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Scanning electron microscopy of hair shaft of Indian spotted deer (*Axis axis*) and blackbuck (*Antelope cervicapra*)

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Abstract

Cross sectional of guard hair of spotted deer varied from oval to round. It was bean shaped in black buck. Medulla was lattice type in spotted deer hair whereas it was non lattice type in black buck hair. SEM studies revealed difference in scale pattern of an individual hair in spotted deer and black buck. Midshaft and base presented flattened imbricate scale pattern while coronal type was seen in tip of the shaft. Margins of the scales were smooth to slightly rippled in mid shaft region and towards the base of the shaft in spotted deer whereas it was smooth in black buck. Trough on surface of hair was an important feature of blackbuck hair that made it easy to differentiate it from that of spotted deer. Medulla consisted of randomly interwoven keratin septa separating numerous air cavities. Medulla is aeriform, non-columnar type of medulla with thin walls was observed in both the species.

Keywords: scale, imbricate, cuticle, coronal, medulla

Introduction

The morphological characteristics of hair vary from species to species. These features are an important tool for identification of animal species (Davis, 2010) [7]. The structure of the cortical and medullar layers of mammalian hair as well as the cuticular pattern and morphology of the scales considerably vary and are used as diagnostic characters for taxon identification in ecology, morphology, and criminalistics (Chernova 2001) [4]. The histoarchitecture of hair forms one of the important tools for identification of animal (Keogh, 1983) [10]. Hair is shed regularly during the course of natural hair growth cycle and may be transferred during the course of criminal activity (Oien, 2009) [15]. It is strongly resistant to decomposition (Lungu *et al.*, 2007) [12] and is stable under adverse conditions (Kshirsagar *et al.*, 2009) [11]. Spotted Deer (Archana *et al.*, 2008) [1] and Blackbuck (Luna, 2002) [16] are listed under Indian wildlife protection act 1972. They are extensively poached for the high price they fetch in the market for meat, skin, and antlers and for flesh and skin respectively. Blackbuck has been classified as nearly extinct species by IUCN since 2003, as its range decreased sharply during the 20th century. The present study was taken up, as hair is important tool in identification of species.

Materials and Methods

For SEM studies, the collected hair samples were first washed two to three times in distilled water, followed by gentle shaking in equal volume of ether and ethanol. To obtain cross sections hairs were cut with sterile surgical blade and were mounted over stubs with double sided carbon conductivity tape. Later the samples were subjected to a thin layer of gold coating using an automated sputter coater (Model – JEOL-1600) for three minutes and immediately scanned under Scanning Electron Microscope (SEM –Model: JOEL-JSM 5600) at required magnification as per the standard protocol (Bozzola and Russell., 1998) [2].

Results and Discussions

Cuticle

SEM studies of spotted deer and blackbuck hair showed scales that formed the cuticle. The scale pattern varied in the tip, mid shaft and base of the hair shaft in spotted deer and blackbuck. Cuticle showed flattened imbricate scale pattern with overlapped scales (Fig.1) in the midshaft and base in both the species. Similar observations were specified by Deedrick and Koch (2004) [8] who described that cuticle pattern in animal hair was coronal, imbricate and

Spinous, Margins of the scales were rippled in mid shaft and smooth to slightly rippled in the base (Fig.2) of the shaft in spotted deer. But, the scale margins of cuticle were smooth in hair shaft of blackbuck (Fig.3). The scales were faint towards the base of hair in both species. Observations of scale margins are in opine with the findings of Marinis and Asprea (2006) [14] who classified the structure of scale margins as smooth, slightly rippled, rippled or heavily rippled

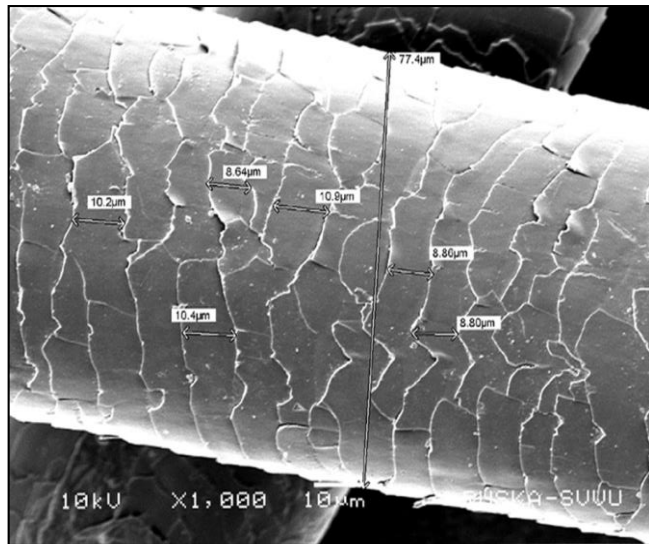


Fig 1: SEM of Midshaft of spotted deer showing the cuticular pattern

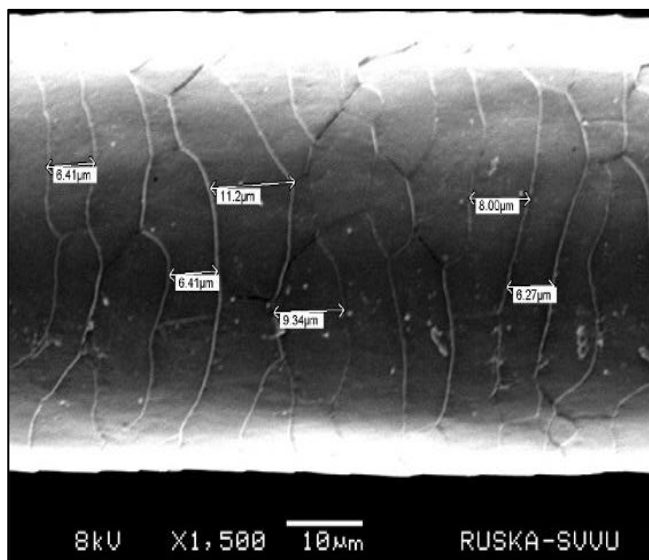


Fig 2: SEM of hair shaft of spotted deer towards base showing imbricate scale

The scales in the tip of the hair were simple coronal type in both species which were arranged in the form of stakes of cup. The scales in tip of the hair in spotted deer showed petals where each petal encircled the shaft (Fig.4). In blackbuck, the scales of the cuticle encircled the shaft. However, the length of the scales in the tip was observed to be uneven (Fig.5) in hair of blackbuck as the scale of one side was lower than the other. Variations of scale pattern within shaft of spotted deer and black buck in present study are similar to those reported by Broeck *et al.*, (2001) [3] in rabbit hair where they noticed different scale pattern in the tip, mid shaft and base of the same hair.

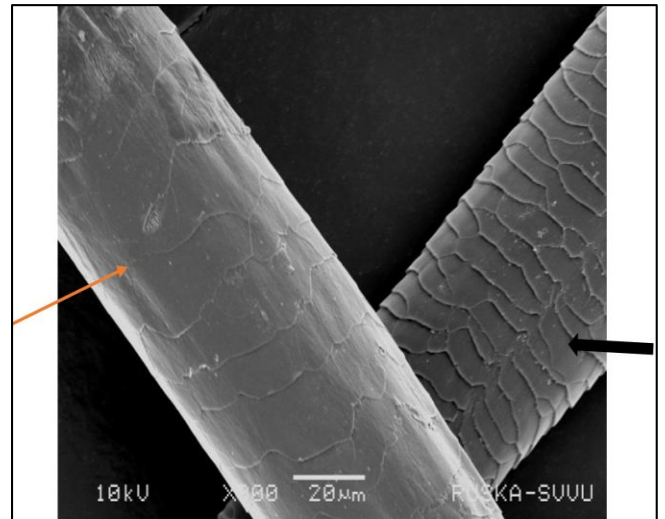


Fig 3: SEM showing the Midshaft (Bold arrow) and Base (arrow) of the hair shaft of Blackbuck

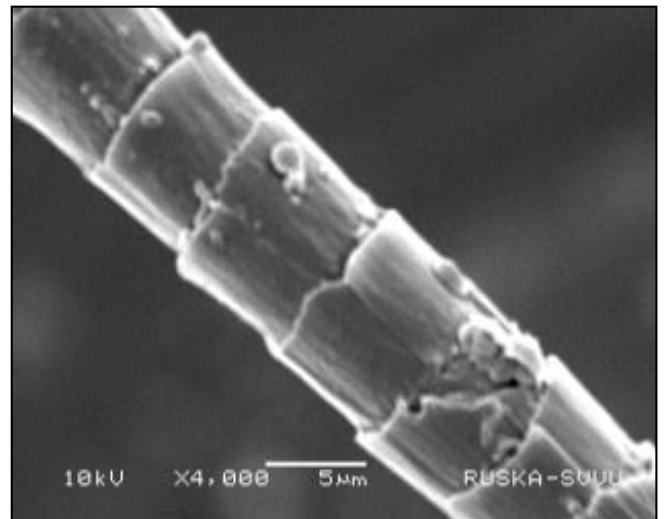


Fig 4: SEM of spotted deer showing scales of cuticle in the tip of the hair shaft

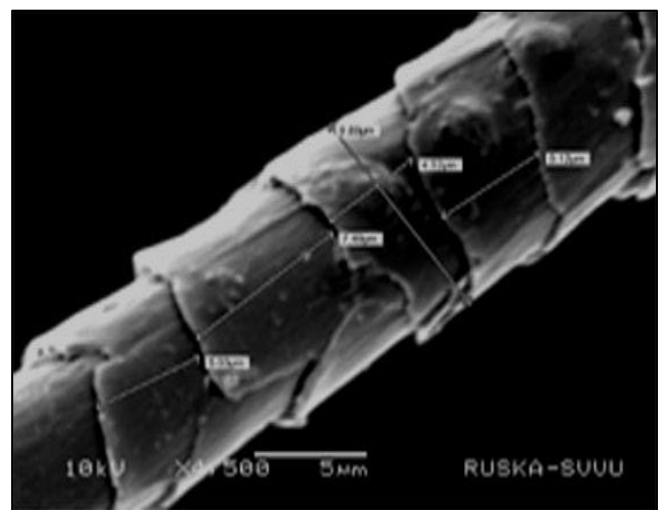


Fig 5: SEM of Blackbuck hair showing cuticle pattern in the tip.

Blackbuck hair showed a longitudinal trough on surface of hair (Fig. 6) that differentiated it from that of spotted deer. Number of scales per 100 µm length of hair were more at the tip in spotted deer (21.55-22.50) than that of blackbuck

(18.05-20.52). These observations are in accordance with the findings of Kristen (2004) who also recorded the numbers of scales per 100 μ m length of hair in fur seal (3-5), African lion and fruit bat (5-10), orangutan and armadillo (10-15) and brown bear (8-12).

The length of the scales in blackbuck hair were ranged between 8.08 μ m to 13.0 μ m and that in spotted deer recorded were 6.4 μ m – 11.2 μ m. The mean inter scale distance in spotted deer and blackbuck was $8.78 \pm 1.65 \mu$ m and $10.91 \pm 1.74 \mu$ m respectively which were similar to the recordings of Dehury *et al.* (2019) [9], in spotted deer ($9.07 \pm 0.3 \mu$ m) and blackbuck ($12.85 \pm 1.4 \mu$ m). The shaft diameter of spotted deer was observed to be less than that of blackbuck.

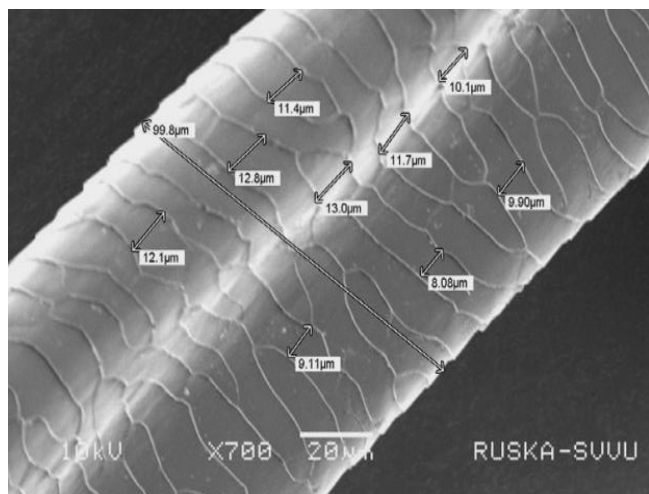


Fig 6: Showing the midshaft of blackbuck with trough (Bold arrow)

Cross Sections

Cross sectional shape of hair shaft of spotted deer was oval (Fig.7) which was justified by Sarkar *et al.*, (2011) [17] who reported that the hair cross sections ranged from round to oval shapes in primate species. Hair of blackbuck was bean shaped in cross sectional view (Fig. 8) due to the presence of longitudinal groove on one side of the shaft as reported by Broeck *et al.*, (2001) [3] in rabbits where they observed altered the hair profile from oval to bean-shape from the distal to mid portion of the shaft. The cross sections of hair revealed the medulla, cortex and cuticle from within outwards. The cortex of the spotted deer was thick compared to that of black buck.

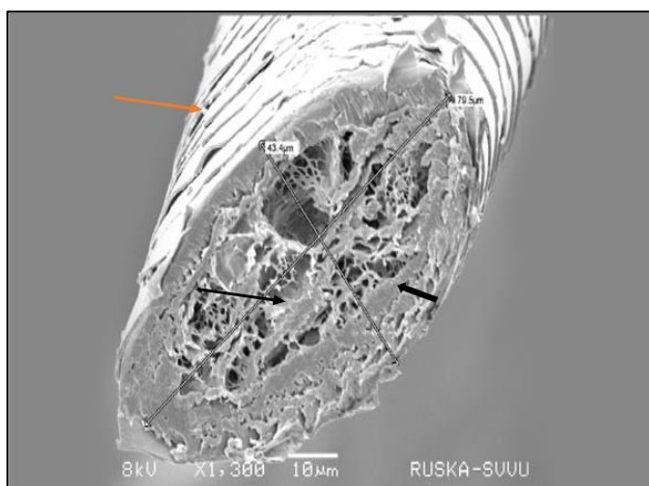


Fig 7: Cross section of spotted deer hair showing Medulla (Black arrow), cortex (Bold arrow) and cuticle (orange arrow)

Medulla

The medulla comprised of medullary cells which were aeriform, multicellular, continuous type in both the species. Spotted deer hair had partially filled lattice type and the blackbuck hair shaft comprised of non-lattice type. Medulla comprised of numerous small air cavities separated by randomly interwoven keratin septa similar to the studies of Chernova, (2014) [5] in chimpanzee. Aeriform, non-ladder, non-columnar, thin walled and reticular medulla was observed in both the species. The medulla of spotted deer and blackbuck comprised of cavities within the cells which devoid of nucleus and made up of thin walls. However, medulla of spotted deer showed even mesh walls with smooth surface while blackbuck consisted of variable mesh with non-smooth walls which were non-porous and prickly as reported by Chernova (2001) [4] in Cervidae and Bovidae. Medulla of spotted deer and blackbuck hair consisted of aerial vesicles separated by smaller vesicles similar to that of Canidae as reported by Clement *et al.*, (1981) [6].

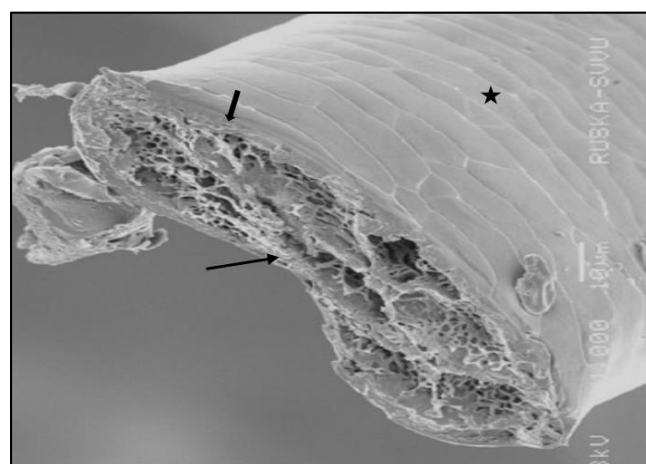


Fig 8: Cross section of blackbuck hair showing Medulla (Black arrow), cortex (Bold arrow) and cuticle (*)

Conclusion

It is concluded that the scanning electron microscopic study is an easy and effective tool in identification of species. The cuticular pattern of hair shaft was imbricate except in the tip which was coronal in both the species. Medulla was Aeriform, non-ladder, non-columnar, thin walled and reticular type in both the species in spotted deer and blackbuck. But the nature of walls separating the cavities varied from each other which is a differentiating feature between the two species. The cross-sectional shape of the shaft is an important feature in identification of the species.

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