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Microscopic Hair Characteristics of South African Blue Wildebeest (*Connochaetes taurinus*), Black wildebeest (C*onnochaetes gnou*) and Red Rock Hare (*Pronolagus crassicaudatus*)

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ABSTRACT Hair identification provides a wealth of information in many fields of research including wildlife management. This research describes the scale pattern and cross sectional morphology of hairs of South African Blue wildebeest **(***Connochaetes taurinus*), Black wildebeest (C*onnochaetes gnou*) and Red rock hare (*Pronolagus crassicaudatus*). Samples were taken from the back of pelts curated at the Ditsong National Museum of Natural History in South Africa. The hairs were examined using FEI Quanta 400 E scanning electron microscopy. Analysis of the hair samples revealed fine details of species-specific scale and cross sectional morphology. However, in one case, the cross section shape of red rock hare was found to have more cavities than observed in other pieces of hair from the same animal. Researchers involved in the study of hair should examine when possible, in addition to guard hairs, examples from different sites on the body and consider geographical differences in sampling.

INTRODUCTION

The identification of cuticular scale patterns on hair samples dates back to the late 1800, and since then, many researchers have investigated these patterns (Brown 2009). Numerous coats of mammals, except for humans and sheep, consist of several types of hair, the main components being the guard hair and under hair (Perrin and Campbell 1980; Kondo 2000; Teerink 2003). The differing hair characteristics among mammals are recognized by the differences in guard hair, based on the morphological characteristics of the cuticle and medulla (Kondo 2000). Guard hair is that long and stiff hair on an animal's back, with a thickening in the distal part called the shield, and a thinner proximal part, the shaft, whereas under hair is thin and less rigid, with an undulating appearance (Teerink 2003). Hair cuticular scales can vary greatly between taxa in many ways, and can be of taxonomic significance, thus aiding identification (Backwell et al. 2009). Hair scale patterns provide most of the diagnostic characteristics for identifying hair samples (Bower and Curry 1983). Cuticular scale patterns are important in hair identification because they show more interspecific variety than other features of hair morphology and are not usually altered while in the digestive tract of a predator (Keogh 1975). The microstructure of hair is a useful tool to identify mammals and is increasingly gaining importance in many areas such as forensic science, ecology, environmental toxicology, wildlife management, epidemiology, assessment of geographic mobility, archaeology and palaeontology (White 1993; Ashraf et al. 1994; O'Connell and Hedges 1999; Quadros and Monteiro 2006).

The South African Blue wildebeest (*Connochaetes taurinus*), Black wildebeest (C*onnochaetes gnou*) and Red rock hare (*Pronolagus crassicaudatus*) are often encountered in illegal trade in South Africa. This research utilizes scanning electron microscopy to identify hairs from these animals, based on cross sectional shape and scale pattern. Microscopic hair characteristics are useful in dealing with wildlife offences such as poaching and illegal trade. In the absence of animals themselves, hair may be used as evidence of poaching, and if utilized properly, microscopic examination of hair can be used to identify the species concerned, and hence lead to the poachers being convicted (Sahajpal et al. 2009). Since time immemorial, human beings have been exploiting wildlife and natural resources for food, clothes, medicine, pleasure, and profit, but the commercial exploitation in the recent years decimated some of the species to the verge of extinction (Sahajpal et al. 2009). Conservation of wild species is therefore a big challenge due to persistent illegal trade in wildlife products.

Even though much is known about European mammalian hair (Teerink 2003; Backwell et al. 2009), relatively little research has been conducted on the hair morphology of South African mammals. This study contributes to a growing database of microscopic hair characteristics of southern African mammals and will undoubtedly assist in wildlife crime investigations and other fields of research.

MATERIAL AND METHODS

Guard hair samples from Blue wildebeest (*Connochaetes taurinus*), Black wildebeest (C*onnochaetes gnou*) and Red rock hare (*Pronolagus crassicaudatus)* were taken from the back of pelts curated at the Ditsong National Museum of Natural History in Tshwane (formerly Transvaal Museum, Pretoria). Ten samples were collected from each individual species for examination. The colour and average length of the hairs were noted. Guard hairs were selected because they give the most characteristic and distinct scale patterns and cross section shapes among different mammals (Kondo 2000; Keogh 1979), and because these are the hair types presented by other researchers (e.g. Williams 1938; Stoves 1942; Mayer 1952; Stains 1958; Keogh 1983; Teerink 2003; Backwell et al. 2009), hence a need to standardize for comparative purposes. Additionally, guard hair is much more regular in shape and easier to work with than fine underhair (Homan and Genoways 1978). Prior to examination, the organic and inorganic dirt from the surface of the hair samples was removed by ultrasonically cleaning with a mixture of absolute alcohol and sulphuric ether in equal proportions. The hairs were washed in distilled water for three minutes and then air dried on a clean watch glass. To obtain cross sections, the hair samples were cut perpendicularly using a fine surgical blade. Finally, the hairs were mounted on stubs with double-sided sticky tabs, sputter-coated with gold and examined using an FEI Quanta 400 E scanning electron microscope at magnifications between 705 and 2272 times

RESULTS AND DISCUSSION

Scanning electron micrographs and descriptions of southern African Blue wildebeest, Black wildebeest and Red rock hare hair are shown in Figure 1 and 2 below. Blue wildebeest hair is slate gray to dark brown in colour and is 35 ± 4 mm in length. In cross section, it is concavo-convex (Fig. 1a). The cortex is thick and the medulla is small to medium in size. Scale position is transversal and scale pattern is irregular waved mosaic. The scale margins are generally smooth to slightly rippled and the distance between scales is near (Fig. 1b). Black wildebeest hair is light brown to black in colour and is also about 35 ± 5 mm in length. In cross section, Black wildebeest hair is circular and the cortex is thick with no distinct medulla (Fig. 1c). The scale position is transversal and the pattern is irregular waved (Fig. 1d). Scale margins are moderately rippled and the distance between scales is near. Red rock hare is very soft, light in colour and approximately 20 ± 5 mm in length. The hair cross section is dumb-bell shaped and the medulla usually contains ten large cavities (Fig. 2a) and occasionally more (Fig. 2b). There is a broad, deep groove along the length of the hair. Both sides of the groove show a coronal scale pattern (Fig. 2c). The distance between scales is near and the scale margins are smooth.

Scanning electron microscopy revealed that Black wildebeest hair cross section is entirely circular, a result not in agreement with De Boom and Dreyer (1953), who sampled wildebeest hair from the Transvaal region of South Africa, and reported concavo-convex cross sections for Black wildebeest. This could be due to variability within species, or geographical differences in sampling. Sahajpal et al. (2009) report that high altitude bovids in India have kinks in their hair cross section shape and a peculiar brittleness that is in contrast to bovids from plains and peninsular parts. The range of Black wildebeest in historical times has been limited to the central inland plateau of South Africa, specifically in the Free State, the southern Transvaal and in the foothills of the Drakensburg range (von Richter 1974). De Boom and Dreyer (1953) did not specify the location in the Transvaal where they collected their samples, and it may have been from a mountainous region. Even though hair samples investigated in this study were from a museum, we confirmed that they did not originate from a mountainous region. Furthermore, De Boom and Dreyer’s pioneering work entailed the use of gelatin impressions, which, relative to scanning electron microscopy, produced poor

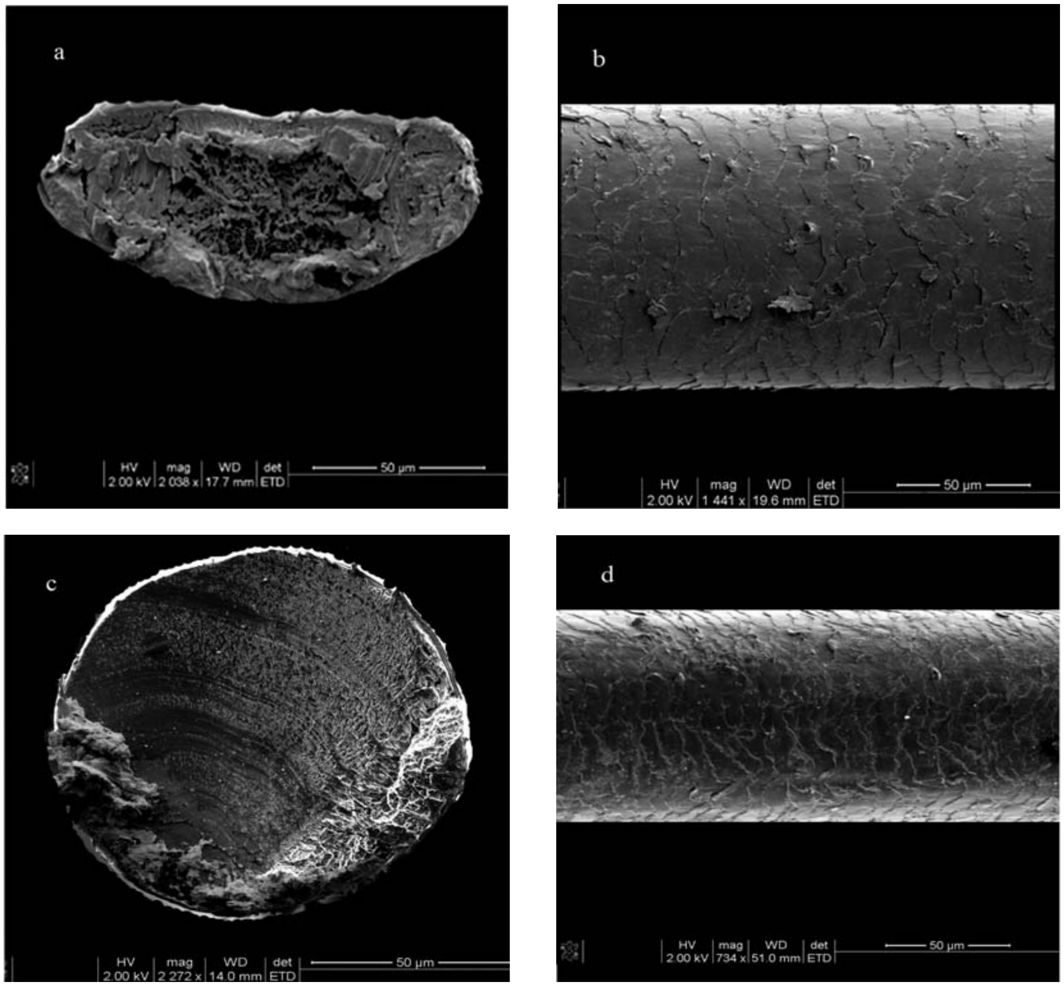

Fig. 1. Blue wildebeest (*Connochaetes taurinus*) hair cross section (a) and scale pattern (b); Black wildebeest (*Connochaetes gnou*) hair cross section (c) and scale pattern (d), scales = 50 µm.

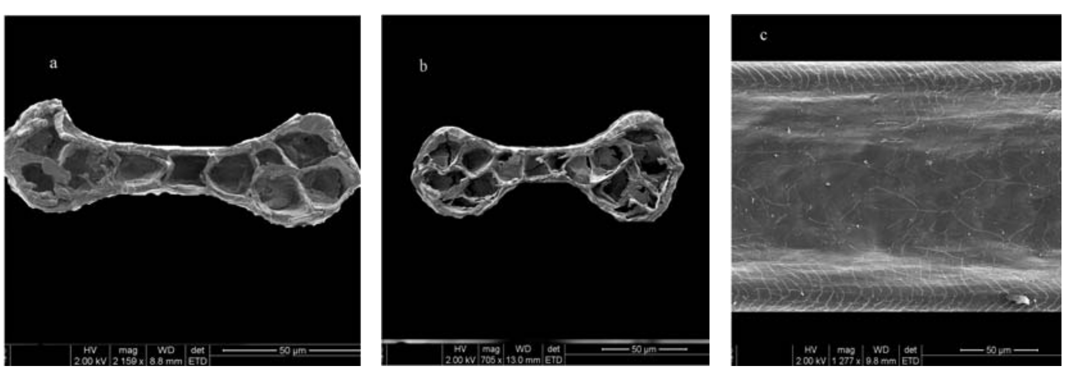

Fig. 2. Red rock hare (*Pronolagus crassicaudatus*) hair cross section containing ten large cavities (a) and cross section containing more than ten cavities (b); Red rock hare hair scale pattern (c), scales = 50 µm.

photographic reproductions, which motivated the current research on the Black wildebeest. On a similar note, Red rock hare hair scales were found to be roughly 'V' shaped with definite crests and pattern (chevron) in samples collected from Udzungwa Mountains, Tanzania (Brown 2009).

CONCLUSION

This research highlights the importance of microscopic hair characteristics in many fields of research. Future research should focus on expanding the taxonomic representation of hair samples from endangered modern southern African mammals which are often poached and encountered in illegal trade, documenting the effects of preparation, as well as the storage of hair on cuticular scale pattern preservation. Such research should provide examples of different types of hair from different sites on the body, as well as from young and old individuals and consider geographical differences in sampling. It is our hope that the presentation of this data will assist in other fields of research and stimulate further inquiry.

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