

Activity-time budget in blackbuck

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Abstract. The activity patterns of blackbuck observed at Mudmal showed that feeding accounted for the maximum frequency (75%) with an average duration of 77 sec followed by standing with a frequency of 62% and an average duration of 19.9 sec. Lying although had only 4% frequency, showed an average duration of over 30 min.

The hourly time budgets for basic activity patterns during the day in a season varied greatly for both females and territorial males. Rhythms of feeding and lying peaks occurred alternately during the day in all seasons. The time budgets for the activity patterns showed seasonal variation. Lying time per day was more than the average time allotted to any activity. In the case of females, the average time spent for feeding per day during summer was 25% which was more than that of monsoon and winter. The time spent in lying was 39% which increased to 48% in monsoon and winter. The average time spent in walking and standing did not show any significant seasonal variation. The time budgets for the territorial males also showed the same tendency as that of the females in all seasons. During winter, however, the feeding time per day was 11% while the lying time was 57%, the former being significantly less and the latter significantly greater than the females.

Keywords. Activity-time budget; blackbuck.

1. Introduction

Few quantitative studies have been published on the daily activity patterns of blackbuck. These include the work of Schaller (1967) and Nair (1976) in India and Mungall (1978) in Texas which describe the distribution of percentage of animals engaged in basic activities in hourly classes from dawn to dusk. Based on a month's study Mungall *et al* (1981) have compared the quantitative time budgets of males and females of different age-classes in different social categories.

The activity patterns are determined by a wide range of factors, both biotic and abiotic, and information is lacking as to how blackbuck adapt and maintain themselves to seasonal changes. In the present paper, the time budgets for basic activities of blackbuck are described for both sexes based on the studies at Mudmal (16°24'N and 77°27'E) during 1979-80 and the seasonal differences discussed.

2. Methods

Data were recorded on all activity categorised as feeding, walking, running, standing, lying, and 'other activities' from dawn to dusk. The recordings made were as follows: The activity of 11 identified territorial males was separately recorded at different times of the day with the help of a stop watch. Recording of activity of females, however, was

difficult due to difficulty to distinguish them individually. One female was randomly selected from a herd and its activities recorded. On occasions when such an individual under observation was confused or was out of sight, another adult female was randomly selected from among the members visible. As a large number of observations thus made showed synchrony among female members, the data collected were fairly accurate. The activity patterns of the territorial males and females obtained thus represent their activities from all social categories of different herd sizes although majority of them were from mixed herds of at least 10 head.

An activity was considered when the time spent in that activity exceeded 30 sec before changing to the next activity. The average time spent by the territorial males in each hour of daylight was calculated separately for summer, monsoon, and winter seasons and expressed in percentage. Thus the activity curves composed of a fraction of the 12 hr rhythms of the individuals recorded on different days in a season.

Most of the continuous observations lasted for 4–6 hr, although on a few occasions activity records were obtained for 10 hr continuously without external disturbance. Observations without continuous record between two consecutive daylight hours were not included in calculations.

The seasonal differences in the activity patterns of the territorial adult males and females were separately calculated for all daylight hours by employing the following formula:

$$d = \frac{(k_1 - k_2)}{\{k(1-k)(1/n_1 + 1/n_2)\}^{1/2}}$$

where $k_1 = a_1/n_1$; $k_2 = a_2/n_2$ and

$$k = (a_1 + a_2)/(n_1 + n_2)$$

a = total time spent in a given activity in a daylight hour over the period of observation in a given season,

n = total time spent for all activities in that hour for the period of observation in that season.

The mean time spent in an activity category in a day was calculated and comparisons made between territorial males and females and the seasonal differences within them.

Apart from the preparation of time budget, nearly 5 hr of continuous record of observation was utilized for obtaining the frequency of occurrence of the activity categories and the association between them through hierarchical cluster analysis (De Ghet 1978). Thus,

$$\text{Jaccard's association coefficient} = A/(A) + (B) + (C)$$

where, A = number of times both activities (say feeding and walking) occurred,

B = first activity (feeding) occurred and second (walking) not occurred,

C = second activity (walking) occurred and first (feeding) not occurred.

The transition probabilities of one activity following the other, as for example feeding followed by walking and so on, was calculated using Markov models (Fagen and Young 1978). Thus, transition probability of an activity P_{ij} = (Number of times activity i followed by activity j)/(Total number of times of occurrence of activity i). The expected probability of an activity i was calculated by the following equation:

$$\frac{\text{Sum of occurrence of an activity } i \times \text{sum of occurrence of an activity } j}{\text{Total number of times of occurrence of all activities}}$$

3. Results

3.1 Activity frequency

The frequency distribution of the activity categories is shown in table 1. Feeding showed highest frequency (37.69%) followed by standing (31.16%). The average duration of feeding, however, was just over a minute. Feeding was disrupted frequently either by standing or by walking. Lying which showed only 4%, on the other hand, was continuous for a longer spell with an average duration of over 30 min. The maximum duration of an individual continuously in lying activity was 2.5 hr.

3.2 Activity sequence

The association between the activity categories is shown in figure 1. Feeding and standing were in maximum association with each other with a value of 0.79. The association index of walking and feeding with standing was 0.71 followed by running (0.36). The association index of lying with the rest was 0.03.

Table 2 gives the transition probability of one activity following the other along with the expected values. The probability of standing followed by feeding was higher than feeding followed by standing. The probability of feeding followed by walking is below the expected value. On the other hand, walking followed by feeding showed a probability higher than that expected. Running had an equal probability of being followed by standing and walking. Similarly lying was either followed immediately by

Table 1. Transition probabilities of one activity following the other.

Preceding acts	Following acts					
	<i>F</i>	<i>S</i>	<i>W</i>	<i>R</i>	<i>L</i>	<i>O</i>
Feeding (<i>F</i>)	0.0 <u>0.0</u>	0.55 <u>0.51</u>	0.42 <u>0.43</u>	0.0 <u>0.02</u>	0.03 <u>0.03</u>	0.0 <u>0.02</u>
Standing (<i>S</i>)	0.69 <u>0.27</u>	0.0 0.0	0.29 <u>0.18</u>	0.02 <u>0.007</u>	0.0 0.01	0.02 0.007
Walking (<i>W</i>)	0.63 <u>0.52</u>	0.31 <u>0.43</u>	0.0 0.0	0.02 <u>0.015</u>	0.02 <u>0.02</u>	0.02 <u>0.015</u>
Running (<i>R</i>)	0.0 <u>0.385</u>	0.5 <u>0.315</u>	0.5 <u>0.265</u>	0.0 0.0	0.0 <u>0.015</u>	0.0 <u>0.02</u>
Lying (<i>L</i>)	0.0 0.39	0.67 0.32	0.33 0.27	0.0 <u>0.01</u>	0.0 0.0	0.0 0.01
Other (<i>O</i>) activities	0.0 <u>0.385</u>	0.5 <u>0.315</u>	0.5 <u>0.27</u>	0.0 <u>0.02</u>	0.0 <u>0.01</u>	0.0 0.0

The underlined numbers indicate the expected probabilities while the others are calculated values. The total in all the cases is 1.

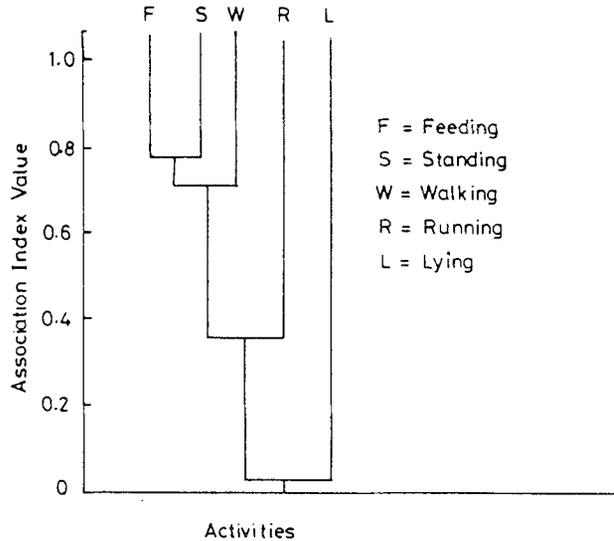


Figure 1. Dendrogram showing association between basic activity patterns.

Table 2. Frequency and duration of activity categories.

Activity	Frequency	% Frequency	Total duration (sec)	% Duration	Average duration (sec)
Feeding	75	37.69	5809	34.29	77.45
Walking	54	27.14	2461	14.53	45.57
Running	2	1.01	8	0.05	4.00
Standing	62	31.16	1237	7.30	19.95
Lying	4	2.01	7375	43.53	1843.75
Other activities	2	1.01	53	0.31	26.50

standing or walking before the start of any other activity, although the former had a higher probability than the latter.

The 'other activities' usually were followed either by standing or by walking with equal chance of occurrence.

3.3 Activity-time budget of females

The time spent by females in the activity categories from 7–8 hr during the three seasons is shown in figure 2. The activity records between 13–17 hr were not represented for summer as the observations were discontinuous. This data, however, showed the animals spending most of the time lying down. Due to this reason it became too difficult to locate them.

In summer bouts of feeding were noticed in all daylight hours observed with at least 20% of time. In winter there were distinct peaks of feeding with a maximum of 66%

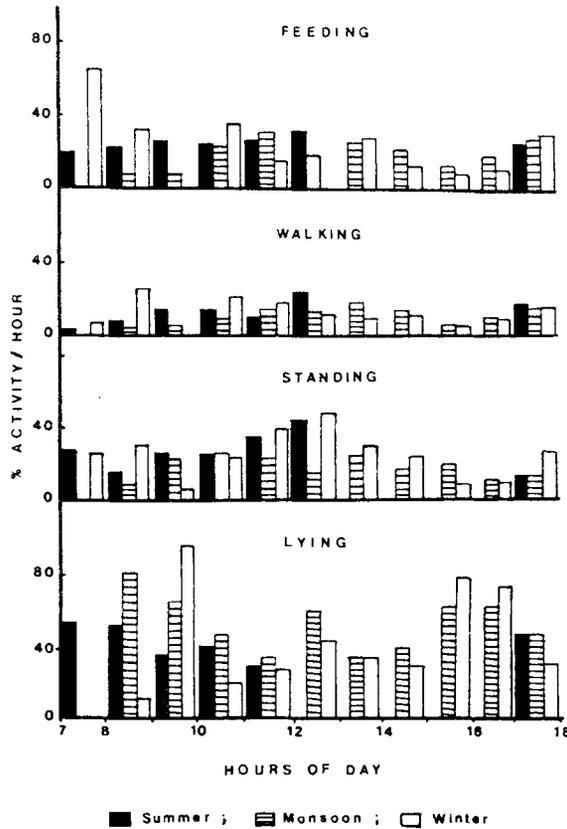


Figure 2. Seasonal activity patterns of females.

between 7–8 hr and 12–13 hr. During the rest of the daylight hours feeding time ranged between 8% and 15%. The time spent in feeding between 7–8 hr in winter was significantly greater than that of summer ($d = 7.02$, $p < 0.001$).

During monsoon, in the early hours feeding was very less (8% between 8–10 hr). However, it increased to 22% during 10–11 hr. Between 11–12 hr feeding time was 32%, the maximum noticed in the season. During the rest of the daylight hours the time apportioned for feeding ranged from 12–26%. There were no significant differences in the feeding time spent in 10–11 hr, 11–12 hr and 17–18 hr of monsoon and summer; 15–16 hr and 17–18 hr of monsoon and winter; and 8–9 hr and 17–18 hr of winter and summer. During the rest of the day hours the differences in feeding time between seasons was significant at $p < 0.001$.

During summer and monsoon, the time for walking showed a gradual increase from 7–13 hr. Contrary to this, winter walking time decreased from 26% (9–10 hr) to 5% (15–16 hr) and again showed an increase after 17 hr.

Standing showed an increase from morning with an afternoon peak in all seasons. The maximum time spent in an hour was 44% (12–13 hr) in summer, 26% (13–14 hr) in monsoon and 48% (12–13 hr) in winter.

Lying showed definite peaks in monsoon and winter. In monsoon, when data was recorded from 8–18 hr, the maximum time spent was 80% between 8–9 hr. The rest of

Table 3. Average proportion of time spent per day by females and territorial males in the activity categories.

Category	Season	% Time				Other activities
		Feeding	Walking	Standing	Lying	
Terri- torial males	Summer	25	11	23	37	4
	Monsoon	17	13	17	47	6
	Winter	11	11	16	57*	5
Females	Summer	25	11	24	39	1
	Monsoon	19	10	23*	48	0
	Winter	16*	10	21*	48	5

*Comparison between females and territorial males and allotment of significantly more time than the other at $p < 0.001$.

the daylight hours showed 30% (11–12 hr) to 64% (9–10 hr). During winter the maximum time allotted was 94% (9–10 hr) in the morning and 64% (15–16 hr) in the afternoon. During the remaining hours of the day the amount of time spent ranged between 10% (8–9 hr) and 72% (16–17 hr).

During summer, over 50% time was spent on lying between 7–8 hr which decreased to 34% between 9–10 hr. It again increased to 40% between 10–11 hr and fell to 28% in the succeeding hour. During 17–18 hr again 45% of the time was spent in this activity.

Females spent an average of 25% of the day time for feeding, 39% for lying while walking and standing shared 11% and 14% respectively during summer season (table 3). The average feeding time decreased to 19% in monsoon and 16% in winter and the time spent in lying increased to 48% in these two seasons. Walking and standing showed a slight decrease.

3.4 Activity-time budget of territorial males

The activity-time budget of the territorial males in the three seasons is shown in figure 3. As in females, feeding and lying were the main activities to be focussed upon among all activities in all seasons. During summer two peaks of feeding were clear between 13–14 hr (58%) and 16–17 hr (61%). Between 7–8 hr and 17–18 hr about 38% of the time was spent in this activity. The minimum time spent in this activity was 14% between 8–9 hr. The rest of the daylight hours have feeding time ranging between 20 and 26%. Between 14–15 hr the data were not represented as the number of observations were very few.

During monsoon and winter there were no significant peaks in feeding activity. The maximum and minimum amount of time spent in feeding was 25% (12–13 hr) and 7% (17–18 hr) respectively. The time allotment for feeding between 7–8 hr, 13–14 hr and 15–16 hr during summer is significantly greater ($p < 0.001$) than monsoon and winter in the corresponding hours. The total time spent in feeding per day was also higher in summer (25%) than in monsoon (17%) and (11%) which was statistically significant ($d = 8.78$ for monsoon and summer; $d = 15.84$ for winter and summer; $p < 0.001$). The total time spent in feeding per day during monsoon was significantly more than that during winter ($d = 9.17$; $p < 0.001$).

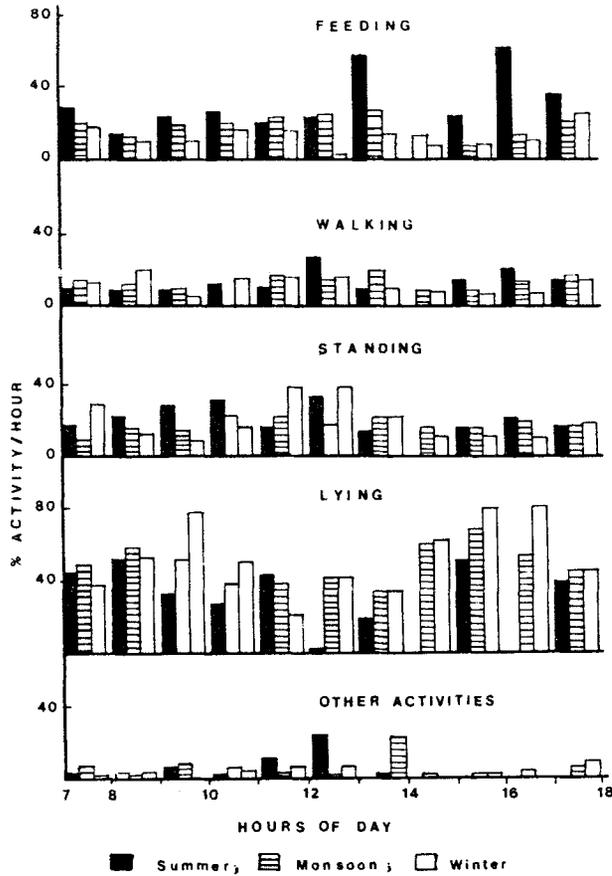


Figure 3. Seasonal activity patterns of territorial males.

There were marked differences in lying in the three seasons. In summer lying was more between 7–8 hr, 11–12 hr and 15–16 hr and the time spent ranged between 54–62%. Between 12–13 hr there was practically no lying. During monsoon, as in the case of summer, morning and evening hours showed more lying activity and there was an afternoon dip. Fifty to sixty per cent of the time was spent in this activity between 7–10 hr while between 10–14 hr only 34–42% time was spent. The subsequent day hours till 18 hr had 46–68% of time in this activity. During winter, there were periodical oscillations in lying. Thirtyeight per cent of time was spent between 7–8 hr which significantly increased to 78% between 9–10 hr. Lying time decreased to 21% during 11–12 hr and again increased to 42% between 12–13 hr. In the subsequent hours there was once again a decrease in this activity. But between 15–17 hr it touched a maximum of 80%. Compared to summer and monsoon seasons, winter had significantly more time in lying between 9–10 hr 11–12 hr; 13–14 hr and 15–17 hr ($p < 0.001$). The total lying time per day was also maximum during winter (57%) followed by monsoon (47%) and summer (37%) and the differences were statistically significant ($d = 10.37$ for summer and monsoon, and for winter and monsoon; $d = 17.45$ for winter and summer; $p < 0.001$).

4. Discussion

The maintenance of life in a mammal requires a variety of activities associated with procurement of food, shelter and protection. Each of these activities had a certain benefit and cost attached to it (Sharatchandra and Gadgil 1980). An obvious principle is that the extent of activity must be adequate to maintain the kind of life permitted by the animal's anatomic and physiological adaptations (Davis and Golley 1963). Through the time budget for basic activities of blackbuck, the following explanation emerges to show as to how they maintain themselves in different seasons.

During summer forage material in general and fresh foliage in particular was very scarce. Blackbuck being mainly grazers and preferring the tender leaf were rather forced to spend much of their time in search of food. This is the reason for their allotting a significantly large proportion of time for this purpose as compared to other seasons (table 3). During monsoon sprouting of grasses was in abundance and they could easily obtain their nourishment. During winter blackbuck take to crops, which are more readily available. The crops have more crude protein content than grasses and hence a lesser quantity may suffice their energy requirements. This probably is the cause for a further drop in feeding time during winter. This enabled them to spare more time for lying and ruminating in monsoon and winter.

Lying time was significantly more while the feeding and standing time was less in

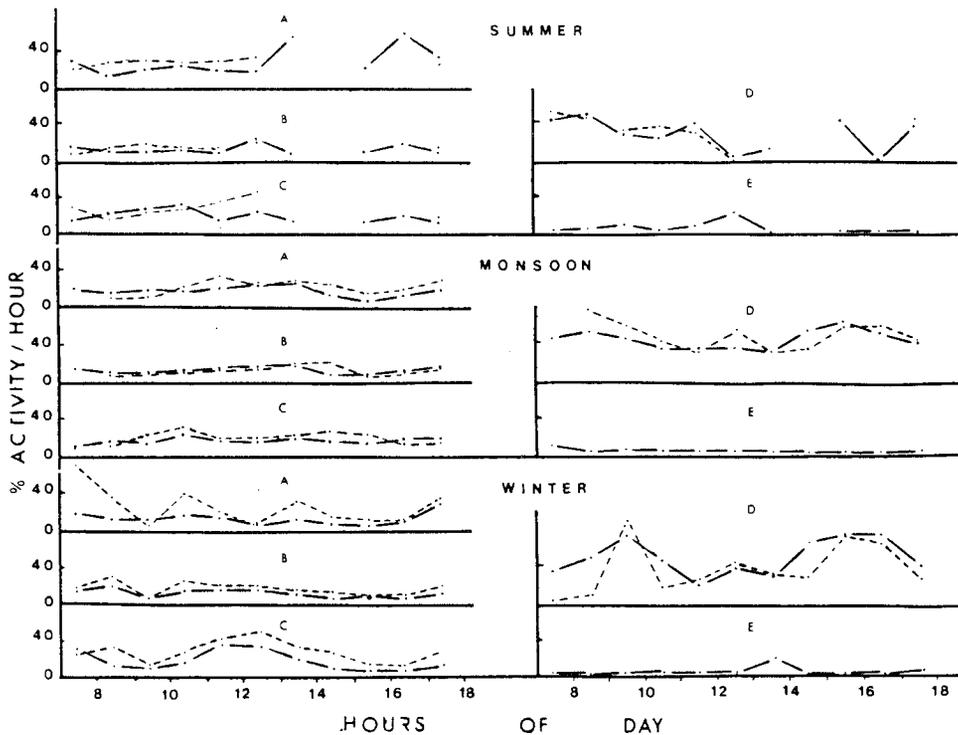


Figure 4. Comparison of activity patterns between females and territorial males. A to E: Feeding, Walking, Standing, Lying and other activities, respectively. Broken line indicates the activity of females while continuous line refers to the activity of the territorial males.

territorial males than in females during winter and monsoon. A major portion of lying time was spent by territorial males within or adjacent to their territories which were located near the cultivated fields. They thus had a better access for a quick bite and hence could spend the remaining time for lying and ruminating. They could also watch the activities of females and keep the bachelor associations away from their territories, which move from one area to the other.

The females showed a significantly more time for standing than the territorial males. A plausible explanation for this could be, the females in general were more cautious and watchful, both while feeding and while at rest, than the territorial males. This may be because the females mostly were seen in groups and could easily be spotted and would probably need to doubly ensure whether there would be any sort of danger before they resort to bedding.

If we look at the hourly activity-time budgets, in most cases the general pattern of curves in both territorial males and females showed a more or less similar tendency of increase and decrease (figure 4). This indicates that their response to the changing conditions in different seasons is more or less the same. The differences in some daylight hours may be due to the environmental parameters such as temperature, relative humidity, presence of shade in the area, wind speed etc. which, however, were not measured during the present study.

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