

Some Observations on Dandruff

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Synopsis—Dandruff and nondandruff subjects were compared with regard to a number of variables. Histologically, the major differences between the dandruff and nondandruff specimens were in the horny layer. Normally, the scalp horny layer consists of 25-35 fully keratinized, closely coherent cells arranged in an orderly pattern. In dandruff, the intact horny layer usually has fewer than 10 cells, parakeratotic cells are common, and the pattern is disordered. Unlike the nondandruff horny layer, crevices occur deep within the dandruff stratum corneum, resulting in "cracking up" into large flakes. The permeability of the dandruff horny layer is increased. This reflects not only the reduced number of coherent cells which can function as a barrier, but increased porosity derived from the "cracking up" of the horny layer. The composition of the microflora is the same in dandruff as in nondandruff, consisting principally of *Staphylococcus epidermidis*, *Corynebacterium acnes* and *Pityrospora* species. However, there is a great numerical increase in the aerobic and fungal flora of dandruff, roughly proportional to the quantity of scaling. Certain antibacterial and antifungal agents effected a great decrease in the microflora without eliminating dandruff. Various methods of studying epidermal kinetics indicate that the epidermal turnover time is decreased in dandruff, i.e., epidermopoiesis is accelerated. It is proposed that dandruff represents a basic change in the rate regulating mechanisms of cornification. Accelerated epidermopoiesis leads to imperfect keratinization and faulty "cracking up" of the horny layer.

INTRODUCTION

There is no want of work or writing in the field of dandruff. Unfortunately, the former has been almost exclusively preoccupied with therapy and the latter with generalities derived from common experience. A rank overgrowth of speculations crowds out any clear idea of the nature of the process and its pathophysiology.

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Our aim has been to examine dandruff in breadth rather than depth as a first step in clarifying many aspects which are now mooted. So disparate are the views on dandruff that some progress will have been made merely by eliminating notions which are false or inaccurate. The main objective has been to delineate the fundamental features of the process, and to evaluate some of the factors which might influence its behavior.

Definition

A major deficiency of many explorations into the nature of dandruff has been a failure to define the disorder precisely. We define dandruff as chronic noninflammatory scaling of the scalp. Although chronic, the fluctuating character of dandruff has long complicated its study. Subjects initially observed to be free of dandruff may suddenly develop it, while others with dandruff of long standing may enter periods of quiescence. Despite these swings, the process is fundamentally persistent and, if observed for a prolonged period, the true dandruff individual will eventually get his "dander up."

Clinically, dandruff is wholly noninflammatory. The absence of inflammation sets dandruff apart from the other principal scaling conditions of the scalp, namely, seborrheic dermatitis and psoriasis. However, inflammation is often exceedingly difficult to detect on the scalp; this is especially true in the Negro where erythema is muted. Seborrheic dermatitis, with which dandruff is frequently grouped, displays not only scaling, but erythema and sometimes crusting. Some authorities regard dandruff as a mild form of seborrheic dermatitis, a view from which we dissent. Psoriasis is often patchy and reddened with a thick silvery scale. The presence of lesions in characteristic locations elsewhere is helpful in differentiating seborrheic dermatitis and psoriasis from dandruff.

The scalp, as all skin, undergoes continuous horny desquamation. In its mildest form, dandruff merges into physiologic scaling. The normal process of desquamation is necessarily more visible on the scalp because the rate of production of horny cells is greater on the scalp than on most parts of the body (1). Moreover, hair retains scale and renders it more visible. Merely not washing for a week or two will create the "appearance" of dandruff in the normal subject. However, there are significant differences between the scales of intense dandruff and normal desquamation.

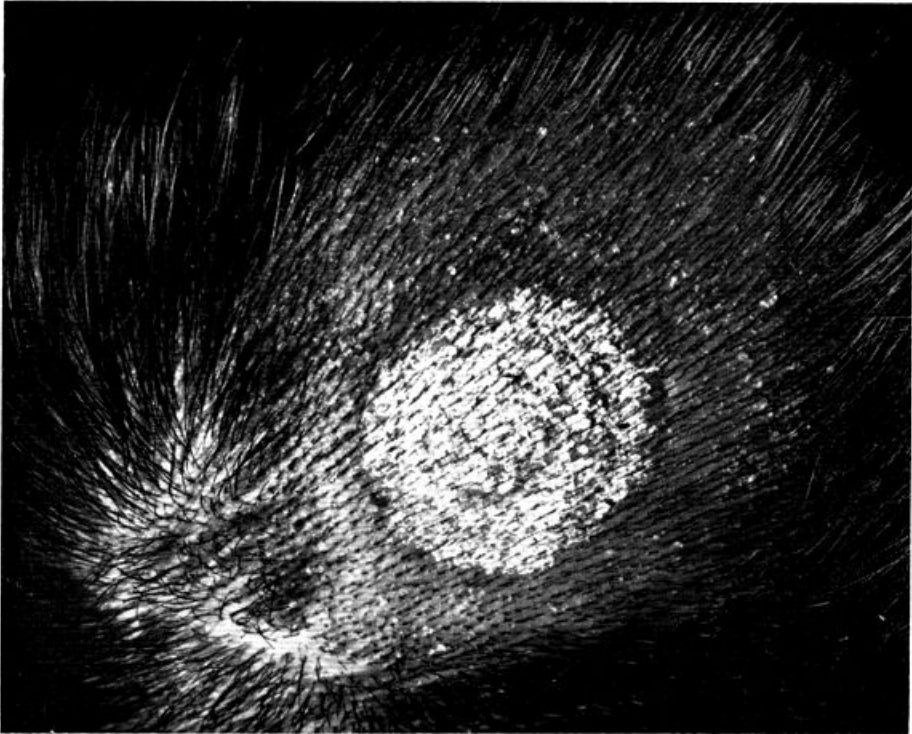


Figure 1. Dandruff visualization enhanced by the ether cup method. Flakes are magnified as lipid, removed by ether, is replaced by light-scattering air

EXPERIMENTAL

Methods of Evaluation

Most methods of estimating the degree of dandruff are highly subjective, a vexation in judging the response to treatment. While quantitation is admirable, no procedure satisfies the traditional criteria of high accuracy and repeatability. Reluctantly, recourse was taken to naked eye evaluation. Visualization was improved by using a fine comb to dislodge scales. The strategy was to contrast extremes so as to bring the differences into sharp relief. Consequently, only nondandruff and heavy dandruff scalps were studied. The proportion of these two polar types in the population is quite unequal. Statistically, some degree of dandruff would appear to be the norm; subjects with slight degrees of scaling were found with exceeding difficulty. For example, it was necessary to survey about 100 subjects to find 5 who were quite certainly without dandruff. Perhaps some of the disagreements in the literature arise from differing criteria as to what is and what is not dandruff.

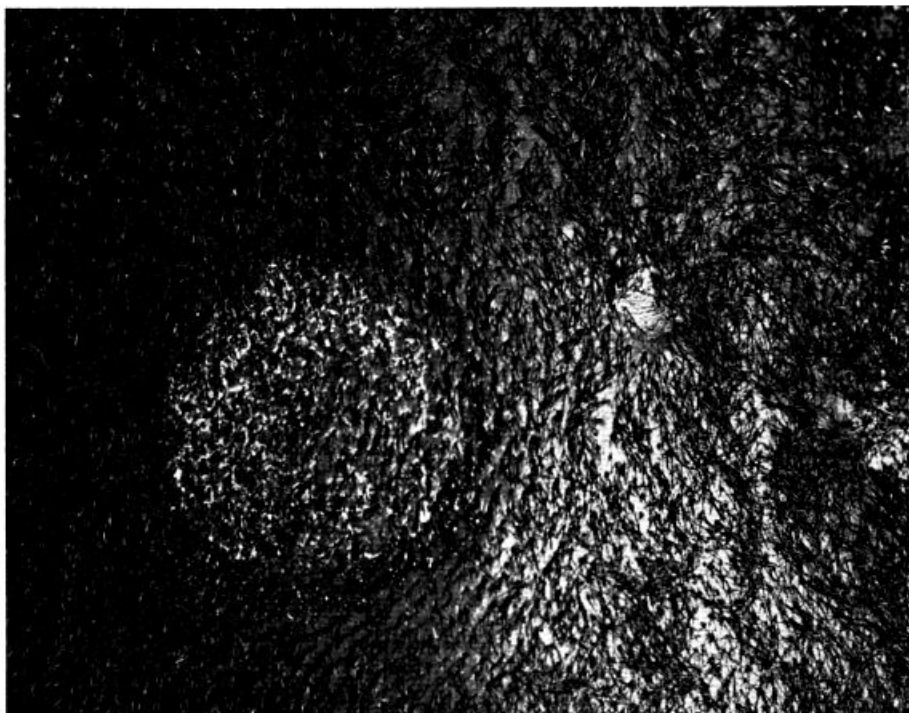


Figure 2. Mild scaling of the nondandruff scalp revealed by ether delipidization

A method found useful for estimating the extent of dandruff consists of applying ether in a cup to the scalp for one minute. The replacement of lipids by air scatters light and the scales become prominent (Figs. 1 and 2).

Experience teaches that a single estimate on unprepared subjects is unreliable. Final judgment was rendered only after the following baseline procedure: The subjects were washed every 4 days with Ivory soap for 12 days with clinical appraisal just before each washing. Nothing else was applied to the scalp; antibacterial soaps were avoided. This 4-day washing regimen was standard procedure throughout each study. The subjects were healthy adult males between the ages of 20 and 40.

Histopathology

It is surprising that a condition as common as dandruff has not been thoroughly studied in respect to its microscopic peculiarities, yet no clear picture of the histopathology of dandruff has emerged.

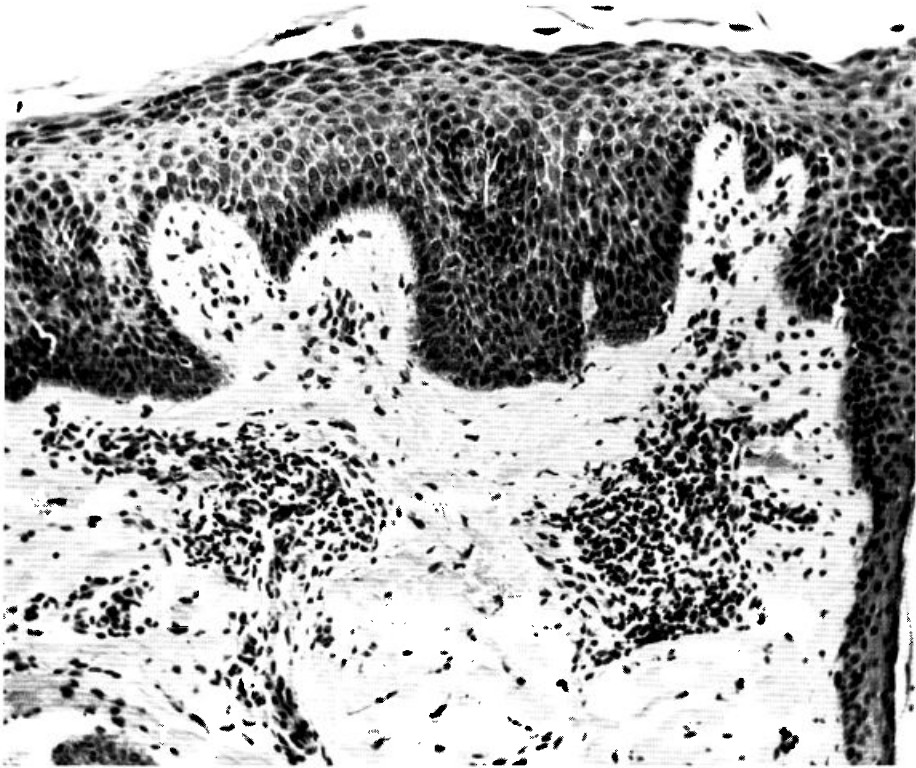


Figure 3. Perivenular lymphohistiocytic infiltrate and apparent epidermal hyperplasia in a nondandruff specimen demonstrating that aggregates of chronic inflammatory cells may be present on the normal scalp

Full thickness excisional biopsies were secured from the mid-parietal areas of 65 scalps. Twenty of these were normal; the rest had heavy dandruff. The specimens were fixed in formalin and stained with hematoxylin and eosin. Additionally, about a third were stained with (a) PAS for glycogen and (b) Hale-Orcein for elastic fibers and acid mucopolysaccharide. One of us (AMK) evaluated the slides without knowing their source.

In describing the results of such a survey, which necessarily deals with subjective appraisals, awareness of the following features is essential to a proper understanding. Firstly, histologic processing invariably distorts and disrupts the horny layer; often much of it is lost in sectioning. Accordingly, histologic evaluation of the horny layer has limited usefulness. Secondly, in searching for evidence of inflammatory changes, especially infiltration of the dermis by mononuclear cells, one is occa-

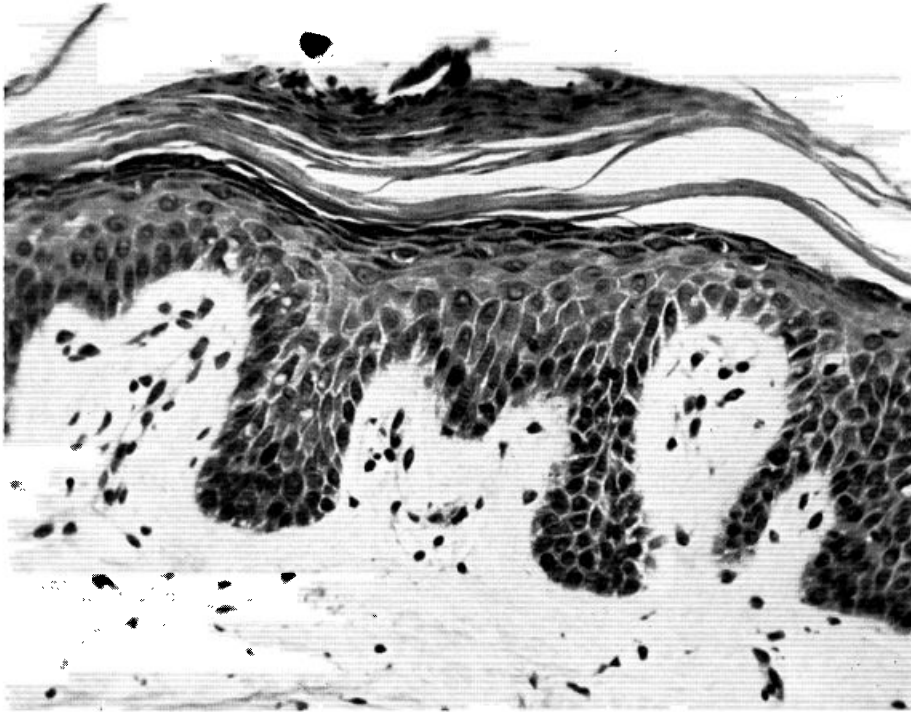


Figure 4. Focal parakeratosis in an otherwise normal-appearing section is characteristic of dandruff. Serial sections may be required to reveal the retained nuclei

sionally surprised by the dense peri-vascular accumulation of such cells in the normal scalp (Fig. 3). Without study of normal scalps, one would often incorrectly classify dandruff as an inflammatory disease at the microscopic level. In fact, many dandruff scalps do not display any notable amount of dermal round cell infiltration. Thirdly, the papillae of the scalp are particularly well-developed so that the dermo-epidermal contour is strongly undulated. Thus, the thickness of the epidermis is not uniform, and appraisal of the presence of epidermal hyperplasia is very difficult indeed, especially if the sectioning is somewhat oblique.

It is worth reporting how our conception of the histopathology of dandruff evolved, *pari passu* with our experience. For a time, we came to believe that there was no basic histologic difference between normal and dandruff scalps, that no single specimen could be declared to be one or the other. When the proportion of specimens showing what was deemed to be epidermal hyperplasia in dandruff scalps was finally determined, much the same incidence was present in the control group. Likewise, inflammatory change was apparently invariable in dandruff and

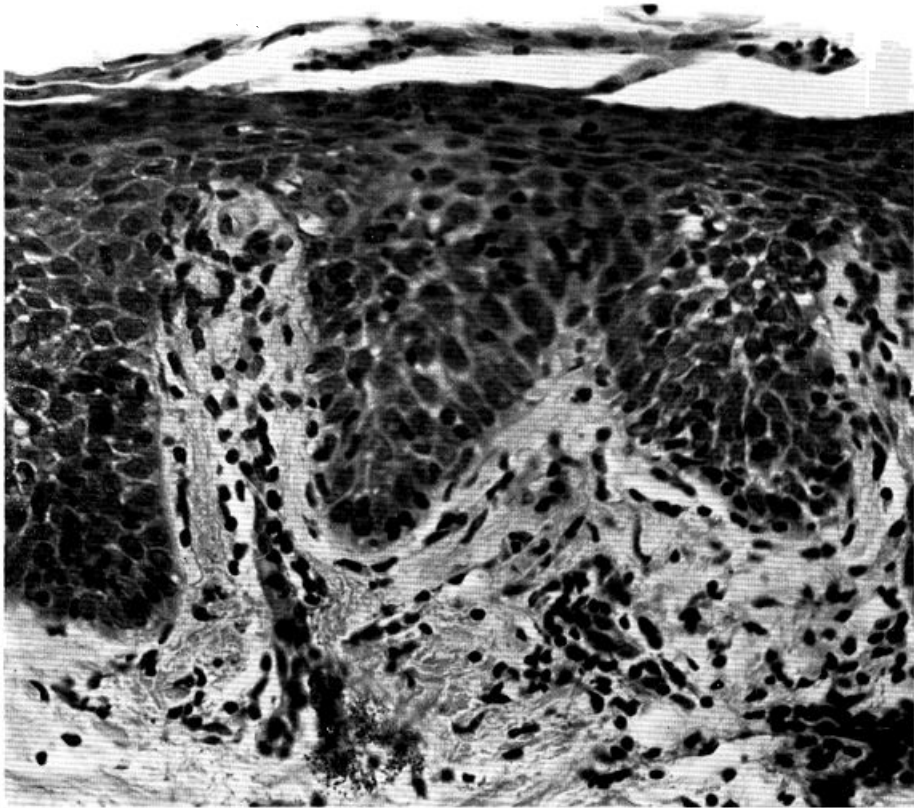


Figure 5. Histology of seborrheic dermatitis showing parakeratosis, spongiosis, exocytosis, and dilated capillaries surrounded by lymphocytes and histiocytes

normal scalps. As regards hyperkeratosis, presumably the histologic expression of excess scaling, loss of scale in sectioning often reduced the diagnostic worth of this feature. We wish to assert nonetheless that the histopathology of dandruff is characteristic and that by appropriate study an accurate diagnosis is almost always possible. The hallmark of dandruff is scattered foci of parakeratosis in a histologic specimen which is otherwise normal (Fig. 4). To find these segments of nucleated horny cells may require viewing of a dozen or more serial sections. They are not subtended by inflammatory dermal changes similar to the "squirting" papillae so graphically described by Pinkus (2) in psoriasis and seborrheic dermatitis (Fig. 5); these latter are the principal diseases which must be differentiated histologically from dandruff. Ordinarily this distinction presents no difficulty. Seborrheic dermatitis and psoriasis chiefly differ from dandruff by (a) unmistakable epidermal hyper-



Figure 6. The alkali swelling technique illustrating the dandruff horny layer with its chaotic patterning, crevices, and buckled, poorly swollen cells

plasia (b) extensive parakeratosis, and (c) signs of inflammation, including a dermal infiltrate with migration of lymphocytes and histiocytes into the epidermis (exocytosis) (2).

The focal nature of the parakeratosis in dandruff is worthy of emphasis. This finding perhaps provides some insight into the pathophysiology of dandruff. As a rule, parakeratosis is a sign of increased epidermal turnover; the cells stream so rapidly to the surface that they do not have time for keratinization to be completed. The focal parakeratosis in dandruff suggests that the rate of epidermal growth is not uniform. Some microscopic segments are turning over at a faster rate than others. This, in turn, might lead to the uneven disruption of the dandruff horny layer and to the production of thick masses of horny cells in some places while elsewhere the horny layer is not thickened and, in fact, may be thinned.

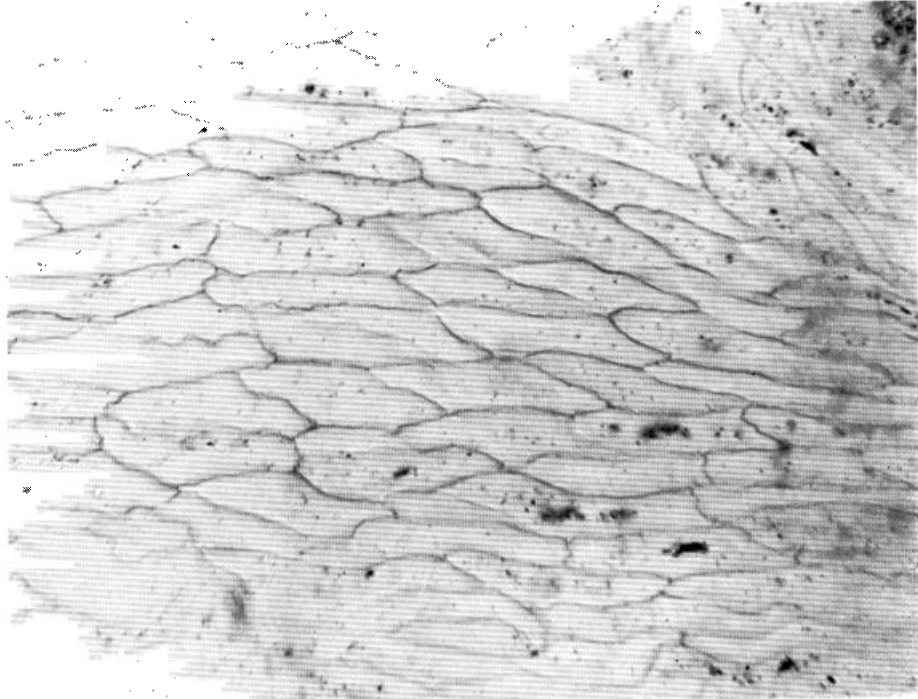


Figure 7. Nondandruff horny layer visualized by the sodium hydroxide swelling method. The cells are coherent, well swollen, and regularly patterned

Organization of the Horny Layer

Cellular Number

That the number of cells in the dandruff intact horny layer is fewer than normal was demonstrated by two methods:

A. Scotch Tape Stripping—After shaving the scalp, the number of strips required to reach the glistening layer was determined in 5 dandruff and 5 nondandruff subjects. The end point was reached much earlier in dandruff. The number of strips was 10 to 15 in dandruff, compared to 26 to 48 in the nondandruff. This suggests a lesser number of cell layers in the coherent stratum corneum or that more cell layers were removed per strip in dandruff.

B. Sodium Hydroxide Swelling—Sheets of horny layer obtained by the cantharidin blister technique (3) were sectioned and the cells rendered visible by swelling with sodium hydroxide (4). Eight dandruff and eight nondandruff horny layers were so studied.

In dandruff, the coherent horny layer is conspicuously thinner, usually 10 or fewer cell layers compared with 25 to 35 in the nondandruff. Moreover, in dandruff the cells swell less and have a disorderly pattern interspersed with crevices (Fig. 6). By contrast, the keratinized cells of the normal horny layer swell easily, are quite regularly arranged and remain tightly bonded (Fig. 7). These observations apply to the coherent nondesquamating portion of the horny layer.

A finding which at first seems paradoxical is that while the intact horny layer is thinner in dandruff, the total number of horny cells is considerably greater than the normal when the loose scale is included. Actually, the dandruff horny layer taken as a whole is very irregular in thickness. The coherent bottom bed is of fairly uniform width, but here and there one finds "boulders" of horny detritus precariously balanced on the bed. There may be 30 or more poorly organized cell layers in the large boulders. One explanation is that the boulders reflect sites of greatly increased horn cell production; the cells stream to the surface at different rates of movement leading to "cracking up" of the stratum corneum in uneven fashion.

Cellular Arrangement

That the dandruff horny layer is imperfectly organized is manifested in several ways. When plastic cups sutured to the scalp were used to prevent loss of horny material, histologic section in which the scale happened to be retained showed considerable irregularity in patterning (Fig. 8). The laminae were undulating instead of flat and curved as if attempting to form whorls. Crevices between the cells were frequent. McOsker and Hannon observed marked changes in dandruff scales studied under the electron microscope (5). Desmosomes were less frequent; the cells tended to separate and fold on themselves and there were numerous intracellular lipid droplets.

These observations suggest that a major alteration in dandruff is the tendency of the horny layer to "crack up" unevenly, whereas, in the normal process of desquamation, tiny fissures occur near the surface and permit the orderly separation of microscopic cell aggregates. In dandruff, breaks occur deeply and irregularly in the horny layer, resulting in dislodgement of very much larger cell clumps. Dandruff scales, like those of psoriasis, appear white due to the presence of air in the clefts between the cellular fragments.

The surface topography of the dandruff scalp is strikingly different from normal; this was particularly well shown in skin replicas (6). The



Figure 8. Occasional instance in which the loose scales of dandruff are not lost during sectioning. Total disarray of the horny layer with cells recurring on themselves and tending to form whorls. Appropriate stains demonstrate innumerable bacteria and yeast between the horn cells

nondandruff surface is rather flat and desert-like. Individual polygonal cells with clear cellular outlines stand out. The dandruff terrain is extraordinarily irregular. Huge craters are formed where chunks of horny cells have fallen out. Boulders of horny cells litter the scene. Individual cell boundaries are hard to discern.

Cytology of the Horny Layer

In order to study the architecture of the horny cells, adhesive-coated slides were pressed against the scalp according to the method of Goldschmidt and Kligman (7). Horny layer cells adhere as with Scotch tape and the broad axis of the cells can be visualized when the slide is stained with Giemsa.

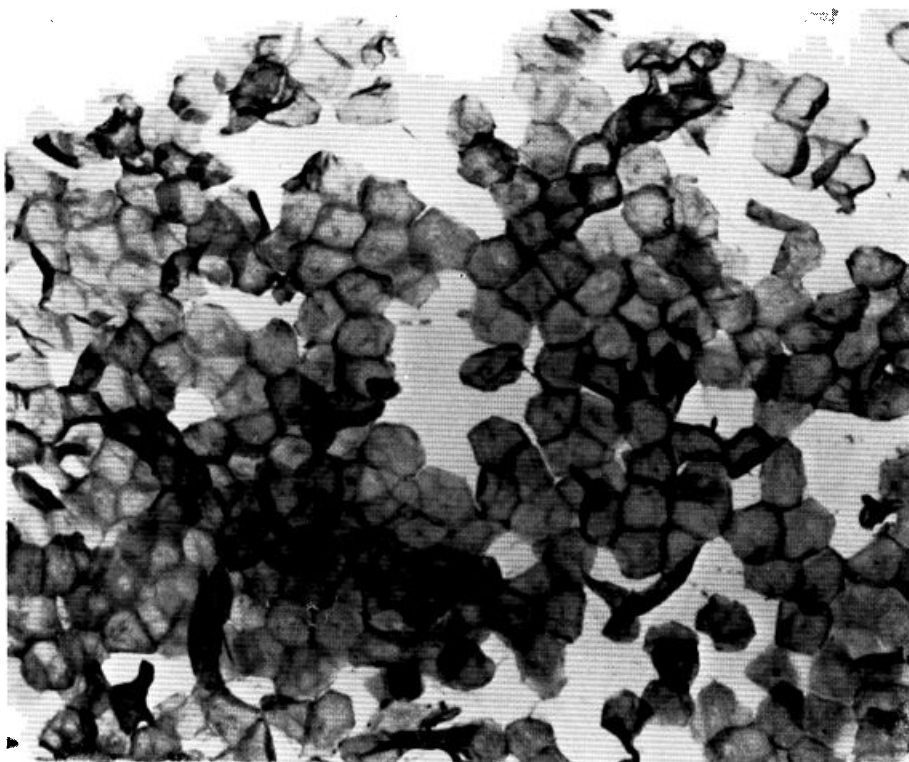


Figure 9. Nondandruff horny cells removed onto an adhesive-coated slide. The cells are predominantly one cell layer thick and form a sheet. Individual cells are clearly distinguishable

Consonant with the grossly increased scale in dandruff, the scales on the first few serial slides are composed of large clumps of many hundreds of cells. Nondandruff scales are also cell aggregates but of considerably smaller size.

In order to insure sampling of the coherent portion of the stratum corneum, the visible scurf was first removed, followed by serial Scotch tape stripping. In contrast to the neatly arranged monolayer sheets of polygonal cells that are the hallmark of the nondandruff scalp (Fig. 9), dandruff cells do not come off in orderly sheets but dehisce in haphazard fashion. There are many randomly scattered small groups of cells, often several layers thick. The individual dandruff cells tend to warp and curl upon themselves and not to lie parallel to the slide surface. This again testifies to faulty organization.

The individual dandruff and nondandruff horny cells were not significantly different. Cell membranes were intact and the size and shape were similar.



Figure 10. Adhesive slide preparation from dandruff scalp. Unlike the nondandruff stratum corneum, these are many cell layers thick and individual cells are hard to see. Note the scattered parakeratosis which is one of the hallmarks of dandruff

A characteristic feature of dandruff revealed by the glue slides was the presence of scattered foci of parakeratotic cells (Fig. 10). These correspond to the parakeratotic segments in histologic sections but they are much easier to find in surface strippings. Parakeratotic horny cells are quite uncommon in the nondandruff scalp. Parakeratosis is not pathognomonic of dandruff, being present in seborrheic dermatitis and psoriasis as well. In these conditions, however, parakeratotic cells predominate. It should be emphasized that the parakeratotic cells in dandruff occur in clusters and not randomly. These reflect microfoci of increased turnover.

Microbiology

Bacterial Flora

The universal presence of antibacterial agents in antidandruff preparations seems to imply a causative role for bacteria. It has been thought that dandruff scalps harbor organisms different from the nondandruff

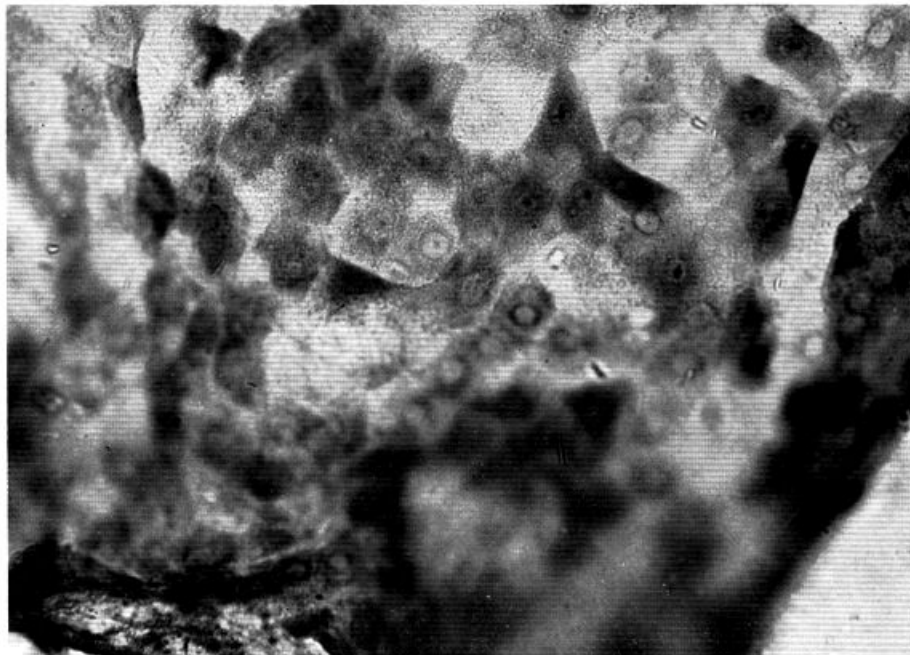


Figure 11. Giemsa-stained adhesive slide from the horny layer of seborrheic dermatitis. Most of the cells have retained their nuclei. Parakeratotic cells are dominant in seborrheic dermatitis and psoriasis

or that there is a characteristic dandruff flora. Clearly detailed information about the nondandruff flora is a prerequisite for judging the possible etiologic role of bacteria.

A fairly extensive analysis of the nondandruff and dandruff scalp was undertaken. The scalp was sampled by the scrubbing technique of Williamson and Kligman (8). The organisms were plated and counted by previously described methods. Thirty-nine nondandruff and 24 dandruff scalps were studied for aerobic organisms; 27 nondandruff and 15 dandruff scalps were examined for anaerobes. The geometric mean aerobic count (expressed per cm^2) for dandruff was 1.482×10^6 , while the dandruff aerobe count was 0.2513×10^6 , a sixfold difference. The dandruff mean anaerobic count was 2.527×10^6 , the nondandruff anaerobes 1.260×10^6 , a twofold difference.

The principal organisms in dandruff were those which occur elsewhere on the skin, the aerobic *Staphylococcus epidermidis* and the anaerobic *Corynebacterium acnes*. Qualitatively there was no difference in composition between the dandruff and nondandruff flora. The number of

aerobic organisms was greatly elevated in dandruff. There was no evidence that certain organisms were more commonly associated with dandruff.

That the dandruff aerobic flora was increased sixfold is entirely in accord with expectations. The resident aerobes are confined to the superficial desquamating part of the horny layer. There are no niches in the coherent portion and McOsker and Hannon (5) found no organisms within it. In dandruff, the loose scales enormously increased the physical surface in which organisms live and also contributed more by-products of keratinization to support bacterial growth. It seems likely that this great increase in aerobic flora of the dandruff scalp is secondary to the scaling and not the cause of it.

Response to Antibacterial Agents

From time to time the notion recurs that bacteria are etiologic in dandruff (9). Presumably this is the rationale for incorporating antimicrobial substances in antidandruff preparations.

Fifteen dandruff subjects were treated daily for 20 days with 1% neomycin sulfate in polyethylene glycol 200 and 15 control subjects with the vehicle alone (Table I). Quantitative bacterial counts were done at the inception and termination of therapy. The scalp was shampooed every fourth day with Ivory soap. Despite an approximately 97% reduction in the number of aerobic bacteria, there was no consistent decrease in the amount of dandruff. Although what appeared to be great benefit from treatment was occasionally observed, similar responses occurred in the controls. Since polyethylene glycol is mildly antibacterial, the post-treatment control values were lower than what might have been expected for an inert vehicle.

Table I
Total Aerobic Bacterial Counts of Dandruff Scalps Sampled in Duplicate

Subject	Pretreatment (10 ⁶), cm ²	Post-treatment (1% Neomycin), cm ²
1	5.8	22,300
	3.2	56,000
2	0.01	73,000
	0.7	1,670
3	3.5	357,879
	4.5	46,666
4	3.5	459,696
	2.9	177,879
Gravimetric means per cm ²	0.51 × 10 ⁶	16,197

We would like to reiterate that accurate evaluation of the efficacy of antidandruff therapy is very difficult. Any shampoo regularly applied is helpful, if only by washing out scurf. Therefore, only consistent or marked diminution in the amount of dandruff can be deemed therapeutically significant. In our estimation, neomycin eliminates aerobic bacteria, but not dandruff. Anaerobes were not studied.

These experiments do not contradict the evidence that some antibacterial agents, zinc pyridine thione for example, diminish dandruff. We postulate, however, that the elimination of bacteria is probably not the mechanism by which these chemicals suppress dandruff. We suppose that they inhibit the rate of proliferation of epidermal cells.

Fungal flora

Of the microorganisms mentioned in the pathogenesis of dandruff, none have been more consistently invoked than *Pityrosporum ovale*. This lipophilic yeast, which is part of the normal cutaneous flora, has achieved fame as the supposed cause of dandruff (10). It has its headquarters on the scalp where it is the dominant fungal element. Actually, recent studies reveal two *Pityrosporum*, *P. orbiculare* as well as *P. ovale* (11).

The quantity of *Pityrosporum* species on the scalps of dandruff and nondandruff subjects was estimated in two ways:

1. Direct visualization by application of adhesion slides to the scalps of 25 dandruff and 15 nondandruff subjects and then staining of the slides with periodic acid Schiff reagent.
2. A more quantitative method using the Millipore filter method in 5 dandruff and 5 nondandruff subjects (12).

Both methods yielded similar results. Every hairy scalp had abundant numbers of *Pityrosporum*, predominantly *P. ovale*. The number of *Pityrosporum* present on the dandruff scalp greatly exceeded that of the nondandruff. Our interpretation is that the greatly increased scaling in dandruff enables larger quantities of organisms to grow. The enhanced fungal flora is probably secondary.

Response to Antifungal Agents

In order to try to assess the possible causative role of *Pityrosporum* species, we undertook to eliminate these yeasts without affecting the bacterial flora. Fifteen dandruff scalps were treated once daily for 20 days with 3% aqueous Amphotericin B,* 5 with 1% aqueous nystatin,†

* Fungizone lotion (3%) Squibb.

† Neomycin sulfate (1%).

and 5 with water. Amphotericin and nystatin dramatically reduced the number of *Pityrosporum* as gauged by glue slides, but, despite almost total eradication of yeast, heavy dandruff persisted in all but three subjects.

It seems likely that the yeasts multiply more abundantly as the amount of scale increases and that they are not in themselves responsible for the increased scaliness.

Epidermal Kinetics

Epidermal turnover refers to the time required for the entire population of epidermal cells, dead and alive, to be replaced. The epidermis grows continually by virtue of random cell divisions in the basal or germinative layer. The rate of loss of horny cells at the surface is necessarily in equilibrium with the production of new cells in the basal cell layer. If more scales are produced in dandruff, then cell turnover must be accelerated. At any given time, there should be more cells in mitosis and the time required for a basal cell to traverse the dandruff epidermis and be cast off at the surface (transit time) should be less.

Heretofore, there has been no direct demonstration of these signs of increased turnover in dandruff. Although our observations are incomplete, they are sufficiently clear to merit disclosure.

Our earliest study, in collaboration with Dr. Eugene Van Scott, measured the mitotic index, the percentage of dividing cells per thousand basal cells. While, on the average this value was about twice normal in dandruff subjects, there were difficulties. This procedure is tedious and difficult, especially in Negroes whose melanin-packed epidermal cells obscure mitoses. In addition, some dandruff subjects had normal values, probably reflecting experimental error.

Radioautographic techniques for studying epidermal kinetics are more crisp and accurate. Weinstein and Van Scott (13) and Epstein and Maibach (14) have pioneered the technique of intradermal injection of radiolabelled substances into human skin. When, for example, tritiated thymidine is injected, this nucleic acid is quickly incorporated into the nuclear chromatin. Biopsy within the next 30–45 minutes shows the number of basal cells which are in the stage of DNA synthesis, a step preparatory to mitotic division and thereafter an index of the latter. Furthermore, biopsies on successive days after injection of tritiated thymidine enable one to determine when the first cells reach the base of the horny layer. In the skin of the back there is fairly good agreement that the turnover time of the living epidermis is about two weeks.

We injected 0.1 ml of a saline solution containing 5–10 μc of ^3H -thy-

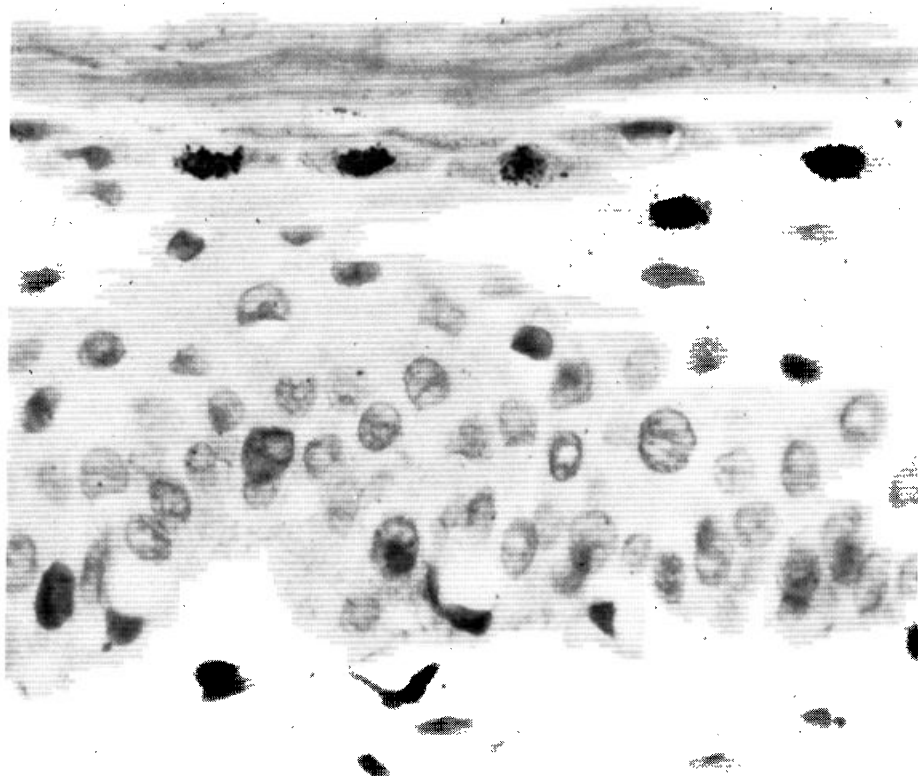


Figure 12. Dandruff specimen 5 days after intradermal injection of ^3H -thymidine. Most of the labelled cells have reached the top of the living epidermis

midine into the scalps of 6 dandruff subjects and 5 normals. The tissues were processed in the standard way. In biopsy specimens taken after 45 minutes, the percentage of labelled basal cells was determined. In the normal, the average was about 7% (range 5–9%). The corresponding figure for dandruff was about 13% (range 8–19%). These figures indicate almost a doubling of the turnover rate in dandruff. There was one additional finding in some of the dandruff specimens which also signified increased turnover, namely, a higher percentage of suprabasalar labelled cells indicating that cells which had left the basal layer were still capable of dividing. This, of course, adds to the germinative population and ultimately to the quantity of cells reaching the surface. Psoriasis is the ultimate example of rapid turnover in which the bottom three layers of

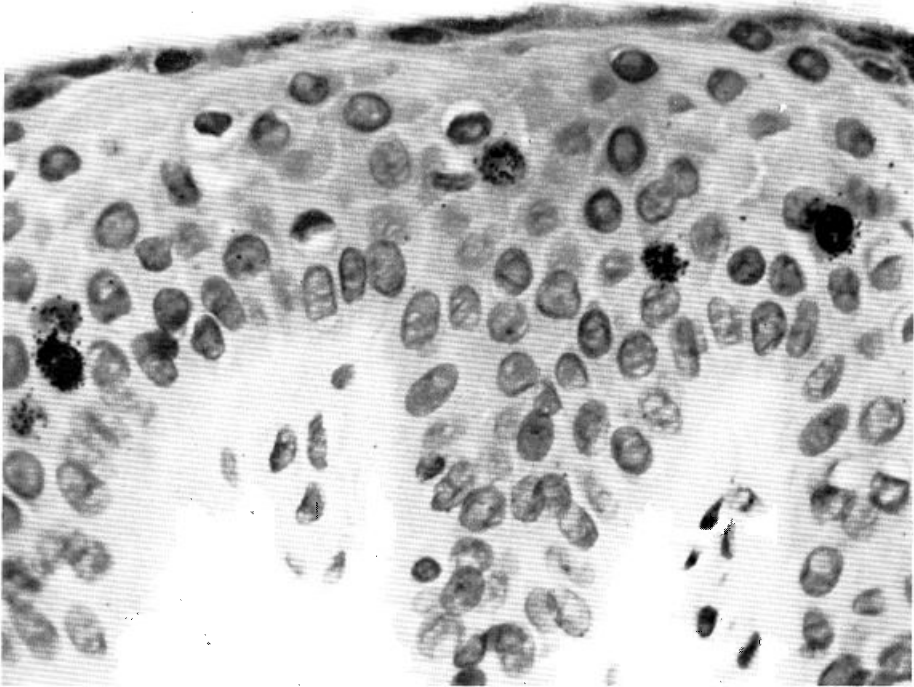


Figure 13. Nondandruff scalp specimen 5 days after intradermal injection of tritiated thymidine. The labelled cells are at the mid-epidermis or below

cells are capable of mitosis, contributing to the remarkably short turn-over time of about 3–4 days.

We examined some specimens obtained 5 days after thymidine injection. Without mensuration, it was apparent which specimens were obtained from dandruff subjects. In these, some granular and even parakeratotic cells were already labelled by 5 days while the remaining labelled cells were distributed in the outer half of the viable epidermis (Fig. 12). In the normal scalp, by contrast, the label had generally not reached the granular layer by 5 days and the majority of cells were at mid-epidermis or below (Fig. 13). In short, the 5-day evaluation proved quite instructive in judging the rate of passive movement of the cells to the surface. In dandruff, the labelled cells and their daughter cells were distributed in the outer portion of the epidermis, while the reverse of this obtained in the nondandruff. Unfortunately, thymidine-labelled cells cannot be followed further than the granular layer owing to disorganization of the nucleus in the horny layer.

DISCUSSION

From the preceding studies a tentative conception of the nature of dandruff has been formulated. It is proposed that profuse scaling of the scalp, the hallmark of dandruff, represents a fundamental alteration in the rate regulating mechanism of horny cell production, i.e., epidermal turnover is increased. The rapid transit of cells to the surface does not allow time for complete keratinization. This is betrayed by the presence of parakeratotic cells. Horny layer coherence is affected and cracks occur deep in the horny layer, producing large flakes. The intensified scaling reflects both a true increase in the production of horny cells and their being rendered more conspicuous by "cracking up" and desquamating as large aggregates.

In dandruff, unlike other conditions in which there is an increased turnover rate of the epidermis, there is no histologic evidence of an antecedent inflammatory stimulus to power the process. Nor is there any other characteristic histologic change in the living part of the skin. The principal pathology is located in the horny layer. The dead horny layer cells must reflect changes that occurred when they were living and made their upward migration. These aberrations in the living epidermis and perhaps the dermis are recondite and will require the more powerful tools of electronmicroscopy and biochemistry to define them. McOsker and Hannon (5), in their electron microscopic studies, did show striking alterations in the stratum corneum, but not in the viable epidermis.

It is therefore postulated that changes in the dandruff horny layer, the chaotic pattern, "cracking up" into large cellular aggregates, crevices, and sporadic parakeratosis, are secondary to more rapid epidermopoiesis and perhaps some subtle change in epidermal physiology. Whenever the rate of keratinization is accelerated, there is faulty cohesion and evidence of incomplete keratinization. In terms of epidermal kinetics, dandruff is perhaps intermediate between normal skin and frankly pathologic conditions such as seborrheic dermatitis and psoriasis.

If the structural and chemical changes characteristic of dandruff are subsequent to increased epidermopoiesis, one might anticipate that the biochemical changes in the dandruff horny layer would correspond to those in psoriasis but to a far lesser extent. Preliminary data suggest that these changes do occur in a diminutive way (15, 16). Dandruff scales contain a high sulfhydryl and pentose content and lower than normal amounts of free amino nitrogen.

ACKNOWLEDGMENTS

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