SYNTHESIS OF DIETHYL β-METHYL-α, γ-DICYANOGLUTACONATE.

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Diethyl β-methyl-α, γ-dicyanoglutaconate could not be obtained by the reaction of ethyl sodio-cyanoacetate and ethyl α-cyanoacetoacetate.(1) The formation of the same substance can not be expected in the reaction of methylchloroform with ethyl cyanoacetate in the presence of sodium ethylate, for it is known that methylchloroform does not react with diethyl malonate in the presence of sodium ethylate.

The condensation of ethyl ethoxy-ethylidene-cyanoacetate (ethyl β-ethoxy-α-cyanocrotonate) $CH_3{\cdot}C(OC_2H_5)=C(CN)COOC_2H_5$ with ethyl sodio-cyanoacetate has been tried with success. In this reaction diethyl α-sodio-β-methyl-α, γ-dicyanoglutaconate is produced according to the following equation:

$$\begin{aligned}&C_2H_5OCO(CN)CHNa+C_2H_5OC(CH_3)=C(CN)COOC_2H_5\\ &= C_2H_5OCO(CN)CNa\text{–}C(CH_3)=C(CN)COOC_2H_5+C_2H_5OH,\end{aligned}$$

and from it diethyl β-methyl-α, γ-dicyanoglutaconate $C_2H_5OCO(CN)CH\text{-}C(CH_3)=C(CN)COOC_2H_5$ is obtained by the action of dilute hydrochloric acid.

In a previous paper(2) the author described the synthesis of the nitrile-esters of dicarboxyglutaconic acid by similar condensations, in which ethoxy-methylene compounds were used instead of the ethoxy-ethylidene compound. Thus it has been ascertained that the reaction represented by the following general equation can take place:

$$XYCHNa+ROCR'=CX'Y' = XYCNa\text{–}CR'=CX'Y'+ROH,$$

where R represents any alkyl group, R′ hydrogen or any alkyl group, and X,X′,Y,Y′ negative groups such as CN or $COOC_2H_5$. It seems possible that the other nitrile-esters of β-methyldicarboxyglutaconic acid will be synthesized by the similar method.

In a previous paper(3) it was shown that the diethyl α-sodio-α, γ-dicyanoglutaconate $C_2H_5OCO(CN)C=CH\text{–}CNa(CN)COOC_2H_5$ does not yield the corresponding free nitrile-ester on acidifying its aqueous solution, but a semihydrate with the formula $(C_{10}H_{12}O_4N)\text{–}C(=NH)\text{–}NH\text{–}CO\text{–}(C_{10}H_{12}O_4N)$ is precipitated as yellow crystals. G. Errera and F. Perciabosco(4) showed that the sodium derivative of triethyl dicyanoaconitate $C_2H_5OCO(CN)C=C(COOC_2H_5)\text{–}$

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(1) This journal, 2 (1927), 305.

(2) This journal, 2 (1927), 278.

(3) This journal 2 (1927), 28.

(4) *Ber.*, **34** (1901), 3704.

$CNa(CN)COOC_2H_5$ is transformed into a semihydrate on acidifying its aqueous solution. But the hydration does not take place in the β-methyl compound, i. e. diethyl β-methyl-α, γ-dicyanoglutaconate, as described above.

The compound, represented by the formula $C_2H_5OC(CH_3)=C(CN)-COOC_2H_5$ and designated with the name of ethyl ethoxy-ethylidene-cyanoacetate, is already known as ethyl β-ethoxy-α-cyanocrotonate and synthesized by the action of ethyl iodide on the silver derivative of ethyl α-cyano-acetoacetate.⁽¹⁾ The author has obtained the same substance by the condensation of triethyl orthoacetate with ethyl cyanoacetate by means of acetic anhydride, a reaction analogous to those in which ethoxy-methylene compounds are formed,⁽²⁾ and has ascertained that the ortho-ester can generally condense with methylene compounds such as ethyl cyanoacetate according to the following equation:

$R'C(OR)_3 + CH_2XY + 2(CH_3CO)_2O \;=\; ROCR'=CXY + 2CH_3CO_2R + 2CH_3CO_2H$, where R represents any alkyl group, R′ hydrogen or any alkyl group, and X,Y negative groups such as CN or $COOC_2H_5$.

Condensation of Triethyl Orthoacetate and Ethyl Cyanoacetate by means of Acetic Anhydride. — Preparation of Ethyl Ethoxy-ethylidene-cyanoacetate. The mixture of triethyl orthoacetate, ethyl cyanoacetate, and acetic anhydride in the proportion of 1 mol: 1 mol: 2mols is heated in a flask with a reflux condenser. The cooling water is stopped from running and a tube bent downwards is attached to the top of the condenser, so that the reflux condenser separates acetic anhydride from ethyl acetate formed during the reaction, when the cooling water is sufficiently warm, and the ethyl acetate is cooled to condense in the bent tube and can be collected. When ethyl acetate reaches the required quantity, and distils no more, the content of the flask is distilled at first under the ordinary pressure and then under diminished pressure. The portion distilling at 152.5° under the pressure of 7 mm. is collected. Otherwise the residue in the flask may be recrystallised from alcohol after acetic anhydride and unchanged esters have been driven off by vacuum distillation.

Ethyl ethoxy-ethylidene-cyanoacetate prepared by the above method is colourless crystals, contains 7.66% of nitrogen (the formula requires $N = 7.65\%$), and, when recrystallised from alcohol a few times, melts at 74–75°. This is the same as ethyl ethoxy-cyanocrotonate synthesized by Haller, and is formed according to the following equation:

$$\begin{gathered}CH_3C(OC_2H_5)_3 + CH_2(CN)COOC_2H_5 + 2\,(CH_3CO)_2O \;=\\ CH_3C(OC_2H_5)=C(CN)COOC_2H_5 + 2\,CH_3CO_2C_2H_5 + 2\,CH_3CO_2H.\end{gathered}$$

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(1) Haller, *Compt. rend.*, **130** (1900), 1223.

(2) *Ann.*, **297** (1897), 1; *Bull, soc. chim.*, [3], **25** (1901), 21.

Condensation of Ethyl Ethoxy-ethylidene-cyanoacetate with Ethyl Sodiocyanoacetate.—Synthesis of Diethyl β-Methyl-α, γ dicyanoglutaconate. Ethyl ethoxy-ethylidene-cyanoacetate prepared by the above method was added to the equivalent amount of ethyl sodio-cyanoacetate in absolute alcohol. The clear reddish yellow solution was allowed to crystallise at the room temperature. The crystalline substance was collected and recrystallised from absolute alcohol. 0.1875 Gr. of the substance gave 16.85 c. c. of nitrogen at 14°, 758.2 mm. (Found: N=10.50. $C_{12}H_{13}O_4N_2Na$ requires N=10.29%.) This compound is diethyl α-sodio-β-methyl-α, γ-dicyanoglutaconate and the condensation is represented by the equation indicated in page 103.

The sodium compound is nearly colourless and very easily soluble in water. The aqueous solution deposited an oily substance on acidifying with dilute hydrochloric acid. This oil was taken with ether, but when the ether was driven away from the solution, it did not remain colourless for a long time and changed into a red crystalline mass. For this reason it was impossible to ascertain the formula of this compound by analysis. (Found: C=56.57,55.91; H=5.68,5.62; N=11.05,11.04. $C_{12}H_{14}O_4N_2$ requires C=57.58; H=5.64; N=11.20%.) That this substance is not a semihydrate is evident from the following facts: (I) It is precipitated immediately when the aqueous solution of the sodium derivative is acidified, and (II) it is soluble in ether.⑴ This is diethyl β-methyl-α, γ-dicyanoglutaconate with the formula $C_2H_5OCO(CN)CH{-}C(CH_3){=}C(CN)COOC_2H_5$.

A silver derivative was obtained in colourless fine crystals when equivalent amounts of the sodium compound and of silver nitrate were mixed in aqueous solutions. It was purified by recrystallisation from alcohol. 0.2953 Gr. of the silver compound gave 0.4319 gr. of CO_2 and 0.0927 gr. of H_2O; 0.2806 gr. of the substance gave 0.4095 gr. of CO_2 and 0.0882 gr. of H_2O; 0.3626 gr. of the substance gave 24.25 c. c. of nitrogen at 15°, 769.3 mm. (Found: C=39.90, 39.81; H=3.51, 3.52; N=7.89. $C_{12}H_{13}O_4N_2Ag$ requires C=40.34; H=3.67; N=7.84%.) These numbers show that the substance could not be perfectly purified by recrystallisation from alcohol.

Another specimen of diethyl sodio-β-methyl-dicyanoglutaconate was prepared by the condensation of ethyl sodiocyanoacetate with ethyl ethoxy-ethylidene-cyanoacetate (ethyl ethoxycyanocrotonate) synthesized from the silver derivative of ethyl cyanoacetoacetate and ethyl iodide, and it was converted into the silver derivative, which was recrystallised from alcohol. 0.2962 Gr. of the substance gave 0.4358 gr. of CO_2 and 0.0948 gr. of H_2O; 0.3449 gr. of the substance gave 23.4 c. c. of nitrogen at 13°, 755.5 mm. (Found: C=40.14; H=3.58; N=7.85. $C_{12}H_{13}O_4N_2Ag$ requires

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(1) Cf. this journal, 2 (1927), 29.

C=40.34; H=3.67; N=7.84%.) The latter specimen seems to be purer than the former, and it is probable that the impurity causing the deviation of the analytical result in the former came from the starting substance, i. e. ethyl ethoxyethylidene-cyanoacetate.

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