SUBSTRUCTURE OF WOOL CORTICAL CELLS*

By C. A. Anderson† and J. D. Leeder†

The morphology of wool fibres and their components has been studied mainly with the optical and transmission electron microscope. In the former, the specimen is observed directly but the resolution is poor; in the latter, the resolving power is very high but the introduction of artefacts during specimen preparation and the indirect nature of the data obtained lead to possible uncertainties in interpretation.

With the scanning electron microscope these difficulties are avoided and the topography of specimens can be observed directly at high resolution. Thus several recent papers describe the substructure of keratin fibres (Bradbury and O'Shea 1969; Kuczera 1969; Sikorski and Hepworth 1969; Anderson and Delmenico 1970; Anderson and Lipson 1970; Bradbury and Leeder 1970; Haly, Snaith, and Anderson 1970; Anderson and Robinson 1971). In this communication, we report on the substructure of cortical cells as observed in the scanning electron microscope.

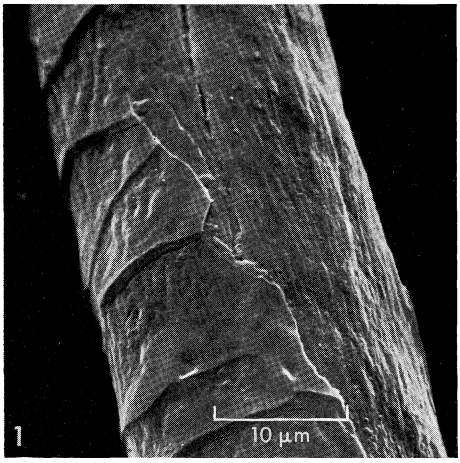
Figures 1 and 2 show the cuticle and outer cortex of virgin Merino 70's wool fibres partially digested at 40°C for 48 hr in pH 8 buffer solution containing papain (0·5%) and sodium bisulphite (1%). The flat ribbon-like cortical cells that occur immediately beneath the cuticle (*F*, Fig. 2) are different from the spindle-shaped cells that are usually obtained from wool fibres (Lehmann 1941). The flat cortical cells probably result from the forces occurring during fibre formation, i.e. the peripheral cortical cells are forced into a configuration intermediate between the flattened *cuticle* cells and the spindle-shaped inner *cortical* cells by the shearing action of the faster-moving inner root sheath in the follicle (e.g. see Auber 1952; Birbeck and Mercer 1957; Kassenbeck 1959; Epstein and Maibach 1969).

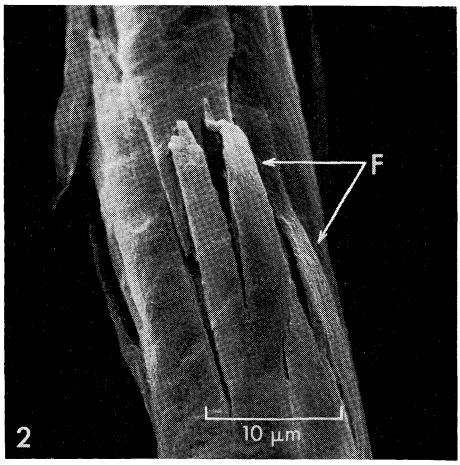
At high magnification these flattened cortical cells are seen to contain fibrils which appear to be made up of smaller elements twisted together in the form of a rope (Fig. 3). Measurement of the diameter of these "ropes" on several micrographs of different magnification gave a value of *c.* 3000 Å. Since Rogers (1959), using transmission electron microscopy of cross-sections, observed fibrillar elements of 3000 Å diameter, which he designated as macrofibrils, we consider that these "ropes" are, in fact, the macrofibrils. However, the identity of the strands making up the macrofibril is not easily reconciled with known fibre morphology, since the next smallest recognized components are the microfibrils of diameter 60–80 Å (Rogers 1959); presumably, these macrofibrillar subunits are composed of groups or bundles of microfibrils. A likely consequence of this rope-like macrofibril is that the constituent microfibrils will not be aligned with the fibre axis and their orientation will vary along the strands. This is supported by the observations of Johnson and Sikorski (1965) that sets of microfibrils may be inclined by as much as 40° to each other, and the results of Rogers (1959) which show that many sets of microfibrils are cut obliquely during transverse sectioning of keratin fibres (see Lundgren and Ward 1963).

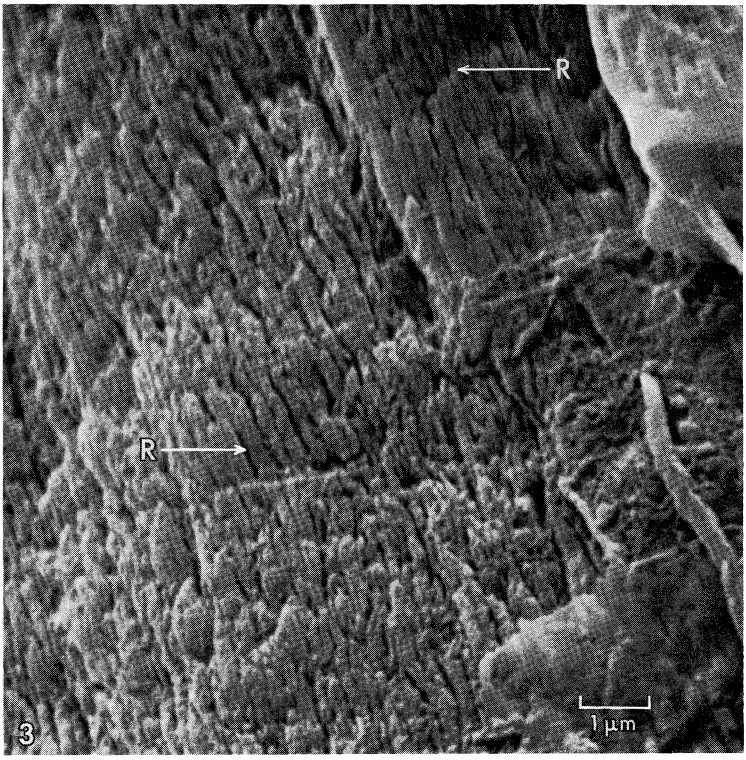
* Manuscript received July 9, 1971.

† Division of Textile Industry, CSIRO, P.O. Box 21, Belmont, Vic. 3216.

The rope-like macrofibrils have been observed on the outer flattened cortical cells only. This may be because these cells are more reactive or more accessible to the reagent







Figs. 1 and 2.—Scanning electron micrographs of the cuticle and cortex of wool fibres. *F*, flat cortical cells.

Fig. 3.—Scanning electron micrograph of flat cortical cells showing rope-like macrofibrils (*R*).

than the inner (spindle-shape) cells or because the substructure of the inner cells is masked by cell membranes which are resistant to the reagent (e.g. see Bradbury,

Leeder, and Watt 1970). In this regard, it should be borne in mind that the scanning electron microscope reveals only the topographical features of a particular sample, so that the presence of even a very thin membrane will effectively mask any underlying structural features. It is not possible to identify ortho- and para-cortices in these treated fibres in the scanning electron microscope, so it is not known whether differences in enzyme susceptibility of these components contribute to the effects obtained.

References

ANDERSON, C. A., and DELMENICO, J. (1970).—Proc. 7e Congr. Int. Microsc. électron. Vol. 1. p. 265.

ANDERSON, C. A., and LIPSON, M. (1970).—*Text. Res. J.* **40**, 88.

ANDERSON, C. A., and ROBINSON, V. N. E. (1971).—*J. Text. Inst.* **62**, 450.

AUBER, L. (1952).—*Trans. R. Soc. Edin.* **62**, 191.

BIRBECK, M. S. C., and MERCER, E. H. (1957).—*J. Biophys. Biochem. Cytol.* **3**, 203.

BRADBURY, J. H., and O'SHEA, J. M. (1969).—*Aust. J. biol. Sci.* **22**, 1205.

BRADBURY, J. H., and LEEDER, J. D. (1970).—*Aust. J. biol. Sci.* **23**, 843.

BRADBURY, J. H., LEEDER, J. D., and WATT, I. C. (1970).—The cell membranes of wool. Proc. 4th Int. Wool Text. Res. Conf., Berkeley. (In press.)

EPSTEIN, W. L., and MAIBACH, H. I. (1969).—Hair growth. In "Advances in Biology of Skin". Vol. 9. Ch. 5. pp. 83–97. (Pergamon Press: Oxford.)

HALY, A. R., SNAITH, J. W., and ANDERSON, C. A. (1970).—*Text. Res. J.* **40**, 1126.

JOHNSON, D. J., and SIKORSKI, J. (1965).—Proc. 3e Int. Rech. Text. Lainière. Vol. 1. p. 147.

KASSENBECK, P. (1959).—*Bull. Inst. Text. France.* **83**, 26.

KUCZERA, K. (1969).—Seifen-öle-Fette-Wächse, Kosmetik Suppl. No. 8. p. 1.

LEHMANN, E. (1941).—*Melliand Textber.* **22**, 255.

LUNDGREN, H. P., and WARD, W. H. (1963).—In "Ultrastructure of Protein Fibres". p. 39. (Ed. R. Borasky.) (Academic Press: New York.)

ROGERS, G. E. (1959).—*Ann. N.Y. Acad. Sci.* **83**, 378.

SIKORSKI, J., and HEPWORTH, A. (1969).—Proc. 2nd Ann. Scanning Electron Microsc. Symp., Chicago. p. 249.