166. *The Preparation of Some Stilbene Derivatives. Part III.*

By H. J. Barber and R. Slack.

Some alkylstilbene diamidines, which are higher homologues of the therapeutically active 4 : 4′-diamidinostilbene (" Stilbamidine "), have been prepared. The preparation of the required intermediates has involved a study of various synthetic methods in the stilbene series.

The fact that diamidines of the type $NH_2{\cdot}C({:}NH){\cdot}C_6H_4{\cdot}CR{:}CR'{\cdot}C_6H_4{\cdot}C({:}NH){\cdot}NH_2$, especially (I; $R = R' = H$) and (II; $R = R' = CH_3$), have shown trypanocidal activity (Kirk and Sati, *Ann. Trop. Med. Parasitol.*, 1940, **34**, 83; Fulton and Yorke, *ibid.*, 1942, **36**, 131; Napier *et al.*, *Indian Med. Gaz.*, 1942, **77**, 321), has prompted further investigation of derivatives, *e.g.* (III; $R = H$, $R' = CH_3$), (IV; $R = H$, $R' = C_2H_5$), and (V; $R = R' = C_2H_5$).

The preparation of (III) and (IV) presented little difficulty, for it was found that the most convenient method of preparation of the monosubstituted stilbenes was from the parent deoxybenzoin, the method used by Dodds *et al.* (*Proc. Roy. Soc.*, 1939, *B*, **127**, 140) for the stilboestrol series. This method had the disadvantage that the carbinols $CH_2R{\cdot}\overset{|}{C}(OH){\cdot}\overset{|}{C}H{\cdot}CH_2R'$ could lead to a mixture of structural isomerides as well as the normal *cis*- and *trans*-stilbenes. This was corroborated by experiments carried out in these laboratories and by Walton and Brownlee (*Nature*, 1943, **151**, 305). This method also failed with mononuclear hydrogenated deoxybenzoins (Ruggli and Businger, *Helv. Chim. Acta*, 1942, **24**, 112).

In seeking an unambiguous route to (V), that of Barber, Slack, and Woolman (J., 1943, 99) for the corresponding αβ-dimethylstilbene (II) was first examined. Bromination of either *meso*- or racemic γδ-diphenyl-*n*-hexane in acetic acid gave a *hexabromo*-compound which was not orientated. From the *meso*-form a solid *dibromo*-compound was also isolated but the racemic hydrocarbon yielded a non-distillable gum. The solid dibromo-compound was converted by way of the nitrile and iminoether into the diamidine, a sequence which indicates probable 4 : 4′-disubstitution. These products are therefore regarded as 4 : 4′-dibromo-, 4 : 4′-*dicyano*-, and 4 : 4′-*diamidino*-γδ-*diphenyl*-n-*hexanes*.

Other methods, *e.g.*, the decomposition of thiopropiophenone (Linnell and Sharma, *Quart. J. Pharm.*, 1939, **12**, 263) and the thermal decomposition of azines (Curtius and Jay, *J. pr. Chem.*, 1889, **39**, 45; Linnell and Sharma, *loc. cit.*; Barber and Slack, *J. Amer. Chem. Soc.*, 1943, **65**, 1776), gave no promise of success. Some experiments were, however, carried out on the decomposition of substituted dibromobenzaldazines (VI; $R = R' = CH_3$ or C_2H_5) by cuprous cyanide in boiling quinoline, in the hope that loss of nitrogen and cyanation would occur simultaneously. The only product isolated, after treatment with mineral acid, was 4-cyanopropiophenone.

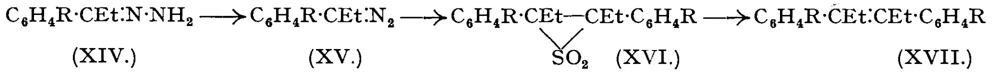
(VI.) $C_6H_4Br{\cdot}CR{:}N{\cdot}N{:}CR'{\cdot}C_6H_4Br$ $C_6H_5{\cdot}CHEt{\cdot}SO_3H$ (VII.)

Model experiments indicated that α-phenylpropyl chloride would not give the sulphonic acid (VII), so Ruggli's method (*Helv. Chim. Acta*, 1931, **14**, 541) was not practicable. Similarly, the direct introduction of the cyano-group by trichloroacetonitrile (Houben and Fischer, *Ber.*, 1933, **66**, 339) failed in the case of stilbene, though a very unstable imine hydrochloride of the type $[CCl_3{\cdot}C({:}NH){\cdot}C_6H_4{\cdot}CH{:}]_2$ was formed. Experiments in other directions included the following scheme :

$$C_6H_4Br{\cdot}CH_2{\cdot}CN \longrightarrow C_6H_4Br{\cdot}CHAc{\cdot}CN \quad \text{(VIII.)} \longrightarrow C_6H_4Br{\cdot}CAc(CN){\cdot}CAc(CN){\cdot}C_6H_4Br \quad \text{(IX.)}$$
$$\longrightarrow C_6H_4Br{\cdot}CHAc{\cdot}CHAc{\cdot}C_6H_4Br \quad \text{(X.)} \longrightarrow C_6H_4Br{\cdot}CAcBr{:}CAcBr{\cdot}C_6H_4Br \quad \text{(XI.}$$

p-Bromophenylacetonitrile reacted smoothly with ethyl acetate in the presence of sodium ethoxide to give *acetyl*-p-*bromophenylacetonitrile* (VIII). Oxidation by perhydrol in glacial acid gave 3 : 4-*dicyano*-3 : 4-*di*-(p-*bromophenyl*)-2 : 5-*diketohexane* (IX), which we failed to hydrolyse.

During this work, Vargha and Kovács (*Ber.*, 1942, **75**, 794) published a synthesis of the intermediate required, *viz.*, 4 : 4′-dibromo-αβ-diethylstilbene, by a modification of a method due to Staudinger (*Ber.*, 1916, **49**, 1942) :



$$C_6H_4R{\cdot}CEt{:}N{\cdot}NH_2 \longrightarrow C_6H_4R{\cdot}CEt{:}N_2 \longrightarrow C_6H_4R{\cdot}\underset{\diagdown\,SO_2\,\diagup}{CEt{-}CEt}{\cdot}C_6H_4R \longrightarrow C_6H_4R{\cdot}CEt{:}CEt{\cdot}C_6H_4R$$

(XIV.) (XV.) (XVI.) (XVII.)

4-*Cyanopropiophenonehydrazone* (XIV; R = CN), when submitted to the above series of reactions, gave a product, presumably 4 : 4′-*dicyano*-αβ-*diethylstilbene* (XVII; R = CN). With the aim of confirming this structure, a parallel synthesis of the well-characterised 4 : 4′-dibromo-αβ-dimethylstilbene (Barber, Slack, and Woolman, *loc. cit.*) from 4-*bromoacetophenonehydrazone* was performed, but the final product contained sulphur (cf. Linnell and Sharma, *loc. cit.*). Similarly 4-cyanoacetophenone failed to give 4 : 4′-dicyano-αβ-dimethylstilbene, so confirmation was still lacking.

The marked influence of R and R′ in the aryl ketones, $C_6H_4R{\cdot}COR'$, on their behaviour in this series of reactions is noteworthy, especially since it is shown that inaccessible anhydrous hydrazine is not always necessary to obtain hydrazones (see table below).

R.	R′.	Product from hydrazine hydrate.	Product from Vargha and Kovács's reactions.
CN	H	Azine	—
Br	CH_3	Hydrazone	No stilbene
Br	C_2H_5	Azine	Stilbene (V. and K., *loc. cit.*)
CN	CH_3	Hydrazone	No stilbene
CN	C_2H_5	Hydrazone	Stilbene

Finally, to settle the structure of our product (XVII; R = CN), we returned to the route from 4 : 4′-dibromodeoxybenzoin with two main aims, *viz.*, the isolation of specimens of *cis*- and *trans*-4 : 4′-dibromo-αβ-dimethylstilbene identical with those obtained from βγ-diphenyl-*n*-butane, and the isolation of a dibromodiethylstilbene, identical with that of Vargha and Kovács (*loc. cit.*), which could be converted into the same dicyanodiethylstilbene as that obtained from *p*-cyanopropiophenonehydrazone.

$$\underset{\text{(XVIII.)}}{C_6H_4Br\cdot CO\cdot CH_2\cdot C_6H_4Br} \longrightarrow \underset{\text{(XIX.)}}{C_6H_4Br\cdot CO\cdot CHR\cdot C_6H_4Br} \longrightarrow \underset{\text{(XX.)}}{C_6H_4Br\cdot CR'(OH)\cdot CHR\cdot C_6H_4Br} \longrightarrow$$

$$C_6H_4Br\cdot CR'{:}CR\cdot C_6H_4Br \quad \text{(XXI.)}$$

An improved method for preparing 4 : 4′-dibromodeoxybenzoin, hitherto made by condensation of *p*-bromophenacetyl chloride with bromobenzene, was found in the addition of the elements of water to 4 : 4′-*dibromotolan* which was readily available from 4 : 4′ : α : β-tetrabromo-αβ-diphenylethane.

4 : 4′-Dibromodeoxybenzoin (XVIII) reacted normally with methyl- and with ethyl-magnesium halides to form 1 : 2-*di*-(p-*bromophenyl*)-n-*propan*-2-*ol* (XX; R = H, R′ = Me) and the corresponding n-*butan*-2-*ol* (XX; R = H, R′ = Et), respectively; these were converted by anhydrous potassium hydrogen sulphate into the corresponding 4 : 4′-*dibromo*-α-*methyl*- and -α-*ethyl*-*stilbenes* (XXI; R = H) and these, in turn, were converted by way of the *nitriles* into 4 : 4′-*diamidino*-α-*methyl*- and -α-*ethyl*-*stilbenes*. *cis*- and *trans*-Forms were obtained in both series but could usually be separated by fractional crystallisation.

4 : 4′-*Dibromo*-α-*methyl*- and -α-*ethyl*-*deoxybenzoin* (XIX; R = Me or Et) were obtained from 4 : 4′-dibromodeoxybenzoin by means of methyl and ethyl iodide, respectively, and 4 : 4′-*dibromo*-α-*benzyldeoxybenzoin* by means of benzyl chloride. The first two compounds reacted normally with methyl- and ethyl-magnesium bromide, respectively. Some difficulty was experienced in dehydrating smoothly the resulting 2 : 3-*di*-(p-*bromophenyl*)-n-*butan*-2-*ol* and 3 : 4-*di*-(p-*bromophenyl*)-n-*hexan*-3-*ol*, (XX; R = R′ = Me) and (XX; R = R′ = Et). Phosphorus tribromide was useless, but acetic anhydride–acetyl chloride or anhydrous potassium hydrogen sulphate was better, and from the resulting oils 4 : 4′-dibromo-αβ-dimethyl- and -αβ-diethyl-stilbenes (XXI; R = R′ = Me or Et) were finally isolated in crystalline form. Treatment of the diethyl compound with bromine gave 4 : 4′ : γ : δ-*tetrabromo*-γδ-*diphenyl*-n-*hexane*.

In this series of experiments, the possibility of the type of rearrangement recorded by Földi (*Ber.*, 1941, **74**, 930), *e.g.*

$$CH_3\cdot O\cdot C_6H_4\cdot CHCl\cdot CO\cdot C_6H_4\cdot O\cdot CH_3 \xrightarrow{2\,C_2H_5MgX} CH(C_6H_4\cdot O\cdot CH_3)_2\cdot CEt_2\cdot OH$$

was not overlooked but unsymmetrically substituted ethylenes were not found in the dehydration products.

EXPERIMENTAL.

Bromination of γδ-Diphenyl-n-*hexane*.—*Solid hydrocarbon*. (*a*) The hydrocarbon (2·3 g.), acetic acid (21 c.c.), and bromine (9·0 g.) were heated under reflux for 4 hours. After cooling, a white crystalline solid (2·8 g.), m. p. 150—190°, separated. Division into two components by washing with ether, followed by separate fractional crystallisation from acetic acid, gave the *dibromo*- (0·4 g.), m. p. 170—172° (Found : Br, 40·2. $C_{18}H_{20}Br_2$ requires Br, 40·4%), and the *hexabromo*-compound, m. p. 215° (decomp.) (Found : Br, 67·1. $C_{18}H_{16}Br_6$ requires Br, 67·2%).

(*b*) The hydrocarbon (10 g.), bromine (33·6 g.), and chloroform (50 c.c.) were heated under reflux for 4 hours, and the solvent then removed by distillation. The solid which separated recrystallised from glacial acetic acid to give the above dibromo-compound (10·2 g., 64·5%).

Liquid hydrocarbon. The hydrocarbon (10 g.), bromine (33·6 g.), and acetic acid (87 c.c.) were heated under reflux until the colour of the bromine had disappeared. When the hot liquors were seeded with a specimen of the hexabromo-compound, this separated in a pure form (4·1 g.), m. p. 215° (decomp.).

4 : 4′-*Dicyano*-γδ-*diphenyl*-n-*hexane*.—Dibromo-γδ-diphenyl-*n*-hexane (10 g.) and cuprous cyanide (11·3 g.) were added slowly to boiling quinoline (100 c.c.). The reaction mixture was worked up with hydrochloric acid, and the crude product recrystallised from glacial acetic acid, giving the *dicyano*-compound (4 g.), m. p. 193° (Found : N, 9·74. $C_{20}H_{20}N_2$ requires N, 9·75%).

4 : 4′-*Diamidino*-γδ-*diphenyl*-n-*hexane*.—The nitrile (2·0 g.), in chloroform solution, was converted into the iminoether hydrochloride in the usual manner (8 days). The free iminoether base, liberated from the hydrochloride by treatment with ice and sodium hydroxide solution, gave the required *amidine isethionate* on being heated with ammonium isethionate in aqueous-alcoholic solution (Found : N, 9·56. $C_{22}H_{32}O_4N_4S_2$ requires N, 9·76%).

α-*Acetyl*-p-*bromobenzyl Cyanide* (VIII).—*p*-Bromobenzyl cyanide (25 g.) was treated with sodium (8·5 g.) in alcohol (85 c.c.). Ethyl acetate (35 c.c.) was then added all at once, and the mixture heated under reflux for 4 hours. It was then poured into water, filtered, extracted once with ether, and acidified; a red oil, which rapidly solidified, was obtained. Crystallisation from benzene gave the *acetyl* derivative (15 g.) as white, rectangular plates, m. p. 134° (Found : N, 5·9. $C_{10}H_8ONBr$ requires N, 5·9%).

3 : 4-*Dicyano*-3 : 4-*di*-(p-*bromophenyl*)-2 : 5-*diketo*-n-*hexane* (IX).—The acetyl derivative (1·0 g.) was dissolved in acetic acid (5·0 c.c.), treated with hydrogen peroxide (1 c.c., 30-vol.), and kept at 100°, the product separating from the hot solution. After cooling, a total yield of 0·6 g. was obtained, and recrystallisation from acetic acid gave the pure *compound*, m. p. 225° (Found : N, 5·9. $C_{20}H_{14}O_2N_2Br_2$ requires N, 5·9%).

p-*Cyanopropiophenonehydrazone* (XIV; R = CN).—*p*-Cyanopropiophenone (5 g.) (B.P. 488,642) was heated with hydrazine hydrate (10·0 c.c., 50% w/w solution) and alcohol (10 c.c.) for 2 hours. The *hydrazone* was isolated by precipitation with water; it was then dissolved in ether, dried (sodium sulphate), and precipitated by addition of ligroin; the unstable product (4 g.), m. p. 80—81°, had to be analysed immediately (Found : N, 23·9. $C_{10}H_{11}N_3$ requires N, 24·2%).

4 : 4′-*Dicyano*-αβ-*diethylstilbene*.—The hydrazone from 5 g. of ketone was shaken in a closed vessel with yellow mercuric oxide (8 g.) and ligroin (50 c.c.) at room temperature for 4 hours. The cherry-red solution obtained by filtration was treated with a rapid stream of sulphur dioxide at 0° to give 1·2 g. of a yellow amorphous solid; when heated to 120°, this lost sulphur dioxide, leaving a gummy mass which on trituration with ether gave crude 4 : 4′-*dicyano*-αβ-*diethylstilbene* (0·5 g.). Crystallisation from alcohol gave white needles, m. p. 216° (Found : C, 83·5; H, 6·2; N, 9·8. $C_{20}H_{18}N_2$ requires C, 84·0; H, 6·3; N, 9·8%).

p-*Bromoacetophenonehydrazone*.—*p*-Bromoacetophenone (20 g.), hydrazine hydrate (10 g., 50% w/w), and alcohol

(100 c.c.) were heated under reflux for 3 hours, then poured into water; the *hydrazone*, m. p. 164°, separated (Found : N, 13·6. $C_8H_9N_2Br$ requires N, 13·1%). In view of the known instability of hydrazones of this type, further purification was inadvisable.

p-*Cyanoacetophenonehydrazone*, m. p. 73—74°, was similarly prepared (Found : N, 26·5. $C_9H_9N_3$ requires N, 26·4%).

4 : 4′-*Diamidino-αβ-diethylstilbene*.—The nitrile (1·0 g.) was converted into the iminoether hydrochloride (5 days) in chloroform (10 c.c.) and alcohol (1·0 c.c.). The iminoether base, obtained as a white solid, m. p. 98—100°, gave the required *amidine dihydrochloride* (0·6 g.) when heated in aqueous alcohol with ammonium chloride (Found : N, 13·3; Cl, 16·46. $C_{20}H_{24}ON_2$ requires N, 13·1; Cl, 16·5%).

4 : 4′-*Dibromotolan*.—4 : 4′ : α : β-Tetrabromo-αβ-diphenylethane (10 g.) was treated with a solution of sodium (9·2 g.) in alcohol (150 c.c.), the mixture heated under reflux for ½ hour (2—3 hours for larger preparations), and poured into water. The crude tolan, m. p. 170—180°, crystallised from chloroform or dioxan, gave 5 g. of *dibromo*-compound, m. p. 182—184° (Found : Br, 47·6. $C_{14}H_8Br_2$ requires Br, 47·6%).

4 : 4′-*Dibromodeoxybenzoin* (XVIII).—4 : 4′-Dibromotolan (40 g.) was heated with concentrated sulphuric acid (200 c.c.) and acetic acid (600 c.c.) to complete solution. Vigorous mechanical agitation was essential. After cooling, the whole was diluted with water, the solid collected, dried, and recrystallised from glacial acetic acid, giving 35 g. of the *deoxybenzoin*, m. p. 137° (Found : Br, 45·1. $C_{14}H_{10}OBr_2$ requires Br, 45·2%). The *semicarbazone* had m. p. 210—212° (Found : N, 10·2. $C_{15}H_{13}ON_3Br_2$ requires N, 10·2%).

1 : 2-*Di*-(p-*bromophenyl*)-n-*propan-2-ol* (XX; R = H, R′ = Me).—4 : 4′-Dibromodeoxybenzoin (40 g.) was added in small portions to the Grignard solution prepared from magnesium (8·2 g.), methyl iodide (52 g.), and ether (250 c.c.) maintained at 0°. After standing overnight at room temperature, the reaction mixture was worked up with ammonium chloride. Distillation of the product, b. p. 195—200°/0·5 mm., gave the *carbinol* (32 g.) as a white solid, m. p. 62° (Found : Br, 43·1. $C_{14}H_{10}OBr_2$ requires Br, 43·3%).

4 : 4′-*Dibromo-α-methylstilbene* (XXI; R = H, R′ = Me).—The above carbinol (5 g.) was heated with anhydrous potassium hydrogen sulphate (2 g.) at 180—190° for 15 minutes. The water formed was removed in a vacuum. Extraction of the reaction mixture with boiling benzene gave 3 g. of the trans-*stilbene*, m. p. 136—137° (Found : Br, 45·4. $C_{15}H_{12}Br_2$ requires Br, 45·5%). From the mother-liquors the cis-*compound* (prisms from methyl alcohol), m. p. 73·5°, was obtained (Found : Br, 45·6%).

4 : 4′-*Dicyano-α-methylstilbene*.—4 : 4′-Dibromo-α-methylstilbene (4·8 g.), cuprous cyanide (2·7 g.), and quinoline (15 c.c.) were heated under reflux for 20 minutes. After being worked up in the usual manner and sublimed in a vacuum, 3·0 g. of crude product were obtained. Recrystallisation from glacial acetic acid gave the *dicyano*-compound (2·6 g.), m. p. 153—155° (Found : N, 11·2. $C_{17}H_{12}N_2$ requires N, 11·5%).

4 : 4′-*Diamidino-α-methylstilbene*.—The dicyano-compound (8 g.) was converted into the iminoether hydrochloride (2 days); this gave the corresponding *amidine dihydrochloride* (6 g.) on being heated for 6 hours at 45° with saturated alcoholic ammonia. It separated from dilute hydrochloric acid in pale yellow crystals (Found : N, 15·0; Cl, 19·2. $C_{17}H_{18}N_4,2HCl,H_2O$ requires N, 15·1; Cl, 19·2%).

1 : 2-*Di*-(p-*bromophenyl*)-n-*butan-2-ol* (XX; R = H, R′ = Et).—4 : 4′-Dibromodeoxybenzoin (50 g.) was added in portions to the cooled Grignard solution from magnesium (10·2 g.), ethyl bromide (46 g.), and ether (500 c.c.), and after being heated under reflux for 2 hours the reaction mixture was worked up with dilute sulphuric acid. Removal of the ether gave the product as an oil (54 g.) which was not distilled, as this causes partial dehydration.

4 : 4′-*Dibromo-α-ethylstilbene* (XXI; R = H, R′ = Et).—The foregoing oil (54 g.) was intimately mixed with anhydrous potassium hydrogen sulphate (24 g.), heated under 16 mm. at 190° for one hour, and the residue distilled; b. p. 190—195°/0·5 mm. 4 : 4′-Dibromostilbene (2·0 g.), m. p. 202°, was separated, and the mixture of cis- and trans-*stilbenes* redistilled; b. p. 183—185°/0·3 mm. (Found : Br, 43·7. $C_{16}H_{14}Br_2$ requires Br, 43·7%).

4 : 4′-*Dicyano-α-ethylstilbene*.—The mixed isomerides (20 g.) and cuprous cyanide (10·8 g.) were boiled in quinoline (40 c.c.) for 30 minutes. The oil which separated on pouring the reaction mixture into concentrated hydrochloric acid was extracted with chloroform, the extract washed with water, dried (sodium sulphate), and the solvent was removed; the residue distilled as a yellow oil (11 g.), b. p. 198—200°/0·4 mm. Treatment of the oil with glacial acetic acid gave 3 g. of the trans-*nitrile*, which, recrystallised from ethanol, had m. p. 126—128° (Found : N, 10·9. $C_8H_{14}N_2$ requires N, 10·9%). The acetic acid liquors gave 5 g. of mixed isomerides from which 2·6 g. of the pure cis-*nitrile*, m. p. 90—92°, were isolated by fractional crystallisation from glacial acetic acid and recrystallisation from ligroin (b. p. 60—80°) (Found : N, 10·9%).

trans-4 : 4′-*Diamidino-α-ethylstilbene*.—The nitrile was converted into the corresponding iminoether base in the usual manner (5 days). Treatment with ammonium chloride in aqueous alcohol gave the *amidine hydrochloride* (Found : N, 14·6; Cl, 18·5. $C_{20}H_{24}N_4,2HCl,H_2O$ requires N, 14·5; Cl, 18·5%).

4 : 4′-*Dibromo-α-methyldeoxybenzoin* (XIX; R = Me).—4 : 4′-Dibromodeoxybenzoin (52 g.) was dissolved in alcohol (75 c.c.) containing sodium (4 g.). Methyl iodide (50 g.) was added all at once. When the vigorous reaction had subsided, the mixture was heated under reflux until neutral to litmus, water was added, and the alcohol removed by distillation. Extraction of the aqueous suspension with benzene, followed by removal of the solvent and crystallisation of the residue from methanol, gave the required *product*, m. p. 69—70° (40 g.) (Found : Br, 43·4. $C_{15}H_{12}OBr_2$ requires Br, 43·5%).

2 : 3-*Di*-(p-*bromophenyl*)-n-*butan-2-ol* (XX; R = R′ = Me).—4 : 4′-Dibromo-α-methyldeoxybenzoin (32 g.) was added to the Grignard solution from magnesium (5·0 g.), methyl iodide (29 g.), and ether (200 c.c.), and the mixture heated under reflux for 3 hours and worked up with ice and dilute sulphuric acid. Trituration of the gummy residue with light petroleum (b. p. 40—60°) gave 22 g. of the required *carbinol*, m. p. 85—90° (Found : C, 50·0; H, 4·4; Br, 41·4. $C_{16}H_{16}OBr_2$ requires C, 50·0; H, 4·2; Br, 41·7%).

4 : 4′-*Dibromo-αβ-dimethylstilbene and* 4 : 4′ : β : γ-*Tetrabromo-βγ-diphenyl*-n-*butane*.—The above carbinol (10 g.) was heated under reflux with acetyl chloride (10 c.c.) and acetic anhydride (10 c.c.) for 4 hours. The solvents were removed by distillation at 14 mm., and the residue distilled, b. p. 190—200°/0·5 mm., giving a thick oil (8 g.) which set, on cooling, to a glass. Dehydration with potassium hydrogen sulphate gave identical results. The product was dissolved in dry chloroform (10 c.c.) and treated with bromine (3·0 g.) in chloroform (10 c.c.). Removal of the solvent and excess of bromine at room temperature gave 4 : 4′ : β : γ-tetrabromo-βγ-diphenyl-*n*-butane, m. p. 180—185° (decomp.); mixed m. p. with an authentic specimen prepared from βγ-diphenyl-*n*-butane by bromination, 182—185°. Reduction of this compound in the manner described by Barber, Slack, and Woolman (*loc. cit.*) gave *cis*-4 : 4′-dibromo-αβ-dimethylstilbene, m. p. 86° (mixed m. p. with authentic sample, 87—90°).

4 : 4′-*Dibromo-α-ethyldeoxybenzoin* (XIX; R = Et).—4 : 4′-Dibromodeoxybenzoin (202 g.) was dissolved in alcohol (400 c.c.) containing sodium (13·3 g.). Ethyl iodide (90 g.) was added, and when the initial vigorous reaction had subsided further quantities of sodium (4·9 g.) in alcohol (100 c.c.) and ethyl iodide (33·7 g.) were added. After being heated under reflux for 5 hours, the reaction mixture was poured into water and kept overnight. The light brown solid was then collected and recrystallised from a large volume of methanol, giving 200 g. of the pure *deoxybenzoin*, m. p. 52° (Found : Br, 41·65. $C_{16}H_{14}OBr_2$ requires Br, 41·7%).

3 : 4-*Di*-(p-*bromophenyl*)-n-*hexan*-3-*ol* (XX; R = R′ = Et).—The α-ethyl compound (90 g.), dissolved in dry ether (350 c.c.), was added dropwise to a Grignard solution prepared from ethyl bromide (77 g.), magnesium (17·2 g.), and dry ether (1 l.). After being heated under reflux for 3 hours, the reaction mixture was worked up with ice and dilute sulphuric acid. Removal of the ether, and then of a small amount of 4 : 4′-dibromostilbene, m. p. 203°, followed by distillation of the residue, b. p. 206—210°/0·4 mm., gave the required *carbinol* as a pale yellow glass (Found : Br, 39·0. $C_{18}H_{20}OBr_2$ requires Br, 38·8%). On standing, this deposited a crystalline compound (10 g.), apparently a solid modification of the carbinol, which can exist in a *meso*- and a racemic form. Crystallisation from ligroin (b. p. 60—80°) gave white needles, m. p. 160° (Found : Br, 38·9%).

4 : 4′-*Dibromo-αβ-diethylstilbene* (XXI; R = R′ = Et).—Dehydration of both forms of the above carbinol was carried out with both potassium hydrogen sulphate and acetic anhydride–acetyl chloride. In each case the same product, b. p. 200°/0·75 mm., was obtained as an almost colourless oil. On standing for many weeks, solidification slowly occurred and a solid (yield about one third of the weight of the oil) was collected and recrystallised from alcohol, forming white needles, m. p. 123° (Found : Br, 40·5. Calc. for $C_{18}H_{18}Br_2$: Br, 40·4%). The *trans*-4 : 4′-dibromodiethylstilbene described by Vargha and Kovács (*loc. cit.*) had m. p. 124°. On redistillation, the residual oil, b. p. 190—192°/0·5 mm., again deposited the same material, but much more slowly. All attempts to convert the oil into a homogeneous product by treatment with iodine in boiling nitrobenzene (to isomerise any *cis*-compound to the *trans*-form) failed.

4 : 4′-*Dicyano-αβ-diethylstilbene from the Dibromo-compound.*—The dibromo-compound (4·0 g.) was heated in boiling quinoline (20 c.c.) with cuprous cyanide (2·7 g.). After being worked up in the usual manner, the residual solid was sublimed repeatedly in a vacuum and finally recrystallised from ethanol, giving the dinitrile, m. p. 214—216°, identical with that previously described.

4 : 4′ : γ : δ-*Tetrabromo-γδ-diphenyl*-n-*hexane.*—4 : 4′-Dibromo-αβ-diethylstilbene (1·0 g.) was dissolved in dry chloroform (5 c.c.) and treated with bromine (0·6 g.) in chloroform (5 c.c.). Uptake of bromine was almost immediate in daylight, and removal of the solvent and excess of bromine at room temperature gave the *tetrabromo*-compound, m. p. 170° (decomp.) after recrystallisation from a very large volume of glacial acetic acid (Found : Br, 55·8. $C_{18}H_{10}Br_4$ requires Br, 55·8%).

4 : 4′-*Dibromo-α-benzyldeoxybenzoin.*—4 : 4′-Dibromodeoxybenzoin (10 g.) was dissolved in alcohol (12 c.c.) containing sodium (0·7 g.). Benzyl chloride (8·9 g.) was added, and when the initial reaction had subsided, this was followed by alcohol (4 c.c.) containing sodium (0·25 g.). Further benzyl chloride (3·3 g.) was then added and refluxing continued to neutrality. The reaction mixture was then poured into water, and the alcohol removed by distillation. Recrystallisation of the residue from alcohol gave the *product* (6·5 g.), m. p. 100—102° (Found : Br, 35·6. $C_{21}H_{16}OBr_2$ requires Br, 36·0%).

The authors wish to express their thanks to Mr. S. Bance for the semi-microanalyses, to Miss P. Z. Gregory for help with some of the preparations, to Dr. A. J. Ewins, F.R.S., for his continued interest, and to the Directors of Messrs. May & Baker, Limited, for permission to publish these results.

CHEMICAL RESEARCH DEPARTMENT, MAY & BAKER, LTD., DAGENHAM. [*Received, June 23rd,* 1944.]