Anal. Calcd. for $C_{22}H_{28}O_4$: C, 74.13; H, 7.92. Found: C, 73.96; H, 7.97.

Reaction of Dihydrostrophanthidin with Raney Nickel and Cyclohexanone.[23]—A solution of 1.0 g. of 20,22-dihydrostrophanthidin in 100 ml. of xylene and 50 ml. of freshly distilled cyclohexanone was refluxed in the presence of Raney nickel for 48 hr. The solvents and steam-volatile by-products were removed by steam distillation, which was continued until the distillate did not give a ferric chloride test for phenol. The residue was then extracted with methylene chloride, and, after chromatography on magnesium silicate, 40 mg. of Xa was obtained, m.p. 270–272° dec., λ_{max}^{EtOH} 280 mμ. The infrared spectrum of this material was identical with that of the sample of Xa obtained in the preceding experiment.

Preparation of Xb.—A solution of 53 mg. of the above phenol in 1 ml. of methanol was purged with nitrogen and treated with 5 ml. of deoxygenated water containing 2 pellets of sodium hydroxide. The mixture was stirred until solution was complete, and the flask and its contents were then cooled to 0°. Dimethyl sulfate (0.3 ml.) was added, and the reaction mixture was kept alkaline to alizarin yellow by the occasional addition of sodium hydroxide. The temperature then was allowed to rise to about 25° and stirring was continued for 2 hr., at the end of which time the solution was acidified to congo red. The product was extracted with ethyl acetate, and after remaining in contact with *p*-toluenesulfonic acid overnight, the organic phase was washed, dried and evaporated. Chromatography on silicic acid afforded crystalline material melting at 163–174°. The analytical sample was obtained by recrystallization from acetone–petroleum ether; m.p. 173.5–174.5°, $[\alpha]_D$ +82.1° (*c* 1.02, chloroform); $\lambda_{max}^{CH_2Cl_2}$ 2.75, 5.64 μ.

Anal. Calcd. for $C_{23}H_{30}O_4$: C, 74.56; H, 8.16. Found: C, 74.75; H, 8.39.

Conversion of II into Xb.—A solution of 70 mg. of ketol II in 2 ml. of methylene chloride containing 10 drops of ethanedithiol was added at 0° to 2 ml. of alcohol-free chloroform saturated with hydrogen chloride. After standing at 0° for 24 hr., ice-water was added, and the product was extracted with ethyl acetate. Removal of the solvents furnished an amorphous residue which showed no ketonic absorption in the infrared. This material was dissolved in 10 ml. of freshly purified dioxane and refluxed with about 2.0 g. of W-5 Raney nickel[24] for 10 hr. Removal of the nickel and evaporation of the solvent gave 63 mg. of oil, which was chromatographed on silicic acid. Elution with benzene–chloroform mixtures yielded 25 mg. of Xb. Recrystallization from acetone–petroleum ether gave a sample melting at 173.0–174.5°, $[\alpha]_D$ +80.2° (*c* 0.98, chloroform); λ_{max}^{MeOH} 278, 286 mμ, ε 1620, 1520, $\lambda_{max}^{CH_2Cl_2}$ 2.75, 5.64 μ. A mixed melting point determination with the specimen of Xb prepared from dihydrostrophanthidin showed no depression, and the infrared spectra of the two samples were identical.

(23) We are indebted to Dr. R. P. A. Sneeden for this experiment.

(24) H. R. Billica and H. Adkins in "Organic Syntheses," Coll. Vol. III, John Wiley and Sons, Inc., New York, N. Y., 1955, p. 176, note 3.

HOUSTON, TEXAS

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY OF THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES]

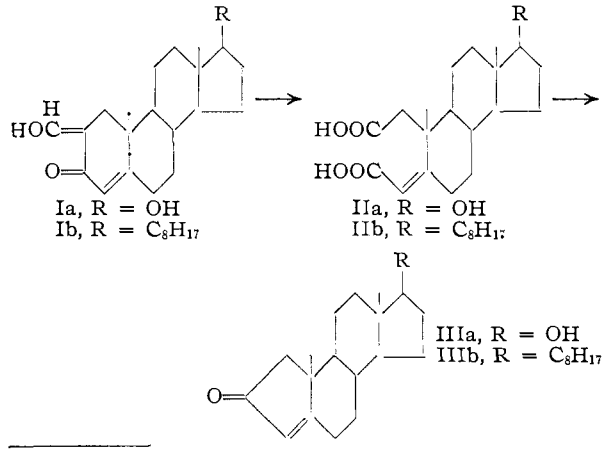
A-Nor-$\Delta^{3(5)}$-cholesten-2-one[1]

BY THOMAS L. JACOBS AND NOBUYOSHI TAKAHASHI

RECEIVED MARCH 17, 1958

A-Nor-$\Delta^{3(5)}$-cholestene-2-one was synthesized from A-norcholestane by dibromination, dehydrobromination of the dibromide to 3-bromo-A-norcholesten-2-one and debromination of the latter by catalytic hydrogenation under Rosenmund conditions. Attempted syntheses by cyclization of 2,3-*seco*-Δ^4-cholestene-2,3-dioic acid or its ester and by conventional methods from the enol lactone 3-oxa-$\Delta^{5,6}$-A-norcholesten-2-one were unsuccessful.

It was of interest to determine the effect of modification of the size of the A ring in various steroids on the physiological activity of these compounds. Acid IIa, a promising intermediate for the synthesis of A-nor-$\Delta^{3(5)}$-testosterone (IIIa), was obtained in connection with other work[2]



during the ozonization of hydroxymethylenetestosterone Ia. It was hoped that this acid was the geometrical isomer shown and that ring closure to IIIa could be accomplished easily. However, neither heating with acetic anhydride, the usual procedure for ring closure of similar saturated acids, nor the Dieckmann condensation of the dimethyl ester of IIa was successful for the preparation of IIIa.

The relative scarcity and cost of testosterone led to investigation of the cholesterol series at this point. Ozonization of Ib was reported earlier[2] to yield mainly a lactol, 5-hydroxy-3-oxa-A-norcholestan-2-one; no attempt was made to isolate IIb. We have obtained IIb from this ozonization, but the yield was never more than 4% and was often less. The yield of crude acidic material from the ozonization was considerably higher, but most of the substance was a glass that could not be obtained in crystalline form. The structure of IIb was shown by its ultraviolet spectrum and by hydrogenation to 2,3-*seco*-cholestan-2,3-dioic acid which readily was cyclized to the known A-norcholestan-2-one.[3] Cyclization of IIb or of its dimethyl ester was not successful.

It seems probable that the failure of attempts to cyclize IIa or b or their esters resulted because the

(1) Taken from a thesis submitted by Nobuyoshi Takahashi in partial fulfillment of the requirements for the Ph. D. degree, University of California, Los Angeles, February, 1958.

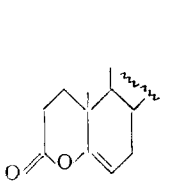
(2) F. L. Weisenborn, D. C. Remy and T. L. Jacobs, THIS JOURNAL, **76**, 552 (1954).

(3) A. Windaus and O. Dalmer, *Ber.*, **52**, 162 (1919).

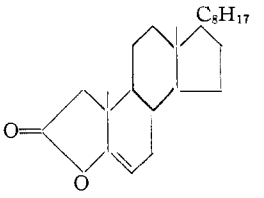
geometrical isomer obtained was not the one shown or because a rearrangement occurred during the thermal treatment. Very few examples of this type of ring closure could be found, but it has been reported that diethyl 3-methyl-2-pentyl-2-hexenedioate was cyclized by refluxing with sodium powder in xylene to give 3-methyl-2-pentyl-2-cyclopentenone after hydrolysis and decarboxylation.[4]

Preliminary attempts were made to effect the ring closure of IIb indirectly by adding bromine to the double bond, cyclizing and debrominating. However, the addition of bromine to IIb gave a glass which could not be obtained crystalline. An attempt to obtain pure 5,6-dibromo-2,3-*seco*-cholestane-2,3-dioic acid by oxidation of cholesterol dibromide also was unsuccessful, so that the route involving ring closure of this dibromodiacid was also abandoned.

Several partial syntheses of cholestenone or related compounds, most of them containing radioactive carbon in the A ring, have been reported.[5-11] These syntheses started from the enol lactone shown in the partial formula IV and involved either condensation with phenyl acetate[5,8] or reaction with a Grignard reagent.[6,7,9-11] Our attempts to prepare



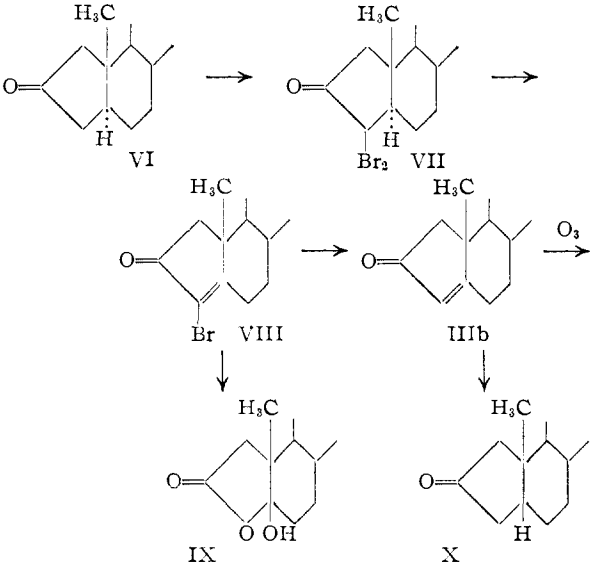
IV



V

nor-A-cholestenone from V by these methods were unsuccessful. It seemed probable that further study would give at best only low yields of the desired compound and work along these lines was discontinued when the synthesis described below was discovered.

As a result of the difficulties encountered in the direct closure of a five-membered ring containing both a double bond and a carbonyl group, attention next was turned to methods involving introduction of a double bond into a cyclopentanone system. Bromination followed by dehydrobromination offers a straightforward approach to this objective, but depends upon introduction of the bromine in the correct position (3 rather than 1) and *trans* to the hydrogen to be eliminated. It was found that bromination of A-norcholestan-2-one (VI) proceeded slowly and a pure crystalline monobromide could not be isolated. Dehydrobromination of the crude bromo derivative did not yield material with the structure of an α,β-unsaturated ketone. Dibromination with two molecular equivalents of bromine in acetic acid gave crystalline 3,3-dibromo-A-nor-cholestan-2-one (VII) in low yield. Collidine dehydrobromination yielded 3-bromo-A-nor-$\Delta^{3(5)}$-cholesten-2-one (VIII) in 58% yield. When VI was dibrominated and the crude product dehydrobrominated directly, the over-all yield of VIII was 56%.



VI VII VIII IIIb IX X

The structure of VIII was determined by ozonization to give the lactol IX, which was identical with material obtained by ozonizing hydroxymethylenecholestenone.[2]

It is not surprising that monobromination of VI gives a bromo compound which cannot be dehydrobrominated to IIIb, because the angular methyl group probably makes attack on the enol form of VI difficult from the top, and the bromine should assume a position *cis* to the hydrogen at 5. When the enol form of the monobromide is attacked by bromine, the halogen already present would be forced into a position *trans* to the hydrogen at 5, and dehydrobromination would be expected to occur readily.

Debromination of VIII to IIIb was accomplished smoothly by catalytic hydrogenation under Rosenmund conditions. Other methods were less successful or failed completely. Compound IIIb gave IX on ozonization and was reduced to A-norcoprostan-2-one (X) by catalytic hydrogenation over platinum in acetic acid.

The ultraviolet spectra of VIII and IIIb are in accord with the suggested structures. In alcohol IIIb shows a strong peak at 235 mμ (log ϵ 4.2) compared with Δ^4-cholesten-3-one which shows λ_{max}^{ether} 234 mμ (corresponding to approximately 241 mμ in alcohol or 244 mμ estimated from Woodward's rule).[12] Bicyclo[4,3,0]non-6-en-8-one absorbs at 228 mμ.[13] Compound VIII shows $\lambda_{max}^{alcohol}$ 251 mμ, log ϵ 4.11, a bathochromic shift of 26 mμ for the bromine. In a series of α-bromo-α,β-unsaturated ketones, the average bathochromic shift for the bromine was 23 mμ.[14]

(4) H. Staudinger and L. Ruzicka, *Helv. Chim. Acta*, **7**, 245 (1924).
(5) R. B. Turner, THIS JOURNAL, **72**, 579 (1950).
(6) (a) G. I. Fujimoto, *ibid.*, **73**, 1856 (1951); (b) G. I. Fujimoto and J. Prager, *ibid.*, **75**, 3259 (1953).
(7) R. D. H. Heard and P. Ziegler, *ibid.*, **73**, 4036 (1951).
(8) M. Gut, *Helv. Chim. Acta*, **36**, 906 (1953).
(9) L. M. Thompson, C. H. Yates and A. D. Odell, THIS JOURNAL, **76**, 1194 (1954).
(10) J. A. Hartman, A. J. Tomasewski and A. S. Dreiding, *ibid.*, **78**, 5662 (1956).
(11) G. D. Meakins and O. R. Rodig, *J. Chem. Soc.*, 4679 (1956).
(12) L. F. Fieser and M. Fieser, "Natural Products Related to Phenanthrene," Reinhold Publishing Corp., New York, N. Y., 1949, third edition, p. 191.
(13) A. M. Islam and R. A. Raphael, *J. Chem. Soc.*, 4086 (1952).
(14) A. L. Nussbaum, O. Mancera, R. Daniels, G. Rosenkranz and C. Djerassi, THIS JOURNAL, **73**, 3263 (1951).

Preliminary attempts to prepare the enol acetate of IIIb for reduction to A-norcholesterol were unsuccessful.

Experimental Part

Melting points were taken in a bath with total immersion Anschütz thermometers and are uncorrected. Infrared spectra were determined on a Perkin–Elmer instrument, model 21 and ultraviolet spectra on a Cary recording spectrophotometer, model 11.

2,3-*seco*-Δ^4-Cholestene-2,3-dioic Acid (IIb).—Hydroxymethylenecholestenone[2] (3.0 g.) was dissolved in 30 ml. of ethyl acetate and 30 ml. of glacial acetic acid, and ozonized at −10 to −15°. Ozone was not absorbed quantitatively by the solution; reaction was continued until approximately 2 molecular equivalents of the reagent had reacted. The light yellow solution was diluted with 30 ml. of water, 7.5 ml. of 30% hydrogen peroxide was added, and the mixture was allowed to stand for 48 hours. Lactol IX,[2] 700 mg., m.p. 157–159°, precipitated and was removed by filtration. The filtrate was diluted with 400 ml. of ether and the organic layer washed 8 times with 75-ml. portions of water to remove the acetic acid. The ether solution was extracted with five 30-ml. portions of 5% sodium bicarbonate solution, the basic extract acidified with 6 *N* hydrochloric acid and the precipitate taken up in ether. The ether solution was washed with water and saturated sodium chloride solution, and dried over anhydrous magnesium sulfate. Removal of the ether left 1.0 g. of slightly-yellow glass which was taken up in small amounts of chloroform; this solution usually deposited crystals of the desired diacid in yields varying up to 120 mg. (3.8%), but sometimes no crystals were obtained. The bulk of the acidic material could not be induced to crystallize. About 225 mg. more of the lactol could be isolated from the neutral solution remaining after the sodium bicarbonate extraction of the diacid. The diacid was recrystallized from ethyl acetate in the form of needles, m.p. 186–187.5°, $\alpha^{26}D$ +88° (ethanol), ultraviolet spectrum $\lambda_{max}^{ethanol}$ 223 mμ, log ε 4.11.

Anal. Calcd. for $C_{27}H_{44}O_4$: C, 74.96; H, 10.25; neut. equiv., 216.3. Found: C, 74.86; H, 10.42; neut. equiv., 215.6.

Attempts were made to improve the synthesis of the diacid by converting hydroxymethylenecholestenone into a piperidine derivative which it was hoped would undergo ozonization more selectively. It was reported[15] that such an enamine as that from 3-ketobisnor-4-cholenaldehyde and piperidine gave progesterone in high yield by selective ozonization. The piperidine derivative from hydroxymethylenecholestenone was a solid, m.p. 125–130°, which was not purified successfully; ozonization of the crude product gave mainly the lactol IX and no diacid was isolated.

Dimethyl 2,3-*seco*-Δ^4-cholestene-2,3-dioate was prepared from 500 mg. of the diacid in 10 ml. of anhydrous ether at 0° by treatment with diazomethane in ether. A glassy material was obtained which recrystallized slowly from methanol, yield 370 mg. One further recrystallization gave material, m.p. 46–47°, ultraviolet spectrum $\lambda_{max}^{ethanol}$ 224 mμ, log ε 4.16.

Anal. Calcd. for $C_{29}H_{48}O_4$: C, 75.61; H, 10.50. Found: C, 75.39; H, 10.54.

2,3-*seco*-Cholestane-2,3-dioic Acid.—Hydrogenation of 300 mg. of the unsaturated diacid IIb in 20 ml. of glacial acetic acid with 128 mg. of pre-reduced Adams catalyst resulted in absorption of one molecular equivalent of hydrogen in 30 minutes. The saturated diacid (270 mg.) was recrystallized twice from ethyl acetate, m.p. 194–195°, not depressed on admixture with authentic 2,3-*seco*-cholestane-2,3-dioic acid.[16]

The saturated diacid (150 mg.) was dissolved in small amounts of acetic anhydride, refluxed for 1 hour, the solvent removed and the residue distilled (b.p. 280° (2 mm.)). The product was recrystallized from 95% alcohol to yield 80 mg., m.p. 101.5–102.5° (no depression when mixed with authentic A-norcholestan-2-one), $[\alpha]^{24}D$ +139° (chloroform). The 2,4-dinitrophenylhydrazone of the ketone melted at 171–172° and the oxime at 197–198°. Windaus[3] reported the m.p. of the ketone as 100–100.5° and of the oxime as 203°. The rotation of the ketone has been reported[17] as $[\alpha]D$ +142° and the m.p. of the 2,4-dinitrophenylhydrazone as 166–167°.

5-Hydroxy-2,5-*seco*-3,4-bisnor-Δ^5-cholesten-2-oic Acid Lactone-(2:5) (V).—Lactol IX (650 mg.) obtained by ozonization of hydroxymethylenecholestenone[2] was refluxed for 44 hours in 10 ml. of acetic anhydride and 4 ml. of acetyl chloride. The solvent was removed under reduced pressure and the residue dissolved in 50 ml. of ether and washed successively with 5% sodium carbonate solution, water and saturated sodium chloride solution. The ether solution was then filtered through anhydrous sodium sulfate, the ether evaporated under reduced pressure and the residue crystallized from acetone to yield 304 mg. of V, m.p. 94–95°. An additional 100 mg. of product, m.p. 94–96°, was isolated from the mother liquor. The total yield was 65%. After two more recrystallizations from acetone, the m.p. was 97–98°, $[\alpha]^{25}D$ −47° (chloroform).

Anal. Calcd. for $C_{25}H_{40}O_2$: C, 80.59; H, 10.82. Found: C, 80.45; H, 11.03.

The compound showed no absorption in the ultraviolet in the region 210–400 mμ. The infrared spectrum was determined on a 10.6% solution in carbon tetrachloride. Strong bands were obtained at 1705 and 1806 cm.$^{-1}$. Usually γ-lactones have carbonyl stretching frequencies in the region 1800–1740 cm.$^{-1}$.[18] Steroidal enol δ-lactones IV show two bands in the region characteristic of unsaturated linkages: a band at 1757 cm.$^{-1}$ attributed to the lactone carbonyl frequency and one at 1667 cm.$^{-1}$ attributed to the carbon–carbon double bond.[19] We prepared Turner's enol lactone[5] for comparison with our compound and found that it had an infrared spectrum very similar in appearance; characteristic strong bands were observed at 1682 and 1756 cm.$^{-1}$. It is not surprising that with our enol γ-lactone these characteristic bands are observed at higher frequencies. Our sample of Turner's enol lactone showed m.p. 93–94°, $[\alpha]^{27}D$ −49.3°(chloroform); reported[5] m.p. 94–94.5°, $[\alpha]D$ −51° (chloroform).

Compound V (100 mg.) was suspended in 10 ml. of 3% aqueous potassium hydroxide solution and heated on a steam-bath until it dissolved. The reaction mixture was acidified with hydrochloric acid, the lactol taken up in ether, the ether solution washed and dried, and the ether removed to yield 70 mg. of lactol, m.p. 165–167°, no depression when mixed with authentic lactol.

Compound V was treated with methylmagnesium iodide following approximately the directions of Fujimoto[6a] for Turner's lactone; no crystalline methyl ketone could be isolated, and the action of methanolic sodium hydroxide on the crude reaction product gave lactol IX (20%) as the only crystalline product. The remainder of the product showed no ultraviolet absorption in the range 210–320 mμ which indicated the absence of an α,β-unsaturated ketone. Similar results were obtained when V was treated with methyllithium.

Compound V also was treated with phenyl acetate following Turner's directions,[5] but the neutral product, a glass, showed no absorption from 210 to 320 mμ. Lactol IX was recovered in 82% yield from the basic extract from the condensation.

Hydrogenation of V.—A solution of 420 mg. of V in 30 ml. of glacial acetic acid was added to a suspension of 60 mg. of pre-reduced Adams catalyst in 15 ml. of glacial acetic acid and hydrogenated at atmospheric pressure and room temperature. After 50 minutes, 1.88 molar equivalents of hydrogen had been absorbed and hydrogenation ceased. The catalyst was removed, the reaction mixture diluted with water, the precipitate taken up in ether, the ether solution washed with water to remove acetic acid and the product separated into acidic and neutral fractions by extraction with 1 *N* sodium hydroxide.

The acidic material (260 mg.) was crystallized from acetone and showed m.p. 155–156°, $[\alpha]^{25}D$ +44.3° (chloroform), neutral equivalent 376 (calcd. for $C_{25}H_{44}O_2$, 376). Tschesche[20] prepared 2,5-*seco*-3,4-bisnorcholestan-2-oic acid

(15) M. E. Herr and F. W. Heyl, THIS JOURNAL, **74**, 3627 (1952).

(16) A. Windaus and C. Uibrig, *Ber.*, **47**, 2384 (1914).

(17) D. E. Evans, A. C. de Paulet, C. W. Shoppee and F. Winternitz, *J. Chem. Soc.*, 1451 (1957).

(18) L. J. Bellamy, "The Infrared Spectra of Complex Molecules," John Wiley and Sons, Inc., New York, N. Y., 1954.

(19) H. Rosenkrantz and M. Gut, *Helv. Chim. Acta*, **36**, 1000 (1953).

(20) R. Tschesche, *Ann.*, **498**, 185 (1932).

and reported m.p. 153–154°, $[\alpha]^{19}D$ +45.7°, neutral equivalent 378.

The neutral material (160 mg.) was recrystallized from methanol to give a compound m.p. 119–121°. After two more recrystallizations from methanol it gave m.p. 126–127°, $[\alpha]^{25}D$ +8.8° (chloroform).

Anal. Calcd. for $C_{25}H_{42}O_2$: C, 80.15; H, 11.30. Found: C, 80.36; H, 11.30.

The infrared spectrum was determined in carbon tetrachloride; a strong peak at 1785 cm.$^{-1}$ and the absence of absorption in the carbon–carbon double bond region suggests a γ-lactone structure. The compound is believed to be 5-hydroxy-2,5-*seco*-3,4-bisnorcholestan-2-oic acid lactone-(2:5), but the configuration of the hydrogen atom at position 5 is not known.

3,3-Dibromo-A-norcholestan-2-one (VII).—To 2.0 g. (0.00536 mole) of A-norcholestan-2-one[3,16] in 50 ml. of glacial acetic acid was added 1.71 g. (0.0107 mole) of bromine in 25 ml. of acetic acid. After 2 days the precipitate was collected and found to consist of the desired product, 400 mg. (14%), m.p. 139–142°. After two more recrystallizations from 95% alcohol it melted at 148–150°, $[\alpha]^{25}D$ +60° (chloroform). The infrared spectrum showed a strong band at 1764 cm.$^{-1}$.

Anal. Calcd. for $C_{26}H_{42}OBr_2$: C, 58.87; H, 7.98; Br, 30.13. Found: C, 58.85; H, 8.23; Br, 29.45.

The filtrate from the bromination was diluted with water, the precipitate taken up in ether, and the ether solution washed with 5% sodium bicarbonate, water and saturated sodium chloride solution. The solution was dried and the ether removed to give 1.70 g. of a brown glass, m.p. 98–110°, which was used directly for the dehydrobromination.

When the A-norcholestanone was dissolved in 30 ml. of acetic acid instead of 50 ml. in the preparation described above, 1.40 g. of precipitate, m.p. 122–124°, was obtained. The infrared spectrum was very similar to that for the compound m.p. 148–150° and had the strong band at 1764 cm.$^{-1}$. The filtrate was worked up as above with similar results.

3-Bromo-A-nor-$\Delta^{3,5}$-cholesten-2-one (VIII).—Compound VII (160 mg.), m.p. 148–150°, was dissolved in 3 ml. of collidine and refluxed for 15 minutes. Collidine hydrobromide was separated and the collidine solution diluted with ether, washed with 5% hydrochloric acid, water and saturated sodium chloride solution, dried over sodium sulfate, the ether removed under reduced pressure and the residue crystallized from 95% alcohol. The yield was 80 mg. (58%), m.p. 107–108°. The same dehydrobromination was carried out on 1.6 g. of VII, m.p. 122–124°, and the brown glass obtained was purified by chromatography on alumina; 637 mg. (64%) of VIII, m.p. 107–108°, was obtained. Similar dehydrobrominations on the glassy residues of VII gave VIII in only slightly lower yields. Overall yields of VIII from A-norcholestan-2-one were 56%. Two recrystallizations of VIII from 95% alcohol gave material, m.p. 110.5–111.5°, $[\alpha]^{25}D$ +27.1° (chloroform), ultraviolet spectrum $\lambda_{max}^{ethanol}$ 251 mμ, log ε 4.11. The infrared spectrum showed strong bands at 1707 and 1614 cm.$^{-1}$.

Anal. Calcd. for $C_{26}H_{41}OBr$: C, 69.47; H, 9.91; Br, 17.78. Found: C, 69.32; H, 9.43; Br, 17.42.

A solution of 340 mg. of VIII in 10 ml. of ethyl acetate and 10 ml. of acetic acid was ozonized at −10 to −15° until a yellow color developed. The reaction mixture was diluted with 10 ml. of water, 5 ml. of 30% hydrogen peroxide was added, and the mixture was left overnight. The precipitate that had formed was separated; it weighed 120 mg. and melted at 162–164°. One recrystallization from ether and pentane gave material melting at 164.5–165.5° and showing no depression when mixed with authentic lactol IX; the infrared spectrum of the product was identical with that of IX.

A-Nor-$\Delta^{3,5}$-cholesten-2-one (IIIb).—Hydrogen was passed continuously through a mixture of 730 mg. of VIII, 50 ml. of *m*-xylene, 0.1 ml. of quinoline–sulfur reagent and 2.30 g. of ~6% palladium-on-barium sulfate catalyst while the mixture was stirred vigorously and refluxed. Titration of the hydrogen bromide in the exhaust hydrogen showed that approximately 90% of the theoretical amount of bromine was removed in 37 hours. The reaction mixture was then filtered, the solvent evaporated and the residue chromatographed on alumina to yield 440 mg. (73%) of IIIb, m.p. 95–96°. After one recrystallization from 95% alcohol it melted at 96–97°, $\alpha^{28}D$ −143° (chloroform), ultraviolet spectrum $\lambda_{max}^{ethanol}$ 235 mμ, log ε 4.20. The infrared spectrum of a 9% solution in chloroform showed strong peaks at 1679 and 1619 cm.$^{-1}$.

Anal. Calcd. for $C_{26}H_{42}O$: C, 84.26; H, 11.42. Found: C, 84.27; H, 11.48.

The 2,4-dinitrophenylhydrazone was prepared using Djerassi's directions[21]; the product was recrystallized from chloroform–alcohol as red needles, m.p. 191–193°.

Anal. Calcd. for $C_{32}H_{46}O_4N_4$: C, 69.79; H, 8.42. Found: C, 69.85; H, 8.21.

Debromination with zinc dust in acetic acid gave IIIb in only 6.6% yield; 42.6% of VIII was recovered. Debromination with zinc dust in ethanol[22] gave 33% of A-norcholestan-2-one and permitted recovery of 48% of VIII; VIII was recovered almost quantitatively when the debromination was attempted with chromous chloride.[23] Hydrogenation of VIII with Adams catalyst was unsuccessful; presumably the catalyst was poisoned by the hydrogen bromide.

Ozonization of 120 mg. of IIIb as described for VIII gave 40 mg. of lactol IX.

Compound IIIb (110 mg.) in 25 ml. of glacial acetic acid over 70 mg. of Adams catalyst absorbed 99% of the theoretical amount of hydrogen in 15 minutes. The product melted at 102–103° after one recrystallization from 95% alcohol, yield 105 mg. The m.p. of A-norcoprostan-2-one has been reported at 106–107°[24] and 101–103°.[17] The hydrogenation product gave a large melting point depression when mixed with authentic A-norcholestanone, m.p. 101.5–102.5°. The product showed $[\alpha]^{28}D$ −43.6° (chloroform) and gave a semicarbazone, m.p. 237–238°. The optical rotation of A-norcoprostan-2-one was reported as +46°[17,25] and its semicarbazone was reported to melt at 245°.[24] The infrared spectrum showed a strong band at 1735 cm.$^{-1}$.

LOS ANGELES, CALIF.

(21) C. Djerassi, THIS JOURNAL, **71**, 1003 (1949).

(22) C. Djerassi and C. R. Scholz, *ibid.*, **69**, 2404 (1947).

(23) C. Djerassi and C. R. Scholz, *J. Org. Chem.*, **13**, 697 (1948).

(24) A. Windaus and K. H. Mielke, *Ann.*, **536**, 116 (1938).

(25) Professor W. G. Dauben, University of California, Berkeley, has indicated (private communication) that he has also observed a negative rotation for A-norcoprostan-2-one.