CCCXXXVI.—*The Unsaponifiable Matter from the Oils of Elasmobranch Fish. Part VII. The Synthesis of α-Glyceryl Ethers and its Bearing on the Structure of Batyl, Selachyl, and Chimyl Alcohols.*

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It has previously been shown that batyl, selachyl, and chimyl alcohols are simple monoglyceryl ethers whose structures correspond to either (I) or (II), where R represents the octadecyl, oleyl, and cetyl radical respectively.

$$\text{(I.)}\quad R{\cdot}\overset{\alpha}{O}{\cdot}CH_2{\cdot}CH(OH){\cdot}CH_2{\cdot}OH \qquad R{\cdot}\overset{\beta}{O}{\cdot}CH(CH_2{\cdot}OH)_2\quad\text{(II.)}$$

Of these the β-structure was at first considered the more likely (Heilbron and Owens, J., 1928, 942), but, for reasons stated later, a reversal of this view was more recently suggested (Report of the Food Investigation Board, 1928, 109). The unsymmetrical α-glyceryl ether structure is also favoured by Knight (*Biochem. J.*, 1930, **24**, 256) as a result of measurements of unimolecular films of the three alcohols.

In continuation of this work and in order conclusively to establish the structure of these alcohols, the synthesis of *α-cetyl glyceryl ether* and *α-octadecyl glyceryl ether* has now been effected. Reference to the literature shows that two general methods have hitherto been employed for the preparation of ethers of this class. The first is due to Reboul (*Annalen*, 1861, Suppl. I, 239), who prepared α-ethyl glyceryl ether by heating α-monochlorohydrin with sodium ethoxide at 200°. The method was modified by Grün and Bockisch (*Ber.*, 1908, **41**, 3465), who found that in the case of the α-methyl glyceryl ether the reaction could be carried out in methyl-alcoholic solution. The second method emanates from Cross and Jacobs (*J. Soc. Chem. Ind.*, 1926, **45**, 320T), who described the preparation of the α-ethyl, *iso*amyl, and benzyl glyceryl ethers by the interaction of the respective alkyl halides with sodium glyceroxide.

We have found that although these methods are readily applicable to the formation of the lower alkyl α-monoglyceryl ethers, several of which we have prepared and characterised by formation of their diphenylurethanes, they cannot be employed for the preparation of the higher homologues such as the α-cetyl or α-octadecyl glyceryl ether. The desired results have, however, been reached by way of the allyl ethers, which are readily obtained by heating the required alkyl chloride with sodium allyloxide in allyl-alcoholic solution. The conversion of the allyl ethers into the corresponding α-glyceryl ethers presented no special difficulty. As methods involving the formation of the βγ-dibromo-α-alkyloxypropanes did not seem suitable in view of the difficulty experienced by Irvine, Macdonald, and Soutar (J., 1915, **107**, 337) in converting βγ-dibromo-α-methoxypropane into α-methyl glyceryl ether, we decided to attempt the direct introduction of the hydroxyl group by means of oxidising agents. Such a method has been employed by Fairbourne and Foster (J., 1926, 3146), who succeeded in converting allyl *p*-nitrobenzoate into the corresponding glyceride ester by employing a 1% solution of aqueous potassium permanganate, but the yield was unsatisfactory. We have now found that a practically quantitative conversion of the cetyl and octadecyl allyl ethers into their α-glyceryl ethers can be effected by means of perhydrol in glacial acetic acid solution according to the method employed by Hilditch (J., 1926, 1828) for the preparation of dihydroxystearic acid from oleic acid. The α-cetyl glyceryl ether was thus obtained in colourless crystals, m. p. 64—65°. It produced no noticeable depression of melting point in admixture with a small amount of material (m. p. 62—63°) which had been isolated from a Japanese shark liver-oil and which appeared to be identical with Toyama's chimyl alcohol (m. p. 60·5—61·5°) (*Chem. Umschau*, 1924, **31**, 61, 153) and it thus appeared that chimyl alcohol was actually the α-cetyl glyceryl ether. Subsequent work has shown us, however, that our supposed pure chimyl alcohol was in reality a mixture of batyl alcohol with some unidentified substance (unpublished work). In this case, therefore, no direct comparison of the synthetic glyceride with the naturally occurring alcohol, if such indeed actually exists, has been possible. On the other hand, we have been able to compare the synthetic α-octadecyl glyceryl ether with an authentic specimen of pure batyl alcohol. The two substances both melt at 70—71° (Toyama, *loc. cit.*, gives m. p. 70·4—71° for batyl alcohol), but a mixed m. p. determination shows a small but definite depression (with equal quantities the m. p. is 68—69·5°). This indication of a difference in structure of the two substances is emphasised in the case of the respective diphenylurethanes : whereas *α-octadecyl glyceryl ether diphenylurethane* melts at 95—96° and batyl alcohol diphenylurethane has m. p. 97·5—98°, a mixture of the two substances has m. p. 93—94°. These results seem to us clearly to indicate that batyl alcohol is *not* identical with α-octadecyl glyceryl ether and must consequently have the isomeric β-structure (II). It follows from this that, as selachyl alcohol readily yields batyl alcohol on hydrogenation, it must by analogy be the β-oleyl glyceryl ether.

We are at present engaged in the attempted synthesis of the β-octadecyl glyceryl ether in order to have complete evidence of its identity with natural batyl alcohol.

EXPERIMENTAL.

α-Ethyl glyceryl ether was readily obtained in good yield as a colourless mobile liquid, b. p. 118—121°/21 mm., by Grün and Bockisch's modification of Reboul's method (*loc. cit.*). The *diphenylurethane* was prepared by heating the alcohol (2·5 g.) with phenylcarbimide (5 g.) for 3 hours at 60°. The glassy mass was extracted with warm benzene and filtered to remove diphenylurea. The urethane, after precipitation with low-boiling petroleum, was repeatedly crystallised from benzene–light petroleum, from which it separated in needle clusters, m. p. 103—104° (Found : N, 8·0. $C_{19}H_{22}O_5N_2$ requires N, 7·8%).

α-Propyl glyceryl ether was prepared in a similar manner from α-monochlorohydrin by treatment with sodium and propyl alcohol (compare Boehringer and Söhne, *Centralblatt*, 1910, **81**, II, 1256). It formed a colourless liquid, b. p. 118—122°/15 mm., $n_D^{18°}$ 1·4400, $d_{4°}^{18°}$ 1·074 (Found : C, 53·3 ; H, 10·2. $C_6H_{14}O_3$ requires C, 53·7 ; H, 10·4%). The *diphenylurethane* crystallised from benzene–light petroleum in needles, m. p. 116° (Found: N, 7·7. $C_{20}H_{24}O_5N_2$ requires N, 7·5%).

α-Butyl Glyceryl Ether.—α-Monochlorohydrin (30 g.) was refluxed for 18 hours with sodium butoxide solution (9·3 g. of sodium in 120 c.c. of butyl alcohol). The butyl alcohol was removed at ordinary pressure from the filtered solution, and the residue fractionated; the pure *α-butyl glyceryl ether* was then obtained as a colourless mobile oil, b. p. 138—140°/22 mm., $n_D^{18°}$ 1·4463, $d_{4°}^{18°}$ 1·002 (Found: C, 56·8; H, 11·1. $C_7H_{16}O_3$ requires C, 56·8; H, 10·8%). The *diphenylurethane* crystallised from benzene–light petroleum in needle clusters, m. p. 94—95° (Found: N, 7·6. $C_{21}H_{26}O_5N_2$ requires N, 7·3%).

Cetyl Allyl Ether.—A solution of sodium allyloxide (10·5 g. of sodium in 90 g. of pure allyl alcohol) and cetyl chloride (40 g.) was gently boiled under reflux for 30 hours. The reaction mixture was diluted with water, neutralised with dilute sulphuric acid, and extracted with ether. The ethereal solution was washed with water and dried over anhydrous sodium sulphate and, after removal of solvent, the yellow mobile oil was fractionally distilled from a Willstätter flask. The main fraction (33 g.), which distilled at 165—176°/7 mm., gradually solidified. Pure *cetyl allyl ether* was obtained after three crystallisations from aqueous alcohol in large colourless plates, m. p. 25° [Found: C, 80·7; H, 13·4; iodine value (Wijs), 90·1. $C_{19}H_{30}O$ requires C, 80·9; H, 13·5%; iodine value, 88·2].

α-Cetyl Glyceryl Ether.—Numerous attempts were made to obtain this compound directly (*a*) by the interaction of sodium cetyloxide with α-monochlorohydrin and (*b*) by the interaction of sodium glyceroxide with cetyl chloride according to Cross and Jacobs' method (*loc. cit.*), but under no conditions could any definite product be isolated. The following method was finally adopted: A solution of cetyl allyl ether (6 g.) in glacial acetic acid (120 c.c.) was treated with perhydrol (9·6 g.), and the whole heated on the steam-bath for 15 hours, further quantities of hydrogen peroxide being introduced at regular intervals until an equivalent of 9 mols. had been employed. The cold solution was neutralised with dilute aqueous ammonia and repeatedly extracted with ether. The residual viscous oil after removal of the solvent was hydrolysed with hot alcoholic potash to decompose any acetyl derivative formed during the reaction. The solution was again diluted with water and extracted with ether. After removal of the ether, a thick oil was obtained which rapidly solidified in the ice-chest. The crude product was crystallised from aqueous acetone, from which pure *α-cetyl glyceryl ether* separated in rosettes of colourless needles,

m. p. 64—65° (Found : C, 72·2; H, 12·8. $C_{19}H_{40}O_3$ requires C, 72·2; H, 12·7%). The *diphenylurethane* was prepared by refluxing for 4 hours a solution of α-cetyl glyceryl ether in dry benzene with excess of phenylcarbimide. It crystallised from benzene in needles, m. p. 93—94° (Found : C, 71·5; H, 8·8; N, 4·9. $C_{33}H_{50}O_5N_2$ requires C, 71·5; H, 9·0; N, 5·1%).

Octadecyl Allyl Ether.—Octadecyl alcohol was quantitatively converted by treatment with phosphorus pentachloride in thionyl chloride solution into the chloride, and this was condensed with sodium allyloxide as detailed above. *Octadecyl allyl ether* crystallised from alcohol in colourless plates, m. p. 27·5—28·5° [Found : C, 81·0; H, 13·5; iodine value (Wijs), 82·1. $C_{21}H_{42}O$ requires C, 81·3; H, 13·6%; iodine value, 81·9].

α-Octadecyl Glyceryl Ether.—The preparation of this compound was carried out in an exactly analogous manner to that of α-cetyl glyceryl ether. The pure substance crystallised from acetone in lustrous plates, m. p. 70—71° (Found : C, 73·2; H, 13·0. $C_{21}H_{44}O_3$ requires C, 73·2; H, 12·8%). The *diphenylurethane* separated from benzene–light petroleum in needles, m. p. 95—96° (Found : N, 5·0. $C_{33}H_{54}O_5N_2$ requires N, 4·8%).

In conclusion we desire to thank the Department of Scientific and Industrial Research for a grant to one of us (W. M. O.) in aid of this investigation.

THE UNIVERSITY, LIVERPOOL. [*Received, September 27th,* 1930.]