and the intrinsic viscosity, H_0. The values of M_n and H_0 are experimentally determined, as is M_z for the first solution. The other quantities are calculated on the basis of our picture.

TABLE I

PHYSICO-CHEMICAL CHARACTERISTICS OF DEGRADED GELATINS

	α	c_p	M_n	M_w/M_n -1	M_z/M_n -1	H_0 at 55°
A	0.00120	0.244	45,700	0.61	0.92	0.47
B	.00175	.129	36,000	.73	1.17	.36
C	.00227	.071	30,000	.81	1.38	.31
D	.00409	.008	19,000	.92	1.59	.18
E	.00540	.002	15,000	.96	1.82	.14

The quantity $(M_z/M_n - 1)$ is a good measure of the size spread. If all the molecules are of the same size, it is zero, and for random splitting of an infinitely long chain, it becomes two. The ratio $(M_w/M_n - 1)$, which increases from zero to one, could also serve. As the fraction of parent molecules decreases, the size spread increases to approach that which would be obtained from infinitely long parent molecules.

Figure 1 shows the size distribution in another way for the same five solutions. The abscissas are molecular weight and the ordinates are the weight fraction of the solute with molecular weights greater than the abscissa, calculated by summing weight fractions from c_{i+1} to c_p. The length of the ordinate at the end of the curve is c_p. For all the curves, about 25% of the material has a molecular weight less than the number average, and about 40% has a molecular weight greater than twice the number average. If the abscissas were given as multiples of M_n, the curves would be very similar except that each would be lopped off at a different point.[7]

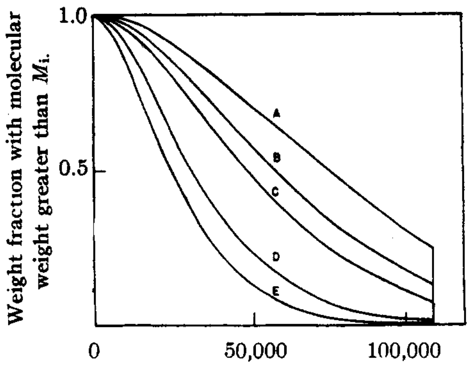


Fig. 1.

Our studies of calfskin and porcine gelatins are as yet less complete. They show no great difference from ossein gelatin. However, we have not yet measured any quantity which depends greatly upon the size of the parent molecule.

[7] A similar picture, which assumes parent molecules so long that they could be taken as infinite, is inconsistent with the measurements of ultracentrifuge equilibrium and double refraction of flow in thiocyanate solution but explains successfully the practically important quantities such as the rate of hydrolysis, the viscosity, sedimentation and diffusion.

RECEIVED OCTOBER 7, 1944

NOTES

m-Trifluoromethylphenyllithium and its Addition to Some Quinolines

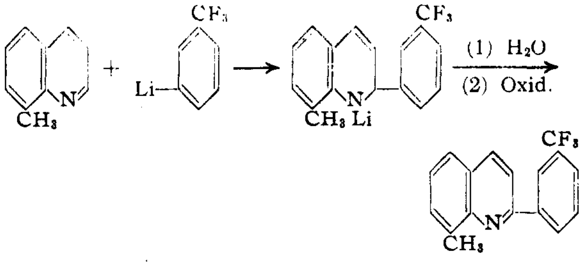
BY HENRY GILMAN AND LAUREN A. WOODS

In connection with the pharmacological examination of some fluorine-containing heterocycles, a need arose for a reactive organometallic compound containing a trifluoromethyl group which would add directly to the azomethylene group of heterocycles like quinoline.

m-Trifluoromethylphenyl bromide does not react under conventional conditions with metallic lithium. However, the desired organolithium compound is conveniently prepared by a halogen-metal interconversion reaction with *n*-butyllithium.

m-$CF_3C_6H_4Br$ + *n*-C_4H_9Li → *m*-$CF_3C_6H_4Li$ + *n*-C_4H_9Br.—It is interesting to note that the smooth formation of a Grignard reagent[1] from *m*-trifluoromethylphenyl bromide is another illustration of the complementary use of magnesium and lithium: some RX compounds which do not react smoothly with one of these metals do react with the other.[2]

The resulting *m*-trifluoromethylphenyllithium adds to the azomethylene group in quinoline and 8-methylquinoline to give the corresponding 2-trifluoromethylphenyl derivatives in satisfactory yields.



This supplements a procedure described recently[3] in which an organolithium compound was

[1] Simons and Ramler, THIS JOURNAL, **65**, 389 (1943).

[2] Gilman, Zoellner and Selby, *ibid.*, **55**, 1252 (1933).

[3] Gilman and Blume, *ibid.*, **65**, 2467 (1943).

added to a quinoline compound containing the trifluoromethyl group.

m-Trifluoromethylphenyllithium.—To a solution of 13.5 g. (0.06 mole) of m-trifluoromethylphenyl bromide in 35 cc. of ether cooled by an ice-bath was added with stirring and over a one hour period, a. solution of 0.067 mole of n-butyllithium in 140 cc. of ether. The solution was stirred at the temperature of the ice-bath for two hours and then allowed to stand for one hour at room temperature. Color test I[4] was strong, and color test II[5] was weak. Carbonation, by pouring on a dry ice–ether slurry, followed by hydrolysis, yielded 7.1 g. (62.2%) of m-trifluoromethylbenzoic acid[6] melting at 97.5–99.5°. When the interconversion reaction with n-butyllithium was carried out at the reflux temperature of ether, the acid obtained was very impure.

In another preparation under the same conditions, 0.59 mole of n-butyllithium in 760 cc. of ether reacted with 130 g. (0.58 mole) of m-trifluoromethylphenyl bromide in 200 cc. of ether. This preparation gave a strong color test I and a negative color test II. This solution, in which a 70% yield of the RLi compound was assumed, was used in the following reactions.

2-(m-Trifluoromethylphenyl)-quinoline.—A solution of 0.2 mole of m-trifluoromethylphenyllithium in 500 cc. of ether was added during one hour to a stirred solution of 25.8 g. (0.2 mole) of quinoline in 50 cc. of ether. After heating at reflux for three hours, the mixture was hydrolyzed by pouring upon 200 g. of ice. The ether layer was separated and mixed with 25 cc. of nitrobenzene. After removal of the ether by distillation, the residue was refluxed gently for twenty minutes. Distillation under reduced pressure gave 37.2 g. (68.2%) of yellowish 2-(m-trifluoromethylphenyl)-quinoline which boiled at 142–144° (1–2 mm.), from a bath heated at 172–178°. The compound crystallized after standing at room temperature for several days, and recrystallization from 95% ethanol gave a product melting at 51–52°. The compound is quite soluble in 95% ethanol, methanol, benzene, chloroform, and acetone, but insoluble in 10% hydrochloric acid.

Anal. Calcd. for $C_{16}H_{10}F_3N$: N, 5.13. Found: N, 5.05 and 5.07.

2-(m-Trifluoromethylphenyl)-8-methylquinoline.—A solution of 0.2 mole of m-trifluoromethylphenyllithium in 500 cc. of ether was added during twenty-five minutes to a stirred solution of 28.6 g. (0.2 mole) of 8-methylquinoline in 50 cc. of ether. The subsequent operations were like those used in the reaction with quinoline, the mixture with nitrobenzene being heated for one hour in a bath at 120°. Distillation at 145–147° (1–2 mm.), from a bath heated at 178–185°, yielded 41.3 g. (72%) of a reddish-yellow oil soluble in 95% ethanol, methanol, chloroform, and benzene, but insoluble in 10% hydrochloric acid; n^{20}_D 1.5406 and d^{20}_4 1.1475.

Anal. Calcd. for $C_{17}H_{12}F_3N$: N, 4.88. Found: N, 4.85.

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[4] Gilman and Schulze, THIS JOURNAL, **47**, 2002 (1925).

[5] Gilman and Swiss, *ibid.*, **62**, 1847 (1940).

[6] Swarts, *J. Chim. Phys.*, **17**, 32 (1919).

DEPARTMENT OF CHEMISTRY
IOWA STATE COLLEGE
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Synthesis of Stilbenecarboxylic Acids

BY GEORGE P. HAGER, A. M. VANARENDONK AND H. A. SHONLE

An investigation was undertaken to provide a satisfactory method for the preparation of certain stilbenecarboxylic acids, since methods reported in the literature are of limited applicability and are not satisfactory for the preparation of the compounds herein described.

A procedure by which 4,4′- and 2,4′-dicyanostilbenes readily can be prepared has been described.[1] It was found that these nitriles are quite resistant to acid or alkaline hydrolysis by the usual methods. The 4,4′-dicyanostilbene was readily converted into the corresponding di-imino ether hydrochloride.[2] When this was heated with water on a steam-bath, it was converted into ethyl 4,4′-stilbenedicarboxylate. This ester was readily hydrolyzed to the acid.

As previously reported,[1] 2,4′-dicyanostilbene yielded only a mono-imino ethyl ether hydrochloride, the cyano group in position 2 having failed to react. Moreover, the cyano ester, resulting on hydrolysis, could not be converted into an imino ethyl ether. The 2,4′-dicyanostilbene was hydrolyzed by acid to 2-cyano-4′-stilbenecarboxylic acid. Further hydrolysis with alkali produced the desired 2,4′-stilbenedicarboxylic acid.

Experimental Part

Diethyl 4,4′-Stilbenedicarboxylate.—4,4′-Dicyanostilbene, prepared from dibenzyl by means of bromination and treatment of the 4,4′,α,α′-tetrabromodiphenylethane with cuprous cyanide and pyridine,[1] was converted in 30-g. lots into the di-imino ethyl ether hydrochloride.[2] The imino ether hydrochloride was suspended in three times its weight of water and heated with stirring on a steam-bath for one hour or until a portion of the fluffy white solid, after washing with water, was shown to be free of nitrogen. The crude ester was filtered from the chilled reaction mixture and recrystallized from 95% alcohol or isopropyl ether. By this means a 67% yield (based on dinitrile) of colorless needles, m. p. 130–131°, was isolated.

Anal. Calcd. for $C_{20}H_{20}O_4$: C, 74.1; H, 6.2. Found: C, 74.1; H, 6.3.

The dimethyl ester, similarly prepared, was found to be far less soluble in organic solvents, and to crystallize in small plates from methyl alcohol, m. p. 227–228°. This compound was previously reported to melt at 226–227°.[3]

4,4′-Stilbenedicarboxylic Acid.—The dimethyl or diethyl ester was hydrolyzed by refluxing with 10% sodium hydroxide in ethylene glycol. In a typical run, a suspension of 12 g. of the diethyl ester in a mixture of 200 cc. of ethylene glycol, 50 cc. of water and 25 g. of sodium hydroxide, was refluxed for six hours. The reaction mixture was diluted with 2 liters of water and boiled with 10 g. of charcoal for fifteen minutes. After filtering, the free acid was precipitated with concentrated hydrochloric acid. The gelatinous precipitate was rendered filterable by heating the mixture on a steam-bath. The filtered acid was washed with water and alcohol, and dried in a desiccator over phosphoric anhydride. A 60–70% yield (based on the ester) of the dicarboxylic acid was obtained; neutral equivalent, 131. Theoretical for $C_{16}H_{12}O_4$, 134.

Anal. Calcd. for $C_{16}H_{12}O_4$: C, 71.6; H, 4.5. Found: C, 71.4; H, 4.6.

4-(ω-[2-Cyanostyryl])-benzimino Ethyl Ether Hydrochloride.—A solution of 11.5 g. of 2,4′-dicyanostilbene[1] in a mixture of 50 cc. of absolute alcohol and 125 cc. of nitrobenzene, contained in a pressure bottle, was saturated with dry hydrogen chloride at 5°. The bottle was tightly stoppered and let stand in a warm place overnight. On chilling and filtering, there was obtained 7 g. (45%) of a light yellow imino ether hydrochloride, m. p. 236–8°. From the mother liquor there was obtained by dilution with ether, 6.3 g. (40%) of a yellow solid, m. p. 223–5°. There was no significant depression in the melting points of mixtures of the two fractions.

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[1] Bance, Barber and Woolman, *J. Chem. Soc.*, 1 (1943).

[2] Ewins and Ashley, U. S. Patent 2,204,983.

[3] Meyer and Hofmann, *Monatsh.*, **38**, 358 (1917).