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THE MICROSCOPE PAST: 40 YEARS AGO

The Simple Scheme for the Individualization of Human Hair[1]

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ABSTRACT

A major problem in police laboratories, and criminalistics generally, is the individualization of human hairs found at crime scenes. If possible, this would be a great aid in establishing guilt or innocence of suspects. An easily measured characteristic of human hair is the shape and size of cortical scales. A simple procedure for preparing a replica of the hair surface, for observation of the scales and for sizing scales is presented.

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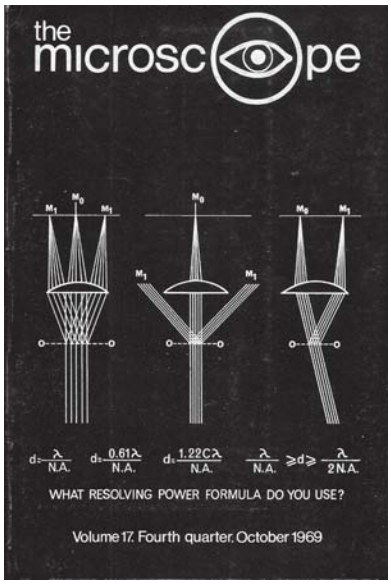
Dr. P.L. Kirk (1) originally suggested that I try to devise a method of classification of human hair from a criminal suspect or other person. It would be of great value in ciminalistics if a definite, yet simple, method could be developed enabling a relatively inexperienced person to characterize a hair in terms of individual origin. This ideal can probably not be achieved; however, the following scheme is simple and requires very little equipment in addition to a microscope, and does give a quantitative characteristic.

It is not expected that the method will definitely identify a person but it is of some help in matching a hair to that of a suspect and frequently in eliminating the individual in question.

The method is based on the following observations: 1) color, 2) medulla, 3) size, 4) shape of scales, 5) scale edges, and 6) scale count.



COLOR

Although there are many colors and shades of hair, it was thought best to limit it to five colors: black, brown, blonde, red and gray. This is about all an experienced individual could hope to distinguish with only one or two strands of hair. And, even here, there would be much overlapping since shades blend into each other. It is also quite possible to have both a gray hair and a pigmented hair from the same individual.

MEDULLA

The presence or absence of the medulla, or core or a hair, can best be observed microscopically at about 100x with the hair mounted in immersion oil. The refractive index of the oil is not crucial; 1·50 ± 0·02 or 1·60 ± 0.02 would be suitable. Figure 1 shows a human hair, with a solid medulla; Figure 2 shows the more often observed intermittent medulla.

[1] Presented at Inter/Micro-69, September 9-11, 1969, Imperial College, London, England. Originally published in *The Microscope*, Vol. 17 (4), October 1969.

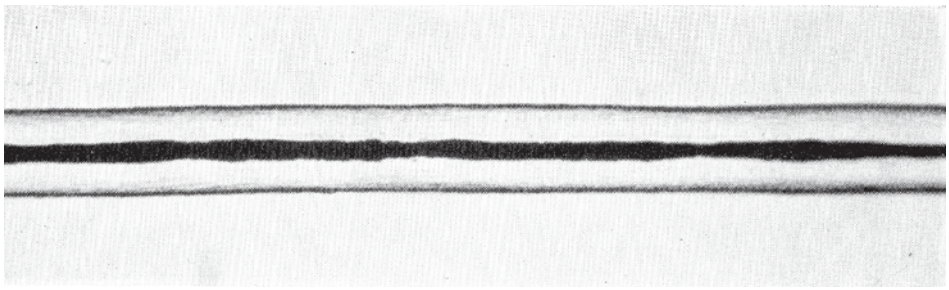


Figure 1. A human hair with solid medulla.

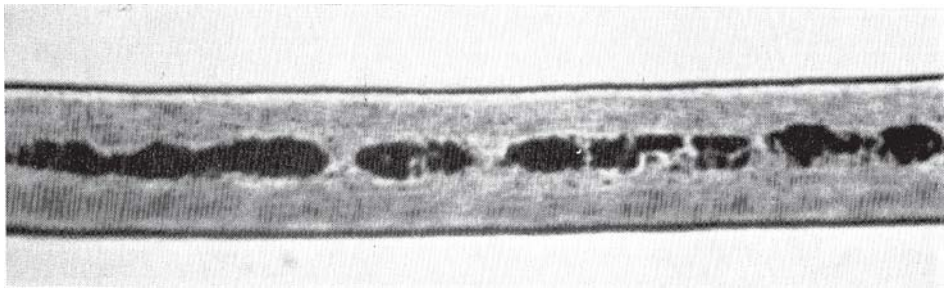


Figure 2. A human hair with intermittent medulla.

DIAMETER

The diameter of human hair varies widely even on the same individual and even along the same hair. Hair is usually smaller towards the outer end but some may also be larger, probably due to the kind and amount of hair dressing used. Probably the best that can be expected is to classify an individual hair as being large or small, the dividing line being about 90 μm. The hairs in Figure 1 were both about 65 μm in diameter. A calibrated ocular micrometer may be used to measure diameters.

SHAPE OF SCALES

The best way to observe the scales of a hair is by making a cast of the hair. The method described by Kirk, Magagnose and Salisbury (2) works well. I have modified this somewhat by using a plastic cover slip. These can be obtained from most laboratory supply houses. The method is simple. Place a plastic cover slip on a microscope slide, lay the hair or hairs on the slip and place another slide on top. Hold the slides together with about four spring clothes pins.

This assembly is then placed in a drying oven at 100 ºC for about an hour. The heat will soften the plastic so the hairs will be partly imbedded. The hair is now removed, leaving a cast of the hair scales in the plastic. If left too long the hairs will sink too deep and may be hard to remove without leaving a jagged edge. Some experimentation may be necessary to determine the best conditions. The hair scale replica can now be observed without difficulty, using a 40x objective and 10x ocular with transmitted light. The replica is observed dry and, for best resolution, replica side up and covered with a second cover glass.

It is not easy to describe exactly the shape of hair scales. Kirk (3) gives a schematic representation of types of hair scales. There is again a gradual change from one shape to another, and I have found it difficult to describe by words the difference. Figure 4 is perhaps close to the average shape for human hair. Figure 3 shows a flattened scale while Figure 5 is of an elongated or more oval shape. Rather than trying to describe the shape, it is better to make photomicrographs of several areas of the hair scales and compare them side by side, or by direct comparison of the scale of a suspect's hair and a hair of known origin.

SCALE EDGES

The edges of the scale also help to describe a hair. The edges may be ragged as in Figure 6 and 8 or comparatively smooth as in Figures 4 and 7.

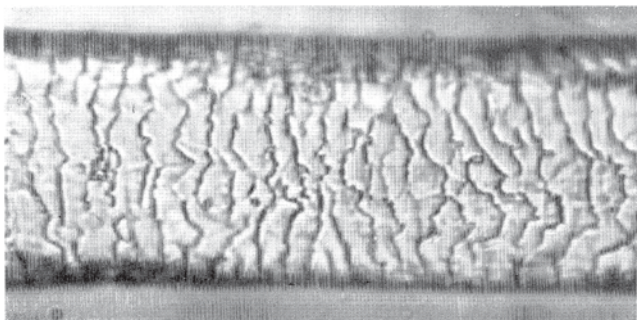


Figure 3. Flattened cortical scales.

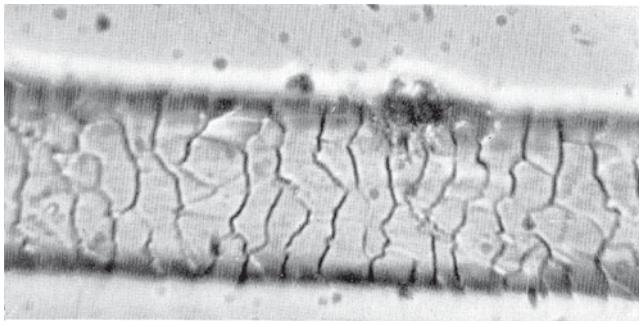


Figure 4. Cortical scales of average shape.

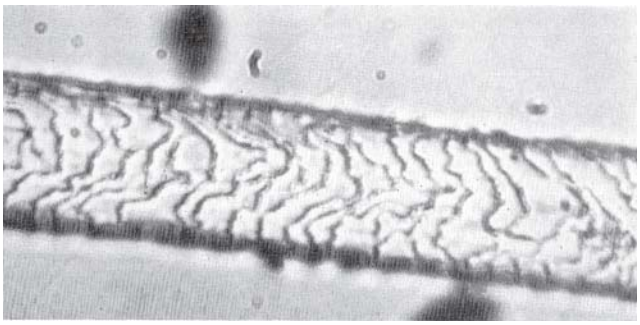


Figure 5. Elongated or oval cortical scales.

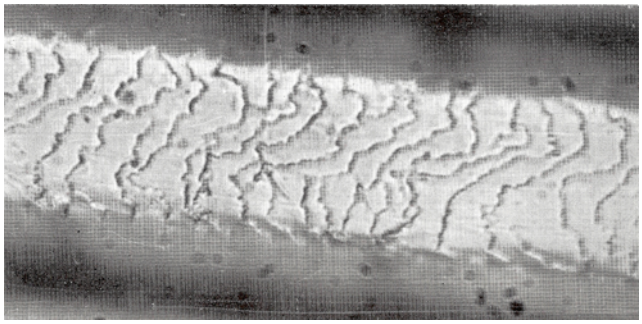


Figure 6. Ragged edges on cortical scales.

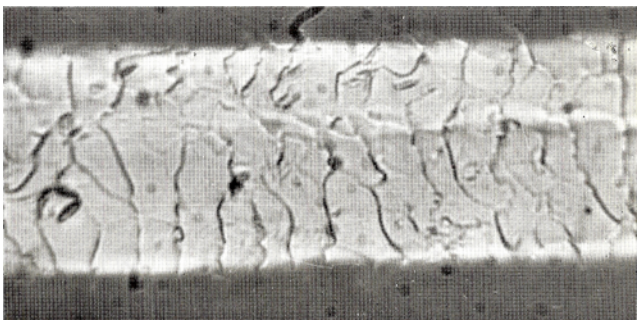


Figure 7. Smooth edges on cortical scales.

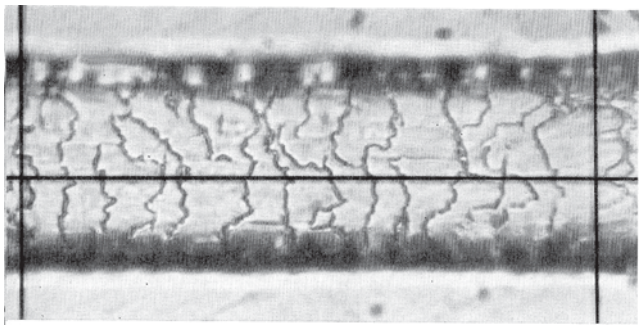


Figure 8. Reticle lines superimposed on hair; the scale count is 15 x 6·7=101 (per mm).

SCALE COUNT

The scale count, that is the number per unit length of a hair, is another useful parameter for comparison of hair samples. An advantage of the scale count is the definite numerical figure that can be recorded and compared with another hair or with a value obtained by another technician.

The most convenient method I have found is to use a reticle in the ocular that has one long line and two cross lines (4). The long line is placed lengthwise and close to the center of the hair. The scale boundaries crossing the long line are counted in the space between the cross lines. Figure 8 shows the reticle lines and how they are used. Comparisons between different hairs can be obtained simply by comparing the boundary counts between the cross lines at a definite magnification or, better, they can be recalculated as scale boundaries/mm. To do this it is necessary to know the distance between the cross lines on the object slide. This can be measured with a stage micrometer. In Fig-

ure 8 the distance between the cross lines is equivalent to 0·15 mm.

The scale count of human hair varies from about 80 to 200/mm. Statistically, the scale count is quite constant for different hairs from the same person or from a different distance from the root on the same length of hair. To get reliable results, at least 25 counts should be made along the same hair and an average taken. It is not to be inferred that a scale count gives a figure that is definite and always reliable; there will be some variation but it is an excellent and simple method for the characterization of hair.

There are several more sophisticated and accurate methods that can be used for hair identification but they require more elaborate apparatus and personnel who are trained in their use. The methods described here are relatively simple and satisfactory for preliminary work and are frequently all that is necessary to show that the hair in question is not that of the suspect. It is far more difficult, if not impossible, to conclude that two hairs come from the same person.

REFERENCES

1. Dr. P.L. Kirk, Professor Emeritus of Criminalistics, University of California, Berkeley, California, USA.

2. *Journal of Criminal Law and Criminology of Northwestern University*, **40**, No. 2. July-August, 1949.

3. *Crime Investigation*, Interscience Publishers, Inc., 250 Fifth Avenue, New York, NY, USA.

4. Suitable reticles can be obtained from Edmund Scientific Company, Barrington New Jersey; Microsale Ltd., Box 3366, Chula Vista, California 92011; Technical Instrument Company, San Francisco. Of course, an ordinary ocular micrometer may also be used.