BEHAVIOURAL ECOLOGY OF SELECTED DEER SPECIES IN CAPTIVITY - A CASE STUDY AT THRISSUR ZOO

By

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THESIS

Submitted in partial fulfilment of the
requirement for the degree of

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DECLARATION

I hereby declare that this thesis entitled "**Behavioural ecology of selected deer species in captivity - A case study at Thrissur Zoo**" is a bonafide record of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

We, the undersigned members of the Advisory Committee of **Mr. Prakash, R.**, a candidate for the degree of **Master of Science in Forestry**, agree that the thesis entitled **"Behavioural ecology of selected deer species in captivity - A case study at Thrissur Zoo"** may be submitted by Mr. Prakash, R., in partial fulfilment of the requirement for the degree.

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Prakash, R.

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Introduction

INTRODUCTION

The history of most of the zoo in India reveals that the majority of them have been traditionally managed. It was from 1960's onwards that the scientific management of zoo animals was taken up *e.g.*, breeding programmes for endangered animals, studying behaviour of captive animals etc. were the result of this new awareness. A zoo is a living university and genetic bank of wild animals. A zoo manager is getting valuable data on the behaviour, health, breeding and life history of the zoo animals by virtue of close association. Some of this information cannot be obtained by conducting studies on free-living wildlife. Zoos and other similar centers are Free-choice Learning Settings (FLS), where social interaction takes place among the people. A zoo is a place where people of all ages meet and interact. Zoo going is a group activity shared by families, relatives and close friends (Cheek *et al.*, 1979; Raju and Venugopal, 1994).

The Sambar Deer (*Cervus unicolor*) is the native of South Asia, resembling the elk in its body size is the largest and most widely spread among Indian deer. They are not gregarious in behaviour the deer has become common and diurnal in National Parks and Wildlife Sanctuaries (Isreal and Sinclair, 1988). Spotted Deer or Chital (*Axis* axis) is one of the most common and widely distributed cervid, seen mostly in the drier parts of the Indian subcontinent. White spots on a russet hair coat are characteristic of all sex/age classes; the face and neck of does are often slightly lighter in color than bucks. The basic social unit of

Spotted Deer is a matriarchal family group consisting of an adult female, her offspring of the previous year, and a fawn. The Hog Deer (*Axis porcinus*) is essentially solitary, although temporary groups of up to 40 animals have been seen in primary feeding areas. The main social group is a female and her fawn.

The Barking Deer (*Muntiacus muntjac*) is the smallest among the cervids. Adult male stag stands one foot eight inches to two feet and weights about 20kgs. These stags have very small antlers, not more than 10cms long, with short brow lines and straight, unforked beams, which grow backwards. The coat is bright chestnut and their gaits are unlike that of the hog deer, with heads down and stiff-legged. Browsers and grazers, Bårking Deer are found in forests through out the country. They come out to feed, mostly in pairs. During the mating season, the adult males fight their rivals. They use their sharp-pointed antlers and razor-sharp canine teeth, badly wounding each other.

The technological advances in recent times have given new thrust to zoo animal management and their behavioural studies. The time activity budget studies play an important role in understanding the behavioural ecology of animals. Generally, field biologists undertake studies on zoo animals including studies on activity patterns, before beginning their studies in the fields. Such studies help zoo managers to understand their behavioural needs so that their environment can be enriched appropriately.

With this backdrop, a study was undertaken in Thrissur zoo with the following objective:

1. To understand the behavioural patterns of selected deer species in the captivity
2. To monitor the nutritional value of the feed given to the deer
3. To conduct an evaluation of the deer enclosures
4. To study the shape and size of the faecal matter
5. To analyze the behaviour and activities of the visitors and zookeepers towards animals in the zoo

Review of Literature

REVIEW OF THE LITERATURE

Studies on the deer in captivity are few and in between. (Krishnakumar, 1991; Asher *et al.*, 1997; Semiadi *et al.*, 1993, 1994 and 1998, Srinivasalu, 1998). Carthy (1965) reported that the animal behaviour is governed largely by the evolutionary processes that have shaped the species. Lee (1974) stated that deer in general are easily maintained in large enclosure whereas they are much more difficult to maintain in smaller quarter. Time invested in these activities (particularly feeding and ruminating) shows marked diurnal and seasonal variations raising questions about the adaptiveness of these patterns (Dulphy *et al.*, 1980). The activity budgets have been documented for a number of northern ruminants including Red Deer and Wapiti (*Cervus elaphus*) (Georgil, 1982, Gates, 1980), Roe Deer (*Capreolus capreolus*) (Turner, 1979 and Cedurlund, 1981) and White-tailed Deer (*Odocoileus virginianus*) (Jacobson, 1973).

Prater (1971) reported that chital herds change in size temporally and in relation to habitat. Horwood and Masters (1981), Kiddie (1982), Koga and Ono (1994) explained the sexual difference in foraging behaviour and reproductive behaviour of Sika Deer (*Cervus nippon*). Pairing of Sambar Deer takes place in November and December and the young ones are born at the commencement of the rains in early June (Panwar, 1982). Chattopadhya and Bhattacharya (1983) explained the basic diurnal activity pattern of black buck. Fritter *et al.* (1984) reported a pocket guide of green plants that are browsed by deer. Eaton and Boddingston (1987) explained the ecological effects of the Sika Deer on Lundy's

east sidelines. Feldhamer (1980) point out the social organization of *Cervus unicolor*. ·Boddingston (1987) described the factors affecting vigilance in Sika Deer.

A through knowledge of activity pattern of any animal is necessary to understand its behaviour and any change in it due to biotic factors. Hughes and Duncan (1988) have said that animal welfare will suffer, when they are few. Brander (1927), Schaller (1967), Prater (1971), Krishnan (1972) and Semiadi *et al.* (1994) have high lightened on morphology, ecology and general behaviour of deer.

Ramachandran (1989) defined activity budget, also known as activity pattern or time budget, as a quantitative description of how animals apportion their time for feeding and other activities. It is important to understand the interactions of external biotic and abiotic stimuli, and reaction of animals to these that account for the behavioural repertoire. and he also opined that the behavioural pattern is probabilistic due to the chance component involved and variation in optimal budgeting of time and energy between foraging versus non-foraging activities.

Krishnakumar (1991) reported that living conditions of deer in zoos are far from that in natural habitats. He observed that in spite of all adversities, the Sambar Deer have learned to adapt amazingly to changing conditions. Semiadi *et al.* (1993) recorded the grazing behaviour of Sambar Deer for 24 hours and found

that Sambar Deer grazed most actively during the night, late afternoon and evening and this pattern was not altered by season or month. In deer species hardening of antlers coincides with rutting season. The prime adult males accomplish most mating and the males establish a system of land tenure or a hierarchical pattern that partly or wholly excludes a certain percentage of their sex from active participation in the rut. Barry *et al.* (1998) determined a mean estrous cycle of 19.3 days (range 17-21) and average gestation of 234.5 days (range 228-239). Single fawns are the norm, twinning is rare (Graf and Nichols, 1966). Semiadi *et al.* (1994) observed that sambar was found to be highly nervous and temperamental when introduced in captivity, but became more settled with regular human contact and feeding with maize and hay. He also reported that in Sambar Deer the calving take place during January to November with a peak in April/May. Most adult stags were in velvet antler between January and April and hard antler between May and November, during the time rutting behaviour was observed. Low quality chaffed meadow hay was fed to four artificially reared Sambar Deer (*Cervus unicolor)* and four Red Deer (*Cervus elephus*) in confined indoors at Palmerston North, New Zealand.

Time budget studies in captivity also help to formulate measures to reduce teasing of captive animals by visitors. The Chamarajendra Zoological gardens Mysore has initiated various types of behavioural studies both on the animals and the visitors (Venugopal and Akbarsha, 1993; Raju and Venugopal 1994). Howse *et al.* (1995) reported that eating and ruminating time per gram of dry matter intake were all greater for Sambar Deer than for Red Deer. The studies on the

diurnal activity patterns of Sambar Deer might help in the conservation of animals (Shyamshanker *et al.* 1995). Barry *et al.*, (1998) observed seasonal cycles in growth and Voluntary Feed Intake (VFI) in the Sambar Deer. But there was no difference between species in digestive efficiency. The Daily Defecation Rate (DDR) of Fallow Deer in winter in Mediterranean area was investigated by Massei and Genov (1998). A mean of 26.5 pellet groups/head was recorded for a day in Fallow Deer. They also suggested that different diets and habitats do not affect daily defecation rate of Fallow Deer. Massei and Genov (1998); Nowak (1991) and Owen-Smith (1998) described the ethology of grazing mammals and Putman (1986) described the activity patterns in grazing.

Shyamshankar *et al.* (1995), reported that main activity period of Sambar Deer was at noon 1100h -1200h and evening 1500h - 1600h. Feeding reached its peak at 1100h - 1200h and at 1500h -1600h. Rumination and sleeping showed peak at 900h -1000h and 1300 - 1400h respectively. Moving was observed more at 1100h - 1200h. Maximum wallowing time was at 1100h -1200h and 1500 - 1600h. Sambar Deer spent about 67.69% of the day time in resting which was pronounced in morning 1000h - 1100h and in afternoon 1200h - 1300h (Schaller, 1967, Krishnan, 1972). Stags spent about 40.94% of the day light hours in lying, 23.06% in standing, 9.58% in feeding, 14.38% in rumination and 12.04% in others. Equivalent figures for hind and fawn are 41.58% (lying), 20.31% (standing), 17.04% (feeding), 9.73% (rumination), 11.34% (others) and 57.81% (lying), 17.52% (standing), 12.19% (feeding), 2.23% (rumination), 10.25% (others) respectively. Mating takes place in Hog Deer is in September and October

and the young ones are born in April and May. Gestation period is around eight months (Sharatchandra and Gadgil, 1978).

Sathyanarayana and Murthy (1995) observed that Gaur living in wild was most active between 0600h to 0900h and 1600h to 1900h. Gaur spent most of the time on feeding and it actively feeds from 0600h to 0900h in the mornings and 1600h to 1900h in the evenings. The Gaur took rest in the shola between 1000h to 1500h.

Venugopal *et al.* (1994) found in Indian rhino that wallowing was the most frequent activity in captivity. About one third of all the activities were constituted by wallowing (33%), this was followed in decreasing order by feeding (19%), standing still (16%), grazing (14%), walking (12%) and other activities (4%). In Indian rhino there were two peak distributions for standing still, a pre-noon peak during 0800h–1100h and post noon peak during 1400h-1600h. lying down was observed during two sessions only 1200h–1300h and 1600h–1800h, with a two-third during the former and one-third during the latter. Resting was found during 1400h–1500h. Wallowing was observed for its frequency distribution, at morning (0600h–0800h), at noon (1100h-1400h) and at evening (1700h-1800h), which constituted 48%, 31% and 21% respectively.

Shyamshankar *et al.*, (1997) found that in Sambar Deer the feeding periods were most intense periods of daily activity. Feeding is more conditioned reflexes

because concentrate feed are supplied in the morning (1100h) and grasses and twigs are fed at 1530h.

In the natural habitat the rhinos have to spend considerable amount of time for foraging and feeding. Animals in captivity, in contrast, are assured about the availability of food and hence energy need not be spent for activities related to food. Venugopal *et al.*, (1994) found that Indian rhino in Mysore zoo was provided with food at about 1600h, once the food was provided, the animal continued to feed until the food was finished. Any amount of disturbance like teasing by visitors did not interfere with its feeding activity. About half of all the feeding was observed in the evening 1500h-1700h, with a few observations during the other hours except the earliest hour and noon hour i.e. 0600h-0700h and 1300h-1400h. It was observed that the Indian rhino had spent about one-third of the day time for feeding related activities such as active feeding (browsing and grazing).

Lying may be to reduce heat loss and to save energy (Mc Farland, 1981). Lying and grooming were not significant among adults but between fawn and adults it was highly significant.

Though moving was consistently observed at all time a slight increase was found before and after peaks of feeding suggesting a good coordination among the two activities where moving is a function of feeding or vice versa. This type of movement from lair to feeding place was stereotyped (Darling, 1937).

Wallowing is a stereotyped activity (Darling, 1937) and was mostly found after feeding. Drinking was found along with wallowing for which the feeding behaviour may be a direct stimulus for drinking (Mc Farland, 1981). Though no consistent time for high or low grooming activity was observed the significant variation in grooming between the hind and its fawn was due to filial relationship between them which existed in the form of allo-grooming usually by the hind by means of licking (Srinivasalu, 1998). Stags indulged in auto-grooming and differed significantly from the fawn. The other significant behaviour were eating concentrate and ruminating. Grazing was highly significant between stag and fawn but the other two combinations showed low significance. Fawn and stag differed significantly in wallowing but it was non significant between adults (stag and hind), hind and fawn.

The most favorite form of activity of the Indian rhino is wallowing. Wallowing may help in reducing body temperature as well as in effectively destroying external parasites (Dutta, 1991). Sathyanarayana and Veeramani (1993) studied the activity patterns of blue peafowl in wild and they concluded that peafowls spent 33% of their total time in feeding, 24% of their time in walking, running and flying. They spent 31% of their time on resting and 3% on

peacocks. They observed that peafowls were mostly active between 0650h–1000h and 1600h-1850h. Similarly Hillgarth (1983) has reported that the peafowls were most active between 0900h-1100h and between 0300h–0600h.

Basavaraju *et al.,* (1993) has reported in Llama that both mother and the young spent most time of the day in resting. The young spent a greater percentage (69.24%) of the time in resting than the mother (42.75%). The young spent 15.8% for sleeping, 0.63% for ruminating, 33.27% for lying and 19.58% for standing in a day. The mother spent 0.33% for sleeping, 8.43% for lying, 15.67% for ruminating and 18.32% for standing. The peak resting period for both individuals was between 0600h and 0700h which gradually decreased from 0700h to 0800h in the mother and 0900h to 1000h in the young. The second peak of resting is between 0800h and 0900h in the mother and between 1000h to 1100h in the young. The third peak was from 1400h to 1500h in the mother but in the young the third peak appeared an hour before. The resting period of mother showed many ups and downs. But in the case of the young it shows a gradual decrease. The mother spent 22.28% of time for moving during day time. But it was comparatively less in the young (17.13%). Overall it appears that the proportion of time spent on moving was consistent throughout the day. The animals were fed twice a day. Their usual time of feeding was once in the morning between 1000h to 1100h and another in the afternoon between 1600h to 1700h. The mother spent 26.2% of its time for feeding. Though the morning food placed between 1000h to 1100h, the first peak of feeding pattern appeared between 0700h to 0800h because the mother fed on left over of the previous day. Second peak feeding hours

appeared between 1200h to 1300h. Following this, a third peak emerged between 1700h to 1800h. In the case of the young, the feeding pattern (suckling milk from the mother) moderately increased from 0600h and attained its first peak hours between 1100h to 1200h. Then it slowly decreased with a slight second peak between 1400h and 1500h. Overall 5.93% of the time was spent for suckling and 1.78% on other food items.

Materials and Methods

MATERIALS AND METHODS

The present study was carried out at Thrissur Zoo, Thrissur district Kerala, Southern India from September 2002 to April 2003. The study concentrated on three deer species *viz.*, Sambar (*Cervus unicolor*), Spotted deer (*Axis axis*) and Hog deer (*Axis porcinus*).

3.1 BEHAVIOURAL STUDIES

The observation of each deer species was made for a period of 24 hours once in every month. The behavioural observations were made for eight months from September 2002 to April 2003. The data on activity pattern and time budget were collected through focal animal sampling method with the aid of binoculars (7 X 50) (Altman, 1974). The selected four animals (two males and two females) were observed, the observation period for each animal was 10 minutes per hour with an interval of 5 minutes in the prescribed data sheet. The observation on each animal was recorded at every 5^{th} second and thus continuously for 5 minutes. Thus on each animal for every 5 minutes 60 observation data were collected. At the 5^{th} minute the observation was changed to the 2^{nd} animal and the similar pattern of observation continued. The same was then carried out for the 3^{rd} and 4^{th} animal for the three species of deer studied as part of the present study. Whenever the animals were found disturbed by the observer, the sampling was terminated and was restarted after the animal settled.

The activity patterns were categorized as follows.

3.1.1 Feeding

When an animal is actively involved in feeding that is both grazing and browsing, or when food provided by the zoo staff, or by the zoo visitors.

3.1.2 Standing

Animal was standing and/or chewing or ruminating.

3.1.3 Walking

Walking at a steady pace or movements from one location to another.

3.1.4 Resting

The animal was considered to be resting while lying on the ground, resting on the boundary wall or wallowing in the muddy water.

3.1.5 Others

Alertness, flehmen, auto-licking, allo-licking, aggressiveness, urination, defaecation, reproductive behaviour, vocalization and rubbing are included under other activity.

3.1.6 Activity per cent

The activity per cent was calculated using the formula,

$$\text{Per cent activity} = \frac{\text{Time spent in an activity in an hour}}{\text{Total time spent for all activities in that hour}} \times 100$$

3.2 EVALUATION OF THE ENCLOSURES

The critical evaluation of enclosures was carried out with reference to the Central Zoo Authority rules and guidelines (CZA, 1992).

3.3 ANALYSIS OF THE FEED

The feed mixtures and green fodder which were fed to the animals were collected during the study period and the contents were analysed for protein, moisture, fat etc using standard methods. Plants fed to the deer were collected and identified with the help of a taxonomist and botanical names were recorded.

3.4 ANALYSIS OF FAECAL MATTER

The size and the shape of the droppings of the three species of deer such as Sambar Deer, Spotted Deer and Hog Deer were measured. For each species 200 pellets each were counted and the standard size was determined.

3.5 VISITORS AND HOUSEKEEPERS BEHAVIOUR

The behaviour of visitors and housekeepers were recorded through a basic questionnaire (Appendix 1). The questions were framed in such a way to find out the sex, age, educational status, motive behind the teasing, feeding and the general perception of the visitors towards the zoo was prepared and analyzed. Fifty visitor groups were selected for this study and thoroughly monitored their activities in the zoo. Apart from that 100 individuals involved in teasing or provocation activities were also monitored. Provocator is a visitor who indulges in any one or more of the activities such as shouting, feeding, throwing stones etc. As the provocators moved away from the exhibit, they were interviewed individually and their responses were noted in the data sheets. The observations were made on the behaviour of the visitors towards animals, response of animals and time taken to observe particular animal species in the zoo.

Results

RESULTS

4.1 BEHAVIOURAL STUDIES

4.1.1 The Sambar Deer (*Cervus unicolor* Kerr, 1792)

The Sambar is the largest deer found in India and it is seen in the Wildlife Sanctuaries and National Parks in Kerala. The herd size of four or five animals is usually seen in the forest but it may go up to 60 to 100 sometimes, in Periyar Tiger Reserve for example. The Sambar is the most widely spread deer species in Asia, covering many countries in the Asian region. Some males are weighing up to 300 kg and can grow to a height ranging from 135-150 cm at the shoulders. The male members have antlers that can grow to a length of 90-95 cm, with a record finding of one that measured 127 cm. These animals have a life expectancy ranging between 16-20 years (Prater, 1971).

They are the preferred prey species of the tiger. Their breeding period is mainly during the month of November and December. The gestation period is six months. The males by this time must have shed their antlers. New pair starts growing almost immediately. The male mostly lead solitary lives and rarely seen associating with each other, except on some occasions during the rutting season. The sambar has extremely sharp senses of hearing and smell. Although the Sambar is found in almost every corner of India, some of the best parks to sight this animal are Kanha, Corbett, Ranthambore, Bandhavgarh, Dudhwa, Manas,

Kaziranga, Bandipur, Nagerhole and Periyar. The rut occurs in the fall, with parturition following in the spring.

It is important to study activity pattern in the light of the influence of temporal and environmental factors on the species to understand the ecological significance of behavioural pattern. Richards (1970) opined that although there exists a great variation in allotment of time and energy in some types of behaviour over others, animals tend to perform any given activity at the most opportune time.

4.1.1.1 Activity pattern of adult male Sambar Deer

Monthly variations in time budgeting by adult male Sambar Deer in different activities are depicted in Fig. 1 and Fig. 2.

In the month of September, 2002 it was observed that the male Sambar Deer was engaged maximum of its time in resting from 0600h to 1400h except at 1100h, 1500h and 1700h, when it was more engaged in feeding (Fig. 1).

In the month of October, 2002 it was observed that the male Sambar Deer was engaged much of its time in resting from 0600h to 1700h except in the 1500h. Standing activity was the second most important activity during October 2002, which was more during 1000h to 1700h except in 1600h, and feeding activity was found only during 1500h and 1700h (Fig. 1)

Fig. 1. Hourly variation in the activity pattern of adult male Sambar Deer in Thrissur zoo from September to December, 2002

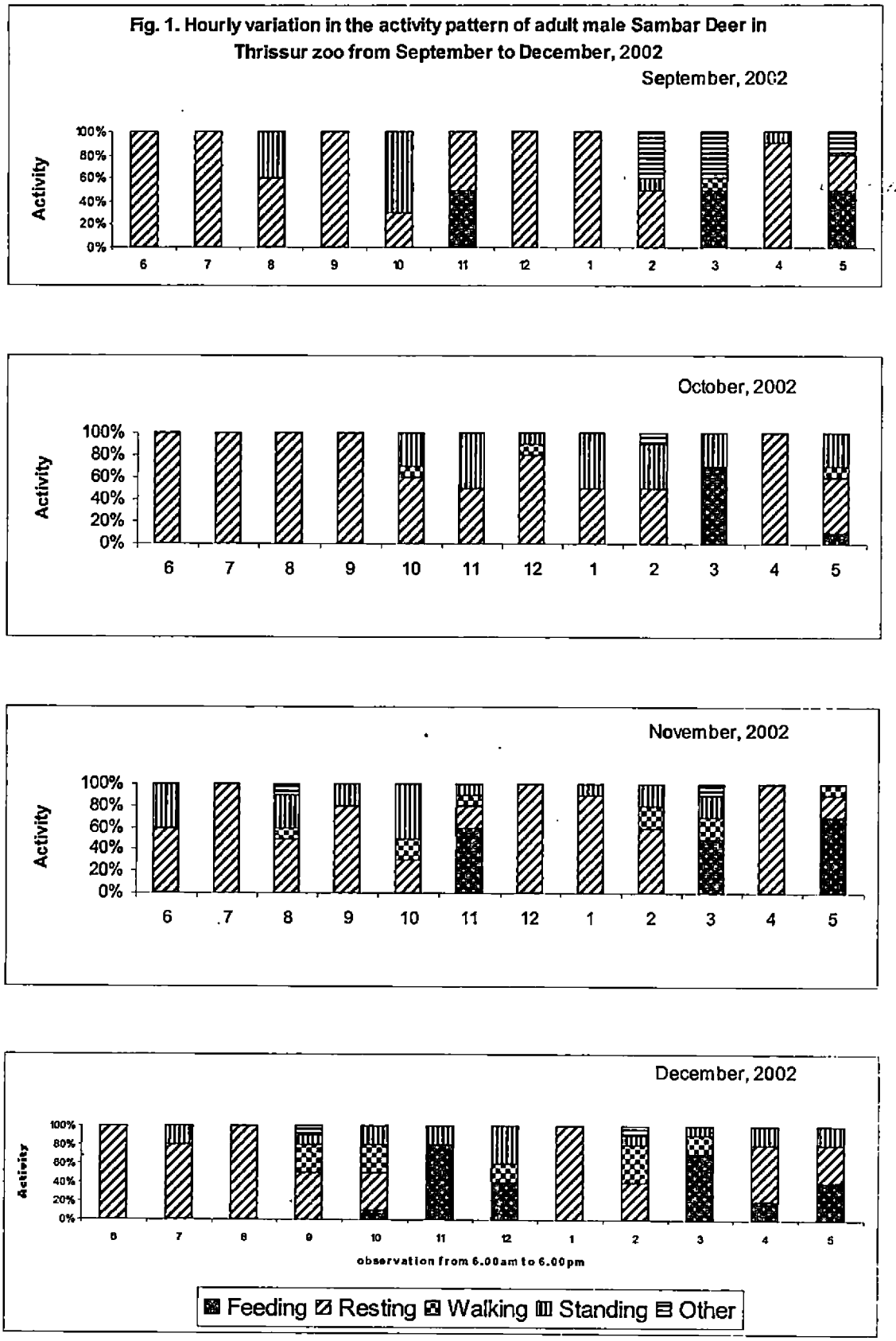
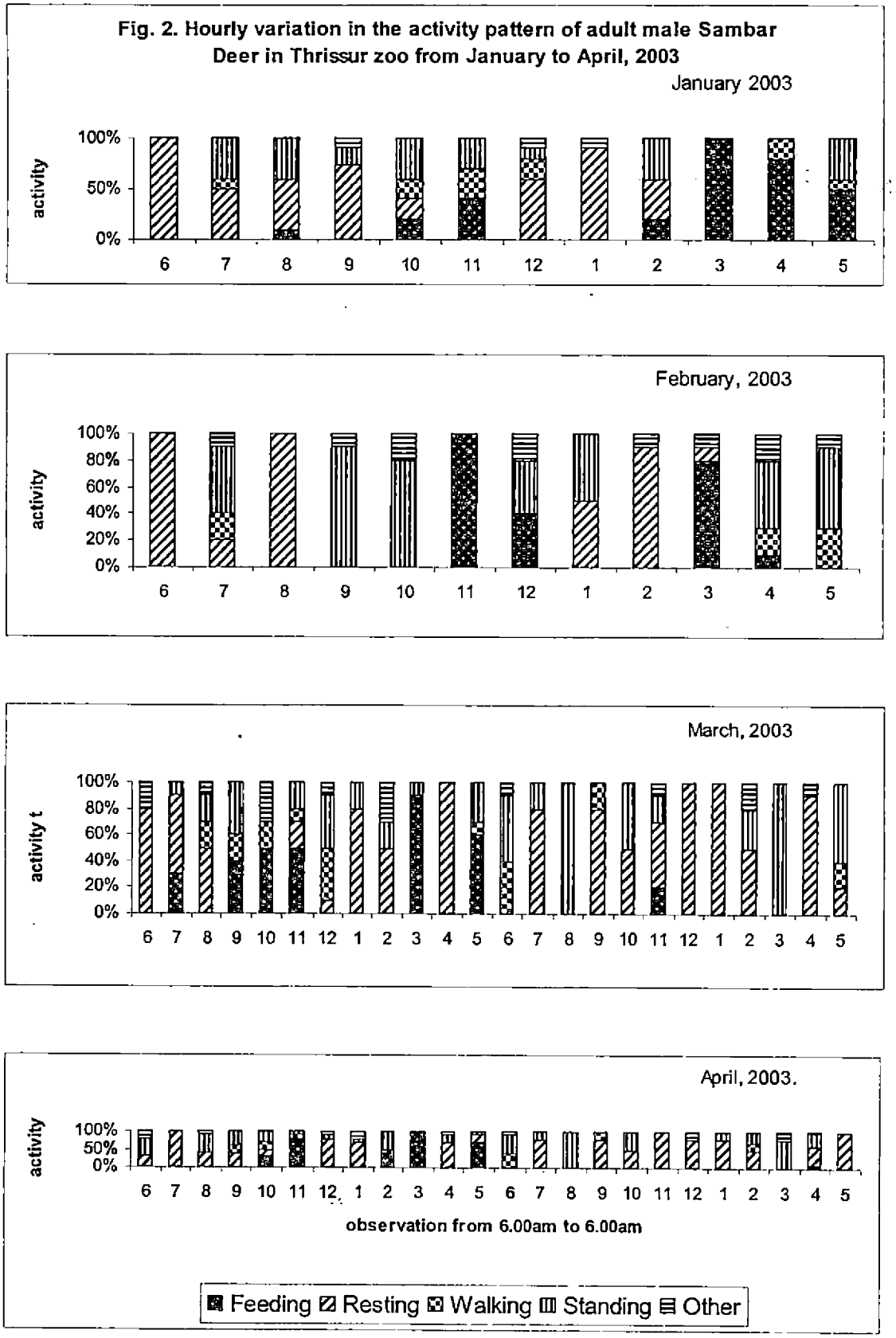


Fig. 2. Hourly variation in the activity pattern of adult male Sambar Deer in Thrissur zoo from January to April, 2003



In the month of November, 2002 it was observed that the male Sambar Deer was engaged maximum of its time in resting from 0600h to 1600h except in the 1500h. Resting was followed by the feeding activity which was more during 1100h, 1500h and 1700h (Fig.1).

In the month of December, 2002 it was observed that the male Sambar Deer was engaged maximum of its time in resting from 0600h to 1000h and again 1300h to 1700h except in the 1500h. This was followed by the feeding activity which was showing a bimodal pattern with two peaks one during 1000h, 1100h, 1200h and other from 1500h to 1700h (Fig. 1)

In the month of January, 2003 also resting was the most important activity performed by the male Sambar Deer from morning 0600h to 0900h and again from 1200h to 1400h. This was followed by feeding activity which was more during 0800h, 1000h, 1100h and again from 1400h and 1700h (Fig. 2)

In the month of February, 2003 it was observed that the male Sambar Deer was engaged most of its time in resting that was from 0600h, 0700h, 0800h and again during 1300h, 1400h, followed by feeding activity which was found at its peak during1100h, 1200h, 1500h and 1600h (Fig. 2)

In the month of March, 2003 it was observed that the male Sambar Deer was engaged maximum of its time in resting, from 0600h to 0800h and 1300h, 1400h, and again from 1900h to 0500h. This was followed by feeding activity

which was more during 0700h, 0900h, 1000h and 1100h and again at 1500h and 1700h (Fig. 2)

In the month of April, 2003 it was observed that the male Sambar Deer was engaged maximum of its time in resting almost for the whole day except during 1400h, 1500h and 2000h. This was followed by feeding activity which was more during 1000h, 1100h, 1400h, 1500h and 1700h (Fig. 2).. During the months of March 2003 and April 2003, 24 hours observation was recorded.

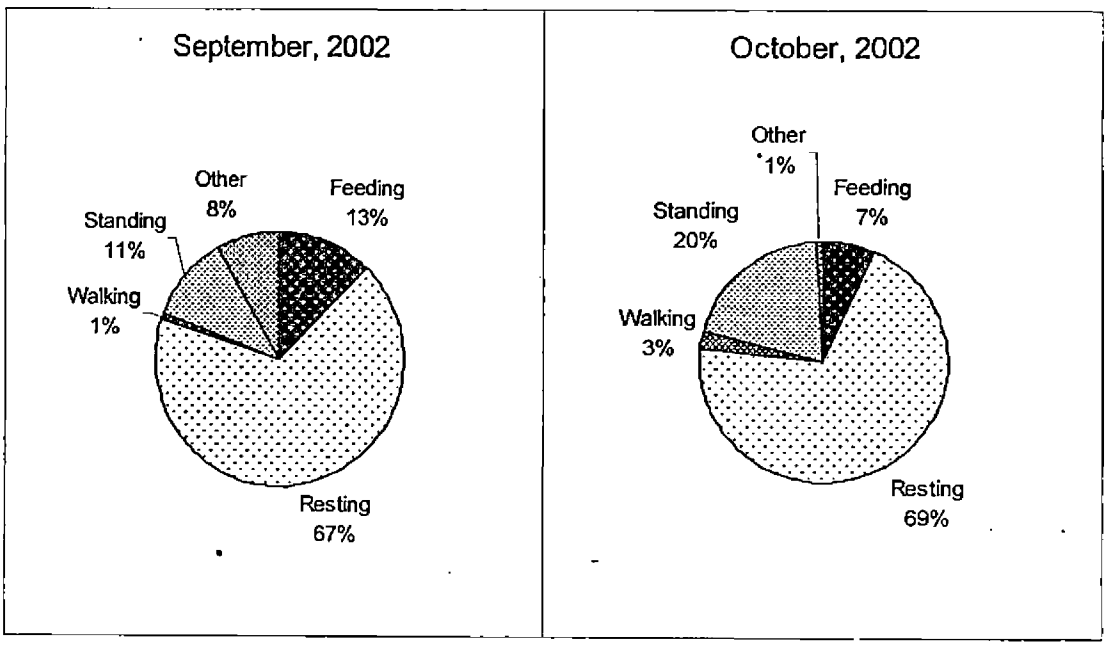
There was no significant variation in activity patterns between months and also between individuals of the same sex.

During the month of September, 2002 the average time allocated by the adult male Sambar Deer for resting activity was 67.00 per cent, followed by feeding activity (13.00 per cent), standing activity (11.00 per cent) and 8.00 (per cent) for other activities (Fig. 3).

In the month of October, 2002 the average time allocated by the adult male Sambar Deer for resting 69.00 per cent, which was followed by standing (20.00 per cent), feeding (7.00 per cent) and walking (3.00 per cent) (Fig. 3).

During the month of November, 2002 average time allocated by the adult male Sambar Deer for resting activity was 58.00 per cent, followed by standing

Fig. 3. Activity pattern of adult male Sambar Deer in Thrissur zoo from September to December, 2002



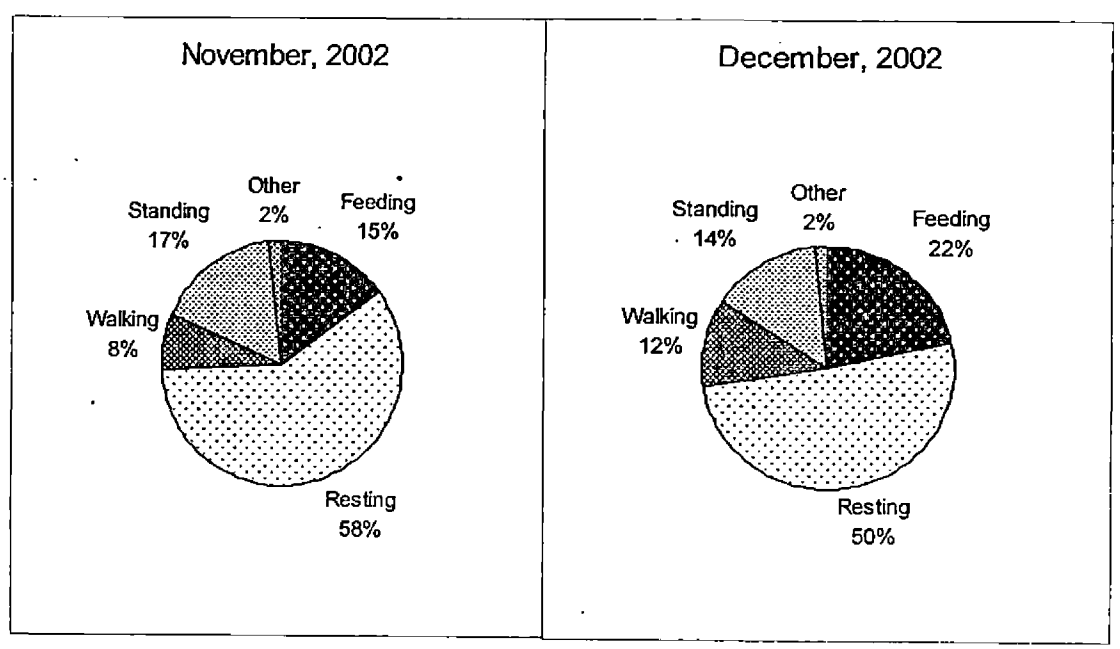
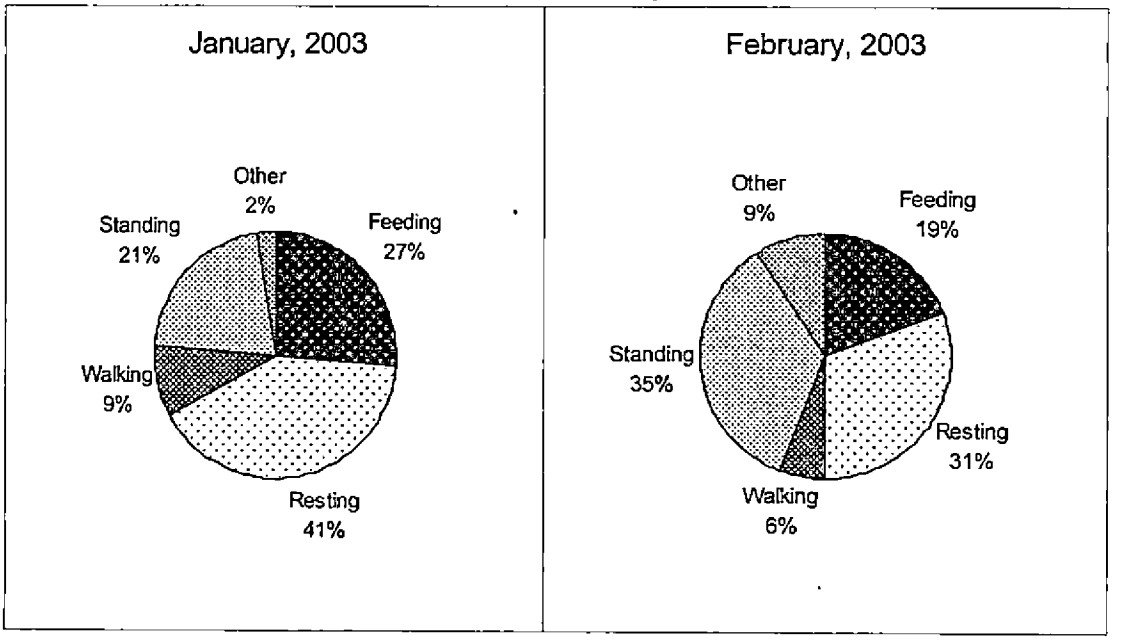
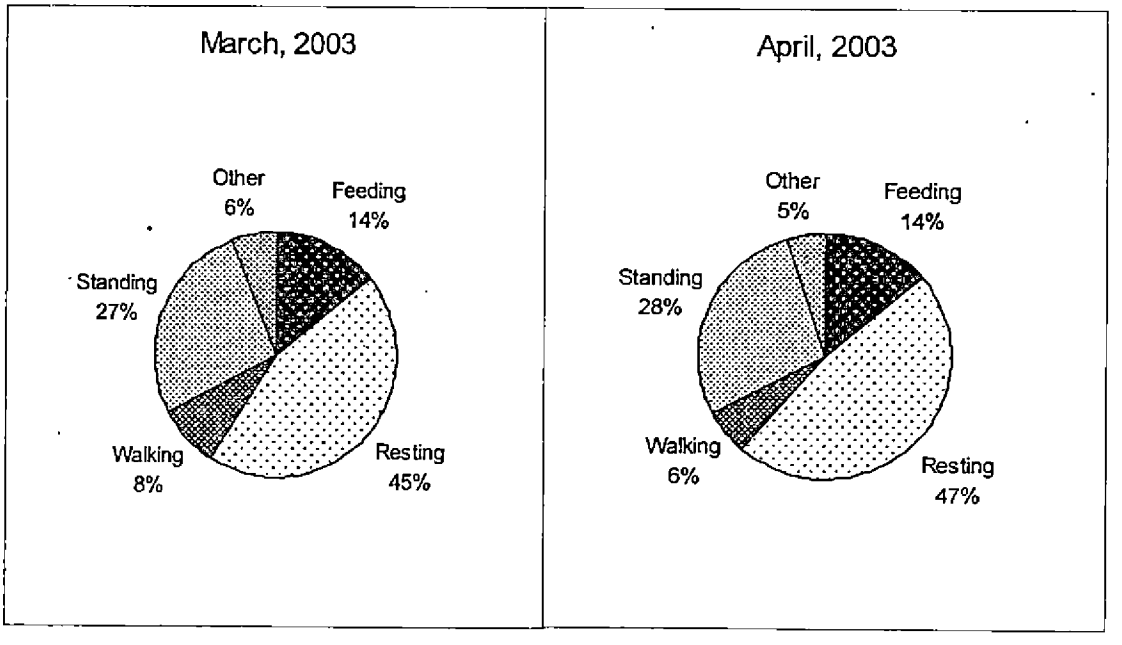


Fig.4.Activity pattern of adult male Sambar Deer in Thrissur zoo from January to April, 2003





activity (17.00 per cent), feeding activity (15.00 per cent) and walking activity (8.00 per cent) (Fig. 3).

During the month of December, 2002 average time allocated by the adult male Sambar Deer for resting activity was 50.00 per cent, followed by feeding activity (22.00 per cent), standing activity (14.00 per cent) and walking activity (12.00 per cent) (Fig. 3).

During the month of January, 2003 average time allocated by the adult male Sambar Deer for resting activity was 41.00 per cent, followed by feeding activity (27.00 per cent), standing activity (21.00 per cent) and walking activity (9.00 per cent) (Fig. 4).

In the month of February, 2003 the average time allocated by the adult male Sambar Deer for standing activity was 35.00 per cent, followed by resting (31.00 per cent), feeding activity (19.00 per cent) and walking activity (6.00 per cent) (Fig. 4).

In the month of March, 2003 the average time allocated by the adult male Sambar Deer for resting was 45.00 per cent, which was followed by standing activity (27.00 per cent), feeding activity (14.00 per cent) and walking activity (8.00 per cent) (Fig. 4).

In the month of April, 2003 the average time allocated by the adult male Sambar Deer for resting was 47.00 per cent, which was followed by standing activity (28.00 per cent), feeding activity (14.00 per cent) and walking activity (6.00 per cent) (Fig. 4).

4.1.1.2 Activity pattern of adult female Sambar Deer

Monthly variations in time budgeting by adult female Sambar in different activities are depicted in Fig. 5 and Fig. 6 throughout the study period.

In the month of September, 2002 it was observed that the female Sambar Deer was engaged maximum of its time in resting from 0900h to 1300h and 1600h, followed by feeding activity which was more during 1100h, 1300h to 1700h (Fig. 5).

In the month of October, 2002 it was observed that the female Sambar Deer was engaged much of its time in resting that was from morning 0600h to 0900h and 1200h, 1400h to 1700h, followed by feeding activity which was more during 1000h, 1100h, 1300h, 1500h and 1600h (Fig. 5).

In the month of November, 2002 it was observed that the female Sambar Deer was engaged much of its time in resting from 0600h to 1000h and again 1200h, 1300h, 1700h, followed by feeding activity which was more during 1000h,1100h and 1400h to 1700h (Fig. 5).

Fig. 5. Hourly variation in the activity pattern of adult female Sambar Deer in Thrissur zoo from September to December, 2002

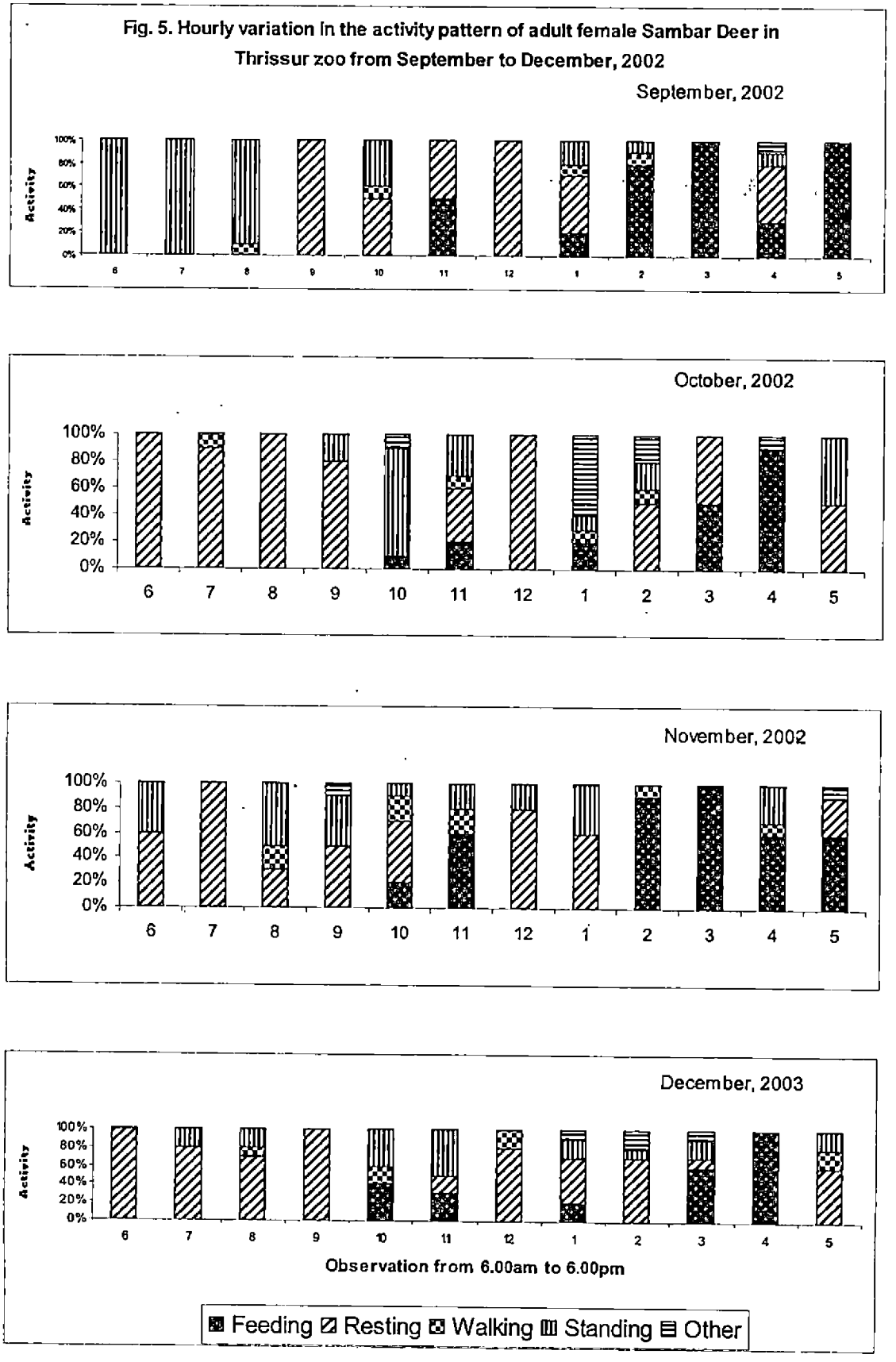
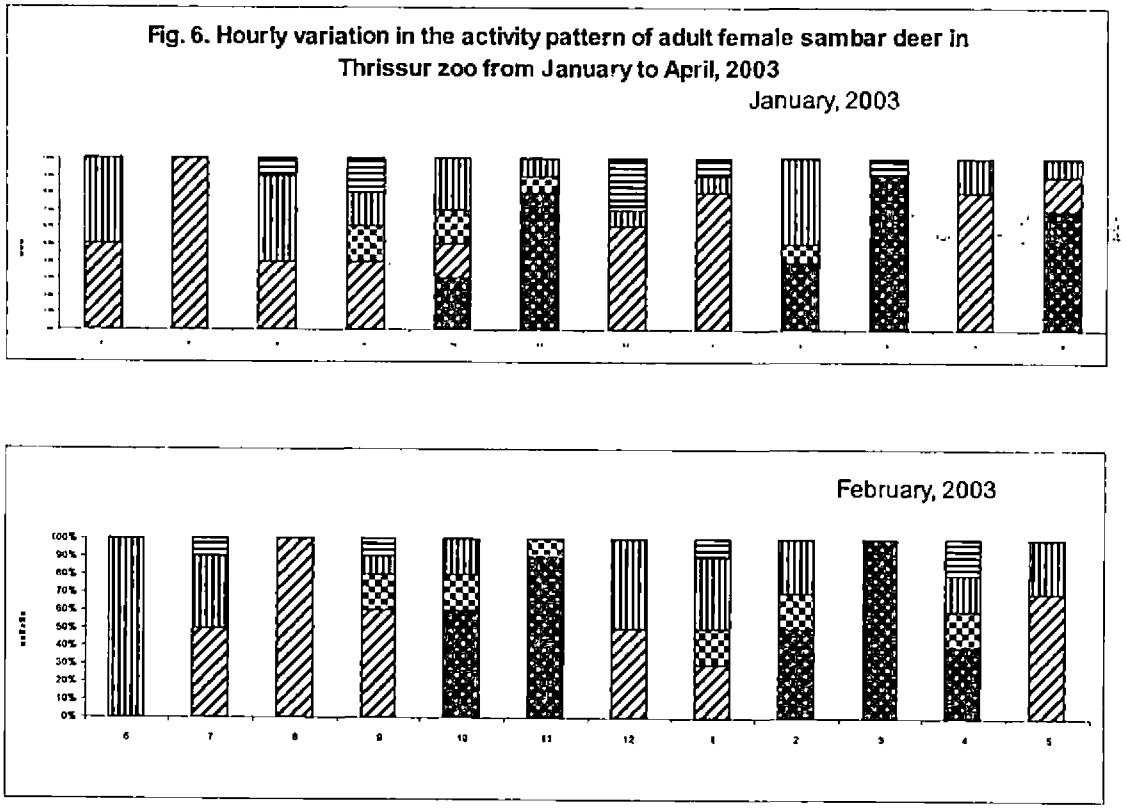


Fig. 6. Hourly variation in the activity pattern of adult female sambar deer in Thrissur zoo from January to April, 2003



In the month of December, 2002 it was observed that the female Sambar Deer was engaged maximum of its time in resting from 0600h to 0900h and again 1200h to 1500h except in the 1600h, followed by feeding activity which was more during1000h, 1100h, 1300h and again at 1500h (Fig. 5)

In the month of January, 2003 it was observed that the female Sambar Deer was engaged maximum of its time in resting from 0600h to 1000h and again at 1200h, 1300h and 1600h, followed by feeding activity which was more during 1000h, 1100h and again at 1400h, 1500h and 1700h (Fig. 6).

In the month of February, 2003 it was observed that Sambar Deer was engaged most of its time in resting that was from morning 0700h, 0800h, 1000h and again during 1200h, 1300h and 1700h, followed by feeding activity which was found at its peak during 1000h, 1100h and from 1400h to 1600h (Fig. 6)

In the month of March, 2003 it was observed that the female Sambar Deer was engaged maximum of its time in resting from 0600h to 1000h and again from 1400h up to early morning 0500h except during 1500h and 1800h; followed by feeding activity which was more during 0700h, 0900h, 1000h and 1100h and 1200h,1300h, 1500h to 1700h (Fig. 6)

In the month of April, 2003 it was observed that the female Sambar Deer was engaged maximum of its time in resting almost for the whole day except during 0800h, 0900h, 1000h, 1500h and 2000h, followed by feeding activity

which was more during 0900h, 1000h, 1100h, 1500h and 1700h and also at early morning 0400h (Fig. 6). During the months of March 2003 and April 2003, 24 hours observation was recorded.

There was no significant variation in activity patterns between months and also between individuals of the same sex.

During the month of September, 2002 the average time allocated for resting activity by adult female Sambar Deer was 33.00 per cent, followed by feeding activity (32.00 per cent), standing activity (31.00 per cent) and walking activity (3.00 per cent) (Fig. 7).

In the month of October, 2002 the average time allocated by adult female Sambar Deer for resting was 55.00 per cent, followed by standing activity (18.00 per cent), feeding activity (16.00 per cent) and walking activity (3.00 per cent) (Fig. 7).

During the month of November, 2002 average time allocated by adult female Sambar Deer for resting activity was 37.00 per cent, followed by feeding activity (33.00 per cent), standing activity (21.00 per cent) and walking activity (7.00 per cent) (Fig. 7).

During the month of December, 2002 average time allocated by adult female Sambar Deer for resting activity was (53.00 per cent), followed by feeding

activity (21.00 per cent), standing activity (17.00 per cent) and walking activity (6.00 per cent) (Fig. 7).

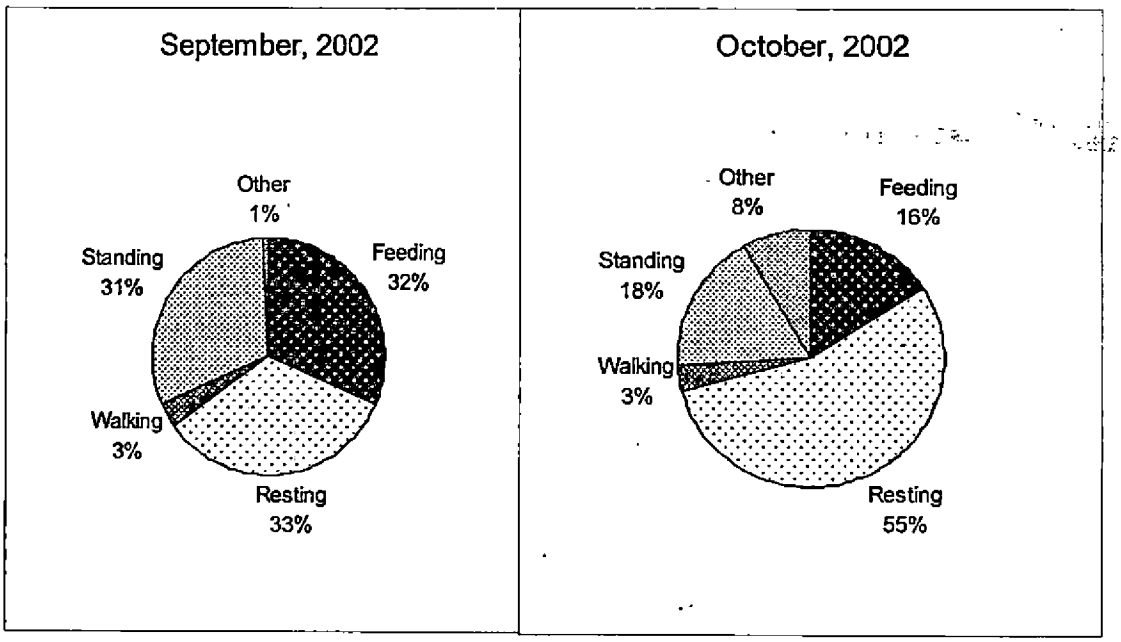
During the month of January, 2003 average time allocated by adult female Sambar Deer for resting activity was 40.00 per cent, followed by the feeding activity (26.00 per cent), standing activity (22.00 per cent) and walking activity (5.00 per cent) (Fig. 8).

In the month of February, 2003 the average time allocated by adult female Sambar Deer for resting was 31.00 per cent, while for feeding activity as well as standing activity 28.00 per cent each and for walking activity (9.00 per cent) (Fig. 8).

In the month of March, 2003 the average time allocated by adult female Sambar Deer for resting was 42.00 per cent, followed by standing activity (22.00 per cent), feeding activity (19.00 per cent) and walking activity (10.00 per cent) (Fig. 8).

In the month of April, 2003 the average time allocated by adult female Sambar Deer for resting was 46.00 per cent, followed by standing activity (29.00 per cent), feeding activity (12.00 per cent) and walking activity (8.00 per cent) (Fig. 8).

Fig. 7. Activity pattern of adult female Sambar Deer in Thrissur zoo from September to December, 2002



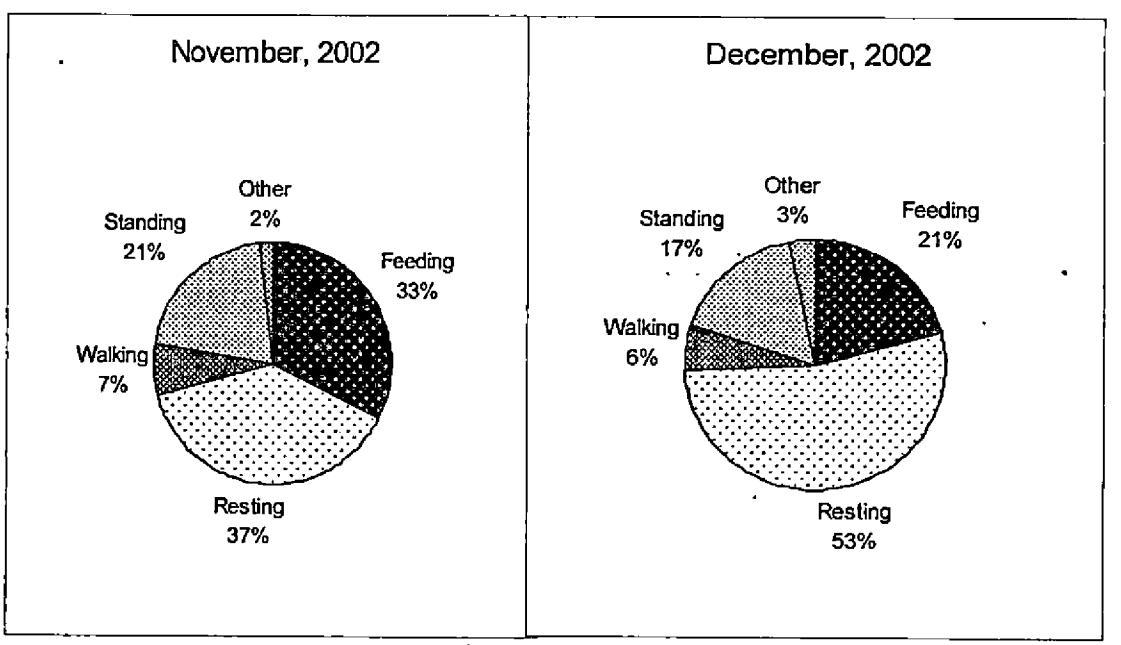
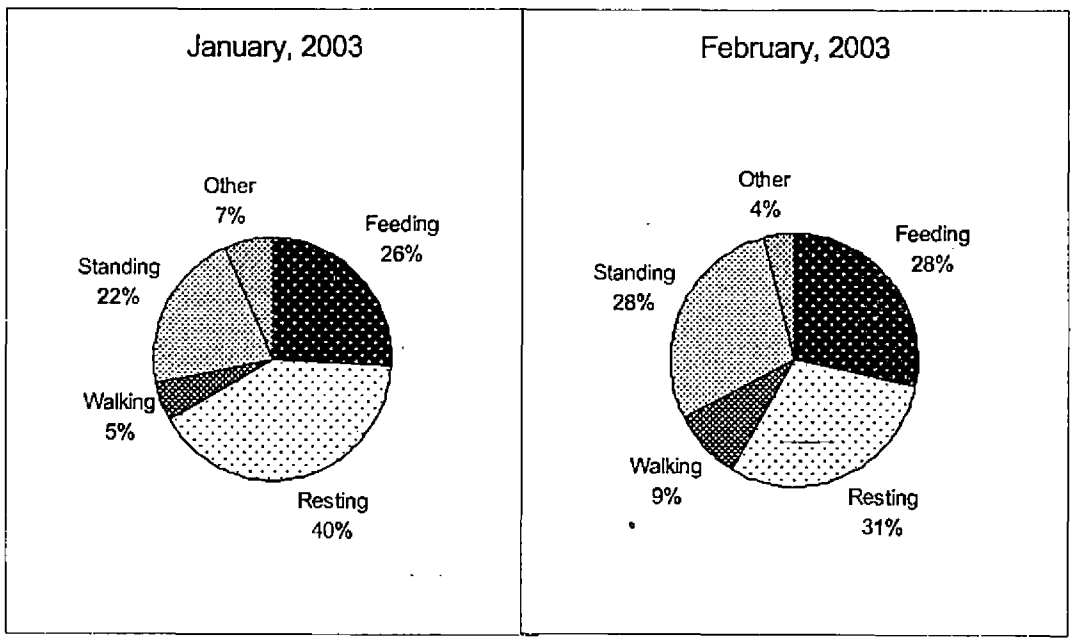
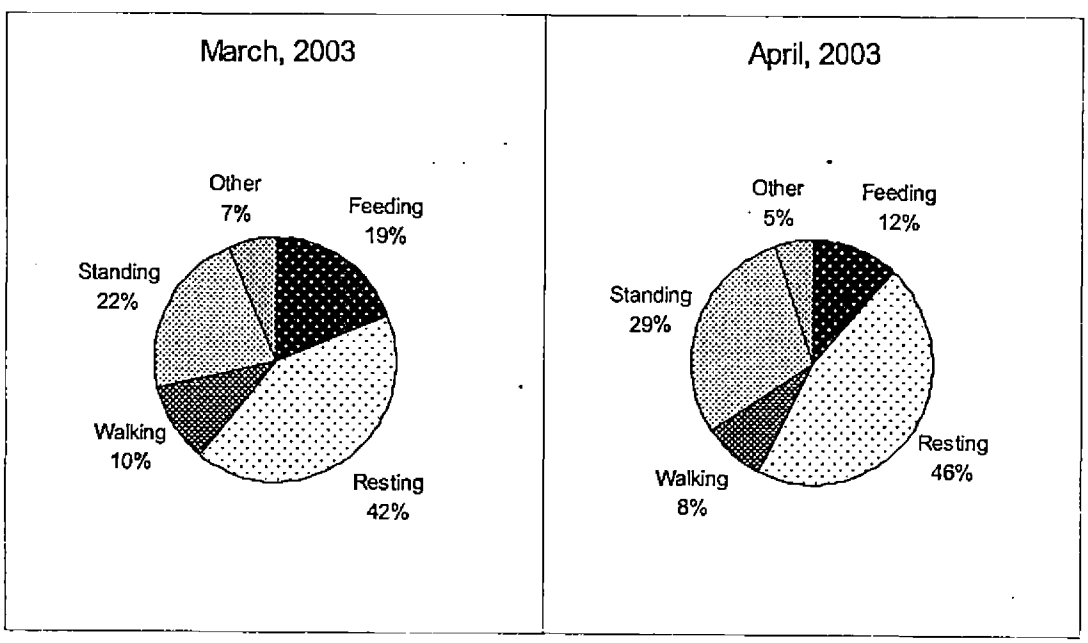


Fig.8. Activity pattern of adult female Sambar Deer in Thrissur zoo from January to April, 2003





4.1.2 The **Chital or Spotted Deer (*Axis axis* Erxleben, 1777)**

The lithe grace and lovely spotted coat of the chital or axis deer (*Axis axis*) have made its favored inhabitant of zoological gardens and parks for centuries. Because of its wide distribution and abundance, it has also been the most persistently hunted deer for meat and sport in its India, Nepal and Sri Lanka, acquiring in certain respects a position similar to the Odocoileus deer in North America. The deer belonging to the genus *Axis*, the chital and Hog Deer, are considered to be among the most primitive of the true cervids, having been present during the Pliocene and Pleistocene in Europe and Asia (Mason, 1991). The Chital is a medium sized deer standing about 0.88 to 1 mts high at the shoulders. Its coat is brown and covered with white spots that persist throughout the life of animal. A dark stripe runs down the back from the nape to the tip of the tail. The abdomen, rump, throat and the insides of the legs, tail and ears are white. Adult bucks have a dark brown, swollen neck during the rut, yearling bucks lack the prominently enlarged neck although its colour is sometimes a darker shade than that of does. There is no seasonal difference in the colour of the coat, except that during the cool season it is somewhat glossier (Prater, 1971).

Axis deer reproduction is seasonal; yet above 90 per cent of mature females produce fawns annually when forage is good (Graf and Nichols, 1966). Most fawns are born from mid-November to April and the peak antler maturation as well as rut activity occurs from April to August. Both sexes reach puberty toward the end of their first year of age, although some females have been known

to breed and conceive earlier. The multiple estrous cycles occur each year. The gestation appears to be seven months and fifteen days.

4.4.2 Activity pattern of adult male Spotted Deer

Monthly variations in time budgeting by adult male Spotted Deer in different activities are depicted in Fig. 9 and Fig. 10. The study period for Spotted Deer was from November, 2002 to April, 2003 as there was problem with tagging Spotted Deer. After tagging the animals with the help of zookeepers the observations were recorded (Plate 1).

In the month of November, 2002 it was observed that the male Spotted Deer was engaged maximum of its time in resting from 0600h to 1700h except during 1000h, 1200h and 1500h, followed by feeding activity which was more during1000h to 1200h and again from 1400h and 1700h (Fig. 9).

In the month of December, 2002 it was observed that the male Spotted Deer was engaged maximum of its time in resting that from 0600h to 0800h and again 1200h to 1400h and 1700h, followed by feeding activity which was more during 0700h, 0900h to 1200h and again from 1400h, 1500h to 1700h (Fig. 9).

In the month of January, 2003 it was observed that the male Spotted Deer was engaged much of its time in resting from 0600h, 0700h, 0900h, 1000h and

Fig. 9. Hourly variation in the activity pattern of adult male Spotted Deer in Thrissur zoo from November,2002 to February, 2003

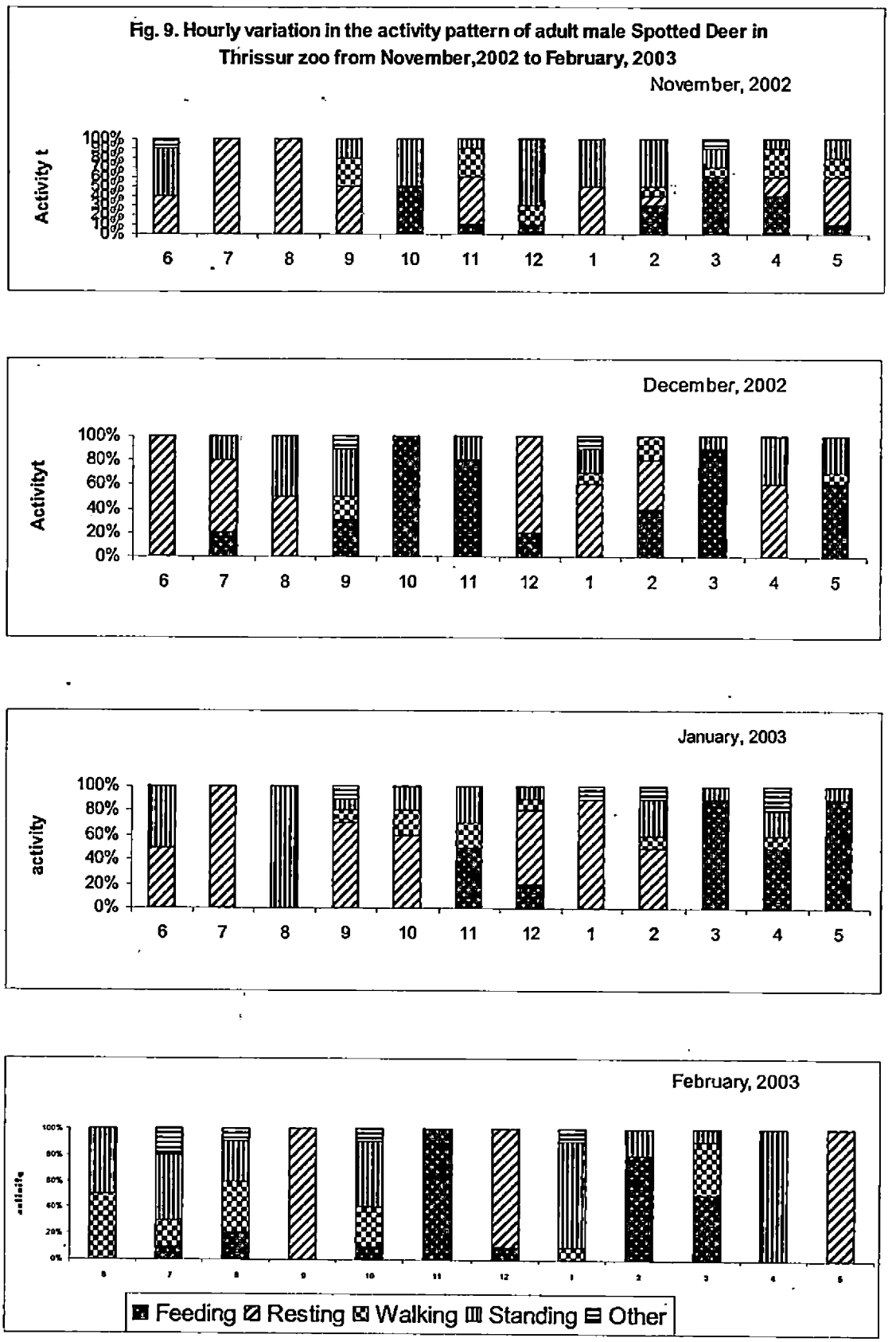
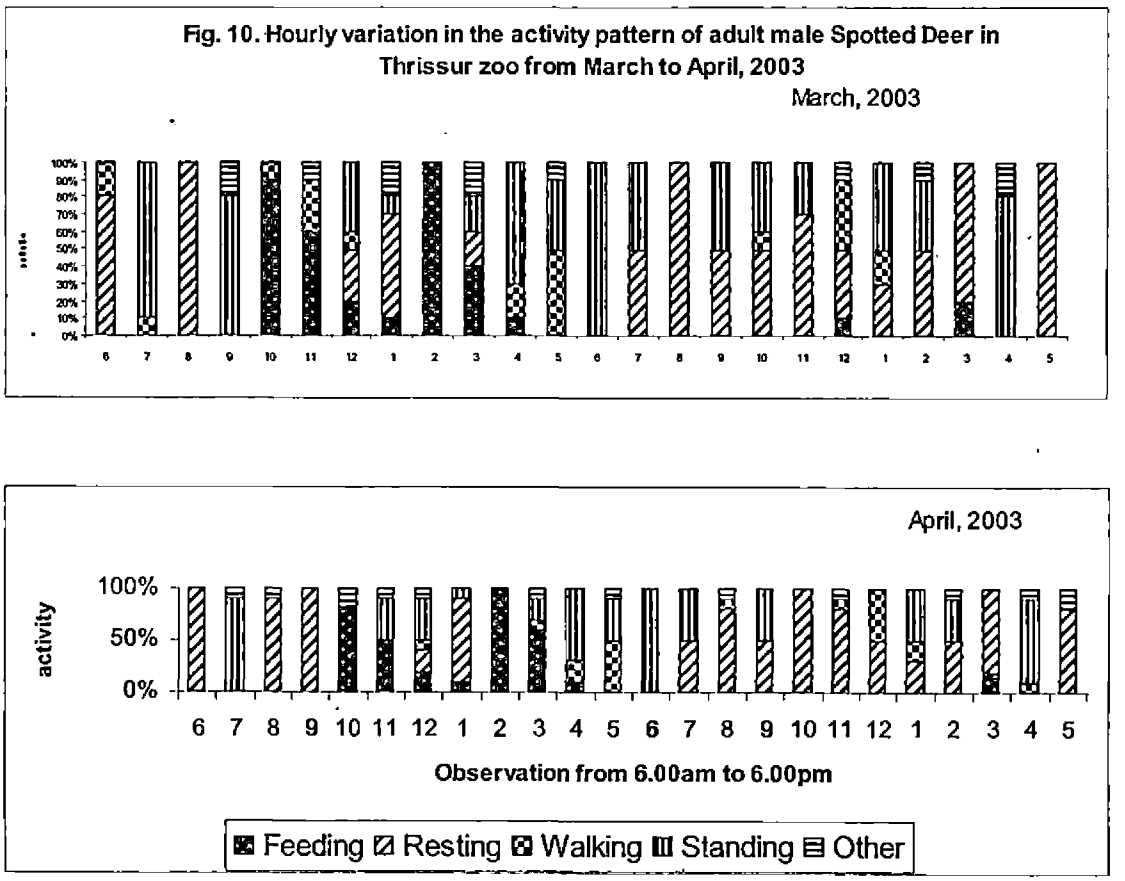


Fig. 10. Hourly variation in the activity pattern of adult male Spotted Deer in Thrissur zoo from March to April, 2003



again from 1200h to 1400h, followed by feeding activity which was more during 1100h, [illegible] and again from 1500h to 1700h (Fig. 9).

[illegible]month of February, 2003 it was observed that the male Spotted Deer was engaged most of its time in standing at 0600h, 0700h, 0800h and again during 1000h, 1300 to 1600h, followed by resting activity which was found at its peak during 0900h, 1200h and 1700h (Fig. 9).

In the month of March, 2003 it was observed that the male Spotted Deer was engaged most of its time in resting almost the whole day except during 0700h, 0900h to 1100h, followed by standing activity, which lasted for almost part of the whole day except during 0600h, 0700h, 1000h and 1100h and 2000h (Fig. 10).

In the month of April, 2003 it was observed that the male Spotted Deer was engaged most of its time in resting almost for the whole day except during 0700h, 1000h, 1100h, 1400h and 1500h, followed by standing activity which was found almost whole day except during 0600h, 0800h to 1000h and 1300h, 1400h (Fig. 10).

There was no significant variation in activity patterns between months and also between individuals of the same sex.

During the month of November, 2002 the most important activity by the male Spotted Deer was resting (38.00 per cent) followed by standing activity (29.00 per cent), feeding activity (18.00 per cent) and walking activity (13.00 per cent) (Fig. 11).

During the month of December, 2002 the most important activity by the male Spotted Deer was resting activity (37.00 per cent) followed by feeding activity (37.00 per cent), standing activity (19.00 per cent) and walking activity (5.00 per cent) (Fig. 11).

During the month of January, 2003 the most important activity by the male Spotted Deer was resting activity (40.00 per cent), followed by feeding activity (25.00 per cent), standing activity (24.00 per cent) and walking activity (7.00 per cent) (Fig. 11).

In the month of February, 2003 the most important activity by the male Spotted Deer was standing activity 33.00 per cent, resting 24.00 per cent and that for feeding activity was 23.00 per cent. The average time allocated for walking activity 16.00 per cent, and for other activities 4.00 per cent (Fig. 11).

In the month of March, 2003 the average time allocation for resting 38.00 per cent, for standing activity (33.00 per cent), followed by feeding activity (15.00 per cent), and walking activity (9.00 per cent) (Fig. 12).

Fig. 11. Activity pattern of adult male Spotted Deer in Thrissur zoo from November, 2002 to February, 2003

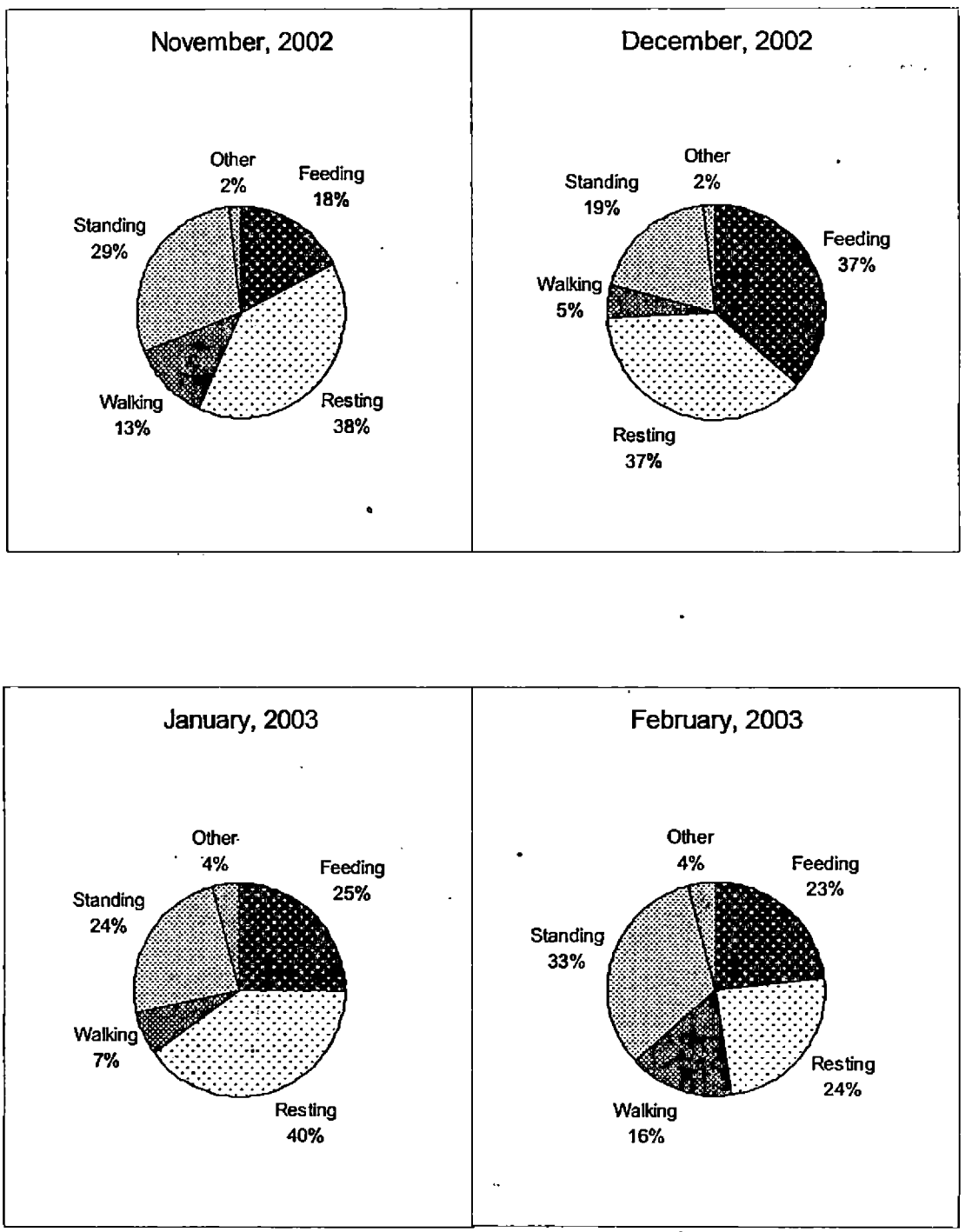
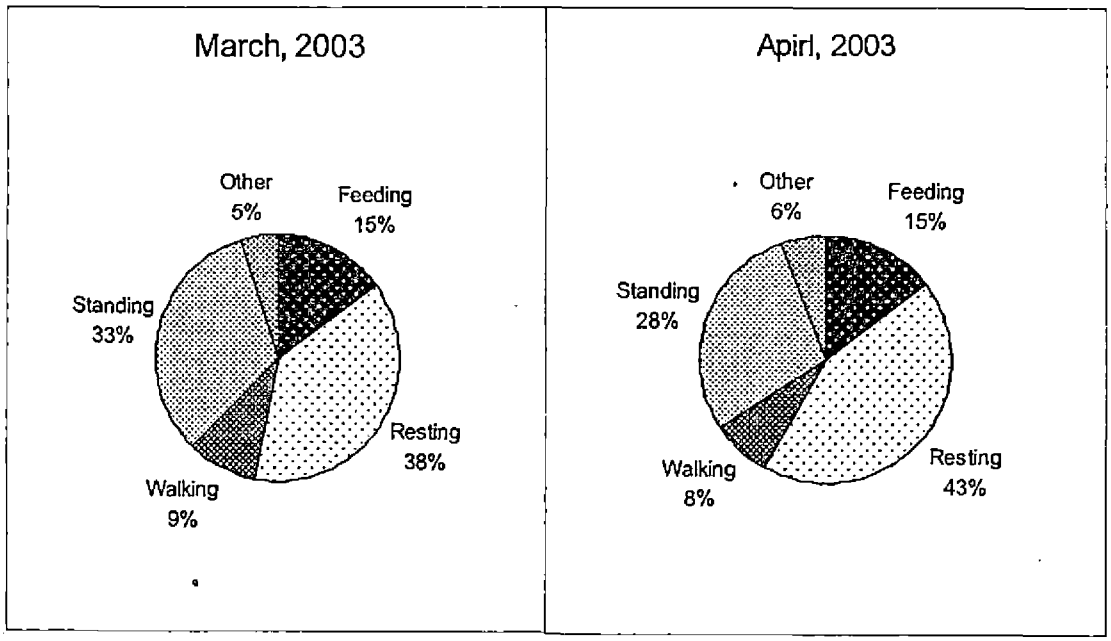


Fig.12. Activity pattern of adult male Spotted Deer in Thrissur zoo from March, 2003 to April, 2003



In the month of April, 2003 the most important activity by the male Spotted Deer was resting (43.00 per cent), followed by standing activity (28.00 per cent), feeding activity (15.00 per cent) and walking activity (8.00 per cent) (Fig. 12).

4.1.2.2 Activity pattern of adult female Spotted Deer

Monthly variations in time budgeting by adult female Spotted Deer in different activities are depicted in Fig. 13 and Fig. 14. The study period for Spotted Deer was from November, 2002 to April, 2003 as there was problem with tagging Spotted Deer. After tagging the animals with the help of zookeepers the observations were recorded.

In the month of November, 2002 it was observed that Spotted Deer was engaged maximum of its time in resting that was from morning 0600h to evening 1700h except during 1000h, 1200h and 1500h, followed by standing activity which lasts from morning 0600h to evening 1800h except during 0700h and 0800h (Fig.13).

In the month of December, 2002 it was observed that the female Spotted Deer was engaged maximum of its time in resting from 0700h, 1300h, 1600h and 1700h, followed by standing activity which was found from 0600 h to 1800h except during 1000h and feeding was found at 0800h, 1000h to 1200h and 1400h, 1500h and 1700h (Fig. 13).

Fig. 13. Hourly variation in the activity pattern of adult female Spotted Deer in Thrissur zoo from November, 2002 to February, 2003

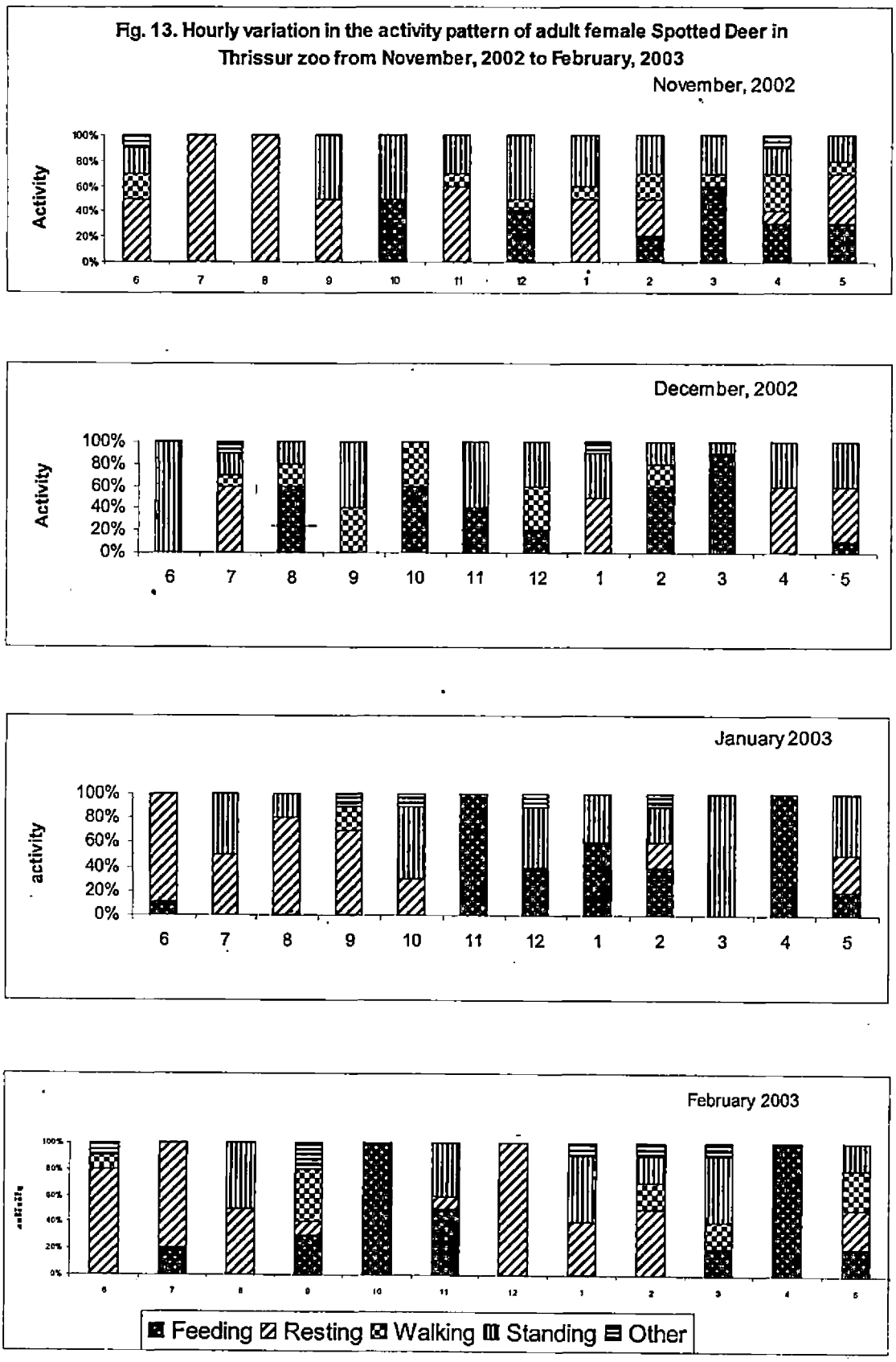
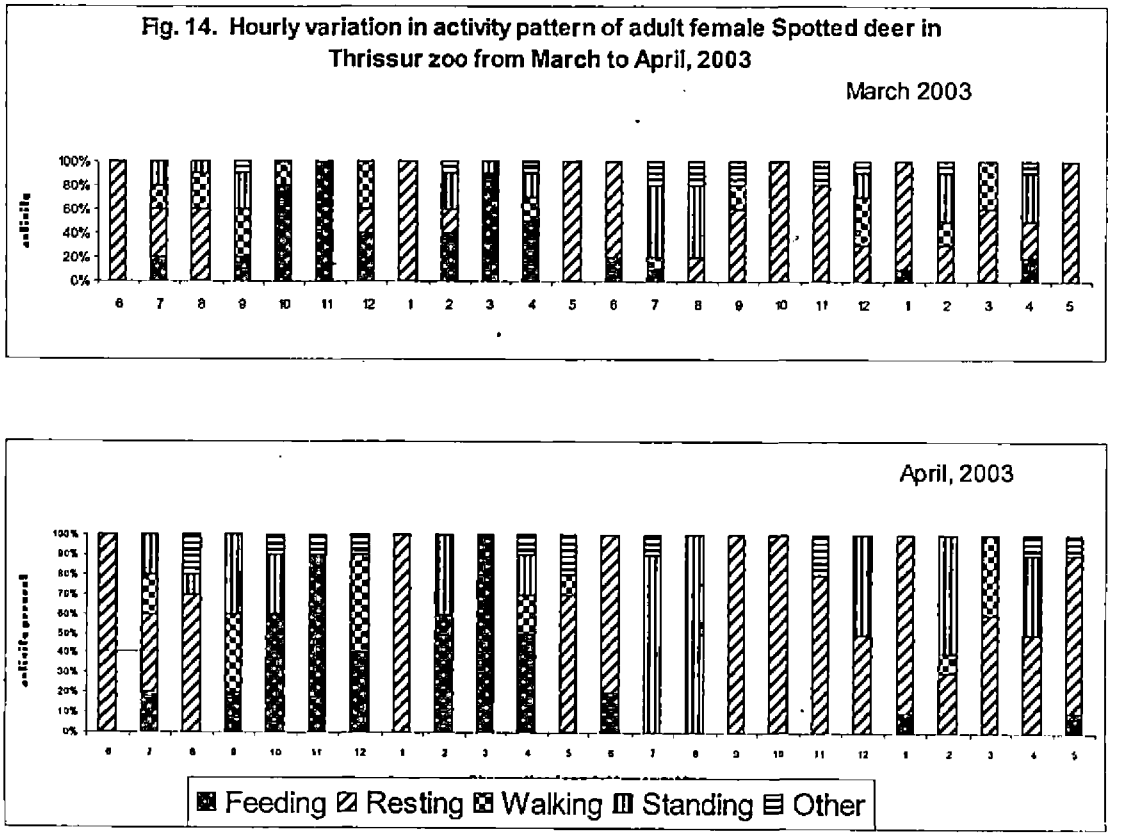


Fig. 14. Hourly variation in activity pattern of adult female Spotted deer in Thrissur zoo from March to April, 2003



In the month of January, 2003 it was observed that the female Spotted Deer engaged much of its time in resting from 0600h to 1000h and again at 1400h to 1700h, followed by standing activity which was more during 0700h, 0800h, 1000h and again from 1200h to 1700h and 1700h (Fig. 13).

In the month of February, 2003 it was observed that the female Spotted Deer was engaged most of its time in resting from 0600h to 0800h and again during 1200 to 1400h and also at 1700h, followed by standing activity which was found at its peak during 0800h, 1100h, 1300h to 1500h and 1700h (Fig. 13).

In the month of March, 2003 it was observed that the female Spotted Deer was engaged most of its time in resting except during 0700h, 0900h to 1100h, followed by standing activity, this activity lasted for almost part of the whole day except during 0600h, 0700h, 1000h and 1100h and 2000h (Fig. 14).

In the month of April, 2003 it was observed that the female Spotted Deer was engaged most of its time in standing 0800h, 1100h, and 1300h to 1500h and also at 1700h, followed by resting activity which was found during 0600h to 0900h, and 1100h to 1400h and also at 1700h (Fig. 14).

There was no significant variation in activity patterns between months and also between individuals of the same sex.

During the month of November, 2002 the most important activity of female Spotted Deer was resting activity (41.00 per cent) followed by standing activity (23.0 per cent), feeding activity (19.00 per cent) and walking activity (10.00 per cent) (Fig. 15).

During the month of December, 2002 the most important activity of female Spotted Deer was resting activity (38.00 per cent) followed by feeding activity (28.00 per cent), standing activity (18.00 per cent) and walking activity (14.00 per cent) (Fig. 15).

During the month of January, 2003, the most important activity of female Spotted Deer was standing activity (33.00 per cent) followed by feeding and resting activity (31.00 per cent) each and walking activity (7.00 per cent) (Fig. 15).

In the month of February, 2003 the most important activity of female Spotted Deer was resting activity (38.00 per cent) followed by feeding activity (28.00 per cent), standing (24.00 per cent) and walking activity (10.00 per cent) (Fig. 15).

In the month of March, 2003 the most important activity of female Spotted Deer was resting (46.00 per cent) followed by feeding activity (21.00 per cent), standing activity (14.00 per cent) and walking activity (13.00 per cent) (Fig. 16).

Fig. 15. Activity pattern of adult female Spotted Deer in Thrissur zoo from November, 2002 to February, 2003

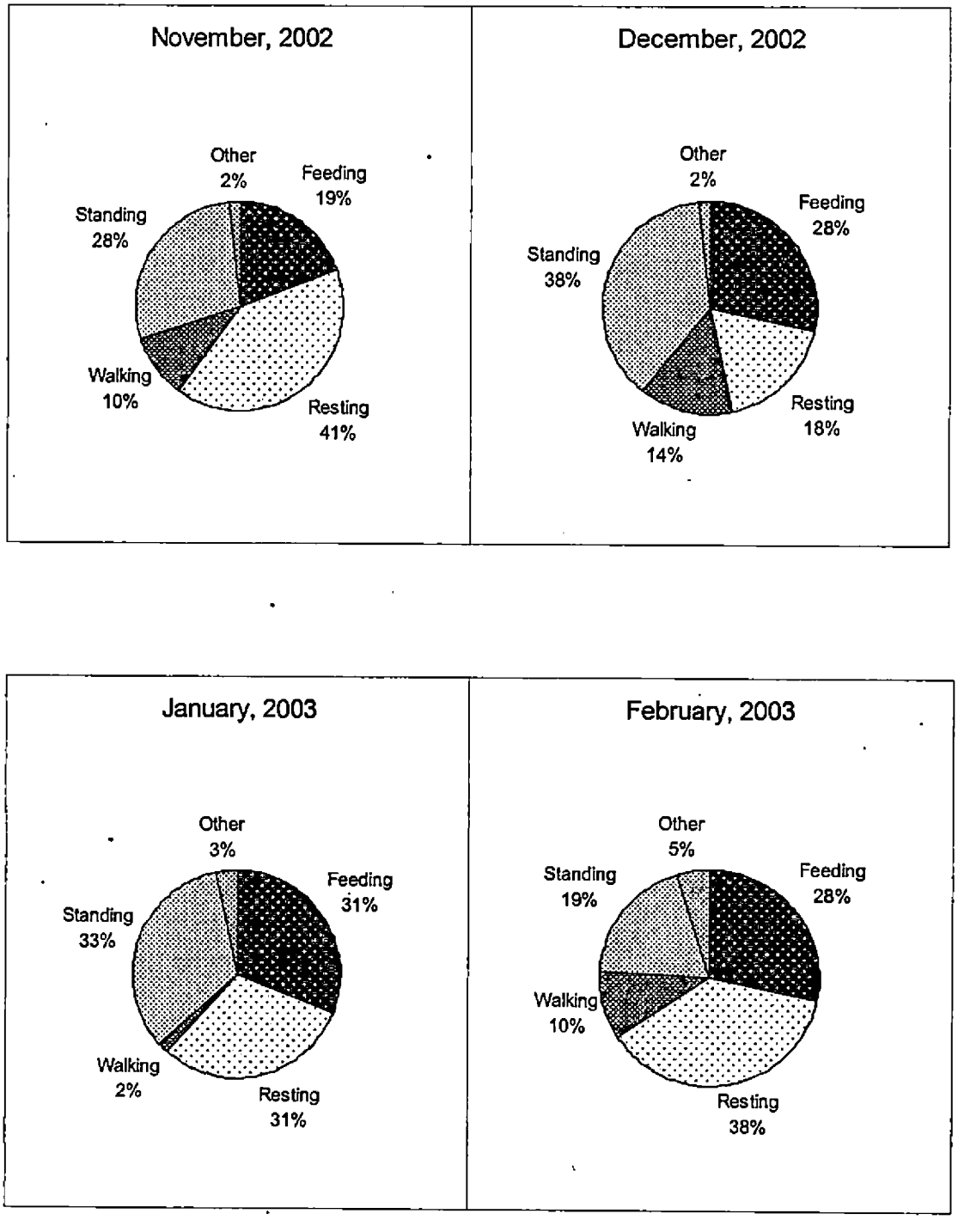
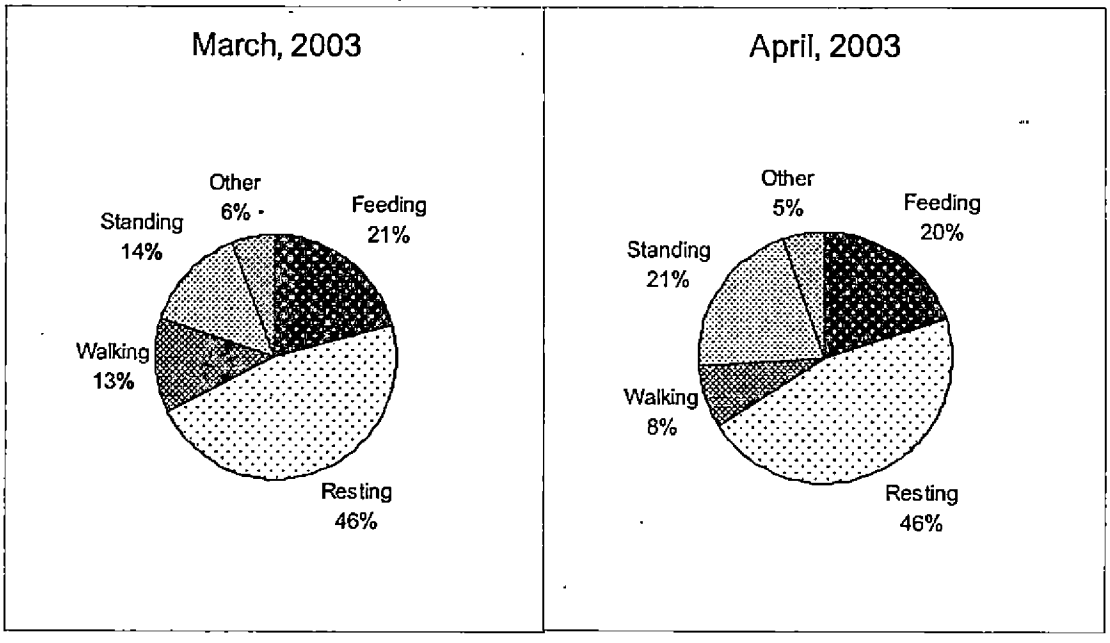


Fig.16. Activity pattern of adult female Spotted Deer in Thrissur zoo from March, 2003 to April, 2003



In the month of April, 2003 the most important activity of female Spotted Deer was resting (46.00 per cent) followed by standing activity (21.00 per cent), feeding activity (20.00 per cent) and walking activity (8.00 per cent) (Fig. 16).

4.1.3 The Hog **Deer (*Axis porcinus* Zimmermann, 1780)**

One of the most primitive "true deer". The name 'Hog Deer' came from this deer's squat frame and pig-like manner of moving through the forest. *Axis* (Latin) is said to be Pliny's name for the chital, though some records show it as "an unknown wild animal in India". *Porcus* (Latin) a hog; *inus* (Latin) suffix meaning like. The coat is an ochre-brown colour, although adult males generally darken with age. The young are spotted with white freckles, and reminiscent faint spots may be visible in the summer coat of adults. There is a darker band running down the spine. Built as a creeper, the Hog Deer has relatively short legs and a stocky figure, which is lower in the front than the back. The face is short and wedge-shaped. Males bear three-tined antlers, mounted on short pedicels on the forehead, which may grow up to 60 cm in length. Essentially solitary, although temporary groups of up to 40 animals have been seen in primary feeding areas. The main social group is a female and her fawn. The term 'Hog Deer' is derived from this deer's habit of running through the forest with its head held low, ducking under obstacles in the manner of a wild pig, rather than leaping over them like most deer. During flight, the tail is held erect, showing the white underside. Hog Deer are gregarious only when conditions are favourable and do not form a "unit"

at these times, fleeing in different directions rather than in a herd. When alarmed, Hog [illegible] make a whistling vocalization or a warning bark (Prater, 1971).

Males are aggressive, and may become territorial at low population densities, marking the boundaries with scent marking. During the rut, males gather in open meadows, pawing the ground during antagonistic encounters. Harems are not created, with males courting and defending a single female at any given time. Unlike many other deer species, Hog Deer do not have a rutting call. The mating season peaks from September to December depending on the region (Prater, 1971).

4.1.3.1 Activity pattern of adult male Hog Deer

Monthly variations in time budgeting by adult male Hog Deer in different activities are depicted in Fig. 17 and Fig. 18.

In the month of September, 2002 it was observed that the male Hog Deer was engaged maximum of its time in resting, from 0600h to 1700h except in the 1000h and 1600h, followed by feeding activity which was more during 0900h to 1100h, 1400h and 1700h (Fig. 17).

In the month of October, 2002 it was observed that the male Hog Deer was engaged much of its time in resting, from 0600h to next day 0600h except in the 1000h and 1700h to 1900h, followed by standing activity which was more

Fig. 17. Hourly variation in the activity pattern of adult male Hog Deer in Thrissur zoo from September to December, 2002

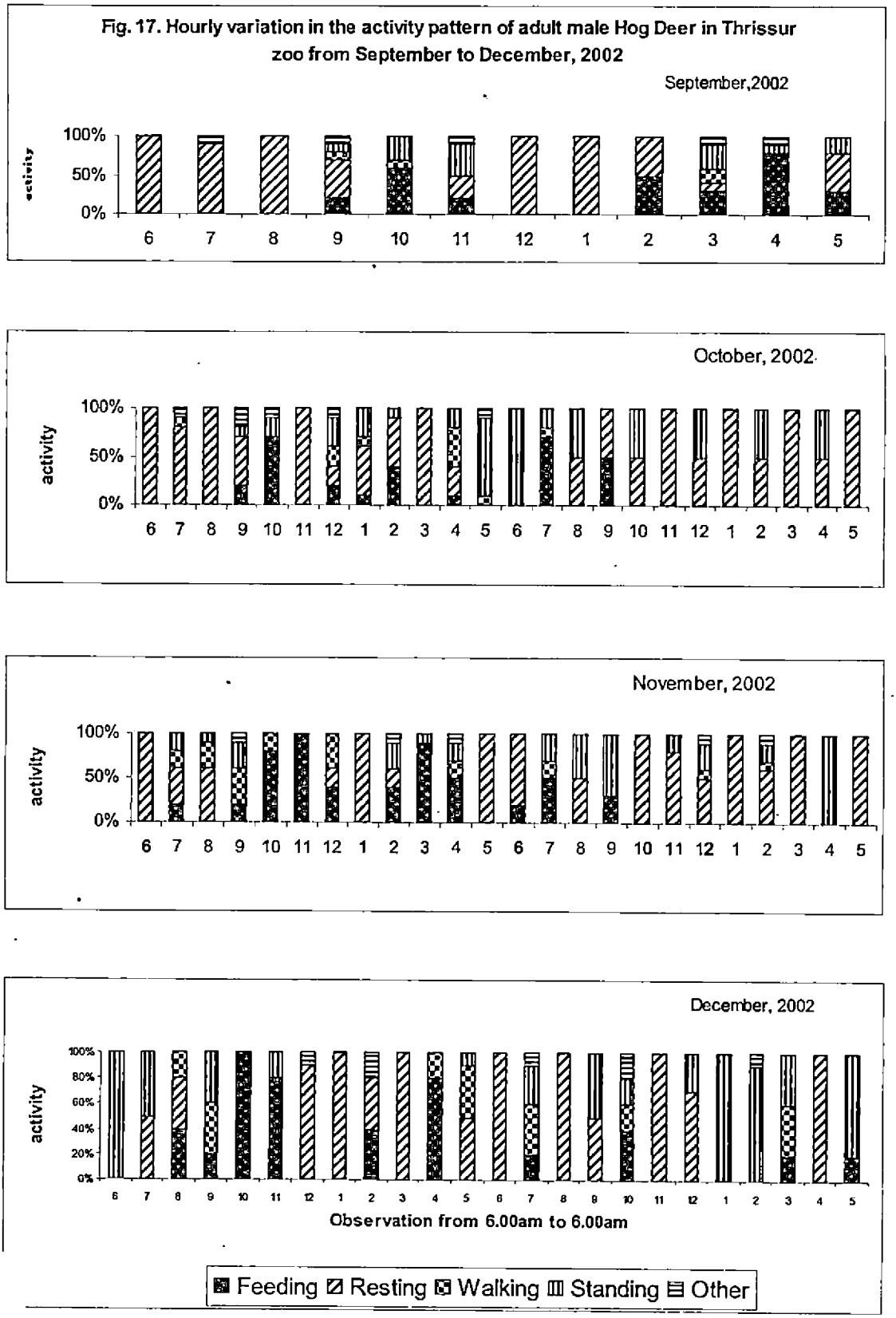
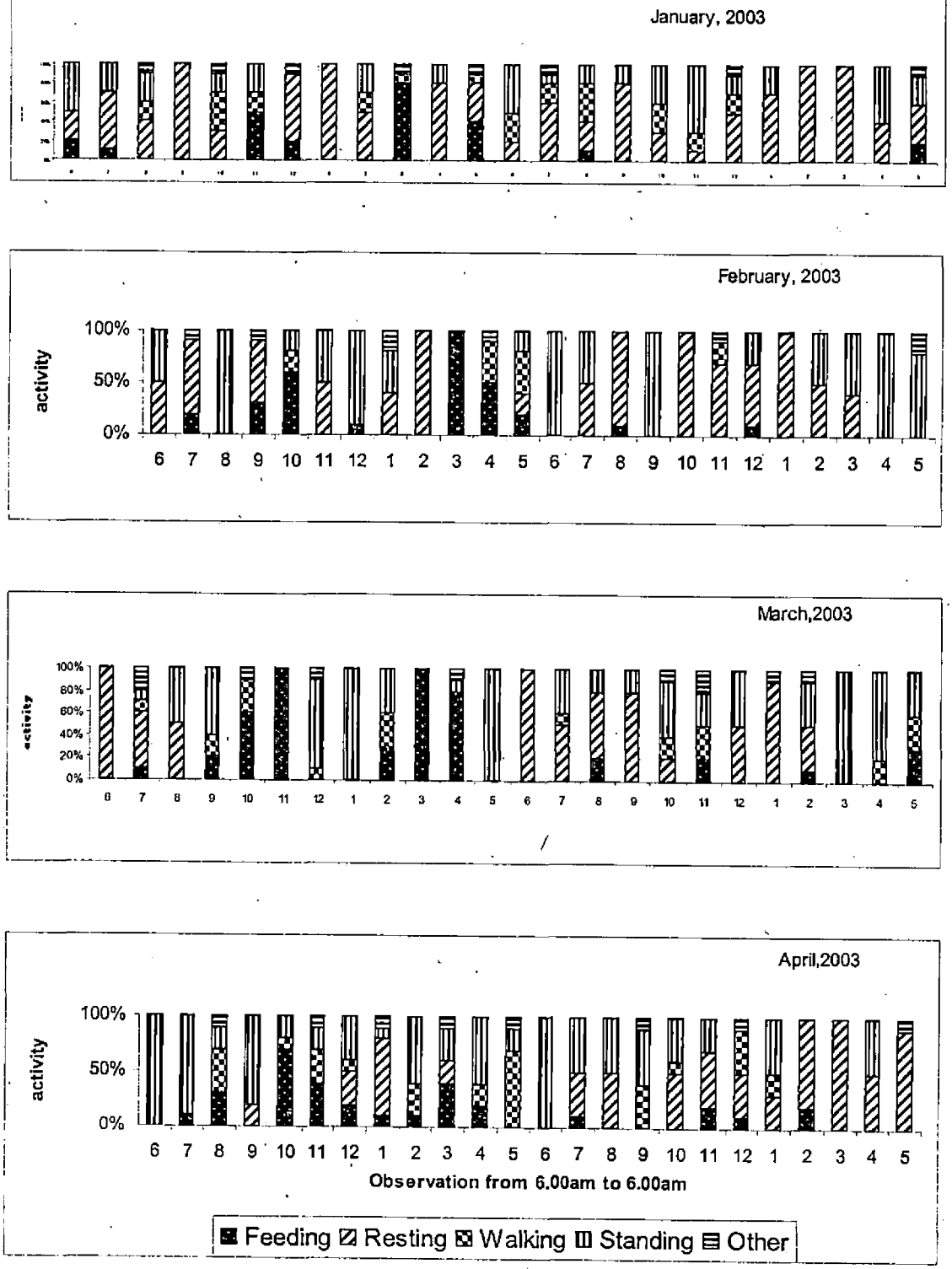


Fig. 18. Hourly variation in the activity pattern of adult male Hog Deer in Thrissur zoo from January to April,2003



during 0900h,1000h,1200h to 1400h, 1800h to 2000h, 2200h, 2400, 0200h and 0400h (Fig. 17).

In the month of November, 2002 it was observed that the male Hog Deer was engaged much of its time in resting, during 0600h to 0800h, 1300h, 1400h, 1700h to next day 0500h except 2100h, followed by feeding activity which was more during 0700h, 0900h to 1200h, 1400h to 1600h, 1800h, 1900h and 2100h (Fig.17).

In the month of December, 2002 it was observed that the male Hog Deer was engaged in resting maximum during 0700h, 0800h, 1200h to 1500h, 1700h, 1800h, 2000h, 2100h, 2300h, 2400h and 0400h, followed by standing activity which was more during 0600h, 0700h, 0900h, 1100h, 1700h, 1900h, 2100h, 2200h, 2400h, 0100h to 0300h and 0500h (Fig. 17).

In the month of January, 2003 it was observed that the male Hog Deer was engaged maximum of its time in resting that was from 0600h to next day 0500h except 1100h and 1500h, followed by standing activity which was more during 0600h to next morning 0500h except during 0900h, 1200h, 1300h, 1500h, 1700h, 0200h and 0300h (Fig. 18).

In the month of February, 2003 it was observed that the male Hog Deer was engaged most of its time in resting except during 0800h, 1000h, 1200h, 1500h, 1600h, 1800h, 2100h, 0400h and 0500h, followed by standing activity

which was found during 0600h, 0800h, 1000h to 1300h, 1700h to 1900h, 2400h and 0 t 0500h (Fig. 18).

month of March, 2003 it was observed that the male Hog Deer was engaged maximum of its time in resting that was from 0600h to 0800h, 1800h to 2200h, 2400h to 0200h, followed by standing activity which was more during 0800h, 0900h, 1200h to 1400h, 1700h, 1900h to 2400h and 0200 to 0500h (Fig. 18).

In the month of April, 2003 it was observed that the male Hog Deer was engaged maximum of its time in standing for the whole day except 1200h, 0200h, 0300h and 0500h, followed by resting during 0900h, 1200h, 1300h, 1400h, 1900, 2000h, 2200h to 0500h (Fig. 18).

There was no significant variation in activity patterns between months and also between individuals of the male Hog Deer.

During the month of September, 2002 the most important activity performed by the male Hog Deer was resting activity (57.00 per cent), followed by feeding activity (24.00 per cent), standing activity (12.00 per cent) and walking activity (3.00 per cent) (Fig. 19).

In the month of October, 2002 the most important activity performed by the male Hog Deer was resting (57.00 per cent), followed by standing activity

(24.00 per cent), feeding activity (12.00 per cent) and walking activity (4.00 per cent) (Fig.19).

During the month of November, 2002 the most important activity performed by the male Hog Deer was resting activity (48.00 per cent), followed by feeding activity (23.00 per cent), standing activity (18.00 per cent) and walking activity (9.00 per cent) (Fig. 19).

During the month of December, 2002 the most important activity performed by the male Hog Deer was resting activity (41.00 per cent), followed by standing activity (28.00 per cent), feeding activity (19.00 per cent) and walking activity (9.00 per cent) (Fig.19).

During the month of January, 2003 the most important activity performed by the male Hog Deer was resting activity (52.00 per cent), followed by standing activity (23.00 per cent), walking activity (12.00 per cent) and feeding activity (10.00 per cent) (Fig. 20).

In the month of February, 2003 the most important activity performed by the male Hog Deer was resting (40.00 per cent), followed by standing activity (39.00 per cent), feeding activity (13.00 per cent) and walking activity (5.00 per cent) (Fig. 20).

Fig. 19. Activity pattern of adult male Hog Deer in Thrissur zoo from September to December, 2003

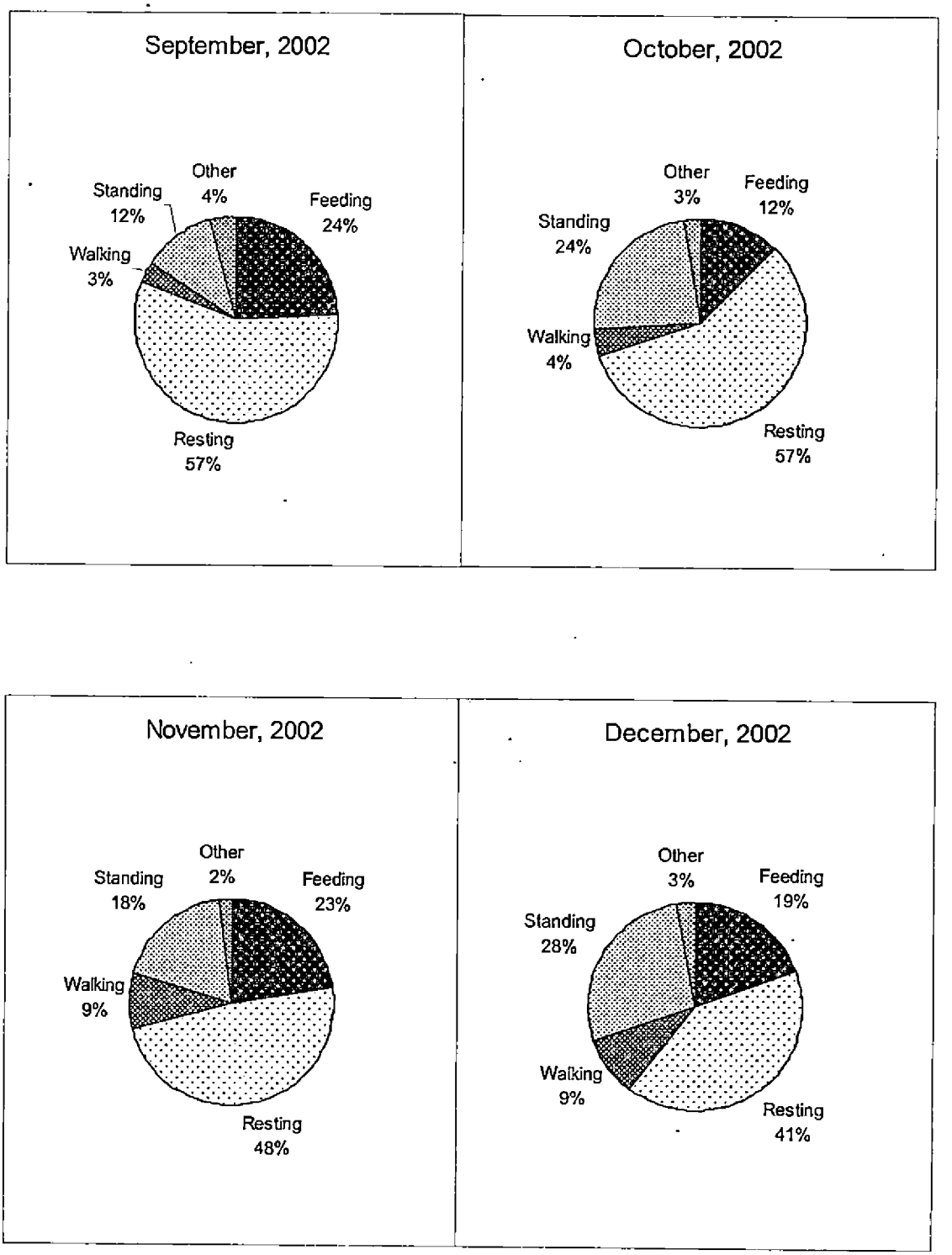
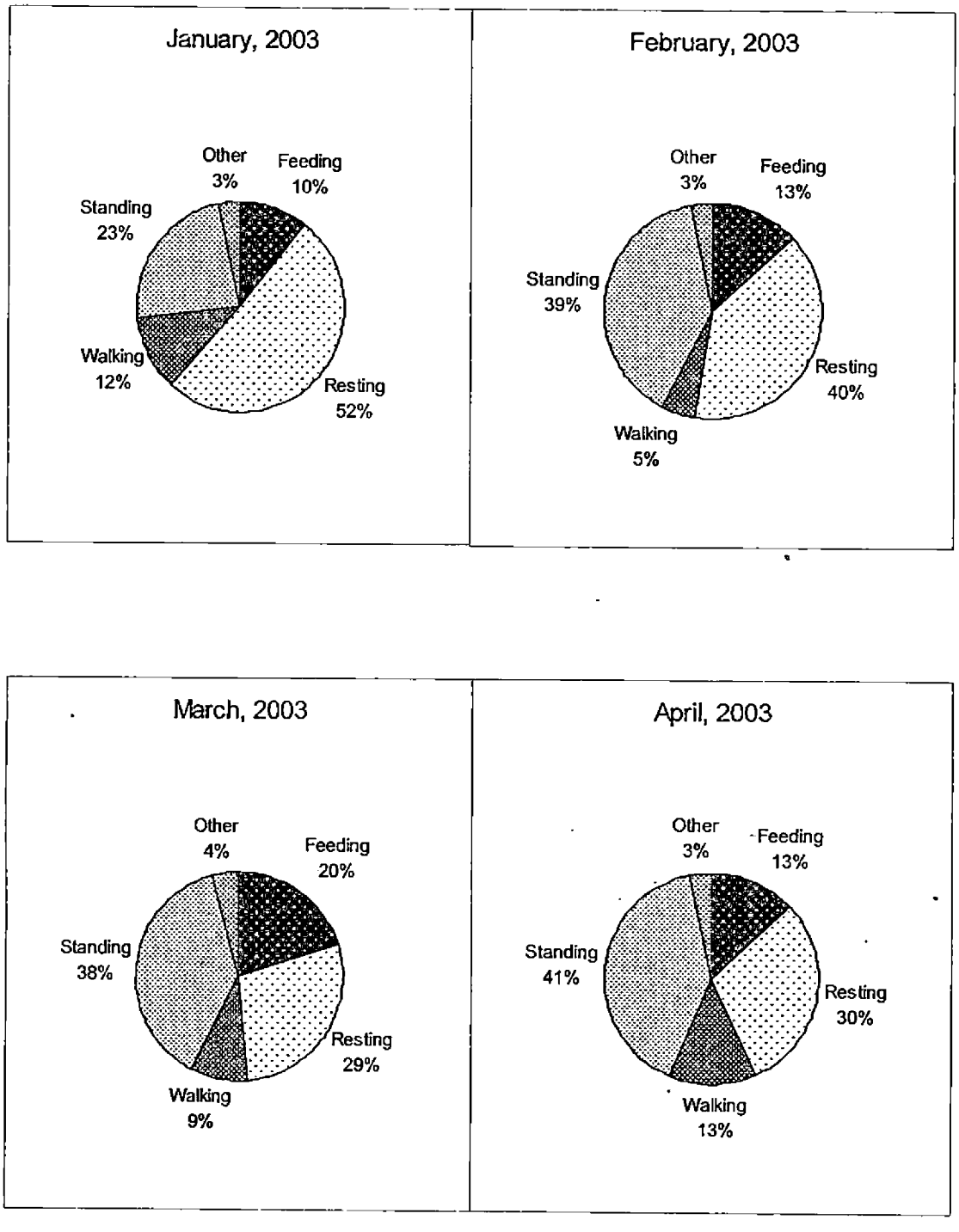


Fig. 20. Activity pattern of adult male Hog Deer in Thrissur zoo from January to April, 2003



In the month of March, 2003 the most important activity performed by the male Hog Deer was standing activity (38.00 per cent), followed by resting (29.00 per cent), feeding activity (20.00 per cent) and walking activity (9.00 per cent) (Fig. 20).

In the month of April, 2003 the most important activity performed by the male Hog Deer was standing activity (41.00 per cent), followed by resting (30.00 per cent), feeding activity (13.00 per cent) and walking activity (13.00 per cent) (Fig. 20).

4.1.3.2 Activity pattern of adult female Hog Deer

Monthly variations in time budgeting by adult female Hog Deer in different activities are depicted in Fig. 21 and Fig. 22. The study period for Hog Deer was from September, 2002 to April, 2003.

In the month of September, 2002 it was observed that the female Hog Deer was engaged maximum in feeding during 0600h to 0900h, 1300h to 1500h and at 1700h, followed by feeding activity which was more during 0600h, 0900h, 1100h, 1200h, 1400h to 1600h (Fig. 21).

In the month of October, 2002 it was observed that the female Hog Deer was engaged much of its time in resting was from 0600h to 0800h, 1000h, 1200h, 1300h, 1500h to 1700h, 1900h to 2100h and 2300h up to 0500h, followed by

Fig.21. Hourly variation in the activity pattern of adult female Hog Deer in Thrissur zoo from September to December, 2002

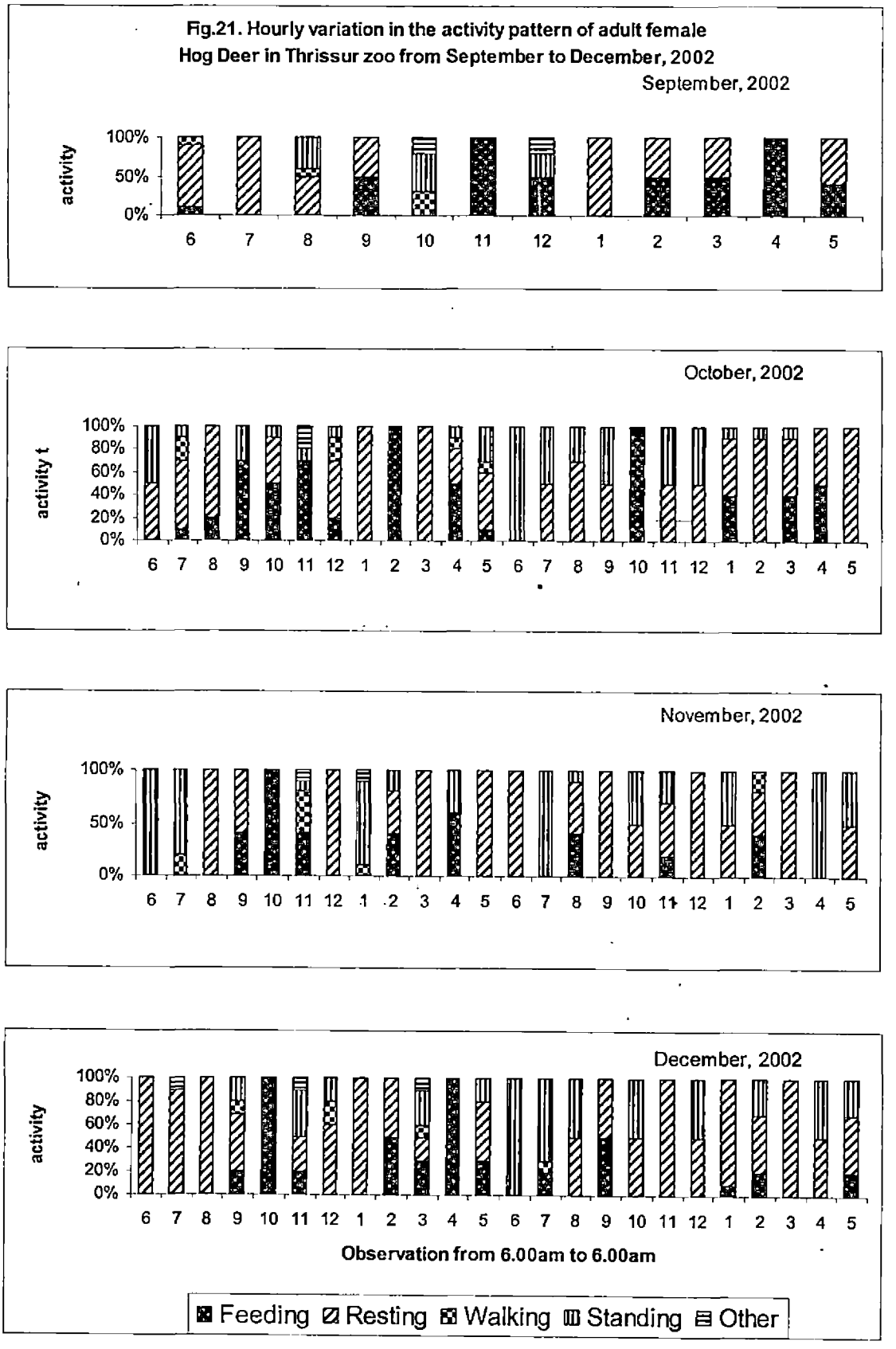
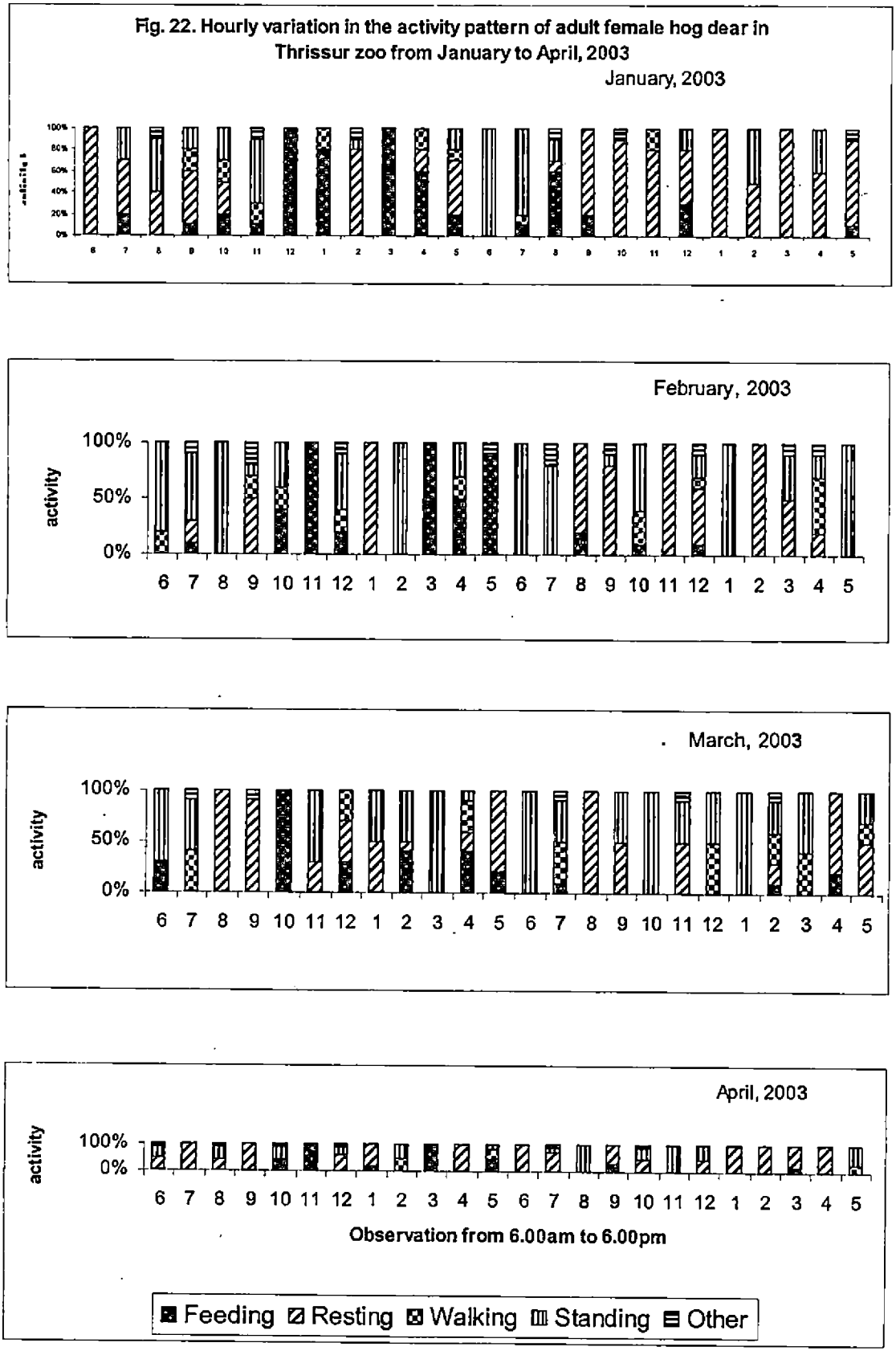


Fig. 22. Hourly variation in the activity pattern of adult female hog dear in Thrissur zoo from January to April, 2003



feeding activity which was more during 0700h to1200h, 1400h, 1600h, 1700, 2200h [illegible], 0300h and 0400h (Fig. 21).

In the month of November, 2002 it was observed that the female Hog Deer was engaged maximum in resting activity during 0800h, 0900h, 1200h, 1400h, 1500h,1700h, 1800h, 2000h to 0300h and 0500h, followed by standing activity which was more during 0600h, 0700h, 1300h, 1600h, 1900h, 2200h, 2300h, 0100h, 0400 and 0500h (Fig 21).

In the month of December, 2002 it was observed that the female Hog Deer was engaged in resting maximum during 0600h to 0900h, 1100h to 1500h, 1700h, 2000h to 0500h, followed by standing activity which was more during 0900h, 1100h, 1200h, 1500h, 1700h to 2000h, 2200h, 0200h, 0400h and 0500h (Fig. 21).

In the month of January, 2003 it was observed that the female Hog Deer was engaged maximum of its time in resting during 0600h to 1000h, 1400h, 1700h, 2100h to 0500h, followed by feeding activity which was more during 0700h, 0900h to 1300h, 1500h to 1700, 1900h to 2100h, 2400h, 0500h (Fig. 22).

In the month of February, 2003 it was observed that the female Hog Deer was engaged most of its time in standing during 0600h to 0800h, 1100h, 1200h, 1400h, 1800h, 1900h, 2100h, 0100h, 0300h to 0500h, followed by resting activity which was found during 0700h, 0900h, 1300h, 2000h, 2100h, 2300h, 2400h, 0200h to 0400h (Fig. 22).

In the month of March, 2003 it was observed that the female Hog Deer was engaged maximum of its time in standing that was from 0600h, 0700h, 1100h to 1500h, 1800h, 2000h, 2100h to 0300h and 0500h, followed by resting activity which was more during 0800h, 0900h, 1100h to 1400h, 1600h, 1700h ,2000h, 2100h, 0200h, 0400h and 0500h (Fig. 22).

In the month of April, 2003 it was observed that the female Hog Deer was engaged maximum of its time in resting almost for the whole day that was at 0600h to 0900h, 1200h, 1300h, 1600h, 1800h, 1900h, 2200h, 2400h to 0400h, followed by standing 0600h, 0800h, 1000h,1200h, 1400h, 1700h, 1900h, 2000h, 2200h to 2400h and 0500h (Fig. 22).

There was no significant variation in activity patterns between months and also between individuals of the same sex of the Hog Deer.

During the month of September, 2002 the most important activity performed by the female Hog Deer was resting activity (45.00 per cent), followed by feeding activity (38.00 per cent), standing activity (10.00 per cent), and walking activity (4.00 per cent) (Fig. 23).

In the month of October, 2002 the most important activity performed by the female Hog Deer was resting (48.00 per cent), followed by feeding activity (26.00 per cent), standing activity (22.00 per cent) and walking activity (3.00 per cent) (Fig. 23).

During the month of November, 2002 the most important activity performed by the female Hog Deer was resting activity (49.00 per cent), followed by standing activity (30.00 per cent), feeding activity (16.00 per cent) and walking activity (4.00 per cent) (Fig. 23).

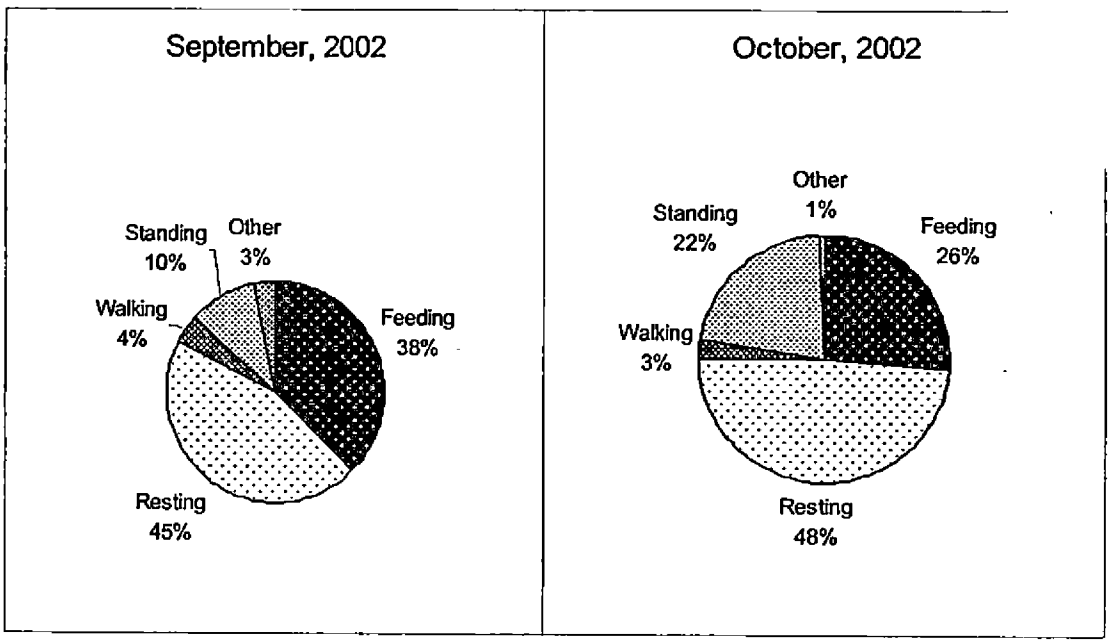
During the month of December, 2002 the most important activity performed by the female Hog Deer was resting activity (54.00 per cent), followed by standing activity (23.00 per cent), feeding activity (20.00 per cent) and walking activity (2.00 per cent) (Fig. 23).

During the month of January, 2003 the most important activity performed by the female Hog Deer was resting activity (46.00 per cent), followed by feeding activity (23.00 per cent), standing activity (22.00 per cent) and walking activity (6.00 per cent) (Fig. 24).

In the month of February, 2003 the most important activity performed by the female Hog Deer was standing activity (41.00 per cent), followed by resting (27.00 per cent), feeding activity (19.00 per cent) and walking activity (8.00 per cent) (Fig. 24).

In the month of March, 2003 the most important activity performed by the female Hog Deer was standing activity (41.00 per cent), followed by resting (32.00 per cent), feeding activity (13.00 per cent) and walking activity (12.00 per cent) (Fig. 24).

Fig. 23. Activity pattern of adult female Hog Deer in Thrissur zoo from September to December, 2002



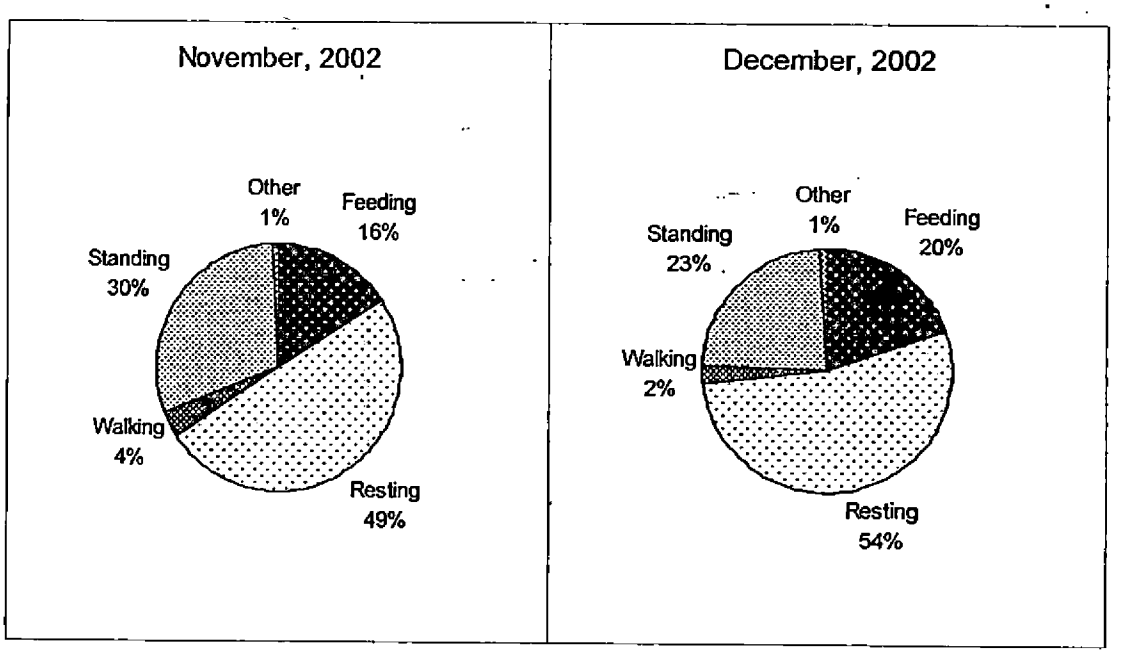
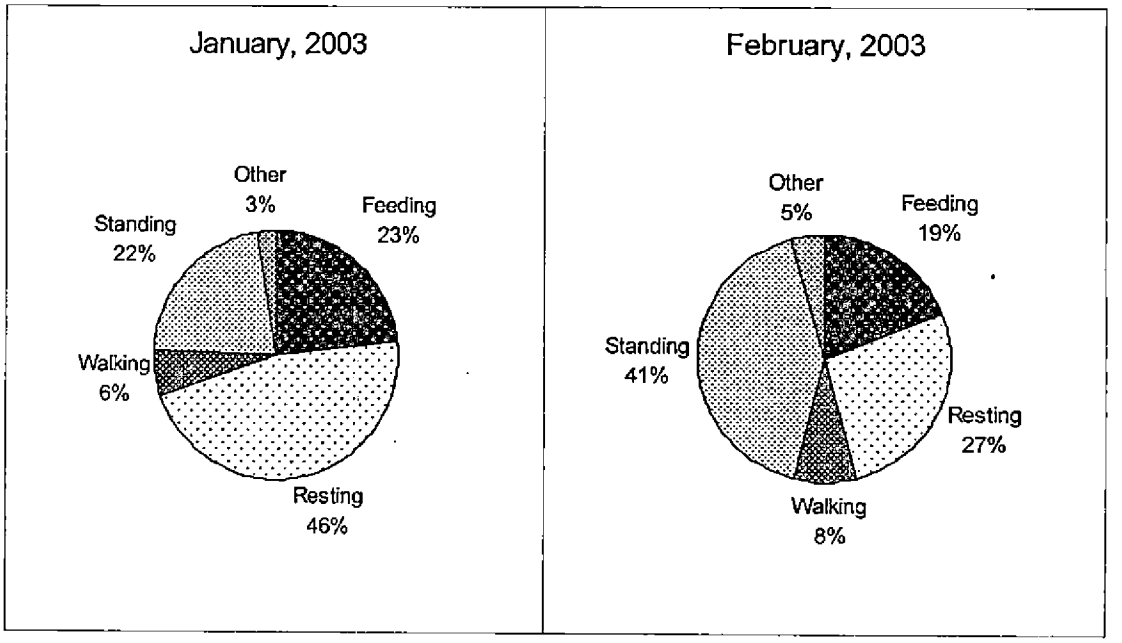
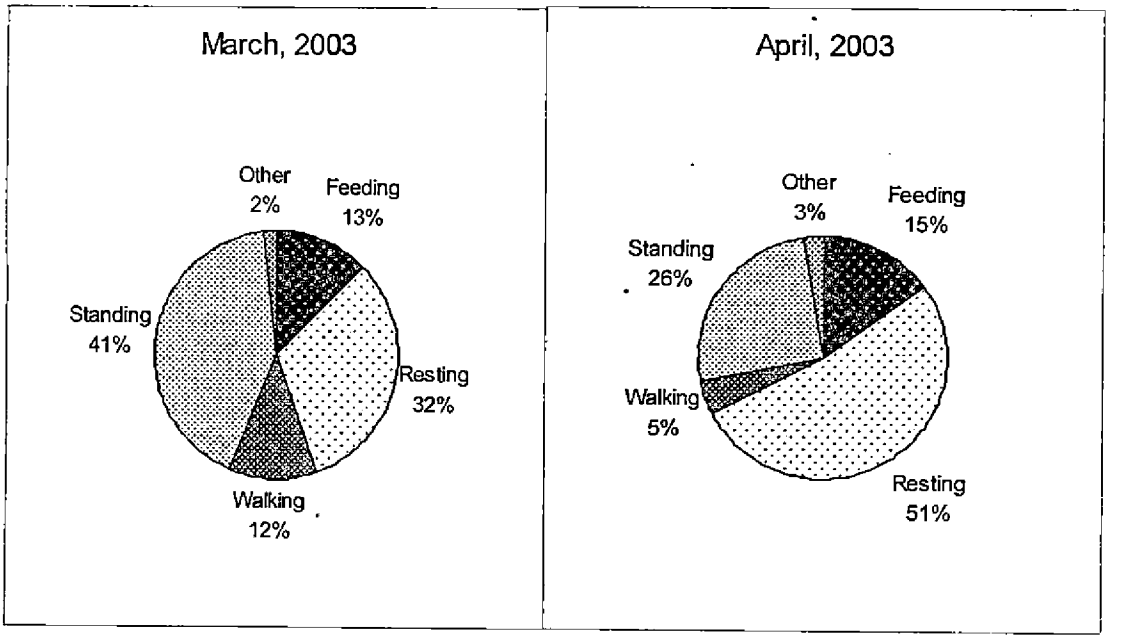


Fig.24. Activity pattern of adult female Hog Deer in Thrissur zoo from January to April, 2003





In the month of April, 2003 the most important activity performed by the female Hog Deer was resting (51.00 per cent), followed by standing activity (26.00 per cent), feeding activity (15.00 per cent) and walking activity (5.00 per cent) (Fig. 24).

4.1.4 The Muntjak or Barking Deer (*Munitiacus muntjak* Zimmermann, 1780)

The word "Muntjac" comes from the "Sunda" (a language of Java) which means "deer". "Deer" comes from the German word "Tier", which simply means "animal". On hearing their name barking deer one may be prompted to ask whether this deer can bark like a dog. The name barking deer was given to them for their loud, sharp calls resemble the barks of dogs. Besides this loud and sharp bark, this deer also produces an indistinct rattling sound when running (Prater, 1971).

This species distributed in the tropical forest up to an altitude of 10,000 feet, the coat is short, shiny and reddish, antlers present only in the male, are twin-pronged, with a maximum length of four or five inches and grow on a high base of skin-covered bone. Distinctive canine teeth protrude from the upper jaw in males and can reach a length of over an centimeter (Prater, 1971).

4.1.4.1 Activity pattern of Barking Deer

udy was aiming to study the behavioural ecology of Barking Deer too but at the observation started on that species the only animal present at the Thrissur zoo died due to illness and so the observation regarding this species could not be collected.

4.2 ANALYSIS OF THE FEED GIVEN TO THE DEER IN THRISSUR ZOO

The deer possess four sets of teeth such as incisor, canine, premolar and molar. The check teeth (molar and premolar) consist of three molars and three pre-molars on each side of both the upper and lower jaw. There are a total of 24 cheek teeth present in the cervids. Cheek teeth are used for grinding up the food. There are eight front teeth, the incisors, on the lower jaw, in deer. These eight lower teeth bite against the gum of the upper jaw. Incisors are very important as those are the most important tooth for the cutting the grass, leaves etc by the deer.

Ingested food is not chewed to any extent and is normally swallowed and stored in a special compartment of the stomach, the rumen. From here it is regurgitated as a bolus and this cud is then chewed and swallowed again, this time to a separate compartment reticulum, then to omasum and finally to the fourth chamber (the abomasum). Cud chewing is done at leisure in a secure place. The cheek teeth are built and arranged as shredders and grinders to break up the tough plant fibres so that the digestive juices and micro-organisms can work effectively

on cellulose. The cheek teeth work as two occluding sets, the upper and lower teeth on each side is working as a pair together. The cheek teeth are made up of folds of enamel, cement and dentine, which produce an abrasive surface of tough, sharp ridges and furrows. These occlusal surfaces working with an elliptical jaw movement that shred the plants. These are the very powerful grinders working with the full power of large masseter muscles that control the vertical movement of the jaw. A finger caught by a jaw stroke will be heavily bruised and lacerated. Chewing the cud is a lengthy process as each bolus takes about fifty strokes before it is swallowed. From the mouth the food passes via a long muscular tube (the oesophagus) to the stomach. From the stomach, the food passes successively through the small and large intestine, in which the nutrients and water are absorbed in to the body. Towards the end of the large intestine the contents become drier and begin to form the distinctive pellet shaped faeces (Dulphy *et al.*, 1980).

At the Thrissur Zoo by 10.30h normally the first feed of the day arrives. The zoo authority claims that, feed consists of cattle feed (rice bran, black gram and green gram) - 150 kg; coconut cake - 45 kg and cottonseed - 28 kg. This is the total food for all the species of deer for one day. On an average each individual gets and average of 800g feed per day. The feed is dumped in the trough, water pumped in to it and made into a mash. When the gruel is ready, the gate is opened and the impatient animals rush in and sometimes even 'fall' on the fall trough. This enthusiasm lasts, but only initially, as many of the deer appears

disinterested in the feed and retreat. Since many of them step in to the trough during feeding and stand on the feed, a large quantity of the feed is wasted.

4.2.1 The composition of the green fodder supplied to deer at Thrissur Zoo

Whether they eat or not, the deer will have to wait till mid after noon for the next consignment of food and this time leaf fodder. This is generally delivered by about 1500 hours. The green fodder is mostly predominated by jack leaves (*Artocarpus heterophyllus*) and grasses. Apart from jack the other species of fodder given to the deer at Thrissur Zoo were *Ficus bengalensis, Ficus relegiosa, Terminalia catappa, Erythrina indica, Samanea saman* and *Phyllanthus emblica.* The species of grasses fed to the deer included *Cynodon dactylon, Saccharum spontaneum, Phragmitis karka, Ardropogon* sp. and *Hetropogon* sp.(Table 1).

The deer relishes green leaves and they leave nothing behind except the gnawed twigs and thick stalks. But this supply depends on availability here and on lean days supply will be uncertain. At times, even *Salvinia* leaves were dumped in substitution of grass and jack leaves. But the deer never relished it, as was evident from the fact that most of the *Salvinia* leaves remained uneaten by the deer. The non-availability of the green fodder may be one of the reasons for the deer getting highly responsive to a visitors invitation with a green leaf. No cattle feed was supplied to the deer on Mondays and on all Mondays the deer was fed only on green fodder in the afternoon.

4.2.3 The chemical composition of green fodder supplied to deer at Thrissur Zoo

4.2.3.1 Tree fodder

The chemical analysis of the feed revealed that among the tree fodder the as well as the grass fodder was predominated by moisture content, followed by dry matter, ash and crude protein. In the case of the tree fodder, the moisture content varied between 86 to 81%, with *Phyllanthus emblica* having maximum moisture content (86%) and minimum for *Artocarpus hetrophyllus* (81%). The dry matter content of the tree fodder varied between 19 to 14% between *Artocarpus hetrophyllus* (19%) and *Phyllanthus emblica* (14%) having the extreme values. The ash content was maximum for *Ficus relegiosa* (11.9%) while was lowest for *Artocarpus hetrophyllus* (8.2%). The crude protein content was maximum for *Ficus relegiosa* and *Samanea saman* (7.1% each), while minimum for *Artocarpus hetrophyllus* (5.5%).

4.2.3.2 Grass fodder

In the case of grass fodder the moisture content varied between 85 to 80.5%, with *Phragmitis karka* having maximum moisture content (85%) and minimum for *Saccharum spontaneum* (80.5%). The dry matter content of the tree fodder varied between 19.5 to 15% between *Saccharum spontaneum* (19.5%) and *Phragmitis karka* (15%) having the extreme values. The ash content was

maximum for *Phragmitis karka* (11.8%) while was lowest for *Ardropogon* sp. (9.2%). The crude protein content was maximum for *Cynodon dactylon* (15.2%), while minimum for *Hetropogon* sp. (6.2%).

Table 1. Chemical compositions of preference status of food plants of deer in Thrissur zoo (in %)

Scientific name	Moisture	Dry matter	Ash	Crude protein
TREE FODDER				
Artocarpus hetrophyllus	81	19	8.2	5.5
Erythrina indica	83.1	16.9	11.1	5.7
Ficus bengalensis	82	18	9.2	6.55
Ficus relegiosa	81.1	18.9	11.9	7.1
Phyllanthus emblica	86	14	11.8	6.3
Samanea saman	82.4	17.6	10.4	7.1
Terminalia cattappa	82	18	9.1	6.3
GRASS FODDER				
Ardropogon sp.	82	18	9.2	6.55
Cynodon dactylon	84	16	12	15.2
Hetropogon sp.	83	17	11	6.2
Phragmitis karka	85	15	11.8	6.3
Saccharum spontaneum	80.5	19.5	11.2	6.82

4.2.4 The chemical composition of feed mixture supplied to deer at Thrissur Zoo

The chemical composition of the different feed mixture given to deer at Thrissur zoo is given in Table 2. Unlike the green fodder the feed mixture was predominated by dry matter content (84.3 to 100%), while the moisture content was between 0 to 15.7%. In the case of feed mixture the dry matter content was 100 % in Black Gram while the lowest dry matter content was recorded for Cotton Seed (84.3%). The moisture content varied between 0 to 15.7% with Cotton Seed maximum moisture content (15.70%) and minimum for Black Gram (0%). The crude protein content was maximum for Green Gram (18.2%), while minimum for Rice Barn (6.2%). The ash content was maximum for Rice Bran and Cotton Cake (5.1%) while was lowest for Black Gram (9.2%) (Table 2).

Table 2. Chemical composition of different types of feed mixture offered to deer (in %)

Food	Dry matter	Moisture	Crude protein	Ash
Rice Bran	88.9	11.1	14.7	-
Black Gram	100	-	15	5.1
Green Gram	98.7	1.3	18.2	4.7
Coconut Cake	90	10	16.5	-
Cotton Seed	84.3	15.7	15.5	3.2

4.3 EVALUATION OF THE ENCLOSURES AT THRISSUR ZOO

! Deer enclosure at Thrissur Zoo

In Thrissur zoo Spotted Deer (*Axis axis*) were kept in two enclosures, interconnected by a gate kept open most of the time at the northeastern corner of the premises. Public roads form the boundaries on the northern side and eastern sides of the pen, while on the southern side there are other enclosures holding Blackbuck (*Antilope cervicarpa*) and Hog Deer (*Axis porcinus*).

The ground inside the pen is barren except for a few palm trees, here and there. There is also one jack tree almost debarked entirely by the deer. 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 of the other end either in groups or singly. The pens were cleaned every morning and debris of the previous day's fodder cleared. Then the animals were herded in to the bigger enclosure and the gate connecting these, closed. The water trough in the smaller enclosure is then cleaned and kept ready.

The size of the enclosure of the different species of deer under investigation at Thrissur zoo in comparison to the dimension of the enclosures proposed by Central Zoo Authority (CZA) is given in Table 3. It is evident from the Table 3 that all the three species of the deer are over crowded within the enclosures at Thrissur Zoo. As per the CZA prescriptions for each pair of the deer species the area prescribed is 0.15 ha. per pair of the deer. In which case for 106

Spotted Deer (53 pairs) should have had an area of 7.95 ha. as against the 0.25 ha availai · ·' t now.

4.3.2 Sambar Deer enclosure at Thrissur Zoo

Sambar Deer were placed on the northern side of the zoo, connected by a bridge. On the western side of the enclosure there is a path and then enclosure of the hippopotamus, on the eastern side there is concrete wall. There is one shed on the corner of the enclosure where animals used to crowd over there to take the food which is provided by zookeepers.

The Sambar Deer (*Cervus unicolor*) 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 obstruct the view from the public through fares, while on the West and South wire mesh fence guard the animals. The total area of these two enclosures together is about 0.25 ha. Water troughs are provided in both the enclosures and leakage of water has created slushy ground in front of it. The animals often use this as wallowing ground. There is a small shed in the middle on both sides of the partition fence. This shed is also bound by wire mesh with a door of the same material. It can be used to isolate any particular animal, if needed.

The 24 (12 pairs) Sambar Deer as per CZA requirement should have had an enclosure size of 1.8 ha. as against the present size of 0.25 ha.

4.3.3 Hog Deer enclosure at Thrissur Zoo

Deer were placed on the eastern side of the zoo. On the northern side of the enclosure there is a museum and many people will be visiting the museum and making noise by talking, shouting and other due to which most of the times animals used to get disturbed by that.

The 18 (9 pairs) Hog Deer as per CZA requirement should have had an enclosure size of 1.35 ha. as against the present size of 0.12 ha.

Table 3. The size of the enclosure of a deer species in Thrissur zoo in comparison with the Central Zoo Authority requirements

Animal	No. of animals in enclosure	Area of enclosure (ha.)	Area of enclosure as prescribed by CZA (ha.)
Spotted Deer	106	0.25	0.15 per pair
Sambar Deer	24	0.25	0.15 per pair
Hog Deer	18	0.12	0.15 per pair

4.4 ANALYSIS OF FAECAL MATTER

It is a well-known physiological process that intake of food and water must be followed by excretion in the form of faeces, urine, sweat and regurgitated pellets. Under free living conditions the study of defecation habits helps in under standing the different aspects of life of several species of wild animals. But the

study of defecation habits in zoo helps immensely in monitoring the health of animals. It is common practice in most of the zoological parks to examine faecal samples of all their inmates at regular intervals to detect any probable endo parasitic infestation before the animal could exhibit the clinical signs of illness.

In deer family the colour, consistency, odour, shape and size of faeces and frequency of defecation vary from species to species. Two types of defecation habits described in wild captive animals, diffused and localized. Diffused type of defecation is seen in deer.

4.4.1 Faecal matter of Spotted Deer

In Spotted Deer pellets are small in size than that of Sambar Deer and rough in texture. Colour varies from black to green. Mean length of the pellets in Spotted Deer is 13.43 mm and mean diameter 8.86 mm (Table 4). The observations on defecation habits of the Spotted Deer indicated that they had diffuse type of defecation spread all over the enclosure.

4.4.2 Faecal matter of Sambar Deer

In Sambar Deer the pellets are found in groups. The Sambar Deer also has the biggest sized pellets compared to other deer species in this study. The pellets are elongated in shape with a colour varying from black to green. Texture

of the pellets is rough and the mean pellet length is 16.5 mm and diameter 10.6 mm.

4.4.3 Pellet Scatter of Hog Deer

In Hog Deer the pellets are found in scattered through out the enclosure. The Hog Deer also has the smallest sized pellets compared to other deer species in the present study. The pellets are elongated in shape with a colour varying from black to green. Texture of the pellets is rough and the mean pellet length is 7.1 mm and diameter 4.98 mm (Table 4).

Table 4. The mean pellet dimension of three species of deer in Thrissur zoo

Animal	Mean pellet length (mm)	Diameter (mm)
Sambar Deer (n=200)	16.5	10.6
Spotted Deer (n=200)	13.43	8.8
Hog Deer (n=200)	7.1	4.98

4.5 VISITORS BEHAVIOUR IN THRISSUR ZOO

Visitors find it recreating and entertaining to visit the zoos. Although captive wildlife supplies considerable number of man-days for recreation, from the animal's point of view, at least in Thrissur Zoo, the visitors cause tremendous amount of stress, discomfort, and torture to the animals either intentionally or

Plate 1. The picture of the tagged Spotted Deer used for focal animal study

Plate 2. Visitor teasing Lion-tailed Macaque in Thrissur zoo

Plate 3. Visitor feeding Spotted Deer in Thrissur zoo

Plate 4. Sambar Deer resting in Thrissur zoo

through ignorance. Quite often visitors have been noticed to hurt caged animals by teasing (Plate 2), provoking and feeding (Plate 3).

The types and the amount of provocations suffered by the zoo animal at Thrissur Zoo are given in Table 5. The major type of provocation to the animals at Thrissur Zoo was pelting stones (33.5%), followed by shouting (32.75%), poking with stick (22.75%) while feeding accounted for 11% (Table 5).

Table 5. Types of provocations to the zoo animals in Thrissur zoo

Types of provocation	%
Pelting stones/ paper/plastic	33.5
Shouting	32.75
Poking with sticks	22.75
Feeding	11.00
Total	**100**

4.5.1 Demography of the visitors In Thrissur Zoo

The study of 100 provocators showed that the majority of the provocators were in the age group of 15-35 years (Table 6). Men (83 per cent) were found to be more provocative than women (17 per cent) and majority were educated at least to the high school level. Although 11 per cent of the provocators were found to feed the animals, only 50 per cent of them were aware that their unconventional

feeding could adversely affect the health of animals. Most of the provocators were unaware of the balanced diet being fed to the animals by the zoo authorities. Moreover many of the provocators not realised that their behaviour could result in a behavioural change of the animals and them feeding the captive stock could attract pests in to the animal enclosure.

Table 6. The proportion of different age group of provocators of zoo animals in Thrissur zoo

Age group of provocators	%
Less than 15	19
15 - 35	79
Above 35	2
Total	**100**

4.5.2 Motive behind teasing the animals in Thrissur Zoo

Motive behind the teasing is given in Table 7. The most important motive was to 'see the reaction of the animal' (34.30%). Another reason for teasing/feeding was 'to make the animal move' (33.75%) and 'to attract the attention of the animals' (31.75%). Surprisingly 0.20% said that they tease the animals due to dislike/hatred towards the animals.

Table 7. Motive behind the teasing of the zoo animals at Thrissur zoo

Motive behind the teasing	%
To see reactions of the animal	34.30
To make the animals move	33.75
To attract attention	31.75
Due to hatred/dislike	0.20

4.5.3 Motive behind feeding the animals in Thrissur Zoo

The reasons for feeding zoo animals at Thrissur zoo are given in Table 8. The most important reason was to see the 'feeding habit of the animal' (37%), then 'to attract the attention of the animals' (32.50%), however, 30.50% of the visitors fed the animals after seeing the pitiable conditions in which these animals lived.

Table 8. Reason for feeding the zoo animals at Thrissur zoo

Reason for feeding animal	%
To see feeding habit of the animal	37.00
To attract attention	32.50
Due to sympathy	30.50
Total	**100**

Discussion

DISCUSSION

Deer are found in most parts of the world, small to large in size, may be solitary or gregarious. The great variety of the deer and their distribution in very different places makes them a fascinating a group to study. Almost all the great problems faced by wildlife today are exemplified within the deer family (Cervidae). The complex relationship between the biology and behaviour of each species and its environment is the climax of tens of thousands of years of evolution. Evolution is a dynamic and continuing process and the selective pressures for the survival of the species are now more intense than ever before.

In Thrissur zoo three deer species are kept in captivity such as Sambar Deer (*Cervus unicolor* Kerr, 1792), Spotted Deer (*Axis axis* Erxleben, 1777) and Hog Deer(*Axis porcinus* Zimmermann, 1780).

5.1 BEHAVIOURAL STUDIES

5.1.1 Sambar Deer

The Sambar Deer in Thrissur zoo showed a bimodal pattern in resting with peaks in the early morning and evening hours. The resting reached the peak between 1000h and 1300h and after 1600h. There was a gradual increase in time spent for resting during the noon hours and this activity is reached a peak during late noon hours and then gradually decreased. Walking was more or less uniform throughout the day.

The Sambar deer used to rest in groups and singly (plate 4) in the enclosures. During the morning hours individual mainly stags and juveniles were seen at [illegible] moving about in the pen indulging in short antagonistic encounter and chasing. The general resting continued till the first quota of feed arrived at about 10am. As the time gets nearer for the feed to arrive the animals anxiously wait in a group looking expectantly in the direction the usual feed arrival. Feeding occurred usually in the late afternoon, during the night, and during the first hours of daylight. In cooler weather, feeding extends throughout the day. The grazing activity was found to occur throughout the day in natural habitats but in the case of captive deer resting is the major activity in the day hours. The deer commonly visited to the water holes in late afternoon and after feeding. Deer feeding activity peaked at dawn and sunset during the cold as well as hot seasons, with more prolonged peaks in the cold season. However, during the rainy season, feeding was in bouts at various hours presumably because of intermittent rain. According Schaller (1967) resting occurs periodically when not feeding, which is in agreement.

Mating behaviour was observed both in the morning and evening hours (plates 7, 8, 9 & 10). It was observed to be the monopoly of the dominant male. 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 day time and sparing encounters lasted for only few movements. But the death of the stag due to injuries and the deep wounds (plate 11) on some others were evident of fierce fight during night time.

Plate 5. Impact of rubbing on coconut tree by Sambar Deer in Thrissur zoo

Plate 6. Spotted Deer drinking water in Thrissur zoo

Plate 7. Mating behaviour of Sambar Deer in Thrissur zoo

Plate 8. The male dominant Sambar Deer in Thrissur zoo

Plate 9 Display of flehmen of Sambar Deer at Thrissur zoo

Plate 10. Sambar Deer in velvet at Thrissur zoo

Plate 11. Sambar Deer injured due to fight in Thrissur zoo

Plate 12. Auto-grooming behaviour shown by Spotted Deer in Thrissur zoo

The Sambar Deer display some difference in their mating habits, a difference associated with their dense forest environment. In forests where Sambar Deer [illegible] is limited and the collection of a harem of hinds is usually impossible. As a Sambar Deer stages generally do not fight in the presence of the assembled hinds or for their possession. They fight for territory, for the possession of the favored 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, 1971). Familiar activity and sound did not disturb the herd. But they were altered and reacted to unfamiliar sounds. They stood then with necks stiff upright, tails raised and listened with cocked ears, till the disturbance stopped.

All the three species of deer always preferred to rest and ruminate in the shade either reclining or standing. Auto grooming and allo-grooming (Plates 12 & 13) were observed during the period of rest hours. Licking various parts of their body by slapping movements as the tongue was observed in the deer herd. As in grooming, the different regions of fore and hind legs, flank, caudal and inguinal regions were licked at a higher frequency. It was noted that the frequency of auto grooming was higher in the males than females.

The deer were seen licking one another, especially when reclining side by side in the shade. Allo-grooming among females was observed at a higher frequency than males. Mutual grooming was seen between female and female, male and female, mother and fawn, also juvenile and juvenile (Plates 15 & 16).

Plate 13. Allo-grooming behaviour shown by Sambar Deer in Thrissur zoo

Plate 14. Fawn of the Sambar Deer in Thrissur zoo

Plate 15. Spotted Deer licking its new born fawn at Thrissur zoo

Plate 16. Fawn of Hog Deer suckling milk from mother at Thrissur zoo

Aggressive encounters started sniffing each other. This was also exhibited by stags in rut. It sniffed the urino-genital region of the female. At Thrissur zoo, no antagonistic behaviour was noticed among the hinds; like chasing, pushing and biting (Plates 17, 18, 19 & 20).

5.1.2 Spotted Deer

The Spotted Deer is primarily a grazer, preferring newly sprouting grasses; yet during the year numerous plant species are eaten (Schaller, 1967). The rate of feeding is about 90 bites per minute (Schaller, 1967), which is comparable with this study. The Spotted Deer have been observed to shift during peak dry periods from eating especially grasses to eating other plants materials, such as fruit of *Emblica* and *Samanea* (Schaller, 1967., Jocobson, 1973 and Lehner, 1996).

Unlike most other deer species, Spotted Deer do not readily jump obstacles, such as fences. Thus a mesh-type fence they cannot step over or pass under initially deters them. Jumping is a last alternative and directly proportional to the deer's motivational state and experience. Deer are inclined to be gregarious and prefer familiar terrain. Once an individual has gotten on the other side of a barrier, it normally desires to return to familiar ground and to rejoin companions (Srinivasalu, 1998).

Once the feed is put in the trough and mixed with water, then there is a mad rush and the deer come and literally falls on the trough. There is no apparent

Plate 17. Aggressive behaviour of Spotted Deer at Thrissur zoo

Plate 18. Alertness exhibited by Spotted Deer in Thrissur zoo

Plate 19. Fighting behaviour shown Spotted Deer in Thrissur zoo

Plate 20. Sambar Deer urinating in Thrissur zoo

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 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 time. One or two stages paced the length of the fence slowly, grinding their teeth incessantly.

5.1.3 Hog Deer

A brief comparison of the behaviour of the Hog Deer (*Axis porcinus*) with that of the Spotted Deer is of interest since both species belong to the same genus, they have been known to interbreed in captivity (Pocook, 1910 and Crandall, 1964) and their range overlaps extensively.

The behaviour of the Hog Deer is in many respects similar to that of the Spotted Deer, especially in its various aggressive, courtships, and alarm displays. Basic differences lie in the hog deer's solitary nature and in its social organization during the rut. Except for the great discrepancy in size between the Spotted Deer and Hog Deer and a preference for somewhat different types of habitat, there seem to be not striking difference between the two species that would prevent them from mating with each other. However, the peak of the rut of the Spotted Deer in zoo was during May and June, whereas that of the Hog Deer was not until September and October.

Zoo or zoological gardens were performed unnatural habitat and every animal has a daily routine, organized by zoo managers, which controls all other activities naturally acquired by animal. In natural condition, the deer spend 53.71 per cent time for feeding activity. Which would depend upon a given deer species occupying a particular habitat, since there is a range of foodstuffs available. However, in captivity it was observed that all the species of deer spend most of their time on resting activity.

5.2-ANALYSIS OF THE FEED GIVEN TO THE DEER IN THRISSUR ZOO

The availability, palatability and nutritional value of particular food vary through the year and over the centuries deer have adapted themselves to pattern of food availability. In captivity, feeding trials may be used to determine food preference and may also be combined with other experimental technique for data on digestibility, analysis of nutrient matter etc. none of this techniques enables to determine the precise diet of wild animals in captivity. The precision can come only from laboratory feeding trials. Field observations from different literature and observations from zoo can however combine to give a broad view of the food spectrum of deer and their preference within this. When backed up by analysis of the nutritional contents of the plants, it is possible to see very good reason for seasonal preference. These methods together give us a useful back ground for predicting the likelihood strategy of a species in captivity. Where this indicates the

likelihood of an adequacy of supply or a season deficiency, appropriate action can be taken either by culling or by improving quantity or quality of food.

Observations from the study had shown that deer preferred green fodder more than concentrate cattle feed. But the green fodder availability was highly seasonal and was less available during the summer months. During the study period, there occurred noticeable reduction in the body size of the deer particularly during summer months. In other words, the animals appeared thinner and thinner with the advancement of summer months. During March - April, there was an acute scarcity in the availability of green fodder, depriving the animals from getting them in sufficient quantity. The nutritional value of the feed consumed by the animals could influence the social behaviour. The population dynamics experiments have shown that aggressive behaviour and surplus energy for play were directly proportional to the availability of food.

The deer appeared healthier and were at their best in appearance during October to December, in the Thrissur zoo. By the end of January the season gets drier and poorer become the availability of green fodder. Green foliage becomes a luxury during the summer months. And the zoo authorities, blaming the precarious financial conditions that the zoo face, do not take any step to get fresh, green foliage for these herbivorous animals. Symptoms of rut in males were observed by about this time. Owing to the scarcity in good fodder the animals thin down. By April, the antler-casting time, these deer present a very emaciated and sad picture.

5.3 EVALUATION OF THE ENCLOSURES AT THRISSUR ZOO

It is evident from the results that all the three species of the deer were over crowded within the enclosures at Thrissur Zoo. None of the three species of deer that were studied had the desired dimension of the enclosure as per CZA rules. In the case of Spotted Deer the area available to them at Thrissur Zoo was lower by more than 7 ha. of land. Similarly the enclosure size was not within the prescribed standards for Sambar Deer neither for Hog Deer. In either case the enclosure size was considerably smaller, making the life of these animals there miserable. The Sambar Deer should have had 1.60 ha. of additional space more, while the Hog Deer should have had 1.30 ha. of extra space to met the CZA requirements.

5.4 ANALYSIS OF FAECAL MATTER

There are two types of defecation habits, diffuse and localized. In the diffuse type of defecation the animal may defecate at random through the enclosure. But in the localized type, the animal defecates in one or more specialized places in its enclosure over a period of time. Concentrations of pellets seemed to be related to time spent at a site; frequently used loafing areas had more pellets than sites merely traversed by deer. Pellets with one end flattened typically had a centralized nipple at the opposite end.

The pellets of the three species of deer under study in the Thrissur zoo vary considerably in their size and shape. This information could be of use in studying the wild cervids from their indirect evidences in the wilderness.

5.5 VISITORS BEHAVIOUR IN THRISSUR ZOO

attract many visitors and that most of them come with an idea of recreation alone and creates problems. Provocations are often seen in combination of shouting, pelting stones, throwing plastic materials and feeding. The major activities were shouting and pelting stones. It was also observed that the teasing and feeding were at the peak when people came in large groups. Male visitors were found to be more provocative. Kumaragurubaran (1992) also made a similar observation. Kumaragurubaran (1992) also observed that teasing and feeding of captive animals were the major problems in Indian zoos. The zoo animals were fed by he visitors with biscuits, popcorns, peanuts, chips, banana etc. though these items are not sold inside the zoo premises.

Generally zoo administrators have shown less interest in visitors for whom the display has been arranged. Lack of awareness and willingness on the part of zoo personnel was another aspect that needs immediate attention. Indeed, the heterogenous nature of zoo visitors presents a diversity of problems for the zoo authorities also.

It was concluded from this study that all deer species adapt very well to changing conditions. Even though the living conditions in captivity of these animals in Thrissur zoos were in sharp contrast to their natural habitats, and the herd composition were highly imbalanced and unnatural, there were over crowding in the enclosures and shortage of adequate supply of green fodder to the

deer, coupled with the misbehaviour, including teasing and feeding of the deer by the visitors, the deer continue to live and thrive in our zoos against all odds, as was evident from this study. But how long will they be able to continue like this is a moot point.

Summary

SUMMARY

A study was carried out at Thrissur Zoo, from September, 2002 to April, 2003. The major objectives of the study were to understand the behavioural pattern of Sambar Deer, Spotted Deer and Hog deer in captivity. The study also aimed at analyzing the nutritional value of the feed given to the deer, evaluation of the deer enclosures and the analysis of the faecal matter. Apart from these yet another objective of the study was to know the behaviour of the visitors in the Thrissur zoo.

The individuals of the different deer species were tagged for observation. Activity patterns were categorized as feeding (when animal was actively feeding), standing (when animal was standing and chewing or ruminating), walking (intentional movement from one location to another looking for food or shelter), resting (sitting or resting in daylight), and others (including behaviour such as grooming, fighting, play, displays, rubbing of antlers and sexual behaviour). The hourly variation in the activity was studied for the above three species of deer at Thrissur zoo from September, 2002 to April, 2003. the period of observation was 12 hours, however, in certain months 24 hours of observation was also recorded.

The enclosures of the three species of the deer were evaluated using the of Central Zoo Authority rules and guidelines. The defaecation pattern was noted for each deer species. The average dimension of 200 deer pellets of the three species in question was measured. The behaviour of visitors and housekeepers were

recorded through a basic questionnaire survey to assess the sex, age, educational status, motive behind the teasing, feeding, conservation strategies, feeding and general awareness was prepared. A total of 100 people were sampled for this study.

The salient findings of the present study were,

1. All the three species of deer such as the Sambar Deer, Spotted Deer and Hog Deer in Thrissur zoo showed a bimodal pattern in resting with peaks in the early morning and evening hours.
2. There was a gradual increase in time spent for resting during the noon hours and this activity is reached a peak during late noon hours and then gradually decreased.
3. Walking was more or less uniform throughout the day.
4. The food consignment supplied to the deer species in a single day claims to consists of cattle feed (rice bran, black gram and green gram) - 150 kg; coconut cake - 45 kg and cottonseed - 28 kg. This is given in the morning, while in the afternoon they were supplied with green fodder.
5. The green fodder supplied to the deer consists of seven species of trees and five species of grasses.
6. The tree fodder species offered to the deer and other herbivores in Thrissur zoo consists of *Artocarpus heterophyllus*, *Ficus bengalensis*, *Ficus relegiosa*, *Terminalia catappa*, *Erythrina indica*, *Samanea saman* and *Phyllanthus emblica*.

7. The grass fodder fed to the deer included *Cynodon dactylon, Saccharum spontaneum, Phragmitis karka, Ardropogon* sp. and *Hetropogon* sp..
8. The chemical analysis of the feed revealed that among the tree fodder the as well as the grass fodder was predominated by moisture content, followed by dry matter, ash and crude protein.
9. In the case of the tree fodder, the moisture content varied between 86 to 81%, with *Phyllanthus emblica* having maximum moisture content (86%) and minimum for *Artocarpus hetrophyllus* (81%).
10. The dry matter content of the tree fodder varied between 19 to 14% between *Artocarpus hetrophyllus* (19%) and *Phyllanthus emblica* (14%) having the extreme values.
11. The ash content was maximum for *Ficus relegiosa* (11.9%) while was lowest for *Artocarpus hetrophyllus* (8.2%).
12. The crude protein content was maximum for *Ficus relegiosa* and *Samanea saman* (7.1% each), while minimum for *Artocarpus hetrophyllus* (5.5%).
13. In the case of grass fodder the moisture content varied between 85 to 80.5%, with *Phragmitis karka* having maximum moisture content (85%) and minimum for *Saccharum spontaneum* (80.5%).
14. The dry matter content of the tree fodder varied between 19.5 to 15% between *Saccharum spontaneum* (19.5%) and *Phragmitis karka* (15%) having the extreme values.
15. The ash content was maximum for *Phragmitis karka* (11.8%) while was lowest for *Ardropogon* sp. (9.2%).

16. The crude protein content was maximum for *Cynodon dactylon* (15.2%), while minimum for *Hetropogon* sp. (6.2%).
17. Unlike the green fodder the feed mixture was predominated by dry matter content (84.3 to 100%), while the moisture content was between 0 to 15.7%.
18. In the case of feed mixture the dry matter content was 100 % in Black Gram while the lowest dry matter content was recorded for Cotton Seed (84.3%).
19. The moisture content varied between 0 to 15.7% with Cotton Seed maximum moisture content (15.70%) and minimum for Black Gram (0%).
20. The crude protein content was maximum for Green Gram (18.2%), while minimum for Rice Barn (6.2%).
21. The ash content was maximum for Rice Bran and Cotton Cake (5.1%) while was lowest for Black Gram (9.2%).
22. All the three species of the deer were over crowded within the different enclosures at Thrissur Zoo. As per the CZA prescriptions for each pair of the deer species the area prescribed is 0.15 ha. per pair of the deer.
23. 106 Spotted Deer (53 pairs) should have had an area of 7.95 ha. as against the 0.25 ha available right now.
24. The 24 (12 pairs) Sambar Deer as per CZA requirement should have had an enclosure size of 1.8 ha. as against the present size of 0.25 ha.
25. The 18 (9 pairs) Hog Deer as per CZA requirement should have had an enclosure size of 1.35 ha. as against the present size of 0.12 ha.

26. Mean length of the pellets in Spotted Deer is 13.43 mm and mean diameter 8.86 mm
27. The mean pellet length is 16.5 mm and diameter 10.6 mm
28. the mean pellet length is 7.1 mm and diameter 4.98 mm
29. The major type of provocation to the animals at Thrissur Zoo was 'pelting stones' (33.5%), followed by shouting (32.75%), poking with stick (22.75%) while feeding accounted for 11%.
30. Majority of the provocators were in the age group of 15-35 years
31. Men (83 per cent) were found to be more provocative than women (17 per cent) and majority were educated at least to the high school level.
32. Although 11 per cent of the provocators were found to feed the animals, only 50 per cent of them were aware that their unconventional feeding could adversely affect the health of animals.
33. Most of the provocators were unaware of the balanced diet being fed to the animals by the zoo authorities.
34. Moreover, many of the provocators not realised that their behaviour could result in a behavioural change of the animals and them feeding the captive stock could attract pests in to the animal enclosure.
35. The most important motive was to 'see the reaction of the animal' (34.30%).
36. Another reason for teasing/feeding was 'to make the animal move' (33.75%) and 'to attract the attention of the animals' (31.75%).
37. Surprisingly 0.20% said that they tease the animals due to dislike/hatred towards the animals.

38. The most important reason was to see the 'feeding habit of the animal' (37%), then 'to attract the attention of the animals' (32.50%), however, 30.50% of the visitors fed the animals after seeing the pitiable conditions in which these animals lived.

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Appendix 1. Questionnaire to study the visitor behaviour at Thrissur Zoo

SL. NO.	PARTICULARS	HIGHLY AGREE	AGREE	DISAGREE	HIGHLY DISAGREE
1.	Satisfied with zoo condition				
2.	Zoo is too small				
3.	Initial expectations are met				
4.	We will recommend others to see this zoo				
5.	Animals are given proper care and hygiene is good				
6.	Improvement of zoo has to be done				
7.	My knowledge regarding wild animals improved				
8.	I have changed my attitude towards captive animals				
9.	Children got benefited				
10.	Managerial aspects of zoo is not sufficient				
11.	I feel this visit was waste of time for me				
12.	There was no sufficient number or variety of animals				
13.	Appropriate space is not provided for animals				
14.	People who come here make troubles to animals				
15.	We got motivated to protect the endangered animals				
16.	Well planned health care is taken				
17.	Entrance fee is reasonable				
18.	I am aware of wildlife conservation				
19.	More extension and awareness programmes about wildlife conservation needed				
20.	Forest department does commendable work to protect our wildlife				
21.	Captive animals maintained in zoos can be introduced to wild to augment wildlife population				

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SL. NO.	PARTICULARS	HIGHLY AGREE	AGREE	DISAGREE	HIGHLY DISAGREE
22.	Present functioning of forest department is good				
23.	This zoo satisfies the role in education				
24.	Money spent for conserving wildlife in PA's is a waste				
25.	Visitors shall not feed the animals in zoo				
26.	Many wildlife species are pests and hence shall be allowed to kill				
27.	Private zoos and wildlife areas shall be promoted and free off direct control by the Government				
28.	Wildlife shall be used for food and other direct economic benefits				
29.	There is corruption going on in forest department				
30.	A zoo shall be there in each town for education and recreation				
31.	Animals are properly fed in zoo				
32.	We shall go for collaborative management of our wildlife (people shall be involved)				

Name :

Marital status :

Educational status :

Occupation :

Income level (annual) :

Address :

Approximate distance of the native :

Start of the travel :

Purpose of visit- :
(part of tour/exclusive for tour/
simply visit/time pass)

Whether it is appealing :
(If not, what they expect)

You like the zoo :
(If not, why)

Source of information about the zoo :
(already known/ told by_____)

Who took the initiative :

Type of the group- :
(couple/school children/excursion party/family)

Which animal they like the most (Why?) :

Which animal that they want to be put here :
(which they didn't see)

Which particular protected area you like the most in Kerala :

Which you protected area you would like to see in future :

If sufficient facilities are provided, are you interested to stay inside the forest :

How many protected areas in Kerala :

For researcher

Which animal is teased most :

Mode of teasing :

Time taken to see zoo :

Maximum time spent at which cage :
(based on chart)

BEHAVIOURAL ECOLOGY OF SELECTED DEER SPECIES IN CAPTIVITY - A CASE STUDY AT THRISSUR ZOO

By

PRAKASH, R.

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Science in Forestry

Faculty of Agriculture
Kerala Agricultural University

Department of Wildlife Sciences

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2007

ABSTRACT

The present study was undertaken with the main objective of generating information on behavioural pattern of selected deer species in captivity, to assess the nutritional value of feed given to the deer, to do a critical evaluation of deer enclosures, to study the texture, shape and size of the faecal matter and to analyze the behaviour and activities of visitors and zookeepers towards animals in the zoo.

The study was conducted on the three deer species viz., Hog deer, Sambar and Spotted deer in captivity at Thrissur zoo during the period September 2002 to April 2003.

It was observed from the study that all deer species adapted very well to changing conditions. During the study period deer spent more time for resting followed by feeding and they engaged less time in other active behaviour patterns (walking, running, playing, fighting, mating etc.). With reference to activity pattern, resting and feeding/moving showed alternative with proportional intensities. It is well established fact that the living condition of the deer in these zoos are far from comparison to their natural habitat. Food, herd size, competition, nearest neighbour relationship etc., are strikingly different from the deer which are found in natural habitat. Inspite of all adversities all deer species have learnt to adapt amazingly to changing conditions and survive fantastically. The physiological activities of their

lives, such as antler casting, rutting, mating, gestation and delivery remain unchanged.

The proximate analysis of the feed provided to the deer revealed that feed that is grass or leaves contain 79-82 per cent moisture, 7-9 per cent protein and 10-11 per cent ash and concentrate feed contain 11-80 per cent moisture, 14-18 per cent crude protein and 5-24 per cent ash.

The area of enclosure which is provided to the deer are evaluated according to the recommendations of the CZA guidelines. The result shows that the area provided is very less and due to which it may affect the behaviour of deer in captivity. This may be the one of the reason for this Thrissur zoo not recognised by the Central Zoo Authority of India.

In sambar pellets are found in groups. The sambar has the biggest sized pellets compared to other deer species in this study. The observations on defecation habits of the spotted deer and hog deer indicated that they had diffuse type of defecation spread all over the enclosure and so no quantitative data could be recorded in this study.

Most of the visitors were unaware of the balanced diet being fed to the animals by the zoo authorities. More over, many of the visitors do not realise the fact that their behaviour could result in a behavioural change of the animals.

It is the high time for all responsible citizens and organizations to come forward with open mind to up keep the endangered animals in the zoo rather than leaving the whole responsibility on the shoulders of the government. General awareness and overall changes in the attitude of Indian citizens towards our vanishing wildlife is the need of the hour. Let us work together to conserve wildlife for our future generation.