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ACTIVITY OF THE HUMAN ECCRINE SWEAT GLAND DURING EXERCISE IN HOT HUMID ENVIRONMENT, BEFORE AND AFTER ACCLIMATIZATION.

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DECLARATION.

I hereby declare that this thesis, which is presented in fulfilment of the requirements for the Degree of Master of Science in Physiology in the University of the Witwatersrand, is my own work and has not been submitted as a thesis for any other degrees at any other University.

.....

J. PETER.

November, 1963.

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My thanks are also due to Mr. A.D. Joffe, late of the Statistical Department of the Chamber of Mines Research Laboratories for his advice on the statistical approach, and, finally, to my wife for typing this thesis.

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J. PETER.

INTRODUCTION.

In man, thermal regulation to stresses imposed by a hot environment is accomplished mainly through the evaporation of sweat from controlled sweating. This paramount role in heat regulation makes the sweat gland apparatus of vital importance.

The increase in sweat rates on repeated exposures to high temperatures is unequivocal. The assumption is an increased activity of the sweat glands, based on the findings of Ito & Adachi (1934) referred by Kuno (1956 p.320). The authenticity of this assumption has not been questioned. It is not known whether the increase in sweat rates due to acclimatization is due to an increment in the activity of the sweat gland or to an increase in the number of active glands, or to both.

The marked decline in high sweat rates on prolonged exposures to high temperatures is well known. This aspect has received more detailed investigation than the above. However, the literature remains dissonant and many widely accepted concepts are tenuous. This decrement in sweat rates is of practical importance in the etiology of heat stroke, and men's activity in certain hot environments

/becomes limited.....2

becomes limited by the decline in their sweat rates.

The present investigations were designed to study sweat gland activity in the unacclimatized and acclimatized state; to see whether there is an increased glandular activity or an increase in the number of active glands due to acclimatization, and to investigate the cause of the decline in sweat rates on prolonged exposures to hot environments in both states of acclimatization.

REVIEW OF THE LITERATURE.

Among the first to report increments in sweat rates due to acclimatization was Moss (1923). He found that the sweat rates of "new" labourers in hot mines were about 2.5 litres per 5 hour shift, while those of "old" labourers were 4.5 to 8.5 litres per 5 hour shift. This sweat increment due to acclimatization was later confirmed by a number of investigators. (Haldane 1935, Adolph & Dill 1938, Dill 1938, Robinson et al 1941). The experimental studies of Horvath & Shelley (1946) showed that the mean sweat rate of sixteen soldiers (two weeks training prior to the experiment) which was 1.6 kgm/hr. increased to 2.0 kgm/hr. by the fourteenth day, and to 2.2 kgm/hr. by the thirtieth day.

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Ladell (1951) in a detailed study on a group of seventeen unacclimatized men, subjected to exercise and rest in a hot room at 93-94°F.W.B. and 100°F.D.B. found that the average total sweat rate, corrected to a mean body weight of 65 kgm, increased from 1.1 kgm on the first day to 1.56 kgm on the ninth day under the same conditions. Similar experiments were made by earlier investigators and similar results were obtained, (Bean & Eichna 1943, Eichna et al 1945). These studies were simple measurements of sweat loss used as indices for acclimatization.

The studies of Ito & Adachi (1934) referred by Kuno (1956) were made to test the training effect of heat upon the sweat gland. The rate of sweat was determined over a confined area on the symmetrical sites of both forearms, while sweat was induced by immersing one leg in a water bath at 43°C. in a hot chamber at 32°C. After repeated applications of hot dry air (80° - 90°C.) to the restricted region of one arm, the sweat rates increased considerably in comparison to the untreated arm. Sweat drop localization, size and count, before and after, indicated no newly activated sweat glands but the activity was considerably augmented.

Fox et al (1962) confirmed this observation and provided more evidence in a different approach. Four subjects were

/acclimatized.....4

acclimatized for 2 hours daily for 15 days with one arm immersed in cold water at 13°C. Their results indicated that acclimatization increased the average sweat rates by 130%. Sweat rates in the untreated arm increased to 425% whereas in the treated arm there was no difference in sweat rates. In both studies, if the number of active glands was ascertained before and after acclimatization, then obviously the increase in sweat rates was due to increased activity.

Cytological changes in the sweat gland after five episodes of 6 hours profuse sweating was studied by Dobson (1960). He found that after the first episode of sweating, the duct and the secretory cells recovered their glycogen content and failed to lose it, despite degenerative changes that occurred in the secretory cells, even after the fifth episode.

Kittsteiner (1913) cited by Sargent, (Montagna et al 1962), was among the first investigators to report on the decline in sweat rates being accompanied by an increase in sodium chloride on prolonged exposures to high temperatures. Later, some observers, studying sweat rates, acclimatization and reaction to heat stresses, confirmed only the decline in sweat rates, while others confirmed both the decline in sweat rates and the alteration in the sodium chloride concentration under different experimental designs. (Johnson et al 1944;

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Ladell 1945 a & b, 1955, 1957; Moreira et al 1945; Gerking & Robinson 1946; Robinson & Gerking 1947; MacDonald & Wyndham 1950; Caplan 1950; Van Heyningen 1951).

Gerking & Robinson (1946) studied in detail six well acclimatized men, working on a treadmill, average metabolic rate 190 Cal./m^2/hr., 128 Cal./m^2/hr., 48 Cal./m^2/hr.(resting), at environmental temperatures of 31.9 to 38°C. with 51-95% relative humidity, and 40.0 to 50.1°C. with 18-38% relative humidity, 55 m/min. wind velocity. Their results indicated: (a) The maximum sweat rates were between the first and second hour. (b) Thereafter the sweat rates declined steadily until the end of the sixth hour of exposure. The decline was from 10-80% of the average first two hours of sweating. (c) The decline occurred at relatively high initial sweat rates. (d) The decline was greater in humid than in dry heat. (e) The decline was neither associated with dehydration nor the strength of the stimulus for sweating. It was attributed to the sweat gland mechanism being fatigued in some way.

The underlying mechanism responsible for this decline in sweat rates is not clear in the literature. Practically every investigator describes a different mechanism. The general evidence points towards peripheral changes rather than a central nervous system fatigue.

/Hancock et al.....6

Hancock et al (1929) attributed the progressive decline in sweat rates to glandular fatigue. Robinson and his associates hold the same view. In association with the decline in sweat rates there is an increase in sodium chloride concentration. Ladell (1945a) expressed the view that it is the activity of the sweat gland that maintains the tonicity of sweat. When glandular activity decreases the sodium chloride concentration increases. Van Heyningen's view (1951) is that high sodium chloride concentration and low sweat rate is unlikely to be indicative of glandular fatigue since reduction of the skin temperature decreases the sodium chloride concentration.

Ladell (1945a, 1951) attributed the decline in sweat rates at high rectal temperatures to sweat gland fatigue. In 1955 and 1957 he suggested that as the decline was reversible, it did not represent a true fatigue, but was rather intrinsic in the nature of the sweat gland response. Since the decline develops in maximal and sub-maximal sweat rates, he suggested in 1957 that adaptation might be the mechanism involved.

Thaysen & Schwartz (1955) in a detailed study on sweat decline, claimed that this decline was due to sweat gland fatigue. They exposed four unacclimatized men to temperatures of 104°F to 113° F.D.B., relative humidity 60 to 90%, for

/5-6½ hours.....7

5-6½ hours. They inhibited sweat secretion with atropine on the left forearm for 4.8 hours. The right untreated symmetrical site showed a marked decline in sweat rate, while the left treated site showed hypersecretion after atropine was abandoned. Repeated infusions of mecholyl resulted in decreasing outputs of sweat until a refractory state was reached.

Collins et al (1959a) commenting on these experiments, doubt that fatigue induced by repeated intradermal injections of mecholyl is the same as thermal fatigue. They have reason to believe that it is an example of "desensitization" analogous to that produced at the neuromuscular junction.

The validity of experiments in which mecholyl or other cholinergic drugs are used is to be held with reserve, as their action on the sweat gland unit is not clearly understood. Depression induced by these drugs is not necessarily preceded by intense or prolonged secretory activity.

On the other hand, Wolkin et al (1944) mooted the possibility of a central nervous failure of the sweat mechanism. They found that in 8 patients (soldiers in the North African desert suffering from heat exhaustion) hypodermic injections of 25 mgm. of mecholyl (which amount is sufficient to produce general sweating) induced sweating on the face and neck only, while the rest of the body remained dry. Their view was

/based on....8

based on the fact that in postoperative cerebral hyperthermia, sweat glands failed to respond, in a similar manner, to cholinergic drugs.

Weiner & Hellman (1960) do not think that this finding rules out sweat gland fatigue in this type of heat exhaustion.

Kuno (1956 p.191), commenting on the decline in sweat rates, believes that the evidence is in favour of a nervous system disorder rather than fatigue of the secretory cells of the sweat gland. His beliefs are based on the findings that sweat rates, after being suppressed on experimental subjects in a severely hot chamber, were restored when they returned to cool air and, further, that depression of sweating was associated with mild neurological symptoms of heat stroke which occurred during the exposure in a Kettering hypertherm.

Hertig (1960) advanced the view of depressed irritability of receptors. When the skin is wet or fully hydrated water diffuses and is retained below the epidermal barrier layer. When this layer is diluted with water, so does the chemical environment around the receptors become diluted, which in turn would depress the irritability of the receptors. However, when the diffusion of water is prevented, the rate of sweating remains the same.

Peiss et al (1956); Peiss & Randall (1957); Randall & Peiss

/1957.....9

(1957), hold the view that the mechanism involved in glandular suppression is hydration of the keratin ring around the sweat gland orifices, producing mechanical occlusion of the sweat pore.

Sargent (Montagna et al 1962 p.205) claims that on histochemical data the large pale cells were irritable during hypohidrosis. On these grounds he refutes the hypotheses that low active gland densities or low gland activity are due to either fatigue of the secretory cells or a neurohumoral block. He advances a view that the output of sweat may be controlled by the activity of the cells in the sweat duct.

Collins & Weiner (1962) using the arm bag method, investigated the site and cause of failure in sweating on prolonged exposure to high environmental temperatures. They concluded that the reduction of sweating in the arm bag may be due to occlusion of the sweat gland ducts by excessive skin hydration. Furthermore they state that,"While more evidence is required to confirm the relationship between sweat suppression in the arm bag and in 'fatigue', the conditions which promote sweat gland failure appear to be the same".

Dobson (1960) on histological studies showed that after profuse sweating for six hours, there were degenerative changes in the large pale cells consisting of atrophy, vacuolization, fusion of adjacent cells and pyknosis of nuclei.

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METHOD.

Six unacclimatized male African Mine Labourers, age 20-25 years, free of skin diseases, were selected at random (Nos. 28215, 125121, 125105, 70432, 70459 and 70548). The experiments were carried out in a climatic tent, with the air temperatures fairly constant at 90°F. Wet Bulb and 93°F. Dry Bulb, (Minich 1960). The subjects stepped on and off an adjustable stool for 4⅓ hours. The length of time chosen was such that all unacclimatized subjects could complete the experimental run. Durations longer than 4⅓ hours could lead to dangerously high body temperatures necessitating withdrawal from the experiment.

The height of the stool was adjusted in accordance with each subject's body weight, so that the work rate was 1560 ft. lb./min., and the oxygen consumption was approximately 0.9 lit/min.

The test was performed twice, during which time hourly pulse rates, rectal temperatures and sweat rates were measured.

In the first test the subjects were completely unacclimatized.

The second test was carried out only after they had been acclimatized at their respective mines by the Chamber of Mines Two Stage Method of Acclimatization.

/The last 11

The last three subjects (70432, 70459 and 70548) besides being acclimatized according to the above method, were acclimatized for a further 4 days in the climatic tent at test temperatures in order to ensure a good degree of acclimatization. The fifth day was set aside for observation.

In order to obtain a representative picture of all the sweat glands in the body, two types were chosen; firstly the active glands on the chest - the site being at mid-point on a line from the left sterno-clavicular joint to the nipple; secondly the less active glands on the back - the site being on the left mid-scapular plate.

A five centimeter square thin aluminium plate with a 12 mm. square central aperture was placed on the body so that the chosen site was in the centre of the aperture. The outside borders of the plate were marked on the skin with a ballpoint pen so that repeated impressions could be taken during the test at the identical point.

To study the activity and number of sweat glands, the skin areas were brushed clean with soap and water, the hair shaved and the plastic impression method of Thomson & Sutarman (1953) was used. The stock plastic solution was prepared by dissolving 25 gm. of polyvinyl formal and 5 cc. of butyl phthalate made up to 500 cc. in ethylene dichloride. At the

/beginning of 12

beginning of each test a fresh sample from the stock solution was used.

The prints were taken by placing the aluminium plate on the marked area of the skin which was blotted dry and immediately painted with the plastic solution by means of a brush ($\frac{1}{2}$" wide) being passed over the aperture with one stroke from right to left. It took approximately 15 seconds for the print to dry, whereafter it was removed with a transparent adhesive tape (cellotape). Consecutive prints were taken every 30 minutes and placed on a numbered glass slide. A point was identified, usually in the centre of the print or close to it, and photographed through a Zeiss microscope-camera attachment. Each sweat gland ostium on the photographic paper was numbered, therefore on consecutive prints the ostia were accurately identified by the pattern of their distribution in relation to the skin groove impressions.

The number of active glands/cm^2 were counted by photometric projection, the screen being 235 cm. from the reflecting prism of the microscope. Five millimeters projected onto the screen measured 56.5 cm., the area of the microscopic field projected was 0.374 cm^2. The number of active sweat glands was counted over one centimeter square. Perforations that reached the upper horizontal and left vertical lines were counted, while only those that had half their area within the lower vertical

/and right.....13

and right horizontal lines were counted.

The relative activity of the identified sweat glands studied from one microscopic field was assessed from the area of the perforation projected on the screen. The average diameter of each perforation was measured to the nearest 0.5 cm. from the horizontal and vertical diameters. The activity of each sweat gland was expressed in terms of the square of each diameter, e.g. $(0.5)^2$, $(1.0)^2$, ...$(4.5)^2$, $(5.0)^2$. $\frac{Pi}{4}$, being a common factor to all figures, was omitted.

In some instances the removal of the prints from the skin resulted in a slight tear to the perforations. These distortions were obvious and therefore disregarded when measuring the average diameters.

Volumes of secreted sweat were not measured. Thomson & Sutarman (1953) showed that for sweat rates below 63.4 mgm/100 cm^2/min. the size of the perforations was directly proportional to the quantity of sweat produced. This corresponds to a sweat rate of 700 cc/hr. in an average man of 1.75 m^2 body surface. Collins, Sargent & Weiner (1959) measured the sweat volume by the capsule method of Dole, Stall & Schwartz (1951) and intimated that this relationship was probably true for sweat rates up to 116.6 mgm/100 cm^2/min. induced by direct heating.

/On the chests of 14

On the chests of three subjects (125121, 125105 and 70432) it was possible to identify and study the same glands before and after acclimatization. On the other sites (chest and back) it was not possible to identify the same glands, although the measurements were the same and could not have been more that $\frac{1}{2}$ centimeter away from the previous site. Plastic prints taken from the backs of 2 subjects (125105 and 70548) were not satisfactory for study, so they were discarded. Skin temperatures were not taken. Water was given ad libitum except for $\frac{1}{2}$ hour prior to taking temperatures.

RESULTS.

Typical changes, mainly the decrease in heart rate and rectal temperature, and increase in sweat rate, which are characteristic features of acclimatization to heat, were observed in each of the six subjects. There were no significant differences between the three subjects who were acclimatized further in the climatic tent and those who were not. The data herein are therefore based on all six subjects unless otherwise mentioned.

Plots of average heart rate, rectal temperature and sweat rates against time for the group as a whole are represented in Figure (1), while the detailed figures for each

/individual are....15

individual are represented in Appendix A. The characteristic changes due to acclimatization were distinct. Sweat rate values for the first hour in the acclimatized state were similar to those in the unacclimatized state. One would expect the sweat rate for the 1st hour to be higher in the acclimatized state, but this was not the case because, although once sweating commenced, the flow was greater, the latent period was more prolonged, particularly in three of the subjects. Thus, the sweating time in the acclimatized state for the first hour was shorter than that in the unacclimatized state. This was probably due partly to a lower initial rectal temperature. The sweat rate at the 4½ hour period appears to show a sharp decline; in reality this was not so, because the value plotted represented the sweat output for only half an hour. The estimated values for the 5th hour would be approximately 250 cc/hr. and 450 cc/hr. unacclimatized and acclimatized respectively.

ACTIVITY OF SWEAT GLANDS BEFORE AND AFTER ACCLIMATIZATION.

For each individual an average figure for the relative activity was obtained for each half hour period. These values were then averaged for the subjects available and the results are given in Table I. Plots showing the average activity per sweat gland on the chest in the unacclimatized and acclimatized states, as well as those on the back, are

/given in.....16

given in Figure 2(A). Figures for each individual gland at half hour intervals over the 4½ hour period are given in Appendix B.

(i) Pattern of Sweat Gland Activity on the Chest.

The activity of sweat glands on the chest in the unacclimatized state showed a progressive increase, reaching its maximum value at the end of the 2nd hour. This activity declined slightly until the end of the 4th hour, after which the decline was rapid. From the 2½ hour period onwards, the half-hourly activity was 88%, 86%, 83%, 77% and 49% of the maximum value.

In the acclimatized state, a different pattern emerged in that the activity progressively increased at a higher rate, reaching a maximum peak at the end of the second hour and subsequently declining rapidly until the end of the experiment. The maximum activity was 66% higher than that of the unacclimatized value, while at the end of the experiment the activity was 53% higher than the corresponding unacclimatized value. From the 2½ hour period onwards, the half-hourly activity was 90%, 67%, 74%, 64% and 45% of the maximum value.

(ii) Pattern of Sweat Gland Activity on the Back.

Sweat gland activity on the unacclimatized back showed a progressive increase until the end of the 1½ hour period when

/it reached its....17

it reached its maximum, which was lower than that of the chest (Figure 4A). After the 1½ hour period there was a pronounced decline until the 2½ hour period, whereafter a steady slow decline was maintained at a low level. From the 2 hour period onwards, the half-hourly activity was 86%, 29%, 25%, 19%, 16% and 15% of the maximum value.

Sweat glands on the acclimatized back showed a pattern of activity similar to those on the acclimatized chest, but at a lower level, and the drop was sharper between the 2nd and 3rd hours, whereafter it showed a slight decline until the 4½ hour period. The maximum activity was 110% higher than that of the unacclimatized value, while at the end of the experiment the activity was 441% higher than the corresponding unacclimatized value. Hence the increment in glandular activity on the back was greater than that on the chest. From the 2½ hour period onwards, the half-hourly activity was 59%, 41%, 50%, 31% and 32% of the maximum value. The rate of decline in glandular activity on the back in both states of acclimatization was sharper than that on the chest.

(iii) Assessment of increased Sweat Gland Activity due to Acclimatization.

In order to assess the increased activity due to acclimatization, the difference between acclimatized and unacclimatized values for each individual at half hourly intervals was

/obtained. 18

obtained. The averages of these differences were then calculated and 95% confidence limits were obtained, (Figure 2B.) (See statistical index.) Where the confidence intervals do not contain zero, there is a significant difference at the 95% level. On this graph the increased activity of the acclimatized sweat glands on the chest is significant at 95% confidence level up to the 3½ hour period, thereafter the significance level declines to below 95%. It could probably be significant at 90% or slightly lower, whereas on the back, the increased glandular activity is significant at the 95% level up to the 3½ hour period, and thereafter slightly below, probably between 90% and 94% level. For the overall period, the increase in glandular activity for both chest and back is significant. (Table V).

THE RELATIVE QUANTITY OF SWEAT SECRETED PER CM^2 BEFORE AND AFTER ACCLIMATIZATION.

The relative quantity of sweat secreted per cm^2 was calculated for each subject by multiplying the average relative activity of the identified active glands by the number of active sweat glands per cm^2 for each half hourly interval. An average was obtained for the subjects as a whole for each interval (Table II), the plots for the chest and back being represented in Figure 3A. Differences due to acclimatization with 95% confidence limits to the average

/differences are....19

differences are represented in Figure 3B.

The results show that the relative sweat output/cm^2 increased in both instances on the chest and back due to acclimatization. The pattern of the graph (Figure 3A) was very similar to that of the activity, rather than the graph of the number of active sweat glands/cm^2 (Figure 6A). Thus the close relationship between sweat output and glandular activity was well exhibited. Although the two patterns were not identical there were minor differences, due to some extent to the number of active sweat glands. Only towards the end of the experiment, after the activity had declined, did the number of active sweat glands assume importance in influencing the sweat output. The overall results showed a significant increase in sweat output after acclimatization. (Table V).

DIFFERENCE IN SWEAT GLAND ACTIVITY AND SWEAT OUTPUT/CM^2 BETWEEN THE CHEST AND BACK.

In this study the values from only four subjects (28215, 125121, 70432, 70459) were taken as the remaining two had no values for their sweat glands on the back.

The average activity for the four subjects was calculated as previously described and comparative plots between chest and back for the acclimatized and unacclimatized states are

/represented in.....20

represented in Figure 4A. Similarly the comparison of sweat output per cm^2 is shown in Figure 5A.

In all cases, the sweat glands on the chest showed higher activity per gland than those on the back. Parallel to this, the sweat output per cm^2 was greater. Figures 4B and 5B show the asymptotes of the 95% confidence limits to the differences. In the unacclimatized state, the sweat gland activity and the output/cm^2 were significantly higher on the chest than on the back. After acclimatization there was no significant difference at the 95% level, but at a lower level the difference would have been significant. This implies that after acclimatization the increment in activity and sweat output on the back was greater than that on the chest. The overall result showed that the chest was significantly more active in both states than the back, but the output was only significant in the unacclimatized and not the acclimatized state. (Table V).

NUMBER OF ACTIVE SWEAT GLANDS PER CM^2 BEFORE AND AFTER ACCLIMATIZATION.

The number of active sweat glands per square centimeter was counted for each individual at half hourly intervals; an average for the whole group was obtained (Table III) and the plots are represented in Figure 6A. Asymptotes with 95% confidence limits to the difference between acclimatized and unacclimatized values are represented in Figure 6B.

/This study was.....21

This study was made from two aspects; firstly, the maximum number of active sweat glands, which was usually reached at the end of the first hour, and secondly, the number of active sweat glands at each half-hourly interval.

The maximum average number of active sweat glands on the chest was found to be 76 per cm^2. There was no significant difference between the acclimatized and unacclimatized states. The number of active sweat glands, subsequent to the maximum count, declined slowly and steadily until the end of the exposure, when the number of active glands was approximately 65% of its maximum value. There was no significant difference between the number of active glands for the overall period before and after acclimatization.

On the back, the maximum number of active glands showed no significant increase at 95% confidence level after acclimatization. The average increase was only from 71/cm^2 to 87/cm^2. The decline in the number of active glands, subsequent to the maximum count, was sharper and more marked in the unacclimatized state where it dropped to approximately 34% of its maximum value at the end of the exposure, as compared to 60% in the acclimatized state. During the first hour there was no significant difference in the number of active glands before and after acclimatization, but after that period the difference was significant until the end of the exposure. For the overall

/period there was....22

period there was a significant increase in the number of active sweat glands in the acclimatized state. This implies that sweat glands on the back show a prolonged activity due to acclimatization.

The 2x2 Chi-square contingency tests, corrected for continuity, were carried out in order to see whether the number of active glands increased with acclimatization. The results of these tests are given in Table IV and generally show a positive tendency for the number of active glands to increase. The quantity considered was the "m" inactive glands out of the "n" identified glands and not the number of active glands/cm^2.

DIFFERENCE BETWEEN THE NUMBER OF ACTIVE SWEAT GLANDS ON THE BACK AND CHEST.

In this case only 4 subjects were studied. Values are represented in Figure 7A and confidence limits in Figure 7B. There was no difference between the maximum number of active sweat glands/cm^2 on chest and back in either state of acclimatization. In the unacclimatized state the decline in the number of active glands/cm^2 was greater on the back than on the chest. Significant values on the chest, at 95% confidence levels, appeared after the second hour and remained positive until the end of the experiment. The overall result for the whole period was significant. In the acclima-

/tized state...23

tized state there was no significant difference between the number of active glands/cm^2 on the chest and back.

RELATIONSHIP BETWEEN ACTIVITY AND SWEAT OUTPUT/CM^2; NUMBER OF ACTIVE GLANDS AND SWEAT OUTPUT/CM^2.

Sweat gland output/cm^2 was calculated as previously described. Plots of sweat gland output/cm^2 in all instances, on chest and back, acclimatized and unacclimatized, against activity, are given in Figure 8a, whilst output against number of active glands is given in Figure 8b. A correlation coefficient could not be calculated because sweat output was calculated from the number of active glands/cm^2 and average activity of the active glands. (This figure is different from average activity per gland).

The graphs indicate that there is a good correlation between sweat output and activity, while there is no correlation between sweat output and number of glands/cm^2. On the other hand, if plots of low sweat output against the number of glands were made, a correlation would be exhibited. (If high outputs on Figure 8b were excluded, a good correlation would appear). Therefore a correlation between sweat output and number of glands is true for low activities or low sweat rates.

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"FATIGUE" OF SWEAT GLANDS.

During the observation of the activity of individual sweat glands it was found that some sweat glands were intermittently active and inactive. A gland that exhibited this transient inactivation was referred to as a "resting gland". The number of "resting glands" was counted for each individual over the whole period and a percentage was calculated. If by the 4 and 4½ hour periods a gland was found to be inactivated, it was referred to as a "fatigue gland". Similarly "fatigue glands" are represented in terms of % of the number of glands observed. Unfortunately such data could not be studied statistically but are represented in Table VI. (These are terms referring to a state of inactivation).

The back showed remarkably higher values for both the "fatigue" and "resting" glands. Although the figures for the chest were lower, they would probably have been much higher had the experimental time been extended to 6 hours. Acclimatization decreased these values and individual variations were wide. The role of acclimatization in prolonging the activity of glands was more evident on the back than on the chest.

Photographs of sweat gland activity, as well as density, are shown in Appendix C. Two different subjects were chosen, one for the chest, and the other for the back. The perforations

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in the photographs illustrate the units for measuring activity as well as the changes due to acclimatization.

DISCUSSION.

This study had advantages in that the plastic impression method used ensured accuracy in identifying the sweat gland ostium for repeated impressions, as well as a better estimation of the activity, as opposed to the starch iodine paper method or direct microscopic observation. The experimental subjects were exposed to moderately hot but not severe conditions. Sweat was not provoked by sudorific agents, nor by the application of radiant heat to different regions, nor by any other artificial method. The environmental conditions and work rate were no different from those commonly experienced by men working in the South African Gold Mining Industry. The simultaneous study of the activity of identified sweat glands in two different regions in the unacclimatized and acclimatized states is a useful method of investigating the complexities of the physiology of sweating.

The data were subjected to statistical analysis which defined the variability of a measured value. A prediction could be made where new values would fall if different groups of subjects were studied.

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CHANGES DUE TO ACCLIMATIZATION.

The most striking change due to acclimatization was the increase in glandular activity. On the chest this increased activity was significant at 95% confidence limits up to the end of the 3½ hour period. Thereafter the rapid decline in activity reduced the confidence limits to below 95%. On the back the increase was significant at the 95% confidence limits until the 3½ hour period and thereafter dropped so slightly that it could be regarded as significant at the 95% level for the whole 4½ hour period. A remarkable feature was the activity of the glands on the back which, being less active than those on the chest in the unacclimatized state, showed a greater increment in activity after acclimatization.

Glandular activity on both sites, chest and back, and in both states of acclimatization declined subsequent to the maximum value. In the acclimatized state the activity on the chest, calculated as a percentage of the maximum activity, declined more rapidly than in the unacclimatized state; whereas on the back it was the reverse. However, in both states the decline in glandular activity on the back was sharper than that on the chest.

There was no increase in the number of active sweat glands after acclimatization. This was well demonstrated

/through studies....27

through studies of active gland densities on the chest. The most prominent feature was that there was no increase nor decrease in the number of active glands in the three subjects where it was possible to study the same identified area and glands before and after acclimatization. On the back, even 'though there was a difference in the average maximum number of active glands, it was not significant at the 95% confidence limits. (The reason for this difference will be discussed later.)

The decrement in the number of active glands subsequent to the maximum count was not significant on the chest in both states of acclimatization. However, on the back, the decrement, subsequent to the maximum count, was significantly smaller in the acclimatized than in the unacclimatized state.

The percentage of transient inactivated glands, "resting glands" and "fatigued glands" was remarkably reduced after acclimatization on both sites. Therefore one could infer that acclimatization prolonged glandular activity.

ACTIVITY OF THE SWEAT GLAND.

When the subjects were suddenly introduced to work in a hot humid atmosphere, there was a latent period before glandular activity commenced, but thereafter it progressively increased to maximal values within approximately one hour in the unacclimatized state and two hours in the acclimatized state.

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After the maximal activity was reached there was a progressive decline until the end of the experimental period.

The duration of the latent period; maximum activity; time when maximum activity of the gland was reached; decrement of activity and time when activity commenced to decrease, differed from subject to subject; region to region in the same subject, i.e. chest and back; gland to gland in the same region, and state of acclimatization.

Nevertheless, despite all these differences, a pattern for the whole group was discernable as the differences were not extremely wide, nor did they complicate the issue, as values for each subject in both unacclimatized and acclimatized states were studied.

It is difficult to advance an explanation for the individual variations. A regional difference could be explained on the following basis: In preliminary experiments, with different subjects, on sweating in response to exercise at ordinary room temperatures (approximately 20°C), sweating commenced first on the forehead and neck, then on the chest, and later on the back and limbs. One could therefore assume that during the normal working day of these subjects in the unacclimatized state, under ordinary or temperate conditions, there would be little sweat gland activity on the back but considerably more on the chest. Therefore on being subjected

/to the unacclimatized...29

to the unacclimatized hot humid study there would be some functional training of the sweat glands on the chest. This assumption was supported by the fact that the increment in the activity of the glands on the back was greater than that on the chest after acclimatization.

Another probable explanation for the regional difference in activity, as well as the interglandular activity in the same region, is based on a difference in histological structure. Kodachi (1942), cited by Kuno (1956) showed that there was a difference in the sizes of sweat glands, also that the sizes differed in different regions. If one sweat gland is larger and has a longer secretory coil than another, then the output of the larger gland would be expected to be greater than that of the other for the same stimulus.

Another factor in connection with the histology of the gland is the difference in blood supply to the glands. Obstruction of the blood supply to a sweating limb diminishes both the sweat output and the number of active sweat glands, (Randall et al 1948; Collins et al 1959; Weiner & Hellmann 1960). That the gland itself becomes "fatigued" is shown by alterations in sweat chemistry (Van Heyningen & Weiner 1952).

The implication of this circulatory aspect can be illustrated in the following example. If an arteriole supplies

/four sweat 30

four sweat glands, the first branch leading to gland No.1, and the second branch to gland No.2 etc., during activity and in hot environments with "peripheral vasodilatation", gland No.1 would be better supplied with blood than Nos. 2, 3 and 4. Then gland No.4 would relatively be ischaemic to 3, 2 and 1, in that order.

Thus the element of circulatory insufficiency in some glands could lead to early fatigue, a low degree of maximal activity or early inactivation. With an improved peripheral circulation, as occurs after acclimatization, there would be an increased maximal activity, delayed onset of fatigue and a delayed inactivation.

A further probable factor in connection with the histology of the gland is the variability of the depths of the glands in the dermis. This is just a suggestion in that, at different depths, a gland might have a different circulatory volume and a different temperature which could influence its function. Research into this aspect is still awaiting accomplishment.

The increased activity due to acclimatization could be explained on the basis of histological and histochemical changes due to the functional activity of the secretory cells. These changes could possibly be an increased mitotic activity of the secretory cells, efficiency in the consumption and/or

/increased 31

increased storage of glycogen or other cellular substances essential for activity. The increased peripheral blood flow due to acclimatization would assist these changes to increase activity.

The range of the activity of a gland is variable and wide. For example, the minimum activity of one gland measured "0.25" and the maximum "25.00". Thus some glands at least have a maximal function capacity of 100 times its minimum. The majority of the glands in the experiment showed a functional capacity of from 30 to 50 times their minimum activity.

A remarkable feature was that some glands maintained their maximal activity during the whole period of observation while other glands declined in activity at the 4th hour, but the majority of glands commenced their decline in activity after 1½ to 2 hours.

Another feature often observed in glandular activity was that some glands showed a transient inactivation which usually occurred after the 2nd hour. The duration of this phenomenon was variable, in some cases lasting for an hour and a half, and, in others, for only half an hour. Some probably lasted less than ½ hour, but it was difficult to judge this as strips were taken half-hourly. An example of this probability is illustrated in subject 125105 chest

/acclimatized.....32

acclimatized (Appendix B) gland No.13 where, at 2½ hours, the activity was "16.00", at 3 hours "4.00" and at 3½ hours "9.00". There could probably have been a short transient inactivation either between the 2½ and 3, or 3 and 3½ hour periods.

The decline in activity will be further discussed under "Fatigue of the Sweat Gland". Nevertheless it is worthwhile mentioning here that as the average activity starts to decline, so does the number of inactive glands start to increase. The decrement of activity is greater at the beginning than the number of inactive glands.

THE RELATION BETWEEN GLANDULAR ACTIVITY AND SWEAT OUTPUT.

The results of this experiment indicate clearly that:
1) There was no significant increase in the maximum number of active glands/cm^2 on the chest before and after acclimatization. One can assume that other regions of the body whose sweat glands have the same activity and active density as, or are hyperactive to those of the chest, will show no increase in the number of glands after acclimatization.
2) The density of the maximum active sweat glands on the unacclimatized back was not significantly different at 95% confidence limits from that of the acclimatized one.

The average difference in maximum count was from 71/cm^2 to 87/cm^2. An explanation for this difference in

/count may be...33

count may be advanced on the basis of:

a) A slight error in counting the glands. As previously mentioned, the technique for counting the glands was such that only those glands which actually touched or exceeded the outer lines of the cm^2 were counted. In the acclimatized state, owing to the perforations being larger, and therefore touching the outer lines, it is possible that more glands were counted than in the unacclimatized state where, on account of the smaller perforations, fewer glands touched the outer lines. In any event this possible error would not affect the count in the state of declined activity, as the number of marginal perforations decreased considerably.

b) The second possibility is that in the unacclimatized state there could be a few glands which were so poorly active that they failed to perforate the plastic impression, and that after acclimatization, with increased activity, they successfully perforated the impression and were therefore counted. However, the number of these glands per cm^2 would be few. If one compares other regions of the body whose glands have similar activity to those on the back, one would not expect an increased number of active sweat glands after acclimatization. However, if such an increase did occur, it could not be more than 5%.

3) The range of glandular activity is wide, ranging from

/30 to 100 times...34

30 to 100 times its minimum activity.

From the above three observations, i.e. that after acclimatization there was no increase in the number of active sweat glands on the chest, nor any significant increase on the back, and that the activity of a sweat gland can be 100 times its minimum activity, it then becomes obvious that sweat rates were proportional to the activity of the glands. The increase in sweat rates after acclimatization can therefore be stated to be due to increased glandular activity.

FATIGUE OF THE SWEAT GLAND.

In considering the subject of fatigue of the sweat glands, one must define "fatigue" and "exhaustion" of the glands and distinguish between them. Fatigue refers to the inability of the gland to maintain a maximal response to a certain constant stimulus. If the gland does not maintain the maximal response, it diminishes gradually until lost. If a resting period is given to the fatigued gland and the same stimulus is applied, a response would be evoked. If during the diminished phase of activity a greater stimulus is applied (provided the first stimulus is not maximal), there would then be an increased response, but for a shorter duration.

/Exhaustion of the 35

Exhaustion of the sweat glands refers to that state wherein the sweat gland fails to respond to any stimulus. The recovery period, in order to evoke a response to a maximal stimulus, is far greater than that of fatigue (probably up to a week or more). Maximal stimulation of fatigue glands leads to exhaustion.

The phenomenon exhibited by these glands in this experiment is considered to be "fatigue", because no increased stimulation was applied to the inactivated glands to test for a response, and because of the short transient inactivated period observed in other glands.

The concept of a nervous fatigue mooted by Kuno (1956 p.191) was based on two types of experiments. One was an acute exposure of men to severe temperatures (40°C to 72°C. D.B. and 38°C to 48°C.W.B.) lasting up to one hour. The other was that of Lee for fever therapy (temperatures 43°C to 50°C saturated) with the head outside the cabinet in an ice bag. Kuno's principal grounds for attributing the decline in sweat rate to nervous fatigue were as follows:

a) Depression of sweating was associated with mild neurological symptoms of heat stroke which occurred during the exposure in a Kettering hypertherm.

b) Sweating was restored after the subjects returned to cool air.

/Dealing with (a).....36

Dealing with (a), these neurological symptoms could only be coincidental with the decline in sweat rates. The subjects in this experiment showed no neurological symptoms, yet the decline in sweat rates and glandular activity was pronounced and significant. Furthermore, in an unpublished series of experiments at the Applied Physiology Laboratory of the Transvaal and Orange Free State Chamber of Mines where subjects were exposed to similar conditions and exercise, but for a longer duration, at the end of the period of exposure the rectal temperatures were higher (103°- 104°F), the sweat rates declined, but their reaction time to light and sound was the same as that previous to the exposure at ordinary room temperature. These subjects showed no neurological symptoms either.

Dealing with (b), Kuno stated that these subjects had to be withdrawn from the experiment to avoid heat stroke. They must therefore have had high skin temperatures as well as high body temperatures. The decline in sweat rates could easily have been due to the influence of high skin temperatures which have an inhibitory action on glandular activity. After being returned to cool air, rapid evaporation cooled their moist skins, thereby removing the inhibitory factor of high temperature and thus storing sweat gland activity. Therefore these phenomena do not seem to have been due to either sweat

/gland fatigue....37

gland fatigue or nervous fatigue.

Wolkin et al (1944) mooted other grounds for a nervous fatigue concept, based on the fact that 8 soldiers in the North African Desert, suffering from heat exhaustion, failed to sweat - except on the head and neck - when injected with mecholyl. Their view was based on the fact that in post-operative cerebral hyperthermia, sweat glands failed to respond, in a similar manner, to cholinergic drugs. Wolkin et al report that in these patients cessation of sweating was preceded by excessive sweating. They also report that after a long rest in hospital, sweating was restored in response to cholinergic drugs. It therefore becomes obvious that in these patients the sweat glands were in a state of "exhaustion". Moreover, mecholyl is not a nervous stimulating drug.

With this background, it is difficult to accept these concepts of nervous fatigue, the bases of which are widely dissonant and inconsequential with other phenomena.

The concept of fatigue of the sweat gland was based on the altered sodium chloride concentration of the sweat in the stage of marked hypohidrosis (Ladell 1945; Weiner & Hellman 1960). Principally the increment of chloride concentration was attributed to the failure of the secretory cells to main-

/tain a hypotonic.....38

tain a hypotonic solution. Sargent (Montagna et al 1962 p.182) criticized these and similar studies in that the chemistry of sweat is related to other variabilities such as skin temperatures, work rates, dietary salt intake, state of acclimatization, activity of the adrenal gland and individual differences.

Various authors have claimed that peripheral factors can influence glandular activity. Ladell (1957) showed a relationship between rectal temperature and sweat rates, and that the response of the sweat glands was proportional to rises in rectal temperatures to a certain degree (approximately 101°- 102°F) whereafter an increase in the rectal temperature caused a decrease in sweat rate. He expressed the view that this was intrinsic in the nature of the sweat gland response.

In this study the decrement of glandular activity does not seem to have been influenced by the rectal temperature. For example, in the unacclimatized state of subject 28215, during a rise in rectal temperature from 101.7° to 102.0°F, the sweat output decreased by 40%. A further rise from 102.0°F to 102.4°F showed virtually no change in sweat output. Similarly, in other subjects, one could find instances where, during a small increment in rectal temperature, there was a vast decrement in sweat rates, and vice versa.

/In the acclimatized...39

In the acclimatized state, an average rectal temperature of 100.5°F for the whole group was associated with an average sweat rate of 1055 cc/hr. for the 2nd hour. For the 3rd hour there was an increment of 0.3°F and a decrement of 25% in sweat rate. Besides, at a given rectal temperature, the difference between the decrement in glandular activity on the chest and back for each individual, or the whole group, was so great and significant that the decline in activity could not have been due to the rise of body temperature. If the temperature did have such an influence, there should not have been such vast differences between the decrement of glandular activity on the chest and back. Therefore, in this study, one could not attribute the decrement in glandular activity to the increment in rectal temperature.

Hydration of the skin and its influence on depressing glandular activity has been described by various authors (Randall & Peiss 1957, Hertig 1960, and recently Collins & Weiner 1962). This factor was carefully examined but in this study hydration of the skin did not cause the decline in glandular activity for the following reasons:

1) Measurements of various distances taken from points of intersections of skin ridges on the photographic prints showed a remarkable consistency throughout the experiment. In one subject, in the unacclimatized state, a print on the

/chest was taken....40

chest was taken before the exposure. The distances of the identified points were measured during the exposure when sweating occurred and in the same area after acclimatization. It was surprising to find that the distances were almost identical before sweating, during the peak of activity and during the decline in activity in both states of acclimatization. In some instances, in other subjects, a slight expansion was measured and this was in the order of 2.5 to 66. This was probably due to a slight stretch of the skin while taking the prints. Expansion of the hydrated skin took place in a vertical direction with very little in the horizontal. Thus,hydration of the poral opening caused little obstruction to the extrusion of sweat from the duct.

2) In the unacclimatized state, the glands on the back showed a marked depression in activity between the 1 hour period and the $2\frac{1}{2}$ hour period, whereas the activity on the chest remained fairly constant. It is unlikely that the skin on the back was more hydrated than the chest to the extent of causing this vast significant difference.

3) After the early onset of hypohidrosis on the unacclimatized back, hydration of the skin appeared to progressively diminish until the backs of most of these subjects became virtually dry, yet hypoactivity was not reversed.

/other factors 41

Other factors have been suggested as influencing glandular activity, such as miliaria rubra and crystalina, adaptation of receptors and dehydration, but these factors do not have any support in this experiment.

In this experiment it was observed that:

1) On the unacclimatized chest there were a number of glands that maintained a fairly constant rate of activity, while other glands showed variable decrements of activity, and the rest lost their activity completely. After acclimatization there was an increment in the number of glands that maintained constant activity.

2) Concurrently, on the unacclimatized back, almost all the glands showed a marked decrement in activity which occurred sooner and was sharper than that on the chest. There was also a rapid increase in the number of glands that lost their activity completely. Acclimatization prolonged activity and significantly reduced the number of inactivated glands.

3) On both sites, and in both states of acclimatization, there were glands that showed transient inactivation. Acclimatization reduced the percentage of inactivation.

These observations do not suggest that the decline in glandular activity was due to either central nervous failure

/or hydration....42

or hydration of the skin or skin temperature, but rather to the failure of the secretory cells to maintain a constant rate of flow. Transient inactivation indicated that the gland was fatigued, since it failed to respond to a stimulus, but after a period of rest it resumed activity.

The above statement can be further illustrated from the photographs in Appendix C. Considering the unacclimatized glands on the chest of subject 125121 at the end of the 3rd hour, there were approximately 8 glands (24%) that were highly active with no or little decrement in activity from previous measurements (Appendix B). There were 6 glands (18%) that lost their activity entirely and 20 glands (58%) with varied decrements in activity. At the 4½ hour period there were 18 active glands (53%), 6 of which (18%) were highly active, and 16 glands (47%) which were inactive. If hydration of the skin, or skin temperature, or a central nervous failure was the cause of the decline in activity, there is no reason why 20-25% of these glands should have been spared. It was previously mentioned that there are three probable factors that could play an influential role in glandular activity, viz. the size and depth of the gland in the dermis and its circulatory volume. The fact that these glands were spared was probably due to these three factors being favourable, and the fact that at the 3rd hour

/18% lost their....43

18% lost their activity entirely was probably due to these factors being unfavourable.

Therefore, the decline in sweat output and glandular activity was attributed to glandular fatigue.

SUMMARY.

Six unacclimatized African mine labourers were subjected to exercise for 4½ hours in a hot humid environment (90° - 93°F W.B./D.B. approximately 90% R.H.). The number and activity of sweat glands was studied on the chest and, in four cases, on the back in the unacclimatized state and after acclimatization.

The patterns of glandular activity and density of active glands at half hourly intervals have been described. Acclimatization increased and prolonged glandular activity. The increment in activity of the sweat glands on the back was greater than those of the chest. There was no increase in the maximum number of active glands on either site after acclimatization. Acclimatization greatly reduced the number of inactive glands, subsequent to the maximum count, on the back, but this was not observed on the chest.

At moderate to high sweat rates sweat outputs were correlated chiefly to the activity of the glands and, to a

/lesser extent 44

lesser extent, to the number of active glands. Only at low sweat rates did active glandular density assume importance, and the increased sweat rates due to acclimatization were due mainly to increased glandular activity. The decline in sweat rates and activity on prolonged exposure to this hot humid environment was due to glandular fatigue. Other factors, such as increased body temperature, hydration of the skin and fatigue of the central nervous system, suggested by other investigators as possibly causing the decline in sweat rates did not have support in this study.

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COMMENTS ON STATISTICAL TEST USED.

I. Confidence Limits.

The standard technique for comparing two quantities both of which are related to time is to fit a regression curve with its appropriate limits. Unfortunately the data dealt with in this analysis could not be represented by a suitable simple relationship and so it became necessary to compare the results for each half hour separately.

In this sort of test it often happens that a few results are just not significant. It is almost definite that if one had been able to fit a curve, significant results would have been obtained in these cases.

Details of the test are as follows: For any particular time let

x_{i1} be the average acclimatized activity of the i^{th} person

and x_{i2} be the average unacclimatized activity of the i^{th} person

then $Z_i = x_{i1} - x_{i2}$ is difference due to acclimatization and $\bar{Z}$ is the average of the Z_i.

In the graphs 95% confidence limits were calculated for $\bar{Z}$ by means of $\bar{Z} \pm \frac{tS}{\sqrt{n}}$

/where 46

where S^2 = pooled residual variance based on m degrees of freedom

t = corresponding 95% t factor based on m degrees of freedom

n = number of subjects with both acclimatized and unacclimatized readings at time T.

When the limits do not overlap zero then there is a significant difference at the 95% level.

II. Consideration of the 4½ hour period.

It was decided to regard the nine half hourly observations as nine independent observations for each subject. Estimates were obtained of the average difference between chest and back results and acclimatized and unacclimatized results,

viz. $$\bar{\bar{x}} = \Sigma\Sigma x_{ij}/N$$

where x_{ij} = j^{th} difference on i^{th} subject

N = total number of observations.

The variance of $\bar{\bar{x}}$ is

$$\bar{\bar{x}} = \frac{\sigma^2_r}{IJ} + \frac{\sigma^2_b}{I}$$

where σ^2_r = pooled within subject variation

σ^2_b = between subject variation

/.....47

I = No of subjects

J = No of observations on each subject.

The next step was to calculate t factors where

$$t = \frac{\bar{x}}{\sqrt{\delta^2_{\bar{x}}}}$$

The values obtained are given in Table V.

Unfortunately due to the fact that $\delta^2_{\bar{x}}$ is the sum of two variances it is not known what the exact degrees of freedom are, however if one were to take a value of $t > 2.0$ as being significant one could place the level of significance as between 90 and 95%.

It was suggested that this factor ($t > 2.0$) be used as the test criterion in this case.

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FIGURES FOR THE TEXT.

FIGURE 1. PULSE RATE RECTAL TEMPERATURE & SWEAT RATE VERSUS TIME. AVERAGE OF ALL BOYS.

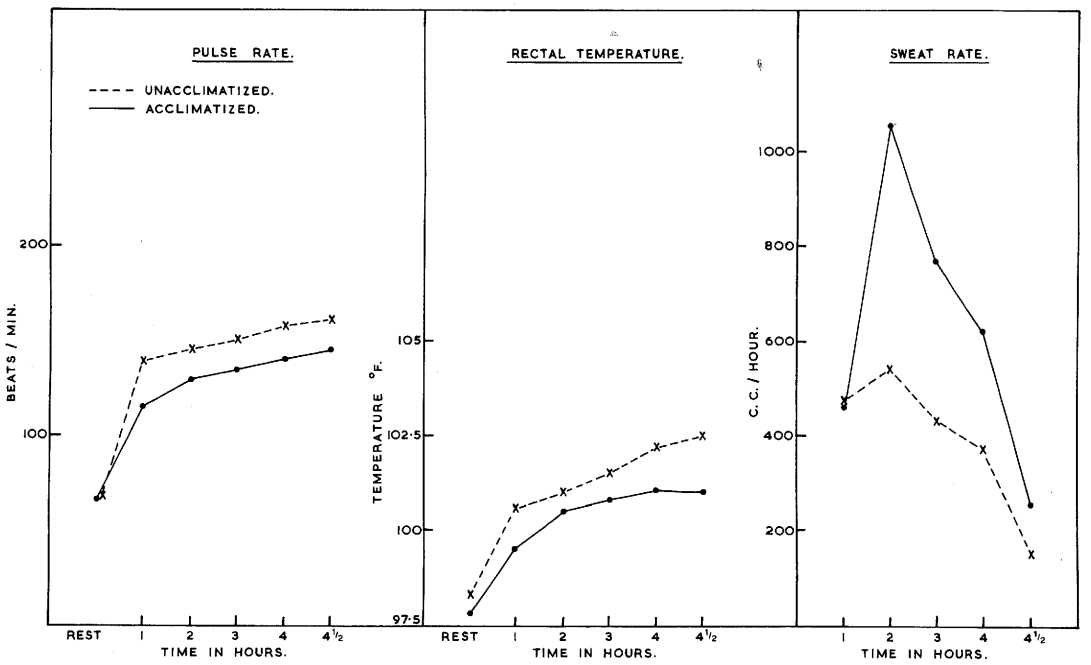


FIGURE 2(A) AVERAGE RELATIVE ACTIVITY PER GLAND OF SUBJECTS WHEN ACCLIMATIZED & UNACCLIMATIZED.

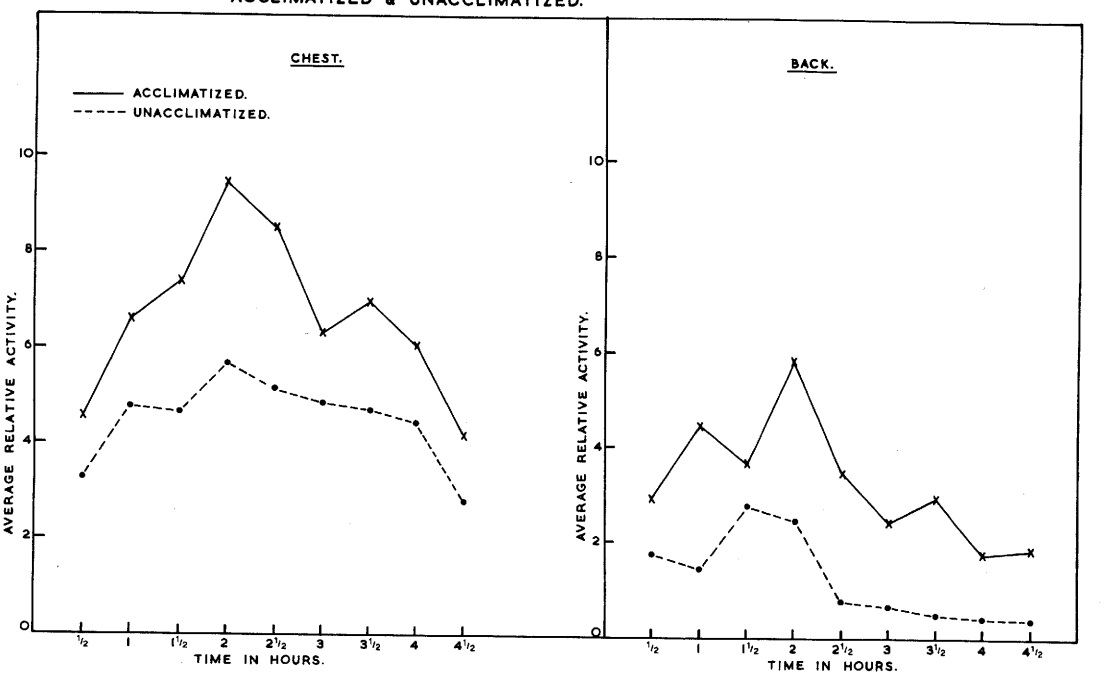


FIGURE 2(B) DIFFERENCE BETWEEN ACCLIMATIZED AND UNACCLIMATIZED RELATIVE ACTIVITY WITH 95 % CONFIDENCE INTERVALS TO THE AVERAGE DIFFERENCES.

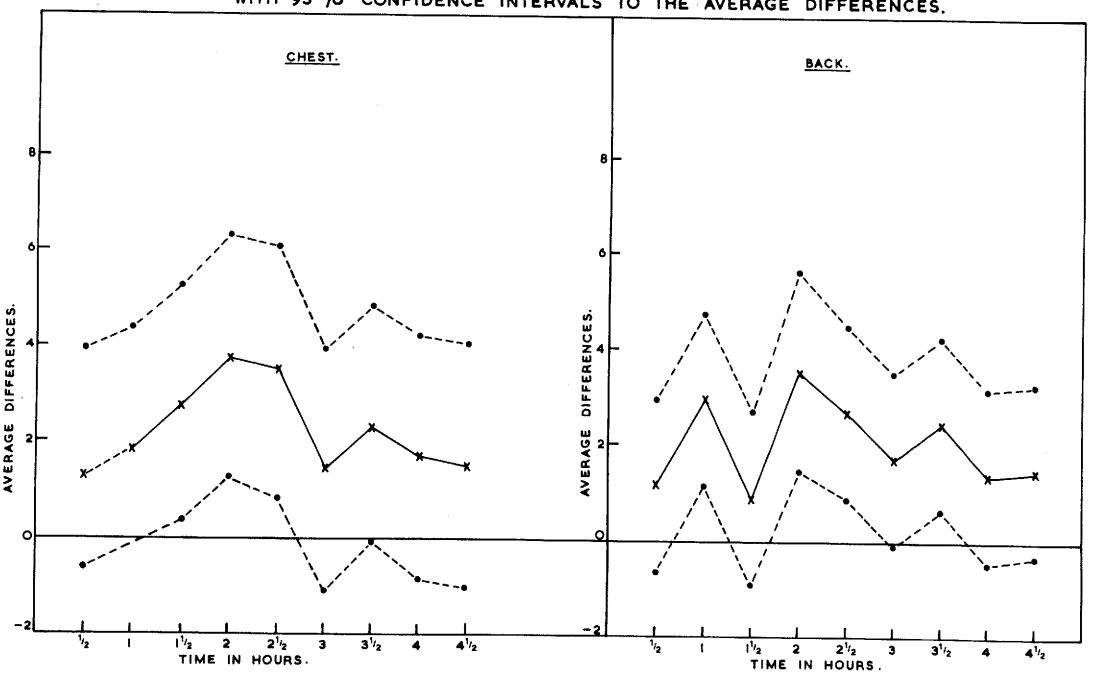


FIGURE 3 (A) AVERAGE RELATIVE SWEAT OUTPUT/CM^2 FOR CHEST AND BACK WHEN ACCLIMATIZED AND UNACCLIMATIZED.

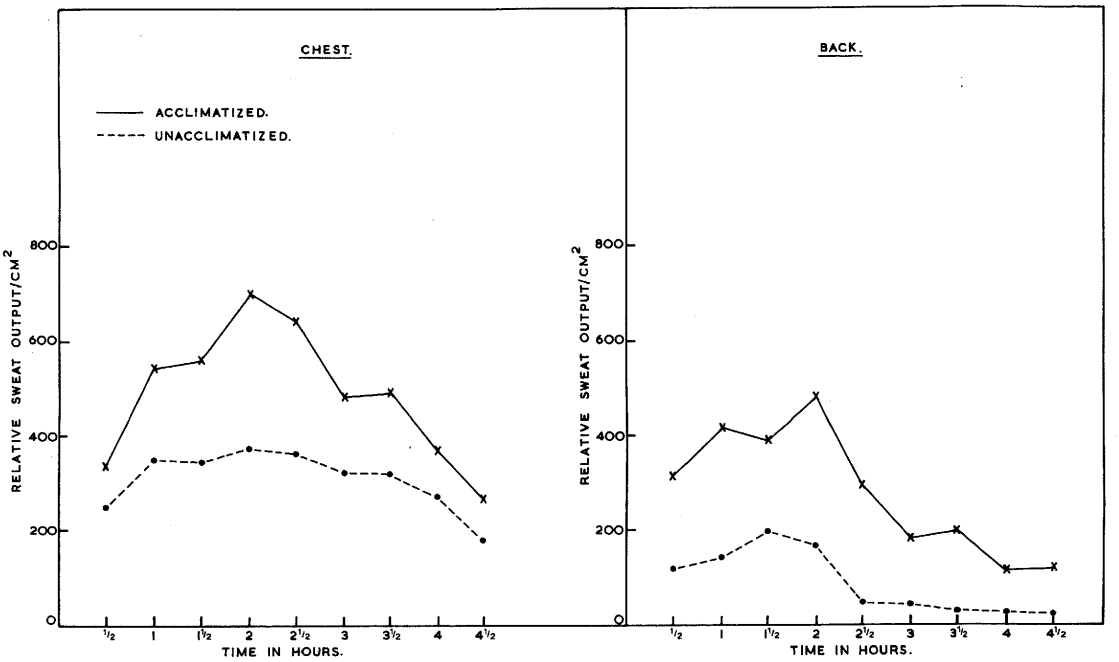


FIGURE 3 (B) DIFFERENCE BETWEEN ACCLIMATIZED AND UNACCLIMATIZED RELATIVE SWEAT OUTPUT/CM^2 WITH 95% CONFIDENCE INTERVALS TO AVERAGE DIFFERENCES.

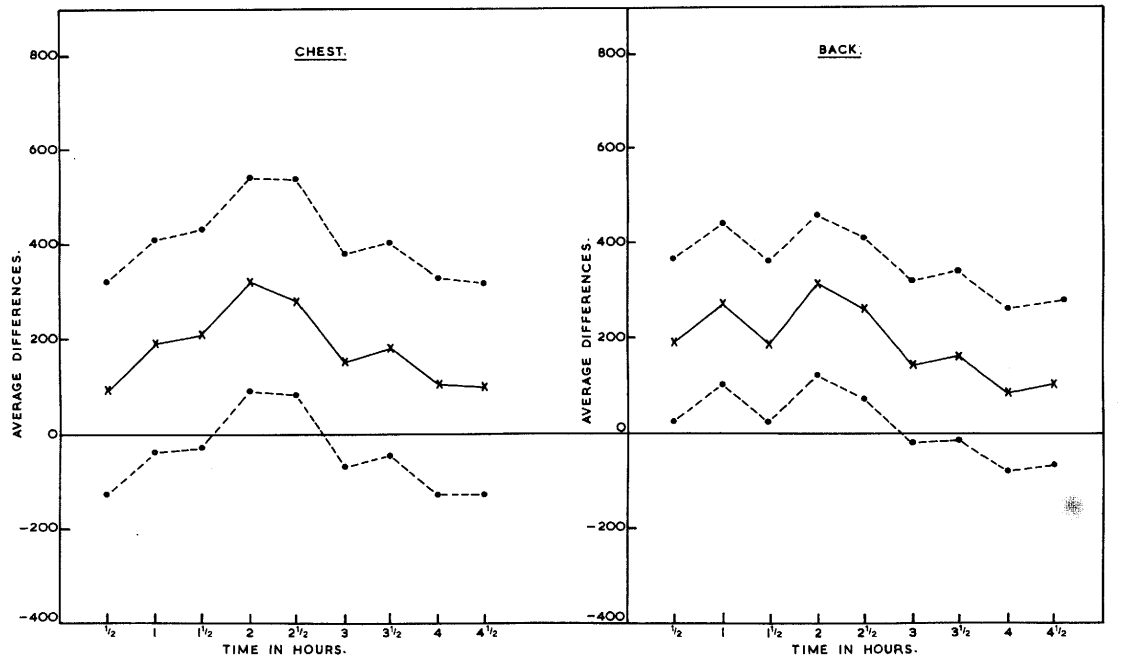


FIGURE 4(A) AVERAGE RELATIVE ACTIVITY OF SUBJECTS. DIFFERENCE FOR CHEST & BACK.

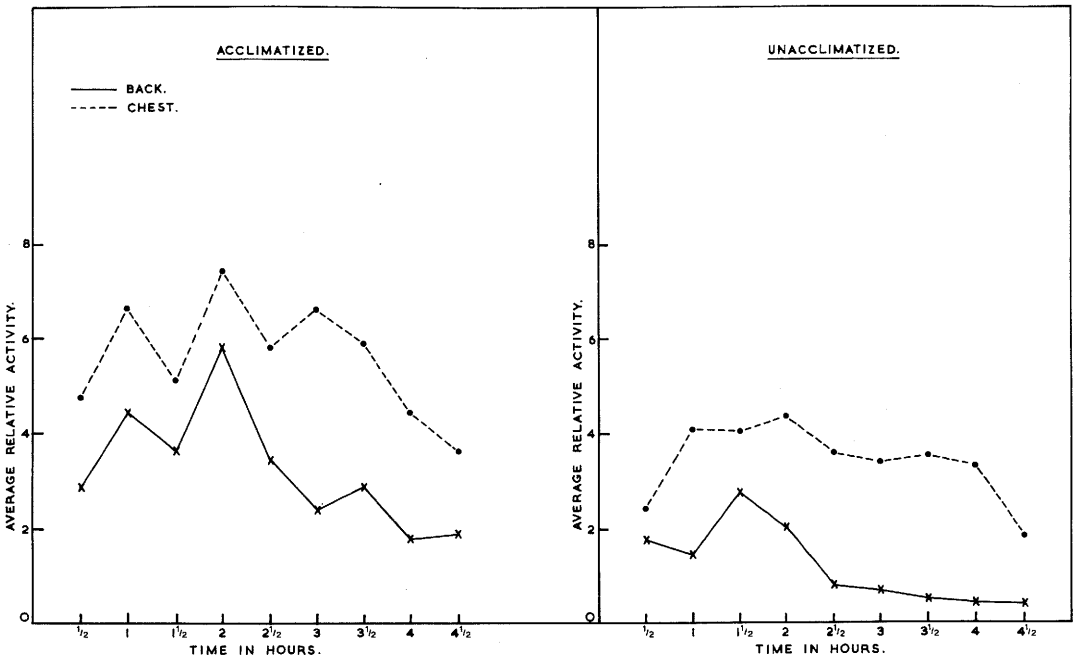


FIGURE 4(B) DIFFERENCE BETWEEN CHEST & BACK ACTIVITY WITH 95 % CONFIDENCE INTERVALS TO AVERAGE DIFFERENCES.

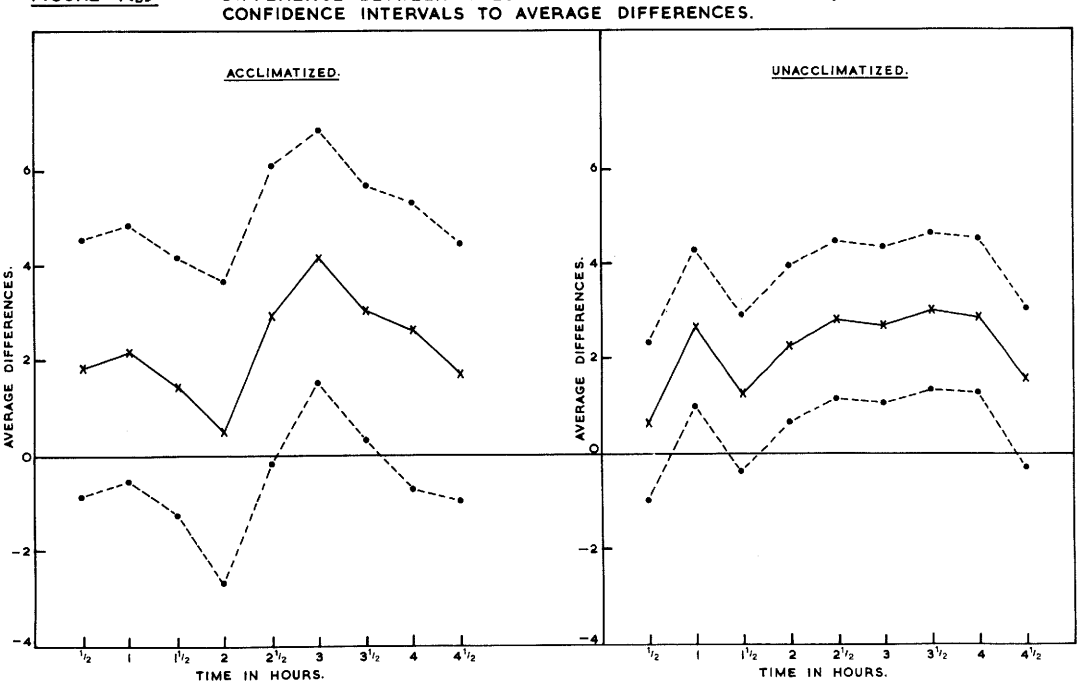


FIGURE 5(A) RELATIVE SWEAT OUTPUT/CM^2 FOR CHEST AND BACK.

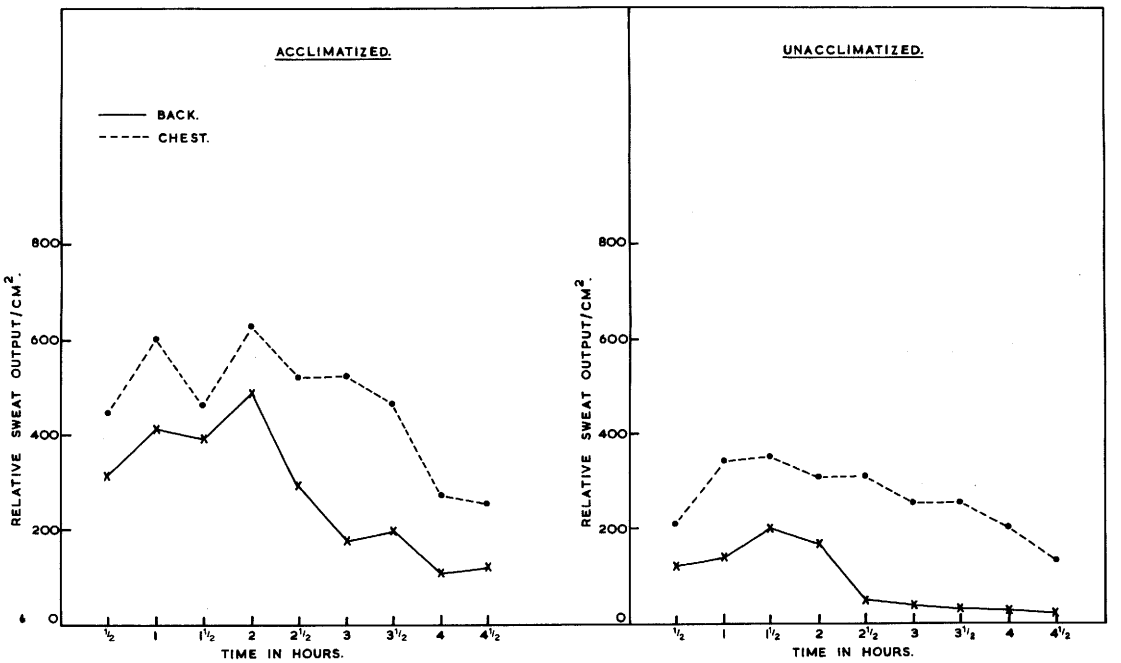


FIGURE 5(B) DIFFERENCE BETWEEN RELATIVE SWEAT OUTPUT/CM^2 FOR CHEST AND BACK WITH 95% CONFIDENCE INTERVALS.

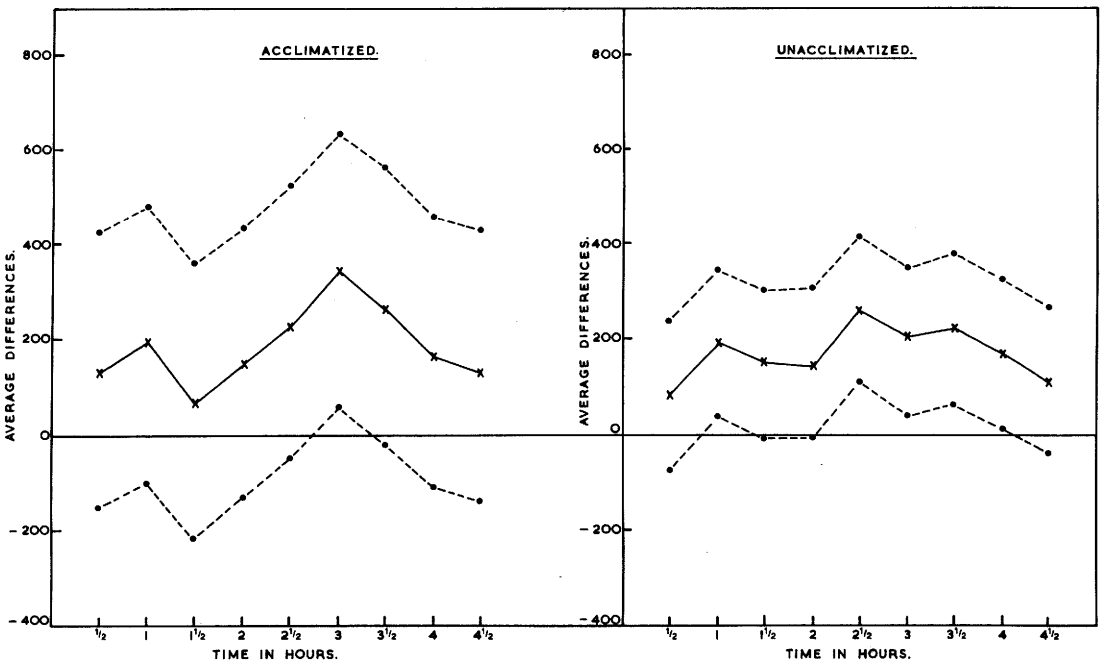


FIGURE 6(A) No. OF ACTIVE GLANDS/CM^2 OF SUBJECTS WHEN ACCLIMATIZED & UNACCLIMATIZED.

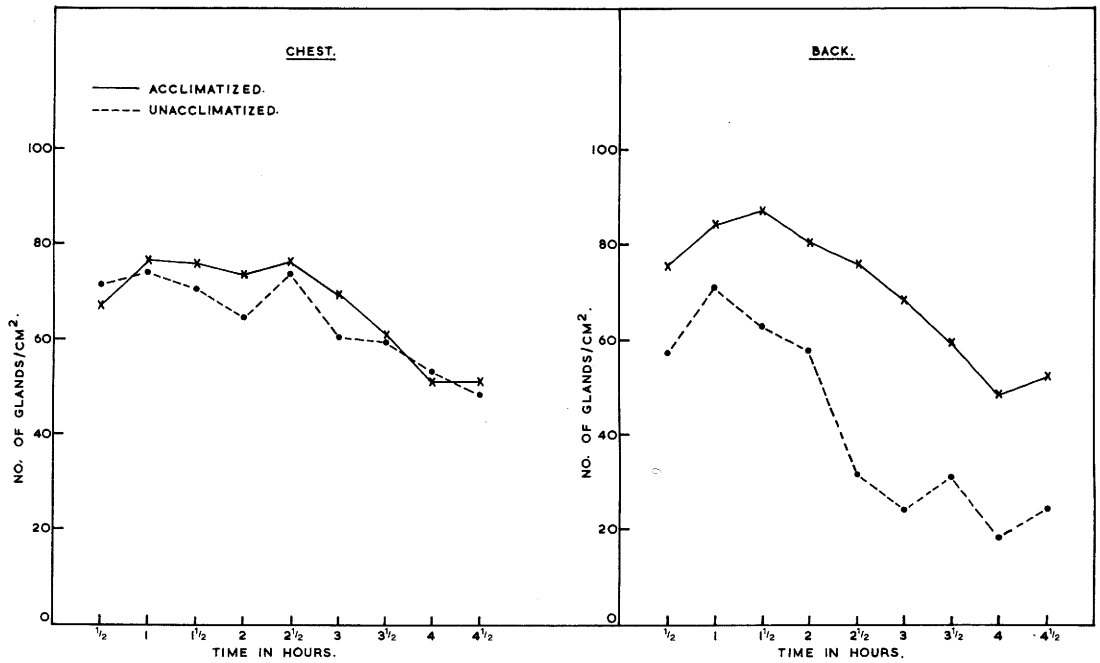


FIGURE 6(B) DIFFERENCE BETWEEN No. OF ACTIVE GLANDS/CM^2 WHEN ACCLIMATIZED & UNACCLIMATIZED WITH 95% CONFIDENCE INTERVALS TO AVERAGE DIFFERENCES.

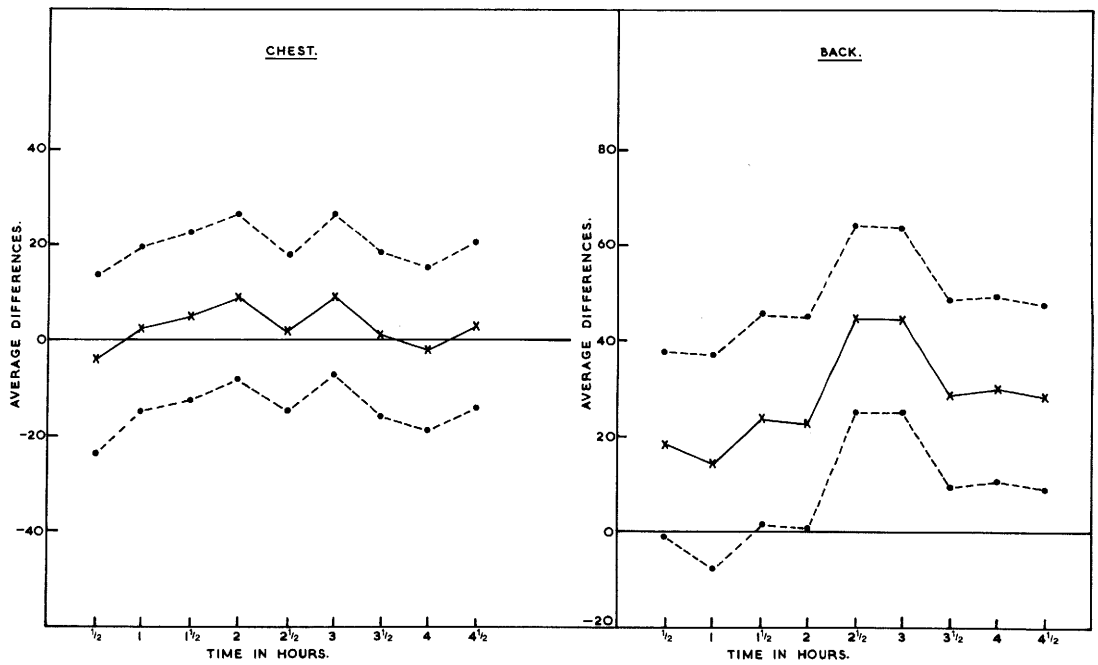


FIGURE 7(A) No. OF ACTIVE GLANDS/CM^2 OF SUBJECTS. DIFFERENCE FOR BACK & CHEST.

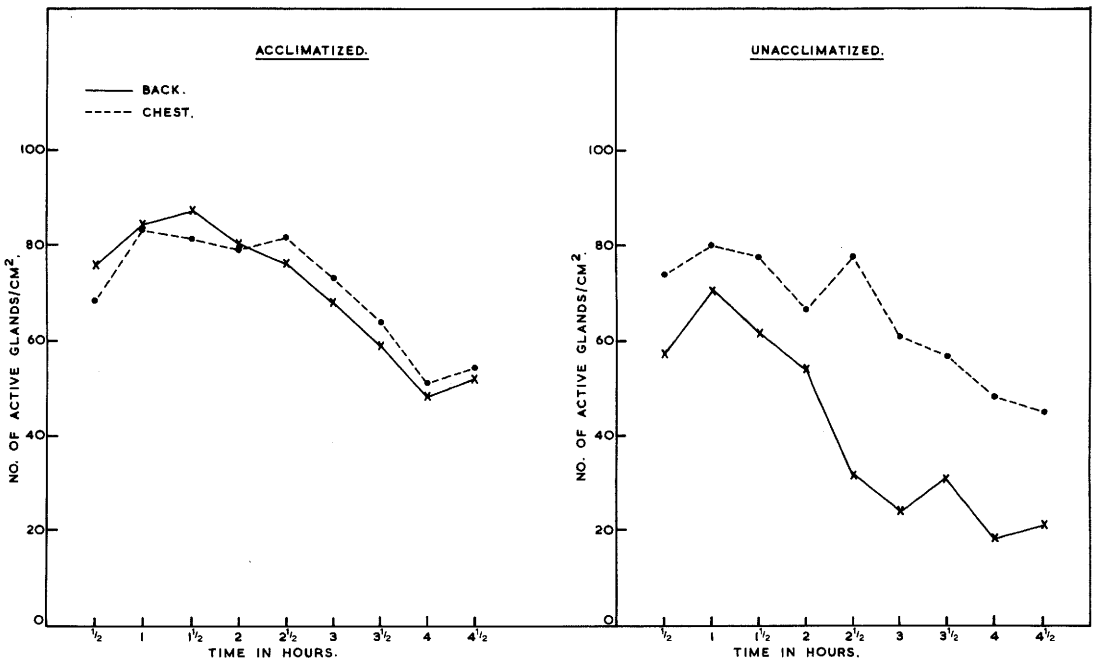
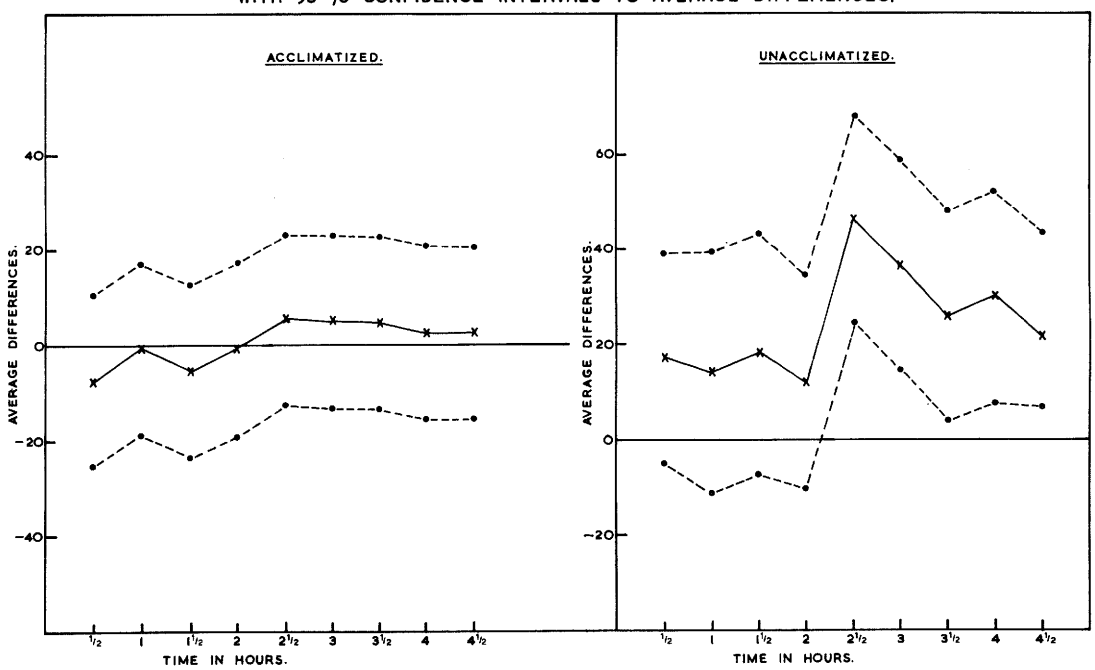


FIGURE 7(B) DIFFERENCE BETWEEN No. OF ACTIVE GLANDS/CM^2 FOR CHEST & BACK WITH 95 % CONFIDENCE INTERVALS TO AVERAGE DIFFERENCES.



RELATION BETWEEN SWEAT OUTPUT/CM^2 AND RELATIVE ACTIVITY/GLAND; AND NUMBER OF ACTIVE GLANDS/CM^2.

FIGURE 8(a)

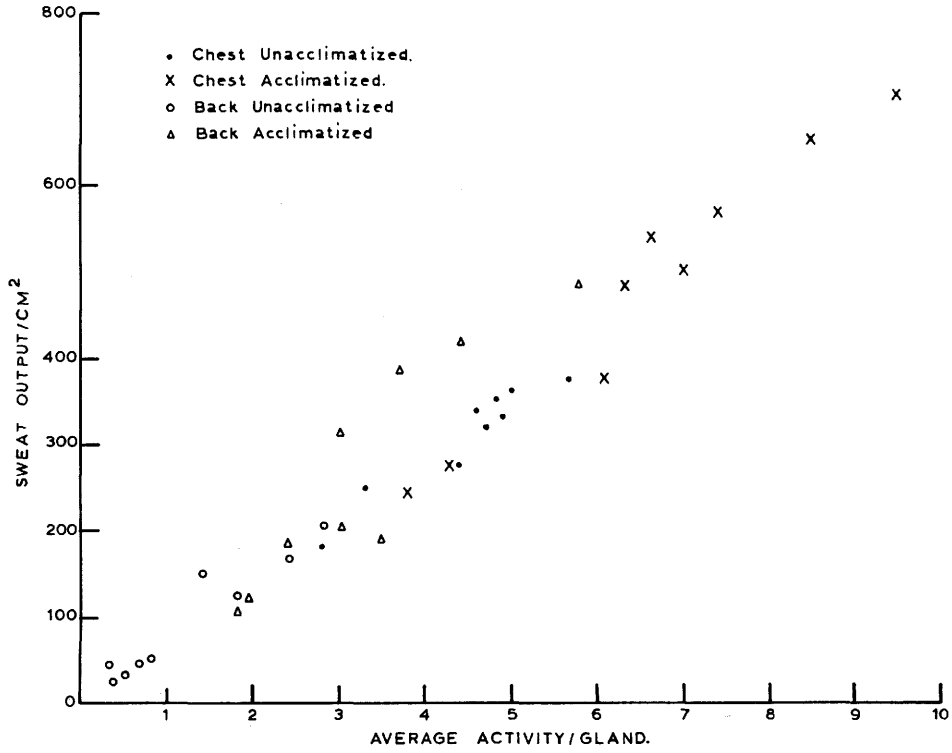
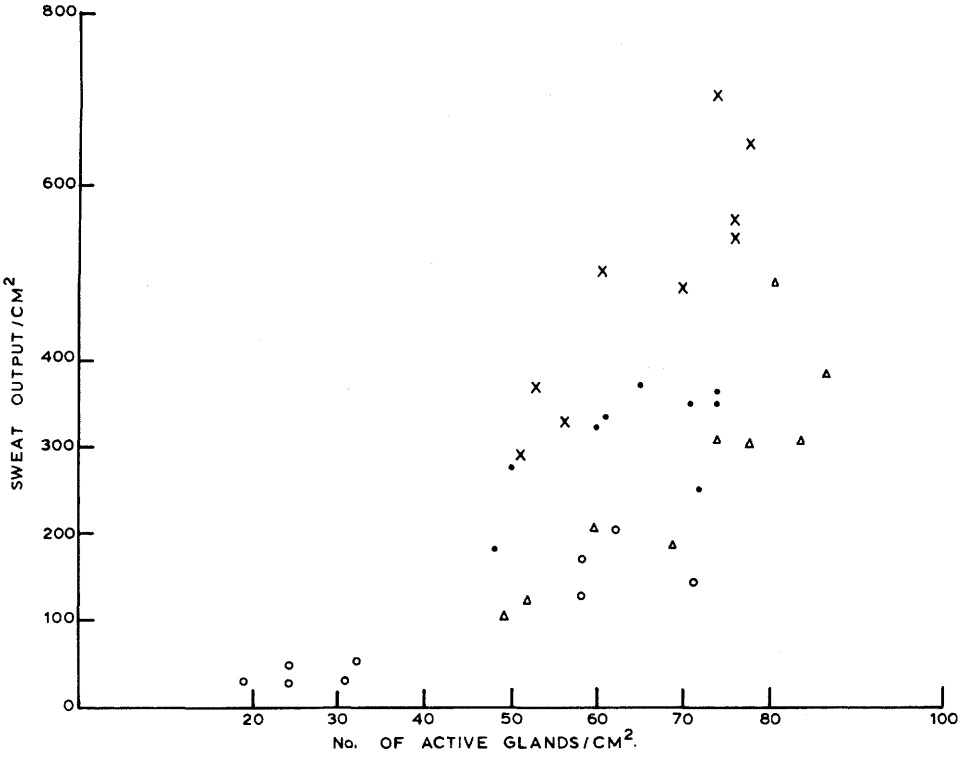


FIGURE 8(b)



TABLES FOR THE TEXT.

(-) Denotes that the plastic impression was unsuitable for study.

TABLE I.

AVERAGE RELATIVE ACTIVITY WITH THE AVERAGE FOR THE WHOLE GROUP.

(a) CHEST UNACCLIMATIZED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	2.61	5.03	3.58	3.05	-	2.25	2.16	1.03	0.63
125121	2.99	5.12	5.09	4.74	4.08	3.76	4.07	2.26	2.40
125105	7.33	9.83	7.66	12.66	8.90	13.56	8.66	7.65	6.91
70432	0.67	3.13	2.45	3.20	4.05	2.94	3.79	3.41	1.71
70459	3.52	3.17	5.11	6.41	3.13	4.65	4.25	6.63	2.53
70548	2.60	2.43	4.01	4.25	-	2.23	5.40	5.60	2.56
Total	19.72	28.71	27.90	34.31	20.16	29.39	28.33	26.58	16.74
Average	3.29	4.79	4.65	5.72	5.04	4.90	4.72	4.43	2.79

(b) CHEST ACCLIMATIZED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	5.69	4.92	2.17	9.05	-	5.39	6.32	5.39	4.27
125121	8.27	12.70	8.58	10.65	8.35	9.96	6.57	3.65	5.15
125105	0.00	10.16	14.16	16.86	16.76	6.85	15.04	12.91	8.07
70432	0.08	4.22	4.41	5.71	4.36	7.50	5.25	5.04	2.58
70459	5.10	4.70	5.39	4.32	4.77	3.63	5.71	3.68	2.50
70548	3.75	3.24	9.81	10.43	-	4.67	3.31	6.07	3.13
Total	22.89	39.94	44.52	57.02	34.24	38.00	42.20	36.74	25.70
Average	3.82	6.66	7.42	9.50	8.56	6.33	7.03	6.12	4.28

TABLE I CONTD.

AVERAGE RELATIVE ACTIVITY WITH THE AVERAGE FOR THE WHOLE GROUP.

(c) BACK UNACCLIMATIZED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	3.35	0.19	2.30	2.55	0.24	1.50	0.58	0.19	0.86
125121	0.63	1.68	2.39	-	0.75	0.26	0.56	0.27	0.26
70432	0.10	2.53	3.81	2.94	0.74	0.45	0.45	0.95	0.13
70459	3.06	1.49	2.66	1.73	1.48	0.59	0.58	0.36	0.47
Total	7.14	5.89	11.16	7.22	3.21	2.80	2.17	1.77	1.72
Average	1.79	1.47	2.79	2.41	0.80	0.70	0.54	0.44	0.43

(d) BACK ACCLIMATIZED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	1.36	3.15	3.06	6.62	5.30	4.20	4.29	2.99	3.02
125121	5.75	8.14	1.88	-	1.55	0.26	0.54	0.16	0.29
70432	0.24	3.15	4.12	5.72	2.42	2.57	2.90	1.33	0.71
70459	4.64	3.32	5.67	5.23	4.64	2.69	4.08	2.66	3.59
Total	11.99	17.76	14.73	17.57	13.91	9.72	11.81	7.14	7.61
Average	3.00	4.44	3.68	5.86	3.48	2.43	2.95	1.79	1.90

TABLE II.

AVERAGE RELATIVE SWEAT OUTPUT/cm^2 FOR THE WHOLE GROUP.

(a) CHEST UNACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	201.19	377.25	211.55	116.62	-	84.38	111.86	37.45	32.81
125121	320.36	516.72	552.48	426.18	411.47	374.13	319.62	48.00	181.67
125105	432.18	589.50	436.76	734.43	507.30	800.19	476.44	459.00	380.19
70432	35.59	228.49	178.85	243.20	283.50	182.28	271.33	228.63	149.63
70459	276.55	238.04	464.32	467.66	253.13	362.38	318.75	470.38	176.97
70548	199.80	173.97	247.59	276.25	-	147.42	416.10	386.69	156.13
Total	1465.67	2123.97	2091.55	2264.34	1455.40	1950.78	1914.10	1630.15	1077.40
Av.	244.28	354.00	348.59	377.39	363.85	325.13	319.02	271.69	179.57

(b) CHEST ACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	443.82	398.52	136.96	678.91	-	420.42	467.68	392.53	299.92
125121	965.21	1384.80	952.42	1161.33	911.44	906.98	587.03	243.32	419.54
125105	0.00	652.54	892.19	994.89	1022.51	445.25	902.25	709.93	443.62
70432	3.20	312.28	308.70	359.73	322.46	570.00	375.00	292.09	189.47
70459	382.21	329.13	442.33	318.79	332.32	210.56	423.23	170.18	107.25
70548	236.25	204.03	657.06	688.50	-	329.88	227.34	417.19	200.52
Total	2030.69	3281.30	3389.66	4202.15	2588.73	2883.09	2982.53	2225.24	1660.32
Av.	338.45	546.88	564.94	700.36	647.18	480.52	497.08	370.87	276.72

TABLE II CONTD.

AVERAGE RELATIVE SWEAT OUTPUT/cm^2 FOR THE WHOLE GROUP.

(c) BACK UNACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	140.50	3.20	99.04	122.29	18.75	63.00	31.50	20.00	31.85
125121	55.61	201.07	236.80	-	32.29	25.33	43.13	19.32	14.50
70432	4.25	215.00	263.06	240.88	45.38	36.00	23.73	39.46	6.79
70459	293.79	155.00	200.85	143.57	126.31	43.44	43.27	22.31	33.00
Total	494.15	574.27	799.75	506.74	222.73	167.77	141.63	101.09	86.14
Av.	123.54	143.57	199.94	168.91	55.68	41.94	35.41	25.27	21.54

(d) BACK ACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	72.68	176.56	226.40	456.71	328.45	303.97	275.00	156.88	207.43
125121	746.85	893.08	464.29	-	244.21	39.57	61.45	19.38	33.20
70432	11.25	286.81	341.48	506.39	235.34	174.32	157.42	77.16	31.90
70459	431.42	295.84	515.67	491.76	371.11	213.13	295.47	185.35	215.09
Total	1262.20	1652.29	1547.84	1454.86	1179.11	730.99	789.34	438.77	487.62
Av.	315.55	413.07	386.96	484.95	294.78	182.75	197.34	109.69	121.91

TABLE III

NUMBER OF ACTIVE SWEAT GLANDS PER CM^2.

CHEST UNACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	74	75	52	26	-	21	29	16	25
125121	101	98	99	90	86	82	60	48	40
125105	59	60	57	58	57	59	55	57	55
70432	51	73	73	76	70	62	63	59	49
70459	72	75	87	73	81	78	75	71	67
70548	74	63	57	65	-	61	77	69	54
Total	431	444	425	388	294	363	359	320	290
Av.	72	74	71	65	74	61	60	53	48

CHEST ACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	78	81	63	75	-	78	74	67	59
125121	113	109	111	109	106	83	65	47	79
125105	0	61	63	59	61	65	60	55	55
70432	8	74	70	63	71	76	60	51	47
70459	75	70	82	71	67	56	57	39	33
70548	63	63	67	66	-	61	50	50	35
Total	337	458	456	443	305	419	366	309	308
Av.	56	76	76	74	76	70	61	52	51

TABLE III CONTD.

NUMBER OF ACTIVE SWEAT GLANDS PER CM^2.

BACK UNACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	40	8	39	32	15	26	18	5	23
125121	77	116	80	-	25	19	45	25	29
70432	17	80	69	82	40	28	29	27	19
70459	96	80	65	60	47	23	31	17	24
Total	230	284	253	174	127	96	123	74	95
Av.	58	71	63	58	32	24	31	19	24

BACK ACCLIMATISED.

Subject No.	Hours ½	1	1½	2	2½	3	3½	4	4½
28215	51	56	74	69	62	62	55	40	49
125121	130	101	104	-	98	90	85	63	87
70432	30	91	80	79	66	46	31	29	21
70459	93	89	91	94	80	76	67	62	51
Total	304	337	349	243	306	274	238	194	208
Av.	76	84	87	81	77	69	60	49	52

TABLE IV

COMPARISON OF THE NUMBER OF ACTIVE GLANDS OF SUBJECTS BEFORE AND AFTER ACCLIMATISATION

(RESULT OF 2x2 CHI-SQUARE CONTINGENCY TESTS)

Subject	Position	Hours								
		½	1	1½	2	2½	3	3½	4	4½
28215	Back	NS	S 95%	NS	S 95%	S 99%	NS	S 99%	S 99%	NS
	Chest	NS	NS	NS	S 95%	-	S 99%	S 99%	S 99%	S 95%
125121	Back	S 90%	NS	S 99%-	-	NS	S 99%	NS	NS	S 95%
	Chest	NS	NS	NS	NS	NS	NS	NS	NS	S 99%
125105	Chest	NS	NS	NS	NS	NS	NS	NS	NS	NS
70432	Back	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Chest	S 99%-	NS	NS	NS	NS	NS	NS	NS	NS
70459	Back	NS	S 95%	NS	S 99%	S 99%	S 99%	S 99%	S 99%	S 99%
	Chest	NS	NS	NS	NS	NS	NS	S 95%-	S 90%-	NS
70548	Chest	NS	NS	NS	NS	-	NS	S 95%-	S 95%-	S 95%-

S 95% indicates significantly more active glands when acclimatised at 95% level.

S 95%- indicates significantly fewer active glands when acclimatised at 95% level.

The quantity considered was the "m" inactive glands out of the "n" observed glands and not the number of active glands/cm^2.

TABLE V.

TABLE OF t VALUES.

AVERAGE ACTIVITY.

	Chest	Back
Acclimatised – Unacclimatised	3.858*(s)	5.196(s)

	Acclimatised	Unacclimatised
Chest - Back	2.123(s)	4.705(s)

RELATIVE SWEAT OUTPUT/CM^2.

	Chest	Back
Acclimatised – Unacclimatised	2.572*(s)	6.531(s)

	Acclimatised	Unacclimatised
Chest - Back	1.532 NS	3.832(s)

NO OF ACTIVE GLANDS/CM^2.

	Chest	Back
Acclimatised – Unacclimatised	1.559* NS	3.731(s)

	Acclimatised	Unacclimatised
Chest - Back	0.027 NS	8.373(s)

* BASED ON 6 SUBJECTS. OTHERS ARE BASED ON 4 SUBJECTS.

(S) Significant at between 90 - 95% Confidence Limits.

NS Not significant at between 90 - 95% Confidence Limits.

TABLE VI

PERCENTAGE OF "RESTING" AND "FATIGUE" GLANDS.

	Unacclimatised		Acclimatised	
Chest	Rest	Fatigue	Rest	Fatigue
28215	48.0	40.0	0.0	4.0
125121	23.5	38.2	41.2	2.9
125105	0.0	0.0	0.0	0.0
70432	0.0	12.0	12.0	8.0
70459	4.2	0.0	16.6	8.3
70548	19.2	0.0	4.5	27.2
Total	94.9	90.2	74.3	50.4
Av.	15.8	15.0	12.4	8.3

	Unacclimatised		Acclimatised	
Back	Rest	Fatigue	Rest	Fatigue
28215	57.1	38.1	14.3	23.8
125121	61.9	61.9	78.0	18.0
70432	50.0	30.0	39.3	28.5
70459	44.8	58.6	7.4	3.7
Total	213.8	188.6	139.0	74.0
Av.	53.5	47.2	34.8	18.5

APPENDIX A.

Detailed figures for the pulse rate, rectal temperature and sweat rate (cc./hr.) for the six subjects before and after acclimatization.

	PULSE RATE.						RECTAL TEMPERATURE.					
Subject	R	1	2	3	4	4½	R	1	2	3	4	4½
28215												
Unacclimat.	106	166	172	176	176	178	99.4	101.2	101.7	102.0	102.5	102.7
Acclimatized	72	118	120	132	138	-	97.8	99.4	100.2	100.6	100.8	100.6
125121												
Unacclimat.	64	124	142	162	176	176	99.1	100.9	101.0	101.9	102.9	103.7
Acclimatized	68	132	144	148	148	156	98.3	101.2	101.6	101.7	101.6	102.0
125105												
Unacclimat.	-	156	160	160	162	166	99.9	100.2	101.1	101.9	102.3	102.6
Acclimatized	66	122	144	154	164	164	99.5	99.1	100.5	101.5	102.2	102.6
70432												
Unacclimat.	67	127	127	130	137	140	97.4	100.5	100.5	101.3	101.8	101.8
Acclimatized	64	104	124	124	132	134	97.2	99.6	100.2	100.2	100.4	100.4
70459												
Unacclimat.	60	143	147	147	160	163	97.0	100.0	100.6	101.1	101.6	102.3
Acclimatized	70	118	130	140	144	144	97.0	99.3	100.3	100.5	101.0	100.6
70548												
Unacclimat.	57	120	127	130	133	143	97.0	100.5	100.8	101.1	101.8	101.7
Acclimatized	56	98	110	112	122	130	97.2	99.3	100.0	100.3	100.7	100.7
Total Unaccl.	354	836	875	905	944	966	589.8	603.3	605.7	609.3	612.9	614.8
Avge. "	71	139	146	151	157	161	98.3	100.6	101.0	101.6	102.2	102.5
Total Acclim.	396	692	772	810	848	728	587.0	597.9	602.8	604.8	606.9	606.7
Avge. "	66	115	129	135	141	146	97.8	99.7	100.5	100.8	101.2	101.1

SWEAT RATE

Subject	1	2	3	4	4½
28215					
Unacclimatised	595	709	393	357	85
Acclimatised	312	765	652	498	312
125121					
Unacclimatised	312	328	300	215	140
Acclimatised	907	754	472	243	170
125105					
Unacclimatised	936	1381	1122	810	413
Acclimatised	765	2499	1961	1834	564
70432					
Unacclimatised	227	240	245	307	85
Acclimatised	142	750	555	429	272
70459					
Unacclimatised	425	284	165	335	113
Acclimatised	425	952	498	413	57
70548					
Unacclimatised	340	312	358	222	113
Acclimatised	210	612	470	300	158
Total Unacclimatised	2835	3254	2583	2246	949
Average "	473	542	431	374	158
Total Acclimatised	2761	6332	4608	3717	1533
Average "	460	1055	768	620	256

APPENDIX B.

Detailed values for glandular activity on the chest and back before and after acclimatization. On subjects 125121, 125105 and 70432, the same sweat glands of the chest were studied before and after acclimatization.

SUBJECT 28215 CHEST UNACCLIMATIZED

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	2.25	4.00	2.25	4.00	2.25	0.25	0.00	0.00	0.25
2	2.25	4.00	4.00	2.25	4.00	2.25	4.00	4.00	2.25
3	4.00	9.00	6.25	9.00	12.25	6.25	9.00	1.00	1.00
4	2.25	2.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	4.00	0.00	4.00	0.00	0.25	0.00	0.00	0.00
6	1.00	2.25	0.00	2.25	0.25	0.00	2.25	1.00	0.25
7	6.25	12.25	4.00	4.00	6.25	9.00	4.00	2.25	2.25
8	4.00	4.00	4.00	4.00	0.00	2.25	4.00	1.00	1.00
9	2.25	4.00	2.25	0.00	0.00	0.00	0.25	0.00	0.25
10	1.00	4.00	12.25	0.00	0.00	0.00	0.00	0.00	0.00
11	4.00	12.25	4.00	4.00	4.00	4.00	2.25	4.00	4.00
12	2.25	2.25	2.25	2.25	0.25	0.00	0.00	0.25	0.00
13	4.00	4.00	4.00	9.00	9.00	4.00	2.25	0.00	0.00
14	2.25	4.00	4.00	9.00	4.00	6.25	4.00	4.00	2.25
15	2.25	9.00	9.00	4.00	16.00	9.00	9.00	4.00	1.00
16	2.25	6.25	4.00	9.00	9.00	6.25	6.25	4.00	0.00
17	2.25	6.25	4.00	4.00	2.25	0.00	0.00	0.00	0.25
18	2.25	4.00	2.25	0.00	2.25	0.00	0.00	0.25	0.00
19	2.25	9.00	6.25	2.25	4.00	0.00	0.00	0.00	0.00
20	1.00	4.00	4.00	1.00	0.00	0.00	0.25	0.00	0.00
21	4.00	0.25	0.25	0.00	0.00	2.25	0.25	0.00	0.00
22	2.25	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	4.00	6.25	4.00	0.00	4.00	4.00	6.25	0.00	1.00
24	4.00	2.25	4.00	0.00	0.00	0.00	0.00	0.00	0.00
25	1.00	4.00	2.25	2.25	0.00	0.25	0.00	0.00	0.00
Total	65.25	125.75	89.50	76.25	79.75	56.25	54.00	25.75	15.75
Av.	2.61	5.03	3.58	3.05	3.19	2.25	2.16	1.03	0.63

SUBJECT 28215 CHEST ACCLIMATIZED

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	4.00	2.25	1.00	6.25	-	4.00	2.25	0.25	0.25
2	2.25	6.25	4.00	9.00	-	6.25	0.25	1.00	6.25
3	2.25	6.25	1.00	6.25	-	4.00	1.00	2.25	4.00
4	4.00	2.25	2.25	9.00	-	0.25	1.00	4.00	9.00
5	4.00	6.25	2.25	9.00	-	4.00	4.00	2.25	6.25
6	4.00	9.00	4.00	12.25	-	6.25	4.00	1.00	2.25
7	6.25	6.25	1.00	12.25	-	4.00	4.00	4.00	0.00
8	9.00	9.00	2.25	9.00	-	12.25	12.25	9.00	6.25
9	6.25	6.25	2.25	-	-	9.00	6.25	6.25	4.00
10	6.25	2.25	2.25	9.00	-	6.25	12.25	6.25	6.25
11	6.25	6.25	2.25	12.25	-	6.25	16.00	9.00	12.25
12	4.00	4.00	-	6.25	-	2.25	0.25	0.00	0.00
13	6.25	4.00	-	9.00	-	9.00	12.25	12.25	9.00
14	6.25	4.00	2.25	4.00	-	9.00	9.00	16.00	9.00
15	9.00	4.00	2.25	6.25	-	6.25	9.00	9.00	2.25
16	9.00	9.00	4.00	12.25	-	12.25	12.25	9.00	6.25
17	6.25	6.25	2.25	9.00	-	6.25	12.25	9.00	6.25
18	4.00	2.25	2.25	9.00	-	1.00	9.00	9.00	4.00
19	6.25	4.00	2.25	9.00	-	1.00	1.00	6.25	4.00
20	6.25	2.25	1.00	6.25	-	4.00	9.00	4.00	0.00
21	9.00	6.25	2.25	12.25	-	9.00	6.25	4.00	0.25
22	6.25	4.00	4.00	12.25	-	4.00	1.00	0.00	1.00
23	4.00	2.25	1.00	9.00	-	1.00	2.25	1.00	4.00
24	2.25	2.25	1.00	6.25	-	1.00	2.25	1.00	4.00
25	9.00	6.25	1.00	12.25	-	6.25	9.00	9.00	0.00
Total	142.25	123.00	50.00	217.25	-	134.75	158.00	134.75	106.75
Av.	5.69	4.92	2.17	9.05	-	5.39	6.32	5.39	4.27

SUBJECT 125121 CHEST UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	4.00	4.00	6.25	9.00	9.00	6.25	4.00	6.25	2.25
2	4.00	6.25	6.25	4.00	4.00	4.00	4.00	9.00	12.25
3	4.00	9.00	9.00	9.00	9.00	9.00	12.25	9.00	6.25
4	2.25	2.25	4.00	4.00	0.25	6.25	2.25	0.00	0.00
5	2.25	6.25	6.25	4.00	6.25	6.25	9.00	2.25	6.25
6	1.00	2.25	2.25	4.00	9.00	4.00	6.25	2.25	6.25
7	2.25	4.00	6.25	6.25	6.25	9.00	12.25	0.00	6.25
8	4.00	6.25	4.00	9.00	4.00	0.00	9.00	0.00	0.00
9	2.25	12.25	9.00	2.25	6.25	9.00	9.00	4.00	9.00
10	4.00	4.00	4.00	2.25	0.25	4.00	4.00	2.25	2.25
11	6.25	9.00	9.00	4.00	9.00	6.25	12.25	4.00	4.00
12	4.00	9.00	9.00	12.25	6.25	12.25	12.25	9.00	4.00
13	2.25	2.25	4.00	2.25	1.00	2.25	0.00	0.00	0.25
14	0.00	0.00	0.00	0.25	0.25	0.00	0.25	0.00	0.00
15	4.00	4.00	6.25	12.25	9.00	4.00	4.00	6.25	4.00
16	4.00	9.00	9.00	9.00	6.25	6.25	0.25	0.00	0.00
17	6.25	4.00	6.25	4.00	1.00	4.00	0.00	0.00	0.00
18	4.00	6.25	4.00	2.25	0.00	1.00	0.25	0.00	0.00
19	4.00	4.00	4.00	6.25	6.25	4.00	4.00	0.00	0.00
20	2.25	4.00	4.00	0.25	0.00	0.00	0.00	0.00	0.00
21	2.25	2.25	0.00	2.25	0.00	0.00	0.00	0.00	0.00
22	2.25	6.25	9.00	6.25	4.00	9.00	9.00	6.25	4.00
23	2.25	4.00	4.00	4.00	4.00	2.25	4.00	6.25	2.25
24	2.25	9.00	6.25	9.00	6.25	6.25	4.00	1.00	0.00
25	4.00	4.00	4.00	0.25	0.00	0.25	0.00	1.00	0.00
26	2.25	4.00	2.25	4.00	4.00	1.00	4.00	1.00	2.25
27	4.00	4.00	6.25	6.25	4.00	1.00	4.00	6.25	4.00
28	2.25	4.00	4.00	4.00	4.00	1.00	4.00	0.00	4.00
29	2.25	6.25	4.00	4.00	2.25	0.00	0.00	0.00	2.25
30	2.25	4.00	6.25	4.00	6.25	6.25	1.00	0.00	0.00
31	2.25	6.25	4.00	2.25	2.25	1.00	1.00	0.00	0.00
32	4.00	4.00	6.25	4.00	2.25	1.00	0.00	1.00	0.00
33	2.25	4.00	4.00	4.00	6.25	1.00	2.25	0.00	0.00
34	0.00	4.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
Total	101.50	174.00	173.00	161.00	138.75	127.75	138.50	77.00	81.75
Av.	2.99	5.12	5.09	4.74	4.08	3.76	4.07	2.26	2.40

SUBJECT 125121 CHEST ACCLIMATIZED

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	6.25	12.25	12.25	12.25	12.25	16.00	16.00	12.25	12.25
2	4.00	12.25	12.25	12.25	12.25	9.00	12.25	9.00	9.00
3	6.25	16.00	9.00	16.00	12.25	9.00	12.25	6.25	12.25
4	-	12.25	4.00	12.25	9.00	6.25	0.00	0.00	4.00
5	-	12.25	-	12.25	12.25	12.25	4.00	0.00	9.00
6	-	-	-	9.00	9.00	6.25	6.25	4.00	2.25
7	0.00	20.25	-	12.25	16.00	20.25	20.25	16.00	12.25
8	12.25	16.00	-	12.25	12.25	25.00	-	9.00	4.00
9	12.25	16.00	9.00	20.25	12.25	20.25	16.00	6.25	6.25
10	4.00	9.00	6.25	6.25	1.00	0.00	1.00	0.00	1.00
11	12.25	12.25	9.00	25.00	12.25	20.25	12.25	9.00	9.00
12	12.25	16.00	16.00	12.25	16.00	12.25	4.00	4.00	6.25
13	6.25	4.00	6.25	6.25	6.25	9.00	2.25	0.00	4.00
14	4.00	12.25	6.25	9.00	9.00	6.25	2.25	0.00	6.25
15	12.25	16.00	16.00	12.25	9.00	16.00	16.00	9.00	12.25
16	12.25	16.00	12.25	12.25	9.00	9.00	4.00	0.00	4.00
17	9.00	12.25	-	12.25	12.25	16.00	12.25	0.25	9.00
18	9.00	16.00	6.25	12.25	6.25	6.25	0.00	2.25	1.00
19	6.25	12.25	6.25	9.00	9.00	12.25	9.00	4.00	6.25
20	6.25	12.25	-	12.25	6.25	6.25	0.25	2.25	1.00
21	9.00	12.25	9.00	2.25	2.25	2.25	0.00	0.25	0.25
22	12.25	16.00	6.25	16.00	12.25	12.25	12.25	0.25	0.25
23	9.00	12.25	6.25	9.00	6.25	12.25	9.00	6.25	6.25
24	9.00	9.00	9.00	9.00	9.00	12.25	12.25	6.25	9.00
25	12.25	12.25	6.25	12.25	9.00	12.25	12.25	6.25	6.25
26	9.00	9.00	6.25	9.00	4.00	4.00	2.25	2.25	1.00
27	9.00	20.25	16.00	9.00	6.25	12.25	0.00	0.00	4.00
28	9.00	9.00	9.00	6.25	6.25	2.25	0.00	0.00	4.00
29	6.25	12.25	6.25	6.25	1.00	0.00	0.00	0.00	0.25
30	6.25	12.25	6.25	9.00	2.25	9.00	0.00	1.00	4.00
31	6.25	9.00	4.00	6.25	9.00	12.25	12.25	6.25	2.25
32	9.00	9.00	12.25	9.00	6.25	9.00	6.25	1.00	0.25
33	6.25	9.00	6.25	9.00	6.25	1.00	0.00	1.00	6.25
34	9.00	12.25	6.25	2.25	0.00	0.00	0.00	0.00	0.00
Total	256.25	419.25	240.25	362.25	283.75	338.75	216.75	124.25	175.25
Av.	8.27	12.70	8.58	10.65	8.35	9.96	6.57	3.65	5.15

SUBJECT 125105 CHEST UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	9.00	4.00	9.00	20.25	16.00	30.25	12.25	6.25	12.25
2	4.00	6.25	4.00	6.25	6.25	12.25	4.00	4.00	4.00
3	9.00	9.00	12.25	12.25	9.00	12.25	9.00	6.25	9.00
4	12.25	12.25	12.25	16.00	16.00	16.00	16.00	12.25	12.25
5	12.25	12.25	12.25	25.00	16.00	25.00	6.25	6.25	4.00
6	9.00	12.25	9.00	16.00	6.25	16.00	6.25	9.00	12.25
7	12.25	12.25	9.00	16.00	12.25	16.00	16.00	9.00	9.00
8	9.00	20.25	6.25	16.00	1.00	9.00	6.25	9.00	6.25
9	6.25	4.00	6.25	16.00	4.00	16.00	9.00	9.00	9.00
10	4.00	4.00	9.00	16.00	4.00	12.25	9.00	9.00	6.25
11	4.00	6.25	9.00	12.25	6.25	16.00	9.00	6.25	6.25
12	9.00	9.00	6.25	16.00	12.25	9.00	6.25	9.00	4.00
13	6.25	12.25	4.00	6.25	9.00	6.25	6.25	12.25	6.25
14	4.00	6.25	4.00	6.25	4.00	4.00	9.00	4.00	4.00
15	6.25	4.00	6.25	9.00	9.00	6.25	4.00	4.00	4.00
16	9.00	9.00	6.25	9.00	16.00	12.25	12.25	6.25	4.00
17	4.00	12.25	9.00	12.25	20.25	16.00	16.00	9.00	9.00
18	4.00	16.00	6.25	6.25	4.00	16.00	4.00	6.25	4.00
19	4.00	16.00	9.00	16.00	6.25	20.25	12.25	16.00	12.25
20	9.00	9.00	4.00	0.25	0.25	0.25	0.25	0.00	0.25
Total	146.50	196.50	153.25	253.25	178.00	271.25	173.25	153.00	138.25
Av.	7.33	9.83	7.66	12.66	8.90	13.56	8.66	7.65	6.91

SUBJECT 125105 CHEST ACCLIMATIZED.

Gland No.		Hours ½	1	1½	2	2½	3	3½	4	4½
1			12.25	20.25	25.00	16.00	12.25	20.25	25.00	9.00
2			9.00	9.00	20.25	20.25	12.25	9.00	12.25	9.00
3			9.00	-	20.25	12.25	9.00	16.00	16.00	9.00
4			20.25	16.00	20.25	25.00	12.25	25.00	16.00	9.00
5			9.00	-	20.25	20.25	16.00	20.25	12.25	6.25
6			9.00	-	20.25	20.25	2.25	12.25	9.00	-
7			12.25	20.25	25.00	25.00	9.00	20.25	20.25	9.00
8			16.00	16.00	25.00	20.25	16.00	16.00	16.00	9.00
9			4.00	9.00	9.00	9.00	1.00	16.00	-	9.00
10			9.00	16.00	16.00	16.00	6.25	12.25	16.00	4.00
11			2.25	12.25	6.25	9.00	4.00	6.25	1.00	4.00
12			12.25	16.00	16.00	9.00	0.25	12.25	12.25	2.25
13			9.00	16.00	20.25	16.00	4.00	9.00	16.00	12.25
14			4.00	12.25	12.25	20.25	6.25	9.00	12.25	9.00
15			0.00	12.25	6.25	16.00	9.00	12.25	4.00	9.00
16			12.25	12.25	20.25	20.25	4.00	12.25	12.25	1.00
17			12.25	16.00	20.25	20.25	9.00	16.00	16.00	12.25
18			20.25	16.00	16.00	20.25	1.00	20.25	2.25	9.00
19			9.00	12.25	12.25	16.00	2.25	16.00	20.25	9.00
20			12.25	9.00	6.25	4.00	1.00	20.25	6.25	12.25
Total			203.25	240.75	337.25	335.25	137.00	300.75	245.25	153.25
Av.			10.16	14.16	16.86	16.76	6.85	15.04	12.91	8.07

No Activity

SUBJECT 70432 CHEST UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	0.25	2.25	2.25	2.25	4.00	4.00	6.25	4.00	2.25
2	0.25	4.00	4.00	4.00	4.00	6.25	9.00	6.25	4.00
3	1.00	4.00	4.00	4.00	6.25	6.25	6.25	6.25	4.00
4	2.25	4.00	2.25	4.00	2.25	2.25	4.00	4.00	1.00
5	0.25	4.00	2.25	2.25	2.25	2.25	4.00	4.00	0.00
6	1.00	2.25	2.25	4.00	6.25	6.25	6.25	2.25	0.00
7	0.25	6.25	2.25	4.00	6.25	4.00	6.25	6.25	4.00
8	0.25	2.25	2.25	2.25	4.00	1.00	4.00	2.25	1.00
9	0.25	0.25	2.25	4.00	2.25	4.00	4.00	4.00	0.25
10	0.25	4.00	1.00	2.25	4.00	4.00	0.00	0.00	0.00
11	0.25	4.00	2.25	4.00	4.00	4.00	4.00	4.00	6.25
12	0.25	4.00	2.25	4.00	4.00	2.25	1.00	2.25	6.25
13	1.00	2.25	4.00	4.00	4.00	2.25	6.25	6.25	6.25
14	0.25	6.25	2.25	2.25	6.25	1.00	0.00	0.00	0.00
15	2.25	6.25	4.00	4.00	6.25	2.25	4.00	6.25	0.00
16	0.25	2.25	2.25	1.00	4.00	2.25	2.25	4.00	2.25
17	1.00	2.25	2.25	2.25	2.25	1.00	2.25	2.25	1.00
18	1.00	1.00	2.25	4.00	2.25	1.00	2.25	2.25	0.00
19	0.25	2.25	2.25	4.00	2.25	2.25	4.00	4.00	0.25
20	1.00	4.00	2.25	2.25	4.00	0.25	0.00	0.00	0.00
21	1.00	1.00	2.25	1.00	2.25	2.25	2.25	2.25	0.00
22	1.00	2.25	2.25	4.00	4.00	4.00	4.00	2.25	0.00
23	1.00	2.25	4.00	4.00	4.00	4.00	4.00	4.00	0.00
24	0.25	1.00	1.00	2.25	4.00	2.25	2.25	2.25	0.00
25	0.00	4.00	1.00	4.00	6.25	2.25	6.25	4.00	4.00
Total	16.75	78.25	61.25	80.00	101.25	73.50	94.75	85.25	42.75
Av.	0.67	3.13	2.45	3.20	4.05	2.94	3.79	3.41	1.71

SUBJECT 70432 CHEST ACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	0.00	4.00	4.00	4.00	2.25	4.00	4.00	2.25	1.00
2	0.00	4.00	9.00	9.00	6.25	12.25	6.25	9.00	6.25
3	0.25	4.00	6.25	6.25	4.00	9.00	0.00	0.00	2.25
4	0.25	6.25	6.25	6.25	6.25	9.00	6.25	12.25	4.00
5	0.00	4.00	4.00	6.25	4.00	9.00	9.00	9.00	6.25
6	0.00	4.00	4.00	9.00	4.00	9.00	0.00	6.25	4.00
7	0.00	2.25	2.25	6.25	2.25	4.00	2.25	4.00	0.00
8	1.00	2.25	4.00	2.25	2.25	4.00	0.00	4.00	0.00
9	0.00	0.25	2.25	2.25	2.25	6.25	0.25	1.00	0.00
10	0.00	6.25	6.25	6.25	9.00	12.25	12.25	9.00	2.25
11	0.00	4.00	2.25	6.25	2.25	6.25	9.00	4.00	4.00
12	0.00	6.25	4.00	9.00	9.00	9.00	9.00	9.00	2.25
13	0.25	6.25	4.00	9.00	4.00	12.25	9.00	0.00	0.00
14	0.25	2.25	4.00	6.25	6.25	6.25	12.25	12.25	12.25
15	0.00	6.25	6.25	4.00	6.25	12.25	9.00	12.25	12.25
16	0.00	4.00	4.00	6.25	4.00	9.00	6.25	6.25	0.00
17	0.00	2.25	4.00	4.00	4.00	6.25	6.25	4.00	0.00
18	0.00	4.00	4.00	6.25	6.25	9.00	4.00	9.00	0.00
19	0.00	6.25	4.00	4.00	2.25	4.00	4.00	4.00	0.25
20	0.00	6.25	4.00	6.25	4.00	6.25	4.00	1.00	0.00
21	0.00	2.25	4.00	6.25	4.00	4.00	4.00	1.00	0.25
22	0.00	4.00	4.00	4.00	4.00	9.00	4.00	4.00	4.00
23	0.00	4.00	1.00	1.00	0.00	2.25	0.00	0.25	1.00
24	0.00	4.00	6.25	6.25	4.00	4.00	6.25	2.25	2.25
25	0.00	6.25	6.25	6.25	6.25	9.00	4.00	0.00	0.00
Total	2.00	105.50	110.25	142.75	109.00	187.50	131.25	126.00	64.50
Av.	0.08	4.22	4.41	5.71	4.36	7.50	5.25	5.04	2.58

SUBJECT 70459 CHEST UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	6.25	4.00	4.00	9.00	4.00	9.00	6.25	9.00	6.25
2	2.25	1.00	0.00	2.25	1.00	4.00	1.00	4.00	2.25
3	4.00	9.00	4.00	6.25	4.00	6.25	6.25	6.25	4.00
4	9.00	4.00	6.25	6.25	4.00	6.25	6.25	6.25	4.00
5	2.25	2.25	6.25	6.25	2.25	4.00	6.25	9.00	1.00
6	4.00	4.00	2.25	4.00	2.25	4.00	2.25	4.00	0.25
7	2.25	2.25	6.25	6.25	2.25	4.00	4.00	6.25	2.25
8	4.00	4.00	9.00	9.00	6.25	6.25	6.25	12.25	4.00
9	4.00	2.25	6.25	9.00	4.00	6.25	6.25	9.00	4.00
10	2.25	6.25	6.25	9.00	4.00	9.00	4.00	9.00	2.25
11	4.00	4.00	6.25	4.00	2.25	2.25	1.00	2.25	2.25
12	4.00	2.25	4.00	6.25	4.00	4.00	4.00	6.25	2.25
13	6.25	2.25	4.00	4.00	2.25	2.25	2.25	1.00	0.00
14	4.00	2.25	4.00	4.00	2.25	0.25	2.25	4.00	2.25
15	2.25	-	6.25	9.00	4.00	4.00	4.00	9.00	4.00
16	6.25	4.00	6.25	9.00	2.25	4.00	4.00	6.25	2.25
17	2.25	4.00	4.00	6.25	4.00	4.00	6.25	6.25	2.25
18	4.00	4.00	4.00	6.25	4.00	4.00	2.25	6.25	0.25
19	4.00	2.25	9.00	9.00	6.25	6.25	9.00	9.00	4.00
20	4.00	4.00	6.25	12.25	4.00	6.25	4.00	12.25	6.25
21	1.00	2.25	4.00	4.00	2.25	4.00	4.00	6.25	0.25
22	2.25	0.25	4.00	6.25	2.25	4.00	4.00	9.00	4.00
23	0.00	2.25	4.00	4.00	1.00	1.00	2.25	2.25	0.25
24	0.00	0.25	6.25	2.25	0.25	6.25	4.00	4.00	0.25
Total	84.50	73.00	122.75	153.75	75.00	111.50	102.00	159.00	60.75
Av.	3.52	3.17	5.11	6.41	3.13	4.65	4.25	6.63	2.53

SUBJECT 70459 CHEST ACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	9.00	9.00	9.00	4.00	12.25	6.25	12.25	9.00	6.25
2	12.25	9.00	9.00	4.00	12.25	9.00	9.00	4.00	4.00
3	4.00	4.00	6.25	4.00	4.00	0.00	0.00	0.00	0.00
4	4.00	4.00	1.00	2.25	4.00	2.25	2.25	0.25	0.00
5	6.25	4.00	6.25	6.25	4.00	1.00	0.00	0.00	0.00
6	4.00	6.25	4.00	4.00	4.00	6.25	6.25	6.25	6.25
7	4.00	4.00	2.25	2.25	2.25	2.25	0.00	4.00	0.00
8	4.00	4.00	4.00	4.00	4.00	4.00	6.25	4.00	4.00
9	4.00	4.00	4.00	4.00	4.00	4.00	9.00	4.00	0.00
10	4.00	4.00	4.00	2.25	6.25	4.00	9.00	4.00	4.00
11	2.25	4.00	1.00	2.25	2.25	2.25	6.25	4.00	2.25
12	6.25	12.25	9.00	6.25	12.25	9.00	16.00	12.25	4.00
13	6.25	4.00	6.25	4.00	4.00	4.00	12.25	6.25	6.25
14	4.00	4.00	4.00	2.25	4.00	2.25	4.00	2.25	0.25
15	4.00	4.00	4.00	4.00	4.00	6.25	6.25	6.25	6.25
16	2.25	2.25	2.25	2.25	2.25	2.25	2.25	0.25	0.25
17	2.25	2.25	6.25	2.25	4.00	4.00	9.00	6.25	6.25
18	9.00	6.25	9.00	6.25	6.25	4.00	0.00	0.00	0.25
19	12.25	12.25	9.00	12.25	0.25	2.25	0.00	0.25	0.00
20	4.00	2.25	4.00	4.00	4.00	4.00	4.00	4.00	4.00
21	4.00	4.00	6.25	6.25	9.00	2.25	6.25	6.25	4.00
22	4.00	4.00	4.00	0.00	0.00	0.25	0.00	0.00	1.00
23	2.25	1.00	6.25	9.00	2.25	2.25	4.00	2.25	1.00
24	4.00	1.00	9.00	4.00	2.25	2.25	9.00	6.25	2.25
25	6.25	6.25	6.25	6.25	6.25	4.00	6.25	1.00	0.25
26	4.00	0.25	4.00	4.00	4.00	4.00	9.00	2.25	2.25
Total	132.50	122.25	140.25	112.25	124.00	94.25	148.50	95.75	65.00
Av.	5.10	4.70	5.39	4.32	4.77	3.63	5.71	3.68	2.50

SUBJECT 70548 CHEST UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	4.00	6.25	4.00	6.25	6.25	4.00	9.00	9.00	6.25
2	4.00	4.00	4.00	9.00	6.25	4.00	12.25	12.25	4.00
3	2.25	0.25	2.25	1.00	2.25	2.25	4.00	2.00	0.00
4	4.00	6.25	6.25	9.00	6.25	6.25	12.25	16.00	4.00
5	2.25	2.25	4.00	6.25	6.25	2.25	4.00	6.25	2.25
6	2.25	4.00	4.00	4.00	4.00	2.25	2.25	4.00	4.00
7	0.25	2.25	4.00	2.25	2.25	2.25	4.00	6.25	2.25
8	1.00	2.25	2.25	2.25	2.25	2.25	2.25	4.00	0.25
9	1.00	0.00	1.00	1.00	0.25	1.00	2.25	0.25	2.25
10	1.00	2.25	4.00	6.25	4.00	2.25	6.25	6.25	2.25
11	4.00	-	2.25	6.25	4.00	2.25	6.25	4.00	2.25
12	4.00	2.25	6.25	4.00	2.25	0.00	6.25	4.00	0.00
13	2.25	2.25	4.00	4.00	4.00	2.25	6.25	6.25	4.00
14	0.00	0.00	0.00	-	0.00	2.25	1.00	1.00	0.00
15	0.25	0.00	2.25	2.25	0.00	2.25	4.00	2.25	0.25
16	4.00	4.00	6.25	6.25	4.00	1.00	9.00	9.00	4.00
17	1.00	1.00	4.00	2.25	0.25	2.25	4.00	4.00	2.25
18	2.25	4.00	4.00	4.00	4.00	2.25	4.00	9.00	2.25
19	4.00	4.00	12.25	9.00	6.25	4.00	9.00	9.00	4.00
20	4.00	4.00	4.00	0.25	2.25	1.00	4.00	6.25	2.25
21	2.25	2.25	2.25	4.00	2.25	0.25	4.00	6.25	1.00
22	2.25	1.00	6.25	0.25	2.25	0.00	4.00	4.00	4.00
23	4.00	1.00	6.25	6.25	6.25	4.00	9.00	-	4.00
24	1.00	1.00	2.25	4.00	2.25	2.25	4.00	2.25	2.25
25	4.00	4.00	6.25	4.00	6.25	2.25	6.25	-	6.25
26	6.25	0.25	0.00	2.25	0.00	1.00	1.00	1.00	0.25
Total	67.50	60.75	104.25	106.25	86.25	58.00	140.50	134.50	66.50
Av.	2.60	2.43	4.01	4.25	3.32	2.23	5.40	5.00	2.56

SUBJECT 70548 CHEST ACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½*	3	3½	4	4½
1	4.00	2.25	12.25	9.00	-	4.00	4.00	9.00	4.00
2	6.25	9.00	16.00	16.00	-	12.25	6.25	12.25	9.00
3	4.00	2.25	9.00	12.25	-	16.00	16.00	16.00	9.00
4	4.00	4.00	9.00	12.25	-	4.00	4.00	12.25	4.00
5	4.00	2.25	20.25	16.00	-	6.25	4.00	9.00	6.25
6	1.00	4.00	6.25	12.25	-	4.00	2.25	6.25	4.00
7	4.00	2.25	6.25	6.25	-	4.00	2.25	6.25	0.00
8	9.00	6.25	16.00	12.25	-	6.25	6.25	9.00	9.00
9	2.25	2.25	9.00	6.25	-	6.25	4.00	4.00	4.00
10	1.00	4.00	9.00	12.25	-	6.25	4.00	12.25	4.00
11	2.25	4.00	16.00	4.00	-	0.00	0.00	4.00	0.00
12	2.25	0.25	12.25	2.25	-	2.25	0.25	1.00	0.00
13	9.00	12.25	16.00	25.00	-	9.00	9.00	16.00	12.25
14	4.00	2.25	4.00	6.25	-	4.00	0.00	0.00	0.00
15	4.00	2.25	12.25	12.25	-	2.25	4.00	6.25	1.00
16	1.00	1.00	6.25	4.00	-	2.25	0.00	0.00	0.00
17	4.00	2.25	9.00	6.25	-	0.00	0.00	0.00	0.00
18	4.00	2.25	12.25	12.25	-	9.00	4.00	9.00	2.25
19	4.00	1.00	6.25	9.00	-	2.25	0.00	0.00	0.00
20	4.00	4.00	2.25	9.00	-	0.00	0.00	0.00	0.00
21	2.25	0.25	4.00	12.25	-	0.25	0.25	1.00	0.00
22	2.25	1.00	2.25	12.25	-	2.25	2.25	0.00	0.00
Total	82.50	71.25	215.75	229.50	-	102.75	72.75	133.50	68.75
Av.	3.75	3.24	9.81	10.43	-	4.67	3.31	6.07	3.13

SUBJECT 28215 BACK UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	6.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	2.25
2	6.25	1.00	4.00	4.00	2.25	4.00	2.25	4.00	2.25
3	4.00	0.25	4.00	0.00	0.00	0.25	0.00	0.00	0.25
4	4.00	0.00	2.25	4.00	0.00	0.00	0.00	0.00	2.25
5	6.25	0.00	2.25	1.00	0.00	0.00	0.00	0.00	0.00
6	4.00	0.25	6.25	6.25	0.00	4.00	0.00	0.00	2.25
7	2.25	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
8	2.25	0.25	6.25	2.25	2.25	0.25	0.00	0.00	2.25
9	2.25	0.25	0.25	0.25	0.00	0.25	0.00	0.00	0.00
10	1.00	1.00	4.00	2.25	0.00	0.00	0.00	0.00	0.00
11	2.25	0.25	1.00	6.25	0.25	4.00	2.25	0.00	2.25
12	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
13	1.00	0.00	4.00	2.25	0.00	4.00	0.00	0.00	0.00
14	4.00	0.25	0.25	6.25	0.00	0.00	0.00	0.00	0.00
15	2.25	0.00	2.25	4.00	0.00	0.00	0.00	0.00	0.00
16	4.00	0.00	0.25	6.25	0.00	4.00	0.00	0.00	0.25
17	4.00	0.00	1.00	2.25	0.25	4.00	2.25	0.00	0.25
18	4.00	0.25	1.00	6.25	0.00	2.25	0.25	0.00	1.00
19	2.25	0.00	4.00	0.00	0.00	0.25	1.00	0.00	0.25
20	4.00	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.25
21	4.00	0.00	0.25	0.00	0.00	4.00	4.00	0.00	2.25
Total	70.25	4.00	48.25	53.50	5.00	31.50	12.25	4.00	18.00
Av.	3.35	.19	2.30	2.55	.24	1.50	.58	.19	.86

SUBJECT 28215 BACK ACCLIMATIZED.

Gland No.	Hours. ½	1	1½	2	2½	3	3½	4	4½
1	1.00	2.25	2.25	1.00	0.25	0.00	0.00	1.00	2.25
2	0.25	2.25	4.00	4.00	6.25	4.00	0.00	0.25	0.00
3	2.25	2.25	4.00	6.25	2.25	0.25	4.00	4.00	4.00
4	2.25	2.25	1.00	6.25	4.00	4.00	4.00	4.00	6.25
5	2.25	-	4.00	9.00	9.00	12.25	6.25	4.00	1.00
6	2.25	-	4.00	6.25	12.25	4.00	9.00	6.25	4.00
7	1.00	2.25	4.00	6.25	4.00	9.00	6.25	4.00	4.00
8	0.25	2.25	2.25	4.00	4.00	6.25	0.25	0.00	0.00
9	1.00	1.00	4.00	9.00	4.00	4.00	6.25	6.25	6.25
10	0.25	4.00	2.25	6.25	6.25	0.00	2.25	0.00	0.00
11	4.00	4.00	4.00	6.25	6.25	6.25	12.25	9.00	6.25
12	1.00	4.00	4.00	6.25	4.00	2.25	6.25	4.00	4.00
13	0.00	4.00	0.25	6.25	4.00	0.25	0.25	0.00	0.00
14	1.00	2.25	2.25	6.25	6.25	2.25	2.25	0.00	0.00
15	2.25	4.00	4.00	9.00	6.25	4.00	6.25	2.25	6.25
16	1.00	4.00	4.00	9.00	4.00	4.00	4.00	2.25	6.25
17	0.25	4.00	1.00	6.25	4.00	0.00	0.00	0.00	0.00
18	1.00	4.00	2.25	9.00	2.25	9.00	6.25	4.00	6.25
19	4.00	4.00	6.25	12.25	9.00	4.00	4.00	0.25	2.25
20	1.00	4.00	2.25	6.25	9.00	6.25	6.25	9.00	2.25
21	0.25	-	2.25	4.00	4.00	6.25	4.00	2.25	2.25
Total	28.50	56.75	64.25	139.00	111.25	88.25	90.00	62.75	63.50
Av.	1.36	3.15	3.06	6.62	5.30	4.20	4.29	2.99	3.02

SUBJECT 125121 BACK UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	2.25	2.25	0.25	0.25	0.00	0.00	0.00	0.25	0.25
2	0.25	2.25	4.00	0.25	0.00	0.00	0.00	0.00	0.25
3	0.00	2.25	4.00	4.00	6.25	4.00	6.25	0.25	0.25
4	1.00	4.00	6.25	0.00	0.00	0.00	0.00	1.00	2.25
5	0.25	2.25	2.25	0.00	1.00	0.00	0.25	0.00	0.25
6	2.25	2.25	4.00	0.00	1.00	0.00	0.25	0.00	0.00
7	1.00	2.25	0.00	0.00	0.25	0.00	0.00	0.00	0.25
8	0.00	2.25	2.25	1.00	0.00	0.00	0.00	0.00	0.00
9	1.00	2.25	6.25	4.00	6.25	0.00	4.00	1.00	0.25
10	0.25	2.25	4.00	0.25	0.25	0.00	0.00	0.00	0.25
11	0.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	1.00	1.00	4.00	1.00	0.25	0.00	1.00	0.00	0.00
13	0.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.25	0.25	2.25	0.00	0.00	0.00	0.00	0.25	2.25
15	0.00	2.25	0.25	1.00	1.00	0.00	0.25	0.00	0.00
16	1.00	0.25	2.25	2.25	0.00	0.00	0.00	0.00	0.00
17	1.00	0.25	0.00	0.00	0.00	0.00	0.25	0.25	0.25
18	0.25	4.00	4.00	4.00	1.00	0.00	1.00	1.00	0.00
19	2.25	4.00	9.00	6.25	0.25	2.25	0.25	2.25	0.25
20	0.25	2.25	4.00	6.25	4.00	0.25	1.00	0.00	0.00
21	0.25	0.25	2.25	0.00	0.00	1.00	0.00	0.00	0.00
22	0.25	1.00	1.00	1.00	0.25	0.00	0.25	0.00	0.00
23	0.25	2.25	4.00	4.00	0.25	0.00	0.25	0.00	0.25
24	0.00	2.25	2.25	0.00	0.00	0.00	0.25	1.00	0.25
25	1.00	1.00	0.25	1.00	0.00	0.00	0.25	1.00	0.25
26	1.00	0.25	1.00	0.00	0.25	0.00	0.00	0.00	0.00
27	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.25	1.00	1.00	1.00	0.25	0.25	0.25	0.25	0.00
29	0.25	2.25	2.25	0.00	0.25	0.00	0.25	0.00	0.25
30	0.25	1.00	0.00	0.00	0.25	0.00	1.00	0.00	0.25
31	1.00	0.00	1.00	0.25	0.25	0.25	0.25	0.00	0.00
Total	19.50	52.00	74.00	37.75	23.25	8.00	17.25	8.50	8.00
Av.	0.63	1.68	2.39	1.22	0.75	0.26	0.56	0.27	0.26

SUBJECT 125121 BACK ACCLIMATIZED

Gland No.	Hours ½	1	1½	2 *	2½	3	3½	4	4½
1	6.25	12.25	6.25	-	1.00	0.25	0.00	0.00	0.25
2	9.00	9.00	0.00	-	0.00	0.25	0.25	0.00	0.25
3	6.25	0.00	0.00	-	0.00	0.00	0.25	0.00	0.00
4	9.00	9.00	6.25	-	0.00	0.00	2.25	0.00	0.25
5	12.25	12.25	6.25	-	0.00	0.25	1.00	0.00	0.25
6	9.00	6.25	0.00	-	4.00	0.25	0.00	0.00	0.25
7	6.25	9.00	0.00	-	1.00	0.25	0.25	0.00	0.00
8	6.25	12.25	1.00	-	0.00	0.25	0.25	0.25	0.25
9	6.25	6.25	6.25	-	4.00	0.00	1.00	0.25	0.25
10	6.25	9.00	0.00	-	0.25	0.00	0.00	0.25	0.00
11	6.25	12.25	6.25	-	4.00	0.25	0.25	0.00	0.25
12	6.25	4.00	4.00	-	9.00	0.25	0.25	0.00	0.00
13	9.00	9.00	0.25	-	0.25	0.25	0.25	0.00	0.25
14	6.25	6.25	0.00	-	0.00	0.00	1.00	0.25	0.25
15	9.00	12.25	9.00	-	0.25	0.25	1.00	0.25	0.25
16	6.25	12.25	4.00	-	2.25	0.25	1.00	0.25	0.25
17	9.00	9.00	12.25	-	0.00	0.25	0.25	0.25	0.25
18	6.25	9.00	2.25	-	0.00	0.25	1.00	0.00	0.25
19	9.00	12.25	2.25	-	1.00	0.00	0.00	0.25	1.00
20	4.00	9.00	0.00	-	0.00	0.00	0.00	0.25	0.25
21	4.00	16.00	6.25	-	0.25	0.00	0.00	0.25	0.00
22	4.00	0.00	0.00	-	0.00	0.00	0.25	0.00	0.25
23	4.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
24	1.00	2.25	0.00	-	0.00	0.00	2.25	0.25	0.25
25	4.00	2.25	0.00	-	0.00	0.00	0.00	0.00	0.25
C/F...	165.00	201.00	72.50	-	27.25	3.25	12.75	2.75	5.50

SUBJECT 125121 BACK ACCLIMATIZED CONTD.

Gland No.	Hours ½	1	1½	2*	2½	3	3½	4	4½
B/F	165.00	201.00	72.50	-	27.25	3.25	12.75	2.75	5.50
26	2.25	0.25	0.00	-	0.25	0.25	0.25	1.00	0.25
27	2.25	0.25	0.00	-	0.00	0.00	0.00	0.00	0.00
28	4.00	9.00	6.25	-	0.00	0.25	0.25	0.00	0.25
29	4.00	6.25	0.00	-	0.25	0.00	0.00	0.00	0.00
30	2.25	9.00	6.25	-	6.25	2.25	0.25	0.00	0.00
31	2.25	0.00	0.00	-	2.25	0.25	0.25	0.25	0.25
32	4.00	6.25	6.25	-	0.25	1.00	0.25	0.25	0.25
33	6.25	9.00	0.00	-	2.25	0.00	0.25	0.25	0.25
34	6.25	9.00	0.00	-	2.25	0.00	0.25	0.25	0.25
35	6.25	6.25	0.00	-	0.25	0.25	0.25	0.25	0.25
36	6.25	4.00	0.00	-	0.00	0.25	0.25	0.25	0.25
37	1.00	4.00	1.00	-	0.25	0.00	0.25	0.25	0.25
38	6.25	9.00	0.00	-	0.25	0.00	1.00	0.00	0.00
39	9.00	12.25	0.00	-	0.00	0.25	1.00	0.00	0.00
40	4.00	12.25	0.25	-	12.25	2.25	2.25	1.00	2.25
41	4.00	0.25	0.00	-	0.25	0.25	1.00	0.25	0.25
42	4.00	12.25	0.25	-	1.00	0.25	0.00	0.00	1.00
43	4.00	1.00	0.00	-	1.00	0.00	0.25	0.00	1.00
44	9.00	25.00	0.00	-	0.00	0.25	0.00	0.25	1.00
45	2.25	16.00	0.00	-	0.00	0.25	0.25	0.25	0.25
46	6.25	6.25	0.00	-	2.25	0.00	0.25	0.00	0.25
47	4.00	4.00	1.00	-	4.00	0.25	2.25	0.25	0.00
48	12.25	16.00	0.00	-	2.25	1.00	2.25	0.25	0.25
49	4.00	16.00	0.00	-	6.25	0.00	0.00	0.00	0.25
50	6.25	12.25	0.00	-	6.25	0.25	1.00	0.25	0.25
Total	287.25	406.75	93.75	-	77.25	12.75	26.75	8.00	14.50
Av.	5.75	8.14	1.88	-	1.55	0.26	0.54	0.16	0.29

* This strip was discarded as it was unsuitable for study.

SUBJECT 70432 BACK UNACCLIMATIZED

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	0.25	4.00	6.25	6.25	0.25	0.00	1.00	2.25	0.00
2	0.25	2.25	4.00	0.25	0.25	0.25	2.25	4.00	1.00
3	0.00	2.25	4.00	1.00	0.00	0.00	0.00	0.00	0.00
4	0.00	1.00	4.00	0.25	0.00	0.00	0.00	0.25	0.25
5	0.00	4.00	6.25	4.00	0.00	0.00	0.00	0.25	0.00
6	0.00	2.25	4.00	2.25	0.00	0.00	0.00	0.00	0.00
7	0.25	4.00	0.25	4.00	0.25	0.25	0.00	0.00	0.00
8	0.25	2.25	4.00	2.25	0.00	0.00	0.00	2.25	0.00
9	0.25	6.25	9.00	6.25	0.25	0.00	0.25	1.00	0.25
10	0.00	2.25	2.25	2.25	1.00	1.00	2.25	0.25	0.25
11	0.00	4.00	0.25	4.00	2.25	4.00	1.00	4.00	0.00
12	0.00	1.00	6.25	2.25	0.25	0.00	0.00	0.00	0.00
13	0.00	0.25	4.00	2.25	0.00	0.00	0.00	0.00	0.25
14	0.25	4.00	6.25	2.25	0.00	0.00	0.25	0.25	0.25
15	0.00	-	4.00	2.25	0.25	2.25	1.00	1.00	0.00
16	0.00	1.00	6.25	4.00	1.00	0.00	0.25	0.25	0.00
17	0.00	-	2.25	1.00	2.25	1.00	0.25	2.25	0.25
18	0.25	-	1.00	4.00	2.25	0.00	0.25	1.00	0.00
19	0.25	0.00	1.00	4.00	2.25	0.00	0.25	0.00	0.00
20	0.00	2.25	1.00	4.00	2.25	0.25	0.00	0.00	0.00
Total	2.00	43.00	76.25	58.75	14.75	9.00	9.00	19.00	2.50
Av.	0.10	2.53	3.81	2.94	0.74	0.45	0.45	0.95	0.13

SUBJECT 70432 BACK ACCLIMATIZED

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	1.00	4.00	4.00	0.00	0.00	0.00	0.25	0.00	0.00
2	0.00	2.25	2.25	4.00	0.00	0.00	0.00	0.00	0.25
3	0.25	2.25	4.00	6.25	2.25	0.25	0.00	0.00	0.25
4	1.00	4.00	6.25	9.00	6.25	4.00	12.25	12.25	0.25
5	0.25	4.00	2.25	4.00	2.25	2.25	2.25	2.25	0.00
6	0.25	2.25	4.00	4.00	4.00	2.25	0.00	0.25	0.25
7	0.00	0.25	2.25	4.00	0.00	0.00	0.00	1.00	0.00
8	0.25	4.00	6.25	16.00	6.25	6.25	12.25	2.25	6.25
9	0.00	4.00	6.25	6.25	4.00	4.00	9.00	1.00	0.00
10	0.25	4.00	4.00	6.25	2.25	0.25	0.00	0.00	0.00
11	0.25	4.00	4.00	12.25	4.00	2.25	9.00	2.25	0.25
12	0.25	4.00	6.25	4.00	4.00	4.00	0.25	1.00	0.25
13	0.25	4.00	9.00	12.25	6.25	1.00	0.25	0.00	0.00
14	0.00	4.00	6.25	16.00	6.25	12.25	12.25	6.25	4.00
15	0.25	4.00	4.00	6.25	4.00	6.25	2.25	0.25	0.00
16	0.25	4.00	6.25	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	4.00	4.00	1.00	2.25	2.25	0.25	0.00	2.25
18	0.00	4.00	4.00	9.00	4.00	4.00	9.00	4.00	1.00
19	0.25	1.00	2.25	6.25	2.25	6.25	9.00	4.00	2.25
20	0.25	2.25	4.00	6.25	2.25	6.25	0.00	0.00	0.00
21	1.00	4.00	2.25	12.25	4.00	4.00	0.00	0.00	0.00
22	0.00	4.00	4.00	9.00	1.00	4.00	1.00	0.00	0.00
23	0.25	4.00	4.00	1.00	0.00	0.00	0.00	0.00	0.00
24	0.25	2.25	4.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	2.25	2.25	0.25	0.00	0.25	1.00	0.25	0.25
26	0.00	2.25	6.25	2.25	0.25	0.00	0.00	0.00	0.00
27	0.25	2.25	0.00	0.25	0.00	0.00	0.00	0.00	0.00
28	0.00	1.00	1.00	2.25	0.00	0.00	1.00	0.25	2.25
Total	6.75	88.25	115.25	160.25	67.75	72.00	81.25	37.25	19.75
Av.	0.24	3.15	4.12	5.72	2.42	2.57	2.90	1.33	0.71

SUBJECT 70459 BACK UNACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	4.00	0.25	6.25	0.25	0.00	0.00	0.00	4.00	2.25
2	2.25	0.00	1.00	0.25	0.00	0.00	0.00	0.00	0.00
3	2.25	0.00	2.25	0.00	0.00	0.00	0.00	0.00	0.25
4	4.00	-	4.00	2.25	0.25	4.00	2.25	2.25	0.00
5	4.00	4.00	4.00	4.00	6.25	0.25	1.00	0.00	2.25
6	2.25	-	4.00	1.00	1.00	0.00	0.00	0.00	0.00
7	1.00	1.00	4.00	2.25	2.25	0.00	0.25	0.25	1.00
8	1.00	0.25	2.25	4.00	1.00	1.00	1.00	2.25	4.00
9	4.00	2.25	4.00	1.00	0.00	0.00	0.00	0.25	0.00
10	4.00	0.00	4.00	1.00	2.25	0.00	0.00	0.25	0.25
11	2.25	4.00	1.00	0.00	0.00	0.00	0.00	0.00	0.25
12	4.00	2.25	2.25	4.00	2.25	0.25	0.25	0.00	0.00
13	2.25	2.25	6.25	4.00	4.00	4.00	4.00	0.00	0.00
14	4.00	2.25	1.00	2.25	1.00	0.00	0.00	0.00	0.00
15	2.25	2.25	0.00	0.00	0.00	0.00	4.00	1.00	2.25
16	4.00	1.00	4.00	4.00	2.25	0.00	0.00	0.00	0.00
17	4.00	2.25	1.00	4.00	4.00	2.25	0.00	0.00	0.00
18	4.00	2.25	2.25	2.25	4.00	4.00	0.00	0.00	0.00
19	6.25	2.25	4.00	2.25	2.25	0.25	0.00	0.00	0.00
20	2.25	0.25	0.25	0.25	2.25	0.00	0.00	0.00	0.00
21	2.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
22	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
23	4.00	-	4.00	0.00	0.00	0.00	0.25	0.00	0.00
24	4.00	2.25	6.25	4.00	4.00	0.00	0.25	0.00	0.00
25	4.00	2.25	0.25	1.00	0.00	0.00	0.00	0.00	0.00
26	2.25	0.00	1.00	2.25	0.00	0.00	0.25	0.00	0.00
27	4.00	2.25	4.00	4.00	4.00	1.00	2.25	0.25	1.00
28	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	2.25	2.25	4.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	88.75	38.75	77.25	50.25	43.00	17.00	16.75	10.50	13.75
Av.	3.06	1.49	2.66	1.73	1.48	0.59	0.58	0.36	0.47

SUBJECT 70459 BACK ACCLIMATIZED.

Gland No.	Hours ½	1	1½	2	2½	3	3½	4	4½
1	1.00	4.00	4.00	4.00	4.00	4.00	0.25	0.00	1.00
2	2.25	2.25	4.00	4.00	6.25	4.00	6.25	0.25	0.00
3	9.00	4.00	9.00	6.25	6.25	2.25	4.00	4.00	1.00
4	4.00	2.25	4.00	4.00	9.00	4.00	6.25	0.25	0.25
5	12.25	6.25	9.00	6.25	6.25	6.25	6.25	6.25	9.00
6	1.00	4.00	4.00	2.25	0.25	0.00	0.00	0.00	0.00
7	2.25	2.25	6.25	2.25	4.00	4.00	9.00	4.00	4.00
8	4.00	2.25	4.00	2.25	4.00	1.00	4.00	1.00	1.00
9	9.00	6.25	9.00	9.00	6.25	4.00	6.25	4.00	4.00
10	4.00	4.00	6.25	9.00	4.00	1.00	0.25	2.25	4.00
11	4.00	4.00	9.00	6.25	4.00	1.00	6.25	2.25	4.00
12	4.00	2.25	4.00	4.00	1.00	4.00	4.00	0.25	4.00
13	4.00	4.00	4.00	4.00	4.00	4.00	2.25	1.00	0.00
14	4.00	4.00	6.25	9.00	4.00	4.00	6.25	4.00	4.00
15	2.25	4.00	6.25	4.00	6.25	2.25	4.00	4.00	6.25
16	4.00	4.00	6.25	4.00	4.00	2.25	4.00	4.00	4.00
17	4.00	0.25	2.25	4.00	4.00	1.00	4.00	6.25	9.00
18	2.25	4.00	6.25	6.25	4.00	1.00	4.00	4.00	9.00
19	6.25	1.00	4.00	4.00	4.00	4.00	4.00	4.00	2.25
20	6.25	4.00	4.00	4.00	4.00	2.25	4.00	0.25	1.00
21	6.25	2.25	4.00	4.00	4.00	1.00	2.25	1.00	0.00
22	4.00	6.25	12.25	9.00	6.25	2.25	6.25	6.25	12.25
23	9.00	4.00	6.25	9.00	9.00	-	6.25	4.00	4.00
24	9.00	4.00	6.25	6.25	6.25	-	4.00	4.00	1.00
25	2.25	1.00	2.25	6.25	2.25	-	0.00	0.00	4.00
26	4.00	2.25	4.00	4.00	4.00	1.00	4.00	2.25	4.00
27	1.00	1.00	6.25	4.00	4.00	4.00	2.25	2.25	4.00
Total	125.25	89.75	153.00	141.25	125.25	64.50	110.25	71.75	97.00
Av.	4.64	3.32	5.67	5.23	4.64	2.69	4.08	2.66	3.59

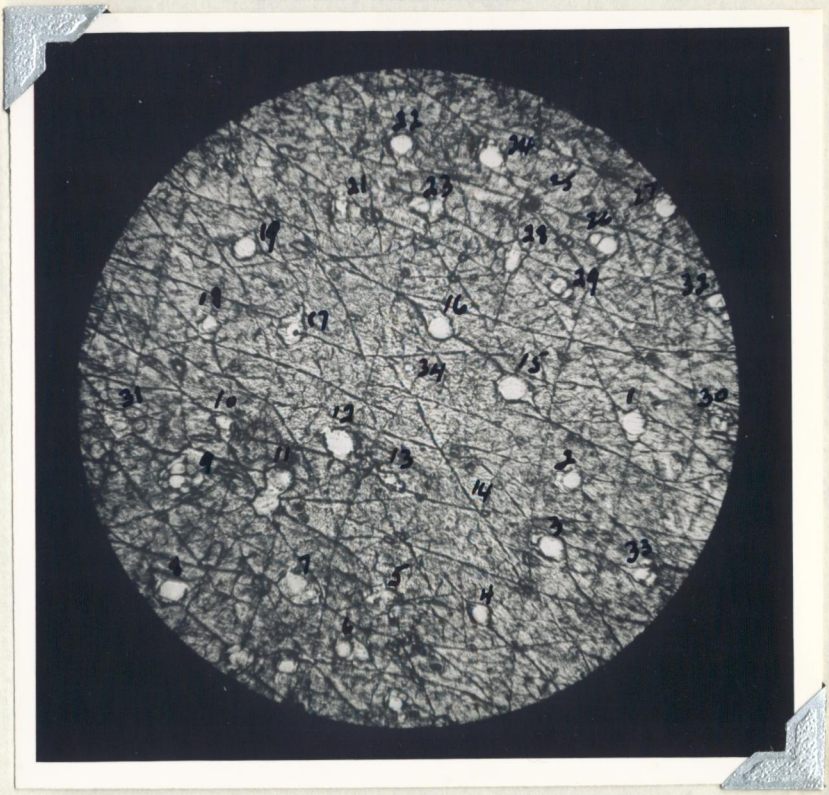
APPENDIX C.

Photographs of the sweat gland activity and density of two different subjects for the chest (Subject No. 125121) and for the back (Subject No. 70459) to illustrate the units for measuring relative activity and changes due to acclimatization.

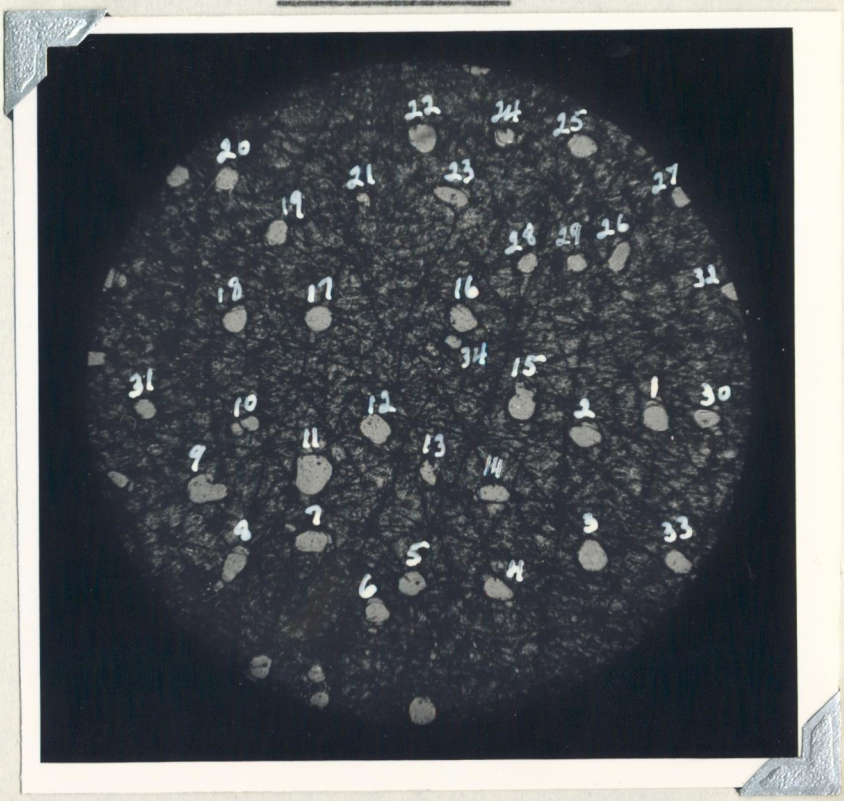
(1)

SUBJECT 125121. CHEST 2 HOURS.

UNACCLIMATISED.



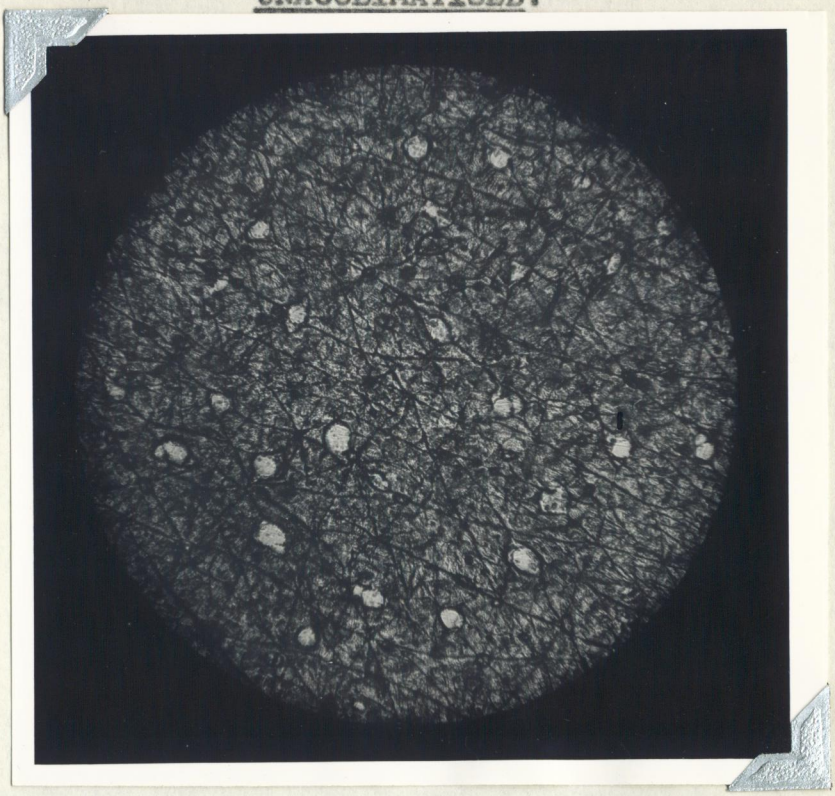
ACCLIMATISED.



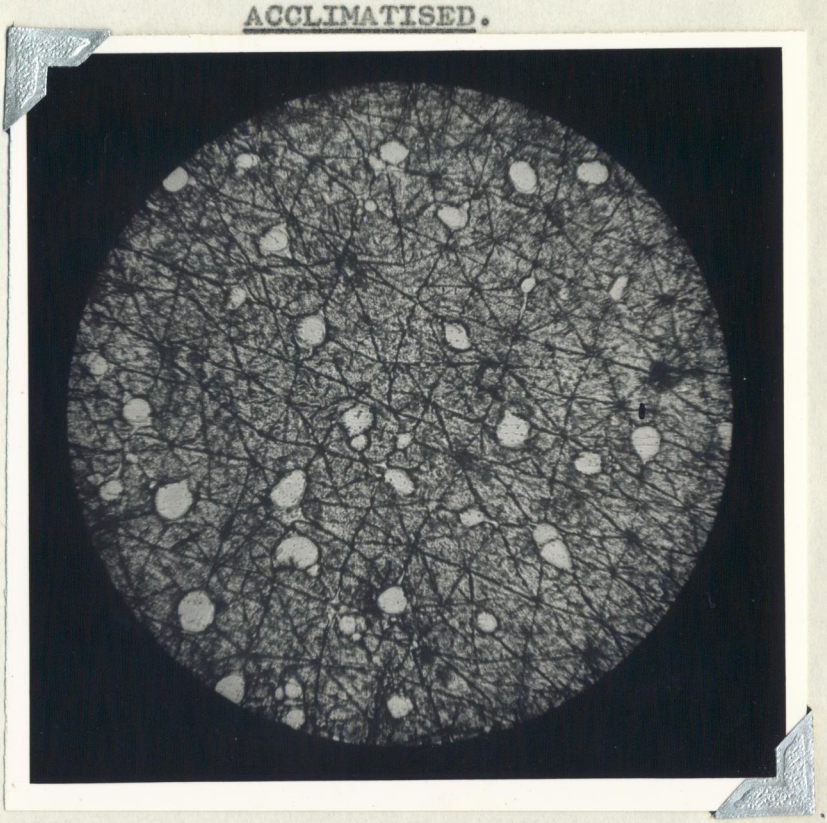
(2)

SUBJECT 125121. CHEST 3 HOURS.

UNACCLIMATISED.



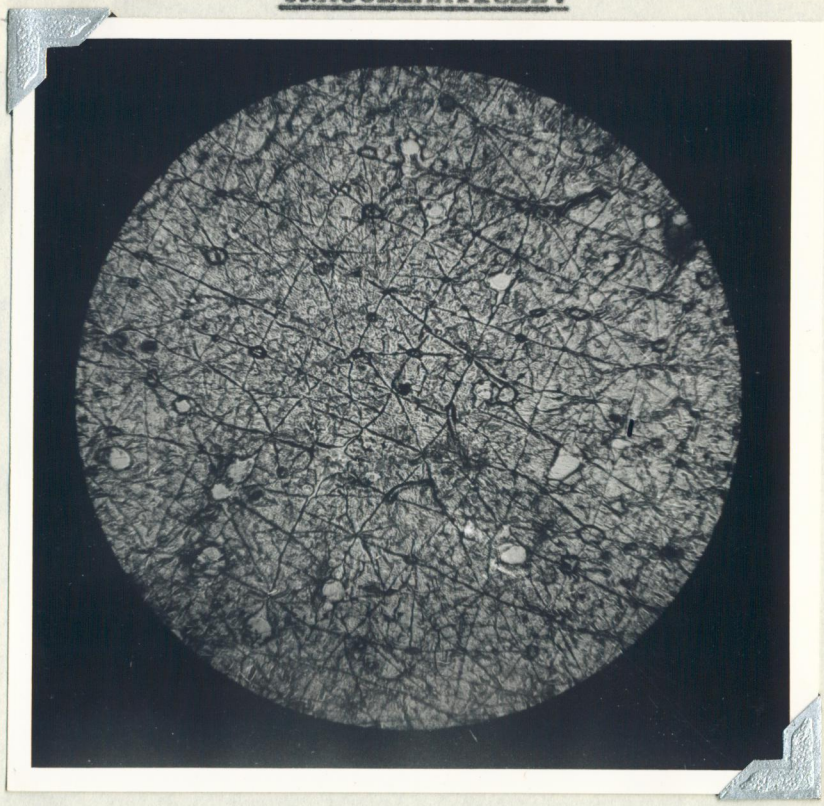
ACCLIMATISED.



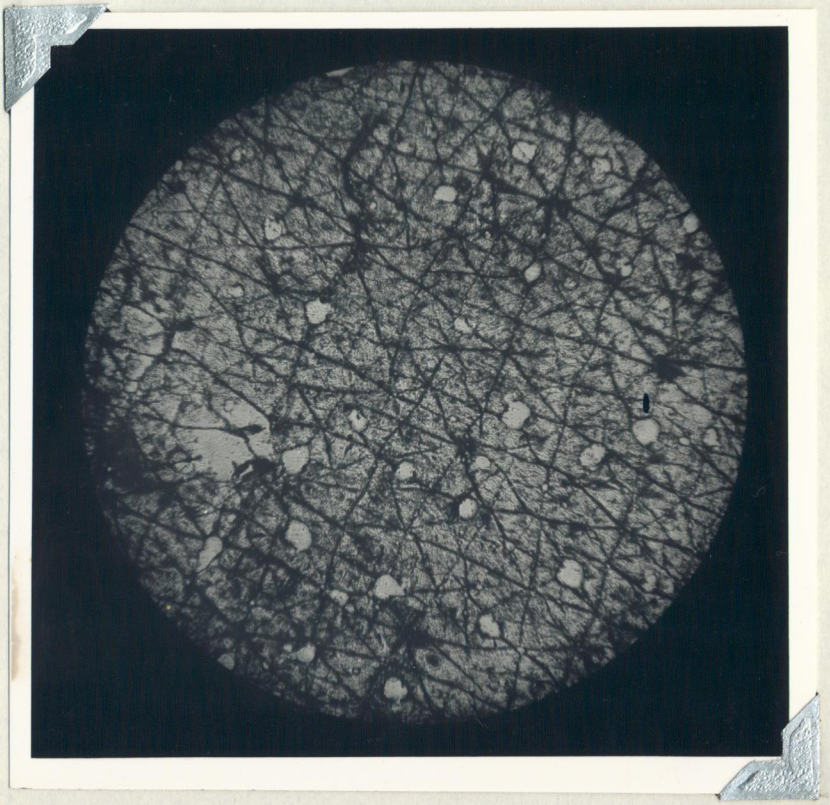
(3)

SUBJECT 125121. CHEST 4½ HOURS.

UNACCLIMATISED.



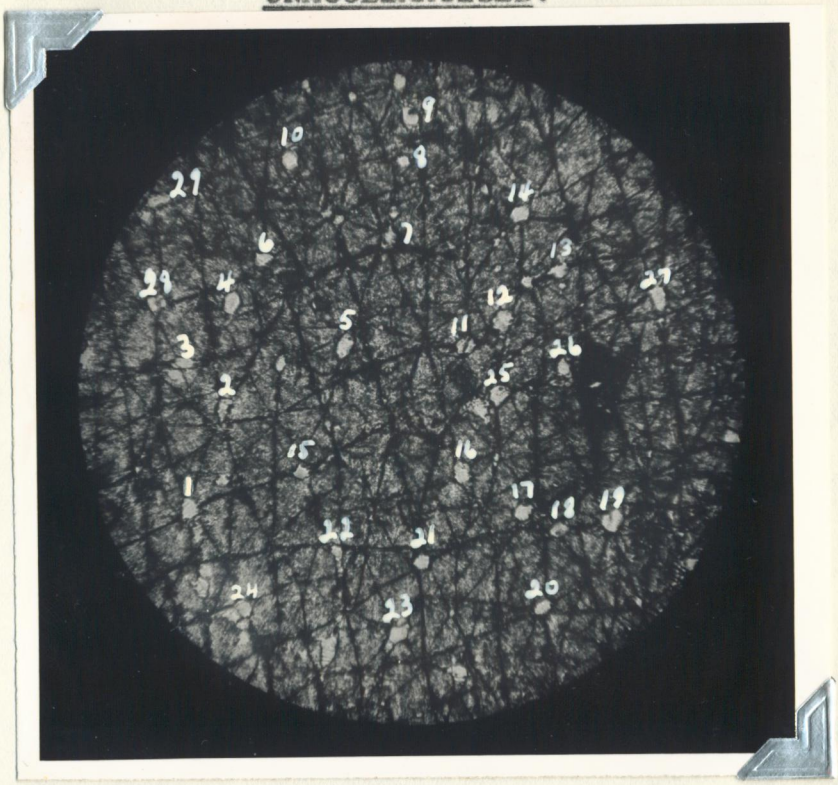
ACCLIMATISED.



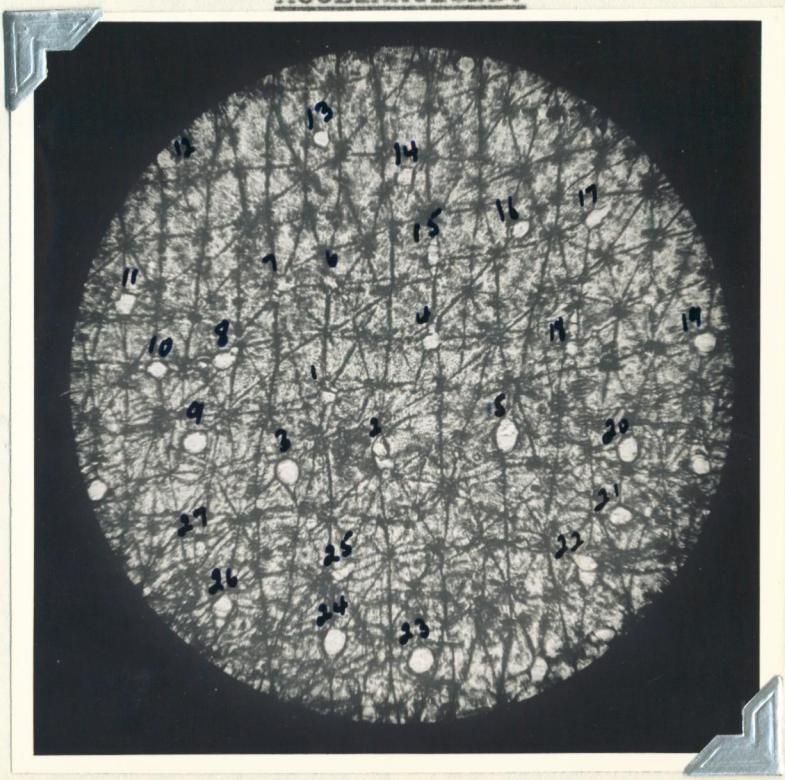
(4)

SUBJECT 70459. BACK ½ HOUR.

UNACCLIMATISED.

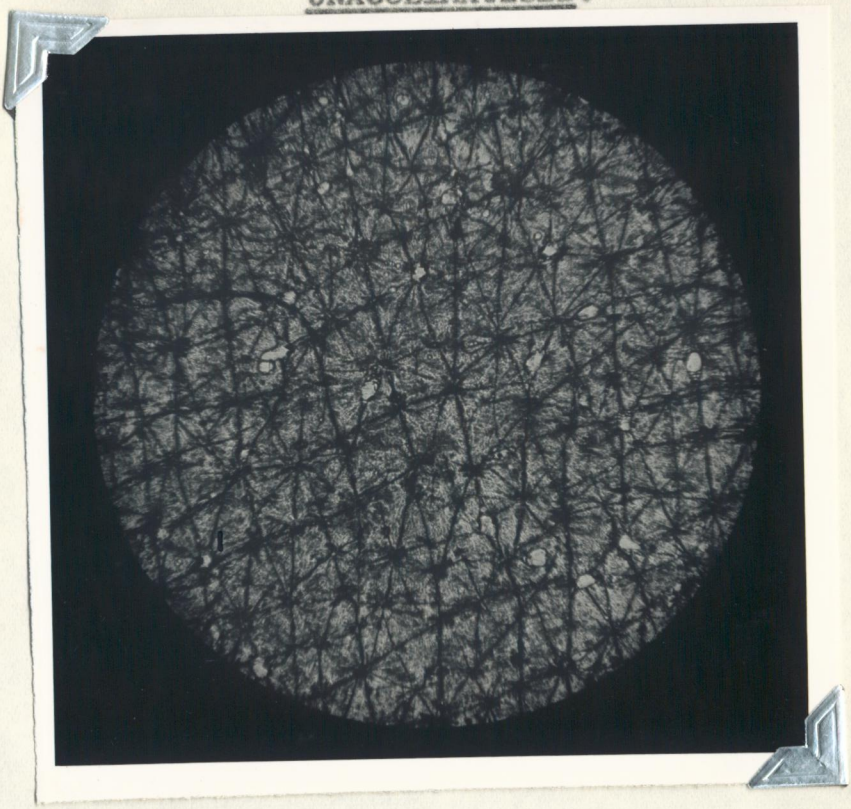


ACCLIMATISED.

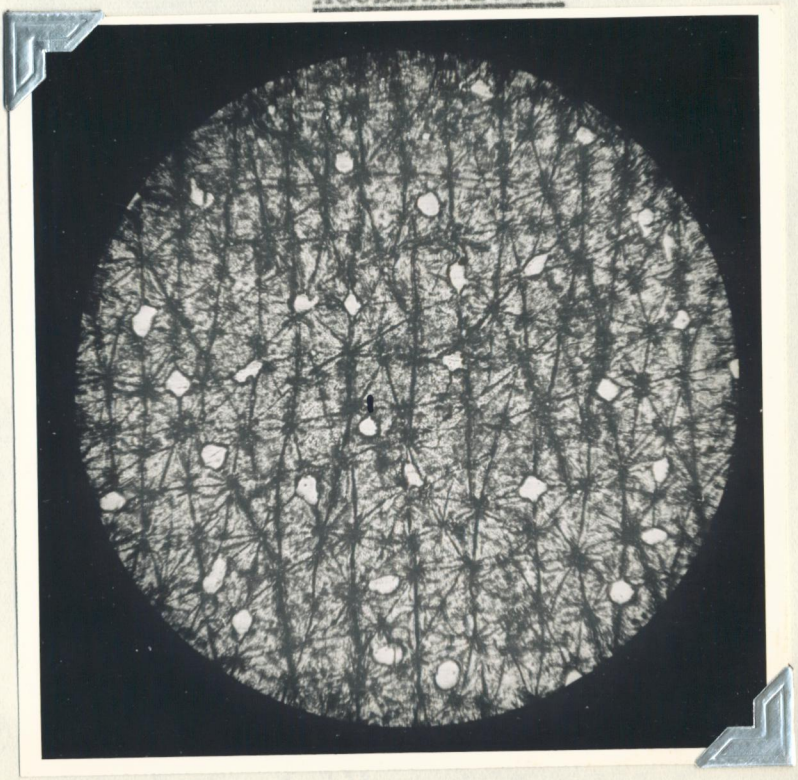


SUBJECT 70459. BACK 2 HOURS.

UNACCLIMATISED.



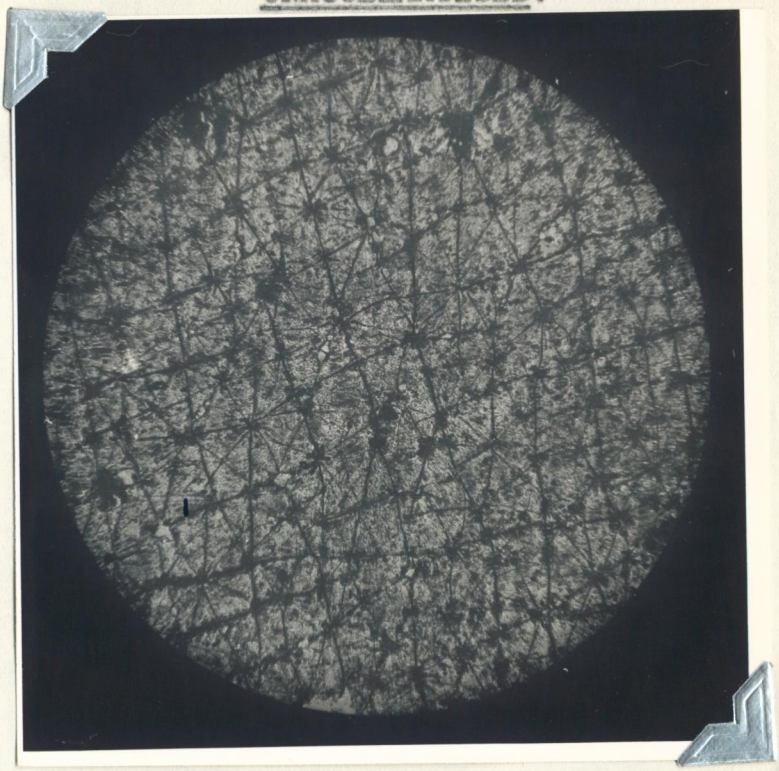
ACCLIMATISED.



(6)

SUBJECT 70459. BACK 4½ HOURS.

UNACCLIMATISED.



ACCLIMATISED.

