TABLE I

DIPOLE MOMENT DATA

N_2	d_{12}	ϵ_{12}
	Cholestan-3-one	
0.00000000	0.873735	2.2729
0.00069839	0.874023	2.2831
0.00137615	0.874371	2.2929
0.00298159	0.875150	2.3141
0.00429121	0.875814	2.3312
α 13.531	ϵ_1 2.2736	d_1 0.87371
β 0.488	$P_{2\infty}$ 315.7	M_R 118.73
(Pe + Pa) 130.60	μ 3.01 D	
	2-Fluorocholestan-3-one	
0.00000000	0.873579	2.2743
0.00038680	0.873977	2.2858
0.00080923	0.874248	2.2974
0.00096282	0.874377	2.3012
0.00111752	0.874433	2.3057
α 27.913	ϵ_1 2.2746	d_1 0.87361
β 0.776	$P_{2\infty}$ 524.2	M_R 118.51
(Pe + Pa) 130.36	μ 4.39 D.	

equatorial),[15] the moment for 2α-fluorocholestanone was calculated to be 4.28 D, while that of 2β-fluorocholestanone was calculated to be 2.95 D.

The dipole moment of the only known 2-fluorocholestanone was measured in benzene solution, and the value found was 4.39 D. The configuration at C-2 is therefore unequivocally established as α and the earlier configurational assignment is confirmed.

EXPERIMENTAL

Cholestanone, m.p. 130–130.5°, was prepared from cholesterol in the usual way. The 2-fluorocholestanone, m.p. 173.0–173.5° was used as received after drying under vacuum for a few hours.

Dipole moment apparatus. The Dipolemeter DM01 manufactured by Wissenshaftlich-Technische Werkstatten obtainable through the Kahl Scientific Instrument Corporation, El Cajon, Calif., was used for the measurements reported herein. The apparatus utilizes the heterodyne beat method and operates at 1,800 kilocycles. It is internally thermostated and of good stability. The cell used was of metal with a gold plated interior and had an effective capacity of about 35$\mu\mu$F with a volume of 40 ml. It was thermostated at 25° ±0.01°.

The dipole moments were measured in benzene solution. The moments were calculated by essentially the method of Halverstadt and Kumler[21] utilizing an IBM 650 computer programmed as described earlier.[22] Since the cholestanone derivatives are of such high molecular weight the usual neglect of the atomic polarization may introduce some error[23] in the present case. Unfortunately there is no very good, simple method for determining the atomic polarization. What has been done in the present case is to set it equal to 10% of the molar refractivity, for both cholestanone and the fluoro derivative. The effect of taking the atomic polarization into account is to lower the experimental moment of cholestanone from 3.10 to 3.01 D, and the moment of the fluoro compound is similarly lowered from 4.46 to 4.39 D. These changes are not of great significance since the experimental error is about 0.03 D, but the values which take atomic polarization into account have been used throughout the paper. The data are summarized in Table I.

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(20) This is an average of values reported for a number of aliphatic fluorides by M. T. Rogers and J. D. Roberts, *J. Am. Chem. Soc.*, **68**, 843 (1946) and by M. T. Rogers, *J. Am. Chem. Soc.*, **69**, 457 (1947).

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17α,20α-Dihydroxy-4-pregnene-3-one

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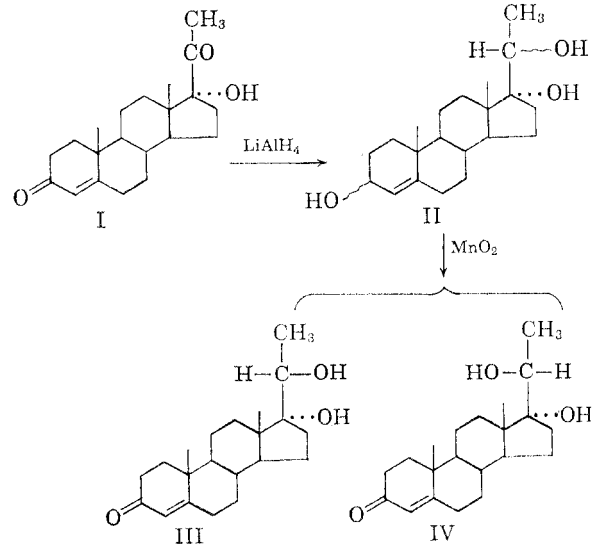
Presumptive evidence for the presence of 17α,-20α-dihydroxy-4-pregnene-3-one in biological material was presented by Sandor and Lanthier,[1] but no physical constants were given and only chromatographic behavior of the compound was included. A search of the literature revealed that this compound was not previously synthesized and we wish to report its synthesis. 17α-Hydroxyprogesterone (I) was reduced with lithium aluminum



hydride. The resulting mixture of epimeric 3ξ,-17α,20ξ-glycols (II) was oxidized with manganese dioxide[2] at room temperature to give a mixture

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(2) F. Sondheimer, C. Amendolla, and G. Rosenkranz, *J. Am. Chem. Soc.*, **75**, 5930 (1953).

of 17α,20α-dihydroxy-4-pregnene-3-one (III) and 17α,20β-dihydroxy-4-pregnene-3-one (IV). The 17α,20-glycols (III and IV) were separated by paper chromatography using the solvent system benzene-formamide[3] (formamide diluted with an equal volume of methanol). Although it was previously shown[4] that reduction of 17α-hydroxy-20-keto-steroids with lithium aluminum hydride affords predominantly the 17α,20α-dihydroxy epimer, we have observed in the present instance that the 17α,20β-isomer constitutes the major product (70%). By a similar reduction of a 17α-hydroxy-progesterone derivative Romo *et al.*[5] have obtained only the 17α,20β-dihydroxy epimer IV. However, it has been possible for us to isolate the 17α,20α-dihydroxy epimer in 30% yield, and as expected it was more polar than the 17α,20β-dihydroxy epimer[4a] and the molecular rotation was lower than its 17α,20β-isomer IV.

EXPERIMENTAL[6]

Melting points. All melting points were determined on samples dried under high vacuum at 60° for 24 hr. and were uncorrected.

Absorption spectra. The ultraviolet absorption spectra were determined in methanol on a Cary Recording Spectrophotometer (Model 11 MS). The infrared absorption spectra were determined in potassium bromide disks on a Perkin-Elmer infrared spectrometer (Model 21).

Optical rotations. All optical rotations were measured in chloroform solution.

Lithium aluminum hydride reduction of I. A solution of 2 g. of 17α-hydroxyprogesterone (I) in 60 ml. of tetrahydrofuran was added with stirring to 3.5 g. of lithium aluminum hydride in 110 ml. of tetrahydrofuran over a period of 15 min., and the mixture was then heated under reflux for 2 hr. The excess reagent was decomposed by addition of ethyl acetate. A saturated solution of sodium sulfate was then added until the precipitate began to adhere to the sides of the flask. Finally 20 g. of solid sodium sulfate was added and the solution was filtered from the salts. Evaporation of the filtrate gave 2 g. of a mixture of epimeric 4-pregnene-3ξ, 17α,20ξ-triols (II) as a crystalline solid. Without further purification this mixture was subjected to manganese dioxide oxidation.

Manganese dioxide oxidation of the mixture of triols II. To a solution of 2 g. of the mixture of aforementioned triols in 100 ml. of tetrahydrofuran 10 g. of manganese dioxide[7] was added and stirred at room temperature (25°) for 4 hr. The solution was then filtered from the catalyst and after evaporating the solvent, 1.8 g. of a mixture of 17α, 20α-dihydroxy-4-pregnene-3-one (III) and 17α,20β-dihydroxy-4-pregnene-3-one (IV) was obtained as a solid.

Separation of III and IV by paper chromatography. One gram of the mixture of III and IV was chromatographed on 200 Whatman No. 1 paper grams in the solvent system benzene-formamide[3] (formamide diluted with an equal volume of methanol) for 5 hr. The positions of III and IV were demonstrated by means of a 2,4-dinitrophenylhydrazene reagent[7] and iodine reagent.[8] Both compounds reacted with the 2,4-dinitrophenylhydrazene reagent to give orange colors on the paper, whereas the iodine reagent gave a blue color with the more polar 17α,20α-dihydroxy-4-pregnene-3-one (III) and a brown color with the less polar 17α,20β-dihydroxy-4-pregnene-3-one (IV). The compounds were then separately eluted from the papers with a mixture of equal volumes of methanol and chloroform. The solvent was evaporated under a stream of nitrogen *in vacuo* at 45° in each case and the residue was crystallized. 17α,20α-Dihydroxy-4-pregnene-3-one (III) which was obtained in 30% yield crystallized from methanol as stout needles, m.p. 208–210°, $(\alpha)_D^{22°}$ +20.4°, MD + 67.7°; $\lambda_{max}^{CH_3OH}$ 242 mμ, ϵ = 19,210), ν_{max}^{KBr} 3483, 2965, 1660, and 1615 cm.$^{-1}$

Anal. Calcd. for $C_{21}H_{32}O_3$: C, 75.86; H, 9.71. Found: C, 75.70; H, 9.53.

17α,20β-Dihydroxy-4-pregnene-3-one (IV) was obtained in 70% yield and crystallized from acetone as prisms, m.p. 204–205.5°, $(\alpha)_D^{22}$ + 72.7°, MD + 241.6°, $\lambda_{max}^{CH_3OH}$241 mμ (ϵ = 16,030), ν_{max}^{KB} 3465, 2960, 1660, and 1615 cm.$^{-1}$

Anal. Calcd. for $C_{21}H_{32}O_3$: C, 75.86; H, 9.71. Found: C, 75.93; H, 9.70. [Lit.[5] m.p. 201–204°, $(\alpha)_D^{20}$ +68.2°, λ_{max} 240 mμ (log ϵ, 4.29).]

The mixture melting point of III and IV showed depression and melted over a range 190–198°.

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Reactions of Vanillin and Its Derived Compounds. XXX.[1] The Reduction of 4,4′-Dibenzyloxy-3,3′-dimethoxybenzil

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Earlier studies on the synthesis of 4,4′-dihydroxy-3,3′-dimethoxybenzophenone from vanillil (4,4′-dihydroxy-3,3′-dimethoxybenzil) (I)[2] indicated that the bisbenzyl ether of vanillil, 4,4′-dibenzyloxy-3,3′-dimethoxybenzil (II) was more amenable to rearrangement with alkali than was the parent I. This greater specific reactivity of bisbenzyl ethers led to the preparation of bisbenzyl ethers of several reduction products of I needed for preparative studies related to products isolated from lignosulfonate oxidation mixtures.[3-5] The present paper

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