

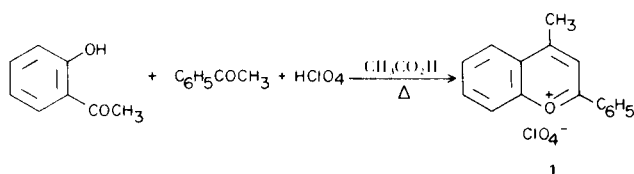
Preparation of 4-Methylflavylium Derivatives

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Wizinger and Tobel (1) prepared 4-methylflavylium perchlorate (**1**) by the reaction of flavone with a methylmagnesium halide, followed by treatment with perchloric acid. We have synthesized **1** from 4-methoxy-2-phenylbenzo[*b*]pyrylium perchlorate and 2,2-dimethyl-1,3-dioxan-5-one (Meldrum's acid) in the presence of diisopropylethylamine, and subsequent treatment with perchloric acid. However, we have found (2) a more convenient method for preparing **1**, shown in Scheme I.

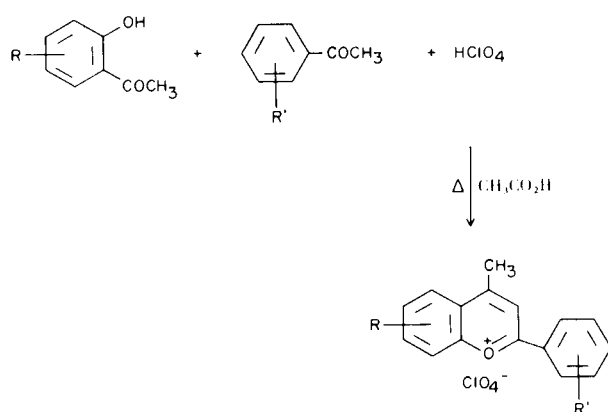
Scheme I



A variety of acid catalysts were tried, but perchloric in acetic acid proved to be the most satisfactory. Good yields of **1** were obtained only when relatively extended (8 hours or more) periods of heating were used.

Several substituted *o*-hydroxyacetophenone and acetophenone derivatives were allowed to react by this procedure to give the 4-methylflavylium compounds listed in Scheme II.

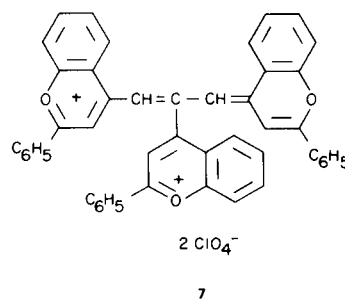
Scheme II



- 2 (R = H; R' = 4'-OCH₃)
- 3 (R = H; R' = 4'-Cl)
- 4 (R = H; R' = 3', 4'-benzo)
- 5 (R = 6-CH₃; R' = H)
- 6 (R = H; R' = 4'-OCH₂CH₂OH)

This method is not completely general for the preparation of 4-methylflavylium salts, since 1-hydroxyacetophenone with acetophenone and *o*-hydroxyacetophenone with 1-acetonaphthone both gave gums which could not be purified.

We have described the unusual dimerization of **1** with pyridine (3). We have now found that a solution of **1** in a wide variety of nonbasic solvents slowly forms an intense blue color, and after an extended period metallic colored crystals separate in small yield. The formation of the dye took place in the dark and in the absence of oxygen. We were unable to find conditions or a solvent which would accelerate the rate at which the dye was formed, or improve the yield of dye. An attempt to follow the formation of the dye in a 10^{-4} M solution in acetonitrile by changes in the spectrum showed that the reaction was complicated, since at this dilution a green solution was formed which absorbed differently (long wavelength λ_{max} 600 m μ) than the dye which had been isolated. A repeat using a more concentrated solution showed that the green species is first formed, but this in turn slowly changes to blue. Since the spectrum of the dilute solution did not change, it seems that the formation of the blue dye is concentration-dependent. On the basis of the analysis and the electronic spectra, the dye has been tentatively assigned structure **7**. The spectrum of **7** is



nearly identical with that of a trimethine congener in which the central methylene carbon is substituted with hydrogen, rather than the flavylium radical (4). The formation of **7** from **1** obviously involves the trimerization of **1**, but we are unable to offer a reasonable mechanism for the reaction.

TABLE I

Compound No.	M.p., °C	Empirical Formula	Analysis Calcd./Found			Yield, %	Recrystallization Solvent
			C	H	Cl		
1	212-213	C ₁₆ H ₁₃ ClO ₅	59.9	4.1	11.1	57	acetic acid
			59.7	4.2	11.0		
2	230-232	C ₁₇ H ₁₅ ClO ₆	58.2	4.3	10.1	53	acetonitrile
			58.0	4.4	9.9		
3	236-237	C ₁₆ H ₁₂ Cl ₂ O ₅	54.1	3.4	20.0	52	acetic acid
			54.0	3.6	20.2		
4	273-275	C ₂₀ H ₁₅ ClO ₅	64.8	4.1	9.6	35	acetonitrile
			64.8	4.4	9.3		
5	278-279	C ₁₇ H ₁₅ ClO ₅	61.0	4.5	10.6	46	acetic + formic acid
			61.0	4.7	10.4		
6	212-213	C ₁₈ H ₁₇ ClO ₇	56.8	4.5	9.3	59	acetic acid
			57.1	4.7	9.1		

EXPERIMENTAL

The method for the preparation of the methylflavylium salts is described as a general procedure, and the properties of the products are collected in Table I.

General Procedure.

A mixture of 0.1 mole each of the *o*-hydroxyacetophenone and acetophenone derivatives in 14 ml. of 70% perchloric acid and 75 ml. of acetic acid was refluxed for 16 hours, cooled, and the solid was collected and crystallized.

4,4'-[3-(4*H*-Flaven-4-ylidene)-1-propen-1,2-ylene]bis(flavylium Perchlorate) (**7**).

A solution of 3 g. of **1** in 100 ml. of acetonitrile was stirred at about 50° (to keep the **1** in solution) for 3 weeks. The yellow solution started to turn green in about an hour and then blue after about one day. The solution was chilled and the solid was collected and recrystallized twice from acetonitrile to give 0.4 g. of glistening needles with a metallic sheen, m.p. 310-311°. The λ max ($\epsilon \times 10^{-3}$) in acetonitrile are 238 (53.5), ~270 (24.0), 373 (47.4), 643 (71.6), and 705 m μ (363.0). The reported λ max for the symmetrical trimethine flavylium dye in acetic acid are 703 and 650 m μ for the two long wavelength absorptions (1).

Anal. Calcd. for C₄₈H₃₂Cl₂O₁₁: C, 67.4; H, 3.3; Cl, 8.3. Found: C, 67.7; H, 4.2; Cl, 7.9.

Other solvents which have been used for the above reaction are alcohol, nitromethane and acetic acid.

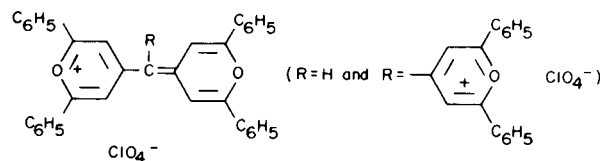
REFERENCES

- (1) R. Wizinger and H. V. Tobel, *Helv. Chim. Acta*, **40**, 1305 (1957).
- (2) G. A. Reynolds and J. A. VanAllan, *J. Heterocyclic Chem.*,

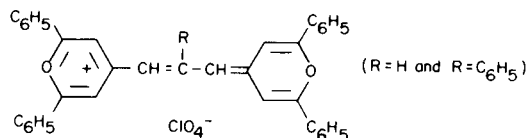
6, 623 (1969).

(3) J. A. VanAllan and G. A. Reynolds, *Tetrahedron Letters*, No. 25, 2047 (1969).

(4) It might be expected that the flavylium group on the central methylene carbon would alter the absorption spectrum relative to that of the hydrogen congener. However, we have noted that the compounds



show long wavelength absorption in acetonitrile at 543 and 575 m μ , respectively. The absorption of trimethine dyes is not affected by substituents on the central trimethine carbon to the extent the monomethine dyes are altered. For example, the monomethine dye shown above in which R is phenyl shows absorption at 598 m μ , and the pair of dyes



show absorption in acetonitrile at 685 and 688 m μ , respectively. On the basis of these spectral comparisons, it is reasonable that **7** and its hydrogen congener would show similar absorption spectra.

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