TRICHOLOGY: A SCIENCE OF HAIR EXAMINATION IN IDENTIFICATION OF DOG BREEDS

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Abstract

Presence of hair is a distinguishing character of Class-Mammalia. The microscopic characters, viz. hair colour, hair length, medullary index, pattern of medulla etc are specific for particular species. Thus hair taxonomic studies, called trichology, can be used in taxonomy, wildlife forensic, archaeology, food habitat studies etc. (Kennedy, 1982; Dagnall et al, 1995). Hair analysis not only identifies species, it can also discriminate the animal breeds. The use of trichology in above sited fields provides excellent reliability, low cost and local breed studies. These will enable the demonstration of adaptability, resistance, hardness and conservation of breeds (Felix et al., 2014). The present study was carried out to study the potential use, application and develop an identification keys for identifying various breeds of dogs from microscopic analysis of hairs. Since animals are involved in any types of crimes (Pilli et al., 2014), and DNA typing from animals enabled homicide investigations and convictions in U.S. and Canada (Halverson, Forensic identification of canine hairs: is heteroplasmy significant?), hair examinations of dog breeds will enable convictions in wildlife crimes where dogs are most commonly used.

Key words- Trichology, medulla pattern, medullary index, identification keys, wildlife forensic.

I. INTRODUCTION

Mammals are characterised by presence of hairs, an epidermal appendages of ectodermal origin, which are involved in thermoregulation, tactile sensation, insulation, physical attractiveness (Terry, 1977), skin healing (Taylor et al., 2000), sexual and social communication (Randall, 2001), protection from cold, sunlight and physical damage (Randall and Botchkareva, 2009), diagnosis of psychoactive drugs metals (Kelly et al., 2000; Khalique et al. 2005), health disorders and identity of hair owner (Gurden et al. 2004) and as a container for sequestering and excreting unwanted compounds (Stenn and Paus, 2001; Paus and Foitzik, 2004). More than 400 breeds and varieties of dogs were recently evolved in canid evolution.

The hairs exhibit three distinct anatomical regions; cuticle, cortex and medulla from outer to inner. The cuticle consists of flattened scale like cells that protects hair from environmental insult. The free ends of scales point towards tip of hairs while basal end interlocks with root sheath cells. Human hairs have non-repeating, imbricate patterns while animal hairs have regular repeating pattern in their cuticular scales.

The cortex forms main body of the hair and consists of elongated, spindle shaped cells. The cortical granules, viz. Eumelanin and phaeomelanin, give characteristic color to hair. Eumelanin imparts brown to black while phaeomelanin gives yellow and red colour to hair. Organization, density, size and distribution of pigments in cortex are used to differentiate hairs between and within species. Cortical fusi, air spaces formed during keratinisation, are found near the root end of hairs. Cortex is also characterised by the presence of ovoid bodies, well defined, highly dense clumps of undispersed pigment (Robertson, 1999).
The last innermost layer called medulla is continuous, discontinuous, fragmentary or absent. Medulla can give an idea about the family or species of animals. The diameter of medulla is also used for identification and comparison purpose.

The root hair may contribute to determination of species of origin and the growth phase of hair cycle. Root morphology also used to distinguish animals between humans as well as within animals.

II. MATERIALS AND METHODS

Collection of hair samples:

Hair samples were collected from mid dorsal region of fifteen breeds of dogs using a combing brush. Hair samples were stored in transparent zip-lock air tight plastic bags until used for analysis.

Histology of hair:

Hair samples were washed three times in acetone followed by deionised water (Chakraborty, et al. 1996). The hairs were imbedded in paraffin wax; paraffin blocks were made and cut into 5 µm sections using microtome. The slides were prepared from the sections. Medullary diameter and shaft diameter were measured using micrometer scale while the hair colour was described after (Ridgway, 1886). Diameter of hair was measured using centimetre scale. The medullary index was calculated by using formula as,

\[
\text{Medullary index} = \frac{\text{Diameter of medulla}}{\text{Diameter of shaft}}.
\]

III. RESULT

The average length of hair sample was found to be highest (60 mm) in Lhasa and Saint Bernard followed by Pomeranian (50 mm), German Shepherd (40 mm), Golden Retriever (35 mm), Cross Labrador (30 mm) and Cross Pomeranian (25-30 mm). Pug and Labrador retriever each have a shaft diameter of 25 mm. French Mastiff (20 mm), Rottweiler (15-20) and Dalmatian (10 mm) follow next. Lowest average shaft length of 5 mm was recorded in Great Dane, Boxer and Doberman.

The colour of hair ranged from white (Cross Pomeranian and Pomeranian) to Black (Lhasa, Doberman, Labrador retriever, Rottweiler and Great Dane). German shepherd, Dalmatian and Saint Bernard exhibited mixed colour patterns. French Mastiff, Cross Labrador and Pug had fawn colored fur coat. Golden Retriever had golden colored hairs while Boxer had brown coloured coat color.

The pattern of Medulla exhibited distinct patterns. Cross Pomeranian, German Shepherd, Dalmatian and French Mastiff had lattice type medulla. Pomeranian and Boxer showed discontinuous medulla. Golden Retriever, cross Labrador, Labrador Retriever and Saint Bernard exhibited continuous medullary patterns. Pug and Doberman showed ladder type medulla while mixed medullary pattern was demonstrated by hairs of Lhasa.

Cross Labrador (176.4 mm) hairs was thickest of all hairs while the hairs of Lhasa (32.76 mm) were thinnest.

Medullary index was highest in Lhasa (0.93) while lowest medullary index was recorded in French Mastiff (0.30). The medullary index for remaining dog breeds was Saint Bernard (0.58), Doberman (0.59), Labrador Retriever (0.52), Boxer (0.59), Dalmatian (0.54), Pug (0.45), Cross Labrador (0.65), Golden Retriever (0.54), Pomeranian (0.48), German Shepherd (0.55) and Cross Pomeranian (0.50).
### Microscopic characteristics of whole mount hair of various Dog breeds (Magnification at 450x)

| Name of Breed | Whole Mount | Hair shaft length (mm) | Hair color | Medulla pattern | Diameter of medulla (µm) | Diameter of entire shaft (µm) | Medullary index |
|---------------|-------------|------------------------|------------|----------------|-------------------------|-----------------------------|----------------|
| Cross Pomeranian | ![Cross Pomeranian](image1.png) | 25-30 | Milky white | Lattices | 50.4 | 100.8 | 0.50 |
| German shepherd | ![German shepherd](image2.png) | 40 | Brown and black | Lattices | 81 | 145.8 | 0.55 |
| Pomeranian | ![Pomeranian](image3.png) | 50 | White | Discontinuous | 34.2 | 70.2 | 0.48 |
| Great Dane | ![Great Dane](image4.png) | 5 | Black | - | - | - | - |
| Golden Retriever | ![Golden Retriever](image5.png) | 35 | Golden | Simple continuous | 72 | 133.2 | 0.54 |
| Breed          | Coat Color | Pattern         | Microscopic Diameter | Normalized Diameter | Specific Gravity |
|----------------|------------|-----------------|----------------------|---------------------|-----------------|
| Cross Labrador | Fawn       | Simple Continuous | 115.2                | 176.4               | 0.65            |
| Pug            | Fawn       | Ladder          | 19.8                 | 43.2                | 0.45            |
| Dalmatian      | Black and White | Lattices     | 72                   | 133.2               | 0.54            |
| Boxer          | Brown      | Discontinuous   | 52.8                 | 88.80               | 0.59            |
| French Mastiff | Fawn       | Lattices        | 31.05                | 103.5               | 0.30            |
| Breed          | Length (cm) | Color | Pattern          | Length of Hair (mm) | Texture | Shape |
|---------------|-------------|-------|------------------|---------------------|---------|-------|
| Rottweiler    | 15-20       | Black | -                | 27                  | -       | -     |
| Labrador Retriever | 25       | Black | Continuous       | 46.8                | 90      | 0.52  |
| Doberman      | 5           | Black | Ladder           | 53.1                | 90      | 0.59  |
| Saint Bernard | 60          | Mix hair color (white black and brown) | Continuous       | 50.4                | 86.4    | 0.58  |
| Lhasa         | 60          | Black | Mixed            | 30.6                | 32.76   | 0.93  |

**IV. DISCUSSION**

Since hairs are readily lost during its cycle and can be readily transferred, it is the most common evidence transferred from culprit to victim at the time of crime (Locard, 1930). The telogen dog hairs are commonly found at crime scene. Though animal hairs are commonly encountered at crime scene, they are often overlooked as a source of forensic evidence. Western countries maintain pet animals like dogs and cats in close proximity as a result pet hairs are commonly found on
clothing, cars, home of owners. As a result, the pet hairs can be used to link suspect to crime (Halverson and Basten, 2005).

The two hypervariable regions of mitochondria (HV1 and HV2) rather than nuclear DNA is used for individualization of dogs which are present between 15458 and 16727 (Okumura et al. 1996). Canine STR loci can be used in pedigree verification, criminal investigation and homicide trails. The medullary fraction can be effectively used to distinguish the dogs and cats (Peabody et al. 1983). Microscopic characteristics of hairs can also be used to discriminate animals most commonly encountered at crime scene (Hicks, 1977). The microscopic analysis and comparison of animal hairs are not as significant as human hairs for individualisation of dog. But it is potential useful to associate suspect’s dog with crime scene (Oien, 2009). Domestic dogs exhibit extraordinary genetic variations across breeds and also have parallel with humans with respect to disease.

Microscopic hair examination, although, does not result in firm identification, it provides strong basis for association and certainly provides strong exculpatory evidence (Oien.). Peabody et al (1983) and Hicks (1977) used microscopic characters to distinguish dogs and cats and animal discrimination respectively. It must, however, be noted that the dog hairs do not possess enough individual microscopic characters to associated a questioned hair to a particular dog from other dogs of same breed (FBI Lab.).

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