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Anatomical structure of hair shaft of Indian spotted deer (*Axis axis*)

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Abstract

Spotted deer (*Axis axis*) is considered as endangered species and are listed under Indian Wild life Act 1972. Microscopic structure of hair of spotted deer comprised of cuticle, cortex and medulla from without inwards. Color variation was evident between the hair of different regions of the body which varied from colorless to blackish brown. Tips of hair shafts were frayed and blunt. The cuticle was a translucent, colorless outer structure with smooth cuticular pattern but forelimb and tail hair was differed with serrated type of cuticle. The cross sections of hair shaft varied from oval to round shape. Cortex was smooth with cortical fusi in the root end. The medulla was lattice type and its margins were scalloped. Tip of the shaft was devoid of medulla, as it gradually narrowed towards tip and that of the base differed from hair to hair with wine glass shape, tapered, fragmentary or widened medulla. The pigment distribution was found to be uniform, medial and random which varied from hair of different regions. A significant difference of mean cortical thickness, medullary diameter, and medullary index was observed between tip, mid shaft and base of the shaft and also differed from hair of different body regions.

Keywords: Spotted deer, hair, cuticle, cortex, medulla

Introduction

Hair is a flexible and keratinized structure covering the entire external surface of the body except the footpads, hooves, glans penis, musculo-cutaneous junctions and teats of some species (Eurell and Frappier, 2006) [7]. Hair consists of shaft and root of which the former can be thought as resembling a lead pencil with outer cuticle, middle cortex and inner medulla (Rowe, 2010) [14]. Hair is shed regularly during the course of natural hair growth cycle and may be transferred during the course of criminal activity (Oien, 2009) [12]. It is strongly resistant to decomposition (Lungu *et al.*, 2007) [10] and is stable under adverse conditions (Kshirsagar *et al.*, 2009) [9]. Mammalian hair is the best source to solve biological problems like species identification and diet analysis of endangered large carnivores. The present work was taken because, the anatomical study of spotted deer hair is very scant in India when compared to that of abroad.

Materials and Methods

The present study was conducted at the Department of Veterinary Anatomy, College of Veterinary Science, Hyderabad. Samples of guard hair from six animals, irrespective of their age and sex were collected from Nehru Zoological Park, Hyderabad. The guard hair from six different regions *viz.*, neck, back, abdomen, fore limb, hind limb and tail were collected from individual animal by plucking. The hair samples were first cleaned in soap solution followed by rinsing in distilled water for two to three times for removal of dirt and debris if any. Later they were cleaned further in a mixture of equal volume of Ether and Alcohol for 2 to 3 minutes and blot dried.

Microscopic physical examination of hair was done by preparing whole mounts of hair samples. The hair shaft was cut into tip, mid and basal parts using a razor and processed. The samples were cleared in Xylene for 15 minutes. All the specimens were dried on filter paper. Each hair was then mounted on microscopic slide in a drop of DPX (Xylene and Din Butyl Phthalate) and covered with cover slip and allowed to dry for 48 hours for light microscopic observation (Drury and Wallington, 1967) [6].

Three parts (tip, mid and basal) of hair shafts were separately mounted on tissue holder in standard embedding fluid and sections of 10µm thickness were taken at – 20 °C using cryostat for studying the shape of hair shaft (Drury and Wallington, 1967) [6].

Individual scale pattern was studied by simple cast techniques where a drop of mixture containing one volume each of uncolored nail varnish and amyl acetate was spread on a microscopic slide on which the full length hair sample was placed. The film was set to dry for ten minutes after which it was carefully pulled away from the slide in one smooth motion. (Drury and Wallington, 1967) ^[6].

Micrometrical studies were carried out by factorizing Occular and Stage micrometer. The diameter of hair shaft, medulla and cortex and Medullary Index (MI) was calculated using the formula - Maximum diameter of medulla / Maximum diameter of shaft (Kshirsagar *et al.*, 2009) ^[9].

Results and Discussion

Microscopic observations

The present findings, the hair shaft of spotted deer was made

up of medulla, cortex and cuticle from within outwards.

The cuticle was thin translucent layer on the exterior surface of the shaft with flattened cells pointed towards the distal end of the hair shaft while the cortex formed the main body of the shaft however few hair samples were devoid of cortex and cuticle as revealed in deer hair shaft by Deedrick and Koch (2004b) ^[5]. The tip of the shaft was frayed (fig.1) in neck, lateral abdomen and tail region hair and was blunt (fig.2) in the forelimb, back and hind limb region hair. The cuticle was smooth however serrated cuticle was observed in the tip of the hair of few samples. The cuticle color varied from was found to be colorless to brown color. These observations are in agreement with Robertson and Aitken (1986) ^[13] who described the cuticle pattern as smooth, serrated, cracked or looped and cuticle color as black or brown.

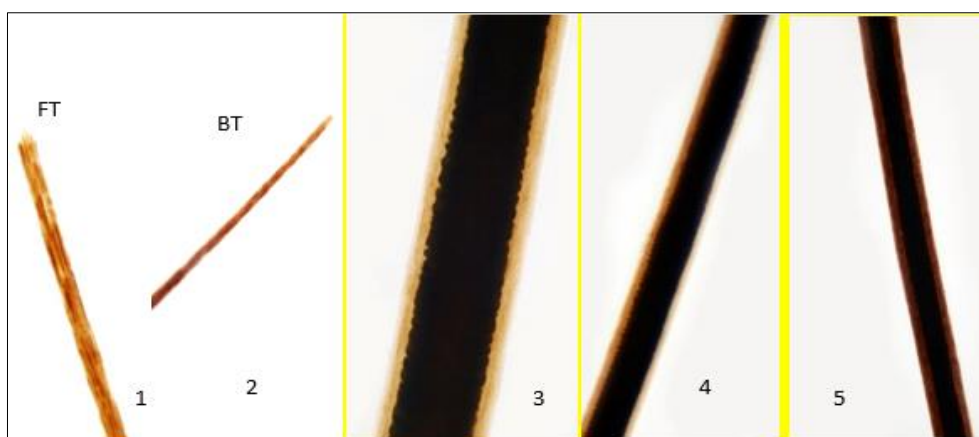


Fig 1-5: Figure showing Tip 1. Frayed Tip (FT) (X160) 2. Blunt tip (BT) 3. Midshaft of tail region with Light brown colored cortex, scalloped medullary margins, smooth - colorless cuticle, and uniform pigment distribution (X400) 4. Midshaft of lateral abdomen with more pigment density on one side (X160) 5. Mid shaft of back region with Dark brown colored cortex and cuticle and uniform pigment distribution (X160)

The distribution of pigment granules was uniform (fig.3) but sometimes more on one side (fig.4) whose intensity and density was decreased towards the base of the shaft. The color of guard hair varied from light brown to dark brown (fig.5) and was faded towards the base which was a variable character as stated by of Marinis and Asprea (2006) ^[11].

Medulla was found to be multicellular, continuous and partially filled lattice type (fig.6) which was as per the classification of Chernova, (2001) ^[12]. Regional wise variation of medulla was noticed. Tapered and fragmented medulla was

observed present towards the tip (fig.7 & 8) and the base (fig.9) which was similar to the studies of by Flores *et al.*, (2007) ^[8] in female house mouse. The wine glass shaped medulla (fig.10) was observed in the base of lateral abdomen and hind limb hair. These varied pattern of medulla type were akin with Cilik (2011) ^[3] who stated that medulla type varied even within the same hair. Generally the medulla was air filled but sometimes it was fluid filled which appeared transparent that demarcated it from the dark air filled medulla (fig.11). The medullary margins were scalloped.

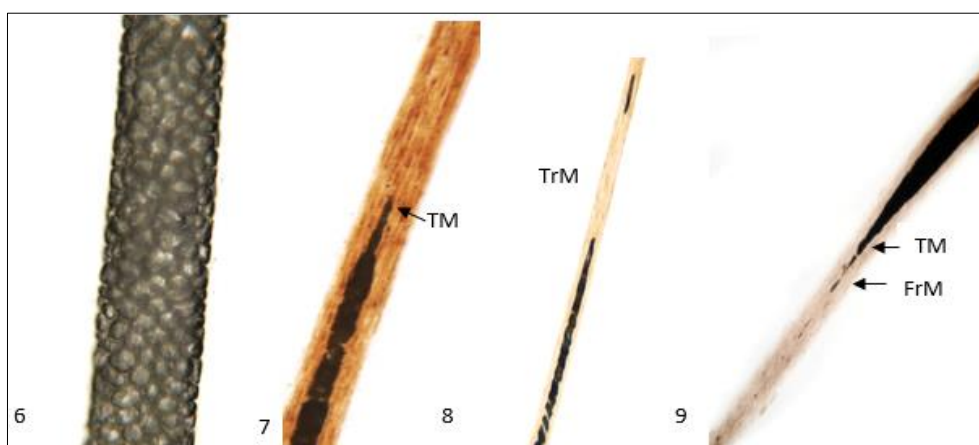


Fig 6-9: Figure showing medulla. 6. Air filled medulla showing multicellular partially filled lattice type of medulla, devoid of cortex and cuticle (X400) 7. Tapered medulla (TM) towards tip and brown colored cuticle (X400) 8. Trace medulla (TrM) towards tip (X160) 9. Base with Tapered medulla (TM) and Fragmented medulla (FrM) (X160)

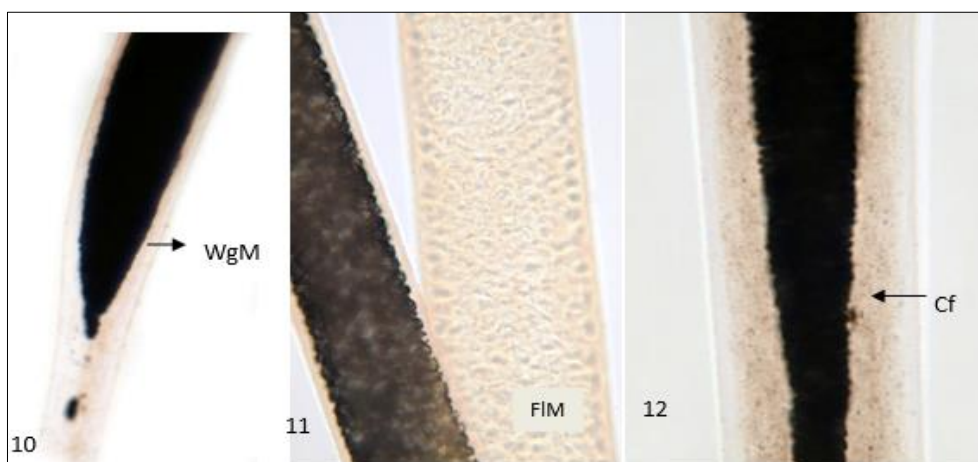


Fig 10-12: Figure showing 10. Base with pale color cortex and Wine glass shaped medulla (WgM) (X400), 11. Mid shaft with fluid (FIM) and air filled medulla (X400) 12. Base with cortical fusi (X400)

The cortex pattern was observed to be smooth in all the hair samples. The present findings revealed the cortical fusi, the small air spaces formed during the process of keratinization, were noticed in the root end of the hair of tail and back regions (fig.12).

Cross sectional shape of hair was oval (fig. 13) to round (fig.14). The variation in the cross sectional profile in the present study is in accordance with the findings of Broeck *et al.*, (2001)^[1] who observed oval shape at the base and bean-shape from in the mid portion of the shaft in the rabbit hair.

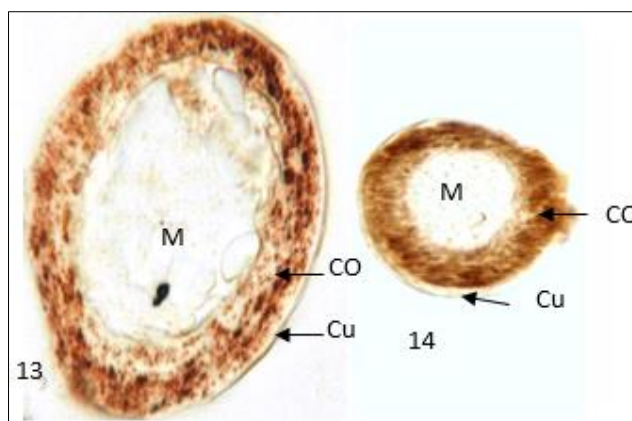


Fig 13-14: Fig. showing cross sections 13. Oval shaped (X400) and 14. Round shaped hair shaft(X400). M - Medulla, Co - Cortex, C - Cuticle

Micrometrical Observations

The cortical thickness, medullary diameter, shaft diameter and medullary index were in range of 5 μm - 27 μm , 25 μm - 130 μm , 50 μm to 160 μm and 0.35 μm - 0.86 μm respectively (Table. 1). The hair of spotted deer was coarse type, as the

hair with 110 to 120 μm shaft diameter was classified as coarse hair by Oien (2009)^[12]. The medullary index of spotted deer hair was more than one third due to greater width of medulla as specified by Deedrick and Koch (2004a)^[4] in hair of mammalian species.

Table 1: Range of cortical thickness, medullary diameter, shaft diameter and medullary index of Spotted deer hair

Region	Cortical thickness (μm)	Medullary diameter (μm)	Shaft diameter (μm)	Medullary index
Neck	Minimum to maximum	Minimum to maximum	Minimum to maximum	Minimum to maximum
Tip	10 – 20	35-50	55-85	0.38-0.59
Middle	10-25	45-100	80-160	0.42-0.77
Base	10 – 20	25-85	60-125	0.36-0.75
Back				
Tip	10 -20	25-60	57-90	0.35-0.61
Middle	10 -20	49-105	77-140	0.48-0.75
Base	5 – 27	40-110	70-135	0.43-0.81
L.abdomen				
Tip	5 – 25	25-63	50-102	0.38-0.60
Middle	10 -20	45-130	82-157	0.47-0.80
Base	6-17	47-121	75-123	0.45-0.75
Forelimb				
Tip	6.5 -25	35-63	72-101	0.37-0.69
Middle	5 -25	40-110	65-128	0.53-0.85
Base	5 – 15	45-100	75-125	0.65-0.85

Hindlimb				
Tip	10 -15	35-60	56-94	0.47-0.67
Middle	10 -25	47-123	84-132	0.49-0.86
Base	5 - 17.5	45-99	57-101	0.42-0.84
Tail				
Tip	5 - 17.5	25 - 65	50-95	0.35-0.68
Middle	7.5 - 17.5	37 - 80	65-115	0.43-0.80
Base	5 -17.5	25 - 80	55-95	0.36-0.72

Scale pattern by cast method

Deedrick and Koch (2004a) [4], described the cuticular pattern in animal hair as coronal (crown like), spinous (petal) and imbricate (flattened) types. The present studies by scale casts technique, revealed that the scale pattern was coronal (Fig.15)

in the hair tip while it was imbricate (Fig. 16) in the mid shaft and base of the hair. The margins were smooth to rippled (Fig. 17) in the mid shaft and that of base were smooth to slightly rippled.

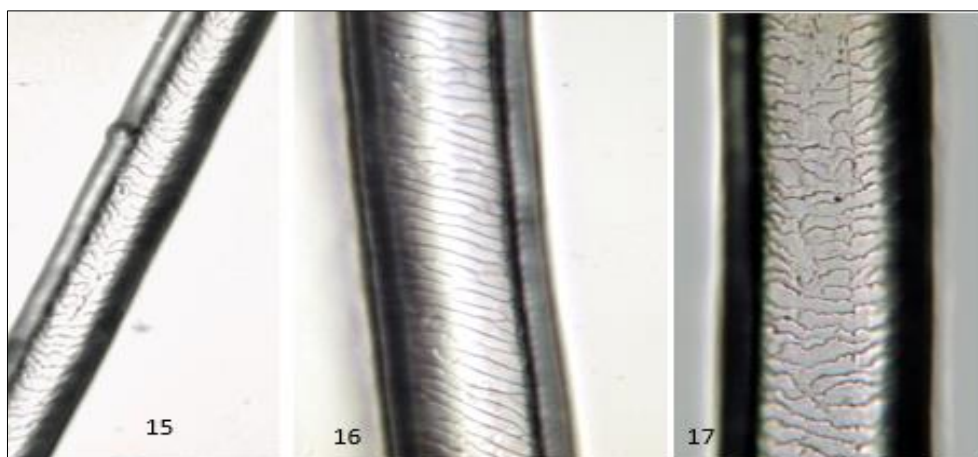


Fig 13-15: Scale casts showing scale pattern 13. Coronal pattern in the tip (X160) 14. Imbricate pattern with smooth scale margins in mid shaft (X400) 15. Mid shaft with rippled scale margins (X400).

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