Social Behaviour, Dominance Hierarchy and Reproductive Behaviour of Sambar Deer (*Cervus unicolor*) in captivity

By

R. Krishna Kumar

Thesis

submitted in partial fulfilment of the requirement for the Degree

Master of Science in Forestry.

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Kerala Agricultural University

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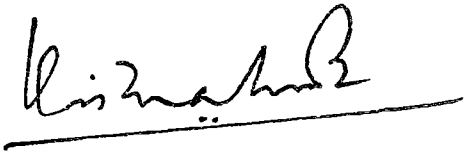
"No man could physically bring himself to stare at fishes, birds or mammals as persistently as is necessary in order to take stock of the behavioural patterns of a species unless his eyes were bound to the object of his observation in that spell-bound gaze which is not motivated by any conscious effort to gain knowledge, but by that mysterious charm that the beauty of living creatures works on some of us "

Konrad Lorenz

DECLARATION

I hereby declare that this thesis entitled "Social Behaviour, Dominance hierarchy and Reproductive Behaviour of Sambar Deer (Cervus unicolor) in captivity" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or society



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CERTIFICATE

Certified that this thesis entitled "Social Behaviour, Dominance Hierarchy and Reproductive Behaviour of Sambar Deer (Cervus unicolor) in captivity" is a record of research work done independently by Sri.R.Krishna kumar under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him

Dr. Jacob V Cheeran,
Chairman,
Advisory Committee.

(Professor,
College of Veterinary
and Animal Sciences)

Approved by

Chairman Dr Jacob V Cheeran 

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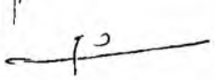
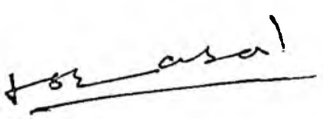
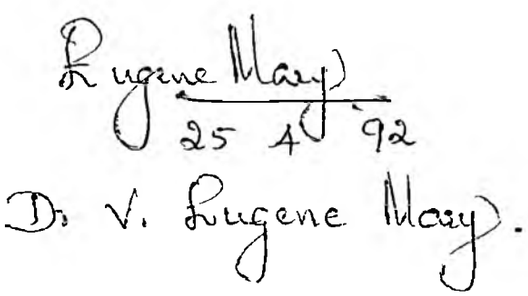
1. Sri. V.R.Krishnan Nair 

2 Dr P S Easa 

3 Sri K L Sunny 

External Examiner



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R KRISHNA KUMAR

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INTRODUCTION

INTRODUCTION

Zoological gardens or zoos were conceived primarily with the intention of rearing wildlife in captivity for the benefit of the people who may not be fortunate enough to see them in their natural habitats in the wilds Though the purpose of this exercise was educative and recreational basically, captive rearing has come to stay as a way of survival from extinction for many an endangered species, in this age of vanishing faunal wealth The success of this process of forcing an animal to live in an entirely strange surrounding, away from its natural habitat and ways, depends to a great extent on the adaptability of the animal to changing circumstances.

The globe is considered to consist of seven main zoo-geographical regions and the distribution of the world faunal wealth is dependent on the adaptability of the species to the particular region Conditions vary with each zone In zoos the world over, there would be representative specimens from different zones and it would be interesting to observe how each species fare in captivity in a totally different atmosphere from its natural habitat.

Though the sambar is a deer mainly of our oriental realm its living conditions in most of the zoos in our country is far from similar to the wild habitat of the

animal The sambar is a very shy, elusive and more or less solitary forest dweller, coming out at night to feed and keeping to heavy cover during the day. Though it is the biggest of our deer species, it is seldom seen in the forests due to its shy nature. They are rarely found in herds of more than 6 to 7 individuals (mainly of hinds and fawns) and lie up in shade during the hot part of the day. They take to water readily and frequent water bodies of the forests in summer.

The conditions available to the deer in captivity in zoos, is a far cry to its natural habitat. In Thrissur zoo, where this study was mostly done, 21 animals are cramped into a dry barren enclosure of about .25 hectares in extent with hardly any tree worthy of that name to provide shade, let alone cover Here in this enclosure, survive a quite "unnatural" herd of sambar comprising of 10 stags, 4 hinds and 7 juveniles and fawns. These animals are of various stock, some of them introduced in fully grown stage from forest, through the Forest Department and some others from private keepers But it is amazing to note that these animals live and multiply under such totally strange circumstances, with a comparatively low mortality rate, as studies show The other side of the picture would be further clear when it is known that all efforts to locate and observe a representative herd of sambar at the Parambikulam Wildlife

Sanctuary, even during the dry period of the year, proved futile for a week Only fleeting glimpses of the wary animal dashing through the cover or slinking away, could be got The references on the behaviour of sambar in its natural habitat are based on the records of Schaller (1967), Prater (1965), and my own whatever limited observations at Parambikulam

No other Indian ungulate has adapted itself to a wider variety of forest types and environmental conditions than the sambar (Schaller '67) It is found in the thorn forests of Gujarat, Rajastan, and other states; in the dry and moist deciduous forests throughout peninsular India;in the pine and oak forests of the Himalayan foothills upto an altitude of 3,000 to 4,000 meters, and in the evergreen and semi-evergreen forest regions of Eastern India. It is probably this enormous adaptability to conflicting living conditions that has made sambar deer a grand success in 'zoo-breeding.' There need be no apprehension about this speies reaching depletion in the near future, as they thrive and breed in whatever conditions provided with

SAMBAR DEER - THE SUBJECT OF STUDY.

SYSTEMATIC POSITION OF SAMBAR

(*Cervus unicolor niger*)

Class	: Mammalia.
Order	: Artiodactyla.
Sub-order	: Ruminantia
Infra Order	Pacora
Family	Cervidae
Genus	: *Cervus*
Species	: *unicolor*
Sub-species	: *niger*

The sambar is the largest deer in South East Asia. A full grown stag stands around 140 cms in height and weighs something between 200-350 kgs The length of the body would be around 250cms, and tail length ranges from 22--35 cms. Schaller (1967) records that two stags in the New york Zoological garden recorded 186 kg and 202 kg at the scales and one hind in the same zoo weighed 163 kg.

The coat of the sambar is coarse and shaggy. In stags, it forms a mane about the neck and throat (Prater, 1965).The tail has either medium long hair or it is bushy with coarse, woolly hair (Grzimek, 1972). In winter, the coat is grey brown to dark brown and adult stags (old stags) appear very dark, nearly black at times (Schaller, 1967). In Kanha park,

cousins in the wild as in Kanha and other forests, as encountered by Schaller In the wild also, Sambar are known for their wallowing habit, but it is a wonder how they maintain their coats in glistening form after all this wallowing

Grzimek (1972) groups sambars into three species and eighteen sub-species. The three main species are:

a) The Indian Sambar (c. unicolor) with six sub-species
b) Sunda Sambar (c. timorensis) with eight sub-species.
c) Philippine Sambar (c. mariannus) with four sub-species.

The sub-species of the Indian Sambar include the Ceylon Sambar (c. unicolor unicolor), the Sumatran Sambar (c. unicolor equinus) and the South Indian Sambar (c. unicolor niger)

Van Bemmel (1949) placed rusa and Sambar deer in the genus Rusa and identified four species. Indian Sambar (Rusa unicolor) from India and Srilanka; Malayan Sambar (R. equina) from Southern China, Indochina, Taiwan, Borneo and Sumatra; Javan rusa (R. timorensis) from Java, Celebes and Molucca and Manila rusa (R marianna) from the Philippines.

Alexander the great of Macedonia, encountered the South Indian Sambar on his Indian campaign, in the years before Christ Thus, Aristotle mentioned about this animal in his

The intention of this task could be well elaborated by borrowing the words of a renowned ethologist "Ethology is behaviour studied by people who love their animals In other words, an ethologist studies the behaviour of an animal for its own sake and because he wishes to understand that particular animal more fully, not because he believes that his work may throw light on human behavioural disorders, on the rules governing the process of learning or for some other extraneous or semi-extraneous reason"

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The scope for review of literature on the subject is unfortunately limited, since very little information is recorded on the species, even in its natural state The nocturnal habits of the animal, its propensity for remaining under heavy cover, its shyness and alertness make it even difficult to locate, let alone observe for long periods in the wild This may be the reason why the literature, whatever available, contain little detailed information on Sambar Useful general accounts are given by Baker (1890), Lydekkar (1898), Blanford (1888-91), Fletcher (1911), Brander (1923), Prater (1965) and Schaller (1967)

Study of Behaviour:

The objective study of animal movements or interpretation of character by the study of gesture is known as Ethology (Thorpe, 1961) Early European naturalists developed this discipline through studying the animals in their natural environment

Behaviour is the genetically modulated experientially modifiable response of an organism to stimulations which constitute a change in the external and in the internal environments (Fox, 1967)

Many of the behavioural patterns are formed as a result of 'inborn skills' Such instinctive activities are parts of the anatomical structures of the animal concerned This need not be fully functional at the time of birth, but may mature gradually (Eibl-Eibesfeldt, 1975 - quoted by Mary, 1981)

There is always a cause for behaviour For its manifestation, external sensory stimuli are just as responsible as internal drive mechanisms of a central nervous system, hormones and internal sensory stimuli A bridge with physiology is thus created by making these physiological causes of behaviour also subject of ethological investigation (Ewer, 1968)

Carthy (1965) records that a stimulus may operate indirectly by having become linked through experience with a particular action or object An animal's response to a given situation is limited by its physical structure and the level of development of its nervous system It's behaviour is governed largely by the evolutionary processes that have shaped the species to which it belongs

To discover the place of a particular piece of behaviour of the animal's own order of priorities, one has to wait for the animal to perform it at the time of it own convenience (Mary, 1981)

Social Behaviour:

Although society has many functions, one of the most important of these in ungulates is to organize the members of a species in such a way that most mating is accomplished by the prime adult males The males establish a system of land tenure or a heirarchial pattern that partly or wholly excludes a certain percentage of their sex from active participation in the rut. The means by which this is accomplished varies from species to species (Schaller, 1967)

In Sambar, the small size of the social groupings precluded a large number of interactions, and except during the main period of rut, the animals were usually encountered as they foraged in the forest, spread over about 100 feet of terrain, or rested within 20 to 30 feet of each other, chewing cud intermittently (Schaller, 1967).

The typical herd is small, numbering fewer than six individuals During rut, most adult Sambar males appear to confine themselves singly to a limited range, in which they join or are joined by females for varying lengths of time The characteristic social unit at Kanha Park was one hind and one fawn or one hind, one yearling and one fawn, although 2 to 3 adult hinds were also seen together on occasions. Yearling stags usually remained with the hinds (Schaller, 1967)

Dominance:

Males in a small herd tend to establish a rank order In the male deer, with their deciduous antlers, there is considerable seasonal variations in the degree of dominance displayed Several forms of redirected aggression, which invovle attacking an inanimate object rather than an opponent, are displayed by male deer Three types of such behaviour are characteristic in Sambar,--Preaching, with the animal standing on its hindlegs and wiping its face on a leafy branch, wallowing during the rut and establishing stamping grounds These forms of behaviour may serve to intimidate an opponent either directly or indirectly by marking the environment with visual signals and with scent from the pre-orbital and other glands (Schaller, 1967)

Ozoga (1972) identifies seven basic aggressive actions in establishing dominance, displayed by white tailed deer feeding on browse felled during winter. Most conflicts consisted of threats rather than actual physical contact The frequency of social strife increased toward late winter, but the intensity of combat decreased Most members of the aggregation met one another during the yarding season and conflict between animals that met frequently was minimal, suggesting that a single, rather stable, social heirarchy promptly developed Adult bucks 2 5 or more years in age generally dominated all other deer, and mature does normally

dominated fawns Despite the social strife and food competition at the cutting, over winter mortality was judged to be considerably lower than that in adjacent over broused areas where deer subsisted on existing forage (Ozoga, 1972)

A system of dominance based primarily on a visual assessment of certain characters rather than on repeated contacts would seem to be a distinct advantage to species with a fluid social organisation since it would lessen the amount of strife and make the establishment of rank almost instantaneous when two individuals met (Schaller, 1967).

Conflict between hinds is rare in Sambar. Among Red Deer hinds, Thouless and Guinness (1986) have recorded that most interactions were won by the older hind of the pair and this was the case ever when both individuals had reached full body size The younger hind was more likely to be the winner if the conflict was escalated or if the two hinds were strangers, in which case escalation was more frequent than usual When outside their normal home range, older hinds were much more likely to lose, and younger ones more likely to win, than usual. This may be due to the hinds using previous experience as a cue for conventional resolution of conflict, with the result that dominance relationships established early in life are perpetuated. No such cue is available if the hinds have not previously met (Thouless and Guinness, 1986).

season of births coincides with the onset of rainfall as in many of the African ungulates New growth of browse is more abundant during the monsoon than any other season of the year (Mishra and Wemmer, 1987)

Schaller (1967) also notes that Sambar gives birth primarily during the monsoon at Kanha It is likely that hinds gave birth to their first fawn when about three years old Each adult female probably bears young once a year and a single fawn is the rule normally

Flehmen:

Many views have been published to explain the exhibition of Flehmen by ungulates and its relation to other behavioural factors

Flehmen is a sexually diethic trait, most frequently shown by males toward females (Henderson, et al., 1980). Estes (1972) proposed that flehmen aided in the detection of estrus through urinalysis by the vomeronasal organ.

Females of the ungulate species perform Flehmen infrequently under natural conditions (Altieri and Muller-Schwarze, 1980, Reinhardt, 1983)

Both male and female urine releases flehmen of equal duration although response of males to female urine occured more frequently in Sambar deer (Mary, 1981)

Sexual/Reproductive Behaviour:

Although the reproductive cycle of wild ungulates in India appears to be dependent on an inherent endocrine cycle, little influenced by obvious environmental conditions, it is surprising to note the striking differences in the rutting and fawning times within the same species from area to area (Schaller, 1967)

Published comments are almost unanimous in stating that the time of rut in peninsular India run from October to December As in other deer, the annual changes in antler development give an indication of the probable state of sexual activity in the animal Schaller (1967) disagrees with most published information in that the rut of the Sambar does not appear to be as discrete as has been suggested but rather to be spread over a period of at least seven months of the year The peak of the rut is during November--December This peak may vary somewhat from area to area as is suggested by the fact that the sore spot, which is present in rutting Sambar at Kanha only from mid-November to mid-December, was seen in three animals at Kaziranga in early May (Schaller, 1967)

During the first week of November, the Sambar suddenly began to wander widely, even at mid-day, becoming highly conspicuous in sharp contrast to their usual elusiveness Solitary stags, hinds and sometimes yearlings walked rapidly

through the forest, appearing nervous, as if looking for something Apparently, the behaviour represented the first stage of the rut, a period when the old social groupings broke up and new ones were formed (Schaller, 1967)

Large stags establish a territory during the rut, which they defend against the intrusion of other stags (Prater, 1965)

Schaller (1967) notes that sexual behaviour was rarely observed "One stag followed a hind closely and sniffed her vulva, another male licked the vulva of a hind on another occasion Once a third stag assumed the low-stretch display, with neck held parallel to the ground and sub-orbital glands everted as he trotted after a hind"

Gibson and Guinness (1980) relates variation in reproductive success among adult Red Deer stags to harem size and the duration and timing of breeding access All three factors were affected by dominance (fighting success) during the rut The number of hinds using a stag's rutting area and the duration of individual rutting activity also affected breeding access (Gibson, Guinness, 1980)

In Chitwan National Park, Nepal, the season of peak births in Sambar coincides with the monsoon, according to Mishra and Wemmer (1987) The breeding cycle of the Sambar appears to be in agreement with the hypothesis that the peak

Flehmen is a general testing of urine and not a specific response to urine of estrous female (Muller-Schwarze, 1979)

Pfeifer (1985) has observed Flehmen among a captive herd of adult female scimitar-horned Oryx and noted its relation to dominance among them Flehmen was used by the Oryx cows to monitor the reproductive status of their herdmates (Pfeifer, 1985)

MATERIALS AND METHODS

MATERIALS AND METHODS

a Study sites

The study was conducted mainly at Trichur zoo. Some observations were made at Trivandrum zoo also, for comparison of conditions Though it was originally intended to cover Mysore zoo also for this purpose, it was not possible due to some technical reasons Similarly field studies at Parambikulam were not fruitful; within the limited time as explained elsewhere

a 1 TRICHUR ZOO

In Trichur Zoo, Sambar deer are kept in two encloures, inter- connected by a gate kept open most of the time;at the North-eastern corner of the premises Public roads form the boundaries on the Northern and Eastern sides of the pen, while on the Southern side there are other encloures holding Blackbuck and Hog deer. The Sambar can be viewed from the Western side which is the 'front' of the enclosure. On the Eastern and Northern sides, the cage is bounded by high masonry walls which obstructs view from the public through-fares, while on the West and South wire-mesh fence guards the animals (Plate I a,b)

The total area of these two enclosures together is about 25 hectares. Water troughs are provided in both the enclosures and leakage of water has created slushy ground in

PLATE I

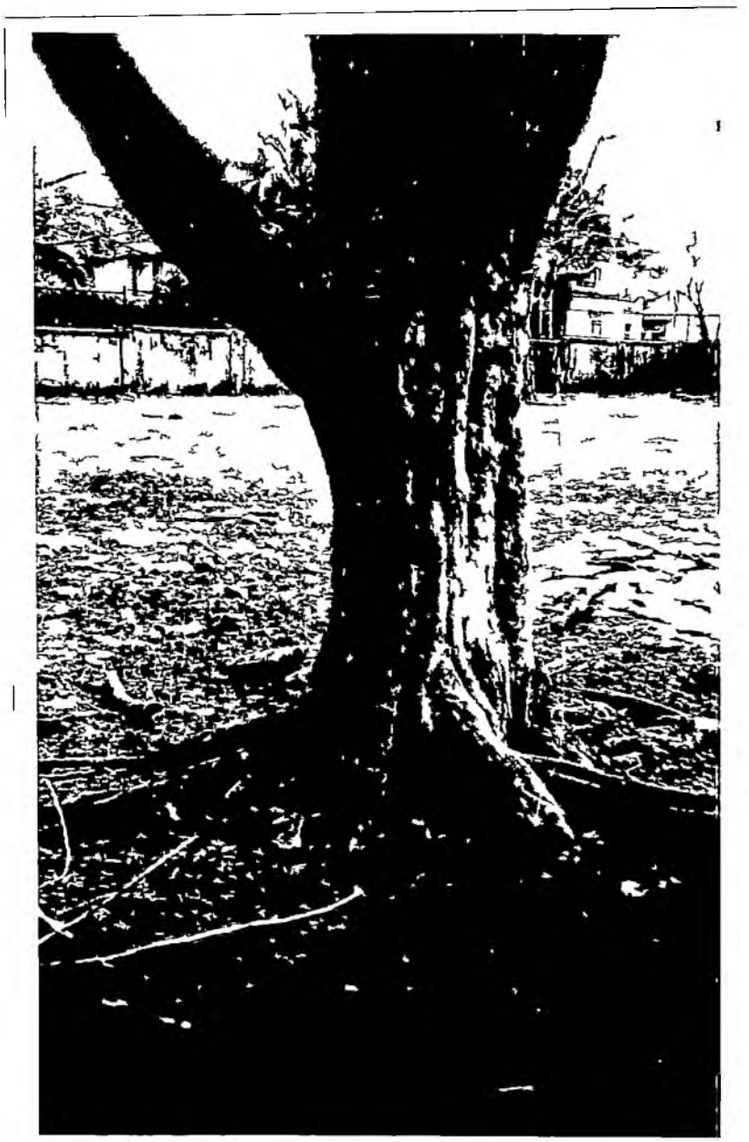
Sambar Enclosure - Trichur Zoo

(a)

(b)

PLATE II

Jack Tree in the Enclosure Debarked by Sambar



front of it This is often used by the animals as wallowing ground There is a small shed [Plate I(a)] in the middle on both sides of the partition fence This shed is also bound by wide mesh with a door of the same material. It can be used to isolate any particular animal, if need be.

The ground inside the pen is barren except for a few palm trees, here and there. There is also one Jack tree (Plate II) almost debarked entirely by the Sambar. These trees are concentrated towards the periphery of the pen. Whatever shade available to the animals, is therefore at the edge of the enclosure. Hence they spend most of the day lying against the walls at the other end - in groups or singly

1 1 **Daily Routine.**

The daily routine for the maintenance of Sambar in Trichur Zoo was observed as follows:

The pens are cleaned every morning and debris of the previous day's fodder cleared. Then the animals are herded into the bigger enclosure and the gate connecting these, closed The water trough in the smaller encloure is then cleaned and kept ready By 10 30 a m normally the first feed of the day arrives, in the following measures:

Cattle feed -- 50 Kg

Coconut Cake -- 13 Kg

Cotton seed -- 7 Kg

PLATE III

(a) View of a part of the herd at Trichur

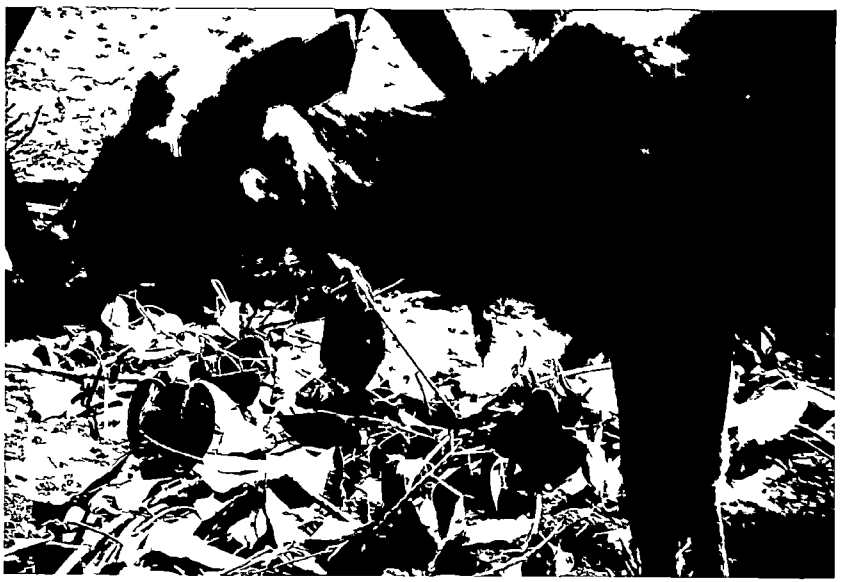
(b) The dominant stag in Trichur herd. Note the ant-orbital gland and exudation from it.

This is the total feed for the sambar deer and the spotted deer in the adjoining cage, together. This makes about 800gms average for each individual animal, since there are about 65 Spotted deer and 21 Sambar About half of this quantity is dumped in the trough, water pumped into it and made into a paste When the gruel is ready, the gate is opened and the impatient animals rush in and 'fall' on the feed trough This enthusiasm lasts, but only initially, as many of the deer appear disinterested in the feed and retreat Since many of them step into the trough during feeding and stand on the feed, a large quantity of feed is wasted

Whether they eat or not, the deer will have to wait till mid afternoon for the next consignment of food-this time leaf fodder This is generally delivered by about 3.00 p.m and the quality depends on availability. Jack leaves and green grass are relished by the deer, and they leave nothing behind except the gnawed twigs (Plate IV a,b). But this supply depends on availability here, and on lean days supply will be uncertain At times, even water lilly leaves were dumped in substitution of grass and jack leaves. But the deer never relished it. You will find the sambar here highly responsive to your invitation with a green leafy bough, on the mornings next

PLATE IV

(a) The supply of green fodder depends on availability. It ranges from grass, jack leaves and fig leaves to water lilly leaves, even.



(b) Juvenile feeding

Mondays are officially off for the cattlefeed supply and hence on all Mondays the Sambar is fed only on the green fodder in the afternoon.

1 2 **Study Sample**

When the study was started in October '88, there were 21 sambar deer in the Trichur Zoo (Plate III a).

Stags (With antlers)	--	10
Does/Hinds	--	4
Juveniles	--	4
Fawns	--	3
Total	--	21

During the course of study, on 17-01-89 a female fawn was born, taking the total to 22. However, on 18-04-89 one of the big stags died due to injuries sustained in fight for dominance, thus bringing the total back again to 21.

a 2 **TRIVANDRUM ZOO.**

In Trivandrum Zoo, sambar deer are kept in an open enclosure of about 0 5 hectares in extent This enclosure is in the form of an open pit, about 3 meters deep from the surrounding ground. Towards the middle of this enclosure, the ground rises to the level of the surrounding area like a hillock providing unhindered view to the spectator. There is

a small enclosure with in this big pen, with a gate to it This is used to isolate any particular animal if necessary.

A no: of big rain trees (Samanea saman), provide welcome shade within the enclosure. The atmosphere therefore, is cooler and more pleasant than that at Trichur This evidently has its telltale effect on the deer too. The animals here appear healthier and well groomed than their Trichur cousins The feeding schedule is also different here

2 1 Daily Routine.

The Sambar are given green grass at 9.00 a.m, everyday. Then at 11 00 a.m another supply of green grass together with cattle feed is given Then in the afternoon by about 2.30 p.m, green fodder (mainly Terminalia catappa, Erythrina etc.) is fed Again at 4 00 p m in the evening, cattlefeed + green gram is supplied

The deer seem to relish the acidic fruits of the rain tree (Samanea), abundant supply of which is littered on the ground, from the overhanging branches

There is no dearth of green grass here, thanks to the Govt Sewage Farm nearby This must be the reason for the better appearence of the animals unlike those of Trichur

2 2 Study Sample.

There were in all 20 deer in Trivandrum Zoo at that time Of these, 4 were adult stags (one had already shed antlers), 2 juveniles, 8 hinds, and 6 fawns and sub adults. The youngest fawn was a 3 month old male.

The Dominant stag is kept separate in the Hog deer enclosure, with the Hog deer and one Manipur Deer for company There is no apparent disharmony in this assorted society ! This stag was shifted from the main sambar pen, after a fierce fight with another big stag for dominance, it was informed "In the forests, Sambar hinds may associate with Swamp deer but not the stags. Spotted deer are perhaps the most tolerant and sociable of all our deer" (Prater 1965)

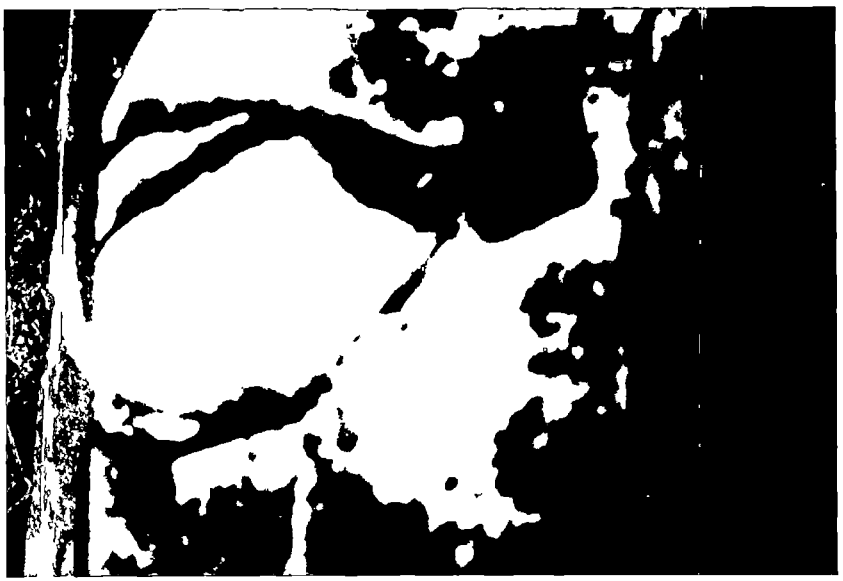
Meena, the oldest and biggest of the hinds was brought from Thekkady, where she was under the care of the Forest Department, in captivity

Methods.

Before fixing the observation periods, perliminary observations were made for a month based on which the most active hours of the day were selected for the purpose of observation The main observations were done at Trichur Zoo only Accordingly, daily observation for two and a half continuous hours were made during the following hours of the day, 8 30 - 11 00 Hrs. and 15 00 - 17.30 Hrs.

PLATE V

(a) Trying to collar one friendly doe at Trichur



(b) The collar intented for tagging

By the month-long preliminary observations, it was possible to familiarise with the Trichur herd closely and identification of individual animals were easy to a great extent Identification of the individuals was made on the basis of general appearence and from various identification marks seen on differ ent parts of their body. (Attempts were made earlier to mark the animals with different colours and to collar them using identifiable collars (Plate V a,b). But the task was abandoned as it was found unsuccessful with the herd consisting of individuals of different tempers) Nature and size of antlers were ideal and very helpful for individual recognition of stags

After the preliminary observations, a representative focal group consisting of 3 stags, 3 hinds, 2 fawns and 1 juvenile was selected for further behavioural observations. The members of this focal group were named as follows:

Stags	--	S1,S2,S3.
Hinds	--	D1,D2,D3.
Juvenile(male)	--	J1.
Fawn (male)	--	F1
Fawn (Female)	--	F2

Behavioural observations were made during a period spanning five months totally, from the month of December 1988 to April-May 1989 on days at random All observations were

made by naked eye During the course of the study, a female fawn was born in January '89 and during April '89 one of the stags in the main group died due to traumatic injuries.

Observations were also made for a short period at Trivandrum Zoo, for comparison, during this time span. Field trips to Parambikulam sanctuary, provided a glimpse of the deer's activities in its natural habitat. One sambar deer was immobilized using chemical dart projector. It was tagged on the ears using yellow livestock tags and released But the animal could never be traced again

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

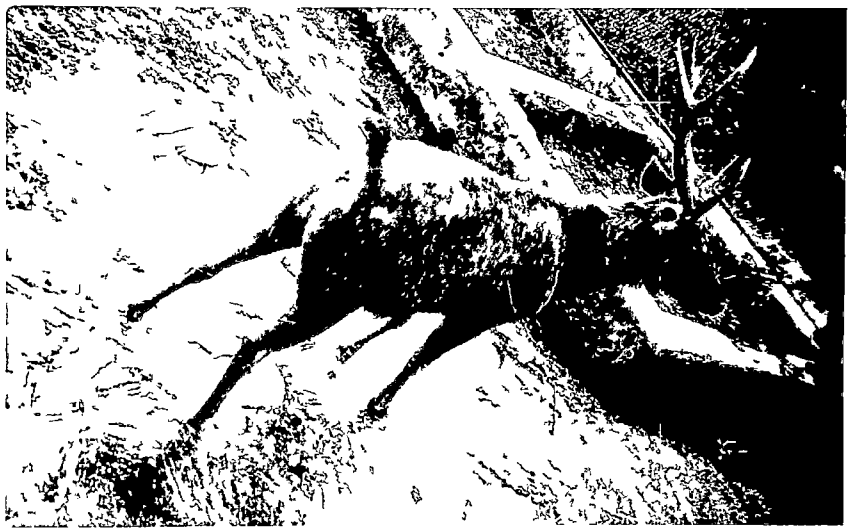
General Behaviour:

The Sambar herd generally rested in groups and singly in the enclosure, during the morning hours Individuals, mainly stags and juveniles were seen at times moving about aimlessly in the pen, indulging in short antagonistic encounters and chasing. But the general resting continued till the first quota of feed for the day arrived by about 10 00 a m As the time gets nearer for the feed to arrive, the animals anxiously wait in a group looking expectantly in the direction of the usual feed arrival

Once the feed is put in the trough and mixed with water, the gate is opened to enable the deer to feed. Then there is a mad rush into the other pen and the Sambar come and literally fall on the trough There is no apparent dominance at the feeding trough

After the exercise at the feed trough, the animals move away singly and in groups and generally repose in available shady spots Some chewed the cud, still others rested quietly with closed eyes and head rested either on the flank or stretched out on the ground A few individuals moved about and engaged in diverse behavioural activities such as sniffing, thrashing, licking or fighting Fawns and juveniles played and frolicked in the water trough, at times

(a) The sub adult male with spike antlers in Trichur Zoo; showing alert.



(b) The wallow (slush) in front of the water trough. Here, one stag is urinating in the typical posture, in the slush.

One or two stags paced the length of the fence slowly, grinding their teeth incessantly

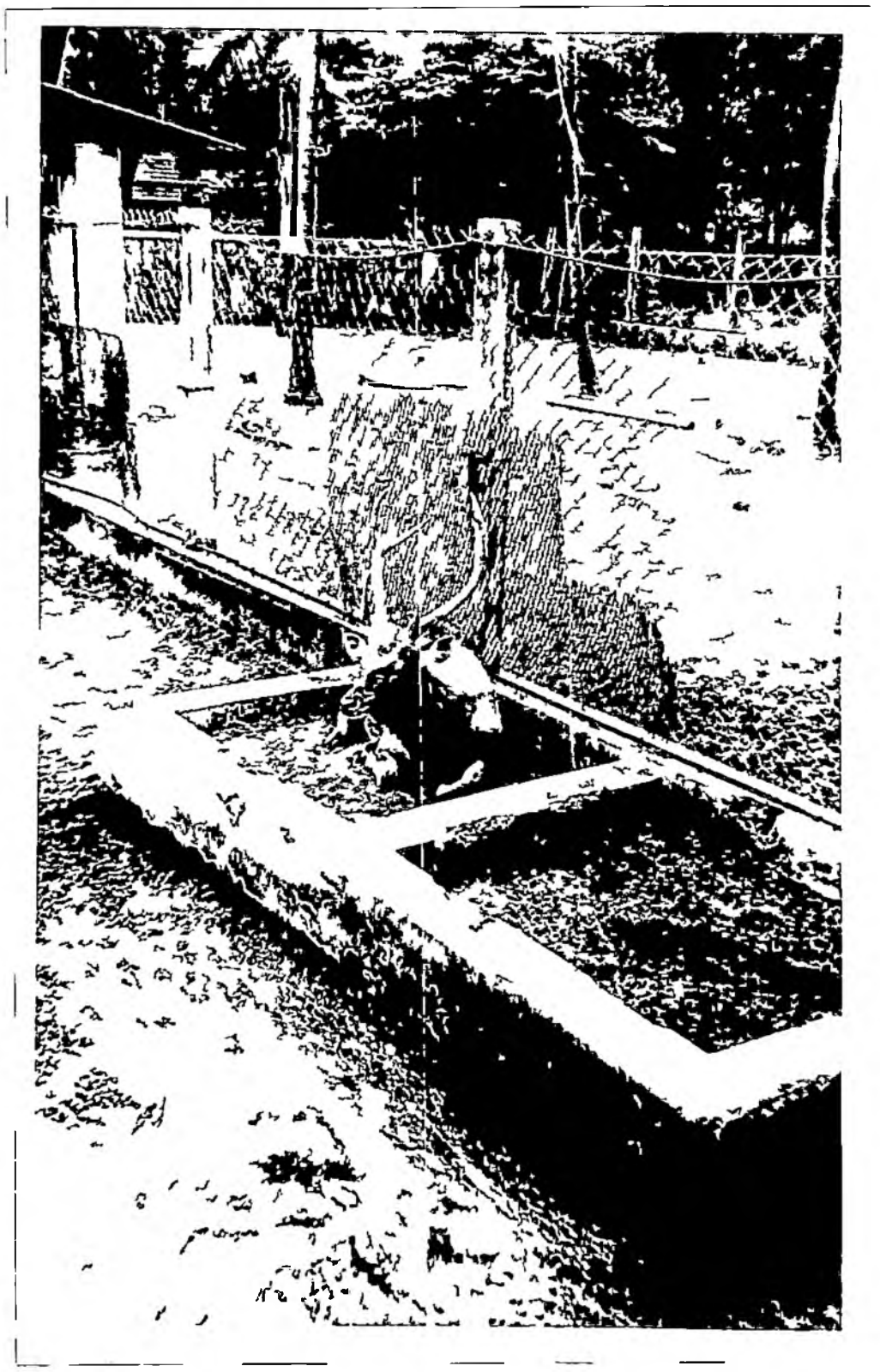
Mating behaviour was observed both in the morning and evening hours (Plate VIII) It was observed to be the monopoly of the dominant male Though mountings were seen, no successful copulation was observed During this time, the dominant male teased the female all the time and did not show any interest in feed or fodder No real aggressive behaviour was exhibited during the daytime and sparring encounters lasted only moments But, death of a stag due to injuries and the deep wounds on some others were evidences of fierce fights during night time (Plate XIV)

"Sambar display some difference in their mating habits, a difference associated with their dense forest environment. In forests where Sambar live, visibility is limited and the collection of a harem of hinds is usually an impossibility. As such Sambar stags generally do not fight in the presence of the assembled hinds or for their possession. They fight for territory, for the possession of a favoured valley, and for the right to summon the hinds living in it The females seek the stag, attracted by his call and the powerful odour of his scent glands".(Prater, 1965)

Rest, they always preferred to rest and ruminate in the shade either reclining on standing Auto grooming and allogrooming were observed during these hours

PLATE VII

(a)



(b)

Stags resting and ruminating

Familiar activities and sounds did not disturb the herd But they were alerted and reacted to unfamiliar sounds They stood then with necks stiff upright, tails raised and listened with cocked ears, till the disturbance stopped

Auto-grooming and Auto-licking (Plate X)

The conspecifics groomed themselves while resting. The process involved tongue, teeth and lips together The fore and hind limbs, flank, ventral, caudal and inguinal regions were groomed at a higher frequency.

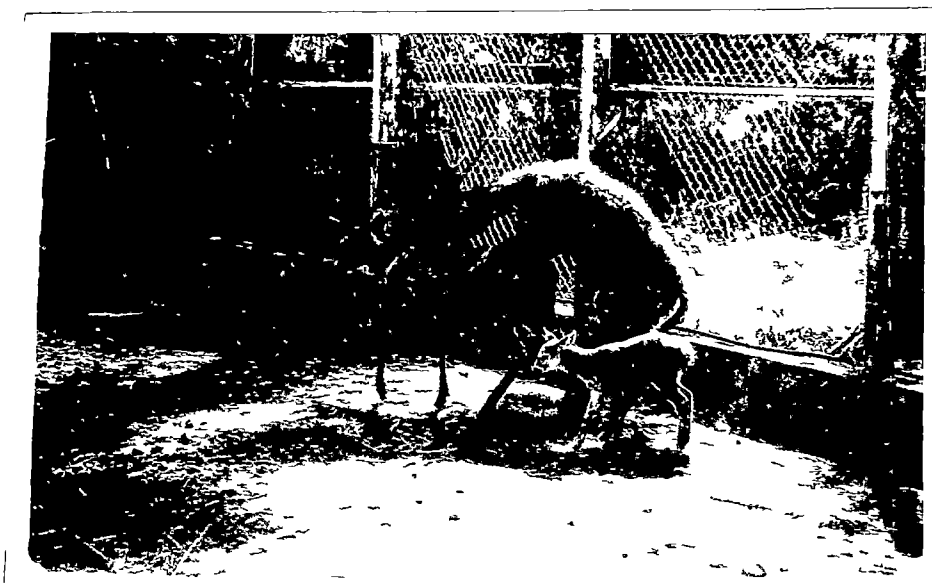
Licking various parts of their body by slapping movements of the tongue was observed in the deer herd. As in grooming, the different regions of fore and hind legs, flank, caudal and inguinal zones were licked at a higher frequency.

It was noted that the frequency of auto-grooming was higher in males than females

Allo-licking and Allo-grooming

The Sambar were seen licking one another, especially when reclining side by side in the shade

Similarly they groomed one another at times; on the forehead, ear pinna, neck and flank regions They sometimes groomed mutually also This was done while reclining or standing in shade. Allo-grooming among females was observed



(c)

Attempt to mount on the move.

at a higher frequency than males Mutual grooming was seen between female and female, male and female, mother and fawn, also juvenile and juvenile

Allo-sniffing:

Sniffing the different body sites of individuals of the same herd is termed 'allo-sniffing'. Aggressive encounters started sniffing each other This was also exhibited by stags in rut It sniffed the urino-genital region of the female

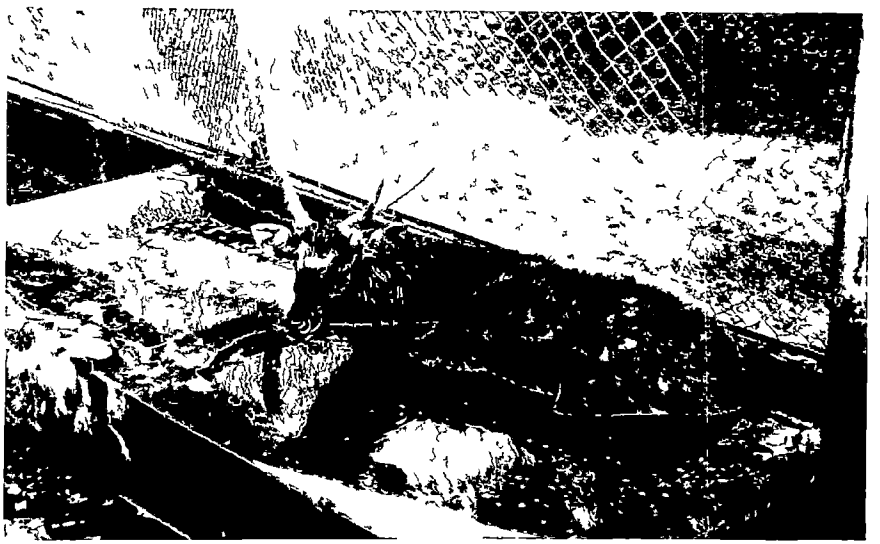
Of all our deer, Sambar have the largest and best developed facial glands. The reason is the Sambar's forest habitat, surroundings in which it is well-nigh impossible for a stag to collect a following of hinds during mating time. A Sambar stag attracts hinds by his call and by the powerful odour of his scent glands which attain their maximum development during the rut (Prater, 1965)

Ant-Orbital marking:

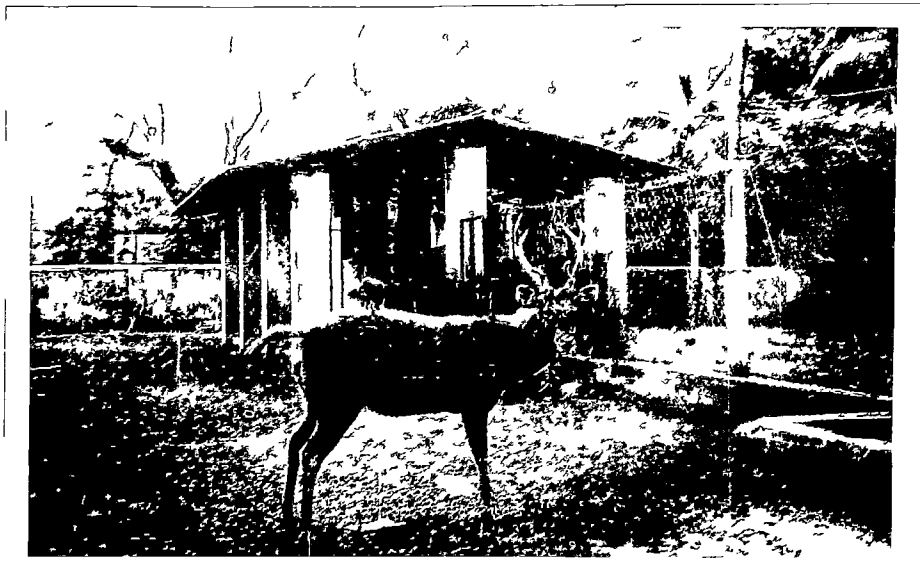
Ant-orbital glands are present in both sexes of the deer (Plate III b) This is pouch like and extends forward from the anterior corner of the eye as an integumentary pocket

When the animal gets excited, in rut or while fighting, this gland dilates and the border of the orifice gets a more conspicuous white colour

PLATE IX



(a) Stag resting in water. Sambar love water and take to it readily to ward off flies etc; and to keep themselves cool.



(b) Another typical urination posture. Crows and Mynahs often ride the deer in search of insect parasites.

Aggressive behaviour (Plates XIII & XIV)

Sparring was frequent among the males, lasting 5-10 minutes each time The sparring stags came close, stood face to face and with bend heads charged each other With their antlers locked together they started pushing with their foreheads each other Then either of the stags made a peculiar sound - something like the squeak of a frog caught by some predatory bird - one or two times The bucks pushed each other for sometime, stopped and stood still in that locked position for a while and started pushing each other again Finally one disengaged rapidly and moved away Sometimes the other buck chased the one who gave up the fight, for some distance

(This squeaking sound was made by a hind, on another occasion, after sniffing the back of a juvenile The young fawn also squeaked while playing in the water trough)

At Trichur Zoo, no antagonistic benaviour was noticed among the hinds, like (i) chasing, (ii) pushing & biting

"In the wilds, sambar stags fight each other to secure territory where hinds can be acquired In such combats, the stags close in with lowered heads The trial of strength which follows is more in the nature of a shoving match Antlers clash or interlock with all the body's force behind them The rivals strain and push at each other, stopping

PLATE X

(a) "Auto-grooming" the caudal zone

(b) "Auto-grooming"

from sheer exhaution, only to fight again The bout goes on till one or the other acknowledges defeat and retires. Wounds from antler thrusts in such combats may be severe, but more often they are of little account and seldom mortal There is more show, and noise than deadly purpose in these combats " (Prater, 1965)

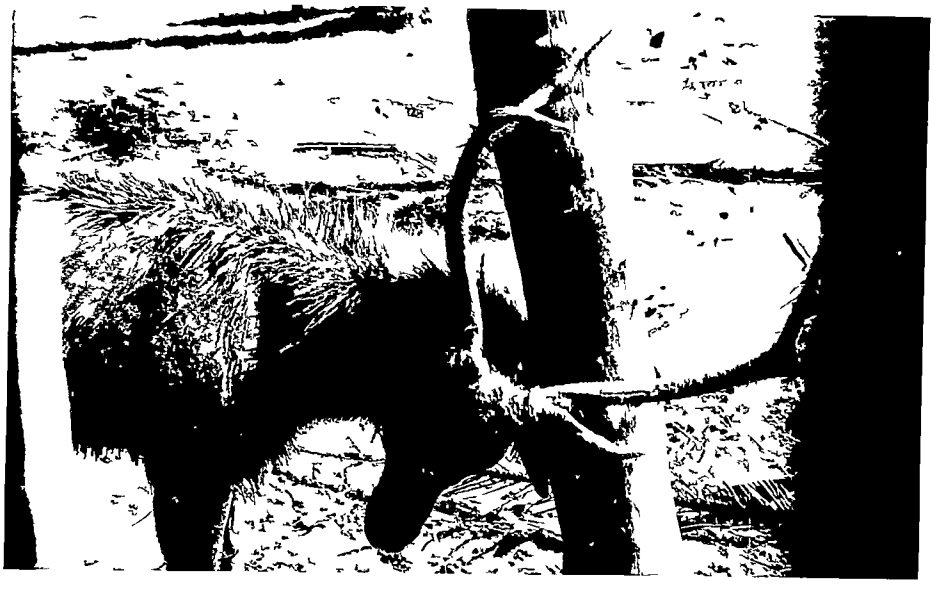
At Trivandrum Zoo, two females were observed confronting each other at the feed trough, on one occasion One hind rose menacingly on her hind legs and tried to stamp the other female with her forelegs At that moment a third hind intervened and chased off the belligerent one by biting at her caudal zone. That ended the fight.

Flehmen reaction:

Flehmen was observed frequently being done by males. (Plate XV) The stag walked upto the urinating female, licked the steady stream, curled up his upper lip and breathed slowly and deeply with the head held high The tail was also slightly lifted during this act The male normally stood still while in 'flehmen', but the dominant stag (S1), while in rut, continued to follow the hind (D2) showing 'flehmen'.

Flehmen reaction was not restricted to mature female urination, it was observed On one occasion, one stag (S3) was seen showing 'flehmen' after sniffing the falling urine

PLATE XI



(a)

(b)

"Wallowing"

PLATE XI

(a)

(b)

"Wallowing"

of a fawn(F2) Similarly, another stag (S2) was observed to exhibit 'flehmen' reacting to the urination of a male juvenile (J1) On both these occasions, these two stags were apparently not in rut as they showed no interest in any female

Flehmen is a general testing of urine and not a specific response to urine of estrous female. (Muller-Schwarze, 1979)

Physical changes:

The physical changes apparent during this six month period were, a) different stages in the development of antlers in stags and b) noticeable changes in body size of the deer

At the beginning of the study in November all the ten stags were sporting antlers at different stages of velvet. One of these was the sub-adult with only spike antlers.(Plate XVI (a)). Three stags had antlers in velvet and the other Six had already rubbed off their velvet by then By December - January the first three had also rubbed off the velvet and were carrying dry antlers

It was interesting to note the strikingly different and fascinating shapes of these antlers No two sets of antlers were alike in the herd and some had curious shapes. 'The antlers after completion of branching increase in size with each renewal They attain a maximum development and then

PLATE XII

(a) The fawn born in January, 1989

(b) Suckling

decline Thus the oldest stags do not necessarily have the largest antlers ' (Prater, 1965)

Antlers are the pride of a stag. To avoid any risk of damage to their growing antlers, Sambar stags may retreat from dense forest to more open grass plots. Here they lead the most secluded lives moving only short distances in quest of food Again, while their antlers are in 'velvet', the deer naturally do not use them in attack or defence (Prater, 1965)

By the middle of April, casting of antlers had begun. The first to cast antlers were the ones whose velvets had worn off earlier to November. By the beginning of June, five stags had cast their antlers

Table (1) shows the approximate weight and length of each cast antler in 5 captive sambar in Trichur Zoo.

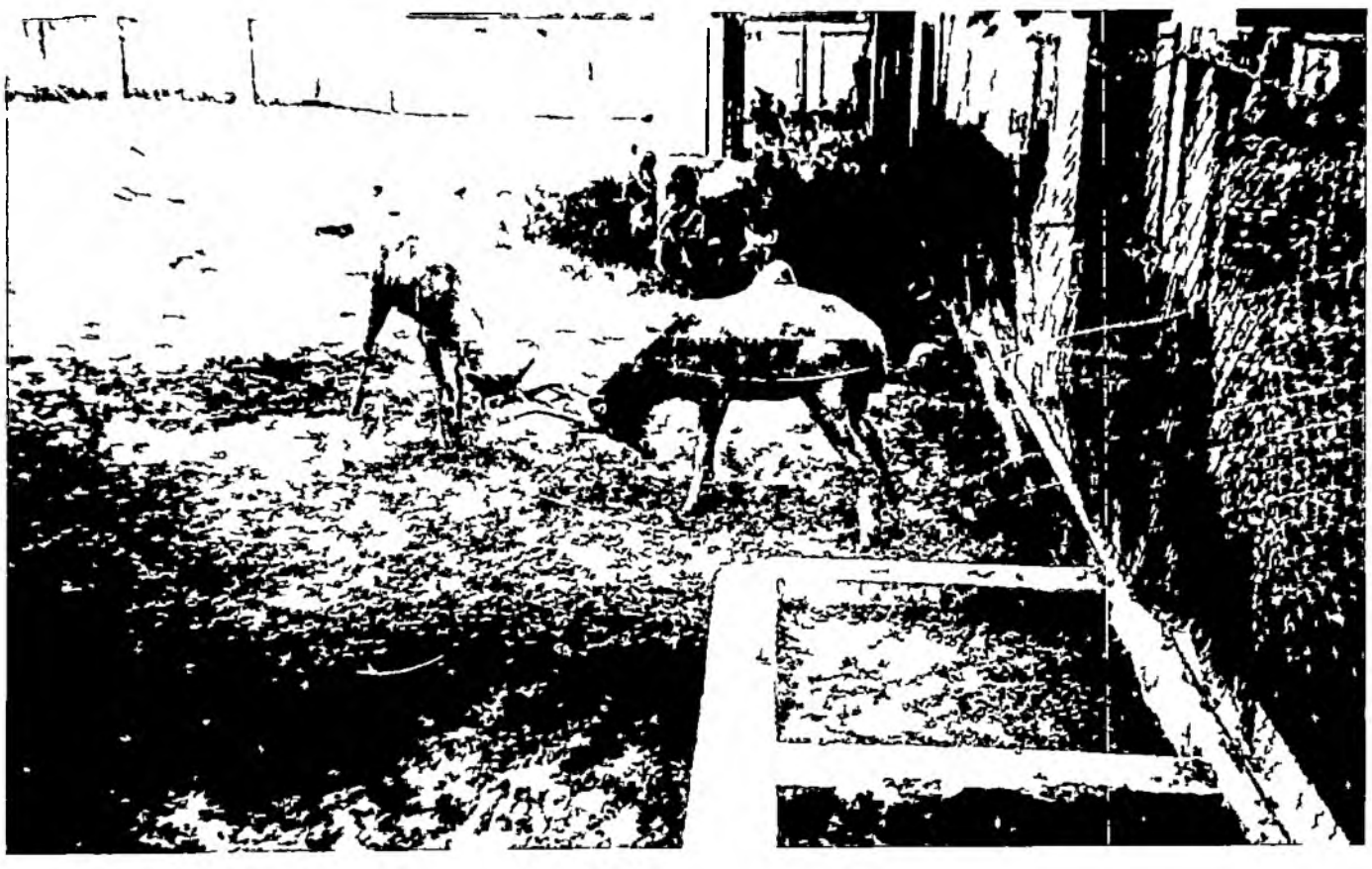
Table 1 Approximate Length and Weight of Cast antlers:-

No	Date Cast	Length (cms) Left	Length (cms) Right	Weight (gm) Left	Weight (gm) Right	Total weight (gms)
1	24-04-89	47	46	400	300	700
2	24-04-89	58	56	700	500	1200
3	17-05-89	71	73	1200	1250	2450
4	15-06-89+	30	31	150	150	300
5	15-06-89	62	60	1100	900	2000

+ Spike antlers.

PLATE XIII

'a)



(b)

Aggressive behaviour (Sparring)

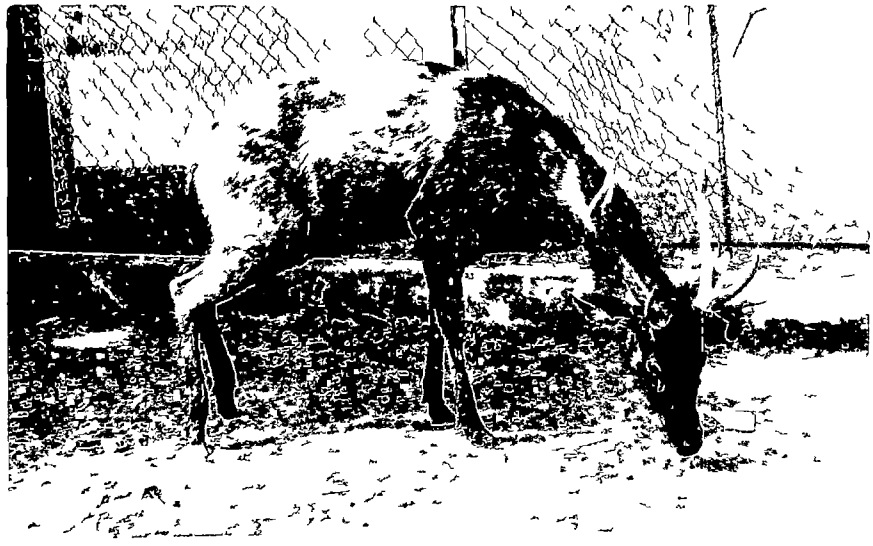
K K Ramachandran (1989) observed that a captive young sambar deer with spike antlers showed aggressive behaviour before the spike shedding It was kept tethered by rope round the neck like cattle and not in cage as in zoo This animal tried to attack the keeper when approached during this period Further, it had grown spike antlers at the age of 9 months and had cast them by about 14 months of age.

'The time of shedding varies with age Young stags shed them earlier than older animals The shedding time may also vary with locality It is said there is connection between food and horn-growth The period of antler-growth everywhere coincides with the season when food is most abundant. It may be that this periodic shedding and growth of antlers is but an outlet for the excess intake of calcium imbibed through grass. In hinds, this calcium is taken care of by the processes of developing embryo and nursing the young Again, irregularity in the shedding may be associated equally with lime deficiency ' (Prater, 1965)

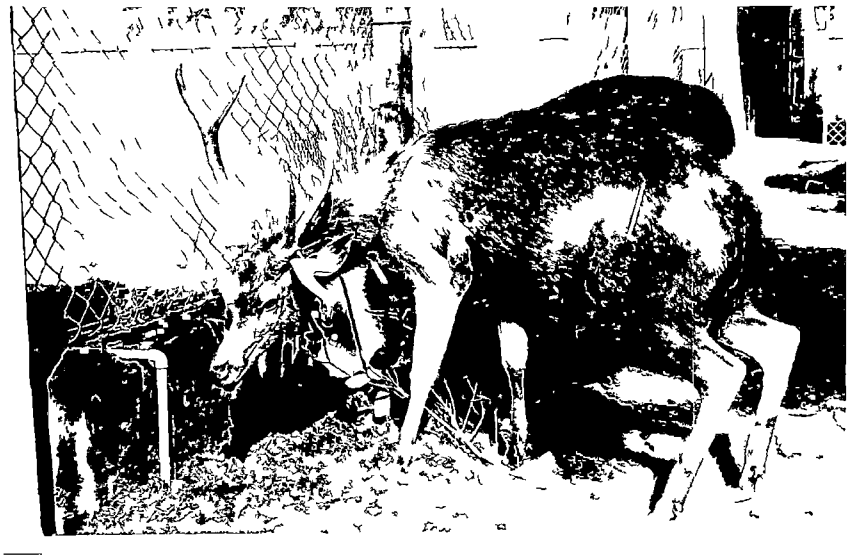
L.N. Acharjyo (1983) recorded that two sambar males born in Nandankanan Park, cast their spike antlers for the first time at ages of approximately 18-20 months. Yet another pair shed their spike antlers at the age of approximately twenty two months (Acharjyo, 1971)

Acharjyo (1971) observed altogether fifteen sheddings of antlers during a 3.5 years period. He records that

PLATE XIV



(a) A wounded and emaciated stag, drugged for treatment.



(b) The wound above left shoulder, and the hanging chemical dart. (Wounds sustained in fight at night)

sheddings were regular every year in all the animals and both the right and left antlers were shed either within a day or in two consecutive days Out of fifteen sheddings, fourteen (93 33%) were observed during the months of April, May and June whereas only one shedding (6 67%) was observed in July.

According to Prater (1965) the majority of Sambar stags in Central and Southern India cast their antlers between the end of March and mid-April M. Krishnan (1975) stated there was no defined season for antler casting, based on his observations at Mudumalai Schaller (1967) working at Kanha, indicated that most castings of Sambar occcured in late May-June He further reported 2 castings in April in Alipore zoo, Calcutta.

Lydekkar (1924) observed that the antlers were not shed regularly every season but only every 2 or 3 years in Himalayas in April, whereas in the plains usually in March, and at Woburn (England) any time of the year Antler casting occured during April - September, but mostly in May - June in European Zoos (Van Bemmel 1949-50). Acharjyo (1971) quotes of a record of shedding of antlers in June in Washington zoo. Crandall (1964) stated that no Sambar in New York zoological park retained its antlers for more than one year, but that Sambar stags in captivity may shed their antlers at any season

PLATE XV

(a) Sniffing urine of female

(b) Flehmen

It can be seen that the Sambar in captivity at Trichur keep to the generally observed schedule of antler-casting in the wild and in other zoos

Same is the case of velvet rubbing period Acharjyo (1983) observed that majority of stags (74 7%) cleared their velvet during September - October; whereas 10 1% occured in November-December. Further, Prater (1965) has stated that antlers began growth in May, were in velvet during the rains (July - October) and were cleared of velvet by November. Schaller (1967) had also observed that between November & May stags were in hard antlers at Kanha

'Sambar have their favourite rubbing trees for cleaning their antlers, and stags may return to a favoured tree night after night The cleansing and hardening of antlers usually coincides with the approach of the rutting season ' (Prater 1965)

During the study period, there occured noticeable reduction in the body size of the deer. In other words, they went thinner and thinner with the advancing dry season. The Sambar especially the males, were at their best in appearance during October - December, in Trichur Zoo. (This is in no way to be compared with a wild population). By the end of January the season gets drier and drier and with it the food supply. Green foliage becomes a luxury Symptoms of rut in males

were observed by about this time, too Whether it was due to the scarcity in good fodder or to the lack of interest in feeding due to other interests this season that the animals thin down, was not defined. By April, the antler-casting time, these deer present a very 'emaciated' picture.

Sore Patch:

NO sore patch was observed in any animal of the herd at anytime during the study period

Survival:

Sambar has established itself to captive life in zoos due to its amazing adaptive characters. It was observed that they continued to breed and survive in all types of conditions They breed at any time of the year, as was observed Fig 1&2 show the rate of Sambar births in each of the 12 Months of a year for a ten year period at Trichur and Trivandrum Zoos respectively

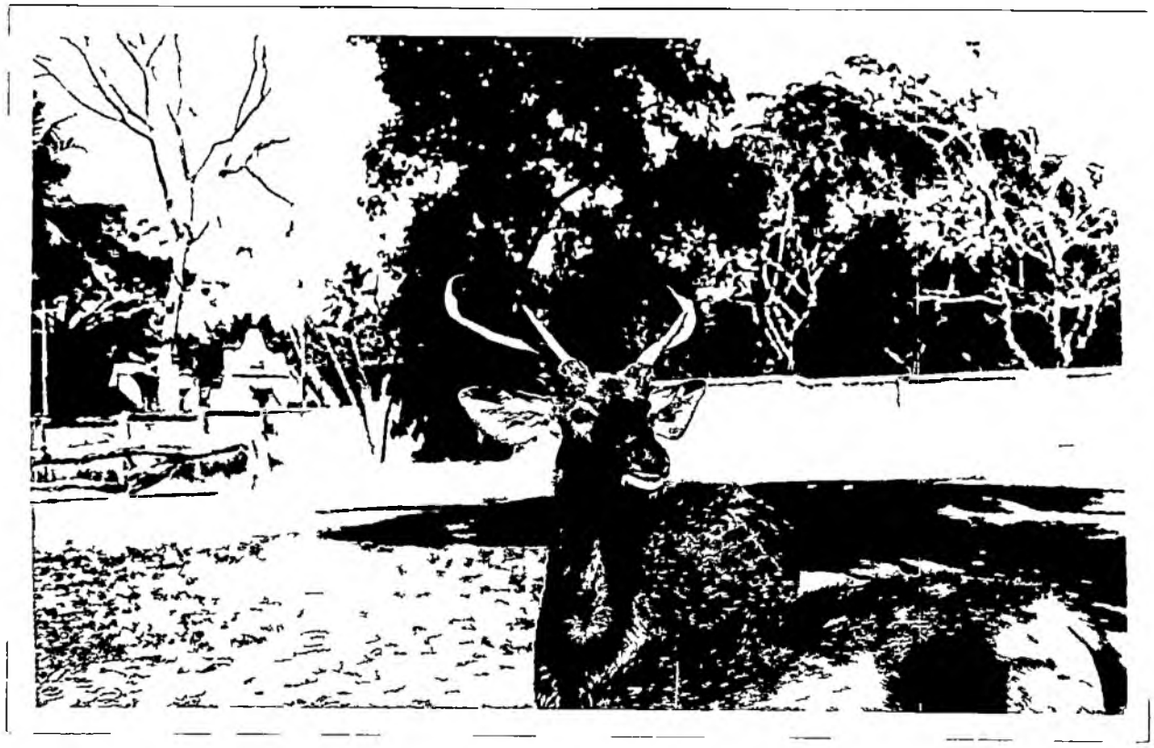
Acharjyo (1970) recorded that always single young were born to all the 30 births at Nandankanan. The birth weight of 9 fawns was between 7 2 KG to 11 7 kg with an average of 8 27 kg One fawn that weighed 7 2 kg died on the second day of birth Crandall (1964) noted only one pair of twins out of 41 births in New Yo rk Zoological Park.

The female fawn born on 17-1-89 at Trichur Zoo weighed 9 kg on 19-1-89 It was observed to be healthy and active during the rest of the study period

PLATE XVI

Different types of antlers

(a) Spike antler



(b) Adult

At Nandankanan, 35 births recorded during a 9.5 year period were distributed almost evenly throughout the year except May (January 1, February 2, March 1, April 2, June 5, July 2, August 5, September 4, October 5, November 3, and December 5) (Acharjyo, 1972) Tables 2 & 3 show the monthly distribution of births over a similar period at Trichur and Trivandrum respectively

Table 2 Monthly distribution of Sambar births over a 10 year period (November 79 to January 89) at Trichur Zoo

JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
16	8	9	---	---	---	---	---	2	3	6	---

Total births = 44

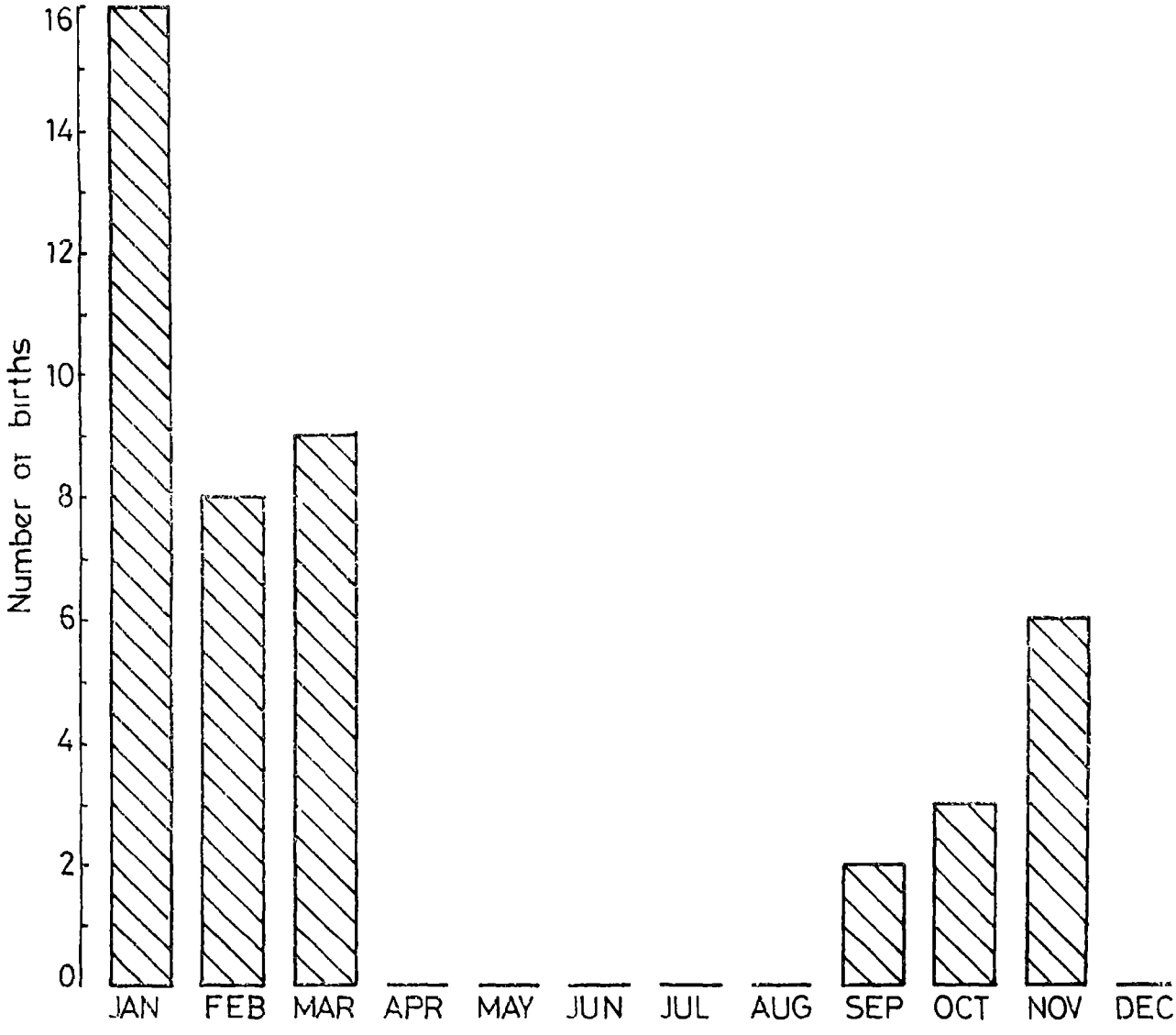
Table 3 Monthly distribution of Sambar births over 11 year Period(Mar 78 to Jan 89) at Trivandrum Zoo

JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1	2	4	---	1	---	----	---	4	1	5	2

Total births = 20

Crandall (1964) observed that births in captivity may occur at any season and distribution of 41 births at New York Zoological Park were January 2, March 1, April4, May 6, June 5, July 4, August 2, September 5, October 7 and November 5 Asdell (1964) states that in London Zoo, births have been spread throughout the year with a peak at the end of May and at Woburn, fawns were dropped at any time of the year. Prater

Fig. 1. Months of Sambar Births in Trichur Zoo over a Ten year period (1979 1989).



(1965) observes that young are born at the commencement of rains in late May or early June in the wild

Also, the bulk of the females are sired by the biggest and strongest males who acquire their harems by right of conquest

Mortality:

Like any other ungulate, Sambar is also exposed to deadly diseases like F M D , T B Pneumonia, Gastro enteritis, Hepatitis, Peritonites etc , while in captivity Kar (et al 1983) reported F.M.D incidence in captive wild Sambar (among other ungulates like cheetal and Blackbuck) at Nandankanan in Orissa, during 1978. Six Sambar were affected and one died.

Mortality pattern:

Following is Epidemiological data in relation to mortality at Nandankanan (Acharjyo L N. and Rao A T.(1987)).

Table 4 Age-specific Mortality in Sambar

0-1 month (Neonatal)	2-12 months	2-5 years	6-10 years	over 10 years
26 (35 62%)	8 (10 96%)	17 (23 29%)	15 (20 55%)	7 (9 58%)

Fig. 2. Months of Sambar Births in Trivandrum Zoo over an eleven year period (1978-1989).

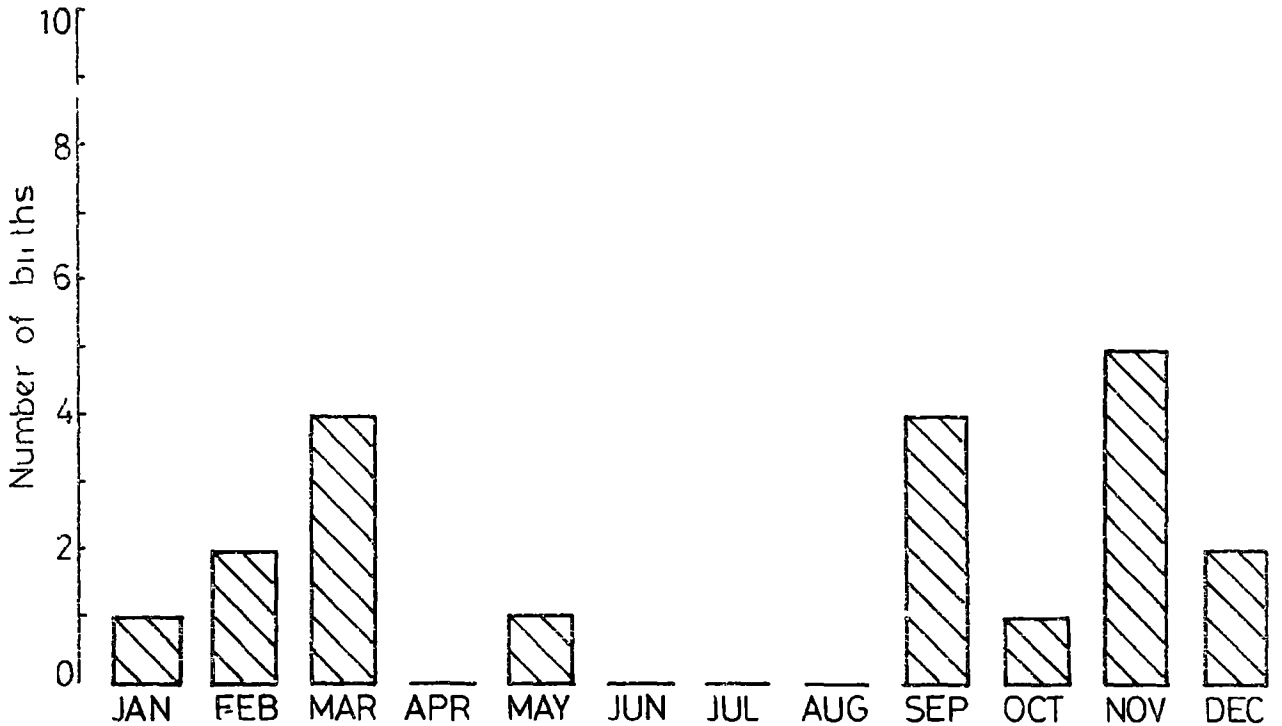


Table 5 Causes of Sambar deaths (Nandankanan)

(1) F M D	(2) T B	(3) Pneumonia	(4) Gastro	(5) Hepatitis	(6) Peritonites
1	5	11	2	2	1

(7) Stress	(8) Drowning	(9) Complications of Tranquilisation	(10) Debility	(11) Traumatic injuries
6	4	1	10	19

(12) Predator	(13) After birth rejection by mother	(14) Hydrocephalus	(15) Still birth	(16) Undetermined causes
1	1	1	4	4

Table 6 Period specific neonatal mortality (Nandankanan)

Still Birth	Immediate Hebdomadal period	Hebdomadal period	Post Hebdomadal
4	6	7	9

The following tables show the mortality pattern of Sambar in captivity at Trichur and Trivandrum Zoos respectively

Fig. 3. Mortality Pattern in Trichur Zoo during 1976-1984.

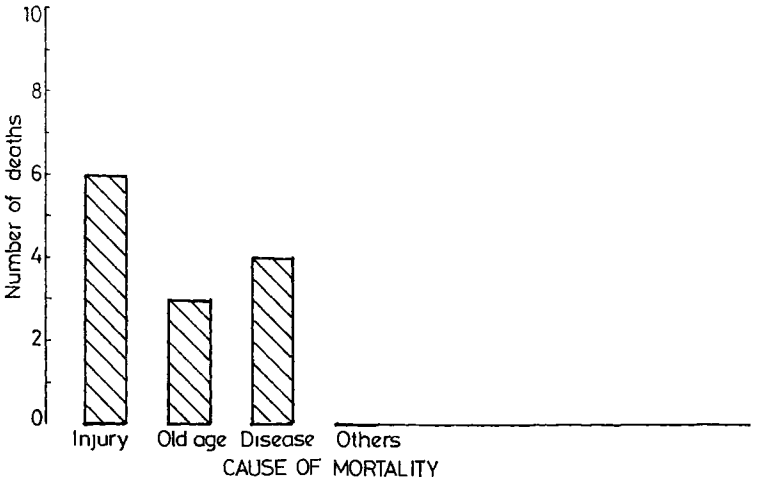


Table. 7 Mortality in Sambar population at Trichur Zoo from 1976-'84

Year	Sex of animal	No. of mortality due to					yearly total
		Injury	Old age	Disease	Others	Not known	
1976	Not recorded	1	1	---	---	---	2
1977	-Do-	---	1	---	---	---	1
1978	M	1	---	---	---	---	1
1979	M,F	1M	---	1F fawn	---	---	2
1980	F	---	---	1F	---	---	1
1981	F	---	---	1F	---	---	1
1983	2M,1F	1M	1F	1M fawn	---	---	3
1984	M,F	2 MF		---	---	---	2
	TOTAL	6	3	4			13

Table 8 Mortality in Sambar population at Trivandrum Zoo from available records

YEAR	SEX OF ANIMAL	No of MORTALITY DUE TO					TOTAL
		INJURY	OLD AGE	DISEASE	OTHERS	UNKNOWN	
1978	Not recorded	---	---	---	2 destroyed.	1	3
1980	-Do-	---	---	6	---	---	6
1985	-DO-	---	---	---	---	2	2
1986	-Do-	---	---	---	---	1	1
1987	-Do-	---	---	---	---	1	1
TOTAL				6	2	5	13

The above data show the animals are exposed to various factors of mortality like disease, injuries, stress, accidents, and so on. Stray dogs and other vermin sometimes find their way into the deer enclosures and predate on them But such instances are fortunately, very rare.

It may be seen from the above that Sambar do well in zoological gardens They adapt themselves to suit the available living conditions wherever they are captives. The biggest disadvantage to these animals, as observed in Trichur, must be the large size of the population in a single enclosure Sambar are rarely found associating in large numbers in their natural habitats Four or five to a dozen are what one usually sees Both stags and hinds are seen singly or a party of hinds and fawns without a stag After rut, stag deserts his harem and lives a solitary life till the next mating season (Prater, 1965). But the conditions Sambar get in Zoo are in conflict to their natural tendencies This must be the reason why a higher number of mortality occurs due to traumatic injuries than other causes here (Fig 3)

SUMMARY

SUMMARY

The study was undertaken with the objectives of investigating the behaviour of Sambar deer in captivity and thereby to evaluate the adaptability of the species to captive breeding It was also intented to compare the life of the deer in its natural habitat with that in captivity

The captive population of the deer in Trichur zoo and Trivandrum zoo were the subjects for this study. Observations were made for a period of nearly six months from November'88 to May-June'89. The daily activities of the population such as social behaviour, dominance heirarchial behaviour at feeding, dominance in courtship, reproductive characteristics, nearest neighbour relationship, and physical changes in antlers and body, were observed for information.

It was observed from this study that this species of deer adapt very well to changing conditions. Even though the living conditions in captivity of these zoos were in sharp contrast to their natural habitats, and the herd compositions were highly unnatural, the Sambar deer continue to live and thrive in our zoos against all odds, as was evident from the results of this study If some care is given, these animals could be quite at home in captivity too.

Recommendations:

It is felt that the following recommendations could be helpful in the better upkeep of Sambar deer in captivity

(a) Maintenance of ideal herd composition:

It was observed that the Sambar populations in both the zoos were cramped into claustrophobic confines of small enclosures in herds of quite unnatural proportions. In Trichur zoo there were 10 fully grown adult stags in the same small pen with the rest of the herd, which is the main reason for the poor state of the animals there There should only be, preferably, a single adult stag in a captive herd at any given time.

The number of hinds and juveniles should also be adjusted accordingly If lack of space is the problem in the captory, rational alternatives like culling, selling out, release into the wilds etc, should be thought of

(b) Supply of green fodder.

This was observed to be a very important factor in the upkeep of Sambar The importance of green grass in the daily diet of the deer, is not to be underestimated. It was noticed that in Trichur zoo, grass and green fodder are scarce commodities during the summer months, and it had its effect on the condition of the animals too Silage can be thought of as an effective compensation for grass during the dry season, in places where grass is rare.

(c) Shade trees and foliage

In this aspect also, there is marked difference between Trichur and Trivandrum zoos, which tells on the animals It is proposed to create adequate number of shade trees and thereby provide better conditions for the deer in Trichur zoo The saplings after planting have to be protected with proper tree guards or brick platforms permanently as the deer would damage them by debarking (Plate II)

(c) Proper record of the animals

The paucity of proper and sufficient records of the deer is a great disadvantage for any research study or even proper maintenance of the animals Births at the zoo have to be properly and correctly recorded The information should contain date and time of birth, sex of the fawn, weight at birth and dimensions, details of the mother etc If the number of stags were regulated as mentioned earlier, the details of the sire could also be available for record Similarly when animals are inducted from outside source, all available details are to be recorded promptly. It would be ideal if weights of the animals could be recorded at periodic intervals Above all, each deer have to be branded with some identifying tag Easily recognizable ear tags could be thought of for this purpose

(d) Enclosures

Enclosures have to be designed to suit the temperament of the captive It was observed that the arena-type of deer enclosure at Trivandrum zoo is more suited and ideal than the fenced pens at Trichur

(e) Volunteer guide Service and Animal Sponsorship

Most of the visitors to our zoos are fully ignorant of even identifying the animals, let alone knowing their habitats and ways This is because of the pitiable position our society has given to wildlife in its affairs There is no facility to learn about the animals in the zoo even if one wanted to Volunteer guide service is an answer to this obstacle There would not be any problem in finding enthusiastic volunteers to render guide service for the cause of wildlife, after some training.

Animal sponsorship is in vogue in foreign countries where they have realised the need for wildlife conservation It is reported that there is always a waiting list of people eager to sponsor some inmate of the zoo.

(f) General

Lack of space for further development was noticed to be the main impediment concerning the zoos in Kerala In the crowded towns of this thickly populated tiny State, one

should not expect anything better too But zoos need not be confined within town limits In an age in which modern means of transport are avilable, no place is far off for this purpose For a small state like Kerala, it is enough to have only one good zoological garden instead of having small, sick, and ill-maintained ones all over the state But that one zoo should be an ideal one, well laid out, well managed and suitably located Zoos are no longer the mere menageries they used to be They are the last straws of hope for many life forms, critically poised on the extinction threshold

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Social Behaviour, Dominance Hierarchy and Reproductive Behaviour of Sambar Deer (*Cervus unicolor*) in captivity

By

R. Krishna kumar

Abstract of the Thesis submitted in partial fulfilment of the requirement for the Degree

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Faculty of Agriculture
Kerala Agricultural University
COLLEGE OF FORESTRY,
VELLANIKKARA,
TRICHUR.

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ABSTRACT

A study was undertaken to investigate the social behaviour, dominance hierarchy and reproductive behaviour characteristics of sambar deer in captivity, mainly with the intention of evaluating the adaptability of the species to captive breeding

This study was conducted on the populations of sambar deer in captivity at Trichur and Trivandrum zoos

Behavioural observations were made during a period spanning five months totally - from November-December 1988 to April-May 1989, on days at random There were 21 deer in the herd at Trichur and 20 at Trivandrum.

It was observed that the living conditions of the deer in these zoos are far from comparison to that of their natural habitats Food, herd size, competition, nearest neighbour relationship etc are strikingly different from nature But, in spite of all adversities, the sambar deer have learned to adapt amazingly to changing conditions, and survive fairly well The physiological processes of their lives, such as antler casting, rut, mating, gestation and delivery remain as scheduled, except for observations that births occur at anytime of the year in captivity sometimes, which is in effect to the advantage of the captive-breeder ! Maintenance of ideal herd compositions at any given time

would help better the living conditions as well as curtail traumatic injuries and casualties Paucity of adequate space is a serious constraint faced by these zoos

It is time that voluntary organisations and individuals came forward with earnest interest in the upkeep of zoos as in foreign countries, rather than leaving the whole show in the sole hands of the government as the present practice General awareness and overall change in the attitude of the public towards our vanishing wildlife is the need of the hour