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Camera trapping data indicates temporal niche segregation among mammals in a tropical deciduous forest

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Abstract

With the objective of getting a clue of a missing tigress, namely ST5, time-stamped infrared-triggered cameras were placed in selected areas of the Sariska tiger reserve (STR). Although the park management could not get any evidence of the missing tigress, however, the camera-based captured data revealed the presence of 22 species of mammals including the desert cat *Felis sylvestris*, a species that was not documented earlier in the study area. Analysis of data showed high mammalian diversity during the night in comparison to day hours. The study also demonstrated the impact of anthropogenic interferences in temporal niche segregation among the wild animals in STR.

Keywords: Anthropogenic interferences, sympatric species, temporal niche, tiger reserve

Introduction

The activity patterns of terrestrial mammals are generally categorized as nocturnal, diurnal, crepuscular (active at twilight) and cathermal (active throughout the day) (Bennie et al., 2014). Factors like day length, temperature, precipitation (Beier & McCullough, 1990), prey-predator or competitive interactions (Linkie & Ridout, 2011; Foster et al., 2013; Diaz-Ruiz, 20160 and human activities (Kilgo et al., 1998) affect these activities patterns. These patterns are highly variable across regions and seasons even within the same species. Although behavioral studies of mammals have been demonstrated through direct observations (Koprowski & Corse, 2005) or telemetry (van Schaik & Griffiths, 1996) however it requires high effort, time, and resources. To overcome these drawbacks, camera-trap survey has received increasing attention during the last decade for monitoring the activity patterns of some mammal species in detail (van Schaik & Griffiths, 1996; Gomez et al., 2005; Azlan & Sharma, 2006; Akbaba & Ayas, 2012).

Camera trapping is widely used in ecology and conservation for investigating species distributions, estimating population densities, and inventorying biodiversity (O'Connell et al., 2011; Burton et a and numerical aspects of species and population ecology (Karanth & Nichols, 1998; Linkie et al., 2007; Tobler et al., 2008), these are also used for species behavior and its interactions with others and their associated consequences for community structure. Only recently have researchers focused attention on the finer scaled temporal data provided by time-stamped camera-trap images (Ridout & Linkie, 2009; Rowcliffe et al., 2014), which detail the timing of wildlife occurrences across points in space. Such temporal data are important for a better understanding of population and community dynamics.

While looking for a clue of a missing tigress (ST5) in February 2018, camera traps were deployed in its home range in Sariska tiger reserve (hereafter called STR). STR, a tiger reserve, is well known for managerial intervention leading to the first tiger re-introduction in 2008. Very high anthropogenic disturbances due to a large number of villages in core and adjoining areas, poaching, high pilgrimage, state highways passing through the core area, and low strength of frontline staff for enforcement were the identified factors responsible for the local extinction of tigers in Sariska that was officially acknowledged in the year 2005 (Bhardwaj, 2018). Following the total extirpation of tigers in STR and with an apprehension of the possible decline of biodiversity in the landscape due to anthropogenic interferences, re-introduction of tigers was initiated from the year 2008. The decline of biological diversity in landscapes with the extinction of flagship species has already been demonstrated (Cardinale et al., 2012; Hooper et al., 2012) earlier. Tigress ST5, one of the re-introduced tigress from Ranthambhore tiger reserve, went missing at the beginning of the year 2018. Although park management could not get any clue about the missing tigress from the whole of the camera trap exercise, however, the capture events recorded in camera traps were viewed as vast data of wildlife, livestock, and other anthropogenic activities. Although there is already mounting evidence from camera-trap studies about human-driven impacts on land-use change (Ramesh & Downs, 2013), human activity (Wang et al., 2015; Ngoprasert et al., 2017), hunting (Di Bitetti et al., 2008), predator control (Brook et al., 2012) and presence of invasive competitors or predators that may alter species' activity patterns and competitive or predatory interactions through altered temporal niche partitioning (Gerber et al., 2012; Zapata-Rios and Branch, 2016), the present study is an attempt to further supplement the findings of the studies done in past. With an objective to investigate the preference of wild animals, especially mammals, to different temporal niches, we analysed the photographic data. We also attempted to investigate the correlation between capture rates of different taxonomic groups of mammals and anthropogenic pressures.

Material and methods

The study was conducted in the central part of STR, a reserve, situated in the Aravalli hill range and lies in the semi-arid part of Rajasthan (Rodgers & Panwar, 1988). The terrain is undulating and has numerous large narrow valleys, two vast plateaus and three large lakes- Silised, Mansarovar and Somasagar. It is located in the Alwar district of the state of Rajasthan, and after expanding its area was increased from 881 square kilometers to 1213.31 square kilometers due to the addition of buffer area (Fig. 1) of district Alwar in north with some part of buffer (Jamwa-Ramgarh wildlife sanctuary) constituting southern part of located district of Jaipur. The vegetation of STR is tropical dry deciduous forests (Champion & Seth, 1968) with *Anogeissus pendula* as dominant species in the undulating area and on the hills. *Boswellia serrata* and *Lannea coromandelica* grow on steep rocky areas. *Acacia catechu*, *Zizyphus mauritiana* and *Butea monosperma* are found in valleys. *Dendrocalamus strictus* is extremely limited in distribution and is located along the well-drained

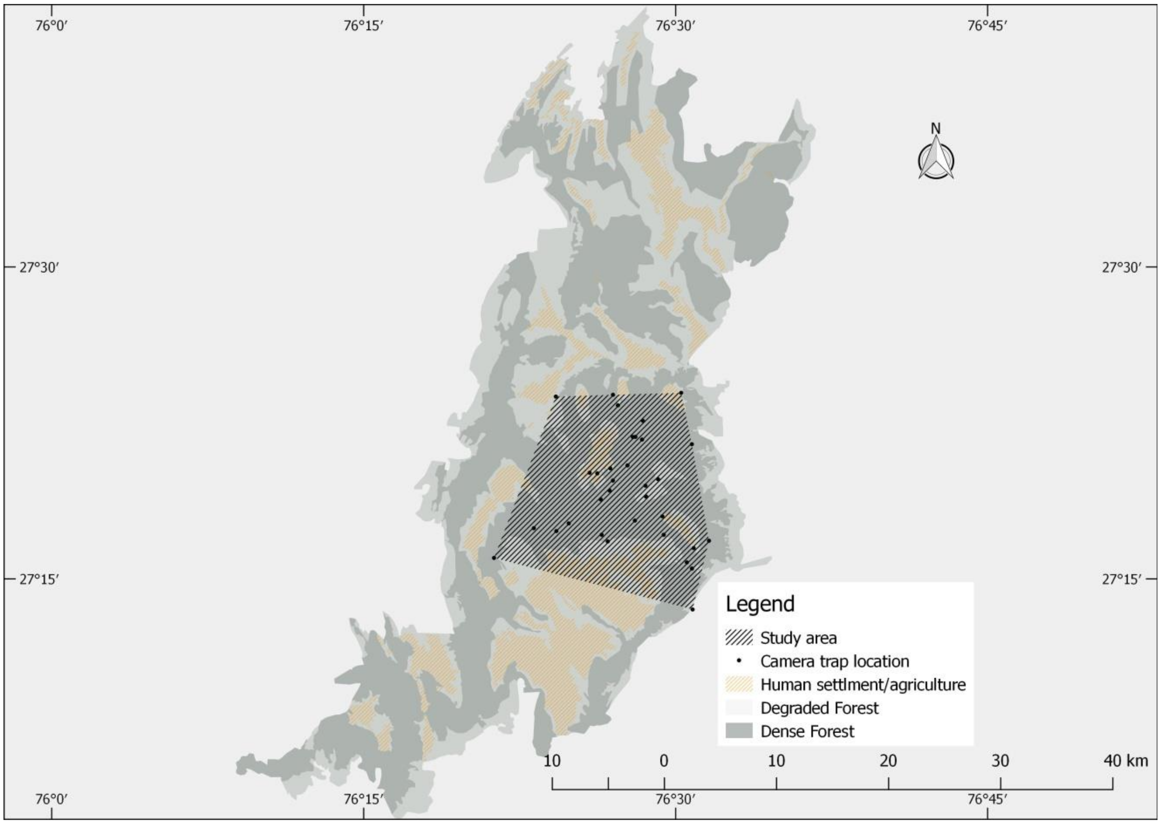

Figure 1. Map showing Sariska Tiger Reserve with study area and camera trap locations during the study period

reaches of the streams and moist and colder part of the hills. Among bushes, *Grewia flavescence* and *Capparis sepiaria* form essential components of vegetation of the reserve. Apart from the tiger *Panthera tigris*, other carnivores include leopard *(Panthera pardus)*, striped hyaena *(Hyaena hyaena)*, golden jackal *(Canis aureus)*, jungle cat (*Felis chaus*), common mongoose *(Herpestes edwardsi*), small Indian mongoose (*H. auropunctatus*), ruddy mongoose (*H. smithi*), palm civet (*Paradoxurus hermaphroditus*), small Indian civet (*Viverricula indica*) and ratel (*Mellivora camensis*). Chital (*Axis axis*), sambar (*Rusa unicolor*), nilgai (*Boselaphus tragocamelus*), and wild pig (*Sus scrofa*) are the dominant natural prey species for tigers found in STR. Other wild prey species include, common langur (*Semnopethicus entellus*), Rhesus macaque (*Macaca mulatta*), porcupine (*Hystrix indica*), rufous tailed hare (*Lepus nigricollis ruficaudatus*), and Indian peafowl (*Pavo cristatus*). About 175 villages are situated in & around STR. Out of these, 26 are located in the critical tiger habitat (core area), and the remaining villages are outside the forest area,thus making this reserve a human dominated landscape subjected to immense anthropogenic pressures.

The present survey, using 35 time stamped infrared-triggered cameras, in STR, was conducted for getting a clue for a missing tigress, ST5. The survey period commenced from second half of March 2018 till May 2018 covering a total 257 camera trap days. Cameras were deployed mostly at waterholes, animal-trails and dirt roads, where signs of tigress were evident earlier. Cameras were strapped to trees approximately one meter above the ground and oriented towards the animal-trails and dirt roads and. We conducted camera management (e.g. data extraction, batteries and exchange of cameras when required) regularly and no major technical difficulties were encountered. All photos taken by the cameras recorded the date and time.

For the sake of comparative analysis we divided a single day into morning, noon, evening and night periods *viz*. morning from 0700hrs to 1100hrs, noon (1100hrs to 1500hrs), evening (1500hrs to 1900hrs) and night (1900hrs to 0700hrs). Different taxa as recorded by camera traps as photographs were identified and divided into birds and mammals. Mammals were further divided into lower mammals, herbivores, large cats and primates.

For the estimation of temporal overlap index between sympatric species/groups Pianka's niche overlap index was used (Pianka, 1973). The mathematical expression of Pianka index is described below;

$pi = \frac{\Sigma(p_{ij} * p_{ik})}{\sqrt{\Sigma(p_{ij})^2 * \Sigma(p_{ik})^2}}$, where as,

pij= percentage of temporal items i of species j,

pik= percentage of temporal items i of species k. The value of index distributes between 0 and 1; higher the value close is the similarity.

The temporal niche breadth of sympatric species were assessed using Levins measure (Levins, 1968), standardized to a scale of 0–1 following Hurlbert (1978). Levin's Niche breadth $B = \frac{1}{\Sigma p_i^2}$ where p_i = Proportion of temporal weightage contributed by particular period i;

Standardized Niche breadth $Bs = \frac{B-1}{n-1}$, where as

n=Total number of time periods.

Mammalian species richness during the day and night hours was compared by computing biodiversity indices including Shannon index (H' Log Base 10), alpha index (α), Simpson (D) and Hill's number (H°) using BioDiversity Pro (version 2.0) (McAleece et al., 1997).

Results

A total of 4029 capture events for wild animals and human presence were observed from 257 cameras (15.68 photos per camera trap-day on average) trap days were recorded in 35 camera trap locations in the central part of STR covering most of the core area (Fig 1). A total of 22 species of mammals and 28 bird species were photographed during this camera trap exercise. Among all observations, herbivores including sambar (*Rusa unicolor*), spotted deer (*Axis axis*), nilgai (*Boselaphus tragocamelus*), wild pig (*Sus scrofa*) showed maximum records (34.5%). Table no. 1 shows the number of observations of different groups as recorded during the exercise.

Table 1. Observations of different members of taxa as captured with camera traps during the survey period

Group	Observations	%age
Herbivores	1389	34.5
Birds	969	24.0
Lower Mammals	517	12.8
Livestock	307	7.6
Human presence	643	16.05
Primates	127	3.1
Large Cats	77	1.9
Total	4029	100

Among birds observations (n=969) of recorded 28 species, the most observed species was Indian peafowl (*Pavo cristatus*) (84%) followed by Rufous Treepie (*Dendrocitta vagabunda*), Feral Pigeon (*Columba livia*), Painted Spurfowl (*Gallopedix lunulate*), etc.

While segregating mammal observations for day and night hours, 1018 were made during the daytime and 1092 during night hours. During the day hours, the maximum was observed during the evening (48.1%) and morning hours (35%) as compared to noon time (16.8%). Table no. 2 shows the mammal species as observed during different time intervals.

Table 2. Different taxa as captured in camera traps during different periods of time intervals in study area during the study period

S.No.	Taxon	Night	Morning	Noon	Evening	Total
1	Asian Palm Civet *Paradoxurus hermaphroditus*	33	0	0	0	33
2	Bat sp.	16	0	0	0	16
3	Common Leopard *Panthera pardus*	46	4	0	11	61
4	Grey Mongoose *Herpestes edwardsii*	0	2	2	2	6
5	Desert Cat *Felis sylvestris*	2	0	0	0	2
6	Jackal *Canis aureus*	30	9	6	3	48
7	Indian Hare *Lepus nigricollis*	87	2	0	2	91
8	Honey Badger *Mellivora capensis*	7	0	0	0	7
9	Indian Fox *Vulpes bengalensis*	2	0	0	0	2
10	Jarakh *Hyaena hyaena*	90	7	2	2	101
11	Jungle Cat *Felis chaus*	9	0	0	1	10
12	Langur *Semnopithecus entellus*	0	34	45	47	126
13	Nilgai *Boselaphus tragocamelus*	22	35	22	37	116
14	Indian Porcupine *Hysterix indica*	164	0	0	0	164
15	Rhesus Macaque *Macaca mulatta*	0	1	0	0	1
16	Ruddy Mongoose *Herpestis smithii*	1	6	7	3	17
17	Sambar *Rusa unicolor*	479	85	45	239	848
18	Small Indian Civet *Viverricula indica*	18	0	0	0	18
19	Spotted Deer *Axix axis*	24	110	26	93	253
20	Three-striped Palm Squirrel *Funambulus palmarum*	0	1	1	0	2
21	Tiger *Panthera tigris*	15	0	0	1	16
22	Wild Pig *Sus scrofa*	47	61	15	49	172
	Total	**1092**	**357**	**171**	**490**	**2110**

Herbivores including sambar, spotted deer, nilgai, and wild pig, were the most photographed mammal species (66% of all captures). Lower mammals including small cats, civets, mongooses, canids, hyenas, porcupines, squirrels, and bats contributed 25% of all observations. While large cats including tiger (*Panthera tigris*) and leopard (*Panthera pardus*) contributed 4% and primates including rhesus macaque (*Macaca mulatta*) and langur (*Semnopithecus entellus*) contributed 6% of all observations. Sambar deer remained the most dominant (n=848) among all 22 species of mammals observed during the camera trap exercise. Spotted deer were captured for 253 and wild pig for 272 times (Table 2). Although the herbivores were captured equally during day and night, lower mammals were observed to remain active mostly during night hours (89% of all small mammal captures (Fig. 2); with the exception of mongoose which was mostly captured during the day hours.

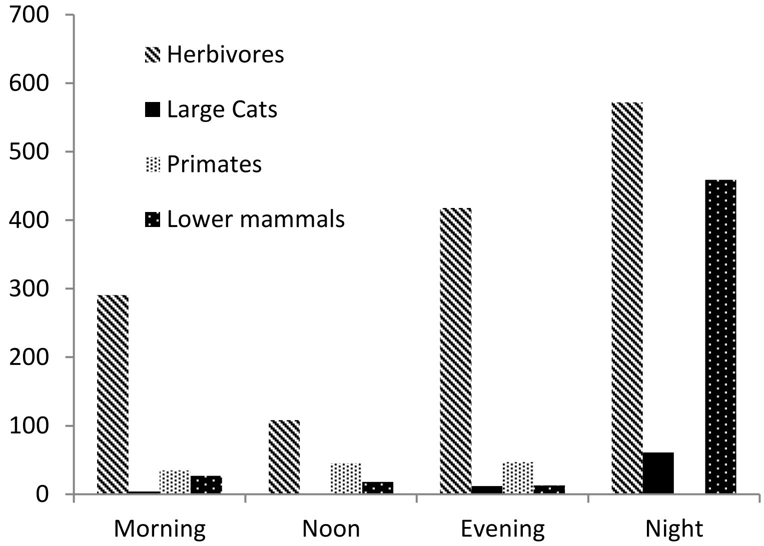

Figure 2. Photographic records of all mammal groups as obtained for different time intervals

Some members of this group include Asian Palm Civet (*Paradoxurus hermaphrodites*), bat species, Desert Cat (*Felis sylvestris*), Honey Badger (*Mellivora capensis*), Indian Porcupine (*Hysterix indica*), and Small Indian Civet (*Viverricula indica*) were camera trapped only during night hours confirming their nocturnal behavior. Large felids including tigers and leopards were observed to be more crepuscular. Primates including langur and rhesus macaque were observed only during days hrs demonstrating their diurnal behavior.

Using Biodiversity*Pro*, while comparing the species richness among mammals between day and night hrs, high values of richness were observed for taxa captured during night hrs as compared to daytime (table 3). Shannon (H') was observed as 0.86 for the captured taxa during night hours while it was computed as 0.77 for day hours. Similarly, 3.06 was recorded as an alpha index (for night hours and 2.5 for daytime. Different diversity indices as computed with Biodiversity*Pro* for the taxa captured for day and night hours are shown in table 3.

Table 3. Different diversity indices as computed with BiodiversityPro for the taxa captured for day and night hours

Index	**Night**	**Day**
Shannon H' Log Base 10.	0.86	0.77
Shannon H_{max} Log Base 10.	1.255	1.176
Shannon J'	0.685	0.654
Alpha	3.065	2.497
Simpsons Diversity (D)	0.234	0.221
Simpsons Diversity (1/D)	4.267	4.523
Hill's Number H0	18	15
Hill's Number H1	25.08	18.59

For estimating the temporal niche partitioning between sympatric species of similar dietary patterns we used the Pianka index for herbivores (Sambar and Chital), and big cats (tiger and leopard). We also attempted to demonstrate temporal niche partitioning between livestock and herbivores having a similar dietary pattern.

The temporal overlap (Pianka index) between the sambar and chital was computed as 55% during the study period. While standardizing the assessed Levin's niche breadth values for sambar and chital (2.43 and 2.91 respectively) we found 0.48 and 0.64 values for sambar and chital (Table 4).

Table 4. Temporal overlap niche between Sambar and Chital

	Sambar	Chital	*pi*S	*pi*C	*pi*S**p*C	(*pi*S)^2	(*pi*C)^2
Night	479	24	0.56	0.09	0.05	0.32	0.01
Morning	85	110	0.10	0.43	0.04	0.01	0.19
Noon	45	26	0.05	0.10	0.01	0.00	0.01
Evening	239	93	0.28	0.37	0.10	0.08	0.14
Total	848	253				0.41	0.34
	∑(*pi*S**pi*C)			0.21			
	∑(*pi*S)^2*∑(*pi*C)^2			0.14			
	Sq root of ∑(*pi*S)^2*∑(*pi*C)^2			0.38			
	Pianka index			0.55			
			Levin's nb	b1=1/∑(pi)^2		2.43	2.91
					b1-1	1.43	1.91
					n-1	3.00	3.00
			Standardized nb		b1-1/n-1	0.48	0.64

Table 5. Temporal overlap niche between Tiger and leopard

	Tiger	Leopard	*p*T	*p*L	*p*T**p*L	$(pT)^2$	$(pL)^2$
Night	15	46	0.94	0.75	0.71	0.88	0.57
Morning	0	4	0.00	0.07	0.00	0.00	0.00
Noon	0	0	0.00	0.00	0.00	0.00	0.00
Evening	1	11	0.06	0.18	0.01	0.00	0.03
Total	16	61			0.72	0.88	0.61
	$\sum(pS*pC)$			0.72			
	$\sum(pS)^2*\sum(pC)^2$			0.53			
	Sq root of $\sum(pS)^2*\sum(pC)^2$			0.73			
	Pianka index			0.98			
			Levin's nb	$b1=1/\sum(pi)^2$		1.13	1.65
					b1-1	0.13	0.65
					n-1	3.00	3.00
			Standardized nb		b1-1/n-1	0.04	0.22

Whereas nb=niche breadthT=tiger, L=leopard

Similarly, 98% temporal overlap between tiger and leopard with 0.04 and 0.22 respectively value of standardized niche was observed (Fig. 5).

The Pianka overlap index between herbivores and livestock with similar food habits was observed as 65% with a niche breadth of 0.74 for herbivores and 0.65 for livestock. We also compared the temporal niche overlap for mega felids (tiger and leopard) for herbivores (table 6) and livestock (table 7). The computed value of overlap was 85% for mega felids-herbivores and 20% for mega felid-livestock. The standardized niche width was found to be 0.18 for mega felids, 0.23 for livestock, and 0.74 for herbivores.

Table 6. Temporal overlap niche between mega carnivores and herbivores

	C	H	*pi*C	*pi*H	*p*C**p*H	(pC)^2	(pH)^2
Night	61	572	0.79	0.41	0.33	0.63	0.17
Morning	4	291	0.05	0.21	0.01	0.00	0.04
Noon	0	108	0.00	0.08	0.00	0.00	0.01
Evening	12	418	0.16	0.30	0.05	0.02	0.09
Total	77	1389			0.38	0.65	0.31
	$\sum(pC*pH)$			0.38			
	$\sum(pC)^2*\sum(pH)^2$			0.20			
	Sq root of $\sum(pC)^2*\sum(pH)^2$			0.45			
	Pianka index			0.84			
			Levin's nb	$b1=1/\sum(pi)^2$		1.53	3.22
					b1-1	0.53	2.22
					n-1	3.00	3.00
			Standardized nb		b1-1/n-1	0.18	0.74

Whereas nb=niche breadth, C=mega felids, H=herbivores

Table 7. Temporal overlap niche between mega carnivores and livestock

	C	L	*pi*C	*pi*L	*p*C**p*L	(pC)^2	(pL)^2
Night	61	13	0.79	0.05	0.04	0.63	0.00
Morning	4	131	0.05	0.49	0.03	0.00	0.24
Noon	0	71	0.00	0.26	0.00	0.00	0.07
Evening	12	67	0.16	0.25	0.04	0.02	0.06
Total	77	269			0.10	0.65	0.37
	$\sum(pC*pL)$			0.10			
	$\sum(pC)^2*\sum(pL)^2$			0.24			
	Sq root of $\sum(pC)^2*\sum(pL)^2$			0.49			
	Pianka index			0.20			
			Levin's nb	$b1=1/\sum(pi)^2$		1.53	2.69
					b1-1	0.53	0.69
					n-1	3.00	3.00
			Standardized nb		b1-1/n-1	0.18	0.23

Whereas nb=niche breadth, C=mega felids, L=livestock

While attempting to demonstrate anthropogenic interferences (AI) including livestock grazing, and human presence in different time intervals, a maximum (95%) was observed during the day hours and the rest (5%) during night hours (Table 8). Even during the daytime maximum, human activities were observed during morning hours (41%) followed by evening hours (23%) and minimum during noon (31%).

Table 8. Correlation of anthropogenic interferences (AIs) with different groups of taxa

Time Period	Birds	Herbivores	Mega-felids Tiger and Leopard	Lower mammals	Primates	AI
Morning	492	291	4	27	35	394
Noon	101	108	0	18	45	291
Evening	302	418	12	13	47	216
Night	74	572	61	459	0	49
σ	**0.73**	**-0.76**	**-0.90**	**-0.85**	**0.73**	

Whereas σ is Pearson's coefficient of correlation and AI is anthropogenic interferences including livestock and human presence

We also attempted to correlate the anthropogenic interferences as observed with wildlife observations during different periods based on Pearson's coefficient of correlation $\sigma\ (x,\ y)=\frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2\sum(y-\bar{y})^2}}$. Although we found a positive correlation of anthropogenic interferences with birds (mostly *Pavo cristatus*) and primates wita valuees of 0.73 each, it was negatively correlated with herbivores (-0.76), lower mammals (-0.85) and large cats (0.90).

Discussion

Coexisting species, especially when they are closely related and share similar morphological traits, may compete for resources (Hutchinson, 1957; MacArthur, 1958). When resources are limited, the principle of competitive exclusion predicts that coexisting species will exhibit resource partitioning (spatial, temporal or dietary segregation) and thus occupy different ecological niches (Pianka, 1981; Schoener, 1974). Temporal niche partitioning can be a viable mechanism for coexistence, but has received less attention than other niche axes.

Animals being active in the same habitat with similar environment but exposes themselves in different time intervals to the effects of different environmental factors, both biotic and abiotic. Animals have different temporal niche utilization characteristics (Tews et al., 2004) and studies on temporal niche differentiation are increasing (Tracy and Christian, 1986; Steenweg et al., 2017; Frey et al., 2017) as it plays a critical role in understanding interspecific relationships (Ahumada et al., 2013; Ferreguetti et al., 2015).

The present study provides information on the co-existence of mammals in the tropical dry deciduous forest of a tiger reserve having the westernmost population of wild tigers in the world. It also provided a database of activity patterns in multiple sympatric mammals under natural conditions. Although the study was initially designed to get a clue about one missing ST5 tigress, however, the mammalian data generated through this camera tap exercise was so intriguing that we analyzed the data with objectives to investigate mammalian temporal diversity, preference of mammals to different temporal niches, and temporal niche overlap and niche breadth.

The observed comparatively high mammalian diversity (Table 3) during night hours (H' Log Base 10=0.86, α=3.1, D=0.22, H^o=18) in comparison to day (H' Log Base 10=0.77, α=0.77, D=0.23, H^o=15) with approximately equal records for both temporal periods may be due to the presence of high anthropogenic interferences during the days hours as compared to night. The nocturnal behavior of most of the lower mammals can also be attributed as a reason for the observation of the high diversity of mammals during night hours. In addition, nocturnal activity may have allowed mammals to avoid antagonistic interactions with anthropogenic interferences.

Among all 22 mammalian species recorded in camera traps, herbivores including sambar *Rusa unicolor*, spotted deer *Axis axis*, nilgai *Boselaphus tragocamelu*s, and wild pig *Sus scrofa* remained dominant contributing 66% of observations of all mammals. These large herbivores were observed to be active during both day and night indicating no clear-cut selection from the four diel categories and can be understood to demonstrate the cathemeral pattern of activity. It is an adaptation to the energy requirements of being large-sized ungulates that require more time to consume food (van Schaik & Griffiths, 1996).

High captures of lower mammals during night hours (89%) especially Asian palm civet *Paradoxurus hermaphrodites*, small Indian civet *Viverricula indica*, honey badger *Mellivora capensis*, Indian porcupine *Hysterix indica*, bat species, desert cat *Felis sylvestris* and jungle cat *Felis chaus* reveal their nocturnal behavior that is inconsistent with earlier studies except that of desert cat and jungle cat. During the study, we observed two small cats, the desert cat *Felis sylvestris* and jungle cat *Felis chaus* which are contrary to other places, especially in reference to a desert cat that has been constantly observed during the daytime in western India. The lead author of this paper has observed desert cats at least 22 times in grasslands of the Thar Desert in western India mostly during the morning and evening hours. This may be due to the high activity of prey food especially the spiny-tailed lizard *Saara hardwickii* during the daytime in arid grassland ecosystems in contrast to the forest ecosystem of STR. Jungle cat, although reported to be diurnal and crepuscular (Prater, 1980), our camera trap results reported the same during night hours which is inconsistent with the findings of Majumder et al. (2011) and Noor et al. (2017). As the diel activity of many felids is correlated to the activities of prey species (Harmsen et al., 2011; Bashir et al., 2014), these small cats being nocturnal in the study area, could be that rodents, their main prey, are generally nocturnal (Prater, 1980; Bashir et al., 2014). The observed nocturnal records of Indian fox (*Vulpes bengalensis*) (although two times) are not consistent with earlier studies as it is more active during morning and evening hours. This observation of nocturnal behavior can be attributed to avoiding too many anthropogenic interferences that are observed during day hours during the study. Although the earlier literature reveals the crepuscular behavior of the Indian hare (*Lepus nigricollis*), however out of 91 total photographic records we recorded 96% of its activity during night hours. This again can be attributed to intense anthropogenic interferences during the daytime.

Although, large-sized bovids including livestock were regularly observed, however, most of them were taken back by the villagers to their cow pens during night hours thereby reducing their temporal niche width with those of mega felids as compared to herbivores. Tiger and leopard are two sympatric predators that inhabit the area and were recorded 16 and 61 times respectively in the camera traps. While the tiger was observed mostly during night hours (except for one observation during late evening hours), the leopard, although observed more during the night hours, was also reported during morning and evening hours. The preference for night hours may be due to less anthropogenic interference (livestock and human presence) during night hours. The time interval for both mega-felids was found to be negatively correlated (-0.90) with that of livestock (table 8).

Sariska tiger reserve, a human-dominated landscape with more than 26 villages located inside the core area (critical tiger habitat) is facing immense anthropogenic pressures including livestock grazing, tree felling, and lopping, human trespassing, religious tourism etc. Most of the natural resources are located in the core area of the reserve which is actually meant for wild animals are actually shared with human and their livestock, thereby affecting the behavior of many wild taxa. To investigate whether the anthropogenic interferences are responsible for temporal preferences by different taxa, we found a positive correlation of anthropogenic interferences with birds (mostly *Pavo cristatus*) and primates with coefficient values of 0.73 each (correlation coefficient), and negatively correlated with herbivores (-0.76), lower mammals (-0.85) and large cats (0.90). It clearly shows strong avoidance of anthropogenic interferences (human preference) by large cats. The same is also observed for lower mammals especially nocturnal animals and herbivores.

Studies on sympatric animals with similar diets demonstrating a reduction in interspecific competition through temporal niche partitioning (Ramesh et al., 2012; Karanth et al., 2017) have already been done in past. Here tiger and leopard are two sympatric species with similar dietary patterns. Although the computed temporal overlap between these mega felids was 98% with niche breadths of 0.04 and 0.22 respectively for each species, the present study did not record a single instance of two species together. It is the trophic niche that may be responsible for avoiding agonistic encounters between these two sympatric species. Comparatively less trophic overlap (53%) was observed between tiger and leopard based on their diet pattern and that was attributed to the differential preference for prey within different taxa of livestock *viz*. Goat>Cow>Buffalo for leopard and Buffalo>Cow>Goat for tiger (Bhardwaj et al., 2020). The computed temporal overlap between natural herbivores (sambar, chital, nilgai, and wild pig) and livestock was 65% with standardized niche breadth respectively 0.74 and 0.65 is due to the fact that the livestock was generally driven back to their villages during night hours thereby shrinking the niche breadth of the livestock. The high temporal overlap between large cats-herbivores (85%) as compared to large cats-livestock (20%) can be attributed to with drawl of cattle from the forest to their cow pens by the villagers during the night hours.

The present camera trapping exercise was helpful in demonstrating the impact of anthropogenic interferences for temporal niche segregation among the wild animals of STR including large cats, lower mammals, and herbivores. It can also be viewed as an informative way to gather ecological data, especially for cryptic or rare species, but is best used in conjunction with other surveys. The exercise documented 22 mammal species with camera trap surveys with one species, the desert cat (*Felis sylvestris*) that had not been documented in past.

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