filtered and concentrated *in vacuo* (water-pump) to a thick sirup. The sirup was diluted to about 250 cc. with acetone and stored at −10 to −15°. Crystallization occurred after several days; yield 5 g.

The product was recrystallized nineteen times from USP chloroform, by allowing 3% solutions to crystallize slowly at −15°.

The purified material was bitter tasting, somewhat hygroscopic, and crystallized as long fine needles which tended to form gels in most solvents. It was quite soluble at room temperature in water, alcohol, acetone, benzene, chloroform, ethyl acetate and carbon tetrachloride; it was more difficultly soluble in ether (USP). The optical rotation was $[\alpha]^{20}D$ +135.4 (H_2O, *c* 4). The capillary m.p. was 86–87°; on a heated stage using polarized light, the m.p. was 81–82°.

Anal. Calcd. for $C_{10}H_{20}O_6$: C, 50.83; H, 8.55. Found: C, 50.5, 50.4; H, 8.80, 8.89. (Analysis made by W. J. Barrett of the Southern Research Institute, Birmingham.)

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The S-Butyl Group in Alkylations. Preparation of Ethyl α-*s*-Butylacetonedicarboxylate

BY EVANS B. REID AND JOHN F. YOST

In connection with the synthesis of 3,5-di-*s*-butyl-*l*-cyclopentenealdehyde[1] various approaches were explored whereby it was hoped to synthesize α,α′-di-*s*-butylglutaric acid (auxin glutaric acid)[2] in quantities sufficient to permit the ultimate transformation of the latter into the appropriate ring system found in auxins a and b.[2] One of the most promising of these approaches appeared to be through the direct alkylation of ethyl acetonedicarboxylate by the Schroeter method.[3] The essential feature in this method is the slow addition of organic base (alkoxide) to a solution of the ester and two equivalents of alkyl halide. By this procedure Schroeter[3] was able to introduce two isopropyl groups into ethyl acetonedicarboxylate, though in poor yield. However there is no report of any attempt to alkylate this ester with the bulkier *s*-butyl group.

An attempted *dialkylation* using *s*-butyl iodide and sodium ethoxide according to Schroeter's directions resulted in the evolution of relatively large amounts of 2-butene. Moreover, when the product (which had been washed with an aqueous solution of sodium chloride) was vacuum distilled, considerable quantities of ethanol were eliminated. In spite of these undesirable by-products, however, a 14% yield of *mono-alkylated* ester was obtained. No evidence of di-alkylation could be found.

Experimentation showed that no 2-butane was evolved from a system containing ethanol, sodium ethoxide, ethyl acetonedicarboxylate and *s*-butyl iodide *provided* the temperature remained below 85° and the *p*H of the solution was not permitted to rise above 8.5. Increase of either temperature or *p*H above these values resulted in gas generation. Substitution of *s*-butyl bromide for the iodide required a higher reaction temperature and gave much 2-butene. It was also demonstrated that equally stringent conditions applied to the isolation of the alkylated ester. Traces of inorganic material, air, or nitrogen dried with calcium chloride rendered the vacuum distillation of the product erratic and resulted in the loss of ethanol.

Under optimum conditions a *mono-alkylation* experiment resulted in a 44% yield of ethyl α-*s*-butylacetonedicarboxylate, considerable tar and a crystalline substance which was identified as the tricarbethoxy resorcinol of Cornelius and von Pechmann[4] and Jerdan.[5] Formation of the latter compound is not encountered during dialkylations of this ester with primary alkyl halides, and its presence here in relatively large amounts is indicative of the inertia attendant upon alkylation with the *s*-butyl group.

When the mono-alkylated ester was treated again, under conditions of mild temperature and low *p*H, the product was a yellow slurry from which no pure compound could be isolated by distillation. A cursory study of this slurry indicated the presence of a mixture of salts. Likewise an attempted alkylation of the mono-alkylated ester under forcing conditions in benzene resulted in a complex mixture from which no dialkylated product could be obtained.

Finally it may be mentioned that attempted alkylation of ethyl 1,1,3,3-propanetetracarboxylate with *s*-butyl iodide was unsuccessful, as were attempts to couple diethyl *s*-butylmalonate with methylene iodide.

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Experimental

Ethyl α-*s*-Butylacetonedicarboxylate.—The optimum conditions for the alkylation consisted in adding a solution of 24 g. (1.05 moles) of sodium dissolved in 276 g. (6 moles) of absolute ethanol through a reflux condenser to a stirred solution of 202 g. (1.0 mole) of ethyl acetonedicarboxylate and 202 g. (1.10 moles) of *s*-butyl iodide in 100 g. of absolute ethanol. The rate of addition was such as to maintain the *p*H of the reactants at about 8.5. This required about 2.5 hours. The temperature of the reactants was maintained at about 80° during the addition of the base, and for an additional period of 6.5 hours. By this time the *p*H of the reactants was nearly 7, and only traces of 2-butene had formed (identified through its dibromide).[6] The alcohol was then removed under reduced pressure in a nitrogen atmosphere, and the residue was poured into ice-water. The ester layer was separated, and the aqueous layer was extracted with benzene. The combined ester and benzene extracts were washed with carbonate solution, dilute hydrochloric acid, and then several times with water. The wet benzene was removed by distillation under nitrogen at aspirator pressure, and the residue was distilled under nitrogen, at 0.10 mm., furnishing 114 g., or 44.2% of monoalkylated product, b.p. 108–110°. The product gave a positive enol (ferric chloride) test.

Anal. Calcd. for $C_{13}H_{22}O_6$: C, 60.4; H, 8.53. Found: C, 60.1; H, 8.48.

The residue from the vacuum distillation solidified to a yellow-brown slurry. The solid was obtained white by recrystallization from ethanol–water and from ligroin; m.p. 96.0–96.5°.

Anal. Calcd. for $C_{16}H_{20}O_8$; C, 56.6; H, 5.9. Found: C, 56.5; H, 6.0.

In all respects this enolic solid was similar to the compound $C_{16}H_{20}O_8$ obtained by Cornelius and von Pechmann[4] and by Jerdan[5] from the treatment of ethyl acetonedicarboxylate

(1) E. B. Reid and J. F. Yost, THIS JOURNAL, **72**, 5232 (1950).

(2) F. Kögl, H. Erxleben, R. Michaelis and H. S. Visser, *Z. physiol. Chem.*, **235**, 181 (1935).

(3) G. Schroeter, *Ber.*, **49**, 2697 (1916).

(4) H. Cornelius and H. von Pechmann, *Ber.*, **19**, 1446 (1886).

(5) D. S. Jerdan, *J. Chem. Soc.*, **75**, 808 (1899).

(6) A. Wurtz, *Ann.*, **144**, 234 (1867).

with sodium or sodium ethoxide at high temperatures. von Pechmann and Wolman[7] reported that their compound was transformed by potassium hydroxide fusion into an acid, m.p. 184° (dec.). Our product duplicated this behavior.

(7) H. von Pechmann and L. Wolman, *Ber.*, **31**, 2014 (1898).

THE CHEMICAL LABORATORIES
THE JOHNS HOPKINS UNIVERSITY
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4,4′-Tetramethyldiaminodiphenyl Ether

BY GEORGE A. REYNOLDS

4,4′-Tetramethyldiaminodiphenyl ether has been prepared in the following manner: Commercially available 4,4′-dinitrodiphenyl ether was reduced, using Raney nickel catalyst, to give the corresponding diamine. Alkylation of the diamine with methyl iodide yielded tetramethyldiaminodiphenyl ether melting at 61–62°. The product formed a picrate which melted at 174–175°.

Holzmann[1] prepared this compound by heating an alcoholic solution of 4,4′-tetramethyldiaminodiphenyl sulfide with two equivalents of alcoholic ammoniacal silver nitrate. Holzmann reported that his product melted at 119° and its picrate at 150°. Since these melting points are almost identical with those of tetramethyldiaminodiphenyl sulfide and its picrate, mixed melting points with authentic samples of the sulfide and its picrate, and analyses were made. The results showed beyond doubt that the compound reported by Holzmann as the ether was actually the starting material.

Experimental

4,4′-Diaminodiphenyl Ether.—4,4′-Dinitrodiphenyl ether (25 g., 0.01 mole) was dissolved in 200 ml. of absolute ethanol. About 5 g. (wet weight) of Raney nickel was added and the mixture reduced in the Parr apparatus at 50 p.s.i. and 75°. The theoretical drop in pressure took place in approximately 30 minutes. The mixture was filtered hot and the filtrate allowed to cool. The product was collected on a Buchner funnel and air-dried (m.p. 186–187°; reported m.p. 186–187°[2]). The yield was 18 g. (90%).

4,4′-Tetramethyldiaminodiphenyl Ether.—A mixture of 11 g. (0.055 mole) of 4,4′-diaminodiphenyl ether, 31 g. (0.22 mole) of methyl iodide and 8.8 g. (0.22 mole) of sodium hydroxide in 9 ml. of water was placed in a pressure tube and the tube sealed. The sealed tube was heated at 100° for 12 hours. The reaction mixture was poured onto 100 ml. of water and the solid collected on a Buchner funnel. Recrystallization from dilute ethanol gave a compound which melted at 61–62° (7 g., 50%).

Anal. Calcd. for $C_{16}H_{20}N_2O$: C, 75.0; H, 7.9; N, 10.9. Found: C, 75.2; H, 8.0; N, 11.0.

The product formed a picrate which, after recrystallization from ethanol, melted at 174–175°.

Anal. Calcd. for $C_{28}H_{26}N_8O_{15}$: N, 15.2. Found: N, 15.0.

Compound Obtained by Holzmann's Method.—Tetramethyldiaminodiphenyl sulfide (20 g., 0.074 mole) reacted with ammoniacal silver nitrate as described by Holzmann.[1] The product obtained by this method melted at 118° after three recrystallizations from ethanol (reported m.p. 119°).[1] Admixture with a sample of tetramethyldiaminodiphenyl sulfide produced no depression in the melting point. Analysis of the compound showed that the starting material had been recovered.

Anal. Calcd. for $C_{16}H_{20}N_2S$: C, 70.4; H, 7.4; N, 10.3; S, 11.8. Found: C, 70.8; H, 7.4; N, 10.2; S, 12.0.

The compound formed a picrate melting at 147° (reported m.p. 150°).[1] Analysis showed this to be the picrate of the starting sulfide.

Anal. Calcd. for $C_{28}H_{26}N_8O_{14}S$: N, 15.4. Found: N, 15.5.

(1) E. Holzmann, *Ber.*, **21**, 2056 (1888).
(2) C. Haeussermann and H. Teichmann, *ibid.*, **29**, 1449 (1896).

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A Synthesis of Unsymmetrical Dimethyl Hydrazine Using Lithium Aluminum Hydride

BY F. W. SCHUELER AND CALVIN HANNA

During the course of synthesizing a group of hydrazonium analogs related to acetylcholine[1] it was found that the laborious reduction of nitrosodimethylamine by zinc and acetic acid which involves subsequent steam distillation and evaporation[2] could be avoided through the use of lithium aluminum hydride in the reduction procedure.

Experimental

To 5.0 g. of lithium aluminum hydride in 150 ml. of dry ether was added slowly a solution of 5.0 g. of nitrosodimethylamine[2] in 100 ml. of absolute ether. After setting one hour wet ether was added to decompose the reaction mixture. To the resultant mixture was then added 75 ml. of 30% sodium hydroxide with stirring and the alkaline solution separated and washed three times with 50-ml. portions of ether. To the combined ether extracts, following filtration, was added 100 ml. of 20% hydrochloric acid solution with agitation and the whole was subsequently evaporated *in vacuo* to a thick sirup on the steam-bath. From this point on the procedure outlined by Hatt[2] was followed in the preparation of the anhydrous base.

Yield of the anhydrous base was 3.1 g. (78%) which formed a methiodide exhibiting no depression of the melting point when mixed with an authentic sample.[3,4]

An attempt was made to apply the above procedure toward the preparation of *unsym*-diphenylhydrazine through the reduction of nitrosodiphenylamine. To 5.0 g. of lithium aluminum hydride in 150 ml. of dry ether was added slowly a solution of 6.6 g. of nitrosodiphenylamine in 100 ml. of absolute ether. The attempted isolation of the hydrazine following the procedure outlined by Fischer[5] yielded only diphenylamine 4.1 g. (74%), m.p. 34.0°. A mixed melting point with an authentic sample of diphenylamine exhibited no lowering. The acetyl derivative melting at 101° likewise exhibited no depression when mixed with an authentic sample of the acetyl derivative of diphenylamine.

(1) F. W. Schueler and Calvin Hanna, *Arch. Internat. Pharmacodyn. Therapie*, in press (1951).
(2) "Organic Syntheses," Coll. Vol. II, John Wiley and Sons, Inc., New York, N. Y., 1943, p. 250.
(3) C. Harris and T. Haga, *Ber.*, **31**, 57 (1898).
(4) E. Fischer, *Ann.*, **199**, 316 (1879).
(5) E. Fischer, *ibid.*, **190**, 175 (1878).

DEPARTMENT OF PHARMACOLOGY
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Dimethyl *p*-Ethylbenzenephosphate

BY RICHARD H. WILEY AND CHARLES HARRY JARBOE[1]

A search of the literature has failed to disclose any reference to the preparation or characterization of esters of *p*-ethylbenzenephosphonic acid. We have prepared and characterized the dimethyl ester. This Note presents the data observed. A study of the yields obtained in the preparation of *p*-ethylbenzenephosphine dichloride and some useful modifications in the experimental procedures for con-

(1) This work was supported in part under Contract No. AT-(40-1)-229 between the Atomic Energy Commission and the University of Louisville. This note is taken from an Honors thesis submitted by Charles Harry Jarboe.