The Solvolysis of 4β-Hydroxy-3β-*p*-tolylsulphonyloxyandrost-5-enes

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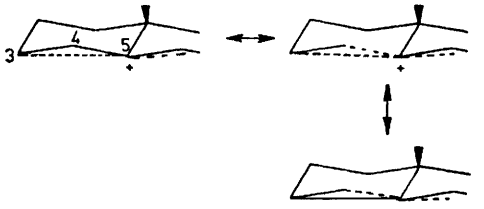
The solvolysis of 3β-*p*-tolylsulphonyloxyandrost-5-enes in acetic acid containing sodium acetate, is retarded by the presence of a 4β-acetoxy- or hydroxy-group. The products of solvolysis include the A-nor-3-formyl-steroids except in the presence of a 7-ketone.

THE homo-allylic participation of the C(5)–C(6) double bond in the solvolysis of steroidal 3β-toluene-*p*-sulphonates is well-documented.[1] The intermediate carbocation can also be established by the solvolysis of the toluene-*p*-sulphonate of a 3β-hydroxymethyl-A-nor-5-ene.[2] Consideration has been given to three contributory canonical forms for the cyclo-steroid carbocation (see Scheme 1).[3] Solvolytic studies on 4-methylated



SCHEME 1

derivatives of cholesteryl toluene-*p*-sulphonate and methanesulphonate reveal a rate-enhancement from a 4α-methyl substituent.[4] This has been interpreted as support for the delocalization of the 4,5-bond in which the electron-releasing character of the 4α-methyl group increases the ability of C-4 to participate in the developing charge deficiency. Solvolysis of a 3β-toluene-*p*-sulphonate of a 3,4-glycol represents the initial step of a pinacol–pinacolone rearrangement. A comparison between the rates of solvolysis of the 4β-alcohol, 4β-acetate, and their corresponding unsubstituted analogues in the saturated and unsaturated series could shed some further light on the effect of a 4-substituent and on double-bond participation in the pinacol rearrangement. If 4,5-bond delocalization played a significant role in facilitating the ionization of the toluene-*p*-sulphonates of the Δ^5-steroids, we would expect an increase in the rate of ionization of the toluene-*p*-sulphonates in the presence of a 4β-alcohol through the ability of the oxygen lone pairs to stabilize the incipient C-4 charge.

The substrates were prepared from dehydroisoandrosterone (1) as in Scheme 2. Changes in the 3-H n.m.r. signal showed that selective mono-acylation of the 3β-(*eq*),4β(*ax*)-diols occurred at the 3-position. 3β,4β-Diacetoxyandrost-5-en-17-one (5) [5] could not be cleanly reduced over palladium–charcoal, but catalytic hydrogenation over platinum afforded a mixture of 17-alcohols and ketones which was subsequently oxidized with 8N-chromium trioxide. 3β,4β-Diacetoxy-5α-androstan-17-one (8) was isolated by fractional crystallization. The hydrogenolysis products, 5α-androstan-17-one (9) [6] and 3β-acetoxy-5α-androstan-17-one (10),[7] were obtained by chromatography of the mother-liquors. 4β-Acetoxy-3β-*p*-tolylsulphonoxyandrost-5-ene-7,17-dione (7) was prepared by oxidation of the olefin (4) [8] with chromium trioxide in acetic anhydride.

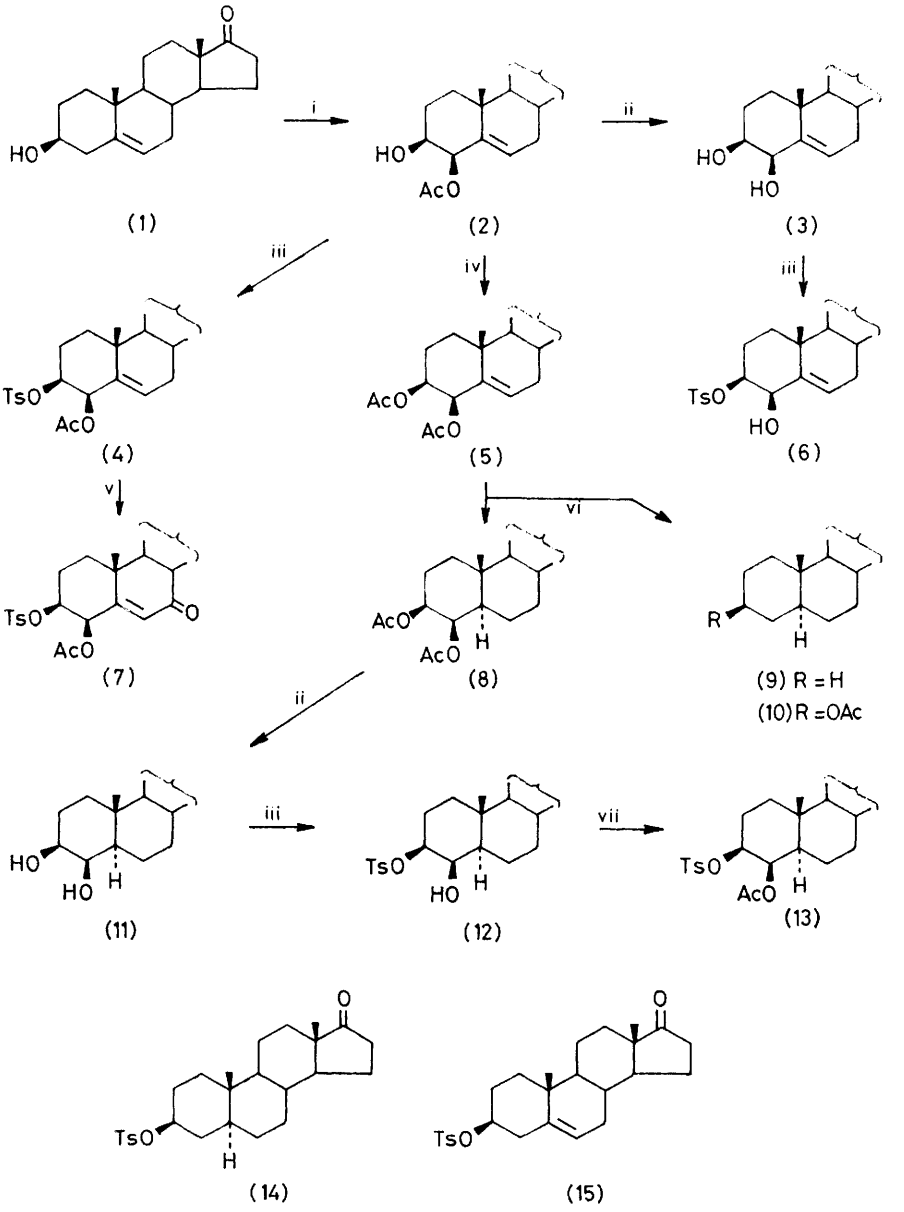
The rates of solvolysis were estimated by carrying out the reaction in an n.m.r. tube at 100 °C in [$^2H_4$]acetic acid containing sodium [$^2H_4$]acetate. The initial step is the formation of the toluene-*p*-sulphonate anion and hence the reaction was followed by measuring the disappearance of the methyl resonance of the toluene-*p*-sulphonate ester (δ 2.55) and the appearance of the methyl resonance of the anion (δ 2.49). This gave reasonable first-order plots. The relative rates are given in the Table. The products of the solvolysis reactions (see Scheme 3) were separated chromatographically. 3β-*p*-Tolylsulphonyloxy-5α-androstan-17-one afforded a mixture (*ca.* 2 : 1) of 5α-androst-2-en-17-one [9] and 3α-acetoxy-5α-androstan-17-one.[10] On the other hand 3β-*p*-tolysulphonyloxyandrost-5-en-17-one gave the corresponding 3β-acetate (22).[11] Solvolysis of 4β-acetoxy-

Relative rates of solvolysis of steroidal toluene-*p*-sulphonates

3β-*p*-Tolylsulphonyloxy-5α-androstan-17-one (14)	1
3β-*p*-Tolylsulphonyloxyandrost-5-en-17-one (15)	36
4β-Hydroxy-3β-*p*-sulphonyloxy-5α-androstan-17-one (12)	0.137
4β-Hydroxy-3β-*p*-tolylsulphonyloxyandrost-5-en-17-one (6)	13.4
4β-Acetoxy-3β-*p*-tolylsulphonyloxy-5α-androstan-17-one (13)	*c* 0.005
4β-Acetoxy-3β-*p*-tolylsulphonyloxyandrost-5-en-17-one (4)	0.076
4β-Acetoxy-3β-*p*-tolylsulphonyloxyandrost-5-ene-7,17-dione (7)	0.0158

3β-*p*-tolysulphonyloxyandrost-5-en-17-one (4) gave two products. One, isolated in 75% yield, was the A-nor-conjugated aldehyde (16) (n.m.r. δ 9.97 C*H*O; u.v. $\lambda_{max.}$ 255 nm, ε 15 400). The presence of two singlet olefinic resonances (δ 134.0 and 170.6) in the ^{13}C n.m.r. spectrum was consistent with the presence of a fully substituted αβ-unsaturated aldehyde. The second compound, obtained in 16% yield, was the geminal diacetate (17). Its structure followed from the n.m.r. spectrum which showed a low-field single proton doublet (δ 6.78, *J* 7 Hz) coupled to a methine proton (δ 2.90) and an olefinic C–H signal (δ 5.44). In the ^{13}C n.m.r. spectrum there was a low-field doublet (δ 91.5) assigned to the acetal carbon. Although the compound contained two acetoxy-groups, there was only one signal which could be assigned to a carbon bearing a singly

bonded oxygen function. On hydrolysis with alkali the diacetate (17) gave the unsaturated aldehyde (16). The diacetate was assigned the 3β-configuration on the basis of the stereo-electronic requirements of the pinacolic ring contraction. The reaction of the alcohol (6) afforded only the αβ-unsaturated aldehyde (16). In enhancement associated with the Δ^5-double bond.[1] Comparison of the reaction rates between the 4β-alcohols and their deoxy-analogues in both the saturated and unsaturated series showed a retardation by the 4β-oxygen function which was of a similar order of magnitude. This retardation was substantially increased by acetyl-



SCHEME 2 *Reagents*: i, Br_2, AgOAc, −70 °C; ii, NaOH, MeOH; iii, TsCl, pyr.; iv, Ac_2O, pyr.; v, CrO_3, Ac_2O; vi, H_2, Pt.; vii, NaOAc

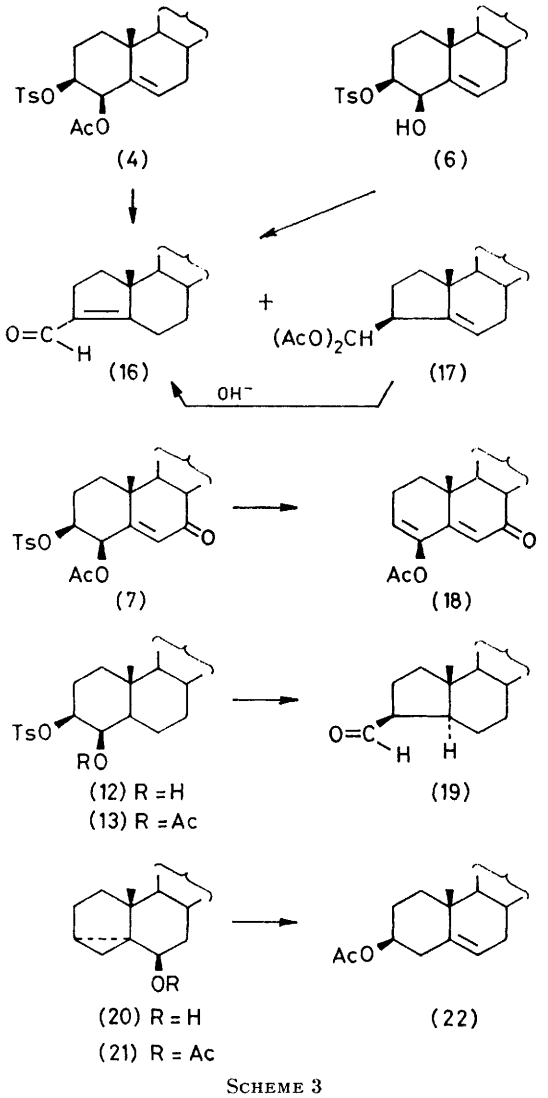
contrast solvolysis of the 7-ketone (7) gave the enol-acetate (18) whose structure followed from its spectral characteristics [n.m.r. δ 2.20 (OAc), 5.09, t, *J* 4 Hz, 3-H; 5.73, s, 6-H; u.v. $\lambda_{max.}$ 278 nm, ε 22 000]. Both 4β-hydroxy-3β-*p*-tolysulphonyloxy-5α-androstan-17-one (12) and its corresponding acetate (13) gave the A-nor-aldehyde (19) (n.m.r. δ 9.5, d, *J* 4 Hz) as the main product.

Comparison of the reaction rates between the saturated and unsaturated steroids revealed the well-known rate-

ation with very little detectable reaction in the case of the 4β-acetoxy-3β-*p*-tolylsulphonyloxy-5β-androstan-17-one (13). Thus there was no increase in the rate of ionization of the toluene-*p*-sulphonates which might be ascribed to the stabilization of the incipient C-4 charge but rather a retardation associated with the inductive electron-withdrawal by the hydroxy-group augmented in the case of the acetates. The insertion of a 7-ketone significantly reduces the electron-availability from the Δ^5-double bond. Surprisingly the reaction is still faster

than in the saturated series, indicating some double-bond participation.

Under the conditions (sodium acetate–aqueous acetone) of the cyclo-steroid rearrangement,[12] 3β-*p*-tolylsulphonyloxyandrost-5-en-17-one (15) affords 6β-hydroxy-3,5-cycloandrostan-17-one (20). However under



SCHEME 3

our more vigorous conditions, 3β-acetoxyandrost-5-en-17-one (22) was the sole product. 6β-Acetoxy-3,5-cycloandrostan-17-one (21) was prepared by acetylation of the corresponding alcohol.[12] In acetic acid–sodium acetate at 100 °C, it was isomerized to 3β-acetoxyandrost-5-en-17-one (22). Thus although attack at the 6β-position affords the products of kinetic control, the 3β-acetoxy-Δ^5-steroid results from thermodynamic control in agreement with the relative stabilities of a cyclopropane ring *versus* a propene.

EXPERIMENTAL

General experimental details have been described previously.[13]

3β,4β-*Diacetoxy*-5α-*androstan*-17-*one* (8).—3β,4β-Diacetoxyandrost-5-en-17-one (5 g) [5] in ethyl acetate (100 ml) was stirred with Adams catalyst (1 g) under hydrogen at atmospheric pressure for 24 h. The solution was filtered and the solvent was evaporated to afford a gum which was dissolved in acetone (100 ml) and treated with the 8N-chromium trioxide reagent (20 ml) for 15 min. Excess of sodium sulphite was added and the solution was concentrated under reduced pressure. The solution was acidified with hydrochloric acid and the steroid was recovered in ethyl acetate. The extract was washed with water and aqueous sodium hydrogen carbonate, dried, and evaporated to afford 3β,4β-*diacetoxy*-5α-*androstan*-17-*one* (8) (2 g) which crystallized from ethyl acetate–ether as prisms, m.p. 286—288 °C, $[\alpha]_D$ −22° (*c* 0.6) (Found: C, 74.4; H, 9.8. $C_{23}H_{34}O_5$ requires C, 74.5; H, 9.9%), $\nu_{max.}$ 1 740 cm^{-1}; δ 0.83 (3 H, s, 18-H), 1.07 (3 H, s, 19-H), 1.93 (3 H, s, OAc), 2.07 (3 H, s, OAc), 4.77 (1 H, m, 3-H), and 5.2 (1 H, m, 4-H). Preparative layer chromatography of the mother liquors on silica in ether–light petroleum (1 : 1) gave three bands. The top band afforded 5α-androstan-17-one (9) (1.25 g) which crystallized from methanol as plates, m.p. 117—118 °C (lit.,[6] 122°), $\nu_{max.}$ 1 750 cm^{-1}; δ 0.83 (3 H, s, 18-H), 0.87 (3 H, s, 19-H). The middle band afforded 3β-acetoxy-5α-androstan-17-one (10) (450 mg) which crystallized from methanol as needles, m.p. 95—96 °C (lit.,[7] 96—97 °C), $\nu_{max.}$ 1 740 and 1 710 cm^{-1}; δ 0.84 (6 H, s, 18 and 19-H), 1.98 (3 H, s, OAc), and 4.64 (1 H, m, 3-H). The lower band afforded 3β,4β-diacetoxy-5α-androstan-17-one (200 mg) identical with the material described above.

3β,4β-*Dihydroxy*-5α-*androstan*-17-*one* (11).—The above diacetate (2 g) in methanol (50 ml) was treated with saturated aqueous sodium hydroxide (2 ml) at room temperature for 1 h. Acetic acid (2 ml) was added, the solution was concentrated under reduced pressure, poured into water and the steroid recovered in ethyl acetate to afford 3β,4β-*dihydroxy*-5α-*androstan*-17-*one* (11) (1.3 g) which crystallized from methanol as plates, m.p. 221—222 °C, $[\alpha]_D$ +77° (*c* 0.6) (Found: C, 74.0; H, 9.9. $C_{19}H_{30}O_3$ requires C, 74.5; H, 9.9%); $\nu_{max.}$ 3 310 and 1 740 cm^{-1}; δ 0.87 (3 H, s, 18-H), 1.07 (3 H, s, 19-H), 3.47 (1 H, m, 3-H), and 3.73 (1 H, m, 4-H). The 3β-*monotoluene*-p-*sulphonate* (12), prepared with toluene-*p*-sulphonyl chloride in pyridine, crystallized from methanol as needles, m.p. 180—181 °C (decomp.), $[\alpha]_D$ +16° (*c* 0.6) (Found: C, 67.5; H, 7.8. $C_{26}H_{36}O_5S$ requires C, 67.8; H, 7.9%), $\nu_{max.}$ 3 520, 1 740, and 1 600 cm^{-1}; δ 0.83 (3 H, s, 18-H), 1.03 (3 H, s, 19-H), 2.47 (3 H, s, Ar-Me), 3.90 (1 H, m, 4-H), 4.4 (1 H, m, 3-H), and 7.33 and 7.8 (each 2 H, d, *J* 9 Hz, Ar-H).

4β-*Acetoxy*-3β-p-*tolylsulphonyloxy*-5α-*androstan*-17-*one* (13).—The above toluene-*p*-sulphonate (4) (250 mg) in acetic anhydride (10 ml) and sodium acetate (250 mg) was heated under reflux for 30 min. The solution was poured into water and the steroid recovered in ethyl acetate to afford 4β-*acetoxy*-3β-p-*tolylsulphonyloxy*-5α-*androstan*-17-*one* (13) (200 mg) which crystallized from ethyl acetate as needles, m.p. 232—233 °C (decomp.), $[\alpha]_D$ +36° (*c* 0.6) (Found: C, 66.9; H, 7.7. $C_{28}H_{36}O_6S$ requires C, 66.9; H, 7.6%), $\nu_{max.}$ 1 740 and 1 600 cm^{-1}; δ 0.84 (3 H, s, 18-H), 1.0 (3 H, s, 19-H), 2.02 (3 H, s, 4-OAc), 2.43 (3 H, s, Ar-Me), 4.38 (1 H, m, 3-H), 5.09 (1 H, m, 4-H), and 7.3 and 7.8 (each 2 H, d, *J* 9 Hz, Ar-H).

4β-*Acetoxy*-3β-p-*tolylsulphonyloxyandrost*-5-*ene*-7,17-*dione* (7).—4β-Acetoxy-3β-*p*-tolylsulphonyloxyandrost-5-en-17-one (6) [8] (1 g) in acetic acid (10 ml) and acetic anhydride

(1 ml) was stirred with chromium trioxide (1.5 g) at room temperature overnight. The solution was poured into an excess of aqueous sodium sulphite. The steroid was recovered in ethyl acetate. The extract was thoroughly washed with aqueous sodium hydrogen carbonate and water and dried. The solvent was evaporated to afford 4β-*acetoxy*-3β-p-*tolylsulphonyloxyandrost*-5-*ene*-7,17-*dione* (7) (600 mg) which crystallized from ethyl acetate as needles, m.p. 189—191 °C, $[\alpha]_D$ −35° (*c* 0.6) (Found: C, 65.5; H, 6.8. $C_{28}H_{34}O_7S$ requires C, 65.3; H, 6.6%), $\nu_{max.}$ 1 740, 1 670, and 1 600 cm^{-1}; $\lambda_{max.}$ 227 cm, ε 21 000; δ 0.87 (3 H, s, 18-H), 1.30 (3 H, s, 19-H), 2.07 (3 H, s, 4-OAc), 2.47 (3 H, s, Ar-Me), 4.4 (1 H, m, 3-H), 5.4 (1 H, d, *J* 4 Hz, 4-H), 5.9 (1 H, s, 6-H), and 7.33 and 7.8 (each 2 H, d, *J* 8 Hz, Ar-H).

Measurements of Rates and Solvolysis.—In a typical experiment 5 × 10^{-5} mol of steroid, 2.5 × 10^{-4} mol sodium [$^2H_3$]acetate, and [$^2H_4$]acetic acid (0.4 ml) were heated on a boiling water-bath in an n.m.r. tube. The ^1H n.m.r. spectra were recorded at suitable intervals (7—12 spectra per sample) on a Perkin-Elmer R 12 60-MHz spectrometer. The fraction of reaction that had occurred was estimated by measuring the height of the methyl resonance in the steroid toluene-*p*-sulphonate (δ 2.55) and dividing this by the sum of this height and that of the methyl resonance of the toluene-*p*-sulphonate anion (δ 2.49). The contribution to the peak height from the methylene envelope was eliminated by using a sloping base line. The δ values were measured relative to the toluene-*p*-sulphonate Ar-H signals and then corrected to the values for the $CDCl_3$ spectra. The pseudo-first-order rate constants (s^{-1}) are:

3β-*p*-Tolylsulphonyloxy-5α-androstan-17-one (14) [9]	−3.3 × 10^{-4}
3β-*p*-Tolylsulphonyloxyandrost-5-en-17-one (15) [12]	−1.18 × 10^{-2}
4β-Hydroxy-3β-p-tolylsulphonyloxy-5α-androstan-17-one (12)	−4.53 × 10^{-5}
4β-Hydroxy-3β-*p*-tolylsulphonyloxyandrost-5-en-17-one (6) [8]	−4.14 × 10^{-3}
4β-Acetoxy-3β-*p*-tolylsulphonyloxy-5α-androstan-17-one (13)	*ca.* −2 × 10^{-6}
4β-Acetoxy-3β-*p*-tolylsulphonyloxyandrost-5-en-17-one (4) [8]	−2.5 × 10^{-5}
4β-Acetoxy-3β-*p*-tolylsulphonyloxyandrost-5-ene-7,17-dione (7)	−5.22 × 10^{-6}

Identification of the Products of Solvolysis.—(i) *From* 3β-p-*tolylsulphonyloxy*-5α-*androstan*-17-*one*. The steroid (12) (1 g) in acetic acid (40 ml) containing sodium acetate (1 g) was heated under reflux for 2 h. The solution was concentrated under reduced pressure and poured into aqueous sodium hydrogen carbonate. The products were recovered in ethyl acetate and chromatographed on alumina. Elution with 20% ether–light petroleum gave 5α-androst-2-en-17-one (400 mg) which crystallized from methanol as needles, m.p. 100—102 °C (lit.,[9] m.p. 104—105 °C), $\nu_{max.}$ 1 740 and 1 650 cm^{-1}, δ 0.8 (3 H, s, 19-H), 0.87 (3 H, s, 18-H), and 5.53 (2 H, m, 2 and 3-H). Elution with 30% ether–light petroleum gave 3α-acetoxy-5α-androstan-17-one (200 mg) which crystallized from methanol as needles, m.p. 161—162 °C, $[\alpha]_D$ +84.5° (lit.,[10] m.p. 164.5—165.5 °C, $[\alpha]_D$ +77°), $\nu_{max.}$ 1 740 cm^{-1}; δ 0.8 (3 H, s, 18-H), 0.87 (3 H, s, 19-H), 2.03 (3 H, s, OAc), and 3.03 (1 H, m, 3-H).

(ii) *From* 3β-p-*tolylsulphonyloxyandrost*-5-*en*-17-*one*. The steroid (15) (1 g) in glacial acetic acid (10 ml) and sodium acetate (1 g) was heated under reflux for 30 min. The solution was concentrated *in vacuo* and poured into aqueous sodium hydrogen carbonate. The steroid was recovered in ethyl acetate. The extract was washed with aqueous sodium hydrogen carbonate and water, dried, and the solvent evaporated to afford 3β-acetoxyandrost-5-en-17-one (600 mg) which crystallized from ethyl acetate as cubes, m.p. 171—172 °C (lit.,[11] m.p. 171 °C); $\nu_{max.}$ 1 745 cm^{-1}; δ 08 (3, H, s, 18-H), 1.0 (3 H, s, 19-H), 2.0 (3 H, s, Ac), 4.53 (1 H, m, 3-H), and 5.3 (1 H, d, *J* 2 Hz, 6-H).

(iii) *From* 4β-*Acetoxy*-3β-p-*tolylsuphonyloxyandrost*-5-en-17-*one*. The steroid (4) (1 g) in acetic acid (20 ml) was heated with sodium acetate (1 g) for 4 h under reflux. The solution was concentrated under reduced pressure and poured into aqueous sodium hydrogen carbonate. The steroid was recovered in ethyl acetate and the products separated by preparative layer chromatography on silica in ether–light petroleum (1 : 1). The faster-running band afforded 3β-*diacetoxy-methyl*-A-*norandrost*-5-*en*-17-*one* (17) (150 mg) which crystallized from ether–light petroleum as plates, m.p. 136—137 °C, $[\alpha]_D$ +24° (*c* 0.6) (Found: C, 70.7; H, 8.1. $C_{23}H_{32}O_5$ requires C, 71.1; H, 8.3%), $\nu_{max.}$ 1 750 and 1 730 cm^{-1}; δ 0.89 (3 H, s, 18-H), 0.95 (3 H, s, 19-H), 2.04 (6 H, s, OAc), 2.9 (1 H, m, 3-H), 5.44 (1 H, m, 6-H), and 6.78 [1 H, d, *J* 7 Hz $(AcO)_2CH$]. The slower-running band afforded 3-*formyl*-A-*norandrost*-3-*en*-17-*one* (16) (500 mg) which crystallized from ether as plates, m.p. 145—147 °C, $[\alpha]_D$ 161° (*c* 0.6) (Found: C, 80.2; H, 9.3. $C_{19}H_{26}O_2$ requires C, 79.7; H, 9.2%), $\nu_{max.}$ 1 740, 1 650, and 1 620 cm^{-1}; $\lambda_{max.}$ 255 ε 15 000; δ 0.93 (3 H, s, 18-H), 1.07 (3 H, s, 19-H), and 9.97 (1 H, s, *CHO*). 3β-Diacetoxymethyl-A-norandrost-5-en-17-one (100 mg) in methanol (25 ml) was treated with saturated aqueous sodium hydroxide (0.5 ml) for 1 h at room temperature. The solution was neutralized with acetic acid, concentrated under reduced pressure, and poured into aqueous sodium hydrogen carbonate. The steroid was recovered in ethyl acetate. The solvent was evaporated to afford 3-formyl-A-norandrost-3-en-17-one (60 mg) which crystallized from ether as plates, m.p. 140 °C; identified by its i.r. and n.m.r. spectra.

(iv) 4β-*Hydroxy*-3β-p-*tolylsulphonyloxyandrost*-5-*en*-17-*one*. The steroid (6) (1 g) in acetic acid (20 ml) and sodium acetate (1 g) was heated under reflux for 30 min. The solution was concentrated under reduced pressure and poured into aqueous sodium hydrogen carbonate. The steroid was recovered in ethyl acetate to afford 3-formyl-A-norandrost-3-en-17-one (16), which crystallized from methanol as plates, m.p. 144—147 °C; identical (i.r. and n.m.r.) with the material described above.

(v) 4β-*Hydroxy*-3β-p-*tolylsulphonyloxy*-5α-*androstan*-17-*one*. The steroid (12) (500 mg) in acetic acid (5 ml) and sodium acetate (0.5 g) was heated under reflux for 12 h. The solution was concentrated under reduced pressure, poured into aqueous sodium hydrogen carbonate, and the steroid was recovered in ethyl acetate. The product was purified by preparative layer chromatography on silica in ether to afford 3β-formyl-A-nor-5α-androstan-17-one (19) (185 mg) which crystallized from ether as needles, m.p. 109—112 °C (Found: C, 78.8; H, 9.8. $C_{19}H_{28}O_2$ requires C, 79.1; H, 9.9%), $\nu_{max.}$ 1 740 and 1 720 cm^{-1}; δ 0.8 (3 H, s, 18-H), 0.9 (3 H, s, 19-H), and 9.5 (1 H, d, *J* 4 Hz, *CHO*).

(vi) 4β-*Acetoxy*-3β-*toluene*-p-*sulphonyloxy*-5α-*androstan*-17-*one*. The steroid (13) (250 mg) in acetic acid (5 ml) containing sodium acetate (250 mg) was heated under reflux for 24 h. The solution was concentrated under reduced pressure and poured into aqueous sodium hydrogen carbonate. The products were recovered in ethyl acetate and purified by preparative layer chromatography. The faster-running band afforded 3β-formyl-A-nor-5α-androstan-17-one (14)

(25 mg), identified by its i.r. and n.m.r. spectra, whilst the slower-running band afforded the starting material (45 mg).

(vii) 4β-*Acetoxy*-3β-p-*tolylsulphonyloxyandrost*-5-*ene*-7,17-*dione*. The steroid (7) (500 mg) in acetic acid (10 ml) containing sodium acetate (1 g) was heated under reflux for 20 h. The solution was concentrated under reduced pressure and poured into aqueous sodium hydrogen carbonate. The products were recovered in ethyl acetate. The extract was washed with aqueous sodium hydrogen carbonate, dried, and the solvent evaporated to afford 4-*acetoxyandrost*-3,5-*diene*-7,17-*dione* (18) (250 mg) which crystallized from ether as needles, m.p. 227—229 °C, $[\alpha]_D$ −207° (Found: C, 73.7; H, 7.6. $C_{21}H_{26}O_4$ requires C, 73.7; H, 7.7%), $\nu_{max.}$ 1 730, 1 650, and 1 590 cm^{-1}; $\lambda_{max.}$ 278 nm, ε 22 000; δ 0.77 (3 H, s, 18-H), 1.23 (3 H, s, 19-H), 2.2 (3 H, s, 4-OAc), 5.73 (1 H, s, 6-H), and 5.9 (1 H, t, *J* 4 Hz, 3-H).

The Isomerization of 6β-*Acetoxy*-3,5-*cycloandrostan*-17-*one*.—The steroid (21) [12] (500 mg) in acetic acid (20 ml) containing sodium acetate (1 g) was heated under reflux for 30 min. The solution was poured into aqueous sodium hydrogen carbonate and the steroids were recovered in ethyl acetate. The extract was dried and the solvent evaporated to afford 3β-acetoxyandrost-5-en-17-one (22) (460 mg), which crystallized from ether as needles, m.p. 172—173 °C (lit.,[11] 168—170 °C); identified by comparison with an authentic sample (t.l.c. and n.m.r.).

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REFERENCES

[1] For a review see D. N. Kirk and M. P. Hartshorn, ' Steroid Reaction Mechanisms,' Elsevier, Amsterdan, 1968, p. 236.
[2] G. H. Whitham and J. A. F. Wickramasinghe, *J. Chem. Soc.*, 1964, 1655.
[3] E. M. Kosower and S. Winstein, *J. Amer. Chem. Soc.*, 1956, **78**, 4347.
[4] R. M. de Sousa and R. M. Moriarty, *J. Org. Chem.*, 1965, **30**, 1509.
[5] D. Baldwin, J. R. Hanson, and A. M. Holtom, *J.C.S. Perkin, I*, 1973, 1704.
[6] G. Rosenkranz, St. Kaufmann, and J. Romo, *J. Amer. Chem. Soc.*, 1949, **71**, 3689.
[7] L. Ruzicka, M. W. Goldberg, J. Meyer, H. Brungger, and E. Eichenberger, *Helv. Chim. Acta*, 1934, **17**, 1395.
[8] B. Ellis, V. Petrow, and D. N. Stannay, B.P. 1,134,071/1968.
[9] R. E. Marker, O. Kamm, D. M. Jones, and L. W. Mixon, *J. Amer. Chem. Soc.*, 1937, **59**, 1363.
[10] J. von Euw and T. Reichstein, *Helv. Chim. Acta*, 1942, **25**, 988.
[11] L. F. and M. Fieser, ' Steroids ', Reinhold, New York, 1959, p. 508.
[12] A. Butenandt and L. A. Suranyi, *Chem. Ber.*, 1942, **75**, 591.
[13] J. R. Hanson and T. D. Organ, *J. Chem. Soc.* (*C*), 1970, 513.