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P. L. Kirk

Stanley Magagnose

Doris Salisbury

CASTING OF HAIRS—ITS TECHNIQUE AND APPLICATION TO SPECIES AND PERSONAL IDENTIFICATION*

P. L. Kirk, Stanley Magagnose, and Doris Salisbury

P. L. Kirk, Professor of Biochemistry, University of California Medical School, has engaged in extensive research in the techniques of hair identification and differentiation. Several of his papers on these studies have appeared in this Journal. In this present article Professor Kirk and associates describe a simple method for casting hairs which may well lead to further criteria in differentiating between hair specimens.

Stanley Magagnose is a graduate of the University of California and was a student in micro-chemistry.

Doris Salisbury is a graduate in the Technical Criminology program offered at the University of California.—EDITOR.

Numerous investigators have pointed out the wide variety of structures found in the cuticular layer of the hairs of different animals. Some attention has also been given to this matter in connection with the individualization of hair in personal identification. The biggest difficulty perhaps in studying the cuticular structure, and the shapes and sizes of hair scales, is due to the interference of pigmentary granules within the hair shaft which makes difficult the observation of the exact scale picture in some species and in fact at times obscures the scale structure completely. Moreover, the hair, in order to be studied, must usually be mounted in the dry state in order to see the surface, and when this is done the optical difficulties that arise from refraction and diffraction of light by the hair are such as to obscure still further the scale picture.

It has become for this reason not uncommon for some investigators of hair to prepare casts of the hair, usually by the technique of placing the hair in a partially hardened layer of collodion or nail polish, spread on a glass slide. After complete hardening the hair is stripped away leaving a negative cast, which being clear, can be studied without interference from the interior hair structures. This technique, while valuable, has many points of difficulty. The spreading of the collodion on the slide must be done precisely or poor results will be obtained, and the amount of drying must be controlled quite closely in the determination of the time at which to place the hair in the collodion. Furthermore, the cast once made is subject to damage, and is often not a very satisfactory reproduction. Experience with the technique has shown that one must be highly familiar with it, and even under these circumstances uniformly good results cannot always be obtained.

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It is a matter of record that animal hairs have been studied by means of impressing them into a somewhat softened thermoplastic (1) in order to produce in the plastic a negative replica of the hair surface. This technique properly developed would seem to offer very great advantage as compared with the collodion technique for casting of hairs. It does not appear from the literature in the field of criminal investigation that any attention has been given to this method, and it is proposed here to describe a procedure which is both simple and relatively certain in its results, requiring little time, and no particular experience to carry out efficiently. The results of casting with this procedure using various species of hair and with various human hairs of different individual origin has shown that much greater value can perhaps be obtained by the use of the casting method than has been true in the past, in spite of the many very fine studies that have been made on the nature of the cuticular layer of hair of different species.

Experimental

The plastic sheet, one of the best of which is "Vinylite," or some other type of thermoplastic sheet such as "Lucite," is obtained in a thickness of $\frac{1}{16}$ inch, which is about the same as the standard microscope slide. It is cut with a bandsaw to the standard 1 by 3 inch size of the microscope slide, giving a thermoplastic slide which can be readily filed in the ordinary slide box, handled by the mechanical stage, and treated as though it were a glass microscope slide.

If the hairs to be cast are as long or longer than 3 inches, that is, the length of a standard microscope slide, the procedure for casting is extremely simple. The hairs are first washed thoroughly with acetone and dried. The process of casting consists simply in laying the hairs lengthwise on a glass slide and fixing them to it at the ends with a thin strip of scotch tape. This will allow full length to be stretched on the slide with as many hairs as convenient. On top of the glass slide on which the hairs are mounted, is placed a "Vinylite," or other thermoplastic slide, and another glass slide on top of this to provide uniform distribution of weight. The sandwich containing the hairs is placed on a small thermostatically controlled, electric hotplate. The temperature is turned to about 100° C. depending somewhat on the size of hair and the type of plastic. With "Vinylite," 100°C is sufficiently hot for all except a few very large hairs in which case it may be necessary to raise the temperature to about 110 or 120°. On top of the slides is placed a

load, preferably a block of lead, which weighs some 5 or more pounds. The slides are allowed to warm for periods of 5 to 10 minutes, again depending on the type of plastic and the thickness of the hair. At the end of this time the slides are cooled and taken apart, and the hair is removed entirely undamaged by the process and available for further mounting or study of any type desired. On the plastic slide there should be a perfect replica of each of the hairs throughout their entire length and all on exactly the same level so that microscopic study may be made throughout the 3 inch length without any appreciable alteration of the focus of the microscope. Furthermore, the slide may have scratched on it a code identification number or symbol, and be filed in the slide box along with any other standard mountings of the same hair or species of hair. If it is desired to cast the entire periphery of the hair, it is only necessary to use 2 plastic slides instead of a glass slide and a plastic slide, and it will be found that a complete cast will result surrounding the entire hair.

When the hairs are shorter than 3 inches, as is usually the case, a modification of the method of setting up the mount is desirable. If they are very short, about the only simple method of handling them is to lay them on the slide and arrange them in an appropriate position under magnification. If however they are as much as an inch or more in length, it becomes relatively simple to make a nice appearing mount, or cast, in which the hairs are all arranged in parallel formation and in good shape for microscopic study. The procedure is as follows: A glass microscope slide is cut to a length somewhat less than that of the hair and is placed on the top of another slide of full size. Past the end of the broken slide at each end is placed a piece of scotch tape which is folded in such a way that the sticky side is on the outside, both top and bottom. The end of the hair is first attached to one of these scotch tape strips, stretched across the intervening short glass slide, and attached to the scotch tape at the other side which holds the hair firmly in a straight position. As many hairs as desired are mounted parallel to each other and are covered by the plastic slide as before, and placed on the hot plate. It will be necessary at times to increase slightly the time of heating when two glass slides are used. At the end of the casting period the cast will appear as a series of parallel indentations in the plastic in the center portion of the plastic slide only. This allows again exceptionally easy microscopic examination for the same reasons as given for long hairs.

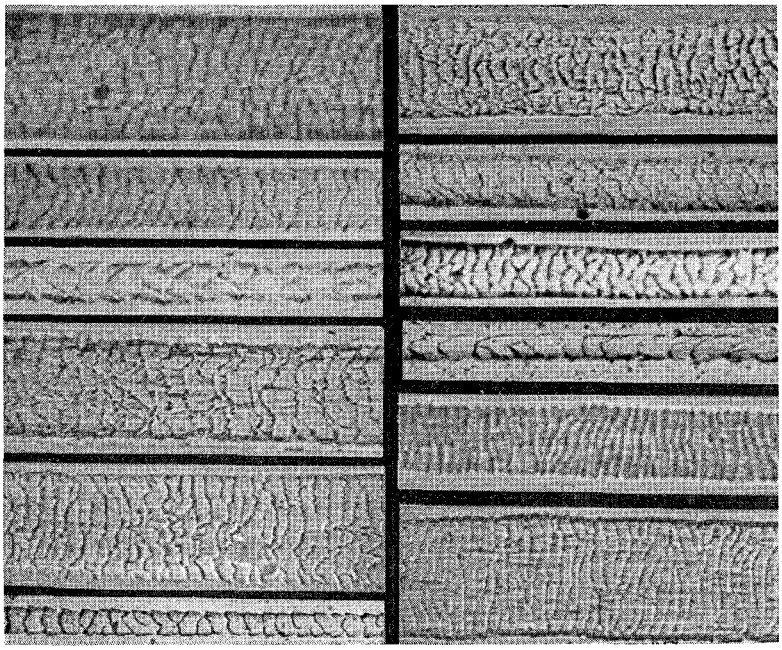

Figure 1
Magnification 150X

1. Cow
2. Cat, mongrel, black
3. Cat, mongrel, yellow-striped
4. Horse, American thoroughbred
5. Squirrel, tree
6. Bat
7. Goat
8. Dog, English Springer Spaniel
9. Dog, Boxer
10. Mouse, Harvest (root-end)
11. Rat, Kangaroo
12. Squirrel, ground

Since it is a matter of only a few minutes to make a cast of a considerable number of hairs, and in view of the ease of setting up multiple units on the same hot plate and casting them at the same time, it is highly profitable to make such casts routinely of all hairs that are to be examined. The cast being clear offers no disturbance or distortion of the optics of the system; they are all clearly visible; and the study of the hair scales can be profitable both in identifying the species of an animal hair and in the study of hair from the standpoint of individual origin if it is human. These points are illustrated briefly in Figures 1 and 2 that are presented herewith. Figure 1 is representations of the appearance of the hair scales of several common animal species in which the scales are quite different, and Figure 2 shows some of the variations found between individuals of the human race. It is simple enough to evaluate the role of hair scales in identifying species, but their use in individualization of hair has not been exploited to any extent as yet. Aside from the use of scale counts and similar studies of a quantitative

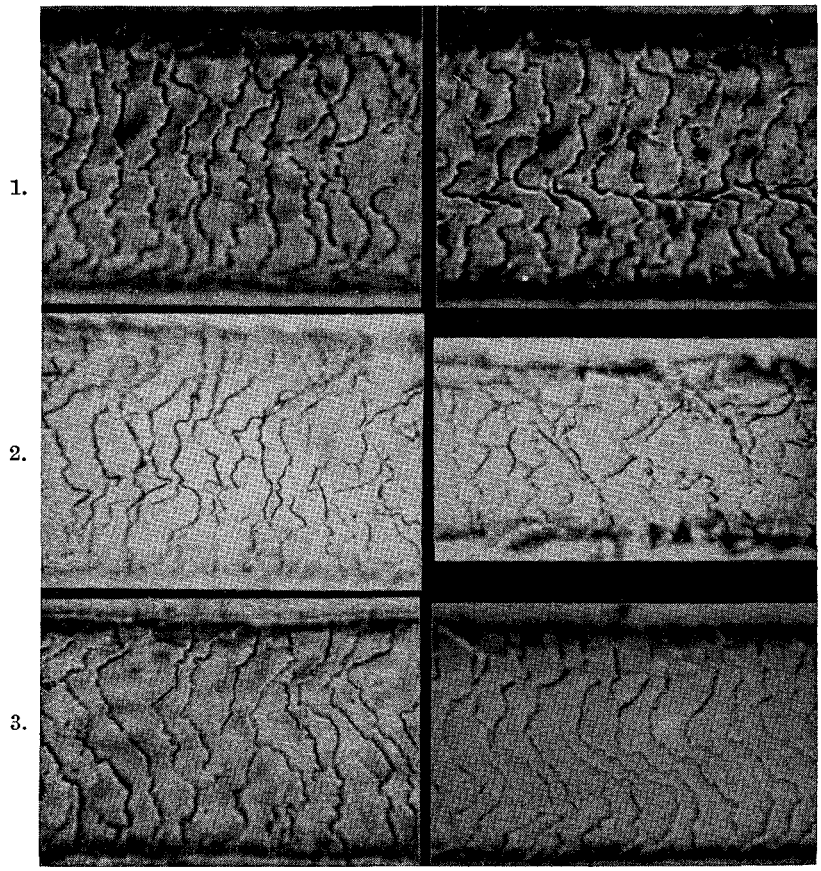

Figure 2.
Magnification 390X

1. and 1a. Human head hair, male, 13 years old. 2. and 2a. Human head hair, female, 23 years old. 3. Human head hair, male, 42 years old. 4. Human head hair, female, 2 years old.

nature, little has been done with the gross differences in the scale pattern and the appearance that it gives. Some preliminary studies have been made to determine reproducibility of the latter factors within different hairs from the same head and considerable difficulty has arisen in interpretating the results, but it is clear that the scale appearance is more similar between hairs of the same head than between different individuals. It is expected that such studies will eventually contribute much to the question of individualization of human crown hair.

The method of casting described is sufficiently simple to be applied to numerous materials other than hairs. Clearly, fibers and other rather minute objects of this type would be well reproduced by this casting procedure provided only they can

withstand the temperature of boiling water. The possibility of applying it to tool mark reproduction is obvious, but preliminary experiments do not indicate any advantages over older procedures. Other applications have not been studied, but in all probability some advantageous uses for plastic casting of this type will be found.

Summary.

A technique for casting of the surface structure of hairs and fibers by use of thermoplastic slides is described.

Some applications to the identification of species and individualization of human hairs are indicated.

Reference

1 Hardy, J. I. and Plitt, T. M., U. S. Dept. of Interior Wildlife Circular No. 7 (1940).