285. *Studies in the Sterol Group. Part XX. The Partial Reduction of Fucosterol.*

By D. H. Coffey, I. M. Heilbron, F. S. Spring, and H. R. Wright.

The algal sterol, fucosterol, has been shown to be isomeric with stigmasterol (Heilbron, Phipers, and Wright, J., 1934, 1572) and to differ from the latter in that both of its ethenoid linkages are contained in the condensed ring system. The possibility of obtaining further insight into their precise position by methods of oxidation has been examined, but no serviceable products have yet been isolated. We have, therefore, directed our attention to

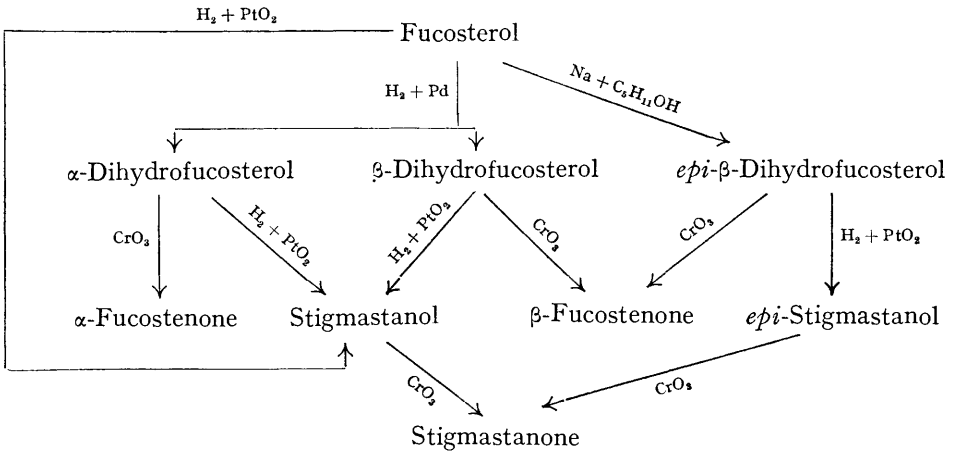
a study of the partial reduction of fucosterol. Hydrogenation of the acetate in ethyl acetate–acetone solution in the presence of palladium-black gives a mixture, fractional crystallisation of which yields α-*dihydrofucosteryl acetate*, m. p. 133—134°, and β-*dihydrofucosteryl acetate*, m. p. 121—122°, giving respectively on hydrolysis α-, m. p. 136—137°, and β-*dihydrofucosterol*, m. p. 132—133°.

Hydrogenation of each dihydrosterol in the presence of Adams's platinum oxide gives stigmastanol, m. p. 134°, a result which proves that they are not stereoisomerides but differ in the location of their ethenoid linkages.

Treatment of fucosterol with sodium and amyl alcohol gives a third partially reduced product, m. p. 159° (*acetate*, m. p. 86°), which we have proved to be epi-β-*dihydrofucosterol* by the following reactions. On hydrogenation, employing Adams's platinum oxide, a saturated sterol, m. p. 173—174·5°, is formed which differs from stigmastanol and, since it yields stigmastanone on oxidation with chromic anhydride, must be the *epi*-isomeride. Furthermore, the oxidation of α-dihydrofucosterol with chromic anhydride gives α-fucostenone, m. p. 158° (2 : 4-*dinitrophenylhydrazone*, m. p. 272°), whereas β-dihydrofucosterol and the alcohol of m. p. 159° both yield the same ketone, β-*fucostenone*, m. p. 136—137° (2 : 4-*dinitrophenylhydrazone*, m. p. 185°).

We are now engaged upon an examination of the α- and β-dihydrofucosterols with a view to locating the position of the ethenoid linkage in each, and consequently the positions of the two ethenoid linkages of fucosterol.

The foregoing results are summarised below :



Experimental.

Hydrogenation of Fucosterol.—A solution of fucosteryl acetate (6 g.) in acetone (200 c.c.) and ethyl acetate (100 c.c.) was hydrogenated by means of a palladium catalyst for 12 hours. The solvent was removed under reduced pressure and the residue crystallised from ethyl alcohol; a micro-crystalline material separated, m. p. 125—126°, repeated recrystallisation of which, first from ethyl and finally from methyl alcohol, yielded α-*dihydrofucosteryl acetate* in needles, m. p. 133—134°, $[\alpha]_D^{20°}$ — 43·53° (l = 1, c = 7·633 in chloroform) (Found : C, 81·1; H, 11·6. $C_{31}H_{52}O_2$ requires C, 81·5; H, 11·5%). Hydrolysis of the acetate with 10% ethyl-alcoholic potash yielded α-*dihydrofucosterol*, crystallising from methyl alcohol in long needles, m. p. 136—137°, $[\alpha]_D^{20°}$ — 38·43° (l = 1, c = 5·8 in chloroform) (Found : C, 84·1; H, 12·3. $C_{29}H_{50}O$ requires C, 84·0; H, 12·2%.)

Concentration of the first mother-liquors from which the α-acetate had been obtained, followed by repeated crystallisation of the separated solid from alcohol, gave β-*dihydrofucosteryl acetate* in needles, m. p. 121—122°, $[\alpha]_D^{20°}$ — 38·7 (l = 1, c = 4·890 in chloroform) (Found : C, 81·45; H, 11·5. $C_{31}H_{52}O_2$ requires C, 81·5; H, 11·5%). Hydrolysis of this acetate yielded β-*dihydrofucosterol*, separating from alcohol in needles, m. p. 132—133°, $[\alpha]_D^{20°}$ — 30·36° (l = 1, c = 6·47 in chloroform) (Found : C, 83·8; H, 12·2. $C_{29}H_{50}O$ requires C, 84·0; H, 12·2%)

Perbenzoic Acid Titration.—(a) α-*Dihydrofucosterol.* After 24 and 48 hours, 0·2174 g. of α-dihydrofucosterol had absorbed the equivalent of 7·9 and 8·08 mg. of oxygen, respectively, corresponding to 0·98 and 0·99 double bond.

(b) β-*Dihydrofucosterol.* The corresponding data for 0·2130 g. of β-dihydrofucosterol were 8·31 and 8·45 mg. of oxygen, corresponding to 1·01 and 1·03 double bond.

Hydrogenation of α- *and* β-*Dihydrofucosterol.*—In each case a solution of the dihydrofucosterol (1 g.) in glacial acetic acid (40 c.c.) and ethyl acetate (80 c.c.) was hydrogenated in the presence of Adams's platinum oxide for 12 hours. After removal of the solvent and precipitation with water, the product was recrystallised from methyl alcohol, separating in needles, m. p. 133—134°, either alone or on admixture with an authentic specimen of stigmastanol. Furthermore, in each case, the product on oxidation with chromic anhydride in glacial acetic acid (Heilbron, Phipers, and Wright, *loc. cit.*) yielded a ketone, m. p. 154—155°, either alone or on admixture with an authentic specimen of stigmastanone.

epi-β-*Dihydrofucosterol.*—A solution of fucosterol (10 g.) in amyl alcohol (750 c.c.) at 110° was treated with sodium (80 g.) added in small pieces over a period of an hour, after which the temperature was maintained at 145° for a further 4 hours, the mixture being mechanically stirred throughout. The product, isolated in the usual manner, formed a semi-solid mass which was repeatedly crystallised from acetone–methyl alcohol, epi-β-*dihydrofucosterol* separating in flat needles, m. p. 159°, $[\alpha]_D^{20°}$ + 12·2° (l = 1, c = 5·2 in chloroform) (Found : C, 84·3; H, 12·25. $C_{29}H_{50}O$ requires C, 84·0; H, 12·2%). The *acetate* separates from methyl alcohol as needles, m. p. 86° (Found : C, 81·5; H, 11·7. $C_{31}H_{52}O_2$ requires C, 81·5; H, 11·5%). After 48 hours, 0·2034 g. of *epi*-β-dihydrofucosterol had absorbed the equivalent of 7·55 mg. of oxygen, corresponding to 0·96 double bond. A solution of *epi*-β-dihydrofucosterol (40 mg.) in chloroform (15 c.c.) was treated with bromine (0·9 g.) in chloroform (120 c.c.) at 0°, until the colour persisted (bromine absorbed, 20 mg. $C_{29}H_{50}O|^{=}_{1}$ requires 15 mg.). The dibromide, m. p. 139°, isolated from the solution, was very unstable and could not be crystallised.

epi*Fucostanol.*—*epi*-β-Dihydrofucosterol (1·0 g.) dissolved in glacial acetic acid (25 c.c.) and ethyl acetate (40 c.c.) was hydrogenated as above. After removal of the solvent and precipitation with water, the product was crystallised from methyl alcohol, giving needles, m. p. 173·5—174·5°, which gave no colour with tetranitromethane in chloroform solution.

Oxidation of epi*fucostanol.* A solution of *epi*fucostanol (0·7 g.) in glacial acetic acid (140 c.c.) was oxidised during 9 hours at room temperature with a solution of chromic anhydride (0·3 g.) in glacial acetic acid (15 c.c.) and water (2 c.c.), the whole being mechanically stirred. The reaction mixture was precipitated with water, and the collected solid crystallised from methyl alcohol, from which it separated in needles, m. p. 153—154°, either alone or on admixture with an authentic specimen of stigmastanone.

α-*Fucostenone.*—α-Dihydrofucosterol (1·0 g.) was similarly oxidised with proportionate quantities of reagents for 5 hours, the reaction mixture poured into water, extracted with ether, and the extract washed with sodium carbonate solution. The residual oily solid remaining after removal of the ether was crystallised from aqueous ethyl alcohol and finally from methyl alcohol, from which α-*fucostenone* separated in small needles, m. p. 158° (Found : C, 84·5; H, 11·3. $C_{29}H_{48}O$ requires C, 84·45; H, 11·65%). The 2 : 4-*dinitrophenylhydrazone* separated from methyl alcohol in pale yellow micro-needles, m. p. 272° (Found : N, 9·55. $C_{35}H_{52}O_4N_4$ requires N, 9·5%).

β-*Fucostenone.*—Oxidation of β-dihydrofucosterol by the same method afforded β-*fucostenone*, which crystallised from methyl alcohol in flat needles, m. p. 135—136° (Found : C, 83·7; H, 11·4%).

Oxidation of epi-β-*Dihydrofucosterol.*—A solution of *epi*-β-dihydrofucosterol in acetic acid was oxidised as in the preceding cases. The product crystallised from methyl alcohol in needles, m. p. 136—137°, either alone or on admixture with β-fucostenone (Found : C, 83·95; H, 11·5%). The 2 : 4-*dinitrophenylhydrazone* separates from chloroform–ethyl alcohol in small plates, m. p. 185° (Found : N, 9·9. $C_{35}H_{52}O_4O_4$ requires N, 9·5%).

THE UNIVERSITY, MANCHESTER. [*Received, July 9th,* 1935.]