

HUMAN BODY ODOR

by

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ABSTRACT

Variation in the axillary apocrine sweat glands of various human populations is explored with a view to establishing whether to commonly-held notion that different varieties of humans may be distinguished by their body odor. A review of the mechanisms of axillary sweating is provided, and the various effects of skin flora, axillary hair, clothing and certain disorders are shown. Although there is some controversy on the subject of "racial" variation in body odor, it is determined that African blacks probably produce the greatest amount of apocrine sweat, which is the known substrate for axillary odor. They are also found to have the highest eccrine gland count, which may play a role in thermal radiation of body sweat. Mongolian populations are found to be quite high in the number of eccrine sweat glands, but have a general paucity of functioning osmidrotic apocrine sweat glands, which would seem to account for their known lack of body odor.

RESUME

Les variations des glandes apocrines axillaires de nombreuses populations humaines sont étudiées dans le but d'établir si la notion communément admise que les différents types humains peuvent être distingués par leur odeur corporelle. On passe à la revue les mécanismes de la transpiration axillaire, ainsi que les différents effets de la flore cutanée, des poils axillaires, des vêtements et de certains troubles. Bien qu'il y ait une certaine controverse sur le sujet de variations "raciales" de l'odeur corporelle, il est établi que les noirs Africains produisent la plus grande quantité de sueur apocrine qui est le substrat connu de l'odeur axillaire. On constate aussi qu'ils ont le plus grand nombre de glandes eccrines, ce qui peut jouer un rôle dans la radiation thermique de la sueur. On constate que les populations Mongoles ont un nombre assez élevé de glandes eccrines, mais elles sont globalement pauvres en glandes sudoripares apocrines osmidrotiques, ce qui semblerait expliquer l'absence reconnue d'odeur corporelle chez eux.

INTRODUCTION

There are three glands which secrete fluids onto the human skin. The "sweat" glands normally refer to the eccrine glands, which are abundant over most of the body, and are capable of secreting their aqueous solution at the rate of about one quart per hour over a sustained period (Ladell 1964, cited in Brues 1977:181). These glands are principally involved in thermoregulation of the internal body temperature, and may be stimulated by mental and emotional factors as well as by heat (Montagna et al. 1962). The sebaceous glands are mostly appendages of hair follicles (Montagna and Parakkal 1974:285) which occur over most of the body, and secrete a mildly aromatic substance, the functions of which are variously considered to be an emollient to the stratum corneum, a bacteriostatic and fungistatic agent, and especially a pheromone, insofar as the scent glands of many mammals are predominantly sebaceous (Montagna and Parakkal 1974:321).

Of special interest, here, however, is the apocrine sweat gland, especially those associated with the axilla. This third type of gland secretes only minute quantities of fluid, but with the breakdown of this oily secretion by bacteria, apocrine sweat is responsible for the production of "body odor" (Brues 1977:142). Control of the pervasive odor of apocrine sweat is regarded by most of modern society as essential, and in the name of the battle against "body odor", Americans alone spend over three million dollars a year on deodorants (Hurley, cited in Moschella et al. 1975:1146).

The glands under consideration here, then, are the apocrine glands of the human axilla. Before investigating the notion that human populations can be characterized by their smell, the factors involved in the emanance of "body odor" from a given individual will be reviewed.

APOCRINE SECRETION AND BODY ODOR

The apocrine sweat glands are found at the axilla, the anogenital region, the mammary areola, the ear canal (ceruminous glands) and the eyelid (glands of Moll) (Hurley and Shelley 1960:3) but are largest in the axilla, where secretion is most prolific. The apocrine glands of the other areas are smaller, and in the view of some, may not function at all (Kligman and Shehadeh 1964, cited in Montagna and Parakkal 1974:356).

In carefully controlled experiments by Shelley, Hurley and Nichols (1953), it was determined that apocrine sweat is odorless and sterile when it initially appears on the skin and that the odor is produced by the action of axillary micro-organisms on the apocrine sweat. In the first experiment samples of pure and contaminated apocrine sweat were collected in vials, incubated at room temperature, and examined at varying intervals. It was found that pure apocrine sweat collected from a "sterile" axilla failed to develop any odor throughout the fourteen-day period of incubation. Tubes containing apocrine sweat from an "unsterile" axilla developed a strong odor within six hours which became very strong at 24 hours. These findings were confirmed in an *in vivo* experiment by the same researchers (1953:433-436) and by Ferguson (1955).

With the intention of isolating the axillary bacteria which were responsible for the production of odor, Shehadeh and Kligman (1963) contaminated and incubated samples of pure apocrine sweat with a variety of bacteria known to occur commonly or rarely in the axilla: coagulase negative staphylococci, diphtheroids, Aerobacter sp., Alkaligenes fecalis, Sarcina sp., coagulase positive staphylococci, Proteus vulgaris, E. coli and Corynebacterium acnes. They concluded that only the gram positive resident organisms, coagulase negative staphylococci and diphtheroids, which completely dominate the axillary microflora generated the typical odor. This refutes a previous study by Strauss and Kligman which stated that odor production was a non-specific property of practically any organism (1956:69). In reference to the notion of "scent glands" in humans, Kligman asserts that "there can no longer be a reasonable doubt that the apocrine glands are not "scent" glands. The characteristic pungent odor of the human axilla is in consequence of bacterial decomposition of apocrine sweat by resident Gram-positive organisms" (Kligman cited Dineen and Hildick-Smith 1965:14).

The other axillary sweat comes from the eccrine glands, and accounts for the majority of secretion in that region. Further to their investigation of the odor-producing capacity of apocrine sweat, Hurley and Shelley performed experiments in a manner similar to those noted above, and determined that no odor developed from pure eccrine sweat, and that the odor that developed from contaminated eccrine sweat collected from the trunk, legs and neck was not pungent or offensive, and was quite distinct from axillary odor (1960:90).

There are however, a number of disorders characterized by unusually scented or prodigious sweat which deserve mention here. Diphtheria ("sweetish"), diabetic coma ("fruity"), scurvy ("Putrid"), yellow fever ("butcher shop"), and typhoid fever ("freshly baked brown bread") are well-known to those attending patients with these

conditions. Osmidrosis is a condition in which a usually offensive, excessive odor is given off by the skin and is either associated with apocrine or eccrine glands (Hurley, cited in Moschella *et al.* 1975:1147-1149). As revealed in the above studies, however, it is evident that the usual source of the malodorous effluvium in the average individual is due to the bacterial action upon axillary apocrine sweat.

Apocrine sweat is the only natural substrate which, when decomposed bacteriologically, gives rise to the classic apocrine odor. Neither sebum, hair, eccrine sweat, keratin scales nor any combination thereof can be substituted for apocrine sweat and result in this odor (Hurley, cited in Moschella *et al.* 1975:1150).

Although Strauss and Kligman (1956:70) refrain from correlating the amount of apocrine sweat secreted with the intensity of body odor, it would seem reasonable to assume that if "intensity" means the density of the vapour rather than the "pugnency" of the odor, then a greater quantity of apocrine sweat broken down by bacteria would vaporize at a greater density and thus be more intense.

The quantity of the axillary apocrine sweat secreted is influenced by the size and number of functioning apocrine glands, and will be discussed later. The quality of the odor derives from the chemical composition of the apocrine sweat which produce short chain fatty acids and ammonia. "A variety of odors - musty, rancid, fecal, sour, and sweet - may be perceived, reflecting individual differences in the chemical composition of axillary sweat" (Hurley, cited in Moschella 1975;1150). Occasional excretion of odoriferous material such as onion, garlic, arsenic, and certain drugs occurs in relation to the eccrine glands (Hurley, cited in Moschella 1975;1147). This may mix with axillary apocrine sweat or be observed "straight". Apart from these foods, no studies on the effect of diet on apocrine or eccrine sweat were found in the literature, although the relationship seems to be generally accepted (Brues 1977:143; Montagu 1974:335).

There are some secondary factors that are involved in body odor. One in particular is of interest because of its correlation with human diversity, and that is axillary hair. Hurley and Shelley's (1960) experiments noted earlier drew attention to the significant role that bacteria plays in the manufacture of odorous substances. To investigate the role of hair in the development of axillary odor, ten subjects each had one of their axillae shaved, then carefully washed both axillae with Ivory soap for ten minutes, and rinsed thoroughly with water. The production of odor was markedly less in the shaved axilla. The reason for this was found to be "the axillary hair acts as

a collecting site for apocrine sweat and debris, makes cleansing of the area more difficult. Moreover, bacteria may cling to such hair" (Hurley and Shelley 1960:89). The cleanliness of clothing is an additional factor, in that it can also harbour odor-causing bacteria (Hurley, In: Moschella 1975;1150; Shelley et al. 1953:438).

In summary, then, the typical axillary odor which is known as "body odor" is the result of the action of certain bacteria present in the skin flora of the axilla on the axillary apocrine gland secretion. The amount of sweat secreted and the cleanliness of the axilla are primary factors in the development of odor. The presence of axillary hair can greatly inhibit thorough cleansing of the axilla.

VARIATION AMONG HUMAN POPULATIONS

The majority of literature dealing with the production of sweat and odor in humans has concentrated on African and American Blacks, Europeans, American Caucasians, and Japanese. There have been few studies involving direct comparison of various combinations of these groups, so in many instances indirect comparisons are drawn upon here to formulate the nature of the diversity between populations.

The intent of this paper is to investigate the assumption that the three major human "races" vary significantly in the amount of sweat produced and in the odor which a member of each population is capable of producing. The belief that "the Negro ... possesses a unique and objectionable body odor" (Montagu 1974:332) is of particular interest because of its obvious sociological implications. The apparent paucity of axillary odor in Mongoloid populations will also be investigated, and the relationship between Caucasoids, Negroids and Mongoloids for this trait will be ascertained insofar as the extant literature permits.

Earlier it was suggested that the amount of apocrine sweat played a direct role in the intensity of the odor emanating from the skin. The difficulty in sterilizing the skin of the hands is well-known by surgeons (Dineen and Hildick-Smith 1965:291-309) and the abundant flora of the axilla was noted earlier. It is likely therefore, that there will usually be a plentiful supply of bacteria at the skin site, and that the more substrate made available, the greater the production of the malodorous axillary substance. Given this, it should be determined what factors influence the amount of apocrine sweat secreted, and whether there is variation in these across populations. One factor might be the number of glands in the axilla. Unfortunately, anatomical studies have excluded this site rather consistently. Schiefferdecker

studied a sample consisting of one Australian aborigine, one Chinese, two Africans, and twelve Germans and suggested that the various human races differ in the abundance of apocrine sweat glands (Schiefferdecker 1922, cited in Homma 1926). Homma found the sample rather small, and made his own study on the bodies of twelve Europeans and thirteen American Blacks with no known "White" genes. Areas examined included the mons veneris, the perianal region, the abdomen and the breast. The axilla was also examined in each case, but not recorded. The frequency of apocrine glands was greater in Blacks than in Europeans, thus supporting Schiefferdecker's suggestion (Homma 1926;370). The total number of sections examined in Blacks was 631, almost 100 more than in Europeans and may possibly account for some of the difference in the frequency with which the apocrine gland were found.

Hurley and Shelley's work does not make mention of the density of axillary apocrine glands in the various groups examined (1960). The relative size of the apocrine gland, however, appears to have been of more interest to researchers. In this regard, Hurley & Shelley found that "the Negro has (axillary) apocrine sweat glands which for the most part are significantly larger than those of the Caucasian. This, of course, results in greater quantities of apocrine sweat which appear on the skin surface" (1960:64). Chinese and Japanese men were also examined and it was confirmed that Orientals have little or no body odor, indicative of (lack of) apocrine gland activity. Kuno indicates that the lack of apocrine body odor is not due to the relatively small number of osmidrotic apocrine glands, but instead anosmidrotic apocrine glands which have only small secretions, relative to the usual secretion from an apocrine gland (1956:49-51). Photographs of the axillary apocrine glands of a "White" and a "Negro" are provided by Hurley and Shelley (1960:10) and even under very low magnification there is a considerable difference in the size of the two glands. The implication was made that difference is typical. Montagna and Parakkal made no reference to this size difference, except to say that "studies of these glands have not been popular" (1974:333).

Whether the amount of apocrine sweat produced in the axilla is due mostly to the number, size or efficiency of the functioning glands remains uncertain. It has been observed, nonetheless, that African Blacks are most capable of producing sizeable quantities of apocrine sweat. In Strauss and Kligman's study (1956) mentioned earlier, Negro subjects were used for the actual collection of apocrine sweat for in general this group appears to have a more abundant outpouring of apocrine sweat. Hurley and Shelley (1960) compared thirty "Negro" and thirty "White" adult male subjects after local epinephrine and emotional stimulation, and it was revealed that the Negro consistently produces greater quantities of apocrine sweat than does the White (1960:42). No variations were found among the Caucasians, and Mongolian groups were not studied for apocrine sweating. In addition,

it has been determined by Hurley and Shelley (1960) that the larger apocrine glands of Blacks tend to have a shorter refractory period (Hurley and Shelley 1960:31).

According to Brues, axillary sweat glands are usually poorly or not at all developed in Mongoloid peoples, but are well-developed in the other major races (1977:143). It is assumed she refers to "apocrine" glands when saying "axillary" glands. It should be mentioned that the use of a single, general term like "axillary" or "sweat" in reference to the axilla is common practise, and this may well be the reason that people equate copious axillary sweating with body odor. Of the three axillary glands, it is the minute secretions of the apocrine gland that are responsible for the familiar axillary odor.

The presence of hair in the axilla enhances the production of odor. It is noteworthy that the Mongoloid populations, who are least hirsute of the three major human groups, also suffer least from axillary odor (Hurley and Shelley 1960:97). In view of the fact that Caucasians have more body hair than Negroids (Brues 1977:148) it could be expected that this would make up for the smaller apocrine glands of the Caucasian and make him capable of producing as much odoriferous axillary substance as the Negroid. In spite of this, Caucasians and Mongoloids may generally still consider blacks more odoriferous than themselves, as evidenced by articles and books which condemn this view as a fallacy.

"The Black has long been incorrectly considered to be more sweaty ... and more oily and malodorous ... than the White ..." (Hurley, cited in Moschella 1975:1711); "One of the most popularly entrenched beliefs concerning the Negro is that he possesses a unique and objectionable body odor" (Montagu 1974:332).

The primary function of the eccrine sweat glands is to regulate internal body temperature by evaporation of their aqueous secretion on the skin. Evaporating water is a volatile environment, required for body heat dissipation. If the apocrine sweat of the axilla mixes with a substantial amount of eccrine sweat during a response to thermal or emotional stimulation, it seems reasonable to expect that the pungent odor will radiate with the eccrine vapours, and thus be perceived at a greater range than it would under its own evaporation. The very mechanism of heat dissipation would be expected to function most efficiently in a body that sweated from a greater number of glands, thus utilizing a greater surface area for evaporation. This has been explored by a number of researchers.

Szabo pointed out that although there are a number of studies which claim that certain races have a greater number of (eccrine) sweat glands (Kawahata *et al.* 1961), they usually refer to the number of functioning glands, and not the absolute number of glands present (Szabo 1975:52). Thomson found that the number of thermally-activated eccrine sweat glands did not differ significantly between 21 European and 26 African males (1954:232). Both groups were acclimatized residents in Nigeria. Kawahata and Sakamoto (1951) studied the number of active eccrine sweat glands in 12 Ainu, six Russians, and a number of Japanese born and residing in various areas of the Far East. They observed that people living in cold climates have a smaller number of active eccrine sweat glands, and were undecided as to whether this should be interpreted as an effect of climate, or a "racial" difference.

Clark and Lhamon (1917) observed a significantly higher number of sweat glands on the fingertips of tropical people than on "northern races" (White Americans) and according to Hurley (In: Moschella *et al.* 1975:1712) African Blacks have about twice the number of functioning eccrine glands and "can far outstrip whites on maximal thermal sweat stimulation". Montagna and Parakkal (1974:367-68) present a Table modified from Roberts *et al.* (1970) which showed the number and regional distribution of activated eccrine sweat glands for a selection of human populations. American Blacks were close to values shown for American Whites. African negroes but not American negroes has more active eccrine sweat glands than Europeans and Koreans according to this report. Sweating in Koreans was higher in the forehead and extremities.

From the foregoing studies, it is not entirely clear whether the difference in activated sweat glands is a matter of environment or true genetic adaptation. However, Montagna and Parakkal (1974) infer that it is genetic because of the low sweat count of the Caingang Indians who inhabit tropical environments similar to the African negroes.

In any case, it is at least clear that African negroes are generally prolific in their production of eccrine sweat, and it seems likely that my earlier hypothesis regarding the role of eccrine sweat in radiating axillary apocrine odor is conceivable. Thomson (1954) observed that the skin temperature difference between his acclimatized African and European subjects was significant and favours the Africans with respect to evaporative heat loss to the environment. The lesser thermal gradient from the core of the body to the surface (2.960F for African, 4.030F for Europeans) indicates readier passage of heat outwards. Conversely, eccrine sweating in Mongoloid populations is less, according to Kuno (1956). In a test of mentally-stimulated axillary sweating "the percentage of the subjects who had sweating of

high degree is 92.6 in Russians, 70.6 in Japanese, 46.6 in Koreans and 37.0 in Chinese. Among 27 Russians there was none who had no sweat secretion on the axilla, while in Japanese and Koreans as well as Chinese there were many who showed little or no sweat at all (Kuno, 1956:162-63).

SUMMARY

Although the evidence available on Caucasian/Negroid sweating is somewhat inconsistent, it would appear that the Negroid population is capable of producing more malodorous substance in the axilla by virtue of the larger size of the apocrine glands and more prodigious amount of secretion observed in experiments. In addition, eccrine sweat gland secretions in Negroids also seem to be higher than in Caucasians, thus providing a volatile medium for radiation of any axillary odor. Mongoloid populations also appear to have active eccrine glands than do Caucasians, but due to the low number of osmidrotic apocrine glands in the axilla, there is a lower level of axillary odor present than in either of the other two groups.

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