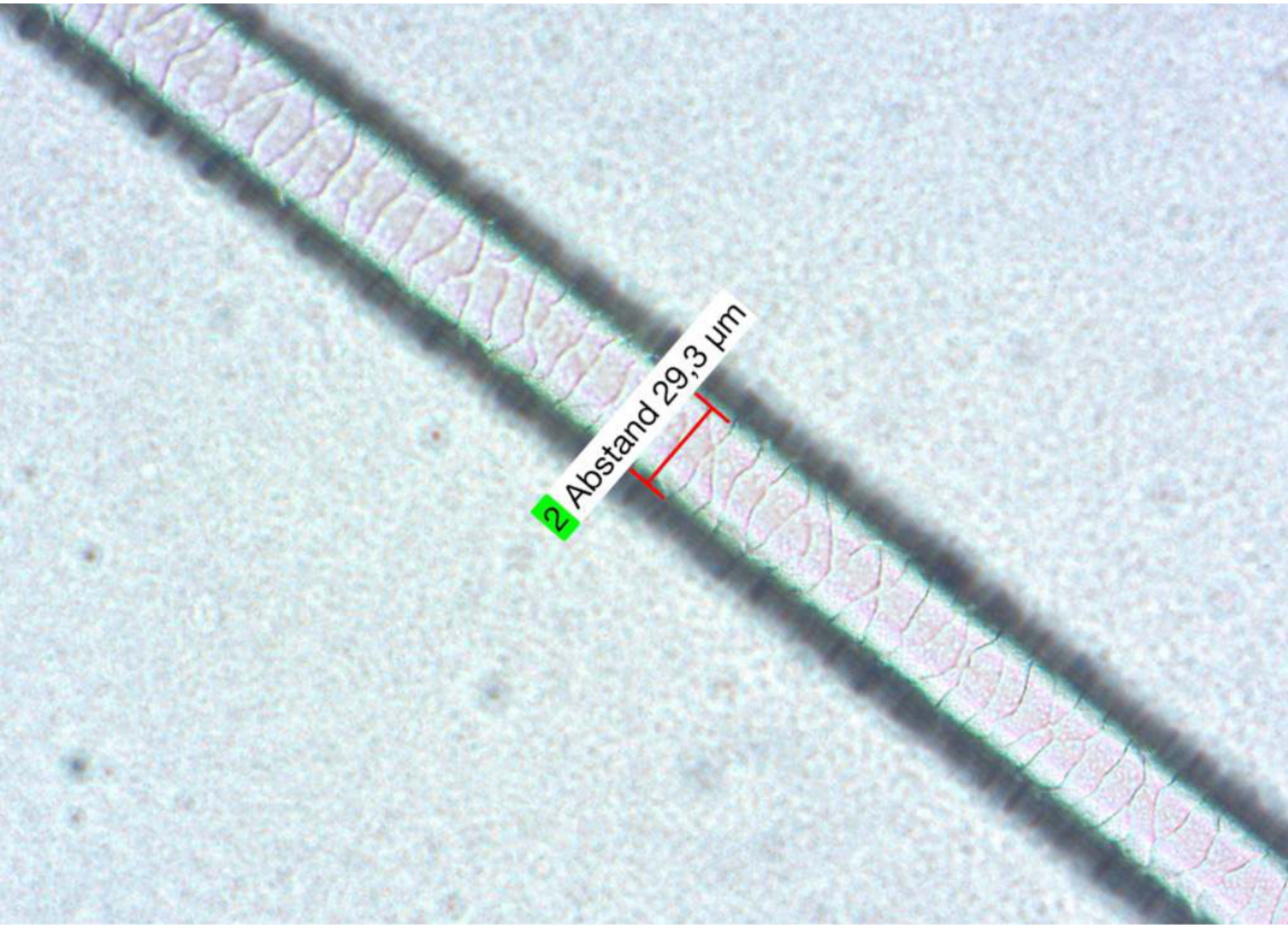

Forensic Animal Hair Analysis

ZEISS Light Microscope

Forensic Animal Hair Analysis

ZEISS Light Microscope

Authors: Dr. Ulrike Schacker, Martin Schatzl
Galantos Genetics GmbH, Germany

Dr. Werner Hecht
Institut für Veterinärpathologie *Giessen, Germany*

Dr. Thorsten Kern, Dr. Michael Gögler, Anke Koenen
Carl Zeiss Microscopy GmbH, Germany

Date: January 2018

Both human and animal hair play a crucial role in the investigation of criminal offenses. In most cases, identifying and differentiating between human and animal hair is relatively straightforward on account of their specific characteristics. Under certain circumstances, however, carrying out a light microscopic analysis of individual structures such as the medulla, pigmentation type, and cuticle structure may be necessary to distinguish between different species.

Introduction

Hair is one of the most common biological fibers. Its analysis can play an important role when investigating theft, in accidents involving wild animals within the scope of settling insurance claims, when investigating customs violations / poaching, and when solving criminal offenses such as murder, among other cases. Depending on the type, number, and condition of the hair samples, different methods of forensic hair analysis are used. The questions that need to be answered include: Is it really a hair or a plant or textile fiber? If it is a hair, is it human hair or animal hair? What part of the body is the hair from? Has the hair been torn out, cut off, squashed, or scorched?

Hair

Every species of mammal has hair with distinctive features such as length, color, root structure, and specific morphological characteristics (Figure 1).

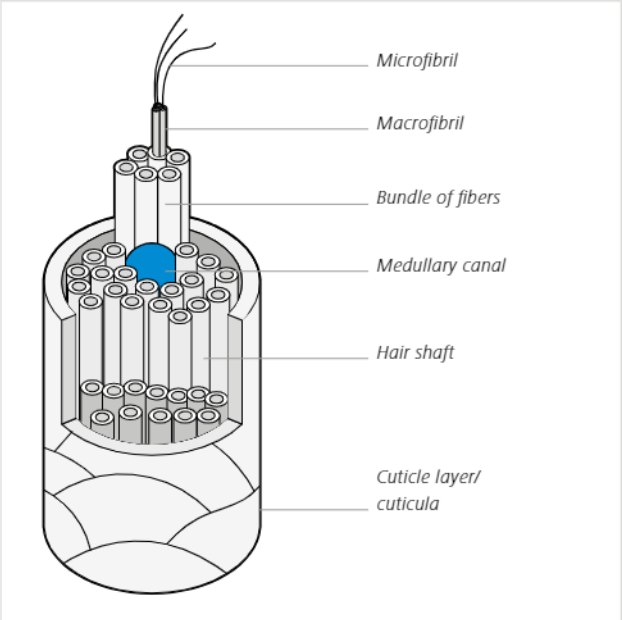

Figure 1 *Basic structure of a hair*

Hair (lat. pili) is a protein filament (Figure 2) primarily composed of keratin and found in all mammals. A hair consists of the hair follicle and the hair shaft. The hair shaft is made up of the medulla, cortex, and cuticle (Figure 1). The cuticle is the outer scaly layer formed from keratinized, dead cells.

The cortex refers to the main fiber of the hair, which is composed of fiber bundles, which in turn are composed of the finest subfibers, the fibrils. The medulla is the inner layer, which can also form cavities.

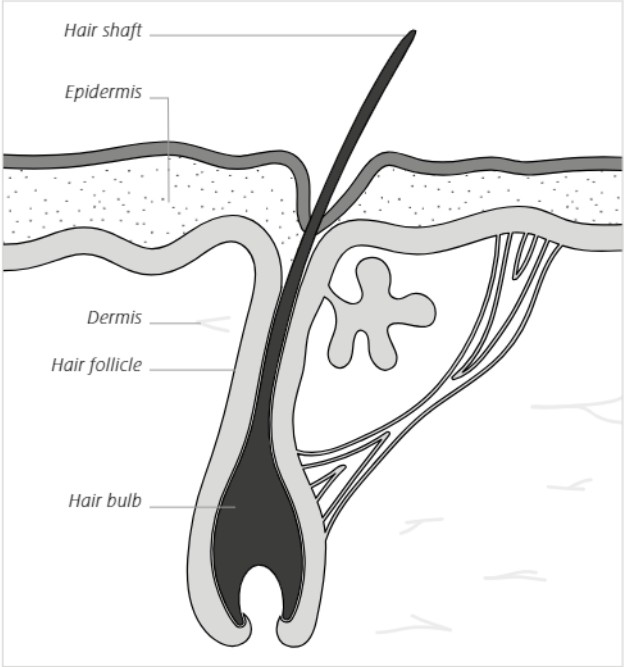

Figure 2 *Schematic cross section of a hair*

Wild Animal Hair under the Microscope

Hair is an extensive source of information when viewed under a light microscope, as light can penetrate the aforementioned structures and carry the information back to our eyes. Every species of mammal has hair with distinctive features such as length, color, root structure, and specific morphological characteristics, and these can be used to determine the species and genus of the mammal. Mammalian hair is usually referred to as fur and is divided into guard hairs (lat. capilli), awn hairs (lat. setae), wool hairs (lat. pili lanei), and long hairs. Many mammals have vibrissae (tactile hair) [1]. Here, the nerve endings around the hair root (follicle) act as sensors. Hair from different parts of the body of the same individual can exhibit considerable variability. The structure of the medulla and cuticle of the hair is highly specific to the species. It therefore also makes it possible to reliably distinguish between humans and animals. The criteria used to accurately determine the species include the structure of the medulla cells, medulla thickness, medullary rays, number of medullary cell layers, and the ratio of the thickness of the medulla to the cortex. In addition, you can also analyze the content and distribution of the pigments and the surface profile of the cuticle cells. A microscopic analysis of the hair follicle makes it possible to determine both the growth phase and to distinguish between a hair that has been torn out versus one that has fallen out. Classical microscopy therefore makes it possible to determine a mammal's species, race, hair type, and hair status [2].
The type, number, and condition of the recovered hairs significantly impact their value as evidence for forensic examination with a light microscope.

The typical, accident-related animal classes are part of the routine examination in most laboratories, since, for example, insurance coverage is often dependent on the type animal that caused the accident. For microscopic observation, the hair is mounted on a microscope slide [3]. Typical magnifications are 10×, 20×, and 40×. In rare cases, a 100× oil lens is also used. Sometimes pigmentation requires the medulla to be specially prepared. Good results are achieved with glycerine as the mounting medium.

Case Study: Synthetic Fiber or Natural Fur

Morphological hair analysis is, to a certain extent, a suitable method of identifying species. Areas of application include, for example, accidents involving wild animals, in which it may be necessary to determine whether game animals were involved. The analysis of fur appliqué on clothing to determine whether it is of animal origin is also of significance, especially if such appliqué is declared to be fake fur. In such cases, clarity can be achieved by conducting a suitable examination. The first step is to check whether the hair is animal hair. This can be achieved by checking for the presence of the cuticle structure typical of animal hair using the impression method. If the result is positive, an additional analysis of the medulla and possibly the hair cross section can be used to determine the species or at least a group of species. The results of the purely microscopic examination in a case of artificial-fur declaration can be seen in Figures 3 to 6. By comparing it with appropriate reference material, the results in this case were: 1. animal hair and 2. hair of a leporid (an animal of the family Leporidae, comprising the rabbits and hares). In other words, this was a clear case of falsely declared fur. In order to definitively identify the species, a DNA test was also performed. This showed that the hair was that of a European rabbit (Oryctolagus cuniculus). Even if a DNA test is ultimately conducted, light microscopic morphological analysis should still be carried out, as it allows a statement to be made even if the DNA test fails. This would no longer be possible after lysis and extraction of the hair.

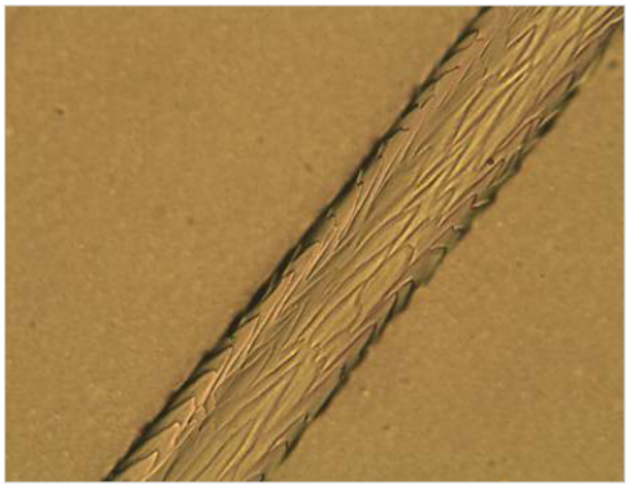

Figure 3 Cuticula medial – *proximal*

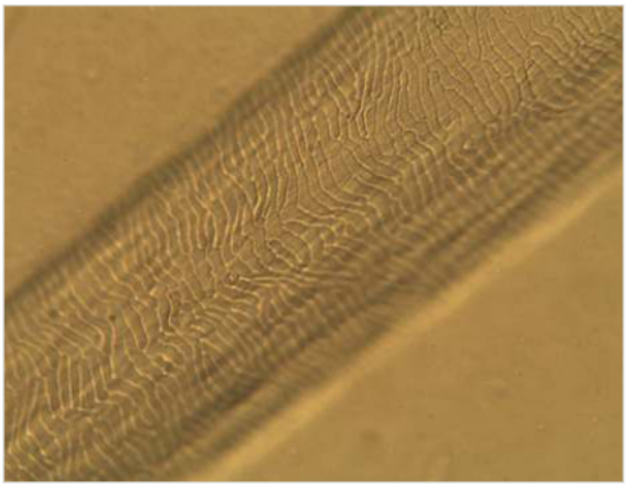

Figure 4 Cuticula medial – *proximal*

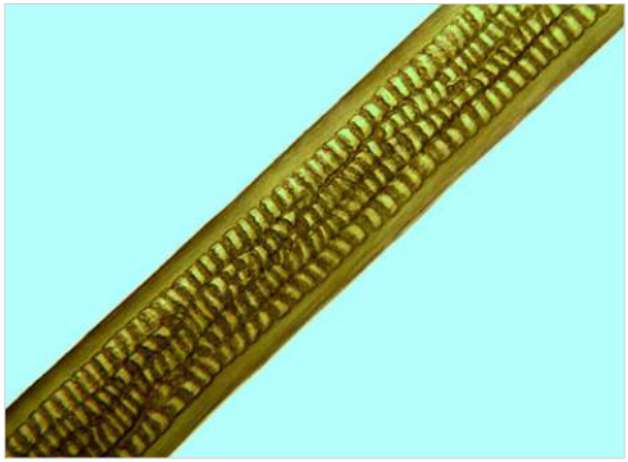

Figure 5 Cuticula medial – *proximal*

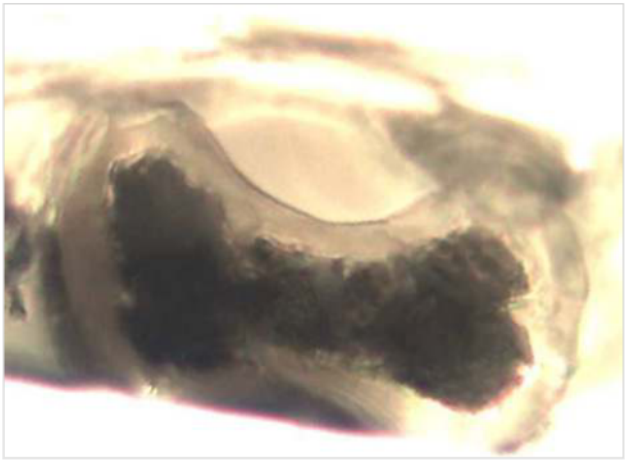

Figure 6 Cuticula medial – *proximal*

Recommended Microscope Equipment

The light microscopes ZEISS Axio Lab.A1 and ZEISS Axio Scope.A1 are upright microscopes suitable for use in laboratories that conduct such analyses. Since it is important to observe the fine structures of the cuticle, both fast and wide-aperture optics are beneficial. The condenser should also be selected to allow the use of darkfield as well as brightfield, such as the ZEISS achromatic – aplanatic condenser with an aperture of 0.9 (H D Ph DIC). For documentation purposes, a microscope camera should be selected that precisely displays the finely resolved structures. A simple, precise image documentation system, such as ZEISS Labscope, can be operated using a standard tablet (iPad) or a Windows PC.

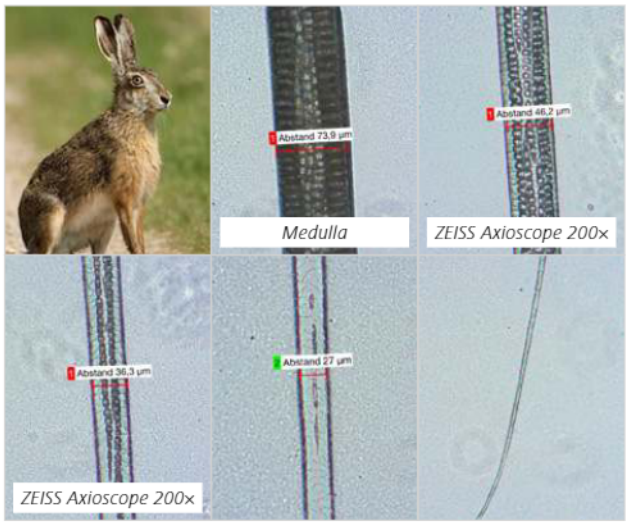

Figure 7 *European hare* (Lepus europaeus)

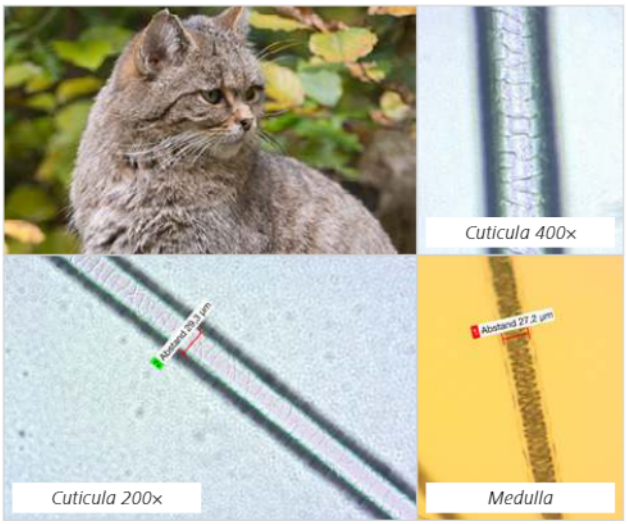

Figure 8 *Wildcat* (Felis silvestris)

Figure 9 *Iltis* (Mustela putorius)

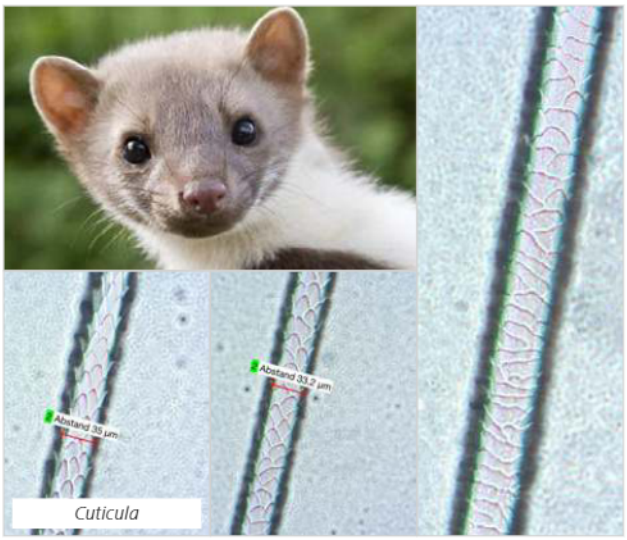

Figure 10 *Mustelid* (Mustelidae)

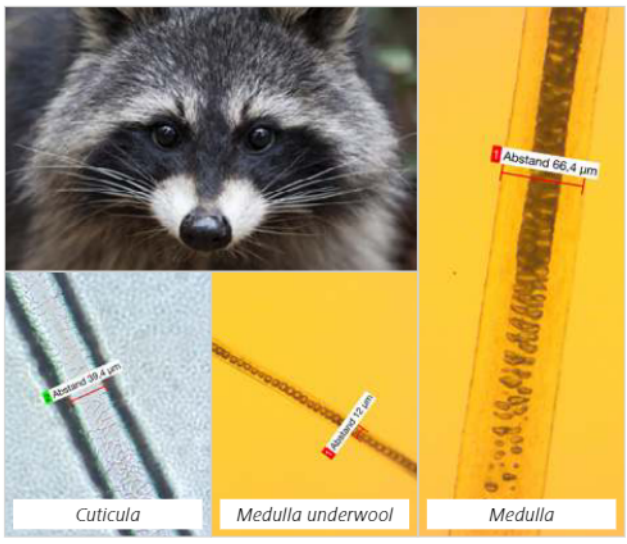

Figure 11 *Raccoon* (Procyon lotor)

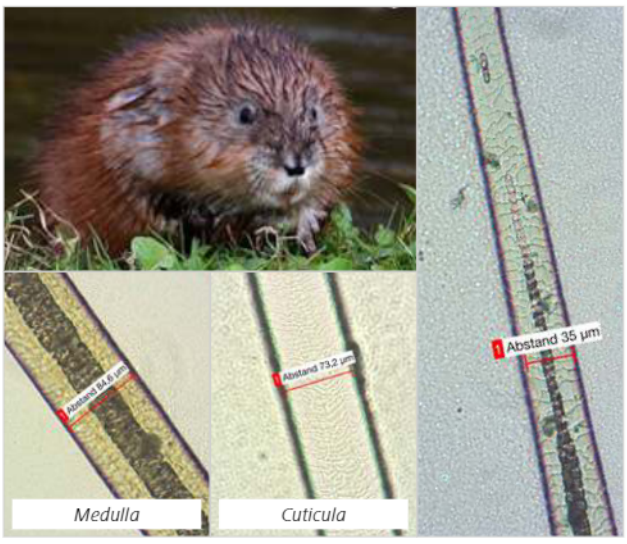

Figure 12 *Muskrat* (Ondatra zibethicus)

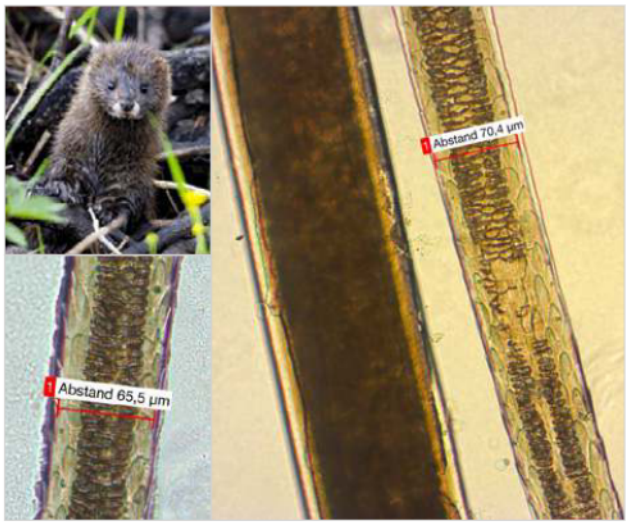

Figure 13 *European mink* (Mustela lutreola)

Figure 14 *Deer* (Cervidae)

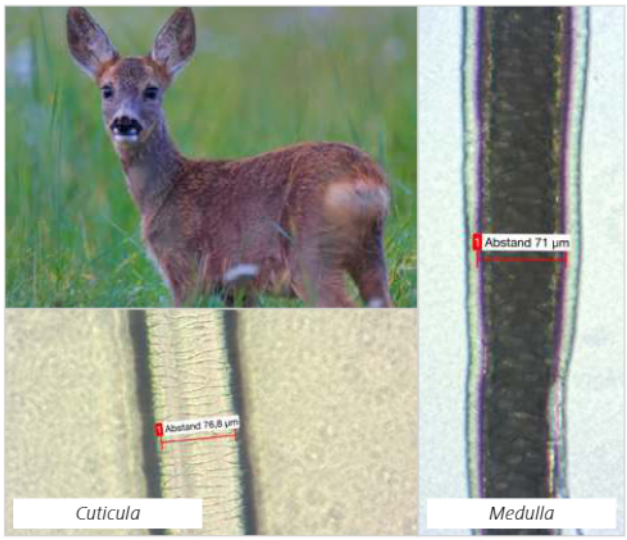

Figure 15 *European roe deer* (Capreolus)

Figure 16 *Horse*

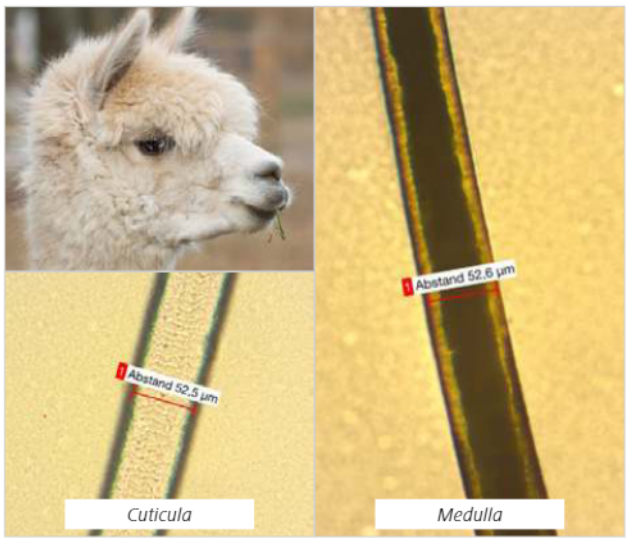

Figure 17 *Alpaca* (Vicunia pacos)

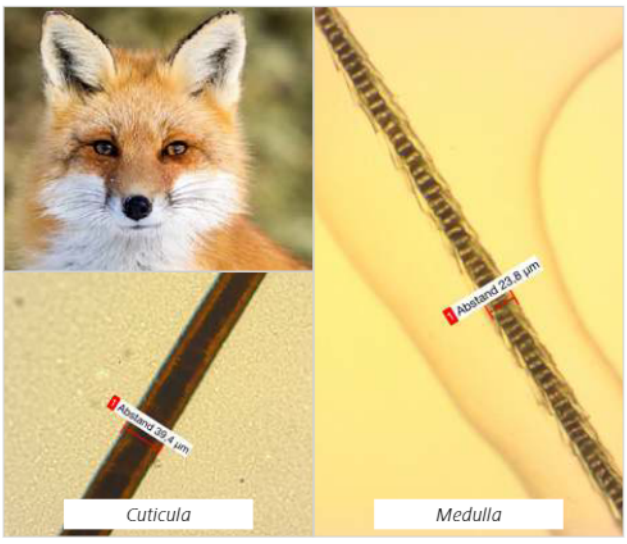

Figure 18 *Red fox* (Vulpes vulpes)

Figure 19 *Cattle* (Bos taurus)

Figure 20 *Dog* (Canis lupus)

Figure 21 *Wild boar*

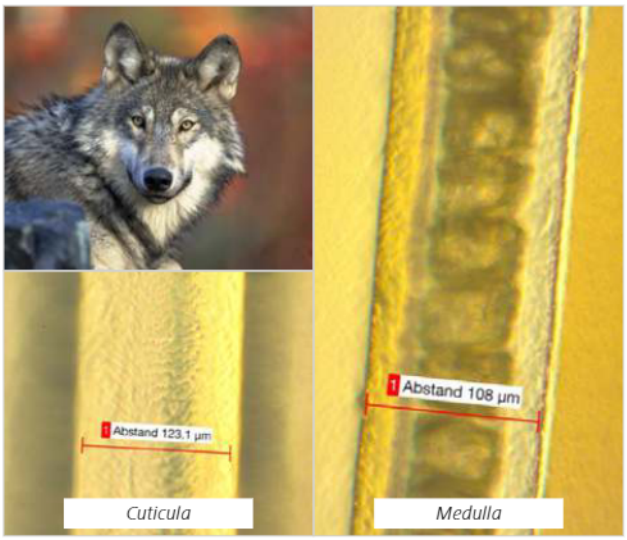

Figure 22 *Gray wolf* (Canis lupus)

References:

[1] https://en.wikipedia.org/wiki/Fur#Composition

[2] https://de.wikipedia.org/wiki/Animal_Forensics#Haare

[3] B.J. Teerink; "Hair of Westeuropean Mammals"; Cambridge University Press; ISBN: 0-521-54577-3

Samples:

Courtesy of:

Mr. Immo Ortlepp, professional hunter, Negenborn

Ms. Gudrun Westermann-Hoyer, Brelingen, Wiesbaden Pheasantry, Dörverden Wolf Center

Carl Zeiss Microscopy GmbH
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/axiolab