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A HISTOLOGICAL COMPARISON OF THE DORSAL AND GENERALIZED HOLOCRINE SKIN GLANDS IN THE KANGAROO RAT, *DIPodomys ORDII*<sup>1</sup>

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ABSTRACT. Skin tissue from 11 adult kangaroo rats, *Dipodomys ordii richardsoni*, including both sexes was examined histologically for morphological differences between the specialized dorsal holocrine sebaceous gland region and the generalized small sebaceous glands of the skin. The author examined the structure and distribution of the unmodified sebaceous glands throughout the skin and compared them to the modified dorsal sebaceous gland. Based on a volumetric comparison, the dorsal gland is significantly different from the generally distributed sebaceous glands. A possible explanation is that the relatively consistent distribution of sebaceous glands functions in pelage maintenance and the sebaceous flow from the distinctive dorsal gland could function in individual scent communication. It is evident that the alveolar volume of the dorsal gland differs from that of the generally distributed glands of *D. ordii*.

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INTRODUCTION

Kangaroo rats in the rodent family Heteromyidae, genus *Dipodomys*, possess a dorsal holocrine skin gland composed of

enlarged and modified sebaceous gland units. The dorsal gland of the kangaroo rat has been described by Quay (1953). Tappe (1941) proposed that the dorsal gland in the Tulare kangaroo rat, *D. beermanni tularensis*, was important for hair and skin conditioning in response to the arid envi-

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ronment. Quay (1953) rejected this proposal both on the assumption that active sebaceous glands are probably distributed through nearly all of the skin, with their secretions functioning as a pelage dressing, and because the dorsal gland is a localized structure. Quay (1953) further suggested that the functional significance of the gland appeared to concern scent responses, while the generalized lipid production could prevent evaporative water loss from the skin (Quay 1965). Randall (1981a) showed that chemical signals communicated information concerning species, gender and perhaps reproductive condition in *Dipodomys*. She further proposed that lipids from both the specialized dorsal sebaceous gland and from the glands spread throughout the skin probably are the signal source.

In this study, I undertook a histological comparison of the glandular regions of the skin (dorsum of the head, ventral body surface, perineal region, inner thigh and lateral hip) to determine whether any morphological differences exist between the distinctive dorsal sebaceous gland and the other cutaneous sebaceous glands in *Dipodomys ordii richardsoni*.

#### METHODS AND MATERIALS

Snap-trapped *D. ordii* were placed in a 10% formalin solution. Skin samples 0.5 cm square were taken from a shaved surface and fixed in Bouin's fixative. The tissues were dehydrated through a series of 50, 70, 95% and absolute ethyl alcohol solutions. Tissues were cleared with xylene, infiltrated with paraffin (melting point 54–56 C) and embedded. Following embedding, blocks were sectioned either longitudinally or vertically at 10 microns thickness using a Spencer 820 microtome. Tissue ribbons were mounted on slides as serial sections. Sections were deparaffinized using xylene and hydrated through a series of 95 to 70% decreasing alcohol solutions. Staining was with Delafield's hematoxylin and eosin counterstain.

Slides were observed with a light microscope. Tissue comparisons were based on a determination of mean alveolar volume of sebaceous glands from the selected cutaneous regions. Each glandular alveolus was measured at its widest point with a calibrated ocular micrometer from the serial section showing maximum surface area. All measurements for each somatic region were averaged in order to obtain a mean alveolar diameter per body region per rat. Alveolar volume was computed according to the

geometric formula for the volume of a sphere. Samples were taken from 11 rats (5 males and 6 females). All rats were adults and were observed to be reproductively quiescent when collected in December from the same population, Sandhills Game Management Area, Pratt County, Kansas.

#### RESULTS

Observation of vertically sectioned skin samples revealed that a sebaceous gland consisted of a cluster of glandular alveoli (acini) converging into a central duct which led to the skin surface. Examination of tissue sections showed that a gland was composed of an average of 5 glandular alveoli. An individual alveolus was composed of holocrine cells with the more mature cells situated toward the center of the sphere. Centrally positioned mature cells ruptured, releasing their component sebum into the neck of the gland and out to the epidermal surface. This is consistent with Quay's findings (1954).

From longitudinally prepared serial sections, measurements of the diameter of glandular alveoli from the selected dermal sites and the dorsal sebaceous gland were made. Mean alveolar volumes for each tissue type were calculated per animal sampled. A grand mean alveolar volume for each tissue area was then calculated (fig. 1).

The degree of association between the sebaceous elements of the skin regions sampled was compared with an F-test (ANOVA) (Sokal and Rohlf 1969). A significant difference ( $P < 0.001$ ) existed among the skin regions sampled. Mean alveolar volume of the modified dorsal gland was significantly greater ( $F = 8.078$ ;  $df = 5,60$ ;  $P < 0.001$ ) than the alveolar volume of other cutaneous regions. No significant sex differences were noted.

#### DISCUSSION

The data indicate that there was uniform distribution of unmodified sebaceous glands throughout the dermis of *D. ordii*. One exception occurred to this uniform glandular distribution. It was the modified dorsal sebaceous gland, which occurred as an aggregation of modified sebaceous glands along the anterior portion of the

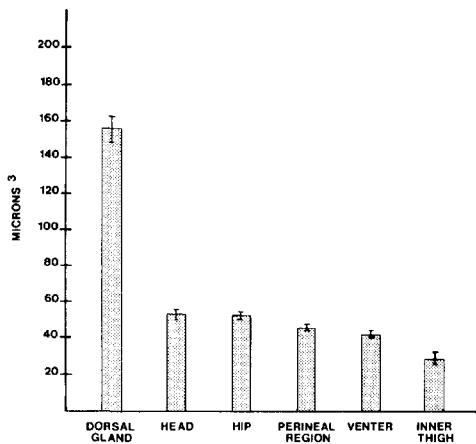


FIGURE 1. Mean alveolar volume in microns<sup>3</sup> ( $\pm$ SE) calculated from alveoli diameter measurements at 100 $\times$  magnification. Tissue samples from 11 adult *D. ordii* (5 males, 6 females).

mid-dorsal line of the body. The area was discernible by a thickening of the skin and an absence of hair follicles. Glandular acini were both more abundant and of a significantly greater volume in the dorsal gland than in any other region of the skin. There was no significant difference in the alveolar volume among male and female *D. ordii*. In a direct measure of the production of hair lipids from *D. merriami* and *D. microps*, Randall (1981b) found no significant sex differences in either species.

Montagna (1962) identified the movement of sebum along a gradient from areas of greater secretion to areas of lesser secretion. This appeared to be the current situation as the dorsal gland has been identified in this study as a region of greater alveolar volume than the other dermal areas examined. The relatively consistent distribution of sebaceous glands through-

out the dermis of the animal would seem to indicate that these glands functioned as the source of sebum for pelage maintenance. This evidence substantiates the hypothesis that the sebaceous flow from the specialized dorsal gland might function in the supplemental capacity of individual scent communication as proposed by Quay (1953) and Randall (1981b) when excess hair oil is present. An excess of sebaceous material presumably produced by the increased volume of the dorsal gland might serve to maximize an olfactory signal.

A comparative analysis of the lipid composition from both the unmodified somatic glands and the modified dorsal gland is needed. Identification of any variation in chemical composition could resolve the question of possible differences between sebum used for scent communication and sebum used for pelage grooming.

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