RESEARCH ARTICLE

Hair Histology and Ultrastructure of Few Wild and Semi-Wild Mammals: A Forensic Approach

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Abstract

In modern days hair is considered as an important tool of study in forensic science to solve complicated vetero-legal cases. The examination of hair from the crime scene is extremely important in the criminal investigation as hair is an appendage of the skin and resist putrefaction; thus, is of an evidential value when other evidence is not available. The present investigation was undertaken to study the hair of few species of wild and semi-wild mammals e.g. Bengal tiger (*Panthera tigris*), Indian one horn Rhinoceros (*Rhinoceros unicornis*), Asian elephant (*Elephas maximus*), Mithun (*Bos frontalis*), Barking deer (*Cervulus muntjac*) and Yak (*Bos grunniens*), to find out the specificity of the hair to the animal-based on indices like color, length, an average diameter of the hair- shaft, cortico-medullary index, and cuticular scale pattern to develop baseline information to solve the vetero-legal cases. The present study revealed that the cuticular scale pattern of a tiger was coronal simple, imbricate crenate in rhinoceros, imbricate flattened in elephant, imbricate crenate in mithun, imbricate flattened in barking deer, and imbricate crenate in yak. The mean diameter of their shafts (in µm) were found to be tiger 140 ± 0.417, rhinoceros 160 ± 1.199, elephant 200 ± 1.958, mithun 150 ± 2.665, barking deer 135 ± 1.864, and yak 150 ± 3.670. Therefore, a cumulative data derived from these indices are helpful to determine the species of animal they belong to.

Keywords: Cuticular Scale pattern, Forensic Approach, Hair Anatomy, Hair medulla.

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Introduction

Hair in mammals is composed of the hair follicle, root, and hair shaft. Follicles are formed only once in the lifetime of an individual. Physiologically hair fibers form a protective layer on the surface of the epidermis, protecting one from injury, snake bites, and electromagnetic rays. Hair responds to external stimuli, and the follicle picks up any fiber movement to transmit a message to the nervous system. The hair fibre can be said as an "antenna" of the mammals to receive sensory signals. Hair also controls the body heat by providing insulation against sudden heat loss or gain.

Hair is important from a physiological point of view and from a forensic aspect as it can help solve the most complicated vetero-legal cases. Due to human activities like poaching and deforestation, most of the mammals are now endangered. Efforts are being made to preserve wild animals by establishing wildlife sanctuaries, national parks, and poaching and trading wildlife substances under WLP Act 1972. Due to this reason, identifying animal species became important in investigating crimes in case of poaching and trading of animal parts.

All hairs, whether used in textiles or not, will be found to have scales on their surfaces, and most hair (ordinarily exempting wool) will show a medulla or core in its center, the width of which will be half or more of the total diameter (Kirk, 1953). Again, hair resists putrefaction, and thus its evidential value is enhanced in case where other evidence is either unavailable or has been rendered unsuitable for examination due to adverse natural environmental conditions. Chernova (2014) proved that hair examination can give some evidence of age. Hair morphology is another important tool that can be used to identify animal species (ENFSI, 2015). Keeping the above facts in mind, the following investigation was undertaken to study the hair of six different species of wild and semi-wild mammals to find out the specificity of the hair to the animal-based on indices like colour, length of hair (excluding hair root), diameter of the hair- shaft, medullary index, cortico-medullary index and cuticular scale pattern to develop a base line information to solve the vetero-legal cases which shall help in species identification.

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Materials and Methods

In the present study 20 strands of randomly selected hairs from each animal belonging to Bengal tiger (*Panthera tigris*), Indian one horn Rhinoceros (*Rhinoceros unicornis*), Asian elephant (*Elephas maximus*), and Barking deer (*Cervulus muntjac*) were collected from the Assam State Zoo, Guwahati, Assam. Hair of mithun (*Bos frontalis* was collected from National Research Centre on Mithun (ICAR), Jharnapani, Medziphema, Nagaland and Yak (*Bos grunniens*) hair was collected from National Research Centre on Yak, Dirang, West Kameng District, Arunachal Pradesh. Length and color of hair were determined with the help of Linear scale and compound microscope (Carl Zeiss) respectively. For studying the Medullary Index and Cortico-medullary Index the hair strands were processed by the standard technique advocated by Bhanobakode *et al*. (2008). Width of cortex and medulla were recorded with the help of an ocular micrometer and calculated as

$$\text{Medullary Index} = \frac{\text{Width of medulla}}{\text{width of shaft (Kirk, 1953)}}$$

$$\text{Cortico - medullary Index} = \frac{\text{C x 100}}{\text{M}}$$

where C = Cortical Width in µm, and M = medullary width in µm.

To examine the cuticular scale pattern (Sarma *et al*., 2008) of the hair samples, hairs of each animal were processed and separately coated with suitable coater and processed as per the standard techniques and examined with Scanning Electron Microscope (JOEL 6280) in the Directorate of Forensic Science, Kahilipara, Guwahati.

Results and Discussion

From the standpoint of species identification, a study of hair played an important role in vetero-legal aspect. The color of hair gave first-hand information regarding the identification of species. In the present study, the color of the hair of the Bengal tiger was brown with black stripes and the abdominal part had white-colored hair. Both brown and white-colored hair was observed in barking deer.

It was found that there was variation in the length and thickness of hair in different regions of the body of the same animal. The hair on the neck region of Yak was about 6 to 7 times the length of that of the hair on the body, and thus this parameter had no taxonomic value.

The histological study observed that hair of the six species under study consisted of three parts - root, shaft, and tip. The root was located in the skin beneath the dermis and the shaft projects beyond the skin surface to a variable distance. The shaft was composed of the medulla, cortex, and cuticle. Medulla was the innermost core of the hair, varied in width in different species, and was irregularly cylindrical in shape as Kirk (1953) opined. Study on a pattern of the hair medulla played an important role in forensics. The medulla contained airspaces and was of various shapes and sizes. A study on the Medullary index (Kirk, 1953) of these six species revealed species-specific (Table 1).

Cortex was the intermediate layer that contained pigment in varying quantities. The pigment distribution in the hair cortex was one of the important parameters that was taken into account in this study. In the cross-section of the hair strands, it was observed that the pigment was uniformly distributed in the Bengal tiger, elephant, and barking deer. In Great Indian, one-horned rhinoceros and coarse hair of Yak pigment were more towards the medulla. However, in mithun pigment was concentrated towards the periphery. Cortico-medullary index value of hair was another important parameter that was taken into account in respect to species identification (Table 1). Bhanubakode *et al.* (2008) reported that the cortico-medullary index value was an important

Table I :-Showing the different parameters on hair shaft

Sl. No.	*Species*	*Hair colour*	*Hair length (cm) (Mean ± SE)*	*Diameter of hair shaft (µm) (Mean ± SE)*	*Medullary index*	*Cortico-medullary index*	*Pattern of medulation*	*Cuticular scale pattern*
1	Bengal tiger (*Pantheratigris*)	Brown, Black, White	1.905 ± 0.149	103.80 ± 0.417	0.549	41.05	Continuous	Coronal, simple
2	One horned rhinoceros (*Rhinoceros unicornis*)	black	3.525 ± 0.413	173.20 ± 1.199	0.339	97.27	Patterned (globular)	Imbricate, crenate
3	Asian elephant (*Elephas maximus*)	black	3.280 ± 0.121	124.74 ± 1.958	0.828	10.37		Imbricate, flattened
4	Mithun (*Bosfrontalis*)	Black, White, brown	3.400 ± 0.162	121.20 ± 2.665	0.861	8.04	continuous	Imbricate, crenate
5	Barking deer (*Cervulusmuntjac*)	Brown, white	1.730 ± 0.076	217.00 ± 1.864	0.824	10.60	continuous	Imbricate, flattened
6	Yak (*Bosgrunnien*) Course Fiber	Black, white	11.540 ± 1.074	66.08 ± 3.670	0.895	5.81		Imbricate, crenate

study in regards to species identification; they observed that the Cortico-medullary index value of tiger was 93.0. jackal 76.56, sambhar 37.66, hyena 29.92, leopard 25.86 and chital 15.25.

The contour of hair shaft studied in the cross-section of hair strands showed that it was different in different species. The contour of the hair shaft in tiger, rhino, mithun, and barking deer was round. In elephant and yak it was oval.

The cuticle was a thin layer composed of scales. The type of cuticular scales is a very important consideration in species identification. Distinctive types of cuticular scales were identified in the six different mammals under study. Based on the study of the cuticular scale pattern (Figure 1) and diameter of the hair shaft an attempt was made to identify the animal species from hair in accordance with the findings of Sarma *et al.* (2008). According to the system adopted (Kirk, 1953) for classification of scale pattern, the hair of Indian one-horned rhinoceros, mithun, and yak were in the same category of imbricate crenate (Figure 1). But it was found that the scales of yak were smooth and stuck to the shaft as compared to the scales of Great Indian one-horned rhinoceros and mithun, which protruded outward from the shaft. The scales of Indian one-horned rhinoceros were broader as compared to the scales of mithun. Considering the height of the scales it was found that it was different in different species. The present study recorded that the diameter of hair shaft (µm), medullary index, and corticomedullary index of mithun and yak were 121.20 ± 2.665, 0.861, 8.04 and 66.08 ± 3.670, 0.895, 5.81 respectively. Whereas in one-horned rhinoceros, it was observed to be 173.20 ± 1.199, 0.339, and 97.27.

In Asian elephant and barking deer the cuticular scale pattern was observed to be Imbricate, flattened. The present study recorded that the diameter of hair shaft (µm), medullary index and cortico medullary index in Asian elephant and barking deer were 124.74 ± 1.958 0.828,10.37 and 217.00 ± 1.864, 0.824, 10.60 respectively. However, Yasser *et al.* (2018) reported that the cuticle scales were imbricate in large herbivores (buffalo, cow, camel, horse) small herbivores (sheep, goat) and carnivores (dog, cat) except in donkey, in which coronal scales were identified. They also reported that the tested animals were clearly differentiated based on scale margin type, shape, and distance. In buffalo, rippled cuticle margins, close-distant, double-chevron shapes were detected. In contrast, cuticle scales with smooth margins, irregular mosaic shape, and wide distances were found in sheep. The dog's scale margin type and distance were similar to that of sheep, but regular in shape. In cat, crenate scale margins, irregular in shape with close distances were detected. In horse and camel, the scale margin type, shape, and distance were similar, appeared as crenate irregular waves with intermediate distances. In cow, the scale margins were also crenate with intermediate distances but appeared as regular waves in shape.

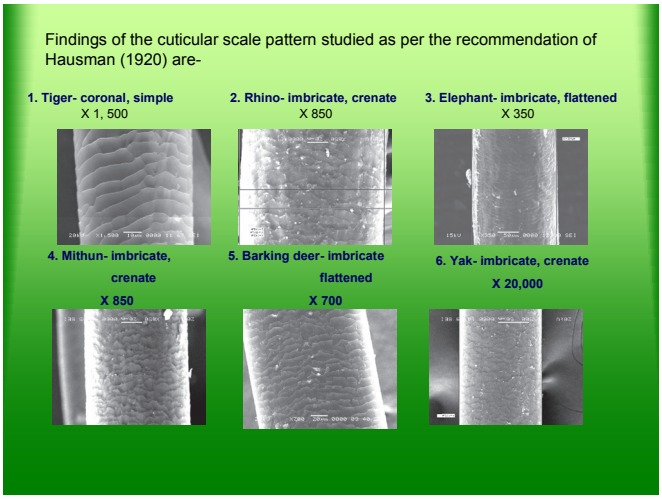

Fig. 1: Showing the cuticular scale pattern of different mammalian species under study.

In Bengal tiger, the cuticular scale pattern was observed to be coronel, simple and hair color was brown-black to white. The diameter of hair shaft (µm), medullary index and corticomedullary index in Bengal tiger was 103.80 ± 0.417, 0.549, and 41.05. However, Yasser *et al.* (2018) reported that the cuticle scales were smooth margins, regular mosaic shape with wide distance in dog and in cat cuticular scale was crenate slightly serrated, close margin with a continuous irregular wave.

Conclusion

The detailed study of the cuticular scales' microstructure showed certain minute characters that were different from one another. Besides, parameters like average diameter and color contributed in the purpose. Therefore, it can be concluded that although there are 8 types of hair fiber in case of mammals, there was a characteristic difference in their cuticular scale pattern. Average diameter of hair shaft, medullary index and cortico-medullary index of hair shaft played an important role in species identification. Hair color gave first-hand information regarding its species.

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References

Bhanubakode,S.B., Chaurasia, D., Gajbe, R.U.,Dalvi, R.S.,Gaykee, D.E. and Charjan, R. (2008). Corticomedullary index of hair as a marker for species identification. Published in the Souvenir and Abstracts of XXIII Annual Convention of Indian Association of Veterinary Anatomists. 57.

Chernova, O.F. (2014). Scanning electron microscopy of the hair medulla of orangutan, chimpanzee, and man. Journal of Biological Science. 456, 199 - 202.

ENFSI. (2015). European Network of Forensic Sciences Institutes. Best practice manual for the microscopic examination and comparison of human and animal hair. *ENFSI-BPM-THG*.,03.

Kirk Paul, L. (1953). Crime Investigation. Physical evidence and the Police Laboratory. Interscience Publishers Inc., New York 1953, 1. Aufl. XXII, 784 S., 151 Abb., gebd.

Sarma, M., Singson,A. and Kalita, S.N. (2008). Study of cuticular scale pattern as an index to species identification: A forensic approach. *Souvenir and Abstracts* of XXIII Annual Convention of Indian Association of Veterinary Anatomists organized by the Department of Veterinary Anatomy & Histology. College of Veterinary Sciences, CCS Haryana Agricultural University,Hissar.,56.

Yasser, A., Ahmed, S. A. and Ahmed, G. (2018). Hair histology as a tool for forensic identification of some domestic animal species. *EXCLI* Journal, 17, 663.