

rial behaved in a manner analogous to the product synthesized by Kühn and Stein.

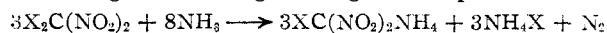
CONVERSE MEMORIAL LABORATORY  
HARVARD UNIVERSITY  
CAMBRIDGE, MASS.

RECEIVED JANUARY 24, 1951

## The Reduction of Certain Halogenated Nitro-paraffins by Liquid Ammonia. II. Brompicrin

BY EDWARD SCHULZ, SEYMOUR MEISEL AND FREDERIC C. SCHMIDT

Schmidt, Sunderlin and Cole<sup>1</sup> showed that dibromodinitromethane, dichlorodinitromethane and chlorobromodinitromethane are reduced by anhydrous ammonia at its boiling point with the loss of a halogen according to the general equation



When bromochlorodinitromethane was used, it was the bromine which was removed.

Hsing-Han Liu and Peter P. T. Sah<sup>2</sup> attempted to prepare guanidine from tribromonitromethane and alcoholic ammonia, but reported that the reaction mixture exploded.

This investigation shows the reaction of tribromonitromethane (brompicrin) with anhydrous liquid ammonia and a possible mechanism for the reaction.

### Experimental

**Preparation of Materials. Brompicrin.**—Brompicrin was obtained from Eastman Kodak Co. and steam distilled. The product was dried over anhydrous sodium sulfate, vacuum distilled and collected over a temperature range of 85–87° (16 mm.);  $d_{20}^{20}$  2.7880;  $n_D^{20}$  1.5790; m.p. 10.2–10.3°.

**Dibromomonitromethane.**—The method of Scholl was used except in the purification of the material. The dibromonitromethane obtained reacted with anhydrous liquid ammonia to give the ammonia salt. The salt was dissolved in distilled water, reforming the dibromonitromethane by the addition of an excess of hydrobromic acid; b.p. 53–54° at 17 mm. pressure;  $d_{20}^{20}$  2.3846;  $n_D^{20}$  1.528.

**Reaction of Brompicrin with Anhydrous Liquid Ammonia.**—A fragile bulb filled with a weighed amount of brompicrin was placed in a reaction vessel which was kept at –33° by a dewar filled with liquid ammonia. The vessel was evacuated, and about 50 ml. of liquid ammonia was distilled into it. The bulb was broken by means of a plunger. A violent reaction occurred between the brompicrin and the ammonia accompanied by a colorless inert gas. The evolved gas was washed free from ammonia and dried overnight over phosphorus pentoxide. After drying, the gas was drawn into an evacuated flask of known volume and the density determined. The molecular weight of the contained inert gas was calculated to be 28; 28.5 for two different determinations. This is in excellent agreement with the molecular weight of nitrogen, 28. The ratio of the moles of brompicrin to moles of nitrogen formed is given in Table I.

TABLE I  
QUANTITATIVE REDUCTION OF BROMPICRIN

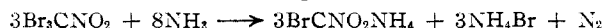
Grams	Moles $\times 10^{-3}$	N <sub>2</sub> liberated moles $\times 10^{-3}$	BrC(NO <sub>2</sub> )/N <sub>2</sub>
1.4214	4.77	1.62	2.94:1
2.2549	7.85	2.49	3.05:1

After the nitrogen had been completely evolved, the excess liquid ammonia was allowed to evaporate leaving a bright yellow solid. This solid, suspected of being a mixture of the ammonium salt of dibromonitromethane and ammonium bromide, was treated with an excess of aqueous

HBr. The heavy oil which separated was washed with water, dried and vacuum distilled:  $d_{20}^{20}$  2.3845;  $n_D^{20}$  1.528. These physical constants are identical with those of dibromonitromethane. The infrared spectrum of this oil was compared to that of known dibromonitromethane and they were found identical.

The other solid, beside the ammonium salt of dibromonitromethane, was shown by analysis to be ammonium bromide in equal molar quantities.

**Discussion of Results.**—The evidence of Table I along with the infrared spectra determinations, density and index of refraction measurements indicates without doubt that the reaction between brompicrin and anhydrous liquid ammonia proceeds according to the equation



This equation is similar to that found by Schmidt, Sunderlin and Cole<sup>1</sup> for dibromodinitromethane.

DEPARTMENT OF CHEMISTRY  
INDIANA UNIVERSITY  
BLOOMINGTON, IND.

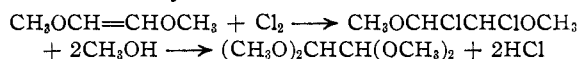
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## A New Synthesis of Glyoxal Tetramethyl Acetal

BY RALPH C. SCHREYER

Glyoxal tetramethyl acetal has been prepared from glyoxal sulfate and methanol<sup>1</sup> or glyoxal sulfate, methanol and calcium chloride.<sup>2</sup> Acetals of glyoxal have also been synthesized from aqueous glyoxal and alcohols.<sup>3</sup>

Recently in this Laboratory the preparation of glyoxal tetramethyl acetal has been accomplished by the addition of chlorine to 1,2-dimethoxyethylene<sup>4</sup> followed by reaction with methanol.



Attempts to isolate the chlorine addition product by vacuum distillation were unsuccessful because of dehydrochlorination of the reactive bis-chloro-ether.

In most cases, it was desirable to add some sodium methoxide after the reaction with methanol in order to drive the reaction to completion and to remove all traces of hydrogen chloride. Higher yields would probably be attained if a stoichiometric amount of sodium methoxide were employed instead of using methanol. This synthesis should be applicable to other 1,2-dialkyloxyethylenes, allowing the synthesis of other acetals or mixed acetals of glyoxal.

### Experimental

**Glyoxal Tetramethyl Acetal.**—Chlorine (24 g., 0.34 mole) was added slowly over a 15-minute period to 30 g. (0.34 mole) of 1,2-dimethoxyethylene stirred at 0°. A white solid separated out from the reaction mixture. Methanol (22 g., 0.69 mole) was then added at 0° and the resulting solution was heated to 60° until the evolution of hydrogen chloride ceased (time about one-half hour). Vacuum dis-

(1) H. O. L. Fischer and C. Taube, *Ber.*, **59B**, 851 (1926).

(2) D. H. Grangaard and C. B. Purves, *THIS JOURNAL*, **61**, 428 (1939).

(3) L. G. MacDowell and R. W. McNamee, U. S. Patent 2,321,094 (1943); U. S. Patent 2,360,959 (1944).

(4) Dimethoxyethylene is prepared by the demethanolation of 1,1,2-trimethoxyethane, W. F. Gresham, U. S. Patent 2,479,068; 1,1,2-trimethoxyethane is synthesized from (1) carbon monoxide, hydrogen, methanol and methylal using a cobalt catalyst, W. F. Gresham and R. E. Brooks, U. S. Patent 2,449,470, or (2) methanol and methoxyacetaldehyde.

(1) Schmidt, Sunderlin and Cole, *J. Org. Chem.*, **9**, 419 (1944).

(2) Hsing-Han Liu and Peter P. T. Sah, Science Reports, National Tsinghua University, A<sub>2</sub> 129-B1 (1933).

tillation gave 36.8 g. of crude glyoxal tetramethyl acetal (72% yield, b.p. 68–71° (25 mm.),  $n_D^{25}$  1.4010). The crude product containing traces of hydrogen chloride was neutralized with sodium methoxide and redistilled at atmospheric pressure. The pure acetal boiled at 159–160°,  $n_D^{25}$  1.4399.

*Anal.* Calcd. for  $C_6H_{14}O_4$ : C, 48.00; H, 9.33; O, 42.67. Found: C, 48.28; H, 9.56; O, 42.86.<sup>5</sup>

(5) C. C. Harris, D. M. Smith and J. Mitchell, Jr., *Anal. Chem.*, **22**, 1297 (1950).

E. I. DU PONT DE NEMOURS & CO.  
POLYCHEMICALS DEPARTMENT  
EXPERIMENTAL STATION  
WILMINGTON, DEL.

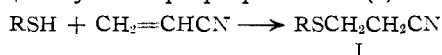
RECEIVED FEBRUARY 3, 1951

### Some Long Chain $\beta$ -Alkylmercaptopropionitriles and their Derivatives

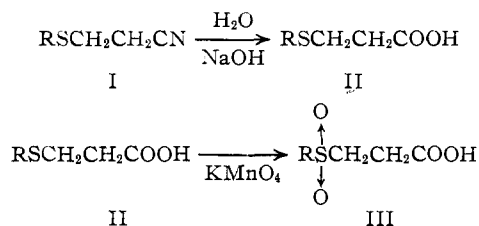
BY DAVID A. SHIRLEY AND JANE W. ALSOBROOK

As a part of a study of modified long chain aliphatic carboxylic acids as potential antitubercular chemotherapeutic agents, we have undertaken to prepare for biological evaluation some of these types containing sulfide and sulfone groups. Compounds of this type have previously been of interest because of their bactericidal properties.<sup>1,2</sup>

In the present work the route chosen for preparation of some sulfur containing aliphatic acids was the well-known cyanoethylation reaction<sup>3</sup> involving the condensation of long chain mercaptans with acrylonitrile in the presence of basic catalysts to give  $\beta$ -alkylmercaptopropionitriles (I).



The corresponding carboxylic acid,  $\beta$ -alkylmercaptopropionic acid (II), was obtained by alkaline hydrolysis of the nitrile, which in turn was oxidized to the  $\beta$ -alkylsulfonylpropionic acid (III) using potassium permanganate.



Cyanoethylation of mercaptans has been shown to proceed in high yield by Gershbein and Hurd<sup>4</sup> and Rapoport, Smith and Newman<sup>5</sup> have previously carried through the sequence of reactions listed above using octyl, nonyl and dodecyl mercaptans as the starting material. We have repeated the sequence using dodecyl mercaptan and in addition have prepared the series of compounds in which R = decyl and octadecyl. The procedure used was similar to that of Rapoport, Smith and Newman<sup>5</sup> except that strong alkali was used for hydrolysis of the nitrile instead of an acidic medium. The alkaline hydrolysis (I  $\rightarrow$  II) gave

(1) Hill and Fager, *THIS JOURNAL*, **65**, 2300 (1943).

(2) (a) Barry, O'Rourke and Twomey, *Proc. Roy. Irish Acad.*, **51B**, 223 (1947); (b) **51B**, 229 (1947).

(3) Bruson, "Organic Reactions," Vol. V, Roger Adams, ed., John Wiley and Sons, Inc., New York, N. Y., 1949, p. 95.

(4) Gershbein and Hurd, *THIS JOURNAL*, **69**, 241 (1947).

(5) Rapoport, Smith and Newman, *ibid.*, **69**, 693 (1947).

near quantitative yields of the alkylmercaptopropionic acid.

Rapoport, Smith and Newman<sup>5</sup> do not report a yield for the hydrolysis of  $\beta$ -dodecylmercaptopropionitrile to the corresponding acid but an overall yield from dodecyl mercaptan to the acid is reported as 62%. Using the basic hydrolysis, we have obtained an over-all yield of  $\beta$ -dodecylmercaptopropionic acid of 81% based on the starting mercaptan.

All of the compounds reported in this paper are being tested *in vitro* for antitubercular chemotherapeutic activity by the Eli Lilly Co. of Indianapolis, Indiana. We are grateful to Dr. Reuben G. Jones for arranging the tests.

We would also like to acknowledge the aid of the Research Corporation of New York for a Frederick G. Cottrell grant which supported a portion of this work.

#### Experimental

**$\beta$ -n-Decylmercaptopropionitrile.**—A mixture of 87 g. (0.5 mole) of *n*-decyl mercaptan<sup>6</sup> and 20 drops of a saturated solution of sodium ethoxide in ethanol was stirred while 53 g. (1.0 mole) of acrylonitrile was added in dropwise fashion over a period of 30 minutes. The reaction mixture was cooled during the addition of the acrylonitrile in order to maintain its temperature in the range of 40–50°. After standing for one hour the mixture was distilled. After removal of the excess acrylonitrile, 78.2 g. of  $\beta$ -n-decylmercaptopropionitrile was collected at 154–156° at 3 mm. pressure. This represented a yield of 69%. The index of refraction of the colorless liquid product was  $n_D^{25}$  1.4714.

*Anal.* Calcd. for  $C_{13}H_{25}NS$ : S, 14.1; N, 6.16. Found: S, 13.9; N, 5.91.

**$\beta$ -n-Decylmercaptopropionic Acid.**—A mixture of 22.7 g. (0.1 mole) of  $\beta$ -n-decylmercaptopropionitrile and a solution of 75 g. of sodium hydroxide in 175 ml. of water was stirred and refluxed until the evolution of ammonia became very slow (eight hours). The resulting solution was acidified with concentrated hydrochloric acid and cooled. The precipitated acid was filtered off and dried. It weighed 23.9 g. corresponding to a 98% yield. The solid acid could not be recrystallized from common solvents. Six grams of the acid was distilled at a pressure of 35 mm. and 4.2 g. of product was collected boiling at 210°. There was considerable decomposition during the distillation. The product was a white solid melting at 42–43°.

*Anal.* Calcd. for  $C_{13}H_{26}O_2S$ : neut. equiv., 246; S, 13.0. Found: neut. equiv., 246; S, 13.1.

**$\beta$ -n-Decylsulfonylpropionic Acid.**—A solution of 10 g. (0.0405 mole) of  $\beta$ -n-decylmercaptopropionic acid in a minimum amount of glacial acetic acid was treated with a 50% excess of a saturated aqueous solution of potassium permanganate in accordance with the method of Bost and Conn.<sup>7</sup> The reaction mixture was shaken thoroughly and allowed to stand overnight. Saturated aqueous sodium bisulfite solution was added until the mixture was decolorized. The resulting white solid was filtered off, washed thoroughly with water and recrystallized from acetone to yield 11 g. (97%) of  $\beta$ -n-decylsulfonylpropionic acid melting at 127–128°.

*Anal.* Calcd. for  $C_{13}H_{26}O_4S$ : neut. equiv., 278; S, 11.5. Found: neut. equiv., 286; S, 11.5.

The compounds listed below were prepared in general accordance with the procedures described above.

**$\beta$ -n-Dodecylmercaptopropionitrile**, b.p. 197–198° at 4 mm. pressure, m.p. 21°,  $n_D^{25}$  1.4709. This compound was prepared by Rapoport, Smith and Newman<sup>5</sup> but no physical constants reported. Harman<sup>8</sup> also reported this compound and a boiling point of 160–185° at 5 mm. was indicated.

(6) The *n*-decyl mercaptan was obtained from the Humphrey-Wilkinson Co. of New Haven, Conn.

(7) Bost and Conn, *THIS JOURNAL*, **62**, 1753 (1940).

(8) Harman, U. S. Patent 2,413,917 (to E. I. du Pont de Nemours and Co.), [C. A., **41**, 2447 (1947)].