

Morphology of the Hairs in the Goat-Breed *Capra prisca*

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Abstract: The morphology of the guard and wool hairs in the Greek Goat (*Capra prisca*) was described and studied using Scanning Electron Microscopy. The diameter of wool hairs ranged from 10-12 μm , whereas the guard hairs possessed diameters ranging from 45-130 μm . The majority of guard hairs were medullated. The cuticle pattern of guard and wool hairs was of the non-annular type. The scale's number as well as the scale's configuration of guard hairs varied accordingly to their diameter. The morphological features of hairs compared with the existing data of other goat breeds. This information could be useful for hair identification of this mammalian species.

Key words: *Capra prisca*, hair, wool, goat, scanning electron microscopy

INTRODUCTION

The mammalian hair fibers represent an interesting biological material which also is used in the textile industry. Generally the hair is composed of the cuticle externally, the cortex or inner sheath, the medulla or central core and pigment granules dispersed in the cortex and medulla (Meyer *et al.*, 2002). 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 species identification in zoology, morphology and forensic sciences. Furthermore, the hair morphology is useful for the study of evolution and domestication of various mammals (Meyer *et al.*, 2000).

In the literature there is a variety of names regarding the terminology of the hairs in the mammals (Den Broeck *et al.*, 2001). The guard hairs are the capilli according to the most recent Nomina Anatomica Veterinaria (General Assembly of the World Association of Veterinary Anatomists, 2005), whereas, the wool hairs are the pili lanei.

In the goat industry, usually the hair production is considered as the third production category after milk and meat, with insignificant profit; the exception is Angora goat, where the mohair fibres are the main production. As direct consequence of the limited industrial use of in goat's hairs other than Angora breed, there is a lack of

systematic information concerning goat's hair morphology (DeMarinis and Asprea, 2006).

Capra prisca is the indigenous goat breed in the area of mainland Greece that its domestication and its use as productive animal is traced into Neolithic Period (6,000-2,000 BC). These animals are durable and well adapted to the local physical environment of mountains and highlands. Currently, the main economic purpose of the rearing of this breed is the milk and meat production. There are not detailed figures of the population of *Capra prisca* in the modern Greece. However, the Greek goat industry consists of 5,200,000 heads according a survey of 2001 and its main body constitutes of the breed *Capra prisca* (Zygoiannis *et al.*, 1992; DADIS, 2007).

The aim of the present study is to describe the morphology of the hair fibers of *Capra prisca*. The study focuses on the recording of the different fiber types accounted and their investigation using Scanning Electron Microscopy (SEM).

MATERIALS AND METHODS

The dorsolateral area of five adult goats' trunk was carefully observed and photographed. Five skin samples were obtained from various parts of the latter body region from each animal. They were fixed in a sodium cacodylate (0,1 M) buffered solution of 2% glutaraldehyde and 2% paraformaldehyde.

Consequently they were washed in several changes of sodium cacodylate buffer, transferred for 1 h to 1% OsO₄ and dehydrated in graded acetone. Tissues were critical point-dried in carbon dioxide, mounted onto stubs and sputter coated with palladium and gold in a Bal-Tec sputter coater. Specimen's observation was performed in a JEOL, JSM 840 scanning electron microscope.

Only the medium part of the hair shaft was investigated (Meyer *et al.*, 2002).

The characterization of hair structures was based on the classification of Chernova (2002, 2003).

RESULTS

The macroscopic observation of the dorsolateral area of the body revealed prominent and long guard hairs. At the base of the hairs, groups of fuzz with curly white wool hairs were observed (Fig. 1).

At the SEM level, the wool hairs had a uniform appearance and often emerged from the skin in groups of 2-3 (Fig. 2). The diameters of the shaft ranged from 10-12 μm. The cuticle pattern was of the non annular type (Chernova, 2002), with scales adhered to the shaft and orientation towards the apex of hair. The shaft encircled from 1-2 scales. The height of the free part of the scales was 3-6 μm (Fig. 3). No medulla in the wool hairs was observed.

The guard hairs exhibited a less uniform appearance, because between the majorities of fibers, appeared randomly hairs with wider diameter. The diameter ranged from 45-60 μm. The bigger hairs possessed a diameter of 100-130 μm. The profile was round and in many of the examined hairs no medulla was observed (Fig. 4). The majority exhibited medulla which was of the thin walled type, according to Chernova (2003) classification (Fig. 5).



Fig. 1: Photo of a portion of the dorsolateral region of the goat trunk

The medulla composed of cavities with irregular and uneven walls which were perforated and possessed prickly processes. The medulla occupied more than the 2/3 of the shaft diameter. The cortex of the medullated hairs had a mean width of 10 μm.

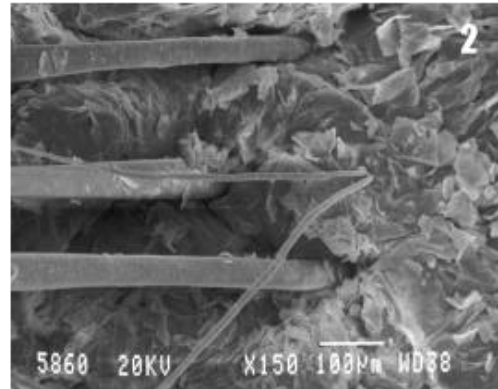


Fig. 2: Surface view of three guard hairs and two wool hairs. The wool hairs emerge from the same follicle

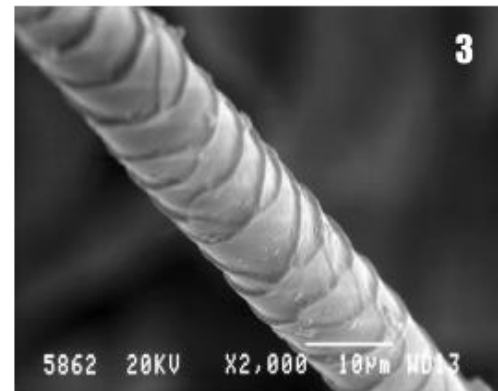


Fig. 3: Cuticle scale of a wool hair

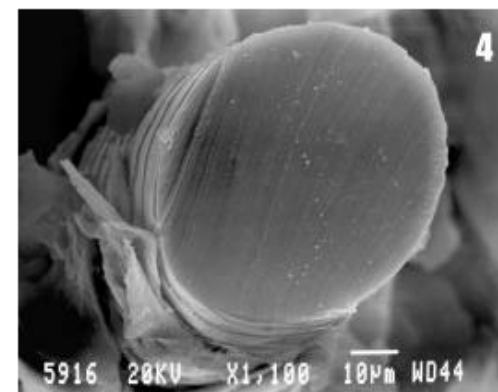


Fig. 4: Transverse section of a guard hair with no medulla

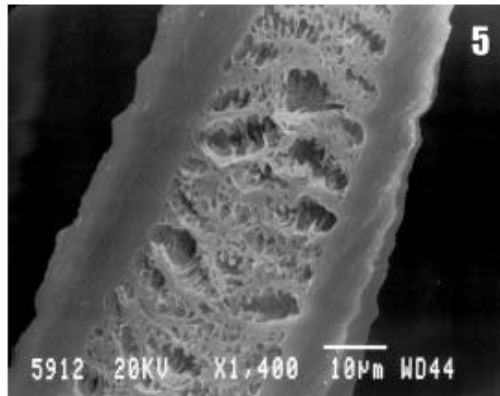


Fig. 5: Longitudinal section of a guard hair with medulla

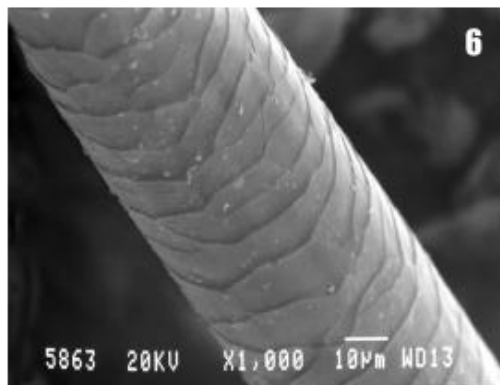


Fig. 6: Cuticle scale of a guard hair

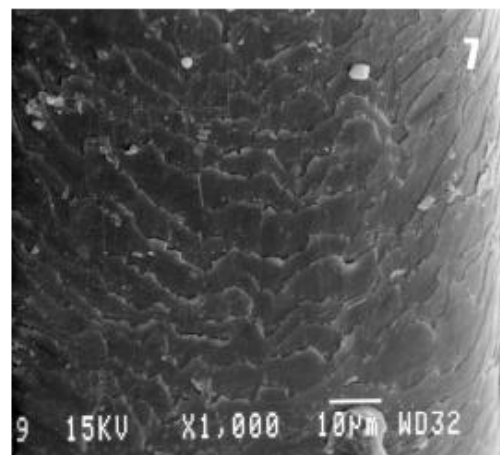


Fig. 7: Cuticle scale of a guard hair with bigger diameter

The scale pattern of the guard hairs was of the non-annular type according to Chernova (2002) classification (Fig. 6). The number of cells embracing the hair shaft was 3-4. The scales were tightly adhered and overlapped to

the shaft with a direction towards the tip. The height of the free part of the scales was low in relation to their width ($K=1/3$) and ranged from 6-10 µm. The appearance of free scale margin was nearly flattened and smooth.

The scale pattern of the bigger hairs was also of the non-annular type. The height of free scale was low and ranged from 2-10 µm. The configuration of free scale margin was rippled (Fig. 7).

DISCUSSION

The existence of a visible wool hair layer in *Capra prisca* recorded here suggests a close evolutionary relation of this breed rearing in continental Greece with Angora goats rearing in Middle East. Furthermore, this layer of wool hairs constitutes an identification key for *Capra prisca*. There is a traditional and empirical knowledge among people in goat-farming communities that the visible layer of wool hairs is disappeared in the second generation of cross breeding of *Capra prisca* with either Alpine breed goats or Saanen breed goats; i.e. the most usual cross patterns in Greece. Consequently for these people, this feature is used as the key of the identification of the pure breed members of *Capra prisca*.

The observations of the hairs shaft with the aid of SEM provided useful information. From the comparison with the fragmentary information on the hair morphology of other Caprinae, seems that there are similarities and differences. The diameter of guard is not in the same range of diameters of the Ibex goat (*Capra ibex sibirica*). That is because in the *Capra prisca* thick guard hairs were observed. In fact, Rollins and Hall (1999) reported diameters of guard hairs in Ibex goat ranging from 50-60 µm. Regarding the wool hairs, *Capra prisca* possessed thinner fibers in relation to Ibex goat and Cashmere goat (*Capra hircus laniger*). Tonin *et al.* (2002), reported a mean fiber diameter of 13.6 µm for Ibex goat and 13.9 µm for Cashmere goat.

On the other hand, the cuticle pattern is variable. In fact, in the Ibex goat the scale pattern of the wool hairs is of the annular-coronal type (Chernova, 2002) and that of the guard hairs is of the non-annular type with rippled scales (Meyer *et al.*, 2002). Also, in the Ibex goat the scale density was higher (Rollins and Hall, 1999). In *Capra prisca* an intermediate scale pattern was observed in the guard hairs with diameter 45-60 µm. This morphological feature could be a distinguishing criterion for this breed. Variable cuticle features revealed about the *Capra aegagrus* hairs (De Marinis and Asprea, 2006). The authors reported a scale pattern with mixed wave shape and mixed scale margin configuration.

No pores in the wall of medulla have been observed in *Capra sibirica* and *C. caucasica*. The different structure of the medulla could be a sign of structural adaptation and evolution of animals because the medulla is related to the thermal insulation of hair coat (Chernova, 2003).

Diameters of hair shaft between species can vary from 10-250 µm and are influenced by the metabolic and nutritional state of the animal (Jones, 2001).

The fiber diameter and the scale pattern type as well as the rate of growth in fiber length and the distance between scale ridges are related according to many authors (Tonin *et al.*, 2002). The present observations confirm the latter statement. The thicker hairs showed higher density of scales.

The morphological characteristics of the hairs of the *Capra prisca* suggest structural modifications influenced by genetic, climatic, nutritional and ecological factors.

CONCLUSION

Investigation of morphological and morphometrical characteristics of hairs, provides useful information for fiber identification purposes. The organization of hair's anatomical components is associated with the ecology and biology of animals. The hairs of *Capra prisca* could be an identification tool for zoosystematic grouping of this breed. The present study confirms the presence of species-specific characteristics as well as breed-dependent variations of the structural hair components in goats.

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