3 females and 3 males) white tigers born to white females of Nandankanan origin and mixed origin white male.

There is also a heterozygous normal coloured tigress of mixed origin having a gene for white coat colour.

The other Indian Zoological Parks possessing white tigers are New Delhi(6), Calcutta(3), Mysore(2), Guwahati(1), Kanpur(1) and Hyderabad(1). In addition to India, white tigers are available in captivity in England (Bristol Zoo) and the U.S.A. (Washington D.C. Zoo; Cincinnati Zoo, Henry Doorly Zoo, Hawthora Circus and Racine Zoo) (Ross, 1982; Roy Choudhury, 1986). At present, there are 33 white tigers in Indian Zoos and about 59 white tigers in captivity in England and the U.S.A.

With an anxiety to produce more white tigers, breeding among close relatives like brother-sister, mother-son, father-daughter etc. over long periods has been practised in most of the zoological parks. Such inbreeding has produced numerous ill effects among white tigers such as weakening of eyes, shortness of legs, neck twisting, lack of development of kidneys, recurrent miscarriages, arching of the backbone, still births, reduced fertility and increased early mortality (Malhotra, 1981; Roy choudhury, 1980).

A study of the inbreeding of white tigers practised in four Zoological Parks (New Delhi, Calcutta, Washington, D.C. and Bristol) revealed that the tigers failed to survive if their inbreeding coefficient attained a level of 0.4687 or higher (Roy Choudhury and Sankhala, 1979). They further stated that regression analysis revealed a tendency for the average litter size to decrease and the early mortality rate to increase with an increase in the value of the inbreeding coefficient. Sandhu and Dhindsa (1986) were of the opinion that there should be an immediate check on the non-planned inbreeding of white tigers, otherwise this animal will be lost forever due to inbreeding depression.

To avoid the ill effects of intensive inbreeding, planned scientific breeding of white tigers of Rewa and Nandankanan strains is being practised at the Nandankanan Biological Park. For this, the inbreeding coefficient of the resultant offsprings of all the possible

combinations of captive white and normal coloured male and female tigers of the park have been worked out with the assistance of Dr. A.K. Roy Choudhury, Bose Institute, Calcutta. Matings among compatible pairs of tigers are arranged in such a manner that the resultant offsprings always have an inbreeding coefficient much below the critical level of 0.4687.

The planned breeding of white tigers in this park is likely to fulfil the following objectives.

i) to give a better chance of survival for the dwindling captive population of white tigers by building up an indigenous pool of healthy white tigers;

ii) to meet the requirement of different zoological parks of the country and elsewhere by increasing their number;

iii) if possible, to rehabilitate the white gene pool in the wild, preferably in the forests where they were known to exist earlier as suggested by Sandhu and Dhindsa (1986).

References

Gee, E.P. 1964. The white tigers. *Animals*, 3(11): 282-286.

Malhotra, A.K. 1981. The 'Pucca Sahib' tigers of Rewa. *Indian Wildlifer*, 1(4): 35-36.

Mishra, Ch. G., Acharjyo, L.N. and Choudhury. 1982. Birth of White Tiger *(Panthera tigris)* cubs to Normal Coloured Tigers in Captivity. *J. Bombay Nat. Hist. Soc.* 79(2): 404-407.

Ross, J. 1982. The White Tiger Enigma. *Your Cincinnati Zoo News*, Spring 1982 issue. pp. 10-14.

Roychoudhury, A.K. and K.S. Sankhala. 1979. Inbreeding in White Tigers. Proc. Indian Acad. Sci. 88B, part 1: 311-323.

Roychoudhury, A.K. 1980. White Tigers – Threat to their survival. *Probe*, 2(1): 10-11.

Roychoudhury, A.K. 1986. Origin of White Tiger at the Mysore Zoo. *Zoo's Print*, 1(2): 19-21.

Saharia, V.B. 1979. Population Dynamics in Captive Tigers. *Wildlife Newsletter*, 7(2): 36-40.

Sandhu, J.S. and M.S. Dhindsa. 1986. On breeding and conservation of White Tiger. *Tigerpaper*, XIII(4): 25-27.

Singh, K.S. 1986. Bihar – Home of the White Tiger. *Tigerpaper*, XIII(4): 24-25.

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White tiger, Nandankan Biological Park, Orissa. (Photo: Deepak Bhattacharya)

Prace i Materialy Zootechniczne 19 (1979)

Effect of limb amputation on antler size in sambar deer *

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The left hind limb was amputated in the juvenile male sambar deer. Afterwards till its death this stag grew every year the asymmetrical set of antlers: the left antler was rather typical for a sambar but the right one was small and without typical branches. The cause of this phenomenon is at present unknown.

In hunting magazines and in scientific literature the leg injuries in deer connected with the antlers asymmetry were reported several times [14-17]. In the present work similar phenomenon which occurred in Zoological Park in a sambar deer (*Cervus unicolor*) was described.

Material and methods

The Nandankanan Biological Park near Bhubaneswar, Orissa State (India) extends over an area of 500 hectares. The main advantage of this Park over most of its kind (in India) is its natural setting in forests, and the presence of a central lake covering 100 hectares with its outflanking swamps and marshes that attract large numbers of migratory birds during the colder months. Land not being a limiting factor, the captive animals here are able to enjoy the benefits of spacious enclosures that provide them with semi-natural conditions as the one for the sambar deer. In 1969 one of the juvenile male sambar deer met with a minor accident, in consequence of which its left hind limb was amputated through the metatarsal. In 1970, it developed antlers for the first time, which were single-spiked as expected. They were shed when the animal was one year and ten months old. Antler pairs shed during the ensuing four years (from 1971) are depicted in Figure 1. The deer un-

* Received 10th October 1977.

The asymmetry of antlers is enhanced further since only the left antlers bore the terminal fork. Moreover, the brow tine in all left antlers is larger than its counterpart where present. The data are given in Table 3.

Table 3. Lengths of brow and trez tines on left and right antlers (in cm)

Year	Brow tine		Trez tine	
	left	right	left	right
1971	2.8	nil	nil	nil
1972	11.0	2.0	0.6	nil
1973	13.8	nil	8.5	nil
1974	18.5	0.5	12.5	nil
1975	23.5	1.5	12.0	nil

In mammals locomotion is accomplished by simultaneous raising or lowering of diagonally placed limbs. Therefore, as the animal walks or runs, at any particular position its entire weight is supported by a set of two diagonal legs. But with a weak and handicapped left hind leg, the animal should have struggled to support its body weight especially while walking. To overcome this handicap, the animal had made a provision for a clear structural adaptation, though partially. The left antler being three to four times heavier than its counterpart, the stag was obliged to hold its head tilted to one side. The right half of head with much reduced weight synchronizes with the movements of the weakened left limb thereby reducing considerably the strain of walking. A heavier left antler enables the head to be tilted further and eases the asymmetrical movement. The extra weight at the left front is in functional synchrony with the normal hind right and forward left limbs. However, such a temporary adjustment to compensate a defective limb would fall into difficulty from the time the antlers are shed and before the fresh antlers grow to maturity. The animal should be handicapped more to move during such periods.

A number of pathological changes connected with deer's antlers have been reported by some authors [4]. These cases throw some light on the factors regulating the growth of antlers as well as its phylogeny. There are also many records of experiments on the effects of inflicting different artificial injuries on the pedicle as well as damage to the growing antlers in various ways. On the other hand, very little is known on the effect of injury of other organs, on the growth, form and shedding sequence of antlers. The notable exception to this is our knowledge on

the effect of castration on deer started by the great philosopher Aristotle [2]. Sex hormones were used effectively to inhibit the growth and shedding of antlers in sika deer [8]. Goss [9] inhibited completely or partly the growth of antlers in male sika deer by extirpation of the distal part of the pedicle bone and closing the wound with full thickness skin. By artificial transplantation, impressive antlers were produced by Jaczewski [11] in red deer while Dove [7] produced a single horn in a bull in the middle of its head. The bull with one horn resembled the mythical unicorn. Acharjyo and Misra [1] induced a substantial change in antler size by amputation of a limb in a barking deer (*Muntiacus muntjak*). They amputed a male barking deer through the right tibia in December 1967, two months after its birth. At the time of its premature death two years later, the animal bore antlers of uneven lengths. The right pedicle (6 cm) was shorter than the left one (9.5 cm) by 3.5 cm, but the right antler was much longer than the left (their length was 11 and 7 cm respectively). These differences in growth were attributed to the amputation of the limb. This assymetry described in the barking deer, although less striking is a good analogy to what has occurred in the sambar deer. Banfield [3] and Davis [5, 6] reported asymmetry of antlers caused probably by a specific function of antlers in reindeer (caribou). The data presented by these authors showed that in a great majority of the animals, the bez tine developed from the left antler, and only in some of them, this extra tine developed from the right antler.

The connections between the injuries of the legs and the antlers asymmetry were described in several species of deer by Rörig [15, 16], Robinette and Jones [14], Żurowski [17], and Marburger *et al.* [13].

Asynchronisation of antler cycles in the same animal were also reported [10, 12].

At present it is difficult to provide a satisfactory explanation of these phenomena and one may only suggest the haemodynamic or nervous influences. However, this curiosity will probably provoke scientists to further investigations.

Summary and conclusions

1. Amputation of the left hind leg in a sambar deer (*Cervus unicolor*) caused a very strong diminution of its right antler.
2. This effect persisted during six antler cycles till the animal death.
3. The cause of this phenomenon is unknown.

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REFERENCES

1. Acharjyo L. N., Misra R., 1972 — Effect of amputation of a hind limb on the growth of antlers of deer in captivity. Indian Forester 98, 507-508.
2. Aristotle, 1902 — History of Animals. Trans. Richard Cresswell. George Beal and Sons, London.
3. Banfield A. W., 1961 — Bulletin No. 177, National Museum of Canada, Ottawa.
4. Bubenik A. B., 1966 — Das Geweih, Hamburg.
5. Davis T. A., 1973 — Asymmetry of reindeer antlers. Forma et Functio 6, 373-382.
6. Davis T. A., 1974 — Further notes on asymmetry of reindeer antlers. Forma et Functio 7, 55-58.
7. Dove W. F., 1936 — Artificial production of the fabulous unicorn. A modern interpretation of an ancient myth. The Scientific Monthly 42, 431-435.
8. Goss R. J., 1968 — Inhibition of growth and shedding of antlers by sex hormones. Nature 220, 5162, 83-85.
9. Goss R. J., 1972 — Wound healing and antler regeneration. From Epidermal Wound healing. Eds. H. I. Maibach and D. T. Rovee, 11, 219-228.
10. Goss R. J., 1976 — Photoperiodic Control of Antler Cycles in Deer. J. exp. Zool. 197, 3, 307-312.
11. Jaczewski Z., 1961 — Observations on the regeneration and transplantation of antlers in deer *Cervidae*. Fol. biol. [Kraków] 9, 47-99.
12. Jaczewski Z., 1967 — Regeneration and Transplantation of Antlers in Deer, *Cervidae*. Z. Säugetierk. 32, 4, 215-233.
13. Marburger R. G., Robinson R. M., Thomas J. W., Andregg M. J., Clark K. A., 1972 — Antler malformation produced by leg injury in white-tailed deer. J. Wildlife Diseases 8, 311-314.
14. Robinette W. L., Jones D. A., 1959 — Antlers anomalies of deer. J. Mammal. 40, 96-108.
15. Rörig A., 1901 — Über Geweihentwickelung und Geweihbildung. IV. Abnorme Geweihbildungen und ihre Ursahen. Arch. Entw. Mech. Organismen 11, 225-309.
16. Rörig A., 1907 — Gestaltende Korrelationen zwischen abnormer Körperkonstitutionen der Cerviden und Geweihbildung derselben. Arch. Entw. Mech. Organismen 23, 1-150.
17. Żurowski W., 1963 — Wpływ okaleczeń na anormalny rozwój poroża u jeleniowatych. Biul. ZHDZ PAN 4, 121-126.

T. ANTONY DAVIS, L. N. ACHARJYO

WPŁYW AMPUTACJI KOŃCZYNY NA WIELKOŚĆ POROŻA U JELENIA SAMBARA

Streszczenie

Na skutek wypadku, cielęciu jelenia sambara amputowano lewą tylną nogę. Po tym zabiegu, w ciągu całego swojego życia, aż do śmierci jeleń nakładał corocznie poroża niesymetrycznie: po stronie lewej tyka miała kształt raczej typowy dla sambara, natomiast po prawej tyka była niewielka i pozbawiona typowych odgałęzień. Zjawisko to omówiono powołując się na piśmiennictwo opisujące podobne przypadki. Przyczyna tego typu zjawiska pozostaje do tej pory nie wyjaśniona.

Т. АНТОНИ ДЕВИС, Л. Н. АХАРИО

ВЛИЯНИЕ АМПУТАЦИИ КОНЕЧНОСТИ НА ВЕЛИЧИНУ РОГОВ У ОЛЕНЯ САМБАРА

Резюме

Вследствие несчастного случая телешку оленя самбара ампутировано левую заднюю ногу. После того, в течение всей своей жизни вплоть до смерти, рога у оленя росли несимметрично: с левой стороны рог имел скорее типическую форму для самбара, зато с правой рог был небольшой и лишен типических разветвлений. Это явление обсуждено, ссылаясь на литературу по сходным случаям. Причина явления этого рода до настоящего времени не выяснена.

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HORNBILL, OCTOBER-DECEMBER, 1977 : 18-19

The lonely tigress

Unlike other zoological parks which are situated in cities and towns, the Nandankanan Biological Park, Orissa, is situated right inside the lush green forests of the Chandaka range (Puri Forest Division). Because of its natural setting of rolling forests, with a 50 hectare lake in the centre and flanked on the outskirts by extensive swamps and marshes, many wild animals and birds freely move about in and around the Park area.

An open-air tiger enclosure with an area of about 1350 sq. metres and a chainlink mesh fence of 5.5 metres high all around it was constructed in December 1966. On the viewers' side there is a water moat measuring 21 metres in length and 5.4 metres in depth including the 90 cm high parapet. The enclosure is quite spacious and it is at a lower level than the ground outside the moat. The vegetation of the area having trees, plants, bushes and bamboo clumps has been left undisturbed so as to give it the appearance of a natural forest. This open-air enclosure with our tiger, Pradeep, was opened to the public on 29th December 1966.

Pugmarks on the soft earth around our old tiger enclosure (prior to the construction of the open-air enclosure) had been frequently seen from the latter part of 1965. On the opening day of the enclosure a tiger was sighted on a road inside the Park. All attempts such as a trap with a live goat or a live fowl bait, digging a capture pit, etc. were made throughout 1966 to capture this tiger without success.

The most interesting tiger incident happened on the night of 4th January 1967 at the enclosure. A full-grown wild tigress, which was apparently in oestrus, jumped into the enclosure of her own accord to meet with our zoo tiger, Pradeep. Though nothing could be seen in the darkness, it is presumed from the noise that was heard that they must have exchanged a fair number of snarls and blows. On the next morning (5th January) the keepers were astonished to see two instead of one tiger. The tigress was seen sitting in the retiring den, rather the worse for wear, whereas the zoo tiger was moving freely in the enclosure. The tigress had apparently tried her best to escape, and in her attempts had bitten the wooden portions of the observation window. In the process she lost both her lower canines.

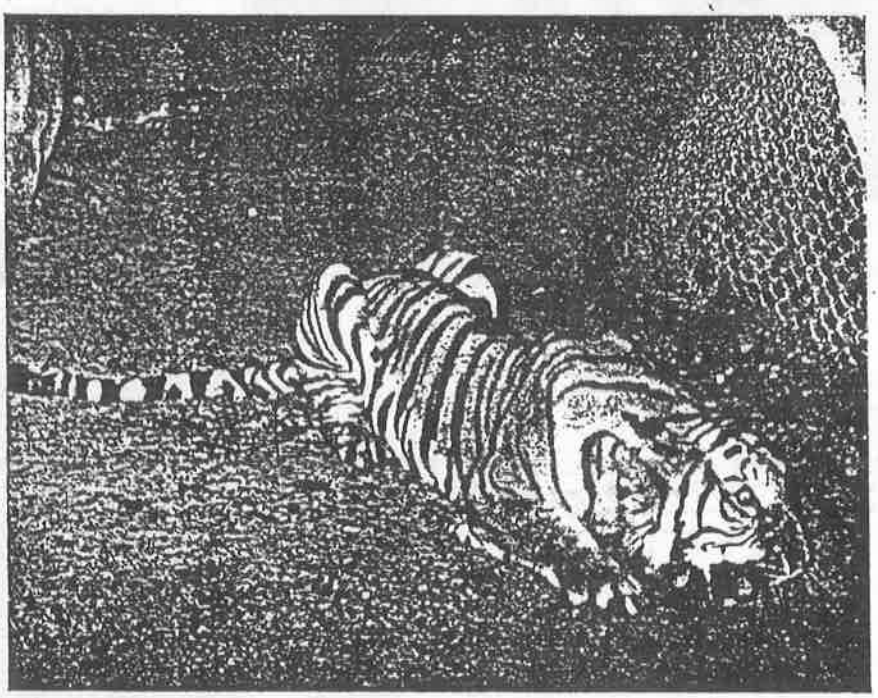
Impression of the pugmarks of the leaping tigress were left in the wet cement plaster of the parapet. They are still there as a mark of remembrance. This was probably the last tigress of the Chandaka range, as there are no more reports of cattle lifting or movement of tigers since then.

For the first fortnight she refused to accept any food such as mutton, beef, live fowl, etc. She was kept on glucose and chicken essence in drinking water. Gradually she started taking the usual zoo diet of about 14 kg beef with bones. The tigress was named Kanan, after the place of her capture.

We tried putting the tigress and the tiger in adjacent cages for several weeks before they were released together into the open-air enclosure intermittently. But each time this was done they fought fiercely and wounded each other. The tiger did not accept her as his mate as he had his own female companion called Sikha.

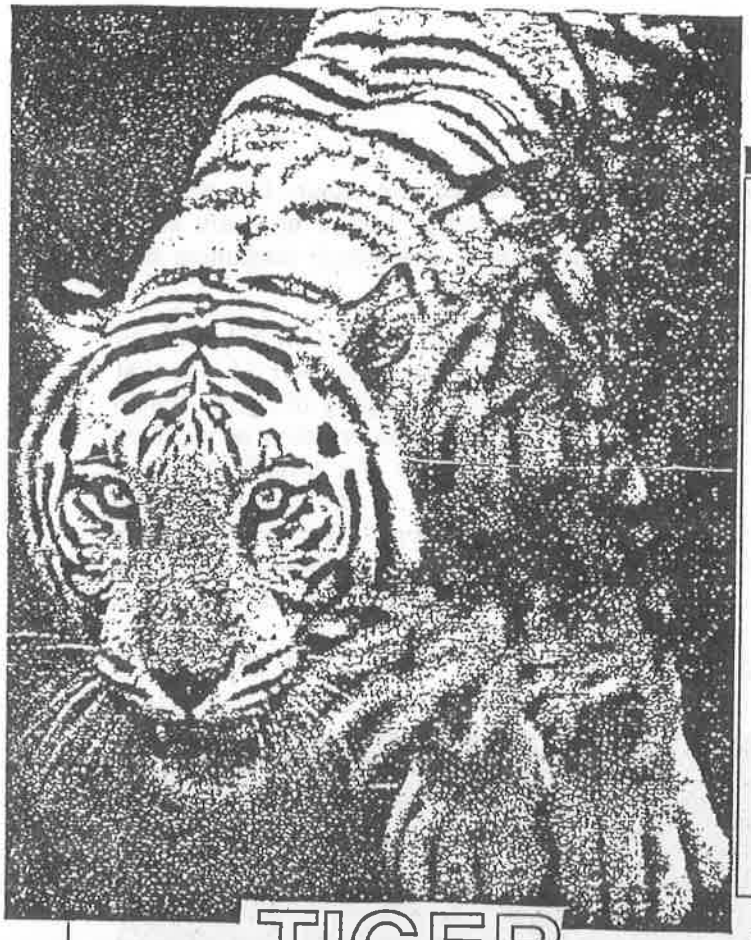
She has now grown old, the estimated age being over 16 years at present. The story of tigress Kanan jumping from freedom to captivity for the sake of a mate is unique in the history of the zoological parks of the world. Her love story is known to the thousands of visitors coming to the Park the last eleven years.

L. N. ACHARJYO



The tigress Kanan—from freedom to bondage

Photo: L. N. Acharjyo



TIGER TIGER DAZZLING WHITE

INDIA is often called the land of tigers. No wonder then that the tiger is our national animal. Today more than half of the world's tiger population lives in the wilderness of India. A 1993 census puts the number of Indian tigers (Panthera tigris tigris), commonly known as the Royal Bengal Tiger, at about 3,750—an increase of over two-fold from 1,827 in 1972. This followed the launching of Project Tiger in 1973 with the creation of nine tiger reserves.

The logic behind the preservation of this species is still questioned by many. But, few understand that through the preservation of this mag-

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S.K. PATNAIK
and
L.N. ACHARJYO

reflect on how the magnificent white tiger was brought back from the verge of extinction

nificent predator, the entire ecosystem of the area is being protected. The tiger is at the apex of the biological pyramid in its habitat. Hence, to sustain each tiger, that particular habitat has to support adequate prey population on whose increment the tiger can thrive. Again for feeding these prey population of herbivores, sufficient vegetation should be available, thus the entire forest gets protection, which in turn provides home to birds, reptiles, insects, plants, mosses, lichens, microflora and fauna. The biodiversity of the area is thus preserved. The result of rigid protection given to the tiger reserves during the last two decades has been spectacular. The tiger population has doubled in the country. The number of tiger reserves has also gone up to twenty three.

In India the tiger is found from Tamil Nadu and Kerala to the forest hills of the Himalayas, from the rain forests of northeast to the mangroves of Sunderbans and the arid regions of Rajasthan. This tawny coated animal with bold black stripes is an excellent swimmer and fast runner over short stretches.

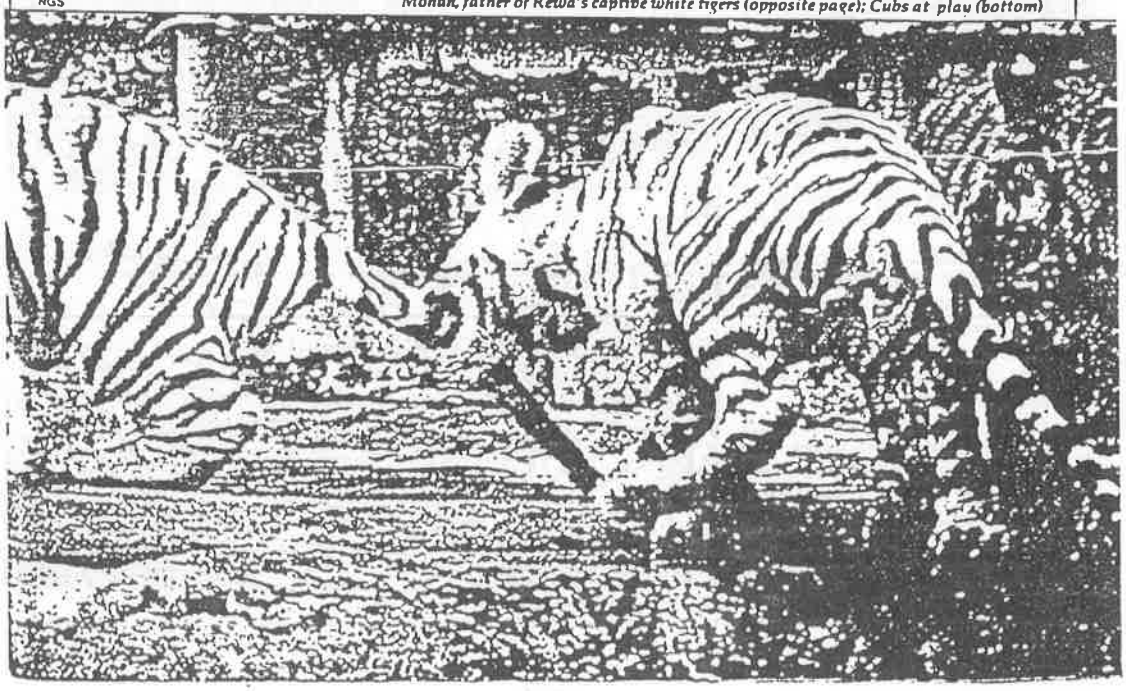
However, more than the coloured varieties, their white cousins are a

NGS

Four-month old Rewati with her keeper at Washington Zoo

NGS

Mohan, father of Rewa's captive white tigers (opposite page); Cubs at play (bottom)



beauty to behold. The white tiger (*Panthera tigris*) is a rare magnificent chalky white feline marked with ash or light black stripes, pink nose and palm pads, and icy blue eyes. They are generally bigger in size than the coloured tigers. The white tiger is not an albino but a mutant. The origin of the white tiger is assumed to be the result of mutation of a gene for normal orange colour coat of a tiger to that of white colour coat in the past. During the process of breeding this mutant gene must have spread among some tigers in the forests. Mating of two coloured tigers, each having a mutant gene, is likely to produce one white in four cubs. When a coloured tiger without a mutant gene is mated with a white one, all offsprings are expected to be normal colour only, indicating that the normal orange colour is controlled by dominant gene and white colour by recessive gene. Mating of two white tigers always produces white offsprings.

NGS

Rewati, pondering over a cup of milk

White tigers with her litter of two white and one coloured cub

The Indian forests are the real homeland of the white tigers. The earliest known record of occurrence of white tiger in India, as mentioned in *Akbar Nama*, dates back to 1561 A.D. After that, sporadic reports of white tigers have been recorded in different parts of the country from time to time.

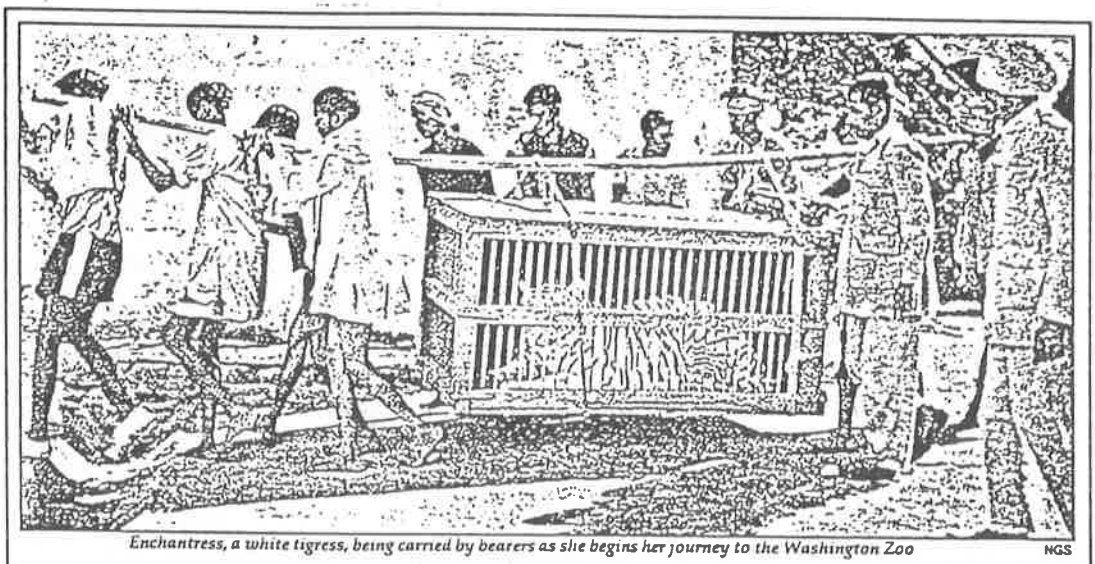
The Bombay Natural History Society has recorded seventeen cases of white tigers shot in India during the period from 1907 to 1933 mostly in the forests of Madhya Pradesh, Bihar, Orissa and Assam. During a period of 55 years ending in 1964, there were only nine reported cases of white tigers in the forests of old Rewa state and the last white tiger shot in that area was in 1947. There were about forty white tigers living in the forests of Bihar during the 1930s, but today one hears of none. Records of Big Game hunting during the forty years ending in 1986 indicate that more than twenty white tigers were shot in the jungles of Bihar. The last record of white tiger shooting in India was in 1958 from the Satganwa Forest Range of Hazaribagh in Bihar.

Besides India, there is only one record of white tiger shooting in Terai area of Nepal in 1939 by the then Prime Minister of Nepal. Although it is said that a white tiger was exhibited at the Calcutta Zoo in 1920, the credit for bringing the white tiger to limelight goes to the then Maharaja of Rewa Sri Martand Deo Singh. A nine month old male white tiger cub from a group of four cubs (three cubs being of normal colour) was trapped alive from the forests of Rewa on 27 May 1951 and shifted to the Maharaja's summer palace at Govindgarh, about twenty kilometres from Rewa. This male white tiger cub was successfully reared to adulthood at the summer palace and was named 'Mohan'.

Mating of this white male with a normal coloured tigress 'Begum' procured from the same Rewa forests resulted in the birth of ten coloured cubs only but no white in three litters between 1953 and 1956. Disappointed with the results of this mating, the Maharaja then arranged the pairing of a female offspring of the second litter named 'Radha' with 'Mohan'. Mating of this father-daughter pair resulted in the birth of four white cubs (one male and three females) on 30 October 1958. This was the first birth of white tigers in captivity. Subsequently, several white tigers were bred with this pair and their offsprings.

One of the female white tigers of the first litter was sold to National Zoological Park, Washington D.C., U.S.A. at the end of 1960. After that the Government of India imposed a ban in 1960 on export of white tigers and made an agreement with the Maharaja of Rewa in 1963. As per this agreement, the Maharaja was permitted to sell a pair of white tigers (one male and one female) to Bristol Zoo in England in 1963. Two white tigers (one male and one female) of the first litter were sent to Delhi Zoo-

KAMAL PUROHIT



Enchantress, a white tigress, being carried by bearers as she begins her journey to the Washington Zoo NGS

logical Park (at present National Zoological Park) in 1963 and all the three cubs (one coloured female and two white) of the second litter were sent to Alipore Zoological Garden, Calcutta in 1963. All these white tigers and their offsprings are the descendants of the white tiger 'Mohan' and the coloured tigress 'Begum' and they may be referred to as white tigers of Rewa origin.

But more recently a normal coloured tigress named 'Ganga' when mated with her father 'Deepak', a normal coloured tiger at the Nandankanan Zoological Park, Orissa gave birth to five white tiger cubs in two litters (two males and three females) on 8 January 1980 and 8 December 1981. A study of the genealogy of these white tigers and the genealogy chart of the white tigers of Rewa origin maintained at the National Zoological Park, New Delhi revealed that there is no biological relation of these white tigers with the white tiger 'Mohan' or his descendants. Hence, these five have formed a separate gene pool of white tigers of Nandankanan origin.

Anxious to produce more white tigers, breeding among close relatives like brother-sister, mother-son, father-daughter etc over long periods has been practised in most of the zoological parks. Such inbreeding has produced numerous ill effects among white tigers such as weakening of eyes, shortness of legs, neck twisting, lack of development of kidneys, recurrent miscarriages, arching of the backbone, still births, reduced fertility and increased early mortality.

Extensive studies on the effects of inbreeding of white tigers practised in four zoological parks (New Delhi, Calcutta, Washington D.C. and Bristol) carried out by A. K. Roychoudhury of the Bose Institute, Calcutta revealed that the tigers failed to survive if their inbreeding coefficient attained a level of 0.4687 or higher. Therefore it is absolutely necessary to have planned breeding of all the available white tigers in a zoo so as to keep the inbreeding coefficient of resultant offsprings much below that critical level. Till 1979 only two zoos of our country—New Delhi and Calcutta—had white tigers and were experiencing the ill effects of inbreeding. Therefore, the Government of India have decided in 1979 to distribute some of the white tigresses from Delhi Zoo to selected zoos of the country for their breeding with non-related coloured tigers to avoid inbreeding. Under this plan white tigers were supplied to zoos at Kanpur, Hyderabad, Mysore and Nandankanan.

A white tigress of Rewa origin named 'Diana' (Subhra) was received from the Delhi Zoo at the Nandankanan Zoological Park in December 1979. 'Diana' was paired with 'Deepak' and subsequent pairings among their offsprings has resulted in a number of white tigers at the Park. This has given new hopes for the survival of white tigers in captivity. Now the white tigers available in captivity belong to three different strains—Rewa, Nandankanan and the mixed strain. The Nandankanan Park has so far supplied sixteen (six males and ten females) to several Indian zoos as well as abroad—Texas in USA and Surobaya in Indonesia.

The timely policy decision taken by the Government of India in 1979 to supply white tigresses of the Delhi Zoo to four selected zoos of the country and the planned breeding at these zoos has prevented inbreeding and brought back the white tigers from the verge of extinction.

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POSSIBLE EXPLANATION FOR VOICELESSNESS IN THE ADULT STORK, IBIS LEUCOCEPHALUS

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MORPHOLOGY of the voice producing system in passerine birds has been extensively studied by Ames (1971) and Warner (1971). Most of the pertinent literature has been well documented by these two authors. Records, on the natural histories of birds, note that the storks are aphonic and that the sound they can produce is only by clattering of their mandibles (Ali, 1968; Whistler, 1963; Dharmakumarsinhji, 1954 and VanTyne aud Berger, 1959). While studying certain aspects of breeding biology of the painted storks, *Ibis leucocephalus* it has been noticed that while the young ones of the storks cry loudly producing a harsh scraping sound, the juveniles aged about 12 to 13 months produce a similar sound with a low amplitude and of a bass type, and the birds aged about one and a half year and above become totally aphonic.

With these observations at hand it was deemed worth-while to investigate the cause for the loss of voice in the adult storks. The present publication deals with the comparative anatomy of the syringes and trachea of the young chicks, juveniles and adults of the painted stork, *Ibis leucocephalus* to explain the possible cause of voicelessness in the adults on the anatomical basis.

MATERIAL AND METHODS

Field observations of the sound producing abilities of the storks at different periods of their post hatching development and in the adults forms were made for six consecutive years (1967-72) while carrying out studies on certain aspects of the breeding biology of the birds at their natural breeding colony established in the wild areas of the Delhi zoological park. For the anatomical studies, five birds from each of the three

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age groups *viz.*, young chicks (40 to 50 days old), juveniles (12 to 13 months old) and adults (of about 2 years and above age) were captured from the breeding colony. The birds were killed under mild anaesthesia and were carefully dissected to expose the syrinx and associated visceral structures. Detailed anatomical observations on the syringes were made under dissection microscope having magnifying capacity upto 30 X. Skeletal elements of trachea and bronchii, syrinx, syringeal muscles and the general features of the syringeal membrane were studied. The nomenclature followed in this study is according to that used by Ames (1971).

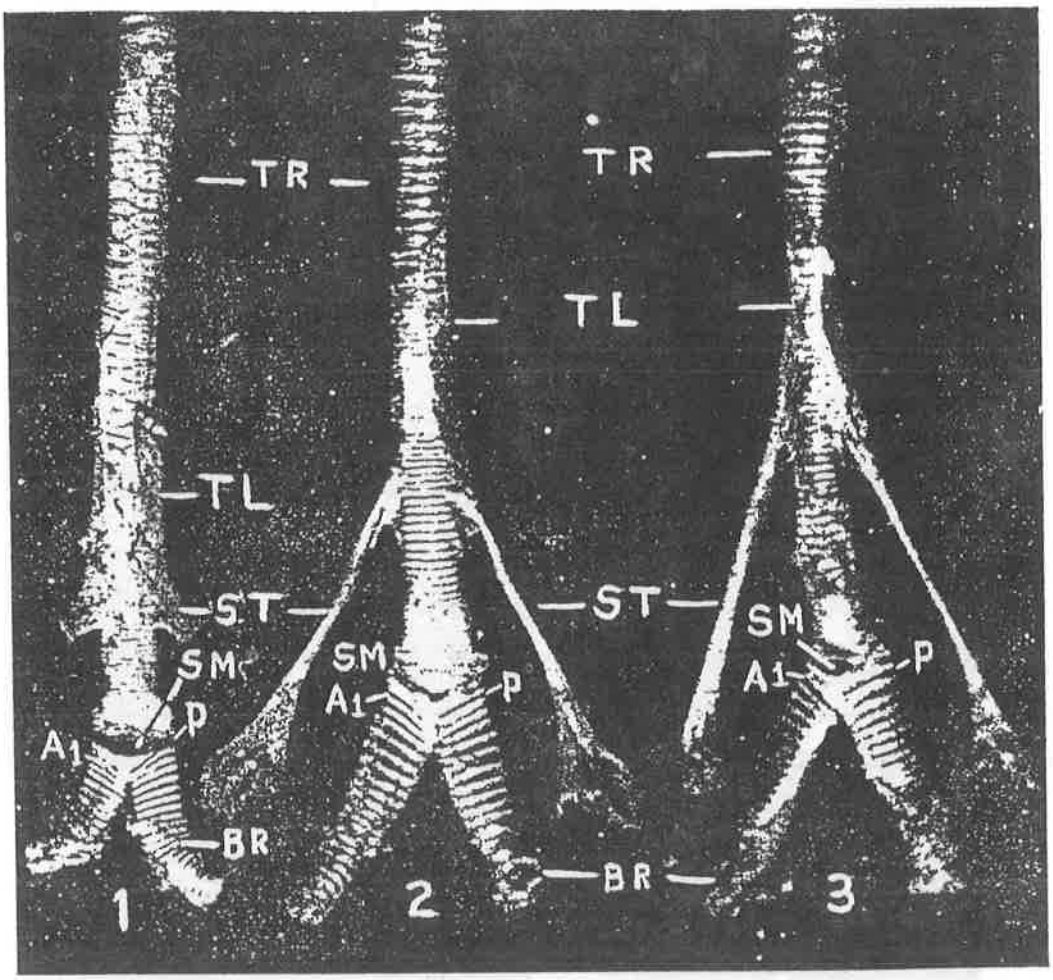
OBSERVATIONS AND CONCLUSION

Field Observations :

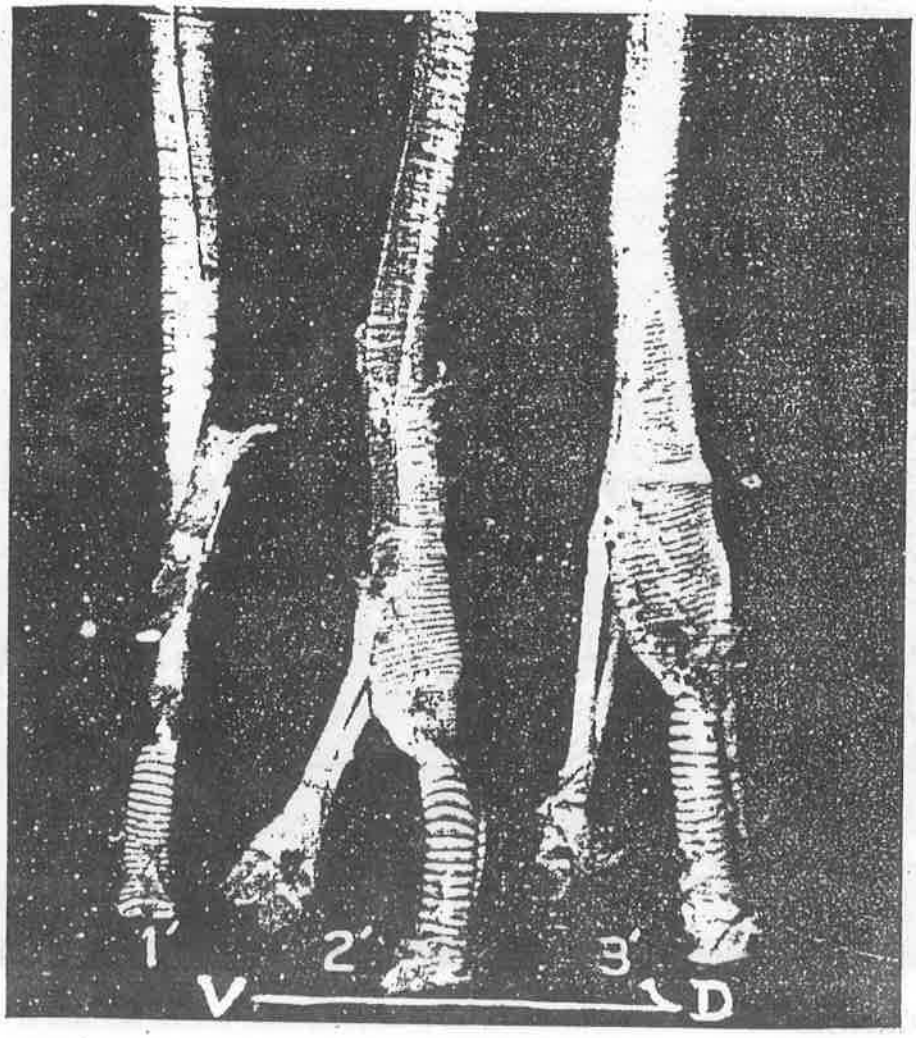
The chicks as soon as they hatch do not produce any sound but after about a couple of hours a low but audible sound could be heard ; but when they are about 8 to 10 hours old their voice becomes fairly loud. As they grow older, the sound becomes louder and a peak volume is reached when they are of about 2 weeks old and such a high peak volume of their sound is retained till they reach the age of 10 to 12 weeks. Thereafter, the amplitude and shrillness of the sound get gradually reduced. Till the age of 12 to 13 months the juveniles continue to produce sound effortlessly, though by now it is of low amplitude and bass quality. The sound in the 14 to 15 months old juveniles becomes more hoarse and soon after this period i.e. at the age of about 16 to 17 months, the storks totally lose their capacity to produce sound and remain mute for the rest of their lives.

The juveniles aged about 15 months reach almost the adult size. A little difference in the size of adults and juveniles, if any, becomes obvious only when they are in close company of one another; otherwise one could easily mistake juveniles (who have a harsh scraping sound) for the adults (voiceless). Whistler (1963) stated that painted storks are voiceless except for they can produce harsh scraping sound. It is quite likely that his observations could be a case of mistaken identity where the juveniles aged about 15 months were mistaken for adults.

It is interesting to note that when the chicks are about 8 to 9 weeks old, besides producing a loud voice they begin to clatter their mandibles and as the age advances, the mandible clattering becomes more frequent and louder and concomitantly their voice becomes low and bass. Ultimately, when they become aphonic the beak clattering remains the only mode of sound (noise) production.



Figs. 1, 2 and 3. Show ventral views of syrinx of the young chick, juvenile, and adult of *Ibis leucocephalus* respectively. The tracheal muscles from the syrinx of young chick have been partly cut out. A_1, First tracheal element; BR, Bronchus; P, Pessulus plate; SM, Syringeal membrane; ST, M. Sternotrachealis; TL, M. Tracheolateralis TR, Trachea.



Figs. 1'. 2' and 3'. Show lateral views of syrinx of the young chick, juvenile and adult of *Ibis leucocephalus* respectively. Note the change in size and shape of trachea, in front of the syringeal membrane, from chick to adult.

Laboratory Observations :

Syrinx in the painted stork is tracheal unlike that in most of the passerines where it is tracheobronchial.

Syrinx in young chicks (*About 40 to 50 days old*) : (Figs. 1 and 4a)

The trachea in the young chicks of this age (group) in question is about 21 to 22 cm long (from glottis to the point of its bifurcation

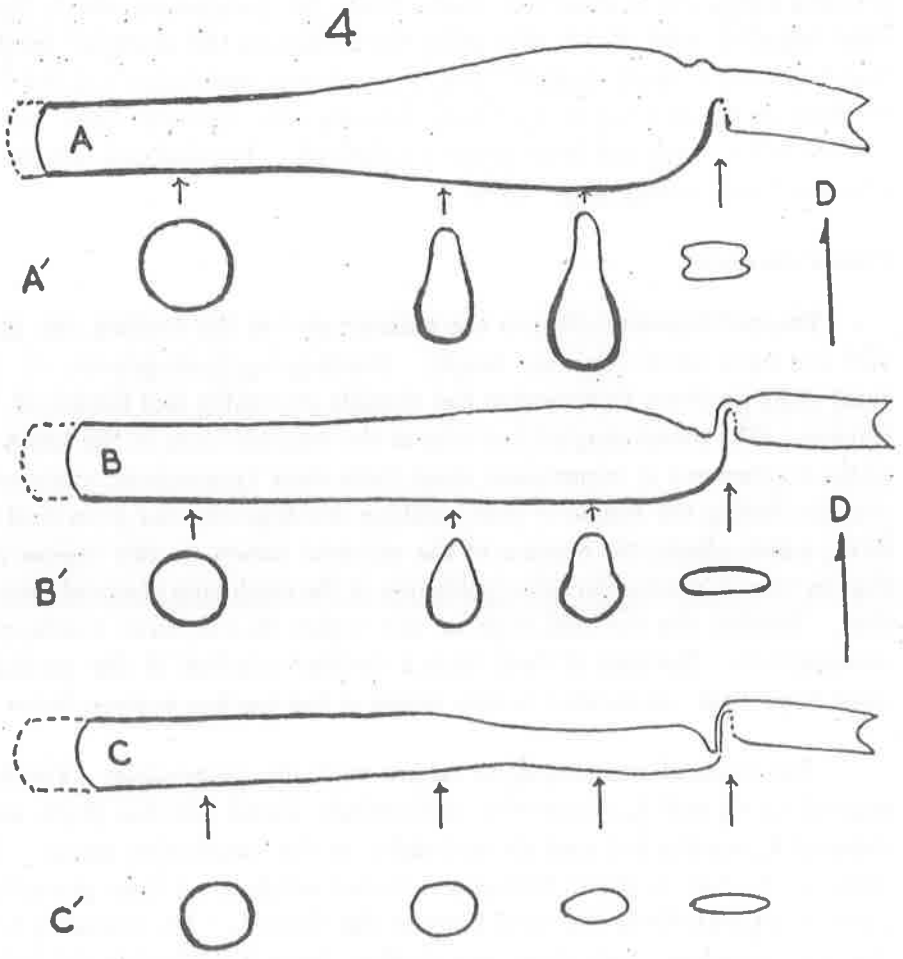


Fig. 4 A, B and C present sagital sections of the syrinx of adult, juvenile and young chick respectively, to show the extent to which sigmoid bending that takes place when trachea is pulled posteriorly backwards and downwards on contraction of the syringeal muscles. (D) with arrow marking indicates dorsal side.
A', B' and C' show cross-sections of trachea at various levels indicated by arrows on the respective sagital sections in case of adult, juvenile and young chick of *Ibis leucocephalus* respectively.

into bronchii). The lumen in the first 17 cm of trachea is round while that in the last 4 to 5 cm is dorsoventrally compressed. The compressed state is not so prominent to start with which has caused increase in trachal breadth but in the last one cm these features are more pronounced. The wall of the last part of trachea, mentioned above, is very thin. There is an oval, thin and vibratile syringeal membrane on the ventral side of the trachea just anterior to the mid-sagitaly placed pessulus plate. It is observed that, when the pulmonary air is forcefully expelled and if at that time the trachea at the syringeal level is flexed to form a sharp sigmoid bend, the syringeal membrane and the thin tracheal region in front of it, where actually the sigmoid bend occurs, vibrate and a shrill and loud sound is produced. The bronchii are relatively short and having large lumen.

Skeletal elements

The cartilagenous rings in the anterior part of the trachea are quite stiff and have relatively more height. Overlapping arrangement of tracheal rings prevents compression but permits stretching and flexion of the trachea. The morphological features of the tracheal rings in the last 5 cm of the trachea are of importance, since these show tremendous anatomical changes during the course of post-hatching development and growth of the birds, which affects the contour of the tracheal lumen in this region and that in turn is of considerable significance in the mechanics of sound production. Besides, the tracheal rings in this region do not have overlapping arrangement. Because of these facts a detailed account of the cartilagenous rings ('A' elements) in this region of the trachea is given below.

The tracheal elements A_1 to A_5 are ventrally incomplete. The free ends of A_1, A_2 and A_3 merge with mid-sagitaly placed pessulus plate, while those of A_4 remain free and are embedded in the connective tissue. The element A_5 has a small ventral component which is medially placed and remains separate from the main body of the element. The elements A_6 to A_{22} are complete, free from one another; have considerably less height and are highly flexible. The trachea in this region (A_6 to A_{22}) is dorsoventrally compressed to a greater extent and its wall is very thin. The elements A_{23} to A_{51} are relatively less flexible and the trachea in this region shows a gradual lessening of the dorsoventrally compressed state. Beyond the level of A_{51} the lumen of the trachea assumes its regular round shape.

The B elements (the skeletal elements of bronchii) are complete, and highly flexible with the exception of the first four to five which are a little stiff. Bronchial lumen is large and oval in shape.

The syringeal membrane is bound anteriorly by the posterior border of the ventrally placed free component of the element A_3, posteriorly by the anterior border of the pessulus plate and laterally by the free ends of the element A_4. The membrane is composed of tough but thin connective tissue.

Syrinx in juvenile storks (12 to 13 months old) (Figs. 2 and 4b):

The elements of trachea beyond A_{51} are more stiff, and have more height than the corresponding ones observed in the young chicks. The lumen of the trachea in this region is round and shows considerable increase in its dimensions. The length of the trachea is about 26 cm.

The elements A_1 to A_{16} have similar features as are noted in corresponding ones in the young chicks but only point of difference is that they have acquired relatively a little more height and stiffness, nevertheless, have remained fairly flexible and are dorsoventrally compressed. The elements A_{17} to A_{23} have lost their dorsoventrally compressed state and are laterally pressed. The lateral pressing is evident in their dorsal halves, while their ventral halves have become stiffer and the inter ring space is considerably reduced. Besides, the lumen of trachea in the region has increased. Such anatomical condition has rendered the trachea in this region relatively less flexible. Like the dorsal halves of the elements A_{17} to A_{23} the corresponding halves of the elements of A_{24} to A_{51} are also laterally pressed but to a lesser degree, however, the lumen size has considerably increased. Tracheal lumen beyond element A_{51} assumes round shape. The B elements in the juveniles have grown a little more but have retained the same anatomical features as were observed in the younger chicks.

The features of the syringeal membrane in juveniles are similar to those of young chicks.

Syrinx in storks aged 16 to 17 months and above: (Figs. 3 and 4 c)

Hardly any change in the skeletal elements of the trachea beyond A_{51} are noticeable except for increase in their height and tracheal lumen. The total length of the trachea is about 27 cm.

The elements A_1 to A_{16} have become more stiff and have lost a good deal of their flexibility and the dorsoventrally compressed state.

These elements show a lateral groove on the either side. However, these elements have remained free from one another and have not formed a tympanum. The size of the tracheal lumen in this region is increased significantly. The elements A_{17} to A_{24} have acquired lateral pressing of their dorsal halves to a maximum extent and their ventral halves have bulged out to form a bulla like structure. With the formation of the bulla, the flexibility of the trachea in this region is almost lost.

The dorsal halves of the elements A_{25} to A_{51} are also laterally pressed as the corresponding halves of the preceding elements are. The lateral pressing is gradually reduced and the tracheal lumen assumes round shape beyond the element A_{51}. The lumen size in this region (A_{17} to A_{51}) of the trachea is greatly increased in the adults as compared to that observed in the corresponding part of the juveniles aged 13 to 15 months.

The B elements do not show changes of any sort in the adults.

The syringeal membrane appears to be slightly smaller which perhaps could be due to the growth of the skeletal elements associated with it.

Syringeal muscles :

Unlike in passerines there are only two pairs of extrinsic muscles with the intrinsic muscles being totally absent. The muscles present are the M. tracheolateralis and M. sternotrachealis.

The M. tracheolateralis is present on the lateral side of the trachea extending from its anterior end to the level of the element A_{31}, whereafter, it merges with the sternotrachealis muscle of its side. The contraction of the M. tracheolateralis aids in the functioning of the M. sternotrachealis.

The M. sternotrachealis arises by a broad tendinous origin from the inner surface of the point of junction of the sternal process and the 2nd rib. After the origin, the muscle becomes fleshy and its slender belly runs forwards, upwards and inwards to come close to the side of the tracheal body. It partly gains insertion on the ventrolateral side of the elements A_{31} to A_{43} and the rest of the muscle merges with the M. tracheolateralis of the same side. Simultaneous contraction of these muscles of both sides pulls the trachea posteriorly downwards and as a result of which a sigmoid bend at the syringeal level (A_1 to A_{22}) is effected which is sharper in the

young chicks, of a lesser degree in the juveniles and very poor in the birds aged 15 to 16 months and above.

The M. strenotrachealis muscle in a young chick is well developed and has relatively more fibre mass and rich blood supply. As the age advances both the fibre mass of the muscle as well as the blood supply get reduced. Finally in the adults the muscle becomes thin with a considerably poor blood supply.

The relative position of the syringeal region of the trachea in the anterior part of the thorax :

In the young chicks the trachea and syrinx occupy a medial position, ventral to the oesophagus. The cervical air sacs are placed lateral to the oesophagus and trachea. A broad, thin and flexible connective tissue membrane, connecting the dorsal region of the pericardium with the medial surfaces of the bronchii and the posterior boarder of the pessulus plate, is present. There are ligamentous membranes equally developed on either side of the oesophagus which hold the oesophagus medially in place. Such a disposition of the trachea and syrinx in the young chick permits easy flexing of the trachea at the level of syrinx into a sharp sigmoid bend which is absolutely essential for the production of loud and shrill sound.

When the chicks grow and attain juvenile age the trachea gets slightly shifted to the right of the oesophagus. Due to this shift, the right cervical air sac and the ligamentous tissue holding the oesophagus get slightly pushed upwards to accommodate the last 5 to 6 cm of the trachea there. With such a displacement the dorsal half of the trachea in this region gets laterally compressed, though to a lesser extent to start with but tending to get more pronounced as the age advances, and finally reaching the maximum level when the birds attain the age of 15 to 16 months. At this stage the lumen and the stiffness of the trachea in the syringeal region are very much increased and shape of the trachea in this region itself is greately changed.

Voice-producing mechanism :

In the young and juvenile storks, the well-developed syringeal muscles, M. sternotrachealis and M. tracheolateralis of either side contract simultaneously leading to a bending of the syringeal region of the trachea into a sharp sigmoid curve in the young ones and to a lesser degree in the juveniles. Such bending of the trachea causes narrowing down of its

lumen into a transverse narrow slit like passage which is much pronounced in the young ones and less prononuced in the juveniles. In acquiring such a bent disposition, the syringeal membrane is brought to such a position that along with the thin tracheal region in front, it would vibrate intensely in the younger storks and with a little lesser intensity in the juveniles when the air from lungs is forcefully expelled. It is due to this vibratory movement of the membrane and thin bent in the trachea in front of it that the sound is produced which is of a loud and shrill type in the young chicks and of a low and bass type in the juveniles.

In the birds aged 16 to 17 months and above, due to a loss of flexibility, widening of the lumen and change in the shape of the trachea in the syringeal region, the possibility of necessary flexing of the trachea needed for the production of sound is lost. Because of this, the air that is expelled from the lung, no matter how much greater the force, just passes out without producing necessary vibrations in the syringeal membrane. Thus, the birds with such conditions fail to produce any sound However, when the air from lungs is expelled with considerable force, sometimes a hissing noise is produced.

From the foregoing account, it becomes distinctly clear that the anatomical changes that occur in the syringeal region of the trachea during the post-hatching development and growth period are mainly responsible for the loss of voice in the adults of the painted storks.

It is pertinent to point out here that the reduction in the mass of the M. sternotrachealis observed during post-hatching development and growth may be due to disuse which perhaps could be to a certain extent as a result of the loss of flexibility of the trachea in the adults. Thus, the action of the muscle having no significant effect, the muscles are possibly not being put to their normal effective use. Perhaps this is a case of disuse atrophy. Investigations on the histological and biochemical aspects of these muscles are in progress to ascertain the view of disuse atrophy of these muscles.

SUMMARY

Comparative gross anatomy of the trachea and syringes of the young chick, juveniles and adults of the painted, stork; *Ibis leucocephalus* has been studied to explain possible cause of voicelessness in the adults on the anatomical basis.

Change in the size, flexibility and general disposition of trachea at the syringeal region of the chick, growing to an adult stage, have been

observed. A gradual loss of flexibility, in sigmoid bending capacity and an increase in the size and change in the shape of the lumen of the trachea at the syringeal level are considered to be the main causes for the gradual loss of voice in the growing chick, ultimately resulting in to an aphonic adult.

Only extrinsic muscles *viz.*, M. tracheolateralis and M. sternotrachialis are present. Progressive reduction in the muscle mass of M. sternotrachialis is observed as the chick grows. Changes in the features of M. sternotrachialis during growth of the stork are recorded.

REFERENCES

Ali, S. 1968. *The book of Indian Birds.* Bombay Natural History Society, Bombay, India.

Ames, P. L. 1971. The morphology of the syrinx in passerine birds. *Bulletin* 37, *Peabody Museum of Natural History*, Yale Univ., U.S.A.

Dharmakumarsinhji R. S. 1955. *Birds of Saurashtra, India.* Published by the author, Times of India Press, Bombay, India.

Van Tyne, J. and A. J. Berger. 1959. *Fundamentals of Ornithology*, John Wiley and Sons Ltd., New York.

Warner, R. W. 1972. The anatomy of syrinx in passerine birds. *J. Zool. Lond.*, 168: 381-393.

Whistler, H. 1949. *Popular handbook of Indian birds.* Gurney and Jackson, London.

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DIET AND FOOD REQUIREMENTS OF PAINTED STORKS AT THE BREEDING COLONY IN THE DELHI ZOOLOGICAL PARK

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THE food ecology and caloric requirements of the Wood Stork (*Mycteria americana*) have been studied by Kahl and he has stated that though largely storks feed on fish, other animal matter is occasionaly taken when opportunity permits (Kahl, 1964). Baker (1929) has reported that the Painted Stork is more exclusively piscivorous than most other storks and the major part of its diet consists of fishes, eels and frogs caught in water. Ali and Ripley (1968) in a general statement have mentioned that the Painted Storks consume frogs, reptiles, crustaceans and insects beside fish which constitutes their main diet. However, no systematic studies on the diet of Painted Storks have been reported (Kahl, 1972). This lack of information prompted us to collect information on these aspects while studies on the breeding biology of the Painted Storks at the breeding colony in the Delhi Zoological Park were undertaken. The Painted Stork (*Ibis leucocephalus*) is a known habitant of India, Bangladesh, Ceylon and South East Asia. A natural breeding colony has been established by the Painted Storks at the Delhi Zoological Park since 1960, which is located in small islands standing in artificially designed ponds and water channels forming a continuous line of water barrier fed by unfiltered water from River Jamuna. Nests were constructed in the upper branches of medium sized Prosopis trees (*Prosopis juliflora*) where other birds like cormorants and egrets also nest. The artificially made swamp has become a favourite locale for the Painted Storks during breeding seasons. During the non-breeding period, they leave the colony and disperse widely. These birds when at the colony constitute the secondary consumer component in the food chain of this shallow water ecosystem which is one of the most productive natural ecosystems, and as reported by Kahl (1964), is ofcourse dependant on the

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marked cycles in primary production resulting from seasonal variations in water levels. Since availability of food is the most important singular factor that regulates the avian breeding cycle, aspects of diet and food requirements are of considerable significance in studies on their breeding biology. Hence an attempt has been made to evaluate the food requirements of the colony of Painted Storks during a single breeding season at the Delhi Zoological Park. The Painted Storks arrive at the Park at the onset of their breeding season (late August or early September) and spend upto 150 to 180 days at the nesting colony. During the remaining period of the year they leave the breeding ground and disperse widely. Little information is available on their movements and activities during the non-breeding periods in India. From September to April, while they are at the breeding ground, they have been observed to feed in the ponds and water channels surrounding their nesting ground in the Zoological Park and also at River Jamuna which runs parallel to the eastern boundary of the Park at a distance of about two Kilometers.

The present report is an average of data collected on the diet of Painted Storks during 1966-1972. The report embodies results of the studies made on (1) items of food taken by nestlings, juveniles and adult Painted Storks, (2) food requirements of nestling stroks from hatching to 70 days of age, and (3) food and energy requirements of the entire colony during a breeding season lasting from late August or early September to April, at the Delhi Zoological Park.

MATERIAL AND METHODS

For the purpose of this study, ten adult Painted Storks were trapped from the colony and ten nestlings of different ages were collected from the nests to record their body weights and measurements of specific body parts. Stomach contents of five adult stroks and five nestlings were examined in 1966-1967 and such studies were also repeated in subsequent years. Observations on the storks feeding in the Zoo ponds were made with unaided eye as well as through 8 × 30 prismatic binoculars.

In 1968, ten chicks of different ages (four chicks immediately after hatching, three chicks of seven days and three chicks 15 days old) were removed from different nests and were hand-reared for varying periods of time from hatching to two years. Young chicks of different age groups were kept in wicker baskets lined with paddy straw to keep them warm till they were three weeks old. During this period, each individual chick

was given 2-15 cm long fishes of the same varieties as normally consumed by the adults (Table 1). After the age of 3 weeks, all the chicks were marked for individual identification and were kept in an aviary.

The chicks were fed six times a day during the first three weeks, three times a day during the next three to six weeks and thereafter only once a day. At each feeding, the fishes were put on the floor, in front of the chicks (of 2-3 days and older) who retrived them without any assistance. Each chick was given as much fish as it would take at each feeding. The quantity of food consumed in a day by each chick was recorded at seven day interval from hatching to the age of ten weeks. The standard metabolism of adult storks was calculated using the formula of King and Farner (1961). Average body weight of adult Painted Stork was obtained from the values of ten adults.

OBSERVATIONS AND DISCUSSION

The results of stomach content analyses indicated that the Painted Storks largely subsist on fish and rarely devour frogs or insects. Quite often some aquatic plant material is also found in their stomach, which may have been taken in unintentionally while capturing fish. The different species of fish taken by the Painted Storks, as revealed by the stomach content analysis, are listed in table 1. It was also noted that the nestlings were fed exclusively on a diet of fish brought by the parents and they were of the same type commonly eaten by the adults. The length of the fishes consumed by the adult storks varied from 5 to 25 cms. Fishes that were regurgitated by the young ones when they were trapped and also those observed in the stomach after sacrificing some of them, varied in length from 2.5 to 16 cms. The average length of fishes consumed by the nestlings varied according to their age. Once or twice, attempts were made to feed the hand-reared one week old nestlings with earthworms (whole and pieces), but they refused the diet ; and when force-fed regurgitated some of the food. Even the ten week old nestlings were reluctant to accept meat pieces given to them. For two days they refused feeding and were not given any other food. Consequently they accepted about 100 grams of meat each on the third day. From this fact it is realised that when starved, they would accept meat diet also. However, from the next day they were put back on fish diet as it was feared that they may grow weak and die.

The plant material found in the stomachs of adult Painted Storks is, ofcourse not their natural diet, and may have been taken inadvertently

along with the food. The significance of mud and small stones found in their stomach could not be ascertained. Though the White Stork (*Ciconia ciconia*) and Wood Stork (*Mycteria americana*) have been reportedly observed eating cowdung (Cerva, 1908; Kahl, 1964), no Painted Stork was observed eating cowdung or excreta of hoofed animals that graze in the Zoological Park.

TABLE 1

Stomach contents of ten adult Painted Storks at the Delhi Zoological Park

Sr. No. of Birds		Species of fish found in stomach	Other material found in stomach
1.	1.	*Cirrhina mrigala* (Mrigal)	Fragments of plant fibres.
	2.	*Wallago attu* (Malli)	
2.	1.	*Wallago attu* (Malli)	
	2.	*Heteropneustes fossilis* (Singi)	
	3.	*Puntius amphibius* (Minor carp).	
3.	1.	*Mystus seenghala* (Seengala)	
	2.	*Ophiocephalus* (Channa) *punctata* (Shouli)	Small frog.
4.	1.	*Notopterus notopterus* (Pholi)	Vegetable debris.
5.	1.	*Catla catla* (Katla)	Plant material
6.	1.	*Catla catla* (Katla)	
	2.	*Labeo rohita* (Rohu)	
	3.	*Cirrhina mrigala* (Mrigal)	
	4.	*Wallago attu* (Malli)	
7.	1.	*Ophiocephalus* (Channa) *striata* (Shouli)	Plant leaves.
	2.	*Puntius amphibius* (Minor carp)	
	3.	*Wallago attu* (Malli)	
8.	1.	*Mystus seenghala* (seengala)	
	2.	*Ophiocephalus* (Channa) *punctata* (Shouli)	Small stones
	3.	*Catla catla* (Katla)	
9.	1.	*Puntius amphibius* (Minor carp)	
10.	1.	*Notopterus chitala* (Chital)	Aquatic insects.

coupled with the relatively inactive life in the early phase of nestling life—hence less energy expense—probably produces higher growth efficiency in altricial birds.

It has been consistently observed that the chicks were fed by parents by regurgitating the food on the floor of the nest. Not a single instance of a parent feeding the young by placing the food directly into their mouth was observed. Even apparently helpless looking freshly hatched chicks without proper muscle tone and control displayed some food grabbing motions at the nest floor, though such attempts were mostly uncoordinated and unsuccessful until about the second day post-hatching, when the chicks were able to locate and pick up the food from the floor of nest. It was also observed that the young chicks of less than three weeks of age were never left alone in the nest, and upto that time, one of the parents remained at the nest while the other went foraging. By the time young were four weeks old and large enough and capable of defending themselves against predators and other storks attempting to steal dry sticks from the nest, both the parents went foraging at the same time. This is necessitated by the fact that by this time young ones start consuming large amounts of food that one of the parents alone is unable to meet the heavy food requirements of the chicks. It would be appropriate to mention here that chicks less than three weeks of age were quite docile and would crouch low in the nest (in nature) or in the corner of aviary when approached, whereas the chicks older than three or four weeks jabbed sharply at the intruder and even moved away from the approaching persons. Such change in behaviour from docile to protective aggression of the young increased their chances of survival further by permitting both the parents to forage simultaneously so that sufficient food supply is guaranteed.

Food and Calculated Energy Requirements :

An adult Painted Stork is about the size of a vulture and stands almost 93 cms tall. No one has previously reported weight of adult Painted Storks. Ten adults were trapped during different periods of the breeding season from the colony; their weights were recorded and the average weight obtained was used for calculating the standard metabolism. The adult weight varied from 3.05 Kg to 3.37 Kg (average weight 3.18 Kg.)

Estimated standard metabolism for a 3.18 Kg stork. (average weight) as calculated using the formula ($\log M = \log 74.3 + 0.744 \log W - 0.074$) given by King and Farner (1961) is 178 K cal/bird/day or

TABLE 2

Body weights of ten adult Painted Storks

Sr. No.	Date of Measurement	Body Wt. (in Kg.)	Sr. No.	Date of Measurement	Body Wt. (in Kg.)
1	22-10-1966	3.150	6	15-9-1967	3.100
2	26-1-1967	3.280	7	20-10-1967	3.250
3	8-2-1967	3.030	8	15-11-1967	3.300
4	17-2-1967	3.370	9	1-11-1968	3.200
5	11-3-1167	3.070	10	18-12-1968	3.050

55 K cal/Kg/day. The standard metabolism of Jabiru Stork (*Jabiru mycteria*) weighing 5.47 Kg was found to be 50 Kcal/Kg/day (Benedict and Fox, 1927). Kahl (1964, 1966), using King and Farner formula, calculated the standard metabolism of Wood Stork (*Mycteria americana*) weighing 2.5 Kg to be 59 K cal/Kg/day and that of Marabou Stork (*Leptoptilos crumeniferus*) weighing 6 Kg to be 49 K cal/Kg/day.

At the Delhi Zoological Park, the captive Painted Storks, adults and young of different ages, kept in an aviary, were given 400 gms of fish/bird/day. Due to limited space in the aviary, the movements of the birds were restricted and they could not fly freely as they do in nature. Nevertheless, they remained active and apparently in healthy condition in captivity, indicating that adult Painted Storks can remain over long periods on such diet without losing weight. Gopalan and Balasubramanian (1963) have listed the caloric value of 11 species of fish mentioned in the list (Table 1) earlier. The caloric value ranges from 0.86 to 1.24 Kcal/gm with an average of 1.1 Kcal/gm for the 11 species. Since the captive Painted Storks at the Delhi Zoological Park ingest about 400 gms of fish per day, their daily caloric intake would be of the order of 440 Kcal per day. If the Painted Stork is similar to the Wood Stork (*M. americana*) in losing about 20% of their ingested energy through faeces and urine (Kahl, 1964), then the captive birds at the Delhi Zoological Park confined to aviary existence would have a metabolism of about 352 Kcal/bird/day.

Wild, free flying storks have a higher metabolic rate than those kept at the aviary, but similar to the latter when wild ones are in breeding period (Kahl, 1964) because during the nesting season, a stork spends most of its time in search of food, close to its breeding grounds and or caring for the young, in either case the activities are not far different from

that of those kept in captivity. It is known that the energy requirements of the animals vary according to the type of work they perform (Brody, 1945). This fact holds good for birds also (Lasiewski, 1961; Graber, 1962). Kahl (1964, 1966) who studied the energy requirements of the Wood Stork (*Mycteria americana*) and Marabou Stork (*Leptoptilos crumeniferus*) estimated the metabolic rate of aviary birds to be roughly two times the standard metabolic rate and that of the free flying storks to be about three times the standard level or 1.5 times the aviary existence level. Assuming therefore, the metabolism of the free-flying Painted Storks to be approximately three times the standard level, it would be approximately 528 Kcal/day (Table 3) in a wild adult Painted Stork. Since about 20% of its ingested energy might be lost through urine and faeces, the assimilation efficiency is assumed to be in the order of about 80% as in the case of captive Wood storks reported by Kahl (1964, 1966). On the basis of this, it could be assumed that a wild adult Painted Stork must ingest enough food to furnish about 660 Kcal daily to maintain the metabolism for free-flying existence. Since the caloric value of fish eaten by Painted Storks is 1.1 (Gopalan and Balasubramanian, 1963), the bird should consume about 600 gms (live weight) of food in nature.

TABLE 3

Estimated metabolized energy of adult Painted Stork averaging 3.18 kg. weight.

Metabolic level	*Kcal/bird/day*	*Kcal/kg/day*
Standard metabolism*	178	55
Aviary existence metabolism**	352	110
Free-flying metabolism	528	166

* Calculated from formula of King and Farner (1961)

** Calculated as per method described by Kahl (1964, 1966)

A nesting colony of Painted Storks with growing nestlings requires enormous quantities of food. The amount of food required for one family of storks was calculated, based on the energy requirements of captive adult Painted Storks and young ones in aviary, and taking the following facts into account:

(a) One gm of live fish has a caloric value of 1.1 Kcal;

(b) Adult storks and fledged birds have metabolic rates of 528 Kcal/bird/day and assimilation efficiency of about 80 per cent;

(c) An average nesting cycle lasts 150 days;

(d) An average of 1.1 young survive to fledgling in each nest (based on composite average of reproductive success of six years from 1966-1967 to 1971-1972. Desai, 1975)

(e) A nestling requires 30.8 Kg of food to reach fledgling age (400 gms/nestling/day for 70 days).

(f) Fledged young remains at the nest/colony for about 45 days after fledging.

Thus the amount of food required by a stork family consisting of two adult birds and 1.1 young (composite average of reproductive success of six years) during one breeding season at the Delhi Zoological Park estimated by adding the calculated values is about 240 Kg of fish (fresh fish weight).

TABLE 4

Estimated Food Requirements of An Average Family of Painted Storks During a Single Breeding Season:

Requirement of two adult birds for 150 days at 0.6 Kg/bird/day	180 Kg.
Requirement of 1.1 nestling for 70 days at 0.4 Kg/nestling/day	30.80 Kg.
Requirement of 1.1 fledged young for 45 days at 0.6 Kg/bird/day	29.70 Kg.
Total	240.50 Kg.

The nesting colony at the Delhi Zoologicaly Park consists of about 100 nests and when the above values are calculated for the entire breeding colony, the amount of food consumed during one breeding season comes to approximately 24,000 Kg or 24 Metric tonnes. These estimates are based on minimal requirements of metabolic levels and also do not take into account the presence of non-breeding birds at the colony or the fact that some fledged birds and adult storks do not leave the colony till April.

SUMMARY

Observations on wild Painted Storks during breeding season have shown that these birds frequent well-watered areas such as ponds, lakes and river in groups for foraging. From the stomach content analysis it has been observed that fish is the chief food item of the Painted Storks at the Delhi Zoological Park.

The pattern of food consumption during post-hatching development of the stork was divided into 3 phases: (1) from the day of hatching to 28 days—period of progressively increasing food intake, (2) from 29 days to 56 days—period of maximum food intake and (3) from 57 days to 70 days—period of gradual decrease in food consumption.

It was estimated that in captivity a young Painted Stork consumes about 30.8 kg. of food during the first 70 days of its life; about 50 per cent of this total quantity of food was consumed during 29 to 56 days.

Theoretically estimated energy requitements of an average sized adult painted stork weighing about 3.18 kg. are:

(1) Standard metabolism = 178/Kcal/Bird/day; (2) Aviary existence metabolism = 352/Kcal/Bird/day; and (3) Free-flying metabolism = 528/Kcal/Bird/day.

One family of Painted Stork wood need about 240 kg. of fish during one breeding season as calculated from above estimates and composite average of six breeding seasons with 1.1 young fledged per nest. A colony of about 100 nests (as it exists in the Delhi Zoological Park) would, therefore consume approximately 24 Metric tonnes of fish in a breeding season. Most of this food is obtained from water channels, ponds and marshy areas of the Delhi Zoological Park and Jamuna River.

REFERENCES

Ali, S. and Ripley, D.S. 1968. *Handbook of the birds of India and Pakistan.* Vol. I. Oxford University Press. Bombay, London, New York.

Baker, E.C.S. 1929. The fauna of British India including Burma and Ceylon. *Birds*, VI. Taylor and Francis, London.

Benedict, F.G. and Fox, E.L. 1927. The gaseous metabolism of large wild birds under aviary conditions. *Proc. Amer. Philos. Soc*,, 66: 511-534.

Brody, S. 1945. *Bioenergetics and Growth.* Reinhold, New York.

Chandy, M. 1970. *Fishes.* National Book Trust, India, New Delhi.

Cerva, F. 1908. Das tranken der jungen storche im nest. *Aquilla.*, 15: 311-531.

Desai, J.H. 1975. Ph.D. thesis entitled "Studies on reproductive pattern, growth and certain behaviour of the Painted Stork. *Ibis leucocephalas* Pennant " submitted to the M. S. University of Baroda, Baroda-2, India.

Gopalan, C. and Balasubramanian, S.C. 1963. The nutritive value of Indian foods and the planning of satisfactory diets. Special report series No. 42. Indian Council of Medical Research, New Delhi.

Graber, R.R. 1962. Food and oxygen consumption in three species of Owls (Strigidae). *Condor.*, 64: 473-487.

Kahl, M.P. 1964. Food ecology of the Wood Stork (*Mycteria americana*) in Florida. *Ecol. Monogr.*, 34: 97-117.

Kahl, M.P. 1966. A contribution to the ecology and reproductive biology of the Marabou Stork (*Leptoptilos crumeniferus*) in East Africa *J. Zool.*, 148: 289-311.

Kahl, M.P. 1972. A revision of the family Ciconidae (Aves). *J. Zool*,, 167 : 457-461.

King, J.R. and Farner, D.S. 1961. Energy metabolism, thermoregulation and body temperature. In: *Biology and comparative physiology of Birds* Ed. A. J. Marshall. Vol. II. Academic Press, New York.

Lasiewski, R.C. 1961. Energy metabolism of hunting birds. *Amer. Zool.*, 1: 156.

Perrins, C. M. 1970. The timing of Birds' breeding seasons. *Ibis.*, 112 : 242-255.

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GROWTH AND DEVELOPMENT OF THE PAINTED STORK, *IBIS LEUCOCEPHALUS*, PENNANT. I. EMBRYONIC DEVELOPMENT

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THE painted stork, *Ibis leucocephalus*, is commonly found in India, Bangladesh, Ceylon and South east Asia. It has a wide distribution in India and often breeds in colonies on tree tops in vicinity of water reservoir or even in the middle of villages. The present report forms part of the study on their breeding biology carried out at the Delhi Zoological Park where the storks have established a nature breeding colony in the crowns of Prosopis trees standing on islands, in an artificial lake of about 0.8 hectares.

Although the descriptive morphological aspects of growth have been reported for many species of birds, not enough quantitative data on embryonic growth pattern in large altricial birds have been reported. With these facts in view, the growth pattern and morphological correlates of development in the painted stork during selected stages of their development were studied.

MATERIAL AND METHODS

Thirty four eggs laid in different nests at the colony during september-October 1971, were used in developing a series of embryos of known ages. All eggs were marked on the day they were laid and kept back in the nests for incubation by the parent birds. Individual eggs were removed from the nests to study the stages of development of embryos at three days intervals from the day of laying to the day of hatching. As per the procedure described by Cooper and Batt (1972), embryonic stages (on day 0, 3, 6, 9, 12, 15, 18, 21, 24, 27 days and also newly hatched chick) of painted stork were studied on the basis of morphological characters, discernible without the aid of any magnifying equipment. Embryos were photographed at each stage beginning from the 3rd to 27th day and also just hatched chick (the average hatching occurs by about 30th day of inclubation). Rate of growth was measured in terms of whole weight of embryo and measuring the length of selected body parts. Linear measurements of the culmen was recorded

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from the 9th day onwards, that of middle toe and tarsus were recorded in embryos of 15 days and older age. Length of the embryo from the base of the beak on the dorsal side to the tip of the tail, with the culmen positioned at right angle to the long axis of the body-was measured from 6th day of incubation onwards. Weights of embryos were recorded from 6th to 30 days of age.

OBSERVATIONS AND DISCUSSION

The following description of the various stork embryos takes into aecount the physical features of growth as well as differentiation of external characters.

Day O :

Blastoderm was round in shape and approximhtely 4-5 mm in diameter.

Day 3 :

Embryo visible without magnification. By now, it was distinct from yolk enclosed in amnion. Eyes acquired pigmentation and limb buds had appeared. Forebrain showed furcate condition (Fig. 1).

Day 6 (Fig. 2) :

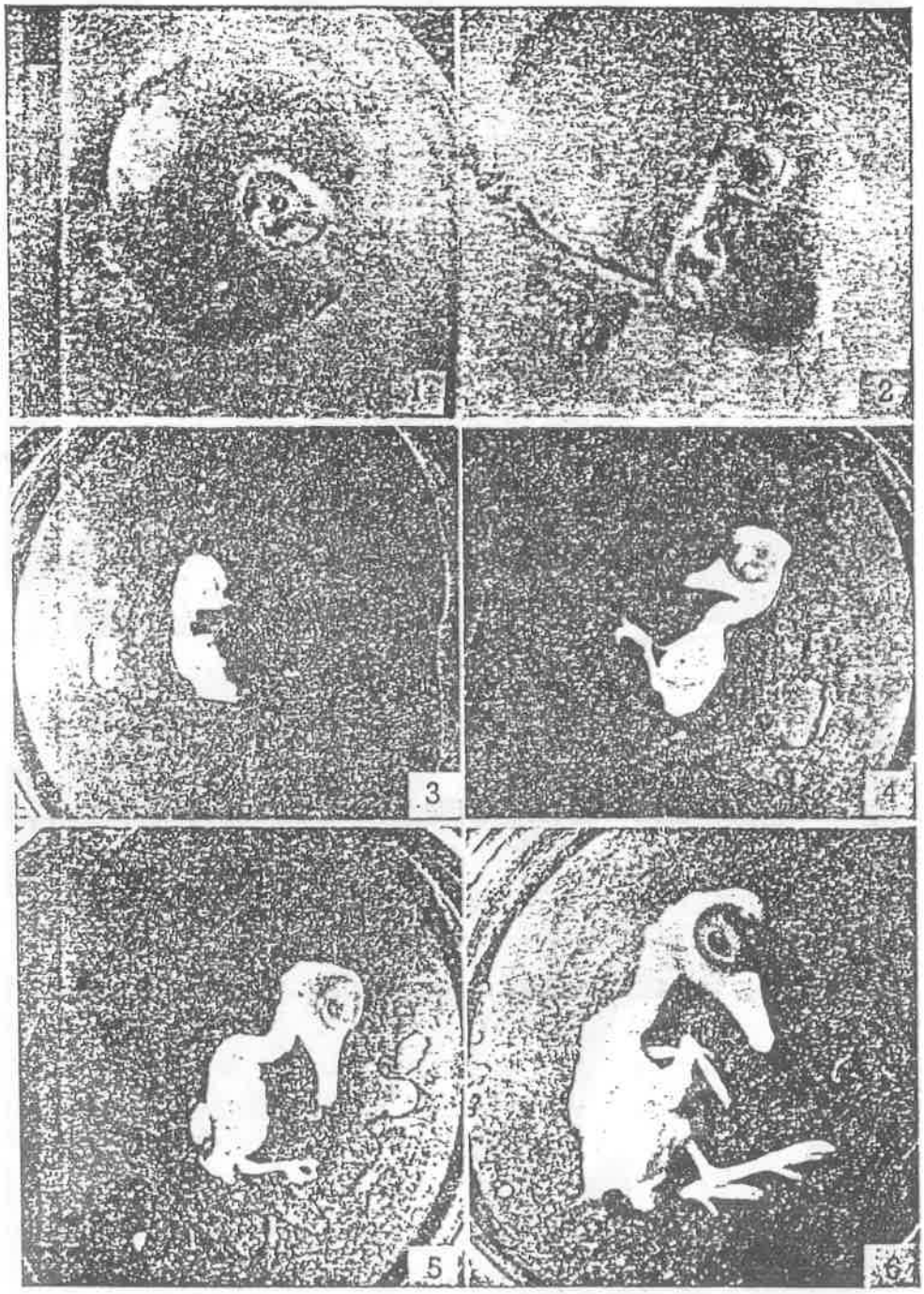
By this stage eyes and limb buds were well deveJoped. Vitelline veins were well developed. Vitelline veins were prominantly seen, with jaws being formed the shape of the head showed changes. Length of embryo was 25 mm and its weight 0.9 gms.

Day 9 (Fig. 3) :

Digital condition of the fore and hind limbs became obvious. Increase in length of the neck and development of the beak to about 3 mm was discernible. Eyes were convex and the head was typically avian in shape. Feather papillae became visible on neck and back. Length of the embryo at this stage was about 28 mm and it weighed 1.4 gms.

Day 12 (Fig. 4):

The feather papillae on back and rump became prominant and well developed. Eyelid slit was open upto the margin of iris. Digits on wing and feet were well differectiated. By this time embryo length reached 35 mm with culmen of 5 mm; and its total weight was about 2.0 gm.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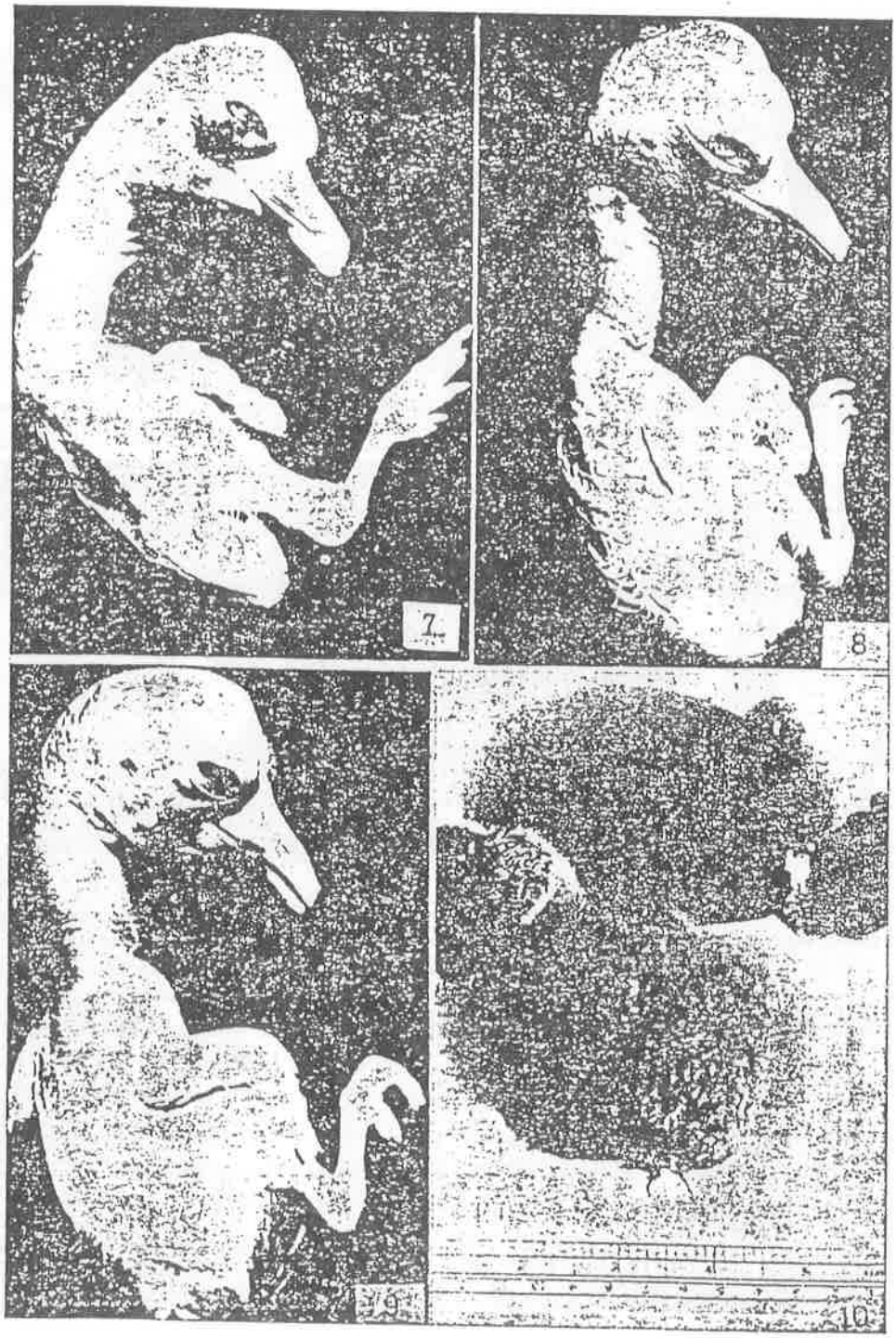
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Day 15 (Fig. 5):

Feather papillae on back, rump, neck and rump of tail and ventral side became well developed. Differentiated digits of hind limbs showed formation of claws. The culmen reached the length of 9 mm, middle toe 5 mm and tarsus 7 mm. The total length of the embryo was 44.5 mm and its weight 4.0 gms.

Day 18 (Fig. 6):

By this time the claws on feet became quite distinct. With the increase in size of beak, nostrils became outlined. Culmen length was 13. 5 mm, middle toe 11.0 mm and tarsus 11.0 mm while the total length of the embryo was 64 mm weight and 8.0 gms.

Day 21 (Fig. 7):

At this stage of development, distinct eyelid slit was noticeable. Transverse grooves appeared on anterior surface of metatarsus which were the evidences of scale formation. Coat of down feathers on dorsum, wings, thigh and head was well developed. The claws on feet became distinct and were white in colour, while the bill and feet were lightly grey coloured. At this stage, the embryo was lying along the long axis of the egg with its head towards the air space. The culmen length had reached 15 mm, middle toe 12 mm, tarsus 13 mm and total length of the embryo was 77 mm and its weight 15 gms.

Day 24 (Fig. 8) :

Well formed eyelids covered the eyes. The length of down feathers increased all over. The egg tooth was well developed. By this time the legs were much longer. Dark pigmentation on upper and lower mandibles and areas around eyes was discernible. Beak had become stronger and had acquired a horny texture. Yolk sac had become smaller as much of the yolk was absorbed. At this stage nostrils appeared well defined and the opercular outgrowths over them were clearly outlined. At this stage, culmen was 16 mm long, the middle toe 15 mm. The total length of embryo was 99 mm and weight 25 gms.

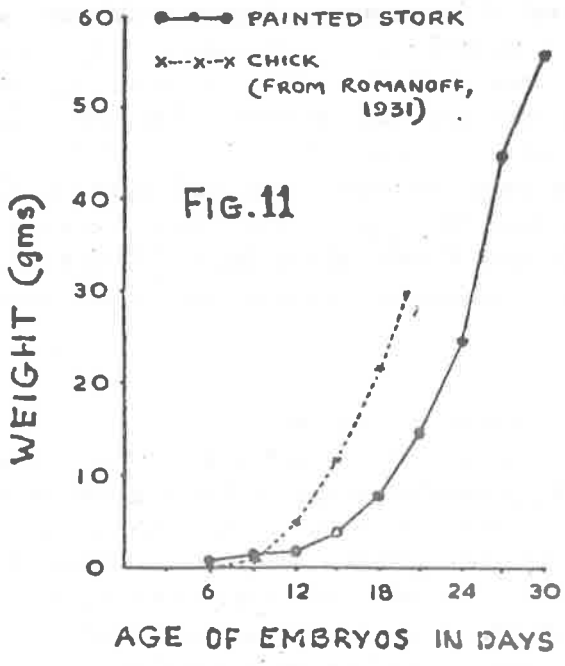
Day 27 (Fig. 9) :

Body was sparsely covered with light grey down. Most of the yolk was drawn in and allantois was almost atropied. Eyes were partially open. Dark

pigmentation around base of bill became evident and the area around the eyes remained darkly pigmented. Skin folds (scales in formation) on the anterior surface of metatarsus appeared. The size of culmen was 17 mm, middle toe 15 mm and tarsus 16 mm. The total length of the embryo was 110 mm and its weight was 45 gm.

Day 30 (Fig. 10)

By this day, the egg shell was pipped. The embryo was fully developed and showed continuous movements and chipping. Yolk sac was completely drawn in and the allantois was atropied. As observed during the earlier phase, body was covered with light grey down. Eyes were fully open. The colouration of the bill was pink with dark pigmentation at the base. Culmen size was 18 mm, middle toe 16.0 mm and tarsus 17 mm. The length of the chick was 115 mm and weight 56 gm.



As can be seen from Fig. 11 growth of the painted strok embryo upto the 12th day was rather slow but after that day there was an appreciable change in the rate of growth. The period of maximum increase in weight was between 21st and 30th days of incubation. Gofman (1952) compared embryonic development of the chick

(Precocial) and the rook (Altricial) and found and that in the chick embryo, growth and development on the whole runs a slower but oarmonious course so that all the organ systems are in readiness to function immediatly after hatching while in the rook, different systems showed a varying of development at hatching time. In such cases some like the digestive system are ready to function, whereas the attainment of functional maturity of some others is incomplete. In the present study similar differential growth pattern is observed in different systems of painted stork. The data obtained from the present study provides basic growth pattern of the developing painted stork chick which can be broadly used to denote age and growth of the bird *in ovo*.

SUMMARY

Gross development of the painted stork embryos of selected stages was studied as per procedure described by Cooper and Batt (1972) and morphological characters described. The growth rate of the embryo was found to be slow upto 12 days, but thereafter an appreciable increase in the rate of growth was noticed. The period of maximum growth was between 21st and 30th days. Chicks hatched out on the 30th day of incubation.

REFERENCES

Cooper. J. A. and Batt, B. D. J. 1972. Criteria for aging Giant Canada Goose embryos *J. Wild. Mgmt.*, 36: 1267–1270.

Gofman, D. N. 1952. O razlichiyakh v tempakh rosta i differentsirovki v embrional'nom razvitii gracha i kurity (Different rates of grouth and differentiation in the Embryonic development of Rooks and Hens). *Vestnik MGU.*, 3: 55.

Romanoff A. L. 1931 As cited by Romanoff. A. L. in "Biochemistry of the avian embryo". 1967. Interscience Publishers.

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STUDIES ON THE REPRODUCTIVE PATTERN OF THE PAINTED STORK, IBIS LEUCOCEPHALUS, PENNANT

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NESTING and breeding habits are known to differ in different species of Storks. Some of them (*Ciconia nigra, Ciconia episcopus, Ephippiorhynchus senegalensis* and *Xenorhynchus asiaticus*) breed solitarily, others, (like *Jabiru mycteria,* the two species of *Anastomus,* the three species of *Leptoptilos, Mycteria americana, Ibis ibis* and *Ibis leucocephalus*) breed in colonies; while a few (*Ciconia ciconia, Sphenorhychus abdimii* and *Dissoura episcopus*) breed either in colonies or solitarily (Baker, 1932, 1935; Ali and Ripley, 1968; Mackworth Praed and Grant, 1957-1960; Haverschmidt, 1949; Lynes, 1925). In Europe, *C. ciconia* breeds solitarily in cultivated and drained land but in colonies in marshy and uncultivated areas where plenty of food is available (Haverschmidt, 1949). Lack (1972) states that probably the storks breed in colonies where food is plentiful and solitary where it is sparse.

The Painted Stork, *Ibis leucocephalus,* that inhabits India, Pakistan, Ceylon, Bangladesh and South-east Asia, breeds in colonies. They nest for this purpose in trees in the vicinity of water reservoir or near human settlements.

Compared to its familiarity and popularity the available information on its nidification, breeding biology and reproductive success is very limited. In order to provide precise information on these aspects the present study was uudertaken from July, 1966 to April, 1972 at the Delhi Zoological Park where the storks have established a natural breeding colony since 1960.

At the Delhi Zoological Park, the nesting and breeding of these birds began in 1960. A group of water birds such as Sarus Cranes, Adjutant

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Storks, Demoiselle Cranes and Ducks were released in the zoo-ponds in 1959 with the idea of stocking a display area for Indian Water birds. Designated; ' The Indian Swamp ', this exhibit was designed to give the visiting public an intimate view of the habitat of the tropical wading birds. On 10th July, 1960, a group of wild Painted Storks arrived. The first group of about 15-20 Storks surveyed the area and went back in the evening. During the next few days more and more storks came. By 1st October, 1960, a total of sixty was counted. Some of these stayed on the trees. Later they built nests and bred for the first time in the Zoo. Since then the storks have considered this area as a favourable nesting site and return to the same site for nesting in increasing number year after year. The nesting colony is now well established and consists of well over hundred nests of Painted Storks besides many others of egrets and herons.

MATERIAL AND METHODS

The entire nesting colony of Painted Storks at the Delhi Zoological Park is located in the crowns of Prosopis trees *(Prosopis juliflora)* which are approximately six to seven meters from the ground levels.

For the study of nidification thirty nesting birds in 15 nests were observed from a platform built on one of the trees in proximity to the nesting site. The top of the platform was slightly above the level of the nests and about thirty five meters away from the nests. Necessary concealment was provided by the foliage of the trees and the birds were undisturbed and unconcerned during observations from the platform. Observations of the nests were made during the early morning, forenoon, midday and late afternoon hours on successive days, covering the full daylight period during a week. On several occasions, observations were also made on full moon nights to determine the nesting activity during such nights. Observations were made with the naked eye as well as through 8×30 prismatic binoculars. Observations were started as soon as the birds arrived at the Park, well in advance of their breeding season, each year.

The identification of material used for the construction of nests and measurements of completed nests were made and recorded for fifteen nests each year. About 24-48 hours since the birds were first observed to bring in the material, regular observations of the nests proper were started.

During the laying and hatching periods, the selected nests were visited in the morning between 8-00 and 9-00 a.m. and again in the evening between 6-00 and 7-00 p m. The eggs for incubation studies were dated with indelible India ink. One or two eggs from selected nests were brought to the laboratory for studies on measurements, weight and general composition.

Data on the general composition of freshly laid eggs have been recorded. For this study twenty eggs were used. Gross weight of the egg, weights of the albumen, yolk and shell were recorded. In addition, to note the gonadal activity in males, testes of twenty five birds were collected during different phases of breeding period. Record of testes weights was made to correlate that with the breeding activity of the birds.

OBSERVATIONS AND DISCUSSION

Breeding Season

The Painted Storks breed from September to January in large olonies and nearly always in company with numerous other species of orks cormorants, egrets, spoonbills etc. (Baker, 1929). According to (1961), the nesting season of the Painted Stork in India is from ugust to January. At a breeding colony in Madras State, South India, the Painted Storks are found in heavy concentrations from November to August (Badshah, 1965). Dharmakumarsinhji (1954) states that in Saurashtra, a part of Gujarat State, the Painted Storks breed from August to December. Smythies (1953) has recorded only one nest of Painted Stork on 22nd November in Burma, which is the only record of nesting available of the bird for the country. Ali and Ripley (1968) state that the Painted Stork breeds from August to October in north India, November to March in South : March to April in Ceylon.

During the six consecutive nesting seasons at the Delhi Zoological Park from 1966-67 to 1971-72, it was observed that the storks arrived during late August or early September and pair formation started more or less soon after their arrival, indicating the commencement of breeding season. Construction or repair of old nests was observed to be taken up soon after the pairing occured and the nest construction was at its peak during the second week of September. Some early breeders laid eggs by the middle of September but most birds of the breeding population did so from 2nd. half of September to middle of Octoder. Young ones were observed in some nests in early October but in most nests, young ones

hatched during middle of October to middle of November. Most of the fledglings left the nests with their parents by the end of March, a few, however, remained at the colony till the end of April.

Correlation Between the Testes and Breeding Cycle

In order to ascertain the gonadal activity in male birds, so as to correlate it with the breeding season, testes of 25 birds were collected during August 1970 to April, 1971. Fig. 1 and table 1 give monthwise testes weights. The testes collected between August and November, on the average, were comparatively more enlarged than those collected between December and April. The maximum testes weight recorded was in September and the lowest in the month of January indicating high gonadal activity at the onset of the breeding period which wanes out as breeding season is over.

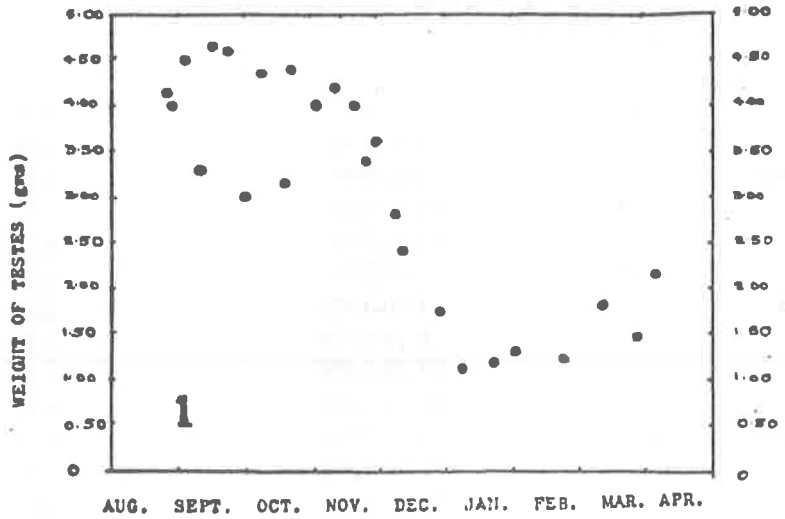


Fig. 1. Variation in the weight of teses of adult wild birds during breeding season 1970-1971. Each dot represents the combined weight of both the testes of an individual bird.

Out of 14 birds collected from August to November, 11 birds had relatively heavier testes indicative of the fact that the birds are in an advanced stage of gonadal development and hence in readiness to breed. Testes of 3 birds with slightly less weight probably indicate that they had not yet attained full breeding potency. From weights of testes collected in December, it seems that the testes had started regressing and the state of almost complete regression was reached by January.

Significance of the increase in gonadal size *i.e.* passing from the non-breeding to the breeding season has long since been known (Dissel-

TABLE 1

Combined Weights of Testes in gm. during different months

Month	Date	Weight in gm.
January	8-1-1971	1.13
	22-1-1971	1.15
February	2-2-1971	1.33
	23-2-1971	1.24
March	12-3-1971	1.82
	27-3-1971	1.45
April	5-4-1971	2.15
	26-4-1971	—
May, June, July	As the birds are not at the colony the data for these months have not been recorded.	
August	26-8-1970	4.15
	28-8-1970	4.00
September	4-9-1970	4.5
	10-9-1970	3.3
	19-9-1970	4.65
	23-9-1970	4.6
October	1-10-1970	3.0
	8-10-1970	4.35
	18-10-1970	3.16
	21-10-1970	4.40
November	3-11-1970	4.00
	11-11-1970	4.2
	20-11-1970	4.00
	25-11-1970	3.40
December	1-12-1970	3.60
	9-12-1970	2.8
	12-12-1970	2.4
	28-12-1970	1.75

horst, 1908). The increase in volume (Likewise in weight) in testes is due to the spermatogenic activity followed by the growth of the interstitial tissue (Nelson, 1953).

According to field observations during six years (1966-67 to 1971-72), the earliest recorded date when Painted Storks arrived at the Delhi

Zoological Park for nesting was 20th August, 1967 and latest date of arrival was 5th September, 1966. On the average, however, they arrived between 25th August to 30th August which fixes the onset of breeding season by about the beginning of September. Apparently, actual breeding activity reaches its full expression during the second half of September. Maximum number of nests with eggs were observed during the second half of September to middle of October. The majority of birds stopped laying by about the 3rd Week of November. Maximum number of chicks observed in the nests were from middle of October to first half of November, The general size and plumage of chicks observed in December, indicated that few were hatched after the first week of that month. Thus the hatching period can be considered to be between mid-October to mid-December, with maximum hatching during mid-October to mid-November.

The correlation between the testes and breeding cycle of the Painted Storks is obvious. Although the birds possess well developed testes as indicated by the testes weight from August they do not start breeding then as perhaps the appropriate external as well as internal stimuli regulating breeding are probably not present. It is quite likely that like ducks (Wislocki *et al.*, 1947), the Painted Stork achieve full reproductive potential by August but the required hormonal levels do not reach their optimum and hence breeding does not commence then. The breeding actually starts in September when conditions favourable for reporduction manifest themselves. Maximum gonadal activity takes place during September to October which corresponds very well with the breeding activities observed at the colony. The birds are not capable of breeding from January to July, since at this stage gonadal activity is minimal as indicated by the low testicular size and weight. Such data on female was not recorded and hence it is not possible to make any comments as far as female gonadal cycle is concerned.

Factors Influencing Breeding Season

There is a general understanding that the breeding season is initiated by a complex of factors like (a) natural instinct and (b) physiological changes brought about by various ecological factors, such as quantum of sunshine (Rowan, 1925, 1927, Bissonnete, 1930) temperature, precipitation, availability of food (Linsdale, 1933) and changing conditions of the habitat etc., which often bring about physical changes also.

It has been suggested that the above mentioned factors affect different species differently in the same or different areas. Nice (1937) and Kluijver (1951) have correlated the rising temperature to egg-laying in some temperate zone species, but in Central America, quite a few species breed when the temperature is falling (Van Tyne and Berger, 1959 ; p. 314). Similarly the enlargement of gonads (hence breeding) has been attributed to the increasing length of the day at higher altitudes, but Humming Birds in the western highlands of Guatemala commence nesting when the days start becoming shorter (Skutch, 1950). Similar to the behaviour of four species of Albatrosses and six species of smaller Petrels in New Zeland (Richdale, 1952). In the desert areas of Africa and Australia, Moreau (1950) and Keast and Marshall (1954) often found the rainfall as the stimulus for reproduction, whereas in Western Guatemala, Skutch (1950) found a great majority of birds nesting at the height of dry season. Nothing could, therefore, be more logical than Skutch's (1950 ; 212) conclusion of his studies on Central American birds, " if any single astronomic of climatic cycle tends directly to stimulate the reproductive activities of birds, its action is so weak that any species which finds conditions peculiarly favourable for reproduction at some divergent season of the year may escape its control." Lack (1972) states that each species of birds has presumably evolved links between its gonadal cycle and whichever environmental factors that give the most reliable indication of the biologically efficient and appropriate time to breed. Further he argues that the breeding season evolved by each species is that which results in its leaving most offsprings, but it has been evolved in relation to the needs of the laying female as well as those of the young.

The breeding season of the storks is so regulated that it concides with the time of availability of abundant food supply. During the studeis in Florida, Kahl (1964) found that the breeding of the Wood Stork (*Mycteria americana*) seems to be triggered by the increased food density that accompanies falling water levels at the beginning of the dry season in early winter.- Heinzman and Heinzman (1965) also consider food availability as an important factor in initiation of the breeding season of the Wood Storks, because a large stork colony requires literally tons of food during a season. In Africa, the breeding seasons of the Marabou Stork (*Leptoptilos crumeniferus*) and the Yellow-billed Stork or the African Wood Ibis (*Ibis ibis*) are also closely geared to the time of increased food availability resulting from inundation of areas near lakes

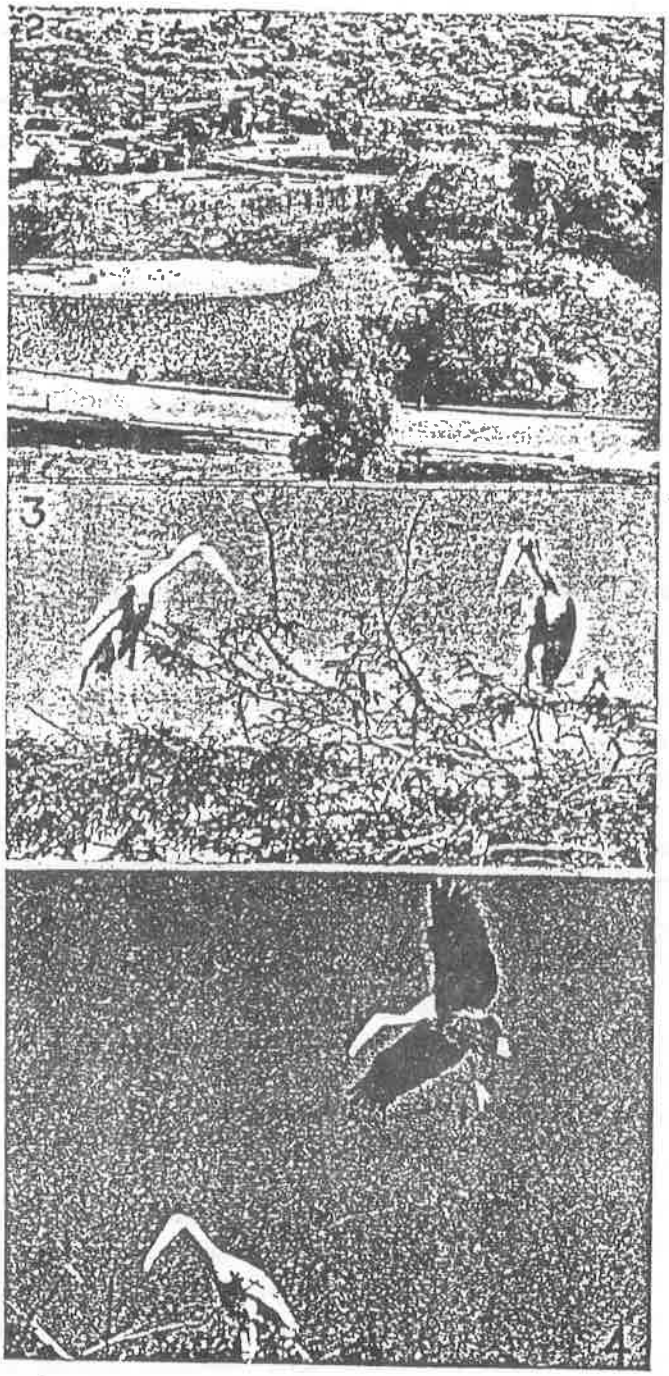
and rivers due to rains (Kahl, 1966, 1972). According to Ali and Ripley (1968), the breeding seasons of the Openbill Stork (*Anastomus oscitans*), the Whitenecked Stork (*Ciconia c. episcopus*), the Blacknecked Stork (*Xenorhynchus asiaticus*), the Adjutant Stork (*Leptoptilos dubius*) and the Painted Storks (*Ibis leucocephalus*) are dependant on monsoon and water conditions. Schuz (1972) states that the Painted Stork breeds in colonies after the monsoon, from September to April, often with other colonial birds. In draught years, the Painted Storks are reported to even skip breeding altogether (Ali and Ripley, 1968).

At the Delhi Zoological Park the Painted Storks commence breeding in September *i.e.* during the last phase of the rainy season when the fishes of right size are available in abundant quantities as most of the carps and cat-fishes breed just before or during rainy season. The shallow areas in the Zoo and marshes along the river Jamuna, where the storks feed, are flooded by rains at this time causing wide dispersal of fish and thereby increasing the feeding areas and availability of food for storks. In summer, the shallow areas and marshes dry up and the fish retreat to the deeper waters where they are unavailable to the birds but during rainy season once more enter the shallow areas and marshes where they are readily available to the storks in abundant quantities. Decreasing water level, during the dry season following monsoon, trap the fish in smaller pockets. The Painted Storks are thus ensured about the availability of food during the entire period of their nesting season.

On the basis of theory of food availability developed by Kahl (1964, 1966, 1972), in the case of the American Wood Stork in Florida ; Marabou Stork and the Yellowbilled Stork in Africa, and the observations conducted at the Delhi Zoological Park, during the present study, it appears that the initiation and the length of the breeding season of the Painted Stork is timed to coincide with the adequate and maximal availability of food rather than with any other single environmental factor.

Nesting Site

It has been observed that the nestlings of Painted Storks thrive exclusively on fish diet. Probably for this reason, most nesting colonies of Painted Storks are observed to be in the near vicinity of a fresh water feeding area. Often breeding colonies are seen on trees in and around water reservoirs in the middle of villages. Suitable feeding areas within flying range probably play a major role in the selection of the specific site for a nesting colony in successive seasons.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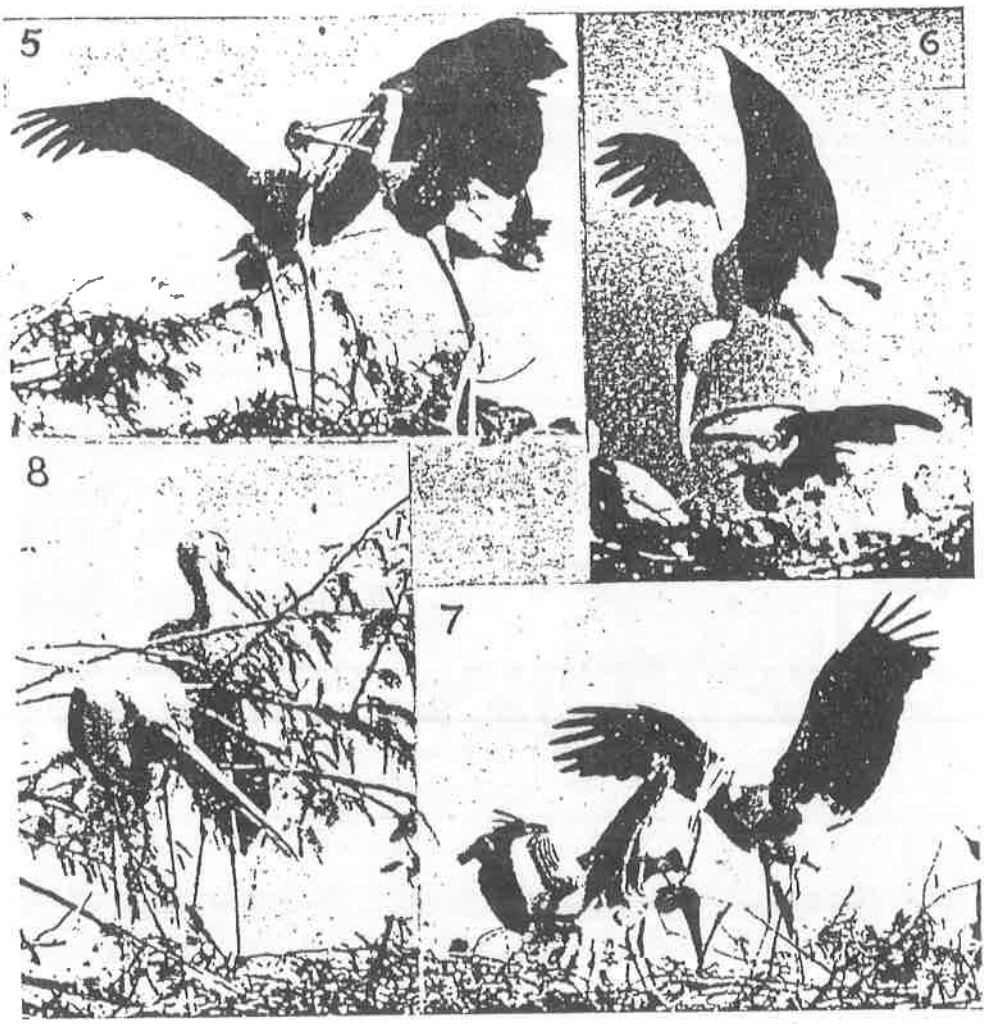
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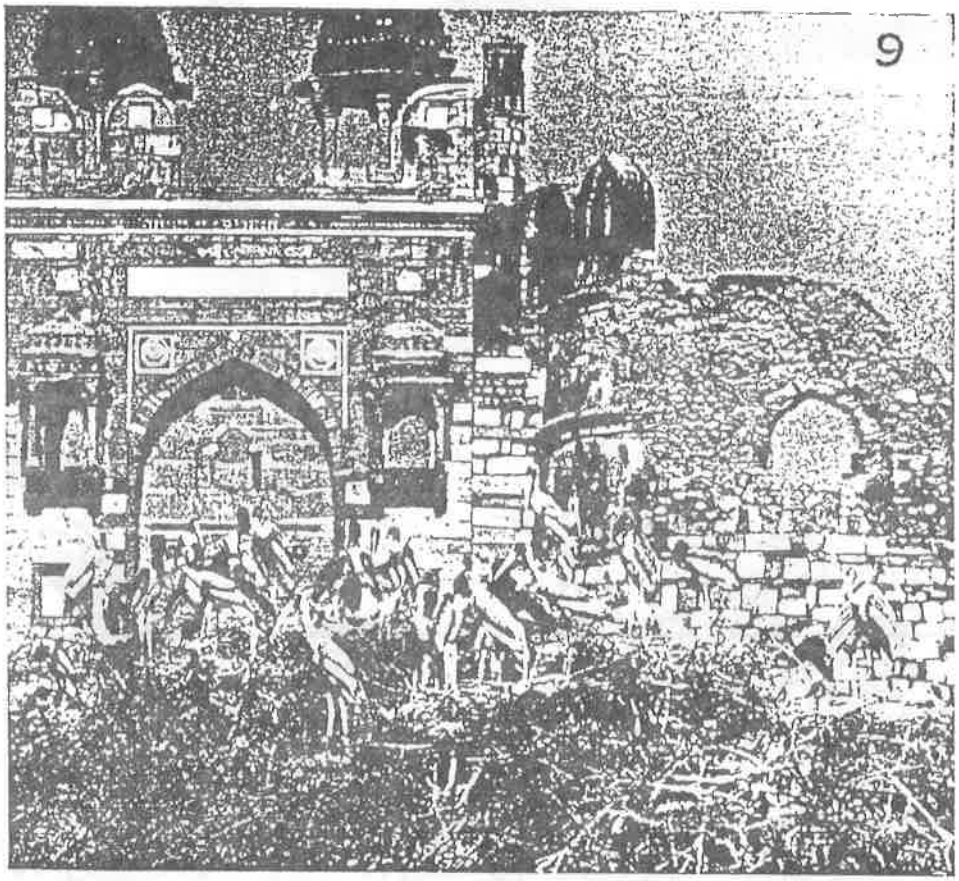
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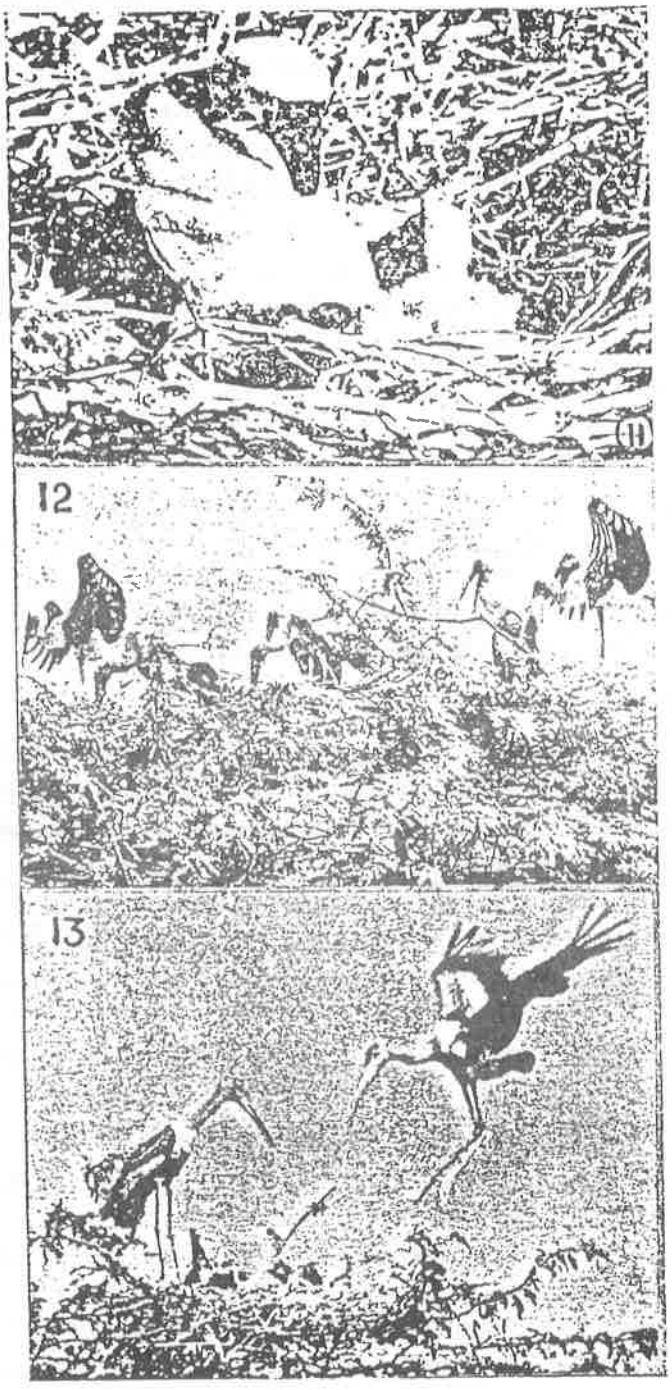
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The nesting site at the Delhi Zoological Park is now well established and the colony has increased in size from year to year. Selection of the same trees for nesting by many individuals over six consecutive seasons has also been observed, although there are many other trees in the vicinity which appear equall ysuitable for nesting. The colony is located on Prosopis trees (*Prosopis juliflora*) standing on three islands in a pond covering about 0.8. hectares (Fig. 2).

Cattle egrets (*Bubulcus ibis*), little egrets (*Egretta garzetta*), Pond herons (*Ardeola grayii*), Night herons (*Nycticorax nycticorax*), Little cormorants (*Phalacrocorax niger*) and Indian Shag (*Phalacrocorax fuscicollis*) also breed at this colony in large numbers along with Painted Storks. Although the breeding seasons of the above-mentioned species are different (Painted Stork, September to April ; Cattle Egret, June to August ; Little Egret, July to September ; Pond Heron, May to September; Indian Shag, August to October), some of them overlap with that of the Painted Stork. The nests of the Painted Storks are located on uppermost part of the trees and those of egrets, herons and cormorants are at lower level, in irregular tiers on the same trees.

Pair Formation

On the approach of the nesting season, the Painted Storks congregate at the nesting site in small groups. Often such groups originate as surveying parties and spend the night on trees in the ponds as roosting birds. Gradually more birds arrive in the afternoon and stay till noon hours next day. They spend many hours at selected places in the trees which are often old nest sites, with the ramnants of nest platform left over from the previous season. Once the individual territories are established, the storks become aggressive and react to any other stork that comes nearby giving the " forward clattering threat " display and even attack the intruder. The trespassers are generally intimidated by such aggressive display and they do not attempt to approach closer.

Some storks (females), however, in spite of continued aggressive display and even bodily assaults by the birds (males) holding the territory, make repeated attempts to enter the territory (Figs. 3, 4, 5) and one of them ultimately succeeds in edging towards the coveted territorial limit. The approaching bird (female) perches at the edge of the territory and by adopting a submissive display with the bill pointed down and wings spread, virtually attempts to enter it. During these tense moments, both

the birds watch each other suspiciously and frequently snap their mandibles, which probably indicate latent hostility. In many cases, during such instances, the approaching bird (female) is driven away with vicious thrusts of the bill by male. However, the bird which is driven away returns to the same site within a short time. Eventually the bird (male) guarding the site allows the other bird (female) to enter and stay in its territory. The birds thus get segregated into pairs at each selected site on the trees in the colony.

After the two mates have been associated for several hours or a day, the first signs of compatibility begin to appear in the form of the " up-down " display, which forms the normal greeting ceremony between the individuals of the pair throughout the remainder of the nesting season. In this display, the stork throws its head up, so that the bill points vertically upwards, then the head is lowered and the bill is brought down with the mandibles clattering loudly. One Stork usually initiates the " up-down " display, the commonest form of " greeting ", and the other bird reciprocates in the same manner. When such displays become frequent, the pair bandage can be considered to be well established. There is no striking sexual dimorphism between the birds of pair *i.e.* the sexes look alike. However, after close and prolonged observations of their early nesting behaviour, the sexes of the two birds forming a pair could be determined among each pair. During such observations, it was also found that of the two birds forming a pair, one was slightly larger than the other and from its behaviour during copulation it was revealed that the large one to be the male.

The courtship or pair formation involve a mixture of hostility and sexual behaviour with complicated ritual of bill clapping, wing flapping, head shaking and posturing (Kahl, 1966). These ritualized social displays given by the Painted Storks have been described in detail by Desai (1975) and only a brief mention will be made here of their nature and significance.

The pairs once formed were found to show great attachment for each other. The two partners were observed feeding and resting together. As they stood side by side, at the nesting site, they often groom each other. Billing also became frequent in which one partner brought its bill to the bill of the other and gently touching it, sometimes giving it a gentle rub. During the entire breeding season both the partners behaved like ideal companions, sharing all domestic responsibilities. However, it was

observed that this bond lasts only for the duration of a single nesting season. The pair bondage breaks up and birds merge into large parties or groups at the close of each nesting season. Six adult Painted Storks (comprising three pairs) whose bills were marked with indelible red paint during 1968-69 nesting season, to study their faithfullness to the natal site, nested again at the colony during 1969-70 season but were observed to pair up with different birds. Thus partners of a pair of one season do not necessarily pair again in the succeeding season.

This behaviour of the Painted Stork compares well with the observations of Lack (1940) which indicate that most birds pair up only during the breeding season, the two sexes staying together for a part or whole of it, according to their accepted share of domestic duties.

Copulation

Most birds copulate during the pair formation, nest building and/or egg laying periods. Some species have been reported to stop copulating with the laying of the first egg (Allen and Nice 1952), while others continue even after the incubation has started (Smith, 1955; Berger, 1957; Lamba, 1963, 1965b) or even after the eggs hatch (Van Tyne and Berger, 1959).

The Painted Storks were observed to copulate very frequently during nest building and egg laying. Copulations were also observed between the pairs (after their young were fledged) in the later part of the breeding season but their frequency was much less. The pairs were observed to copulate only at their nest sites and never on ground or in water.

During copulation the male bird steps on the female's back from one side, hooks its feet over her shoulder and bends legs to lower himself into position for cloacal contact. The female holds wings open in horizontal plane and the male flaps his wings for maintaining balance. (Fig. 6) The male then starts clattering its bill rapidly for some time and such chattering was found to be regularly repeated. The bill of the male is held alongside of that of the female. Both birds usually hold their bills low and slighty open at the tip. The male continues to clatter along side the bill of the female and beats its bill against that of the female in a roughly back and forth manner, throughout the duration of the copulation. A completed copulation is usually followed by a series of up-down display by both members of the pair and prolonged self and mutual preening.

The timings of fourteen copulations, observed in detail, averaged ten seconds (range eight seconds to thirteen seconds), from stepping on to stepping off by the male. The Painted Stork is observed to be monogamous and after pair formation no overtures are made by either sex to individuals of other pairs in the colony.

Nest Construction

The Stork's nest is a platform of sticks in trees, on cliffs or on buildings (Van Tyne and Berger, 1959). The American Wood Stork constructs a flimsy nest, a compratively small platform, which measures 30 to 36 inches in diameter and is made of sticks, twigs, Spanish moss, and, almost invariably, freshly added green leaves (Heinzman and Heinzman, 1965). The nest of the Painted Stork is a large stick platform with a shallow depression sparsely lined with leaves, straw and water weeds (Ali and Ripley, 1968).

During the present study it was observed that soon after pair formation, nest construction or repair of old nests was taken up in right earnest. Although a large number of old nests, constructed during previous seasons, were observed to be occupied by the storks year after year, since no ringing was done, it could not be ascertained if the ownership remained same or changed every year. The birds who made use of the old nests, loosened up the compact block of nest mass of previous seasons by stabbing and plucking beak movements. New sticks were added and rearranged to the required shape and size. Few new nests were also added to the colony each year.

The material used in the construction of nests consisted of dry sticks, usually 30 to 60 cm in length, picked up from the ground under the trees or green twigs wrenched off the branches. The green twigs were mostly used for lining of the nest depression. The sticks were selected according to their flexibility and manoeuvrability; dry sticks were moistened in water before use. Not a single nest was observed during the present study in which straw, water weeds or leaves other than those on the green twigs of Prosopis were used as linging material although these items were readily available in the Park.

It was observed that the male did most of the stick gathering from nearby trees or the ground, while the female arranged the sticks in the nest (Figs. 7, 8). The stick gathering partner made as many as five to six trips per hour to the nest. This activity was more pronounced during

forenoon and afternoon hours. The birds spend most of the noon hours standing, preening or resting on the nest, or soaring in the sky. Both birds of a pair maintained almost constant attendance at the nest in the beginning.

In the earlier stages of construction, the sticks were arranged in a criss-cross fashion resulting in a circular platform. When the platform was seven to eight sticks thick, additional sticks were laid on it tangentially, forming a shallow depression. The inside of the depression was mostly unlined except for the leaves or green twigs which were mostly used during the construction of the floor and sides of the depression. Even the appararently completed nests were also constantly repaired and the sticks continued to be added throughout the breeding season. Nests, nearly complete or in the advanced stage of construction were never left unattended. The sticks in unattended nests were found to be irresistable to other storks constructing their nests. It was observed that abandoned or unattended nests were usually picked apart within a day or two by other storks.

All the nests were located on the crown of the Prosopis (*Prosopis juliflora*) trees. The nests were constructed at places where three or four stout branches of the tree criss-crossed each other. At the peak of the breeding season, the crowns of the trees were so crowded with nests that the distance between any two nests was not more than 20 to 25 cm (Fig. 9). The birds occupying two adjacent nests tolerated each other well but any attempt on their part to trade on the territory of other met with jabbing thrusts of heavy bill of the bird defending its territory, although such skirmishes did not result in prolonged or repeated confrontations. Frequent fights were observed when the chicks grew up, either due to restricted space in the nest or with sheer inquisitiveness when they ventured to move closer to the adjoining nest. Several days were usually required for a pair of Painted Storks to complete their nests, since they worked only two to three hours a day. From observations made on 15 nesting pairs in 1967 (Table 2), it was found that it took from four to eight days to complete a nest. Similar findings were recorded in subsequent years also. Pairs which start construction early in the breeding season take relatively more time than those which start rather late. Such hurying up of nest building by birds who commence late could be an instance of being instinctively pressed against time, to provide nest for egg laying which is to take place soon. The actual construction of the nest was observed to

be done by females along, males only help by bringing in suitable material. The females did a little of stick collecting when the material supplied by the males was found inaqeduate or not up to the mark.

TABLE 2

Nest Dimension and time required for nest construction

Sr. number of the pair	Construction started on	Construction finished on	Time taken in days	Outer dimension (in cms)	Innder dimension	Depth
1	30 Aug.	6 Sept.	7	64	30	10
2	1Sept.	7 Sept.	6	62	28	9
3	31 Aug.	6 Sept.	6	63	26	10
4	2 Sept.	8 Sept.	6	62	29	8
5	3 Sept.	8 Sept.	5	60	24	8
6	3 Sept.	10 Sept.	7	64	29	9
7	2 Sept.	10 Sept.	8	64	30	9
8	31 Aug.	7 Sept.	8	63	29	8
9	7 Sept.	11 Sept.	4	58	28	8
10	6 Sept.	13 Sept.	7	62	28	8
11	9 Sept.	14 Sept.	5	59	26	7
12	4 Sept.	12 Sept.	8	64	29	10
13	8 Sept.	13 Sept.	5	56	26	8
14	10 Sept.	15 Sept.	5	55	25	6
15	9 Sept.	16 Sept.	7	60	26	9
Mean			6.26	61.73	27.53	8.42

Eggs, egg laying and clutch size

Ali and Ripley (1968) state that the eggs of the Painted Stork are dull sullied white, sometimes sparsely spotted and streaked with brown.

The eggs observed at the Delhi Zoological Park showed some variation in shape and size. The eggs were generally ovoid in shape, however, elliptical ones were also encountered. Freshly laid eggs were chalky white in colour but they generally became dull, stained and dirty after a few days in the nest.

A total of sixty eggs were measured and weighed during the year 1967, 1968 and 1970 (Table 3). The size of the eggs ranged from 66 mm

to 75 mm. in length (long axis) and from 41.5 mm to 48 mm at the maximum width (short axis) with mean size of 69 583 (± 2.056) by 43.916 mm (± 1.496). Baker (1932) reported 69.5 × 49.0 mm. as average size of 50 eggs of Painted Storks.

TABLE 3

Size of Egg of the Painted Stork in the years 1967, 1968 and 1970

	1967	1968	1970	Composite measurement of 60 eggs laid during 1967, 1968 and 19.0
Long axis	Range :-66-72 mm	67-72.5 mm	67.5-75 mm	66.75
	Mean :-68.95	69.1	70.7	69.583
	S.D. 1.972	2.03	1.77	2.056
	S.E. of mean 0.441	0.454	0.396	—
Short axis	Range:-41.5-47 mm	41.5-46 mm	42-48 mm	41.5-48 mm
	Mean:-43.9	43.47	44.37	43.916
	S.D. 1.698	1.38	1.31	1.496
	S.E. of mean 0.38	0.309	0.294	—

Some variation in the weight of eggs laid during three years was observed. Those laid during the years 1967 and 1968 averaged 73.25 gms (± 1.1) and 72.45 gms (± 1.03) respectively, while those laid during the year 1970 averages 76.35 gms (± 1.05). The overall average weight of sixty eggs studied during three seasons was 74.01 gms (± 0.643), the range being 66 gms to 85 gms (Table 4). The average weight of the egg of the Painted Stork forms 2.45 per cent of its average body weight (average weight of ten adult birds is 3.18 kg.). The egg weight, in proportion to the weight of the bird in the Stork family (Ciconii) ranges from 2 to 4 per cent as given by Lack (1972).

The shell of the egg of Painted Stork is thick, tough and comparatively heavier than that of the hen's egg. The three different components *viz*, shell, yolk and albumen of twenty eggs were calculated in 1970 by weighing each component separately (Table 5). The average ratio of different components to the total weight of an egg (shell 9.15%; Yolk

TABLE 4

Weight of Eggs (gms) of Painted Storks at Delhi Zoological Park

	1967	1968	1970	Composite weight of 60 eggs laid during 1967, 1968 and 1970
Range :—	66-82	66-81	68-85	66-85
Mean	73.25	72.45	76.35	74.01
S.D.	4.956	4.608	4.712	4.977
S.E. of mean	1.1	1.03	1.054	0.643

13 8%; Albumen 77.0%) compares well with that of the altricial birds compiled by Romanoff and Romanoff (1949).

The ratio of the three major egg components varies in different birds. The difference between the types of young-precocial or altricial-is apparently determined by a different chemical composition and by a different ratio of egg components (Rolnik, 1968). Romanoff and Romanoff (1949) state that as the size of the egg decreases, the proportion of yolk increases to compensate for the loss of heat through a thin shell. According to Tret'yakova (1938) (hen egg) and Tret'yakova (1951) (duck egg), eggs with a greater content of thick albumen have a higher hatchability.

The successive eggs in a clutch are laid two to four days apart. However, occasionally, the time lapse between two successive eggs was even more (Table 6).

In Ciconiformes, the eggs are laid two or more days apart, incubation starts with the first egg and the youngs hatch one or more days apart (Lack, 1972). He further states (1972), that asynchronous hatching is characteristic of the large birds with small broods and long fledging periods. The synchronous hatching is advantageous because when food is plentiful, the whole brood can be raised, but when food is sparse, the oldest which is most active and strong obtains virtually all of the food until it is satisfied. No food under such conditions is wasted on young that would die due to starvation and hence the brood size is soon reduced to that for which the parents can find enough food (Lack, 1947, 1948, 1954, 1966). In *C. ciconia* (Schuz, 1942) and *Area cinerea* (Owen, 1960) when food is in short supply, one or more of the young, *i.e.* those last to hatch, quickly die of starvation, but when food is plentiful, they are raised successfully.

TABLE 5

Difference in the contents of Shell, Yolk and Albumen in the Egg of the Painted Stork.

	Total weight of egg in gms.	Weight of shell in gms.	Percent	Weight of yolk in gms.	Percent	Weight of Albumen in gms.	Percent
Range	68–85	6–8	8.5–9.4	10–11.5	12.7–15	51.8–66.2	76.0–78.1
Mean	76.35	6.915	9.15	10.68	13.8	58.74	77.0
S.D.	4.712	0.541	—	0.365	—	4.032	—
S.E. of mean	1.054	0.121	—	0.082	—	0.902	—

TABLE 6

Time lapse between successive eggs in 12 nests during 1967

	NEST NUMBERS											
	4		6	7	8	9	10	11	12	13	14	15
1st egg laid on	10th Sept.	12th Sept.	11th Sept.	9th Sept.	9th Sept.	14th Sept.	15th Sept.	15th Sept.	14th Sept.	15th Sept.	16th Sept.	18th Sept.
2nd egg laid on	14th Sept.	15th Sept.	13th Sept.	13th Sept.	16th Sept.	26th Sept.	19th Sept.	17th Sept.	16th Sept.	22nd Sept.	19th Sept.	20th Sept.
3rd egg laid on	—	18th Sept.	15th Sept.	17th Sept.	—	—	—	20th Sept.	18th Sept.	29th Sept.	22nd Sept.	22nd Sept.
4th egg laid on	—	—	17th Sept.	—	—	—	—	—	—	—	25th Sept.	—

* The clutches in nest numbers 1, 2 and 3 consisted of only one egg.

Mostly eggs were laid in the morning hours between 7 A.M. and 10 A.M., but occasionally, before or after this period. It was noticed that ten females out of fifteen observed in 1967, laid eggs between 7 A.M. and 10 A.M. Of the remaining five two laid before 7 A.M., two after 11 A.M. and one laid sometime between mid day and 4 P.M.

In order to derive information on the egg laying patterns in the progress of nesting season, as many as fifty nests were observed at the interval of ten days during three nesting seasons of 1968, 1969 and 1970. The trends of egg laying in relation to time were analysed.

Although each nesting season progressed in its own peculiar fashion, egg laying or nest establishment began at about the same time each year. A nest was considered to be established from the day the first egg of the clutch was laid. The laying progressed rapidly and in all the three nesting seasons, the peaks came within the same period of twenty days (Fig. 9). The rates of egg laying for the three years were generally similar before the peaks were reached, except that nesting got off to a somewhat better start in 1969 than in the other years. However, following the peaks, the pattern showed some variations. In 1968, the rate of laying declined rapidly after 11th October, whereas, in the other two years, the rate tended to descend more slowly.

It is indicated from the graph (Fig. 10) that the time of egg laying did not vary greatly from year to year, suggesting thereby that during the period of this study, the environmental or other internal factors did not have much of varying influence on the egg laying time.

Baker (1929) states that three to five or, rarely, six eggs are laid by Painted Storks. Ali (1961) and Ali and Ripley (1968) report that the clutch size of the Painted Storks varies from two to five—most commonly three to four.

Out of ninety clutches recorded over a period of six years at the Delhi Zoological Park, it was found that the clutch size consisted of one to four eggs. Clutches of 2 to 3 eggs were more common. 41 clutches of 3 eggs each (45.5%), 32 clutches of 2 eggs each (35.5%); 10 clutches of only one egg each (11.1%) and 7 clutches of four eggs each (7.7%) were recorded comprising a total of 90 clutches during six years. The mean clutch size for the years 1966, 1967, 1968, 1969, 1970 and 1971 was 2.8, 2.46, 2.33, 2.53, 2.2 and 2.66 respectively, with an overall six year average of 2.49 eggs per each clutch (Table 7).

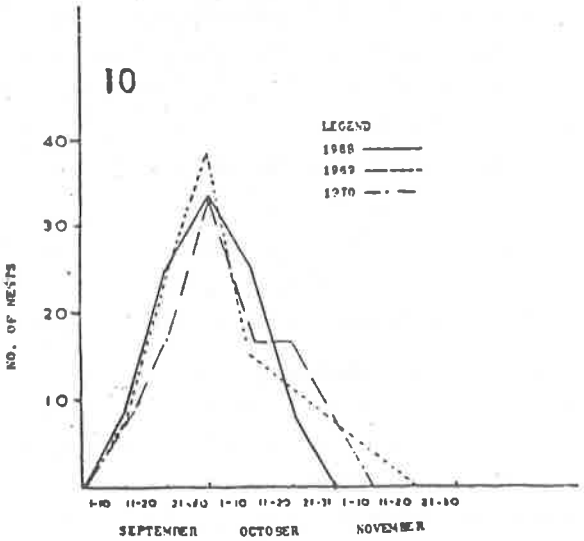

Fig. 10. Egg laying trends of painted stork at the Delhi Zoological Park during 1968, 1969 and 1970.

TABLE 7

Clutch size of Painted Stork as recorded at Delhi Zoological Park from 1966 to 1971

Year	No. of eggs in a clutch				Mean clutch Size
	1	2	3	4	
1966	1	3	9	2	2.8
1967	3	4	6	2	2.46
1968	2	7	5	1	2.33
1969	1	6	7	1	2.53
1670	3	6	6	—	2.2
1971	—	6	8	1	2.66
Total	10	32	41	7	14.98/2.49
Percentage	11.1	35.5	45.51	7.7	

The variation in clutch size as observed among the population of Painted Storks at the Delhi Zoological Park as well as those recorded from elsewhere is a phenomenon commonly observed in most avian species. Geographical variation of clutch size have been reported in several Central

American birds (Skutch, 1949 and 1954) and also African (Moreau, 1944) and European birds (Lack, 1947, 1948). Annual fluctuations in the average clutch-size on account of scarcity or abundance of food (Elton, 1942) and scanty or heavy rainfall (Lack, 1947, 1948; Gilbert, 1936) have also been reported.

According to Van Tyne and Berger (1959), there are a number of environmental, physiological and individual factors influencing the size of the clutch among birds, such as brooding capacity, physiological capacity, mortality rate, availability of food and feeding capacity. On the basis of the present study, it is not possible to single out any one of the above mentioned factors as solely responsible for the determination of clutch-size in the Painted Stork. Probably, a combination of more than one of these factors regulate the size of the clutch.

Incubation

Incubation starts soon after the first egg is laid and this is consistent with the observations reported in case of some other stork species, from other parts of the world (Van Tyne and Berger, 1959; Heinzman and Heinzman, 1965; Kahl, 1966; 1972). Such a behaviour, it is believed, aids in protecting the eggs from predators, but Lack (1947) suggests that it is an adaptation to bring brood-size and available food supply into correspondence by asynchronous hatching. He further states that this is an advantageous adaptation in *Ciconiiformes* and other nidicolous birds because when food is plentiful the whole brood can be raised, but when food is sparse the oldest and or most active young can survive while those hatch last die soon of starvation. Hence the brood-size is reduced to that for which the parents can find enough food.

It was observed that both sexes shared incubation of eggs. However, the female shouldered major responsibility in incubation. The male relieved her at intervals during the day when she went out for food or a short flight. The relieving partner settled on the nest to incubate as soon as possible after its mate vacated the position. The relieved partner wasted no time in leaving, after having been in attendance for several minutes or in some cases even hours.

The female incubated during most of the morning hours and her mate usually sat on the eggs during the afternoon. It was observed that the parent which was incubating remained seated on the eggs for a period of 15 to 30 minutes at a stretch, if it was not relieved by then, it stood up

in the nest, preened, repaired the nest or took a short flight around the nest and then settled down to incubate once more. The duration of such an unattended period ranged from three to five minutes.

Skutch (1957) has suggested that incubation by both sexes was the primitive methods among birds. It, therefore, follows that as far as incubation is concerned, the Painted Stork could be considered to follow a primitive pattern.

Incubation period in other stork species is recorded as 32 days in *Mycteria americana* (Heinzman and Heinzman, 1965) 30 days in *Leptoptilos crumeriferus* (Kahl, 1966); 32 days in *Ciconia ciconia* (Grzimek and Schuz, 1972). Lack (1972) has given the incubation period in Ciconiidae as 30 to 33 days. Ali and Ripley (1968) mention that the incubation period of the Painted Stork is undetermined.

Forty four nests were observed over a period of four years for the determination of the incubation period of the Painted Stork at the Delhi Zoological Park. Seven out of forty four marked eggs failed to give any result (three eggs did not hatch, two were found missing and two were broken). Out of remaining 37 eggs, 21 eggs hatched at 30 days (56.8%), 8 eggs at 31 days (21.6%) and 3 eggs each at 28, and at 32 days (8.1%) and 2 eggs hatched at 29 days (5.4%). Average period of incubation for 37 eggs was found to be 30.16 days (Table 8).

Theories to explain differences in length of incubation time in various orders of birds as well as individuals of the same species have been postulated. Nice (1954) has contended ' rate of development of embryo' to be the most critical factor in determination of incubation period. Lack (1972) has stated that the incubation period seems to have been evolved primarily in relation to the growth rate of the young. Van Tyne and Berger (1959) mention that several writers have commented that long incubation and nestling periods are found in birds that are relatively safe from predation and other dangers. According to Lack (1972), the duratiion of incubation and length of the fledging period are positively related atleast in nidicolous birds.

Van Tyne and Berger (1959) suggest that prolonged incubation behaviour may result if the eggs fail to hatch and that the non-passerine birds may continue to incubate for two to three times the normal period in cases where eggs fail to hatch, while the passerine birds tend to incubate about twice the normal period before they desert the eggs.

TABLE 8

Incubation Period

Year	Nest No.	Laid on	Hatched on	Incubation period in days
1966	2	21st Sept.	18th Oct.	28
	6	21st Sept.	20th Oct.	30
	11	21st Sept.	20th Oct.	30
	9	21st Sept.	20th Oct.	30
	4	9th Oct.	8th Nov.	31
	5	9th Oct.	7th Nov.	30
	10	9th Oct.	9th Nov.	32
1968	8	9th Sept.	8th Oct.	30
	6	11th Sept.	10th Oct.	30
	4	16th Sept.	15th Oct.	30
	1	16th Sept.	—	Broken
	7	22nd Sept.	20th Oct.	29
	12	25th Sept.	25th Oct.	31
	14	27th Sept.	24th Oct.	28
	15	29th Sept.	28th Oct.	20
	5	8th Oct.	6th Nov.	30
	3	8th Oct.	—	Did not hatch
	2	10th Oct.	9th Nov.	31
	9	12th Oct.	12th Nov.	32
1969	4	10th Sept.	9th Oct.	30
	3	13th Sept.	12th Oct.	30
	11	18th Sept.	18th Oct.	31
	14	18th Sept.	—	Did not hatch
	8	22nd Sept.	22nd Oct.	31
	10	24th Sept.	23rd Oct.	30
	6	25th Sept.	—	Did not hatch
	5	25th Sept.	—	Missing
	1	30th Sept.	30th Oct.	31
	7	7th Oct.	5th Nov.	30
	9	10th Oct.	8th Nov.	30
	12	11th Nov.	10th Dec.	30
	15	11th Nov.	11th Dec.	31
1970	8	10th Sept.	9th Oct.	30
	6	11th Sept.	10th Oct.	30
	5	11th Sept.	12th Oct.	32
	12	21st Sept.	20th Oct.	30
	14	24th Sept.	23rd Oct.	30
	9	28th Sept.	26th Oct.	29
	15	28th Sept.	28th Oct.	31
	2	7th Oct.	5th Nov.	30
	3	8th Oct.	—	Missing
	7	20th Oct.	18th Nov	30
	4	20th Oct.	—	Broken
	1	24th Oct.	20th Nov.	28

Similar behaviour was observed in the Painted Stork also during the course of present study. In one nest in 1966, the parents were observed to incubate one egg for six weeks which ultimately did not hatch and was finally deserted. During 1969, one egg each in two nests were incubated for 38 and 39 days respectively which were ultimately deserted.

Hatching Pattern and Success

Since incubation commence before the clutch is completed, the eggs hatch out one after the other, at intervals of one or more days, more or less in the order of the time gap with which the eggs were laid. Therefore, the nests were never found to contain chicks of the same size and the oldest chick was found to be about seven days or more older than the youngest (Fig. 11).

The hatching success was found to be quite high in the Painted Stork population at the Delhi Zoological Park. Out of a total of 225 eggs in 15 marked nests observed during six consecutive years, only 71 eggs were found to be unsuccessful due to predation, infertility, breakage, death of embryo and other unspecific reasons. The average hatching success, therefore, was 68.44% during the period of the present study (Table 9).

TABLE 9

Hatching success of Painted Storks in 15 nests during 1966-1971

Year	No. of eggs laid	No. of eggs hatched	Percentage of hatched eggs	No. of unsuccessful eggs	Percentage of unsuccessful eggs
1966	42	26	61.9	16	38.09
1967	37	28	75.67	9	24.32
1968	35	21	60.0	14	40.00
1969	38	27	71.05	11	28.94
1970	33	24	72.7	9	27.3
1971	40	28	70.0	12	30.00
Total	225	154	68.44	71	31.55

Survival and Mortality of Nestlings

During the present study, it was observed that out of 154 nestlings that hatched in 15 nests marked for close observations during six nesting seasons, as many as 55 died or failed to fledge. The mortality, therefore, was about 35.71%. (Table 10).

TABLE 10

Nestling mortality

Year	No. of eggs hatched	No. of hatched young that fledged	Percentage	No. of hatched young that failed to fledge	Percentage
1966	24	17	65.38	9	34.61
1967	28	20	71.42	8	28.57
1968	21	12	57.14	9	42.85
1969	27	16	59.25	11	40.74
1970	24	15	62.50	9	37.50
1971	28	19	67.85	9	32.14
Total	154	99	64.29	55	35.71

The parents on arrival at the nest with the food, regurgitated on the floor of the nest and the stronger and the bigger chicks gobbled up almost all the food. The younger chicks were not able to feed till the older chicks had finished. Thus the younger ones steadily lost the ground with passage of time and became so weak that they were not even able to raise their bills to pick up food from the nest floor. The parents did not seem to take notice of such weaklings and certainly did not make any special attempt to feed them. The weaker ones died due to starvation and were thrown out of the nest by the parents.

Mortality among the chicks due to starvation was high during the first two weeks of post hatching development. Several observers have pointed out that this could well be one of the means of perpetuating the species because it assures that at least a few chicks will survive even in lean years. If the chicks were of the same size, they would all starve when the food supply was not sufficient (Heinzman and Heinzman, 1965 ; Kahl, 1966, 1972 and Lack, 1972).

Predation was another serious cause of mortality among chicks and during the six-year observations, predation accounted directly for losses of 49.09% (Table 12). This is not surprising as Crows (*Corvus splendens* and *C. macrorhynchus*) and Pariah Kites (*Milvus migrans*) were mainly responsible for the predation during the early part of the nesting season of the Painted Storks. The density of predatory birds especially that of

TABLE II

Summary of causes of mortality among chicks in 15 nests

Causes	1966	1967	1968	1969	1970	1971	Total	Percentage
Predation	4	2	7	6	5	3	27	49.09
Starvation	4	4	2	3	3	5	21	38.18
Accidential and Unknown	1	2	—	2	1	1	7	12.72
Total :	9	8	9	11	9	9	55	99.99

TABLE 12

Reproductive suceess of the Painted Stork at the Delhi Zoological Park

Year	No. of eggs laid (in 15 nests)	No. of hatched young that fledged (in 15 nests)	Reproductive success in percentage	No. of fledged young eared per pair
1966	42	17	40.4	1.13
1967	37	20	54.05	1.33
1968	35	12	34.2	0.8
1969	38	16	42.1	1.06
1970	33	15	45.4	1.0
1971	40	19	47.5	1.26
Total	225	99	44.0 (Average)	1.1 (Average)

pariah kite in Delhi is unusually high (Galushin, 1971). They have been seen diving low over the nests when the nests were found unguarded, although such occasions were very few.

It was observed that once the chicks reached the age of three to four weeks, their prospects of survival from predators were much higher as they were, by now large enough to defend themselves and were usually left uncared for longer duration by their parents.

Deaths due to accidental fall from the nests, diseases and unknown reasons accounted for a small percentage (12.72%) of mortality (Table II).

Nestling Period

The nestling period of the Painted Stork at the Delhi Zoological Park ranged from 100 to 140 days varying considerably with individuals. Although the young began exercising their wings at the age of 25 to 30 days, they were unable to fly till the age of about 60 to 70 days. Even after they were able to fly well, the young remained in their nests for several weeks to roost at night and part of the day. Although the parents brought food for the young during this period, the fledged young also collected fish from the nearby ponds. The average nestling period of ten young during 1968-1969 nesting season from the day of hatching till they left their nests was 115 days. In comparison, the young of the American Wood Ibis are fully fledged at 60 to 65 days of age (Kahl, 1962 ; Heinzman and Heinzman, 1965) and the Marabou Storks need 116 days till they can fly and about 130 days until they finally leave the nest (Kahl, 1966).

Reproductive Success

Although the entire colony of the Delhi Zoological Park consisted of more than a hundred nests, a total of fifteen marked nests observed closely were taken up into consideration each year for estimating the reproductive success during the six breeding seasons. Compared with the other nests, these fifteen nests were clearly visible from the observation platform and considered suitable for the purpose of this aspect of the study. The data for the fifteen nests are summarized in Table 12.

During the course of present study spreading over six consequtive breeding seasons, a total of 225 eggs were laid in fifteen nests which were marked and a total of 99 young fledged and flew away. The average or composite reproductive success was 44.0% or 1.1 young per pair.

The American Wood Stork (*Mycteria americana*) and the Marabou (*Leptoptilos crumeniferus*) seems to be similar in this respect with their reproductive performance of average 1.1 and 1.14 young respectiveiy produced per pair as reported by Kahl (1964, 1966).

Reproductive potential and loss due to mortality factors :

Mortality factors acting on both eggs and nestlings considerably reduced the possible reproductive potential of the Painted Storks at the Delhi Zoological Park (Fig. 14). Mortality in nestlingis ranged from 21.42 to 28.94% with an average of 24.41% during the six nesting seasons. Mortality in eggs was highest (40%) in 1968 and lowest (24.32%) during 1967 with an overall average of 31.55%. The combined

mortality rate in eggs nestlings thus accounted for 56% loss in reproductive potential during the six nesting seasons recorded.

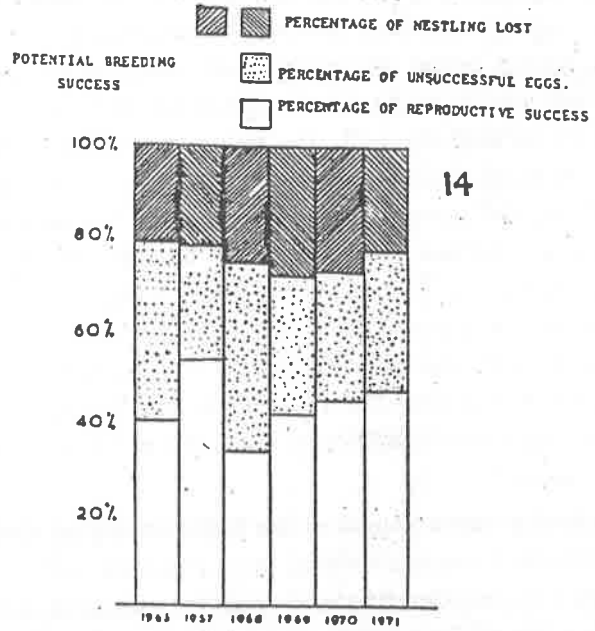

Fig. 14. The effects of mortality factors in reducing breeding success.

Van Tyne and Berger (1959) state that the percentage of young surviving to nest leaving varies widely among different species; within the same species it varies geographically, seasonally and annually. Nice (1957) stated that the success rate of open nests of altricial birds in the North Temperate Zone ranged from 38 to 77%, averaging 49 and the fledging success ranged from 22 to 70%, averaging 46. The potential breeding success, among the birds of prey, may be reduced by one cause and/or another to an actual level of productivity, which is usually only half the potential or less (Brown and Amadon, 1968). They further state that probably the most important single factor controlling breeding success and productivity is food supply, and it may act upon one or several of the other causes to produce the final effect.

Reproductive Performance and Rainfall :

From the reproductive data of the Painted Stork collected for six breeding season, it is evident that the year 1967 was most productive in all respects as compared to the other five years. In contrast, the year 1968 was the least productive. Reproductive performance improved again in the year 1969 and during the following years. The 1966 season

was better as compared to 1968 in terms of productivity but less successful than the seasons of 1967, 1969 and 1971. In fact the reproductive performance during the 1971 was the second best during the six seasons. During the years 1969 and 1970, there was little variations in the reproductive performance, similarly productivity during the year 1966 and 1969 was also at par.

As discussed earlier the breeding cycle of the Painted Stork is very closely related to the highest availability of food and the food density or availability depends on the water levels at the feeding grounds *i.e.* food availability proportionately varies with the amount of rainfall.

There was unusually high rainfall in 1967, consequently there was an abundance of food for the Storks during the breeding season following heavy rains which probably accounted for the highest number of nestlings reared (1.33) per pair during that year. The low reproductive performance in 1968 could have direct relation to the character of their nutrition during the breeding season of that year when the rainfall record was poor which in turn must have influenced the fish population and thus the poor food supply must have resulted in low reproductive performance (only 0.8 young reared per pair). In the year 1971 again there was high amount of rainfall and consequently the reproductive performance was relatively much better (1.26 young per pair). The amount of rainfall received during the years 1969 and 1970 and 1966 and 1968 did not show striking variation (Table 1) and the reproductive data of these years also showed similar trends. Tables 11, 13 and Fig. 15 give the comparative picture of the reproductive performance and of rainfall of different years.

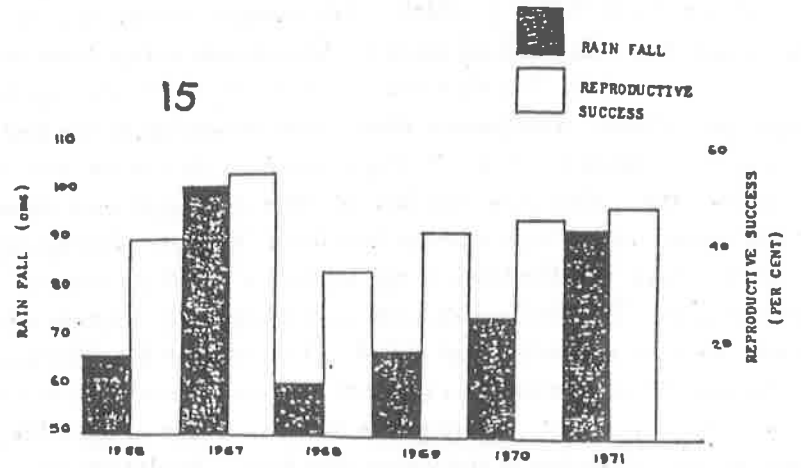

Fig. 15. Reproductive success and rainfall during six breeding seasons at the Delhi Zoological Park.

Although the present data is inadequate for a full analysis of the subject and various other factors may also have been responsible for the variations in productivity, it seems likely from the above data, that a certain degree of correlation exists between the reproductive success and the rainfall which influences the availability of food.

SUMMARY

Reproductive pattern of the Painted Stork was studied during the six consecutive nesting seasons at the Delhi Zoological Park from 1966-1967 to 1971-19·2. The breeding season commenced in early september during the last phase of the rainy season each year when the fish were available in large quantities. Correlation between food supply and onset of breeding are thus amply clear. Maximum testicular weights was seen during September to October, but the actual breeding starts in September when environmental conditions favour reproduction.

After congregation of birds at the Colony, on the onset of breeding season, male birds establish territories. Paires are formed, when after repeated attempts the females are allowed to enter the territory of the male birds. Duration of copulations averaged about ten seconds. Four to eight days were spent by the nesting pairs to construct their nests. The males played major part in collection of the nest material while females arranged the material brought by the males. The first egg of a clutch was generally laid within one to three days after completion of the nest. A total of sixty eggs averaged 69.583 mm (± 2.056 S.D.) in length and 43.916 mm (± 1.496 S.D.) in width. The average weight of sixty eggs was 74.01 gm (± 0.643 S.E. of mean). Clutch size varied from one to four but clutches of 2 to 3 eggs were most common, the average being 2.49 eggs per clutch. Incubation starts with the laying of the first egg and both sexes incubate by turn. Average period of incubation was found to be 30.16 days. Maximum number of nests with eggs were observed during the second half of September to middle of October. The egg laying period of 20 days and the rates of egg laying for the three seasons were generally similar. The chicks hatch out a synchronously because incubation starts as soon as the first egg is laid. The average hatching success during the present study was 68.44 per cent Overall mortality rate among chicks was 35.71 per cent. During the first two weeks of their life, the mortality among chicks due to starvation was high. Predation accounted for 49.09 per cent of total mortality rate among chicks. Mortality due to

accidental fall from trees, diseases and other unknown reasons accounted for a small percentage (12.72).

The nestling period ranged from 100 to 140 days, the average for 10 young being 115 days. Even after the young were fledged, they remained in nests for several weeks to roost at night and part of the day.

Data on reproductive success in 15 nests marked for close observation showed that 68.44 per cent of the total eggs laid during the six consecutive seasons hatched and 75.58 per cent of the chicks fledged. The overall reproductive success was 44.0 percent or 1.1 young fledged per nest. Since the availability of food (fish) for the Painted Stork depends on the water levels at the feeding grounds (i.e., food availability proportionately varies with the amount of rainfall), the reproductive performance of the Painted Stork at the Delhi Zoological Park during the six nesting seasons seemed to bear a certain degree of correlation with the amount of rainfall.

REFERENCES

Ali, S. 1968. *The book of Indian Birds*. Bombay Natural History Society, Bombay, India (Also Editions of 1961 and 1963).

Ali, S. and Ripley, D. S. 1968. Handbook of the birds of India and Pakistan. Vol. I Oxford University Press, Bombay. London. New York.

Allen, R. W. and Nice, M. M. 1952. A study of the breeding biology of the Purple Martin (*Progne subis*). *Amer. Midl. Nat.*, 47 : 606-665.

Badshah, M. A. 1965. Breeding colony of Painted Stroks. *Peacock*, 3 : 15-17.

Baker, E. C. S. 1929. The fauna of British India including Burma and Ceylon. Birds VI. Taylor and Francis, London.

Baker, E. C. S. 1932. Nidification of the birds of the Indian Empire 1. Taylor and Francis, London.

Baker, E. C. S. 1935. Nidification of the birds of Indian Empire 4. Taylor and Francis, London.

Berger, A. J. 1957. Nesting behaviour of the House Sparrow. *Jackpine Warbler*, 35 : 86-92.

Bissonnette, T. H. 1930. Studies on the sexual cycle in birds. *Amer. Jour. Anat.*, 45 (2) : 289-305.

Bissonnette, T. H. 1930. Studies on sexual cycle in birds. *Amer. Jour. Anat.*, 46 (3) : 477-497.

Bissonnette, T. H. 1932. Light or exercise as factors in sexual periodicity in birds. *Science*, 76 (1969) : 253-255.

Bissonnette, T. H. 1932. Light and diet as factors in relation to sexual periodicity. *Nature*, 129 (3260) : 12.

Blair, W. F.; Blair, P.; Brodkorb, P.; Cagle, F. R.; Moore, G. A. 1957. Vertbrates of the United States. McGrow-Hill Book Company, Inc., New York.

Brody, S. 1945. Bioenergitics and growth. New York : Reinhold.

Brown Leslie and Dean Amadon. 1968. Eagles Hawks and Falcons of the World. Vil. I, Country Life Books, Hamlyn Publishing Group Ltd.

Desai, J. H. 1975. Ph.D. Thesis submitted to the M. S. University of Baroda, Baroda-2, India.

Dharmakumarsinghji, R. S. 1954. Birds of Saurashtra. Author, Bombay.
Disselhorst, R. 1908. Gewichts and Volumszunahmen der mannlichen Kumdrussen bei Vogeln und Sauzern in der Parrungszeit. *Anat. Anz.*, 32 : 113.
Elton, C. 1942. Voles, mice and lemmings. Oxford.
Galushin, Vladimir M. 1971. A huge urban population of birds of prey in Delhi, India, *Ibis*, 113 : 552.
Gilbert, P. A. 1936. Some notes on *Hypotaenidia Phillipenses*. *Emu*, 36 : 10-13.
Goodfellow, C. F. 1958. Display in the Hamerkop, *Scopus umbretta Ostrich*, 29 : 1-4.
Haverschmidt, F. 1949. The life of the white stork. Leiden : E. J. Brill.
Heinzman, G. and Heinzman, D. 1965. Nesting of the Wood Stork. *Natural History*. Vol. LXXIV, 4 : 30-34.
Kahl, M. P. 1962. Bioenergitics of Growth in nestling Wood Storks. *Condor*, Vol. 64, 3 : 169-183.
Kahl, M. P. 1964. Food ecology of the Wood Stork (*Mycteria americana*) in Fiorida. *Ecol. Monogr.* 34 : 97-117.
Kahl M. P. 1966. A conrbution to the ecology and reproductive biology of the Marabou Stork (*Leptoptilos crumeniferus*) in East Africa. *Jour. Zool.*, 148 : 289-311.
Kahl, M. P. 1966. Comparative Ethology of the Ciconiidae. Part I, The Marabou Stork, *Leptoptilos crumeniferus* (Lesson). *Behaviour*, Vol. 37 : 76-106.
Kahl, M. P. 1972. A taste for survival—In : The Marvels of Animal Behaviour. Ed. by Thomas B. Allen. National Geographic Society.
Keast, S. A. and Marshall, A. J. 1954. The influence of drought and rainfall on reproduction in Australian desert birds. *Proc. Zool Soc.*, London, 124 : 493-499.
Kluijver, H. N. 1951. The population ecology of the Great Tit, *Parus M. major L. Ardea*, 39 : 1-135.
Lack, D. 1940. Pair formation in birds. *Condor*, 42 : 269-286.
Lack, D. 1947. The significance of clutch-size. *Ibis*, 89 : 302-352.
Lack, D. 1948. The significance of clutch-size. *Ibis*, 90 : 25-45.
Lack, D. 1954. The Natural Regulation of Animal Numbers. Clarendon Press, Oxford.
Lack, D. 1966. Population Studies of Birds. Clarendon Press, Oxford.
Lack, D. 1972. Ecological adaptations for breeding in birds. Chapman and Hall, London.
Lamba, B. S. 1963a. The nidification of some Common Indian Birds Part I. The common Indian House Crow, *Corvus splendens* (Vicillot), with notes on brood parasitism on it by the Indian Koel, *Eudynamys scolopacea* (Linn.). *J. Bom. Hist. Soc.*, 60 : 121-133.
Lamba, B. S. 1963b. The nidification of some Common Indian Birds. 4. The common Myka (*Acridotheres tristis*, Linn.) *Res. Bull. Punjab Univ.*, 14 : 11-20.
Lamba, B. S. 1963c. Nidification of some common Indian Birds. 7. The spotted billed or Grey pelican (*Pelecanus phillippensis* Gmelin) *Pavo*, 1 : 110-119.
Lamba, B. S. 1965b. Nidification of some Common Indian Birds. 9. The Indian Hoopoe, *Upupa epops ceylonensis*, Reichenbach. *Proc. Zool. Soc.*, Calcutta, 18 : 97-106.
Linsdale, J. M. 1933. The nesting season of birds in Doniphan County, Kansa. *Condor*, 35 : 155-160.
Lynes, H. 1925. On the birds of North and Central Darfur. *Ibis*. 1967 : 399-401, 550.
Mackworth-Preed, G. R. and Grant, C. H. B. 1957-60. Birds of Eastern and North Eastern Africa. Series I. Vols. 1-2. 2nd. Ed. Longmans, Green London.
Moreau, R. E. 1944. Clutch size : A comparative study with special reference to African birds. *Ibis*, 86 : 286-347.
Moreau, R. E. 1950. The Breeding Seasons of African birds—1 Land Birds. *Ibis*, 92 : 223-267.

Naik, R. M. and Razack, A. 1967. Studies on the House Swift, *Apus affinis* (G. E. Gray) 8.. Breeding seasons and their regulation. *Pavo*, **5** : 75-96.

Nelson, O. E. 1953. Comparative Embryology of the Vertebrates. The Blakiston Company. Inc., New York 982.

Nice, M. M. 1937. Studies in the life history of the song. Sparrow. *I. Trans. Linn. Soc. N.Y.*, **4** : 1-247.

Nice, M. M. 1954. Problems of incubation periods in North American birds. *Condor*, **56** : 173-197.

Nice, M. M. 1957. Nesting success in Altricial Birds. *Auk*, **74** : 305-321.

Owen, D. F. 1960. The nesting success of the Heron *Ardea cinerea* in relation to the availability of food. *Proc. Zool. Soc. Lond.* **133** : 597-617.

Richdale, L. E. 1952. Post-egg period in Albatrosses. Dunedin, New Zealand. Published by Auther.

Rol'nik, V. V. 1968. Bird Embryology. Academy of Sciences of the U.S.S.R. Sechenov Int. of Evolutionary, Physiology and Biochemistry. Translated by Israel Program for Scientific Translations, Jerusalem, 1970.

Romanoff, A. L. and Romanoff, A. J. 1949. Avian Engg. Chapman and Hall. London.

Rowan, W. 1925. Relation of light to bird migration and developmental changes. *Nature*, **115** (2892) : 494-495.

Rowan, W. 1927. Migration and reproductive rhythm in birds. *Nature*, **119** (2992) : 351-352.

Schuz, E. 1942. Bewegungsnormen des Weissen Storchs. *Z. Tierpsychol.*, **5** : 1-37.

Schuz, E. 1942. Bestandsregelnde Einflusse in der Umwelt des Weissen Storches *C. ciconia*. *Zool. Jahrb. Syst.*, 75 : 103-120.

Schuz, E. 1943. Uber die Jungenaufzucht des Weissen Storches (*C. ciconia*). *Zeit. fur. Morph. Und. Okol. der Tiere*, **40** : 181-237.

Schuz, E. 1972. Other stork species. In—Grzimek's Animal Life Encyclopedia. Ed-in-chief Dr. H. C. Bernhard Grzimek. Van Nostrand Reinhold Company.

Skutch, A. F. 1949. Do Tropical birds rear as many young as they can nourish? *Ibis*, **91** : 430-458.

Skutch, A. F. 1950. The nesting seasons of Central American Birds in relation to climate and food supply. *Ibis*, **92** : 185-222.

Skutch, A. F. 1954. Life histories of Central American Birds. Pacific *Coast Avifauna*, No. **31.**

Skutch, A. F. 1957. The incubation Pattern of birds. *Ibis*, **99** : 66-93.

Smythies, B. E. 1953. *The birds of Burma*. Oliver and Boyd, London.

Summers-Smith, D. 1955. Display of the House Sparrow *Passer domesticus*, *Ibis*, **97** : 292-305.

Tretyakova, E. I. 1938. Otsenka Kachestva yaitsa do inkubatsii (Evaluating Egg Quality prior to Incubation). —*Sovetskoe Ptitsevodstvo*, Vol. **12** : 15.

Tretyakov, N. P. 1951. Inkubatsiya yaits sel'skokhozyaistvennykh ptits (Incubation of Poultry Eggs)—Moskava, Sel'Khozgiz.

Van Tyne, J. and Berger, A. J. 1959. Fundamentals of ornithology. John Wiley and Sons. Inc., New York. London. (Also Edition of 1958).

Wislocki, G. B. 1943. Studies on growth of deer antlers : II. Seasonal changes in the male reproductive tract of the Virginia deer (Odocoileus).

Wislocki, G. B., Joseph, C. Aub and Charles, M. W. 1947. The effects of gonadectomy and the administration of Testosterone propionate on the growth of antlers in male and female deer. *Endcrinology*, 49 (3) : 202-224.

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FEATHER LOSS FROM THE CAPITAL TRACTS RELATED TO GROWTH AND MATURITY OF THE PAINTED STORKS. II- DISTRIBUTION OF GLYCOSAMINOGLYCANS AND PHOSPHATASES IN THE INTEGUMENT

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PROGRESSIVE transformation of the capital feather tracts into an apteric zone as a normal feature during post-hatching development and maturity of the Painted Storks (*Ibis leucocephalus* PENNANT) and evidence for secretory function of the secondarily formed apterium has been reported earlier (Shah *et al.*, 1977). Morphogenesis and acquisition of functions are known to be preceded by chemodifferentiation exemplified by accumulation and/or loss of chemical components, enzymes etc (Moog, 1965): Of considerable importance in this respect are the glycosaminoglycans and nonspecific phosphatases, implicated in a number of biological functions including secretory activities and development and organogenesis of integumentary derivatives (Dapson, 1970; Moog, 1965; Koning and Hamilton, 1954: Hamilton 1965; Shah and Menon, 1971; 1974). Changes in the relative contents of various types of mucopolysaccharides noted during development and aging in vertebrate are considered as significant developmental events (Lash *et al.*, 1974) and phosphatases are known to accumulate in tissues prior to their attainment of functional maturity (Moog, 1965). Though there is a gamut of information available on the significance of these chemical constituents in development of feathers, practically nothing is known about their concentration and distribution pattern in avian skin accompanying transformation of previously feathered region into an apteric zone, and hence the present study was undertaken.

MATERIAL AND METHODS

Sequence of plumage development, feather loss and accompanying changes in the integument are described earlier (Shah *et al.*, 1977).

(Pavo, Vol. 15, Nos. 1 & 2, pp. 155 to 163, 1977)
(Published in 1978)

Nestlings of Painted Stork were obtained from the natural nesting colony at the Delhi Zoological Park, New Delhi, India. Stages were selected and biopsy samples of skin were taken from the birds under local anaesthesia as described in the previous publication. From a biopsy sample, small pieces of skin were fixed in Bouins fluid and cold 10% neutral formalin. Paraffin sections were stained with Alcian blue as well as Alcian blue-PAS techniques for demonstration of glycosaminoglycans (mucopolysaccharides) as per methods described by Pearse (1960). Sections of 10-15 μ thickness were cut on a Pelcool (MSE) freezing microtome from the formalin fixed tissue for histochemical localization of phosphatases. In case of immature (1 year old) and adult (2 years and above) birds, the skin from apteric zone with the adjoining parts of feather tracts was taken so as to have a comparative idea of enzymological differences in the two adjoining regions of the skin which are morphologically different. The azo dye coupling method described in Sigma Technical Bulletin No. 85 (1971) was used for demonstration of acid and alkaline phosphatases, with Napthol AS–MX phosphate as the substrate and Fast Blue RR salt as the dye. An incubation time of 4 hours was found to be satisfactory for the skin. The skin sections treated prior to incubation with distilled water at 80°C served as controls.

OBSERVATIONS

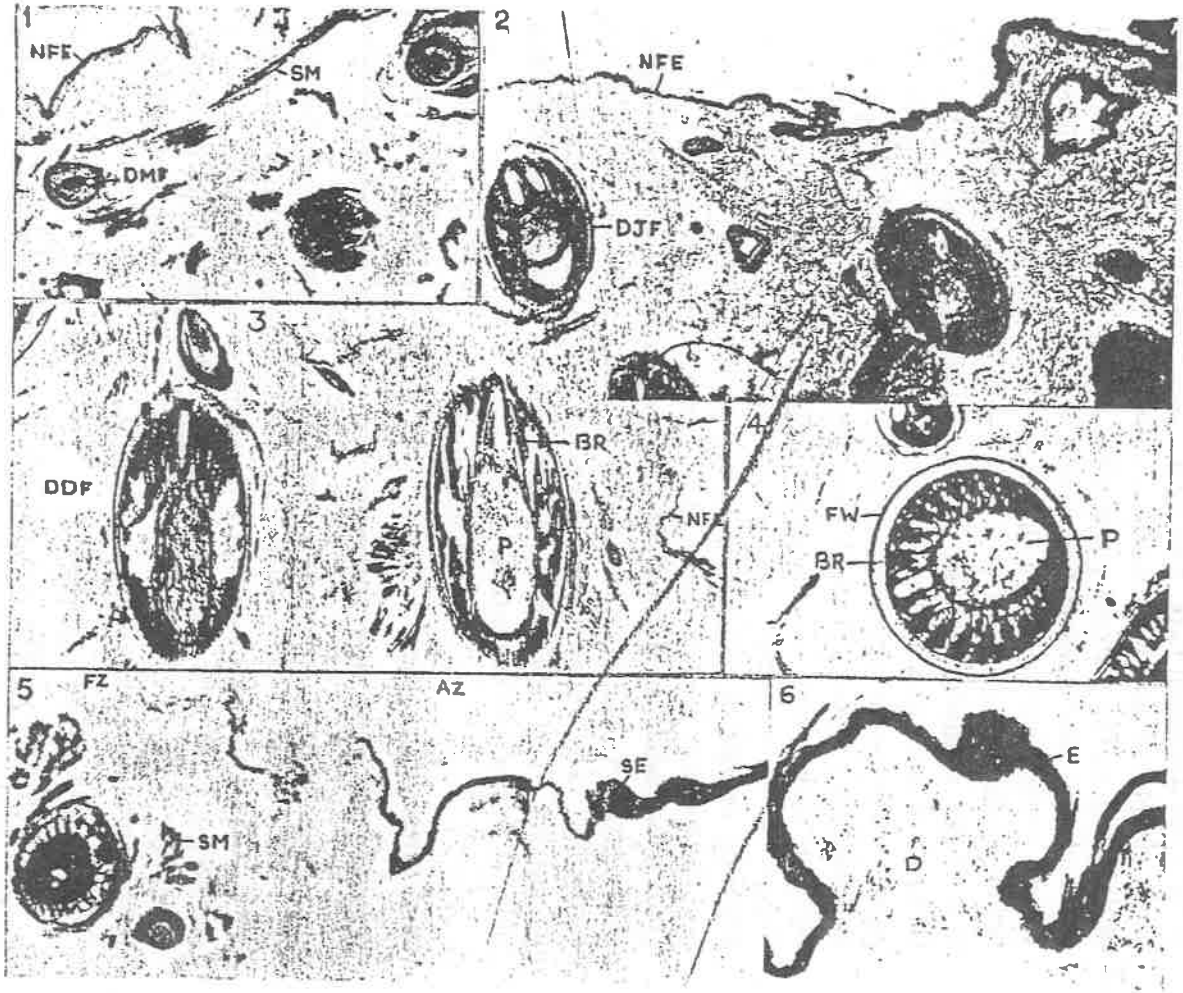
(A) Glycosaminoglycans

Nestlings with natal down feathers:

All components of the skin, especially the epidermis, stained intensely with alcian blue. With AB-PAS staining, it appeared that most of the superficial part of dermis was non-alcianophilic but PAS positive, whereas the deeper parts were stainable with both. Pulp cells of the developing mesoptiles were faintly stained with PAS as well as alcian blue while feather epithelia were strongly alcianophilic.

Nestlings with mesoptile feathers:

Strong alcianophilia was noticed in the components of developing contour feathers (which were to replace the mesoptiles in near future) and interplumar epidermis. Distal parts of the developing feathers where keratinization was advanced, were PAS positive whereas the proximal regions where keratinization was poor were alcianophilic and PAS negative. Interplumar epidermis was also faintly stained with PAS technique. Dermis exhibited only a weak alcian blue positive staining. Increased PAS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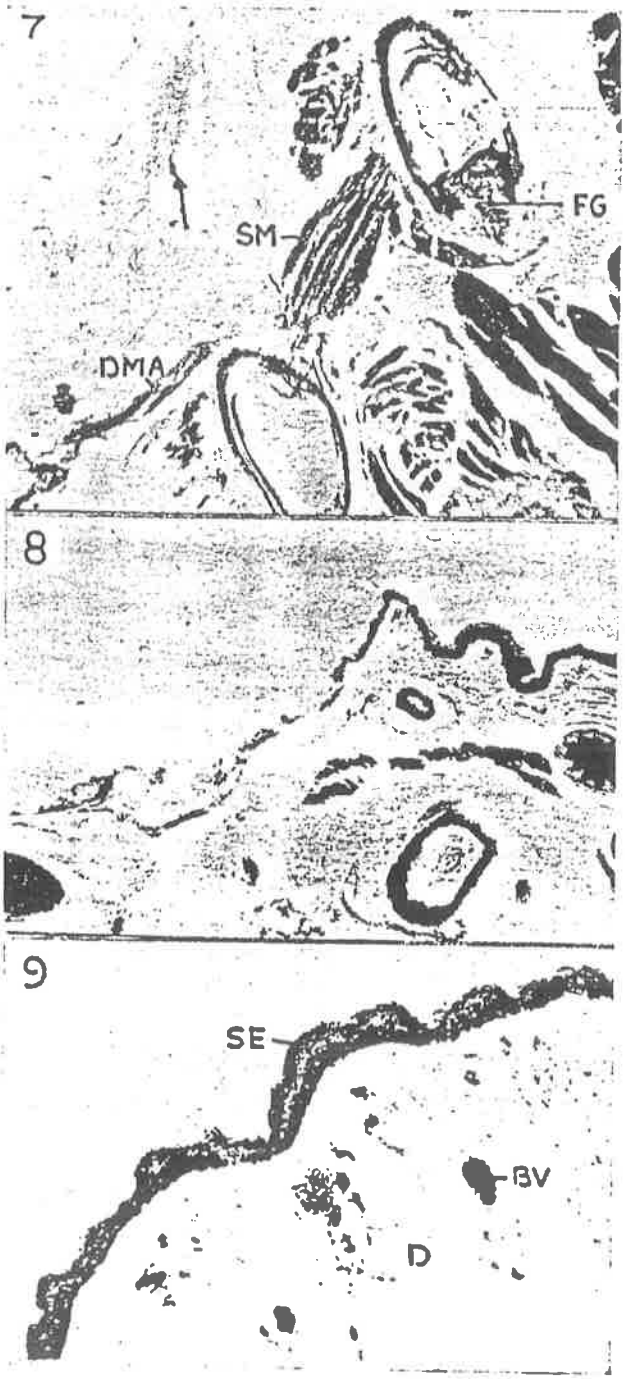
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EXPLANATION FOR FIGURES

Fig. 1. Section of skin from a five day old Painted Stork showing alkaline phosphatase activity in developing mesoptiles and other components.

Fig. 2. Section of capital skin from a painted Stork chick bearing mesoptiles. Note the enzyme activity in developing juvanal feathers.

Fig. 3. Section of capital skin bearing juvanal feathers. Note the enzyme reactivity in feather components.

Fig. 4. Transverse section of a Juvanal feather showing alkaline phosphatase reactivity.

Fig. 5. Section of skin passing through the secondary apterium as well as feather tracts of a one year old stork. Note abrupt increase in the enzyme activity in epidermis of the apterium.

Fig. 6. Epidermis from the apterium of one year old bird, showing intense enzyme activity in the epidermis.

Fig. 7. Feather follicles bordering apterium in an year old strok. Note that the muscles in anterior portion with less enzyme activity, also shows degenerative changes.

Fig. 8. Photomicrograph showing transition from low to high alkaline phosphatase activity in the junction of apterium and feather tracts.

Fig. 9. Photomicrograph showing epidermis and dermis from a portion of the secondary apterium from an adult, showing the enzyme activity.

ABBREVIATIONS

AZ—Apteric zone; BR—Barb ridges; BVS—Blood vessels; D—Dermis; DDF—Developing definitive feathers; DJF—Developing juvanal feathers; DMF—Developing mesoptiles; DMA—Dystrophic muscles; EPM—Errector ptilorum muscles; FZ—Feathered zone; FG—Feather germ; FW—Follicular wall; NFE—Nonfeather epidermis, P—Pulp; SM—Smooth muscles; SE—Secretory epidermis;

positive staining in most of the components of the dermis was noted as compared to that in the corresponding tissues during the previous stage.

Juvanal storks with contour feathers :

The crown skin of birds at this stage was strongly alcianophilic in most of the components including the feathers which may be at various stages of their development. PAS positive staining was noticed in the connective tissue components of the dermis and also in pulp cells of feathers though with a lower intensity in the latter.

Immature (1 year old) with partial feather loss from head:

Striking differences observed between feathered and secondarily formed apteric zones was also reflected in the distribution of acid mucopolysaccharides. While all the components of skin in the feathered area in general, were alcianophilic (with the exception of a mild PAS staining in some of the dermal components), only the epidermis in the apteric zone was strongly alcianophilic whereas the dermal components were strongly PAS positive.

Adult storks with fully formed capital apterium :

Like in the previous stage, in the crown region that has now become apteric, only the epidermis was alcianophilic whereas dermis was intensely PAS positive. Most of the skin components in the feathered areas of cervical region adjoining the capital apterium were predominantly alcianophilic.

(B) Phosphatases :

Nestlings with natal down feathers :

All the skin components were negative for acid phosphatase reactivity. However, strong reactivity for alkaline phosphatase was noted in the pulp and epithelial cells of the developing mesoptiles and smooth muscles of the follicles. While stratum germinativum of the inter-plumar epidermis showed low enzyme activity, the other components remained negative. (Fig. 1).

Nestlings with mesoptile feathers:

Distribution and intensity of reactivities of acid and alkaline phosphatases in all the components of the skin resembled that observed in the previous stage (Fig. 2)

Juvanal storks with contour feathers:

Acid phosphatase activity was nil in the skin components, as was the case in both the previous stages, while alkaline phosphatase reactivity

was noted in the components of developing feathers; smooth muscles of follicles, interplumar epidermis and blood vessels in the dermis (Fig. 3 & 4). The enzyme response was intense in the pulp cells of feathers and smooth muscles compared to that in other components of the skin.

Immature (1 year old) storks with partial feather loss from the capital tracts :

Acid phosphatase activity was not discernible in any of the skin components. In the feathered areas, alkaline phosphatase activity was high in the feather germs and smooth muscles while it was low in the interplumar epidermis (Fig. 5). In the stratum germinativum of the epidermis in the secondarily apteric zone, the enzyme response was comparatively very high (Fig. 6). The sharp change in enzyme distribution pattern from the feather tracts to the apterium was noted. Resting germs of feathers that are adjacent to the apterium (and which are destined to be lost in the subsequent moult whereby the whole capital tracts will be converted to apterium) exhibited an intense reactivity for the alkaline phosphatase. Errector ptilorum muscles in the feather tracts adjacent to the apterium; which extend into the apteric zone, showed the enzyme response only in parts that are very close to the follicles; whereas the structural details and enzyme reactivity were obscured and diminished respectively in the parts of muscles extending into the apteric zone (Fig. 7).

Adult storks with fully formed capital apterium :

Like in the previous stages, acid phosphatase reactivity was nil in the epidermis of capital apterium. However, a very faint indefinite and diffused reactivity for the enzyme was noticed in the dermis of this region. As for alkaline phosphatase, the stratum germinativum in the apterium showed intense histochemical response; whereas in the dermis only capillary walls were enzyme reactive (Fig. 9). No trace of feather germs or follicular muscles could be discerned in the apteric zone even by using the histochemical localization of the enzyme as a tool. In the feather tracts of cervical region adjoining the capital apterium, the pattern of distribution and intensity of enzyme reactivity was similar to that noticed in the feather tracts of capital tracts in the immature storks. As far as the interplumar epidermis is concerned, transition in the pattern of enzyme reactivity from feathered to apteric zone was abrupt and highly conspicuous (Fig. 8).

DISCUSSION

The present attempt to characterize the glycosaminoglycans (GAG) in the integument from capital region of the Painted Stork revealed that

the relative amount of alcianophilic (sulphated) and PAS positive (non-sulphated) components of GAG undergo changes during plumage replacement and subsequent feather loss related to growth and maturity of these birds. Variation in the localization and intensity of alkaline phosphatase reactivity that accompany such morphological and histophysiological changes in the integument are of interest, since these two chemical components have been implicated in a variety of metabolic functions of the integument and developmental processes of cutaneous appendages in vertebrates (Koning and Hamilton, 1954 ; Johnson and Bevelander, 1946 ; Hamilton, 1965). Predominantly alcianophilic response of skin of nestling storks with natal down feathers (protoptiles) indicate that most of the GAG are composed of sulphated mucopolysaccharides, localised chiefly in the interplumar epidermis, follicular muscles and developing mesoptile feathers which would soon replace the protoptiles. It is not surprising to note the presence of intense alkaline phosphatase activity in these components of the skin, since GAG and the enzyme have been accredited with significant roles in exchange and diffusion of many types of metabolites (Dunstone, 1960, Laurent, 1966 ; Raekallio, 1970), a function that is of paramount importance to tissues undergoing development and maturation. Besides, alkaline phosphatase is known to be essential for proper feather development (Hamilton, 1965) and coexistence of GAG and the enzyme in developing down feathers of chick has been noticed by Koning and Hamilton (1954). It appears from the present findings that the sulphated mucopolysaccharides are more important in the epithelial cell differentiation in developing feathers. Though the PAS positive (non-sulphated) component of GAG in the skin registered an increase by the time natal downs were replaced by mesoptiles and remained so during development of juvanal feathers, this increase was mainly noted in the dermis, while epithelial cells of the developing feathers (down and definitive) still showed alcianophilia and intense alkaline phosphatase activity which is indicative of continuing morphogenetic activity. Alkaline phosphatase has been implicated in synthesis of mucopolysaccharides (Kroon, 1952) and a multifarious role has been attributed to the enzyme during developmental process of definitive feathers (Shah and Menon, 1974). Presently noted localization of the enzyme in the errector ptilorum muscles of the integument of the storks deserves mention, since its activity was not demonstrable in the follicular muscles of the fowl (Scheen and Winkelman, 1960) or pigeons (Shah and Menon, 1974). The differences might probably be due to the histochemical methods used.

Shah and Menon (1971) demonstrated presence of acid phosphatase in the developing definitive feathers of pigeon. Presently noted absence of acid phosphatase in the feather follicles at various stages of development is a little puzzling. It is possible that the specimens from which biopsies were obtained had feathers in the early stages of development and the enzyme may be appearing in feathers at a later stage when regression of pulp occurs. Similarly, the near negative response of adult skin components to acid phosphatase activity is also difficult to explain at this juncture.

The differential and varied distribution pattern of the two types of glycosaminoglycans (sulphated and non-sulphated) and alkaline phosphatase in the feather tracts and apteric zones of skin from the capital region of immature (1 year old) and adult (2 years and above) storks in relation to feather loss is interesting. The obvious differences in morphological and histological profile between the feathered and secondarily apteric zones are also reflected in the presently studied aspects of histochemistry of the skin. While dermis in the feather tracts adjoining the apteric zone largely contained sulphated mucopolysacharides and alkaline phosphatase in many of its components, in the secondarily formed apterium the GAG of the dermis was of the non-sulphated type and alkaline phosphatase activity was nil. It is pertinent to recall here that dermal components like smooth muscles and feather papillae which had shown intense alkaline phosphatase reactivity and the presence of sulphated mucopolysaccharides disappeared from the skin during its transformation into apterium and thus the alcianophilic characteristics of dermis in this part is lost. With increase in the connective tissue mass, the dermis become more PAS positive. However, when these facts are viewed in the light of other changes occurring in the dermis *i.e.*, accumulation of lipid droplets and increase in vascularity, changes in the relative contents of GAG and loss of alkaline phosphatase activity of the dermis seem to be a significant event concerned with the functional morphogenesis of the apterium. In view of the present observations and functions attributed to alkaline phosphatase, *viz.*, involvement in the exchange and diffusion of metabolites and the implication of chondroitin sulphate and related mucopolysaccharides (AB positive) in regulation of enzymic and other metabolic processes, it becomes imperative that whatever factors cause the formation of secondarily apteric zone in the capital regions of these storks (genetic, endocrine etc.) alter the distribution pattern of these key tissue components as part of the chemical regulatory mechanism. Thus,

it is possible that loss of feather germs and associated structures like smooth muscles of the follicles, might result from loss of essential enzymes like alkaline phosphatase, and changes in the contents of glycosaminoglycans involved in enzymic and/or metabolic regulation. In the secondarily formed apteric zone, the functional state of dermis may undergo changes as could be visualised from the present findings. Disappearance of AB positive components of GAG like chondroitin sulphate; known to show a tendancy for heavy hydration; may be related to the tremendous increase in the dermal lipids accompanying transformation of capital tracts into apterium (Shah *et. al.*, 1977). Since glycosaminoglycans in the dermal matrix determins to a great extent, properties of skin, it is possible to consider that feather loss and subsequent exposure of skin necessitates changes in its physical properties. Retention of alcianophilia and high alkaline phosphatase activity in the epidermal cells of the secondarily apteric zone (as opposed to negligible activity of the enzyme in the interplumar regions of feather tracts) indicates active metabolic processes possibly related to lipoid secretion and carotinoid metabolism that occur there. Distribution of both alkaline phosphatase and glycosaminoglycans have been studied extensively in the skin glands of various vertebrates and their roles in secretory activities have by now been well documented (Kar, 1950; Das and Ghosh, 1959; Bhattacharya and Ghosh, 1958; Dapson, 1970; Dapson *et al.*, 1973). Thus, histochemical differences between the two regions of the skin, *viz.*, pterylae and apteric zone, offer a positive clue as to the differences in their functional state.

The rich colouration of the secondarily apteric skin in the capital region is due to carotinoid pigments abundant in the epidermis. Though lipids are the solvents for these pigments, it is difficult to ascertain at present whether the highly enhanced secretory activity of epidermis is solely for the purpose of colouration. In this context, it would be revealing if the seasonal secretory activity of the particular area of skin under the feathers surrounding the naked face of the Japanese Crested Ibis (*Nipponia nippon*), producing the so-called 'Black substance' (Uchida, 1970) is studied in greater detail. In this case, a characteristic behaviour of repeated rubbing of the side of head on shoulder is reported to impart the grey colour peculiar to this region during breeding season.

SUMMARY

The patterns of distribution and localization of glycosaminoglycans (GAG) and nonspecific phosphatases in the integument from capital region

of the Painted Stork, (*Ibis leucocephalus* (Aves, Ciconiformes) accompanying transformation of capital feather tracts into an apterium—a normal feature during growth and maturity of the species—was investigated histochemically. Absence of histochemically detectable acid phosphatase activity in the skin components was noticed in all stages studied, except for a negligible response in the adult. Alkaline phosphatase was found to be localised in developing feathers; resting feather germs and errector ptilorum muscles. In the secondarily apteric zone of a one year old as well as the adult storks, these components are absent and hence the enzyme activity was not detectable in the dermis. In contrast, epidermis of capital apterium, active in lipoid secretion, showed intense alkaline phosphatase activity. The interplumar epidermis in feathered areas registered only a low histochemical response for the same. Changes in the GAG composition was reflected in increased PAS positive staining of the dermis in apteric zones whereas the secretory epidermis retained intense alcianophilia. Importance of aclianophilic components of GAG and alkaline phosphatase activity in secretory activity of epidermis is realised. Qualitative changes in GAG in the skin accompanying its transformation into apteric zone is discussed in relation to possible changes in functional status and physical properties of the skin.

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REFERENCES

Bhattacharya, S. P. and Ghosh, A. 1958. Alkaline phosphatase in uropygial gland. *Curr. Sci.*, 27 : 401-402.

Bentley, J. P. 1968. The biological role of ground substance mucopolysaccharides. In "*Advances in Biology of Skin. Vol. X The Dermis.* Eds. W. Montagna, J. P. Bentley, K. L. Dobson. Appleton-Century-Crofts, Educational division, Meridith Corporation, New York.

Dapson, R. W. 1970. Histochemistry of mucus in the skin of the frog, *Rana pipiens. The Anat. Rec.*, 166 : 615-625.

Dapson, R. W., Feldman, A. T. and Wright, O. L. 1973. Histochemistry of the granular (poison) secretion in the skin of the frog, *Rana pipiens. The Anat. Rec.*, 177 : 549-560.

Hamilton, H. L. 1965. Chemical regulation of development in the feather. In. '*Biology of skin and Hair growth*' Eds. A. G. Lyne and B. F. Short., Angus and Robertson, Sydney.

Johnson, P. L. and Bevelander, G. 1946. Glycogen and phosphatase in the developing hair. *Anat. Rec.*, 95 : 193-199.

Kar, A. B. 1950. Alkaline phosphatase in the uropygial gland of normal and androgen treated pigeons. *Proc. Nat. Inst. Sci. India.*, 16 : 41-45.

Koning, A. L. and Hamilton, H. L. 1954. Localization of enzyme system, nucleic acids and polysaccharides during morphogenesis in the down feathers of the chick. *Am. J. Anat.*, 95 : 75-108.

Kroon, D. B. 1952. Phosphatase and the formation of protein-carbohydrate complexes. *Acta. Anat.*, 15 : 317-328.

Lash, J. W., Saxen, L. and Kosher, R. A. 1974. Human chondrogenesis : Glycosaminoglycan content of embryonic human cartilage. *J. Exp. Zool.*, 189 : 127-131.

Laurent, T. C. 1966. *In Vitro* studies in the transport of macromolecules through the connective tissue. *Fed. Proc.* 25 : 1128-1134.

Moog, F. 1965. Enzyme development in relation to functional differentiation In '*The Biochémistry of Animal Development*' Ed. R. Weber, Academic Press, New York and London.

Menon, G. K. 1974. Ph.D. thesis submitted to the M. S. University of Baroda, Baroda-2, India.

Pearse, A. G. E. 1960. *Histochemistry, theoretical and applied.* 2nd Edition. Little, Brown and Co., Boston.

Raskallio, J. 1970. Enzyme histochemistry of wound healing. *Progr. Histochem. Cytochem.*, 1 : 1-101.

Shah, R. V. and Menon, G. K. 1971. Histochemical studies on pigeon definitive feathers during post-hatching, induced and regenerative modes of development. I. Acid phosphatase. *Pavo*, 9 : 48-61.

Shah, R. V. and Menon, G. K. 1974. Histochemical studies on pigeon definitive feathers during post-hatching, induced and regenerative modes of development. II. Alkaline Phosphatase. *J. Anim. Morphol. Physiol.*, 21 : 8-18.

Shah, R. V., Menon, G. K., Desai, J. H. and Jani, M. B. 1977. Feather loss from capital tracts of Painted Storks related to growth and maturity. 1. Histophysiological changes and lipoid secretion in the integument. *J. Anim. Morphol. Physiol.*, 24 : 99-107.

Scheen, S. R. and Winkelmann, R. K. 1960. Alkaline phosphatase in the skin of certain animals. *Arch. Dermatol.*, 83 : 439-446.

Sigma Technical Bullettin. NO; 85. (1971). The histochemical demonstration of acid and alkaline phosphatases. Sigma chemical company, U.S.A.

Uchida, Y. 1970. On the color change in Japanese Crested Ibis. A new type of cosmetic coloration in birds. *Misc. Rep. Yam. Inst., Ornithol.* 6 : 54-72. (In Japanese with English summary).

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FEATHER LOSS FROM CAPITAL TRACTS OF PAINTED STORKS RELATED TO GROWTH AND MATURITY : 1. HISTOPHYSIOLOGICAL CHANGES AND LIPOID SECRETION IN THE INTEGUMENT.

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IN the light of recent advances in integumentary research and reconsideration of the term "Secretion", the concept of avian integument as relatively inactive as far as secretory function is concerned, has become obsolete. Functional biologists have considered even the production of hard structures like feathers as 'Secretory' function of the avian integument (Quay, 1972). Lucas and Stettenheim (1972) who furnished evidence for secretion of lipoid substances by the avian epidermis considered the whole integument as a holocrine gland. Formation of feathers involve an array of morphogenetic events following a highly complex and orderly pattern of development and hence deserve to be termed as 'organogenesis' rather than secretion. Thus the two major functions of avian integument that find morphological expression are the production of cutaneous appendages and holocrine secretion. Distribution of feathers are restricted to pterylae that are formed early during development in the life of birds, and the patterns of which are species specific. Sengel and Kieney (1967) have shown that in avian embryos, feather germs could be experimentally induced to develop in areas normally destined to become apteric zones, and thus demonstrated the potential of the entire integument to give rise to feathers. However, development of apteric zones from previously feathered areas as a normal feature during growth and development of certain birds has received little attention despite the fact that morphological differences between natal and adult pterylosis in many birds are known. Stettenheim (1972) mentioned that head of young Sacred Ibis (*Threskiornis aethiopica*) is covered by down feathers while in adults, it becomes bare. In case of the Painted Stork (*Ibis leucocephalus*), natal

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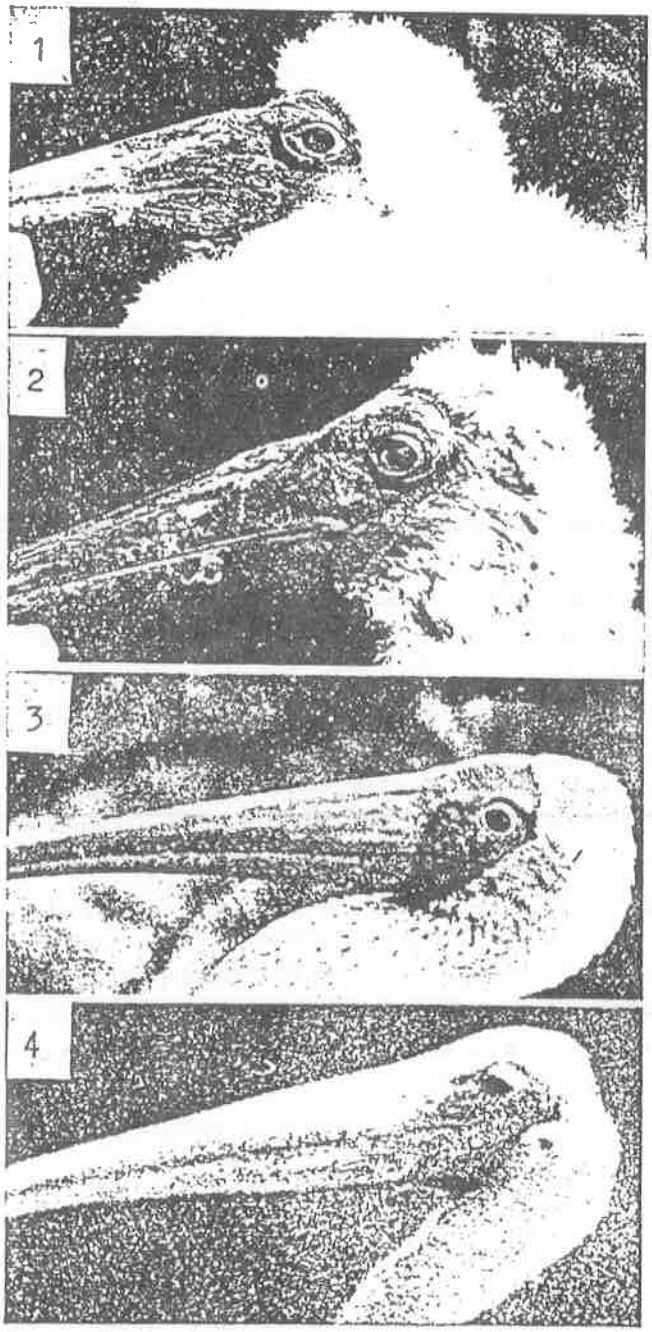
downs are replaced successively by a generation of mesoptiles and then by the contour feathers. With growth and development of the birds, these contour feathers are progressively lost from the forehead and crown; and in a two year old bird, the head becomes completely bare. The type of feathers and degree of feathering in these regions have been employed by Desai (1975) as some of the criteria for age determination in the early life of these birds. Following is the sequence of moults and feather loss from the capital tracts of Painted Stork. On hatching, the head of nestling is covered sparsely with grey natal down feathers (prosoptiles) which are subsequently replaced with white mesoptiles (after about the 10th day of post-hatching development—Fig. 1). With the subsequent moult, the mesoptiles are replaced by contour feathers (juvanal feathers which impart a grey colour to the plumage of the head which is clearly discernible by about the 45th day post-hatching—Fig. 2). These are replaced by white definitive feathers after the birds undergo post-juvanal moult. The frontal tract and anterior parts of the coronal region become bare in a one year old bird (Fig. 3), whereas the occipital region bear white definitive feathers. After the second annual moult, the coronal region and anterior parts of the occipital region also become bare and the skin of face and head turn bright yellow in colour, almost similar to that of the adult Painted Stork (Fig. 4). However, at this stage the birds are not sexually mature. Sexual maturity is attained only when they are three year old (Desai, 1975). Feather loss from the forehead and crown regions is observed in both the sexes. Though general morphological account of plumage succession and feather loss in this instance have been recorded, there is no information available on the histological and histochemical changes in the integument that accompany the transformation of feather tracts into apteric zones. It was therefore deemed worthwhile to study some of these aspects. In the present paper, observations on histological and histochemical changes as far as localization of neutral and acidic lipids are concerned, during various phases of formation of the apterium are recorded.

MATERIAL AND METHODS

Nestlings of Painted Stork, at various stages of post-hatching development were collected from the natural nesting colony at the Delhi Zoological Park, New Delhi, India. Stages were selected according to the type of feathers present on the crown region, *viz.*, prosoptiles, mesoptiles, juvanal feathers etc as described by Desai (1975). One year old storks with bare forehead and partial loss of feathers from the crown, and adult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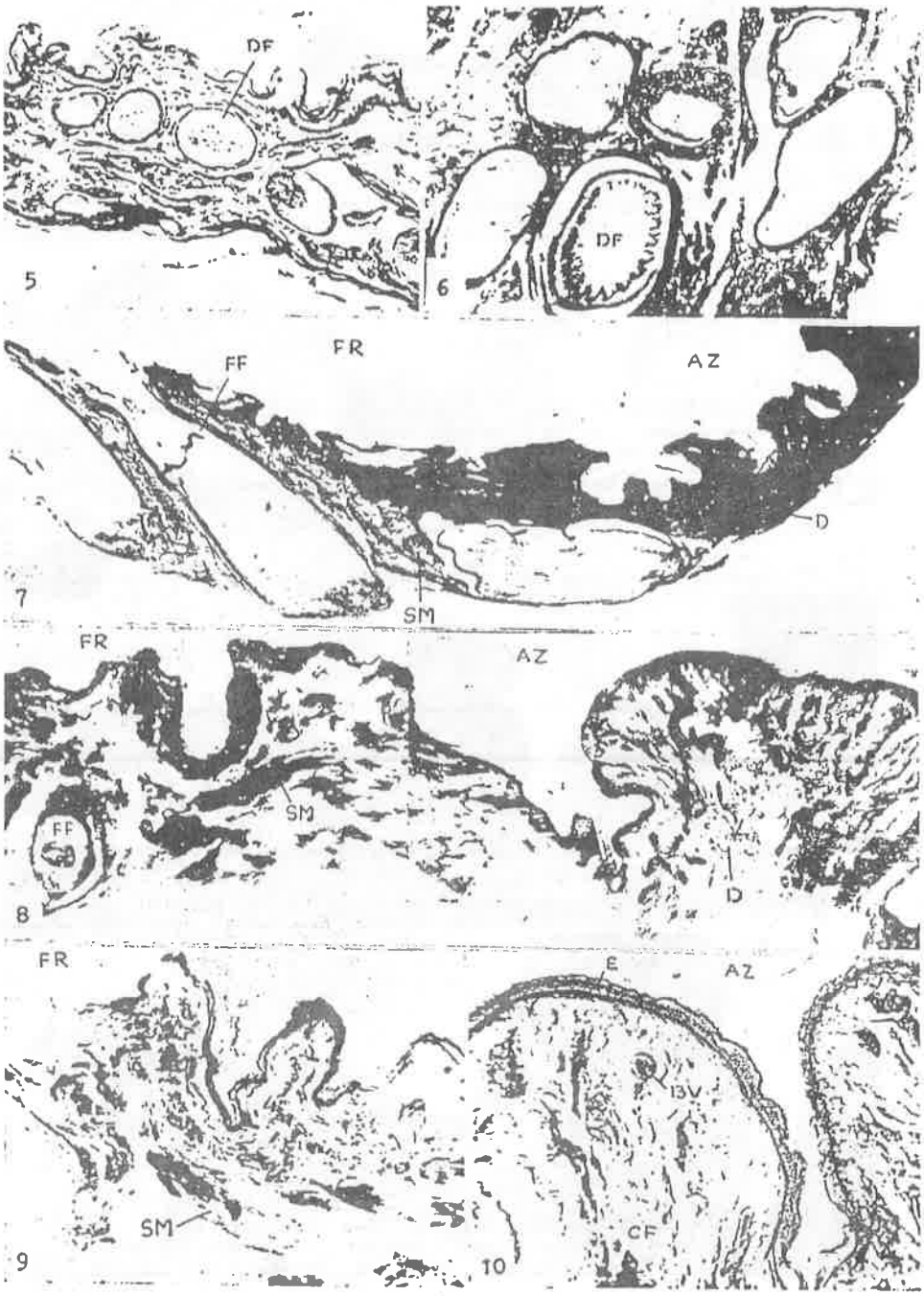
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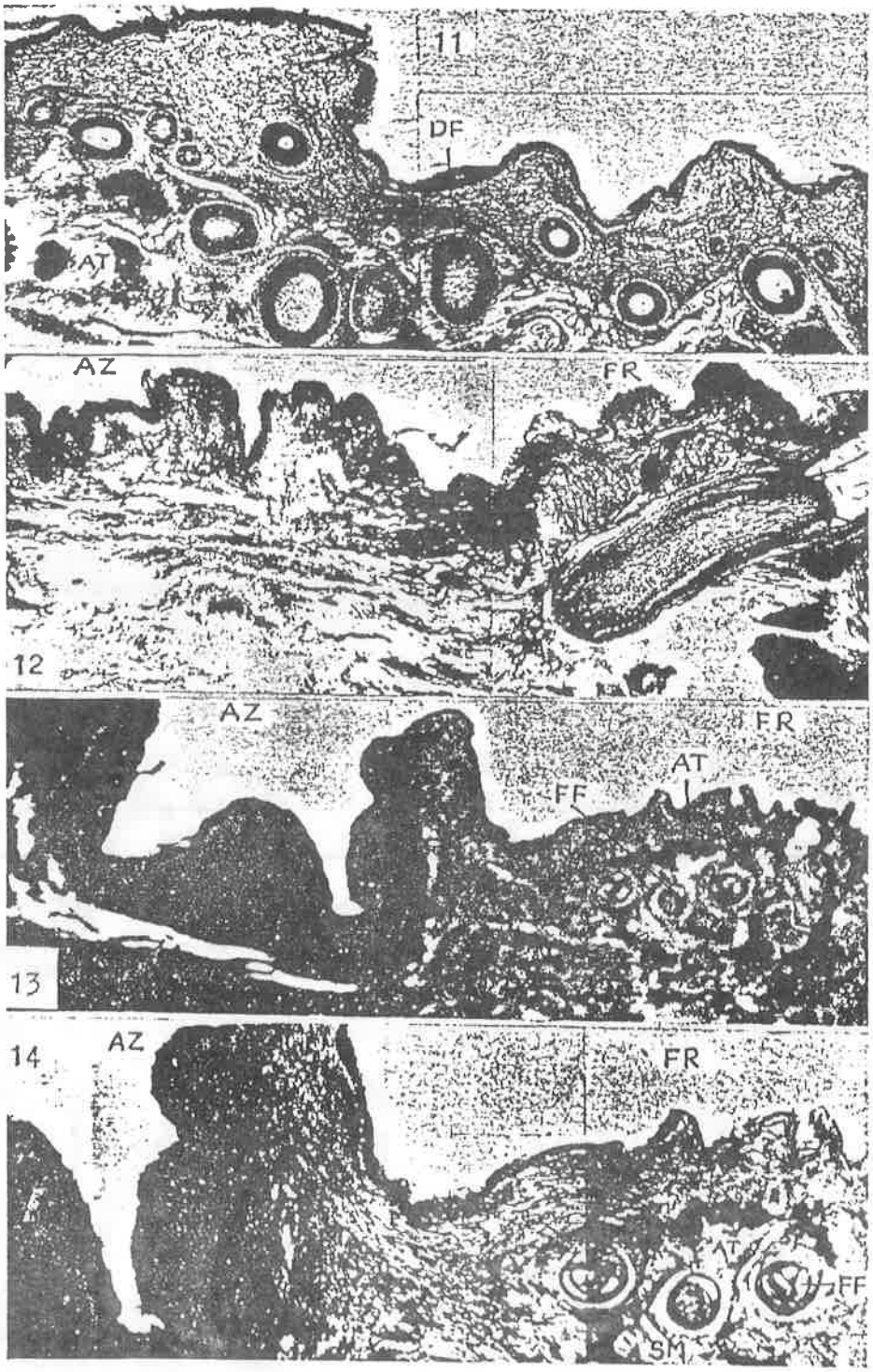
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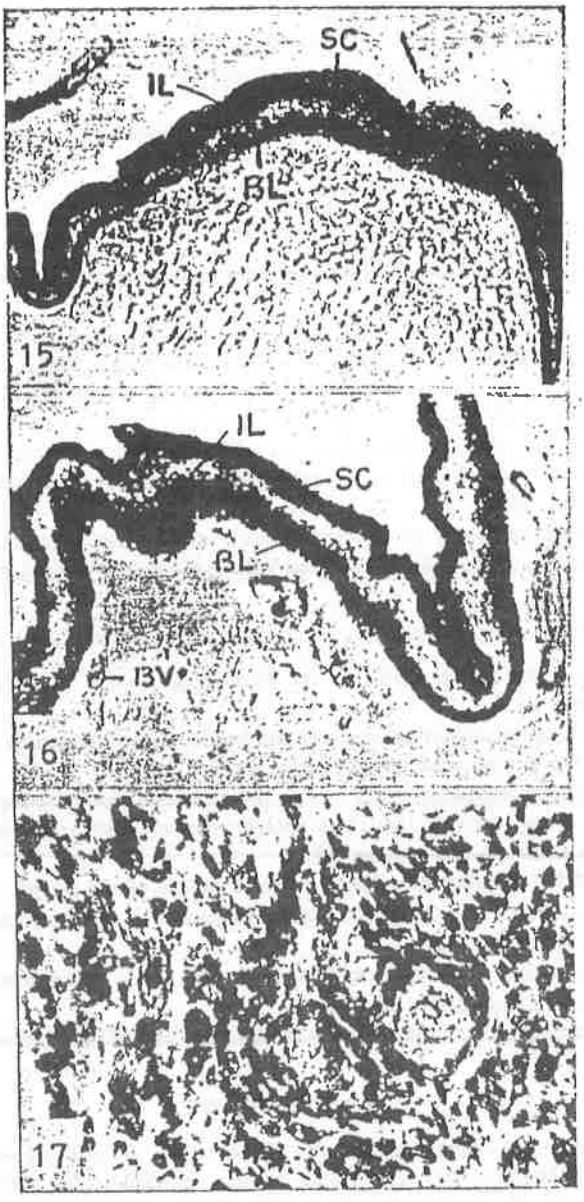
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Explanation for Figures

Figs. 1 to 4 : Gross morphology of plumage succession in the capital region and formation of apterium in the Painted Storks.

Fig. 1. Nestling (aged about 15 days) bearing mesoptiles.

Fig. 2. Nestling wherein mesoptiles are being replaced by the grey contour (juvanal) feathers. Age about 45 days.

Fig. 3. Subadult (1-year old) with partial feather loss. Note white definitive feathers in the coronal region.

Fig. 4. Adult stork with fully formed capital apterium.

Figs. 5 to 10 : Histology of the integument.

Fig. 5. Skin from capital region of a 5-day old nestling bearing natal down. Note develcping mesoptiles in follicles. 25 X.

Fig. 6. Skin from capital tract of a 45 day old nestling. Note developing contour feathers. 50 X.

Fig. 7. V. S. of skin from capital region of one-year old stork. Note feather follicles and smooth muscles in the feathered region (FR) and changes in dermis in the secondarily apteric zone (AZ). 25 X.

Fig. 8. Section of skin from coronal region and adjoining cervical feather tracts (FR) of an adult stork. Note absence of feather follicles and smooth muscles in the dermis of apteric zone. 25 X.

Figs. 9 and 10. Enlarged parts of feathered region and apteric zone respectively at same magnification (50 X). Note increased vascularity and epidermal stratification in the apteric zone.

Figs. 11 to 17 : Photomicrographs depicting distribution of neutral lipids in the integument.

Fig. 11. Distribution of neutral lipids in the developing juvanal feathers and other skin components. 25 X.

Fig. 12. Skin from capital region of one year old stork. Note differences in distribution of lipids in the apteric zone and feathered regions. 25 X.

Fig. 13. Section of skin from adult stork. Note the abrupt change in lipid concentration from feathered areas (cervical tracts) to apteric zone and differences in lipid content of epidermis from the two regions. 20 X.

Fig. 14. A part of Fig. 13 slightly enlarged to show details of the dermis. 25 X.

Fig. 15. Photomicrograph showing neutral lipid distributicn in secretory epidermis from a one-year old stork. 50 X.

Fig. 16. Photomicrograph of secretory epidermis of adult stork. Note distribution of lipids in the layers of epidermis. 50 X.

Fig. 17. Photomicrograph of part of dermis from apterium of adult stork showing neutral lipid globules. 25 X.

ABBREVIATIONS

AT—Adipose tissue; AZ—Apteric zone; BL—Basal layer; BV—Blood vessels; CF—Collagenous fibres; D—Dermis; DF—Developing feathers; E—Epidermis; FF—Feather follicle; FR—Feathered region, IL—Intermediary layer; SC—Stratum corneum; SM—Smooth muscle.

storks where transformation of the feather tracts into apterium is complete, were trapped and used for the studies. Biopsies of the skin from head region were taken under local anaesthesia. After taking biopsy material, the skin was stitched and applied with antibiotic ointment. Birds were later released. The biopsy material was always taken from the same region. The material so obtained was fixed in Bouin's fluid for histological procedures and in Baker's calcium formol for histochemical demonstration of lipids. Paraffin sections were stained with Haematoxylin-Eosin; Haematoxylin-Picro ponceau S and Mallory's triple stain as per methods described by Gurr (1956). A pelcool freezing microtome (MSE) was used for cutting frozen sections of calcium formol fixed material. Sections of 10-15 μ thickness were cut and stained with Fettrot 7 B and aqueous Nile Blue Sulphate for demonstration of neutral and acidic lipids respectively (Pearse, 1960). Control sections were treated prior to staining, with chloroform : methanol mixture (1:2 v/v). Sections were mounted in glycerine jelly. The carotinoid nature of the orange yellow pigment in the bare crown skin of adult Painted Storks was confirmed by treatment with concentrated H_2SO_4 which gives rise to a characteristic bluish colour (Pearse, 1960).

OBSERVATIONS

Histology :

Nestlings with down feathers (Fig. 5) :

Follicles with mesoptile feathers at various stages of development are seen. Interplumar epidermis was four to five cell layers thick. In the dermis, errector ptilorum muscle bundles are present though only poorly developed. Besides, adipose tissue in the early stages of formation is also discernible.

Juvanal with contour feathers (Fig. 6)

At this stage, feather follicles and juvanal feathers in various stages of development are discernible. Interplumar epidermis appears to be slightly thinner than that was seen in the previous stage. Dermis is well developed wherein well formed follicular muscles, fibrocytes, collagenous fibres and adipose tissue are observed.

Immature Stork (One-year old, partially defeathered head—Fig. 7)

While the feathered areas of skin exhibited the histological features similar to that described for the skin of juvanal birds, the areas which secondarily became apteric showed marked differences in its histological

features. Marked changes are noticed both in epidermis and dermis at the junction between the feathered and defeathered areas. Major points of difference noticed in the defeathered areas are total absence of feather follicles and loss of major part and typical pattern of follicular muscle arrangement. Feather follicles present near the junction in the feathered area have well developed follicular muscles disposed on their posterior and lateral aspects, while in the anterior ones adjacent to apteric region they were generally dystrophied, apparently due to loss of their functional use. In the dermis of the apteric zone, considerable increase in the vascularity and reduction in the number of dermal fat cells is noted. Besides, extensive development of collagenous fibres is the most striking histological feature of the dermis wherein a few remnants of muscle fibres and adipocytes are still detectable. Epidermal hyperplasia and stratification resulted in the formation of thick epidermis in the apteric region.

Adult stork (*Figs. 8., 9 & 10*).

The bare skin on the head of adult Painted Stork showed considerable wrinkles. The epidermis in this part has become highly stratified due to hyperplasia. Compactness of the dermis, which is characteristic in the feathered region, is lost in the apteric region wherein the collagen fibres are interspersed with lipid globules. The lipid gets removed during processing for histological preparation and hence these places appear as empty spaces in the dermis. Presence of lipoid globules is confirmed in frozen sections. High degree of vascularity is also noticed in the apteric regions where most of the vessels are confined to the superficial part of dermis. A few scattered muscle fibres (remnants of well formed muscle bundles of the feather follicles of earlier stages) are observed, however, no distinct adipose tissue cells or rudiments of feather follicles could be seen in the secondarily formed apteric zone.

Histochemical Observations on Distribution of Lipids :

Nestlings with prosoptiles and mesoptiles :

In the skin from capital region of a 5-day old stork nestling, moderate amounts of neutral lipids are observed in the cells of stratum germinativum of the interplumar epidermis, pulp cells of the developing mesoptile feathers and adipose tissue cells present in a scattered manner in the dermis. Other components of the dermis, including the smooth muscles had a low neutral lipid content. Acidic lipids, though low in concentration, were noticed in components of the developing feathers and smooth muscles.

In the nestlings bearing fully formed mesoptiles with definitive feathers developing within their follicles (Fig. 11), the skin components *viz.*, all parts of interplumar epidermis and adipose tissue which is well formed by now, registered an increased content of neutral lipids. Compared to these, other dermal components and the developing contour feathers showed only a moderate level of neutral lipid concentration. Acidic lipid content was fairly high in the epithelial cells of the developing feathers, smooth muscles of the follicles and cells of stratum germinativum of interplumar epidermis, but the fibrocytes showed only a low concentration of this metabolite. Cells of stratum corneum did not reveal presence of acidic lipids in them and were stained pink with Nile Blue Sulphate which indicated presence of large amount of neutral lipids.

Juvanals with contour feathers :

Moderate neutral lipid content was noticed in all the parts of the interplumar epidermis and pulp cells of juvanal (contour) feathers at different stages of development. Dermal components (except adipose tissue) exhibited quite low concentration of neutral lipids. Acidic lipid content was high in components of developing feathers and stratum germinativum of interplumar epidermis. Muscle fibers and fibrocytes had moderate amount of this type of lipids. However, cells of stratum corneum showed only a poor concentration of neutral lipids.

Immature stork (One-year old—Fig. 12).

The sharp demarcation observed at this stage in the histological features between feathered and the bare regions of the crown skin (secondarily formed apterium) was also evident in the distribution pattern of lipids in these regions. While the neutral lipid content in the epidermal components of the interplumar region in the feathered areas was low, the basal and corneous layers of epidermis in the apteric region had very high neutral lipid content (Fig. 15). However, in this region, the transitional layers had more acidic lipids. In the dermis of feathered region, follicular muscles and the resting feather germs exhibited moderate neutral lipid content. Similarly, the dermal components in the apterous zone showed moderate amounts of neutral lipids.

Adult storks with completely bare head (Figs. 13 & 14).

Striking differences in lipid content and distribution pattern between the feathered and apteric zones in the skin of occipital region of adult storks was noticed (the apteric zone mentioned here corresponds to the

feathered portion in immature birds, and feathered region corresponds to skin from the dorsal cervical region confluent with the capital apterium). Whereas the feathered region had only a low lipid content in the inter-plumar epidermis, feather follicles and dermal components with the exception of adipose tissue, the apteric zone showed tremendous amounts of neutral lipids in epidermis and dermis, in spite of the fact that there is a near total loss of demarcated distinct adipose tissue and muscles, and complete lack of feather follicles (Figs. 16 & 17). Distribution of acidic lipids was of the same pattern as noticed in the crown skin of immature storks-the transitional layer of epidermis being rich in acidic lipids and the corneous and basal layers in neutral lipids.

DISCUSSION

Histological and histochemical profile of skin from the crown region of Painted Storks during the post-hatching development and replacement of successive plumage generation conform to the general pattern known for all birds. Presence of lipids in avian integument and their significance in normal metabolic processes as also in development of integumentary derivatives are by now well established (Bell and Thathachari, 1963; Matoltsy, 1969; Lucas and Stettenheim, 1972; Shah and Menon, 1972).

Observations made on some of the histological and histochemical changes that accompany partial feather loss from the head (that is, from the frontal tract of the capital tracts) which in a one year old stork results in transformation of that region into an apteric zone, are quite noteworthy. The most striking histological features observed in the apteric region are, total absence of feather follicles, loss of follicular muscles and their pattern, almost complete loss of well defined dermal adipose tissue, acquisition of high degree of vascularity in the superficial parts of the dermis and increased stratification of the epidermis. Absence of feather follicles could be due to complete degeneration of the feather germs resulting in their total demolition in the secondarily apteric zone probably by a process of programmed cell death, which is a normal feature of organogenesis during embryogenesis of many species of animals (Saunders, 1966). Thus, unlike the hairless mutant mice (Rigdon and Packchanian, 1974), where the animals lose hair during post-natal period and become bare, but possess microscopic features of hair follicles in their so called nude skin, the skin in the forehead region of Painted Stork once it becomes featherless, loses even the follicle structure and the follicular

muscle pattern. Stages of feather germ degeneration in the crown skin of storks have not been observed which perhaps may be due to the fact that such degeneration occurs within a very short time during either moulting period or just after it. Unfortunately the material collected was not during either of these periods mentioned. Detailed studies during these periods are needed to clarify this aspect of the problem. The mechanism of moulting before the skin becomes bare, would be of interest in this connection, since Watson (1963) has shown that normal moulting results from the old feathers being pushed out by the developing feathers of the next generation. The loss of follicular muscles and their pattern of arrangement appears to be mainly due to extensive fibrosis in the smooth muscles. Similar changes are noted in the coronal tracts accompanying further loss of feathers from this region and its transformation into apteric region in the adult storks.

It is feasible to visualise the concomitant changes in distribution pattern of lipids as an apparent adaptation to a secondarily acquired form and function of this part of the integument. The tremendous increase in dermal lipids would enhance the flexibility of the secondarily apteric skin which is subjected to considerable stretching during the diverse and ritualised social displays that are used for communication by the aphonic adult storks. The varied distribution pattern of the two types of lipids, *viz.*, neutral and acidic, in the different layers of the epidermis noticed herein reflect alterations in lipid metabolism associated with the functional maturation of secretory epidermal cells—aptly called as hybrid "keratinosebocytes" (Freinkel, 1972)—that finds expression in production of waxy esters and decline in phospholipid content accompanying cornification.

Results of the present study clearly underscores the fact that adult avian integument bearing feather tracts has the potential to be transformed into apteric zones. Such transformation which results in loss of one function *i.e.*, production of feathers, also involves an enhancement of the other functional activity of the integument, *viz.*, holocrine secretion— which no more remains confined to the former interplumar regions, but become so active in regions where formerly feathers existed. Feather loss (and suppression development of feather germs) resulting in the formation of temporarily bare regions, as a function of the endocrine system is known in birds which develop the incubation patch during the breeding seasons. It is also known that the incubation patch in House Sparrow shows increased integumentary lipid contents (Selander and Yang, 1966) and increased

lipoid secretion by the hyperplastic epidermis (our unpublished observation). It may be safely assumed that the permanent loss of feathers from the capital feather tracts accompanying normal growth and development of the Painted Storks and exaggerated secretory activity by the newly formed apterium could be as a result of certain hormonal interplay. Comparatively higher secretory activity in the capital apterium noted in the adult storks (sexually mature) could be attributed to the breeding season whence the hormonal levels are predictably high. In this context it is feasible to assume that the high lipid content of epidermis observed in the secondarily apteric region of skin of adult stork is also for providing solvent medium for carotinoid pigments which gives bright colouration to the skin, and in fact, this part of skin becomes increasingly brighter in colouration owing to such pigments during the breeding season. The epidermal lipids are known to serve as a solvent for carotinoids (Vericak, 1938), and would also be helpful in maintaining the exposed skin flexible and soft and prevent dessication and cracking of the epidermis. The acquisition of hypervascularity in the subepidermal region can be of thermoregulatory advantage. If so, the epidermal lipids could be of considerable value in curtailing excess of evaporative water loss from the integument.

SUMMARY

Morphohistological changes and distribution pattern of lipids in integument from the crown region of Painted Stork, *Ibis leucocephalus* PENNANT, were investigated during selected stages of post-hatching development to study the transformation of capital feather tracts into an apterium which is a normal feature associated with growth and maturity of the birds of this species. While the forehead and anterior part of the coronal region become bare in a one-year old stork resulting from loss of definitive feathers, whole of coronal and anterior portions of occipital regiors are also transformed apteric in a two-year old bird. Histological changes in the secondarily apteric skin include loss of feather follicles, follicular muscles and adipose tissue while the epidermis shows highly exaggerated activity as regards lipoid secretion. Based on the findings in this instance and in other functional integumentary modifications like incubation patch in birds, a hypothesis in proposed that the loss of one function (production of feathers) results in an enhancement of the other functional activity of the skin, *viz* , holocrine secretion. Possible functional significance of the secondarily formed apterium and the enhanced lipoid secretion by epidermis is discussed.

ACKNOWLEDGEMENT

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REFERENCES

Bell, E. and Thathachari, Y. T. 1963. Development of feather keratin during embryogenesis of the chick. *J. Cell Biol.*, 16 : 215-223.

Desai, J. H. 1975. Ph.D. thesis submitted to the M. S. University of Baroda, Baroda-2, India.

Freinkel, R. K. 1972. Lipogenesis in epidermal differentiation of embryonic chick skin. *J. Invest. Dermatol.*, 59 : 332.

Gurr, E. 1956. *A practical manual of Medical and Biological staining techniques.* Leonard Hill (Books) Ltd., London.

Lucas, A. M. and Stettenheim, P. R. 1972. *Avian Anatomy : Integument* II. Agriculture handbook, 362, United States Department of Agriculture.

Matoltsy, G. A. 1969. Keratinization of the avian epidermis an ultrastructural study of the new born chick skin. *J. Ultra structure Res.*, 29 : 438-458.

Pearse, A. G. E. 1960. Histochemistry, theoretical and applied. 2nd Ed. Little, Brown and Co., Boston.

Quay, W. B. 1972. Integument and the environment. Glandular composition, function and evolution. *Amer. Zool.*, 12 : 95-108.

Rigdon, R. H. and Packchanian, A. A. 1974. Histological study of the skin of congenitaly athymic 'nude' mice. *Tex. Res. Biol. Med.*, 32 : 711-724.

Selander, R. K. and Yang, S. Y. 1966. The incubation patch of the House Sparrow, *Passer domesticus*, Linnaeus. *Gen. Comp. Endocrinol.*, 6 : 325-333.

Saunders, J. W. Jr. 1966. Death in embryonic systems. *Science.*, 154 : 604-612.

Sengel, P. and Kieney, M. 1967. Production d'une ptéryle supplémentaire chez l'embryon de Poulet. I. Etude morphologique. *Archs Anat. microsc. Morph. exp.*, 56 : 11-30.

Shah, R. V. and Menon, G. K. 1972. Histochemical studies on Pigeon definitive feathers during post-hatching, induced and regenerative modes of development. III. Lipids, lipase and β-hydroxy butyrate dehydrogenase. *Pavo.*, 10 : 30-42.

Stettenheim, P. R. 1972. "The integument of Birds" in *Avian Biology*, Vol. II. Ed. D. S. Farner, Academic Press, Inc., New York and London.

Vericak, T. D. 1938. Neues über Auftreten und Bedeutung von Fettsubstanzen in der Guflügelhaut (speziell in der Epidermis). *Z. Mikrosk-Anat. Forsch.*, 44 : 119-130.

Watson, G. E. 1963. Mechanism of feather replacement during natural moult. *Auk.*, 80 : 486-495.

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短 報 Short Notes

Growth and development of the Pariah Kite *Milvus migrans govinda*

J. H. Desai* and A. K. Malhotra*

Among the birds of prey, there is considerable variation in the length of the fledging periods. The small Merlin fledges in twenty five days and the large California Condor in five months (Lack 1972). Since the nestlings are highly vulnerable to predators and adverse environmental conditions during early phase of life, it is advantageous for them to grow as fast as possible as it shortens the critical period and adds to their survival value.

The purpose of the present study is to provide data on growth pattern of the Pariah Kite and the extend the scope of existing knowledge about the species.

Material and methods

The present study was carried out at the Delhi Zoological Park where the Pariah Kites nest on various tree species, growing naturally in the park. During 1973-75 ten chicks from six nest were removed for hand rearing up to the fledging stage. At the time of removal all the ten chicks were ten days old.

Of the ten chicks, three were fed on pieces of buffalo calf meat and the remaining seven were given small fishes, cut into small pices. The chicks were fed four times a day during the first twenty days and 2-3 times thereafter. At each feeding the meat or fish pieces were dipped in water and kept in front of the chicks. Sometimes the chicks picked up food readily themselves while at other times they were helped. The total quantity of food intake at each feeding and the total food consumption per day was recorded. In addition, ten chicks reared naturally by parents in seven nests were marked. Measurements of their growth in terms of body weight, length of culmen, tarsus, middle toe and longest primary were recorded weekly upto 42 days.

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Growth and development

At hatching the young Pariah Kite were very feable and weak in appearence. It was sparsely covered with light brown prosoptiles. The down was dense at the dorsal surface but the ventral surface of the body was almost naked. It was not able to stand on its feet, but was able to lift and rotate its head on the neck and it squeaked frequently.

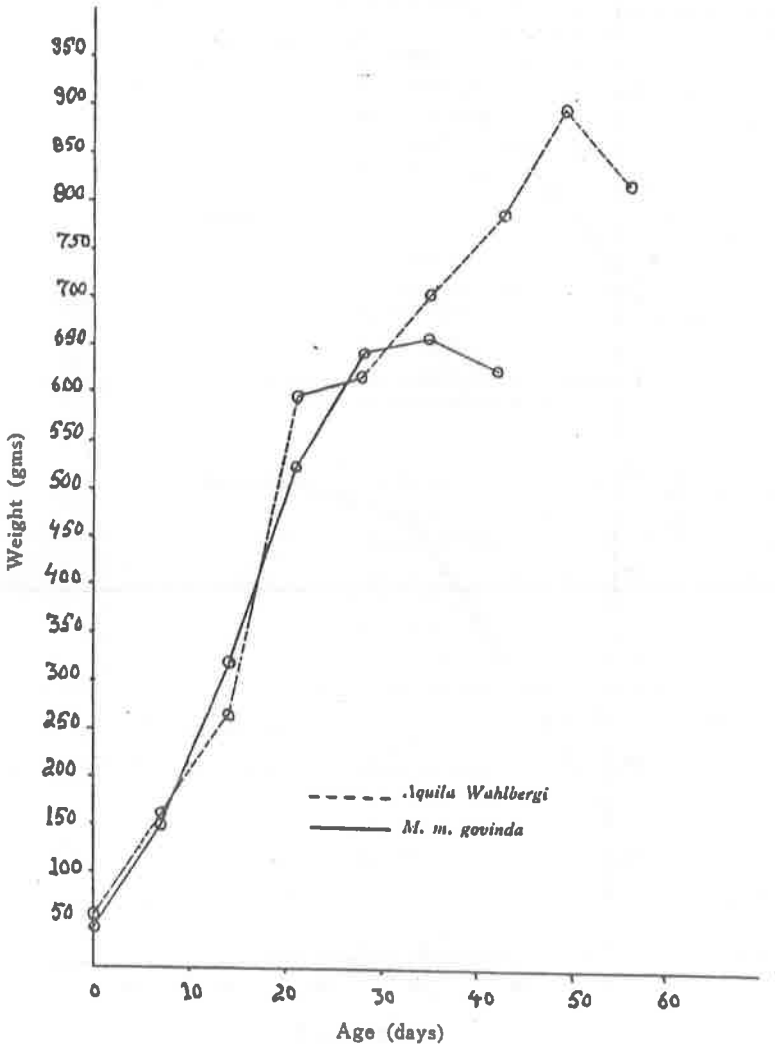

Fig. 1. Mean growth in body weight of ten nestlings of Pariah Kite (*M. m. govinda*) at Delhi Zoological Park, compared with *Aquila wahlbergi* (Brown & Amadon 1968).

The average weight at hatching of twenty five chicks of Pariah Kite was 43.72 gms. During the first week after hatching, the increase in the weight was slow but in the 2nd and 3rd week it gained rapidly. Between the 4th and 5th week the weight increased at a slower rate. It was found that at six weeks of age the chicks lost weight (Fig. 1).

This decrease in body weight in case of the Pariah Kite occured at the fledging period.

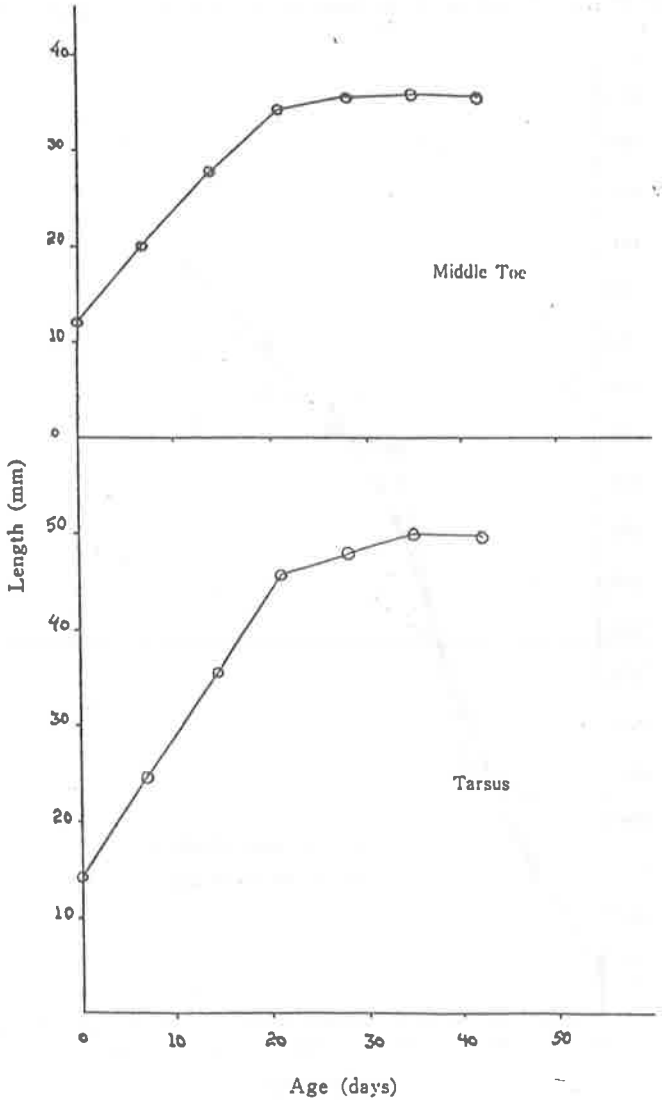

Fig. 2. Mean increase with age of two body parts in ten nestlings of Pariah Kite (*M. m. govinda*) at the Delhi Zoological Park.

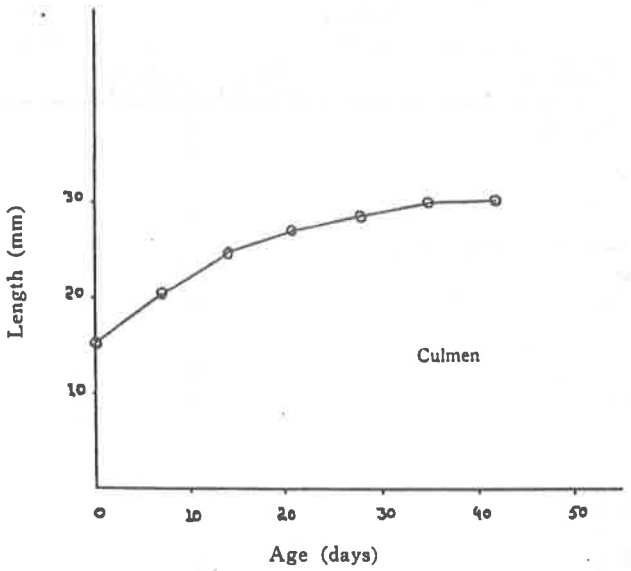

Fig. 3. Mean increase with age of culmen of ten nestlings of Pariah Kite (*M. m. govinda*) at the Delhi Zoological Park.

Similar decrease in body weight at the time of fledging period in case of *Aquila wahlbergi* has been reported by Brown and Amadon (1968). They (Brown & Amadon 1968) mention that this reduction in weight was correlated with the reduction in feeding frequency by the parents. The period of maximum growth was between 7th to 21st day as indicated by the gross gain in body weight.

The average growth of the tarsus and middle toe of ten chicks were approximately similar to that of the body weight. During the first three weeks of life the growth of these two components was rapid. This rapid growth of tarsus and middle toe was checked during the 4th and 5th week while during the 6th week it continued to grow uniformly (Fig. 2). The culmen developed more or less at a uniform rate from hatching till fledging stage (Fig. 3), however, it continued to grow for quite sometimes after the young left the nest. The average size of culmen of 10 adulats measured 36.6 mm. In larger species of birds of prey the growth of the tarsus and the bill is practically completed by half way through the fledging period or a little later (Brown & Amadon 1968). The longest primary feather first broke through the skin between 10 to 12 days (Table 1) and attained maximum rate of growth between 22nd to 35th days of age, it was still growing at a slower rate at the end of 42 days (Fig. 4). Various authors (Portmann 1945, Sumner 1933, Weller 1957, Kahl 1962, Brown & Amadon 1968) have suggested that the development of flight feathers in young birds may cause a reduction in the growth of other body parts. Thus during the period of maximal growth of the longest primary feather, the growth rate of other components,

Table 1.

Development of Flight Feathers	Age of nestling in days First observed	Common
1) Calamus over the body	3	3-4
2) Primaries	10	10-12
3) Secondaries	12	12-14
4) Rectrices	12	12-15
5) Vaxillum on Primaries and Secondaries	19	19-20
Motor development		
1) Standing on toes	24	24-26
2) Wing flapping	30	30-35
3) First flight	46	46-66
4) Flying out of tree	56	56-76

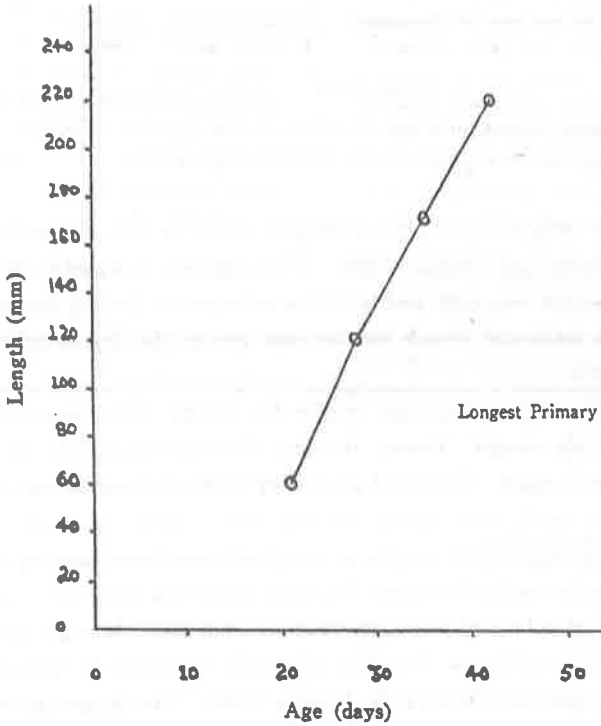

Fig. 4. Linear growth of longest primary of ten nestlings of Pariah Kite (*M. m. govinda*) at Delhi Zoological Park.

namely body weight, middle toe and to some extent culmen decreased indicating that the flight feathers competed with the other body parts in utilizing the energy.

It was observed that the general development and growth pattern of the ten handreared

nestlings was similar to those of naturally reared youngs in 1973-74; 1974-75.

The Pariah Kite chicks showed faster rate of growth during the first week and gained 3.6 times its weight at hatching. At the age of 21 days it reached more than half (525.5 gms.) of its adult size. The rapid increase in weight dropped after 4th week and by the 6th week it started losing weight. In case of *Accipiter minullus* and *Aquila wahlbergi* the weight starts decreasing at the age of 20 and 29 days respectively according to Brown and Amadon (1968).

Motor development and gross morphological changes

The motor development and gross morphological changes from hatching to fledging of the Pariah Kite was recorded and are briefly summarized as follows.

Age	Remarks
0 to 5 days.	The newly hatched chick of Pariah Kite was weak but able to raise its head and rotate it. It squeaked frequently. Its eyes were black, tarsii were pink while toes were of dark green colour. It was covered with dark brown prosoptiles. On the second day the area around naval started becoming dark where as on 3rd day black colour calamus appeared. On the 4th day the pink colour of tarsus faded and toes become dark. The chick was unable to stand on its feet.
6 to 10 days.	The calamus became more prominent and started replacing the filoplumes. The primary feathers emerged. The chick was capable of making short movements on tarsii in nest. Squeaking become louder and of longer duration when someone approached the nest. Toes and tarsii were dark in colour.
11 to 15 days.	Filoplumes replaced with dense woolly, mesoptiles. Movements became more coordinated. On 13th day the toes and tarsii become uniformly white. The chick was still unable to stand on toes. Brown and Amadon (1968) state that in case of Red Kites (*Milvus milvus*) the chicks are entirely downy till fourteen days of age.
16 to 20 days.	Sense of defence developed. It bit strongly when approached. Primaries, Secondaries and Rectrices grew at a faster rate. The Vaxillum appeared on the 19th day. In Red Kites the feathers break through at 20 days of age (Brown & Amadon 1968).
21 to 25 days.	Sense organs well developed. When approached, it defended strongly by biting and moving away. It was able to stand on toes on 22nd day with the aid of extended wings and became capable of standing on toes on 25th day without support. The body was covered by dark brown plumage. According to Brown and Amadon (1968) the body feathers appear through the down at about 20 days, grow rapidly to cover the back by about 25 days in case of Black Kites.
26 to 30 days.	Movements perfectly coordinated. It started flapping its wings.
31 to 35 days.	The nestling acquired more or less the size of an adult kite with dark brown feathers all over the body. Flapping of wings was frequently observed. It was able to pick up food from the floor of the nest and also developed the tearing habit. The toe and tarsii were of grey whitish colour. The young still solicited food from its parents.
36 to 40 days.	It was able to perch on branches near the nest. Usually remained standing in the nest and defended vehemently by bitting and attacking with claws.

41 to 45 days. Although it usually remained away from the nest on the adjoining branches for most of the time, it still relied on parents for food.

46 to 50 days. The chick usually roosted on the branches away from the nest. All the external body parts were more or less fully developed. A few were capable of flying.

Food consumption and growth

At the Delhi Zoological Park the parents started feeding the chicks from the day of hatching. The food intake of chicks increased rapidly with age. The pattern of food consumption can be devided into three phases: —

1. Hatching to 24 days: Period of increase in food consumption
2. 25 to 31 days: Period of maximum food consumption
3. 32 to 52 days: Period of gradual decrease in food consumption.

During the early period of life the young Pariah Kite consumed much larger quantity of food in proportion to its size. The chicks captured for handrearing were found to con-

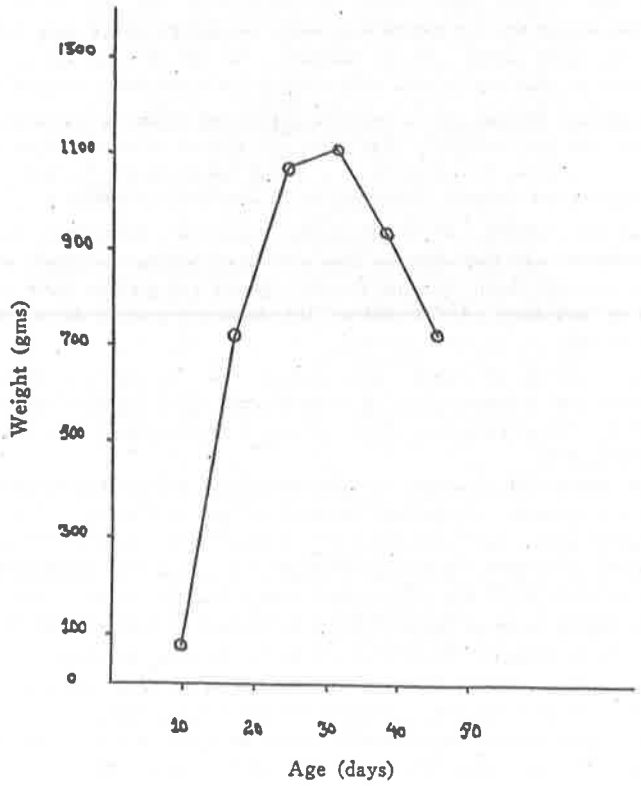

Fig. 5. Mean weekly food consumption of ten nestlings of Pariah Kite (*M. m. govinda*) at Delhi Zoological Park.

sume about 50% of own weight in food per day till they were about two weeks old. In the third week the intake of food in relation to body weight declined (33%) and by the 6th week the young consumed only 14% of their body weight in food. On the basis of average food consumption of ten nestlings, it is estimated that a young Pariah Kite consumed 5.550kg of food during 10 to 52 days of its life (Fig. 5). According to Brown and Amadon (1968) the food requirement of Peregrine is about 11-12% of its body weight in warm weather, rising to 15-16% in cold weather and the average daily food consumption varies from 80-100gms according to temperature, smaller reces probably eat less than 80gms per day in the tropics and large Arctic Peregrines consume up to 120 to 150gms.

During the study it was observed that the three chicks which were reared on only buffalo calf meat suffered from nutritional deficiency in about 8 to 10 days. They were unable to stand on their legs, their wings dropped, which later became arched and rickety and the chicks almost became paralytic. These chicks were immediately put on fish diet as given to the other chicks. The ailing chicks started showing improvement from the third day and from the fifth day onward all the three chicks were again able to stand on their feet. It was felt that the fish diet being rich in calcium and phosphate probably compensated for the deficiency resulting from the chicks being kept only on buffalo calf meat.

Graham (1976) states that all-meat diets are severly deficient in vitamin D and Calcium and are marginaly sufficient in phosphorus and that Avitominosis-A, rickets and osteomalacia, nutritional secondary hyperpara thyroidison and hypocalcesmic tetany are attributable to unsupplemented all meat diets. Young altricial birds can ingest and metabolise large quantities of food in relation to its size and grow rapidly during early life when growth efficiency is highest (Kahl 1962). Such rapid growth pattern reduces mortality among chicks from predation, starvation, adverse weather and other similar factors. By shortering the period of Vulnerability this mechanism enhances their survival value.

Literature Cited

Brown, L. and D. Amadon 1968. *Eagles, Howks and Falcons of the world.* Vol. I. Country Life Books, Hamlyn Publishing Group Ltd.

Graham, D. L. 1976. Malnutrition in captive birds of prey. in: *Wild Life Diseases.* ed. Page, L.A.: 84-94. Plenum Press, New York.

Kahl, M. P. 1972. Bioenergitics of Growth in nestling Wood Storks. Condor 64(3): 169-183.

Lack, D. 1972. *Ecological adaptations for breeding in birds.* Champan and Hall. London.

Portmann, A. 1945. Die post embryonale Entwicklung des Graureiher (*Ardea cinerea*) und ihre vergleichendbiologische Bedeutung. schweiz. Arch. Fur. Ornith. 2: 181-184.

Summer, E. L. Jr. 1933. The growth of some young raptorial birds. Univ. Calif. Publ. Zool. 40: 277-308.

Weller, M. W. 1957. Growth weight and plumages of the Redhead, *Aythya americana.* Wilson Bull. 69: 5-38.

Summary: The growth of ten nestlings of Pariah Kite raised under natural conditions during 50-75 days of nestling period was studied. Weekly measurements of weight and four body part (culmen, tarsus, middle toe and longest primary) were recorded. The increase in weight was

higher during the 2nd and 3rd week, but in the 6th week, the weight decreased considerably. It was found that the growth of the tarsus and middle toe was similar to that of body weight. The development of culmen was at a uniform rate throughout the nestling period. The longest primary reached the highest rate of growth between 22nd to 35 days of age.

Motor development and gross morphological changes in the young Pariah Kites were studied from hatching to 50 days of age and it was found that the motor development of the young Pariah Kites proceeded at a rapid rate. At the time of hatching the chicks were feable and weak, but after 15 days, they became strong enough to defend themselves by biting and attacking. The prospotiles were replaced by mesoptiles between 11 to 15 days. Feather broke out of skin between 12 to 14 days whereas in Red Kites (*Milvus milvus*) the feathers broke out at the age of 20 days. (Brown & Amadon 1968). Although the youngs started flapping their wings at about 30 days of age, they were not actually able to fly till they were 40 days of age. Food consumption of the young Pariah Kites raised in captivity was recorded weekly and on the basis of average food consumption it was estimated that a young Pariah Kite consumed 5.550kg of food during 42 days.

Pariah Kite の雛の生長と発育

J. H. デサイ　A. K. マルホトラ

Delihi 動物園構内で繁殖する Pariah Kite (*Milvus migrans govinda*) の 10 羽の雛を，1973-75 年に人工育雛し，週に 1 度体重と体の 4 部位（嘴峰，跗蹠，中趾，翼長）を測定した。雛は孵化後 10 日目より，50～75日目まで人工育雛した。雛の食物摂取量についても論じた。

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Embryonic development of Pariah Kite *Milvus migrans govinda*

J. H. Desai* and A. K. Malhotra*

Introduction

Embryonic Development of Giant Canada Goose and the Painted Stork have been studied by Cooper and Batt (1972) and Desai (1975) respectively. While studying the breeding biology, growth and development of the Pariah Kite *Milvus migrans govinda* from 1973 to 1976 in the Delhi Zoological Park, it was thought worthwhile to take up the study of embryonic development of Pariah Kite to add to the present knowledge about the growth and development.

Materials and Methods

During the period 1973–76, a detailed study regarding the breeding biology, growth and development of the Pariah Kite has been conducted at the Delhi Zoological Park. During this study 30 eggs of the Pariah Kite in the different nest were marked with India ink on the day they were laid. Individual eggs were removed from the nest to study the development of embryos at three days interval from the day of laying to the day of hatching.

As per the procedure described by Cooper and Batt (1972) and Desai (1975) the embryonic stages of the Pariah Kite were studied on the basis of the external morphological character visible to the eyes. A set of three embryos were studied for each stage of development. Embryos were photographed at each stage with 35 mm still camera. Linear measurement of the culmen were recorded from 15th day onwards. Measurements of middle toe and tarsus were recorded of embryo of 15 days and older. Length of the embryo from the top of the skull to the tip of the tail, with the culmen positioned at right angle to the long axis of the body was measured from 6th day onwards. Weight of embryos were recorded from 6 to 30 days of Age.

The following description of the various stages of the Pariah Kite embryos, takes into account the physical features of growth as well as differentiation of external characters. Measurements given are mean of three embryos.

Description

Day

0 Blastoderm was round in form and approximately 3.4 mm in diameter (Plate 1).

3 Embryo with black spot like eye distinct from yolk.

6 Eyes and limb buds were well developed. Vitelline veins prominent, head taking shape (Plate 3). Length of the embryo was 20 mm (Fig. 3) & its weight 0.7 gms (Fig. 1).

* Delhi Zoological Park, New Delhi-3 India.

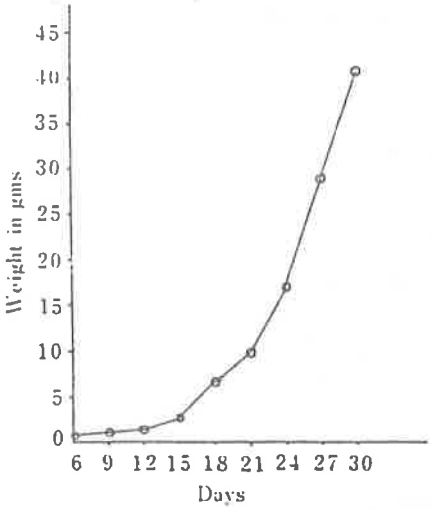


Fig. 1. Mean increase of weight of embryo of Pariah Kite at Delhi Zoological Park, New Delhi.

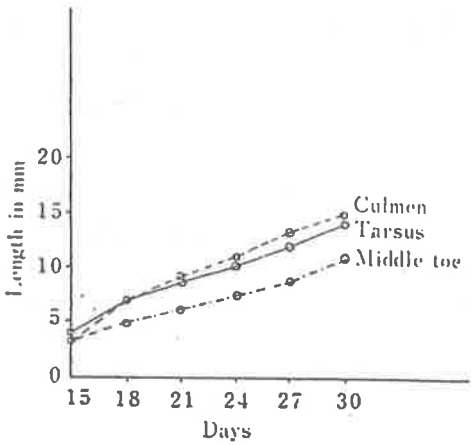


Fig. 2. Mean increase of culmen, tarsus and Middle Toe of the embryo of Pariah Kite at Delhi Zoological Park, New Delhi.

9 Eyes were convex and the head was typically avian in shape. Increase in length of neck and development of beak observed. Digital condition of the fore and hind limbs became obvious (Plate 4). Length of the embryo at this stage was 24 mm (Fig. 3) and its weight 0.87 gms (Fig. 1).

12 Eyes and head prominent. Digits on wing and feet were well differentiated (Plate 5). By this time embryo. Length was 29 mm and its total weight 1.3 gms.

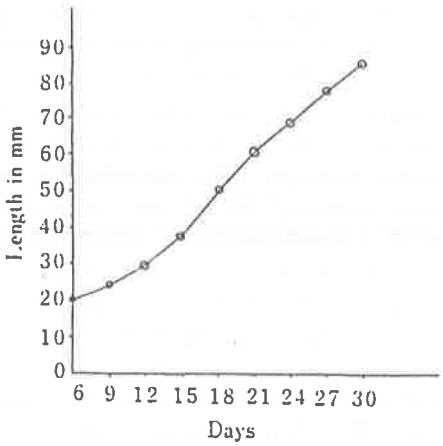


Fig. 3. Mean increase in length of embryo of Pariah Kite at Delhi Zoological Park, New Delhi.

15 Eyes and beak became more distinct. Differentiated digits of hind limbs showed rudiments of claws, (Plate 6). The culmen reached the length of 3 mm, tarsus 3.5 mm and middle toe 3 mm (Fig. 2). The total length of the embryo was 38 mm (Fig. 3) and its weight 2.6 gms (Fig. 1).

18 At this stage distinct eyelid slit above the pupil was noticeable. By this time claws on the feet became quite distinct. With the increase in size of beak, nostrils became distinct. The whole embryo was covered with long black filoplumes (Plate 7). Culmen length was 7 mm, middle toe 5 mm and tarsus 7 mm

(Fig. 2) while the total length of the embryo was 50 mm (Fig. 3) and weight 6.45 gms (Fig. 1).

21 Eyelid slit more distinct. Coat of down feathers on back, wings, legs and head was well developed (Plate 8). The claws on feet became distinct and were white in colour, while the bill has black in colour. At this stage embryo was lying along the long axis of the egg shell with its head towards airspace. The culmen length reached 9 mm middle toe 6 mm and tarsus 8.5 mm. Length of embryo was 61 mm and its weight 9.85 gms.

24 The length of down all over body increased. The well developed eyelids covered the eyes. The egg tooth well developed. The legs were much longer (Plate 9). Culmen had become stronger and reached 11 mm in length. The nostrils were more prominent. Middle toe was 8 mm in length, tarsus 10 mm (Fig. 2). The total length of the embryo was 69 mm (Fig. 3) and weight 16.90 gms (Fig. 1).

27 Body was sparsely covered with dark brown down. Allantois was almost atrophied. Eyes partly opend. Dark pigmentation around the base of bill became noticeable and area around eyes remained darkly pigmented. Skin folds on anterior surface of metatarus appeared (Plate 10). The size of the culmen was 13 mm middle toe 9 mm and tarsus 11.8 mm (Fig. 2), length of the embryo was 78 mm (Fig. 3) and its weight was 29.35 gms (Fig. 1).

30 The embryo was fully developed and showed continuous movements and squeaking. Yolk was completely drawn in and the allentois was atrophied. The body was sparsely covered by soft down feathers, dark brown on dorsal side and brownish on all other parts of the body. The chick was able to raise the neck and move it freely. The bill was made of soft texure, black in colour with a white egg tooth at the tip of beak (Plate 11). The culmen size was 15 mm, middle toe 11 mm and tarsus 14 mm (Fig. 2). The length of the embryo was 86 mm (Fig. 3) and weight 41 gms (Fig. 1).

References

Cooper, James A. and Batt, Bruce D. J. 1972. Criteria for aging Giant Canada Goose Embryos *J. Wildl. Mgnet.* 36 (4): 1267–1270.

Desai, J. H. 1975. Studies on the reproductive pattern, growth and certain behaviour of the Painted Stork (*Ibis leucocephalus*). A thesis submitted to M. S. University of Baroda, Baroda, India.

Desai, J. H. and Malhotra, A. K. 1977. Growth and Development of the Pariah Kite, *Milvus migrans govinda*. Misce. Rep. Yamashina. Inst. Ornith. 9: 88–96.

インドトビ (*Milvus migrans govinda*) の卵の発生

J. H. Desai* & A. K. Malhotra*

1973–76 年に Pariah Kite の卵 30 個を用いて，卵の発生の様子を観察した。産卵日から孵化日までの卵を数日おきに，巣から採取し，卵発生の段階を記録した。

* デリー動物園・ニューデリー，インド．

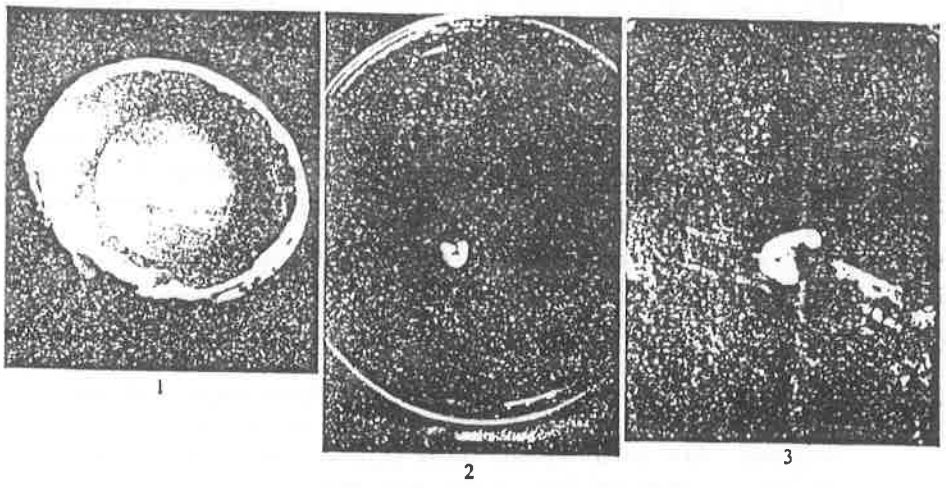


Photo. 1. 0 day old enbryo of pariah kite.
Photo. 2. 3 days old embryo.
Photo. 3. 6 days old embryo.

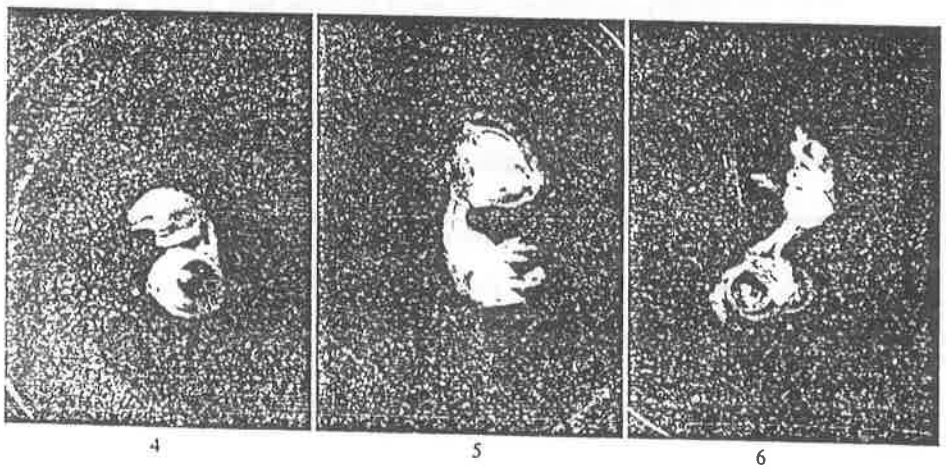
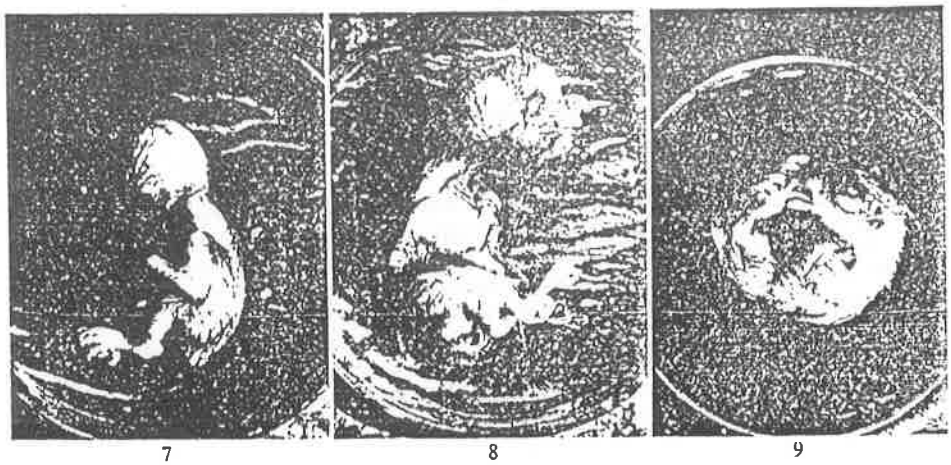
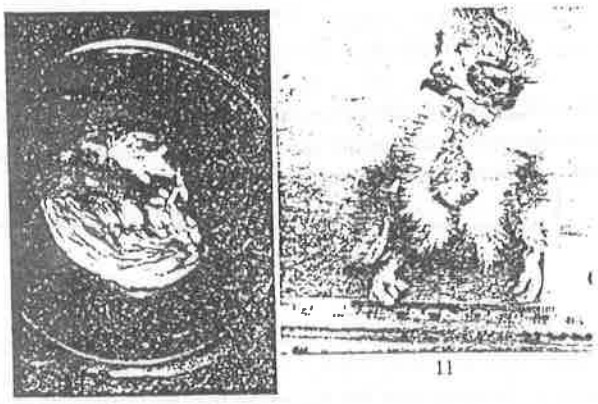


Photo. 4. 9 days old embryo.
Photo. 5. 12 days old embryo.
Photo. 6. 15 days old embryo.



7 8 9

Photo. 7. 18 days old embryo.
Photo. 8. 21 days old embryo.
Photo. 9. 24 days old embryo.



10 11

Photo. 10. 27 days old embryo.
Photo. 11. 30 days old embryo.

J. Yamashina Inst. Ornith., 14: 143–150, 1982

Annual Gonadal Cycle of Black Kite *Milvus migrans govinda*

J. H. Desai* and A. K. Malhotra*

Abstract The annual gonadal cycle of the Black Kite indicated that during the breeding season the birds gained body weight. In the sexually active phase the right testis was larger than the left. All stages of spermatogenesis were observed during the the sexually active phase. Retrogression of the testis occurred during May and June and testes were smallest during the inactive phase. Recrudescence occurred in November when the testis begins to increase in size. During the active phase the single left ovary attained maximum size. The retrogressive phase occurred during May and June and the ovaries desreased in size and weight. Ovarian size was smallest during the quiescent phase, from July until October. Maturation of ovastarted during the recrudescent phase which occurred in November.

Introduction

Although studies of the reproductive cycle of various Indian birds have been made very little information is available on the annual gonadal cycle of the Black Kite *Milvus migrans govinda*.

This paper describes the annual reproductive cycle of the Black Kite, which was studied from September 1976 to August 1977, at Delhi Zoological Park. Black Kites nest on various tree species in the park between November and April.

The Delhi territory stretches along the western bank of the Jamuna river between latitudes 28°12′N and 28°53′N and between longitudes 76°50′E and 77°23′E. During this study the average yearly maximum and minimum temperature were 30.7°C and 18.9°C respectively, while the average rainfall was 90.6 cm.

Results and Discussions

1. Body weight

Birds weighed during December and January were found to be heavier than those weighed during May, June and July. Males were found to be lighter than females (Fig. 1); the mean weight of 23 males was 745.9 g while that of 19 females was 834.8 g. It was also observed that during the sexually active phase the weight of 11 males and 8 females averaged 782.8 g and 907 g respectively, whereas in the inactive phase 7 males averaged 682.2 g and 6 females averaged 772.6 g. Thus during the sexually active phase, birds of both sexes were heavier.

According to Misra (1961) the body weight of Black Kite increases during the breeding season as observed in many other Indian birds at Banaras (India). Vyas (1967) has also described an increase in body weight during the breeding season in the Black Kite, House Crow (*Corvus splendens*), Bank Myna (*Acridotheres ginginianus*) in

* Delhi Zoological Park, New Delhi-3, India.

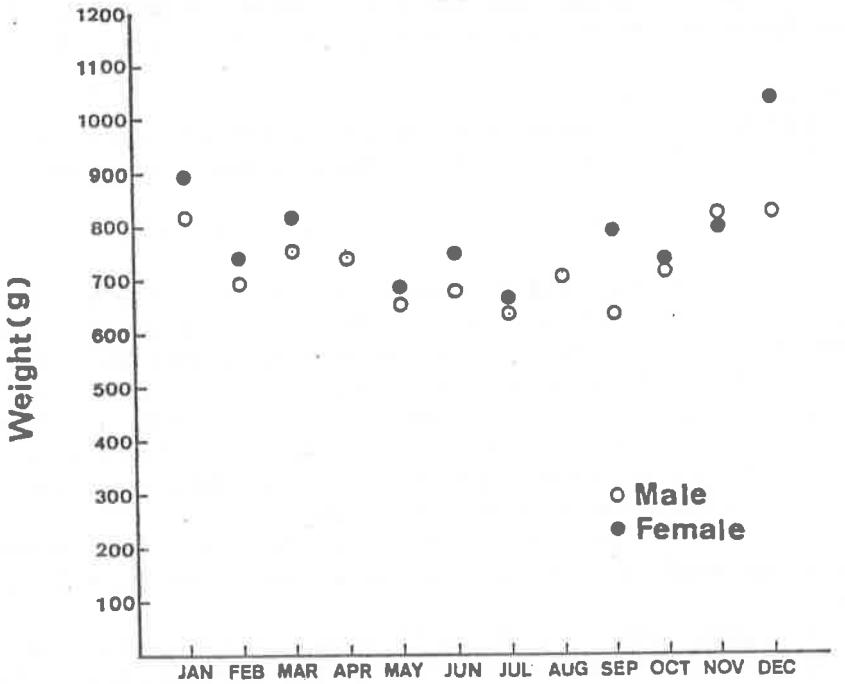


Fig. 1. Seasonal variation in mean weight of male and female Black Kites at Dehli Zoological Park.

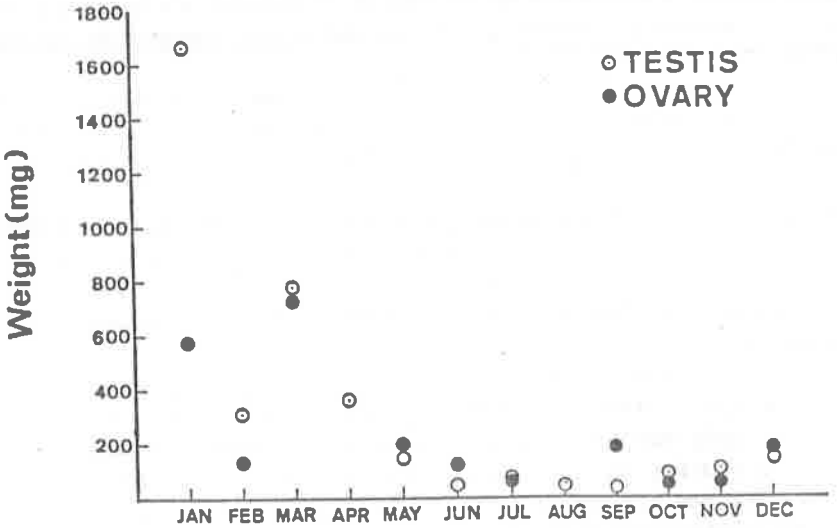


Fig. 2. Seasonal variation in mean weight of the gonads of Black Kites at Dehli Zoological Park.

Rajasthan. Our observations agrees with those of the above workers since at the Delhi Zoological Park Black Kites also gained body weight during the breeding season.

2. Male reproductive cycle

The Black Kite has two well-developed testes, of which the right mature testis is usually larger than the left. Testes were found to be heavier in January than in June (Fig. 2.).

The reproductive cycle of male Black Kites can be divided into the following four phases.

(1) Active phase: The breeding season of the Black Kite at Delhi is from December to April, with peak breeding activity in January and February. During the active phase the testes attained their largest size in terms of volume and weight (Table 1). Histological pictures of the testis revealed all the stages of spermatogenesis including the presence of spermatozoa in the enlarged lumen of the germinal tubules. The leyding cells of the testicular interstitial tissue were prominent, the cells and nuclei were deeply stained. The total area of interstitial cells appeared much compressed and reduced because of the enlargement of the germinal tubules (Fig. 3A).

While in general, the breeding season of Kites is from December to April, a number of Kites became sexually active even in November showing full breeding behaviour, including egg-laying.

(2) Retrogressive phase: Our observations suggest that the period of retrogression in the Black Kite is brief. In most of the birds testicular retrogression occurred during May and June, although in some birds it was initiated in late April. The germinal tubules showed reduction in diameter and the germinal cells appeared to slough off from the basement membrane into the tubule lumen where they underwent necrosis and absorption. Because of reduction in the diameter of the germinal tubules the interstitial tissue appeared massive and the leyding cells were seen in large clumps in the interstitial spaces (Fig. 3B).

(3) Inactive phase: Testicular regression was completed by July, thereafter, the Kites entered the non-breeding phase which lasted untill October. The testes were at their smallest during this phase (Table 1) and the diameter of the germinal tubules showed drastic reduction (Fig. 3c).

The lumen of most of the germinal tubules appeared obliterated and the tubules were lined by a single layer of epithelial cells. This layer was composed of resting spermatogonial cells with a few sertoli cells interposed between them. The interstitial tissue also appeared very much reduced in comparison with testes examined during the retrogressive phase.

(4) Recrudescent phase: Like the retrogresive phase the recrudescent phase was also brief. In most individuals this phase occurred during November. However, the spermatogenic cycle was initiated as early as October in some individuals and they became sexually active during November, exhibiting full reproductive behaviour. During recrudescence, both testicular volume and weight increased and the diameter of the germinal tubules increased (Table 1). The tubule lumina was distinctly visible, the spermatogenic cycle was initiated and the germ tubules exhibited spermatogonia,

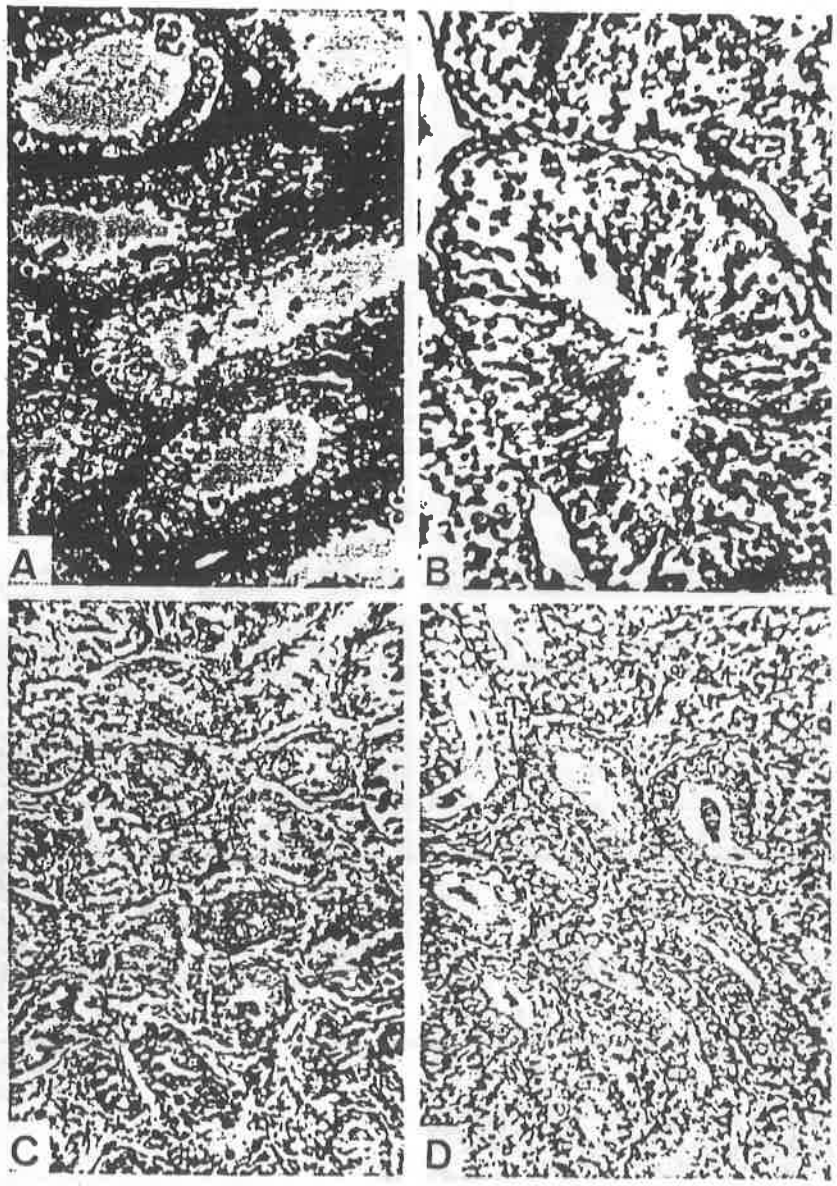


Fig. 3. Photomicrograph of the testis of the Black Kite.
A. Active phase (February) showing enlarged germinal tubules and spermatogenesis. HE × 200. B. Retrogressive phase (May). Note cessation of spermatogenesis and reduction in diameter of the germinal tubles. HE × 200. C. Inactive phase (September) showing very small germinal tubules. HE × 200. D. Recrudescent phase (November). Note enlargement of tubule diameter, reappearance of tubular lumina and initiation of spermatogenesis. HE × 200.

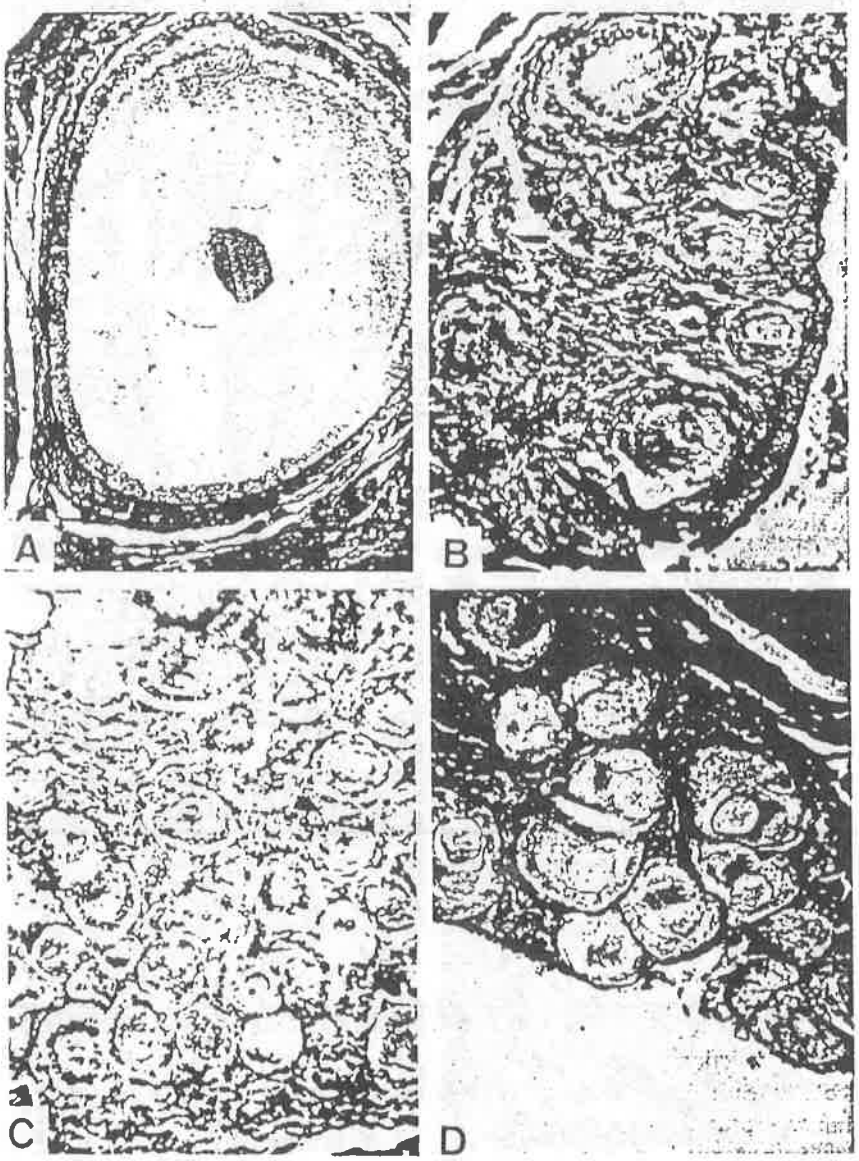


Fig. 4. Photomicrograph of the ovary of the Black Kite.
A. Active phase (January) showing a large preovulatory follicle. HE × 100. B. Retrogressive phase (May). Note atresia of the follicles. HE × 200. C. Inactive phase (August) showing numerous small follicles. HE × 200. D. Recrudescent phase (November) showing initiation of vitellogenesis and an increase in size of the follicle. HE × 200.

spermatocytes and spermatids (Fig. 3D).

In a few tubules spermateleosis was completed and spermatozoa were visible in the lumina. The interstitial tissue also began to hypertropy and leyding cells increased in number.

Witschi (1945), reported asymmetry between centralateral testes of sexually active Starlings (*Sturnus* sp.) during the breeding season. Riddle (1918), Law & Kosin (1958) and Vyas (1967) respectively showed that the right testis is longer than left in the Pigeon (*Columba livia*), Turkey (*Meleagris gallopava*) and Black Kite. On the other hand Etzold (1891) and Domm (1939) have reported that the left testis is longer than the right in the House Sparrow (*Passer domesticus*) and other birds species.

During the breeding season, the right testis of the Black Kite was found to be longer, and bean-shaped, while the left one was smaller, broad at one end and narrower at the other. However, in the non-breeding season both testes were more or less of the same size and shape.

Various authors (Bissonnettee 1930, Bissonnette & Chapnick 1930, Crough 1939, Misra 1961, Vyas 1967) have also described an increase in the weight and size of the testes of various bird species during the sexually active phase, including the Black Kite.

The size, volume and weight of the testes of Black Kites were observed to increase during the breeding season at Delhi Zoological Park. The testes were found to be heavier and larger during January than during June.

3. Female reproductive cycle

A single left ovary is present in the Black Kite. Ovarian weight and size exhibited seasonal variations, the largest ovary was recorded during January, i.e. at the peak of the breeding season, while the smallest ovary was recorded during the non-breeding season in July (Fig. 2). The largest ovum, which measured 0.55 cm in diameter, was also found during January. The ovary forms 0.034% of the body weight.

Like the male reproductive cycle, the reproductive cycle of the female Black Kite is divisible into the following four phases.

(1) Active phase: In the majority of females, ovulation and egg-laying occurred during December to April. However, a few females discharged ova in November. During the active phase, the ovary attains maximum size and weight (Table 2). Histological sections of the ovary revealed the presence of large yolk-filled ova in their follicular sheaths (Fig. 4A). Besides the large preovulatory follicles, the ovary also contained ruptured postovulatory follicles in females which had deposited eggs. During the active phase, active and rapid vitellogenesis occurred in the ova and the follicles reached their maximum size prior to ovulation. It also appeared that deposition of yolk was contributed mainly by the follicular granulosa cells which hypertrophied and appeared highly secretory as evidenced by their large size and vacuolated cytoplasm.

(2) Retrogressive phase: This phase was relatively brief in the Black Kite and occurred in May and June and marked the beginning of the non-breeding season. The ovary decreased in size, weight and volume (Table 2). It appears that active vitellogenesis in the ova ceases and possibly the larger follicles containing yolk also undergo

Table 1. Seasonal variation in mean testes size of the Black Kite at Delhi Zoological Park.

Phase and mouth	Weight (gm)	Size (mm) Long axis & short axis	Mean volume (ml)
Active (December to April)	618.5 ± 263.39	13.1 ± 0.15 × 8.1 ± 0.22	66 ± 0.05
Retrogressive (May, June)	84.2 ± 6.41	8.0 ± 0.06 × 2.5 ± 0.05	14 ± 0.02
Regressive (July to October)	50.4 ± 5.95	8.1 ± 0.09 × 2.0 ± 0.01	14 ± 0.02
Recrudescent (November)	90 ± 15.00	9.2 ± 0.11 × 2.0 ± 0.00	17 ± 0.02

Table 2. Seasonal variation in the mean size of ovaries and ova of the Black Kite at Delhi Zoological Park.

Phase and mouth	Weight (gm)	Mean volume in (ml)	Diameter of largest ovum (mm)
Active (December to April)	388.4 ± 107.42	45 ± 11.29	31 ± 0.07
Retrogressive (May to June)	147.5 ± 44.51	25 ± 0.3	22 ± 0.03
Quiescent (Regressive) July to October	140.0 ± 12.29	19 ± 0.01	21 ± 0.01
Recrudescent (November)	150.0 ± 0.00	30 ± 0.00	25 ± 0.00

atresia, since in the following quiescent phase, such yolk-containing ova are not present (Fig. 4B).

(3) Quiescent phase: During this phase from July to October ovarian volume was at its smallest (see Table 2), and ovaries showed many very small follicles with no evidence of vitellogenesis. Possibly, during this phase, the ovaries are replenished with the primary follicles (Fig. 4C). The oviducts also regress and attain their minimum width during this period.

(4) Recrudescent phase: This was a relatively short phase and marked the beginning of the breeding season for most females in November. During this pahse the ovary increased in volume (Table 2) and showed relateively larger follicles in comparison to the quiescent phase (Fig. 4D). Vitellogenesis was initiated during this phase, the ova increased rapidly in size and attained maturity by December.

Kummarlowe (1930), Witschi (1932), Fitzpatrick (1933), Stanley (1937), and Shaw (1938) have reported that in various species of hawks, both the ovaries may persist, but that the right oviduct is vestigeal. Furthermore, they reported that the right ovary was largest in the Accipitrinae and smaller in the Falconinae, Butoeninae and Cathartinae. However, in the Black Kite only a single left ovary persists. Keck (1934) and Marshall (1961) have described that the ovary and oviducts of wild birds show seasonal changes. Bissonnette &

Zujko (1936) also observed changes in the ovary of the Starling during the breeding and non-breeding season. Vyas (1967) has also reported an increase in the size and weight of the ovary and oviduct during the breeding season in the Black Kite in Rajasthan. Similarly, in Black Kites at the Delhi Zoological Park, the largest ovary both in weight and volume was recorded during January and smallest during July (the non-breeding season).

References

Bissonnette, T. H. 1930. Studies on the sexual cycle in birds. Amer. Jour. Anat. 45: 289–305.

Bissonnette, T. H. & Chapnick, M. W. 1930. Studies on sexual cycle in birds. Amer. Jour. Anat. 46: 477–497.

Bissonnette, T. H. & Zujko, A. J. 1936. Normal progressive changes in the ovary of the Starling (*Sturnus vulgaris*) from Dec. to April. Auk 53: 31.

Crough, J. E. 1939. Seasonal changes in the testes of the passerine bird, *Phainopeplanitens lepida*. Proc. Soc. Exp. Bio. N.Y. 40: 218.

Domm, L. V. 1939. Modifications in sex and secondary sexual characters in birds. In *Sex and Internal Secretions*. (2nd ed.) Allen, E., Danforth, C. H., & Doisy, E. A. eds. pp. 227–323. Baltimore, Williams and Wilking Co.

Etzold, T. 1981. Die Entwicklung der Testikel von *Passer domestica* von der Winterruhe bis zum Eintritt der Brutzeit. Z. Wiss. Zool. 52: 46–84.

Fitzpatrick, F. L. 1933. Bilateral and unilateral ovaries in Raptorial brids. Anat. Rec. 57 (Suppl.): 68.

Keck, W. N. 1934. The control of the secondary sex characters in the English Sparrow, *Passer domesticus* (Linnaeus) J. Expt. Zool. 67: 315–347.

Kummerlowe, H. 1930. Vergleichende Untersuchungen über das Gonadensystem weiblicher Vogel. I & II Z. mikr anat. Forsch. 21: 1, 22: 259.

Law, G. R. J. & Kosin, I. L. 1958. Seasonal reproductive ability of male Domestic Turkeys as observed under two ambient temperatures. Poultry Sc. 37: 1034–1047.

Marshall, A. J. 1961. *Biology and Comparative Physiology of Birds*. Vol. II. Academic Press. New York. London.

Misra, A. B. 1961. The annual reproductive cycle of some Indian birds. J. Scient. Res. Part I, 12(1), Banaras Hindu University.

Riddle, O. 1918. Further observations on the relative size and form of the right and left testes of pigeons in health and disease and as influenced by hybridity. Anat. Rec. Anat. Rec. 14: 283–334.

Shaw, T-H. 1938. Double ovaries in some Chinese birds of prey. Nature. Lond. 142: 1079.

Stanley, A. J. 1937. Sexual dimorphism in North American hawks. I. Sex organs J. Morph. 61: 321.

Vyas, D. K. 1967. Histochemical studies of some endocrine glands in the representative birds of Rajasthan. Ph.D. Thesis, Univ. of Rajasthan, Jaipur.

Witschi, E. 1932. Sex deviations, inversions and parabiosis. In *Sex and Internal Secretions* (1st ed.). E. Allen, E. Williams & Wilkins, eds. Baltimore, London.

Witschi, E. 1945. Quantitative studies on the seasonal development of the different ducts in passerine birds. J. exp. Zool. 100: 549.

BREEDING BIOLOGY OF THE PARIAH KITE *MILVUS MIGRANS* AT DELHI ZOOLOGICAL PARK

The Pariah Kite *Milvus migrans* is one of the commoner birds of prey in India. Several authors have given details of the nest, clutch size and measurements of eggs (Donald 1918, Ali 1926, Baker 1928, Dharamkumarsinghji 1954, Meyburg 1967, 1971) but, in spite of its abundance and importance, the species has not been thoroughly studied in India. Its density in Delhi is unusually high (Gallushin 1971). This paper treats data collected at the Delhi Zoological Park during 1973–1976. The Park is a woodland area of 240 acres (97 ha), in which Pariah Kites have nested in naturally occuring trees since its inception.

In all, 60 nestings occurred in the three years. The birds were watched through 8×30 prismatic binoculars. For the study of reproductive performance 15 occupied nests were followed each year. These nests were examined daily from December–April.

Eggs were marked with indelible ink for the determination of the incubation period, and weights and measurements of 102 were taken.

OBSERVATIONS

During the three successive seasons 1973–1974 to 1975–1976, some pairs laid eggs in November and December but the peak period was during January and February. Some nests with young were observed during December but in most nests the young hatched during February and March. Some nestlings left their nests in March, but most left during April–May and very few in June.

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During June–August, few Pariah Kites were present in the Park. During September numbers increased, to reach a maximum in December–March. It is likely that the birds moved into the Park to nest from adjoining neighbourhoods. The birds arrived already paired at the nesting ground. Soon after their arrival, construction of a new nest or repair of an old nest commenced. Nests were located at the bases and also at forks of the branches

TABLE 1

Dimensions and time required for construction of 15 nests in 1973–1975

Nest-building started	Time taken to complete (days)	Height of nest from ground level (m)	Length & width (cm)	Diameter of depression (cm)	Depth (cm)
26 Oct.	67	7·30	60 × 44	22·9	7·5
14 Nov.	59	7·35	46 × 37·5	25·4	6·5
21 Nov.	47	7·90	60 × 48·5	20·3	6·5
24 Nov.	68	8·80	60 × 47·0	20·3	5·1
25 Nov.	38	9·40	70 × 41	22·8	6·5
16 Dec.	46	9·10	48·5 × 43·5	27·5	5·1
18 Dec.	18	8·15	45 × 30	20·3	5·1
19 Dec.	26	8·25	48·5 × 41	25·4	7·5
19 Dec.	43	5·50	45 × 35	22·8	7·5
19 Dec.	27	10·45	50 × 40	20·3	5·1
19 Dec.	42	8·30	60 × 30	20·3	7·6
20 Dec.	29	8·90	48·5 × 36	30·4	6·5
20 Dec.	51	9·10	40 × 35	20·3	6·5
28 Dec.	23	7·95	46 × 37·5	25·4	6·5
31 Dec.	24	10·00	46 × 30	22·8	6·5

of *Prosopis juliflora*, *Ficus religosa*, *Eucalyptus* sp. or *Salmalia malbaricum*, at heights of 7–10 m from the ground. Although a few sites were occupied by kites year after year, it could not be ascertained if the ownership remained the same, or changed. Those birds which occupied an old nest rearranged the twigs and added new material. Every season new nests were also constructed. Nest material consisted chiefly of 30–60 cm long dry twigs, picked by the birds from the ground, with the addition of iron wire, paper, rags, cotton, clods of soil, dry leaves, feathers, bones, etc.

In the initial stages of nest construction the sticks were arranged in a criss-cross fashion, to form an oval platform. As the sticks increased on the sides, a shallow depression was formed in the centre. This depression was enlarged and later lined with thin,

TABLE 2

Time lapse between the completion of the nest and laying of the 1st egg, 1974–1976

Date nest completed	28 Dec.	29 Dec.	2 Jan.	7 Jan.	7 Jan.	14 Jan.	16 Jan.	16 Jan.
Days to first egg	10	7	5	12	13	7	14	13
Date nest completed	23 Jan.	31 Jan.	4 Feb.	13 Feb.	28 Feb.	2 Mar.	23 Mar.	
Days to first egg	9	9	4	3	13	8	4	

dry twigs, within which was placed an inner layer of cotton, rags or even mud. The nest-building continued after the eggs were laid. It was observed that sticks were collected by both partners, but most by the female. Cumulatively they made 3–10 trips per day to bring sticks, and it took 18–68 days for a pair to complete the nest (Table 1).

Frequent copulations were observed during the nest-building period and even after the eggs were laid. Twenty copulations averaged 5·5 s (range 2–13 s) from stepping on to stepping off by the male. The eggs were laid 3–14 days after the completion of nests (Table 2). The successive eggs in a clutch were generally laid two or three days apart, but occasionally the interval was greater.

TABLE 3

Clutch size of Pariah Kite at Delhi Zoological Park

Season	No. of eggs in a clutch			Av. clutch size
	1	2	3	
1973–1974	2	13	6	2·0
1974–1975	3	5	13	2·5
1975–1976	1	8	9	2·4
Total	6	26	28	2·3

Note: The freshly laid eggs were light green in colour, sometimes spotted with brown, and became dull and dirty coloured as incubation progressed. 102 eggs measured on average 53·9 mm in length (range 48·7–63·5 mm) and 42·6 mm (39·7–48·2 mm) in width. The average weight of 102 eggs laid during the three seasons, recorded within 24 h of laying, was 49·8 g (range 39·7–78 g). The average weight of the eggs thus formed 6·6% of average body weight (756·5 g, $n = 20$ adults).

TABLE 4

Hatching success of 102 eggs of Pariah Kite in annual samples of 15 nests, 1973–1976

Year	Eggs laid	Eggs hatched	Hatching success (%)
1973–1974	33	19	57·6
1974–1975	37	20	54·1
1975–1976	32	17	53·1
Total	102	56	54·9

Of 60 clutches completed during the three years, 28 clutches (46·6%) were of three eggs, 26 (43·3%) of two eggs and 6 (10%) of only one egg (Table 3).

Incubation began soon after the laying of the first egg. Both sexes shared in incubation, but the female played the major part. The male usually remained nearby; he also brought food for the female. In ten nests, on average, the incubation contribution by the male amounted to 33·3% of observation time, by the female 61·8%, while 4·8% of the time the eggs were unattended. The incubation period was taken as the interval between the laying of an egg and its hatching. Thirty-six marked eggs successfully hatched. The position of these eggs in the laying sequence, and the size of the clutch of which they were part were not noted. Three of these eggs (8·3%) hatched after 29 days, 9 (24·9%)

after 30 days, 11 (30·5%) after 31 days, 3 (8·3%) after 32 days, 6 (16·6%) after 33 days, one (2·8%) after 34 days, and three eggs (8·3%) after 35 days, average 31·4 days. The interval between the pipping and final hatching of 28 chicks ranged from 1–3 days. Since most chicks hatched at intervals of at least one day, the nests rarely contained chicks of the same size, and the first chick was often five or more days older than the youngest. The hatching success of 102 eggs in sample nests was 55% (Table 4); 46 eggs failed to hatch due to infertility, predation, breakage, death of the embryo or other undetermined reasons.

TABLE 5

Fledging success in 15 sample nests each year, 1973–1976

Year	Eggs hatched	Young fledged	Fledging success (%)
1973–1974	19	15	79
1974–1975	20	17	85
1975–1976	17	12	71
Total	56	44	78

Newly hatched chicks weighed on average 39·8 g (range 29–49 g, $n = 25$). They were guarded by both parents. The female played a major role in rearing the chicks and also went in search of food more frequently than her partner. The male generally sat on a nearby tree or in the nest tree.

The first attempt to feed the young was made when it was a day old. The female brought the meat in pieces in her beak and fed the chick by cutting it into still smaller pieces. Fish measuring 2–3 cm were also brought by the parents. The frequency of feeds dropped as the young developed. In a nest containing two chicks, the parents made 5–6 trips a day during the first 15 days, but only 2–3 trips per day when the chicks were 30–45 days old. Although the young were fed at any time during the day, food was commonly brought during the forenoon hours. The female was also observed to bring water for the young. The stronger (bigger) chicks fed first and, until satisfied, did not allow younger ones to approach the parents. On several occasions it was also observed

TABLE 6

Summary of causes of mortality among chicks in 15 nests each year, 1973–1976

Causes	1973–1974	1974–1975	1976–1977	Total (%)
Starvation	—	1	—	1 (8·2)
Predation	1	1	2	4 (33·2)
Accidental fall from nest, and unknown	2	2	3	7 (58·4)
Total	3	4	5	12

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Feeding ecology and nesting of Painted storks *Ibis leucocephalus* at Delhi Zoo

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INTRODUCTION

Although basic facts concerning the life history of the legendary White stork are available in literature (Haverschmidt, 1949), very little is known about the ecology and breeding biology of the Painted stork *Ibis leucocephalus*. The majority of the storks are found in the warmer parts of the world, with the largest sympatric number being found in Africa (Kahl, 1966).

The Painted stork, locally known as Janghil o Dokh, is a very familiar Indian bird (Baker, 1929). It usually occurs in pairs, parties or large congregations near jheels and marshes (Ali, 1961). It spends the day standing 'hunched up' and inert, or sauntering about sedately on grassy marshland in quest of fish and frogs. Its white plumage is closely barred and marked with glistering greenish black above, delicate rose pink about the

shoulders and on wings with a black band across the breast.

The Painted stork is a very good soarer and, within a short time, a stork in a strong thermal current can rise almost out of sight. Although some birds flew out from our colony in the morning, most of the birds waited until thermals developed about noon. Similarly most of the storks returned before the thermals waned in the late afternoon (see Figure 1).

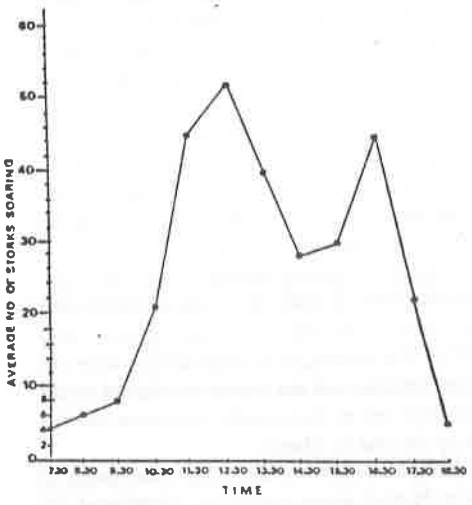

Figure 1. Soaring activity of Painted storks *Ibis leucocephalus* at the breeding colony at Delhi Zoo. The noon peak consisted mainly of birds leaving the colony and the afternoon peak of returning birds.

The present study was carried out at Delhi Zoo where the Painted storks have established a breeding colony in a canopy of *Prosopis* trees in an artificial lake of about 0·8 hectares (two acres).

METHODS

The entire nesting colony at Delhi Zoo contained up to 109 nests. The colony was located in the crown of Prosopis trees *Prosopis juliflora* approximately 6 to 7 m (20 ft) high.

For the purpose of this study 30 nesting birds in 15 nests were observed from a platform built in a tree near the site of the nests. The top of the platform was slightly above the level of the nests and about 35 m (115 ft) away from the nests. Necessary concealment was provided by the foliage of the trees and the birds were undisturbed and unconcerned during observations from the platform.

Over 2,700 nest-hours of observations were made during the periods January to July 1965, and July 1966 through April 1967. Observations were made with a 7 × 35-power binoculars as well as with the unaided eye. The birds were photographed with a 35 mm still camera.

One nestling was hand-reared from hatching up to 17 days. Twelve nestlings of eight weeks and over were trapped from nests and kept in an aviary for a period of three months. Food consumption and growth records of the hand-reared nestling were kept. Food consumption of the captive storks was recorded. Five adult Painted storks were trapped, weighed and measured.

Observations of the nests were made during the early morning, forenoon, mid-day and late afternoon on successive days, covering the full daylight period during a week. On several occasions observations were also made during full-moon nights to determine the nest activity during the hours of darkness.

FOOD ECOLOGY

The Painted stork is more exclusively piscivorous than most storks and the major part of its diet consists of fishes, eels and frogs caught in the water (Baker, 1929). At Delhi Zoo the Painted storks eat a variety of items which include fish, raw meat pieces and offal. They are gregarious birds in feeding and nesting. They feed mainly during the day, wading in shallow water with bill immersed and partly open, swaying from side to side (Ali, 1961). The heavy bill, which is bright yellow in adults and greyish black in juveniles, equips the bird for a groping type of feeding rather than for stabbing. Foot stirring and wing movements are also sometimes used, probably to startle small fish and invertebrates into movement. Smaller fish are generally swallowed whole immediately after capture. Larger fish are usually killed first and then swallowed.

Five adult Painted storks were trapped and weighed. They ranged from 3·030 kg to 3·370 kg (6·5–7·5 lb), the average mean weight being 3·18 kg (7 lb). The standard metabolism as calculated from the formula given by King & Farner (1961) for a 3·18 kg (7 lb) bird is 178 Kcal/day or 55 Kcal/kg/day. The standard metabolism

in another species of stork (*Jabiru mycteria*) weighing 5·47 kg (12·5 lb) was found to be 50 Kcal/kg/day (Benedict & Fox, 1927). Kahl (1966) calculated the standard metabolism of Marabou stork *Leptoptilos crumeniferus* weighing 5 kg (11 lb) and found it to be 49 Kcal/kg/day.

An adult Painted stork takes an average of 400 g (14 oz) of fish or raw meat per day as shown by adult captive birds at Delhi Zoo. They thrive and remain vigorous and apparently healthy in captivity indicating that adult Painted storks can survive for long periods on such a diet.

The caloric value of such a diet is about 1·25 Kcal/kg (wet weight) (Kahl, 1966). The captive Painted storks, therefore, ingest about 500 Kcal of food per day. Kahl (1964) has found that adult Wood storks *Mycteria americana* lose approximately 20% of their ingested energy through the faeces and urine. If the Painted stork is assumed to be similar in this respect, then our captive birds have a metabolism of about 400 Kcal/day when confined to aviary existence (see Table 1).

METABOLIC LEVEL	KCAL/BIRD/DAY	KCAL/KG/DAY
Standard metabolism	178	55
Aviary-existence metabolism	400	125
Free-flying metabolism	600	188

Table 1. Estimated metabolised energy of adult Painted stork weighing 3·18 kg.

If we assume the free-flying metabolism to be three times the standard rate of 1·5 times the aviary-existence metabolism, it would be approximately 600 Kcal/day. It could be assumed, therefore, that the Painted storks eat an average of 600 g (20 oz) of food per day in nature.

The nestlings were fed on fish by their parents. Once or twice we attempted to feed the hand-reared, one-week-old nestling with earthworm (whole and pieces). The nestling refused to accept this diet, and when force-fed it regurgitated some of the food. Even the ten-weeks-old captive nestlings were reluctant to accept meat pieces given to them. For two days they refused feeding but on the third day they accepted about 100 g of meat each. They were immediately put back on fish diet. Adult Painted storks were, however, observed to feed on meat pieces and offal.

BREEDING CYCLE

The Painted stork breeds from September to January in large colonies and nearly always in company with numerous other storks, cormorants and so on (Baker, 1929). According to Ali (1961), the nesting season of the Painted stork is from August to January. At a breeding colony in Madras State, South India, the birds are found in heavy concentrations from November to August (Badshah, 1965).

At Delhi Zoo the Painted storks established a breeding colony in 1960, for the first time as far as we know. They have shown considerable faithfulness to their natal site and have returned to the same site to nest year after year.

In the three nesting seasons in the Delhi Zoo from 1963–64 to 1965–66, it was observed that storks arrived during late August or early September. The maximum number of eggs were laid during October and the highest number of chicks were observed in November. The storks left the site by the end of March.

During the 1966–67 season, the first group of 15–20 Painted storks arrived on 1 September. By 10 September, 124 Painted storks were counted and also six nests with eggs were observed. On 21 September the influx of Painted storks was highest and 438 storks were counted on trees. For want of nesting space, some of the Painted storks flew away and by 26 September the stork population was estimated to be 332. Finally, a total of 270 storks and 109 nests was counted on 8 October. The trees were so crowded that the average distance between two nests was not more than 25 cm (10 in).

The first young of the season, three chicks in two nests, were seen on 9 October 1966. Two clutches hatched in late November. In one nest one egg hatched in December. The eggs which were laid in September and the chicks hatched in October were capable of flying by December. They left the natal site by 10 March 1967.

NESTING SITE

Most nesting sites of the Painted storks are observed to be in the vicinity of a freshwater

feeding area. Often breeding colonies are seen in the middle of villages in the near vicinity of a reservoir. Suitable food sources within flying range probably play a major role in the selection of the specific site for a nesting colony in successive seasons. The nesting site at Delhi Zoo is now firmly established and may increase in size over the next few years. Selection of some of the same trees for nesting over four consecutive seasons has also been observed, although there are many trees in the area. The colony is located in a pond of about 0·8 hectares (2 acres), punctuated with islands. The pond is a display area for Indian wading birds which include 19 pinioned Painted storks and other Indian birds.

PAIR FORMATION

At the approach of the nesting season, the Painted storks arrive at the nesting site in groups. On arrival, these groups spend the night on trees in the pond. They spend many hours at chosen places in the trees which are often old nest sites, with the remnants of platforms left over from the season before. The birds eventually establish territories and react aggressively towards any other stork that comes nearby.

There is no visible difference between the birds and the sexes look alike. However, on close observation, one can notice a slight size difference between the two birds on a nest. The courtship of the Painted stork involves a mixture of hostility and sexual behaviour. Once pairing begins, it proceeds rapidly. Pair formation involves a complicated ritual of bill clapping, wing flapping, head shaking and posturing.

After a pair is formed, or after the two storks have been associated for several hours or a day, they begin to greet each other by the 'up down' display. In this display the stork throws its head upwards and then downwards. It also clatters the mandibles loudly. When the 'up down' displays are frequent, the pair can be considered to be established.

NEST CONSTRUCTION

As soon as a compatible pair is formed, nest construction or repair of the old nest starts in earnest. The larger bird, probably the male, does most of the stick gathering from nearby trees or the ground while the smaller bird, probably the female, arranges the sticks in the nest. The stick gathering partner makes as many as five or six trips per hour to the nest. This activity is more pronounced during morning and afternoon hours. The birds pass most of the noon hours standing on the nest, preening, resting or soaring in the sky. Both birds are almost in constant attendance at the nest in the beginning.

The construction of a nest takes four to eight days. It is a well constructed platform of sticks measuring 60–64 cm (about 2 ft) in diameter. Its floor is mostly unlined and there is a shallow depression of 8–10 cm (3–4 in) in the centre. Its inner diameter varies from 28 to 30 cm (about 11 in). It is constantly being repaired and sticks continue to be added throughout the nesting season.

After construction is completed and the eggs are laid, the nest and its contents are never left alone. This may be due to the fear of predation of eggs and hatchlings by birds of prey. In any case, sticks in unattended nests are irresistible to other storks constructing their nests. It was observed that abandoned nests are usually picked apart within a day or two by other storks.

EGG LAYING AND INCUBATION

Frequent copulations were observed during the initial nest building period. The average duration of copulation is ten seconds as calculated from 14 matings observed. The eggs are laid soon after copulation.

The size of the clutch of the Painted storks varies from two to five (Ali, 1961), but according to Baker (1929) three to five or, rarely, six eggs are laid. During the 1966–67 breeding season the average of 15 clutches was 2·8 (range 1–3). The eggs were laid at one to three days interval. Incubation began with the laying of the first egg.

The eggs of the Painted storks are chalky white. They generally become stained and dirty after a few days in the nest. Seven eggs of the Painted storks were weighed and measured. They measured 66–77 × 42–47 mm. The average weight of the eggs was 75·42 g (extremes being 66 g and 82 g).

Both sexes share in incubation. It was observed that a parent remained seated on the eggs for a period of 15 to 20 minutes. The parents then stood up in the nest, preened, repaired the nest, took a short flight around the nest and then sat down to incubate once more. The duration of such

an unattended period ranged from three to five minutes.

The smaller of the two partners, which we thought was the female, incubated during the morning. Its mate usually sat on the eggs during the afternoon. The relieving parent settled on the nest to incubate as soon as possible after its mate vacated the position. The relieved partner wasted no time in leaving, often having been in attendance at the nest for several hours. The duties usually changed at midday.

The incubation period for six eggs at Delhi Zoo in 1966–67 averaged 30·16 days (range 28 to 32 days). One pipped egg took only 30 minutes to hatch. This time was quite variable and took longer in other eggs.

Parents may continue to brood even if one egg fails to hatch. One egg was observed in a nest for more than six weeks without hatching before it disappeared. The shells of hatched eggs are usually thrown out of the nest by the parents.

PARENTAL CARE

The young, unlike those of many other birds, do not hatch all at approximately the same time. They may hatch days apart, and the sizes of the chicks in the nest were never found to be the same.

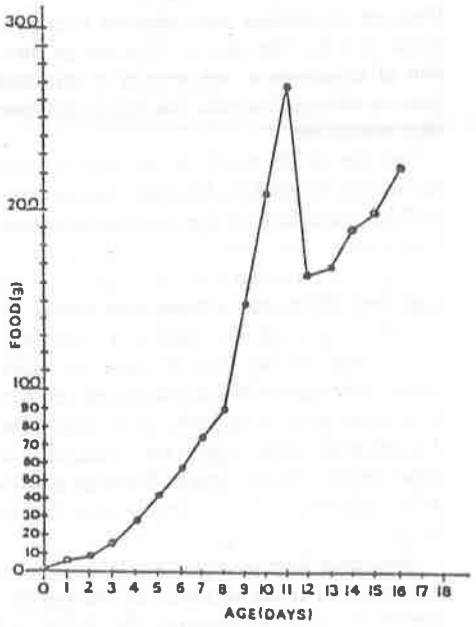

Figure 2. Daily food consumption of a hand-reared nestling Painted stork *Ibis leucocephalus* at Delhi Zoo.

The newly hatched Painted stork is weak and sparsely feathered. It requires constant protection from the extremes of weather and is brooded a large part of the time until it is two weeks old. Brooding is less frequent at midday when it is hot but is constant during the morning and late afternoon. The parents protect their young from direct exposure to the sun by standing over them with their wings spread.

One of the two partners always remains at the nest all the time, while the other makes frequent trips to the feeding grounds.

The parents regurgitate food on the floor of the nest and the young retrieve it without any assistance. At first, the food is partially predigested but a little later fish up to 15 cm (6 in) long are deposited almost intact and are then devoured whole by the young.

Newly hatched nestlings probably do not accept food until they are about a day old, but food consumption soon increases rapidly (see Figure 2). At first the nestlings are fed frequent small meals but later the frequency lessens as the young develop the ability to eat a larger quantity of food. Although the young were fed at any time during the day, feeding was more common during the early noon hours. During the night there was no active feeding.

Both the parents were observed to participate in feeding the young. However, it has been observed that the larger partner fed the young more often. Feeding was carried out at intervals of 15 to 20 minutes. It was also observed on a few occasions that the parents also brought water in their gullet and the water was given to the chicks. The American Wood stork and the Marabou also water their young according to Kahl (1963, 1966).

DEVELOPMENT OF THE YOUNG

One pipped egg was removed from a nest on 16 October 1966. The young hatched completely in my hand in 30 minutes and weighed 56 g (2 oz). It was hand-reared for 17 days. Its growth in weight was measured (see Figure 3). Unfortunately it died on 2 November after vomiting the first feed of the day. Up to then it had been healthy and the growth pattern appeared normal as compared with naturally reared chicks.

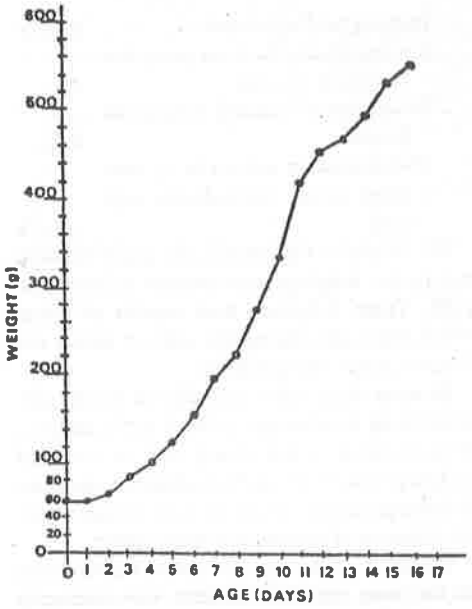

Figure 3. Weight increase of hand-reared nestling Painted stork *Ibis leucocephalus* at Delhi Zoo.

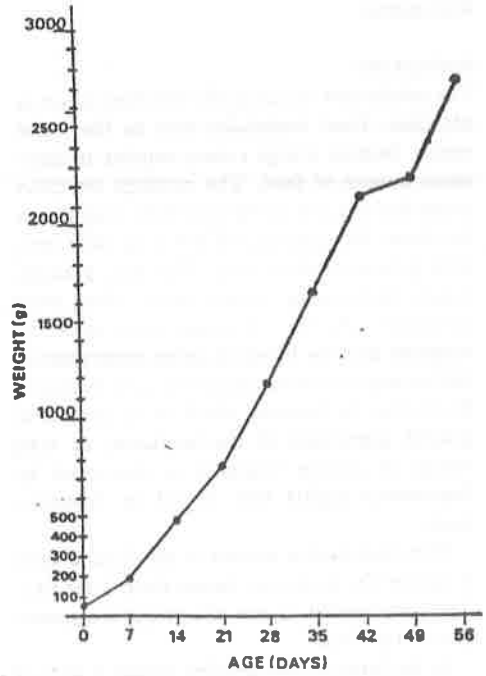

Figure 4. Weight increase of a naturally reared nestling Painted stork *Ibis leucocephalus* at Delhi Zoo.

Adult Painted storks weigh about 3–3·5 kg (7–8 lbs) and the naturally reared young in the nests weigh about 3 kg (7 lb) in about eight to nine weeks. The first hovering flight of the nestlings hatched on 10 October 1966 was observed on 20 November 1966. They were capable of flight when they reached the age of eight weeks.

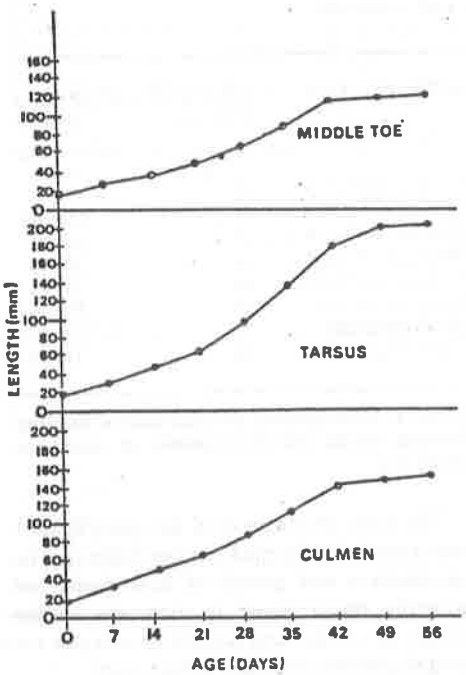

Figure 5. Growth of naturally reared nestling Painted stork *Ibis leucocephalus* at Delhi Zoo.

At hatching, the young is sparsely covered with a light grey down and the pink skin is clearly visible through the down covering. The down is thickest on the dorsal surface of the wings. The beak is generally pinkish, soft with a black band at the base. The ventral surface of the young is almost naked. The eyes are black. The feet are pinkish and it squeaks loudly for its size when hungry.

Age 1–5 days. Body sparsely covered with light grey down. By the third day the young was more active and always hungry. When five days old, it looked like a ball of cotton.

Age 5–10 days. Ventral surface of the body covered with sparse down. It was capable of moving its head and neck at will. By eight days

[Reprint, from *J. Bombay nat. Hist. Soc. 68 (1) : 243. 15-9-1971] 1971*

MISCELLANEOUS NOTE

4. NOTE ON BREEDING OF RUDDY SHELDUCK, *TADORNA FERRUGINEA* (PALLAS) AT DELHI ZOOLOGICAL PARK

During winter months, the ponds of Delhi Zoological Park teem with water fowl of every description. Eleven species of migratory ducks including Ruddy Shelduck have been observed and recorded from November to February each year.

The ponds which were constructed in 1959 for displaying pinioned water birds are about two acres in area. These ponds are part of a continuous channel system forming a barrier on one side for the animal enclosures. A few prosopis trees growing on four small islands in the ponds, provide ideal nesting places for cormorants, egrets, herons and painted storks which congregate on these trees in large numbers during their nesting season. Clusters of typha and other reeds growing along the banks of these ponds provide good cover for the birds to nest.

The Ruddy Shelduck is largely a palaearctic breeding species and it is thus of interest to record that Ruddy Shelducks have bred twice in the ponds of Delhi Zoological Park which is outside their usual breeding range.

On 22nd April, 1969, a pair were seen with seven freshly hatched ducklings in the ponds. The parents kept a constant watch always keeping them in sight. Out of the seven, four fledged, and three were killed by crows and kites.

Again in 1970, a Shelduck laid six eggs on one of the islands of the pond. Four hatched on 27th April, 1970 and all the four ducklings fledged.

DEPUTY DIRECTOR,
DELHI ZOOLOGICAL PARK,
NEW DELHI,
November 19, 1970.

J. H. DESAI

[Reprint, from *J. Bombay nat. Hist. Soc. 73 (2) : 392-394. 28-3-1997] 1976*

MISCELLANEOUS NOTE

9. A NOTE ON INCUBATION PERIOD AND REPRODUCTIVE SUCCESS OF THE REDWATTLED LAPWING, *VANELLUS INDICUS* AT DELHI ZOOLOGICAL PARK

The Redwattled Lapwing is a familiar bird in India frequenting open cultivation, ponds and rivers (Whistler 1941). In spite of its wide distribution and familiarity, information about its reproductive biology is lacking in literature. Jayakar & Spurway (1968) recorded 28.5 days as incubation period in Yellow-wattled Lapwing (*Vanellus malabaricus*). Ali & Ripley (1969) mention that the incubation period in Redwattled Lapwing is not recorded. The incubation period in Charadriidae is 25 days (Lack 1972).

The present study was carried out during 1973 and 1974 at the Delhi Zoological Park which extends over an area of 240 acres. The park which is developed as a woodland has large open-air animal enclosures bounded on one side by water moats. There are also ponds and channels in the park for the display of free-flying water birds. The Redwattled lapwing is a free-flying resident species and was observed to nest regularly on the plain ground in the open animal enclosures, lawns and other areas of the park. For the purpose of this study more than 20 nests were observed during 1973 and 1974. The measurements and weights of eggs and chicks were taken with vernier callipers and analytical balance. The period of incubation was calculated as the interval between the day of laying to the day of hatching (inclusive of both days) for each individual egg. Observations of the nests were made during early morning, forenoon, and late afternoon on successive days. Ten nests during each year were taken into consideration for estimation of reproductive success.

Thirty eight eggs were weighed and measured during 1973 and 1974. The eggs weighed between 16.5 gm to 21 gm with an average of 19.25 gm. The average size of the eggs was 41.7 x 33.5 mm with a range of 43.5 to 39.6 mm x 31.8 to 29.5 mm.

The incubation in the Redwattled Lapwing started with the laying of the first egg. Both the sexes shared in the incubation of the eggs. Ten eggs were marked with indelible India ink for the determination of the incubation period at the Delhi Zoological Park.

The incubation period ranged from 28 days to 30 days with an average of 29.2 days. Out of the ten eggs studied, 2 eggs hatched in 28 days, 4 hatched in 29 days and the remaining 4 hatched in 30 days (Table 1).

The young of the Redwattled Lapwing are nidifugous. At hatching, the chicks are covered with brown down feathers. Eight chicks were weighed and measured soon after they were hatched. The chicks weighed 14.80 gm to 13.20 gm, the average weight was 14.02 gm. The bill average 11 mm in length and the middle toe ranged from 16 mm to 19 mm with an average of 17.1 mm.

During the present study ten nests were taken into consideration each year for determining the reproductive success of the Redwattled Lapwing. The data for the ten nests are summarised in Table 2. The overall reproductive success was 40% during 1973 and 41.02% during 1974. Jayakar & Spurway (1965) stated that the reproductive success of Yellowwattled Lapwing ranged from 54% to 64%.

The heavy predation on the eggs at the Delhi Zoological Park accounted for the low reproductive success of the Redwattled Lapwing. During 1973, 51.4% eggs (18 eggs out

gate measuring 6 cm in diameter were as the nest of common myhna is open, cup shaped measuring 11-13 cm in diameter. In most of the cases in pied Myhna the entrance has been found to face for the sky. The material used in both the cases was dry grasses, feathers, rags and threads etc. In both the species the nest is build by both the partners and take 9 to 20 days to complete.

Egg laying pattern

In both the species successive eggs were laid after a gap of 24 hours (Table 1). Majority of the eggs were laid in the forenoon while fewer in the noon and late afternoon.

Table 1

Egg laying pattern in pied and common Myhna

	1st egg laid on	2nd laid on	3rd laid on	4th laid on	5th laid on	6th laid on
Pied Myhna	31.5.82	1.6.82	2.6.82	3.6.82	—	—
	28.5.82	29.5.82	30.5.82	1.6.82	2.6.82	—
	23.6.82	24.6.82	25.6.82	26.6.82	27.6.82	28.6.82
Common Myhna	23.5.82	24.5.82	25.5.82	26.5.82	27.5.82	—
	1.6.82	2.6.82	3.6.82	4.6.82	—	—
	1.6.82	2.6.82	3.6.82	4.6.82	5.6.82	—

Clutch Size

The clutch size of 6 nests of Pied Myhna comprised of 3 to 6 eggs, whereas that of common Myhnas consisted of 4 to 6 eggs in 5 nests.

Egg

The eggs were oval in shape and bluish green in colour in both the species. However, the eggs of Common Myhna were bigger in size than Pied Myhna. 15 eggs of Pied and 23 of Common Myhna were weighed and measured. The average weight was 5.22 gram (range 4.80 to 5.75) Size 2.73 ×2.01 cm (range 2.4 to 3.00 × 1.9 to 2.1 cm) in case of pied myhna while that of common myhna the average weight was 6.27 gram (range 5 to 6.50 gram) and size 2.87 × 2.15 cm (range 2.8 to 3.1 × 2.0 to 2.3 cm).

Incubation

In this two species, both the parents incubated the eggs. However, the period of incubation shared between the sexes could not be ascertained because sexes are identical.

Period of Incubation

Incubation period was calculated as the time elapsed between the date of laying and date of hatching. In pied myhna 10 eggs were marked to determine incubation period of which 8 hatched out successfully (Table 2) after an average of 16.3 days (range 15 to 19 days).

On the other hand 10 eggs were marked to determine the incubation period of common myhna out of which 7 hatched out successfully with an average of incubation period of 14.2 days with (range 13 to 15 days) (Table 2).

Table 2

Incubation period of Pied and Common Myhna

Pied Myhna			Common Myhna		
Date of laying	Date of hatching	Incubation period	Date of laying	Date of hatching	Incubation period
31.5.82	15.6.82	15	23.5.82	7.6.82	15
1.6.82	20.6.82	19	24.5.82	8.6.82	15
2.6.82	20.6.82	18	25.5.82	8.6.82	14
3.6.82	lost	—	26.5.82	8.6.82	13
28.5.82	13.6.82	16	27.5.82	lost	—
29.5.82	14.6.82	16	1.6.82	15.6.82	14
30.5.82	14.6.82	15	2.6.82	lost	—
23.6.82	9.6.82	16	3.6.82	16.6.82	14
24.6.82	10.6.82	16	4.6.82	17.6.82	14
25.6.82	lost				

Hatching and reproductive success

The hatching success for Pied and Common Myhna was 63.7% and 74.7% respectively in 1982. However the overall reproductive success was 36.3% and 39.1% in pied and common myhna (Table 3).

The low reproductive success in myhnas is due to the heavy predation by crows, infertility of eggs and inadequate food supply by the parents to the chick.

Table 3

Hatching and Reproductive success of Pied and Common Myhna during 1982 at N.Z.P.

	No. of nest	Total eggs	Eggs lost to predator	Inter-tile	No. of hatched cut	% of hatching	Chick lost to predation starvation	% of Reproductive success
Pied Myhna	5	22	1	7	14	63.7	6	36.3
Common Myhna	5	23	1	5	17	74.7	8	39.1

Nestling life

Age in days	Remarks
0-5	The newly hatched Chicks were fleshy, pink in colour and generally naked. The gape was yellow and the eyes were closed. In few cases traces of filoplumes on dorsal side of the chicks was observed. They were unable to stand but were able to raise their necks and open mouths to receive food. The average birth weight was 4.80 gram of 5 chicks in pied myhna while in common myhna the average birth weight of 5 chicks was 5.70 gm. The bill, middle toe and tarsus measured 5 mm, 5 mm and 6 mm in pied myhna and 5.5 mm, 5.5 mm and 6 mm in common myhna respectively.
6-10	In both the species chicks gained weight about six times during the period. Eyes opened at the age of 6-8 days in both the cases. Chicks were still unable to stand. The ventral side became dark in colour. Primary and secondary quill feathers grew up. Dark filoplumes were seen in the dorsal side.
11-15	The chicks gained weight. Tha primary and secondary feathers measured 16 mm and 14 mm in pied myhna and 22 mm and 20 mm in common myhna. Unable to stand on toe. Rectrices made appearance. Head covered with black feathers.
15-20	At this age, in pied myhna, the dorsal side was covered with black and white feathers. Ventral side had white feathers on the sides except in the midline. Tail with vaxillum grew out. Able to run on ground and flap wings. Middle Toe, Bill and tarsus growing uniformaly Fig-2 & 3 in both the species. The chicks of common myhna were almost covered with black feathers on dorsal side. Ventral side was without feathers. Legs become yellow, toe dark brown. Able to perch. Tail prominent. Primary with white feathers observed. Cries frequently when disturbed.
21-25	The chicks left their nests at the age of 21 to 26 days. They were covered with black and white feathers all over the body. Depends upon parents for food.

Table 4

Morphological and motor development of nestling of pied and common myhna

Development of flight feathers	Commonly seen at age (days)	
	Pied myhna	Common mynna
Quill feathers over the body	3	4
Primaries	3	3
Secondary	3	3
Rectries	7	8
Vaxillum on primary and secondary	10-12	10-12
Eyes open	6-8	6-8
Wing flaping	15-16	15-16
Leaving the nest	22-26	21-25

General Behaviour

It has been observed that common myhna is more aggressive than the pied. Both have strong recognition power. As and when the nest was examined by climbing, the myhnas cried loudly and tried to attack the observer (specially common myhna). Their aggressiveness was more profound when the nest had chicks. When the young were about to leave the nest, they spent most of the time in the tree. During that period parents made frequent trips to feed them. After this the chicks followed their parents for feeding.

Discussion

Narang, Tyagi and Lamba (1980) described the breeding season of pied myhna from late Feb. to August at Dehra Dun while Ali (1968) described it from March to September in Pied Myhna and April to August in Common Myhna. At National Zoo, myhnas breed from March to July. According to Ali and Ripley (1972) the incubation period in common myhna is 17 to 18 (Lamba) and 13-14 days (Sen Gugta) while the incubation period of pied myhna is undetermined. Narang, Tyagi and Lamba (1980) calculated 14-15 days as incubation period of pied myhna at Dehra Dun. According to our observation the incubation period for pied myhna is from 15 to 19 days with an average of 16.3 days and for common myhna it is from 13 to 15 days within average of 14.2 days. We found the average weight and measurement of eggs of pied myhna as 5.22 gm and 2.73 × 2.01 cm while those of common myhna weighed 6.27 gm and 2.87 × 2.15 cm. According to Narang etc. (1980) the hatching suceess was 79% and 88% in 1975 and 1976 respectively. The freshly hatched young weighed 5.12 gm, and the young leave the nest after

3 weeks of age in case of pied myhna. At National Zoological Park the hatching success for 1982 was 63.7% and 74.7% for pied and common myhna respectively and the overall reproductive success in these species was 36.3% and 39.13%. Further the newly hatched young weighed 5.22 gm in pied myhna and 6.22 gm in common myhna. The young of both the species left the nest at the age of 21-26 days at National Zoological Park.

References

Ali, S.1968. The Book of Indian Birds, Bombay Nat. Hist. Society.

Ali, S & Ripley, D.S. 1972. Hand book of the birds of India and Pakistan, Vol.5, pp. 172-180, Oxford University Press Bombay, London, New York.

Baker, E.C.S.1926. The fauna of British India, Vol.III. Taylor and Francis, London.

Narang, N.L., Tyagi, A.K. & Lamba, B.S. 1980. A contribution to the ecology of Indian Pied Myhna, *Sturnus contra contra* Linnaeus, J. Bom. Nat. His. Soc. Vol., 75, pp. 1157-77.

Whistler, H. 1919. Some birds of Ludhiana Dist., Punjab. Journal Bom. Nat. His. Soc. 26, 585-600.

Whistler, H. 1963. Popular hand book of Indian birds. 4th Ed. Oliver & Boya, London.

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7. A NOTE ON THE CATCHING OF MIGRATORY BIRDS WHICH VISIT ALIPORE ZOO, CALCUTTA IN WINTER

(With a photograph)

Several thousands of migratory birds (wild ducks) visit the Alipore Zoological Garden, Calcutta each Winter and take shelter in its lake. These birds include the following —

1. Lesser Whistling Teal — [*Dendrocygna javanica* (Horsfield)]
2. Garganey Teal — [*Anas querquedula* (Linnaeus)]
3. Greater Whistling Teal — [*Dendrocygna bicolor* (Vieillot)]
4. Pintail Duck — [*Anas acuta* (Linnaeus)]
5. Comb Duck — [*Sarkidiornis melanotos melanotos* (Pennant)]

Among these birds, Lesser Whistling Teals come in large numbers and represent about 70% of the total population. The precentage of Garganey Teal is about 29% and the remaining 1% is represented by Greater Whistling Teals, Pintail Ducks and Comb ducks. They generally start coming in the middle of October and leave the Garden at the end of April each year. The number of these birds in the Zoo varies from time to time but the number of birds is generally seen in the month of January.

Photo. 1. Photograph of a kite showing fishing hooks being tied with the flying string.

The birds during their stay at the Zoo spend the day in the lake and leave at dusk to feed many miles away in the countryside and come back to the lake at dawn. These movements of birds at dusk and at dawn take place throughout their stay (about 6 months) at this Zoo.

It has been observed that some people of the nearby Orphanage market area fly Kites, the threads of which are full of fishing hooks tied at intervals of 6 to 8 inches (as shown in the plate) with the threads for catching the birds. The kites are flown in the evening and also in the early morning on the flight paths of the duck. These birds generally fly in flocks, of 5 to 15 birds in each flock. The bird-catchers fly the kites in such a way that they can easily put the threads with hooks on the flight paths of the birds by alternately pulling and releasing the kite's string. Some of the ducks during their flight to and from the lake of the Zoo become entangled with the fishing hooks and are caught.

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to Shri Humayun Abdulali, 75, Abdul Rahman Street, Bombay-400 003 for his encouragement.

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Studies on the behavioural pattern of the Satyr Tragopan *(Tragopan satyra)* in captivity.

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Abstract:

To obtain base-line information on the behavioural pattern of Satyr Tragopan in captivity, the present study was conducted at Padmaja Naidu Himalayan Zoological Park. Darjeeling, during May—June 1993. It was observed that the male specimen showed higher degree of feeding activity than the female and both of them showed a marked preference to grass. Several movement activities like standing, resting, walking, running and jumping were found to be higher in the male than in the case of the female. Other activities like flapping of wings, neck scratching, defaecating and threat behaviour were not well-pronounced.

Introduction :

The Satyr Tragopan *(Tragopan satyra*, Galliformes, Phasianidae) is one of the rare and little studied species among the pheasants. The species is distributed in the Himalayan region extending from Garhwal to Arunachal Pradesh at an altitude between 2,400 m—4,300 m descending to 1,800 m in severe winters (Ali and Ripley 1980) The Singhalila National Park, Neora Valley and the Senchal range of the Darjeeling district are reported to form a part of its natural habitat. The bird is considered to be "vulnerable" by IUCN/Bird Life International and has been awarded the status of a Schedule I species in the Indian Wildlife (Protection) Act, 1972 (Amended by Act 44 of 1991). Wide-scale habitat destruction and poaching

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for its meat and beautiful plumage have proved to be the main threats to the survival of this bird species. The earliest work on the pheasants in Darjeeling was conducted by Louis Mandelli an Italian Tea Planter and pioneering Ornithologist in the 19th century (See Pinn, 1985).

Most of the published literature on the ecology and behaviour of the Satyr Tragopan are from the wild. Inglis (1933) in his series of writings on the game birds of Sikkim and Darjeeling and Jalpaiguri districts of West Bengal discussed the morphology and some behavioural aspects of the Satyr Tragopan.

Gaston (1980) has suggested some census techniques for estimating breeding populations of this bird. Lelliot and Yonzon (1980) conducted a study on the behaviour and ecology of the Satyr Tragopan including habitat identification, population assessment, feeding and breeding behaviour in Nepal.

Later, Pal and Dasgupta (1982) found malaria parasite in a Satyr Tragopan obtained from the Zoological Park, Darjeeling for post-mortem examination and identified it as *Plasmodium relictum.* Earlier, Scot (1926) also reported a malarial infection in the blood of this bird in the London Zoo. However we have not been able to trace any published information on the behaviour of the species in captivity. The present study was therefore undertaken to obtain baseline information regarding the behaviour of the species in captivity.

Material and Methods :

A pair of Satyr Tragopan have been kept in the Padmaja Naidu Himalayan Zoological Park, Darjeeling. The male bird hatched in the Zoological Park Aviary while the female was brought from the wild. The male measured about 70cm. and its general plumage was crimson on the neck and breast, mottled towards the rump and belly, with white spots all over. The female specimen measured about 50cm. and the general plumage was rufous or barred and blotched with buff or brown. In the Zoological Park the Aviary was rectangular in shape having dimensions of 4.5x2. 95x2. 10—2.80m. The ground was covered by patches of grass locally known as "dubo" *(Poa annuae).* Other vegetation included two trees locally known as "Bains" *(Salix babylonica)* and "Dudila" *(Ficus nemoralis)* and two clumps of "Pareng" bamboo *(Arundinaria hookeriana).* Other aviary implements

included a small shade, a feeding tray, a basket serving as a nest, a water tank and a small night-house. The diet of the Satyr Tragopan was wholly vegetarian consisting of grass and leaves. Supplementary diet in the form of wheat grains was also provided. The present observations were carried out for fourteen consecutive days spending 7 hours a day between 10 to 17 hours during May-June 1993 at an average temperature of 15°C and relative humidity of 88±2. Several aspects of the behaviour of the bird species viz., eating, drinking, resting, walking, standing, preening etc were observed and recorded in the form of ethogram charts.

Observations and Discussion :

During the period of study the time spent in performing the various activities during the daytime were recorded in ethogram charts. The most dominant activities shown by these birds were feeding, walking, resting and preening It was observed that the feeding frequency in the male was higher than in the female. It was also noted that the bird species showed a marked preferance towards grass *(Poa annuae)* though supplementary food in the form of wheat grains were provided everyday. Besides, they showed a tendency of scratching the ground in search of microorganisms, specially arthropods on which they feed. However, the consumption of water was minimum in both the cases.

Comparative analyses of data on different activities related to movement like standing, resting, walking and jumping in both the sexes revealed that the male bird showed higher degree of activity during the day time than the female while the female took rest more frequently than the male. It was also observed that the male bird preferred to rest with folded legs whereas the female preferred to take rest by standing still. While preening, the birds used their beaks and claws and the frequency of preening in male was twice that in the female. In calling behaviour, only the female bird was heard calling on the first three days of the observation. This behaviour may be correlated with the temperature, relative humidity and condition of the sky (whether clear or overcast) on the days of observation or may be due to some other factors. Other activities like scratching, defaecating, wing-flapping, running, threat behaviour, neck-stretching, neck-swaying, digging and pecking are not remarkable as reported in the case of other pheasants.

Acknowledgement :

The authors are grateful to B. Dasgupta Emeritus Professor of Zoology, Darjeeling Government College for his constant encouragement and providing valuable suggestions and guidance.

References :

Ali, S. (1978). *Field Guide to the birds of Eastern Himalayas.* Oxford University Press, Delhi.

Ali, S. and Repley, S. D. (1980). *Handbook of the birds of India and Pakistan.* 2nd ed. Vol. 2, Megalopodes to Crabplovers, Oxford University Press, Delhi.

Cowan, A. M. and Cowan. J. M. (1929), *The Trees of Northern Bengal including Shrubs, Woody Climbers, Bamboos, Palms and Tree Ferns.* Bengal Secretariat Book Depot, Calcutta.

Gaston, A. J. (1980). Census techniques for Himalayan Pheasants including notes on individual species. *J. World Pheasant Association*, 5 : 41—53.

Inglis, C. M. (1933). Game birds of Sikkim including the Darjeeling District and of the Jalpaiguri District, Bengal. *Journal of the Darjeeling Natural History Society.* Vol. VII, No. 3, pp. 81—88,

Lelliot, A. D. and Yonzon, P. B. (1980). Studies of Himalayan Pheasants in Nepal *J. World Pheasant Association* 5 : 11—30.

Pal, N. L. and Dasgupta, B. (1982). Malarial parasites of some Indian birds *Proc. Zool. Soc.* Calcutta, 33 : 87—109

Pinn, F. (1985). *L. Mandelli — Darjeeling Tea Planter and ornithologist.* Auropress, Auroville. Pondicherry, India.

Scot, F. (1926). Report on the death occuring in the Society's Garden during the year 1925. *Proc. Zool, Soc. Lond,* 1 : 231—244.

Prakruti—Utkal University Journal—Science
Vol 10 (1 & 2): 145, 1973

OCCURRENCE OF ALBINO HOUSE CROW (*Corvus splendens*) IN ORISSA

The House Crow *(Corvus splendens)* is widely distributed toroughout the Indian Union, Pakistan, Bangladesh, Sri Lanka and Burma (Ali, 1964); but it appears that there are not many reports on the occurrence of albino house crows though they have been exhibited for sometime or the other in some of the zoos.

A white house crow chick was collected along with one normal coloured house crow chick from a nest on 23rd July, 1974 by Shri Sheik Hakim Mian of village Kaipadar in Puri District of Orissa from a tree near his village. He supplied the white coloured one to the Nandankanan Biological Park, Orissa on 28th July, 1974.

The body colour is white throughout with light grey at the tail tip and at the tip of the wing feathers. The eyes, the bill and the limbs are pink in colour. The size, shape, behaviour such as walking, feeding, flying and call are similar to that of the house crow. It is omnivorous and is surviving well on a diet of boiled rice, bread, milk, mutton 'khima' and red tree ants along with their eggs.

The authors are thankful to Shri N. Das of Bhubaneswar for the photograph.

REFERENCE

ALI, SALIM, 1964—The book of India Birds, Seventh Edition, Bombay Natural History Society, Bombay.

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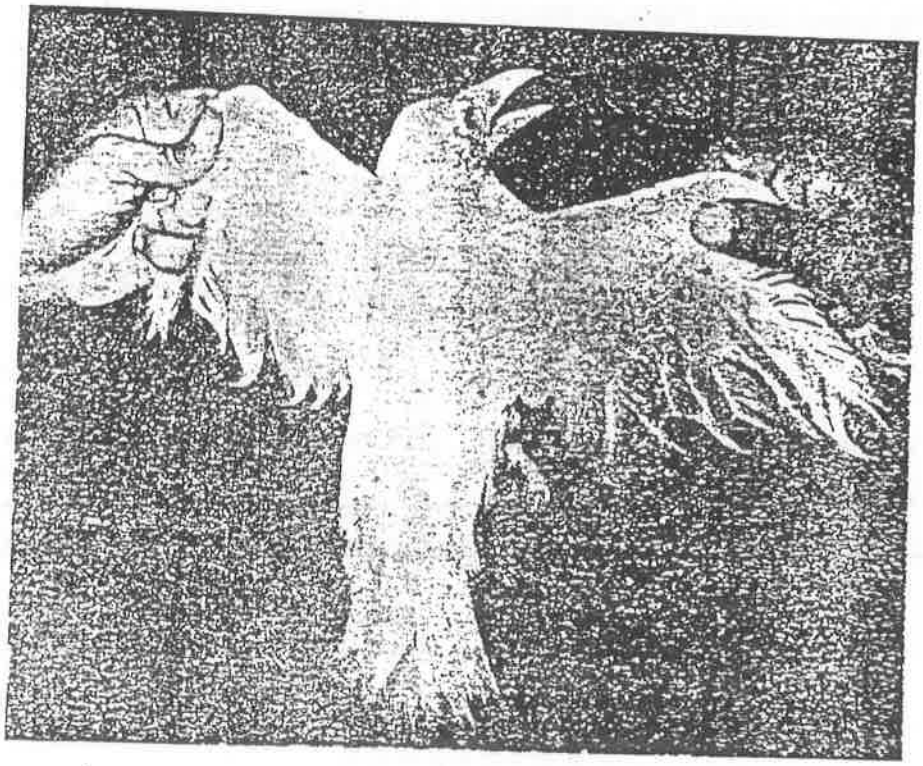
Prakruti—Utkal University Journal—Science
Vol 10 (1 & 2): 145, 1973



An albino house crow at Nandankanan Biological Park, Orissa.

[Reprint, from The *Indian Forester, Vol.* 99, No. 2 : 141 February 1973]

II

Sir,

Subject:—Shedding of ocellated tail-train feathers of the Common Peacock (*Pavo cristatus*) in captivity.

Recently the use of ocellated train feathers of our national bird, the peacock as a source of earning foreign exchange has drawn considerable attention. The shed feathers of peacock's train are collected in Gujarat and Rajasthan and exported in fairly large quantities. As per the press report (The Amrit Bazar Patrika, Calcutta, 21.4.1970) the National Sample Survey has already begun a sample census of peacocks in Gujarat and Rajasthan where they are mostly found for establishing their market abroad. It is necessary to know the probable time of shedding of the feathers of peacock's train in different regions for their easy and perfect collection. Some information on the time of shedding of train feathers of peacocks observed at Nandankanan Biological Park, Orissa during the last five years may be of some interest and so they are presented here.

During the period of five years of observation from 1967 to 1971, twenty one sheddings of train feathers of peacocks (5 in 1967, 5 in 1968, 5 in 1969, 3 in 1970 and 3 in 1971) were observed. Out of these 20 sheddings were observed in August and September (95.24%) whereas only one shedding was observed in October and November during the year 1969 (4.76%).

Gee (1964) stated that the peacocks shed all their tail feathers every year and grow new ones. Henry (1955) reported that the peacocks in Ceylon moult in autumn. According to Scott (1964) train feathers of peacocks are shed in late summer and grow back by December. The ocellated tail feathers of peacock's train are shed after the breeding season and the breeding seasons are given as after the break of the rains in June, continuing through September in northern and central part of its range; chiefly April and May in southern India and in Ceylon chiefly January to March (Ali and Ripley, 1969). The breeding season of this species observed in this Park is from March to August.

Yours faithfully,
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* * *

[Reprint, from The *Indian Forester, Vol.* 102, No. 9 : 634-635 September 1976]

(II)

Sub. :— **"Breeding of Nicobar Pigeon (*Caloenas nicobarica*) in captivity".**

Sir,

Two pairs of Nicobar Pigeons (*Caloenas nicobarica*) were received at Nandankanan Biological Park, Orissa on 13.4.1972. A bamboo basket with opening at the top was provided at a height of about 2.25 metres over a dry branch of a tree planted inside their enclosure.

An egg was laid in the basket on 28.3.1973. The egg was white in colour measured 5 cm × 3.50 cm and weighed 31.20 grams. One chick has hatched out on 26.4.1973 after an incubation period of 29 days. The chick, within a few hours of hatching weighed 37.50 grams and measured 12 cm from tip to tip. The chick was naked, black in colour and its eyes were closed. The eyes opened on the third day. The mother pigeon was feeding the chick with regurgitated food. It was fully feathered at the age of four weeks. The chick was able to come out of the nest to the ground for the first time on the 43rd day (7.6.1973). Weekly weight growth records were taken at the end of every week and an abstract of the growth records of this chick upto the age of six months was as follows :

Date	*Age in weeks*	*Weight in grams*
26.4.1973	Soon after hatching	37.50
10.5.1973	2	170
24.5.1973	4	309
7.6.1973	6	433
21.6.1973	8	444
5.7.1973	10	490
19.7.1973	12	531
3.8.1973	14	535
17.8.1973	16	534
31.8.1973	18	535
14.9.1973	20	538
28.9.1973	22	542
12.10.1973	24	546
26.10.1973	26	546

At the age of six months the chick was apparently as large as the parents in size.

Though the actual date of egg laying was not observed another chick has hatched out in the nest on 2.7.1974 and this chick died on 14.8.1974. It is presumed that the egg

might have been laid sometime in the first week of June, 1974. Another egg weighing 26.20 grams and measuring 4.50 cm × 3.20 cm was laid in the same nest by a Nicobar Pigeon on 13.5.1975 and it was found spoiled after two weeks of incubation.

Baker (1913) reported that these pigeons breed freely in captivity and they have frequently reared their single young ones in the Calcutta Zoo. He further states that the eggs are pure white, spotless, measure 49.10 mm × 33.90 mm in size on an average and both the parents share in the incubation of the egg and the care of the young bird. According to Hume (1890) the normal number of eggs laid by this bird is only one. He further states "Many of the nests I examined contained young ones only a day or two old perfectly devoid of even down, with closed eyes; in fact exactly like the young of the domestic pigeon when first hatched".

References

Baker, E.C. Stuart (1913).— Indian Pigeons and Doves, Witherby and Co., London, pp. 114–119.

Hume, Allan O. (1890).— The Nests and Eggs of Indian Birds, Vol. II, R.H. Porter, London, pp. 365–66.

Yours faithfully,

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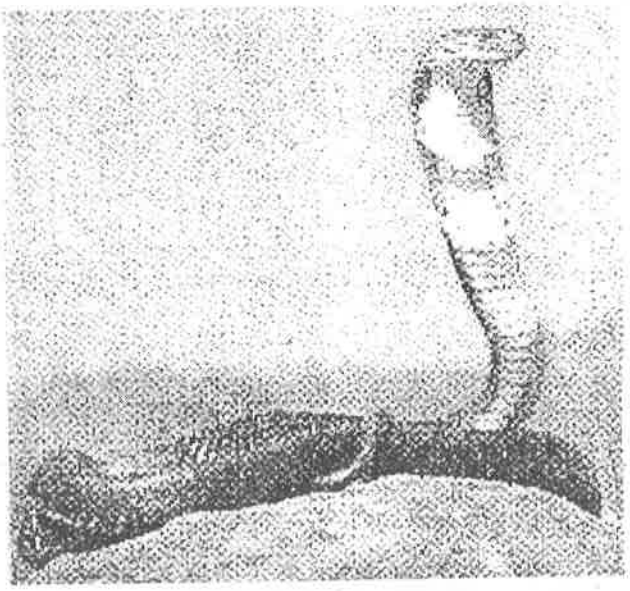
Dated : 1-3-76

A COMPENDIUM OF PUBLICATIONS FROM INDIAN ZOOS
VOL-II (ANIMAL BIOLOGY AND CONSERVATION), 1998



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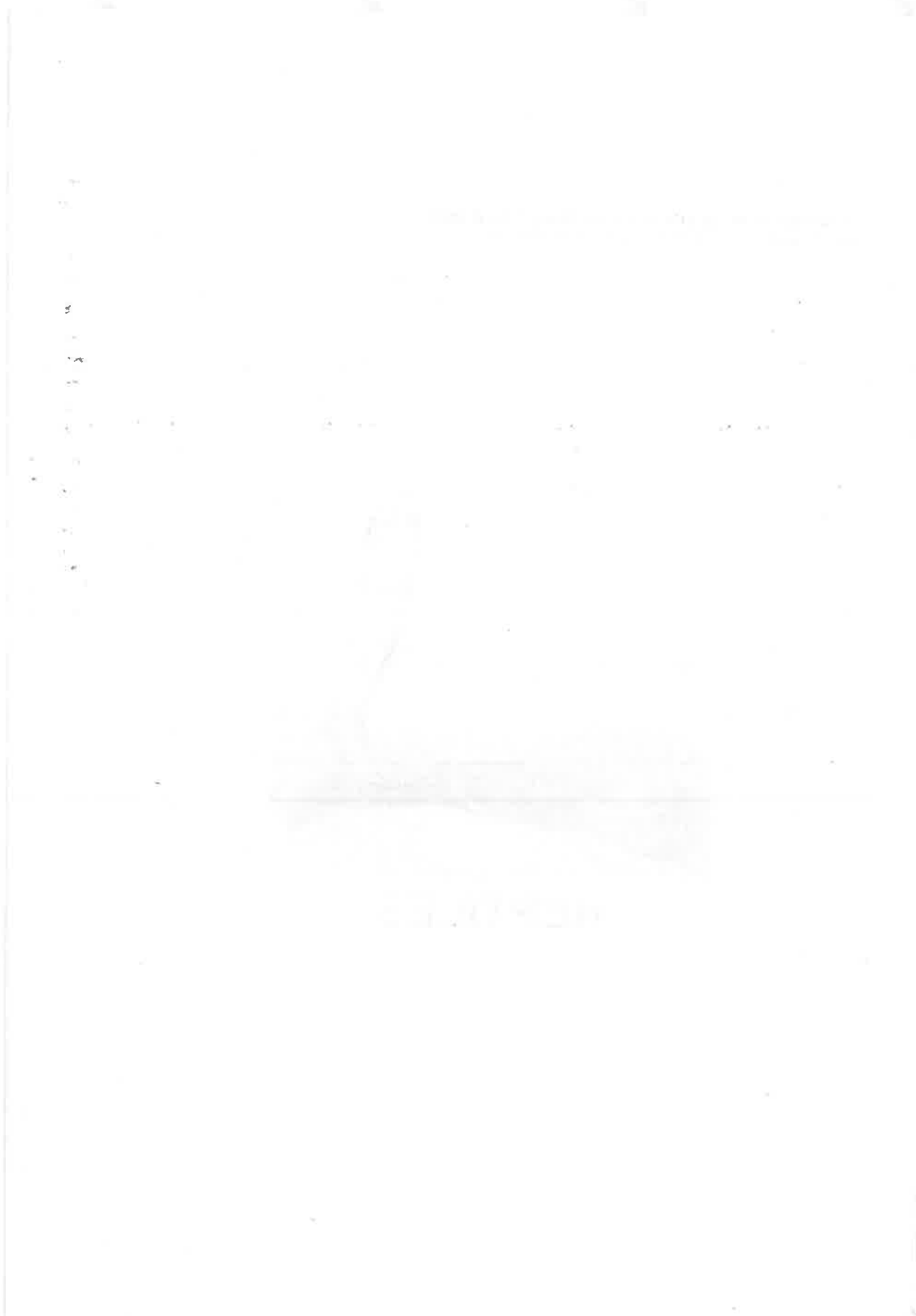

BRITISH JOURNAL OF HERPETOLOGY, Vol. 6, pp. 221–222 (1982)

EMBRYONIC TAIL DEFORMATION IN THE SALTWATER CROCODILE (*CROCODYLUS POROSUS*, SCHNEIDER) IN ORISSA, INDIA

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(*Received* 2 *March* 1981)

The clutch of 48 eggs laid in 1975 which gave rise to a "white" hatchling described in the paper immediately preceding (Kar and Bustard, 1982) also produced one abnormal embryo. This embryo developed to full-term but died without slitting the egg shell. On examination it was found to have a deformed and stunted tail similar to that described and figured for *Crocodylus novaeguineae* by Bustard (1969), where the cause was thought to be the result of high temperature egg incubation.

Saltwater crocodile eggs are usually laid during the last week of May/first week of June in Bhitarkanika. It is assumed that this nest was laid on 1 June then it incubated for 50 days prior to collection under an imperfectly known temperature regime. The nest was collected at 11 a.m. on 20 August 1975 (monsoon season). However, there was no rain on that day or on the two preceeding days and the weather had alternated between sunny and overcast. The nest temperature at the top of the egg mass at the time of collection was 31.0°C. This compares with a mean nest temperature of 31.9°C for a sample of 25 nests (Kar, 1981). Kar found that the mean nest temperature was considerably lower than air temperature throughout the day (by a mean of 2.3°C in the morning and 2.0°C in the afternoon) presumably due to evaporative cooling. In the present case air temperature was only 31.5°C, that is 0.5°C above nest temperature, at the time of collection. This is explicable on the basis that this nest was dry, so evaporation was minimal. The nest was also very compacted with much mud used in its construction resulting in reduced gaseous exchange with the outside. The nest was located in a generally shady place which may also account for the temperature being slightly lower than normal.

The eggs were incubated in an artificially prepared mound consisting of vegetation used in the natural nest. The temperature in the nest at egg level, measured

through a stoppered bamboo pipe permanently inserted into the middle of the egg mass, averaged 28.5°C (range 27–30°C) during the remaining 31–33 days of incubation. Possible morphological abnormalities resulting from low temperature incubation are not known.

It is possible, though unlikely, that water deficiency could have caused the deformity as has been described for chelonian embryos by Lynn & Ullrich (1950). However, the 24 eggs which hatched all produced normal hatchlings except for the "white" individual described in the preceeding paper. The remaining 23 eggs, which failed to hatch, were apparently infertile. Water relationships of crocodile eggs are little known. Preliminary work carried out by Bustard (1976) indicated, that eggs dessicated rapidly when water was not available in the external medium. However, Bustard noted that eggs which had lost approximately 20% of their weight as a result of dessication still produced normal hatchlings.

A detailed study of the water relationships of crocodile eggs at different developmental stages, particularly if related to the natural situation, would most valuable.

REFERENCES

Bustard, H. R. (1969). Tail abnormalities in reptiles resulting from high temperature egg incubation. *British Journal of Herpetology* 4, 121–123.

Bustard, H. R. (1971). Temperature and water tolerance of incubating crocodile eggs. *British Journal of Herpetology* 4, 198–200.

Kar, S. K. & Bustard, H. R. (1982). Occurrence of partial albinism in a wild population of the saltwater crocodile (*Crocodylus porosus*, Schneider) in Orissa, India. *British Journal of Herpetology* 6, 220–221.

Kar, S. K. (1981). Studies on the Saltwater Crocodile (*Crocodylus porosus* Schneider) Ph.D Thesis submitted to Utkal University, Orissa, India.

Lynn, W. G. & Ullrich, M. C. (1950). Experimental production of shell abnormalities in turtles. *Copeia* 1950, 253–262.

[Reprint, from *J. Bombay nat. Hist. Soc. Vol.* 76 No. 1 : 166-167]

12. MALFORMATION AT BIRTH IN THE SALTWATER CROCODILE (*CROCODYLUS POROSUS* SCHNEIDER) IN ORISSA, INDIA

A clutch of 64 eggs collected, gave rise to an abnormal hatchling which now lives along with other normal animals in the hatchling pool of the Salt water Crocodile Research and Conservation Project, located at Dangamal. The abnormality is in both the neck and the tail. A similar type of embryonic deformation occurred in a full term embryo which died without slitting the eggshell (Bustard and Kar, in press) on examination it was found to have a deformed and stunted tail, similar to that described by Bustard (1969) for *Crocodylus novaeguineae* where the cause was thought to be high temperature egg incubation.

The eggs were collected on 30.5.77 from Forest Block No. VIII of Bhittar Kanika Sanctuary and brought to the project hatchery site and hatched between 6.8.77 and 10.8.77. During this period the eggs occupied a middle position in the artificially prepared nest mound inside the hatchery. Egg nest temperature was taken starting from implantation of eggs upto the end of hatching time (measured through a stoppered bamboo pipe permanently inserted in the middle of egg mass) averaged 29.5 (range 37 - 34°C) during 66-70 days incubation period. Fourtyone hatchlings hatched, of which three hatchlings died after 24 hours.

The deformation occurred in both neck and tail portions. The neck is bent to the left at an angle of about 65-70°C and the tail is twisted. It is possible, though unlikely, that water deficiency could have caused the deformation as has been described for chelonian embryo by Lynn and Ullrich (1950). However, fortyone eggs hatched and produced normal hatchlings. Seven fullgrown embryos failed to hatch due to some abnormality in the neck portion which was very thin. Sixty eggs which failed to hatch were apparently infertile.

Preliminary work, carried out by Bustard indicated that eggs dessicated rapidly when water was not available in the external medium. Here, rain was allowed to fall over the nest to keep the nest slight damp by which the nest can maintain correct temperature by the decomposition of the nesting material. Maximum sunshine was allowed to fall on the nest. The incubation period being in the rainy season it was hard to maintain equal temperature all the time. However, Bustard noted that eggs which had lost approximately 20% of their weight as result of dessication still produced normal hatchlings.

The deformation in both the neck and the tail may be due to high temperatures or may be due to the fluctuation of the temperature at the time of incubation. A detailed study of the water relationship of crocodile eggs of different developmental stages, would reveal the actual cause of deformation.

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October 16, 1978.

REFERENCES

BUSTARD, H. R. (1969): Tail abnormalities resulting from high temperature egg incubation. *Brit. J. Herpetol*, *4*: 121-23.

——— (1969): Temperature and water tolerances of incubating crocodile eggs. ibid. 4: 198-200.

LYNN, W. G. & ULLRICH, M. C. (1950): Experimental production of shell abnormalities in turtles. *Copeia*, Ann Arbor, pp. 253-262.

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16. TERRITORIALITY IN IMMATURE CAPTIVE SALTWATER CROCODILES (*CROCODYLUS POROSUS* SCHNEIDER)

Since 1975, extensive rearing of saltwater crocodiles, hatched in captivity, has taken place at Dangmal, Orissa as one facet of a conservation programme on this endangered species (FAO, 1975).

Hatchlings show a strong tendency to aggregate, but by about eight months old they start to loose this aggregation tendency becoming progressively more solitary if space permits. In the early spring (February/March) of their third year, at an age of 2½ years, signs of territoriality/dominance behaviour commenced in groups in two successive years (Table 1)). This behaviour was exhibited by both sexes.

The dominant female of the all female batch hatched in 1975, did not allow the other four females to enter the 4×4×1 m deep pool when she was in the pool or to approach her on land. In September 1978 this female was removed and housed separately, following which the next largest female in the group became dominant. The 1976 batch showed similar dominance behaviour from February/March 1978, the dominant in this year being a male. Towards the end of the third year the dominants commenced actual physical attacks on the subordinate members of their respective groups. This behaviour was very marked during the fourth year resulting in injuries to the head, jaws and back legs.

We consider that this dominance behaviour results from territoriality which cannot find expression in a confined space, hence resulting in the development of a dominance hierarchy.

The development of strong territoriality is surprising in immature individuals assumed to have at least a further 5 - 7 years of immature life prior to first breeding (Yangprapakorn 1971). Furthermore, the existence of strongly developed female territoriality is likewise unexpected. However, as pointed out by Neill (1971) virtually nothing is known of the biology of *C. porosus* outside of nesting. Furthermore, crocodilians may represent a behaviourally more diverse group than hitherto limited data have suggested.

It is standard practice in large-scale crocodilian rearing to restrict the numbers per pool, to keep year classes separately, and to resort individuals within year classes so that similar-

TABLE 1

DEVELOPMENT OF TERRITORIALITY/DOMINANCE BEHAVIOR IN GROUPS OF IMMATURE SALTWATER CROCODILES. SIZES (M) AND WEIGHTS (KG)

Date of birth	Time/Age of commencement of territorial/dominance behaviour	Composition of group	Dominant		
			Sex	Size	Weight
21 August 1975	Feb/Mar 1978 (2½ years)	5 Females	Female	1.42	10.5
17 August 1976	Feb/Mar 1979 (2½ years)	3 Females 2 Males	Male	1.29	7.5

sized individuals are kept together. This is done to prevent bullying of smaller individuals by larger animals. However, the behaviour described here for *C. porosus* is markedly different in degree from our experience with other crocodilian species.

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REFERENCES

FAO (1975): India: Gharial and Crocodile Conservation Management in Orissa (based on the work of H. R. Bustard) FAO, Rome (FO:IND/71/033).

NEILL, W. T. (1971): The Last of the Ruling Reptiles. Columbia Univ. Press. New York.

YANGPRAPAKORN, U. (1971): Captive Breeding of Crocodiles in Thailand. *In* Crocodiles. IUCN Publs. N.S. Suppl. *33*: 98-101.

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SOME OBSERVATIONS ON NESTING HABITS AND BIOLOGY OF *VARANUS SALVATOR* (LAURENTI) OF BHITARKANIKA SANCTUARY, ORISSA[1]

S. BISWAS[2] AND S. KAR[3]

(With a plate & two text-figures)

INTRODUCTION

So far little is known about the nesting habits and biology of *Varanus salvator* (Laurenti) which is mainly distributed in the coastal region of West Bengal and Orissa and also in Assam of Eastern India. However some observations have been made on the breeding and egg laying habits of the species in captivity in Madras Snake Park (1976 & 1978), Ahmedabad Zoo (1970) and Nandankanan Biological Park (1977). The present observation was carried out in the Bhitarkanika island situated in the Mahanadi Baitarani estuary of Orissa. Bhitarkanika, an area of 176 sq Km, has now been declared as a Crocodile sanctuary by the Orissa Government. Four nests with eggs of *Varanus salvator* were located within the sanctuary from an area of nearly 1 sq km adjacent to Dangmal village and four hatchlings of another species, *Varanus flavescens* (Gray) were also collected from the same area (Biswas & Kar 1979). The Water Monitor is now thriving well here, protected from exploitation by skin traders. It is presumed that mongoose is the predator of eggs of the monitor as they are common in this area.

This paper is a preliminary report on observations on the nesting habit and incubation experiment on the eggs of *V. salvator*. One clutch of freshly laid eggs was collected which did not hatch out but another clutch collected in an advanced stage of development, hatched out in the hatchery.

Selection of nest site: In Bhitarkanika *V. salvator* nests in the month of June during the wet season. The nesting places are always selected on high ground in secluded places. Bhitarkanika estuarine area is inundated by tide water twice daily and in the full-moon and new-moon the tide reaches its maximum. Therefore selection of nest site is made in such a way that even in maximum high tide, water does not reach the nest. Almost all the nests are seen placed in secure places free from human disturbance since there is no village situated on the island. All the villages are either close to or away from the river and its associated creek systems, which encircle the main Bhitarkanika island.

The most interesting observation in their selection of nesting site is that the monitor invariably selects a termite mound. The nesting mother selects one or two already existing holes of the mound and enlarges them into a cavity (Figs. 1 & 2). Though generally the nesting site is free from biotic interferences sometimes it may be situated close to human settlements inside the sanctuary. Selection of the nesting site is mainly guided and determined by the availability of termite mounds. The monitor prefers termite mound so much that it does not mind even if the

[1] Accepted March 1980.

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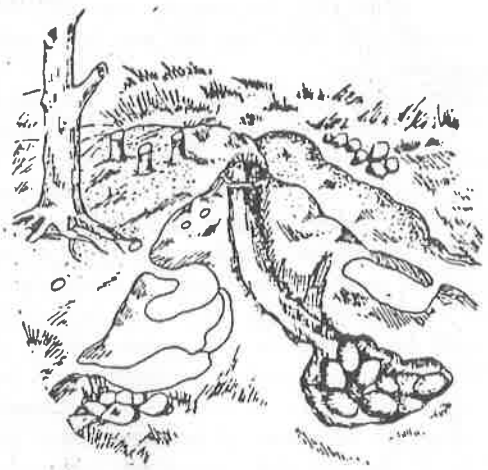


Left: Fig. 1. Diagram of a termitarium mound.
Right: Fig. 2. Diagram of the same dug up mound showing the location of eggs.

mound is close to the road or houses or in unused fields.

Nest hole or the cavity: The nest soil is mainly hard and loamy. The varanus selects a nest-hole in the slope of the termitarium at a high level from its base. In two nests measured the height from the base of the mound to the nest cavity is 9" and 12". The mother makes the hole wider and deeper by scraping soil from the mound by both fore and hind limbs and does not spend much energy for preparation of the nest. The shape of the nest is somewhat flask shaped, narrow neck with wide bottom (Figure 2). Four nests of *V. salvator* were examined (Table 1).

The nest nos. 1 and 4 are same. It is presumed that the same monitor utilised the nest for laying her eggs.

It appears from the Table 1 that the nest size depends on the size of the clutch.

Egg laying and its collection: Egg laying was observed on one occasion by a person who was working a few yards away from the nest (nest no. 1). On 24th June 1977 near about 7-30 A.M., a female varanus was seen on a way side termite mound scraping the soil with her limbs. After sometime she rested, with her head towards the top of the mound and the tail on the ground. The presence of the observer disturbed her and she left the nest site.

TABLE 1

No. of nests	Date	Nest size	No. of eggs	Nest temp. at the time of coll.	Air temp.	Time
1	24.6.77	30×21 cm	20	29.5°C	32°C	10 A.M.
2	25.2.78	22.5×17.5 cm	9	28.5°C	30°C	1 P.M.
3	18.6.78	20×19 cm	6	28.0°C	27°C	4 P.M.
4	19.6.78	27.5×17.5 cm	Nil	29.5°C	30°C	8 A.M.

When the site was examined, the nest hole was seen filled up with scraped up soil and it is possible that the varanus was observed when she was filling up the nest hole after laying the eggs.

Eggs were collected from three nests (nest nos. 1, 2 and 3) but the eggs of the 4th nest were found broken. The eggs of nest no. 2 were accidentally collected while some workers were clear felling an area and digging up a termite mound for soil. The nine eggs of this nest were in an advanced stage of development and hatched just eight days after they were placed for incubation. The embryos were already in a mature stage when three out of the 9 eggs were broken at the time of collection to ascertain the status of development of the embryo. One hatchling from these three eggs died immediately but the two other eggs were kept with the other incubating eggs.

Incubation: For incubation of the collected eggs an artificial nest mound of size, 45 × 30 cm was built with sand in the crocodile hatchery at Bhitarkanika and for recording temperature inside the nest a hollow bamboo pipe with a stopper on the top end of the pipe was inserted in the middle of the mound.

The incubation experiment on eggs of nest No. 1 was unsuccessful. After keeping the eggs inside the artificial nest for 43 days from 24.6.77 to 5.8.77 the nest was opened for inspection but it was found that eggs were all rotten and the shells were covered with fungal growth. The eggs of the 2nd nest required only eight days of incubation and no experiment was conducted on the eggs of the 3rd nest.

Incubation experiment on the eggs of nest No. 2 indicated that if the egg is an advanced stage is broken but the embryo of the broken egg case is not disturbed and incubation is continued, the hatchlings may survive.

The temperature record of the two clutches of eggs, Nest No. 1 (N-1) sterile and Nest No. 2 (N-2) consisting of eggs in advanced stage of development, placed for incubation in an artificial nest is given in Table 2.

TABLE 2

Clutch & Nest No.	Nest temp.			Range	Average
25°C 33°C	8°C	27.6°C	N-1	Minimum at 6 P.M. Maximum at 2 P.M.	
24°C 30°C	6.5°C	25.8°C	N-2	Minimum at 6 A.M. Maximum at 2 P.M.	

Weight and measurement of eggs:

The egg is elongated with both ends tapering bluntly and the shell is white, soft and leathery.

The measurement and weight of the three clutches of eggs, N-1, freshly laid but sterile, N-2, in advance stage of development and N-3, status unknown, is given in Table 3.

TABLE 3

Nest Nos.	N-1	N-2	N-3
Nos. of eggs	20	6	3
Range of length	68 to 79 mm.	68 to 76 mm.	64 to 77 mm.
Average of length	71.6 mm.	72.3 mm.	75.5 mm.
Range of breadth	38 to 41 mm.	44 to 47 mm.	35 to 38 mm.
Average of breadth	39.16 mm.	46 mm.	36.5 mm.
Range of weight	52.40 to 65.90 gm	77.50 to 87.20 gm	55 to 60.50 gm
Average of weight	58.24 gm	82.35 gm	58.87.gm

If the average breadth and weight (39.16 mm. and 58.24 gm) of the freshly laid eggs are compared with that of eggs of advanced stage of development (46 mm. and 82.35 gms.) then it may be presumed that the eggs of the 3rd clutch (36.5 mm. and 58.87 gms) were also freshly laid. The increase in egg size is more in width than in the length.

Hatching out of hatchlings out of the egg case: No indication was available of the time of emergence of the hatchlings except for the flow of the egg fluid when the hatchlings made slits on the egg case with their egg tooth. The fluid adhering to the thermometer inserted in the nest gave the indication that the hatchlings were ready to come out of the egg case. When the eggs were examined after opening the nest, 2 to 3, 2.5 to 5 cm long longitudinal slits or cracks on the egg shell were seen. These had been made by the sharply pointed egg tooth on the lip below the snout of the hatchling. After opening the nest on 5.3.78, the first batch of three hatchlings emerged from the egg shell. Two of the hatchlings still had chords but these became detached after 45 and 53 minutes and in one case after 2 hours of their emergence. The remaining 5 hatchlings emerged a day later.

Two slightly broken eggs were also kept for incubation along with the 6 other eggs. These two also hatched on 6.3.78 but the hatchlings were very inactive and their stomachs were swollen with chord attached with the egg membrane. It took 25 hours for freeing the chord from the egg cases.

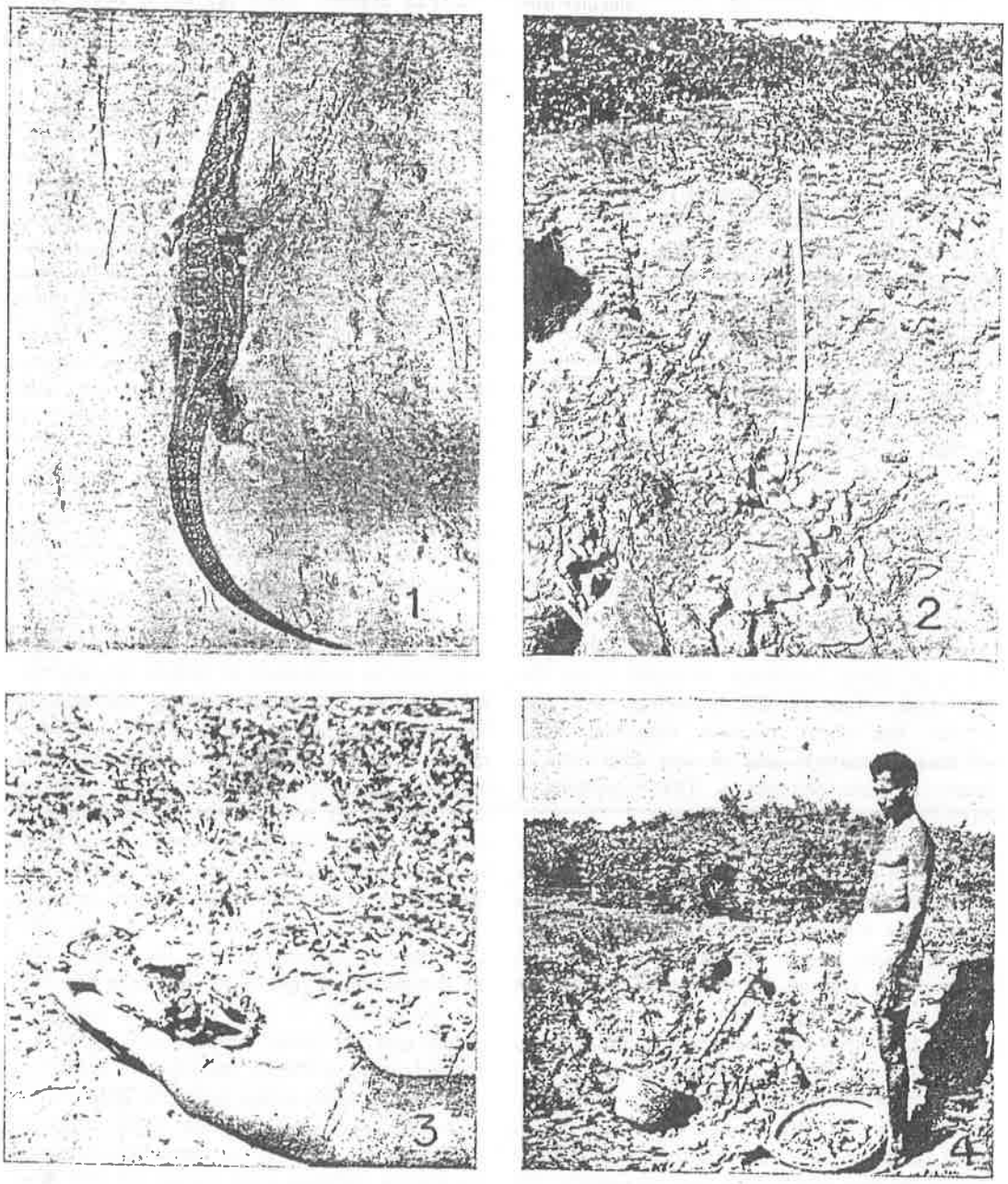
The hatchlings were very active immediately after hatching. One just after emergence went up a wooden pole of *c* 50 cm hight. If disturbed they hissed with swollen neck and raised head and during this moment the tongue would be seen darting out very frequently. All the hatchlings excepting two were very active and immediately after coming out of the egg shell they started moving about the hatchery and climbing on its poles and wire netting.

In colour, the hatchlings were very black with yellow spots arranged dorsally in transverse rows.

Parental care: Though parental care in varanus was not studied in detail, observations on the mother varanus were continued after collecting her eggs from the nest on 24.6.77. She was found on the same night, on the nest for nearly about one hour scraping soil to fill up the opened but empty nest hole. On the morning of 25.6.77 she was again seen near the nest, disappeared immediately on seeing the observer. This varanus was kept under regular observation upto 2.7.77. Mostly in the evenings it was seen in a hole close to the nest, with the snout protruding from the hole. But on 3.7.77 it was disturbed during the day by village boys and from that day onwards she was not seen coming near her nest.

The observations on the mother varanus could not be completed to decide whether she takes special interest in opening the nest to help the hatchlings to emerge. But it has been observed in the case of artificially incubated eggs that the hatchlings produced no noise inside the nest as is produced by hatchlings of crocodiles. Therefore, it is presumed that there is no parental assistance for opening the nest. The nature of the soil of the selected nest site in termitarium, particularly from the soil used by the mother to close the nest it can be deduced that there is no necessity for help for the hatchling to come out of its nest. The closed nest not being compact, it is very easy for the active and agile hatchling to come out of the nest without the mother's help.

It will appear from the table that in the hatchling there is an approximate equal proportion between total length of the body to the weight and the tail to snout vent proportion which is nearly 1.5.



Varanus salvator (Laurenti)
Fig. 1. View of an adult female.
Fig. 2. Dug out egg nest in a termitarium showing actual position of eggs with a measuring tape. Fig. 3. Showing just hatched out hatchling. Fig. 4. Showing a view of partially dug out nest in the natural surroundings.

Weight and measurement of hatchling:

Sl. No.	Length total in cm.	S.V. Length in cm.	Tail length in cm.	Weight in gm.	Average L & W
1	33.2	14.0	19.2	35.0	
2	33.0	14.0	14.0	30.0	Length=32.3 cm.
3	32.0	13.4	18.6	35.5	Weight=32.80 gm.
4	32.0	13.5	18.5	30.8	
5	31.8	13.5	18.3	32.0	
6	32.5	13.8	18.7	31.0	
7	32.0	13.5	18.5	33.5	
8	32.0	14.0	18.5	34.6	

Post hatching care of the hatchling:

The hatchlings were kept in a concrete pool of the size 3 × 3 × 1 m., one side of which was sloping. The pool was one third filled with water. Phoenix canes were kept inside the dry portion of the tank to be used as hide-out by the hatchlings. On the ground of the enclosure of the pool some artificial burrows were provided as it was observed in the wild condition that varanus hide inside bushes and live in existing or prepared burrows.

The hatchlings were not provided with any food till five days after hatching and from the 6th day they were each supplied with prawns, about 2 gms. each for the 1st fortnight and 3 gms. afterwards. It was observed that nearly a week after the supply of food they did not take any but afterwards started feeding.

The hatchling when 80 days old (hatched out 26.4.78 and reared upto 24.7.78) reached a length of 37 cm. The average length of a just hatched out hatchling being 32.3 cm. it grew about 4.7 cm. during this period in the abnormal condition of captivity.

It was observed that hatchlings spent more time in a dry place than in the water and only occasionally went in to the water. They hide immediately when some one approached the enclosure. The experiment could not be continued further as the hatchlings died during a period of cyclonic weather in the region

Remarks: The preference for termite mounds by Varanus for egg laying had been observed by Annandale (1922) in case of *Varanus bengalensis* (Daudin) at the Barkuda island of Chilka Lake, Orissa. In September, 1920 a half grown embryo was dug out of the interior of a mound of *Termes* (*Odontotermes*) *obesus*.

Biswas and Acharjyo (1977) found eggs of water monitor in a cage and David (1970) collected hatchlings which developed out of the laid eggs in a zoo enclosure probably in a burrow. So, it may lay eggs during its captivity in abnormal situations. A termitarium is probably selected as a convenient and safe place for the protection and development of the eggs in an esturine condition. Therefore, if an artificial termitarium is provided for the egg nest we hope to get good results in egg laying and incubation of eggs of Water Monitor in captive conditions.

Biswas and Acharjyo (loc. cit.) recorded an egg laying incidence on 29th July, 1971 of a water monitor at Nandankanan Biological Park and Madras Snake Park (1976 & 1978) also had mentioned incidences of laying once of four eggs on 16th June, 1976 at intervals of two to three hours and another fourteen eggs on 19th June, 1977. According to Smith (1935) in Thailand the species lays eggs in June, at the beginning of rainy season. Therefore, it can be safely deduced that egg laying

season of this species is June and July.

Further according to Smith (loc. cit.) the number of eggs laid at a time, i.e. the clutch size is 15 to 30 whereas in the three nests we have got only 6 to 20 eggs. The average measurement of freshly laid eggs of this species from the Bhitarkanika is 71.6 × 39.16 mm which comes very near to the 70 × 40 mm mentioned by Smith.

Honegger (1971) mentioned in respect of incubation experiment on eggs of *V. salvator* by incubator in laboratory condition that the incubation period is 207 to 209 days at an average temperature of 30°C (range 29°C to 31°C). So, we may presume that when nest temperature varies between 25.8°C to 27.6°C in natural condition then incubation period may be longer than the above mentioned incubation period. In the natural condition when in winter atmospheric temperature goes down the nest temperature may not be higher than 25°C.

In this connection we like to point out that David (loc. cit.) collected hatchlings on 1st April, 1969; the actual coming out of egg case may be a few days earlier, when he was maintaining five *Varanus salvator* in an enclosure of Ahmedabad Zoo. Taking into consideration that water monitor lay eggs in June and the hatchlings come out in the March or April (David and our observation) we may presume a prolonged incubation period of eggs (nearly 270 days) of this species. This observation is further supported by the report of the Madras Snake Park (1978) that one egg took 260 days to hatch out.

According to David (loc. cit.) the size of the two breeding males and three females was 1.4 to 1.5 m. Four hatchlings were 30-32 cm long but in the present case the average length of eight hatchlings is 32.3 cm.

Finally this report shows the importance of Bhitarkanika sanctuary as a breeding place for two species of varanus by the location of four nests of *Varanus salvator* within an area approximately 1 sq. km. near the Dangmal village within the sanctuary and also the collection of hatchlings of *Varanus flavescens* (Gray) within this area (Biswas and Kar 1977).

ACKNOWLEDGEMENTS

We thank the Director, Zoological Survey of India and the Chief Conservator of Forest, Dept. of Forest, Govt. of Orissa for providing facilities for study, we are also indebted to Dr. K. K. Tiwari for going through this paper.

REFERENCES

ANNANDALE, N. (1921): The Reptiles and Batrachia of Barkuda. *Rec. Ind. Mus.* 22 (4): 331-333.

ANON. (1976): Births at the Madras Snake Park. *Newsletter of the Madras Snake Park Trust. 1* (2): 1.

——— (1978): News from the Madras Snake Park and Crocodile Bank. *Newsletter of the Madras Snake Park Trust. 3* (2): 4.

BISWAS, S. AND ACHARJYO, L. N. (1977): Notes on ecology and biology of some reptiles occurring in and around Nandankanan Biological Park, Orissa. *Rec. Zool. Surv. India. 73*: 95-109.

——— AND KAR, S. (1979): Two new Record of the species belonging to the genus *Varanus* Merrem. 1820 (Reptilia: Varanidae) from Orissa. *Bull. Zool. Surv. India* (in press).

DAVID, R. (1970): Breeding the Mugger crocodile and water Monitor. *Crocodylus palustris* and *Varanus salvator* of Ahmedabad Zoo. *International Zoo. Yearbook, 10*: 116-117.

HONEGGER, RENE' E. (1971): Zoo breeding and crocodile bank. IUCN Publication New Series. Supplementary paper. 32. Morges, Switzerland. pp. 86-97.

SMITH, M. A. (1935): Fauna of British India. Reptilia and Amphibia, Vol. II-Sauria.

7. MATERNAL CARE AMONG PYTHONS

Pythons are amongst the few reptiles in which maternal care has evolved. A female Burnese Python *(Python molurus bivittatus*) was observed at Jersey Wildlife Preservation Trust during March 1993, while it laied and incubated eggs in a box provided in the exhibit. The process of laying eggs took more than four hours. After laying approximately 52 leathery, oval, white eggs, the female gathered her coils and the eggs were completely surrounded and covered by her body. When the surrounding temperature dropped, she began making spasmodic muscular contractions. Herpetologists call these contractions "shivering". Shivering was observed at 30 contractions per minute, which seemed to consume a lot of her energy. However the incubating female python often would not leave her eggs to search for food. She remained with the clutch until it was removed from the exhibit. The female went away briefly to drink water on a few occasions. Water was sprayed on her body twice in a day. This water was licked by the python.

Pythons give maternal care only to their eggs. Once a clutch hatches the young are on their own and get no further attention from their mother.

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Notes on Two-headed Snakes

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A two-headed checkered keelback watersnake (*Xenochropis piscator*) hatchling estimated to be about one week old was received at the Nandakanan Zoological Park, Orissa on April 3, 1986 through a villager of Kalapathar (Cuttack District, Orissa). The hatchling was collected from the bank of a village tank. It had two equally well developed distinct heads and measured 19.5 cm from tip of the tail to the tip of the snout of each head. It was maintained in a special tray and offered fingerlings but unfortunately it died after two weeks without taking food.

As they are anatomically defective, the two-headed snakes usually do not survive long after birth (Whitaker, 1971) although a two-headed king snake (*Lampropeltis gerulus californiae*) lived for six and a half years. Earlier records of two-headed snakes from India are in dog-faced water snake, (*Cerberus rhynchops*) from near Madras city; checkered keelback water snake (*Xenochropis piscator*) from near Nagercoil, Tamilnadu (Whitaker, 1971) ; common sand boa, *Eryx conicus* from Shimoga district in Karnataka (Indian Express, Bombay, August 16, 1988); wolf snake, *Lycodon aulicus*; cobra, *Naja naja* and Russell's viper *Vipera russellii* (JBNHS, 1971). According to Whitaker (1971) there are records of two-headed rattle snake (*Crotalus*) and garter snake (*Thamnophis*) in addition to king snake. The Pore Elizabeth Museum and Snake Park once had a two-headed sand snake. One of its heads swallowed the other! (Anonymous, 1964) One out of ten hatchlings of Russell's viper (*Vipera russellii*) born on 9th June 1994 at Calcutta Snake

Park, Calcutta had two heads, but survived for only 23 days (Mitra, 1994)

The authors wish to thank Dr. Sushil K. Dutta, department of Zoology, Bhubaneswar for the photograph. (See cover)

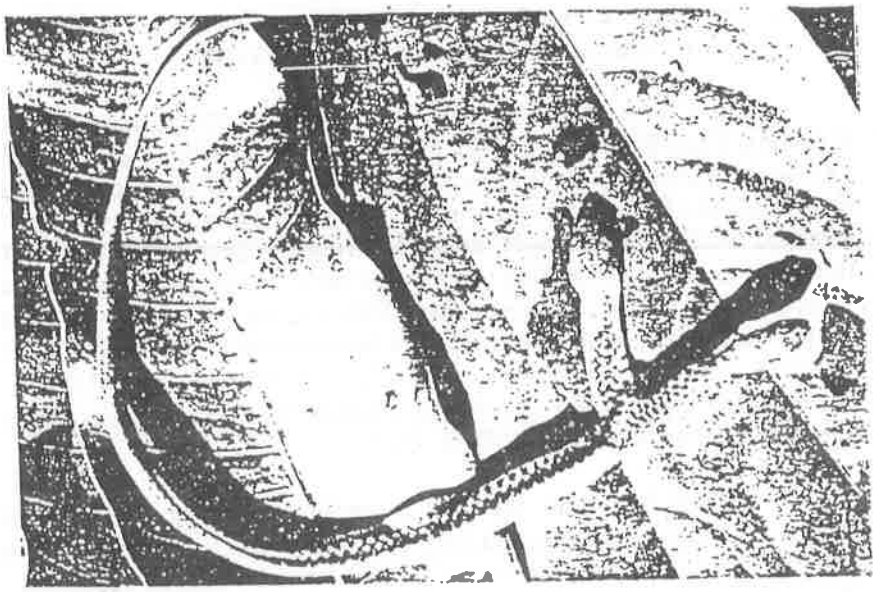
Reference :

Anonymous (1964) : *Animals*. 4 (11) : 312.

Editors (1991) : *J. Bombay Nat. Hist. Soc.* 68 (2) : 462.

Whitaker, R. (1971) : Notes on Indian Snakes - 1 *J. Bombay Nat. Hist. Soc.* 68 (2) : 461 -463.

Mitra, Dipak (1994) : The birth of double headed Russell's Viper, *Zoo's Print*, ix (11) : 22.



Observations on Breeding of Mugger (*Crocodilus palustris*) at the Nandankanan Zoological Park, Orissa

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Orissa is the only State in the country having all the three species of Indian Crocodilians (*Gavialis gangeticus, Crocodilus porosus* and *Crocodilus palustris*). As the population of all the three species were dwindling in the natural habitats of Orissa, a special conservation-oriented research project was initiated during the year 1975-76. Under this project a captive breeding programme for all three species was taken up at the Nandakanan Zoological Park, Orissa from 1975-76 by the State Forest Department, with assistance from Government of India and F.A.O./ U.N.D.P. This communication is intended to place on record some of the observations made on the breeding of mugger (*Crocodilus plaustris*) at the Nandanakanan zoological Park, Orissa.

For the first time, the park procured two young mugger from Alipore Zoological Garden, Calcutta on 02.01. 1964. Unfortunatelly one died on 15.03.1964 and other escaped into the near by lake on 10.05.1965. Since then , five young mugger were recieved from different parts of Orissa (two specimens from river Mahanadi on 02.11.1964 and 15.05.1967, one from Balimela reservoir in Koraput district on

27.03.1977 and two specimens from reservoirs in Ganjam district on 05.05.1983 and 23.12.1984). All these specimens died within few months of their arrival. This species used to occur previously in Brahmani, Baitarani, Mahanadi, Sileru and hill streams in Mayurbhanj district including Budhabalang, Khiri and Bhandan and the population has been greatly depleted in Orissa (Kanungo, 1976). The occurence of this species in Ganjam district is being reported for the first time in this communication.

Breeding pool :

A special mugger breeding pool was constructed inside the park during 1978-79. The pool measures 38 m at the longest part and 17 m at the widest part with a depth of 2 m. The pool has the capacity to hold 8,26,000 litres of water. The land area of the pool complex is about 1,250 sq.m. with suitable vegetation. A compound wall of 2.1m high was erected all around except 23m on the viewer's side with 0.6m high parapet. A dry moat was provided on this side to discourage the mugger coming near the visitors. There is provision for removing the stagnant water and refilling with fresh water from the near-by lake.

Breeding population :

Two adult males and three female mugger procured from Tamilnadu were released in this pool in January, 1979. To these, four more (2 males & 2 females) mugger of Tamilnadu origin were added in October, 1980. However, one male and one female died in October,1980 and January, 1981 respectively leaving three males and four females in the breeding pool.

Breeding :

The details of egg laying, clutch size and hatching recorded in the park from 1981 to 1992 are appended in Table-1.

Table-1 : Details of Mugger breeding .

Sl. No.	Date of egg-laying	Female mugger number	Clutch size	Date of hatching (incubation period in days)	No. of hatch-lings.	Remarks
1.	March '81	1	29	did not hatch	-	All eggs infertile.
2.	08.03.82	1	30	16.05.82 (73)	5	23 eggs were broken and soiled. 2 did not hatch.
3.	05.03.83	2	22	20.05.82 (74)	2	7 eggs were broken & soiled. Rest (13) did not hatch.
4.	05.03.83	1	29	29.05.83 (86)	4	Rest did not hatch.
5.	05.03.83	3	25	25.05.83 (82)	13	Rest did not hatch.
6.	08.03.83	2	16	25.05.83 (79)	5	Rest did not hatch.
7.	05.03.84	1	24	19.05.84 (76)	10	Rest did not hatch.
8.	10.03.84	3	20	20.05.84 (72) & 22.05.84 (74)	14	Rest did not hatch.
9.	12.03.85	1	4	did not hatch.	-	All eggs were spoiled.

Table 1. (Continued)

Sl. No.	Date of egg-laying	Female mugger number	Clutch size	Date of hatching (incubation period in days)	No. of hatch-lings.	Remarks
10.	14.03.85	2	19	did not hatch	-	All eggs were spoiled.
	During 1986,1987 & 1988 no egg laying were recorded.					
11.	04.03.89	1	17	31.05.89 (89) 01.06.89 (90) 02.06.89 (91)	9	Rest did not hatch.
12.	01.03.90	1	20	did not hatch.	-	All egge were spoiled.
13.	04.03.91	1	12	04.06.91 (93) 06.06.91 (95)	3	2 eggs were spoiled. Rest 7 did not hatch.
14.	10.03.92	1	23	28.05.92 (80) 09.06.92 (92)	17	Rest did not hatch.
TOTAL	-	-	290	-	82	-

The study of the table reveals that the eggs were laid invariably during March and the eggs hatched from mid-May to early June (16th May to 9th June). 290 eggs were laid in 14 clutches with a mean of 20.7 eggs. 82 hatchlings hatched out of these 290 eggs (percentage of hatching is 28.3). Incubation period recorded in 10 cases varied from 72 to 95 days with a mean of 81.3 days. This variation of incubation period recorded in different years may be due to the influence of local climatic conditions.

The egg size recorded in April, 1990 and 1991 in 30 cases varied from 7.0 - 8.2 X 4.2 - 5.1 cm.

The nests observed twice in April, 1990 and April, 1991 were at a distance of 8.4m. and 8.2m from the water edge, respectively. The nests were more or less circular with an average diameter of 50 cm and with depth varying between 19 & 25 cm.

The three hatchlings hatched in June, 1991 measured 27.0 - 27.5 cm in total length and tail lengths varied from 13.5 to 14.0cm. The weights were 80 gm in two cases and 90 gm in one case.

According to Daniel (1983) the female mugger lays her eggs (3 to 40 or more in a clutch) in a pitcher shaped hole about 50 cm deep and 30 cm in diameter and about 2 to 500 m away from water. The egg size varies from 7.0 X 5.0 to 8.0 X 5.0 cm. He further states that the incubation period is slightly in excess of two months but may go upto 90 days depending on the prevailling temperature which agrees with the present observations.

In an earlier report the egg size of 10 eggs ranged between 7.2 X 3.8 to 8.0 X 4.0 cm (Whitaker & Whitaker, 1978).

Female mugger lay an average of 25 - 30 eggs in holes within 10 m of the water. Incubation averages 66 days and hatchlings averaged 27cm in total length (Whitaker & Whitaker, 1984). At Jeypore Zoo, a female mugger nested between 25th April and 22 May and hatching occured between 26th June and 6th July during the period 1967 to 1971 (Prakash, 1971). The breeding season in mugger is November to June in

South India and a month later in the North ((Whitaker & Whitaker, 1984). One of the nests of a female mugger in captivity had 28 eggs and had the longest incubation period of 117 days (Daniel *et. al.* 1991). They had attributed the cause of longer duration of incubation to shade above nest and prolonged cool weather.

Congenital Anamoly :

Out of 82 hatchlings observed over the period in the Park, one hatched on 04.06.91 was blind (1.2 %) with no trace of development of the eyes. Soon after hatching it weighed 90 gm and measured 27.5 cm in total length, tail length alone was 14.0cm. Singh (1995) reported two cases of eye defect with poor vision as evident from poor responses to stimuli. Conginetal deformities related to longer incubation period in this species have been reported from Orissa (Singh and Sagar, 1992). The blind mugger hatchling in the park hatched after longer incubation period of 93 days which agrees with the findings of Singh and Sagar (1992). Singh and Rout (1995) reported a case of twinning abnormality in mugger from Orissa.

Mortality :

Out of 62 hatchlings that hatched during the period from 1982 to 1989, 9 died within 6 months of age, 10 died within 7 to 12 months of age and 21 died within 2 to 5th year of age (total- 40).

Two hatchlings of 10 days age were accidentally devoured by a juvenile saltwater crocodile of the adjacent yearling pool. Almost all the 27 mugger of 2nd to 5th year of age died from traumatic injuries resulting from infighting probably due to insufficient space and shifting from one enclosure to another. The other causes of death were egg-yolk peritoniatis (1), debility (1), stress (3), pneumonia (7), gastroenteritis and hepatitis (3) and toxaemia (2).

Bustard (1980) reported the commonest diseases of hatchlings/ young crocodiles in general as gastroenteritis, mouth cancer, injuries resulting from fighting and dehydration and resultant emaciation. Out of 434 mugger reared at the Crocodile Breeding Centre, Tadoba

(Maharastra) during the period of 1977 to 1992, 213 (49.1 %) died (Khawarey, 1995).

Rehabilitation of Mugger :

Twelve park-bred mugger of over one metre in length were released in the hill streams inside Similipal Tiger Reserve under rehabilitation programme on 23.02.88. Similarly, two mugger have been realeased in the Kumarkunti reservoir on 19.11.90 and two were released into Ambilopokhari tank on 30.01.96 inside Chandaka-Dampara Wildlife Sanctuary. Out of 434 mugger reared at Crocodile Breeding Centre, Tadoba (Maharastra), 126 were released into nine wetlands located mostly in protected areas (Kharwarey, 1995).

Supply to other zoos :

Two mugger were supplied to Sepahizala Zoological Park (Tripura) on 24 April 1985, one mugger to Kapilash Deer Park (Orissa) on 13 September 1985 and four mugger were supplied to Jawaharlal Nehru Biological Park, Bokaro Steel City (Bihar) on 5 Febuary 1990.

References :

Bustard, H.R. (1980) : Captive Breeding of Crocodiles, in The care and breeding of captive Reptiles - A collection of papers published by the British Herpetological Society, London, pp. 1-20.

Daniel, J.C. (1983) : The Book of Indian Reptiles, Bombay Natural History Society, Bombay, pp. 10-12.

Dani, C.S., Sagar, S.R. and Singh, L.A.K. (1991) : Mugger Crocodile research at Ramtritha : A Review, *Indian Forester.* 117 (10) : 881-891.

Kanungo, B.C. (1976) : An Integrated Scheme for Conservation of Crocodiles in Orissa with Management Plan for Satkosia Gorge and Bhitarkanika Sanctuaries. Forest Department, Orissa. pp. 1-128.

Khawarey, K.N. (1995) : Crocodile Breeding Centre at Tadoba, *Tigerpaper*, xxii (3) ; pp. 15-16.

Prakash, M. (1971) : Crocodile (*Crocodilus palustris*) Breeding at Jaypore Zoo. *J. Bombay Nat. Hist. Soc.* 68(3) 835-837.

Singh, L.A.K. and Sagar, S.R. (1992) : Prolonged egg Incubation and congenital tail deformities in *Crocodilus palustris* (*Reptilia, Crocodilia*). *J. Bombay Nat. Hist. Soc.* 89(2) : 194-198.

Singh, L.A.K (1995) : Congenital eye defects in Mugger Crocodiles (*Crocodilus palustris*), *Zoo's Print*, 10(7) : 46.

Singh, L.A.K and S.D. Rout (1995) : Twinning abnormality in *Crocodilus palustris* (*Reptilia, Crocodilia*). *Zoo's Print*, 10(7) : 37-38.

Whitaker, Z. and Whitaker, R. (1978) : Notes on Captive Breeding in Mugger *(Crocodilus palustris) J. Bombay Nat. Hist. Soc.* 75(1) : 228-231.

Whitaker, Z. and Whitaker, R. (1984) : Reprodective Biology of the Mugger *(Crocodilus palustris) J. Bombay Nat. Hist. Soc.* 81(2) : 297-317.

HERPETILE Vol. 1 No. 2 : 5-6, July-December, 1997

Bent Neck In Gharial Hatchlings

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Developmental difficulties in the gharial (**Gavialis gangeticus**) at birth have been reported by Singh and Tandon (1978), Subba Rao and Bustard (1979), Singh and Bustard (1982), Acharjyo and Singh (1989), and Acharjyo et al (1991). The present observations add further to the studies.

Thirty six eggs were laid by a gharial on 22 March, 1990 in the sand bank of the breeding pool of Nandankanan Biological Park. Twenty out of the 36 eggs were shifted to artificial hatchery on 23 April, 1990 and the rest (16) were left in the Natural nest. Due to heavy rain from April to June, 1990, all the 16 eggs left in the natural nest were spoiled. Out of 20 shifted eggs, 15 hatched after 89 days of incubation. Six out of 15 hatchlings were with bent neck and all of them survived. Similar deformity has also been observed by Singh and Bustard (1982). As mentioned above, the eggs hatched after 89 days of incubation, which is incidentally the longest incubation period recorded in the Biological Park during a 15 year period (1980-1994). Congenital deformity in **Crocodylus palustris** hatchlings has also been observed in longest incubation periods of 117 days (Dani **et al.**, 1991). Thus, the developmental anomaly observed in the gharial is perhaps due to prolonged incubation period of the eggs.

REFERENCES

Acharjyo, L. N. & Singh, L. A. K. (1989). Twining abnormality in **Gavialis gangeticus** (Reptilia, Crocodilia). **Journal of the Bombay Natural History Society** 86 (2) : 248-250.

Acharjyo, L. N., Singh L A. K. & Patnaik, S. K. (1991). Occurence of congenital blindness in gharial, **Gavialis gangeticus** (Reptilia : Crocodilia). **Journal of the Bombay Natural History Society** 88 (1) : 117-118.

Bustard, H. R. (1969). Tail abnormalities in reptiles from high temperature egg incubation. **British Journal of Herpetology** 4 : 121-123.

Bustard, H. R. (1971). Temperature and water tolerance of incubating crocodile egg. **British Journal of Herpetology** 4 : 198-200.

Dani, C. S., Sagar, S. R. and Singh, L. A. K. (1991). Mugger crocodile research at Ramtirtha : A review. **Indian Forester** 117 (10) : 881-891.

Kar, S. K. (1978). Malformation at birth in the saltwater crocodile (Crocodylus porosus Schneider) in Orissa, India. **Journal of the Bombay Natural History Society** 76 (1) : 166-167.

Kar, S. K. & Bustard, H. R. (1982). Embryonic tail deformation in the saltwater crocodile (Crocodylus porosus Schneider) in Orissa, India. **British Journal of Herpetology** 6 : 221-222.

Singh, A. N. & Tandon, B. K. (1978). Significance of the absence of optic nerves in **Gavialis gangeticus** (Gmelin) (Gavialidae, Crocodilia, Reptilia). **Journal of Comparative Physiology and Ecology** 4 : 113.

Singh, L. A. K. & Bustard, H. R. (1982): Congenital defects in the gharial **Gavialis gangeticus** (Gmelin). **British Journal of Herpetology** 6 : 215-219.

Subba Rao, M. V. & Bustard, H. R. (1979). Sequence of the hatching of the blind baby gharial, **Gavialis gangeticus** (Gmelin) (Gavialidae, Crocodilia, Reptilia). **Journal of Comparative Physiology and Ecology** 4 : 113.

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III

Subject:—**On the laying habits of the Common Garden Lizard (*Calotes versicolor*)**

Sir,

Ditmars (R.L. : 1961, Reptiles of the World, Mc. Millan Co., N.Y., P.P. 52-53) has mentioned that the female of *Calotes versicolor* lays about a dozen oval, soft shelled eggs of the size of half an inch long and burries them in soft debris of a rotten log or in mould.

Fig. A common garden lizard in an attacking pose with wide open mouth when disturbed during the process of laying eggs.

One morning on 9-8-1971, we observed that a Common garden lizard dug a round tappering hole on the ground of 6 cm diameter at the surface and 7 cm deep on the ground and laid 12 oval size eggs in a clutch. The eggs were soft shelled, measured 1.25 cm long, 0.75 cm wide and weighed 0.425 g on an average. The eggs were placed in the hole longitudinally. After laying, the mother covered the eggs with earth and grits on dragging with fore limbs and packing by repeatedly striking the loose soil with lower jaw and head. A Common garden lizard, usually a timid reptile generally goes out of sight of man or other intruders. But when it was disturbed during this process for collection of eggs, became furious and was in an attacking pose with wide open mouth (Fig.). In spite of all disturbances, it did not leave the place but went on with its work. At last it dragged some dry broken leaves and twigs and concealed the place in such a manner that it cannot be spotted out easily. The whole process (excluding the time taken for digging the hole) took about one hour.

Yours faithfully,
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&
Sd. L.N. Acharjyo
Vety. Asst. Surgeon, Nandankanan Zoo,
Barang, Orissa.

Dated : 15-1-1972

[Reprint, from The *Indian Forester, Vol.* 102, No. 3 : 189-190 March 1976]

SOME OBSERVATIONS ON THE KING COBRA (*OPHIOPHAGUS HANNAH*) AT NANDANKANAN BIOLOGICAL PARK, ORISSA

By

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The King Cobra or Hamadyard is one of the most deadly and vicious poisonous serpents. This Park has procured four of these reptiles in recent times. Out of these, three were from the forests of Keonjhar district and one from Bhitarkanika area of Cuttack district of Orissa. Besides these areas, they are also said to occur in the forests of Mayurbhanj district and in some areas of Puri district as well.‡‡ The details of weight and measurement of these four specimens are given in Table I.

Table 1

Sl. No.	Date of recording of weight & measurements	Length from tip to tip	Girth at the thickest part	Weight	Remarks
1.	2.6.1973	390 cm	21 cm	6.000 kg	Died on 31.12.73
2.	1.1.1975	4 cm	14 cm	1.570 kg	Here since 2.12.73
3.	1.1.1975	263.5 cm	14.5 cm	2.050 kg	Supplied to Ahemedabad Zoo on 15.1.75
4.	1.1.1975	260 cm	15 cm	1.670 kg	Here since 28.6.74

All these specimens were caught and supplied to this Park by the snake catchers of Patia village situated at a distance of about 8 km from the Park. These persons are professional snake-charmers, engaged in catching King Cobras and other snakes from the above mentioned forests and depend on snake shows to earn their liveli-hood. The authors have seen a number of King Cobras with these snake-charmers from time to time.

At present there are two specimens housed together in the Zoological Park at Nandankanan. During winter they are seen always remaining coiled up under heaps of straw provided inside the house to keep their bodies warm. When these photos were taken on 17.12.1974 the snakes were very reluctant to come out in the open or raise their hoods. After a number of attempts these snaps could be taken. During summer they remain frequently submerged inside the water through. They seem to be more active during summer specially from late in the evening to early morning. For part of the day they remain coiled

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‡‡A Press report with a photograph (The Statesman, Calcutta 1.8.1971) states that a 16 feet long King Cobra was caught from the forests of Mayurbhanj district near Baripada.

up on a dry branch of a tree provided inside the house. At slightest disturbance they rise with the expanded hood up to a height of about 3 feet from the ground. The poisonous fangs are removed by the keeper to prevent accidents. The snakes are very friendly with the keeper Sri Purna Chandra Das who comes from the Patia village from a traditional snake charmer's family.

They are fed here with non-poisonous snakes such as *Natrix piscator* (water snake). *Ptyas mucosus* (Dhaman or Rat Snake) etc., after killing them. once fortnight. Their food intake is much reduced during winter. Biswas et al (in Press) observed the detailed feeding habits of this species in the Park according to whom the habit of taking dead snakes appears to have developed in captivity. Gowda (1963) reports that in Mysore Zoo when the King Cobra feels hungry, it swiftly prowls to its prey, stings it and injects only so much of venom as is required to drive the prey to a state of unconsciousness but not to kill it and then begins to swallow the snake entirely from the head region. Polder (1969) reports that at Rotterdam Zoo frozen snakes have been successfully used as food for King Cobras and these frozen snakes after thawing were moved inside its enclosure to induce it to bite.

A King Cobra under observation from June 1973 to December 1973 had shed its skin thrice :—between 2.6.1973 and 4.6.1973, 5.9.1973 and 7.9.1973 and again between 16.10.1973 and 20.10.1973. Two other King Cobras were under observation for sloughing of skin from November, 1974 to March, 1975. No sloughing of skin of these two King Cobras were observed during November 1974, December 1974 and January 1975 However, sloughing of skin by one of these King Cobras was observed from 21.2.1975 to 22.2.1975 and that of the other from 5.3.1975 to 6.3.1975 in pieces. The sloughing of skin was completed in two to five days, always in pieces. Skin from head region with eye caps intact or broken were shed along with the skin of the rest of the body. The eyes which were opaque before sloughing become clear after shedding. After sloughing the body colour becomes brighter and the snakes become very agile. Gowda (*loc. cit.*) states that the King Cobras go on shedding their skin frequently and after each discard, a layer will form like a cap on the eyes. He further states that these caps are not generally removed along with the skin as they are adhesive and they are to be removed with help of a scalpel.

Agressive behaviour of the two King Cobras was observed at times in captivity. These two rise up with their hoods expanded facing each other and strike at each other with force for a few times. Then one catches the upper jaw of the other with its mouth whereas the other one catches the lower jaw of the first one. During this process their bodies become inter-twined and they roll on the ground. At this stage the keeper Purna comes to their rescue and catches the head of both the snakes and another keeper with the help of a slender stick pricks into the nostrils of the one having the nostrils at the top after which they release each other. At times injuries with mild bleeding were observed in the head region which were cured after treatment.

References

Biswas, S.; Acharjyo, L.N. and Misra, R. (1974).—On the feeding habits of King Cobras *Ophiophagus hannah* at Nandankanan Biological Park, Orissa. *J. Bombay nat. hist. soc.* (In press).

Gowda, C.D. Krishnan (1963).—Rearing King Cobras in captivity. The Hindu, Sunday, July 21, 1963.

Polder, J.J. W. (1969).—Feeding King Cobras (*Ophiophagus hannah*) at Rotterdam Zoo. International Zoo year Book, Vol. 9, Zoological Society of London pp. 56.

King Cobra with its keeper

Photo—H.S. Kumar

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(III)

Sub:—Catching and transferring adult Gharials (*Gavialis gangeticus*).

Sir,

Gharial is one of the critically endangered species of raptiles. To save the species from extinction, attempts are being made to protect them in nature and to breed them in captivity.

A gharial breeding pool has been constructed by the Orissa Forest Department at the Nandankanan Biological Park. The pool measures 60 m at the longest part, 30 m at the widest part and has a depth of 9.15 m at the deepest part. It holds 2.70 million litres of water. The pool is filled by a 40 H.P. electric pump from the lake nearby. By the help of a 10 H. P. electric pump about 0.45 million litres of water is taken out everyday, and the pool is refilled with fresh water. Thus a slow current of water is maintained. There is an eight feet high sand bank on one side of the pool, provided with suitable vegetation so as to give the pool an appearance of a miniature Sutkosia gorge of the river "Mahanadi", the ideal natural habitat of the gharial Dr. H.R. Bustard, the F. A. O./U. N. D. P. consultant for crocodiles in India who is at present advancing expertise for the project considers this pool to be the largest of its kind in the world.

Three gharials were housed in a small concrete tank inside the Biological Park. Their measurements are as follows:-

Details	*Male*	*Female*	*Female*
Length snout to vent	1.62 M	1.26 M	1 42 M
Length vent to tail tip	1.08 M	1.24 M	1.23 M
Total length	2.70 M	2.50 M	2.65 M
Girth at the thickest part	1.03 M	1.30 M	0.91 M
Snout length	0.34 M	0.33 M	0.32 M

These three gharials ara considered matured enough for the breeding purpose. It was necessary to transfer the animals from the concrete tank to the newly constructed pool. The process of catching and transferring was accomplished on 13. 2. 1976 in the following manner.

Ten persons were ready with six wooden poles (two metres long and forked at one end); three pieces of cotten ropes and a wooden plank (2 metres long and 0.5 metre wide). The animals were to be tackled one by one.

The concrete tank was dewatered just before catching. The animals were at that time basking on the sand bank. One of the females was approached and was pinned down

with the help of the forked ends of the poles: the first and second poles were put just in front and behind the forelimbs, the third and fourth poles were put just in front and behind the hind limbs the fifth one was placed over the head and the sixth one over the middle of the body. The animal was well within control. The snout was tied up with a piece of rope. The forelimbs were tied up over the back, so as to see that no portion of the limb touched the ground. Similarly the hind limbs were also tied. Now the creature was almost immobile. It was then physically lifted and placed on the wooden plank and was carried to the breeding pool. The process was repeated with the second female and then the male. It was experienced that the male could be handled with comparative ease.

The animals were released near the breeding pool; about a metre away from water. The male and one of the females got inside the water soon after their release, while the other female remained still quite for sometime and then got inside.

It is hope that the animals will soon adjust themselves to the new environment and will breed satisfactorily.

The scheme also envisages breeding of the other two species of crocodiles i.e. saltwater crocodile (*Crocodylus porosus*) and the marsh crocodile (*Crocodylus palustris*).

Yours faithfully,
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Sd /-L.N. Acharjya
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Dated : 24-3-76

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LETTER TO THE EDITOR

(II)

To,

The Honorary Editor,
Indian Forester,
P.O.—New Forest,
Dehra Dun (U.P.)

Sub :—**Return of the Captive Marsh crocodile (*Crocodylus palustris*) into the wild.**

Sir,

Two marsh crocodiles (*Crocodylus palustris*), each measuring 170 cm. tip to tip were received at the Nandankanan Biological Park, Orissa from the Alipore Zoological Garden. Calcutta on 2-1-1964. One died on 15-3-1964.

The second one escaped into the nearby lake (area 50 hectares) on 10-5-1965. All attempts to spot it out failed. It was spotted on 16-9-1968 at night by some local villagers at a place 100 metres away from the lake. It was caught on 18-9-1968 by the inhabitants of Rangamatia village, 8 km away from the lake. It was badly injured. It had a wound about 25 cm deep for which it was kept under treatment. But it died on 30-9-1968, It measured 220 cm tip to tip.

There were heavy showers of rain during September, 1968 and particularly on 16-9-1968 causing overflow of water from the lake. This facilitated the crocodile to escape, Apparently, therefore, the Crocodile remained in the lake for about 3 years and 4 months. It is interesting to note that although the lake was in constant use, the crocodile had never attacked or injured any human-being or livestock. It was apparently living only on fishes and aquatic birds. From the observation it is inferred that the animal could grow from 170 cm to 220 cm (50 cm) during a period of about 4 years and 9 months.

Yours faithfully,
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LETTER TO THE EDITOR

II

To,

The Hony. Editor,
Indian Forester,
P.O. New Fo est, Dehra Dun

Sub :—**Eggs of the Water Monitor** (*Varanus salvator*) **Laid in Captivity**

Sir,

The only female water monitor (*Varanus salvator*) of the Nandankanan Biological Park, Orissa laid seven infertile eggs on 7.6.1977 and again laid nine infertile eggs on 8.6.1978. On both the occasions the eggs were laid inside the pool. The eggs were white, soft-shelled and elongated with blunt ends. They measured 6.80—8.40 × 2.90—3.60 cms and weighed 39.200—60 700 grams. The monitor measured 143 cm tip to tip (snout to vent 61 cm + vent to tail tip 82 cm) and weighed 6.650 kg on 10.6.1977. The inter egg-laying period (observed once) was exactly one year.

According to Smith (1935) the eggs are laid at the begining of the rainy season, about June; 15 to 30 eggs are laid at a time and they measure 70 mm × 40 mm. One egg of water monitor laid on 29.7.1971 measured 9.5 × 3.5 cm and weighed 48 grams (Biswas and Acharjyo, 1977).

References

1. Biswas, S. and Acharjyo, L N. (1977).—Notes on ecology and biology of some reptiles occurring in and around Nandankanan Biological Park, Orissa, Rec. Zool. Surv. India, 73 : 95—109.

2. Smith, M.A. (1935).—The fauna of British India, Reptilia and Amphibia, Vol. II—Sauria, Taylor and Francis, London, pp. 406—407.

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HORNBILL, OCTOBER-DECEMBER, 1978 : 36-37

An incubating python

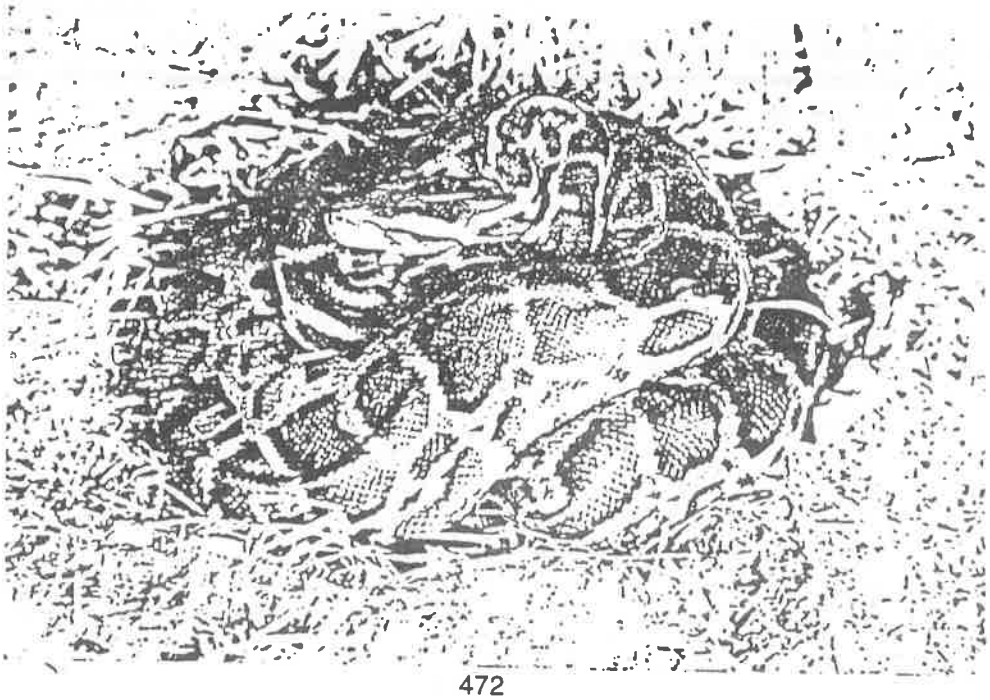
India's largest snake, the Indian Python (*Python molurus*) mates in February and lays eggs in late April or early May, after a gestation period of 82-83 days. The clutch size varies from about a dozen to about 107 eggs depending upon the size of the egg-laying female.

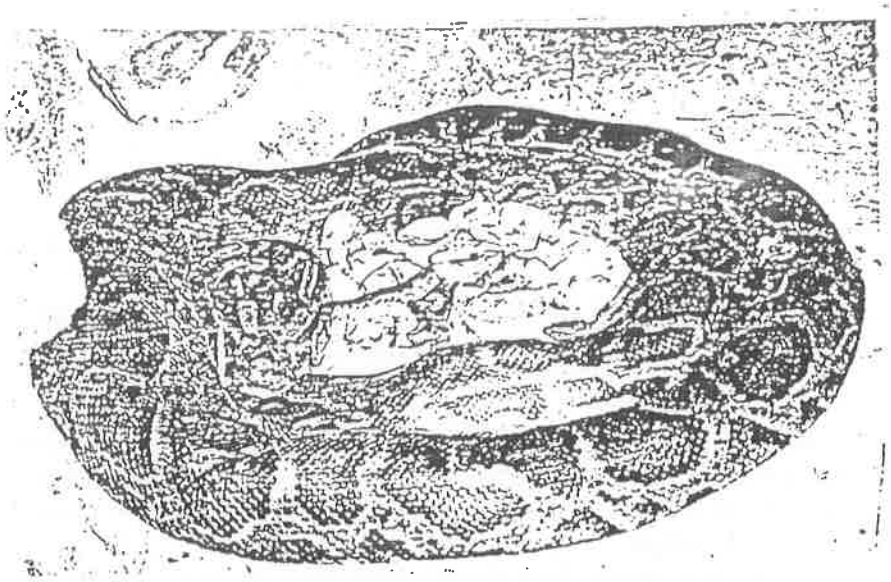
The size and weight of the eggs varies to a great extent from 2.4 x 2.1 cm (weight 10 g) to 9.5 x 6.1 cm (weight 178 g). The normal sized eggs are generally white but there may be some small subnormal eggs in a clutch with light brown colour. These eggs are generally infertile. The newly laid eggs adhere to one another in a mass.

The female python soon after egg-laying coils round the eggs, keeping the head at the top in such a way that no egg is visible to the outside. During incubation she resents approach of any one by moving the head in the direction of the intruder and at times hissing. While incubating she makes frequent body jerking movements which may be muscular function for raising the body temperature to facilitate egg incubation.

One to three days before hatching of the baby pythons, the mother exposes the eggs in the middle and coils round the eggs. At this time the eggs crack and the heads of the baby pythons appear through the openings. The young hatch and come out one after another, after an incubation period of 56-58 days. She refuses food and does not slough during the entire period of incubation.

Python incubating *Photo*: P. K. Patnaik





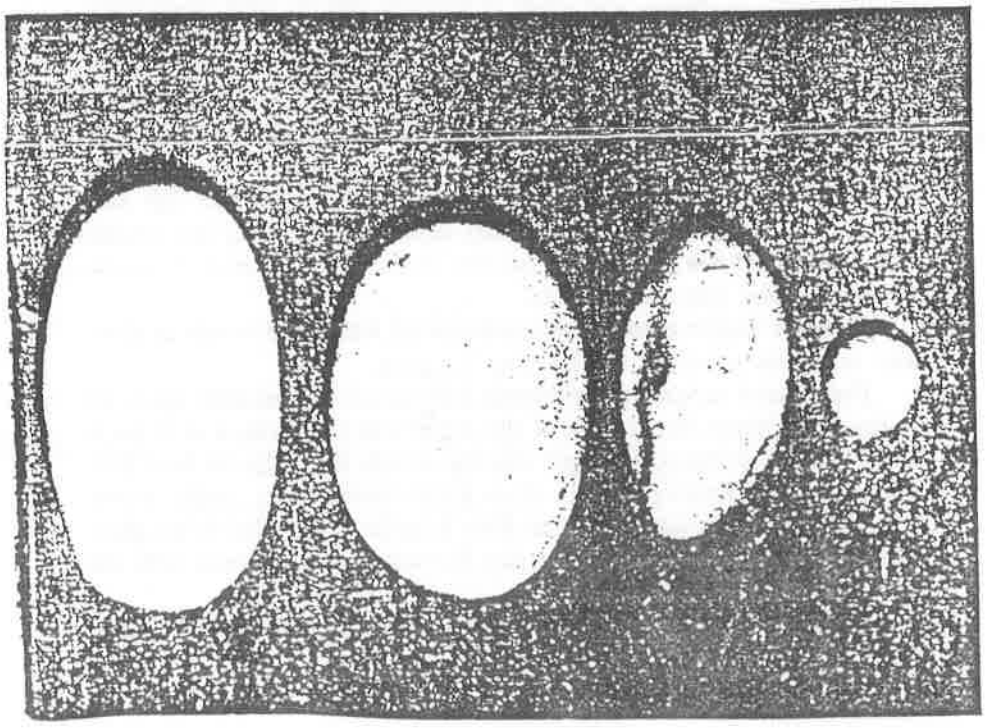
Python and clutch of eggs

It is observed at the Nandankanan Biological Park, Orissa that the mother python resents the removal of the empty shells and spoiled eggs even at the termination of incubation. The percentage of hatching in one observation was 71.7%. The mother shows no interest in the newly hatched young.

L. N. ACHARJYO

A selection of eggs from a python clutch

Photos: N. Das



JOURNAL, BOMBAY, NATURAL HIST. SOCIETY Vol. 72 (2) : 558-560 1975

17. SOME NOTES ON GHARIAL [*GAVIALIS GANGETICUS* (GMELIN)] IN CAPTIVITY

(*With a plate*)

In view of the very limited information available regarding the food and habits of the Gharial [*Gavialis gangeticus* (Gmelin)] the following notes on captive specimens in Nandankanan Biological Park, Orissa, may be of interest.

Since 1963, sixteen baby gharials have been received, 1 in March, 2 each in June, July and October, and 3 each in August, September and November. All were accidentally captured in fishing nets in the river during floods.

At present three gharials (1♂ 2.56 metres; 2♀♀ 2.45 and 2.48 metres) and two crocodiles [*C. palustris* Lesson (one 3 metre and the other 2 metre)] are kept together in an artificial cement tank of water with irregular sides, of an area of about 750 square feet and a depth of about 3½ feet. The shore is sandy in places and covered with laterite stones in others. The water is changed two or three times every month.

About 20 kgs of live fish, mostly *Channa gachua* (Ham.), *Channa marulius* (Ham.), *Channa punctatus* (Bloch), *Channa striatus* (Bloch), *Heteropneustes fossilis* (Bloch), *Clarias batrachus* (Linn.) *Notopterus notopterus* (Pallas), are dropped into the pond once a week, usually in the evening. The replenishment is guided by the number left and determined at the time of clearing the tank. The surviving fish suggest that *Heteropneustes fossilis* and *Anabas testudineus* are least favoured. Generally dead fish are ignored.

Once the bigger crocodile jumped out of water and caught a monkey sitting on a branch overhanging the tank.

The gharial catches a swimming fish across the middle, raises its entire snout above the surface of the water and then with 2 or 3 snaps turns the fish, bringing it deeper into the mouth and gulps its head first. These jerks of floating gharial often synchronise with a similar movement of the tail outside the water. Fish fingerlings were fed to the gharials when first received and the size increased in proportion with the growth of the gharials.

A baby gharial weighing about 600 gm and measuring about 70 cm

was released into the tank on 15th August 1970 and immediately swallowed by one of the crocodiles. Though care had to be taken with the young animals, grown-up gharials and crocodiles lived peacefully together in the same tank. Three turtles [*Lissemys punctata granosa* (Schoepff)] also lived in the same tank for several years being unharmed by the gharials or crocodiles and helped to clean the tank of dead fish and other material.

If not disturbed by visitors, the saurians in winter spent most of the day basking in the sun on the sand. They were also seen out of water sometimes on winter nights.

During summer, they left the tank for some time early in the morning and late in the evening and during the hottest part of the day remained submerged in water.

At times a sort of hissing sound was produced in the process of exhalation.

The specimens have become very tame and can be approached and examined at close quarters.

At 8 a.m. on 31st January 1974, the larger of the two females was resting on the border of the cemented tank with the front portion of the body outside the water. During one hour of observation, the male approached this female three times. He first rubbed his snout and body on her body. On the second occasion he placed his snout over her body, rested for some time and then went away. The third time he placed himself over the body of the female with his snout reaching over her head. It was also observed that the male often followed this female in water, while the other rested quietly on the sand. This was presumably sex play and may well be the commencement of the season for Prashad (1914) found matured eggs in the oviduct in March, and local evidence indicates that they lay in April, May and June.

On the same day (31st January 1974), we approached one of the female gharials lying outside the water. Until we were two metres away, there was no response, but it then opened its eyes for a moment and then closed them again probably because it did not suspect any danger. A female resting at the angle of the tank suddenly jumped into the water on hearing a bus passing at a distance of about 6 metres.

Coloration: The general colour of a fully-grown gharial when out of water is olive of various shades, the head and snout being darker. Numerous indistinct black spots are scattered over the body. When it is swimming in the water, the black spots *expand or disperse* and form 8 or 9 distinct wide black bands across the dorsal surface of the body (Pl., A). When in water, these bands appear more prominent due to the refractive index of the water but gradually disappear when it comes out of the water to the sun (Pl., B). This is due to the contraction of black pigment in the melanophores. The colour of the ventral side also

varies from greenish-olive to yellow-white and this change of colour may be influenced by temperature and sunlight.

When cleaning the tank, a number of teeth of both gharials and crocodiles were found, mostly of the former. Empty spaces in the jaws and growing teeth of varying sizes were observed in the open mouths of the gharials at close quarters. It would appear that the teeth are periodically shed and regrown, one or two at a time. Its teeth are also longer, narrower and more pointed at the tip than those of the crocodile. Those of the crocodile can be easily distinguished by their stoutness, shortness, and the greater number of striations thereon.

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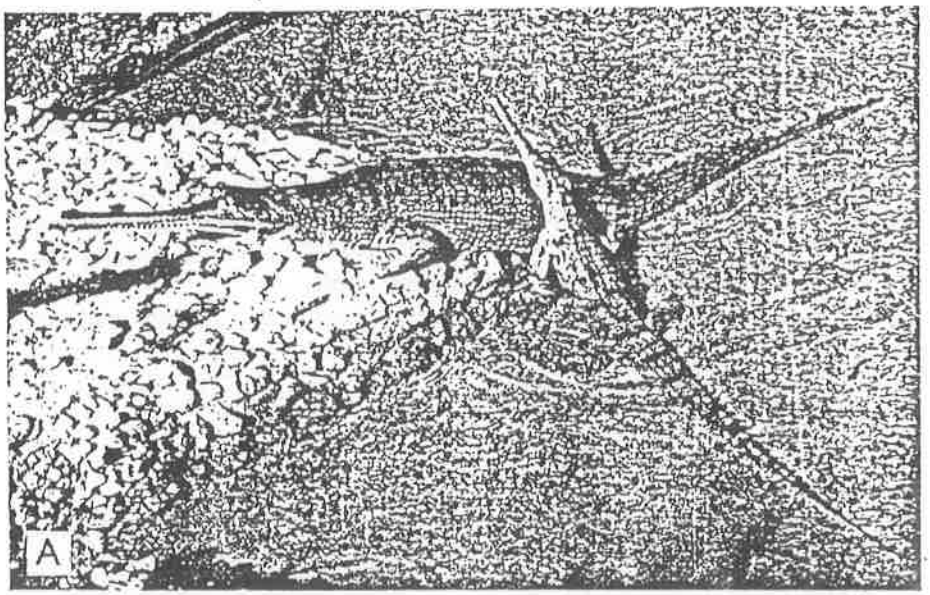
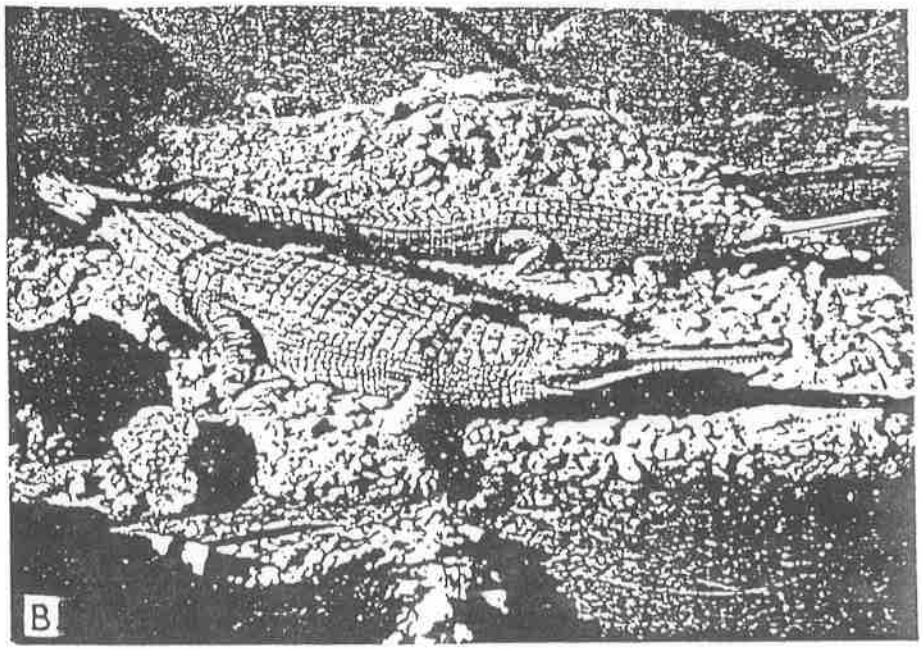
August 12, 1974.





A. Two gharials are just coming out of water. The black bars on the body are clearly visible.
B. Same gharials are returning to water after staying sometime on the land. The black bars on the body have almost disappeared.

[Reprint, from *J. Bombay nat. Hist. Soc. Vol.* 72 (3) 862] 1975

Miscellaneous Note

17. A SNAKE-TOAD INCIDENT

Humayun Abdulali's note [*J. Bombay nat. Hist. Soc. 68*(2):463] reminds us that during the rainy season of 1966, a male Green Keelback (*Macropisthodon plumbicolor* Cantor) was found struggling inside the campus of the Veterinary Dispensary at Chandaka, Puri District, Orissa. The animal was secured and found to be about 51 cm long and had the left forelimb of a Common Toad (*Bufo melanostictus*) piercing the right abdominal wall at the 66th ventral scale.

It would appear that such accidents occasionally happen and we may also, refer to an interesting note on 'The Biological Control of Dung' in the *Scientific American* for April 1974, p. 179, where D. F. Waterhouse mentions a Dung Beetle (*Onthophagus cunniculatus*) which broke through the body of a small Australian toad which had swallowed it!

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[Reprint, from *J. Bombay nat. Hist. Soc.* 73 (1) : 223, 1976]

MISCELLANEOUS NOTE

18. EGG LAYING OF THE MUGGER (*CROCODYLUS PALUSTRIS*) IN CAPTIVITY

The female of a pair of Mugger (*Crocodylus palustris*) at the Nandankanan Biological Park, Orissa laid 27 eggs on the morning of 11-vi-1974. The eggs were white, hard shelled and blunt at both ends. Eleven of these measured 6.7-8.2 cm × 3.7-4.3 cm and weighed from 69 to 80 gm. Unfortunately the mother crocodile was found dead and floating in the tank on 13-vi-74. On autopsy six more eggs were collected from the posterior part of the oviduct. These white, hard shelled eggs measured 6.8-7.2 cm × 3.9-4.2 cm and weighed from 71 to 81 gm. The crocodile measured 142 cm from snout to vent and 132 cm from vent to tip of the tail (Total length 274 cm). However all the eggs were found spoilt when examined after over 3 months of incubation in the sand hole. Probably all were infertile.

David (1970)[1] states that mating of this species takes place in December and January in the water and eggs are laid in March and April in Ahmedabad Zoo. He further states that one female has laid 28 eggs out of which 23 young hatched out on 6-vi-1969 in the same zoo.

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[1] DAVID, REUBEN (1970): Breeding the Mugger Crocodile and Water Monitor—*Crocodylus palustris* and *Varanus salvator* at Ahmedabad Zoo. International Zoo Yearbook, *10*:116-117.

[Reprint, from *J. Bombay nat. Hist. Soc.* 73 (1) 1976 : 224]

MISCELLANEOUS NOTE

19. NOTES ON THE SKIN SLOUGHING OF RETICULATED PYTHON IN CAPTIVITY

The periodicity of sloughing of skin in the snake is a well known fact and varies according to the sex, age and seasons. It is more frequent in summer and less during the colder seasons. According to Deoras (1965) the inter sloughing period varies usually 72 to 210 days in the snakes. But study of sloughing in Pythons under captivity has shown specific differences in the two species, *Python molurus molurus* Linn. and *P. reticulatus* (Schneider). So far we have not come across of any detailed sloughing record of Reticulated Python. Records of sloughing of this species was maintained continuously for two years at the Nandankanan Biological Park, Orissa.

A female Reticulated Python measuring approximately 1½ metres was procured on 8-iv-69 for the Park. Sloughing of skin of this snake was observed for two years from May 1973 to April 1975. The snake measured 404 cm on 13-viii-73 and later 435 cm with a circumference of 41 cm at the thickest part on 21-i-75. Within this two years period it sloughed 20 times and the inter-sloughing period varied from 22 to 105 days, being longest between 12th November, 1974 to 26th-28th February, 1975. At another time the duration was 56 days from 2nd December, 1973 to 28th January, 1974. Just before sloughing the body colour turns dull and the covering of the eyes becomes milky white. The snake becomes inactive and generally refuses to feed. For the completion of the process sometimes it takes two or three days and the outer epidermal layer is cast off by bits starting from the tip of the nose. After the sloughing the snake looks brighter, becomes active and accepts food.

Further the above measurements show that in 4 years 4 months it grew 254 cm but in the last two years it grew in length only 31 cm. It is interesting that the interval between sloughs was 50 days in the winter of 1974, 105 days in the winter of 1975.

Biswas & Acharjyo in a separate publication which is in press, have observed the inter-sloughing period of two adult *Python molurus* as 37 to 128 and 31 to 97 + ? days respectively. Here also the inter-sloughing period has been noted to be longer in the winter and in the case of a female when it was incubating. The variations of inter-sloughing period is lower in *P. reticulatus* than *P. molurus*.

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REFERENCES

BISWAS, S. & ACHARJYO, L. N. (In press): Notes on Ecology and Biology of some reptiles occurring in and around Nandankanan Biological Park, Orissa. *Rec. Zool. Surv. India.*

DEORAS, P. J. (1965): Snakes of India. National Book Trust, New Delhi, pp. 25-26.

[Reprint, from *J. Bombay nat. Hist. Soc. Vol.* 73 (1) : 1976 : 225-226]

MISCELLANEOUS NOTE

20. ON THE FEEDING HABITS OF THE KING COBRA *OPHIOPHAGUS HANNAH* (CANTOR) AT NANDANKANAN BIOLOGICAL PARK, ORISSA

These observations on the feeding habits of two King Cobras *Ophiophagus hannah* (Cantor) were made at the Nandankanan Biological Park, Orissa.

On 20-xi-1973, a dead rat snake [*Ptyas mucosus* (Linn.)] measuring about 157 cm (61 inches) was given to one of the King Cobras measuring about 390 cm (13 feet) at about 9.30 a.m. At 12 noon it bit at the middle portion of the rat snake's body and then slowly shifted its grip towards the head without leaving it completely. It reached the head after 15 minutes and then started swallowing the rat snake, taking another 30 minutes to swallow it entirely, uncoiling itself during the process.

On 19-xii-1973, the same King Cobra was given a live rat snake measuring about 150 cm (c. 6 feet) in the forenoon. The rat snake moved about inside the cage and the King Cobra did not show any interest in it. The vertebral column of the rat snake was struck and the snake immobilised and it was offered to the King Cobra in the afternoon. Then it caught hold of the middle of the body and swallowed it as described above, taking about the same time.

As the other King Cobra measuring 268 cm (8'-9") had refused to eat a live *Xenochrophis piscator* (Schneider) measuring 81 cm (*c.* 2½') repeatedly offered to it the previous week, the Keelback was immobilised in the same manner and offered on 27-i-1974. The cobra twice examined the prey with its tongue during ten minutes of our observation but refused to take it and moved away. The Keelback was then killed and offered, and within a few minutes the cobra caught hold of the anterior part of the body and swallowed it in 15 minutes.

Before taking the prey the King Cobra usually examines it with the tongue and its willingness to eat it is indicated by "yawning" once or twice. During the process of swallowing, the upper jaw remains more or less stationery and the lower jaw by sideways movements takes the prey and slowly pushes it inside the gullet. After completely swallowing the prey, it also "yawns" twice or thrice. During this process of swallowing the peristaltic movements of the abdomen were also visible. Attempts were made earlier to offer live pigeons, bandicoots and guinea-pigs but none were taken.

According to Gowda (1963) who observed it in Mysore Zoo, the King Cobra when hungry approaches its prey, bites it and injects venom only sufficient to reduce it to a state of unconsciousness, and not to kill it; then it begins to swallow the snake entirely from the head region. He further stated that the whole process from the time of attack to the time it completely swallowed its prey took about half an hour, and that it did not feed on dead snakes.

At the Rotterdam Zoo, frozen snakes have been successfully fed to the King Cobra after thawing, though it was necessary to move the body inside the enclosure to induce it to bite it, prior to eating (Polder 1969).

The main diet of the King Cobra in a state of nature is snakes, presumably taken alive, and it is possible that this habit and method of taking dead and disabled snakes has developed in captivity.

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REFERENCES

GOWDA, C. D. KRISHNA (1963): Rearing King Cobras in captivity. The Hindu, Sunday, July 21st 1963.

POLDER, J. J. W. (1969): Feeding King Cobras (*Ophiophagus hannah*) at Rotterdam Zoo, International Zoo Year Book, Volume 9, Zoological Society of London, p. 56.

[Reprint, from *J. Bombay nat. Hist. Soc.* 74 (3) : 536-537. 27-11-1978] 1977

MISCELLANEOUS NOTE

15. A NOTE ON THE PROTUBERANCE OR KNOB ON THE SNOUT OF MALE GHARIAL [*GAVIALIS GANGETICUS* (GMELIN)]

The protuberance or the knob at the end of snout of adult male gharial is so prominent that it is popularly named as 'gharial' from its resemblance of a 'ghara' a word of north Indian origin, meaning an earthen pot. An adult male is easily distinguished by this character from a female but young male and female gharials are not distinguishable. Though the gharial young are now (April 1977) more than one year old at the Gharial Research and Conservation Unit at Tikerpada, Orissa the sex differentiation by the knob is not yet possible. One male gharial was received at Nandankanan Biological Park, Orissa on 22.iii.1963 when it measured 135 cm without any visible sign of the protuberance at the end of its snout. The estimated age on that date of it was 20 months taking July 1961 as the probable month of its hatching by comparison with Singh's (1976) record of average length 274 mm and weight 97 gm of a gharial young soon after hatching. The first visible knob appeared in the beginning of 1973 at the age about eleven and half years when its length was about 2.5 metres. When one of us visited the Park in January 1974 it measured 2.56 metres long (Acharjyo, Biswas & Misra 1975) and the knob was a little developed and the male was distinguishable. In February, 1976 this male measured 2.70 metres (Mohapatra, Acharjyo & Misra 1976) and during this time the knob was well developed. The knob was measured

Date of measurement	Length of male	Age	Size of the knob
22nd March 1963 ..	.. 135 cm	.. 20 months taking. July, 1961 as the probable hatching month.	Nil
January 1973 ..	.. 2.5 metres	.. 11 years 6 months	visible
January 1974 ..	.. 2.56 metres	.. 12 years 6 months	Slightly more developed. Now the male could be distinguished from the female.
February 1976 ..	.. 2.70 metres	.. 14 years 7 months	Well developed
February 1977 ..	.. 2.70 metres	.. 15 years 7 months	Very well developed ; 5 × 6, (4) × 3.5 cm.

on 3.ii.1977 as : Length 5 cm, anterior width 4 cm, posterior width 6 cm, thickness from the upper base to the top of the knob 3.5 cm.

In our earlier note (loc. cit.) we have already recorded the sex play of the male when it was approximately 12 years 6 months old and 2.56 metres long with a developed nose knob and when the first author visited the Nandankanan in 1975 he observed the further development of nose knob in the same male gharial. Therefore it can be presumed that 13 or 14 years old gharial with nose knob developed is an almost mature male. The reproductive activity in captivity can be presumed to be the same in nature.

The knob or the ' Ghara ' develops from the upper base of the nostril and grows over it in such a way that the nostrils come to lie ultimately underneath the knob. Therefore, when the male comes out of water usually a hissing sound is heard (Acharjyo, Biswas & Misra 1975) which is produced due to obstruction of the exhalation within the knob.

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REFERENCES

ACHARJYO, L. N., BISWAS, S. & MISRA, R. (1975) : Some notes on Gharial [*Ga.ialis gangeticus* (Gmelin)] in captivity. *J. Bombay nat. Hist. Soc.* 72 (2) : 558-560.

MOHAPATRA, S., ACHARJYO, L. N. & MISRA, R. (1976) : Catching and transferring adult Gharial (*Gavialis gangeticus*). *Ind. For.* 102 (9) : 636-637.

SINGH, LALA A. K. (1976) : Newsletter of Madras Snake Park Trust, Madras. 1 & 2 ; 4 & 5.

[Reprint, from *J. Bombay nat. Hist. Soc.* 74 (3) : 539-540. 27-11-1978] 1977

MISCELLANEOUS NOTE

18. OBSERVATION ON THE FEEDING HABIT OF THE TREE SNAKE, COMMON INDIAN BRONZE-BACK, *DENDRELAPHIS TRISTIS* (DAUDIN)

The following observations, were made on the feeding habits of a Bronze-back snake at Nandankanan Biological Park, Orissa in the natural condition. The snake was seen on 5.iii.77 on a tree at a height of about 2.5 metres from the ground. It came down to about 1.5 metres above the ground on seeing a garden lizard *Calotes versicolor* (Daudin) on a bush of about 0.75 m height near the tree. The snake jumped over accurately from the tree on to the lizard covering a distance of 0.75 m and caught hold of the middle of the lizard and climbed back on to the tree. There it gradually slipped its mouth hold towards the head of the lizard and started swallowing it head first. The process of swallowing is the same as described in the feeding habit of King Cobra by Biswas, Acharjyo & Misra (1976). The snake took about 10 minutes for catching and swallowing the lizard.

This observation explains two facts in case of the tree snake, that they have good eye sight so that the prey, a garden lizard of body length 60 mm, could be detected from a distance of more than 2 metres. The second fact is ability to jump in case of tree snakes which use a gliding movement from a great height to a lower height as has been pointed out by Shebbeare (1939-40) in respect of two species *Chrysopelia ornata* (Shaw) and *Dendrophis pictus* (Gmelin) [*Dendrelaphis tristis* (Daudin)] though Smith (1943) has doubted this ability in the present genus, 'That they can fly or plane as can *Chryopelea ornata*, has not yet been definitely established' and Wall (1910), 'So far as *tristis* is concerned, however, the evidence, though suggestive is not well authenticated'. It is generally accepted that the tree snakes which possess hinge type of ventrals are able to glide.

This snake is also known to feed in captivity (Wall 1910) on lizards and frogs but Shaw as mentioned by Shebbeare (loc. cit.) found it difficult to get them to feed in captivity and in another case Caldwell had to set free one because it refused to feed.

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References

Biswas, S. Acharjyo, L. N. & Misra, R. (1976): On the feeding habits of the King Cobra *Ophiophagus, hannah* (Cantor) at Nandankanan Biological Park, Orissa. *J. Bombay nat. Hist. Soc.* 73 (1) : 225-226.

Shebbeare (1939): Flying snakes and tree Shrews and Mimicry. *J. Bengal nat. Hist. Soc.* 14 : 60-67.

Smith, M. A. (1943): Fauna of British India, Taylor & Francis, London.

Wall, F. (1910): A popular treatise on the Common Indian snakes. *J. Bombay nat. Hist. Soc.* 19: (4) 775-787.

[Reprint, from *J. Bombay nat. Hist. Soc. Vol.* 75 No. 1 : 234-236] 1978

MISCELLANEOUS NOTE

20. ON SKIN SLOUGHING OF KING COBRAS, *OPHIOPHAGUS HANNAH* (CANTOR) IN CAPTIVITY

It is well known that snakes shed their skin at intervals which vary according to species, age, season and perhaps sex. But, perusal of the available literature (Deoras 1965; Gowda 1963 and Misra *et al.* 1976) did not reveal much information on the frequency of skin sloughing in King Cobras, *Ophiophagus hannah* (Cantor). This note, records some observations on sloughing of King Cobras in Captivity.

Two female King Cobras of Nandankanan Biological Park, Orissa, India, housed in a spacious semi-outdoor enclosure having a floor space of approximately 36 square metres; height 1.5 metres, were kept under observation for a period of 25 months from 1.ii.1975 to 7.iii.1977. In the Park, the King Cobras are offered freshly killed non-poisonous snakes such as *Ptyas mucosus* (Linn.) and *Xenochrophis piscator* (Schneider) once a week but the food intake is much reduced during cooler months.

Observations

At the beginning of observations, the two King Cobras measured 244 cm (Weight 1.57 kg) and 260 cm (Weight 1.67 kg) and 267 cm (Weight 2.43 kg) respectively on 1.i.1977. Both were therefore adults during the observation and little growth was observed.

The data summarised in Table I indicate that the King Cobras sloughed 21 and 20 times respectively during the 25 months period. Sloughing has been observed in all months except January. The process of shedding was completed in one, two and three consecutive days, beginning from the tip of the nose. During sloughing the skin of the head region with eye caps intact or broken was shed along with the skin of the rest of the body. The data indicate sloughing is more frequent during the period May to mid-November (hot and wet season) than in the cooler months. The inter-sloughing period in the first snake varied from 17 to 104 days with an average of 35.70 days and in the second from 17 to 84 days with an average of 35.60 days. The inter-sloughing period averaged 25.80 and 28.40 days respectively for the two snakes between May and mid-November (15 and 14 observations on each snake) as against averages of 65.40 and 55.80 days respectively for the two snakes during the period from mid-November and April (5 observations on each snake).

As is usual with other snakes, before sloughing, the body colour of king cobras becomes dull and the white stripes on the back become faint. A milky white opaque covering forms over the eyes. At this stage they cannot see well, remain inactive and generally refuse food. Soon after sloughing the eyes become clear, the body colour looks brighter, the animals become active and readily accept food.

Discussion

Misra *et al.* (loc. cit.) observed that a King Cobra shed its skin thrice in June, September and October during a period of 7 months from June, 1973 to December, 1973. They could not observe any sloughing in two other King Cobras during the months of November, 1974, December, 1974 and January, 1975.

According to Gowda (loc. cit.) King Cobras in captivity go on shedding their skins frequently and after each discard a layer will form like a cap on the eyes and as they are adhesive these layers are generally not removed along with the skin. He further states that these caps are to be removed with the help of forceps and a scalpel and attributed the

TABLE 1

DETAILS OF SKIN SLOUGHING OBSERVED IN TWO KING COBRAS

Dates of last Sloughing.	Dates of Subsequent Sloughing.	Inter-Sloughing period in days.	Dates of last Sloughing.	Dates of Subsequent Sloughing.	Inter-Sloughing period in days.
Specimen No. I			*Specimen No. II*		
21.2.75 to 22.2.75	27.4.75	63	5.3.75 to 6.3.75	15.5.75	69
27.4.75	26.5.75	28	15.5.75	2.6.75	
26.5.75	20.6.75	24	2.6.75	30.6.75 to 2.7.75	27
20.6.75	8.7.75 to 9.7.75	17	30.6.75 to 2.7.75	28.7.75	25
8.7.75 to 9.7.75	1.8.75	22	28.7.75	28.8.75	30
1.8.75	31.8.75	29	28.8.75	19.9.75	21
31.8.75	29.9.75	28	19.9.75	15.10.75	25
29.9.75	22.10.75 to 23.10.75	22	15.10.75	11.11.75	26
22.10.75 to 23.10.75	18.11.75 to 20.11.75	25	11.11.75	25.12.75 to 27.12.75	43
18.11.75 to 20.11.75	30.12.75 to 31.12.75	39	25.12.75 to 27.12.75	21.2.76 to 22.2.76	55
30.12.75 to 31.12.75	4.3.76 to 5.3.76	63	21.2.76 to 22.2.76	22.3.76 to 24.3.76	28
4.3.76 to 5.3.76	3.5.76	58	22.3.76 to 24.3.76	7.5.76 to 9.5.76	43
3.5.76	1.6.76	28	7.5.76 to 9.5.76	23.6.76 to 24.6.75	44
1.6.76	4.7.76	32	23.6.76 to 24.6.76	13.7.76 to 14.7.76	18
4.7.76	L8.76	27	13.7.76 to 14.7.76	5.8.76	21
1.8.76	23.8.76	21	5.8.76	9.9.76	34
23.8.76	18.9.76	25	9.9.76	5.10.76 to 6.10.76	25
18.9.76	18.10.76 to 20.10.76	29	5.10.76 to 6.10.76	17.11.76 to 18.11.76	41
18.10.76 to 20.10.76	20.11.76	30	17.11.76 to 18.11.76	11.2.77 to 12.2.77	84
20.11.76	5.3.77	104	11.2.77 to 12.2.77	—	—

causes to unnatural conditions in captivity such as lack of ponds, drains, thorny bushes, and rough narrow crevices etc. in their enclosure. This condition is not observed in the Park's specimens because they have been provided with suitable housing to cast off their skin in the natural process. To achieve this, rockeries with irregularly projecting stones, bushes, holes, dry tree trunks, rough stony wall and a big water pond to swim about have been provided inside the King Cobra enclosure.

Deoras (loc. cit.) states that the snakes slough more frequently in the summer and less during cooler season and the periodicity of sloughing ranges from 72 to 210 days. Re-

gular sloughing of skin is considered as a sign of good health among snakes.

The observations on growth further suggest that the King Cobras grew 6 to 7 cm only during a period of two years. This suggests that the growth of King Cobras in later part of their lives is very slow especially in captivity.

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REFERENCES

DEORAS, P. J. (1965): Snakes of India, National Book Trust, New Delhi, pp. 25-26.

GOWDA, C. D. KRISHNA (1963): Rearing King Cobras in Captivity. The Hindu, Sunday, July 21st, 1963.

MISRA, R., ACHARJYO, L. N. AND KUMAR, H. S. (1976): Some observations on the King Cobra (*Ophiophagus hannah*) at Nandankanan Biological Park, Orissa. *Indian Forester*, *102*(3):189-190.

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MISCELLANEOUS NOTE

9. NOTES ON DISTRIBUTION, SEXUAL DIMORPHISM AND GROWTH IN CAPTIVITY OF *GEOCHELONE ELONGATA* (BLYTH)

(*With a text-figure*)

Distribution: This species is so far known to occur in India from Jalpaiguri district, E. Bengal and Singbhum district, Bihar (Chaibassa and Chotanagpur) as recorded in the collection of Zoological Survey of India excluding the female specimen from Orissa mentioned below. Outside India the species occurs in Nepal, Bangladesh (Akyab and Chittagong Hill tracts), Burma, Thailand. According to Smith (1931)[1] Nepal is the north eastern limit of the range of the species in the Indian subcontinent. This is an example of an Indochinese species in Peninsular India. This common land tortoise of eastern India is becoming rare with the restriction of Sal forest.

Habits and habitats: Two specimens were collected from the forest floor of hill "Sal" forests while moving among the dry Sal leaves. Their preference for fallen flower petals within the enclosure suggests that they possibly feed on fallen Sal flowers in nature. Their distribution also is closely associated with the Sal (*Shorea robusta*) and Teak (*Tectona grandis*) forests of the Indian and Indochinese subregion. In winter they are less active than in the summer or rainy season.

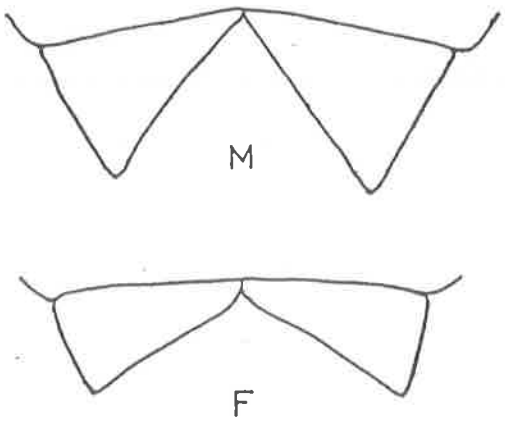

Fig. 1. *Geochelone elongata* Blyth.
Life size figure showing the anal bifurcation in male (M) and female (F).

[1] Smith, M. A. (1931): The Fauna of British India. Vol. I.

Sexual dimorphism: The distinguishing characters of this species are prominent. The body of the male is comparatively narrower and deeper than the females. The nuchal shield, as well as the angle of bifurcation of anal shields (plastron) (Text-fig. 1) in male are much narrower and also the tail is longer and more curved than in the female. In rare cases the nuchal may be absent. Smith (loc. cit.) found the nuchal wanting in one out of 60 specimens and Anderson in 4 specimens. There is no colour difference. The shell is greenish-yellow or yellow and each shield has a irregular black blotch. In our specimen's shell this blotch is wanting.

Growth: Measurements and weight were taken of the male and female on 27-1-74 and after a gap of two years the male was measured and weighed on 27-1-77 and 23-1-78. From the size and weight it is presumed that both were of the same age group but the male is slightly larger. The annual weight gain by the male was more in the 4th year (245 gm) than in its 2nd year (150 gm). The following measurements indicate that the growth of the species is very slow in captivity:

Food: The two tortoises were fed everyday on cut pieces of Banana, "Sag" or vegetables, soaked Bengal gram, "Doob" grass (*Cynodon dactylon*). They took all these food and also petals of flowers fallen inside the enclosure.

Breeding season: The breeding season appears to start in the month of July because the male was observed to try and mate twice

Sex	♀	♂	♂		
Dt. of measurement	27-1-74	27-1-74	25-1-75	23-1-76	23-1-78
Length of carapace in mm.	220	238	—	242	244
Breadth of carapace	154	148	—	166	168
Length of Plastron	190	192	—	195	197
Weight in Kg.	1.675	1.770	1.920	2.105	2.350
Depth of body	103	112			

on 7.7.77 and 9.7.77 with a female *G. elegans*.

The female reported herein was collected on 27th April 1969 from a forest in Puri district and the male on 22nd February 1971 from the forests of Simuli Pahar, Mayurbhanj district by the D.F.O., Puri Division and A.C.F., National Park, Joshipur respectively and were sent to the Nandankanan Biological Park. Unfortunately the female died on 26.5.74. The male is now being kept with 4 specimens of star tortoise *G. elegans* (Schoepff).

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16. A NOTE ON THE DISTRIBUTION OF *BARKUDIA INSULARIS* ANNANDALE, A RARE LIMBLESS LIZARD FROM ORISSA

The limbless lizard, *Barkudia insularis* Annandale, was originally reported by Annandale (1917) on a single specimen dug up by Gravely from loose earth at the root of a banyan tree at Barkuda Island in Chilka Lake, Orissa in July, 1916. Later in the rainy season of 1919 Gravely sighted (Annandale 1927) another specimen in the same locality and attempted to catch it but failed due to the rapidity with which the skink burrowed into the earth among the roots of a fig-tree, only the tail remaining in the hands of Dr. Gravely. A third specimen was obtained from the same locality by O. B. Chhotani of the Zoological Survey of India. For a long time the species was believed to be confined to Barkuda island, till Dr. P. N. Ganapati, Professor of Zoology, Andhra University, recorded the species from the Andhra University Campus at Waltair in 1952 (Ganapati & Krishnan 1952). A recent find of this skink from the Nandankanan Biological Park, 15 km. north east of Bhubaneshwar in Orissa, however, shows that the species may have much wider distribution than hitherto known.

In all four specimens were collected from this locality by one of us (LNA), two on 2-11-1973, one on 15-8-78 and the fourth on 7-9-78. The first two, one of which was collected from below the mud of an almost dry tank, were examined and measured.

The limbless lizard, like uropeltid snakes, is a burrowing form and presumably nocturnal in habit. This may account for the rare frequency of its collection. According to Gravely it is a very fast burrower and thus hard to catch. Because of its burrowing habits it may not be easily seen during dry season when the individuals may go deeper in the burrow and not come up frequently. Most of the specimens of this species were collected (or spotted) near about during the rainy season when the burrows get frequently inundated compelling the lizards to come up.

From the records of the species it appears that this is distributed along the coastal belt in Orissa and Andhra Pradesh.

The type collection on which Annandale (1917) based the description of the this genus seems to have been lost in the Varuna flood in 1943 when the Zoological Survey of India was temporarily shifted to Varanasi.

Material examined: 2 examples; Reg. No. 23659; Loc: Nandankanan Biological Park, Barang, Dist. Cuttack, Orissa; Coll.: L. N. Acharjyo; date: 2-11-1973.

Measurements: Snout to vent 12.5 mm, Tail 7.5 mm, Breadth 6.7 mm. and Snout to vent 15 mm, Tail 8.7 mm, Breadth 7.7 mm.

The blunt snout (dorsoventrally flattened) and tail (rounded at the tip) have earned the name "DEEMUNDIA" (two-headed) to this lizard locally in Orissa. It is cream-coloured with six prominent dorsal, broken up lines, between the back of head and tip of tail. Similar, but faint, spotted lines are present on the flank on both sides. The head and terminal 30 mm. of the tail tip are brown in one specimen; in the other only the head is brown and the six longitudinal spotted lines are continued upto the tip of the tail. Underside in both is cream coloured.

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REFERENCES

ANNANDALE, N. (1917): A new genus of limbless skinks from an island in the Chilka Lake. *Rec. Ind. Mus. 13*: 17-21.

———— (1921): The Reptiles and Batrachia of Barkuda. *Rec. Ind. Mus. 22*: (4): 331-333.

GANAPATI, P. N. (1952): Occurence of limbless lizard belonging to the genus *Barkudia* Annandale in the Andhra University Campus. *Current Science 21*: 105-106.

———— (1955): Bionomics and some anatomical peculiarities of the limbless lizard *Barkudia insularis* Annandale. *Rec. of Ind. Mus. 52*: (1 & 2): 279.

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21. GROWTH RATE OF INDIAN PYTHON, *PYTHON MOLURUS MOLURUS* (SERPENTES: BOIDAE) IN CAPTIVITY WITH SPECIAL REFERENCE TO AGE AT FIRST EGG-LAYING

(With two text-figures)

The growth rate of Indian Python from the time of hatching to the age at first egg-laying has rarely been reported. Acharjyo and Misra (1976) reported on the mating, gestation period, egg-laying, incubation, behaviour of the brooding female, hatchlings and quarterly growth rate to the age of one year of Indian Python observed at Nandankanan Biological Park, Orissa, India. They have also stated that it was intended to rear a batch of these hatchlings to sexual maturity. This communication

TABLE 1

QUARTERLY GROWTH RATE OF YOUNG INDIAN PYTHONS FROM 12TH MONTH TO THE AGE OF 51ST MONTH

Dates	Age in months	Sample size	Mean length (Range) cm	Mean weight (Range) g
1	2	3	4	5
4 July 1975	12	11	136.41 (126.5–153)	942.91 (720–1535)
25 Sept. 1975	15	9	142.72 (127-142)	1251 (780-2330)
25 Dec. 1975	18	6	144.83 (128–179.5)	1152 (635–2170)
25 March 1976	21	5	167.60 (151–194)	1813 (1210–3005)
25 June 1976	24	5	215.50 (190-237)	4755 (2390–6640)
25 Sept. 1976	27	4	215.80 (194–240)	4378 (2250–6110)
25 Dec. 1976	30	4	218.25 (194–240)	4378 (2250–6110)
25 March 1977	33	4	219.75 (195–241)	5551 (3220–7535)
25 June 1977	36	4	233.25 (214–249)	7945 (6580–8540)
25 Sept. 1977	39	4	241.00 (220–257)	8444 (7250–8910)
25 Dec. 1977	42	4	245.75 (233–261)	8408 (7440–8870)
25 March 1978	45	4	246.75 (235–262)	9090 (7750–10,600)
27 June 1978	48	4	248.75 (235–266)	8523 (5570–10,970)
25 Sept. 1978	51	4	250.25 (236–267)	9565 (7430–10.940)

is a follow up to these earlier observations. In this, studies on the quarterly growth rate of 4 to 9 hatchlings of Indian Pythons from the 12th month to the age of the first egg-laying and beyond observed in the same park are reported.

Growth Rate: The quarterly growth rate of 11 to 38 Indian Python babies from the time of hatching to one year old has already been reported by Acharjyo and Misra (loc. cit.).

Our further observations on growth rate from the 12th month to the age of 51st month are as follows (Table 1, Figs. 1 & 2).

Examination of this table and the graphs reveals that the average growth rate in total length in the first year was maximum (75.70 cm) and the growth rate during the second year (44.99 cm) and third year (51.85 cm) remained almost the same. But during the fourth year the average growth rate was much reduced (15.50 cm).

The weight increase graph (Fig. 2) reveals that the maximum average growth in weight (5115 grams) was recorded during the third year of life and the minimum average growth in weight (578 grams) was recorded in the fourth year.

Two of the (female) pythons first laid eggs in the fourth year and as usual starved for about two months during incubation.

Age at first egg-laying: Two female pythons hatched in the Park during the period from 23 to 25 June 1974 (whose matings were not observed) laid eggs on 27 April 1978 and 4 May 1978 respectively at the age of 3 years 10 months and 3-5 days and 3 years 10 months and 10-12 days respectively. Taking the gestation period as 82-83 days (Acharjyo and Misra, loc. cit.) the age of sexual maturity in these two cases can be said to be about 3 years and 7½ months.

The two females weighed 7.750 Kg (Total length 235 cm) and 8.920 Kg (Total length 250 cm) on 25 March 1978 before egg laying. These two weighed 5.570 Kg (Total length 235 cm) and 6.880 Kg (Total length 251 cm) on 27 June 1978 after the incubation was over.

The two male pythons weighed 9.090 Kg (Total length 262 cm) and 10.600 Kg (Total length 240 cm) on 25 March 1978. They weighed 10.970 Kg (Total length 266 cm) and 10.670 Kg (Total length 243 cm) on 27 June 1978. Since no mating was observed and since all the eggs were found infertile and spoiled, it is presumed that the male pythons require a longer time to reach sexual maturity than females.

Clutch size and eggs: The clutch size of one female which laid eggs on 27 April 1978 was 13 (eight normal sized white coloured eggs and five small sized light brown coloured eggs) whereas the clutch size of the other female which laid eggs on 4 May 1978 was 17 (two normal sized white coloured eggs and fifteen small sized light brown coloured eggs).

Five white coloured eggs measured 8.5-12.0 × 4.7-5.2 cm and weighed 165-207 grams. Five light brown coloured eggs measured 7.4-9.6 × 3.9-5.0 cm and weighed 73.97 g.

Discussion

Deoras (1965) states that in the laboratory an Indian Python of unknown age and unstated size and weight grew 6-8 inches (15-20 cm).

Pope (1962) states that the Indian Python holds the record growth rate of 3½ feet per year for the first two years of life. Our observations partly agrees with his observations in that maximum average growth rate in total length (75.70 cm) was recorded in the first year of life but was less than recorded by Pope

(loc. cit.). This partly reflects the natural conditions under which pythons are kept with a marked winter period during which feeding was greatly reduced.

About this species Smith (1943) states that "the rate of growth in nature is not known, and the records of growth in captivity vary so greatly that they are obviously influenced by the conditions under which the snakes live". According to Grzimek (1975) the boids grow fairly quickly until they are 2-3 metres long, but after that time, growth proceeds at a much slower rate. Eight hatchlings of this species grew from an average length of 19¾ inches to 6 feet 7 inches in twenty months, a fourfold increase (Pope, loc. cit.).

Fig. 1 shows the effect of the cooler weather (monsoon quarter) on growth in length. In the year one ,growth was slow in the winter quarter (October-December), picked up in the next quarter (January-March) and was maximum in summer (April-June).

The following comments on the Orissa climate are essential for proper understanding of the discussion. First quarter (January-March) winter gives way to a very brief spring followed by warm weather during February; second quarter (April-June) hot (very hot) season; third quarter (July-September) monsoon season (cooler); fourth quarter (October-December) autumn and winter, feeding much reduced.

In the second year there was marked reduction in growth in the monsoon and winter quarters and rapid growth thereafter which was marked in the monsoon quarter of the third year. After this, growth slowed down as is to be expected with attainment of sexual maturity.

Fig. 2 shows these effect also and makes interesting comparison with Fig. 1. Marked increase in weight commenced in the third quarter of the second year at eighteen months of age and continued until the age of three years (36 months) with the sole exception of the fourth quarter (October-December) of 1976, when actual loss of weight was recorded due to cessation of feeding. Weight increase was minimum in the fourth year. This partly reflects brooding by the females but also marked reduction in growth following attainment of sexual maturity. There was a good weight increase in the third quarter of 1978 but this reflects more regaining weight lost during the fasting incubation period.

The rapid increase in length was over by 27th month of age, having commenced at sixth month, thus covering 21 months. The rapid weight increase was over at 36th month, having commenced at 18th month and thus occupying 18 months. Hence growth in length was followed subsequently by weight increase which took more time to catch up. The idea of Williamson (1967) that about half of the total length may be attained in the first 3 to 4 years of life is extremely interesting. This hypothesis receives some confirmation from Bustard's finding in the Green Sea Turtle, *Chelonia mydas* (Bustard 1972). To put this more concisely this means the maximum size of the indvidual depends upon early growth, the rate of which is clearly dependent upon genetic and environmental factors (Bustard, Singh and Choudhury, MS) as observed in Indian Mugger Crocodile (*Crocodylus palustris*).

It is clear that much faster growth rates than here reported could have been achieved by winter heating resulting in greatly enhanced feeding during the winter quarters. Such growth rates would however have been much faster than occurs in nature as occurring in the Indian Crocodile (Bustard, Pers. Comm.).

Our own figures are considered to be more

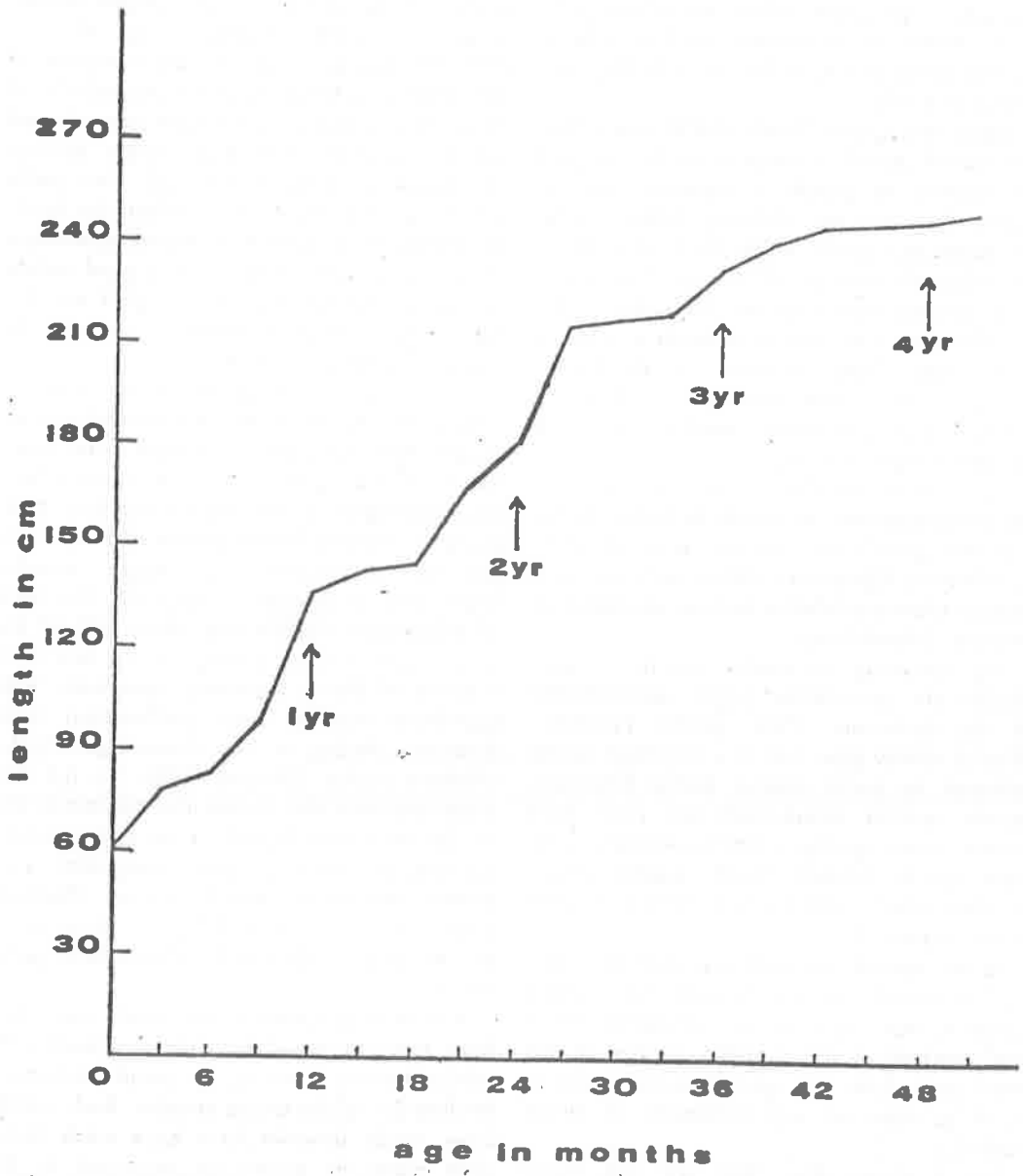

Fig. 1. Graph showing quarterly average growth rate in total length of Indian Pythons from the time of hatching to the age of 51 months (4 years and 3 months).

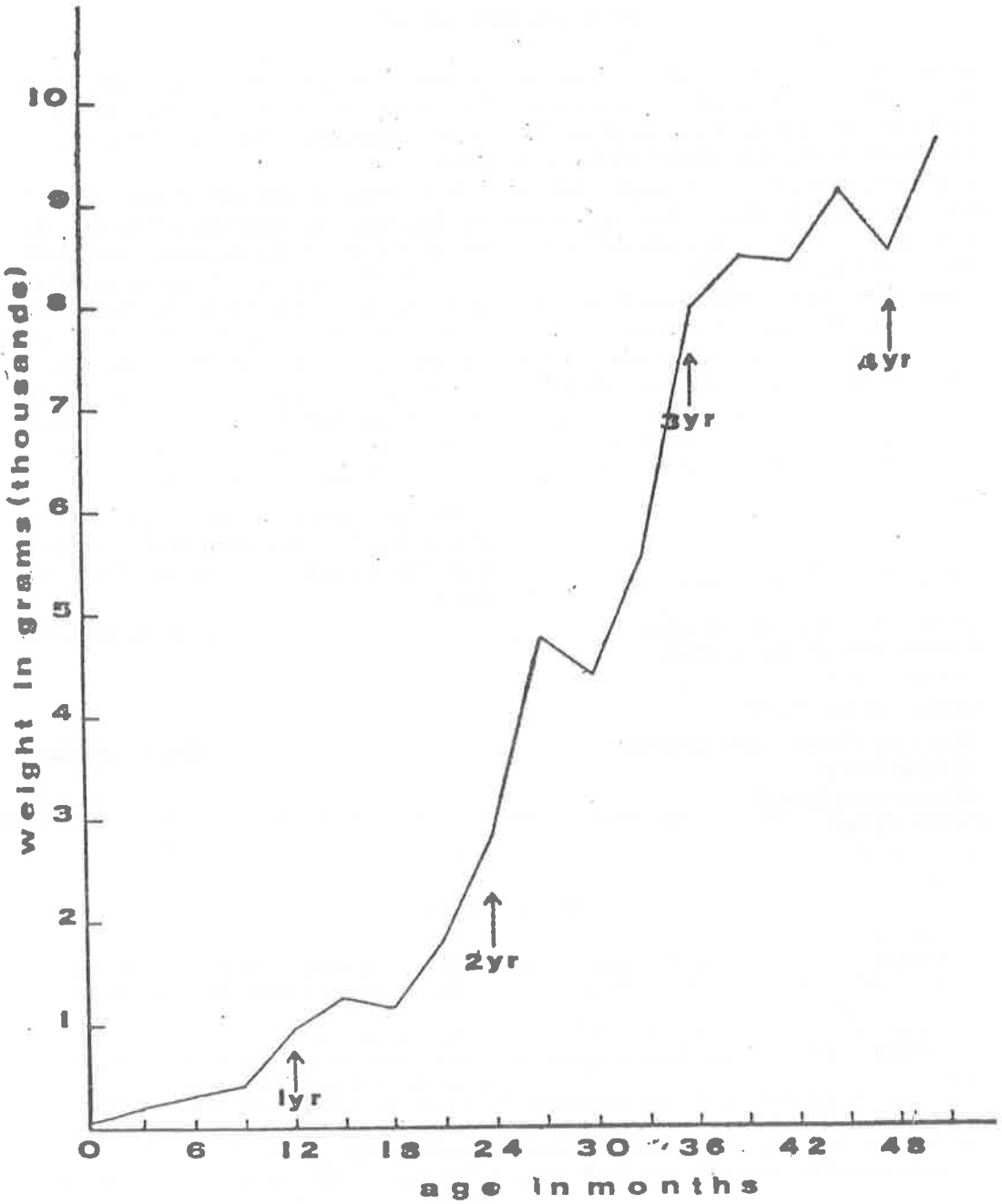

Fig. 2. Graph showing quarterly average growth rate in weight of Indian pythons from the time of hatching to the age of 51 months (4 years and 3 months).

closely approximates natural growth being recorded out-doors under ambient temperature conditions within the natural range of the species. However they may exceed wild growth as a result of enhanced food supply. This in itself may have resulted in first egg laying at an early age than is naturally the case in nature (Bustard, Pers. Comm.).

The boids reach sexual maturity in three years in captivity (Grzimek, loc. cit.). According to Pope (loc. cit.) the smallest Indian python to produce fertile eggs was only 8 feet 6 inches (2.55 m). He further states that the female of a mated captive pair of this species laid fertile eggs at the age of less than three years.

SUMMARY

The quarterly growth rate of 4 to 11 Indian pythons from the 12th month to the age of 51st month were observed in a natural environment at Nandankanan Biological Park, Orissa, India.

The average growth rate in total length in the first year was maximum (75.70 cm) and the growth rate during the second year (44.99 cm) and third year (51.85 cm) remained almost the same. But during the fourth year growth rate was much reduced (15.50 cm). The maximum average growth in weight (5115 g) was recorded during the third year of life and the minimum average growth in weight (578 g) was recorded in the fourth year.

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REFERENCES

ACHARJYO, L. N. AND MISRA, R. (1976): Aspects of Reproduction and Growth of the Indian Python, *Python molurus molurus*, in captivity. *British Journal of Herpetology*, 5: 562-65.

BUSTARD, H. R. (1972): Sea-Turtles: Their Natural History and Conservation. Collins, London & Sydney.

——— SINGH, L. A. K. AND CHOUDHURY, B. C. (M.S.): Growth of Three Populations of Mugger Crocodiles, *Crocodylus palustris* Lesson (Reptilia, Crocodilia) from Tamilnadu, South India. M S.

DEORAS, P. J. (1965): Snakes of India. National Book Trust, India, New Delhi.

GRZIMEK, BERNHARD (1975): Animal Life Encyclopedia, Vol. 6, Reptiles. Van Nostrand Reinhold Company, New York, Cincinnati, Toronto, London, Melbourne, pp. 363-380.

POPE, CLIFFORD H. (1962): The Giant Snakes. Routledge & Kegan Paul, London.

SMITH, M. A. (1943): The Fauna of British India, Reptilia and Amphibia. Vol. III, Serpentes, Taylor & Francis, London, pp. 102-110.

WILLIAMSON, MICHAEL A. (1967): Notes on the Growth Rate of *Python reticulatus* (Serpentes: Boidae). *Herpetologica*, Vol. 23, No. 2, pp. 130-132.

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19. EGG-LAYING AND NEST-GUARDING BEHAVIOUR OF ESTUARINE CROCODILE (*CROCODYLUS POROSUS*, SCHNEIDER) IN CAPTIVITY

The present communication deals with egg-laying and nest-guarding behaviour observed in an estuarine crocodile (*Crocodylus porosus*) at the Nandankanan Biological Park, Orissa, India.

The female estuarine crocodile laid eggs for the first time when she attained a length of 255 cm and at an estimated age of ten years. The number of eggs laid in four clutches was 29, 34, 35 and 34 eggs.

The nest-guarding behaviour in the crocodile was observed for a period of 2½ months, corresponding with the period of incubation.

In India, the estuarine or saltwater crocodile (*Crocodylus porosus*) is known to occur in the tidal mangrove forests of Sunderbans in West Bengal, Bhitar Kanika in Orissa and in the Union Territory of the Andaman and Nicobar Islands. This communication presents data on egg-laying and nest-guarding behaviour of the estuarine crocodile observed at Nandankanan Biological Park, Orissa, India.

A female specimen of this species, measuring about one metre and with an estimated age of about 27 months, was received at the Park from Paradip area (adjacent to Bhitar Kanika) on 19th November 1967. It is fed live fresh-water fish.

From early 1975 the female crocodile has been housed alone (there being no mate) in a 10.5 × 9.3 m enclosure of which approximately 1/3 (32.5 sq. m) is taken up by the pool.

Results

Egg-laying

This female first laid on 30 May 1975 inside the pool, out of which one damaged egg was seen floating. The female has laid in each succeeeding year and the dates of laying and clutch size are given in Table 1. The nest is constructed at a distance of about half a metre from the water's edge and consists of soil, sticks and dry leaves in a heap of about 30 cm high above. Although actual egg-laying was not observed, it is presumed that the eggs were laid very early in the morning on all four instances.

TABLE 1

NESTING DATE AND CLUTCH SIZE IN FOUR SUCCESSIVE YEARS

Date of Laying	Number of Eggs
30 May 1975	29
4 June 1976	34
2 June 1977	35
22 May 1978	34

The mother crocodile laid eggs for the first time when it had attained a length of 2.55 m and at an estimated age of about ten years.

The oval, hard-shelled, and white-coloured eggs measured 69-80 × 40-48 mm (N = 50) and weighed 70.5-90 g. (N = 19).

Nest-guarding behaviour

In the first year the mother corocodile did not show any interest in the eggs as the eggs were laid inside the pool. But in the subsequent years it remained for most of the time very near the nest in a dug out wallow or inside the pool or sometimes partly over the nesting site, zealously guarding the nest. At the sign of the slightest disturbance, it used to reach the nest-site in one leap with open mouth.

The nest-guarding by the mother continued for a period of about 2½ months, corresponding with the period of incubation. Throughout the period she remained vicious and never al-

lowed even the keeper to go inside the enclosure.

Discussion

As there was no male, all the eggs were infertile but even then the mother crocodile exhibited the nomal nest-guarding behaviour of the species. The egg laying season, at least in captivity, is restricted to late May and the first few days of June. The inter-egg-laying period observed numbers 370, 362, and 353 days respectively.

According to Yangprapakorn (1971) this species reaches sexual maturity at the age of 12-15 years, clutch size is 30-50 eggs and the incubation period is 78-80 days. Smith (1931) states that the mother crocodile of this species remains in the vicinity until the young are hatched, possibly to assist them to water when they emerge from the shell. He further states that the clutch size of two nests from Java were 50 and 60 eggs and the eggs were about 85 × 55 mm in size. It is prone to attack human beings more especially in the breeding season which takes place during the months of June and July (Lydekker 1896, Bustard and Choudhury 1979). The mother *Crocodylus porosus* digs two wallows wider than but not so long as her body, close to the nest and in one or the other crocodile remains there during the period of incubation (Loveridge 1946). The number of wallows seen near the nests of this species in North Andaman Island varies from one to three (Choudhury and Bustard 1979) and one to four in Northern Australia (Webb *et al.*, 1977).

The clutch size of 775 nests of nile crocodile (*Crocodylus niloticus*) is given as 25-95 eggs with an average of 60.4 per nest (Cott 1961). He further states that very few females (less than 2%) of nile crocodile were nesting before they had attained a length of 8 feet (2.44 m) and the largest number of breeding females occur in the length ranges between 9 feet 6 inches and 11 feet 6 inches (approximately 3-3½ m) [(mean length 10 feet 5 inches (3.2 m)].

Wild female gharial shows nest-guarding behaviour (Singh and Bustard 1977). Nest-guarding behaviour in Nile crocodile (*Crocodylus niloticus*), American alligator (*Alligator mississippiensis*) and marsh crocodile (*Crocodylus palustris*) has been observed (Cott 1971). Parental care in crocodilians has also been reviewed by Bustard (1979). Nest-guarding behaviour has also been observed in spectacled Caiman (*Caiman crocodilus*) in Mexico (Alvarez 1969) and in the American crocodile (*Crocodylus acutus*) (Ogden and Singletary 1973).

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REFERENCES

ALVAREZ, DEL TORO M. (1969): Breeding the spectacled caiman (*Caiman crocodilus*) at Tuxla Cutierrez Zoo. *Intnl. Zoo. Yrbk. 9*: 35-36.

BUSTARD, H. R. (1979): Parental care in crocodilia, with special reference to Indian Crocodiles—a review. *Indian Crocodiles—Conservation and Research.* Occ. Publs. 1. Gen. Croc. Br. Mgmt. Trg. Inst., Hyderabad, India.

BUSTARD, H. R. AND CHOUDHURY, B. C. (1979): Parental care in Saltwater Crocodile (*Crocodylus porosus* Schneider). *Indian Crocodiles-Conservation and Research.* Occ. Publs. 1. Cen. Croc. Br. Mgmt. Trg. Inst., Hyderabad, India.

CHOUDHURY, B. C. AND BUSTARD, H. R. (1979): Predation on Natural Nests of the Saltwater Crocodile (*Crocodylus porosus*, Schneider) on North Andaman Island with Notes on the Crocodile Population *J. Bombay nat. Hist. Soc. 76* (2): 311-323.

COTT, H. B. (1961): Scientific results of an Enquiry into the ecology and economic status of the Nile Crocodile (*Crocodylus niloticus*) in Uganda and Northern Rhodesia. *Trans. zool. Soc. Lond., 29*, 211-358.

——————— (1971): Parental care in crocodilia with special reference to *Crocodylus niloticus*. *Crocodiles. I*, I.U.C.N. Publs. N.S. Suppl. Pap. No. 32: 166-180.

LOVERIDGE, A. (1946): Reptiles of the Pacific World. New York, Macmillan.

LYDEKKER, R. (1896): The Royal Natural History. Vol. V, Frederick Warne & Co., London and New York, pp. 22-24.

OGDEN, J. AND SINGLETARY, C. (1973): Nights of the Crocodile. *Audubon 75*(3): 32-37.

SINGH, L. A. K. AND BUSTARD, H. R. (1977): Studies on the Indian Gharial (*Gavialis gangeticus*, Gmelin) (Reptilia, crocodilia). V: preliminary observations on material behaviour. *Ind. Forester. 103* (10): 671-678.

SMITH, M. A. (1931): The Fauna of British India. Reptilia and Amphibia. *1*. Taylor and Francis, London, pp. 42-44.

WEBB, G. J. W., MESSEL, H. AND MAGNUSSON, W. (1977): The Nesting of *Crocodylus porosus* in Arnhem Land, Northern Australia. *Copeia 1977* (2): 238-250.

YANGPRAPAKORN, U. (1971): Captive breeding of crocodiles in Thailand. *Crocodiles. I*, I.U.C.N. Publs. N.S. Suppl. Pap. No. 32: 98-101.

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OBSERVATIONS OF THE REPRODUCTIVE BIOLOGY OF THE INDIAN CHAMELEON, *CHAMAELEO ZEYLANICUS* (LAURENTI)[1]

L. A. K. SINGH[2], L. N. ACHARJYO[3] AND H. R. BUSTARD[4]

The Indian chameleon, *Chamaeleo zeylanicus* was studied in Orissa, in captivity and in the wild. Captive specimens were housed in enclosures with ample vegetation, and maintained on an insect diet. Smallest female with functional ova was 375 mm in length. Mating occurred during the last week of August, and egg laying in October. The shape and size of the nest depended on the suitability of the ground. On soft fine sand the nest was an oblique hole, 22 cm in depth, 9 cm in diameter at the mouth. The eggs were 15-22.5 mm x 9-12 mm x 1.0-2.0 gm. There was indication of increase in size and weight of the eggs during incubation. Hatching occurred after eight months in June when small insects were available in large numbers. In three of the four cases reported, the female died within 1-42 days after egg laying. Females move less and are more territorial. Females are intolerant of close approach of other chameleons of either sex except of suitor males during a period of a few days when they are ready to mate. Mating is preceded by display by female and 'chase and escape' behaviour between the male and the female. Display by female and male (against other males) included assumption of deep green body colouration with dark spots and blotches, lateral flattening of the body, and hissing with open mouth.

INTRODUCTION

The Indian chameleon, *Chamaeleo zeylanicus*, an oviparous species, is distributed from Punjab in the north to Sri Lanka in the south (Boulenger 1890, Parshad 1914, Smith 1935, Deraniyagala 1953). Knowledge of the species' reproductive biology was based on Trench (1912). Then considered to be *Chamaeleon calcaratus*, Trench (1912) studied the behaviour of a male and female in captivity. Both individuals were obtained from 'Jubbulpore, C. P.' (= Jabalpur, Madhya Pradesh). Deraniyagala (1953) has provided preliminary data on the habits, reproduction and dimensions of male and female individuals. Biswas and Acharjyo (1977), while giving a general account on the ecology and biology of some reptiles occurring in and around the Nandankanan Biological Park, Orissa gave the species' distribution in Orissa, clutch sizes and egg measurements.

The solitary habit, procryptic behaviour and appearance make *C. zeylanicus* difficult to study in the wild, and it is difficult to keep for long periods in captivity without elaborate arrangements. Observations made on aspects of the reproductive biology in captivity and in the wild are presented in this paper.

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Materials and Methods

Two of us (LAKS and HRB) observed the species at and around the Gharial Research and Conservation Unit, Tikerpada (GRACU) within the Satkoshia Gorge Sanctuary situated in 84°47'E longitude and 20°35'N latitude, and LNA observed it at the Nandankanan Wildlife Sanctuary, in 86.25°E longitude and 20.25°N latitude. All the observations were made between 1975 and 1980.

Chameleons reared in captivity at GRACU were kept in enclosures used for rearing crocodilians. One enclosure was 23.7 x 4.9 x 2.6 m and another 12 x 12 x 2.5 m with ample vegetation cover inside. The chameleons reared at NBP were in an enclosure measuring 4 x 3 x 2.5 m. All specimens were maintained on an insect diet, and were measured and sexed when received. The base of the tail is somewhat swollen in males due to the hemepenes, which can be extruded by applying gentle pressure from back to the front.

Captive observations are based on four females — three at GRACU (CF1, CF3 and CF4) and one at NBP (CF2), and three males (CM1, CM2 and CM3) at GRACU. Observations in the wild are based on one male (WM1) and two females (WF1 and WF2) at Tikerpada.

Courtship observations were made from WM1, WF1, CF1, CM1 and CM3. Data on nesting are recorded from CF1, CF2, CF4 and WF2, and on the clutch size and female-size from WF2, CF3 and CF4. Egg biometrics and information on changes of these during incubation were obtained from clutches obtained from WF2, CF2 and CF3. Eggs were incubated in sand, kept moist at approx. 7% water by weight. No attempt was made to record the nest temperatures although the ambient temperature in a standard Stevenson Screen fluctuated between 4.5°C and 46.0°C, since the duration of incubation included winter and summer seasons. Observations on hatchlings were made possible from the nest laid by CF4 the precise location of which was not known until actual hatching took place.

Courtship and Mating

Courtship behavious was observed during the second week of August. During this period CM1 became markedly territorial towards the other males, CM2 and CM3, displaying a deep green colour with black blotches and spots and hissing loudly with laterally flattened body as has been described for *C. gracilis* by Bustard (1967). Frequently CM1 was also seen chasing the other males trying, and actually biting these, particularly on the flanks as reported for *C. gracilis* (Bustard 1967).

Initially the female was not receptive to any of the males and it moved away with vigorous rocking movements or displayed hissing with open mouth and laterally flattened body. This 'chase and escape' behaviour between the territory-holding male and CF1 persisted for a week except during heavy showers and at night when these chameleons used to perch asleep on the same plant at a distance of at least 15 cm.

Courting records from the wild included observation of the 'chase and escape' behaviour between WM1 and WF1 over two days. On the morning of the third day, at 0600 hours these had moved and could not be traced.

Mating was observed in captivity only once in the morning at 1000 hours. It lasted about three minutes. CM1 was partly over the back of CF1, holding it with all four limbs. CM1 had also bent down its hind quarters down below CF1. Both appeared motionless. After mating CF1 confined itself to a large *Butea*

superba and after a week it became territorial and displayed at CM1 and the other males, which kept away from the *Butea*.

During the period CM1 and CF1 were courting they did not eat but later they fed voraciously. The female, however, showed low appetite after about a month, and completely stopped feeding 55 days after mating.

NESTING

LNA observed CF2 on 3.10.75 at about 16.30 hours when it was unsuccessfully trying to dig a nest hole inside the enclosure. After several unsuccessful diggings, by 07.15 hours on 5.10.75 it had already laid the eggs and was covering the nest. Five eggs were still partly visible. The female was deep green and facing away from the nest with its tail held in the air. Two different types of limb actions were observed during covering the nest. In one, both fore limbs, acting alternately, dragged the soil close to the hind limbs, which, also acting alternately, pushed the soil back over the eggs. In the other type of limb action, the limbs of only one side acted at a time — the fore limb brought the soil near the hind limb of its side which in turn shifted it over the nest. During covering of the nest the female often rested for short periods and changed to the limbs of the other side. On a few occasions it also attempted to collect soil from stony areas on either side of the nest. When the female was covering the nest it reacted to any disturbance with puffed body and hissing with open mouth, the display directed towards the source of disturbance.

At about 11.30 hours covering of the nest was complete. Thereafter the female appeared tired and inactive and remained within 2 m of the nest. At about 14.00 hours on 6.10.75, the day after egg laying, it was found dead near the nest. On autopsy no more eggs were obtained from the body. On excavation of the nest, 34 eggs were collected. The nest was almost saucer shaped, 17 cm diameter and 5 cm in depth.

CF1 was observed while nesting in captivity on 20.10.75. About a week before this the female was restlessly moving in the enclosure. Suspecting that it was ready to lay eggs, a 25 cm thick sand-bed was provided but CF1 constructed its nest 4 m away from this. The details of nest construction were not recorded. However, after laying the eggs and covering the nest it too appeared exhausted and refused to eat. It was found dead on 2.11.75, 13 days after egg laying.

At about 2200 hours on 14.10.77 a group of fishermen of the Tikerpada village had located WF2 on the sand of a nearby stream. They kept the chameleon under a bucket and brought it to GRACU on the next morning. It had moist sand smeared all over the limbs and head. On questioning, the fishermen informed that "it had dug a hole in an attempt to escape out of the bucket cover". On an examination at the spot the hole was found to be obliquely dug, 10 cm deep and 7 cm diameter at the mouth. On digging it further 32 eggs were recovered within 15-20 cm depth from the surface. About 20 m away on the bank there was a 'pit', 12 cm deep and 9 cm diameter at the mouth. Further away from this another equal-size pit was located among the bushes. Both these pits were dug oblique to the ground and presented a superficial resemblance to the actual uncovered nest with the eggs. However, these were not fresh and it could not be ascertained if these were dug by WF2.

Eggs collected from the nest by WF2 were kept under incubation in an enclosure in two divided batches. The female, also kept in the

same enclosure, refused to accept any food and died after 42 days, on 25.11.77.

The nest of CF4, which was discovered after the young hatched, was dug in sand and was 22 cm deep and 10.5-11.0 cm in diameter at the bottom. Like other females which had nested, CF4 also died in captivity. Since the exact date of egg-laying was not known, the date of the death cannot be related to nesting.

The Eggs

At an early stage of development the ova are pinkish in colour. At postmortem on 4.6.77 a female, outside the present study sample, contained over fifty developing ova, all pinkish in colour and 1-3 mm in diameter. The female measured 375 mm in total length, 175 mm in snout-vent length and 105 gm in weight.

Gravid females had yellowish-red patches on the lower half of the body and thus were readily recognised. Such females also had a skinny appearance with extended abdomens where eggs could be felt when the abdomen was gently palpated. CF3, a freshly killed female received at GRACU on 3.10.75, measured 200 mm for SV (snout-vent) and weighed 153.5 gm. The tail was missing as it had been removed for medicinal use. The oviducts contained 40 eggs, weighing in total 43.0 gm (mean 1.075 gm). A sample of ten eggs measured as below: 5 eggs were 19 x 12 mm, 2 eggs 19.5 x 12 mm, 1 egg each 20 x 12 mm, 21 x 11 mm and 22.5 x 11 mm. The eggs were fully formed with white shell, clearly on the point of deposition.

The eggs from the clutch laid by CF2 were 1.0-1.1 gm in weight, 15-18 mm in length and 9-11 mm in breadth. The female was not measured.

Of the 32 eggs collected from the clutch of WF2 31 were normal — 18.15-20.0 mm in length, 10.5-11.5 mm in breadth and 1.25-2.0 gm in weight, and one was smaller than the rest — 16.0 mm x 9.0 mm x 1.0 gm.

CF4, measuring 170 mm in SV, 380 mm in total length and weighing 115 gm had laid a clutch of 34 eggs. (Table 1).

Incubation and Development

Eggs of none of the clutches obtained from CF1, CF2, CF3 and WF2 hatched. However, measurements and weights of eggs from the clutches of CF2, CF3 and WF2 showed slight increase in size and weight during incubation (Table 2). The study could not be pursued since the eggs spoiled due to rotting or ant-invasion.

Table 1

Size of three female *Chamaeleo zeylanicus* and their clutch size

Female Chameleon	Date measured	Total body length (mm)	Snout-vent length (mm)	Body-weight (gm)	Clutch size (no.)
CF3	3.10.75	—	200	153.5 (with eggs)	40
CF4	18.9.77	380	170	115 (with eggs)	34
WF2	14.10.77	365	170	72 (no eggs)	32

TABLE 2

CHANGE IN THE EGG SIZE AND WEIGHT OF EGGS OF *C. zeylanicus* ARTIFICIAL INCUBATION

Chameleon no.	Stage of incubation (weeks)	No. of eggs measured	Egg length (mm)	Egg breadth (mm)	Egg weight (gm)
CF3	0	10	19.0–22.5	11.0–12.0	1.075 av.
	2	10	19.0	12.0	2.0
CF2	0	10	15.0–18.0	9.0–11.0	1.0–1.1
	4	10	17.0–19.0	11.0–12.0	1.3–1.5
	11	3	19.0–21.0	12.0–13.0	2.0–2.3
WF2	0	31	18.25–20.0	10.5–11.5	1.2–2.0
	5	12	21.5–22.75	12.2–13.2	1.5–2.0
	9	7	22.2–24.0	13.0–14.0	2.5–3.0

HATCHING

Between 21.6.78 and 23.6.78 nine living and two dead chameleon hatchlings were found close to the nest of CF4. Upon examination of the nest the following information was recorded. At the surface the nest had two small openings, through which the hatchlings had escaped. The openings were approx. 1.5 cm in diameter and 2.0 cm apart. Hatching had taken place in the early morning of 21.6.78 because inspite of a 29 mm rain during the previous night the holes were not blocked with sand.

The nest contained a total of 34 eggs of which white and empty shells numbered 15 (hatching of 44.1%), black empty shells indicating early fungal attack in 7 eggs (20.5%), eggs with early embryonic mortality 5 (14.7%) and with late embryonic mortality 7 (20.5%). Dead late-stage embryos were found in the egg with limbs folded and directed forward and tail coming forward almost to the neck and twisted round it from its left. The tongue was slightly protruded in all dead embryos.

THE HATCHLING

When discovered, the hatchlings were green in colour, showing slow rocking movements like the adults. Defensive behaviour was also like the adult — laterally flattened body, assumption of black blotches over the green coloration and hissing with low noise from open mouth. The hatchlings were different from the adults in not possessing the casque although the head at this presumptive area was slightly convex. Four live hatchlings measured 70.0-72.5 mm (total length), 33.0-34.5 mm (SV), and seven hatchlings weighed 6.5 gm (mean 0.92 gm).

DISCUSSION

Bustard (1965, 1966a) provided the details of colour, body shape and behaviour in *C. hohnelii* and *C. bitaeniatus* to distinguish the sexes. There is, however, no noticeable sexual dichromatism in *C. zeylanicus*, except that gravid females exhibit yellowish-red blotches

on the lower half of the abdomen. Trench (1912) has also mentioned of a change in the colour of his female chameleon during the period following mating. But Deraniyagala (1953) has not mentioned any such colour difference in the sexes although he has noted that males are larger than the females.

The gravid female colouration advertises the condition of the female and is a direct parallel to the dominant and non-dominant colour patterns shown by *C. hohnelii* (Bustard 1965). Presumably it has a similar function of preventing unnecessary interaction/conflict situations by preventing males making unnecessary mating attempts which could be rebuffed.

As described for *C. hohnelii*, *C. bitaeniatus* and *C. gracilis* (Bustard 1965, 1966a, 1967), in *C. zeylanicus* too, colour display plays an important role in social behaviour.

Female *C. zeylanicus*, like most *Chamaeleo* species, are intolerant of close approach of other chameleons of either sex except for suitor males during a period of a few days when they are ready to mate. Actual mating is preceded by a prolonged 'chase and escape' behaviour which is explicable in an analogy to other vertebrates (Manning 1972) where because of the solitary nature, the first response of a potential mate to the other's approach may show elements of attack and escape Since coloration has not been observed to be a sex-advertising sign in *C. zeylanicus* at this stage of the life, the immediate response of a territory-holding female to a male is of that towards an intruder. This response results in display. Later, following a male's continued attempt at contact, the response is escape. Perhaps some chemical communication comes into play at a still later stage to effect mating.

Bustard (1965) mentions for *C. hohnelii* that the tendency for males to wander may be important in increasing the probability of their locating mates, since they are solitary animals. Similar to the above observation, for *C. zeylanicus* too, we believe that the males wander more than the females because during this study and from our unpublished records we noticed many more males than females — an observation also recorded by Biswas and Acharjyo (1977).

Male displays are directed only to other males competing or thought to be competing to court a female. Such male displays include close approach, pausing to inflate and hiss, and attacks on the flanks. These male displays have also been recorded by Bustard (1965) in *C. hohnelii*.

Females on the other hand move less. The post-mating male avoidance behaviour of the female is highly pronounced. Trench (1912), who had also noticed this, stated: after mating the female "showed rage if the male came near her, rocking her body to and fro and gaping at him with faint hissings. He on the other hand would fly in ludicrous terror falling head long from his perch if she came near, as though paralysed."

Position taken during mating — male holding the female with all four limbs — is similar to the description given earlier by Trench (1912) for this species (*C. zeylanicus*) and by Schreiber (1912) for *C. chameleon*, Bustard (1963) for *Microsaura pumila* and Bustard (1966a) for *C. bitaeniatus*.

Fully formed eggs were seen in autopsy of females during the middle of September but egg laying began only between the 1st and 3rd weeks of October. Actual laying of eggs occurred after two days of digging — an observation also recorded by Trench, who, however, mentioned egg-laying in November. The difference in this may be due to the difference in latitude. (Trench made his observation at Jabalpur, Madhya Pradesh at approx. 23°N

and 80°E.) Deraniyagala (1953) have mentioned of a female captured at Marichchukate in November, 1933 that contained 22 eggs.

Deraniyagala (1953) have noted that the gestation period is one month for *C. zeylanicus*. In the present study the gap between mating and egg laying is from six to eight weeks.

In the present study four females have been noted as dying after egg laying. CF2 died after the day of nesting, CF1 after 13 days, WF2 (caught from the wild) after 42 days, and for CF4 the gap period is not known.

The shape and size of the nests depended on the nature of the ground in which these were dug. When the ground was of soft, fine, sand the nest was an oblique hole up to 22 cm deep and 9 cm diameter at the mouth, but when the ground was hard the nest was wider (17 cm) and shallower (5 cm). About two days of unsuccessful digging may precede actual completion of nest digging and egg laying.

Egg sizes provided for the species by Trench (1912) are 13 x 7 mm, by Smith (1935) 19 x 12 mm, by Deraniyagala (1953) 18-19 x 12-12.5 mm, and by Biswas and Acharjyo (1977) 16-19 x 10-12 mm. In the present study the measurements recorded were 15.0-22.5 x 9-12 mm x 1.0-2.0 gm. From Table 2 it is noted that during incubation the eggs tend to increase in size and weight as is observed in agamid eggs (Bustard 1966b). Since the chameleonidae are considered to be a descendant from agamid stock, certain behavioural similarities as pointed out by Bustard (1965) are expected.

The incubation period was eight months, which is apparently timed so that the hatchlings emerge when there is abundant small insect food at the onset of the monsoon in June.

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REFERENCES

BISWAS, S. & ACHARJYO, L. N. (1977): Notes on ecology and biology of some reptiles occurring in and around Nandankanan Biological Park, Orissa. *Rec. Zool. Surv. India, 73*: 95-109.

BOULENGER, G. A. (1890): The Fauna of British India, including Ceylon and Burmah. Reptilia, Batrachia. Taylor and Francis. London.

BUSTARD, H. R. (1965): Observations on the life history and behaviour of *Chamaeleo hohnelii* (Steindachner). *Copeia 1965*(4): 401-410.

——— (1966a): Observations on the life history and behaviour of *Chameleo bitaeniatus* Fischer. *Herpetologica, 22*(1): 13-23.

——— (1966b): Notes on the eggs, incubation, and young of the Bearded Dragon, *Amphibolurus barbatus barbatus* (Cuvier). *Brit. J. Herpetol. 3*(10): 252-259.

——— (1967): The comparative behaviour of chameleons: fight behaviour in *Chameleo gracilis* Hallowell. *Herpetologica, 23*(1): 44-50.

DERANIYAGALA, P. E. P. (1953): A colored atlas of some vertebrates from Ceylon. Vol. II: Tetrapod *Reptilia*. Ceylon National Museum Publication. The Ceylon Government Press.

MANNING, A. W. G. (1972): An Introduction to Animal Behaviour. The English Language Book Society and Edward Arnold (Publishers) Ltd., London.

PARSHAD, B. (1914): Extension of range of the chameleon. *J. Bombay nat. Hist. Soc., 23*: 370.

SCHREIBER, E. (1912): Herpetologica Europea. *Jena. G. Fischer*, 960 pp.

SMITH, M. (1935): The Fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. II. Sauria. Taylor and Francis, London.

TRENCH, C. C. (1912): Notes on the Indian chameleon (*Chamaeleon calcaratus*). *J. Bombay nat. Hist. Soc., 21*: 687-689.

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16. OBSERVATIONS ON *GEOCHELONE ELEGANS* (SCHOEPFF) IN CAPTIVITY, ORISSA, INDIA

Four adult Star Tortoises, *Geochelone elegans* (Schoepff) were obtained from a collector of the Park and kept for a minimum of three years in the Nandankanan Biological Park, Orissa, India, for captive breeding (see Table 1). All three females died during winter, and although the cause of death was not determined, all females were reproductively active. One animal laid 4 eggs which ranged from 37 to 41 mm in length, 29 to 34 mm in breadth and 21.3 to 24.5 mm in height.

These observations show that females as small as 21.0 cm (straight line) carapace length can reproduce. They also show that, at least in Orissa, nesting can occur from October through January. This is consistent with Hutton's report (in Smith, 1931: 139) of a captive nesting in November with 4 eggs. In contrast Deraniyagala (1930) recorded captive nesting in June and October in Sri Lanka. The egg dimensions reported here are comparable to those described by Deraniyagala but smaller than those reported by Smith (1931).

The fact that the females died while reproductively active suggests that they incur increased risks between vitilization and oviposition. It is known in other turtles that nonviable eggs may not be laid (Ewert 1979), and egg-bound females frequently die due to difficulty in oviposition.

TABLE 1

MEASUREMENTS (IN STRAIGHT LINE DISTANCES IN CM) AND OBSERVATIONS ON CAPTIVE *Geochelone elegans* IN NANDANKANAN BIOLOGICAL PARK

No.	1	2	3	4
Sex	27.5	22.5	21.0	26.5
Carapace length	20.0	14.0	13.0	16.5
Carapace width	13.0	10.5	12.0	—
Body depth	24.0	18.5	17.0	22.5
Plastron length	17.0	14.0	11.0	15.5
Plastron width	3.020	1.530	1.100	1.200
Weight (kg)		(14.i.1982)	(xii.1980)	(3.x.1981)
Date died		enlarged	6 shelled,	laid 4 eggs
Remarks		follicles	oviducal eggs	

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REFERENCES

EWERT, M. A. (1979): The embryo and its egg; Turtles, Prospective and Research, Edited by M. Harless & H. Mirlock. pp. 333-413, John Willy & Sons.

DERANIYAGALA, P. E. P. (1939): Tetrapod reptiles of Ceylon, Dulau & Co. Ltd., London, i-xxxii, 1-412.

SMITH, M. A. (1931): The Fauna of British India. Vol. 1. Taylor and Francis, London, 1-155.

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22. A NOTE ON THE BREEDING OF ESTUARINE CROCODILE (*CROCODYLUS POROSUS*, SCHNEIDER) AT NANDANKANAN BIOLOGICAL PARK, ORISSA

A lone female estuarine crocodile (*Crocodylus porosus*) which has been laying infertile eggs since 1975 at Nandankanan Biological Park, Orissa (Acharjyo and Mishra 1981) was paired with an adult male of the same species procured from Crocodile Research Centre, Kukrail (Uttar Pradesh) from April 1, 1983. Both of them were put together in a specially built breeding pool having a capacity of holding approximately 8,26,000 litres of water and with a depth of 2 metres. The land area of the pool complex is about 1500 square metres. There is a compound wall of 2.1 metres high all around except over a length of 23 metres on the viewer's side. There is provision of filling this pool with fresh water and wetting the surrounding land area at regular intervals. The pool complex has been suitably planted with some local and mangrove vegetation. The details of egg laying from 1975 to 1986 are given in Table 1.

The eggs were laid during the three month period, April-June and the clutch size varied from 16 to 35 eggs (mean 28.67). Though the egg laying was an annual feature from 1975 to 1978 and again from 1984 to 1986, the egg laying was on alternate years from 1979 to 1983.

The eggs were laid inside a mound nest consisting of dried leaves, twigs, sticks, soil etc. collected from inside the pool complex. The nests of 1985 and 1986 measured 125 × 135 cm., height 45 cm and 145 × 155 cm, structed underneath a tree at a distance of height 50 cm respectively. The nests were conabout 10 metres from the edge of the pool.

TABLE 1

Year	Date of egg laying	Number of eggs laid	Remarks
1975	30 May 1975	29	Infertile eggs
1976	4 June 1976	34	Infertile eggs
1977	2 June 1977	35	Infertile eggs
1978	22 May 1978	34	Infertile eggs
1979	No eggs were laid		
1980	16 June 1980	34	Infertile eggs
1981	No eggs were laid		
1982	15 June 1982	33	Infertile eggs
1983	No eggs were laid		
1984	26 April 1984	22	Infertile eggs
1985	15 April 1985	16	Fertile eggs
1986	18 April 1986	21	Fertile eggs

The eggs were white and hard shelled. Five infertile eggs of 1985 measured 7.1-7.8 × 4.1-4.6 cm. The mother used to zealously guard the nest from a dug out wallow near the nest as described earlier by Acharjyo and Mishra (1981).

The details of hatching of eggs laid during 1985 and 1986 are given in Table 2.

TABLE 2

Date of egg laying	Number of eggs laid	Dates of hatching	Number hatched	Incubation period in days	Percentage of hatching
15 April 1985	16	5&6 July 1985	11	82-83	68.75
18 April 1986	21	30 June & 1 July 1986	9	74-75	42.86

Eight newly hatched hatchlings of 1985 measured 28.5-30 cm (mean 29.01 cm) and weighed 55-75 grams (mean 69.63 gm).

This species has been bred in captivity at Higashi Izu zoo, Japan; Singapore zoo and Djakarta zoo (Bustard 1980), at Melbourne zoo (Dunn 1981) and at Madras crocodile Bank (Whitaker, pers. comm.). Earlier workers (Acharjyo and Mishra 1981, Choudhury and Bustard 1979, Daniel 1983, Dunn 1981, Groombridge 1982, Smith 1931, Webb *et al.* 1977, Yangprapakoran 1971) have reported on different aspects of reproductive behaviour of this species both in captivity and free living state.

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REFERENCES

ACHARJYO, L. N. & MISHRA, CH. G. (1981): Egg-laying and Nest-guarding Behaviour of Estuarine Crocodile (*Crocodylus porosus*, Schneider) in Captivity. *J. Bombay nat. Hist. Soc.* 78(2): 387-390.

BUSTARD, H. R. (1980): Captive Breeding of Crocodiles. *In*: The care and breeding of captive Reptiles. The British Herpetological Society, London. pp. 1-20.

CHOUDHURY, B. C. & BUSTARD, H. R. (1979): Predation on Natural Nests of the Salt-water crocodile (*Crocodylus porosus*, Schneider) on North Andaman Island with Notes on the Crocodile Population. *J. Bombay nat. Hist. Soc.* 76(2): 311-323.

DANIEL, J. C. (1983): The Book of Indian Reptiles. Bombay Natural History Society, Bombay. pp. 13-14.

DUNN, R. W. (1981): Breeding the Estuarine Crocodile. *Crocodylus porosus* at Melbourne zoo. *Int. Zoo Yb.* 21: 79.

GROOMBRIDGE, B. (1982): The IUCN Amphibia-Reptilia Red Data Book, Part 1. IUCN Conservation Monitoring Centre, Cambridge. pp. 371-390.

SMITH, M. A. (1931): The Fauna of British India. Reptilia and Amphibia. I. Taylor and Francis. London. pp. 42-44.

WEBB, G. J. W., MESSEL, H. & MAGNUSSON, W. (1977): The Nesting of *Crocodylus porosus* in Arnhem Land, Northern Australia. *Copeia* 1977 (2): 238-250.

YANGPRAPAKORAN, U. (1971): Captive Breeding of Crocodiles in Thailand. Crocodiles I. IUCN Publs. N. S. Suppl. pap. No. 32: 98-191.

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21. TWINNING ABNORMALITY IN *GAVIALIS GANGETICUS* (REPTILIA, CROCODILIA)

Singh and Tandan (1978) and Subba Rao and Bustard (1979) have recorded congenital blindness in *Gavialis gangeticus*. Besides blindness, eleven other developmental abnormalities have been recorded for the species by Singh and Bustard (1982). In the present note we put on record the occurrence of twinning abnormality that has not been reported earlier.

Observations

A captive breeding population of gharial is maintained under simulated natural conditions in the Nandan Kanan Biological Park, Orissa. During the 1986 season five nests were made in the breeding pen. Out of 33 eggs laid on 23 March 1986 in one nest, 17 were shifted from the pen for hatchery incubation. Two of the shifted eggs were infertile, while the other 15 eggs produced live hatchlings. From one of these eggs one live and one dead hatchling were recovered. These measured and weighed 34.2 cm, 78 g and 25.8 cm, 30 g respectively. The small and dead hatchling was fully developed, with snout-vent length of 13.4 cm and tail 12.4 cm long.

Other known types of twinning abnormalities in *Gavialis gangeticus* are: a double-yolked egg in a wild-laid nest of 51 eggs from river Chambal (1981, unpublished data) and twin hatchlings of the same pattern as stated earlier in the above except that here both the young ones were dead (D. Basu, *pers. comm.* 1982). Further details on these are not available.

Discussion

Ferguson (1985) has catalogued three types of twinning in Crocodilians: double yolks, twins and axial bifurcation causing partial twinning.

The twins recorded at Nandan Kanan correspond to stage 28 (Ferguson 1985) in *A. mississippiensis*. Similar to our record, full term hatchling twins have been reported only for *O. tetraspis* (Tryon 1980) and *C. niloticus* (Hutton and Loveridge, *pers. comm.* in Ferguson 1985). Out of the two hatchlings at Nandan Kanan, the large live one is comparable to a normal hatchling (Singh 1978). The small dead hatchling, however, is smaller by almost a quarter in length and relatively lighter in weight. Also, unlike the normal condition, the smaller hatchling had a relatively smaller tail length. Double-yolked eggs and the eggs producing two developing young are less than double the size and weight of normal size eggs. Therefore, the twins may be registering some competition to attain normal hatchling size. The reason why one hatchling grows larger may depend on its orientation inside the egg and perhaps is an end result of a complex system of competition. Singh (1978) states that the proportion of different regions of the body are determined through 'egg-space economy' and the 'hatching-time significance' of a corresponding region. Both these phenomena are also expected to be in operation within a 'twin-egg'. It is presumed that, if one of the twins has a positive edge in development, it attains the normal size, while the other hatchling grows so as to be accommodated in the remaining space. This appears to be further supported by the proportionately smaller tail length in the smaller twin; as per Singh's (1978) hypothesis the tail grows in the distal region to a length to 'utilise' the space available inside the egg (and of course bears a survival value for the hatchlings upon hatching).

Double-yolked eggs have been reported to have occurred in *C. acutus* (Neill 1971), *C. noiloticus* (Blomberg 1979), *A. mississippiensis* (Ferguson and Joanen 1983) and *C. porosus* (Webb *et al.* 1983). Double-yolked eggs in *A. mississippiensis* are stated to be laid first or last by young females (Ferguson and Joanen 1983). If it is to be believed as a general principle, a double-yolked condition in a clutch of 51 eggs in *Gavialis gangeticus* could be a freak. Such a clutch is the characteristic of gharials in their latter half of breeding age.

Acknowledgements

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References

Blomberg, G.E.D. (1979): Double yolked eggs in the Nile Crocodile. *J. Herpetol. 13(3):* 368-369.

Ferguson, M.W.J. (1985): Reproductive Biology and Embryology of the Crocodilians. *In:* (Ed. C. Gans, F. Billet and P.F.A. Maderson): Biology of the Reptilia, Vol. 14, Development A. 328-491.

Ferguson, M.W.J. & Joanen, T. (1983): Temperature dependent sex determination in *Alligator mississippiensis*. *J. Zool., 200:* 143-177.

Neill, W.T. ((1971): The last of the Ruling Reptiles: Alligators, Crocodiles and Their Kin. Columbia University Press, New York and London.

Singh, A.N. & Tandan, B.K. (1978): Significance of the absence of optic nerves in a teratological specimen of *Gavialis gangeticus*. *Cheetal 19(4):* 55-56.

Singh, L.A.K. (1978): Ecological studies on the gharial *Gavialis gangeticus* (Gmelin) (Reptilia, Crocodilia). Ph.D. thesis, Utkal University, Bhubaneswar.

Singh, L.A.K. & Bustard, H.R. (1982): Congenital Defects in the gharial *Gavialis gangeticus* (Gmelin). *British Journal of Herpetology 6*: 215-219.

Subbarao, M.V. & Bustard, H.R. (1979): Sequence of hatching of the blind baby gharial, *Gavialis gangeticus* (Gmelin) Gavialidae, Crocodilia, Reptilia). *Journal of comparative*

Physiology and Ecology, 4: 113.

TRYON, B.W. (1980): Observations on reproduction in the West African Dwarf Crocodile with a description of parental behaviour. *In:* Reproductive Biology and Diseases of captive Reptiles (J.B. Murphy and J.T. Collins, eds.). Vol. 1 SSAR contributions to Herpetology, 167-185.

WEBB, G.J.W., SACK, G.C., BUCKWORTH, R. & MANOLIS, S.C. (1983): An examination of *Crocodylus porosus* nests in two northern Australian freshwater swamps, with an analysis of embryo mortality. *Aust. Wildl. Res. 10:* 571-605.

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23. AGE AT SEXUAL MATURITY OF GHARIAL *GAVIALIS GANGETICUS* (REPTILIA: CROCODILIA)

McCann (1940) advocated that with reptiles, "It is perhaps better to arrive at the size at which they breed rather than place any reliance on age". Bustard and Singh (1981) mentioned, "It is not known if there is an age or size 'over-ride' in crocodilians" as far as the attainment of first breeding is concerned. Data on sizes of some of the small breeding gharial *Gavialis gangeticus* females are available in Hornaday (1885), Parshad (1914), Srivastava (1981) and Bustard and Maharana (1982). The sizes are 2.70 m, 2.97 m, 3.12 m, and 3.0-3.17 m respectively.

The gharial referred by Bustard and Maharana (1982) were obtained by the Nandankanan Biological Park from river Mahanadi at sizes of 1.35 m (on 22 March 1963) and 0.90 m (on 10 November 1964). Singh (1978) estimated these juveniles to be respectively 17 months and 33 months old at the time of capture. Therefore, at the time

TABLE 1
EGG LAYING BY 3 CAPTIVE GHARIALS AT NANDANKANAN

Sl. No.	Egg laying Date	Nos. of eggs	Hatching Date	Nos. of hatchling	% of hatchling
1.	22 Mar. '84	33	20/22 May '84	29	87.9
2.	28 Mar. '84	29	21/23 May '84	26	89.7
3.	23 Mar. '85	30	17 May '85	26	86.7

of first breeding in 1980 (Bustard and Maharana 1982) the females were 16.5 to 19.9 years old. These figures are undoubtedly high because of the protracted captivity without a suitable breeding pen and breeding male.

We present here more direct data on the age at first breeding for three female gharials, all hatched in captivity from wild-collected eggs. The ages were 8.5 years for two females and 9.5 years for another.

During April-June 1977 a total of 26 captive-reared gharials, hatched in June 1975, were released from the Gharial Research and Conservation Unit, Tikarpada, into river Mahanadi. Nine of these were subsequently recaptured by accident (Bustard *et al.*–1982). Out of these recaught gharials three were received at the Nandankanan Biological Park. The tail scute clippings confirmed the origin and date of release of these juveniles. These three juveniles were housed in the main gharial breeding pen, where they grew up to lay their first clutches of eggs as shown in Table 1.

The size of the females was not measured at Nandankanan. The sizes of other female gharials of the same year of hatching, retained at Tikarpada, were a maximum of 3.24 m (mean 3.10 m, n=10) at 9 years old and a maximum of 3.30 m at 10 years and 3 months old (Singh 1990).

Two of the 1975-hatched female gharials laid eggs at Nandankanan in 1984 when they were 8 years and 9 months old. Since breeding activity commences from December the receptive age for breeding reduces further to 8.5 years. The sizes of these females are expected to be close to 3.0 m at first egg laying, because relatively larger (in 1977) females of the same brood retained for rearing at Tikarpada were 3.10 m at 9 years old.

The third female of the same brood laid eggs a year later in March 1985 suggesting variation in growth and age at first breeding with juveniles of the same brood.

The maiden clutch sizes of the three female gharials are 29-33. These appear large considering reports of a clutch of 10 eggs from a female in Mahanadi during 1976 (Singh 1978), 15 eggs from a 2.7 m female (Hornaday 1885) and 17 from a female in Chambal during 1985 (Rao and Singh 1990). The clutch sizes may have direct relation with food and hormonal levels, which needs further investigation.

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REFERENCES

BUSTARD, H.R. & MAHARANA, S. (1982): Size at first breeding in the gharial *Gavialis gangeticus* (Gmelin) (Reptilia, Crocodilia) in captivity. *J. Bombay nat. Hist. Soc., 79(1)*:206-207.

BUSTARD, H.R. & SINGH, L.A.K. (1981): Age at onset of sexual maturity in male Indian mugger *Crocodylus palustris* Lesson reared under ideal husbandry conditions in captivity. *ibid, 78(3)*:607-610.

BUSTARD, H.R., SINGH, L.A.K. & ACHARJYO, L.N. (1982): Rehabilitation of the Gharial in Orissa. *In*:Indian crocodiles Conservation and Research, p. 20. (Singh, L.A.K. and Choudhury, B.C. Eds.). Forum of Crocodile Researchers, India, Hyderabad.

HORNADAY, W.T. (1885): Two years in the jungle: The experiences of a hunter and naturalist in India, Ceylon, the Malayan Peninsula and Borneo. New York.

MCCANN, C. (1940): A reptile and amphibian miscellany. *J. Bombay. nat. Hist. Soc. 41(4)*:742-747.

PARSHAD, B. (1914): The gharial *Gavialis gangeticus*. *ibid, 23*:36-370.

RAO, R.J. & SINGH, L.A.K. (1990): Communal nesting of the gharial *Gavialis gangeticus* (Gmelin) Reptilia, Crocodilia) in the National Chambal Sanctuary. MSS. Singh L.A.K. (1978): Ecological studies on Indian gharial *Gavialis gangeticus* (Gmelin) (Reptilia, Crocodilia). Ph.D. thesis, Utkal University, Bhubaneshwar, Orissa.

SINGH, L.A.K. (1990): Growth: Characteristics and ecological significance in gharial. *In*: A technical expedition with Indian crocodiles pp.479-511. MSS.

SRIVASTAVA, A.K. (1981): Some ecological studies on the gharial *Gavialis gangeticus* with particular reference to the natural population. Ph.D.thesis. University of Lucknow, Lucknow.

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20. OCCURRENCE OF CONGENITAL BLINDNESS IN GHARIAL *GAVIALIS GANGETICUS* (REPTILIA: CROCODILIA)

Introduction

During 1975 out of 70 eggs of gharial *Gavialis gangeticus* incubated at the Gharial Research and Conservation Unit, Tikerpada, two hatchlings were blind (Subba Rao and Bustard 1979). During 1976, 60 eggs were incubated at Katerniyaghat, which produced one blind gharial (Singh and Tandan 1978). Again at Tikerpada, during 1976 three blind gharials were produced from 140 eggs (Singh and Bustard 1982a). All these instances relate to eggs which originated from Gangetic rivers of Kamali-Girwa and Kali-Narayani-Gandak in Nepal or in India, along the Indo-Nepal border. This feature had then led us to suggest the possible presence of a deleterious 'blind' gene in the populations of gharial in these rivers.

Here we present information recorded after the hatching of a blind gharial in captivity at Nandankanan Biological Park, Orissa. We also discuss the general frequency of occurrence of blindness reported for the species hitherto. Retarded growth in blind gharial, as observed by Singh and Bustard (1982b) has also been observed at Nandankanan.

Results

Captive gharials at Nandankanan bred for the first time during 1980. There were two females, Juli and Mili, both procured from river Mahanadi during 1963 and 1964. The male, with an uncertain origin, was received from the Frankfurt Zoo in 1979.

On 20 March 1982, Mili laid 28 eggs. 12 were left for incubation *in situ* and 16 were shifted for hatchery-incubation. In the breeding pen six young ones hatched on 29 May 1982. These included one blind hatchling. All six, along with eight others hatched in the hatchery on 2 June, were shifted to hatchling pools for rearing under identical husbandry conditions.

The blind gharial did not have any trace of the eye and fitted the description and photograph given by Singh and Bustard (1982a). On 10 August 1988 the blind gharial died when its SV length was 59 cm, total body length 120 cm and body weight 4.800 kg.

Discussion

Frequency of blindness: The frequency of occurrence of blindness in gharial as per the published information (Singh and Tandan 1978, Subba Rao and Bustard 1979, Singh and Bustard 1982a) and the present observation are 1.67% at Girwa (Katerniyaghat), 2.86% and 2.14% at Tikerpada, 0.42% at Chitwan and 3.57% at Nandankanan. Only the last record is from captive breeding while the others are from eggs collected from the wild. The mean frequency is 2.1% ± 1.2% of the total eggs incubated.

Though the origin of the male which participated in captive breeding at Nandankanan is not known, its origin from the Gangetic system along Nepal/India terai cannot be ruled out. If such an origin is correct then the possible presence of a deleterious 'blind' gene in the concerned region can gain further ground. If the origin is from somewhere else, then either the male or the female could have been responsible for the blindness. Since no further blindness in gharial have been recorded from any of the places mentioned earlier, it is argued that 'blindness' is one of the 12 congenital defects recorded for the species by Singh and Bustard (1982a) and can occur at any time like any other defect. However, it is an observed fact that blind gharials need to be helped out of the egg and the whole process of captive management and gharial conservation had received greater attention and care during the period from which all published reports have come. Therefore, the possibility of having missed to help a blind gharial

out of the egg' cannot be ruled out. In such a case, the frequency of occurrence of blindness can be accepted as 2.1% of the eggs incubated.

Retarded growth: Singh and Bustard (1982b) recorded 186 cm and 15.4 kg for the blind gharial five years after hatching, against 278 cm and 71.8 kg for normal gharial captive reared under identical conditions at Tikerpada. In the present study we recorded 120 cm and 4.8 kg nearly 6.5 years after hatching for the blind gharial at Nandankanan. These data indicate that blind gharials are not only difficult to hatch alive but also do not grow at normal rates.

We are grateful for facilities received from the Principal Chief Conservator of Forests and Chief Conservator of Forests (Wildlife), Orissa. Office facilities were availed by LAKS at Similipal Tiger Reserve.

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REFERENCES

SINGH, A.N. & TANDAN, B.K. (1978): Significance of the absence of optic nerves in a teratological specimen of *Gavialis gangeticus* (Reptilia, Crocodilia). *Cheetal 19:* 55-56.

SINGH, L.A.K. & BUSTARD, H.R. (1982a): Congenital defects in the gharial *Gavialis gangeticus* (Gmelin). *British Journal of Herpetology 6:* 215-219.

SINGH, L.A.K. & BUSTARD, H.R. (1982b): Growth and behaviour of a blind gharial *Gavialis gangeticus* (Gmelin). *J. Bombay nat. Hist. Soc. 79(3):* 681-684.

SURUA RAO, M.V. & BUSTARD, H.R. (1979): Sequence of hatching of a blind baby gharial, *Gavialis gangeticus* (Gmelin) (Gavialidae, Crocodilia, Reptilia). *Journal of Comparative Physiology and Ecology 4:* 113.

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STUDIES ON CAPTIVE BREEDING OF THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN) IN ORISSA[1]

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Key words: gharial, captivity, breeding pool, courtship, mating, egg-laying, nests, clutch size, incubation & hatching, hatchlings

The gharial *Gavialis gangeticus* Gmelin bred in captivity for the first time at the Nandankanan Biological Park, Orissa in 1980. Since then, breeding of this species is a regular feature in the park. This paper embodies data on courtship, mating, egg-laying, nests, clutch size, incubation and hatching success recorded in the park during the fifteen year period from 1980 to 1994.

Introduction

The river Mahanadi and its tributaries in the State of Orissa are within the southern most limit of distribution of the gharial (*Gavialis gangeticus*), considered as an endangered species. Several attempts are being made in the country to save the species from extinction. Captive breeding is considered as one such attempt. The Government of Orissa (State Forest Department) has initiated a project on captive breeding of gharial at the Nandankanan Biological Park (the park lies within the geographical range of the species) with assistance from Government of India since 1975 - 76. The technical expertise for this project was provided by FAO / UNDP Consultant Dr. H.R. Bustard.

A large oval-shaped concrete breeding pool, with a capacity of 2.7 million litres was constructed inside the park. The pool measured 60 m at the longest part, 30 m at the widest part and had a depth of 9.15 m at its deepest. There was a 2.4 m sand bank with suitable riverine vegetation on one side of the enclosure for egg-laying and basking. The area was fenced with a 2 m high wall all around the area except 30 m on the viewers' side where a dry moat and a parapet 0.5 m high was provided.

The three near adult gharials, then available in the park, measuring 2.7 m (male), 2.5 and 2.65 m (females) were released into this breeding pool during February, 1976. Subsequently, four more sub-adult females measuring 2.3 m (one) and 1.5 to 1.8 m (three) were added in 1979 to this pool. In January, 1980, an adult male measuring 3.7 m received on breeding loan from the Frankfurt Zoological Society, Germany was added, increasing the breeding population to eight (2:6). Unfortunately, the resident male was killed by the Frankfurt male during the breeding season in February, 1980.

The first successful breeding of the Gharial was recorded in 1980 and since then, the species is breeding regularly. This paper records the observations made on aspects of breeding of the Gharial in the Nandankanan Biological Park, Orissa during the last fifteen years from 1980 to 1994.

Observations and Discussion

Courtship, mating and egg-laying: Courtship and mating of the gharials have been observed during the winter months (January and February) every year. All the 57 clutches of eggs laid by six female gharials during a period of 15 years (1980-1994) was recorded regularly during the month of March (8-30) only. According to Table 1 the first female laid only five clutches during eight years from 1980 to 1987 and no further egg-laying was recorded for this female from 1988 to 1994 (seven years). The second

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TABLE 1

YEAR OF EGG-LAYING : CLUTCH SIZE

Sl. No.	Particulars of Female Gharials	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total Number of eggs Laid (Total Number of Clutches)	Mean Clutch Size (Range of Clutch Size)
1.	First	25*	Nil	27	15	27	Nil	Nil	28	Nil	Nil	Nil	Nil	Nil	Nil	Nil	122 (5)	24.40 (15-28)
2.	Second	Nil	5*	28	14	28	29	31	26	32	32	36	38	39	Nil	Nil	338 (12)	28.17 (5-39)
3.	Third	Nil	Nil	Nil	5*	Nil	12	25	15	5	35	Nil	36	42	Nil	21	196 (9)	21.78 (5-42)
4.	Fourth	Nil	Nil	Nil	Nil	33*	32	32	37	42	34	39	39	31	51	26	396 (11)	36.00 (26-51)
5.	Fifth	Nil	Nil	Nil	Nil	29*	35	36	Nil	37	32	42	42	51	47	57	408 (10)	40.80 (29-57)
6.	Sixth	Nil	Nil	Nil	Nil	Nil	30*	33	34	2	46	38	50	44	47	48	372 (10)	37.20 (2-50)
	Total Number of Eggs (Number of Clutches)	25 (1)	5 (1)	55 (2)	34 (3)	117 (4)	138 (5)	157 (5)	140 (5)	118 (5)	179 (5)	155 (4)	205 (5)	207 (5)	145 (3)	152 (4)	1832 (57)	32.14 (2-57)

* Indicate first egg laying.

female laid 12 clutches of eggs from 1981 to 1992 continuously but egg-laying was not recorded during the subsequent two years (1993 and 1994). The third female laid nine clutches of eggs from 1983 to 1994 with no record of egg-laying during 1984, 1990 and 1993. The fourth female laid 11 clutches in 11 years from 1984 to 1994. The fifth female laid 10 clutches of eggs from 1984 to 1994 with no egg-laying during 1987. The sixth female laid 10 clutches of eggs continuously from 1985 to 1994. These observations suggest that annual egg-laying is not a regular feature in all the individual female gharials. It was not possible to ascertain the reasons of failure of the first female to lay eggs continuously for seven years since 1988. In no year, more than five female Gharials laid eggs. It is presumed that one male might not be able to mate with more than five females during each breeding season.

According to Whitaker and Basu (1982) mating of gharial takes place between December - January (the winter months) with low water levels and low temperatures. Mating occurs in water in cold weather months of December - January (Daniel 1983). He further states that the gharials nest in late March, early April and the nesting season does not vary by more than 10 days in any year and the females in an area nest more or less within a week. All the nine nests of 1976, located in the Narayani and Kali-Gandaki Rivers in Nepal were laid between 29th March to 21st April (Bustard 1980). No information on the frequency of egg-laying of individual gharials could be found in the available literature.

Nest: Observations on 28 nests of five egg-laying females were made between 1986 to 1991. The distance of the nest on the sand bank from the water's edge of the breeding pool varied from 5.71 m to 10.94 m (mean 8.02 m). The nests were pitcher shaped, diameter varying from 38 to 120 cm (mean 56.6 cm, n = 21 nests). The upper depth of the nest varied from 20 to 45 cm (mean 28.4 cm) and the lower depth of the nests varied from 33 to 70 cm (mean 45.04 cm). The eggs were laid in layers.

One of the nests in the Satkosia Gorge Sanctuary, Orissa was at a distance of 5.9 m from the water's edge at a height of 2.6 m above the water level (Singh and Bustard 1977). Whitaker and Basu (1982) stated that gharials dig their pitcher-shaped nest holes on steep sandy river banks at night and the average nest hole is 40 cm deep. The first layer of eggs in one clutch laid in Satkosia Gorge Sanctuary was 37.5 cm below the surface and the bottom 30 x 22.5 cm (Singh and Bustard 1977). The study of 28 nests in Chambal river revealed that nests were located at a distance of 4.6 to 14.5 m (mean 9.5 m) and at a height of 1.5 to 3.5 m (mean 2.4 m) from water (Whitaker and Basu 1982). They stated that three nests along Girwa river were situated 2.5 to 4.0 m (mean 3.2 m) and at a height of 1.0 to 3.0 m (mean 2.0 m). Nest depth varied from 30 to 37 cm with a width of 22 cm (Daniel 1983).

Clutch size: Table 1 shows that six female gharials laid 1832 eggs in 57 clutches from 1980 to 1994. The clutch size varied from 2 to 57 (mean 32.14). The clutch size of first female varied from 15 to 28 (mean 24.40); second female 5-39 eggs (mean 28.17); third female 5-42 eggs (mean 21.78); fourth female 26-51 eggs (mean 36.00); fifth female 29-57 eggs (mean 40.80) and sixth female 2-50 eggs (mean 37.20). Each female gharial laid a single clutch during each breeding season. There is great variation in clutch size of individual female gharials. More observations on the breeding biology of captive gharials are required to understand such variation.

The clutch size of eggs recorded in Narayani and Kali-Gandaki Rivers in Nepal in 1976 (nine nests) varied from 16 to 39 eggs (mean 25.5); in 1977 (16 nests) the range was 16 to 61 (mean 36.9) eggs and in 1978 (10 nests) the range was 18 to 45 (mean 31.0) eggs (Bustard 1980). The clutch size varies from 10 to 96 with an average of 40 eggs (Daniel 1983). The study of clutch size of gharial eggs of Girwa / Chambal Rivers in India and Rapti / Narayani Rivers in Nepal during 1976 to 1980 reveals that 3147 eggs were laid in 80 clutches with a mean of 39.30 eggs (range 18-95) (Whitaker and Basu 1982). According to Smith (1931), gharials lay about 40 or more eggs in sand banks.

Incubation and Hatching: The incubation period observed in 47 cases (date of egg laying to

the date of hatching, both days inclusive) in nest varied from 55 to 79 days with a mean of 65.1 days. Similarly the incubation period observed in 44 cases in artificial hatchery varied from 57 to 89 days, with a mean of 71 days. This variation of incubation period recorded in different years may be due to the influence of local climatic factors. It is interesting to note that the incubation period observed in artificial hatchery was invariably longer than in natural nests. This might be due to the fluctuations in temperature during the process of translocation of eggs from natural nests to artificial hatchery.

Incubation period ranged from 72 to 92 days with a mean 84.5 days (Daniel 1983). According to Bustard (1980) the mean incubation period observed during 1976 and 1978 in Narayani and Kali-Gandaki Rivers in Nepal was 84 and 83 days, respectively, whereas the mean incubation period observed among 16 nests during 1977 in the same area was 94 days and this was attributed to low temperature existing in the natural sand bank in that year as a result of early April pre-monsoon shower at the time of egg laying, which persisted till the onset of the monsoons in June. Singh and Bustard (1977) stated that Gharial eggs incubated at Tikerpada in April-June, 1975 under artificial hatchery conditions, hatched after 71-76 days. Gharial nests on the Chambal took an average of 60 to 65 days to hatch (Whitaker and Basu 1982). Young gharials appear in March and April (Smith 1931).

Of 1832 eggs, 1046 eggs were allowed to incubate in natural nest and the rest 786 were shifted to an artificial hatchery about 50 m away for incubation. The eggs were shifted to the hatchery invariably during the second half of incubation period, i.e. from late April to early May.

In all, 576 hatchlings hatched during May and June (7 May to 11 June) out of 1046 eggs kept in the natural nest (55.07% hatching success), whereas 659 eggs have hatched (7 May to 15 June) out of 786 eggs kept in the artificial hatchery (83.84% hatching success). Thus, 1235 hatchlings hatched, out of total 1832 eggs laid (67.41% hatching success). The percentage of hatching was higher in hatchery in comparison to natural nest, which may be due to controlled temperature and moisture conditions in the hatchery.

The weight and measurements recorded in 49 newly hatched gharial hatchlings during the year 1986, 1990 and 1991 revealed that the hatchlings measured from 35 to 40 cm with mean of 37.35 cm including tail lengths of 18 to 21 cm (mean 19.6 cm). The weight ranged from 100 to 124 gm with a mean of 116.34 gm. According to Smith (1931) the newly hatched gharial hatchlings measure 375 mm. Hatchlings measured on an average 325-375 mm at birth with a weight range of 75-97 gm (Daniel 1983).

References

Bustard, H.R. (1980): Clutch size, incubation and hatching success of Gharial (*Gavialis gangeticus* Gmelin) eggs from Narayani river, Nepal, 1976-1978. *J. Bombay nat. Hist. Soc. 77(1)*: 100-105.

Daniel, J.C. (1983): The Book of Indian Reptiles. Bombay Natural History Society, Bombay. pp. 15-16.

Singh, L.A.K. & H.R. Bustard (1977): Studies on the Indian Gharial (*Gavialis gangeticus* Gmelin) (Reptilia, Crocodilia) V: Preliminary observations on maternal behaviour. *Indian Forester 103(10)*: 671-678.

Smith, M.A. (1931): The Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, Vol. I. Taylor and Francis, London, pp. 39-40.

Whitaker, R. & D. Basu (1982): The Gharial (*Gavialis gangeticus*): A review. *J. Bombay nat. Hist. Soc. 79(3)*: 531-548.

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Observation on incubating eggs of *Lepeidochelys olivacea* (Eschscholtz) from Orissa coast in natural and artificial condition

Not much information on the breeding habit and on the incubation of the eggs of this species in the Indian coast at present is available. Greaves[1] observed a turtle lay 122 eggs at the Malad-Merve beach of Maharastra and Vall apan and Whitaker[2] recently studied some aspects of breeding habit of the Olive Ridley in the Tamilnadu coast. Deraniyagaia[3] and Curr[4] have studied the breeding of Olive Ridley on Pacific Ridley population of the SriLanka and Eastern Pacific coast respectively.

Undermentioned two observations were carried out, one on the laying of eggs by Ridley and its incubation in its field condition and another clutch of eggs from the Konarak beach in the artificial laboratory condition of Nandankanan Biological Park, Orissa.

Gahirmatha Sea coast in Cuttack District. This area is approachable from Chandbali in Balasore District.

In this area on 20.1.74 at about 11 P.M. it was observed that a nesting female was laying eggs in a scooped out hole on the beach approximately 50 meters up from the surf. The nesting behaviour are more or less of the same pattern that had been observed by others. The presence of man at a distance about 5 meter did not affect its nesting behaviour. After her return to the sea, the hole was examined and found to contain 105 eggs at the depth of about 50 cm. On exploration of adjacent areas three more nests containing 145, 119 and 90 eggs respectively were found.

The first lot of 105 eggs were removed out of the hole on 21.1.74 at about 7 A.M. and brought to the camp site at about 10 meter up of the surface of the sea shore. These were kept exposed till 8-30 P.M. Then a hole was made about the size of 50×50×50 cm. The eggs were arranged in layers in the hole coverd with sand and rammed it with sand properly. From 21.1.74 to 25.3.74 no operation or treatment was given except keeping a close watch against predators such as dogs, hyenas, jackals etc. On 26.3.74 the hole was examined to check up the condition of eggs and found that young are hatched out of the egg shells but eyes were still covered with their screen like skin. The hole was then covered with sand to observe the normal behaviour of its coming out of the nest. On 28.3.74 at about 6 A. M. a small hole appeared on the nest and young started coming out in line one after the other. The young directly started moving towards the sea just after coming out of the nest. The nest was opened completely and altogether 70 young and 35 unhatched eggs were collected. Out of 70 hatchlings 50 were released into the sea and 20 were carried to the Nandankanan Biological Park in sea water to observe the survival rate in unnatural laboratory condition. In the laboratory they were kept in a trough containing 30% saline water. Two young lived for a maximum period of 48 days under artificial laboratory condition.

Size and weight of eggs and hatchlings

Diameter of 5 eggs 34 to 38 mm. on 1.4.75
Weight „ „ 30 to 33 gms „
„ „ 10 hatchllings 12.2 to 15.5 gms.

Length of Carapace 40-40 mm.

Konarak coast of Puri District : On 12.2.75 night soon after laying of eggs by a turtle in the Konerak beach, the nest was

opened and 79 eggs were collected. Those eggs were received in the Nandankanan Biological Park on 14.2.75, 70 eggs were buried on the same day in a dug out hole of 50×50×50 cm. and covered by the sand of the park in an open place exposed to the sun and rains. 30% saline water used to be sprinkled over the artificial nest on alternate days. On 28.2.75 three eggs were taken out of the nest and found no sign of development on 14.3.75. Again on 28.3.75 out of the four examined eggs, two were with developing embryos and two infertile. Four hatched young came out of the nest on 10.4.75 and another on 11.4.75. On 12.4.75 when the nest was examined 10 empty egg shells, 3 dead young at different depths of the pits, 16 eggs containing dead embryos of different stages of development and the remaining 30 spoiled and putrified eggs were found.

Out of the five living young kept in the laboratory one lived upto 45 days.

Size and weight of eggs and hatchling

Weight of 20 eggs	23.5 to 27.2 gms.
Diameter of 20 eggs	35 to 37 mm.
Weight of 10 hatch	13.5 gm. to 16 gms.
Length x breath of carapace	34 to 42 mm. x 30 to 32 mm.
,, ,, ,, plastron	30 to 3.3 cm. x 26 to 30 cm.

Average mean temperature (O°C.)

Months	Chandbali area 1974	Nandankanan area 1975
January	21	20
February	23	24.5
March	22	28.5
April	28.5	30.9
May	30.5	32.6

Remarks : In natural condition t incubation success of the 1st lot of e was 66.66% whereas in unnatural a artificial condition it was 14.3% and t experiment further demonostrate hardin of hatchlings. Ths collection of eggs Vallapan and Whitaker[2] from eleven ne are 43 to 140 and from five nests of c collection are 79 to 145. However accordi to Derianiyagala[3] the number varies fr 90 to 135 in the Sri Lanka breeding popu tion. The egg laying season or the heig of breeding period of this species see to appear for Madras breeding populati December and January, for the Oris coast population January and Februa and for the Sri Lanka population fr September to January. The incubati period of our 1st lot was 66 days and t the 2nd lot 54 days in the month of Ap and May and for the Madras populati it is 50 to 63 days during the period December to March. According to Der niyagala (1oc. cit.) under natural conditio the eggs hatch in 50 days but, if weath conditions are unfavourable, the peri might extend to 60 days. However the var tion of hatching period has got a defin relation of the average air temperature duri the hatching period.

The authors are thankful to the Directo Zoological Survey of India for sanctioni a survey tour in Orissa coast and to t Wildlife conservation Officer, Orissa, Cutta for the help received in carrying out t experiments in connection with this work Nandankanan, Biological Park, Orissa.

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[1] J. B. Greaves, Notes on the Loggerhead turtle *Caretta ceretta olivacea* (Eschscholtz) depositing its eggs. *J. Bombay Nat. Hist. Soc.*, 37, 1 & 2, 494-495, 1933.

[2] S. Valliapan, and R. Whitaker, Olive Ridleys on the coromandal coast. Madras Snake Park, Madras 1974.

[3] P. E. P. Derianiyagala, The Tetrapod Reptiles of Ceylon, 1939, (Dulau and Co., London.)

[4] Archie Curr, Handbook of Turtles. Com. Stock Publishing Associates, vii, 1-542, 1961.

Published by Samarjit Kar, on behalf of the Indian Science News Association, 92, Acharya P. C. Road, Calcutta-9 and printed at Troika press, 204/1, B. T. Road, Calcutta- 35.

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NOTES ON THE STUDY OF THREE SPECIES OF RIVER TURTLES IN ORISSA

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ABSTRACT

The authors have discussed the distribution of three species of freshwater chelonians from rivers of Orissa, *Trionyx gangeticus* Cuvier and *Kachuga tectum tentoria* (Gray) from river Mahanadi and *T. leithi* Gray from Sileru river. They have also made observations on the egg laying of one species and about growth of another in captivity.

Introduction

In connection with the study of ecology and biology of freshwater turtles in Orissa, three species were collected from rivers of Orissa and some live specimens of those species have been studied in the Nandankanan Biological Park under captive condition.

The work of Annandale (1912) on the aquatic Chelonia of river Mahanadi and its tributaries is so far the only important work on freshwater turtles in Orissa. He described one new subspecies, *Trionyx gangeticus mahanaddicus* Annandale and recorded *T. leithi* Gray, *Emyda punctata granosa* (Schoeff) and *Kachuga tectum itermedia* Blanford from Mahanadi. Smith (1931) synonymised the new subspecies under *Trionox gangeticus* Cuvier and other two subspecies in *Lissemys punctata granosa* (Schoeff) and *Kachuga tectum tentoria* (Gray).

The subspecies *L. p. granosa* after Annandale was not again collected from Mahanadi but authors (Biswas & Acharjyo, 1977) found them occurring in lakes and ponds of Orissa. This species is an important item of supply from Orissa for the consumption of Calcutta market. Lastly the authors feel that a thorough turtle survey in the rivers of Orissa is needed to fill up the gap of our knowledge of distribution and status of freshwater Chelonians.

Order : Testudines

Family : Tronychidae

Trionyx gangeticus Cuvier

(Oriya name : Bada Pani Kaincha)

1931. *Trionyx gangeticus*, Smith, *Fauna of British India*, Vol. I : 167 & 168.

Material : One female collected from Mahanadi river near the Village Banragoda, Cuttack Dist., on 8.10.1981.

Measurement and weight : Carapace : 51 × 40 cm ; Plastron—41 × 36 cm ; Weight—14.600 kg.

Distribution : The range of distribution for this species is the Indus, Ganges, and Mahanadi. Recently Zoological Survey of India received a specimen from Bhopal, Madhya Pradesh but the distribution of the species from M. P. and Western part of Orissa is poorly known.

Observation ; The colour pattern of the specimen closely conforms to the description given by Smith (loc. cit). The carapace is deep olive with faintly spotted yellow marks. There are three pairs of oblique longitudinal markings on the head.

The specimen was collected by a local fisherman on 8.1.82 and received in Biological Park on the next day. On the same day night 5 white, round eggs like Ping Pong balls were laid inside the water. The diameter of five eggs are 3.0 to 3.3 cm. and weight 22,100 to 23.800 gms. It again laid 3 eggs each time on 17.1.82 & 18.1.82 and died on 31.1.82. On post mortem examination more fully developed eggs were recovered from the oviduct.

Remarks : It is presumed that the specimen was collected by the fisherman when it came out off water of laying eggs but did not lay due to disturbance. Sometimes the turtles are caught in fishing nets. It could only lay eggs when it was released in the water of the turtle enclosure. Thus this egg laying incidents in, January is only a month or broadly winter is the laying season of this species. There are many records of death in turtle and tortoises due to disturbances in their laying activity (Ewert 1979). Minton (1966) mentioned about a female weighing 13.2 kgs. collected from Indus river in October which contained in its oviduct three full grown eggs (diameter 33 mm.) and many immature eggs.

Trionyx leithi Gray

(Pl. VIII, fig. A & B)

Material : Two female specimens where collected from Balimela reservoir, Koraput Dist. and received on 3.9.78 and 30.1.78 respectively at the Nandankanan Biological Park from Shri P. C. Sarangi, D. F. O., Afforestation Division.

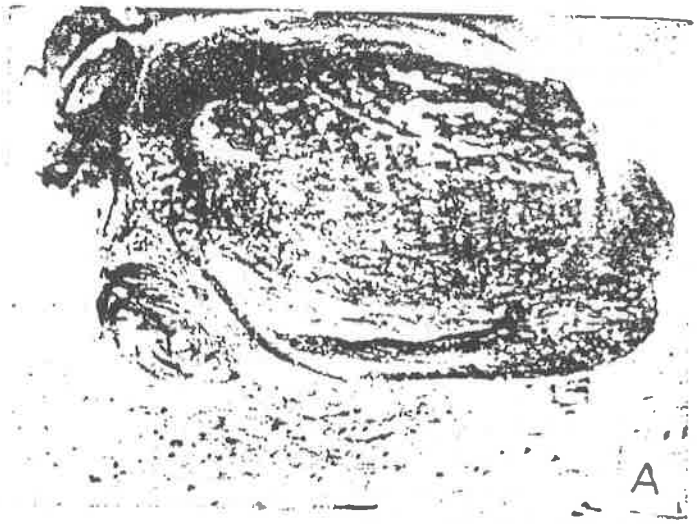
Distribution : The range of distribution is the Ganges and rivers of peninsular India as far south as Madras. Balimela reservoirs are on the Sileru river at Chitrakonda in Koraput Dist. of Orissa adjoining Madhya Pradesh. The river originates in the hilly plateau of south eastern M. P.

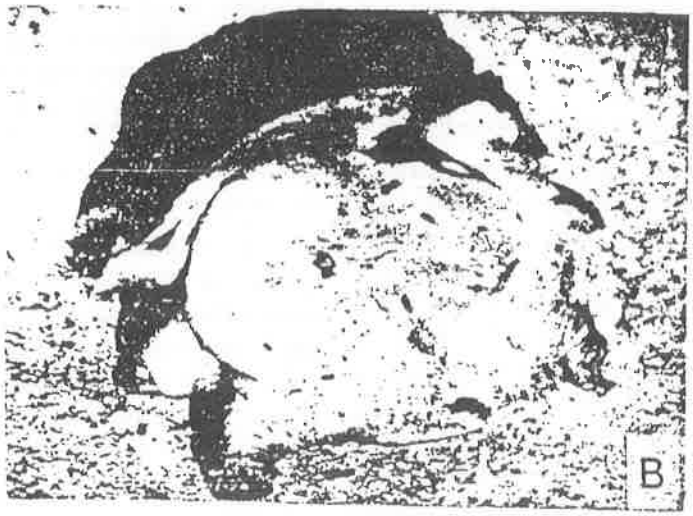
Observation : The identification of the specimens belonging to the species appeared confusing as the usual colour pattern is usually lacking in grown up specimens. The heads and carapaces are uniformly dark olive and their probosises are less pointed comparatively to specimens belonging to *T. gangeticus*. We are referring the two specimens in the above mentioned species based on the patch of warty skin on the anterior flap of the disc and the prominant anterior boss on the carapace.

Observation in captivity : One of the two turtles of Balimela is being maintained successfully for more than two years in a small cemented pool of approximately 5×5 mts. in size with a depth of .45 cm. They thrived well on the fishes that were regularly being supplied to the aquatic birds.

Measurements and weight during their captivity period are mentioned below :

Remarks : The weight gained by the first turtle in captivity in 2 years and 10 months on the fish diet is an encouraging point to undertake further investigation on its develop-





Trionyx leithi Gray, Photo No. A. Dorsal view of one of the female specimen. B. Ventral view of the same specimen.

Measurements and weight during their captivity period are mentioned below :

Date of Measurement	Wt. Kgs.	Carapace length (cm)	Carapace width (cm)	Plastron length	Turtle No.
30.1.78	11.200	49	40	37	I
3.7.78	11.800	49	40	38	
30.1.80	12.000	51.5	40.5	39	Presently
24.11.80	12.800	52	42	40	alive
30.9.78	12.000	46.5	39	38	II
30.1.80	12.000	48	39	39.5	Died on 8.2.80

ment and growth in captivity as well as in natural condition. The growth of the second turtle was less, gaining no weight within 16 months of its captivity. Whereas the first specimen gained 600 gms within seven months of its captivity. Perhaps it could not adapt to its new habitat due to some internal infection and therefore died suddenly.

Family : Emydidae

Kachuga tectum tentoria (Gray)

(Oriya name : Pani Kaincha)

1931. *Kachuga tectum tentoria*, Smith, *Fauna British India*, Vol. I : 128-129.

Material : 1 ♂; Naraj, Cuttack Dist, Mahanadi river. 2 ♀ ♀ ; Tikarpara, Dhenkanal Dist., Mahanadi, Coll. *E. O. Moll* & *S. Biswas* ; 20.2.83.

Measurements (in mm) : 1 ♂, Carapace length 77, breadth 67, depth 50, plastron lenght 73 ; 2 ♀ ♀, Carapace length 183, 178, breadth 137, 135, depth 90, 91, Plastron length 189, 183.

Distribution : According to Smith (loc. cit) the species occurs in the Mahanadi and Godavari and probably in Krishna. It has been earlier recorded from Hasdo river, a tributary of Mahanadi, Madhya Pradesh, Blanford (1870).

Observation : This subspecies differs from the typical *K. t. tectum* in having a second vertebral shield shorter than third and the colouration of their head being dull olive with a conspicuous red patch behind the tympanum. This olivaceous and the yellow streaks, if present, are fewer and less distinct than the typical one.

Remarks : It is the common turtle of Mahanadi. They are often found basking in the winter season on stones and floating logs of the rivers. The habitat of this species is rocky or stony sides of the river.

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References

Annandale, N. 1912. The aquatic Chelonia of the Mahanadi and its tributaries. *Rec. Indian Mus.*, 7 : 261-266.

ANNANDALE, N. 1912. The Indian Mud-Turtles (Trionychiidae). *Rec. Indian Mus.*, 7 : 251-78.

BLANFORD, W. S. 1870. Notes on some Reptilia and Amphibia from Central India. *J. Asiat. Soc. Bengal.* 39 : 335-76.

EWERT, M. A. 1979. The embryo and eggs ; Development and Natural History. In Turtles : Perspective and Research, Harless, M. & Morlock. H. Wiley—Intersience Publication.

BISWAS, S. & ACHARJYO, L. N. 1977. Notes on ecology and Biology of reptiles occurring in and around Nandankanan Biological Park, Orissa. *Rec. zool. Surv. India*, 73 : 45-109.

MINTON, S. A. 1966. A contribution to the herpetology of West Pakistan. *Bull. Am. Mus. nat. Hist.*, 134 (2) : 27-184.

SMITH, M. A. 1933. *Fauna of British India*, Reptilia and Amphibia Vol. 1. Loricata, Testudines, London (Taylor & Francis).

Rec. zool. Surv. India 73 : 95—109, 1977

NOTES ON ECOLOGY AND BIOLOGY OF SOME REPTILES OCCURRING IN AND AROUND NANDANKANAN BIOLOGICAL PARK, ORISSA

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(With 4 plates)

Six species of reptiles occurring in the Nandankanan Biological Park and its surroundings were collected and studied in the laboratory excepting *Varanus salvator* (Laurenti) which is not occurring in this region but has been kept in this park. The results of these observations are summarized.

The Nandankanan Biological Park is situated in the most natural surroundings of the green forests of Chandaka near Bhubaneswar. The facilities for studying reptilian ecology and biology are consequently good. The main advantage of this park is its natural setting of forests and the central lake with its flanking swamps and marshes. As the park is not enclosed by a boundary wall, but only by a barbed-wire fence, many reptiles enter the cage and the enclosures at night. The northern and western sides of the park are hilly with bushy forests.

Some of the observations made are not new but serve to confirm previous observations. We intend to continue this work on other species of reptiles occurring in this area.

Family COLUBRIDAE

Enhydris enhydris (Schneider)

(Oriya name : Dhanda Sap, Pani Dhanda, Mati Birali)

Distribution.—This species is distributed throughout north eastern India and in the south up-to Vizagapatnam District. It occurs all over Orissa.

Habits and Habitat.—These snakes are fairly common in ponds, irrigated fields, and sluggish waters. They occur in the central lake of Nandankanan Biological Park and in the water logged marshes and swamps near about. Some specimens of this species were kept in captivity. Here they are generally seen at the water edges with tip of the nose sticking out and the remaining portion of the body lies inside water. With some disturbance they sink down and swim away. Some were seen completely submerged in the water where as some were seen on the land near the water basking in the sun during January, 1974.

Food.—The snake feeds principally on fishes and frogs but one from Barrgkok disgorged a skink (Smith, 1945).

Observations.—On 14.6.1973 at about 5 p. m. on the road near the Museum of Nandankanan at a distance of about 160 metres from the border of the lake one *Enhydris enhydris* was detected laying live young snakes one after another. The snake was lazy and sluggish. Its hind part near the vent was bulged out and a portion of the tail of a young snake that was being born was visible out of the vent. As the mother moved slowly forward, one after another young ones were being dropped and left behind. It took about half an hour to give birth to ten young. The bulged hind portion above the vent contracted while giving birth. There was no attempt of parental care. The young first moved a little and then remained still before they made another attempt to move. They were wet and encased in thin membranes which were lost. The colour pattern was prominent and distinct. After giving birth the mother remained almost still probably due to stress and exhaustion and could not be induced to move even when pocked with a stick. Then it was collected and preserved. After autopsy, four more young ones were recovered from the mother's body cavity starting from the 100th ventral scale to vent. The fourteen young measured 175 to 185 mm. The colour pattern of the adult female was fainter than the young ones.

Another female of this species caught on January 25, 1974 contained 29 eggs of the following sizes 20 mm. × 11 mm., 16 mm. × 10 mm. and 9 mm. × 7 mm. between 104th to 142 nd ventral scale of the body. The specimens are deposited in the Z. S. I. collection.

Measurement and scale count of two females.

Sl. No.	Details	No. I	No. II
1.	Length-snout to vent	406 mm.	615 mm.
2.	Length-vent to tail tip	98 mm.	120 mm.
3.	Ventral scales	151	157
4.	Subcaudal scales	50	49

Parasites.—Some nematodes belonging to the species *Tanqua anomala* (Linstow), Baylis, 1916, were found in the empty stomach of the mother snake.

Remarks.—Though *Enhydris enhydris* is mainly an aquatic. snake it has to come to land to give birth. This breeding habit indicates that it was originally terrestrial, but subsequently changed to an aquatic habit. It gives birth six to eighteen young at a time (Smith, 1943). These two observations suggest that the breeding season may be from January to June.

Family COLUBRIDAE

Ptyas mucosus (Linn.)
(Oriya name : Dhamana Sap)

Distribution.—The species occurs throughout India and the Andaman Islands. Outside India, it occurs in Yunnan, South China, Hainan Indo-China, Java and Sumatra. It is common throughout Orissa.

Habits and Habitat.—They are very swift snakes found here and there inside the park. They are mostly found around aviaries of small birds such as Budgerigars, Quails, and Bulbuls. Here these snakes feed on the birds and rodents which in turn feed on the food of birds. Sometimes they are seen moving along the wire netting walls in search of a hole. Many have been killed in these aviaries. Many were seen beneath heaps of stones. Some were seen basking in the sun inside the deer paddock during winter mornings but ran away upon slight disturbance.

Food.—Though rats and frogs are its main food, the snakes do not seem particular in its choice of food. On autopsy rats and birds have been recovered from the stomach of some of the rat snakes. Once four Budgerigar chicks were regurgitated by one snake when it was caught.

Observations.—One rat snake collected in the park on 4.7.1968, was kept in a wooden cage and laid 11 eggs on 18.7.1968. The eggs were white, soft shelled, shrunken and elongated with blunt ends. These 11 eggs measured 50 to 52.50 mm.×27.50 to 32.50 mm. (Pl. IV, 2).

Another female specimen killed in the park on 27·5·1973 After dissection it was found to contain two sets of ovaries with several advanced egg follicles and in the oviducts some small eggs.

A baby rat snake measuring 576 mm. was caught from the lawns or the garden on 30·8·1973.

Two rat snakes of unknown sex were fighting near the nursery garden of Nandankanan on 1·8·1973. These two snakes were in an area

of about 10 metres × 10 metres from 10 A. M. to 4 P. M. Both were twisted on each other. The heads were facing each other with a space of a few centimetres in between them. The heads were about 45 cm. above the ground. There was continuous twisting movement of both snakes for several minutes at a time inside bushes and grasses. Some times they break apart and again repeat the same type of fighting.

They ignored the presence of human beings at a distance of about 6 to 7 metres.

Parasites.—Nematodes from the lungs of two rat snakes killed on 26·12·1972 and 27·5·1973 were recovered.

Remarks.—According to Smith (1943) mating of this species takes place in hot weather, May and June, eggs 6-14 in number are deposited in August and September, the young emerge between the end of September and December. The eggs measure 45.50 mm. × 30.40 mm. and the new born young measure 370-380 mm. (Smith, *loc. cit.*) Nicholson (1893) gives the egg depositing time of Bangalore population as May to September, 7-13 in number.

From our above mentioned observations on egg size of the second female, it is persumed that the mating may start in May and from the observation of the first female, the egg depositing time can be said to be July. In our collection the size of the eggs are also little larger. Wall and Evans (1900) noted the incubation period of a brood of eggs and Derianiyagale (1960) observed the mating behaviour. However a brood of nine eggs recorded by Wall (1907) from Fyzabad agrees approximately (2"-2½" × 1½").

Since mating of this snake takes place in hot weather May and June (Smith, *loc. cit.*) this fighting behaviour observed in August may be the struggle of two males. Carthy (1964) mentioned about such a behaviour among sand vipers as struggling between two males and Schmidt & Inger (1957) is also being referred in this connection. However Prater (1933) mentioned about a sex play of a pair of this species in which case the female contained eggs in advance stage.

Family BOIDAE

Python molurus molurus Linn.
(Oriya name: Ajagar Sap, Boda Sap)

Distribution.—Range: India, Peninsular India to the North East, West Bengal and to the West Punjab and Rajasthan. Outside India, Sind and Punjab or Pakistan, Sri Lanka and Bangladesh.

This species occurs throughout Orissa. It has been collected from Puri, Cuttack, Mayurbhanj and Phulbani Districts for this park. Mani-

bhadra Pahad (Hill) near Gonia in Puri District is well known for its occurrence.

Habits and Habitat.—In captivity they remain coiled up in a corner of the house during the day but move often late in the evening and at night. Often they are completely or partially submerged in the water tank. Most of the baby Pythons collected from the aviaries were found early in the morning. During July, 1971 to September, 1971 we could collect 7 baby pythons and 4 baby pythons were collected during the period from July,.1973 to October. 1973 from an aviary of small birds situated just at the edge of portion of the lake which is full of submerged grasses, marshes and bushes. One python was seen inside heaps of laterite stones and bushes in a hillock at Barang about 2 Kilometres from the park. This was caught by the workers of Barang glass factory and sent to the park on 4.1.1974.

Food.—Pythons can take any manageable animals and birds. Generally they prefer live ones but dead birds and small animals have also been accepted in captivity. They have been observed taking the common langur, ducks, common goose eggs and a number of species of other birds. In captivity they are generally fed with live fowls, pigeons and guineapigs.

While clearing the forests for the construction of buildings one python was seen swallowing a young spotted deer in the forests near Bhubaneswar during the year 1957-1958. (Pl. V).

Feeding mechanism of one year old baby python was studied by supplying immobilised sparrows (Pl. VI).

Observations.

Table—1. The weight and size of eight large pythons received so far in this park.

Sl. No.	Weight in kg.	Maximum circumference in cm.	Length tip to tip in cm.
1.	33.5	45.5	435
2.	37	—	396
3.	21	—	396
4.	30.500	—	411
5.	—	—	435
6.	29.4	38	465
7.	10.6	28	288
8.	11.4	26	284

No python longer than 465 cm. has been recorded in this Park or in any part of Orissa.

Table—2. The details of four baby pythons recently collected from a aviary of the park.

Sl. No.	Date of collection	Length in cm.	Circumference in cm.
1.	17.7.1973	79	8
2.	5.8.1973	80	8
3.	14.8.1973	81	8
4.	16.10.1973	90	9.5

The details of collection of some of the pythons from Nandankanan park area as follows :

(a) One was collected on 7.4.1966 while swallowing a common langur at the bank of the lake underneath a tree.

(b) One was caught in May, 1966 in a fishing net while it was taking a duck inside the lake.

(c) One was caught on 25.4.1971 from the common goose enclosure where it was lying coiled up after taking four spoiled common goose eggs. All the four eggs were regurgitated out after catching it.

(d) Seven were caught during the period from July, 1971 to September, 1971 and four were caught during July, 1973 to October, 1973 from an aviary of small birds such as bulbuls, mynas, doves and barbets where they devoured some of these birds. Most of these birds were regurgitated soon after the snakes were caught.

(e) One was collected on 1-10-1969 from the oven (chulla) of Zoo kitchen.

(f) One was collected from submerged grasses inside a portion of the lake in August, 1973.

The monthly distribution of python collected or received in the park including 20 collected from this park area itself is as follows :

January	— 7	May	— 1	September	— 5
February	— 0	June	— 2	October	— 6
March	— 0	July	— 7	November	— 8
April	— 4	August	— 6	December	— 2
			Total 48		

From this it can be seen that inter sloughing period observed in one case was from 37 days to 128 days whereas in the other case it was from 31 to over 97 days. The process of sloughing was completed either in one day or within three consecutive days.

Table—3. The details of sloughing of the skin observed in two captive adult Indian pythons.

Sl. No.	Date of last sloughing	Date of sub-sequent sloughing	Inter sloughing period in days	Remarks
		Specimen No. I (Sl. No. 1 of Table I)		
1.	11.5.73 to 12.5.73	23.6.73 to 24.6.73	41	
2.	23.6.73 to 24.6.73	4.8.73 to 5.8.73	40	
3.	4.8.73 to 5.8.73	17.10.73	42	
4.	17.10.73	23.2.74 to 25.2.74	128	Winter
5.	23.2.74 to 25.2.74	4.4.74	37	
6.	4.4.74	30.6.74	86	Under incubation from 28.4.74 to 25.6.74.
7.	30.6.74	19.8.74	49	
8.	19.8.74	13.10.74	54	
9.	13.10.74	17.12.74	64	
		Specimen No. II (Sl. No. 6 of Table I)		
1.	14.11.73 (Date of Procurement)	20.2.74	97+?	Winter
2.	20.2.74	24.3.74	31	
3.	24.3.74	11.6.74	78	
4.	11.6.74	23.8.74	72	
5.	23.8.74	18.11.74	86	

Mating of a pair of Indian pythons was observed in the first week of February, 1974 in this park. The female measuring 435 cm., weighed 33.5 kg. and had a circumference of 45.5 cm. Whereas the male measured 288 cm. weighed 10.6 kg. and had a circumference of 28 cm. at the time of mating.

Parasites : Helminth parasites i.e., *Bothridium pythonis*, *Blainvilie*, 1824 and *Ophioascaris filaria*, Dujardin, 1845 (= *O. Ajgariasis*, Khera, 1954) were found on autopsy of this species in the park (Patnaik and Acharjyo, 1970).

Remarks.—Wall (1911 & 1912) dealt elaborately with the food and feeding habit of Pythons and some more information can be gathered from Candell (1913) Campbell (1923), Jerdon (1959) and Stewart (1917). Corbett (1957) encountered pythons which have swallowed cheetal and barking deer.

In respect of sloughing our observations shows that the inter sloughing period is longer during winter and hybernation period.

From the period of gestation and the season when eggs are deposited Wall (*loc. cit*) extrapolated mating seasons from December to February. In the Paris Zoo. they were observed to mate in January and February and eggs were deposited in May. Our observation of mating in the February confirms the same. It is interesting to note that the copulation takes place in the winter at the time of their hybernation. Vinger *et al.* (1970) has studied metabolism and thermoregulation of this genus during breeding.

According to Smith (1943) hatchling measure on an average 2'-5" (73.66 cm.). Therefore the above four measurements of the baby pythons may be of the same brood, they might have hatched one or two months before capture in case of first three and three to four months in case of the fourth one because it is comparitively longer than the other three.

Since the start of the park (19.12.1960 to 28.2.1974) 48 pythons of different sizes have been received or collected in the park and out of these, 20 have been collected from this park area. This shows how common this species is in Orissa in general and Chandaka forest area in particular.

Now-a-days pythons are rarer in some parts of India due to indiscriminate killing of this species for their skins. In the markets of Puri, Bhubaneswar and other cities there is a great demand of its skin for making shoes, ladies handbags, belts and purses.

Family VARANIDAE

Varanus salvator (Laurenti)
(Oriya name; Pani Godhi, Pani Goisap)

Distribution.—Range. India including Andaman and Nicobar islands, Sri Lanka, Burma, Indochina, Southern China, East Indian Archipelago and Northern Australia.

It occurs in West Bengal, Eastern Himalayas but not in the Peninsular India, therefore it is not likely to be found in Orissa. The specimens in the Zoo were received from a supplier of Calcutta.

Observations : Three water monitors were received in the Park on 2-7-1970 from an animal dealer of Calcutta. On the morning of 29-7-1971 one egg was found in their enclosure. The egg was elongated with blunt ends on both sides, soft shelled and white. It measured on that day 9.5 cm. ×3.5 cm. and weighed 48 gms. (Pl. No. 1, 3). In this connection the observation of Deraiyagala (1958) on the reproduction of *Varanus bengalensis* (Daudin) is useful for further study on this species.

They were being fed with beef, without bones six days in a week with one day fasting. They also took eggs, small dead birds, rats, sometimes fishes and once one of them took even a young land monitor. While taking its feed, first it examines with its tongue, lifts the food by mouth and then gulps it. It takes eggs with or without breaking which pass entirely through the gullet.

Most of the time they are found submerged inside the water tank with the head remaining out of water. When annoyed at times it used to give lashing with its tail.

Parasites.—Duthiersia Fimbriata (*Dies*, 1850) *Mont Et. Crety*, 1891. It was recovered from stool of these monitors after medication (Acharjyo *et. al.*, 1970).

Remarks.—Regarding the size of the egg in the collection it is bigger than that of mentioned by Smith (1935) as 70×40 mm. and about the number of eggs laid at a time are 15 to 30. In the present case the lizard also might have laid more eggs, but as all the lizards were kept together and as natural condition was not provided, they might have swallowed the rest of eggs due to their egg taking habit. According to Smith (*loc. cit.*) usually the laying season is June in Thailand but in this case it was July.

Order SAURIA

Family CHAMAELEONIDAE

Chamaeleon zeylanicus (Laurenti)
(Oriya name; Bahurupi Endua or Pohola Endua)

Distribution.—Range. Peninsular India, South Gangetic Plains, Cutch and Sri Lanka.

In Orissa this species is known to occur in the districts of Puri, Cuttack, Ganjam, Keonjhar, Mayurbhanj, Dhenkanal and Sambalpur and may be in other districts also.

The collection of Zoological Survey of India contain three specimens from the upper Godavari Dist., Betul Dist. and Midnapore (Reg. No. 6840), West Bengal. Wide distribution of this species in Orissa justifies its occurrence in some parts of Midnapore Dist. adjoining Orissa. Theobald (1876) also recorded it from Midnapore.

Habits and Habitat.—They were found on plants and bushes in the rainy season or just after rains. In other times it is very rare in Nandankanan area though some are seen during summer months. Many were collected mostly from the ground on the roads and paths while they were passing from one side to the other. Others were taken from plants. The monthwise collection of eleven specimens of this species during 1972 and 1973 were: July 6, August 3 and September 2.

One was collected by Dr. N. K. Mohanty of Burla Medical College in April, 1973 at Burla (Sambalpur Dist.). Insects are plenty during rains and so the chameleon's activities are mostly observed during rains as they come out in search of their food.

Food.—Chameleons are voraceous eaters. They were fed chiefly, with insects such as grass hoppers, sand hoppers, flies and butterflies.

Observations.—Of the eleven specimens, three were females and eight males. A chameleon was collected from the park area on 3 .9.1972 and was kept in all indoor cage provided with water and small branches of a tree. In captivity most of them refuse to take food. Attempts were made to feed it with grass hoppers and sand hoppers holding the insect by forceps loosely a few inches in front of it. They were also seen taking cockroaches not more than 2 or 3 per day. These were readily taken. The chameleon remained motionless in the cage most of the time but used to be slightly active on showing the insects. Both its habits and movements were slow and deliberate and the movemenst of the eyes were independent of each other.

It was taking its food from 30-9-1972 to 21.10.1972 but refused to take food from 22.10.1972, laid 28 eggs on 25-10-1972 and found suddenly dead on 31.10.1972. After death three more white, hard shelled eggs were found in oviduct. The eggs deposited were oval, soft shelled, shrunken and some of these were studded with black dots and patches. The 31 eggs measured 1.6 cm. to 1.9 cm×1 cm. to 1.2 cm. (pl. IV, 1).

Another female kept in captivity since 24.8.1973 took some insects at times from a forceps but found suddenly dead on 22.9.1973. On autopsy the whole of abdominal cavity was packed with 21 fully formed eggs pressing the lungs, and liver. These eggs were white oval, soft shelled, leathery to touch smooth and measured more or less the same as above.

A newly caught Indian chameleon when disturbed opens its mouth with a hissing sound and gives an attacking pose.

Two male chameleons were observed to fight in captivity. A male when gets ready for attacking an incoming another male, becomes flat vertically, thin and wide in its body. The body colour turns yellow with dark green stripes. In this posture, it nodds its head with open mouth and strikes at the fore-quarters of the other male. The other male after repeated strikes just withdraws. At this time the submissive male is only green in colour and in its usual natural size.

At other times fighting of two males were also observed. During fighting each gets thinner and wider in their bodies, turn yellow with green stripes and strike with open mouth at each other. No biting or injury due to fighting was ever observed. At the end, the defeated one withdraws. This may be a defence of territorial behaviour.

One chameleon in the collection of Dr. N. K. Mohanty, of Burla Medical College was seen moving about in the cage with open mouth. It then sat in the water pot submerging its lower portion, probably due to extreme heat during May, 1973 when the temperature was 48.3°C.

Sloughing of skin from the head and neck of one only was observed in captivity from 24.7.1973 to 27.7.1973. The process was slow and pieces of white skin like tissue paper peeled off.

Measurement of some adult specimens

Sl. No.	Sex	Length Snout to vent in cm.	Length tail in cm.	
1.	Male	15.1	18.2	Specimens are deposited in the Z. S. I. collection
2.	Male	16.3	17.2	
3.	Male	17.4	18.8	
4.	Female	16	17.9	
5.	Female	15.1	17.3	

Inspite of all attempts all these specimens died within two months in captivity. But one chameleon in the collection of Dr. N. K. Mohanty is still living for over 10 months on a daily diet of cockroaches and water is sprinkled daily several times over the leaves of a plant kept inside the cage for licking.

Parasites.—Nematodes were collected from intestine of one and peritoneal cavity of two chameleons. They belong to the species *Polydelphis hexametra* (Gedoclst, 1916).

Remarks—Our observations of number of eggs laid at a time agree with those of Trench (1972) but the size of this (13×7 mm.) is smaller. The size of our eggs conform to the eggs kept in the British Museum (19×12 mm.) Smith (1935). The black dots and patches on some of the eggs might be due to the development of mould.

The present specimens laid eggs after 26 days of capture, according to Trench (*loc. cit*) the gestation period is 36 days. In another female which was kept with males since 24.8.1973, fully formed eggs were collected from the abdominal cavity after death on 22.9.1973 on the 30th day of capture. However, no mating in captivity could be observed. A third female caught on 15.7.1973 and died on 11.9.1973, on autopsy revealed functional ovaries but no eggs. Therefore, the eggs of the lizards may have been fertilized in nature 10 days before its capture in the first case and a few days before its capture in the second case.

Hence, the breeding time of this lizard can be taken as August to October. In case of Trench's (*loc. cit*) specimen it was bit delayed due to mating delay.

The ability for changing colour to match their environment is well known in the chameleon (Schmidt and Inger, 1957). Though factors such as changes in light intensity or temperature are mostly responsible but change of emotion is also responsible for their colour change (Pl. VII).

The popular belief among the local people of the area is that the tail of these lizards has some curative properties for some diseases of infants, so tails of these lizards are cut on some auspicious days. In our collection 3 out of 11 were with mutilated tails. Such belief is wide spread in its range of distribution in India. It has been reported by Trench (*loc. cit*) that in Madhya Pradesh (Southern districts) people also believe that these lizards have some magical properties or charm. To save such a fascinating looking, entertaining and useful lizards the wrong ideas of the people should be dispelled and some protective measures might well be adopted.

Order TESTUDINES

Family TRIONYCHIDAE

Lissemys punctata granosa Schoepff
(Oriya name: Kaincha)

Distribution.—The Indian Peninsula, South of Ganges and Sri Lanka. In Orissa it occurs in Mahanadi and its tributaries and also in ponds, tanks and lakes. It is very common in Nandankanan lake.

Habits and Habitat.—This turtle is aquatic. It occurs in canals, marshes and ponds, though mainly lives in rivers. In some places it

wanders ashore at night in search of food. Sometimes it aestivates in the summer particularly in time of drought. This turtle is kept in temple tanks. In captivity they are kept in the same tank along with Gharials (*Gavialis gangeticus*) and muggers (*Crocodilus palustris*) for several years without injury or death. Tney sometimes emerge, but immediately return to the water at the approach of the keeper. At times they sit on the back of the Gharials.

Food.—This species is mainly carnivorous. It feeds largely upon fishes, molluscs, frogs and tadpoles whether or not its food is alive. They often take rejected and dead fishes found in the tank of gharials and muggers.

Observations.—(a) One of the turtle kept along with the crocodiles and gharials laid 4 round, grey colqured and hard shelled eggs on 30.11.1971 and two on 1.12.1971. The weight of the turtle was 2.300 kg. the diameter of eggs was from 3 cm. to 3.25 cm. and the weight were from 12.200 gm. to 13.800 gm.

(b) While digging pits adjacent to a dried up formerly water-logged area, 6 eggs were excavated out on 28.5.1973 from a depth nearly 23 cm. Some of the eggs were broken and the developing young died after an hour.

(c) From the same area two very small young were collected on 29.5.1973. They had probably hatched within the last one or two days. One weighed 8.700 gm. and the other 9.500 gm. The plaston length was 3.5 cm.

A small cartilaginous raised knob occurred just above the entoplaston. It was shed in the second week, post hatching of both juveniles.

The two hatchlings were kept in a tray and maintained on a diet of wheat flour and small cut pieces of greens upto 24.6.1973. One young which weighed 9.500 gm. on 29.5.1973 weighed 10.300 gm. on 25.6.1973. They were never seen taking any of the food though they remained always active.

(d) One young turtle with blackish shell colour measuring 5 cm. × 5 cm. and weighing 17.500 gm. was caught on 21.6.1973 when water was pumped from a muddy shallow tank at Nandankanan.

Remarks.—According to Smith (1931) this species lays 10 to 12 eggs at a time and keep them burried in the ground close to the water. The eggs measure 40 to 33 mm. in diameter. The measurements, of eggs given by Deraniyagala (1939) agree with ours but the weight (17 to 19.25 gms.) differs from our non-fertilised eggs (12.200 to 13.800) gms.

From the above mentioned observations it appears that the species lays eggs from November upto December and the young hatch in May or June. The incubation period seems to be about six months.

This turtle is eaten by people living near about Nandankanan, but the flesh of it is not sold in the local market. There is a belief among some people that this turtle will cure some chronic ailments. It is sometimes caught accidentally in fishing nets but no regular turtle fishing is practiced here. In West Bengal there is a good demand for the turtle meat and the meat of *Trionyx gangeticus* and *Lissemys punctatus punctatus* are often sold in local markets. Consignments of these species from other states also come to the market of West Bengal. Therefore there is a good possibility and scope for starting turtle fisheries in Orissa.

SUMMARY

This paper notes some observations on biology of six species of reptiles occurring in and around Nandankanan Biological park. Earlier reports are also summarized.

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REFERENCES

ACHARJYO, L. N.; PATNAIK, M. M. and PATRO, K. C. 1970. Treatment of Diphyllobothrid tape worm infection in Water Monitor (*Varanus salvator*). *Orissa Vet. J.*, 5 : 32.

CAMPBELL, J. M. 1923. A Python's meal. *J. Bombay nat. Hist. Soc.*, 29 : 566.

CARTHY, J. D. 1964. The fighting spirit. *Animals*, 3(14), pp. 372-375.

CADELL, P. R. 1913. Voracity of Pytnon. *J. Bombay nat. Hist. Soc.* 23 : 202

CORBETT, J. 1957. *Man-eaters of India*. London.

DERANIYAGALA, P. E. P. 1939. *The Tetrapod reptiles of Ceylon*, Colombo. pp. ix-xxii Fig. 137., 24 pls., 62 tables.

DERANIYAGALA, P. E. P. 1960. Mating of the Rat Snake. *Spolia Zeylanica*, 29(1) : 39.

DERANIYAGALA, P. E. P. 1958. Reproduction in Monitor lizard. *Varanus bengalensis* (Daudin). *Spolia Zeylan*; 28(2), pp. 161-166.

JARDON, T. C. 1959. A Python's meal. *J. Bombay nat. Hist. Soc.*, 56, pp. 349-350.

NICHOLSON, E. 1893. *Indian Snakes.* An Elementary treatise on Ophiology, Madras. Higgintothaam and Co.

PATNAIK, M. M. and ACHARJYO, L. N. 1970. Notes on the Helminth Parasites of Vertebrates in Barang Zoo. (Orissa). *Indian Vet. J.* 47 : 723.

PRATER, S. N. 1933. The social life of snake. *J. Bombay nat. Hist. Soc.*, 36 (1 & 2) : 469.

SMITH, M. A. 1931. *Fauna of British India,* Reptilia and Amphibia Vol. I-Loricata, Testudines, London (Taylor & Francis)

SMITH M. A. 1935. *Fauna of British India,* Reptilia and Amphibia Vol. II-Sauria, London (Taylor & Francis)

SMITH, M. A. 1941. *Fauna of British India,* Reptilia and Amphibia Vol. III-Serpentes, London (Taylor & Francis).

STEWART, C. G. 1917. Feeding habit of the Python (*Python molurus.*) *J. Bombay nat. Hist. Soc.*, **25** : 150.

SCHMIDT, K. P. and INGER, R. F. 1957. *Living Reptiles of the World.* Hamish Hamilton Ltd.

THEOBALD, W. 1876. *Descriptive Catalogue of the Reptiles of British India.*

TRENOH, J. 1912. Notes on the Indian Chameleon. *J. Bombay nat. Hist. Soc.*, **21** : 887.

VINEGER, A. *et. al.* 1970. Metabolism and Thermoregulation during brooding of snakes of the genus *Python. Zoologica.*, 55(2) : 19.

WALL, F. and EVANS, G. H. 1900. Incubation of a brood of *Zamenis mucosus. J. Bombay nat. Hist. Soc.* 13, : 189.

WALL, F. 1907. Hatching of Dhaman (*Zamenis mucosus*) eggs and observation on egg tooth. *J. Bombay nat. Hist. Soc.*, 17(4) : 1033.

WALL, F. 1911-12. A popular treatise on the common Indian snakes. *J. Bombay nat. Hist. Soc.*, **21** : 447.

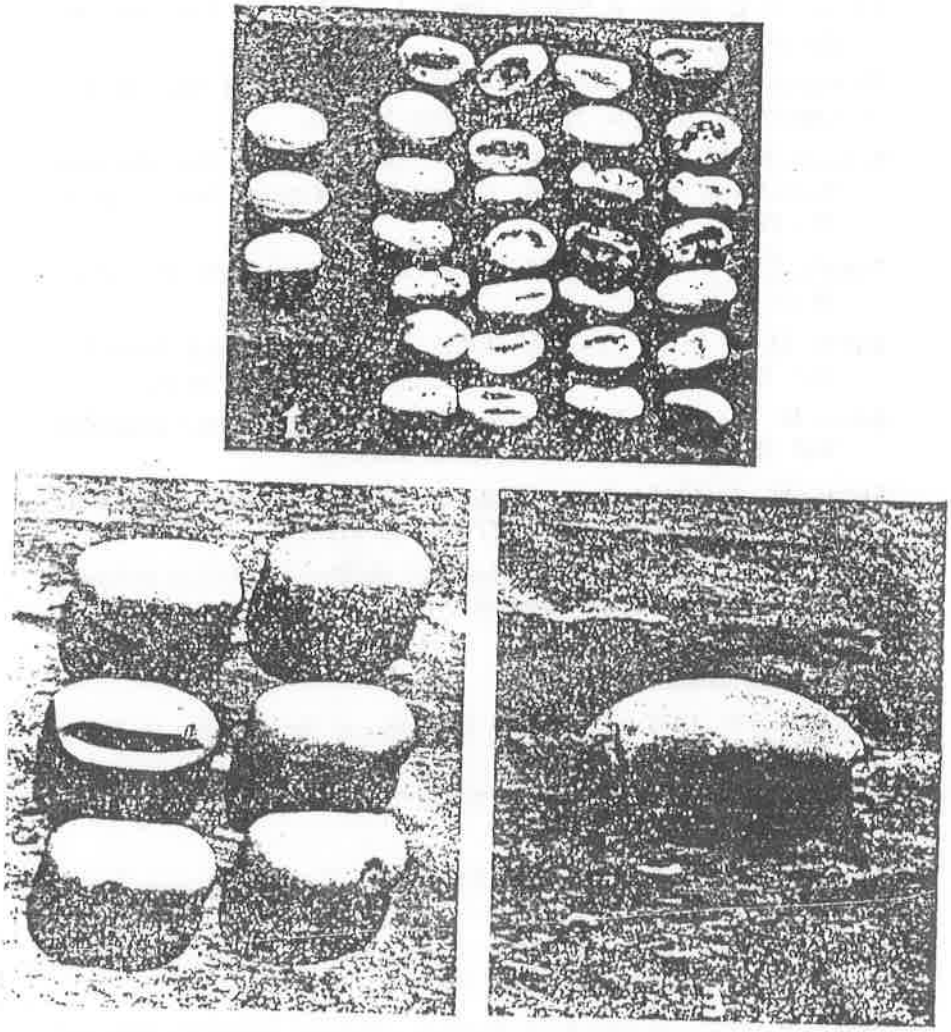
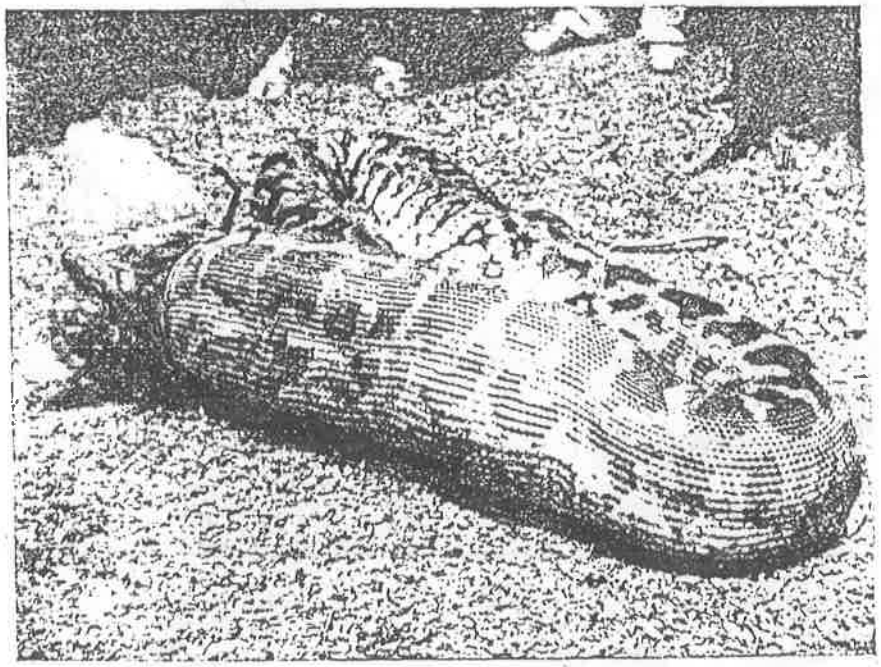
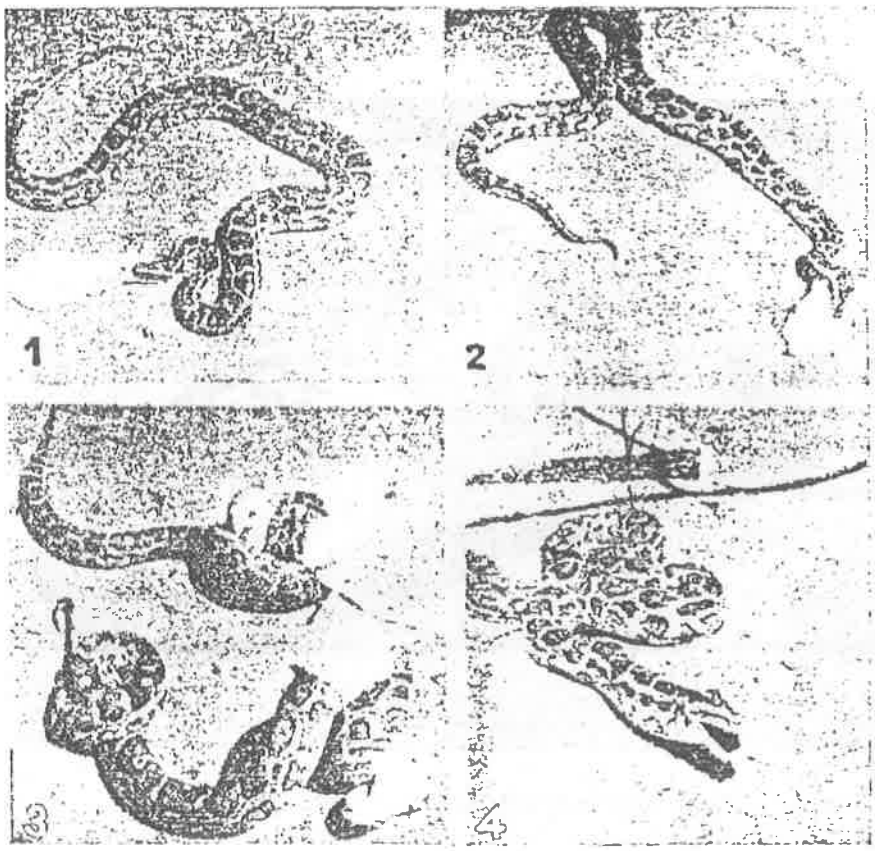


Fig. 1. Eggs of *Chameleon zeylanicus* (Laurenti)
Fig. 2. Eggs of *Ptyas mucosus* (Linn.)
Fig. 3. Egg of *Varanus salvator* (Laurenti)



Python molurus molurus Linn. swallowing a Cheetal.



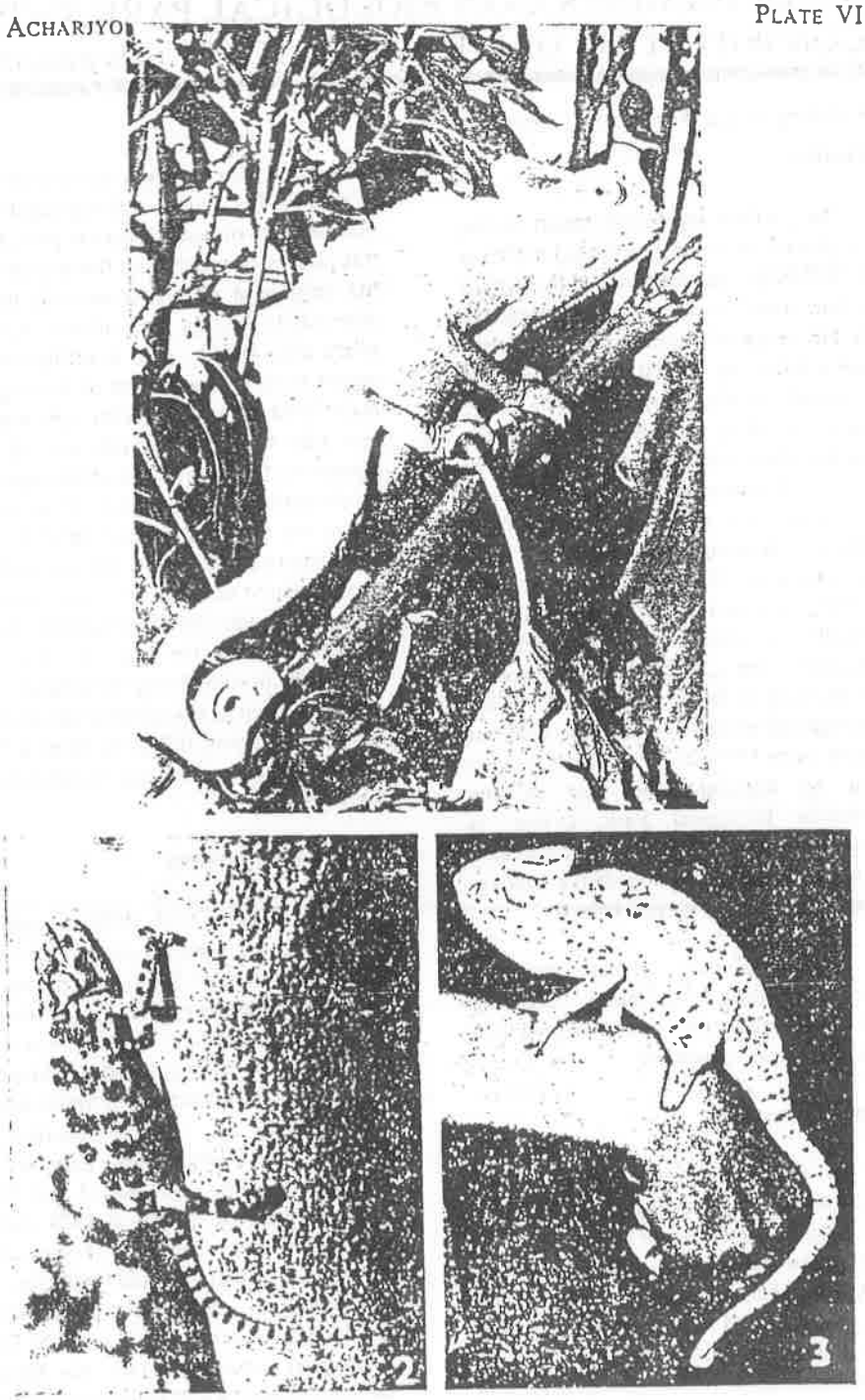
Four different poses of a young *Python molurus molurus Linn* in its food taking mechanism.

Fig. 1. Just caught the head of the prey.

Fig. 2. Progressing in its swallowing action.

Fig. 3. Coiling action on its prey.

Fig. 4. Gaping mouth action to facilitate further progress of the prey inside the gullet.



Figs. 1, 2. 3 *Chameon zeylanics* (Laurent) showing different colour changes.

ROLE OF NANDANKANAN BIOLOGICAL PARK, ORISSA, IN CONSERVATION OF THE GHARIAL *(Gavialis gangeticus)*

by L.N. Acharjyo, S.K. Kar and S.K. Patnaik

Introduction

The preliminary survey report on the status of gharial (*Gavialis gangeticus*) in Orissa by an FAO/UNDP consultant, Dr. H.R. Bustard during June 1974, indicated that this species was on the verge of extinction. At that time there were only five gharials (two males and three females) in Orissa State's Satkosia Gorge Sanctuary, and three sub-adult gharials at the Nandankanan Biological Park (FAO, 1974). The report further suggested that as this species was rare in Orissa, every effort should be made to breed the species in captivity, utilizing the three existing sub-adult gharials of the park after constructing a suitable breeding enclosure. Accordingly, a scheme was prepared and implemented by the State Forest Department for captive breeding of the gharials, as well as the two other species of Indian crocodilians present in the park since 1975-76. The present paper is intended to highlight the role of the Nandankanan Biological Park, Orissa, in conservation of the gharial through its breeding in captivity and rehabilitation of the captive-bred specimens in their natural habitat.

Details of the gharial breeding enclosure, breeding population, breeding success and rehabilitation of the captive-bred young ones are also described.

Breeding Enclosure

An area measuring 71 x 51m was utilized for the gharial breeding enclosure inside the park. A compound wall 2m high was erected all around the area, except for 30m on the viewer's side, where a dry moat and 0.5m high parapet was provided to prevent the escape of gharials and disturbance by visitors. An oval-shaped concrete pool measuring 60m long, 30m wide and 9.15m deep was constructed inside the enclosure. The pool has the capacity to hold 2.7 million liters of water. There is provision to fill this pool with water from the nearby lake with the help of a 40 horsepower electric pump. About 0.45 million liters of water is taken out every day, and the pool is refilled with fresh water; thus, a slow current of flowing water is maintained. There is a 2.40m high sandbank on one side of the pool with suitable riverine vegetation that gives the pool the appearance of a miniature Satkosia Gorge of the Mahanadi River, the ideal natural habitat of the gharials (Mohapatra et al., 1976). The enclosure was so constructed to fulfil the minimum requirements for breeding the species in captivity. During the breeding season, the enclosure was closed to visitors to minimize the disturbances. Special care was taken to always keep the water level of the breeding pool full to the brim to facilitate easy movement of the egg-laying females onto the sand bank.

Breeding Population

On February 13, 1976, the three resident gharials in the park - a male (2.7m) and two females (2.5m and 2.65m), were introduced into the pool for breeding purposes (Mohapatra *et al.*, 1976). At that time, the male was estimated to be about 16 years old, and the females about 12-13 years old (Bustard and Moharana, 1985). On February 20, 1979, a sub-adult female gharial from Trivandrum Zoo in Kerala, measuring 2.3m, was added into the pool. Subsequently, on January 4, 1979, three more sub-adult females born in 1975 (measuring 1.5-1.8m) were introduced. And finally, on January 11, 1980, an adult male measuring 3.7m, obtained as a breeding loan from the Frankfurt Zoological Society, Germany, was released into the pool (Bustard and Moharana, 1985).

The resident male suffered a prolapse of the genitals and cloaca for several minutes during the 1977 and 1978 breeding seasons, which were successfully treated both times (Mohanty et al., 1980). Unfortunately, during the 1980 breeding season (January-February), the Frankfurt male became dominant, frequently aggressively chasing the resident male, resulting in its death in February (Bustard and Moharana, 1981). Thus, the breeding population consisted of the adult male from Frankfurt zoo and six adult and sub-adult females.

Breeding Success

The first successful breeding in captivity of gharial was recorded in this park in 1980 (Acharjyo, 1981). Subsequently, regular breeding involving 1-5 out of the 6 female gharials in the breeding enclosure has been observed. Details of the breeding results recorded from 1980 to 1994 are given in the table below.

Month/Year	No. of egg-laying females (No. of clutches)	Total no. of eggs laid (Range of clutch size)	Month of hatching	Total no. of hatchlings	% of hatchlings during the year
March/1980	1 (1)	25 (25)	May	24	96
March*/1981	1 (1)	5 (5+)	Eggs did not hatch	Nil	0
March/1982	2 (2)	55 (27-28)	May/June	25	45
March/1983	3 (3)	34 (5-15)	May	22	65
March/1984	4 (4)	117 (27-33)	May	107	91
March/1985	5 (5)	138 (12-35)	May	105	76
March/1986	5 (5)	157 (25-36)	May/June	118	75
March/1987	5 (5)	140 (15-37)	May/June	93	66
March/1988	5 (5)	118 (2-42)	May/June	101	86
March/1989	5 (5)	179 (32-46)	May/June	163	91
March/1990	4 (4)	155 (36-43)	May/June	75	48
March/1991	5 (5)	205 (36-50)	May/June	139	68
March/1992	5 (5)	207 (31-51)	May/June	155	75
March/1993	3 (3)	145 (47-51)	May	79	54
March/1994	4 (4)	152 (21-57)	May	29**	19
Total	57 clutches	1,832		1,235	

**not recorded, but probably in March*

***112 eggs were taken by predators*

As can be seen from the Table above, a total of 1,872 eggs were laid in 57 clutches by six females over the 15-year period from 1980-1994. Each female laid one clutch of eggs per annum. The number of females that laid eggs during each breeding season were as follows: 1980 and 1981: 1; 1982: 2; 1983 and 1993: 3; 1984, 1990 and 1994: 4; 1985, 1986, 1987, 1988, 1989, 1991 and 1992: 5. Although all six adult females were in the egg-laying stage, in no year did all six lay eggs at the same time. The clutch size varied from 2-57 eggs, with a mean of 32.14. The eggs were always laid during March and hatched in May or early June. Out of 1,832 eggs laid, 1,235 hatchlings were born, giving a hatching percentage of 67.41.

Rehabilitation Programme

So far, 331 captive-bred and reared gharials (yearlings/juveniles) from the park measuring over 1.0m in length have been released in different locations in Mahanadi River of Satkosia Gorge Sanctuary between October, 1986, to July, 1993 as detailed below:

Date of release	No. released
24.10.1996	35
07.01.1987	36
04.04.1987	60
04.10.1987	65
14.10.1987	03
06.11.1989	60
21.07.1993	72
Total	331

Besides serving the rehabilitation programme, the park was also able to meet the demands of different captive rearing facilities located in India, as well as abroad. So far, 74 captive-bred juvenile gharials have been supplied, either on a sale or exchange basis, to several places including the Forest Department, Tripura; Forest Department, Arunachal Pradesh; Madras Crocodile Bank; Madras Snake Park; and zoological parks at Vandalur (Madras), Baroda, Junagarh, Bombay, Mysore, Bokaro, Pune, Trivandrum, Trichur, Bhilai, and Singapore.

Discussion

Gharials have been successfully bred at the Nandankanan Biological Park since March, 1980, and continues to be an annual occurrence. The park's gharial breeding enclosure fulfills the requirements of three key factors found in the gharial's natural habitat, i.e. a deep pool, flowing water, and a high nesting bank (Bustard and Moharana, 1985). Proper day-to-day management and feeding practices, coupled with health care, have facilitated the successful breeding of the animal. Since the park lies within the range of distribution of the species, no special arrangements for control of climatic factors are needed.

The clutch size of the 12 nesting female gharials in the Chambal area ranged from 10-64, with an average of 42 (Whitaker and Basu, 1982). According to Daniel (1983), the clutch size of the species varies from 10-96, with an average of 40.

The percentage of hatching success of gharial eggs collected in Uttar Pradesh during 1975-1980 varied from 55.3% to 88.8% (Whitaker and Basu, 1982), whereas at Tikarpada in Satkosia Gorge Sanctuary, the hatching success was 53% (Singh, 1976), against 67.41% in the present park study.

The first recorded release of into the wild of a captive-reared gharial hatched from an egg collected from the wild took place at Tikarpara in Satkosia Gorge Sanctuary (Orissa) in April, 1977 (Das, 1981). So far, 609 juvenile gharials have been released into the Mahanadi River of Satkosia Gorge Sanctuary, including 331 animals from the Nandankanan Biological Park.

Conclusion

The basic objective of gharial conservation through captive breeding and rehabilitation of the captive-bred specimens in their natural habitat, has been successfully achieved at the Nandankanan Biological Park, Orissa, as per the programme conceived by the

State Forest Department in 1975-76.

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References

Acharjyo, L.N. 1981. Cited by Groombridge, B. (1982) in the **IUCN Amphibia-Reptilia Red Data Book Part I,** pp.405-413.

Bustard, H.R. and S. Moharana. 1981. **Fatal male-male conflict in the Gharial,** *Gavialis gangeticus* **(Gmelin)** (Reptilia, Crocodilia). 78(1):171-173.

Bustard, H.R. and S. Moharana. 1985. **Captive breeding of the Gharial (*Gavialis gangeticus*).** *Asra - The Journal of the Association for the study of Reptilia and Amphibia* 2(4):23-45.

Daniel, J.C. 1983. **The book of Indian** Reptiles. Bombay Natural History Society. Bombay, pp.15-16.

Das, G.M. 1981. **Conservation and research** on Gharial in Orissa. *Indian Forester*, 107(1):42-50.

FAO. 1974. **A preliminary survey of the prospects for crocodile farming (based on the work of Dr. H.R. Bustard).** FO:IND/74/04.

Mohapatra, S., Acharjyo, L.N. and B. Mishra. 1976. **Catching and transferring adult Gharials (*Gavialis gangeticus*).** Indian Forester, 102(9):636-637.

Mohanty, J., Tripathy, S.B., Acharjyo, L.N., Pradhan, P.C. and B. Mishra. 1980. **Prolapse of the genitals, including prolapse of cloaca in male Gharial (*Gavialis gangeticus*): A clinical case report.** Indian Vet. J. 57(4):347-349.

Singh, L.A.K. 1976. **Rearing Gharial in captivity.** *Newsletter of the Madras Snake Park Trust and Conservation Centre*, 1(2):5-6.

Whitaker, R. and D. Basu. 1982. **The Gharial (Gavialis gangeticus) - A review.** *J. Bombay Nat. Hist. Soc.*, 79(3):531-548.

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ASPECTS OF REPRODUCTION AND GROWTH OF THE INDIAN PYTHON, PYTHON MOLURUS MOLURUS, IN CAPTIVITY

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The 3 Indian pythons described have lived in Nandankanan Biological Park, Orissa, India for 3 to 5 years. They are housed with 4 others in an outdoor enclosure (area 5.25 x 4.50 metres; height 1.45 metres). The floor is sandy; there are a few bushes and a spacious water tank. The top is partially covered by a thatched roof and a chainlink mesh. The sides include a chain-link mesh wall and a rough wall embedded with stone pieces.

Despite maintaining a collection of *Python molurus molurus* for 13 years no previous matings or egg laying occurred. The Indian python periodically lays eggs in zoos but this has seldom been recorded in India—the natural habitat. In the present case actual mating, the gestation period and incubation and the growth of 11 to 14 of the young were followed in the natural environment; for the park is within range of the species and locally caught individuals are kept here for a full year.

Mating: Mating was observed on 4 and 5 February, 1974. The matings, seen once a day in the morning, each lasted for about an hour. The female was 435 cm long; the circumference at the thickest part was 45.5 cm and she weighed 33.5 Kg. The male was much smaller; 288 cm long; the circumference at the thickest part was 28 cm and he weighed 10.6 Kg.

Gestation Period: The female of the previous pair laid 53 eggs on 28 April 1974. The gestation period was 82-83 days.

Egg-Laying: Egg-laying was not observed; presumably eggs were laid in the early morning. Eggs were white and leathery and adhered to one another in a gum-like mass. Four of the 48 normal eggs were 8.0-8.6 cm long x 5.4-5.5 cm broad and each averaged 150-172 grams in weight. There were also 5 small abnormal eggs, of light brown colour and one of them measured 6.6 x 4.4 cm and weighed 60 grams.

Another female, (smaller than the first), whose mating was not seen, laid 19 eggs on 2 May 1974, of similar colour and texture. 13 white eggs measured 7.9-9.9 cm x 4.9-6.8 cm and weighed 150-178 grams; 6 abnormal light brown coloured eggs measured 2.4-7.5 cm x 2.1-4.5 cm and weighed 10-75 grams.

Incubation: Pythons brood their eggs and remain coiled round them till they hatch (Smith, 1943).

The female remained coiled round the eggs, its head at the top kept in such a way that no egg was visible. She resented the approach of any one. The frequent jerking body movements at this time may be a muscular function raising body temperature to facilitate egg incubation (Bustard, *Pers. comm.*).

On 22 June 1974 the python exposed her eggs in the middle and coiled all around the eggs. Eggs began to crack and some newly hatched python heads appeared through the openings. The mother moved her head in the direction of the keeper when approached. The first young hatched on 23 June 1974 and the last ones on 25 June 1974. The incubation period was 56-58 days.

The second python unfortunately discontinued incubation during the fourth week; all the eggs died.

Before final hatching at frequent intervals some young pythons poked their heads and anterior part of their bodies out of the egg for distances of up to 10-30 cm. They retreated into the shell at the slightest disturbance. Complete emergence of a hatchling took about 10 minutes. 38 young hatched from 53 eggs laid (71.7%). Examination on 25 June 1974 of the rest of the eggs revealed that 4 embryos had died at various stages of development; 5 eggs showed no signs of development and were assumed to be infertile and 6 fully formed dead embryos, with unabsorbed yolk failed to emerge.

Behaviour of the Brooding Female: Throughout the incubation period the mother refused food though this was frequently offered. After the incubattion period on 30 June 1974 she accepted her usual food of live fowl. Only once was she seen near the water tank. She resented removal of the empty egg shells and spoiled eggs, even at the termination of hatch on 26 June 1974. She sloughed on 4 April 1974 3 weeks before laying and on 30 June 1974, 5 days after completion of incubation. No sloughing occurred during the entire period of incubation. The inter-sloughing period of this female (May, 1973 to August, 1973, when not incubating eggs) was 40-41 days.

Hatchlings: Soon after emerging from the egg the young moved over the mother's body and adjacent areas. She showed no interest in the newly

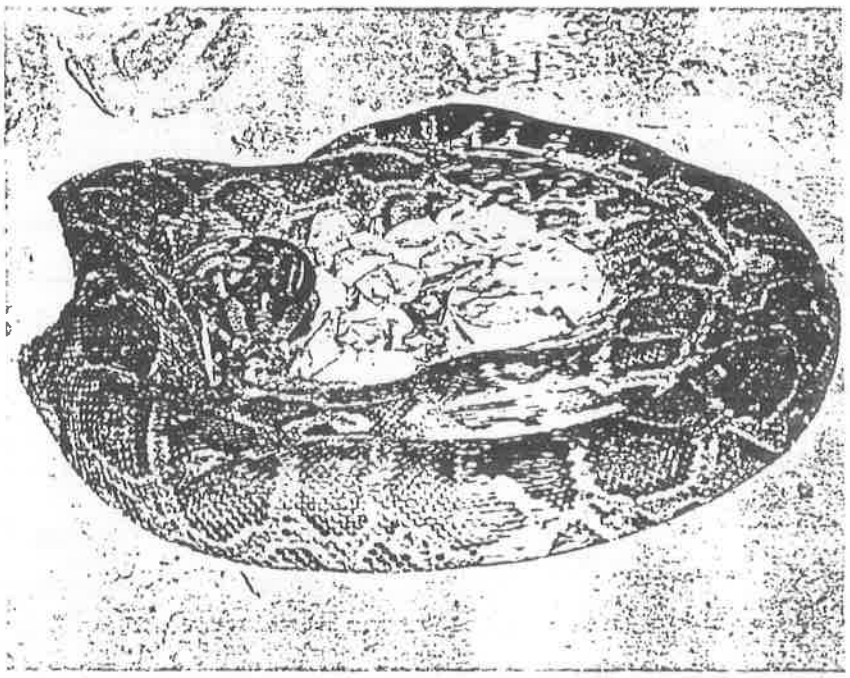

FIG. 1. A mother Indian python in an advanced stage of incubation (24 June 1974). Some empty shells and heads of young pythons are seen poking out of the egg shells.

FIG. 2. A young Indian python seen in the process of swallowing its bird prey.

hatched young. After hatching the young were 58.5-66.5 cm long and weighed 77-103 grams.

One newly hatched python took a small live bird on 26 June 1974 constricting it exactly as in the adult. First sloughing by the newly hatched pythons occurred from 5 July 1974 to 8 July 1974 when they were about two weeks old. They were separated from the adults and fed with small live birds e.g. house sparrows, munia etc, and albino rats though freshly killed ones are also readily taken.

Growth: There is great variation in size and weight, which probably relates to the quantity and frequency of ingested food (Table 1).

TABLE 1. Quarterly growth rate of young pythons to 1 year old.

Dates	Age in months	Sample size	Mean length (Range) cm.	Mean weight (Range) grams
23 June 1974 to 25 June 1974 (Date of hatching)	—	38	61.71 (58.5-66.5)	90.29 (77-103)
25 Sept. 1974	3	14	78.25 (65.5-85)	187.43 (82-265)
25 Dec. 1974	6	11	82.55 (72-90)	307.64 (215-395)
25 Mar. 1975	9	11	98.73 (83-109)	388.91 (232-535)
4 July 1975	12	11	136.41 (126.5-153)	942.91 (720-1535)

Within three and half months of hatching out of 38 young 17 died by (accidental) cannibalism through attacking each other; one died by asphyxiation while trying to escape; 3 escaped and 6 died mainly from starvation for they refused to accept food.

DISCUSSION

In northern India mating of *Python molurus molurus* occurs during hibernation (during the cooler months in northern India little activity occurs; Smith, 1943). Eggs vary slightly in size, some laid in a Berlin Aquarium averaged 120 x 60 mm. Up to 107 eggs can be laid and hatchlings average 73 cm long. In reptiles clutch size increases with increasing size of the female (Bustard, 1970, 1972).

The incubation period recorded (56.58 days) is about the same as that described by Deoras (1965), about 60 days.

The period of 1 to 2 days when young remain in the egg during hatching probably permits final absorption of the yolk sac. A similar phenomenon has been noted in crocodiles and gharials (Bustard, *Pers. comm.*).

An Indian Python at the Zoological gardens at Jaipur laid 48 eggs from which 23 young survived (*Anon*, 1965). Cannibalism is common in snakes; Russell's viper may eat its own young and two young vipers swallowed each other to death. In the laboratory an Indian python of unknown age grew 6-8 inches (15-20 cm) per year (Deoras, 1965). According to Street (??) there are many cases of snakes which do not normally feed on other snakes yet nevertheless eat their cage mates. Usually both snakes seize opposite ends of the same prey and as they approach one another, one engulfs the other.

In view of our hatchling losses it is important to ensure good husbandry and only a small number of young should be kept together. They should be fed simultaneously and a close watch kept during feeding, particularly during the first 4 to 6 months. However, even when one year old several pythons are often attracted to the same prey and constrict around each other. This does not occur with adults.

It is intended to rear a batch of these hatchlings to sexual maturity.

SUMMARY

Mating, gestation, egg-laying, incubation and behaviour of the brooding female, hatchlings and growth up to one year of the Indian python (*Python molurus molurus*) were observed in a natural environment at Nandankanan Biological Park, Orissa, India.

Mating occurred in the first week of February, the gestation period was 82-83 days; 53 eggs and 19 eggs were laid by 2 Indian pythons in the last week of April and first week of May respectively, 38 young hatched (from 53 eggs laid) in the first python in the fourth week of June, after an incubation period of 56-58 days. Soon after emergence hatchlings were 58.5-66.5 cm long and weighed 77-103 grams. The mother refused to feed though frequently offered food and did not slough during the period of incubation. 11 one year old hatchlings measured 126.5-153 cm and weighed 720-1535 grams.

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REFERENCES

ANONYMOUS (1965). Wildlife Bulletin of the Indian Board for Wildlife, New Delhi, No. 1, pp. 20.

BUSTARD, H. R. (1970). *Australian Lizards*, Collins, Sydney.

BUSTARD, H. R. (1972). *Sea-Turtles: Their Natural History and Conservation*, Collins, London & Sydney.

DEORAS, P. J. (1965). *Snakes of India*, National Book Trust, India, New Delhi.

SMITH, M. A. (1943). *The Fauna of British India*, Reptilia and Amphibia, Vol. III, Serpents, pp. 106-9, Taylor & Francis, London.

STREET, P. (??). *Animals in captivity*, Faber & Faber, London.

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STUDIES ON THE KING COBRAS OF ORISSA, INDIA

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Introduction

Studies on the king cobra (*Ophiophagus hannah*)—the world's longest and most venomous serpent—both in the wild and captive conditions have attracted the attention of herpetologists for long. However, a lot of unauthenticated information and even the observations of a casual nature have found a place in the accumulated literature on the subject. It is, therefore, encouraging to note that a scientific study of the biology of this serpent is being undertaken now in the Reptile Houses, Zoos, Biological and Snake Parks and such other places where the king cobras are maintained alive. The present account is based on long-term studies made on the king cobras received from different parts of the State of Orissa, India and maintained at Nandankanan Biological Park, 15 km off Bhubaneswar, the capital city of Orissa (see map). The only publications pertaining to the study of king cobras of Orissa are those by Behura (1966), Biswas *et al.* (1976), Mishra *et al.* (1976) and Acharjyo *et al.* (1978). It is hoped that the present account will stimulate an interest and further the study of the king cobra whose life history is imperfectly known.

Physiography of Orissa

The State of Orissa lies on the eastern coast of the Indian Peninsula and is situated approximately between 17° 49′ to 22° 34′ N and 81° 27′ to 87° 29′ E. The Bay of Bengal runs along the entire eastern belt of the State for a stretch of 480 km. The total land area of the State is 155,844 sq. km. out of which some 67,460.98 sq. km. amounting to 43.28 percent of the total geographical area of the State is forested. The State presents a diversified topography with mountains as high as Deomali (1673 M), hills, deep gorges, valleys, rivers, dense forests, mangrove forests and lastly the coastal man-made casuarina forests. The coastal belt is intercepted by many major and small rivers namely, Mahanadi, Brahmani, Baitarini, Subarnarekha, Budhabalang, and Rushikulya, all flowing from west to east and emptying into the Bay of Bangal. The State of Orissa is divided into thirteen districts for administrative convenience.

There are three well defined seasons—winter (November-February), summer (March—June), and rainy season (July-October). Rainfall is mainly derived from the SW monsoon and the annual rainfall of the State is 148 cm. with 75 rainy days in a year. The mean annual temperature is 32.5°C which rises to 41°C in April and May. The mean minimum temperature is 24°C which falls to 20°C—15°C in December and January.

Distribution of King Cobra in Orissa

The king cobra called "Ahiraj" or "Sankhachuda" in Oriya is recorded from the

mangrove forests of Bhitarkanika (Cuttack District), northern tropical semi-evergreen forests of Simulipal Hills (Mayurbhanj District), and the northern tropical moist deciduous forests (Keonjhar District). Behura (*loc. cit.*) reports its occurrence in Soleri Hills (Puri District). One of us (LNA) along with two other forest officials had chance encounters with a king cobra of 3 m near the Forest Rest House, Dangamal in Bhitarkanika area on the evening of May 13, 1978. Like all other snakes it had just disappeared into the bushes on being approached.

King Cobra Catchers of Orissa

The residents of a small village called Padmakesharipur in Patia area situated at a distance of 8 km off Nandankanan Biological Park are known as "Khera" locally and all of them are professional snake catchers cum charmers. They mainly catch and handle the king cobras and other kinds occasionally from all over the State, all meant for snake-shows only. They are always on the move in and outside the State eking out their livelihood by the display of their repertoire. The majority of the king cobras housed in the park are supplied by them.

Studies in Captivity

Specimens under study: Since June 1973, nine specimens taken from the various forested areas of Orissa have been received at the Nandankanan Biological Park for study. All the individuals under study were defanged by the suppliers soon after they were picked up probably as an advance precaution. The details of length

Table 1.

Sl. No.	Date of recording measurement and weight	Length in cm snout to vent	Length in cm vent to tail tip	Total length in cm tip to tip	Girth at the thickest part in cm	Weight in kg	Remarks
1	2	3	4	5	6	7	8
				of living specimens			
1	2. 6. 1973	—	—	390. 0	21. 0	6. 000	
2	1. 1. 1977	209. 0	41. 0	250. 0	16. 0	2. 370	
3	1. 1. 1977	222. 0	45. 0	267. 0	16. 0	2. 430	
4	16. 10. '78	308. 0	66. 0	374. 0	22. 5	4. 710	
5	1. 1. 1975	—	—	263. 5	14. 5	2. 050	
6	1. 11. '75	—	—	396. 0	21. 0	7. 000	
				of dead specimens			
7	10. 2. '81	171. 0	29. 0	200. 0	—	1. 500	Short blunt tail
8	10. 7. '81	220. 0	52. 0	272. 0	—	4. 200	
9	10. 8. '81	179. 0	40. 0	219. 0	—	0. 967	

and weight of the specimens under study are summarized in Table 1.

The foregoing table gives an idea of the normal size and weight of the king cobras of Orissa. The largest specimen measured 396 cm and weighed 7 kg. One of us (LNA) had the opportunity to encounter at least twenty other live king cobras at different times during the last 8 years in the company of the snake catchers but none appeared to exceed the length of the largest individual housed in the park. In the five specimens with normal tails, the tails were $\frac{1}{6}$, $\frac{1}{5.9}$, $\frac{1}{5.7}$, $\frac{1}{5.2}$, and $\frac{1}{5.5}$ of the total lengths.

The ground colouration of the specimens was olive green characterised by the white cross bars on the dorsum. The posterior one-third of the body was, however, almost black.

Smith (1943) comments that the king cobras rarely exceed 14 or 15 feet (420–450 cm) in length barring one exceptional individual from Siam (Thailand) which measured 18 ft. 4 in. (5.5 M). He adds further that the tail formed nearly one-fifth of the total length of this individual. Whitaker (1978) has given the average length of the king cobras as 3 m, maximum lengths as 5 m–6 m in the case of specimens from Thailand. Choudhury (1971) has recorded a female king cobra of 345 cm from the forests of Uttar Pradesh, India. Whitaker and Whitaker (1981) reported on their sighting of a 12 ft. (360 cm) long king cobra in the Western Ghats, South India. A press report published in the daily, 'The Statesman' of Calcutta dated August 1, 1971 mentions that a 16 ft. (480 cm) long king cobra was caught from the forests of Mayurbhanj District, Orissa. Gowda (1963) reports that these snakes generally vary in length from 11 ft. to 18 ft. (330 cm to 540 cm) in length with a girth of 1 foot (30 cm) at the thickest part.

Housing: The king cobras of the park are housed in a spacious semi-outdoor enclosure provided with a floor space of approximately 36 sq. metres which was raised to a height of 1.5 m. The rockeries with irregularly projecting stones, bushes, holes, dwarf bamboo clump, artificial tree trunk and a rugged stony wall formed the suitable background. A big water pond also was constructed inside the enclosure. The

floor was sandy while the roof covered with wire mesh was partly thatched. The enclosure was erected at a height of 0.8 m from the ground. On the viewer's side there was a double layered wire mesh with a vacant space of 30 cm in between to avoid any unforeseenable mishaps. During the winter the king cobra was found to emerge only after the sun had shone bright whereas during the summer when the mercury was shooting up, it was seen freely getting into the water. It was found on the whole to be more active during the early hours in the morning and again in the mid-day. Water was sprinkled regularly all over the enclosure to keep it cool even during the severe summer. Sometimes the snakes were seen climbing up the dwarf bamboo clump and the artificial tree trunk provided in the enclosure. Since the Park is ideally situated almost within the range of the species, the need for making further arrangements to maintain temperature and humidity never arose.

Food and Feedings: The king cobras of the park were usually fed with freshy killed non-poisonous snakes such as the checkered keelback (*Xenochrophis piscator*), the Rat Snake (*Ptyas mucosus*) and the Freshwater Snake (*Enhydris enhydris*) once a week but their intake was found to be poor during the cooler months and before skin-shedding. A large individual under study was seen swallowing the common cobra (*Naja naja naja*) housed in the same enclosure. As mentioned earlier, all the individuals of the park were devoid of their fangs and hence their preference for the freshly killed snakes. The snakes under study showed no interest in the Indian Chameleon (*Chamaeleo zeylanicus*) which was released as a possible prey. Also, attempts made to feed them with alternate food such as pigeons, bandicoots, rats, toads, and guinea pigs met with no success. Smith (*loc. cit.*) states that the king cobra's diet consists mainly of snakes—harmless and poisonous species—and it is not averse to devour snakes of its kind. He reports further about its attacks on pythons and includes the monitor lizards (*Varanus sp.*) in the dietary of the animal which is a deviation from its exclusively ophidian food.

The king cobra catches the food snake a few centimetres away from the head and then slowly extends its grip towards the head and then commences the act of swallowing with the head first. Gowda (*loc. cit.*) states that the king cobras of Mysore Zoo, India when hungry approach the prey, bite it and inject venom sufficient to make the prey unconcious but not to kill it, then they begin to swallow the food snake entirely from the head region. The time taken for swallowing a snake seemed to depend on several factors such as the length and size of the food snake, the time of feeding and the actual mood and appetite of the animal. Whitaker (*loc. cit.*) stated that the king cobra takes on an average 15 minutes to kill a large sized rat snake and it suffocated its prey by striking at its throat and probably envenomating it as well in the process.

Skin sloughing: Two apparently healthy adult king cobras maintained in the Park were kept under regular observations for skin sloughing for a period of 21 months from February, 1976 to October, 1978 and the data thereof are summarized in Table 2.

A study of the table reveals that each specimen has sloughed for as many as 17 times during the period of 21 months of observation. In the first specimen the inter-sloughing period varies from 21 to 112 days with a mean of 34.7 days. In the sec-

Table 2.

Sl. No.	Dates of last sloughing	Dates of subsequent sloughing	Intersloughing period in days	Sl. No.	Dates of last sloughing	Dates of subsequent sloughing	Intersloughing period in days
1	2	3	4	1	2	3	4
	SPECIMEN I				SPECIMEN II		
1	5. 3.77	22. 4.77	47	1	11. 2.77 & 12. 2.77	22. 3.77	37
2	22. 4.77	25. 5.77 & 26. 5.77	32	2	22. 3.77	4. 5.77 & 5. 5.77	42
3	25. 5.77 & 26. 5.77	19. 6.77 & 20. 6.77	23	3	4. 5.77 & 5. 5.77	30. 5.77 & 31. 5.77	24
4	19. 6.77 & 20. 6.77	12. 7.77	21	4	30. 5.77 & 31. 5.77	29. 6.77 & 30. 6.77	28
5	12. 7.77	19. 8.77 & 20. 8.77	38	5	29. 6.77 & 30. 6.77	14. 8.77	44
6	19. 8.77 & 20. 8.77	15. 9.77	25	6	14. 8.77	9. 9.77	25
7	15. 9.77	12.10.77 & 13.10.77	26	7	9. 9.77	3.10.77 & 4.10.77	23
8	12.10.77 & 13.10.77	18.11.77 & 19.11.77	35	8	3.10.77 & 4.10.77	8.11.77	34
9	18.11.77 & 19.11.77	12. 3.78 to 14. 3.78	112	9	8.11.77	7. 3.78 to 9. 3.78	118
10	12. 3.78 to 14. 3.78	2. 5.78 & 3. 5.78	48	10	7. 3.78 to 9. 3.78	26. 4.78 to 29. 4.78	47
11	2. 5.78 & 3. 5.78	27. 5.78 & 28. 5.78	23	11	26. 4.78 to 29. 4.78	21. 5.78 & 22. 5.78	21
12	27. 5.78 & 28. 5.78	21. 6.78 to 24. 6.78	12	12	21. 5.78 & 22. 5.78	29. 6.78 & 30. 6.78	37
13	21. 6.78 to 24. 6.78	17. 7.78	22	13	29. 6.78 & 30. 6.78	22. 7.78	21
14	17. 7.78	14. 8.78 & 15. 8.78	27	14	22. 7.78	23. 8.78 & 24. 8.78	31
15	14. 8.78 & 15. 8.78	11. 9.78	26	15	23. 8.78 & 24. 8.78	13. 9.78 & 14. 9.78	19
16	11. 9.78	9.10.78	27	16	13. 9.78 & 14. 9.78	15.10.78	30

ond specimen the inter-sloughing period varies from 19 to 118 days with a mean of 36.3 days. Sloughing has been regular throughout the year except during the winter months of December and January. Mishra *et al.* (*loc. cit.*) observed that during a brief period of 7 months from June, 1973 to December, 1973 the king cobra sloughed its skin thrice in June, September, and October. Acharjyo *et al.* (*loc. cit.*) report that the sloughing in this species in more frequent during the summer months i.e. May to mid November than in the cold season. The inter-sloughing period in two specimens for a period of 25 months varied from 17 to 104 days (mean 35.70 days) and from 17 to 84 days (mean 35.60 days) respectively. The entire process of skin sloughing commencing always at the tip of the nose was completed in a single day or it lasted four days consecutively. The skin of the head region was sloughed with the eye caps intact or broken along with the skin of the rest of the body in loose shreds. Gowda (*loc. cit.*) states that the king cobras in captivity go on sloughing their skins frequently and that after each discard a layer will form like a cap on the eyes and as they are sticky they are not generally peeled off along with the rest of the skin and suggests that these caps are to be removed carefully with the aid of fine forceps and scalpel. The lack of natural conditions such as ponds, drains, thorny bushes and rough crevices in the enclosures of these snakes might be responsible making the snake to slough in a natural way. However, the snakes maintained at the Nandankanan Biological Park did not experience this inconvenience as the enclosure provided them a suitable habitation.

Just before sloughing the colouration of the king cobra turned dull and became almost black and the conspicuous visible white stripes have either faded out or became invisible. While the snake was sloughing its skin, it became inactive and lacked appetite. However, it became active, returned to its characteristic colouration and showed signs of hunger once the process is over.

Table 3.

Date of recording measurement and weight	Length tip to tip in cm	Weight in kg
1. 1. 1975	244	1. 570
1. 1. 1977	250	2. 370
1. 1. 1978	254	3. 565
1. 1. 1979	257	3. 440
1. 1. 1980	260	3. 625
1. 1. 1982	268	3. 875

Growth: The growth rate and weight of one adult female king cobra for a period of 7 years were summarized in Table 3.

The table indicates that the total increase in the length of a specimen in the course of seven years was only 24 cm (mean 3.4 cm per year) and the addition to its weight was only 1.995 kg (mean 0.285 kg per year).

According to Whitaker and Whitaker (*loc. cit.*) the baby king cobras soon after hatching at Madras Snake Park measured 45 cm, and that after one year their average was 1.5 m and three years later a larger male attained a length of 3 m. Smith (*loc. cit.*) gives the length of the young king cobras at the time of birth as 500 mm to 530 mm.

Longevity: Of all the specimens under study, only two individuals have survived for over four years in the Park. One specimen was 4 years, 5 months and 12 days when it died. One specimen is still surviving since December 2, 1973 thus establishing a record of life span among the king cobras in captivity at least as far as the

survival periods of these snakes in the Zoos of India are concerned. Gowda (*loc. cit.*) opines that usually the king cobras do not thrive well in captivity and Whitaker and Whitaker (*loc. cit.*) suggest that the king cobras caught as adults do not live long in captivity.

Behaviour: The freshly caught individuals were found to be more aggressive in disposition than the specimens kept in captivity.

Two female king cobras housed together in the same enclosure displayed agonistic behaviour towards each other. At times both the specimens reared up to their menacing lengths while simultaneously expanding their hoods. Then they came face to face and struck at each other which appeared to be a real fight. Then followed the act of intertwining of their bodies and rolling on the ground. As if to complete the fighting act, one of them caught hold of the upper jaw of the other in its mouth while the other caught hold of the lower jaw of its rival. The situation then became too bad when the services of the park's snake keeper (who incidentally hails from a family of the professional king cobra catchers) to separate the fighting reptiles. Mishra *et al.* (*loc. cit.*) report the similar behaviour displayed by the king cobras of this park.

Conservation of King Cobras of Orissa

The Indian Wild Life (Protection) Act, 1972 has afforded conservation of the king cobras of Orissa and it is gratifying to note that the State Forest Department has set up a wing to protect the wild life of Orissa.

The Bhitarkanika Sanctuary (141 sq. km) which incidentally is one of the best king cobra habitats of the State has been gazetted as a sanctuary for affording total protection to the king cobra and a host of other equally endangered reptiles like the Water Monitor, Estuarine Crocodile and Sea Turtles. The Simulipal Hills and the valleys around with an area of 303 sq. km are also declared as a sanctuary to provide protection to several species of wild life which naturally include the king cobra. While these are welcome signs ensuring a fresh lease of life to the king cobras, the real protection of these creatures can be accomplished by putting an end to the gradual destruction of their habitat in Orissa and elsewhere.

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References

1) Acharjyo, L. N., Mohapatra, S. and Mishra, B. (1978): The skin sloughing of king cobra, *Ophiophagus hannah* (Cantor) in captivity. *J. Bombay nat. Hist. Soc.*, 75(1): 234–236.
2) Behura, B. K. (1966): Snakes of Orissa (Oriya script). Zoological Society of Orissa, Cuttack, pp. 91–112.
3) Biswas, S., Acharjyo, L. N., and Misra, R. (1976): On the feeding habits of the king cobra, *Ophiophagus hannah* (Cantor) at Nandankanan Biological Park, Orissa. *J. Bombay Nat. Hist. Soc.*, 73: 225–226.
4) Choudhury, S. R. (1971): The King Cobra. *Cheetal*, 14(1): 48–49.
5) Gowda, C. D. Krishne (1963): Rearing of the King Cobra in Captivity. The Hindu, Madras (Sunday Edition, July 21, 1963).
6) Mishra, R., Acharjyo, L. N. and Kumar, H. S. (1976): Some observations on the king cobra (*Ophiophagus hannah*) at Nandankanan Biologi Park, Orissa. *Indian Forester*, 102(3): 189–190.
7) Smith, M. A. (1943): *The Fauna of British India, Reptilia and Amphibia*, 3, Serpentes: 436–439.

8) Whitaker, R. (1978): Common Indian Snakes —A Field Guide. pp. 61-63 (Macmillan Company of India, Madras).
9) Whitaker, R. and Whitaker, Z. (1981): The Real King of the Jungle. Indian Wild Life, 1(1): 8-13.

要　約

インド，オリッサ州におけるキングコブラの研究

L.N. Acharjyo[1] and T.S.N. Murthy[2]

オリッサ州は，インドの東海岸に位置し，ベンガル湾に面している。全域の43%は森林になっている。キングコブラは，ビタルカニカのマングローブ林と，北部の熱帯性亜常緑林，熱帯性落葉林，ソレリヒルの4ケ所に分布している。

1973年6月以降，9個体のキングコブラがオリッサ州のさまざまな森林から，ナンダンカナン動植物園にもたらされた。これらの長さや重さは表1に示された。最大の個体で，全長 396 cm，体重 7 kg だった。背面はオリーブグリーンの地に白い横帯があり，体の後部 1/3 はほとんど黒色だった。

同園のキングコブラは，広さ 36 m², 高さ 1.5 m の半野外式の飼育場で飼育された。場内には岩や，竹ヤブ，擬木などと大きな池が作られている。一般に早朝と昼ごろに活動が見られた。エサとしては，ヘビ類の新鮮な死体が与えられた。カメレオンが放されたが食べることはなく，ハトやネズミなども食べられなかった。

2個体のキングコブラについて，21ケ月にわたり，脱皮の周期が調べられた(表2)。期間中にそれぞれの個体で17回の脱皮があり，間隔は 19-118 日，平均して，34.7と36.3日だった。これは冬期 (12-1 月) をのぞくと規則的だった。

ある1個体の7年間の成長が表3に示されたが，全長は 24 cm，体重は 1.995 kg の増加だった。また9個体のうち4年以上生きたのは，2個体だった。捕獲されたばかりのキングコブラは攻撃的で，2頭のメスが互いにかみあうようなケースも見られた。

ビタルカニカとシムリパルヒルの2ケ所のキングコブラ生息地は，聖域として，森林自体が保護されるようになった。

1) Nandankanan Biological Park, Orissa. 2) Zoological Survey of India, Madras.

Explanation of Figures

PLATE-1

Fig. A. A king cobra with its raised hood.
Fig. B. Shri Purna Chandra Das, a professional snake catcher who was one time snake keeper of the park handling a king cobra.

PLATE-2

Figs. A-D. A king cobra feeding on the water snake (*Xenochrophis piscator*). (A complete sequence in four stages).

PLATE-3

Fig. A. A freshly caught king cobra rearing up when disturbed.
Fig. B. Two female king cobras displaying agonistic behaviour in captivity.

PLATE-1

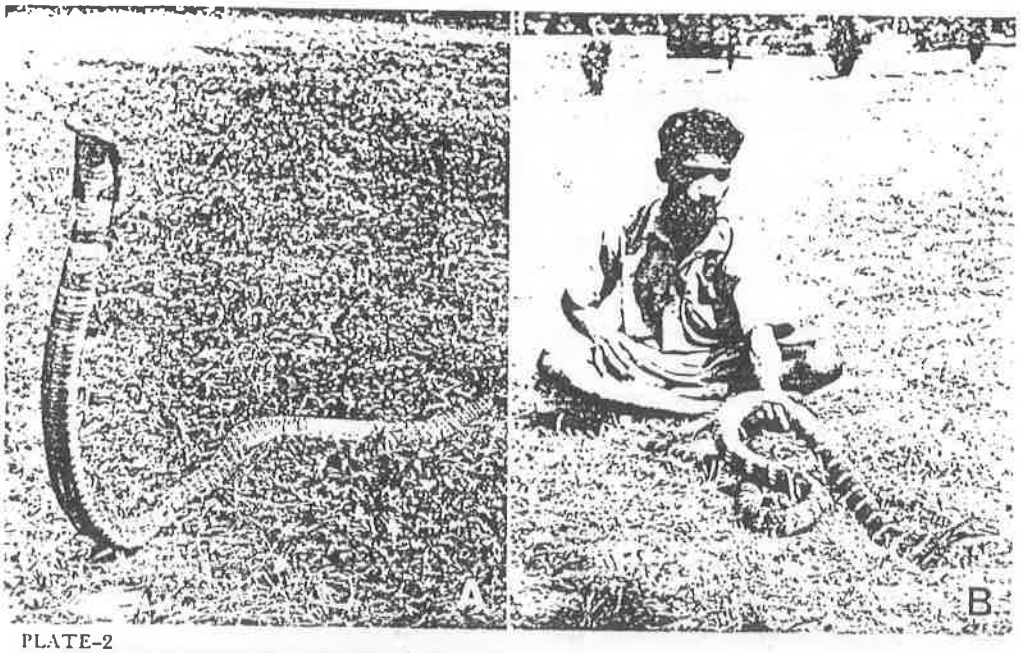


PLATE-2

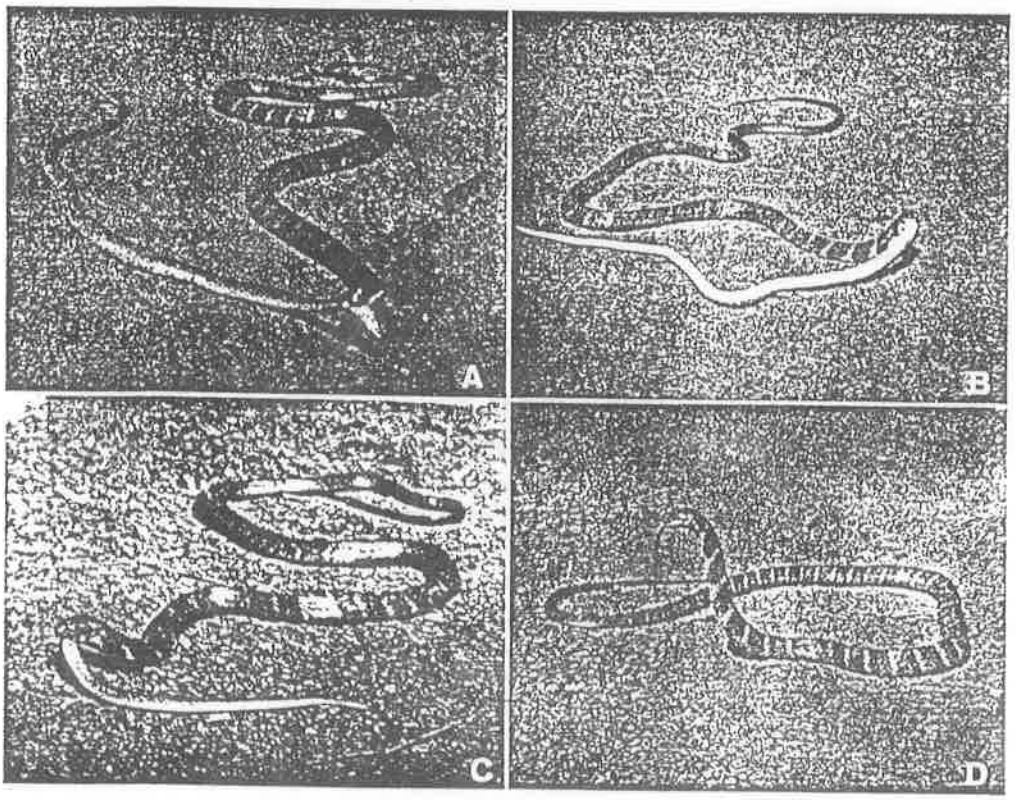
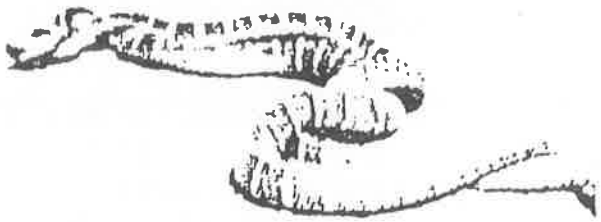


PLATE-3



B

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