453. *Steroids. Part XXIV.* The Preparation and Nuclear Magnetic Resonance Spectra of Some 6-Substituted 4-Methylcholest-4-enes*

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In a series of 6-substituted 4-methylcholest-4-enes the 6β-epimer is shown to be the more thermodynamically stable. The nuclear magnetic resonance spectra of the epimeric 3,3-ethylenedithio-4-methylcholest-4-en-6-ols and their acetates show homoallylic coupling between the 4-methyl group and the 6β-proton but not between the 4-methyl group and the 6α-proton. Similarly the 4-methyl group in 4-methylcholest-4-en-3-one is coupled with the 6β-proton, but not with the 6α-proton in 6β-bromo- or 6β-acetoxymethyl-4-methylcholest-4-en-3-one.

The rigid conformation of the steroid nucleus makes it a suitable vehicle for study of the effect of variation in structure on the nuclear magnetic resonance spectra. Numerous publications deal with the additive influence of substituents on the chemical shifts of the angular methyl groups,[1-5] long-range shielding,[6-9] applications of the Karplus

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rule,[10-14] and long-range coupling.[15] An investigation of allylic coupling in the n.m.r. spectra of a series of 6-substituted cholest-4-en-3-ones has shown [16] that the vinyl proton at C4- is coupled to the axial 6β-proton but not to the equatorial 6α-proton, thus providing a new means of determining stereochemistry at C-6. Physical methods previously used for determination of configuration at this position, namely ultraviolet,[17,18] optical rotatory dispersion,[18] and infrared [19] spectroscopy, epimerisation,[20] and optical rotation,[21] may involve the isolation of both epimers. The shape of the signal due to the proton at C-6 in the n.m.r. spectrum (broad for axial protons, relatively narrow for equatorial protons [22]) can also be used for assignment of configuration at C-6 but this proton would not be expected to give rise to a discrete signal unless the substituent at C-6 were electronegative.

Theoretical considerations led us to expect that in 6-substituted 4-methylcholest-4-enes homoallylic coupling [23] between protons of the methyl group on C-4 and protons at C-6 would exhibit angular dependence analogous to that found for allylic coupling in 6-substituted cholest-4-en-3-ones,[16] because both types of long-range spin-spin coupling are believed to involve a σ-π configuration interaction mechanism.[15,24-30]

A similar angular dependence has already been observed [23] in the homoallylic coupling between the methyl group at C-4 and the protons at C-6 in the santonin series (I). The 4-methyl group is coupled with the axial 6β-proton in α-santonin, but appears as a singlet in 6-epi-α-santonin, in which the 6α-proton is equatorial. An identical geometrical dependence of homoallylic coupling has been observed in aphid pigments [31] and is also evident from consideration of scattered examples of homoallylic coupling in the literature.[15]

Interest in the probable homoallylic coupling in 6-substituted 4-methylcholest-4-enes, with a view to establishing configuration at C-6, prompted us to synthesise a number of 6α- and 6β-derivatives of 4-methylcholest-4-enes, and examine their n.m.r. spectra.

Cholest-4-en-3-one (II) was treated with formaldehyde in the presence of toluene-ω-thiol under basic conditions to give 4-benzylthiomethylcholest-4-en-3-one,[31] desulphurised with Raney nickel [32] to give 4-methylcholest-4-en-3-one (III). The n.m.r. spectrum reveals the 4-methyl group as a poorly resolved unsymmetrical doublet at τ 8·28 (J 1·2 c./sec.). A second product, 6β-hydroxymethyl-4-methylcholest-4-en-3-one (IV; R = H), was identified by its ultraviolet and infrared absorption spectra. The n.m.r. spectrum of compound (IV; R = H) shows a complex signal corresponding to two protons at τ 6·7, which was assigned

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[31] D. W. Cameron, R. I. T. Cromarti, Y. K. Hamied, P. M. Scott, N. Sheppard, and Lord Todd, *J.*, 1964, 90.
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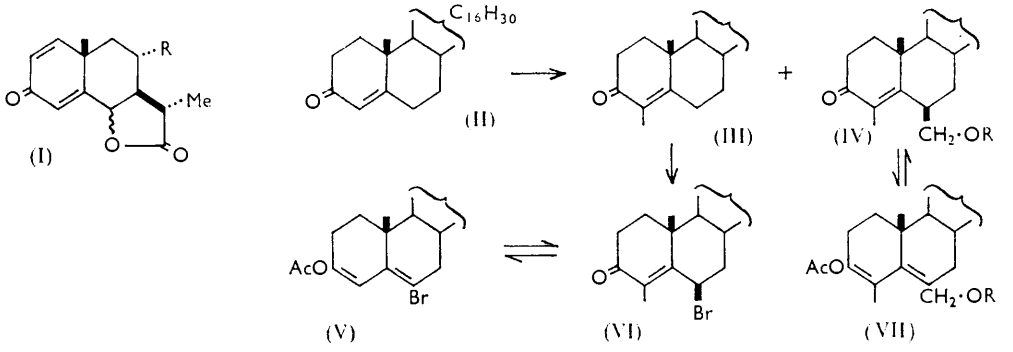
to the methylene group attached to C-6. It is well known [33-35] that the signals due to methylene groups attached to unsymmetrical centres often exhibit splitting patterns indicating that the two protons are non-equivalent. The corresponding multiplet in the acetate (IV; R = Ac) occurs at τ 5·9. The signal for the 4-methyl group in (IV; R = H) occurs as a sharp singlet for three protons at τ 8·25, indicating that the substituent has the 6β-configuration. Presumably this product was formed by an aldol type reaction at C-6, further reaction with excess of thiol being precluded by steric hindrance.



Allylic bromination of the ketone (III) with *N*-bromosuccinimide gave the expected 6β-bromo-4-methylcholest-4-en-3-one (VI). The β-configuration at C-6 is assigned on the basis of analogy with the preparation of 6β-bromocholest-4-en-3-one [36] and is supported by the ultraviolet absorption. The n.m.r. spectrum shows (Table) the signal for the 4-methyl

Nuclear magnetic resonance data [a]

Compound	C-10 Me	C-13 Me	H-6	C-4 Me
4-Methylcholest-4-en-3-one (III)	8·83	9·29	—	8·28, poorly resolved doublet, J 0·8 c./sec., W_H = 2·3 c./sec.
3,3-Ethylenedithio-4-methylcholest-4-ene	8·97	9·32	—	8·10, unresolved multiplet, W_H = 1·7 c./sec.
6β-Hydroxymethyl-4-methylcholest-4-en-3-one (IV; R = H)	8·85	9·27	—	8·25, sharp singlet
6β-Acetoxymethyl-4-methylcholest-4-en-3-one [b] (IV; R = Ac)	8·82	9·27	—	8·14, sharp singlet
6β-Bromo-4-methylcholest-4-en-3-one (VI)	8·52	9·22	4·67 W_H = 9 c./sec.	8·21, sharp singlet
3,3-Ethylenedithio-4-methylcholest-4-en-6α-ol (X; R = H)	8·94	9·31	5·5 W_H = 16 c./sec.	7·79, poorly resolved doublet, J 0·8 c./sec., W_H = 1·9 c./sec.
3,3-Ethylenedithio-4-methylcholest-4-en-6α-yl acetate [c] (X; R = Ac)	8·86	9·32	4·5 W_H = 17 c./sec.	7·96, unresolved multiplet, W_H = 2·4 c./sec.
3,3-Ethylenedithio-4-methylcholest-4-en-6β-ol (XI; R = H)	8·80	9·31	5·11 W_H = 7 c./sec.	7·99, sharp singlet
3,3-Ethylenedithio-4-methylcholest-4-en-6β-yl acetate [d] (XI; R = Ac)	8·85	9·28	4·06 W_H = 7 c./sec.	7·96, sharp singlet [e] or 7·94

[a] N.m.r. spectra were obtained for deuterochloroform solutions (approximately 10% w/v) on a Varian A60 instrument. Chemical shifts are quoted in τ values and the coupling constants are derived from first-order considerations only. The resolution obtainable was such that the half-height width (W_H) of the singlet due to tetramethylsilane used as internal reference was between 0·4 and 0·6 c./sec. [b] -Ac 7·94. [c] -Ac 7·91. [d] -Ac 7·96 or 7·94. [e] In benzene solution the two singlets are almost equally sharp and appear at 7·67 and 8·34.

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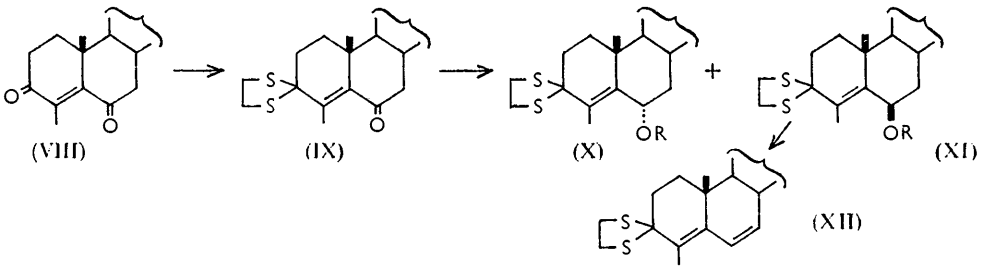
group as a singlet and the signal assigned to H-6α as a narrow multiplet which also indicate β-configuration at C-6.

Attempts to epimerise the axial 6β-substituents in compounds (IV; R = Ac) and (VI) by hydrolysis of the derived enolacetates (VII) and (V) regenerated the 6β-substituted ketones (IV; R = H) and (VI). Similarly, an attempt to epimerise the ketone (VI) with dry hydrogen chloride in acetic acid was unsuccessful. An examination of Dreiding models of the ketones (IV; R = H or Ac) and (VI) shows that the non-bonded repulsion between the 10β-methyl group and a 6β-substituent is less than the interaction between the 4-methyl group and the corresponding 6α-substituent. Thus in 4-methylcholest-4-en-3-ones an axial substituent at C-6 is more thermodynamically stable than the corresponding equatorial substituent. A similar finding has recently been reported in the case of the 6α- and 6β-methyl derivatives of 4-methylcholest-4-en-3-one.[37]

Preparation of the epimeric 6-derivatives of 4-methylcholest-4-enes by indirect methods was successful and gave the epimeric 3,3-ethylenedithio-4-methylcholest-4-en-6-ols and their acetates. Treatment of cholest-4-ene-3,6-dione with diazomethane and pyrolysis of the resulting pyrazoline[38] gave 4-methylcholest-4-en-3,6-dione (VIII). The 3,3-mono-



ethylene thioketal derivative (IX) was prepared in good yield by reaction with ethanedithiol and boron trifluoride etherate in acetic acid;[39] none of the 3,3:6,6-bisthioketal was isolated (as was the case with cholest-4-ene-3,6-dione [39]), presumably on account of increased steric hindrance at the 6-position by the 4-methyl group.

Lithium aluminium hydride reduction of 5α-cholestan-6-one gives mainly the 6β-ol.[40] However, the presence of the 4-methyl group in the ketone (IX) greatly increases steric hindrance on the α-side to give mainly the 6α-ol (XI; R = H). Acetylation of the mixture of epimers with pyridine–acetic anhydride gave the 6α-acetate (X; R = Ac), together with some 3,3-ethylenedithio-4-methylcholesta-4,6-diene (XII). Attempts to purify the mixture of alcohols (X, XI; R = H) by chromatography on aluminium oxide resulted in elimination of water from both isomers to give the diene (XII).

Conversion of the 6α-ol (X; R = H) into the more stable 6β-ol (XI; R = H) was effected by Light's silica gel. Contact for 5 hr. gave a mixture of the two alcohols (X; R = H) and (XI; R = H) and the diene (XII), as shown by thin-layer chromatography and n.m.r. spectroscopy. After 12 hr. the 6α-ol (X; R = H) was completely isomerised and the resulting 6β-ol (XI; R = H) was readily separated from the diene (XII) by column chromatography, and was converted into its acetate (XI; R = Ac). The 6α-ol (X; R = H) was not epimerised by Davison silica gel, nor was there any significant elimination; consequently, this silica gel was used for all chromatographic purifications of these alcohols.

The equatorial allylic 6α-ol and its acetate (X; R = H or Ac) are labile substances; the 6α-ol underwent epimerisation in part and decomposition in part to the diene (XII) on being kept at 20° for several days, whilst the 6α-acetate decomposed extensively to the

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diene (XII) at 20° in 7 days. The axial 6β-ol and its acetate are crystalline and relatively stable compounds; the 6β-ol decomposed to give the diene (XII) only after being kept at 20° for 5 weeks, whilst the 6β-acetate appeared to be stable at 20° over long periods. The elimination reactions (X) ⟶ (XII) and (XI) ⟶ (XII) probably proceed at 20° by an E_1 mechanism; we suggest that the greater lability of the equatorial 6α-epimers (X; R = H, Ac) may be due to steric acceleration of the heterolysis leading to the allylic 6-carbonium ion, which precedes formation of the diene (XII).

The configuration of the 6α- and 6β-epimers (X) and (XI) is confirmed by the width of the n.m.r. signal of the proton at C-6 [16,22] (Table). Axial halogen substituents at C-6 have been shown [5] to deshield the C-10-methyl group to a much greater extent than the corresponding equatorial substituents. In the case of the 6β-ol (XI; R = H) the C-10-methyl signal appears at 0·17 p.p.m. downfield (compared with the parent compound 3,3-ethylenedithio-4-methylcholest-4-ene), while the C-10-methyl group of the 6α-ol (X; R = H) is deshielded by only 0·03 p.p.m. A similar deshielding effect by C-6-hydroxy-substituents occurs with the C-4-methyl group. However, in the case of the 6-acetoxy-compounds (X; R = OAc) and (XI; R = OAc) both epimers show equal (and substantial) deshielding of both the C-10- and C-4-methyl groups indicating that configurational assignments based on shielding effects of substituents are not always reliable.

The appearance of the signals assigned to the C-4-methyl groups in the n.m.r. spectra of (X) and (XI) (cf. Table) further confirms that detectable homoallylic coupling is confined to compounds with a β-hydrogen at C-6. Lack of complete resolution of some of the signals assigned to C-4-methyl groups (Table) is attributed to second-order phenomena.[15,16] As expected, the chemical shifts of the C-13-methyl group throughout the series are constant (cf. Table).

Experimental

Melting points were determined on a Kofler hot-stage apparatus. The values for $[\alpha]_D$ refer to chloroform solutions at room temperature. U.v. absorption spectra (in ethanol) and i.r. absorption spectra (in carbon tetrachloride) were measured with Perkin-Elmer 4000 A and 221 spectrophotometers, respectively. N.m.r. spectra were measured on a Varian A60 instrument with deuterochloroform as solvent and tetramethylsilane as internal reference. Thin-layer chromatography (t.l.c.) was carried out on silica gel plates with benzene as solvent; the plates were " developed " with iodine vapour.

4-Methylcholest-4-en-3-one.—A solution of cholest-4-en-3-one (30 g.), toluene-ω-thiol (22 ml.), formaldehyde (30 ml. of 40%) and triethanolamine (36 ml.) in ethanol (60 ml.) was maintained at 65° for 72 hr. Water was added and the solution extracted with ether. The ether layer was washed with water until neutral, dried, and evaporated. The resultant yellow oil was treated with Raney nickel (deactivated by refluxing in acetone for 1·5 hr.; 200 ml. of an acetone suspension prepared according to Vogel [41]). The Raney nickel was removed by filtration and the filter-cake washed with hot ethanol (3 l.). Evaporation gave an oil which was chromatographed on alumina (1 kg.) in hexane. Elution with benzene–hexane (1 : 1) and crystallisation from methanol gave 4-methylcholest-4-en-3-one (9 g.), m. p. 103°. Elution with benzene gave starting material (10 g.), m. p. and mixed m. p. 82°, whilst elution with chloroform gave a complex mixture of solids (10 g.), which was rechromatographed on alumina. Elution with chloroform–ether (1 : 24) and crystallisation from acetonitrile gave *6β-hydroxymethyl-4-methylcholest-4-en-3-one* (4 g.), m. p. 151°, $[\alpha]_D$ +40° (*c* 1·1); $\lambda_{max.}$ 253 mμ (log ε 4·16); $\nu_{max.}$ 3633, 1665, and 1583 cm.$^{-1}$ [Found (after being dried at 100°/0·2 mm. for 10 hr.): C, 80·9; H, 11·4. $C_{29}H_{48}O_2$ requires C, 81·3; H, 11·3%]. Acetylation with acetic anhydride–pyridine at 135° for 10 min. and chromatography of the product on silica gel in hexane gave by elution with ether–hexane (3 : 17) 6β-acetoxymethyl-4-methylcholest-4-en-3-one as a colourless oil, which although homogeneous on t.l.c. could not be crystallised; $\nu_{max.}$ (liquid film) 1733 (C=O), 1666 (αβ-unsat. C=O), 1587 (C=C), and 1219 (C–O) cm.$^{-1}$.

[41] A. I. Vogel, " Practical Organic Chemistry," Longmans, Green and Co., London, 3rd edn,.1956, p. 870.

6β-*Bromo*-4-*methylcholest*-4-*en*-3-*one*.—4-Methylcholest-4-en-3-one (1 g.) and *N*-bromosuccinimide (400 mg.) were refluxed in dry carbon tetrachloride (75 ml.) for 15 min. with ultraviolet irradiation. Evaporation of the solvent, extraction with ether, and re-evaporation gave a solid, which was chromatographed on silica gel (100 g.) in hexane. Elution with ether–hexane (1 : 9) and crystallisation from acetone gave 6β-*bromo*-4-*methylcholest*-4-*en*-3-*one* (1·1 g.), m. p. 135°, $[\alpha]_D$ −112° (*c* 1·0); $\lambda_{max.}$ 262 mμ (log ε 4·11); $\nu_{max.}$ 1675 cm.$^{-1}$ [Found (after being dried at 80°/0·2 mm. for 10 hr.): C, 70·9; H, 9·6. $C_{28}H_{43}BrO$ requires C, 70·4; H, 9·5%].

Attempted Epimerisation of 6β-*Hydroxymethyl*-4-*methylcholest*-4-*en*-3-*one*.—This compound (200 mg.) and toluene-*p*-sulphonic acid monohydrate (50 mg.) were dissolved in isopropenyl acetate (100 ml.); solvent (20 ml.) was distilled off and the solution refluxed for 24 hr. The solvent was evaporated and the residue worked up in the usual way to give 3-acetoxy-6-acetoxymethyl-4-methylcholest-3,5-diene as an oil; $\lambda_{max.}$ (cyclohexane) 241 mμ (calc. 239 mμ); $\nu_{max.}$ (liquid film) 1748 and 1728 cm.$^{-1}$. Chromatography on either alumina or silica gel resulted in partial hydrolysis. The oil was refluxed in ethanolic potassium hydroxide solution (100 ml.; 0·5%) for 0·5 hr.; dilution with water and isolation by ether extraction gave starting material (identical infrared spectrum).

Attempted Epimerisation of 6β-*Bromo*-4-*methylcholest*-4-*en*-3-*one*.—(*a*) This bromide was treated with isopropenyl acetate as above to give 3-acetoxy-6-bromo-4-methylcholest-3,5-diene as an oil; $\lambda_{max.}$ (cyclohexane) 246 (calc. 244 mμ, assuming the bromine atom to cause a bathochromic shift of 10 mμ); $\nu_{max.}$ (liquid film) 1745 and 1204 cm.$^{-1}$. As before, chromatography caused partial hydrolysis; hydrolysis (as above) gave starting material (identical infrared spectrum).

(*b*) The bromide (500 mg.), dissolved in glacial acetic acid (100 ml.), was treated with dry hydrogen chloride for 0·5 hr., and the solution allowed to stand for one week. The usual working up procedure gave starting material, m. p. and mixed m. p. 135—137° from hexane (identical infrared spectrum).

4-*Methylcholest*-4-*ene*-3,6-*dione*.—The pyrazoline derivative (10 g.) of cholest-4-en-3,6-dione [38] was heated strongly with a free flame until all nitrogen evolution ceased. After standing overnight, the residual black tar (which had partially crystallised) was dissolved in hexane and introduced on to alumina (100 g.) in hexane. Almost all the black colour passed through the column by elution with hexane. Elution with benzene–hexane and with benzene gave 4-methylcholest-4-ene-3,6-dione (7·3 g.) as yellow crystals, m. p. 116°, from ethanol.

3,3-*Ethylenedithio*-4-*methylcholest*-4-*ene*-3,6-*dione*.—This diketone (490 mg.) in acetic acid (20 ml.) was treated with 11 ml. of a solution of ethanedithiol (1·2 ml.) in acetic acid (100 ml.). Boron trifluoride etherate (2 ml.) was added and the solution kept at 20° for 17 hr. The solvents were removed under reduced pressure, and the residue worked up in the usual way to give 3,3-*ethylenedithio*-4-*methylcholest*-4-*ene*-3,6-*dione* (435 mg.), m. p. 190°, $[\alpha]_D$ +164 (*c* 1·37); $\nu_{max.}$ 1675 and 1600 cm.$^{-1}$ after crystallisation from ethanol [Found (after drying at 65°/0·5 mm. for 6 hr.): C, 73·9; H, 9·9. $C_{30}H_{48}OS_2$ requires C, 73·8; H, 9·8%].

6α-*Acetoxy*-3,3-*ethylenedithio*-4-*methylcholest*-4-*en*-3-*one*.—The ketone (IX) (400 mg.) in dry ether (50 ml.) was refluxed with lithium aluminium hydride (400 mg.) with stirring for 2 hr. whereafter excess of the reagent was destroyed by careful addition of water. The ethereal solution was washed with water and dried ($MgSO_4$); t.l.c. of this solution showed it to be largely the 6α-ol (X; R = H) but small amounts of the 6β-ol (XI; R = H) and the diene (XII) were also present. Evaporation gave an oil, which was acetylated with acetic anhydride (2 ml.) and pyridine (2 ml.) at 25° for 24 hr.; ethanol was added to destroy excess of anhydride and the mixture evaporated in a high vacuum at 40°. T.l.c. showed the product to be mainly the 6α-acetate (X; R = Ac) with a little diene (XII); column chromatography on Davison silica gel (40 g.) with elution by ether–hexane (1 : 49) gave 6α-acetoxy-3,3-ethylenedithio-4-methylcholest-4-en-3-one (X; R = Ac) (350 mg.) as a colourless oil; $\nu_{max.}$ (liquid film) 1720 cm.$^{-1}$. The oil was homogeneous on t.l.c. but after 1 week at 20° in a stoppered flask had undergone extensive decomposition (t.l.c.) to give mainly diene (XII) and several other (unidentified) products.

6α-*Hydroxy*-3,3-*ethylenedithio*-4-*methylcholest*-4-*en*-3-*one*.—The acetate (X; R = Ac) (350 mg.), dissolved in the minimum of ether, was treated with ethanolic 0·4N-potassium hydroxide (70 ml.). After 2·7 hr. at 25°, the volume was reduced to 15 ml. by evaporation under reduced pressure at 40°, and the product isolated by ether extraction. T.l.c. showed hydrolysis to be about 75% complete; a small amount of diene (XII) was formed. The resulting oil was chromatographed on Davison silica gel (35 g.) in hexane. Elution with ether–hexane (1 : 24)

gave a mixture of diene (XII) and residual acetate (X; R = Ac), whilst elution with ether–hexane (3 : 47) gave 6α-hydroxy-3,3-ethylenedithio-4-methylcholest-4-en-3-one (X; R = H) (260 mg.) as a colourless oil, $\nu_{max.}$ (liquid film) 3575 cm.$^{-1}$, which was homogeneous by t.l.c. After 5 days, a sample of this material was shown by t.l.c. to consist of 6α-ol (X; R = H), 6β-ol (XI; R = H), diene (XII), and six other (unidentified) products.

6β-*Hydroxy*-3,3-*ethylenedithio*-4-*methylcholest*-4-*en*-3-*one*.—(*a*) The ketone (IX) (209 mg.) was reduced with lithium aluminium hydride (as above), the resulting oil introduced on to a column of Light's silica gel (15 g.) in ether–hexane (1 : 24), and kept for 18 hr. All material was eluted from the column with ether–hexane (3 : 7) and the eluant rechromatographed on Davison silica gel (20 g.). Elution with ether–hexane (1 : 24) gave the diene (XII), whilst elution with ether–hexane (1 : 9) gave 6β-*hydroxy*-3,3-*ethylenedithio*-4-*methylcholest*-4-*en*-3-*one* (XI; R = H) (150 mg.), double m. p. 130—135° and 160°, $[\alpha]_D$ +26° (*c* 1·0), $\nu_{max.}$ 3584 cm.$^{-1}$ after crystallisation from methanol [Found (after being dried at 20°/0·2 mm. for 24 hr.): C, 73·5; H, 10·2. $C_{30}H_{50}OS_2$ requires C, 73·5; H, 10·2%].

(*b*) Another sample of the initial epimeric mixture was kept on a column of Light's silica gel for 5 hr. Elution with ether–hexane (1 : 12) gave some diene (XII); further elution with the same solvent mixture gave an approximately equimolar mixture of the epimeric alcohols (X; R = H) and (XI; R = H) as shown by t.l.c. and n.m.r. spectroscopy.

(*c*) Another sample (20 mg.) of the initial epimeric mixture was introduced on to a column of Davison silica gel (2 g.) in ether–hexane (1 : 23) and kept for 20 hr. T.l.c. of the material eluted with ether–hexane (3 : 7) showed that the initial ratio of epimers was unchanged and that very little diene (XII) had been formed.

6β-*Acetoxy*-3,3-*ethylenedithio*-4-*methylcholest*-4-*en*-3-*one*.—Acetylation of the 6β-ol (XI; R = H) was carried out as for the 6α-ol (X; R = H). The product was chromatographed on Davison silica gel; elution with ether–hexane (1 : 49) gave a small amount of diene (XII), whilst elution with ether–hexane (1 : 24) and crystallisation from acetone gave 6β-*acetoxy*-3,3-*ethylenedithio*-4-*methylcholest*-4-*en*-3-*one*, m. p. 153°, $[\alpha]_D$ +78° (*c* 1·1); $\nu_{max.}$ 1721 and 1260 cm.$^{-1}$ [Found (after being dried at 20°/0·2 mm. for 24 hr.): C, 72·1; H, 9·6. $C_{31}H_{50}O_2S_2$ requires C, 71·8; H, 9·65%].

3,3-*Ethylenedithio*-4-*methylcholest*-4,6-*diene*.—The ketone (IX) was reduced with lithium aluminium hydride as above and the product introduced on to a column of alumina (11 g.). After 2 hr. the column had turned yellow and elution with benzene–hexane (1 : 4) gave 3,3-*ethylenedithio*-4-*methylcholest*-4,6-*diene* (XII), m. p. 189°, $\lambda_{max.}$ 253 mμ, log ε 4·41 after recrystallisation from acetone [Found (after being dried at 20°/0·1 mm. for 24 hr.): C, 76·3; H, 10·15. $C_{30}H_{48}S_2$ requires C, 76·3; H, 10·15%]. On standing at 20° the compound developed a yellow colour in a few days.

3,3-*Ethylenedithio*-4-*methylcholest*-4-*en*-3-*one*.—The ketone (III) (114 mg.) was triturated with ethanedithiol (0·15 ml.) and boron trifluoride etherate complex (0·15 ml.) for 5 min.; methanol was added and after a few minutes the precipitate was filtered off. Chromatography on Davison silica gel (8 g.) in hexane gave 3,3-*ethylenedithio*-4-*methylcholest*-4-*en*-3-*one*, m. p. 135°, $[\alpha]_D$ +113: (*c* 0·9), after crystallisation from ethanol [Found (after being dried at 80°/0·2 mm. for 4 hr.): C, 76·4; H, 10·6. $C_{30}H_{50}S_2$ requires C, 75·95; H, 10·55%].

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