

Possible Bottleneck Effect Prediction in small Fragmented Populations of Blackbuck (*Antilope cervicapra* L.) in Western Haryana, India

Vikram Delu, Dharambir Singh, Naveen Kumar

Received 16 January 2023, Accepted 6 May 2023, Published on 21 June 2023

ABSTRACT

Habitat loss, loss of true grassland due to agricultural intensification along with the newly emerged predator i.e., feral dogs are the main reasons for the reduced population size of blackbuck in Haryana specially in its western part. Here we predicted population bottleneck for these fragmented and isolated populations of this state animal based on the information from old British Gazetteer of Joint Punjab, available literature and our current field observations. However it is reported that there is a literature gap on the species population trend in this region. We predicted that the population may undergo extinction in western parts of Haryana in upcoming decades based on bottleneck

hypothesis. Detailed genetic study is required to prove this hypothesis and in Haryana context, habitat management is the only ground solution for the recovery of the species in future.

Keywords Grassland, Feral, Bottleneck, Extinction, Genetic.

INTRODUCTION

Population bottleneck or genetic bottleneck (sometimes called effect) is a sharp decline of population, due to natural or anthropogenic activities, cause to reduce the genetical variation in the gene pool, which may lead to (or predict) population survival/extinction in future (Grossen *et al.* 2020). This effect is observed in populations having three major characteristics: Reduced population size, restricted gene flow, and loss of genetic diversity, in a short period of time (Frantz *et al.* 2020, Kaňuch *et al.* 2021). We observed potential bottleneck in the blackbuck population of western Haryana from critical evaluation of our recent study (2018-2021) and analysis of previous reports. Blackbuck holds the status of state animal of agrarian Haryana state (India) and it is an endemic, grassland species of Indian sub-continent, listed in schedule-1 of Wildlife Protection Act, 1972. It is majorly present in the western part of Haryana, and we surveyed most common hotspots of blackbuck population of this region, in and around Hisar (Mangali-Rawat Khera, Balsamand, Adampur) and Fatehabad district (Dhan-

Vikram Delu^{1*}, Dharambir Singh²

¹PhD Research Scholar, ²PhD Assistant Professor

Department of Zoology and Aquaculture, Chaudhary Charan Singh Haryana Agricultural University (CCS-HAU), Hisar, Haryana 125004, India

Naveen Kumar³

³PhD Research Scholar

Department of Zoology, Institute of Science, Banaras Hindu University, Varanasi 221005, UP, India

Email: vikramdelu29@hau.ac.in

*Corresponding author

gar (a community Reserve for Blackbuck) and Badopal) and some previous reports (Lalpur Jheel, Hisar, Jyoti and Rai 2021). These blackbuck habitat areas lie in biogeographic province 4-A, Semi-arid, Punjab Plains (Rodgers *et al.* 2000) and the “Trans-Gangetic Plains Regions” agroclimatic zone under the “Arid to Semi-arid” climatic region, which is characterized by scanty rainfall, aridity, and extremes of temperature. The vegetation comprises predominantly xerophytes and is characterized as “tropical desert thorn”. Most of the above-mentioned sites are the natural patches (Private or Panchayat land where agriculture cultivation is mainly depends on rainfall) surrounded by a semi-arid agro-ecosystem. Adjoining agricultural fields are used for growing crops such as wheat, maize, other cereals, cotton and pulses.

MATERIALS AND METHODS

Possible bottleneck in the blackbuck population of western Haryana was predicted from critical evaluation of our recent study (2018-2021) and analysis of previous reports, research articles and old British gazetteers.

RESULTS AND DISCUSSION

Reduced population size, its causes and impact on the population

Based on our study and critical evaluation of previous literature, Blackbuck population have declined to greater extent in these areas and present in small, fragmented and isolated patches, surrounded by high human habitation. Once this species roamed across the Haryana, and Ranjitsinh (1989) reported 2410 blackbuck from Hisar district alone (now Hisar and Fatehabad), out of 4852 Blackbucks in whole state, which formed around 50% populations in a single district. In another older literature, British Regime Gazetteer of Joint Punjab and Haryana, mentioned about the large herds of Blackbuck in parts of Hisar, especially Hisar Bir and its surrounding Bishnoi community villages (District Gazetteer 1883-84, 1892, 1915, 1987). Our census survey (2018-21) revealed that the population size is critically reduced, and it is present in a few isolated pockets of small 8-10 sub-populations, mostly fragmented, with an

average sub-population size of below 150 individuals, roughly less than 1000 individuals in total studied area (unpublished observation). Presently, most of Blackbuck population in western Haryana is present in Bishnoi's dominated areas, who are known for wildlife protection activities where as a rule, shooting and killing them is prohibited (Delu *et al.* 2021, Sinha and Singh 2020).

Once this area harbored major Blackbuck population in large herds (Hisar District Gazetteer 1883-84, 1892, 1915, 1987), but recent intense agricultural activities caused habitat destruction and simultaneously population got reduced. The intense agricultural activities in late 1900s and early 2000s exponentially increased with agricultural revolution and better irrigation system which exploited the true grassland habitat of blackbuck to null. The species has left with no choice but to survive on the available habitat and plant species, where it occasionally roams in agricultural fields, sometimes consuming crops to fulfill its nutritional requirement (Delu *et al.* 2021). The survival cost can cause changes in feeding pattern, even to non-preferred food, for a bigger goal i.e., to save the gene pool. But it also caused human wildlife conflicts, resulting in wire fencing around agricultural fields which potentiated with the killing of species by feral/stray dogs. These factors (feral dogs and wire fencing) were the reason behind 90.90% Blackbuck deaths from 2012-17 in Haryana comparing to 4% natural deaths (Kumar *et al.* 2018 RTI 2013). Another recent RTI report of Hisar district showed the severity of feral dogs killing, from January 2016 to May 2020, where these killed over 361 Blackbuck (87%) followed by illness (6%), poaching (1%) and other (6%), forming the major highlight in national and local newspapers. Feral dogs have emerged as potential predator of this species and caused an irreversible loss to this beautiful antelope in last two or three decades.

These non-natural factors including destruction of their natural habitat for cultivation, feral dogs, cattle grazing, human habitation, barbed wire fencing led to catastrophic reduction in population size in a short period, from thousands to thousand in a century as per local interviews. However, the disease factor remains constant during this time frame of 1883-2021,

because no major outbreak was reported in Blackbuck population in this time period. These conditions forced species to restrict its territorial size, which may result in decreased reproductive and survival fitness. This disastrous decline in short period of time favored the small, fragmented and patched sub-population, which overall may be diminishing variation in gene pool and allelic frequencies through reduced genes of dead individuals. This loss of genetic variability also undermines population resilience and persistence.

Rise of true sub-population causing reduced gene flow

The Blackbuck population in these areas are now separated into various true subpopulations through sharp demarcation and evolution of true boundaries by public roads, villages and wire fencing around farmlands. These sub-population have very least probability to meet or mate, due to very less or no local migration and herd distance between them which may have changed random distribution of alleles in population. Presently there are total 10 subpopulations (9 reported by us and one Lalpur Jheel reported by Jyoti and Rai (2021)), which contain around 30-170 individual per subpopulation, and only two of them, occasionally, locally migrate. Presence of a population in such small patch of sub-populations, reduces the free gene-flow between populations causing a sharp decline in genetic mix-up of alleles. Another common observation with sub-populations is continuous stake of fight for survival, as survival is more important at any cost, so later on can produce progeny to inherit their gene pool (Frankham 2005, Currat *et al.* 2008, Frankham *et al.* 2017). These small sub-populations, there about selected irrespective of their genetic superiority or inferiority, are under the heavy evolutionary pressure from non-natural causes.

Reduced population and gene flow in short period of time cause loss of genetic diversity

This long-standing Blackbuck habitat is largely transformed for agriculture, and true grasslands habitat are greatly reduced or snatched. This shrunk habitat and survival pressure induced some survival eleventh-hour behavioral changes, may be varied from other geo-wild counterpart. This restricted area

doesn't favor typical territorial behaviors, and very few adult males reported to establish their territory, however with reduced territorial qualities. Conversely, females mate character selection like morphological features, pheromone secretions were not observed in high frequency. In this context, Solo lek territories were observed instead of true clustered lek for mating purpose, leading to more intra than inter mating in populations. This declining population's reproduction interactions will be leading to decreased reproductive frequency and efficiency, thereby may cause loss of some alleles and ultimately reducing the genetic diversity of the species.

CONCLUSION

Summarizing the arguments, this reduced population arises as non-overlapping sub-populations of a particular gene-pool of unknown superiority or inferiority and hampered free gene-flow which may favor genetic homogeneity and inbreeding depressions. Here, Blackbuck population of western Haryana may undergo extinction as noted in Pakistan and Nepal or may recover as in certain parts of India or world. The reduced size over a short period of time may leads to a population bottleneck that characterized by the reduces genetic variance at genetic loci and increases nonrandom associations between different loci as a result of the increased importance of genetic drift as postulated by Pannell (2013). Man-made conditions caused destruction of the true habitat in almost entire Haryana for this species and similar patterns were observed in the population at agrarian district Hanumangarh (Rajasthan) (Singh *et al.* 2020). The only plausible way to avoid extinction of this charismatic species is through conserving its habitat and obsoleting man-made jerky evolution pressure, which can provide this species natural strength for survival and reproduction for the recovery of population to save its genetic diversity and gene-pool. Though there is a large literature gap for the population characterization in this region but available literature and current status of population are indicating an alarming situation of bottleneck. Therefore our present discussion strongly agrees with the existence of potential bottleneck effect among population of western Haryana, however further detailed genetic study is required in favor of this hypothesis.

ACKNOWLEDGMENT

The authors are highly thankful for the kind support and financial assistance provided by the Department of Zoology and Aquaculture, CCS Haryana Agricultural University Hisar, Haryana. The contribution of forest officials has been counted worthy. While all authors including VD would like to extend special thanks to Vinod Karwasra, the Haryana state president, Akhil Bhartitya Bishnoi Jeev Rakshya Sabha (ABBIRS) and all local stakeholders around the study sites for their kindly support and guidance.

REFERENCES

- Curat M, Ruedi M, Petit RJ, Excoffier L (2008) The hidden side of invasions: Massive introgression by local genes. *Evol Int J Organ Evol* 62(8): 1908-1920.
- Delu V, Singh D, Dookia S, Priya Kiran (2021) Seasonal food preferences and group activity pattern of Blackbuck *Antelope cervicapra* (L.1758) (Mammalia: Cetartodactyla: Bovidae) in a semi-arid region of western Haryana, India. *J Threatened Taxa* 13(13): 19937-19947. <https://doi.org/10.11609/jot.7086.13.13.19937-19947>
- Frankham R (2005) Genetics and extinction. *Biol Conserv* 126(2): 131-140.
- Frankham R, Ballou JD, Ralls K, Eldridge MDB, Dudash MR, Fenster CB, Sunnucks P (2017) Genetic management of fragmented animal and plant populations. Oxford University Press.
- Frantz LA, Bradley DG, Larson G, Orlando L (2020) Animal domestication in the era of ancient genomics. *Nature Rev Genet* 21(8): 449-460.
- Grossen C, Guillaume F, Keller LF, Croll D (2020) Purging of highly deleterious mutations through severe bottlenecks in *Alpine ibex*. *Nature Communications* 11(1): 1-12.
- Hisar District Gazetteer (1883-84) Reprinted (1999) Revenue and Disaster Management Department, Haryana, Chapter, pp 16.
- Hisar District Gazetteer (1892) Reprinted (1998) Revenue and Disaster Management Department, Haryana, Chapter 1, pp 19.
- Hisar District Gazetteer (1915) Reprinted (1998) Revenue and Disaster Management Department Haryana, Chapter 1, pp 16.
- Hisar District Gazetteer (1987) Revenue and Disaster Management Department, Haryana, Chapter 1, pp 10.
- Jyoti, Rai D (2021) Measures of Sociality, Social Organization and Population Structure in Blackbuck, *Antelope cervicapra* (Linnaeus, 1758). *Proc Zool Soc* (July-Sept 2021), 74(3): 268-279. <https://doi.org/10.1007/s12595-021-00371-9>
- Kañuch P, Berggren Å, Cassel-Lundhagen A (2021) A clue to invasion success: genetic diversity quickly rebounds after introduction bottlenecks. *Biol Invasions* 23(4): 1141-1156.
- Kumar V, Sharma N, Sharma A, Verma K, Singal K, Kumar M (2018) A data-based study in support of Blackbuck related cases from Haryana. *Data Brief* 17: 1196-1200.
- Pannell JR, in Brenner's Encyclopedia of Genetics (2013) 2nd edn.
- Ranjitsinh MK (1989) The Indian Blackbuck. Natraj Publishers, Dehradun, pp 155.
- Rodgers WA, Panwar HS, Mathur VB (2000) Wildlife Protected Area Network in India: A Review (Executive Summary). Wildlife Institute of India, Dehradun.
- RTI details based on - <https://www.tribuneindia.com/2013/20131006/people.htm#3>.
- Singh M, Choyal R, Kumar A, Charan PD (2020) Distribution of Blackbuck (*Antelope cervicapra*) and its conservation strategies in Hanumangarh district of Rajasthan, India. *Ind For* 146 (10): 945-948. DOI: 10.36808/iff/2020/v146i10/153623.
- Sinha BL, Singh A (2020) Embodying a Preparedness to Die: Why Bishnois of Western Rajasthan Rise in Defence of the Blackbuck and the Chinkara? *Sociol Bull* 69(1): 34-50.