28. *The Composition of the Fat of the Puma or American Lion* (Felix concolor).

By Francisco Giral.

The reserve fat of the carnivorous puma (or American lion) was found by ester-fractionation to contain the following acids: myristic 1·3, palmitic 22·4, stearic 26·9, arachidic 3·7, hexadecenoic 12·6, oleic 26·2, linoleic 2·3, and unsaturated C_{20}, 4·6% (wt.). It contained more stearic than palmitic acid, this being somewhat exceptional for an animal fat, other than in some instances of herbivorous animal and insect fats. The puma fat was also notable for its unusually high content of hexadecenoic acid, in comparison with the proportion (3—4%) of this acid which has been recorded in the reserve fats of almost all the larger mammals so far examined.

It has been pointed out (Hilditch, "The Chemical Constitution of Natural Fats," London, 1940, p. 76) that the component acids of the fats of carnivorous animals have not been determined with any degree of precision. Partial analyses of a few fats are available, including those of the mink (Lode, *Fettchem. Umschau*, 1935, **42**, 205) and of the American black bear (Hoyt, *Oil and Soap*, 1934, **11**, 85; Rasmussen *et al.*, *ibid.*, 1943, **20**, 159), and detailed accounts have now been given of the component acids of depot fats of the lion, cat, baboon, and some omnivorous or herbivorous wild animals (Hilditch and Sime, *Biochem. J.*, 1942, **36**, 98) and of human body fats (Cramer and Brown, *J. Biol. Chem.*, 1943, 151, 427).

The present communication deals with the fat from an adult male puma, shot in August, 1943, near Ozaluma, a village in the tropical region in the north of the state of Vera Cruz, Mexico. The natives render the fat from the subcutaneous and perinephric tissues of the puma, and attribute to it useful medicinal properties, especially for rheumatic conditions, but this appears unlikely to rest on any scientific basis. The animal feeds mainly on herbivorous mammals, especially species of deer and their young, and also on sheep and young horses.

EXPERIMENTAL.

The puma fat was a white solid with a slight yellow tinge, melted at 40—45°, and possessed the following analytical characteristics: saponification equivalent 324·7, iodine value 38·8, acid value 3·6, unsaponifiable matter 1·3%. The mixed fatty acids of the puma fat melted at 45—48°, and had mean molecular weight (equivalent) 278·7 and iodine value 46·7.

Determination of Component Acids.—The filtered fat (150 g.) was hydrolysed with alcoholic potassium hydroxide, and the resulting aqueous soap solutions were extracted continuously with ether for 30 hours in order to remove the unsaponifiable constituents. After the extracted aqueous solution had been acidified, the recovered mixed fatty acids were found to yield no acids volatile in steam, and were therefore submitted to separation of their lead salts from alcohol:

	G.	%.	Mean *M*.	Iod. val.
"Solid" acids from insoluble lead salts	59·0	56·9	272·8	9·3
"Liquid" acids from soluble lead salts	44·7	43·1	275·3	99·7

The acids in each group were esterified with methanol in presence of sulphuric acid, and the methyl esters obtained, after removal of small proportions of unesterified acids, were distilled at 2 mm. pressure from a Willstätter bulb (Hilditch, *op. cit.*, pp. 367 *et seq.*). The characteristics of the ester-fractions obtained are in Table I.

TABLE I.

Fractionation of Methyl Esters from Puma Fat.

Esters of "solid" acids.					Esters of "liquid" acids.				
No.	G.	B. p.	Sap. equiv.	Iod. val.	No.	G.	B. p.	Sap. equiv.	Iod. val.
S 1	3·57	145—152°	268·3	2·0	L1	2·60	148—157°	262·3	67·9
S 2	4·03	152—154	270·3	3·8	L2	3·15	157—160	269·4	70·2
S 3	4·14	154—155	277·1	4·6	L3	4·53	160—164	278·7	89·7
S 4	5·08	155—156	280·3	5·4	L4	4·86	164—166	284·1	92·6
S 5	3·78	156—157	285·6	5·9	L5	5·38	166—167	289·4	91·2
S 6	3·31	157—158	287·5	6·3	L6	4·32	167	296·4	93·3
S 7	3·96	158—161	290·9	7·2	L7	3·18	167—168	300·0	97·5
S 8	2·45	161—163	294·2	7·9	L8	2·88	168—171	309·5	113·4
S 9	6·28	163—164	297·3	9·6	L9	2·35	Residue	315·7	120·2
S10	4·70	164—166	300·6	9·9					
S11	3·40	166—172	305·9	10·9		33·25			
S12	3·50	Residue	310·9	19·9					
	48·20								

Individual acids were identified as follows :

Palmitic acid (from fractions S3 and S4), recrystallised from alcohol, m. p. 60—61°, M.M.W. 261·2.
Stearic acid (from fractions S7, S8, and S9), recrystallised from alcohol, m. p. 68—69°, M.M.W. 282·3.
Arachidic acid (admixed with stearic, from fractions S11 and S12), recrystallised from alcohol, m. p. 71—72° M.M.W. 301·6.

The original puma fat in acetic acid solution gave no precipitate on addition of bromine, but in light petroleum solution gave a slight precipitate with bromine; these tests indicate the absence of linolenic and the presence of some linoleic acid in the fat.

The data in Table I. when calculated to mixtures of saturated, hexadecenoic, oleic, linoleic, and unsaturated acids of the C_{20} series, lead to the proportions of component acids given in Table II.

TABLE II.

Component Acids (% wt.) of Puma Fat.

	"Solid" acids (56·9%).	"Liquid" acids (43·1%).	Total acids, %.
Myristic	0·6	0·7	1·3
Palmitic	20·5	1·9	22·4
Stearic	26·9	—	26·9
Arachidic	3·7	—	3·7
Hexadecenoic	—	12·6	12·6
Oleic	5·2	21·0	26·2
Linoleic	—	2·3	2·3
Unsaturated C_{20}	—	4·6	4·6

DISCUSSION.

Although the chief component acids of the puma fat are palmitic, oleic, and stearic, the proportions of these exhibit certain differences from those observed in other animal depot fats, and in addition there is a larger proportion of hexadecenoic acid than is usual in this type of fat.

It is rather unusual to find more stearic than palmitic acid in an animal fat. It should be noted, however, that the proportion of palmitic acid is lower than in most animal fats, of which it usually forms 30 ± 3% of the total fatty acids (Hilditch, *op. cit.*, pp. 11, 80); on the other hand, the total amount of C_{16} acids (palmitic and hexadecenoic), 35·0%, is similar to that observed in the great majority of animal fats so far examined. The presence of more stearic than palmitic acid in a natural fat, although a characteristic feature of the seed fats of certain tropical families of plants, has only been noted in the animal kingdom in a few other instances :

	Palmitic, %.	Stearic, %.	
Indian goat	25·5	28·1	(Dhingra and Sharma, *J. Soc. Chem. Ind.*, 1938, **57**, 369).
South American sheep	21	30	(Armstrong and Allan, *ibid.*, 1924, **43**, 216T).
Australian sheep	25	31	(Collins *et al.*, *ibid.*, 1929, **48**, 46T).
Mylabris pustulata (insect)	13	32	(Iyer and Ayyar, *J. Indian Inst. Sci.*, 1931, **14***A*, 40).
Melanopsus sp. (insect)	6·7	9·1	(Giral, unpublished observation).

The proportion of stearic acid in the puma fat, although large, does not exceed the limits of 28—30% which appears to be the maximum amount of this acid likely to occur in an animal depot fat (Hilditch and Murti, *Biochem. J.*, 1940, **34**, 1301). Nevertheless, the occurrence of over 20% of stearic acid in mammalian depot fats has hitherto been noted only in those of the herbivora (some of which are, incidentally, the chief food of the puma).

The unsaturated acids of puma fat are unusual only in their relatively high content of hexadecenoic acid (12·6%). This is as large as the proportion found in many marine animal oils, of which it is a characteristic, major component, and is larger than the amounts of this acid usually observed in the fats of birds or rats, other than those of rats fed on intensive carbohydrate or protein diets (Longenecker, *J. Biol. Chem.*, 1939, **128**, 645). The proportion of hexadecenoic acid in fats of the larger mammals, herbivorous or carnivorous is usually only 3—4%, but the fat of the Ceylon bear (Hilditch and Sime, *loc. cit.*) contains 11% of this acid, *i.e.*, approximately the same proportion as the puma fat now described. Apart from the comparatively low content of oleic acid, the remaining acids of the puma fat are, in kind and amount, similar to those of many other animals and call for no special comment.

Species, dietary and climatic conditions may all contribute to variations in the component acids of animal reserve fats, and it is not possible in the present instance to distinguish between the influence which any one or all of these factors may exert in the development of the two acids, stearic and hexadecenoic, which appear to be unusually prominent.

My thanks are due to Miss Sara Garcia Iglesias for supplying the specimen of puma fat, and to Miss Alicia Ayluard for her technical help with the experimental work.

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[*Received, June* 19*th*, 1944.]