

# STUDIES ON PERSPIRATION

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“Count what can be counted,  
Measure what can be measured  
And what is not measurable  
Make it become so.”

Galileo 1564–1642

THE FUNCTION of the sweat gland has already been investigated by various authors who have used several tests, the best known being that of Minor (1). Certain authors give a subjective interpretation in order to avoid the use of complicated methods. Our goal at the Dermatological Clinic of Geneva in the last ten years has been to establish methods which are not only objective but also simple, easy and rapid. In general, the more precise a method, the less easy it will be to carry out, and therefore, impossible to test a large number of individuals. It is necessary to find a median between the precision and the applicability of a method.

When studying sweat secretion, the intra- and interindividual variations are relatively important, and it is not necessary to discover methods which would put into evidence differences of approximately 1 per cent.

The three methods which we have elaborated are all based on the evaluation of colored spots, classified *de visu* according to standard scales.

## TEST FOR AXILLARY PERSPIRATION

A Ping-pong ball is coated with a thin layer of Vaseline® then sprinkled with the following mixture:

Bromphenol blue.....	5%	Starch.....	40%
Sodium Carbonate.....	15%	Tragacanth.....	40%

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The ball thus prepared is dressed in a square-shaped piece of gauze and placed in the armpit in the same manner as a thermometer for ten minutes. The gauze is then unfolded and the size of the blue stain produced by the perspiration is evaluated (2, 5) (Fig. 1).

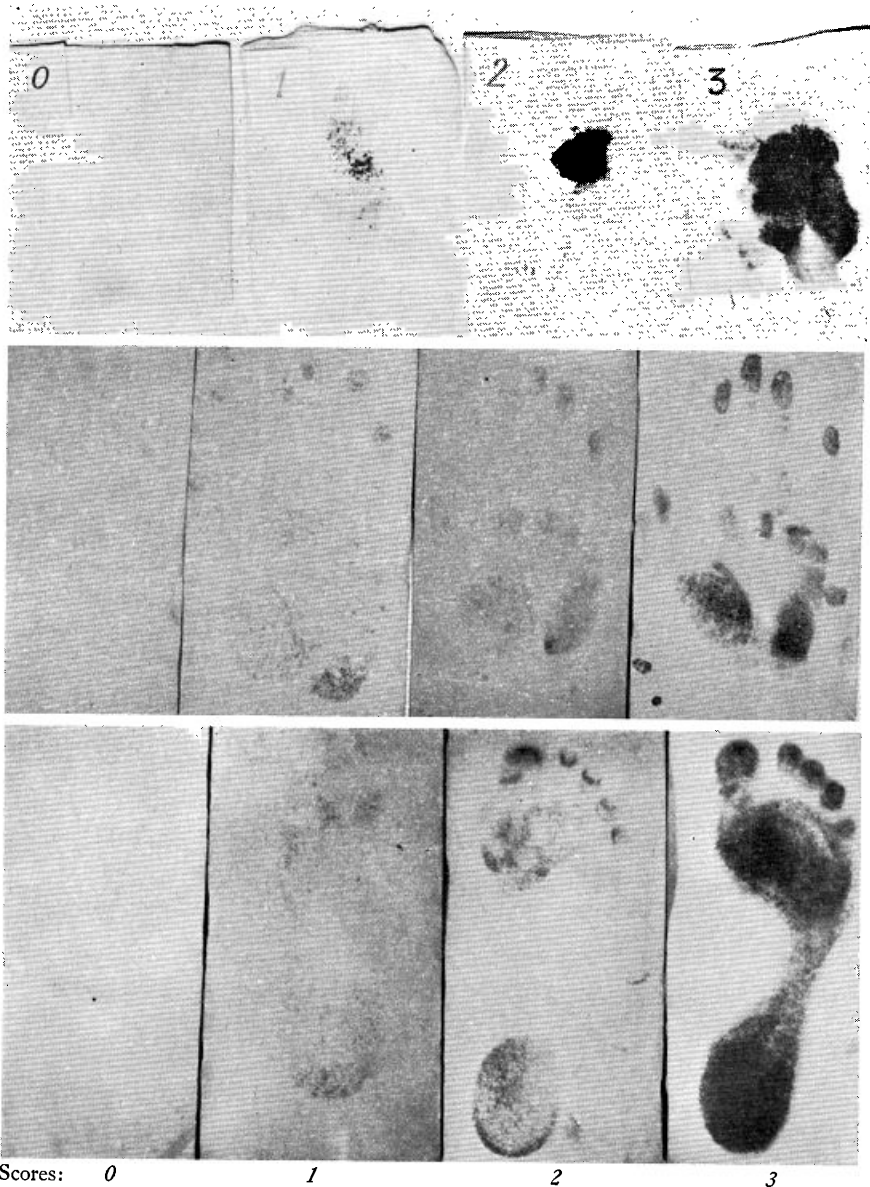


Figure 1, 2, 3.—Standard Scales, Axilla, Palm, Sole.

**PAPER TESTS ENABLING THE EVALUATION OF SMALL  
QUANTITIES OF PERSPIRATION (PRUSSIAN BLUE TEST)**

A strip of Scotch tape is sprinkled with the following mixture (finely ground):

$\text{Fe}_2(\text{SO}_4)_3$ anhydrous . . . . .	35%
$\text{K}_4(\text{FeCN}_6)$ anhydrous . . . . .	65%

The test paper, light gray before application, becomes colored in contact with water. Very fine drops of sweat are thus detected, each spot representing the lumen of a sweat gland. This test has the advantage over that of Minor's in that it does not necessitate the painting of the skin with iodine which could modify the terrain. The Prussian blue test paper is rapidly saturated and is not adequate for the evaluation of abundant sweating (3, 6) (Fig. 4).

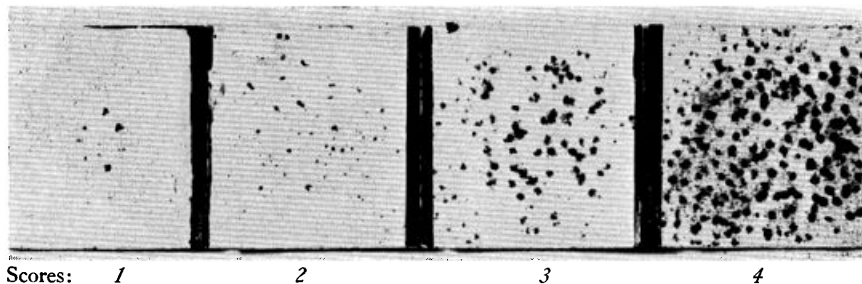


Figure 4.—Standard Scale, Prussian blue test paper.

**PAPER TEST FOR HANDS AND FEET**

We have elaborated a test paper which permits the evaluation of abundant sweat secretion. A Whatman filter paper is impregnated with a 1 per cent bromophenol blue solution in anhydrous ether. In the absence of humidity, this paper becomes yellow; by the action of water it changes to dark blue. Our principal objective in elaborating this test was to find a method permitting the evaluation of plantar and palmar sweating (5, 7) (Figs. 2 and 3).

**STUDY OF THE ACTION OF VARIOUS DRUGS ON THE SWEAT  
GLAND (6, 8)**

A series of drugs influencing the autonomic nervous system were introduced in the skin by means of iontophoresis. By applying the Prussian blue paper tests at regular intervals on the treated site, the duration of action, and intensity of effect of a drug can be estimated (see Table 1). Drugs which inhibit sweating by their action on the autonomic nervous

TABLE 1—DURATION OF LOCAL PERSPIRATION INDUCED BY A FEW PARASYMPATHICOMIMETIC DRUGS

Drug	Dose	Average Time
Acetylcholine	$2 \cdot 10^{-6}$ Mole	30 min.
Pilocarpine	“	2 hours 40 min.
Mecholyl	“	12 “
Dilvasene	“	36 “
Doryl	“	47 “

system can be examined in the following manner. An iontophoresis of the drug to be examined is made on a large surface of skin, then at regular intervals pilocarpine is introduced in order to induce perspiration. By means of the Prussian blue paper test subsequently applied, it can be noted whether there is an inhibition or a decrease of local perspiration (see Table 2).

TABLE 2—DURATION OF ANTISECRETORY ACTION OF A FEW PARASYMPATHICOLYTIC DRUGS

Drug	Dose	Total Inhibition of Local Perspiration (Average Time)
Prantal	$2 \cdot 10^{-6}$ Mole/9 cm. <sup>2</sup>	15 min.
Probanthine	“ “	2 hours
Antrenyl	“ “	12 “
Atropine	“ “	19 “
Scopolamine	“ “	30 “

To evaluate antiperspirants acting by local application as, for example, aluminum salts, the following procedure is carried out.

The solution to be examined is applied twice a day for three days on the arm, then on the fourth day a local perspiration is induced by iontophoresis of pilocarpine on the treated site and on a symmetrical site as control. The Prussian blue test is applied and the intensity of color of both papers is compared. The same procedure is followed for the axilla, palm of the hand and sole of the foot, but the Ping-pong test and the bromophenol blue

TABLE 3

	Con- centr.	pH	Wetting Agent	Number of Cases	Reducing or Inhib- iting Effect (on Perspiration Induced by Pilocarpine)
AlCl <sub>3</sub>	Mol.	1.8-2	1% Triton X 100	33	Good
Al(NO <sub>3</sub> ) <sub>3</sub>	Mol.	2.6	id.	5	Good
Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Mol.	1.8-2	id.	6	None
Al-acetotartrate	10%	3	id.	5	Bad
MgCl <sub>2</sub>	Mol.	1.8-2	id.	8	Middle
Phosphotungstic acid	Satur.	0.8-1	...	6	None
Sulfosalicylic acid	10%	0.8-1	1% Triton X 100	4	None
Tannic acid	10%	2.7-3	0.5% Aerosol OT	3	None

paper, respectively being used. For these studies the normal perspiration is generally sufficiently abundant, thus precluding the need for pilocarpine. The effect on the arm of various solutions, such as aluminum or magnesium salts, or drugs known to coagulate proteins, has been studied. It can be seen in Table 3 that aluminum chloride and aluminum nitrate are the only drugs acting on the sweat secretion, while magnesium chloride acts only to a certain extent. Solutions of aluminum chloride with or without a wetting agent were compared in the axilla. A significant influence of the wetting agent on the effect of the drug was noted (2).

#### PROTECTIVE ROLE OF THE SEBACEOUS LAYER (9)

By a similar procedure, experiments can be carried out showing the protective role of the sebaceous layer. If an aluminum chloride solution without a wetting agent is applied on a site cleaned by means of ether

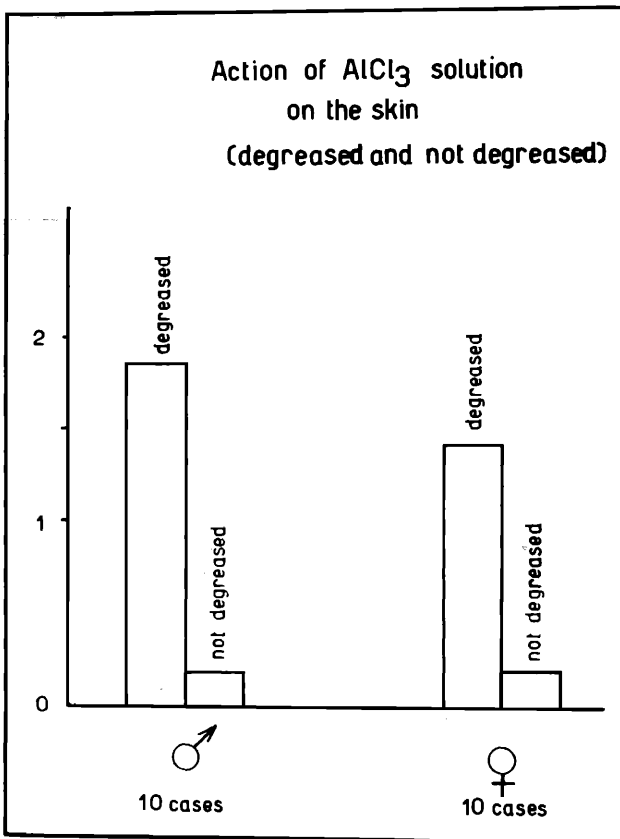


Figure 5.

alcohol and on a symmetrical site which has not been cleaned, by the action of aluminum chloride on the sweat gland, it can be observed whether the sebum has prevented the penetration of the solution or not. For this, a locally induced perspiration by ionophoresis of pilocarpine and a Prussian blue test paper is applied on each of the sites treated. In a group of ten men and ten women of twenty to thirty years (the age group where the sebaceous layer is high), a significant difference between the formerly cleaned and noncleaned sites is noted (see Fig. 5).

Thus, it can be seen that the sebaceous layer protects the skin against the action of an aluminum chloride solution.

Figure 6. INFLUENCE OF AGE AND SEX ON PERSPIRATION

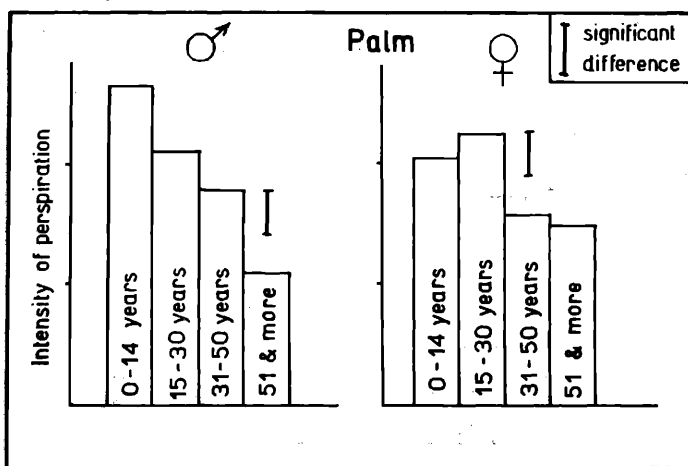


Figure 7. INFLUENCE OF AGE AND SEX ON PERSPIRATION

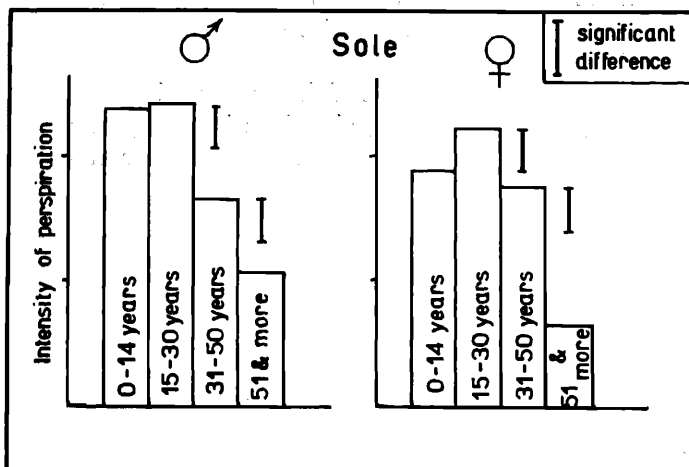
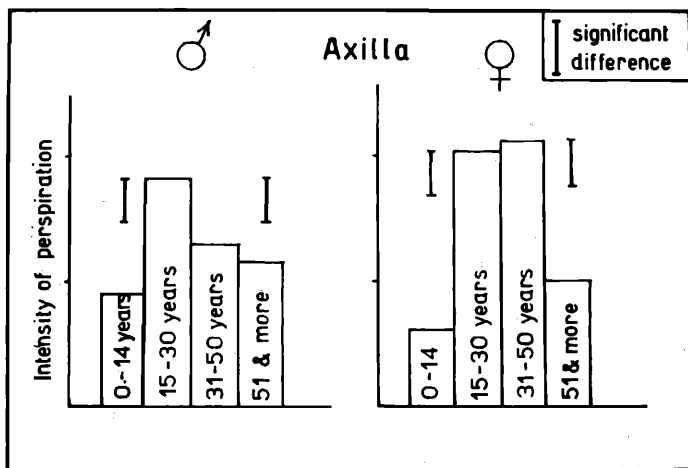


Figure 8. INFLUENCE OF AGE AND SEX ON PERSPIRATION



#### PHYSIOLOGY OF PALMAR, PLANTAR AND AXILLARY PERSPIRATION (5, 7)

The tests described have also permitted the authors to study systematically the influence of age and sex on the intensity of the palmar, plantar and axillary perspiration in the normal subject.

The study of approximately 200 persons has given the following results.

Palmar and plantar perspiration decreases with age. Abundant in children and adolescents it decreases little by little to become scanty in old people (see Figs. 6 and 7). On the other hand, the statistical analysis shows a correlation between the intensity of the "hand" and "feet" tests, even if the influence of age is excluded. This means that it is very probable that persons who perspire abundantly on the hands also show strong perspiration of the feet.

The axillary perspiration shows a different curve in that it is at first nonexistent or slight until puberty, abundant in young adults and then diminishes in function according to age from thirty years onwards in men and from fifty years onwards in women (Fig. 8).

#### CONCLUSION

In order to investigate the physiology of perspiration or the action of antiperspirants, it is indispensable to elaborate methods of investigation (tests). Only objective tests will give some value to the results obtained.

The clinical observations, if possible, should always be controlled by a test. The results of the tests, on the other hand, should be controlled clinically.

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## THE USE IN COSMETICS OF A NEW SYNTHETIC AMINO ACID: FURYLGLYCINE

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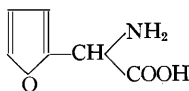
RECENTLY (1) WE REPORTED ON the action of three new synthetic amino acids: *dl*-1-amino cyclohexane carboxylic acid, *dl*-1-amino 3-methyl carboxylic acid and *dl*-1-amino cyclopentane carboxylic acid.

The results obtained have induced us to continue further studies in this field. This time we have kept in mind the economic factor which plays an important part in our industry.

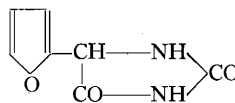
The studies have been directed toward the synthesis of an amino acid, furyl glycine, whose basic material, furfural, is economically produced. Furfural is easily obtained from a variety of waste products, such as bran, straw, olive husks, wild plants, etc.

On the other hand, the chemical structure of furyl glycine is of particular interest because there is a heterocyclic nucleus with a lipophilic characteristic linked to the amino and carboxylic functions (which are definitely hydrophilic).

We have also studied the action on the skin of the intermediate product in the synthesis of furyl glycine (I), that is 5-furylhydantoin (II).



I



II

Quite a number of research workers having observed the close relationship between hydantoins and alpha amino acids, have suggested that hydantoic acids and hydantoins might be present in proteins.

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