difficulty was experienced in inducing the substance to crystallize. Success was attained, however, by dissolving it in a warm mixture of benzene and ligroin and seeding with a few crystals which were obtained by allowing a little of the solution to remain on a watch glass at room temperature for several days. The substance was obtained as thick, white plates melting at 43–44° (corr.).

Preparation of *sym-m*-Chloro-*p'*-methoxydiphenylethylene.—This stilbene was obtained in 60% yield by heating for thirty minutes the above carbinol with twenty parts of a solution consisting of 20% concentrated hydrochloric acid in glacial acetic acid. The crude material was isolated by diluting the solution with water. Recrystallized from alcohol the substance was obtained as cream colored leaves melting at 96° (corr.).

Summary

The explanation of the mechanism of the reduction of unsymmetrical benzoins which was previously advanced has been substantiated in the present work.

m-Chlorobenzanisoin, which has not been described previously, is shown to be *m*-chloro-α-hydroxybenzyl *p*-methoxyphenyl ketone by an independent synthesis.

When reduced under suitable conditions this benzoin was found to produce *m*-chlorobenzyl *p*-methoxyphenyl and *p*-methoxybenzyl *m*-chlorophenyl ketones, the structures of which were established. In the course of this work thirteen new compounds were prepared and characterized.

BALTIMORE, MARYLAND

RECEIVED JUNE 15, 1933
PUBLISHED SEPTEMBER 5, 1933

[CONTRIBUTION FROM THE KEDZIE CHEMICAL LABORATORY, MICHIGAN STATE COLLEGE]

Some Mono and Dibromo Derivatives of Meta Cresol. II

BY RALPH C. HUSTON AND WALTER J. PETERSON

In a recent report[1] from this Laboratory several new bromo derivatives of *m*-cresol were prepared and their structures conclusively proved. A continuation of this work has resulted in the preparation of several new derivatives. Two new methods for the protection of positions during bromination have been developed.

6-Bromo-*m*-cresols

From 6-Amino-*m*-cresols.—Pure *m*-cresol was nitrated according to the method of Staedel and Kolb,[2] and the isomeric products separated by steam. The volatile 6-nitro product (m. p. 56°) was converted to the 6-amino hydrochloride by reduction in alcohol with stannous chloride and hydrochloric acid.[3] Attempts to change the hydrochloride (m. p. 212°) to the free base were unsuccessful. The free amine (m. p. 157°) may be obtained by reduction of the nitro compound in accordance with the method of Hodgson and Beard.[4] 6-Nitro-*m*-cresol (33 g.) was treated with 400 cc. of water containing

---

[1] Huston and Hutchinson, THIS JOURNAL, **54**, 1504 (1932).

[2] Staedel and Kolb, *Ann. Chem.*, **259**, 210 (1890).

[3] (a) Raiford and Leavell, THIS JOURNAL, **36**, 1505 (1914); (b) Raiford, *Am. Chem. J.*, **46**, 419 (1911).

[4] Hodgson and Beard, *J. Chem. Soc.*, **127**, 498 (1925).

60 g. of sodium carbonate. This was treated at the boiling point with 126 g. of solid sodium hydrosulfite. 6-Amino-*m*-cresol[5] was deposited on cooling in almost colorless fine needles melting at 157–159°.

Ten grams of the hydrochloride, dissolved in 16 g. of concd. sulfuric acid and 80 cc. of water, was diazotized below 20° with a solution of 6 g. of sodium nitrite in 125 cc. of water. Replacement of the diazonium group with bromine was effected by dropping the solution into a hydrobromic acid–cuprous bromide solution[6] (from 5 g. of copper sulfate), while a vigorous current of steam was passed through the reaction mixture. The oil in the distillate was extracted with ether and distilled. Four grams of 6-bromo-*m*-cresol came over at 81–82° (4 mm.). The identity with the product formed by direct bromination[1] was proved by boiling point at atmospheric pressure, analysis and bromination[7] to 4,6-dibromo-*m*-cresol[1] (m. p. 65–66°), the benzoyl ester of which melted at 84–85°.

2-Bromo-*m*-cresol

From 2-Nitro-*m*-cresol.—Nitration of *m*-cresol was carried out in fuming sulfuric acid of higher sulfur trioxide content than that used by Gibson,[8] or Hodgson and Beard.[4] A cold solution of 150 g. of *m*-cresol in 100 cc. of fuming sulfuric acid (23% SO_3) was treated with a mixture of 100 cc. of fuming sulfuric acid and 46 cc. nitric acid (1.5) and allowed to stand overnight. The mixture was diluted with 500 cc. of water and heated to 180° on an oil-bath. Decomposition with superheated steam gave 43 g. of 2-nitro-*m*-cresol (m. p. 39°) and 40 g. of *m*-cresol.

Reduction of 33 g. of the nitrocresol by means of sodium hydrosulfite gave 20 g. of 2-amino-*m*-cresol. Eleven grams of this gave, upon diazotization and decomposition with hot hydrobromic acid–cuprous chloride solution (see above), 7.5 g. of an oil which boiled at 83–84° (4 mm.) and solidified on standing. Recrystallization from alcohol gave large monoclinic crystals melting at 58.5–59°.

Anal. Calcd. for C_7H_7OBr: Br, 42.78. Found: Br, 42.62.

A portion of the 2-bromo-*m*-cresol, brominated in cold carbon tetrachloride with one mole of bromine, yielded a portion of uncrystallizable oil (probably 2,6-dibromo-*m*-cresol) and a crystalline fraction which was proved to be 2,4-dibromo-*m*-cresol by melting point (65°) and ester formation.

Methylation of the sodium salt of 2-bromo-*m*-cresol by means of methyl iodide gave a methyl ether melting at 39.5–40°. Hodgson and Beard[4] give 35.5–36.5°.

Anal. Calcd. for C_8H_9OBr: Br, 41.13. Found: Br, 40.98.

By Bromination in Fuming Sulfuric Acid.—To a cold solution of 108 g. of *m*-cresol in 450 cc. of fuming sulfuric acid (23% SO_3), 160 g. of bromine was added very slowly. After 24 hours, the liquid was diluted with 500 cc. of water and heated on an oil-bath to 180°. Steam was passed through the hot solution for about three hours, during which time the temperature was maintained between 180 and 210°. Repeated distillations of the product, using a 20-cm. column and a vacuum of 4 mm., resulted in a large fraction (100.7 g.) boiling at 80–85° and 13.5 g. boiling at 114–116°. The 80–85° fraction, when seeded with a crystal of the 2-bromo-*m*-cresol prepared by diazotization, crystallized immediately. After standing overnight in an ice box, the 2-bromo-*m*-cresol, which made up more than half of the weight of the fraction, was filtered off by suction and recrystallized from alcohol, m. p. 58.5–59°. The uncrystallizable oil came over after refractionation at 80–81° (4 mm.). Preparation of its benzene sulfonyl ester

---

(5) Auwers, Borsche and Weller, *Ber.*, **54**, 1315 (1921).

(6) Bigelow, "Organic Syntheses," Vol. V, p. 21.

(7) Bromination in cold chloroform with 1 mole of bromine gave, in addition to 4,6-dibromo-*m*-cresol, a small amount of oil having the properties of 2,6-dibromo-*m*-cresol.

(8) Claus, *J. prakt. Chem.*, [2] **39**, 61 (1888).

(m. p. 92–93°) proved it to be 6-bromo-*m*-cresol. Ester formation of the fraction boiling at 114–116° proved it to be 2,6-dibromo-*m*-cresol.

By Bromination of the Disulfonic Acid in Alkaline Solutions.—A mixture of one mole (108 g.) of *m*-cresol and 3.5 moles (350 g.) of concentrated sulfuric acid in a three-liter three-necked flask was heated on a steam-bath for three to four hours. At the end of this time the reaction mixture was cooled, the stirring motor attached and the mixture made alkaline with a solution of 7 moles (280 g.) of sodium hydroxide dissolved in 700 cc. of water. The alkaline solution was then cooled to room temperature and brominated slowly with one mole (160 g.) of bromine (during this operation the temperature may be allowed to rise to 40–50°). The mixture was then steam distilled over an oil-bath at 150°. This removed any tribromo-*m*-cresol present. When no more of the tribromo product was observed in the distillate, the distillation was stopped and the mixture, still on the oil-bath, evaporated to a thick pasty mass. This was then allowed to cool and acidified with 800 cc. of concentrated sulfuric acid. (This must be done slowly due to the rapid evolution of hydrogen bromide.) The mixture was again distilled by steam, this time in an oil-bath at 200–210°. The distillate on fractionation gave 37.3 g. boiling at 80–85° (4 mm.) which crystallized on being seeded with 2-bromo-*m*-cresol. From this fraction 13.1 g. of an uncrystallizable oil was separated which boiled at 80–81° (4 mm.) and which was identified as 2-bromo-*m*-cresol. This method of bromination yields a larger portion (43.0 g.) of the 2,6-dibromo-*m*-cresol boiling at 114–116° (4 mm.) than does bromination in fuming sulfuric acid.

2,6-Dibromo-*m*-cresol

From *p*-Nitro-*m*-cresol.—Fifty-eight grams of *p*-nitro-*m*-cresol, when brominated in glacial acetic acid at 15–20° with two moles of bromine, yielded 56.9 g. of 2,6-dibromo-4-nitro-*m*-cresol[8] melting at 134°.

The hydrochloride of 2,6-dibromo-4-amino-*m*-cresol was prepared by reduction in alcohol with stannous chloride and hydrochloric acid according to the method of Raiford.[3b]

For replacement of the amino group with bromine, a modification of the procedure of Bigelow, Johnson and Sandborn[9] for the preparation of *m*-bromotoluene was used. To a cold mixture of 48 cc. of 45% alcohol and 12 cc. of sulfuric acid in one-liter round-bottomed flask provided with a mechanical stirrer was added 20 g. of the hydrochloride of 2,6-dibromo-4-amino-*m*-cresol. The solution was cooled to 10° and a solution of 9 g. of sodium nitrite in 16 cc. of water was added from a separatory funnel. Stirring was continued for a half hour. To the diazotized solution was added 3 g. of reduced copper powder. The stirrer was replaced by a reflux condenser. The flask was warmed cautiously until a vigorous evolution of gas began and was then immersed in ice water. When the reaction had moderated, the flask was heated for ten minutes on a steam-bath. One hundred and twenty cc. of water was added and the mixture was steam distilled. The distillate, after washing and extraction, was fractionated. The bulk of the yellow oil (8.3 g.) came over at 114–116° (4 mm.).

Anal. Calcd. for $C_7H_6OBr_2$: Br, 60.15. Found: Br, 60.32.

A portion of the oil brominated in carbon tetrachloride in the cold yielded 2,4,6-tribromo-*m*-cresol, melting at 80–81°.[10]

By Bromination of the Para Sulfonic Acid in Alkaline Solution.—A mixture of one mole (108 g.) of *m*-cresol and one mole of concentrated sulfuric acid (96 g.) in a two-liter three-necked flask was heated in a water-bath for three hours. The mixture was then cooled and 160 g. of sodium hydroxide in 375 cc. of water was added. The alka-

---

[9] Bigelow, Johnson, Sandborn, "Organic Syntheses," Vol. VI, p. 16.

[10] Werner, *Bull. soc. chim.*, 2, 46, 276; Auwers and Richter, *Ber.*, **32**, 3382 (1899); Bures and Balada, *Casopis Ceskoslov. Lekamista*, [6] **107**, 190 (1926).

line solution was cooled to room temperature and brominated (40–50°) with 320 g. of bromine. The rest of the procedure (steam distillation, evaporation and distillation) was carried out as in the preparation of 2-bromo-*m*-cresol by the similar method. The fractionated distillate yielded, besides some tribromo-*m*-cresol, 48 g. of 2,6-dibromo-*m*-cresol. Esters were prepared by the method of Einhorn and Holland.[11]

TABLE I

Benzoyl ester of *m*-cresol	Crystals from alcohol	M. p., °C.	Bromine, % Calcd.	Bromine, % Found
2-Bromo	Small colorless plates	59 – 60	27.49	27.58
6-Bromo	Small needles	87.5– 88	27.49	27.58
2,4-Dibromo	Fine needles	81 – 81.5	43.24	43.18
2,6-Dibromo	Fine needles	89.5– 90	43.24	43.40
2,4,6-Tribromo	Small needles	84 – 85	53.45	53.39
Benzene sulfonyl ester of *m*-cresol				
2-Bromo	Small plates	70 – 71	24.46	24.39
6-Bromo	Small plates	92 – 93	24.46	24.34
2,4-Dibromo	Small plates	92 – 92.5	39.41	39.49
2,6-Dibromo	Small plates	94 – 95	39.41	39.52
2,4,6-Tribromo	Plates	117 –117.5	49.28	49.20
p-Toluene sulfonyl ester of *m*-cresol				
2-Bromo	Needle-like plates	85 – 85.5	23.43	23.34
6-Bromo	Needle-like plates	72.5– 73	23.43	23.52
2,4-Dibromo	Small plates	89.5– 90	38.00	38.13
2,6-Dibromo	Fine needles	122 –123	38.00	38.09
2,4,6-Tribromo	Small plates	113 –114	48.09	48.17

Summary

1. New bromine derivatives of *m*-cresol were prepared.

2. A new method for the bromination of *m*-cresol in fuming sulfuric acid was developed.

3. Simple diazotization methods have been found applicable for the replacement of amino groups in phenolic compounds with hydrogen and bromine.

EAST LANSING, MICHIGAN

RECEIVED JUNE 16, 1933
PUBLISHED SEPTEMBER 5, 1933

---

(11) Einhorn and Holland, *Ann.*, **301**, 95 (1898).