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Long-chain fatty acids in the anal gland of the red panda, *Ailurus fulgens*

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1. Subjects and source

The red panda (*Ailurus fulgen*) is reddish brown, long-tailed mammal, found in the mountain forests of the Himalayas and adjacent areas of eastern Asia, which subsists mainly on bamboo (Choudhury, 2001). This species as with most Carnivora, possesses paired anal glands used by both sexes to scent-mark. Red pandas emit a musky odor from these glands when excited (Nowak, 1991), and according to Roberts and Gittleman (1984) secretions from these anal glands, in addition to urine and feces, are used to mark territories.

2. Previous work

There are no previous reports on the composition of the anal gland secretions of *A. fulgen* (family Ailuridae). This secretion has been analysed for other members of the Musteloidea, including the families Mephitidae (Wood, 1990; Wood et al., 1991; Wood et al., 1993; Wood et al., 2002), Procyonidae (Schildknecht and Ubl, 1985), and Mustelidae (Crump, 1980a; 1980b; Crump and Moors, 1985; Davies et al., 1988;

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Schildknecht et al., 1981; Schildknecht and Birkner, 1983; Schildknecht and Hiller, 1984).

3. Present study

The green, oily, glandular secretion was obtained from a single, 12-year-old, 5.89 Kg female (Shambhala) red panda, who was fed a leafeater diet (extruded biscuit, Marion Zoological), with bamboo as an enrichment item. The secretion was obtained by digital expression of the material from the gland into a vial. Several ml of CH_2Cl_2 were added to the vial as a preservative and solvent for analysis, which were stored at −20 °C.

The CH_2Cl_2 extract was analyzed by gas chromatography-mass spectrometry (GC-MS) in a splitless mode (0.5 min), using a Hewlett-Packard GCD Plus fitted with a 30 m × 0.25 mm cross-linked phenyl methyl silicone capillary column (HP-5MS). The gas chromatograph was programmed so the oven temperature was kept at 40 °C for 4 min, then increased to a final temperature of 325 °C at a rate of 30 °C/min and kept at the final temperature for 5 min. Mass spectral fragments below m/z 39 were not recorded.

The volatile components of the red panda anal sac secretion are long-chain fatty acids, 2-piperidinone, squalene and cholesterol (Table 1). All compounds were initially identified by comparison of mass spectra in the NIST 1998 computerised mass spectral library. These identifications were confirmed by comparison of spectra and retention times to those of authentic standards (Sigma-Aldrich Chemical Co., Milwaukee, Wisconsin, and Fisher Scientific (Arcos), Pittsburgh, Pennsylvania). The

Table 1
Volatile compounds in the anal gland secretion of the red panda

Compound	Retention time (min)	% of TIC
2-piperidinone	8.15	2.3
Tetradecanoic acid	10.55	1.0
Isomer of pentadecanoic acid[a]	10.78	2.1
Pentadecanoic acid	10.91	3.4
Unknown	11.18	1.9
Hexadecanoic acid	11.27	15.8
Heptadecanoic acid	11.57	4.3
Oleic and linoleic acid[b]	11.85	19.3
Stearic acid	11.90	9.9
Isomer of octadecadienoic acid[c]	11.99	18.0
Isomer of octadecadienoic acid[c]	12.08	1.8
Squalene	13.65	1.0
Cholesterol	14.67	19.2

[a] Mass spectrum was identical to that of pentadecanoic acid.
[b] Oleic and linoleic acid coeluted.
[c] Mass spectrum was identical to that of (9*E*,12*E*)-9,12-octadecadienoic (linoleic) acid.

compounds identified of as isomers of pentadecanoic acid and octadecadienoic acid had identical mass spectra as the authentic standards but different retention times.

4. Comparative aspects

The red panda was recently recognized as the only extant member of the family Ailuridae within the Musteloidea (Flynn and Nedbal, 1998; Flynn et al., 2000), which also includes the families Procyonidae (racoons and allies), the Mephitidae (skunks) and the Mustelidae (weasels, otters, badgers). The anal gland secretion of the only procyonid investigated, the North American racoon (*Procyon lotor*) contains many compounds not found in red panda secretion (Schildknecht and Ubl, 1985). Both secretions contain long-chain saturated and unsaturated fatty acids and cholesterol. The raccoon's secretion also contains short-chain carboxylic acids, 3-phenylpropanoic acid, 4-hydroxyphenylpropanoic acid and mandelic acid. Two compounds found in red panda secretion, 2-piperidinone and squalene, were not reported from the raccoon secretion.

Red panda anal sac secretion is quite different from those of the mephitids and most mustelids. The major compounds in the defensive secretion of striped (*Mephitis mephitis*), hooded (*M. macroura*), spotted (*Spilogale putorius*) and hog-nosed skunks (*Conepatus mesoleucus*) are malodorous thiols (Wood, 1990; Wood et al., 1991; Wood et al., 1993; Wood et al., 2002). Odoriferous cyclic sulphides (thiatanes and dithiolanes) are found in most Mustilid secretion. Mink, stoat, ferret, and weasels contain these sulphur compounds (Buglass et al., 1991; Crump, 1980a; 1980b; Crump and Moors, 1985; Schildknecht et al., 1981; Schildknecht and Birkner, 1983), but not the European badger (*Meles meles*) (Davies et al., 1988; Schildknecht and Hiller, 1984). This badger's secretion contains long- and short-chain carboxylic acids and several long chain ketones.

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