699. *Steroids. Part IV.* Stigmasta-7 : 9(11) : 22-trien-3β-yl Acetate.*

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22 : 23-Dibromostigmasta-7 : 9(11)-dien-3β-yl acetate and stigmasta-7 : 9(11) : 22-trien-3β-yl acetate have been obtained from α-spinasteryl acetate.

The nuclear ethylenic linkage of α-spinasterol was shown to be located between $C_{(7)}$ and $C_{(8)}$ by Barton and Cox (*J.*, 1948, 1354; Barton *J.*, 1945, 813). Fieser, Fieser, and Chakravarti (*J. Amer. Chem. Soc.*, 1949, **71**, 2226) confirmed the structure of α-spinasterol as stigmasta-7 : 22-dien-3β-ol by its partial synthesis from stigmasterol. An efficient method for the conversion of α-dihydroergosterol (ergosta-7 : 22-dien-3β-ol) into ergosterol-D [ergosta-7 : 9(11) : 22-trien-3β-ol] has recently been described (Anderson, Stevenson, and Spring, *J.*, 1952, 2901). The present communication describes the application of this method to the analogously constituted α-spinasterol.

Treatment of α-spinasteryl acetate with bromine gives a tetrabromostigmastenyl acetate in poor yield. Partial debromination of the tetrabromo-derivative by using sodium iodide yields 22 : 33-dibromostigmasta-7 : 9(11)-dien-3β-yl acetate which exhibits the characteristic ultra-violet absorption spectrum of 7 : 9(11)-dienic steroids. Debromination of the dibromo-derivative with zinc gives stigmasta-7 : 9(11) : 22-trien-3β-yl acetate which is also obtained by oxidation of α-spinasteryl acetate with mercuric acetate. The most efficient method for the preparation of stigmasta-7 : 9(11) : 22-trien-3β-yl acetate from α-spinasteryl acetate is by treatment with bromine at a low temperature followed by direct debromination of the reaction product with zinc dust.

Experimental

M.p.s are uncorrected. Specific rotations were measured in chloroform, except where otherwise stated, a 1-dm. tube being used at approximately 15°. Ultra-violet absorption spectra were measured in ethanol with a Unicam SP. 500 spectrophotometer. Grade II alumina was used for chromatography.

α-Spinasteryl Acetate.—An extract from lucerne was supplied to us by Dr. W. Mitchell of Stafford Allen and Sons, Ltd., to whom we express our thanks. The non-saponifiable matter (105 g.) from lucerne, in benzene (2 l.), was chromatographed on alumina (50 × 6 cm.). The fractions eluted with benzene (7·5 l.), benzene–ether (9 : 1; 1 l.), benzene–ether (7 : 3, 1 l.), benzene–ether (1 : 1, 3 l.), and benzene–methanol (199 : 1, 3 l.) were discarded. Continued elution with benzene–methanol (199 : 1, 8 l.) gave a brown wax (approx. 50 g.). A solution of this wax in pyridine (200 c.c.) and acetic anhydride (40 c.c.) was kept at room temperature; after 18 hours the separated crystalline solid (8 g.) was collected and recrystallised from methanol–chloroform, giving α-spinasteryl acetate (2·7 g.) as plates, m. p. 182—185°, $[\alpha]_D$ −3·5°, −5° (*c*, 2·0, 1·9) (Found: C, 82·0; H, 11·4. Calc. for $C_{31}H_{50}O_2$: C, 81·9; H, 11·1%). A solution of the solid obtained from the acetic anhydride–pyridine mother liquors, by precipitation with water, in benzene (1 l.) was chromatographed on alumina (50 × 6 cm.), and the column was washed with benzene (2 l.). The solid (12 g.) obtained by evaporation of the benzene filtrate was crystallised from chloroform–methanol to give α-spinasteryl acetate (2·8 g.), m. p. 177—180°, $[\alpha]_D$ −3° (*c*, 2·5). Hydrolysis of α-spinasteryl acetate gave α-spinasterol as plates, m. p. 167—169°, $[\alpha]_D$ −2°, −1° (*c*, 0·8, 2·0).

Tetrabromostigmastenyl Acetate.—A solution of α-spinasteryl acetate (500 mg.) in dry ether (35 c.c.) was treated at 0° with a solution of bromine in glacial acetic acid (10%; 3·5 c.c.) with shaking. The mixture was immediately cooled to −50° and then allowed to attain 0° during 4 hours. The ether was removed under reduced pressure at room temperature; the solid (190 mg.; m. p. 123—127°) separating from the acetic acid solution was collected and crystallised from light petroleum (b. p. 60—80°), from which *tetrabromostigmastenyl acetate* separated as clusters of small plates, m. p. 130—131° (decomp.), $[\alpha]_D$ +237°, +239° (*c*, 0·5, 0·5 in benzene) (Found: C, 48·65; H, 6·4; Br, 40·8. $C_{31}H_{48}O_2Br_4$ requires C, 48·2; H, 6·3; Br, 41·4%).

* Part III, *J.*, 1952, 3410.

22 : 23-*Dibromostigmasta*-7 : 9(11)-*dien*-3β-*yl Acetate*.—A solution of tetrabromostigmastenyl acetate (130 mg.) in benzene (10 c.c.) was mixed with one of sodium iodide (0·6 g.) in ethanol (10 c.c.). After 18 hours the mixture was diluted with water, the benzene layer separated, and the aqueous layer extracted with benzene. The combined benzene solutions were washed successively with sodium thiosulphate solution and water. The solution was concentrated to 50 c.c. under reduced pressure and then percolated through a column of alumina (2 × 1 cm.). The filtrate was evaporated and the solid crystallised from methanol–chloroform, giving 22 : 23-*dibromostigmasta*-7 : 9(11)-*dien*-3β-*yl acetate* as needles (70 mg.), m. p. 203—205° (decomp.), $[\alpha]_D$ +35°, +35·5° (*c*, 0·6, 0·7) (Found: C, 60·8; H, 8·2. $C_{31}H_{48}O_2Br_2$ requires C, 60·8; H, 7·9%). Light absorption: Maxima at 2350 (ε = 16,000) and 2420 Å (ε = 18,000) with an inflection at 2500 Å (ε = 12,000). The dibromide gives an orange-red colour with tetranitromethane in chloroform.

Stigmasta-7 : 9(11) : 22-*trien*-3β-*yl Acetate*.—(*a*) A solution of 22 : 23-dibromostigmasta-7 : 9(11)-dien-3β-yl acetate (53 mg.) in a mixture of ether (10 c.c.) and ethanol (15 c.c.) was heated under reflux for 3 hours with zinc dust (300 mg.). The product, isolated in the usual manner, was crystallised from methanol–chloroform, giving *stigmasta*-7 : 9(11) : 22-*trien*-3β-*yl acetate* as plates (28 mg.), m. p. 164—167°, $[\alpha]_D$ +45° (*c*, 0·7) (Found: C, 82·4; H, 10·8. $C_{31}H_{48}O_2$ requires C, 82·2; H, 10·7%). Light absorption: Maxima at 2360 (ε = 17,000) and 2420 Å (ε = 19,000) with an inflection at 2500 Å (ε = 12,500). The compound gives an orange-red colour with tetranitromethane in chloroform.

(*b*) A solution of α-spinasteryl acetate (1·5 g.) in dry chloroform (25 c.c.) was mixed with one of mercuric acetate (3·5 g.) in glacial acetic acid (50 c.c.); mercurous acetate quickly separated. The mixture was shaken for 22 hours, and the mercurous acetate (2·5 g.) was collected and washed with chloroform. The combined filtrate and washings were concentrated under reduced pressure below 50° and the solid (450 mg.), separating on cooling, recrystallised from methanol–chloroform, giving stigmasta-7 : 9(11) : 22-trien-3β-yl acetate as plates (390 mg.), m. p. 159—163° undepressed on mixing with a specimen prepared as described in (*a*), $[\alpha]_D$ +40° (*c*, 2·4) (Found: C, 82·1; H, 11·0%). Light absorption: Maxima at 2360 (ε = 16,000) and 2420 Å (ε = 18,000) with an inflection at 2500 Å (ε = 12,000).

(*c*) A solution of α-spinasteryl acetate (400 mg.) in dry ether (30 c.c.) at 0° was treated with a solution of dry bromine in glacial acetic acid (8%; 2·5 c.c.) with shaking. The solution was cooled to approximately −40°, kept at this temperature for 3 hours, and treated with activated zinc dust (3 g.) and the mixture stirred for 3 hours at −40° and then kept at 0° overnight. After filtration the solution was washed with water and dried (Na_2SO_4), and the solvent removed under reduced pressure. A solution of the solid residue in benzene (100 c.c.) was filtered through a column of alumina (5 × 1·7 cm.), and the column washed with benzene (250 c.c.). The combined benzene filtrates were evaporated and the residue crystallised from methanol–chloroform, giving stigmasta-7 : 9(11) : 22-trien-3β-yl acetate as plates (185 mg.), m. p. 163—166°, $[\alpha]_D$ +46°, +44° (*c*, 0·7, 1·3) (Found: C, 82·2; H, 10·8%). Light absorption: Maxima at 2360 (ε = 16,000) and 2420 Å (ε = 17,000) with an inflection at 2500 Å (ε = 10,500).

Stigmasta-7 : 9(11) : 22-*trien*-3β-*ol*.—A solution of stigmasta-7 : 9(11) : 22-trien-3β-yl acetate (100 mg.) in methanolic potassium hydroxide solution (30 c.c.; 1%) was heated under reflux for 1½ hours. The product, isolated by means of ether, was crystallised from methanol–chloroform, giving *stigmasta*-7 : 9(11) : 22-*trien*-3β-*ol* as needles, m. p. 164—165°, $[\alpha]_D$ +44° (*c*, 0·5) (Found: C, 84·3; H, 11·4. $C_{29}H_{46}O$ requires C, 84·8; H, 11·3%). Light absorption: Maxima at 2360 (ε = 13,500) and 2430 Å (ε = 15,500) with an inflection at 2500 Å (ε = 10,000).

Stigmasta-7 : 9(11) : 22-trien-3β-ol was acetylated in the usual way to give stigmasta-7 : 9(11) : 22-trien-3β-yl acetate which formed plates, $[\alpha]_D$ +45° (*c*, 0·8), m. p. 161—163°.

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