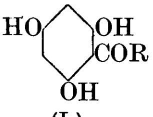
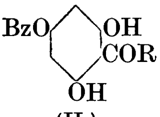
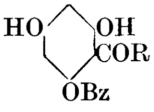
CLXV.—*Hydroxy-carbonyl Compounds. Part II. The Benzoylation of Ketones derived from Phloroglucinol.*

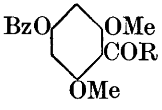
By FREDERICK W. CANTER, FRANK H. CURD, and ALEXANDER ROBERTSON.

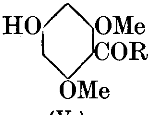
THE partial benzoylation of phloroglucinaldehyde gave as the main product a monobenzoate (Robertson and Robinson, J., 1927, 1710) which has been shown by Robinson (J., 1928, 1455) to be 2-*O*-benzoylphloroglucinaldehyde. In view of the interesting behaviour of this aldehyde, which, as Robinson has pointed out, may be contrasted with that of phloroglucinolcarboxylic acid (Fischer, *Annalen*, 1910, **371**, 303), a study of the benzoylation of ketones derived from phloroglucinol was undertaken. Accordingly, therefore, the experiments described below were carried out under conditions comparable with those employed in the preparation of the benzoate of phloroglucinaldehyde.

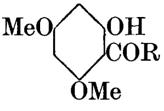

(I.)


(II.)


(III.)


(IV.)


(V.)


(VI.)

On benzoylation, phloracetophenone and *phlorpropiophenone* formed mainly the *p*-monobenzoates (II, R = Me) and (II, R = Et).

In addition, small amounts of the isomeric esters (III, R = Me) and (III, R = Et) were obtained. Phlorbutyrophenone (Karrer, *Helv. Chim. Acta*, 1919, **2**, 466) and phlorbenzophenone afforded only the corresponding *p*-benzoates (II, R = *n*-Pr) and (II, R = Ph), but it must be noted that, owing to the practical difficulties experienced in purifying the products, traces of the isomeric esters may have escaped detection. Dibenzoates do not appear to be formed in any appreciable amounts but, curiously enough, under slightly modified conditions phlorbenzophenone readily forms a *tribenzoate.*

Sonn and Bülow (*Ber.*, 1925, **58**, 1696) describe a mono- and a di-benzoate of phloracetophenone which they obtained by the action of benzoyl chloride on an aqueous solution of the monosodium salt. Neither of the products obtained by us appears to be identical with the monobenzoate described by these authors.

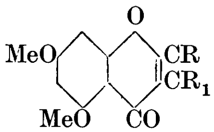
The orientation of the esters of the type (II) is established by methylation to the dimethyl ethers, type (IV), and subsequent hydrolysis with the formation of the corresponding hydroxydimethoxy-ketones (V). Sufficient material was not available to enable us to undertake the methylation of the *O*-benzoates of phloracetophenone and phlorpropiophenone. In order to prove that this derivative of phloracetophenone (III, R = Me) is a benzoate and not a benzophenone it was converted by means of benzoyl chloride and pyridine into 2 : 4 : 6-*tribenzoyloxyacetophenone.* This tribenzoate, which can also be obtained directly from phloracetophenone, is readily debenzoylated, yielding the original ketone.

The condensation of the appropriate nitriles with phloroglucinol dimethyl ether by the method of Hoesch and hydrolysis of the resulting ketimines afforded an independent method of preparing the ketones (V, R = Me), (V, R = Et), and (V, R = *n*-Pr) together with the corresponding isomerides (VI). In the case of acetonitrile the ketimines were separated by crystallisation before hydrolysis; with propionitrile, to effect a separation of the ketones, advantage was taken of the different rates of hydrolysis of the two ketimines (compare Johnson and Robertson, J., 1930, 21). The *p*-hydroxyketones (type V) are soluble in dilute sodium carbonate solution, and in the case of the *n*-butyro-derivatives this property was utilised in separating the isomerides obtained by hydrolysis of the mixed ketimines. The two classes of ketone may also be readily distinguished, since (VI) gives a ferric chloride reaction and (V) does not.

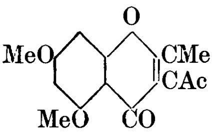
The condensation of acetonitrile and phloroglucinol dimethyl ether has been previously described by Shinoda (*J. Pharm. Soc. Japan*, 1927, 111), who obtained as the final products the known ketone

(VI, R = Me) and a diketone, m. p. 152—153°. The production of a diketone in this manner appears to be unique. Despite a careful search, the only product in addition to (VI, R = Me) which we were able to isolate was the ketone (V, R = Me), m. p. 185·5°.

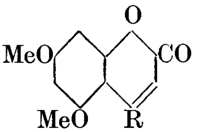
The orientations of 2-*hydroxy*-4 : 6-*dimethoxypropiophenone* and 2-*hydroxy*-4 : 6-*dimethoxy*-n-*butyrophenone* are established by ring closure with sodium acetate and acetic anhydride to the 1 : 4-benzopyrones (VII, R = Me; R_1 = Me) and (VII, R = Me; R_1 = Et). The *flavone* (VII, R = Ph; R_1 = Me) is obtained from the former ketone by Robinson's procedure.



(VII.)



(VIII.)



(IX.)

The conclusion that the products (VII, R = Me; R_1 = Me) and (VII, R = Me; R_1 = Et) are 1 : 4-benzopyrones and not the coumarins (IX, R = Et) and (IX, R = *n*-Pr) is based on the behaviour of analogous ketones under the same conditions (Kostanecki and Rôżycki, *Ber.*, 1901, **34**, 102; Kostanecki and Lloyd, *ibid.*, p. 2942; Crabtree and Robinson, J., 1918, **113**, 859; Baker, J., 1925, **127**, 2349; Robinson and co-workers, J., 1929, 61, 152, which see for further references).

Vigorous acetylation of 2-hydroxy-4 : 6-dimethoxyacetophenone gives rise to a product which we consider to be 5 : 7-*dimethoxy*-3-*acetyl*-2-*methyl*-1 : 4-*benzopyrone* (VIII). Evidence of this constitution is afforded by the results of Nagai (*Ber.*, 1892, **25**, 1284), Tahara (*ibid.*, p. 1302), Kostanecki and co-workers (*loc. cit.*), and Wittig (*Ber.*, 1924, **57**, 88; *Annalen*, 1925, **446**, 155). These authors find that the formation of 2-methyl-1 : 4-benzopyrones from *o*-hydroxyacetophenones by means of acetic anhydride and sodium acetate is sometimes accompanied by acetylation in the 3-position. In addition, in certain cases Wittig obtained unsubstituted pyrones together with the isomeric coumarins. The latter substances do not appear to form *C*-acetyl derivatives under these conditions and hence it appears unlikely that our product is a derivative of (IX, R = Me). The formation of 2-methyl-1 : 4-benzopyrones from ω-substituted *o*-hydroxyacetophenones ($CO{\cdot}CH_2X$, where X may be OMe, Me, etc.) is not accompanied by nuclear acetylation (compare Kostanecki and co-workers, *loc. cit.*; Allan and Robinson, J., 1924, **125**, 2192; Baker, *loc. cit.*; Wittig, *loc. cit.*). This fact is in agreement with the view that the *C*-acetyl group is in the 3-position.

EXPERIMENTAL.

Benzoylation of Phloracetophenone.—(A) A mixture of phloracetophenone (5 g.), benzoyl chloride (5·8 g.), and pyridine (20 c.c.) was kept at room temperature for 1·5 hours and then poured into water (350 c.c.). An ethereal extract of the reaction mixture was washed several times with water and, on evaporation of the solvent, the product (3 g.) solidified. Recrystallised from methyl alcohol, 2 : 4 : 6-*tribenzoyloxyacetophenone* formed squat prisms, m. p. 117—118° (Found: C, 72·3; H, 4·6. $C_{29}H_{20}O_7$ requires C, 72·5; H, 4·2%). The substance is insoluble in alkali and does not give a ferric chloride reaction. It is sparingly soluble in alcohol and readily soluble in ether or acetone. Evaporation of the methyl-alcoholic residues gave a small amount of unchanged phloracetophenone.

A suspension of the tribenzoate (2·5 g.) in a mixture of methyl alcohol (25 c.c.) and 10% aqueous potassium hydroxide (25 c.c.) was heated on the water-bath for ½ hour. After cooling, the clear solution was kept for 1·5 hours at room temperature and then acidified with 5% hydrochloric acid. The precipitate was collected and treated with aqueous sodium bicarbonate solution to remove benzoic acid. The residual phloracetophenone had m. p. and mixed m. p. 217—218° after crystallisation from ethyl acetate–ligroin.

(B) A solution of phloracetophenone (10 g.) in 2·1% aqueous potassium hydroxide (200 c.c.) was cooled to − 1°; part of the potassium derivative crystallised. Benzoyl chloride (8·4 g.) was then introduced in six portions with very vigorous shaking, which was finally continued for 15 minutes. The mixture was poured into saturated sodium bicarbonate solution (250 c.c.) and after 2 hours the solid was collected, washed with water, and dissolved in ether. The ethereal solution was twice extracted with 10% sodium carbonate solution (100 c.c.), washed with water, and dried. Removal of the solvent left 4-O-*benzoylphloracetophenone* as a solid (3 g.) which crystallised from methyl alcohol in elongated plates, m. p. 210—211° (Found: C, 65·9; H, 4·5. $C_{15}H_{12}O_5$ requires C, 66·2; H, 4·4%). The substance is sparingly soluble in cold alcohol and readily soluble in warm benzene. It gives with alcoholic ferric chloride a reddish-brown coloration which becomes brown on dilution with water.

Acidification of the combined sodium carbonate extracts with hydrochloric acid gave impure 2-O-*benzoylphloracetophenone* (1 g.). After several crystallisations from methyl alcohol a small amount of the pure substance was obtained in colourless short prisms, m. p. 168° (Found: C, 66·0; H, 4·7%). The ferric chloride reaction is wine-red and is unchanged by the addition of water. A mixture of the two monobenzoates melted at about 158°.

On treatment with benzoyl chloride and pyridine, 2-*O*-benzoylphloracetophenone gave the tribenzoate, m. p. and mixed m. p. 117°.

4-*Benzoyloxy*-2 : 6-*dimethoxyacetophenone* (IV, R = Me).—4-*O*-Benzoylphloracetophenone (5 g.) was dissolved in acetone (100 c.c.) and methylated by means of methyl iodide (15 c.c.) and anhydrous potassium carbonate (25 g.) during 12 hours on the steam-bath. After filtration from potassium salts, the acetone and excess of methyl iodide were removed by distillation and the residue was extracted with hot ligroin. On cooling, the *dimethyl* ether (5 g.) crystallised; on recrystallisation from the same solvent, it formed colourless rectangular prisms, m. p. 119° [Found : C, 68·0; H, 5·5; OMe, 20·7. $C_{15}H_{10}O_3(OMe)_2$ requires C, 68·0; H, 5·3; OMe, 20·7%]. The compound is readily soluble in alcohol and ethyl acetate, and does not give a ferric chloride reaction.

4-*Hydroxy*-2 : 6-*dimethoxyacetophenone* (V, R = Me).—A solution of the foregoing benzoate (3 g.) in 8% methyl-alcoholic potassium hydroxide (120 c.c.) was kept at room temperature for 2·5 hours and then neutralised with hydrochloric acid. After evaporation of the methyl alcohol in a vacuum, the solid residue was washed with sodium bicarbonate solution to remove benzoic acid and then with water. Crystallisation of the dried solid from warm ethyl acetate gave the *ketone* in slender prisms, m. p. 185·5° [Found : C, 61·3; H, 6·4; OMe, 31·6. $C_8H_6O_2(OMe)_2$ requires C, 61·2; H, 6·1; OMe, 31·6%]. The compound is readily soluble in alcohol and does not give a ferric chloride reaction. Unlike 2 : 4-*O*-dimethylphloracetophenone, it dissolves in aqueous sodium carbonate solution.

Condensation of Phloroglucinol Dimethyl Ether and Acetonitrile.—A solution of phloroglucinol dimethyl ether (5 g.) and acetonitrile (1·5 g.) in ether (50 c.c.) was saturated with hydrogen chloride in the presence of zinc chloride (2 g.). Two days later, the liquid was decanted and the mixed ketimine hydrochlorides were washed with ether. A suspension of the mixture in water (100 c.c.) was heated on the steam-bath for 10 minutes and, after cooling, the solid was collected and dissolved in warm alcohol. The crystalline ketimine which separated from the cooled solution was collected and hydrolysed by boiling for 20 minutes with water (50 c.c.). The resulting 4-hydroxy-2 : 6-dimethoxyacetophenone (2 g.) crystallised from ethyl acetate in slender prisms, m. p. and mixed m. p. 185·5° (Found : C, 61·3; H, 6·5%). Benzoylation by means of benzoyl chloride and pyridine gave the benzoate, m. p. and mixed m. p. 119°.

On addition of ethyl acetate to the alcoholic filtrate from the foregoing ketimine a precipitate of the isomeric compound was obtained. Hydrolysed by boiling for 1 hour with water (80 c.c.), it gave 2-hydroxy-4 : 6-dimethoxyacetophenone which, on crystallisation from alcohol and then from light petroleum, formed irregular prisms, m. p. 80—81° unchanged by repeated recrystallisation (compare Friedländer and Schnell, *Ber.*, 1897, **30**, 2152; Kostanecki and Tambor, *ibid.*, 1899, **32**, 2262; Asahina and co-workers, *J. Pharm. Soc. Japan*, 1927, 133). Acetylation by means of acetic anhydride and sodium acetate on the steam-bath for 3 hours afforded the acetate, m. p. 106—107°.

5 : 7-*Dimethoxy*-3-*acetyl*-2-*methyl*-1 : 4-*benzopyrone* (VIII).—A mixture of 2-hydroxy-4 : 6-dimethoxyacetophenone (1 g.), sodium acetate (1·3 g.), and acetic anhydride (8 c.c.) was heated at 180° (oil-bath) for 12 hours. On isolation, the *pyrone* crystallised from methyl alcohol and then from ethyl acetate–ligroin in colourless prisms, m. p. 169° (Found : C, 64·2; H, 5·6. $C_{14}H_{14}O_5$ requires C, 64·1; H, 5·3%). The colourless solution of the substance in concentrated sulphuric acid exhibits a faint green fluorescence in the light of a carbon arc.

Phlorpropiophenone (I, R = Et).—Phloroglucinol (6 g.) was dissolved in ether (30 c.c.) and condensed with propionitrile (2·9 g.) by means of hydrogen chloride in the presence of zinc chloride (1 g.). After 60 hours, the ketimine hydrochloride was isolated and hydrolysed by boiling with water (50 c.c.). Crystallised from water, the ketone separated as a *hydrate* in colourless needles, m. p. 174—175° (Found : C, 53·8; H, 6·4. $C_9H_{10}O_4,H_2O$ requires C, 54·0; H, 6·0%). The substance is readily soluble in alcohol and warm water. With alcoholic ferric chloride it gives a purple coloration unchanged on dilution with water.

Benzoylation of Phlorpropiophenone.—A solution of the ketone (10 g.) in 1·5% aqueous potassium hydroxide (300 c.c.) was treated with benzoyl chloride (7·7 g.). The isolation of the product and the separation of the isomerides were carried out in the manner described for corresponding benzoates of phloracetophenone. On crystallisation from benzene and then from methyl alcohol, 4-O-*benzoylphlorpropiophenone* (II, R = Et) formed colourless needles (3 g.), m. p. 193° after sintering at 188° (Found : C, 66·8; H, 5·0. $C_{16}H_{14}O_5$ requires C, 67·1; H, 4·9%). The compound is moderately easily soluble in warm alcohol and sparingly soluble in boiling benzene. It gives with alcoholic ferric chloride a reddish-brown coloration which fades on the addition of water.

The crude 2-O-*benzoylphlorpropiophenone* (III, R = Et) (1·2 g.) was purified by repeated crystallisation from benzene and then from methyl alcohol, forming short rhombic prisms, m. p. 191—192° after sintering at 187—188° (Found : C, 66·9; H, 4·9%). The substance is readily soluble in alcohol and gives with alcoholic ferric chloride an intense wine-red coloration which is unchanged on dilution with water. A mixture of the two monobenzoates melts at about 167°.

4-*Benzoyloxy*-2 : 6-*dimethoxypropiophenone* (IV, R = Et).—The monobenzoate (5 g.) was methylated by means of methyl iodide (15 c.c.) and excess of potassium carbonate in boiling acetone (75 c.c.) during 30 hours. After isolation, the *dimethyl* ether crystallised from methyl alcohol in needles, m. p. 103° [Found: C, 68·8; H, 5·9; OMe, 19·2. $C_{16}H_{12}O_3(OMe)_2$ requires C, 68·8; H, 5·7; OMe, 19·8%]. It does not give a ferric chloride reaction.

4 - *Hydroxy* - 2 : 6-*dimethoxypropiophenone* (V, R = Et).—15% Methyl-alcoholic potassium hydroxide (40 c.c.) was added to a solution of the foregoing compound (2 g.) in methyl alcohol (40 c.c.), and the mixture kept at room temperature for 2 hours and then acidified with acetic acid. The methyl alcohol having been removed in a vacuum, the residual solid was washed with sodium bicarbonate solution and then with water. Crystallised from ethyl acetate, the *substance* formed colourless elongated prisms, m. p. 180° (Found: C, 63·3; H, 6·8. $C_{11}H_{14}O_4$ requires C, 62·9; H, 6·7%). It is soluble in 5% aqueous sodium hydroxide and does not give a ferric chloride reaction.

Condensation of Phloroglucinol Dimethyl Ether and Propionitrile.—A solution of phloroglucinol dimethyl ether (8·8 g.) and propionitrile (3·4 g.) containing zinc chloride (2 g.) in suspension was saturated with hydrogen chloride. Two days later, the mixed ketimine hydrochlorides were collected and washed with ether. A suspension of the mixture in water (150 c.c.) was boiled for ½ hour; on cooling, the oily product solidified. The solid was dissolved in a small volume of hot alcohol and, on cooling, 2-*hydroxy*-4 : 6-*dimethoxypropiophenone* (4·5 g.) crystallised. Recrystallised from the same solvent, it formed elongated plates, m. p. 111° [Found: C, 62·8; H, 7·0; OMe, 28·4. $C_9H_8O_2(OMe)_2$ requires C, 62·8; H, 6·7; OMe, 29·5%]. The compound is insoluble in cold 5% aqueous sodium hydroxide and gives a wine-red ferric chloride reaction.

On addition of ethyl acetate to the alcoholic filtrate obtained after removal of the foregoing crude ketone the ketimine of 4-hydroxy-2 : 6-dimethoxypropiophenone crystallised. Hydrolysis of this derivative was effected by boiling for 1·5 hours with water (100 c.c.). The resulting ketone separated from ethyl acetate in prisms, m. p. and mixed m. p. 180° (Found: C, 63·1; H, 7·1; OMe, 28·5%). Benzoylation of the substance by means of benzoyl chloride and pyridine gave the benzoate (IV, R = Et), m. p. and mixed m. p. 103°. Vigorous acetylation with acetic anhydride and sodium acetate at 180° afforded the *acetate*, which separated from dilute alcohol in elongated rectangular plates, m. p. 76° (Found: C, 61·7; H, 6·6. $C_{13}H_{16}O_5$ requires C, 61·9; H, 6·4%).

5 : 7-*Dimethoxy*-2 : 3-*dimethyl*-1 : 4-*benzopyrone* (VII, R and R_1 = Me).—A mixture of 2 : 4-*O*-dimethylphlorpropiophenone (2·5 g.), sodium acetate (2·5 g.), and acetic anhydride was heated at 180° for 13 hours. After isolation, the *substance* crystallised from dilute methyl alcohol in colourless rhombic prisms, m. p. 189—190° (Found : C, 66·6; H, 6·4. $C_{13}H_{14}O_4$ requires C, 66·7; H, 6·0%).

5 : 7-*Dimethoxy*-3-*methylflavone*.—An intimate mixture of 2 : 4-*O*-dimethylphlorpropiophenone (1·5 g.), sodium benzoate (2 g.), and benzoic anhydride (10 g.) was heated (oil-bath) for 12 hours at 180—190°. The cooled melt was dissolved in warm alcohol (80 c.c.), a solution of potassium hydroxide (10 g.) in water (10 c.c.) introduced, and the mixture gently refluxed for 15 minutes. After isolation, the *flavone* crystallised from methyl alcohol in colourless rectangular prisms, m. p. 178—179° (Found : C, 73·0; H, 5·7. $C_{18}H_{16}O_4$ requires C, 73·0; H, 5·4%). The pale yellow solution of the compound in concentrated sulphuric acid exhibits a bright blue fluorescence.

Benzoylation of Phlorbutyrophenone.—In preparing phlorbutyrophenone by the method of Karrer (*loc. cit.*) it was found necessary to use only a fifth of the volume of water recommended for the hydrolysis of the ketimine, otherwise the ketone did not separate from the cooled solution. It has m. p. 183° (Karrer gives m. p. 179—180°).

Phlorbutyrophenone (10 g.) was dissolved in warm 10% aqueous potassium hydroxide (43 c.c.), and the solution cooled to room temperature, diluted with water (150 c.c.), and then cooled to 0°; the greater part of the potassium derivative separated in plates. Benzoyl chloride (6·9 g.) was then introduced in six portions with very vigorous shaking, which was continued until the odour of the chloride had disappeared. The resulting mixture was stirred with excess of aqueous sodium bicarbonate for 1 hour, and the solid collected, washed with water, and dried. A solution of the product in ether (100 c.c.) was filtered to remove traces of insoluble material and washed four times with 10% sodium carbonate solution (30 c.c.). Removal of the solvent left 4-O-*benzoylphlorbutyrophenone* as a gum which crystallised from hot benzene. On repeated crystallisation from methyl alcohol, it was finally obtained in tiny rectangular prisms (0·7 g.), m. p. 164° (Found : C, 68·0; H, 5·6. $C_{17}H_{16}O_5$ requires C, 68·0; H, 5·3%). The substance is readily soluble in alcohol and ether and moderately easily soluble in warm benzene. It gives a red ferric chloride reaction. Evaporation of the methyl-alcoholic filtrates gave a mixture from which a definite compound could not be isolated.

On acidification of the combined sodium carbonate extracts, a small amount of resin separated. Extraction of the filtered solution with ether afforded only a trace of solid, m. p. 164°, which was found to be identical with the above benzoate.

4-*Benzoyloxy*-2 : 6-*dimethoxybutyrophenone* (IV, R = *n*-Pr).—The benzoate (1 g.) was dissolved in boiling acetone (50 c.c.) and methylated by refluxing for 10 hours with methyl iodide (5 c.c.) and excess of potassium carbonate. After isolation, the *dimethyl* ether crystallised from 60% methyl alcohol in elongated rectangular prisms (0·9 g.), m. p. 86° [Found: C, 70·0; H, 6·2; OMe, 18·8. $C_{17}H_{14}O_3(OMe)_2$ requires C, 69·5; H, 6·1; OMe, 18·9%].

4-*Hydroxy*-2 : 6-*dimethoxybutyrophenone* (V, R = *n*-Pr).—Hydrolysis of the benzoate (0·5 g.) was effected by means of 6% methyl-alcoholic potassium hydroxide (35 c.c.) at room temperature during 24 hours. The mixture was acidified with acetic acid, the alcohol removed by distillation under diminished pressure, and the product separated from potassium acetate and potassium benzoate by extraction with ether. The *ketone* crystallised from ethyl acetate–ligroin in rectangular prisms, m. p. 107° (Found: C, 64·6; H, 7·4. $C_{12}H_{16}O_4$ requires C, 64·3; H, 7·1%). The compound is readily soluble in ether and alcohol, and sparingly soluble in warm water. It dissolves in dilute aqueous sodium hydroxide or sodium carbonate solution.

Condensation of n-*Butyronitrile and Phloroglucinol Dimethyl Ether*.—A solution of phloroglucinol dimethyl ether (12 g.) and *n*-butyronitrile (8 g.) in dry ether (150 c.c.) was saturated with hydrogen chloride at 0° in the presence of zinc chloride (4 g.). After 24 hours, the crystalline mass of mixed ketimine hydrochlorides was collected, washed three times with ether, and hydrolysed by heating with water (200 c.c.) on the steam-bath for 15 minutes and then under reflux for 1 hour. On cooling, the oil was dissolved in ether, and the ethereal solution extracted four times with 10% sodium carbonate solution (50 c.c.), washed with water, and dried. Removal of the solvent left 2-*hydroxy*-4 : 6-*dimethoxybutyrophenone* as a solid which separated from 50% alcohol in long rectangular prisms (5 g.), m. p. 70° [Found: C, 64·5; H, 7·4; OMe, 26·7. $C_{10}H_{10}O_2(OMe)_2$ requires C, 64·3; H, 7·1; OMe, 27·7%]. With alcoholic ferric chloride this ether gives a dark brownish-red coloration. It is very sparingly soluble in hot water.

The combined sodium carbonate extracts were acidified with dilute hydrochloric acid and the isomeric ketone was isolated by means of ether. Crystallised from ethyl acetate–ligroin, it formed rectangular prisms (1 g.), m. p. and mixed m. p. 107° (Found: C, 64·6; H, 7·3; OMe, 27·0%). This compound does not give a ferric chloride reaction.

5 : 7-*Dimethoxy*-2-*methyl*-3-*ethyl*-1 : 4-*benzopyrone* (VII, R = Me;

R_1 = Et).—A mixture of 2-hydroxy-4 : 6-dimethoxybutyrophenone (1 g.), anhydrous sodium acetate (2 g.), and acetic anhydride (6 c.c.) was heated at 170—180° (oil-bath) for 10 hours. The mixture was poured into excess of water and acidified with hydrochloric acid, Congo-red being used as an indicator. After 24 hours, the solid was collected, washed with water, and crystallised from dilute methyl alcohol. The *pyrone* formed small rectangular prisms, m. p. 118° [Found: C, 67·8; H, 6·7; OMe, 25·2. $C_{12}H_{10}O_2(OMe)_2$ requires C, 67·7; H, 6·5; OMe, 25·0%]. The compound is readily soluble in ethyl or methyl alcohol. It forms a colourless solution in concentrated sulphuric acid which exhibits a bluish-green fluorescence.

Benzoylation of Phlorbenzophenone.—(A) A solution of phlorbenzophenone (10 g.) in 1% potassium hydroxide (300 c.c.) was cooled to 0°, and benzoyl chloride (6 g.) introduced in 6 portions with very vigorous shaking, which was finally continued until the odour of the chloride had disappeared. Aqueous sodium bicarbonate (300 c.c.) was then added to the mixture and after 1 hour the gum was collected, dried, and extracted with boiling benzene. Part of the benzene was removed by distillation; on cooling, 4-O-*benzoylphlorbenzophenone* separated. The benzoate was recrystallised from benzene and then from chloroform–ligroin, forming colourless needles (2 g.), m. p. 186° (Found: C, 71·8; H, 4·6. $C_{20}H_{14}O_5$ requires C, 71·9; H, 4·2%). The compound is readily soluble in methyl or ethyl alcohol and gives a reddish-brown ferric chloride reaction. A second isomeride could not be isolated from the residues.

(B) When the quantity of potassium hydroxide is increased from 1·25 mols. to 1·5 mols. in the above experiment the main product is the *tribenzoate.* The crude material was dissolved in ether (150 c.c.), and the solution twice extracted with 10% sodium carbonate solution (150 c.c.). After removal of the ether the residual oil solidified and, on crystallisation from methyl alcohol, the substance formed elongated rectangular prisms (2·5 g.), m. p. 125—126° (Found: C, 75·9; H, 4·2. $C_{34}H_{22}O_7$ requires C, 75·3; H, 4·0%). It is readily soluble in alcohol and does not give a ferric chloride reaction.

Acidification of the combined sodium carbonate extracts gave a small amount of material, m. p. about 96°, from which a definite compound could not be isolated.

4-*Benzoyloxy*-2 : 6-*dimethoxybenzophenone* (IV, R = Ph).—The monobenzoate (4 g.) was methylated by means of methyl iodide (20 c.c.) and potassium carbonate (16 g.) in boiling acetone (75 c.c.) during 6 hours. After isolation, the *dimethyl* ether (3·3 g.) was crystallised from alcohol and then from ethyl acetate–ligroin, forming colourless octahedral prisms, m. p. 170—171° [Found : C, 72·8; H, 5·2; MeO, 16·9. $C_{20}H_{12}O_3(OMe)_2$ requires C, 72·9; H, 5·0; MeO, 17·1%].

A solution of the compound (2 g.) in 10% methyl-alcoholic potassium hydroxide (80 c.c.) was kept at room temperature for 2 hours and then acidified with acetic acid. After removal of the alcohol by distillation the residue was washed with sodium bicarbonate solution and crystallised from aqueous alcohol. 4-Hydroxy-2 : 6-dimethoxybenzophenone separated in rhombic plates, m. p. 178—179°, and was identical with a specimen prepared by the method of Karrer and Lichtenstein (*Helv. Chim. Acta*, 1928, **11**, 789) (Found : C, 70·2; H, 5·6. Calc. for $C_{15}H_{14}O_4$: C, 69·8; H, 5·4%).

The authors are indebted to the Chemical Society for grants which have partly defrayed the cost of this investigation.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE,
UNIVERSITY OF LONDON. EAST LONDON COLLEGE.

[*Received, March 16th*, 1931.]