

## SUMMARY

**THE EFFECTS** of keeping mice in different environmental temperatures for the first 6 months of their lives was to affect the weight of body hair as follows : 33°C, 22.8 mg; 21°C, 41.9 mg; 8°C, 58.5 mg. The largest single factor accounting for this great increase in weight of fur in the animals kept in the cold was the number of mature hairs retained by the follicles. At 33°C 90% of follicles contained 1 or 2 hairs, at 21°C 80% of follicles contained 1 to 3 hairs while at 8°C 80% of follicles contained 4 to 8 hairs.

## INTRODUCTION

Although it has been observed (2) that arctic mammals and birds tend to be larger and therefore have a relatively small surface to volume ratio, Scholander and his associates (9, 10, 11, 12) believed this to be of little importance in climatic adaptation. Whether this is true or not, he and his colleagues report that the differences in fur thickness have a profound effect on thermal insulation. Indeed, arctic mammals have thick fur coats whereas tropical mammals have relatively sparse hair covering. It is therefore of interest to determine whether or not environment temperature determines the growth of body hair so that the appropriate form is produced for a particular environmental condition.

## MATERIALS AND METHODS

### 1. Weight of body hair

Inbred albino mice aged 5 - 6 months were maintained at 33°C, 21°C and 8°C (6, 5 and 6 mice respectively) from the age of 23 days and were killed when 5 or 6 months old. They were killed by cervical dislocation, weighed to the nearest 0.5 mg and then painted with a depilating paste (8). After 15 minutes the whole body hair (including the vibrissae was

# Some Observations on the Effects of Environmental Temperature on the Growth of Body Hair

By F. Al-Hilli\*

scraped off with a spatula. The animals were then washed in running water, carefully dried and then reweighed so as to obtain the weight of hair by difference.

### 2. Length and thickness of body hair

34 mice of the same age group maintained at 33°C, 21°C, and 8°C (14, 9 and 11 mice respectively) since the age of 23 days were also used. The body hairs of these animals were examined under a dissecting microscope to determine the number of hairs per follicle (all types of hair follicles were used).

Samples of body hair (monotrich type) were plucked from the abdominal, interscapular and dorsocaudal regions. The hairs were mounted on microscopic slides and their lengths and maximum widths measured.

3. The external changes in the distribution and pigmentation of body hair were also observed.

## RESULTS

### 1. Weight of body hair

Table 1 shows the weights of total body hair in the 3 groups. The hair weight in the cold group (8°C) was 256% heavier than that of the hot (33°C) and 140% heavier than the control (21°C) group.

### 2. Lengths, widths and number of hairs per follicle.

Table 2 shows the number of hairs per hair follicle in the 3 groups of mice. In the hot group 90% of the body hair occurred in hair follicles containing 1 or 2 hairs. In the control group 80% of the hairs were seen in follicles with 1 to 3 hairs. The cold group has follicles containing a variable number of hairs with 80% of these follicles containing 4 to 8 hairs.

Table 3 and 4 shows the length and width of the body hair in the 3 groups. Generally, the body hairs of the cold group were longer and thicker than those of the control and hot groups. The length and thickness of the control and hot groups fall within the same range.

However, in all the groups the hair lengths of the interscapular region were similar. The hair thickness in the interscapular region of the control and cold groups were also similar.

### 3. External change.

It was found that when the young mice were housed at 33°C the fur became progressively sparser and thinner. In some cases, the mice appeared almost hairless while in others there was patchy loss of body hair especially from the abdominal and cervical regions.

\* Department of Pathology,  
Salmaniya Medical Centre,  
Bahrain.

In the adult animal, the ears, forepaws, hindpaws, external genitalia and the base of the tails of the cold group were better covered by hair than the hot group. The hanging scrotal sacs of the males of the hot group were deficient in hair.

Certain pigmentation changes in the body hair were also seen, particularly in the males of the hot group and to a lesser extent in the control group. A patch of light chocolate brown discolouration was noted over the interscapular region which extended to just below the ears. In addition, creamy streaks were seen over the abdomen and the region around the external genitalia was yellowish. These colourations were not removed by washing. The body hair of the cold group was pure white.

## DISCUSSION

The method of re-weighing animals after depilation is suitable for estimating the total amount of body hair although the results are affected by the dryness of the animals when re-weighed. This method provided a reasonable comparison of the effects of environmental temperature on the growth of body hair in the mouse. The results confirm the view of many workers (9, 10, 11, 12, 13, 14, 15) that the main function of fur is insulation and that its thickness is closely related to the environmental temperature. The subcutaneous fat is a poor insulator compared with fur and in the mouse does not seem to play the major role of insulation found in some aquatic arctic mammals. In tropical primates the fur of animals is generally thin.

The increased weight of body hair in the cold group compared with the other groups was found to be most closely related to the number of hairs per hair follicle although the length and thickness made a minor contribution.

The growth of body hair in mice occurs in cycles (3, 5, 6) so that the old hairs fall out and are replaced by new hairs. The fewer number of hairs per hair follicle in the hot group may be due to an acceleration of the cyclic hair moulting so as to provide the thinnest fur covering and thus facilitate body cooling. In the cold environment the cyclic hair growth seems to have continued but the hairs were prevented from falling. The retained hairs thus provide the animals with the maximum number of hairs per hair follicle to ensure good insulation.

The body hair of the mouse has been divided by Dry (4) into 4 types: monotrich, awls, auchenes and zig-zag. Although the zig-zag hairs provide the mouse with most of the fluffy fur covering, for convenience only the widths and lengths of the monotrich type were measured in this study.

Again, the longer and thicker hair in the cold group compared with the other groups provided the mice with a better protective insulation of fur. On the other hand, the hair lengths of the control and hot groups were seen to fall within the same range and therefore the thermal insulation of the fur in these groups was probably similar.

Some regional differences were also seen. The similar lengths of the

interscapular hair of the 3 groups and the identical thickness of the hair of the same region in the cold and control groups may be related to the underlying brown adipose tissue (1). The heat generated by this form of fat may have maintained the interscapular region at a similar temperature in the cold group and would account for the similar lengths of hairs. In the hot environment this form of fat was transformed to the ordinary white adipose tissue (1) which has no thermogenic properties but the environmental heat would have maintained the temperature in this area.

Scholander et al (9, 10, 11, 12) and Sundstroem (15) also reported severe loss of body hair in the hot environment. This might be analogous to the alopecia associated with febrile disease in man (7). The patchy loss of body hair over the abdominal and cervical regions may be related to the cyclic hair growth which begins in the ventral regions of the mouse and spreads dorsally (13, 5, 6).

The pigmentary changes observed in the hot and control groups could not be attributed to the lack of cleanliness because the colour was not removed by washing. They could not, however, be referred to diet because the mice of the cold group which ate more did not show any colour manifestation. Similar findings were also reported by Sundstroem (15) who regarded the pigmentation as due to the presence of melanin in the hair or tyrosinase in the skin but he failed to demonstrate the latter and was in doubt about the former. It seems that these pigmentary changes are probably metabolic but there is no evidence of their exact nature.

**Table 1**  
**The weights of total body hair in the 3 experimental groups. P indicates the significance of difference between the control and hot and cold groups.**  
**P between the hot and cold group was  $\leq 0.001$ .**

	HOT (33°C)	CONTROL (21°C)	COLD (8°C)
No. of animals	6	5	6
Range	18.1 - 26.9 mg	39.1 - 45.4 mg	51.7 - 63.6 mg
Mean	22.8 mg	41.9 mg	58.5 mg
S.D.	4.0	3.0	4.0
P.	0.001		0.001.

**Table 2**  
**The number of body hairs/hair follicle in the three environmental groups.**

No. of hairs/hair follicles	1	2	3	4	5	6	7	8	+ 8
HOT (33°C) No.	138	151	26	3	2				
(14 mice) %	43.1	47.2	8.1	0.9	0.6				
CONTROL (21°C) No.	57	62	105	36	13	7			
(9 mice) %	20.4	22.1	37.5	12.9	4.6	2.5			
COLD (8°C) No.	22	15	17	49	35	60	47	68	19
(11 mice) %	6.6	4.5	5.1	14.8	10.5	18.1	14.2	20.5	5.7

**Table 3**  
**The lengths of body hair from the abdominal, interscapular and dorsocaudal regions**

		HOT (33°C)	CONTROL (21°C)	COLD (8°C)
No. of animals		14	9	11
1. Abdominal hair	No. of hairs examined	64	60	58
	Range (mm)	3.70 — 4.18	3.52 — 4.26	6.36 — 7.22
	Mean (mm)	3.89 $\pm$ 0.17	3.88 $\pm$ 0.30	6.75 $\pm$ 0.44
2. Interscapular hair	No. of hairs examined	66	61	73
	Range (mm)	4.07 — 6.85	3.70 — 5.99	4.48 — 6.55
	Mean (mm)	5.89 $\pm$ 0.89	5.78 $\pm$ 0.91	5.67 $\pm$ 0.37
3. Dorsocaudal hair.	No. of hairs examined	78	83	96
	Range (mm)	4.44 — 5.74	3.70 — 4.59	5.92 — 9.99
	Mean (mm)	5.28 $\pm$ 0.43	4.06 $\pm$ 0.41	7.01 $\pm$ 1.45
4. Total mean length	(mm)	4.87	4.57	6.48

**Table 4**  
**The thickness of body hair of the abdominal, interscapular and dorsocaudal regions.**

		HOT (33°C)	CONTROL (21°C)	COLD (8°C)
No. of animals		14	9	11
1. Abdominal hair	No. of hairs examined	64	60	58
	Range (um)	28.23 - 37.65	25.00 - 38.64	35.29 - 49.41
	Mean (um)	33.65 $\pm$ 3.65	31.82 $\pm$ 4.55	41.31 $\pm$ 4.57
2. Interscapular hair	No. of hairs examined	66	61	73
	Range (um)	9.41 — 18.82	25.00 — 38.64	28.23 — 40.00
	Mean (um)	14.35 $\pm$ 2.82	32.20 $\pm$ 5.07	32.22 $\pm$ 4.80
3. Dorsocaudal hair	No. of hairs examined	78	83	96
	Range (um)	14.12 — 18.82	18.18 — 25.00	25.88 — 40.00
	Mean (um)	16.47 $\pm$ 1.66	23.49 $\pm$ 2.75	33.72 $\pm$ 4.08
4. Total mean thickness	(um)	21.41	29.17	35.75

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