Hexa-*p*-cyclohexylphenylethane and Tri-*p*-cyclohexylphenylmethyl Peroxide.—A solution of 0.5244 g. (0.001 mole) of tri-*p*-cyclohexylphenylchloromethane in 10 cc. of dry toluene was shaken for about forty-eight hours with 0.04 g. of molecular silver in an atmosphere free from oxygen. Light was excluded by wrapping the tube in dark paper. When the silver chloride was allowed to settle after the shaking period, the solution was a deep red. Cooling this mixture in a solid carbon dioxide–acetone bath did not diminish appreciably the depth of the color, thus indicating a high degree of dissociation of the ethane.

When the tube was opened to the air, the color was discharged almost instantly. The solution was filtered, and most of the toluene was evaporated. The residue was crystallized from an ether–alcohol mixture. The pure peroxide melted at 151–152°.

Anal. Calcd. for $C_{74}H_{90}O_2$: C, 87.85; H, 8.98. Found: C, 87.62; H, 9.20.

Tri-*m*-tolylchloromethane.—This product was prepared by the same general procedure described above for tri-*p*-cyclohexylphenylchloromethane. From 86.5 g. of *m*-bromotoluene, 28 g. of crude tri-*m*-tolylcarbinol was obtained. This was a viscous, light yellow oil. Treatment with hydrogen chloride in ether solution gave the chloromethane. After recrystallization from low-boiling petroleum ether saturated with hydrogen chloride, the yield of product was 10 g.; m. p. 84–85°.

Anal. Calcd. for $C_{22}H_{21}Cl$: Cl, 11.05. Found: Cl, 11.18.

Hexa-*m*-tolylethane and Tri-*m*-tolylmethyl Peroxide.—The ethane was prepared as above from 0.3206 g. (0.001 mole) of the chloromethane in 10 cc. of toluene. This hydrocarbon solution was distinctly orange in color. Cooling the solution in a solid carbon dioxide–acetone bath caused the color to fade to a light yellow.

The tube was opened, and the contents filtered. The color was soon discharged. The toluene was evaporated, and the product was crystallized from a mixture of benzene and alcohol. The peroxide melted at 158–159°.

Anal. Calcd. for $C_{44}H_{42}O_2$: C, 87.66; H, 7.03. Found: C, 87.73; H, 6.90.

Summary

1. Hexa-*p*-cyclohexylphenylethane and hexa-*m*-tolylethane have been obtained in solution, and the corresponding peroxides have been characterized.

2. Comparisons of the colors of toluene solutions of equivalent concentrations indicate that hexa-*p*-cyclohexylphenylethane is less highly dissociated than is hexabiphenylethane, and that hexa-*m*-tolylethane is dissociated to about the same extent as hexa-*p*-tolylethane.

URBANA, ILLINOIS RECEIVED APRIL 8, 1937

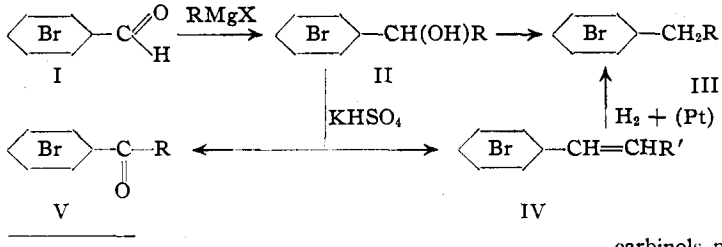
[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS]

Hexaalkylphenylethanes. IV. Preparation of Some Alkylbromobenzenes[1]

BY J. H. BROWN AND C. S. MARVEL

In connection with the study of the effect of alkyl groups on the dissociation of hexaarylethanes, considerable work has been expended on a study of the preparation of a series of alkylbromobenzenes. Since it will likely be some time before the corresponding hexaalkylphenylethanes can be prepared from these intermediates, it seems wise to describe these synthetic experiments at the present time.

The general reaction which has been used in this work has been to treat *m*- or *p*-bromobenzaldehyde (I) with a Grignard reagent to yield the corresponding alkylbromophenylcarbinol (II), which was then reduced or dehydrated and reduced to yield the alkylbromobenzene (III). One interesting fact which was uncovered is that attempts to dehydrate the *p*-alkylbromophenylcarbinols (II) by heating them with potassium bisulfite leads to their oxidation to ketones (V), as well as to their dehydration to olefin derivatives (IV).



m-Bromoethylbenzene was prepared by the above general method, and also in 12% yields from ethylbenzene by nitration, reduction, acylation, bromination, hydrolysis and diazotization, followed by replacement of the diazonium group with hydrogen.

Experimental Part

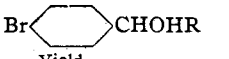
***p*-Alkylbromophenylcarbinols.**—Using the usual technique for the Grignard reaction, *p*-bromobenzaldehyde was treated with various alkylmagnesium halides, and the carbinols purified by distillation under reduced pressure or, in the case of *p*-laurylbromophenylcarbinol, by re-

(1) For the third communication in this series, see Brown and Marvel, THIS JOURNAL, **59**, 1175 (1937).

crystallization from 95% alcohol. The results of these experiments are collected in Table I.

TABLE I

p-ALKYLBROMOPHENYLCARBINOLS



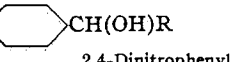
R	B. p., °C.	Mm.	Yield, %	d^{20}_4	$n^{20}D$	Bromine, % Calcd.	Found
n-C_4H_9	122–127	1	85	1.2994	1.5416	32.88	31.65
n-C_7H_{15}	149–150	1	74	1.1975	1.5305	28.03	27.46
n-$C_{10}H_{21}$	185–188	2	82	....	....	24.43	24.26
n-$C_{12}H_{25}$	49–50[a]		66	....	....	22.50	22.54

[a] Melting point.

a warm solution was used, the halogen was removed from the molecule rather rapidly.[3]

Reduction of the carbinols with red phosphorus and iodine in glacial acetic acid gave satisfactory yields of the desired *p*-alkylbromobenzenes. The general procedure used was to dissolve 2 g. of iodine in 75 cc. of glacial acetic acid, and add 2.5–3 g. of red phosphorus. After about fifteen minutes, 1 cc. of water and 20–30 g. of *p*-bromophenylalkylcarbinol were added, and the mixture was boiled under a reflux condenser for four to six hours. A few grams of mossy zinc was then added, and the solution was boiled for about another hour. The mixture was filtered and poured into water. The product was collected in ether, washed with sodium bicarbonate solution, and purified by distillation under reduced pressure. The results of these experiments are collected in Table III.

TABLE II

DEHYDRATION OF 

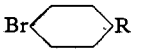
R Group	Carbinol used, g.	Temp. of bath, °C.	Time of heating hrs.	Yield of ketone	M. p. ketone, °C.	Anal. Br, % Calcd.	Found	2,4-Dinitrophenylhydrazone M. p., °C.	N, % Calcd.	Found	Yield olefin, %	B. p. of olefin °C.	Mm.
n-C_4H_9	40	150–165	2	None	...	...	...	.....	...	...	21	98–100	1
n-C_4H_9	20	180–200	3	Trace[a]	...	...	...	.....	...	...	12	101–102	2
n-C_7H_{15}	50	150–170	4	6%	68–69	28.23	28.34	149–150	12.09	12.15	16	145–155	1
n-$C_{10}H_{21}$	50	175–180	4	Some	56–57	24.58	24.33	113–114	11.08	11.20	31	166–169	1
n-$C_{12}H_{25}$	40	175	5	Considerable	63–64[b]	[c]	[c]	109–110	10.20	10.58	25	198–200[d]	2
n-$C_{12}H_{25}$	15	195–205	3	Trace	...	...	...	.....	...	...	11	198–200	2

[a] The presence of a ketone was demonstrated by the formation of a 2,4-dinitrophenylhydrazone, but the quantity was too small for the isolation and purification of a sample for analysis. [b] The semicarbazone of this ketone melts at 107–108°. [c] Calcd. for $C_{19}H_{29}OBr$: C, 64.60; H, 8.29. Found: C, 64.32; H, 8.17. [d] M. p., 28–30°. Calcd. for $C_{19}H_{29}Br$: C, 67.63; H, 8.67. Found: C, 67.26; H, 8.55.

Dehydration of *p*-Alkylbromophenylcarbinols with Potassium Acid Sulfate.—A mixture of one part of carbinol and two parts of fused potassium acid sulfate was heated at temperatures varying from 150 to 180°. The salt was then washed out with water, and the residual organic material was distilled under reduced pressure. The product thus obtained proved to be a mixture of the desired olefin derivative and the ketone which would be expected from oxidation of the carbinol. By treating the crude reaction mixture before distillation with cold alcohol, some of these ketones were obtained in a pure form. Experiments at different temperatures indicated that the temperature influenced the rate of the competing reactions, dehydration and oxidation. If dehydration was accomplished quickly, less ketone was present in the final product. Most of the olefin derivatives obtained by this method were contaminated with some ketone, however, and the analytical results and physical constants do not seem to be especially significant. Hence, only the boiling points will be recorded for the olefin derivatives. The ketones were usually obtained in a pure condition, and derivatives were obtained for confirmation. The results of these experiments are given in Table II.

***p*-Alkylbromobenzenes.**—Catalytic reduction of the olefin derivatives obtained in the experiments just described was carried out, using the platinum oxide–platinum black of Adams, Voorhees and Shriner.[2] This reaction proved to be rather unsatisfactory, as the higher *p*-bromophenylalkenes were not soluble in cold alcohol, and when

TABLE III

p-ALKYLBROMOBENZENES. 

R =	Yield, %	B. p., °C.	Mm.	d^{20}_4	$n^{20}D$	Anal. Br, % Calcd.	Found
n-C_5H_{11}	60	113–115	5	1.2379	1.5545	35.19	35.13
n-C_8H_{17}	74	125–126	1	1.1446	1.5311	29.70	29.68
n-$C_{11}H_{23}$	56	165–166	2	1.0917	1.5179	25.69	25.80
n-$C_{13}H_{27}$	67	182–185	1	[a]		23.56	23.21

[a] Solid, m. p. 31–32°.

***m*-Bromophenylmethylcarbinol.**—The Grignard reagent prepared from 57 g. of methyl iodide was treated with 63 g. of *m*-bromobenzaldehyde. On working up this reaction mixture, 46 g. (66% of the theoretical amount) of *m*-bromophenylmethylcarbinol boiling at 136–140° at 20 mm. was obtained; $n^{20}D$ 1.5655; d^{20}_4 1.4697.

Anal. Calcd. for C_8H_9OBr: Br, 39.74. Found: Br, 39.62.

***m*-Bromostyrene.**—A solution of 30 g. of the above carbinol in 100 cc. of dry benzene was refluxed for five hours with 10 g. of phosphorus pentoxide. The benzene solution was then decanted from the excess phosphorus pentoxide and the phosphoric acid, and the product isolated by distillation. The yield was 14 g. of product boiling at 90–94° at 20 mm.; $n^{20}D$ 1.5855; d^{20}_4 1.4059.

(2) Adams, Voorhees and Shriner, "Organic Syntheses," Coll. Vol. I, John Wiley and Sons, Inc., New York, 1932. p. 452.

(3) See Brown, Durand and Marvel, THIS JOURNAL, **58**, 1594 (1936).

The product polymerized rather quickly, and had to be used immediately to avoid loss.

Anal. Calcd. for C_8H_7Br: Br, 43.65. Found: Br, 43.29.

Dehydration of the carbinol with potassium acid sulfate gave a low yield of the styrene derivative.

m-Ethylbromobenzene.—A solution of 14 g. of freshly prepared *m*-bromostyrene in 50 cc. of alcohol was reduced in the usual fashion with hydrogen in the presence of platinum oxide–platinum black.[2] Twelve grams of *m*-ethylbromobenzene, boiling at 85–86° at 20 mm.; $n^{20}D$ 1.5470, was obtained.

An alternate method of preparation for *m*-ethylbromobenzene consisted of nitrating 100 g. of ethylbenzene by the method of Schultz and Flacksländer[4] to yield 70 g. of mixed ethylnitrobenzenes, boiling at 120–145° at 20 mm. The mixed nitro compounds (40 g.) were dissolved in alcohol (100 cc.) and reduced with hydrogen under three atmospheres pressure, using Rainey nickel[5] (5 g.) as a catalyst. The crude amine mixture was treated with acetic acid and acetic anhydride and brominated, the acetyl group was removed and the remaining mixed ethylbromoaminobenzenes were diazotized and treated with alcohol, as described for the corresponding preparation of *m*-bromotoluene from *p*-toluidine in "Organic Syntheses."[6] From 250 g. of ethylbenzene, 53 g. (12% of the theoretical amount) of *m*-ethylbromobenzene was obtained, b. p. 200–208°; $n^{20}D$ 1.5465; d^{20}_4 1.3493.

Anal. Calcd. for C_8H_9Br: Br, 43.21. Found: Br, 43.11.

(4) Schultz and Flacksländer, *J. prakt. Chem.*, [2] **66**, 153 (1902).

(5) Covert and Adkins, THIS JOURNAL, **54**, 4116 (1932).

(6) "Organic Syntheses," Coll. Vol. I, John Wiley and Sons, Inc., New York, 1932, p. 128.

Summary

p-n-Amyl-, *p-n*-octyl-, *p-n*-undecyl-, *p-n*-tridecyl- and *m*-ethylbromobenzenes have been synthesized, and these many intermediate compounds have been characterized.

URBANA, ILLINOIS RECEIVED APRIL 8, 1937

[CONTRIBUTION FROM THE BORDEN COMPANY, RESEARCH LABORATORIES]

Significance of Quantitative Relationships in Vitamin B Complex Studies[1]

BY R. C. BENDER AND G. C. SUPPLEE

The vitamin B complex is rapidly becoming resolved into a number of chemical entities which may be studied with precision and accuracy of interpretation from the biological point of view. The pure antineuritic factor (vitamin B_1) and pure lactoflavin (vitamin B_2 or G) employed as supplements in suitable basal rations have already served to expedite such research. Substitution of these pure supplements required for maintenance and for the promotion of growth, as well as purification of the gross ingredients of the basal diet, has established the existence of at least one other entity of the vitamin B complex, namely, the antidermatitis or antiacrodynia factor now commonly designated as vitamin B_6.

Vitamin B_1 and lactoflavin are known to be necessary for growth, and other things being equal growth rate of experimental animals is influenced, within limits, by the amount of these factors provided. It appears that vitamin B_6 may also influence rate of growth, but this cannot be stated as a firmly established fact, because it has not been isolated as yet. Notwithstanding this limitation, this factor may be demonstrated by the degree of protection which it provides against the acrodynia type of dermatitis and wherein the growth rate bears an inverse relationship to the incidence of dermatitis.

The data to be presented illustrate a simplified basic scheme for determining the influence of known amounts of pure vitamin B_1 and of pure lactoflavin upon growth rate and the influence of variable amounts of vitamin B_6 for the prevention of dermatitis and its concurrent effect upon growth rate. The significance of the interrelationship of each of these factors upon growth is also shown.

(1) Presented at the Symposium on the Vitamin B Complex, American Chemical Society, Chapel Hill, N. C., April 13, 1937.

Experimental

The basal ration employed was one previously reported from these Laboratories[2] and consisted of the following: vitamin free casein (Labco),[3] 20 parts; sucrose, 69 parts; hydrogenated vegetable oil,[4] 3 parts; salt mixture No. 40,[5] 4 parts; powdered agar-agar, 2 parts; and cod liver oil, 2 parts. White rats from twenty-two to twenty-five days old and weighing from 40 to 45 g. were placed upon this unsupplemented basal ration until initial growth had ceased and decline in weight or stationary weight had

(2) R. C. Bender, S. Ansbacher, G. E. Flanigan and G. C. Supplee, *J. Nutrition*, **11**, 391 (1936); S. Ansbacher, G. C. Supplee and R. C. Bender, *ibid.*, **11**, 401 (1936).

(3) Labco Vitamin Free Casein is distributed by The Casein Co. of America, Inc., Labco Products Dept., New York City.

(4) Crisco.

(5) H. Steenbock and E. M. Nelson, *J. Biol. Chem.*, **56**, 355 (1923).