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Ecology and Ethology of the spotted-deer
Axis axis axis (Erxleben)
(Artiodactyla : Cervidae)

by

P. C. TAK & B. S. LAMBA

Issued by the Director
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सत्यमेव जयते

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**ECOLOGY AND ETHOLOGY OF THE SPOTTED-DEER,
AXIS AXIS AXIS (ERXLEBEN)
(ARTIODACTYLA : CERVIDAE)**

By

P. C. TAK AND B. S. LAMBA

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INTRODUCTION

The Spotted Deer or Cheetal, *Axis axis axis* (Erxleben), is one of the most common and perhaps the handsomest member of the deer family (Cervidae) in India. The colour is rusty brown with numerous white spots all over the body. The full grown stag stands about a metre high and has a crown of long antlers in the breeding season (Plate 1).

The species is distributed from Sri Lanka and Peninsular India northward to Kumaon (in Uttar Pradesh), Nepal, Sikkim and Bengal. According to Ellerman and Morrison-Scott (1951) there are two subspecies viz., *Axis axis ceylonensis* (Fischer) which is confined to Sri Lanka, and *Axis axis axis* (Erxleben) found in the rest of the species range.

In spite of numerous publications little precise information in depth on its ecology and ethology is available. Most of short notes ; these are by : Blanford, 1888-91 ; Brander, 1923 ; Lydekker, 1924 ; Falkenstein and Kreeps, 1938 ; Shinghji, 1941 ; Pratabgarh Maharawat, 1942 ; Pocock, 1944 ; Fooks, 1945 ; Nothenus, 1945 ; Hiteshi, 1947 ; Rossel, 1948 ; Taibel, 1948 ; Webbepole, 1948 ; Chur, 1950 ; Ellerman and Morrison-Scott, 1951 ; Stanford, 1951 ; Banerji, 1956 ; Ara, 1960 ; Editors, J. B. N. H. S., 1960 ; Davidar, 1964 ; Pillai and Hingorani, 1964 ; Shah *et al.*, 1965 ; De Alvis, 1966 ; Pillai, 1966 ; Choudhury, 1966 ; Dathe, 1966 ; Davidar, 1968 ; Ramsey, 1968 ; Walker, 1968 ; Rao and Acharjyo, 1969 ; Titcomb, 1969 ; Walker, 1969 ; Acharjyo, 1970 ; Mandal, 1970 ; Prater, 1971 ; Acharjyo and Padhi, 1972 ; Eisenburg and Lochart, 1972 ; Krishnan, 1972 ; Rao and Acharjyo, 1972 ; Rao, Mishra and Acharjyo, 1972 ; Whitehead, 1972 ; Ables and Ramsey, 1974 ; Banerjee and Mukherjee, 1977 ; Lamba and Tak, 1977 ; Dey, 1978 ; Rao, 1978 ; Bhattacharya and Chattopadhyay, 1979 ; Gadgil, 1979 and Miura, 1981.

Among the more comprehensive recent studies are as follows : De and Spillett (1966) gave the results of a four month study in the Corbett National Park and dealt briefly with such topics as population density, movement etc. (Our own study presented here was also made in the same area but lasted two and a half years). Graf and Nichols (1966) gave a detailed account of its biology etc. in the Hawaiian Islands (Pacific Ocean) where the species was introduced about a hundred years ago and has flourished. Schaller (1967) gave a brief account of its population density, sex ratios, general behaviour etc. in the Kanha National Park in M. P. Sharatchandra and Gadgil (1975, 1980) gave an interesting account of its population growth rate, mortality, fertility etc. in the Bandipur National Park in Karnataka.

The present study deals with two broad topics namely Ecology and Ethology and deals with such topics as population density, herd composition, herd movements, food and feeding habits, the daily schedule of activities and social and reproductive behaviour in considerable detail. Wherever necessary comparison is made with a previous work on the species.

THE STUDY AREA

a). General

Observations were made for a continuous period of 30 months in the Corbett National Park during the Years January, 1977-June, 1979.

The Corbett National Park lies in two sub Himalayan districts of Uttar Pradesh, viz., Pauri Garhwal and Naini Tal districts between the latitudes $29^{\circ}31' N$ to $29^{\circ}35' N$ and longitudes $78^{\circ}33' E$ to $78^{\circ}46' E$. At an altitude varying from 380 to 1040 metres above sea level. It covers an area of about 525 sq km. The natural forest of the Park is confined to the Bhabar tracts of the Siwalik formation, with varied topography of many marshy depressions, ravines and plateau land (figure 1). With the construction of a dam for the Ramganga Multipurpose Hydel Project at Kalagarh a large freshwater lake has sprung up engulfing about 10% of the Park area and almost 80% of the savanah type grassy glades in the hinterland of the Park. Besides this, there are a number of thickly forested ridges in the park. The largest and the longest (though not the highest) ridge "Central Ridge" runs through the middle of the Park in an east-west direction from Sajagadi sot to Leedpani sot. The highest ridge the Kanda Ridge lies to the north

of Dhikala, the highest point in the Park being Kandø Forest Rest House (1040 m).

b). The Intensive Study Area

The intensive study area was, however, carved out at Dhikala in a patch of about 20 sq km in the vicinity of Dhikala Rest House and can be characterized as follows :—

The vegetation : The vegetation is of three broad types, viz., the forest (mainly Sal, *Shorea robusta*), savanah grassland (or Dhikala 'Chaud' as locally called), and the river bed.

The highest point in this area is about 670 m at the top of the Central Ridge. The Central Ridge forms the southern boundary of the area and the river Ramganga, which flows NE-SW, forms the northern boundary. The up coming lake created by the dam forms the western boundary, and a dense patch of sal fringes the 'Chaud' on the east.

The forest is dominated by the sal trees (*Shorea robusta*) forming almost pure stands. Indeed, this forest is composed of three different storeys or canopies : upper, middle, and lower. The upper canopy is mainly formed of sal trees, which is associated with other trees like *Adina cordifolia* (Haldu), *Terminalia belerica* (Bahera), *T. tomentosa* (Tun), *Lannea woodier* (Jhingan) and various species of *Ficus*, e.g., *Ficus glomerata* (Gular), *F. religiosa* (Pipal), *F. retusa* (Lakar), *F. roxbergii* (Timla), *F. bengalensis* (Bargad or Bar), *F. rumphii* (Pilkhan), etc. The middle canopy covers comparatively small tree like *Mallothus phillipinensis* (Rohini), *Cassia fiscula* (Amaltas), *Cordia dichotoma* (Libhera), *C. myxa* (Lissora) etc. The lower canopy is composed of smaller trees like *Murraya koenigii* (Karipatta or Jalneem), *M. peniculata* (Kamini), *Clerodendron infortunatum*, *Callicarpa macrophylla* (Dhaia), *Lantana* species and developing trees etc.

The grassland holds a great variety of grasses. As many as 37 species of grass (Graminaceae) are known to occur in the Park. Only 15 species were however recorded from the Dhikala 'Chaud' and surrounding area. These are : *Apluda mutica*, *Aurandinella bengalensis*, *Chloria dolihostachya*, *Chrysopogon montanus*, *C. serrulatus*, *Cynadon dactylon*, *Dendrocalamus strictus*, *Heteropogon contortus*, *Imperata cylindrica*, *Saccharum bengalensis*, *S. munja*, *S. spontaneum*, *Setaria* species, *Themeda arundinacea*, *Vetivria zizanioides*. These grasses are

intermingled with many shrubs, grass-like plants and creepers of which a few common ones are : *Trichodesma indicum*, *Crotalaria medicaginea*, *Desmodium microphyllum*, *Grewia polygms*, *G. sapida*, *Vicoa indica*, *Moghania* sp., *Murraya koeingii*, *Chalanthus farinosa*, *Helectoceros isora* (Maror fali), *Evolvulus alsinoides*, *Oxalis corniculata*, *Lenceas hypifolia*, *Acacia arabica* (Babul), *A. catechu* (Khair), *Canabis sativa* (Bhang), *Lantana camara* (Kuri) — spreading very rapidly on the grassland, and *Zizyphus jujuba* (Ber) etc. A few groves of sal trees and an occasional large tree like ; *Bombax ceiba*, now *Ceiba malabaricum* (Semal), *Emilica officinalis* (Awla), *Philiostima malabaricum* (Kachnar) etc. also exists on the Dhikala 'Chaud'

During rains these grasses grow in height, some of them gaining a height of three metres by the end of rainy season. The tall grass obscures the view and reduces the visibility from July to December. After the rains the grasses begin to dry and wither. Large patches of dried-up grasses are set on fire by the forest department in December-January to improve the quality of food during the winter rains. As a result the visibility in the study area also improves and is at its best from January to June (inclusive).

The river bed is sandy, pebbly, rocky and narrow with high banks till about Khinanauli Forest Rest House (Plate 2A). But in the intensive study area, in fact, a little east of Khinanauli it starts widening giving rise a number of "Islands" where *Dalbergia sisso* (Sheeshum) grows in abundance. These wooded tracts in the river bed are known as "Sheeshum Islands" Such Islands are occupied by a number of shrubs, herbs and grass species of which the most common and abundant ones are : *Canabis sativa* (Bhang) and Elephant grass.

With the annual creeping and receding of lake a curious change in the vegetation was observed. In the areas of the river bed, 'Chaud' and sheeshum islands which remained under water for more than four months the native vegetation of such areas was being replaced by succulents like *Glinus lotoides*, *Panicum ramosum*, *Fimbristylis squarrosa*, *Solanum nigrium* etc. (Plate 2B). In the areas that were submerged in two successive years all vegetation dried up and died except the tree stumps (Plate 3). This repeated inundation resulted in the disappearance of these succulents and devoid of vegetation.

c). The Climate

There are three distinct seasons, viz., the cold (November to February), the hot (March to mid-June) and the rainy season (mid-June to October).

Rainfall : The total average annual rainfall as recorded at Sarapduli Observatory of the forest department is 1653 mm (Table 1). The bulk of it is received during the summer monsoon, from mid-June to mid-September. A little rain is also received during the winter months, mostly from December to February. November is the driest month.

Temperature : The maximum and minimum temperatures were recorded on a spring operated "Thermohydrograph" for the year 1978. These records revealed the lowest temperature 5.5°C in December and the maximum temperature 41.5°C in May (Figure 2). In the inner areas of the forest day temperatures rarely exceed 33°C in the shade during March. The months of April and May are fairly hot and June is the hottest month, but the maximum shade temperature rarely exceeds 44°C even in a severe hot weather.

Humidity : The relative humidity is low during April to June and is high during the monsoon months (Figure 3). But as the area is surrounded by thick sal forest of good canopy the monthly mean relative humidity at 0800 hrs hardly ever comes down below 57% during May and generally lies between 75% to 95%.

Frost, dew and fog : From November to February the nights can be very cold with much frost and dew, and in low lying localities such as the Patlidun a dense fog lingers often till after 10 A.M.

From March to the onset of the monsoon, frost and fog are absent, but dew is deposited or up to April.

Winds and breeze : A characteristic feature is coolness of the nights caused by the valley wind, locally known as 'dadu' which blows down the valley, beginning at about 9 P.M. and dying down at about 8 A.M. In 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. During this period the air becomes very dry with much dust in suspension, giving rise to a thick yellow haze, which is only interrupted by thunderstorms.

TABLE 1—Showing monthwise total rainfall (in mm) for the years 1977-78 at Sarapduli (Corbett National Park)

Months	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Years												
1977	36.2	2.0	nil	19.0	24.1	146.6	401.5	374.5	182.4	27.6	nil	79.9
1978	7.0	24.8	44.0	21.0	nil	227.3	325.9	606.7	663.8	32.0	48.4	11.0

MATERIAL AND METHODS

The animals were studied in nature in the area already mentioned above.

The technique of "direct observation" was used. Observations were made daily for four days a week on foot and three days a week on elephant back. Observation on diurnal rhythm of activities, movements, food and feeding, and behaviour, etc. were made on foot, whereas observations on herd composition, population distributions, were made on elephant back. Dull coloured clothes were worn, and bright colours were avoided. The same timings were kept as far as possible, and the same type of equipment was carried. A 10×50 prismatic field binocular was used for direct observations. For three days in a month a Jeep car was used for observations as it provided the advantage of covering the whole area in a single trip.

Location and daily routes of movements of herds and subherds were plotted on maps in the field itself. The main observation hours were : three hours in the morning, starting at about half an hour before sunrise, and three hours in the afternoon terminating at about an hour after sunset. The total number of observation hours for the entire study of 30 months was about 2,500.

For herd composition four sex and age classes were recognized, *viz.*, adult males, adult females, yearlings of both sexes, and fawns. Counts were made from an elephant back as it had the advantage of height and close approach. The observations were recorded on a five digit electronic telecounter for the sake of speed and accuracy.

To collect information on food and feeding, each food plant was collected from the original site after visual observations were made on plants where an individual or herd was feeding.

The food preference was determined on the basis of the number of instances on which the cheetal, individuals or herds were observed to feed and also the length of time for which such feeding was continued. Leaves and flowers, where available, of the food plant were collected and got identified from the Botanical Survey of India, Dehra Dun.

Ethological observations were normally made on selected herds from specially constructed observation posts (Machans) high up in

trees (Plate 4). In a few instances where it was not possible to construct such posts, long distance observations were made from through a 1000 mm "Questar" telescope.

To support this study photographs were taken by 35 mm SLR camera of Exakta, Ashai Pentax and Nikon makes, using 28 mm wide angle, 50 mm normal, 90-230 and 50-300 zoom lenses, and 500 mm and 1000 mm telephoto lenses. Calls were recorded by means of a tape recorder.

OBSERVATIONS AND DISCUSSION ON

I. LOCATION MOVEMENTS AND HOME RANGE

1. Observations

Observations during the period of maximum visibility (January to June) revealed that at least four district "superherds²" consisting of eleven herds, occupied the Dhikala 'Chaud'. Each herd, as a rule, used the same patch or game track to enter or emerge from the forest cover (ecotone) in the mornings and in the evenings respectively. For convenience, these superherds were named A, B, C and D according to well demarcated night resting areas used by them in the 'Chaud' (Figure 4).

With sunrise and increase in temperature the superherds divided themselves into herds. Which headed for the forest cover by different game tracks or forest paths, they were recognised by these tracks and were named $A_1, A_2, A_3, B_1, B_2, B_3, C_1, C_2,$ and D_1, D_2, D_3 (Figure 5 and Plate 5).

As seen in Figure 4, superherd A used the vicinity of Forest Rest House west and east of 'Khari Sarak' as its night resting place. Superherd B utilized the area around the staff colony to this purpose. Superherd C always spent the night in the vicinity of 'pakka machan' (observation post No 4). Superherd D preferred to stay for the night in the vicinity of cross road II and central crossing.

Each morning, superherd A divided itself into three herds which started moving in the general direction of forest cover while grazing leisurely. When entering the forest the herd used three distinct points

2. We have used this term for designating a large night gathering of the cheetal

or game tracks (their own) on the basis of which they were termed A_1 , A_2 and A_3 (Figure 5). Herd A_1 moved in a north-east direction, entering a small patch of mixed forest at the bank of the river Ramganga about 300 metres to the east of the Forest Rest House. In very hot weather, herd A_1 did not stay in the forest cover on the river bank during the day but moved to the sal forest generally used by A_2 , taking the same route as of A_2 .

Superherd B also divided itself into three herds, and used three different game tracks. Accordingly they were named as herds B_1 , B_2 and B_3 (Figure 4, 5). Herd B_1 moved in south-east direction and took shelter in a small patch of sal trees situated to the east of 'Khari sarak' near the forest Rest House. During very hot weather herd B_1 also did not use this area as a day resting place but used the same route as B_2 (which was also south-east of their night place) while entering in forest cover. Herd B_3 moved south of its night resting place to take shelter in the forest (Figure 4).

Superherd C divided itself into two herds which moved south-east of their night resting area towards the sal forest. They too used two distinct patches, situated east of the cross road I, and were thus named C_1 and C_2 (Figures 4, 5).

Superherd D divided itself into three herds D_1 , D_2 and D_3 and moved in a south-western direction, always using the same game tracks for entrance into the forest cover using their own game tracks. The game tracks used by D_1 and D_2 were situated east of cross Road II but well separated from each other. The path used by herd D_3 for entering in the forest cover was west to cross Road II (Figures 4, 5).

During January to March observations showed most of these herds rested in the 'Chaud' itself during day time in patches where sufficient shade was available. Here they were closely studied from observation posts. With the commencement of the hot season and increase in temperature from March onwards the herds started entering the forest for cover each herd using a different game track. On very hot days they entered the forest even before sunrise and came out after sunset.

The home ranges of individual herds could not be studied owing to lack of equipment for marking, tagging and monitoring such as tranquiliser guns, radio collars and wireless receivers etc. As our studies were

carried out entirely by visual observations, monitoring of the movement was possible only in the 'Chaud' area. When they entered the forest it was no longer possible to keep track of their movements or activities on account of poor visibility. Some efforts were, however, made to track or follow these herds inside the forest on a number of occasions and it was noticed that the herds disintegrated into smaller groups of 2 to 9 individuals. It was not possible to follow their movements inside the forest by stalking as the animals did not allow the observer to approach closely and bolted away on the slightest suspicion. It was difficult to be sure whether or not these herds or subherds kept their entities once they got into the forest. The some indirect evidence pointed in that direction. It was observed that when a herd emerged from the forest in the evening it consisted of almost the same number of individuals as had entered in the morning through that very game track. This near consistency of numbers (while entering into or emerging from the forest cover) was maintained by different herds on days on end. On a few occasions it was also possible to locate an entire herd in a single cool patch or under a large fruit tree where monkeys were feeding.

For these reasons, only an approximate grazing range in the 'Chaud' and composite home range of all these herds were worked out.

The grazing ranges of various superherds overlapped to the extent of 0.54 to 0.99 sq km (38% to 41%) (Table 2), the ranges of each superherd being as follows (sq km) — superherd A, 1.4 ; B, 1.8 ; C, 2.4 ; and D, 2.4.

TABLE 2—*Showing the area (In sq. km.) of grazing range and overlapping (commonly used) grazing range of each superherd from January-June*

Superherd	Grazing range	Overlapping Area		Common area used between two superherds
		On the eastern side	On the western side	
A	1.4	nil	0.54	0.54
B	1.8	0.54	0.90	0.94
C	2.4	0.90	0.99	0.99
D	2.4	0.99	nil	
	(—) 1.0			
	After inundation			

For determining the composite home range of the four superherds a total of 1122 observations were made and plotted on the maps in the field itself. By joining the outermost sighting points, the composite home range was determined as about 18 sq km for the year 1979 and 19 sq km for the years 1977-78 (Figure 6).

Discussion

Home range in mammals has been defined by Burt (1940) as "that area about its established home which is traversed by an animal in its normal activities for food gathering, mating and caring for the Young" For primates Roonwal and Mohnot (1977 p. 7) have elaborated this definition and stated that "It remains constant, though often overlapping the home range of another group, at least for a time, and does not include the areas traversed during occasional explorations."

A number of extensive and intensive studies on home range, movements, seasonal activities and dispersal have been carried out by a number of workers on various deer species. Lowe (1966) studied dispersal of the Red Deer (*Cervus elephas*) on Rhum Island in Scotland and in the U. S. A. ; Robinette (1966) studied home range and dispersal of Mule Deer (*Odocoileus hemionus*) ; Sparrowe and Springer (1970) and Verme (1973) worked out the seasonal activity pattern and movements of White Tailed Deer (*Odocoileus virginianus*) ; Phillips, Bery and Sniff (1973) carried out studies on movement patterns and range of Moose Deer (*Alces alces*). These studies which were made by using advance techniques revealed not only the ranges of the species concerned but also the individual movement ranges of the various sexes and age classes of the species concerned. But unfortunately the equipments required for these techniques are not easily available to the Indian workers, and hence, our studies of this aspect of the cheetal were limited. Presumably, as a consequence of these previous workers like De and Spillett (1966), Graf and Nichols (1966) and Schaller (1967) made only a mention of the area occupied or used by the cheetal herd or population. None of the previous workers including Graf and Nichols ventured to delimit the area of grazing ranges, home ranges or composite home range of this species.

The present study of the subject showed that the cheetal population of Dhikala had a composite home range of 19 sq km in the years 1977 and 1978, and 18 sq km in the year 1979. The grazing ranges

of each superherd varied from 1.4 to 2.4 sq km. The grazing ranges of various superherds overlapped to the extent of 0.54 to 0.99 sq km (38% to 41%).

II. POPULATION

1 Observations

a). *Structure*

Components : The cheetal population at Dhikala consisted of 11 herds belonging to at least four superherds as given above.

Size and density : Studies on population size and density were carried out in Dhikala 'Chaud' only on account of good visibility there. The technique used was a combination of two widely accepted census techniques, viz., "King-Strip Method" and "Roadside Count Method"

The Central Car Road, dividing the Dhikala 'Chaud' longitudinally, was selected as a transect or strip (Plate 6). The population counts were made along this road on four different days every month, in the morning and in the evening. The morning observations started an hour before sunrise and lasted till two hours after sunrise. The evening observations were started two hours before sunset and terminated about an hour after sunset. Counts were made twice, once while going up and again while returning. The larger of the two counts was accepted. This technique is discussed in detail elsewhere (Tak and Lamba, 1980).

Size : Although the counts were made four times a month, only the two highest fortnightly counts were taken into consideration. The counts revealed that the maximum number of cheetal were seen in the months of March and April, which coincided with the optimum visibility in the intensive study area. The maximum number encountered at this time was 324 in April, 1977 ; 627 in March, 1978 and 418 in March, 1979 (Figure 7).

From July onwards, with the onset of the monsoon, the river bed area of the intensive study area, along with a part of the Dhikala 'Chaud' area was inundated by the rising dam water, and from June onwards there was a rapid growth of grass, bringing down the visibi-

TABLE 3—Showing the maximum monthwise population density (number of individuals per sq. km.) in the Dhikala 'Chaud' area for the Years 1977, January to 1979, June

Months	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	28.8	40.4	33.5	47.6	45.3	25.1	77.4	77.4	4.1	1.2	1.0	1.6
1978	5.4	33.0	92.1	54.4	65.6	37.2	6.2	1.8	1.2	1.0	3.0	6.6
1979	12.8	42.9	61.5	55.3	39.1	33.9	—	—	—	—	—	—

TABLE 4—Showing the maximum monthwise population density (number of individuals per sq. km.) in the 'composite home range' area for the Years 1977, January to 1979, June.

Months	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	10.3	14.5	12.0	17.0	16.2	9.0	27.7	27.7	1.5	0.4	0.3	0.6
1978	2.0	12.5	33.0	20.0	24.7	14.0	2.3	0.4	0.4	0.5	1.2	2.5
1979	4.8	16.2	23.2	17.5	14.6	12.8	—	—	—	—	—	—

lity in the rest of the 'Chaud' which have been responsible for the sudden drop in population figures of July to December (Figure 7).

In the year 1977 a large portion of the river bed, which had remained under water for a few months in the previous year, grew a heavy crop of succulents just after the onset of monsoon. The succulents appeared to attract the cheetal. As a result, the animals congregated in this limited area of clear visibility giving the all time high figure of 526 for July and August in 1977 (Figure 7). This has already been recorded in detail elsewhere (Lamba and Tak, *in press*).

Density : The maximum monthwise population density per sq km fluctuated from 1.0 in November to 47.6 in April 1977 ; 1.0 in October to 92.1 in March, 1978 and 12.8 in January to 61.5 in March, 1979. The yearly zenith was registered at 47.6 in April, 1977 ; 92.1 in March, 1978 ; and 61.5 in March, 1979 (Table 3).

As the major portion of the population of the intensive study area congregated in Dhikala 'Chaud' for night resting it is presumed that the counts made in the Dhikala 'Chaud' area are practically valid for the whole of the composite home range area of about 19 sq km in 1977 and 18 sq km in 1978-79, in which circumstance the population density per sq km for the composite home range area will fall to 0.3 in November, 17.0 in April, 1977 ; 0.5 in October, 33.0 in March, 1978 and 4.8 in January, 23.3 in March, 1979 (Table 4).

Trends : The 3 year data collected during the period of maximum visibility (January-June) revealed no definite trend of the Dhikala cheetal population as it fluctuated from month to month and year to year, most probably because the intensive study area was a small pocket of the Park while the other adjoining populations kept on coming in and out of these area as and when their own particular area went under water. Presumably after short stay in the 'Chaud' these refugee population dispersed or scattered in the neighbourhood. The population size in the years of the study 1977-79 varied from 37 to 196 in January, 225 to 292 in February, 228 to 627 in March, 316 to 370 in April, 266 to 446 in may and 171 to 253 in June (Table 5). Other indirect evidence (discussed later on in this chapter), however, indicate that the population of cheetal at Dhikala is falling slowly and steadily.

TABLE 5—*Showing monthwise maximum numbers of cheetal recorded for the Years 1977-79*

Months Years	January	February	March	April	May	Jun
1977	196	275	228	324	308	171
1978	37	225	627	370	446	253
1979	67	292	418	316	266	229

b). *Factors Influencing Population Changes*

The foregoing observations on the population size, density and trend showed that the population structure does not remain constant. It kept on changing from month to month or year to year. It was influenced by factors like births, deaths, migration/movements, predation and the ecological changes in the intensive study area like submersion, patchy concentration of food (succulents growth) etc.

Births : Due to protracted fawning season and poor visibility after the onset of the monsoon, it was difficult to assess the accurate number of fawns produced in a particular year. For the purpose of estimating annual birth a Fawn : Female ratio index was adopted instead (Table 11). As will be seen from the table the annual average birth rate was 22.2% in 1977, 12.1% in 1978 and 4.1% in 1979.

Deaths : Since the study area has been a "Reserve Forest" since 1935 and a "Tiger Reserve" since 1974, no instance of shooting/hunting, trapping and road side accident was seen or noticed in the intensive study area during the period of study. Deaths due to disease 'Amphistomiasis' caused by immature Amphistomes was seen only once during 1977 (Tripathi pers. comm.).

Predation was found to be the main factor influencing the deaths (in the intensive study area). Predators like Tiger, Panther and Jackal (Predator of fawns) exist in considerable number in this area. Audiovisual observations revealed that at least four tigers, one panther and six Jackals existed in the area during the study period. In addition to cheetal they preyed upon Hog-Deer, Sambar, Wild Boar and Porcupine. But cheetal constituted their main item of diet. As these predators, normally carried their kills in thick undergrowth and secluded places, it was not always possible to see the kills. It was

TABLE 6—Showing number and species of predator kills observed in the intensive study area during the study period.

Serial No.	Species killed	Male	Female	Yearling	Infant	Undetermined	Total	%
1	<i>Axis axis axis</i>	7	7	1	9	6	29	74.35
2.	<i>Axis porcinus porcinus</i>	1	1	—	—	—	2	5.12
3.	<i>Cervus unicolor unicolor</i>	2	1	—	—	1	4	10.25
4.	<i>Hvstrix indica indica</i>	—	—	—	—	3	3	7.69
5.	<i>Sus scrofa cristatus</i>	1	—	—	—	—	1	2.56
Total		11	9	1	9	10	39	99.91

possible to discover only 39 kills during study period. Out of these 29 were of cheetal of various ages and sex, which indicated that the cheetal constituted (74%) of the total kills (Table 6).

2. Discussion

Size and Trend :—De and Spillett (1966) gave a maximum of 976 heads of cheetal in Dhikala 'Chaud'. During the present study, maximum counts in the 'Chaud', however, never went beyond 627. This shows a downwards trend in the population size in the intensive study area over the past twelve years. These authors further stated regarding the area not to be submerged, "Almost 600 cheetal were counted in these compartments" But during this study maximum counts of that area never exceeded 418. This again strengthens the assessment of the falling population sizes.

A number of factors seem to be responsible for this downwards trend. Since the declaration of the Park as 'Tiger Reserve' in 1974 the tiger population of the Park has risen from 55 in May, 1975 to 79 till June, 1978 (Singh 1979), which means steadily increasing predatory pressure.

Density :—The population density of this species has, previously, been worked out by various workers in different parts of the country. Schaller and Spillett (1966) gave figures of 45 individuals per square mile (41/km²) for Kanha population in Kanha National Park. Recently, Sharatchandra and Gadgil (1975) calculated a density of 36/km² in their study area of 23 km² at Bandipur. From De and Spillett (1966) total population of 976 cheetal in Dhikala 'Chaud' (11 km²) the density works out to be 88.7/km².

According to the present study the yearly highest density as calculated for the composite home range area never went beyond 17 individuals/km² in April, 1977; 33/km² in March, 1978 and 23.2/km² in March, 1979.

A comparison of the present study with the previous work reveals that the population density of the intensive study area was much lower comparatively.

III. HERDS

1. Observations

a) *Structure*

Herd study presented here is based on 24, 380 observations of 811 herds during a period of 30 months.

The term "herd" (or "group") is generally used to designate any temporary aggregation of two or more individuals which were together when observed, but were spatially separated from other aggregations of that species in the area. But in the present study the term "herd" is applied to designate only aggregations of three or more individuals which were composed of individuals of both sexes and various ages.

The following terms have been adopted to delimit the various types of the aggregations :

- i) Aggregations
- ii) Herds (mixed herds)
- iii) Female-young associations, and
- iv) All-male associations

i) Aggregations :— Any type of aggregation of three or more individuals irrespective of sex and age classes.

ii) Herds (mixed herds) :— The aggregations that were composed of individuals of both sexes and all ages were classified as herds. The presence of at least one male, one female and one young (yearling/fawn) was considered an essential prerequisite for this (Plate 7A, B).

iii) Female-young associations :— The main feature of this association was the absence of the buck. It comprised of an adult female and its yearling and/or fawn (Plate 8A).

iv) All-male associations :— The characteristic feature of this association was the complete absence of females. It comprised only male individuals with developing/developed velvet antlers. This associations was met only in the non rutting season (Plate 8B).

Components : The smallest herd was generally composed of (i) an adult doe ; (ii) and adult buck ; and (iii) sometimes yearlings and fawns. Fawns always accompanied the mother. The female yearling sticks to the mother, sometimes even after giving birth to her first fawn, whereas the male yearling may leave the mother to join another herd.

Size : Observations on 325 aggregations comprising 10, 244 individuals revealed and average size of 31.5 individuals per aggregation. Their size ranged from 3 to 526 individuals per aggregation. The larger aggregations were observed during February-August when the average size gradually rose from 22.4 in February to 90.7 in August. Smaller aggregations were met with from September to December, the average size varying 5.3 in October to 13.6 in January (Table 7). As the average size rose the size of the largest aggregation also increased. In fact, it started increasing slightly earlier, i.e., from January itself (1977 : 70 individuals) and continued to rise till April/May (April 1978 : 291 individuals). It came down slightly in May and June (1977 : 171 individuals) where after it dropped abruptly in July/August except in the year 1977 when, on the contrary it rose abruptly to 526 individuals (Table 7).

TABLE 7—*Showing monthwise average size and range of all types of social aggregations observed during the Years 1977-78*

Months	Number of aggregations	Number of individuals	Average aggregation size	Range
January	25	340	13.6	3 70
February	37	857	22.4	5 60
March	71	2294	32.2	3 98
April	31	1726	55.7	7 291
May	45	1845	41.0	6 200
June	29	1121	38.6	6 171
July	8	639	79.8	5 526*
August	10	907	90.7	5 526*
September	9	79	8.7	3 18
October	8	43	5.3	3 8
November	8	61	7.6	3 21
December	44	332	7.5	3 20

*All four superherds combined

The size of the herds (mixed herds) ranged from 3 to 526 individual per herd. These were most abundant from April to August, when the average size varied from 66.4 to 104.5 individuals per herd. The

minimum average herd size of five individuals was seen in October. Thereafter it rose gradually till January, when it was of 16.8 individuals (Table 8).

TABLE 8—*Showing average size and range of herds (mixed herds) observed during the Years 1977-78*

Months	Number of herds	Total number of individuals	Average herd size	Range
January	16	268	16.8	3 - 44
February	23	599	26.0	4 - 52
March	38	1254	33.0	7 94
April	24	1594	66.4	7 291
May	33	1619	49.0	8 135
June	24	1070	44.6	3 153
July	6	627	104.5	3 - 526*
August	10	907	90.7	5 526*
September	5	55	10.6	8 - 18
October	3	15	5.0	4 - 7
November	3	18	6.0	3 6
December	10	75	7.5	3 12

*All the four superherds combined

The size of the female-young associations ranged from 3 to 44 individuals per association. In November the average size of this was observed to be 8.6. After which it increased almost steadily to 7.7 in December, 8.2 in January, 14.9 in February, till it reached its peak in March when it became 18.2. Thereafter it fell gradually to 17.8. in April, 16.8 in May, 11.0 in June, 4.7 in July till it disappeared completely in August (Table 9).

The size of the all-male associations ranged from 4 to 92 individuals per association. This association came into existence in December and remained till June only. At the time of the appearance of this association its average size was at its minimum i. e. 4.0 in December and reached the peak of 39.1 in March (Table 10).

TABLE 9—*Showing average size and range of female-young associations observed during the Years 1977-78*

Months	Number of associations	Number of individuals	Average Association size	Range
January	6	49	8.2	3 14
February	7	104	14.9	5 44
March	12	218	18.2	3 44
April	4	71	17.8	9 25
May	8	134	16.8	6 43
June	4	44	11.0	9 14
July	2	12	4.7	3 10
August	—	—	—	—
September	4	24	6.0	3 13
October	5	28	5.6	4 8
November	5	43	8.6	3 21
December	33	253	7.7	3 20

TABLE 10—*Showing average size and range of the all male associations observed during the Years 1977-78*

Months	Number of associations	Number of individuals	Average Association size	Range
January	3	23	7.7	5 11
February	7	154	22.0	4 60
March	21	822	39.1	6 92
April	3	61	20.3	6 40
May	4	92	23.0	5 57
June	1	7	7.0	7 7
July	—	—	—	—
August	—	—	—	—
September	—	—	—	—
October	—	—	—	—
November	—	—	—	—
December	1	4	4.0	4 - 4

b). *Seasonal changes in herds and other social associations :*

As indicated by the foregoing observations on herds and other social associations, there are marked seasonal changes in the average herd size.

The analysis of the percentage of sightings (existence) revealed that the various herds and associations increased or decreased in an inverse ratio i. e. when sighting of one type increased in particular season, the sighting of other one or two types decreased and vice-versa.

Although the mixed herds were sighted in varying percentages throughout the year their sightings increased almost steadily from January onwards till they achieved their peak in August. In January the sighting was 47 to 100%, in February 52 to 83.3%, in March 50 to 64.7%, in April, 71.4 to 82.4%, in May 71.9 to 76.9%, in June 81.0 to 87.0%, in July 66.6 to 66.6% and in August the zenith of 100% was reached (1977-78). At the same time the sighting of the female-young associations was falling proportionately with varying percentages from 35.3% in January, to 28% in February, 20.4 to 5.9% in March, 17.6 to 7.1% in April, 21.9 to 7.6% in May, 19% in June, 24% in July, till it touched the nadir of 0.0% in August (1977-78). During the same period the all-male associations appeared, attained their peak and disappeared. The sighting increased steadily from 0.0% to 17.6 in January, 16.6 to 20.0% in February till March when the all time high of 29.4 to 29.6% was registered. Thereafter, it started declining gradually from 21.4% in April, 15.4 to 6.3% in May, 12.5% in June till July when it disappeared.

After August the sighting of herds (mixed herds) fell steadily from September to December. It showed a decline from 75% to 50% in September, 66.6 to 33.3% in October, 40 to 33.3% in November till December when it touched the lowest of 27.3 to 18.2% (1977-78). During this period the sighting of the female-young associations rose proportionately from 25 to 50% in September, 33.3 to 66.7% in October, 60 to 66.6% in November till it had the zenith of 68.2% in December (1977-78). At this time the all-male associations were conspicuous by their absence (Figure 8).

c) *Herd composition*

The herd composition studies were also carried out in the Dhikala 'Chaud' area only on account of good visibility conditions. The counts

were taken at 15-days intervals during the maximum activity period of the fauna i. e. an hour before and two hours after sunrise. Counts were made from an elephant back as it had the advantage of height and close approach. The observations were recorded on the spot on a five digit electronic telecounter for the sake of speed and accuracy.

Although observations were made throughout the year, the data collected after the month of June have not been included in this study. After the onset of South-West monsoons by mid-June the grass in the 'Chaud' grew rapidly and as a result, the visibility decreased drastically. The sample size figures suddenly dropped by more than 75% and hence considered unreliable.

A total of 450 herds comprising 10, 703 individuals were observed and classified. The ratios of the various components were worked out as against a unit of 100 females.

It was observed that the herd components did not exhibit a fixed pattern. The various components registered a high degree of variation not only during the different months of the year but also in their daily structure.

The ratio of males fluctuated from 20 (per 100 females) in May to 61 in February, 1977 ; 12.6 in January to 98.3 in June, 1978 and 5 in January to 45 in June, 1979. The ratio of fawns varied from 5.7 (per

TABLE 11—*Showing monthwise herd composition for the Years 1977-79*
(Note : M—Males, F—Females, Y—Yearlings, FA—Fawns,
NH—Number of herds classified and NI—Number of
individuals classified).

Months	M	F	1977			
			Y	FA	NH	NI
January	32.0	100	22.5	6.8	9	182
February	61.0	100	19.8	5.7	13	202
March	39.1	100	17.0	16.9	30	387
April	40.6	100	20.7	32.9	33	564
May	20.0	100	11.0	43.7	42	442
June	23.9	100	7.0	27.3	26	464
Total	216.6	600	98.9	133.3	153	2241
Average	36.1	100	16.5	22.2	25.5	373.5

100 females) in February to 43.7 in May, 1977 ; 6.4 in February to 19.1 in May, 1978 and 0.7 in January to 6.4 in April, 1979 and the ratio of yearlings varied from 7.9 (per 100 females) in June to 22.5 in January, 1977 ; 8.7 in June to 26.5 in January, 1978 and 3.3 in May to 17.9 in January, 1971 (Table 11).

2. Discussions

Size :— The gregarious nature and the other social traits of this species have been described to a certain extent by a number of workers in the past. Prater (1971 : 293) writing on the subject stated “They are seen in herds of 10-30, which may contain two to three stags, but essembles numbering several hundreds have been met with.” Walker (1964-68: 1388) maintained “The spotted deer is the most gregarious of all Eastern deer.” De and Spillett (1966:589) stated that number of individuals counted in groups varied from 2 to 315. According to Schaller (1967:67) during the monsoon months the size of herds increased greatly, herds of 100-200 individuals were common at Kanha. Recently, Sharatchandra and Gadgil (1972 : 638) wrote, “Herds upto 150 individuals are not uncommon” A large herd consisting more than 500 individuals was seen by Mr. E.R.C. Davidar (1966) on 25th October, 1964.

On the contrary, in an introduced population, in Hawaii Islands Graf and Nichols (1966 : 682) stated that “The basic unit of the herd appears to be the family group, usually composed of an adult doe, her yearling fawn and her new fawn, if she has one----. The larger groups may be made up of several of these family units, which may join together temporarily for companionship when feeding, travelling, or resting. In size, the herds on Lanai (Hawaii) usually number about seven to eight deer or less, although some are occasionally seen with ten or more. Larger herds are more common on Molokui, where 15 to 25 were commonly seen. There is no justification for the herd of 200 or even more that one often hears about”

The present study revealed a herd (mixed herd) of the size of 3 to 526 individuals per herd. The year round climatic changes in the study area influenced the ecology, which in turn affected the herd size. After the onset of rains, when the grazing and browsing was good, small size herds of 3-8 individuals were seen in abundance.

with the commencement of the winter season the grazing area started shrinking, as the grasses in the 'Chaud' became unfit for grazing, and as a result the browse also became scarce. At about this time the driedup tall grass in the 'Chaud' was burnt. The winter rains ushered in a fresh sprouts of grasses like *Apluda mutica*, *Arundinella bengalensis*, *Chrysopogon serrulatus*, *Eragrostus tenella*, *Heteropogon contortus*, *Saccharaum bengalensis* etc.. More and more herds were attracted to this area. As a result, the number of herds and individual herd sizes started increasing in the 'Chaud'

During January, herd size increased from 3-44 individuals. It kept on increasing gradually till April when the larger herds of 7-291 individuals were encountered. These larger herds started disintegrating in smaller herds from July and August onwards when the onset of rains augmented the size of the grazing and browsing area. The herd size was at its lowest (4-7) in October (Table 8).

The only exception to this observed during the study period was in July/August 1977. When the water of the lake (Dam) receded considerably denuding a large area of the river bed in which fresh succulents sprouted, the size of the largest herd in this area was observed to be of 526 individuals. In the year 1978 the lake water did not recede much and only 50% of the area denuded in 1977 was available for grazing ; also the quantity of succulents sprouted was much less. Consequently the size of the largest herd observed here in July 1978 was 42 individuals only (Figure 7).

Herds and other social association : The word "herd" has been mentioned for all types of associations of individuals of this species by previous workers. None of them has ventured to delimit the term "herd" The word has apparently been used to describe any type of the aggregation, which may be a herd (mixed herd), female-young association or all-male association (Graf and Nichols, 1966 ; De and Spillett, 1966 ; Schaller, 1967 ; Krishnan, 1972 and Sharatchandra and Gadgil, 1975).

The present study on herds (Components, size, herds and other social associations, seasonal changes in the herds and other social associations and herd composition) revealed that the herds (mixed herds) are the main stream (basic unit) of the social structure in the cheetal,

which is not a rigid but rather a fluid structure from which and into which movements of males and females are quite frequent. These movements of males and females are, possibly, due to the sexual urges, which cause movements of the males from one herd to another in search of respective females during the rutting season. Further, detachment of the males for the purpose of dropping off of the antlers during non-rutting season, when they develop a tendency to form temporary associations of their own kind. Similarly, when the female gets pregnant and is in an advanced stage of pregnancy, it drops out of the herd. After the birth of the fawn its movements are restricted on account of the partial mobility of the fawn. It is at this stage the "family units" as advocated by Graf and Nichols are observed.

It is doubtful whether it will be justified to call an association of such dropout as "herd" Graf and Nichols (1966) have, however, preferred to call the smallest herd or the basic unit of the herd as 'family group' They did not consider a buck as an essential part of the herd. But it is our contention that a family unit cannot be called complete if the male is excluded.

Thus it would be logical to say that the mixed herd is the basic unit of the social structure (organisation) in cheetal, whereas female-young and all-male associations are purely temporary social associations.

Seasonal changes in herds and other social association : The appearance and disappearance of various social association is a well known phenomenon of the deer family (Cervidae). These various social associations can be as many as of eight different types, theoretically, as under :

- i) All-does association (Females of various ages)
- ii) All-buck association (Males of various ages)
- iii) Buck and does without their young ones (Yearling/fawn)
- iv) Buck and does with their young ones (Yearling/fawn)
- v) Does with yearling (Fawns of the previous year)
- vi) Does with fawns
- vii) All-yearlings
- viii) All-fawns

At least two or more types of these associations have been studied for a number of deer species of the world, e. g. the firm existence of sperate all-male groups and female-young groups have been worked out for whitetailed Deer on Crab, Southern Illinois, U. S. A. by Hawkins and Klimstra (1970) ; for Red Deer on the Island of Rhum, Scotland by Lowe (1966) ; and Lincol, Youngson and Short (1970) ; for Barasingha or Swamp Deer in Kanha National Park, India by Martin (1975). Barmley (1970) studied six different types out of the eight above said, for Roe Deer in Cheddington Wooded, Dorset.

During the present study only three different types of social associations i. e. i) herds (mixed herds) ii) female-young associations and iii) all-male associations were worked out, which revealed that herds (mixed herds) were sighted throughout the year from 18.2 to 27.3% sightings in December to 100% sightings in August (1977-78). While the female-young associations were seen in relatively low percentage of 0.0% in August to 68.2 to 81.8% in December (1977-78). Whereas the all-male associations existed only for a limited period with very low percentages of sightings i.e. 0.0 to 4.0 in December to 29.4 to 29.6% in March (1977-78).

Thus, according to the present study although the herds (mixed herd) are found throughout the year, yet there is a well demarcated sighting of the female-young and all-male associations. Almost a similar social behavioural pattern has been recorded by Espmark (1964) for the Reindeer.

Herd composition : In the existing literature very limited information is available regarding sex and age ratios of wild populations of the cheetal. Studies of the following eco-ethologist revealed that age and sex ratios varied not only in different localities but also in the same locality during successive years. The age and sex ratios studied so far have always been in favour of the females. De and Spillett (1966 : 585) for Dhikala, Corbett National Park ; Schaller (1967 : 43) for Kanha, Kanha National Park (Table 12) ; and Sharatchandra and Gadgil (1975 : 635) for Bandipur National Park.

The present study revealed a similar pattern. The average ratio of males to 100 females was 36 in 1977, 48.2 in 1978 and 31 in 1979. While the average ratio of fawns to 100 females was 22.2 in 1977, 12.1

TABLE 12—*Showing sex ratio of various herd's components as studied by the previous workers*

Author and year	Location	Bucks	:	100 Does	:	Fawns
De and Spillett (1966 : 585)	Corbett National Park, (U. P.)	52—60	:	100	:	31—37
In Schaller (1967 : 43) January-December 1964	Around Kanha meadow, K. N. P., (M. P.)	42—72.4	:	100	:	15.6—68.4
January, 23-31	C. N. P., (U. P.)	69.6	:	100	:	17.1
February, 11-22	Keoladeo Ghana Sanctuary, (Raj.)	70.8	:	100	:	35.4
February, 25 — March, 5	West Kheri Forest (U. P.)	78.8	:	100	:	26.2
March, 8-10	Van bihar Sanctuary	72.9	:	100	:	53.1
April, 1-11	West Bastar Dist.	69.2	:	100	:	53.8

in 1978 and 4.1 in 1979. Whereas the average ratio of yearlings to 100 females was 16.4 in 1977, 16.7 in 1978 and 8.6 in 1979 (Table 11).

These variations and fluctuations of the herd composition revealed that the ratio of various components of the herds are governed by a number of physiological cum behavioural and ecological factors. The physiological factors are responsible for growth of antlers in males, while the ecological factors involved are mostly ; availability of food and predatory pressure. Predators like Tigers, Panthers, and Jackals were present in the intensive study area in good number and were mainly responsible for the variations and fluctuations of the composition of the various herd components.

Further, with the creeping up of the lake in the area animals from the inundated area (their original habitat) have been pushed steadily eastwards year after year. The repeated dislodging from their niches in the original habitat has put the animals under great stress. It is a well known fact that animals do not breed freely/normally under conditions of stress and strain. It is suspected something like that was at work in this area. This suspicion was subsequently confirmed by the rapidly falling annual average ratio of fawn to 100 females from 22.2 in 1977 to 4.1 in 1979 (Table 11).

IV FOOD AND FEEDING

1. Observations

a) *Food Plants*

Detailed observations were made in all the three vegetational types, i.e. forest, grass land and river bed, in the study area.

The cheetal is primarily a grazer. It prefers sprouting grasses above all other types of plants. The grass cover of the study area is a heterogenous one. It is a mixture of some 15 species (Table 13). It is well nigh impossible to ascertain the individual species eaten, without sacrificing the animal itself and examining the stomach contents. The only alternative was to observe the grazing animals in a patch of heterogenous grassland. Later, when these grasses were fully grown and in flower, samples were collected and identified. This method revealed that at least 15 species of grasses were being utilised as food in the Dhikala 'Chaud' (Table 13).

TABLE 13—*Showing species of grasses grazed by cheetal in and around Dhikala 'Chaud' Corbett National Park*

Sl. No.	Species	Family	Local Name	Plant	Frequency	Season
1	<i>Apluda mutica</i>	Graminaccae	—	Young shoots, dried bladetip	Brisk, frequent	Growing season i.e. cool-dry and hot-dry season (Jan. to June)
2.	<i>Arundinella bengalensis</i>	..	—	..	..	..
3.	<i>Chloris delichostechya</i>	..	Pengi	..	..	..
4.	<i>Chrysopogon montanus</i>	..	Gooria	..	..	..
5.	<i>Chrysopogon serrulstus</i>	..	Bhuri	..	..	..
6.	<i>Cynodon dactylon</i>	..	Dub	..	..	..
7.	<i>Dendrocalamus strictus</i>	..	Bans	..	..	..
8.	<i>Heteropogon contortos</i>	..	Kumeria, Girwala	..	..	..
9.	<i>Imperata cylindrica</i>	..	Pula, Sirhi	..	..	..
10.	<i>Saccharum bengalensis</i>	..	—	..	..	..
11.	<i>Saccharum munia</i>	..	Munj	..	..	..
12.	<i>Saccharum spontaneum</i>	..	Kans	..	..	..
13.	<i>Setaria species</i>	..	Ballu	..	..	..
14.	<i>Themeda arundinacea</i>	..	Serkanda, Ula	..	..	..
15.	<i>Vetiveria zizanioides</i>	..	Khas, Gamara	..	..	..

The cheetal supplements its diet by browsing on other plants, particularly during winter when sprouting grass is scarce. A total of 38 such plants were recorded (Table 14). This includes five species of genus *Ficus* which were, however, available artificially and two species of *Nerium* and one species of *Boungainvillea* (Which was present as ornamental plant) in the Dhikala area.

In addition to these two major categories of plants feeding, the cheetal occasionally feeds on fallen flower petals and fruits dropped by monkeys feeding on such trees. So eaten was *Terminalia bellirica* (bahera) and the flowering trees *Bombax ceiba* (Semal) and *Philiostima malabaricum* (Kachnar).

Preference of the food plants eaten varied seasonally, presumably, depending upon the presence of certain plants in season.

By the end of the rainy season, grasses grew to their full height and early in the winter they started drying up. The river bed in winter was covered with dam water. As a result food in this area became scarce, and by October, the cheetal resorted to browsing on leaves. Later in the cold season, when grasses in some area had been burnt and some winter rains had been received, most of the grasses in the 'Chaud' sprouted. This made the cheetal revert to grasses, reducing the leaf browsing considerably.

By April grass sprouts outgrew their utility as food. They became tough and tall, no longer a desirable item of food. Consequently, the cheetal went back to browsing in order to supplement its grazing. By this time the succulents had appeared in the river bed from where the dam water had receded. The grazing was thus extended to the river bed.

During the wet season the monsoon provided a new lease of life to the vegetation, augmenting the feeding area. In this season the cheetal scattered over a large area in the river bed and made use of a large variety of plants as food.

b). *Chemical Composition of Food Plants*

Some of the food plants were chemically analysed, (through the courtesy of professor D. C. Joshi, I. V. R. I., Izatnagar). The main

TABLE 14—Showing browse species of plants eaten (except grasses, for which table 13) by the cheetal in the intensive study area, Corbett National Park.

Sl. No.	Species	Family	Local Name	Habit type	Plant parts eaten	Frequency	Season in which eaten
1.	<i>Acacia arabica</i>	Febaceae	Babul	Shrub	Leaves	Occasional	Winter
2.	<i>Ageratum conyzoides</i>	Asteraceae	—	..	..	Frequent	..
3.	<i>Artemisia nilagirica</i>	—	—	..	..	Occasional	..
4.	<i>Bombax ceiba</i>	Bombacocae	Semal	Tree	Leaves & flowers petals	Very frequent	..
5.	<i>Cordia dichotoma</i>	Ehretieaceae	Libhera	Small tree	Leaves	Frequent	..
6.	<i>Cordia myxa</i>	Ehretiaceae	Lissora	..	..	..	..
7.	<i>Dalbergia sisso</i>	Fabaceae	Sheeshum	Tree	..	Occasional	..
8.	* <i>Ficus arnottiana</i>	Moraceae	Khabar	..	..	Very frequent	..
9.	* <i>F. bengalensis</i>	..	Bar, Barged	..	..	Frequent	..
10.	* <i>F. religiosa</i>	..	Pipal	..	..	Very frequent	..
11.	* <i>F. ratosa</i>	..	Lakar	..	..	Frequent	..
12.	* <i>F. rumphii</i>	..	Pilkhan	..	..	..	..
13.	<i>Fimbristylis squarrosa</i>	Cyperaceae	—	Herbs	..	..	Summer
14.	<i>Glycus lotides</i>	Aepoaceae	—	Herbs	..	..	..
15.	<i>Glycosmis arbores</i>	Rutaceae	Pilu	Shrub	Leaves	Frequent	Winter, Summer
16.	<i>Grewia sapida</i>	Tiliaceae	Phalse	Small Shrub	..	..	Summer
17.	<i>Heiictoceros isora</i>	Sterculiaceae	Marorfeli	..	..	Occasional	..
18.	<i>Holarrhana antidysentrica</i>	Apocynaceae	Safeda, Kura	Shrub	..	Frequent	Winter

19. <i>Jasminum multiflorum</i>	—	—	..	..	Occasional	..
20. <i>Lantana camara</i>	Verbenaceae	Lantana, Kuri	..	Young Shoots	Frequent	..
21. <i>Litsea monopetala</i>	Lauraceae	—	Small tree	Leaves	Occasional	Winter
22. <i>Mallotus philippensis</i>	Euphorbiaceae	Rohini	Tree (Young)	..	..	..
23. <i>Milletia auriculata</i>	—	Ganj	Small tree	..	..	..
24. <i>Moghonia strobilifera</i>	Fabaceae	Salpan	Shrub	Leaves of young plant	..	Monsoon
25. <i>Murraya koenigii</i>	Rutaceae	Kari-patta, Jal-Neem	Small tree	Leaves	Very frequent	Winter
26. <i>Murraya paniculata</i>	..	Kamini	..	..	..	..
27. <i>Nerium indicum</i>	Apocynaceae	Kaner	..	..	..	..
28. <i>Nerium odorum</i>	..	..	..	..	..	..
29. <i>Philiostima malabaricum</i>	Fabaceae	Kachnar	Tree	Leaves & flower petals	Frequent	Winter till March
30. <i>Polygonium polbsium</i>	Polygonaceae	—	—	Leaves	Frequent	Summer
31. <i>Solanum nigrum</i>	Solanaceae	Mukai	Small shrub	Young leaves & shoots	..	Summer, Monsoon
32. <i>Golanum varium</i>	..	Jangli Began	..	Leaves	..	..
33. <i>Shorea robusta</i>	Dipterocarpaceae	Sal	Tree	Dried & wet leaves	..	Winter
34. <i>Gyxyaium cumini</i>	Mystaceae	Jamun	Tree	Leaves	..	..
35. <i>Terminalia alata</i>	Combretaceae	Asna	Tree	..	..	Winter, Summer
36. <i>T. belirica</i>	..	Bahera	..	Leaves & fruits	..	..
37. <i>T. tomentosa</i>	..	Asna	..	Leaves	..	..
38. <i>T. Zizphus jujuba</i>	Rhaminaceae	Ber	Shrub	Leaves (dried Occasional Winter also)		

*These are tall trees : only very young plants, cut and fallen branches (leaves) are browsed upon

constituents analysed were crude protein, ash, calcium and phosphorus. The results have been expressed on percent dry matter basis, i.e., g/100 DM of the plant (s) samples (Table 15).

TABLE 15—Showing per cent chemical composition of plant samples from the intensive study area, Corbett National Park (on dry matter basis), g/100 DM.

I Grass (more than one species which occur in the 'Chaud' and collected at random)

Sample No.	Crude protein	Ash	Calcium	Phosphorus
1	11.0	11.12	01.30	0.142
2.	05.18	04.36	00.33	0.136
3.	03.39	08.99	00.79	00.150
4.	03.13	10.60	01.24	0.142
5.	19.13	12.18	00.87	0.276
6.	05.03	05.78	00.68	0.187
Species II Other Plants' Leaves				
7. <i>Solanum nigrium</i> & other spp. also	17.17	25.25	02.99	0.223
8. ..	11.96	37.93	03.96	0.145
9. <i>S. nigrium</i> only	19.91	17.60	02.06	0.203
10. <i>Murraya paniculata</i>	12.11	07.33	08.32	0.204
11 <i>Murraya koenigii</i>	22.10	13.61	02.71	0.185
12. <i>Helictoceros isora</i>	16.31	10.39	01.65	0.228
13. <i>Ficus rumphii</i>	09.71	09.85	01.97	0.177
14. <i>F. religiosa</i>	13.39	14.67	03.31	0.336
15. <i>F. bengalensis</i>	03.39	08.99	00.79	0.150
16. <i>Glyconis arbora</i>	12.55	12.70	02.08	0.212

2. Discussion

Little is known about food and feeding habits of the cheetal. In the Corbett National Park itself, De and Spillett (1966) had reported six species of browse plants and two types of fruits eaten at Dhikala. In Kanha, (Madhya Pradesh) Schaller (1967) listed eight species of grass, eight species of grass-like plants, 32 browse species and eight types of fruits consumed by the cheetal. In the Bandipur (Karnataka), Sharatchandra and Gadgil (1975) mentioned grasses (species not given),

young shoots of lantana, *Phyllanthus* and bamboos, were eaten as food, supplemented by nine browse species including, interestingly enough, *Calotropis gigantea* which is a highly lactiferous and poisonous plant.

The present study revealed at least 15 species of grass, 38 different browse plants, two types of flowers and one variety of fruit on which the cheetal fed at Dhikala.

It would be interesting to note in both Schaller's (1967) area, and the present study area, seven of the grass species are common. Among the browse species 24 are common to these two areas ; and the rest are new to the present study.

V. DAILY SCHEDULE OF ACTIVITIES

1. Observation

(a). *General Activities*

Generally, the cheetal became active well before dawn and started its morning activities in the vicinity of the night resting places. The morning activities comprised chiefly restricted movements of individuals for feeding, grooming (both of self and social), body-stretching, calling, drinking, urination, defecation, basking in the sun (during winter in particular), stumping, yawning, tail movements, tongue movements, loafing and herd movements etc. Before heading for the day-resting places, the whole or part of a herd may go for a drink of water (plate 9A). On their way to day-resting places they may stop here and there to graze or browse if food grazing or browsing is available on the way.

On reaching the day-resting place the various members of the herd retired in available shade (plate 9B). Some members of the herd normally took up the watch and ward duties, while the others were resting. The ratio of such individuals to the others hardly exceeded 1 : 10. Occasionally, one or the other of such individuals would sit down to rest while another would get up and start moving in and around the herd while nibbling occasionally. These were the individuals which always took notice of any disturbance nearby and were the first to pass on the danger signals to the rest of the herd. While resting, most individuals indulged in chewing the cud. About 28-32 chews were

recorded for each bolus in 30-35 seconds (plate 18A) When chewing the cud is over the individual may lie in a posture rest (plate 9B) In the afternoons, about a couple of hours before dusk the herd left the day-resting place to begin its evening activities which were similar to the morning activities but in the reverse order of herd movements i. e. from day resting place to night resting place.

Night activities could not be studied in detail. Some casual observations for locations and movements of these herds were, however, made whenever possible, with the help of artificial light. Such observations revealed that evening activities may continue for about a couple of hours even after sunset. Thereafter, the herd may move towards water or remain and rest in the night-resting Place.

(b). *Factors Influencing the Daily Schedule of Activities*

Weather conditions, predator activity and sudden disturbances caused by other larger animals, including man, disrupted the daily schedule of entry and emergence from the ecotone and grazing hours.

Temperature :

It was noticed that daily temperature effected the daily entry and emergence of the cheetal from the ecotone to a large extent. The rise or fall in temperature was directly responsible for early or delayed retirement of the herds to the day-resting places (ecotone). In the cooler periods of January to March when the temperature fluctuated between 9.0—16.0°C (minimum) and 15.0—20.5°C (maximum), the major part of the population remained on the 'Chaud' (meadow) throughout the day, using the shadows available in the 'Chaud' as day resting places. During warmer periods of April to June, when temperature rose to 19.0—25.0°C (minimum) and to 28.0—36.0°C (maximum). they started entering the ecotone. In winter the cheetal entered the ecotone, if at all, well after the daybreak (about 1100 hrs.) and came out early in the afternoon (about 1530 hrs.), spending more time in the 'Chaud' than in the ecotone. During summer, on the other hand, the animals entered the forest early in the morning and came out very late in the evening, sometimes after sunset (about 1925 hrs.). Thus, they spent comparatively less time on the 'Chaud' and more time in the ecotone (Table 16). The only exception to this was in the summer of 1978 when a part of the local population of about 150-200 individuals stayed near the lake and in the river bed for the whole day (plate 10).

TABLE 16—*Showing relationship between temperature and time of entrance and emergence from the ecotone during the period January to June 1978.*

Dates	Temperature		Hours of		Local time of	
	Minimum	Maximum	Entrance	Emergence	Sunrise	Sunset (in hrs)
Jan. 18	9.0	15.0	1155	1530	0720	1740
31	9.4	16.5	1100	1540	0710	1750
Feb. 23	10.0	17.0	1000	1530	0700	1800
24	10.0	17.0	1040	1530	0700	1802
28	13.0	19.5	1015	1630	0658	1804
Mar. 4	16.0	20.0	0930	1630	0655	1805
5	16.5	20.0	0945	1645	0655	1810
7	16.5	20.0	0930	1645	0655	1810
8	16.0	20.5	0930	1645	0654	1810
9	16.0	20.5	0945	1645	0647	1813
Apr. 1	14.5	28.0	1000	1700	0623	1825
11	19.0	34.5	0915	1740	0619	1842
14	20.5	35.0	0915	1800	0617	1833
16	22.5	35.5	0910	1810	0619	1833
May. 5	25.0	37.0	0645	1715	0557	1845
15	23.0	38.0	0615	1730	0557	1845
18	22.0	39.0	0615	1800	0545	1855
Jun. 12	24.5	36.0	0605	1915	0535	1900
13	25.0	36.0	0555	1825	0535	1903

Further, observations made on some particular herds, viz., A₁, A₂, A₃, B₁, and B₂, revealed that during cooler months, when the temperature was comparatively low, the cheetal drank water only once a day, normally after morning grazing. In summer, when the temperature was comparatively high they drank water twice a day—once before entering the forest i.e. in the early hours of the morning (around sunrise) and again in the afternoon, before or after evening grazing. Stray cases of drinking at high noon were also observed.

Fog and dew :

The study area being semi-dry deciduous forest, fog and dew occurred

quite often during winter i.e. November to mid-January. On days when the dew was heavy the animals which spent the night in the open delayed their entry in the ecotone, presumably to avoid wet vegetation. Similarly, on days when there was heavy fog the animals grazed in open areas for longer periods and entered the ecotone after the fog lifted.

Clouds and rains :

On cloudy days the animals remained on the meadow for a longer time, sometimes even for the whole day. Light drizzle did not force them to take cover, they continued their normal activities in the open instead. During heavy rains a herd would take shelter under a selected or favourite patch of trees. When caught by rain away from this shelter, the animals ran fast to reach it quickly.

Storm :

During heavy storms the whole herd generally assembled under a large, thickly foliated tree or a grove of trees inside the favourite shelter area. Thunder storms too appear to affect herd activity. The first peals of thunder drive the herd headlong in to the nearest shelter.

Predator activity etc. :

Predator activity and sudden disturbances including those caused by man, affected the entrance and emergence of herds from the ecotone to a considerable extent. On several occasions it was observed that the presence of a tiger in the vicinity of the entry or exit point of the ecotone, delayed the entry or exit of the herd by as much as two and half hours. As long as the herd could sense the presence of the predator through audiovisual or olfactory clues, it would remain agitated, moving to and fro but avoiding the general direction of the danger, members often emitting alarm calls and signals. They would come out or go in only when they felt that the predator had moved away.

Besides this, on a number of occasions, it was also observed that the presence of larger animals like the elephants, also influenced their (cheetal) entry and emergence from the ecotone (for details see inter-specific interactions in the next chapter).

c). *Diurnal Activity Profiles*

For this purpose only those herds which stayed in the open and could be observed clearly were selected, and four such herds were

studied. Observations on one herd at a time were recorded every hour from sunrise to sunset. The following parameters were covered :

- i) Feeding
- ii) Bedding (or sitting, both alert and relaxed)
- iii) Moving
- iv) Standing

In all, 4084 observations were made spread over a period of 82.0 hours embracing all the three seasons. The visibility in the study area is almost nil during September till end of January on account of tall grass. It was, therefore, not possible to study this aspect at this time of the year. By the end of January the grass is burnt by the forest department to provide new sprouting grasses to herbivorous animals. It was thus possible to observe the herds for the diurnal activities profile from February to August.

A. *Cold-season* (Representative days February, 12th and March, 10th, 1979).

(i) Feeding :- During the cold-season, feeding was at its peak at sunrise and again around sunset. Almost all individuals of the herd were seen feeding between 0600 and 0900 hrs. Thereafter, they started lying down to rest (bedding). The number of grazing individuals dropped from 100% during 0600 to 0900 hrs. to 75% during 0900 to 1000 hrs. to 43.7% during 1000 to 1100 hrs. to 7.1% during 1100 to 1200 hrs. and to 1% during 1200 to 1300 hrs. After a virtual cessation of this activity at mid-day it started increasing again from 1300 - 1400 hrs, to 56.2% between 1400 - 1500 hrs, to 75% between 1500 - 1700 hrs, till it registered its peak of 100% between 1700 - 1900 hrs. (Figure 9A).

(ii) Bedding :- Bedding follows feeding. After an individual has, presumably, satisfied its hunger it lies down to ruminate. At day-break this activity is completely absent. By 1000 - 1100 hrs. some of the individuals start bedding. The percentage of such individuals was noticed to be 56.2% between 1000 - 1100 hrs. The numbers of individuals bedding increased gradually to 85.7% between 1100 - 1200 hrs. The peak was reached between 1200 - 1300 hrs. When 93.0% individuals were noticed bedding. The zenith incidentally was reached when the first mentioned activity i.e. feeding was at its nadir of 01.0% some individuals, presumably early bedders, get up and start feeding after

1300 hrs. and others keep joining them during the afternoon. As a result the percentage of individuals bedding declines from 68.5% between 1300 - 1400 hrs., to 18.7% between 1400 - 1500 hrs. and to 21.1% between 1600 - 1700 hrs. After 1700 hrs. hardly any bedding individuals were seen (Figure 9A).

This activity also embraces movements which are made for taking water, but not enough of such movements could be recorded in respect of a herd under observation. A number of other herds or individuals were seen on their favourite watering places, normally, after morning feeding during this season (Please see discussion also).

(iv) Standing :- While feeding the animals do not stand still. They keep on moving and nibbling. In the hot months, during middle of the day most of them preferred to stand rather than bed. But at this time of the year hardly any standing activity was noticed (Figure 9A).

B. *Hot season* (Representative days May, 13th and June, 18th, 1978)

(i) Feeding :- During the hot season also the feeding activity was at its maximum during 0600 - 0700 hrs. around sunrise and sunset. As the sun rose and the temperature increased individuals started bedding. Their number increasing every hour. The number of feeding individuals dwindled in the inverse ratio. From 75.0% between 0600 - 0700 hrs. the number of feeding individuals fell to 52.0% between 0800 - 0900 hrs. to 41.6% between 0900 - 1000 hrs., to 27.6% between 1000 - 1100 hrs. to 10.2% between 1100 - 1200 hrs. to 6.7% between 1200 - 1300 hrs. After reaching its lowest during 1300 - 1400 hrs. this activity picked up again from 1400 hrs. onwards. The percentage of feeding individuals rose from 15.2% between 1400 - 1500 hrs. to 21.4% between 1600 - 1700 hrs. to 29.9% between 1700 - 1800 hrs. to 65.3% between 1800 - 1900 hrs. till its attained its peak of 99.2% between 1900 - 2000 hrs. (Figure 9B).

(ii) Bedding :- During hot season the mid-day bedding activity was accompanied by standing during mid-day. This phenomenon was responsible for two peaks a day in bedding activity in this season. This activity started around 0600 hours. During 0600 to 0700 hrs. 5.3% individuals were noticed bedding down. Bedding increased gradually till 1000 hrs. when 49.0% individuals were observed bedding. As the

day advanced further a number of bedded individuals were seen rising and standing still. Thus the number of bedding individuals fell constantly from 1000 hrs. onwards. During the mid-day hours (1200 to 1400 hrs.) only 2.5% of the individuals remained bedded. After 1400 hrs. the trend reversed. A considerable number of individuals started bedding again. By 1700 - 1800 hrs. the percentage of bedding individuals rose to 61.2%, only to fall again to 0.4% by 1900 hrs. (Figure 9B).

(iii) Moving :- During this season there was hardly any movement from one grazing place to another or from a grazing place to the preferred bedding place in the 'Chaud'. Only 0.0 to 19.6% of the individuals indulged in this activity which also includes the movements of individuals going to drink water available nearby the staying herd (Figure 9B). More than 70% of the population, however, moved into the forest cover by 0630 hrs.

(iv) Standing :- Standing activity was, perhaps, the most prominent activity during this season. It commenced in the morning between 0700 - 0800 hrs. when 11.2% individuals were observed standing. The number of standing individuals observed rose steadily till it reached a maximum percentage of 91.6% between 1300 - 1400 hrs. Thereafter their number decreased to 44.4% between 1400 - 1500 hrs, 34.9% between 1500 - 1600 hrs, 27.1% between 1600 - 1700 hrs, 5.9% between 1800 - 1900 hrs. till it touched the lowest of nill/ 0.0% between 1900 - 2000 hrs. (Figure 9B).

C. *Rainy season (Monsoon)* (Representative days July 27th and August 7th, 1978)

Whereas during the cold and hot seasons there was a fixed pattern of activities i.e. feeding ; bedding (standing) bedding ; feeding ; in the wet season this sequence was not maintained presumably on account of intermittent rain. The various activities increased or decreased abruptly with no gradual overlap.

(i) Feeding :- Feeding activity kept on changing abruptly. 73.3 - 86.6% individuals were observed feeding between 0600 - 0800 hrs. But during 0800 - 0900 hrs. the activity ceased suddenly. Hardly any individual was found feeding. In the next hour (0900 - 1000 hrs.) 38.3% individuals were again feeding, and 63.6% between 1100 - 1200 hrs.

But their percentage dropped abruptly to 3.3-4.5% during 1200 - 1400 hours. And again rose suddenly to 85.2% during 1400 - 1500 hours. Once more it came down to 4.4% between 1700 - 1800 hrs. and went up abruptly to 96.6% during 1800 - 2000 hrs. (Figure 9C).

(ii) Bedding :- Similarly, bedding activity also did not follow any fixed pattern or sequence. It was commenced by 82.9% between 0800 - 0900 hrs. immediately decreased to 30.3% in the next hour, and 47.0% between 1000 - 1100 hrs. but dropped suddenly to nil between 1100 - 1200 hrs. again increased abruptly to 93.1% between 1200 - 1300 hrs. Once again came down to 6.9-8.2% during 1400 - 1600 hrs. and rose suddenly to 45.8% between 1600 - 1700 hrs. And finally again went down to 1.6-3.3% during 1800 - 2000 hrs. (Figure 9C).

(iii) Moving :- This activity was apparently most pronounced during this season. Whereas in the cold and hot season it was observed to be minimal, never exceeding 25.0% it rose to 51.1% during this season (Figure 9C). This is perhaps the only activity that did not adhere to any fixed pattern or sequence in any of the seasons (see also discussion).

(iv) Standing :- During the rains this activity was greatly reduced although it followed the earlier pattern of hot season, culminating between 1300 - 1400 hrs. when as many as 46.6% of the individuals got involved (Figure 9C).

2. Discussion

Most of the previous workers such De and Spillett (1966), Schaller (1967), Prater (1971) and Sharatchandra and Gadgil (1975) have made a casual mention of the daily activities of the species. Only Graf and Nichols (1966) attempted a general account of routine activities like daily movements, resting, effects of weather on daily movements, seasonal movements, water-use, trailing, etc. None of them made any attempt to study the 'diurnal activities profile' of the cheetal by observing the animals continuously from sunrise to sunset, at various times of the year and the present is the first such study.

(i) Feeding :- Feeding activity, as the name indicates, consists of food ingestion. This activity had been mentioned by most previous

workers. It starts a little before daybreak and ends sometimes after sunset. There are breaks in this activity during the day when the animals follow other pursuits. Feeding activity does not appear to follow a uniform pattern throughout the year. It varies from season to season. During the cold season the activity lasted well into the forenoon and was resumed again early in the afternoon. Around day break and again around sunset, this activity was observed to reach its peak when the whole population was found feeding.

During summer, although the general pattern remained the same, the feeding decreased to a major extent within a couple of hours after daybreak and was not resumed in full swing till about an hour before sunset.

During the rains this general pattern of the two foregoing seasons was abandoned. Although the feeding was resumed before sunrise it failed to reach the two daily maximum or peak periods. More than 50% of individuals were seen feeding at odd hours throughout the day. This aberration was perhaps due to moderate temperature and abundance of food giving the animals a wide variety of choice of time and food material. This assumption is supported by the fact that with the rise in temperature during summer the activity became confined to early mornings and late evenings when it was comparatively cooler. The same factor lengthened the feeding hours during the winter days.

(ii) Bedding :- After the animal has fed for a period of time and its hunger is satiated it sits down to rest and ruminate. This activity is known as bedding. Bedding occurs both during the day as well as the night.

During the cold season, as has already been stated the feeding activity lasts well into the forenoon and is resumed early in the afternoon. The animals bed for a very short period of about four hours during mid-day

During the hot season this activity was initiated much earlier. About 5.0% of the population started bedding a couple of hours after sunrise. Between 0900 and 1000 hours maximum individuals were found bedding. It was interesting to find that during mid-day, contrary to the pattern in winter, this activity decreased drastically, only to be resumed from 1400 hrs onwards a second peak around 1700-1800

hrs. It is rather difficult to hazard an explanation for this change, Presumably the animals have to undergo more physical strain in finding food during the scarcity months of summer. This combined with the exhausting heat, forces them to rest earlier and on several occasions during the day.

During the rains this pattern (of the two foregoing seasons) too was abandoned. Bedding became erratic and unpredictable. During the one hour as many as 80.0% were seen bedding. In the very next hour or two not even a single individual could be seen sitting. The same factors (probably intermittent rain) which cause the aberration of feeding activity are, probably responsible for this also.

(iii) Moving : As already stated, the movement considered here includes only those movements which were made by an individuals in search of better grazing from one place to another or from a grazing place to a bedding place and vice-versa.

During winter a major part of the population stayed in the 'Chaud' throughout the day. Most of individuals which were feeding hardly moved a far in search of food. Most of them bedded quite near or in the grazing area itself.

During summer more than 70.0% of the population moved into the forest cover (the day bedding place) by 0630 hrs. It was impossible to observe the animals once they entered the forest cover. There were, however, two superherds ('C' and 'D') which remained near the edge of the lake throughout the day in summer. In these superherds hardly more than 25.0% of moving activity was noticed (Figure 9B). As these two superherds made up about 30% of the total cheetal population, it will perhaps be more realistic to say that the moving activity is at its maximum during the summer involving as much as 77.0% of the whole population. The histograms (Figure 9B) pertain only to the superherds 'C' and 'D' which showed the minimal moving activity and are likely to mislead one at the first glance.

During rains this activity, too, was thrown out of gear. Movements occurred sporadically at almost all hours of the day, involving 5.0 to 51.11% of the population observed.

(iv) Standing : During the summer of 1978 a curious phenomenon was observed in the herds under observations, viz., that they did

not enter the forest. In between the two peaks of bedding activity of individuals of 55.0 to 91.0% of all ages and sexes were seen to stand up and stay like that without any movement for hours at a stretch (maximum 3 hours.). The particular portion of the home range when these superherds 'C' and 'D' stayed for the whole day during summer was about 2 kilometres from the edge of the forest. This area was inundated during late 1978 and hence was not available in 1979. As a result those superherds, too moved into the forest in the summer 1979.

A possible explanation to the riddle of these animals standing motionless during the hot mid-day hours could be that they were merely trying to catch the cold breeze coming across the lake when lying down became too uncomfortable. This reasoning is further strengthened by fact that no standing activity was noticed either during winter or during the rains.

VI. GENERAL BEHAVIOUR

1. Observations

As already stated, four superherds (divided into eleven herds) existed in the study area. Their daily routine of activities, diurnal activity profiles, locations, movements and favourite day and night resting places have already been discussed in the foregoing chapters. Herd behaviour was mostly observed from the specially constructed observations posts in the home range of various herds.

General behaviour was studied under the following two broad categories : (a) Intraspecific interactions and (b) Interspecific interactions. Each of these two categories was studied under normal as well as under stress conditions.

a) *Intraspecific Interactions*

Intraspecific consisted mainly of two types of interactions, viz., herd leadership and interherd interactions.

Herd leadership :

Leadership in cheetal herds exhibited a tendency towards matriarchy as will be evident from the following observations. The term 'leader' has been applied here for an individual who usually led or directed the herd members during various herd activities. In the majority of cases it was females, who are, as a rule, more alert than

males, performed this function, the female leader was often accompanied by its fawn. The following types of leadership behaviour were observed under normal conditions :

(i) Herd C_1 , after performing its morning activities proceeded towards the day resting place. It was always led by an adult female. As soon as the leader reached a suitable resting place she stopped in her tracks, scanning the scene warily and was on the look-out for the slightest unfamiliar or dangerous movement or sound. An out of place undulation of the grass blades, the slightest movement or sound from the observation post, even the dropping of a twig by a vulture nesting in the tree near the observation post, immediately attracted her attention. Whenever she caught a glimpse of such a movement or heard a sound, she started off in search of another suitable place. Other members of the herd followed her. Even those who had in the mean time bedded down, got up and followed the moving herd. At no time was the leadership questioned by any section of the herd, which dutifully followed the leading female.

(ii) Very early in the morning large night gatherings (superherds) broke up into herds and subherds. For example, superherd 'A' divided itself into three herds, i. e. A_1 , A_2 and A_3 . Each of these herds started moving to its respective feeding or watering place, moving in a single file. In 304 separate observations of various herds on almost 80% of such occasions these herds were seen being led by an adult female.

(iii) Similarly, a female was almost always seen leading these herds and subherds when they moved towards the day resting places or forest cover often in a single file.

(iv) Almost the same pattern was repeated when herds emerged out of ecotone in the afternoons or evenings.

(v) On rare occasions, when these herds broke up in the face of danger or in the pursuit of normal activities like watering, etc., the splinter group again were led by a female, although one or more males were present in the splinter group.

However, under conditions of extreme stress and strain, *viz.*, discovery of a stalking predator, the member first to notice the danger and make a move, whether a male or a female became the leader of the herd in race to safety.

Interherd interactions :

Under normal circumstances herds or subherds kept their entities insomuch as their members stuck together. Occasionally a certain number of individuals detached themselves from a herd or subherd which was moving towards the forest cover, and moved to either to its usual watering place or to another herd which was either grazing or resting at a distance of a kilometre or more.

During the rutting season, however, lone rutting bucks were often seen wandering from one herd to another presumably in search of receptive females (Plate 21B).

Under unusual conditions, like threat posed by the presence of a predator, or patchy availability of food caused by gradual ecological changes, different herds intermixed freely without showing any aggression.

In the monsoon months of 1977, different herds were seen integrated in a single large herd of as many as 526 heads ; this was the largest herd encountered in the study area.

On a number of occasions it was observed that the sudden discovery of a stalking tiger by herd member evoked an abrupt alarm call. On hearing the call all members of the herd left their occupation of the moment to freeze in an alert posture, gazing in the general direction of the danger.

Whenever an alarm call was given out by a herd member it was generally taken up by other herds or subherds present in the vicinity. The members of such herds became alert and started looking in the direction of the danger. Some individuals of such herds did not, however, pay much attention to the alarm broadcast except that they looked for a while and again turned their attention to their, grazing, etc. (Plate 11A). An example will illustrate the point. On the 6th of August, 1977 at 1200 hrs. alarm calls were heard repeatedly.

On investigation through a pair of binoculars the source was found to be two herds, viz., Hx and Hy, which were in greatly agitated state in the river bed. The Hx individuals were sending alarm calls while the Hy individuals were running towards the river. Suddenly a tiger was observed in a clearing in the area from which the herd Hy was

fleeing. Hx members were still calling. The tiger was holding a large cheetal stage in its mouth in full view of herd Hx. The emergence of the tiger did not make the Hx individuals run away. They held their ground but kept on emitting the alarm calls, while the Hy individuals were running for dear life.

b). *Interspecific Interactions*

These interactions fall into two broad categories, viz., (i) interactions with other sympatric herbivorous species; and (ii) interactions with predators, specially the tiger, living in the area.

(i) Other herbivorous species involved were as follows: Barking deer, Sambar, Elephant, Wild boar, Hog-deer and Swamp deer.

The last one (a female swamp deer) appeared all of a sudden on the 9th of March, 1978 in the area. It was seen accompanying one or the other cheetal herds of the study area. It lived for a couple of weeks and then disappeared as suddenly as it had appeared, after the 26th of March, 1978 (Plate 11B)

Barking Deer and Sambar: Both the Sambar and the Barking Deer kept mainly to the forest and hardly invaded the grassland. The Sambar did invade the grassland occasionally, specially in summer. But the number of such animals was never more than half a dozen in the whole of the 'Chaud' at a time and hence insignificant for any interaction.

Elephants: Elephants did not stay in the study area round the year. They kept on migrating from one part of the Park to another visiting the study area mostly in summer. By April the winter sprouting grass in the 'Chaud' attained sufficient height to attract their attention. During such periods, elephant herds occupied those areas of the 'Chaud' where the grasses were rather tall and unfit for consumption by cheetal so there was not direct clash of interests.

It often happened that a grazing herd of elephants blocked an entry or exit route of a cheetal herd. Whenever confronted with such a situation, the herd or subherd would circumvent the elephant herd and make a detour for their entrance to or emergence from the forest. They were never seen to trespass or open up a corridor in an area where

the elephants were grazing. As a rule, they kept at a respectable distance of 50 to 500 metres, even while feeding in the vicinity of an elephant herd.

Wild boar : The wild boar also utilized the 'Chaud' area as their feeding ground. But they mostly fed on the roots in contrast to the cheetal which feeds on blades. This considerably reduced the area of conflict. The cheetal generally avoided the area or patches where wild boars were actively digging. When invaded by wild boar, cheetal would yield ground rather tamely ; they moved away to accommodate the invader and started grazing in close vicinity. On four occasions it was seen that a wild boar dashed into a grazing cheetal herd, disrupted their grazing, displaced them and started digging in the area. An example, as observed on the 5th of March 1979, is described below in detail.

At 1645 hrs herd C₁ (20 individuals) was seen grazing near observation post Number 4 (see map). Suddenly, a male boar dashed into this herd, from a grove west of the herd. On observing the boar hurtling upon them and crashing through the vegetation, members of the herd hurriedly moved out of its way, watching it all the time with alarm and curiosity. The boar halted its rush when it had reached almost the center of herd and stood watching belligerently. None of the cheetal around it showed any signs of hostility. Instead, they moved slightly northwards leaving the boar in full possession of the patch they were grazing on. The boar started digging as soon the cheetal moved away. After having moved about 20 metres or so the herd stopped and gazed at the boar which went on digging most unconcernedly, satisfied that the boar was content with his occupation and had no further hostile design the herd too resumed its grazing.

Hog-Deer : Hog-Deer was the only other deer which shared the 'Chaud' with cheetal for grazing, resting and bedding throughout the year. They utilized different locations in the 'Chaud' for resting and bedding but associated actively with the cheetal while feeding. The cheetal was observed to maintain dominancy of sorts over the Hog-Deer which is smaller in size and poorer in numbers. On a number of occasions, individuals Hog-Deer were seen conceding a favourite bedding or resting spot or a food plant or bush to a cheetal. Even female cheetal were observed to push over a full grown Hog-Deer.

This submissive behaviour of the Hog-Deer was most prominent at the salt licks provided near the observation posts. Whenever a cheetal

or a cheetal herd was at salt block, no Hog-Deer dared approach. On occasions when a Hog-Deer was first to reach the salt lick, it gave up licking and tamely moved away on the approach of a cheetal. It preferred to wait at a short distance away till the antagonistic cheetal cleared away rather than offer resistance.

(ii) Interactions with predator especially the tiger : The predator species existed in the area were as follows : The panther, the tiger and the jackal (predator of fawns).

Although these predator species existed in a considerable number in the Park, yet no panther could be seen, by the observers in the study area. The only indirect evidences observed were occasional tracking of pug-marks (foot prints) and are sighting of a fresh kill (an adult female cheetal) which was lying in a Panther's larder (a *Ficus religiosa* tree) situated slightly east of the intensive study area. This very thin existence of the panther in the area was probably due to interspecific competition between the tiger and the panther. Thus no significant interaction between the panther and the cheetal could be studied.

But the sighting of tigers and jackals was quite frequent and existed in a considerable number in the intensive study area. As already stated in Chapter II, the audiovisual observations revealed that at least four tigers and six jackals lived in the area. As the tiger is a nocturnal animal, interactions studied with it usually were quite limited. Observations showed that when a cheetal or cheetal herd discovered a stalking tiger they left their occupation of the moment and took up an alert posture mostly accompanied by repeated alarm calls (for detail see examples given under the headings interherd interactions and communication).

Interactions observed with jackals (predator of the fawns) revealed that whenever a stalking jackal was discovered by a cheetal or cheetal herd they became alert and kept a scanning watch so long as the jackal remained in the vicinity. As soon as the jackal disappeared they resumed their occupation of the moment like grazing etc.

2. Discussion

A number of ethological studies have been carried out under natural and near natural conditions on a number of deer species in various parts of the world. The comparatively recent ones, are :

Altmann (1952), Picton (1960) and Craighead and *et al.* (1973) : Elk ; Chaplin and White (1970) : Fellow Deer ; Espmark (1971) Muntjak ; Espmark (1964) : Rein Deer ; Espmark (1969) : Roe Deer ; Lowe (1966) and Linchol *et al.* (1970) : Red Deer ; Hawkins and Klimstra (1970), Sparrove and Springer (1970) and Verme (1973) : White-tailed Deer ; Pimolt (1959) and Phillips *et al.* (1973) : Moose and Robinette (1966) : Mule Deer.

Among the Indian Deer, the Barasingha or Swamp Deer was studied by Schaller (1967) and Martin (1975). Some behavioural aspects of the spotted Deer have also been studied by De and Spillett (1966), Graf and Nichols (1966), Schaller (1967), Krishnan (1972) and Sharatchandra and Gadgil (1975).

It is a well-known fact that herd leadership in the deer family is confined to the female. Herd leadership by female cheetal as reported here, was also revealed by studies of De and Spillett (1966) and Schaller (1967). In other mammals also such herd leadership by females is known to exist e. g. the 'African Elephant' (Iain and Oria, 1977) ; the 'Ass' (Antonis, 1937) ; and the 'Banteng' (Hoogermorf, 1978) etc.

Although a number of previous workers such as De and Spillett (1966), Graf and Nichols (1966), Schaller (1967) and Sharatchandra and Gadgil (1975) studied ethology of the cheetal, none of them ventured to describe interactions among various herds of the cheetal and its interspecific interactions.

The foregoing observations on interspecific interactions revealed that there was hardly any interaction with Barking Deer and the Sambar, which is probably due to the different habitations in the area. Interactions with elephants were also meagre, presumably due to utilization of different pockets in the area. But interactions between the cheetal and wild boar and between the cheetal and Hog-Deer were confined to dominance only. The present study revealed that the Wild Boar dominated over the cheetal, whereas the dominance of the cheetal was observed to be over Hog-Deer. However, no severe fights resulting in injury were observed. Obviously, due to availability of sufficient area for existence, food and water in the area. One more important point which may be an explanatory one is a proportionate populations of these sympatric species, e.g., the maximum ratio between

Hog-Deer and Cheetal populations was about 1 : 10 during the study period.

VII. SOCIAL BEHAVIOUR

1. Observations

(a) Occupation of Bedding Sites

Cheetal herds and subherds observed from January to June exhibited a great diversity of age and sex ratios. Mixed herds, which were sighted throughout the year, were composed of all age and sex classes. Observations made on such herds at specially provided salt licks near observation posts and herds resting in their day bedding grounds showed that they had a certain 'order' for occupation of favourable sites. On reaching the day-resting ground, after the morning grazing, various members of the herd started bedding. While bedding there was always a scramble for more cosy, comfortable or protected spots. The occupation of a coveted spot was always decided by superior body build and size. Yearlings occupying a better spot were nudged and pushed away by adult females. The later, in turn, gave ground when accosted by an adult male. The adult male yielded tamely to the nudge and push of heavier males or bigger antlered male. The challenged one always got up and moved away, while the challenger made itself comfortable on the vacated spot.

As an example, the following account of the social behaviour of herd C₁ on 26th March, 1978, will further elaborate the points made above. At 0930 hrs herd C₁, which was being led by an adult female, reached its day-resting place, a large 'semal' tree (*Bombax ceiba*) near observation post No. 3. The herd consisted of 16 individuals, (3 adult males, 3 yearling males, 4 adult females, 3 subadult females, 1 yearling male, and 2 fawns). For convenience of recording various herd members were distinguished as follows :

Males :

- Adults : M₁..... Possessed c 60 cm long hard antlers.
 M₂..... Possessed c 40 cm long velvet ,,
 M₃..... Possessed c 18 cm long velvet ,,
- Yearlings : M₄..... Possessed hard spike antlers.
 M_{5, 6}..... Possessed velvet spike antlers.

Females :

- Adults : F_{1, 2, 3}...Largest females of the herd.
 F₄.....Large female but being accompanied by a fawn.
- Subadults : F_{5, 6}Smaller than adults.
 F₇ As above, but accompanied by a fawn.
- Yearlings : F₈ Smallest among the females but larger than fawns.

Their social behaviour as observed for four hours is recorded below :

<i>Time</i>	<i>Behaviour, etc.</i>
0945 hrs	All individuals are lying in the shade of the 'semal' tree.
1000 hrs	The spot occupied by F ₁ loses shade.
1023 hrs	F ₁ nudges F ₅ and occupies the later's place.
1050 hrs	M ₃ stands up and starts nibbling grass.
1125 hrs	M ₃ reaches near F ₁ pushes her gently and occupies her place.
1147 hrs	The spot occupied by M ₁ also loses shade.
1221 hrs	M ₁ nudges M ₃ and occupies the later's resting spot.

b). *Mother-Fawn Relationship*

Female-fawn relationship is the strongest social bond on account of the mother sticking to the fawn (and vice versa) for at least a year and sometimes even two or more years. The bond is established at the birth of the fawn.

Pregnant females, often lone, were sighted most often during November. The maximum number of fawns were observed from December to March. Females, in advanced stages of pregnancy, dropped out of the herd and remained in the vicinity of thick cover for the purpose of parturation. No actual parturation could, however, be observed. On a number of occasions newborn fawns were observed (Plate 12A). On one occasion the parturation was so recent that neither the mother nor the fawn could stand up and walk in spite of their efforts to do so when they found the elephant carrying the observers almost stepping on them (Plate 12A). Freshly born fawns were seen to be licked extensively by the mother. Within about four to six hours of the birth, the fawn was able to get up and walk though it was a little wobbly at first (Plate 13A, B and 14A).

Such newly born fawns were kept hidden or remained well camouflaged with such efficiency that their presence was noticed only when one was about to step on them (Plate 12B). The mother remained in the vicinity of such fawns. She fed in a limited area around the spot where the fawn was hidden and suckled the fawn from time to time. This arrangement was maintained for a week or so. By this time the fawn became strong enough to accompany its mother. At this stage the female joined the herd and participated in various herd activities. This was in fact the time when most newborn fawns were sighted during casual observations.

The ultimate reaction of herd in the face of danger was to make a bolt for safety. On such occasions the young (10-30 days old) fawns were unable to keep pace with the herd. They headed for the nearest thick cover and froze there. After the danger was over the mother returned to the original spot in search of the missing fawn. These females could be distinguished easily by their distinctive posture and mode of approach. They approached the spot walking slowly, with the neck extended, ears raised and facing in front (Plate 14B). Every now and then they would stop to listen by orienting the direction of the upraised ears. It is difficult to say how exactly they could detect the exact spot where the fawn was hidden. No sounds (audible to human ear), movement or sign were made by the fawn which stuck to its position till the mother joined it in the cover. Perhaps olfactory clues also play an important role in this search in which ears and eyes were seen to be used prominently.

Such females were a common sight during the fawning period. It may take upto two or more hours for a female to recover her lost offspring. On one occasion (March 21st) such an incident was noted in detail. At 0745 hrs, herd B_g was chased by a tiger near observation post No. 2. One of the females left its fawn behind. The fawn took shelter in a patch of tall grass west of the post. At 0835 hrs a lone female was seen approaching the observation post area from a distance of about a kilometre. She came at a good pace at first but on reaching the spot from where the herd had bolted, she slowed down. All the while she had her neck extended in front and ears raised. It took her 12 minutes to cover the distance. On reaching the patch of grass where she had left the fawn she scanned the surroundings, as if watching for danger and proceeded very slowly towards the cover where the fawn was hiding. After every few steps she would halt and scan.

It took her nearly seven minutes to cover the last 50 metres. At 0855 hrs she had disappeared in the grass cover where she remained for about 15 minutes, presumably suckling and grooming the fawn. At 0910 hrs she emerged from the cover followed by the fawn and proceeded towards the general direction of herd B₃ which had by now reached the edge of the forest near their entry point to the ecotone. The return of the mother to the endangered spot within an hour or so to retrieve its young one jeopardizing her own safety in the process, indicates the existence of a very strong female-fawn social bond.

Whenever a fawn strayed away from its mother and started following another female in the herd, the mother would invariably walk up to the erring fawn and groom it. After this treatment the fawn started following the mother once again (Plate 15A, B and 16A).

(c). *Suckling*

Suckling starts soon after birth. On many occasions the suckling behaviour was studied during the fawing season (Plate 16B). The typical posture of the fawn adopted for the purpose was to insert its muzzle through mother's front or hind legs to reach the teats. Having reached the teats the fawn would commence suckling often nudging the mammary glands and occasionally waving its tail. The process normally lasts for a minute or two, at the end of which it was usually the mother who moved and dislodged the teats. The fawn having lost hold of the teats, kept on following the mother, in the hope of another opportunity to feed

(d). *Preferential Mother-fawn Relationship*

On a few occasions it was seen that a single female who was being followed by two fawns behaved differently towards them. She would be partial to the one of them by grooming and suckling it. It is difficult to say whether one of the fawns earned the displeasure of the mother through misbehaviour (like biting the teats of excessive nudging) or because of its being foster offspring, which having lost its own mother tagged itself to this particular female.

In one such case it was observed that the mother was the consistently partial to one of the two fawns accompanying her. This made one wonder if the non-favourite was a foster-child. At least it appeared to be so. If true this opens a very interesting vista in the realm of social behaviour in cervidae.

(e). *Grooming*

Grooming has both biological and social functions. Two types of grooming were observed in the cheetal, viz., self grooming and social grooming.

Self grooming :

The organs chiefly involved in self grooming are : tongue, teeth (lower incisors), hooves (mostly hind hooves) and antlers (usually hard antlers in case of the male). Individuals of all age and sex classes used these organs for the purpose. Tongue, teeth and antlers are normally used for grooming the whole of the body except the neck and head. The later parts of the body are usually groomed by the hind hooves.

The various grooming gestures studied were as under :—

Tongue :— It is used for grooming the whole body including genital organs except the neck and head region.

Teeth :— Are used for grooming the whole body except the neck and head region (Plate 17A & B).

Antlers :— Are also used for grooming the whole body except neck and head region.

Hooves :— Are used for grooming the neck and head region,

Social grooming :

Social grooming, which is supposed to make social bonds stronger, was observed to be much more common in the case of mother-fawn and male-female associations. The tongue is the only body organ involved in this type of grooming. The following social grooming were noticed : (i) Mother-fawn (ii) Female-yearling and (iii) Male-female.

(i) **Mother-fawn grooming :—** The mother-fawn grooming began soon after the birth of the fawn. The mother started grooming her newborn fawn vigorously, possibly to remove the excess moisture and placental remains from the fur of the fawn. Presumably also this early grooming leaves some sort of olfactory indicator for recognition. Later, when the fawn started accompanying its mother, it frequently groomed the mother especially after receiving a grooming from her. Whenever

the fawn strayed away or started following a female other than the mother the mother walked upto the erring fawn and started grooming its (Plate 15A, B and 16A).

(ii) Female-yearling grooming :— The female-fawn grooming may continue till the fawn to be a yearling. But the frequency of grooming decreased with the increase in the age of the fawn. Such grooming was noticed on a few occasions even when the female was accompanied by a new fawn.

(iii) Male-female grooming :— Grooming between male and female was seen frequently during the rutting period, but did not follow any fixed pattern. Sometimes it was the male who started the process and the female reciprocated. At other times the female herself was observed to initiate the grooming which the male returned. This type of grooming appeared essentially 'sexual' in character and hence is dealt with in detail in the next chapter.

(f). *Communication*

The cheetal was observed to receive signals through all the five senses i.e., hearing, sight, smell, taste and touch. It transmitted or conveyed the signals through the following means :—

- (i) Calls (warning, danger and rutting)
- (ii) Postures (alert, threatening and appeasement)
- (iii) Stumping
- (iv) Scenting (olfactory stimuli)
- (v) Testing

Broadly, communication falls in the following five categories :— Visual, auditory, vocal, olfactory and tactile.

Visual :

Vision does not appear to be the strongest sense in the cheetal. Whereas it can see a moving object, even from a distance of a couple of kilometres, it often fails to take cognisance of a stationary object. Vision was observed to communicate danger signals as well as exhibit social behaviour.

On many occasions the observer stood unhidden but without making any movement on places, where a cheetal herd was expected

to come. The herd approached the spot without any apparent hesitation or show of alertness. Often it came within 10-15 metres of the observer. Thereafter the animals appeared to make a distinction between the observer and the surrounding natural objects as they became alert and did not approach any further. If a member discovered even the slightest movement it would raise its tail and start stumping, to draw the attention of the rest of the herd. Sometimes it even emitted an alarm call. The whole herd then becomes alert and watched the observer. If the observer could keep his fixed stance for about 10 minutes the fear was allayed and they restarted their activity of the moment. But any further movement in front of the watchful herd made them bolt, giving out alarm calls.

Visual communication was mostly accomplished by means of particular posture or action. The posture consisted of raising the head, erecting and facing the ears in front, gazing in general direction of the danger and raising the tail all the time. This posture may be termed as the 'alert posture' (Plate 14B). The action on the other hand, consisted of lifting a fore leg and tapping it on the ground in a rhythmic motion. This is known as stumping.

The body postures and actions i.e., the 'alert' posture or stumping are normally used to convey the presence of danger, usually a tiger. On ten occasions when these signals were being given out by a herd, the matter was investigated. On nine occasions it was possible to see the tiger which was causing it. On the tenth occasion, perhaps, it was the observer himself who gave the 'alert'

Visual communication was also made use of for exhibiting dominance during social gatherings and the dominant male or the winner of the sparring match struck the 'threat posture' head-up display or 'thrashing posture' (For details see Chapter VIII on reproductive behaviour).

Auditory :

The cheetal appears to possess an acute sense of hearing. The linear parabolic shape and almost 180 degrees mobility of the external ears strongly indicate a well developed mechanism to catch the slightest of sounds efficiently.

In fact the slightest of sounds or noise heard in the vicinity made the individual first to perceive the sound strike an alert posture, point its erected ears in the general direction of the sound and try to pinpoint its source. It does not lower its guard till it is convinced of the nature of the sound. A sound considered to be dangerous is reacted to by the emittance of an alarm call. But if the sound is deciphered as a harmless one, the disrupted activity of the moment is resumed. More than once an individual or a herd was observed to pick up the click of a hidden camera from a distance of about 15 metres. Even at the waterhole where the natural noise of the flowing water combined with the noise made by the animals themselves while drinking would be expected to impair the listening capacity, the animals were able to hear a camera click from a distance of 10 metres.

Natural sounds like the dropping of fruits, twigs of leaves, breaking of twigs, sudden burst of birds songs etc. were generally ignored but unnatural sounds like the whirring, of a movie camera, click of a shutter, human cough or sneeze, rustling of dress, creaking of shoes and conversation even when carried out in whispers was instantly picked up.

The individual cheetal and herds were seen to react to the vocalization of other animals especially the alarm calls of other species like Sambar, Barking-deer, Hog-deer, Langur, Rhesus monkey, Peacock, Red Jungle fowl and Red-wattled lapwing etc. even from a long distance.

Vocal :

A total of six different types of vocal sounds produced by the cheetal could be heard and recognised in the field. They can briefly be described as under :—

(i) Alarm call :— Whenever a cheetal is confronted with a sight or sound that arouses its curiosity or fear, it gives out a call which resembles a comparatively long drawn y-o-o-p or b-o-o-k. This call is given only once and is meant to invite the attention of others of the herd to the source of distraction. If the source persists the call may be repeated at intervals. The interval between these alarm calls varies from a few seconds to almost a minute and not more than two or three such calls are given.

(ii) Danger call :— An alarm call may often be followed by comparatively short-toned brisk y-u-p, b-o-k produced repeatedly with greater pressure. This happens when the animal becomes sure of the dangerous nature of the distraction. The sight of a tiger is sure to draw this response. The call is given out simultaneously by a number of individuals in the herd and at very short intervals of 5-10 seconds or even less. They keep on given out the call even when being chased by or fleeing away from the predator.

(iii) Female-fawn communication call ? :—(a) A short low pitched c-h-e-e or c-h-e, loud in the beginning but decreasing in intensity was produced by the fawn on the move in a herd. (b) A similar but louder sound was often produced by adult females also. As this type of sound was not heard from any other class of individuals in the herd, it is presumed that this sound served as some sort of communication between the female and its fawn and vice versa.

(iv) Sneeze :— A sneeze is part vocalization and part expulsion of air through the nostrils. Possibly the sneeze is a biological cum physiological phenomenon and has nothing to do with communication. Cheetal of all classes of sex and age sneeze.

(v) Rutting call :—This is a long-drawn horase sound 'yo-o-o-w-w' or 'h-h-a-o-u-u-h' produced by bucks during the rutting season. It has been termed as a bellow in literature. Two to seven such bellows constitute a single call. Three different calls i.e., 1st, 2nd and 5th could be recorded on a cassette tape tape-recorder.

Olfactory :

This was also observed to be one of the most acute senses of this deer. This acuteness was, however, evident indirectly. It was seen to be involved in discovery and conveying the presence of the danger, sexual receptivity, social aggression and social banhomie or welfare.

Although the tiger approaches or stalks its pray from up wind direction or the down wind of the prey, yet sometimes it was observed that a sudden change in the wind direction resulted in the immediate discovery of the predator by one or the other members of the herd, even when the predator was completely hidden and camouflaged as will be seen by the following incident. On 13, March, 1978 at 1800 hrs when the observer was coming back along the transect situated in

the east of the observation post number 1. A tiger was seen stalking, rather sitting and awaiting for a doe cheetal who was proceeding in the direction of the tiger, unknowingly. When a sudden change in the wind direction occurred, the doe did not proceed further; immediately it ran to about 150 metres away from the predator, at right angles and approached a place about 300 metres on its left, where some individuals of herd A₁ were grazing.

Similarly, on almost every observation day during the rutting season a rutting buck was observed to poke its nose towards the vulva of the females, obviously to determine the receptivity of the females. Not only this, but also such bucks were seen to sniff at some spots on the ground, viz., the place where some female had been sitting.

Such olfactory preceptions were also observed to be involved in conveying social aggression of the dominant males who 'Preached' against a tree and rubbed the eye region of their preorbital glands, presumably, to leave some smell. This was, however, detected by other male individuals, which also preached and rubbed the same region either back and forth or up and down on the same tree.

Tactile :

The sense of touch was mostly used in checking the receptiveness of the females, suitability of the available food etc. Observations made on feeding animals revealed that it was quite frequent to see the cheetal touching their food with the black region of the nose (rhinarium) before nibbling it.

During the rutting season the rutting buck also licked pouring urine of the female, tasted it with the tongue and finally detected the state of receptivity of the female.

2. Discussion

Studies of Graf and Nichols (1966) and Schaller (1967) throw considerable light on some aspects of the social behaviour like self grooming and communications, dominance and aggression, home range, social structure, suckling and mother-fawn relationship in this species. Their studies, however, either failed to elucidate or make a mention of a number of interesting aspects like 'order' of occupation of favourite spots, preferential mother-fawn behaviour, fawn behaviour, protective

behaviour in mother-fawn relationship, social grooming and vocal communications. In the present study these aspects were studied in detail along with the ones already dealt with by the foregoing (Graf and Nichols, 1966 and Schaller, 1967) workers.

Study of social behaviour along with herds study (Chapter III) showed that the basic unit of the social organisation in the cheetal is a mixed herd which is not a rigid but rather a fluid structure. Mixed herds occur throughout the year, whereas female-young and all-male associations are purely temporary and more common at times (in the non-rutting season). In this respect the cheetal resembles several foreign and Indian deer species, viz., Red deer, Roe deer, White-tailed deer, Sika deer, Kashmir stag, Brow-antlered deer and Swamp deer etc. which are known to live in large social groups or herds.

In some of these social deer species, e. g., Roe deer : in which males form groups of their own kind and live in the form of bachelor herds during the non breeding season, such males are observed to establish their own territories during the non-breeding season in Cheddington Wood in Dorset, England (Bramley, 1970). But they join the female-young groups in the rutting season. Although males of cheetal were observed to form all-male associations during the non rutting season, yet no male was seen to establish its territory by defending it against the individuals of its own kind.

However, Graf and Nichols (1966) studied the underlying social structure of the cheetal as the 'territorial and sign spot' behaviour pattern, but they also concluded it as "there is no definite territory to defend, or if it is defended it is done psychologically"

Further, it would be interesting to compare mother-fawn relationship of the cheetal with that of the White-tailed deer of which social behaviour was studied by Altmann (1952), who stated that "The cows defend calves against coyotes quite vigorously, even if it involves them in defensive fighting" However, no such defensive fight behaviour of the mother-cheetal was seen. Whenever, the cheetal faced danger like the presence of a predator, even a jackal, the mother-cheetal also fled away (in the race for) her own safety, but she was observed to return to the endangered spot to retrieve its young one, jeopardizing her own safety in the process.

Although the previous workers such as Graf and Nichols (1966) and Schaller (1967) studied vocal communications in the cheetal, they failed to elucidate the existence of the mother-fawn vocal communication.

VIII. REPRODUCTIVE BEHAVIOUR

1. Observations

In the Corbett National Park (at Dhikala) the cheetal was observed to breed throughout the year, the peak being reached from June to November. By 'breeding activity' here is meant rutting, copulation, gestation and the birth of the fawn. Most rutting bucks were observed during May to October, most pregnant females were noticed between October and December and most fawns were sighted during December to March. During the breeding period, the rutting male develops hard-antlers, shows agonistic behaviour, spars for the possession of females, courts them and copulates with them. The pregnant female goes through a gestation period and parturates. All these aspects of reproduction were studied in detail, and are discussed below under the following heads :—

- a) Growth of the young and the development of antlers.
- b) Agonistic behaviour, and
- c) Sexual behaviour.

a) *Growth of the Young and the Development of Antlers :*

The new-born fawn, as described in the previous chapter was able to stand up and walk within a few hours of its birth. It was not possible to record the height, weight and body length of fawns at birth as not many such young were encountered. In one instance only could these measurements be taken which were recorded as:

Body weight	: 03.2 kg
Height at shoulder	: 37.8 cm.
Body length	: 72.3 cm.

The growth of the fawn is comparatively rapid during the first six months or so. At about sixty days of age, the fawns start wearing and feeding upon grasses, etc. At the age of one (now called a yearling) they look almost two-thirds of the adult body size. Thereafter, growth is gradual and is rather difficult to assess, except for the growth of antlers in the males.

As the studies were made in nature the exact age when the antlers made their first appearance could not be determined. But it is known from the studies carried out on captive cheetal by Graf and Nichols (1966) that a yearling male possesses spike (dagger shaped) antlers of about 15-20 cm length. Taking this as a starting point some observations were made on the growth of antlers in the male during the rutting season when the maximum antler growth is achieved.

Some of the young ones (fawns of the previous season) were observed to develop rounded knob-like structures of pedicles placed between the eyebrows and the ears during August to October. They were assessed to be males of about 6-8 months of age, as December was the peak fawning month. Dagger-like spike antlers covered with velvet (soft hairy skin) were seen emerging out of these knobs at an angle of about 45°, and by December and January most yearling males carried 15 to 20 cm. long spike-antlers in velvet (Plate 18A). The main function of velvet of the antlers is to supply an ample quantity of blood for growth and also to protect the tender antlers.

Thereafter, yearlings were seen to rub-off or strip-off the velvet by rubbing the antlers against hard stems of saplings, small trees and the like. By May-June, when the young males were about 16-18 months of age. They were observed to carry hard antlers as was the case in older males. At the point where the velvet was removed from the pedicle, a rough ring-like structure, known as burr, was also noticed for the first time in these young males. These polished, hard, spiked antlers were shed one by one at the end of the first and subsequent rutting seasons.

During the next fawning season, when fawns were being brought forth and the spike-antlered yearlings were being sighted, another type of partially developed antlers was seen in some of the males. This type of antlers was slightly longer than the spiked antler and had an additional tine at the base, at right angles to the beam (spike) just above the eyebrow and hence called 'brow-tine' (Plate 18B). Some of these males also exhibited a bifurcation of the beam.

In captivity Graf and Nichols (1966) have already indentified this type of antler with two or three-year old males. On the basis, in the field the main beam always showed a bifurcation at 2 to 3 years of age. The two resultant arms were unequal. The tine growing backwards is

known as the terminal tine or inner tine and the one growing upwards and outwards as the 'continuation of the beam' or outer tine (Figure 10).

Antlers in both stages of development i.e., in velvet and hard stages were seen throughout the year. There were, however, certain periods or seasons when one particular antler condition was more common than the other.

Among 1304 males observed during the year 1978 it was noticed that the occurrence of hard antlered males increased from February to October. The sighting of males with hard antlers rose from 3.8% in February to 7.6% in March, 15.6% in April, 25% in May, 66.6% in June and 100% in July, and remained almost constant till October. Thereafter, it fell suddenly to 33.3% in November and slid to a mere 11.9% in January. The occurrence of the velvet antlers, on the other hand, decreased from February onwards in an inverse ratio to the hard antlers. The sighting of males with velvet antlers fell from 96.1% in February, to 92.3% in March, to 84.5% in April, 75.0% in May, 33.3% in June and was 0% in July and remained almost stable till October and escalated to 88.8% in January (Figure 11).

(b). *Agonistic Behaviour*

Individuals of both sexes become aggressive at times though for totally different reasons. Their agonistic behaviour was studied throughout the year.

Aggression among males :

Males did not exhibit much aggression during normal herd life in the non-breeding season. Such aggression, when present could be directed towards members of their own sex or the opposite sex. This aggression may take the form of nudging, biting, leg fighting, thrashing etc.

Nudging : Consisted of pushing of the opponent. The opponent could be of any sex and age class. Normally it was done so to disrupt and dislodge the opponent for in order to acquire better grazing or bedding spot.

Biting : Biting was accomplished by the lower incisors. This was done, normally, when the opponent was being nudged or the leg fighting was being exhibited.

Leg fighting : It was exhibited mostly when the males possessed developing velvet antlers. It was done with the opponent rearing on hind legs and striking at each other with hooves. Sometimes, it was also accompanied by biting (Plate 21A).

Thrashing : Consisted of jerking or swinging of head against the opponent. The opponent could be of any sex and age class. Further, it could be a bush, or the ground (against which was seen being exhibited). It appeared to be an aggressive behavioural pattern chiefly exhibited to express the 'hierarchy'

The first signs of sexual aggression appeared along with the hardening of the antlers and after the removal or rubbing off of the velvet. The hard antlered males exhibited aggression through thrashing, pawing, preaching, threat posture or head-down display, actual combat or sparring and dominance display or head-up display. During the breeding season and specially when rutting, males showed greater antagonism towards other males. The form and intensity of the behaviour varied from individual to individual and class to class. It was observed that the males with a larger pair of antlers also had a stouter body normally. Four distinct classes could be distinguished in the males based on their antler length and size, as follows :-

Class I Males having spike-antlers.

Class II Males having *c* 30 cm long antlers.

Class III Males having *c* 30 to *c* 60 cm long antlers.

Class IV Males having more than 60 cm antlers.

A total of 807 instances of aggressive behaviour exhibited by various classes of males and covering various types were observed at Dhikala during the course of two rutting seasons (Table 17). These are discussed below :

Thrashing : This consisted of jerking or swinging of the head. A male cheetal with hard antlers would exhibit it either against an opponent of either sex, against a bush, small tree, shrub or even the ground. It appeared to be exhibited purely to express aggression. A total of 139 such thrashings were recorded, 97.1% were exhibited by males of the class IV and the rest 2.9% by class III (Table 17).

Pawing : An aggressive buck was observed to scrape the ground with either of its forelegs, which might or might not result in the formation of a undulating mark (of ridges and furrows). Sometimes it was possible to see such marks in the cleared areas of the river bed or near the lake. This (pawing) was exhibited by either or one of the sparring bucks. It was noticed that such pawings consisted of 1-3 scrapes normally but as many as 6 scrapes by each of the forelegs. A total of 73 pawings which were observed-revealed that 57.5% were performed by the males of the class IV, 31.5% by class III and 10.9% by class II (Table 17).

Preaching : Sometimes the rutting bucks, aggressive in behaviour, were observed to stand on their only two legs i.e. hind legs on all the such occasions it was exhibited against a small tree or shrub. While standing on its hind legs against a tree, even a dry and dead tree, the male rubbed the face-region of its preorbital gland on a twigs of the tree (Plate 19A). Such males stood in this posture and were in a normal standing posture soon before they started preaching once again. This behaviour appeared to be attributed, apparently to leave some smell of chemical substance (fluid) being secreted by the preorbital gland of the bucks. Another male of the herd was also seen to repeat this type of behaviour against the same tree. Only on five occasions could this be seen of which 80% was exhibited by the males of class IV and rest 20% by class III (Table 17).

Head down display or threat posture : On a number of occasions the rutting males that were aggressive in behaviour were observed to exhibit this posture. But only those instances which resulted in the actual combats or sparring matches have been shown in the table. These males displayed their heads downwards, the antlers pointing at the opponent of their own kind. By presenting this posture such males challenged the opponent. The challenged one may not accept the challenge of the challenger. If the challenge was accepted the challenged one also displayed a similar posture, which resulted in an actual combat. In case the challenge was not accepted the challenged male exhibited a submissive display by presenting a head-down or side display. In this submissive display the antlers were not pointed at the challenger. This type of the behaviour was displayed apparently to decide their 'rank order' in linear-hierarchy. A total of 148 instances of threat posture recorded showed 77.0% of this was done by males of the class IV and only 22.9% by class III (Table 17).

TABLE 17—*Showing instances and percentage of various types of agonistic behaviour as observed against each class of males at Dhikala, 1977-78.*

Type Class	Thrashing	Pawing	Preaching	Head-down display	Sparring display	Head-up display	Total
I	—	—	—	—	—	—	—
II	—	8 (10.9%)	—	—	—	—	8 (10.9%)
III	4 (2.9%)	23 (31.5%)	1 (20%)	34 (22.95%)	34 (11.5%)	30 (20.2%)	126 (15.6%)
IV	135 (97.1%)	42 (57.5%)	4 (80%)	114 (77%)	262 (88.5)	118 (79.7%)	673 (73.4%)
Total	139 (100%)	73 (99.9%)	5 (100%)	148 (99.9%)	296 (100%)	148 (99.9%)	807 (99.9%)

Actual combats or sparrings : The accepted challenge by the challenged male resulted in a combat, in which the heads of both the sparring males were brought in contact, and the antlers locked (Plate 19B, 20A). Each of these sparring males made a foremove and tried to push-back the opponent. Sometimes, the stronger male pushed its opponent even upto 50 metres or so. The combatants may unlock (disengage) their antlers for a while before making the next collision. As many as 20 times such unlocking (disengagings) and momentary stops were recorded during a single sparring match which lasted for about 22 minutes. Such momentary stops and disengagings of the antlers were often accompanied by pawing. When the combat was over the winner invariably exhibited its dominancy by a head-up display whereas the defeated one or the loser of the combat assumed a submissive posture by presenting its head-down or side-display and became busy with occupation of the moment like grazing etc.

A total of 148 such combats were observed in which 296 individuals, males of various classes, indulged. 88.5% of the individuals involved in the sparring matches belonged to the class IV and 11.5% to class III (Table 17).

The undecided sparring matches have not been included for the purpose of the analysis. Apparently these combats were play for deciding the rank-order in the linear hierarchy as none of the combats observed were injurious or fatal.

Head-up display : After having won the combat the winner invariably presented its dominancy by exhibiting a head-up display, in which he raised his head and muzzle directing them towards the sky, antlers pointing to the ground and eyes almost closed (Plate 20B). Sometimes this may be accompanied by a rutting call. A total of 148 instances of such displays were recorded, 79.7% were exhibited by males of the class IV and the remaining 20.3% by class III (Table 17).

It is apparent from the foregoing analysis of various types of agonistic-behaviour (807 instances) that the stronger and older males of the higher rank participated to the extent of 73.4% (Table 17), whereas the younger males of the lower ranks i.e., III, II and I ; took part in gradually decreasing numbers i.e. 15.6%, 10.9% and 0% respectively. Obviously this was done so to decide their rank order in the linear hierarchy. Further the analysis revealed that out of 148

combats observed 88.5% were participated in by males of the class IV who indulged in this behaviour, while only 11.5% by the class III, and 0% by II and I. This clearly shows that when the males were old enough they indulged in this type of behaviour to decide their rank-order i.e. 11.5% at the stage of class III and 88.5% at the stage of class IV. Thus the class IV males dominated over the remaining classes III, II and I.

Aggression among females :

Females too exhibited a certain amount of aggression in the course of their normal herd life, i.e., while feeding, resting etc. This behaviour was generally committed against adult members of their own sex, subadults of both sexes, yearlings and fawns. The purpose of such aggression appeared mainly to dislodge the opponent from a better patch of feeding or resting ground. This behaviour consisted mainly of : Dashing, biting (with lower incisors), nudging and leg fights, as discussed below :

Dashing : Consisted of dashing or running upto the opponent followed by a nudge or a bite.

Biting : Biting was accomplished by the lower incisors and may follow a dash or a nudge.

Nudging : It took the form of a push by the head and may or may not be followed by a bite.

Leg fighting : Leg fighting was done with the opponents reared upon hind legs and striking at each other with hooves. It may sometimes be accompanied with biting (Plate 21A).

(c) *Sexual Behaviour*

Sexual behaviour was studied during two successive rutting seasons in 1977 and 1978. Such behaviour in males, consisted of the following types, which normally followed one another in the given sequence which however, could be interrupted at any point :—

1. Rutting call or bellowing.
2. Approach.
3. Sniffing.
4. Licking.

5. Flehmen.
6. a. Mounting
b. Driving.
7. Copulation (or Pseudo-copulatory behaviour).
8. Post-coital behaviour.

A rutting male was easily identified by its hard, polished antlers, comparatively swollen and black neck, prominent white throat patch, and more conspicuous testicles. Such males were often seen shifting from one herd to another (Plate 21B).

Rutting call or bellowing : A rutting call consisted of one to seven bellows given out in a quick succession. As already described elsewhere a bellow (yo-o-o-w-w or h-h-a-o-u-u-h) sound was characteristically a long-pitched hoarse vocal sound. Only the males in rutt bellowed. A total of 560 such bellows were recorded from May to October. A bellow lasted, on an average, one to two seconds. A long bellow was more high pitched than a short one. The frequency of rutting calls increased steadily during the first two months of the rutting season. Thereafter, it fell off gradually and disappeared by November.

For a detailed study of the rutting call herd C_1 and C_2 were selected. Observations were made on an hourly basis from 0600 to 0900 hrs in the mornings and from 1600 to 1900 hrs in the evenings for two days a week. The calls averaged (hourly) 1.00 in May, 4.4 in June, 2.0 in July, 1.3 in August, 0.9 in September and 0.5 in October. No calls were heard in November (Figure 12).

Approaching : A rutting buck did not take for granted that all females in the herd were receptive. His approach appeared to be cautious and restricted only to such females which, according to his judgement, could be in oestrus. The sense of smell appeared to play a pivotal role in his assessment. A male may sometimes, sniff at a patch of ground from where a sitting female had just departed in order to ascertain her state of receptivity. The age and linear hierarchy appeared to play a significant role in this sexual behaviour. The more mature males (with higher rank) approached the females more frequently and with greater surety whereas the younger, inexperienced males of lower ranks made fewer and hesitant approaches. These approaches of the rutting bucks could be from one female to another within a herd or from one herd to another (Plate 22A, B).

A total of 194 instances of such approaches were recorded ; 67% approaching was done by males of class IV, 18% by class II, 12.9% by class III and only 2.8% by class I (Table 18).

Sniffing : Having approached the female either by walking upto her or just by raising and extending his neck, if she was standing, sitting or grazing next to him, the male had a good sniff at the vulva. He sniffed or even tasted her urine if she urinating at that time (Plate 23A). To determine the state of receptivity the buck may, frequently, sniff the ground on which she had been sitting previously (Plate 23B). The analysis of 182 instances of sniffings recorded revealed that it was again the older and mature males of higher rank that undertook this activity more often than the younger males of lower ranks. Whereas 65.9% of the males of class IV were involved in the exhibition of this behaviour, only 10.9% of class III, 6.0% of class II and 17.0% of class I were involved (Table 18). Apparently the very young rutting bucks were more active in sniffing than their slightly older and experienced counterparts.

Licking : After having satisfied himself or the respectivity of the female by sniffing etc. the rutting buck would then proceed to lick her vulva and sometimes even the other parts of her body like the muzzle, the rump etc. which may be reciprocated by the female (Plate 24A, B). The males were seen also licking their own genital organs (Plate 25A, B). In this behaviour again, as expected, only older and maturer males of higher rank took the leading part. Out of 166 instances of licking recorded, 83.7% were done by males of the class IV, 9.6% by class III 6.6% by class II, and no class I male could be seen to undertake this activity (Table 18).

Flehmen or up-curling of the upper-lip : After having had a few licks, the rutting male would raise his head and curl his lips (Plate 26A). He may do this even after having sniffed at the place just vacated by a female, her genitalia or urine or his own erected unsheathed penis (Plate 26B). Out of 175 instances of flehmens recorded 76.0% were done by males of the class IV, 10.9% by I, 8 0% by III and 5.1% by the class II (Table 18).

Mounting : Having sufficiently aroused the female by licking etc. and depending upon his own condition, the rutting buck made an attempt to mount the female by raising his forelegs and placing them

TABLE 18—Showing instances and percentage of various types of sexual behaviour as observed against each class of males at Dhikala 1977-78

Type Class	Approach	Sniffing	Licking	Flehmen	Driving	Mounting	Copulation	Total
I	4 (2.8%)	31 (17.0%)	—	19 (10.9%)	—	—	—	54 (6.9%)
II	35 (18.0%)	11 (6.0%)	11 (6.6%)	9 (5.1%)	—	—	—	66 (8.5%)
III	25 (12.9%)	20 (10.9%)	16 (9.6%)	14 (8.0%)	6 (13.9%)	1 (9.0%)	—	82 (10.6%)
IV	130 (67.0%)	120 (65.9%)	139 (83.7%)	133 (76.0%)	37 (86.0%)	10 (90.9%)	4 (100%)	573 (73.9%)
Total	194 (100.7%)	182 (99.8%)	166 (99.9%)	175 (100.0%)	43 (99.9%)	11 (99.0%)	4 (100%)	775 (99.9%)

on her. He rested his head on the rump of the female. If the female did not move away he raised his front legs, placed them, one each on either flank and tried to hold the female by the lower abdomen (Plate 27). The female, if not desirous of copulation, may move away even at this stage. Only 11 occasions of mounting were observed 90.9% were done by males of the class IV, the rest 9.0% by class III. No individuals of the class II and I males class could be seen to undertake this activity (Table 18).

Driving: For mounting a male may even approach a resting female, go through the sniffing, licking routine and nudge her to stand up. The unwilling female when pestered like this may get up and run away. On many such occasions the male attempted to mount. He may or may not be successful. He may either get disillusioned and drop off or he may, be chased away by a superior male, who may be the lucky one to mount the female. The analysis of 43 instances of drivings showed that it was once again the older and mature males of higher rank that indulged in this activity more than the younger males of lower ranks. In 43 instances of drivings observed, 86.0% was exhibited by the males of class IV, and rest 13.9% by class III. No individuals of the class I and II could be observed to exhibit this behaviour (Table 18).

Copulation: After securing firm hold, of the female, the male brought his erect penis in contact with the vulvar opening by pushing forward his own pelvis (Plate 27). He may have to try more than once to gain entrance which is followed by the final thrust for deep penetration. The penetration was not followed by any friction, retention or boring. The ejaculation appeared to be quick as the whole process of copulation i.e. mounting, penetrating, withdrawal and dismounting took only 10-15 seconds.

Pseudo-copulatory (homosexual?) behaviour: On a number of occasions it was observed that mounting was attempted by males over males or females over females. This was, however, common in females who kept on mounting even in the nonbreeding season. A spike-antlered (class I) male may sniff and lick (anal region) another male of the same class before mounting. No actual anal penetration or ejaculation could be observed.

Post-coital-behaviour : On having consummated the sexual union, the male, as often as not, would come round to give a few licks on muzzle of the female before taking leave. The partners would then engage themselves in the activity of the moment like grazing, resting etc.

It is obvious from the foregoing analysis of the various types of sexual behaviour (775 instances) that the stronger and older males of the higher rank participated to the extent of 73.9% in the sexual behaviour (Table 18), whereas the younger males of the lower ranks i.e. III, II and I; took part in gradually decreasing numbers, i.e. 10.6%, 8.5% and 6.9% respectively.

2. Discussion

Existing knowledge on reproductive behaviour of the cheetal provides only fragmentary and rather confusing information regarding the period of gestation, number of fawns and period of fawning.

According to Hodgson (1847) and Shull (1962) in Schaller (1967 p. 52), Prater (1971) the gestation period is 6 months. Walker (1964-68) stated it to be 7 to 8 months. Asdell (1964) fixed it at 7 to seven and a half months. De and Spillett (1966) found it to be seven and a half months and Schaller (1967) conjectured it (as indicated by peaks of rutting and fawning) to be eight to eight and a half months. It is not possible to determine the gestation period directly for wild population. Indirect evidence was therefore, taken into consideration. Most lone pregnant females were seen from November to December, the peak of fawning was noticed from December to April and the maximum rutting activity was observed from June to October. The intervening period between the peaks of rutting and fawning indicate a gestation period of about seven months. This coincides with the estimation given by Walker (1964-68) and Asdell (1964) who described it as seven to seven and a half months respectively.

Regarding the numbers of fawns parturated by a female cheetal Brander (1923) and Walker (1964-68) stated that "it is usually two (twins), but one or three are uncommonly seen" On the contrary, Prater (1971) and Schaller (1967) stated that "it is usually one" The present study also showed that only one fawn is normally, delivered. The same was the finding of Acharjyo (1970), Asdell (1964) and Crandall (1965) who observed this species in captivity. The incidence of

twins in their studies occurred only in one out of 80 births and one out of 225 births respectively.

According to Prater (1971), Graf and Nichols (1966) and Krishnan (1972) there is no definite breeding season and the fawns may be met at any time of the year or in any season. On the other hand, De and Spillett (1966), Schaller (1967) and Sharatchandra and Gadgil (1975) asserted that there is a definite peak fawning season. The present study showed that although occasional sighting of the newborn fawns may be there throughout the year, yet there is a well defined peak "fawning period" from December to April during which majority of fawns are born.

During the present study it was found that there is also a peak period (November-January) during which a majority of males shed their antlers. From January to June they regrow their antlers and during June-August they carry hard and polished antlers. A comparison with the previous studies revealed that a general pattern of the antler growth, condition and shedding remain almost the same but the time of the commencement of the process differs from locality to locality (Table 19).

TABLE 19—*Showing the peak period of antlers shedding as observed by the previous workers*

Authors & Years	Peak period of shedding of the antlers	Locality
1. Schaller & De (1964)	March-June & perhaps July	Kanha National Park (M.P.)
2. Walker (1964-68)	Usually in August	—
3. Schaller (1967)	August-October	Kanha National Park (M.P.)
4. Prater (1971)	August-September	M.P. & S. India
5. Phillips (1972)	April-May	Southern Ceylon
6. Sharatchandra & Gadgil (1975)	September-November	Bandipur National Park, S. India

The foregoing study of agonistic and sexual behaviour of the cheetal showed that the stronger and older males of higher rank participated more in these activities than the males of lower rank and the former

dominated invariably over the later. This natural rank order or dominance hierarchy seems to be an important factor in deciding the reproductive success of the male and hence act as a biological regulator in the population. Almost a similar conclusion was arrived at by Schaller (1967) who studied this species in Kanha National Park.

Further, this dominance hierarchy is not an isolated behaviour in cheetal alone. It is known to exist in several deer species of the world, viz., Elk (Altmann, 1952 ; Picton, 1960 and Craighead et al., 1973) ; Fellow Deer (Chaplin and Whitte, 1970) ; Roe Deer (Espmark, 1969) ; Red Deer (Lowe, 1966 and Lincoln et al., 1970) ; White-tailed Deer (Sparrove and Springer, 1970 and Verme, 1973) ; Moose Deer (Pimlott, 1959 and Phillips et al., 1973) and Mule Deer (Robinette, 1966) etc.

SUMMARY

This study covered a period of 30 months, from January, 1977 to June, 1979 in the Corbett National Park, Uttar Pradesh and about 2,500 of observation-hours. The study area was around the Dhikala 'Chaud' (meadow) area and covered an area of about 20km². It consisted of observation of various activities of all the herds present in the area and systematic sampling of some particular behaviours of selected herds. The following aspects were studied :— locations, movements and home ranges ; population and herd studies ; food and feeding ; daily schedule of activities ; and social and reproductive behaviour. Meteorological data were also collected in order to understand the possible influence of physical environment on these behaviours. Wherever possible, the results are compared with other reports of field studies of free-living populations and also with members of the family-cervidae.

At least four distinct 'superherds' (large night gathering), consisting of eleven herds, occupied the Dhikala 'Chaud'. Their day and night resting places and routes of daily movements are described. Grazing ranges of these super-herds overlapped to the extent of about one-half to 1 km², the grazing ranges of each superherd being as follows (in km²) :— Superherd A, 1.4 ; B, 1.8 ; C, 2.4 and D, 2.4. The composite home range of all the herds was about 18 km². The maximum number of cheetal encountered in the 'Chaud' was 324 in April, 1977 ; 627 in March, 1978 ; and 418 in March, 1979.

Herd studies were made in detail. The following terms have been adopted to determine the various types of groupings :—aggregations, herds, female-young associations, and all-male associations. Aggregation size ranged from 3 to 526 individuals, and average size was 31.5 individuals. Herd size ranged from 3 to 526, and the monthwise average size varied from 5 to 104.5. The size of female-young associations ranged from 3 to 44 and the monthwise average size varied from 4.7 to 18.2. The size of all-male associations ranged from 4 to 92 and the monthwise average sized varied from 4 to 39.

Herd composition did not exhibit a fixed pattern and showed a high degree of variation not only during different months but also in day to day structure. The yearly average of various components of herd as worked out against a unit of 100 females was as follows :—

Males	: 100 females	: Yearlings	: Fawns	Year
36.1	100	16.5	22.2	1977
48.2	100	16.8	12.1	1978
31.0	100	8.6	4.1	1979

Study of seasonal changes in herds and other social associations showed that the herds (mixed herds) are the main stream (basic unit) of the social structure in case of the cheetal, which is not a rigid but rather a fluid structure from which and into which movements of males and females are quite frequent.

The cheetal is entirely herbivorous, and eats various components of some 38 different plants, 15 grass species, flower-petals of two species of plants and fruit of one species. The main chemical constituents of some of these food plants, e.g. crude protein, ash, calcium and phosphorous, were also determined.

The drinking of water is a herd activity and the cheetal drinks like other deer and ungulates, by sucking with mouth.

The rise or fall in temperature was directly responsible for early or delayed retirements of the herds. For studying, 'diurnal activity profiles' observations were made on hourly basis for all the three different seasons. The daily rhythm falls in four broad types, as follows : Feeding, bedding, moving and standing.

Feeding, during the cold season, lasted well in the forenoon and were resumed early in the afternoon, while during summer it decreased to a major extent and was not resumed in full till before sunset. During the rains this general pattern of the two foregoing seasons was abandoned and feeding became irregular.

Bedding, during the cold season, commenced late in the forenoon and lasted till early in the afternoon. In the hot season this activity was initiated earlier, interrupted with standing, only to be resumed to reach a second peak in the afternoon. During the rains this pattern of the two foregoing seasons was abandoned and did not exhibit any fixed pattern.

In winter a major part of the population stayed in the Dhikala 'Chaud' and during summer more than 70% of the population moved into the forest cover, but in rainy months this practice was thrown out of gear.

Standing, during summer was, perhaps, the most prominent activity, but in winter and rains it was hardly noticed.

Several ethological aspects were studied, especially general behaviour, social behaviour and reproductive behaviour. Under normal conditions the female cheetal leads the herd but under condition of stress and strain, viz., discovery of a stalking predator, the member first to notice the danger makes a move, whether it is a female or a male. Under normal circumstances herds or subherds kept their entities in so much as their members stuck together, but under unusual conditions, like the presence of a predator, or patchy availability of food, different herds intermixed freely without showing any aggression.

Regarding interspecific interactions, there was hardly any interaction with the Barking Deer and the Sambar. Interactions with elephants were also quite meagre presumably due to utilisation of different pockets in the area. But interactions with the wild boar and the Hog Deer were common and showed dominance. The wild boar dominated over the cheetal, whereas the cheetal dominated over the Hog Deer, however, no severe fighting was seen.

Social behaviour showed that the various members of the herd had a certain 'order' for the occupation of the favourite sites, in which the larger and stronger individual displaced the smaller and lighter members. Mother-fawn relationship exists to the extent that the mother returns to the endangered spot within an hour or so to retrieve its young one, jeopardizing her own safety in the process. The suckling behavior is the same as in other ungulates. Grooming and communications (visual, auditory, vocal and tactile) are described in some detail.

The peak breeding season occurs from June to November. Most rutting bucks were observed during May to October ; most pregnant females from October to December, and most fawns were shighted from December to March. Aggression among males as well as females exists. The various types of aggressive behaviour studied were : Dashing, biting, nudging and leg-fighting in the case of females, and thrashing, pawing, preaching, head-down display or threatening posture, actual combats and head-up display or victory signal of the spar. Four distinct classes could be distinguished in males based on their antler length and size as follows :

- Class I Males having spike-antlers.
- Class II Male having 30 cm long antlers.
- Class III... .. Males having 30 cm to 60 cm antlers.
- Class IV Males having more than 60 cm long antlers.

The various types of aggressive as well as sexual behaviour were studied against each male class. Quantification of 807 instances of various types of this behaviour revealed that the stronger and older males of higher ranks showed aggression to the extent of 83.4% whereas younger males of lower rank i.e. III, II and I ; took part in gradually decreasing numbers i.e. 15.6%, 0.9% and 0% respectively.

The various types of sexual behaviour studied were as follows : Rutting calls, approaching, sniffing, licking, flehmen or up-curling of the upper lip, mounting, driving, copulation and post coital behaviour. Quantification of 775 instances of this behaviour showed that the stronger and older males of higher ranks participated to the extent of 73.9%, whereas the younger males of the lower ranks i.e. III, II and I ; took part in gradually decreasing numbers, viz., 10.6%, 8.5% and 6.9% respectively.

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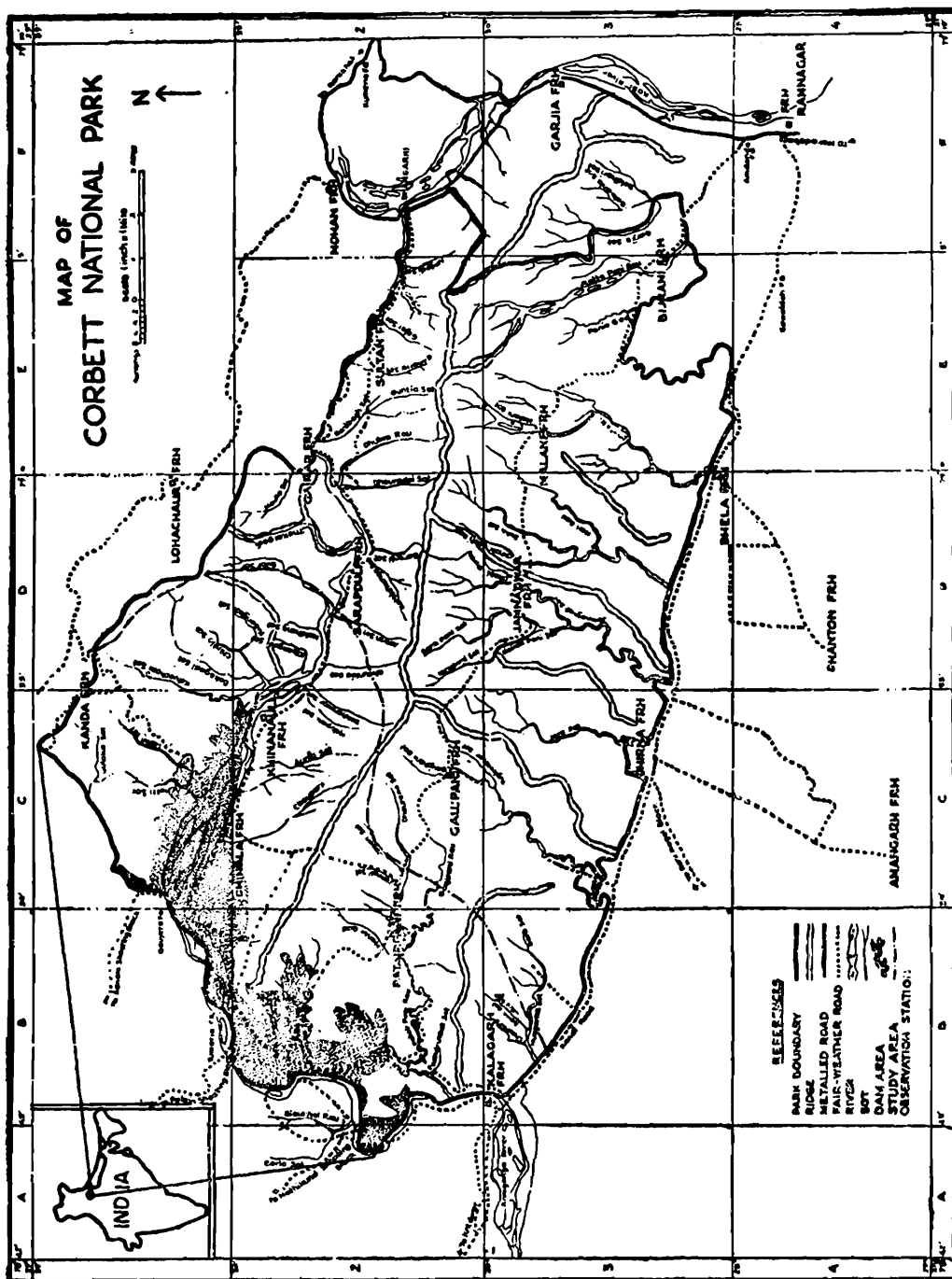
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The study area : Corbett National Park

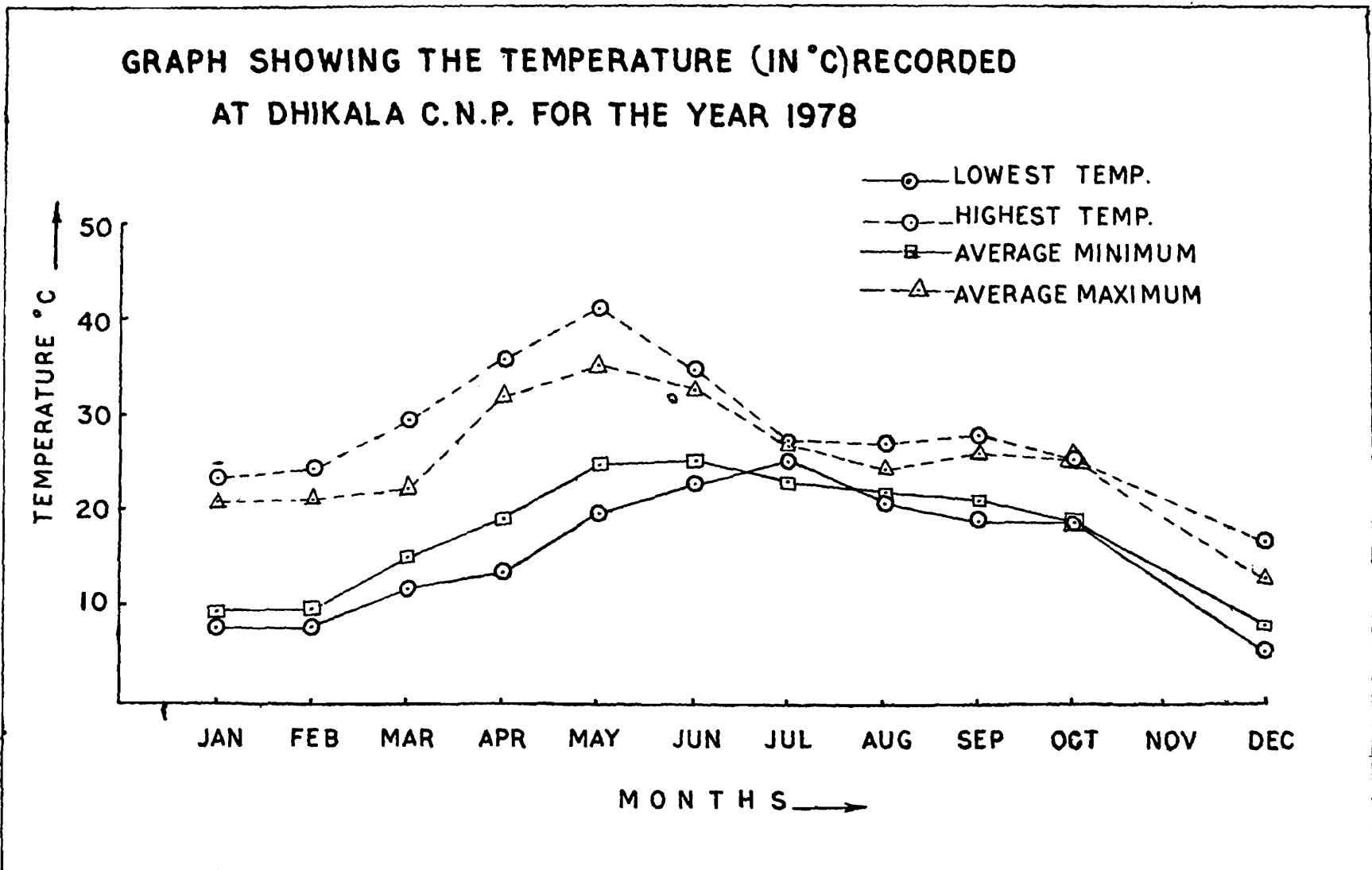
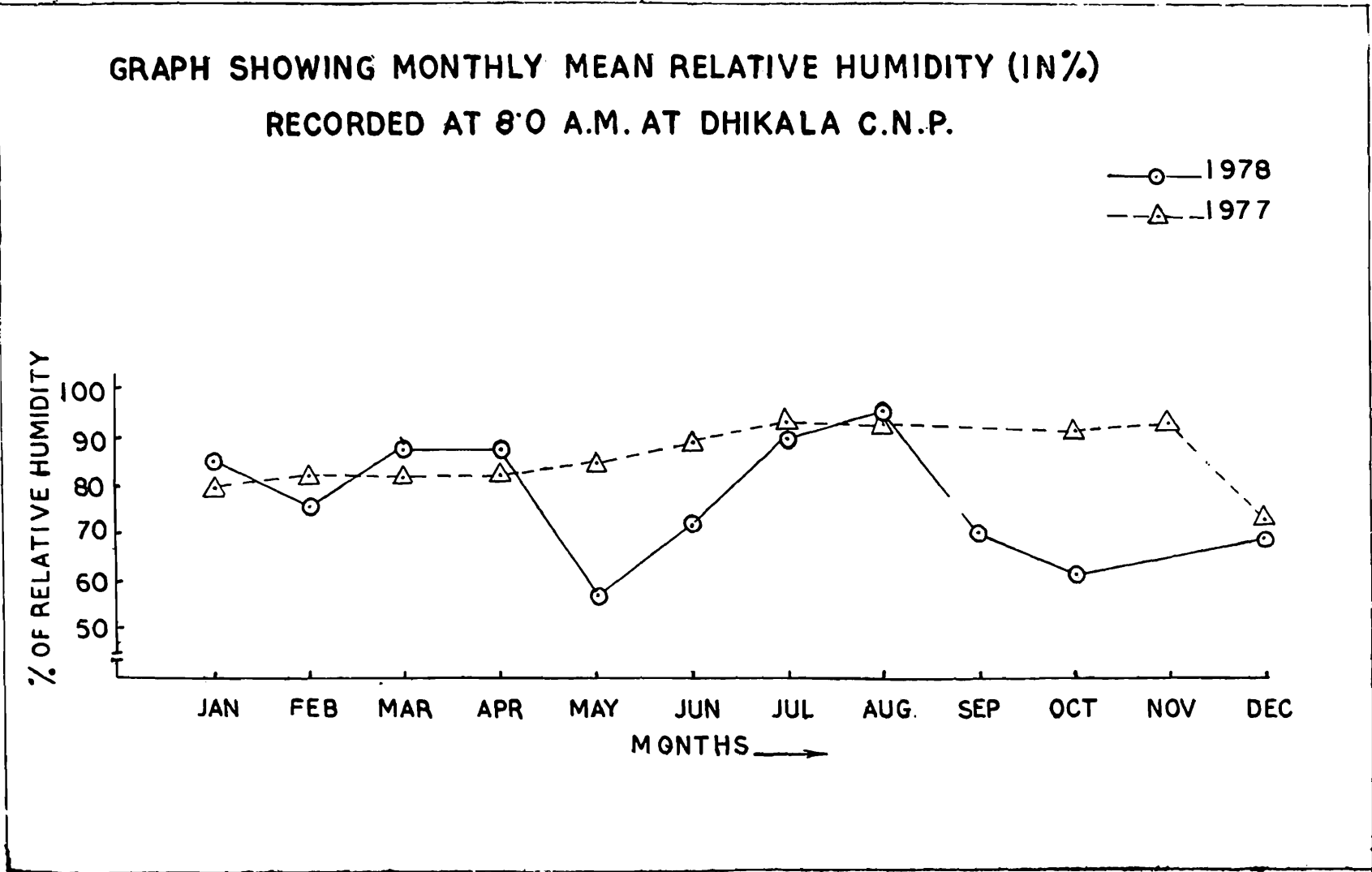


Fig. 2



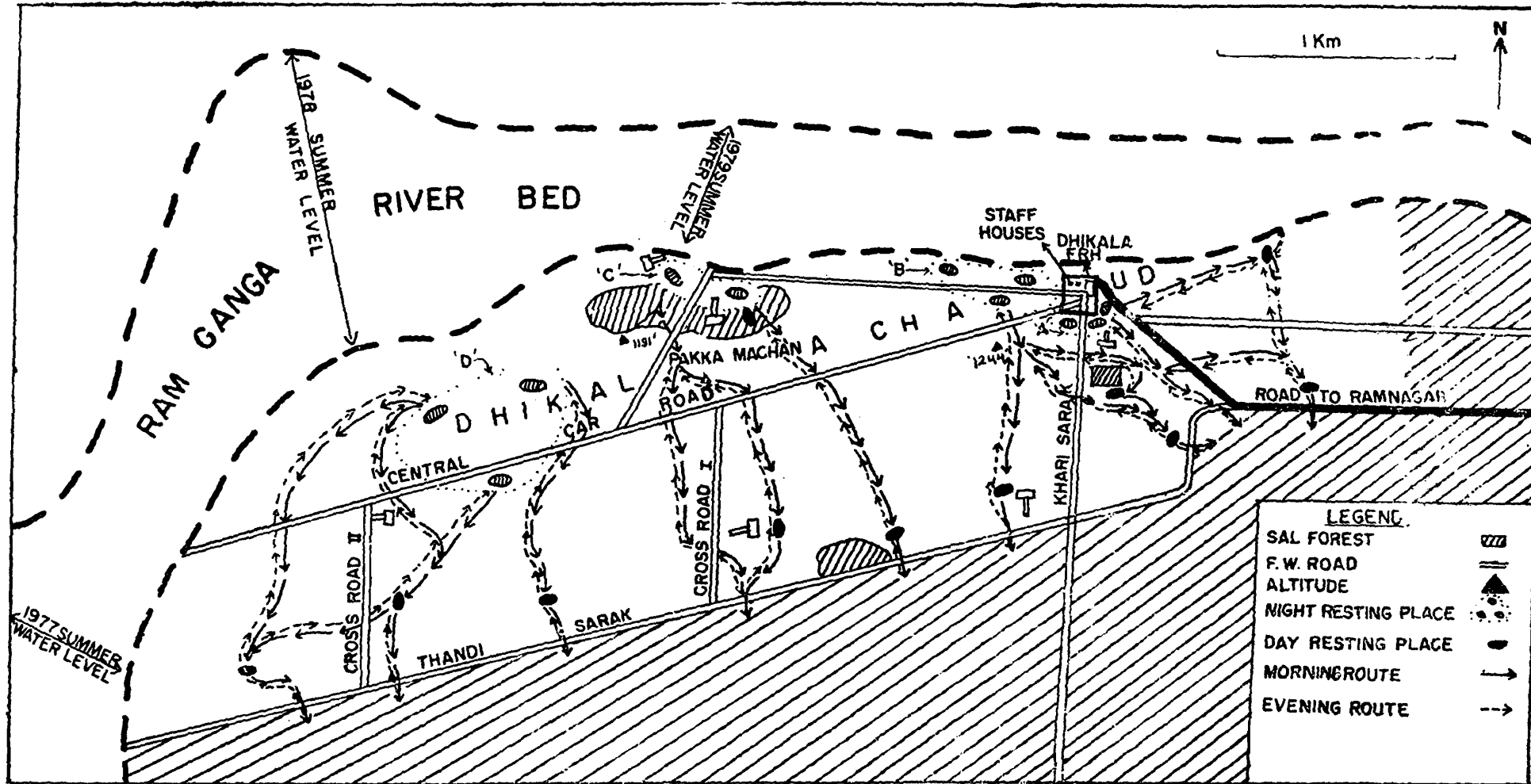


FIG. 4 SHOWING RESTING PLACES AND ROUTES OF DAILY MOVEMENTS OF VARIOUS HERDS FROM JANUARY TO JUNE

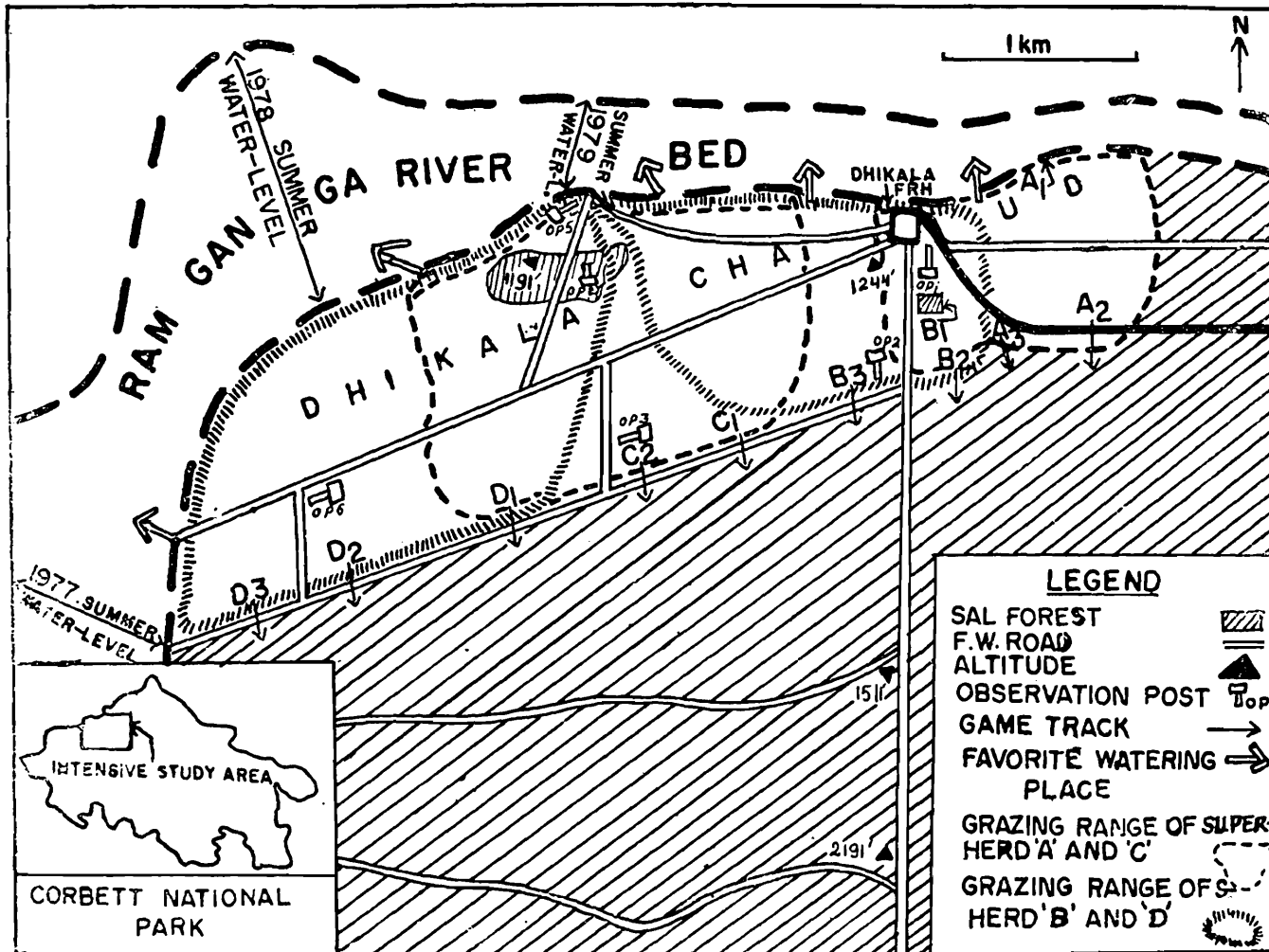


FIG.5. SHOWING APPROXIMATE GRAZING AREAS AND FAVORITE WATERING PLACES OF FOUR SUPERHERDS AT DHIKALA

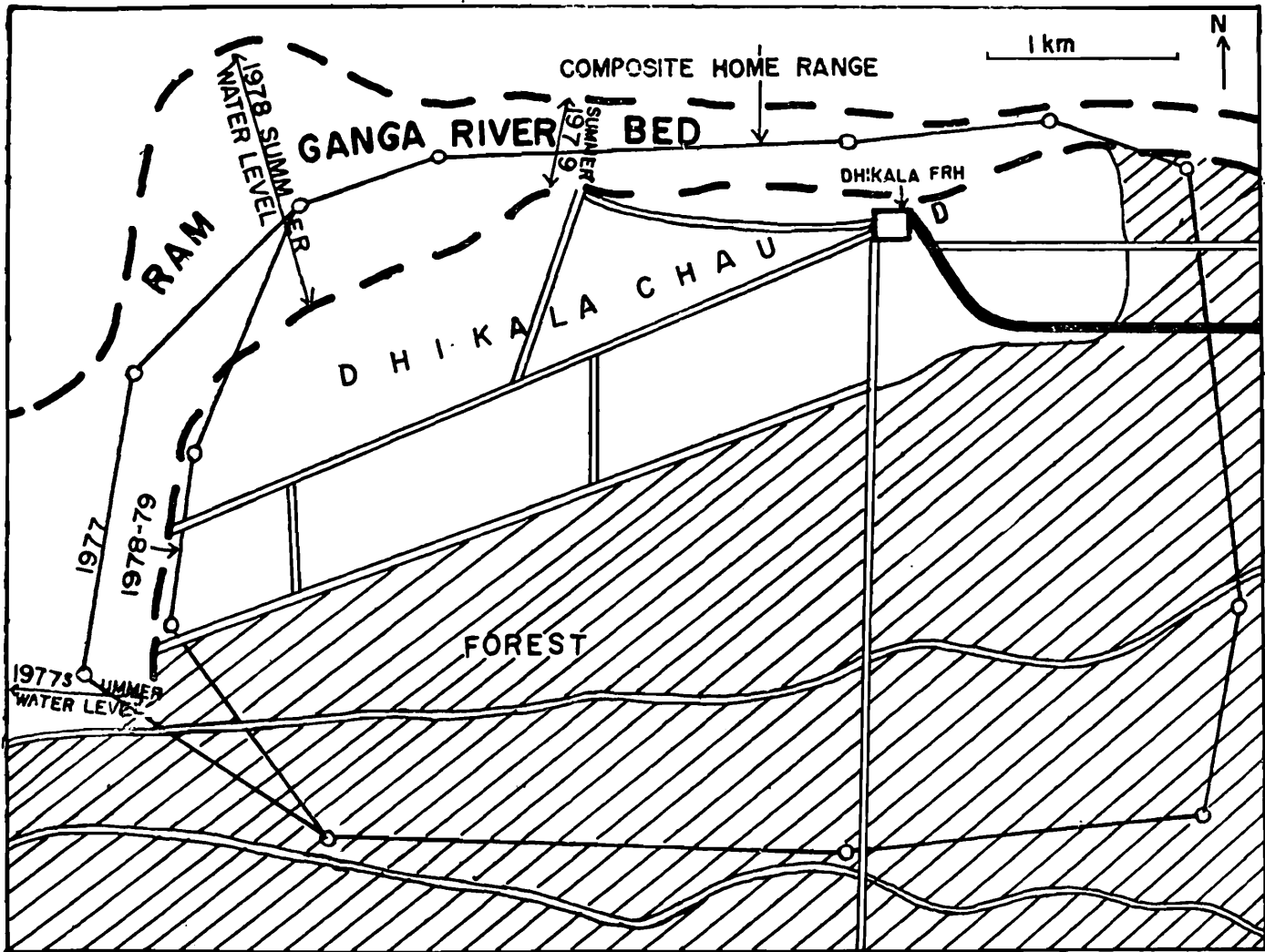


FIG.6. SHOWING COMPOSITE HOME RANGE OF VARIOUS HERDS AT DHIKALA

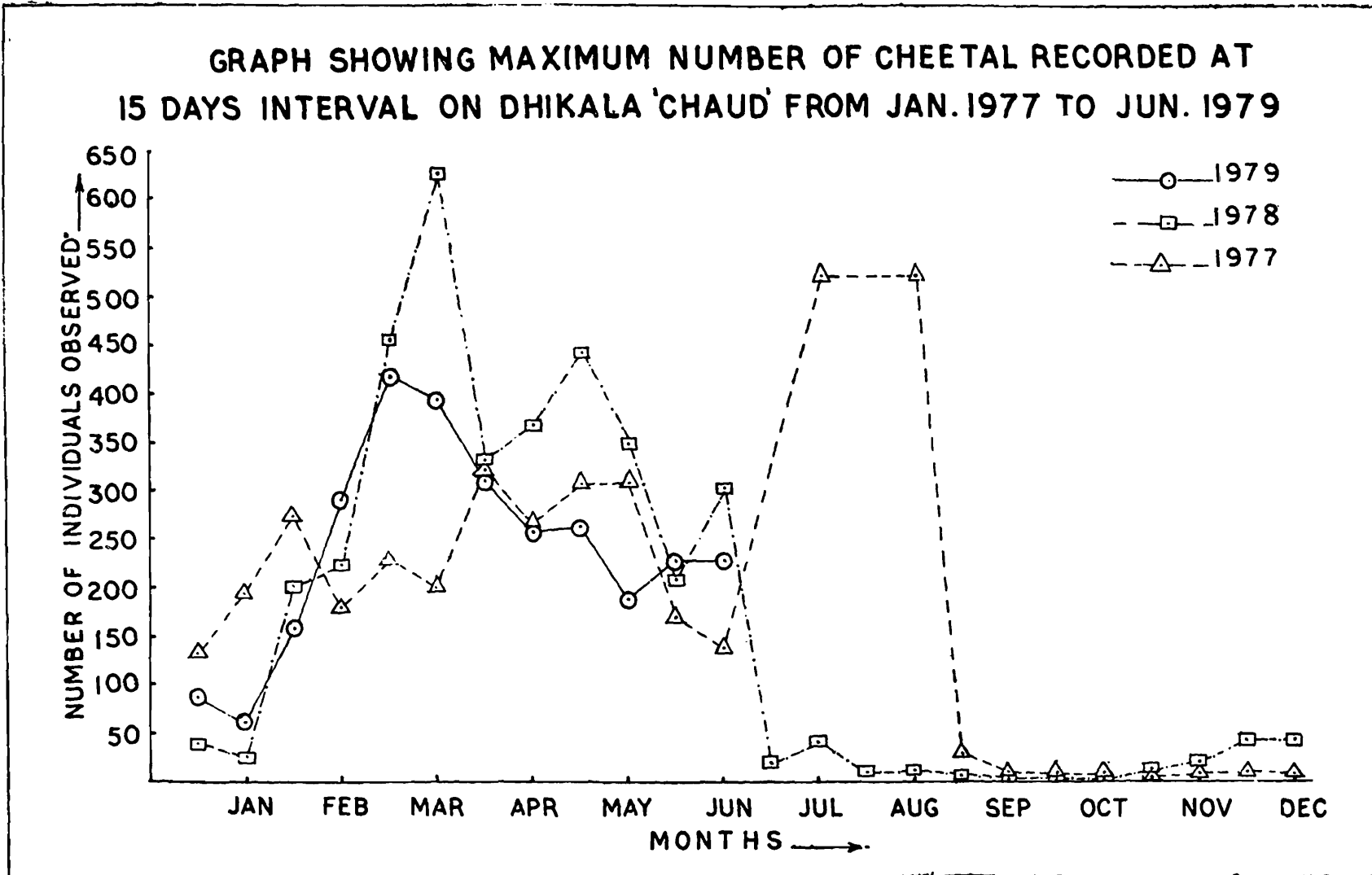
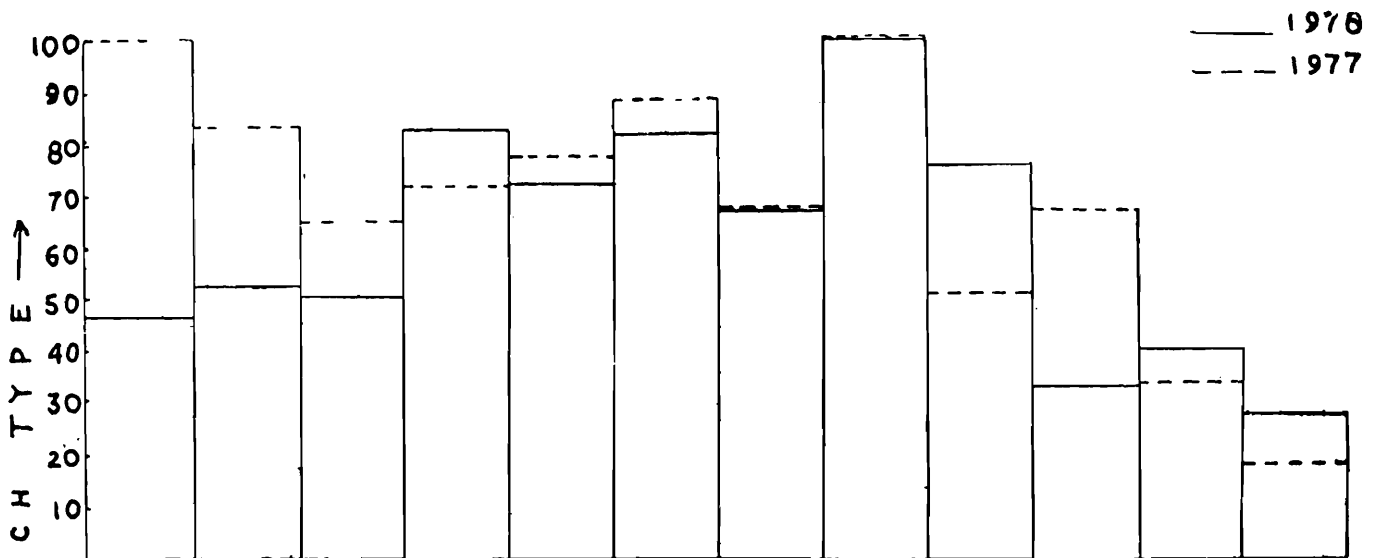
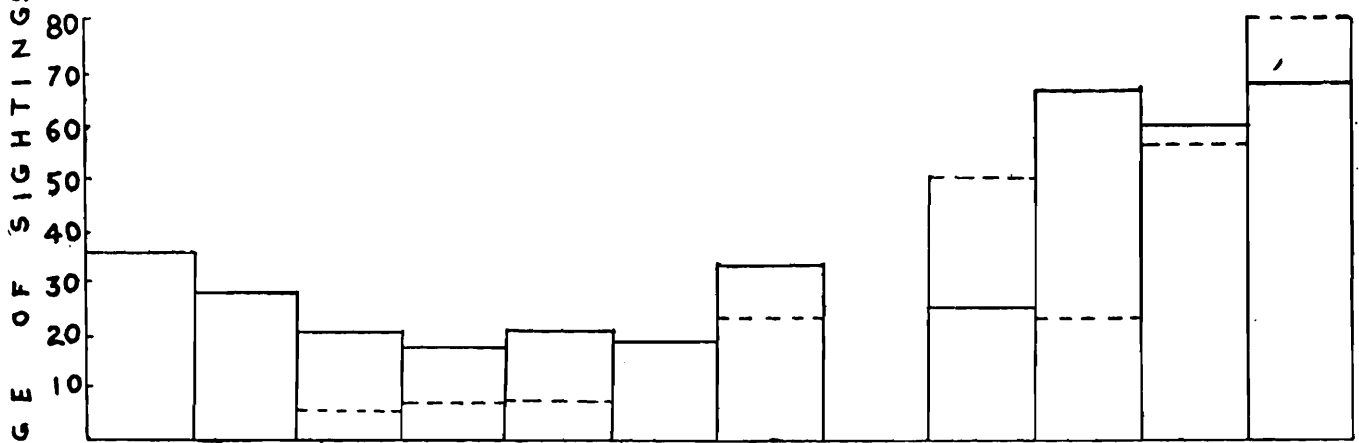


Fig. 7

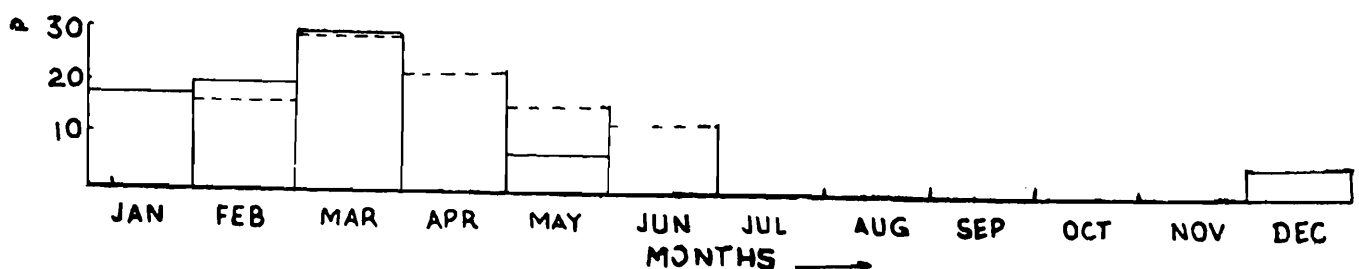
HISTOGRAM SHOWING PERCENTAGE OF SIGHTINGS OF HERDS AND OTHER SOCIAL ASSOCIATIONS



A. HERDS

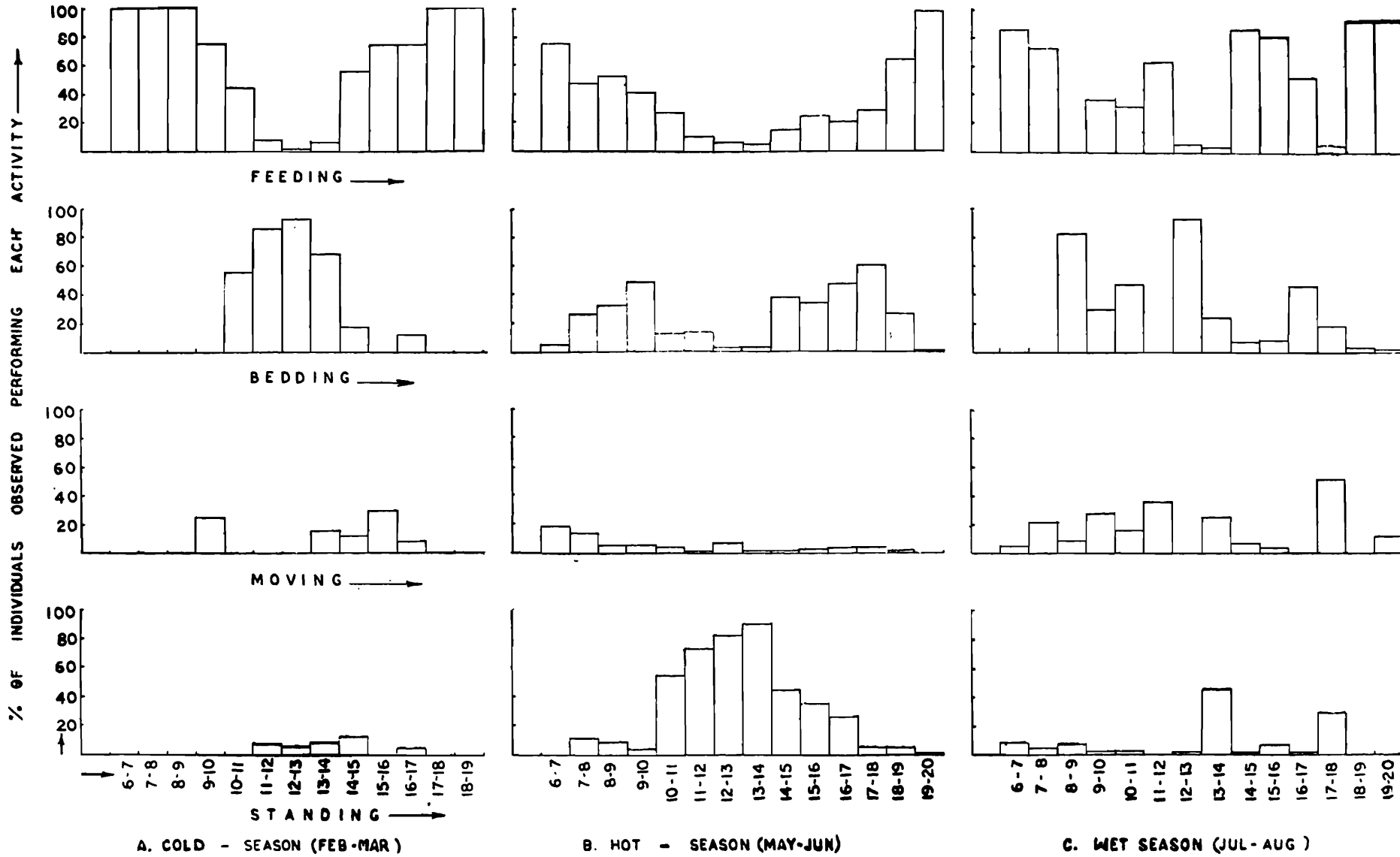


B. FEMALE-YOUNG ASSOCIATION

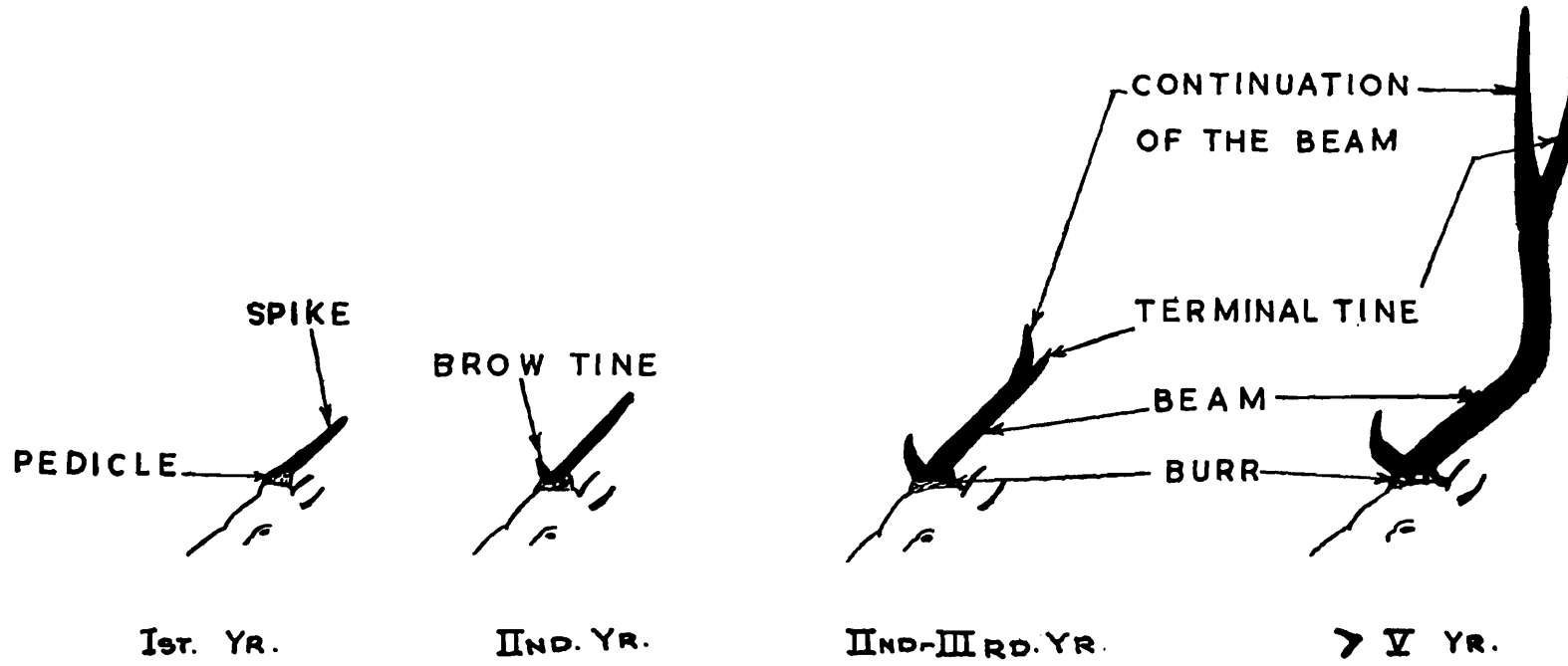


C. ALL-MALE ASSOCIATION

Fig. 2. HISTOGRAM SHOWING DIURNAL ACTIVITIES PROFILE OF *Axis axis axis* — (FOR THREE DIFFERENT SEASONS—(DAY HRS. ONLY)
 SUNRISE BETWEEN 0555' AND 0700 Hrs. LOCAL TIME AT SMIKALA
 SUNSET BETWEEN 1755 AND 1905 Hrs. LOCAL TIME AT SMIKALA



SHOWING DEVELOPMENT OF THE CHEETAL ANTLER



ASSUMPTIVE AGE IN YEARS

Fig. 10

GRAPH SHOWING ANTLERS CONDITIONS BY
PERCENTAGE OF OCCURRENCE AND MONTHS
1978

—○— PERCENTAGE OF HARD ANTLERED
BUCKS OBSERVED
- -△- - PERCENTAGE OF VELVET ANTLERED
BUCKS OBSERVED

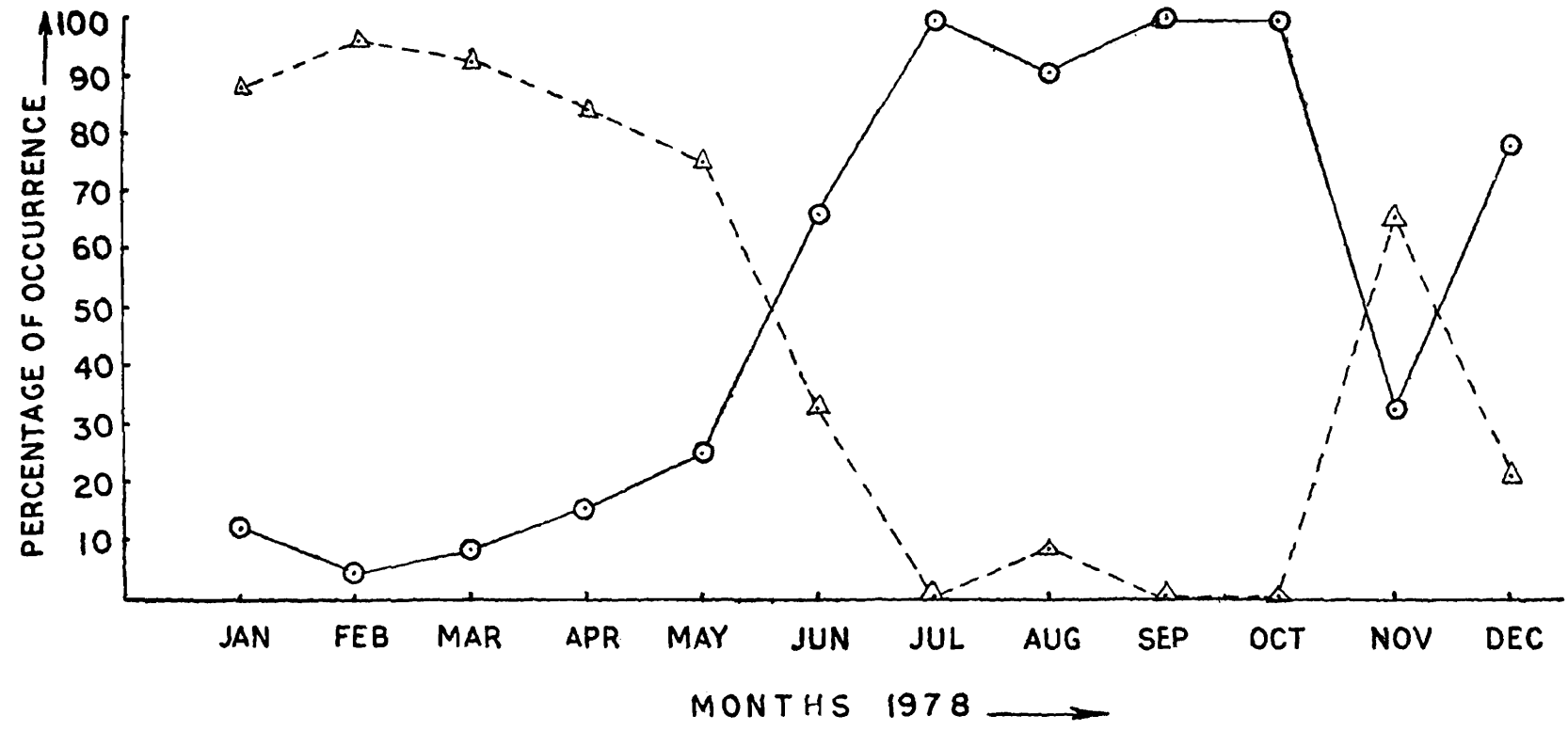


Fig. 11

HISTOGRAM SHOWING AVERAGE NUMBER OF RUTTING CALLS HEARD OF A HERD AT AN HOURLY BASIS DURING VARIOUS MONTHS OF THE YEAR 1978

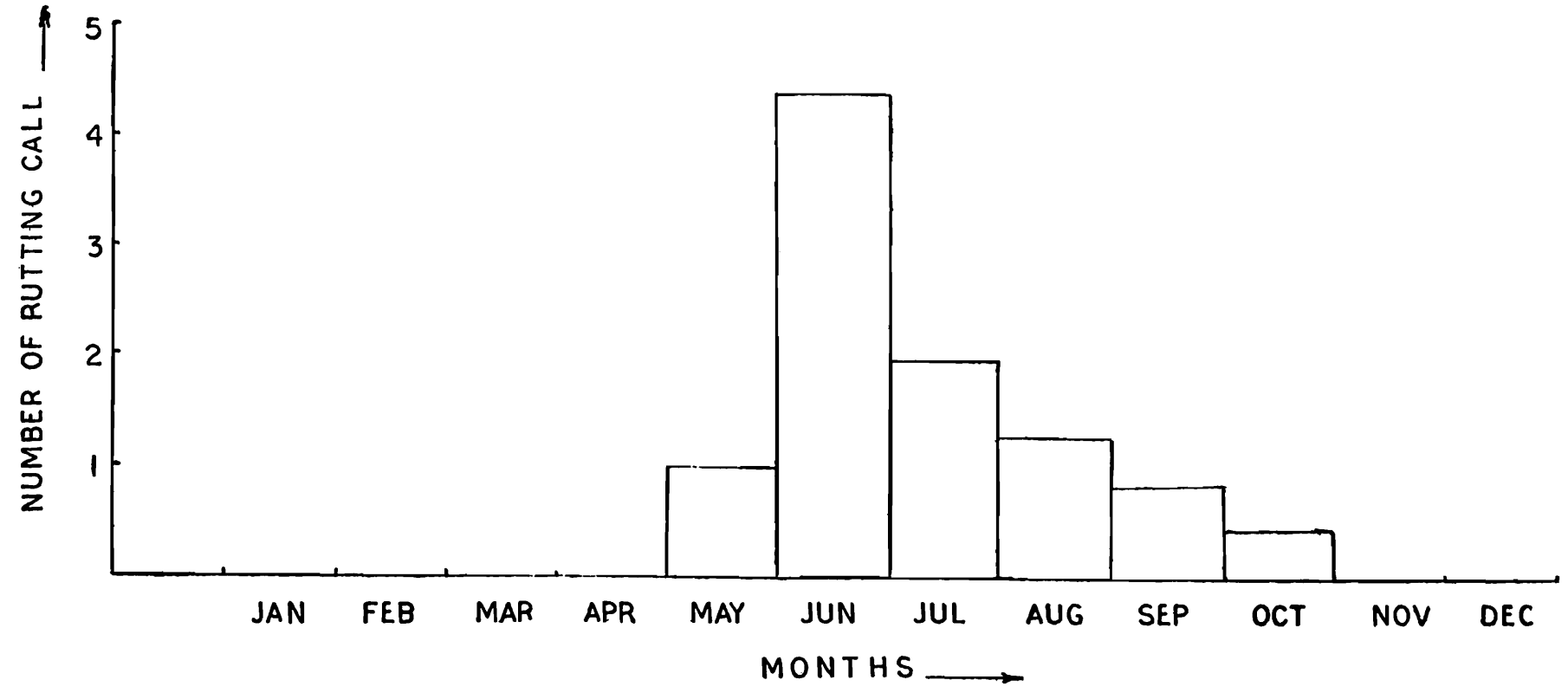


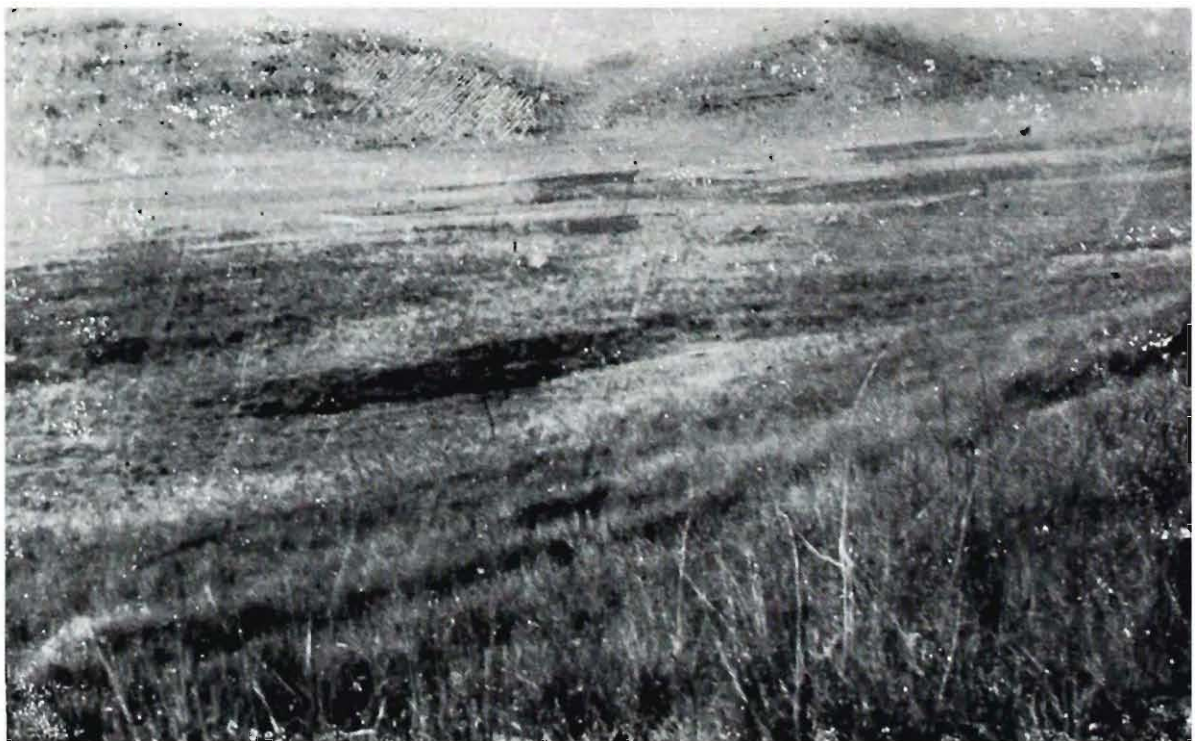
Fig. 12



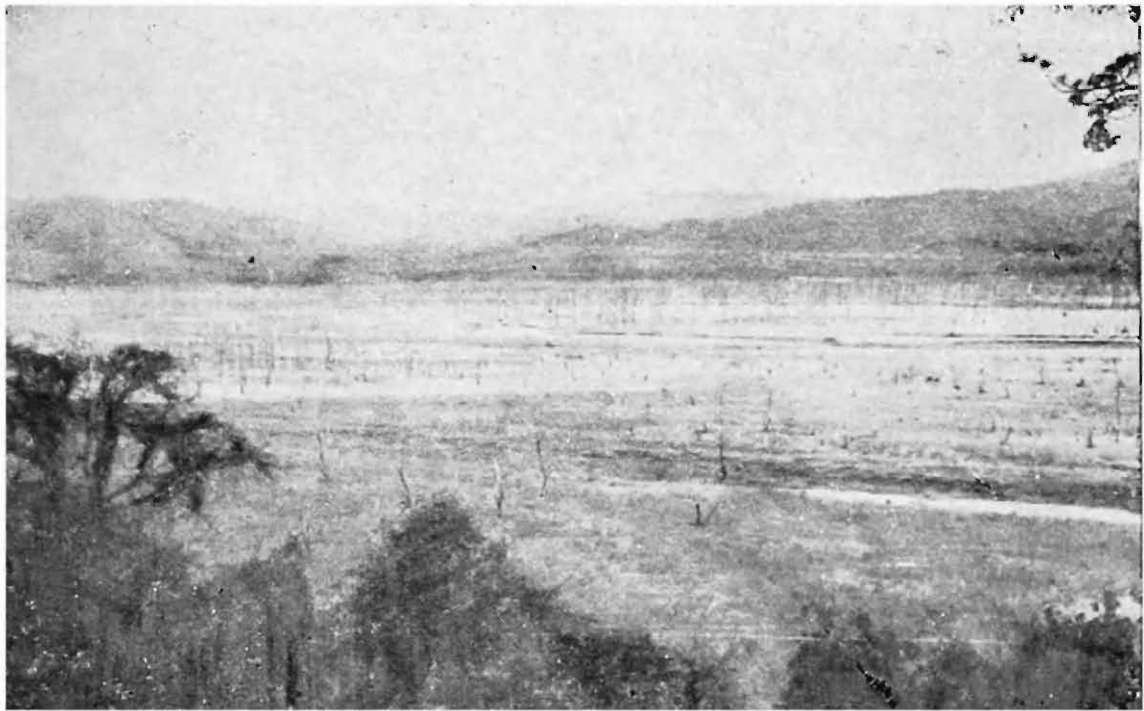
A cheetal stage.



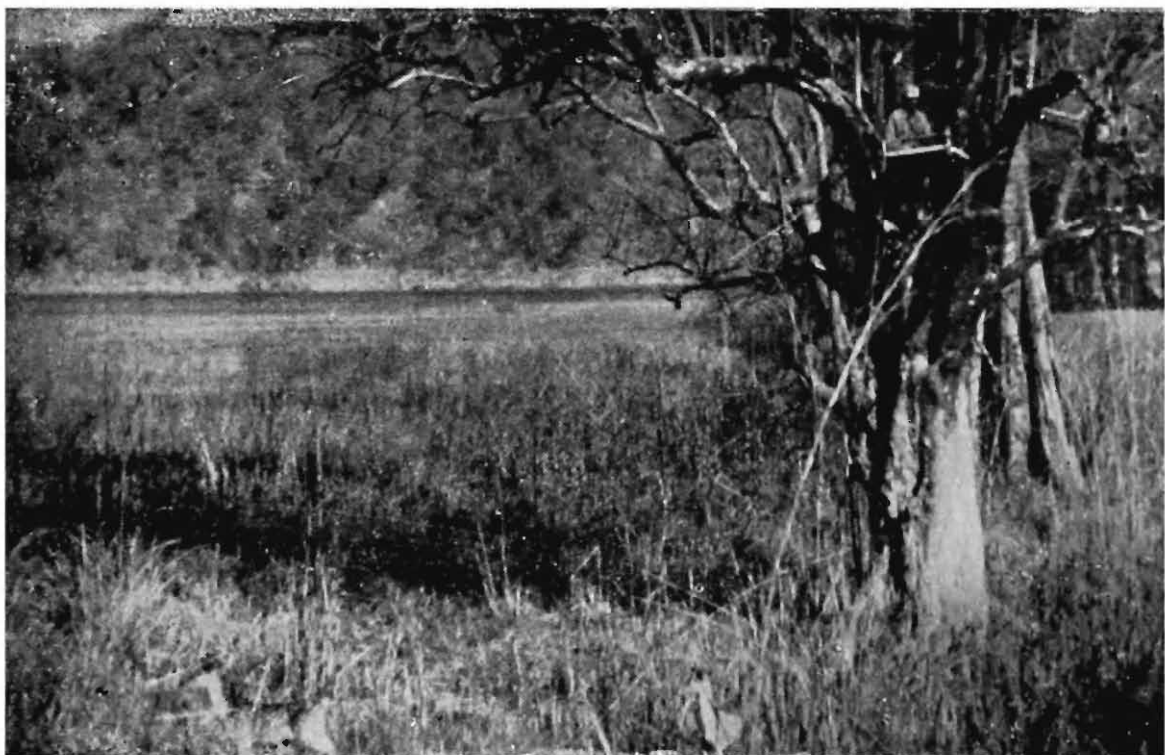
The river bed is sandy, pebbly and narrow.



The area that remained under water for more than four months the native vegetation of such area was being replaced by succulents.



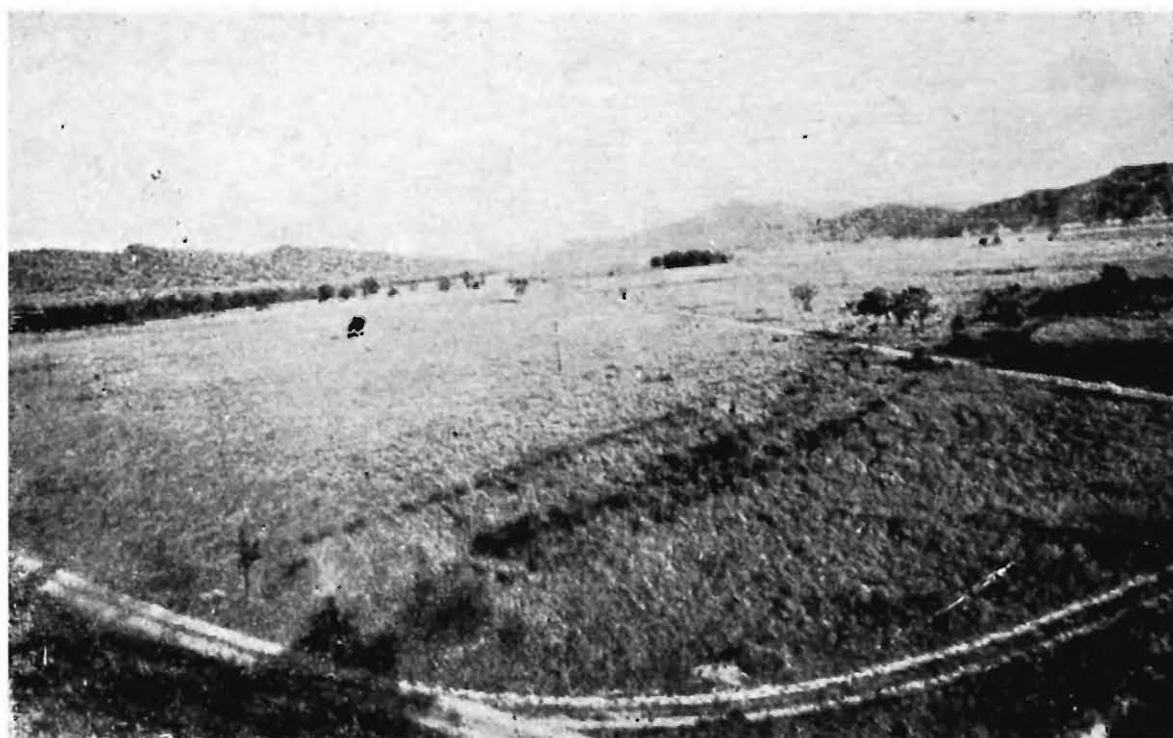
The areas that were submerged in two or more successive years, all vegetation dried up and died except the tree stumps.



The ethological observations were normally made on selected herds from specially constructed posts (Machans) high up in trees.



The herds were recognized by the individual game track or forest path used by them : Herd A₁ during winter.

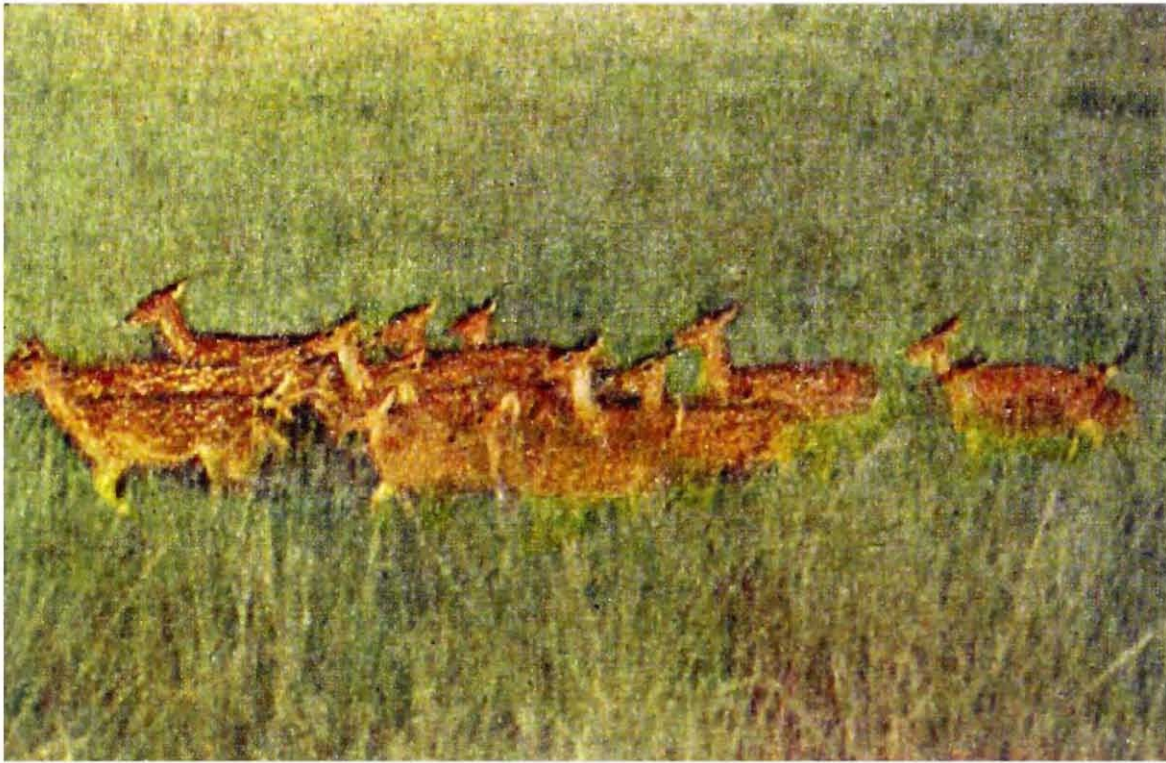


The central car road dividing the Dhikala 'Chaud' longitudinally was selected as transect or strip.

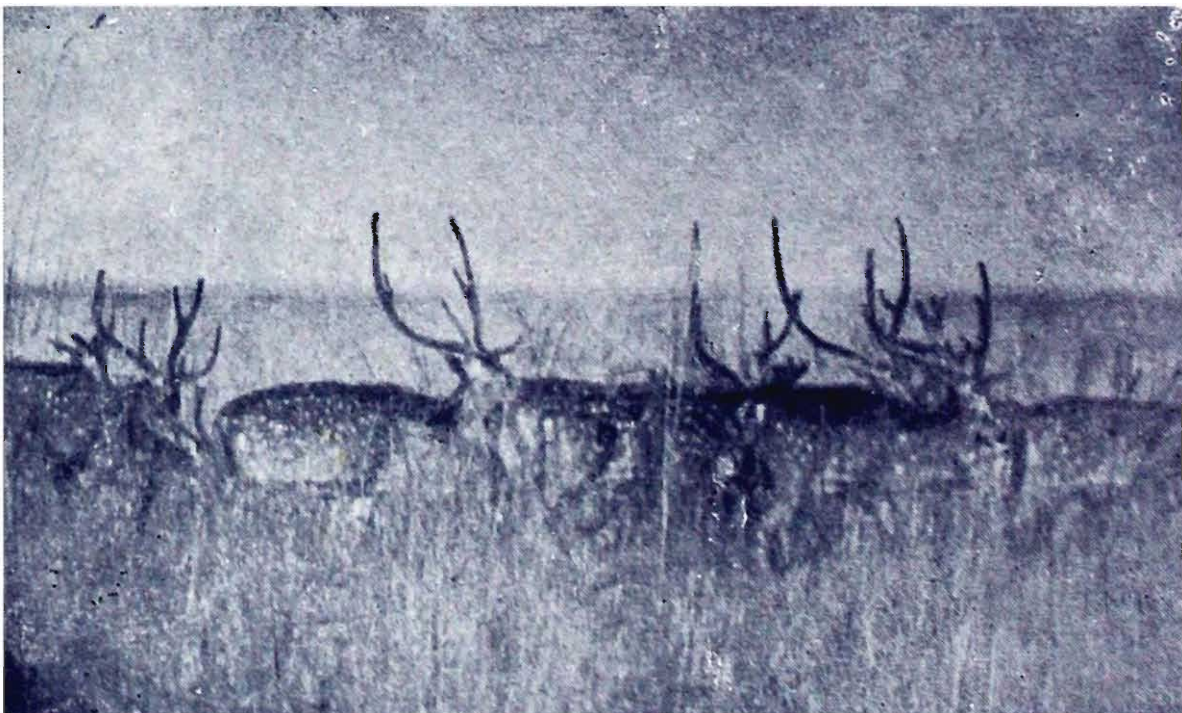


↑
The aggregations that were composed of individuals of both sexes and all ^{*} ages were classified as herds (mixed herds).
↓





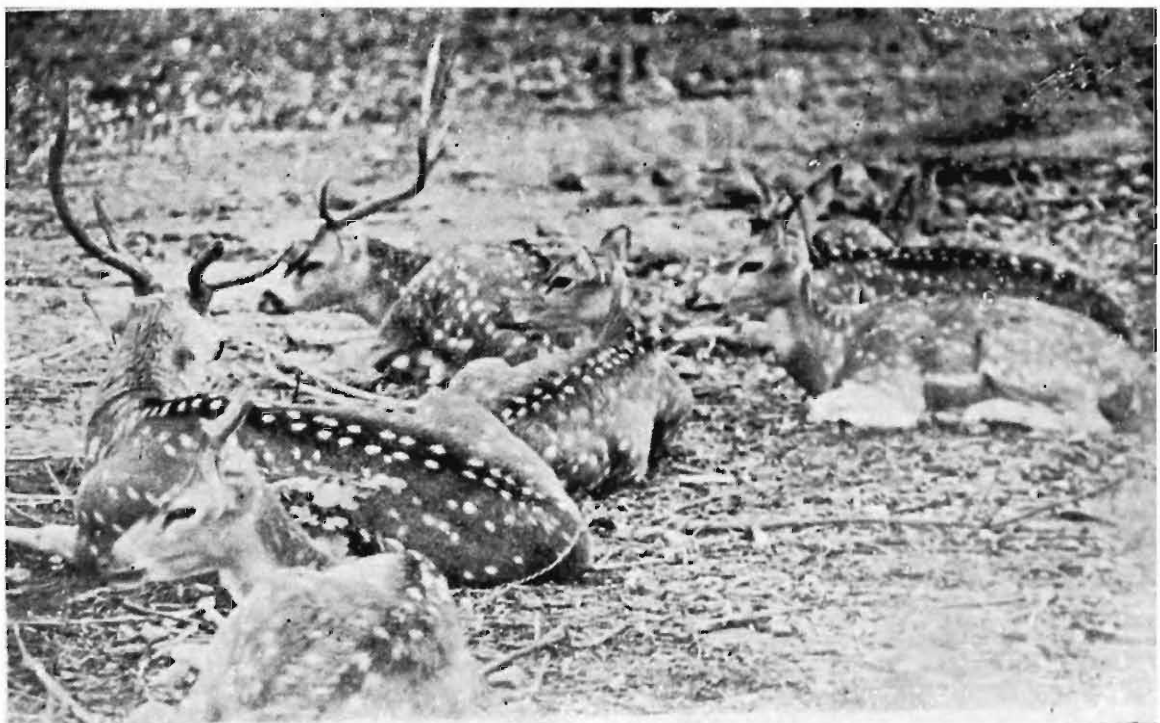
The main feature of the female-young associations was the absence of the buck.



The characteristic feature of the all-male associations was the complete absence of females.



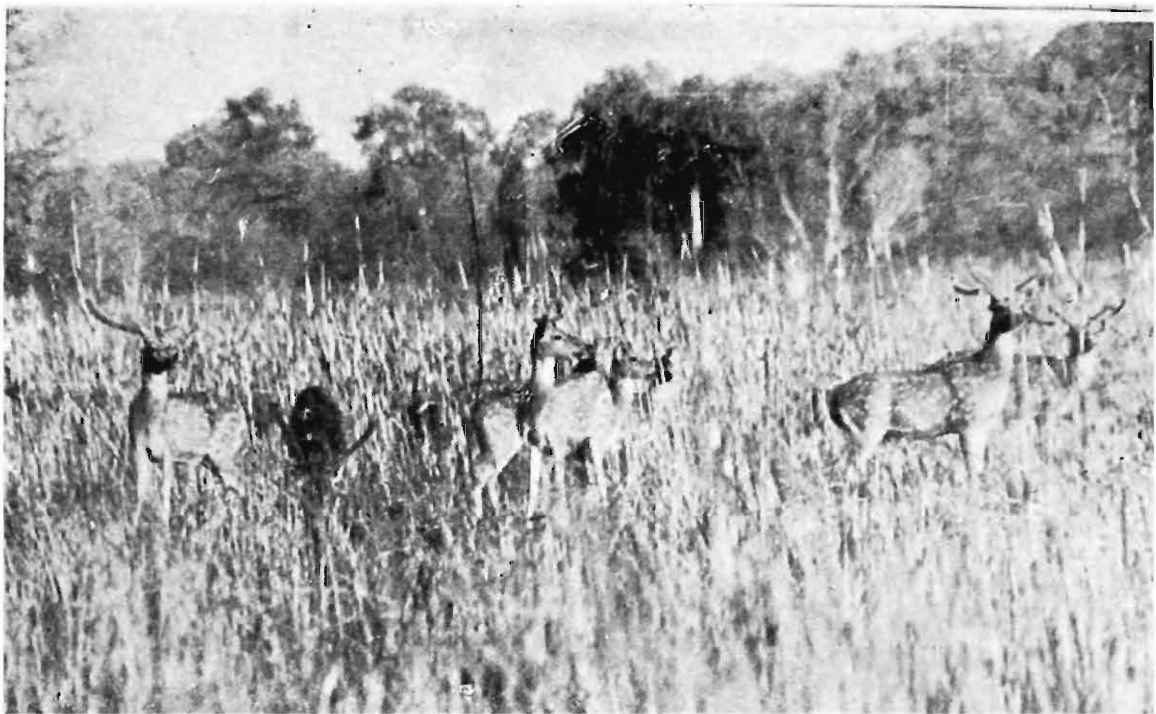
The whole or part of the herd may go for a drink of water : Herd A, on its favourite water place.



On reaching the day resting place the various members of the herd retire in available shades.



The only exception to this was in the summer of 1978 when a part of the local population 150-200 individuals stayed near the lake and in the river bed for whole of the day.



Whenever an alarm call was given out by a herd it was generally taken up by other herds present in the vicinity.



A stray female Swamp deer.



On a number of occasions newborn fawns were sighted.



Such newly laid fawns were kept hidden or remained well camouflaged.



↑
Within about four to six hours of the birth the newly laid fawn was able
to get up and walk, a little wobbly at first.
↓

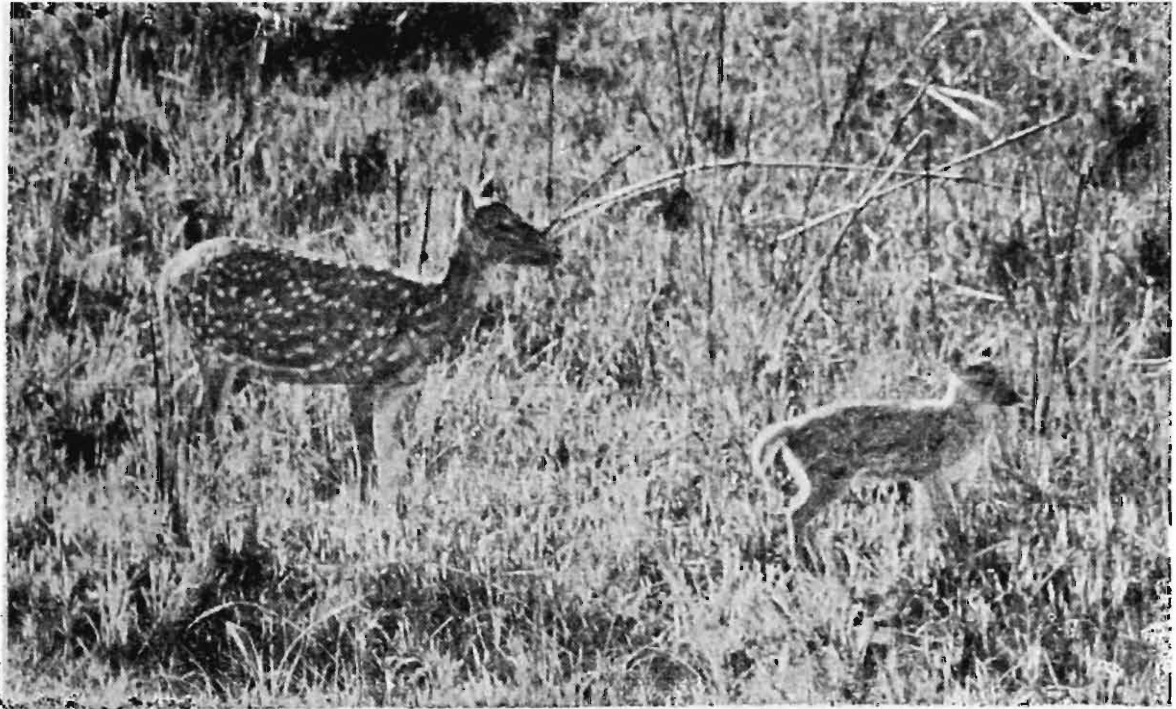




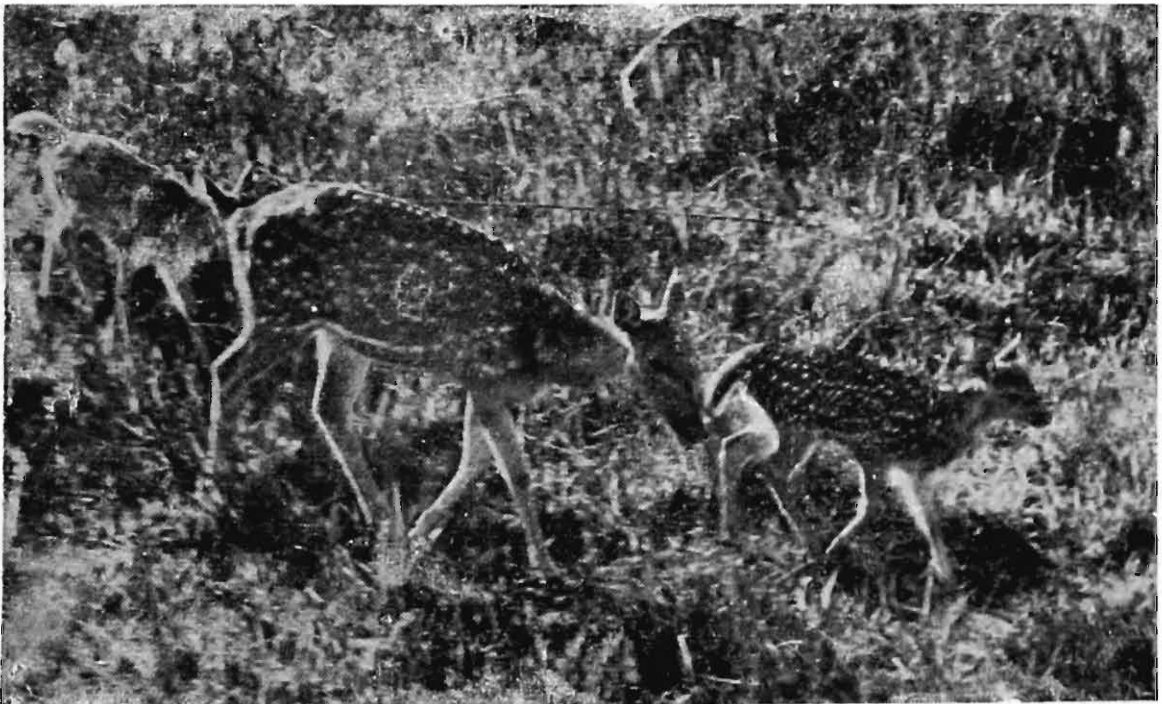
Within about four to six hours of the birth the newly laid fawn was able to get up and walk, a little wobbly at first.



The female (mother) approached the spot walking slowly with neck extended, ears raised and facing in front.



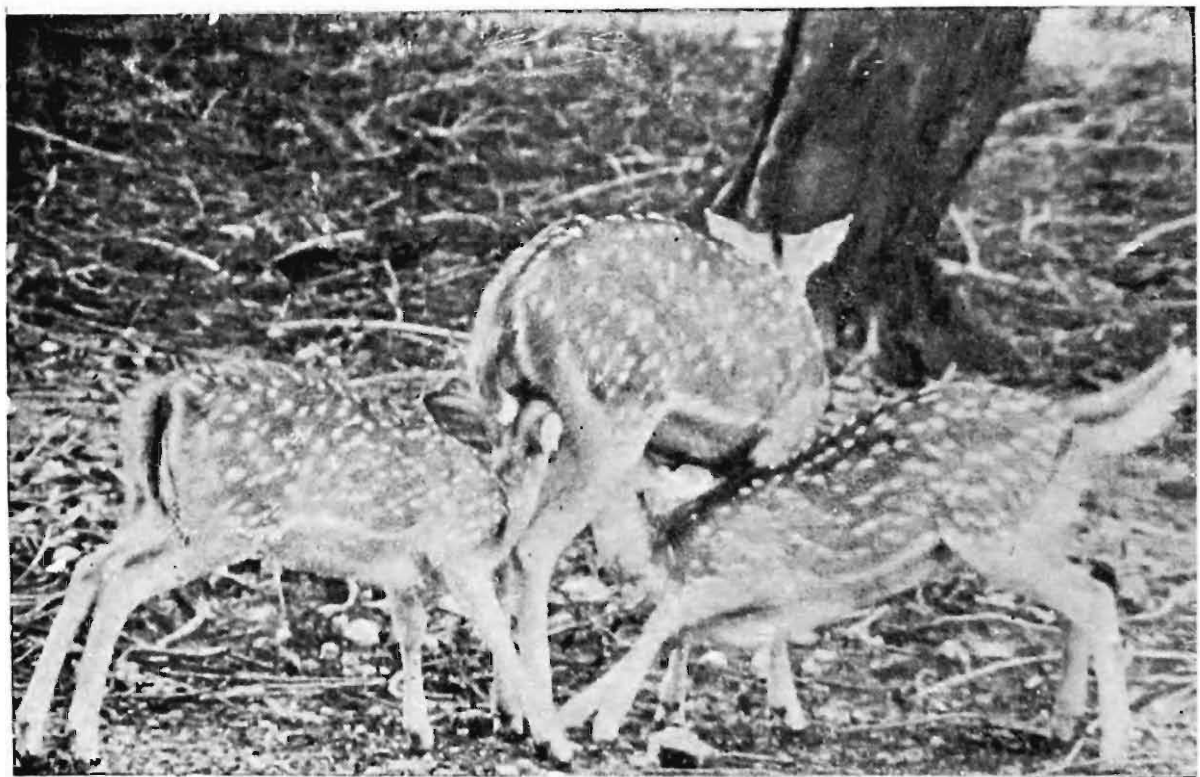
Whenever a fawn was being strayed away from its mother.



And started following another female in the herd.



The mother would invariably walk up the erring fawn and groomed it.



On many occasions suckling behaviour was studied during fawning season.



Self grooming : A yearling male grooming with its lower incisors.



An adult doe grooming with its teeth (lower incisors).



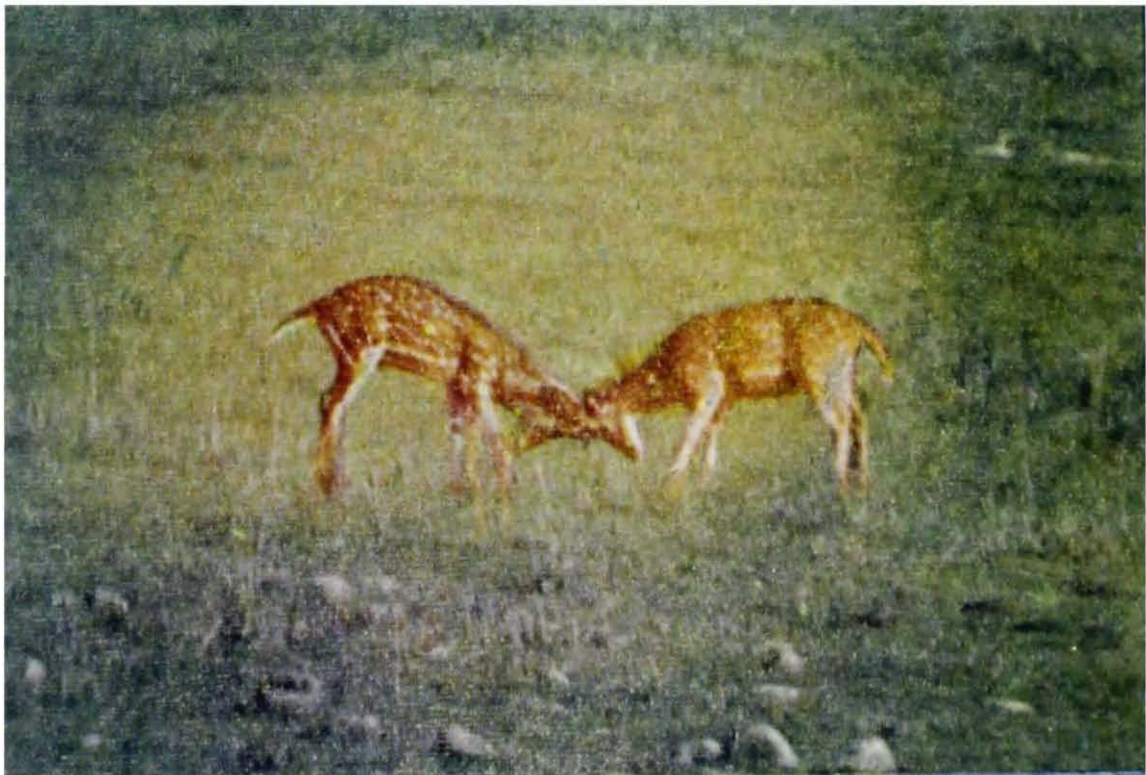
A yearling male possesses spike (dagger shaped) antlers.



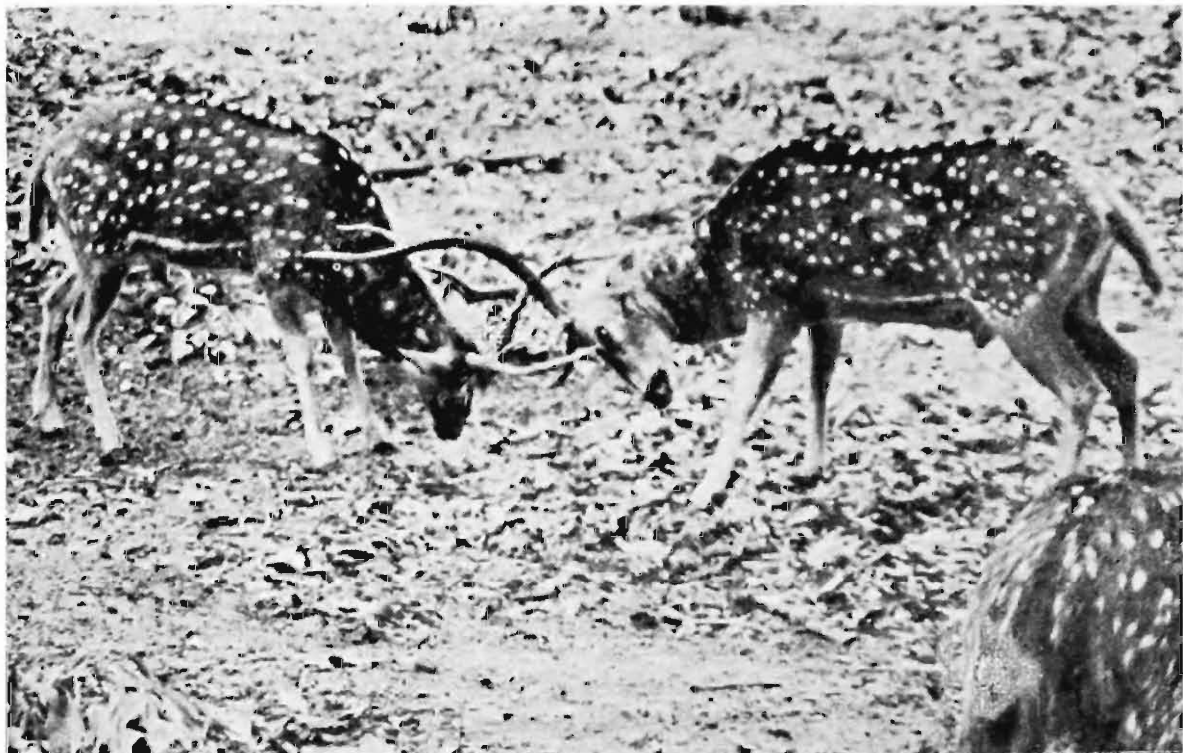
A two years old buck.



While standing on hind legs against the tree, even a dry and dead tree the male rubbed face region of the preorbital gland 'Preaching'



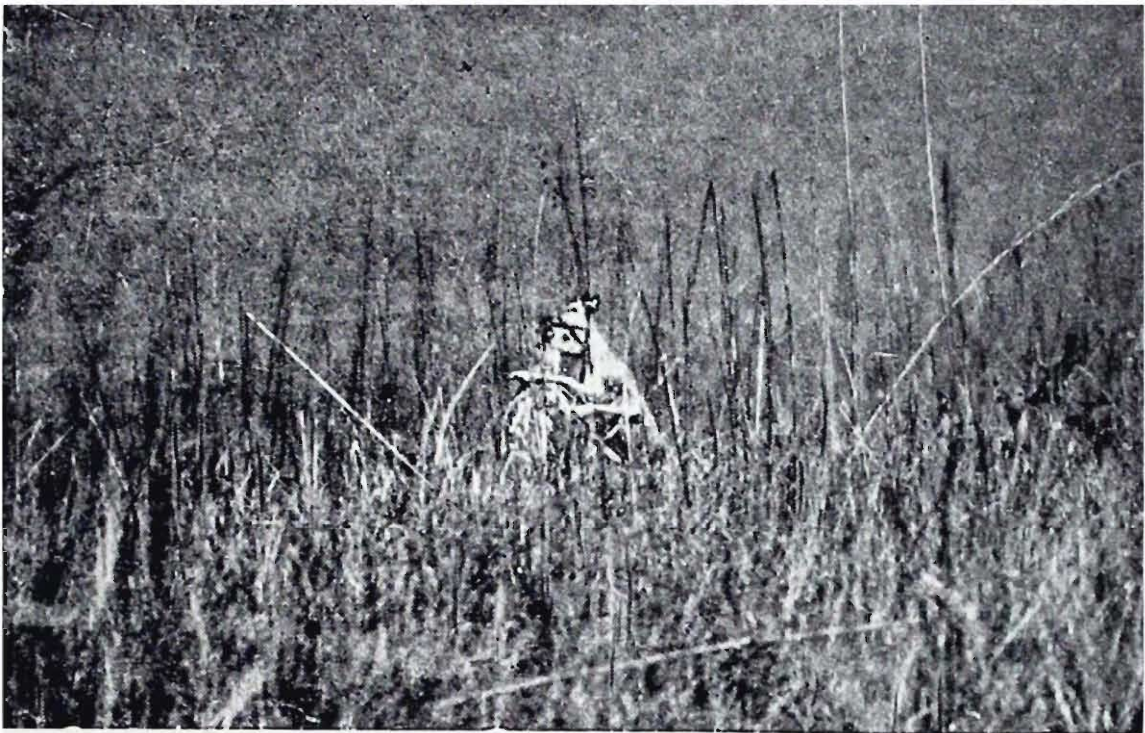
The heads of both the sparring males were brought in contact and the antlers locked.



A close up of 19B



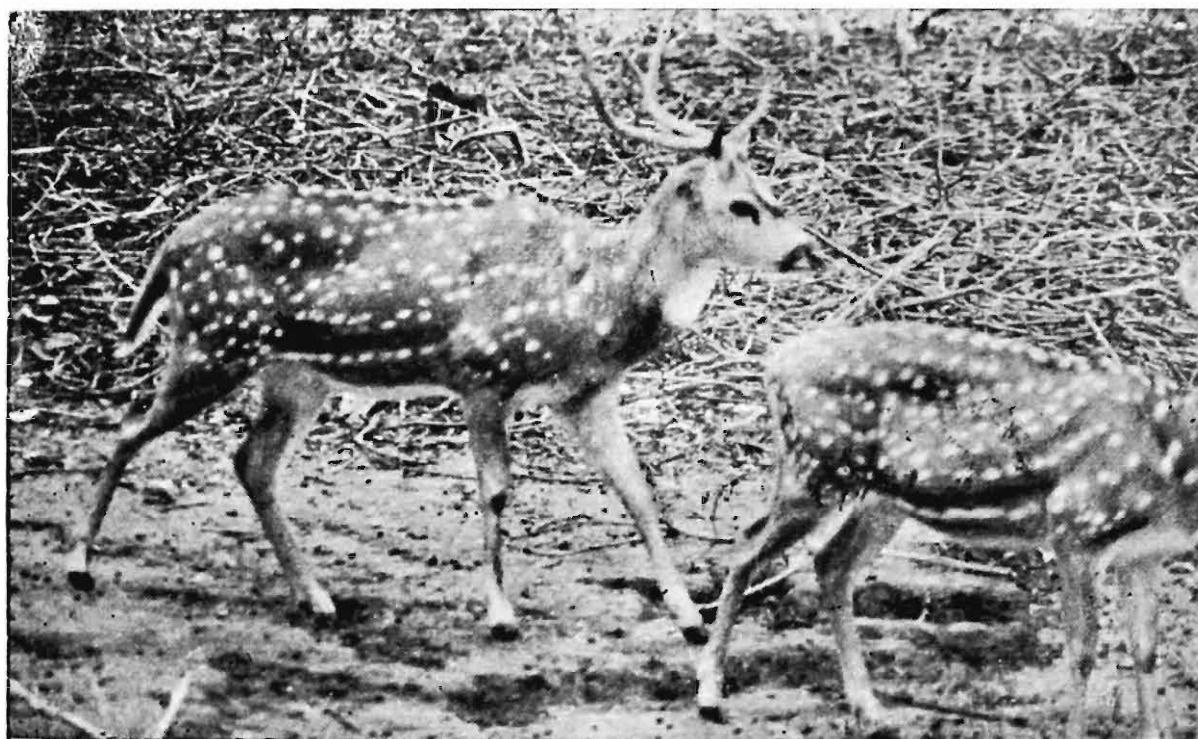
After having won the combat the winner invariably presented its dominance by exhibiting a head-up display.



Leg fighting was done with the opponents reared upon hind legs and striking at each other with hooves.



Lone rutting males were often seen shifting from one herd to another.



The approach of the rutting buck could be from one female to another within a herd or from one herd to another.

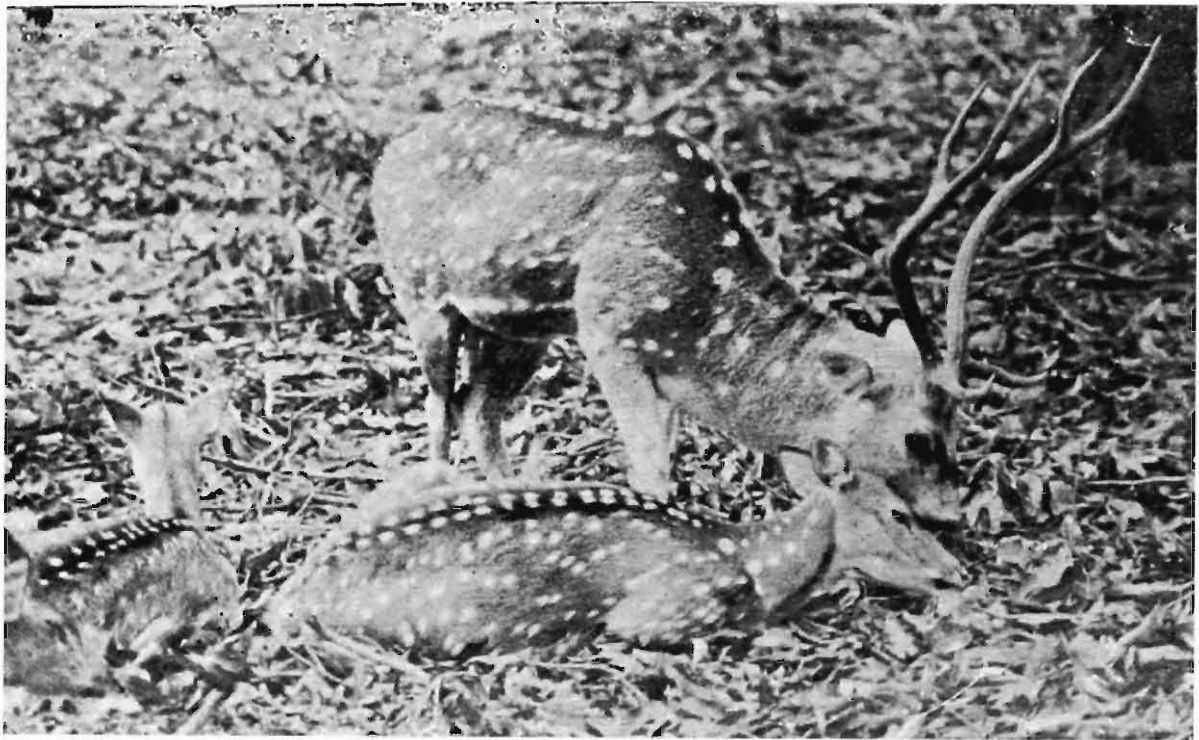




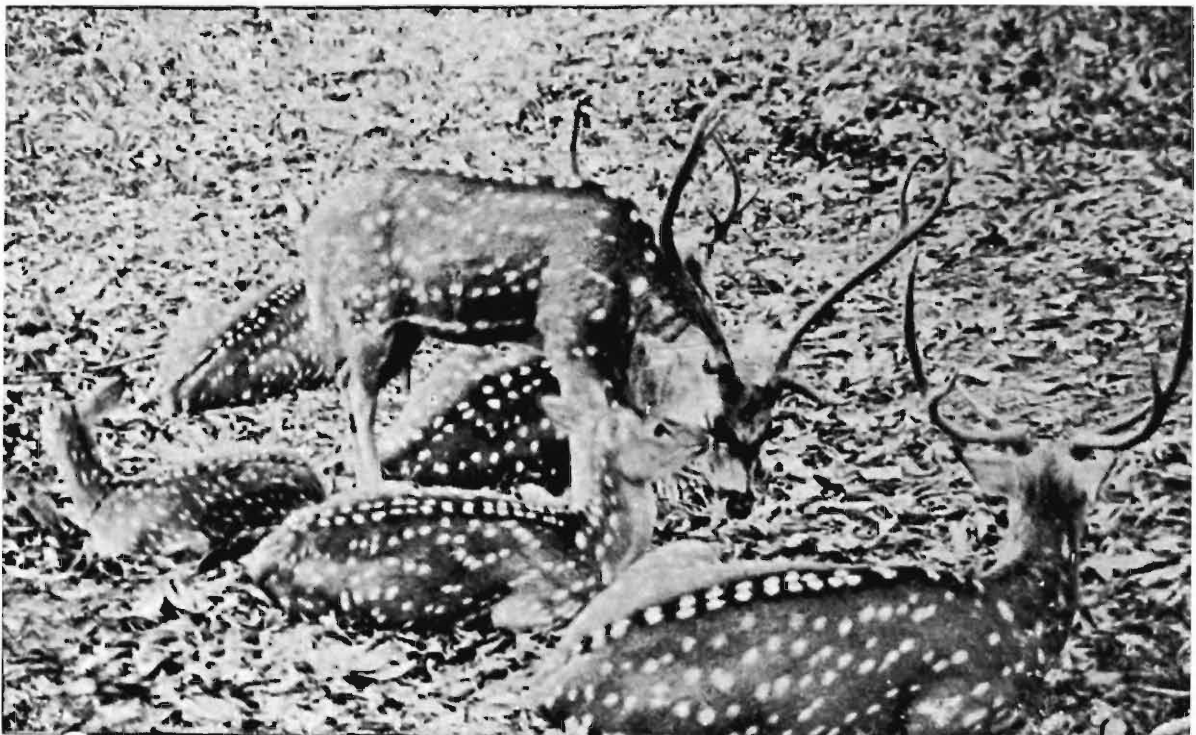
The males had a good sniff at the vulva of the female.



To determine the state of receptivity of the doe the buck may sniff the ground (spot) on which she had sat.

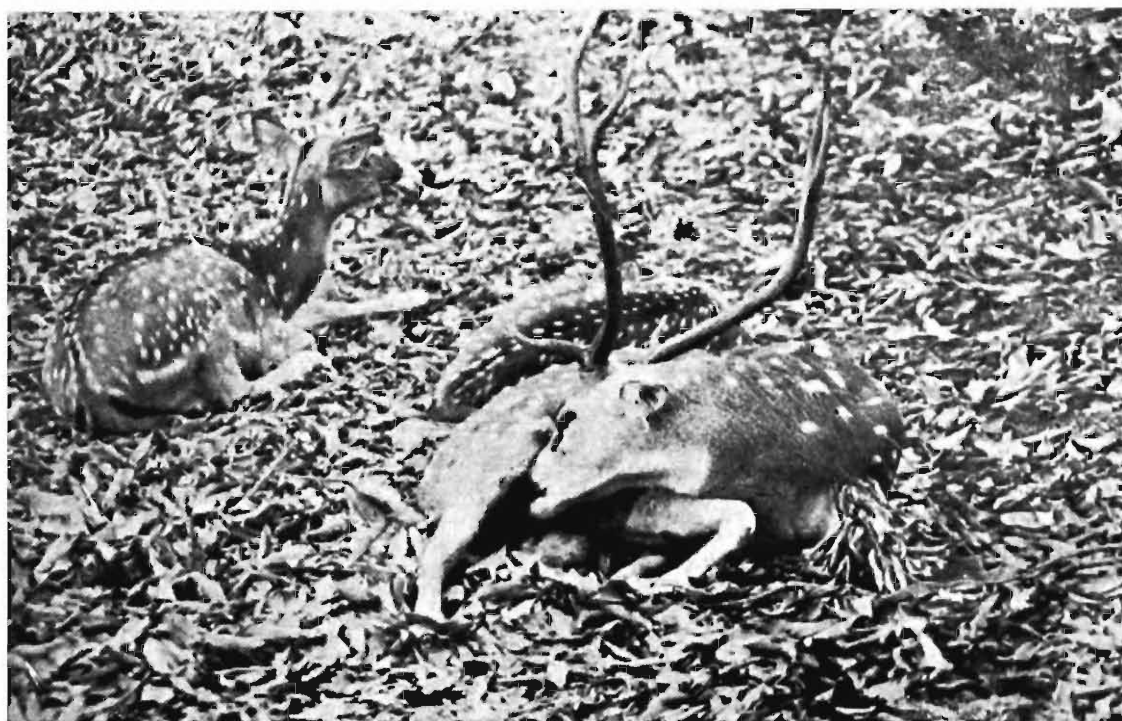


After sniffing the male would then proceed to lick her vulva and sometimes even the muzzle etc. which may be reciprocated by the female.





The males were seen also licking their own genital organs.





After having had a few licks, the rutting male would raise his head and curl his lips (Flehmen).

