Ecological Insights into Population Structure, Habitat Preferences and Foraging Ecology of Blackbuck, *Antilope cervicapra* (1758) in Nahar Wildlife Sanctuary, Haryana

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Abstract

A year-long, extensive fieldwork was conducted (August 2024 to July 2025) in the Nahar Wildlife Sanctuary, Haryana, to investigate the population structure, habitat preferences, and foraging behaviour of the Blackbuck

(Antilope cervicapra). Using line transect and scan sampling methods, 208 individual sightings were recorded. Individuals were stratified into four age classes: 1) 0- 6 months; 2) 1 year; 3) 1-3 years, and 4) >3 years, displayed significant variation in abundance (mean±SE: $17.33^{a} \pm 1.39$; $14.91^{a} \pm 1.39$; $38.75^{b} \pm 1.24$; and $37.66^{b} \pm 1.24$). Gender-wise distribution (male, female, and fawn) also exhibited a significant difference ($17.33^{a} \pm 1.12$; $28.83^{b} \pm 1.15$, and $36.69^{c} \pm 1.28$), validated by one-way ANOVA (F-values of 303.44 and 299.42, $p<0.001$). Six distinct social group types were documented; the mixed herds observed throughout the year, whereas unimale-unifemale groups occurred exclusively during the rutting season, indicating seasonal social structuring. Habitat utilisation analysis (one-way ANOVA and linear regression) showed a strong affinity for scrubland, with lesser but notable utilisation of barren land, wetlands and agricultural land, while clear avoidance of built-up areas. The dietary analysis using Kruskal-Wallis and Jonckheere-Terpstra tests revealed 39 consumed identified plant species out of the 51 recorded, with a marked preference for the Poaceae family. A distinct seasonal shift in the utilisation of 19 plant species was recorded, reflecting temporal adjustments in diet. These findings highlight the importance of constant monitoring of population dynamics, habitat preferences, and feeding behaviour is vital for the formulation of effective and targeted conservation measures for this endemic species.

Keywords: Blackbuck, Foraging behaviour, Habitat preference, and Population structure.

Introduction

Blackbuck (*Antilope cervicapra*) is the lone surviving delegate of the genus *Antilope,* known for its pronounced sexual dimorphism and is considered as one of the most elegant and charismatic antelope species in Asia. Endemic to the Indian subcontinent, primarily inhabiting semi-arid regions across India. It displays a broad spectrum of behavioural activities that vary across both spatial and temporal scales (Gehlot and Jakher 2007; Khanal and Chalise 2011; Debata 2017; Meena and Jaipal 2020; Delu et al. 2021; Jaipal and Meena 2022; and Kumar and Rahmani 2024). The scientific name of the Blackbuck originates from two classical languages: the genus name *Antilope* came from the Greek term “anthalops”, representing the horned animals, while the specific epithet *cervicapra* is drawn from the Latin word “cervus” signifying deer and “capra” meaning sheep/goat (Rai and Jyoti 2020; Tahir et al. 2020; Jaipal and Meena 2022).

Currently, the Blackbuck falls under the ‘Least Concern’ category of the IUCN Red List, listed under Schedule I of the Wildlife (Protection) Act, 1972 and in Appendix III of CITES (Das and Kar 2015; IUCN 2017; Meena and Jaipal 2020; Bhaskar et al. 2021; Bist et al. 2021; Sathiskumar et al. 2023; and Latif et al. 2024). Despite this, its population has declined significantly in recent decades, predominantly due to game hunting and poaching. Presently, its distribution is confined to the semi-arid zones of southern, eastern and western India, including parts of the south-eastern (coastal area) belt of the Indian Peninsula (Bhaskar et al. 2021). Substantial populations now exist in states, Haryana, Rajasthan, Gujarat, Tamil Nadu, Madhya Pradesh, Karnataka, Telangana and Uttar Pradesh, whereas populations in Bihar and West Bengal have nearly vanished (Das & Kar, 2015).

It predominantly inhabits scrublands, open grasslands, agricultural lands, and wastelands, while typically avoiding dense forest areas, urban environments, and hilly terrains. Scrublands account for nearly one-third of the Earth’s terrestrial surface- have historically harboured a rich and diverse array of wildlife. However, extensive land-use changes, predominantly for agriculture and intensive livestock grazing, have led to significant degradation of scrublands (Sagar and Antoney 2017).

Ecologically, the Blackbuck is herbivorous, demonstrating both grazing and browsing (Isvaran 2007; Khalil et al. 2020; Bhaskar et al. 2021; Delu et al. 2021). Its browsing diet includes leaves, pods, flowers, and fruits of

shrubs and trees, while grazing is focused mainly on grasses and herbaceous vegetation. Additionally, it also consumes pulses and cereal crops, often resulting in Human-Wildlife conflict due to crop depredation. Notably, Blackbuck shows a marked dietary inclination towards short grasses over long grasses (Khalil et al. 2020; Kumar and Kumara 2023), and due to their reliance on grasses, the foraging behaviour exhibits significant seasonal variations (Meena et al. 2017).

Despite Blackbuck's ecological importance, no comprehensive study has been conducted on the population structure, habitat preference, or foraging behaviour of Blackbuck in Nahar Wildlife Sanctuary, Haryana. The lack of reliable data on population dynamics and demography poses challenges to effective conservation planning. Understanding habitat utilisation and preferences is crucial for evaluating the habitat requirements and potential consequences of habitat alterations, and formulating evidence-based conservation and management strategies. Although a habitat suitability assessment was previously conducted in the Nahar Wildlife Sanctuary by Chandel et al. (2022), no study has thus far addressed the detailed ecological aspects, such as population dynamics, habitat preference, and foraging behaviour. Therefore, the present study aims to address this gap by pursuing the following study objectives:

- To estimate the population dynamics and structure of Blackbuck in Nahar Wildlife Sanctuary, Haryana.
- Model the covariates influencing the habitat preference.
- Assessment of foraging ecology and seasonal variation in diet preferences.

Material and Methods

Study area

Nahar Wildlife Sanctuary is located in the Kosli subdivision of Rewari district, Haryana (Figure 1-3), located between 28°24′10″-28°25′00″ N and 76°24′00″-76°25′50″ E. Historically, the area now forming the sanctuary was a meadow owned by the Nawab of Dujana. It used to be a Reserve Forest, but it was declared a sanctuary officially in 1987, vide Govt. notification no. S.O.9/C.A.53/72//S.18/87, reflecting its ecological implications and the need for enhanced conservation. The sanctuary encompasses an area of 522 acres, subdivided into three unequal parts, measuring 331 and 93 acres and the third segment of 98 acres. Rewari district forms part of the Indo-Gangetic alluvial plain of the Yamuna sub-basin, and the hill range forms a part of the extensive Aravalli chain. The Rewari district experiences a primarily arid climate with sandy soil, characterised by blazing summers and chilly winters. The minimum and maximum mean temperature of the area range from 5.6°C - 41°C in January and May-June, respectively, with an annual rainfall of 553 mm (Datta et al. 2016; Chandel et al. 2022).

Data Collection

The field visits were conducted over 12 months, visiting the study site twice a month from August 2024 to July 2025, employing the scan sampling recorded (Mitlohner et al. 2001; Pullin et al. 2017) and the line transect method (Gaston 1975). Before starting the formal field survey, a preliminary reconnaissance survey was conducted to identify representative Blackbuck habitats and to assess the feasibility of recurrent field visits. On the basis of this evaluation, eight fixed transects (N1-N8), were determined within the accessible area of the Nahar Wildlife Sanctuary, Haryana, asserting inclusion of diverse microhabitats. Transects were systematically laid to ensure maximum coverage of the study area, each with adequate spacing to prevent any sampling overlap and pseudo-replication, while optimising habitat representativeness. The coordinates of each transect's starting point were as follows: **N1:** 28º24'31" N, 76º24'49.84" E; **N2:** 28º24'30.98" N, 76º24'50.45" E; **N3:** 28º24'30.10" N, 76º24'51.15" E; **N4:** 28º24'24.06" N, 76º24'47.70" E; **N5:** 28º24'21.01" N, 76º24'50.68" E; **N6:** 28º24'21.98" N,

76º24'58.02" E; **N7:** 28º24'24.19" N, 76º24'58.51" E; **N8:** 28º24'21.08" N, 76º25'3.19" E (Figure 4). Geographic coordinates were acquired using a mobile-based GPS and subsequently plotted onto a multi-temporal Landsat image. The Landsat imagery went through an unsupervised classification in ArcGIS 10.8.1 software (ESRI, Redlands, California, USA), which classified five land-use categories: scrub land, barren land, wetland, agricultural land, and built-up area. Observations were carried out from 07:00-18:00 hr, by dividing a full day into three time blocks: 1) Early morning (07:00-10:30 hr); 2) Mid-day (10:30-15:30 hr); and Evening (15:30-18:00 hr) (Isvaran and Jhala 2000). Field observations were executed from a distant place using a field binocular, causing the least disturbance to the wildlife and for ground truthing, pictures were captured using a Nikon Coolpix P950 digital camera. Along with fixed transect surveys, the opportunistic observations were made in adjacent areas. This integrated approach enabled a thorough evaluation of population structure, habitat preference and foraging behaviour.

Data Analysis

For all the statistical analyses, the IBM SPSS 16.0 software was used. A OneOne-Way analysis of variance (ANOVA) was applied to study the population structure (Anjali and Rana, 2024), and Tukey's Honest Significance Difference (HSD) test was used for post-hoc pairwise comparisons to establish statistically significant differences. Linear Regression and one-way ANOVA tests were performed to assess habitat preferences. Kruskal-Wallis (Gyawali et al. 2020) and Jonckheere-Terpstra tests were applied to test the seasonality in diet preference.

and Discussion

Population

A total of 208 individual sightings of unique individuals were recorded across diverse habitats throughout the study period (Plate 1). The observations revealed a positive trend in population growth, with the highest count documented in July 2025, marking the peak of population growth during the study. Notably, no neonatal mortalities were recorded during the March-May breeding season; however, two fawn mortalities were documented during the mid-August to mid-October breeding season. During the fortnightly visits, the researcher systematically documented and georeferenced the precise GPS coordinates of each sighting, which were subsequently mapped for spatial analysis. were systematically documented and plottedFor the assessment of the population dynamics and relative abundance across gender and age classes, a one-way ANOVA followed by post-hoc comparisons using Tukey'sTukey's B, Tukey's HSD post-hoc and Duncan's multiple range tests were applied (Figure 6; Plate 1). The population was stratified into four age classes: 1) 0- 6 months, 2) 1 year, 3) 1-3 years, and 4) >3 years. The mean population distribution (mean±SE) across various age classes was as follows: 1) 0- 6 months ($17.33^{a} \pm 1.39$), 2) 1-year ($14.91^{a} \pm 1.39$), 3) 1-3 years ($38.75^{b} \pm 1.24$), and 4) >3 years ($37.66^{b} \pm 1.24$) (Table 1; Table 2). Statistical analysis revealed a significant difference in relative abundance among age classes ($p < 0.001$ and F-value=303.44). One-way ANOVA test signified that the highest no. of individuals were recorded in 1-3 years age group, followed closely by >3 years, while the least abundance was found in the 1-year age class.

Likewise, a statistically significant variation in relative abundance was observed across gender based categories (Table 3): 1) Male ($17.33^{a} \pm 1.12$), 2) Female ($28.83^{b} \pm 1.15$), and 3) Unspecified ($36.69^{c} \pm 1.28$), with corresponding $p < 0.001$ and 299.42, p and F-value, respectively. Notably high F-value in both analyses indicates substantial variance between groups relative to within-group variance, emphasising the influence of both age and gender on relative abundance patterns.

Blackbuck demonstrates multiple social organisations, including (see Plate 2):

1) Solitary and bachelor herds of males,

2) Female herd (comprising females of all age classes and fawns),

3) Uni-male and Uni-female herd (breeding season)

4) Harem,

5) Mixed herd. (Isvaran 2007; Sagar and Antoney 2017; Rai and Jyoti 2020; Tahir et al. 2020).

Group dynamics among Blackbuck are fluid, involving frequent formation, disbanding, and reformation of groups. The group living provides various advantages, such as improved access to resources, enhanced defensive capabilities, lowered predation risk and minimised infanticide by predators. Group living also facilitates prior detection of predators and offers protection through confusion and dilution effects or cooperation.

Habitat Preferences

One-way ANOVA, followed by Tukey's B, Tukey's HSD post-hoc, Duncan test, along with linear regression analysis, were performed to evaluate habitat preferences of the Blackbuck. The analyses revealed statistically significant differences in habitat usage across various habitat types at a significance level of $p<0.05$. The results signified that the Blackbuck exhibits the highest affinity for the scrublands (Figure 4; 7), which are characterised by open, sparsely vegetated grasslands primarily served as foraging grounds, with a mean population abundance of 131.58 ± 7.6^{b}, followed by barren lands, which are ideal habitat for basking and resting (23.50 ± 7.6^{a}), wetlands, predominantly visited for drinking purposes (18.75 ± 7.6^{a}), and agricultural lands, occasionally utilized for foraging activity (11.08 ± 7.6^{a}) (refer Table 4).

The linear regression analysis (see Figure 5; Table 5) further revealed a statistically significant association between the relative abundance of Blackbuck and habitat type, with a regression coefficient (B) of -0.067, a R^2 value of 0.45, F statistics 38.05, and $p< 0.001$, indicating a moderate degree of collinearity, suggesting that habitat type is a significant predicator of Blackbuck abundance. These findings demonstrate that relative abundance is significantly modulated by habitat-specific variables, underscoring the ecological significance of habitat heterogeneity in shaping the distribution and abundance of Blackbuck. This emphasises the ecological importance of conserving a mosaic of habitat types to encourage the long-term viability of Blackbuck populations.

Floral Composition of the Study Area

The chief plant species of the sanctuary are illustrated (Figure 8) as *Hyparrhenia dregeans, Acacia Senegal, Cuscuta reflexa, Ocimum gratissimum, Cynodon dactylon, Parthenium hysterophorus, Prosopis juliflora, Calotropis procera, Eragrostic spp., Dactyloctenium aegyptium, Digera muricata, Digitaria spp., Cyperus rotundus, Aerva javanica, Cucumis callosus, Xanthium strumarium, Tephrosia purpurea, Setaria viridis, Pupalia lappacea, Chenopodium album, Euphorbia prostrata, Trifolium repens, Cenchrus clandestinus, Lactuca serriola, Achyranthes aspera, Abutilon palmeri, Prosopis cineraria, Commiphora virgata, Capparis decidua, Azadirachta indica, Bougainvillea spectabilis, Vachellia nilotica, Ziziphus lotus, Saccharum spontaneum, Saccharum munja, Triticum aestivum, Sorghum bicolor, Malvastrum coromandelianum, Ageratum conyzoides, Alternanthera sessilis, Bidens spp., Bothriochloa pertusa, Echinochloa spp., Eleusine indica, Boerhavia diffusa, Heliotropium europaeum, Sorghum bicolor, Trianthema portlacastrum, Youngia japonica, Brachiaria spp., Dichanthium annulatum* etc. Plant species were initially identified in the field and subsequently brought to the laboratory for further taxonomic verification (Upadhyay et al. 2022).

Feeding Preferences

To assess dietary preferences, both the Kruskal-Wallis (Table 6) and Jonckheere-Terpstra tests (Table 7) were utilised. The calendar year was categorised into four distinct seasons: Winter (December-February), characterised by cool and dry conditions; Pre-Monsoon (March-May), marked by hot and arid conditions with dried grasses; Monsoon (June-August), featuring heavy rainfall and an abundance of grasses; and Post-Monsoon (September-November), during which rainfall declines and grass availability reduces, although vegetation remains relatively green. The results indicated a statistically significant variation in foraging preferences and seasonal dietary patterns. The Kruskal-Wallis test yielded a chi-square value of 11 with an asymptotic significance of 0.012, highlighting a notable difference in diet composition across the seasons. To further examine the seasonal influence on the consumption of individual plant species by Blackbuck, the Jonckheere-Terpstra test was applied. Among the 39 plant species consumed, a distinct seasonal shift in the exploitation of 19 plant species was observed, suggesting significant temporal variation in preferences. The observations signify the highly preferred plant species, *Acacia senegal, Prosopis cineraria, Achyranthes aspera, Sorghum bicolor, Youngia japonica, Calotropis procera, Bothriochloa pertusa, Cynodon barberi, Cynodon dactylon, Echinochloa spp.,* and *Triticum aestivum.* Overall, Blackbuck foraged on a range of plant types: 4 tree species, 16 herbaceous species, 4 shrub species, and 15 grass species, irrespective of the degree of preference. The foraging behaviour of Blackbuck varied on the basis of plant species- leaves of trees were consumed, while leaves, pods and fruits of herbs and shrubs were eaten. In contrast, entire grass plants were ingested. This study offers valuable insights into the foraging behaviour of Blackbuck, underscoring the critical importance of preservation of foraging grounds for the sustained survival of Blackbuck. Effective conservation strategies should prioritise the protection and restoration of these essential habitats, while simultaneously minimising anthropogenic disturbance in areas of high human activity.

The findings of this study reiterate the population structure, habitat use and foraging behaviour of Blackbuck reported by prior research conducted. The four different age-classes and six distinct categories of social organisation were reported by our observations (Jhala 1997; Isvaran 2007; Ban and Singh 2012; Meena et al. 2017; Sagar and Antoney 2017; Rai and Jyoti 2019; Khalil et al. 2020; Meena et al. 2020; Rai and Jyoti 2020; Bist et al. 2021; Bhaskar et al. 2021; Delu et al. 2021; Rai and Jyoti 2021; Upadhyay et al. 2022; Kumar and Kumara 2023; and Sathishkumar et al. 2023). Such variety in social structures within a particular species is relatively exceptional and may display adaptive responses to environmental pressures, reproductive strategies and resource distribution. This flexibility probably confers ecological advantages, enabling individuals to adjust social behaviour based on spatial or seasonal variation in habitat condition and population density. The Blackbuck considerably depends on scrublands, highlighting that habitat preference is closely tied to foraging and survival requirements, with a clear avoidance of built-up areas. Additionally, habitat dependency varies seasonally, with remarkable variations in habitat preference throughout the year. The habitat was confined by the excessive proliferation of natural factors, *Prosopis juliflora* (Chandel et al. 2022). This pattern underscores the importance of semi-arid habitats for the Blackbuck's ecological requirements.

The scrublands provide optimal foraging opportunities, guarding from predators and nesting sites. Dietary preferences further underscore the Blackbuck's ecological adaptability and specialisation. Strong variation in diet preference was evident, with noteworthy variation across both plant species and seasons. The seasonality in diet allows the species to exploit various food resources according to their availability throughout the year.

Putting together these findings proposes Blackbuck is both ecologically specialised and behaviourally flexible, characteristics that may improve its resilience to environmental changes.

Ecological studies play a vital role in the conservation of endangered species and in promoting a positive outlook among local people toward their conservation. Govt. ensures the protection of such species by designating their natural habitats as protected areas, thereby safeguarding them from threats and promoting their conservation. Blackbucks have disappeared from numerous regions, primarily due to the relentless destruction of their natural habitats. In the current context, a long-term management plan is essential to balance the needs of both humans and Blackbucks, ensuring their coexistence. This will guide habitat utilisation and Blackbuck conservation, improving habitat quality and supporting their long-term survival. Conservation plans must involve local communities, ensuring they get significant benefits while working closely with the forest department. These plans must include managing habitats outside protected areas and the establishment of functional corridors to enable safe movements across regions.

Conclusion:

This study significantly contributes to the understanding of the demographic traits, habitat utilization, dietary preferences, and seasonal foraging behaviour of the Blackbuck (*Antilope cervicapra*), highlighting the profound influence of climatic factors, habitat structure, and fodder availability on their ecological necessities. The formulation of effective management strategies necessitates an understanding of the Blackbuck's sociality, survival, reproduction, habitat use patterns and foraging ecology. Through meticulous observation, this study provides a detailed assessment of habitat preferences, making a valuable contribution to the conservation of Blackbuck. Keen observation has identified the critical environmental variables influencing the habitat use in Nahar Wildlife Sanctuary, Rewari. The key factors affecting habitat preference include forage availability, predator detection and escape, neonatal concealment, canopy cover, and access to water resources. The analysis indicates a marked seasonal shift in dietary composition, with a marked preference for palatable, soft-textured grasses that offer higher digestibility and nutritional value. Such feeding behaviour underscores the imperative for grassland conservation and management as a cornerstone of Blackbuck conservation. Marked seasonal variations exert a substantial impact on the interplay among climatic factors, plant species, and the availability of resources. In light of these findings, the following management recommendations are proposed: effective management of Blackbuck habitat and the flora of the Sanctuary, to enhance forage quality and availability, thereby improving the population density and ecological stability; establishment of a long-term ecological monitoring program to systematically study population dynamics, habitat integrity, and climatic influence. Encouraging collaborative academic and institutional partnerships to endorse ongoing behavioural and ecological research.

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REFERENCES

Anjali and Rana S (2024) Habitat Preference and Threats to Black-Headed Ibis, *Threskiornis melanocephalus* and Red-Naped Ibis, *Pseudibis papillosa* in Iba Dighal, Haryana, India. Journal of the Bombay Natural History Society (JBNHS) 121:113-118.

Bhaskar R, Kanaparthi P, and Sakthivel R (2021) Genetic diversity and phylogenetic analysis of blackbuck (*Antilope cervicapra*) in southern India. Molecular Biology Reports 48(2):1255-1268. https://doi.org/10.1007/s11033-021-06180-9

Bist BS, Ghimire P, Poudyal LP, Pokharel CP, Sharma P, and Pathak K (2021) From extinction to recovery: the case of Blackbuck, *Antilope cervicapra* from Nepal. Mammal Research 66(3):519-523. https://doi.org/10.1007/s13364-021-00576-5

Chandel P, Kumar R, Bishnoi P, Kumar V, and Kumar KEM (2022) Habitat suitability analysis for Blackbuck (*Antilope cervicapra*) in Nahar Wildlife Sanctuary, Haryana, India. Current Science 122(5):609.

Das UK, and Kar S (2015) Study on the population dynamics and habitat occupancy of Blackbuck (*Antilope cervicapra*) in Ganjam District, Odisha, India. Journal of Natural Sciences Research 5(3):94-109.

Datta A, Sethi M, Basak N, Yadav AK, Chinchmalatpure AR, Khurana ML, and Barman A (2016) Salt-affected soils of Rewari District, Haryana: distribution and characteristics. Journal of Soil Salinity and Water Quality 8(2):144-152.

Debata S (2017) Population size, herd structure and sex ratio of the Blackbuck *Antilope cervicapra* (Mammalia: Cetartiodactyla: Bovidae) in a human-dominated area in Odisha, India. Journal of Threatened Taxa 9(11):10953-10955. http://doi.org/10.11609/jott.2658.9.11.10953-10955

Delu V, Singh D, Dookia S, Priya, and Kiran (2021) Seasonal food preferences and group activity pattern of Blackbuck *Antilope cervicapra* (L., 1758) (Mammalia: Cetartiodactyla: Bovidae) in a semi-arid region of western Haryana, India. Journal of Threatened Taxa 13(13):19937-19947. https://doi.org/10.11609/jott.7086.13.13.19937-19947

Gaston AJ (1975) Methods for estimating bird populations, Journal of the Bombay Natural History Society 72(2):271-283.

Gehlot HS and Jakher GR (2007) Distribution, status and conservation of Blackbuck *Antilope cervicapra* in Thar Desert of Rajasthan (India). Tiger paper 34:19-23.

Gyawali U, Mandal RA, Mathema AB, and Subedi A (2020) Assessing the Population Dynamics of Blackbuck, Its Habitat Condition and People's Interaction in Blackbuck Conservation Area, Khairapur Nepal. Annals of Archaeology 3(1):1-8.

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(2):435-444. DOI 10.1007/s00442-007-0840-x

Isvaran K, and Jhala Y (2000) Variation in lekking costs in Blackbuck (*Antilope cervicapra*): relationship to lek-territory location and female mating patterns. Behaviour 137(5):547-563.

IUCN (The IUCN Red List of Threatened Species. Version 2017–2. Available at: www.iucnredlist. org. Accessed: 14 September 2017.

Jaipal Ak and Meena M (2022) A study on seasonal variation of Blackbuck in reference to food habits and in comparison with other ungulates in western Rajasthan, PhD thesis, Jai Narain Vyas University, Rajasthan.

Jyoti and Babbar DR (2020) A study on the ecology and behaviour of Blackbuck, *Antilope cervicapra* Linnaeus 1758, PhD thesis, Kurukshetra University, Kurukshetra, Haryana.

Khanal L, and Chalise MK (2011) Impacts of livestock grazing on Blackbuck at BCA, Bardiya. Special issue on the occasion of 16th Wildlife Week 2068:14-22.

Kumar S, and Rahmani AR (2024) Predation by wolves (*Canis lupus pallipes*) on Blackbuck (*Antilope cervicapra*) in the Great Indian Bustard Sanctuary, Nannaj, Maharashtra, India. International Journal of Ecology and Environmental Sciences 34(2):99-112.

Kumar V, and Kumara V (2023) A Promising Habitat Space for Blackbuck *Antilope cervicapra* Delimited by Declining Open Grassland Tracts and Increasing Tall Vegetations. Ecology, Environment and Conservation 29(2023):S272-S283. http://doi.org/10.53550/EEC.2023.v29i01s.042

Latif MA, Hussain T, Junaid N, Saeed A, Altaf M, Rafay M, and Khan EU (2024) Population Dynamics and Diurnal Budget of Behavioural Activities of Blackbuck (*Antilope cervicapra*) at three protected areas in Cholistan Desert, Pakistan, Journal of Xi'an Shiyou University, Natural Science Edition 20(5):558-581.

Meena M, Jaipal Ashok K, and Garg K (2020) Crop Damage by the Blackbuck (*Antilope cervicapra*) and other Ungulates in around Rohat region, Rajasthan, India. Alocahna Chakra Journal 9(5):2866.

Mitlöhner FM, Morrow-Tesch JL, Wilson SC, Dailey JW, and McGlone JJ (2001) Behavioural sampling techniques for feedlot cattle. Journal of animal science 79(5):1189-1193.

Pullin AN, Pairis-Garcia MD, Campler MR, and Proudfoot KL (2017) Validation of scan sampling techniques for behavioural observations of pastured lambs. Animal Welfare 26(2):185-190.

Rai D, and 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. DOI: 10.11609/jott.4788.11.9.14194-14203

Rai D, and Jyoti (2021) Measures of sociality, social organisation and population structure in Blackbuck, *Antilope cervicapra* (Linnaeus, 1758). Proceedings of the Zoological Society, New Delhi 74 (3):268-279. https://doi.org/10.1007/s12595-021-00371-9

Sagar SC, and Antoney PU (2017) Measuring Indian Blackbuck, *Antilope cervicapra* (Mammalia: Cetartiodactyla: Bovidae) abundance at Basur Amruth Mahal Kaval Conservation Reserve, Chikkamagaluru, southern India. Journal of Threatened Taxa 9(7):10468-10472. http://doi.org/10.11609/jott.2971.9.7.10468-10472

Sathishkumar S, Arandhara S, and Baskaran N (2023) Determinants of diet selection by Blackbuck, *Antilope cervicapra* at Point Calimere, southern India: quality also matters. Journal of Threatened Taxa 15(3):22791-22802. https://doi.org/10.11609/jott.8117.15.3.22791-22802

Tahir R, Ghaffar A, Samra, Zafar J, Turabi TH, Du X, Khalil S, Safeer M, Riaz S, Jamil H, and Noor U (2020) Biology and ecological adaptations of Blackbuck (*Antilope cervicapra*): a review. Agrobiological Records 4:23-31. https://doi.org/10.47278/journal.abr/2020.023

Upadhyay AK, Emmanuel AA, Varghese AS, and Narasimhan D (2022) Plant diversity of Point Calimere Wildlife Sanctuary and fodder species grazed by the Blackbuck *Antilope cervicapra* L. Journal of Threatened Taxa 14(1):20433-20443. https://doi.org/10.11609/jott.5942.14.1.20433-20443

TABLES AND ILLUSTRATIONS

Table 1. Mean distribution of individuals across various age cohorts reported in different seasons

Seasons	AF		SAF		AM		SAM		YM		F		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Autumn 2024	28	15.6	28	15.6	44	24.5	52	29.1	13	7.2	14	7.8	179
Winter 2025	31	17.5	24	13.5	45	25.4	50	28.2	14	7.9	13	7.3	177
Spring 2025	35	18.1	24	14.1	44	24.5	52	26.9	16	8.2	22	11.3	193
Summer 2025	32	16.9	28	14.8	40	22.7	53	28.1	17	8.9	19	10.1	189

(AF: Adult female; SAF: Sub-adult female; AM; Adult male; SAM: Sub-adult male; YM: Yearling male; and F: Fawn)
(Autumn: Sep-Nov; Winter: Dec-Feb; Summer: June-Aug; and Spring: Mar-May)

Table 2. Distribution of individuals across various age classes

Age group	Distribution (Mean ± SE)	95% CI (Min-Max)	p	F	Corrected Model (F-Value)	Intercept (F-Value)	Total Observation
0-6 Months	17.33^{a} ± 1.39	-24.91-6.45					
1 Year	14.91^{a} ± 1.39	-27.33-1.62	0.00	303.44	179.10	3.42	24
1-3 Years	38.75^{b} ± 1.24	-1.77-27.33					
>3 Years	37.66^{b} ± 1.24	-3.93-26.24					

Table 3. Distribution of individuals among gender

Gender	Distribution (Mean ± SE)	95% CI (Min-Max)	p	F	Corrected Model (F-Value)	Intercept (F-Value)	Total Observation
Male	17.33^{a} ± 1.12	5.48-22.36					
Female	28.83^{b} ± 1.15	-10.23-14.68	0.00	299.42	179.10	3.42	24
Unspecified (Fawn)	36.69^{c} ± 1.28	-22.36-(-8.31)					

Significant differences were found at the 5% level of significance. Different alphabets accompanying mean values in a column indicate significant variation in relative abundance among various age classes and genders at $P < 0.05$ (one–way ANOVA and Tukey's HSD post-hoc test).

Table 4: Individual sightings in each habitat type of Nahar Wildlife Sanctuary, Rewari (One-way ANOVA)

Habitat type	Area (Ha)	Habitat Availability (%)	Total Sightings	Distribution (Mean ± SE)	95% CI (Min-Max)	Total Observation
Scrub land	22.9	10.8	68	131.58 ± 7.6^{b}	87.7-140.8	

Agricultural land	1.50	0.71	9	11.08±7.6[a]	-140.8-12.6	
Wetland	0.11	0.05	12	18.75±7.6[a]	-133.2-28.0	
Barren land	0.21	0.10	18	23.50±7.6[a]	-128.4-32.7	
Forest Cover	186.2	88.1	-	-	-	24
Built-up area	0.48	0.22	-	-	-	
Total	211.4	100				
P-Value	0.00					
F-Value	112.5					

Significant differences were found at the 5% level of significance. Different alphabets accompanying mean values in a column indicate significant differences among various habitats at P<0.05 (One–way ANOVA and Tukey's HSD post-hoc test).

Table 5. Linear Regression analysis showing co-linearity in habitat abundance across habitat types

Predictor	B (Unstandardized coefficient)	Std. Error	t	B (standardised coefficient)	95% CI (LB-UB)	R^2	P	F
Constant	252.00	33.84	7.44	-0.67	183.88-320.13	0.45	0.00	38.05
Habitat	-31.65	5.13	-6.16		-41.98-(-21.32)			

Table 6. Kruskal-Wallis test showing seasonality in diet preference

Statistics	Value
Asymp. Sig.	0.012
df	3
Chi-square	11
N	24

A significant difference was found at the 5% level of significance. Different alphabets accompanying values in table indicate significant differences in foraging among different seasons at P<0.05 (Kruskal-Wallis Test).

(Asymp. Sig: Asymptotic Significance; df: degree of freedom; N: total no. of observations)

Table 7. Food preferences table showing parts eaten of a particular species and its preference & seasonality (Jonckheere-Terpstra test)

(+++, High preference, ++, Moderate preference, and +, Low preference)
(CP-Complete Plant, L-Leaves, P-Pods, F-Fruits, and S-Stem)

SI. No.	Plant Species	Family	Plant part eaten	JT Statistic (Observed)	Mean ± SD of JT Statistic	Z (Std.) JT Statistic	p-Value	Significant (p<0.05)	Intake Level
1.	*Acacia senegal*	Mimosaceae	L	45	27 ± 6.06	2.96	0.00	Yes	+++
2.	*Prosopis cineraria*	Fabaceae	P & L	45	27 ± 6.06	2.96	0.00	Yes	+++
3.	*Prosopis juliflora*	Fabaceae	P & L	40.5	27 ± 5.25	2.56	0.01	Yes	++
4.	*Vachellia nilotica*	Fabaceae	P & L	45	27 ± 6.06	2.96	0.00	Yes	+
5.	*Achyranthes aspera*	Amaranthaceae	CP	22.5	27 ± 6.45	-0.69	0.48	No	+++
6.	*Aerva javanica*	Amaranthaceae	L	40.5	27 ± 5.25	2.56	0.01	Yes	+
7.	*Alternanthera sessilis*	Amaranthaceae	CP	27	27 ± 6.06	0.00	1.00	No	++
8.	*Bidens spp.*	Asteraceae	CP	22.5	27 ± 6.45	-0.69	0.48	No	++
9.	*Boerhavia diffusa*	Nyctaginaceae	L	4.5	27 ± 6.45	-3.48	0.00	Yes	+
10.	*Chenopodium album*	Amaranthaceae	CP	13.5	27 ± 5.25	-2.56	0.01	Yes	+
11.	*Cucumis callosus*	Cucurbitaceae	F	22.5	27 ± 5.25	-0.85	0.39	No	+
12.	*Digera muricata*	Amaranthaceae	CP	22.5	27 ± 6.45	-0.69	0.48	No	+
13.	*Euphorbia prostrata*	Euphorbiaceae	CP	4.5	27 ± 6.45	-3.48	0.00	Yes	+
14.	*Heliotropium europaeum*	Boraginaceae	CP	22.5	27 ± 6.45	-0.69	0.00	Yes	+
15.	*Pupalia lappacea*	Amaranthaceae	S & L	4.5	27 ± 6.45	-3.48	0.00	Yes	+
16.	*Sorgham bicolor*	Poaceae	CP	31.5	27 ± 5.25	0.85	0.39	No	+++
17.	*Tephrosia purpurea*	Fabaceae	P & L	4.5	27 ± 6.45	-3.48	0.00	Yes	++
18.	*Trianthema portulacastrum*	Aizoaceae	CP	40.5	27 ± 5.25	2.56	0.01	Yes	+
19.	*Xanthium strumarium*	Asteraceae	CP	27	27 ± 6.06	0.00	1.00	No	+
20.	*Youngia japonica*	Asteraceae	CP	27	27 ± 6.06	0.00	1.00	No	+++
21.	*Capparis decidua*	Capparaceae	F	31.5	27 ± 6.45	0.69	0.48	No	++
22.	*Commiphora virgata*	Burseraceae	L	31.5	27 ± 6.45	0.69	0.48	No	++

23.	***Calotropis procera***	Ascelpiadaceae	L	40.5	27 ± 5.25	2.56	0.10	No	+++
24.	***Ziziphus lotus***	Rhamnaceae	F & L	40.5	27 ± 5.25	2.56	0.10	No	+
25.	***Bothriochloa pertusa***	Poaceae	CP	27	27 ± 6.06	0.00	1.00	No	+++
26.	***Brachiaria spp.***	Poaceae	CP	27	27 ± 6.06	0.00	1.00	No	+
27.	***Cynodon barberi***	Poaceae	CP	27	27 ± 6.06	0.00	1.00	No	+++
28.	***Cynodon dactylon***	Poaceae	CP	27	27 ± 6.06	0.00	1.00	No	+++
29.	***Cyperus rotundus***	Cyperaceae	CP	49.5	27 ± 6.45	3.48	0.00	Yes	++
30.	***Dactyloctenium aegyptium***	Poaceae	CP	49.5	27 ± 6.45	3.48	0.00	Yes	++
31.	***Dichanthium annulatum***	Poaceae	CP	49.5	27 ± 6.45	3.48	0.00	Yes	++
32.	***Digitaria spp.***	Poaceae	CP	49.5	27 ± 6.45	3.48	0.00	Yes	+
33.	***Echinochloa spp.***	Poaceae	CP	27	27 ± 6.06	0.00	1.00	No	+++
34.	***Eleusine indica***	Gramineae	CP	49.5	27 ± 6.45	3.48	0.00	Yes	++
35.	***Eragrostic spp.***	Poaceae	CP	49.5	27 ± 6.45	3.48	0.00	Yes	+
36.	***Saccharum munja***	Poaceae	CP	40.5	27 ± 5.25	2.56	0.10	No	++
37.	***Saccharum spontaneum***	Poaceae	CP	40.5	27 ± 5.25	2.56	0.10	No	++
38.	***Setaria viridis***	Poaceae	CP	31.5	27 ± 5.25	0.85	0.39	No	+
39.	***Triticum aestivum***	Poaceae	CP	13.5	27 ± 5.25	-2.56	0.01	Yes	+++

FIGURES

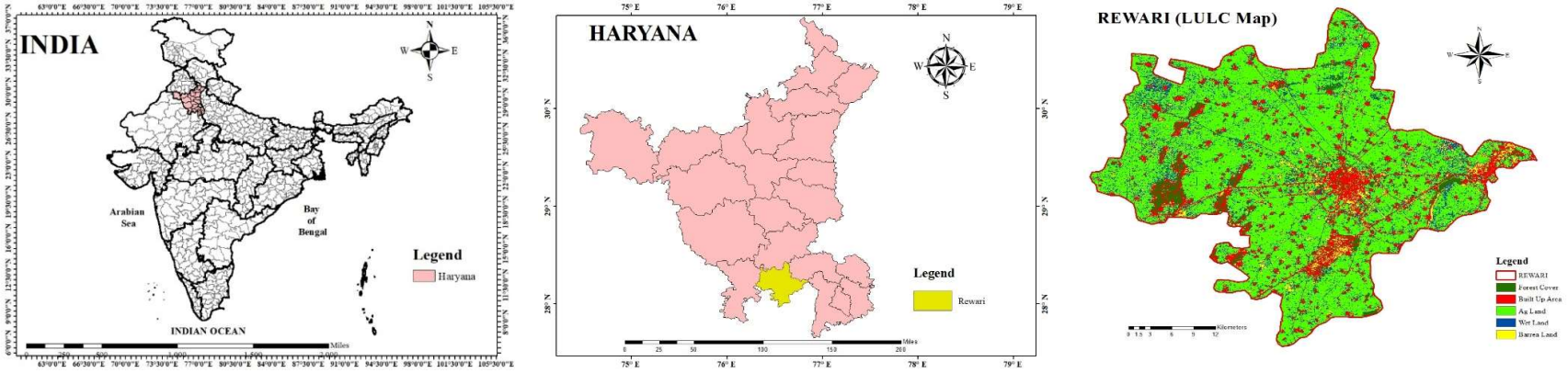

Figure 1: Map of India, Haryana and LULC map of Rewari district

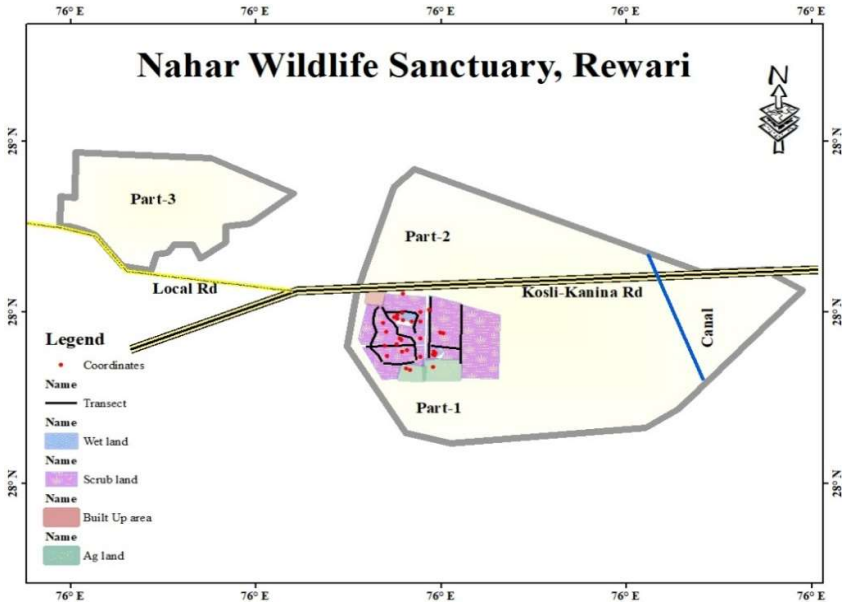

Figure 2: Map of Nahar Wildlife Sanctuary, Rewari showing transects used to collect data and individual sightings in different habitat types

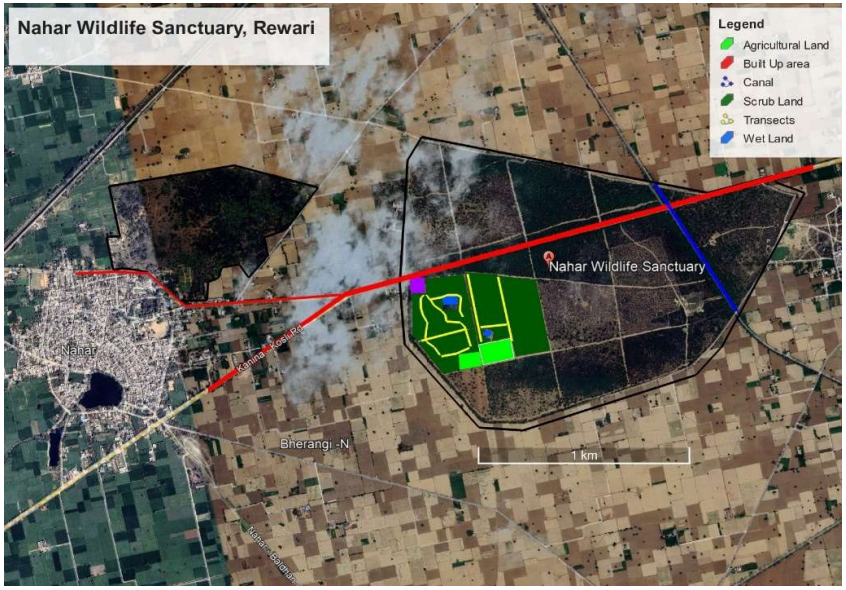

Figure 3: Satellite map of Nahar Wildlife Sanctuary, Rewari

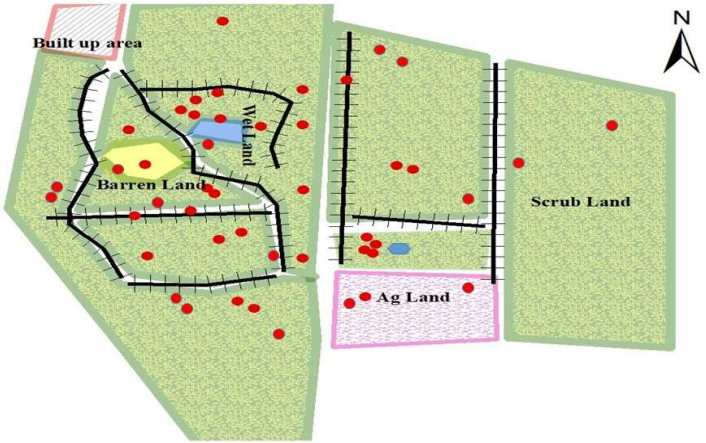

Figure 4: Map showing different habitats with the coordinates of individual sightings in study area

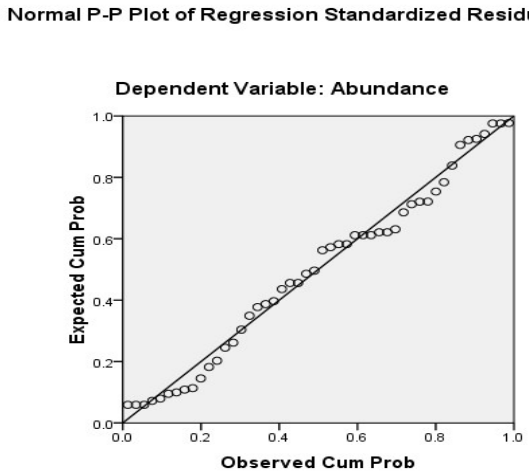

Figure 5: Linear Regression graph showing co-linearity between Blackbuck abundance in various habitats

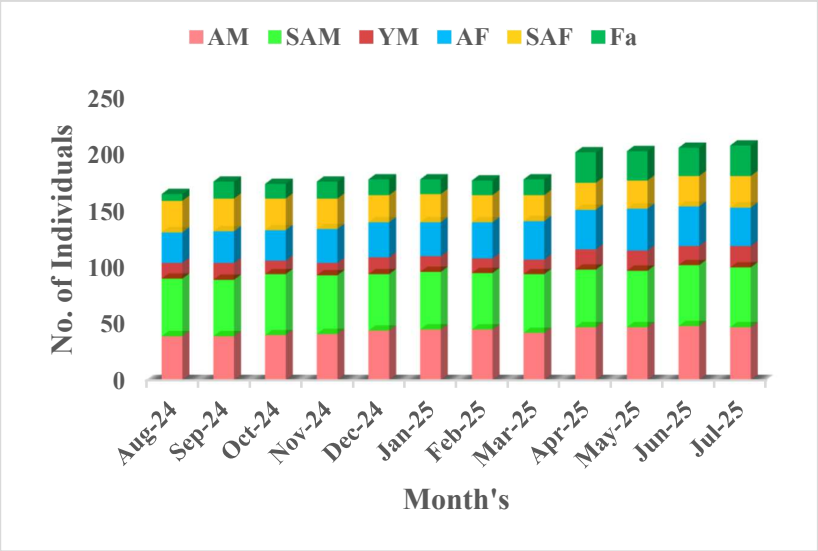

Figure 6: Population abundance across age classes
(AM-Adult male, SAM-Sub-adult male, YM-Yearling male, AF-Adult female, SAF-Sub-adult female, & Fa-Fawn)

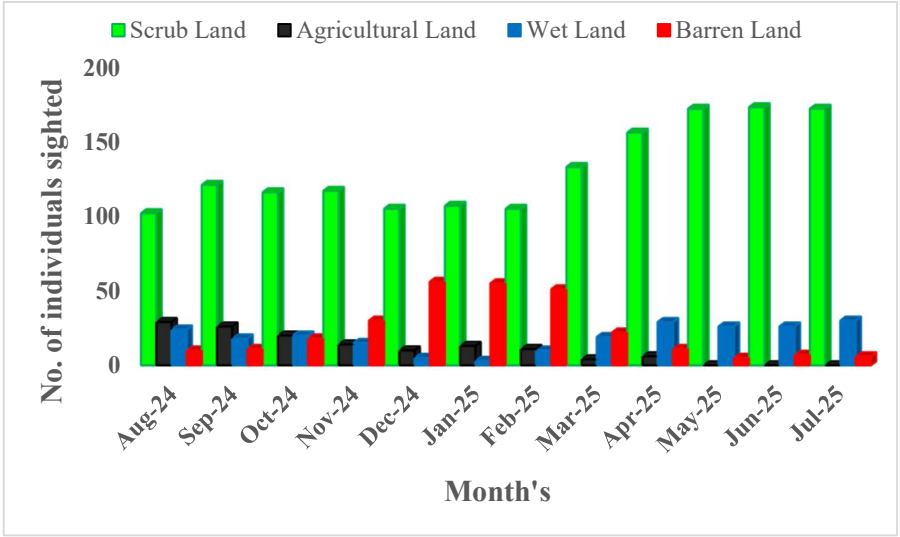

Figure 7: Population abundance across habitats

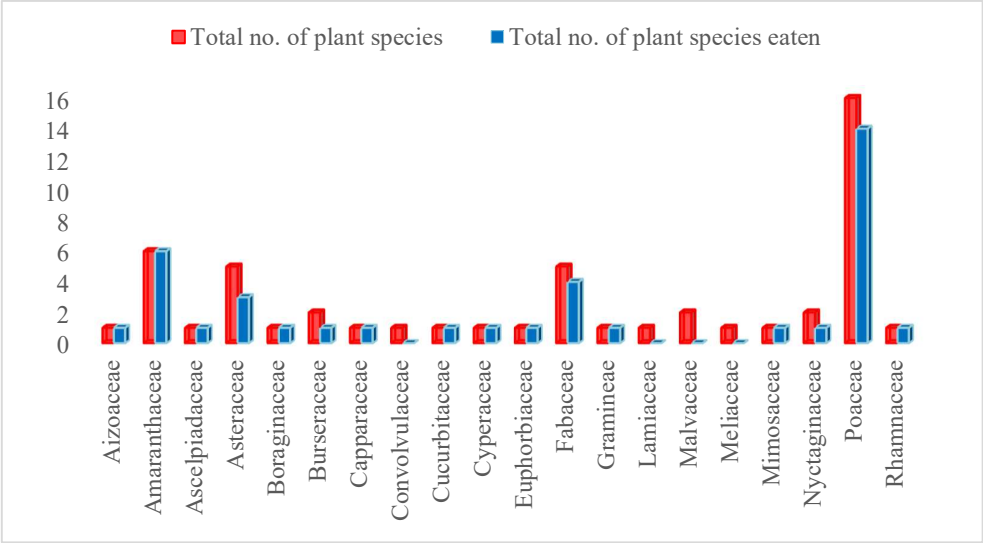

Figure 8: Plant families found in the study area

		
Adult female in scrub land	**Sub-adult female in barren land**	**Adult male in scrub land**
		
Sub-adult male in barren land	**Yearling male in agricultural land**	**Fawn in scrub land**
Plate 1: Age-Classes in Blackbuck, *Antilope cervicapra* spotted in various habitats		

		
Bachelor herd	**Mixed herd**	**Female herd**
		
Lone territorial male	**Unimale-Unifemale**	**Harem**

Plate 2: Social Organisation in Blackbuck, *Antilope cervicapra*