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## Histological structure of the abdominal gland and other body regions involved in olfactory communication in Pine martens (*Martes martes*)

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In pine martens (*Martes martes*), two types of specialized glands have been described: 1. the anal glands, common to all mustelids, having their outlets into two pouches just within the anus (STUBBE 1969) and 2. the abdominal or ventral glands located on the ventral surface of the abdomen in an elongated depression of the skin (HALL 1926). Previous observations on the behaviour of captive animals (DE MONTE and ROEDER 1990) clearly showed that martens exhibit mostly abdominal marking, associated with a particular body posture. No such behaviour suggesting anal marking was observed. Although histological studies have been undertaken on anal glands, no similar work has been carried out on abdominal glands or on other body regions (cheek, neck, flank) being also involved in olfactory contact and rubbing movements. The aims of the present study were to describe the histological structure of the abdominal glands in both sexes and to determine whether the densities of sebaceous glands were identical in the three main body regions implicated in nasal contacts.

Skin samples were collected from two adult martens (one female and one male) immediately after death. Four samples from the abdominal gland were collected from each animal, one from the frontal region, two from the central and one from the caudal region of the gland. Skin samples were collected from the cheek, neck and median flank on the left side. After fixation for 5 days in Bouin's fluid, tissue blocks were embedded in paraffin and sections cut at a thickness of 7–10  $\mu\text{m}$ . Sections of the skin and taken from samples tangent to the surface were stained with hematoxylin and eosin. They were analysed with an image analysing computer (Ibas 1, Zeiss) coupled with a camera microscope system (magnification from microscope to graphic screen giving a value of 151 for 1 mm). Data concerning regions involved in body rubbing were recorded from 11 to 36 histological sections from each body area. The parameters recorded were: the total number of sebaceous glands shown on the screen (density) and the mean area of the sebaceous glands on each section. The densities of sebaceous glands in the different body regions were compared using the Mann Whitney U Test with 15 histological sections from the neck (each section involving a mean of 20 acini), 17 from the cheek and 20 from the median flank in the male; 20 from the neck and from the flank and 11 from the cheek in the female. The different sections were randomly chosen for each region. For the analysis of areas, results were analysed only in relation to their correlation with densities.

Abdominal glands occupy an area on the ventral surface of the abdomen, measuring  $8.0 \times 4.0$  cm, being located in front of the penis in the male, and  $1.0 \times 6.4$  cm, situated behind the caudalmost nipples in the females. Histological examination shows that abdominal glands are exclusively composed of holocrine sebaceous acini (Fig. 1A). Structurally, they consist of two well-circumscribed glandular regions in the outer skin. These two regions are limited exteriorly by a layer of keratinized cells, and internally by

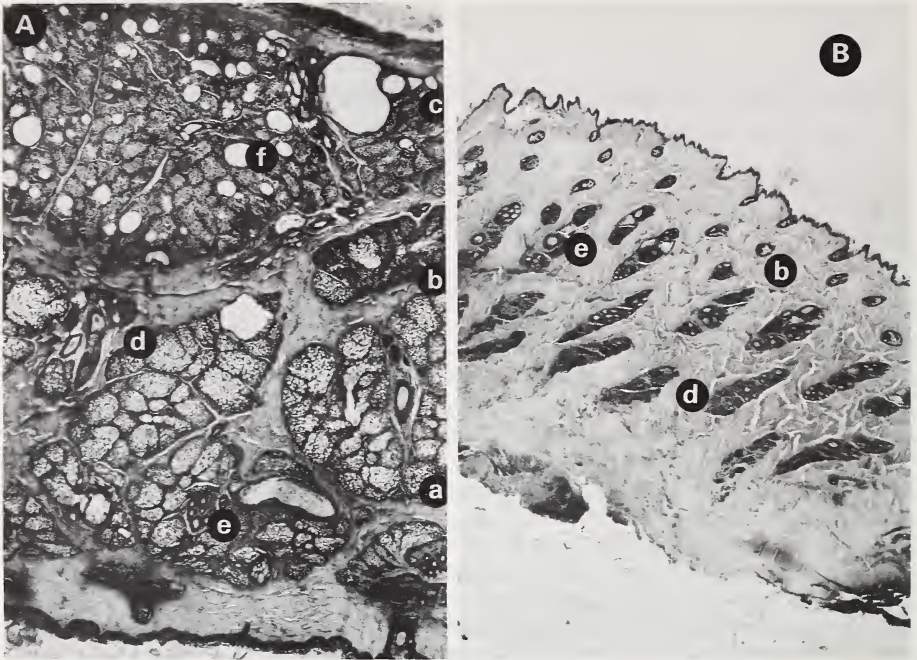


Fig. 1. Histological section ( $\times 40$ ) of the abdominal gland (A) and from the skin of the cheek (B) in the male marten. a = external zone, b = connective tissue, c = internal zone, d = acini, e = hair shaft, f = liposome

connective tissue. The outmost zone consists of a loose collection of sebaceous acini embedded in connective tissue; each glandular group is associated with several hair follicles. The deep zone (separated from the exterior zone by a layer of connective tissue) consists of dense tissue formed almost exclusively of glandular groups. Each group is associated with only one hair follicle. This zone is very rich in liposomes. No structural differences were observed either between the male and the female, or between the different regions of the abdominal gland.

No specialized glands were found in the different regions of the skin sampled (cheek, neck and median flank). Histological examination revealed sebaceous glands in association with hair follicles and embedded in abundant connective tissue (Fig. 1B). The highest densities are found in the cheek area (see Table): they differ significantly from those found in flank areas in both sexes, and from those found in the male's neck area only in the male. The only statistically significant difference between neck and flank was found in the female. Generally, the areas are larger from cheek to flank, whereas the densities increase in the reverse order, although we found no significant correlation between densities and areas ( $r = -0.65$ ,  $p = 0.15$ , Spearman correlation test).

The ventral gland discharging through the abdominal skin anterior to the genital orifice is typical of some subfamilies of mustelids (MACDONALD 1985). Its external structure has been described by HALL (1926), who found a glandular area marked externally by shorter hair in the American marten (*Martes americana*) and the wolverine (*Gulo gulo*). POCCOCK (1925) described such a gland in the male of *Taxidea*. Histological studies of these glands have never been undertaken. Our study shows that in pine martens, the abdominal gland is composed exclusively of sebaceous acini in contrast to the anal glands which are composite, consisting of sebaceous glands and tubular apocrine cells (STUBBE 1969). The

Densities and sizes of sebaceous acini from different body regions in both sexes

Body region	Male		Female	
	Density	Mean areas	Density	Mean areas
Cheek	16.67 ± 2.77	488.9 ± 88.0	10.13 ± 2.55	530.2 +106.4
Neck	9.44 ± 1.33	661.4 ± 109.5	8.05 ± 1.77	502.8 +100.5
Flank	8.43 ± 1.36	667.5 ± 182.2	6.06 ± 1.56	836.4 ± 249

\* P < 0.05, Mann-Whitney test.

histological structure of the gland did not differ between the male and the female. The histological study of skin samples shows decreasing densities of sebaceous glands from cheek to flank in both sexes. These results are in accordance with the decreasing frequencies of contact involving these body regions: 42.5 % of all contacts by females on males are directed to the face, reaching 41 % between two females. Sniffing frequencies decrease from the head to the hindquarters of the animals. Sniffing by males on females is essentially directed to the anogenital region (52 %). However, the face contacts reached 23 %, but only 19 % when contacts were directed to the flank (DE MONTE and ROEDER 1990).

Cheek, neck and flank are also involved in body rubbing movements. Such rubbing movements have been described in many species of carnivores and have generally been defined as scent rubbing (RIEGER 1979). In martens, body rubbing cannot be considered as scent rubbing because it is never oriented towards odoriferous substances (chemical, food or scent marks). However, the high density of sebaceous glands and the high frequency of nasal contacts with these regions involved in body rubbing suggest the existence of an olfactory message. Therefore, it would be interesting to know what kind of information may be conveyed both by such behaviour and by abdominal marking.

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