solvent. A small amount of the chloride is run into the flask and the mixture is gradually heated until a sharp rise in temperature takes place, indicating that the reaction has started. (*Caution:* The reaction must get started before a large amount of the chloride has been added or an explosion may result.) More halide is then slowly added, keeping the mixture at the temperature at which the reaction started. At the end of the addition the mixture is decomposed with dilute hydrochloric acid, washed, dried and the hydrocarbon distilled from the solvent through a column. A second distillation gives a product boiling over a range of 1 to 2°. A considerable amount of gas or a low-boiling fraction is always obtained, either during the reaction or the distillation. This was not investigated but is probably a mixture of saturated and unsaturated hydrocarbons.

Summary

1. Improvements in the preparation and manipulation of zinc alkyls are given.

2. The zinc alkyls have been used to prepare a number of hydrocarbons of the type R_4C.

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS]

THE CLEAVAGE OF DIETHYL ALPHA,ALPHA'-DIBROMO-ADIPATE BY SECONDARY AMINES[1]

BY REYNOLD C. FUSON AND RAYMOND L. BRADLEY

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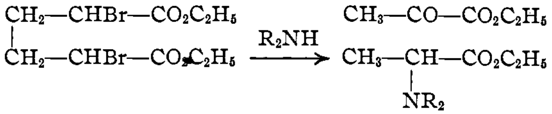
It has been shown by von Braun, Leistner and Münch[2] that diethyl α,α'-dibromo-adipate when treated with certain secondary amines is cleaved in such a way as to give ethyl pyruvate and an amino ester reported by them to be ethyl α-dialkylaminopropionate.



$$\begin{array}{l} \mathrm{CH_2{-}CHBr{-}CO_2C_2H_5} \\ | \\ \mathrm{CH_2{-}CHBr{-}CO_2C_2H_5} \end{array} \xrightarrow{\mathrm{R_2NH}} \begin{array}{l} \mathrm{CH_3{-}CO{-}CO_2C_2H_5} \\ \mathrm{CH_3{-}CH{-}CO_2C_2H_5} \\ \qquad | \\ \qquad \mathrm{NR_2} \end{array}$$

They reported that diethylamine, di-*n*-propylamine, copellidine and di-*iso*-amylamine produce the same type of cleavage, yielding in each case ethyl pyruvate and an α-dialkylaminopropionic ester. This list has subsequently been extended by von Braun, Jostes and Wagner[3] to include a number of similar amines of this class. Dimethylamine and piperidine, however, gave no cleavage but were found to react normally to give the corresponding tetra-alkyldiamino-adipic esters.

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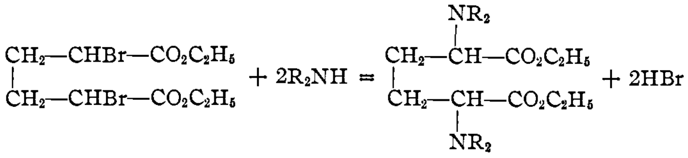
[1] This work was presented before the Midwest Regional Meeting of the American Chemical Society at Minneapolis, June 9, 1928.

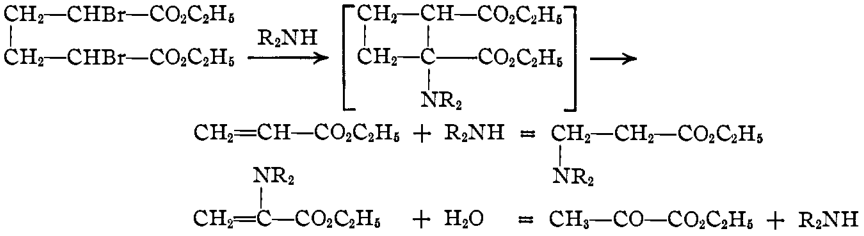
[2] Von Braun, Leistner and Münch, *Ber.*, **59B**, 1950 (1926).

[3] Von Braun, Jostes and Wagner, *ibid.*, **61B**, 1423 (1928).



$$\begin{array}{l} CH_2-CHBr-CO_2C_2H_5 \\ | \\ CH_2-CHBr-CO_2C_2H_5 \end{array} + 2R_2NH = \begin{array}{l} \quad\;\; NR_2 \\ \quad\;\; | \\ CH_2-CH-CO_2C_2H_5 \\ | \\ CH_2-CH-CO_2C_2H_5 \\ \quad\;\; | \\ \quad\;\; NR_2 \end{array} + 2HBr$$

In a recent paper Fuson[4] presented a mechanism to explain the apparently novel type of chain rupture, assuming the formation of a cyclobutane derivative as an intermediate compound.



$$CH_2{=}CH-CO_2C_2H_5 + R_2NH = \begin{array}{l} CH_2-CH_2-CO_2C_2H_5 \\ | \\ NR_2 \end{array}$$

$$\begin{array}{l} \quad\;\; NR_2 \\ \quad\;\; | \\ CH_2{=}C-CO_2C_2H_5 \end{array} + H_2O = CH_3-CO-CO_2C_2H_5 + R_2NH$$

It was pointed out that a dissociation of this hypothetical intermediate into two molecules of ethylenic character, a type of reaction characteristic of cyclobutane derivatives, would yield, respectively, ethyl acrylate and ethyl α-dialkylamino acrylate. The former would be expected to combine with a molecule of the dialkylamine to give ethyl β-dialkylaminopropionate; the acrylic ester would be hydrolyzed to ethyl pyruvate.

The proposed mechanism agreed with the findings of von Braun, Leistner and Münch except in that it postulated the formation of β-dialkylpropionic esters instead of the α-esters reported. This difficulty was cleared away when it was shown that in the reaction between diethyl-α,α-dibromoadipate and diethylamine the amino ester obtained is actually ethyl β-diethylaminopropionate and not the α as reported by von Braun and his co-workers.[3]

The importance of this point in relation to the theory is such that it has been checked also in the case of di-*n*-propylamine. As was to be expected, ethyl β-di-*n*-propylaminopropionate was obtained and not the corresponding α-ester. The position of the amino group was established as in the previous case by a mixed melting-point determination of the methiodide of the amino ester with that of the authentic specimen. The amount of cleavage in the case of di-*n*-propylamine was 85%.

Von Braun and his co-workers believe that the tendency of a given amine to produce the cleavage is dependent on the form of the amine. Thus they point out that while piperidine does not produce cleavage the pipecolines and copellidine do so. This, they say, is because piperidine is dish-shaped and may be inserted into the adipic ester molecule without

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[4] Fuson, This Journal, **50**, 1444 (1928).

disrupting it. Amines which cause cleavage do so, it is asserted, because of their more three-dimensional form.

On the basis of the proposed cyclobutane mechanism for the cleavage, it is difficult to understand why the slight difference between piperidine and the pipecolines should have such a profound effect on the tendency to cause cleavage. The action of piperidine has, therefore, been re-examined.

It has been shown that, contrary to the findings of von Braun and his students, cleavage takes place, giving in addition to the diethyl α,α'-dipiperidino-adipate reported by them the cleavage products ethyl pyruvate and ethyl-β-piperidinopropionate. The former, owing presumably to the fact that it is readily hydrolyzed by water, was obtained in a relatively small amount. The yield of ethyl-β-piperidinopropionate, however, was 75% of the theoretical. It was proved to be the β- and not the α-amino ester by comparing its methiodide with an authentic specimen.

Experimental

Meso-diethyl-α,α'-dibromo-adipate and Di-_n_-propylamine.—The method of von Braun, Leistner and Münch[2] was used. A mixture of 36 g. (0.1 mole) of _meso_-diethyl-α,α'-dibromo-adipate and 60.6 g. (0.6 mole) of di-_n_-propylamine was heated gently until reaction had begun. The reaction was allowed to proceed under its own heat until it had moderated somewhat. The mixture was then heated for five hours on the steam-bath, cooled and shaken with ether and excess dilute hydrochloric acid. The ether layer was removed, dried over sodium sulfate and distilled. Only a small amount of ethyl pyruvate was obtained.

The aqueous layer was made alkaline with sodium hydroxide and extracted thoroughly with ether. The ether extract was dried over sodium sulfate and distilled. The ethyl-β-di-_n_-propylaminopropionate distilled at 112–114° (20 mm.). (This base was prepared by von Braun, Leistner and Münch, who identified it as ethyl-α-di-_n_-propylaminopropionate. They reported a boiling point of 102–104° (12 mm.) for the base and a melting point of 76° for its methiodide.) The yield was 15 g. or 85% of the theoretical. The identity of the ethyl-β-di-_n_-propylaminopropionate obtained was confirmed by means of a mixed melting-point determination. When its methiodide was mixed with that of an authentic specimen of the base (preparation described below) there was no depression of the melting point.

Ethyl-β-di-_n_-propylaminopropionate.—Ten g. of di-_n_-propylamine dissolved in dry benzene was treated with 3 g. of ethyl-β-chloropropionate. The mixture was heated on the steam-bath for an hour, cooled and washed with water to remove the di-_n_-propylamine hydrochloride. The benzene solution was dried and distilled. The ethyl-β-di-_n_-propylaminopropionate boiled at 112–114° (20 mm.). Its methiodide melted at 76°.

Meso-diethyl-α,α'-dibromo-adipate and Piperidine.—The method of von Braun and Münch[5] was used but inasmuch as the results were considerably different, the exact procedure is indicated. Thirty g. of _meso_-diethyl-α,α'-dibromo-adipate was heated under reflux for one and one-half hours with 50 g. of piperidine. The reaction was very vigorous and the flask had to be cooled somewhat at the beginning. The reaction products were isolated in the manner indicated above in the experiment with di-_n_-propylamine. Only a small amount of ethyl pyruvate was isolated. It was identified

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[5] Ref. 2. p. 1947.

by means of a mixed melting-point determination with its phenylhydrazone (m. p. 118°) and that of an authentic specimen of ethyl pyruvate.

Of the basic product twelve g. distilled at 114–116° (22 mm.) and was shown (see below) to be ethyl-β-piperidinopropionate; yield, 75% of the theoretical; d_{20}, 0.927.

Anal. Calcd. for $C_{10}H_{19}O_2N$: C, 64.85; H, 10.35. Found: C, 64.6; H, 10.0.

The methiodide melted at 100–102°. A mixed melting-point determination with the methiodide prepared from a known sample of the piperidino ester, whose preparation is described below, served to identify the compound.

The residue from the distillation proved to be diethyl-α,α′-dipiperidino-adipate. Four g. of this compound was isolated. After four recrystallizations from ether and one from petroleum ether the compound melted sharply at 94° (von Braun and Münch give 99° as the melting point).

Anal. Calcd. for $C_{20}H_{36}O_4N_2$: C, 65.2; H, 9.8. Found: C, 65.3; H, 9.8.

Ethyl-β-piperidinopropionate.—Seventeen g. of piperidine dissolved in 50 g. of dry benzene was refluxed with 6 g. of ethyl-β-chloropropionate. The product distilled at 113–116° (22 mm.). The methiodide melted at 100–102°.

Summary

Meso-diethyl-α,α′-dibromo-adipate is cleaved by piperidine to give a 75% yield of ethyl-β-piperidinopropionate.

Di-*n*-propylamine gives ethyl-β-di-*n*-propylaminopropionate in a yield of 85%.

The identity of ethyl-β-piperidinopropionate and of ethyl-β-di-*n*-propylaminopropionate has been established by mixed melting-point determinations of the methiodides with authentic specimens.

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE COLLEGE OF LIBERAL ARTS, NORTHWESTERN UNIVERSITY]

THE REPLACEMENT OF CARBOXYL BY MERCURY IN CERTAIN 3-SUBSTITUTED PHTHALIC ACIDS. PRELIMINARY PAPER

BY FRANK C. WHITMORE AND PAUL J. CULHANE

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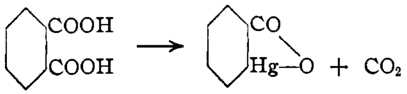
It has long been known that the treatment of phthalic acid with mercuric acetate gives an *o*-mercurated benzoic acid.[1] The present study was



undertaken to determine the mechanism of the mercuration and to find the effect of substituents on the reaction.

The first step in the reaction is the formation of an insoluble mercuric salt, as is the case in the mercuration of benzoic acid. The mercuric phthalate may then lose carbon dioxide with the replacement of the carboxyl by mercury. Another alternative is that the mercuric salt under

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[1] Pesci, *Atti accad. Lincei*, [5] **10**, 1, 362 (1901).