SYNTHESIS OF 5-METHYL-19-NOR-5β-PREGN-9-ENE DERIVATIVES*

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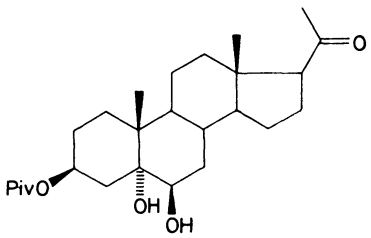
3β,5,6β-Trihydroxy-5α-pregnan-20-one 3-pivalate (*I*) was converted into 3β,6β-dihydroxy-5-methyl-19-nor-5β-pregn-9-en-20-one 3-pivalate 5-acetate (*II*) under conditions of Westphalen rearrangement. Deoxygenation in the position 6β was effected by treatment of the corresponding 6β-thiobenzoate or thioimidazolide with tributyltin hydride. Progesterone analogues *XII* and *XIII*, prepared from the 6-deoxy compound *IX*, exhibit abortive activity.

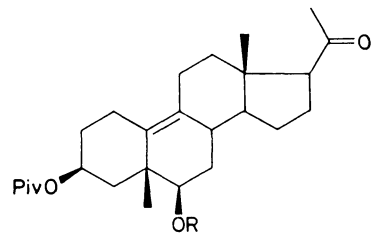
In our search for new types of therapeutically useful antigestagens we intended to verify possible activity of progesterone analogues in which the steroid skeleton is modified by shift of the angular methyl group from the 10β- into the 5β-position. It could be expected that the analogue *XIII*, containing both an acetyl group in position 17 and an α,β-unsaturated keto group in position 3, might bind to gestagen receptors without producing hormonal response.

As one of the suitable approaches to these compounds we may utilise the Westphalen rearrangement of 5,6-disubstituted derivatives of type *I* with subsequent reductive removal of the 6β-substituent. Kočovský[1] described the preparation of 3β-hydroxy-6β-chloro-5-methyl-19-nor-5β-pregn-9-en-20-one 3-acetate and its dehalogenation; however, this route required preparation of only one of the two[2] epoxides (3β-hydroxy-5,6α-epoxy-5α-pregnan-20-one 3-acetate) arising in the epoxidation of the Δ^5-double bond. However, we used a mixture of both epoxides which on hydrolysis afforded solely the 5α,6β-dihydroxy derivative *I*; in this case, after the Westphalen rearrangement it was necessary to remove the oxygen functionality in position 6β in compound *III*. The classical deoxygenation of the hydroxyl via mesylate or tosylate affords products of rearrangement[3] (4a-methyleno-A-homo-B,19-di-nor-5β-pregn-9-ene derivatives) and fragmentation. Thus, the only way to these compounds consisted in oxidation of 6β-alcohol followed by the Huang–Minlon reduction of the 6-ketones[4]. Of all the mentioned methods, deoxygenation of the 6β-hydroxy group with tributyltin hydride via thiobenzoate or thioimidazolide seemed to be the most promising and it is the subject of our present communication.

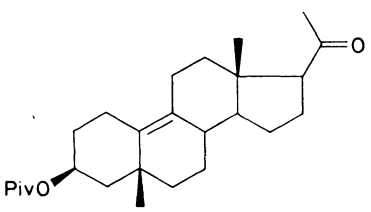
* Part CCCLI in the series on Steroids; Part CCCL: Collect. Czech. Chem. Commun. *55*, 1243 (1990).



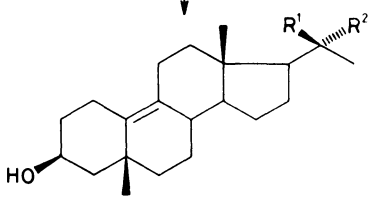
I



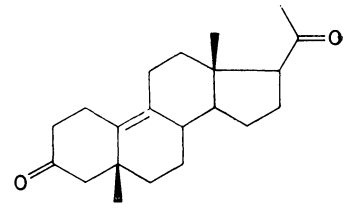
II, R = Ac
III, R = H
VI, R = CSPh
VII, R = CSIm
X, R = CH_2Ph



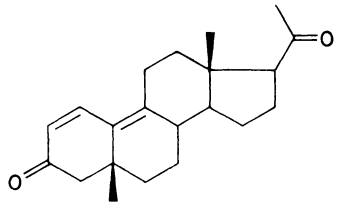
IX



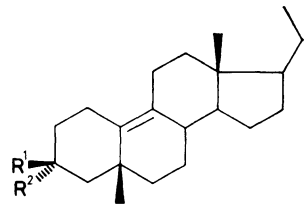
XIa, R^1 = H ; R^2 = OH
XIb, R^1 = OH ; R^2 = H



XII



XIII



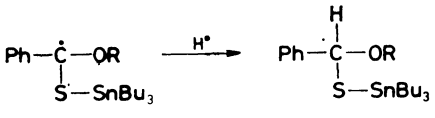
XV, R^1 = OH ; R^2 = H
XVI, R^1 + R^2 = O

Ac = acetyl ; Im = imidazol-1-yl ; Ph = phenyl ; Piv = pivaloyl

SCHEME 1

As the starting compound we used pregnenolone 3-pivalate, This compound was treated with peroxyacetic acid and the formed mixture of epoxides was converted into 3β,5,6β-trihydroxy-5α-pregnan-20-one 3-pivalate (*I*) which was subjected to Westphalen rearrangement[5]. The obtained diester *II* was smoothly partially hydrolyzed to alcohol *III*.

According to Barton and coworkers[6], the corresponding alcohols *III* and *IV* were treated with N,N-dimethylbenzamide, phosgene and hydrogen sulfide to give thiobenzoates of rearranged steroidal alcohols in the cholestane (*V*) and pregnane (*VI*) series. In an alternative derivatization method, reaction of the starting alcohol *III* with thiocarbonyldiimidazole afforded thioimidazolide *VII*. These derivatizations were accompanied by a strong downfield shift of the H-6 signal in the NMR spectrum and by occurrence of protons of the corresponding thiocarbonyl acid (see Experimental). The thiocarbonyl derivatives *V*–*VII* were reduced with tributyltin hydride under conditions of radical reaction[7]. It is known that this deoxygenation reaction is considerably selective: it tolerates all kinds of functional groups except halogen substituents, sulfur-containing groups and double bonds conjugated with a carbonyl group[8]. The reaction of compound *VI* afforded, in addition to the desired deoxy product *IX*, also a side product which we assigned the benzyl ether structure *X* on the basis of its mass (M^+ 506), infrared (aromatic bands) and ^{1}H NMR spectra (3·24 dd, 1 H; 4·42, 4·62, AB system (J = 12 Hz)). We tentatively explain the formation of this compound by high initial concentration of the reagent. As the result, the radical *XX* instead of disproportionating to the alkyl radical, reacts with another molecule of tributyltin hydride to give the intermediate *XXI* (see Scheme 2). Thermal cleavage of the C–S bond then affords the benzyl ether radical which is reduced with another molecule of the reagent under formation of benzyl ether *X*.



XX *XXI*

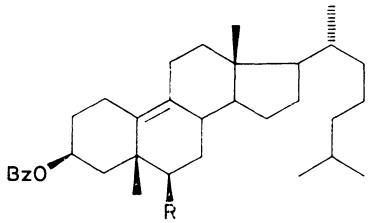
Ph = phenyl ; Bu = butyl ; R = steroidal part of compound *VI*

SCHEME 2

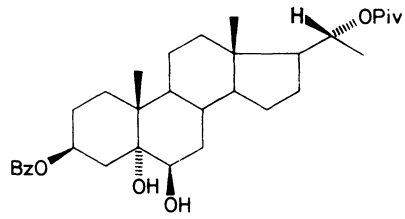
The 3-pivalate *IX* was first reduced with lithium aluminium hydride to give a mixture of diols *XIa* and *XIb* which was converted into dione *XII* by Jones oxidation. Treatment of *XII* with DDQ afforded the conjugated diene-dione *XIII* in 40% yield.

Since under the conditions of Westphalen rearrangement the side chain on C-17

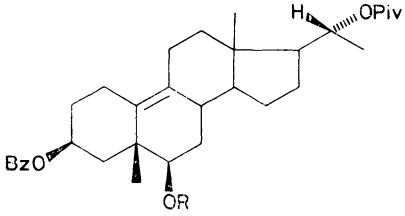
might epimerize, the whole reaction sequence was performed analogously with (20*R*)-5α-pregnan-3β5,6β-20-tetrol 3-benzoate 20-pivaloate (*XIV*) in which no enolization of the carbonyl group on C-20 (and thus no epimerization of the side chain on C-17) could take place. As in the preceding example, also in this case the corresponding 6-acetate *XVII* was acid-hydrolyzed to give the 6β-alcohol *XVIII* which was deoxygenated to diester *XIX* via the corresponding thioimidazolide. Cleavagae of *XIX* with lithium aluminium hydride afforded diol *XIa* which on Jones oxidation afforded diketone *XII*, identical with the compound prepared as mentioned above (see Experimental). It thus appeared that equilibration of the 20-ketone did not reduce substantially the yield or the purity of the product.



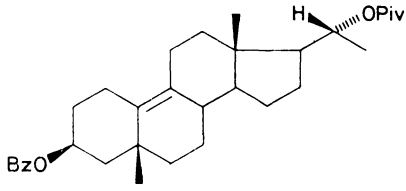
IV, R = OH
V, R = OCSPh
VIII, R = H



XIV



XVII, R = Ac
XVIII, R = H



XIX

Ac = acetyl ; Bz = benzoyl ; Ph = phenyl ; Piv = pivaloyl

For the study of binding of these synthetic hormone analogues to the gestagen receptor we converted the 20-ketone *IX* by the Huang-Minlon reduction into the 20-deoxy derivative *XV* which was then converted into ketone *XVI* by Jones oxidation.

The compounds *XII* and *XIII*, described in this paper, exhibit abortive activity in biological tests (see ref.[9]).

EXPERIMENTAL

Melting points were determined on a Koffer block and are uncorrected. Analytical samples were dried over phosphorus pentoxide at 50°C/100 Pa. Optical rotations were measured in chloroform at 23–25°C, IR spectra on a UR-20 (Zeiss, Jena) instrument in chloroform (unless stated otherwise), the wavenumbers are given in cm^{-1}. ^1H NMR spectra were taken in deuteriochloroform with tetramethylsilane as internal standard on a Tesla BS-497 (100 MHz, FT mode) spectrometer. Chemical shifts are given in ppm (δ-scale), coupling constants J are in Hz. ^{13}C NMR spectra were measured on a Varian XL-200 (200 MHz, FT mode). The solutions were dried over sodium sulfate. Analytical as well as preparative chromatography was performed on silica gel containing 5% of gypsum (Woelm). Solutions of the compounds in organic solvents were dried over sodium sulfate.

3β,6β-Dihydroxy-5-methyl-19-nor-5β-pregn-9-en-20-one 3-Pivalate 6-Acetate (*II*)

Concentrated sulfuric acid (3·5 ml) was added to a solution of 3β,5,6β-trihydroxy-5α-pregnan-20-one 3β-pivalate (*I*; 100 g, 0·23 mol) in acetic anhydride (800 ml) and glacial acetic acid (5 l). After standing at 20°C for 24 h, the solution was concentrated in vacuo to about 1/3 of the original volume. Methanol (500 ml) and pyridine (3 ml) were added, the solution was allowed to stand at room temperature for 2 h and taken down almost to dryness. The residue was dissolved in a mixture of benzene and ether (1 : 1) and washed with potassium carbonate solution. The organic layer was dried, the solvent evaporated and the residue layered with methanol (100 ml). The mixture was briefly boiled and then set aside in a refrigerator for several days. The separated crystals were collected and recrystallized from methanol to give 13·5 g (13%) of compound *II*, m.p. 145–146°C, $[\alpha]_D$ +151° (*c* 2·1). IR spectrum: 1 740, 1 246 (CH_3COO); 1 730, 1 283, 1 160 (($CH_3)_3CCOO$); 1 708 (CH_3CO). ^1H NMR spectrum: 0·74 s, 3 H (3 × H-18); 1·19 s, 3 H (CH_3-5); 1·22 s, 9 H (($CH_3)_3CCOO$); 2·08 s, 3 H (CH_3COO); 2·10 s, 3 H (CH_3CO); 4·91 t, 1 H (H-6, J = 5); 5·09 p, 1 H (H-3, J = 4). For $C_{28}H_{42}O_5$ (458·6) calculated: 73·33% C, 9·23% H; found: 73·07% C, 9·03% H.

3β,6β-Dihydroxy-5-methyl-19-nor-5β-pregn-9-en-20-one 3-Pivalate (*III*)

Concentrated hydrochloric acid (12 ml) was added to a solution of diester *II* (11·5 g, 25 mmol) in chloroform (200 ml) and methanol (600 ml). The mixture was stirred at 20°C for 80 h, the acid neutralized with 5% solution of sodium hydrogen carbonate and the solvents were evaporated. The almost dry residue was crystallized from a mixture of dichloromethane and heptane to give 9 g (86%) of compound *III*, m.p. 147°C, $[\alpha]_D$ +172° (*c* 2·0). IR spectrum: 3 625, 1 039 (OH); 1 724, 1 287, 1 165 (($CH_3)_3CCOO$); 1 711, 1 360 (CH_2CO). ^1H NMR spectrum: 0·75 s, 3 H (3 × H-18); 1·19 s, 3 H (CH_3-5); 1·22 s, 9 H (($CH_3)_3CCOO$); 2·10 s, 3 H (CH_3CO); 3·50 dd, 1 H (H-6, J = 4·5; J' = 12); 5·09 p, 1 H (H-3, J = 4). For $C_{26}H_{40}O_4$ (416·6) calculated: 74·96% C, 9·68% H; found: 75·01% C, 9·68% H.

5-Methyl-19-nor-5β-cholest-9-ene-3β,6β-diol 3-Benzoate 6-Thiobenzoate (*V*)

N,N-Dimethylbenzamide (0·2 g, 1·3 mmol) was added to a stirred solution of phosgene (0·17 g, 1·7 mmol) in dichloromethane (2 ml). After standing for 17 h at 20°C, the mixture was taken down and the residue dissolved in dichloromethane (1·7 ml). This solution was added dropwise to a solution of alcohol[10] *IV* (0·2 g, 0·39 mmol) in tetrahydrofuran (1·6 ml). After stirring for 15 min, pyridine (1 ml) was then added and hydrogen sulfide was introduced into the mixture for

15 min. The solvents were evaporated and the residue was crystallized from dichloromethane–methanol to give 136 mg (56%) of thiobenzoate *V*, m.p. 198–199°C, $[\alpha]_D$ +73° (*c* 1·5). IR spectrum: 1 720, 1 275, 712 (benzoate); 1 240, 692 (thiobenzoate). ^{1}H NMR spectrum: 0·91 s, 3 H (3 × H-18); 1·57 s, 3 H (CH_3-5); 5·36 p, 1 H (H-3, J = 3·5); 5·72 dd, 1 H (H-6, J = 7·5; J' = 10); 7·3–8·2 m, 5 H (H-arom.). For $C_{41}H_{54}O_3S$ (626·9) calculated: 78·55% C, 8·68% H, 5·11% S; found: 78·32% C, 8·65% H, 5·5% S.

3β,6β-Dihydroxy-5-methyl-19-nor-5β-pregn-9-en-20-one 3-Pivalate 6-Thiobenzoate (*VI*)

The 6β-hydroxy derivative *III* (4 g, 9·6 mmol) was converted into thiobenzoate *VI* (4·7 g, 91%) analogously as described for the preparation of thiobenzoate *V*. The title compound *VI* melted at 200–201°C, $[\alpha]_D$ +36° (*c* 2·1). IR spectrum (CCl_4): 1 729, 1 282, 1 161 ($(CH_3)_3CCOO$); 1 711, 1 361 (CH_3CO); 1 240 (C=S); 690 (C_6H_5). ^{1}H NMR spectrum: 0·78 s, 3 H (3 × H-18); 1·23 s, 9 H ($(CH_3)_3CCOO$); 1·50 s, 3 H (CH_3-5); 2·12 s, 3 H (CH_3CO); 5·09 p, 1 H (H-3, J = = 3·5); 5·76 dd, 1 H (H-6, J = 7·5; J' = 10); 7·3–8·2 m, 5 H (H-arom).). For $C_{33}H_{44}O_4S$ (536·8) calculated: 73·84% C, 8·26% H, 5·97% S; found: 74·01% C, 8·29% H, 6·00% S.

3β,6β-Dihydroxy-5-methyl-19-nor-5β-pregn-9-en-20-one
3-Pivalate 6-Thioimidazolide (*VII*)

1,1'-Thiocarbonyldiimidazole (0·8 g, 4·5 mmol) was added to a solution of alcohol *III* (975 mg, 2·3 mmol) in boiling 1,2-dichloroethane (10 ml). The reaction mixture was refluxed for 3 h, cooled, the solvent evaporated and the residue partitioned between water and ether. The ethereal layer was extracted with 5% aqueous sodium hydrogen carbonate solution and water and dried over sodium sulfate. Evaporation of the solvent afforded 1·25 g of crude thioimidazolide *VII* which was used in the next step without purification. ^{1}H NMR spectrum: 0·78 s, 3 H (3 × H-18); 1·23 s, 9 H ($(CH_3)_3CCOO$); 1·41 s, 3 H (CH_3-5); 2·12 s, 3 H (CH_3CO); 5·11 t, 1 H (H-3, J = 3·5); 5·56 dd, 1 H (H-6, J = 6; J' = 10); 7·05 s, 1 H (H-2' of imidazole); 7·61 s, 1 H (H-5' of imidazole); 8·33 s, 1 H (H-4' of imidazole). For $C_{30}H_{42}N_2O_4S$ (526·7) calculated: 68·39% C, 8·04% H, 5·32% N, 6·09% S; found: 69·01% C, 8·12% H, 5·30% N, 6·13% S.

5-Methyl-19-nor-5β-cholest-9-en-3β-ol Benzoate (*VIII*)

A solution of thiobenzoate *V* (154 mg, 0·26 mmol) in toluene (5·5 ml) was added under argon to a stirred boiling 1M tributyltin hydride solution in benzene (0·75 ml), containing azo-bis-(isobutyronitrile) (1 mg). The solution was refluxed until it decolorized and then for 1 h more. After evaporation of the solvents, the residue was chromatographed on silica gel (20 g) in light petroleum–ethyl acetate (19 : 1) to yield 100 mg (83%) of compound *VIII*, m.p. 118°C, $[\alpha]_D$ +56° (*c* 1·3). ^{1}H NMR spectrum: 0·89 s, 3 H (3 × H-18); 1·27 s, 3 H (CH_3)-5); 5·35 p, 1 H (H-3, J = 3); 7·24–8·14 m, 5 H (H-arom.). For $C_{34}H_{50}O_2$ (490·8) calculated: 83·21% C, 10·27% H; found: 83·11% C, 10·10% H.

3β-Hydroxy-5-methyl-19-nor-5β-pregn-9-en-20-one Pivalate (*IX*)

A) A solution of thiobenzoate *VI* (3·8 g, 7·1 mmol) in toluene (75 ml) was added under argon to a stirred boiling 1M tributyltin hydride solution in benzene (25 ml), containing azo-bis-(isobutyronitrile) (1 mg). The solution was refluxed till it decolorized and then for 1 h more. The solvents were evaporated and the residue chromatographed on silica gel (200 g) in light petroleum–ethyl acetate (19 : 1). The following compounds were successively eluted: Compound

IX (1·14 g, 40%), m.p. 126°C (methanol), $[\alpha]_D$ +143° (*c* 1·9). ^{1}H NMR spectrum: 0·74 s, 3 H (3 × H-18); 1·21 s, 9 H ($(CH_3)_3CCOO$ and CH_3-5); 2·11 s, 3 H (CH_3CO); 5·08 p, 1 H (H-3, *J* = 3·5). IR spectrum (CCl_4): 1 728, 1 286, 1 173, 1 163 ($(CH_3)_3CCOO$); 1 711, 1 360 (CH_3CO). For $C_{26}H_{40}O_3$ (400·6) calculated: 77·95% C, 10·06% H; found: 77·59% C, 10·11% H. Benzyl ether *X* (715 mg, 20%): IR spectrum: 3 090, 3 070, 3 035, 1 101, 1 077, 702 ($C_6H_5CH_2O$); 1 727, 1 287, 1 166 ($(CH_3)_3CCOO$); 1 711, 1 362 (CH_3CO). ^{1}H NMR spectrum: 0·74 s, 3 H (3 × H-18); 1·22 s, 9 H ($(CH_3)_3CCOO$); 2·10 s, 3 H (CH_3CO); 3·24 t, 1 H (H-6, *J* = 8); 4·42 and 4·62, AB system ($CH_2C_6H_5$, *J* = 12); 7·33 s, 5 H (H-arom.). ^{13}C NMR spectrum ($CDCl_3$, noise decoupled): 12·80 (C-18), 20·32 (CH_3–C-5), 26·95 ($(CH_3)_3CCOO$), 30·98 (CH_3CO), 36·87 (C-8), 55·85 (C-14), 63·12 (C-17), 68·95 (C-3), 81·03 (C-6), 70·81 (OCH_2Ph), 131·48 (C-9), 131·91 (C-10), 138·76 (C′-1 arom.), 127·37 and 127·92 (C′-2, C′-3, C′-5, C′-6), 127·08 (C′-4), 177·60 (COO), 208·67 (C-20). For $C_{33}H_{46}O_4$ (506·7) calculated: 78·22% C, 8·15% H; found: 78·54% C, 8·34% H. Further fractions contained compound *III* (523 mg, 18%), identical with the sample prepared above.

B) A solution of thioimidazole *VII* (1·25 g, 2·37 mmol) in toluene (25 ml) was added under argon to a stirred boiling 1M solution of tributyltin hydride in benzene (7·5 ml) containing azo-bis(isobutyronitrile) (1 mg). The solution was refluxed till it decolorized and then for 1 h more. The solvents were evaporated and the residue chromatographed on silica gel (100 ml) in light petroleum–ethyl acetate (19 : 1) to give compound *IX* (0·8 g, 84%), identical with the product obtained by the procedure *A*).

(20*R*)-5-Methyl-19-nor-5β-pregn-9-ene-3β,20-diol (*XIa*)

Compound *XIX* (70 mg, 0·14 mmol) was reduced with lithium aluminium hydride (60 mg, 1·58 mmol) in boiling tetrahydrofuran (2·6 ml). After 1 h the reaction mixture was poured on an ice-water mixture, acidified with 5% hydrochloric acid and the product was taken up in ether. The organic layer was washed with 5% hydrochloric acid, 5% solution of sodium hydrogen carbonate and water, the solvent evaporated and the residue crystallized from dichloromethane and hexane to give 44 mg (99%) of compound *XIa*, m.p. 168–170°C, $[\alpha]_D$ +27° (*c* 2·4). IR spectrum: 3 625, 1 049, 1 018 (OH). ^{1}H NMR spectrum: 0·87 s, 3 H (3 × H-18); 1·25 s, 3 H (CH_3-5); 3·71 m, 1 H (H-20); 4·11 p, 1 H (H-3, *J* = 3). For $C_{21}H_{34}O_2$ (318·5) calculated: 79·19% C, 10·76% H; found: 78·89% C, 11·01% H.

(20*R* + 20*S*)-5-Methyl-19-nor-5β-pregn-9-ene-3β,20-diol (*XIa* + *XIb*)

Compound *IX* (700 mg, 1·75 mmol) was reduced in the same manner as described for diol *XIa*. The usual work-up procedure afforded a mixture of diols *XIa* and *XIb* (550 mg, 98%). Oxidation according to Jones gave diketone *XII* (540 mg, 98%), identical with the sample prepared from diol *XIa*.

5-Methyl-19-nor-5β-pregn-9-ene-3,20-dione (*XII*)

A solution of diol *XIa* (44 mg, 0·14 mmol) in acetone (1 ml) was treated with Jones reagent The reaction mixture was washed up as usual and the ethereal solution dried over magnesium sulfate. The solvent was evaporated and the crude product crystallized from methanol; yield 42 mg (96%) of diketone *XII*, m.p. 148–149°C, $[\alpha]_D$ +101° (*c* 2·0). IR spectrum: 1 731 (C=O); 1 717 (CH_3CO). CD spectrum (dioxane): $\Delta\varepsilon$ +2·22 (293 nm). ^{1}H NMR spectrum: 0·76 s, 3 H (3 × H-18); 1·01 s, 3 H (CH_3-5); 2·12 s, 3 H (CH_3CO). For $C_{21}H_{30}O_2$ (314·5) calculated: 80·21% C, 8·62% H; found: 80·31% C, 8·60% H.

5-Methyl-19-nor-5β-pregna-1,9-diene-3,20-dione (*XIII*)

A solution of dione *XII* (850 mg, 2·7 mmol) in toluene (30 ml) was mixed with 2,3-dichloro-5,6--dicyano-1,4-benzoquinone (1·2 g, 5·2 mmol). After refluxing for 8 h, the mixture was cooled, filtered and the precipitate on the filter extracted with benzene. The benzene solution was washed with aqueous sodium hydrogen carbonate and water. The solvent was evaporated and the residue chromatographed on silica gel (55 g) in light petroleum–ethyl acetate (7 : 3). After 170 mg (20%) of the starting dione *XII*, the chromatography afforded 340 mg (40%) of compound *XIII*, m.p. 144°C, $[\alpha]_D$ +478° (*c* 2·1). IR spectrum: 3 045 (C=C—H); 1 706, 1 359 (CH_3CO); 1 680,1 611 (C=C—C=O). ^{1}H NMR spectrum: 0·84 s, 3 H (3 × H-18); 1·12 s, 3 H (CH_3-5); 2·12 s, 3 H (CH_3CO); 5·84 dd, 1 H (H-1, J = 3·5; J' = 11); 7·42 m, 1 H (H-2). For $C_{21}H_{28}O_2$ (312·5) calculated: 80·73% C, 9·03% H; found: 80·19% C, 8·89% H.

5-Methyl-19-nor-5β-pregn-9-en-3-one (*XVI*)

A solution of ketone *IX* (2·3 g, 5·8 mmol) in ethylene glycol (100 ml) was mixed with hydrazine hydrate (13 ml, 0·26 mmol) and potassium hydroxide (3·6 g, 61 mmol). The mixture was heated to 140°C for 30 min, the excess hydrazine hydrate distilled off and the reaction completed by refluxing for 4 h. After cooling, the mixture was poured into water, the precipitate was filtered and dissolved in ether. The solution was washed with water and dried over sodium sulfate, the solvent was evaporated and the residue chromatographed on silica gel (100 g) in light petroleum–-ethyl acetate (19 : 1). The main fraction contained 5-methyl-19-nor-5β-pregn-9-en-3β-ol (*XV*; 520 mg, 30%). ^{1}H NMR spectrum: 0·69 s, 3 H (3 × H-18); 1·25 s, 3 H (CH_3-5); 4·11 p, 1 H (H-3, J = 4). The alcohol *XV* (520 mg, 1·72 mmol) was dissolved in acetone (5 ml) and the solution was titrated with Jones reagent. The mixture was worked up as described for the preparation of dione *XII*, yield 500 mg (87%) of ketone *XVI*, $[\alpha]_D$ +96° (*c* 1·9). ^{1}H NMR spectrum: 0·70 s, 3 H (3 × H-18); 1·01 s, 3 H (CH_3-5). IR spectrum (CCl_4): 1 731, 1 754 (C=O). For $C_{21}H_{32}O_4$ (300·5) calculated: 83·94% C, 10·73% H; found: 82·99% C, 10·5% H.

(20*R*)-5-Methyl-19-nor-5β-pregn-9-ene-3β,6β,20-triol
3-Benzoate 6-Acetate 20-Pivalate (*XVII*)

The title compound was prepared from diol *XIV* (2·5 g, 4·5 mmol) in the same manner as compound *II* from compound *I*. Yield of *XVII* 370 mg (14%); m.p. 234—235°C, $[\alpha]_D$ +114° (*c* 1·2). IR spectrum: 1 738, 1 247 (CH_3COO); 1 726, 1 163 ($(CH_3)_3CCOO$); 1726, 1 278 (C_6H_5COO). ^{1}H NMR spectrum: 0·78 s, 3 H (3 × H-18); 1·18 s, 9 H ($(CH_3)_3CCOO$); 1·55 s, 3 H (CH_3-5); 2·01 s, 3 H (CH_3COO); 4·91 m, 2 H (H-20 and H-6); 5·36 p, 1 H (H-3, J = 3); 7·0—8·5 m, 5 H (H-arom.). For $C_{35}H_{84}O_6$ (564·8) calculated: 74·44% C, 8·57% H; found: 74·69% C, 8·81% H.

(20*R*)-5-Methyl-19-nor-5β-pregn-9-ene-3β,6β,20-triol 3-Benzoate 20-Pivalate (*XVIII*)

The title compound (300 mg, 93%) was obtained by hydrolysis of triester *XVII* (350 mg, 0·62 mmol) analogously as described for compound *III*. The product *XVIII* had $[\alpha]_D$ +127° (*c* 2·1). ^{1}H NMR spectrum: 0·65 s, 3 H (3 × H-18); 1·05 s, 3 H (CH_3-5); 1·18 s, 9 H ($(CH_3)_3$. .CCOO); 3·63 t, 1 H (H-6, J = 3·5); 4·93 m, 1 H (H-20); 5·38 p, 1 H (H-3, J = 3·5); 7·2—8·1 m, 5 H (H-arom.). IR spectrum: 3 625, 1 039 (OH); 1 728, 1 170 ($(CH_3)_3CCOO$); 1 728, 714 (C_6H_5COO). For $C_{33}H_{46}C_5$ (522·7) calculated: 75·83% C, 8·87% H; found: 75·84% C, 8·88% H.

(20*R*)-5-Methyl-19-nor-5β-pregn-9-ene-3β,20-diol 3-Benzoate 20-Pivalate (*XIX*)

In the same manner as compound *V*, the hydroxy derivative *XVIII* (108 mg, 0·21 mmol) was converted into the corresponding 6-thioimidazolide which, without isolation, was deoxygenated (analogously as described for compound *VI*) into compound *XIX* (93 mg, 89%); m.p. 152–153°C, $[\alpha]_D$ +119° (*c* 1·5). IR spectrum (CCl_4): 1 728, 1 170 ($(CH_3)_3CCOO$); 1 728, 814 (C_6H_5COO). ^1H NMR spectrum: 0·64 s, 3 H (3 × H-18); 1·09 s, 3 H (CH_3-5); 1·19 s, 9 H ($(CH_3)_3CCOO$); 4·88 m, 1 H (H-20); 5·36 p, 1 H (H-3, J = 3·5); 7·2–8·1 m, 5 H (H-arom.). For $C_{33}H_{45}O_4$ (493·7) calculated: 78·38% C, 8·97% H; found: 78·38% C, 8·89% H.

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