PRE-TRANSFORMATION STRETCHING OF THE SO-CALLED 5.1 A AND 1.5 A SPACINGS IN α-KERATIN

by

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It is now some twenty years since we first demonstrated, in our X-ray and related studies of the molecular structure and elastic properties of mammalian hairs, that the α–β transformation is preceded by a reversible stretching of the spacing of the characteristic 5.1 A reflection on the meridian

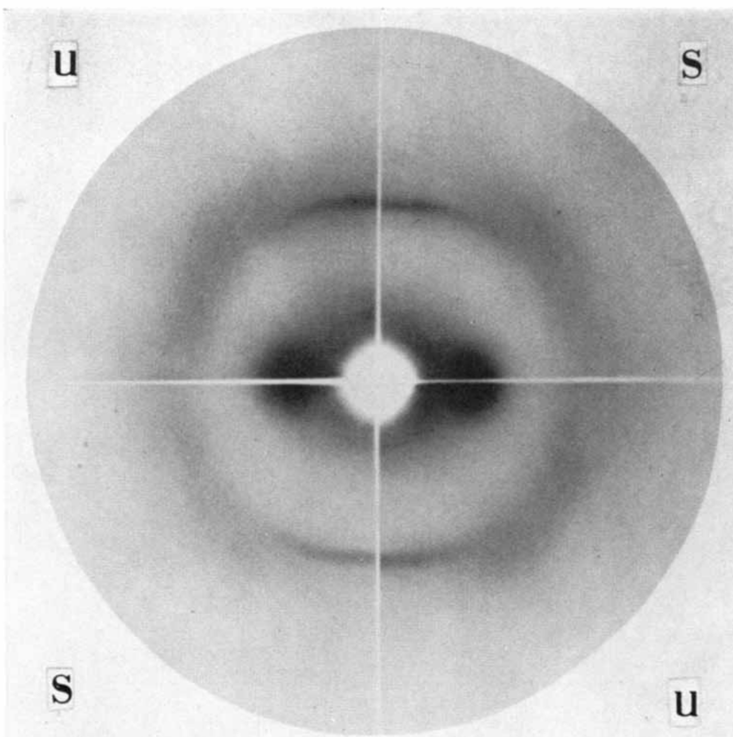

Fig. 1. X-ray sector comparison photographs showing the approximate 2% stretching of the 5.1 A spacing in porcupine quill before the onset of the α–β transformation. (Flat plate; U = unstretched, S = stretched.)

of the α-diagram[1]. Apparatus was devised for the purpose of taking strictly comparable "quadrant photographs" such as that shown in Fig. 1, in which, on a single photographic plate, one pair of diametrically opposite quadrants represents unstretched porcupine quill and the other pair represents the same specimen stretched by a few per cent. The idea was to be able to detect, simultaneously on both meridian and equator, small changes of spacing about which one might feel uncertain from comparisons between separate photographs. Porcupine quill was used in order to avoid the slight stretching which must take place when a bundle of hairs is drawn parallel. In this way we obtained the result that, before the onset of the α–β transformation, the so-called 5.1 A spacing stretches by an approximate 2% corresponding to the Hooke's Law region of the load-extension curve.

On keratin photographs taken with a cylindrical camera MACARTHUR[2] later recorded a number of shorter-spacing meridional reflections, and in particular the one at about 1.49 A which has recently assumed special significance[3] in relation to the helical model put forward by PAULING AND COREY to explain both the natural α-structures and certain synthetic polypeptides. In this model the amino-acid residues do in fact follow one another at about 1 ½ A along the direction of the fibre axis, and the prominent meridional reflection at this spacing is therefore strongly in its favour; but so far there is nothing like equivalent convinction in the proposed reasons why the same model should give, also on the meridian in the natural fibres, the very much stronger reflection at 5.1 A.

We have no wish to suggest that the 5.1 A and 1.5 A reflections are not orders of the same diffraction series, though it would not be inconceivable in view of the known two-component make-up of the actomyosin diagram and similar indications as regards natural keratin and other members of the k-m-e-f group[4]; but we felt that it would link them together beyond all doubt if we could show that the 1.5 A spacing behaves like the 5.1 A in also stretching reversibly over the 2% or so that precedes the α–β transformation, while providing incidentally a little more information on the sort of length-range permissible to the residues of the α-structure. The results of the experiment are illustrated in Fig. 2, again two strictly comparable photographs of unstretched and stretched porcupine quill, but this time on a single cylindrical film. It will be seen that beyond the 5.1 A there

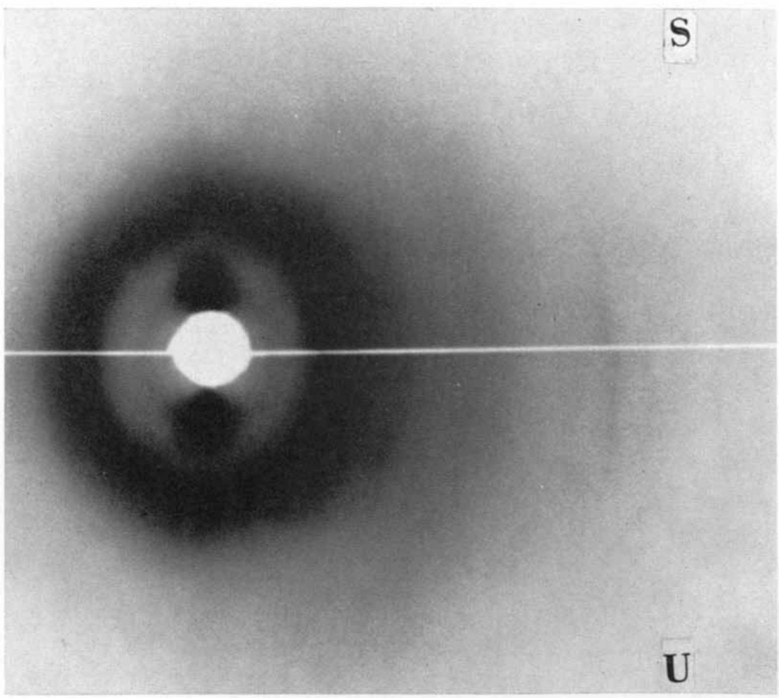

Fig. 2. X-ray comparison photographs showing also the corresponding stretching of meridional spacings in porcupine quill beyond the 5.1 A. (Cylindrical film; U = unstretched, S = stretched.)

is actually a series of spacings which stretch correspondingly, the 1.5 A being merely the most obvious. Our estimates of the unstretched spacings and intensities observable in these particular photographs of porcupine quill are as follows: 5.1_1 A (vvs), 3.9_5 A (s), 3.4_0 A (w–m), 3.0_1 A (m–s), 2.5_6 A (w–m), 1.48_6 A (m–s); and we estimate that the last-named can be stretched to about 1.52 A, *i.e.* by 2% at least, but probably a little over.

We should like to thank Mr. A. Millard specially for help in the difficult reproduction of Fig. 2.

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