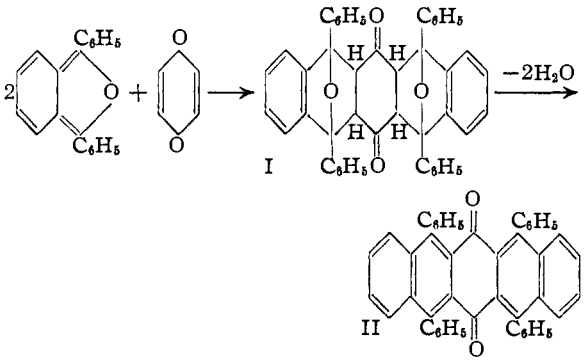
isobenzofurans[5] it was found that two molecules of 1,3-diphenylisobenzofuran very easily added to one molecule of benzoquinone, giving the partially reduced, polyphenylated pentacenequinone I. The presence of the ring system was shown by its conversion to the known tetraphenylpentacenequinone II[6] by the action of concentrated sulfuric acid at room temperature. A similar addition was observed with 1,3-diphenyl-5,6-dimethylisobenzofuran. No attempt was made to isolate any of the 1,1-addition product (if present) described by Barnett.[7]



This new synthesis makes it possible to obtain symmetrical or unsymmetrical polyarylated pentacenes, which are only difficultly or not at all accessible in other ways. It also confirms the structure previously[6] assigned to II, which had been arrived at by an examination of the products of degradation. It is limited only by the nature of isobenzofurans available, but these are now relatively accessible substances.[8,9,10]

(5) Allen and Gates, THIS JOURNAL, **65**, 1283 (1943).
(6) Allen and Bell, *ibid.*, **64**, 1253 (1942).
(7) Barnett, *J. Chem. Soc.*, 1326 (1935).

Experimental

5,7,12,14-Tetraphenyl-7,12,5,14-dioxido-5,5a,6a,7,-12,12a,13a,14-octahydro-6,13-pentacenequinone I: A suspension of 5.4 g. of 1,3-diphenylisobenzofuran in 200 cc. of alcohol containing 1 g. of benzoquinone was refluxed for two hours, cooled, and the addition product filtered. It was recrystallized from chlorobenzene, from which it separates in rods, m. p. 197–198°.

Anal. Calcd. for $C_{46}H_{32}O_4$: C, 85.2; H, 4.9. Found: C, 84.9; H, 5.1.

The 2,3,9,10-tetramethyl derivative (rods) was obtained in a similar manner.

Anal. Calcd. for $C_{50}H_{40}O_4$: C, 85.2; H, 5.7. Found: C, 84.8; H, 6.0.

5,7,12,14-Tetraphenyl-6,13-pentacenequinone II resulted when 0.5 g. of the octahydroquinone I was dissolved in 5 cc. of concentrated sulfuric acid at −10° and allowed to stand for one hour at room temperature; after it had been decomposed by ice and after subsequent appropriate manipulation, the already known quinone was isolated in a yield of 0.2 g. after crystallization from pyridine. The melting point alone and on admixture with the known specimen on hand[6] was 397–398°.

Summary

A new synthesis of the pentacene ring system has been described. It consists in adding two molecules of an isobenzofuran to one molecule of benzoquinone.

A tetraphenylpentacenequinone, whose structure had been deduced by degradation, has been synthesized.

(8) Adams and Gold, THIS JOURNAL, **62**, 56 (1940).
(9) Allen and Gates, *ibid.*, **65**, 1230 (1943).
(10) Norton, "Diels-Alder Synthesis," *Chem. Rev.*, **31**, 474 (1942).

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[CONTRIBUTION FROM THE SQUIBB INSTITUTE FOR MEDICAL RESEARCH, DIVISION OF ORGANIC CHEMISTRY]

The Preparation and Properties of the 7-Epimeric Cholestanediols-3(β),7

BY O. WINTERSTEINER AND MILDRED MOORE

The preparation of the 7-epimeric cholestanediols-3(β),7 and their esters was undertaken with two objectives in mind First, it seemed of interest to establish by comparison of the specific rotations their stereochemical relationship with other 7-epimeric steroids, especially with the corresponding unsaturated diols, the 7-hydroxycholesterols, which cannot be directly converted into the saturated diols.[1] Second, we needed 3-mono-esters of the saturated diols for the dehydration experiments which are described in the following paper.

The only previous reference to the preparation of a cholestanediol-3,7 we could find is in a paper by Marker and Rohrmann.[2] These authors obtained a diol melting at 166° by hydrogenation of 7-keto-cholesteryl acetate with platinum oxide in acetic acid and subsequent hydrolysis, or alternatively by reduction of 7-ketocholestanyl acetate with aluminum isopropylate. The product

(1) Wintersteiner and Ruigh, THIS JOURNAL, **64**, 2453 (1942).
(2) Marker and Rohrmann, *ibid.*, **61**, 3022 (1939).

obtained by the first method could not be crystallized directly and was therefore hydrolyzed, whereby it yielded the diol m. p. 166°. In our hands the catalytic method afforded without hydrolysis a small amount of crystalline material which, however, proved to be a mixture of 3(β)-cholestanyl acetate and 7-ketocholestanyl acetate. It was necessary to resort to the chromatographic fractionation to secure the main products, the epimeric 3(β)-acetoxycholestanols-7, which melt at 117 and 74°, respectively. The hydrolysis product of the lower-melting acetate is, to judge from its melting point (168°), identical with the diol of Marker and Rohrmann. The diol obtained from the higher-melting acetate melted at 153°. As expected, both diols are precipitable by digitonin. The epimeric character of the two monoesters followed from their oxidation with chromic acid to 7-ketocholestanyl acetate.

It is noteworthy that some 5 to 10% of β-cholestanyl acetate always could be isolated from the reduced material, though the hydrogen uptake corresponded to the theoretical 2 moles. Contamination of the starting material with cholesterol may be excluded as it had the correct melting point (158°). More probably the formation of this by-product occurred via the unsaturated diols by hydrogenolysis of the 7-hydroxyl group. Apparently reduction of the keto group precedes, in a small portion of the substrate, that of the double bond under the conditions employed. This difficulty can be obviated by conducting the hydrogenation of the unsaturated ketone in two stages. We confirmed the observation of Marker and Rohrmann that when a neutral solvent is employed with platinum oxide as the catalyst, the hydrogen uptake is practically limited to one mole and 7-ketocholestanyl acetate is the sole product. Indeed, this method yielded a somewhat purer product than the hydrogenation with palladium black according to Windaus and Kirchner.[3] When the saturated ketone acetate was then hydrogenated with the same catalyst in glacial acetic acid, the crude product crystallized immediately after removal of the solvent and yielded on recrystallization from methanol the monoacetate m. p. 117°. The epimeric acetate m. p. 74° is much more soluble in this solvent and can be secured in pure state only by chromatographic separation of the mother liquor material.

(3) Windaus and Kirchner, *Ber.*, **53**, 614 (1920).

TABLE I

SPECIFIC ROTATIONS OF 7-EPIMERIC CHOLESTANEDIOLS-3(β),7 AND Δ⁵-CHOLESTENEDIOLS-3(β),7

Compound	Saturated	Unsaturated (Δ⁵)
Diol-3(β),7(α)	+52.9°[a]	+ 7.2°[1]
-3-monoacetate	+35.3°	...
diacetate	+54.7°	+ 51.8°[1]
dibenzoate	+67.6°	+ 94°[4]
Diol-3(β),7(β)	+ 8.1°[b]	− 87.6°[5]
-3-monoacetate	0	...
diacetate	−17.2°	−174.6°[5]
dibenzoate	+23.0°	−107.5°[5]

[a] Diol m. p. 168°. [b] Diol m. p. 153°.

In Table I the specific rotations of the epimeric cholestanediols-3(β),7 and their derivatives are recorded together with those of the corresponding unsaturated (Δ⁵)-diols and derivatives. It is evident from the rotation data that the saturated diol m. p. 168° should be designated 7(α) and its epimer m. p. 153° 7(β) to conform with the (arbitrary) designations in use for distinguishing the unsaturated epimers. This choice of prefixes is in accord with that of Windaus and Naggatz[6] for the 7-epimeric Δ⁵-cholestenediols-3(α),7 (7(α): $[\alpha]_D$ +38.1°; 7(β): $[\alpha]_D$ +9.1°), and of Reichstein and Fuchs[7] for the 7-epimeric 3(β),7-diacetoxy *etio*-allo-cholanic acid methyl esters (7-(α): $[\alpha]_D$ +64.1°; 7(β): $[\alpha]_D$ −3.1°). However, on the same token there is disagreement with the nomenclature proposed by Iwasaki[8] to indicate the configurations of the 7-hydroxyl groups in the epimeric 3(α),7-dihydroxycholanic acids, ursodesoxycholic acid and cheno-(anthropo)-desoxycholic acid. Of this pair, the former acid, designated 7(β), has a higher dextrorotation (+51.1°) than its epimer (+11.9°). Iwasaki based his choice of prefixes on chemical evidence tending to show that the 7-hydroxy group in ursodesoxycholic acid is in *trans* position to the 3(α)-hydroxy group and consequently *cis* to the 10-methyl group. The proof for the "absolute" configurations at C_7 involved the oxidation of the epimers with hypobromite to the corresponding 3,4-dicarboxylic acids. Unfortunately, this procedure is not applicable to the cholestanediols-3,7, as one should expect the latter to yield 2,3-dicarboxylic acids in analogy with the behavior of cholestanol-3.

3(β)-Acetoxycholestanol-7(α) was converted

(4) Windaus, Lettre and Schenk, *Ann.*, **520**, 98 (1935).
(5) Barr, Heilbron, Parry and Spring, *J. Chem. Soc.*, 1437 (1936).
(6) Windaus and Naggatz, *Ann.*, **542**, 204 (1939).
(7) Reichstein and Fuchs, *Helv. Chim. Acta*, **22**, 1160 (1939).
(8) Iwasaki, *Z. physiol. Chem.*, **244**, 181 (1936).

quantitatively into the 7-tosylate by toluenesulfonyl chloride in pyridine, and into a 7-chloride by phosphorus pentachloride in chloroform. No such derivatives could be obtained from the 7(β)-epimer. Instead, elimination of the 7-hydroxyl group with double bond formation occurred. The resulting products, which can also be obtained by thermic dehydration of the 7(β)-epimer, are described in a subsequent paper.[9]

The specific rotation (−21.7°) of the chloride derived from 3(β)-acetoxycholestanol-7(α) is considerably more negative than those of the parent compound and its esters, and falls well into the rotation range of the 7(β)-series. This raises the question whether a Walden inversion has occurred in its formation. Attempts to test this possibility by replacing the chlorine atom with hydroxyl were unsuccessful. Aqueous or methanolic alkali merely saponified the 3-acetoxy group, while various other treatments resulted in the elimination of hydrogen chloride and double bond formation.[9] Both epimeric monoacetates furthermore were treated with thionyl chloride under various conditions. No crystalline products could be obtained, except in one experiment with the 7(α)-epimer, in which ether was used as the solvent. However, the reaction product contained sulfur instead of chlorine. Its composition approximated that of a di-(3-acetoxycholestanol-7) sulfurous acid ester; on hydrolysis it yielded cholestanediol-3(β),7(α).

Experimental

7-Epimeric 3(β)-Acetoxycholestanols-7. (a) By Hydrogenation of 7-Ketocholesteryl Acetate.—Three grams of 7-ketocholesteryl acetate (m. p. 157–158°) in 75 cc. of glacial acetic acid was hydrogenated in the presence of platinum oxide catalyst (300 mg.) until the hydrogen uptake stopped after about two hours with a little more than 2 moles consumed. The filtered solution was evaporated *in vacuo* and the partly crystalline residue was recrystallized from methanol (915 mg.). Since analysis of the purified material (m. p. 126–128°) showed that it was a mixture, a part (265 mg.) was chromatographed in hexane solution on a column of aluminum oxide.[10] The fractions eluted with hexane–benzene 9.5:0.5 yielded on recrystallization from methanol 110 mg. of β-cholestanyl acetate, m. p. 109.5–110°, $[\alpha]^{22}D$ +16° (0.75%).[11] Elution with hexane–benzene 1:1 and benzene alone afforded fractions which on recrystallization from methanol yielded 63 mg. of 7-ketocholestanyl acetate m. p. 149–149.5°, $[\alpha]^{22}D$ −36.0° (−0.86°, 23.9 mg. in 2 cc., 2 dm.).

Anal. Calcd. for $C_{29}H_{48}O_3$; C, 78.31; H, 10.80. Found: C, 78.64; H, 10.93.

The non-crystalline portion of the reduction product was combined with the mother liquors of the crystalline mixture and chromatographed in the same manner. Thorough washing with hexane eluted all the β-cholestanyl acetate still present. From the following eluates with hexane–benzene 4:1 more of the saturated ketone (170 mg.) was isolated. Hexane–benzene 1:1 eluted partially crystalline material, which when dissolved in a small amount of absolute methanol and allowed to stand in the refrigerator deposited large prismatic crystals (200 mg.) of **3(β)-acetoxycholestanol-7(α)** melting at 73–75°. The melting points observed after subsequent crystallizations from methanol varied between 71 and 75°, apparently depending on the size of the crystals. It is necessary to pulverize and thoroughly dry the preparations to obtain reliable melting point readings; $[\alpha]^{23}D$ +35.3° (+0.34°, 19.248 mg. in 2 cc., 2 dm.)

Anal. Calcd for $C_{29}H_{50}O_3$: C, 77.96; H, 11.29. Found: C, 77.81; H, 11.50.

The following eluates with benzene and with benzene–ether 1:1, together about 1 g., were recrystallized repeatedly from 80% ethanol. 665 mg. of **3(β)-acetoxycholestanol-7(β)** melting at 116–117° was thus obtained. The compound forms glittering, rod-shaped crystals from dilute ethanol, and hexagonal plates from absolute methanol. It sometimes crystallizes from the former solvent as a polymorphous modification melting at 124°; $[\alpha]^{23}D$ 0° (α = 0°, 10.34 mg. in 1 cc., 1 dm.).

Anal. Calcd. for $C_{29}H_{50}O_3$: C, 77.96; H, 11.29. Found: C, 78.16; H, 11.30.

(b) By Hydrogenation of 7-Ketocholestanyl Acetate.—Three methods of catalytic hydrogenation were explored for the preparation of the saturated ketone from 7-ketocholesteryl acetate: hydrogenation with palladium in acetic acid; with the same catalyst in ethyl acetate; and with platinum oxide in ethyl acetate. The last-named method was found to be superior to the others in regard to speed of hydrogen uptake, and yield and purity of the reaction product.

A solution of 31.5 g. of 7-ketocholesteryl acetate in 500 cc. of ethyl acetate was shaken with 500 mg. of reduced platinum oxide catalyst (Baker) in an atmosphere of hydrogen. More than half of the required gas volume (1750 cc.) was consumed in five minutes, the rest within forty minutes. The reaction was then proceeding very slowly, and was allowed to continue till an additional 100 cc. had been taken up. The filtered solution was evaporated to dryness and the residue was recrystallized from 800 cc. of methanol. The crude product (20.7 g.) melted at 146–147.5°. One more recrystallization yielded almost pure 7-ketocholestanyl acetate m. p. 148–149°. More of the compound was obtained from the mother liquors.

Three grams of the acetate was hydrolyzed with boiling 5% methanolic potassium hydroxide solution for forty-five minutes. The hydrolysis product was recrystallized from absolute ethanol, yielding 2.5 g. of 7-ketocholestanol m. p.

(9) Wintersteiner and Moore, THIS JOURNAL, **65**, 1507 (1943).

(10) Harshaw Chemical Co., brand 2–350, washed with 50% acetic acid, and reactivated by heating to 150° for twenty-four hours was employed in all chromatographic fractionations described in this and the following two papers.

(11) The solvent used in all specific rotation measurements recorded in this paper was chloroform.

164–165°. Further recrystallization did not change the melting point, $[\alpha]^{25}D$ −32.8° (−0.68°, 20.7 mg., 2 cc., 2 dm.); literature, m. p. 156–157°,[3] 157–159°.[2] The specific rotation has not been reported previously.

7-Ketocholestanyl acetate (32.8 g.) was hydrogenated in glacial acetic acid (400 cc.) in the presence of 500 mg. of reduced platinum oxide (Baker). The uptake of hydrogen stopped after three and one-half hours with 1765 cc. consumed (calcd. 1780 cc. = 1 mole equivalent). The solvent was removed from the filtered solution by vacuum distillation. The crystalline residue was dissolved in 125 cc. of warm methanol. On cooling 3(β)-acetoxycholestanol-7(β) separated as hexagonal plates which were filtered off after two hours of standing at room temperature (15.1 g., m. p. 106–112°). After four recrystallizations from 80% ethanol a product sufficiently pure for practical purposes was obtained (10.7 g., m. p. 114.5–116°).

The combined mother liquor material was dissolved in 100 cc. of hexane and chromatographed on a column of aluminum oxide. The column was washed successively with 400 cc. each of hexane, hexane–benzene 4:1 and 1:1, and ether. The non-crystalline hexane–benzene eluates contained a high proportion of the α-epimer, as evidenced by their dextrorotations (+32 to 35°). These fractions, together 11.3 g., were combined and dissolved in 15 cc. of methanol. On standing in the refrigerator the material crystallized, yielding on purification 5.5 g. of 3(β)-acetoxycholestanol-7(α) melting at 73–75°. From the ether eluate (9 g.) an additional 4.5 g. of the β-epimer, m. p. 115.5–117°, was recovered.

3(β)-Acetoxycholestanol-7(β) (63 mg.) dissolved in 1 cc. of glacial acetic acid was oxidized at room temperature with chromic anhydride (50 mg.). After seventeen hours the mixture was worked up in the usual fashion. The neutral fraction (59 mg.) was recrystallized twice from methanol and yielded 7-ketocholestanyl acetate (m. p. 148.5–149°), identified by its melting point in mixture with an authentic sample, and by its specific rotation (−35.1°). 3(β)-Acetoxycholestanol-7(α) (100 mg.) oxidized in the same manner yielded 66 mg. of neutral products; two recrystallizations afforded the saturated ketone (m. p. 148.5°).

Cholestanediol-3(β),7(α).—3(β)-Acetoxycholestanol-7-(α) (5.5 g.) was refluxed with 5% methanolic potassium hydroxide (80 cc.) for one hour. The hydrolysis product (4.7 g.) melted at 157–160°. One recrystallization from 80% ethanol sufficed to raise the melting point to the constant value of 167–168°, $[\alpha]^{24}D$ +52.9° (1.085°, 20.5 mg. in 2 cc., 2 dm.).

Anal. Calcd. for $C_{27}H_{48}O_2$: C, 80.12; H, 11.96. Found: C, 79.96; H, 11.81.

The diol crystallizes from dilute ethanol in fine needles, but on a few occasions a mixture of these and of hexagonal platelets was obtained. That the latter represent a lower melting polymorphous modification is indicated by the fact that the melting point of such a preparation, obtained from a crude product which melted at 164°, remained constant at 156–158° on repeated recrystallization, but was found to be 167–168° a few months later.

The **diacetate** was prepared from the 3-monoacetate (52 mg.) with acetic anhydride (2 cc.) and pyridine (1 cc.) at room temperature. The resinous product (58 mg.) in a small amount of absolute ethanol crystallized after several days of standing in the refrigerator. The melting point of the crystals (42 mg.) was 81–87°; on recrystallization from the same solvent 64–69°, afterward rising to 74–78°. Another preparation, crystallized from absolute methanol, exhibited similar irregularities in its melting point behavior. We ascribe this to the existence of polymorphous modifications, although no difference was apparent in the crystal shape (rhombohedral plates) of the various crops: $[\alpha]^{24}D$ +54.7° (0.33, 6.18 mg. in 1.025 cc., 1 dm.). The analytical sample lost no weight on drying at 56° and 2 mm.

Anal. Calcd. for $C_{31}H_{52}O_4$: C, 76.17; H, 10.73. Found: C, 76.35; H, 10.69.

The **dibenzoate** was obtained from the 7(α)-diol (108 mg.) by reaction with benzoyl chloride (0.7 cc.) and pure pyridine (2 cc.) at room temperature for forty-eight hours. Two recrystallizations of the crude material (126 mg., m. p. 150–151°) from benzene–ethanol 1:5 yielded large rhombohedral plates (m. p. 151–152°); $[\alpha]^{23}D$ +67.6° (1.305°, 19.3 mg. in 2 cc., 2 dm.).

Anal. Calcd. for $C_{41}H_{56}O_4$: C, 80.34; H, 9.22. Found: C, 80.26; H, 9.27.

3(β)-Acetoxycholestanol-7(α) *p*-Toluenesulfonate.—3(β)-Acetoxycholestanol-7(α) (190 mg.) and *p*-toluenesulfonyl chloride (210 mg.) were dissolved in pure pyridine (3 cc.) and allowed to stand at room temperature for two days. The solution was poured into ice-water, extracted with ether, and the ether phase washed in succession with dilute sulfuric acid, sodium carbonate solution and water. Evaporation of the solvent yielded a crystalline residue (267 mg.) which was recrystallized from absolute ethanol, and then from methanol, in which the compound is sparingly soluble; 150 mg. of needles melting at 152.5–153° was obtained, $[\alpha]^{24}D$ +11.6° (0.120°, 10.52 mg. in 1.025 cc., 1 dm.).

Anal. Calcd. for $C_{36}H_{56}O_5S$: C, 71.94; H, 9.40; S, 5.34. Found: C, 71.97; H, 9.32; S, 5.10.

Cholestanediol-3(β),7(β) was obtained by hydrolysis of the corresponding 3-monoacetate (965 mg.) as described for the α-epimer. The crude product (923 mg.) was practically pure. The compound on crystallization from methanol or 80% alcohol formed rosets of shiny needles, m. p. 152–153°; $[\alpha]D$ +8.1° (0.166°, 20.4 mg. in 2 cc., 2 dm.).

Anal. Calcd. for $C_{27}H_{48}O_2$: C, 80.12; H, 11.96. Found: C, 80.28; H, 11.82.

The diacetate and the dibenzoate were prepared in the same manner as the epimeric derivatives.

Cholestanediol-3(β),7(β) diacetate forms elongated prisms from methanol, m. p. 138–139°; $[\alpha]^{22}D$ −17.2° (−0.14°, 8.343 mg. in 1.025 cc., 1 dm.).

Anal. Calcd. for $C_{31}H_{52}O_4$: C, 76.17; H, 10.73. Found: C, 76.47; H, 10.68.

Cholestanediol-3(β),7(β) dibenzoate crystallizes from ethanol in rosets of fine needles, m. p. 153–154°; $[\alpha]^{24}D$ +23.0° (+0.396°, 17.2 mg. in 2 cc., 2 dm.).

Anal. Calcd. for $C_{41}H_{56}O_4$: C, 80.34; H, 9.22. Found: C, 80.41; H, 9.53.

3(β)-Acetoxycholestane Chloride-7.—A mixture of 3(β)-acetoxycholestanol-7(α), (1 g.), anhydrous calcium car-

bonate (1 g.) and dry chloroform (12 cc.) was cooled to 0° in a glass-stoppered flask. Freshly sublimed phosphorus pentachloride (850 mg.) was added in small portions to the contents over a period of one and three-fourths hours, while the flask was shaken mechanically in an ice-bath. The shaking was continued for one-half hour, when 15 cc. of a cold saturated sodium bicarbonate solution was added to the mixture and the shaking resumed for another one-half hour. The chloroform solution was separated, filtered, dried and evaporated. The slightly brownish crystalline residue (1.09 g.) was recrystallized several times from absolute ethanol, yielding needles (725 mg.) melting at 118–119°, $[\alpha]^{23}D$ −21.7° (−0.26°, 12.27 mg. in 1.025 cc., 1 dm.).

Anal. Calcd. for $C_{29}H_{49}O_2Cl$: C, 74.86; H, 10.62; Cl, 7.63. Found: C, 74.76; H, 10.37; Cl, 7.78.

Cholestanol-3(β) Chloride-7.—The acetate (100 mg.) was refluxed with 20% methanolic potassium hydroxide (5 cc.) for one hour, and the material recovered by ether extraction. By two recrystallizations from methanol long needles (56 mg.) melting at 170.5–171.5° were obtained; $[\alpha]^{22}D$ −19.8° (−0.248°, 12.5 mg. in 2 cc., 2 dm.).

Anal. Calcd. for $C_{27}H_{47}OCl$: C, 76.63; H, 11.20; Cl, 8.39. Found: C, 76.55; H, 10.99; Cl, 8.75.

The compound is precipitated by digitonin in 80% ethanol, yielding a crystalline digitonide melting in the crude state at 192–197°.

Boiling of the chloroacetoxy compound with 12% aqueous potassium hydroxide solution for seven hours eliminated only traces of hydrogen chloride. The reaction product was identical with that obtained with methanolic alkali, but the yield was less satisfactory.

Di-(3-(β)-acetoxycholestanol-7(α))-sulfurous Ester.—3(β)-Acetoxycholestanol-7(α) (527 mg.), dissolved in absolute ether (8 cc.), and calcium carbonate (2.5 g.) were shaken at ice temperature, while thionyl chloride (1.6 g.) was added in small portions over a period of three-fourth hour. The mixture was allowed to stand in the refrigerator overnight. It was then transferred to a separatory funnel containing crushed ice. More of the solvent was added, and the ether phase was thoroughly extracted with saturated bicarbonate solution and washed with water. The residue of the dried ether solution, dissolved in a few drops of ethanol, crystallized after several days in the refrigerator. The crystals were filtered, washed with a little cold alcohol (329 mg.). Several recrystallizations from pentane yielded rosets of white needles (76 mg.) melting at 131.5–133.5°.

Anal. Calcd. for $C_{58}H_{98}O_7S$: C, 74.14; H, 10.52; S, 3.42. Calcd. for $C_{58}H_{98}O_7S \cdot H_2O$: C, 72.72; H, 10.53; S, 3.35. Found: C, 73.20; H, 10.66; S, 3.75, 3.64.

21.6 mg. of the compound was refluxed with 2 cc. of 5% methanolic potassium hydroxide for one and one-half hours. The material recrystallized from methanol melted at 167–168° and gave no depression of the melting point in mixture with cholestanediol-3(β),7(α).

The microanalyses were carried out by Mr. J. F. Alicino.

Summary

The 7-epimeric 3(β)-acetoxycholestanols-7 have been prepared by catalytic reduction of 7-ketocholesteryl acetate or of 7-ketocholestanyl acetate. The corresponding diols and several of their derivatives are described. The epimeric compounds have been correlated sterically with other epimeric 7-hydroxysteroids by rotation data.

NEW BRUNSWICK, N. J. RECEIVED MARCH 27, 1943

[CONTRIBUTION FROM THE SQUIBB INSTITUTE FOR MEDICAL RESEARCH, DIVISION OF ORGANIC CHEMISTRY]

The Dehydration of the 7-Epimeric 3(β)-Acetoxycholestanols-7. Some Transformation Products of γ-Cholestenol

BY O. WINTERSTEINER AND MILDRED MOORE

For the extension of our studies on the autoxidation of sterols,[1] we needed the double bond isomers of cholesterol with ethylenic bonds in the positions 8–14, 14–15, 7–8 and 8–9 (α,β,γ, and δ-cholestenols, respectively). None of these isomers are easily accessible. The first three have been prepared so far only via 7-dehydrocholesterol,[2] which is difficult to obtain in pure form, and the preparation of which in the amounts needed by us is troublesome. The starting material for δ-cholestenol, in which we were particularly interested, is the practically inaccessible isodehydrocholesterol ($\Delta^{6,8-9}$-cholestandienol-3-(β)), a by-product in the industrial manufacture of 7-dehydrocholesterol.[3] An alternative route to this cholesterol isomer was suggested by the observation of Eck and Hollingsworth[4] that cholestanol-7 on treatment with anhydrous copper sulfate in boiling xylene containing a small amount of propionic acid is dehydrated to Δ^{8-9}-cholestene. When this reaction was applied to 3(β)-acetoxycholestanol-7(β)[5] it yielded crystalline products which, however, in spite of their homogeneous appearance proved to be mixtures,

(1) Bergström and Wintersteiner, *J. Biol. Chem.*, **141**, 597 (1941); **145**, 327 (1942).

(2) Schenk, Buchholz and Wiese, *Ber.*, **69**, 2696 (1936).

(3) Windaus, Linsert and Eckhardt, *Ann.*, **534**, 22 (1938).

(4) Eck and Hollingsworth, THIS JOURNAL, **63**, 2986 (1941).

(5) Wintersteiner and Moore, *ibid.*, **65**, 1503 (1943).