

## Microtopography of the human skin

### Studies with metal-shadowed replicas from plastic impressions

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#### INTRODUCTION

Some new information about the microscopic surface pattern of human skin has been obtained from metal-shadowed transparent secondary replicas made from primary impressions of the skin surface taken with a silicone rubber plastic. The technique, adapted by Sarkany (1962) from that of Sampson (1961) has distinct advantages in that it allows views of the surface of up to  $\times 1500$  magnification.

The results presented demonstrate the scope and versatility of the method, and include the ridge and furrow pattern of the surface, the surface details of individual cells of the stratum corneum, and the shape of the eccrine sweat gland and pilosebaceous follicle openings.

#### METHOD

From 1 to 2 ml. of liquid plastic silicone rubber monomer\* is poured on to a glass microscope slide. One to 2 drops of a liquid catalyst (supplied with the monomer by the manufacturer) is added and the liquids quickly mixed with an orange stick. The mixture is then transferred to the area of skin to be examined, which should be held still and in a relaxed position whilst the material dries. The plastic hardens within a few minutes, and is gently peeled off the skin. This flexible rubber impression now carries a permanent record of the skin surface pattern, and can be used at once to yield secondary transparent nitro-cellulose replicas of this pattern.

A thin film of a nitro-cellulose preparation, such as clear nail varnish, is painted on to the surface of the rubber impression with a fine brush. This procedure is done with meticulous care to ensure that no air bubbles are trapped between the rubber and the varnish. The rubber mould is placed in a desiccator over anhydrous phosphorus pentoxide and dried for a minimum of 24 hr. and preferably for several days. The surface layer of varnish is removed from the rubber mould with a pair of fine forceps. This constitutes the secondary replica and may be examined by transmitted or reflected light directly or after it has been metal shadowed. The shadowing is performed with aluminium in an Edwards High Vacuum Coating Apparatus (Edwards High Vacuum, Ltd., Crawley, Sussex).

#### RESULTS

*Surface ridge pattern.* The pattern of the skin ridges, furrows and polygonal figures is obvious to the naked eye and differs in the various regions. The main distinguishing features at the sites examined can be summarized as follows (Fig. 1 (1)–(4)). On the centre of the palm the ridges and furrows are shallow, and in the main

\* 'Silflo' Dental Plastic, Flexico Developments Ltd., 25 Devonshire Place, London, W. 1.

parallel; there is a relatively ill-defined rectilinear pattern. On the dorsum of the hand there are marked long deep furrows, intersecting to enclose triangular and quadrilateral plateaus. On the forehead the furrows are straight and shallow and enclose rectangular plateaus. On the instep of the foot the furrows are themselves shallow and do not intersect one another as they do elsewhere but are arranged in whorls and concentric circles with long mound-like ridges between. The eccrine sweat glands are placed at regular intervals along these ridges.

The pattern at a given site seems to be reasonably constant among all the subjects so far examined. Preliminary experiments to determine the factors controlling these patterns have been inconclusive. The finer pattern seems to be a fixed shape of the horny layer itself; it does not correspond with the pattern of the underlying papillary body as seen in histological material.

*Stratum corneum.* Fig. 2 (1) illustrates the surface appearance of the superficial cells of the horny layer of the skin of the sole of a human adult, as seen in a shadowed replica photographed at a magnification of  $\times 1480$ . The mode of apposition of adjoining horny cells can be seen. At other sites, for example the forearm, palm, dorsum of the hand, calf and face, the cells do not lie side by side, but their contiguous edges overlap like tiles on a roof. On microscopical examination in transmitted light of the replica made from the sole a rippled appearance of the surface of individual cells is seen more clearly than in the illustration.

Impressions have been made after the use of the 'stripping' procedure, as described by Pinkus (1952), in which a piece of adhesive tape (Sellotape) is repeatedly applied to and removed from the same area of skin, thus removing the outermost layer of horny cells. When viewed under the same magnification as impressions of the surface, these impressions show that the horny cells revealed after twenty to thirty 'strips' have been removed are larger than the surface horny cells. The outline size of the surface horny cells is also larger in acromegaly, a condition with recognized visceral and organ enlargement.

*Appendageal openings.* It is known from microscopical studies, and from the study of whole mounts of human epidermis by Hambrick & Blank (1954) that the eccrine sweat ducts open along the ridges of the superficial skin pattern. Impressions taken from the finger tips and from the sole of the foot confirm this, and show the eccrine duct openings in detail (Fig. 1 (4) and (6)). There is a distinct impression of

Fig. 1 (1). Surface pattern of an aluminium-shadowed replica of the centre of the palm of a young adult. Eccrine sweat duct openings are regularly spaced on the ridges.  $\times 35$ .

(2). Surface pattern of an aluminium-shadowed replica of the dorsum of the hand of a young adult. Triangular and quadrilateral plateaus are produced by the intersection of deep, narrow furrows.  $\times 35$ .

(3). Surface pattern of an aluminium-shadowed replica of the forehead. Rectangular shallow plateaus are interspersed with pilo-sebaceous gland orifices.  $\times 35$ .

(4). Surface pattern of an aluminium-shadowed replica of the instep. Eccrine orifices are larger than those seen on other parts of the body (compare Fig. 1 (1)).  $\times 35$ .

(5). Surface pattern of an aluminium-shadowed replica of the finger tip of a child aged 6 with congenital ectodermal dysplasia. There is complete absence of eccrine sweat duct openings. The absence of eccrine glands was confirmed histologically.  $\times 35$ .

(6). Surface pattern of an aluminium-shadowed replica of the finger tip of a normal child aged 6. Compare with Fig. 1 (5), and note regular eccrine duct openings, some of which show the presence of globules.  $\times 35$ .

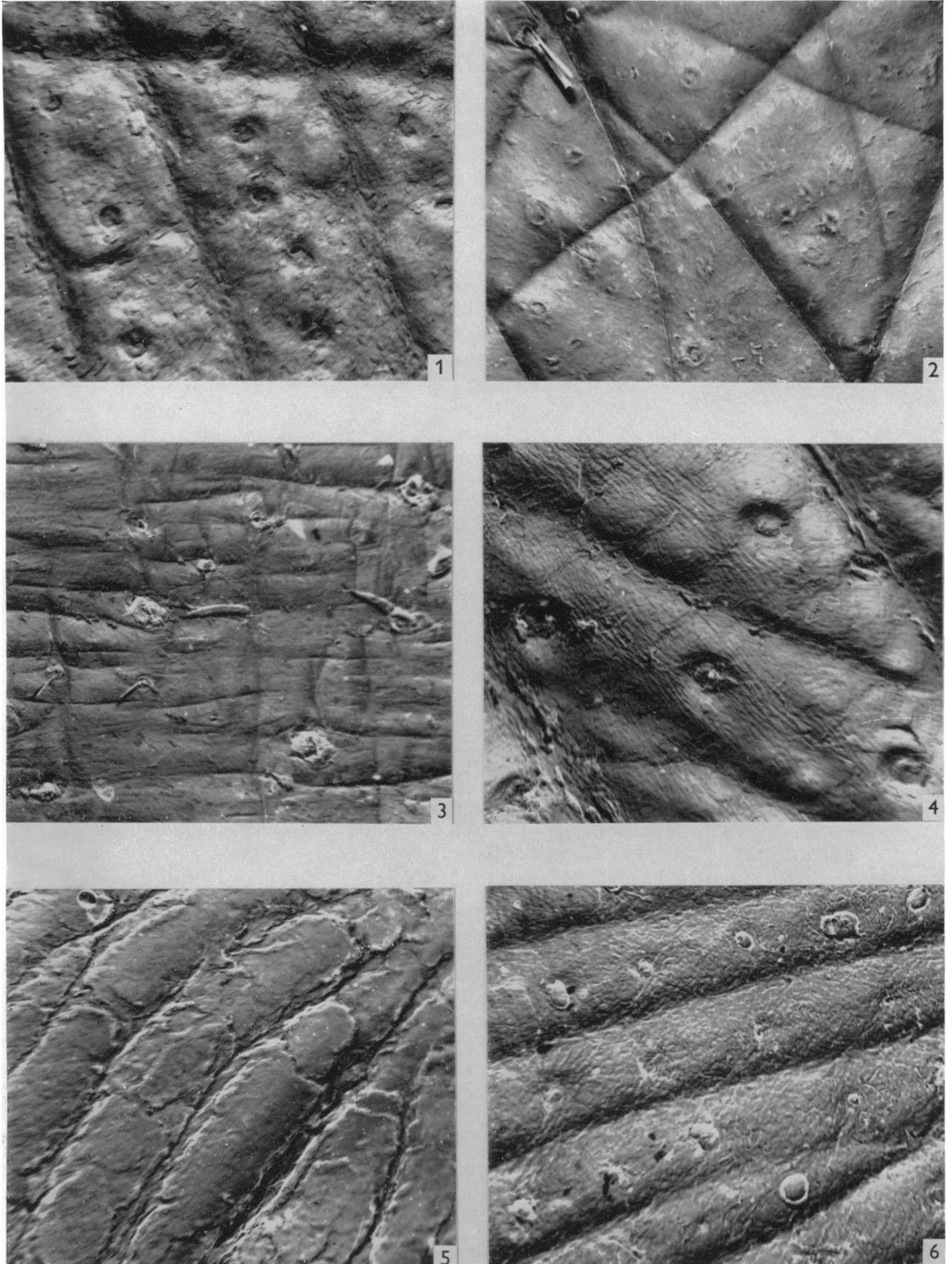


Figure 1. Legends on facing page

a spiral arrangement of the eccrine ostium, and the actual aperture of the duct is a split or cleft to one side of the spiral structure (Fig. 2 (2)). The 'epidermal eccrine sweat duct unit' of Lobitz, Holyoke and Montagna (1954) is known to form a spiral in the stratum spinosum. Hambrick & Blank (1954) have also demonstrated that the superficial portion of the eccrine duct is a spiral structure and their photographs of whole mounts bear a marked similarity to the patterns at the eccrine duct openings seen in the shadowed replicas.

The eccrine openings on the sole are markedly larger than on the palm: such regional differences in size have been hitherto unsuspected.

In Fig. 2 (3), a vellus hair and the surface pattern of a pilo-sebaceous follicle from the skin of the calf of a young adult is shown. A ringed structure can be recognized at the mouth of the follicle, encircling the hair. This infundibular ring or collar corresponds to that seen on the surface of whole mounts of human epidermis (compare figure 3c of Hambrick & Blank, 1954). It is of interest to observe that the hair emerges from the follicle in an eccentric position.

The pilo-sebaceous follicles of the face consist of two populations: one population is of small vellus follicles resembling those seen on the calf. The other consists of larger sebaceous openings with very small eccentrically placed hair shafts. In some of these large sebaceous openings hairs are absent. The disparity between the size of sebaceous openings and the hairs emerging on the face is thought to be important in the pathogenesis of acne vulgaris.

#### DISCUSSION

Replicas obtained by this technique reproduce the topography of the skin surface very accurately. Thus the fine detail of the spores of *Malassezia furfur*, of approximately 3-5  $\mu$  in diameter, can be seen in replicas taken from the skin in pityriasis versicolor. Furthermore, replicas from skin on which a small amount of blood has been allowed to dry portray accurately the shape of the crenated red blood cells (Fig. 2 (4)).

This method should be of value in the study of the skin surface in health and disease. Since it was first described by Sarkany (1962) other workers have described similar (Façq, Kirk & Rebell, 1964) or slightly different (Chin & Dobson, 1964) impression techniques for skin surface study. A rather striking example of the method's potential utility is illustrated in the replica shown in Fig. 1, (5), which is from the finger tip of a child with congenital ectodermal dysplasia. In this condition there is heat intolerance due to a congenital absence of eccrine sweat glands. There are no eccrine openings present. The finger tip of a normal child is shown in

Fig. 2 (1). Surface pattern of an aluminium-shadowed replica of the sole. Clearly defined horny cells show a rippling effect on their surface. There is little overlapping.  $\times 1480$ .

(2). Surface pattern of an aluminium-shadowed replica of a single eccrine orifice showing the spiral nature, and the eccentric cleft-like aperture.  $\times 270$ .

(3). Surface pattern of an aluminium-shadowed replica of a pilo-sebaceous opening. Note an infundibular ring, previously observed in whole mounts of human epidermis.  $\times 108$ .

(4). Surface pattern of an aluminium-shadowed replica of an area of skin on which blood had been allowed to dry. This shows accurately the various degrees of crenation of the red blood corpuscles.  $\times 555$ .

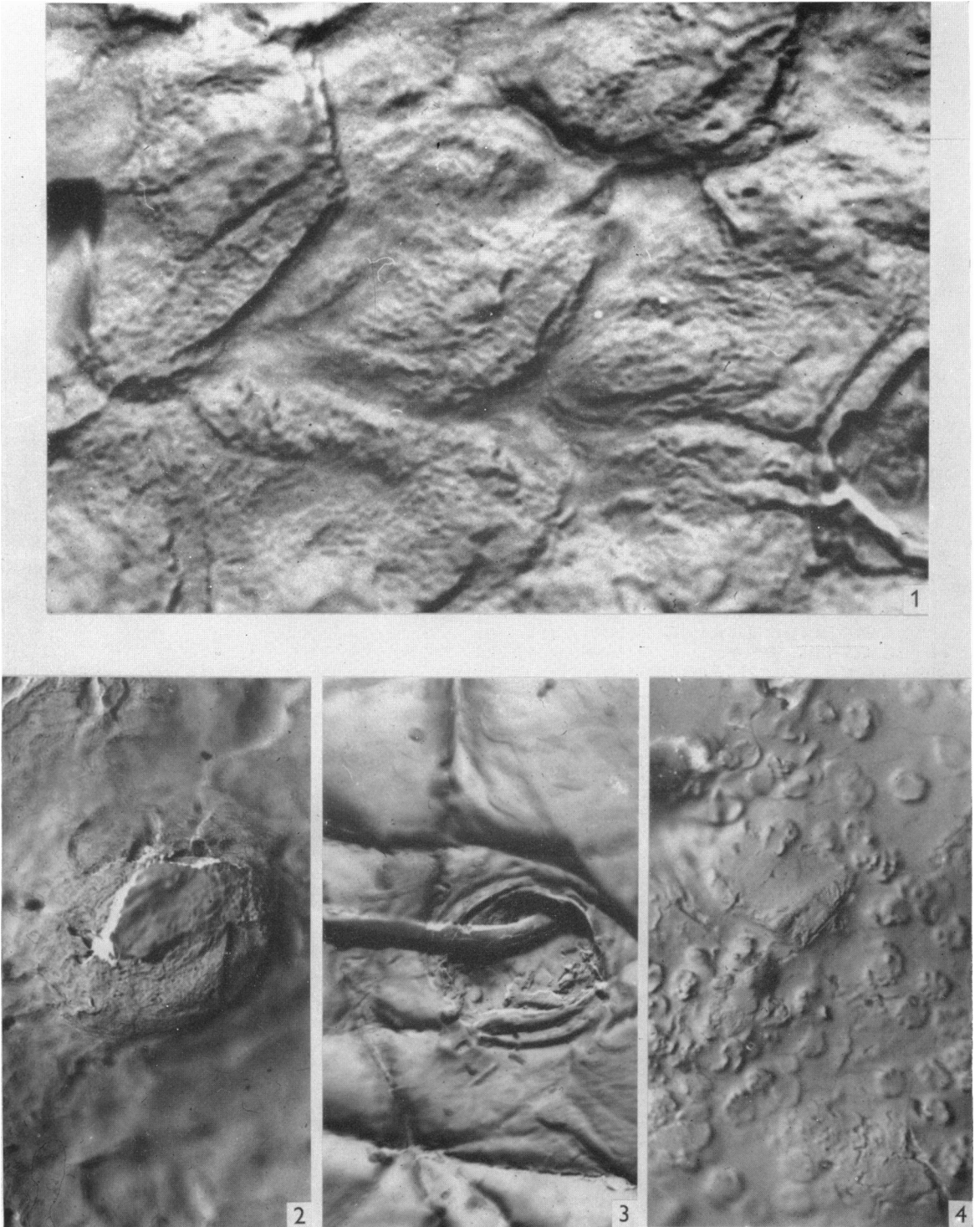


Figure 2. Legends on facing page

Fig. 1 (6), for comparison. A study of this patient's relatives by the skin replica technique has shown a quantitative reduction in eccrine duct openings, due presumably to partial effects of the gene responsible.

## SUMMARY

1. A method is reported by which permanent replicas of the skin surface pattern can be made, and which permit study of the skin surface to be made at magnifications of up to  $\times 1500$ .

2. The differences in the ridge and furrow pattern of the surface in various sites are illustrated. Details of the shape and surface characteristics of individual horny cells are described.

3. A spiral structure can be recognized at the eccrine sweat duct openings, and a keratinous ring can be seen around the pilo-sebaceous openings. The technique has revealed that the eccrine duct openings on the sole are larger than elsewhere.

4. The potential value of the method is illustrated by the striking demonstration of the complete absence of eccrine duct openings in a replica made from a child with congenital ectodermal dysplasia.

We thank the Medical Research Council for a personal grant to one of us (I.S.) and the Peter Samuel Royal Free Fund for support. We are most grateful to Miss Christine M. Petri, B.Sc. (Hons.), for technical assistance, and to Mr R. R. Phillips, A.I.B.P., A.R.P.S., for the photography.

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