C. **Using Morpholine.**—A solution of 2 g. (7.56 mmoles) of the Mannich base and 10 ml. of morpholine (b.p. 127–129°) (distilled from barium oxide) was refluxed for 22.5 hours under a guard tube packed with sodium hydroxide. After chilling, the reaction mixture was acidified with dilute (1:1) hydrochloric acid and then extracted with benzene. The extract was washed with dilute acid, then with water until neutral and finally extracted with 5% sodium hydroxide. Acidification of the basic solution with acetic acid gave a solid which was washed and dried, 0.38 g. (2.64 mmoles, 35%). After recrystallization from carbon tetrachloride the solid melted at 115–119°. The melting point was not changed significantly by additional recrystallizations.

The 1-benzeneazo derivative melted at 131–132° (reported 128.5–129.5°;[42] 133°,[43] 134°.[44–46]

Anal. Calcd. for $C_{16}H_{12}N_2O$: C, 77.40; H, 4.87; N, 11.29. Found: C, 77.72; H, 4.79; N, 11.57.

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(42) R. Möhleau and E. Strobach, *Ber.*, **33**, 804 (1900).

(43) M. Betti and G. Leoncini, *Gazz. chim. ital.*, **30, II**, 164 (1900).

(44) C. Liebermann, *Ber.*, **16**, 2858 (1883).

(45) B. Fischer and H. Wimmer, *ibid.*, **20**, 1577 (1887).

(46) G. Ciusa and U. Pestalozza, *Gazz. chim. ital.*, **41I**, 391 (1911).

BROOKLYN 1, NEW YORK

[CONTRIBUTION FROM KOPPERS CO., INC., MONOMER FELLOWSHIP AT MELLON INSTITUTE]

Steric Hindrance. I. 2,6-Dimethylacetophenone and 2,6-Dimethylstyrene[1]

BY L. H. SCHWARTZMAN AND B. B. CORSON

RECEIVED JUNE 22, 1953

The spectra of 2,6-dimethylacetophenone and 2,6-dimethylstyrene show the effect of diortho substitution. These compounds were synthesized from 2-iodo-*m*-xylene *via* the lithiumalkyl derivative and acetaldehyde. 2,6-Dimethylacetophenone fails to respond to the usual diagnostic tests for a ketone, but it takes part in the Schmidt reaction to yield 2,6-dimethylacetanilide. 2,6-Dimethylstyrene is more difficult to hydrogenate than styrene, and it is oxidized to 2,6-dimethylbenzoylformic acid under conditions which convert styrene to benzoic acid.

The sterically hindered compounds, 2,6-dimethylacetophenone (IV) and 2,6-dimethylstyrene (II), were prepared from 2-iodo-*m*-xylene *via* the Grignard reaction; lithium was found to be preferable to magnesium.

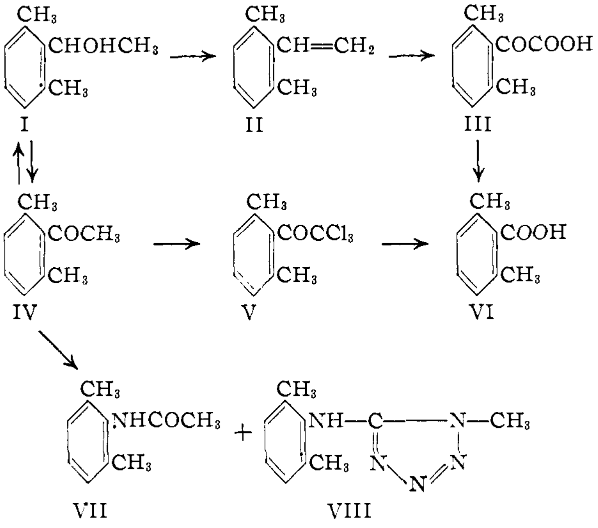
2,6-Dimethylphenylmagnesium iodide treated with acetaldehyde to give anomalous results. In one experiment, very poor yields of 2,6-dimethylphenylmethylcarbinol (I) and 2,6-dimethylstyrene (II) were obtained; in another experiment, the product, still in poor yield, was the ether of 2,6-dimethylphenylmethylcarbinol.

The infrared spectrum of α,α'-di-[2-*m*-xylyl] ethyl ether indicated the presence of an ether linkage and vicinal trisubstituted aromatic rings. Hydrolytic cleavage of the ether with hydrobromic acid produced 2,6-dimethylphenylmethylcarbinol (I) and its dehydration product, 2,6-dimethylstyrene (II).

Fuson, Rabjohn, Schenk and Wallace[2] treated mesitylmagnesium bromide with acetaldehyde and obtained a small yield of the corresponding carbinol, but the major product was a compound which they assumed to be the ether of the carbinol, on the basis of analysis.

In contradistinction to the behavior of the magnesium complex, the lithium derivative of 2-iodo-*m*-xylene gave a high yield of 2,6-dimethylphenylmethylcarbinol (I), and although this carbinol is readily dehydrated, we were able to prepare its 3,5-dinitrobenzoate and phenylurethan derivatives.

Carbinol I was oxidized to 2,6-dimethylacetophenone (IV), which resembles the similarly hindered acetomesitylene in that it fails to give the usual carbonyl reactions.[3] Attempts to prepare the 2,4-dinitrophenylhydrazone and oxime derivatives of 2,6-dimethylacetophenone failed.



The infrared spectrum of 2,6-dimethylacetophenone shows strong ketocarbonyl absorption at 5.95 μ and an intense band at 12.9 μ, the latter being characteristic of the vicinal trisubstituted benzene ring. The ultraviolet spectrum of acetophenone (Fig. 1) displays well-defined absorption at 239 mμ, whereas acetomesitylene and 2,6-dimethylacetophenone show poorly-defined absorption in the ultraviolet, with maximum absorption well below 240 mμ.[4] These spectra are consistent with the concept of steric inhibition of resonance owing to diortho substitution, which inhibits coplanarity of the "first excited state" (ionic state), thus increasing the energy of the ionic state relative to the ground state and shifting the absorption maximum to shorter wave lengths.

Kohler, Stone and Fuson[5] made use of the Grig-

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[1] Presented before the 124th meeting of the American Chemical Society, Chicago, Illinois, September 6–11, 1953.

[2] R. C. Fuson, N. Rabjohn, W. J. Schenk and W. E. Wallace, *J. Org. Chem.*, **9**, 187 (1944).

[3] P. de Jong, *Rec. trav. chim.*, **61**, 539 (1942); L. I. Smith and C. Guss, THIS JOURNAL, **59**, 804 (1937).

[4] M. T. O'Shaughnessy and W. H. Rodebush, *ibid.*, **62**, 2906 (1940).

[5] E. P. Kohler, J. F. Stone and R. C. Fuson, *ibid.*, **49**, 3181 (1927).

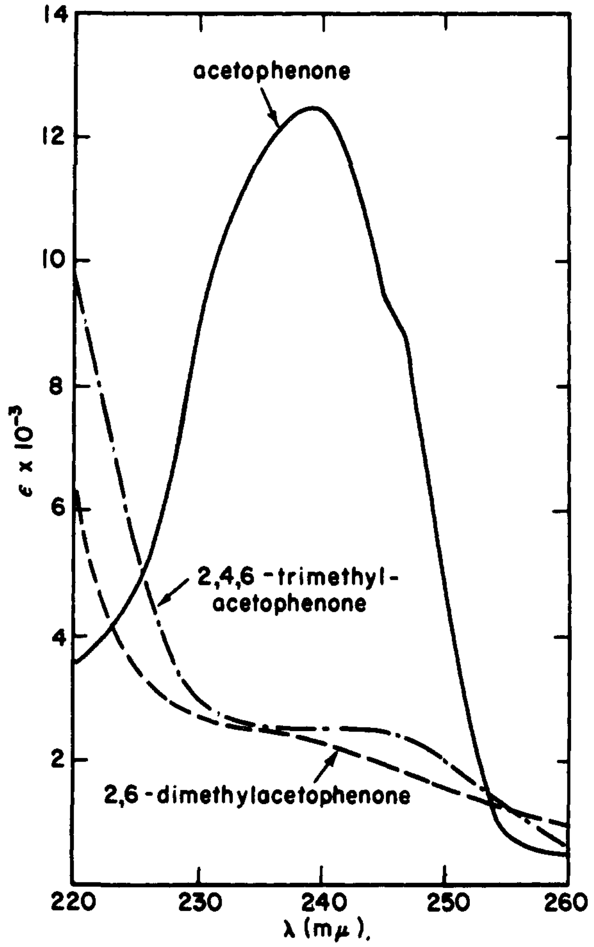


Fig. 1.—Ultraviolet spectra of: acetophenone (—); 2,6-dimethylacetophenone (– – – – – –); 2,4,6-trimethylacetophenone (-.-.-.-.-.).

nard reaction to measure the relative amount of steric hindrance in substituted ketones. They found that one mole of acetomestitylene reacted with methylmagnesium iodide to liberate one mole of methane, indicating that enolization predominated 100% over 1,2-addition to the carbonyl group. Similarly, we found that 2,6-dimethylacetophenone reacted 100% in the enol form with methylmagnesium iodide.

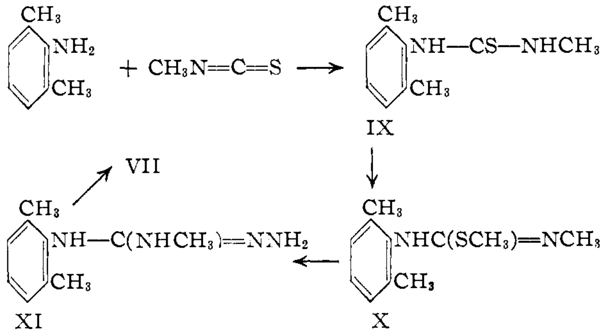
Whereas methylmagnesium iodide reacts with the enolic modification of hindered ketones, thereby promoting enolization, lithium aluminum hydride liberates hydrogen equivalent to the enol tautomer present in the equilibrium mixture and reduces the keto tautomer to the carbinol. Thus acetomesitylene[6] and 2,6-dimethylacetophenone liberate no hydrogen when reacting with lithium aluminum hydride, demonstrating the absence of enol, and are reduced in essentially quantitative yields to the corresponding carbinols.

Fuson and co-workers[7] demonstrated that the haloform oxidation of acetomesitylene produces relatively stable trichloro and tribromo derivatives, but only the monoiodo and diiodo derivatives. This divergence in behavior was attributed to the greater steric hindrance encountered by the iodine atom as compared with the bromine and chlorine atoms.

Similarly, 2,6-dimethylacetophenone failed to respond to the iodoform test, but it reacted with hypochlorite to give α,α,α-trichloro-2,6-dimethylacetophenone (V) in excellent yield. The freshly distilled trihalide was colorless, but it rapidly turned yellow. Alkaline hydrolysis converted it to 2,6-dimethylbenzoic acid (VI).

2,6-Dimethylacetophenone reacted with sodium azide under the conditions of the Schmidt reaction to yield two products—2,6-dimethylacetanilide (VII) and 1-methyl-5-[2-*m*-xylylamino]-tetrazole (VIII).

The general method of Finnegan, Henry and Lieber[8] was employed to develop an unequivocal synthesis of the tetrazole VIII. 2,6-Dimethylaniline reacted slowly with methyl isothiocyanate to give a good yield of 1-methyl-3-(2-*m*-xylyl)-thiourea (IX). The thiourea was converted in essentially quantitative yield by means of methyl iodide to the corresponding 1,S-dimethyl-3-(2-*m*-xylyl)-isothiourea (X), which in turn reacted with hydrazine to produce 1-methyl-2-(2-*m*-xylyl)-3-aminoguanidine (XI). Conversion of the iodide salt of the aminoguanidine (XI) to the nitrate and subsequent reaction of the latter at ice temperature with nitrous acid produced 1-methyl-5-[2-*m*-xylylamino]-tetrazole[9] (VIII), which gave no melting point depression when admixed with the product obtained from the Schmidt reaction with 2,6-dimethylacetophenone.



Badger, Howard and Simons[10] were unable to obtain the Schmidt reaction with benzoylmesitylene, and they attributed this failure to steric hindrance. Along the same line, Kohler[11] showed that the phenyl group adjacent to the carbonyl in benzalacetophenone hinders 1,2-addition of the Grignard reagent more than the methyl group in benzalacetone. Also, both acetomesitylene and benzoylmesitylene are able to add various Grignard reagents 1,2 to the carbonyl group.[12] Therefore,

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[6] F. H. Hochstein, THIS JOURNAL, **71**, 305 (1949).

[7] R. C. Fuson and J. T. Walker, *ibid.*, **52**, 3269 (1930); R. Johnson and R. C. Fuson, *ibid.*, **57**, 919 (1935).

[8] W. G. Finnegan, R. A. Henry and E. Lieber, *J. Org. Chem.*, **18**, 779 (1953).

[9] No evidence is at hand to establish whether or not VIII exists as the tautomer, 1-methyl-5-[2-*m*-xylylimino]-1,2-dihydrotetrazole.

[10] G. M. Badger, R. T. Howard and A. Simons, *J. Chem. Soc.*, 2849 (1952).

[11] E. P. Kohler, *Am. Chem. J.*, **38**, 511 (1907).

[12] R. C. Fuson, M. D. Armstrong, W. E. Wallace and J. W. Kneisley, THIS JOURNAL, **66**, 681 (1944); W. G. Young and J. D. Roberts, *ibid.*, **66**, 2131 (1944).

if the mechanism of the Schmidt reaction[13] is 1,2-addition of hydrazoic acid to the carbonyl, followed by elimination of nitrogen and rearrangement to the amide, it would be expected that 2,6-dimethylacetophenone would be more amenable to the Schmidt reaction than benzoylmesitylene. This reasoning fits the facts.

2,6-Dimethylstyrene (II), readily obtained by dehydrating 2,6-dimethylphenylmethylcarbinol (I) over activated alumina at 275°, also exhibits steric hindrance. Its ultraviolet spectrum shows the effect of the steric inhibition of resonance, in that the characteristic maximum absorption of styrene (at 245 mμ) is shifted to 238 mμ. Its infrared absorption at 13 μ indicates vicinal trisubstitution of the benzene ring, and there is the typical styrene absorption at about 6.1 μ.

2,6-Dimethylstyrene reacted rapidly with bromine to yield a crystalline dibromo derivative. 2,6-Dimethylstyrene was not hydrogenated at atmospheric pressure and temperature in the presence of palladium–carbon (which rapidly hydrogenated styrene), but it was hydrogenated to 2,6-dimethylethylbenzene in the presence of Adams platinum catalyst. Permanganate oxidation of 2,6-dimethylstyrene produced 2,6-dimethylbenzoylformic acid (III) rather than 2,6-dimethylbenzoic acid (VI). No trace of the latter was found. It is true that styrene,[14] under certain conditions, can be oxidized to benzoylformic acid, but under the conditions employed with 2,6-dimethylstyrene, styrene was oxidized in almost quantitative yield to benzoic acid.

Crude 2,6-dimethylbenzoylformic acid (III) showed no tendency to crystallize, but after purification through its ethyl ester, it was obtained in crystalline form. 2,6-Dimethylbenzoylformic acid was identified by decarbonylation to 2,6-dimethylbenzoic acid by means of sulfuric acid according to the general method of Bouveault.[15]

Experimental

2-Iodo-*m*-xylene.—2-*m*-Xylidine, purified through crystallization of its hydrochloride, followed by distillation of the free amine through a 35-plate column [b.p. 210–211° (736 mm.), $n^{20}{}_{D}$ 1.5604, $d^{20}{}_{20}$ 0.9819, f.p. 11.01°][16] was converted through the Sandmeyer reaction, in 60% yield to 2-iodo-*m*-xylene. The latter was distilled through a 50-plate column [b.p. 102–103° (14 mm.), $n^{20}{}_{D}$ 1.6037, $d^{20}{}_{20}$ 1.6518, f.p. 11.18°].[16,17]

Grignard Reaction (A).—A solution of 2-iodo-*m*-xylene (46.4 g., 0.2 mole) in 300 ml. of dry ether was added during 1.5 hours at room temperature to a stirred mixture of 5.5 g. (0.23 mole) of magnesium and 200 ml. of dry ether. After stirring for an additional hour, the reaction mixture was cooled in ice, and a solution of 15 g. (0.34 mole) of acetaldehyde in 200 ml. of dry ether was added with stirring during 0.5 hour. The reaction mixture congealed and stirring had to be discontinued. After standing for 15 hours at room temperature, the mixture was decomposed with cold aqueous ammonium chloride. The ether layer was separated, washed with dilute aqueous thiosulfate followed by water, dried over magnesium sulfate, concentrated, and the residue was distilled to give three brown-colored fractions (total weight 12 g.).

Fraction 1 [b.p. 70–74° (11 mm.)], dissolved in 200 ml. of petroleum ether (b.p. 30–60°), was chromatographed over activated alumina. Distillation of the colorless eluant produced a small quantity of 2,6-dimethylstyrene [b.p. 65–66° (10 mm.), $n^{23}{}_{D}$ 1.5285].

Anal. Calcd. for $C_{10}H_{12}$ with 1 double bond: H_2, 221 ml. Found: H_2, 220 ml.

Fractions 2 [b.p. 74–105° (11 mm.)] and 3 [b.p. 105–115° (11 mm.)] were combined, dissolved in 200 ml. of petroleum ether (30–60°), and chromatographed over activated alumina. Elution of the chromatogram with 10% ethanol–90% petroleum ether, followed by evaporation of the solvent and distillation of the residue, yielded small quantities of 2-iodo-*m*-xylene and 2,6-dimethylphenylmethylcarbinol (I) [b.p. 112–117° (10 mm.), m.p. 68.5–69.5° after recrystallization from petroleum ether (b.p. 30–60°)].

Anal. Calcd. for $C_{10}H_{14}O$: C, 80.0; H, 9.39. Found: C, 80.1; H, 9.48.

The carbinol I failed to give an iodoform test and its response to the Lucas test was ambiguous. When the carbinol was heated with phenyl isocyanate at 170° in the absence of solvent, the product was diphenylurea (m.p. 235–237°), the necessary water resulting from dehydration. The carbinol, however, reacted with phenyl isocyanate in boiling *n*-heptane to produce a white, crystalline urethan, which after recrystallization from petroleum ether (b.p. 60–80°) melted at 126–128°.

Anal. Calcd. for $C_{17}H_{19}NO_2$: N, 5.20. Found: N, 5.25.

Reaction of the carbinol with 3,5-dinitrobenzoyl chloride in pyridine gave a white, crystalline 3,5-dinitrobenzoate (m.p. 129–130°, crystallized from aqueous ethanol).

Anal. Calcd. for $C_{17}H_{16}N_2O_6$: N, 8.14. Found: N, 8.10.

Grignard Reaction (B).—The reaction was repeated as described above except that 73.5 g. (0.32 mole) of iodo compound, dissolved in 1500 ml. of ether, was added to 8.4 g. (0.35 mole) of magnesium during 6 hours. The product was chromatographed and the eluant was distilled to yield 17 g. of colorless 2-iodo-*m*-xylene and 9 g. of residue. The latter, after crystallization from ethanol, followed by sublimation, gave white crystals of α,α'-di-[2-*m*-xylyl] ethyl ether melting at 143.5–145°. Infrared scanning revealed bands corresponding to an aliphatic ether (at 9.2 μ) and a vicinal trisubstituted aromatic ring (at 13.0 μ).

Anal. Calcd. for $C_{20}H_{26}O$: C, 85.1; H, 9.28. Found: C, 84.9; H, 8.93.

The ether (5 g., 0.018 mole) was refluxed under nitrogen for 4.5 hours with a mixture of 27 ml. of acetic acid and 27 ml. of 48% hydrobromic acid. The solution was poured onto ice and extracted with ether. The ether extract was concentrated, and the residual oil was refluxed for 4 hours with aqueous potassium hydroxide, sufficient ethanol being added to homogenize the solution. The reaction mixture was poured onto ice, extracted with ether; the ether extract was washed with water until neutral, and dried over anhydrous magnesium sulfate. It was then distilled to give small amounts of 2,6-dimethylstyrene (II) boiling at 65–67° (10 mm.), which decolorized bromine rapidly, and 2,6-dimethylphenylmethylcarbinol (I) boiling at 115–117° (10 mm.). Recrystallization of the carbinol I from petroleum ether (b.p. 30–60°) produced a white solid (m.p. 67–68°) which gave no melting point depression when admixed with an authentic sample.

Grignard Reaction (C).—A solution of 300 g. (1.29 moles) of 2-iodo-*m*-xylene in 1500 ml. of dry ether was added with stirring, under dry nitrogen, at room temperature, during 12.5 hours, to a mixture of 500 ml. of ether and 20 g. (2.88 moles) of lithium ribbon (cut into small pieces). The mixture was stirred for an additional hour, cooled in an ice-bath, and to it was added during 5 hours, a mixture of 70 g. (1.59 moles) of acetaldehyde and 1000 ml. of ether. The reaction mixture was stirred for 4 hours at *ca.* 30°, cooled in an ice-bath, and decomposed with ethanol followed by water. The ether layer was separated and washed successively with water, dilute aqueous thiosulfate and water. After drying, it was distilled to yield 130 g. (67%) of 2,6-dimethylphenyl-

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(13) H. Wolff, "Organic Reactions," Vol. III, John Wiley and Sons, Inc., New York, N. Y., 1947, Chapter 8.

(14) C. D. Hurd, R. W. McNamee and F. O. Green, THIS JOURNAL, **61**, 2979 (1939).

(15) L. Bouveault, *Bull. soc. chim.*, **17**, 262 (1897).

(16) S. F. Birch, R. A. Dean, F. A. Fidler and R. A. Lowry, THIS JOURNAL, **71**, 1362 (1949).

(17) Boiling points and melting points are uncorrected. The melting points were determined by means of the Fisher–Johns melting point apparatus. Freezing points were measured by a platinum resistance thermometer that had been certified by the National Bureau of Standards.

methylcarbinol boiling at 112–117° (10 mm.) and melting at 68.5–69.5° after recrystallization from petroleum ether (b.p. 30–60°). It gave no melting point depression when admixed with the carbinol I obtained from Grignard reaction A nor with the carbinol obtained by hydrolysis of the ether of 2,6-dimethylphenylmethylcarbinol.

2,6-Dimethylacetophenone (IV).—2,6-Dimethylphenylmethylcarbinol (I, 60 g., 0.4 mole) was added, with stirring, during 50 minutes, to a cold solution of 251 g. (0.86 mole) of potassium dichromate, 185 ml. of 96% sulfuric acid and 1150 ml. of water. The temperature rose from 28 to 37° during the addition. The mixture was immediately steam distilled, and the distillate was saturated with salt and extracted with ether. Distillation of the dried ether solution produced 47 g. (80%) of 2,6-dimethylacetophenone[3]; b.p. 111–112° (23 mm.), n^{20}_{D} 1.5162, d^{20}_{20} 0.9943, f.p. 20.77°, λ_{max} 3.40 μ, 5.95, 6.25, 6.85, 7.05, 7.24, 7.40, 8.00, 8.08, 8.60, 9.07, 9.50, 10.45, 11.00, 12.95, 13.41. This ketone failed, under the usual reaction conditions, to form an oxime, or a 2,4-dinitrophenylhydrazone, or to respond to the iodoform test.

Reaction of 2,6-Dimethylacetophenone with Methylmagnesium Iodide.—In an apparatus similar to that described by Zaugg and Lauer,[18] a solution of methylmagnesium iodide in absolute di-*n*-butyl ether was treated with a di-*n*-butyl ether solution of 2,6-dimethylacetophenone.

Anal. Calcd. for $C_{10}H_{12}O$: active hydrogen, 0.68. Found: active hydrogen, 0.68.

Likewise, acetomesitylene in di-*n*-butyl ether reacted with methylmagnesium iodide in di-*n*-butyl ether.

Anal. Calcd. for $C_{11}H_{14}O$: active hydrogen, 0.62. Found: active hydrogen, 0.62.

Reaction of 2,6-Dimethylacetophenone with Lithium Aluminum Hydride.—In the same manner as above, 2,6-dimethylacetophenone was treated with lithium aluminum hydride.

Anal. Calcd. for $C_{10}H_{12}O$: active hydrogen, 0.68. Found: active hydrogen, 0.00.

2,6-Dimethylacetophenone (17 g., 0.115 mole) in 200 ml. of dry ether was added during 30 minutes, with stirring, to 3 g. (0.079 mole) of lithium aluminum hydride in 50 ml. of dry ether. After stirring for an additional hour the mixture was chilled and decomposed with cold water. The ether layer was washed, dried and concentrated under reduced pressure to yield 17 g. (98%) of 2,6-dimethylphenylmethylcarbinol [m.p. 68–69°, crystallized from petroleum ether (b.p. 30–60°)].

α,α,α-Trichloro-2,6-dimethylacetophenone (V).—To 0.1 mole of potassium hypochlorite[19] in 130 ml. of water at 55° was added, with stirring during 5 minutes, 5 g. (0.03 mole) of 2,6-dimethylacetophenone. Stirring was continued for 2.5 hours. The temperature rose from 55 to 68° and then fell to room temperature. After stirring for 17.5 hours, the excess hypochlorite was destroyed by bisulfite. The cooled mixture was extracted with ether, and the alkaline layer was acidified. No acidic product was obtained. Distillation of the dried ether extract gave 6.5 g. (87%) of colorless α,α,α-trichloro-2,6-dimethylacetophenone [b.p. 147–148° (20 mm.), n^{20}_{D} 1.5443, d^{20}_{20} 1.3212]. It rapidly turned yellow.

Anal. Calcd. for $C_{10}H_9OCl_3$: Cl, 42.5. Found: Cl, 40.5.

Four grams (0.016 mole) of the trichloro compound V was refluxed with 100 ml. of 2 *N* sodium hydroxide for 12 hours. The cooled solution was filtered, extracted with ether, and the aqueous layer was acidified to give 2 g. (84%) of white crystalline 2,6-dimethylbenzoic acid melting at 114.5–115°. There was no melting point depression when it was mixed with an authentic sample.

Anal. Calcd. for $C_9H_{10}O_2$: mol. wt. by neut. equiv., 150.2. Found: mol. wt. by neut. equiv., 149.5.

Schmidt Reaction of 2,6-Dimethylacetophenone.—To 15.4 g. (0.1 mole) of an ice-cooled solution of 2,6-dimethylacetophenone (IV) in 71 ml. of 90% sulfuric acid was added 8.3 g. (0.13 mole) of powdered sodium azide during 2 hours. The mixture was stirred for an additional 6 hours at ice temperature and for 8 hours at room temperature. The mixture was poured onto cracked ice and the resulting oil was extracted with ether. Concentration of the dried ether solution gave 5.5 g. of brown solid, which crystallized from water to give white crystals of 1-methyl-5-[2-*m*-xylylamino]-tetrazole melting at 154–155°.

Anal. Calcd. for $C_{10}H_{13}N_5$: C, 59.1; H, 6.45; N, 34.5. Found: C, 58.9; H, 6.45; N, 34.6.

The sulfuric acid layer was made alkaline, but no oil or solid was produced. However, five extractions with ether removed 7.5 g. of brown solid. After several crystallizations from benzene (with bone-blacking) a white crystalline compound was obtained which melted at 175–177°.

Anal. Calcd. for $C_{10}H_{13}NO$: C, 73.6; H, 8.03; N, 8.58. Found: C, 73.5; H, 8.08; N, 9.10.

This compound gave no mixed melting point depression with 2,6-dimethylacetanilide, and its infrared spectrum was identical with that of 2,6-dimethylacetanilide.

1-Methyl-3-(2-*m*-xylyl)-thiourea (IX).—2,6-Dimethylaniline (7.2 g., 0.06 mole) and methyl isothiocyanate (4.4 g., 0.06 mole) reacted in 10 ml. of absolute alcohol. No heat of reaction was observed, but after standing at room temperature for six days with a five-minute heating (70°) period each day, a copious white precipitate was formed. Recrystallization of the solid from ethanol–water gave 8 g. (70%) of white 1-methyl-3-(2-*m*-xylyl)-thiourea melting at 140–141°.

Anal. Calcd. for $C_{10}H_{14}N_2S$: S, 16.5. Found: S, 16.4.

1,S-Dimethyl-3-(2-*m*-xylyl)-isothiourea (X).—To an ice-cooled solution of 1-methyl-3-(2-*m*-xylyl)-thiourea (9.5 g., 0.049 mole) in 25 ml. of absolute ethanol was added 7.4 g. (0.052 mole) of methyl iodide. The mixture was kept at −5° for 21 days, refluxed for 1 hour, and filtered. Dry ether was added to produce 15.7 g. (96%) of 1,S-dimethyl-3-(2-*m*-xylyl)-isothiourea hydroiodide, which after recrystallization from absolute alcohol–ether melted at 177–178°.

Anal. Calcd. for $C_{11}H_{17}N_2SI$: S, 9.5. Found: S, 10.0.

1-Methyl-2-(2-*m*-xylyl)-3-aminoguanidine (XI).—An absolute ethanol (40 ml.) solution of 1,S-dimethyl-3-(2-*m*-xylyl)-isothiourea hydroiodide (13.5 g., 0.04 mole) and hydrazine (1.5 g. of 95%, 0.04 mole) was refluxed for 4 hours, after which no odor of mercaptan was noticeable. The alcoholic solution was evaporated to dryness under reduced pressure. The solid residue was dissolved in the minimum amount of absolute ethanol and precipitated by the addition of dry ether to give 11 g. (85%) of 1-methyl-2-(2-*m*-xylyl)-3-aminoguanidinium iodide melting at 135–138° (dec.).

Anal. Calcd. for $C_{10}H_{17}N_4I$: I, 39.6. Found: I, 39.9.

1-Methyl-5-(2-*m*-xylylamino)-tetrazole (VIII).—A solution of 4 g. (0.013 mole) of 1-methyl-2-(2-*m*-xylyl)-3-aminoguanidinium iodide in 125 ml. of water was warmed to 50° and acidified with 0.16 g. (0.008 mole) of concentrated nitric acid. A solution of 2.12 g. (0.013 mole) of silver nitrate in 26 ml. of water was added dropwise with stirring during 0.5 hour. After an additional 0.3 hour of stirring, excess silver ion was precipitated with 0.2 ml. of concentrated hydrochloric acid. The silver iodide was filtered and washed with two 20-ml. portions of warm water, and the washings were added to the filtrate. The filtrate was cooled to 5° and 1 ml. of concentrated hydrochloric acid was added, after which a solution of sodium nitrite (0.86 g., 0.013 mole) in 26 ml. of water was added with stirring during 0.8 hour. After an additional 0.2 hour of stirring, anhydrous sodium carbonate (1.5 g., 0.014 mole) was added portionwise. The resulting mixture was stirred at room temperature for 0.5 hour, reacidified with concentrated hydrochloric acid (slightly acid to litmus), and the resulting brown solid was filtered. Crystallization (with clarification) from boiling water produced 1.5 g. (59%) of white 1-methyl-5-(2-*m*-xylylamino)-tetrazole which melted at 154–155° and gave no melting point depression with the tetrazole produced by the Schmidt reaction with 2,6-dimethylacetophenone.

2,6-Dimethylstyrene (II).—2,6-Dimethylphenylmethylcarbinol (I, 29 g., 0.19 mole) was dehydrated over activated alumina at 270–280° under 10 mm. of nitrogen. The catalyzate, collected in a Dry Ice trap, was warmed to room temperature, separated from water, dried and distilled under nitrogen in the presence of 2 g. of *p*-*t*-butylcatechol to give 19 g. (75%) of 2,6-dimethylstyrene; b.p. 65.8–66.0° (10 mm.), n^{20}_{D} 1.5314, d^{20}_{20} 0.9094, $\lambda_{C_6H_{12}\ max}$ (ϵ) 238 mμ (7240),

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[18] H. E. Zaugg and W. M. Lauer, *Ind. Eng. Chem., Anal. Ed.*, **20**, 1022 (1948).

[19] M. S. Newman and H. L. Holmes, "Organic Syntheses," Coll. Vol. II, John Wiley and Sons, Inc., New York, N. Y., 1943, p. 429.

λ_{max} 3.38 μ, 3.63, 4.23, 5.23, 5.44, 6.12, 6.28, 6.81, 7.15, 7.23, 8.60, 9.15, 10.05, 10.90, 13.00.

Anal. Calcd. for $C_{10}H_{12}$: C, 90.8; H, 9.15. Found: C, 91.1; H, 9.27.

2,6-Dimethyl-α,β-dibromoethylbenzene.—To an ice-cooled, stirred solution of 10.9 g. (0.083 mole) of 2,6-dimethylstyrene in 130 ml. of dry ether was added 13.2 g. (0.083 mole) of bromine during 30 minutes. The bromine was consumed rapidly. The reaction product was concentrated and distilled to give 19.5 g. (81%) of 2,6-dimethyl-α,β-dibromoethylbenzene [b.p. 132–137° (7 mm.)]. It solidified in the receiver (with evolution of heat) and was crystallized from petroleum ether (b.p. 30–60°) to give white crystals melting at 48–50°.

Anal. Calcd. for $C_{10}H_{12}Br_2$: Br, 54.7. Found: Br, 54.9.

2,6-Dimethylethylbenzene.—An ethanol solution of 12 g. (0.091 mole) of 2,6-dimethylstyrene was shaken at room temperature under 18 p.s.i.g. of hydrogen in the presence of 0.5 g. of 10% palladium–carbon catalyst. Hydrogen was not absorbed. The palladium–carbon was replaced by 0.1 g. of platinum oxide catalyst, whereupon reduction proceeded at room temperature under 18 p.s.i.g. of hydrogen. When hydrogen absorption ceased (2 hours) the mixture was filtered and concentrated under reduced pressure to yield 11 g. of liquid residue. The residue was washed with 100 ml. of 2% aqueous permanganate followed by water, dried over anhydrous magnesium sulfate, and distilled from sodium to produce 7 g. (58%) of 2,6-dimethylethylbenzene boiling at 81–82° (20 mm.). Its ultraviolet and infrared spectra indicated the presence of 4 mole % of 2,6-dimethylstyrene. Therefore, 3.7 g. of the impure material was brominated at room temperature in petroleum ether (b.p. 30–60°) with 6 mole % of bromine. Distillation of the reaction product gave 2,6-dimethylethylbenzene whose ultraviolet and infrared spectra were identical with those reported in the literature[20]; b.p. 81–82° (20 mm.), n^{20}_D 1.5100, d^{20}_4 0.8915; literature values,[16] b.p. 82.2° (20 mm.), n^{20}_D 1.5107, d^{20}_4 0.8905.

2,6-Dimethylbenzoylformic Acid (III).—2,6-Dimethylstyrene (17 g., 0.13 mole) was stirred and refluxed with 300 ml. of 1.5% aqueous potassium hydroxide while 60 g. (0.38 mole) of potassium permanganate was added during 2 hours. The mixture was stirred and refluxed for 18 hours. The reaction mixture was filtered, the filtrate was extracted with ether, and the aqueous layer was cooled and acidified. The resulting yellow oil was removed by ether, and the extract was dried and concentrated to yield 23 g. of acid. The acid was refluxed azeotropically with a mixture of 200 ml. of benzene, 50 ml. of absolute ethanol and 2.5 ml. of 96% sulfuric acid. After water was no longer produced, the reaction mixture was concentrated under reduced pressure. The residue was dissolved in ether, and the ether solution was washed with aqueous sodium bicarbonate and water, dried over anhydrous magnesium sulfate, and distilled to give 5.5 g. of ethyl 2,6-dimethylbenzoylformate [yellow liquid boiling at 89–91° (0.3 mm.), n^{20}_D 1.5072, d^{20}_{20} 1.0837].

Anal. Calcd. for $C_{12}H_{14}O_3$: mol. wt. by sapn. equiv., 206. Found: mol. wt. by sapn. equiv., 201.

Ethyl 2,6-dimethylbenzoylformate (5 g., 0.024 mole) was refluxed for 3 hours with 40 ml. of 5% aqueous potassium hydroxide. The cooled reaction mixture was extracted with ether, and the aqueous layer was heated on a steam-bath to remove traces of ether, then cooled and acidified to yield a yellow oil which was extracted with ether. The extract was dried and concentrated to produce 4.3 g. of 2,6-dimethylbenzoylformic acid (III). The acid, crystallized from carbon bisulfide or carbon tetrachloride, melted at 76–78°.

Anal. Calcd. for $C_{10}H_{10}O_3$: C, 67.4; H, 5.66. Found: C, 67.3; H, 5.80.

The *p*-bromophenacyl ester of 2,6-dimethylbenzoylformic acid, crystallized from ethanol, melted at 100–100.5°.

Anal. Calcd. for $C_{18}H_{15}O_4Br$: C, 57.6; H, 4.03; Br, 21.3. Found: C, 58.0; H, 4.03; Br, 21.1.

2,6-Dimethylbenzoylformic acid was converted to the acid chloride by means of thionyl chloride, and the latter was treated with *p*-bromoaniline to produce the *p*-bromoanilide of 2,6-dimethylbenzoylformic acid; m.p. 138–139°, crystallized from aqueous ethanol.

Anal. Calcd. for $C_{16}H_{14}NO_2Br$: C, 57.8; H, 4.25; N, 4.22; Br, 24.1. Found: C, 58.2; H, 4.18; N, 4.49; Br, 24.0.

2,6-Dimethylbenzoylformic acid (III, 2 g., 0.011 mole) was dissolved in 10 ml. of cold 96% sulfuric acid and the orange solution was heated at 40–50° for 2 hours with occasional stirring while carbon monoxide was liberated. When no further gas was evolved, the solution was cooled and poured onto cracked ice to produce a white crystalline compound, which was washed with water and recrystallized from petroleum ether (b.p. 60–80°) to yield 0.5 g. (30%) of 2,6-dimethylbenzoic acid melting at 115–116° which gave no melting point depression when admixed with an authentic sample.

Permanganate Oxidation of Styrene.—Styrene (13.5 g., 0.13 mole) was refluxed and stirred with 300 ml. of 1.5% aqueous potassium hydroxide solution while 60 g. (0.38 mole) of potassium permanganate was added during 2 hours. The mixture was stirred and refluxed for 18 additional hours. The hot alkaline mixture was filtered and neutralized to give 15 g. (97%) of benzoic acid melting at 121–122°.

Ultraviolet and Infrared Spectra.—Ultraviolet spectra were measured in cyclohexane solution with a Carey recording quartz model 11 spectrophotometer, and infrared spectra were measured with a Baird recording infrared spectrophotometer. Liquids were run without solvent in a 0.020-mm. cell, whereas solids were run in carbon bisulfide solution or in a Nujol mull.

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(20) Am. Pet. Inst. Res. Proj. 44, Carnegie Inst. Tech. Catalog of Infrared Spectral Data, Serial No. 735, 2,6-dimethylethylbenzene, contributed by Shell Development Co., *ibid.*, Catalog of Ultraviolet Spectral Data, Serial No. 150, 2,6-dimethylethylbenzene, contributed by Shell Development Co.