



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

COMMUNICATION

CROWDING, GROUP SIZE AND POPULATION STRUCTURE OF THE BLACKBUCK ANTILOPE *CERVICAPRA* (LINNAEUS, 1758) (MAMMALIA: CETARTIODACTYLA: BOVIDAE) IN THE SEMI-ARID HABITAT OF HARYANA, INDIA

Deepak Rai & Jyoti

26 July 2019 | Vol. 11 | No. 9 | Pages: 14194-14203

DOI: 10.11609/jott.4788.11.9.14194-14203



For Focus, Scope, Aims, Policies, and Guidelines visit <https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-0>

For Article Submission Guidelines, visit <https://threatenedtaxa.org/index.php/JoTT/about/submissions#onlineSubmissions>

For Policies against Scientific Misconduct, visit <https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-2>

For reprints, contact [<ravi@threatenedtaxa.org>](mailto:ravi@threatenedtaxa.org)

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

Partner



صندوق محمد بن زايد
للمحافظة على
الكائنات الحية

The Mohamed bin Zayed
SPECIES CONSERVATION FUND

Member



Publisher & Host





ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

PLATINUM
OPEN ACCESS



Journal of Threatened Taxa | www.threatenedtaxa.org | 26 July 2019 | 11(9): 14194–14203

CROWDING, GROUP SIZE AND POPULATION STRUCTURE OF THE BLACKBUCK *ANTILope CERVICAPRA* (LINNAEUS, 1758) (MAMMALIA: CETARTIODACTYLA: BOVIDAE) IN THE SEMI-ARID HABITAT OF HARYANA, INDIA

Deepak Rai¹ & Jyoti²

^{1,2} Department of Zoology, Kurukshetra University, Thanesar, Kurukshetra, Haryana 136119, India.
¹ drbkuk@gmail.com (corresponding author), ² jyoti.aggroia02@gmail.com

Abstract: To understand the population growth dynamics and life history parameters of the Blackbuck, 24 fortnightly visits were made in and around Lalpur Jheel, Dobhi Village of district Hisar (Haryana) from March 2017 to February 2018. Scan sampling method was used to record the Blackbuck population. In the present study, a total of 68 sightings of Blackbuck were made including a minimum of one sighting per visit to a maximum of seven sightings per visit with group size varying from one individual to a maximum of 58 individuals per sighting. The overall mean group size and crowding of the Blackbuck population were 13.84 ± 1.89 S.E. and 31.31 (N=941 individuals), respectively. The population structure of Blackbuck revealed six different age and sex classes, namely, adult male, adult female, sub-adult male, sub-adult female, yearling male, and fawn. As far as the social organization of the Blackbuck is concerned, six different types of social grouping were recorded, namely lone territorial male (adult male), unimale-unifemale (adult male and adult female), bachelor herd (adult male(s)/ sub-adult male(s)/ yearling male(s)), mixed herd (adult male(s)/ sub-adult male(s)/ yearling male(s)/ adult female(s)/ sub-adult female(s)/ fawn(s)), harem herd (1 adult male/ adult female(s)/ sub-adult female(s)/ fawn(s)), and female herd (adult female(s)/ sub-adult female(s)/ fawn(s)). It was concluded that Blackbuck shows partial social organization as both the solitary and herd were observed during the present study.

Keywords: Antelope, growth dynamics, Hisar District, Lalpur Jheel, life history parameters, social organization, ungulates.

DOI: <https://doi.org/10.11609/jott.4788.11.9.14194-14203>

Editor: L.A.K. Singh, Bhubaneswar, Odisha, India.

Date of publication: 26 July 2019 (online & print)

Manuscript details: #4788 | Received 09 January 2019 | Final received 31 May 2019 | Finally accepted 20 June 2019

Citation: Rai, D. & Jyoti (2019). Crowding, group size and population structure of the Blackbuck *Antilope cervicapra* (Linnaeus, 1758) (Mammalia: Cetartiodactyla: Bovidae) in the semi-arid habitat of Haryana, India. *Journal of Threatened Taxa* 11(9): 14194–14203. <https://doi.org/10.11609/jott.4788.11.9.14194-14203>

Copyright: © Rai & Jyoti 2019. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by adequate credit to the author(s) and the source of publication.

Funding: None.

Competing interests: The authors declare no competing interests.

Author details: DR DEEPAK RAI is an Assistant Professor in Department of Zoology, Kurukshetra University, Kurukshetra. His field of research includes ornithology, animal ecology and wildlife conservation. MS JYOTI is a research scholar and pursuing her PhD from Department of Zoology, Kurukshetra University, Kurukshetra.

Author contribution: Deepak Rai and Jyoti conceived and designed the study. Jyoti collected the field data and prepare rough draft of the manuscript. Deepak Rai guided the research, analyzed the data and wrote the final draft of the manuscript.

Acknowledgements: The authors are grateful to the Department of Zoology, Kurukshetra University, Kurukshetra, for providing necessary facilities to successfully carry out this research work. We are thankful to the UGC for providing a Junior Research Fellowship during the research period.



INTRODUCTION

Grouping behaviour in antelopes is largely accompanied by predation pressure, but the maximum group size is limited through dispersion and availability of food resources in a particular area (Jarman 1974). Group size in ungulates also depends on habitat structure as it increases with habitat openness such as on grasslands and decreases with dense vegetation as in scrubby forest area (Lagory 1986). In this context a group can be defined as the numbers of individuals usually present less than 10m apart and behaving in a coordinated fashion when first observed (Mungall 1978). As we consider the group size, it refers to the sum of number of individuals belonging to different age classes and having an integer value $n=1$ (Ramesh et al. 2012a).

Considering normal distribution of a species, researchers mostly deal with calculating mean group size of a population in most of the ecological studies. Due to changing climatic conditions, however, nowadays normal distribution is converted into clumped distribution especially in birds and mammals (Reiczigel et al. 2008). To overcome these problems, initially Jarman (1974) described a new phenomenon termed as 'typical group size' that reflects the group size as experienced by an average individual, which was later named as 'crowding' by Recizigel et al. (2008). Crowding can be defined as the group size as experienced by an individual in a particular group because average individuals come from a group larger than the mean group size of a population (Recizigel et al. 2008; Ramesh et al. 2012b).

Under demographic changes over time, age structure is an important parameter to understand the population dynamics and various life history parameters (Caughly 1977; Stearns 1992). Along with this, data regarding the sex ratio of a population reflects the reproductive potential of a species (Ramesh et al. 2012b). In ecosystems, antelopes share an important role in maintaining the biodiversity that ensures sustainability of organisms across various trophic levels in the food chain including predators that feed on antelopes and the plant population on which antelopes feed. But it is presumed that due to environmental changes arising through fragmentation, degradation or destruction of natural habitats, deforestation, agricultural expansion, increased urbanization, grazing pressure due to enhanced livestock population and more commonly through illegal hunting and poaching, the population of antelopes is continually declining. Blackbuck being endemic to the Indian subcontinent needs more attention to be explored.

The Blackbuck *Antilope cervicapra* (Linnaeus, 1758) is

a medium-sized antelope, the only representative of the sub-family Antilopinae and the genus *Antilope* (Prater 1971). The word antelope is used to describe a number of species of the family Bovidae, but the scientific name *Antilope* is restricted only to the Blackbuck (Ranjitsinh 1989). It is known as 'Kala Hiran' or 'Krishna Mriga' in Hindi due to its distinctive dark brown or black coloration in sharp contrast to white for which the species is named (Mungall 1978; Ranjitsinh 1989; Jhala 1992). Currently, Blackbuck is categorized as Least Concern (IUCN SSC Antelope Specialist Group 2017), which was previously categorized as Near Threatened (Mallon 2008). Despite the overall habitat loss, the conservation status of Blackbuck has improved probably due to unintentional creation of more suitable habitat, i.e., open habitat by converting dense scrub land and woodland to agricultural area (IUCN SSC Antelope Specialist Group 2017). On the other hand, farmers are regularly complaining about their crop damage due to crop raiding by Blackbuck and for this, they are using various protective measures to prevent their crops which may ultimately lead to changes in the normal ecology of Blackbuck. So, the study of ecology and behaviour of Blackbuck is becoming important in such areas where a significant number of Blackbucks are commonly seen by inhabitants and farmers of the villages (Rai & Jyoti 2018).

A number of studies have been conducted on different ecological and behavioural aspects of Blackbuck in India (Gupta & Bhardwaj 1990; Gehlot & Jakher 2007, 2011; Kumar & Rahamani 2008; Vats & Bhardwaj 2009a, b; Mahato et al. 2010; Dookia et al. 2011; Sharma & Sharma 2013; Gangotri & Gangotri 2014; Baskaran et al. 2016; Prashanth et al. 2016; Debata 2017; Sagar & Antony 2017; Meena & Chourasia 2018) and also in Khairapur, Bardia District, Nepal (Bhatta 2008; Khanal & Chalise 2010). Among these, most of the studies were conducted in protected areas of India and fewer studies were conducted outside the protected areas. It is observed that very few studies regarding the ecological aspects of Blackbuck have been conducted in Haryana, especially in district Hisar after Ranjitsinh (1989) who had reported that out of total 4,852 Blackbuck populations in the state of Haryana, 2,410 individuals of blackbuck were recorded from district Hisar alone.

The present study was conducted to record the group size, crowding pattern, herd composition, social behaviour and seasonal variation in sightings of Blackbuck in Lalpur Jheel, Dobhi Village, Hisar (Haryana) which would be helpful in understanding the life history parameters of this species and current status in the study area.

MATERIALS AND METHODS

Study Area

Lalpur Jheel is situated in village Dobhi (29.130°N & 75.505°E) of district Hisar, Haryana (India) at an altitude of 218m and covering an area of about 340 acres (Fig. 1). This area exhibits tropical monsoon climate with hot summers and cool winters. The extreme temperatures and scanty rainfall are unique features of the weather of this area. Based on the climatic conditions of the area, the year is divided into four distinct seasons: summer (March to May), monsoon (June to August), autumn (September to November), and winter (December to February).

In addition to Blackbuck, other ungulate species found in the area include Nilgai *Boselaphus tragocamelus* and Sambar *Rusa unicolor*. As far as the diversity of flora

is concerned, the area includes Kikar *Acacia nilotica*, Neem *Azadirachta indica*, Oak *Calotropis procera*, Dub *Cyaadon dactylon*, Shisham *Dalbergia sissoo*, Dhatura *Datura stramonium*, Dhab *Desmostachya bipinnata*, Safeda *Eucalyptus* sp., Peepal *Ficus religiosa*, Jand *Prosopis cineraria*, and different types of herbs and shrubs. The study area can be divided into three major habitats such as agricultural land, fallow land and scrubby forest. Major proportion of the study area is covered with scrubby forest having small patches of fallow land and surrounded by agricultural land.

Data Collection and Analysis

To record the group size and herd composition of Blackbuck, visits every fortnight were conducted in Lalpur Jheel, Dobhi Village from March 2017 to February 2018. Following Chopra & Rai (2010), scan sampling

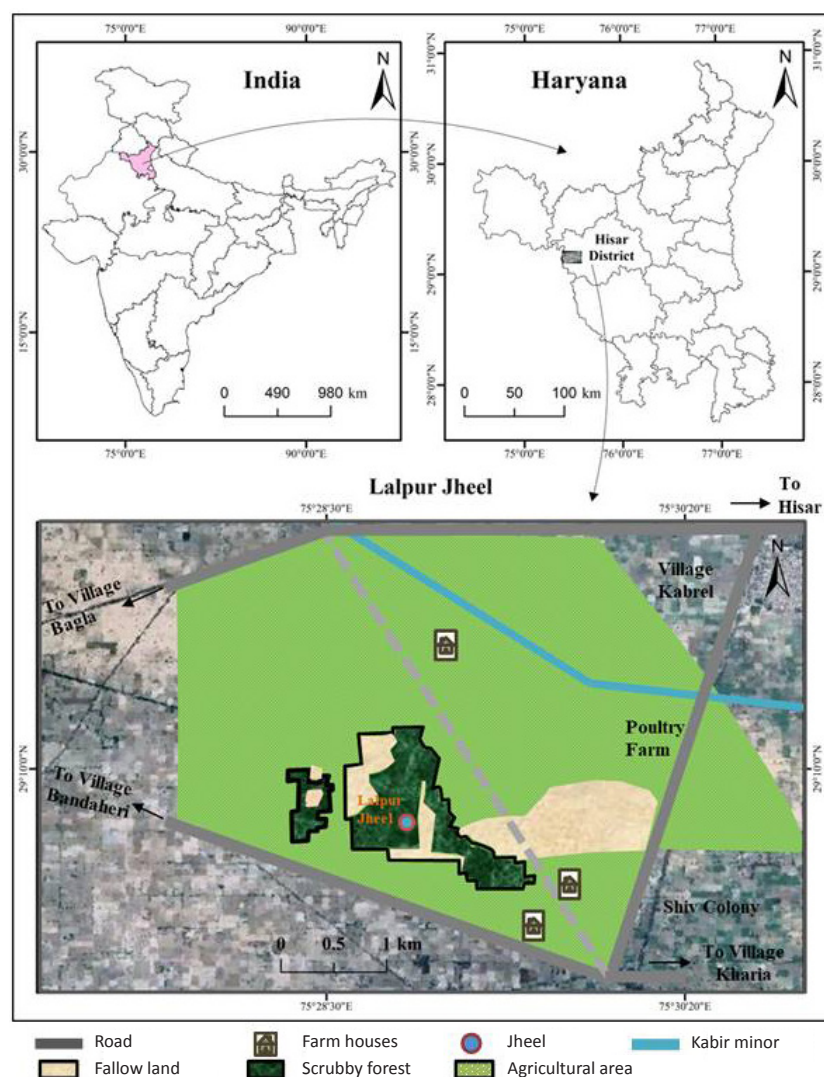


Figure 1. Lalpur Jheel, Dobhi Village in district Hisar, Haryana (India).

method (Altmann 1974) was used to observe Blackbucks using binoculars. The method of instantaneous or scan sampling is in use in various forms of behavior studies, as stated in Altmann (1974), and the method refers to records on current activity of a group or individual at pre-selected time intervals. Photographs in the present study were taken with Canon PowerShot SX50HS digital camera. The time of observation was divided into three diurnal phases, i.e., morning phase (06.30h to 11.00h), noon phase (11.00h to 15.00h), and evening phase (15.00h to 18.30h).

On each sighting of Blackbuck, the number of individuals per group as well as numbers of such groups were recorded (Arcese et al. 1995), followed by recording of data on their age and sex classes. Following Mungall (1978) and Mahato et al. (2010), Blackbucks were categorized into six different age classes namely, adult males (having long horns with 3–4 spiral turns with black and white pelage on dorsal and ventral sides, respectively), sub-adult males (having comparatively short horns with 1–2 spiral horns and dark brown pelage dorsally), yearling males (approximately one year of age with only short spikes like horns having no spiral turn and yellowish pelage dorsally) adult females (more than two years of age having yellowish to tan color dorsally but no spiraling horns), sub-adult females (approximately 1–2 years of age having similar pelage as of adult females but comparatively smaller in size than adult females) and fawn (less than six months of age with light brown pelage but not in contrast to white) including both male and female due to absence of morphological demarcation.

As far as the type of herd is concerned, Blackbuck herds were classified into six different types: lone territorial male (single adult male), unimale-unifemale (one adult male and one adult female), bachelor herd (adult male(s), sub-adult male(s) and yearling male(s)), harem herd (single adult male, adult female(s), sub-adult female(s) and fawn(s)), female herd (adult female(s), sub-adult female(s) and fawn(s)), and mixed herd (adult male(s), sub-adult male(s), yearling male(s), adult female(s), sub-adult female(s) and fawn(s)). Along with mean group size of Blackbuck, mean crowding was also calculated which represents the intensity or infrapopulation size of group from individual's point of view (Reiczigel et al. 2005). Both mean group size and mean crowding were calculated by using program Flocker 1.0 (Reiczigel & Rozsa 2006; Reiczigel et al. 2008) and obtained data was also cross checked by using the following formulae as per Jarman (1982) who used typical group size instead of mean crowding.

$$\text{Mean group size of Blackbuck} = \frac{\text{Number of Blackbucks seen}}{\text{Number of sightings}}$$

$$\text{Mean crowding} = \frac{\sum_{i=1}^n (x_i)^2}{N}$$

where,

x_i = number of individuals in the i^{th} group/sighting

n = number of groups

N = total number of individuals

RESULTS

During the study, a total of 68 sightings of Blackbuck were recorded with a minimum of one sighting (in 5th and 17th periodic visit) per visit to a maximum of seven sightings (4th periodic visit) per visit (Fig. 2). During the eighteenth periodic visit, no sighting of Blackbuck was recorded in the field survey because of the disturbances caused by plying of vehicles for construction of concrete road in the study area. As far as the group size of Blackbuck is concerned, it ranged from 1 to 58 individuals with a mean group size of 13.84 ± 1.89 S.E. and the mean crowding value was 31.31 ($N=941$ individuals) (Table 1). The lowest mean group size and mean crowding was observed during autumn 2017. In contrast to this, the highest mean group size was observed during winter 2017–18 and the highest mean crowding was recorded during summer 2017, which indicates clumped distribution of Blackbuck. Data also revealed that more than 70% of Blackbuck groups were recorded between group sizes ranging from 1 to 30 individuals in all the seasons.

Fawns were sighted throughout the year but two peaks were observed, i.e., during summer and autumn seasons, reflecting that the peak fawning period in Blackbuck are March to May and September to October. The average adult male: adult female: fawn ratio of Blackbuck was 25.18: 100: 14.91 ($N=573$ individuals) (Table 2). It was also observed that adult male: sub-adult male: adult female: sub-adult female ratio was 35: 100 which was comparatively higher than the adult male: adult female ratio indicating that the population of Blackbuck is increasing. Data regarding the population structure of Blackbuck revealed that of the 941 individuals of Blackbuck recorded during the one year field survey, 31.15% were males, 62.38% were females, and 6.48% were fawn. Out of 293 male individuals, 35.15% were adult males, 35.15% were sub-adult males, and 29.70% were yearling males. Similarly, out of 587 female individuals, 69.68% were adult females, and

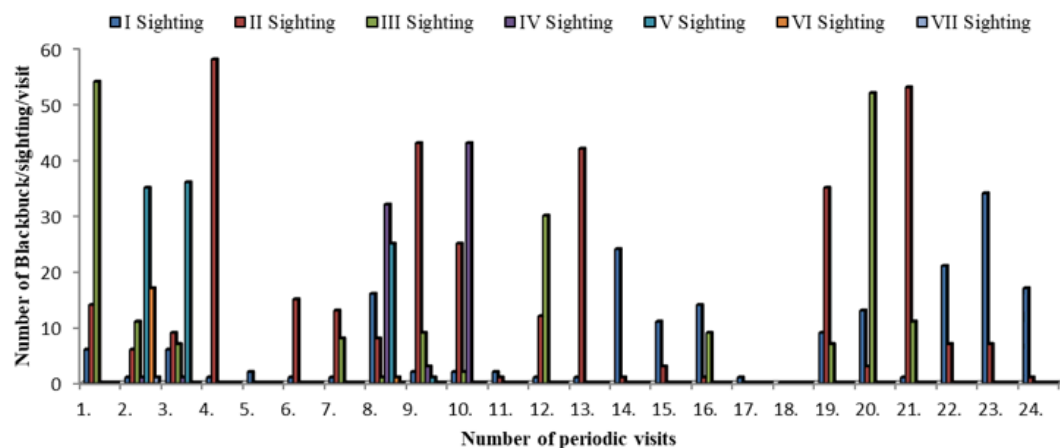


Figure 2. Number of Blackbuck sightings/visit and number of individuals/sighting in and around Lalpur Jheel, Dobhi Village during March 2017 to February 2018.

Table 1. Seasonal grouping patterns of Blackbuck in Lalpur Jheel, Dobhi Village of district Hisar, Haryana (India) from March 2017 to February 2018.

Season(s)	NG	NA	LGO	MC	MeC	MGS	MeGC	SE	Group Size (% of groups)					
									1–10	11–20	21–30	31–40	41–50	>50
Summer (March–May)	20	282	58	35.04	36.00	14.10	6.50	3.84	60.00	20.00	0.00	10.00	0.00	10.00
Monsoon (June–August)	23	281	43	27.33	30.00	12.22	8.00	2.83	60.87	13.04	13.04	4.35	8.70	0.00
Autumn (September–November)	10	107	42	25.71	24.00	10.70	6.00	4.01	60.00	20.00	10.00	0.00	10.00	0.00
Winter (December–February)	15	271	53	33.77	35.00	18.07	11.00	4.35	46.67	20.00	6.67	13.33	0.00	13.33
Annual data	68	941	58	31.31	34.00	13.84	8.00	1.89	57.35	17.65	7.35	7.35	4.41	5.88

NG—number of groups | NA—number of animals | LGO—largest group observed | MC—mean crowding | MeC—median crowding | MGS—mean group size | MeGS—median group size | SE—standard error.

Table 2. Sex ratio of Blackbuck in Lalpur Jheel, Dobhi Village of district Hisar, Haryana (India) from March 2017 to February 2018.

Season(s)	Adult male	Adult female	Fawn	Number of individuals classified
Summer 2017 (March–May)	26.12	100	24.32	167
Monsoon 2017 (June–August)	29.75	100	9.92	169
Autumn 2017 (September–November)	23.53	100	15.69	71
Winter 2017–18 (December–February)	20.63	100	11.11	166
Overall Data	25.18	100	14.91	573

30.32% were sub-adult females (Table 3).

The Blackbucks were sighted more in groups than as solitary animals which reflect their partial social organization. Along with 18 lone territorial male sightings, 13 mixed herds, 18 bachelor herds, 12 harem herds, five female herds, and two unimale-unifemale

herds were recorded (Fig. 3; Image 1). Detailed information on seasonal variation in the type of herds observed, group size range and mean group size is given in Table 4.

Table 3. Age structure of Blackbuck in Lalpur Jheel, Dobhi Village of district Hisar, Haryana (India) from March 2017 to February 2018.

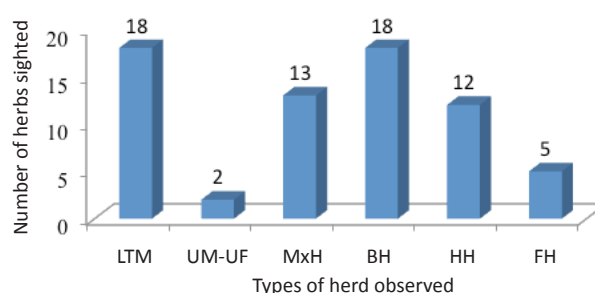
Season(s)	AM		SAM		YM		AF		SAF		FW		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Summer 2017 (March–May)	29	10.28	31	10.99	28	9.93	111	39.36	56	19.86	27	9.57	282
Monsoon 2017 (June–August)	36	12.81	40	14.23	32	11.39	121	43.06	40	14.23	12	4.27	281
Autumn 2017 (September–November)	12	11.21	7	6.54	9	8.41	51	47.66	20	18.69	8	7.48	107
Winter 2017–18 (December–February)	26	9.59	25	9.23	18	6.64	126	46.49	62	22.88	14	5.17	271
Overall Data	103	10.95	103	10.95	87	9.25	409	43.46	178	18.92	61	6.48	941

AM—adult male | SAM—sub-adult male | YM—yearling male | AF—adult female | SAF—sub-adult female | FW—fawn.

Table 4. Seasonal variations in the total sightings of Blackbuck, group size range and mean group size \pm S.E. in Lalpur Jheel, Dobhi Village from March 2017 to February 2018.

Seasons	Type of herds seen	Total sightings (N)	Group size range	Mean group size \pm S.E.
Summer 2017 (March–May)				
	LTM	6	1	1 \pm 0
	MxH	7	6–58	27 \pm 8.38
	BH	4	2–17	7.75 \pm 3.22
	HH	2	14–35	24.5 \pm 10.53
	FH	1	7	7 \pm 0
Monsoon 2017 (June–August)				
	LTM	6	1	1 \pm 0
	UM-UF	2	2	2 \pm 0
	MxH	2	25–32	28.5 \pm 3.51
	BH	8	2–25	9.63 \pm 2.82
	HH	4	13–43	32.25 \pm 7.11
	FH	1	8	8 \pm 0
Autumn 2017 (September–November)				
	LTM	4	1	1 \pm 0
	MxH	2	3–24	13.5 \pm 10.53
	BH	1	14	14 \pm 0
	HH	1	42	42 \pm 0
	FH	2	9–11	10 \pm 1.00
Winter 2017–18 (December–February)				
	LTM	2	1	1 \pm 0
	MxH	2	7–52	29.5 \pm 15.05
	BH	5	3–11	7.4 \pm 1.33
	HH	5	13–53	30.4 \pm 7.19
	FH	1	21	21 \pm 0
Annual 2017–18		68	2–58	13.84 \pm 1.89

LTM—lone territorial male | UM-UF—unimale-unifemale | MxH—mixed herd | BH—bachelor herd | HH—harem herd | FH—female herd.

**Figure 3. Variation in sighting of different types of herds of Blackbuck recorded in and around Lalpur Jheel, Dobhi Village from March 2017 to February 2018. LTM—lone territorial male | UM-UF—unimale-unifemale | MxH—mixed herd | BH—bachelor herd | HH—harem herd | FH—female herd.**

DISCUSSION

Mammalian herbivores, especially ungulates, form groups that are effectively conspicuous in the field. There are two principle rationales regarding the group-behaviour of ungulates. The first proposes that when in groups the animals can counteract or maintain a strategic distance from the predators as compared to when they are alone and this could be possible through an assortment of strategies including predator recognition, active group defense and predator perplexity (Hamilton 1971; Wirtze & Lorsche 1983). Alternative rationale connects the animal's social organization with the dispersion and accessibility of its resource supply (Jarman 1974). According to previous studies, Blackbucks were seen both solitary and in groups reflecting their partial social organization. This is also seen in the present study. Ranjitsinh (1989) recorded six different types of social grouping of Blackbuck including solitary female, solitary male, a female with one or two offspring, females and young-groups, bachelor herd, and mixed herd involving harem herd also. Isvaran

Table 5. Group size and sex ratio of Blackbuck *Antelope cervicapra* (Linnaeus, 1758) from protected areas of India.

Study site	Group size	Adult male: adult female	Source
Lalpur Jheel, Haryana	2–58	0.25: 1	Present study
Mudmal Village, Andhra Pradesh	2–36	1: 2.47	Prasad 1983
Point Calimere Sanctuary, Tamil Nadu	2–129	1: 4.7	Nair 1976
Proposed Community Reserve for Blackbuck, Ganjam District, Odisha	2–32	1: 1.51	Mahato et al. 2010
Balipadar-Bhetnoi Blackbuck Conservation Area, Odisha	1–51	1: 3	Debata 2017
M.C. Zoological Park, Chhatbir, Punjab	10–25	-	Vats & Bhardwaj 2009a
Sorsan Grassland, Baran District, Rajasthan	4–100	-	Meena & Chourasia 2018
Tal Chappar Blackbuck Sanctuary, Rajasthan	-	1: 1.29	Dookia et al. 2011
Pipli Deer Park, Kurukshetra	8–25	-	Gupta & Bhardwaj 1990

(2007) reported three different types of herd sightings in Blackbuck namely; all male groups, female groups, and mixed-sex groups. During the present study, in the total 68 sightings of Blackbuck, six different types of social organization were observed including lone territorial male, unimale-unifemale, mixed, bachelor, harem, and female herds. The occurrence of different types of social organization was due to the seasonal variation in the distribution and availability of food resources (Jarman 1974). Habitat structure, predation pressure and resource availability are the main ecological factors responsible for the formation of groups (Lott 1991; Brashares & Arcese 2002) while the group size is mainly determined by habitat characteristics as it increases with open habitat and decreases with forested habitat (Leuthold 1970; Lagory 1986). In Lalpur jheel, the largest herd of 58 individuals was sighted in fallow land i.e. open habitat which confirms with Ranjitsinh (1982) and Barucha & Asher (1993) as they also recorded the larger groups of Blackbuck in open habitat comprising 430 and 200 individuals in Velavadar National Park and Rehukari Wildlife Sanctuary, respectively. Predation pressure was not very important in the study area due to the absence of large carnivores, as ascertained during our periodic visits. One of the major threats emerging to the Blackbuck population is the rise of feral dog population which was also reported by Gehlot & Jakher (2007). They found that 45% mortality in the Blackbuck population is caused by feral dogs. Along with habitat structure and predation pressure, resource availability is also one of the major factors which affect the group size in ungulate population. When resources are distributed in relatively small and distant areas then it favors small group sizes because in large group size the cost of competing for food surpasses any possible benefits (Chapman et al. 1995). The mean group size of Blackbuck population

calculated as per the present study was 13.84 ± 1.89 and the group size range was 2–58 which was in accordance with the previous studies from different parts of India (Table 5). The mean group size parameter is beneficial only when there is normal distribution of organisms in a particular area, but during recent times clumped distribution is observed which makes the crowding phenomenon to be useful for the studies. Similar studies based on crowding phenomenon had been reported for megaherbivores, however, no such studies have been conducted on the Blackbuck (Ramesh et al. 2012b). The highest mean crowding value was recorded during the summer season because of scarcity of food resources in the study area. This favours formation of many small herds and only a few large herds. The crowding value increased as calculated according to Reiczigel et al. (2008). Fawning period in Blackbuck in Lalpur Jheel indicates that there was no distinct seasonality but two peaks were observed, the first during the summer season and second during the autumn season which is in consonance with observations by Schaller (1967), who reported the two peaks of fawning in March–April and August–October in Kanha National Park. The adult-male: adult-female ratio from the study area was low as compared to previous studies as shown in Table 5, which may be due to the hunting of adult males for its meat and horns which were further used in Ayurveda and to cure skin diseases. A positive side of this skewed sex ratio is that a population with more females than males has a higher reproductive potential than the one which is predominately composed of males (Spillet 1966) because the adult female: fawn ratio had increased, i.e., 6.70: 1 which was high as compared to the other study as in the proposed community reserve for Blackbuck, Ganjam District, Odisha, India (Mahato et al. 2010).

The major threats to Blackbuck population are



Image 1. Different types of herds recorded during periodic visits at Lalpur Jheel, Dobhi Village, Hisar: a—lone territorial male | b—unimale-unifemale | c—bachelor herd | d—harem herd | e—mixed herd | f—female herd. © Jyoti.

habitat loss, human-Blackbuck interaction, competition with livestock, predation pressure from fox, road kill and killing by feral dogs that decreases the overall population size in comparison to the status in past decades in Sorsan grassland, Rajasthan, India (Meena & Chourasia 2018). In the present study there were many factors responsible for limited sightings of Blackbuck in the study area including fragmentation of habitat through the construction of a concrete road, movement of vehicles, encroachment by cattle and increased feral dog population, as reported by Gehlot & Jakher (2007) in the Thar Desert of Rajasthan. This study area requires regular monitoring and effective conservation strategies as viable population of Blackbuck were reported both through fortnightly periodic visits as well as opinion survey findings.

REFERENCES

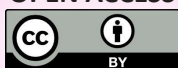
- Altmann, J. (1974). Observational study of behaviour: sampling methods. *Behaviour* 49: 227–265. <https://doi.org/10.1163/156853974X00534>
- Arceze, P., G. Jongejean, and A.R.E. Sinclair (1995). Behavioural flexibility in a small African antelope: Group size and composition in the Oribi (*Ourebia ourebi*, Bovidae). *Ethology* 99: 1–23. <https://doi.org/10.1111/j.1439-0310.1995.tb01085>
- Barucha, E. & K. Asher (1993). Behaviour patterns of the Blackbuck, *Antelope cervicapra*, under sub-optimal habitat condition. *Journal of the Bombay Natural History Society* 90(3): 371–393.
- Baskaran, N., K. Ramkumar & G. Karthikeyan (2016). Spatial and dietary overlap between Blackbuck (*Antelope cervicapra*) and feral horse (*Equus caballus*) at Point Calimere Wildlife Sanctuary, southern India: competition between native versus introduced species. *Mammalian Biology* 81(3): 295–302. <https://doi.org/doi:10.1016/j.mambio.2016.02.004>
- Bhatta, S.R. (2008). People and blackbuck: current management challenges and opportunities. *The Initiation* 2(1): 17–21. <https://doi.org/10.3126/init.v2i1.2514>
- Brashares, J.S. & P. Arceze (2002). Role of forage, habitat and predation in the behavioural plasticity of a small African antelope. *Journal of Animal Ecology* 71: 626–638. <https://doi.org/10.1046/j.1365-2656.2002.00633.x>
- Caughly, G. (1977). *Analysis of Vertebrate Populations*. John Wiley & Sons, London, 234pp.
- Chapman, C.A., R.W. Wrangham, & L.J. Chapman (1995). Ecological constraints on group-size: an analysis of spider monkey and chimpanzee subgroups. *Behavioral Ecology and Sociobiology* 36: 59–70. <https://doi.org/10.1007/BF00175729>
- Chopra, G.C. & D. Rai (2010). Ecological studies on population structure and food habits of Nilgai, *Boselaphus tragocamelus* Pallas (Artiodactyla, Bovidae) in Saraswati Plantation Wildlife Sanctuary, Haryana (India). *Journal of Experimental Zoology (India)* 13(1): 43–49.
- Debata, S. (2017). Population size, herd structure and sex ratio of the Blackbuck *Antelope cervicapra* (Mammalia: Cetartiodactyla: Bovidae) in a human dominated area in Odisha, India. *Journal of Threatened Taxa* 9(11): 10953–10955. <https://doi.org/10.11609/jott.2658.9.11.10953-10955>
- Dookia, S., S.K. Das, S.S. Poonia, G. Gupta, Rajlakshmi & K. Das (2011). Taal Chhappar Blackbuck Sanctuary, Rajasthan, India: a threatened ecosystem, pp70–77. In: Proceedings of the National Seminar on the Natural Resource Management and Environmental Issues, GLPG, College, Churu, Rajasthan, 170pp.
- Gangotri, V.M. & M.S. Gangotri (2014). Time-budget of different life-history stages of the Blackbuck, *Antelope cervicapra* (Linnaeus), pp71–77. In: *Advances in Biotechnology and Patenting*. Elsevier Publication, New Delhi, 339pp.
- Gehlot, H.S. & G.R. Jakher (2007). Distribution, status and conservation of Blackbuck *Antelope cervicapra* in Thar Desert of Rajasthan (India). *Tigerpaper* 34(4): 19–23.
- Gehlot, H.S. & G.R. Jakher (2011). Habitat selection patterns of Blackbuck *Antelope cervicapra* and Chinkara *Gazella bennetti* in Thar Desert of Rajasthan (India). *Tigerpaper* 38(3): 17–23.
- Gupta, R.C. & C.S. Bhardwaj (1990). Seasonal changes in the herd structure and composition of Indian Blackbuck *Antelope cervicapra* at Pipli Deer Park in Kurukshetra District of Haryana State. *Journal of Environmental Biology* 11: 313–319.
- Hamilton, W.D. (1971). Geometry for the selfish herd. *Journal of Theoretical Biology* 31: 295–311. [https://doi.org/10.1016/0022-5193\(71\)90189-5](https://doi.org/10.1016/0022-5193(71)90189-5)
- Isvaran, K. (2007). Intraspecific variation in group size in the Blackbuck antelope: the roles of habitat structure and forage at different spatial scales. *Oecologia* 154: 435–444. <https://doi.org/10.1007/s00442-007-0840-x>
- IUCN SSC Antelope Specialist Group (2017). *Antelope cervicapra*. The IUCN Red List of Threatened Species 2017: e.T1681A50181949. Downloaded on 13.11.2018. <https://doi.org/10.2305/IUCN.UK.2017-2.RLTS.T1681A50181949.en>
- Jarman, P. (1974). The social organization of antelopes in relation to their ecology. *Behaviour* 58: 215–267. <https://doi.org/10.1163/156853974X00345>
- Jarman, P.J. (1982). Prospects for interspecific comparison in sociobiology, pp323–342. In: King's College Sociobiology Group (eds). *Current Problems in Sociobiology*. Cambridge University Press, Cambridge, 395pp.
- Jhala, Y.V. (1992). Water in the Ecophysiology of Blackbuck. *Journal of the Arid Environments* 22: 261–269. [https://doi.org/10.1016/S0140-1963\(18\)30644-X](https://doi.org/10.1016/S0140-1963(18)30644-X)
- Khanal, L. & M.K. Chalise (2010). Population status of Blackbuck (*Antelope cervicapra*) at Khairapur, Bardiya, Nepal. *Journal of Natural History Museum* 25: 266–275.
- Kumar, S. & A.S. Rahmani (2008). Predation by Wolves (*Canis lupus pallipes*) on Blackbuck (*Antelope cervicapra*) in the Great Indian Bustard Sanctuary, Nannaj, Maharashtra, India. *International Journal of Ecology and Environmental Sciences* 34(2): 99–112.
- Lagory, K.E. (1986). Habitat, group size and the behaviour of white-tailed deer. *Behaviour* 98: 168–179. <https://doi.org/10.1163/156853986X00955>
- Leuthold, W. (1970). Observations on the social organization of Impala *Aepyceros nlelampus*. *Zeitschrift für Tierpsychologie* 27: 693–721. <https://doi.org/10.1111/j.1439-0310.1970.tb01896.x>
- Lott, D.F. (1991). *Intraspecific Variation in the Social Systems of Wild Vertebrates*. Cambridge University Press, Cambridge, 245pp.
- Mahato, A.K.R., Ramakrishnan & M. Raziuddin (2010). *Status, Ecology & Behaviour of Antelope cervicapra* (Linnaeus, 1758) in Proposed Community Reserve for Blackbuck, Ganjam District, Orissa, India. Zoological Survey of India, Kolkata, 160pp.
- Mallon, D.P. (2008). *Antelope cervicapra*. The IUCN Red List of Threatened Species 2008: e.T1681A6448761. Downloaded on 09.11.2016. <https://doi.org/10.2305/IUCN.UK.2008.RLTS.T1681A6448761.en>
- Meena, R. & V. Chourasia (2018). Influence of Anthropogenic Activities on Blackbuck Population at Sorsan Region of Baran District, Rajasthan, pp553–559. In: 13th International Conference on Recent Trends in Engineering Science and Management. Vedant College of Engineering and Technology, Tulsi, Rajasthan, 559pp.
- Mungall, E.C. (1978). *The Indian blackbuck antelope: A Texas View*. Kleberg Studies in Natural Resources. The Texas A&M University, India, 184pp.
- Nair, S.S. (1976). A population survey and observation on the

- behaviour of the Blackbuck in the Point Calimere Sanctuary. *Journal of the Bombay Natural History Society* 73(2): 304–310.
- Prasad, N.L.N.S. (1983).** Seasonal changes in the herd structure of Blackbuck. *Journal of the Bombay Natural History Society* 80: 549–554.
- Prashanth, M.B., A. Saravanan, M. Mathivanan & T. Ganesh (2016).** Conservation of a fragmented population of Blackbuck *Antelope cervicapra*. *Current Science* 3(3): 543–549.
- Prater, S.H. (1971).** *The Book of Indian Animal*. Bombay Natural History Society, Bombay, 348pp.
- Rai, D. & Jyoti (2018).** Status and ecological aspects of Blackbuck, *Antelope cervicapra* (Linnaeus, 1758) through opinion surveys in and around Hisar, Haryana (India). *Journal of Experimental Zoology (India)* 21(2): 1195–1201.
- Ramesh, T., K. Sankar, B. Qureshi & R. Kalle (2012a).** Group size, sex and age composition of Chital (*Axis axis*) and Sambar (*Rusa unicolor*) in a deciduous habitat of Western Ghats. *Mammalian Biology* 77: 53–59. <https://doi.org/10.1016/j.mambio.2011.09.003>
- Ramesh, T., K. Sankar, B. Qureshi, & R. Kalle (2012b).** Group size and population structure of megaherbivores (Gaur *Bos gaurus* and Asian Elephant *Elephas maximus*) in a deciduous habitat of Western Ghats, India. *Mammal Study* 37: 47–54. <https://doi.org/10.3106/041.037.0106>
- Ranjitsinh, M.K. (1982).** Territorial behaviour of Indian Blackbuck *Antelope cervicapra* (Linnaeus, 1758) in the Velevar National Park, Gujarat. *Journal of the Bombay Natural History Society* 79(2): 241–246.
- Ranjitsinh, M.K. (1989).** *The Indian Blackbuck*. Natraj Publishers, Dehradun, 155pp.
- Reiczigel, J. & L. Rozsa (2006).** Flocker 1.0. Available at <http://www.behav.org/flocker/>. Accessed on 20.09.2018.
- Reiczigel, J., Z. Lang, L. Rozsa & B. Tothmeresz (2005).** Properties of crowding indices and statistical tools to analyze crowding data. *Journal of Parasitology* 91: 245–252. <https://doi.org/10.1645/GE-281R1>
- Reiczigel, J., Z. Lang, L. Rozsa & B. Tothmeresz (2008).** Measures of sociality: two different views of group size. *Animal Behaviour* 75: 715–721. <https://doi.org/10.1016/j.anbehav.2007.05.020>
- Sagar, H.S.S.C. & P.U. Antoney (2017).** Measuring Indian Blackbuck *Antelope cervicapra* (Mammalia: Cetartiodactyla: Bovidae) abundance at Basur Amruth Mahal Kaval Conservation Reserve, Chikkamagaluru, southern India. *Journal of Threatened Taxa* 9(7): 10468–10472. <https://doi.org/10.11609/jott.2971.9.7.10468-10472>
- Schaller, G.B. (1967).** *The Deer and The Tiger*. Chicago University Press, Chicago, USA, 384pp.
- Sharma, A.K. & S. Sharma (2013).** Daily Activity Pattern of Blackbuck *Antelope cervicapra* Linn. of Tal Chhapar Wildlife Sanctuary, Rajasthan and its Seasonal Variation. *Asian Resonance* 2(3): 38–43.
- Spillet, J. (1966).** A report on wildlife surveys in south and west India. *Journal of the Bombay Natural History Society* 65: 296–325.
- Stearns, S.C. (1992).** *The Evolution of Life Histories*. Oxford University Press, Oxford, 249pp.
- Vats, R. & C.S. Bhardwaj (2009a).** Investigation in activity time budget and social organization of Indian Blackbuck *Antelope cervicapra* Linn. (Mammalia Artiodactyla) at M.C. Zoological Park, Chhatbir (Pb.), India. *Current World Environment* 4(1): 97–102. <https://doi.org/10.12944/CWE.4.1.13>
- Vats, R. & C.S. Bhardwaj (2009b).** A Study of Reproductive Behaviour of Indian Blackbuck *Antelope cervicapra* Linn. with Reference to Courtship, Breeding, Fawning and Colouration. *Current World Environment* 4(1): 121–125. <http://doi.org/10.12944/CWE.4.1.18>
- Wirtz, P. & J. Lorsche (1983).** Group sizes of antelopes in an East African national park. *Behaviour* 84: 135–156. <https://doi.org/10.1163/156853983X00327>





PLATINUM
OPEN ACCESS



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

July 2019 | Vol. 11 | No. 9 | Pages: 14087–14246

Date of Publication: 26 July 2019 (Online & Print)

DOI: 10.11609/jott.2019.11.9.14087-14246

www.threatenedtaxa.org

Article

Species richness and abundance of monogonont rotifers in relation to environmental factors in the UNESCO Sakaerat Biosphere Reserve, Thailand
– Nattaporn Plangklang, Chaichat Boonyanusith & Sujeephon Athibai, Pp. 14087–14100

Communications

Distribution and habitats of *Paphiopedilum* Pfitzer (Orchidaceae) known to occur in Bhutan
– Dhan Bahadur Gurung, Nima Gyeltshen, Kezang Tobgay, Stig Dalström, Jangchu Wangdi, Bhakta Bahadur Ghalley, Lekey Chaida, Phuntsho, Ngawang Gyeltshen, Kelzang Dawa, Tandin Wangchuk, Rebecca Pradhan, Thomas Hoijer & Choki Gyeltshen, Pp. 14101–14111

Diurnal *Serianthes nelsonii* Merr. leaflet paraheliotropism reduces leaflet temperature, relieves photoinhibition, and alters nyctinastic behavior
– Thomas Edward Marler, Pp. 14112–14118

Pollination ecology of *Brownlowia tersa* (Malvaceae), a Near Threatened non-viviparous true mangrove shrub
– Aluri Jacob Solomon Raju, Pp. 14119–14127

A note on the taxonomy and natural history of the Summer Clicker *Lahugada dohertyi* (Distant, 1891) (Insecta: Hemiptera: Cicadidae) along with its distribution in northern West Bengal, India
– Vivek Sarkar, Pp. 14128–14136

Observations on nesting activity, life cycle, and brood ball morphometry of the Bordered Dung Beetle *Oniticellus cinctus* (Fabricius, 1775) (Coleoptera: Scarabaeidae) under laboratory conditions
– Amar Paul Singh, Kritish De, Shagun Mahajan, Ritwik Mondal & Virendra Prasad Uniyal, Pp. 14137–14143

Spiders of Odisha: a preliminary checklist
– Sudhir Ranjan Choudhury, Manju Siliwal & Sanjay Keshari Das, Pp. 14144–14157

Status of water birds in Haripura-Baur Reservoir, western Terai-Arc landscape, Uttarakhand, India
– Tanveer Ahmed, Harendra Singh Bargali, Deepa Bisht, Gajendra Singh Mehra & Afifullah Khan, Pp. 14158–14165

Bird diversity in the coastal talukas of Sindhudurg District, Maharashtra, India
– Golusu Babu Rao, Santhanakrishnan Babu, Goldin Quadros & Vijaykumar Anoop, Pp. 14166–14186

Greater One-horned Rhinoceros *Rhinoceros unicornis* (Mammalia: Perissodactyla: Rhinocerotidae) population census in the Rajiv Gandhi Orang National Park, Assam, India
– Deba Kumar Dutta & Parikshit Kakati, Pp. 14187–14193

Crowding, group size and population structure of the Blackbuck *Antelope cervicapra* (Linnaeus, 1758) (Mammalia: Cetartiodactyla: Bovidae) in the semi-arid habitat of Haryana, India
– Deepak Rai & Jyoti, Pp. 14194–14203

Short Communications

An updated checklist of Indian western Himalayan gymnosperms and lectotypification of three names
– Jibankumar Singh Khuraijam & Jaideep Mazumdar, Pp. 14204–14211

New record of Blue Perch *Badis badis* (Anabantiformes: Badidae) from Godavari River basin of Telangana State, India
– Kante Krishna Prasad & Chelmala Srinivasulu, Pp. 14212–14215

First record of the Small Bamboo Bat *Tylonycteris fulvida* (Peters, 1872) (Mammalia: Chiroptera: Vespertilionidae) from Nepal
– Basant Sharma, Anoj Subedi, Bandana Subedi, Shristee Panthee & Pushpa Raj Acharya, Pp. 14216–14219

Is canine distemper virus (CDV) a lurking threat to large carnivores? A case study from Ranthambhore landscape in Rajasthan, India
– Nadisha Sidhu, Jimmy Borah, Sunny Shah, Nidhi Rajput & Kajal Kumar Jadav, Pp. 14220–14223

Notes

Extended distribution of the vulnerable Cooper's Stone Flower *Corallodiscus cooperi* (Gesneriaceae) in India
– Vikas Kumar, Samiran Panday, Sudhansu Sekhar Dash, Bipin Kumar Sinha & Paramjit Singh, Pp. 14224–14227

Extended distribution record of two bellflower species of *Codonopsis* (Campanulaceae) from the Indian state of Arunachal Pradesh
– Khilendra Singh Kanwal, Umeshkumar Lalchand Tiwari, Lod Yama & Mahendra Singh Lodhi, Pp. 14228–14231

First record of the Blue-and-white Flycatcher *Cyanoptila cyanomelana* (Temminck, 1829) (Aves: Passeriformes: Muscicapidae) from Bhutan
– Kado Rinchen, Kinley Kinley, Chhimi Dorji & Dorji Wangmo, Pp. 14232–14234

Butterflies collected using malaise traps as useful bycatches for ecology and conservation
– Augusto Henrique Batista Rosa, Lucas Neves Perillo, Frederico Siqueira Neves, Danilo Bandini Ribeiro & André Victor Lucci Freitas, Pp. 14235–14237

Notes on the hairstreak butterflies *Eusaspa* Moore, 1884 (Lepidoptera: Lycaenidae) with new distribution records to the Indian eastern Himalaya
– Gaurab Nandi Das, Subrata Gayen, Motoki Saito & Kailash Chandra, Pp. 14238–14241

First report of the Australian gall midge *Actilasioptera tumidifolium* Gagné, 1999 (Diptera: Cecidomyiidae) from Andaman Islands, India
– Duraikannu Vasanthakumar & Radheshyam Murlidhar Sharma, Pp. 14242–14243

New record of Blanford's Fox *Vulpes cana* (Mammalia: Carnivora: Canidae) in central Oman: a connection between the northern and southern populations
– Taimur Alsaid, Abdulrahman Aluwaisi, Sultan Albalushi, Zahran Alabdulsalam, Said Alharsusi & Steven Ross, Pp. 14244–14246

Partner



صندوق محمد بن زايد
للمحافظة على
الكائنات الحية
The Mohamed bin Zayed
SPECIES CONSERVATION FUND

Member



Publisher & Host

