

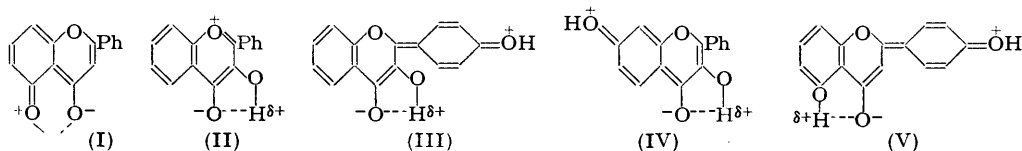
981. Chelate Systems. Part II.*

By B. L. SHAW and T. H. SIMPSON.

Comparison the R_M values of a number of 4'- and 3'-hydroxyflavones shows that a 4'-hydroxyl group stabilises the carbonyl-3-hydroxyl more than the carbonyl-5-hydroxyl chelate system. The results support the electronic mechanisms suggested in Part I.

Preparation of a number of 3'-hydroxyflavones is described.

IN Part I,* the use of paper partition chromatography in the study of hydroxylic behaviour was discussed. It was shown that chelation may readily be detected by the resulting deviation from the characteristic R_M contribution of the hydroxyl group and it was inferred that the magnitude of the R_M change is related to the strength of hydrogen bonding. Thus, the chromatographic behaviour of a group of flavones revealed hydrogen bonding between the pyrone carbonyl group and a 5- or 3-hydroxyl group and indicated that chelation was stronger with the former than with the latter hydroxyl group. In interpretation of these results, it was suggested that the carbonyl-5- and -3-hydroxyl linkages arose from the respective contributions of structures (I) and (II—IV) to the resonance state of the molecules.



This formulation of the carbonyl-3-hydroxyl chelate system is unusual in that the negative end of the dipole constituting the hydrogen bond gains its charge by electron transfer from remote atoms not directly involved in the chelate ring. The present study was undertaken to provide additional evidence.

The R_M values of a number of 4'- and 3'-hydroxyflavones are listed in Table 1. The solvents used comprised the water-poor components of the mixtures indicated at the foot of the table.

Table 2 gives an analysis of the effects of 3- and 5-hydroxyl group on the differences between the R_M values of 4'- and 3'-hydroxyflavones. The third column gives the differences,

* Part I, *J.*, 1952, 4638.

$R_M^{4'-OH} - R_M^{3'-OH}$, for a number of non-chelated flavones. The 4'- are slower-moving, *i.e.*, more hydrophilic, than the corresponding 3'-hydroxyflavones. Similar effects have been observed for isomeric alkylphenols (Campbell, Shewan, and Simpson, forthcoming publication) and 2'- and 4'-hydroxyflavones (Simpson and Whitham, unpublished data). They appear to be due to steric causes, though other factors may make some contribution.

TABLE I.

Flavone substituents	R_M			Flavone substituents	R_M		
	Solvent A	Solvent B	Solvent C		Solvent A	Solvent B	Solvent C
4'-Hydroxy-	-0.10	-0.06	-0.68	3 : 3'-Dihydroxy-7-			
3'-Hydroxy-	-0.62	-0.31	-0.86	methoxy-	+0.11	-0.09	-0.90
4'-Hydroxy-5-methoxy-	+0.78	+0.77	-0.11	3 : 7 : 4'-Trihydroxy-	+1.06	> +1.19	+0.69
3'-Hydroxy-5-methoxy-	+0.22	+0.47	-0.38	3 : 7 : 3'-Trihydroxy-	+0.85	> +1.19	+0.60
4'-Hydroxy-7-methoxy-	+0.09	0.0	-0.72	5 : 4'-Dihydroxy-.....	-0.47	-0.63	> -1.09
3'-Hydroxy-7-methoxy-	-0.38	-0.22	-0.91	5 : 3'-Dihydroxy-.....	-0.82	-0.81	> -1.09
4'-Hydroxy-5 : 7-di-				5 : 7 : 4'-Trihydroxy-	+0.56	> +1.19	+0.35
methoxy-	+0.93	+0.85	-0.09	5 : 7 : 3'-Trihydroxy-	+0.19	+1.06	+0.06
3'-Hydroxy-5 : 7-di-				5 : 4'-Dihydroxy-7-			
methoxy-	+0.42	+0.60	-0.34	methoxy-	-0.21	-0.49	< -1.09
7 : 4'-Dihydroxy-.....	+0.93	> +1.19	+1.0	5 : 3'-Dihydroxy-7-			
7 : 3'-Dihydroxy-.....	+0.46	> +1.19	+0.66	methoxy-	-0.60	-0.69	> -1.09
3 : 4'-Dihydroxy-.....	+0.12	-0.13	-0.78	3 : 5 : 7 : 4'-Tetra-			
3 : 3'-Dihydroxy-.....	+0.20	-0.11	-0.78	hydroxy-	+0.92	> +1.19	+0.52
3 : 4'-Dihydroxy-7-				3 : 5 : 7 : 3'-Tetra-			
methoxy-	+0.30	-0.01	-0.82	hydroxy-	+0.54	+1.13	+0.22

Solvents: A, cyclohexane: PrⁿOH : H₂O = 2 : 1 : 3 (vol.); B, MeNO₂ : C₆H₆ : H₂O = 1 : 9 : 10 (vol.); C, MeNO₂ : C₆H₆ : H₂ = 3 : 4 : 5 (vol.).

TABLE 2. Differences between R_M values of 4'- and 3'-hydroxyflavones.

Solvent	Substituents *	R_M difference	Substituents *	R_M difference	Substituents *	R_M difference	Substituents *	R_M difference
A	None	+0.52	3-OH	-0.08	5-OH	—	—	—
B		+0.25		-0.02		+0.35		—
C		+0.18		0		+0.18		—
A	7-OH	+0.47	3 : 7-(OH) ₂	+0.21	5 : 7-(OH) ₂	+0.37	3 : 5 : 7-(OH) ₃	+0.38
B		—		—		+0.29		—
C		+0.34		+0.09		+0.29		+0.30
A	7-OMe	+0.47	3-OH-7-OMe	+0.19	5-OH-7-OMe	—	—	—
B		+0.22		+0.08		+0.39		—
C		+0.19		+0.08		+0.20		—
A	5 : 7-(OMe) ₂	+0.56	—	—	5-OH	—	—	—
B		+0.30		—		+0.35		—
C		+0.27		—		+0.18		—
A	5 : 7-(OMe) ₂	+0.51	—	—	5-OH-7-OMe	—	—	—
B		+0.25		—		+0.39		—
C		+0.25		—		+0.20		—

* Other than 4'- or 3'-hydroxyl.

Reading across the table, it can be seen that the addition of a 3-hydroxyl group markedly decreases the R_M difference. Since the 3'-hydroxyl group is remote from, and is not conjugated with, the carbonyl group it must be assumed that it has no effect on the chelate system. The decrease in the R_M difference may therefore be considered as an overall decrease in hydrophilic character caused by the effect of a hydroxyl group in the 4'-position on the carbonyl-3-hydroxyl chelate ring. This observation that the chelate system is stabilised, *i.e.*, displays a smaller hydrophilic activity, by a 4'-hydroxyl group supports the electronic formulations suggested in Part I. Further, the stabilisation is considerably greater for 4'-hydroxy- than for 7 : 4'-dihydroxy- or 4'-hydroxy-7-methoxy-flavone. This is in agreement with the postulated chelation since a contribution from the structure (IV) to the stability of the chelate ring must reduce the stabilising contribution of (III).

From the seventh column of Table 2 it is apparent that addition of a 5-hydroxyl group causes a small but significant decrease in the difference between the R_M values of 3'- and 4'-hydroxyflavones. The third and fourth rows show that a similar decrease accompanies demethylation of a 5-methoxyl group. This indicates that, contrary to expectation, the carbonyl-5-hydroxyl chelate system derives some stability from a hydroxyl group in the 4'-position and that the effect is considerably smaller than that observed in the case of the carbonyl-3-hydroxyl system discussed above. It seems likely therefore that (V) and similar forms corresponding to (II) and (IV) make a dominant contribution to the chelation of the 5-hydroxyl group and that their effect is opposed by contributions from (I). Thus, the increase in the strength of hydrogen bonding expected to result from the addition of a 4'-hydroxyl group is not fully realised since it is partly balanced by a reduction in the stabilising contribution of (I).

From the ninth column of Table 2 it is seen that the simultaneous chelation of 3- and 5-hydroxyl groups with the pyrone carbonyl group is also stabilised by a 4'-hydroxyl group, and that this effect is of the same order as for the carbonyl-5-hydroxyl system.

Table 3 lists the R_M changes resulting from the addition of 3- or 5-hydroxyl groups to 3'-hydroxyflavones. This shows, independently of the results given in Table 2, that a 7-hydroxyl or -methoxyl group increases the stability (decreases the hydrophilic component) of the carbonyl-3-hydroxyl more than that of the carbonyl-5-hydroxyl chelate system.

Chromatographic results similar to those given in Tables 2 and 3 were obtained with different developing solvents, e.g., benzene-butanol-water and benzene-triethylamine-water.

TABLE 3.

Parent flavone	3-OH, ΔR_M			5-OH, ΔR_M		
	A	B	C	A	B	C
3'-Hydroxy	+0.82	+0.20	+0.08	-0.20	-0.50	—
7 : 3'-Dihydroxy	+0.39	—	-0.06	-0.27	—	-0.60
3'-Hydroxy-7-methoxy	+0.49	+0.13	+0.01	-0.22	-0.47*	—

* This value may be subject to serious experimental error since great difficulty was encountered in determining the position of 5 : 3'-dihydroxy-7-methoxyflavone.

The flavones required were prepared by known methods. The yields of 3-substituted chalcones were uniformly lower than those obtained for the corresponding 4-substituted compounds, probably because of greater competition from the accompanying Cannizzaro reaction.

Attempted fission of the 5-methoxyl group of 3'-hydroxy-5 : 7-dimethoxyflavone with aluminium chloride (Gulati and Venkataraman, *J.*, 1936, 267; Venkataraman *et al.*, *Proc. Indian Acad. Sci.*, 1942, 19, 139) gave mixtures of starting material and fully and partly demethylated flavones. The desired compound was obtained, chromatographically pure and in excellent yield, by heating the dimethyl ether with a mixture of equal volumes of acetic and hydriodic acids.

EXPERIMENTAL

Analyses are by Miss Corner of the Chemical Research Laboratory and by Drs. Weiler and Strauss of Oxford. M. p.s were determined on a Kofler block.

Partition Chromatography.—This was carried out at 20° on Whatman's No. 1 paper as indicated in Part I. In order to minimise local variations in the paper support, the 4'- and 3'-hydroxyflavones were run in adjacent positions. After development of the chromatograms, the compounds were located by viewing in ultra-violet light and by spraying with bisdiazotised benzidine solution. R_M values were measured by the chromatogram-analysing device described in Part I.

3'-Hydroxy-7-methoxy- and 7 : 3'-Dihydroxy-flavone.—To 2-hydroxy-4-methoxyacetophenone (4 g.) and *m*-benzyloxybenzaldehyde (7 g.) in alcohol (75 ml.), aqueous sodium hydroxide (7 g. in 15 ml. of water) was added. Next day, after the addition of excess of ether, the sodium salt was collected and decomposed with dilute acetic acid. 3-Benzoyloxystyryl 2-hydroxy-4-methoxyphenyl ketone separated from alcohol in pale yellow, rectangular plates (6.5 g.), m. p. 128° (Found: C, 76.5; H, 5.5. $C_{23}H_{20}O_4$ requires C, 76.7; H, 5.6%). This compound (2.5 g.) was heated with selenium dioxide (resublimed; 3 g.) in amyl alcohol (50 ml.) under reflux for

12 hours. The mixture was filtered and the residue well washed with boiling amyl alcohol. The combined filtrate and washings were steam-distilled, leaving a viscous residue which slowly solidified. On repeated recrystallisation from methyl alcohol, this yielded 3'-benzyloxy-7-methoxyflavone in cream-coloured needles (1.8 g.), m. p. 149° (Found: C, 76.9; H, 5.2. $C_{23}H_{18}O_4$ requires C, 77.1; H, 5.1%). The ether (2 g.) was heated with acetic acid (10 ml.) and concentrated hydrochloric acid (10 ml.) on the water-bath. After 30 minutes, the mixture was saturated with hydrogen chloride and heated for a further $\frac{1}{2}$ hour. The mixture was then steam-distilled to remove benzyl chloride and most of the acetic acid. The resulting precipitate was collected and recrystallised from aqueous acetic acid. 3'-Hydroxy-7-methoxyflavone was obtained in colourless needles (1.2 g.), m. p. 249—250° (Found: C, 71.2; H, 4.6; OMe, 12.0. $C_{15}H_9O_3 \cdot OMe$ requires C, 71.6; H, 4.6; OMe, 11.6%). The acetate separated from alcohol in colourless, irregular plates, m. p. 139° (Found: C, 69.8; H, 4.5. $C_{18}H_{14}O_5$ requires C, 69.7; H, 4.5%).

Demethylation of the above ether (1 g.) was effected by 1 hour's refluxing with hydriodic acid (d 1.7; 15 ml.) and acetic anhydride (7 ml.). The solid deposited after dilution with dilute sulphurous acid was recrystallised from acetic acid, yielding 7 : 3'-dihydroxyflavone (cf. Hattori, *Acta Phytochim.*, 1932, 6, 131) in cream-coloured needles (0.5 g.), m. p. 291° (lit., 276—277°) (Found: C, 70.9; H, 4.3. Calc. for $C_{15}H_{10}O_4$: C, 70.9; H, 4.0%).

7 : 3'-Dimethoxyflavone (cf. Hattori, *loc. cit.*) was conveniently prepared by dehydrogenation of 2-hydroxy-4-methoxyphenyl 3-methoxystyryl ketone (3.5 g.) with selenium dioxide as described above. Recrystallised from methyl alcohol, it formed colourless, felted needles (2.2 g.), m. p. 153° (Found: C, 72.5; H, 4.8. Calc. for $C_{17}H_{14}O_4$: C, 72.3; H, 5.0%). On demethylation by refluxing hydriodic acid and acetic anhydride, this yielded 7 : 3'-dihydroxyflavone in cream-coloured needles, m. p. and mixed m. p. 290—291°.

3'-Hydroxy-5 : 7-dimethoxy-, 5 : 3'-Dihydroxy-7-methoxy-, and 5 : 7 : 3'-Trihydroxy-flavone.—2-Hydroxy-4 : 6-dimethoxyacetophenone (6 g.) was condensed with *m*-benzyloxybenzaldehyde (10 g.), and the product isolated as above. 3-Benzyloxystyryl 2-hydroxy-4 : 6-dimethoxyphenyl ketone was obtained in yellow, felted needles (7 g.), m. p. 128°, from alcohol (Found: C, 73.7; H, 5.6. $C_{24}H_{22}O_5$ requires C, 73.8; H, 5.6%). This compound (6 g.) with selenium dioxide (6 g.) and amyl alcohol (125 ml.) under reflux (15 hours) yielded 3'-benzyloxy-5 : 7-dimethoxyflavone in pale yellow needles (5 g.), m. p. 138°, from methyl alcohol (Found: C, 74.1; H, 5.3. $C_{24}H_{20}O_5$ requires C, 74.2; H, 5.1%). On debenzoylation as above, this flavone (4.5 g.) yielded 3'-hydroxy-5 : 7-dimethoxyflavone in cream-coloured needles (2.7 g.), m. p. 268—269°, from aqueous acetic acid (Found: C, 68.5; H, 5.4. $C_{17}H_{14}O_5$ requires C, 68.5; H, 4.7%). Its acetate separated from alcohol in needles, m. p. 170° (Found: C, 67.2; H, 4.7. $C_{19}H_{16}O_6$ requires C, 67.0; H, 4.8%).

Selective demethylation occurred when 3'-hydroxy-5 : 7-dimethoxyflavone (1 g.) was heated with hydriodic acid (d 1.7; 18 ml.) and acetic acid (18 ml.) on the water-bath for 3 hours. When isolated by the addition of excess of dilute sulphurous acid and repeatedly recrystallised, 5 : 3'-dihydroxy-7-methoxyflavone formed clusters of yellow prisms, (0.7 g.), m. p. 237—238°, from alcohol. It gave an intense red-brown colour with ferric chloride and alcohol and was chromatographically pure (Found: C, 67.6; H, 4.5; OMe, 11.0. $C_{15}H_9O_4 \cdot OMe$ requires C, 67.6; H, 4.2; OMe, 10.9%). Its diacetate crystallised from alcohol in irregular plates, m. p. 165—166°, from alcohol (Found: C, 65.2; H, 4.4. $C_{20}H_{16}O_7$ requires C, 65.2; H, 4.3%).

3'-Hydroxy-5 : 7-dimethoxyflavone (1.5 g.) was completely demethylated by refluxing it for 2 hours with hydriodic acid (d 1.7; 10 ml.) and acetic anhydride (7 ml.). The solid deposited on dilution with excess of dilute sulphurous acid was recrystallised from acetic acid, yielding 5 : 7 : 3'-trihydroxyflavone (cf. Kostanecki and Streuermann, *Ber.*, 1901, 34, 112), cream-coloured needles (0.9 g.), m. p. 313—314° (lit., 299°) (Found: C, 66.6; H, 3.6. Calc. for $C_{15}H_{10}O_5$: C, 66.7; H, 3.7%). Its triacetate crystallised from methyl alcohol in needles, m. p. 166° (Found: C, 63.9; H, 3.9. Calc. for $C_{21}H_{16}O_8$: C, 63.6; H, 4.0%).

3 : 3'-Dihydroxy-7-methoxy- and 3 : 7 : 3'-Trihydroxy-flavone.—To the slurry, formed by the addition of aqueous sodium hydroxide (8.5 g. in a minimum of water) to 3-benzyloxystyryl 2-hydroxy-4-methoxyphenyl ketone (1 g.) in alcohol (75 ml.), hydrogen peroxide (100-vol.) was added in portions, until the vigorous reaction ceased. The resulting pale yellow solution was diluted with water and acidified with hydrochloric acid. The precipitate recrystallised from alcohol, yielding 3'-benzyloxy-3-hydroxy-7-methoxyflavone in slender yellow prisms (0.35 g.), m. p. 153°, which gave a violet-brown ferric colour in alcohol (Found: C, 74.0; H, 4.9. $C_{23}H_{18}O_5$ requires C, 73.8; H, 4.8%). The acetate separated from alcohol in prisms, m. p. 136° (Found: C, 71.8; H, 4.8. $C_{25}H_{20}O_6$ requires C, 72.1; H, 4.8%).

This compound (1.5 g.) was heated with acetic acid (20 ml.) and concentrated hydrochloric acid (15 ml.) and the product isolated by the usual method. 3 : 3'-*Dihydroxy-7-methoxy-flavone* crystallised from alcohol in pale yellow needles (0.9 g.), m. p. 215—217°, giving a violet-brown colour with ferric chloride and an apple-green fluorescent solution with sulphuric acid (Found : C, 67.6; H, 4.0; OMe, 11.4. $C_{15}H_9O_4 \cdot OMe$ requires C, 67.6; H, 4.2; OMe, 10.9%). The *diacetate*, separated from alcohol in prisms, m. p. 196—198° (Found : C, 64.9; H, 4.3. $C_{20}H_{16}O_7$ requires C, 65.2; H, 4.3%).

The last ether was demethylated by heating it under reflux for 1 hour with hydriodic acid and acetic anhydride. Worked up in the usual way, the product yielded 3 : 7 : 3'-trihydroxy-flavone, identical with an authentic specimen, m. p. and mixed 303—304°.

7-*Hydroxy-3 : 3'-dimethoxy-*, 3 : 7 : 3'-*Trihydroxy-*, 5 : 7-*Dihydroxy-3 : 3'-dimethoxy-* and 3 : 5 : 7 : 3'-*Tetrahydroxy-flavone*.—An intimate mixture of ω -methoxyresacetophenone (4 g.), sodium *m*-methoxybenzoate (6 g.), and *m*-methoxybenzoic anhydride (25 g.) was kept at 185° for 5½ hours. To a solution of the product in boiling alcohol (250 ml.), potassium hydroxide (20 g. in a minimum of water) was added, in small portions. After 20 minutes' refluxing, the alcohol was removed under reduced pressure, and the residue dissolved in water (2 l.). On the solution's being saturated with carbon dioxide, a solid was deposited which was recrystallised from alcohol. 7-*Hydroxy-3 : 3'-dimethoxyflavone* was obtained in colourless, felted needles (3.8 g.), m. p. 214—215° [Found : C, 68.3; H, 4.4; OMe, 20.8. $C_{15}H_8O_3(OMe)_2$ requires C, 68.5; H, 4.7; OMe, 20.8%]. The *acetate* crystallised from aqueous alcohol in plates, m. p. 109° (Found : C, 67.1; H, 4.6. $C_{15}H_{16}O_6$ requires C, 67.0; H, 4.8%).

Refluxing the dimethyl ether with hydriodic acid (*d* 1.7) gave 3 : 7 : 3'-trihydroxyflavone (cf. Kostanecki and Widmer, *Ber.*, 1904, 37, 4160) as pale yellow needles (0.6 g.) [from acetic acid (charcoal)], m. p. 303—304°. It gave a brown colour with ferric chloride and a green fluorescent solution with sulphuric acid. Its *triacetate* crystallised from alcohol in needles, m. p. 169° (Found : C, 63.4; H, 3.8. $C_{21}H_{16}O_8$ requires C, 63.6; H, 4.0%).

5 : 7-*Dihydroxy-3 : 3'-dimethoxyflavone* was prepared from ω -methoxyphloracetophenone (4 g.), sodium *m*-methoxybenzoate and *m*-methoxybenzoic anhydride, as above. After repeated recrystallisation from alcohol, it formed cream-coloured leaflets (3.2 g.), m. p. 245—246°, which gave a brown colour with ferric chloride and alcohol (Found : C, 65.0; H, 4.5. $C_{17}H_{14}O_8$ requires C, 65.0; H, 4.5%). Its *diacetate* formed slender needles, m. p. 143°, from aqueous alcohol (Found : C, 63.3; H, 4.8. $C_{21}H_{18}O_8$ requires C, 63.3; H, 4.6%).

The last ether (2 g.) was demethylated by refluxing (1 hour) hydriodic acid (*d* 1.7; 20 ml.) and acetic anhydride (10 ml.). On the addition of excess of dilute sulphurous acid, the product deposited a dark solid which could not be recrystallised without serious loss. It (1.3 g.) was acetylated by pyridine and acetic anhydride (2 hours at 100°). The solid deposited on dilution of the cooled reaction product with ice-cold water was recrystallised (charcoal) from alcohol. 3 : 5 : 7 : 3'-*Tetra-acetoxyflavone* formed colourless needles (1.8 g.), m. p. 177—180° (Found : C, 60.5; H, 3.8. $C_{23}H_{18}O_{10}$ requires C, 60.8; H, 4.0%). Hydrolysis by warm alcohol and sodium hydroxide gave 3 : 5 : 7 : 3'-*tetrahydroxyflavone* as yellow needles (from aqueous acetic acid), m. p. 269—270°, which gave a green-brown colour with ferric chloride and alcohol (Found : C, 62.9; H, 3.8. $C_{15}H_{10}O_6$ requires C, 62.9; H, 3.5%).

3'-*Hydroxy-5-methoxy-* and 5 : 3'-*Dihydroxy-flavone*.—The product from 2-hydroxy-6-methoxyacetophenone (5 g.), *m*-benzyloxybenzaldehyde (10 g.), and aqueous sodium hydroxide (15 g. in a minimum of water) in alcohol (40 ml.) was set aside overnight. On dilution with water and acidification, 3-*benzyloxystyryl 2-hydroxy-6-methoxyphenyl ketone* was deposited. Recrystallised from methyl alcohol, this formed orange needles (7.2 g.), m. p. 67°, giving a brown colour with ferric chloride and alcohol (Found : C, 76.9; H, 5.5. $C_{23}H_{20}O_4$ requires C, 76.7; H, 5.5%). This compound (5 g.) was dehydrogenated by selenium dioxide, and the product isolated by the usual procedure. After repeated recrystallisation from benzene, 3'-*benzyloxy-5-methoxyflavone* was obtained in yellow needles (3 g.), m. p. 153—154° (Found : C, 77.1; H, 5.1. $C_{23}H_{18}O_4$ requires C, 77.1; H, 5.1%). Debenzylated by acetic acid and concentrated hydrochloric acid this yielded 3'-*hydroxy-5-methoxyflavone* in pale yellow prisms, m. p. 237—238.5°, from alcohol, and gave no ferric colour (Found : C, 71.3; H, 4.9; OMe, 12.0. $C_{15}H_9O_3 \cdot OMe$ requires C, 71.6; H, 4.5; OMe, 11.6%). Its *acetate* crystallised from benzene-light petroleum in needles, m. p. 139° (Found : C, 69.8; H, 4.4. $C_{18}H_{14}O_5$ requires C, 69.7; H, 4.5%).

5 : 3'-*Dihydroxyflavone* resulted from the interaction of the methyl ether (2.6 g.), hydriodic acid (*d* 1.7; 25 ml.) and acetic anhydride (5 ml.). Isolated by the usual method, it separated from alcohol in pale yellow, irregular prisms (1.5 g.), m. p. 259°, giving a green-brown ferric

colour in alcohol (Found : C, 70.9; H, 3.9. $C_{15}H_{10}O_4$ requires C, 70.9; H, 4.0%). The *diacetate* formed needles, m. p. 165°, from alcohol (Found : C, 67.6; H, 4.5. $C_{19}H_{14}O_6$ requires C, 67.5; H, 4.6%).

3'-Hydroxy- and 3 : 3'-Dihydroxy-flavone.—Condensation of *o*-hydroxyacetophenone with *m*-methoxybenzaldehyde, by the established method, yielded *2-hydroxyphenyl 3-methoxystyryl ketone*. Recrystallised from alcohol, this formed pale yellow, lustrous plates, m. p. 95° (Found : C, 75.8; H, 5.3. $C_{16}H_{14}O_3$ requires C, 75.6; H, 5.6%). This cyclised on reaction with selenium dioxide; *3'-methoxyflavone* was obtained in colourless, lustrous plates m. p. 140°. Demethylation by the usual method yielded *3'-hydroxyflavone* (cf. Kostanecki and Tambor, *Ber.*, 1901, **34**, 1692), colourless prisms, m. p. 208°, from alcohol.

To a solution of the above styryl ketone (1 g.) in hot alcohol (15 ml.), alcoholic potassium hydroxide (N; 7 ml.) was added, followed immediately by hydrogen peroxide (100-vol.; 2 ml.). After the vigorous reaction had ceased (15 mins.), the mixture was diluted with water and acidified. The resulting solid was collected and repeatedly recrystallised from alcohol, yielding *3-hydroxy-3'-methoxyflavone* in yellow plates (0.55 g.), m. p. 131° (Found : C, 71.7; H, 4.5; OMe, 11.9. $C_{15}H_9O_3 \cdot OMe$ requires C, 71.6; H, 4.5; OMe, 11.7%). It gave a violet-brown colour with ferric chloride and alcohol, and a yellow solution with a faint, green fluorescence with sulphuric acid. The *acetate* formed needles, m. p. 115°, from methyl alcohol (Found : C, 70.0; H, 4.3. $C_{18}H_{14}O_5$ requires C, 69.7; H, 4.5%).

On demethylation by the usual procedure, the ether (2.3 g.) yielded *3 : 3'-dihydroxyflavone* (cf. Gutzeit and von Kostanecki, *Ber.*, 1905, **38**, 935) in pale yellow needles (1.3 g.), m. p. 241—242° (lit., 237°), from alcohol (Found : C, 70.9; H, 3.9%). The *diacetate* separated from alcohol in needles, m. p. 161° (Found : C, 67.4; H, 4.2%).

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TORRY RESEARCH STATION, DEPARTMENT OF SCIENTIFIC & INDUSTRIAL RESEARCH,
ABERDEEN.

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