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Ecology of Blue bull, Boselaphus tragocamelus in and around Sariska Tiger

Reserve, Alwar, Rajasthan, India.

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ABSTRACT:

The blue bull (Boselaphus tragocamelus), also known as the nilgai, is a large antelope found throughout India. They are particularly interesting inhabitants of the Aravalli Hills and the surrounding areas, including Sariska Tiger Reserve. Blue bulls favour open scrublands, grasslands, and woodlands within the Aravalli landscape. Sariska, with its mosaic of these habitats, provides a suitable home for them. They are well-adapted to dry environments and can tolerate variations in rainfall. Their ability to digest low-quality forage allows them to thrive in areas with limited resources. Blue bulls are primarily grazers, consuming a variety of grasses, leaves, and shrubs. They are known to be selective feeders, choosing more nutritious plant parts when available. Their diet adapts to seasonal changes. During the dry season, they may consume more bark and woody plants to compensate for limited green forage. Blue bulls exhibit a unique social structure. Females and young form herds of up to 30 individuals, while males are typically solitary. They are primarily diurnal animals, meaning they are most active during the day. However, they may adjust their activity patterns based on weather conditions and predator activity. Habitat destruction due to deforestation and conversion of land for agriculture is a major threat to blue bulls in and around Sariska. Competition for resources with livestock can be another challenge, particularly during periods of drought. Collisions with vehicles pose a significant threat, especially near protected areas where blue bulls may venture outside. Sariska Tiger Reserve plays a vital role in providing a safe haven for blue bulls. Efforts to restore degraded habitats and create corridors between fragmented areas can improve blue bull populations. Educating local communities about the importance of blue bulls and encouraging coexistence can help reduce human-wildlife conflict. By understanding the ecology of blue bulls in Sariska and implementing effective conservation strategies, we can ensure the continued presence of this magnificent animal in the Aravalli ecosystem.

KEY WORDS: Ecology, Blue bull, Sariska Tiger Reserve, Aravalli landscape, Antelope.

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Introduction

The Blue bull, Boselaphus tragocamelus inhabits most part of the Rajasthan and other regions of the country (Frank, 1929; Prater, 1980; Dundar, 1982; Roonwal, 1983; and Prakash, 1986). Blue bull is a clumsy-looking animal with a massive body and long legs. The name "blue bull" means is refered to the iron-grey coat of the mature male. It is the largest antelope with very wide geographical distibution, in the great Indian Desert and in the adjoining area of Harvana, Gujrat and Madhya Pradesh (Majupuria, 1982). It is a hardy animal, it survives very well in arid conditions and less water (Roonwal, 1983). Blue bull, Boselaphus tragocamelus is a voracious eater, it lives in herds which are of two types, 'male herds' and the 'bisexual herds'. Each types of herd is led by a physically strong male as its leader. Its ranges are fast declining because of biotic interferences, more prominently being the extention of agriculture and exotic weed species. But, local people quite often blaim this animal for its crop rading behavior and invading agriculture fields and orchards. Villagers have also assumed that the population of Bluebull had increased manifold in the recent past. The present study was conducted in and around Sariska Tiger Reserve. Blue bull survives very well in various parts of Rajasthan including Aravalli, Vindhya and Thar Desert. This is primarily because of differences in eco-adaption, land use change, feeding compition, exotic flora, etc.

Material and Methods:

Study site: Sariska Tiger Reserve is a tiger reserve in Alwar district, Rajasthan, India. It stretches over an area of 881 km2 (340 sq mi) comprising scrub-thorn arid forests, dry deciduous forests, grasslands, and rocky hills. This area was a hunting preserve of the Alwar state and was declared a wildlife sanctuary in 1958. It was given the status of a tiger reserve making it a part of India's Project Tiger in 1978. The wildlife sanctuary was declared as tiger reserve and national park in 1982, with a total area of about 273.8 km2 (105.7 sq mi). Altitude varies from 900 to 3200 feet metric system above a level. Sariska is characterized by distinct winter, summer and monsoon. During summer, temperature fluctuates between 30 - 350C, and reach may 480C during May and June. Mean winter temperature is 50C, and may go down to 20C during December – January. The average annual rainfall is about 825 mm; minimum 423 mm and maximum 950 mm. This

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wide range of climatic conditions along with the great altitudinal variations provides different micro- habitats. Therefore, this sanctuary encompasses different vegetation types such as deciduous, dry-deciduous, dry-savannah-forest, euphorbia scrub and dry grasslands.

Topography: The Sariska Tiger Reserve is situated in the eastern parts of the Aravalli Mountain ranges and the flat land adjoining it. These hills form watershed between the low-lying plains of Matsya Pradesh. The Aravalli ranges run from northeast to southwest and consists of series of detached hills and ridges, which rises to heights varying from 274 to 1055 meters.

Geomorphology: The main geological formation in the sanctuary is Aravalli, Raialo and Delhi quartzite's rocks which forms central axes of Aravallis. All these rocks are of varying metamorphic nature consisting of phyllites to fine mica, shirts, argillaceous sand stone, gneiss, quartzite's slates, lime stone with frequent binding of marble and granite. The whole rock system has been disturbed and is very greatly fissured, while various strata are usually repeated several times in sections.

Methods:

Data was collected as and when encountered during travelling and regular field visits recorded from December 2016 to December 2018 in and around Sariska National Park. A well-planned questionnaire was prepared for generating information on type of crops, crop raid behaviour, seasonality food preference, crop protection strategies, economic loss estimation and such other issues concerning livelihood and wildlife conservation. Besides this scane sampling and ad-libitum sampling methods (Altamann, 1974) were also used to collect additional information by direct observations. Total 80 questionaire were completed from 10 villages, 10 interview each villages. About 500 hours were devoted to these interviews. Photography and videography were also done to confirm the presence of vertebrate pests in the study area. Data on the wildlife population were obtained through annual animal census conducted by State Forest Department. Besides this regular census by means of direct sightings and other supplementary evidence like calls, kills, pugmarks, droppings, etc. were also conducted during this long-term study. In the home range of the Hanuman langur study

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troops quadrates were laid, all trees were identified, enumerated and their location mapped. These quadrates were checked for new tree cutting once every month with phenological observations. The number of persons entering the sanctuary for tree cutting and amount of head loads, wood carts, camel carts, etc. were counted. One or two days in a month, sitting close to wood cutters' route near the entrance of the sanctuary or forest, the number of men and women entering and leaving with wood, grass, leaves, fruits, seeds, gum and other plant products were accounted during the course of study.

The forest is broadly dry deciduous or woodland type dominated by 'gorya dhawa' (*Anogeissus latifolia*), dhawa (*A. pendula*), salar (*Boswellia serrata*), gol (*Lannea coromandelica*), kherni (*Wrightia tinctoria*), kumbat (*Acacia senegal*), khair (*A. catechu*), ber (*Zizyphus mauritiana*), palas (*Butea monosperma*), etc. The undergrowth mainly consists of jharber (*Z. nummerlaria*), ardnsa (*Adhatada vasica*), gangan (*Grewia tenex*), franger (*G. flavescens*), kanter (*Capparis separaia*), lantana (*Lantana indicus*), etc. with some climbers and little grasses are also found.

Results & Discussion

Two basic types of herds observed are bisexual herds and all-bull (male) herds, but some solitary bulls are also seen. Bisexual herds size range from 4 to 15 individual (average 6 animal) and all bull herd size varies from 2 to 10 individual (average 4 animals). The results presented here are based on surveys conducted in and around Sariska Tiger Reserve and adjoining villages.

Population of Blue bull:

The population of blue bull at Sariska Tiger Reserve has shows a definite increase in the last 15 years. This growth in the population shows the success of blue bull and its ecological adaptation in the nature. Because, beside the fact that there are many predators in and around the Sariska Tiger Reserve like panther wolf, jackal and dogs. The population of blue bull growing every year. This is mainly due to plenty of natural food in side the sanctuary and cultivated food on the periphery of the sanctuary, successful breeding and above all no hunting of the animal due to religious attitude of people.

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Range use:

The Blue bull herds move in a wide area covering insider the Sariska Tiger Reserve and outside the common lands. The herds often change their location, which is directly related to availability of food and protection from predators. At the same time these herds show preferences for certain areas. For example, they move in areas where they get food, shelter, protection and little or no human interference. Their night lodgings are always away from the sanctuary area. It is also observed that the Blue bull shift their location only under human threat and pressure of predator and where natural resources like water, food and forage are in short supply for their survival. It has been found that the reasons of Blue bull range shifts is linked with lack of food, water, and feeding competition in their traditional home range. This is because of over grazing, encroachments and increasing agriculture activity in their home ranges. Some time after breeding seasons they move with young ones to the area with fewer predators.

Food and feeding:

(a) *Natural food*: Blue bull is a well-known voracious herbivore, which are primarily grazer as well as browser. At SARISKA TIGER RESERVE blue bull observed feeding on 48 plant species of which 26 are natural plants and 22 cultivated plants species including crops vegetables, fruit trees, etc. (Table 1 and 2). It feeds on variety of natural plant taxa, particularly the trees hrubs, shrubs and grasses even which are often avoided by other animals. Such food habits made the blue bull a hardy animal who can survive in adverse environmental conditions.

(b) *Cultivated food*: Ganwar (*Cyamopsis tetragonaloba*), Genhu (*Triticum eastivum*), Chana (*Cicer arietinum*), Moong (*Phaselus radiatus*), Rizka (*Medicago sativa*), Makka (*Zea mays*), Moth (*Vigna aconitifolia*), Ganna (*Saccharum officinarum*), Kakri (*Cucumis sativys*), Tamatar (*Lycopersicon lycopersicum*), Band gobi (*Brassica oleracea L. Var. Capitatal*), Ful gobi (*Brassica oleracea L. Var. botrytis*), Matira (*Citrullus lanatus*), Amrood (*Picidium guajava*), Anar (*Punica granatum*), Papita (*Carica papaya*), Hajara (*Tagetes erecta*) and Gulab (*Rosa indica*).

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Local Name	Botanical Name	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Aranjia	Acacia leucophloea	RF	-	YL	-	-	-	-	FB	FB	FL	UF	RF
2. Arjun	Terminalia arjuna	-	-	-	YL	ML	-	FB	FL	UF	UF, RF	RF	-
3 Bargad		RF	-	UF	RF	AR	AR	AR	UF	UF	RF	RF	RF
5. Durguu	Ficus benghalensis	iu iu		01	hu	7110	7110		01	01	, nu	, nu	nu
4. Ber	Ziziphus mauritiana	RF	RF	YL	YL, ST	YL	-	-	-	-	-	RF	RF
5. Farangnee	Grewia flavescens	-	-	YL	YL	ML	ML	FL	UF	RF	ML	ML	-
6. Gangan	Grewia damine	-	-	YL	-	ML	UF, ML	RF, ML	RF	ML	ML	ML	ML
7. Gular	Ficus racemosa	-	YL	YL	UF	RF	RF	AR	AR	UF	RF	AR	-
8. Imli	Tamarindus indica	UF	UF, RF	YL, RF	YL	-	ML	-	-	-	FL	FL	FL
9. Jamun	Syzygium cumini	-	YL	YL	YL, UF	UF	UF, RF	RF	RF	RF	-	-	-
10. Jhar Ber	Ziziphus nummularia	RF	RF	YL,	ST,	YL,	ML	YL	-	FL	UF	UF,	RF
				RF	YL	ML						RF	
11. Jhinjha	Bauhinia racemosa	ML	YL	YL	YL	YL	ML	FL	FL	YL, UF	YL, SE	SE	SE
12. Kolai	Dichrostachys cinerea	-	-	YL	YL	ML	ML	ML	ML, FL	FL	UF	UF	ML
13. Latina	Lantana camara	UF	FL	FL	FL	UF	-	-	YL	YL	FL	FL	UF
14. Palas	Butea monosperma	YL	YL, FB, GU	YL, FB, GU	FL, YL, GU	FL	BR	BR	-	-	-	-	GU
15. Pepal	Ficus religiosa	-	-	YL	UF	-	-	-	-	-	RF	RF	-
16. Salar	Boswellia serrata	-	-	-	YL	YL, FB	YL, FB	ML, FL	ML, FL	-	-	-	-
17. Gundi	Cordia gharaf	-	-	-	FL	UF	RF	-	-	-	-	-	-
18. Aam	Mangifera indica	-	-	-	FL	FL, UF	UF, GU	-	-	-	-	-	-
19. Sitaphal	Annona squamosa	-	-	-	-	YL	YL	-	-	UF	RF	-	-
20. Samel	Bombex ceiba	-	FB	FB, FL	FL	YL, UF	YL, RF	-	-	-	-	-	-
21. Beel	Aegle marmelos	-	-	-	YL	UF	RF	RF	RF	-	-	-	-
22. Timru	Diospyros melanoxylon	YL	YL	YL	-	UF	RF	RF	-	-	-	-	-

Table 1: Natural plants and their parts eaten by Blue Bull in different months at Sariska Tiger

YL = Young leaves; ML = Mature leaves; FB = Flower buds; FL = Mature flower; UF = Unripe fruits; RF = Ripe fruits; SE = Seeds; GU = Gum; BR = Bark; AR = Arial root; ST = Stem.

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Table 2: Cultivated plants and their parts eaten by Blue Bull in different months at Sariska Tiger Reserve .

Local Name	Botanical Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep	Oct	Nov.	Dec.
Rizka	Medicago sativa	-	-	-	ML	ML	ML	ML	-	-	-	-	-
Makka	Zea mays	-	-	-	-	-	-	-	ML	UF	RF	-	-
Moth	Vigna aconitifolia	-	-	-	-	-	-	-	ML	UF	MF	-	-
Ganwar	Cyamopsis tetragonaloba	-	-	-	-	-	-	YL	ML, FL	UF	RF	RF	SE
5. Genhu	Triticum eastivum	UF	UF	-	-	-	-	-	-	-	-	YL	FB
6. Chana	Cicer arietinum	UF	RF	RF	-	-	-	-	-	-	-	-	-
Moong	Phaselus radiates	-	-	-	-	-	-	YL, ST	ML	UF	MF	-	-
Papita	Carica papaya	-	-	-	FL	UF	UF	-	-	-	-	-	-
Band gobi	Brassica oleracea L. Var. Capitatal	ML	ML	-	-	-	-	-	-	-	YL	YL, ML	ML
Ful gobi	Brassica oleracea L. Var. botrytis	FL	-	-	-	-	-	-	-	-	YL	YL	FL
Matira	Citrullus lanatus	-	-	-	-	-	-	-	FL	FL	UF	-	-
Amrood	Picidium guajava	-	-	-	-	-	-	-	YL, ML	ML	FL	UF	-
Anar	Punica granatum	-	-	-	-	-	-	-	YL, ML	ML, FL	FL, UF	UF	-
17. Hajara	Tagetes erecta	FB	FB, FL	FL	-	-	-	-	-	-	-	-	YL, FB
18. Gulab	Rosa indica	FB	FL	FL	-	-	-	-	-	-	-	-	-
19. Graffted bare	Ziziphus mauritiana	UF, RF	RF	RF	-	-	-	-	YL	ML	ML, FL	ML, FL	FL, UF

YL = Young leaves; ML = Mature leaves; FB = Flower buds; FL = Mature flower; UF = Unripe fruits; RF = Ripe fruits; SE = Seeds; GU = Gum;

BR = Bark; AR = Arial root; ST = Stem.

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Plate 1: Blue bulls in the crop fields around Sariska Tiger Reserve

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Without exception every one in the village reported that Bluebull brings about damage to their standing crops as they raid crops quite frequently. Amongst the crops they like Moth, Gawar, Moong, Til, Gehun, Makka, Jeera, Dhania, Raira and a variety of vegetables, which are grown in the area. Of these, Makka and Gehun is the most preferred crops as they frequently raid wheat fields and eat before grain rips. Raira is the least damaged crop amongst the vegetable and fruit trees. It was found that they do not leave any opportunity to invade cabbage and tomato fields.

Chilies do no attract them while Dhania is their most favorite vegetable. It was observed that they repeatedly attract Dhania fields in spite of full vigil and protection by the field owners. This suggests that they prefer Dhania the most; its small probably attracts them. Amongst horticulture, the grafted Beer and Nembu is the most common victim because of their large-sized leaves and fruits. They also like local fruits grown in the agriculture fields like Papita, Mango, Banana, Amrud and Anar. It was essential that the adult animal consumes on an average 13 to 15 kg of plant material in a day. Therefore, these animals have been become a serious crop pest in many parts of the country (Prakash, 1986; Rajpurohit and Mohnot, 1988; Chouhan & Sarwarkar, 1989; Rajpurohit and Chouhan, 1986; Chhangani, 1994; Chhangani, et. al., 2002).

(iv) Inter-species behavior:

In the past they have been very shy since they used to keep themselves isolated from human habitation. They used to avoid mixing with livestock. But, in the recent past with the increasing population of blue bull and livestock in and around Sariska Tiger Reserve, they are regularly coming in contact with village livestock and human beings. This has made them bold and aggressive with little fear and flight. Besides their interaction with goat, sheep, camel, cow and buffalo. Artificial feeding near the road sides in and around Sariska they commonly observed feeding with many herbivores and primates, Spotted deer, Wild boar, Sāmbhar and Hanuman langurs. Also observed feeding with a variety of birds including peacocks, partridge, jungle

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Plate 2 : Blue bulls in the Sariska Tiger Reserve with other wild and domestic animals

fowl, in a close proximity. In Sariska Tiger Reserve Tiger, Leopard are the main predator of blue bull, where as some time chasing by wolves and dogs to young ones were also observed. However, in the normal situation they do keep certain distance with human being which ranges between 50 to 100 meters.

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Plants species	Parts left out or fall					
Gular (ficus recemosa)	Unriped and ripe					
Bargad (ficus benghalensis)	Unriped and ripe					
Jamun (syzizium cuminii)	Unriped and ripe					
Salar (boswellia serrata)	Flowers, leaves, branches					
Dhawe (anogeissus pendula)	Leaves, fruits, flowers					
Safad dhawe (aenogeissus latifolia)	Leaves, fruits, flowers					
Bare (zizyphus mauritiana)	Riped fruits					
Palas (butea monosparma)	Flowers					
Zinja (bohinia racemosa)	Leaves, Fruit					
Arunjia (acacia leucopholia)	Fruit					
Neem (Azadirachta indica)	Leaves, Fruits					
Pipal (Ficus religiosa)	Leaves, Fruits					
Godal (Lannea coromandelica)	Leaves					
Aam (Mangifera indica)	Leaves, Fruits, Seeds					
Khirni (Wrightia tinectoria)	Leaves, Flowers					
Imli (Tamarindus indica)	Leaves, Fruits, Flowers					
Vilayti babul (Prosopis Juliflora)	Leaves, Flowers, Fruits					
Kumbhata (Acacia Senegal)	Leaves, Fruits, Seeds					

 Table 3: Plant Parts Left out by Langurs & Consumed by Blue bull

Blue bulls have a particular association with the langurs during feeding in the deep forest of sanctuary. Langurs usually feed on the variety of flowers, fruits, seeds and leaves from trees (Chhangani, et al 2002), which are generally out of reach of blue bull. Langurs in general very selective feeder, they feed a particular plant part in specific seasons and period of the year. For example, if they are feeding on seeds, they through the rest of the part of the fruit, if the feed on a young leave or ripped fruit they through the mature leaves' unripe fruits, which are eaten by blue bulls following langurs on ground. Table-3 shows the left-out parts eaten by blue bull, thrown by langurs.

(v) Predation:

Tiger, Leopard are the main predator of blue bull, where as some time chasing by wolves and dogs to young ones were also observed at Sariska Tiger Reserve. In many parts of the country blue bull have no natural predators. Where as in many national parks and wildlife sanctuaries

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they have potential predators like lion, tiger and leopard (Prater, 1971; Choudhary, 2000). In the present study it was found that panthers predating blue bulls occasionally. During the present study in the scat analysis of panther shows clearly, that blue bull is about 8-10% of the diet of leopard (Chhangani, et al 2002). Similarly, Mukharjee et. al. (1994a) found about 10% of hairs in the scate of leopard (Panthara pardus) in Gir National Park, Western India and Mukherjee et. al. (1994b) found 12 to 15% of hairs of blue bull in the diet of Lion (*Panthra leo perrica*). But, the areas like Western Rajasthan, Punjab, Haryana and part of Gujarat, M.P. where blue bull have no natural predator, they have predation by feral dogs killed young ones. This lack of natural predator seems to be the major factor for population increase and imbalance in the ecosystem in which blue bull is living (Chhangani at. el., 2002). Other mortality factor includes shooting, road killing, etc.

VI. Habitat Contamination by the Pesticides

Another potential threat which has been quite neglected by the wildlife researchers till date is pesticide contamination through the consumption of the pesticide contaminated food and water by vertebrate pests. Usually around the wildlife habitats there are crop fields, which are the perfect sites for the application of the fertilizers and pesticides. This aspect needs to be highlighted here is the pesticide contamination of the environment leading to the decline in the population of the animals especially by organochlorine pesticides (OCPs). Since many animals live in water and on shores and thrive on fishes and other aquatic animals therefore, they get exposed to OCPs because of bioconcentration and biomagnification of these xenobiotics. Here an example of bald eagle from USA needs to be considered. The bald eagle is the North American species with a historic range from Alaska and Canada to northern Mexico, is the national bird of the USA which has been an endangered species for many years. The reasons being the Habitat destruction and degradation, illegal shooting, and the contamination of its food source, because of DDT contamination, there is a decline in the eagle population, The banning of DDT by the Federal government of USA and related pesticides, habitat protection done by the Endangered Species Act, and conservation actions taken by the general American public have helped bald eagles to survive. Nevertheless, DDT and its residues contaminated nearby water areas, where aquatic plants and fish absorbed it and biomagnified it. Bald eagles, in turn, were poisoned with DDT as and when they consumed the contaminated fish. As a consequence, their eggs had shells so thin that they usually broke during incubation or otherwise failed to hatch at all. DDT contamination and its

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residues also affected other species such as peregrine falcons and brown pelicans. Many Other pesticides having the same structure as DDT are suspected to have caused increased death, in addition to the harmful effects on reproduction. By 1963, with only 417 nesting pairs of bald eagles existing, the species was facing the danger of extinction. At the time, a controversial step of banning the use of DDT and some related pesticides in the United States was taken by the federal government of the USA. That was in 1972, and it was the first step on the road to recovery for the bald eagle (U.S. Fish & Wildlife Service Migratory Bird Program, February 2021). This shows how dangerous DDT contamination is how disastrous it can be for the avian fauna. More scary studies have indicated that we have largely over looked the darker side of these chemicals as OCPs are reported to be carcinogenic (Mathur et al, 2002 & Ingber et al 2013) mutagenic (Ingber et al 2013&Yaduvanshi et al 2012) teratogenic (Yaduvanshi et al 2012 & ATSDR. Atlanta, GA.1994) immunosuppressive (Repetto. R & Baliga. S.S, 1997 & Corsinia et al, 2003) create endocrine dysfunction such as hypothyroidism or high estrogenic activity (Dewailly et al, 2000 & Rathore et al, 2002) disturb reproductive processes (Pant et al ,2007 & Tiemann.U. 2008) growth depressants (Colborn et al, 1993 & Mercier. M, 1981) induces several psychogenic and neurogenic abnormalities in adult stages (Mactutus & Tilson, 1986 & Van Wendel de Jood et al,2001) and are associated with abortions, premature deliveries, still births and infants with low birth weights (Saxena et al, 1981; Saxena et al, 1980; Tyagi et al 2015; Chen. Q et al 2014 & Sharma & Bhatnagar, 1996). OCPs have been in use in India nearly for a half century now. Even after having clear cut evidence suggesting that these chemicals have the ability to eliminate entire species from the planet, the annual consumption of pesticides in India is about 85,000 tons of which OCPs comprise the bulk (India Environment Portal Knowledge for change, 30/10/1998.). Therefore, today OCPs are perhaps the most ubiquitous of the potentially harmful chemicals encountered in the environment and are still widely detected in humans despite the considerable decline in environmental concentrations (Dewan et al. 2003). This kind of environmental Contamination with organochlorine pesticides (OCPs) has also been reported by Sharma and her coworkers in 1996, from Jaipur City. She reported contamination of human samples like mothers' blood, cord blood, placenta and mothers' milk with OCPs. Presence of pesticides with OCPs shows that how these xenobiotics have contaminated our Mother Nature and now faunal diversity is facing danger of existence and Smooth-coated Otters is not staying away from this potential

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danger. It can be concluded that the magnitude of pollution is quantitatively enough to contaminate the food and environment and reaching out to all faunal diversity. It can be concluded that the magnitude of pollution is quantitatively enough to contaminate the food and environment and the pesticides reach the human body through various sources mainly by absorption form the gastrointestinal tract through contaminated food chain, are circulated in blood, stored milk and secreted during lactation resulting in sufficient neonatal intake. The battle against the harmful insects would be much less costly and more efficient, and the problem of contamination of the environment by toxic materials would be vastly reduced, if insect activities are controlled by natural means. The use of pest-specific predators; parasites or pathogens; sterilization of insects with the help of radiations; trapping insects using insect attractants like pheromones; use of juvenile hormones or hormone inhibitors may therefore be suggested as alternate ways of pest control (Sharma, 1996; Sharma & Bhatnagar, 1996 & 2017, Sharma, 2018).

Conclusion:

The preliminary study suggests that the blue bull have very wide moving ranges and their herds move from one place to another and shift their lodgings. The results are giving the impression that the blue bull population is increasing and causing lot of damage to the variety of crops. During the onset of monsoon these animals have fairly abundant vegetation in the sanctuary and will probably not raid the crops as they are exclusively surviving on natural plant material.

It seems that the extension of agriculture in the recent past intercepted with blue bull's traditional moving routes and foraging areas on the periphery of the sanctuary. This forces them to invade the fields occasionally while they are on their foraging journeys (Chhangani, et. al., 2002). Net land cover changes in agriculture at Kumbhalgarh region is very fast in the last 15 years the agricultural activities increase 315% in the same area from 1986 to 1999 (Robbins, 2001).

This study also suggests that their preferences for the natural vegetation and to keep them in the undisturbed area are a usual practice. Their association with hillocks is also evident. During and after monsoon their visit to the crop fields decreases, this further suggests that in the normal circumstances they also keep themselves away from crop fields. It is clear from the present data that Blue bull do not want to come in contact with human beings and if they

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raid the crops or vegetable fields or orchards they have to encounter humans and face tough situation not conducive for their survival.

Their population size in the SARISKA TIGER RESERVE suggests an alarming situation. The feeding adaptation to crop fields and exotic weed species and low natural predation along with religious attitude of people provides them better survival. This seems to be the major factor of population increase and imbalance in the ecosystem of Sariska Tiger Reserve in which Blue bull is surviving.

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