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Population density and various stress factors affecting number of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India)

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Abstract: Line transect method (Sale and Berkmuller, 1988) was used to record population density and various stress factors affecting number of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India). Population density/Km^2 of sighted Rhesus Macaques varied from a minimum of 154.76 individuals/Km^2 (November) to a maximum of 347.61 individuals/Km^2 (April) with an average of 234.71±4.97 individuals/Km^2 were recorded in the study area. Conflict with man and their domestic dog and Hanuman Langur, increase human activity in forest, less number of fruit tree in forest, well develop agricultural area nearby forest, searching food toward road side (because people thrown food items on Ladwa-Pipli road that is passes in the forest) and Hanuman Mandir in particular day, *i.e.*, Tuesday and Friday of each week in each months of year; increases artificial plantation (nursery) in forest, use of electrical fencing by farmers nearby agricultural of forest and less water resources is main reason of monthly as well as seasonally variation in population density of Rhesus Macaques in study area.

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Keywords: Rhesus Monkey, Population Density, Stress Factor, Bir Sonti Reserve Forest, Kurukshetra, Haryana.

Introduction:

Rhesus Monkey (*Macaca mulatta*) is old world monkey. It is a typical macaque, common throughout Afghanistan to northern India and southern China. Rhesus Macaques are sexually dimorphic. Adult male Rhesus Macaques measure approximately 53 centimeters on average and weigh an average of 7.7 kilograms. Females are smaller, averaging 47 centimeters in length and 5.3 kilograms in weight. They are brown or grey in color and have pink faces which are typically bereft of fur. Their tails are of medium length and average between 20.7 and 22.9 centimeters. They typically have a lifespan of about 25 years. India supports eight species of macaque out of the total ten species of Macaques occur in South Asia and thrive in 8 diverse habitats, namely, temples, urban, villages, village-cum-pond, pond, roadside, canal side and forest having varying degrees of human interactions (Richard *et al*., 1989; Smith and Mc Donough, 2005; Kumar *et al*., 2007; Sambyal and Sahi, 2007; Kumar, 2014; Kumar and Kadian, 2016). Rapid loss of vegetations in and around of rural and urban areas, increased urbanization, a good number of Rhesus Macaque has been living as commensal animal with human. Although this kind of commensalism has been seen in various temples of India where people have considered Rhesus Macaques as one of their Gods' (Pirta *et al.*, 1997; Jolly, 1985). Conflicts with man and his pets (domestic dog, *Canis familiaris*), habitat destruction through illegal felling, less numbers of fruit trees in forest area, habitat destruction, increase human population density, shifting of rhesus macaques for searching food items is the major reasons for decline the numbers of Rhesus Macaques (Kumar, 2015; Kumar, 2016). The Rhesus Macaque (*Macaca mulatta*) which is a "Least Concern" species (IUCN, 2012) has been put in the Schedule-II category by the Wildlife Protection Act of India, 1972 (amended upto 2002). Less and scanty information are available on the various aspects of population density of Rhesus Monkey in Haryana, particular. Hence the present study was planned to record population density and various stress factors affecting number of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India).

Materials and Methods:

Bir Sonti Reserve Forest (30° 0' N latitude and 77° 1' E longitude) occupied an area of 474.50 acres and located on Kurukshetra-Ladwa link road around 10 Km toward East side of Pipli Bus Stand (located on Delhi-Amritsir highway or National Highway-1 or Grant Trunk road or Sher Shah Suri Marg) (Fig. 1). This area was declared as reserve forest in the year 1946. However, it came under the jurisdiction of forest department, Government of Haryana in the year 1966. Dominant species of birds, namely, *Acridotheres tritis, Corvus splendens, Dendrocitta vagabunda, Turdoides caudatus, Turdoides striatus, Phalacrocorax carbo, Ardeola grayii, Dendrocygna javanice, Anas clypeate, Haliaster indus, Povo cristatus, Columba livia, Prisyaculla krameri, Haycyon smyrnesis* and *Saxicola torquata* are prevalent in Bir Sonti Reserve Forest (Kumar, 2014). Dominant tree species (*Acasia nilotica, Acasia Leucopholia, Albizza lebbek, Azadirachata indica, Bauhinia variegate, Butea monosperma, Cordea dichtoma, Crataeva nurvala, Dalbergia sissoo, Eukalyptus hybrid, Ficus glomerata, Ficus religiosa, Ficus rumphi, Morus alba, Parkinsonia aculeate, Prosopis cineraria, Prosopis juliflora, Salvadora oleoides, Tamarise aphylla, Tamarise cumini* and *Zizyphus mauritiana*), herbs and shrubs species (*Adhatoda vasica, Argemone maxicana, Brassica campestris, Capparis sepiaria, Capparis desidua, Carissa opaca, Calotropis procera, Chenopodium album, Kochia indica, Solanum nigrum, Trifolium alexandarium, Triticum aestivum, Oryza sativa* and *Zizyphus mauritiana*, and grasses, climber and sedges species (*Cuscuta reflexa, Desmostachya bipinnata, Cyprus rotundus, Cenchrus ciliaris, Dichanthium annuattum, Sporobolus marginatus, Saccharum spontaneum, Typha elephantia* and *Vetiveria zizanoides* are prevalent in Bir Sonti Reserve Forest (Kumar and Malhotra, 2014). This Forest is also an artificial forest and contains majority of the cultivated plants. A major part of the area is being used as plant nursery by the forest department, Haryana. The area has dark colored, alluvial soil rich in organic matter and having high water retention capacity. There are two tube wells (one in middle of the forest and second is present towards the main gate of forest) supply the water to the forest area as well as faunal species. A Hanuman Mandir (holy temple) is also situvated on Ladwa-Pipli road around 2Km toward South side of forest.

Line transect method (Sale and Berkmuller, 1988) was followed to record population density of Rhesus Monkey, *Macaca mulatta*. Different age classes, *viz.*, all male, all female, Juvenile and Infants were identified following age-sex wise classification of Rhesus Monkey given by Kent *et al.*, 1994. Four transects, namely, T-1 (0.10 Km^2), T-2 (0.12 Km^2), T-3 (0.08 Km^2) and T-4 (0.12 Km^2) with total area 0.42 Km^2 were selected in the study areas. The total area scanned in these selected habitats were measured with the help of GPS (Geographical Positioning System). The data collected from study sites was analysed to estimate the population density of Rhesus Monkey on monthly basis, seasonally as well as on annual basis using following formula (Chetry *et al.*, 2007 and Kumar, 2016).

$$\text{Population density} = \frac{n}{L} \times 2 \times B$$

n = Number of individuals sighted

L= Length of transect

B= Perpendicular visual distance along each transect (a distance of 50 meter was scanned in each side of all four selected transects in the study area.

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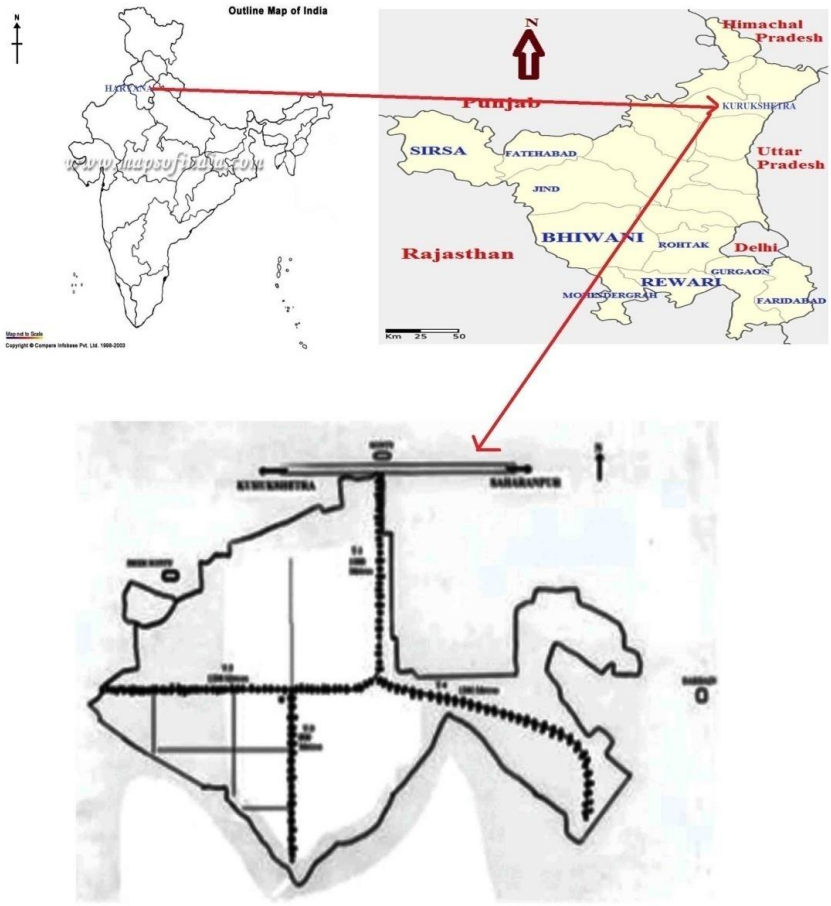

Fig. 1 Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India).

Results and Discussion: Kurup (1984) recorded 79 troops of Hanuman langur, *Prebytis entellus* (population density 5.00 individuals/Km^2) in Andhra Pradesh, 241 troops (population density 3.96 individuals/Km^2) in Karnataka and 341 troops (population density 22.51 individuals/Km^2) in Tamilnadu of India. Population of 162 Barbary macaques (six groups) inhabiting the Ghomaran fir forests of the Moroccan Rif mountains had a density of 6.73 individuals/Km² (Mehlman, 1989). Rhesus macaques actually sighted numbered 695 in 21 groups (Himachal Pradesh) and 323 in 22 groups (in Haryana), and 25 and 6 Hanuman langur groups that were encountered contained a total of 533 individuals in Himachal Pradesh and 62 individuals in Haryana, respectively (Tiwari and Mukhrjee, 1992). Ragmi and Kandel (2008) recorded a total of 213 Assamese macaques were encountered in 9 groups and group density was 0.0790 groups/Km² with a population density of 1.8691 individuals/Km². The seasonal average numbers, *i.e.*, 16.16±0.88 (summer season), 71.66±3.88 (summer season); 15.33±1.08 (summer season) and 13.33±1.02 (monsoon season) of all male, all female, juvenile and infants of Rhesus Macaques, respectively, were sighted in Saraswati Plantation Wildlife Sanctuary (Kumar, 2015). A total of numbers 170 (17.66±1.22 in summer season), 760 (75.33±2.98 in summer season), 134 (14.33±1.37 in summer season) and 114 (11.66±1.33 in monsoon season) individuals of all male, all female, juvenile and infants Rhesus Macaques were recorded in Bir Sonti Reserve Forest (Kumar, 2016). Population density/Km^2 of sighted rhesus macaques varied from minimum of 90.27 individuals/Km² (July, 2008; December, 2008) to a maximum of 183.33 individuals/Km² (April, 2008) with an average of 132.63±5.95 individuals/Km² were recorded from Saraswati Plantation Wildlife Sanctuary (Kumar, 2016).

In the present study, monthly variation in population density/Km^2 of all male Rhesus Macaques varied from a minimum of 19.04 individuals/Km^2 (November) to a maximum of 50.00 individuals/Km^2

(April) with an average of 33.72±2.71 individuals/Km^2; population density/Km^2 of all female rhesus macaques varied from a minimum of 90.47 individuals/Km^2 (November) to a maximum of 226.19 individuals/Km^2 (April) with an average of 150.78±4.41 individuals/Km^2; population density/Km^2 of sighted juvenile of rhesus macaques varied from a minimum of 19.04 individuals/Km^2 (December) to a maximum of 38.09 individuals/Km^2 (March and September) with an average of 28.56±1.92 individuals/Km^2 and population density/Km^2 of sighted infants of rhesus macaques varied from a minimum of 9.52 individuals/Km^2 (February and March) to a maximum of 35.71 individuals/Km^2 (April) with an average of 21.62±2.01 individuals/Km^2 (Table 1 and Fig. 2). Overall population density/Km^2 of sighted rhesus macaques varied minimum of 154.76 individuals/Km^2 (November) to a maximum of 347.61 individuals/Km^2 (April) with an average of 234.71±4.97 individuals/Km^2 were recorded in Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India) (Table 1). The population density of Rhesus Macaques in Bir Sonti Reserve Forest is minimum in the month of November because all the troops with their family members migrates for searching foods toward Hanuman Mandir, holy temple (one week bhandara organize by village committee members) and macaques spent their maximum time in nearby holy temple. Also population density of Rhesus Macaques in Bir Sonti Reserve Forest is maximum in the month of April because during this month all the crops nearby agricultural area of forest harvested by farmers, so the macaques spent their maximum time in forest. April month is reproductive periodic month of rhesus macaques and mated female perform rest activity during this month, hence family member stay in forest so it is another reason of maximum population density of rhesus macaques during this month.

Kumar (2015) observed seasonal variation in the population density/Km^2 of sighted all male, all female, juvenile and infants varied from a minimum of 54.16 individuals/Km^2 (winter season), 219.44 individuals/Km^2 (monsoon season), 41.66 individuals/Km^2 (winter and monsoon seasons) and 27.77 individuals/Km^2 (winter season) to a maximum of 69.44 individuals/Km^2 (summer season), 298.44 individuals/Km^2 (summer season), 63.68 individuals/Km^2 (summer seasons) and 55.55 individuals/Km^2 (monsoon season), respectively, in Saraswati Plantation Wildlife Sanctuary. Similarly, in the present study seasonal variation in the population density/Km^2 varied from a minimum of 9.47 individuals/Km^2 (autumn season) to a maximum of 126.19 individuals/Km^2 (summer season) of sighted all male Rhesus Macaques; varied from a minimum of 402.38 individuals/Km^2 (winter season) to a maximum of 538.09 individuals/Km^2 (summer season) of sighted all female Rhesus Macaques; varied from a minimum of 69.04 individuals/Km^2 (winter season) to a maximum of 104.76 individuals/Km^2 (summer seasons) of sighted juvenile Rhesus Macaques and varied from a minimum of 38.09 individuals/Km^2 (winter season) to a maximum of 78.57 individuals/Km^2 (monsoon season) of sighted infants of Rhesus Macaques were recorded in Bir sonti reserve forest (Fig. 3).

The average seasonal population density/Km^2, *i.e.*, 16.16±0.88 (summer season), 71.66±3.88 (summer season);,15.33±1.08 (summer season) and 13.33±1.02 (monsoon season) of all male, all female, juvenile and infants of Rhesus Macaques, respectively, were sighted more frequently in Saraswati Plantation Wildlife Sanctuary (Kumar, 2015). Similarly in the present study, variation in the average population density/Km^2 of sighted male is 31.07±1.90 in monsoon season, all female is 179.36±2.99 in summer season, all juvenile is 34.92±1.95 in summer season and infants is 26.19±2.88 in monsoon season were sighted more frequently during the study year (Table 2). No significant variation ($t = 6.7$, $p<0.05$) in group size and composition and seasonal population density/Km^2 were observed among the forested Rhesus Monkeys in different habitats, *i.e.*, semi-evergreen forest, evergreen forest, deciduous forest, mangrove forest, planted forest, tea garden and scrub forests (Hasan, 2003; Hasan, 2010; Hasan *et al.*, 2013; Kumar, 2014; Kumar and Kadian, 2015; Kumar, 2016). In present study, Duncan's multiple range test (DMRT) results revealed that there was no significant difference ($p\leq0.05$) recorded in average seasonal population density of sighted individuals of all males, all females, juveniles and infants in different seasons in study area (Table 2).

Earlier coworkers likes Khan and Ahsan (1981); Richard *et al.* (1989); Stanford (1991); Koganezawa (1995); Hasan (2003); Hasan (2010); Kumar (2015) observed that conflicts with man, domestic dog (*Canis familiaris*), Hanuman Langur (*Presbytis entellus*); human population increase; habitat destruction through illegal felling; less numbers of fruit trees in forest areas; shifting of Rhesus Macaques for feeding in particular day, *i.e.*, Tuesday and Friday as well as in particular season nearby agricultural areas, villages areas and various holy places were the major reasons in monthly and seasonally variation in its numbers as well as population density of rhesus macaques in study areas. Similarly in the present study, conflict with man and their domestic dog and Hanuman Langur; increase human activity in forest; less number of fruit tree in forest; well develop agricultural area nearby forest; searching food toward road side (because people

thrown food items on Ladwa-Pipli road that is passes in the forest) and Hanuman Mandir in particular day, *i.e.*, Tuesday and Friday of each week of month; increases artificial plantation (nursery) in forest; use of electrical fencing by farmers nearby agricultural of forest and less water resources is main reason of monthly as well as seasonally variation in population density of Rhesus Macaques in study area.

Table 1. Monthly variation in population density of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India).

Months of year	Population density/Km^2				
	All male	All female	Juveniles	Infants	Overall
February, 2008	38.09	171.42	23.80	9.52	242.85
March, 2008	40.47	164.28	38.09	9.52	252.38
April, 2008	50.00	226.19	35.71	35.71	347.61
May, 2008	35.71	147.61	30.95	28.57	242.85
June, 2008	26.19	116.66	23.80	26.19	192.85
July, 2008	23.80	107.14	23.80	23.80	178.57
August, 2008	45.23	214.28	35.71	28.57	323.80
September, 2008	33.33	161.90	38.09	26.19	259.52
October, 2008	38.09	178.57	23.80	21.42	261.90
November, 2008	19.04	90.47	23.80	21.42	154.76
December, 2008	23.80	100.00	26.19	14.28	164.28
January, 2009	30.95	130.95	19.04	14.28	195.23
Mean±S.E.	33.72±2.71	150.78±4.41	28.56±1.92	21.62±2.01	234.71±4.99

Table 2. Seasonal variation in average population density of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Saraswati Plantation Wildlife Sanctuary in district Kurukshetra, Haryana (India).

Sighted individuals	Seasons			
	Winter	Summer	Monsoon	Autumn
All male	30.95±1.81^A	42.06±1.98^A	31.07±1.90^A	30.15±1.84^A
All female	134.12±2.87^A	179.36±2.99^A	146.03±2.91^A	143.65±1.89^A
Juvenile	23.01±1.04^A	34.92±1.95^A	27.77±1.67^A	28.57±1.71^A
Infants	12.69±1.21^A	24.60±2.01^A	26.19±2.87^A	23.01±2.17^A

Mean with same letter in the same row are not significantly different (p<0.05) (Duncan, 1955).

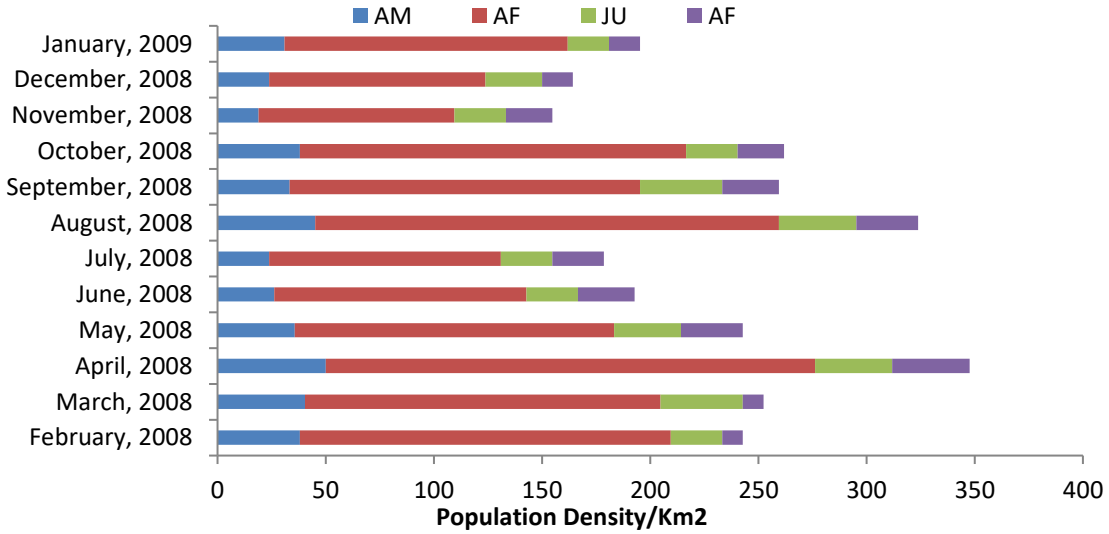

Fig. 2 Monthly variation in Population density/Km^2 of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India).

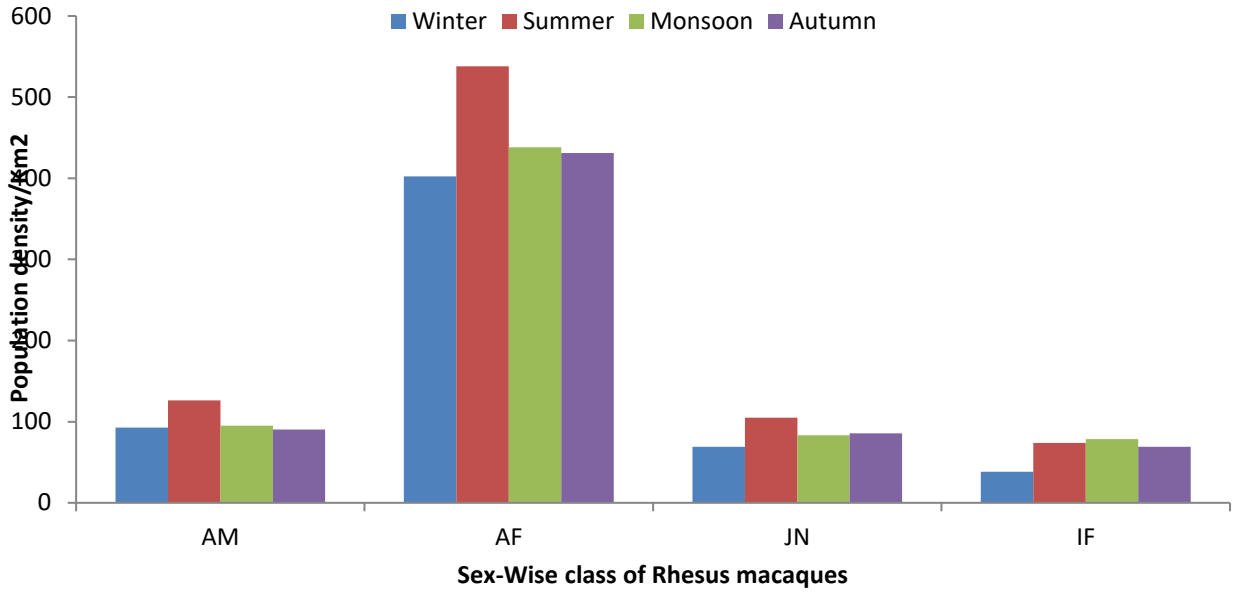

Fig. 3 Seasonaly variation in Population density/Km^2 of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Sonti Reserve Forest in district Kurukshetra, Haryana (India).

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