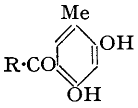
449. *Rottlerin. Part VIII.* The Rottlerone Change.*

By Alexander McGookin, Alexander Robertson, and T. H. Simpson.

In earlier papers (for references see text) it was shown that rottlerin and its hydrogenation products were unsymmetrical polyhydroxydiarylmethanes which underwent the reversible rottlerone change. In order to investigate the general applicability of this reaction a series of symmetrical and unsymmetrical polyhydroxydiphenylmethanes, types (V), (VI), and (VIII), have been synthesised by the standard procedure. The majority of these compounds have been shown to disproportionate in the expected manner. In general, the diphenylmethanes derived from phloroglucinol react more readily than those from resorcinol. Further, the unsymmetrical polyhydroxydiphenylmethanes which can be formed by reversing the rottlerone change are those which can be synthesised from two dissimilar ketones by the phenol–formaldehyde reaction. The decomposition of polyhydroxydiphenylmethanes according to the scheme $R{\cdot}CH_2{\cdot}R + 2R'H \longrightarrow R'{\cdot}CH_2{\cdot}R' + 2RH$ has also been studied.

In earlier papers in this series (Part II, *J.*, 1938, 309; Part IV, *J.*, 1939, 1579; Part V, *J.*, 1939, 1587) it has been shown that rottlerin and its hydrogenation products are unsymmetrical polyhydroxydiarylmethanes of the type $R{\cdot}CH_2{\cdot}R'$ which, on treatment with warm acidic or alkaline reagents, undergo disproportionation according to the scheme $2R{\cdot}CH_2{\cdot}R' \longrightarrow R{\cdot}CH_2{\cdot}R + R'{\cdot}CH_2{\cdot}R'$, *i.e.*, the rottlerone change. In the case of the hydrogenation products this reaction is best effected by boiling acetic acid, with which the formation of resinous by-products is much less marked. Further, with the aid of this reagent it was possible to establish the reversibility of the reaction, thus: $2R{\cdot}CH_2{\cdot}R' \rightleftharpoons R{\cdot}CH_2{\cdot}R + R'{\cdot}CH_2{\cdot}R'$ (Part VII, *J.*, 1948, 113). In view of the interesting behaviour of the rottlerin derivatives a study of the application of the rottlerone change to a series of analogous symmetrical and unsymmetrical diphenylmethanes, of types (V) and (VI), derived from *C*-methylresorcinol and *C*-methylphloroglucinol has now been made.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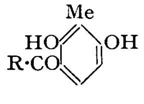
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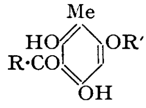
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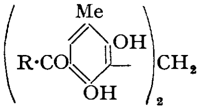
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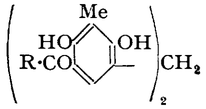
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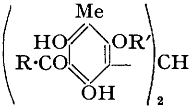
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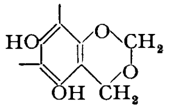
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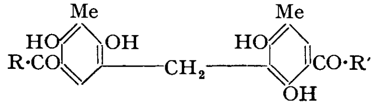
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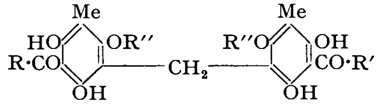
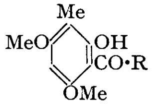
(IX.)



(X.)

By the action of 40% aqueous formaldehyde and alcoholic sulphuric acid on appropriate ketones of the type (I), (II), and (III) the following symmetrical diphenylmethanes were synthesised: (IV; R = Me), (IV; R = Ph), (V; R = Me), (VI; R = Ph, R′ = H), (VI; R = R′ = Me), (VI; R = Ph, R′ = Me), and (VI; R = $Ph{\cdot}CH_2{\cdot}CH_2$, R′ = Me). With the ketones (III; R = Pr^n, R′ = H) and (III; R = $Ph{\cdot}CH_2{\cdot}CH_2$, R′ = H) the use of aqueous formaldehyde gave products consisting mainly of oils along with a little of the required diphenylmethanes, but when paraformaldehyde was employed excellent yields of (VI; R = Pr^n, R′ = H) and (VI; R = $Ph{\cdot}CH_2{\cdot}CH_2$, R′ = H) were obtained. It seems likely that the oils were mixtures of cyclic formals (type VII), which are known to be sometimes formed in the condensation of phenols and formaldehyde with acidic reagents (cf. Borsche and Berkhout,

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* Part VII, *J.*, 1948, 113.

Annalen, 1904, **330**, 82; Chattaway and Goepp, *J.*, 1933, 699; Ziegler, *Ber.*, 1941, **74**, 1871). As formaldehyde is liberated very slowly from paraformaldehyde in acid solution, its concentration is small and thus the tendency for the intermediate hydroxybenzyl alcohols to give formals is reduced.

By the procedure employed in the synthesis of tetrahydro- and tetrahydro*allo*-rottlerin a series of unsymmetrical diphenylmethanes was prepared from aqueous formaldehyde or paraformaldehyde and mixtures of the appropriate pairs of ketones, *viz.*, (VIII; R = Ph, R′ = Me), (VIII; R = R′ = Me), (VIII; R = R′ = Ph), (IX; R = Me, R′ = Ph·CH_2·CH_2, R″ = H), (IX; R = Me, R′ = Pr^n, R″ = H), (IX; R = Me, R′ = Ph·CH_2·CH_2, R″ = Me), and (IX; R = Me, R′ = Ph, R″ = Me). As expected, each of these compounds was accompanied by the appropriate pair of symmetrical products. With either of the following pairs of ketones, *viz.*, (I; R = Me) and (I; R = Ph), (II; R = Me) and (II; R = Ph), or (I; R = Ph) and (II; R = Me), (III; R = Me) and (III; R = Ph), or (III; R = Ph) and (III; R = Pr^n), the unsymmetrical product was not formed in quantities detectable by fractional crystallisation and chromatography. Attempts to prepare the hydroxybenzyl alcohols from the last-mentioned ketones by the alkali–formaldehyde method (cf. Lederer and Manasse, *J. pr. Chem.*, 1894, **50**, 223) were unsuccessful and hence it was not possible to prepare the unsymmetrical diphenylmethanes by this route. Similarly, the chloromethyl derivatives (cf. Blanc, *Bull. Soc. chim.*, 1923, **33**, 313, and Sommelet, *ibid.*, 1933, **53**, 853) required for this purpose also could not be obtained.

On being boiled with acetic acid containing a little water, the following unsymmetrical diphenylmethanes derived from resorcinol were slowly converted into the expected pairs of symmetrical compounds, thus

$$\begin{aligned}
&(\text{VIII; R = Ph, R}' = \text{Me}) &&\longrightarrow (\text{IV; R = Me}) + (\text{V; R = Ph})\\
&(\text{VIII; R = R}' = \text{Me}) &&\longrightarrow (\text{IV; R = Me}) + (\text{V; R = Me})\\
&(\text{VIII; R = R}' = \text{Ph}) &&\longrightarrow (\text{IV; R = Ph}) + (\text{V; R = Ph})
\end{aligned}$$

but unchanged material invariably remained in each case. When the appropriate pairs of symmetrical diphenylmethanes on the right-hand side above were subjected to the same treatment, the corresponding unsymmetrical products on the left-hand side were formed in small amounts. A comparison of the yields in these reversible reactions indicated that the equilibrium point was not attained during the time of heating (48 hours), whereas with longer treatment the products became more resinous. In the phloroglucinol series the reversible reactions,

$$(\text{IX; R = Me, R}' = \text{Ph}\cdot\text{CH}_2\cdot\text{CH}_2,\ \text{R}'' = \text{H}) \rightleftharpoons (\text{VI; R = Me, R}' = \text{H}) + (\text{VI; R = Ph}\cdot\text{CH}_2\cdot\text{CH}_2,\ \text{R}' = \text{H})$$

and

$$(\text{IX; R = Me, R}' = \text{Pr}^\text{n},\ \text{R}'' = \text{H}) \rightleftharpoons (\text{VI; R = Me, R}' = \text{H}) + (\text{VI; R = Pr}^\text{n},\ \text{R}' = \text{H})$$

proceeded readily and the equilibrium was established in 4 hours. In these cases the disproportionation took place to a slight extent on heating for short periods with solvents used in the purification of these compounds, *e.g.*, alcohol. On the other hand, the reactions,

$$(\text{IX; R = Me, R}' = \text{Ph}\cdot\text{CH}_2\cdot\text{CH}_2,\ \text{R}'' = \text{Me}) \rightleftharpoons (\text{VI; R = R}' = \text{Me}) + (\text{VI; R = Ph}\cdot\text{CH}_2\cdot\text{CH}_2,\ \text{R}' = \text{Me})$$

and

$$(\text{IX; R = Me, R}' = \text{Pr}^\text{n},\ \text{R}'' = \text{Me}) \rightleftharpoons (\text{VI; R = R}' = \text{Me}) + (\text{VI; R = Pr}^\text{n},\ \text{R}' = \text{Me}),$$

which were shown to be reversible, were not complete after 15 hours. On being warmed with aqueous acetic acid at 70° for 20 minutes (IX; R = Me, R′ = Ph·CH_2·CH_2, R″ = H) was partly converted into (VI; R = Me, R′ = H) but the second component could not be isolated. This unsymmetrical diphenylmethane also disproportionates in warm dioxan containing hydrochloric acid, giving both symmetrical products.

In general, the results obtained in the foregoing experiments indicate that the unsymmetrical polyhydroxydiphenylmethanes which can be formed from the two requisite symmetrical compounds (*i.e.*, reversing the rottlerone change) are the products which can be synthesised by the application of the phenol–formaldehyde condensation. Conversely, certain unsymmetrical polyhydroxydiphenylmethanes can be prepared neither by the phenol–formaldehyde reaction nor by the disproportionation method. The disproportionation reaction is clearly a reversible hydrolysis (cf. Granger, *Ind. Eng. Chem.*, 1937, **29**, 1125; Burawoy and Chamberlain, *J.*, 1949, 624, 626) and may be represented thus :

$$
\begin{aligned}
&(a)\ R{\cdot}CH_2{\cdot}R' + H_2O \rightleftharpoons R{\cdot}CH_2{\cdot}OH + R'H\\
&(b)\ R{\cdot}CH_2{\cdot}R' + H_2O \rightleftharpoons R'{\cdot}CH_2{\cdot}OH + RH\\
&(c)\ R{\cdot}CH_2{\cdot}OH + RH \rightleftharpoons R{\cdot}CH_2{\cdot}R + H_2O\\
&(d)\ R'{\cdot}CH_2{\cdot}OH + R'H \rightleftharpoons R'{\cdot}CH_2{\cdot}R' + H_2O
\end{aligned}
$$

Of the steps (*c*) and (*d*) it is clear that if one is much more rapid than the other the final product of the forward reaction will be almost wholly a symmetrical compound involving the more reactive phenol and the reverse reactions (*c*) and (*d*) will be suppressed. On this view it seemed likely that a polyhydroxydiphenylmethane formed from a less reactive phenol should be completely or almost completely decomposed on being heated with a more reactive phenol, thus: $R{\cdot}CH_2{\cdot}R + 2R'H \longrightarrow R'{\cdot}CH_2{\cdot}R' + 2RH$. In agreement with this it has been found that when the compounds (VI; R = R' = Me), (VI; R = Ph, R' = Me), and (VI; R = $Ph{\cdot}CH_2{\cdot}CH_2$, R' = Me) were each heated with *C*-methylphloracetophenone almost theoretical yields of 5 : 5'-diacetyl-2 : 4 : 6 : 2' : 4' : 6'-hexahydroxy-3 : 3'-dimethyldiphenylmethane (VI; R = Me; R' = H) were obtained along with the respective less reactive phenols (III; R = R' = Me), (III; R = Ph, R' = Me), and (III; R = $Ph{\cdot}CH_2{\cdot}CH_2$, R' = Me).

The ketones (III; R = $Ph{\cdot}CH_2{\cdot}CH_2$, R' = Me) and (III; R = Ph, R' = Me) were prepared from *C*-methylphloroglucinol β-methyl ether and the appropriate nitrile by the Hoesch method. The orientations of these products follow from the fact that on methylation by the methyl iodide–potassium carbonate method they were converted into (X; R = $Ph{\cdot}CH_2{\cdot}CH_2$) and (X; R = Ph) because in this reaction trimethoxy-derivatives would have been formed if the ketone group had been in the *o*-position to the methoxyl group (Curd and Robertson, *J.*, 1933, 437).

EXPERIMENTAL.

5 : *5'-Diacetyl-*2 : 6 : 2 ': *6'-tetrahydroxy-*3 : *3'-dimethyldiphenylmethane* (IV; R = Me).—2 : 4-Dihydroxy-5-methylacetophenone has been prepared from 2 : 4-dihydroxytoluene (Johnson and Lane, *J. Amer. Chem. Soc.*, 1921, **43**, 356) by Yanagita (*Ber.*, 1938, **71**, 2271) by the Nencki reaction, but the Hoesch reaction has been found to give more satisfactory results. Formed by the interaction of the phenol (5 g.), methyl cyanide (4 ml.), zinc chloride (2·5 g.), and excess of hydrogen chloride in ether (40 ml.) during 2 days, the ketimine salt was hydrolysed with boiling water (50 ml.) for ½ hour, and the resulting ketone crystallised from water, forming long, slender, pale yellow needles (4·5 g.), m. p. 169°.

Concentrated sulphuric acid (2 ml.) was added dropwise to a mixture of 2 : 4-dihydroxy-5-methylacetophenone (1 g.), alcohol (10 ml.), and 40% aqueous formaldehyde (2·5 ml.) at 10°, and next day the pale pink crystalline solid was isolated and recrystallised from alcohol, giving 5 : *5'-diacetyl-*2 : 6 : 2' : *6'-tetrahydroxy-*3 : *3'-dimethyldiphenylmethane* (0·8 g.) in tiny colourless needles, m. p. 258° (decomp.) (Found : C, 66·4; H, 6·0. $C_{19}H_{20}O_6$ requires C, 66·3; H, 5·9%). This compound was sparingly soluble in hot alcohol or acetone, moderately soluble in hot acetic acid, readily soluble in chloroform and benzene, and gave a reddish-brown ferric reaction in alcohol. Prepared by the acetic anhydride–pyridine method, the *tetra-acetate* separated from aqueous alcohol in colourless needles, m. p. 163·5—164° (Found : C, 63·3; H, 5·6. $C_{27}H_{28}O_{10}$ requires C, 63·3; H, 5·5%).

5 : *5'-Diacetyl-*2 : 4 : 2' : *4'-tetrahydroxy-*3 : *3'-dimethyldiphenylmethane* (V; R = Me).—Concentrated sulphuric acid (2 ml.) was added dropwise to a solution of 2 : 4-dihydroxy-3-methylacetophenone (Rangaswami and Seshadri, *Proc. Indian Acad. Sci.*, 1939, **8**, *A*, 214) (1 g.) in alcohol (5 ml.) and 40% aqueous formaldehyde (2·5 ml.) at room temperature. The product was isolated three days later and, on recrystallisation from aqueous alcohol, gave 5 : *5'-diacetyl-*2 : 4 : 2' : *4'-tetrahydroxy-*3 : *3'-dimethyldiphenylmethane* in long colourless needles (0·7 g.), m. p. 263—264°, moderately soluble in alcohol, readily soluble in benzene, chloroform, or acetone, and having a purple ferric reaction in alcohol (Found : C, 66·4; H, 5·9%). The *tetra-acetate* formed colourless needles, m. p. 180—181°, from aqueous alcohol (Found : C, 63·5; H, 5·3%).

2 : *4-Dihydroxy-5-methylbenzophenone* (I; R = Ph).—A mixture of 2 : 4-dihydroxytoluene (5 g.), phenyl cyanide (5 ml.), zinc chloride (2·5 g.), and anhydrous ether (30 ml.) was saturated with hydrogen chloride. Three days later the reaction mixture was again saturated with hydrogen chloride and kept for a further 2 days. Hydrolysis of the resulting ketimine salt with boiling water (100 ml.) for 2½ hours gave an oil which slowly solidified. Repeated crystallisation of this from benzene and then water gave 2 : *4-dihydroxy-5-methylbenzophenone* in pale yellow needles (6 g.), m. p. 137·5—138°, soluble in alcohol, sparingly soluble in cold benzene or cold water, and having a brownish-red ferric reaction in alcohol (Found : C, 73·6; H, 5·5. $C_{14}H_{12}O_3$ requires C, 73·7; H, 5·3%). The *diacetate* separated from dilute alcohol in long colourless needles, m. p. 88—89° (Found : C, 69·5; H, 5·3. $C_{17}H_{16}O_5$ requires C, 69·2; H, 5·2%). The 2 : *4-dinitrophenylhydrazone* formed dark red needles, m. p. 259° (decomp.), from alcohol (Found : N, 13·6. $C_{20}H_{16}O_6N_4$ requires N, 13·7%).

5 : 5′-*Dibenzoyl*-2 : 6 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* (IV; R = Ph).—The interaction of the foregoing ketone (1 g.) in alcohol (10 ml.), 40% aqueous formaldehyde (2·5 ml.), and concentrated sulphuric acid (2 ml.) at room temperature during 24 hours gave 5 : 5′-*dibenzoyl*-2 : 6 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane*, which separated from alcohol in pale yellow needles (0·75 g.), m. p. 240°, sparingly soluble in hot alcohol or hot acetone, readily soluble in benzene or chloroform, and having a reddish-brown ferric reaction in alcohol (Found : C, 74·2; H, 5·3. $C_{29}H_{24}O_6$ requires C, 74·4; H, 5·2%). The *tetra-acetate* formed colourless needles, m. p. 184—185°, from aqueous alcohol (Found : C, 69·7; H, 5·3. $C_{37}H_{32}O_{10}$ requires C, 69·8; H, 5·1%).

5 : 5′-*Dibenzoyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* (V; R = Ph) was prepared from 2 : 4-dihydroxy-3-methylbenzophenone (Jones and Robertson, *J.*, 1932, 1693) (1 g.), 40% aqueous formaldehyde (2·5 ml.), and sulphuric acid (2 ml.) in alcohol (5 ml.) during 3 days and formed small yellow cubes (0·7 g.), m. p. 207—208°, from 80% alcohol, readily soluble in chloroform, benzene, hot alcohol or hot acetic acid and having a reddish-brown ferric reaction in alcohol (Found : C, 74·1; H, 5·4%). The *tetra-acetate* crystallised from aqueous alcohol in tiny colourless needles, m. p. 176—177° (Found : C, 70·0; H, 5·2%).

5 : 5′-*Dibenzoyl*-2 : 4 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* (VIII; R = R′ = Ph).—Concentrated sulphuric acid (2 ml.) was added dropwise to a solution of 2 : 4-dihydroxy-3-methylbenzophenone (0·5 g.) and 2 : 4-dihydroxy-5-methylbenzophenone (0·5 g.) in alcohol (7 ml.) containing 40% aqueous formaldehyde (2·5 ml.), and 7 days later the mixed product (0·7 g.) was collected, washed well with water, and extracted with boiling 80% alcohol. Crystallisation of the residue (0·2 g.), m. p. 204°, from alcohol gave 5 : 5′-dibenzoyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (IV; R = Ph), m. p. and mixed m. p. 238—240°. The cooled alcoholic extract deposited 5 : 5′-*dibenzoyl*-2 : 4 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* in yellow needles (0·2 g.), m. p. 219—224°, which on recrystallisation from 95% alcohol had m. p. 222—224°, and gave a reddish-brown ferric reaction (Found : C, 74·1; H, 5·3%). Prepared by the pyridine method during 7 days, the *acetate* formed clusters of colourless needles, m. p. 189—191°, from alcohol (Found : C, 69·8; H, 5·3%). On admixture with its 2 : 4 : 2′ : 4′-tetrahydroxy-isomer, this compound had m. p. 186—188°, and with its 2 : 6 : 2′ : 6′-tetrahydroxy-isomer had m. p. 203—206°.

On being diluted with water (5 ml.) the original extract left after the isolation of 5 : 5′-dibenzoyl-2 : 4 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane deposited a solid (0·3 g.) which on recrystallisation from 70% alcohol gave 5 : 5′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (V; R = Ph), m. p. and mixed m. p. 205—207°.

5-*Acetyl*-5′-*benzoyl*-2 : 4 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* (VIII; R = Ph, R′ = Me).—The interaction of 2 : 4-dihydroxy-5-methylacetophenone (0·5 g.), 2 : 4-dihydroxy-3-methylbenzophenone (0·5 g.) in alcohol (10 ml.), 40% aqueous formaldehyde (2·5 ml.), and concentrated sulphuric acid (2 ml.; added dropwise) during 3 days gave a mixture (0·7 g.) which was extracted with boiling alcohol (2 × 20 ml.). Crystallisation of the insoluble residue (0·22 g.), m. p. *ca.* 210°, from alcohol, gave 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (IV; R = Me), m. p. 258° (decomp.). On being kept the combined extracts deposited a product in yellow needles (0·28 g.), m. p. 228—235° which, on being recrystallised twice from alcohol, furnished 5-*acetyl*-5′-*benzoyl*-2 : 4 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* in pale yellow needles, m. p. 239—240°, moderately soluble in hot alcohol and having a brownish-red ferric reaction in alcohol (Found : C, 71·1; H, 5·5. $C_{24}H_{22}O_6$ requires C, 70·9; H, 5·5%). Admixed with its 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-analogue this compound had m. p. 190—200°, and with 5 : 5′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane had m. p. *ca.* 180°.

Prepared by the pyridine method in the course of 10 days the *tetra-acetate* crystallised from aqueous alcohol in clusters of rectangular plates, m. p. 150—151° (Found : C, 66·8; H, 5·4. $C_{32}H_{30}O_{10}$ requires C, 66·9; H, 5·3%).

After the isolation of the crude 5-acetyl-5′-benzoyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane, dilution of the extract with water (100 ml.) gave a flocculent precipitate (0·2 g.), m. p. *ca.* 160°, from which a small quantitiy of 5 : 5′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (V; R = Ph), m. p. 207—208°, was isolated by recrystallisation (4 times) from alcohol.

5 : 5′-*Diacetyl*-2 : 4 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* (VIII; R = R′ = Me).—The mixed product (0·85 g.) from the interaction of 2 : 4-dihydroxy-3-methylacetophenone (0·5 g.), 2 : 4-dihydroxy-5-methylacetophenone (0·5 g.), 40% aqueous formaldehyde (2·5 g.), and concentrated sulphuric acid (2 ml.) in alcohol (10 ml.) during 4 days was triturated with boiling alcohol (10 ml.), leaving a colourless residue (0·2 g.) of slightly impure 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane, m. p. 255°. On cooling, the alcoholic liquor deposited a pinkish solid, m. p. 224°, which on purification from alcohol gave 5 : 5′-*diacetyl*-2 : 4 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* in colourless needles (0·3 g.), m. p. 237—239° (decomp.), readily soluble in hot acetic acid or benzene and having a red-violet ferric reaction in alcohol (Found : C, 66·6; H, 6·1. $C_{19}H_{20}O_6$ requires C, 66·3; H, 5·9%). Mixtures of this compound and 5 : 5′-diacetyl-2 : 4 : 2′ : 4′- and 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane had m. p. *ca.* 220° and m. p. *ca.* 231°, respectively. The *tetra-acetate* formed colourless needles, m. p. 171—172° (Found : C, 63·2; H, 5·7. $C_{27}H_{28}O_{10}$ requires C, 63·3; H, 5·5%).

Dilution of the residual alcoholic extract with water (50 ml.) furnished a flocculent precipitate which was crystallised 3 times from alcohol, giving 5 : 5′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (0·15 g.), m. p. and mixed m. p. 263—264°.

Disproportionation of 5 : 5′-*Diacetyl*-2 : 4 : 2′ : 6′-*tetrahydroxy*-3 : 3′-*dimethyldiphenylmethane* (VIII; R = R′ = Me).—A solution of this compound (0·7 g.) in acetic acid (40 ml.) and water (5 ml.) was heated under reflux for 48 hours, the greater part of the solvent was evaporated in a vacuum, and the residue was diluted with water (50 ml.). Next day the resulting light brown solid (0·6 g.) was extracted with boiling alcohol (2 × 20 ml.), and the residue (0·075 g.), m. p. 240°, crystallised from alcohol (charcoal), giving 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (IV; R = Me) in tiny, almost colourless needles, m. p. 258° (decomp.). On recrystallisation the pale pink solid (0·42 g.), m. p. 220° (approx.), deposited by the cooled alcoholic extracts gave unchanged 5 : 5′-diacetyl-2 : 4 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane, m. p. and mixed m. p. 236—239° (decomp.). After the separation of this product the extracts were diluted with water (100 ml.), giving a somewhat resinous precipitate (0·09 g.) which, on recrystallisation from aqueous acetic acid and then alcohol (charcoal), furnished a small amount of 5 : 5′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (V; R = Me), m. p. and mixed m. p. 263—264°.

A mixture of 5 : 5′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy- (V; R = Me) (0·5 g.) and 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (IV; R = Me) (0·5 g.), acetic acid (50 ml.), and water (5 ml.) was heated under reflux for 48 hours, the solvent was evaporated in a vacuum, and the light brown solid, m. p. *ca.* 160—180°, was extracted with boiling alcohol (50 ml.), leaving a residue (0·35 g.) which, on recrystallisation from alcohol (charcoal), gave unchanged 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane, m. p. 258° (decomp.). The alcoholic extract deposited light pink needles (0·12 g.), m. p. 190—200°, consisting of 5 : 5′-diacetyl-2 : 4 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (VIII; R = R′ = Me) mixed with a little unchanged 2 : 4 : 2′ : 4′-tetrahydroxy-compound which was removed by recrystallisation from hot alcohol. The extract was then evaporated to a small volume and diluted with water (5 ml.), giving a somewhat resinous solid (0·3 g.) from which a small amount of unchanged 5 : 5′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane was obtained by crystallisation from alcohol.

Disproportionation of 5′-Acetyl-5-benzoyl-2 : 4 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (VIII; R = Ph, R′ = Me).—This compound (0·75 g.) was heated under reflux with acetic acid (40 ml.) and water (5 ml.) for 48 hours. The product left on distillation of the solvent was separated into 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (IV; R = Me), m. p. 258° (decomp.), unchanged 5′-acetyl-5-benzoyl-2 : 4 : 2′ : 6′-tetrahydroxy-3 : 3′dimethyldiphenylmethane (0·32 g.), m. p. 239°, and 5 : 5′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (V; R = Ph), m. p. 207—208°, by the procedure employed in the case of 5 : 5′-diacetyl-2 : 4 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane.

A solution of 5 : 5′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy- (0·5 g.) and 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (0·5 g.) in acetic acid (50 ml.) and water (3 ml.) was heated under reflux for 48 hours, evaporated to small volume, and diluted with water (50 ml.). The solid (0·85 g.) was separated into 5 : 5′-diacetyl-2 : 6 : 2′ : 6′-tetrahydroxy- (0·41 g.), 5′-acetyl-5-benzoyl-2 : 4 : 2′ : 6′-tetrahydroxy- (0·11 g.), and 5 : 5′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-3 : 3′-dimethyldiphenylmethane (small quantity).

C-*Methylphloroglucinol.*—Phloroglucinolaldehyde dihydrate (5 g.), dissolved in ethyl acetate (100 ml.), was reduced with a Raney nickel catalyst (Parlic and Adkins, *J. Amer. Chem. Soc.*, 1946, **68**, 1471) (10 g. of moist catalyst) and hydrogen at 65 lb./sq. in. during 15 hours. After the removal of the catalyst, which was well washed with ethyl acetate, the solution was concentrated in a vacuum and the solid was dried and recrystallised from ethyl acetate–light petroleum, giving *C*-methylphloroglucinol in tiny colourless needles, m. p. 213—215° (yield, 3·2 g., 96%)

Applied to 2 : 4-dihydroxy-6-methoxybenzaldehyde, the same procedure afforded a much more convenient route to *C*-methylphloroglucinol β-methyl ether than either the method of Herzig and Wenzel (*Monatsh*, 1902, **23**, 80) or that of Curd and Robertson (*J.*, 1933, 1179). Under the same conditions the reduction of this aldehyde (Head and Robertson, *J.*, 1930, 2440) was complete in 4 hours and gave *C*-methylphloroglucinol β-methyl ether, forming colourless prisms (4·3 g.), m. p. 117—119°, from benzene.

2 : 4 : 6-*Trihydroxy*-3-*methyl*-β-*phenylpropiophenone.*—Formed by the condensation of *C*-methylphloroglucinol (4·5 g.) and β-phenylpropionitrile (Henley and Turner, *J.*, 1931, 1183) (6 ml.) in ether (150 ml.) with zinc chloride (2 g.) and an excess of hydrogen chloride during 24 hours, the semi-solid ketimine salt was dissolved in water (100 ml.), and the solution (almost neutralised with sodium hydrogen carbonate) heated under reflux for 2 hours. On cooling, the resulting dark oil solidified and on crystallisation from benzene and then from water gave 2 : 4 : 6-trihydroxy-3-methyl-β-phenylpropiophenone as the *monohydrate* (2·9 g.) in almost colourless lustrous needles, m. p. 138° (Found : H_2O, 6·6. $C_{16}H_{16}O_4,H_2O$ requires H_2O, 6·3%). The anhydrous *ketone* had m. p. 173—174° (Found : C, 70·4; H, 6·0. $C_{16}H_{16}O_4$ requires C, 70·6; H, 5·9%). This compound, which was readily soluble in alcohol and moderately soluble in hot water, gave a violet ferric reaction in alcohol.

Warmed for 3 minutes with alcoholic diazoaminobenzene, the ketone gave 2 : 4 : 6-*trihydroxy*-3-*methyl*-5-β-*phenylpropionylazobenzene*, which formed scarlet needles, m. p. 182—183°, from 95% acetic acid (Found : C, 70·4; H, 5·5; N, 7·5. $C_{22}H_{20}O_4N_2$ requires C, 70·2; H, 5·4; N, 7·5%). Methylation of this ketone (0·5 g.) with methyl iodide (4 ml.) and potassium carbonate (6 g.) in boiling acetone (20 ml.) for 4 hours, with the addition of more iodide (3 ml.) and carbonate (6 g.) after 2 hours, gave 6-*hydroxy*-2 : 4-*dimethoxy*-3-*methyl*-β-*phenylpropiophenone*, which formed colourless needles (0·4 g.), m. p. 144—145°, from alcohol, soluble in dilute aqueous sodium hydroxide and giving a green ferric reaction in alcohol [Found : C, 63·9; H, 4·9; OMe, 20·8. $C_{16}H_{14}O_2(OMe)_2$ requires C, 64·0; H, 4·7; OMe, 20·7%].

2 : 4 : 6 : 2′ : 4′ : 6′-*Hexahydroxy*-3 : 3′-*dimethyl*-5 : 5′-*di*-β-*phenylpropionyldiphenylmethane* (IX; R = R′ = $Ph{\cdot}CH_2{\cdot}CH_2$, R″ = H).—A mixture of 2 : 4 : 6-trihydroxy-3-methyl-β-phenylpropiophenone (0·5 g.), powdered paraformaldehyde (0·2 g.), concentrated sulphuric acid (7 drops), and alcohol (10 ml.) was gently agitated for 48 hours, and the light pink product crystallised from alcohol (charcoal), giving 2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyl*-5 : 5′-*di*-β-*phenylpropionyldiphenylmethane* in pale yellow needles (0·4 g.), m. p. 203—205°, soluble in hot alcohol, sparingly soluble in benzene, and having a

brownish-green ferric reaction in alcohol (Found: C, 71·1; H, 6·0. $C_{33}H_{32}O_8$ requires C, 71·2; H, 5·8%). Attempts to acetylate or to methylate this compound gave intractable products. Interaction of this diphenylmethane (0·5 g.) with diazoaminobenzene (0·5 g.) in alcohol (5 ml.) on the steam-bath for 5 minutes yielded 2 : 4 : 6-trihydroxy-3-methyl-5-β-phenylpropionylazobenzene, m. p. and mixed m. p. 182—183°, after recrystallisation.

5-*Acetyl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-5′-β-*phenylpropionyldiphenylmethane* (IX; R = Me, R′ = Ph·CH$_2$·CH$_2$, R″ = H).—A mixture of 2 : 4 : 6-trihydroxy-3-methylacetophenone (Curd and Robertson, *J.*, 1933, 441) (0·5 g.) and 2 : 4 : 6-trihydroxy-3-methyl-β-phenylpropiophenone (0·75 g.), paraformaldehyde (0·4 g.), concentrated sulphuric acid (10 drops), and alcohol (10 ml.) was agitated gently for 48 hours, and water (4 ml.) then added to complete the separation of the product which on isolation was washed with water to remove acid and then extracted with hot 85% acetone (35 ml.). On crystallisation from aqueous dioxan the residual solid (0·25 g.), m. p. 270—280°, gave 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane, m. p. 291° (decomp.), identical with an authentic specimen (McGookin *et al.*, *J.*, 1939, 1585). Spontaneous evaporation of the aqueous acetone extract to about half its volume furnished an orange-yellow solid, m. p. 250—258° (0·4 g.), which on purification 3 times from aqueous acetone gave 5-*acetyl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyl*-5′-β-*phenylpropionyldiphenylmethane* in microscopic, light yellow needles, m. p. 258—260° (decomp.), moderately soluble in acetone or hot alcohol and giving a red-brown ferric reaction in alcohol (Found: C, 66·8; H, 6·0. $C_{26}H_{26}O_8$ requires C, 66·9; H, 5·6%). Warmed with a solution of diazoaminobenzene (0·4 g.) in alcohol (7 ml.) on the steam-bath for 5 minutes this diphenylmethane (0·4 g.) gave 5-acetyl-2 : 4 : 6-trihydroxy-3-methylazobenzene, m. p. 202°, identical with an authentic specimen. A second crystalline azo-derivative could be isolated.

Evaporation of the acetone extract left after the separation of 5-acetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-5′-β-phenylpropionyldiphenylmethane gave 2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5 : 5′-di-β-phenylpropionyldiphenylmethane, m. p. and mixed m. p. 203—205°, after repeated purification from alcohol.

Disproportionation of 5-*Acetyl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyl*-5′-β-*phenylpropionyldiphenylmethane* (IX; R = Me, R′ = Ph·CH$_2$·CH$_2$, R″ = H).—(*a*) A solution of this compound (0·75 g.) in acetic acid (40 ml.) and water (5 ml.) was gently heated under reflux for 6 hours and then filtered to remove solid (0·18 g.), m. p. about 270°, which, on recrystallisation from aqueous dioxan, gave 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (IX; R = R′ = Me, R″ = H), m. p. 290°. The acetic acid liquor was concentrated in a vacuum and diluted with water (30 ml.), and the solid (0·45 g.) separated by slow crystallisation from cold acetone (50 ml.) into unchanged 5-acetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-5′-β-phenylpropionyldiphenylmethane (0·32 g.), m. p. approx. 250°, which on purification had m. p. 258—260°, and a somewhat resinous product (0·1 g.), which, on crystallisation from aqueous alcohol (charcoal) 3 times, gave a little 2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5 : 5′-di-β-phenylpropionyldiphenylmethane (IX; R = R′ = Ph·CH$_2$·CH$_2$, R″ = H), m. p. and mixed m. p. 202—205°.

A mixture of 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·4 g.), 2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5 : 5′-di-β-phenylpropionyldiphenylmethane (0·55 g.), acetic acid (45 ml.), and water (5 ml.) was gently heated under reflux for 6 hours and then filtered to remove unchanged 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·25 g.), m. p. *ca.* 275°, which on purification had m. p. 288°. On evaporation in a vacuum the filtrate yielded a resinous solid (0·65 g.), m. p. approx. 180°, which was separated as above into a little 2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5 : 5′-di-β-phenylpropionyldiphenylmethane and slightly impure 5-acetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5′-β-phenylpropionyldiphenylmethane (0·4 g.), m. p. 254°.

(*b*) A solution of 5-acetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5′-β-phenylpropionyldiphenylmethane (0·5 g.) in 2N-aqueous sodium carbonate (30 ml.) was kept at 70° for 20 minutes, cooled, and acidified with dilute hydrochloric acid. The precipitate (0·4 g.) was extracted with a hot mixture of acetone (20 ml.) and water (5 ml.), and the residue (0·09 g.) crystallised from aqueous dioxan, giving 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane, m. p. 291° (decomp.). Evaporation of the acetone extract gave unchanged 5-acetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5′-β-phenylpropionyldiphenylmethane (0·25 g.) and a resinous product from which a definite compound could not be obtained.

(*c*) A mixture of 5-acetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5′-β-phenylpropionyldiphenylmethane (0·5 g.), dioxan (15 ml.), and concentrated hydrochloric acid (0·5 g.) was heated under reflux for ½ hour and evaporated in a vacuum, leaving a brown-yellow solid which was separated by means of dilute acetone into impure 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·09 g.), m. p. 288—291°, unchanged 5-acetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyl-5′-β-phenylpropionyldiphenylmethane (0·25 g.), m. p. 258—260° (decomp.), and an amorphous residue.

5 : 5′-*Di*-n-*butyryl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyldiphenylmethane* (IX; R = R′ = Pr^n, R″ = H).—Karrer's method (*Helv. Chim. Acta*, 1919, **2**, 481) was found to give poor yields of this compound, and the condensation of 2 : 4 : 6-trihydroxy-3-methyl-*n*-butyrophenone (Karrer, *loc. cit.*) with 40% aqueous formaldehyde by either concentrated sulphuric acid or hydrochloric acid gave a small yield of a resinous product.

A mixture of 2 : 4 : 6-trihydroxy-3-methyl-*n*-butyrophenone (0·5 g.) in methanol (7 ml.) and water (2 ml.), paraformaldehyde (0·15 g.), and concentrated sulphuric acid (10 drops) was agitated for 24 hours. The precipitate consisted of 5 : 5′-di-*n*-butyryl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane, forming tiny pale yellow needles (0·45 g.), m. p. 212° from alcohol, which gave resinous products on acetylation or methylation.

5-*Acetyl*-5′-n-*butyryl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyldiphenylmethane* (IX; R = Me, R′ = Pr^n, R′′ = H).—A mixture of 2 : 4 : 6-trihydroxy-3-methyl-*n*-butyrophenone (0·5 g.) and 2 : 4 : 6-trihydroxy-3-methylacetophenone (0·5 g.), alcohol (10 ml.), water (3 ml.), paraformaldehyde (0·25 g.), and concentrated sulphuric acid (10 drops) was agitated for 48 hours, and the solid (0·8 g.) washed with water and extracted with a mixture of hot 85% acetone (35 ml.), leaving a residue (0·32 g.) of 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane, m. p. 265—270°, which on purification from hot dioxan had m. p. 289—291° (decomp.). Evaporation of the acetone extract gave a solid (0·15 g.), m. p. 242—246°, which on being thrice crystallised from aqueous acetone furnished 5-*acetyl*-5′-n-*butyryl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyldiphenylmethane* in very pale yellow needles, m. p. 246—248°, moderately soluble in hot alcohol, and having a bright red ferric reaction in alcohol (Found : C, 62·0; H, 6·0. $C_{21}H_{24}O_8$ requires C, 62·4; H, 6·0%). After the removal of this compound 5 : 5′-di-*n*-butyryl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·25 g.) was isolated.

Disproportionation of 5-*Acetyl*-5′-n-*butyryl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyldiphenylmethane*.—This compound (0·5 g.) was heated under reflux with acetic acid (25 ml.) and water (2 ml.) for 5 hours and the hot mixture filtered to remove 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (IX; R = Me, R′ = H) (0·17 g.), m. p. 270°. The solid obtained by evaporation of the acidic liquor gave unchanged 5-acetyl-5′-*n*-butyryl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·09 g.) and a small amount of 5 : 5′-di-*n*-butyryl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane.

A mixture of 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·4 g.) and 5 : 5′-di-*n*-butyryl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·5 g.), acetic acid (40 ml.), and water (5 ml.) was gently heated under reflux for 5 hours, giving unchanged material (0·3 g.), 5-acetyl-5′-*n*-butyryl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·14 g.), and a small amount of the 5 : 5′-di-*n*-butyryl compound.

2 : 4 : 6-*Trihydroxy*-3-*methylbenzophenone*.—The condensation of *C*-methylphloroglucinol (5 g.) and phenyl cyanide (6 ml.) in ether (150 ml.) by means of zinc chloride (2 g.) and excess of hydrogen chloride yielded a dark viscous oil which on hydrolysis with boiling water (100 ml.) for 75 minutes gave a semi-solid. Crystallised from hot 2N-sulphuric acid and then hot water (charcoal), this product gave 2 : 4 : 6-*trihydroxy*-3-*methylbenzophenone* in yellow rhombic plates (4·5 g.), m. p. 139—140°, moderately soluble in hot water, readily soluble in alcohol, and giving a dark red ferric reaction in alcohol (Found : C, 68·7; H, 5·1. $C_{14}H_{12}O_4$ requires C, 68·9; H, 5·0%). The *triacetate* separated from aqueous alcohol in colourless plates, m. p. 112—113° (Found : C, 64·5; H, 4·6. $C_{20}H_{18}O_7$ requires C, 64·8; H, 4·9%). Interaction of the ketone with warm alcoholic diazoaminobenzene for 3 minutes gave 3-*benzoyl*-2 : 4 : 6-*trihydroxy*-5-*methylazobenzene*, which formed red, crescent-shaped needles, m. p. 184—185°, from acetic acid (Found : C, 68·9; H, 4·9. $C_{20}H_{16}O_4N_2$ requires C, 69·0; H, 4·6%).

Methylation of this ketone by the methyl iodide–potassium carbonate method gave 2-*hydroxy*-4 : 6-*dimethoxy*-3-*methylbenzophenone*, which formed lustrous, almost colourless plates, m. p. 136—137°, from dilute alcohol, soluble in dilute aqueous sodium hydroxide and having a violet ferric reaction in alcohol (Found : C, 70·5; H, 6·0; OMe, 20·9. $C_{16}H_{16}O_4$ requires C, 70·6; H, 6·0; OMe, 22·8%).

5 : 5′-*Dibenzoyl*-2 : 4 : 6 : 2′ : 4′ : 6′-*hexahydroxy*-3 : 3′-*dimethyldiphenylmethane* (IX; R = R′ = Ph, R′′ = H) was prepared from 2 : 4 : 6-trihydroxy-3-methylbenzophenone (1 g.), 40% aqueous formaldehyde (2 ml.), and alcohol (15 ml.) containing concentrated sulphuric acid (15 drops) in the course of 24 hours and formed yellow needles (0·8 g.), m. p. 242—243°, from dilute alcohol, readily soluble in alcohol and having a red-brown ferric reaction (Found : C, 69·4; H, 5·0. $C_{29}H_{24}O_8$ requires C, 69·6; H, 4·9%). The *hexa-acetate* separated from dilute alcohol in colourless rhombic plates, m. p. 136—138° (Found : C, 65·2; H, 5·0. $C_{41}H_{36}O_{14}$ requires C, 65·4; H, 4·8%). Methylation of this diphenylmethane by the methyl sulphate–potassium carbonate method during 4 hours gave the *hexamethyl ether*, which separated from light petroleum (b. p. 40—60°) and then aqueous alcohol in colourless needles, m. p. 168—169° [Found : C, 71·9; H, 6·3; OMe, 32·5. $C_{29}H_{18}O_2(OMe)_6$ requires C, 71·9; H, 6·2; OMe, 31·9%].

3 : 3′-*Diacetyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-6 : 6′-*dimethoxy*-5 : 5′-*dimethyldiphenylmethane* (IX; R = R′ = R′′ = Me) was prepared from 2 : 6-dihydroxy-4-methoxy-3-methylacetophenone (Curd and Robertson, *J.*, 1933, 1179) (1 g.) by the formaldehyde–sulphuric acid method and on isolation formed very pale yellow prisms (0·8 g.), m. p. 218—219° (decomp.), from alcohol, having a green ferric reaction in alcohol [Found : C, 62·4; H, 6·2; OMe, 15·1. $C_{19}H_{18}O_6(OMe)_2$ requires C, 62·4; H, 6·0; OMe, 15·3%]. The hexamethyl ether had m. p. 102—103°, and was identical with an authentic specimen (McGookin *et al.*, *J.*, 1939, 1585). The *tetra-acetate* formed squat prisms, m. p. 146—147°, from aqueous alcohol (Found : C, 61·0; H, 5·8. $C_{29}H_{32}O_{12}$ requires C, 60·8; H, 5·6%).

2 : 6-*Dihydroxy*-4-*methoxy*-3-*methyl*-β-*phenylpropiophenone*.—The condensation of *C*-methylphloroglucinol β-methyl ether (3·8 g.) and β-phenylpropionitrile (4 ml.) by Hoesch's method gave a viscous product which on hydrolysis with boiling water (100 ml.) for ½ hour furnished 2 : 6-*dihydroxy*-4-*methoxy*-3-*methyl*-β-*phenylpropiophenone*. This ketone separated from alcohol in lustrous yellow plates (2 g.), m. p. 172—173°, moderately soluble in hot benzene, sparingly soluble in hot water, and giving a dark violet ferric reaction in alcohol (Found : C, 71·2; H, 6·5. $C_{17}H_{18}O_4$ requires C, 71·4; H, 6·4%). The 2 : 4-*dinitrophenylhydrazone* formed scarlet needles, m. p. 212—214°, from ethyl acetate–light petroleum (b. p. 60—80°) (Found : N, 12·2. $C_{23}H_{22}O_7N_4$ requires N, 12·0%), and the *diacetate* colourless rhombic plates, m. p. 75—76°, from dilute alcohol (Found : C, 68·2; H, 6·2; OMe, 8·2. $C_{20}H_{19}O_5{\cdot}OMe$ requires C, 68·1; H, 6·0; OMe, 8·4%).

Methylation of this ketone by the methyl iodide–potassium carbonate method furnished 2-hydroxy-4 : 6-dimethoxy-3-methyl-β-phenylpropiophenone, m. p. 144—145·5°, identical with an authentic specimen.

2 : 4 : 2′ : 4′-*Tetrahydroxy*-6 : 6′-*dimethoxy*-3 : 3′-*di*-β-*phenylpropionyl*-5 : 5′-*dimethyldiphenylmethane* (IX; R = R′ = $Ph\cdot CH_2\cdot CH_2$, R″ = Me) was prepared from 2 : 6-dihydroxy-4-methoxy-3-methyl-β-phenylpropiophenone by the formaldehyde–sulphuric acid method and separated from alcohol in lustrous pale yellow plates, m. p. 171—172°, readily soluble in hot acetic acid and having a green ferric reaction in alcohol [Found : C, 71·7; H, 6·4; OMe, 10·6. $C_{33}H_{30}O_6(OMe)_2$ requires C, 71·9; H, 6·2; OMe, 10·6%]. The *tetra-acetate* formed colourless prisms, m. p. 114—115°, from ethyl acetate–light petroleum (Found : C, 68·3; H, 6·1. $C_{43}H_{44}O_{12}$ requires C, 68·6; H, 5·9%).

3-*Acetyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-6 : 6′-*dimethoxy*-3′-β-*phenylpropionyl*-5 : 5′-*dimethyldiphenylmethane* (IX; R = Me, R′ = $Ph\cdot CH_2\cdot CH_2$, R″ = Me).—The interaction of 2 : 6-dihydroxy-5-methoxy-3-methyl-β-phenylpropiophenone (0·75 g.), 2 : 6-dihydroxy-4-methoxy-3-methylacetophenone (0·5 g.), 40% aqueous formaldehyde (2·5 ml.), and concentrated sulphuric acid (15 drops) in alcohol (10 ml.) during two days gave a mixed product (1 g.) which was separated by fractional crystallisation from alcohol into 2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyl-3 : 3′-di-β-phenylpropionyldiphenylmethane (0·3 g.), m. p. and mixed m. p. 171—172°, 3-*acetyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-6 : 6′-*dimethoxy*-5 : 5′-*dimethyl*-3′-β-*phenylpropionyldiphenylmethane* in almost colourless needles, m. p. 189—191°, from alcohol, having a green ferric reaction [Found : C, 68·0; H, 6·2; OMe, 12·8. $C_{26}H_{24}O_6(OMe)_2$ requires C, 68·0; H, 6·1; OMe, 12·6%], and a small amount of 3 : 3′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethylphenylmethane, m. p. 216—219°.

Disproportionation of 3-acetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyl-3′-β-phenylpropionyldiphenylmethane (0·6 g.) in boiling acetic acid (30 ml., containing 2 ml. of water) for 15 hours gave a brownish-yellow solid of indefinite m. p. which on fractional crystallisation from alcohol was resolved into 2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyl-3 : 3′-di-β-phenylpropionyldiphenylmethane (0·15 g.), m. p. 170—172°, unchanged 3-acetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyl-3′-β-phenylpropionyldiphenylmethane (0·2 g.), and a small amount of 3 : 3′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane, m. p. 217—219°.

2 : 6-*Dihydroxy*-4-*methoxy*-3-*methylbenzophenone* was prepared from *C*-methylphloroglucinol β-methyl ether (3 g.) and phenyl cyanide (3 ml.) by Hoesch's method and on crystallisation from benzene and then aqueous alcohol formed lustrous bright yellow prisms (2·5 g.), m. p. 143—144°, moderately soluble in alcohol, sparingly soluble in hot water, and having a reddish-brown ferric reaction (Found : C, 69·7; H, 5·6; OMe, 10·7. $C_{14}H_{11}O_3\cdot OMe$ requires C, 69·8; H, 5·5; OMe, 12·0%). The 2 : 4-*dinitrophenylhydrazone* separated from acetic acid in orange-red needles, m. p. 215—216° (Found : N, 12·6. $C_{21}H_{18}O_7N_4$ requires N, 12·6%), and the *diacetate* from aqueous alcohol in colourless rhombic prisms, m. p. 134—135° (Found : C, 66·7; H, 5·3. $C_{19}H_{18}O_6$ requires C, 66·7; H, 5·3%).

On methylation by the methyl iodide–potassium carbonate method for 8 hours this ketone gave 2-hydroxy-4 : 6-dimethoxy-3-methylbenzophenone, m. p. and mixed m. p. 136—137°, after purification.

3 : 3′-*Dibenzoyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-6 : 6′-*dimethoxy*-5 : 5′-*dimethyldiphenylmethane* (IX; R = R′ = Ph, R″ = Me) was prepared from 2 : 6-dihydroxy-4-methoxy-3-methylbenzophenone by the formaldehyde–sulphuric acid method in the course of 24 hours, forming yellow felted needles (0·3 g.), m. p. 202—204° (decomp.), from alcohol, readily soluble in hot acetone, and having a red-brown ferric reaction in alcohol [Found : C, 70·3; H, 5·5; OMe, 12·8. $C_{29}H_{22}O_6(OMe)_2$ requires C, 70·4; H, 5·4; OMe, 11·7%]. The *tetra-acetate* separated from ethyl acetate–light petroleum (b. p. 60—80°) in colourless needles or plates, m. p. 165—166° (Found : C, 67·2; H, 5·3. $C_{39}H_{36}O_{12}$ requires C, 67·4; H, 5·2%). Methylation of this ketone by the methyl sulphate–potassium carbonate method gave 3 : 3′-dibenzoyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexamethoxy-5 : 5′-dimethyldiphenylmethane, m. p. 168—169°, identical with an authentic specimen.

3-*Acetyl*-3′-*benzoyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-6 : 6′-*dimethoxy*-5 : 5′-*dimethyldiphenylmethane* (IX; R = Me, R′ = Ph, R″ = Me).—The mixed solid from the interaction of 2 : 6-dihydroxy-4-methoxy-3-methylbenzophenone (0·6 g.) and 2 : 6-dihydroxy-4-methoxy-3-methylacetophenone (0·5 g.) in alcohol (15 ml.), containing 40% aqueous formaldehyde (3 ml.) and concentrated sulphuric acid (1 ml.), during 24 hours was separated by crystallisation from alcohol into 3 : 3′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane, m. p. 218—219° (decomp.), 3 : 3′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane, m. p. 201—204° (decomp.), and 3-*acetyl*-3′-*benzoyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-6 : 6′-*dimethoxy*-5 : 5′-*dimethyldiphenylmethane*, forming yellow needles (0·3 g.), m. p. 195—196°, from alcohol and having a green ferric reaction (Found : C, 66·8; H, 5·8. $C_{26}H_{26}O_8$ requires C, 66·9; H, 5·6%). The *tetra-acetate* of the last compound separated from aqueous alcohol in colourless needles, m. p. 157—159° (Found : C, 64·4; H, 5·5. $C_{34}H_{34}O_{12}$ requires C, 64·3; H, 5·4%).

Disproportionation of 3-*Acetyl*-3′-*benzoyl*-2 : 4 : 2′ : 4′-*tetrahydroxy*-6 : 6′-*dimethoxy*-5 : 5′-*dimethyldiphenylmethane.*—On being boiled with acetic acid (45 ml., containing 3 ml. of water) for 15 hours this compound gave a dark yellow solid (0·7 g.) which was separated by fractional crystallisation from alcohol into 3 : 3′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane, m. p. 219° (decomp.), unchanged 3-acetyl-3′-benzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane (0·22 g.), and a small amount of 3 : 3′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane. When a mixture of 3 : 3′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane (0·5 g.), 3 : 3′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane (0·6 g.), acetic acid (45 ml.), and water (2·5 ml.) was boiled for 15 hours a mixture of the same products was obtained.

Action of C-*Methylphloracetophenone on Symmetrical Diphenylmethanes.*—(*a*) When a solution of 5 : 5′-diacetyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane (0·2 g.) and *C*-methylphloracetophenone (0·2 g.) in acetic acid (30 ml., containing 5 ml. of water) was gently heated under reflux (oil-bath at 140°), a pale yellow crystalline material began to separate and after 4 hours the mixture was cooled and filtered. Recrystallisation of this yellow solid (0·2 g.), m. p. 282—290°, from aqueous dioxan gave 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane in microscopic pale yellow needles, m. p. 291°. When the acetic acid filtrate was evaporated to a small volume in a vacuum and then diluted with water (20 ml.), a brown solid (0·18 g.), m. p. 184°, separated which on crystallisation from benzene (charcoal) yielded 2 : 6-dihydroxy-4-methoxy-3-methylacetophenone in pale yellow needles, m. p. 197—198°.

(*b*) When a mixture of 3 : 3′-dibenzoyl-2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyldiphenylmethane (0·2 g.) and *C*-methylphloracetophenone (0·17 g.) was employed in the reaction (*a*), the product consisted of 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (0·16 g.), m. p. 289—291°, and 2 : 6-dihydroxy-4-methoxy-3-methylbenzophenone (0·16 g.), m. p. 143—144°.

(*c*) Similarly, a mixture of 2 : 4 : 2′ : 4′-tetrahydroxy-6 : 6′-dimethoxy-5 : 5′-dimethyl-3 : 3′-di-β-phenylpropionyldiphenylmethane (0·2 g.) and *C*-methylphloracetophenone (0·17 g.) gave 5 : 5′-diacetyl-2 : 4 : 6 : 2′ : 4′ : 6′-hexahydroxy-3 : 3′-dimethyldiphenylmethane (III; R = Me, R′ = H) (0·16 g.), m. p. 291°, and 2 : 6-dihydroxy-4-methoxy-3-methyl-β-phenylpropiophenone (0·18 g.), m. p. 172—173°.

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