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# Food habits and prey selection of tiger and leopard in Mudumalai Tiger Reserve, Tamil Nadu, India

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## Abstract

Food habits and prey selection of tiger (P*anthera tigris*) and leopard (P*anthera pardus*) in Mudumalai Tiger Reserve, Tamil Nadu were assessed from January to August 2008. Chital, *Axis axis* was the most common prey species in the study area with a density of 55.3 ± 6.28 animals/km$^2$ followed by common langur *Presbytis entellus* with 25.9 ± 3.59 animals/km$^2$ and gaur *Bos gaurus* with 11.4 ± 2.14 animals/km$^2$.The estimated mean biomass of the potential prey species was 8365.02 kg/km$^2$. A total of 179 tiger scats and 108 leopard scats were collected and the prey remains were analyzed. Sambar and chital were the principle prey species for tiger and leopard, respectively, as inferred from the relative biomass consumption of prey remains in tiger and leopard scats. The preferred prey species of leopard and tiger were sambar, common langur, wild pig and cattle. The dietary overlap between these two predators was 82% in terms of percentage frequency of occurrence of prey remains in the scats. In terms of biomass consumed, the estimated dietary overlap between tiger and leopard was 72%.

**Keywords :** food habits, line transect, *Panthera pardus*, *Panthera tigris*, prey availability, scat analysis, sympatric carnivores, vehicle transect

## INTRODUCTION

Tiger (*Panthera tigris tigris)* and leopard (*Panthera pardus fusca)* are the two large felids found in Mudumalai Tiger Reserve, Tamil Nadu, South India. Tiger is the largest of all the felids and is found in diverse habitat types including dry deciduous, moist deciduous, semi evergreen, wet evergreen, riverine, swamp and mangrove forests. They are socially dominant over other sympatric carnivores (Karanth *et al*., 2004). Both felids are territorial and wide ranging, but the effective size of the territory is the function of density and biomass of larger prey species in its habitat (Sunquist 1981; Karanth, 1991). They show remarkable tolerance to variation in altitude, temperature and rainfall regimes (Sunquist *et al*., 1999). Tigers prey upon the large ungulates in all the ecosystems in which they occur (Seidensticker 1997; Karanth, 2003). They can potentially hunt prey varying from small mammals to the largest of the bovids with the mean weight of the species hunted is reported to be 60 kg (Biswas and Sankar, 2002). Although tiger do kill smaller prey, ranging from peafowl to prawns, they cannot survive and reproduce if a habitat does not support ungulates with adequate densities (Sunquist and Sunquist, 1989).

The leopard is the most adaptable and widely distributed among all the big cats (Bailey 1993; Nowell and Jackson, 1996). According to Hamilton (1976) the leopard had the reputation of being one of the least studied of the large carnivores despite being the most abundant. This species is known for its use of habitat edges and its ability to live in close to human habitation (Seidensticker *et al*., 1990). Leopard shows plasticity in changing behaviour as conditions changes (Daniel, 1996). Leopard's ability to feed on a broad spectrum of prey makes them the most successful predator among big cats and its size gives the ability to feed on a variety of prey species ranging in size from the smallest rodent to a young buffalo (Eisenberg and Lockhart 1972; Santiapillai *et al*.; 1982, Johnsingh, 1983, Rabinowitz 1989; Seidensticker *et al*. 1990, Bailey 1993; Karanth and Sunquist, 1995; Daniel 1996; Edgaonkar and Chellam 1998; Sankar and Johnsingh 2002; Goyal and Chauhan 2006; Qureshi and Advait 2006; Andheria *et al*. 2007; Arivazhagan *et al.* 2007; Ahmed and Khan, 2008). Tiger and leopard co-exist by feeding large to small size animals (Johnsingh 1983; Karanth and Sunquist, 1995; Sankar and Johnsingh 2002; Andheria *et al*. 2007). The adaptations in the food habits of tiger and leopard are the major indications for the successful co-existence of these sympatric large carnivores (Sidensticker, 1976; Johnsingh, 1983; Karantha and Sunquist, 2000).

## STUDY AREA

Mudumalai Tiger Reserve (MTR) (110 32' & 110 43' N and 76022'& 76045' E) is a newly created Tiger Reserve in the country (established in April 2007) and situated at the tri-junction of Tamil Nadu, Karnataka and Kerala states. It is contiguous with Wayanad Wildlife Sanctuary on the west, Bandipur Tiger Reserve on the north and in south and east with the Singara and Sigur Reserved Forests which forms the boundary of Nilgiri North Division. The MTR is located within the Nilgiri Biosphere Reserve. The area of the reserve is 321 km$^2$.

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The Core Zone of this Sanctuary (100 km$^2$) has been notified as National Park. The intensive study area (107 km$^2$) constituted central area of the park including some parts of the Core Zone. The general terrain of this Tiger Reserve is gentle undulating. The elevation ranges from 960 m to 1266 m.

The vegetation types (Champion and Seth, 1968) found in Mudumalai are: Southern Tropical Dry Thorn forest, Southern Tropical Dry Deciduous forest, Southern Tropical Moist Deciduous forest, Southern Tropical Semi-Evergreen forest, Moist Bamboo Brakes and Riparian forest. The climate of the Mudumalai is moderate. There is a decreasing rainfall gradient from the west and south to the east and north (Venkataraman *et al*., 2005). Mudumalai experiences cold weather during the month of December or the beginning of January and hot weather during March and April. The average maximum and minimum temperature is 32°C and 8°C, respectively.

Tiger , leopard and dhole *(Cuon alpinus)* are the three major carnivores present in the study area. The potential ungulate prey species of the tiger and leopard in the Tiger Reserve are chital (*Axis axis),* sambar (*Cervus unicolor),* muntjac (*Muntiacus muntjak),* wild pig (*Sus scrofa),* Indian chevrotain (*Tragulus meminna)* and gaur (*Bos gaurus).* Asian elephants (*Elephus maximus)* are distributed throughout the park. Black naped hare (*Lepus nigricollis),* bonnet macaque (*Macaca radiate),* common langur (*Presbytis entellus),* Indian porcupine (*Hysterix indica),* Malabar giant squirrel (*Ratufa indica)* and peafowl (*Pavo cristatus)* are the other prey species found. Domestic livestock (cattle, buffalo and goat) occur in the village areas present inside the Sanctuary.

## METHODS

### Estimation of prey availability

Transect method (Burnham *et al.* 1980, Buckland *et al*., 1993, Sunquist and Sunquist 1989) was used to estimate densities of prey species in the study area. This method has been widely applied to estimate densities of prey species in tropical forests (Karanth and Sunquist 1992, 1995; Khan *et al.,* 1996; Biswas and Sankar 2002; Bagchi *et al.,* 2003; Jathanna *et al.,* 2003; Karanth *et al.,* 2004).

Twenty foot transects varying in length from 2 to 3 km were laid in the study area covering all major vegetation types (Figure 1). The total transect length of 82.82 km was monitored two times during the beginning of the day and late after noon resulting in 165.64 km of total effort. For each prey species sighting on a transect, the following were recorded: (1) total number of individuals, (2) animal bearing and (3) angular sighting distance. In addition to foot transects, five vehicle transects ranging from 15 to 23 km were monitored in the study area (Figure 1). The total length of 93.5 km was monitored by a four-wheel drive vehicle twice during the beginning of the day and late afternoon, resulting in 187 km of total effort. On each sighting of prey species along the vehicle transects, the following were recorded: (1) total number of individuals and (2) perpendicular sighting distance.

The density of all prey species was calculated using the Distance program *Version 5.0* (Laake *et al*. 1994) by pooling the line and vehicle transect data. The best model was selected on basis of the lowest Akaike Information Criteria (AIC) (Burnham *et al*. 1980; Buckland *et al.* 1993). All the density estimates were done after 1% truncation of the farthest sighting data from transect. While estimating the density of prey species for the study area, half normal key function with cosine adjustment gave the best fit for all the prey species.

### Reconstruction of diet

Tiger and leopard scats were collected where ever encountered in the intensive study area. A total of 179 scats of tiger and 108 scats of leopard were collected and analyzed. Tiger and leopard prefer to use roads or animal trails as travel routes and are likely to leave scats and tracks on such routes (Smith *et al*., 1989; Karanth and Nichols, 2000). To maximize overall capture effort, tiger scats were collected by walking on predetermined forest roads once in a month. Total length walked was 908 km. In addition to this, animal trails were also sampled for scat collection. Tiger and leopard scats were distinguished from one another by the size of the scats and the presence of ancillary signs like pugmarks (Sunquist 1981; Karanth and Sunquist 1995; and Biswas and Sankar, 2002), and other supplementary evidences such as the diameter of scat, scrapes, claw marks etc., Tiger scats are found to be less coiled and having larger distance between two successive constrictions within a single piece of scat, when compared to leopard which were mostly coiled and have similar distance between constrictions (Johnsingh pers.comm.).

The hair of the prey is relatively undamaged in carnivore scat and can thus be used to identify the prey species eaten (Mukherjee *et al.,* 1994a; Ramakrishnan *et al.,* 1999). Thus these undigested prey hairs which remain in the scat after washing were used for the identification of prey species. At least, 20 hairs were picked up randomly from each scat for the preparation of the slides. A combination of hair characteristics like hair width, medullary structure, and the ratio of medulla width to hair width (Mukherjee *et al*., 1994b) of the prey hairs of each scat collected were observed microscopically and were compared with the reference slides available in the laboratory of Wildlife institute of India, Dehra Dun.

### Estimation of biomass and number of prey consumed by tiger and leopard from scat analysis, using a correction factor

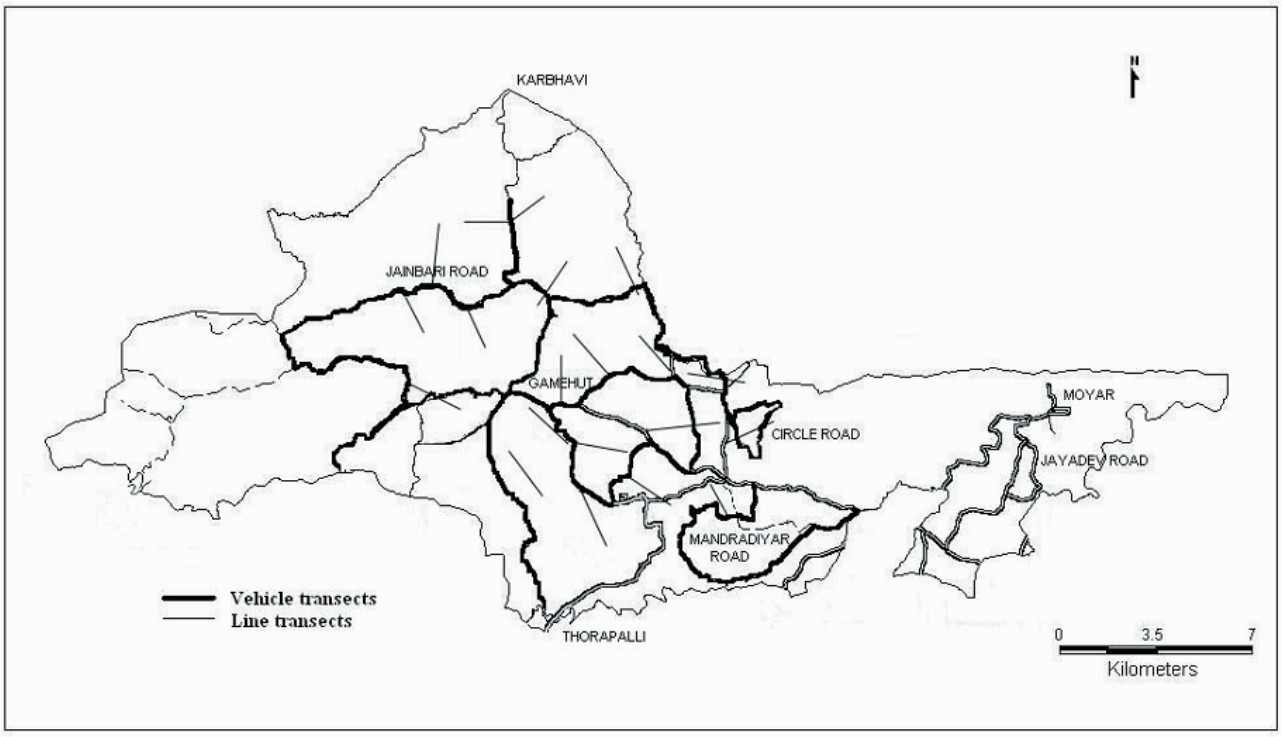


**Figure 1.** Study area showing the location of line and vehicle transects utilized for the present study

The biomass and the number of individuals of the prey consumed by tiger and leopard was estimated using the following Ackerman's equation (Ackerman *et al.,* 1984) to get a more accurate estimate of prey consumption.

Y= 1.980+0.035X

X= Average weight of a particular prey type

Y=Kg of prey consumed per field collectable scat (Ackerman *et al.,* 1984).

This method has already been used in various studies for the estimation of prey consumption by tigers (Karanth and Sunquist 1995; Biswas and Sankar 2002; Sankar and Johnsingh 2002) and leopard (Henschel *et al.,* 2005; Sankar and Johnsingh, 2002; Andheria *et al.,* 2007). The assumption for extrapolation of the above equation is that the tigers and cougars have similar utilization and digestibility (Karanth and Sunquist, 1995). We also presume that the scats containing various prey items have similar decay rate and their detection is equally probable.

**Estimation of prey selectivity**

Prey selectivity by tiger and leopard was estimated for each species by comparing the proportion of the prey species utilized from scats with the expected number of scats in the environment for each of the prey species consumed.

The expected proportion of scats in the environment (i.e. availability) was calculated using the following equation (Karanth and Sunquist, 1995):

$fi=\{(di/di * \lambda i/ \Sigma \{(di/ \Sigma di-dn) * \lambda i\}$, where

fi= expected scat proportion in the environment.

di= density of i th species

$\Sigma$ di—dn= sum of the density of all species.

$\lambda i$= X/Y = the average number of collectable scats produced by tiger from an individual of i th prey species.

X = Average Body weight of the species

Y = Ackerman's equation

The prey selection was measured by using Ivelev's index (Ivelev, 1961)

E = (U – A) / (U + A), where

U = relative frequency occurrence of prey items in predator scats.

A = expected scat proportion in the environment.

and multinomial likelihood ratio test (Chesson 1978; Reynolds and Aebischer 1991; Link and Karanth 1994; Karanth and Sunquist, 1995). The exact variability of prey items in scats is not known and in order to account for that sensitivity analysis was done by changing coefficient of variance from 10% to 40% (Link and Karanth, 1994). Program SCATMAN (Link and Karanth, 1994)

was used for this analysis and sensitivity analysis was done by bootstrapping data 1000 times.

**Dietary overlap index**

To asses the similarity of food composition between tiger and leopard, the Pianka's niche overlap index was used (Pianka, 1973). Where:

$$\text{Pianka index} = \frac{\Sigma pij * pik}{\Sigma_i (pij)\, 2 * \Sigma_i (pik)^2}$$

Pij = percentage of prey items i of predator j.

Pik = percentage of prey items i of predator k.

The index distributes between 0 & 1; the similarity is higher as the index is close to 1.

**RESULTS**

**Availability of prey species**

The individual prey densities were estimated for all prey animals (Table 1). The estimated mean biomass of the potential prey species was 8365.02 kg/km$^2$.

**Composition of tiger and leopard diet**

The analysis of 179 tiger scats and 108 leopard scats revealed the remains of eleven and ten prey species, respectively, with a high predominance of medium to large sized ungulates in both tiger and leopard diets (Table 2 and 3). Ninety five percent of tiger and leopard scats contained single prey species and 5% contained two prey species. No scat had remains of multiple prey species (> 2). Of the prey species identified from the tiger scats, sambar constituted 59.79%, chital 22.75%, common langur 5.29%, wild pig 4.23%, gaur 2.65%, cattle 2.12%, buffalo 1.06%, hare 0.53%, sloth bear 0.53%, porcupine 0.53% and unknown bird species 0.53% (Table 2). The leopard diet comprised of 37.72% of chital, 28.95% of sambar, 17.54% of common langur, 3.51% of wild pig, 3.51% of cattle, 2.63% of gaur, 2.63% of unknown snake species, 1.75 % of hare, 0.88 % of buffalo, and 0.88 % of mouse deer as inferred from the prey remains (Table 3). The total available prey biomass in the study area was estimated to be 8365.02 kg. The estimated mean biomass/sq.km of different prey species in the study area was chital 2488.5 kg, gaur 5130 kg, sambar 350 kg, common langur 207.2 kg, wild pig 15.2 kg and cattle 167.4 kg. The dietary overlap between these predators was 82% in terms of percentage of frequency occurrence of prey remain in the diet. In terms of percentage of biomass consumed, the estimated dietary over lap between tiger and leopard was 72%.

**Estimation of prey selectivity**

Sambar and wild pig were consumed by tiger more than the availability of individuals (Table 4 and Figure 2). Cattle were consumed in proportion to their availability. Common langur, chital and gaur were consumed less

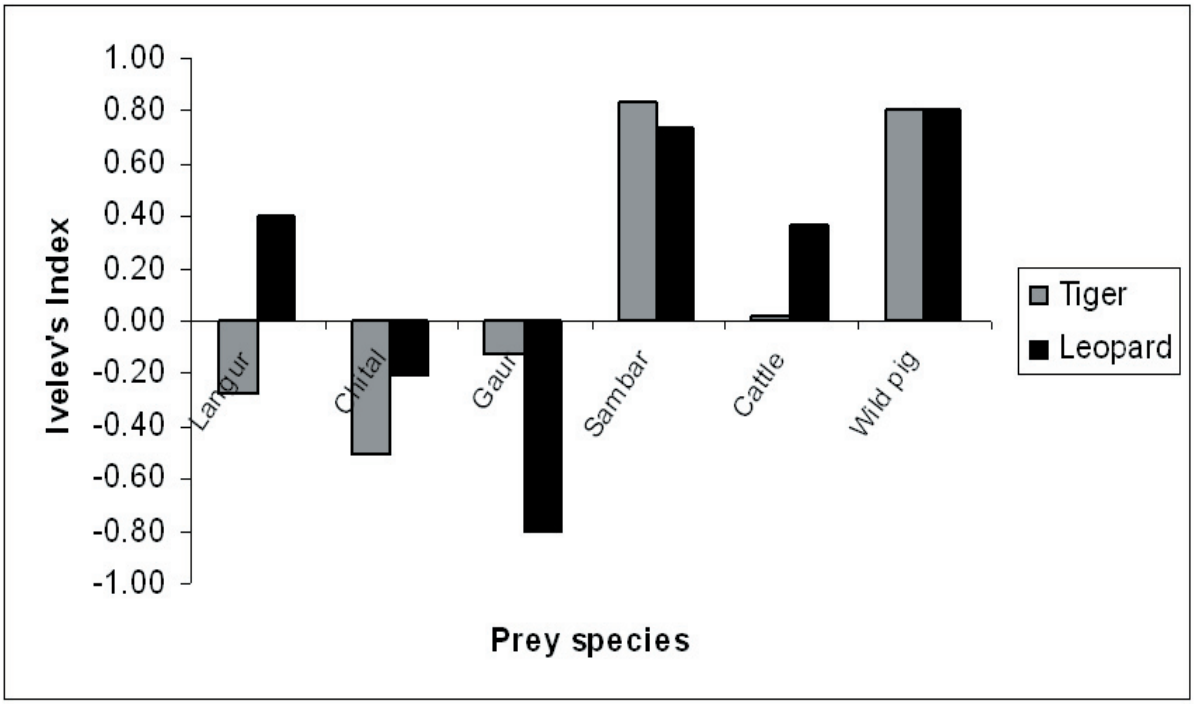


**Figure 2:** Prey selection of tiger and leopard in Mudumalai Tiger Reserve, Tamil Nadu (January to August

**Table 1.** Density of prey species in Mudumalai Tiger Reserve, Tamil Nadu (January to August 2008)

| Species | Density (ind/sq km) | SE | CV (%) | Mean group size | SE | Detection probability | No. of observations | No. of individuals |
|---|---|---|---|---|---|---|---|---|
| Common langur | 20.1 | 3.21 | 15.9 | 4.8 | 0.24 | 0.3 | 222 | 1080 |
| Chital | 30.3 | 6.28 | 20.7 | 13.2 | 0.88 | 0.4 | 334 | 1458 |
| Gaur | 6.4 | 2.01 | 31.4 | 7.3 | 0.24 | 0.1 | 118 | 883 |
| Elephant | 4.1 | 1.2 | 28.4 | 4.2 | 0.37 | 0.2 | 108 | 448 |
| Nilgiri langur | 3.4 | 0.74 | 20.5 | 7.8 | 1.87 | 0.8 | 51 | 145 |
| Sambar | 2.8 | 0.61 | 21.8 | 1.12 | 0.25 | 0.1 | 39 | 243 |
| Wild boar | 3.2 | 0.52 | 16.8 | 1.3 | 0.18 | 0.4 | 85 | 233 |
| Gaur calf | 0.72 | 0.24 | 33.8 | 1 | 0.22 | 0.3 | 26 | 83 |
| Dhole | 0.24 | 0.18 | 75.8 | 5 | — | 0.1 | 1 | 5 |
| Wild pig | 0.48 | 0.16 | 33.3 | 1.3 | 0.18 | 0.3 | 48 | 99 |
| Barking deer | 0.32 | 0.12 | 37.5 | 1.2 | 0.18 | 0.2 | 48 | 99 |
| Endangered squirrel | 1.8 | 0.32 | 17.8 | 1.1 | 0.15 | 0.2 | 85 | 218 |
| Sloth bear | 0.21 | 0.12 | 57.1 | 1 | — | 0.1 | 2 | 2 |
| Grey jungle fowl | 1.1 | 0.28 | 25.1 | 1.8 | 0.28 | 0.1 | 26 | 121 |
| Hanuman squirrel | 0.36 | 0.12 | 33.8 | 1.2 | 0.12 | 0.1 | 4 | 7 |

**Table 2.** Composition of tiger diet (*n*=179) and relative biomass contribution of different prey species in Mudumalai Tiger Reserve, Tamil Nadu (January to August 2008)

| Species | Frequency of Occurrence | Percent frequency of occurrence (A) | Average Body Weight (kg) (B) | Correction Factor (kg/scat) (C) | Relative proportion of Biomass consumed (D) | Relative proportion of Individuals consumed (E) |
|---|---|---|---|---|---|---|
| Sambar | 113 | 59.79 | 125.0 | 6.355 | 0.660 | 0.400 |
| Chital | 43 | 22.75 | 45.0 | 3.555 | 0.140 | 0.230 |
| Common langur | 10 | 5.29 | 8.0 | 2.260 | 0.0210 | 0.190 |
| Wild pig | 8 | 4.23 | 38.0 | 3.310 | 0.024 | 0.048 |
| Cattle | 4 | 2.12 | 180.0 | 8.280 | 0.030 | 0.012 |
| Gaur | 5 | 2.65 | 450.0 | 17.730 | 0.082 | 0.013 |
| Hare | 1 | 0.53 | 2.1 | 2.050 | 0.0019 | 0.680 |
| Buffalo | 1 | 1.06 | 273.0 | 11.535 | 0.0210 | 0.005 |
| Sloth bear | 1 | 0.53 | 135.0 | 6.705 | 0.0062 | 0.030 |
| Porcupine | 1 | 0.53 | 14.0 | 2.470 | 0.0022 | 0.010 |
| Bird (unknown) | 1 | 0.53 | --- | --- | --- | --- |

B) Estimated mean live weight (kg) of individuals consumed
C) Estimated weight of prey consumed per collectable scat produced, when such prey is the only item in a scat
D) = (A*C)/Σ(A*C)
E) = (D/B)/Σ(D/B)

**Table 3.** Composition of leopard diet ($n$ =108) and relative biomass contribution of different prey species in Mudumalai Tiger Reserve, Tamil Nadu (January to August 2008)

| Species | Frequency of Occurrence | Percent frequency of occurrence (A) | Average Body Weight (kg) (B) | Conection Factor (kg/scat) (C) | Relative proportion of Biomass consumed (D) | Relative proportion of Individuals consumed (E) |
|---|---|---|---|---|---|---|
| Chital | 43 | 37.72 | 45.0 | 3.555 | 0.380 | 0.180 |
| Sambar | 33 | 28.95 | 125.0 | 6.355 | 0.290 | 0.051 |
| Common langur | 20 | 17.54 | 8.0 | 2.260 | 0.180 | 0.480 |
| Wild pig | 4 | 3.51 | 38.0 | 3.310 | 0.036 | 0.020 |
| Cattle | 4 | 3.51 | 180.0 | 8.280 | 0.036 | 0.004 |
| Gaur | 3 | 2.63 | 450.0 | 17.730 | 0.027 | 0.001 |
| Snake | 3 | 2.63 | --- | --- | --- | --- |
| Hare | 2 | 1.75 | 2.1 | 2.0535 | 0.018 | 0.185 |
| Buffalo | 1 | 0.88 | 273.0 | 11.535 | 0.009 | 0.0007 |
| Mouse deer | 1 | 0.88 | 3.0 | 2.085 | 0.009 | 0.064 |

A) Percent frequency of occurrence
B) Estimated mean live weight (kg) of individuals consumed
C) Estimated weight of prey consumed per collectable scat produced, when such prey is the only item in a scat
D) = (A*C)/Σ(A*C)
E) = (D/B)/Σ(D/B)

in comparison to their availability. The index of prey selection by tiger at individual species level was in the following order: sambar > wild pig > cattle > chital > gaur > common langur (Table 4).

For leopard, common langur, sambar, wild pig and cattle were preferred more than their availability (Table 5 and Figure 2). Chital and gaur were consumed less than their availability. The index of prey selection by leopard at individual species level was in the following order: wild pig > sambar > common langur > cattle > gaur > chital (Table 5).

## DISCUSSION

### Availability of prey species

The high abundance of different prey species in the present study may be attributed to the availability of variety of vegetation types ranging from dry thorn forests to semi evergreen forests, availability of food plants, water resources and forest protection. Chital, which were observed to be the most abundant prey species in the study area, were largely found in forest edges having palatable grass species as undergrowth. The study area has good network of roads and fire lines creating a mosaic of openings, an optimal habitat for chital. Chital is known to prefer ecotone or forest edges (Schaller 1967; Johnsingh and Sankar, 1991). The densities of chital in the study area are comparable with sites such as Kanha (Schaller, 1967) and Pench (Biswas and Sankar, 2002) and Nagarahole (Karanth and Sunquist, 1992) Tiger Reserves (Table 1 and 6). The common langur had the second highest abundance in the study area (25.9 individuals/ km$^2$) and this may be attributed to the canopy continuity of the forest types and availability of food plants through out the year. The densities of common langur in the study area are comparable with Nagerhole (Karanth and Sunquist, 1992) (Table 1 and 6). The barking deer is a shy animal and occurs in low densities across its present distributional ranges (Schaller 1967; Barrette, 2004). Though peafowl and Indian giant squirrel were distributed throughout the study area, their density was 3.7 individuals/km$^2$ and 1.6 individuals/km$^2$, respectively, on transects. The do-

**Table 4.** Prey selection by tiger in Mudumalai Tiger Reserve based on availability of individuals and utilization based on scat data (January to August 2008)

| Species | Chi-Square value | Adjusted p-value (10% cr) | Adjusted p-value (40% cr) | Ivlev's index |
|---|---|---|---|---|
| Langur | 6.7626 | 0.0112 | 0.0200 | -0.272 |
| Chital | 18.8883 | 0.0001 | 0.0006 | -0.513 |
| Gaur | 109.6599 | 0.0001 | 0.0001 | -0.124 |
| Sambar | 1826.6754 | 0.0001 | 0.0001 | 0.830 |
| Cattle | 0.5299 | 0.4761 | 0.4821 | 0.018 |
| Wild pig | 0.6804 | 0.4274 | 0.4840 | 0.808 |

a-

tion based on scat data (January to August 2008)

| Species | Chi-Square value | Adjusted p-value (10% cr) | Adjusted p-value (40% cr) | Ivlev's index |
|---|---|---|---|---|
| Langur | 4.8454 | 0.0303 | 0.0406 | 0.403 |
| Chital | 0.0111 | 0.9151 | 0.9252 | -0.204 |
| Gaur | 65.9241 | 0.0001 | 0.0001 | -0.599 |
| Sambar | 229.5148 | 0.0001 | 0.0001 | 0.732 |
| Cattle | 3.4312 | 0.0668 | 0.0691 | 0.361 |
| Wild pig | 48.2768 | 0.0001 | 0.0001 | 0.807 |

**Table 6.** Comparison of densities (individuals/km$^2$) of prey species from different areas in India

| Species | PS | MTR | NGH | BDP | PNCH | KNP | STR |
|---|---|---|---|---|---|---|---|
| Common langur | 25.9 | - | 25.8 | 7.5 | 37.16 | 46.2 | 14.13 |
| Spotted deer | 56.3 | 25.05 | 50.6 | 40.0 | 20.75 | 3.2 | 27.62 |
| Gaur | 11.4 | 14.38 | 9.6 | 0.5 | 0.34 | 0.7 | NP |
| Sambar | 4.9 | - | 0.92 | 5.0 | NP | NP | NP |
| Barasingha | 3.4 | - | 5.5 | - | - | - | - |
| Sambar | 2.8 | 6.61 | 5.5 | 7.0 | 6.09 | 0.9 | 5.44 |
| Wild pig | 0.40 | - | 4.2 | 2.5 | 2.59 | 0.5 | 17.52 |
| Muntjac | 0.32 | - | 4.2 | 1.0 | - | 0.4 | NP |

**PS** - present study area; **MTR (Mudumalai)** - Varman and Sukumar 1995; **NGH (Nagarahole)** - Karanth and Sunquist 1992; **BDP (Bandipur)** - Johnsingh 1983; **PNCH (Pench)** - Biswas and Sankar 2002; **KNP (Kanha)** - Schaller 1967; **STR (Sariska)** - Avinandan 2003

mestic livestock were not seen inside the National Park area but encountered only in Sanctuary. Since sloth bear is nocturnal (Schaller, 1967) the two sightings obtained on sloth bear during the study period may be a chance encounter. Though the overall prey species density recorded in the study area was one of the highest in the Indian sub-continent, the estimated overall biomass of the prey species in the study area (8365.02 kg/km$^2$) was high as compared to Kanha (Schaller, 1967), Bandipur (Johnsingh, 1983), Nagarahole (Karanth and Sunquist, 1992) and Pench (Biswas and Sankar, 2002).

**Prey selection by tiger and leopard**

Sambar was observed to be the principle prey species for tigers as inferred from the percentage occurrence of prey remains in tiger scats (Table 2). Sambar also contributed to highest biomass of prey consumed by the tiger and was consumed more than the availability of individuals (Table 5 and Figure 2). Sambar's preference by tiger could be attributed to the larger body weight and wide distribution of sambar across the study area and hence there could have been higher frequencies of encounter since both the species are crepuscular in habits (Johnsingh, 1983). Similar results were obtained by other studies in the country (Schaller 1967; Karanth and Sunquist 1995; Biswas and Sankar, 2002). Chital constituted 22.75% of the tiger diet during the present study which is less than that was reported from other areas *i.e.*, Pench- 53.01% (Biswas and Sankar, 2002), Kanha-52.2% (Schaller, 1967), Nagarahole- 31.2% (Karanth and Sunquist, 1995) and Bandipur- 39% (Johnsingh, 1983).

Leopard in the study area fed on 10 different prey species. Chital, sambar and common langur constituted 84.2% of leopard's diet (Table 3) which is similar to the findings reported from Nagarahole (Karanth and Sunquist, 1995). In Sariska (Sankar and Johnsingh, 2002), chital, sambar and common langur constituted only 47.2% of the leopard's diet. However in Sariska, Sankar and Johnsingh, (2002) reported a high percentage of (45.6%) rodent remains in leopard scats and the reason for the same was attributed to the high rodent availability. On the contrary, during the present study no rodent remains were recorded in the leopard scats.

The leopard preferred common langur, sambar and wild pig in the study area (Figure 2). It was observed that both tiger and leopard showed preference for sambar in the study area. Since leopard is nocturnal and tiger is crepuscular in habits (Prater, 1980) they may show preference for the same prey species but their utilization might be in different times (hours) of a day.

The observed high dietary overlap (>72%) for the utilized prey species in terms of percentage of frequency occurrence of prey remain in the diet and percentage of biomass consumed by tiger and leopard may be attributed to high prey availability in the study area.

**Conservation of tiger and leopard in Mudumalai**

In Mudumalai tiger and leopard are found in very high densities (Jhala *et al.,* 2008). These two species co-exist in areas where there is a high prey base availability (Sankar and Johnsingh, 2002). However, the ecological separation between tiger and leopard lies in leopard's ability to survive on multiple prey species as well as small bodied prey. The high density of tiger and leopard in Mudumalai may be due to the availability of high prey base, continued forest cover (in the west with Wynad Wildlife Sanctuary, Kerala, Bandipur Tiger Reserve, Karnataka in the north and in south with Nilgiri North forest division) and forest protection. Thus, protection of the habitat along with regular monitoring of these large carnivores and their prey population using comparable scientific methods is essential for Mudumalai to emerge as one of the most important areas for tiger and leopard conservation in Western Ghats.

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