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Group composition, sex ratio and seasonality of spotted deer (*Axis axis*) in the Yala Protected Area Complex, Sri Lanka

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Abstract

The spotted deer population in the Yala Protected Area Complex (YPC) was studied monthly during 1995–96. Of 7,922 sightings of individuals during the 14-month study period 6,929 were classified into adult males (29.11%), adult females (49.68%), yearling males (3.71%), yearling females (7.83%), juveniles (6.94%) and fawns (2.73%). The largest group observed comprised 179 individuals. The average group size was 10.99, varying from 15.36 in the rainy season and 7.67 in the wet season, to 5.72 in the dry season. The highest frequency of animals (13.83%) was in the size group of 11–15 individuals. Only 1.14% of the animals were observed as solitary individuals. Of the groups (i.e. those containing more than 2 individuals), only 13.01% had more than 20 and only 3.16% had more than 50 individuals. The groups of more than 50 individuals were observed only during the wet season and are probably temporary aggregations of several smaller groups. The observed female-male ratio of the adult spotted deer was 1:0.59, while that of the yearlings was 1:0.47. The fluctuation of the sex ratio between the seasons was found to be insignificant (c^2 test). The skewed sex ratio indicates a probable differential mortality between adult males and adult females.

Spotted deer are mainly active in grazing and drinking in the late afternoons and early mornings, the noon hours usually being spent resting in shade. They breed throughout the year in YPC, except perhaps during the peak drought months of July and August. There appears to be an increased birth period during the latter part of the December–February rainy season. The leopard is the only significant predator of the spotted deer in YPC; deer continue to be poached despite the legal protection.

Introduction

There are four species of cervids in Sri Lanka, namely, the sambar (*Cervus unicolor*), spotted deer (*Axis axis*), barking deer (*Muntiacus muntjak*) and hog deer (*Axis porcinus*). The spotted deer has a narrow distribution, being confined to peninsular India and Sri Lanka; the insular population has been allocated to the subspecies *A. axis ceylonensis* (Fischer, 1829). The species occurs throughout the forests of the lowland 'dry zone' (Phillips, 1984) (Fig. 1). Its habitat continues to dwindle as these forests are cleared for human settlements and agriculture. Despite being the most gregarious and abundant, as well as the most poached, large mammal in the island, the spotted deer is gradually becoming confined to protected areas as national parks and nature reserves. The small, fragmented populations surviving outside protected areas are highly vulnerable to poaching and habitat destruction and their long-term survival is unlikely.

As Sri Lanka's protected-areas network is highly fragmented (Fig. 1), their small deer populations could be subject to genetic drift and even inbreeding depression. However, the spotted deer is likely to lend itself to management practices (Schaller, 1987). Thus, with proper management, the species may well remain a conspicuous and economically valuable member of the Sri Lankan forest fauna.

Ecological work on spotted deer in Sri Lanka has been confined to Wilpattu National Park (WNP) (Eisenberg & Lockhart, 1972) and Block I of the Ruhuna National Park (RNP): Balasubramaniam et al. (1980), studied habitat utilisation patterns in the Block I of RNP, which is a part of the Yala Protected Area Complex (YPC); and Ashby & Santiapillai (1986) and de Silva & de Silva (1993) studied life expectancy and population dynamics respectively, in the same area.

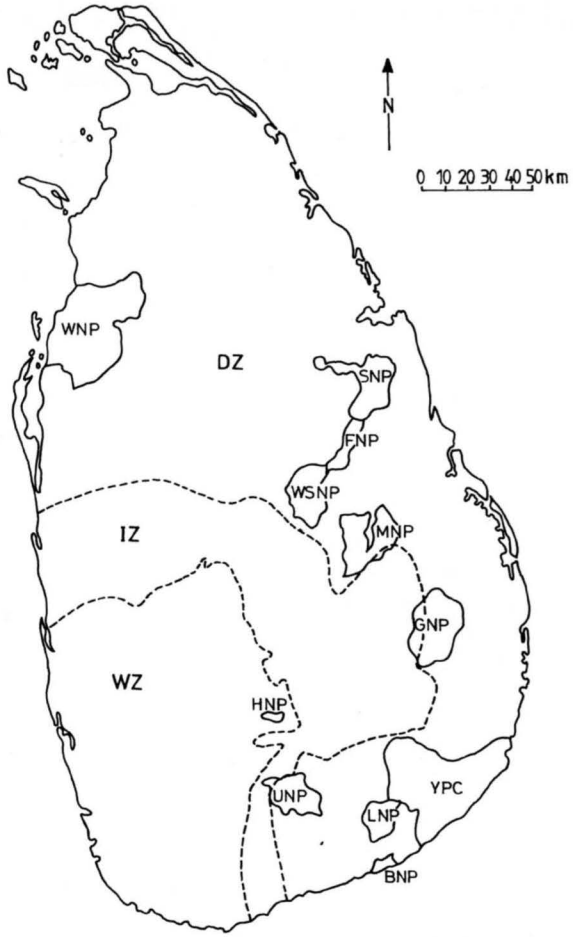

Figure 1. Location of Yala Protected Area Complex and the eco-climatic zones of Sri Lanka. Major protected areas are also indicated. (DZ, dry zone; IZ, intermediate zone; WZ, wet zone; BNP, Bundala National Park; FNP, Flood Plains National Park; GNP, Galoya National Park; HNP, Horton Plains National Park; LNP, Lunugamvehera National Park; MNP, Maduru Oya National Park; SNP, Somawathiya National Park; UNP, Udawalawe National Park; WNP, Wilpattu National Park; WSNP, Wasgomuwa National Park; and YPC, Yala Protected Area Complex.)

Study area and habitats

Situated in the south-eastern corner of Sri Lanka (Fig. 1), the YPC comprises a group of contiguous protected areas (Fig. 2) set in the island's lowland dry zone, one of three major eco-climatic zones, characterised by low and seasonal rainfall (the other two zones are the Intermediate and the Wet— see Fig. 1). YPC has an area of 1,518 km^2 and is bordered by the sea on the south and east. Its vegetation consists mainly of forest, forest-scrub and short-grass grasslands. A few natural waterholes and several man-made seasonal reservoirs are scattered within the park. The two rivers, the Menik and the Kumbukkan, together with several mostly seasonal streams, drain the area. Mean annual rainfall is about 1,300 mm, of which the major part (ca. 64%) is received in late October to early January and the most of the rest (about 27%) in April and May (Fig. 3). However, rainfall can vary considerably between years. There is a north-south gradation of rainfall, being high in the northern part (>1,600 mm p.a.) and low in the southern part (<1,000 mm p.a.). The monthly mean temperature in the area varies between 26°C and 29°C (Müeller-Dombois, 1968).

For the purposes of this study, we recognise three rainfall-dependent seasons (Fig. 3): the main rainy season of October to January; the wet season of February to May (in which the rainfall is less than that in the rainy season but nevertheless significant); and the dry season of June to September (during which the rainfall is low and much of the vegetation, especially the grass, desiccates). Although the drought is usually confined to July–August, the dry season sometimes extends up to September and even October. Several water bodies dry up during periods of drought, almost all waterholes and streams running dry and even the major rivers being reduced to a series of scattered pools during prolonged drought,.

Materials and methods

The present study was carried out during the months of January, February, March, May, June, July, August, September, November and December 1995 and January, April, July and October, 1996, each study session comprising 5–10 days of field work. Different PAs within YPC were visited and the different habitats in each PA studied by traversing along roads by vehicle and along transects on foot. Various habitats were visited during different times of the day. Precautions were taken to minimise disturbance to wildlife while walking along transects. The number and the categories of spotted deer observed were recorded (the following categories were recognised by Eisenberg & Lockhart (1972): adult males with hard antlers, antlers in velvet and antlers shed, yearling males with hard antlers and antlers in velvet, adult females and yearling females, juveniles, and fawns).

Yala East NP and Kudumbigala SA were not studied.

Results

During the 14-month study period, 7,922 individuals were sighted of which it was possible to classify 6,929 into the categories defined above. The frequencies (%) of these categories are given in Fig. 4.

Although the largest group observed consisted of 179 individuals, the highest frequency of animals (13.83%) was in groups of 11–15 individuals. Only 1.14% of the animals was observed as solitary

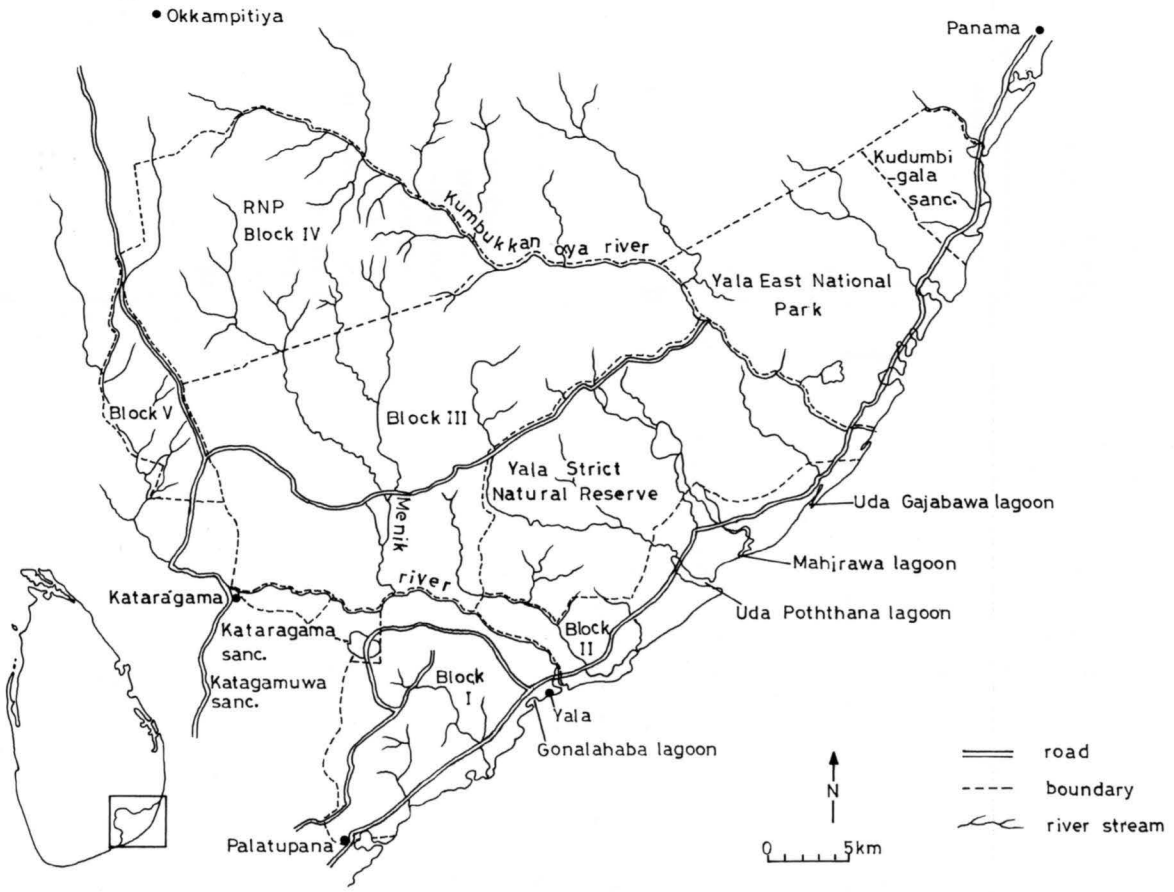

Figure 2. Yala Protected Area complex.

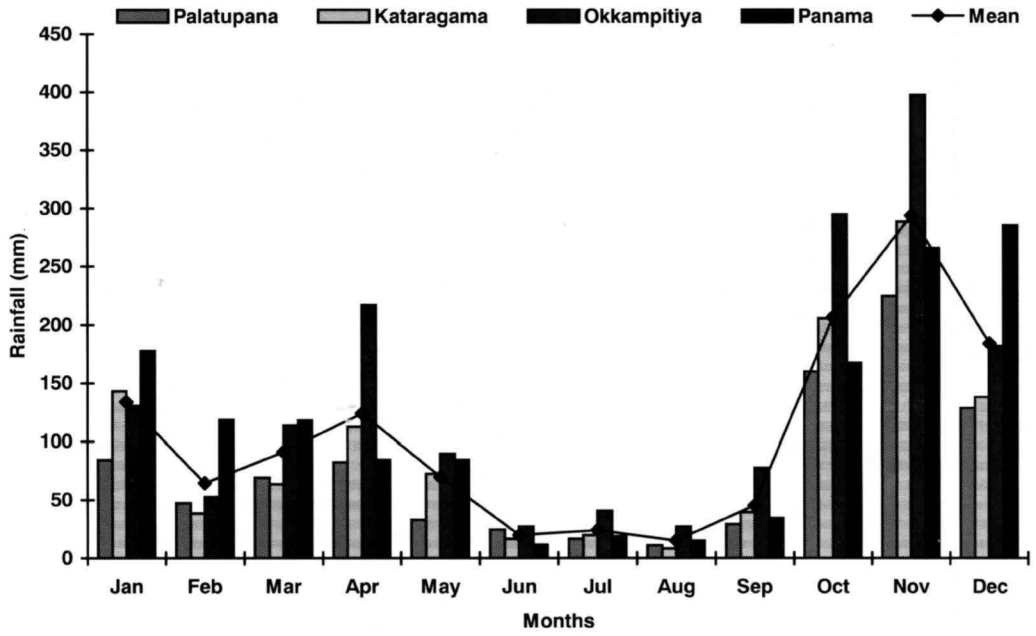

Figure 3. Mean monthly rainfall of the 15-year period 1980–1994 at different locations near YPC. The locations of rainfall stations are shown in Fig. 2.

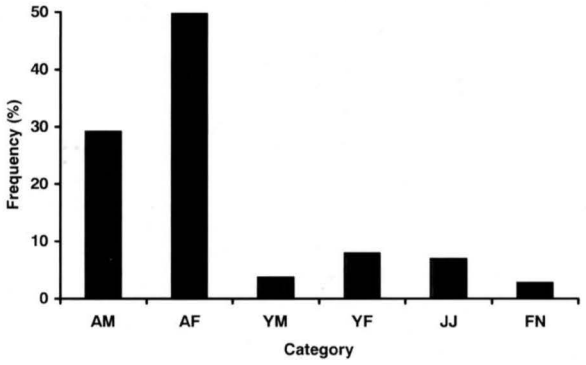

Figure 4. Frequency of different categories of spotted deer in YPC. (AM, adult male; AF, adult female; FN, fawn, JJ, juvenile; YF, yearling female; YM, yearling male) (n=6,929).

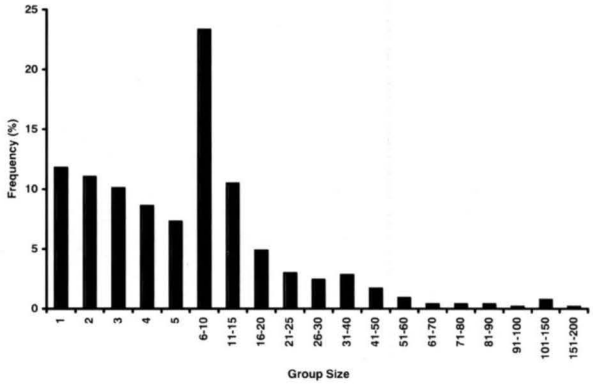

Figure 5. Grouping tendency of the spotted deer in YPC.

individuals. Of the groups (i.e. those containing more than 2 individuals), only 13.01% had more than 20 individuals and only 3.16% had more than 50 individuals. The groups of more than 50 individuals were observed only during the wet season suggesting that these were temporary aggregations of several smaller groups near waterholes. The average group size for the entire study period was 10.99, but it varied during different seasons, being 15.36 in the rainy season, 7.67 in the wet season and 5.72 in the dry season. The frequencies of various size groups are shown in Fig. 5. Solitary individuals represent only a small proportion of sightings (Table 1). The proportion of solitary males was higher than that of solitary females. The proportions of both solitary males and solitary females were highest during the wet season and lowest during the rainy season.

Some groups consisted of males only; the largest all-male group contained 24 individuals, 13 hard-antlered males, 2 velvet-antlered males, 5 spike yearlings and 4 velvet-spike yearlings. There were also groups containing only females, the largest of which contained 15 individuals, all of them adults. Yearling males or females were not observed in groups of their own. Table 2 shows the fraction of adult males and adult females that were in all-male or all-female groups during different seasons. The fraction of adult females in all-female groups is somewhat higher than that of adult males in all-male groups. The frequencies of all-male and all-female groups are highest in the wet season and lowest in the rainy season (Table 2).

Table 1. Fraction (%) of solitary males and females among males and females during different seasons (AF, adult female; AM, adult male).

Season	Duration	AM	AF
Rainy	October–January	1.75	0.62
Wet	February–May	8.81	3.58
Dry	June–September	4.74	1.78
All		4.28	1.63

Table 2. Fraction (%) of individuals in all-male and all-female groups during different seasons (AF, adult female; AM, adult male).

Season	Duration	AM	AF
Rainy	October–January	16.40	21.73
Wet	February–May	31.74	39.67
Dry	June–September	23.25	24.59

Spotted deer were observed throughout the day. They usually graze in the grasslands and drink from waterholes in the late afternoons and early mornings and were observed to move into grasslands from the forested areas well into the night, when they were seen gathered in large groups in grasslands, especially in those with associated waterholes. During the midday hours (1000 to 1500 h) they rested, standing or lying down under the shade of a tree in grasslands or in the forest. Often an entire group, except for a few individuals, was seen lying down under a tree during early afternoon.

The frequency of observation per unit time during different times of the day during the rainy, the wet and the dry seasons is shown in Fig. 6. In all three seasons, fewer deer are seen during the early afternoon (1200–1500 h), but this is especially pronounced during the dry season (Table 3). During the dry season, most animals are seen either during the late afternoon or early morning.

The observed sex ratio (female:male) of adult spotted deer in the YPC was 1:0.59, while that of

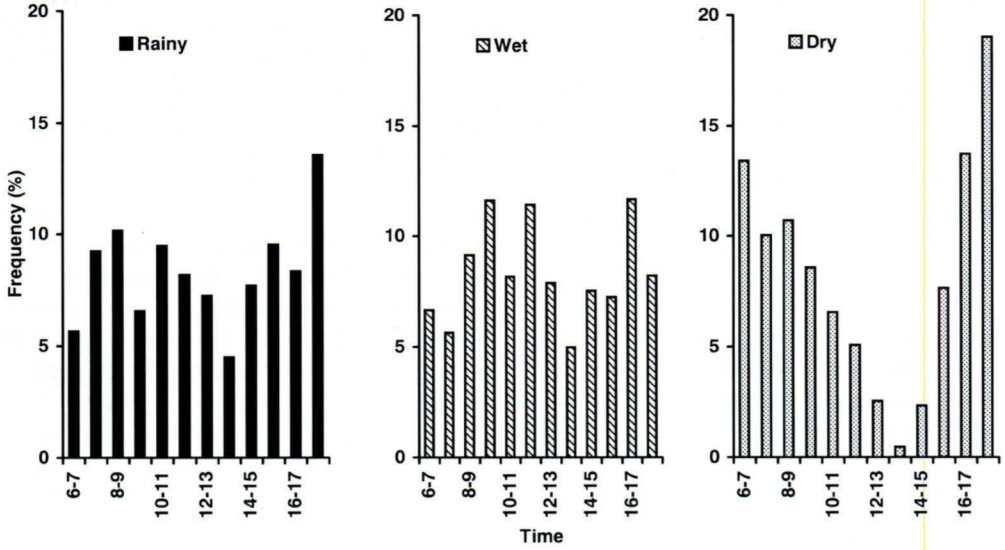

Figure 6. Number (%) of spotted deer observed (per unit time period) during different hours during different seasons.

yearlings was 1:0.47. The sex ratio fluctuated only slightly between the seasons, the adult female:male ratio being 1:0.59 in the rainy season, 1: 0.56 in the wet season and 1:0.62 in the dry season. However, these fluctuations were found to be insignificant in a c^2 test (c^2 =0.1949, d.f.=2). The skewed sex ratio indicates a probable differential mortality between adult males and adult females.

The antler cycle of the spotted deer in YPC is shown in Fig. 7. The frequency of hard-antlered males is at its minimum in March, begins to increase in April and reaches its peak in October. Velvet-antlered males are at a maximum in March and a minimum in October. Males with antlers shed are seen at a low frequency during all months but at a relatively high frequency during the period January–April with a small peak in March. Velvet antlers apparently appear with the onset of rains. Combat between males was observed during the months of March and May.

Fawns were observed during all months except July and August (Fig. 8). Thus, it appears that the spotted deer breeds throughout the year in YPC, except perhaps during the peak drought months of July and August. There appears to be an enhanced birth season

Table 3. Frequency of observation of the spotted deer during different times.

Time	Season		
	dry	rainy	wet
0600–0859	34.11	25.02	21.40
0900–1159	20.18	24.20	31.17
1200–1459	5.33	19.39	20.33
1500–1759	40.38	31.39	27.10

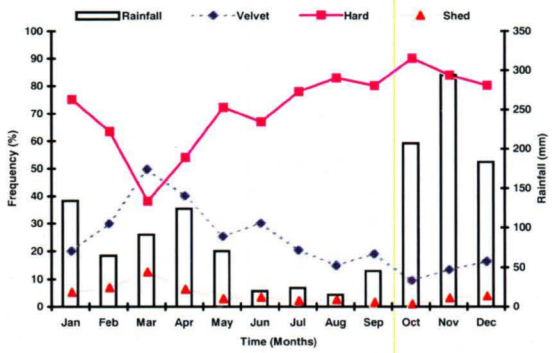

Figure 7. Frequency of different categories of adult males (those with hard antlers, velvet antlers and antlers shed) observed during the study period (April and October data from 1996 surveys, others from 1995 surveys); the rainfall pattern is also shown.

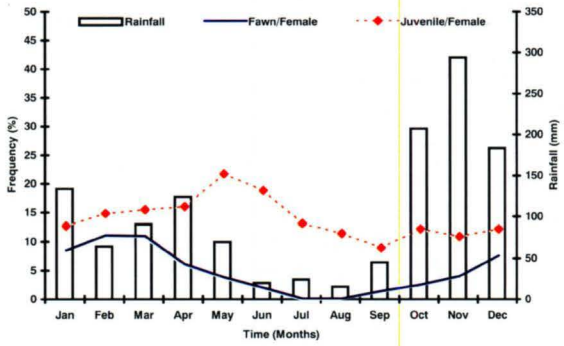

Figure 8. Frequency of fawns and juveniles per adult female during different months (April and October data from 1996 surveys, others from 1995 surveys); the rainfall pattern is also shown.

from December to March (Fig. 8), during the latter part of the rainy season.

The most important predator of spotted deer in YPC appears to be the leopard (*Panthera pardus*). Crocodiles (*Crocodilus porosus* and *C. palustris*) and jackal (*Canis aureus*) may also prey on young spotted deer. Despite the protection offered by the park complex however, the deer are subject to a high degree of poaching.

Discussion

The highest number of adult males with hard antlers was found in October while that of adult males with antlers in velvet was found during March. This is in agreement with the observations of the seasonal study carried out in 1992 by de Silva & de Silva (1993) and during 1978–1980 by Santiapillai and Chambers (pers. com) in Block I of RNP. de Silva & de Silva (1993) found the highest numbers of hard-antlered and velvet-antlered males in October and March, respectively. Santiapillai & Chambers (pers. com.) found that adult males with antlers in velvet reached their highest number during the month of May, while adult males with hard antlers were frequent in July and November in 1978 and 1979. In Wilpattu National Park in north-eastern Sri Lanka (Fig. 1), adult males with antlers in velvet were frequent during the period of April to June, while males with hard antlers were frequent from August to October (Eisenberg & Lockhart, 1972).

Eisenberg & Lockhart (1972), Balasubramaniam *et al.* (1980) and Putman (1988) observed that spotted deer groups appear to change in both size and composition according to season and habitat. This was found to be so in the present study too, as group size varied from season to season. In YPC, groups containing more than 50 individuals were seen in grassland areas near waterholes as had earlier been observed by de Silva & de Silva (1983). These large groups (n=50) appear to be temporary aggregations of a number of smaller units attracted to the grasslands and waterholes for food and water. Such feeding groups usually break up into smaller units as they retreat into the forest after feeding (pers. obs.).

Large aggregations in plains could be advantageous to herbivores also as an anti-predator strategy. In the forest however, this advantage is lost and a smaller group size is advantageous for purposes of concealment. The sambar, which is more a forest herbivore, does not form large groups, the mean group size observed in YPC being 2.21 (de Silva, 1999). However, grassland is not an ideal hunting ground for the leopard: in Serengeti Park, of the terrestrial carnivores (lion (*Panthera leo*), cheetah (*Acinonyx jubatus*), leopard, spotted hyena (*Crocuta crocuta*) and hunting dog (*Lycaon pictus*)), the leopard has the lowest speed of pursuit (up to 60 km hr^{-1}) except for the lion, the lowest distance from prey when the chase starts (5–20 m), the lowest distance of pursuit (up to 50 m) and the lowest success rate (5%) (Bertram, 1979). The gathering of spotted deer in large groups in grasslands at night is also probably for protection from predators.

All-male groups have earlier been observed in the RNP (de Silva & de Silva, 1993). Such groups are said to comprise subdominant adult males. All-female groups were also observed in the present study. The higher number of solitary individuals in the wet season may indicate that during this season, more individuals, especially the males, leave the original groups and wander around (joining new groups subsequently).

Although the spotted deer is more a grassland species than a forest species, it avoids the heat of the day in the open. Its grazing and drinking activity is largely crepuscular, especially during the dry season.

The spotted deer breeds throughout the year, although there is enhanced breeding during some months (Eisenberg & Lockhart, 1972; Mishra & Wemmer, 1982). Our observations agree with this. Enhanced breeding appears to be related to the rainfall. The number of fawns in the YPC increased from October to February and March and then decreased up to June. Fawns were not observed in July and August. This suggests that most births occur during the latter part of the rainy season and the early part of the wet season. In Chitwan National Park, Nepal, the number of births of spotted deer was very low in June and July, increased gradually up to December and then decreased up to June (Mishra & Wemmer, 1982). The rains there occur mainly in June, July and August (Dinerstein, 1982). Thus, in Chitwan National Park, the birth season of spotted deer is completely out of phase with the rainy season, although that of sambar is in phase with the rainy season (Mishra & Wemmer, 1982). The advantage of having the birth season in phase with the rainy season is obvious in an area where rainfall is seasonal. With the rains, the dried-up vegetation (especially the grasslands and scrub) grows new green and food is available in plenty to the lactating mothers and grazing fawns. However, extensive rains leading to flooding could be disadvantageous to fawns.

The gestation period of spotted deer has been estimated to be seven months (Phillips, 1984). Thus, if there is an enhanced breeding period in December–March, there must be enhanced rutting during the period May–August. From May to October there is a high frequency of hard-antlered males and this agrees with the postulated enhanced rutting period. In Chitwan National Park, the births of spotted deer are high during the period December–February, and as expected, the frequency of hard-antlered males is high

during the period May–July (Mishra & Wemmer, 1982). In YPC, the frequency of hard antlered males remains high in September and October, too: it could be that the antlers are retained for some time after the rut.

The female:male sex ratio of adults of 1:0.59 is quite similar to that of 1:0.56 observed in the Wilpattu National Park by Eisenberg & Lockhart (1972) but somewhat different from that of 1:0.48 earlier observed in the Block I of RNP by de Silva & de Silva (1993). According to Putman (1988), a ratio biased in favour of the females could be expected in species such as deer in which polygyny is the norm and where bucks compete for the does. Such a skewed sex ratio may also arise from a skewed foetal sex ratio, differential mortality between males and females, or emigration of males. It is not known whether foetal sex ratio is skewed in the spotted deer of Sri Lanka, although skewed foetal sex ratios have been observed in other species such as the red deer and the white-tailed deer (Clutton-Brock et al., 1986; DeGayner & Jordan, 1982). In YPC, no sexually selective migration was observed between the habitats studied. Thus, the skewed sex ratio observed is likely to be the result of differential mortality. However, Ashby & Santiapillai (1986) in their life-expectancy studies of spotted deer in RNP found no evidence to suggest that adult males and adult females suffered differential mortality. The observed skewed sex ratio of 1:0.47 of the yearlings favouring females could be a sampling artefact: until spike antlers are visible yearling males are difficult to identify as such, and we may inadvertently have classified some yearling males as yearling females.

According to Ashby & Santiapillai (1986), the life expectancy of spotted deer in RNP is short. Through a study of annual layering of molar cementum, they estimated average life expectancy of spotted deer in RNP to be about 5.6 years with a maximum of 14 years. Phillips (1984) states that the average life expectancy of the spotted deer in captivity is about 10 years but some individuals have lived for 14–17 years of age.

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