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Distribution, ecology and conservation status of blackbuck (*Antilope cervicapra*): An update

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Abstract
Blackbuck is the most elegant member of the antelope family. It has long association with Indian culture. Male and females have sharp sexual dimorphism – adult males are dark with long spiral horns while female and fawn are yellowish brown. They show variation in its diploid chromosome number. The Blackbuck is native to India and can be seen in the majority of Indian grasslands. Seasonal food availability and its quality, the sun elevation and temperature of the area are important factors for foraging activity. They feed on fresh tender leaves, grass, crops, cereals, vegetables and leaves of shrubs and trees. Due to combined efforts of communities and forest department of India, the population is increasing in various habitats.

Keywords: breeding, genetics, mythology, taxonomy, threats

Introduction
The blackbuck (*Antilope cervicapra)* is a medium-sized ungulate species of antelope native and endemic to the Indian subcontinent [1]. The general name "blackbuck" refers the dark brown to black colour of the dorsal (upper) part of the coat of the male. Blackbuck is the state animal of Punjab, Haryana and Andhra Pradesh. Common names for the blackbuck are Indian antelope (in English), kadiyal, kala hiran, krishna mrig and krishnasaar (in Hindi); krishna jinka (in Telugu); and iralai maan, velimaan (in Tamil) (Figure 1) [2, 3].

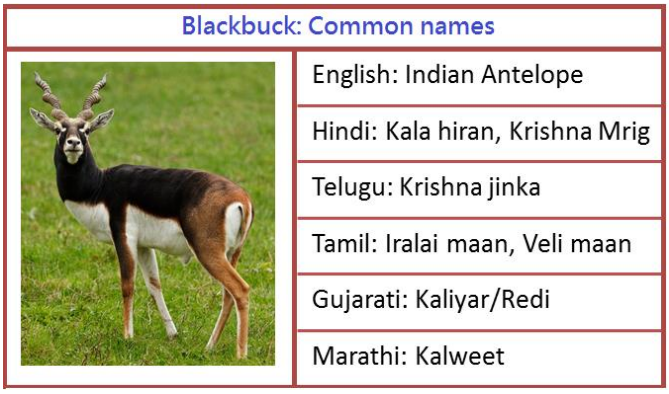

Fig 1: Common name of blackbuck in different Indian languages

Taxonomy
Blackbuck belongs to order Artiodactyla, family bovidae and subfamily antelopinae. The blackbuck is the only living species belonging to the genus Antilope [4, 5]. The generic name of *Antilope cervicapra* is derived from the Latin word antalopus ("horned animal"). The specific name cervicapra is composed of the Latin words cervus ("deer") and capra ("she-goat") [6, 7]. The systematic position of blackbuck is Figure 2.

Systematic Position	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Subclass:	Theria
Infraclass:	Eutheria
Order:	Artiodactyla
Family:	Bovidae
Subfamily:	Antelopinae
Genus:	Antilope
Species:	*Antilope cervicapra*
Subspecies:	1. *Antilope cervicapra cervicapra* 2. *Antilope cervicapra rajputanae*

Fig 2: Systematic position of blackbuck

India has two subspecies of blackbuck namely [8]

1. *Antilope cervicapra cervicapra* [9]
It is smaller in size as compared to second subspecies. It has short and fine hair. In males body colour is dark of the upper side running all down the limbs to the hoofs, white eye- ring narrowed above the eye. Horns are relatively short, not very divergent, with a relatively open spiral. It is distributed mainly in Tamil Nadu and Karnataka in south and Bengal in eastern parts of India.

2. *Antilope cervicapra rajputanae* [10]
It is larger, with longer, roughened pelage; males, in the breeding season, with a grey sheen; shanks largely white, with little or no extension of the dark colour from the upper limb segments; white eye-ring broad all around the eye. Horns

tending to be longer, more divergent and more closely spiralled. It is distributed in Punjab, Haryana, Rajasthan and Gujarat [11].

Groves and Grubb [12] suggested that there is a possibility that the two recognized subspecies may actually be distinct species, but more needs to investigated about their individual variations.

Association with Indian culture and mythology

The blackbuck has very old links with the Indian culture. McIntosh [13] and Van der Geer [14] suggested that blackbuck might have been a source of food in the Indus Valley civilization (3300–1700 BC) and bone remains of blackbuck have been discovered in sites such as Dholavira and Mehrgarh. The painting of Mughal era in India often depicts the royal hunt of blackbucks using hunting leopard (*Acinonyx jubatus*) in miniature paintings [15, 16]. According to the Hindu mythology, the blackbuck is considered as the vehicle (vahana) of the Vayu (the wind god) and Chandrama (the moon god). The blackbuck is also considered to be the vehicle of the Hindu goddess Korravai [14].

According to the Garuda Purana of Hindu mythology, it bestows prosperity in the areas where they live [3]. It is also believed that the blackbuck pulls the chariot of Lord Krishna. In Rajasthan, there is the belief that the goddess Karni Mata is the protector of the blackbucks [17]. Even today communities such as the Bishnois actively protect and care for most of the wild animals including the blackbuck [18, 19]. The skin of blackbuck plays an important role in Hinduism as Brahmin boys are traditionally required to wear a strip of the unleathered hide after performing Upanayanam. The hide of the blackbuck is considered to be sacred in Hinduism. The blackbuck hide is used as the carpet to sit upon only by Brahmins, Sadhus, Yogis, forest-dwellers and Bhikshus [3, 20].

Characteristics

Blackbucks resemble very large extent with the gazelle found in the Arabian Peninsula. They can be distinguished mainly by the fact that while gazelles are brown in the dorsal parts, blackbuck develops a dark brown or black colour in these parts [21]. Blackbucks are slender with a head-to-body length of about 100-150 cm. They are around 70 to 80 cm high at the shoulder [5]. Blackbuck exhibit pronounced sexual dimorphism. Males are larger than females [22]. Adult males range in weight from 35 to 55 kg while adult females weigh 30 to 40 kg. They differ in the colouration of the head and back. Female and sub-adult male blackbucks are yellowish brown coloured on the back and on the outside of the limbs; the lower parts are white. The two colours of back and belly are sharply divided by a distinct pale lateral band. The important characteristics are highlighted in figure 3.

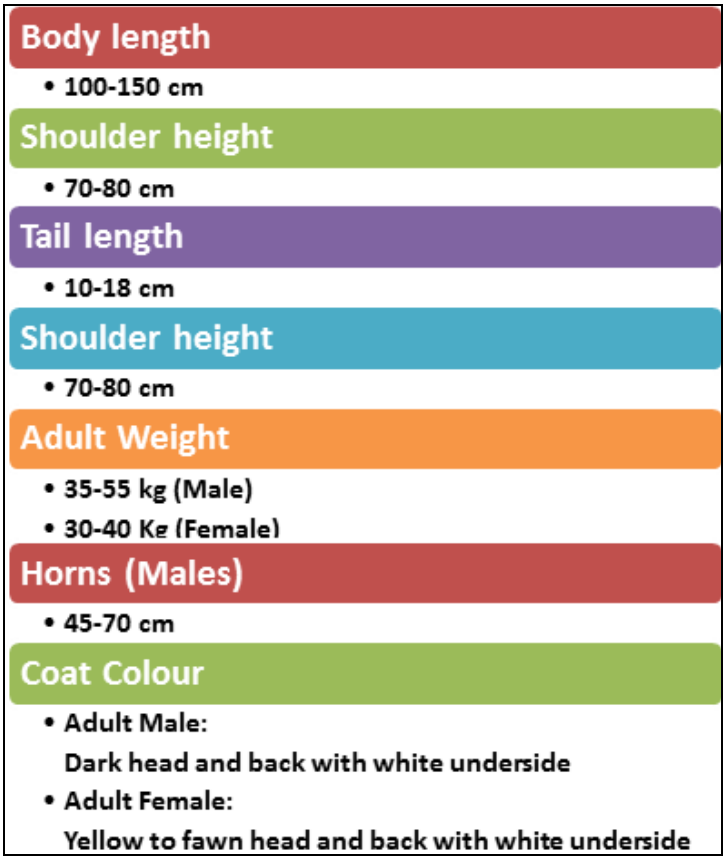

Fig 3: Important characteristics of blackbuck

Old male bucks are blackish brown on the back, on the sides and front of the neck. They become almost black with age, only the nape remains dark, rufous brown and the pale lateral band disappears [23]. Both sexes have white under-parts,

including the insides of the legs and lower chest, as well as a white ring surrounding the eye and a white chin. Both melanism [24] and albinism have been observed in wild blackbuck [25]. Males have horns that are diverging, cylindrical, spiral, and ringed throughout. The rings are closer together near the skull (Figure 4a). The turns of the spiral vary from less than 3 to 5 [4]. Horns are 45.6-68.5 cm long [5] and can be as long as 70 cm. The blackbuck closely resembles kobs [26]. The female blackbucks generally do not even have horns (Figure 4b). Even the few females that have horns lack the rings and spirals that characterize the male blackbuck horns. They possess a short tail which is compressed and is about 10-18 cm. Strong eyesight and speed are the primary defense features of blackbuck against predators [27]. The normal lifespan of Blackbuck is about 12 to 15 years. The maximum age recorded was 16 years and 10 months [28].

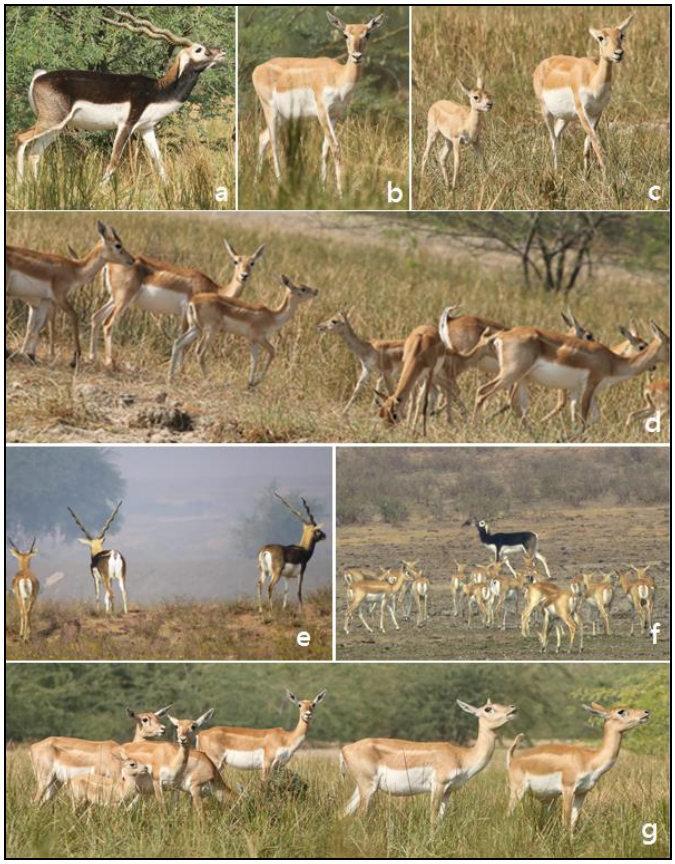

Fig 4: (a) Adult male blackbuck (b) Adult female blackbuck (c) Female blackbuck with fawn (d) Mixed herd (e) Bachelor herd (f) Territorial herd (g) Female herd

Genetics

The blackbuck shows variation in its diploid chromosome number. Males have 31 to 33 chromosomes while females have 30 to 32 chromosomes [29]. Males have a one X and two Y chromosome [30]. Usually, the X chromosome constitutes 5 % of the haploid genome in mammals but in case of blackbuck, the X chromosome constitutes 14.96% of its genome [31]. In Indian blackbuck, unilateral testicular hypoplasia (mainly in right testis) is observed as high as 20%. Cytogenetic analysis revealed the cause is chromosomal aneuploidy which had a 34, XY^1, der(13) karyotype with loss of the acrocentric (autosomal) Y^2 and an aberrant chromosome 13 [30].

Distribution

Blackbucks are found in wide range of habitat but it attains greatest densities in semi-arid grasslands [32, 33]. The Blackbuck (*Antilope cervicapra)* is native to India and Nepal and earlier occurred across almost the whole of the Indian subcontinent grasslands. Their distribution decreased during the 20th century and they are now nonexistent in wild in Bangladesh and Pakistan [34, 35]. Although blackbuck has disappeared from numerous areas due to habitat destruction for anthropocentric development in India, still they are increasing in many protected areas and areas specially dominated by Vishnoi communities in Rajasthan, Gujarat and Haryana [18, 19, 36]. Blackbuck population has been also reported in Maharashtra, Odisha, Bengal, Punjab, Andhra Pradesh, Tamil Nadu and Karnataka, with a few small pockets in central India (Figure 5). In Nepal, the last surviving population of blackbuck (184 individuals) is found in the Blackbuck Conservation Area south of the Bardia National Park [37]. In Pakistan, blackbucks are very rarely sighted along the border areas with India. They are kept in enclosures in the Lal Suhanra National Park for possible reintroduction [38]. The blackbuck has been introduced to grasslands of the United States of America (Texas) and Argentina [35].

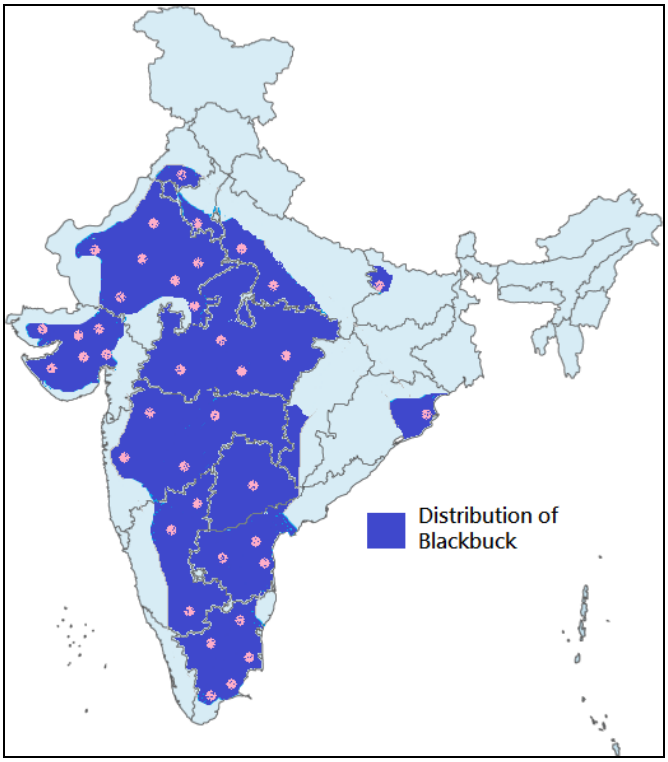

Fig 5: Distribution of blackbuck in India

Population estimates

It has been speculated that the population may have numbered 4 million a couple of centuries ago but only around 80,000 individuals were estimated in 1947. The population in India

increased from an estimated 22,000-24,000 in the 1970s to an estimated 50,000 (out of which 35,000 are mature individuals) by the year 2000, with the largest numbers in the states of Rajasthan, Punjab, Madhya Pradesh, Maharashtra, and Gujarat [36].

In India, no systematic census has been conducted and therefore no robust population estimates of current population size are available. However, it remains widespread and numerous in many places. The species has adapted to the margins of agricultural land and there is some evidence that clearance of scrub and woodland benefit it by creating suitable habitat. Presence of blackbuck in the Punjab state is confined only to Abohar Wildlife Sanctuary, Fazilka. While the number of blackbucks in the 2011 census stood at 3,500, in the recent census conducted jointly by the Punjab Biodiversity Board (PBB) and department of forest and wildlife preservation, Punjab, at Abohar Wildlife Sanctuary in 2017, the population count stands at 3,273. In Velavadar Black Buck National Park, Velavadar, Gujarat population of blackbuck in 2001 was estimated to be around 25025 and in 2015 reports suggest that it has reduced to 14281.

In Orissa, according to the recent census that was conducted by the forest department in 2017, there are 3,806 blackbucks in the Ganjam district. During the 2011 census, the number was only 2,194. Debata [39] reported 7134 blackbucks in a human-dominated area of Balipadar-Bhetnoi Blackbuck Conservation Area during 2012-2013. In Tamil Nadu, the population of Blackbuck seems to have seen a significant increase in the Moyar Valley pointing to increased protection of the species by the Forest Department. The Blackbuck population, believed to be anywhere between 800 to a 1,000 individuals strong in the Nilgiri Biosphere Reserve, is found in parts of the lower Nilgiris, the Bhavani Sagar range in Erode and even parts of Coimbatore forest division. In Karnataka, the blackbucks are found in highest number in Ranebennur Blackbuck Sanctuary which is located in Haveri District. This sanctuary had the population of over 6000. In Bidar district of Karnataka, there are 886 Blackbuck. It is the second highest number in Karnataka next to Ranebennur Blackbuck Sanctuary.[40] In Jayamangali Blackbuck Conservation Reserve, Mydanahalli, Tumkur 454 Blackbuck was counted during the census of 2009 [41]. Basur Amruth Mahal Kaval Conservation Reserve, Chikkamagaluru has 193 individuals of blackbuck [42].

The major increase in blackbuck population has been observed in Rajasthan state, where the forest department data suggest that population has increased from 13457 in 2011 to 30530 in 2016 [43]. In Gajner wildlife sanctuary, Bikaner the total Blackbuck population is 86 individuals [44]. Hemsingh and Jakher [18] reported that highest population density of blackbuck was found in Jodhpur district, followed by Nagaur district which may be due to the availability of good habitat and protection from the local people. In some areas, the population has increased so much that the Blackbuck has become an agricultural pest.

The blackbuck was introduced in 1932 in Texas, USA. Reports suggest that the population had increased and the blackbuck was the most populous exotic animal in Texas after the chital [22]. The population in the United States had been estimated as 35,000 individuals in 2000. Blackbucks have also been introduced into Argentina in 1906 and it was estimated that there are 8,600 individuals in 2000 [38]. Bashistha *et al*. [34] reported around 200 individuals of blackbuck in Nepal.

Habitat and foraging ecology

Blackbucks are mainly grazer and prefer open areas such as grassland, wasteland and marginal agricultural fields [45]. In summer blackbucks may migrate to long distance for the search of water and food [33, 46]. Deal [47] suggested that scrublands are a good source of forage and cover for blackbuck and cold climates do not suit them.

Seasonal fodder availability and its quality, the sun elevation during day and temperature of the area are important factors for foraging activity [1, 18]. Blackbucks feed on fresh tender leaves, grass, crops, cereals, vegetables and leaves of shrubs and trees. They forage for a long time, select succulent grasses, tender shoots of crops and plants which help them to maintain water balance in their bodies [33].

Blackbucks mainly behave as grazers during monsoon season when grass and other forage arability are very high and same animals spend most of the time as browsers during summer when food availability is scarce. During winter season they behave as mixed feeders [33, 48]. Grasses like *Dichanthium annulatum* are preferred during and after monsoon season while in summer mainly fallen leaves and pods of tree like *Prosopis juliflora* and *Acacia* species meets the food requirements [33, 38, 49]. Pathak *et al*. [50] suggested that oats (*Avena sativa*) and berseem (*Trifolium alexandrinum*) can be used as nutritious feed for blackbucks in captivity.

Blackbuck spends lesser activity time for foraging in summer [51]. Digestion of nutrients including crude proteins was lesser in summer, but more efficient in the rainy and winter seasons [52, 53]. Thus, crude protein intake in summer was very low, even below the recommended value [54]. Blackbucks have evolved mechanisms for water conservation and when deprived of water, they can increase the concentration of urea in their urine and reabsorb water from their faeces [1].

Behavioral Ecology

The blackbucks are active mainly during the day, though activity slows down at noon as days grow hotter toward summer [5, 7, 51]. Blackbucks show extraordinary kind of social organization and behaviour. Although the individual wandering male can be seen in isolation, they rarely live in isolation, they are mostly found in herds. The average group size is 10-30 individuals but in suitable habitats herds having more than 100 individuals can be seen. The social organizations of Blackbucks includes (Figure 6)

1. Mixed herd formed by males and females of different age groups (Figure 4d).
2. Harem herd or territorial herd with one territorial male and females with all age groups (Figure e).
3. Bachelor herd of all male members (Figure 4f).
4. The herd of all female members (Figure 4g).

Group size varies with availability of forage and type of resources in habitat. The benefit of the large herd is that predator can be spotted faster with very lesser time invested for vigilance individually, thus maximum time can be utilized for foraging activities. A limitation of large group size is the

dilution of resources and increase in foraging time [46]. Herd size is generally smaller in summer as compared to monsoon or winter [2].

Breeding Behaviour

Females become sexually mature at age of eight months to 1 year but give birth to young one once they attain the age of about two years. They can breed throughout a year, but rutting mainly takes place during August to October and from March to April [2]. During the rut, the mature males establish a large territory marked by urination-defecation spot or rubbing the ground, bushes and trees at particular points. Males are extremely aggressive during this time and defend their territories from other males by giving out loud grunts and engaging in serious head-to-head fights, pushing each other using horns [5]. Aggressive display of blackbuck males includes thrusting the neck forward and raising it, folding the ears and raising the tail.

Blackbuck males may adopt lekking as a tactic to attract females for mating [55]. Lekking is a challenging strategy, as the males often have to bear injuries - thus it is a method typically adopted by strong, dominant males [56]. The dominant male chases the female with his nose pointing upward, smells her urine and shows a flehmen response. The female displays her receptivity by waving her tail and thumping the rear legs on the ground. This is followed by several mounting attempts followed by copulation. This whole process may last as long as six hours. The female remains motionless for some time after copulation, after which she may start foraging. The territorial male may then move on to mate with another female.[2, 57] Antelope mating strategies can facilitate seed dispersal and invasion of grasslands by a woody weed likes *Prosopis julifilora* [49]. Most adult females are likely to calve once a year but those in good body condition could produce two calves at the gap of six months, one during the post-monsoon peak (September) and another during the March-April peak [1]. Female black buck antelopes have a gestation period of approximately five to six months [58]. Usually only one young is born at a time [22]. The new born can stand on their own soon after birth [5]. Females can mate again with the male after a gap of one month of parturition. The female blackbuck requires tall grass or small bushes to delivers the calf. The fawn of blackbuck spends the first two weeks after his birth in the grass, between nursing. Only after completing the first two weeks does the fawn join the group [5].

Threats

The decreasing natural resources lead to conflicts and threats to the wild population. The cause of threat to the population of blackbuck (*Antilope cervicapra***)** is developmental work and human encroachment of grassland area [33]. Human population pressure and change in the land use pattern has further restricted the habitat of blackbuck. Due to habitat destruction, the blackbuck can become restricted to limited areas, its gene pool gets reduced and there are increased chances of inbreeding. Another emerging threat is competition between blackbuck and cattle stock for grazing and territory. Blackbuck causes heavy damage to the crops and thus come in direct conflict with the inhabitants. Most of blackbuck habitats are close to the National or State Highway due to which many animals meet the accident while crossing the road [33]. Illegal hunting and poaching is another emerging threat to the blackbuck population. Blackbucks are hunted for their flesh and skin. Occasional incidents of poaching still occur. The major threats to the population of blackbucks are listed in figure 6.

Fig 6: Different threats to blackbuck population

Conservation Efforts

The blackbuck, which was twice thought to be Extinct due to hunting in the late 1800s and 1920s, has now improved in status. It has moved from the "Near threatened" to "Least Concern" in Red Data Book of IUCN (International Union for Conservation of Nature and Natural Resources) [35]. In CITES (Convention of International Trade for Endangered Species of Wild Flora and Fauna) is categorized in Appendix III. In India, hunting and poaching of blackbuck are prohibited under Schedule I of the Wildlife Protection Act of 1972 [19, 33]. The present status for blackbuck is shown in figure 7.

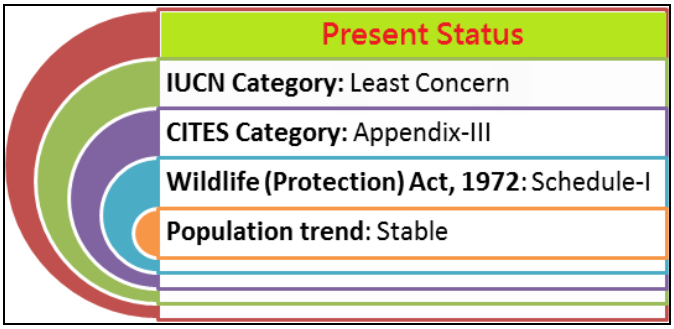

Fig 7: The present status of blackbuck

At present, due to combined efforts of communities and forest department of different states, the population trend is toward positive side in various blackbuck habitats [19]. Blackbucks occur in several protected areas of India which includes.

- Punjab: Abohar Wildlife Sanctuary, Bir Moti Bagh

Wildlife Sanctuary, Bir Bhunerheri Wildlife Sanctuary

- Rajasthan: Tal Chhapar Sanctuary, National Chambal Sanctuary, Ranthambhore National Park, Jod Beed Gaadwala conservation reserve, Guda vishnoiyan conservation reserve, Gogelao conservation reserve, Rotu conservation reserve, Bilaspur reserve,
- Gujarat: Velavadar Wildlife Sanctuary, Gir Forest National Park, Indian wild Ass Sanctuary
- Madhyapradesh: Bagdara Wildlife Sanctuary, Kanha National Park
- Bihar: Kaimur Wildlife Sanctuary
- Maharashtra: Great Indian Bustard Sanctuary, Rehekuri Blackbuck Sanctuary, Karanja-Sohal Black Buck Wildlife Sanctuary
- Odisha: Balukhand-Konark coastal plain/wildlife sanctuary in Puri District
- Andhra Pradesh: Mahavir Harina Vansthali National Park, Nagarjuna Sagar - Srisailam Tiger reserve, Rollapadu Wildlife Sanctuary
- Karnataka: Ranibennur Blackbuck Sanctuary, Jayamangali Blackbuck Reserve, Basur Amruth Mahal Kaval Conservation Reserve
- Tamil Nadu: Satyamangalam Wildlife Sanctuary, Point Calimere Wildlife and Bird Sanctuary, Vallanadu Wildlife Sanctuary, Guindy National Park.

India is the place where conservation of flora and fauna is the religion. Various local communities including Bishnois consider trees as sacred, but their empathy extends to every living being on earth [59]. So they protect the entire ecosystem that exists in their villages. Animals like blackbucks and chinkaras, and birds like vultures, partridges, peacocks and even the endangered Great Indian Bustard, find the village a safe haven. A major change that can be seen in local communities/conservation volunteer is their shift from passive conservation to active conservation. The forest department also played important role in the conservation of blackbuck and other species. Forest officers were able to generate awareness for conservation and community participation [60]. The success of blackbuck (*Antelope cervicapra*) conservation programme will throw problem of plenty, which can become a cause of worry for the forest authorities. With the growing population of this ruminant the cases of accidental deaths by road kill and other issues are on the rise [19]. The frequency of raiding fields and eating and destroying standing crops of farmers is also increasing [61, 62]. Realizing the seriousness of the problem, poor farmers may gradually become intolerant to damage to their crops [63]. Some may develop outright aggressive attitudes toward the blackbuck. Blackbuck possesses a number of attributes which can lead uncontrolled population rise if kept unchecked. It is necessary to develop the sustainable models for the long term coexistence of human and blackbucks.

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