The Anal Sac Secretion of Viverrids from the Genus *Genetta**

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The chemical composition of the secretions from the anal sacs of three species from the genus *Genetta* has been analysed by means of gas-liquid chromatography and mass spectrometry. The main constituents of the secretion are free fatty acids, hydrocarbons, mono- and diester waxes, triglycerides, alkane diols, and free alcohols. Composition of the secretion in the three species is fundamentally similar, but there are some remarkable quantitative differences of the components mentioned. Some of the alkane-1,2-diols in these secretions have never been found before in nature.

Introduction

In viverrids, like in other members of the Carnivora, there is a couple of quite complex glandular organs, each of them positioned laterally at one side of the anal channel. These structures are known as "anal sacs" and, apart from the perineal glands, owned by many viverrids as well, they are the most obvious glandular structures in these animals. Functional importance of the secretions, mainly of the perineal glands, for chemical communication has been proved by behavioural studies performed for instance by Ewer and Wemmer [1], Gorman [2], Kleiman [3], Rasa [4], Roeder [5], Verberne and Leyhausen [6], and Wemmer [7]. In this literature and elsewhere, it is chiefly referred to scent marking by the perineal glands, whereas the biological role of the anal sacs remains obscure.

Up to now, there is also only rather scarce information available on the interesting morphology of these organs and on the biochemistry of their complex secretions. Besides of some older morphological investigations by Pocock [8, 9], Schaffer [10], and Ortmann [11], only Gorman *et al.* [12], and Kayanja and Schliemann [13], reported on the histology and fine structure of skin glands of viverrids. Gorman *et al.* [12] contributed to the biochemistry of the secretions from the anal sacs of *Herpestes auropunctatus,* and Jacob and Schliemann [14] published on the chemical composition of the secretion from the anal sacs of *Civettictis civetta.* Obviously, both species, belonging to different subfamilies of the viverrids, *i.e.* the Hepestinae and the Viverrinae resp., show some remarkably different compositions of these secretions. Gorman *et al.* found short-chained saturated fatty acids, whereas the secretions of *Civettictis* mainly consist of cholesterol esters, monoester waxes, cholesterol, and free fatty acids chain length not less than C_{12}.

This paper presents data on the chemical composition of the secretion from the anal sacs of three species of the Genus *Genetta,* opening the opportunity to compare the results between three closely related species which belong to the same subfamily as *Civettictis, i.e.* the Viverrinae. Systematics of the Genus *Genetta* are still problematic. According to Coetzee [16] this nearly exclusively african genus comprises eight species, of which *G. genetta* has the widest distribution in Africa, in general preferring savanna habitats and occurring even in some southern parts of Europe, in Palestine and Arabia. *G. tigrina* is found south of the sudanese arid zone with the exception of rain forests, whereas *G. pardina* is confined to a small zone in west Africa, living in forests.

Genets are semiarboreal animals, living almost completely nocturnal, a fact which explains that their biology is not sufficiently known and that there are only very few informations about their behaviour based on reliable field observations. Captive animals

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and their behaviour have been studied by Dücker [15], Leyhausen [17], Roeder [18], and Wemmer [7]. Attention to scent marking behaviour has especially been given by Roeder [5, 18] and Wemmer [7]; additional information on this subject is available from Rosevear [19] and Smithers [20]. According to these authors, it is obvious that scent marking plays an important role for communication of these animals. Nevertheless, the biological context, in which scent marking is used, is not always sufficiently understood. Especially the significance of the anal sacs and their secretions remains uncertain, which to some extent is also due to the fact that most authors reporting about the use of the perineal organ give only little information about the anal sacs which produce such a variety of chemical substances. Apart from further ethological investigations, research work on the morphology and biochemistry of these organs will have to be done to improve our knowledge on the anal sacs.

Materials and Methods

Materials

For analysis of the secretions, the following animals were used; 1. One male individual of *Genetta tigrina* (Schreber, 1776) from Liberia; this animal has been kept for several years in the Bernhard-Nocht-Institut für Schiffs- und Tropenkrankheiten at Hamburg and is now living in the animal house of the Zoologisches Institut und Zoologisches Museum/ Hamburg. 2. One female of *Genetta genetta* (L., 1758), and 3. One male of *Genetta pardina* I. Geoffroy, 1832; both animals are living in Berlin Zoo where they have been brought to several years ago. The secretions were obtained under light anaesthesia by squeezing the anal sacs.

Methods

The freshly collected crude secretions were distributed between chloroform/methanol/water (2:1:1, v/v; 60 ml). Lipids (more than 90% of the total secretion) remain in the chloroform phase and were found to consist of hydrocarbons, monoester and diester waxes, triglycerides, free alcohols, alkandiols and free fatty acids by means of thin-layer chromatography. Free fatty acids were separated with methanolic NaOH as sodium salts and recovered by acidifying with HCl and extraction with chloroform. The remaining lipids were separated by column chromatography on silica (5 g silica, 14,5% water content) using a cyclohexane/benzene/chloroform gradient. Details have been published previously [21].

Free fatty acids were esterified, monoester and diester waxes as well as triglycerides were *trans*-esterified with 5% methanolic HCl (20 ml; 45 min) at boiling-point temperature. After addition of water (20 ml), esters were extracted with chloroform. In case of monoester and diester waxes, alcohols were separated from methyl esters by column chromatography on silica. Alcohols and diols were converted into their trimethylsilyl ethers by silylation with Trisil/N,O-bis-trimethylsilyl-trifluoacetamide [22]. In addition, aliquots of them were oxidized with CrO_3/ acetic acid in cyclohexane to the corresponding acids which then were esterified by CH_3OH/HCl as described above. Under these conditions, alkane-1,2-diols were converted into acids which have one carbon atom less than the original diols. For determination of the double bond position of the unsaturated fatty acids, in case of *Genetta tigrina* they were oxidized with OsO_4 in pyridine/dioxane to the corresponding dihydroxy acid methylesters which subsequently were converted into their trimethyl silyl ethers by silylation as described above [23]. For identification, aliquots of unsaturated fatty acid methyl esters were reduced to their saturated homologues with Pd/H_2 in cyclohexane.

Identification of all lipid constituents was achieved by comparing gas-chromatographic retention times (via equivalent chain length indices) with authentic samples as well as by mass spectrometry. Gas chromatography was carried out with 50 m glass capillaries coated with CPsil 5 at 150 °C or 200 °C column temperature (isothermically), at 200 °C injection port and detector temperature by using a Perkin-Elmer Sigma 2 instrument adapted to an electronic integrator Spectra-Physics SP 4100-02. Gas chromatography/mass spectrometry was carried out with a mass spectrometer Varian-MAT 112S instrument adapted to a Perkin-Elmer gas chromatograph as above. Mass spectra were recorded at 70 eV and 200 °C ion source temperature.

Results and Discussion

Thin-layer chromatography of the crude lipids from the anal gland secretions of the species investigated evidenced the presence of hydrocarbons, monoester and diester waxes, triglycerides, free al-

cohols, alkane-1,2-diols, and free fatty acids the quantitative ratio of which is given in Table I.

The lipid distribution is similar in all three species investigated, although free alcohols were detected in *G. pardina* and *G. genetta* only. The hydrocarbons predominantly consist of squalene as identified by GC and mass spectrometry ($M^+ = 410$). Minor amounts of *n*-alkanes (mainly even-numbered) and 3-methylalkanes (mainly odd-numbered) were found in *G. genetta* and *G. pardina* (Table II).

The monoester waxes from all three species investigated are characterized by predominance of (ω-1)- and (ω-2)-methyl-substituted fatty acids and alcohols (Table III). Despite all differences, *G. genetta* and *G. pardina* show a broader variety of structures than there has been found in *G. tigrina*. Apart from (ω-1)- and (ω-2)-position, a methyl-substituent can also be located at 4- or 6-position exclusively or in addition, resulting in unusual structures such as 4,(ω-1)-, 4,(ω-2)-, and 6,(ω-1)-dimethyl-substituted fatty acids and alcohols. 4-Methyl-substituted fatty acid methyl esters can readily be recognized from their mass spectra resulting in m/z 87 >> m/z 74 and a typical (M-49)- and (M-73)-fragment as well as a very small

Table I. Quantitative composition of the lipids from the anal gland secretion of three *Genetta* species. Data are given in per cent of the total lipids; in brackets absolute amounts found in mg.

	Genetta genetta		*Genetta pardina*		*Genetta tigrina*	
Hydrocarbons	9.7	(6.8 mg)	20.2	(14.1 mg)	13.1	(13.6 mg)
Monoester waxes	18.1	(12.7 mg)	22.4	(15.7 mg)	11.8	(12.2 mg)
Diester waxes	14.4	(10.1 mg)	11.0	(7.7 mg)	21.3	(22.0 mg)
Triglycerides	16.0	(11.2 mg)	3.1	(2.2 mg)	17.9	(18.5 mg)
Free alcohols	5.4	(3.8 mg)	8.0	(5.6 mg)	–	–
Alkane-1,2-diols	5.0	(3.5 mg)	8.0	(5.6 mg)	11.6	(12.0 mg)
Free fatty acids	31.4	(22.0 mg)	27.3	(19.1 mg)	24.3	(25.2 mg)

Table II. Composition of the hydrocarbon fraction from the anal gland secretion of three *Genetta* species, in per cent of the total fraction as determined by GC.

	ECL*	*G. genetta*	*G. pardina*	*G. tigrina*
Squalene	27.70	94.7	88.2	100.0
n-Alkanes (total)		(4.6)	(8.0)	(–)
n-C_{14}	14.00	0.7	–	–
n-C_{16}	16.00	1.6	1.3	–
n-C_{18}	18.00	1.2	3.0	–
n-C_{19}	19.00	–	0.1	–
n-C_{20}	20.00	0.6	1.8	–
n-C_{21}	21.00	–	0.1	–
n-C_{22}	22.00	0.3	0.9	–
n-C_{23}	23.00	–	0.1	–
n-C_{24}	24.00	0.1	0.4	–
n-C_{25}	25.00	–	0.1	–
n-C_{26}	26.00	0.1	0.2	–
3-Methylalkanes (total)		(0.2)	(1.3)	(–)
3-C_{15}	15.75	tr.	0.3	–
3-C_{17}	17.75	0.1	0.2	–
3-C_{19}	19.75	0.1	0.2	–
3-C_{21}	21.75	tr.	0.1	–
3-C_{23}	23.75	tr.	0.2	–
3-C_{25}	25.75	–	0.3	–
unidentified		(0.5)	(2.5)	(–)

* ECL = equivalent chain length.

Table III. Composition of the monoester wax constituents from the anal gland secretion of three *Genetta* species, in per cent of the total fraction as detected by GC.

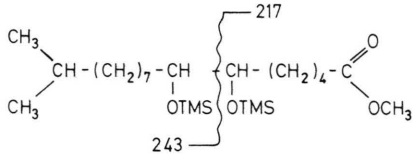
	ECL*	*G. genetta*	*G. pardina*	*G. tigrina*
Fatty acids				
Saturated unbranched (total)		(12.7)	(17.6)	(17.4)
n-C_{12}	12.00	–	–	0.5
n-C_{14}	14.00	–	1.7	0.6
n-C_{16}	16.00	2.6	3.5	3.7
n-C_{17}	17.00	–	–	0.3
n-C_{18}	18.00	10.1	10.2	12.3
n-C_{20}	20.00	–	2.2	–
Saturated branched (total)		(83.1)	(61.4)	(57.9)
(ω-1)-methylsubstituted				
7-C_8	8.70	0.2	–	2.6
8-C_9	9.70	–	1.3	–
9-C_{10}	10.65	0.9	–	1.8
10-C_{11}	11.65	1.9	5.1	0.2
11-C_{12}	12.65	–	–	0.8
12-C_{13}	13.65	2.5	5.4	–
13-C_{14}	14.65	–	0.4	5.1
14-C_{15}	15.65	3.2	7.3	0.7
15-C_{16}	16.65	–	0.9	27.4
16-C_{17}	17.65	9.7	20.7	3.4
17-C_{18}	18.65	–	0.8	10.1
18-C_{19}	19.65	–	3.9	–
20-C_{21}	21.65	–	0.4	–
(ω-2)-methylsubstituted				
10-C_{12}	12.75	5.4	–	–
11-C_{13}	13.75	–	0.5	–
12-C_{14}	14.75	5.5	0.3	0.5
13-C_{15}	15.75	–	–	0.2
14-C_{16}	16.75	13.6	0.7	3.0
15-C_{17}	17.75	1.4	–	–
16-C_{18}	18.75	7.2	0.6	2.1
4-methylsubstituted				
4-C_{10}	10.55	0.3	–	–
4-C_{11}	11.50	0.3	–	–
4-C_{12}	12.50	2.4	–	–
4-C_{13}	13.50	1.1	–	–
4-C_{14}	14.50	0.5	–	–
4-C_{15}	15.50	1.4	–	–
4-C_{16}	16.50	3.6	0.2	–
4-C_{17}	17.50	1.6	–	–
4-C_{18}	18.50	0.4	–	–
4,(ω-1)-dimethylsubstituted				
4,10-C_{11}	12.15	2.9	1.3	–
4,14-C_{15}	16.15	–	1.8	–
4,15-C_{16}	17.15	–	2.2	–
4,(ω-2)-dimethylsubstituted				
4, 8-C_{10}	11.25	0.3	–	–
4,10-C_{12}	13.25	2.6	0.7	–
4,11-C_{13}	14.25	6.8	–	–
4,12-C_{14}	15.25	1.2	0.5	–
4,13-C_{15}	16.25	2.7	–	–
4,14-C_{16}	17.25	3.5	1.3	–
6-methylsubstituted				
6-C_{19}	19.45	–	3.6	–
6,(ω-1)-dimethylsubstituted				
6,12-C_{13}	14.10	–	1.5	–
unsaturated, unbranched (total)		(–)	(–)	(1.1)
$C_{16:1}$	15.70	–	–	0.1

	ECL*	*G. genetta*	*G. pardina*	*G. tigrina*
$C_{18:1}$	17.70	–	–	1.0**
unsaturated, branched (total)		(–)	(21.0)	(22.7)
(ω-1)-methylsubstituted				
12-$C_{13:1}$	13.35	–	1.7	–
13-$C_{14:1}$	14.35	–	1.4	0.5
14-$C_{15:1}$	15.35	–	4.2	0.6
15-$C_{16:1}$	16.35	–	0.6	16.2***
16-$C_{17:1}$	17.35	–	7.1	0.6
17-$C_{18:1}$	18.35	–	–	0.9
18-$C_{19:1}$	19.35	–	1.3	–
20-$C_{21:1}$	21.35	–	0.2	–
(ω-2)-methylsubstituted				
13-$C_{15:1}$	15.45	–	1.0	–
14-$C_{16:1}$	16.45	–	–	3.9
15-$C_{17:1}$	17.45	–	3.5	–
unidentified		(4.2)	(–)	(0.9)
Alcohols****				
Unbranched (total)		(14.0)	(31.9)	(16.2)
n-C_9	9.00	1.6	–	–
n-C_{10}	10.00	0.4	–	–
n-C_{12}	12.00	0.8	–	0.7
n-C_{13}	13.00	–	–	0.3
n-C_{14}	14.00	1.7	2.6	0.7
n-C_{15}	15.00	0.4	1.2	0.5
n-C_{16}	16.00	3.6	9.6	1.9
n-C_{17}	17.00	–	1.3	2.2
n-C_{18}	18.00	5.5	11.6	9.9
n-C_{20}	20.00	–	3.7	–
n-C_{22}	22.00	–	1.9	–
branched (total)		(86.0)	(67.6)	(83.8)
(ω-1)-methylsubstituted				
12-C_{13}	13.65	0.7	4.2	0.4
13-C_{14}	14.65	1.1	0.6	3.1
14-C_{15}	15.65	7.9	12.5	4.8
15-C_{16}	16.65	3.1	2.5	39.4
16-C_{17}	17.65	8.8	30.2	5.6
17-C_{18}	18.65	–	1.2	19.5
18-C_{19}	19.65	–	11.4	–
20-C_{21}	21.65	–	1.6	–
(ω-2)-methylsubstituted				
8-C_{10}	10.75	0.9	–	–
9-C_{11}	11.75	0.7	–	–
10-C_{12}	12.75	1.3	–	–
11-C_{13}	13.75	1.0	–	–
12-C_{14}	14.75	2.9	0.3	–
13-C_{15}	15.75	3.2	–	0.6
14-C_{16}	16.75	50.3	0.8	9.3
15-C_{17}	17.75	0.6	–	–
16-C_{18}	18.75	3.5	–	1.1
4,(ω-1)-dimethylsubstituted				
4,14-C_{15}	16.15	–	2.3	–
unidentified		(–)	(0.5)	(–)

* ECL = equivalent chainlength.
** double bond located in 9-position.
*** double bond located in 6-position.
**** ECL-values measured for the corresponding fatty acid methyl esters after CrO_3-oxidation.

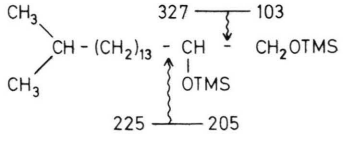
or absent (M-43)-fragment [24]. Methyl esters with a methyl-substituent at 6-position can be recognized from the intense (M-76)-fragment. The ion series (M-15)/(M-47)/(M-65), together with an intense (M-15)-fragment, indicate an (ω-1)-substitution, whereas the series (M-29)/(M-61)/(M-79) and the ratio (M-29) > (M-31) are indicative for a methyl-substitution at (ω-2)-position. The structures are confirmed by their equivalent chain length as given in Table III.

In addition, unsaturated fatty acids were found in *G. pardina* and *G. tigrina*. Double bonds in the acids from *G. tigrina* are located predominantly in 6-position as indicated by the mass spectra from the trimethylsilyl ethers of their dihydroxy-derivatives obtained after OsO_4 oxidation and subsequent silylation:



The methyl-substitution of the unsaturated fatty acid methyl esters at (ω-1)- or (ω-2)-position was recognized by mass spectrometry of the corresponding hydrogenated homologues as obtained by reduction with Pd/H_2 in cyclohexane.

The diester waxes which were found in all three *Genetta* species consist of normal and methyl-branched alkane-1,2-diols esterified with fatty acids of the same structural type as found in the monoester waxes. The mass spectra of the diol trimethylsilyl ethers indicate the position of the OH-groups to be located at C-1 and C-2 by the fragments *m/z* 103, *m/z* 327 and *m/z* 205 [25]. Apart from the fragment *m/z* 147 which indicates vicinal configuration of the OTMS-groups, prominent (M-15)-fragments are observed:



Since the methyl-substitution of the carbon chain is difficult to recognize from these spectra, the diols were oxidized with CrO_3/acetic acid to corresponding fatty acids with one carbon atom less, the methyl esters of which were subsequently analysed by mass spectrometry. GC analysis and mass spectrometry gave evidence of the presence of (ω-1)-, (ω-2)-monomethyl-, 4,(ω-1)-, and 4,(ω-2)-dimethyl-substituted as well as unsaturated (ω-1)-methyl-substituted alkane-1,2-diols. Composition of the diols and acids composing the diester waxes is presented in Table IV.

The compositions of the triglycerides and the free fatty acids resemble those found in the other lipid classes (Table V) and the same also holds true for both the free alkanols and the free alkane-1,2-diols (Table VI). Some more volatile individuals with shorter chain length are, however, found among the free fatty acids which have not been detected in complex lipids. Direct gas-chromatography of the crude secretion did not give any evidence of the presence of more volatile constituents others than found after separation into the various lipid classes.

Conclusions

As to the over-all composition of the secretions from the three species it seems to be remarkable that no highly volatile substances have been found. In this respect, the anal sac secretions of *Genetta* fundamentally differ from those of *Herpestes* [12], *Vulpes, Panthera* [26], *Canis* [27], and the mustelidae hitherto investigated [28–31]. Gorman *et al.* [12] found short-chained saturated carboxylic acids (acetic, propionic, isobutyric, butyric, isovaleric and valeric acid) in *Herpestes,* whereas in genets, free fatty acids only from a chain length of at the minimum 8 C-atoms have been detected. According to Preti *et al.* [27], in *Canis familiaris* and *Canis latrans,* short chained acids (C_2-C_6) and methylamine are the main constituents of the anal sac secretion. Albone and Perry [32] reported on volatile fatty acids (C_2-C_6) in the secretions of the anal sacs of the red fox and the lion. In addition putrescine, cadaverin, and ammonia have been found. Sokolov *et al.* [28], who analysed the anal sac secretions of the mink, *Mustela vison,* described volatile fatty acids, ammonia, and amines, in which putrescine was included, being the main constituents of the major head space volatiles; besides these substances several sulfur compounds have been detected. The occurrence of a greater number of sulfur containing constituents in this species has been confirmed by Schildknecht *et al.* [31], who additionally could find substances like indol, phenol, and *n*-decanol, doubtlessly representing products of

Table IV. Composition of the diester wax constituents from the anal gland secretion of three *Genetta* species, in per cent of the total fraction as detected by GC.

	G. genetta	*G. pardina*	*G. tigrina*
Fatty acids			
Saturated unbranched (total)	(23.9)	(27.1)	(11.7)
n-C_{10}	0.9	–	–
n-C_{11}	0.4	–	–
n-C_{12}	4.9	0.3	–
n-C_{14}	4.9	2.4	0.5
n-C_{15}	0.8	–	–
n-C_{16}	3.7	8.1	4.0
n-C_{17}	2.4	1.4	0.2
n-C_{18}	5.9	12.2	7.0
n-C_{20}	–	2.7	–
saturated branched (total)	(74.1)	(56.7)	(42.0)
(ω-1)-methylsubstituted			
8-C_9	0.9	–	2.2
9-C_{10}	1.2	–	1.6
10-C_{11}	3.0	2.9	0.4
11-C_{12}	–	0.1	1.2
12-C_{13}	2.5	4.0	0.2
13-C_{14}	–	0.3	4.9
14-C_{15}	3.0	6.9	0.8
15-C_{16}	1.5	1.1	19.9
16-C_{17}	0.8	20.2	3.9
17-C_{18}	–	0.6	0.7
18-C_{19}	–	6.5	0.1
(ω-2)-methylsubstituted			
6-C_8	1.4	–	–
8-C_{10}	1.4	–	–
10-C_{12}	6.3	–	0.7
11-C_{13}	–	0.8	–
12-C_{14}	4.7	0.2	0.4
13-C_{15}	–	1.5	–
14-C_{16}	11.9	0.8	2.8
15-C_{17}	1.6	–	–
16-C_{18}	5.0	0.7	3.2
4-methylsubstituted			
4-C_{10}	1.2	–	–
4-C_{11}	2.0	–	–
4-C_{12}	4.9	–	–
4-C_{13}	1.3	–	–
4-C_{14}	0.6	0.3	–
4-C_{15}	1.2	–	–
4-C_{16}	7.6	0.4	–
4-C_{17}	3.3	–	–
4-C_{18}	0.4	–	–
4,(ω-1)-dimethylsubstituted			
4,10-C_{11}	0.7	0.6	–
4,12-C_{13}	–	0.6	–
4,14-C_{15}	–	1.4	–
4,15-C_{16}	–	1.6	–
4,17-C_{18}	–	0.9	–
4,(ω-2)-dimethylsubstituted			
4,10-C_{12}	2.4	–	–
4,11-C_{13}	1.4	–	–
4,12-C_{14}	0.2	3.3	–
4,14-C_{16}	1.7	–	–
4,16-C_{18}	–	1.0	–
Unsaturated (total)	(–)	(16.2)	(43.4)

	G. genetta	*G. pardina*	*G. tigrina*
unsaturated unbranched			
n-$C_{18:1}$	–	–	2.3*
unsaturated branched			
(ω-1)-methylsubstituted			
11-$C_{12:1}$	–	–	0.5
12-$C_{13:1}$	–	0.1	–
13-$C_{14:1}$	–	0.6	0.2
14-$C_{15:1}$	–	3.0	1.1
15-$C_{16:1}$	–	0.6	21.9**
16-$C_{17:1}$	–	5.5	3.6
17-$C_{18:1}$	–	0.4	6.3
18-$C_{19:1}$	–	–	1.4
(ω-2)-methylsubstituted			
12-$C_{14:1}$	–	–	0.8
14-$C_{16:1}$	–	0.4	5.3**
15-$C_{17:1}$	–	4.2	–
16-$C_{18:1}$	–	1.4	–
unidentified	(2.0)	(–)	(2.9)
Diols			
unbranched (total)	(15.2)	(33.5)	(30.9)
n-C_{12}-1,2-diol	–	2.9	–
n-C_{13}-1,2-diol	–	0.8	–
n-C_{14}-1,2-diol	–	0.4	0.2
n-C_{15}-1,2-diol	–	0.1	0.6
n-C_{16}-1,2-diol	1.0	8.9	0.6
n-C_{17}-1,2-diol	3.4	0.2	4.7
n-C_{18}-1,2-diol	6.1	18.5	17.2
n-C_{19}-1,2-diol	4.2	1.7	1.0
n-C_{20}-1,2-diol	0.5	–	6.6
branched, saturated (total)	(84.0)	(59.7)	(52.3)
(ω-1)-methylsubstituted			
13-C_{14}-1,2-diol	–	1.6	0.4
14-C_{15}-1,2-diol	2.2	1.6	0.6
15-C_{16}-1,2-diol	5.2	1.5	22.1
16-C_{17}-1,2-diol	25.1	32.2	6.2
17-C_{18}-1,2-diol	1.0	0.5	10.1
18-C_{19}-1,2-diol	–	5.3	7.0
(ω-2)-methylsubstituted			
12-C_{14}-1,2-diol	–	3.4	–
13-C_{15}-1,2-diol	1.5	4.3	–
14-C_{16}-1,2-diol	17.5	2.8	1.6
15-C_{17}-1,2-diol	8.1	–	1.2
16-C_{18}-1,2-diol	23.4	–	3.1
4,(ω-1)-dimethylsubstituted			
4,12-C_{13}-1,2-diol	–	0.6	–
4,13-C_{14}-1,2-diol	–	0.6	–
4,14-C_{15}-1,2-diol	–	1.1	–
4,15-C_{16}-1,2-diol	–	1.1	–
4,(ω-2)-dimethylsubstituted			
4,13-C_{15}-1,2-diol	–	1.7	–
4,14-C_{16}-1,2-diol	–	1.4	–
unsaturated (total)	(–)	(–)	(13.1)
(ω-1)-methylsubstituted			
14-$C_{15:1}$-1,2-diol	–	–	0.1
15-$C_{16:1}$-1,2-diol	–	–	0.4
16-$C_{17:1}$-1,2-diol	–	–	1.0
17-$C_{18:1}$-1,2-diol	–	–	10.7
18-$C_{19:1}$-1,2-diol	–	–	0.9
unidentified	(0.8)	(6.8)	(3.7)

* Double bond located in 9-position.
** Double bond located in 6-position.

Table V. Composition of the triglycerides (TG) and the free fatty acids (FFS) from the anal gland secretion of three *Genetta* species, in per cent of the total fraction as detected by GC.

	G. genetta		*G. pardina*		*G. tigrina*	
	TG	FFS	TG	FFS	TG	FFS
Saturated unbranched (total)	(9.1)	(8.4)	(17.6)	(16.9)	(14.9)	(–)
n-C_{11}	–	–	–	–	1.4	–
n-C_{12}	–	–	–	–	0.4	–
n-C_{13}	–	–	–	–	0.3	–
n-C_{14}	–	–	1.6	2.0	0.8	–
n-C_{16}	3.4	0.7	5.0	4.4	5.9	–
n-C_{17}	0.6	0.5	1.3	0.9	0.7	–
n-C_{18}	5.1	5.9	8.2	8.7	5.4	–
n-C_{19}	–	1.3	0.2	–	–	–
n-C_{20}	–	–	1.3	0.9	–	–
saturated branched (total)	(84.2)	(83,2)	(51.1)	(71.8)	(34.2)	(100.0)
(ω-1)-methylsubstituted						
7-C_8	–	–	–	–	–	34.8
8-C_9	–	0.3	–	–	–	–
9-C_{10}	–	–	–	2.8	1.0	tr.
10-C_{11}	1.7	1.3	1.5	11.3	0.7	7.1
11-C_{12}	–	–	–	–	1.2	–
12-C_{13}	–	1.7	1.9	5.4	0.8	–
13-C_{14}	0.5	–	0.1	–	4.2	9.0
14-C_{15}	1.7	2.2	4.5	5.9	0.8	5.1
15-C_{16}	0.9	1.0	1.6	0.9	12.5	31.0
16-C_{17}	5.3	6.4	16.3	16.2	1.7	7.2
17-C_{18}	4.2	0.5	1.4	0.4	3.1	3.9
18-C_{19}	–	–	3.7	4.2	1.5	tr.
(ω-2)-methylsubstituted						
6-C_8	–	0.4	–	–	–	–
8-C_{10}	0.1	0.6	–	–	–	–
10-C_{12}	3.6	3.9	–	–	0.7	–
11-C_{13}	1.4	–	–	–	0.4	–
12-C_{14}	3.3	4.0	0.3	–	0.6	–
13-C_{15}	1.0	2.2	0.9	–	0.6	–
14-C_{16}	7.9	9.6	1.1	0.9	3.4	1.9
15-C_{17}	2.1	1.3	–	–	–	–
16-C_{18}	17.3	6.6	0.6	–	1.0	–
17-C_{19}	–	–	0.3	0.3	–	–
18-C_{20}	–	–	–	1.4	–	–
4-methylsubstituted						
4-C_{10}	–	0.9	–	–	–	–
4-C_{11}	–	0.8	–	–	–	–
4-C_{12}	–	3.0	–	–	–	–
4-C_{13}	0.4	0.9	0.4	–	–	–
4-C_{14}	0.3	0.2	–	–	–	–
4-C_{15}	0.7	0.2	0.4	–	–	–
4-C_{16}	2.4	3.8	0.3	0.4	–	–
4-C_{17}	0.8	1.4	0.9	–	–	–
4-C_{18}	0.8	0.2	0.2	2.2	–	–
4-C_{19}	0.8	2.0	–	–	–	–
4,(ω-1)-dimethylsubstituted						
4,9-C_{10}	–	–	–	3.0	–	–
4,10-C_{11}	2.6	tr.	0.2	3.6	–	–
4,14-C_{15}	–	–	1.0	1.5	–	–
4,15-C_{16}	–	–	1.8	1.7	–	–
4,16-C_{17}	–	–	0.5	0.6	–	–
4,17-C_{18}	–	–	0.7	–	–	–
4,18-C_{19}	–	–	0.7	–	–	–
4,(ω-2)-dimethylsubstituted						
4,7-C_9	–	0.5	–	–	–	–

	G. genetta		*G. pardina*		*G. tigrina*	
	TG	FFS	TG	FFS	TG	FFS
4,8-C_{10}	1.0	0.3	–	7.0	–	–
4,9-C_{11}	1.3	2.3	–	–	–	–
4,10-C_{12}	1.5	2.4	–	1.3	–	–
4,11-C_{13}	3.3	5.4	–	–	–	–
4,12-C_{14}	0.7	0.8	2.1	–	–	–
4,13-C_{15}	3.4	4.8	–	–	–	–
4,14-C_{16}	1.7	3.0	0.9	0.8	–	–
4,15-C_{17}	9.6	8.3	–	–	–	–
4,16-C_{18}	1.9	–	6.4	–	–	–
4,17-C_{19}	–	–	0.4	–	–	–
unsaturated (total)	(–)	(–)	(23.3)	(11.3)	(44.7)	(–)
unbranched (total)	(–)	(–)	(–)	(–)	(10.0)	(–)
n-$C_{14:1}$	–	–	–	–	2.2	–
n-$C_{16:1}$	–	–	–	–	0.8	–
n-$C_{18:1}$	–	–	–	–	7.0	–
unsaturated branched (total)	(–)	(–)	(23.3)	(11.3)	(34.7)	(–)
(ω-1)-methylsubstituted						
10-$C_{11:1}$	–	–	–	5.1	–	–
11-$C_{12:1}$	–	–	–	–	1.9	–
13-$C_{14:1}$	–	–	0.3	–	1.5	–
14-$C_{15:1}$	–	–	2.6	0.9	2.7	–
15-$C_{16:1}$	–	–	0.6	–	14.9	–
16-$C_{17:1}$	–	–	8.9	2.2	1.2	–
17-$C_{18:1}$	–	–	1.6	–	1.5	–
18-$C_{19:1}$	–	–	1.3	0.5	3.9	–
(ω-2)-methylsubstituted						
12-$C_{14:1}$	–	–	–	–	1.1	–
13-$C_{15:1}$	–	–	1.5	–	1.7	–
14-$C_{16:1}$	–	–	–	0.9	4.3	–
15-$C_{17:1}$	–	–	4.4	–	–	–
16-$C_{18:1}$	–	–	0.2	–	–	–
17-$C_{19:1}$	–	–	1.9	0.3	–	–
18-$C_{20:1}$	–	–	–	1.4	–	–
unidentified	(6.7)	(8.4)	(8.0)	(–)	(6.2)	(–)

microorganisms from the anal sac. Sulfur containing compounds are characteristic also of other members of the family Mustelidae; they have been detected in *Mephitis mephitis* (Andersen and Bernstein [33])) as well as in *Mustela putorius* f. furo and *Mustela erminea* (Crump [29, 30]).

All these substances are missing in the anal sac secretions of the three *Genetta* species investigated. Nevertheless, the quite high portion of free fatty acids compared to the amount of triglycerides could be a hint to microbial hydrolysis. Besides the lack of highly volatile substances, the occurrence of hydrocarbons is characteristic, of which squalene is the main constituent; hydrocarbons have not been found in *Civettictis* [14]. The anal sac secretion of this viverrine species contains considerable amounts of cholesterol and cholesterol esters, on the other hand lacking in all three genet species but having been observed in the anal sac secretions of other carnivores as well as squalene, other hydrocarbons and ester waxes. Free alkane-1,2-diols which have been detected in all three genet species were obviously never found before in anal sac secretions.

It is not yet possible to give any information as to the intraspecific and individual variation of the composition of the secretion in genets. Brinck *et al.* [34] found that, in *Mustela vison,* complex patterns of peaks in the gas chromatogram of less volatile substances were characteristic of individuals over a certain period of time. Schildknecht *et al.* [31] demonstrated that each individual animal has its own specific profile of volatile substances but they failed to detect differences in the composition of the relevant constituents of the anal sac secretion which were related to sex or reproduction. It cannot be taken for granted that such differences do not exist in viver-

Table VI. Composition of the free alkanols (FA) and the free alkane-1,2-diols (AD) from the anal gland secretion of three *Genetta* species, in per cent of the total fraction as detected by GC.

	G. genetta		*G. pardina*		*G. tigrina*	
	FA	AD	FA	AD	FA	AD
Unbranched (total)	(12.2)	(13.2)	(26.1)	(27.2)	(–)	(41.3)
n-C_{10}	0.4	–	–	–	–	–
n-C_{12}	1.0	–	–	0.7	–	–
n-C_{13}	–	–	–	1.7	–	–
n-C_{14}	1.6	–	1.9	1.3	–	–
n-C_{15}	–	–	1.0	–	–	–
n-C_{16}	3.5	1.0	9.1	1.7	–	–
n-C_{17}	–	2.3	0.3	–	–	11.1
n-C_{18}	5.7	5.8	9.9	21.8	–	30.2
n-C_{19}	–	4.1	–	–	–	–
n-C_{20}	–	–	2.4	–	–	–
n-C_{22}	–	–	1.5	–	–	–
branched (total)	(87.8)	(86.8)	(73.3)	(68.0)	(–)	(58.7)
(ω-1)-methylsubstituted						
12-C_{13}	0.4	–	5.1	–	–	–
13-C_{14}	1.2	–	0.8	1.2	–	–
14-C_{15}	8.2	1.0	14.4	1.4	–	–
15-C_{16}	2.9	6.4	1.9	2.4	–	40.6
16-C_{17}	8.6	27.3	34.7	41.9	–	8.4
17-C_{18}	–	1.0	1.0	1.1	–	9.7
18-C_{19}	–	–	10.7	6.9	–	–
20-C_{21}	–	–	1.2	–	–	–
(ω-2)-methylsubstituted						
10-C_{12}	1.4	–	–	–	–	–
11-C_{13}	1.0	–	–	–	–	–
12-C_{14}	2.9	–	0.7	1.2	–	–
13-C_{15}	3.9	1.8	–	4.7	–	–
14-C_{16}	52.8	17.3	0.9	3.1	–	–
15-C_{17}	0.6	9.2	–	–	–	–
16-C_{18}	3.9	22.8	–	–	–	–
4,(ω-1)-dimethylsubstituted						
4,14-C_{15}	–	–	1.9	–	–	–
4,15-C_{16}	–	–	–	2.1	–	–
4,(ω-2)-dimethylsubstituted						
4,14-C_{16}	–	–	–	2.0	–	–
unidentified	(–)	(–)	(0.6)	(4.8)	(–)	(–)

rids. Roeder [5] observed that male and female individuals of genets showed considerable differences in scent marking behaviour related to season and social status of males. Nevertheless, it seems to be justified to consider some of the basic differences in the composition of the anal sac secretions species specific.

Table I shows the similarity of the quantitative composition of the secretions in all three genet species, except the lack of free alcohols in *G. tigrina*. Common to all three species there is a predominance of branched fatty acids as constituents of ester waxes, free acids, triglycerides, free alcohols, and free alkane-1,2-diols. Unsaturated constituents have not been observed in *G. genetta*, but considerable amounts do occur in both other species, especially in *G. tigrina*. In *G. genetta*, noteworthy amounts of 4-methylsubstituted and (ω-2)-methylsubstituted fatty acids and alcohols are found, whereas in *G. pardina* and *G. tigrina*, (ω-1)-methylsubstituted compounds predominate. Altogether, it is obvious that between *G. trigrina* and *G. pardina*, there is a greater similarity in the chemical composition of the secretions than between either of them and *G. genetta*.

As to the biological significance of the anal sac secretions, it is interesting that according to Wemmer [7], dung heaps of *Genetta* have a long lasting

odour which, as has been pointed out earlier [14], cannot be achieved by highly volatile substances. The importance of dung heaps for forwarding information has been emphasized by Kleiman [35] and is easily understood in *Civettictis* which regularily uses the same heaps for defecation. Since we have only scarce information on the biology of genets, we do not exactly know about the importance of dung heaps for these animals, but it seems conceiveable that the anal sac secretions of *Genetta*, by adding them to the faeces, do carry various informations. The variety of the constituents of the secretions is in accordance with such an assumption.

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