The Cuticle of Mammalian Hair

STUDIES in these laboratories have suggested that the arrangement of scales in the cuticles of mammalian hairs can be more accurately revealed by the examination of fibre sections, using ultra-violet light, than by the use of the electron microscope. This work has shown that the thickness of the cuticle of mammalian hair depends upon the arrangement of the component scales.

Thin transverse and longitudinal sections of human hair, hog bristle, alpaca and wool have been prepared at thicknesses varying from one to five microns. After staining some of the sections by the Champy-Kull method and others with indigo-carmin, they were examined under the phase-contrast microscope and the normal microscope, using the 3650 Å. line.

Thickness of cuticle, as can be seen in a longitudinal section of human hair (Fig. 1), depends upon the number of layers in the cuticle, these being formed by the amount each scale overlaps its neighbour. The cuticles of human hair, hog bristle and alpaca are comparatively thick. The whole cuticle can be seen quite clearly under the $\frac{1}{4}$ -in. objective, and individual scales which form the cuticle are clearly seen under the $\frac{1}{2}$ -in. objective. In human hair these scales are approximately 0.33 micron thick and approximately 30 microns in length; the latter measurement being taken from a point on the lower margin of the scale, which abuts on to the cortex, to a point on the upper margin of the scale which is on the surface of the fibre. (These measurements were made on photomicrographs of longitudinal sections of fibres.) Of this length, only about one-sixth forms the outer surface of the fibre, the remaining five-sixths being covered by the adjacent overlapping scale. The result of this is a scale pattern where the scale margins are relatively close together, as seen in human hair and hog bristle.

Longitudinal sections of Lincoln and Leicester wool fibres show that individual scales are approximately the same length as the scales in human hair but in some cases thicker, up to 0.66 micron. The proportion of longitudinal overlap is the reverse of human hair, namely, only approximately one-sixth of the total length is covered by another scale, and five-sixths of the length forms the outer surface of the fibre. It may be noted that both these types of wool fibres have a scale pattern with scale margins fairly widely spaced.

Both transverse and longitudinal sections of wool fibres show that the cuticle is much thinner than the cuticle of human hair, hog bristle or alpaca, due to a different arrangement of scales. In a wool fibre the cuticle is only one scale thick except in parts where the scale overlaps. Fig. 2 is a typical example of a transverse section of a wool fibre. In the other fibres mentioned above the cuticle is thick, due to closely overlapping scales. In both types of fibres, scales overlap in a lateral direction, showing that one scale does not extend around the whole circumference of the fibre. In human hair overlapping scales can be seen within and on the surface of the cuticle.

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X-Ray Diagram and Ultra-Violet Absorption Spectrum of 'Renatured' Silk-Fibroin

Coleman and Howitt¹ have observed the interesting fact that if one dissolves denatured silk-fibroin in cupriethylene-diamine, a product is obtained which does not differ essentially from the native fibroin, and therefore they have called it the process of "renaturation".

In an earlier communication², we have stated that the air-dried native silk gland gives a very sharp X-ray diagram which by means of mechanical treatment of the sample, for example, stretching and rolling, changes into the well-known diagram of the cocoon filament. We suggested the names 'Silk I' and 'Silk II'. If 'Silk II' is treated with alkali, there appear small-angle interferences at the equator, which are due to a 45-Å. net plane distance in the side-chain direction. This form of the silk we named 'Silk III'.

In view of these results, it seemed of considerable interest to investigate the renatured silk of Coleman and Howitt. If the dialysed aqueous solution of the fibroin is dried *slowly*, films are obtained with the diagram of 'Silk I'. Nevertheless, the diagram is much less pronounced than the diagram obtained from the native silk gland. Only two reflexions allowed satisfactory measurement, namely, those with values of D of 7.3 Å. and 4.4 Å. They correspond quite definitely, both in appearance of the diagram and density distribution in the diffuse background, with the reflexions formerly found of 7.5 and 4.5 Å. This points to a distinct, if insignificant, contraction of the lattice.

If moistened with 50 per cent ethanol, the renatured silk films could be stretched plastically more than 300 per cent without losing their solubility in water and without any increase in tensile strength. The X-ray diagram of these stretched films shows no orientation. But the sharp diagram changes into a smeared amorphous diagram with two maxima which are identical with the strongest reflexions of 'Silk II', about 9.2 Å., corresponding with A_1 , and 4.4.8 Å., corresponding with the region of the

Longitudinal section (8 μ) of human hair (ultra-violet light, 3650 Å.; $\times 930$)

Transverse section (5 μ) of Leicester wool fibre (phase contrast; $\times 1,000$)