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ASPECTS OF THE ODLAND BODIES IN THE SYNTHESIS OF KERATOHYALIN

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Abstract. A suggested role in keratinization, i.e. the formation of orthokeratosis, is most frequently ascribed the formation of keratohyalin, presumably related to an ambiguous association with tonofilaments (the keratohyalin–tonofilament complex). The appearance of Odland bodies or keratinosomes has only hypothetically been discussed in connection with the formation keratohyalin and the consecutive orthokeratosis. In the present paper submicroscopical evidence is presented, for the first time, demonstrating conclusively that the Odland bodies are directly involved in the synthesis of keratohyalin via an association with tonofilaments. Thus the observed keratohyalin–tonofilament complex, considered as a precursory stage in the formation of orthokeratosis, is a cytomorphological phase in the process of development culminating in orthokeratosis.

The statement of Odland that "their [Odland bodies] appearance precedes and heralds the formation of the earliest keratohyalin granules" now seems to be clarified submicrographically.

The intermediate developmental stage between the orthokeratotic layer and keratohyalin-containing layers is still ambiguous.

The normal stratum corneum consists of several layers of cornified or keratinized cells, the submicroscopic appearance of which is well known (Fig. 3) as presented in several submicroscopic surveys (10, 11, 12). This layer is preceded by the stratum granulosum, the most distinguishing feature of which is the electron-dense keratohyalin material (Fig. 1) uniformly spread throughout the cytoplasm and increasing in size and number towards the stratum corneum (10, 11, 12). Keratohyalin has repeatedly been observed in association with tonofilaments. This association has been claimed to play a role in the synthesis of keratohyalin (10, 11, 12). Contradictory opinions still exist, however. A certain quantity of keratohyalin seems to be essential for normal keratinization, i.e. the formation of orthokeratosis with A- and B-cells. A deficiency or absence of keratohyalin as in fully developed psoriatic lesions seems to be related to defective keratinization, i.e. the formation of parakeratosis (4). The transformation of keratohyalin-containing cells to the completely keratinized A- and B-cells of the orthokeratotic stratum corneum is, from a submicroscopical point of view, not understood in detail. It would seem, however, that keratohyalin has a keratogenous function.

Although the synthesis of keratohyalin has been connected with the above-mentioned association with tonofilaments and ribosomes (10, 11, 12), there is no convincing evidence that this is the only solution to this conundrum.

As well as in the stratum granulosum and in the stratum spinosum—and even in the stratum germinativum—varying numbers of small intracytoplasmic ovoid bodies, thick-walled granules with a tripartite membrane, are observed (10, 11, 12). Especially in the superficial parts of the spinous layer these bodies seem to be supernumerary (10). These small granules were first depicted by Selby (13) and Charles & Smiddy (1), and noted by Selby as dense granules. The small spherical granules were first described in detail by Odland (8) who observed their appearance in the upper spinous layer and their disappearance from the cells when keratohyalin is fully developed. The designation of these small particles as Odland bodies originates from this inimitable analysis. According to Odland (9) these particles may precede and herald "the formation of the earliest keratohyalin granules". Other authors, however, have ascribed the Odland bodies contradictory functions,

Abbreviations:

ID	= intercellular disc
IS	= intercellular space
KH	= keratohyalin
KP	= keratin pattern
O1	= Odland bodies
O2-OKH	= gradual association of Odland bodies with tonofilaments
TF	= tonofilaments

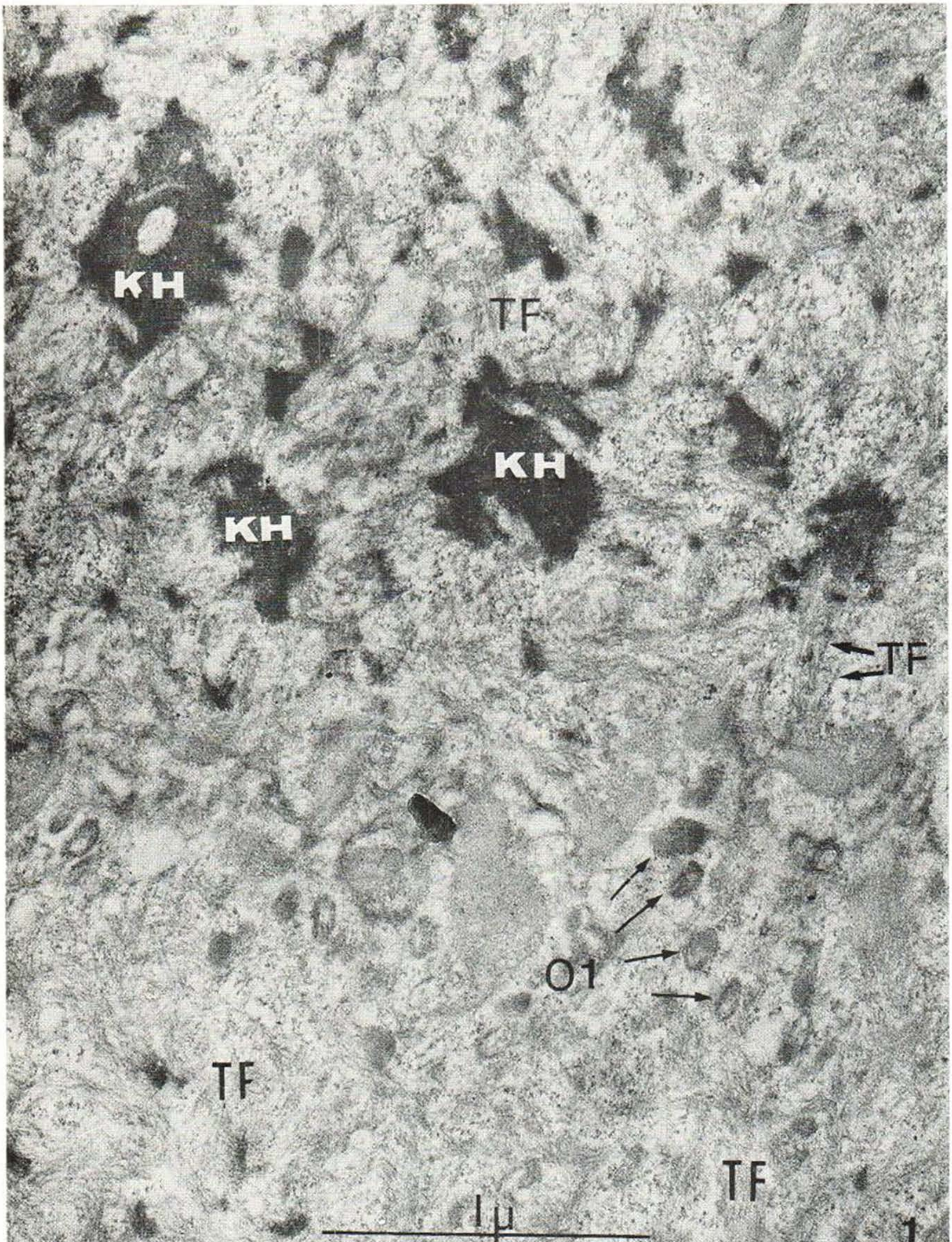

Fig. 1. Cytoplasm of keratohyalin-containing cells depicting the keratohyalin–tonofilament complex and Odland bodies. × 47 000.

i.e. granules amphibologically coating the outer surface of the plasma membrane, creating a certain resistance and thus participating in keratinization (=membrane coating granules) (5). Another conjecture, based upon the demonstration of acid phosphatase activity within the granules, is that they may represent some kind of lysosomal activity (20). In view of the not indecorous participation of the

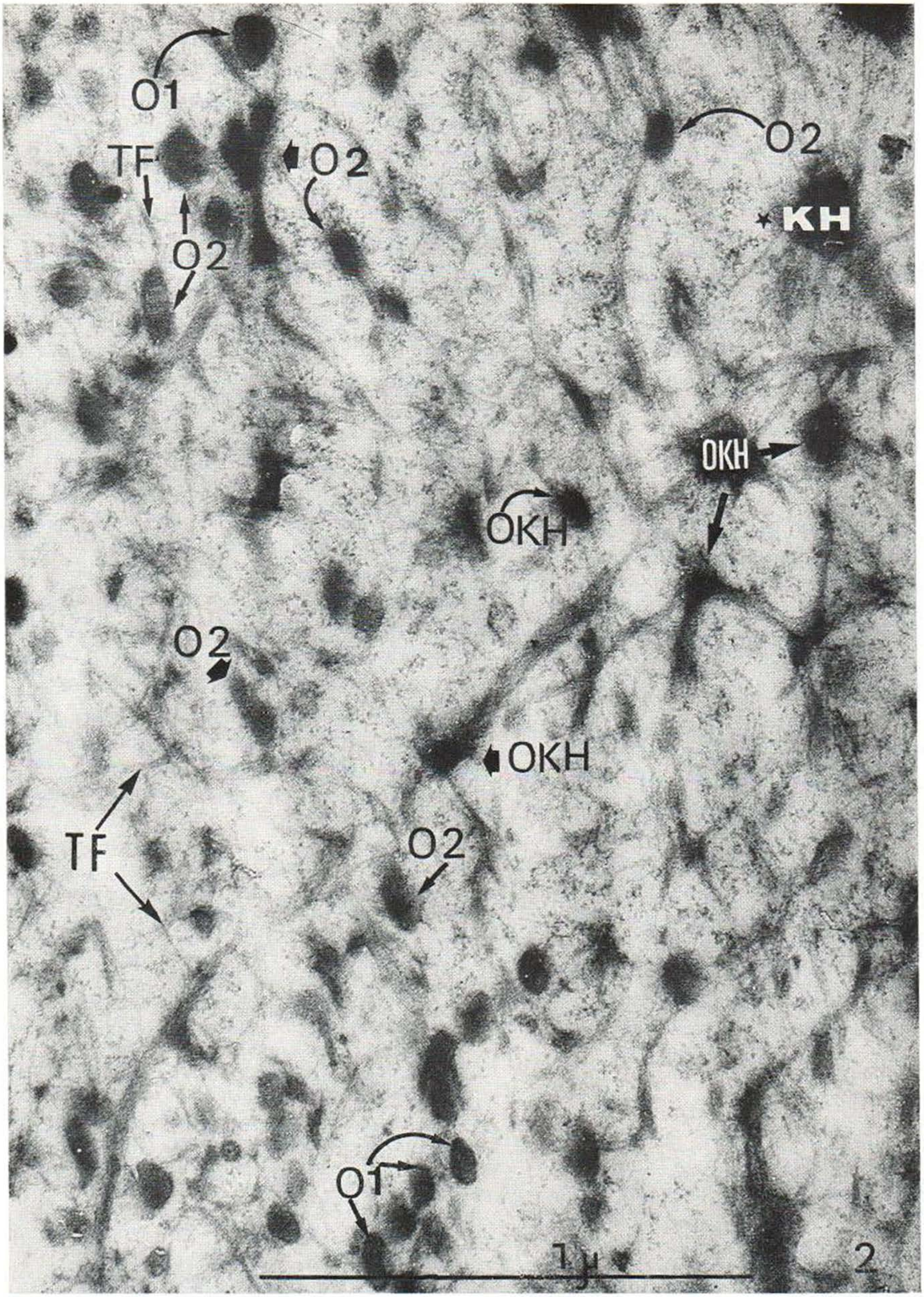

Fig. 2. Micrograph of transformational epidermal cell, demonstrating the gradual association of Odland bodies with tonofilaments, progressively forming keratohyalin. ×73 000.

Odland bodies in keratinization, other authors (6, 16, 17, 18) have proposed the desirous name keratinosome.

MATERIAL AND METHODS

The material consisted of skin biopsies from 3 male persons, aged 21–50 years, without any skin disease, and 3 male persons aged 20–43 years, with psoriatic lesions of 3–7 days' duration. None of the patients with psoriasis had received any kind of treatment because of skin lesions. The specimens were fixed by immersion in 2% OsO_4 buffered with veronal acetate at pH 7.4 for 2 hours at +4°C. Dehydration was carried out in increasing concentrations of acetone. The embedding was performed in Vestopal W.

RESULTS

In the material representing unchanged epidermis as well as in that consisting of early psoriatic lesions, the formation of Odland bodies (O) was observed, followed by an abrupt appearance of keratohyalin in the supraposed epidermal layer. Multitudinously an association of tonofilaments and keratohyalin is certainly observed—as in Fig. 1, where tonofilaments (TF) can be discerned in the keratohyalin (KH).

The pertinent problem of the transformation of the Odland-bodies-containing layers into a keratohyalin-carrying layer is depicted in Fig. 2, in which Odland bodies are observed singly—O1—or gradually associating with tonofilaments—O2—progressing through this association to form keratohyalin (OKH → KH). Orthokeratosis as depicted in Fig. 3 is generally considered to be the final maturational product of the epidermopoiesis (12). Howver, the intermediate developmental stage, between the orthokeratotic layer and the more or less keratohyalin—containing layers, is submicromorphologically not distinguishable in this material, and has also never been depicted by other observers.

DISCUSSION

A presumed role of keratohyalin in the synthesis of orthokeratosis, as briefly mentioned in the introduction to the present paper, is nowadays widely accepted, though contradictory opinions still exist (7, 11, 12, 15). A probable association of tonofilaments and keratohyalin has been observed (2, 3, 4, 9, 10, 14, 19) and the increase in size and number of keratohyalin has been directly related to a decrease in tonofilamentous material (11). In spite of extensive submicroscopical analyses of the stratum spinosum and stratum granulosum, the causality of the abrupt formation of keratohyalin and/or the keratohyalin–tonofilament complex and the nature and role of Odland bodies or keratinosomes (18) abundantly observed in spinous suprastrata seem to be unknown. Except for the statement of Odland (9) that "their [Odland bodies] appearance precedes and heralds the formation of the earliest keratohyalin granules", the other proposed cytomorphological functions of the Odland bodies seem not to be completely clarified. Different types of Odland bodies have been observed and amphibologically different or multifaceted properties (12) have been proposed.

The solicitous submicroscopical analyses of the present material including transformational epidermal cells between the spinous and granular layers certainly allow of a submicroscopical interpretation of at least one of the functional properties of the Odland bodies. The precursory association of Odland bodies and tonofilaments in the keratohyalin formation is obvious (Fig. 2). Thus the role of the Odland bodies in the synthesis of keratohyalin, seen from a submicroscopical point of view, seems important. The earlier reported finding of an association between tonofilaments and keratohyalin is only a registration of a later developmental stage in this process, thus reflecting the difficulties encountered in isolating the observed transformational epidermal cells.

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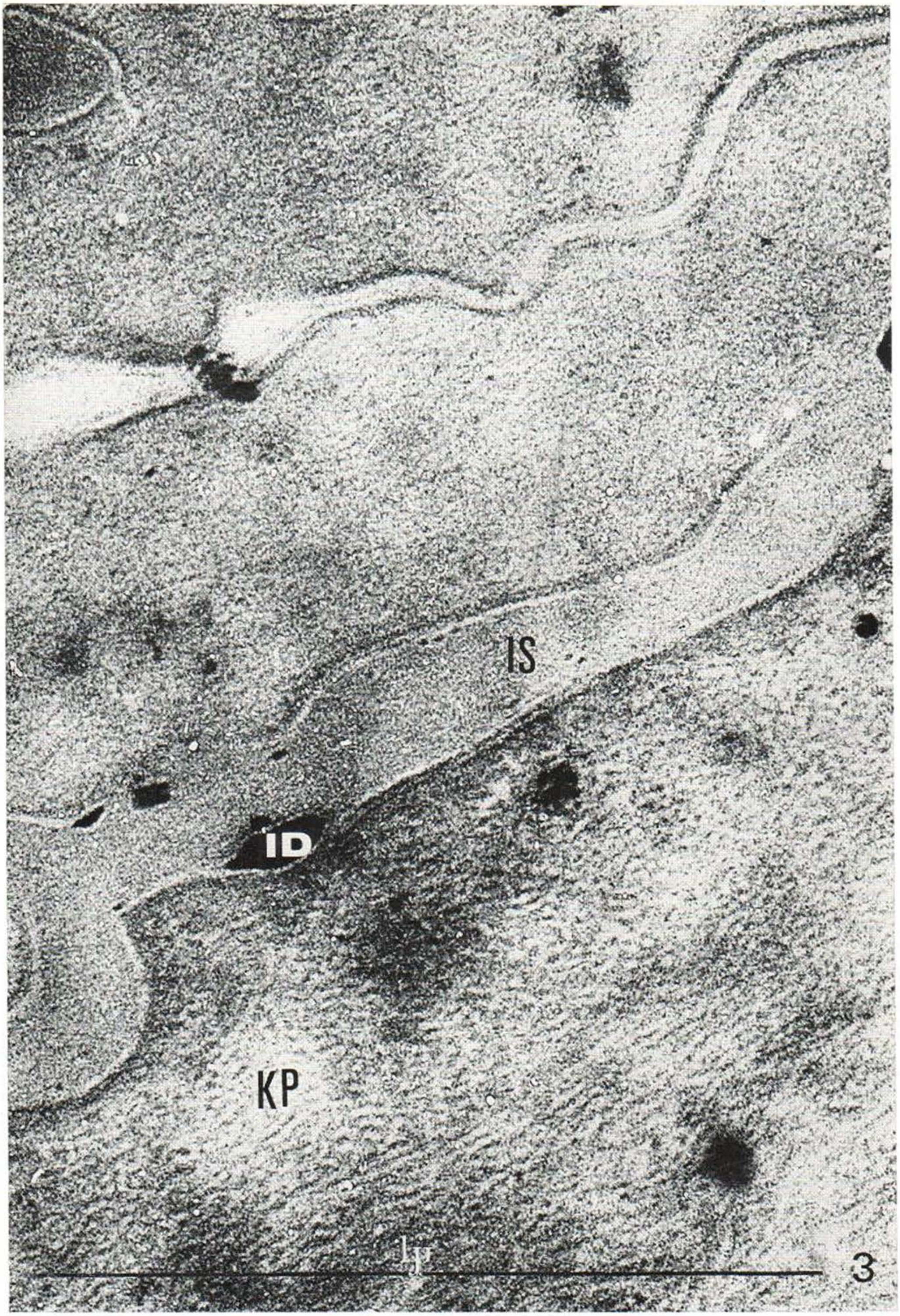

Fig. 3. Part of the orthokeratotic layer, revealing a typical keratin pattern. × 120 000.

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