SEBACEOUS GLANDS ON THE HINDQUARTERS OF THE VOLE, *MICROTUS AGRESTIS*

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Sexually mature male voles, *Microtus agrestis*, in our colony develop oily fur on the hindquarters at the age of about 3 months. In the following 1 to 2 months, hair is lost from these regions revealing raised patches of bright pink skin. Each patch is about 20 mm long and 15 mm wide, has a coarse texture, one or two characteristic folds (Pl. 1, Fig. 1) and a musty odour. Histologically, the skin contains very greatly enlarged holocrine sebaceous glands (Pl. 1, Fig. 2). These specialized sebaceous patches persist for as long as 14 months. They do not occur in females.

In view of the significance of androgens in the control of the growth and activity of sebaceous glands (Ebling, 1963), the rôle of the testes and of androgen in the maintenance and development of these sebaceous patches was studied in laboratory voles. The androgen was testosterone chloral hemiacetal acetate as an aqueous suspension (Caprosem, Leo Pharmaceutical Products). Doses were given subcutaneously in 0.1 ml. The occurrence of the patches was also investigated in voles from the field.

Standardized sections of the patches were assessed by: (1) estimating the total amount of sebaceous tissue using a Weibel 42 point eyepiece graticule (Weibel, Kistler & Scherle, 1966); (2) counting the sebaceous alveoli in a section; (3) counting the cells in alveoli; (4) estimating the size of sebaceous cells by counting the nuclei in the squares of a standard eyepiece grid.

Eight breeding colony males, with sebaceous patches developed to the extent shown in Pl. 1, Figs 1 and 2, were castrated and, at the same time, a small biopsy was taken from the centre of one patch. Additional biopsies were taken alternately from the two sides 4, 8, 10 and 12 weeks later. Treatment with Caprosem was begun immediately after removal of the Week-8 biopsy. Doses of 10 or 1 mg were given subcutaneously at weekly intervals for 4 weeks. Animals were killed 12 weeks after castration. By the 8th week, the patches had been so reduced that they were hardly recognizable. They had shrunk in area, were no longer raised and the folds had disappeared. The skin lacked the coarse surface texture, was not bright pink and was covered with oil-free hair. There was no musty smell. Treatment with testosterone at either dose level reversed these castration effects. There were no statistically significant differences between the 10 and 1 mg doses in the values of measurements on the sebaceous tissue in the biopsies. Results have therefore been combined and are given in Table 1. The data show that following castration there was a decline in the total amount of sebaceous tissue (compare also Pl. 1, Figs 2 and 3), and
that testosterone treatment restored it almost to its precastration level. The changes in the amount of sebaceous tissue involved corresponding alterations in the number of sebaceous alveoli, their size and the size of the sebaceous cells. Analysis of variance showed that the treatments had a statistically significant effect upon the four parameters of sebaceous development.

Sixteen sexually mature laboratory males (8 to 12 weeks old) were allotted at random to four treatments; intact, castrated, castrated plus 0·1 mg and castrated plus 1·0 mg Caprosem weekly. Those in the intact and castrated treatments were injected weekly with 0·1 ml distilled water. Animals were killed 1 week after the fourth injection. The hair on the hindquarters of testosterone-treated animals had become slightly oily. The castrated animals had very much less sebaceous tissue than either the intact or the testosterone-treated animals. Measurements on the sebaceous tissue showed essentially the same differences between the treatments as those recorded in Table 1 for the biopsies from intact, castrated and castrated-testosterone treated animals. Analysis of variance showed statistically significant effects of treatments on the total amount of sebaceous tissue, the number and size of alveoli and cell size. From weights of seminal vesicles and development of sebaceous glands, the physiological dose of testosterone was between 0·1 and 1·0 mg weekly. Similar effects on this sebaceous tissue were obtained with sixteen males initially 3 weeks old, assigned to the same four treatments, and killed 4 weeks later.

Sexually mature females were injected with 0·1 mg (four animals) or 1·0 mg (four animals) Caprosem weekly for 4 weeks. They were killed 1 week after the last injection, together with four other sexually mature females which had been injected weekly with 0·1 ml distilled water. Sebaceous tissue occurred very sparsely on the hindquarters of the untreated females so that even with the statistically significant ten- to fifty-fold increase in the total amount of sebaceous tissue observed in the androgen-treated females, the tissue was still only about one third as abundant as in intact or androgen-treated males. The increase in the sebaceous tissue also involved an increase in the number and size of the alveoli, and in the size of the sebaceous cells.

These results with laboratory animals indicate that the sebaceous patches on the hindquarters of voles are dependent for their development and maintenance, at least in part, upon secretions of the testis.

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EXPLANATION OF PLATE 1

Scale in Fig. 1 is in millimetres. Figures 2 to 5 are haematoxylin-and-eosin-stained sections of sebaceous patches from voles in different physiological states and are at the same magnification. Scale line given in Fig. 3 is 200 \( \mu m \). Figures 2 and 3 are biopsies from the animal shown in Fig. 1.

Fig. 1. Hindquarters of a sexually mature, intact, laboratory-bred, male vole, showing bare sebaceous patches with folded skin on which the openings of large sebaceous ducts can be seen.

Fig. 2. Biopsy from an intact animal, in which numerous sebaceous alveoli are seen, one of which is opening into the large duct running to the skin surface which is filled with sebaceous secretion.

Fig. 3. Eight weeks after castration. Very much fewer and smaller alveoli (arrowed). Hair follicles present.

Fig. 4. Breeding season field animal.

Fig. 5. Non-breeding season field animal. One sebaceous alveolus arrowed. Hairs in cross section beyond epidermis.
Table 1
Sebaceous Development in Biopsies from Intact, Castrated, Castrated-Testosterone Treated Laboratory Voles, and in Voles Trapped in the Field

<table>
<thead>
<tr>
<th></th>
<th>Intact</th>
<th>Time (weeks) after castration*</th>
<th>Field animals</th>
<th>Non-breeding season (December)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>No. of animals</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Total sebaceous tissue†</td>
<td>31.1 ± 1.7</td>
<td>3.1 ± 0.5</td>
<td>5.8 ± 3.0</td>
<td>22.7 ± 2.4</td>
</tr>
<tr>
<td>Alveoli/mm</td>
<td>23.0 ± 5.9</td>
<td>15.6 ± 3.3</td>
<td>14.7 ± 3.5</td>
<td>25.5 ± 4.4</td>
</tr>
<tr>
<td>Cells/alveolus</td>
<td>138.4 ± 31.3</td>
<td>24.4 ± 2.3</td>
<td>20.6 ± 5.2</td>
<td>75.7 ± 7.6</td>
</tr>
<tr>
<td>Cell size†</td>
<td>4.5 ± 0.4</td>
<td>2.2 ± 0.2</td>
<td>2.3 ± 0.2</td>
<td>4.1 ± 0.5</td>
</tr>
</tbody>
</table>

Mean ± S.E. given for each parameter of sebaceous development.

* Testosterone given weekly for 4 weeks, commencing immediately after removal of Week-8 biopsy.
† In arbitrary units.
Males were trapped alive in the Oxford University Biological Reserve, Wytham, Berkshire, in the summer, when voles are in breeding condition, and in winter, when breeding generally stops (Clarke & Forsyth, 1964). The testes and seminal vesicles respectively weighed 580±29 and 206±22 mg in eight animals caught in May, 391±40 and 118±16 mg in eighteen caught in August, and 100±36 and 25±12 mg in eight caught in December. None of the field animals had bare sebaceous patches but some May and August (breeding season) males had slightly oily fur on the hindquarters. Microscopically, the animals caught during the breeding season had well-developed sebaceous glands over an area on each side corresponding to the bare patches seen in laboratory breeding stock (Pl. 1, Fig. 4). In males caught in the winter, the sebaceous tissue on the hindquarters was no more developed than in other parts of the skin (Pl. 1, Fig. 5). Measurements showed that there were statistically significant changes during the year in the four parameters of sebaceous development (Table 1). These can presumably be attributed to the seasonal changes in androgen production by the testes, inferred from the seasonal alteration in the size of seminal vesicles (Clarke & Forsyth, 1964). The animals trapped in August had less well developed sebaceous patches than those trapped in May (Table 1). One third of the August animals were not yet fully developed sexually, which, with their body weights, suggests that they had been born in June or July. The May animals were all much heavier and were fully developed sexually, and so were probably survivors from the previous breeding season (Chitty, 1952). The difference in the development of the sebaceous patches between the two sub-samples of the breeding season is probably a reflection of their difference in age and sexual development.

Sebaceous patches are apparently more highly developed in our breeding stock than in sexually mature wild-type animals (Table 1, and compare Pl. 1, Figs 2 and 4). There are at least three possible explanations for this. (1) Differences may exist between sexually mature laboratory voles and field voles of comparable age in the total amount and pattern of androgen which has circulated through target tissues during their lives. Assessed by prostate weight, laboratory-bred voles have a rising titre of androgen in the blood during the first 12 weeks of life. Thereafter, plasma androgen levels appear to remain constant and high (Jorne-Safril, 1968). Animals living in the field from one breeding season to the next will have had a low androgen output during the winter (Clarke & Forsyth, 1964). Such differences between laboratory and field animals might be expected to affect the development of the sebaceous patches. (2) High fertility, for which selection has been practised in the laboratory stock, may be linked with accentuation of sebaceous patches. (3) The small sample of field animals in the present study may have been misleading.

The sebaceous patches of Microtus agrestis correspond to the hip glands recognized by Quay (1968) as occurring in some microtine rodents. Several other rodents also possess specialized areas of sebaceous tissue which depend, at least in part, upon androgens for their maintenance (Quay, 1953; Beaver, 1960; Martan, 1962; Mitchell, 1965; Stoddart, 1972). The significance of the hip glands for Microtus remains to be established. Mykytowycz (1970) has drawn
attention to the rôle of skin glands in communication relating to a number of different mammalian activities. Olfactory stimuli appear to play a part in evoking aggressive behaviour in male voles (Clarke, 1953), and some social factors which may involve a male pheromone accelerate sexual development of female voles (J. R. Clarke, unpublished observations). The hip glands of Microtus agrestis might also serve to mark territory or home range, as Stoddart (1972) has suggested for the sebaceous flank glands of the water vole.

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