TABLE VII

PREPARATION OF ALKALI METAL REAGENTS

Halide or other compound	G.	Mole	Solvent[a]	Metal	Addn. of RX to Na Temp., °C.	Addn. of RX to Na Time, min.	Stirring cond. after addn. Temp., °C.	Stirring cond. after addn. Time, min.	Yield of RNa, %
$C_5H_{11}Cl$	26.6	0.25	P	Na	−10	60	−10–25	60	75–80
$C_5H_{11}Cl$		.25	P	K[b]	−10–15	60	−10–0	25	3
C_6H_5Cl	28.2	.25	P	Na	25	60	25	120	86
C_6H_5Cl			B	Na	30[c]	60	30	240	74[d]
C_6H_5Cl			C	Na	30[c]	60	30	240	73[d]
C_6H_5Br			P	Na	15	60	25	240	53[d]
C_6H_5Cl			P	K	−20[e]	60	25	60	Trace
					+20	60	25	60	Trace
C_6H_5F			P	K	20	60	25	60	Trace
$(C_6H_5)Hg$	35.5	.10	P	K	20[f]	80	20–30	180	44[d]
$(C_6H_5)_2Hg$	35.5	.10	B	K	25	120	25	240	40[d]
p-$C_3H_7C_6H_4Cl$[g]	24	.22	P	Na	20	60	25	240	37[d]
p-$C_3H_7C_6H_4Br$		.22	P	Na	20–25	60	25	120	73?[d]

[a] P = pentane. B = benzene. C = cumene; 200 ml. of solvent usually used. [b] 0.625 g. atom of potassium used in place of the usual 0.5 g. atom, although theoretical quantities were used in some of the runs not recorded in this table. [c] 45° at start of reaction. [d] The yield is determined at the end of the polymerization reaction. [e] +20 at the start of the reaction. [f] 30° at the start of the reaction. [g] This chloro compound appeared to contain some of the ortho isomer.

Summary

In the polymerization of butadiene, phenylsodium exerts a catalytic effect, which is distinct from the stepwise addition process imparted by amylsodium.

Amylpotassium at 0° causes an addition polymerization but at −30° causes a catalytic process.

Phenylsodium prepared from chlorobenzene and sodium makes a far better agent than phenylsodium from bromobenzene and sodium. A reagent prepared from p-chloroisopropylbenzene is also better than one from p-bromoisopropylbenzene. These facts accord with the view that a complex between the phenylsodium and sodium chloride is present.

Benzene has little influence on the addition polymerization induced by amylsodium but markedly affects the one caused by phenylsodium. Triethylamine accelerates addition polymerization by amylsodium but changes the character of the phenylsodium process from a catalytic process to a stepwise addition process.

Mercury has a deleterious effect on the polymerization caused by phenylsodium probably because of a destruction of the organoalkali metal reagent.

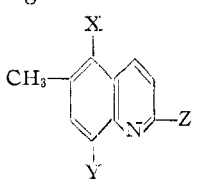
CAMBRIDGE, MASS. RECEIVED APRIL 1, 1946

[CONTRIBUTION FROM THE ROSS CHEMICAL LABORATORY, ALABAMA POLYTECHNIC INSTITUTE]

Some Derivatives of 6-Methylquinoline

BY JULIUS D. CAPPS

The purpose of this investigation was to study certain previously unreported nitro, amino, substituted amino and arsonic acid derivatives of 6-methylquinoline. Conditions were worked out for the successful application of heretofore recorded reactions to the synthesis of compounds I through XIV.



(see Table I for compounds IX through XIV)

I	Z = OH, X = NO_2, Y = H
II	Z = Cl, X = NO_2, Y = H
III	Z = OH, X = NH_2, Y = H
IV	Z = Cl, X = NH_2, Y = H
V	Z = Cl, X = H, Y = NH_2
VI	Z = Cl, X = C_6H_5CONH—, Y = H
VII	Z = Cl, X = H, Y = C_6H_5CONH—
VIII	Z = Cl, X = H, Y = CH_3CONH—

An attempt to reduce nitro compound I with tin and hydrochloric acid, however, gave chiefly a chloroamine.

Experimental

6-Methylquinoline.—A combination of the procedure reported by Clarke and Davis[1] with that of Cohn[2] for synthesizing quinoline was used to convert p-toluidine into 6-methylquinoline needed in this investigation.

6-Methyl-5-nitroquinoline.—6-Methylquinoline (130 g.) was nitrated by the method of Bogert and Fisher[3] to give 170 g. (99.3% yield) of 6-methyl-5-nitroquinoline.

6-Methyl-5-aminoquinoline.—The directions of Noelting and Trautmann[4] sufficed to produce 6-methyl-5-aminoquinoline (30.0 g., 93.8% yield) from 6-methyl-5-nitroquinoline (38.0 g.).

2-Hydroxy-6-methyl-5-nitroquinoline (I).—Subjection of 6-methyl-5-nitroquinoline to the action of hypochlorite

(1) H. T. Clarke and Anne W. Davis, "Organic Syntheses," Coll. Vol. 1, 2nd ed., 478 (1941).

(2) Essie W. Cohn, THIS JOURNAL, **52**, 3685 (1930).

(3) M. T. Bogert and H. L. Fisher, *ibid.*, **34**, 1570 (1912).

(4) E. Noelting and E. Trautmann, *Ber.*, **23**, 3657 (1890).

TABLE I

ARSENICALS

5-Quinolinearsonic acid		Yield, %	M. p., °C.	Formula	As analyses, % Calcd.	Found
6-Methyl-	(IX)	9.85	257[a]	$C_{10}H_{10}AsNO_3$	28.05	28.10
2-Hydroxy-6-methyl-	(X)[b]	14.4	250	$C_{10}H_{10}AsNO_4$	26.48	26.40
2-Chloro-6-methyl-	(XI)	16.0		$C_{10}H_8AsNClO_3$	24.86	24.80
8-Quinolinearsonic acid						
6-Methyl-	(XII)[c]	11.8	280[c]	$C_{10}H_{10}AsNO_3$	28.05	28.04
2-Chloro-6-methyl-	(XIII)[d]	13.1	323–324[d]	$C_{10}H_9AsNClO_3$	24.86	24.75
2-Hydroxy-6-methyl-	(XIV)[e]		306[e]	$C_{10}H_{10}AsNO_4$	26.48	26.50

[a] Decomposed. [b] Pale tan-colored needles collected into rosets. [c] Long, slender needles from water that darkened at 270° and melted down at 280°. [d] Colorless, prismatic needles that darkened at 302° and melted down at 323–324°. [e] Prepared by hydrolyzing 0.75 g. of the chloro derivative in 10 ml. of 25% sulfuric acid at 173° in an autoclave followed by reprecipitation of its solution in sodium hydroxide; darkened at 265° and melted down at 306°.

in slightly acid solution according to the method of Capps and Hamilton[5] gave an 80% yield of 2-hydroxy-6-methyl-5-nitroquinoline. Crystallization from glacial acetic acid, after treating with norite (charcoal) and filtering, resulted in the formation of long yellow needles; started to darken at 305° and melted down sharply at 312–313°.

Anal. Calcd. for $C_{10}H_8N_2O_3$: N, 13.72. Found: N, 13.74.

2-Hydroxy-6-methyl-5-aminoquinoline (III).—2-Hydroxy-6-methyl-5-nitroquinoline (3.50 g.) was suspended in 250 ml. of absolute ethanol. Raney nickel catalyst was added and the system heated in hot water-bath until ethanol began to boil. Hydrogen was then passed in at 35–40 pounds per square inch pressure with shaking. Reduction occurred slowly. The temperature of the system was again increased to boiling temperature of solvent and filtered. The residue R was suspended in water and treated with dilute sulfuric acid. All organic matter dissolved after heating for several minutes on hot-plate. Separation of undissolved material by filtration followed by precipitation of dissolved amine with ammonia water enabled recovery of 0.80 g. of 2-hydroxy-6-methyl-5-aminoquinoline.

Some more of the amine (0.69 g.) crystallized from the alcoholic filtrate obtained when the residue R was removed. This portion of amine was separated, and the alcoholic filtrate thus obtained was concentrated by distillation. The concentrated alcoholic solution was treated with dilute hydrochloric acid and evaporated to 75-ml. volume. A third portion of the amine was recovered by rendering this acidic concentrate alkaline with ammonia water and filtering. The amine crystallized from absolute ethanol as a yellow substance which began to darken at 296° and melted down with decomposition at 311–312°; overall yield 2.26 g. (76.0%).

Anal. Calcd. for $C_{10}H_{10}N_2O$: N, 16.08. Found: N, 16.07.

1,6-Dimethyl-2-quinolone.—The method of Perkin and Robinson[6] for converting quinoline into 2-quinolone was modified by substituting benzene for diethyl ether and oxidizing at 60° with the alkaline ferricyanide instead of at boiling point of diethyl ether; yield 64.0%.

2-Chloro-6-methylquinoline.—1,6-Dimethyl-2-quinolone was converted into 2-chloro-6-methylquinoline according to the directions outlined by Hammer.[7]

2-Chloro-6-methyl-5-nitroquinoline (II). A.—2-Chloro-6-methylquinoline (7.0 g.), 22.0 ml. of sulfuric acid (sp. gr. 1.84), and 9.50 ml. of nitric acid (sp. gr. 1.5) were heated together in a boiling water-bath for fifteen minutes and poured, when cool, into a mixture of cracked ice and water. The crude 2-chloro-6-methyl-5-nitro-quinoline was separated by filtration, washed with water, and purified by crystallizing from ethanol solutions that had been decolorized with norite (charcoal); m. p. 170–171°.

B.—2-Hydroxy-6-methyl-5-nitroquinoline (7.30 g.) and phosphorus oxychloride (10.0 ml.) were heated together under reflux condenser in oil-bath at 125° for thirty-five minutes. The reaction mixture was poured into 400 ml. of cracked ice and water with good stirring. Crude 2-chloro-6-methyl-5-nitroquinoline was filtered from water solution, washed with water and dried. Some impurities failed to dissolve in hot acetone. Dilution of the acetone solution with water caused precipitation of 2-chloro-6-methyl-5-nitroquinoline. Further purification was effected by dissolving in absolute boiling ethanol, decolorizing with norite, separating the norite by filtration, and permitting to cool slowly; 6.30 g. (79.5%) recovery; m. p. 170–171°.

Anal. Calcd. for $C_{10}H_7N_2ClO_2$: N, 12.59. Found: N, 12.66.

2-Chloro-6-methyl-5-aminoquinoline (IV).—2-Chloro-6-methyl-5-nitroquinoline (4.40 g.) was dissolved in 200 ml. of hot acetone and Raney nickel added. Hydrogen at 35–40 pounds per square inch pressure reduced the nitroquinoline to 2-chloro-6-methyl-5-aminoquinoline. Hiflo super cel was added to coagulate the finely divided nickel, and the solid was filtered from the acetone solution of the amine. Removal of the acetone under reduced pressure by heating in the hot water-bath, gave almost the theoretical yield of the solid amine. Recrystallization from ethanol–water solution produced yellow-green needles; m. p. 173°.

2-Chloro-6-methyl-5-nitroquinoline was also reduced catalytically in absolute ethanol.

Anal. Calcd. for $C_{10}H_9N_2Cl$: N, 14.54. Found: N, 14.60.

2-Chloro-6-methyl-5-benzamidoquinoline (VI).—2-Chloro-6-methyl-5-aminoquinoline (0.80 g.), 2.0 ml. of benzoyl chloride, and 20 ml. of 5% sodium hydroxide in water were shaken together until precipitation ceased. The solid was separated by filtration, washed with water, and finally crystallized from 95% ethanol. A white flaky solid giving qualitative test for chlorine resulted; m. p. 233–234°.

Anal. Calcd. for $C_{17}H_{13}N_2ClO$: N, 9.44. Found: N, 9.45.

2-Hydroxy-6-methyl-5-acetamidoquinoline (?).—2-Chloro-6-methyl-5-aminoquinoline (0.80 g.), 20 ml. of glacial acetic acid, and 3.0 ml. of acetic anhydride were refluxed for thirty minutes. The reaction mixture was poured into 250 ml. of cracked ice and water while stirring. Filtration separated the solid which was washed with water. This solid was dissolved in hot glacial acetic acid and decolorized with norite. A white flaky solid separated that gave a negative qualitative test for chlorine and failed to dissolve in hot 95% ethanol to any appreciable extent; m. p. greater than 339°.

Anal. Calcd. for $C_{12}H_{12}NO_2$: N, 12.96. Found: N, 12.88.

(5) J. D. Capps and C. S. Hamilton, THIS JOURNAL, **60**, 2105 (1938).

(6) W. H. Perkin and R. Robinson, *J. Chem. Soc.*, **103**, 1977 (1913).

(7) F. M. Hammer, *ibid.*, 209 (1928).

p-**Acetotoluidide.**—*p*-Toluidine was acetylated by the method of Lumière and Barbier[8] to yield *p*-acetotoluidide (94.5% yield).

3-Nitro-*p*-toluidine.—An 80.0% yield of 3-nitro-*p*-toluidine was obtained when *p*-acetotoluidide was nitrated according to conditions described by Gattermann[9] and hydrolyzed.

6-Methyl-8-nitroquinoline.—3-Nitro-*p*-toluidine (152.1 g.) was subjected to a modified Skraup ring closure according to conditions recommended by Richter and Smith.[10] Crystallization followed successive charcoal treatments in dilute sulfuric acid, glacial acetic acid, and finally 95% ethanol solutions of the 6-methyl-8-nitroquinoline; 98.5 g. recovery.

6-Methyl-8-aminoquinoline.—6-Methyl-8-nitroquinoline was reduced in ammoniacal solution of hydrogen sulfide as outlined by Noelting and Trautmann.[4]

1,6-Dimethyl-8-nitro-2-quinolone.[11]—6-Methyl-8-nitroquinoline (25.0 g.) and 40.0 ml. of dimethyl sulfate (Eastman Kodak Co. practical) were heated in an oil-bath maintained at 120–130° for one and a quarter hours, and the mixture was held in the atmosphere of the room for one and one-half hours. Water (110 ml.) was added and the system twice extracted with diethyl ether (50 and 20 ml.). The clear water solution of 1,6-dimethyl-8-nitroquinolinium salt was treated with finely powdered potassium iodide, while stirring, to precipitate the 1,6-dimethyl-8-nitroquinolinium iodide. Precipitation in fractions followed by filtration gave best results. The combined fractions were dissolved in 200 ml. of hot 95% ethanol and cooled to room temperature while agitating mechanically. A solution of 18.0 g. of potassium hydroxide pellets in 64.0 ml. of water was added slowly from a dropping funnel. "Superoxol" (30% hydrogen peroxide, 160 ml.) was introduced with good mechanical agitation over a period of thirty minutes. Mechanical agitation was continued until the system cooled to room temperature and stopped. After standing for an hour at room temperature, the 1,6-dimethyl-8-nitro-2-quinolone was separated by filtration and washed with 50% ethanol–water solution; 25.1 g. dried at 65°.

2-Chloro-6-methyl-8-nitroquinoline.[11]—The 1,6-dimethyl-8-nitro-2-quinolone (25.1 g.) was converted into 2-chloro-6-methyl-8-nitroquinoline according to conditions used by Ing[11] and purified by crystallization from acetone; yield 19.5 g.

2-Chloro-6-methyl-8-aminoquinoline (V).—2-Chloro-6-methyl-8-nitroquinoline (5.00 g.) in 150 ml. of acetone, containing suspended Raney nickel catalyst, was reduced at 50° with hydrogen under 35–40 pounds per square inch pressure. Removal of the catalyst followed by the acetone under reduced pressure, gave the solid amine which was crystallized from ethanol–water solution as a hydrate; brown prismatic needles (dried at 3 mm. pressure for three hours over sulfuric acid (sp. gr. 1.84)); m. p. 87–88°.

Anal. Calcd. for $C_{10}H_9N_2Cl \cdot H_2O$: N, 13.30. Found: N, 13.39.

Drying at 118° under 3 mm. pressure for twenty minutes dehydrated the amine which solidified as a brown-green solid upon cooling; m. p. 80–81°.

Anal. Calcd. for $C_{10}H_9N_2Cl$: N, 14.54. Found: N, 14.48.

(8) Lumière and Barbier, *Bull. soc. chim.*, [3] **33**, 783 (1905).

(9) L. Gattermann, *Ber.*, **18**, 1483 (1885).

(10) F. Richter and G. F. Smith, THIS JOURNAL, **66**, 396–398 (1944).

(11) H. R. Ing, *J. Chem. Soc.*, 2202 (1931).

2-Chloro-6-methyl-8-acetamidoquinoline (VIII).—2-Chloro-6-methyl-8-aminoquinoline (1.00 g.) was dissolved in 20 ml. of glacial acetic acid and treated with 3.0 ml. of acetic anhydride. The system was heated in a boiling water-bath for twenty minutes and poured into a mixture of cracked ice and water. Repeated crystallization from ethanol–water solutions gave clusters of fine, colorless needles melting at 100–102°.

Anal. Calcd. for $C_{12}H_{11}N_2ClO$: N, 11.93. Found: N, 12.12.

2-Chloro-6-methyl-8-benzamidoquinoline (VII).—A mixture of 2-chloro-6-methyl-8-aminoquinoline (0.80 g.), 2.0 ml. of benzoyl chloride, and 20 ml. of 5% sodium hydroxide in water was shaken until no more solid formed. The solid was separated by filtration and washed with 5% sodium hydroxide in water, followed by water. Upon dissolving in 95% ethanol, decolorizing with norite, and permitting to stand overnight, long, hair-like, colorless needles formed. Dilution of mother liquor yielded additional crystals of 2-chloro-6-methyl-8-benzamidiquinoline; 0.70 g. over-all recovery; m. p. 139–140°.

Anal. Calcd. for $C_{17}H_{13}N_2ClO$: N, 9.44. Found: N, 9.38.

Some Quinolinearsonic Acids.—The quinolinearsonic acids listed in Table I were prepared by diazotizing the corresponding amines and subjecting them to the modified Bart conditions described by Capps and Hamilton[5] for converting 2-chloroaminoquinolines into 2-chloroquinolinearsonic acids.

Summary

1. 2-Hydroxy-6-methyl-5-nitroquinoline, 2-hydroxy-6-methyl-5-aminoquinoline, 2-chloro-6-methyl-5-nitroquinoline and 2-chloro-6-methyl-5-aminoquinoline were prepared from previously described 6-methyl-5-nitroquinoline.

2. It was shown that 2-chloro-6-methyl-5-nitroquinoline resulted from the nitration of 2-chloro-6-methylquinoline.

3. 2-Chloro-6-methyl-8-nitroquinoline was reduced to 2-chloro-6-methyl-8-aminoquinoline.

4. 2-Chloro-6-methyl-5-benzamidoquinoline and 2-chloro-6-methyl-8-benzamidoquinoline resulted from the action of benzoyl chloride on 2-chloro-6-methyl-5-aminoquinoline and 2-chloro-6-methyl-8-aminoquinoline, respectively.

5. 2-Chloro-6-methyl-8-aminoquinoline acetylated to give 2-chloro-6-methyl-8-acetamidoquinoline.

6. 6-Methyl-5-quinolinearsonic acid, 6-methyl-8-quinolinearsonic acid, 2-hydroxy-6-methyl-5-quinolinearsonic acid, 2-chloro-6-methyl-5-quinolinearsonic acid, and 2-chloro-6-methyl-8-quinolinearsonic acid were prepared from the corresponding amines.

7. 2-Chloro-6-methyl-8-quinolinearsonic acid hydrolyzed to 2-hydroxy-6-methyl-8-quinolinearsonic acid.

AUBURN, ALABAMA RECEIVED JULY 3, 1946