The Photochemical Dehydrogenation of 7-Dehydrocholestene.

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Ergopinacone, $C_{56}H_{86}O_2$, which is formed on exposing ergosterol, $C_{28}H_{44}O$, to sunlight with eosin in alcoholic solution in the absence of oxygen, was at first considered to be a pinacone and to be produced by the condensation of ergosterol and a ketone formed intermediately by the dehydrogenation of ergosterol.(1) Subsequently it has been shown from various sides that ergopinacone is not really a pinacone and is not produced by the intermediate formation of a ketone: Ergopinacone yields easily a diacetate,(2) which is also obtained by exposing ergosteryl acetate to sunlight with eosin.(3) The methyl ether of ergosterol gives similarly ergopinacone dimethyl ether.(3) Ergopinacone can be converted into a diketone after hydrogenation.(3) Thus it can be regarded as established that ergopinacone is a di-secondary dihydric alcohol. Then it is very probable that the carbon atom 3 or the hydroxyl group there does not take part in the formation of ergopinacone.

Besides ergosterol, many analogously constructed steroids, viz., dehydroergosterol,(4) 22-dihydroergosterol,(5) 7-dehydrocholesterol(6), 7-de-

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(1) A. Windaus and P. Borgeaud, *Ann.*, **460** (1928), 235.

(2) A. Windaus, H. H. Inhoffen, and K. Buchholz, "Über Sterine, Gallensäuren und verwandte Naturstoffe" by H. Lettré and H. H. Inhoffen, 135, Stuttgart (1936).

(3) K. Buchholz, "Über einige Versuche in der Reihe der Sterine", Inaugural Dissertation, Göttingen, 1937.

(4) A. Windaus and O. Linsert, *Ann.*, **465** (1928), 148.

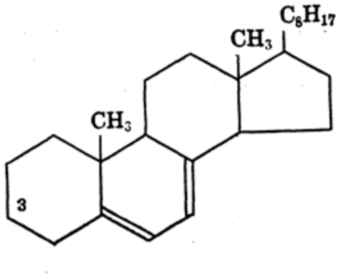
(5) A. Windaus and R. Langer, *Ann.*, **508** (1933), 105.

(6) Y. Urushibara and T. Ando, this Bulletin, **11** (1936), 802; **12** (1937), 495; F. Schenck, K. Buchholz, and O. Wiese, *Ber.*, **69** (1936), 2696.

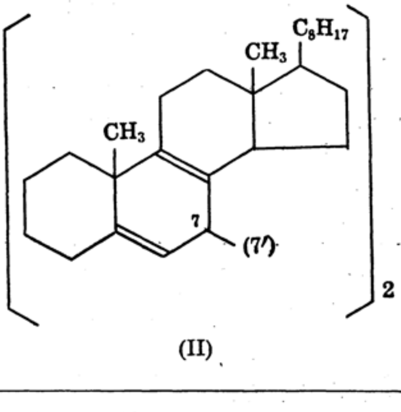
hydrositosterol,⁽⁷⁾ dehydrolumisterol,⁽⁸⁾ pyrocalciferol,⁽⁹⁾ 7-dehydrostigmasterol and 3-hydroxy-$\Delta^{5,7}$-choladienic acid,⁽¹⁰⁾ have been shown to be dehydrogenated to similar dimolecular compounds. All these steroids possess hydroxyl groups at carbon atoms 3. Since it seemed desirable to see whether or not a C_3-hydroxyl group (or equivalents) was necessary for the formation of an ergopinacone analogue, the author prepared 7-dehydrocholestene (I) according to the method of Dimroth and Trautmann⁽¹¹⁾ and subjected it to the photochemical dehydrogenation.

In spite of every effort in adjusting the experimental conditions, the pyrolysis of 7-hydroxycholestene benzoate gave specimens of 7-dehydrocholestene contaminated with more or less isomeric cholestadiene, as revealed by the ultraviolet absorption spectra of the products. Since it was however expected that the isomeride would remain unaffected by insolation, the mixture was used in the photochemical dehydrogenation.

The alcohol–benzene solution of the material with eosin was exposed to sunlight after removing air by passing carbon dioxide. In the course of a week's irradiation, micaceous crystals separated out gradually, which were collected and recrystallized from chloroform–methanol. The substance thus obtained forms glittering micaceous plates, melts at 269–270° (corr.) with decomposition, is soluble in benzene and chloroform but insoluble in ether and alcohol, shows a specific rotation $[\alpha]_{\mathrm{D}}^{30^\circ} = +260^\circ$ in chloroform, and gives the colour reactions of steroids. The analysis and the molecular weight determination by Rast's method indicate that the substance possesses the expected formula $C_{54}H_{86}$. Thus it has been shown that the hydroxyl-free 7-dehydrocholestene undergoes a similar dehydrogenation to yield a dimolecular product analogous to ergopinacone. The dehydrogenation product from 7-dehydrocholestene may be called "7-dehydrocholestene-pinacone" for lack of an appropriate nomenclature for the substances of this type, and Inhoffen's ergopinacone formula⁽¹²⁾ requires formula II for this new "pinacone".



(I)



(II)

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(7) W. Wunderlich, *Z. physiol. Chem.*, **241** (1936), 116.
(8) K. Dimroth, *Ber.*, **69** (1936), 1123.
(9) T. Kennedy and F. S. Spring, *J. Chem. Soc.*, **1939**, 250.
(10) G. A. D. Haslewood, *Biochem. J.*, **33** (1939), 454.
(11) K. Dimroth and G. Trautmann, *Ber.*, **69** (1936), 669.
(12) H. H. Inhoffen, *Naturwissenschaften*, **25** (1937), 125.

The formation of 7-dehydrocholestene-pinacone affords a more reliable evidence that the carbon atom 3 or any group attached there does not take part in the formation of "pinacones", and that the seat of change must be sought at the other reactive group, the conjugate double bonds, thus favouring Inhoffen's ergopinacone formula.

Experimental.

Preparation of 7-Dehydrocholestene. 7-Dehydrocholestene was prepared according to the directions of Dimroth and Trautmann(11) from cholesterol through the following intermediates.

Cholesteryl chloride.(13) Colourless needles, m.p.97° (corr.).

Cholestene.(14) Colourless needles from alcohol, m.p.93–94° (corr.). Mauthner and Suida gave m.p. 89–90°.

7-Ketocholestene.(15) Cholestene (31 g.) was oxidized with chromic anhydride (39 g.) in glacial acetic acid at 75–80°. After two hours an excess of alcohol was added to decompose chromic anhydride. The neutral fraction from the reaction mixture was recrystallized several times from acetone, m.p. 130–130.5° (corr.) (Found: C, 84.84, 84.12; H, 11.84, 11.85. Calculated for $C_{27}H_{44}O$: C, 84.30; H, 11.54%). $[\alpha]_D^{28°} = -138°$ (13.4 mg. in 1 c.c. chloroform solution, $l = 1$ dm., $\alpha_D^{28°} = -1.85°$). M.p. 145°(15) and 125°(16) are recorded in the literature. Oxime, needles from alcohol, m.p. 179–180° (corr.) (Found: N, 3.80, 3.84. Calculated for $C_{27}H_{45}ON$: N, 3.50%).

7-Hydroxycholestene.(11) Thick plates from acetone, m.p.87–94° (corr.). It gave the Rosenheim reaction.

7-Hydroxycholestene benzoate.(11) Fine needles from acetone–methanol, m.p. 106–108° (corr.).

7-Dehydrocholestene.(11) (a) The above benzoate was decomposed and distilled at 120–125° under a pressure of $3\text{–}7 \times 10^{-4}$ mm. in the course of about thirty hours. The distillate was taken in ether and the ethereal solution was washed with dilute alkali and with water. The residue from the ethereal solution was recrystallized from ether–methanol. Needles, m.p. 89–91° (corr.), $[\alpha]_D = \pm 0°$ (in chloroform).

(b) The benzoate was decomposed and distilled at 110–113° in the vacuum of a mercury diffusion pump ($3\text{–}7 \times 10^{-5}$ mm.) in the course of about eighteen hours. The distillate was treated with alkali as described above and recrystallized from ether-methanol, m.p. 90–91° (corr.), $[\alpha]_D^{17°} = -22°$ (in chloroform). The substance dissolved in hexane showed ultraviolet absorption maxima at 295, 282, and 273 mμ due to 7-dehydrocholestene and another at about 240 mμ probably due to isomeric cholestadiene.

(c) The distillation was carried out as (b), but the distillate was cooled with water to keep it from heat during distillation. The solidified distillate melted at 80–86° (corr.) and recrystallization gave a substance melting at 91° (corr.).

The specimens obtained in (a), (b) and (c), showed no melting point depression when mixed with one another.

Photochemical Dehydrogenation of 7-Dehydrocholestene. 7-Dehydrocholestene prepared as described above was treated according to the directions of Inhoffen(17) for the preparation of ergopinacone from ergosterol. 7-Dehydrocholestene (300 mg.) and eosin (300 mg.) were dissolved in a mixture of 95% alcohol (190 c.c.) and a small amount (5 c.c.) of benzene and carbon dioxide was passed through the solution to remove air. The solution was exposed to sunlight for a week. In the course of irradiation the colour of eosin was faded and micaceous plates separated out. The

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(13) O. Diels and D. Blumberg, *Ber.*, **44** (1911) 2837.
(14) J. Mauthner and W. Suida, *Monatsh.*, **15** (1894), 86.
(15) A. Windaus and A. Kirchner, *Ber.*, **53** (1920), 488.
(16) A. Windaus and A. von Staden, *Ber.*, **53** (1920), 614.
(17) H. H. Inhoffen, *Ann.*, **497** (1932), 130.

precipitate was collected (40 mg.), washed with alcohol and with water, and recrystallized from chloroform–methanol. The product thus obtained forms glittering micaceous plates melting at 269–270° (corr.) with decomposition (Found: C, 88.51, 88.28; H, 11.77, 11.73. Calculated for $C_{54}H_{86}$: C, 88.21; H, 11.79%). $[\alpha]_D^{30°} = +260°$ (3.3 mg. in 1 c.c. chloroform solution, $l = 1$ dm., $\alpha_D^{30°} = +0.87°$). Molecular weight by Rast's method 750 (0.413 mg. in 4.000 mg. camphor, depression of m.p. 5.5°). Calculated for $C_{54}H_{86}$: 735. The substance is soluble in benzene and chloroform but insoluble in ether and alcohol. In the Liebermann–Burchard test it gives rose, red, violet, and finally dark blue colours, while in the Rosenheim test light pink, wine red, and blue colours.

Summary.

7-Dehydrocholestene was exposed to sunlight with eosin in alcohol–benzene solution in the absence of oxygen. A product analogous to ergopinacone from ergosterol was obtained. Thus it was demonstrated that the carbon atom 3 or any group attached there does not take part in the photochemical dehydrogenation of ergosterol and its analogues.

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