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The Component Acids of some Seal Blubber and Liver Fats

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The fatty oils of seals have received little detailed investigation, but their general analytical characteristics as recorded in the literature (cf. Halden & Grün, 1929) reveal considerable variations in the blubber oils, iodine values from 122 to 163 having been reported. This unusually wide range is reflected in the two specimens of seal blubber oil which have so far been examined in greater detail, namely, a commercial sample (probably of Newfoundland origin) with an iodine value of 135.8 (Burke & Jasperson, 1944) and the blubber fat of a grey Atlantic seal (*Halichoerus grypus*) caught off the coast of Pembroke, with an iodine value of 162.2 (Hilditch & Pathak, 1947). The chief differences observed in the detailed analyses of these two seal oils consisted in variation in the proportions of unsaturated C_{16} acids, unsaturated C_{18} acids, and unsaturated C_{22} acids.

When Prof. A. N. Worden of the University College of Wales, Aberystwyth (who had very kindly put material from the grey Atlantic seal at our disposal earlier), informed us that similar specimens from two common seals (*Phoca vitulina* L.) were to be available, it was felt desirable to undertake similar examination of their blubber and liver lipids in

order to add to the somewhat meagre knowledge of the fatty acids present in the fats of members of this family. Prof. Worden was accordingly good enough to secure for us samples of blubber and of liver from two common seals taken off the Norfolk coast in July 1947, the lipids from which were extracted and examined in our laboratory.

METHODS

The tissues (blubber or liver) were cut into small pieces and extracted exhaustively with hot acetone until no further lipid was removed. The material left after removal of the acetone was taken up in light petroleum (b.p. 40–60°), the solution separated from the water which had also been entrained by the acetone, and the lipids recovered. The liver lipids contained appreciable quantities of phosphatides as well as glycerides, and these were separated by keeping their acetone solutions at 0° for several days, when the phosphatides were precipitated. The component fatty acids of the blubber oils and (so far as the quantities available permitted) of the liver glycerides and phosphatides were determined by the methods used in our earlier work (Hilditch & Pathak, 1947) on the blubber and liver oils of the grey Atlantic seal. These are briefly as follows:

(a) The mixed fatty acids from the oil were first partly resolved by crystallization from acetone and from ether at

low temperature. Crystallization from 10% solution in acetone at -60° left in solution nearly all of the polyethenoid acids of the C_{20} and C_{22} series, with some oleic and much of the hexadecenoic acid; in one instance further quantities of the more unsaturated acids were obtained by subsequent recrystallization from acetone at -60° of the insoluble and soluble portions obtained in the first crystallization. In all instances the acids finally left insoluble in acetone at -60° were crystallized from 10% solutions in ether at -40° , when material of very low iodine value was deposited, leaving in solution a concentrate of mainly monoethenoid acids, accompanied by small amounts of saturated acids and polyethenoid acids of the C_{20} series.

(b) Each group of acids thus obtained was separately converted into methyl esters, which were fractionally distilled in a vacuum through an electrically heated and packed column. From the iodine values and equivalents of the resulting ester fractions the compositions of the latter were calculated by methods which have been described elsewhere (Hilditch, 1947). The mean unsaturation, expressed by the fractional number of hydrogen atoms short of saturated, e.g. -2.0 (monoethenoid), was determined by interpolation or extrapolation from the respective ester fractions in each group from which the mean equivalent of each of the homologous ester groups (C_{16} , C_{18} , C_{20} and C_{22}) follows. In this manner the fatty acid composition of each separated group of fatty acids, and thence that of the original seal blubber or liver lipid, was finally obtained.

RESULTS

The animals from which the lipids were obtained were: I, a female about 2 or 3 weeks old, 915 mm. long (snout to tip of tail), girth at axilla 510 mm.; II, a yearling male, 1020 mm. long, girth at axilla 735 mm. The specimens will be referred to as I and II throughout this paper.

Blubber oils

The blubber fats were almost wholly glyceridic and contained no phospholipids separable by deposition from acetone at 0° . They were pale yellow oils with the following analytical characteristics:

	Oil of seal I	Oil of seal II
Iodine value	140.0	145.4
Saponification equivalent	289.0	292.3
Free fatty acid (as oleic) (%)	0.2	0.1
Unsaponifiable matter (%)	0.1	0.3

Component acids of blubber oil from seal I. The mixed fatty acids (186 g.) were crystallized first from acetone at -60° , the deposited acids then being further crystallized from ether at -40° :

Group	Description	Weight		Iodine value
		(g.)	(%)	
A	Insoluble in ether at -40°	25.7	13.8	4.9
B	Soluble in ether at -40°	75.4	40.6	99.6
C	Soluble in acetone at -60°	84.9	45.6	218.1

The ester-fractionation data for the methyl esters of each of these three groups of acids are summarized in Table 1, and the values allotted to

Table 1. *Fractionation of methyl esters of seal I blubber oil acids A, B and C*

Fraction	Weight (g.)	Saponification equivalent	Iodine value
Methyl esters of acids A			
A 1	2.89	247.6	0.4
A 2	3.73	269.0	1.9
A 3	3.50	269.8	2.1
A 4	3.56	271.5	2.8
A 5	3.77	271.9	3.0
A 6	3.61	282.6	3.6
A 7	3.54	313.5*	23.9
	24.60		
Methyl esters of acids B			
B 1	2.82	254.2	52.2
B 2	4.20	266.8	85.9
B 3	4.66	266.9	88.1
B 4	3.87	273.0	88.4
B 5	5.11	280.7	88.6
B 6	5.30	294.3	88.6
B 7	5.54	295.1	89.0
B 8	4.99	296.2	89.2
B 9	3.98	296.8	92.3
B 10	3.73	305.7	92.9
B 11	3.25	313.1	117.4
B 12	3.05	321.3*	152.8
	50.50		
Methyl esters of acids C			
C 1	4.12	247.1	92.1
C 2	3.28	268.4	99.7
C 3	3.90	270.1	103.2
C 4	4.68	275.7	109.7
C 5	4.08	281.7	120.5
C 6	3.86	283.3	123.0
C 7	3.92	285.2	125.0
C 8	3.52	287.1	151.0
C 9	4.09	311.1	236.7
C 10	6.16	330.9	330.7
C 11	4.58	335.1	380.6
C 12	4.50	338.6	373.5
C 13	3.10	346.8*	334.7
	53.79		

* Equivalents of esters (freed from unsaponifiable matter): A 7, 303.7; B 12, 314.6; C 13, 342.7.

Table 2. *Equivalents, iodine values and mean unsaturation employed in calculating the composition of unsaturated methyl ester fractions from groups B and C*

Methyl esters of acids	Saponification equivalent	Iodine value	Mean unsaturation
Group B			
C ₁₄	240.0	105.8	- 2.0
C ₁₆	268.0	94.8	- 2.0
C ₁₈	295.9	90.1	- 2.1
C ₂₀	321.6	173.8	- 4.4
C ₂₂	—	—	—
Group C			
C ₁₄	240.0	105.8	- 2.0
C ₁₆	267.9	99.5	- 2.1
C ₁₈	294.0	172.8	- 4.0
C ₂₀	319.0	270.3	- 7.0
C ₂₂	343.0	407.3	- 11.0

the various homologous groups of unsaturated C_{14} , C_{16} , C_{18} , C_{20} and C_{22} acids in each series are shown in Table 2.

The percentage composition (by weight) of each group of acids was then calculated, and therefrom the composition of the total fatty acids of the blubber oil (Table 3).

Component acids of blubber oil from seal II. In this case the first crystallization of the mixed fatty acids (235.5 g.) of the oil from acetone at -60° caused 90.9 g. (iodine value 70.1) to be deposited, and left in solution 144.6 g. (iodine value 202.8). The latter acids, on repetition of this process (acetone at -60°), deposited 40.7 g. (*D*, iodine value 84.1) and left in solution 103.9 g. (*E*, iodine value 250.2). The acids deposited in the original crystallization were also recrystallized from acetone at -60° , when there were left in solution 20.1 g. (*C*, iodine value 145.3), and 70.8 g. (iodine value 47.0) were deposited and then crystallized from ether at -40° . This led to the separation of 32.5 g.

(*A*, iodine value 2.6), leaving in solution in the ether 38.3 g. (*B*, iodine value 84.4).

There were thus obtained the following five groups of acids, each of which was methylated and fractionally distilled in the usual manner:

Group	Weight		Iodine value
	(g.)	(%)	
<i>A</i>	32.5	13.8	2.6
<i>B</i>	38.3	16.3	84.4
<i>C</i>	20.1	8.5	145.3
<i>D</i>	40.7	17.3	84.1
<i>E</i>	103.9	44.1	250.2

It is perhaps unnecessary to devote the space required for the presentation of the detailed ester-fractionation data (as in Table 1) and it is, therefore, proposed only to quote the fatty acid compositions finally obtained for each of the five groups of acids (% w/w) and, therefrom, of the total fatty acids of the seal II blubber oil (Table 4).

Table 3. *Component acids in groups A, B, C and in the whole seal I blubber oil*

Acid	Component acids in groups			Fatty acids in the whole oil		
	<i>A</i>	<i>B</i>	<i>C</i>	(% w/w)	(% by mol.)	Mean unsaturation
	(13.8%)* (%)†	(40.6%)* (%)†	(45.6%)* (%)†			
Myristic	9.7	1.6	0.9	2.4	2.9	—
Palmitic	65.0	3.2	—	10.3	11.1	—
Stearic	16.5	0.6	—	2.5	2.4	—
Arachidic	2.2	—	—	0.3	0.3	—
Unsaturated C_{14}	Trace	1.9	4.7	2.9	3.6	— 2.0
Unsaturated C_{16}	1.6	28.5	30.4	25.7	27.8	— 2.1
Unsaturated C_{18}	3.3	51.8	24.3	32.6	31.8	— 2.7
Unsaturated C_{20}	1.2	12.3	15.2	12.1	10.8	— 5.9
Unsaturated C_{22}	—	—	24.4	11.2	9.3	— 11.0
Unsaponifiable	0.5	0.1	0.1	—	—	—

* Group as % (w/w) of total oil. † Component acids as % (w/w) of group.

Table 4. *Component acids in groups A–E and in the whole seal II blubber oil*

Acid	Component acids in groups					Fatty acids in whole oil	
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	(% w/w)	(% by mol.)
	(13.8%)* (%)†	(16.3%)* (%)†	(8.5%)* (%)†	(17.3%)* (%)†	(44.1%)* (%)†		
Myristic	6.5	2.5	2.0	1.5	1.0	2.2	2.7
Palmitic	58.3	5.8	3.3	7.3	—	10.6	11.4
Stearic	28.7	2.1	1.4	0.1	—	4.4	4.3
Arachidic	2.3	—	—	—	—	0.3	0.3
Unsaturated C_{14}	Trace	2.5	3.4	2.0	2.6	2.2	2.7
Unsaturated C_{16}	1.0	14.1	32.1	28.1	24.2	20.8	22.7
Unsaturated C_{18}	2.1	66.2	33.2	49.7	25.2	33.7	33.2
Unsaturated C_{20}	0.7	6.5	22.7	11.2	19.4	13.6	12.4
Unsaturated C_{22}	—	—	1.5	—	27.2	12.2	10.3
Unsaponifiable	0.4	0.3	0.4	0.1	0.4	—	—
Mean unsaturation of:							
Unsaturated C_{14}	— 2.0	— 2.0	— 2.0	— 2.0	— 2.0	— 2.0	—
Unsaturated C_{16}	— 2.0	— 2.0	— 2.0	— 2.0	— 2.1	— 2.1	—
Unsaturated C_{18}	— 2.0	— 2.0	— 2.5	— 2.0	— 3.0	— 2.4	—
Unsaturated C_{20}	— 2.0	— 5.0	— 7.5	— 4.5	— 8.0	— 7.2	—
Unsaturated C_{22}	—	—	— 11.0	—	— 11.0	— 11.0	—

* Group as % (w/w) of total oil. † Component acids as % (w/w) of group.

Liver lipids

Seal I. The moist liver tissue (338 g.) yielded to acetone a total quantity of 14.6 g. of lipids soluble in light petroleum, and contained 249 g. of water. The dry liver tissue thus contained 16.4% of lipids (4.3% on the moist tissue). These were dissolved in ten times their weight of acetone, and the solution left at 0° for some weeks, when 3.4 g. of sticky dark-brown material (phosphatides) were precipitated, leaving in solution 11.2 g. of glyceridic oil.

Phosphatides (crude) thus formed about 23% of the liver lipids. The amount available was too small to permit any examination of the fatty acids present. The material contained 4.7% P and 1.9% N (P:N ratio, 1:1.1).

About 77% of the seal liver lipids consisted of *glycerides* which, however, contained 18.5% of unsaponifiable matter. A portion (7.25 g.) of the liver-glyceride mixed fatty acids, from which unsaponifiable matter had been removed, was crystallized first from acetone at -60°, the deposited acids being further crystallized from ether at -40°. From the iodine values of the three fractions so obtained an approximate estimate of the saturated, monoethenoid and polyethenoid acids present was derived (assuming average iodine values of 90 and 350 respectively for the monoethenoid and polyethenoid material):

	Weight		Equivalent	Iodine value
	(g.)	(%)		
(i) Insoluble in ether at -40°	1.77	24.4	270.7	14.2
(ii) Soluble in ether at -40°	1.48	20.4	289.3	88.9
(iii) Soluble in acetone at -60°	4.00	55.2	312.1	267.0

from which is calculated:

	Approximate component acids (expressed as % of total acids)		
	Saturated	Monoethenoid	Polyethenoid
(i)	20.5	3.9	—
(ii)	0.3	20.1	—
(iii)	—	17.7	37.5
	20.8	41.7	37.5

The component acids of the *seal I* liver *glycerides* consisted, therefore, of about 20% saturated acids and about 40% each of monoethenoid and polyethenoid fatty acids.

Seal II. The moist liver tissue (409 g.) yielded to acetone 43.6 g. of lipids soluble in light petroleum, i.e. 10.7% on the moist tissue. The moisture content of the latter is unfortunately uncertain, but the lipid content of the dry tissue must have been of the order of at least 50%. Thus the liver of the common seal II had a much higher fatty content than either that of the common seal I or that of the

grey seal studied earlier (Hilditch & Pathak, 1947), and the subsequent examination showed that the increase in lipid content was wholly due to liver *glycerides*: the crude liver lipids (43.6 g.), after keeping in acetone solution at 0° for some weeks, deposited 2.3 g. of crude phosphatidic material, and left in solution 41.3 g. of glyceridic oil.

Crude phosphatides thus formed only 5% of the total liver lipids, and, again, were too small in amount for their fatty acids to be examined. The crude material contained 2.4% P and 1.0% N (P:N ratio, 1.06:1).

The crude *glycerides* contained 9.7% of unsaponifiable matter, so that the actual *glyceride* content of the liver lipids was about 86% (as compared with about 63% in the liver lipids of seal I). After removal of the unsaponifiable matter, the quantity of glyceridic mixed fatty acids (32.6 g.) available was sufficient for approximate analysis by ester fractionation (Table 5). The acids were first resolved into two fractions by crystallization from acetone at -60°:

Group	Description	Weight		Iodine value
		(g.)	(%)	
A	Insoluble in acetone at -60°	16.3	50.0	67.7
B	Soluble in acetone at -60°	16.3	50.0	299.4

Table 5. *Fractionation of methyl esters of seal II liver-glyceride fatty acids A and B*

Fraction	Weight (g.)	Saponification equivalent	Iodine value
Methyl esters of acids <i>A</i>			
<i>A</i> 1	2.15	269.3	15.5
<i>A</i> 2	1.77	276.2	23.6
<i>A</i> 3	2.58	283.9	36.3
<i>A</i> 4	3.21	298.2	60.1
<i>A</i> 5	2.84	299.5	72.5
<i>A</i> 6	3.20	316.3*	90.6
	15.75		
Methyl esters of acids <i>B</i>			
<i>B</i> 1	1.81	268.1	87.3
<i>B</i> 2	2.46	298.4	160.9
<i>B</i> 3	2.84	314.5	294.5
<i>B</i> 4	3.05	326.3	328.4
<i>B</i> 5	2.44	338.8	373.7
<i>B</i> 6	3.34	349.4*	300.6
	15.94		

* Equivalents of esters (freed from unsaponifiable matter): A6, 310.8; B6, 344.3.

The unsaturation of the homologous esters in group B was estimated to be as follows:

Methyl esters of acids	Saponification equivalent	Iodine value	Mean unsaturation
C ₁₆	268.0	94.8	- 2.0
C ₁₈	294.5	151.0	- 3.5
C ₂₀	318.0	319.2	- 8.0
C ₂₂	343.0	407.3	- 11.0

The fatty acid composition (% w/w) of groups A and B, and thence those of the total fatty acids in the seal II liver glycerides, based on the ester-fractionation data in Table 5, are shown in Table 6.

At first sight it would appear that, as might be expected, the compositions of the fatty oils from the two common seals, taken at the same time in the same area, are not very different. Actually the only

Table 6. *Component acids in groups A and B, and in the whole seal II liver glycerides*

Acid	Component acids in groups		Fatty acids in whole oil	
	A	B	(%, w/w)	(%, by mol.)
	(50.0%)* (%)†	(50.0%)* (%)†		
Myristic	0.3	0.2	0.2	0.3
Palmitic	22.1	0.7	11.4	12.9
Stearic	15.4	—	7.8	7.9
Arachidic	0.3	—	0.1	0.1
Unsaturated C ₁₆	6.8 (-2.0)‡	10.4 (-2.0)‡	8.6 (-2.0)‡	9.8
Unsaturated C ₁₈	40.4 (-2.0)	15.1 (-3.5)	27.9 (-2.4)	28.7
Unsaturated C ₂₀	14.3 (-2.0)	32.9 (-8.0)	23.7 (-6.2)	22.5
Unsaturated C ₂₂	—	40.4 (-11.0)	20.3 (-11.0)	17.8
Unaponifiable	0.4	0.3	—	—

* Group as % (w/w) of total oil.

† Component acids as % (w/w) of group.

‡ Mean unsaturation.

DISCUSSION

Seal blubber oils

The data obtained in the course of the present work are most usefully considered in conjunction with the detailed component-acid figures which have been given for other seal blubber oils, namely, the grey seal (Hilditch & Pathak, 1947) and the mixed specimen of seal oil probably from Newfoundland or the north-eastern Atlantic seaboard (Burke & Jaspersen, 1944). The percentages by weight of the component acids of all four oils are collected in Table 7.

significant difference is in the somewhat greater proportion of unsaturated (hexadecenoic) C₁₆ acids in the oil of seal I, which is offset by minor decreases in unsaturated C₁₈, C₂₀ and C₂₂ acids and in stearic acid as compared with the oil of seal II. The mean unsaturation of the C₂₀ acids in the oil of seal II is definitely greater than in the oil of seal I. Apart from these points, however, the two oils are not dissimilar: the chief component is the unsaturated C₁₈ group (about 33% of the total acids, and largely oleic acid) followed by about 21–25% of hexadecenoic acid; saturated acids, especially palmitic acid, are remarkably constant not only in these two oils, but in all four seal oils quoted in Table 7.

Table 7. *Component acids (% w/w) of seal blubber oils*

	Common seal I	Common seal II	Grey seal	Newfoundland (?) seal
<i>Iodine value of oil</i>	140.0	145.4	162.2	135.8
Acid:				
Myristic	2.4	2.2	3.7	5.1
Palmitic	10.3	10.6	10.5	10.7
Stearic	2.5	4.4	2.0	1.3
Arachidic	0.3	0.3	—	0.6
Unsaturated C ₁₄	2.9	2.2	1.6	1.8
Unsaturated C ₁₆	25.7	20.8	15.5	10.5
Unsaturated C ₁₈	32.6	33.7	30.8	39.6
Unsaturated C ₂₀	12.1	13.6	16.5	17.6
Unsaturated C ₂₂	11.2	12.2	18.1	10.6
Unsaturated C ₂₄	—	—	1.3	2.1
Mean unsaturation of:				
Unsaturated C ₁₆	- 2.1	- 2.1	- 2.2	- 2.1
Unsaturated C ₁₈	- 2.7	- 2.4	- 2.7	- 2.4
Unsaturated C ₂₀	- 5.9	- 7.2	- 5.7	- 5.6
Unsaturated C ₂₂	- 11.0	- 11.0	- 10.6	- 9.3
Unsaturated C ₂₄	—	—	- 11.0	- 10.9

It is only when comparison is made with the earlier results that it appears that the component acids of different seal blubber oils may vary to a considerable degree. The grey seal belongs to a different genus of the family, whilst the biological source of the Newfoundland oil cannot of course be given with any certainty. Whilst species differences may well account for at least part of the difference in composition between the blubber oils of the grey seal and the common seal, it is noteworthy that in these four oils we have a marked range of variation in some of the component acid groups, and that this is most evident in the hexadecenoic acid group, which lies between the extremes of about 10 and 26% of the total acids. In three of the four oils the unsaturated C_{18} (mainly oleic) acid content is similar, but in the Newfoundland oil, with lowest unsaturated C_{16} acid content, the percentage of the unsaturated C_{18} group rises to nearly 40% of the total acids. Similarly, whilst the combined content of unsaturated C_{20} and C_{22} (and C_{24}) acids in the blubber oils of the common seal is about 23–26%, this rises in the grey seal oil to 36%; in the Newfoundland oil the unsaturated C_{20} acid group is similarly high, but the unsaturated C_{22} group is still at the level observed in the common seal oils. Apart from the C_{20} acids in seal oil II (already mentioned), the mean unsaturation of the various series of acids appears to remain fairly constant in all the oils, irrespective of the variations in their proportion to which attention has just been drawn.

In the only other group of marine mammalian blubber oils—those of the Balaenidae—which have been studied to any extent, there are fairly well-defined differences in the proportions and average unsaturation of the different groups of component acids as between different genera and species of whales; but a number of independent specimens of Antarctic whale oil taken in different years show closely similar fatty acid compositions. So far as the few instances discussed above go, the conclusion may be hazarded that the blubber oils produced by different species of seal vary more widely in composition between themselves than those produced by different groups of the whale family. The present results may perhaps indicate further that the blubber fats of one and the same species of seal tend to exhibit more variation in composition than those from a single species of whale. This, again, may be connected with the diet of the seal, which is likely to be much more variable than that of the whale.

It is accordingly not easy to assign any very general characteristics to the component acids of seal blubber oils, except that their content of saturated acids is usually about 18% (10–11% palmitic acid), that unsaturated C_{18} (mainly oleic) acid forms about 33% of the total acids, and that the rest is made up of unsaturated C_{16} acids (about

15–25%) and polyethenoid acids of the C_{20} and C_{22} series (23–30%, mean unsaturation of the C_{20} acids about –5 to –6 H, and of the C_{22} acids –10 to –11 H).

Seal liver lipids

The liver tissue of the seal contains only a low proportion of lipids, which consist of glycerides and phosphatides in varying proportions. The liver of the common seal II apparently contained more lipid (glycerides) than the average, and in this instance we were able to make an ester-fractionation analysis of the liver-glyceride fatty acids. Comparative figures for the liver lipids of the common seal and of the grey seal are collected in Table 8.

Table 8. *Composition of seal liver lipids*

	Common seal I	Common seal II	Grey seal
Total lipid content of liver (moist) (%)	4.3	10.7	2.8
Composition of liver lipids (% w/w):			
Phosphatides (crude)	23	5	29
Glycerides	63	86	50
Unaponifiable matter	14	9	21
Approximate composition of liver glyceride fatty acids (% w/w):			
Saturated	20	20	37
Monoethenoid	40	38	46
Polyethenoid	40	42	17

The composition of the liver lipids thus appears to be somewhat variable, with a ratio which perhaps in normal seal livers is of the order of two or three parts of glyceride to one of phosphatide. The component acids of the liver glycerides of the grey seal which we examined earlier (Hilditch & Pathak, 1947) were much less unsaturated than those of the corresponding blubber oil or of the liver glycerides of the common seal which we have now studied, and contained much less polyethenoid acids and nearly twice as much saturated acids as either of the latter. The detailed component acid figures for the liver and blubber glycerides of the common seal II are compared in Table 9.

Table 9. *Component acids of the liver and blubber glycerides of common seal II*

Acid	Liver (% w/w)	Blubber (% w/w)
Myristic	0.2	2.2
Palmitic	11.4	10.6
Stearic	7.8	4.4
Arachidic	0.1	0.3
Unsaturated C_{14}	—	2.2 (–2.0)*
Unsaturated C_{16}	8.6 (–2.0)*	20.8 (–2.1)
Unsaturated C_{18}	27.9 (–2.4)	33.7 (–2.4)
Unsaturated C_{20}	23.7 (–6.2)	13.6 (–7.2)
Unsaturated C_{22}	20.3 (–11.0)	12.2 (–11.0)

* Mean unsaturation.

The liver glycerides contained considerably less hexadecenoic acids, somewhat less oleic and polyethenoid C_{18} acids, and considerably more polyethenoid C_{20} and C_{22} acids; the degree of unsaturation of the unsaturated components was similar in both liver and blubber glycerides. No comparable data are available for the liver and blubber glycerides of the whale or any other marine mammal, whilst similar comparisons in a number of fish species seem to indicate that no generalization can yet be made. Thus, in the sturgeon (Lovern, 1932b) and groper (Shorland & Hilditch, 1938) there is less fat in the liver than in the peritoneal cavity and pancreas (sturgeon) or the head (groper); but the component acids of liver and depot fats are similar in composition in the respective fish. This also obtains in the tunny (Lovern, 1936), in which the liver and flesh contain about the same proportion of fat. On the other hand, in halibut and turbot (Lovern, 1932a, 1937) the liver is the main fat depot, and the flesh contains but little fat: in both of these instances the unsaturated C_{16} acid contents of the liver glycerides are much higher, and the amount of polyethenoid C_{20} and C_{22} acids much lower, than in the corresponding flesh fats. This lack of correlation stands in contrast to the fats of land animals in which (Hilditch & Shorland, 1937) the liver glycerides are distinguished by definitely lower contents of stearic acid, and higher contents of hexadecenoic and of polyethenoid acids of the

C_{20} and C_{22} series, in comparison with the corresponding depot fats.

SUMMARY

1. The composition of the blubber and liver lipids from two specimens of the common seal (*Phoca vitulina* L.) has been investigated.

2. The component acids of the blubber glycerides of the two animals were not dissimilar, but differed considerably from that of the grey seal (*Halichoerus grypus*). These differences are probably due partly to difference in species, but it also appears likely that differences in the food ingested by individual seals may be responsible to some extent for variations in the fat laid down.

3. The liver lipids of seals also appear to differ in amount and in their composition. One of the two common seal livers examined was exceptionally rich in glycerides as compared with phosphatides. Contrary to what was observed in the grey seal, the liver glycerides of the common seal are very similar in composition to its blubber oil.

4. So far, no correlation has been discernible between the composition of the liver glycerides and the glycerides of the flesh, head or other tissues of marine animals which may function as fat depots.

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The Action of Trypsin on Insulin

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In previous studies (Butler, Dodds, Phillips & Stephen, 1948) it was found that the action of trypsin on insulin is comparatively slight. It appeared likely that the slow action observed was due to a small proportion of chymotrypsin (about 0.5%) known to be present in the trypsin, and it was doubtful if there was any residual effect which might be ascribed to trypsin itself. In some further

experiments with the same materials it was found that the extent of the action was rather variable, and appeared to depend on several factors, e.g. the method of preparing the insulin solution, the age of the solution at the time of enzyme addition. The possibility that trypsin might cause a slight hydrolysis of insulin without decreasing its potency has led us to re-examine its action, using eventually