Olfactory communication in gibbons?

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It is generally believed that olfactory communication in apes is of minor importance (Marler, 1965; Marler & Tenaza, 1977). Among hominoids, a sternal gland has been reported for the orang-utan (Schultz, 1921; Wislocki and Schultz, 1925), but not for *Gorilla*, *Pan*, or *Homo*. These latter genera show specialised concentrations of mainly apocrine glands in the axillary region, the so-called axillary organs (Geissmann, 1987). When this study was started, specialised skin glands in gibbons, or lesser apes (*Hylobates* spp.), were virtually unknown, in contrast to the situation in catarrhine, platyrrhine and strepsirhine primates (Epple, 1986; Geissmann, 1987). Research in this direction appeared to be promising, however, because observations on captive siamangs (*Hylobates syndactylus*) made by the present author indicate that these animals have a specialised glandular area on the chest (Geissmann, 1987).

Materials and methods

For the present study, a large number of captive individuals and preserved carcasses of all gibbon species were examined. Behavioural observations of captive gibbons were carried out on all species. Captive animals and preserved carcasses were studied by TG in zoos and museum collections in China, England, France, Germany, the United States and Switzerland. Most of the histological sections were carried out by AMH, a few by TG. Because of space limitations, details on the study animals and the methods must be reserved for a future report.

Results

Macroscopic Findings

Macroscopic evidence for the presence of sternal glands was found in all examined gibbon species (9 out of 10). The Kloss gibbon (*H. klossii*) was not available for macroscopic examination. Figure 1 shows the sternal gland in a female pileated gibbon (*H. pileatus*). The macroscopic evidence of sternal glands consists of skin stained by a coloured secretion, hairs glued together by secretion, or large skin pores filled with coloured secretion. The size of the sternal gland shows little variation between gibbon species. In adult animals,

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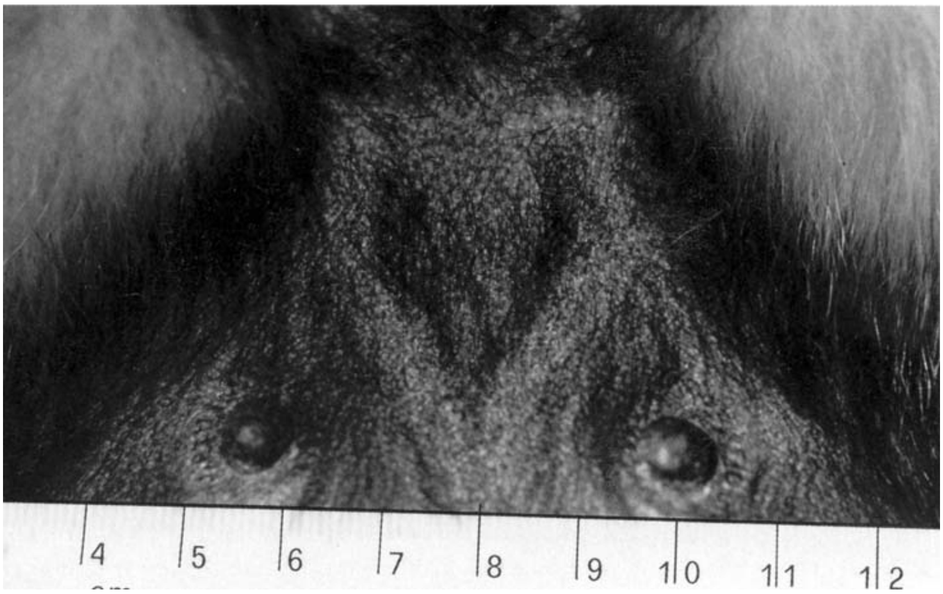

Fig. 1. Sternal gland of adult female pileated gibbon (*H. pileatus*) 'Gray'. Photograph taken on anesthetised animal at Zürich Zoo (18 May 1987).

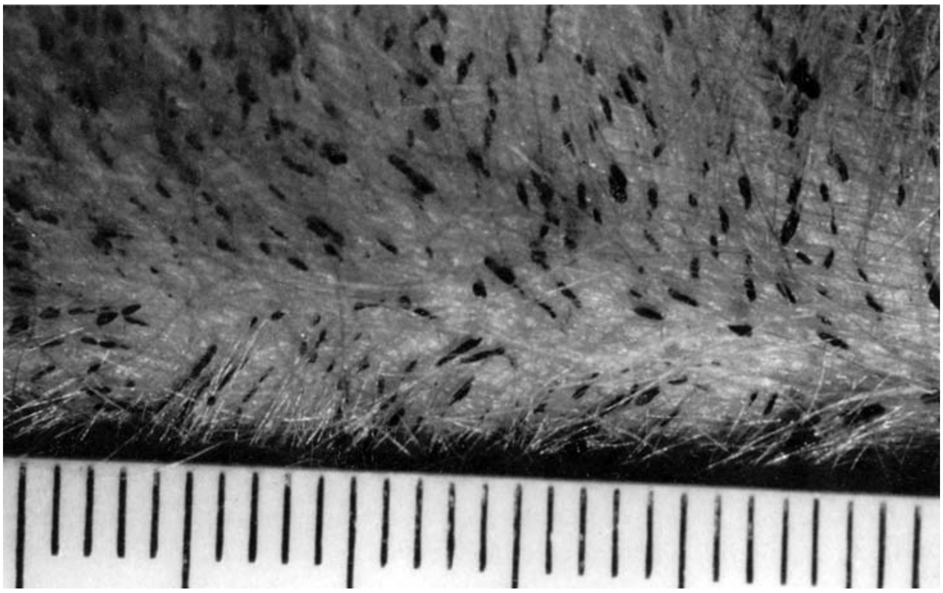

Fig. 2. Axillary glandular concentration in an adult female lar gibbon (*H. lar*) 'Virgo'. Photograph taken on anesthetised animal at the LEMSIP Primate Center (New York, 15 Aug. 1988).

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the cranio-caudal length of the gland ranges from about 3 to 8 cm, and the breadth from 2 to 5 cm.

In some animals the sternal gland was not distinct. Among the adult gibbons available for close examination, the sternal gland was clearly demarcated in 100% of the siamangs (*H. syndactylus*) and pileated gibbons (*H. pileatus*), and 50% of the lar gibbons (*H. lar*), but it was almost invisible in all white-cheeked gibbons (*H. leucogenys*). These numbers include only animals which were available for close examination (mostly animals anesthetised for management reasons). The sternal gland appears to be reduced in white-cheeked gibbons and possibly in other gibbons of the *concolor* group. Although some gibbons of the *concolor* group do have a distinct sternal gland, these individuals were not available for close examination and were therefore not counted.

The sternal gland is most distinctly developed in siamangs. In this species, the gland has a very strong smell which can be recognised in outdoor enclosures at a distance of several metres. In all other gibbon species examined, sternal gland secretions can only be smelled at close range, if any smell can be recognised at all.

Fields of coloured pores may occur in other areas of the skin. Figure 2 shows the axillary region of a female lar gibbon (*H. lar*). Dried glandular secretion of red-brown colouration can clearly be seen near the hair roots. These concentrations of coloured pores generally occur in the clavicular, axillary and inguinal regions of the skin. Figure 3 shows the distribution and density of these glandular concentrations in two adult gibbons. These differ from the sternal glands in that they are not sharply delimited. Instead, glandular density gradually changes over the surface of the skin.

Concentrations of coloured pores are most pronounced in gibbons of the *concolor* group in which a glandular secretion appears to be responsible for reversible changes in fur colouration: The fur colouration of adult females of the white-cheeked gibbon is sometimes very pale, almost whitish, but at other times, the fur can become bright orange colour in some regions, especially around the neck, shoulders, inguinal area and lower legs. This appears to be the result of glandular activity in these regions. Female gibbons of the *concolor* group have repeatedly been observed to switch back and forth between whitish and orange fur colouration. The same phenomenon cannot be directly observed in males, because their fur is black. But sometimes, when handling males of the *concolor* group, the author’s hands became stained with a dry reddish secretion. In these males, small reddish particles were visible in the

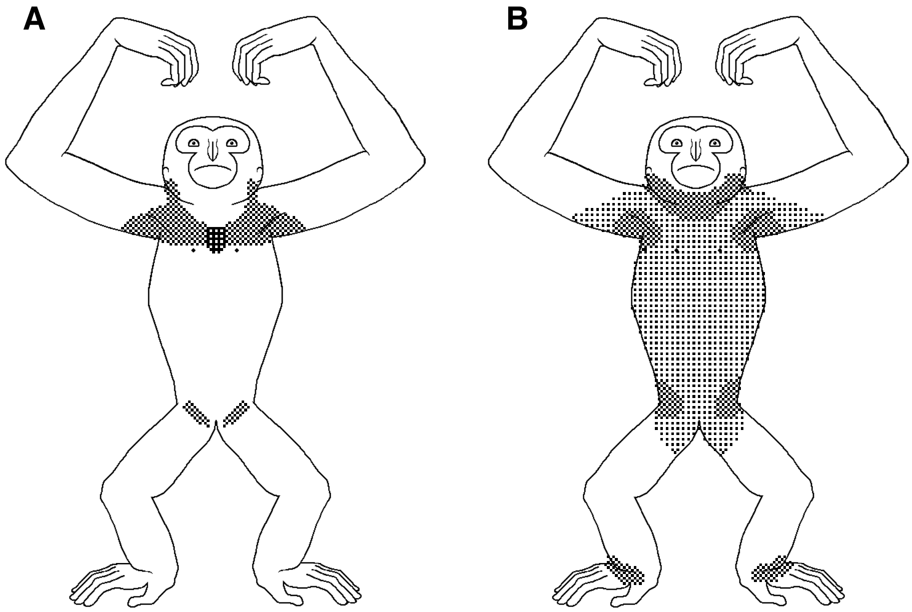

Fig. 3. Fields of coloured pores on the skin of two adult gibbons. The density of pores is indicated by three different intensities of grey shading (darker shading represents higher concentration of pores. A – *H. syndactylus*, female 'Mücke' (Munich Zoo, 11 Feb. 1988); B – *H. leucogenys*, female 'Püppi' (Duisburg Zoo, 1 Mar. 1988).

fur, but only at very close range. Nothing similar has been observed in gibbon species, excepting those of the *concolor* group.

The timing of these colour changes in females of the *concolor* group is unclear. No consistent pattern emerged from interviews with staff members in several zoos or from the author's own observations. Some females were said to change seasonally, others were said to change to saturated colouration when giving birth, others were observed to show this change upon being separated from their mate, while in some females no colour changes had been noticed.

Histological Sections:

In the skin, apart from that of the sternal gland, almost exclusively sebaceous glands (attached to hair roots) were found. Figure 4a shows a section of the lateral chest in an adult male siamang.

In contrast to this, the skin in the sternal region contained a conspicuous concentration of coiled tubular glands (Figure 4b). The tubular glands are more voluminous and form a veritable carpet of considerable thickness, which is separated from the more superficial layer of smaller sebaceous glands. In some sections, two different types of tubular glands appear to coexist: The dominant type is very abundant and forms large coils with relatively wide lumina. This type may correspond to the apocrine glands in humans. The second, less frequent, type consists of very small coils with much narrower lumina; this

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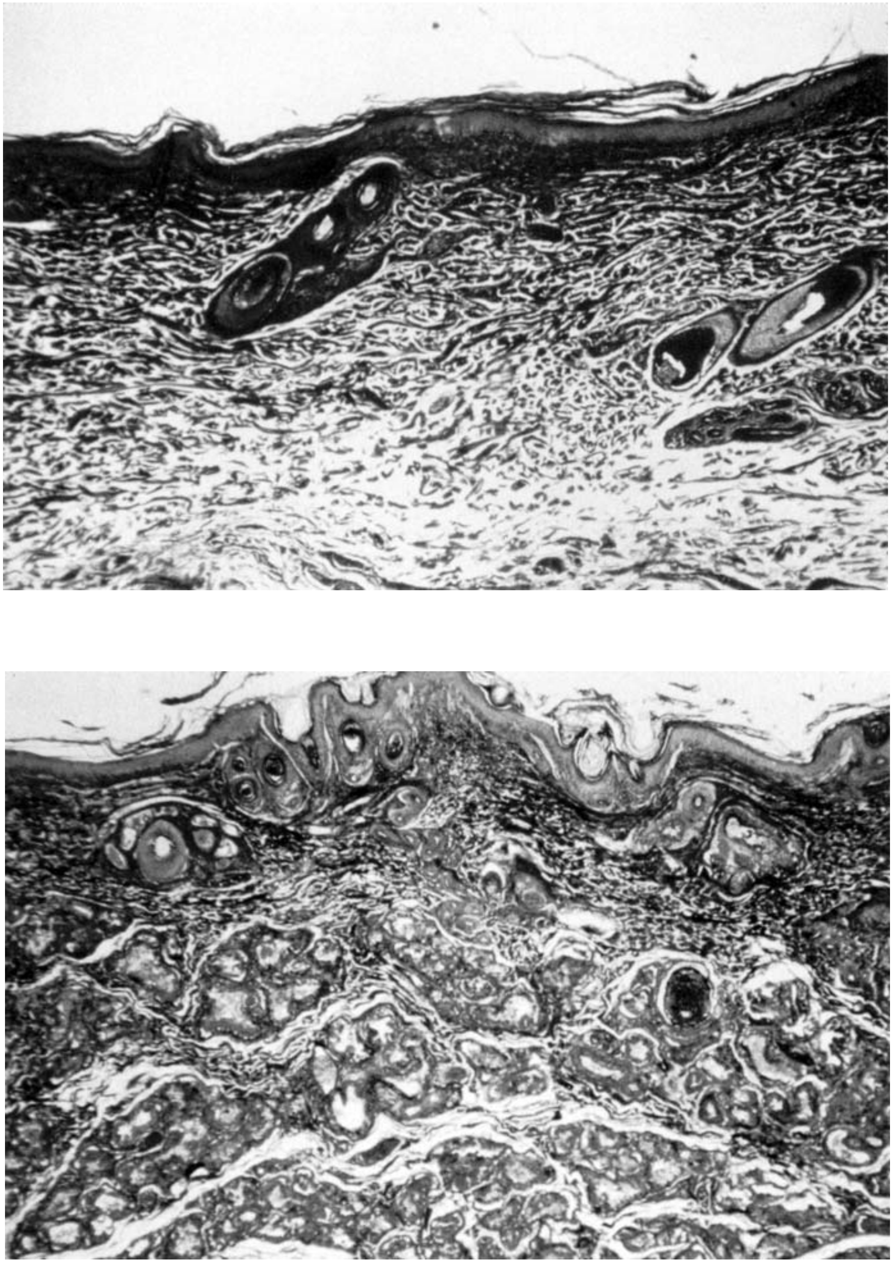

a

b

Fig. 4. Photomicrographs of a vertical section through the skin of an adult siamang (wild-shot specimen, preserved at the Anthropological Institute of Zürich University, AIMUZ 7297). Section stained with Masson’s Trichrome technique. A – Lateral chest, showing hair follicles associated with sebaceous glands, but no tubular glands. B – Sternal gland, showing the superficial layer of sebaceous glands and the deeper layer of densely packed, coiled tubular glands.

Table 1. Occurrence of tubular glands in skin samples of gibbons and numbers of individuals analysed.

Species	Body area					
	Lateral chest	Sternal	Axilla	Lateral abdomen	Inguinal	Dorsal
H. hoolock		+ 2	– 1		(+) 1	
H. klossii			– 1		– 1	– 1
H. lar	– 1	+ 4	– 4	– 1	(+) 4	– 2
H. leucogenys		(+) 1		– 1	– 1	
H. moloch		+ 2	– 2		– 2	
H. muelleri	– 1	+ 2	(+) 2		– 1	
H. pileatus	– 1	+ 1	– 1	– 1	– 1	(+) 1
H. syndactylus	– 3	+ 7	(+) 2		(+) 1	

– no glands; (+) few glands; + massive concentration of glands.

type may correspond to the human eccrine glands. The same structure of glandular layers was also found in the axillary glands of humans (Talke, 1903; Schiefferdecker, 1922) and the African apes (Brinkmann, 1909; Schiefferdecker, 1922; Straus, 1950).

Table 1 summarises the findings from the histological sections. Heavy concentrations of large tubular glands were found only in the sternal region. In other areas, occasional small tubular glands were seen with varying frequency. No heavy concentrations of tubular glands were found in the sternal gland of white-cheeked gibbons (*H. leucogenys*). Although this finding must be regarded as tentative, as only one animal of this species was available for histological analysis, this corresponds to the findings obtained from the macroscopic examination described above.

Discussion

There are very few observations which have any bearing on the function of gibbon skin glands. Sternal glands are usually thought to play an important role in olfactory communication. In many primates and other mammals, they are known to be used in elaborate and characteristic motor acts usually known as “marking behaviour” (Geissmann, 1987). The present author failed to find any evidence of marking behaviour in gibbons, in spite of having spent thousands of hours observing all species in captivity, and no marking behaviour has been reported in any other study of the behaviour of wild and

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captive gibbon groups. Similarly, no marking behaviour has been reported in great apes and humans.

Direct observations indicate that glandular activity of sternal glands in siamangs and of other skin glands in white-cheeked gibbons is particularly high under elevated body temperature and during arousal. In addition, the characteristic body odour of the siamang is especially strong and conspicuous in these situations. It is interesting to note that the main secretory activities of the axillary organ of humans occur in almost the same situations (Montagna, 1981; Montagna, 1982).

Certain steroid hormones produced in the axilla are thought to be of major importance in human olfactory communication (Gower et al., 1988; Labows, 1988). The present author has found that steroid hormones are accumulated in the skin glands of some gibbon species. These results will be published elsewhere.

As described above gibbons may exhibit concentrations of coloured pores in various parts of the skin, and the axilla is one of these regions. In view of the number of morphological, histological, physiological and biochemical similarities between skin gland system in gibbons and axillary glands in humans, it is possible that an analogy in function may also exist to some degree. Although the function and importance of the axillary organ are still poorly understood, it has been suggested that it may play a role in thermoregulation (Keele et al., 1982; Montagna, 1962) and in olfactory communication (Gower et al., 1988; Labows, 1988; Stoddart, 1990). In gibbons of the *concolor* group, glandular secretion is apparently responsible for yet another previously undocumented feature: The observation that glandular activity may cause a reversible change in the colouration of females raises the intriguing possibility that skin glands in these gibbons might, in addition to olfactory communication, play a role in visual communication as well.

In conclusion, all gibbon species (except the Kloss gibbon, for which no reliable data are available) exhibit a system of specialised tubular skin glands. This system includes a sternal gland (most developed in the siamang) and fields of coloured pores in other areas of the skin (most developed in gibbons of the *concolor* group). This surprisingly complex glandular system appears to differ in several respects (fields of coloured pores, absence of marking behaviour, etc.) from what has been described so far in non-hominoid primates. Instead, similarities are found between this system and the axillary glands of humans and the African apes. Although it is not possible, as yet, to conclusively explain the function of gibbon skin glands in communication (hence the question mark in the title of this paper), a role in olfactory communication and thermoregulation is likely. In gibbons of the *concolor* group, an additional role in visual communication should be considered.

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