relative line intensities of the diffraction patterns shows that $BaTiO_3$ retains the cubic perovskite structure throughout the temperature range 200 to 1372°. The patterns could be indexed in the cubic system, all lines being accounted for. The unit cell dimensions listed in Table I were determined from the back-reflections using the Bradley–Jay[6] extrapolation method. The value of a_0 at 201° is in close agreement with the value a_0 = 4.0040 ± 0.0005 Kx. at 200° obtained by Megaw.[1] We estimate that the probable error in our values of a_0 amounts to about 0.0003 Kx. unit.

(6) A. J. Bradley and A. H. Jay, *Proc. Phys. Soc.*, **44**, 564 (1932).

Acknowledgment.—We wish to acknowledge the assistance of the Linde Air Products Co. in support of this investigation.

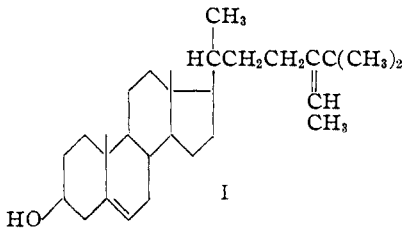
COLUMBUS, OHIO RECEIVED DECEMBER 22, 1950

NOTES

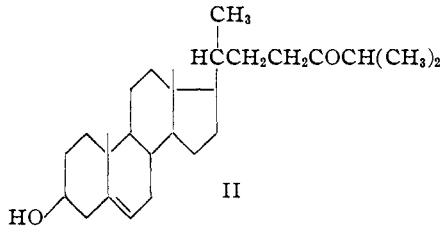
Sterols of Algae. II. The Structure of Fucosterol[1]

BY WERNER BERGMANN AND MARYLIN KLOSTY

During the past years a systematic study of the sterols of algae has been carried out in this Laboratory.[2] In the course of these investigations the structure for fucosterol (I) which has been proposed by MacPhillamy[3] has been substantiated by converting this sterol in a variety of procedures to the known 24-ketocholesterol (II).[4] The report on



I



II

these observations was anticipated in all its significant features by a recent British publication.[5] The present communication is therefore restricted to those experiments which have not already been described by the British authors.

It has been found that the conversion of I to II may readily be carried out by way of *i*-fucosteryl methyl ether. The latter was ozonized in a carbon tetrachloride solution, and the ozonide was converted by reduction with zinc in acetic acid followed by a treatment with zinc acetate into the acetate of (II).

(1) Contributions to the Study of Marine Products. XXVII.
(2) Bergmann and Feeney, *J. Org. Chem.*, **15**, 812 (1950).
(3) MacPhillamy, THIS JOURNAL, **64**, 1732 (1942).
(4) Riegel and Kaye, *ibid.*, **66**, 723 (1944).
(5) Hey, Honeyman and Peal, *J. Chem. Soc.*, 2883 (1950).

Experimental

***i*-Fucosteryl Methyl Ether.**—A solution of 1.1 g. of fucosteryl *p*-toluenesulfonate in 75 ml. of anhydrous methanol and 1.3 g. of freshly fused potassium acetate was refluxed for four hours. The solvent was then removed under reduced pressure, and the residue triturated with water and extracted with ether. The ether extract was washed with a 4% solution of sodium hydroxide and then water until neutral to litmus, dried over anhydrous potassium carbonate and evaporated to dryness under reduced pressure. The residual sirup, 0.8 g. ($[\alpha]_D$ +33°) was dissolved in 10 ml. of hexane and shaken with 2 g. of activated alumina. After filtration and removal of the solvent there remained 0.6 g. of a sirup, $[\alpha]^{23}D$ +36.1° (*c* 1.0, in chloroform) which failed to yield crystalline material.

24-Ketocholesteryl Acetate.—A stream of oxygen containing 4.5% of ozone was passed at room temperature through a solution of 1 g. of *i*-fucosteryl methyl ether in 30 ml. of carbon tetrachloride for 20 minutes. The solvent was then removed under reduced pressure at room temperature, and the residue was dissolved in 20 ml. of glacial acetic acid. The solution was then stirred vigorously with 1 g. of zinc dust and one drop of a 1% silver nitrate solution for 15 minutes. The zinc dust was removed by centrifugation, and the solution was refluxed for two hours with 1 g. of anhydrous zinc acetate. The mixture was then diluted with water and extracted with ether, and the ether extract was washed free of acetic acid, concentrated and diluted with methanol. A crystalline material appeared which was recrystallized several times from methanol (0.4 g.), m.p. 127–128°; $[\alpha]^{22}D$ −41.1 (*c* 0.97, in chloroform). The m.p.'s reported for ketocholesteryl acetate are 127–128°; $[\alpha]_D$ −41°,[5] and 124–131°; $[\alpha]_D$ −41°.[4]

Anal. Calcd. for $C_{29}H_{46}O_3$: C, 78.75; H, 10.40. Found: C, 78.53; H, 10.50.

The 2,4-dinitrophenylhydrazone melted at 168–169°; reported[5] m.p. 169–170°.

STERLING CHEMISTRY LABORATORY
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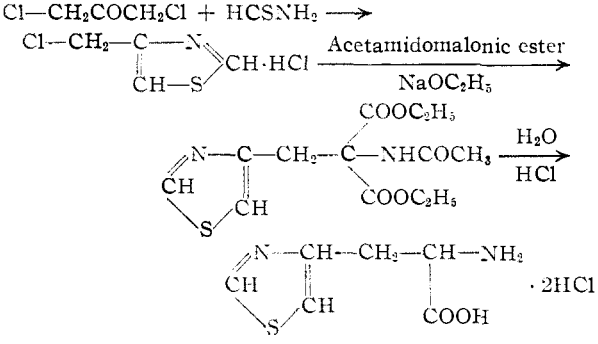
The Synthesis of 4-Chloromethylthiazole Hydrochloride and β-(4-Thiazolyl)-alanine Hydrochloride[1]

BY WILLIAM T. CALDWELL AND SIDNEY M. FOX[1]

For some time we have been engaged in preparing compounds containing the 4-thiazolylmethyl radical by syntheses which depend upon direct introduction of the latter by means of 4-chloromethylthia-

(1) Taken from a thesis submitted by Sidney M. Fox in partial fulfillment of the requirements for the M.A. degree in June, 1947.

zole hydrochloride. Although our program has not yet been completed, the recent appearance of an article by Jones, Kornfeld and McLaughlin[2] describing the use of a solution containing 4-chloromethylthiazole (not isolated and purified) by what appears to us a less convenient process than ours moves us to a preliminary report on a part of our work. We are therefore submitting a description of a simple procedure for the preparation of crystalline 4-chloromethylthiazole hydrochloride and an illustration of its use in making β-(4-thiazolyl)-alanine dihydrochloride through the intermediate ethyl α-acetamido-α-carbethoxy-β-(4-thiazolyl)-propionate. (This intermediate was prepared also by Jones, Kornfeld and McLaughlin.[2])



Experimental

4-Chloromethylthiazole Hydrochloride.—Crude thioformamide[3] (15 g.) in 250 cc. of acetone was added with stirring to a solution of 25.4 g. of *sym*-dichloroacetone in 100 cc. of acetone. There was no apparent reaction but, by the next day, crystals appeared in the flask. These crystals, and those that formed on standing for five days, were filtered off and, when dry, weighed 21 g. Repeated recrystallization from a mixture of ethyl acetate and absolute methanol gave a pure product that melted with evolution of gas and sublimed rapidly at 166–167°. However, purification by recrystallization was impractical because of large attendant loss of material and it was found to be much more satisfactory to purify the product first by sublimation and then recrystallization from a 60–40 anhydrous ethyl acetate–methyl alcohol mixture. In this way a yield of 48% based upon the dichloroacetone used was obtained. In a run that stood for three days, a yield of 24% was obtained; standing, however, for ten days did not increase the yield above 48%.

Anal.[4] Calcd. for $C_4H_5Cl_2NS$: Cl, 41.7; N, 8.2. Found: Cl, 41.84; N, 8.11.

Ethyl α-Acetamido-α-carbethoxy-β-(4-thiazolyl)-propionate.—To a solution of 2.3 g. of freshly cut sodium in 200 cc. of absolute ethanol was added 21.7 g. (0.1 mole) of ethyl acetamidomalonate. When the solution became clear, it was cooled and 8.5 g. (0.05 mole) of 4-chloromethylthiazole hydrochloride was added rapidly with stirring. A precipitate of sodium chloride formed at once but the mixture was permitted to stand at room temperature for two hours before filtering through a layer of charcoal. The pale yellow oil that remained after evaporation was dissolved in hot water. Part of the water needed for solution was evaporated before chilling in ice. The crystals that separated were recrystallized from water; yield 9 g. or 53% based upon the 4-chloromethylthiazole used. After two recrystallizations the m.p. was 104–105°.

Anal. Calcd. for $C_{13}H_{18}O_5N_2S$: N, 8.92. Found: N, 8.72, 8.84.

β-(4-Thiazolyl)-alanine Dihydrochloride.—Six and five-tenths grams of the above ester was added to 100 cc. of concentrated hydrochloric acid and the mixture was then refluxed for five hours. Upon concentration under reduced pressure, a pale yellow solid remained that was recrystallized from a mixture of dilute hydrochloric acid and acetone; yield 1.5 g. that decomposed at 222–226°.

Anal. Calcd. for $C_6H_{10}Cl_2O_2N_2S$: Cl, 28.98; N, 11.43. Found: Cl, 29.24; N, 11.39.

DEPARTMENT OF CHEMISTRY
COLLEGE OF LIBERAL ARTS AND SCIENCES
TEMPLE UNIVERSITY
PHILADELPHIA 22, PENNA. RECEIVED JANUARY 10, 1951

(2) R. G. Jones, E. C. Kornfeld and K. C. McLaughlin, THIS JOURNAL, **72**, 4526 (1950).

(3) R. Willstätter and T. Wirth, *Ber.*, **42**, 1911 (1909).

(4) Analysis by Carl Tiedcke, 366 Fifth Avenue, New York, N. Y.

An Improved Preparation of 2,6,8-Trichloropurine[1]

BY JOHN DAVOLL[2] AND BERTRAM A. LOWY

2,6,8-Trichloropurine is a valuable intermediate for the preparation of a number of purine derivatives. The present communication describes a convenient synthesis of this compound by direct chlorination of uric acid with phosphoryl chloride in the presence of dimethylaniline.

Unlike previously described syntheses of trichloropurine from uric acid,[3] this method does not involve the isolation of 2,6-dichloro-8-hydroxypurine as an intermediate, or the use of phosphoryl chloride in sealed vessels at high temperatures. The yield from uric acid (16–25%) compares favorably with those obtained by the older procedures.

Experimental

Uric acid (40 g.) was suspended in 200 ml. of redistilled phosphoryl chloride and treated with 91 ml. (3 moles per mole of uric acid) of dimethylaniline, which had been dried over potassium hydroxide. The mixture was boiled gently under reflux with exclusion of moisture for 20 hours. The dark solution was then evaporated under reduced pressure to about half-volume and, with stirring, poured slowly on to 1000 g. of crushed ice. After one hour the mixture was filtered and the solid washed by decantation with three 250-ml. portions of ether, each of which was then used to extract the aqueous filtrate. The combined ether extract was evaporated to dryness and the solid residue extracted with 120 ml. of boiling 3 *N* aqueous ammonia. On cooling, the filtrate deposited the ammonium salt of 2,6,8-trichloropurine as a mass of fine needles; yield 9–14 g. (16–25%). A solution of the ammonium salt in 75 parts of boiling water was acidified with dilute sulfuric acid, treated with a little Norit, and filtered hot. On cooling, trichloropurine pentahydrate separated in fine needles, and was dried at 110° to give anhydrous 2,6,8-trichloropurine, m.p. 185° (dec.).

Anal. Calcd. for $C_5HN_4Cl_3$: Cl, 47.6. Found: Cl, 47.9.

(1) The authors wish to acknowledge the support of the National Cancer Institute of the United States Public Health Service and the James Foundation of New York, Inc.

(2) Postdoctorate Research Fellow of the National Cancer Institute, United States Public Health Service.

(3) E. Fischer and L. Ach, *Ber.*, **30**, 2208 (1897); E. Fischer, *ibid.*, **30**, 2220 (1897); Boehringer and Sons, German Patents 94076, 94286, 96363; J. Davoll, B. Lythgoe and A. R. Todd, *J. Chem. Soc.*, 833 (1946).

SLOAN-KETTERING INSTITUTE FOR CANCER RESEARCH
NEW YORK, N. Y. RECEIVED FEBRUARY 2, 1951

Some Acylamino Acid Esters and Amides[1,2]

BY SIDNEY W. FOX AND HARRY WAX

In the course of enzymic experiments with a number of acylamino acids,[3] esters or amides of a num-

(1) Journal Paper No. J-1859 of the Iowa Agricultural Experiment Station, Project 1111. This project is supported in large part by the National Cancer Institute of the National Institutes of Health, Public Health Service.

(2) From the Ph.D. thesis of Harry Wax, Iowa State College, 1949.

(3) S. W. Fox and H. Wax, THIS JOURNAL, **72**, 5087 (1950).