



# Anatomical observations on the hair distribution patterns in the deer, goat and sheep

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## Abstract

*Hair distribution patterns in the deer, goat and sheep were studied using skin samples collected from spotted deer brought for post mortem at College of Veterinary and Animal Sciences, from the Thrissur zoo and forest department and from goats and sheep freshly slaughtered at the Meat Technology Unit, Mannuthy. Samples of 1cm<sup>3</sup> were collected from 27 regions of skin, viz. muzzle, infraorbital, horn glands, dorsal face, lateral face, ventral face, ear pinna, dorsal neck, lateral neck, ventral neck, dorsal abdomen, lateral abdomen, ventral abdomen, dorsal forelimb, palmar, dorsal hindlimb, plantar, interdigital part of fore limb, interdigital part of hind limb, forelimb foot pad, hindlimb foot pad, inguinal, preputial scrotal regions of male dorsal thorax, perineum and dorsal nasal regions. The hair arrangement in the three species was simple, but arranged in groups. Mostly two to three hairs formed a group and they emerged out very closely but not from a single orifice unlike in the case of compound hairs. The muzzle region lacked hair on the rostral aspect and sparse wool hairs were found on the dorsal surface. Dorsal nasal and carpal regions consisted of dense population of short, stout hairs. Maximum hair density per microscope field under low power was noticed in the lateral aspect of neck, dorsal abdomen, palmar, interdigital aspect of hind limb, lateral abdomen and dorsal aspect of hind limb in deer. Hair was absent in the muzzle followed by dorsal face region in all three species in the present study. Maximum hair density per microscope field under low power was noticed on the dorsal aspect of fore limb, palmar aspect, pinna of ear, dorsal abdomen and interdigital space of hind limb in goat with minimum hair distribution on the ventral abdomen followed by lateral face region. Maximum hair density per microscope field under low power was noticed on the dorsal aspect of neck, interdigital space of fore limb, lateral aspect of neck and infraorbital in sheep with minimum hair distribution on the ventral abdomen, dorsal face and lateral face. In general, density of hair distribution was more in the deer than the goat and sheep.*

**Keywords:** Deer, goat, hair distribution, sheep

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Animal species identification can be done based on many features including morphology of animal remains, particularly hair and bone. Hair morphology is an important tool that can be used to identify animal species (Yasser *et al.*, 2018).

Hair consists of two parts, root which is embedded in the dermis of the skin, and shaft which extends above the epidermis as a cylindrical structure. The hair shaft consists of three distinct morphological layers, medulla (the central layer), cuticle (the outer layer) and the cortex (between the medulla and the cuticle) (Debelica and Thies, 2009). Regional skin variations relating to the amount and type of hair coat, distribution and type of glands and skin thickness occur as functional adaptations to suit the organism to its environment (Banks, 1981). The objective of the present study was to investigate the differences in hair distribution pattern of skin in the three species of wild and domestic small ruminants.

## Materials and Methods

Hair distribution patterns in deer, goat and sheep were explored using skin samples collected from six each of spotted deer brought for post mortem at the College of Veterinary and Animal Sciences, Mannuthy, from Thrissur zoo and forest department and of goat and sheep freshly slaughtered at the Meat Technology Unit, Mannuthy. Samples of 1cm<sup>3</sup> were collected from 27 regions of skin, viz. muzzle, infraorbital, horn glands, dorsal face, lateral face, ventral face, pinna ear, dorsal neck, lateral neck, ventral neck, dorsal abdomen, lateral abdomen, ventral abdomen, dorsal forelimb, palmar, dorsal hindlimb, plantar, interdigital part of fore limb, interdigital part of hind limb, foot pad of forelimb, foot pad of hind limb, inguinal, preputial, scrotal regions of male), dorsal thorax, perineum and dorsal nasal region.

Morphology of skin was studied by using a digital camera (Canon) with 5x zoom and 16 mega pixels. The gross morphological observations were studied under a stereo zoom microscope. Specimens for histological study were fixed in 10 percent neutral buffered formalin (10% NBF), for 48 hours. The fixed specimens

were processed for paraffin embedding (Luna, 1968). Further, serial sections of 5µm thickness were made and stained with Haematoxylin and Eosin for routine studies (Luna, 1968). Samples of 1 mm<sup>3</sup> size were fixed in 2.5% gluteraldehyde in 0.1 M phosphate buffer (pH 7.2) for 24 hrs at 4°C and processed for Scanning Electron Microscopy (SEM - Model: JOEL-JSM 5600) as per the standard procedures (Bozzola and Russell, 1998) at Ruska labs, College of Veterinary Science, Hyderabad.

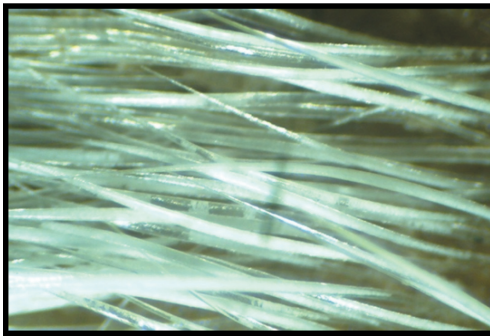
## Results and Discussion

**Morphology:** The hair arrangement in the three species in the present study was simple, but hairs were arranged in groups (Figs.1 to 4). Mostly two to three hairs formed a group and they emerged out very closely but not from a single orifice unlike in the case of compound hairs. This was in accordance with the observations of Eurell and Frappier (2013) and they stated that simple hair follicles were evenly distributed in ruminants and equines and were seen in groups of three in porcine. Variations in the thickness of the skin were also reported in different regions of the body, with the epidermis being thin in regions with heavy protective hair coat and thicker in non-hairy parts of the skin and at the muco-cutaneous junctions.

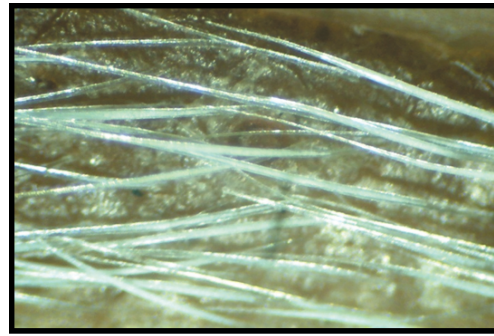
**Histology:** Maximum hair density per microscope field under low power was noticed on the lateral aspect of neck, dorsal abdomen, palmar, interdigital part of hind limb, lateral aspect of abdomen and dorsal aspect of hind limb with an average of 44, 25, 20, 16, 12 and 11 in deer.

Maximum hair density per microscope field under low power was noticed on the dorsal aspect of fore limb, palmar, pinna of ear, dorsal aspect of abdomen and interdigital space of hind limb with an average of 27, 19, 16, and 11 each in goat. Hair distribution was minimum on the ventral abdomen with two hair follicles per field in goat. This was followed by lateral aspect of face region with an average number of three in goat.

Maximum hair density per microscope field under low power was noticed on the dorsal



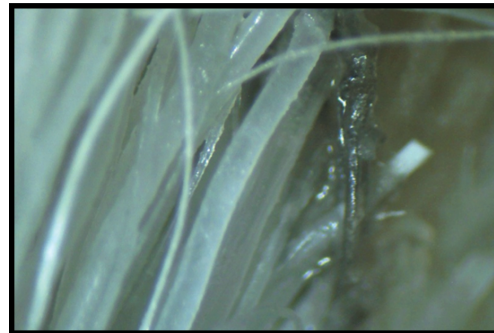
**Fig. 1.** Hair distribution on the pinna. Dorsal Aspect. 5 months–old male Crossbred Malabary Goat. Stereo zoom microscopy x 200



**Fig. 2.** Hair distribution on the pinna. Ventral Aspect. 5 months–old male Crossbred Malabary Goat. Stereo zoom microscopy x200



**Fig. 3.** Hair distribution on the abdomen. Dorsal Aspect. 6 year–old female Sambar deer. Stereo zoom microscopy x100



**Fig. 4.** Hair distribution on the abdomen. Dorsal Aspect. Adult male sheep. Stereo zoom microscopy x200

aspect of neck, interdigital aspect of fore limb, lateral aspect of neck and infraorbital with an average of 11 each in former two and 10 each in latter two each in sheep. Hair distribution was minimum on the ventral abdomen, dorsal and lateral aspect of face with three hair follicles per field in sheep.

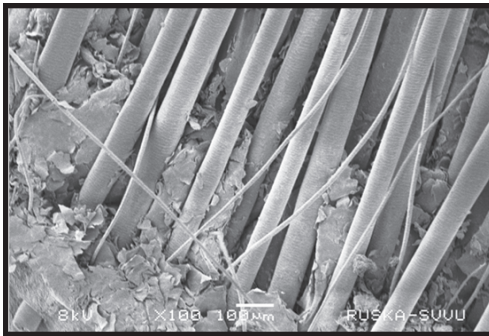
In general, density of hair distribution was more in the deer (11.880) than the goat (9.714) and sheep (5.940) probably owing to an adaptation to the wild environment.

Among the three species studied, the muzzle region had the thickest epidermis. Adult deer had the greatest thickness for the region (619  $\mu\text{m}$ ) followed by goat (413  $\mu\text{m}$ ). Epidermis was thinnest in sheep (234  $\mu\text{m}$ ).

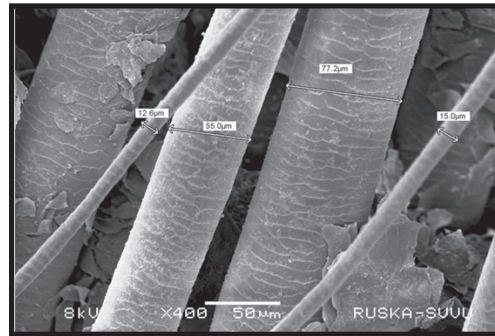
#### **Scanning Electron Microscopy:**

Scanning electron microscopic studies revealed that three hair types viz. primary, secondary and tertiary were present in all three species with higher hair density and less sloughing off in the deer (Fig. 5 to 8). Scale like cells covered the hair surface and there was a difference in width between hair types with a maximum in primary, decreased in secondary and tertiary (Fig. 6). The distance between every two successive scale margins were close in all the three species studied. The scales showed flattened edges in goat and sheep, but slight serrations were present in the deer.

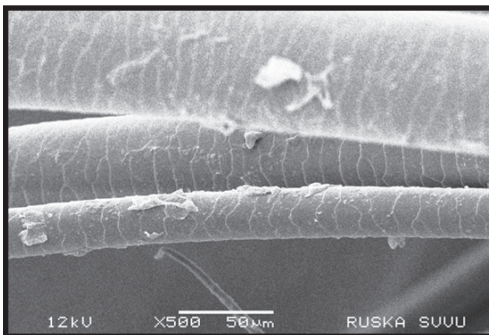
Debelica and Thies (2009) also described the cuticle, the outermost layer of hair, as consisting of overlapping keratin scales. Two main patterns of cuticle scales were identified, the first being the imbricate, this includes ovate, acuminate, elongate, flattened



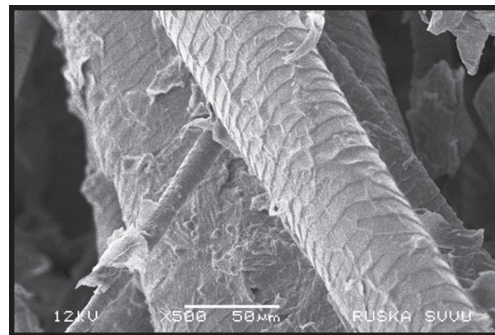
**Fig. 5.** Surface view of skin showing base of hair groups. Dorsal abdomen. Five- months old male sheep. SEM x 100



**Fig. 6.** Surface view of hair on Dorsal abdomen of Five- months old male sheep. SEM x 400



**Fig. 7.** Surface view of Dorsal abdomen of One week-old female deer. SEM x 500



**Fig. 8.** Hair types. Surface view of Dorsal abdomen of Adult male sheep. SEM x 500

and crenate cuticles and the second being the coronal, which include simple, serrate or dentate cuticles. The distance between every two successive scale margins can be close, intermediate or wide, depending on the animal species.

According to Brunner and Coman (1974), the pattern of the cuticle scales, the type and the diameter of the medulla and/or the characteristics of pigmentation can be used for animal species identification as well as for differentiation between animal and human hair in forensic cases.

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