



Research Article

TRICHO-TAXONOMIC STUDY OF GUARD HAIRS OF THREE SPECIES OF BOVIDAE OF SAURASHTRA REGION OF GUJARAT, INDIA

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ABSTRACT

Dorsal guard hairs are very much important for identification of mammalian species. The present study was carried out to identify one antelope and two bovine species, viz. *Gazelle bennettii*, *Tetraceros quadricornis* and *Boselaphus tragocamelus* under the family Bovidae based on macroscopic and microscopic characteristics of dorsal guard hairs. Hair samples were collected from captivity at Sakkarbaug Zoo-Junagadh from the above mentioned animals for investigation. A total of thirty randomly collected dorsal guard hairs of each species were studied using light microscope with inbuilt camera facility. Cuticular structures as well as medullary configuration of hairs were studied carefully. The highest Medullary Index ($0.81 \pm 0.01 \mu\text{m}$) were recorded in *Gazelle bennettii*, followed by *T. quadricornis* ($0.78 \pm 0.02 \mu\text{m}$) and lowest in *B. tragocamelus* ($0.62 \pm 0.03 \mu\text{m}$).

Keywords: Guard Hair, Bovidae, Saurashtra, Gujarat, Cuticle, Medulla, Hairs.

INTRODUCTION

The significance of Tricho-taxonomic study is widely accepted in the field of food habit analysis of predators and also in controlling illegal trade of wildlife and its derivatives (De & Chakraborty, 2012). Identification of mammalian species with hairs has practical applications in forensic science, taxonomy, paleontology, zooarchaeology, anthropology and ecology (De Marinis & Asprea, 2006). Analysis of scats of carnivores predators may help in identifying prey species through hair structure as this technique is non-destructive and scats are easy to collect throughout the year. It will ultimately help in describing diet of large carnivores. It may be noted that wild and domestic ungulates represent the main component of medium and large size predators found in Saurashtra region of Gujarat, which is very famous habitat for the Asiatic lion. Mammalian hairs play a significant role in thermoregulation, waterproofing and protection from the variety of pollution. There are mainly

two types of hair found in mammals viz., guard hairs which are usually thick and bristle and fine hairs which are curled and comparatively thin (Lee *et al.*, 2014). The identification of species through the hair characteristics were initially performed by Hausman (1920). The tricho-taxonomy for identification of mammalian species through various microscopic characteristics of hairs is well accepted for almost a century (Tridico, 2005). The cuticular scale and medullary structures of hair have been widely used in various disciplines like wildlife biology, ethology, conservation, ecology, veterinary and forensic science (Lungu *et al.*, 2007). The peculiar medullary index for each species is very much useful for species identification/confirmation and also useful to identify the prey species of large and medium sized carnivores through their scat analysis. The scale count and scale pattern are also found to be important to identify the species with the help of all macroscopic microscopic features of the hair (Italiya *et al.*, 2017).

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The study on the hairs of different species of mammals were made by many workers viz., Hausman (1920), Adorjan & Kolenosky (1969), Moor *et al.* (1974), Brunner & Coman (1974), Koppikar & Sabnis (1976), Wallis (1993), De (1993), De Marinis & Asprea (2006), Bahuguna (2010) and Joshi *et al.* (2012). The dorsal guard hairs of *Boselaphus tragocamelus* and *Gazella bennettii* was studied by De & Chakraborty (2012), Kamalakannan (2015) and Kamalakannan (2017).

Saurashtra region is the only habitat for Asiatic lion (*Panthera leo*) which is mainly dependent upon wild and domestic ungulate species as a prey (Mukherjee *et al.*, 1994). The identification of prey species through scat analysis, collected from the movement ranges of Asiatic lion in Saurashtra peninsula is very much important for conservation of this species in the area. It is expected that

present study will help in identification of mammalian species from hair samples and also help in enforcement of wildlife Acts to check illegal trades.

MATERIALS AND METHODS

The study has been conducted on dorsal guard hairs collected from one species of antelope and two species of bovine under the family bovidae in the Sakkarbaug Zoo, Junagadh district of Gujarat. The guard hairs were selected from one antelope species and two bovine species belonging to under the family Bovidae (Table 1). Among the studied species, *Gazella bennettii* is Schedule II and *Tetracerus quadricornis* is schedule-I and *Boselaphus tragocamelus* is Schedule-III species as per the Indian Wildlife (Protection) Act, 1972.

Table 1. Systematic position and conservation status of three wild ruminants.

Classification	Common name	Scientific name	IUCN, 2017	IWPA, 1972	CITES
Order: Artiodactyla	Chinkara	<i>Gazella bennettii</i>	LC	Schedule-II	NA
Family: Bovidae	Four-horned antelope	<i>Tetracerus quadricornis</i>	VU	Schedule-I	III
Sub-family: Antilopinae	Blue bull	<i>Boselaphus tragocamelus</i>	LC	Schedule-III	NA

LC - Least concerned; VU – Vulnerable.

The hair samples of scats collected from different pockets of Saurashtra region were compared with hair samples collected from above three species of Sakkarbaug Zoo, Junagadh. Each hair samples was separately labeled for microscopic examination. A total of thirty (30) hairs samples of each species were properly washed in running water for several times to remove dirt and were preserved in acetone for overnight.

Ten numbers of hairs of each species were randomly taken up for microscopic examination. The hairs were embedded in gelatin layered microscopic slide (or cellulose sheet) for obtaining casts /impression of surface structure of hairs. Then the slide was observed under Fluorescence light microscope with inbuilt measurement software and attached camera for capturing images in finer scale. Photographs of surface structures were taken at first in 10 X magnifications and then in 40X magnification. Other characteristics such as Cuticular structure, medullary configuration, scale pattern and cross-sectional details were studied after (Brunner & Coman, 1974). Structural nomenclature in respect of surface structure and medullary configuration is followed after (Brunner & Coman, 1974; Moor *et al.*, 1974).

The macroscopic features of the hair shaft were recorded and necessary measurement was noted in details. Microscopic features of medulla and cuticular scales were studied thoroughly and recorded separately in the data sheet. On the basis of all macroscopic as well as microscopic structures of dorsal guard hairs, identification of species can be made easily.

RESULT AND DISCUSSION

The macroscopic features such as colour of hairs, diameter, length, band pattern, hair profile etc. and microscopic characteristics viz., medullar pattern, scale pattern, margin of scales, width of scales, medullar index and surface smoothness of guard hair of three wild bovine species are given in table 2. Medullar pattern, scale pattern, colour of hairs and hair surface of these three species are recorded more or less very similar. The blue bull has wide and simple type of medulla whereas chinkara has a wide medulla and four horned antelope has wide cellular lattice type medulla. All the three species have similar type of scale pattern as well. The quantitative values (mean \pm SD) of hair anatomical features like hair shaft and medulla are summarized in tables 3.

Medullary Index (MI) i.e. the ratio between width of medulla and width of cortex is one of the important parameters for taxonomic study of mammalian hairs and it is varied between different species of mammals. In the present investigation, the mean medullary index (MI) was recorded highest in chinkara ($0.81 \pm 0.01\mu\text{m}$), followed by four-horned antelope ($0.78 \pm 0.02 \mu\text{m}$), and lowest medullary index value is found in bluebull ($0.62 \pm 0.03 \mu\text{m}$) (Table 3). It has also been shown in figure 1. The fraction of hair shaft within medulla was recorded highest in chinkara (79.41%), followed by four-horned antelope (77.36%) and lowest in blue bull (61.54%).

Table 2. Morphological features of hair of the three wild species of the Family-Bovidae.

Sr. No.	Species	Medulla pattern	Scale pattern	Colour of hair (naked eye)	Hair surface
1	Chinkara	Wide medulla lattice	Regular and irregular wave	White-brown/black	Smooth
2	Four-horned antelope	Wide cellular lattice	Regular and irregular wave	White/brown	Smooth
3	Blue bull	Wide and simple medulla	Regular and irregular wave	White-brown / black	Smooth

Table 3. Physical and microscopical characters of hair of the three species of Bovid.

Sr. No.	Species	Mean length of hair (cm)	Mean diameter of shaft (µm)	Mean diameter of medulla (µm)	Medullary index (mi)	Standard error
1	Chinkara	4.33	34	27	0.81 ± 0.01 µm	0.006
2	Four-horned antelope	2.32	53	41	0.78 ± 0.02 µm	0.01
3	Blue bull	3.00	39	24	0.62 ± 0.03 µm	0.003

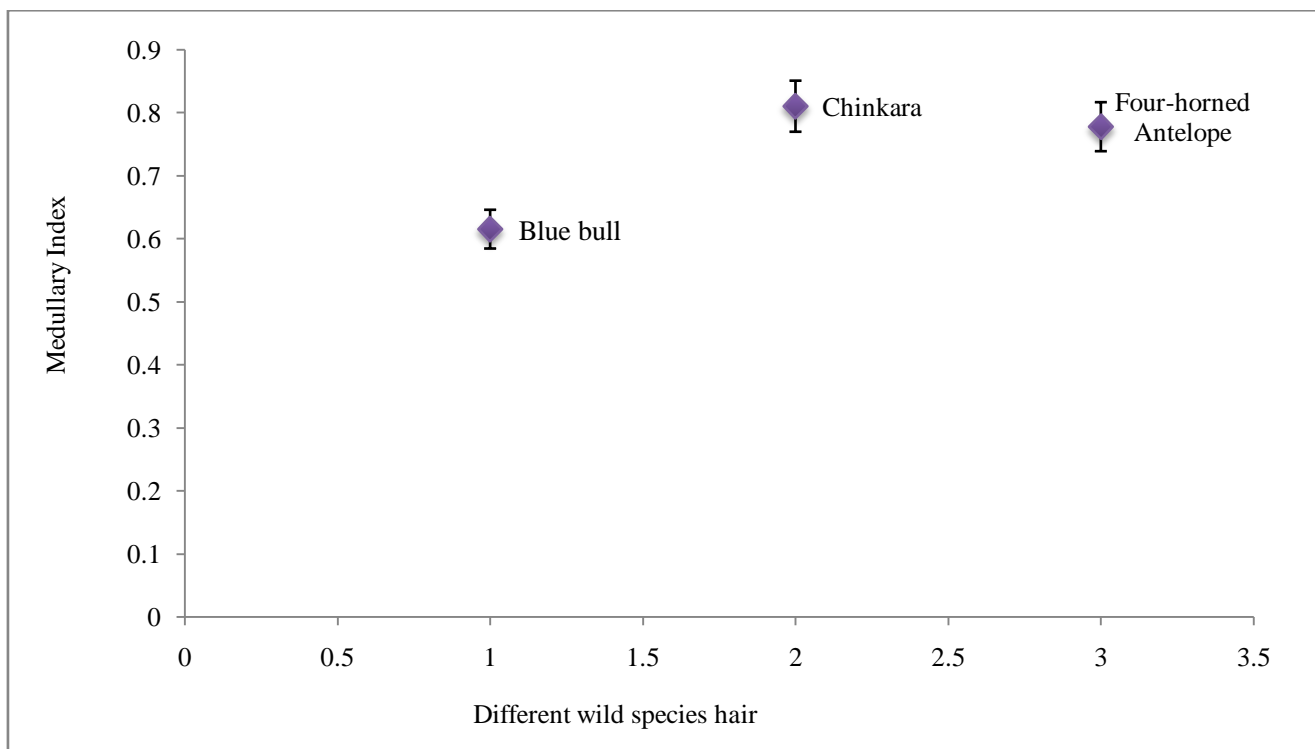


Figure 1. Medullary index of the three different wild bovine species with standard error (%).

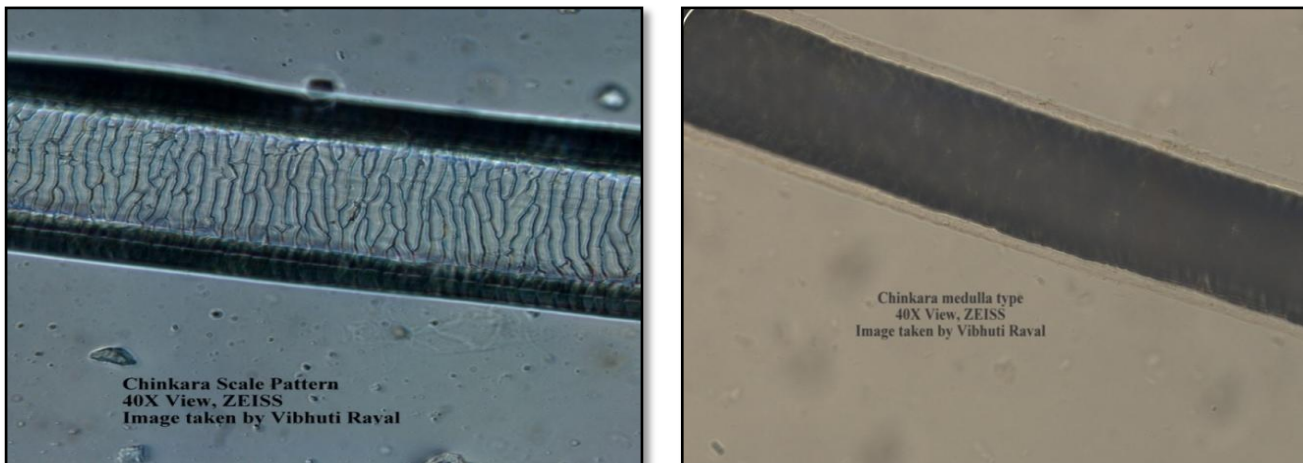


Figure 2. Scale (left) and medulla (right) pattern of the hair of *Gazella bennettii*.

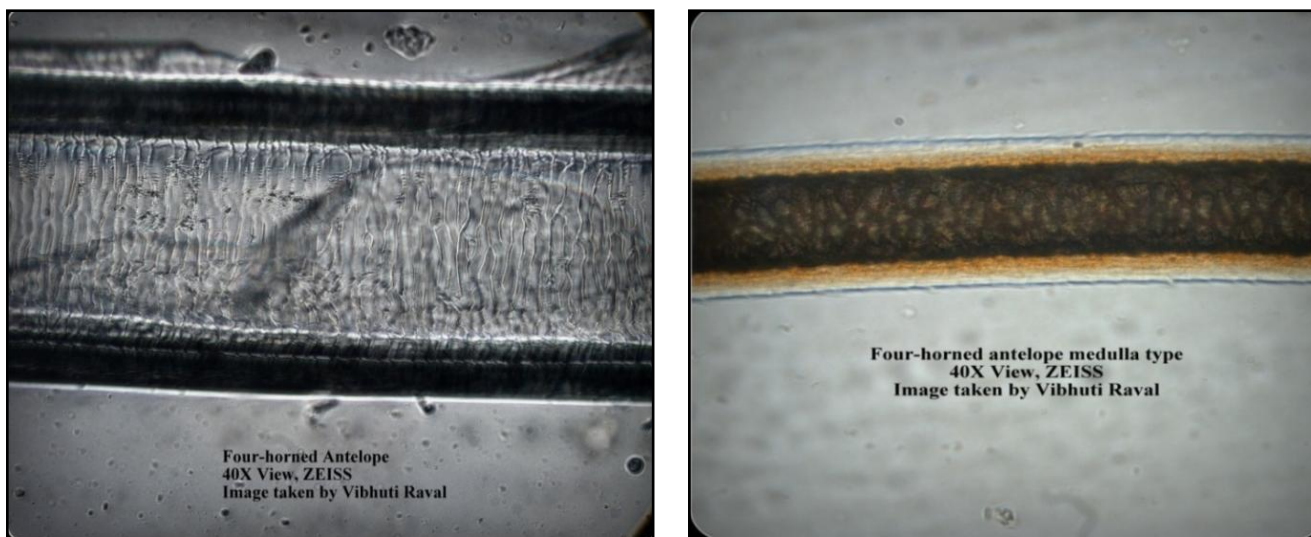


Figure 3. Scale (left) and medulla (right) pattern of the hair of *Tetracerus quasricornis*.

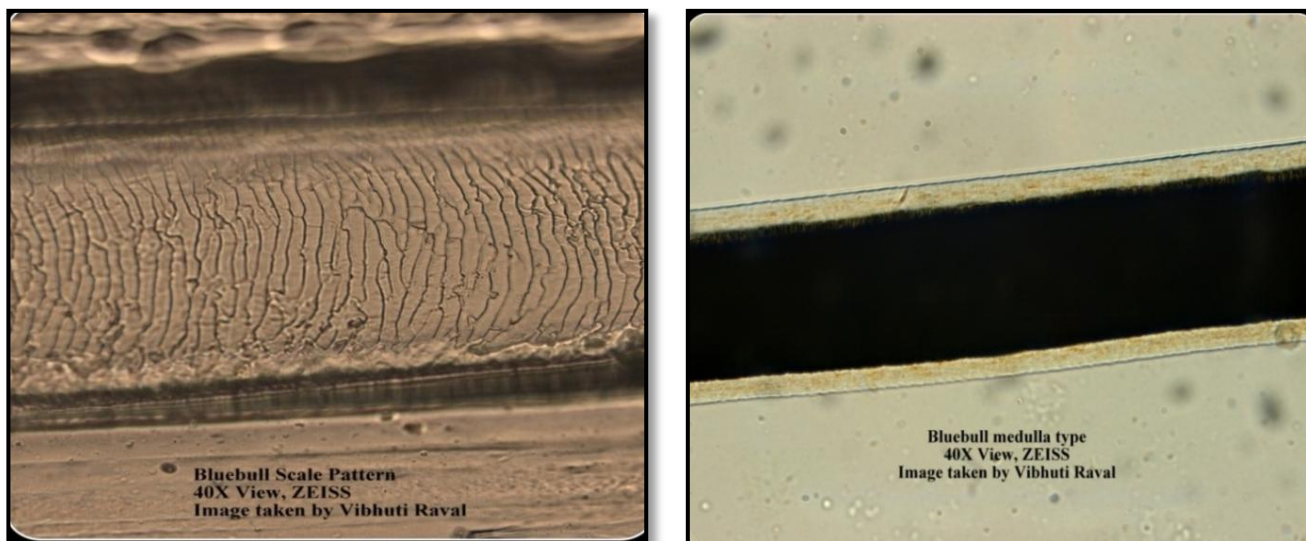


Figure 4. Scale (left) and medulla (right) pattern of the hair of *Boselaphus tragocamelus*.

De & Chakraborty (2012) recorded the medullary index ($0.84 \mu\text{m} (\pm 0.025 \mu\text{m})$) in *Boselaphus tragocamelus* and $0.93 \mu\text{m} (\pm 0.003 \mu\text{m})$ in *Gazella bennettii*, which was much higher than the present investigation. The scale pattern and medulla pattern of studied species is shown in figure 2 to figure 4.

The present investigation shows that the mean length of hair of *G. bennettii* is $43.3 \text{ mm} (\pm 3.32)$ which is more than the length of hair (21.09 ± 2.60) recorded by De & Chakraborty (2012) and 18 to 22 mm observed by Koppikar & Sabnis (1976). Similarly, the hair length of *B. tragocamelus* is recorded as $30 \text{ mm} (\pm 2.21)$ which is less than the length of hair (55- 94 mm) recorded by Koppikar & Sabnis (1976) and more than the length of hair (23- 27 mm) recorded by De & Chakraborty, (2012). The lowest diameter of hair shaft recorded in *G. bennettii* is $34 \mu\text{m}$ which is lower than the lowest diameter (45 ± 3.45) observed by De & Chakraborty (2012) and lowest diameter ($54 \mu\text{m}$) recorded by Koppikar & Sabnis (1976). Similarly average diameter of hair shaft ($39 \mu\text{m}$) in *B. tragocamelus* observed in the present study is much lower than the diameter ($120 \mu\text{m}$) and ($140 \mu\text{m}$) recorded by De & Chakraborty (2012) and Koppikar & Sabnis (1976) respectively.

The variation in length of hairs among the same species may be due to the species distributed in different geographical areas and ecological condition as observed by De (1993) and De & Chakraborty (2012).

CONCLUSION

Physical characters, surface structure and medullary configuration are very much significant for identification of various mammalian species. This study may also be useful in forensic science and in detection of crime in illegal trades of wildlife and its derivatives. The present work provides complete combination of characters such as hair colour, texture, cuticle scale type and medulla along with hair length, shaft diameter, medullary index and other measurements are taken into consideration for identification of a species, as the single character does not help for species identity. The above three wild bovid show regular wave pattern cuticular scale is observed in middle where as irregular wave type scale is found at end portion (proximal or distal) of the hair. On the basis of medulla type only blue bull shows wide and simple medulla type.

Tricho-taxonomic studies of *G. bennettii* and *B. tragocamelus* were done by several workers. But very meager information is available on the hair study of *T. quadricornis*. This study will also be helpful in scat analysis of various large and medium size predator species and it may be consider as baseline data for further intensive study for conservation of wild species found in this region.

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REFERENCES

- Adorjan, A.S., & Kolenosky, G.B. (1969). *A Manual for the Identification of Hairs of Selected Ontario Mammals*. Toronto: Research Branch, Ontario Dept. of Lands and Forests, No. 90, p. 63.
- Bahuguna, A., Sahajpal, V., Goyal, S.P., Mukherjee, S.K. and Thakur, V. (2010). Identification from Guard Hair of Selected Indian Mammals: A Reference Guide. Wildlife Institute of India, Dehradun, India, p.1-438.
- Brunner, H. and Coman, B. (1974). *The Identification of Mammalian Hair*. Inkata Press, Melbourne.
- De, J. (1993). Study of surface structure of hair of some primates of Indian subcontinent. *Records of the Zoological Survey of India*, 93(1-2), 31-34.
- De, J., & Chakraborty, R. (2012). Identification of dorsal guard hairs of nine species of the family Bovidae (Artiodactyla: Mammalia). *Records of the Zoological Survey of India*, 112(2), 39-52.
- De Marinis, A. M., & Asprea, A. (2006). Hair identification key of wild and domestic ungulates from southern Europe. *Wildlife Biology*, 12(3), 305-320.
- Hausman, L. A. (1920). Structural characteristics of the hair of mammals. *The American Naturalist*, 54(635), 496-523.
- Italiya, Ashvinkumar H., Ansari, N. and Menon, S. K. (2017). Non destructive techniques for individualizing porcupine quillthrough trace evidence analysis. *International Journal of Current Advanced Research*, 6 (12), 8228-8232.
- Joshi, H.R., Gaikwad, S.A., Tomar, M., & Shrivastava, K. (2012). Comparative trichology of common wild herbivores of India. *Advances in Applied Science Research*, 36, 3455-3458.
- Kamalakaran, M. (2015). *Tricho taxonomic studies of indian mammal species belonging to the orders Artiodactyla and Lagomorpha*. Ph. D. Thesis. University of Kalyani, West Bengal, India.
- Kamalakaran, M. (2017). Identification of Dorsal Guard Hairs of Nilgai *Boselaphustragocamelus* (Pallas, 1766) (Bovidae: Artiodactyla: Mammalia) Bull,

- Environmental Pharmacological Life Science*, 6(5), 95-98.
- Koppikar, B., & Sabnis, J. (1976). Identification of hairs of some Indian mammals. *J. Bombay Nat. Hist. Soc.*, 73(1), 5-20.
- Lee, E., Choi, T.Y., Woo, D., Min, M.S., Sugita, S., & Lee, H. (2014). Species identification key of Korean mammal hair. *Journal of Veterinary Medical Science*, 76(5), 667-675.
- Lungu, A., Recordati, C., Ferrazzi, V., & Gallazzi, D. (2007). Image analysis of animal hair: morphological features useful in forensic veterinary medicine. *Lucrari Stiin Medicine and Veterinary*, 40, 439-446.
- Moor, T., Spence, L., & Dungolle, C. (1974). Identification of the dorsal guard hairs of some mammals of Wyoming. Wyoming Game and Fish Department Bulletin No. 14, p.77.
- Mukherjee, S., Goyal, S.P., & Chellam, R. (1994). Refined techniques for the analysis of Asiatic lion *Panthera leo persica* scats. *Acta Theriologica*, 39(4), 425-430.
- Tridico, S. (2005). Examination, analysis, and application of hair in forensic science animal hair. *Forensic Science Review*, 17(1), 17-28.
- Wallis, R.L. (1993). A key for the identification of guard hairs of some Ontario mammals. *Canadian Journal of Zoology*, 71(3), 587-591.