

## 229. *Studies in the Sterol Group. Part XIV. $\beta$ -Ergosterol and its Derivatives.*

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THE isomerisation of  $\alpha$ -ergosterol (m. p. 131—132°) was first studied by Reindel, Walter, and Rauch (*Annalen*, 1927, 452, 34), who obtained, by the action of hydrogen chloride on  $\alpha$ -ergosterenyl acetate, as main product a supposed  $\beta$ -acetate, m. p. 94—95°, together with a small quantity of a second compound, m. p. 110—111°, which gave on hydrolysis a sterol, m. p. 141—142°. Reindel and Walter later showed (*Annalen*, 1928, 460, 212) that the  $\beta$ -acetate was not a pure compound but an inseparable mixture of the  $\alpha$ -acetate with the  $\beta$ -isomeride (compare also Hart, Speer, and Heyl, *J. Amer. Chem. Soc.*, 1930, 52, 2016).

We have now investigated the action of hydrogen chloride on  $\alpha$ -ergosterenyl benzoate, and have obtained a high-melting isomeride, m. p. 158—160°. This compound, which is undoubtedly pure  $\beta$ -ergosterenyl benzoate, gave on hydrolysis  $\beta$ -ergosterol, m. p. 141—142°,  $[\alpha]_D^{20} + 19.4^\circ$ , from which ergostanol (*allo*- $\alpha$ -ergostanol of Reindel and Walter, *loc. cit.*) was quantitatively obtained on hydrogenation. In contrast to  $\alpha$ -ergosterol,  $\beta$ -ergosterol and its derivatives do not give an immediate Tortelli-Jaffe reaction, but a coloration is obtained on standing.

When  $\beta$ -ergosterol was distilled with copper-bronze powder in a high vacuum, the corresponding ketone,  $\beta$ -ergosterone, m. p. 149—151°, was obtained in good yield. Reduction of  $\beta$ -ergosterone by Clemmensen's method gave rise to  $\beta$ -ergostene, m. p. 87—88°, which was also obtained by reduction of  $\beta$ -ergosterenyl chloride with sodium and amyl alcohol.

### EXPERIMENTAL.

**$\beta$ -Ergosterenyl Benzoate.**—Dry hydrogen chloride was passed during 2 hours through an ice-cold solution of  $\alpha$ -ergosterenyl benzoate (10 g.; m. p. 118°) in dry chloroform (20 c.c.). The solution was evaporated to dryness under reduced pressure, the residue dissolved in hot benzene (25 c.c.), and this solution diluted with twice its volume of hot alcohol. On cooling, crude  $\beta$ -ergosterenyl benzoate separated (m. p. 145—152°). After repeated crystallisation from benzene-alcohol,  $\beta$ -ergosterenyl benzoate (7.5 g.) was obtained in large prisms, m. p. 158—160°, very sparingly soluble in alcohol, acetone, and glacial acetic acid but readily soluble in benzene and chloroform;  $[\alpha]_D^{20} + 18.3^\circ$  ( $c = 4.65$  in chloroform) (Found: C, 83.1; H, 10.2.  $C_{34}H_{50}O_2$  requires C, 83.3; H, 10.2%).

Treatment of  $\beta$ -ergostenyl benzoate (1 g.) in chloroform (5 c.c.) with hydrogen chloride at  $0^\circ$ , and fractional crystallisation of the product from benzene-alcohol, yielded a first crop (0.7 g.), m. p.  $145-148^\circ$ , and a second crop (0.2 g.), m. p.  $110-112^\circ$ , which was identified as  $\alpha$ -ergostenyl benzoate.

$\beta$ -Ergostenol,\* obtained by hydrolysis of the benzoate with alcoholic potash, crystallised from alcohol in large plates and from ether, acetone, and ethyl acetate in fine needles, m. p.  $141-142^\circ$  (after drying at  $100^\circ$ );  $[\alpha]_D^{20} + 19.4^\circ$  ( $c = 5.3$  in chloroform) (Found: C, 83.7; H, 12.0.  $C_{27}H_{46}O$  requires C, 83.9; H, 11.9%).

$\beta$ -Ergostenyl acetate, prepared from the sterol by means of acetic anhydride, crystallised from alcohol in shining plates, m. p.  $111-112^\circ$ ,  $[\alpha]_D^{20} + 13.1^\circ$  ( $c = 5.45$  in chloroform) (Found: C, 81.2; H, 11.2.  $C_{29}H_{48}O_2$  requires C, 81.3; H, 11.2%).

Ergostanol from  $\beta$ -Ergostenol.—A solution of  $\beta$ -ergostenol (0.8 g.) in ethyl acetate (50 c.c.) was hydrogenated at room temperature with palladium (0.5 g.) as catalyst. The crude product had m. p.  $135^\circ$  and gave only a faint Liebermann-Burchard reaction. It was converted into its acetate, which on crystallisation from alcohol readily yielded pure ergostanyl acetate, m. p.  $145^\circ$ , from which ergostanol, m. p.  $143-144^\circ$ , was obtained on hydrolysis.

$\beta$ -Ergostenone.— $\beta$ -Ergostenol (2 g.) was boiled under 0.5 mm. pressure with copper-bronze powder (2 g.) for  $\frac{1}{2}$  hour and then rapidly distilled. When the distillate, which formed a horn-like mass, was crystallised from alcohol,  $\beta$ -ergostenone separated (oxime, m. p.  $220^\circ$ ), m. p.  $149-151^\circ$ ,  $[\alpha]_D^{20} + 36.4^\circ$  ( $c = 10$  in chloroform). Its identity was established by comparison with  $\beta$ -ergostenone prepared according to Reindel's method (*Annalen*, 1928, 466, 131).

$\beta$ -Ergostene.—(a) *By reduction of  $\beta$ -ergostenone.*  $\beta$ -Ergostenone (2 g. in 10 c.c. of xylene) was reduced by boiling for 30 hours with concentrated hydrochloric acid (200 c.c.) and amalgamated zinc (50 g.). The xylene was removed with steam, and the residue extracted with ether. The oily product from the dried extract solidified on standing, and after several crystallisations from acetone gave  $\beta$ -ergostene as small shining leaflets (0.7 g.), m. p.  $87-88^\circ$ ,  $[\alpha]_D^{20} + 21.3^\circ$  ( $c = 1.5$  in chloroform) (Found: C, 87.5; H, 12.4.  $C_{27}H_{46}$  requires C, 87.6; H, 12.4%).

(b) *By reduction of  $\beta$ -ergostenyl chloride.* A mixture of dry  $\beta$ -ergostenol (2.6 g.), precipitated calcium carbonate (1 g.), and chloroform (4 c.c.) was intimately rubbed with phosphorus pentachloride (2.5 g.). The product was treated with hot water and

\* Since this work was completed Hart and Emerson (*J. Amer. Chem. Soc.*, 1932, 54, 1070) also have obtained this compound in 5% yield by fractionation of partly isomerised  $\alpha$ -ergostenol.

extracted with ether. Evaporation of the dried extract yielded the chloride as an oil (2 g.), which, without further purification, was reduced with sodium in boiling amyl alcohol, and the solvent removed with steam. The crude product was repeatedly crystallised from acetone;  $\beta$ -ergostene, m. p. 83—85°, was then obtained which gave no depression on admixture with the hydrocarbon prepared from  $\beta$ -ergostenone.

The authors desire to express their thanks to Messrs. Imperial Chemical Industries Ltd. for valuable financial assistance, and to the Department of Scientific and Industrial Research for a grant to one of them (D. G. W.). They are also indebted to Mr. W. Doran, M.Sc., and Mr. W. F. Boston for carrying out by micro-methods the recorded analyses.

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[Received, March 31st, 1932.]

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