583. *Studies in the Steroid Group. Part LXI.* Oxidation of 5α-Hydroxy- and 5α-Acetoxy-Δ⁷:⁹-steroids.*

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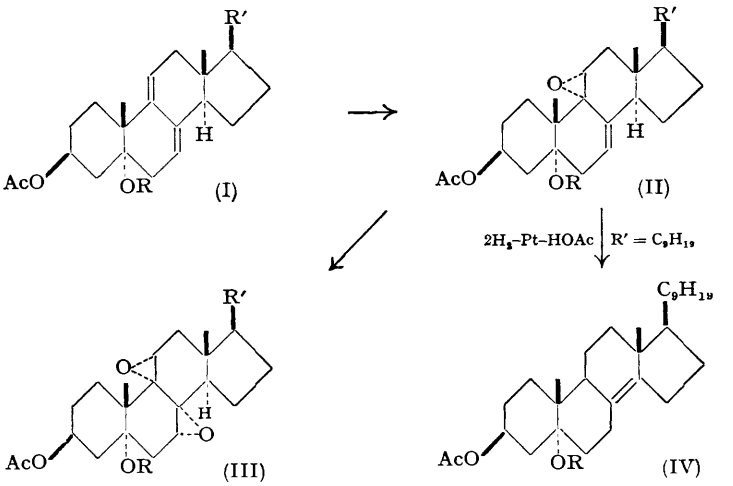
Peracid oxidation of 7 : 9-dienes of the above type results first in the formation of 9α : 11α-epoxides. Further oxidation then leads to either 7 : 8-9 : 11-diepoxides or to 7-keto-9 : 11-epoxides; the latter are converted into 11α-hydroxy-7-keto-5 : 8(9)-dienes on treatment with alkali. The unreactivity of the Δ⁷-bond in 3 : 5-diacetoxy-9α : 11α-epoxy-Δ⁷:²²-steroids permits selective ozonolysis of the side-chain double bond.

In earlier papers in this series (Parts LVI and LVII; *J.*, 1952, 4883, 4890) methods of preparing 5α-hydroxy- and 5α-acetoxy-Δ⁷:⁹-steroids (I) were discussed, the presence of the substituents at the 5-position being thought to be of considerable value for the eventual formation of 3-keto-Δ⁴-steroids. After a study of the oxidation of such dienes had been commenced with a view to the introduction of an 11-oxygen function, several reports have appearedd escribing the peracid oxidation of ergosterol-D, the 5-hydrogen analogue of our compounds, the most important observation being the formation of a monoepoxide by means of perbenzoic or monoperphthalic acid (cf. Chamberlin, Ruyle, Erickson, Chemerda, Aliminosa, Erickson, Sita, and Tishler, *J. Amer. Chem. Soc.*, 1951, **73**, 2396; Heusser, Eichenberger, Kurath, Dällenbach, and Jeger, *Helv. Chim. Acta*, 1951, **34**, 2106).

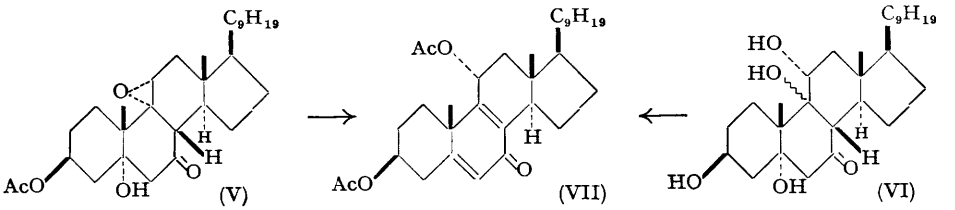


Treatment of the 5α-hydroxy-7 : 9-dienes (I; R = H) containing C_9H_{19}, CMe:CH·OAc, and COMe side chains with 1 mol. of monoperphthalic acid afforded the corresponding 9α : 11α-epoxides (II; R = H), the structures of the products being confirmed by their further reactions (see following paper). Better yields of 9α : 11α-epoxides were obtained by starting with 5α-acetoxy-7 : 9-dienes (3 : 5-diacetoxy-compounds) (I; R = Ac), the 5-acetate group not hindering the approach of peracid to the 9 : 11-bond. Conversion of the diacetate–epoxide (II; R = Ac, R′ = C_9H_{19}) into the 5-hydroxy-epoxide (II; R = H, R′ = C_9H_{19}), by hydrolysis of both acetate groups followed by mild acetylation, proved that similar epoxides were being formed in both series. Hydrogenation of these monoepoxides with R′ = C_9H_{19} took place with platinum and acetic acid, but the products were 5α-hydroxy-Δ⁸⁽¹⁴⁾-compounds (IV; R = H and Ac). Further oxidation of the 5-hydroxy-epoxide (II; R = H, R′ = C_9H_{19}) with monoperphthalic acid gave an excellent yield of the diepoxide (III; R = H, R′ = C_9H_{19}), whereas the corresponding 5-acetate

* Part LX, *J.*, 1952, 2015.

was mostly recovered unchanged under the same conditions. The steric hindrance apparently imposed by the α-orientated 5-acetoxy-group in this last reaction suggests that 7 : 8-epoxide formation in the 5-hydroxyl series takes place by rearwise approach of peracid, and thus a 7α : 8α-epoxy-configuration can be assigned provisionally.

The reaction of performic acid with 7 : 9-dienes (R′ = C_9H_{19}) has also been studied. Stirring the two-phase mixture of the steroid in chloroform and excess of aqueous performic acid afforded somewhat similar results to those described above, the 5-hydroxy-compound yielding the same 7 : 8-9 : 11-diepoxide, and the 5-acetate the same 9 : 11-monoepoxide, together, however, with some of the 5-acetate diepoxide (III; R = Ac, R′ = C_9H_{19}), the structure of which was confirmed by complete hydrolysis followed by mild acetylation to (III; R = H, R′ = C_9H_{19}), identical with that prepared in the 5-hydroxy-series. On the other hand, when the performic acid reaction with (I; R = H, R′ = C_9H_{19}) was conducted in homogeneous solution (addition of dioxan), a 7-keto-9α : 11α-epoxide (V) could be isolated by crystallization from methanol in about 25% yield [the same keto-



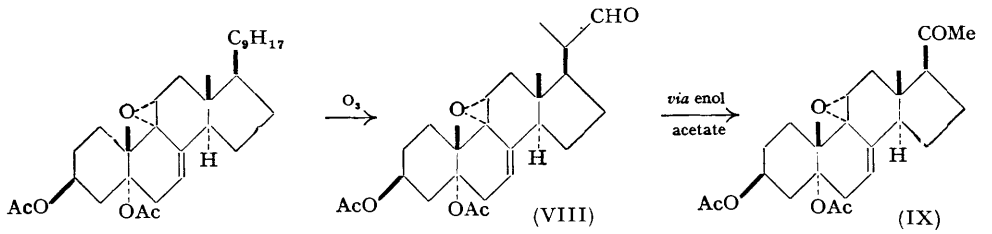
oxide was formed in small amount together with the 9 : 11-epoxide and some 7 : 8-9 : 11-diepoxide when (I; R = H, R′ = C_9H_{19}) was treated with 1·4 mols. of monoperphthalic acid in ether]. (In the 5-acetate series, " homogeneous " performic acid gave a mixture which could not be separated by chromatography on alumina owing to changes occurring on the column.) Another product of the reaction with the 5-hydroxy-compounds appeared to be the 3-acetate 9(or 11)-formate of the tetrol (VI), for treatment of the methanolic mother-liquor (after the crystallization of V) with dilute hydrochloric acid caused separation of the rather insoluble tetrol itself in about 40% yield. Acetylation of (VI) under mild conditions afforded a 3 : 11-diacetate, indicating an α-configuration for the 11-hydroxyl group—the 9-hydroxyl group should be β-orientated according to the method of formation, but this is as yet without experimental confirmation.

The formation of a 7-keto-9α : 11α-epoxide by the reaction of performic acid with a 5-unsubstituted 7 : 9-diene is the key step in the method first described by Stork, Romo, Rosenkranz, and Djerassi (*J. Amer. Chem. Soc.*, 1951, **73**, 3546) for the introduction of an 11-oxygen substituent. These authors describe the ready isomerization of such epoxy-ketones into 11α-hydroxy-7-keto-$\Delta^{8(9)}$-steroids under alkaline conditions. Similar alkaline treatment of the 5-hydroxy-compound (V) or the tetrol (VI) gave (after acetylation) the doubly unsaturated ketone (VII) with loss of the 5-hydroxyl group. Again, the ready acetylation of the 11-hydroxyl group leading to (VII) provides confirmation of the α-orientation of the original 9 : 11-epoxide group.

The formation of different major products from (I) by using performic acid in homogeneous or " two-phase " reaction conditions is probably related to the different acidities of the media in which the steroid is dissolved. It is believed that in both cases a 9 : 11-monoepoxide is first produced which, in the two-phase method is transformed into the diepoxide by the low concentration of performic acid in the chloroform layer. In the homogeneous solution (with a relatively high concentration of formic and performic acids), the 9 : 11-monoepoxide undergoes isomerization (*via* a $\Delta^{8(9)}$-7 : 11-diol) into a 7-keto-$\Delta^{9(11)}$-steroid which is then epoxidized or hydroxylated to give (V) or (VI).

The lack of reactivity of the 7 : 8-bond in the 3 : 5-diacetates (II; R = Ac) towards peracids paralleled that of 9 : 11-double bonds in compounds containing a 5 : 8-epidioxy-bridge (cf. Part LVIII, *J.*, 1952, 4894). It was shown in Part LVII (*loc. cit.*) that a compound of the latter type, 3β-acetoxy-5α : 8α-epidioxyergosta-9 : 22-diene, could be ozonized selectively at the side-chain double bond. When the same ozonolysis technique is used,

controlled oxidation of (II; R = Ac, R′ = C_9H_{17}, following paper) yields the aldehyde (VIII). The enol acetate of (VIII) was identical with that prepared by the action of mono-



perphthalic acid on the corresponding 7 : 9-diene (see above); on further selective ozonolysis it afforded the 20-ketone (IX).

Experimental

M. p.s were determined on a Kofler block. Rotations were measured in chloroform solution in a 1-dm. tube at room temperature (18—25°), and ultra-violet light absorption measurements were made in ethanol solution. Peter Spence alumina (Grade H) was used for chromatography; when necessary it was deactivated with dilute acetic acid as described by Farrar, Hamlet, Henbest, and Jones (*J.*, 1952, 2657).

3β-*Acetoxy*-9α : 11α-*epoxyergost*-7-*en*-5α-*ol* (II; R = H, R′ = C_9H_{19}).—Monoperphthalic acid (1·4 mols.), dissolved in dry ether (50 c.c.), was added to a solution of 3β-acetoxyergosta-7 : 9-dien-5α-ol (1·75 g.) in dry ether (200 c.c.). After 24 hr. at 0° and 48 hr. at 25°, the mixture was diluted with ether and washed with dilute alkali, water, and ferrous sulphate solution, dried, and evaporated to dryness under reduced pressure. The residue was dissolved in light petroleum–benzene (1 : 1) and introduced on to a column of deactivated alumina (200 g.). Elution with benzene (1·1 l.) gave, after recrystallisation from *iso*propyl ether, 3β-acetoxy-7α : 8α-9α : 11α-diepoxyergostan-5α-ol (330 mg.) as fine needles, m. p. and mixed m. p. with an authentic sample (see below) 221—226°, $[\alpha]_D$ +3° (*c*, 0·91). Further elution with benzene (1·2 l.) afforded 3β-*acetoxy*-9α : 11α-*epoxyergost*-7-*en*-5α-*ol* (450 mg.), crystallizing from methanol as plates, m. p. 222—227°, $[\alpha]_D$ +15° (*c*, 0·74) (Found: C, 75·95; H, 10·15. $C_{30}H_{48}O_4$ requires C, 76·2; H, 10·25%). Elution with benzene–ether (19 : 1) (600 c.c.) gave, after crystallization from methanol, 3β-acetoxy-9α : 11α-epoxyergostan-7-one (120 mg.), m. p. and mixed m. p. with an authentic sample (see below), 184·5—186°, $[\alpha]_D$ −44° (*c*, 0·65).

This experiment shows the nature of the products obtained by using considerably more than 1 mol. of peracid. When 1—1·1 mols. of peracid were used, the 9 : 11-epoxide could be isolated by crystallization of the product from methanol, in 50% yield.

Hydrolysis of 3β-acetoxy-9α : 11α-epoxyergost-7-en-5α-ol with warm 5% methanolic potassium hydroxide yielded the corresponding 3β : 5α-*diol*, crystallizing from *iso*propyl ether–methanol (1 : 1) as blades, m. p. 214·5—219·5°, $[\alpha]_D$ −6° (*c*, 0·69) (Found: C, 78·35; H, 10·6. $C_{28}H_{46}O_3$ requires C, 78·1; H, 10·75%).

3β-*Acetoxy*-7α : 8α-9α : 11α-*diepoxyergostan*-5α-*ol* (III; R = H, R′ = C_9H_{19}).—(*a*) Solutions of (i) 3β-acetoxyergosta-7 : 9-dien-5α-ol (5 g.) in chloroform (100 c.c.) and (ii) 100-vol. hydrogen peroxide (25 c.c.) in 95% formic acid (25 c.c.) were stirred together for 16 hr. at 20°. Formic acid was removed from the chloroform layer by washing with alkali, and the solvent was then removed under reduced pressure. Crystallization from methanol afforded the *diepoxide* (2 g.), m. p. 224—226°, $[\alpha]_D$ +3° (*c*, 1·0) (Found: C, 73·6; H, 9·9. $C_{30}H_{48}O_5$ requires C, 73·75; H, 9·9%).

Alkaline hydrolysis gave the 3β : 5α-*diol*, crystallizing from methanol as needles, m. p. 253—256°, $[\alpha]_D$ −1° (*c*, 1·0) (Found: C, 73·3; H, 10·6. $C_{28}H_{46}O_4,CH_3{\cdot}OH$ requires C, 72·75; H, 10·55%).

(*b*) Monoperphthalic acid (2 mols.) in dry ether (20 c.c.) was added to a solution of 3β-acetoxy-9α : 11α-epoxyergost-7-en-5α-ol (200 mg.) in dry ether (20 c.c.). The mixture was kept at 0° for 24 hr. and then at 25° for 72 hr., after which it was washed with dilute alkali, dried, and evaporated. Chromatography on deactivated alumina (25 g.) gave the diepoxide (130 mg.), m. p. and mixed m. p. 222—227°, $[\alpha]_D$ +2° (*c*, 0·98), and also some starting material (50 mg.).

3β : 5α-*Diacetoxy*-9α : 11α-*epoxyergost*-7-*ene* (II; R = Ac, R′ = C_9H_{19}).—Monoperphthalic

acid (1·1 mols.) in ether (30 c.c.) was added to a solution of 3β : 5α-diacetoxyergosta-7 : 9-diene (3·1 g.) in dry ether (25 c.c.). The reaction was allowed to proceed, and the mixture was then worked up as described above for the 5-hydroxy-compound. Crystallization of the total product from methanol gave the 9 : 11-*epoxide* (2 g.) as needles, m. p. 144·5—147·5°, $[\alpha]_D$ +71° (*c*, 0·86) (Found: C, 74·95; H, 9·95. $C_{32}H_{50}O_5$ requires C, 74·65; H, 9·8%). When this epoxide (200 mg.) was treated with an excess of monoperphthalic acid at 20° for 2 days, 180 mg. of pure starting material were recovered after chromatography.

3β : 5α-*Diacetoxy*-7α : 8α-9α : 11α-*diepoxyergostane* (III; R = Ac, R′ = C_9H_{19}).—Solutions of 3β : 5α-diacetoxyergosta-7 : 9-diene (1·5 g.) in chloroform (30 c.c.) and of 30% hydrogen peroxide (7·5 c.c.) in 98% formic acid (7·5 c.c.) were stirred together at 20° for 18 hr. The steroid was isolated with chloroform, and the gummy product chromatographed in benzene on deactivated alumina (75 g.). Light petroleum–benzene (3 : 1) eluted the 9α : 11α-monoepoxide (350 mg.), m. p. and mixed m. p. with the product from the previous experiment, 145—147°, $[\alpha]_D$ +66° (*c*, 0·4). Elution with light petroleum–benzene (1 : 1) afforded the 7α : 8α-9α : 11α-*diepoxide* (300 mg.), crystallizing from methanol as needles, m. p. 178—179°, $[\alpha]_D$ +22° (*c*, 0·5) (Found: C, 72·3; H, 9·6. $C_{32}H_{50}O_6$ requires C, 72·5; H, 9·45%).

Hydrolysis of 5α-*Acetoxy-epoxides*.—A solution of lithium aluminium hydride (4 mols.) in ether was added to 3β : 5α-diacetoxy-9α : 11α-epoxyergost-7-ene (400 mg.) in ether (10 c.c.) at −70°. The mixture was allowed to warm to 20°, and the excess of hydride decomposed with ethyl acetate. Isolation with ether, followed by crystallization of the product from *iso*propyl ether–methanol (1 : 1), gave the 3 : 5-diol, m. p. and mixed m. p. (see above) 215—220°, $[\alpha]_D$ −4° (*c*, 0·78). Mild acetylation gave the 3-acetate, m. p. and mixed m. p. (see above) 221—226°.

Similar treatment of 3β : 5α-diacetoxy-7α : 8α-9α : 11α-diepoxyergostane afforded (after mild acetylation) 3β-acetoxy-7α : 8α-9α : 11α-diepoxyergostan-5α-ol, m. p. and mixed m. p. 217—223°, $[\alpha]_D$ 0° (*c*, 0·4), identical with the product described above.

Hydrogenation of 9α : 11α-*Epoxy*-Δ^7-*compounds*.—3β-Acetoxy-9α : 11α-epoxyergost-7-en-5α-ol (200 mg.) in acetic acid (25 c.c.) was shaken with hydrogen and prereduced Adams catalyst (50 mg.) for 10 hr., 2·1 mols. being taken up. Filtration, evaporation under reduced pressure, and crystallization of the product from methanol gave 3β-acetoxyergost-8(14)-en-5α-ol (IV; R = H) as needles, m. p. and mixed m. p. 156—158°, $[\alpha]_D$ −3° (*c*, 1·3).

Similar reduction of the corresponding 3 : 5-diacetate afforded 3β : 5α-diacetoxyergost-8(14)-ene (IV; R = Ac), m. p. and mixed m. p. 98—104°, $[\alpha]_D$ +20° (*c*, 1·34).

3β : 22-*Diacetoxybisnorchola*-7 : 9 : 20(22)-*trien*-5α-*ol and its Acetylation to* (I; R = Ac, R′ = CMe:CH·OAc).—3β : 22-Diacetoxy-5α : 8α-epidioxybisnorchola-9 : 20(22)-diene (2 g.) in boiling acetic acid (25 c.c.) was treated with zinc dust (2 g.) in small portions. The mixture was cooled and filtered and the product isolated with chloroform. Crystallization from methanol gave the 5α-*hydroxy*-compound (1·3 g.), m. p. 162—165°, $[\alpha]_D$ +31° (*c*, 0·97) (Found: C, 72·85; H, 8·6. $C_{26}H_{36}O_5$ requires C, 72·9; H, 8·45%). Ultra-violet absorption: Max. 2360 and 2420 Å; ε = 20,600 and 20,700. Infra-red spectrum (in Nujol): peaks at 3750 (hydroxyl), 1750, 1215 (enol acetate), 1730, 1250 (acetate), and 1657 $cm.^{-1}$ (Δ^7, Δ^9, $\Delta^{20(22)}$).

Acetylation was achieved by heating under reflux for 24 hr. a solution of the compound (1·3 g.) in chloroform (15 c.c.), pure acetyl chloride (13 c.c.), and dimethylaniline (17 c.c.). The steroid was isolated with ether; crystallization from methanol afforded 3β : 5α : 22-*triacetoxybisnorchola*-7 : 9 : 20(22)-*triene* (1·1 g.), m. p. 171—175°, $[\alpha]_D$ +101° (*c*, 0·93) (Found: C, 71·1; H, 8·25. $C_{28}H_{38}O_6$ requires C, 71·45; H, 8·15%). Ultra-violet absorption: Max. 2350 and 2420 Å; ε = 22,300 and 22,200. Infra-red spectrum (in Nujol): peaks at 1747, 1225 (enol acetate), 1738, 1722, and 1250 $cm.^{-1}$ (acetate).

3β : 5α : 22-*Triacetoxy*-9α : 11α-*epoxybisnorchola*-7 : 20(22)-*diene* (II; R = Ac, R′ = CMe:CH·OAc).—Treatment of the foregoing triacetoxy-triene with monoperphthalic acid (1·1 mols.) in ether at 20° for 36 hr. gave a good yield of the 9α : 11α-*epoxide* (needles from methanol), m. p. 184—186°, $[\alpha]_D$ +47° (*c*, 1·1) (Found: C, 69·05; H, 7·7. $C_{28}H_{38}O_7$ requires C, 69·1; H, 7·9%). Infra-red spectrum (in Nujol): peaks at 1740, 1205 (enol acetate), 1720, 1250 (acetate), and 1665 $cm.^{-1}$ (Δ^7, $\Delta^{20(22)}$). When the reaction was allowed to proceed for insufficient time a molecular *complex* of the 9 : 11-epoxide and the starting material crystallized (as needles from methanol), m. p. 165—166°, $[\alpha]_D$ +69° (calc., +74°) (Found: C, 70·25; H, 8·1. $C_{28}H_{38}O_7$,$C_{28}H_{38}O_6$ requires C, 70·3; H, 8·0%).

3β-*Acetoxy*-9α : 11α-*epoxy*-5α-*hydroxy*allo*pregn*-7-*en*-20-*one* (II; R = H, R′ = COMe).—3β-Acetoxy-5α-hydroxy*allo*pregna-7 : 9-dien-20-one (200 mg.), dissolved in dioxan (3 c.c.) and ether (3 c.c.), was treated with monoperphthalic acid (1·1 mols.) in ether. The mixture was

kept at 0° for 24 hr. and at 20° for 12 hr.; then the steroid was isolated with ether. Crystallization from methanol afforded a good yield of the 9α : 11α-*epoxide* as needles, m. p. 223—228°, $[\alpha]_D$ +48° (*c*, 0·5) (Found : C, 71·2; H, 8·6. $C_{23}H_{32}O_5$ requires C, 71·1; H, 8·3%).

3β-*Acetoxy*-9α : 11α-*epoxy*-5α-*hydroxyergostan*-7-*one* (V) and 3β : 5α-9ξ : 11α-*tetrahydroxyergostan*-7-*one* (VI).—Dioxan (300 c.c.) was added to a mixture of 3β-acetoxyergosta-7 : 9-dien-5α-ol (11·3 g.) dissolved in chloroform (200 c.c.), 100-vol. hydrogen peroxide (60 c.c.), and formic acid (60 c.c.), and the resultant homogeneous solution was kept at 20° overnight. The steroid was isolated with chloroform and, after removal of solvent, the product was dissolved in methanol (50 c.c.) and kept at 0° for 2 days. The product (m. p. 175—185°) which separated was recrystallized from methanol, to give the 9 : 11-*epoxy*-7-*ketone* (1·8 g.), m. p. 187—190°, $[\alpha]_D$ −45° (*c*, 1·45) (Found : C, 73·8; H, 9·95. $C_{30}H_{48}O_5$ requires C, 73·75; H, 9·9%). Infra-red spectrum (in Nujol) : peaks at 3450 (hydroxyl), 1720 (acetate and keto-groups), 1245 cm.$^{-1}$ (acetate).

The pale yellow mother-liquors were treated with a few drops of concentrated hydrochloric acid. After 3 days at 20°, the solution was concentrated to a small bulk under reduced pressure, and the solid (3·4 g.), m. p. 230—240°, filtered off. A portion was recrystallized from chloroform methanol and from ethanol, to give the *tetrahydroxy*-7-*ketone* as plates, m. p. 240—245° (decomp.), $[\alpha]_D$ −27° (*c*, 1·075 in pyridine) (Found : C, 72·5; H, 10·25. $C_{28}H_{48}O_5$ requires C, 72·35; H, 10·4%). Infra-red spectrum (in Nujol) : peaks at 3550, 3510, 3290 (hydroxyl groups), 1718 (7-keto-group), but no peak at 1245 cm.$^{-1}$ (acetate absent).

Acetic anhydride and pyridine at 20° converted the tetrol into 3β : 11α-*diacetoxy*-5α : 9ξ-*dihydroxyergostan*-7-*one*, crystallizing from ethyl acetate as needles, m. p. 243—245°, $[\alpha]_D$ −29° (*c*, 1·37) (Found : C, 69·95; H, 9·4. $C_{32}H_{52}O_7$ requires C, 70·05; H, 9·55%).

3β : 11α-*Diacetoxyergosta*-5 : 8(9)-*dien*-7-*one* (VII).—(*a*) A solution of 3β-acetoxy-9α : 11α-epoxy-5α-hydroxyergostan-7-one (255 mg.) and potassium hydroxide (3 g.) in methanol (30 c.c.) was kept at 20° for 16 hr. The steroid was isolated with ether and reacetylated with acetic anhydride and pyridine. Crystallization from methanol afforded a 60% yield of the *diacetate* as needles, m. p. 203—205°, $[\alpha]_D$ +75° (*c*, 1·04) (Found : C, 74·7; H, 9·55. $C_{32}H_{48}O_5$ requires C, 74·95; H, 9·45%). Ultra-violet absorption : Max. 2520 and 3320 Å; ε = 13,500 and 40 respectively. Infra-red spectrum (in Nujol) : peaks at 1721, 1240 (acetate), 1660 (7-ketone), 1620 (Δ^5), and 1604 cm.$^{-1}$ ($\Delta^{8(9)}$); no hydroxyl bands.

(*b*) A solution of 3β : 11α-diacetoxy-5α : 9-dihydroxyergostan-7-one (50 mg.) and potassium hydroxide (200 mg.) in methanol (2 c.c.) and dioxan (2 c.c.) was kept at 20° for 70 hr. Isolation with ether and methylation as in (*a*) gave a product which crystallized from methanol as needles, m. p. and mixed m. p. 202—204°, $[\alpha]_D$ +68° (*c*, 0·5).

3β : 5α-*Diacetoxy*-9α : 11α-*epoxybisnorchol*-7-*en*-22-*al* (VIII).—A solution of 3β : 5α-diacetoxy-9α : 11α-epoxyergosta-7 : 22-diene (9·3 g.) in ethyl acetate (250 c.c.) at −70° was treated with 1·1 mols. of ozone dissolved in ethyl acetate at −70°. Nitrogen was bubbled through while the solution was allowed to reach 20°, then the ozonide was decomposed by shaking the solution with aqueous ferrous sulphate and washed with water and 2% aqueous sodium hydroxide to remove acidic materials. After being dried ($CaCl_2$) the ethyl acetate was evaporated under reduced pressure. The residual gum in benzene was chromatographed on deactivated alumina (200 g.). Light petroleum–benzene (2 : 1) eluted a gum, but elution with benzene yielded the *aldehyde* (1·8 g.) (crystallized from *iso*propyl ether), m. p. 166—173°, $[\alpha]_D$ +63° (*c*, 2·06) (Found : C, 69·95; H, 8·35. $C_{26}H_{36}O_6$ requires C, 70·05; H, 8·2%). Infra-red spectrum (in Nujol) : peaks at 2700 (aldehyde C⁻H stretching), 1735 and 1250 (acetate), and 1721 cm.$^{-1}$ (aldehyde).

3β : 5α : 22-*Triacetoxy*-9α : 11α-*epoxybisnorchola*-7 : 20(22)-*diene* (II; R = Ac, R′ = CMe:CH·OAc).—The foregoing aldehyde (1·74 g.), redistilled acetic anhydride (6 c.c.), and fused potassium acetate (0·39 g.) were heated in an oil-bath at 120—130° for 6 hr. The product was extracted with benzene and, after removal of solvents under reduced pressure, was redissolved in benzene and introduced on to deactivated alumina (100 g.). Elution with benzene yielded the enol acetate, which on crystallization from methanol gave needles (0·91 g.), m. p. 180—185°, $[\alpha]_D$ +44° (*c*, 0·4) (Found : C, 68·95; H, 8·05. Calc. for $C_{28}H_{38}O_7$: C, 69·1; H, 7·9%). The infra-red spectrum was identical with that of the previous material (see above).

3β : 5α-*Diacetoxy*-9α : 11α-*epoxy*allo*pregn*-7-*en*-20-*one* (IX).—The enol acetate (0·9 g.) in ethyl acetate (25 c.c.) was ozonized at −70° as described for the preparation of the aldehyde. The material was purified by elution through deactivated alumina (75 g.) with benzene, the *ketone* (0·3 g.) being obtained. Crystallization from methanol gave needles, m. p. 160—169°, $[\alpha]_D$ +52° (*c*, 0·9) (Found : C, 69·65; H, 8·25. $C_{25}H_{34}O_6$ requires C, 69·75; H, 7·95%). Infra-red spectrum (in Nujol) : peaks at 1735, 1730, 1250 (acetate), and 1715 cm.$^{-1}$ (20-ketone).

Thanks are offered to Glaxo Laboratories Ltd. for financial assistance (to P. B.) and for gifts of materials. One of the authors (G. W. W.) thanks the Department of Scientific and Industrial Research for a maintenance grant. The infra-red spectra were determined under the direction of Dr. G. D. Meakins, and the microanalyses are by Messrs. E. S. Morton and H. Swift.

THE UNIVERSITY, MANCHESTER, 13. [*Received, April 11th,* 1953.]