Volatile components of the anal gland secretion of the striped polecat *Ictonyx striatus*

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The volatile components of the anal gland secretion of an adult, male, *Ictonyx striatus* were separated and identified by dynamic solvent effect sampling, capillary gas-liquid chromatography, and mass spectrometry. The major component was 2-ethylthiacyclobutane. Nine other sulphur compounds, a ketone, and a hydrocarbon were also identified. Some of these occur in the anal gland secretions of other mustelids.

Die vlugtige komponente van die anale klierafskeiding van die volwasse, manlike *Ictonyx striatus* is geskei en geïdentifiseer deur dinamiese oplosmiddeleffek-monsterneming, gaschromatografie, en massaspectrometrie. Die hoofkomponent was 2-etieltiasiklobutaan. Nege ander swaelverbindings, 'n ketoon, en 'n koolwaterstof is ook geïdentifiseer. Van hierdie verbindings kom ook in die anale klierafskeiding van ander mustelidae voor.

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The striped polecat *Ictonyx striatus* is a small, African mustelid which in appearance, habits and ecology resembles the skunks of North America. Its biology has been authoritatively reviewed by Smithers (1983). Like the North American skunks *Mephitis mephitis* and *Spilogale interrupta*, *Ictonyx* is equipped with a well developed anal gland whose foul-smelling secretion is used for defence. The chemistry of this secretion has not previously been reported. We deal here with the identification of the major volatile components which give the secretion its defensive properties.

Anal gland secretion was taken from an adult male *Ictonyx* obtained as a fresh road casualty in the northern Cape Province, South Africa and kept deep-frozen until analysis. The anal gland was excised and its secretion expelled into a 10 ml glass tube. Volatiles were accumulated from 10 ml of the head space above the secretion by dynamic, off-line, solvent effect sampling (Apps, Pretorius, Lawson, Rohwer, Centner, Viljoen & Hulse 1987) using n-hexane as solvent at 25°C.

Table 1 Volatile components of the anal gland secretion of a male *Ictonyx striatus*

Peak[1]	Identification	Criterion[2]
1	2–methylthiacyclobutane	L
2	2,2-dimethylthiacyclobutane	P a
3	3-methyl-1-butanethiol	L
4	1-pentanethiol	L
5	2-ethylthiacyclobutane	P b,d
6	2-ethyl-3-methylthiacyclobutane	P c
7	4-methyl-3-heptanone	P e
8	propylthiacyclobutane isomer	I
9	methyldithiacyclopentane isomer	I
10	a ketone	I
11	1,2-dithiacycloheptane	P b
12	2-methyl-1-decene	L
13	ethyldithiacyclopentane isomer	I
14	a ketone	I
15	a ketone	I

[1]Peak numbers correspond to Figure 1.
[2]L = found in mass spectra library, P = published spectrum: a, Brinck *et al.* 1983; b, Brinck *et al.* 1978; c, Crump & Moors 1985; d, Sokolov *et al.* 1980; e, Stenhagen *et al.* 1974, I = mass spectrum interpretation.

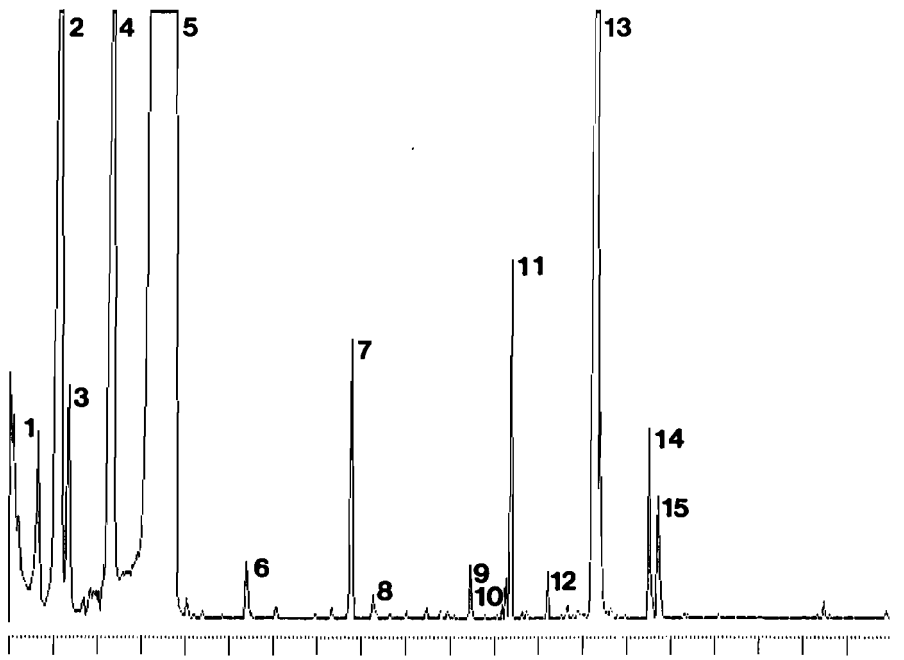

Figure 1 Total ion chromatogram of volatiles from 10 ml of headspace above the anal gland secretion of a male *Ictonyx striatus* sampled by dynamic solvent effect. For analytical conditions see text.

Table 2 Occurrence among Mustelidae of compounds found in anal gland secretion of *Ictonyx striatus*

	Mustela erminea[a]	*Mustela nivalis*[a]	*Mustela putorius*[a]	*Mustela putorius furo*[a]	*Mustela vison*[a]	*Mephitis mephitis*[b]
1. 2-methylthiacyclobutane	–	–	–	–	–	–
2. 2,2-dimethylthiacyclobutane	o	o	o	o	x	–
3. 3-methyl-1-butanethiol	–	–	–	–	–	x
4. 1-pentanethiol	–	–	–	–	–	–
5. 2-ethylthiacyclobutane	x	–	–	–	x	–
6. 2-ethyl-3-methylthiacyclobutane	–	–	–	o	–	–
7. 4-methyl-3-heptanone	–	–	–	–	–	–
8. propyldithiacyclobutane isomer	o	–	o	o	–	–
9. methyldithiacyclopentane isomer	–	–	–	–	–	–
11. 1,2-dithiacycloheptane	–	–	–	–	x	–
12. 2-methyl-1-decene	–	–	–	–	–	–
13. ethyldithiacyclopentane	–	o	–	–	o	–

x = same isomer; o = different isomer (based on published mass spectral); [a]Brink *et al.* (1983); [b]Andersen & Bernstein 1975.

Accumulated volatiles were separated and identified by high resolution gas-liquid chromatography — mass spectrometry. A dynamic solvent effect inlet (Apps *et al.* 1987) was used to transfer the volatiles to a 25 m × 0,3 mm × 0,4 μm methylpolysiloxane capillary column in a Varian 1400 gas chromatograph. The carrier gas was helium with a linear flow rate of 30 cm/s. The injector was held at 40°C for 7 min then heated ballistically to 220°C. The column was held at 40°C for 10 min then programmed at 4°C / min to 180°C. The column was coupled by an open-split interface to a Micromass 16 F mass spectrometer operating in the electron impact mode with an electron energy of 70 eV.

Components were identified by comparison of their mass spectra with library material or with published spectra, or by mass spectral interpretation. Where possible chromatographic retention data were used for confirmation.

The anal gland secretion of the male *Ictonyx striatus* consisted of a light, mobile, yellow oil and a colourless, translucent aqueous phase. The secretion emitted a strong, penetrating, metallic odour.

Fifteen clearly resolved peaks appeared on the total ion chromatogram (Figure 1), of which 12 were identified (Table 1).

The occurrence in other mustelids of the compounds identified in *Ictonyx striatus* is summarized in Table 2.

The presence of sulphur compounds conforms to expectation since these are usually strong-smelling and are important components of the anal gland secretions of other mustelids. The major, volatile component of the *Ictonyx* secretion; 2-ethylthiacyclobutane, made up 90% of the headspace volatiles. This compound was found as a minor component of the anal gland secretion of mink *(Mustela vison)* by Sokolov *et al.* (1980 compound V) but was then incorrectly identified as a dimethylthiacyclobutane isomer (compare Brinck, Erlinge & Sandell 1983 compound 5). The offensive, odorous compounds of the anal gland of the striped skunk are trans-2-butene-1-thiol, 3-methyl-1-butanethiol and trans-2-butenyl-methyldisulphide (Andersen & Bernstein 1975). Of these only 3-methyl-1-butanethiol was found in the striped polecat where it was a minor component.

The presence of ketones is unusual among the mustelidae (Brinck *et al.* 1983) although they are important components of fox *(Vulpes vulpes)* urine (Jorgenson *et al.* 1978).

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References

APPS, P.J., PRETORIUS, V., LAWSON, K.H., ROHWER, E.R., CENTNER, M.R., VILJOEN, H.W. & HULSE, G. 1987. Trace analysis of complex organic mixtures using capillary gas-liquid chromatography and the dynamic solvent effect. *J. High Resolut. Chromatogr. Chromatogr. Commun.* 10: 122–127.

ANDERSEN, K.K. & BERNSTEIN, D.T. 1975. Some chemical constituents of the scent of the striped skunk *Mephitis mephitis*. *J. Chem. Ecol.* 1: 493–499.

BRINCK, C., ERLINGE, S. & SANDELL, M. 1983. Anal sac secretion in mustelids. A comparison. *J. Chem. Ecol.* 9: 727–745.

BRINCK, C., GERELL, R. & ODHAM, G. 1978. Anal pouch secretion in mink *Mustela vison*. *Oikos*: 68–75.

CRUMP, D.R. & MOORS, P.J. 1985. Anal gland secretions of the stoat *(Mustela erminea)* and the ferret *(Mustela putorius* forma *furo)* some additional thietane compounds. *J. Chem. Ecol.* 11: 1037–1043.

JORGENSON, J.W., NOVOTNY, M., CARMACK, M., COPLAND, G.B., WILSON, S.R., KATANA, S. & WHITTEN, W.K. 1978. Chemical scent constituents in the urine of the red fox (*Vulpes vulpes* L.) during the winter season. *Science*: 796–798.

SMITHERS, R.H.N. 1983. The Mammals of the Southern African Subregion. University of Pretoria, Pretoria.

SOKOLOV, V.E., ALBONE, E.S., FLOOD, P.F., HEAP, P.F., KAGAN, M.Z., VASILIEVE, V.S., ROZNOV, V.V. & ZINKEVICH, E.P. 1980. Secretion and secretory tissues of the anal sac of the mink. Chemical and histological studies. *J. Chem. Ecol.* 6: 805–825.

STENHAGEN, E., ABRAHAMSSON, S. & MCLAFFERTY, F.W. 1974. (eds) Registry of Mass Spectral Data. John Wiley & Sons, New York.