18-Norandrosta-8,11,13-trienes. Part IV.[1a] 7-Hydroxy-derivatives

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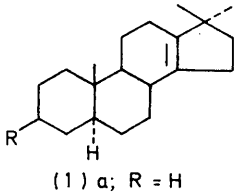
Direct dehydrogenation of 18-norandrost-13-enes (1a and b) with selenium dioxide gave the corresponding 7α-hydroxy-18-norandrosta-8,11,13-trienes (2a and b) in one step. The corresponding 7α-acetates (2c and d) were obtained together with the epimeric 7β-acetates (9a and b) on treatment of the 18-norandrosta-7,13-dienes (8a and c) with mercury(II) acetate. The mechanisms for both aromatisation processes are discussed.

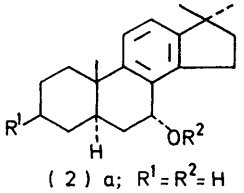
PREVIOUS papers[1] described the formation of ring-C-aromatic steroids from 18-norandrost-13-enes, by using bromination–dehydrobromination to introduce the two additional double bonds. In continuation of our programme to evaluate the biological activities of ring-C-aromatic compounds the present paper describes two useful routes to 18-norandrosta-8,11,13-trienes hydroxylated at position 7: the reaction of 18-norandrost-13-enes with selenium dioxide and the reaction of 18-norandrosta-7,13-dienes with mercury(II) acetate.

The introduction of further double bonds into unsaturated steroids by using selenium dioxide is a well established technique,[2] proceeding by allylic hydroxylation [2e,g] followed by dehydration of the alcohol formed.[2a,g] Application of this reaction to the 18-norandrost-13-enes (1a and b) gave, in one step, the 7α-hydroxy-18-norandrosta-8,11,13-trienes (2a and b). The structures were confirmed by the n.m.r. spectra of the acetates (2c and d), which show a quartet due to two aromatic protons (δ 7·02 and 7·27, J_{AB} 8 Hz) and an equatorial 7β-proton signal (δ 5·9—6·0, $W_{\frac{1}{2}}$ 6 Hz).

The reaction is presumed to proceed as shown in Scheme 1 by allylic hydroxylation of the 13,14-double bond at either position 8 or position 12 to give the unsaturated alcohols (3) or (4). Since no products from processes involving unsaturation or oxidation at position 15 are isolated, it is assumed that no allylic attack occurs

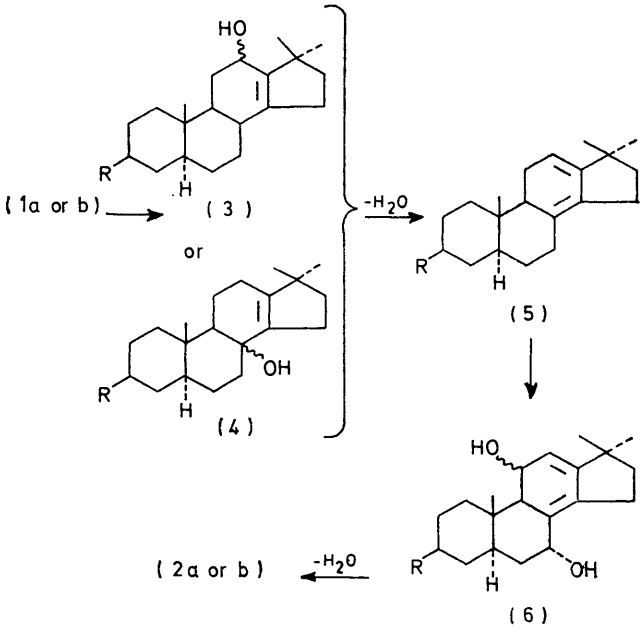


(1) a; R = H
b; R = OH
c; R = OAc



(2) a; $R^1 = R^2 = H$
b; R^1 = OH, R^2 = H
c; R^1 = H, R^2 = Ac
d; R^1 = OAc, R^2 = Ac

at that position. Under the conditions of the reaction both alcohols (3) and (4) undergo dehydration with allylic rearrangement, which appears to be the preferred mode of elimination,[2] to give the dienes (5). Hydroxylation of the dienes (5), again in the allylic positions,



SCHEME 1

gives the 7,11-diols (6), which lose the 11-hydroxy-group along with the 9α-proton, possibly also with allylic rearrangement within ring C, to give the 7α-hydroxy-18-norandrosta-8,11,13-trienes (2a and b). Some acid-catalysed dehydration also occurs, due to the presence of the selenous acid, and small amounts of 18-norandrosta-6,8,11,13-tetraenes (7a and b) can be detected in the crude products.

The introduction of a further double bond [2b,3] or of an allylic acetoxy-group [4] into an olefinic compound by using mercury(II) acetate is a well known reaction, believed to occur by electrophilic attack of mercury(II)

[1] (*a*) Part III, C. L. Hewett, S. G. Gibson, J. Redpath, and D. S. Savage, *J.C.S. Perkin I*, 1974, 1432; (*b*) Part II, C. L. Hewett, I. M. Gilbert, J. Redpath, D. S. Savage, J. Strachan, T. Sleigh, and R. Taylor, *ibid.*, p. 897.

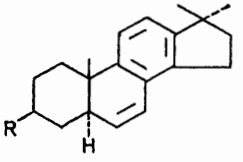
[2] (*a*) N. Rabjohn, *Org. Reactions*, 1949, **5**, 331; (*b*) J. C. Eck and E. W. Hollingsworth, *J. Amer. Chem. Soc.*, 1942, **64**, 140; (*c*) A. L. Morrison and J. C. E. Simpson, *J. Chem. Soc.*, 1932, 1710; (*d*) R. K. Callow and O. Rosenheim, *ibid.*, 1933, 387; (*e*) L. J. Bellamy and C. Dorée, *ibid.*, 1941, 176; (*f*) R. K. Callow, *ibid.*, 1936, 462; (*g*) L. F. Fieser and G. Ourisson, *J. Amer. Chem. Soc.*, 1953, **75**, 4404.

[3] (*a*) W. V. Ruyle, T. A. Jacob, J. M. Chemerda, E. M. Chamberlin, D. W. Rosenburg, G. E. Sita, R. L. Erickson, L. M. Aliminosa, and M. Tishler, *J. Amer. Chem. Soc.*, 1953, **75**, 2604; (*b*) A. Zürcher, H. Heusser, O. Jeger, and P. Geistlich, *Helv. Chim. Acta*, 1954, **37**, 1562; (*c*) A. Windaus and O. Linsert, *Annalen*, 1928, **465**, 148; (*d*) A. Windaus, *ibid.*, 1931, **488**, 91; (*e*) A. Windaus, U. Riemann, and G. Zühlsdorff, *ibid.*, 1942, **552**, 135; (*f*) D. H. R. Barton and W. J. Rosenfelder, *J. Chem. Soc.*, 1951, 2381; (*g*) G. Saucy, P. Geistlich, R. Helbling, and H. Heusser, *Helv. Chim. Acta*, 1954, **37**, 250.

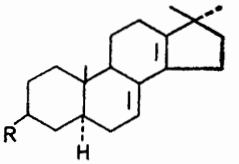
[4] (*a*) W. Treibs, G. Lucius, H. Kögler, and H. Breslauer, *Annalen*, 1953, **581**, 59; (*b*) W. Treibs and H. Bast, *ibid.*, 1949, **561**, 165; (*c*) W. Treibs and M. Weissenfels, *Chem. Ber.*, 1960, **93**, 1374.

acetate on the double bond to give a symmetrical ion,[5] followed by elimination of a proton to form an intermediate with the mercury atom at the least substituted position.[6] This undergoes solvolytic demurcuration to give an allylic acetate, either by a concerted attack [3f] or *via* an allylic carbocation.[3a] With unstable allylic acetates the elements of acetic acid are lost to introduce a second double bond. It seemed probable therefore that treatment of an 18-norandrost-13-ene with mercury(II) acetate would give either an allylic acetate or a diene, and that a subsequent similar step might reasonably be expected to give an aromatic product. However, the 18-norandrost-13-enes (1a and c) were recovered after treatment with mercury(II) acetate, a result probably due to steric hindrance associated with the 13,14-double bond.

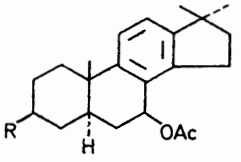
Treatment of the 18-norandrosta-7,13-dienes [1b] (8a and c) with mercury(II) acetate, however, resulted in a mixture of the corresponding 7α- and 7β-acetoxy-18-norandrosta-8,11,13-trienes (2c and d) and (9a and



(7) a; R = H
b; R = OH
c; R = OAc



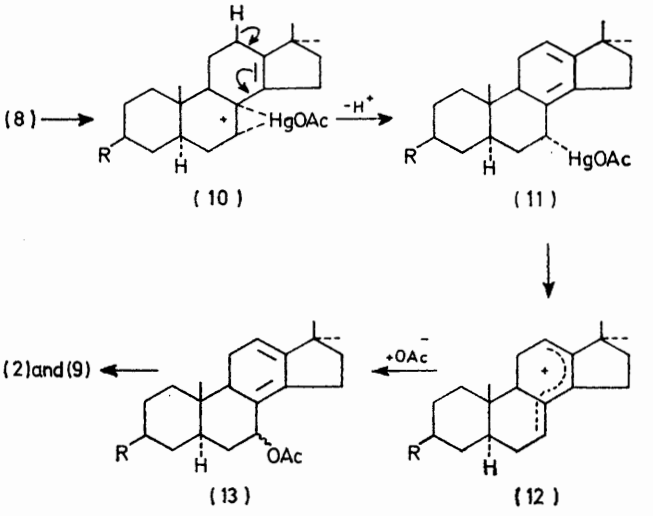
(8) a; R = H
b; R = OH
c; R = OAc



(9) a; R = H
b; R = OAc

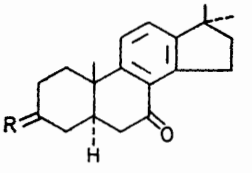
b), respectively. The reaction is believed to involve formation of the ion (10) by electrophilic attack across the 7,8-double bond as shown in Scheme 2. A proton is eliminated to give an organomercurial intermediate (11), which undergoes demercuration *via* a delocalised carbocation (12) to the 7-acetate (13). A similar electrophilic attack on this diene (13) by mercury(II) acetate gives the aromatic 7α- and 7β-acetates. If the reaction is carried out at reflux temperature or for a prolonged period, the presence of the corresponding tetraenes (7a and c) in the reaction mixtures can be demonstrated.

The pure 7α-acetate (2d) isolated from the epimeric mixture was identical with the product obtained *via* selenium dioxide. The 7β-epimer (9b) could not be obtained pure. In the other series no separation of the epimers [(2c) and (9a)] could be achieved.



SCHEME 2 R = H or OAc

The 18-norandrosta-6,8,11,13-tetraenes (7a and b) could be obtained in good yield by treatment of the alcohols (2a and b), the acetates (2c and d), or the epimeric mixtures with sulphuric acid. The assignment of the additional double bond to position 6 is confirmed by the n.m.r. spectra of the compounds, which show both the 6- and 7-proton signals as quartets (δ 5·64 and 6·53, respectively) because of coupling with the adjacent 5α-proton (J 2—3 Hz). This confirms that the original acetate group is at position 7 and discounts the possibility that the products from the mercury(II) acetate aromatisation could be 15-acetates since these would be deacetoxylated to give Δ^{15}-compounds which would show both 15- and 16-proton signals as doublets in the n.m.r. spectra. Additional evidence on this point is provided by the ketones (14a and b) produced on oxidation of the alcohols (2a and b). The i.r. absorption of the 7-carbonyl group occurs at 1667—1677 cm^{-1} (typical



(14) a; R = H_2
b; R = O

for an α-tetralone [7]), whereas the 15-ketone would be expected [7] to show i.r. absorption characteristic of an indanone at 1705—1715 cm^{-1}.

EXPERIMENTAL

M.p.s were determined with a Kofler hot-stage apparatus. I.r. spectra were determined with a Perkin-Elmer 457 spectrometer. U.v. spectra were determined with a

[5] (*a*) K. B. Wiberg and S. D. Nielsen, *J. Org. Chem.*, 1964, **29**, 3353; (*b*) Z. Rappoport, P. D. Sleezer, S. Winstein, and W. G. Young, *Tetrahedron Letters*, 1965, 3719; (*c*) Z. Rappoport, S. Winstein, and W. G. Young, *J. Amer. Chem. Soc.*, 1972, **94**, 2320; (*d*) Z. Rappoport, L. K. Dyau, S. Winstein, and W. G. Young, *Tetrahedron Letters*, 1970, 3483.

[6] P. D. Sleezer, Ph.D. Thesis, U.C.L.A., 1963, cited in ref. 5*b*.

[7] (*a*) L. J. Bellamy, 'The Infrared Spectra of Complex Molecules,' Methuen, London, 2nd edn., pp. 137—138; (*b*) D. C. Gutsche, *J. Amer. Chem. Soc.*, 1951, **73**, 786.

Perkin-Elmer 402 spectrometer and are for solutions in ethanol. Optical rotations were measured for solutions in chloroform at room temperature unless otherwise stated. G.l.c. was performed with a Pye-Argon chromatograph. N.m.r. spectra (solvent $CDCl_3$) were determined at 60 Hz with a Varian A60 or a Perkin-Elmer R12 B spectrometer, with tetramethylsilane as internal standard. Light petroleum refers to the fraction of b.p. 40—60°.

Unless otherwise stated, products were isolated by diluting the reaction mixture with water, extracting with ether, washing the extract with sodium hydrogen carbonate solution and water until neutral, drying (Na_2SO_4), and removing the solvent under vacuum.

17,17-*Dimethyl*-18-*nor*-5α-*androst*-13-*ene* (1a).—A suspension of 17α-methyl-5α-androstan-17β-ol (25·0 g) in 98—100% formic acid (80 ml) was boiled under reflux for 15 min, cooled, diluted with water, and filtered. The solid was washed neutral with water, dried *in vacuo*, and recrystallised from acetone to give 17,17-*dimethyl*-18-*nor*-5α-*androst*-13-*ene* (1a) (20·6 g) as prisms, m.p. 58—60°, $[\alpha]_D$ −39° (*c* 1·1), $\lambda_{max.}$ 214 nm (ε 2700), δ 0·76 (3H, s, 10-Me) and 0·93 (6H, s, 17,17-Me_2) (Found: C, 87·9; H, 11·6. $C_{20}H_{32}$ requires C, 88·2; H, 11·8%).

17,17-*Dimethyl*-18-*nor*-5α-*androsta*-7,13-*diene* (8a).—Bromine (42 ml) in methylene chloride (40 ml) was added slowly to a solution of 17,17-dimethyl-18-nor-5α-androst-13-ene (1a) (137 g) in ether (840 ml) and methylene chloride (140 ml) at −70°. The temperature of the solution was then allowed to rise to −15°. Sodium iodide (160 g) in acetone (1·1 l) was added slowly, and the solution was heated to reflux temperature, boiled for 45 min, cooled, diluted with ether (1·5 l), washed in turn with aqueous sodium sulphite, water, and brine, and dried. The solvent was evaporated off and the residue was dissolved in acetone (200 ml); the product was precipitated by addition of aqueous sodium sulphite at 0°. The solid was filtered off, redissolved in acetone, and reprecipitated with aqueous sodium sulphite. The product was isolated and dissolved in ether; the solution was filtered through a column of acid-washed alumina [8] (1 kg), which was then eluted with ether. Evaporation of the eluate and crystallisation of the residue from ether–methanol at 0—5° gave the 7,13-*diene* (8a) (118 g). Recrystallisation from the same solvent furnished a sample of m.p. 46—50°, $[\alpha]_D$ −192° (*c* 2·2), $\lambda_{max.}$ 247 nm (ε 18,800), δ 0·93 (3H, s, 10-Me), 0·99 (6H, s, 17,17-Me_2), and 5·38 (1H, m, 7-H) (Found: C, 89·0; H, 11·3. $C_{20}H_{30}$ requires C, 88·8; H, 11·2%).

17,17-*Dimethyl*-18-*nor*-5α-*androsta*-8,11,13-*trien*-7α-*ol* (2a).—A solution of 17,17-dimethyl-18-nor-5α-androst-13-ene (1a) (20 g) in dioxan (100 ml) and water (20 ml) was heated until it was almost boiling, selenium dioxide (30 g) was added, and the mixture was boiled under reflux for 20 min, cooled, and filtered. The filtrate was diluted with water and the product (22·0 g) was isolated and dissolved in light petroleum (40 ml). The solution was filtered down a column (3 × 1 in) of alumina. Elution with light petroleum (150 ml) yielded a fraction (18·1 g) which was rechromatographed in light petroleum on a column (10 × 2·5 in) of alumina. Elution with light petroleum (1·2 l) and benzene (1·4 l) yielded impure fractions which were discarded; further elution with benzene (1·0 l) and diethyl ether (1·2 l) yielded a fraction (9·3 g) which was crystallised from light petroleum to give 17,17-*dimethyl*-18-*nor*-5α-*androsta*-8,11,13-*trien*-7α-*ol* (2a) as prisms, m.p. 118—121·5°, $[\alpha]_D$ +13° (*c* 1·0), $\nu_{max.}$ (KCl) 3400 (OH) and 818 cm^{-1} (aromatic), $\lambda_{max.}$ 270 (ε 1150) and 278 nm (1260) (Found: C, 84·3; H, 10·0. $C_{20}H_{28}O$ requires C, 84·45, H, 9·9%).

Treatment of the corresponding 7,13-dienes (8) with selenium dioxide under the same conditions gave intractable mixtures.

7α-*Acetoxy*-17,17-*dimethyl*-18-*nor*-5α-*androsta*-8,11,13-*triene* (2c).—Acetylation of 17,17-dimethyl-18-nor-5α-androsta-8,11,13-trien-7α-ol (2a) (1·22 g) in pyridine (5 ml) and acetic anhydride (5 ml) overnight at room temperature gave the 7α-*acetate* (2c), which crystallised from acetone as prisms (800 mg), m.p. 113—115·5°, $[\alpha]_D$ +43° (*c* 1·07), $\nu_{max.}$ (CH_2Cl_2) 1725 and 1240 (3-OAc) and 824 cm^{-1} (aromatic), δ 1·02 (3H, s, 10-Me), 1·19 and 1·26 (6H, 2s, 17,17-Me_2), 2·04 (3H, s, 7α-OAc), 2·7 (2H, m, 15-H_2), 5·9 (1H, m, 7β-H), 7·02 (1H, d, *J* 8 Hz, 12-H), and 7·27 (1H, d, *J* 8 Hz, 11-H) (Found: C, 81·1; H, 9·4. $C_{22}H_{30}O_2$ requires C, 80·9; H, 9·3%).

Treatment of 17,17-*Dimethyl*-18-*nor*-5α-*androsta*-7,13-*diene* (8a) *with Mercury*(II) *Acetate*.—A solution of the diene (8a) (100 g) in dioxan (250 ml) and acetic acid (750 ml) was stirred with a suspension of mercury(II) acetate (200 g) at 70° for 40 h. The solution was filtered through Dicalite, cooled, and diluted with water (10 l). The product was isolated by extraction and the residue (108 g), dissolved in dry ether (1 l), was added carefully to a stirred suspension of lithium aluminium hydride (36 h) in dry ether (1·2 l). The suspension was stirred at room temperature for 20 min, diluted carefully with aqueous ether (3 l), and filtered through Dicalite. The solution was dried ($MgSO_4$), concentrated, and chromatographed on a column of acid-washed alumina [8] (1·5 kg). Elution with cyclohexane gave starting material (12·0 g). Further elution with ether gave a mixture of 7α- and 7β-epimers of 17,17-dimethyl-18-nor-5α-androsta-8,11,13-trien-7-ol (68 g), δ 1·01 (3H, s, 10-Me), 1·25 (6H, s, 17,17-Me_2), 1·68 (1H, s, 7-OH), 3·0 (2H, m, 15-H), 4·77 ($W_{\frac{1}{2}}$ 5 Hz, 7β-H), 5·0 ($W_{\frac{1}{2}}$ 7 Hz, 7α-H), and 7·02 and 7·23 (2H, q, *J* 8 Hz, 11- and 12-H).

17,17-Dimethyl-18-nor-5α-androst-13-ene (1a), treated with mercury(II) acetate in a similar manner, was unchanged.

17,17-*Dimethyl*-18-*nor*-5α-*androsta*-6,8,11,13-*tetraene* (7a).—(*a*) A solution of 17,17-dimethyl-18-nor-5α-androsta-8,11,13-trien-7α-ol (2a) (1·0 g) (prepared by using selenium dioxide) in dioxan (10 ml) was heated under reflux with sulphuric acid (10N; 0·05 ml) for 20 min, then cooled; the product was isolated by the normal procedure and crystallised from ether–propan-2-ol to give the *tetraene* (7a) (337 mg), m.p. 57—59·5, $[\alpha]_D$ −153° (*c* 1·0), $\nu_{max.}$ (KCl) 3040 and 823 cm^{-1} (aromatic), $\lambda_{max.}$ 273 nm (ε 9600) (Found: C, 90·1; H, 9·8. $C_{20}H_{26}$ requires C, 90·2; H, 9·8%).

(*b*) A solution of a mixture of 7α- and 7β-epimers of 17,17-dimethyl-18-nor-5α-androsta-8,11,13-trien-7-ol (10 g) (2a) and (9a) [prepared by using mercury(II) acetate] was heated under reflux in dioxan (100 ml) with sulphuric acid (10N; 10 ml) for 15 min. The product was isolated and crystallised twice from methanol–ether to give the tetraene (7a) (7·8 g), m.p. 55—57°, δ 0·97 (3H, s, 10-Me), 1·25 (3H, s, 17-Me), 1·30 (3H, s, 17-Me), 5·64 (1H, q, *J* 10 and 2 Hz, 6-H), 6·53 (1H, q, *J* 10 and 3 Hz, 7-H), 6·92 (1H, d, *J* 8 Hz, 12-H), and 7·09 (1H, d, *J* 8 Hz, 11-H) * (Found: C,

* The more downfield signal is assigned to the 11-H by analogy with the 1-oxo- and 1-hydroxy-analogues.[1a]

[8] K. R. Farrar, J. C. Hamlet, H. B. Henbest, and E. R. H. Jones, *J. Chem. Soc.*, 1952, 2657.

90·3; H, 9·8%), identical (u.v. and i.r. spectra and t.l.c.) with the sample prepared before.

17,17-*Dimethyl*-18-*nor*-5α-*androsta*-8,11,13-*trien*-7-*one* (14a).—Jones reagent [9] (60 ml) was added slowly at 20° to a solution of 17,17-dimethyl-18-nor-5α-androsta-8,11,13-trien-7α- and -7β-ol (68 g) in acetone (650 ml) and stirring was then continued for 10 min. The product was isolated and crystallised from methanol–water to give the 7-*ketone* (14a) (51 g). Recrystallisation from the same solvent gave a sample of m.p. 66—67°, $[\alpha]_D$ +68° (*c* 1·22), $\nu_{max.}$ (KCl) 1670 (7-ketone) and 830 cm^{-1} (aromatic), $\nu_{max.}$ (CH_2Cl_2) 1667 and 830 cm^{-1}, $\lambda_{max.}$ 257 (ε 10,500) and 314 nm (3500), δ 1·15 (3H, s, 10-Me), 1·22 (6H, s, 17,17-Me_2), 2·41 (2H, m, 6-H_2), 3·29 (2H, m, 15-H_2), and 7·2 (2H, t, *J* 8 Hz, 11- and 12-H) (Found: C, 85·1; H, 9·3. $C_{20}H_{26}O$ requires C, 85·1; H, 9·3%).

3β,7α-*Diacetoxy*-17,17-*dimethyl*-18-*nor*-5α-*androsta*-8,11,-13-*triene* (2d).—(*a*) A solution of 3β-hydroxy-17,17-dimethyl-18-nor-5α-androst-13-ene (1b) [1b] (18 g) in dioxan (90 ml) and water (18 ml) was heated until it was almost boiling, then selenium dioxide (27 g) was added. The mixture was boiled under reflux for 5 min, filtered to remove selenium, and cooled; the product (19·5 g) was then isolated and dissolved in ether. The solution was filtered through a column (5 × 1½ in) of alumina. Elution with ether followed by ethyl acetate gave a reddish brown gum (14·7 g) which was acetylated with pyridine (22·5 ml) and acetic anhydride (22·5 ml) on a water-bath for 2 h. The product was extracted into ether and the extract was washed with ammonium hydrogen sulphate solution and water, dried (Na_2SO_4), and evaporated to dryness. Trituration of the residue (16·1 g) with ether yielded the 3β,7α-*diacetoxy-triene* (2d) (4·5 g). Two recrystallisations from ether furnished a sample of m.p. 208·5°, $[\alpha]_D$ +14° (*c* 0·8), $\nu_{max.}$ (KCl) 1723 and 1245 (3-OAc) and 832 cm^{-1} (aromatic), $\lambda_{max.}$ 223 (ε 10,300), 272 (1780), and 280 nm (1780) (Found: C, 75·0; H, 8·3. $C_{24}H_{32}O_4$ requires C, 75·0; H, 8·4%).

(*b*) Mercury(II) acetate (160 g) was added to a stirred, boiling solution of 3β-acetoxy-17,17-dimethyl-18-nor-5α-androsta-7,13-diene (8c) [1b] (80 g) in glacial acetic acid (800 ml) and heating under reflux was continued for 10 min. The solution was cooled and filtered through Dicalite, and the product was isolated and crystallised from ether–hexane giving the 3β,7α-diacetoxy-triene (2d) (27 g). Recrystallisation from ether gave a sample of m.p. 202—206°, $[\alpha]_D$ +6·5 (*c* 0·89), $\nu_{max.}$ (KCl) 3070, 3030, and 1725 and 1240 cm^{-1} (OAc), $\nu_{max.}$ (CH_2Cl_2) 1730 and 1225 (OAc), and 830 cm^{-1} (aromatic), δ 1·10 (3H, s, 10-Me), 1·23 (3H, s, 17-Me), 1·26 (3H, s, 17-Me), 2·08 (3H, s, OAc), 2·09 (3H, s, OAc), 2·83 (2H, m, 15-H_2), 4·80 (1H, m, 3α-H), 5·99 (1H, m, $W_{\frac{1}{2}}$ 6 Hz, 7β-H), 7·02 (1H, d, *J* 8 Hz, 12-H), and 7·27 (1H, d, *J* 9 Hz, 11-H) (Found: C, 75·4; H, 8·7%), identical (i.r. spectrum and t.l.c.) with the sample previously prepared. Recrystallisation (ether–hexane) of the material from the mother liquors gave a second crop (21 g) containing a mixture of the 3β,7α-diacetate (2d) and the 3β,7β-diacetate (9b). The mother liquors slowly solidified; trituration with methanol gave a solid which crystallised from ether–petroleum to yield 3β-*acetoxy*-17,17-*dimethyl*-18-*nor*-5α-*androsta*-6,8,11,13-*tetraene* (7c) (3·4 g), m.p. 144—145°, $[\alpha]_D$ −114° (*c* 1·8), $\nu_{max.}$ (KCl) 1725 and 1230 cm^{-1} (acetate), δ 1·0 (3H, s, 10-Me), 1·21 (3H, s, 17-Me), 1·24 (3H, s, 17-Me), 2·03 (3H, s, OAc), 2·83 (3H, m, 5α-H and 15-H_2), 4·80 (1H, m, 3α-H), 5·64 (1H, q, 9·5 and 2 Hz, 6-H), 6·55 (1H, q, *J* 9·5 and 2 Hz, 7-H), and 7·0 (2H, t, *J* 8 Hz, 11- and 12-H) (Found: C, 81·5; H, 8·9. $C_{22}H_{28}O_2$ requires C, 81·4; H, 8·7%).

17,17-*Dimethyl*-18-*nor*-5α-*androsta*-8,11,13-*triene*-3,7-*dione* (14b).—(*a*) A mixture of 3β,7α- and 3β,7β-diacetoxy-17,17-dimethyl-18-nor-5α-androsta-8,11,13-triene [(2d) and (9b)] (2 g) [prepared by using mercury(II) acetate], in ether (50 ml), was added slowly to a suspension of lithium aluminium hydride (1 g) in ether (30 ml), and stirring was continued at room temperature for 4 h. Aqueous ethyl acetate was added carefully and the solution was filtered through Dicalite and dried (Na_2SO_4). The solvent was evaporated off to give 17,17-dimethyl-18-nor-5α-androsta-8,11,13-triene-3β,7-diol (1·7 g) as an epimeric mixture which could not be crystallised. The material (1·4 g) was dissolved in acetone (2·5 ml) (redistilled over potassium permanganate), Jones reagent [9] (2 ml) was added slowly at room temperature, and stirring was continued for 10 min. Isolation of the product and crystallisation from ether–light petroleum gave the 3,7-*dione* (14b) (1·01 g) as needles. Recrystallisation from ether–light petroleum gave a sample of m.p. 150—152°, $[\alpha]_D$ +60° (*c* 0·88), $\nu_{max.}$ (KCl) 3060, 1713 (3-ketone), 1677 (7-ketone), and 830 cm^{-1} (aromatic), $\nu_{max.}$ (CH_2Cl_2) 1710, 1670, and 830 cm^{-1}, $\lambda_{max.}$ 258 (ε 11,200) and 314 nm (3600), δ 1·26 (6H, s, 17,17-Me_2), 1·42 (3H, s, 10-Me), 3·33 (2H, m, 15-H_2), and 7·33 (2H, t, *J* 10 Hz, 11- and 12-H) (Found: C, 81·3; H, 8·1. $C_{20}H_{24}O_2$ requires C, 81·0; H, 8·2%).

(*b*) Hydrolysis of 3β,7α-diacetoxy-17,17-dimethyl-18-nor-5α-androsta-8,11,13-triene (2d) (0·9 g) (prepared by using selenium dioxide), in methanol (9 ml), with aqueous potassium hydroxide (10N; 1 ml) gave the diol (2b) as a non-crystalline residue (0·74 g). Kiliani's reagent [10] (6 ml) was added to a solution of the diol (0·7 g) in acetic acid (5·0 ml) and the solution was stirred at room temperature for 45 min. The product (0·5 g) was isolated and crystallised from ether to give the 3,7-diketone (14b) as needles, m.p. 148—152°, $[\alpha]_D$ +58° (*c* 1·1), identical (i.r. spectrum and t.l.c.) with the sample prepared before.

17,17-*Dimethyl*-18-*nor*-5α-*androsta*-6,8,11,13-*tetraen*-3β-*ol* (7b).—A solution of 3β,7α-diacetoxy-17,17-dimethyl-18-nor-5α-androsta-8,11,13-triene (2d) (10 g) in dioxan (500 ml) containing sulphuric acid (10N; 25 ml) was heated under reflux for 2 h, concentrated (50 ml), and cooled. The product (7·5 g) was isolated, transferred as a solution in ether onto a column of deactivated alumina [8] (200 g), and eluted with ethyl acetate. Concentration of the eluate and crystallisation from light petroleum gave the *alcohol* (7b) (5·1 g). Recrystallisation from light petroleum gave a sample of m.p. 99—101°, $[\alpha]_D$ −138° (*c* 0·42), $\nu_{max.}$ (KCl) 3280 (OH) and 820 cm^{-1} (aromatic), $\nu_{max.}$ (CH_2Cl_2) 3600 and 825 cm^{-1}, $\lambda_{max.}$ 273 nm (ε 11,400), δ 1·02 (3H, s, 10-Me), 1·23 (3H, s, 17-Me), 1·27 (3H, s, 17-Me), 2·87 (2H, m, 15-H_2), 3·7 (1H, m, 3α-H), 5·65 (1H, q, *J* 9·3 and 2 Hz, 6-H), 6·55 (1H, q, *J* 9·3 and 2 Hz, 7-H), and 7·0 (2H, t, *J* 8 Hz, 11- and 12-H) (Found: C, 85·3; H, 9·5. $C_{20}H_{26}O$ requires C, 85·1; H, 9·3%).

17,17-*Dimethyl*-18-*nor*-5α-*androsta*-6,8,11,13-*tetraen*-3-*one*.—Jones reagent [9] (6 ml) was added slowly at room temperature to a stirred solution of 17,17-dimethyl-18-nor-5α-androsta-6,8,11,13-tetraen-3β-ol (7b) (4 g) in redistilled acetone (40 ml) and stirring was then continued for 10 min.

[9] K. Bowden, I. M. Heilbron, E. R. H. Jones, and B. C. L. Weedon, *J. Chem. Soc.*, 1946, 39.
[10] H. Kiliani, *Ber.*, 1901, **34**, 3564.

Isolation of the product and crystallisation from ether–hexane gave 17,17-*dimethyl*-18-*nor*-5α-*androsta*-6,8,11,13-*tetraen*-3-*one* (2·8 g). Recrystallisation from ether–hexane furnished a sample of m.p. 155—157°, $\nu_{max.}$ (KCl) 3030, 1720 (ketone), and 820 cm^{-1} (aromatic), $\lambda_{max.}$ 274 nm (ε 9900), δ 1·20 (3H, s, 10-Me), 1·23 (3H, s, 17-Me), 1·26 (3H, s, 17-Me), 2·9 (2H, m, 15-H_2), 5·6 (1H, q, *J* 9 and 1 Hz, 6-H), 6·62 (1H, q, *J* 9 and 2 Hz, 7-H), 6·97 (1H, d, *J* 8 Hz, 12-H), and 7·13 (1H, d, *J* 8 Hz, 11-H) (Found: C, 85·9; H, 8·7. $C_{20}H_{24}O$ requires C, 85·7; H, 8·6%).

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