

16678

Comparison of the Preputial Glands in the Alexandrine, The Wild, and the Domestic Norway Rat.*

CHARLES E. HALL.† (Introduced by C. P. Richter.)

From the Psychobiological Laboratory, Johns Hopkins Medical School, Baltimore, Md.

During routine autopsies on wild Alexandrine and wild Norway rats, it appeared that the preputial glands of these wild rats were much larger than those found in the common domestic Norway rats. To check these impressions, the weights of the preputial glands were determined in the 3 forms for all sized rats from the smallest to the largest individuals.

Material and methods. For this study 78 domestic Norway, 121 wild Norway, and 90 Alexandrine rats were used.

The domestic Norways were obtained chiefly from our colony. These are descendants of Wistar rats established here over 20 years ago. The wild Norways were trapped in Baltimore streets and alleys and on surrounding farms by the Rodent Ecology Division of the Johns Hopkins School of Hygiene; the Alexandrines came from ships in the Baltimore harbor, where they had been killed by fumigation.‡

The domestic and wild Norways were killed with ether and autopsied immediately. The Alexandrines were not available for autopsy until 3 to 6 hours after they had been killed by fumigation.

At autopsy the rats were weighed; the preputial glands were removed and weighed on a torsion balance to the nearest 0.1 mg. In every case when sections were made, the glands were taken from recently killed animals and fixed in Bouin's solution with a minimum of handling.

* This work was begun under a grant from the Rockefeller International Health Board and completed under a grant from the Public Health Service.

† Now at the University of Texas, Medical Branch, Galveston, Texas.

‡ Dr. M. F. Haralson, until recently in charge of the Quarantine Station of the City of Baltimore, kindly supplied these rats.

Results. Gross anatomy: Fig. 1 shows a photograph of typical pairs of preputial glands taken from 3 female animals, a domestic Norway, a wild Norway, and a wild Alexandrine, all having about the same body weight. The glands from the wild Alexandrine are several times larger than those from the wild Norway and many times larger than those from the domestic Norway.

These glands are flattened, pear-shaped structures that lie between the skin and the lower abdominal musculature, one on either side of the penis or clitoris. Each gland terminates in a duct that emerges on the surface of the skin in a papilla-like opening. In the male, when the penis is fully retracted and thus ensheathed in the prepuce, the openings in the prepuce are located at the very end of the penis, whereas when the penis is fully erected and thus freed from the prepuce, the openings are located on the two sides at the base of the penis. In the female, the ducts emerge at the homologous points with relation to the clitoris.

A slight pressure exerted on the glands causes droplets of secretion to appear on the surface of the skin. These droplets help to locate the openings. In non-albinos, the presence of pigmentation in the walls of the ducts further helps to locate the openings.

Microscopic anatomy: A dense connective tissue capsule encloses the glandular parenchyma, which is composed of large, flat, polyhedral cells grouped into rounded acini and characterized by vesicular, pale-staining nuclei. Dissolution of the epithelial cells forms a secretion that appears as a granular eosinophilic mass within the numerous branched ducts.

Large wild Norway rats frequently have atypical glands in which numerous large cysts mar the usual smooth glandular surface (Fig. 2A). Such glands are found to consist of

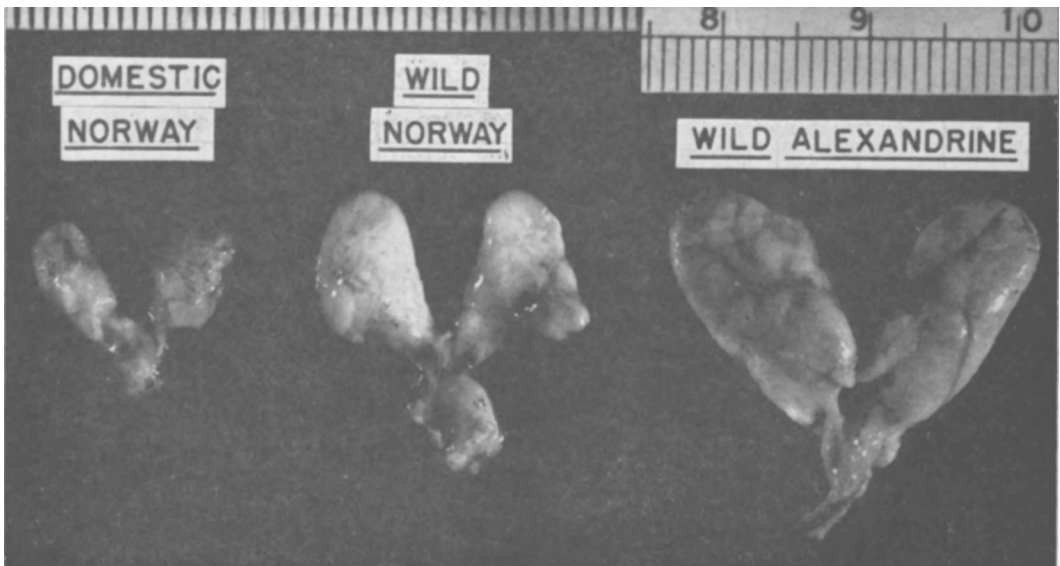
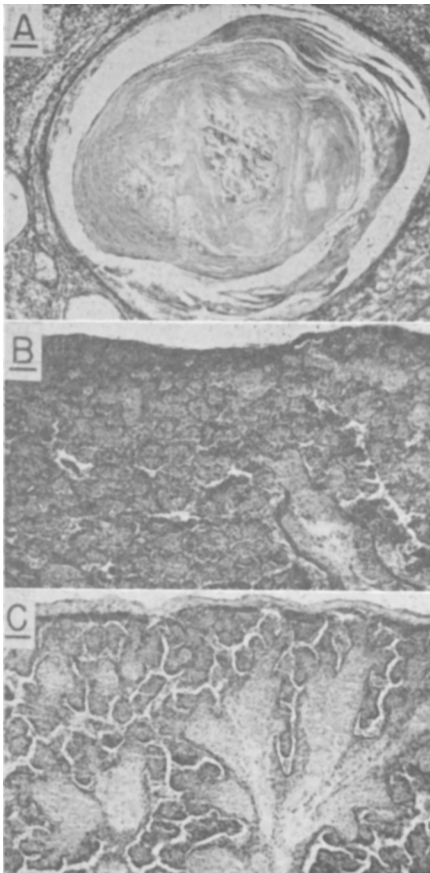


FIG. 1.

Photograph of the 3 pairs of preputial glands from a domestic Norway, a wild Norway, and a wild Alexandrine rat. Each rat weighed 250 g. (Scale—centimeters).



numerous dilated ducts, separated by strands of connective tissue. Many of these ducts show hyperkeratosis. Such cysts are generally associated with a chronic inflammatory reaction. It is not clear whether the inflammation causes, accompanies or results from the epithelial cysts.

Apart from this abnormality, routine staining with hematoxylin and eosin does not reveal any essential difference in glandular structure between the 3 types of rats. Figs. 2B and C are photomicrographs which show the typical structure of the preputial glands in Alexandrine and domestic Norway rats.

FIG. 2-A.

Low power view ($\times 100$) of a section from a preputial gland from a wild Norway rat. The center of the field is occupied by a large cystic dilatation containing a typical laminated epithelial "pearl" in the center of which degenerating acini may be seen.

FIG. 2-B.

Low power view ($\times 100$) of a section from the preputial gland of a domestic Norway rat. A branch of one of the ducts extends upwards from the lower right hand corner.

FIG. 2-C.

Low power view ($\times 100$) of a section of the preputial gland from a wild Alexandrine rat. A large multibranched duct is the most prominent feature.

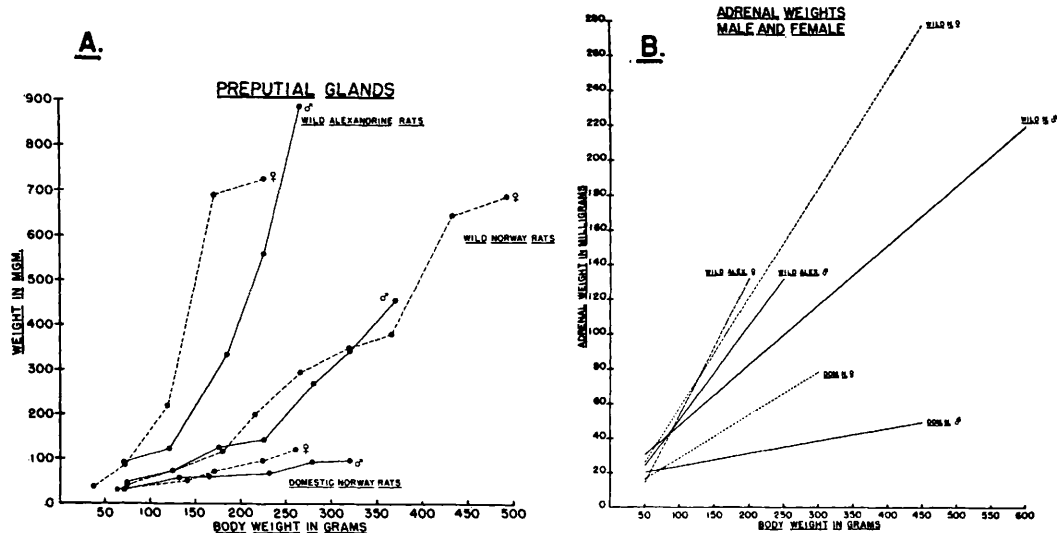


FIG. 3-A.

Graphs showing the relationship between the weights of the preputial glands and body weight in the 3 forms of rats: wild Alexandrines (45 ♂, 45 ♀); wild Norways (61 ♂, 60 ♀); domestic Norways (39 ♂, 39 ♀).

FIG. 3-B.

Graphs showing the relationship between the weights of the adrenals and body weight in the 3 forms of rats. (Data taken from Rogers and Richter).

Physical characteristics of preputial secretion: A considerable quantity (0.1-0.3 cc) of the sebaceous secretion usually may be expressed from the ducts of the glands by gentle manipulation in the mature wild Norway and the Alexandrine rats. It is seldom possible, however, to obtain as much from the glands of the domestic rat. In many rats the secretion is a viscous yellow mass; in some it may be quite liquid. In the former case it emerges in ribbon form, whereas in the latter droplets are formed.

Growth and size of preputial glands: Fig. 3A shows the relation between the weight of the preputial glands (in mg) and body weight. The lines connect points representing average values obtained in the various body weight classes.

a) *Wild Norways.* The weights of the preputial glands in female rats increased from 30 mg at an average body weight of 75 g to 695 mg at 500 g, or a 23-fold increase. The gland weights of the males increased at much the same rate.

b) *Domestic Norways.* The glands weighed much less in all body-weight classes of the domestic rats than in the wild forms, and

their size increased at a much less rapid rate. The weights of the glands of female rats increased from 25 mg at an average body weight of 60 g to 115 mg at 350 g, or a 4.5-fold increase. Over the same weight range the glands of the wild Norways increased 11-fold. In general, female rats had larger preputial glands than males of the same size.

c) *Alexandrine rats.* At body weights of 250 g, the glands averaged 760 mg for Alexandrines, 200 mg for wild Norways, and 90 mg for domestic Norways. Thus the glands of Alexandrines weighed about 4 times as much as the glands of wild Norways and about 8.5 times as much as those of domestic Norways.

A comparison of the heaviest glands found at any time in each species further brings out the species differences: 143 mg in the domestic rat, 984 mg in the wild Norway, and 1200 mg in the wild Alexandrine.

The sharp increase that occurs in the size of the glands in the wild Alexandrine rat at body weights between 75 and 125 g, and in the wild Norways between 175 and 250 g, may coincide with the onset of puberty in the two species.

In the domestic Norway, which always has small glands, the variations from the mean for any weight group are small, whereas in the other two forms which have large glands, there is much more scattering, especially in the largest animals.

While comparing the size of the preputial glands in the three forms, one should bear in mind that the Alexandrine rat is normally a smaller animal than the Norway. A 250 g Alexandrine is an old adult of maximal size, but a 250 g wild Norway is barely an adult. If a comparison could be made of the relationship between preputial gland size and age, the difference between Alexandrine and wild Norway rats probably would not be as great as indicated by the present method. Unfortunately it is not possible to determine the age of trapped wild rats accurately, and laboratory raised Alexandrines of known age have not been available.

The preputial glands of both wild Norway rats and Alexandrine rats attain a greater size than has ever been produced experimentally with any form of treatment in the domestic Norway. Glands weighing about 300 mg have been reported in domestic rats following treatment either with potent adrenocorticotrophic extracts of the hypophysis (Noble and Collip,¹) or androgens (Korenchevsky, *et al.*,²⁻⁴) but these are of moderate size compared to those found normally in adult Alexandrine or wild Norway rats.

Cross breeding: The offspring of both sexes from a cross between a wild Norway male and a domestic Norway female were used to determine the effects of cross breeding on the size of the preputial glands. Table I shows the relationship between the size of the preputial glands and body weight in the offspring of this cross as compared with wild Norway and domestic Norway rats of equal

TABLE I.
Weights of Adrenal and Preputial Glands in Wild and Domestic Norway Rats and in First Generation Crosses.

Type	No. of females	Body wt g	Preputial glands mg	Adrenals mg	No. of males	Body wt g	Preputial glands mg	Adrenals mg
Wild Norway	7	215 (200-245)	224 (144-335)	90.1 (58.3-120.0)	6	358 (330-370)	426 (243-708)	103.6 (74.5-158.0)
Wild x Domestic (F ₁)	7	216 (205-229)	111 (90-136)	66.5 (47.1-80.1)	6	355 (327-369)	126 (94-168)	46.8 (45.0-48.2)
Domestic Norway	7	220 (212-224)	108 (72-127)	52.9 (41.3-67.6)	4	355 (352-359)	109 (100-115)	27.8 (20.6-35.3)

¹ Noble, R. L., and Collip, J. B., *Endocrinology*, 1941, **29**, 934, 943.

² Korenchevsky, V., Dennison, M., and Simpson, S. L., *Biochem. J.*, 1935, **29**, 2534.

³ Korenchevsky, V., Dennison, M., and Eldridge, M., *Biochem. J.*, 1937, **31**, 467, 780.

⁴ Korenchevsky, V., Hall, K., and Burbank, R., *Biochem. J.*, 1939, **33**, 213, 372.

size. In the cross-bred offspring, the glands are markedly smaller than those in wild Norway rats and only slightly larger than those in domestic Norways.

Relation of preputial glands to adrenals: Fig. 3B gives the average adrenal growth curves obtained for 100 (50 ♂ and 50 ♀) each of wild Alexandrine, wild Norway, and domestic Norway rats (data redrawn from Rogers and Richter⁵). The ordinates give the combined weights of both adrenals in milligrams; and abscissas, body weight in grams. Like the preputial glands, the adrenals of the wild rats are much larger than those of the domestic rats, and in each form the females have the larger glands. Unlike the preputial glands, however, the adrenals are only slightly larger in the wild Alexandrines than in the wild Norways.

In crosses between wild and domestic Norway rats the adrenals, like the preputial glands, are only slightly larger than in the domestic forms.

Discussion. The common laboratory Norway rat has undergone great changes in behavior during the course of domestication. It is tame, tractable and trusting; the wild rat is fierce, intractable, and suspicious. Some of the behavior changes can be correlated with anatomical modifications, such as the decrease in size of the adrenal glands (Rogers and Richter,⁵) or the decrease in the number of taste papillae on the surface of the tongue (Fish and Richter⁶). No such correlation can be readily detected between behavior and the

recession of the preputial glands. The lack of any definite knowledge about the function of these glands makes a correlation difficult.

Since the ducts in males are located on the penis, it is possible that this highly sebaceous secretion may serve a lubricating function during copulation (Schaffer⁷). It seems unlikely, however, that it serves such a function in females, since in them the ducts do not end near the vaginal opening.

The secretion, through its odor (Noble and Collip¹), might play a part in sex attraction. The fact that domestic rats have lived in cages for such a long time may be related in some way to the atrophy of these glands. Mates are provided for domestic rats, so that they no longer have to depend on finding their mates by scent.

The larger size of the preputial glands in the wild Alexandrines remains unexplained. The Alexandrine rats live more in ceilings, where any scent left would not be destroyed by rains, etc., as it is on the ground. Perhaps scent plays a larger part in their life than in that of the wild Norways.

Summary. 1. The domestic Norway rat, the animal commonly used in laboratories throughout the world, has much smaller preputial glands than does its wild ancestor.

2. The preputial glands are definitely larger in the wild Alexandrine than in the wild Norway.

3. In all 3 forms, the glands are larger in females than in males.

4. The preputial glands and the adrenals seem to show the same growth relationships in the three forms.

⁵ Rogers, P. V., and Richter, C. P., *Endocrinology*, 1948, **42**, 46.

⁶ Fish, H. S., and Richter, C. P., *Proc. Soc. Exp. Biol. and Med.*, 1946, **63**, 352.

⁷ Schaffer, J., *Z. mikr.-anat. Forsch.*, 1933, **34**, 1.