***Original Research Article***

**Documentation of Scent Marking with the Preorbital Gland in Banbakri Antelope (Boselaphus tragocamelus)**

**ABSTRACT**

Scent marking using the preorbital gland in the Banbakri antelope, also known as the white-footed antelope (Boselaphus tragocamelus), was studied at the Haryana Agriculture Farm, VKS College of Agriculture, Dumraon. This study investigated the behaviour of Banbakri antelopes concerning preorbital gland opening under various conditions, including stress, starvation, and maturity. The research aimed to assess this behaviour as part of a broader investigation into the phenotypic and behavioural characteristics of Banbakri/Nilgai to enhance their well-being and improve resource management. The research is important because it will expand the understanding of this elegant species' behaviour and the functional role of its preorbital gland. Its potential applications in antimicrobial drug development will be explored as well.

In mature Banbakri antelopes, the preorbital glands measured approximately 2.1 cm in length and 1.0 cm in width. These exocrine glands, appearing as trench-like slits of dark blue to black coloration, were located beneath the eyes. Under free-roaming conditions, both male and female, B. tragocamelus, rarely exhibited preorbital gland opening. However, the gland was observed to open under stress, particularly when the animal was restrained with a halter for the first time, either at night or occasionally during the day. Preorbital gland opening was also noted during maturity, hunger, and stressful conditions. The findings suggest that this behaviour may serve as a key indicator for differentiating between playful, courtship, and aggressive social behaviours, particularly in stressful situations or stages of maturity. Additionally, the gland may secrete pheromonal substances that facilitate olfactory communication.

To the best of our knowledge, no prior studies have reported the opening of the preorbital gland in Banbakri antelopes (B. tragocamelus). This study presents the first recorded observation of this behaviour in captive white-footed antelopes, contributing novel insights into their behavioural ecology.

**Keywords:** Antelope, habitat, stress, Banbakri calf, behaviour, pheromone.

1. **INTRODUCTION**

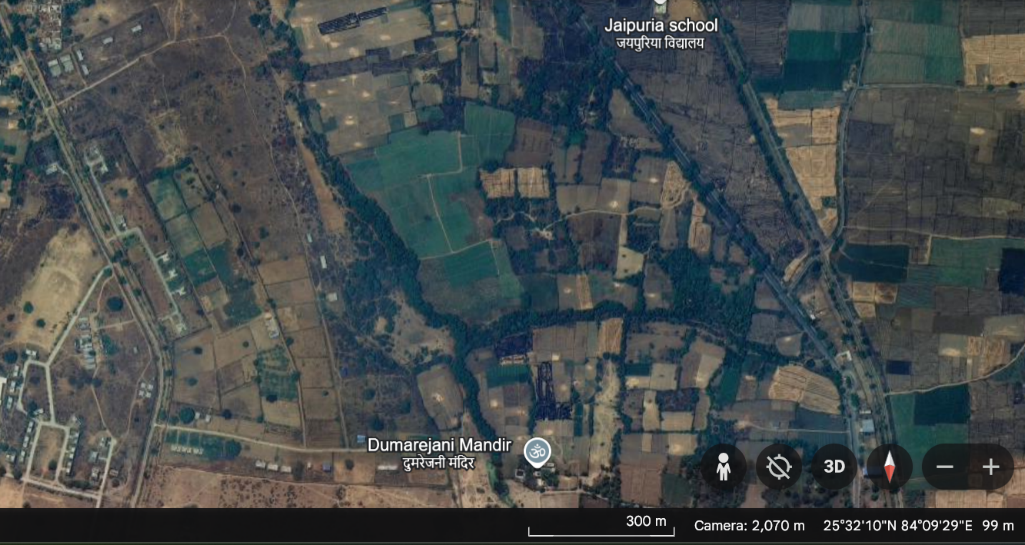
The importance of chemical communication in wild mammals is well recognized; however, our knowledge of this subject remains limited. The preorbital gland is a paired exocrine gland, appearing as a slit-shaped cavity located anterior to the eye. It is found in many ungulates, particularly in the families Bovidae, Cervidae, and various antelope species [1,2,3]. The preorbital gland serves different roles across artiodactyl species. It's opening functions in both visual communication and scent marking [4]. Most studies on preorbital glands have linked their use to various behaviours, including maternal care in red deer (*Cervus elaphus*) calves [5], alertness in captive pudu (*Pudu puda*) and red brocket deer (*Mazama americana*) [6], and sexual behaviors during aggressive interactions in rusa deer (*Rusa timorensis*) [7]. A study done on red brocket males (*Mazama rufa*) revealed that male 1 and male 2 walked from one wall to another, without scent-marking or eating during pacing. This type of invariant and repetitive behaviour pattern had no apparent goal or function, being characterized as a stereotypic pacing. Pacing is common in captive wild animals, described as an animal walking in a distinct, unchanging pattern within its cage, ranging from slow in the exact same pattern [29]. Another study was conducted on *Subulo gouazoubira* to understand their territorial marking behaviors. One of the social communication strategies employed by *S. gouazoubira* is chemical communication, often exhibited through the use of latrines. Latrines are specific sites where continuous odoriferous secretions, typically feces and at least one additional secretion, are deposited, serving both intra- and interspecific communication purposes [30].

The Banbakri (*Boselaphus tragocamelus*), commonly known as Nilgai, exhibits unique ecological functions and mutualistic relationships with humans [8,9,10]. It is a large bovid species currently free-roaming in 18 Indian states, including almost all districts of Bihar [11]. Banbakri is protected under Schedule III of the Wildlife (Protection) Act of 1972 and is categorized as an animal of Least Concern by the IUCN [12]. Despite many Indian state governments having declared this White Footed Antelope (WFA) (*Boselaphus tragocamelus*) as vermin due to huge damage of crops, and moreover some states have instructed to slay them in favour of agriculturists. However, it often receives negative attention in agrarian societies in India. Banbakri (*B. tragocamelus*) give a positive sign and survives an extreme ecological condition, it may be used in agriculture, husbandry, animal transport, probably a new source of food, medicine, and industrial products after domestication [11]. The Banbakri works as a soil doctor, their dung assists in agricultural farming and afforestation. They provide ecological advantage and are also eco-friendly with the soil. The faeces of the Nilgai antelope accommodated practically 1.6 percent nitrogen, enhancing the quality of the soil to a depth of 30 cm (10 inches). Seeds in the dropping could easily germinate, and also assist in agricultural farming and afforestation [31]. This species primarily inhabits agricultural fields and undulating open habitats, avoiding forests, making it easier to observe. Several behavioural studies on Banbakri or Blue buck have been published [13,14,15,16,17]. Previous behavioural studies on Nilgai (WFA) Blue buck and Blackbuck have shown that urine and droppings play a significant role in territorial marking behaviour [2,18,19]. Compared to some cervids, the preorbital gland in Banbakri is pronounced [3]. However, there is no prior report describing the opening of the preorbital gland in the Banbakri(*Boselaphus tragocamelus*) for any specific purpose.

This study documents, for the first time, the opening of the preorbital gland in Banbakri under various contexts, expanding our understanding of this elegant species' behaviour and the functional role of its preorbital gland.

1. **MATERIALS AND METHODS**

The study was conducted on a Haryana Agricultural Farm (Banbakri Research Farm) at VKS College of Agriculture, Dumraon, Buxar, located at 25.53° N latitude and 84.15° E longitude, at an elevation of 76±4 meters (250±6 feet) (Shown in Google Map).



**Figure 1: A Google map showing the study area, Haryana Agriculture farm, Dumraon**

Dumraon is a subdivision of District Buxar and harbours many fascinating wild mammalian species, including the WFA (*Boselaphus tragocamelus***),** Prasad et al 2020 [20]. The behaviour of male and female Banbakri was observed in captivity (Fig. 2a & b). During winter, the Banbakri was kept indoors in a 10x20 feet room. Occasionally, it was released into a large outdoor enclosure during summer, winter, and rainy seasons. The enclosure was surrounded by wire fencing approximately 200 by 150 feet (LxW) and 6 feet in height. The enclosure had a savanna-like appearance during the rainy and winter seasons, with most of the area covered by short grass interspersed with large trees. The boundaries of the enclosure were densely vegetated with herbs, shrubs, and trees, including cucumbers (*Cucumis sativus*), cabbage (*Brassica oleracea*), Moong (*Vigna radiata*), Green gram (*Vigna radiata*) Pigeon pea, (*Cajanus cajan*) Jharbar shrubs, (*Ziziphus nummularia*) Ber shrubs, (*Ziziphus mauritiana)* and various grasses. Trees such as sesame (*Sesamum indicum*), Indian rosewood (*Dalbergia sisso),* Neem (*Azadirachta indica*)*,* Babool (*Acacia nilotica*)and other wild species were also present. The WFA was fed a diet consisting of fruits, vegetables, grasses, and the fruits, seeds, and leaves of Indian Jujube, Pigeon Pea and wild trees.

**a**

**b**

**Figure 2. (a) Banbakri calf sitting in the field and (b) Close-up view of preorbital gland**

During rearing, the appearance of the preorbital glands in calves, juveniles, and maturing was noted, and photographs were taken whenever possible, using ad libitum sampling [21] (Altmann, 1974). Observations were conducted daily for over a year (16 months), from October 2023 to January 2025. All observations of marking and gland opening were made between 07:00 and 10:30 am, as the Banbakri was most active during this period.

1. **RESULTS AND DISCUSSION**

Banbakri of the subfamily Bovinae mark with the small preorbital gland in front of each eye. The structure of this gland differs from that of other ruminants. A pair of preorbital glands in Banbakri (*Boselaphus tragocamelus*) were small, shiny black, oily in appearance, and covered with densely distributed hair (Fig. 2). In mature females, the glands measured approximately 2.1 cm in length and 1.0 cm in width. These exocrine glands were located beneath the eyes (Fig. 2b). The frequency of gland opening was highest in newborn calves and decreased with habituation over time. Preorbital gland opening was uncommon under free-roaming conditions for both males and females. However, the gland was observed to open under stress, such as when the animal was tied with a halter in controlled conditions during the night or occasionally during the day. The colour of the gland secretion ranges from colourless to blackish-blue. The details of preorbital gland opening are summarized in Table 1 and Fig. 3.

When a female Banbakri (WFA) was released into the outdoor enclosure after being kept indoors for several days, the first thing she usually did was mark. She primarily marked the trunks, branches, and leaves of saplings growing around the edges and middle of the enclosure. She moved from sapling to sapling, often covering the entire perimeter one or more times before beginning to feed or rest. It is likely that the preorbital gland secretes a scent that calves or other Banbakri can detect, possibly serving as a form of communication.

**Table 1: Preorbital Gland Opening Observations in *Boselaphus tragocamelus***

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Condition of Preorbital gland** | **Month/Year** |
| 1 | Opened after birth, secreting scent | 2-5 October 2023 |
| 2 | Closed during normal conditions | 6-16 October 2023 |
| 3 | Opened during 2–4 hours of hunger | 17 October 2023 |
| 4 | Opened during stress (e.g., tied with a halter) | 15–20 May 2024 |
| 5 | Opened as females approached sexual maturity | 25 January 2025 |



**Figure 3. Opening of preorbital gland during stress and starvation period**

We observed the glands opening and closing in captive Banbakri while nursing their calves, suggesting a role in scent communication between mother and calf. This is the first report documenting preorbital gland opening in Banbakri (*Boselaphus tragocamelus)*. The preorbital gland serves different roles in many ungulates, such as sheep, horse, antelope, cow and a few marsupials, the apocrine glands are widely distributed, and act as scent glands to produce pheromones. Pheromone-containing secretions from the gland may help establish dominance, particularly in preparation for breeding, marking territory, or providing pleasurable sensations to the animal [22]. It has previously been reported and is being used for marking or display during the precopulatory stage in Eld’s deer [23]and in Indian sambar [2,14]. It hasalso been established that the diurnal variation and distribution of scent marking behaviour of captive male (*Antelope cervicapra*) also influence the marker. Whereas [24]recorded for sexually receptive red deer hinds during soliciting behaviour to the stag, although preorbital gland opening by females in a sexual context appears to be much rarer. Therefore, we suggest that preorbital gland opening may be an important behavioural indicator of real maturity of the individual in the sexual context and also in a stress condition. Our findings are also in line with the suggestion of [1, 2,7]. They reported that olfactory signals from the preorbital gland may have some role in the sexual behaviour of cervids and cervicapra.

**b**

**a**

**Figure 4. (a) Open view of preorbital gland during maturation and (b) close-up view**

**b**

**a**

**Figure 5. (a) Banbakri scent marking by rubbing its face against leaves and (b) rubbing against the branches of trees**

In the present observation, it was noted that the Banbakri or Blue Bull (Boselaphus tragocamelus) exhibited the ability to discriminate scents deposited near food substances, branches, trunks, leaves of trees, bushes and grasses. Banbakri may rely heavily on the scent glands to communicate with other members of their species, and possibly even with members of other species. This behaviour may be used to indicate presence, attract males for mating, and signal social behaviour (Fig. 4 and 5a&b). Both males and females often selected specific locations for urination, defecation, and preorbital gland scent marking, (Figure 6. a&b). We often observe Banbakri sniffing faecal pellets or urine on the ground, which may have further behavioural consequences. However, during the rut, urine left by females is particularly attractive to males. The male invariably stops, sniffs, and licks the urine, repeatedly displaying the flehmen response to each urine patch he encounters, similar to behaviours reported in other ungulates [24,25].

**b**

**a**

**Figure 6. (a) and (b) Both males and females often selected the same specific locations for defecation and urination**

Preorbital glands in other ungulates secrete complex mixtures of chemical compounds, and variations in gland size and positioning may reflect differences in social structures and marking behaviours [26, 27]. Red deer calves reportedly open their preorbital glands during stressful procedures, while relaxed calves do not [27]. In contrast, no such behaviour was observed in wild female Barasingha (*Rucervus duvaucelii*)3. Our study aligns with previous findings that suggest that olfactory signals from preorbital glands may play a role in sexual behaviour in cervids and other ungulates [1,2,7]. This study may prove to be a potential source for drug development and production of new antimicrobial agents against pathogenic skin microorganisms [28].

1. **CONCLUSION**

In conclusion, this is the first report of preorbital gland opening in Banbakri (*B. tragocamelus*). We observed that this gland opens in Banbakri antelope under stress, starvation, or sexual maturity contexts, and may serve as an essential behavioural indicator. This could help distinguish between playful, courtship, aggressive, social status, and other behaviours to communicate with other members of Banbakri (*Boselaphus tragocamelus*). These findings may pave the way for further research on communication in this species and its potential applications in antimicrobial drug development.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

**REFERENCES:**

1. Ceacero, F., Landete-Castillejos, T., Bartoˇsová, J., García, A.J., Bartoˇs, L., Komárková,M., Gallego, L., 2014. Habituating to handling: factors affecting preorbital gland opening in red deer calves. J. Anim. Sci. 92, 4130–4136.
2. Rajagopal, T. and Archunan, G., 2011. Histomorphology of preorbital gland in territorial and non-territorial male blackbuck *Antelope cervicapra*, a critically endangered species, Biologia, 66(2):370-378. DOI: 10.2478/s11756-011-0015-4
3. Pluhácek, Francisco Ceacero, Peter Lupták 2015, First records of preorbital gland opening in rare wild Barasingha (*Rucervus duvaucelii*) in social contexts may help to explain this phenomenon in cervids. Behavioural Processes. 119;28–31. <http://dx.doi.org/10.1016/j.beproc.2015.07.009>
4. Lawson, R.E., Putman, R.J., Fielding, A.H., 2000. Individual signatures in scent gland secretions of Eurasian deer. J. Zool. 251, 399–410.
5. Bartoˇsová, J., Ceacero, F., Bartoˇs, L., 2012. Pre-orbital gland opening: part of sucking behaviour in red deer (*Cervus elaphus)* calves. J. Anim. Sci. 90, 3207–3212.
6. MacNamara, M., Eldridge, W.D., 1987. Behaviour and reproduction in captive Pudu (Pudu puda) and red brocket (Mazama americana), a descriptive and comparative analysis. In: Wemmer, C.M. (Ed.), Biology and Management of Cervidae. Smithsonian Institution Press, Washington, D.C, pp. 371–386.
7. Ceacero, F., Pluháˇcek, J., Komárková, M., Zábransk´y, M., 2015. Pre-orbital gland opening during aggressive interactions in rusa deer (*Rusa timorensis*). Behav. Proc. 111, 51–54.
8. Kyle R (1990) An antelope for All Seasonings: New Scientist: 126(1711):54-57.
9. Prasad, S. Ahmed, R., 2016. The Indian Antelope Nilgai (*Boselaphus* *tragocamelus*) for all interests; A Now hope in Indian Farming. Progressive research. An International Journal 1(sp-x): 6638-6641.
10. Ortega-Santos JA, Hewitt DG, Campbell TA 2016 Nilgai in south Texas: Nuisance or Asset? Society of Range Management. 1-2. https:/ rangelandgedeway.org.
11. Prasad, S., 2022. High Time of Pacing Nilgai Antelope (*Boselaphus tragocamelus*) into Mainstream as Community Conservation for Influencing Macroeconomics. Asian Journal of Research in Zoology. 5(1): 21-30.DOI**:**[10.9734/ajriz/2022/v5i130128](https://doi.org/10.9734/ajriz/2022/v5i130128).
12. Mallon, D. P. 2008. *Boselaphus tragocamelus*, In: IUCN 2012 Red list of Threatened species.Version 2012.2. [www.iucnredlist.org](http://www.iucnredlist.org).
13. Prasad, S., Prabhakar, C.S., Sah, R.K, Kumar, A., 2019. Is domestication of Nilgai possible? Current science 116(7): 1045-1046. doi.org/10.18520/cs2Fv1162Fi72F1045-1046.
14. Leslie, D.M., 2008. *Boselaphus* *tragocamelus* (Artiodactyls: Bovidae) Mammalian species American society of Mammologist. 813: 1-16. 1–16, [doi.org/10.1644/813.1](https://doi.org/10.1644/813.1).
15. Chopra G, Rai D. A 2009. Study on the ecology of Nilgai (*Boselaphus tragocamelus*, Pallas) and its status as an unconventional pest of agricultural in and around Beer-Sonty reserve forest. Haryana, India. Journal of Applied and Natural Science. 1(2):245-249.
16. Oguya BRO, Eltringham SK. 2009. Behavioural of nilgai (*Boselaphus tragocamelus*) antelope in captivity. Journal of Zoology. 223(1):91-102.
17. Bohra HC, Goyal SP, Ghosh PK, Prakash I 1992 Studies on the ethology and eco-physiology of the antelopes of the Indian Desert. Ann. Arid Zone,31:83–96.
18. Kusum, 2018. Studies on, the ranging pattern and dung piles habit of Nilgai (*Boselaphus* *tragocamelus*) around Jodhpur, Rajasthan, India. IJRAR. 5; 555-559.
19. Rajagopal T., Manimozhi A. & Archunan G. 2010. Diurnal variation in scent preorbital gland marking behaviour of captive male Indian Blackbuck (*Antelope cervicapra*) and its territorial significance. Biol. Rhythm Res. DOI:10.1080/092910110036931.
20. Prasad S., Singh D. K., Kumar U., and Kumar S., 2020. Biodiversity and Ecology of Wild mammals in Dumraon, Buxar Bihar, J. Exp. Zool. IndiaVol. 23, No. 1, pp. 643-648,www.connectjournals.com/jez
21. Altman J., 1974. Observational study of behaviour sampling methods. Behaviour*.* 40:227-265.
22. Kaufmann, B. 2024. Understanding Deer gland, Huntley llinols: Hunting Network LLC, 2024. Retrieved, 20.11.2024.
23. Blakeslee, C.K., Rice, C.G., Ralls, K., 1979. Behaviour and reproduction of captive brow-antlered deer Cervus eldi thamin (Thomas1918). SäugetierkundlicheMitteilungen 27,114–127.
24. Azeve do Cvm, Menezes, AAL, Queiroz, J. M., Moreing, L.F.S 1996. Circadian and ultradian periodicity of grooming behaviour in family groups of common marmosets (*Callithrix facchus*) in captivity. Biol. Rhythm Res. 24(3):374-385.
25. Gosling LM, Roberts SC. 2001. Scent marking by male mammals: cheat proof signals to competitors and mates. Adv Study Behav. 30:169–217.
26. Burger, B.V. 2005. Mammalian semi chemicals" In Schutz, s(ed.). the chemistry of pheromones and other semi chemicals II (PDF). Topics in current chemistry. vol. 240. Berlin springer-Verlag. PP-231-278. doi: 10.1007/b98318.
27. Bartusova-Vichova, J., Bartos, L., and Svecora. L. 2007. Preorbital gland opening in red deer (*Cervus elaphus*) calves as an indicator of stress, J. Anim. sci. 8: 494-996. doi: 10.2527/jas. 2006. 446.
28. Wood, W.F., 2010. “Synthesis and antimicrobial of activity of long chain 3, 4 epoxy, -2- alkenones" Scientia Pharmaceutica, 78(4):745-751
29. Sandoval ED, Neto VN, Baldini MH, Cerezo MP, Duarte JM, da Costa MJ. Scent-marking and maintenance behaviour of captive red brocket males (Mazama rufa) kept eight hours in a new environment: Marcação de odor e comportamento de manutenção de machos veado-mateiros (Mazama rufa) mantidos oito horas em um novo ambiente. Brazilian Journal of Animal and Environmental Research. 2022 Nov 22;5(4):3908-21.
30. Srbek-Araujo AC, de Carvalho Alzuguir L. Use of latrines and territorial marking behaviors by Subulo gouazoubira in a remnant of the Atlantic Forest in southeastern Brazil. Neotropical Biology and Conservation. 2024 Aug 23;19(3):367-78.
31. Prasad S. High Time of Pacing Nilgai Antelope (Boselaphus tragocamelus) into Mainstream as Community Conservation for Influencing Macroeconomics. Asian J. Res. Zool. 2022 Jan. 15;5(1):21-30.