WILD LIFE ECOLOGY

ZOOLOGICAL SURVEY OF INDIA

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Proceedings of the Workshop
on

WILD LIFE ECOLOGY

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FOREWORD

Since the turn of the 20th century as many as three species of birds and one species of mammal have ceased to exist in India alone. Another 18 species of reptiles, 46 species of birds and 76 species of mammals are facing the same fate. It is true that no animal or plant species is everlasting, and that none has yet existed for more than a few million years without evolving into something different or going extinct. The process of extinction has been usually slow in the historic past, but the pace of extinction of species in the recent times is alarmingly rapid. This phenomenon can be directly or indirectly attributed to the ruthless and thoughtless exploitation of natural resources by Man for his own survival and well-being. Wildlife, a natural resource, and renewable one at that, appears to have borne the brunt of Man's so called development activities. Not only the population of individual species has gone down drastically, but also their habitat has either shrunk or is being systematically made unfit for human use.

Although the matter of conservation of wildlife has been receiving the attention of the Government of India since the British times, yet a lot remains to be done. The National Government, since Independence in 1947, have brought in a number of legislations for conservation of wildlife, but these are hardly effective because of inadequate enforcement machinery and appreciation by the general public. Even the literates and intelligentsia of the country exhibit a profound lack of interest in this subject. Scientific researches on various problems on wildlife conservation still remains a far cry.

It was primarily to popularise the cause of wildlife conservation that the Zoological Survey of India organised this Workshop. It was considered imperative to involve the universities, in such a venture. The University Grants Commission not only very kindly agreed to sponsor 20 University teachers for the purpose but also spared Dr. Shanker Narayan, its Additional Secretary, to deliver the focal theme address. The Forest Research Institute and Colleges at Dehra Dun showed a keen interest in the organisation of such a workshop and offered to host it. The Workshop was finally held at the Forest Research Institute and Colleges, Dehra Dun, under the joint auspices of the Zoological Survey of India, the University Grants Commission and the Forest Research Institute and Colleges, Dehra Dun, from 9 to 11 January, 1978.

The universities responded wonderfully by delegating members of their faculties to the Workshop. The wildlife departments of the various States also responded equally warmly. The result was the Workshop was attended by 88 participants (and observers) who presented 39 papers, covering various aspects of the ecology of wildlife in India. A few papers could not be accommodated due to certain limitations, but a major part of the contributed papers have been included.

The credit for the excellent organisation and success of the Workshop undoubtedly goes to the local Secretaries, Dr. B. S. Lamba, Deputy Director, Northern Regional Station, Zoological Survey of India, and his band of dedicated colleagues, and to Shri Pratab Singh, Senior Scientific Officer of the Forest Research Institute and Colleges.

The Proceedings are now before you. I am sure that along with the abstracts of papers issued at the time of the Workshop it will make an interesting reading both for those interested in the subject and the laymen alike.

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Calcutta 700 012
Dated : 28th August, 1981

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SOME OBSERVATIONS ON 'MUSTH' IN WILD INDIAN ELEPHANT, *ELEPHAS MAXIMUS* LINNAEUS

By
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(2 Plates)

Abstract

The phenomenon of '*musth*' in elephants, in spite of its fascination, is still shrouded in a veil of obscurity. In its external manifestation it consists of periodical bouts of excitement to which elephants, both tame and wild, are subjected to, on attaining a certain age Though generally characteristic of the male, the female may also occasionally pass through the *musth* stage. The duration of *musth* may last from a few weeks to as long as five months. Three cases of *musth* in wild bull elephants were observed one each in Betla National Park, Jaldapara Wild Life Sanctuary and Bandipur Tiger Project area. The extraordinary sexual behaviour is not necessarily correlated with the period of *musth* in elephants

I. Introduction

The phenomenon of *musth* in elephants, in spite of its fascination, is still shrouded in a veil of obscurity. In its external manifestation it consists of periodical bouts of excitement to which elephants, tame and wild, are subjected to on attaining a certain age. Though generally characteristic of the male, the female may also occasionally pass through the *musth* stage.

According to Fernando *et al* (1963:108) the histological structure of temporal gland consists of compound tubular alveoli interspersed within a loose connective tissue matrix, which is separated into numerous lobes by septa of dense connective tissue. Structurally the gland is identical with the temporal gland of African elephant (*Loxodonta africana* Blumenbach) and its development is similar to that of mammary gland confirming a common origin with apocrine sweat glands (Estes & Buss, 1976:435).

Sanderson, G.P. (1878) observed full *musth* twice in the newly caught wild cow elephants, and he believed that this condition never occurred in tame cows. But Gee (1964:33) has mentioned several cases of tame cow elephants being effected by *musth*, and Krishnan (1972:297) speaks of instances of such occurrence among wild cows as well.

During such an excitement the temporal glands give off unusual amount of an oily tar-like secretion that has a strong, somewhat offensive odour, which in extreme cases flows down staining a portion of the animal's cheeks. According to Sanderson, G.P. (1878) and Sanderson, I.T. (1960:327), the duration of *musth* may last from a few weeks to as

long as five month. A reputed elephant-trapper, Shri Prakritish Chandra Barua (commonly known as 'Laljee') cited an example of one of his captive tuskers, named 'Partab Singh', which used to be in *musth* for a period of over five months (personal communication.) During the *musth* condition, 'Partab Singh' neither posed any danger to his attendants nor sought company of a mate.

Most of the recent workers, such as Sanderson, I.T (1960:326), Gee (1969:33), Krishnan (1972:247) and Eisenberg *et al* (1971:197) seem to agree tnat *musth* is not primarily a sexual manifestation, although it may result in such actions in the bull elephants that may appear to have sexual significance. It can not be correlated with any cyclical sexual urge on the part of either the bull or the cow. Jayasinghe and Jainudeen (1970:63) reported that *musth* never appears in captive bulls under 10 years of age and that it occurs sporadically in younger bulls of 14 to 20 years age-group, but all bulls between 20 and 25 years of age exhibit *musth* periodically.

Eisenberg *et al* (1971:197) hold the view that *musth* is a rutting period and is probably indicative of high androgen titers in the male's blood. They further stated that a bull could impregnate a cow whether in *musth* or out of it and that the condition of *musth* is clearly related to the bull's ability to achieve a status of high dominance on an annual basis. They, however, found that the *musth* manifests itself most strongly during the months of March-April and October-November among the captive males in Ceylon. Both these seasons are the periods of heavy rain in Ceylon, and have been reported to be coinciding with the peak of *musth*.

Buss *et al* (1976:449) observed that stress triggers liberation of temporal gland secretion in African elephants. Secretory activity of their temporal glands was more frequent during dry than during wet seasons. A cow elephant, the leader of the herd developed prominent *musth* after an hour and 45 minutes of vigorously defending three of her family members. Further, they added that the temporal gland functions as a scent gland helping to recognize other members of the group.

II. Observations on 'Musth' in Wild Indian Elephant

The present author while conducting ecological studies with special reference to the breeding aspects of the elephants in India during 1972-77, had the occasion to observe three cases of *musth* in wild bull elephants in three different sanctuaries. The first was a solitary *makna* (tuskless male) with roguish tendencies at Kamaladh Lake area in the Betla National Park, Palamau (Bihar) during the last week of February 1972. It was bold enough to face approaching danger rather than leave the ground. The second observation also related to a *makna* at Jaldapara Wild Life Sanctuary (West Bengal) during the third week of February, 1974. It

was in full *musth* and was courting with a tame cow elephant stationed at Hollong camp. During our stay from 17th to 24th February 1974, it covered the cow several times, mostly in the afternoons, without being shy. The third was a tusker in the Bandipur Tiger Project area (Karnataka) during the last week of March 1976. On 28th March 1976 around 16.00 hours a herd of 10 elephants was fonnd scattered in a radius of about 100 metres. A group of five (ad♀ 2, J♀ 2 and calf 1) was seen in a grassy patch on the right side of our vehicle approximately 30 metres away. On being alarmed, the elephants moved ahead, crossed the road and joined another group of three (ad♀ 2 and J♀ 1) females on the opposite side of the road. Simultaneously, a third group of two (adm 1 and ad♀ 1) came out of the thickets and joined them. All of them being alarmed formed a haphazard group placing the calf between the adults and juveniles, and watched for the source of disturbance for a short while (nearly five minutes) before moving away from the spot. All of them disappeared from our sight by 16.15 hours. In the vicinity there was a small pool of water towards which they went. We also approached the pool from the other direction and reached the spot before the arrival of this herd. At 16.45 hours the herd, led by the tusker (Fig. 1) reached the pool. It was followed by the adult females, youngest calf, juveniles and the oldest female as a rear-guard. Orderly at first in a file, but on reaching the bank at 16.53 hours they broke the rank. The tusker was in *musth* and was first to negotiate the water (Fig. 2). Five of them including the calf and juveniles, formed an irregular group keeping, however, the calf well-protected (Fig. 3), drank water at the bank slightly away from the tusker, while the rear-guard and another adult female remained behind. After drinking, around 17.05 hours, the mother and the calf went behind a bamboo clump. The other members including the rear-guard then drank water. The juveniles which had been in the pool lumbered out on to the bank and were in a playful mood. They scooped up dust and blew it over their bodies. None of the members of the herd took the usual bath. The tusker remained in water till around 17.17 hours when they re-entered the forest, led by the oldest female who was the rear-guard while approaching the pool. On their way back the tusker assumed the position of the rear-guard (Fig. 4).

It is evident from the foregoing accounts that the *musth* occurs usually at the begining of summer in India, though a few cases may be observed in other seasons as well*. The *musth* which gives a strange physiological and physical superiority to a competent bull elephant is

*According to Dr. V. Krishna Murthy (Forest Veterinary Officer, Coimbatore, Tamil Nadu) cases of *musth* in Mudumalai Wildlife Sanctuary is also observed during May-September, which coincides with heavy rains. But in Annamalai Wildlife Sanctuary *musth* appears during November-March, i.e. in colder months.

nature's device for the future welfare of the population. Hence, such a bull may do all to establish its exclusive sexual rights over the eligible cows not only of the herd but also of the surrounding area. As observed in Bandipur, it appears that in the absence of competitors a *musth* bull may even associate itself with the herd, can be tolerant of the other members and be functioning in its role within the herd. Probably such bulls in *musth* are harmless and do not develop an aggressive attitude even towards human beings. But there are always some exceptions, a few may be bad-tempered while others may be docile, for instance, as stated by Gee (1969) : "On three occasions I have encountered a wild bull elephant in full *musth,* twice in Kaziranga and once in Periyar, but each time the animal has been harmless and not at all aggressive. M. Krishnan has also found wild bull elephant in *musth* to be harmless" Further, Krishnan (1972) reported some cases from North Bengal, Assam and Karnataka where the *musth* bulls were dangerous and aggressive. Perhaps these bulls, which might have been succeeded by other competent bulls depriving them of their sexual rights over their mates, turned aggressive. Hence it may be presumed that stress caused by any factors, both external (environmental) and internal (physiological) may initiate the secretion of temporal glands and appearance of *musth* among the elephants. The cases of excessive or increased secretion cause extreme cases of *musth.*

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Fig. 1. Tusker leading the herd.

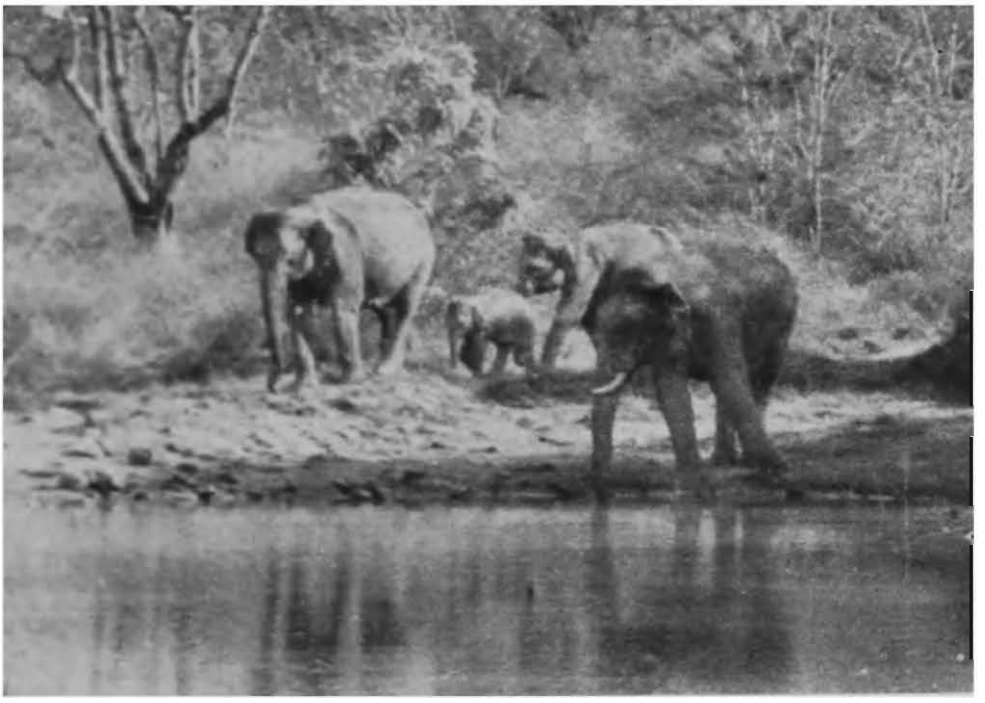

Fig. 2. Leading tusker negotiating the pool.

Fig. 3. A herd drinking water at the pool, with the calf well protected.

Fig. 4. The herd leaving the pool to re-enter the forest, with the leading tusker now as a rear-guard.

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CERTAIN ASPECTS OF BREEDING BIOLOGY IN THE INDIAN ELEPHANT, *ELEPHAS MAXIMUS* LINNAEUS

By

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Zoological Survey of India, Calcutta

(5 Plates)

Abstract

Elephant starts breeding generally between 17 and 19 years, but a female as young as 8 years has been recorded to drop her first calf at Munich Zoological Park, Germany in 1932. They are not monogamous except perhaps in captivity. Courting and mating is a long drawn process which may continue for days, weeks and months. The adult female may pass through oestrus cycle every month in captivity. The gestation period is reported to vary from 17 to 24 months. Hereditory factors also influence the length of gestation. The growth rate of calf in captivity is not uniform. The percentage of calves in elephant herds, as observed in Betla National Park, Bandipur Tiger Project area, Mudumalai wildlife sanctuary, Nagarhole wildlife sanctuary and Periyar wildlife sanctuary is 10%, 13.72%, 14.54%, 14.17% and 13.92% respectively.

I. Introduction

Sketchy notes on various aspects of breeding in the Indian elephant have been reported from time to time. Slade (1903 : 111) and Gonzalez (1939 : 731) have given descriptive accounts of copulation only. Hundley (1922 : 537) and Wilson (1922 : 1128) commented on the length of gestation while Seth-Smith (1932 : 816), Foot (1935 : 392) and Robinson (1935 : 950) remarked on the age of onset of puberty. Flower (1943 : 21) and Burne (1943 : 27) compiled data from the notes they kept for several years concerning the age of sexual maturity, gestation period, and the growth rate of calves of the working elephants in Burma. Mayberry (1962 : 80), Anchi (1962 : 83), Dittrich (1966 : 193) and Krishna-Gowda (1969 :99) have dealt with the gestation period and rearing of the Indian elephant in Zoos at Portland, Budapest, Hannover and India, respectively.

In recent years, Eisenberg *et al.* (1971 : 193) have made useful contribution on the reproductive behaviour of the Indian elephant in which they included such topics as the physiological and morphological aspects, contact-promoting and precopulatory behaviours culminating in copulation.

The present author made some observations during 1972-77 on both wild and tame elephants on their probable age at maturity, courtship,

mating, delivery of calf, its growth and natality. These observations have been made in the states of Assam, Bihar, West Bengal, Orissa, Karnataka, Kerala and Tamil Nadu.

In the present paper the author has endeavoured to analyse his own observations and has compared them with the earlier studies with a view to developing a comprehensive account of the breeding pattern of the elephants in India. The method followed for the study consisted of grouping the elephants observed into three categories in. (i.e.), infants, (ii) immature and (iii) mature animals, based on developmental stages and reproductive status.

II. Breeding Biology of Indian Elephant

It is difficult to make observations on all the aspects of the breeding biology in the wild elephants for obvious reasons. Data on these aspects have obviously to be supplemented from the observations of the captives and this has perforce limited to a few cases only.

The study on captive elephants were mainly made at Mudumalai Wildlife Sanctuary (Tamil Nadu). The elephants rarely breed in full domestication, probably due to segregation of sexes, hard work and improper food. But in semi-natural conditions they do breed fairly well and regularly.

During the period of observation, Mudumalai camp had 36 elephants (ad ♂9, ad ♀16, calves of different age groups 11). These elephants enjoy a comparatively free life as they are hobbled every night in the nearby forest. This enables them to secure natural fodder and to wander at will in surrounding forest. Consequently this free life permits them to mix up with the wild stock and breed under almost natural conditions.

Some details were also obtained from the Jaldapara Wildlife Sanctuary (West Bengal). Besides, personal enquiries were made from the knowledgeable person-a reputed elephant trapper Sri Prakritish Barua, commonly known as Laljee Barua of Gauripur, Assam, who has a fairly good experience of rearing elephant calves, born in his elephant camp, and Dr. V. Krishna Murthy, Forest Veterinary Officer, Coimbatore (Tamil Nadu) who has exceptionally good knowledge of wild elephants of his forests. He has also the captive elephants of Mudumalai camp in his direct charge and maintains the records of individual elephants of his camp.

Breeding season :

Asdell (1946 : 13) states that some mammals breed at all times of the year while others have a more or lsss restricted season at a definite time of the year. In general, tropical species have less restricted seasons than those living in the temperate region. The present author is of the opinion that elephants can breed at any time, particularly in an area where the conditions are fairly uniform throughout the year (Fig. 10). It is also

possible to see a calf of a few weeks of age in a herd, at any time of the year in other areas as well.

Age at maturity

In developing the criteria for the estimation of age at probable maturity, the author has mainly relied on the data drawn from the elephants in captivity, both based on his observations as well as those of others. Ali (1977 : 63) has already stated that the determination of age of a wild elephant is a moot problem. Among the captive elephants, except for those individuals which are known from birth, an estimation of age has to be made. The teeth criterion is helpful in estimating the age only from dead elephants. In a living individual the age is estimated by its body-built and the height at the shoulder. But this has its limitations. The age and height table published by Flower (1943 : 25) or the growth curve constructed by McKay (1971 : 31) is applicable, in normal cases, for estimating the age.

The data on birth records of Mudumalai camp elephants indicate that a female, named "Meenakshi", herself born in captivity, calved when she was only 13 years old. But "Devaki", another female, gave birth to her first calf at an approximate age of 18 years, while three other female elephants, namely "Bommi", "Swarnavathi" and "Rathi", had their first calves when they were around 19 years of age.

Burne (1943 : 26) cited eight examples from the working elephants of Burma to state that three females gave birth to their first calves at the age of 18 years while five others at the age of 16, 20, 21, 22 and 23 years.

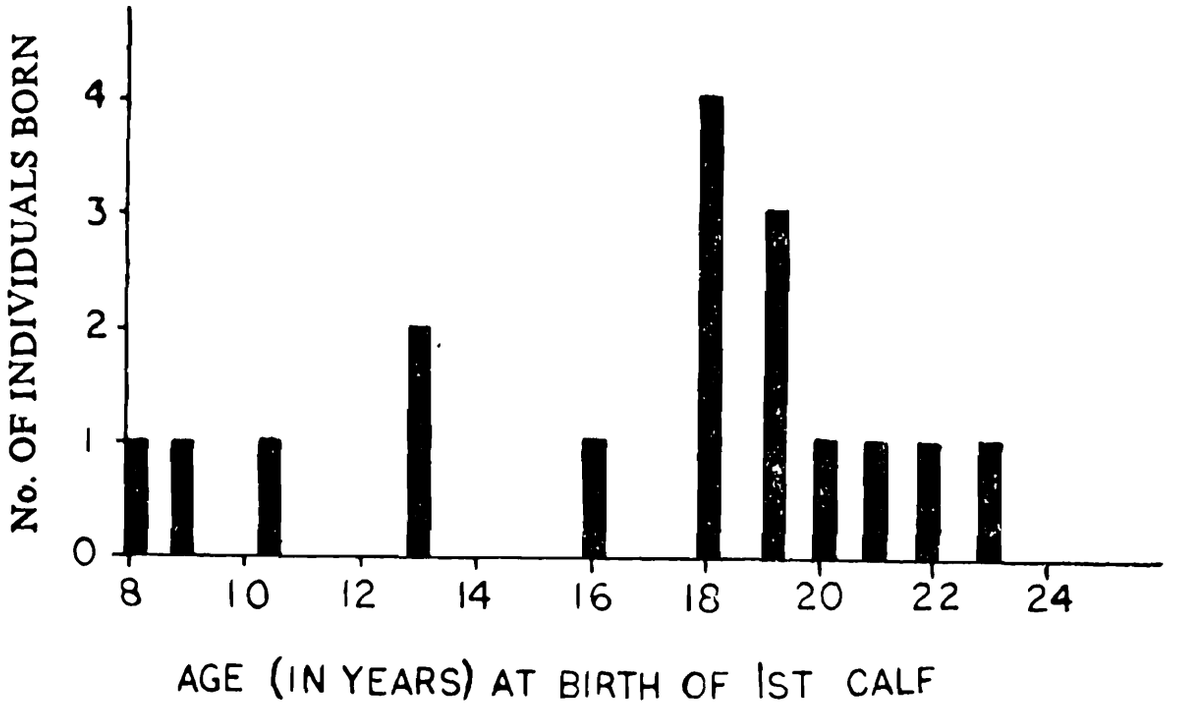
Flower (1943 : 22) stated that a female elephant named "Ellen" calved when she was only 13 years old in Copenhagen Zoological Garden in 1907 and another female gave birth when she was believed to be only 10½ years old in Leipzig Zoological Garden in 1936. Seth-Smith (1932 : 816) quotes the age of a female elephant to be a little over 9 years when she dropped her first calf. Furthermore, Foot (1935 : 392) speaks of a female, named 'Cora', which produced her first calf even at the age of only 8 years at Munich Zoological Garden in 1932.

Inspite of the above-mentioned records from European Zoological Gardens, Flower (1943 : 22) concluded that the usual age for a female elephant to produce her first calf is 15 to 16 years. Sanderson, I.T (1960: 309) held the view that elephants usually have their first calf between the ages 16 and 20 years. An analysis of birth records suggests that the majority of elephants drop their first calf at the age of 18 and 19 years (Fig. 1). But those births, reported from the age of 13 years and earlier may also be possible as exceptional cases, since McKay (1971 : 30) has stated that puberty among wild elephants in Ceylon probably occurs between the ages of 8 and 10 years.

A male about 20 years old is generally considered mature and periodically exhibits the bursting of its temporal glands, the 'musth' Jayasinge

and Jainudeen (1970 : 63) state that 'musth' never appears in males under 10 years of age and appears sporadically in young males from 14 to 20 years. But all males in the 20 to 25 years of age-group periodically exhibit 'musth'

This suggests that elephants may attain puberty several years before they attain their full 'sexual maturity' According to Asdell (1946 : 10), 'sexual maturity' is the time when the animal reaches its full reproductive power, and it is usually much later than puberty. Hence, female elephants attain maturity at an age generally ranging from 16 to 20 years, commonly between 17 and 19 years (Fig. 1), depending upon the physiological



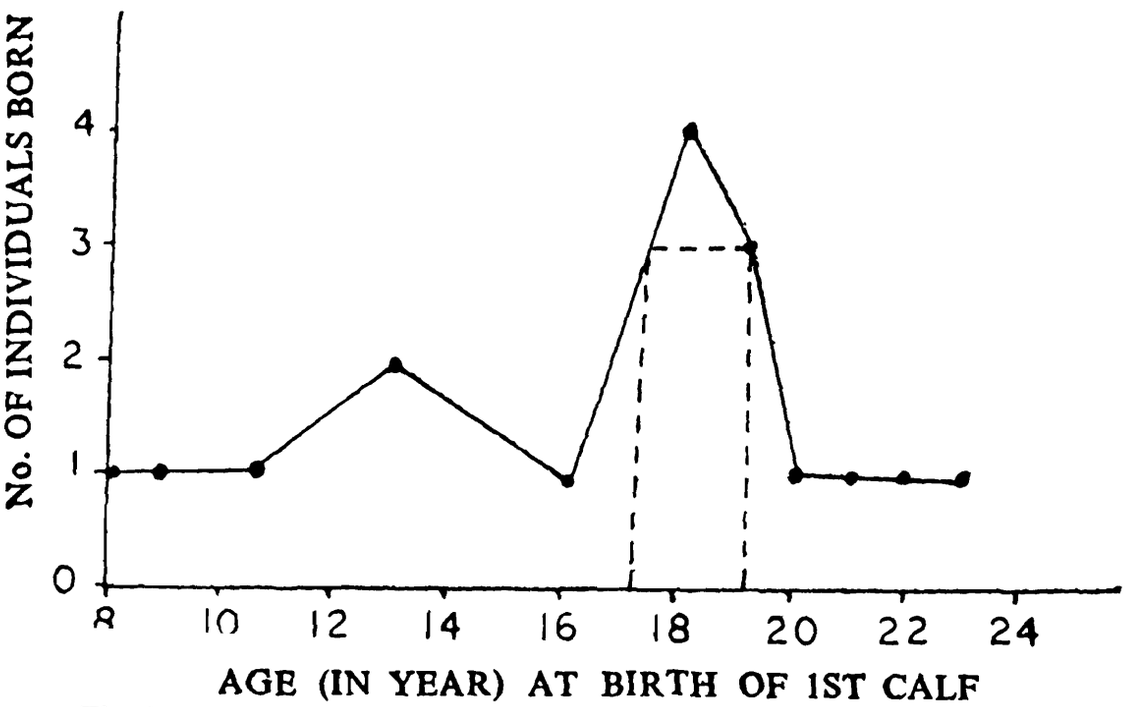


Fig. 1. Histogram (upper) and curve (lower) showing mother's age (in years) at birth of first calf in elephants.

changes in an individual and probably several other factors including habitat, climatic conditions, etc. which require further investigations.

However, at maturity, a physiological change comes about in the individuals which stimulates breeding capabilities.

Courtship

Marshall (1922 : 47) states that the elephants in captivity are polyœstrous and may have persistent oestrus for 3 to 4 days. Apparently there is no external manifestation in a cow elephant during oestrus period. Hundley (1922 : 538) has recorded a similar observation, but Slade (1903 : 112) and Evans (1910 : 94) are of the opinion that a female in season, signifies her condition to an eligible male by moving her tail slightly to one side and submits by bending her hind quarters. Wilson (1922 : 1128) reported that a cow elephant in season will very often have a slight discharge from the temporal glands which is visible, when the skin of the elephant is dry. Krishnan (1972 : 310) further adds that a cow elephant coming into season advertises her condition and she soaks the hairs of her tail-tip in her genital discharge, the tail is then held aloft in the air and weved about as a scent-flag. However, a female in season, attracts the attention of an eligible male and courts his society. Males appear to be ready and keen to mate at all times of the year.

The courting is a long drawn out process, which may last for days, weeks or months. During the process besides mutual smelling of genital organs (Fig. 2.), a male and a female may often be seen caressing each other with their trunks, sometimes standing either neck to neck crossed or trunks intertwisted. Several such advances between the two may be repeated before the actual copulation. A male extending its trunk along the back of the female, is an indication that the male is ready to mate. Courtship may occur either within or away from the herd. When it takes place within the herd, other members are apparently indifferent. It is of common occurrence in the forest and can be observed without difficulties as the elephants are not shy. Eisenberg *et al.* (1971 : 198) described in detail the contact-promoting and pre-copulatory behaviour in the Ceylonese population which is confirmed by the observations of the present author (Figs. 3 to 6).

Mating

Copulation has been well described by Slade (1903 : 112) and Eisenberg *et al* (1971 : 205) and needs no further elaboration. I may, however, add my own observation that after the mounting of the male, the female may support herself by holding an object like a tree (Fig. 5) and submits to the male only when the penis comes in contact with her vulva. The female usually squates compelling the male to assume almost a sitting posture probably to receive deep penetration of the penis (Fig. 6). The

male gradually starts raising itself till his hind legs are upright. By this time the coition is over, which may take hardly 12 seconds. After the congress, the female appears to be excited, as she rapidly flaps her ears and whisks her tail whereas the male is relatively quiet. Slade's (1903 : 112) observation is, thus, confirmed by mine. All the mountings of a male may not lead to the successful coition (Fig. 7), therefore, copulation is repeated for several days, probablytill the female is impregnated.

Pregnancy

This aspect has probably not yet been recorded. A successful sexual union shall naturally lead to conception. As pregnancy advances, the female may be observed to remain slightly away from the herd, avoids climbing on high hills, its movements become comparatively slower, it urinates frequently. Such a female maintains a distance from the advances of other eligible males and demonstrates a defensive behaviour by keeping her ears low and tail tucked in between her hind legs. The mammary glands become prominent around nine months in the case of first pregnancy and at the end of twelve months in subsequent ones. These are stretched upwards directing the nipples outwards. An expectant mother may be seen with another adult female (probably which has already undergone the experience of parturition) in the advanced stages of pregnancy. This companion probably assists the expectant mother at the time of delivery and in bringing up of the calf.

Gestation period

Sanderson (1878) states that the length of gestation may be 18 to 20 months if the female is carrying a cow calf and up to 22 months if it is a bull calf. Wilson (1922 : 1128) based on records extending over a number of years puts the period of gestation at 22 months. But he further says that a working elephant on account of overwork may drop calf after 20 months. Such a calf if born alive will be weaker than a full term calf. In premature parturition usually still-born calves are dropped.

Burne (1943 : 27) has published the figures of gestation period for 25 cases and which give the average of 21 months 3 days with the minimum of 17 months 17 days and a maximum of 25 months. In 10 out of his 25 cases, however, he was not quite sure of his data. Flower (1943 : 22) quotes two definite cases, one of 20 months 18 days and the other of 20 months 20 days. A summary of all notes in his possession up to 1939 gave the usual period of 19 to 21 months with a minimum of 17 and a maximum of 24 months. Eisenberg *et al.* (1971 : 195) on the basis of published records, state that the period of gestation around 22 months is reasonable. Shri Laljee Barua (personal communication) states that all the four of his cow elephants in five confinements having been served by his captive male elephant named "Partab Singh" dropped five calves. The gestation period varied from 17 months 20 days to 18 months 25 days.

His cow elephants gave birth to calves as follows : (i) Paban Payari to a ♂ (tusker), (ii) Shevini to a ♀; (iii) Bulbuli to a ♂ (makhna); (iv) Kananballa to a ♂ (makhna) and again Paban Payari to a ♀. The calves were all born during 1950-1957 between July and August either in his forest camps at Gauripur or at Goalpara in Assam.

The present author had the records of two definite cases from Mudumalai Wildlife Sanctuary camp elephants. One of the cow elephants named "Suguna" was covered in the night of May 3 and 4, 1948 and delivered a male calf named 'Rana' on 21st March, 1950. The other cow elephant 'Godavari' was covered in the night of October 18 and 19, 1951 and she delivered a female calf named 'Avvai' on 20th July, 1953. The gestation period, therefore, works out to 684 days for 'Suguna' carrying a male and 639 days for 'Godavari' carryigg a female. The available records on the gestation suggest a variation from 17 months 17 days to 24 months (Flower, 1943 : 22) or 25 months (Burne, 1943 : 27). The present author is of the opinion that the gestation period may vary from 17 to 23 months on account of several reasons.

In monotocus animals males are carried longer and are heavier at birth than the female. According to Asdell (1946 : 28) the hereditary factors also influence the length of gestation. Environmental factors probably also contribute to variations. Above all, the calculations based on congress may account for a major factor in variable data, since all mountings of the males are not successful coverings.

Delivery of calf

Hundley (1922 : 538) reported that calves among the working elephants in Burma had appeared unexpectedly either during work or while the mother was grazing. However, the present author, on the basis of his field observations, is of the view that the birth in a wild elephant is anticipated by the herd, and the herd under such circumstances continues to stay longer in a particular area. The restlessness and groaning sound of the expectant mother during the labour pain is the indication to the herd of the impending delivery, when other members of the herd start trumpeting occasionally and congregate on the spot. The birth-spot is selected close to a water pool and is generally a grassy patch. The size of the birth-spot is variable, probably depending upon the size of the herd. It was observed twice at Betla National Park, Palamau (Bihar) that the size of the birth-spot was c 12.2×18.3 m and c 18.3×30.5 m, respectively. The constant paddling of the elephants makes this spot-quite smooth. During the period of delivery the spot is well guarded by all the members of the herd, including the adult males. The cases of delivery in both the wild and tame elephants that are available go to show that it takes place mostly in the night under tremendous heaves of sighs and groans. The process of delivery in the wild elephants has not been properly observed

so far. Informations were collected from those attendants of Mudumalai Wildlife Sanctuary who have witnessed the birth in a few elephants of the camp. They state that during the labour pain some fluid begins to flow from the genital organ and the calf emerges, shoulder first with its head tucked between its fore-legs and is gently lowered to the ground. The entire process takes about 4 to 5 minutes. The statement of Sanderson (1960 : 311) is confirmed by the above observations. The placenta may be passed immediately after delivery or may be delayed by a few hours and is normally eaten by the mother herself. Similar observation has also been reported by Evans (1910 : 67). The author could not find the placenta on both the occasions of births observed by him.

Once in Mudumalai wild Life Sanctuary area, just after the delivery by a member of a wild herd, the herd had to move away due to constant disturbance around the birth-spot, leaving behind the placenta. It weighed about 14 kg. (personal commu nication from Dr. V. Krishna Murthy, Forest Veterinary Office, Coimbatore and Shri Silverraj, Range Officer, Mudumalai Wildlife Sanctuary).

Normally one calf (Fig. 8) is born at a time but twins are also reported. Hundley (1921 : 628) reported the birth of twin elephant calves by a working elephant in Burma. They were male and female calves, each measuring 95.6 cm. Among the camp elephants of Mudumalai a cow elephant named 'Tara' delivered 13 calves in twelve confinements. The ninth birth in captivity was that of identical male twin on 25th May, 1960. Another female elephant 'Devaki' also dropped identical male twin in her sixth confinement on 20th May, 1971 (Fig. 9).

Normally the calf is able to stand on its legs within an hour, but the herd will continue to stay in the area for 2 to 3 days, probably until such time as the new-born calf can accompany the mother in her movements. The mother is extremely protective of her young and, during the first few weeks after birth, keeps it quite near or directly under her body as she walks about. The mother suckles the calf at an interval of every 15 to 20 minutes during the first few weeks.

Birth among the camp elephants of Mudumalai takes place all the year round but the maximum number of calves are dropped in May and November and the minimum during January and June (Fig 11.) Among the wild elephants in dry deciduous tract of Betla National Park, Palamau, calves are generally born during winter months from December to February. In the captive elephants of Jaldapara Wildlife Sanctuary (West Bengal) the births have been recorded in September, December, February and March, whereas in Assam during July-August. Shri S.C. Neginhal, Asstt. Conservator of Forests, Mysore (personal communication) states that the calves are born more during the rainy season at Nagarhole Wildlife Sanctuary area. Sanderson (1878) mentions that females give birth

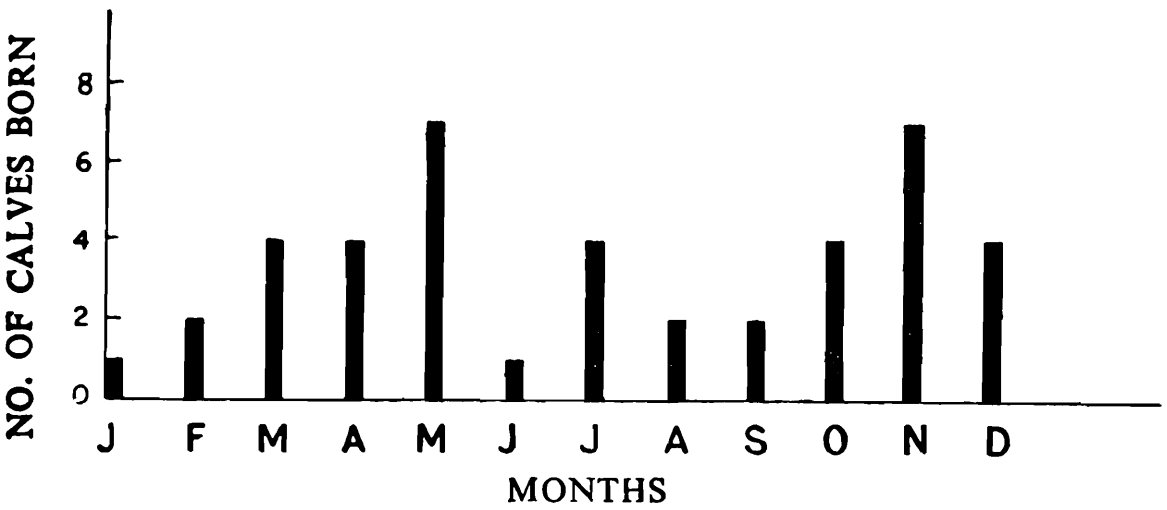


Fig. 11. Histogram showing Monthwise birth frequencies among the camp elephants of Mudumalai.

at every 2½ years and the majority of calves are dropped in Mysore between September and November, towards the end of the rainy season. Williams (1950), however, writes that in Burma most elephant calves are born between March and May, which in that area is the onset of the rainy season.

From Table 1, it would appear that a minimum interval between the two calves is 2 years 1 month 2 days and the maximum is 8 years 7 months in the same female named 'Tara' Further, 'Tara' has delivered her thirteenth calf a female ('Rajeshwari') (Fig. 10) on 20th July, 1976 at an approximate age of 67 years. It may be presumed from the above records that a female elephant may continue to breed beyond 65 years of her age.

Growth of calf

Growth rate among the elephants is not uniform (Ali, 1977 : 26). Both sexes are almost of the same height at birth and during the first two years there is a very rapid growth in both of them. The male, however, has been observed to be growing faster than the female. This confirms the earlier observations of Flower (1943 : 25).

Natality

The production of new individuals by a population is a major factor for determining the potential yield in a particular area. It is normally calculated by the number of young produced per 100 breeding females per year. However, the net increase in a population is influenced by several factors, such as population of the species, minimum and maximum breeding ages of the individuals, sex-ratio, breeding habits, number of individuals produced per year, rate of their servival, etc.

It is apparent from the foregoing accounts that the elephants usually breed after they are 13 years old. Generally a single calf is born but

TABLE 1. BIRTH RECORD OF MUDUMALAI CAMP. ELEPHANTS

NAME OF FEMALES	DATE OF CAPTURE	AGE IN YEARS WHEN CAPTURED	BIRTH OF CALVES IN CAPTIVITY												REMARKS
			1	2	3	4	5	6	7	8	9	10	11	12	
TARA	15 APRIL 1935	25 INTV.	12 SEP 1935 → 2Y. 10M. 3D.	15 JULY 1938	13 AUG. 1942 → 4Y. 28D.	16 APR. 1946 → 3Y. 8M. 3D.	18 MAY 1948 → 2Y. 1M. 2D.	15 DEC. 1950 → 2Y. 6M. 27D.	22 JAN. 1955 → 4Y. 1M. 7D.	19 AUG. 1957 → 2Y. 6M. 27D.	25 MAY 1960 → 2Y. 9M. 6D.	15 JUNE 1963 → 3Y. 20D.	20 DEC. 1967 → 4Y. 6M. 5D.	20 JUL. 1976 → 8Y. 7M.	
RATHI	11 MAR. 1942	11 INTV.	1 OCT. 1950 → 4Y. 6M. 14D.	15 APR 1955 → 2Y. 7M. 1D.	16 NOV. 1957 → 3Y. 10D.	16 SEP. 1961 → 3Y. 2M.	16 NOV. 1964 → 4Y.	16 NOV. 1968 → 3Y. 4M. 10D.	26 MAR. 1972 → 2Y. 8M. 26D.	22 DEC. 1974					
DEVAKI	11 FEB. 1942	12 INTV.	7 MAY 1948 → 5Y. 8M.	7 MAR. 1954 → 3Y. 7M. 29D.	6 NOV. 1957 → 4Y. 5M. 4D.	11 APR. 1962 → 3Y. 6M.	11 OCT. 1965 → 5Y. 7M. 9D.	20 MAY 1971 → 3Y. 8M. 25D.	15 FEB 1975						
GODAVARI	2 MAR 1931	16 INTV.	20 JUL. 1953 → 7Y. 5M. 10D.	30 DEC. 1960 → 2Y. 10M. 21D.	21 NOV. 1963										1ST BIRTH AT THE AGE OF 38 YEARS I.E 22 YEARS OF CAPTURE
SUGUNA	2 JUNE 1939	28 INTV.	21 MAR. 1950 → 4Y. 1M. 3D.	24 APR. 1954 → 6Y. 1 8D.	12 MAY 1960	5 DEC 1963 LATE ABORTION	25 NOV 1970 → 2Y. 7M. 25D.	20 JUL 1973							
GOWRI	9 FEB 1966	26 NTV.	OCT 1967 → 7Y. 5M. APPROX.	31 MAR 1975											SHE WAS CAPTURED WITH A ♂ CALF OF 2 YEARS IN AGE
BOMMI	16 DEC 1974	18	16 OCT 1975												
SWARNA - VATHI	—	—	23 NOV 1973 (19 Y)												

INDEX Y. YEAR. M-MONTH D = DAY. INTV. = INTERVAL BETWEEN TWO CALVES

Table 2. Percentage of Calf and natality in wild elephants.

Locality	Year	Mature		Immature		Infant unsexed	Total Animals siguted	Percentage of Calf in over all population	Natality Infant/ 100	Remarks
		Male	Female	Male	Female					
Betla N P., Bihar.	1972	3	20	Unsexed 6		3	32	9 37		
-do-	1974	4	11	8		2	25	8.00	15.38	
-do-	1975	3	15	4		2	24	8.65		
-do-	1977	1	6	2		1	10	10 00		
Bandipur Sanctuary, Karnataka	1976	3	21	3	10	6	43	13.72	25.37	
-do-	1977	10	46	7	8	11	82	13.41		
Nagarhole Sanctuary, Karnataka	1976	7	44	7	20	13	91	14.17	29.54	
Mudumalai Sanctuary, Tamil Nadu	1976	6	30	3	9	7	55	14.54	28.84	
-do-	1977	5	22	9	13	8	57	14.21		
Periyar Sanctuary, Kerala	1976	6	46	3	13	11	79	13.92	23.91	

occasionally twins are also produced. Consequently a population will consist of a high percentage of non-breeding individuals. The gestation period is 17 to 23 months. Usually they do not breed during the period when the calf is being actively nursed. Hence, a female elephant at best can produce one calf in two years or at longer intervals ranging from 3 to 9 years. (Table 1). Thus the maximum number of calves that may be expected from a cow elephant is 15 to 17 during her productive period, if she survives over 70 years of age. However, during the period of study the natality as observed was 15.38%, 25.37%, 29.54%, 28.84% and 23.91% at Betla, Bandipur, Nagarhole, Mudumalai and Periyar, respectively (Table 2).

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Addendum

Subsequent to submission of the manuscript some more information was received in respect of birth records. A cow elephant, Meenakshi (born in captivity on 9th March 1889 at Madumalai camp) delivered the calves as under :

No.	Name of calves	Date of birth	Sex	Mother's age in
1.	Doshi Jahan	27th Dec. 1902	♀	13
2.	Roshini	28th Jan. 1908	♀	19
3.	Parwathy	21st Nov. 1911	♀	22
4.	Still born	9th Feb. 1915	♀	26
5.	Mogul	13th Oct. 1919	♂	30
6.	Chandra	16th Jan. 1923	♀	34
7.	Saraswathy	19th Nov. 1928	♀	39
8.	Hilla	30th Nov. 1931	♀	42
9.	Sundari	21st Jul. 1935	♀	46
10.	Andi	20th Feb. 1938	♂	49
11.	Venu	11th Jul. 1943	♂	54

Meenakshi died in 1957.

An analysis of 53 (42 referred earlier+11 post-symposium data) birth records suggests that the maximum number of calves are born in November, instead of May and November.

Fig. 2. Bull elephant smelling genital organ of a cow elephant.
(Photo by courtesy Shri N Sundarraj Bangalore)

Fig. 3. Bull elephant (left) approaching a cow elephant (right).

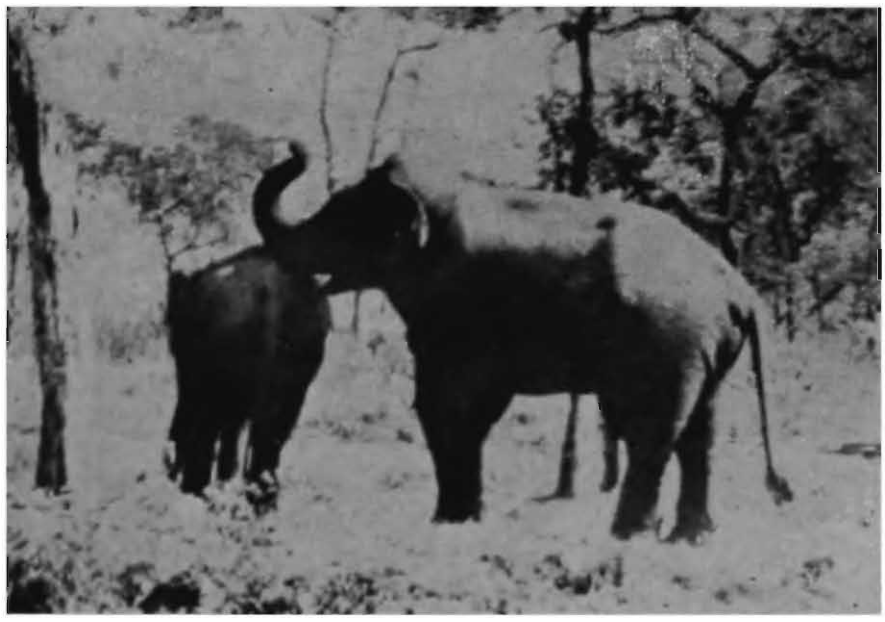

Fig. 4. Bull elephant pressing the rump of a cow elephant by the base of his trunk to submit.

Fig. 5. After the mounting of a bull the cow takes additional support by holding a tree by her trunk.

Fig. 6. Successful copulation in which the cow squates to receive deep penetration.

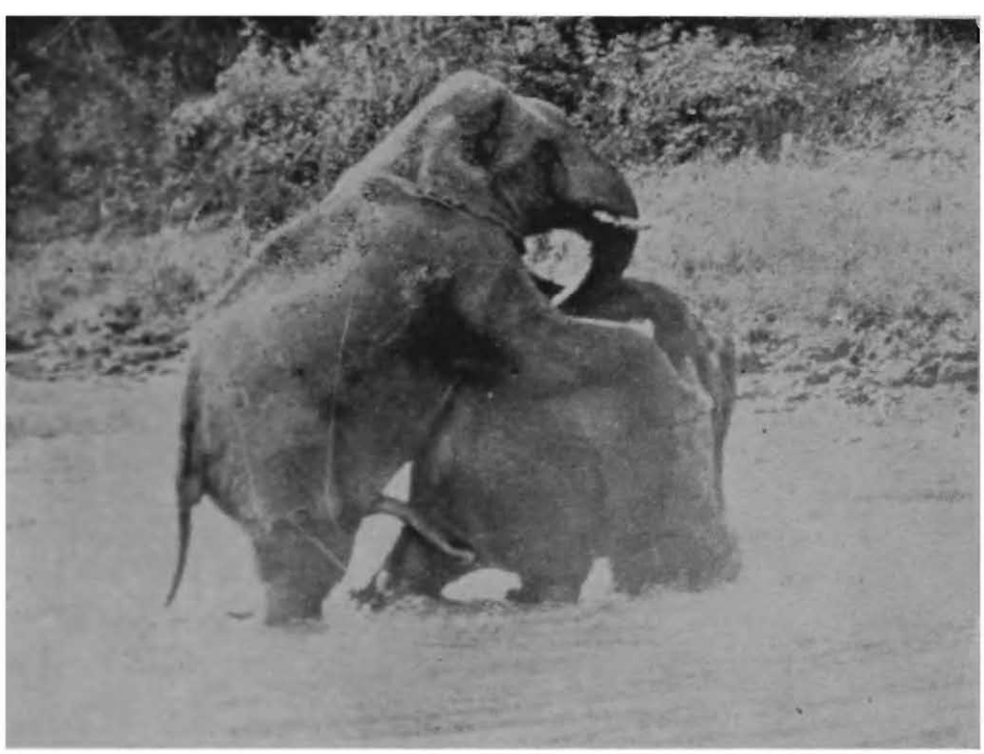

Fig. 7. Unsuccessful mating (Photo by courtesy Shri N Sundarraj, Bangalore).

Fig. 8. 'Jaimala' with her 13 days old female calf at Jaldapara Wildlife Sanctuary, West Bengal.

Fig. 9. 'Devaki' with her identical male twin at Mudumalai Wildlife Sanctuary (Photo by courtesy Shri Gopi Nath, Calicut).

Fig. 10. 'Tara' (67 years) with her thirteenth calf at Mudumalai Wildlife Sanctuary August, 1977.

Proc. Wild Life Workshop : 21-26

POLLUTION AND ITS BEARING ON WILD LIFE

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Abstract

In the present paper pollution and its affect on wild life has been discussed. Emphasis has been laid on the effects of pesticides. It destroys the reproductive conditions and disturbs the metabolism which ultimately cause death or may result in elimination of species over a long period of time. Mammoth problems in environmental pollution—with waste effluents and chemicals, oil, sewage, poisonous gases, smoke and other hazards have directly threaten to exterminate our fauna and flora. Pollution by pesticides, fertilizers and radioactive wastes also pose grave danger to wild life, directly through the food cycle Although nature can recover from minor modifications of her environment but it has a limit to recover from continuous abuse. If pollution is continued, the nature's life supporting system will fail. Hence, we are to apply the methods to reverse pollution of the environment.

I. Introduction

Many wild life species have already become extinct and so many are on the verge of extinction. Pollution is one of the important factor for the depletion of our wild life. The ever-expanding industrialization, urbanization and increasing demand for growing more food have produced severe problems in environmental pollution, which has directly threatened to exterminate our fauna and flora. There are indications that if large-scale pollution of the environment is continued, the earth's life-supporting system will fail, with disastrous consequences.

Several insecticides are being effectively used in controlling various pests. Ultimately these insecticides find their way from different sources into the rivers, streams and ponds and create problems for aquatic life living therein, and also when the insecticides are sprayed in the fields and forests, they enter the body of the animals and effect the life. In the present paper efforts are made, to know how pollution caused by non-degradable pollutants effect the wild life.

In order to assess the degree of toxicity of certain pollutants, some bioassays were performed with dieldrin and lindane on certain species of fishes by one of us (D.S.M.) and with dimecron and endrin on some snails by the other author (H.P.A.). The changes in the animal tissues or body were observed.

II. Observations

(A) *Effect of insecticides*

The effect of dieldrin and lindane in case of some fishes was as follows :—

(a) *Effects on liver*

1. *Channa punctatus*

The hepatic cells were moderately vacuolated. There was slight atrophy of cells in the peripheral and central regions. The common pathological findings reveal variable changes such as necrosis or atrophy or combination of both. The most common lesion was degeneration of liver cells. There was slight alteration of the nuclei. The original polygonal shape of the liver cells was changed and the whole area of cells looked like a complicated mass.

2. *Heteropneustes fossilis*

The affected liver cells were found scattered. There was clumping of cytoplasmic granules. Cells in the central region had atrophied. Necrosis was localised. The centre of the cells appeared empty due to loss of cytoplasm. The change in the parenchymatous cells consisted of marginaion of the cytoplasmic granules. At a few places the cells had completely degenerated.

3. *Trichogaster fasciatus*

The hepatic cells were moderately vacuolated. The chief lesion was degeneration of the cytoplasm of the cells in the form of vacuoles. At a few places localised necrosis was very much marked. Hypertrophy was not noticed. A few cells had disappeared.

4. *Puntius sophore*

Intercellular spaces got developed due to the loss of cells. Necrosis was pronounced. The chief alteration was hypertrophy of the cells.

(b) *Effect on kidneys*

In kidneys degeneration of the epithelium was observed and it was ruptured at several places. Some parenchymatous cells of the renal tubules were also affected. In the central portion the tissue was much ruptured. The cells were accumulated in the form of patches.

(c) *Effect on gills*

In case of gills there was loss of different types of cells. The respiratory and blood cells were also degenerated. The blood vessels became atrophied. At certain places a fusion of adjacent gill lamellae was seen. Localised necrosis of some parts of tissues and the atrophy of large acidophil glandular cells were also observed.

The following physiological changes were noticed in the snail, *Lymnaea acuminata*, due to the effect of dimecron and endrin :

(i) There was no change in the calcium and magnesium content of the blood as compared with that of normal snail.

(ii) An increase in the lactic acid accumulation to about 25 times, as compared with that of normal snail, was noticed.

(iii) The pH of the blood changed from 7.3 to 4.3.

In order to find out the effect of these insecticides on the circulatory system, the snails subjected to insecticides were opened and kept in petri dish containing Pila ringer (Lal and Agrawal, 1968). The rate of heart beat was seven beats per minute while in the normal snail the rate is about 25 beats per minute. This shows decrease in the cardiac activity.

(B) *Effect of pollution caused due to industrial wastes* :

The pollution of rivers and streams by industrial wastes has been the problem since time immemorial because it produces the most unsanitory conditions in the environment.

The paper factory wastes cause oxygen depletion which is the most common difficulty because of long term biochemical oxygen demand due to the presence of lignin and chemical oxygen demand of the wastes. The water becomes highly toxic due to the presence of the free chlorine, sulphur compounds and other dissolved compounds. The presence of fine colloidal particles of lignin and cellulose clog the gills of fishes and hamper the normal gaseous exchange resulting in high mortality. The reddish brown colour of the combined waste makes the river water brownish and blackish reducing the penetration of the light, thus indirectly affecting the aquatic fauna. The definite increase of other factors like pH, specific conductivity, sulphate and sulphide affect the biota variously.

Industrial effluents containing sulphuric acid effects the eggs and larvae of fishes. The effect of SO4 ion is great on developing eggs. In order to protect aquatic life from effects of effluents, special settling tanks or other purifying installations are set up at factories. If industries are properly organised, it would be possible to protect water masses from pollution.

Toxic effect of metallic compounds leads firstly to the coagulation of the mucous secretion of the gills and protoplasm of the living cells which disturb the metabolism. Secondly the iron poisoning the gills covers them with a dense brown coating which makes respiration difficult.

One of the hazards that man has introduced into the water, a chlorinated pesticide—'Toxaphene', is causing a lot of damage to fish, incapitating them for life. It is suspected that toxaphene reduces the vitamin C content of the body but it needs verification.

For mammals, toxaphene is one of the more toxic chlorinated hydrocarbon insecticide and which is used widely as an insecticide on farm crops and as a poison to control undesirable fish population (Henderson et al., 1959).

Mercury and its compounds are widely used in industries, medicines and agriculture, and their uncontrolled release to the environment is now a significant cause of injury to, and even death of, wild life. In Sweden, the decline in the bird population has been traced to seed grains treated with menthly mercury preservatives. In Canada and USA, it has been the same story.

In a number of cases mechanical pollution may also be caused by refuse, for example, the product of timber rafting. This type of pollution has a particularly bad effect on rivers in which the Salmon spawns.

III. Discussion

All the insecticides and industrial wastes are highly toxic to animal life. It is really difficult to assess particular factors responsible for mortality. According to Ellis (1937) the chemicals may affect the animals in the following ways :

(i) by causing respiratory and circulatory interference;

(ii) by toxic action after absorption through gastrointestinal wall; and

(iii) by specific toxic action.

It seems that due to toxic effects, pathological changes occur in tissues and organs, primarily liver and circulatory system. Probably the primary target is the circulatory system where an apparent stasis and congestion is followed by the appearance of precipitated material. This material probably represents a product from damaged erythrocytes. As observed in snails, one of the significant changes of the toxic effects is the lowering of the circulatory efficiency of the body fluids. This indicates the non-utilization or non-availablility of the energy producing systems needed for the physiological activity of organs such as the heart. This potentially results in anoxia. The metabolic changes in snails are due to development of such an anoxic condition. The insecticides taken in along with water, damage the intestinal mucosa due to the free exchange of ions between the gut and submucosal capillaries.

David (1956) pointed out the direct and indirect effects by the paper factory effluents. The pH value less than 5.0 and more than 9.0 affects the organisms directly. The pH of the stream water in the polluted zone ranges between 6.4 to 7.2, hence it has no direct effect on stream biota. A good reserve and natural bicarbonate alkalinity acts as a safe-guard against an increase and decrease in the pH value.

The temperature of the effluent, as it comes out from the factory, is always higher than the atmospheric or normal water temperature of the stream, but it becomes normally equal as the effluent falls into the stream. The effluent temperature and the river temperature show that the maximum limit remained the same for both, but differences exist in the lowest limit i.e., about 8°C to 10°C, while the oxygen consumption of the aquatic fauna nearly doubles itself for each 10°C rise in the temperature (Ruttner, 1926).

Henderson and Tarzwell (1957) mentioned that all the industrial wastes are chemically very complex and it is very difficult to find out which particular factor is responsible for mortality. The pollution in the stream is organic. The decompositian of organic matter by the action of certain bacteria and micro-organisms which consume the organic matter and combine with oxygen available from the environment, affect the life in the stream. The effluent stagnates in the drain and the stream for a long time, the biological action starts and obnoxius condition soon develops. Thus septic condition results in the production of hydrogen sulphide gas imparting black colour to the effluent. David (1956) stated that the presence of hydrogen sulphide and free chlorine is well known to be toxic to fish. Duoderoff and Kartz (1960) have mentioned that even the traces of these substances in polluted water is hazardous to life.

IV. Conclusion and Suggestions

Pollution control is a necessity and must be given highest priority if we are to restore, maintain and develop our natural resources.

We are to find out the biodegradable insecticides (insecticidal esters), which can safely be used as potent insecticides.

The industrial wastes, if discharged untreated, can hamper or deplete the aquatic organisms in a water body. It, therefore, becomes essential to know the safe permissible concentrations of various industrial wastes. A biologist can easily measure the degree of toxicity in any waste, by means of bioassay methods and assess the extent to which it should be diluted or otherwise treated, before discharge to the receiving waters.

The basic research needed is for the effects of pesticides on ecosystem rather than the effect of a pesticide on a particular type of animal; these date will be of great importance if can be related to competition, variation and population and other ecological consequences. Monitoring programme should be accompanied by the histological and ecological studies to relate contamination effect from one population to another.

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WILD LIFE BIOLOGY OF SUNDARBAN FORESTS

—Further study on the habitat and behaviour pattern of Sundarban Tiger—

By

A.B CHAUDHURI AND K. CHAKRABARTI

Abstract

The present study on euryphagous and eurythermal carnivore of Sunderbans-the Tiger. is in continuation of a series of works published earlier by the authors. Varied types of habitats have been described. Twelve vegetation formations have been classified earlier. indicating density of crop, incidence of casualty and pug marks of tigers In this study detailed list of plants and biota has been made. Salinity and total salt contents of water and soil have been analysed to establish correlation between these factors on human casualty pattern, if any The present analysis of various behaviour pattern and casualty figures not only conform with the earlier findings that, (i) the tiger kills human being primarily between 7 a.m. and 9 a.m. and between 3 p.m. and 5 p m (ii) the age group of humnn being killed falls between 35 to 45 years. It establishes their migration and rhythmic activity theory, facts on population increase and designed maneating urge. Further study is sure to unearth more thrilling facts on their behaviour pattern.

Introduction

From time immemorial the cattle lifting tigers have enjoyed the dubious distinction of a public enemy. Anthropomorphic anecdotes of cattle lifters are abundant, those on man-eaters are many, but very scanty on the estuarine man-eaters. The view that the predatory aberration has been a persistent deviation from normal is held by a group of experts. It has to be established in respect of the estuarine tiger. In the estuarine tract, physical, chemical, mechanical and animate environments create a series of specialised niches where aggression, tenacity, battle for survival are retentless and supreme.

The author's initial investigational reports on the tiger of the Sunbarbans estuary were detailed in a series of articles published in 'Cheetal', 'Science & Culture' and in 'The Bulletin of the Botanical Society of Bengal" during 1972 and 1973.

Besides these and other observations on vegetation and habitat, studies on the breeding habit and bio-ecological aspects on various fish species, honey bee (*Apis dorsata*) and several species of birds in relation to tigers, have been made in a separate series of publications. (Science & Culture, Volume 40, March 1974, Science & Culture, Volume 38, June

1972, Science & Culture, Volume 39, January 1973, Cheetal, Volume 15, July 1972 and Cheetal, Volumel 5, March 1973). Extensive data have been collected on soil, water, pugmarks, human casualties, etc. and those have been analysed. Some of these findings are enumerated in this paper.

A. *Earlier findings between 1970-72*

(a) Tigers are present in all the fifteen (15) blocks in the Sundardan Tiger Reserve (2,585 sq. km.) and casualties are recorded in all the compartments (65 nos.) of these 15 blocks; in fact 21 blocks of the entire Sundarban forests record the incidence of man-eaters.

(b) Tigers migrate from block to block as was evident from pug-marks on muddy, sandy and loamy soil and on actual sightings.

(c) About 40 persons are killed every year on an average (unofficial reports record about 100).

(d) Maximum casualty is in April and May during the honey collection season. Minimum casualty is during the rains. Fisher-men are the highest victims.

(e) Permit holders of all professions die; in the timber coupes where the maximum number of workers stay and work together (contrary to fishermen who are isolated all over the areas) have comparatively minimum casualty.

(f) Casualty in a particular block do not maintain a uniform level; it fluctuates in a regular *rhythmic* pattern (Table No. 2 also refer to graphs produced in earlier papers referred to in para 3 under introduction).

(g) (i) Maximum casualty (80%) is between 7.00 hours and 9.00 hours, 15.00 hours and 17.00 hours and at 23.00 hours.

(ii) The age of persons killed varies between 35 to 45 years in 80% of the cases.

(iii) Those killed at night are attacked at their boat after the tiger swam to the boat and mounted on it, selected the victim and jumped with it back into water.

(h) Salinity is suspected to have positive correlation with the ferocity of the animal. Damage of liver and kidney has been suspected.

(i) The tigers understand the human mind meticulously and all their plans of attack are designed on human movement.

(j) All the forests were classified into types or formation on the basis of tidal level and on their tree associations; the density of such forests were determined and the human casualty pattern in such types and formations enumerated.

(k) Pugmarks were measured and classified into various size classes and assessment of the younger class was made. It was observed that the younger class was poorly represented.

(l) Recovery of the human body could be done only in 28.5% of the cases, whereas in 71.5% cases dead body could not be recovered from the tiger. This indicated the tenacity and ferocity of the man-eaters as the persons engaged in retrieving the dead body were attacked.

(m) The initial attack was always on the right hind part of the neck and the injury inflicted on the jugular vein and the cerebellum by the right and left paws respectively.

(n) Pigs and deer were the primary prey animals; but circumstances compel the tigers to take monkey, fish, bird, lizard and even crab. They have been observed to eat honey but this may not be a regular feature.

(o) Striking uniformity in the number of persons killed in honey collection over the years showed that the number of man-eaters was quite small and static (in average 17 honey collectors were killed out of about 1300 men engaged in this job each year).

(p) Maximum casualty zones were the areas of high salinity.

(q) The man-eater did not cross into human habitation for predation, which is a striking feature of the Sundarbans tiger.

(r) The sex ratio of the female to male was 1:3.

(s) The man-eater dug up recently burried human body to eat it.

(t) Man-eaters were mostly male. No human female has been killed by a man-eater as per record.

(u) There was no source of sweet water in the entire tract and although the animals drunk only saline water, yet sweet water was an attraction and was preferred to saline water.

B. *Findings after complete closure of high density tiger populated areas to permit-holders in mid-1974.*

All the aforesaid observations made under paragraph A were found correct on later observations. About census, the Project authorities found an increase in tiger population excess of 112 (in 1979 census the number was 206) which was assessed earlier in 1972. Further, the Tables 1 and 2 show the corresponding casualty figures during (i) 1960-69, (ii) 1969 to 1973 and (iii) 1974 (September) to 1978.

The following are the analyses of data and findings :—

1. The wave of human casualty maintained the same rate of about 40 persons a year. It is significant that eight blocks out of a total of 15 in

Table 1. Total Casualty in 'Project Tiger' and Pre-Project Tiger Periods.

Forest Block	Chamta 1	Matla 2	Arbesi 3	Gosaba 4	Netidhopani 5	Chandkhali 6	Pirkhali 7	Bagmara 8	Katuashuri 9	Others 10	Total
Pre-Tiger Project period (i) 1960-69 (10 years)	(80)	(41)	8	(37)	17	16	22	22	12	81	336
(ii) 1969-1973 (4 years)	39	36	20	12	13	15	8	—	8	21	172
Total	119	77	28	49	30	31	30	22	20	102	503
Project Tiger period (iii) 1974-1978 upto (Sept.) (5 years)	17	25 (Matla 2 & 3)	16	1	(27)	(52)	(37)	—	17	Panchamukhani 32	224

N.B Bold figures show high incidence of kill of human being during pre and post Project Tiger period.

Table shows casualty figure in 9 blocks out of 15, the last column shows total casualty in 6 blocks (except Panchamukhani). Of the 9 blocks, Chamta, Matla, Gosaba & Bagmara are in core area of Project Tiger where no permit-holders were allowed to enter; obviously the casualty figure was very low in these four blocks.

In columns 6,7 & 10, i.e. the blocks Chandkhali, Pirkhali & Panchamukhani record sudden burst in high casualty figures. It shows that Pirkhali-7 and Netidhapani 1,2 & 3 register 64 casualties, Chandkhali 1,2 & 3 adjacent to Chamta, register 52 casualties. Analysis may be seen in the body of the article.

Table 2. Fluctuations of Casualty in Different Blocks

Block/ Year	1961-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72
Chamta	9	13	7	15	5	10	17	2	4	—
Gosaba	5	5	4	7	1	3	4	5	4	—
Matla	4	3	2	—	3	5	2	5	14	10

	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79 (up to Sept.)
Chamta	1	5	9	8	1	4	3
Gosaba	—	3	—	—	—	—	—
Matla	2	2	1	1	—	—	—

the project area were closed to the permit-holders from 1974 (September); yet the rate of death was the same. This positively indicated :—

(a) Migration of tigers from the blocks which were made out of bound for the permit-holders to the areas where the permit-holders were now working. It is evident that the concentrated zone of the heaviest kill in the Chamta and Matla blocks got diluted owing to migration of tigers to the adjoining Chandkhali, Netidhopani, Panchamukhani and Pirkhali-7 blocks.

Prior to this period the incidence of casualty, especially in Chandkhali and Pirkhali-7, was very low, and the maximum was in Chamta, Matla and Gosaba blocks.

(b) The rhythmic activity in the Tiger behaviour pattern as common with many micro and macro-animals owing to daily tidal movement, lunar cycles, etc. In the past 17 years it has been found that the zone of the maximum kill frequently shifted, and that a particular area did not maintain high incidence of casualty for a long period. In the present case the inactive tiger of Netidhopani, Chandkhali and Pirkhali-7 might have burst into activity owing to lunar periodicities or some endogenous oscillations; or the inherent man-eaters migrated from Chamta and Matla blocks.

(c) Increase in tiger population is also indicated, if the aforesaid analyses of migration and rhythmic activity were not accepted.

(d) The entire land area of all these blocks was not regularly inundated by tidal water.

(e) Salinity and tiger activity might have some positive correlations, but this might be a controversial issue unless proved with sufficient data.

2. It was a conspicuous factor that the Chamta and Netidhopani blocks of forests with an open crop of low height and patches of *Phoenix* (Hental) formation which were above daily tidal inundation level, have recorded high concentration of the tiger.

3. Another very conspicuous fact was that the three blocks-Netidhopani, Chamta and Pirkhali-7, which flank the rivers Netidhopani, Naubanki and Panchamukhani, the entry and exit water route to central and southern Sundarban blocks, record the maximum human casualty.

4. These factors also proved high degrees of intelligence and diabolical understanding of human behaviour by the man-eater of the area. The salinity concentration, therefore, may not be a deciding factor in high human casuality although the Gosaba river flanking Chamta, Netidhopani and Pirkhali has the maximum salinity. Strict protection of the 'core' area of the 'Project Tiger' from the permit-holders were sure to reveal more facts. It is essential that anatomical and biochemical examination of blood, liver and kidney of the man-eaters are made in detail.

5. It should be possible to isolate the Inherent man-eaters and deal with them separately to save loss of precious human lives.

6. Aerial photographs of the Tiger habitat showed limitation of suitable territory, smaller number of saline blanks (such blanks are many and big-sized in Namkhana Range west of the Tiger Reserve). There were too many creeks which made the movement of tigers extremely difficult.

7. There was adequate cover all over the forests.

Discussion and Conclusion.

1. Predatory aberration of Sundarbans Tiger must be looked into carefully and steps taken to mitigate the circumstances leading to acquisition of such behaviour.

The genesis and the tragic death of human being due to predatory aberration of estuarine tiger is perhaps due to combined effect of environmental attributes and human activity pattern. The saline water, muddy terrain, recurrent high tide, dense vegetation etc. coupled with difficulty in preying upon animals bring about a psychological change in the tiger behaviour. This type leads to be cyclic and chronic giving the tiger predatory proficiency.

Habitat amelioration is not possible in this tract but the human activity pattern has to be changed. It may be a necessity to isolate the man-eaters.

2. It follows, therefore, that the study of the habitat and behaviour pattern of Sundarbans tiger is a subject of research and deep study. It is a difficult task. It should be possible to isolate the man-eaters and study

their nature. Creation of large enclosures (if at all possible) in the forest habitat and releasing captured man-eaters to study their behaviour should be the subject of present investigation. Investigation on the blood, urine, kidney, liver, etc. of this animal is an immediate necessity. It is the research, and not management, on tiger which is of prime necessity in this estuarine tract. Fantastically high death rate in Chandkhali, Pirkhali-7 and Netidhopani-5 leads one to accept either of the three theories— (i) migration of inherent man-eaters or (ii) increase or concentration of tiger population or (iii) man-eating tendency revitalised in the dormant ones showing a *rhythmic pattern* of activity.

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AN APPEAL TO SAVE PACIFIC RIDLEY TURTLES FROM MASS-KILLING IN WEST BENGAL AND ORISSA

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Abstract

Pacific Ridley turtles start migrating in large numbers towards the east coast of India from the South-East Asian seas in fall, just before winter. As the migration is made for laying eggs in the coastal sandy beach above the high tide mark, thousands of mature females carrying fertilized eggs are captured by the fishermen and villagers for transportation It has been found that from Puri area alone 10,000 specimens are transported to Calcutta market each month during winter. Capture made in other areas are also high but not properly recorded.

It is pitiable that not only brood females are killed but along with this fortilized eggs are also destroyed. Eggs deposited in the sandy coast are, in many places, destroyed by man and other animals. Young ones, newly hatched from the eggs, are to a great extent destroyed by predators. The species, hence, may soon be extnict. In order to protect this meat-producing turtle from extinction this species should be placed in the schedule of wild animals to be protected under the wild life protection Act of 1972 Need for the establishment of shallow water reserves as turtle sanctuaries both for protection of this species, as well as for regular establishment of turtle fisheries for meat supply is focussed in the original communication.

Pacific Ridley turtles, *Lepidochelys olivacea** are omnivorous, tropicopolitan, aquatic reptiles found in the warm seas especially of Indo-Pacific region. Despite mass-killing of this altruistic species is done every year by human agency, considering their flesh has commercial value in the market as food, these are still found in large rumber in the seas of South-East Asia. Owing to their easy availability and the volume of flesh present in each animal, large number of the females, as the males very seldom come to the coastal area, are captured while coming to the beach for egg laying.

Each year swarms of Pacific Ridley turtles leave their natural abode of the South East Asian seas, in the fall preceding the winter, and a portion of them. probably the Andaman and Nicobar Islands population, migrate towards the Eastern coast of India. In the eastern zone of India large number of catches of the female, therefore, are made with fertilized eggs within, either from the shallow area of the sea and the estuary or while they leave water at night for egg laying and heave their heavy body laboriously across the sand to above the high tide mark. Those which survive can deposit eggs in holes made by them in the sand and then can lumber back to the

*Popularly known as Loggerhead or Olive Ridley.

safe haven of the sea to meet the males waiting off-shore for subsequent copulation. The sperms are stored within the female genital tracts for the fertilization of the eggs in the next breeding season.

The report from World Wildlife Fund, India subscribes that wide spread capture of Pacific Ridley turtles are taking place at the sea side of Puri district, Orissa. The Eastern Regional Office of WWF, India has brought the matters to the attention of the Government as, according to the Asst. Director of Wild life Preservation, Government of India, approximately about 10,000 specimens per month are despatched to Calcutta from Puri alone. As the marine turtles are not yet included in Section 2 of the Wildlife Protection Act 1972 the situation is being watched and it has been thought essential by the Government of Orissa that harvesting of marine turtles by the villagers and fishermen should be gradually controlled.

In the coastal area of West Bengal large numbers of the Pacific Ridley turtles come to breed in the secluded sandy beaches around Digha, Midnapore district and deltaic Sunderbans, 24 Parganas. During winter fishing, these are harvested by the fishermen and villagers for marketing to distant places and also for local consumption. Mostly the mother turtles are caught easily and marketed. It is pitiable that no measure from the Government has so far been taken to curb down indiscriminate killing which, if continues further, is apt to reduce the number to a very large extent within a short time due to the following direct reasons :

(a) Fertilized eggs are destroyed with each brood mother.

(b) Clutches of eggs deposited by the survived mothers are concentrated in small area above high tide mark on the laying beaches while hordes of predators gather to dig most of them up—the destructive predators being man, jackals, street dogs and certain birds.

(c) Due to shortage of mature females competition between waiting males in the offshore area may start for mating which causes the death of some males too in the sea.

(d) After hatching of the eggs that may survive, the baby turtles, on their journey across the beach for water, run the gauntlet of hungry crabs, mammals and hovering sea gulls. Those that survive are met in the water by swarms of predatory fish and sharks. Yet the Ridley turtles are surviving miraculously due to the safe return of some of the youngs and mothers escaped from the hands of fishermen and villagers.

It is considered that this animal should be saved from mass destruction, which may ultimately lead into its extinction. For this, proper care should be taken to prevent marked decline in the population results from the activity of human hunter in waylaying the females on the beach and

capturing them from coastal water before they deposit their eggs. Prohibition of the capture of Pacific Ridley turtles in the breeding season should be included in the Wild Life Protection Act of 1972. Beside this vigilance should be taken to protect the laid eggs on the beach from man, beasts and birds. Shallow-water turtle sanctuaries should be established at places in the line suggested by Hoffmann (1963) for rearing the young turtles and protecting them from predation.

If these measures be taken and wherever possible regular turtle-fisheries are established with proper open and close season for the capture of the turtles, definite profit earning concerns can be established on one hand and protection of this species can be achieved on the other. *It is, therefore, highly desirable that most of the shallow saline water areas of Bengal and Orissa coasts should be developed in the line suggested by Hoffmann for turtle farming.

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*It has been reported that both the Government of West Benga land Orissa have started captive breeding programme of this turtle.

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STUDIES ON BIRD MIGRATION IN CORBETT NATIONAL PARK

By

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Abstract

Migration is a common phenomenon of the animal world, embracing a large number of vertebrates and invertebrates. Most of these animals migrate when faced with hostile weather or when taken up with the urge to breed. Birds top the list of emigrants. Not only a large number of species are involved in these seasonal movements but also the distances covered are often fantastic, from one hemisphere to other across the equator, covering thousands of kilometres. In the Indian sub-continent approximately 350 sub-species of birds have been observed to arrive in autumn and leave in spring. In addition to these winter visitors, a large number of endemic species indulge in various types of short or local migrations. These are known as summer migrants, passage migrants, altitudinal migrants, etc., depending upon the type of migration indulged.

While working on a MAB Project "Impact assessment of biological changes in the faunal patterns brought about by the partial submersion of Corbett National Park as a result of Ram Ganga Multipurpose hydel project". the authors were engaged in enumeration of the avifauna of the Park and in working out the relative densities of certain selected species The daily observations, when compiled in annual ones, revealed that certain species of birds appeared in or disappeared from the Park periodically. It was discovered that out the 587 sub-species of birds observed in the Park, approximately 286 sub-species indulged in one or other type of migration. To augment our knowledge, detailed observations were started. Upto date data on 75 sub-species have been gathered. The high light of the information gathered so far is the periodic appearance of the following species, not reported or observed in this area before.

1. *Gypaetus barbatus aureus* (Hablizl)
2. *Falco vespertinus amurensis* Radde
3. *Larus fuscus fuscus* Linnaeus
4. *Larus icthyaetus* Pallas
5. *Hypopicus hypopicus hyperythrus* (Vigors)

Out of these, number 2, has been recorded very far away (a few thousand km.) from its known ranges. We we have been able to photograph *Falco vespertinus,* a passage migrant to the Park.

I. Introduction

The word 'migration' has been derived from Latin verb 'Migrare' which means to go from one place to another. When applied to most animals, in general, it means their dispersal or immigration, implying no return journey. But when used in context of birds, migration means 'two way journey or say a year round trip with seasonal coming and going.'

Migration is a common phenomenon of the animal world embracing a large number of Invertebrates and Vertebrates. Most of these animals migrate often covering long distances when faced with hostile weather or when taken up with the urge to breed.

Birds top the list as migrants. Not only a large number of species is involved in these seasonal movements but also the distances covered are often tremendous, even from one hemisphere to the other across the equator, covering thousands of miles.

Our knowledge of the bird migration in the Indian subcontinent is based on observations made by naturalists, bird watchers and ornithologists since the later half of nintcenth century, supplimented by bird rining studies undertaken by Bombay Natural History Society in collaboration with Princely states (before Indian independence), Dr. B. Biswas of Zoological Survey of India, World Health Organisation, and Smithsonian Institution of U.S.A.

From 1959 to 1969 within ten years 1,32,368 migratory and resident birds of 25 families which includes 150 species have been ringed by Bombay Natural History Society in different parts of India. Some of these have been recovered from time to time. Upto 1969 a total of 520 ringed birds were recovered. Out of these 451 birds were recovered from outside India, i.e. Burma, East and West Pakistan, Afghanistan, U.S.S.R. and Cyprus. Sixtynine birds were recovered from different parts of India. Also a number of birds have been recovered in India having the rings of the bird ringing centers of Germany, Hungery, and U.S.S.R. (Mathew, 1971)

In Indian subcontinent approximately 350 sub-species of birds have been observed to arrive in autumn and leave in spring. They are mainly palaearctic forms and have to fly over the Himalayas. Highest altitude of flight is recorded at Dehra Dun in India (Dorst, J. 'The migration of birds' page 224) where Geese have been observed to fly at an elevation of nearly 29,500 feet. Some of these palaearctic forms pass through Afghanistan, Pakistan or Nepal before entering India.

In addition to these intereontinental migrants there are innumerable species of Indian birds which indulge in intercontinental migration of some sort or other. These migrant birds show a lot of diversity in their movement. Broadly speaking they can be categorised as follows :

(A) Winter Visitors (or Migrants) :—As the name implies these birds vi it Indian subcontinent in winter. These palaearctic birds have to leave their home land (breeding grounds) on account of very severe winters. They move to warmer places like our subcontinent to tide over this unfavourable period, when food and shelter becomes extremely scarce in their own area. Such migrants often cover thousands of miles during their migration Usually they stay for about 4-6 months at the feeding grounds leaving in early spring.

(B) Summer migrants (or visitors):—These birds are usually residents and move in inter-tropical regions with the change of seasons. This migration does not involves such tremendous distances as in the case of winter visitors. Normally these summer migrants stay for about 3 to 4 months before returning or moving away.

(C) Passage migrants :—The winter migrants and the summer migrants when on their way to or back from the feeding grounds, pass through long stretches, when they are observed locally in waves for very short periods.

(D) Altitudinal migrants :—These birds normally reside and breed at altitudinally distinct ranges but move up or down seasonally during incliment or favourable weather conditions. The birds from higher altitudes may migrate down under severe winter conditions. While birds from lower altitudes may migrate up in summer.

(E) Local migrants :—Certain birds move locally according to the availability of food in the various parts of their habitats. Insectivorous birds may follow the abundance of the insects and the fugivorous ones may move from place to place in accord anes with different fruiting seasons of different plant species.

II. Material and Method

(i) While working for the project "Impact assessment of Bioecological changes in the faunal patterns (Selected groups) brought about by the partial submersion of Corbett National Park as a result of Ram Ganga Multipurpose Hydel Project Dam; especially in the areas contiguous to the proposed water line." The authors had to keep daily records of observations to enumerate and monitor the various avain species in the Park area.

These records revealed that a number of species of birds which appeared in the Park area in a particular part of the year disappeared after sometime. These observations when pursued developed into the theme of this study.

(ii) *Study area* :—The Corbett National Park was established in the year 1937 under the name of 'Haily National Park.' After going through a quick succession of changes in its name it got its present name "Corbett National Park" after the death of Jim Corbett, the celeberated naturalist and shikari from Kumaon. With the coming into being of "Project Tiger" in the year 1973 the Park was declared as one of the nine 'Tiger Reserves' in India. Today the Corhett National Park covers an area of about 529 sq. km. between 29°13′ and 29°35′ N. lat., and 78°33′ and 78°46′ E. long. at an altitude varying from 350 to 1050 m above sea level.

There are three distinct seasons. From November to February the nights can be very cold with much frost and dew, and in the low

lying localities, such as Patlidun, a dense almost freezing, fog lingers often till 10 a.m. From March to the onset of the monsoon, frost and fog are absent, but dew is deposited uptil April. Day temperature rarely exceeds 33°C in the shade during March. The months of Aprial and May are fairly hot, June is the hotest month, but the maximum shade temperature rarely exceeds 44°C even in a bad hot weather. A characteristic feature is the coolness of the nights caused by a cold wind, known as *Dadu*, which blows down the valley, beginning about 9 p.m. and dying down about 8 a.m. In the hot months from the middle of March till the middle of June it is followed by a hot wind blowing up the valleys from 10 a.m. to 10 p.m. during this period, air becomes very dry with much dust in suspension, giving rise to a thick yellow heat haze, which is only interrupted by thunderstorms. From the break of monsoon in mid-June until the middle of September the atmosphere is permanently laden with moisture. The monsoon rains may persist well into October and are followed by a short period of bright warm weather. The average annual rainfall at Sarapduly and Kanda in 1969 was 1609 and 2571 mm respectively. (Supplied by the Indian Meteorological Department).

The Natural forest of the Park is confined to the Bhabar tract of Siwalik formation at altitudes of 350 to 1050 m, with varied topography of many temporary marshy depressions ravines and plateau land. With the construction of a dam for the Ram Ganga Multipurpose Hydel Project at Kalagarh a large fresh water lake has sprung up, which when full, will engulf about 10% of the Park area and almost 80% of the Savanah type grassy glades in the hinterland of the Park.

Vegetation of the Park consists chiefly of dense *Shorea robusta* (Sal) forest, open deciduous and scrub forests consisting chiefly of *Adina cordifolia*, *Holarrhena antidysenterica*, *Bombax ceiba* (the silk cotton tree), *Anogeissus latifolia*, *Piliostigma malabarica*, *Bauhinia racemosa* and *Cassia fistula* (the Indian laburnum). Interspersed in the Sal belt, deciduous and scrub forests are patches of Savanah type grassland. The dominant grass species being *Thimeda rundinaca*, *Thysanolena maxima* and *Vetiveria zizanioides*. Near Dhikala the river bed expands considerably and there are large "Shisham Islands" in the river bed. There are short stretches of Bomboo forest near Taulia chowki, Fulai block and surrounding area of Khinanauli. In all 123 subspecies of trees, 73 subspecies of shrubs, 118 subspecies of herbs, 15 subspecies of climbers and 32 subspecies of grasses have been reported from the park area.

(iii) *Methodology* :—The methodology adopted for this study is very simple. It consists of visual observations in nature. The daily observations are recorded. The daily lists are collated into monthly, seasonal and yearly observations.

The enumerated species are then catagorised into the residents and the migratory one. The migrants of the following catagories are listed separately :—

(A) Winter visitors.
(B) Summer visitors.
(C) Passage migrants.
(D) Altitudinal migrants.
(E) Local migrants.

Enumeration and recording was done by visual means. A 30 × 50 prismatic binocular was used to spot and identify the birds. In case of very shy species like thrushes etc. the monitoring is done by auditory means also. Where it is not possible to identify the bird by sight or sound, efforts were made to photograph it for indentification, by 35 mm Exakta Camera with 200 mm F/4 telephto lens or 1000 mm Quester telelense. In very rare cases of very small and shy birds mist nets were used to capture the birds which were released after identification.

Dates of arrivals and departure of individual species were recorded during two consecutive years. Daily observations were subjected to periodic analysis for relative abundance.

The recorded species were then listed and arranged according to their systematic positions.

III. Observations

(i) We have been able to list a lotal of 577 subspecies of birds out of which 286 subspecies have been observed to indulge in one or other type of migration. All these species are now under detailed observations. Arrival and departure dates of seventy five (75) subspecies have already been recorded (Annexure 1). The following type of migrants were noticed during the study.

(A) Winter Visitors:—Approximately eighteen (18) species of winter visitors were observed during the study. They includes Gerebs, Storks, Ducks, Teals, Pochards, Kites, Harriers, Plovers, Sandpipers, Gulls, Chats, Thrushes and Wagtails.

(B) Summer Visitors:—Five (5) species of summer migrants were observed which includes Swallows, Orioles, and Flycatchers.

(C) Passage migrants:—Seven (7) species of passage migrants were observed which includes, Ibises, Ducks, Falcons, Avocet, Gulls, Cuckoos, and Starlings.

(D) Altitudinal migrants:—Twelve (12) species of altitudinal migrants were observed during the study, which includes, Egrets, Vultures, Lapwings, Pigeons, Nightjars, Woodpeckers, Pittas, Drongos, Red starts, Thrushes and Buntings.

(E) Local migrants:—Local migrants includes thirty-three (33) species which are Cormorants, Darter, Herons, Egrets, Bitterns, Jacanas, Lapwings, Plovers, Pigeons, Doves, Parakeets, Cuckoos, Nightjars, Bee-eaters, Rollers, Hornbills, Barbets, Shrikes, Robins, Chats and Tits.

(ii) Important observations made so far :—

In addition to the records of the aforesaid species of migrants, as are known to visit the area, the following species have been observed as migrant for first time in the Park area :

1. Himalayan Bearded Vulture or Lammereier, *Gypaetus barbatus aureus* (Hablizl).

   According to Salim Ali and Ripley (1968: 314) this species normally remains between 1200 and 4000 metres elevation. We have observed on January 19th, 1977 three specimens of this species at Dhikala Chaud which is situated at an altitude of 385.5 metres.

2. Eastern Redlegged Falcon *Falco vespertinus amurensis* Radde. According to Salim Ali and Ripley (1968: 361), this species has not been reported from N.W. India. Its normal route of migration to and from E. and S. Africa traverses India between 14°-16°N. Latitude in the peninsula. We have observed a flock of approximately 300 individuals in Corbett National Park (29°N Lat) from 29th October to November 2nd, 1977. Photographs of some of birds were taken by 1000 mm Quester telelense.

3. Lesser Blackbacked Gull *Larus fuscus fuscus* Linnaeus. According to Salim Ali and Ripley (1969: 28) its distributional range in western India is upto Delhi in the north.

   We have observed solitary specimens upto 9 appear at the Lakeside in December and disappear in May. They generally keep company of Great Blackheaded Gulls.

4. Great Blackheaded Gull *Larus ichthyaetus* Pallas According to Salim Ali and Ripley (1969: 29) the distributional range of this species is coasts of India, rivers and lakes of Rajasthan, Delhi, Nepal and upper Assam.

   We have observed this species in Corbett National Park appears in flocks of 20 to 40 individuals at Lakeside from December to May.

5. Rufousbellied Woodpecker *Hypopicus hyperythrus* (Vigors). According to Salim Ali and Ripley (1970: 211) this species is resident in Himalayas between 800 to 4100 m.

   We have observed this species in the Park in the month of January 1977, at an altitude of 385.5 m. This is the first record of this species at this altitude (Lamba and Garg, 1977).

Annexure 1*

Winter Visitors :

S No.	Name of the Species	Arrival	Departure
1.	Great Crested Gereb, *Podiceps cristatus cristatus* (Linnaeus)	20.12.77	8.4.78
2	Black stork *Ciconia nigra* (Linnaeus)	19.1.77 2.11.77	17.3.77 11.4.78
3.	Ruddy Shelduck of Brahminy Duck, *Tadorna ferruginea* (Pallas)	29.1.77 15.12.77	4.6.77 24.5.78
4.	Common Shelduck, *Tadorna tadorna* (Linnaeus)	20.12.76 1.1.78	16.2.77 6.3.78
5.	Common Teal *Anas crecca crecca* Linnaeus	30.12.77	16.4.78
6.	Redcrested Pochard, *Metta rufina* (Pallas)	20.2.77 22.10.77	—— 6.3.78
7.	Brahminy Kite, *Haliastur indus indus* (Boddaert)	9.1.77 26.9.77 4.8.78	19.2.77 14.3.78 ——
8.	Pale Harrier. *Circus macrourus* (S.G. Gmelin)	1.12.77	27.2.78
9.	Indian little Ringed Plover, *Charadrius dubius jerdoni* (Legge)	17.1.77 29.9.77	18.6.77 19.6.78
10.	Green Sandpiper *Tringa ochropus* Linnaeus	20.12.77	6.5.78
11.	Wood or Spotted Sandpiper, *Tringa glareola* Linnaeus	20.12.76	5.5.77
12.	Common Sandpiper, *Tringa hypoleucos* Linnaeus	3.12.77	6.5.78
13.	Lesser Blackbacked Gull, *Larus fuscus fuscus* Linnaeus.	3.2.76 1.12.77	—— 6-5.78
14.	Great Blackheaded Gull, *Larus ichthyactus* Pallas	19.12.77 4.12.77	31.3.77 6.5.78
15.	Tibetan Collared Bush Chat, *Saxicola torquata prezevalskii* (Pleske)	31.1.77 28.10.77	18.4.77 15.4.78
16.	Blackthroated Thrush *Turdus ruficollis atrogularis* Jarocki	19.1.77 23.1.78	18.4.77 22.2.77
17.	Blueheaded yellow Wagtail, *Motacilla flava beema* (Sykes)	13.1.77 2.10.77	3.5.77 27.4.78
18.	Indian White Wagtail, *Motacilla alba dukhunensis* Sykes	1.12.76 2.10.77	3.5.77 18.3.78
	Summer Visitors		
1.	Indian Wiretailed Swallow, *Hirundo smithii filifera* Stephens.	20.4.77 11.4.78	3.10.77 ——
2.	Indian Cliff Swallow, *Hirundo fluvicola* Blyth	13.2.77	8.8.77
3.	Indian Golden Oriole, *Oriolus oriolus Kundoo* Sykes	4.6.77 20.4.78	29.10.77 10.8.78
4.	Verditer Flycatcher, *Muscicapa thalassina thalassina* Swainson	5.3.78 5.8.78	19.4.78 ——
5.	West Himalayan Paradise Flycatcher, *Terpsiphone paradisi leucogaster* (Swainson)	8.4.77 6.4.78	8.8.77 8.8.78
	Passage migrants.		
1.	Glossy Ibis, *Plegadis falcinellus falcinellus* (Linnaeus)	20.12.76	22.12.76
2.	Scaup Duck, *Aythya marila marila* Linnaeus	13.1.77 1.1.78	28.1.77 18.1.78
3.	Eastern Redlegged Falcon, *Falco vespertinus amurensis* Radde	29.10.77	2.11.77

4.	Avocet. *Recurvirostra avosetta* Linnaeus	9.4.78	23.4.78
5.	Brownheaded Gull, *Larus brunnicephalus* Jerdon	3.4.77	25.5.77
6.	Pied Crested Cuckoo, *Clamator Jacobinus serratus* (Sparrman)	17.6.77 19.6.78	5.8.77 2.8.78
7.	Common Indian Starling *Sturnus vulgaris poltaratskyi* Finsch	1.12.77	24.2.78
	Altitudinal Migrants		
1.	Cattle Egret, *Bubulcus ibis coromandus* (Boddaert)	18.12.76 1.12 77	16.6.77 19.5.78
2.	Himalayan Bearded Vulture or Lammergeier, *Gypaetus barbatus aureus* (Hablizl)	19.1.77	——
3.	Redwattled Lapwing *Vanellus indicus indicus* (Boddaert)	12.1.77 20.1.78	18.6.77 6.8.78
4.	Kokla or Wedgetailed Green Pigeon, *Treron sphenura sphenura* (Vigors)	17.1.77	——
5.	Himalyan Jungle Nightjar, *Caprimulgus indicus hazarae* Whistler & Kinner	12.1.77 19.2.78	2.10.77 6.8.78
6.	Refousbellied Woodpecker *Hypopicus hyperythrus* (Vigors)	27.12.76 3.12.77	4.2.77 8.3 78
7.	Hooded or Green breasted Pitta, *Pitta sordida cucullata* Hartlaub	4.5.77 14.5.78	5.8.77 ——
8.	North Indian Black Drongo or King Crow, *Dicrurus adsimilis albirictus* (Hodgson)	18.12.76 13.12.77	8.8.77 ——
9.	Plumbeous Redstart, *Rhyacornis fuliginosus fuliginosus* (Vigors)	26.12.76 27.10.77	4.5.77 20.4 78
10.	Whitecapped Redstart or River Chat, *Chaimarrornis leucocephalus* (Vigors)	29.1.77 1.11.77	24.3.77 12.2.78
11.	Himalayan Whistling Thrush, *Myiophoneus caeruleus temminckii* (Vigors)	13.12.76 2.11.77	5 5.77 20 3.78
12.	Crested Bunting, *Melophus lathami* (Gray)	13.1.77 29.9.77	2.4.77 28.4.78
	Local migrants		
1.	Large Cormorant, *Phalacrocorax carbo sinensis* (Shaw)	4.12.77	4.8.78
2.	Little Cormorant, *Phalacrocorax niger* (Vieillot)	19.12.76 28.10.77	16.6.77 16 4 78
3.	Darter or Snake-bird, *Anhinga rufa melanongaster* Pennant	3.1.77	9.8.78
4.	Eastern purple Heron, *Ardea purpurea manilensis* Meyen	1.11.77	16.6.78
5.	Indian Pond Heron or Paddybird, *Ardeola grayii grayii* (Sykes)	22.12.76 1.12.77	25.2.77 24.5.78
6.	Little Egret, *Egretta garzetta garzetta* (Linnaeus)	26.1.77 24.12.77	18.6.77 6.5.78
7.	Night Heron, *Nycticorax nycticorax nycticorax* (Linnaeus)	6.1.77	4.6.77
8.	Chestnut Bittern, *Ixobrychus cinnamomeus* (Gmelin)	1.1.77 1.12.77	4.8.77 10.8.78
9.	Pheasant-tailed Jacana *Hydrophasianus chirurgus* (Scopoli)	28.10.77	7.4.78
10.	Spurwinged Lapwing *Vanellus spionosus duvaucelii* (Lesson)	24.1.77 20.12.77	17.6.77 19.6.78
11.	Great Stone Plover, *Esacus magnirostris recurvirostris* (Cuvier)	8.4.77 31.1.78	12.6.77 6.5.78
12.	Bengal Green Pigeon, *Treron phoenicoptera phoenicoptera,*	6.4.77 24.4.78	19.12.77 ——

13.	Indian Ring Dove *Streptopelia decaocto d. caocto* (Frivaldszky)	4.1.77 30.1.78	1.10.77 ——
14.	Indian Red Turtle Dove, *Streptopelia tranquebarica tranquebarica* (Hermann)	5.12.76 4.2.78	6.8.77 9.8.78
15.	Indian Spotted Dove, *Streptopelia chinensis suratensis* (Gmelin)	27.12.76 10.12.77	30.10.77 ——
16.	Large Indian Parakeet, *Psittacula eupatria nipalensis* (Hodgson)	18 12.76 3.12 77	15.4.77 18.4.78
17.	Northern Blossomheaded Parakeet, *Psittacula cyanocephala bengalensis* (Forster)	17.1.77 9.12 77	3.6.77 21.6.78
18.	Himalayan Slatyheaded Parakeet *Psittacula himalayana* (Lesson)	7 2.77 20.12 77	—— 20.4.78
19.	Common Hawk-Cuckoo or Brainfever Bird, *Cuculus varius varius* Vahl	6 4 77 5.3.78	8.8.77 10.8.78
20.	Indian Cuckoo *Cuculus micropterus micropterus* Gould	6.4 77 10.4.78	16.6.77 20.6.78
21.	Indian Koel *Eudynamys scolopacea scolopacea* (Linnaeus)	6.4.77 5.3.78	29.9.77 ——
22.	Indian Jungle Nightjar, *Caprimulgus indicus indicus* Latham	12.1.77	8.5.77
23.	Bluetailed Bee-eater, *Merops philippinus philippinus* Linnaeus	1.5.77 11.4.78	8.8.77 9.8 78
24.	Indian small green Bee-eater, *Merops orientalis orientalis* Latham	25.2.77 27.2.78	2.10.77 ——
25.	Northern Roller or Blue Jay, *Coracias benghalensis benghalensis* (Linnaeus)	15.3.77 23 2.78	8.8.77 8.8.78
26.	Himalayan Broadbill Roller *Eurystomus orientalis cyanicollis* Vieillot	4 5.77 26.4.78	8.8.77 ——
27.	Indian Pied Hornbill, *Anthracoceros malabaricus malabaricus* (Gmelin)	3.4.77 1.4.78	8.8 77 5.8.78
28.	Great Pied Hornbill, *Buceros bicornis homrai* Hodgson	30.7.77 1.8.78	1.10.77 ——
29.	Himalayan Great Barbet, *Megalaima virens marshallorum* Swinhoe	16.3.77 20.3.78	16.6.77 ——
30.	Rufousbacked Shrike *Lanius schach erythronotous* (Vigors)	20.12.76 3.8.77 2.8.78	29 4 77 11.4.78 ——
31.	Indian Magpie-Robin, *Copsychus saularis saularis* (Linnaeus)	25.3.77 26.2.78	25.12.77 ——
32.	Northern Pied Bush Chat, *Saxicola caprnta bicolar* Sykes	25 2.77 23.2.78	31.10 77 ——
33.	Nepal Grey Tit, *Parus major nipalensis* Hodgson	16.12.77	10.8.78

*Revised and brought upto date till August 1978.

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THE GHARIAL [*GAVIALIS GANGETICUS* (GMELIN)]: STATUS AND SOME SUGGESTIONS FOR PRESERVATION AND PROPAGATION

By

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Abstract

The present status of gharial *(Gavialis gangeticus)* has been given. Attempts for its preservation during last two decades have been reviewed. In view of the present danger to this species, it is suggested that a pilot project for its farming should immediately be started in Bihar, where some natural habitats of this species are still existing along the Kosi and Gandak rivers.

I. Introduction

The gharial, *Gavialis gangeticus*, was once very commonly found in the rivers of North India. Smith (1931) reported its occurrence in the Indus, Ganges, Mahanadi and Brahmputra rivers as well as their tributaries and in the Kaladan river, Arakan, in Burma. A few decades ago they could easily be observed basking in groups of 20 to 30 at suitable places on the banks of these rivers. In the persuit of trophies, luxury goods like shoes and lady's handbags, etc. man has been wantonly killing these harmless creatures. Pressing needs for agricultural and other developmental activities of man have also resulted in the loss of natural habitat of gharials. They have so acutely diminished in number and distribution that the I.U.C.N. has included *Gavialis gangeticus* in its Red Data Book under endangered species. Since 1969, the Government of India, the I.U.C.N. and the Indian naturalists (Misra, 1969) have been seriously devoting their attention to the cause of preservation and propagation of gharials.

In 1971, a meeting of the I.U.C.N. Crocodile Specialist Group was held to try to initiate steps to at least increase our knowledge of the status of the gharial, a prerequisite step for its protection. Dr. H.R. Bustard, Founder-Secretary of this group, agreed to undertake this work. He conducted a three-month field investigation beginning May, 1974, in ten states where three crocodilian species are or were once found. During this investigation, U.P., Orissa and Rajasthan and subsequently, in 1975, Bihar, were surveyed by Dr. Bustard, for gharial habitats. Whitaker et al. (1974) also made a preliminary survey of the gharial. The findings of these surveys and the recommendations contained in the report submitted

to the F.A.O. (1974) by Dr. Bustard are summarised in two papers by Bustard (1975 & 1976).

On the basis of availability of all the three endangered Indian crocodilian species *Crocodylus palustris, C. porosus* and *Gavialis gangeticus* and extremely favourable husbandary conditions, Bustard (1975) suggested the location of pilot farming project in Orissa and West Bengal. Accordingly a Central Co-ordinated battery type farm for gharial was established at Satkosia Gorge (Tikerpara, Orissa). Recently, a number of papers dealing with various aspects of the life of gharial have been contributed by Acharjyo, Biswas and Misra (1975), Biswas (1970), Bustard (1975), Bustard and Singh (1977), Misra (1969), Murthy and Menon (1977), Shahi (1974), L.A.K. Singh (1976), V.B. Singh (1975), Singh and Bustard (1977 and in press a, b), Venkateswarlu (1975), Venkateswarlu, Nath and Sanyal (1971) and Whitaker et al. (1974).

Appreciating the steps for protection of gharials and other animals like tiger and Blackduck, the Govt. of India have categorised them in Schedule I of the Wild Life (Protection) Act, 1972 declaring them as threatened with extinction. Various suggestions have been enumerated by Shahi (1974) and Bustard (1975, 76). It is evident that these steps have not yielded desired results. The attempts of the officials of Forest Department of U.P. (V.B. Singh, 1975) and pilot farming project at Satkosia Gorge (Orissa) do not appear to have been very fruitful in the propagation of gharials.

It is felt that the potential areas regarding availability of *Gavialis gangeticus* have not been properly assessed by earlier workers. The reports by Venkateswarlu, Nath and Sanyal (1971) and Shahi (1974) indicate that gharials are still frequently found in Bihar specially in the river Narayani, also known as Gandak, and the river Kosi. Our recent enquiries lead us to believe the continued existence of gharials around Patna where the Gandak or the Narayani river joins the river Ganges on its northern bank. The reports of gharials of various age and sizes reaching Patna fish market can be heard frequently. Due to legal complications the fishermen and public are shy to divulge the details regarding persons involved in the trade of gharials. Only the story about the arrival of gharials to fish markets remain.

II. Suggestions for Preservation

Due to ineffective legal protection and continued poaching the threat to the extinction of *Gavialis gangeticus* is becoming greater with the passage of every day. The fate of attempts at Satkosia Gorge (Orissa) is uncertain. Therefore, it is suggested that attempts should be made to provide greater protection to this species in Bihar and U.P. where the natural habitats of this species are still available.

Since we cannot be sure of the results of our protection measures, a pilot farming project should immediately be started in Bihar where natural habitats are still reported to be available. The location of this farm should be decided after examination of various factors. Once this pilot project gets going, young gharials can be distributed to state forest departments and zoos where they can enjoy comparatively secure life at least for a few years till suitable protective measures can be enforced by state forest departments.

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VEGETATION OF NATIONAL PARK AND SANCTUARIES OF ASSAM

By

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Abstract

The largest plain in North-east India is the Brahmaputra valley. This riverine area is not only of great significance for agriculture and industry of this region, but also for its rich vegetation preserved in the National Park and the wild life sanctuaries. There are six sanctuaries viz Manas, Orang Garampani, Sonai-Rupa, Pava and Laokhowa, and one National Park i e Kaziranga National Park. The author has studied the flora and vegetation of all the sanctuaries and the National Park of the Brahmaputra valley. The accounts of plants are under preparation. The paper describes the location, area, vegetation types, important constituents of forest vegetation and conservation aspects

I. Introduction

The largest plains in North-east India is the Brahmaputra valley. This riverine area is not only of great significance for agriculture and industry of this region, but also for its rich vegetation preserved in the National Park and the Wild life sanctuaries. There is one National Park i.e. Kaziranga National Park and six sanctuaries, viz. Manas, Orang, Sonai-Rupa, Garam Pani, Pava and Laokhowa.

Several paper have been published on the importance of Wild Life in India, but they deal primarily with animal life. Almost nothing has been written about the plant cover that constitutes the natural environment in which the animal exists. It is most urgent to pay our attention to the nature of plant life in the National Parks and Sanctuaries of the country.

Lately, however several papers have emphasised the need to study the flora and vegetation of such areas, as well as the significance of conserving the rare and endangered species (Maheshwari, 1963, 1971; Naithani, 1966; Qureshi & Kaul, 1971; Sahni; 1971, Santapau, 1969, 1971; Subramaniyam and Jain, 1972; Vartak, 1975).

The current research projects of Botanical Survey of India, Eastern Circle include a survey of the existing plant resources of National Park and Sanctuaries of North East India. The author has studied the flora and vegetation of all the sanctuaries and National Park of the Brahmaputra Valley and the accounts of plants are under preparation. The present

paper describes the location, area, vegetation types, important constituents of forests vegetation and conservation aspects.

II. Kaziranga National Park

The Kaziranga National Park is in the Nowgang and Sibsagar districts of Assam. It is bounded in the north and west by the Brahmaputra river, in the south by Mora Diphalu river, Mikir Hills and different villages of Nowgang and Sibsagar districts, in the east and west by Nowgang and Sibsagar districts. The terrain is flat with an area of about 450 sq. km. It is reached by road, from Gauhati (217 km.).

Kaziranga was constituted as Wild Life Reserve in 1916 and it has been administered as Wild Life Sanctuary. This Wild Life Sanctuary has been converted into National Park in 1974.

Vegetation:—The vegetation of Kaziranga National Park can be broadly classified into (i) Eastern alluvial grasslands (Inundated Type of Rajkhowa, 1961), (ii) Northern tropical wet evergreen forests, (iii) Northern tropical semi-evergreen forests.

(i) *Eastern alluvial grasslands* :—

There are extensive patches of grasslands in Kaziranga and the dominant grasses are *Saccharum procerum, Saccharum spontaneum, Vetiveria zizanioides, Themeda villosa, Apluda mutica, Arundinella bengalensis, Digiteria setigera, Hygroryza aristata, Narenga porphyrocoma, Phragmites karka, Sclerostachya fusca* etc. Almost two-third of the park is covered by grasslands. Amidst grasses there are number of herbaceous plants and some scattered trees of *Salmalia malabarica, Dillenia indica, Careya arborea, Emblica officinalis* etc.

(ii) *Northern tropical wet evergreen forests* :—

Besides grassland there are patches of evergreen forests near Kanchanjhuri, Panbari and Tamulipathar block. The common trees in these forests are *Aphanamyxis polystachya, Dillenia indica, Syzygium balsamifera, Talauma hodgsonii, Garcinia tinctoria, Ficus rumphii, Cinnamomum bejolghota* etc.

(iii) *Northern tropical semi-evergreen forests* :—

(Assam Valley semi-evergreen forests of Rajkhowa, 1961)

This type occurs in the Baguri, Bimali and Haldibari surrounding. Here the common trees are *Albizia procera, Duabanga grandiflora, Lagerstroemia speciosa, Crateva unilocularis, Sterculia urens, Grewia serrulata, Mallotus philippensis, Bridelia retusa etc.*

III. Manas Wild Life Sanctuary

The Sanctuary falls under the Tiger Project area of Assam and is bounded in the north by the International boundary between India and Bhutan, in the south by the thickly populated regions of north Kamrup district of Assam but in the east and west the different reserved forests of the sanctuary either extend into other forests or are separated by cultivated fields and gardens. Of the total area of 2837 sq. km. under the Tiger Project Manas has about 580 sq. km. It was established in 1928. The terrain is a flat land gently sloping to the south with a number of rivers draining from north to south.

Vegetation:—The vegetation of Manas Wild Life Sanctuary is basically (i) Eastern Wet alluvial grasslands but there are patches of (ii) Eastern *Dillenia* swamp forests (High savanah *Salmalia-Albizia* type of Rajkhowa, 1961), (iii) Assam alluvial plains semi-evergreen forests and (iv) Tropical Riparian fringing forests.

(i) *Eastern Wet Alluvial grasslands* :—

There are extensive patches of grasslands and the common grasses are *Apluda mutica*, *Brachiaria*, *Chrysopogon aciculatus*, *Cynodon dactylon*, *Cyrtococcum accrescens*, *Digitaria ciliaris*, *D. longiflora*, *Echinochloa colonum*, *Eleusine indica*, *Erianthus longisetosus*, *Hemerthria protensa*, *Imperata cylindrica*, *Neyraudia reynaudiana*, *Saccharum procerum*, *Saccharum spontaneum* etc. In the grasslands several tree species occasionally grow, these are *Dillenia pentagyna*, *Emblica officinalis*, *Bombax ceiba*. The common shrubs and herbs are species of *Clerodendrum*, *Grewia*, *Premna* and *Mussaenda*.

(ii) *Eastern Dillenia Swamp forests* :—

A fairly dense forest of medium height with many evergreen and semi-evergreen species and this type occurs on flat topography which is flooded during the wet seasons but drying out between. This type of vegetation is met with near Mothanguri and Uchilla Beat of Manas Sanctuary.

The outstanding species in this area are *Dillenia indica*, *Bischofia avanica*, *Albizia procera*, *Lagerstroemia speciosa*, *Terminalia chebula*, *Bombax ceiba*, *Duabanga grandiflora* etc.

(iii) *Assam alluvial plains semi-evergreen forests* :—

In this type of vegetation common trees are *Aphanamixis polystachya*, *Anthocephalus chinensis*, *Syzygium cumini*, *S. formosum*, *S. oblatum*, *Bauhinia purpurea*, *Mallotus philippensis*, *Cinnamomum bejolghota*, *Actinodaphne obovata* etc.

The undergrowth consists mainly of *Leea aequata*, *Coffea bengalensis*, *Pjhlogacanthus thyrsiflorus*, *Adhatoda vasica*, *Piper diffusum* etc. This kind of

vegetation is met chiefly along the International boundary of India and Bhutan.

(iv) *Tropical Riparian fringing forests* :—

This type of vegetation is met with along the banks of Manas, Mora Manas, Jongrong, Gyati and Rabang rivers inside the Sanctuary. A few species of large trees forming a narrow fringe along the water courses. They stand widely spaced with smaller trees and shrubs between and often much coarse grass mainly *Saccharum* spp. The common trees are *Bischofia javanica, Polyalthia simiarum, Aesculus assamica, Lagerstroemia speciosa, Bridelia* sp., *Macaranga denticulata, Litsaea salicifolia, Trema orientalis* etc.

IV. Orang Wild Life Sanctuary

Orang Wild Life Reserve was constituted in 1915. It is proposed to upgrade it as a Sanctuary which is under the consideration of Government. The Reserve is in the Darrang District of Assam and the area is about 24 sq. km. It is 260 km from Gauhati by road on the Gauhati-Tezpur road. The area is surrounded by different villages of Darrang District, Dhansiri river and Brahmaputra river.

Vegetation:—The vegetation of Orang is basically (i) Eastern wet alluvial grasslands. In the grasslands several tree species are occasionally found. The common grasses are *Saccharum spontaneum, Saccharum procerum, Imperata cylindrica, Themeda villosa, Apluda mutica, Arundinella decempedalis, Erianthus longisetosus* etc.

V. Sonai-Rupa Wild Life Sanctuary

The Sanctuary is in the Darrang District of Assam. It is bounded in the north by the boundary of Kameng district of Arunachal Pradesh and in the south, east and west by different villages of Darrang district. The total area is about 195 sq km and was established in 1934 (approved by Government but formally not notified as such).

The forest is very much disturbed and as the Michamari Army establishment is very near to the Sanctuary most of the wild animals are not seen near the boundary.

Vegetation:—The vegetation of Sonai-Rupa Sanctuary can be broadly classified into (i) Tropical moist and dry deciduous forests, (ii) Tropical semi-evergreen forests and (iii) Alluvial grasslands.

(i) *Tropical moist and dry deciduous forests* :—The dominant species are *Bombax ceiba, Sterculia villosa, Dillenia pentagyna, Emblica officinalis, Gmelina arborea* etc.

(ii) *Tropical semi-evergreen forests* :—The dominants are *Dillenia indica, Saracca indica, Polyalthia simiarum, Aphanamyxis polystachya, Duabanga grandiflora, Ficus* spp., *Elaeocarpus* sp., *Aesculus assamica, Canarium* sp. etc.

(iii) *Alluvial grasslands* :—In the grasslands common grasses are species of *Cymbopogon* (lemon grass), *Saccharum* etc. *Calanthe angusta* a very rare ground orchid is very common in this area.

VI. Garampani Wild Life Sanctuary

The Garampani Wild Life Sanctuary is a small area of less than 3 sq km was constituted as a Sanctuary in 1952 in the Nambor Reserve of Sibsagar district and Karbi Anglong and is famous for wild elephants.

Vegetation:—The vegetation is basically Uppar Assam Valley Tropical Evergreen Forests. The dominants are *Dillenia indica, Talauma hodgsoni, Garcinia ovalifolius, Garcinia tinctoria, Camellia caudata, Camellia drupifera, Vatica lanceaefolia, Mansonia dipikae, Pterospermum lanceaefolium, Sterculia roxburghii, Elaeocarpus granitus, Aglaia spectabilis, Aphanamixis polystachya, Canarium benghalensis, Caralia brachiata, Syzygium bracteata, Syzygium formosum, Duabanga grandiflora, Castanopsis kurzii, Knema angustifolia, Saraca indica* etc.

VII. Pava Game Reserve

It was notified as a Reseve in 1941 and since then it is known as Milroy's Buffalo Sanctuary although no formal notification has been issued by Government.

Vegetation :—The vegetation is basically of (i) Tropical semi-evergreen forests and (ii) Alluvial grasslands. In the semi-evergreen forests common plants are *Dillenia indica, Aphanamyxis polystachya, Bischofia javanica, Crataeva religiosa, Trewia nudiflora, Salmalia malabarica, Schumannianthus dichotomus* etc.

VIII. Laokhowa Wild Life Reserve

It has been notified in the year 1905 as Laokhowa Game Sanctuary for the purpose of closing the area to hunting of animals.

Vegetation :—The vegetation can be broadly classified into (i) Eastern Wet alluvial grasslands and (ii) Eastern *Dillenia* Swamp forest. The dominants are *Bombax ceiba, Albizia procera, Lagerstroemia speciosa, Dalbergia sissoo, Grewia semulata, Saccharum spontaneum, Saccharum procerum* etc.

IX. Utilitarian aspects of the Flora

The vegetation and flora of the Sanctuaries and National Parks have considerable utilitarian value. The wild animals in the National Park

and Sanctuaries depend on the plants for their food. The following plants are eaten by wild animals. The local names of plants eaten by wild animals are given against each species, such as *Alpinia alughas* (Tora), *Musa ornata* (Kal-Goss), *Saccharum procerum* (Kush-Bon or Ikara), *Saccharum spontaneus* (Kush-Bon), *Eichhornia crassipes* (Pani-Meteca), *Albizia odoratissima* (Sirish), *Albizia procera* (Koroi), *Bombax ceiba* (Simolu), *Dillenia indica* (Ou-Tenga), *Calamus floribundus* (Bet), *Ficus scandens* (Dimoru), *Lippia geminata* (Bon-Tulshi), *Alternanthera sessilis* (Mati-Kaduri), *Oenanthe stolonifera* (Bon-Joni), *Hygroryza aristata* (Dal-Ghah) etc.

The flora of the sanctuaries includes also some well-known medicinal and economic plants such as : *Phyllanthus emblica, Terminalia bellirica, Terminalia chebula, Rauvolfia serpentina, Hodgsonia macrocarpa, Stephania hernandifolia, Dillenia indica, Gmelina arborea, Toona ciliata, Calamus floribundus, Dioscorea bulbifera* and *Dioscorea pentaphylla.*

X. Endangered Plants

It is of common knowledge and now matter of concern that many plants are becoming scarce in nature and unless early and planned steps are taken for their conservation many of them may become rare in their original homes or may ultimately become extinct. The National Park and Sanctuaries provide good habitat for conservation of endangered plants as of other flora and fauna. The author has collected many endangered species from the National Park and Sanctuaries of Assam, such as, *Gnetum gnemon, Gnetum scandens, Rauvolfia serpentina, Helminthostachys zeylanica, Dischidia rafflesiana, Anoectochilus sikkimensis, Acanthephippium sylhetense, Eulophia mannii* etc.

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STUDIES ON THE HANUMAN LANGUR, *PRESBYTIS ENTELLUS* (Dufresne) (PRIMATES CERCOPITHECIDAE), AT KANHA NATIONAL PARK, M.P.

By

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(1 Plate)

Abstract

Socio-ecological observations were recorded on the langurs of Kanha National Park in the month of April, 1977. Fifty one groups were located and the group composition of forty was studied. The average group size was worked out to be 17.47 and 8.22 for bisexual and all-male-groups respectively. Most of the bisexual groups had one male. The adult sex ratio was 1 : 6.757. Observations were made regarding home range, roosting places, feeding habits and social interaction within the group. A list of plants and part of the plants on which they were observed feeding is provided.

I. Introduction

The present paper deals with the studies made on the socio-ecological aspects of *Presbytis entellus* (Dufresne) in Kanha National Park, Mandla and Balaghat district, M.P. during March-April, 1977.

Studies of Jay (1965) and Sugiyama (1967) at Orcha village near Bastar and Raipur respectively, were in Madhya Pradesh and close to the present study area. Kurup (1964) and Rahaman (1973) made available a good account on social life and allied aspects of the langur in Gir Sanctuary, Gujarat. In Ceylon, Ripley (1967) studied forest population of the gray langur, *Presbytis entellus thersites.* All the above studies were wholly or partly forest-based.

II. Description of the study area

A brief description and ecological condition in the area is provided here. The Park extends between latitudes 22°00′ and 22°30′ N. and longitudes 88°25′ and 81°07′ E. in the two districts, Mandla and Balaghat, of Madhya Pradesh. The heart of the park, Kanha forest village, is about 54 km. southeast of Mandla town. It was constituted as National Park in the year 1955 with an area of 253 sq. kms. The area of the park gradually increased and now it has an area of 1208.15 sq. km. The park is a stretch of wild and hilly country with a broad tableland surrounded

in circular manner by range of hills, about 914 m high in the northern part of the park. The southern part of the park is mainly hilly with chain of hills of varying heights. The top of hills are flat. The main portion of the park is a plateau rising up to 893 m. above MSL.

The geology of the area is associated with the formation of the Deccan trap. The common soil of the trap area in the lowlying portion is stiff clayey black soil or black cotton soil. In other parts, the soil is pale or yellow sandy known as 'Sahara'

Rainfall is fairly heavy with average annual rainfall about 1825 mm. Sinha and Singh (in press) have recorded 2606 mm and 2568 mm rainfall in 1970 and 1971 respectively. The maximum rainfall (upto 95 per cent) was recorded during rainy season (June-October). The park falls under the catchment area of Banjar river, a main tributary of river Narmada. There are a few perennial streams and a large number of seasonal streams present in the park. Water remaining in numerous pools in these nalas throughout the year. There are three perennial tanks, namely Shravantal, Kislital and Deotal. In spite of these tanks, park authorities are maintaining at least 10 dams and anicuts in the different parts of the park to provide sufficient water to wild life during the pinch period.

Both moist deciduous and dry deciduous forests occur in the same area as the area is in the transition of the two type of forests. Major portion of the park is occupied by mixed forest with considerable portion under sal forest. The forest beneath the canopy in the meadow is quite open and conspicuous, second storey is generally absent (see Plate 1). (For a fuller description of the park ecology, see Sinha and Singh, in press.).

The study was confined to the western part of the park although few trips were made to eastern part also.

III. Equipments, period and methods of study

The present report is based on a study of the langurs between 31.3.77 and 16.4.77 at the Kanha National Park. The following seasonal factors helped during recording observations.

(a) During the period of study many trees were more or less leafless, promoting visibility.

(b) Because of scarcity of water in the season the groups were concentrated around few water holes which could easily be located.

(c) During this period the ground is completely covered with fallen dry leaves. Any slight movement on the leaves produces sufficient noise to detect the moving object. The roads were always free from leaves because park authorities cleared them for fire lines. This helps noiseless movement of the observer.

(d) Association of langur with deer especially of chital is a common phenomenon and has also helped to locate langurs easily.

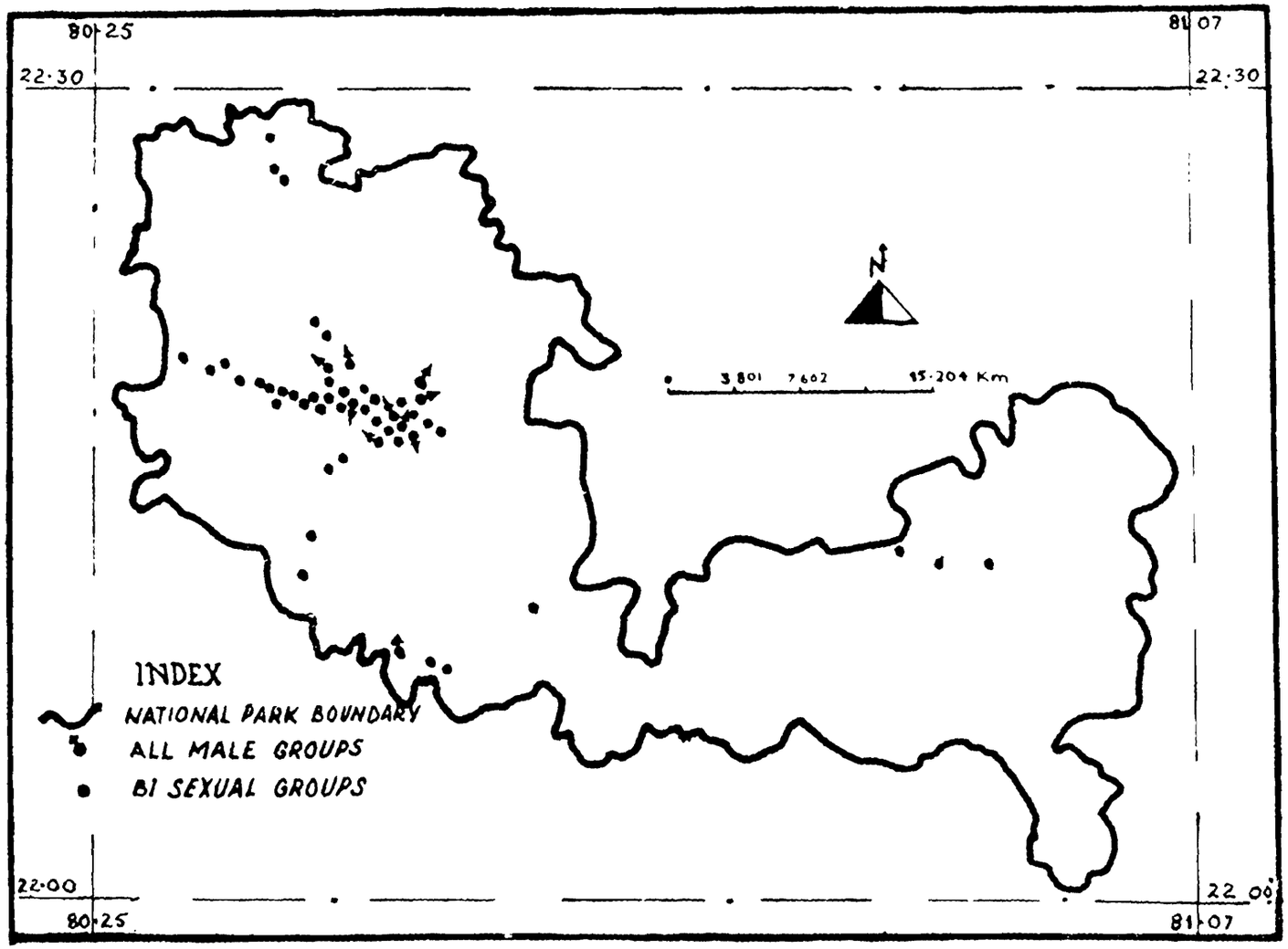
Nearly all important roads and water holes were searched for presence of langurs. Two of the groups at Deshi Nala were followed for whole day and observations recorded were with respect to home range, roosting places and social interactions within and between the individuals of two groups. Arrangements were also made to identify trees and shrubs on which langurs fed.

IV. Observation

(A) *Population*—During the study period at Kanha, 51 groups of langurs were located. Of these, 48 belong to western region and 3 to the eastern region. Although more groups were reported, only those groups which were actually seen, were marked on the map (Text-fig. 1). Forest department census figure, 1975 showed that there are 2453 langurs in the park. During the period of study only 599 were observed. The distribution of groups appears more or less uniform in the park. A total of 599 langurs were counted in 40 groups and composition of these groups was studied (Table 1). Out of forty, thirty were bisexual groups, nine all male groups and one solitary male. Among the bisexual groups, the largest one had 45 individuals and the smallest five. The average group size was 17.47 at Kanha, whereas the average for Hanuman langur was reported to be 15.1 at Dharwar, Karnataka (Sugiyama *et al.*, 1969) and 18.6 at Orcha village in Bastar (Jay, 1965 : 206). The adult sex ratio was 1: 6.757 at Kanha whereas the ratio was 1: 4.4 at Dharwar (Sugiyama et al., 1969) and 1: 1.5 at Orcha village, Bastar (Jay, 1965 : 207). Among the all male groups, the largest group had 14 individuals and smallest five. The average group size was 8.22. Frequency of occurrence of different group sizes was shown (Text-fig. 2). One solitary male was seen near Mukki village of the park.

Most of the groups (65% studied at Kanha) were one male reproductive groups, while 10% multimale reproductive groups, 22.5% all male groups and 2.5% solitary male. It has been noted that members of a group often gather in small parties, irrespective of age, sex and status. It was interesting to note that juvenile, infant and male were never seen together Some forest dwellers had informed that there were some macaque (*Macaca mulatta*) groups in the eastern region of the park but none was encountered during the trips.

(B) *Home Range and Roosting Places*—Two groups near the rest house at Deshi Nala anicut were selected for detailed studies such as daily movement, number of roosting places, extent of home range and other social interactions. The movement of groups was drawn (Text-fig. 3).

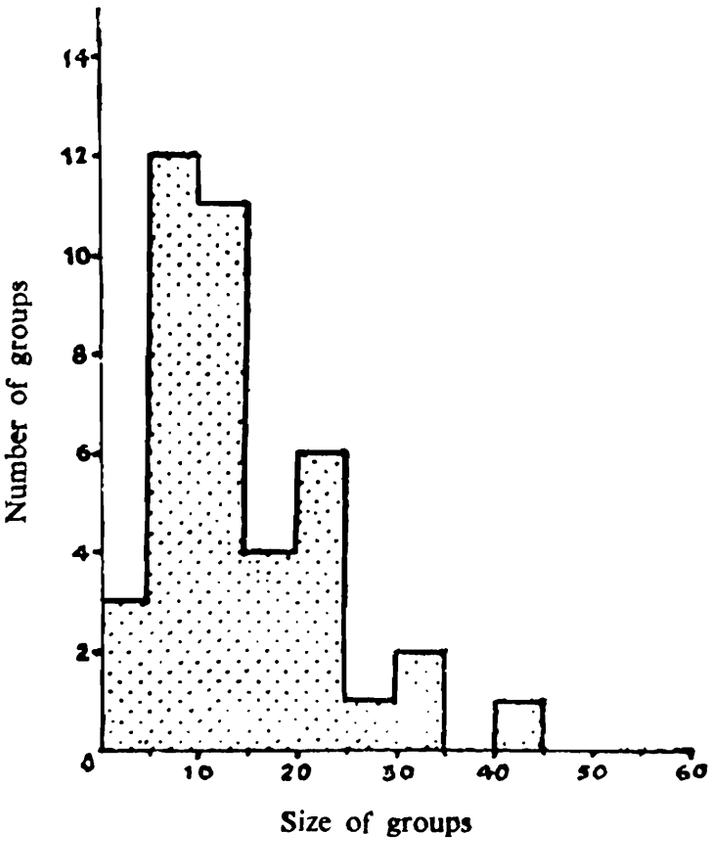


Text-fiig. 1.—Location of fifty one langur groups at Kanha National Park.

Table 1—Composition of the Langur groups studied at Kanha.

S No	Name of the group	Adult Male	Adult Female	Juve-nile	Infants	Total
1.	KK/I/22/1	1	11	7	3	22
2.	KK/II/14/1.5	1	8	2	3	14
3.	KK/III/15/2.3	1	11	2	1	15
4.	KK/IV/7/2.6	1	2	2	2	7
5.	KK/V/11/2.8	1	4	4	2	11
6.	KK/VII/16/4.8	1	7	6	2	16
7.	KK/IX/14/5.2	1	7	3	3	14
8.	KK/X/8/6	1	5	2	–	8
9.	KK/XI/18/8	1	10	2	5	18
10.	KK/XII/31/8.2	1	14	9	7	31
11.	KK/XIII/45/7.5	7	29	6	3	45
12.	KA/I/26/0.5	1	14	4	7	26
13.	KA/II/18/1.5	1	6	9	2	18
14.	KA/III/14/1.7	1	7	3	3	14
15.	KA/IV/10/4	1	4	2	3	10
16.	KA/V/6/5	6	–	–	–	6
17.	KA/VI/21/14	3	10	3	5	21
18.	KA/VII/15/14.5	1	9	2	3	15
19.	KA/VIII/23/16	2	13	4	4	23
20.	SL/I/9/2	9	–	–	–	9
21.	HR/I/25/1.5	1	12	5	7	25
22.	BR/I/7/1.5	1	5	1	–	7
23.	BR/II/6/1.5	6	–	–	–	6
24.	BR/III/21/1	3	14	3	1	21
25.	RH/I/8/East	8	–	–	–	8
26.	RH/II/33/North	1	16	2	14	33
27.	KB/I/10/1	1	6	1	2	10
28.	KB/II/22/3.8	1	10	8	3	22
29.	KB/III/12/4.4	1	8	3	–	12
30.	SR/I/8/2	8	–	–	–	8
31.	SR/II/5/3	5	–	–	–	5
32.	ST/I/5/2	1	4	–	–	5
33.	ST/II/16/South	1	11	3	1	16
34.	ST/III/9/East	9	–	–	–	9
35.	ST/IV/14/3	14	–	–	–	14
36.	ST/V/15/2.1	1	6	4	4	15
37.	EN/I/15/West	1	7	7	–	15
38.	EN/II/15/South	1	7	7	–	15
39.	KM/II/9/3	9	–	–	–	9
40.	KM/V/1/3.5	1	–	–	–	1
		116	277	116	90	599

The first groups named "KA/I/26/0.5" comprises 1 adult male, 14 adult females, 4 juveniles and 7 infants and second named "KB/I/10/1" 1 adult male, 6 adult females, 1 juvenile and 2 infants. The former move in the area of approximately three-quarter square kilometre largely between Aurai and Kisli roads while the later on the either side of Sijora

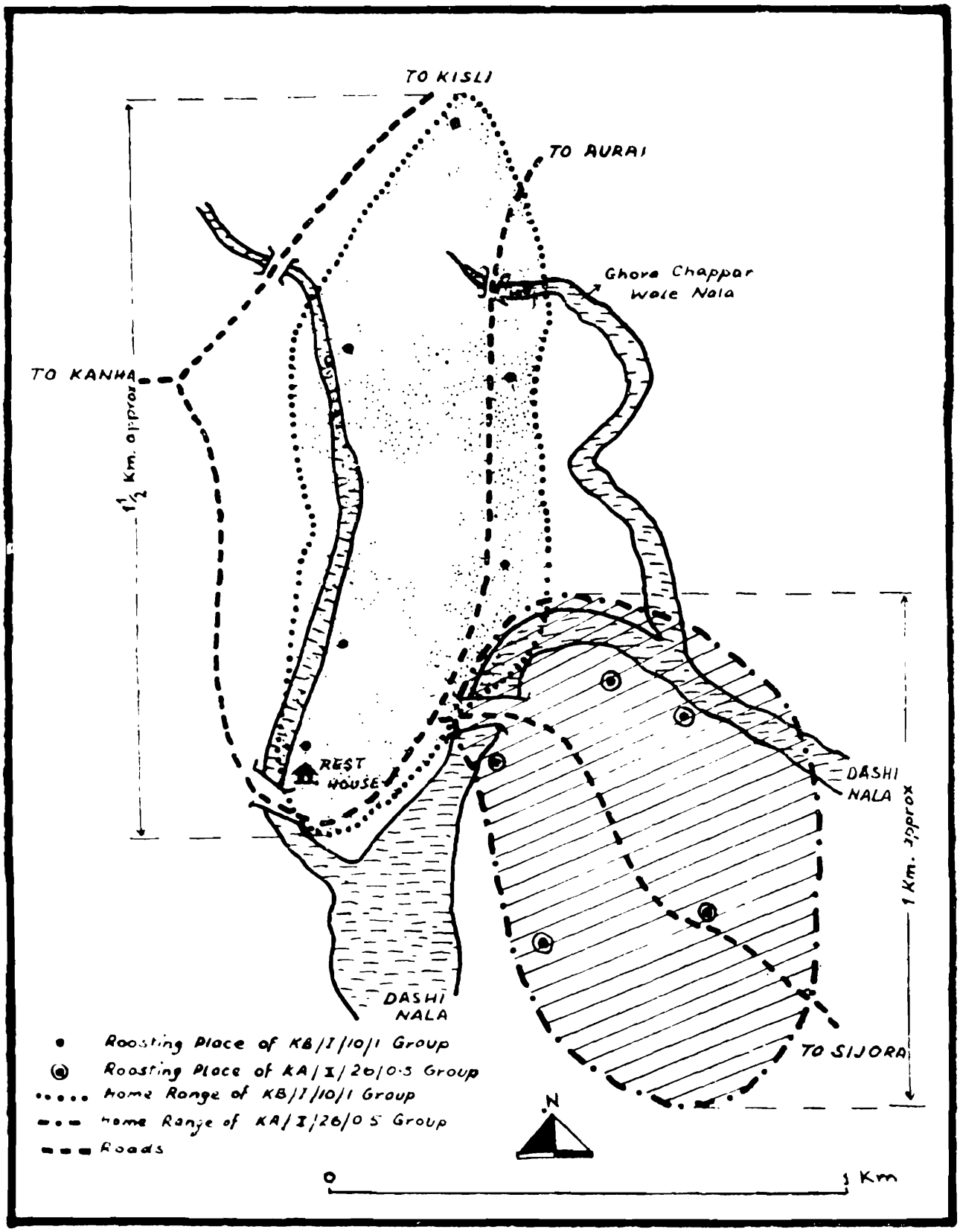


Text-fig. 2.—Frequency of occurences of langur groups of different size in Kanha National Park.

road covering approximately the same area. An area of about 70 yards on the bed of Deshi Nala was overlapped by both groups.

All the roosting places which were recorded for the two groups were mostly located on the periphery of their home ranges. They used to roost on more than one tree which were dense. There was a quarrel for places before retiring. As darkness fell after 1850 hrs., thery settle preferably on the peripheral branches of the trees. Sometimes, there may be whoop calls of leader and these were often noted when there was much quarrel before retiring. In the morning, they were awake before sunrise at 0545 hrs. Usually, the leader gives the whoop calls before leaving the tree and up to the time of dawn, members come down, on the ground and rest for some time. Before they started feeding at 0730 hrs., juvenile and infants spend this time in playing, females groom their infants and sometimes other females, while the leader was resting. The period of their morning activities which includes feeding also, spreads from 0730 hrs. up to 1030 hrs. In the evening they again started their activities which reached their peak during dusk. Hotter hours of the day were spent in dozing and resting.

A distance of about seventy yards on the bed of Deshi Nala was noticed as zone of overlap without any intergroup interactions. Members of the group may mingle around the ditches of water on the bed of Nala. After drinking they separate and returen to their own home ranges. Males avoid using overlapping areas.



Text-fiig. 3.—Showing home range and roosting places of two groups of langur at Kanha National Park.

(C) *Day Ranges*—(a) Movement—Whenever there is any movement of an individual it appears to be mainly for food, shelter or reproduction. Duripg group movement it was often observed that the individual moved for a short distance and sat for some time, observed the surroundings and when satisfied moved again. It may be possible that another individual may come and sit at the same place and this may or may not be before leaving the place by predecessor what Rahaman (1973: 304) called relay race. It was interesting to note that when langurs passed through high grasses their walk was interrupted by bipedal movement. During this posture they stand on hind feet with their hands resting on the knees, tail curved or flat on the ground and neck stretched to its maximum length. This posture enables them to scan the surroundings. During progression, all the individuals including young ones held their tails curved over the backs with the tip facing forward and downward as reported by Rahaman (1973: 305) for langurs of Gir. This physical pose was different from that of Dharwar langur whose tail arched back with tips facing down and to the rear The definite succession and leading individuality during procession was not recorded.

(b) Feeding : Morning (0730 to 1030 hrs.) and evening (1600 to 1900 hrs.) were vigorously devoted to feeding activities The langurs eat leaves, flowers and fruits of variety of trees and shrubs (Table 2). There was no sign of competition for food as it is in abundance in the park. The members usually sit in the party of 2 to 5 individuals of differents ages and sex and eat together. But the leader was not seen joining any party. He always fed alone. The fruits of *Emblica officinalis*, *Madhuca indica*, *Ficus bengalensis*, *Ficus racemosa*, *Bauhinia retusa*; leaves of *Ficus racemosa*, *Mallotus philippiensis*; and flowers of *Butea monosperma* were most preferred. Manipulation before eating the food was not observed. Langurs were often seen licking at salt licks. Rahaman (1973: 305) reported that in Gir, langurs fed on the pupae found on leaves but it was not observed at Kanha. Kurup (1964: 7) had also reported that he never observed them eating insects or making any effort to catch the same.

(c) Social Grooming : Langurs spent considerable time in grooming. It may be either self grooming or grooming one another. The grooming was intense when other individuals were inactively relaxing or dozing. A total of 169 cases of grooming were observed. Out of these, 72 groomed on ground and 97 on trees. The leader groomed another in 10cases *i.e.*, 5.9% of the total number recorded. Grooming was observed most frequently during the period of 0600 to 0830 hrs. and 1130 to 1600 hrs. It could occur in any combination irrespective of age, sex and status. The process may have a short duration as in the case of a juvenile grooming another. But it was of considerably longer duration when a mother groomed her infant or an adult female groomed adult male. Instances of scratching were also observed and they were mostly performed by leaders.

Table 2—List of Trees and Shrubs on which Langurs feed.

S. No	Scientific Name	Local Name	Part Eaten
1.	*Bauhinia retusa*	Thaur	Fruits
2.	*Bauhinia vahlii*	Mahul	Fruits
3.	*Bridelia retusa*	Kasai	Leaves
4.	*Buchanania lanzan**	Achar	Fruits
5.	*Butea monosperma**	Palas	Flowers
6.	*Carrisa spinarum**	Karonda	Fruits
7.	*Cleistanthus collinus*	Garari	Leaves
8.	*Diospyros melanoxylon**	Tendu	Flowers
9.	*Emblica officinalis*	Aonla	Fruits
10.	*Ficus bengalensis*	Bar	Fruits
11.	*Ficus racemosa**	Umar	Fruits & Leaves
12.	*Fiscus religiosa*	Pipal	Fruits & Leaves
13.	*Garuga pinnata**	Kekad	Leaves
14.	*Gmelina arborea**	Khamer	Fruits & Leaves
15.	*Grewia tiliaefolia*	Dhamen	Fruits & Leaves
16.	*Lagerstroemia parviflora*	Lindia	Leaves
17.	*Lannea coromandelica*	Gunja	Leaves
18.	*Madhuca indica**	Mahua	Fruits
19.	*Mallotus philippinensis*	Sanduri	Leaves
20	*Magnifora indica**	Aam	Fruits, Leaves & Flowers
21.	*Moghania semialata*	Ban-rahar	Fruits & Leaves
22	*Phoenix acantis*	Chhind	Fruits
23.	*Pterocarpus marsupium*	Bija	Leaves
24.	*Salmalia malabaricas**	Semal	Fruits & Leaves
25.	*Schliechera oleosa*	Kusum	Fruits
26.	*Schrebera swietanoides**	Monka	Flowers
27.	*Semecarpus anacardium*	Bhilma	Fruits
28.	*Shorea robusta**	Sal	Fruits, Leaves & Flowers
29.	*Storculia urens*	Kulu	Fruits
30.	*Syzygium cumini*	Jamun	Fruits & Leaves
31.	*Terminalia belelica*	Bahera	Fru ts & Leaves
32.	*Terminalia chebula*	Harra	Fruits
33.	*Terminalia tomentosa*	Saja	Leaves
34.	*Zizyphus glabarrima*	Ghont	Leaves
35.	*Zizyphus mauritiana*	Ber	Fruits

*Plants in in flowering season during study period.

(d) Social Play : In comparison to adults, juveniles and babies spent considerable time of the day in playing. This includes, activities such as attempts to bite, grasping of one animal by another, pulling in attempt to displace or turn over, rolling over, jumping, loosing its balance repeatedly, sliding off tree trunks and other imitative incomplete activities.

(D) *Hierarchy*—No inter-group interactions were observed. But it appears that there was no clear cut hierarchy in the social structure of the colony of langurs. But it was the male whos settle the intra and

inter group disputes by giving the whoop calls and displaying vigorous movement. At the same time, he did not lead the procession of the group nor occupied any privileged position during feeding. Kurup (1964: 9) writing about Indian langurs stated that "each troup has a leader whose authority is conspicuous only when the troup faces danger or disturbance" Sugiyama *et al.*, 1969, also stated that Hanuman langurs neither exhibit a strict functional ranking order nor a differentiation in their social organisation. Male was least bothered on the presence of an intruder though he approached more closely than any other member of the group.

(E) *Mating and Meternal Behaviour*—Babies of nearly fifteen to sixty days old were most frequently seen in the study area. This suggests that these may have been born during spring. If the gestation period is 196 days (Walker, 1968: 463) then it is obvious that their mating season falls in the monsoon season.

Bebies feed on the mother's breast for a long time. Once even a juvenile was seen attempting to catch the nipple in spite of active disappointment by female. When the mother was on the ground the baby mostly rested or suckled or played with others. It is the general behaviour of infants that whenever they are stared at by an intruder, they start producing screeching noise continuously, until they have contact with their mothers. Similar activities were also recorded for juveniles but they often move towards higher branches of the tree under such circumstances. Once a juvenile caught an infant between fore arms and walked a distance of 3 feet on hind legs to approach the infant's mother. The mother slapped gently on the back of juvenile and allowed him to play with infant.

(F) *Interspecific Interactions and Predation*—On April 11, a female feeding on the ground was under observation. Suddenly, a village dog ran towards the female and before he reached her, she climbed the tree and reached to the top and started producing screeching noise continously. Leader male while resting on the tree nearby started giving whoop calls and threats and the dog soon departed from under the tree. Encounters between dogs and langurs are quite frequent.

Chital *(Axis axis axis* Erxleben*)* were often seen running and eating under the trees which were occupied by langur groups (Gurm *el al.*, 1977: 41). It was intersting to note that the all-male-groups are rarely seen with chital. Only 2 out of 9 all-male-groups studied at Kanha were seen with chital.

Acknowledgements

I take this opportunity of recording my sincere thanks to Dr. M.L. Roonwal, Emeritus Scientist (CSIR), for going through the manu-

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*Not consulted in original.

KANKANE : PLATE I

Plate 1. Lack of under canopy increases penetrating visibility : typical in study area.

Proceeding Wild Life Warkshop : 73-78

ECOLOGICAL PROBLEMS OF NON-HUMAN PRIMATES* OF NORTH-EAST INDIA**

By

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Zoological Servey of India, Solan

(1 Plate)

Abstract

Out of seventeen Indian species of Primates twelve occur in North-east India. Occurrence of more unrecorded taxa is possible, *e.g* snub-nosed langur reported to be sighted A new species of langur was recently described by the author from this area. The populations are truely wild and healthy. They are in great demand for exhibition, meat and fur. However, their ecological study present special difficulties such as prolonged rainy season with devastating floods, inadequate communication system with division of the area into a large number of small states, all having international border, tribal monkey eating population, shifting cultivation, etc. It has been possible to collect ecological data only on some of species particularly the said new langur. The paper reviews the information so far available with suggestions on the solution of the said difficulties.

I. Introduction

Non-human Primates of north-east India are of special interest for a variety of reasons such as exhibition, fur, food for tribals, etc. Out of seventeen species occurring within Indian Union, twelve occur in this small area and the species found in other parts of India can be shown to be their descendents. However, their ecological problems for proper management present special difficulties, i.e. prolonged rainy season lasting for about six months with devasting floods, inadequate communication system, divison of the small area into seven states all having international border, tribal and monkey-eating human population and shifting cultivation. Except one rare species, the recently discovered golden langur (*Presbytis geei* Khajuria), only stray notes are available on their habits in the wild within this area. The author has been studying the problem since 1955 and has stayed in the area intermittently for about sixteen months. An attempt is here made to review the ecological information available and to suggest solutions of the special problems enumerated above.

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*The controversial tree shrews are being excluded from Primates for the time being.

**North-East India is here considered to include states of Assam, Arunchal Pradesh, Nagaland, Manipur, Tripura, Mizoram and Meghalaya.

II Taxonomy and Distribution

[1] *List of Primates recorded from N.E. India with their Indian distribution* :—

Family Lorisidae

1. *Nycticebus coucang bengalensis* Fischer, Slow Loris

Family Cercopithecidae

2. *M. m. mulatta* Zimmermann; Rhesus Macaque.
   Northern Peninsular India, North Kamrup [Assam].
3. *M. a. assamensiss* M'clelland, Assamese Macaque.
   Assam, Mishmi & Naga Hills.
4. *Macaca nemestrina blythi* Pocock, Pig-tailed Macaque.
   Nagaland.
5. *M. a. arctoides* I. Geoffray, Stump-tailed Macaque.
   N.E. India (part.).

Family Colobidae

6. *Presbytis entellus* Dufresne, sub sp.? Hanuman Langur.
   Peninsular India, Sikkim, Kashmir.
7. *P. geei* Khajuria, The Golden Langur.
   Assam (Part).
8. *P. p. pileatus* Blyth, Capped langur,
   Garo, Khasi, Jaintia & Naga Hills, Assam.
9. *P. p. brahama* Wroughton
   Seajulia, Dafla Hills, Northern Lakhimpur, Upper Assam.
10. *P. p. durga* Wroughton,
    Upper Assam, Lakhimpur, Naga Hills, Cachar,
11. *P. p. tenebricus* Hinton,
    Mutunga River, Northern Kamrup, North of Brahmaputra.
12. *Presbytis phavrei atrior* Pocock, Phayre's leaf monkey
    Distributian :—?
13. *Presbytis barbei* Blyth, Barbe's Leaf monkey (Status uncertain)
14. *Rhinopithecus* sp., Snub-nosed Langur.
    Distribution :—?

Family Hylobatidae

15. *Hylobates hoolock* Harlan, The Hoolock gibbon.
    N.E. India (part.)

(ii) *Relationship*—It is interesting to note that species in other parts of India can be shown to be descendents of N.E. Indian species on the basis of the external characters including external genitalia and skeletons, etc. The relationships between N.E. Indian species and those found in other parts of India is given in Table I.

The occurrence of species related to N.E. Indian species in South India can be explained on the basis of Satpura hypothesis (Hora 1948). The Western Ghats species are the Nilgiri Langur, the Lion tailed Macaque, the Bonnet Macaque and the Slow Loris.

Table 1—Relationship between N.E. Indian monkeys and other species found elsewhere in India.

Sl. No.	*Ancestral N.E. Indian species*	*Related species in other parts of India*
1.	Slow Loris	Slender Loris
2.	Assamese Macaque	Bonnet Macaque and Rhesus Macaque
3.	Pig tailed Macaque	Lion-tailed Macaque
4.	Capped Langur	Nilgiri Langur
5.	Golden Langur	Common Langur

III. Special problems

1. *Prolonged rainy season* :—The rainy season generally lasts from May to October and cause devasting flood probably because of large scale deforestation which also destroys the habitat of Primates. The difficulty can be overcome by having a number of survey parties working in different parts of the area in winter and selection of easily accessible areas for more detailed study throughout the year. The deforestation also needs proper planning.

2. *Inadequate communication system* :—This difficulty can be solved to some extent by sending a detailed questionare to forest and village authorities and by covering certain tracts where there is a concentration of Primates by such conveyances as elephant and ponies.

3. *Division of area into seven states* :—This difficulty does not appear to be unsurmountable if the authorities concerned are given proper instructions by Central Government. As far as the study near the international border is concerned, the help of army is necessary.

4. *Tribal monkey eating population* :—A suitable number of representatives of population should be included in the survey parties. Their monkey eating habits can be dealt with by impressing upon them that they can get more money for monkeys than for their livestock and should harvest them yearly under management guidelines.

5. *Shifting cultivation* :—The governments concerned are dealing with the problems by proper publicity and education.

IV. Brief review of ecological information

The rhesus macaque and the common langur which also occur in some parts of N.E. India are well studied species. Though their ecology does not appear to be explored in this part of India, voluminous literature on their ecology has been ably reviewed by Roonwal and Monhot (1977).

Except the golden langur, no planned effort appear to have been made to study the ecology of other Primates in this area in the wild. Even

stray notes on habits of the taxa are available on very few species : *Nycticebus coucang bengalensis*, *Macaca assamensis* and *M. arctoides*, *M. memestrina*, *Presbytis pileatus pileatus*, and *Hylobates hoolock*. The available ecological information on the golden langur has been reviewed by the author (Khajuria, 1977). The other important information mainly collected in the area is summarized below.

1. *Nycticebus coucang bengalensis*

Food : insects, small birds ?, bird eggs, fruit, leaves, shoots.

Reproduction : No well-defined breeding season; estrous cycle about 42 days; usually single young at birth, gestation period about 193 days, young weaned after about 9 months.

Miscellaneous notes : Nocturnal, savage if disturbed, growls like a cat with other vocalizations, hangs by branches by hind legs particulary for catching food; also pounces on prey by standing on hind legs; grooming and urine marking observed (observations made mostly in captivity); male may be found with female and infant.

2. *Macaca a. assamensis*

Food : Vegetable matter including crops, insects.

Reproduction : Young seen in fall near Sikkim, usually single young born at birth; sex skin present.

Miscellaneous notes : Groups of varying size usually of 10-25 individuals; sound, *pio-pio*, eaten by some local people but apparently kept secret (Khajuria, 1962 a).

3. *Macaca a. arctoides*

Food : All parts of plants; seeds of a palm which are about 2.5 cm in diameter are also taken, preference for *Ficus* plants; insects, birds; extra food may be held by feat.

Reproduction : Estrus and menstruation difficult to detect, no dismounting by male immediately after ejaculation, parturition usually on alternate years.

Miscellaneous notes : The group may contain about 2 dozen individuals of all sex and age groups; usually an overlord; solitary males noticed, vocalization is a harsh bark, squeels or chatters. Various facial expressions, Roonwal and Monhot (1977) has given a detailed account of habits of the species in captivity some of which may apply to this subspecies.

4. *Macaca namestrina* blythi

Food : Possibly omnivorous.

Reproduction : Probably breeds in late spring.

Miscellaneous notes : Gives out a short note like 'kang', more arboreal than stump-tailed macaque with which it occurs, very rare; some of

the detailed account of Roonwal and Monhot (1977) probably applies to this subspecies.

5. *Presbytis pileatus*

Food : Buds, leaves and fruit, seldom coming down to drink.

Reproduction : Polygamous, usually single young at birth in cold season.

Miscellaneous notes : Shy, but bold when attacked (Khajurla 1962b) sound, squeels or bark, usully seen in small parties of about 6-12 individuals.

6. *Presbytis geei*

Food : Leaves, buds, flowers of *Terminalia* spp., *Bombax celia, Acacia Beuhina Ficus* sp., *Cedrela toona, Lannea grandis, Albizzia lebbek, Bischofia javanica, Gmelina arborea, Oroxylum indicum, Salmalia malabarica, Dilleria pentagyna, Careya arborea, Bauhina vahli,* some *Leguminosae, Castanopris trib, uloides, Dalbergia sissoo, Derris sp., Anoora wallichi, Truwia nudiflora,*

Reproduction. The breeding season appears peculiar in being excessively prolonged from autumn through winter to spring. A single young a birth, unisexual troups present, according to Mukherjee & Saha (1974) about 60% of females found with infants in May and June.

Population : Gee (1961) estimated the total population as 450 langurs. In 162.3 hectares surveyed by Mukherjee & Saha 1974 about half of the area was found to be cultivated or occupied by human dwellings. The total area inhabited by the golden langur about 600 sq. km. in India.

Management : Prevention of poaching for meat, introduction into adjoining areas because of limited distribution within Indian limits; provision of water during dry season, planting of vegetation taken as food preference.

Miscellaneous notes : Rare in India, shows several adaptation to its habitat; mixed deciduous or semideciduous, semi-moist sal forest; seldom vocalises although capable of producing number of sounds; fed upon by man and probably by tiger, common leopard and clouded; leoperd, can make excellent pet because of docility and esquisite beauty. Other mammals recorded from the area are, *Tupia sp., Macaca mulatta, Ratufa bicolor, gigantea, Collosciurus pygerythrus, Cannomys badius, Hystrix hodgsoni, Caprolagus hispidus, Axis axis, Axis porcinus,* and *Rusa unicolor.*

7. *Hylobates hoolock*

Food : Tender vegetation, leaves, fruits, insects, spiders, birds (?) and their eggs.

Reproduction : Age of maturity about seven years; estrous cycle 20-23 days, mating before rainy season; a single young usually born during winter or spring.

Miscellaneous notes : Usually found in small family parties consisting of a male and a female and an immature with a territory but a number of such parties may come together for feeding. The voice is characteristic loud 'whoka' with slight modifications.

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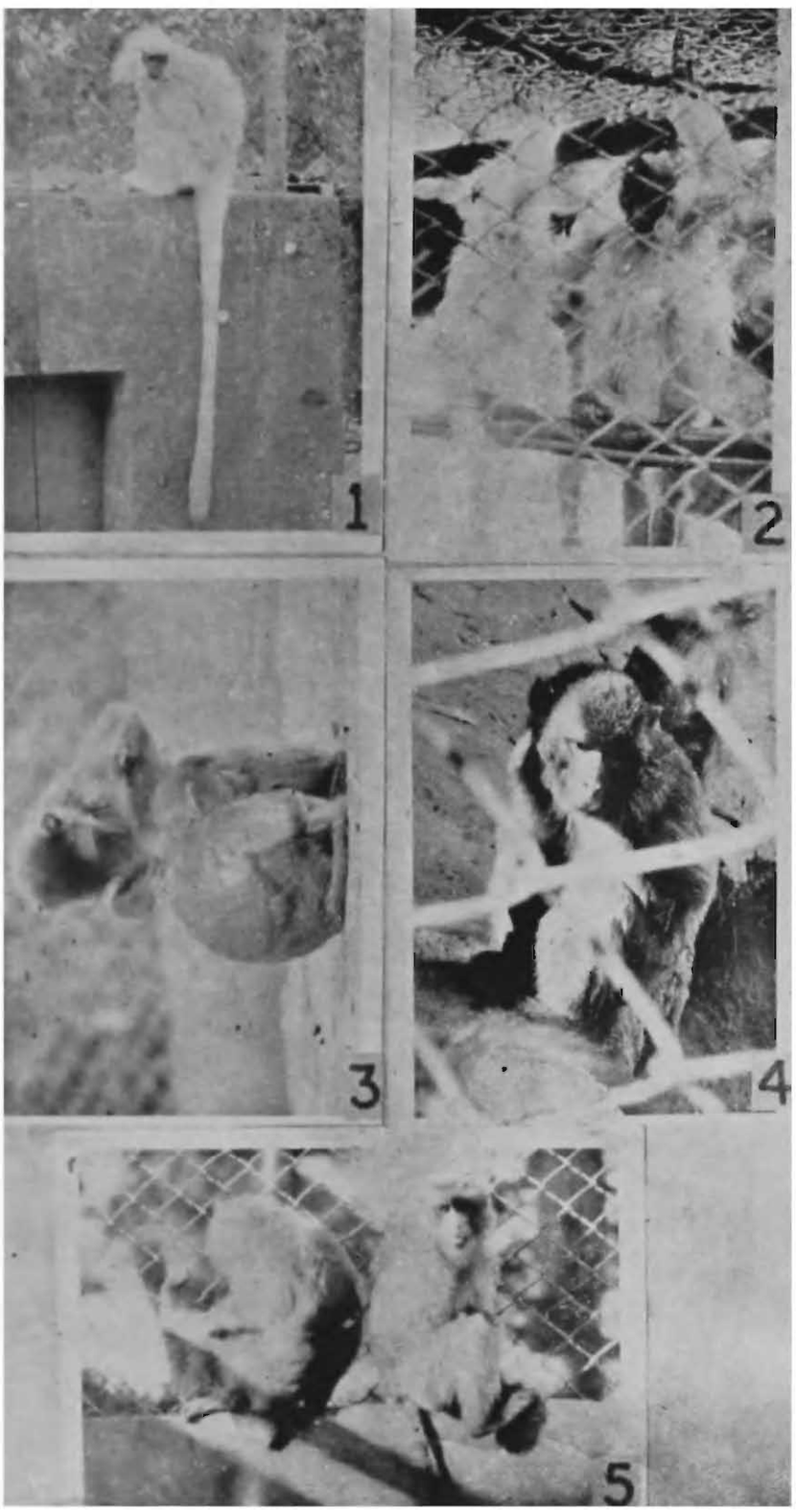

1. The Golden langur, *presbytis geei* Khajuria.
2. The capped langur, *Presbytis pileatus* Blyth.
3. The Assamese Macaque, *Macaca a. assamensis* Maclelland.
4. The stumped tailed macaque, *Macaca speciosa* Linn.
5. The pig tailed macaque, *Macaca nemestrina* Linn.

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WILDLIFE DISEASES IN INDIA

By

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Abstract

The prevalence of epizootic diseases among the wildlife has been one of the factors associated with the decline in numbers of some species of wildlife populations. In recent years, these diseases have assumed significance, because of (i) their direct effect on the wildlife populations themselves, (ii) possible impact of these diseases on the health of domestic animals and (iii) hazard to human health.

The available information on the reported occurrence of epizootic diseases, such as rinderpest, foot and mouth disease, rabies, anthrax, etc., is briefly reviewed.

The diseases of non-human primates are of particular concern not only from the standpoint of their effect on the health of non-human populations and the export trade of these animals, but also because of a wide variety of diseases transmissible between these animals and man.

The available information points to the urgent need of undertaking surveys to determine the prevalence of wildlife diseases and formulation of measures to minimise losses from these diseases.

The prevalence of epizootic diseases among the wildlife has been one of factors—in some instances a major factor—associated with the decline in numbers of some species of wildlife populations. Although the available information on the occurrence of diseases among wildlife in the country is meagre and fragmentary, yet there is ample evidence to suggest that these diseases have been frequently responsible for heavy loss of wildlife in different parts of the country.

In recent years wildlife diseases have assumed considerable significance and, therefore, emerged as important field of epidemiological research. There is an increasing need to understand the nature and extent of these diseases from the stand point of wildlife conservation, particularly in a country like India where the great diversity of wildlife fauna is one of its magnificient natural assets. Since the wildlife constitutes one of the important reservoirs of numerous infectious diseases affecting domestic livestock, it is necessary to detect and control these diseases in the infected foci. Some of the diseases encountered in the wildlife such as rabies, tuberculosis, leptospirosis, etc., are also a public health hazard and deserve serious attention while evolving an effective programme for their control and eradication.

In the following presentation, the reported information on some of the important diseases encountered among the different species of wildlife is briefly reviewed :—

Rinderpest

Hallen *et al.* (1871) cited several observations on rinderpest in deer, wild buffalo and wild boars. The devastating effect of this pestilence on the Gaur (*Bos gaurus*) population in wildlife reserves and sanctuaries in the country, has been reported on a number of occasions during the past fifty years (Burton, 1953; Schaller, 1967). More recently this disease had almost wiped out Gaur populations of Mudumalai Sanctuary in 1968 and Periyar Sanctuary in 1974. According to Mehta (cited by Schaller, 1967) many barasingha *(Cervus duvanceli)* died during an out break of rinderpest that occurred in Kanha Park area in 1925 and 1926. Both Srivastava (1957) and Singh (1958) have contended that rinderpest has greatly reduced deer populations in the Uttar Pradesh.

The disease is believed to spread from the infected domestic cattle and buffaloes to the wild animals through pastures grazed by both groups of animals. In addition to the bovines, more than fifty species of other artiodactyles may contract natural disease (Scot, 1970). Among the wildlife in this country, these include nilgai, sambar, spotted deer, hog deer, four horned antelope, etc. (Gupta and Verma, 1949). The epidemiologic characteristics of the disease encountered in these species are not known. It is also not known whether epizootics may occur which may remain confined only to the Gaur population and other species of susceptible wildlife when the disease has not been noticed in the domestic bovine population in the area over a period of time preceding the observed outbreak in wildlife. The possibility of any other species of wildlife becoming carriers of rinderpest virus infection during the inter-epizootic periods has not been investigated.

Foot and Mouth Disease

Outbreaks of Foot and Mouth Disease (FMD) in the Gaur populations associated with high mortality, have been reported to occur frequently during the past several decades. FMD is a highly contagious disease with a wide host range among artiodactyles (including waterbuck, yak, gaur, oryx, nilgai, etc.) and has a high morbidity rate among several species of domestic animals. This disease has been reported to responsible for mortality in gaur populations (Ali, 1935). The disease may occur in animals other than artiodactyles such as hedgehogs and even the rats have been considered as potential carriers. There is some evidence to suggest that elephants may also contract infection. It has been contended that the presence and the persistence of FMD virus infection in certain species of wild animals may play a vital role in the general epidemiology of this disease (Mc Diarmid, 1975).

Rabies

In India, apart from dog which is generally acknowledged as the most common transmitter of urban and rural human rabies, a number of wildlife hosts such as wild dog, jackal, wolf, fox, wild cat and mongoose are some of the known species found to contract and transmit the disease to other susceptible animals and man. However, there is little reported information on the sylvatic rabies cycle in the country. It is known that rabies tends to cycle within host species and only rarely spills over to other species so that it may be present in jackals or foxes without being observed for many years. The extent of wildlife rabies hazard to the human and the domestic livestock populations, is illustrated by a recent observation reported by Shah and Jaswal (1976). In February, 1973, a rabid wolf travelled over 23 km in 12 hours in Aurangabad district and attacked 12 persons and 6 animals in 15 different places. Three persons and 3 animals died of rabies. One animal had died of injuries immediately after the attack. One pig that was bitten, became aggressive and was killed and burried. This was dug up and eaten by 4 dogs. One of these dogs had onset of rabies 12 days latter. All the 4 dogs were destroyed. Burton (1950) reported two cases of rabies in tiger. Rabies cases have also been reported in mongoose (Greval, 1933) and ground squirrels (Greval and Nickolas, 1940). D'Souza *et al.* (1968) suspected bandicoots (*Bandicota malabarica*) as an inapparent reservoir of rabies.

Anthrax

This highly fatal disease has a wide host range. The disease is endemic in the country and almost all species of domestic herbivores are susceptible. There is, however, little information on the incidence of this disease in the wildlife. Peacock (1933) has recorded this disease as one of the causes of mortality in gaur. According to Lahan and Sonewal (1973) this disease and another unidentified disease were responsible for heavy casualties among rhinoceros population in Kaziranga wildlife sanctuary in 1944 and 1947.

African Horse sickness

A large number of wild ass were reported to have died of African Horse sickness in November and December 1961 and again in 1969 in the Little Rann of Kutch (Spillett, 1968). The disease was contracted from domestic equines. This disease has since been eradicated from the country.

Surra

In 1958 and 1960, this disease accounted for some deaths in the wild ass in the Little Rann of Kutch. The domestic equines and bovines (possibly a number of other species) may harbour the infection which is transmitted from the infected to susceptible animals through insect vectors mainly the *Tabanid* and *Stomoxys* flies.

Leptospirosis

It is well known that the wildlife plays an important role in the epidemiology of leptospirosis. Continuing search for sources of infection for domestic animals and man has revealed an expanding host range in the wildlife belonging to five orders of animal Kingdom namely, Rodentia, Lagomorpha, Insectivora, Chiroptera and Artiodactyle (Twigg *et al.*, 1969). Besides domestic and laboratory animals, already pathogenic leptospires have been isolated from 118 species of wild mammals and 2 species of birds (Communicable Disease Centre, 1966). Small mammals belonging to families *Muridae, Erinacidae* and *Soricidae* are the primary hosts and the main source of infection for most of the leptospiral types infecting man and domestic animals.

Leptospirosis is prevalent in the domestic livestock and human populations in the country. However, so far little work has been done to survey leptospiral infection in the wildlife and, therefore, there is no published information on its prevalence among the wildlife species.

Influenza

Influenza has been considered to be a serious disease problem among human beings for centuries. There has been much speculation about the role of animals and birds as reservoirs of influenza viruses. Current studies are confirming expectations that influenza viruses are endemic in many wild bird populations (Beveridge, 1975). Limited studies in this country have yielded isolation of influenza A virus from wild birds (Mullick, B.B., 1977—personal communication).

Parasitic infections

There is little information on the prevalence of parasitic infections in the wildlife and their impact on population dynamics of different species in this country. The available literature from abroad seems to indicate that parasites are significant pathogens of wildlife (Davis and Anderson, 1971). According to Bennett *et al.*, (1975), protozoan parasites, particularly haemosporidians, flagellates and coccidiosis act as limiting factors on avian populations. Kutzer (1975) has stated that certain groups of arthropods can essentially influence wild animal populations in their numerical composition. Though the loss of the population caused by ectoparasites can be serious, it can never be endangered in its further existence.

Diseases among non-human primates

Several species of non-human primates which inhabit different parts of this country, are prone to suffer from a variety of epidemic and other diseases, most of which are communicable between these animals and man. Because of their high susceptibility to some of the diseases transmissible to human being, these simians may even serve as sentinals of human diseases as was observed in the case of Kayasamur forest disease. This disease

caused by an arbovirus of the Russian Spring Summer Encephalitis (RSSE) Group had not been known to occur in India until 1955. Late in 1955, a large number of bonnet macaques (*Macaca radiata*) and langurs (*Presbytis entellus*) were found dead in Kayasamur forest area in Karnataka. About the same time, cases of severe fabrile illness called the "monkey disease" by the natives occurred among the humans in this area. A second outbreak began early in 1957 over a much wider area. Investigations by the Virus Research Centre, Poona showed that the disease in both monkeys and man was caused by an arbovirus closely related to the virus of RSSE, which is endemic in Western Siberia (Webb, 1969).

Deaths from tuberculosis have been recorded among Rhesus monkeys *(Macaca mulatta)* (Krishnan, 1936; Singh *et al.* 1951; Nair and Ray, 1955). A fairly high proportion of monkeys exported from India have been found to suffer from Salmonellosis (Rowe, 1969), Shigellosis (Cook, 1969; Hartley, 1975) and several other bacterial and viral infections. A recent investigation by Mohan *et al.* (1975) showed that out of 1502 apparently healthy rhesus monkeys *(Macaca mulatta)* examined by them, 238 (15.8 per cent) were found to shed enteropathogenic bacteria in their faeces; *Shigella* species in 175 cases, *Salmonella* species in 15 and enteropathogenic *Escherichia coli* in 48 cases. Monkeys in this country have also been shown to suffer from malaria caused *Plasmodium cynomolgi* (Prakash and Chakrabarti, 1962) and *P. fragile* (Choudhary *et al.* 1963).

Miscellaneous disease conditions

During the past few decades, materials received from different wildlife species located in the zoological gardens in the country and examined at the Indian Veterinary Research Institute have revealed the existence of a variety of disease conditions in these animals. While most of these diseases may be responsible for sporadic cases and tissue damage in vital organs such as lungs, kidneys, liver, etc. (characterised by pneumonia, hepatitis, nephritis etc.), some of the diseases such as canine distemper and feline viral enteritis can prove extremely dangerous for wildlife members of dog and cat families, which are susceptible to these diseases and may suffer from heavy mortality rates.

Survey of wildlife diseases

The available information on the reported occurrence of a number of epizootics which were responsible for heavy mortality among different species of already declining wildlife populations during the past several decades clearly points to the urgent need for effective measures to minimise losses from these diseases. This in turn would necessitate surveys of wildlife to determine the prevalence of disease in different species of wildlife and to investigations to elucidate the nature of relationships between the domestic livestock and the wildlife, which facilitate the spread of disease between them. Some insight into the diseases of free living wildlife can be gauged also by extending these studies on captive animals

in the zoological gardens and limited colonies maintained for biomedical research.

Similar studies abroad have shown that because of high cost involved in such work, it is economical to combine wildlife disease surveys with the ecological and biological research in wildlife.

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SOME PARAMETERS OF TIGER SURVIVAL IN INDIA

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Abstract

Some of the apparent and not so apparent ecological and behavioural parameters playing a crucial role in the conservation of tiger in its Indian habitats are discussed here on the basis of available data. Factors of population dynamics, particularly the reproductive rate and recruitment are worked out to arrive at a sample annual net increment or turnover of a tiger population in a protected reserve. It is shown that a tiger population of 10 animals, the average number in many tiger reserves in India, would increase by 1.75 young annually or about 17 young per hundred of total population subject to adult mortality. If adult mortality is taken as 5 per cent, the net annual increment of tiger population is obtained as about 12 per cent.

As regards the food demand and supply in relation to tiger requirements, it is shown that a standing ungulate crop in a minimum area of 2 sq. miles (5.18 Km^2) is needed to sustain one tiger for one year in a sample habitat Available data on the population dynamics of three ungulate prey species are worked out, and the annual rate of net increment in population in numbers as well as in biomass for these species is shown. Annual biomass increment of prey species per sq miles (2.59 Km^2) of habitat is shown to be about 740 lbs (336 Kg) in this example. Based on this it is estimated that tiger population would require about 9 to 10 sq miles (24 Km^2) of habitat per adult tiger to be stable and viable, using only the food increment and not the food capital stock. Although these figures are applicable only to the sample area, it is believed that similar figures would hold good for comparable reserves

Other limiting factors such as changes in fertility and recruitment rates, and social behaviour, in population regulation of tiger are also discussed. Factors already dealt with indicate that population homeostasis in tiger presently operates through reduced breeding as well as pre and post natal mortality. Evidences pointing to the operation of social behaviour as an important limiting factor are discussed and shown to be functioning through the spacing mechanism decided through dominance particularly in the male. The cover factor, the role of early social and stress in modifying the spacing behavionr and such not so apparent aspects deserve behaviour proper study.

I. Introduction

Though the tiger's distribution in the past ranged through the greater part of Palaearctic and Oriental regions, from approximately longitude 145°E to 40°E and latitude 55°N to 10°S, most of the tiger population except for remnant portions in widely scattered parts of the range

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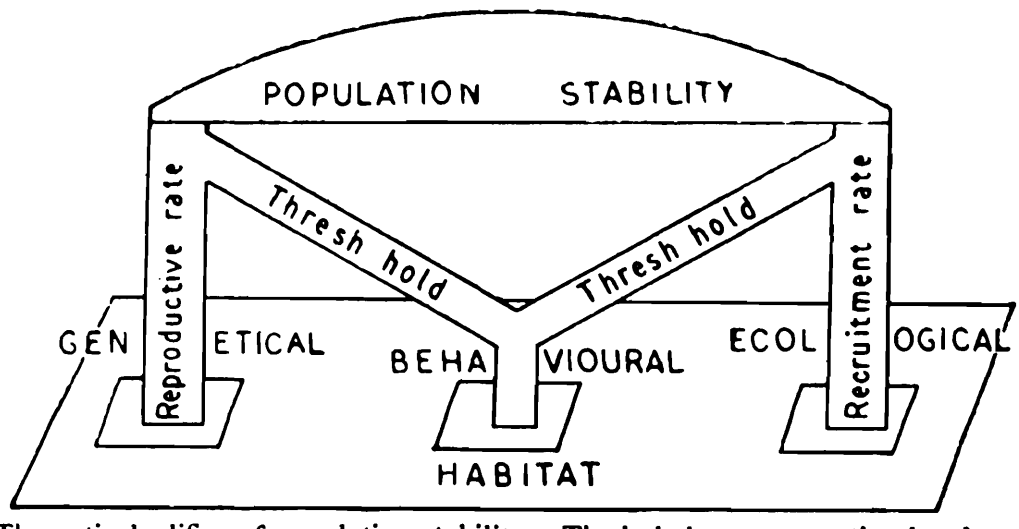
are now confined to the Oriental region south of 30°N latitude. It seems therefore that the nominate race, *Panthera tigris tigris* widely ranging in India, Bangla Desh, and Burma, and its eastern populations in China, Malaysia and Indonesia sometimes seggregated as *Pantheratigris corbetti* (Mazak, 1968) are the only populations left of this magnificent species in a wide enough scale to ensure its survival in a large part of its former range.

Thus deforestation and hunting have almost exterminated the temperate races of the tiger, making it almost a tropical species contrary to its evolutionary origin. It seems therefore, that the only hope of ensuring its survival lies in the tropical forests of south and south east Asia.

The first phase of any conservation effort will have to be naturally protective in measure, by constituting reserves, etc., and already considerable progress has been achieved in this respect. But the protective phase, while retarding the forces of decimation does not necessarily reverse them. Determination of ecological factors responsible for the decline of the species will lead to very different means of conservation.

Here the problem of tiger conservation is viewed from a few ecologically conventional as well as not so conventional angles to obtain a perspective which I hope is relevant in evolving a sound management code for our tiger reserves. The most significant study yet done in India on tiger ecology is that of Schaller (1967) and the data contained therein is of definite assistance in formulating some of the views presented here. The basic precept from which I have viewed this problem is that the population stability at an optimum level and survival of a species depend on the genetically determined reproductive rate, ecologically influenced turn over cum recruitment rate and food supply, and the behavioural thresh-hold wide enough to compensate for the imbalances in the reproductive and ecological factors. It is therefore, these aspects that are mainly considered here.



1. Theoretical edifice of population stability. The imbalances operating in the genetical and ecological factors of a species could be adjusted through wide thresholds of mitigating behavioural compensations.

II. Reproductive Rate and Turnover

Schaller (op. cit.) calculates that the average number of young raised per adult tigress per year is about one, on the assumption that each has a litter every two years and an average of two cubs from each littre survives to independence. Thus if a tigress has her first litter at four years of age and a life span of 18 years the potential turnover rate of a single tigress would be 14 animals under ideal conditions, but it is pointed out that this rate is never achieved.

The major reason for this nonrealization of potential turnover rate in tiger appears to be natal mortality. In Schaller's small sample of 8 cubs, 3 cubs (38%) died as yearlings. Of this 4 cubs of one tigress survived because of easy availability of domestic cattle and of buffalo kills offered partly during the study.

Average littre size in captivity is shown to be 2.8 or say 3 but the available information indicates that at best not more than two large cubs survive into second year which is not always the case. Even accepting this 33% mortality and assuming another 10% mortality in the second year, mortality in tiger till maturity at three years may be taken as 40%. This compares favourably with the 50% mortality of lion cubs till the age of two years reported by Stevenson-Hamilton (1954). Parturition conception interval of tiger is said to be about two years as the tigress does not come into estrous during the period of dependency of her cubs and the cubs are dependent on the mother for about two years (Brander, 1923; Schaller, op. cit.). Thus the average production rate of a tiger is three young in about 28 months or say, in two and half year or thirty months, working out to be 1.2 young per year. This would be limited by a combined natal and juvanal mortality of 40% which would mean a potential recruitment rate of .7 young or 70 young to the breeding population per hundred adult tigress. But even this potential is further limited considerably by the fact that only a few of the tigresses reproduce and bear cubs. Of the eight tigresses identified and one whose tracks were noted by Schaller only three or one third had cubs. He also cites the combined records of Gordon (1872) and Rice (1887) which are also similar.

Data available for sex ratio of tiger are meagre. Schaller (op. cit.) records 4:1 in favour of females. Data from shooting records suggesting 2:1 may be biased as the males are more daring, conspicuous and first to approach kills. For the present we may assume a middle ratio of 3:1 in favour of females and based on this a tiger population of 10 individuals would have 7.5 tigresses (75%) of which one third will breed at the rate of .7 young per year giving a recruitment rate of 1.75 or 17% young.

As for the next aspect, i.e., for the amount of adult mortality again, there is no reliable data. Of course till recently hunting, poaching and poisoning by man were the main constituents of adult mortality of tiger which must have been many times over the combined total of all other

causes, like fights with other species, through porcupine quills, predation by wild dogs and by disease. For the present purpose however, tiger population decimation by man is not taken into consideration although this is by no means fully abated, as considerations discussed here are with reference to natural processes within protected reserves. Judging from the relative infrequency of natural tiger deaths reported in the past and also bearing in mind that a dominant predator like tiger is fairly at the end of the food web in nature, natural mortality in adult tiger may be taken as not exceeding 5%. Thus the over all net increment of tiger populations is obtained as about 12% annually under adequate food supply.

III. Food Demand and Supply

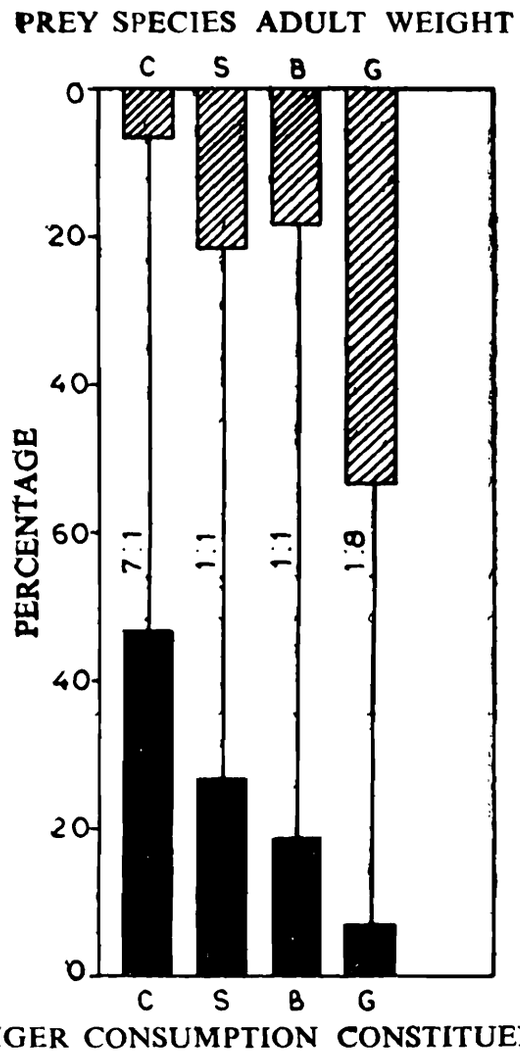
Schaller (op. cit.) estimates the daily food requirements of tiger as 12 to 15 pounds (5.44 to 6.80 kg,) or 4,380 to 5,475 pound (1987 to 2483 kg.) per year. But since only 70% of a kill animal is edible and consumed by the tiger, this means that an average tiger has to make kills of 6,257 (2,838 kg.) to 7,821 (3,548 kg.) pounds per year. Taking an average of 7,000 pounds (3,174 kg.), the amount of biomass and number of four major ungulate species of prey required annually for one tiger is shown in Table 1. (Based on Schaller, op. cit.).

Table 1. : Average annual food requirement of adult tiger

Speces	Percentage in diet	Biomass in pounds	Average adult weight	Equivalent no. of heads
Chital	47	3290 (1492 kg.)	130 (59 kg.)	25
Barasingha	19	1330 (603 kg.)	350 (159 kg.)	4
Sambar	27	1890 (857 kg.)	400 (181 kg.)	5
Gaur	7	490 (222 kg.)	1000 (454 kg.)	0.5
Total	100	7000 (3174 kg.)	—	34.5

Thus a tiger would require about 34.5 units of ungulate prey species in a year of which chital when present in adequate numbers would be the main constituent. According to Wright (1960), the average demand of a lion is estimated to be 36 kills annually.

Data on ungulate biomass is available from few wildlife reserves. Following is derived from Schaller (op. cit.).



2. C : Chital; S : Sambar; B : Barasinga; G : Gaur.
Connecting lines represent the ratio of average adult weight of the prey species to the percentage of its constituent in the total food consumption by the predator species. The ratio would show the influence of size in prey sclectivity and predation success Here the smallest prey species, chital, forms the highest food constituent where is the biggest prey animal, Gaur, forms the lowest constituent.

Table 2. : Biomass data for three ungulate species per sq. ml. (2.59 km²) in Kanha Park

Species	Biomass (lbs.)	Density	Percentage of total ungulates
Chital	900 (408 kg.)	7.7	28
Sambar	800 (363 kg.)	2.0	25
Gaur	1500 (680 kg.)	1.5	47
Total	3200 (1451 kg)	11.2	100

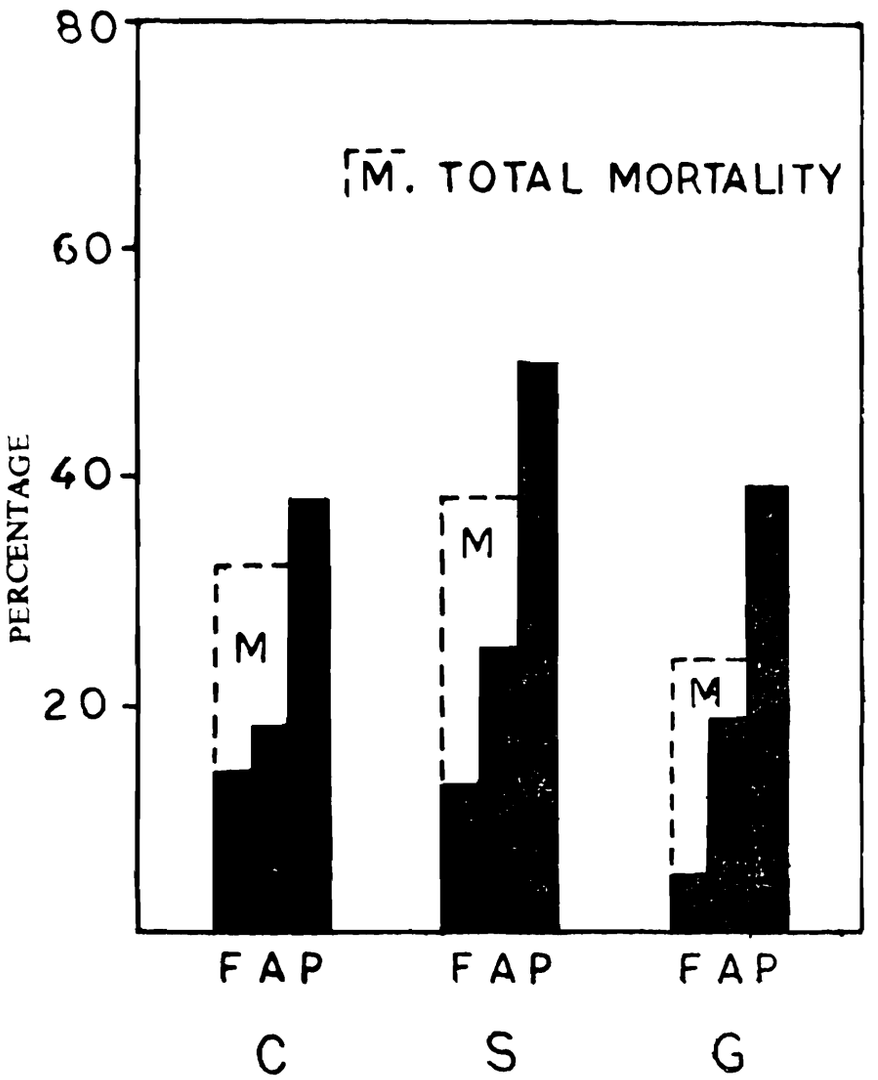
Above data shows that standing crop of above ungulate species in a minimum area of over 2 sq. miles (5.18 km²) is required to sustain one tiger for one year in this habitat. The size of such area would of course differ according to the richness or otherwise of the standing crop it contains, but more or less hold good for comparable habitats. An idea of

the variations of this minimum food stock area according to predominance of only one of these species due to temporary or long term absence or decline of others can also be obtained from the above table. But data on the amount of standing crop and the degree of its utilization is particularly relevant only during the initial year or two of the management of a reserve or where the introduction of a new species takes place. The population stability and survival of a species depend more on the turn over rate and increment of the standing crop in a year. In this connection the population of the most common ungulate species, viz., the chital, the sambar and the gaur are given in Table 3 estimated from the data for Kanha Park.

Table 3. : Population structure and dynamics of three prey species.

	Chital Per cent	Sambar Per cent	Gaur Per cent
	Population structure		
Adult male	19	14.9	32
Yearling male	10	3.5	4
Adult female	28	51.4	39
Yearling female	14	9.8	6
Fawns	29	20.0	19
	Population Dynamics		
Production potential	38	50	39
Fawn mortality out of total fawn population	48	50	50
Fawn mortality out of total population	18	25	19
Adult mortality	14	13	5
Increment	6	12	15

Here the net increment has been calculated on the basis of potential turn over rate of production of young and not on the actual rate, as completa date for latter is not available for any of our reserves. Thus for a total population of 100 deer in the case of chital the potential production is estimated to be about 38 young out of which 18 die before becoming yearlings. At the same time another 14 of the adult age class is also eliminated due to adult mortality and therefore the net increment in the year would be six individuals per hundred. It is evident that any exploitation of the chital population at this place either by predator species like tiger or man would have to be at a level below six per cent of the total chital population or otherwise the predators would be eating into the capital food stock leading to the depletion of the prey species or their population crash.



3. F : Fawn mortality; A : Adult mortality; P : Production potential of population. Sambar with maximum production potential inspite of maximum mortality rate appears to be a key prey species in the sanctury.

The total biomass increment as well as the biomass increment per unit of habitat (1 mi² or 2.59 km²) for the three ungulate prey species combined could be estimated from Table 4.

Based on averge body weght already used, biomass increase for three ungulate species contained per hundred of total population would be 6,860 lbs. (3112 kg.). So using the total density figure of 10.8 animals per sq. mi., it is seen that hundred ungulate animals would require about 9.25 sq. miles (24 km²) of habitat, and on above biomass increment of hundred ungulates, the increment per sq. mile would be 740 lbs. (336 kg. or 130 kg. per km²).

Table 4. : Annual biomass increment of three prey species

Species	Total population	Increment in animals	Average adult weight (lbs.)	Biomass increment
Chital	100	6	130 (59 kg.)	710 (lbs) (354 kg)
Sambar	100	12	400 (181 kg.)	4800 (lbs) (2177 kg)
Gaur	100	15	1000 (454 kg.)	15000 (lbs) (6804 kg)
Total	300	33	1530 (694 kg.)	20580 lbs) (9335 kg)
Per 100 ungulates :		11	510 (231 kg.)	6860 (lbs) (3112 kg)

So if we accept the annual food requirement of one tiger as about 7,000 lbs. (3,175 kg.) of kills, then it is obtained that the ungulate prey population dynamics being as shown earlier in a sanctuary like Kanha, a viable tiger population with assured food supply cropped from the annual food increment without depleting the capital food stock, would require about 9.5 sq. miles (25 km^2) of habitat per adult tiger. Of course it is apparent that this figure is not absolute and that the required range will vary according to the variables in population dynamics of the prey species, other predators. and local conditions.

IV Population Limiting Factors

The term limiting factor is used here to designate such causative factors which help to limit the breeding population of a species in contrast to those factors which affect the total population. That the population increase of a species is limited by a critical level of food supply is evident and needs no labouring. But this does not mean that in nature food supply is always a limiting factor in regulating a population. Food as a limiting factor operates only when a critical stage is reached and there are many an instance in nature where a stable population is homeostatically regulated at much lower level than is determined by a critical food ceiling (see Myers, 1966 on rabbits, and Calhown, 1949, 1950, 1963 on brown rats). Significance of factors other than food supply in limiting a population such as social behaviour is now widely recognised although there is still no uniformity of views in regard to the relative importance of these factors in regulating a population. Lack (1970), for instance maintains that the density dependent mortality is the mechanism which sets the upper limit to the numbers of animals whereas the food supply through natural selection determines the reproductive rate of all higher animals but that this upper limit is rarely reached in species limited by predation. Watson and Moss (1970) on the other hand stresses the importance of behavioural factors especially dominance and spacing such as are involved in territorial behaviour in limiting the population. Waynne Edwards (1970) holds the view that population regulation generally depends upon density dependent changes in fertility and recruitment on one hand and in self imposed mortality on the other and that no

external intervention is necessary in the form of predation, diseases, extreme climate, etc.

Changes in fertility and recruitment : Population density is primarily geared to productivity of the habitat in terms of usable food. And the mechanism for maintaining the equilibrium between population density and the food productivity of the habitat seems to be operating through changes in fertility and recruitment rate. There is a strong case in favour of the view that the reproductive rate has been evolved in relation to the availability of food for the breeding adult (Lock, op. cit.). The fact that the littre size in tiger may occasionally reach up to seven, while three or four cubs are quite common, might indicate that the reproductive rate in tiger has been evolved in conditions of abundant populations of ungulate prey. Decline of the latter is a relatively recent occurnance. A review of the reproductive processes, recruitment rate and final turn over of tiger populations already dealt with would show that population homeostasis in tiger persently operates through reduced breeding and pre- and post-natal mortality.

V. Social Behaviour as Limiting Factor

Watson and Moss (op. cit.) give the main criteria to determine whether or not social behaviour operates as a limiting factor in a breeding population in any one breeding cycle. These are :

(1) A substantial part of the population does not breed even though,

(2) Such non-breeders are physiologically capable of breeding if the more dominant or territorial (i.e. breeding) animals are removed.

(3) Breeding animals are not completely using up some resources like food, space, nest sites etc.; only they prevent others from using it.

Available evidences some of which are already discussed show that the first and third criteria certainly and second also most probably are met with as far as the tiger population is concerned. It has already been discussed that a substantial portion, i.e., one third of the population of adult tigresses do not breed. As to the question whether the breeding population of the tiger is completely using up the resources there is evidence to show that at least in regard to food resources it is not so. Table 5 shows the net annual ungulate biomass production and its annual consumption by tiger population in Kanha park.

The figures show that the food consumption by tiger in this instance is more or less in equilibrium with annual food production increase. The tiger population in this case utilizes just the annual increment only and most of the standing food crop is available for any short term fluctuation of food need. Thus at least in this instance food supply is evidently not fully exhausted during a breeding cycle. As regards the second point

Table 5. : Estimated annual biomass production and its consumption by tiger population in Kanha Park

(A)

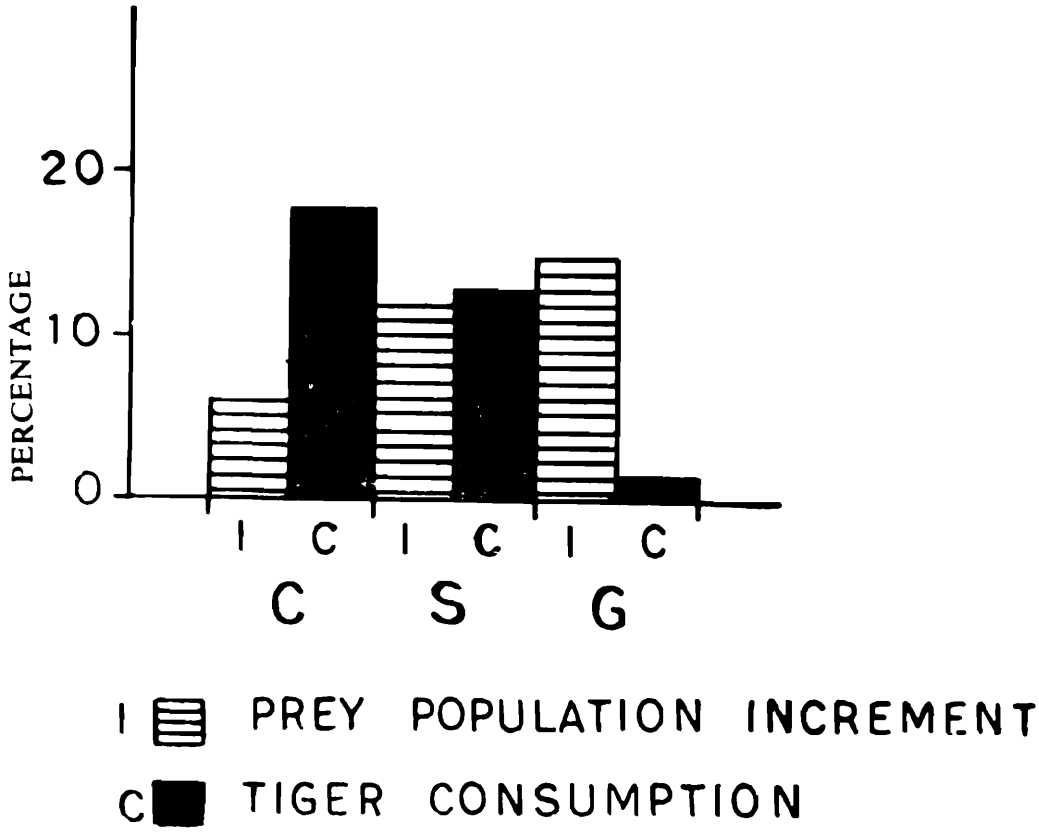
Species	Population	Annual increment in nos.	Annual increment percentage	Annual increment in biomass (lbs)
Chital	900-1000	54-60	6	7020-7800 (3184-3538 kg.)
Sambar	200-300	24-36	12	9600-14400 (4354-6531 kg.)
Gaur	165-210	25-32	15	25000-32000 (11340-14515 kg.)
Total	1265-1510	103-128	11 (mean)	41620-54200 (18879-24585 kg.)

(B) *Annual consumption by tiger*

Residents	Migrants	Equivalent residents	Annual per capita consumption	Total consumption (lbs.)	Balance
4	6-11	*6-7.6	7000 lbs. (3175 kg.)	42000-53200 (1905-24131 kg.)	—380-+1000 (-172-+454 kg.)

*Note : Schaller estimates 10-15 tigers in Kanha Park of which only 4 are residents (1:3 average). Here 3 migrants are treated as equivalent to one resident in range use.

namely, whether or not the non-breeders are physiologically capable of breeding, once the dominant breeders are eliminated, we have no direct evidence at present, but indirect evidences point to the possibility that the non-breeders are capable of doing so. Although evidences show that one-third of the females do not breed in the wild, this feature is not reflected in captivity where most of the females reproduce. This shows that it is mostly lack of enough male contact that leaves a sizeable proportion of females unfertile. We have already seen that the sex ratio in tigers is heavily weighted in favour of females. Coupled with this there are also the factors that the female is in receptive oestrus only for about five to seven days and that ovulation is perhaps not spontaneous, but rather induced by copulation. There is also the factor that many of the tigers are territory holders with fixed home range, where there might be a number of tigresses claiming his attention. It is probably due to this that estrus tigress wanders widely in quest of more males and mating opportunities. But due to the contribution of all these circumstances, particularly that of adverse sex ratio, the end result is that a sizeable portion of tigresses do not breed, although most of them are physiologically capable of breeding.



4. The equilibrium between tiger consumption and population increment of prey species is mainly maintained in Kanha Park by the increment in Gaur where the predation is least Predation by tiger is shown to be closely related to the volume of increment in the other two species.

Thus, it appears that social behaviour is an important limiting factor in tiger population. This seems to be operating through the spacing mechanism determined through dominance, particularly in the male. Although a number of tigresses could live in the territory of a resident male, another male is tolerated there only as a transient. This perforce, leaves a small or large part of the male population, depending upon the total habitat area and conditious, as transients or floating. Territory holders are clearly dominant over the non-territory holders and the former thereby comes to have access to a number of tigresses, much more than he ever needs. Given this territorial behaviour of male in a population where there is already a great disparity in sex ratio, this further lumping and batching of females drastically reduce the reproductive potential to such an extent that it is not relieved by the behavioural antidote of wandering by the estrus female and roaming transient males.

There is considerable evidence to show that the physical structure of the environment greately affects spacing behaviour and population dispersion (Watson and Moss, op. cit.). Availability and the volume of suitable cover is an instance relevant in the case of tiger. Given equal food and resources conditions, the tiger's territory selection and its size may considerably be influenced by the cover availability factor. The role played by the physical structure of the environment independently of the

food sources in spacing and dispersal of tiger remains to be studied; so also the role of early social behaviour, stress etc. in modifying the spacing behaviour and their effects on population limitation.

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Wild Life Workshop: 99-104

FIELD ECOLCGY AND BEHAVIOUR OF THE RHESUS MACAQUE (*MACACA MULATTA*) 3. INTERGROUP RELATIONS IN THE ASARORI FOREST

By

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Abstract

These observations were made on 8 groaps over a 9-month period. Even though home range overlaps widely intergroup encounters are not common. Four types of encounters are recorded : Overt-aggressive, aggressive, aggressive-tolerance and approach-withdrawal

Groups are intolerant to the proximity of other group, and intergroup spacing or avoidance found. During encounters display is common and fighting very rare. Subordinate males usually leads chasing or fighting. Intergroup dominance is positively correlated with group size. During stress situations alpha male may mount a female of his own group.

I. Introduction

Recent field and laboratory studies of higher primates, indicate that the rhesus macaque, *Macaca mulatta* (Zimmermann 1780), is more aggressive both within the group and between the groups than other primates. It shows an extensive repertoire of aggressive behaviours which ranges from visual threats and displays to severe fighting.

Relations within the group have emphasized in various studies, but relations and behaviours between the groups, especially in the natural state have been only meagerly, and the available information has been summarized in Roonwal (1976) and Roonwal and Mohnot (1977).

Part 1 and 2 of this series (Makwana, 1978, 1979) dealt with ecology and some behavioural aspects of the rhesus macaque of the Asarori Forest, near Dehra Dun, at the foot hills of the Himalayas. The present account deals with the intergroup interactions and behaviours of wild population of the rhesus macaque of the Asarori Forest.

II. Results

In spite of the extensive overlapping of the home ranges in neighbouring groups (the overlapping varies from 32.8-100% of the total area of a home range; Makwana, 1978) interactions between groups are

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infrequent. During a 9-month long period, totalling about 1,100 hours of observations only 19 interactions were observed in the 8 groups*. The encounters observed is probably a small percentage of the total number that occurred during the study period. Group size varied from 5-c.90, and home ranges from 0.6-7.8 km² (Table 1). Group sizes of groups A, B, S, and X could be assessed approximately, while those entimations for the remaining ones are more precise.

Table 1. *Macaca mulatta.* Group size, home range, and intergroup encounters in seven groups of Asarori Forest, 1976. (See Text for abbreviations).

Items	Groups						
	B	A	S	H	HA	R	C
Group size	c.90	c.65	c.60	31	19	13	5
Home range (km²)	7.8	Over 4.0	Over 4.5	4.5	3.8	1.4	0.6
Total number of interactions.	4	3	3	4	3	10	9
No. of times the group was dominant (and its percentage).	4 (100)	2 (66.6)	1 (33.3)	3 (75.0)	0 (0)	8 (80.0)	0 (0)
No. of times the group was subordinate (and its percentage).	0 (0)	1 (33.3)	2 (66.6)	1 (25.0)	3 (100 0)	2 (20.0)	9 (100 0)

The interactions are summarised in Table 2. The period of confrontation ranged from two minutes to as long as one hour. The boundaries of home ranges, with the locations of interactions, are shown in Fig. 1. the arrow marks indicates the directes of withdrawal of a group. It is interesting to note that all the interactions occurred within the overlapped areas of home ranges.

For convenience, the interactions are grouped into four categories.

1. *Overt-aggressive.* Includes fight between the groups. Occurred very rarely (5.3% of the cases).

2. *Aggressive.* Includes visual threats, dominance displays and chase by both the interacting groups. Occurred in 36.8% of the cases.

3. *Aggressive-tolerance.* Includes visual threats by one group and tolerance by the other. In the two encounters observed (10.5% of the cases) the subordinate group showed aggression while the dominant group showed tolerance or avoidance.

*Out of these 8 groups, 5 were study groups (See Makwana, 1978), 2 groups (A and S) came across occasionally, while one (X) was observed only twice. These groups were : Amsult (A), Bada (B), Choki (C), Harbhajwala (H), Harbhajwala 'A' (HA), Rest House (R), Sukhroa (S) and a strange group (X).

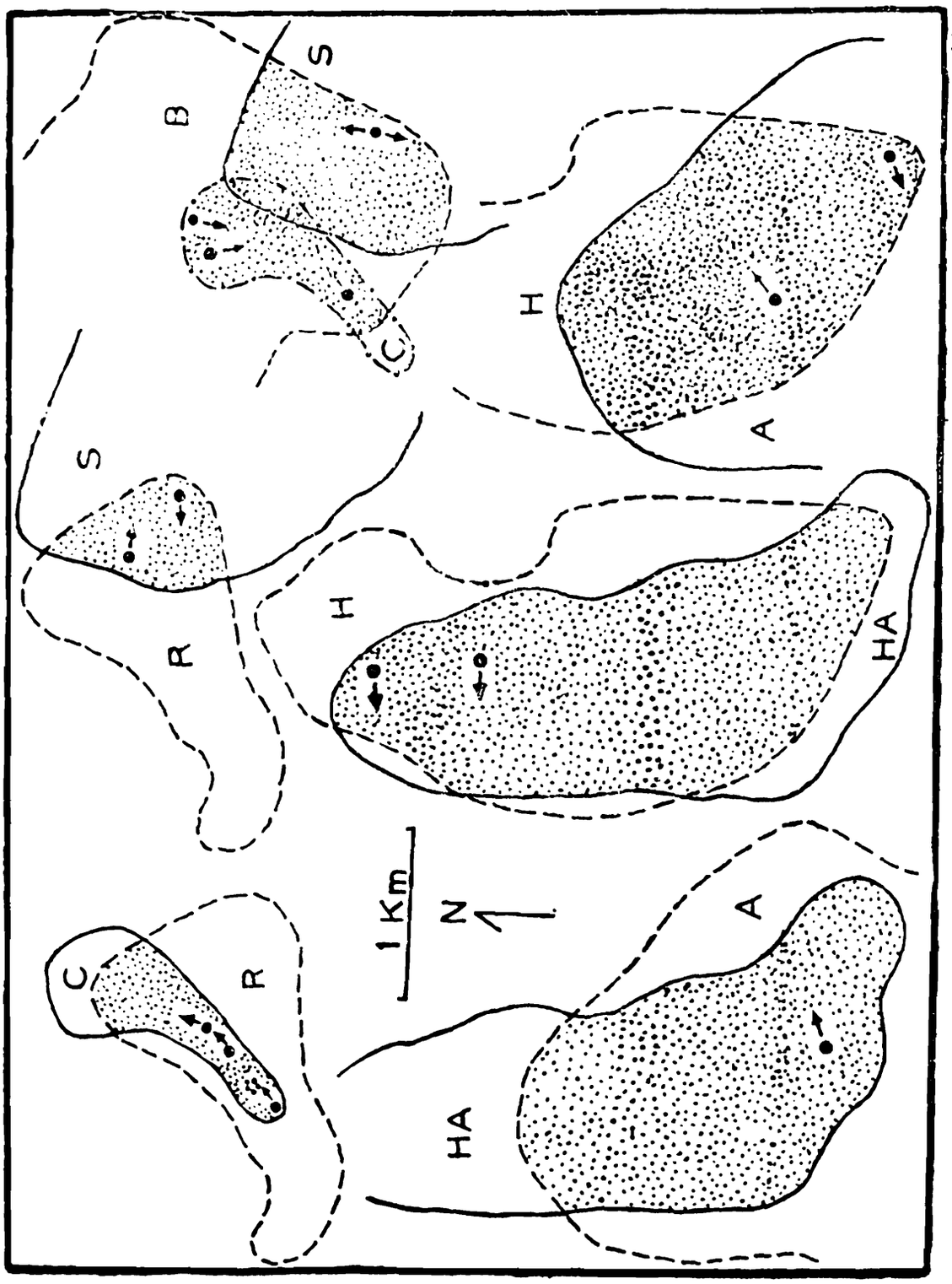

Fig. 1. *Macaca mulatta*. Location of intergroup interections of rhesus macique in the Asarori Forest, with the boundaries of home-ranges of interecting groups.

4. *Approach-withdrawal.* Includes approach by the dominant group and withdrawal or avoidance by the subordinate group (with frequent visual scanning, Fig. 2, at the approaching group). Occurred in 47.4% of the cases and was the most common type.

It was noted that in 89.5% of the interactions, group size was significant for determining intergroup dominance (Table 2). In the remaining 10.5% cases, some other factors apparently played a part, e.g., possibly rank, the number of participants, the location of the interaction site etc.

One group (B) was completely dominat, while two groups (HA and C) were completely subordinate in all the interactions. The remaining four groups were dominant in some and subordinate in other encounters (Table 1).

Table 2. Summary of intergroup interactions of *Macaca mulatta* in the Asarori Forest, 1976 (For abbreviations, see Text; foot note).

Sl. No.	Interaction between groups I	II	Date of interaction	Time and duration of interaction	General reaction of group Of I	Result=Dominant/ Subordinate	Of II
1	2	3	4	5	6	7	8
1	B	C	4.ii 76	15.20-15.25 hrs. (5 min.)	Approach	Withdrawal	B/C
2	,,	,,	24.ii.76	14.20-14.25 hrs. (5 min.)	,,	,,	,,
3	,,	,,	6.iv 76	11 40-11.50 hrs. (10 min.)	,,	,,	,,
4	B	S	27 viii.76	09.15-10.15 hrs. (60 min)	Fight	Fight	B/S
5	A	H	7.v.76	13.40-14.30 hrs. (50 min.)	Chase	Retreat, Chase, Withdrawal	A/H
6	A	H	15.vi.76	09.15-10 00 hrs. (45 min.)	Chase; Withdrawal	Chase	H/A
7	A	HA	3.vi.76	05.40-05.55 hrs. (15 min.)	Chase	Chase Withdrawal	A/HA
8	S	R	22.ix.76	07.30-08.10 hrs. (40 min.)	Display, Chase, Withdrawal	Display, R/S Chase, Display	
9	S	R	22.ix.76	09.40-09.50 hrs.	No reaction (avoidance)	Visual threats, Withdrawal	S/R
10	H	HA	26.ii.76	13.30-13.45 hrs. (15 min.)	Chase	Chase, Withdrawal	H/HA
11	H	HA	22.ii.76	16.15-16.25 hrs. (10 min)	,,	,,	,,
12	R	C	4 ii.76	17.30-17.33 hrs. (3 min.)	Approach	Withdrawal	R/C
13	,,	,,	14.ii.76	14.25-14.27 hrs. (2 min.)	,,	,,	,,
14	,,	,,	17.ii.76	09.10-09.12 hrs. (2 min.)	,,	,,	,,
15	,,	,,	19.ii.77	09.20-09.25 hrs. (5 min)	,,	,,	,,
16.	,,	,,	22 ii.76	13 05-13.15 hrs. (10 min.)	,,	,,	,
17	,,	,,	8.x 76	17.20-17.25 hrs. (5 min.)	,,	,,	,,
18	R	X	5.v.75	16.55-17.05 hrs. (10 min.)	Visual threats, Retreat	Avoidance	X/R
19	R	Ad ♂ (Solitary)	25.v.76	08 15-08 45 hrs. (30 min.)	Chase	Withdrawal	R/Ad ♂

Although home ranges overlap widely, yet an intolerance of the proximity of other group was observed. On encounter, dominance was expressed by the "alpha" (most dominant) male by raising up the tail, piloerection, branch shaking visual threats and occasionally (in stress situations) by mounting female of his own group.

III. Discussion

Though the rhesus macaque lacks any broadcast signal for the neighbouring groups, a tendency toward intergroup spacing and avoidance is evident, and such avoidance was observed in 57.9% of the total cases. Again, even though the rhesus is very aggressive in nature, fighting during encounters is rare; I observed only one case of fighting in a period of 9 months. In the same locality, Lindburg (1971) recorded no fighting. From a study of temple group in Aligarh, Southwick et al. (1965) had also concluded that subordinate groups usually try to avoid dominant groups, though some times fighting resulted, in case of sudden, unexpected encounters and inability of the subordinate group to retreat in time.

Mounting during stress situations by a male to female of his own group, as recorded above, had not been observed earlier.

Overt aggressive contacts are comparatively more common in free ranging colonies and in urban and semi-urban situations, as recorded by Vanderbergh (1967), in the La Parguera Island, 22%; Vessey (1968), in the La Cueva Island, 48% and Lindburg (1971) near Dehra Dun, 36.6% cases.

At Asarori, intergroup dominance is directly correlated with group size, as also recorded by Southwick et al. (1965), Vanderburgh (1967) Vessey (1968), Lindburg (1971) and Roonwal (1976). Monkeys were intolerant of the proximity of other graup. Grooming, mounting, inspecting and playing between the member of two groups, as observed by Lindburg (1971), Hausfater (1972), Boelkins and Wilson (1972) and some other workers, were not observed by me.

In aggressive encounters, young subordinate males of the dominant group first made contact with the opposite (subordinate) group; sometimes adult females and juveniles also accompanied them. In most cases, the subordinate group withdrew on, or before, the closer approach of the alpha male of the dominant group. Dominant males of the interacting groups usually engaged in display, rarely they were involved in chasing or fighting.

Acknowledgements

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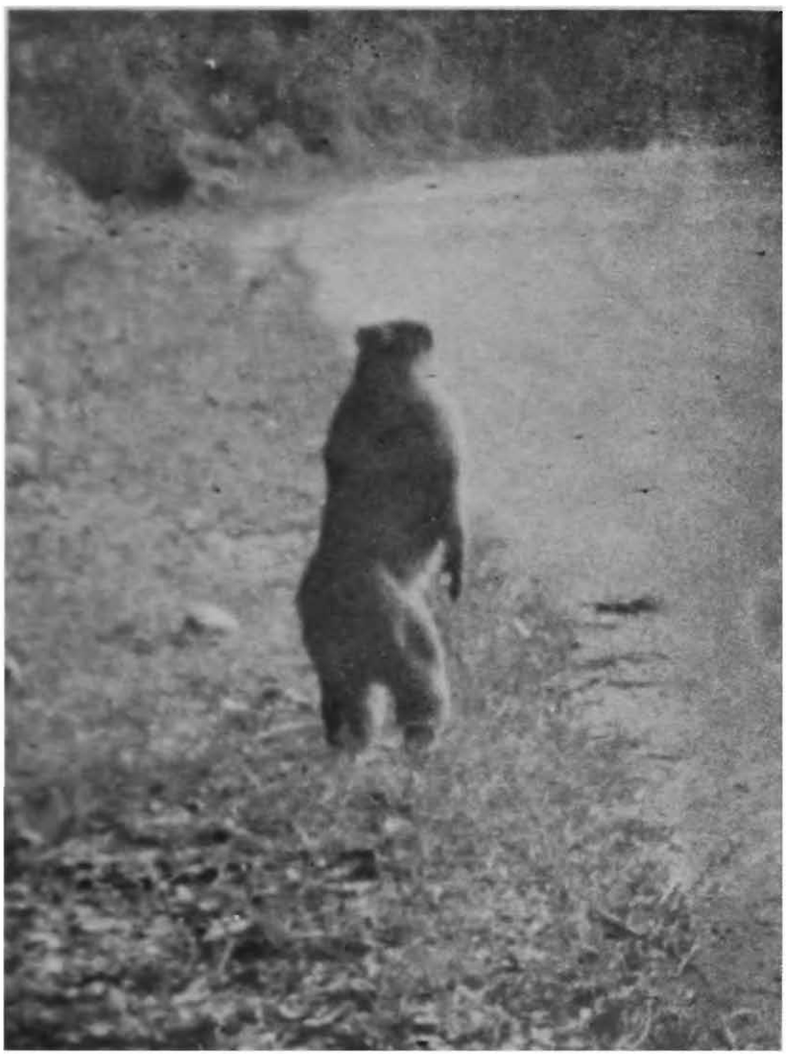

Fig. 2. *Macaca mulatta*. Visual scanning by alfa male of the R-group at another group

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PROBLEMS OF WILDLIFE MANAGEMENT IN INDIA

By

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Abstract

Wildlife is a renewable resource which can be utilised by the human society at the time of needs, and its management means intelligent exploitation of nature with all its biological and physical components in its original form as far as practicable.

The management of Indian wildlife is beset with several problems including the developmental programmes like the establishment of new townships, industries, hydro-electric projects, etc. The article contains some suggestions for the planners of India, in addition to the steps taken by the Government of India and some private bodies for the management of Indian wildlife.

The word 'wildlife' though old in usage, yet there is no agreed definition of it, and it varies from authority to authority. For instance, Gee (1964 :154) in his book "Wild life of India" said "the term 'wild life embraces all living creatures and implies their conservation" Stracey (1963 : 6) considers "the term wildlife is appropriate when dealing with the management, control and conservation of the wild animal population as a whole as distinct from the purely game animals" According to the Wildlife Society, Washington, 'wildlife includes all wild vertebrates and larger invertebrates important from aesthetic, sporting, utilitarian and nuisance standpoint' According to the Wild Life (Protection) Act (1972) of the Government of India, "wildlife' includes any animal, bees, butterflies, crustacea, fish and moths; and aquatic or land vegetation which forms part of any habitat" The present writer thinks that by the term 'wildlife' one should consider all animals and plants in their wild state. Generally speaking the wildlife management should be equated with the management of nature with all its biological and physical components in its original form as far as practicable. The scientific management and conservation of nature gained importance practically after the second world war, when human population explosion took place in different parts of the world, which demanded more room for human habitation and greater exploitation of natural resources for raising the standard of living.

Every one of us agrees that man is comparatively a newcomer into this earth, but with his intelligence he is ruling over other creatures, killing them according to his needs and whims. No one actually knows

how many species became extinct at the dawn of civilization. Recently, the International Union for the Conservation of Nature listed 275 species of mammals and 300 species of birds as rare and endangered (Southwick *et al.* 1970). Bates (1958 : 100) considered that in modern times, an average of one species of bird and one species of mammal has become extinct somewhere in the world every year. Cloudsley-Thompson (1971 : 38) reported the historical evidence in the changes of the faunal composition of the Sahara. Mukherjee (1974) cited some examples of faunal impoverishment and faunal regression in India. The rate of wildlife extinction is likely to be increased with the steady increase of human population and exploitation of the remaining wilder regions.

The management and conservation of wildlife in practice demand intelligent exploitation of nature. It helps the plants and animals to retain their existence. This in turn keep the soil and water in original condition in spite of the changing landscape. Human society can also utilise this renewable resource at the time of needs.

What difference does it make, one may ask, if panther, tiger, lion or python go tomorrow, or the cheetah and the white-winged wood-duck disappear ? Like all other aspects of human ecology it also has both credit and debit sides; and the following recent publications, *viz.* Street (1961), Southwick *et al.* (1970) and Misra (1971) enumerate the importance of wildlife management. Our Prime Minister Shrimati Indira Gandhi, in her message on the occasion of the inauguration of the 'Project Tiger' at the Corbet National Park on 1st April, 1973, answered the question very intelligently by saying "The narrow outlook of the accountant must give way to a wider vision of the recreational, educational and ecological value of totally undisturbed areas of wilderness. Is it beyond our political will and administrative ingenuity to set aside about one or two per cent of our forests in their pristine glory for this purpose?"

In order to preserve the wild regions in their natural state we have framed a complex system of national, state and local game laws since the dawn of history. Many of the laws were framed before we gained sufficient ecological knowledge related to the problem. In India, for instance, in Kautilya's *Arthasastra* we find mention of *Abhaya Aranya* (protected forest) and a list of animals prohibited from killing. Similar lists are also available in the Emperor Asoka's edict on the fifth pillar. Gradually we are realizing the importance of scientific management of wild nature. The wildlife management is now considered as a multidisciplinary science and is an important profession in India and abroad. It has separate departments, professional societies and technical journals. In India, there is a course named Wild Life Management Course, introduced in the Indian Forest College, Dehra Dun, in 1970. The Government of India has declared that the first week of the October of

every year should be observed as the wildlife week throughout the country. In addition to these efforts, the Government has also declared nature conservation as one of the basic duties of all Indian citizens in the 42nd amendment of the Constitution of India.

The practical experiences gained by the present writer in different forests of India led him to believe that the wildlife management in India is beset with several problems. The most important of which is that the people living near the forests do not know the value of conservation of nature. They poach or help in poaching being bribed. The Government of India is also hard pressed with the steady increase of human population, superstition and illiteracy among the general mass. Under these circumstances, the Government has been bound to take up some projects to accommodate the growing population and to boost industries, hydro-electric projects, construction of reservoirs, etc. by cutting down forests. Among these projects, the erection of Tungabhadra dam in South India, Bhakra-Nangal dam in Punjab, dams of the Damodar valley corporation and the reclamation of the Salt Lake in eastern India are worthy to mention. Some of these projects have raised some serious problems too, such as sitling problem in the Bhakra-Nangal dam which needs immediate attention. In addition to these projects, the cultivation of cash crops, *viz.* tea, coffee, rubber, Eucalyptus, etc. has also disturbed the normal ecological set up of the wild animals Although these projects are no doubt beneficial to the present generation or to the next few generations also, they are actually harmful to the future generations of *Homo sapiens*. For this reason, our Prime Minister Shrimati Indira Gandhi, during the inauguration of the first meeting of the National Committee on Environmental Planning and Coordination in April, 1972, cautioned the planners by saying, "We must be able not only to choose our direction, but to know where to stop and when to turn. We must be mature enough to resist temptation of non-essentials which glitter for a while" In these circumstances, the National Committee on Science and Technology has allotted more than hundred lakhs of rupees for the establishment of a separate institute for the wildlife science. In the present context, the writer considers that the authorities of the future wildlife institute should work in collaboration with the forest departments, institutes dealing with zoology, botany, agriculture, geology and allied subjects, for the proper ideas and objectives of the institute. The following points should be taken into consideration.

(1) Attractive monetary incentives to be offered to the person/persons (who may or may not be in the forest services) helping in apprehending the poachers, and in saving the weak and disabled wild animals.

(2) Arrangements should be made for audio-visual education of villagers, living near the forests, to explain to them the value of conservation of wildlife and other components of nature. They should also

be educated about the relationship of family planning and nature conservation and their impact on future generations.

(3) Certain portion of the revenue earned from certain forests should be set apart for the benefit of the local people.

(4) Larger numbers of people should be trained for thorough ecological knowledge of the threatened wild animals.

(5) Before installation of industries and hydro-electric projects to be located in or near a forest, studies on the probable impact of such projects on wildlife should be made, so that an intelligent plan could be made before destroying the wild nature.

(6) Programme should be set to remove, reduce, minimize and prevent environmental deterioration of all kinds.

(7) Encouragement should be given in the planning of man's activities, the utilization of all available knowledge of earth, its biological community, man's society and technology, so that man's environment may be not only biologically sufficient but rich in conceptual, social, biological and physical diversity and beauty.

(8) Full and sympathetic consideration should be given to the population of both game and non-game wildlife before any chemical pest control programme is undertaken.

(9) Support for research on non-target insects and other invertebrates should be increased because these creatures constitute a vital and interesting portion of our native fauna and it is necessary to know as to how severely these animals are affected by chemical pest control programmes and to take appropriate action to protect them.

(10) Animal control programme should be carefully planned, justified, carried out and evaluated on the basis of total social benefits, so that the damage/loss due to wildlife can be minimized.

(11) Forestry practices designed to squeeze the last rupee out of our wild regions must be radically reoriented at least within the sanctuaries and national parks.

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THE STATUS OF INDIAN NON-HUMAN PRIMATES

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Abstract

India is known for its faunal diversity. This diversity is best represented by the non-human primates found in the country. The Indian primate species vary not only in their habitat disposition, but also in their shape, size, population status and their utility in biomedical research. As many as 8 genera having 19 species and 38 subspecies (two-third of the total of 130 subspecies found in the world) are known from India alone. Of these, 7 species, *Anathona ellioti*, *Tupaia nicobarica*, *Macaca assamensis*, *M radiata*, *M. silenus*, *Presbytis geei* and *P. johnii* are exclusively Indian in their distribution. Except for *M silenus*, *P. geei* and *P. johnii*, subspecies of others have been reported. In some cases 'forms' and 'races' also exist. Some authors have considered the Golden langur, *P. geei* as a subspecies of *P. pileatus*, and the long-tailed Macaque, *M fascicularis* that of the Rhesus monkey, *M. mulatta*. But in both the above cases there is a uncertainty about their conspecificity.

The presence of subspecies in the case of stump-tailed Macaque, *M. arctoides* and the Golden Monkey, *Rhinopithecus roxellanae* is disputed. The genus *Rhinopithecus* has been considered as a subgenus of genus *Pygathrix* by some taxonomists.

Few nomenclature changes have also been incorporated in the recent past. For example, *M. speciosa* is now known as *M. arctoides*, and *M irus* as *M. fascicularis*. These changes are necessary as per the nomenclature rules. In both cases no generic names were given by the authors while describing them. The oft-used common name "Crab-eating Macaque" for *M. fascicularis* is misleading. Crabs though eaten when available, do not constitute main natural food of *M. fascicularis*. The alternative name "Long-tailed Macaque" is thus more appropriate.

In the absence of large scale surveys for population status and subspeciation, it is difficult to ascertain natural population and range of distribution of most of our primate species. Except for the intensive survey of *M mulatta* in parts of northern India, over a long period of time, only pocket surveys have so far been conducted on some other species like, *P. entellus*, *P. johnii*, *M. radiata* and *M silenus*. These, as a matter of fact do not provide a clear picture either of the population trend or of the extent of geographical distribution. It is likely, that, in many areas from where different subspecies have been reported in the past, we may not even succeed in relocating them due to large scale destruction of primate habitats (mainly forests) for human usage. Local extinction of several species have come to our notice in the last 2 decades. Because of this ecological vulnerability, several primate species have not only shown signs of depletion, but have even reached the level of extinction.

Keeping in view the importance of our primates in the country's economy (we have been exporting thousands of rhesus and bonnet monkeys every year to different parts of the world) and in biomedical research, a country wide plan for the maintenance of our species and wise use is the urgent need Studies about distribution, population status, and taxonomy of *Loris tardigradus*, *Nycticebus coucang*, *M. arctoides*, *M. assamensis*, *M. silenus*, *P. geei*, *P. johnii*. *R. roxellanae* and *Hylobates hoolock*, are urgently required.

I. Introduction

India is known for its faunal diversity. This diversity is well represented by the non-human primates occurring in the country. The Indian primate species vary not only in their habitat disposition, but also in their shape, size, population status and their utility in biomedical research. As many as 8 genera having 19 species and 38 subspecies (about two-third of the total of 130 subspecies found in the world) are known from India alone (Table 1). In some cases forms and races have also been reported. Of these 19 species, *Anathana ellioti*, *Tupaia nicobarica*, *Macaca radiata*, *M. silenus*, and *Presbytis johnii*, five in all are exclusively Indian in their distribution.

As many as 11 species including a common tree shrew, a Slow loris, four macaques, four langurs and a gibbon are confined to tropical wet evergreen, semi-evergreen, and moist deciduous forests of eastern India. Four species, a Slender loris, two macaques and a langur are restricted in tropical dry deciduous, moist deciduous, and moist evergreen forests of the peninsular India. The remaining four species, which includes a tree shrew, a langur and two macaques predominantly inhabit in tropical thorn, dry deciduous and moist deciduous sal forests. Amongst these, *Macaca mulatta* and *Presbytis entellus*, are two most adaptable species found in varied ecological niches and are not representative of a particular forest type, like other species. Both are fairly abundant.

II. Subspecies

Except for *Macaca silenus*, *Presbytis geei* and *P. johnii*, the remaining 15 species have 1-13 recognised subspecies. However, problem with regard to subspecies, forms and races continues to exist. The common tree shrew, *Tupaia glis belangeri*, collected by Roonwal (1949) from Manipur needs further investigation for subspecies. Similarly, subspecies problem needs further study in the case of *M. arctoides*, *M. fascicularis*, *M. mulatta*, and the Golden langur, *P. geei*. Opinion of primatologists differ with regard to these macaques. Bertrand (1969) refers to the number of synonyms in *M. arctoides*. Fooden (1964) regards *M. fascicularis* as a subspecies of *M. mulatta*, while Hill (1972) consider *fascicularis* as a independent species on the basis of its morphology, blood groups, etc. Weiss and Goodman (1972) though recognise the close relationship of these macaques but do not consider them conspecific.

In the Wynaad district, Tamil Nadu, Krishnan (1972, p. 537) noticed "a miniature bonnet monkey, hardly half the size of the common specimens..... An adult female was seen carrying an infant only the size of a loris." No clear subspecies of *M. silenus* are recognised. Hutton (1949) refers to two forms, a large form (weight 11.3-15.9 kg) on the Wynaad plateau and the High Wavy Mountains, and a smaller form

Table 1.—Distribution of 19 species of non-human primates found in India.

Indian non-human primate species	Total number of subspecies	Subspecies found in India	Distribution in India	Remarks
1	2	3	4	5
(A) Tupaiidae				
1. *Anathana ellioti* (Waterhouse, 1850)	3	3	India south of Satpura Range on the west and south of the river Ganga on the east.	Exclusively Indian
2. *Tupaia glis* (Diard, 1820)	49	2	West Bengal, Sikkim, Assam, Meghalaya, Nagalad, Manipur and Tripura.	Ellerman and Morrison-Scott (1951) recognises three subspecies; Agrawal (1975) recognises two
3. *Tupaia nicobarica* (Zelebor, 1869)	2	2	Nicobar Islands (Bay of Bengal).	Exclusively Indian.
(B) Lorisidae				
1. *Loris tardigradus* (Linnaeus, 1758)	6	2	Southern India.	
2. *Nycticebus coucang* (Boddaert, 1785)	4	1	Eastern India (Assam, Meghalaya, Nagaland and Tripura).	
(C) Cercopithecidae				
1. *Macaca arctoides* (I Geoffroy, 1831)	4	1	Assam, Meghalaya, Nagaland and Tripura.	
2. *Macaca assamensis* (McClelland, 1840)	2	2	The Himalayas from northern Uttar Pradesh east to Arunachal and south to Sunderban (?)	
3. *Macaca fascicularis* ((Raffles, 1821)	21	1	Nicobar Islands (Bay of Bengal).	

1	2	3	4	5
4. *Macaca mulatta* (Zimmermann, 1780)	4	2	Northern India from along the Himalayas south to the river Tapti in the west and river Godavari in the east. Some troops are also known from south of this range.	
5. *Macaca nemestrina* (Linnaeus, 1766)	4	1	Only authentic record is from Nagaland.	Fooden (1975) recognises 3 subspecies.
6. *Macaca radiata* (E. Geoffroy, 1812)	2	2	Peninsular India, north to Satara and the Godavari River.	Exclusively Indian
7. *Macaca silenus* (Linnaeus, 1758)	—	—	Peninsular India In all probability, it is at present confined to Kerala and western Tamil Nadu.	Exclusively Indian. Monotypic. No clear subspecies are recognised.
8. *Presbytis entellus* (Dufresne, 1797)	15	13	Occurs in most parts of India not encountered in extreme western desert tracts of the Indian Desert	Represent highest primate habitat in the world, going upto *c* 3660 m
9. *Presbytis geei* (Khajuria, 1955)	—	—	North-western Assam and south-central Bhutan	
10. *Presbytis johnii* (Fischer, 1829)	—	—	Western Ghats.	Exclusively Indian.
11. *Presbytis phayrei* (Blyth, 1847)	3	1	Tripura.	Agrawal (1974)
12. *Presbytis pileatus* (Blyth, 1843)	5	4	North-eastern India.	
13. *Rhinopithecus roxellanea* (Milne-Edwards, 1870)	—	—	Its occurrence in India is based on doubtful sight records	Subspecies, and distribution disputed
(D) Hylobatidae				
1. *Hylobates hoolock* (Harlan, 1834)	2	1	South and east of Brahmaputra and Lohit rivers.	

(weight 6.8-9.1 kg) in the Anaimalai Hills. Field studies in Wynaad district might help provide more information about these forms.

Oboussier and Maydell (1960, p. 154) regards *P. geei* as subspecies of *P. pileatus*. The Snub-nosed monkey, *Rhinopithecus roxellanae*, about which very little is known as it has not been seen in the wild for the last two decades resulting into some dispute pertaining to its subspecies, distribution and existence in India. Groves (1970, p. 568) refers it to the subsequently discovered *P. geei*.

III. Nomenclature

A few nomenclature changes have been incorporated recently by Roonwal and Mohnot (1977). For example, the Stump-tailed macaque, *M. speciosa*, is now known as *M. arctoides*, and the Long-tailed macaque, *M. irus* as *M. fascicularis*. These changes are necessary as per the nomenclature rules. In both the above cases no generic names were given by the authors when described. The oft-used common name "Crab-eating macaque" for *M. fascicularis* is misleading. Crabs, though eaten when available, do not constitute the main food of *M. fascicularis* in nature. The alternative name "Long-tailed macaque" is thus more appropriate.

IV Population Status

In the absence of large scale surveys for population status, it is difficult to ascertain population status and range of distribution of most of our primate species. Except for the intensive surveys of *M. mulatta* in parts of northern India over a long period of time, only pocket surveys have so far been conducted for other species like, *P. entellus*, *P. johnii*, and *M. radiata*, which provide only limited information of a particular habitat. In the case of *M silenus*, clear population status is now known because of its small numbers and restricted distribution range in *Sholas* of Nilgiri Hills. Southwick and Siddiqi (1977) have given a clear picture of population trend of rhesus of north India. Their data since 1959 indicates decline in population in unprotected cohort and increase in semi-protected cohort. They are of the opinion that if monkeys do not receive protection from local people they will be eliminated from most agricultural areas of India within 25 years. Further, it is likely that in many areas wherefrom different subspecies have been reported in the past, we may not even succeed in relocating them due to large scale destruction of primate habitats (mainly forests) for human usage. Local extinction of some species have also come to our notice in the last two decades. Because of their ecological vulnerability, some species have not only shown signs of depletion, but have even reached the level of extinction. One noteworthy example is the Lion-tailed monkey, *M. silenus*, which has become the rarest of all Indian primate species in the recent past. It faces the danger

of imminent extinction due mainly to habitat destruction and hunting. Green and Minkowski (1977) have given a workable plan for preserving *Sholas* where the Lion-tailed monkey inhabits.

The results of 10-year study around Jodhpur on a model population of *P. entellus* will provide us overall information of langur social life and population trend of a open scrub habitat. Vogel (1977) writing on this population has correctly assessed the potentiality of this habitat for a long-range study.

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Proc. Wild Life Workshop : 119-120

THE BENGAL FLORICAN, *EUPODOTIS BENGALENSIS BENGALENSIS* (GMELIN) IN EASTERN INDIA

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Abstract

The Bengal Florican, once common in the Tarai and Duars grassland that extended from the River Jamuna in the west to the Brahamaputra Valley in the east, in the 19th and earlier part of the present century, has fast disappeared from much of its range. It is now rarely found in non-protected grassland. Few birds still exist in some sanctuaries along the north-eastern rivers of Bengal and Assam In a recent survey conducted by the author in 1976 in Manas Sanctuary (Kamrup district) and the Kaziranga National Park (Nowgong and Sibsagar districts), which have extensive grassland comprising *Andropogon* sp., *Chrysopogon* sp., *Saccharum* sp., it was found that they shelter some 50 birds in approximately 400 km². Shrinkage of grassland, late grass burning coinciding with the breeding period, exposure of adults and chicks to predation owing to burning of the grass and unprecedented floods are the major reasons for its decimation.

Among the resident bustards (family Otididae) that inhabit the grasslands of the Ganga-Brahamaputra plains and valleys, is the Bengal Florican [*Eupodotis b. bengalensis* (Gmelin)]. It is a long-legged, peafowl-sized bird excluding the trail and stands about a metre high. The male is glossy black, moppy crested, white winged, whereas the female is overall rufous buff and brown with no crest at all.

The grassland, in which the Florican inhabits, comprises grasses of *Andropogon* sp., *Chrysopogon* sp., *Imperata cylindrica*, *Saccharum* spp., etc. These grasses when a metre high are ideal ground for its foraging, sheltering and nesting. It generally shares the terrain of domestic cattle, Wild Buffalo, Rhinoceros, and the Hog and Swamp Deer. Groups of four or five, sometimes eight are seen in breeding time and in non-breeding time single or pairs are generally noticed. Males and females are in equal ratio. Its food is mixed insects, frogs, slugs, berries, grass-seeds, etc. It has been observed to have a liking for roasted seeds and insects driven out when grass is put on fire. It avoids watered tracts and prefers dry or high grasslands. Its skulking habit makes it difficult to flush When driven it flies for 100-300 metres and drops in grass to disappear. Nests are concealed and flight to nest is never direct. Eggs are generally two. Predation is common by carnivores, crow-pheasants, raptores, and other animals.

The bird once common in the grasslands throughout the eastern districts of Uttar Pradesh, North Bihar and the Duars of West Bengal and Assam, has become uncommon today. From the Tarai grassland of Uttar Pradesh and Bihar there is hardly any recent record.* C.M.

*The author was able to sight a pair in Dudhwa National Park, Uttar Pradesh in June 1980.

Inglis collected 4-5 birds from north-eastern Bihar some 50 years ago which is the last racord of its occurrence in that area. In northern Bengal, Jalpaiguri district, the author had once sighted the bird in 1955 and since then there is no record of it. In the late part of the 19th century it was recorded from Malda and Nadia districts. Stuart Baker in 1884 colleted the last specimen from Nadia district south of the Ganga river It existed in Sylhet, Rangpur and Chittagong in Bangladesh, mention and records of which have been made by T.C. Jerdon, A.O. Hume and others in classical ornithological books, now almost a century old. Since no report of the occurrence of this bird in their previous locales has been made, it is presumed, the bird has been exterminated from such areas which lie south of 26° latitude, roughly south of Ganga in West Bengal and the Garo, Khasi and Jaintia Hill ranges.

A thorough investigation of the status of this bird was conducted in eastern India, in the years 1975, '76 and '77 and revealed the following:—

1 The bird is sparsely present in the grassland in the northern districts (Darjeeling, Jalpaiguri and Cooch Behar) of West Bengal. It is absent in Malda and West Dinajpur districts.

2. It exists in the protected grasslands of northern bank of Brahamaputra, *viz.*, Goalpara, Kamrup, Darrang, and western part of north Lakhimpur district. In Orang and Sonai Rupa sanctuaries there were about two dozen birds (1977). In Manas sanctuary 30 birds were found in four blocks (1977).

3. In some islets of the Brahamaputra in Sibsagar and Jorhat districts which bear thatched grass, the bird is said to exist but its number is insignificant.

In the south bank of Brahamaputra except for Kaziranga National Park which harboured about 40 birds in 8 blocks (1977) it has not been seen elsewhere. Approximately 50 birds were found in 400 km sq. in the National Park.

A fair estimate of the total number of birds in Assam should be about 250.

After studying the present status it is felt that there is every chance of losing this magnificant bird as it is flushed easily by elephants and dogs and shot from elephants's back. Shrinkage of grassland due to pressure of extensive cultivation, inadequate cover due to grass burning, cropping of thatch grass (*Ulu*) from unprotected areas, unprecedented floods in its breeding areas which are generally on both banks of the Brahamaputra, are the major causes for its decimation.

It is therefore, suggested that:

1. The bird should be protected under Schedule 1 of Wild Life (Protection) Act of 1972 instead of Schedule IV where it finds its place at present.

2. Breeding the bird in captivity to enlarge its population.

Proc. Wild Life Workshop : *121-122*

STATUS OF THE ANDAMAN TEAL, *ANAS GIBBERIFRONS ALBOGULARIS* (HUME)

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Abstract

The Andaman Teal, an endemic bird, was quite common Good-sized flocks frequented fresh water jheels and creeks in south Andaman and adjacent islands. about a 100 years ago. Gradual opening up of new settlement areas, agricultural extension, etc , have disturbed the bird as a result of which it no more conforms to the previous status as recorded by earlier naturalists. Since 1960 the bird is no more common in south, middle and north Andaman, About half a dozen faunistic surveys have been able to record not more then a dozen birds. A survey conducted by the author in 1972 in south and middle Andaman could estimate the existence of about 200 birds in accessible areas Its populations in hostile tribal areas and undisturbed islands is not known. In general it may be said that the bird is fast depleting.

About a century back when the Andaman Islands were sparsely populated, the Andaman or Oceanic Teal [*Anas gibberifrons albogularis* (Hume)] an endemic bird was common in most of the islands. Hume and Marshall (1881) stated "In the South Andaman it is a premanent resident but whatever it may have been in past times, is at present far from common" Butler (1899) reported that in Port Blair the birds were many, on creeks they associated with the Common Whistling Teal. Osmaston (1906) stated that the Oceanic Teal arrives in Port Blair in large numbers in summer. In the winter months they frequent freshwater jheels in nearby islands. Jean Delacour (1936) mentions "they are confident but retiring and they soon leave localities where they have been disturbed...They are common but not numerous" Williams (1957) refers to tens of thousands on a freshwater lake in North Reef Island and Abdulali (1965), while conducting the avifaunal survey of the Andaman and Nicobars, observed only one party of five birds in the Middle Andaman. The statements on the status of the bird are rather confusing.

In 1972 (January-March) when a party of Z.S.I. under my leadership visited the main Andaman Island, a check up of freshwater pools, swamps and tidal creeks in and around Port Blair, Port Maut, Chiriatapu-Wrightmyo, Wimberleyganj did not reveal any Andaman Teal from such areas which were very much expected to harbour it in winters when it is supposed to congregate in large flocks. In the Middle Andaman which is still less congested and some areas that are practically out of bounds

of the civilized man because of hostile tribal, the bird seems to have still some strongholds. A survey of the Pitchernullah for about eight kilometres from Betapur tidal creek to the undulating plains in the further north revealed about two dozen birds and my rough guess is that in the Middle Andaman there should not have been more than 200 birds at the time we searched for it in the open area. In the North Andaman parties of the Zoological Survey of India visiting the areas between 1960-70, have not been able to report this bird except one example collected from a flock of 5-6 from Neill island, which lies between the Middle and South Andamans. R. Whitaker in his article on 'two reptile nests' published in "Hornbill" (April-June 1977) states 'The naturalist visitor to the Andamans (who does not merely do a "launch and rest house" tour) is shocked at the rapid denudation of the original island vegetation and wild creatures.

The bird generally lays eggs in large natural hollows of dead trees but it may also nest on ground among grass by the sides of water pools and creeks, like the Lesser Whistling Teal. The normal habit is to dive for fishes, crustaceans, molluscs, brine shrimps and duck weed. It takes wild grass seed and has also developed to a new taste of cultivated crop. Since it forages in the cultivated crop areas specially when shoots bear seeds, it becomes an easy prey of local hunters and snarers, and its ground nests are also destroyed.

Delacour (1956, p. 78) remarked : 'It is however, the kind of island form whose status should be carefully watched, and it would be most desirable to establish again a breeding stock as a safety measure against its possible extinction in Andamans'

The bird has been observed to freely forage mixed with domestic ducks. It has also been reported to associate with the Whistling Teal, as such one should be sure enough to identify the Andaman Teal before concluding that its population is large enough. From the literature and my personal experience I may say that although the bird is not common it is very likely that it may be thriving well in isolated pockets which are not easily accessible.

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Proc. Wild Life Workshop : 123-127

WILD LIFE IN THE SUNDARBAN, WEST BENGAL

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Abstract

The mangrove forest of the Sundarban is spread over 2403 km² (land-mass) on the delta island facing the Bay of Bengal. The major plant community comprises 10 species of trees, 2 species of palms and a single species of sand binding grass. 'Baen' (*Avicennia* sp), is the most common tree and, Sundri (*Heritiera* sp.), after which the forest is named, is very poorly represented.

The vertebrate fauna comprises 35 species of mammals, large number of birds and fishes, several reptiles, amphibians, etc Big and small colonies of breeding birds, specially of water-birds are common during the monsoons. The most important carnivore, the tiger, much depends on herbivores, i.e. the Spotted Deer, Wild Boar and the Rhesus Monkey, which are all present in fair numbers. The tiger, like the fishing cat, also preys upon crustaceans and fishes. All these animals lead an amphibious life and do not depend on sweet water. The Estuarine Crocodile, which was common 30 years ago, is rare and the population of the Water Monitor is also dwindling rapidly. Some animals which have disappeared from this swamp within the last 100 years are the Javan Rhinoceros, Swamp Deer, Wild Buffalo, and the Barking Deer. Factors responsible for gradual upset in the balance of nature are mainly, increase in the salinity and the pollution of river water. Illegal hunting, fire wood and timber collection have created additional pressure on the biota.

I. Introduction

The mangrove forest of the Sundarban is spread over 2400 sq km (approx. land mass) on the delta islands and faces the Bay of Bengal. Till the end of the 18th century this forest had flourished within a few kilometres south of Calcutta. It was felt necessary to clear the forest to improve the arroundings of the then Capital of the British India, which also provided opportunities for extension of cultivation and human settlement and also to clear the hideouts of sea pirates and criminals. In 1773, Collector General Mr. Claude Russel executed reclamation and within 50 years almost half the Sundarban Forested Area was lost and gradually the original forest area of 8200 sq km was reduced to 2400 sq km. The deforested reclaimed area known as 'Abad' serves as a typical example of environmental changes and its effect on the biota. From the reclaimed area, almost all the natural resources such as firewood, timber, thatching palm leaves and grass, food-fishes and other sporting animals were lost. As a result the remaining forested area has been subjected to human pressure for his living. Firewood, timber, fish, venison, pork, honey and wax are regular traffic with or without official permit. More-

over due to inadequate supply of freshwater from rivers of Ganga and Brahamaputra systems, there is a gradual increase in salinity in estuarine rivers and added to it is the draining of mills and factory effluents into the rivers which have rendered conditions unsuitable to the thriving of certain species of plants and animals. The major part of the Sundarban within the Indian territory has almost lost the valuable timber tree, like the '*Sundari*' after which the forest is named and the 'Golpata' a palm, leaves of which are very much in use for thatching, has been greatly reduced in number. Most of the trees have become stunted and leaves have turned leathery. The *Sundari* is now confined only along the border of India-Bangladesh, and *Golpata* in the lower reaches of the estuaries.

II. Wild Life in Sundarban

Within the course of about 100 years, some animals known from this area have disappeared and some are losing ground. Such animals are :

1. Javan Rhinoceros (*Rhinoceros sondiacus*)

The species was well known throughout the Sundarban and is also said to have occurred as far south as the Mahanadi delta in Orissa. The last record of this rhinoceros is based on a specimen collected in 1870 and displayed in the Zoological Galleries of the Indian Museum.

2. Wild Buffalo (*Bubalus bubalis*)

The Wild Buffalo roamed about in the Sundarban till 1885 and by the end of the 19th century the whole population was wiped out.

3. Swamp Deer (*Cervus davaucelli*)

The Swamp Deer existed in fair number till the early part of the present century. It is no more in the Sundarban within the Indian limits.

4. Barking Deer (*Muntiacus muntjak*)

The Barking Deer represented about four per cent of the total deer population in the early part of the present century. It doubtfully exists in Halliday and Bullcherry and some other seaface islands.

5. Fishing Cat (*Felis viverrina*)

It was known to exist some 50 years ago but recent surveys do not reveal its presence in negotiable islands. A few may be present in some sea-face islands.

6. Estuarine Crocodile (*Crocodylus porosus*)

The Crocodile was quite common half a century back and was frequently met with in Matla, Raimangal, Jhilla and Gosaba rivers in the northern parts of the Sundarban. It prayed on domestic animals and also sometimes devoured man, fishing in inhabitated areas. In the recent years due to increase in the river traffic, excessive hunting pressure for its

skin, flesh and oil and also pollution of water, its numbur has been seriously reduced. Only in undisturbed regions in southern parts of the Sundarban it may be seen. Attempts are being made to increase its number by collection of eggs to hatch them in captivity. In Bhagwatpur, south-west Sundarban, a crocodile farm has been started and it is a happy news that some 80 crocodile hatchlings have been obtained from two egg clutches in 1977 and the young crocodiles are doing well.

7. Water monitor (*Varanus salvator*)

The Water Monitor was quite common throughout the Sundarban but in recent years craze for monitor skin for shoes, bags and belts etc., have reduced their number from greater part of the Sundarban specially in areas contiguous to habitation. Its number in protected sanctuaries is satisfactory.

8. Indian Python (*Python molurus*)

Dealers of live-stock and skins have not spared the Sundarban Python which attains a considerable length and girth and has lusturous skin. Its population has greatly decreased.

The successful animals, that have been able to withstand the changing environment in the forested areas, have undergone some physiological changes and modified their habits. They drink salt water or tolerate certain degrees of salinity and live on specialised plants or animals that are peculiar to salt-water. Almost all mammals lead amphibious life. The following important animals and their peculiarities and status are worth mentioning :—

1. Tiger (*Panthera tigris*)

The Tiger is quite common. It leads an amphibious life, quite capable of crossing wide rivers and moves about from one island to another. During tidal bores it clings to low mangrove branches or is driven to elevated parts of some islands. Besides hunting wild animals such as the Spotted Deer, Wild Boar, large marsh birds, it often attacks man who comes to work in the forest. It is the only man-eating tiger population known in the world. During 1881-1884, some 329 men were carried away. It also enters villages bordering forest for cattle lifting. It has been seen to fish in shallow waters in creeks.

During in last five years its number has increased. The present population is comprised of 187 individuals (1977) in the Tiger Project area.

2. Spotted Deer (*Axis axis*)

It occurs in quite good number. Like other deer it does not depend much on grass but generally feeds on 'Keora' (*Sonneratia apetala*) leaves, fruits and buds. Since 'Keora' is more common near the sea, the population of the Spotted Deer is more on sea-face islands It has been seen to drink saline water. Besides 'Keora' it also browses on the leaves and shoots of

young trees like *Sonneratia, Excoecaria, Rhizophora,* but strangely it does not take the common grass 'Bani Dhan' (*Oryza coarctata*) which grows plentifully everywhere.

3. Wild Boar (*Sus scrofa*)

The Wild Boar is perhaps the most adapted of all the mammals in this saline marsh. It feeds practically on all underground tubers but prefers dead fishes, crustaceans, molluscs, and scavanges on everything in forest including offal. It has been seen to dig in sand bank to drink percolated saline water. It is common in all parts of the forest.

4. Rhesus monkey (*Macaca mulatta*)

Under conditions unfavourable to any primate to live in the saline marsh where sweet water does not normally occur except during the monsoon, the Rhesus has adapted itself by modifying its habits. It behaves as a leaf-eating monkey as well as a crab-eating monkey. The tender leaves of *Keora* are its favourite food but succulent leathery leaves of other mangrove trees are also taken. It licks dew drops to compensate sweet water when sweet water, accumulated in small ditches during monsoon, dries up. It has been observed to eat crabs, mushrooms and honey combs. It is very shy. On man's approach it descends down the tree and runs to climb trees in the interior. Troups consisting of 20-30 individuals have been seen along the Indo-Bangladesh border and the sea-face islands. Its distribution and movement is almost that of the Spotted Deer.

III. Protection and Conservation

The Sundarban has three official sanctuaries namely (i) Lothian Island, (ii) Halliday Island, (iii) Sajnakhali (Pakirala). The sanctuary area covers 402 sq km. While the first two are chiefly for the Chital and Wild Boar, the last one is mainly a vast breeding area of water birds, having an area of 358 sq km. The more important resident birds that breed in the sanctuary are the Little Cormorant (*Phalacrocorax niger*), The Openbill Stork (*Anastomus oscitans*), Large Egret (*Egretta alba*), Smaller Egret (*Egretta intermedia*), Little Egret (*Egretta garzetta*), Cattle Egret (*Bubulcus ibis*), Purple Heron (*Ardea purpurea*), Night Heron (*Nycticorax nycticorax*). Besides these there are two pheasants namely the Red Jungle Fowl (*Galius gallus*) which is in fair number and the Swamp Partridge (*Francolinus gularis*) which are very few. The water monitor is quite common that predates on chicks and eggs of birds. Besides, there are tigers, cheetals and boars. The Tiger Project area which is 1330 km^2 includes the Sajnakhali sanctuary.

IV. Suggestions for Conservation of Wild Life

1. Since the Sundarban is a very vast area, vigilence of the whole stretch is not practicable with the present staff, more men and petrol boats

are necessary. In the sanctuary new plants should not be introduced. Even digging of tanks for freshwater should be avoided.

2. The tigers that visit the reclaimed area for cattle lifting should be captured by tranquilization or by traps and sent to Zoological parks. Public opinion of killing them for damage to cattle life should be curbed.

3. Frequent petrolling of speed boats, motorized launches should be avoided in the sanctuary areas.

4. Mass education by audio-visual method should be imparted to the villagers to let the forest and its product grow for their future benefit.

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DISTRIBUTION AND PRESENT STATUS OF THE GOLDEN LANGUR, *PRESBYTIS GEEI* KHAJURIA, IN SOME FORESTS OF ASSAM, INDIA

By

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Abstract

Survey of the golden langur were conducted in the forests of Goalpara and Kamrup districts of Assam to study the distribution and present status of this little known colobid monkey in India. They were encountered in maximum numbers in Jamduar forests, where it was further revealed that the concentration of these langurs increases in winters. Reason for their concentration during this part of the year at Jamduar has been studied An average of one group in every 8.0 km distance was observed during summer months, whereas during winter months an average of one group in every 4.6 km distance was recorded.

Group size and composition, sex ratio of adult males and females, ratio of adult to immature females, number of all male and bisexual groups, etc., have been studied

I. Introduction

The golden langur, *Presbytis geei* Khajuria, which was discovered about two decades back, is mainly distributed in a restricted area along the Indo-Bhutan border. There are reports of its existence in the south of Brahamaputra river in Khasi and Garo hills but no systematic survey has been conducted in these parts to confirm these reports. Its number is more on the Bhutan side of the border than on the Indian side but not much is known about their distribution and status in Bhutan.

Mukherjee and Saha conducted a survey of Jamduar, Raimona and Kachugaon in the months of May and June, 1973 and their findings were published in the year 1974. Since then two more surveys were conducted, one in the same localities in the month of December, 1973 and another in Manas Sanctuary in the month of January, 1976, to study the present status and ecology of this langur. Jamduar, Raimona and Kachugaon fall under Goalpara district whereas Manas falls under Kamrup district of the Assam state. In the earlier publication (Mukherjee and Saha, 1974 : 15), the ecology of the three localities, i.e., Jamduar, Raimona and Kachugaon has been given whereas the ecology of Manas has been given in another paper which is under publication. All these localities have the essential environmental factors such as tall trees, plenty of food and water to support the population of this langur. This paper deals with the distribution and abundance of golden langur in these

forests of Assam. The study methods adopted were the same as given in the earlier paper (Mukherjee & Saha, 1974 : 15). All the surveys were conducted on foot.

In the sub-adults population, the infants are classified as langurs of less than one year old, dependent upon their mothers, pre-weaned and carried by the mothers during group movements. The juveniles are identified as langurs of more than one year old, independent of their mothers and post weaned.

II. Results

Earlier reports indicate that this langur is found from east of Sankosh to west of Manas river along the Indo-Bhutan border (Fig. 1). In the survey conducted it was found in those forests which were adjacent to Bhutan and were observed more in numbers in the forests of Jamduar and Raimona than in Manas Sanctuary. Even in the forest of Jamduar and Raimona, it was found more in numbers at Jamduar than at Raimona (Table 1). During the survey no group was observed in the forest of Kachugaon but their presence in this forest close to Bhutan territory had been reported by the local people. In Manas Sanctuary it is restricted in its distribution to west of Manas river, in Bhutan Manas, and on the east of this river it is replaced by capped langur. During the survey conducted in the months of May and June, 1973, 7 and 3 groups of golden langur were seen at Jamduar and Raimona, respectively. Out of 3 groups counted at Raimona, one was an all male group. In the same areas when surveyed again in the winter month of December, 1973, 15 and 2 groups were observed (Table 1). Out of the 15 groups that were observed at Jamduar, 3 were all male groups. A total of 3 groups were observed on the west of Manas river in Manas Sanctuary but it was possible to make study on 2 groups only as the other group disappeared in the thick forest before any observation was made. Table 1 indicates the distribution and percentage composition of population of golden langur in three different habitats. The percentage of male population observed was less in Manas Sanctuary than in the other two habitats. It is also apparent that the concentration of this langur, at Jamduar, increases during the winter month of December. This seasonal concentration may be due to the severe cold on the neighbouring mountains of Bhutan and availability of water and favourite food at Jamduar.

The number of langurs counted during different months in the three habitats; the percentage of adult males, adult females, juveniles and infants; the adult sex ratio and the percentages of infants to adult females; and the sub-adults to total population, are given in Table 1. The population of adult males varied from 7.0% to 22.2% whereas that of adult females from 34.6% to 44.8% and that of juveniles and infants varied from 20.2% to 31.0% and 17.2% to 25.8%, respectively. The adult sex ratio varied from 13.3% to 39.0% and that of the infant and adult female and

Table 1—Population composition of golden langur at Jamduar, Raimona and Manas Sanctuary.

Location	Months & Year	Number of groups	Number of Monkeys	♂♂ %	♀♀ %	J J %	I I %	♂♂/Ad %	I I/♀♀ %	Sub adult/ Total %
JAMDUAR	May-June, 1973	7	89	13.5	40 5	20 2	25 8	25 0	63 9	46.1
	December, 1973	15*	136	22 1	34.6	22.8	20 5	39 0	59 6	43 4
RAIMONA	May-June, 1973	3**	36	22.2	36 2	22 2	19 4	38.1	53.8	41.7
	December, 1973	2	15	13 3	40.0	26.7	20.0	25 0	50 0	33 3
MANAS SANCTUARY	January, 1976	2	29	7.0	44 8	31.0	17.2	13 3	38.5	48.3
TOLAL	—	29	305	17.7	37 7	23.0	21.6	31.9	57.4	44 6

*Out of 15, 3 were all male groups but the calculation is based on all the 15 groups

**Out of 3, 1 was all male group but the calculation is based on all the 3 groups.

Table 2—Incidence, abundance and group structures of golden langur at Jamduar, Raimona and Manas Sanctuary.

Location	Groups counted	Distance covered (km)	Km per group	Adults ♂♂	Adults ♀♀	Sub-adults J J	Sub-adults I I	Average group size
JAMDUAR (May-June, 1973)	7	55	7.8	1.7±0 4	5.1±0 6	2.6±0.5	3.3±0.3	12.7±1.3
RAIMONA (May-June, 1973)	3	25	8.3	2.7±1.2	4.3±2.6	2.7±1 3	2.3±1.2	12.0±3.8
AVERAGE JAMDUAR	10	80	8.0	2.0±0.5	4.9±0.8	2.6±0.5	3.0±0 4	12.5±1 3
(December, 1973) RAIMONA	15	55	3 6	2.0±0.6	3.1±0.6	2 1±0.4	1.9±0.4	9.1±1.0
(December, 1973) MANAS	2	25	12.5	1.0±0.0	3.0±0 0	2.0±0.0	1.5±0.5	7.5±0.5
(January, 1976)	2	8	4.0	1.0±0.0	6.5±0.5	4.5±0.5	2.5±0.5	14.5±1.5
AVERAGE	19	88	4.6	1.8±0.5	3.5±0.5	2.3±0 4	1.9±0 3	9.5±0.9

the sub-adult to total varied from 38.5% to 63.9% and 33.3% to 48.3%, respectively.

In the survey conducted during the summer months, an average of one group in every 8.0 km was seen, whereas during the winter months an average of one group in every 4.6 km was observed (Table 2). Out of the three localities, Jamduar showed the maximum concentration and during summer months one group was observed in every 7.8 km, whereas during the winter months the incidence of distribution was one group in every 3.6 km in this area. The average group size was 12.5 individuals of the 10 groups that were counted during the summer months of May and June. It consisted of 2.0 adult males, 4.9 adult females, 2.6 juveniles and 3.0 infants. The average group size of 19 groups that were counted during the winter months of December and January was 9.5 individuals which composed of 1.8 adult males, 3.5 adult females, 2.3 juveniles and 1.9 infants.

III. Discussion

Surveys of Jamduar, Raimona, Kachugaon and Manas Sanctuary were conducted to study the ecology, distribution and present status of golden langur in its major habitats of Assam. It is apparent from this study that a small population of this langur inhabits in these forests. Golden langur is mainly distributed in Bhutan, so to get an estimate of the present population it is necessary also to study them on Bhutan side. The present study shows that this animal is distributed from east Sankosh to west of Manas river and is more in abundance at Jamduar than in any other study areas. It also shows increase in concentration in this area during the winter months and this may be due to the severe cold on the neighbouring Bhutan hills and the availability of favourite food and water in this forest during in this part of the year. Seasonal concentration of rhesus monkey in Corbett National Park was also reported by Southwick *et al.* (1961 : 42). In the groups studied the group size and structure shows that juveniles and infants are well represented. So until and unless there is shrinkage in habitat or human interference there is no immediate danger for this species.

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METHODS OF ASSESSMENT OF THE FOOD INTAKE OF BIRDS WITH SPECIAL REFERENCE TO TWO SPECIES OF INDIAN MYNAS

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Abstrast

A considerable amount of work has been done on the food analysis of birds but it is very difficult to correlate the results of various workers because of the different methodology used by different workers to determine the food intake of birds.

Hartley (1948) reviewed the various methods being then used. He came to the conclusion that there is no ideal method for the study of food of birds because every method involves the making of assumptions which are hard to justify about either the nature of food or the implications of the data presented. His findings hold good even today.

There are four important methods to collect the samples of food taken by birds for laboratory analysis These are :—

1. Crop and gut contents method, 2. Direct observations of feeding birds, 3. Pellet study method, 4. Artificial nestling method.

The advantages and disadvantages of these methods are discussed individually.

While working on the food habits of Indian Pied Myna, *Sturnus contra contra* Linnaeus, we obtained the study material from the crops and gizzards of freshly shot birds in the morning when they had finished or almost finished their morning feed.

Todate three methods have been used by various workers to determine the food of birds quantitatively :—

1 Numerical method, 2. Gravimetric method, and 3 Volumetric method.

Numerical method has been recommended by Mason (1912). He stated that it is number of insects or number of grains which is more important and not their volume. Numerical method is applied in three ways :— 1. Enumeration of occurrences, i e. the number of birds taking a particular food, 2. Enumeration of foods, i e the number of each food found in the diet, 3. Enumeration of occurrences and foods which is a combination of first two methods.

Gravimetric methods have been used by Rorig (1903) and Mukherjee (1969-76), who lays more stress on weight rather than on number or volume.

The volumetric system has been advocated by MacAtee (1912) and Collinge (1924-27), who maintains that volumetric assessment conveys better impressions. Each of these systems has its advantages and disadvantages which have been discussed in the paper.

We have in our studies on the food of Indian Mynas, profitted by the experience and logic of these workers and have followed a combination of numerical and volumetric methods for analysing the animal diet, for vegetable diet we have used the combination of numerical and gravimetric methods.

While presenting the data in case of vegetable diet we state the number of birds in which each item of food is found (enumeration of occurrences), the maximun weight of item of diet in any single bird and maximum percentage (by weight) of the food in the total diet. In case of animal diet we state the enumeration of occurrences, the maximum volume of the item of food found in any single bird and the maximum percentage (by volume) of the food in the total diet.

Thus we have evolved a hybrid system of assessment of food intake in birds by taking good points of all the methods We believe that this method reduces the margin of error to minimum

I. Introduction

A lot of work has been done on the food analysis of birds by various workers. But it is very difficult to correlate the results of various workers because different workers have adopted different methods to determine the food intake of birds. Each worker selected a form of presentation of data which seemed best to him and tried to explain its advantages. Since the beginning of food habits studies, a constant need has been felt to devise a uniform method of assessment of food intake of birds. But in spite of nearly hundred years of work such a method still eludes us.

As early as 1948, Hartley had reviewed the various methods being employed for the study of food of birds. He (Hartley, 1948) came to the conclusion that there is no ideal method for the study of food of birds. According to him "it is very difficult to find any method which does not involve the making of assumptions hard to justify about either the nature of food or the implications of the data presented" He (Hartley, 1948) even ventured to explain the diversity in the methods used by saying "many investigations of the food of birds have been undertaken not so much to increase knowledge as to discover the economic status of this or that species." One finds it very hard to disagree with his statements even today.

Because of the fact that no universal method has been used for the estimation of the food of birds, most of the work in this field has been done qualitatively and very little data is available quantitatively.

II. Material for study

Material for study or the samples of food part taken by birds can be collected by a number of methods. The most important methods are :

1. Crop and stomach analysis method;
2. Direct observation of feeding birds;
3. Pellet study method;
4. Artificial nestling method.

Ever since the beginning of studies in economic Ornithology, the food of birds has been studied almost entirely by the examination of crop and stomach contents. Forbes (1880), whom Kalmbach (1934) called as the

founder of modern food habits studies, also used stomach analysis as the foundation of much of his study. Other workers like Beal (1898), Newstead (1908), and Collinge (1924-27) were also of the opinion that the examination of the stomach furnishes the most reliable data on which to base assumptions. But stomach examinations can not be carried out in all the cases because in many cases of birds, the population is so small that it is not possible to kill or collect the desired number of examples. For this reason one has to rely upon other sources of information.

Before discussing the other sources of information it will be desirable if we make a reference to the examination of gut contents. Collinge (1924) has suggested the examination of whole digestive tract, but this method seems to give more importance to foods which are hard enough to resist digestion. We (Lamba and Narang) while working on the food habits of Indian Pied Myna, *Sturnus contra contra* Linnaeus, have examined the contents of crops and gizzards only as we observed that the food particles retained recognisable shape upto gizzard only. In our present studies on the food habits of Common Myna, *Acridotheres tristis* we are following this very system.

Another method which can be used to determine the nature of food in birds is to observe the birds in the field while they are feeding. The advantage of this method is that it does not involve the killing of birds and population of a species remains uneffected. But it is very difficult to ascertain all the item of a food or the relative quantities of the various items by field observation alone. Yet one has to rely upon field observations for a number of food items which can not be identified in stomach analysis even if they are found undigested. For example, weed seeds and seeds of wild grasses can not be identified all by themselves. For their proper identification one must have full plants of the weed seeds or wild grasses in question. We have, in our studies, very successfully supplemented our data upon the analysis of the gut contents by this method of direct field observation of birds while feeding.

Observational methods other than the field observations have been used to study the food of birds. Errington (1932) made a assessment of diet of youngs by keeping the nests under constant observation. But the drawback of this method, as he himself points out, is that it is time consuming and very few nests can be watched in a season. Short spells of nest observation or even occasional nest visits at regular intervals could however, provide a good clue to the nature of food of young nestlings.

Another method which has been tried by workers in the past is the pellet study method. Errington (1930) studies the food of predatory birds by the examination of their pellets. By using this method it is possible to know the occurrence of vertebrates and hard beetles but soft bodied preys can not be studied by this method.

An extremely accurate and dependable method of food determination in nestlings was used by Betts (1954). He used artificial nestlings to collect samples of food brought by the adults to a brood of Pied Flycatchers. But the greatest handicap of this method is that it can neither be employed on a large scale nor for adult birds.

Besides the above listed methods of collection of material for study, there are a number of other techniques which have been used to obtain food samples of birds. Errington (1932) collected samples of food by squeezing the gullets of young hawks but young owls resisted such treatment. Kirkpatrick (1940) collected food samples by alarming birds with stone throwings. The birds threw out the freshly taken food when alarmed.

While working on the food habits of Indian Mynas, we obtained the material largely by collecting specimens from the field. Birds were shot 3-4 hours after sunrise, after they had finished or almost finished their morning feed. The crops and gizzards were then opened and contents were put in screen sieves washed with water and then placed on a blotting paper and dried for five minutes. The animal and the vegetable matter was broadly separated into Phyla and Classes and weight and volume were recorded on individual data sheets. The data thus collected was further supplemented by field observations, i.e. the observation of the material on which the birds were feeding in the field. We have not used any other method to collect the food material.

III. Methods of Study

Generally three methods are used for the quantitative assessment of food of birds. These are 1. Numerical method, 2. Gravimetric method and 3. Volumetric method.

Out of these which method is most suitable and how the data should be presented is, perhaps, still a matter of individual preference with various workers in the field. Hartley (1948) has said that there is no ideal method of food analysis of bird. This statement seems to hold good as there is no method which does not involve the making of assumptions. If we go through the findings of MacAtee (1912), Collinge (1927) and Hartley (1948), it will be clear that every method has some drawbacks.

Numerical method has been strongly recommended by Mason (1912). He says that "Comparative bulks of food, if expressed merely as percentages, are of absolutely no value whatever, and cannot give any idea as to the true economic ratio of the food of the bird in question" We do agree with this point that percentages do not express the economic values. But numerical system which is not applicable in many cases of food will also supply information which is likely to introduce error. Supposing we find a scale of a fish in the food of a bird. Are we to con-

sider it as one number of complete fish ? Moreover it is not possible to count the number of individuals when the animal matter is crushed. In our study on the food of Indian Mynas, we could not count the number of earthworms and beetles because the food was crused and broken into pieces. Not it was possible to count the flower, parts of silve oak, *Grevillea robusta* Cam. and fruits of *Ficus* although we did enumerate the occurrences.

Mason further says "what we want to know is the exact number of grains of corn, the number of insects etc." But we fail to understand what useful purpose it is going to serve if we count the number of grains of insects. Firstly it is just impossible to count the number of insects because they are usually crushed and broken into parts. Supposing the insect food is intact even then how we can establish the economic status of the bird unless we know the size of insects. To make it more clear let us suppose that a bird eats 7 beneficial insects and 50 injurious insects. Does it mean that the bird does good and harm in the ratio of 50 to 7 ? Certainly not unless the insects are of equal size.

Numerical system is usually applied in three ways :— Enumeration of occurernces, which means the number of birds taking a particular food, 2. Enumeration of foods, which means the number of each food found in the diet; 3. Enumeration of occurrences and foods which is a combination of first two methods. This method has largely been used by Steven (1933), Hartley and Fisher (1936), Ford, Chitty & Middleton (1938) and Lumsdon & Haddon (1946). Gross (1946) also advocated the numerical system. He (Gross, 1946), in his study of food of Snowy owla *Nyctea scandiaca,* says that in a predatory bird the use of either weight or volume alone for the estimation of diet would give misleading results.

One great advantage of the numerical system as stated by Hartley (1948) is that it takes no account of the state of digestion of the food. We, in our studies in the food of Indian Pied Myna, could identify the beetle *Coccinella* by their elytra alone. Lumsden and Haddon (1946) identified many fishes eaten by Shags by the Otoliths alone. If we use volumetric or gravimetric methods for the estimation of partially digested food material then the ratio of such foods to the bulk of stomach contents would be highly misleading.

Gravimetric method has been used by Rorig (1903) in Germany and Mukerjee (1969-76) in India. The main disadvantage of this method is that the higroscopic qualities of different food material will effect the estimation of samples from crops. Moreover, some foods are easily digested than the others. For example beetles, which are hard to digest will remain much longer in the stomach after the soft bodied insects have been digested.

MacAtee (1912) and Collinge (1924-27) seems to have spent all their energies in criticising the numerical system and advocating the

volumetric system. It is generally done by water displacement method. This method has been used as such and in combination with other methods by Ford, Chitty and Middleton (1938), Lay (1940) and Campbell (1946). Forbes (1880) who is considered as the founder of modern food habits study in birds also adopted the percentage by bulk system. He says that "in stomach examination opportunity is afforded for careful and trustworthy estimates of the ratios each element bears to the others, so that the average significance of the food can be discovered"

The great advantage of the volumetric method is that there is no form of food which can not be measured by it. Finely crushed food or vegetable food like leaves and grasses, pulpy food can not be counted in numbers. Graphic representation of the food is possible only by volumetric method and we can compare the food of one species with another.

There are a number of items of food which are taken by the birds in very small quantity. Numerical method gives unnecessary importance to such foods whereas by volumetric method their ratios would be almost negligible. For example in our study, a few birds had eaten gramineae seeds. Now under the enumeration of occurrence method we have mentioned that 3% of birds had taken the gramineae seeds although by volumetric method the ratio of the gramineae seeds was not even 1% of the total diet.

The volumetric method too has some drawbacks. In case of nector feeding birds or birds which sipp juices of fruits, this method can not be used.

As the objective of our study is to establish the status of the Indian Mynas as 'friend' or 'foe' of the farmer, we have opted for a combination of the known methods. For analysing the animal diet we use a combination of numerical and volumetric methods. The advantage of this method is that if we are to determine the economic status of any item of animal diet, especially insects, we must know its numbers and size to determine the extent of its involvement. Numerical information along with the volumetric data is necessary if the published data are to have any ecological significance. For example when we merely say that a bird had taken 50 ml. of fish *Labeo*, it is not fully illustrative. Because this may have been a portion of a big fish, one fish or 10 small fish.

For vegetable diet we use a combination of numerical and gravimetric methods. It seems more appropriate to express the vegetable matter by weight rather than by volume. For example the statement that 'a bird crop contained 20 ml. of wheat' does not convey the meaning as forcefully as the statement that 'the bird consumed 20 grms of wheat during a single feed in a day' as it gives a clear idea of the damage done by the bird.

After the assessment of all the items of food has been completed, one faces the question of presentation of the collected data. The best way to do this is, to publish the full details of every bird examined, with summaries upon as many bases as possible, and the expression of these summarized results as percentages. But it is wondered if any journal can afford to publish these details in these hard times of paper shortage and inflation of publication costs and only the summaries can be published. While presenting the massed data in ease of vegetable diet, we state the number of birds in which each item of food is found (enumeration of occurrences), the maximum weight of the item of food found in any single bird and maximum percentage (by weight) of the food in the total diet. In case of animal diet we state the enumeration of occurrences, the maximum volume of the item of food (all the example of any one species) found in single bird and the maximum percentage (by volume) of the food in the total diet.

Thus we have evolved a hydrid system of assessment of food intake in birds by taking good points of all the known methods. We believe that this system will reduce the margin of error to minimum.

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WILDLIFE—A NATIONAL BONANZA

By

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Abstract

The concrete contributions made by wildlife resources to Gross National Product (GNP) are not fully identified at present. In recent years emphasis has markedly shifted from insensate destruction to planned conservation and development of the fast dwindling wildlife assets. Such a change in the policy has overtly been inspired by the intrinsic value of wildlife as a renewable resource and the recurring benefits accruing through it to the country's economy. The benefits are tangible and intangible. The paper endeavours to evaluate these benefits in terms of money and to enlist their direct and indirect impact on Forestry Sector's contribution to GNP. It is, no doubt, a difficult field but the object is to assess as rationally as feasible the inimitable potential benefits from this source. Statutorily, public ownership of wildlife resources is a clear indication of an implicit willingness of society to pay for its adequate maintenance. And so, the benefits from wildlife can be approximately regarded equivalent to the cost of its maintenance, if not more. Two approaches: (i) cost of input, and, (ii) capital growth, have been suggested for measuring yearly benefit of wildlife resources. However, the monetary benefit alone, as brought out in this paper, is a poor indicator of the overall advantages conferred upon the society by the wildlife.

I. Introduction

Public opinion is fast shifting from the extravagence of mere hunting to the more enduring ecological benefits of wildlife. An objective evaluation of the role of this dynamic resource to the national economy is, therefore, imminently expedient. This paper discusses on the basis of studies pursued at the Forest Research Institute, Dehra Dun, India, the subtleties of the subject involved. Presently, the current concepts regarding the contribution of the wildlife resources to the Gross National Product (GNP)[1] are vague, cursory and unscientific. A country's GNP serves as an index to its economic growth. It reflects on its overall economy and portrays the cumulative output of its goods and services conventionally expressed in terms of annual monetary flow. The many resources of the Forestry Sector including wildlife are an integral constituent of the GNP. In computing GNP, the present system

[1]GNP is defined as the total market value of all final goods and services produced in the economy in one year. All goods produced in a year may not be sold, som emay be added to inventories. The increase in inventories should be included in the GNP regardless of whether or not it is sold.

largely evaluates dead forest resources; the biological aspects of forestry and its tangible and intangible services remain unrecorded. In 1974-75, India's GNP of the Forestry and Logging Sector was Rs. 6,740 million (Rs. 8.60=1 U.S. dollar) or 1.09% of her GNP[2]. This does not include the value of cogent services rendered by forest organisms and their tempering elemental and environmental influences. A comprehensive appraisement of the overall contribution of Forestry Sector is strongly advocated to obviate the illusion of a grossly mutilated, unrealistic and lopsided system of evaluation currently in vogue.

II. Present Method of Computing the GNP (Adopted by the CSO)

The GNP is computed by the value-added method. The economic activities are divided into a number of non-overlapping but exhaustive set of sectors. For each sector the value-added is calculated and the total of all the sectors represents the GNP.

The statistical data for the national accounting system are collected by the CSO through the various state forestry agencies in the country.

The cumulative monetary values put together constitute the "Gross National Product"

The Forestry Sector :

Non-foresters[3] are likely to misconstrue India's Forestry Sector as different packages of goods and services. To avoid any misconception, an attempt to elucidate the economic meaning of this term would be helpful. Forestry is the art and science of managing and appraising the forest resources of a place/region/state/country with the object of producing goods and services on a sustained basis for the welfare of mankind. In very broad terms–considering the role of the trees in generating oxygen, synthesis of food, water and soil conservation, etc. using the biomass concept "Forest is a society whose biggest member is the tree" (Baker, 1977). Statutorily, "Forest" means any area of land proclaimed as such under law or tradition. Forest land in the economic sense includes all animate and inanimate objects (exclusive of man) all elements–appertinent to it and covers all material and forces, which are nature's bounty to man including rivers, mines, wind, light, heat, gravitation, etc. (Alfred Marshall's definition of land modified). (Pant, 1977).

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[2]National Account Statistics, 1960-61 to 1974-75, Central Statistical Organization (C.S.O.), Cabinet Secretariate, Government of India, Ministry of Planning, New Delhi, October, 1976, pages 14-15.

[3]Forester is a person engaged in the profession of forestry. He is required "to have the earthy and intimate forest understanding of the silviculturist, the long-range view point of the planner, the skill of the administrator, and the alertness, flexibility, and all round resourcefulness of the successful business man" (Kenneth Davis, 1966).

Goods and Services of the Forestry Sector :

Goods : The goods produced by the Forestry Sector include: wood, food crops raised through agri-silvicultural practices, wild animals (both live and dead), diverse animate living organisms, grasses, herbs, stones, minerals and group of resources called minor forest products.

Services : Most services provided by the Forestry Sector generate externalities and are of the nature of public goods. The main services are: (1) grazing (serving both domestic cattle and wild animals) and lopping; (2) hunting and fishing; (3) forestry as handmaid of agriculture; (4) environmental influence (ecosystem on air, water, soil, climate, noise, wind, etc.); (5) recreation and amenity, and tourism (service concerned with outdoor recreation in forest environment); (6) landscape (concerned with the worth and value of forest ecosystem in landscape formation and planning); (7) scientific and educational value; (8) protection and conservation; and (9) military defence.

Wildlife Resources based Goods and Services presently unaccounted for in the GNP :

Forestry, besides it's material benefit, also provide uninterrupted social services[4] to a region, which reflect favourably on the populace. More monetary benefits gauged from the GNP are, therefore, a poor indicator[5] of the overall productive influences of forestry mainly because several goods including the wildlife nurtured by the forest resources and most services provided by the forestry sector (97% public ownership of forests in India) are not being presently valued and credited to the Forestry Sector's GNP.

In the present system of evaluating mainly the "dead" forest resources, some services such as hunting and trapping, recreation as well as income from zoological parks, zoos, game sanctuaries, etc., are *only partly accounted for in the GNP but strangely enough not as the contribution of the Forestry Sector.* For example in U.P. alone, the amount received from hunting fee, etc., during 1971-72 exceeded *Rs. 101,860 and it found a place, perhaps inadvertantly, in the GNP of the Agricultural Sector instead of Forestry.*

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[4]Purification of air by converting carbon dioxide into oxygen, pollution control, flora's role in the water cycle in nature, photosynthesis—the mechanism for converting solar energy into food (for plants, animals, and human beings), are examples to cite.

[5]Measuring the contribution of the Forestry Sector to the GNP in money terms is, therefore a difficult job—something like measuring the value of the services of the Election Commission for holding general elections in a democratic country in terms of the money spent, the booths opened, the votes counted or the manpower deployed but ignoring the value and quality of peaceful and fair elections in terms of the country's prestige in the world and in terms of law and order problems that may arise as a result of rigged elections.

III. Suggested Evaluation Methods—A Discussion

The main question examined in this paper is how to measure the value of goods and services produced by the Forestry Sector's wildlife resources[6]—wild animals in particular.

The value of wildlife based *recreation and amenity service* which is an experience resulting from a very complex interaction between the individual, his objective, his usual environment, his cultural background, the forest ecosystem and a host of other factors (Clowson, 1966) is difficult to gauge in terms of the revenue derived from licence fee or the gate money. Their moral, aesthetic, sensuous and spiritual values hold by far the greater fascination to human health and imagination. These services are partly tangible and partly intangible. Recreational hunting and fishing fall under the former category, and outdoor abstract recreational possibilities come under the latter.

The products of hunting and fishing, may have a market value but their recreational value is immeasurable. The sensuous pleasures imbibed by sportsmen greatly outweigh the material advantages associated with the pursuit. The thrill and diversion provided are, indeed, ecstatic and ethereal.

The *market value of hunting and trapping* could be regarded as the total of what the hunters pay : shooting and trapping fee, royalty for the animals shot, etc., provided this fee was market determined. This fee is usually fixed on an *ad-hoc* basis without precise consideration for the associated costs and benefits and without any scientific study of the systematic harvesting (supply) of the species equivalent to the allowable sustained annual yield of wildlife and the demand. The shooting fee for all the shooting blocks within a state is the same irrespective of their location, convenience of travel (although the cost incurred by the hunter in reaching the block is different for different blocks) and incidence of game. Also, the permissible species that can be shot in one block may be different in another block (therefore, the probable benefit could be different), However, as it is, the value of this service could be regarded as the sum total of the license and game fees realised during a year.

Wildlife is an integral part of the Forestry Sector and is presently thriving mainly on the service—grazing. The annual value of this service is measurable in terms of (1) the opportunity cost of resources necessary (forage, meat : the carnivorus animals indirectly depend on the grazing animals they prey upon, flowers and fruits, water, salt, licks, habitat, etc.) for the upkeep and maintenance of the domestic cattle and wild animals grazing in the forests, and (2) annual increments in the inventory of the wild animals.

[6]The other goods and services have been discussed by the author in a separate paper "Forestry Sector– Its contribution to Gross National Product" Indian Forester, Vol. 103, No. 11, Nov., 1977.

We can possibly conceive *two ways of making an estimate of the contribution of wildlife resources of the Forestry Sector to the GNP* : (1) the cost of inputs approach, and (2) the capital growth approach. In the cost of inputs approach it could pertinently be assumed that if the society wants to enjoy a certain status and level of wildlife, it should be willing to pay annually at least as much for the goods and services as would be necessary to maintain the wild animals, up to that status and level, if not more. This means that the value of the benefits flowing to the society annually should be at least equal to the cost of maintaining the said level and status of wildlife. In reality, the benefit may be much higher than the cost, but for the purposes of GNP it might be assumed with equanimity that the benefit cost ratio is equal to unity, if not more.

In the capital growth approach, it may be assumed that the annual growth in the number, size and density of the entire wild animal population is the net output of the Forestry Sector. Both these approaches need a census of the country's fauna, the former requiring the absolute number during a year and the latter, the annual or periodical rate of growth, as may be seen from the following discussions :

The Input Approach :

The economic arguments for the approach are obvious : the society desires conservation and protection of the wild animal resources and hence their public ownership in the country under law. In the absence of forests, the suitable habitat and the needed ecological conditions, in the form of zoological gardens, etc , could only be created artificially at a cost to the society. How much would the Society be willing to pay for the Nation's Wildlife Capital ? Theoretically, it should be equal to the initial cost necessary for wild animal stocking and establishing its habitat, etc., and thereafter, its annual feed and maintenance cost. The inputs for the wild animals production process, if viewed as a commercial unit, would be : suitable habitat, ecological conditions and food (forage, salt, water, meat, flowers, fruits, seeds, etc.), which in the natural state are all provided by the forests. Out of these inputs, the cost of the food alone is appreciable. The per year feed costs for the different kinds of wild animals (mammals, birds, reptiles, amphibians, fishes) found in the country[7] would be the sum total of the value of the various kinds of food consumed by these. Mathematically it can be represented by the expression :

$$P_1 \times q_1 \times N_1 + P_2 \times q_2 \times N_2 + \ldots\ldots\ldots + P_n \times q_n \times N_n$$

$$\text{or Rs} \sum_{1}^{n} P.q.N \qquad (1)$$

[7]In the India many species of wild animals are recognized : 500 mammals (Prater, 1965); 1200 birds (Ripley, 1961); 375 reptiles and 130 amphibians (Smith, 1931, 1935 and 1943) and 19000 fishes (Dey, 1876).

Where N_1, N_2,.....N_{n-1}, N_n etc., represent the population of the different species of wild animals; q_1, q_2,.....q_{n-1}, q_n, etc., the average quantities of food items consumed by these wild spenies; and P_1, P_2..... P_{n-1}, P_n, etc., the average prices of the food items, respectively. This method can be illustrated by computing the value of one term say $P_1 \times q_1 \times N_1$, of the above equation No. 1. An average adult tiger needs about 10 kg of meat every day, and roughly 3.65 tons per year, to remain in prime condition. As only 60-70% of each prey animal is edible (the rest being hyde, bones, entrails, etc.) each tiger is estimated to prey, assuming no wastage, 5.3 tons every year. For maintaining a tiger population of say 4,000 (Gee, 1964), in India, 20,856 tons of prey animals, or 14,600 tons of meat valued at over Rs. 73 million would be needed yearly. Needless to emphasize that the value of 20,856 tons of prey animals would greatly outweigh the value of ordinary marketable meat.

An estimate of the annual feed costs of other species of wild animals can also be made from the actual feed cost of individual members of wild animals at a Zoological garden. In Kanpur and Delhi Zoological Parks the annual costs among others are : Black bear-Rs. 2,263; Black swan, Mute swan-Rs. 186 each; Black buck, Chinkara-Rs. 879; Blue bull Rs. 4,505; Clouded leopard-Rs. 1,825; Cockatoo (Kind of parrot)-R. 211; Common fox, Jackal, Wild cat-Rs. 913 each; Crocodile-Rs. 1,600; Elephant-Rs. 10,950 to 17,580; Grey horn bill-Rs. 263; Himalayan bear-Rs. 1,163; Hippopotamus-Rs. 12,580; Hunting cheeta-Rs. 6,720; Hyaena-Rs. 2,738; Leopard-Rs. 2,738; Lion-Rs. 9,125; Mangoose-Rs. 146; Mynah, Bulbul and Thrush-Rs. 204 each; Monkey and langoor-Rs. 548 each; Panthar-Rs. 4,563; Parakeets-Rs. 104; Pea fowls-Rs. 150; Porcupine-Rs. 280; Rabbit-Rs. 50; Rhinoceros-Rs. 8,213 to Rs. 16,985; Sambhar and Swamp deer-Rs. 1,533; Spotted deer-Rs. 1,100; Tree pie and Mag pie-Rs. 109; Pheasants, Partridges, Pigeons, Doves-Rs. 183; Tortoise-Rs. 296; Water ducks, goose, grebes and other swimming birds-Rs. 46 each; Wild ass-Rs. 1,770; Wild bear-Rs, 825; Wolf-Rs. 1,325. The population of each of these "i" species if known, the value could be computed as $\sum_{1}^{i} P.q.N.$

Similar data for sundry species of the country's fauna can be built up on the basis of their population and the estimated cost of their respective feed. The $\sum_{1}^{n} P.q.N$ will amount to several million rupees every year.

Considering that several inputs other than food are needed for the upkeep and maintenance of the desired status and level of wildlife,

$\sum_{1}^{n}$ P.q.N. derived on the above basis is likely to be an underestimation of the annual value of wildlife to the society. However, in the absence of any other methods of measuring the dynamic aspects of wildlife, $\sum_{1}^{n}$ P.q.N. will give an idea of the mute contribution that the wildlife resources make to the GNP.

The main criticism of this approach may perhaps be based upon the plausibility or otherwise of the assumption that the benefit from wildlife, is at least as much as the cost of it's maintenance. It may also be argued that the declaration of wildlife as a public property, constituted a purely political and subjective decision, unsupported by facts and economic analysis, whatever. However, the fact remains that wildlife is Nation's cultural heritage; the decision makers' conclusion that the best way to protect the wildlife, was, therefore, to declare it a public property, and entrust it's management to the Wildlife Preservation Organisation, a wing of the Forest Service. The propriety of the decision might be assailed by some, but the fact that the decision was taken at a time when many a wild animal had become extinct (for example, hunting *cheeta*) and many others were reaching the point of "no return", lends tremendous credibility to the wisdom and farsightedness of this epoch making decision. The international unanimity of opinion in this context bears ample evidence to the sanity and appropriateness of the measure adopted.

The Capital Growth Approach :

Wild animals represent capital stock which can be sold for scientific, recreational and educative values and for their meat, skin, antlers, fat, bones, etc. Wildlife also provides valuable sources of physical, emotional and psychological benefits to society. The value varies with each species. For instance, a shot jungle fowl may be worth Rs. 20 and a killed spotted dear Rs. 300-500 but their intrinsic value would be much greater when alive. The annual reproduction and growth of the forest fauna render this economy viable in perpetuity. The assets are prone to progressive development under scientific management. For example, the tiger population in the "Project Tiger" areas in India has reportedly increased from 258 in 1973 to 470 in 1975 giving an annual growth rate of about 22%. The monetary value of this recurring increment represented by the commercial value of the animals adds further to the GNP.

Assuming a market value of Rs. 20,000 per tiger, the growth in the capital value of the tiger in the "Project Tiger" areas alone is more than

Rs. 1.14 million per year. This growth for the tiger population in the country and similarly for all wild animal species in the country can be computed at least theoretically. Expressing mathematically, this value would be :

$$P_1 \times Q_1 + P_2 \times Q_2 + \ldots\ldots\ldots P_{n-1} \times Q_{n-1} + P_n \times Q_n$$

$$\text{or} \quad \text{Rs} \sum_{1}^{n} \text{P.Q.} \qquad (2)$$

Where P_1, P_2,.. ... P_{n-1}, P_n, etc., represent the prices of the various "n" wild animal species in the economy; and Q_1, Q_2,.....Q_{n-1}, Q_n, etc. the increase in their respective inventories in the economy during the year.

The contribution of the wild animal resources to the GNP can be represented by :

$$\text{Rs} \sum_{1}^{n} \text{P.Q.}$$

The assets in respect of certain protected prized animals, such as tiger, lion, rhinoceros, leopard (snow and clouded), cat (golden, fishing, rusty, spotted, marbled, pallas's), wild buffalow, bharal, markhor, thar, black buck, swamp deer, musk deer, pygmy hog, great white crane, pheasant (chir, monal, peacock), pink headed duck, crocodile, etc., can be judged from the value any wildlife trader/zoological park/circus, etc., would be willing to pay for these animals in the world market. For example, the value of the rhinoceros at present varies from Rs. 0.2 to 0.5 million, and this price would be the value-added to the economy in case the rhino population increased by one. This price, undoubtedly, in the absence of free market, will always be highly subjective. But for purposes of making estimates of GNP, some accepted norms, in consultation with the world traders in wildlife and wildlife experts, can always be worked out periodically. *Presently, the capital growth of wildlife is not being recorded and reported to the CSO.* There is thus a pressing need for carrying out the wild animal's census periodically, say, once in three years, to evaluate the rate of increase in the capital stock.

IV. Contribution of the Dynamic Aspects of Wildlife

For computing $\sum_{1}^{n} \text{P.q.N.}$ and $\sum_{1}^{n} \text{P.Q.}$, the number of animals in the

country is an important variable. And, accurate census of wildlife is a difficult job. Estimates for the same could, however, be made through sample surveys conducted periodically. The census work is a specialized job and is beyond the scope of this paper. However, the need and aptness of periodic censuses of the various species, especially of the important ones (to start with) need prompt identification.

The wildlife capital growth and the value of the expression $\sum_{1}^{n}$ P. Q. which are not being reckoned at present, will give a realistic picture of the contribution of wildlife to the Gross National Product. In this method, besides the growth rate of each species of wild animals, another important variable difficult to determine is the price of different species. In the absence of a ready market, it is bound to be highly subjective.

The cost of input approach leading to $\sum_{1}^{n}$ P.q.N. gives the second best estimate of the contribution of wildlife resources to the GNP. For computing $\sum_{1}^{n}$ P.q.N., the cost of food items may be easy to find, and in any case, "shadow prices" for these can be worked out. If the census figures of wild animals are known, the value of this expression can be calculated. Adoption of either of the above two methods, will obviously give measures for the evaluation of the presently intangible services produced by wildlife resources.

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ECODEVELOPMENT OF RHESUS MONKEYS *(MACACA MULATTA)* IN FORESTS OF DOON VALLEY

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Abstract

Rhesus monkey, a laboratory subject of biologists, psychologists, anthropologists and medical scientists, since the last century, is fast vanishing from it's natural habitat in North India owing to several reasons. This decline has greatly pressed the need to protect the natural reserves of this species, particularly in the forest area. In this preliminary study an attempt was made to estimate the population of rhesus monkeys in Dehra Dun forests Approximately 1147 monkeys were counted in 74 km^2 of different forest parts, (a) Siwalik Range, northern slopes-573 monkeys in 32 km^2, (b) Siwalik Range, southern slopes-272 monkeys in 27 km^2 and (c) Himalayan foot hill side-302 monkeys in 15 km^2. About 15.5 monkey lived per km^2 and group of 38.5 individuals occupied about 2.5 km^2 of a forest area. The social composition of groups is discussed. Some factors which influence the survival of this species are discussed, which are directly or indirectly under human control.

I. Introduction

The "Sewalik hills" near Dehra Dun were abounded with "wild elephants,.. tigers (shere dharidar), sloth bears (jhabur), leopards (shere guldar), hyenas (lukur bugha), the jerow (maha or sambar), spotted deer (chowsingha), the gooral, barking deer (khakur), pigs, porcupines, monkeys, langur of Himalaya, hog deer (parha) and huge pythons" wrote Williams (1874:18) more than a century back. Among these species, the monkeys *(Macaca mulatta)* and langurs *(Presbytis entellus)* seem to be successfully competing in their struggle for existence without human protection. Southwick et al. (1961a: 538) surveyed the rhesus monkey population in the villages of Dehra Dun and reported that approximately 11% villages were with resident monkey groups. Surprisingly in 1974, when we started exploring for monkeys in Doon Valley, not even a single group was located in villages. However, we found groups in urban areas, e.g., Hardwar (5 groups), Rishikesh (3 groups), Mussoorie (2 groups) and 2 monkeys in the city of Dehra Dun. Southwick et al (1961b:698)

had long back warned that the tolerance of villagers in India toward monkeys was decreasing and that the survival of the monkeys inhabiting villages in Northern India; and which constitute 46% of the total rhesus monkey population, was in danger.

Southwick et al. (1961b: 698) and Lindburg (1971:1) also pointed out that the sampling of forest dwelling population was insufficient. We undertook the assessment about the current state of rhesus monkeys in the forests of Doon Valley, and the results of our observations (June-November, 1975) on the number of rhesus are reported in this paper.

II. Study area

Doon Valley is bordered by the Siwalik Hills in the South and the Himalayan foothills in the North. On its East and West flow the Ganges and the Yamuna rivers, respectively. Approximately 1100 km^2 of the Valley area is covered by tropical, mixed, deciduous forests. For the purpose of the present study three areas were selected in different parts of this forest region (Fig. 1), thus :

(a) Siwalik Southern Side—27 km^2 of the Mohand Range
(b) Siwalik Northern Side—32 km^2 of the Asarori Range
(c) Himalayan Foothill Side—15 km^2 of the Jhajra Range.

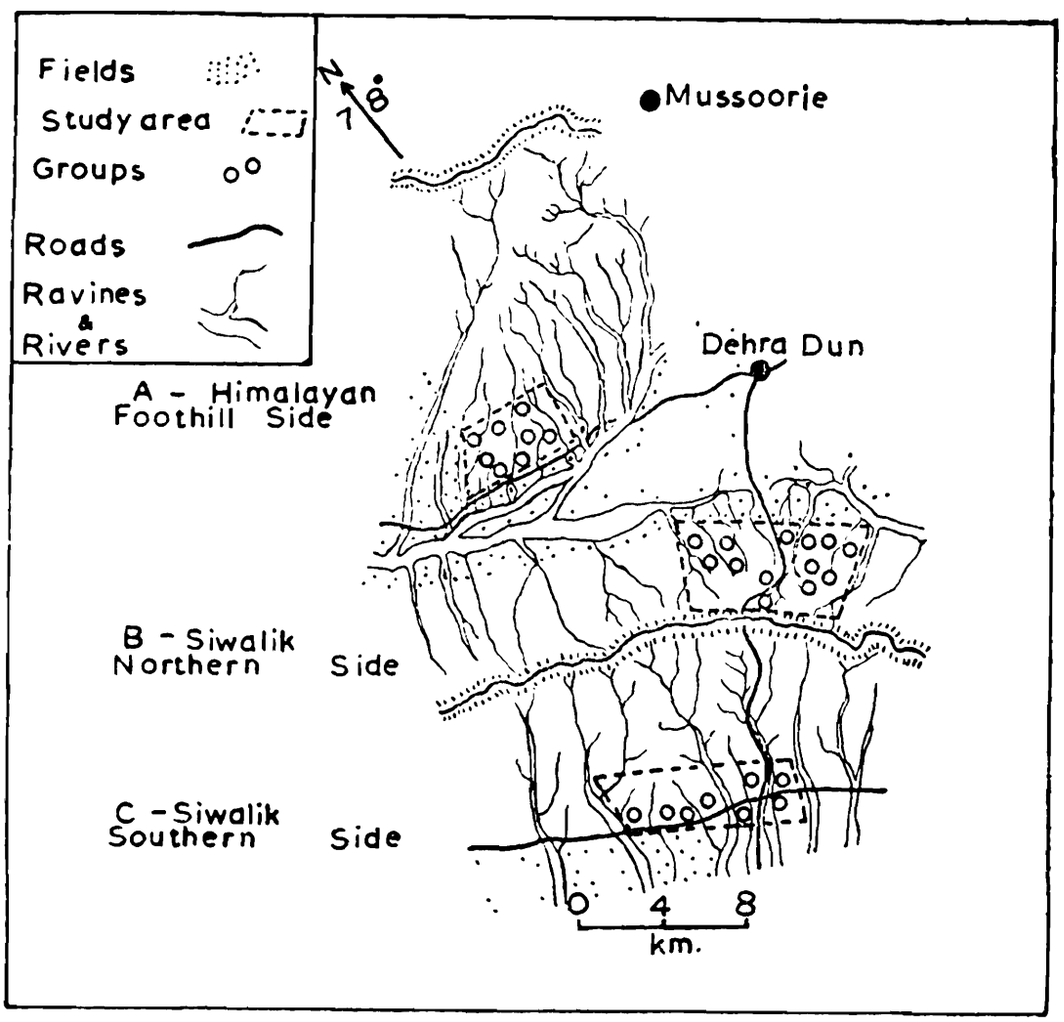
All these three areas are characterised by typical "Tarai" and "Bhabar" area vegetations. The physical features of the Valley are described by Lindburg (1971:1, 1976: 261) and Pirta (1977-78: 123).

III. Method of study

The base camp was established at the Asarori Forest Rest House situated about 13 km from the city of Dehra Dun. The aim was to collect information on size and composition of all the rhesus monkey groups located in the above mentioned study areas. Whenever a group was encountered, it was followed from few minutes to several hours at a stretch. Sometimes maize grains were given to monkeys, so as to enable us to observe them from a closer range.

After reaching in a particular area we went around on foot, following ravines, raos, forest roads, forest lanes etc. in search of monkey groups. In each walk we travelled from 5 km to approximately 40 km, taking cues of monkeys from sounds, foot prints, human beings, faecal matter, and in the later stages, by calling them by making the sound "AAOO, AAOO"

The results presented in this paper are based on the surveys conducted during June to November, 1975, i.e., just after the breeding season. Each group was counted after proper identification, and each member of the group was placed in one of the four age--sex categories, viz., adult



Frgure 1. Location of study areas and rhesus monkey groups.

males, adult females, juveniles and infants. The criteria of classification was based on Southwick et al (1961a:538). All counts were made visually by the first author (R.S.P.).

IV. Observations

Group Composition : 29 groups of rhesus monkeys with 1147 individuals inhabited the forest area of 74 km². The average group size of 38.5 individuals comprised 4.1 adult males, 12 adult females, 15.1 juveniles and 7.3 infants. The group size and composition of monkeys noted in the three areas of forest are given in Table 1, and are discussed below.

Table 1: Incidence and group composition of rhesus monkeys observed in forest areas of Doon Valley

Location	Area km²	Groups counted	Km² per group	Group Size Range	Group Size Average	Group Composition MM	FF	JJ	II
Siwalik Southern Side (Mohand Range)	27	8	3.4	17-45	34.0	4.7	11 2	11.4	6.6
Siwalik Northern Side (Asarori Range)	32	13	2.5	4-100	44.0	3.6	13 0	20.1	7.3
Himalayan Foothill Side (Jhajra Range)	15	8	2.0	23-65	37.7	4.1	11.5	14.0	8.1
On the whole	74	29	2.5	4-100	38 5	4.1	12.0	15.1	7 3

MM :—Adult males; FF :—Adult females; JJ :—Juveniles; II :—Infants

(a) Siwalik Southern Side : 8 groups were located in 27 km² of forest of this area, which yielded an average of one group per 3.4 km². Of the total 272 individuals counted in this area, 14% were adult males, 33.1% adult females, 33.4% juveniles and 19.5% infants. A composition of 4.7 adult males, 11.2 adult females, 11.4 juveniles and 6.6 infants made an average group of 34 individuals. This area forms a part of Rajaji Sanctuary, but we came across two cases of illicit trapping of monkeys during our survey.

(b) Siwalik Northern side : This area of 32 km² has been extensively surveyed (Pirta, 1977-78:123) since June, 1973. The 13 groups of monkeys located involved 573 individuals, of which 8.4% were adult males, 29.2% adult females, 45.7% juveniles and 16.7% infants. An average group of 44 individuals was composed of 3.6 adult males, 13 adult females, 20 juveniles and 7.3 infants.

Of these 13 groups, only 3 were found raiding the crops frequently. Trapping in this area was done by the Psychology Department of Meerut University, in which a total of 139 individuals (6 adult males, 49 adult females, 48 juveniles and 36 infants) were removed for experimental studies during the years 1974 and 1975.

(c) Himalayan Foothill Side : In this 15 km² of forest area, 8 groups of rhesus monkeys were observed yielding an average of one group per 2 km² area. An average group of 37.7 individuals consisted 4.1 adult males, 11.5 adult females, 14 juveniles and 8.1 infants. Of the total 302 individuals counted, 10.9% were adult males, 30.5% adult females, 37.1% juveniles and 21.5% infants. Six groups in this area were frequent visitors of agricultural fields.

Population Composition : Of the total 1147 individuals counted in the three forest areas, 10.4% were adult males, 30.5% adult females, 40.6% juveniles and 18.5% infants. The socionomic sex ratio was 1 (adult male) to 3 (adult females), and the adult female to juvenile ratio was 1:1.4 (Table 2).

The total forest area in Doon Valley is approximately 1100 km².

Table 2: Population composition of rhesus monkeys in different forest areas

Location	No. of monkeys counted	MM	FF	JJ	II	MM : FF	FF : JJ
		%	%	%	%		
Siwalik Southern Side	272	14.0	33.1	33.4	19.5	1 : 2.4	1 : 1.07
Siwalik Northern Side	573	8.4	29.2	45.7	16.7	1 : 3.6	1 : 1.20
Himalayan Foothill Side	302	10.9	30.5	37.1	21.5	1 : 2.8	1 : 1.20
On the whole	1147	10.4	30.5	40.6	18.5	1 : 2.9	1 : 1.40

The present survey revealed that an average group of 38.5 individuals is located in 2.5 km² of forest area. It estimates the total population of rhesus monkeys in the forests of Doon Valley to be approximately 16,720.

It is remarkable to note that Southwick et al. (1961b: 698), who counted about 7000 monkeys in different habitats of Northern India, found only about 9.5% juveniles in the total population, while percentage of adult males (21.4%), adult females (43.6) and infants (25.5%) was much higher. According to these investigators, such a difference was due to "intensive trapping pressure" directed against the juveniles. In their survey, they counted 5 forest groups in Corbett National Park (4 groups) and in a forest near Nainital (1 group). The percentage of juveniles was higher than other classes but lower than females. However, in Lindburg's (1971:1) and the present surveys, the juveniles were found to outnumber all other classes. Although in Corbett National Park, trapping of monkeys is prohibited but it is possible that large cats and hawks prey upon the young monkeys resulting in low juvenile population (Tripathi, J.C., Zoological Survey of India; personal communication).

Pirta (1977-78: 123) compared the group size of monkeys in naturally protected and unprotected areas of Dehra Dun forest. The monkeys in unprotected areas were found to have a smaller group size. Siddiqi and Southwick (1975: 36) also reported that in comparison with unprotected groups, the protected groups in urban areas showed higher birth rates, lower infant mortality and lower adult loss, resulting in higher annual population turn over. Probably the same factor (trapping pressure) accounts for the differences in the group size of 50, 28 and 32 individuals respectively of forest monkeys reported in surveys conducted by Southwick et al. (1961b: 698), Neville (1968: 110) and Jay and Lindburg (in Lindburg, 1971: 1).

The 8 groups of Siwalik Northern Side were previously counted in 1974 and the average group size was found to comprise 51.5 individuals. During 1974 and 1975, monkeys were trapped from these groups (Pirta, 1977-78: 123). When counted again in 1975, the average group size came down to 47.4 individuals (Table 3), and at present it stands at 44 individuals due mainly to the trapping in this region discussed in above paragraph.

Table 3: Changes in group composition after Trapping in Siwalik Northern Side

	No. of groups	No. of monkeys	Group size Range	Group size Average	Group composition MM	FF	JJ	II
Before trapping (June-July, 1974)	8	412	11-127	51.5	4.9	15.0	22.7	9.0
After trapping (June-July, 1975)	8	379	4-100	47.4	4.4	14.4	20.9	7.75
Present Study	13	573	4-100	44.0	3.6	13.0	20.1	7.30

V. Discussion

Ecodevelopment implies the development of a given population, in harmony with the ecological, the economic, the social and the cultural

factors. For the growth of rhesus monkeys, all these factors need to be kept in mind. These macaques have become a highly economical species due to their use in biomedical and other life sciences researches (Southwick, 1975: 32), but their natural habitat (forest) is fast diminishing due to human interference, deforestation and the economic forestry plans, The changes in the attitudes of the villagers and hygenic attitudes of the urban people are important social factors inhibiting the growth of this species. For centuries, this monkey has enjoyed a semisacred status in Hindu Culture, and the rapid change in the religious thoughts of younger generation is harmful for the development of these macaques. If these social and cultural attitudes are not modified, the 80% of the rhesus monkey population inhabiting the urban areas of Northern India may probably become extinct in next few years.

The rhesus monkey population of Doon Valley represents a valuable resource for ecological and behavioral research. The studies which require trapping of monkeys should be restricted to certain selected groups. The indiscriminate trapping in the forest, and forcibly caging several monkeys in one cage made for housing just one animal (as had been the practice of Psychology Department of Meerut University), is not only unethical but also a misuse of this valuable animal. The words of Lorenz (1976: 64) should be treated as an instruction : "it is imperative to take only such animals as, under the conditions that can be offered, really live instead of just dying slowly."

The large human colonies of 100 to 3,000 persons have come up in the interior forest areas (especially in the Rajaji Sanctuary). They cultivate the recently cleared forest till the new plantation comes up. They are a big threat to the surrounding wild life especially the monkeys because the monkeys concentrate around the cultivated land and become habituated to human beings to be an easy prey for the trappers. In our interrogations with the people living in such colonies, it was noticed that they were afraid to report against trapping of the monkeys in these areas because of the threats by the poachers. These forestry practices, designed to squeeze the last rupee out of jungles, must be radically reoriented. The outlook of accountant must be oriented to a wider vision of the educational and ecological value of the totally undisturbed areas of wilderness. Finally, we equivocally agree with Lorenz (1976: 75) who mentioned : "I take very seriously the task of awakening, in as many people as possible, a deeper understanding of awe—inspiring wonder of nature and I am fanatically eager to gain proselytes."

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WILDLIFE CENSUS AND MONITORING IN INDIA A REVIEW

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Abstract

There has been a general lack of a coordinated systematic policy for wildlife census in India and only a few records of census of some important species like Asiatic lion are available. As a result the data available on wildlife is very meagre. Studies on population dynamics of various animal species are practically non-existent. Only very recently a national attempt of censusing the tiger was made in 1972 before launching the Project Tiger.

The paper reviews some of the census operations which have been carried out in different parts of the country, particularly census of tiger and the lion and discusses the methodology adopted, the information obtained and need for refinement of techniques with a view to monitoring periodic changes, preparation of life tables and study of population dynamics as important tools in wildlife management.

The paper also suggests standardization of techniques for population estimates for different species so that properly reliable estimates initially comparable can be obtaind and reliable forecasts of population trends can be made.

I. Introduction

The term "wildlife census" is normally used for the process of estimating the wildlife population including the collection of data concerning animal numbers and age and sex classification. In a general sense the term as used in India, includes census estimates, census index, and other forms of sample censuses.

Since populations of wild animals rarely are static monitoring of animal populations in a time series and their analysis are important considerations in any understanding of the ecology of a given animal species, and its management. The term 'Population dynamics' is used for the study of structural changes in a given population and the dynamics of its growth. It studies "the age and sex composition" of a population and the forces controlling the past and future composition of their numbers. Fluctuations of numbers almost invariably are accompanied by changes in structure. A study of population dynamics therefore provides knowledge of the internal workings of a population and gives a good indication of any probable future changes in the animal population, its growth and health, its ecological relationship with the range and provides a numerical measure to the effects of any wildlife management effort.

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In this paper an attempt has been made to study some of the wild-life census operations which have been conducted in this country for the past few years. The analysis has been made of the methodology of the censuses adopted, the results obtained, their reliability, consistency and the depth of information regarding the structure of the population for purposes of study of population dynamics. Though scattered attempts at estimation of various animal populations have been made in various parts of the country, systematic continuous inventories are rare. As a consequence only those censuses have been analysed in this paper for which continuous census data has been collected over the past few years with some sort of a regularity. An attempt has also been made at suggesting modifications in the census techniques as well as the depth and quality of data collection. Methodology for study of population dynamics have also been discussed.

II. Census of the Asiatic Lion in Gir Forests

The Gir forests of Gujarat State are now the only known preserve of the Asiatic lion in the world, being confined to nearly 700 km area in the erstwhile Junagadh State, thanks to the special protection measures taken by the erstwhile ruler and subsequently by the Govt. of Gujarat by declaring the Gir forests as a sanctuary for the lion. Regular census of the lion population has been done for the last 30 years now at roughly 5-years interval. Dharamkumarsinhji (1969) has reported the results of 1950 to 1968 census as summarised in Table 1.

Table 1

Year	Male	Female	Cubs	Total
1950	179 to 187		40	219-227
1955	141	100	49	290+24 reported in the Bombay State area of the Gir forests.
1963	82	134	69	285
1968				
(May 28-29)	48	80	38	166°
(June 2-6)	55	59	51	162*
	5	10	—	15°

*—by visual count.
°—by pug marks.

The 1950 census was carried out by measuring and counting the pug marks of the lion and as such can be more appropriately called a census index. The method used was that on a specified date in summer all the lion pug marks near various water holes were cleared and then on the next day fresh pug marks on the water holes were counted and their

length and breadth measurements were recorded with the help of marking sticks using different colour sticks for length and breadth. With the help of these measurements the estimates of the population were obtained. Classification of male and female was not done and adults and sub-adults were grouped in one category and cubs were grouped in another category.

The same method was repeated in the year 1955 but here classification of male, female and cubs has been done separately. In 1963 the census was conducted by the Forest Department and initially it was intended to do visual count by marking the animals but later on this plan was abandoned and old method of counting pug marks was followed (Dharamkumarsinhji 1969). In 1968, the census was again conducted by the Forest Department with the help of R.S. Dharamkumarsinhji. The method of visual counting on baits was followed though a preliminary pug mark survey was also conducted (Table 1).

Since there is only one known population of the Asiatic lion in the Gir forests and the entire population is supposed to be counted, it may be called a complete census. However, analysis of the population shows obvious discrepancies and a lot of subjectivity in the interpretation of the census index used in the first 3 censuses, i.e. the classification of the population into male, female and cubs on the basis of length and breadth ratio of the pug marks with the help of the marking sticks. Comparing the 1955 census with the 1963 census it is observed that whereas the sex ratio in the 1955 census was 140 males to 100 females, in the 1963 census it is 82 males to 134 females or a sex ratio of 61:100, i.e. a drop of more than 100% in the ratio of adult males in the population though in terms of absolute numbers the total population in 1955 and 1963 is almost constant. Side by side the number of cubs has increased from 49 to 69 giving the mother to cub ratio of 100:51 in 1963 against the ratio of 100:49 in 1955. Though the cubs are not sexed, during the 8 years period from 1955 to 1963 it would appear that all the maturing cubs were only females and most of the mortality was confined to adult males only as the number of female population has risen from 100 to 134 while the number of male population has come down from 141 to 82 only. Both these assumptions appear highly unlikely and therefore it can be safely concluded that the interpretation of the census index of classifying pug marks into male and female has been a highly subjective operation and as such makes any population analysis almost impossible.

During 1968, prior to visual counting, censusing of lion was done by enumerating the foot prints (Dharmkumarsinhji, 1964) which is also given in Table 1. Though the total fiugres arrived at by the two methods are fairly close to each other the classification into males, females and cubs is highly erratic. While the visual count places the number of males as 55 the number of males as classified by pug marks is only 48—a difference of seven. In case of females the number as per

visual count is 56 while on the basis of pug marks the figure is 80—a difference of 24, while the number of cubs as per visual count is 51 and as per the pug marks evidence it is 38—a difference of 13. It is therefore evident that even a broad sex and age classification based on pug-mark evidence is highly subjective, and cannot be relied upon.

This subjectivity in the interpretation of pug marks not only renders the previous figures in classification highly unreliable but would also seem to be placing a premium on the use of visual count method as more reliable than the pug mark census which was followed earlier, though how duplication in counting could be avoided without following any form of marking procedure, is not understood.

With the above highly variable classification it was not possible to arrive at any conclusion regarding the correct sex ratio or a mother-cub ratio. In 1955 census the mother : cub ratio was 100 : 49, in 1963 census it is 100 : 51 while in the 1968 census it becomes 100 : 91.

To understand the population dynamics of the lion better, it is suggested that in future censuses the lion population may be grouped on the basis of the number of prides and the composition of each pride recorded because in the case of the lion a pride can be taken as a basic structural unit, for the study of population dynamics.

III. Winter track census of Palamau National Park

A sample census of wildlife in the 'Palamau National Park' on an annual basis, in permanently demarcated, parallel, census tracks has been started by Mishra and is carried out on 7th January each year. The first such sample census was however done on 4-1-1970 and has been repeated annually.

The object of the census as defined by Mishra (1970) 'is not to enumerate the exact number of animals residing in the park but to obtain a figure of minimum number of wild animals residing therein. If on these fixed tracks every year a census is carried out during the fixed period of the year, it would surely reveal the increasing or diminishing trend in the population of wildlife. This trend is of utmost importance to the wild-life conservationist'

The method of laying out the number of tracks has been described in detail by Mishra (1970). In all, 147 track lines, nearly 400-500 yards apart, have been laid out in the 5 different census blocks in which the area of the park has been divided. No census track is more than 5 miles in length and the tracks have been laid in a manner that the track men may easily move to the starting points of their track line. Enumeration figures of the various animals in the park for the period 1970-73 as reported in the various winter track census reports of Mishra (1970, 1971, 1972a and 1972b) are summarised in Table 2.

Table 2

Name of animal		Number of animals as per winter track census 1970	1971	1973	1972
1.	Tiger	12	14	6	2
2.	Leopard	1	4	1	0
3.	Hynae	2	3	4	0
4.	Wolf	12	1	4	0
5.	Wild dog	0	9	0	0
6.	Elephant	0	6	17	24
7.	Gaur	61	81	53	73
8	Sambhar	139	148	125	160
9.	Blue bull	7	14	15	20
10.	Cheetal	597	625	541	623
11.	Barking Deer	62	95	65	94
12.	Wild Boar	263	333	251	349
13.	Bear	2	7	1	3
14.	Pea Cock	123	213	182	151
15.	Porcupine	0	5	0	0

The study of the comparative figures for the last four censuses, as per Table 2, shows that in spite of the clearly defined objective no concrete conclusion can be drawn regarding population trends on the basis of the sample census undertaken. For instance, the population of elephants in 1970 is found to be nil, in 1971 it is 6, in 1972 it is 17, and in 1973 it is 24. It could not be argued that there were no elephants in the area in 1970 and suddenly in 4 years the population has become 24. Similarly for large populations like those of Sambhar, Cheetal or Gaur with adequate and regular dispersal a definite trend could have been obtained, the figures do not give any indication. It is therefore clear that there is something evidently wrong in the method of the sample census. Chaudhari (1971) has suggested among other things that the average and maximum sighting distances should be assessed for each strip to give the width of the strip enumerated which can be projected over the entire park, less the areas of hills which has been excluded from the purview of the strips.

The winter track census in Palamau National Park is an exercise in sampling both in time as well as in space. Any sampling census design will therefore have to account for errors caused due to variance through time and variance through space.

As an illustration: if on the same strip a second or a third count is repeated on successive days the figures for each strip and each animal will be different giving a certain measure of variance in time. Similarly in a spatial distribution the probability of sighting a given animal is a combination of (a) the distance at which the animal is flushed, (b) the cover type, (c) the dispersal of the animal throughout the range and its preference for a particular micro habitat.

The variability in time can be measured by repeating the census on 2 or 3 successive days on the same strips, tabulating the variation for each species and statistically culcating the variance together with mean value, or taking the coefficient of variation as a measure of temporaral variation. Populations with high coefficient of variations will require more repetitions.

Regarding spatial distribution it will be desirable to measure the flushing/sighting distance of each animal with its vertical projection on the track line. The sighting distance can be used as a measure of the probability 'p_r' of sighting an individual animal and population P_r from which it is drawn can be taken as $P_r=\frac{1}{P_r}$ and a measure of total population can be given by $P = \Sigma P_r = \Sigma \frac{1}{p_r}$ (Haine's modification of King's method) and $p_r = \frac{2d_r}{D}$ where d_r = Flushing distance, D = Length of the area (Distance between two successive transacts). The shortcomings of the winter-tract census can therefore be summarised as follows :

The objective set for the winter track census is stated as not to enumerate the exact number of animals but to obtain a minimum figure. However, no attempt has been made in designing this experiment to :

(1) measure the reliability of the estimate of this minimum number at any given count, i.e. to allow for chance fluctuations in terms of time and space and measure these fluctuations so that over a span of time the trends can be clearly interpreted in terms of (a) fluctuations due to chance variations, and (b) real changes in numbers,

(2) highly territorial animals like tiger and leopard should not be censused by strip method of sampling as their number can be ascertained by territory-mapping method using cooperation census techniques,

(3) animals with small populations like wolf, hynae, wild-dogs and bear can also be censused through (a) use of census indices, (b) study of known population concentrations,

(4) the method of track census can be limited only to species with large populations, and wider more homogeneous dispersion like bison, sambar, cheetal, barking deer, wild boar and peacock.

Suggestions :

The following modifications in the track census technique as adopted in Palamau National Park are therefore suggested :

(1) The sample census count should be repeated at least 3 times to measure the variability in time and mean variations.

(2) The sighting distances should be estimated side by side with sighting of each individual animal noting at the same time the cover type where the sighting is made.

An estimate of the population can be made from the formula

$$P = \Sigma \frac{1}{p_r} = D \times \Sigma \frac{1}{2d^r}$$

and the density of the population can be given by the formula

$$\text{Density} = \frac{1}{L} \Sigma \frac{1}{2d_r}$$

where L = length of the plot and L and d_r are measured in same units.

A measure of variance of the estimate is obtained by estimating the density (or total population) from each transact and then calculating the variance among these estimates.

(3) The animals sighted should be classified both for their sex and ages as was done for the first census and appears to have been given up in the subsequent census. No study of population dynamics is possible without such a classification and building up a time series of observations.

IV Black Buck Survey at Point Calemere Sanctuary in Tamil Nadu

The area of 4120.7 acres at Point Calemere in Tanjore District of Tamil Nadu contains one of the biggest concentrations of the few pockets of the black-buck population which exists in the country today. Two censuses—Daniel (1967) and Nair (1974) have been made. Daniel estimated the population in 1967 at nearly 750 animals while Nair's census in 1974 has placed this number at 333, i.e. a reduction of more than 1/2 over a period of 7 years. The details of the two censuses are reproduced in Table 3 and Table 4 below :

In 1967, census was conducted on 25th May. Daniel used direct visual counting technique. Most of the black buck population was concentrated in the Foreshore area which is a coastal strip about 1/2 mile wide. Entire strip was censused by Daniel and V Subbaiah walking abreast along the centre of the strip and counting all the animals along the strip towards their right and left respectively. For forested areas, all the areas known to be holding black buck were visited and animals counted.

Table 3 (Daniel 1967)

Area	No. of herds	Male Sub. Ad.	Ad.	Female Sub. Ad.	Ad	Fawns	Un-sexed	Total Cound	Esti-mate
Foreshore	41	128	24	219	30	23	125	549	600
Forest	6	25	4	66	9	2	4	110	150
Total :	47	153	28	285	39	25	129	659	750

Herd size ranges between 3 and 47; normal 12.
Average Flushing distance—300 yards.
Ad.=Adult Sub-Ad. = Sub-adult

Table 4 (Nair, S.S. 1974)

Males				Females			
Adults							
Black	Yellow	Yearlings	Total	Adult	Yearlings	Total	Fawns
37-39	7-9	12	58	258	15	273	2

Herd composition : 1. Hetro sexual groups–54 sightings.
Range of herd-size–2-129
Average herd-size–23
2. Unisexual groups–26 sightings.
(a) Only males–17 groups.
Average size–4
(b) Only females–9 groups
Average size-15

In 1974, census was conducted by S.S. Nair from 19th to 27th October, 1974. The method used consists of :

(1) direct visual counting,

(2) suitable route determined by zig-zagging from one end to another end of the sanctuary dividing the maidan into 15 triangular plots,

(3) herds were stalked and approached with the least disturbance to the animals,

(4) counting, sexing and classification was done with the help of "7 × 50" binaculars,

(5) 85 animal sightings were made in 9 sorties,

(6) on consecutive days herds were counted alternately in the forenoon/afternoon in plots 1-9.

Both Daniel and Nair have used visual counting method but have adopted a different approach in sub-dividing the area for counting. The zig-zag path followed by Nair unless demarcated on the ground appears difficult to have been followed each time in all the 9 sorties. Though both Daniel and Nair have tried to make age and sex classification, the classification followed is not uniform as Nair recognsied 3 age groups in the males while Daniel has recognised only 2 age groups. The sex ratio in Daniel's survey is 54 males to 100 females while in Nair's survey it is 17.23 to 100 females which shows a heavy mortality in males as compared to females. It fact the female population (which is sexed) in Daniel's survey and the female population in the Nair's survey is more or less constant with a marginal decrease but the male population has dropped to nearly 1/3rd in 1974. The doe : fawn ratio in Daniel's survey is 100:8.77 while in Nair's survey this ratio has dropped to *100:0.77*. Nair has reported that 7 females appear pregnant. The difference in the doe-fawns ratio may partly be attributed to the difference in the period of census as peak fawning is expected sometimes in November-December and the previous year's births have been grouped in yearlings. Taking into account the pregnant females the deo-fawn ratio becomes 100:3.5 as

against 100:8.77 in Daniel's survey. The reproductive rate in this population is very low as adult females are capable of producing one young per year (Schaller, 1967). This shows that this population is not breeding *properly*. The reduction in this population from 750 to 333 is a matter of serious concern. However, the reduction in the number of males also suggests a hunting pressure which may be entirely due to poaching. A study to investigate the poor reproductive rate is called for in view of the rare nature of this population which is one of the last concentrations of this species in the country.

It is also suggested that a standard age and sex classification pattern should be adopted for the population census and census should be repeated biannually for the species. The period of census should be (i) during peak-rutting, and (ii) immediately after peak-fawning. Since the area is too small use of drive census method can be made to estimate the population more clearly.

V. Tiger Census

The estimate of tigers in the country has always been a wild guess. Gee (1966) estimated the existence of 40,000 tigers at the end of the 19th century and about 4,000 tigers in 1965. According to Corbett (1955) the number of tigers was not more than 2,000. Sankhala (1970) estimated the number of tigers existing in the country to be about 2,500. Singh (1969) has estimated tiger population in U.P. as 481. However, a countrywide Tiger Census was done in the year 1972 to assess the status of the tiger, after the Survival Service Commission of the I.U.C.N. had drawn pointed attention to the threatened existence of the Royal Bengal tiger (*Panthera tigris tigris*) and the need for its complete protection. The result of the 1972 tiger census is given in Table 5.

Table 5*

State	No. of tigers	State	No. of tigers
Andhra Pradesh	35	Maharashtra	160
Arunachal Pradesh	62	Mizoram	Not counted
Assam	147	Mysore (Karnataka	102
Bihar	85	Nagaland	80
Goa	—	Orissa	142
Gujarat	8	Rajasthan	74
Haryana	—	Tamil Nadu	33
Kerala	60	Tripura	7
Manipur	1	Uttar Pradesh	262
Madhya Pradesh	457	West Bengal (excluding 4/5 of Sunderbans)	73
Meghalaya	32		
		Total	1827

*Report Project Tiger, India—1972

Census technique

The methodology adopted for this national census has been called as "Cooperation census" (Chaudhari, 1970 & 1972). The method consists of the following basic operations :

The States having tiger habitats were grouped into 5 zones each under a Zonal Coordinator :

(i) *Northern Zone* — Uttar Pradesh and Bihar.

(ii) *Eastern Zone* — Bengal, Assam, Arunachal Pradesh, Meghalaya, Mizoram, Manipur, and Tripura.

(iii) *Central Zone* — Madhya Pradesh and Orissa.

(iv) *Western Zone* — Maharashtra, Rajasthan, Goa and Gujarat.

(v) *Southern Zone* — Tamil Nadu, Andhra Pradesh, Kerala and Karnataka.

Each State within the zone was placed under a Chief Coordinator. Each Division was a separate unit under a Chief Organizer. Each Range was placed under an Organizer. The smallest enumeration unit was either a beat or a counting sheet and the initial enumeration was done by the Beat Guard called a participant or cooperator. The work of 5 or 6 participants or cooperators was coordinated by a Coordinator.

The areas of Ranges/Divisions was divided into counting sheets. The division into counting sheets was based on territorial habits of the tiger and was roughly a Forest Guard's beat. Firstly the presence or absence of the tiger was shown on the counting sheet by the coordinator indicating whether there was a tiger in his area or anywhere in his adjoining counting sheets. The evidence could be based on personal knowledge, personal sighting, evidence of cattle lifting or man-eating or any other reliable information. This was further confirmed by the evidence of pug marks on the specified date of counting. The position of pug marks located in the area was plotted on the map and the pug-marks lifted with the help of a tiger tracer, the training about the use of which was given from the Zonal Coordinator downwards to the actual cooperator or participant as phase I of the operation. The two evidences were then combined through the counting sheets and the tracings into an integrated map which could eliminate overlaps of areas as well as pug marks. In fact this whole method amounts to "territory mapping" of the tiger on a National basis. If properly done the method can provide fairly accurate information and it appears to be a method most suited for tiger census, for the reasons that :

(1) The tiger is normally a solitary animal.

(2) It is a highly territorial animal with fairly well-defined territories except during the mating season or when the tigress is accompanied by cubs.

The census was carried out in 2 stages :

(i) for the eastern region from 22nd to 28th April, 1972.

(ii) for the rest of the country from 15th to 31st May, 1972.

Unfortunately, full details of the census regarding age and sex distribution of the tigers are not available with me and as such no analysis is possible.

VI. Project Tiger

Based on the above census, Project Tiger has been launched in the country from 1972 in 8 tiger reserves and the 9th reserve of Sunderbans has been added recently. The position of the tiger in the proposed tiger reserves as envisaged in 1972 is given in Table 6.

Table 6*
Population in Project Tiger Areas

Name of Tiger Reserve	Existing area (sq. km.)	Proposed area (sq km.)	Population in Project area		Total
			Existing	Proposed	
Manas	270	2900	12	30	42
Palamau	240	1500	6	31	37
Simplipal	300	—Not estimated—			
Corbett National Park	560	560	30	--	30
Ranthambore	155	300	14	—	14
Kanha National Park	250	1380	30	6	36
Melghat	352	900	--	--	42
Bandipur (Nagarhole)	56	264	--	--	18
				Total	219

In January 1977 a Newsletter from Project Tiger (Vol. 1, No. 1) has informed that there is an increase in tiger population in all the reserves. The comparative figures given by the Newsletter are given in Table 7.

Table 7

Tiger Reserve	Population (1972)	Population (1976)
Manas	31	41
Palamau	22	30
Simplipal	17	50
Corbett National Park	44	55
Ranthambore	14	20
Kanha National Park	43	48
Melghat	27	32
Bandipur	10	19
Total	208	295

*Report Project Tiger, India--1972

Analysis of Tables 6 and 7 shows that the tiger population as envisaged in the tiger reserves in the Project Tiger Report in 1972 do not compare to the corresponding figures as given in the Newsletter with which the 1976 fiigures have been compared. This will require further scrutiny.

However, latest census figures for Bandipur Nagarhole Tiger Reserve and Melghat Tiger Reserve are available from personal communication. The last tiger census in Bandipur was done from 14th to 16th October, 1976. The reported figures are :

Bandipur Tiger Reserve*

Area of the reserve	Population Male	Female	Cubs	Total
689.52 sq. km.	9	14	3	26

Melghat Tiger Reserve†

Area of the Reserve		Population Male	Female	Cubs	Total
381.58	(1975)	20	16	9	45
sq.km.	(1976)	23	21	13	57
	(1977)	30	25	2	57

The above two census figures show remarkable variation from the figures given by the Newsletter of Project Tiger for the two tiger reserves.

In the Melghat Tiger Reserve a time series data is available over the 3 years period 1975-77. The increase in the adult tigers in the 1976 population over the 1975 population is 8 (3 males and 5 females). The total cub population in 1975 is 9 which shows that 8 of the cubs had matured over this period into adults which would mean that all the 9 cubs in the 1975 census except 1 were sub-adults and attained adulthood in 1976. Mortality is estimated as nil or at the most 1 cub out of the 9 might have disappeared. It that case the production of cubs in 1976 is 13 or probably 12+1 of the previous year. In 1977 again the gain in the adult population is 11 (7 male, and 4 females) evidently the gain coming from 13 cubs in 1976 population leaving 2 cubs. Now this would mean that (1) all cubs are maturing at one year age (an absurd conclusion!), (2) there is no mortality amongst cubs during the period 1975-77, (3) there has been no production of cubs during 1976-77. All the 3 conclusions which can be derived on the basis of the above figures do not appear to be correct and as such these figures also need proper verification. In fact the comparative analysis of the various figures in the various tiger reserves shows a number of discrepancies and that throws some doubts on the reliability of the figures.

*Communication from Field Director, Project Tiger, Mysore.

†Communication from Shri B.R. Koppikar, C.F. & Field Director, Melghat, Paratawada.

Complete census data with age and sex classification for all the tiger reserves will be needed to carry out a complete analysis of the population dynamics. However, the figures will require thorough scrutiny and cross-checking.

VII. Conclusions

The above analysis of the various censuses highlights the following weaknesses in the conduct of various wildlife census and monitoring in India :

(1) Standard techniques for the census/estimation of different wildlife populations have not been evolved. Even in the same area the methodology followed for censusing the same population in two successive census has been changing depending upon the person carrying out census without examining various alternatives and studying the suitability of a particular type of method. As a consequence the results which are available lack initial comparability and statistical reliability.

(2) Attempts at studying the structural aspects of wildlife populations as a part of census estimation are not properly emphasised. In this connection studies in ageing and sexing of the population have to be developed further.

(3) Studies on 'natality' and 'mortality' are lacking especially as a part of census study for purposes of studying the population dynamics.

(4) Survival rates and age-specific mortalities for populations under study should form an essential part of population estimation.

(5) It is suggested that studies of population dynamics are immediately taken up for all the populations of animals which are rare or threatened and on the verge of extinction, like the black buck in Point Calemere where the results of the two census surveys reveal an almost complete absence of reproductive activity and consequent degeneration of the population. Similar studies will be needed for rare species like 'hangul' in Kashmir (Dachigam), Swamp deer, the brow-antlered deer or the Sengai etc.

(6) A study of the age and sex structure of the lion and the tiger is also essential as the different census figures available show inherent contradictions.

(7) Census and monitoring operations as a regular management practice is on a different footing. The type of census estimation which is being made in the Palamau winter track census needs to be statistically refined as suggested in the paper so that results can be analysed on more scientific lines. It is suggested that similar continuous censuses may be made a part of regular wildlife management practice in all wildlife reserves and sanctuaries in the country.

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ECOLOGICAL STUDY ON THE FISH AND FISHERIES OF GARHWAL WATERS WITH A NOTE ON SOME APPLIED PROBLEMS

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Abstract

The freshwater ecosystems of Garhwal harbour about 50 species of hillstream fishes. of which about 22 are found in the river Alaknanda alone. The *Schizothorax* and the *Tor* species are the most important food and game fishes of the Garhwal waters and are most suitable for the establishment of coldwater fisheries to increase the production of protein food for the poor masses of this region. The declining fisheries of the Garhwal waters can be saved by more ecological studies on various problems including the optimum-yield, overfishing, environmental change, and seed-destruction etc.

I. Introduction

The Garhwal region comprises five districts: Pauri, Tehri, Uttarkashi, Chamoli and Dehra Dun and the freshwater resources of this region support a very rich and colourful fish fauna. The main rivers of this region are Alaknanda, Bhagirathi (both meeting at Deoprayag to form the river Ganga), Yamuna, Nayar, Bhilangana, Nandakini, Pindar, Mandakini, and Song, etc. Besides these rivers, a number of rivulets and streams also harbour a good number of fishes. However, till recently we had little knowledge of the ichthyofauna of the Garhwal hills. But now the districtwise reports on the fish fauna are available. In the first report Badola and Pant (1973:37) reported 18 species of fish from Uttarkashi district. This was followed by a second report by Badola (1975:57) who described 43 species of fish from Pauri district. The eastern Doon fishes have been surveyed by Lal and Chaterjee (1962:230). Recently Badola and Singh (in press) have reported 27 and 33 species of fish from the district of Chamoli and Tehri respectively. Thus, the freshwater ecosystems of Garhwal support about 50 species of fish. The important genera are *Schizothorax* (4 sps), *Puntius* (4 sps), *Noemacheilus* (9 sps), *Barilius* (5 sps), *Glyptothorax* (5 sps), *Garra* (3 sps), *Danio* (3 sps), *Tor* (2 sps), *Labeo* (2 sps), *Pseudecheneis* (1 sps, *sulcatus*), *Channa* (1 sps, *gachua*), *Mastacembelus* (1 sps, *armatus*), *Homaloptera* (1 sps, *brucei*), *Lepidocephalichthys* (1 sps, *guntea*), *Crossocheilus* (1 sps, *latius latius*), *Chagunius* (1 sps, *chagunio*), *Salmo* (1 sps, *trutta fario*), and *Cyprinus* (1 sps, *carpio*).

Of the above, about 22 species are found in Alaknanda alone (Badola and Singh, in press). These fishes are killed by different fishing methods (Badola and Pant, 1973:37; Badola and Singh, 1977:177) and form a good part of the food for local people. The most important food and game fishes of Garhwal are *Schizothorax* sps (*richardsonii*, *sinuatus*, *plagiostomus*, and *progastus*) and the Mahseer or *Tor* species (*tor*, and *putitora*).

II. Observations and Discussion

Recently the authors have started some ecological studies on the hillstream fishes of Garhwal region. The hydrological studies indicate that the temperature of the Alaknanda waters varies from 8°C to 17°C. The maximum temperature recorded was in the month of April and minimum in December and January. The pH remains 7.0 in December and January which is the minimum and the maximum is 8.2 in the months of July to September. It has been reported by Badola and Singh (in press) that the low temperature of water, the neutral pH, clarity of water, and high content of the dissolved O_2 are the main factors governing the abundance of *Schizothorax* in Alaknanda. The same may be true for other major rivers of Garhwal in which *Schizothorax* is found throughout the year.

After *Schizothorax* the second important food fish of Garhwal is *Tor*, the Mahseer. However, very little biological work has been done on the Mahseer of the Garhwal Himalaya. The work done on the biology of Mahseer found in other parts of the country has been reviewed by Jhingran (1975: 216) which shows differences in the spawning period of the Mahseer of different waters. Recently Badola and Singh (in press) have reported that the fish comes to Alaknanda waters from Ganga for breeding in March to June. Thereafter, the spent fish return downwards or into deeper waters and their fry and fingerlings are available in side and back waters all round the year. It has been suggested that the presence of suitable and isolated breeding grounds, the high percentage of O_2 in the water, and the abundance of insect larvae which form the food of the Mahseer are some of the factors that attract this fish to ascend the Alaknanda waters for breeding. However, the population of *Tor* species is continually decreasing and more work is needed on the spawning migration and other biological aspects of this fish.

However, the following applied problems are also to be studied :

The optimum-yield problem : The Garhwal waters are highly suitable for the establishment of coldwater fisheries, especially the *Schizothorax* and *Tor* fisheries. With the development of these fisheries the fish yield of this area can be very much increased. However, the problem of optimum yield must be studied for all Garhwal waters and for all important fisheries of this region. If we want to manage a fishery we would obv

not catch the fingerlings and young fishes for they would give little food and less profit. On the other hand we would prevent the fishes from growing too old. So the optimum point to harvest the fishes will be between the above two conditions.

For a fishery the "optimum yield" may be the maximum yield of fish over some weight (1/2 kg to 2 kg or more depending on the fish). Accoding to Russel (1931: 3), natural mortality and fishing mortality decrease the weight of the catchable stock during a year. Similarly two factors, growth and recruitment increase the weight of the stock. The following equation given by Russel (1931: 3) describes the relationship.

$S_2 = S_1 + R + G - M - F$, where
S_2 = weight of the catchable stock at the end of the year.
S_1 = weight of the catchable stock at the beginning of the year.
R = weight of new recruits
G = growth in weight of fish remaining alive.
M = weight of fish removed by natural deaths.
F = weight of fish removed by catching or fishing.

If we wish to balance the fish population in Garhwal waters we will have to be careful about (a) recruitment rate, (b) growth rate, (c) natural mortality, and (d) exploitation and the effort will have to be made by recent scientific methods to increase the (a) and (b) and to reduce the 1973 405 (c) and (d). However, according to Moen (1973:405), the population growth in each generation is far more dependent on conditions that affect the productivity of the living animals than on the number of animals that are removed by harvest or natural causes. If this statement of Moen made about wild animals holds good for fishes also, then the study of the conditions affecting the productivity of fishes in Garhwal waters is essential.

Overfishiug problem : The most serious problem posing a danger to the fisheries of Garhwal is the overfishing problem. At all times the people have been codsidering the natural fishery resources as "inexhaustible" and the greed, scientific and ecological ignorance, and mismanagement have collaborated to deplete the fishery resources. If we want to save the fisheries from further depletion or overexploitation, we will have to develop an ecological conscience and may also have to depend on law, etc.

Environmental change problem : Today the "environmental change hypothesis" is the most suitable explanation for the depletion of the fish fauna in all natural waters. The Garhwal waters are not an exception to this. Recently Das (1977: 39) has very aptly pointed out the effect of development on the environment in the Himalayan region. A number of factors including the construction of roads, dams and bridges, deforestation, landslides and soil-erosions, disposal of municipal sewage into river waters, floods, and the killing of fishes by dynamite, ichthyotoxic plants and chemicals, etc. have brought a considerable change in the natural

environments of the hillstreams and the rivers of Garhwal region. The 1970 flood of Alaknanda had the worst effect on the fish population of Alaknanda because the flood had left a bed of dead fishes on the banks of the river.

Seed-destruction problem : The fishes leave a very large number of eggs in the shallow waters of the sides of the river which ultimately develop into fry and fingerlings. But he latter are destroyed when the water recedes, first leaving small patches of water which later on dry up. The fry of *Tor* and *Schizothorax* so destroyed may be collected and used if coldwater fisheries is established in Garhwal. It has also been observed that a very large number of fish eggs are destroyed by the logs of timber that are left by timber contractors in the river for transport. The logs coming towards the banks usually strike the stones and rocks having the eggs.

However, part of the reason for the overfishing of the *Schizothorax* and *Mahseer* in Garhwal waters and for other related problems can be found in ecological ignorance. At present there is almost no information on the age structure and the spawning population sizes of the fish for any of the waters of Garhwal. Consequently, there is no way to know how many spawners are needed to produce an adequate return or to keep a proper balance.

Thus, if we want to save the declining fisheries of Garhwal from extinction, we will have to depend on ecological approach and methods. In fact it should be the duty of every citizen to protect and improve the natural environment including forests, lakes, rivers, and wildlife and to have compassion for living creatures of all habitats.

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SOME LIMITING FACTORS AND DISTRIBUTION OF SWAMP DEER *CERVUS DUVAUCELI* CUVIER

By

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Abstrast

The swamp deer was widely distributed up to the end of nineteenth century in the sal forests throughout the base of Himalayas, in plains from Rohri in Sind through Indo-Gangetic plains to Assam and Sunderbans and throughout the areas between the Ganges and the Godavari rivers. The species gradually started loosing its foothold in various areas and now the two subspecies *Cervus duvauceli duvauceli* and *Cervus duvauceli branderi* are known to occur only in a few pockets in the foot hills of Himalayas and in Kanha National Park in central India.

The decline in the population of these two subspecies is due to afforestations, soil conservation and utility practices, poaching and increase in the number of small predators. These causes are discussed in some detail in this present paper.

I. Introduction

The Indian swamp deer, *Cervus duvauceli*, locally called as "Gond" or "Barasingha" is the most handsome and magnificent deer of its tribe. It is the second largest deer in India next to sambar.

On the basis of morphological characteristics and distribution, Pocock (1943: 556) described two subspecies. One the nominate subspecies *Cervus duvauceli duvauceli* Cuvier, occurring in swamps in the sal forests of Uttar Pradesh along the foot hills (Terai) of Himalayas in northern India and Assam and West Bengal and the other *Cervus duvauceli branderi* Pocock, named by him after the noted naturalist, Mr. A.A. Dunbar Brander, is restricted to hard open ground of central India. The ecology of the latter in central India where practically no swamp exists except at a few patches in monsoon months, is very different from that of the former in northern India where the swamp is a permanent feature. The main morphological features by which the subspecies, *branderi* differs from the nominate one, as given by Pocock (1943: 557-558), are smaller size of the body as indicated by the length of skull, hard and well knit hooves suitable for galloping on the hard ground, darker colour of the body and antlers and rough texture of antlers. Later, Ellerman and Morisson-Scott (1951: 363) upheld these two subspecies of swamp deer.

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II. Distribution of Swamp Deer

(a) *Earlier records :*

Colbert (1935: 40) and Tripathi (1958: 147, 164; 1970: 560, 563, 565) have recorded fossils of swamp deer from the alluvial deposits of Pleistocene and Quarternary times of rivers the Indus, the Ganges, the Narmada and of the Brahmaputra.

The species was widely distributed, up to the end of nineteenth century mostly, in the sal forests throughout the base of Himalayas and in the plains from Rohri in Sind through the Indo-Gangetic plains. It was also known from the areas between the Ganges and the Godavari rivers (Brander, 1923: 194; 1953: 47-51; Forsyth, 1889: 86-92; Jerdon, 1867: 254-255; Martin, 1977: 62-65 and Schaller, 1967: 95). Their localisation in these areas suggests that they essentially inhabited the moist deciduous, semi and wet evergreen forests with swampy places in the plains. At the edvent of present century, the species started loosing its foot hold gradually from various pockets of inhabitations and was completely wiped out from the western parts of the distribution range (Burton, 1932: 860-861). It, however, was a very common deer in Assam as late as 1935, and a fairly large number of animals were seen in various districts (Bh dian, 1935: 486). In central India also it was abundant (Brander, 1923:193-194).

(b) *Present records :*

(i) Northern Indian subspecies :

Martin (1977: 64) has given an account of the status of the swamp deer in North and North-eastern India. According to his report the swamp deer were found only in the forest divisions of Pilibhit, North Kheri, South Kheri and Bahraich in the year 1972, where 1,800 to 2,000 heads were reported. The cause of their total disappearance from the eight localities out of the eleven mentioned by Schaller (1967 : 8-100) was attributed by Halloway (1973: 46) to the raising up of Eucalyptus planta tions and the release of forest land to the agriculturists. Schaller (op. cit.-98) reported their occurrence in South-western Nepal and estimated the population to be between 400-1200. Martin (op. cit. : 64) has suggested re-estimation of swamp deer population in Nepal, and according to him about one thousand heads inhabiting Sukla Phanta Reserve of South-western Nepal alone. There are no data on the estimation of the population of this species in West Bengal and while the population of swamp deer in other parts of North-eastern India h s shown a decrease it has, however, increased in the Kaziranga Wild Life Sanctuary. In 1964-65 the population of swamp deer in North-eastern India was about 500-600 (Schaller, op. cit. : 100). Out of this 200-250 were estimated by him in Kaziranga Wild Life Sanctuary, where the population is growing at a steady pace due to better protection (Burnett, 1959: 318-319). It had at one time decreased to a meagre number of about 20 in 1950 in

this sanctuary (Gee in Schaller, op. cit. : 100). But after this it gradually increased till 1953 when the number rose to 522 and remained fairly constant up to 1972 (Forest Department census figure of 1963 and 1972). Sinha (1974:41) has given the distribution of swamp deer in northern India. According to him they occur ".. in the sub-montane tract of eastern Uttar Pradesh from little east of Bareilly to Assam where still they are plentiful. They are also said to exist in the valley of Brahmaputra."

(ii) Central Indian subsepecies :

Forsyth (1889: 86), Jerdon (1867: 255) and Rudman (1912:104) have given the distribution of swamp deer in central India in the states of Maharashtra, Orissa and Bihar. Brander (1923: 193) visited most of the areas of their occurrence in central India and confirmed their presence in some suitable pockets in Jagmandal, Banjar (now Kanha National Park) and Amarkantak ranges of Mandla district, in sal forests of Balaghat, Bilaspur and Bastar in Madhya Pradesh and in the Bhandara and Chandrapur districts of the neighbouring Maharashtra state. Two isolated herds were also reported by him from near Sarastal, north of Narmada river and another from Sahpura Forest Range in the neighbourhood of Dindori road. The herd of Pachmarhi reported earlier by Forsyth (op. cit. : 192) could not however, be spotted by Brander (op. cit. : 194) and he concluded that it had become extinct. Their presence in Chindwara district could also not be confirmed by him and about their occurrence in sal and the mixed forest, he remarked "...it has been asserted that the barasingha confines himself to sal forests, but this is not so, as he occurs in Jagmandal and in Bandra and South Chanda in ordinary mixed forest."

Forsyth (op. cit.: 86) and Rudman (op. cit.: 103-104) reported a big population of this species in Mandla district near the area which is now known as the Kanha National Park. A countless number of herds had their strongholds in the valleys of Godavari, Mahanadi and Narmada rivers but due to the encroachment by man of their habitats for agricultural purposes there has been separation of herds and then their gradual elimination came through the unrestricted shikar and poaching. The maximum harm has, however, been done by local tribals, the Gond and the Baigas, who killed them mercilessly irrespective of their age and sex. In this context it will be worthwhile to mention about my visit to Bastar in 1973 where the local tribals celebrate 'Parad' festival during the beginning of monsoon when sowing is undertaken. Just before the sowing time or with first shower of monsoon, they keep the seeds of grain in open field and go for mass hunting. The success of their hunting, they say, is a forecast for their prosperity in the coming crop season. It may also be mentioned that immediately before the monsoon, the extreme scarcity of water in the area forces the wildlife to congregate in the vicinity of a few available water holes and shikar by whole of community near these water holes does maximum damage to the wildlife of the area. Almost

all the houses in the interior villages, which I visited, to my great surprise had horns and skins of various animals. The horns and skins were also sold to the visitors by the tribals.

There has been no published record of their presence in the various parts of central India since 1923 till the publication of Schaller's work in 1967. The Forest Department of Madhya Pradesh, however, has maintained an annual record of swamp deer in the Kanha National Park since 1938, when their number in the park was 3023. Schaller (op. cit : 99-101) tried to verify the presence of swamp deer in other places of central India but confirm their presence only in the Kanha National Park where meagre population of about 82 and 55 animals were reported to be present in January, 1964 and 1965, respectively. He estimated the presence of fairly average sized herd of about 100 individuals near Orissa-Madhya Pradesh border and at a few other localities but doubted their presence in the Western parts of Bastar District. A Geological Survey of India party (pers. comm.) reported the occurrence of a small herd around Golapalli—Kistaram road in Palachelma area of South Bastar in the year 1973, but during the two survey tours (one led by the author) conducted by the Central Regional Station, Zoological Survey of India, Jabalpur, in the area, in two different seasons, could not spot any herd. Krishnan (pers. comm.), however, saw a recent cast of swamp deer antler in the house of the Divisional Forest Officer, Kutru (Bastar) in 1973, but unfortunately the officer could only say that it was presented to him by a local tribal after collecting it from the forest of his division. There is as such a possibility of the existence of a small herd in southern Bastar, but it needs further investigation. The author, during the course of his investigations visited other areas from where Schaller (op. cit.: 99-100) had reported their possible existence, but the presence of the species could not be confirmed in any of the pockets mentioned by him.

Except for a very small population in Bastar district which may, however, be wiped out if necessary precaution are not taken, the central Indian swamp deer is at present entirely confined to the small area of the Kanha National Park. According to 1977 census taken by Forest Department in June the swamp deer numbered 283 (Panwar, pers. comm.). It is heartening to note that due to the efforts of the authorities, now in charge of the Kanha National Park, the population has increased four fold in the last 7 years. The lowest figure was 66 in June, 1970.

III. Limiting Factors

Khajuria and Sinha (in press) have studied the limiting factors in the population dynamics of swamp deer. They have brought out altogether 29 limiting factors and their remedies. In addition the following new data have been collected from the Kanha National Park.

1. Apart from the meat and trophy the animals have also been killed for the alleged medicinal value of their antlers. According to Martin (1977: 71), the antler ground to powder form is mixed with the extract of *Euphorbia* spp. and that this mixture has healing power against rheumatism and asthama. The local people say that tnis paste is applied on chest for curing pneumonia also. This treatment for the above diseases is adopted by the tribals as well as other persons of the area.

2. There is a direct competition for the selected species of grasses amongst the grazers. As such some of the grasses grazed by the swamp deer and also by spotted deer etc. are gradually disappearing.

3. Spotted deer population is menace since the creation of the sanctuary in 1879 Due to their fast growth they were controlled by intermittent killiug upto 1952, and their population was kept approximately under 1,000. This population of 1,000 remained constant till 1965. Since then they are increasing at an alarming rate and now they are about 15,000. The growth of population has not reached the saturation point so far. They have also not crossed the limit of carrying capacity of the park but their huge numbers have certainly created the quality food problem.

4. During the advance stage of pregnancy, the sexes remain separate. The separation of sexes at this time of life results in heavy mortality of the individuals of both the sexes. The stag both adult and yearling live separately during the growth of antlers to protect it from being eaten by the pregnant hind.

5. The population of predators specially the smaller ones (wild dog, jackal, fox etc.) is increasing every year. These predators are able to kill up to yearlings of deer. These small predators are probably responsible for heavy mortality of the youngones.

6. The blood sucking flies, *Tabanus striatus* and *T jucundus* grow in large number during the end of summer and early monsoon. According to Sinha and Rane (1979: 549), these flies are responsible for the change in diurnal activity and migration of the species.

7. At birth the fawn is very weak and becomes an easy prey.

8. It has been noticed personally that the recent kills are some times lifted by the tribal people for eating the remaining meat. The predator is thus deprived of its food and so may kill another animal.

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A REVIEW OF CENSUS AND MONITORING TECHNIQUES OF WILD LIFE POPULATIONS AND ORSERVATIONS ON RELATIVE ABUNDANCE OF SOME MAMMALS IN CORBETT NATIONAL PARK

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Abstract

A number of techniques and methods for estimation of population densities of wild life species present in a given area have been suggested by various workers from time to time The techniques and methods are as varied and diverse as they are numerous Following are some of the better known methods/techniques :

i) Territory mapping method.
ii) Drive counts method,
iii) Temporal census method.
iv) Aerial surveys of bounded counts,
v) The King strip method,
vi) Flush radius method,
vii) Total capture method.
viiii) Time area counts method,
ix) Sample or quadrate method,
x) The auditory index method,
xi) Track count method,
xii) Pellet count method and
xiii) Road side count method.

All these methods are discussed briefly, outlining their merits and drawbacks and their applicability to Indian conditions. None of these methods is so elastic as to embrace all groups and all types of habitats (topographically speaking) in India.

At Corbett National Park the authors are engaged in monitoring studies involving 10 species of mammals (also 17 species of birds, six species of reptiles and three species of frogs not dealt within this paper). A resume of observations made during past six months (April-Sept., 1977) is given. Various factors effecting the counts are discussed

It is suggested that in Indian conditions, where large areas embracing varied topography are involved a combination of King strip method/Road side count at absolute densities.

The existance of road in Sanctuaries and Parks in India makes the application of this system easier where the existing roads can be treated as transects or strips.

In conclusion we would like to state that in our experience it is much easier and at the same time equally effective to monitor the relative densities of wild life populations rather than their absolute densities.

I. Introduction

A number of techniques and methods for estimation of population densities of Wildlife species, present in a given area, have been suggested by various workers from time to time. These methods and techniques are as varied and diverse as they are numerous. However, no single technique, so far known, is so elastic as to embrace all groups and all habitats. An essential feature of most of these techniques is a statistical base.

All census techniques aim at a total estimation of populations or determination of absolute densities in a given area. The monitoring techniques, on the other hand aim at the presence/absence and /or relative abundance. In this paper the applicability and practicability of these methods in relation to Indian conditions generally and in specific reference to our studies at the Corbett National Park, are discussed.

Following are the some of the important, established methods and practices for estimation of population :

(i) Territory-mapping method
(ii) Drive count
(iii) Temporal census
(iv) Total capture
(v) Aerial surveys or bounded counts
(vi) The king strip method
(vii) Flush radius
(viii) Time area counts
(ix) Sample or Quadrate method
(x) The Auditery index
(xi) Track counts
(xii) Pellet counts
(xiii) Road side counts.

(i) *Territory-mapping method*

This method has been advocated by Rosene (1957) for game birds like bobwhite quail. The method requires that the area of interest be surveyed repeatedly until the distinct coveys are identified and counted by listing to this morning and noon calls.

As we all know that the game birds are polygamous, it is not possible to assess the number of females accompanying the calling male.

(ii) *Drive count*

This is frequently used for a fair estimation of populations of deer. Morse (1943) advocated this technique for reducing man-power in deer drive census. The method requires two crews of observers, one to drive the area and other to be stationed around the area to count the deer leaving or entering the area. All monitors look in the same direction (e.g. clock-wise) around the boundary and each counts all the deer leaving the

area, and the all entering the area between his post and that of the next observer. The monitor counts are discontinued as soon as the drive crew pass.

The total number of animals is then calculated as the sum of the animals leaving the area ahead of the drive crew and of the animals passing through the drive line. The sum of animals entering the area ahead of the drive crew and the sum of animals passing forward through the drive line are then subtracted from total count to yield the net count.

However, this count is not feasible on account of its impracticability in large areas, like our 'National Parks' and big sanctuaries for unaccurate results, and for the need large number of persons required for driving the area of interest.

(iii) *Temporal census*

This technique is applicable for the migratory animals, using a well defined route, as done in case of the interstate deer herd (Interstate Deer Herd Committee 1950 : 29) which summers in Oregon and winters in California.

As far as in our knowledge goes there is no true migratory species of deer (or any other mammal) in India, therefore, this method is not applicable for the Indian deer at least.

(iv) *Total capture or Extermination*

This method involves capturing or killing of the total population of deer in shooting preserves to eliminate old stock before introducing "fresh" deer. This technique can not yet be used in India as we have no such shooting or cropping preserves.

(v) *Aerial Surveys or Bounded counts*

A technique of aerial surveys was propounded by Erickson and Siniff They (Erickson and Siniff, 1963) carried out aerial surveys of brown bears. Counts were made three times a day on each of the nine days. The total number of the population of the brown bear was then determined by applying the following formula :

$$N = 2n_K - n_{K-1}$$

Where n_K is the highest count and n_{K-1} is the next highest count, and N=total number of individuals in a population.

For Indian conditions these aerial surveys are not advisible, because they are not applicable to the Indian conditions, where the thick and close canopy of forests obliterate the view, with the exception of a few sanctuaries like Nanda Devi.

(vi) *The King-Strip method or the Transect method*

Hayne (1949) was perhaps the first to elucidate this method, in which one walks along a 'census line' or transect, usually a blazed, per-

manet trail through the area of interest and measures the distance between each animal or groups of animals, observed. Principle variants involve the difference in definition the distance perpendicularly from observer to the observation, and differences in methods of calculation of the effective width of strip from the measurements.

Then the estimation of population can be made by applying a relevant statistical formula :

$$\hat{N} = \sum_{obs} 1/Pj = (D/2) \sum_{obs} 1/dj,$$

Where, D=the distance of the side; j=animals persent; dj=proportion between the distance (d) approached by the observer for animals j; and the probability of observing the animals.

If an estimate of total number of animals on the plot, is divided by its area, one obtains an estimate of density by the formula :

$$\frac{\hat{N}}{A} = \frac{Dc}{2A} \sum_{obs} 1/dj = \frac{c}{2L} \sum_{obs} 1/dj,$$

It is identical to Hayne's formula for density (A=DL, C is a conversion factor for units, and L is the length of the transect).

Obviously this method can easily be practised by an educated and trained census worker.

(vii) *Flush radius*

It is generally applicable for the birds. This is direction specific and is defined only towards the of direction approach, in which the probabilities of observing the animals are proportional to the widest part of the pattern. Gates et al. (1968) proposed a statistical distribution for flush distances in a paper dealing with modification of the king method.

They applied the following formula for arriving at their census figures :

$$Pj=g\ (dj\ \ominus j) \text{ or } Pj=g\ (dj, hj)$$

Where, dj=distance from observer to flush point, $\ominus$j=angle of the obsesvation from the line or distance, dj, plus perpendicular distance hj, from flush point to the line.

Then plug Pj into the formula for estimation of population :

$$(\hat{N}) \quad \text{i. e. } \hat{N} = \sum_{obs} 1/Pj$$

This method, obviously, could be followed by a trained field worker well conversant with statistics.

(viii) *Time-area counts*

This method of taking census has been used for the squirrels. In this method the observer sits down at a selected point and counts the squirrels for 30 minutes. The distance to the farthest squirrel seen defines the 'area' of the sample. Then the squirrels seen per 100 acres is calcu-

lated on a cumulative daily basis and the census is terminated when index ceases to fluctuate. Goodrum (1940) used this method for his population studies of the grey squirrel in eastern Texas. Uhlig (1956), who carried out census studies on the grey squirrel in West Virginia, suggested that the counts should be made between 6 and 9 A.M. Other observer have also utilized afternoon counts. This technique provides a good index to estimate squirrel populations.

In our opinion, this method can be successfully applied at least for squirrels and other diurnal, small mammals in India.

(ix) *Sample or Quadrate method*

This method is normally used for the larger areas in which census is desired. A smaller area or a quadrate is marked out in the bigger area at random. A thorough count is then carried out in the quadrate. This can be accomplished either by dividing the quadrate into a number of transects (the width of the transect depending on the visibility factor) and working out all the transect at the same time by employing a number of observers or by drive counts of the whole quadrate. Tyson (1952) presented an estimate of total deer population from drive counts on a sample of plots. This was done by dividing the total area (universal area) into sampling units of smaller or i^{th} area. He calculated the total population by applying the following formula :

$$T = \Sigma \quad Y^{i}$$

Where Y^{i} = the number of individuals over i^{th} area, i.e., the sample; and T = total count of individuals over the universal area.

This method is one of the most commonly used and applied methods. Fundamentally, it is based on the fact that smaller the unit lesser the errors. And it can also be successfully applied to vast areas with varied vegetations and topography.

(x) *The Auditory index*

A fair estimate of the bird population can be made by listening to the calls (normal, mating or alarm) of different species, at different times of the year, e.g., estimation of a spring population of a species.

A number of workers in the past have made use of this method.

Stoddard (1931), McClure (1939), Kimbal (1949), Bennitt (1951), Petreborg et al. (1953), Hungerford (1953), Kozicky et al. (1954), Foot et al. (1958), Wight and Baysinger 1963) to quote a few, have given their own designs for this method.

The design given by the last two forms the basis for the current management routes or transects. In general, the index is standardized as to the selection of route, starting and stopping time, number of listening stations per route, duration of time and season of the year at which

the index is determined. This technique is widely used for determining the management indices for quails, doves, pheasants and wood cocks.

(xi) *Track counts*

Estimation of population by counting fresh tracks have also been attempted. Tyson (1952, 1959) attempted to model the counts of tracks as a population index of deer. He assumed that the deer bed is essentially the same place on successive days and that nightly activity is confined to a "range" of travel, D.

He calculated the deer per sq. mile (Y) by applying the formula :

$$Y = 4N/D^2 = t/D$$

Where 4N=total tracks; N=total deer; $D^2/4$=area of circle; D= circumference of circle. Thus, trcks per mile t=4N/D.

Although, this derivation is not very satisfactory, yet it has got a fair validity. Anyway, this technique can be applied at least to the areas where the ground is impressionable enough to permit the marking of tracks. It becomes inoperative in areas of thick forest, undergrowth, long grass, scrub and hard ground, all of which hinder observation of clear and full tracks. Unfortunately most of our Sanctuaries and National Parks areas fall in these categories.

(xii) *Pellet counts*

A reasonable population figure in an area can be arrived at by counting the pellets of a particular spccies.

This method has been used for a variety of species, e.g. deer and other larger ungulates, rabbits, small mammals, and also some gallinaceous birds. Application of this is as follows :

A number (n) of plots are marked in such a manner that the study area is adequately represented. Then the number of pellet groups is counted in each plot. The population index is then arrived at by applying the following formula :

$$\text{Pellet groups per unit area (t)} = \frac{(1)}{na'} \Sigma Y = \frac{1}{a} \Sigma Y$$

Where ΣY = sum of groups counted over all 'n' plots; a' = area of one plot and a = na' is the area of entire sample.

Eberhart & Etten (1956) evaluated the Pellet count technique as a deer census method and found it satisfactory.

This method can be adopted in areas in which the preservation of Pellet group is optimal or its rate of disintegration can be worked out fairly accurately under various weather conditions the year round. The most recent use of this technique, in India, was made for Barasingha by Claude Martin (1977) (Ecology and Status of Barasingha *c.d. branderi* in Kanha National Park, in M.P., India, but his concentration was more in respect of the correlation of the sympatric species than towards census.

(xiii) *Road side counts*

The easiest and most wide spread method of working out indices of relative densities of populations is perhaps the method of counting the numbers seen while travelling along a particular road in the working area, periodically. This technique can be applied and is being applied for large areas for obtaining trend indices. Greeley et al. (1962) used this technique to obtain estimates of the abundance of the main game species.

The principal operation of this technique is that the country roads are traversed for the specific purpose of counting the number of individuals of the species being censused, which is then related to the number of kilometres travelled, e.g., in case of rabbits, if a 20 km census route was driven or travelled, and 10 rabbits seen, the census index would be given as 0 5 rabbit per kilometre.

Newman (1959) stated that investigators who ignore the factors like—activity of the animals as affected by hour of day, food-supply, weather, and condition of road-side cover, are getting or obtaining useless informations.

Dasmann and Taber (1956) have discussed in detail the seasonal variation in habits, visibility, sex, age, etc. of black-tailed deer. Howell (1951) combined features of several methods to develop a road-side estimate of considerable promise for birds.

It is thus apparent that none of these techniques is a standard one or universally adopted. Some special standardizations are required for each technique depending upon the area to be surveyed and the particular type of investigation.

It is opined that the road side count technique can be usefully applied for estimation of total or relative densities of animal populations in Sanctuaries and National Parks, in India, where the roads are present and are well maintained. These roads should be taken as transects of King-strip method. For greater accuracy this method should be used in combination with the Sample or Quadrate method.

II. Observations in Corbett National Park

At present, we are engaged in the study of "Impact assessment of Bio-Ecological changes in the faunal patterns (selected groups) brought about by the partial submersion of Corbett National Park as a result of Ram Ganga Multi-purpose Hydel Project Dam; especially in the areas contiguous to the proposed water line" The intensive study area (Figs. 1 & 2) of more than 100 sq km comprises a savanah type grassland and the evergreen deciduous forest dominated by the Sal *(Shorea robusta)* trees. It has been divided into three observation stations, i.e. I, II and III, manifested with eleven observation roads, i.e. IA, B, C, D; IIA, B; and

STUDY AREA

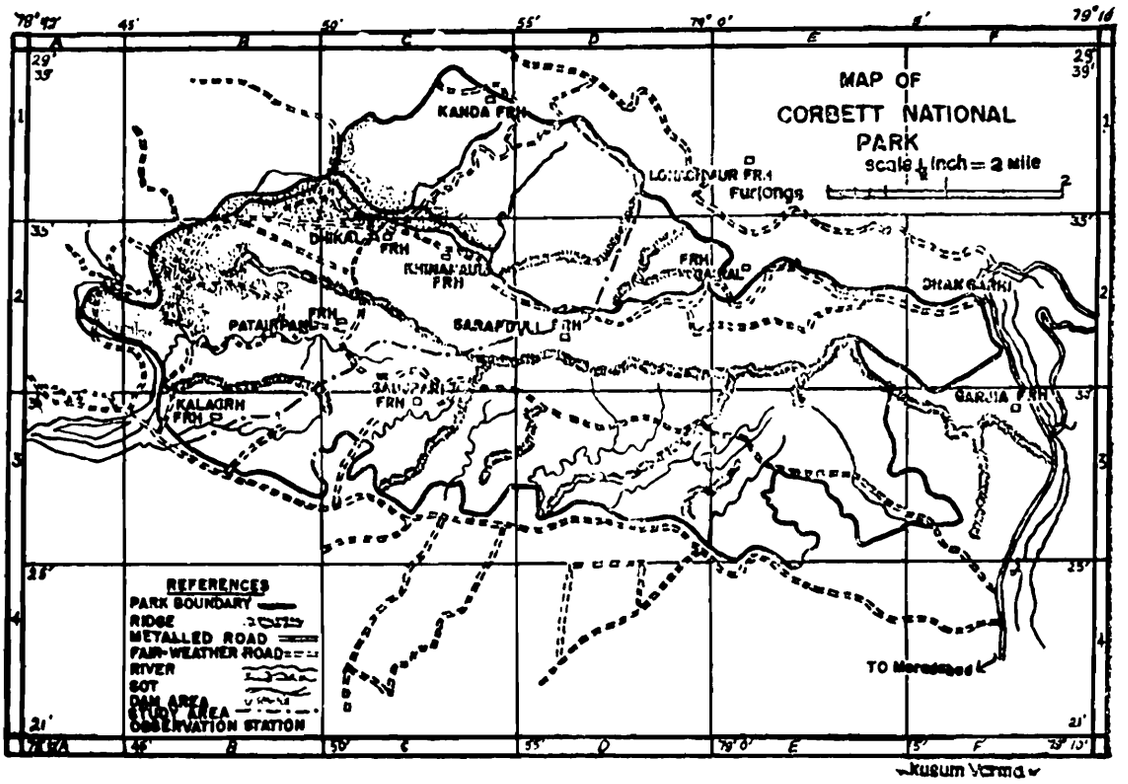

Fig. 1

INTENSIVE STUDY AREA

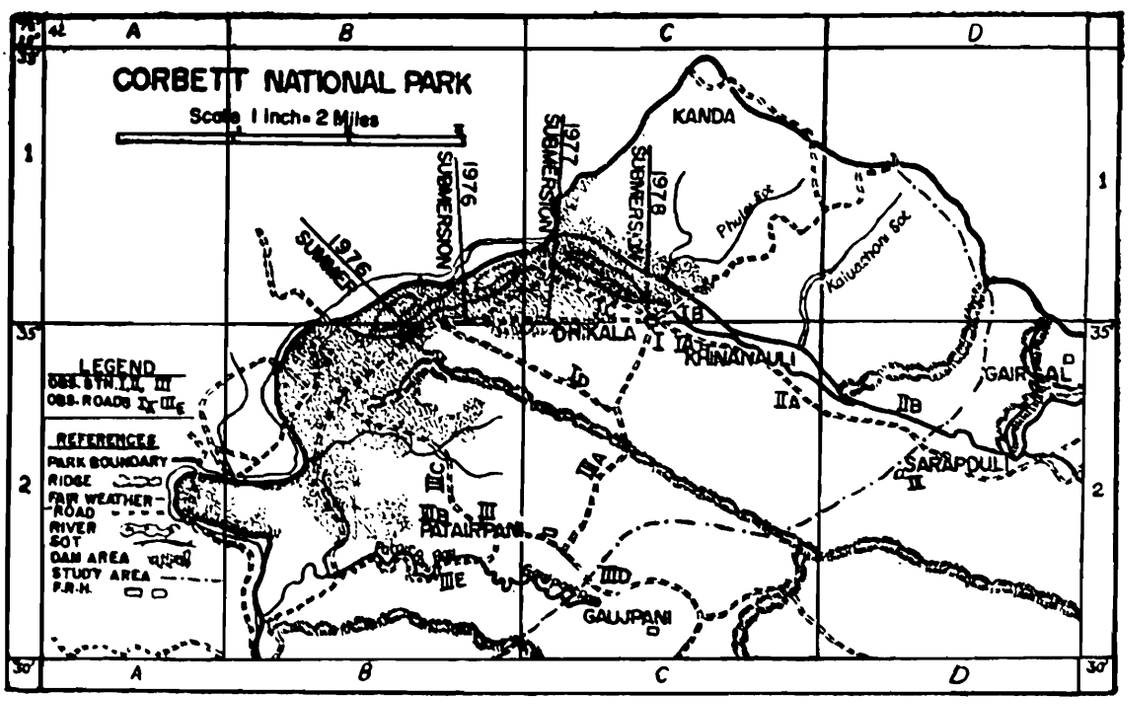

Fig. 2

III A, B, C, D, E (Fig. 2). Observations are made along each road for a scheduled time in each month (e.g., five days in a month). Daily observations are made twice a day, i e., in the forenoon and afternoon and the observation hours are three-hours in the mornig (starting half an hour before sun-rise) and three-hours in the evening (terminating about half an hour after sun-set). The observations are made throughout the year but it has been our experience that the best time for working out indices is from February to June when the visibility is at the optimum.

Ten species of mammals, 17 of birds, six of reptiles and three of frogs have been selected as indicators. Counts of individuals of these selected species are made along the observations roads while going up and down. The larger number of the counts made during the up and down journies is taken into consideration, e.g., if we observe ten individuals of a species while going and fifteen while coming back, along the same observation road, the latter number is taken into account, so as to have an optimum estimation for that species over a certain distance travelled.

Here, in this paper, an attempt is made to present the results of monitoring done for six months in the year 1977, for ten selected species of mammals (Table 1). The relative abundance or monthly percentage of each selected species, in relation to the other nine is shown in Table 2, and Table 3 shows the size of the largest herd of *Axis axis* and *Elephas maximus*, observed at monthly intervals for the year 1977.

Only two species were monitored the year round. These species are *Axis axis* and *Elephas maximus*. The monitoring was done mainly to ascertain the herd-formation patterns in the said species. The results are tabulated in Table 3.

To evaluate meaningfully the population dynamics of any group of wildlife in a given area, monitoring or census figures for at least two to three successive years, with monthly data are needed, yet from the monitoring figures for six months in a single year (Table 1) we find that we are able to analyse a number of behavioral aspects of the species observed. Before proceeding any further it must be noted that there are three main factors which vitally affect the monitoring process, i.e. visibility, time or the observation hours and the area of interest. In our observations the first factor, i.e., visibility was variable, while the latter two factors were constant.

It will be clear from Table 1 that the monthly average for most species falls from July onwards when visibility becomes poor.

The reduction in the monthly average figures from 13.75 in April to 4 0 in September for *Macaca mulatta* and for *Presbytis entellus* it fall from 14.63 in April to 4.75 in June, and again goes up or rises upto 40 in September. It can not, however, be explained by variability in visibility.

Table 1—Results of monitoring of ten selected mammalian species observed during April to Sept. 1977 in Corbett National Park.

Sl. No.	Species	April			May			June			July			August			September		
		Period of observation (in days)	Number of individuals observed	Average	Period of observation (in days)	Number of individuals observed	Average	Period of observation (in days)	Number of individuals observed	Average	Period of observation (in days)	Number of individuals observed	Average	Period of observation (in days)	Number of individuals observed	Average	Period of observation (in days)	Number of individuals observed	Average
1.	*Macaca mulatta villosa*	16	220	13.75	13	177	13.61	5	75	15.0	3	18	6.0	3	26	8.6	1	4	4.0
2.	*Presbytis entellus schistaceus*	11	161	14.63	6	68	11.33	4	19	4.75	3	48	16.0	2	25	12.5	1	40	4.0
3.	*Canis aureus*	8	11	1.37	10	21	2.1	10	20	2.0	1	1	1.0	5	10	2.0	1	1	1.0
4.	*Elephas maximus*	11	211	19.18	18	531	29.5	7	202	28.8	1	7	7.0	2	12	6 0	–	–	–
5.	*Axis axis axis*	15	2571	171.4	13	1690	130.0	7	649	92.71	3	1433	477.7	3	1433	477.7	3	37	12.3
6.	*Axis porcinus porcinus*	12	40	3.3	11	26	2.36	8	20	2.5	1	3	3.0	3	15	5.0	1	3	3.0
7.	*Cervus unicolor unicolor*	15	47	3.13	14	53	3.78	7	24	3.42	1	3	3.0	1	2	2.0	–	–	–
8.	*Muntjacus muntjak vaginalis*	12	26	2.16	15	25	1.6	8	15	1.87	1	2	2.0	1	1	1.0	–	–	–
9.	*Sur serofa cristatus*	12	54	4.5	25	91	3.6	11	46	4.18	1	3	3.0	–	–	–	–	–	–
10.	*Hystrix indica*	6	9	1.5	12	17	1.4	3	3	1.0	1	1	1.0	2	3	1.5	–	–	–

Table 2. Relative abudance (percentage) of ten selected mammalian species, observed in Corbett Notional Park during April to September, 1977.

S. No.	Species	April	May	June	July	August	September
1.	*Macaca mulatta villosa*	6.56	6.55	6.98	1.18	1.70	4.70
2.	*Presbytis entellus schistaceus*	4.80	2.51	1.77	3.15	1.63	47.0
3.	*Canis aureus*	0.02	0.7	1.86	0.06	0.65	1.17
4.	*Elephas maximus*	6.29	19.67	18.82	0.46	0.78	0.00
5.	*Axis axis axis*	76.74	62.61	60.48	94.33	93.84	43.52
6.	*Axis procinus porcinus*	1.19	0.96	1.86	0.19	0.98	3.52
7.	*Cervus unicolor unicolor*	1.40	1.96	2.23	0.19	0.13	0.00
8.	*Muntjacus muntjak vaginalis*	0.77	0.92	1.39	0.13	0.06	0.00
9.	*Sus serofa cristatus*	1.61	3.37	4.28	0.19	0.00	0.00
10.	*Hytrix indica*	0.17	0.62	0.27	0.06	1.19	0.00

Table 3. Largest herds of *Axis axis axis* and *Elephas maximus* observed at monthly interval during 1977, in Corbett National Park

Species	Jaunary	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
A. a. axis Erleben.	40	60	98	200	200	171	400	526	11.0	22.0
E maximus Linnaeus.	9	6	14	38	38	72	7	7	5*	1†

That is perhaps due to some sort of local movement on account of fruiting in the adjoining areas, which are yet to be investigated.

Again the same can be said for *Elephas maximus*, in which case the monthly average falls from 19.18 in April to almost nil in September.

In the case of deer and wild boars the monthly average fluctuates according to the season and comes down from 171.4, 3.3, 3.13, 2.16, and 4.5 in April to 12.13, 3.0, nil, nil and nil in September, for *A. axis*, *A. procinus*, *C. unicolor*, *M. muntjak*, and *S. scrofa*, respectively.

The principle variation or the reduction in number occurs with the detoriation of visibility. The only exceptions to this pattern are *A. axis* and *A. procinus*. Their average rises suddenly up to the 477.7, 477.7 and 3.5 in July and August respectively and comes down again in September. The reason being that during July-August their populations come out of the dense grass and jungle into the clear grassy areas in the river bed etc. where new grasses come up after rains and thus showing up in increasing number. By August end or early September these clear areas of river bed are inundated by the rising of the dam water and the deer populations are pushed back into the thick cover thus reducing the visibility and hence the average. For a clear picture reference may be made to Table 3.

*Fresh tracks were observed of a small herd of about five individuals.

†Fresh tracks of a lone elephants were observed.

Another factor which affects the averages greatly is the availability of food. Restricted and patchy availability of food results in formation of larger herds in such areas where the food is in abundance. When the food is available evenly throughout the area it causes dispersal, i.e., disintegration of larger herds into smaller ones.

After making such observations/monitoring for a couple of years, it will be possible to calculate the seasonal indices for these species, and analyse statistically the populations of the selected species.

In conclusion we would like to state that in our experience it is much easier and at the same time equally effective to monitor the relative densities of Wildlife populations than the absolute densities of different species in a large and diverse area like the Corbett National Park.

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INDIAN BIRDS THREATENED WITH EXTINCTION : SOME SUGGESTIONS FOR THE CONSERVATION OF

By

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Abstract

By virtue of its location in the tropics, its vast undulating plains and plateaus, its mighty mountain and sub-mountain ranges covered with a variety of rich forests, its large river systems and vide deltas, India has been endowed with one of the richest and most varied exotic bird life. In the past seventy five years or so the socio-economic and sociopolitical pressures emanating from population explosion and ensuing execution of development plans have gradually eroded the habitat of a number of endemic bird species. As a result the following species have been greatly reduced in numbers :—

1. The Himalayan Bearded Vulture or Lammergeier, *Gypaetus barbatus aureus* (Hablizl),
2. The Pinkheaded Duck, *Rhodonessa caryophyllacea* (Latham),
3. The whitewinged Wood Duck, *Cairina scutulata* (S. Muller),
4. The Chir Pheasant, *Catreus wallichii* (Hardwicke),
5. The Great Indian Bustard, *Choriotis nigriceps* (Vigors),
6. The Mountain Quail, *Ophrysia superciliosa* (J.E. Gray),
7. The Nicobar Megapode, *Megapodius freycinet nicobariensis* Blyth,
8. The Monal Pheasant, *Lophophorus impejanus* (Latham),
9. The Tragopan Pheasants,
   (i) *Tragopan melanocephalus* (J.E. Gray),
   (ii) *T satyra* (Linnaeus)
   (iii) *T blythii* (Jerdon)
   (iv) *T temminckii* (J.E. Gray)
10. Elwes's Eared Pheasant, *Crossoptilon crossoptilon harmani* Elwes,
11. Jerdon's or Double banded Courser, *Cursorius bitorquatus* (Blyth),
12. Great Pied Hornbill, *Buceros bicornis homarai* Hodgson,

Infact nothing has been heard of Pinkheaded Duck, Jerdon's Coarser and Mountain Quail for the past 40, 60 and 100 years respcetively. In all probability they have crossed the point of no return. However, India is a vast country and a remote possibility of a few individuals surviving in some obscure part of their habitat, still exists. A thorough and well planned search should be made before giving them up as 'gone for good'. It found, modern scientific techniques to be applied for their revival and dispersal are detailed.

Fortunately for all these threatened species their habitat has not been totally destroyed. Some of the species like the pheasants can be successfully reared in captivity and released in their former habitats from which they have disappeared. This coupled with a system of involving local population in the conservation programmes by offering a share in the game revenues is likely to bring the species back to abundance.

Other species like the Himalayan Bearded Vulture, the Whitewinged Wood Duck, the Great Indian Bustard, the Great Pied Hornbill and Norcondam Hornbill can easily be revived by a strict enforcement of conservation (total protection from shooting and killing) measures over a number of years. Given adequate freedom from interference and prosecution one and all of these species can revive and spread normally, in their natural habitat which still exists through greatly reduced in size

I. Introduction

Since the first quarter of the twentieth century the socio-economic pressures have been building up in India at a very rapid pace which has resulted, among other things, in greater exploitation of forest and mineral resources and a large scale deforestation for providing more land for agriculture. With the clearing up of the forests and eradication of marshes and wet lands the habitat of wild birds went on shrinking. They were gradually pushed on to comparatively unproductive patches of their habitat where they were faced with scarcity of food and water. This has resulted in their foraging in the neighbouring agricultural lands, where shorn of their protective cover they were exposed to the greedy poacher. Millions were killed every year for flesh and feathers and thousands were trapped for the table, export or pet trade. At the same time their shrunken habitat has impared their breeding activity and hence their population growth rate. As a result the populations of wild birds gradually went down. So much so that at present the following species are in a rather precarious conditions and it is feared that further reduction in their numbers may result in their total extinction :

1. The Himalayan Bearded Vulture or Lammergeier, *Gypaetus barbatus aureus* (Hablizl).
2. The Pink headed Duck, *Rhodonessa caryophyllacea* (Latham).
3. The Whitewinged Wood Duck, *Cairina scutulata* (S. Muller).
4. The Chir Pheasant, *Catreus wallichii* (Hardwicke).
5. The Great Indian Bustard, *Choriotis nigriceps* (Vigors).
6. The Mountain Quail, *Ophrysia superciliosa* (J. E. Gray)
7. The Nicobar Megapode, *Megapodius freycinet nicobariensis* Blyth.
8. The Monal Pheasant, *Lophophorus* impejanus (Latham).
9. The Tragopan Pheasants,
   (i) *Tragopan melanocephalus* (J.E. Gray).
   (ii) *T satyra* (Linnaeus).
   (iii) *T blythii* (Jerdon).
   (iv) *T temminckii* (J.E. Gray).
10. Elwe's Eared Pheasant, *Crossoptilon crossoptilon harmani* Elwes.
11. Jerdon's or Double Banded Courser, *Cursorius bitorquatus* (Blyth).
12. Great Pied Hornbill, *Buceros bicornis homrai* Hodgson.

1. Himalayan Beared Vulture or Lammergeier, *Gypaetus barbatus aureus* (Hablizl).

An eagle-like vulture, was fairly common in Himalayas from Ladakh in Kashmir to N.E. Assam between c. 1200 and 4000 metres. It was also recorded from N. Cachar hills.

The bird normally roars at considerable heights above the mountain slopes and valleys in a vulture-like fashion with a loud droning of wings at a lower height. Large bones are the normal diet of this bird. The bones are picked up in the claws, are carried upto a considerable height and dropped upon the rocks below. The bones thus dropped break down into small pieces. These small pieces are then consumed by the bird. Same spot is normally used for dropping the bones day after day. This habit has helped the hunters to locate the bird.

This handsome vulture has gone down in numbers because of the belief of the hill people in the medicinal qualities of its flesh. They are hunted near their feeding areas as well as from their nests. As a result its population level is sinking year by year.

2. Pinkheaded Duck, *Rhodonessa caryophyllacea* (Latham).

This bird has not been recorded since 1935 when C.M. Inglis reported it from Darbhanga, Bihar in the month of June. About 180 years back when it was first described, it was reported from Assam, Manipur, Bengal, Bihar and Orissa. Later it was recorded from Lucknow (U.P.), Rupar (distt. Punjab), Delhi, Mhow (M.P.), Ahmadnagar (Maharashtra), Nellore (Andhra) and Pulicat lake (Tamil Nadu).

Known to be timid and shy this duck inhabited patches of tall grass around the ponds and lakes in the countryside. Due to increasing human population and the resultant demand of agricultural land the natural habitat of this species has been destroyed. This species is considered to be extinct now.

3. Whitewinged Wood Duck, *Cairina scutulata* (S. Muller).

This bird was resident in Assam and Manipur upto 900 metres. Like the Pinkheaded Duck it lived in patches of tall grass (grass jungles) around ponds and lakes. This species too has suffered like the preceeding one. But fortunately it has not gone extinct.

4. Chir Pheasant, *Catreus wallichii* (Hardwicke).

This species is known to be a resident of Himalayas between 1400 and 3500 metres altitude from Kashmir through Punjab, Himachal Pradesh to Garhwal and Kumaon. It is also reported from West Nepal.

It inhabits steep and rugged hillsides in oak forests which are covered with long grass and Berberis scrub. It keeps in coveys of 5 or 6 which feed on the open hillside well hidden in the undergrowth. When chased, it hurtles down the 'khud' at a terrific speed.

The bird remains silent during the day time but becomes very noisy before retiring for the night and also just before the day break. When it can be heard from a distance and thus becomes vulnerable to the

poachers. As a result of poaching and shrinking habitat the population of this species has gone down considerably. About 20 years back its distinctive call in the morning and evening was a familiar sound in its habitat. Nowadays one has to cover many miles to hear it.

5. Great Indian Bustard, *Choriotis nigriceps* (Vigors).

Nearly hundred years ago this bird was very widely distributed in India. But at present it is restricted to remote areas of Rajasthan, Gujarat and Maharashtra only.

It is found in the parties of 5 or 6. One male may have 3 to 5 hens. The bird is extremely shy and wary normally but has a queer habit of hiding behind a bush rather than take to wing when disturbed. It hardly bothers about approaching jeeps and camels which are extensively used by poachers for its decimation. Hence the steep decline in its numbers. This rapid reduction has been further supplemented by rather slow rate of reproduction. Normally only one egg is laid, rarely two. Eggs are laid on the ground near the base of a bush open to destruction from marauding house crow.

6. Mountain Quail, *Ophrysia superciliosa* (J.E. Gray).

Mountain Quail was, for the first time reported by J.E. Gray in 1846 from Mussoorie. Only ten skins of this species exist which lie scattered in various world museums. All of these came from a small area in Western Himalayas above Dehra Dun between Jharipani and Mussoorie (1650-2100 metres elevation) and Sher Ka Danda near Nainital. The last specimen of this species was in fact collected at Sher Ka Danda in 1876. Some attempts made in the past to rediscover this bird have been unsuccessful. Thus it has been presumed that the species has gone extinct. This species was known to occur in coveys of 5 or 6 birds, in long grass and scrub on steep hillsides. It was known to be a very shy bird, extremely reluctant to fly. It kept under cover most of the time and flew only when about to be trampled. With such habits it would not be surprising to come across a few of these birds in some remote slopes if a proper search is made.

7. Nicobar Megapode, *Megapodius freycinet nicobariensis* Blyth.

This bird was fairly common in the Nicobar group of Islands lying north of Sombrero channel except Chowra and Car Nicobar.

This species lived in pairs or in fairly large mixed parties or droves of adults and young. The eggs are laid, possibly by several females, in the same mound since as many as 20 have been recorded from a single mound. The eggs are said to be excellent eating when fresh, and are greedily gathered by the natives for eating. It seems that the mass destruction of the eggs has reduced this species to a stage of extinction.

8. Monal Pheasant, *Lophophorus impejanus* (Latham).

Resident in the Himalayas from Kashmir to Bhutan from where *L. selateri* Jerdon takes over up to Luhit district, Arunachal Pradesh between *c.* 2600 and 5000 metres.

The Monal is largest and most spectacular of all the Himalayan pheasants. It is met with singly or in parties of 3 to 4 birds with one male and 2-3 females. Found near the snow line this pheasent has, from the times immemorial been hunted for the brilliantly coloured crest of the male and of course the flesh. As a result the numbers of this once abundant pheasant have decreased alarmingly more so of *L. sclateri* the Mishmi Hill race.

9. Tragopan Pheasants :

Tragopan melanocephalus (J.E. Gray).

This species occurs from Kashmir through Himachal Pradesh to Garhwal seasonally between *c.* 1,350 (winter) and 3,600 metres altitude and normally breeds above *c.* 2,400 metres.

T satyra (Linnaeus)

This species has been recorded from Garhwal, Sikkim, Nepal, Bhutan and adjoining parts of Arunachal Pradesh, western and eastern limits, as presently known are roughly the Alaknanda river in Garhwal (*c.* 79°30'E) and Darrang north of Brahmaputra river in Assam, between 2,400 and 4,250 metres elevation. It comes to *c.* 1800 metres in severe winters.

T blythii (Jerdon)

Blyths Tragopan has been reported from Assam south of the Brahmaputra river in the Patkai, Naga, and Barail hill ranges, Manipur and Mizoram (Lushai Hills) from 1800 metres upwards.

T temminckii (J.E. Gray)

This Tragopan has been reported from Luhit district, Arunachal Pradesh (Mishmi Hills, upper Dibang and Tsangpo valleys, etc.), between *c.* 2,100 and 3.500 metres aititude.

All the four species have habits more or less common to the genus. The birds are seen singly or in pairs, sometimes small family parties are met with in non-breeding season. During breeding season the males become noisy. They call throughout the day, more so in the mornings and evenings, often sitting in an exposed position. This habit has cost very dearly to these pheasants since the poachers can get at them easily during this period. Their habitat too has been shrinking gradually under socio-economic pressures. As a result the numbers of all these species has gone down considerably in the twenty five years or so.

10. Elwes's Eared Pheasant, *Crossoptilon crossoptilon harmani* Elwes

It occurs in extreme northern fringes of the Siang and Subansiri districts of Arunachal Pradesh, normally between 3,000 and 5,000 metres altitute.

These birds are found in flocks of 5 to 10 in dwarf rhododendron jungle. They come out in the grassy clearing to feed. They are reluctant to fly but when disturbed or flushed fly into a tree. They have been hunted for flesh.

11. Jerdon's or Doublebanded Courser, *Cursorius bitorquatus* (Blyth)

This species was recorded in 1848 from Andhra Pradesh where it was known to occur in a limited area in Panner and Godawari valleys. The birds inhabited rocky undulating ground within forest and the scrub. Last authentic record of this species was made in 1900. Since then thorough searches by competant ornithologists have failed to reveal the presence of this bird in its former habitat.

12. Great Pied Hornbill, *Buceros bicornis homrai* Hodgson.

The Great Pied Hornbill enjoys a wide distribution. It is found in Western Ghats complex from about Khandala (18'N, 74'E) in Maharashtra, through Goa, Western Karnataka, Western Tamil Nadu (Nilgiri and associated hills), Kerala, in the South. A disjunct population is met with in the lower Himalayas from Kumaon through Nepal, Sikkim, Bhutan, Assam, Nagaland, Manipur and Mizoram from plains level to 1500 metres in the Ghats and to 2,000 metres in Himalayas.

This bird is found in pairs or small parties of 3 to 5, covers enormous feeding circuits in the course of the day and is remarkably punctual in its visits to the various feeding and roosting trees. It follows the same route day after day which makes it vulnerable to poachers and shikaries. The flesh is valued for its taste and medicinal properties. Even the female and young are taken out of nest by the local tribals. Its flesh was considered "for superior to any fowl or pheasant" even by the Europeans. An increasing destruction of its native habitat has taken a heavy toll of its once abundant population.

II. Measures suggested for Conservation

It is already too late, perhaps, to do anything for :

1. The Mountain Quail (Last reported 100 years back)
2. The Jerdon's Courser (Last reported 60 years back)
3. The Pinkheaded Duck (Last reported 40 years back)

These birds have not been reported for the past 40 to 100 years. In all probability they have crossed the point of no return. However before giving them up for good one last effort should be made to comb their likely habitats thoroughly by setting up nets/traps and beating the likely patches to flush the birds into nets/traps for live capture. The birds if captured should be ringed/tagged or harnessed (transmitter harness, telemetry technique) for subsequent observations. The areas from which the birds are captured, if at all, should be sealed off (as far as possible), to minimise further interference. Food troughs should be provided in such

areas and the predators should be controlled and their absolute or relative densities should be monitored periodically by capture/recapture methods and or by actual counts. If after a period of time, the numbers increase, some birds may be captured and transfered to specially designed breeding farms, preferably in the habitat itself. The designs of such farms should be based on the breeding behaviour as observed during a few years of study. If and when the birds start breeding successfully the out flow/the surplus should be released in such likely patches of habitat which have escaped destruction.

Fortunately the conservation prospects for the other species are not so bleak. The habitats of the pheasants have not been destroyed totally. Most of these pheasants can and have been breed in captivity. All that is required is to set up breeding farms and then release the birds in their natural habitats. This restocking effort has to be coupled with strict conservation enforcement and the education of local people. The local population has to be told not only of the aesthetic values of conservation but also of the economic returns, this natural resource can bring them by way of shooting fees etc. if handled at village level by Panchayats. Efforts should be made to involve the village level populations in the conservation programmes.

For the species which do not or can easily be made to breed in captivity like the Great Indian Bustard, the Nicobar Megapode, Great Pied Hornbill and Himalayan Bearded vulture, the best procedure seems to be a stricter enforcement of conservation laws in such pockets of their original habitat where sizeable populations still exist. It is true that their natural habitat has shrunk greatly but luckily it has not been destroyed totally. Given adequaete freedom from interference and persecution one and all of these species can revive and spread naturally.

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VEGETATION OF PERIYAR WILD LIFE SANCTUARY, KERALA, AND ITS ROLE IN NATURE CONSERVATION

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Abstract

The rapid destruction of forests which has resulted in the dwindling of wild life and destabilisation of microclimate is causing great concern. The Sanctuaries/National Parks are the prime centres, best suited for nature conservation and the literature on these areas has been reviewed for a better understanding.

The Periyar Wild Life Sanctuary, situated in Southern-Western Ghats is one of the most potential sanctuaries in India with its combination of evergreen and deciduous forests, savannahs and a lake. A synopsis of the location. toporaphy, climate, rainfall, history, vegetation and the interdependence of the flora and fauna of the sanctuary are presented. The salient features of the vegetation are typical of the Southern Western Ghats. The high incidence of endangered plants and the wide range of the animals conserved, *in situ* here, make this as one of the national treasures.

The luxuriant vegetation of the Sanctuary has a very vital influence on the climate and rainfall and in arresting the environmental deterioration. The selection of this Sanctuary and other allied areas as biosphere reserves will put nature conservation in India on a sound footing

I. Introduction

Nature conservation is one of the important burning problems facing the country today. The great concern now is, the rapid destruction of forest areas due to the increasing industrialisation and population. The indiscriminate felling of trees and destruction of forests have destablished the micro-climate, rainfall and ground water pattern. Hence, nature conservation is intimately associated with the survival problem of man himself. When we turn our attention to the conservation programmes, our first thinking goes to the Sanctuaries/National Parks, which are the prime centres where one or several ecosystems are not materially altered by human exploitation and occupation. They also depict areas of special scientific, educative and recreative interest where plants and animals live in perfect harmony. In addition to this, these areas are located in the most significant geographical areas of the country and these are the storehouses of botanical wealth and also harbour a wide range of species of animals. Apart from their aesthetic qualities and scientific importance the main concern on these areas is two-fold : (1) to preserve the forest types along with the fauna which are threatened with the danger of ex-

tinction, and (2) vital function which they perform in influencing the climate and rainfall of the country.

Vegetation with its varied floral contents is a basic entity of nature and this is not given proper attention. Krishnan (1971: 531) remarked that "even in the conferences of the national and state Wild Life bodies, the term 'wild life' is still used mainly to connote the larger wild mammals, or at times these along with birds and few other animals, and the flora is considered something quite distinct, a mere setting, at best" The paucity of scientific data on the vegetation, the current growing awareness of rapidly changing environment, and the close interaction of vegetation with animal life which remains un-emphasised make the botanists of Botanical Survey of India to launch exploration programmes to study the vegetation of Sanctuaries/National Parks which is a pre-requisite for any other detailed study. In recent years, either preliminary or detailed accounts, on the flora of Krishnagiri National Park, Maharashtra (Santapau and Randkeria, 1955:185 to 200); Kanha National Park, Madhya Pradesh (Maheshwari, 1963:117 to 140); Pakhal Wild Life Sanctuary, Andhra Pradesh (Sebastine and Henry, 1967:304 to 311); Bandipur Wild Life Sanctuary, Karnataka (Naithani, 1967:252 to 263); Point Calimere Wild Life Sanctuary, Tamil Nadu (Sebastine and Ellis, 1967:190 to 200), and Corbett National Park, Uttar Pradesh (Pant, 1976:287 to 295) came to light. In addition to this, exploration part in Neyyar and Vazhani, and Peechi Sanctuary of Kerala; Vedanthangal Water Bird Sanctuary, and the Guindy National (Deer) Park and Mudumalai Wild Life Sanctuary of Tamil Nadu has been completed. The works of Gee's (1952:1 to 17) 'The Management of India's Wild Life Sanctuaries and National Park's; Croix's (1960:618 to 634) 'Some Notes on Sanctuaries and Wild Life in South India (1959)'; Spillet's (1968:633 to 663): 'A Report on Wild Life Surveys in South and West India'; Sankhala's (1970:27 to 31) 'Conservation, not Exploitation' and Waller's (1972:574 to 590) 'Observations on the Wild Life Sanctuaries of India' enriched the knowledge on these areas.

II. Periyar Wild Life Sanctuary

The Periyar Wild Life Sanctuary is situated on the Southern Western Ghats, in the Idukki District of Kerala, adjoining Tamil Nadu, and lies between 9° 17′ and 9° 37′ N and 76° 56′ and 77° 25′ E. This is one of the most splendid Sanctuaries in India both scenically with its combination of a lake, evergreen and deciduous forests, grasslands and zoologically as a viable eco-unit having an area of 777 sq. kms., varying in elevation from 800 to 1,800 metres. Waller (1972:580) aptly pointed out (excerpts from a report submitted to I.U.C.N. and W.W.F.) that, "it holds the greatest potential of all India's Sanctuaries for a future first class National Park... ..It is the largest of all Indian Parks or Sanctuaries

and approaches nearest to the requirements of a true National Park." The topography of the Sanctuary is generally undulating and typical of Western Ghats particularly towards east and south having an altitude of more than 1,400 metres. The conspicuous peaks are the Pachamalai, Vellimalai, Sivagirimalai and Sundaramalai. The Periyar River originating from the Sivagiri Hills flows towards north and the Periyar lake is formed by the construction of a dam. The lake has an area of 26 sq. kms., and 31 kms. length, and its maximum depth is 46 metres. The area has a moderate climate throughout the year except for the summer months. The rainfall is generally heavy since the area is benefitted by south-west and north-east monsoons. The average annual rainfall is about 1,720 mm and the quantum is increased towards west, particularly in Sabarimalai side.

In the beginning Periyar project was started as an irrigation project and the dam was constructed about 1897 to divert the montane river Periyar which is emptying itself into the western sea to the vast tract of barren plains of Madurai District, Tamil Nadu. Subsequently this project was converted into an irrigation-cum-hydro-electric one. Krishnan (1971:514) in his ecological survey of mammals of India, pointed out, "It was never intended as a Sanctuary, *ab initio*" Only in the year 1933, the then Maharaja of Travancore and his Government appointed Mr. S.C.H. Robinson as the first Game Warden for the preservation of Wild Life in the forest of the State. As per his recommendations, a small area of Periyar Lake reserve was constituted as a Sanctuary called Nellikampatty Sanctuary during the year 1934. This was subsequently enlarged to the present Periyar Wild Life Sanctuary in the year 1952. (from the pamphlet published by Kerala Forest Department, and Director of Public Relations).

III. Vegetation

The main types of vegetation encountered in the Sanctuary are (1) Southern Tropical Wet Evergreen Forests (2) Southern Tropical Semi-Evergreen Forests and (3) South Indian Moist Deciduous Forests. Apart from this, large tracts of South Indian Sub-tropical Hill Savannah (low level grassland) are also met with (Champion & Seth, 1968). The lofty, dense evergreen forests present a complex and bewildering falcade with a multiplicity of species on multi-storeyed canopies and the forests mount on forests like clouds on clouds. In the eastern side of the Sanctuary, and in Sabarimalai and Mangal Devi areas particularly in higher elevations, Southern Hill Top Tropical Evergreen forests are common. Many of the trees found are characteristic of Southern Western Ghats attaining their best development here. Examples are *Hopea glabra* Wt. & Arn., *Mesua ferrea* Linn., *Semecarpus travancorica* Bedd. and *Vateria indica* Linn. Besides these, the other common trees are : *Actinodaphne hirsuta*

Hook. f., *Artocarpus hirsuta* Lamk., *Canarium strictum* Roxb., *Cullenia exarillata* A. Robyns, *Elaeocarpus serratus* Linn., *Gordonia obtusa* Wall. ex Wt., *Kurrimia indica* (Bedd.) Gamble, *Myristica beddomei* King and *Polyalthia fragrans* Bedd. The undergrowth constitutes the following shrubs and herbs : *Apama siliquosa* Lamk, *Calamus* spp., *Chassalia ophioxyloides* (Wall.) Craib., *Gomphandra polymorpha* Wt., *Lepianthes umbellata* (Linn.) Raf., *Nilgirianthes barbatus* (Nees) Brem., *N. beddomei* Brem., *Psychotria flavida* Talbot, *P. thwaitesii* Hook. f. and *Sarcandra grandifolia* (Miq.) Subr. & Henry. In the areas where moisture content is more *Elatostema lineolatum* Wt., *Rhynchoglossum notonianum* (Wall.) Burtt, *Rhynchotechum permolle* (Nees) Burtt are common. Climbers such as *Capparis moonii* Wt., *Cayratia pedata* (Lamk.) Juss. ex Gagnep., *Cynanchum callialata* Buch.-Ham., *Dumasia villosa* DC., *Gnetum ula* Brongn., *Jasminum flexile* Vahl, *Mucuna hirsuta* Wt. & Arn., *Shuteria vestita* Wt. & Arn., *Tetrastigma muricatum* (Wall. ex Wt. & Arn.) Gamble and *Thunbergia mysorensis* T And. are common. Epiphytes such as *Aeschynanthus perrottetii* A. DC., *Hoya pauciflora* Wt., *Impatiens parasitica* Bedd., *Medinilla beddomei* C.B. Clarke and *Peperomia wightiana* Miq. and epiphytic orchids such as *Coelogyne breviscapa* Lindl., *Dendrobium herbaceum* Lindl., *Ephemerantha macraei* (Lindl.) P.F. Hunt, *Eria nana* A. Rich., *E. pauciflora* Wt., *Liparis longipes* Lindl., *Luisia* spp., *Oberonia* spp., *Polystachya flavescens* (Bl.) J. Sm. and *Sirhookera latifolia* (Wt.) O. Ktze. are common it these forests. Some of the common epiphytic/terrestrial ferns collected from this area are *Angiopteris evecta* (Forst.) Hoffm., *Asplenium nidus* Linn., *Egenolfia asplenifolia* (Bory) Fée, *Elaphoglossum beddomei* Sledge and *Pseudocyclosorus ochthodes* (Kze.) Holttum. In the beds of streams large populations of *Impatiens verticillata* Wt. are common. *Ochlandra travancorica* Gamble and *O. wightii* C.E.C. Fischer are the common reeds.

The moist deciduous forests occur in and around Thekkadi and lower elevations. *Tectona grandis* Linn. f. is common in this type. *Anogeissus latifolia* (Roxb.) Bedd., *Aphanamyxis polystachya* (Wall.) Parker, *Bombax ceiba* Linn., *Dalbergia latifolia* Roxb., *Emblica officinalis* Gaertn., *Grewia tiliaefolia* Vahl, *Hydnocarpus wightiana* (Dennst.) Sleumer, *Pterocarpus marsupium* Roxb., *Radermachera xylocarpa* (Roxb.) K. Sch., *Terminalia chebula* Retz., *T paniculata* Roth and *Xylia xylocarpa* Taub. are also found here. In the undergrowth the following shrubs are common: *Desmodium triangulare* (Retz.) Merr. var. *congestum* (Prain) Sant., *Grewia* spp., *Helicteres isora* Linn. and *Pavetta indica* Linn. Orchids such as *Cymbidium aloifolium* Sw., *Dendrobium herbaceum* Lindl., *D. macrostachyum* Lindl., *Oberonia* spp., *Pholidota imbricata* (Roxb.) Lindl., and *Vanda* spp. are commonly met with. *Bambusa arundinacea* (Retz.) Roxb. occur in gregarious patches in some areas of the forest.

In the South Indian Sub-tropical Hill Savannah (low level grassland) amidst grasses like *Arundinella ciliata* (Roxb.) Nees ex Miq., *Cymbopogan*

citratus (DC.) Stapf. *Themeda cymbaria* Hack., *T triandra* Forsk., *T tremula* (Nees ex Steud) Hack. *Phoenix humilis* Royle var. *pedunculata* Bece. is found in abundance. *C. walkeri* Arn., *Emilia sonchifolia* (Linn.) DC., *Exacum* bicolor Roxb., *Crotalaria multiflora* Benth., *Smithia bigemina* Dalz., *S.* blanda Wall. ex Wt. & Arn., *Sopubia trifida* Buch.-Ham. ex D. Don, *Tephrosia pulcherrima* Wt. ex Baker and *Vernonia indica* C.B.Cl. are also common in these grasslands. Amidst grasses ground orchids like *Habenaria heyneana* Lindl., *H. longicorniculata* Graham, *H. perrottetiana* A. Rich. are met with. In marshy places and on wet rocks after rains *Burmannia pusilla* (Miers.) Thw., *Dimeria ornithopoda* Trin., *Drosera indica* Linn., *D. peltata* Sm., *Eriocaulon* spp., *Gynura pseudochina* DC., *Impatiens* spp., *Sonerila* spp , *Utricularia uliginosa* Vahl and *U. smithiana* Wt. were encountered. The explorations and studies conducted in this area during 1972-76 for a total period of 90 days have yielded about 750 taxa of vascular plants and a plant new to science, viz., *Cassia intermedia* Sharma, Vivek and Rathak. (1974:301 to 306) was described from this area.

The aliens like *Eupatorium adenophorum* Spr. and *Lantana* spp., and extensive plantation of *Eucalyptus grandis* Linn. have considerably affected the vegetation of the Sanctuary in many places. *Centrosema pubescens* Benth., *Clidemia hirta* (Linn.) D. Don, *Mitracarpus verticillatus* (Schum. & Thonn.) Vatke and *Solanum aculeatissumum* Jacq. are the recent entrants to this flora. The peripheral forests of the Sanctuary have been depleted in recent years by human exploitations for various purposes. Added to this the pilgrims to Sabarimalai temple and the renovation of Mangal Devi Temple stand as new hazards to the Wild Life and floral resources of the Sanctuary.

In this vast assemblage of plants, the attention was previously drawn only to the valuable timber trees, and medicinal and other economic plants. But, now there is a growing awareness for the conservation of rare and endangered plants. Santapau in the 10th General Assembly of I.U.C.N. held at Delhi, during 1969, presented a paper on 'Endangered plant species and their habitats' making a special plea for Indian Orchids, which are exploited without any thought being given to their perpetuation Melville (1970:475) estimated that between 5 and 10 per cent of the total number of Angiosperms species of the world, that is somewhere between 10,000 and 20,000 species fall in the group of endangered, rare and depleted. Tinker (1971:408) reports that "twenty thousand plant species in danger of extinction ...The essential preliminary to any conservation programme is a precise catalogue of what these species are, but so far only 68 are listed in I.U.C.N.'s Red Data Book." The articles of Subramanyam and Sreemadhavan (1969·719 to 723) and Subramanyam and Nayar (1971:147 to 151) stressed the importance of conservation and the role of taxonomists in preparing an inventory list of plants, that needs conservation. Jacob (1977:2828) realising the difficulties and drawbacks

of tropical countries in conservation programmes and preparing Red Data Lists of plants stated that "It may be sensible in civilized temperate countries with a poor flora widely known : in the humid tropics it is out of the question. There are too many species and neither books nor people are available to identity them, not to speak of implementation." Maheshwari (1977:22) in the All India Symposium on Floristic Studies in India organised by Botanical Survey of India reviewed the 'Conservation of Rare Plants Indian scene vis-a-vis World scene' He has estimated about 1000 species of higher plants in India need conservation and also pointed out that the Wild Life (Protection) Act 1972, promulgated in India does not provide lists of scheduled protected plants. Eventhough the precise information about these plants is really wanting, a list of 100 plants suggested recently as rare and endangered, by the Expert group of National Man and Biosphere Committee and Flora wing of Wild Life Board fills the gap in the knowledge. Based on the rich collections of Madras Herbarium and literature, a preliminary list of 220 flowering plants are sorted out as rare and endangered plants of South India and this will be published soon.

IV. Threatened Species

The importance of Periyar Wild Life Sanctuary has gone up due to the presence of the following plants which are now facing extinction.

(1) **Angiopteris evecta** (Forst.) Hoffm. (MARATTIACEAE)

This fern is widely distributed in India, Ceylon and S.E. Asia but nowhere in abundance in this country.

(2) **Belosynapsis vivipara** (Dalz.) C.E.C. Fischer (COMMELINACEAE)

A rare epiphytic herb reported from Wynaad in Kerala, Anamalai Hills of Tamil Nadu and from Karnataka. Located in this area recently.

(3) **Ceropegia beddomei** Hook. f. (ASCLEPIADACEAE)

A slender climber reported from Peermade and hills of Cochin from Kerala. Collection are not available in Madras Herbarium until the present one from this area.

(4) **Debregeasia ceylanica** Hook. f. (URTICACEAE)

A small tree reported from Ceylon, Anamalai and Travancore hills. Fischer (1957:972) reports as 'Very little known in South India'

(5) **Decussocarpus wallichianus** (Presl) de Lauben.

(=*Podocarpus wallichiana* Presl) (PODOCARPACEAE)

The only indigenous conifer of the Peninsular India known only by a few collection in Anamalai hills, Nilgiri hills and Tirunelveli hills of Tamil Nadu.

(6) **Dendrobium haemoglossum** Thw. (ORCHIDACEAE)

Fischer (1957:990) reports it as 'Rare' This epiphytic orchid was collected in Malabar and Wynaad area and recently located in Thekkadi itself.

(7) **Hoya retusa** Dalz. (ASCLEPIADACEAE)

A slender epiphyte so far reported from South Canara in Karnataka. Located in Sabarimalai as a new record for Kerala.

(8) **H. wightii** Hook. f. (ASCLEPIADACEAE)

A stout epiphytic climber reported from W. Ghats in the hills of Coimbatore, Nilgiris and also in Cannanore, Idukki, and Trivandrum districts.

(9) **Ipomoea bracteata** Wt. (CONVOLVULACEAE)

Reported from W. Ghats, Anamalais and hills of Cochin and Travancore and inadequately represented in Madras Herbarium until the recent collection from the area.

(10) **Ophioglossum gramineum** Willd. (OPHIOGLOSSACEAE)

An interesting rare and tiny species difficult to distinguish the plant when growing along with grasses (Nair & Ghosh, 1973:130). Although reported from Bombay, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh and Tamil Nadu, it is very scarce.

(11) **Pectelis susannae** (Linn.) Raffin. (ORCHIDACEAE)

(=*Platanthera susannae* (Linn.) Lindl.)

Even though widely distributed in countries like Burma, Yunnan, Vietnam, Cambodia, Laos, Malaya, Java etc. the plant is rare and much searched by native collectors. Fischer (1957:1031) reports as 'never common or gregarious' Reported from Anamalai, Pulneys, and Nilgiri hills and in the hills of Idukki District.

(12) **Psilotum nudum** Linn. (PSILOTACEAE)

Terrestrial or epiphytic herb reported throughout India and also in the Andamans. The plant is scarce, although it has been recorded from a number of localities.

The area is rich in orchids and about 45 species are collected from here. In addition to this, there is a large amount of endemic and characteristic plants of Southern Western Ghats occurring here.

V. Conclusions

Altogether the vegetation of Periyar Wild Life Sanctuary is a National Treasure to be kept in tact for posterity, not only for the beauty and tranquility of the terrain and for the occurrence of rare and endangered Wild Life that abode there but also for one more vital reason namely its supreme influence on the climate and rainfall and its role in

the prevention of environmental deterioration. The dense evergreen forests of the area are characterised by multi-storeyed canopies of vegetation including huge trees, shrubs, herbs, climbers, stragglers and epiphytes and most of them have broad leaves. This provide a high rate of transpiration and keep the atmosphere cool and moist which influences the rainfall of the region. In addition, the dense vegetation and grassy slopes prevent the frontal attack of the heavy downpour of monsoon. Without this vegetation the soil get eroded and washed away in one monsoon. It also effects to conserve the rain water which descends to the ground in rivers, streams and reservoirs.

Recognising the important role of Natural Vegetation the National Committee of Environmental Planning and Co-ordination and the Sub-Committee on Man and Biosphere are now engaged in selecting, 'Biosphere Reserves' for preservation of life in its totality *in situ*. Periyar Wild Life Sanctuary is one among the important areas considered for selection as a 'Biosphere Reserve' Such conservation programmes will put Nature Conservation in India on a sound footing.

VI. References

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(*original not seen)

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