POPULATION DYNAMICS OF SAMBAR *CERVUS UNICOLOR*, IN PERIYAR TIGER RESERVE

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Introduction

The Sambar *Cervus unicolor* is widely distributed in the forests of Southern Asia, but little studies have been done on its biology. Several short accounts are available on the biology of the species (Krishnan, 1972; Schaller, 1967; Johnsingh, 1983 etc.). These short accounts together give a good background of the species. Sambar is found in a wide variety of habitats and is an animal of high adaptability.

In all the reserves of Indian Subcontinent where studies on the predator-prey relations have been carried out, Sambar is second only to Chital as the major prey species (Schaller, 1967). But in Periyar, the Chital is absent as it is a wet evergreen habitat. Here the Sambar is the major prey species of Tiger and Wild Dogs and an increased predation pleasure is likely to occur on Sambar. Hence a study on the food, habitat use, and population of Sambar in the reserve was taken up in 1992 with a view of identify management problems of the species.

The objectives of this study are :

1. To determine the habitat use of the Sambar in Periyar;
2. To determine the Seasonal change in food habits;
3. To estimate the population in the reserve, and
4. To identify factors affecting population of Sambar in Periyar (breeding, mortality, predation, disease etc.)

Study Area and Methods

Studies were conducted in selected parts of Periyar Tiger Reserve. Intensive studies were carried out at Edapalayam, Manakavala and monthly monitoring of the population was carried out at fixed transects (3 each) having an average length of 8 km at Thannikkudy, Methakanam and Pachakkanam. In the areas of intensive study, the Sambar was followed on two days every week (two days at Edapalayam and two days at Manakavala) and the following details were recorded, number of individuals according to age and sex, behaviour (time budget study), food and feeding habits, reproductive behaviour, mortality (predation, diseases). For studying the habitat preference, the grasslands are divided into those on the lake bed, and the rest. The food habits were studied in the field by direct observation and in the laboratory through micro-histological analysis of faecal contents (Wallamo *et al.*,

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1973; Hansen *et al.*, 1971). In the latter, a key of all possible food plants: grasses, herbs and shrubs was first prepared. The faecal pellets collected in the field were washed, preserved in 5% formalin and the leaf fragments were compared with the key prepared, and identified.

Population was studied by direct counting and by pellet counting method. For pellet counting, 1x1 m plots were taken in the study area and these plots were regularly monitored (Lautenschlager and Jordan, 1993). Monthly counting of Sambar was carried out at Medhakanam, Thannikkudy, Pachakkanam and Manakavala along the fixed transects.

Grassland and Community in the Study Area

Grasses and herbs though most abundant at hilltops and savannahs are less so at the lake side. *Chrysopogon* spp., *Cymbopogon flexuosus, Eragrostis* spp., *Heteropogon contortus, Imperata cylindrica, Themeda cymbaria, T. triandra* and *Arundinella* spp. are the dominant grasses in the hilltop and savannah. In the lake side, dominant species are *Panicum repens, Cynodon dactylon, Eragrostis* spp., *Dimeria* spp. and *Chrysopogon aciculatus*. In the moist deciduous forests, the number of grasses is less, when compared to the number of herbs. The important grass species of this area are *Cyrtococcum muricatum, C. oxyphyllum, Ottochloa nodosa, Oryza granulata* and *Oplismenus compositus*. Species diversity of grasses in lake bed is less when compared to the hilltops and savannah.

Results and Discussions

Sambar has an uneven distribution throughout Periyar. But usually they avoid dense evergreen forests. The species is seen singly and in herds of upto 60 individuals. Out of 436 observations, 22.7% are solitary individuals, 19.5% two individuals, 25.69% in groups of 2-5, 13.99% in groups of 5-10 and 18.12% above 10 individuals (Table 1). Single individuals are seen mostly during summer months and larger herds in the winter months.

In species like Sambar where groups are constantly changing in size, a 'group size' concept is not applicable. The term 'fluid groups' (Barrette, 1991) would be more applicable to the groups of this species. The frequency distribution of number of animals in Sambar group in Periyar during this study is different from that observed in 1977 (Ramachandran *et al.*, 1987) which has shown that solitary individuals formed 30.5% of the total population and the herd size seldom exceeded 8 individuals. As per the present study, 22.7% are solitary individuals while 18% of the herds sighted are above 10. Larger herds of upto 60 individuals were sighted near Edapalayam area where habitat is open and Wild Dog predation is a regular occurrence. As described in by Barrette (1991), Sambar groups could also be called fluid groups. Groups are formed which may increase in size, last upto several hours and disperse. Since the groups are ever changing, one cannot present the size of the several groups encountered. Barrette (1991) has presented a dual scale of group size, such as 10 classes from 1-10, then all groups from 11-20 in a single class, 21-30 in another class and so on. But in our study we have 5 group classes: (i) solitary, (ii) two individuals, (iii) 3-5, (iv) 6-10 and (v) above 10. The fluidity and social character is evidently seen once we follow a fleeing Sambar. The Sambar disturbed by an observer is found running

Table 1

Aggregations of Sambar in Periyar

Month	Solitary	Upto Two	Upto Five	Upto Ten	Above Ten
January	9	2	3	1	4
February	3	2	1	-	6
March	5	2	1	-	5
April	15	6	9	2	16
May	2	4	8	4	5
June	4	8	5	3	5
July	6	9	17	12	10
August	14	14	19	13	8
September	15	23	32	16	7
October	13	4	9	2	4
November	7	7	6	5	2
December	6	4	2	3	7
Total	99	85	112	61	79
Percentage	22.71	19.50	25.69	13.99	18.12

towards another Sambar; the two in turn to another individual of their species and so on. Again a search for larger group in the area, a day after they were located, often becomes a futile attempt. Schaller (1967) mentions a leadership, often an adult hind in the movements, which supports our observations in Periyar.

Larger Sambar groups are seen in open areas than in forest areas as observed in the case of Axis Deer by Barrette (1991). Similar effect was also reported for various other species (Leuthold and Leuthold, 1975; Santipillai *et al.*, 1984; Takatsuki, 1983). Larger groups in open areas is interpreted as an anti predator strategy, where animals use each other as cover (Altman, 1974; Bertram, 1978; Jarman, 1974; Pulliam and Craco, 1984). This seems to be applicable in the case of Sambar in Periyar as the Sambar fluid groups are seen mostly in open areas, where the species is more prone to predation than other areas.

The density of Sambar is calculated to be 2.1/km^2. This estimate however excludes evergreen vegetation (305 km). A density of 2.7/km has recorded by Eisenberg and Lochhart (1972) in Wilpattu National Park, Sri Lanka.

Sex Ratio : The male-female ratio was calculated to be 1:3.8 (Table 2). This almost agrees with a 1:3.5 ratio of males and females estimated from the Wild Dog kills.

Habitat preference : Habitat preference of Sambar in Periyar during different months of the year is given in Table 3. They showed a preference for grasslands (37.6%), when the grasslands on the hilltop, slope and lake shore are put together (21.2 + 16.44). They show least preference for *Eucalyptus* plantations and evergreen forests (1.07 and 5.66% respectively). Though Sambar is observed in grasslands throughout the year, they are found in savannah type vegetation and moist deciduous forests from April -

Table 2

Sex Ratio in Sambar (Cervus unicolor) in Periyar Tiger Reserve

Months	Adult Male	Adult Female	Total Adults	Calves
January	7	8	15	1
February	1	6	7	-
March	7	1	8	-
April	6	47	53	3
May	17	26	43	2
June	14	33	47	4
July	35	157	192	44
August	86	275	361	67
September	101	272	373	26
October	38	115	153	12
November	12	22	34	8
December	11	31	42	1
Total	355	1293	1628	168
Percentage	20.6	79.5		

Male : Female = 1 : 3.85

Nov. This may be due to the availability of grass, herbs and shrubs with fresh leaves during this period. The wild fire usually occurs from Dec. to March, after which, grass shoots, herbs and shrubs sprout along with the first showers (pre-monsoon).

A study on the food habits of Sambar supports the above view as grasses constitute the major portion of the food of Sambar (Table 4) followed by herbs. It consumed leaves of shrubs and trees and different types of fruits. Types of food of Sambar observed in different months of the year is given in Table 4. The table shows that Sambar consumed a variety of grasses almost throughout the year and shrubs and tree leaves, mostly after monsoon. Major food plants consisted of grasses such as *Cyrtococcum oxyphyllum, Garnotia* spp., *Oplismenus compositus, Panicum repens* and *Themeda triandra*, herbs such as *Urena lobata, Heckeria subpeltata* and *Synedrella nodiflora*, shrubs like *Helicteres isora* and *Lantana aculeata* and the tree *Grewia tiliaefolia*. They consumed fruits of *Mangifera indica* and *Emblica officinalis*. Most of the food plants except the herbs observed in the field were identified in the faeces and rumen samples. The lesser number of non-grasses in the faeces/rumen samples may be due to the fact they took less time for digestion than the grasses as the latter has Silica in them. The differential rate of digestion of different plants in Ungulates. A comparative study of the food habits of Sambar *(Cervus unicolor(*, Gaur *(Bos gaurus)* and the domestic cattle in the Reserve during monsoon season through micro-histological analysis of faecal content has shown that there is considerable overlap in the dietary habits of the three species. But as observed by Bell (1971) in Serengetti, we did not have data to show whether the three species take components from different levels of the herb layer.

Table 3

Habitat Preference of Sambar

Vegetation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Percentage
Grassland	4	6	5	16	5	5	10	8	7	4	2	7	79	21.20
Savannah	9	-	-	11	5	1	11	22	25	1	6	1	92	24.70
Moist Deciduous	-	-	3	3	3	6	15	25	47	5	4	3	114	30.72
Semi-evergreen	1	-	-	1	1	-	-	11	4	1	1	1	21	5.66
Plantation	-	-	-	-	1	-	-	3	-	-	-	-	4	1.07
Lake bed	-	-	-	3	4	8	10	8	2	20	2	4	61	16.44
Total													371	

Table 4

Frequency of Food Consumption by Sambar

Plant Type	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Apr.	May
	1992												1993			
Grass	3	14	2	4	10	9	14	10	6	3	9	12	9	9	11	10
Herb	1	2	4	3	2	3	2	-	1	4	1	-	3	2	2	2
Shrub	-	-	-	-	1	-	1	-	-	-	-	-	2	2	2	1
Tree	1	1	1	2	1	-	-	-	2	1	-	-	-	-	1	-
Fern	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Behaviour : Behaviour pattern of Sambar was recorded by time budget study. A comparative account of the various activities of the species is shown in Table 5. Sambar spends a lot of time for feeding. Longest duration for feeding bout was observed between 11 AM and 12 noon and between 3 and 4 PM. It was always difficult to get closer to the Sambar for observation. As mentioned by Krishnan (1972) it seems that they have an acute sense of hearing and smell.

Feeding Association : Sambar was observed feeding along with the Elephants, Gaur and Wild Boar in the same area without any conflict. They were also found together with grazing domestic livestock in and around several areas of Thekkady.

Anti-Predator Behaviour : Wild Dogs and Tiger are the major predators of Sambar in Periyar. The first response on seeing the Wild Dogs or a Tiger is an alarm 'dhank' (Krishnan, 1972), a loud, hoarse and brief call (Schaller, 1967). As mentioned by Johnsingh (1983), Sambar seems to have an excellent sense of smell. The animal wait for a minute and watch and then run away. Though we have recorded a couple of Tiger kills, we have never observed a Tiger killing a Sambar. But predation by Wild Dog was observed on a number of occasions, during different times of the day, mostly before noon.

The mode of hunting by Wild Dogs and the anti-predator response of Sambar were described by Schaller (1967), Johnsingh (1983) and Rice (1986). Not much difference was noted in Periyar. All the Sambar kills by Wild Dogs recorded, were near the lake. Sambar often showed a tendency to run towards lake when pursued. But Sambar running in the opposite direction was also noted on a few occasions. In self defence or defending a fawn, on the land, the Sambar lowers its head muzzle and neck stretched forward and rushes at the Dogs. At times the Sambar slows down the movement towards the Dog but kicks at it with its forelegs. Often the pursued Sambar takes refuge in water and the Dogs follow. In the lake the Sambar repeatedly splashes water with its forelegs at the Dog. In water, the Sambar gets the advantage as it can stand more easily in a metre deep water whereas the Dogs have to swim.

Reproductive Behaviour : Very little information is available on the reproductive behaviour of Sambar. Krishnan (1972) has observed young fawn in Mudumalai in March. In Periyar, mating of Sambar seem to take place mostly in winter months, November-January. Adult stags are found with females/herds during this period unlike other times of the year when they move alone. Mating was observed only once in December, while attempts for mounting were observed thrice during this period. Males were observed following individual females during this period, at feeding intervals. The first and most common physical contact that a female allows a courting male to do is vulva licking. The female may move ahead at the instant of contact or stand for many seconds and urinate while the male actively licks her vulva and drinks the urine. The male often lipcurls either before or after the female has moved ahead. The full sequence of mating however could not be observed in a single pair as the female often moved into cover.

Males with antler shed and with velvet were sighted almost throughout the year. A photoperiod effect on antler shedding was observed in captive White-tailed Deer *(Odocoileus virginianus)* (Schultz and

Table 5

Activities of Sambar (Time Budget Study)

Time (hrs)	Resting	Feeding	Bathing	Swimming	Moving	Fighting	Drinking	Anti-Predatory	Suspicious Look
6-7	3	1							
7-8	-	2			1			1	
8-9	3	6			2			1	
9-10	2	8			3		1		
10-11	8	17		1	4				1
11-12	4	24	1		3				
12-13	3	21			2				
13-14	1	10			3				
14-15	1	17			1				
15-16	1	25			2				
16-17	2	5			-				
17-18	-	11			1	1			1

Johnson, 1992). More number of stags with velvet are found in December and January. Fawns are seen almost throughout the year. Four new borns were observed; one in late June and three in July. One full grown foetus was found in June 1994.

Mortality

Predation, disease, poaching and tourism are the factors influencing mortality of Sambar in Periyar.

Predation : Sambar is the major prey species of Tiger and Wild Dogs in Periyar. Effect of predation on Sambar has not been fully worked out in Periyar. Kurup (1971) has recorded that there was clear signs of a heavy predation on Sambar by Wild Dogs in early 1970s. He is of opinion that there is of course some mitigation for Sambar as it is a nocturnal feeder, feeds in the early and later part of the day. The Wild Dogs track them and flush them out of cover. An estimate of kills in a 25 km area of tourism zone from June 1992 - May 1993 has shown that 39 Sambar were killed by Wild Dogs and two by Tiger during this period. On three occasions, Wild Dogs were chased away from the kills by local people who tried to take away the carcass. Such incidents also must have gone unnoticed and Wild Dogs must have compensated by killing another Sambar.

Disease : Five Sambar died in and around the study area during the study period due to unknown reasons. The digestive track of one of those dead specimens was full of Amphistomes. There was no sign of Rinderpest disease, though several cattle and buffaloes graze in the tourist zone of the reserve. A detailed pathological investigation is necessary to arrive at some conclusions.

Poaching : Only one incident of poaching was recorded during the study period. In this case, one Sambar was reportedly trapped and killed by a local man, who is a retired government Officer. On several occasions we have heard shooting sound

from the Kurisumalai/Anchuruli areas and the local Tribals informed us that Sambar was the target.

Impact of Tourism

Indirectly tourism has caused death of Sambar on two occasions :

(1) One Sambar was run over/hit by a motor vehicle at Thekkady breaking its legs. The animal died after a few days.

(2) Another one was hit by a jeep, but escaped with injury.

One Sambar was electrocuted near Pachakkanam, in the Vallakadavu Range, (After the period of study in May 1996, one Sambar died of some disease with symptoms resembling rabies and two others got electrocuted at Pachakkanam (in July). There is a good population of Sambar on either side of the Kumily-Thekkady road between Forest Check Post and Boat Landing. Small herds (upto 7) are often seen crossing the road, between the Office of the Assistant Wildlife Preservation Officer and the Park and they are disturbed by fast moving motor vehicles and tourists. Wild Dogs are often seen chasing Sambar in this are, though frequented by human beings and domestic cattle.

Impact of Fire

The annually occurring fire doesn't seem to affect the movement of Sambar adversely. Sambar is the first animal to enter a burnt area, a day or two after the fire, to feed on the sprouting tender shoots of grasses.

SUMMARY

Sambar in Periyar enjoys a wide distribution in the Reserve. It is the major prey species of Tiger and Wild Dogs here. Sambar was seen singly and in groups of upto about 60 individuals. They eat a variety of grasses, herbs, shrubs and leaves and fruits of various trees. The Sambar in Periyar prefers grasslands, but usually avoids evergreen forests. They spend considerable time foraging in moist deciduous forests and 'savannah' type vegetation. Density of population of the species in the reserve (excluding evergreen tract) is estimated to be 2.1/km They spent a lot of time for feeding, mostly in the mornings and evenings. Active feeding as well as 'fluid grouping' are mostly seen in open areas. This may be an anti-predator device. Male-female ratio among adult individuals was 1 : 3.86. Males are seen with females/herbs mostly during the reproductive season - December-January. Mating was observed only once occasion. In cases, which are clearly know, young ones are born in June/July months. Males with velvet are mostly found in December-February months, though it is also found throughout the year. Sambar in Periyar is threatened by several factors' disease, poaching, tourism and grazing by domestic livestock.

पेरियार बाघ संरक्षित क्षेत्र में सांभरों (*सेर्वुस युनिकलर*) की संख्या गतिकी

जी० हरीकुमार, बेन्नीचन थामस, के०जे० जौजेफ व वी०जे० जकारियास

सारांश

पेरियार में सांभर इस संरक्षित क्षेत्र में दूर-दूर तक वितरित मिलते हैं । बाघ और जंगली कुत्तों की यहां यह प्रधान शिकार बनने वाली जाति है । सांभर यहां अकेले और लगभग 60 तक के झुण्डों में मिलते देखे जाते हैं । वे सब तरह की घास, शाक, क्षुप और पत्तियाँ तथा तरह-तरह के वृक्षों के फल खाते हैं । पेरियार के सांभरों को घासभूमि पसन्द है और सदाबहार वनों से वे प्राय: कतराते हैं । आर्द्र पर्णपाती वनों में लम्बी घास वाले क्षेत्रों में वे अपना काफी समय बिताते हैं ।

संरक्षित क्षेत्र में सांभरों की संख्या सघनता (जिनमें सदाबहार भाग सम्मिलित नहीं है) अनुमानत: 2.1 किमी है । भोजन करने में वे बहुत समय लगाते हैं अधिकतर सवेरे और संध्या में सक्रिय भोजन और द्रव संयोजन खुले मैदानों में चलता है । यह एक प्रकार से हिंसता विरोधी युक्ति हो सकती है । प्रौढ़ पशुओं में नर मादा अनुपात 1:3.86 था । मादा झुण्ड के साथ नर बहुधा पुनरूत्पादन काल, दिसम्बर-जनवरी में देखे जाते हैं । संभोग करते उन्हें मौसम में एक बार ही देखा गया । भली भांति ज्ञात मामलों में बच्चे जून-जुलाई में होते देखे गए । नरम सींग वाले नर अधिकतर दिसम्बर-फरवरी में मिले, यद्यपि ये पूरे वर्ष भर भी मिल जाते हैं । पेरियार में सांभर कई कारणों से खतरे में आया हुआ है - रोग, चोर-शिकार, पर्यटन और पालतू पशुओं द्वारा किया जाने वाला वनों में चरान ।

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