pounds containing trimethylsilyl groups. This difficulty was not encountered with tetrakis(*p*-trimethylsilylphenyl)tin which was readily soluble in concentrated sulfuric acid. Nitric acid was added in small portions until oxidation was complete. Tin was determined by difference after volatilization from silica with ammonium iodide.[7]

The remaining four compounds, Table I, were analyzed by fusion with sodium peroxide in a Parr bomb.[8] The germanium in the Ge-Si compound volatilized as germanium tetrachloride incidental to the work-up of the fusion mixture.

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Carbonation of Lithium Derivatives of Certain Quinolines and Isoquinolines

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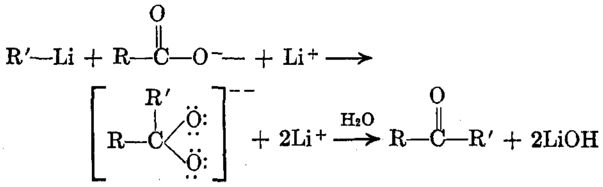
In a recent splendid investigation, Normant[1] found that excellent yields of the Grignard reagents could be obtained with alkyl and aryl chlorides by employing tetrahydrofuran as the solvent. This solvent has been used in this laboratory to include the preparation of phenyllithium from chloro- and fluoro benzene[2] with lithium wire, and 2-quinolyllithium from 2-bromoquinoline by menas of a halogen-metal interconversion reaction with *n*-butyllithium at −60°.

On carbonating 2-quinolyllithium, which was prepared in tetrahydrofuran, by pouring jet-wise onto a slurry of dry ice–tetrahydrofuran, the 2-quinolinecarboxylic acid was obtained in a yield of 50%. The same intermediate, however, when made in diethyl ether and carbonated by employing a dry ice–ether slurry, yielded 2,2'-diquinolyl ketone in 34% yield and a trace of acid. When this intermediate in diethyl ether was carbonated at −100°, both acid and ketone were obtained.

Ketone formation on carbonation of organolithium derivatives has been noted earlier.[3] This reaction has been shown to involve the initial formation of the carboxylic salt which is again attacked by the organolithium reagent.[4] The intermediate was found to be the dilithio ketal which resisted further substitution or loss of lithium oxide (I).[4]



$$R'{-}Li + R{-}\overset{O}{\overset{\|}{C}}{-}O^{-} + Li^{+} \longrightarrow \left[R{-}\overset{R'}{\overset{|}{C}}\begin{matrix}\ddot{O}{:}\\ \ddot{O}{:}\end{matrix}\right]^{--} + 2Li^{+} \xrightarrow{H_2O} R{-}\overset{O}{\overset{\|}{C}}{-}R' + 2LiOH$$

I

Since the stability of the ketal was shown to be enhanced by the presence of electron-attracting groups,[5] the electrostatic effect of the nitrogen atom can be considered to have been involved in the stabilization of the quinolyl ketal. Further evidence in support of this hypothesis was the isolation of only the acids on carbonation of 3-quinolyl- and 4-isoquinolyllithium under the same conditions.

The greater basicity and solvating effect of tetrahydrofuran may have been responsible for reducing the effective formation of the intermediate ketal, thereby favoring the production of the acids in preference to the ketones.

2-Quinolyl- and 1-isoquinolyllithium have been prepared for the first time. The general procedure used was a low temperature halogen-metal interconversion reaction with *n*-butyllithium. Each of these organolithium compounds was characterized by a reaction with benzophenone to give the corresponding tertiary alcohols. 3-Quinolyllithium was reported earlier,[6] and 2-quinolylmagnesium bromide has been prepared with difficulty and in low yield.[7]

EXPERIMENTAL[8]

2-Quinolyllithium and α,α-diphenyl-2-quinolinemethanol. To a rapidly stirred solution of 0.025 mole of *n*-butyllithium in 50 ml. of anhydrous ether which was cooled by means of a dry ice–acetone bath to −50°, there was introduced very quickly 5.2 g. (0.025 mole) of 2-bromoquinoline. The color of the reaction mixture became yellow and, finally, dark red. Color Test II[9] was negative, but Color Test I[10] was positive within 15 min.

To the 2-quinolyllithium which was maintained at −50°, there was added 4.5 g. (0.025 mole) of benzophenone in 100 ml. of anhydrous ether. After 70 ml. of this solution had been added, Color Test I[10] was negative. The reaction mixture was dark brown in color and contained a yellow precipitate. After hydrolysis with saturated ammonium chloride solution, a solid which was insoluble in both the ether and water layer was separated by filtration. The yield of this crude product was 5.45 g. or 70% (m.p. 189–191°). The melting point of the purified compound which was crystallized from an ethanol-benzene solvent pair was 193.5–195.0°.

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(2) Oita, Doctoral Dissertation, Iowa State College, Ames, Iowa, March, 1955.

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(4) Bluhm, Donn, and Zook, *J. Am. Chem. Soc.*, **77**, 4406 (1955).

(5) Tegner, *Acta. Chem. Scand.*, **6**, 782 (1952).

(6) Gilman and Spatz, *J. Am. Chem. Soc.*, **63**, 1553 (1941).

(7) Wibaut and Herringa, *Rec. trav. chim.*, **74**, 1003 (1955).

(8) All melting points are uncorrected.

(9) Gilman and Swiss, *J. Am. Chem. Soc.*, **62**, 1847 (1940).

(10) Gilman and Schulze, *J. Am. Chem. Soc.*, **47**, 2002 (1925).

Anal. Calcd. for $C_{22}H_{17}NO$: N, 4.50. Found: N, 4.41, 4.36.

1-Isoquinolyllithium and α,α-diphenyl-1-isoquinolinemethanol. The preparation of the 1-isoquinolyllithium was carried out in the same manner as that described for the 2-quinolyllithium.

To the 1-isoquinolyllithium, there was added 4.5 g. (0.025 mole) of benzophenone in 100 ml. of anhydrous ether. The temperature of the reaction mixture rose to −40° and remained there for the rest of the addition. After the introduction of 75 ml., Color Test I[10] was negative. The color of the reaction mixture was blue-black, and a considerable amount of white solid had separated. After hydrolysis, the ether extract was dried over sodium sulfate. On concentration of the ether solution, the crude product was obtained in a yield of 5.33 g. (68%). After crystallization from ethanol, the melting point of the pure compound was 144–145°.

Anal. Calcd. for $C_{22}H_{17}NO$: N, 4.50. Found: N, 4.40, 4.42.

Carbonation of 2-quinolyllithium at −50°. The 2-quinolyllithium which had been prepared from 5.2 g. (0.025 mole) of 2-bromoquinoline at −50° was carbonated by pouring jet-wise onto a slurry of dry ice–ether. The carbonation mixture was extracted with 100 ml. of 10% sodium hydroxide solution. The ether layer was separated, and the basic portion extracted with 50 ml. of ether. The ether extracts were combined and dried over anhydrous sodium sulfate.

The basic layer was treated with charcoal, filtered, concentrated, and acidified to a *p*H of 3. Quinaloic acid was isolated in a yield of 0.9%.

The ether extract was concentrated by distillation of the solvent. The residue was crystallized from ethanol to give 1.5 g. (34%) of 2,2′-diquinolyl ketone which melted at 166–167° (lit. value 165–166°).[11] The oxime was prepared and melted at 205–206° (lit. value 201–202°).[11]

Carbonation of 2-quinolyllithium at −100°. The 2-quinolyllithium was prepared in a flask which was equipped with a stopcock at the bottom in exactly the same manner as above. The stopcock was opened, and the 2-quinolyllithium flowed over the dry ice–ether slurry which was cooled to −100° by means of an ether-ethanol liquid nitrogen slurry.

The carbonation mixture was treated with 100 ml. of 10% sodium hydroxide. This basic layer which was separated from the ether layer was treated with charcoal, filtered, acidified to a *p*H of 3, and concentrated. The acid which was obtained in a yield of 1 g. (25%) melted at 158.0–158.5°. A mixed melting point with an authentic sample of quinaldic acid was not depressed.

From the ether extract, there was obtained 2,2′-diquinolyl ketone in a yield of 0.6 g. (21%).

Carbonation of 1-isoquinolyllithium. The procedure was identical to that described for 2-quinolyllithium. The yield of 1,1′-diisoquinolyl ketone was 2 g. (44%). The melting point was 198–199°.

Anal. Calcd. for $C_{19}H_{12}N_2O$: N, 9.85. Found: N, 9.96, 10.07.

The oxime was prepared in a yield of 0.44 g. (92%) and melted between 252.5–253.0°.

Anal. Calcd. for $C_{19}H_{13}N_3O$: N, 14.04. Found: N, 13.88, 13.82.

Preparation and carbonation of 4-isoquinolyllithium. Into a three necked 500-ml. round bottomed flask, there was introduced 0.025 mole of *n*-butyllithium in 50 ml. of anhydrous ether. This solution was cooled to −50° by means of a dry ice–acetone bath, and 5.2 g. (0.025 mole) of 4-bromoisoquinoline was added as a solid. The color of the reaction mixture became yellow. Color Test II was negative[9] within 10 min., and Color Test I was positive.[10] The 4-isoquinolyllithium was carbonated by the usual procedure and worked up to give 1.93 g. (46%) of 4-isoquinolinecarboxylic acid which melted at 246–248°. A mixed melting point with an authentic specimen was not depressed. The organic layer was concentrated, but no ketone was isolated.

Carbonation of 3-quinolyllithium. The 3-quinolyllithium was prepared and carbonated by the same procedure as described for 4-isoquinolyllithium. On acidification of the basic extract, there was obtained 2.2 g. (50%) of 3-quinolinecarboxylic acid which melted at 269–270°. A mixed melting point with a known sample was not depressed. On the workup of the ether extract, there was no ketone isolated.

Preparation of phenyllithium from chlorobenzene in tetrahydrofuran. Into a 500-ml. three necked round bottomed flask, there was introduced 100 ml. of anhydrous tetrahydrofuran[12] and 0.29 g.-atom of lithium wire which was cut into small pieces (1/4″). To this mixture which was stirred and cooled by an ice bath to 7°, there was added dropwise a solution of 0.1 mole of chlorobenzene (11 g.) in 52 ml. of tetrahydrofuran. The addition was so regulated that it required 45 min. After the addition of 10 ml., the temperature of the reaction mixture began to slowly rise and the cloudy mixture became light red. The temperature was maintained at 15° for the remainder of the addition at which time the color was wine red. Color Test II was positive.[9] The reaction mixture was carbonated and worked up in the usual way.

The basic extract was acidified to given an oil which solidified when dry air was blown over its surface. The yield of crude benzoic acid was 5.5 g. (54%), melting at 114–118°. A mixed melting point of the purified acid and an authentic specimen of benzoic acid showed no depression.

Preparation of 2-quinolyllithium in tetrahydrofuran at −50° and carbonation. This reaction was carried out exactly as described for the preparation of 2-quinolyllithium in diethyl ether except that tetrahydrofuran was employed as the solvent. The reaction mixture was carbonated by pouring jet-wise onto a dry ice–tetrahydrofuran slurry and worked up by the usual procedure.

The basic extract upon acidification to a *p*H of 3 and concentration gave 2.2 g. (50%) of 2-quinolinecarboxylic acid which melted at 156–157°. A mixed melting point with an authentic specimen was undepressed. Two other runs gave the same results.

The organic layer was dried and concentrated, but no ketone was isolated.

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[11] Scheibe and Schmidt, *Ber.*, **55**, 3159 (1922).

[12] The tetrahydrofuran was dried and purified by first shaking with sodium hydroxide pellets, refluxing over sodium metal for several hours and finally distilling immediately before use from lithium aluminum hydride.

Condensations of Unsymmetrical Ketones. IV. Participation of Methyl and Methylene Groups in Condensation Reactions

Raymond P. Mariella and Edith Godar[1]

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In the condensation of unsymmetrical ketones with various reagents, varying reports have been published concerning the site of reaction.[2]

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[1] Taken in part from the M.S. thesis of Edith Godar.

[2] (a) Benary, *Ber.*, **59**, 2198 (1926). (b) Tracy and Elderfield, *J. Org. Chem.*, **6**, 70 (1941). (c) Hauser and Adams, *J. Am. Chem. Soc.*, **66**, 345 (1944). (d) Mariella, *J. Am. Chem. Soc.*, **69**, 2670 (1947). (e) Royals and Covington, *J. Am. Chem. Soc.*, **77**, 3155 (1955). (f) Cason and Chang, *J. Org. Chem.*, **21**, 449 (1956).