Circadian variability and diurnal generosity of stray street cow in Seepat, Bilaspur, India

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Abstract

This research article documents circadian variability in behavioural variables, namely resting and standing in stray street cow of Seepat, Bilaspur, Chhattisgarh India. We also estimated the abundance as a function of time of the day and gender in a population of stray cow inhabiting road side of the urban area.

We determined the abundance of street cows at six hotspots using the photographic capture-recapture technique and Lincoln index equation. At the same time, we also determined the density cows six randomly selected urban areas. We recorded the resting and standing activities of the stray street cows using still and video cameras at three times of the day continuously over a longitudinal timescale of 72 hours.

The sightings of cows were always more during the evening and night-time irrespective of the investigated routes and hotspots. Further, we also observed that the abundance of female cows was always significantly more as compared with their counter parts. These findings were complimentary to the observed circadian variability in the resting and standing behaviour of the stray street cows.

Despite a few limitations, this study documents a statistically significant circadian rhythm with reference to gender in activities of street cows. These data might also help in addressing street cow menace– one of the major problems the people and administrative authorities of most of the Indian cities and elsewhere worldwide are experiencing since quite long.

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Cow became in scarce supply as food producers[19] and through a complex interplay of cultural and socio-economic factors, reverence for the cow became a centre piece of Hindu culture[14]. The population of street cows in Indian cities is increasing in tandem with the rapid strides in urbanization, Gowen[10], Arya *et al.*[1], Sahu *et al.*[23]. It has been estimated that about 1.5 billion cows live in India's cities and towns[8]. This is a challenging issue and has been linked to many public health and safety problems for both the human being as well as cows. The street cow exhibit several problems such as road accidents, ingesting plastic, cow slaughter-illegal exporting *etc.*[4,6,20,28].

In India, many road accidents take place on account of street cows[28]. Mostly the bike riders, pedestrians and cyclists are the victims and they meet with incurable moments. Although there are no separate official records of road accidents caused solely due to the involvement of street cows. On the contrary, a homeless cow that has become particularly bloated as a result of ingesting plastic, heavy metals and carcinogens which exhibit severe problems for the not only to humans but also to the cow population[1,7].

The farmers of Asia does not wants to be instrumental in cow slaughter, may be inclined to set loose their unprofitable cows[15]. Apparently, existence of community grazing lands, separated from farmlands was sufficient. Imaginably, such grazing lands have shrunk drastically. Therefore, many cows seek their fortune in the city, where they are more likely to meet with ominous disaster[22]. Steadily Indian state laws came into effect and several prosecutions followed, mainly against cow slaughters and illegal exports, hide merchants, butchers and other such shareholders in the cattle industry[2,16,25]. Modern day sees ample media reports of vigilantism by self-proclaimed cow protectors, biased court prosecutions and blocking of cow slaughter and illegal exporters[3,25]. Presently, Indian laws have implemented strictly, resulting in a largely unproductive surplus cow population either roaming the streets or living in animal shelters. Many members of the Indian community do not necessarily look upon this as a negative, since they place intrinsic value in saving the animals from premature slaughter and illegal exports[3,26]. The government of Chhattisgarh launched the *Godhan Nyay Yojna* to buy cow dung from livestock owners and covert it to fertilizer, this phenomenon would help to minimize the street cow population (http://agriportal.cg.nic.in).

In summary, the stray street cows are one of the largest issues of discussion. It is evident from the foregoing that most of the studies on stray street cows are related to the consequences[1,23,24]. The behaviour of Indian street cows has been not studied adequately[1,23,24]. Therefore, in this study, we made an attempt to determine the circadian rhythm and diurnal generosity of cow along a longitudinal timescale spanning 72 hours continuously.

Subject and study area :

This is the direct study methods of finding the population density in which we took the street cows (*Bos indicus*) of Seepat, Bilaspur as the subjects. However, we did not

make any investigations to identify their lineage. The present study consisted of estimation of population of street cows using two different approaches. We chose the Seepat tehsil, Bilaspur (District: Bilaspur; State: Chhattisgarh; Country: India) as our study area. It is an urban area located at 22°114'N and 82°2902'E around 22 km away from Bilaspur city. According to the 2011 census about 0.27 million people live in its jurisdiction. The total road length of the city is about 58 km (www.cgrdc.in). The roads are narrow and lack adequate sidewalks for pedestrians. We randomly selected six different locations of the seepat for the study (Figure 1; Table-1). We called these locations cow hotspots. In our pilot studies, we discovered that these locations have a high density of free-ranging street cows. We estimated the population of the free-ranging street cows using photographic capture and recapture technique comparable to that employed by Goswami et al.,[9]. On the first day, we took the photo graphs of the street cows present in groups at a selected cow hotspot and on the fourth day and seventh day at the same place we took their photographs again approximately at the same time. We repeated this procedure for all six cow hotspots. We recorded the body colour and gender of each cow that we encountered and photographed. We noted other identifying features in mobile notes. On the basis of our field notes and comparison of pictures of all the three days we ascertained absence and/or addition of new cows at each location on the third day of the study.

Analytical method :

We used Lincoln index method to compute the population of the street cows (http://www.country sideinfo.co.uk/lincoln.htm). This method is akin to capture-mark-recapture method which is used routinely to estimate the population of a given animal species, where it is almost impossible to enumerate every individual. "It is the proportion of marked animals in the second sample is the same as the proportion of marked animal to unmarked within the whole population (http://www. countrysideinfo.co.uk/lincoln.htm)." Prior to this, few authors used this technique successfully to estimate the population of street cattle in the urban Sambalpur[1,27]. According to the Lincoln index equation: $n3 / n2, n1/ N$ Thus, $N = n2 \times n1 \div n3$ where $n1$ defines the number of total animals sighted and photographed on the 1st day, $n2$ defines the total number of animals sighted and photographed on the 3rd day, $n3$ is the number of photographed animals sighted on the 1st as well as on the 3rd day, and N is the estimated total population. Population density along representative routes we counted the number of stray street cows per kilo-meter road length following the standard protocol[13]. We carried out the route and location surveys using Google apps, like 'Google maps' and 'My maps,' downloaded in the Android platforms of smartphones. We carried out the head counting of all stray cows sighted along the left flank of the designated routes both during up and down rides. We followed this method for all three routes chosen prior to the beginning of the actual study. We used a motorbike to complete the survey along all three selected routes (Table-2). Using Google Map App we measured the length of each route and confirmed it from the readings on the milometer of the bike. We selected routes that were not more than 20 km

considering the feasibility of completing both up and down rides in less than 4 hours. We kept the speed of the bike optimum enabling us to take photographs of the sighted dogs, ascertain their gender and colour of the fur coat. The speed of the bike was also adequate enough for the exclusion of double counting[13]. We performed the survey on each route thrice a day, *i.e.*, morning (07:00–08:00), afternoon (12:00–13:00) and evening (17:00–18:00) to gauge diurnal variability in the abundance of cows along the selected routes. In total, we carried out six surveys, two in the morning, two in the afternoon and two in the evening, for each route.

Study on circadian variability :

We carried out the study on circadian variation in activity patterns of street cows in all six selected locations, namely Janji, Pondi, Machkhanda, Navagaon, Darra and karma (Figure 1). We monitored the resting/standing activity of stray cows around 6- hour intervals (07.00, 12.00 and 18.00) through direct observations and still/video photography. We carried out these methods at all six sites continuously for three consecutive days. Recently, this technique was used successfully to study circadian variation in different types of activities of street cattle in urban areas of Sambalpur[1] and Raipur cities[24].

Ethical statement :

The research methods employed in our study were appropriate, ethical and also were in conformity with the principles of good research practice.

Statistical analyses :

In this study, we determined the Pearson's correlation coefficients to ascertain any relationships between behavioural and environmental variables using the SPSS in which we performed Fisher's exact test to ascertain the significance of the association between time of the day and gender apropos sighting of cows on the streets.

Author considered six hotspots and took pictures of the street cows on the first day and on the third day at about the same time and at each site on both occasions (Table 1). Figure 2 illustrates pictures of the cows present in a given site on both morning, afternoon and evening time. We applied the same procedure at each hotspot locality for the estimation of the population of street cows. We estimated about 140 street cows in all six designated study sites in Seepat Bilaspur (Table-1). Estimation of population density along representative routes Table-2 depicts the density of stray street cows for three randomly selected routes from Seepat to precinct of Seepat, Bilaspur . The density of cows varied as function of route, gender and time of the day of the study. The number of sighted females was always more than that of their counter parts, irrespective of the routes and time of the study. However, the evening density of the cows per km was always higher than that of the morning density (Table-2).

This is the preliminary research on circadian rhythm in resting and/or standing activity pattern of the stray street cows. Author attempted to elucidate two different activities over a longitudinal timescale. We also measured the abundance of stray street cows adopting

two different methods. Originally, we employed photographic capture-recapture technique to estimate the size of the population in six hotspot localities of the Seepat, Bilaspur urban jurisdiction. Prior to this authors worked on catles behaviours on diverse pattern[1,10,23], while we worked on six hotspots which was fixed, means the author observed the density of cows on the first day through photographs and recaptured photographs on the third day in each and every hotspot approximately at the same time of the day. Although there are several studies on population estimation of cows[1,5,18,23], we did not find any studies adopting the technique we used to estimate the abundance of cows. However, recently Swain and Pati used this technique successfully to estimate the population of street dogs and cattles in Sambalpur and Raipur, both are Indian cities[1,23,27]. The average distance we covered per hotspot was of 6.8 km. Secondly, we estimated the population density of street cows along six randomly selected routes from Seepat to Bilaspur, Seepat to Champa-Janjgir, Seepat to Korba, respectively. We covered almost 40 km to find out the density of cows.

Furthermore, we estimated the population of density of street cows along three randomly selected routes from seepat, Bilaspur. We covered 3.2 km in the Route # 1, 7 km in Route # 2 and 11 km in Route # 3 and sighted 55, 38 and 60 cows, respectively. These data correspond to 17.155, 5.428 and 5.454 cows per km along the three routes, respectively. The similar studies were conducted earlier in different countries, namely Bosnia, Serbia, Romania, Puerto Rico, Costa Rica and Nepal to find out density of dogs[13]. Reliant upon the routes and time of the day in the current study the probable projected abundance of street cows varied from 900 to 15000 in Bilaspur. This is an estimation only based on a single time point during the year. This figure would surely change when a comprehensive study would be conducted every month covering all seasons along a yearlong times scale.

The density of roaming cows, as indicated by the number of roaming cows recorded per km of street surveyed is sufficiently sensitive to expose significant difference with reference to gender. We argue it is also an important and relevant indicator, as it reflects the experience citizens have of roaming cows in their community, for example as they commute to work and school.

In the present study, we found that the cow density varies as function of the factor, 'time of the day.' Moreover, this study is the first one to report temporal variation in the density of cows. We report gender-specific data on cow density. Irrespective of studied routes we always sighted fewer male cows on the streets than that of their counter parts. The authors did not investigate gender-specific cow density; therefore, it is not possible to compare the present data with the previous studies. Further, the Fisher's exact test revealed that both males and females were sighted less in the morning. This implies that time factor is not significantly associated as regards the presence of cows along the three investigated routes.
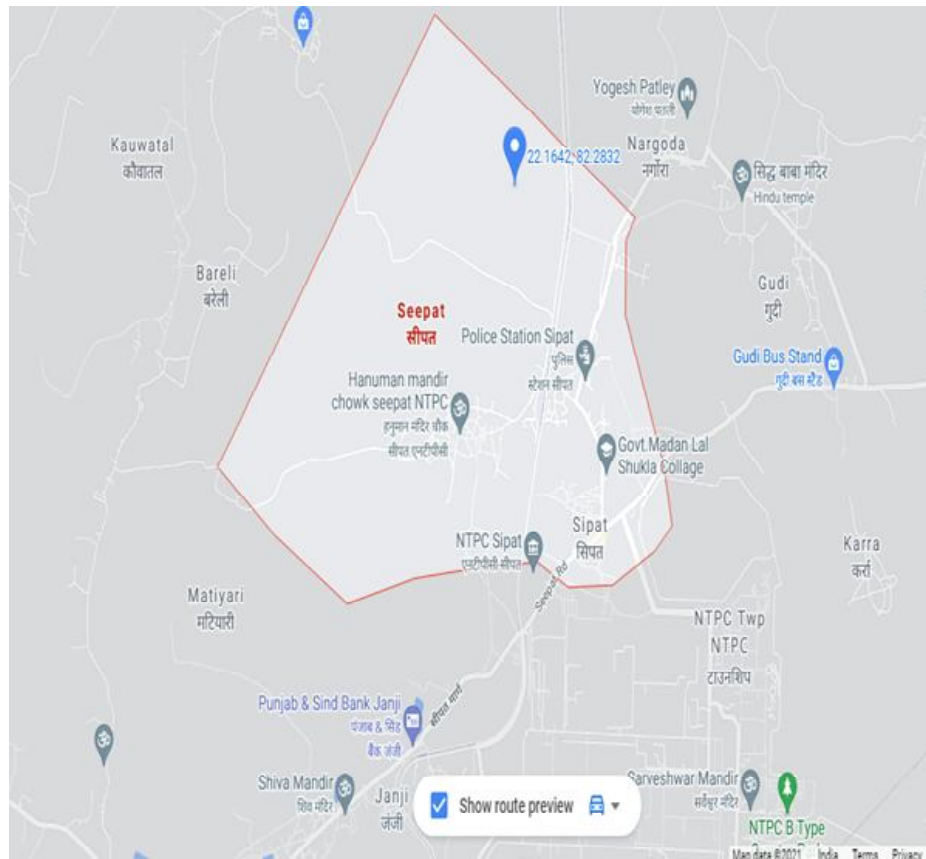
Figure 1 Map of Seepat Bilaspur displays the study area

Figure 2 Illustrative example of cows in Darra street on the morning (L), afternoon (M) and the evening (E)

Table-1. Estimated abundance of street cows in Seepat Bilaspur

Hotspot	Coordinate	Distance in km	n1	n2	n3	N
Janji,	22°13 N 82°27E	3.2 km	18	22	14	28.2
Pondi,	22°19 N 82°31E	13 km	12	7	5	16.8
Machkhanda	22°12 N 82°16E	7 km	13	7	4	22.7
Navagaon	22°28 N 82°17E	0.5 km	17	20	13	26.1
Darra	22°12 N 82°32E	6.1 km	9	15	7	19.2
Karma	22°12 N 82°29E	11 km	19	14	11	24.2
		40.8 km(Average 6.8 km)				140
Unbiased estimation based on sums of the Columns, n1, n2 and n3			88	85	54	138.5[®]

n1Number of cow photographed on the first day; n2Number of cow photographed on the third day; n3 Number of cow sighted on the first day and were also present on the third day; N Estimated total population; [®] Estimated population based on the sum total of n1, n2 and n3 of all 10 hotspot sites.

Table-2. The density of cows for three randomly selected routes from Seepat, Bilaspur

Route	Distance	Time	Total Cow sighted	Male cow sighted	Female cow sighted	Fisher's exact test p-value	Cows[-1] km^{-1}		Probable Population of cows in Seepat Bilaspur [d]
							Morning 07:00-08:00	Evening 17:00-18:00	
Route#1[a]	3.2km	07:00-08:00	18	7	11	0.0038	5.625		230
		17:00-18:00	37	15	22			11.56	472
Route#2[b]	7 km	07:00-08:00	13	7	6	0.0002	1.857		76
		17:00-18:00	25	12	13			3.571	146
Route#3[c]	11 km	07:00-08:00	19	6	13	0.0161	1.727		71
		17:00-18:00	41	18	23			3.727	152

[a]Seepat, Bilaspur To Janji

[b]Seepat, Bilaspur To Machkhanda

[c]Seepat, Bilaspur To Karma

[d] Cows[-1] km^{-1} 40.8 km (Total length of Study area)

permision to carry out.

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