

OBSERVATIONS ON THE SWEAT GLANDS OF TROPICAL AND NORTHERN RACES

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TWO FIGURES

The present preliminary report on the sweat glands was begun as a part of a joint investigation suggested by the late Paul C. Freer, Director of the Bureau of Science of Manila. The general problem was the supposed untoward effect of a tropical residence on the white man and the supposed constitutional adaptability of the dark races to a tropical climate. The investigations were undertaken in a coöperative way by chemists and physiologists of the Bureau of Science, the departments of Anatomy, Pharmacology, Physiology and Physics of the University of the Philippines and the United States Army Medical Board for the Study of Tropical Diseases.

Certain claims of Daubler ('00) and Aron ('11) seem to indicate at least one definite adaptation of the dark races to the tropics and lead us to investigate the sweat glands. Daubler states that the size of the sweat glands of the native of tropical Africa is much greater than that of the European. Aron finds that the sweating apparatus of the aborigines of the Philippines, the Negritos, is much superior to that of the white man. This superiority he says is shown by the difference in the manner of sweating rather than in the amount of sweat produced. According to Aron, the Negrito secretes small beads of sweat over the entire body, which soon forms a thin film. As the whole surface of the body is covered by this water film, the maximum cooling effect from evaporation is obtained. In the case of the white man, on the other hand, the sweating is practically limited to certain areas of the body surface. In these areas the sweating

may be quite profuse, but, as most of it drops off, comparatively little cooling effect from evaporation is produced. He suggests that the Negrito has a greater number of sweat glands which are more equally distributed over the entire body.

We have attempted to compare the sweat glands of the tropical races with those of the northern races. Our observations at present scarcely extend beyond a comparison of the number of sweat glands in certain definite skin areas of various races. Similar comparisons of other areas will be made as material is collected. A comparison as to size is an almost endless task as is shown by the work of Huber and Adamson ('03). These investigators have found from measurements of reconstruction a great variation in the size of the sweat glands in the Caucasian. The length of the tubule in the coiled portion of the gland from the plantar region of the foot of an adult was 4.25 mm. A gland from the hairy portion of the pubic region of a woman was found to measure 10.4 mm. They have further shown, and we have confirmed their findings, that it is almost impossible to determine with any degree of accuracy the size of sweat glands without making reconstructions of them. It is even

now and then exceedingly difficult in a series of sections to trace with certainty a single gland, especially toward the beginning and end of a series of sections of any one gland. Loops of neighboring glands are often in close proximity and are apparently surrounded by a common layer of somewhat denser connective tissue so that a separation of tubules belonging to two, or now and then even three, contiguous glands can be made with certainty only by reconstruction.

In maceration preparations of skin from the palmar region and from the chest in both American and Filipino we have noted a great variation in the size of the glands in each piece of skin taken. Frequently a given gland was fully twice as large as its neighbor. It is thus apparent that a racial comparison of sweat glands as to size to be of any pretence to accuracy must be based upon measurements of a vast number of glands in different portions of the skin of the several races.

TECHNIQUE

In our study of the number and distribution of the sweat glands we find that there is less variation in those occurring on the plantar surface of the foot and the palmar surface of the hand than in other regions of the body. The sweat glands first make their appearance in the embryo in these regions. These areas also lend themselves readily to an extensive enumeration of the sweat glands. Our observations so far have been made principally on these regions. In a warm climate prints of the fingers, palms, toes and plantar surfaces of the feet can be made which in many cases will give a negative impression of every gland duct in the area printed. We have employed the method which is in use in the recruiting office of the United States Army. A very thin layer of the best printer's ink is rolled out with a small hand roller upon a glass plate. The subject's finger (hand or toe, etc.) is carefully and lightly pressed first upon the ink, and next upon a special type of glazed paper. The impressions, when made under suitable conditions, are remarkably clear and the duct of every sweat gland can usually be accounted for. Skin with much cornified epithelium will not make a satisfactory print unless pains are taken to macerate with a dilute caustic and scrape off the surface tissue.

The gland ducts may be counted directly upon the hands and feet with the aid of a good hand lens of about 12 diameters magnification. This is facilitated by first rubbing a little powdered graphite upon the surface of the skin to be examined. This method is far more tedious and has been used only as a check upon the print method. The print method is obviously not adapted to those areas of skin where hair and wrinkles occur. As the ducts of sweat glands frequently open into hair follicles the glands can not be counted by direct inspection. Here we have resorted to maceration methods and to stained sections of skin cut parallel to the surface. The latter method was used by Krause in his study of the number of sweat glands in the skin of the various regions of the body.



Fig. 1 Photograph of a finger print of the distal phalanx of the fourth finger (left) of an American white soldier. $\times 6.5$



Through the courtesy of the surgeon-general's office United States Army and of the office of the chief surgeon, Philippien Division of the United States Army we have had the opportunity of examining finger prints of 300 American white soldiers, 200

In counting sweat glands a glass slide with a graduated square (0.5 cm. each way) was placed over the print, graduated surface down, and the specimen magnified 10 diameters. In good prints, as stated above, every sweat duct can be counted (fig. 1). The graduated square was always placed over the print of the distal phalanx in counting the glands of the fingers, and over that area where the cristae cutis form a whorl or delta.

We have counted 248,998 sweat glands in $\frac{1}{4}$ square centimeter areas of 1,572 fingers and 38,736 in the palms, toes and plantar surfaces of the feet. Table 1 shows the average counts per square centimeter of skin area for the various races. Rather uniform variations have been observed in the distribution of sweat glands in the fingers. The number of glands varies in different areas of the volar surfaces of the fingers. The number is greatest near the distal ends and smallest in the immediate region of the flexion groove at the joints. As stated above, the

[illegible]

number is most nearly constant in the region of the whorl or delta than in other regions. Comparatively few prints of the thumb have been examined. In all of these, however, the number of sweat glands has been distinctly lower than in any of the other fingers. Of the other fingers the second or index finger has shown the lowest average number of glands per unit of skin area, while the fourth or ring finger has shown by far the greatest number of glands. A more detailed comparison of the number of sweat glands per square centimeter of skin for the different fingers in the several races is given below in table 1. The average number of glands per square centimeter of skin area for the finger for all the races examined is 624.4.¹ The greatest number was found in prints of the fingers of Negrito children. It was found that the number of glands per unit of skin area for the hands, feet and toes bears a rather close racial relation to the number on the fingers, and in the different individuals varies directly with the number on the fingers. As regards the different races our results show a greater number of sweat glands in all the tropical than in the northern races.

Taking the American white soldier as the standard, the number of sweat glands per unit of skin area was found to be 6.83 per cent greater in the American negro soldier, 16.61 per cent greater in the Filipino soldier, 22.34 per cent greater in the Moro soldier, 26.81 per cent greater in the adult Negritos, 31.72 per cent greater in the Hindu and 69.82 per cent greater in the Negrito youths and children. Additional details of these counts will be found in table 1. The greater number of sweat glands per unit area with the Negrito youth and child is no doubt due to a corresponding difference in size of the individuals. As all the sweat glands are fully formed at birth² it is merely a

¹ This average is much lower than the estimation of earlier authors, thus—
 “Über die Menge der Knäueldrüsen haben wir ältere Angaben von Krause senior denen zufolge ihre Zahl zwischen 400-600 (Rücken, Wangen, erste zwei Abschnitte der unteren Extremitäten) und 2600-2736 auf 1 □ Haut schwankt und die grösseren Zahlen an der Handfläche und Fusssohle sich finden. Neuere Zählungen von Hörschelmann ergeben viel näher stehende Grenzzahlen von 641 Fussrücken, und IIII (vola manus) auf 1 □ cm und viel mehr drüsen.”—Koelliker.

² At the fourth month according to Wilder ('16).

question of the increase in skin area during growth bringing about a dispersion of the glands. The ratio of the number of sweat glands in the American white soldier (100 per cent) to that of the Filipino soldier (116.93 per cent) and the Negrito adult (124.05 per cent) shows a wider variation than the differences in size³ of the individuals of these respective groups. The American negro soldier is of the same approximate size as the American white soldier, and there are 6.83 per cent more sweat glands per unit of skin area in the former. The Hindus examined were of a larger average size⁴ than the American soldiers and showed the highest sweat gland count for adults (131.76 per cent). Thus racial variation in size does not account for the difference in ratio of the sweat glands per unit of skin area.

The number of sweat glands was determined in a similar manner from prints of the palmar surface of the hand and the plantar surface of the feet of Americans (white) and Filipinos. Successful prints were made from these areas of 6 American university men and 6 Filipino students; 325 separate areas were counted, giving a total of 38,736 glands. The average number of sweat glands on the palmar surface was 438.0 per square centimeter in the American, and 473.6 in the Filipino. On the plantar surface of the feet there were 436.4 glands per square centimeter in the American and 498.4 in the Filipino. On the plantar surfaces of the toes there was an average of 527 and 525.5 sweat glands per square centimeter in the American and Filipino respectively. Thus the number of sweat glands in the Filipino was in this series 8.1 per cent greater on the palm and 14.1 per cent greater on the plantar surface of the feet than in corresponding areas in the American. In all these counts there was very little individual variation. Different individuals of the same group gave almost the same count.

³ Captain Davis of the recruiting office of the United States Army in Manila tells us the average weight of the American white soldier is approximately 150 pounds and of the Filipino scout approximately 130 pounds. The Negritos are smaller and can be estimated at about 120 pounds.

⁴ All these Hindoos were tall, large and portly and averaged 160-165 pounds in weight.

We are not able to confirm Aron's observation that the tropical aborigines secrete only small beads of sweat over the entire body. On two tramping expeditions in the mountains of the Philippines which we were fortunate enough to arrange with a number of Negritos we observed streams of sweat running down the back, and copious sweating on scalp, forehead and face and sweat dripping from the chin. When making finger prints in camp it was necessary repeatedly to dry off droplets of sweat from the fingers of the Negritos.

From the few maceration preparations mentioned above we are not able to discern any difference in the size of the sweat glands of the American and the Filipino.

As regards number, all our observations show a higher count in all the tropical races. These counts, furthermore, were made on those areas in which the number of sweat glands is the most nearly constant.

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