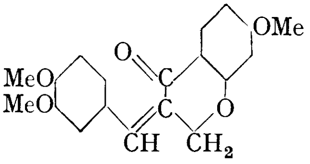
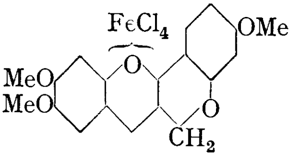
332. *Pyrylium Salts with Two Fused Benzopyran Nuclei.*

By E. Keller and Robert Robinson.

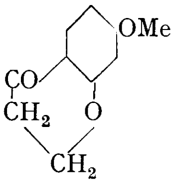
A reaction of a novel type was encountered by Perkin, Rây, and Robinson (J., 1926, 950), who showed that 7-methoxy-3-veratrylidenechromanone (I) could be oxidised and condensed by means of ferric chloride in acetic anhydride solution with formation of a salt formulated as (II). No proof of this constitution, other than the composition of the ferrichloride and the difficulty of devising an alternative explanation, was offered. We have now found that the same substance can be obtained by the condensation of 7-methoxychromanone (III) with 2-hydroxy-4 : 5-dimethoxybenzaldehyde (IV) (Head and Robertson, J., 1930, 2441) by means of hydrogen chloride, followed by conversion into the ferrichloride.



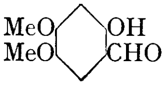
(I.)



(II.)



(III.)



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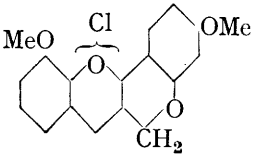
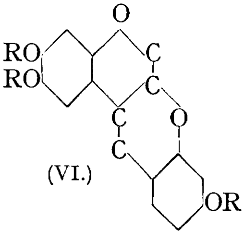
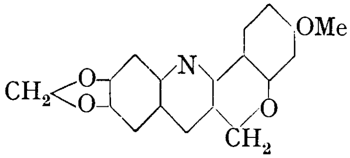


(V.)



(VI.)



(VII.)

The tetranuclear ring-system of (II) has some resemblance to that (VI) of rotenone (La Forge, Robertson, Takei, Butenandt) and hence it seemed desirable to study the physiological properties of typical members of the series. A start was made by the synthesis of some of the readily accessible pyrylium salts of the group; for example, *o*-vanillin and 7-methoxychromanone yield (V) and an extension to analogous pyrones was contemplated. Professor A. Robertson has, however, informed us that he has planned a comprehensive investigation along similar lines and this part of our project will therefore not be pursued.

It is intended to study further the pyrylium salts and the quinoline derivatives; the latter are not readily formed from 7-methoxychromanone and only one instance is mentioned in this communication. A poor yield of the base (VII) is obtained by condensation of the ketone with 6-aminopiperonal.

EXPERIMENTAL.

7-*Methoxychromanone* (compare Perkin, Rây, and Robinson, J., 1926, 945; 1927, 2097).—The ring-closure of β-*m*-methoxyphenoxypropionic acid was studied under a graded series of conditions and the best yield (62%) was obtained by the use of 75% sulphuric acid.

Methoxyphenoxypropionic acid (3·5 g.) was dissolved in 75% sulphuric acid (25 c.c., *d* 1·677/19°) and the mixture was heated during 2 hours to 60—70° and then during 4 hours to 90°. The product was isolated in the known manner. When 78% sulphuric acid was used, the yield dropped to 53% (80% acid, 48%; 82%, 45%; 85%, 42%). We think that it will be worth while to try sulphuric acid of even a lower concentration than 75%.

7-*Hydroxy*-2 : 3-[7′-*methoxychromeno*(4′ : 3′)]*benzopyrylium Chloride*.—When hydrogen chloride was passed through a saturated solution of 7-methoxychromanone and β-resorcylaldehyde in acetic acid, the resulting yield of *pyrylium* salt was 15%. Under the following conditions the yield was almost theoretical. A solution of 7-methoxychromanone (3·6 g.) and β-resorcylaldehyde (2·8 g.) in dry ethyl acetate (30 c.c.) was saturated with hydrogen chloride during 4 hours and the mixture was later maintained at 25—30° for 2 hours and kept at room temperature for 24 hours. The separated crystals (yield, 95%), recrystallised from 5% hydrochloric acid, formed slender red needles (Found in material dried at 50° in a vacuum : C, 61·3; H, 4·5. $C_{17}H_{13}O_4Cl,H_2O$ requires C, 61·0; H, 4·5. Found in material dried at 110—120° : C, 64·3; H, 4·2. $C_{17}H_{13}O_4Cl$ requires C, 64·4; H, 4·1%). The salt is sparingly soluble in acetic acid, readily in alcohol; all its reddish-orange acid solutions exhibit a strong, greenish-yellow fluorescence. The quinone base obtained by the action of sodium acetate has the typical blood-red colour of its class; it is sparingly soluble in benzene to a deep red solution and is reconverted by 5% hydrochloric acid into the orange-red pyrylium salt.

The catalytic reduction of this salt presented unexpected difficulty. When an active platinum catalyst was used in acetic acid solution, only one molecule of hydrogen was absorbed and aerial re-oxidation to the pyrylium salt occurred readily. By using zinc dust and acetic acid, reduction was brought about, but the product, possibly a dimerised compound, could not be crystallised.

8-*Methoxy*-2 : 3-[7′-*methoxychromeno*(4′ : 3′)]*benzopyrylium Ferrichloride* (V).—When *o*-vanillin is substituted for β-resorcylaldehyde, an equally facile condensation occurs; the resulting chloride is soluble in dilute aqueous acids to orange-red solutions which do not exhibit fluorescence. The *ferrichloride*, obtained in the usual way, crystallised from acetic acid in well-formed orange needles, m. p. 202° (unsharp) (Found : C, 44·0; H, 3·0. $C_{18}H_{15}O_4Cl_4Fe$ requires C, 43·9; H, 3·1%).

7-*Hydroxy*-5-*benzoyloxy*-2 : 3-[7′-*methoxychromeno*(4′ : 3′)]*benzopyrylium Chloride*.—This *salt* was obtained, like the derivative from β-resorcylaldehyde, by the use of 2-*O*-benzoylphloroglucinaldehyde (yield, 72%). It is very sparingly soluble in hot dilute hydrochloric acid to a red solution exhibiting a yellow fluorescence and it is readily soluble in alcohol to an intensely red solution. It crystallised from a mixture of equal volumes of alcohol and 10% aqueous hydrochloric acid in very slender, red, microscopic needles (Found in material dried at 80° in a vacuum : C, 66·2; H, 4·3. $C_{24}H_{17}O_6Cl$ requires C, 66·0; H, 3·9%).

6 : 7-*Dimethoxy*-2 : 3-[7′-*methoxychromeno*(4′ : 3′)]*benzopyrylium Ferrichloride* (II).—The condensation of 7-methoxychromanone and 2-hydroxy-4 : 5-dimethoxybenzaldehyde (for a specimen of which we are greatly indebted to Professor A. Robertson) was carried out in ethyl acetate saturated with hydrogen chloride at 0°, the mixture being kept for 6 days. An almost theoretical yield was obtained of a bright red chloride, which was converted into the ferrichloride in the usual way. This characteristic substance crystallised from acetic acid, in which it was sparingly soluble, in crimson elongated prisms with a blue reflex (Found : C, 43·5; H, 3·3. Calc. for $C_{19}H_{15}O_5Cl_4Fe$: C, 43·6; H, 3·3%). The substance had m. p. 213° (decomp.), alone or mixed with a specimen made by the method of Perkin, Rây, and Robinson (*loc. cit.*), and direct comparison confirmed the identity.

6 : 7-*Methylenedioxy*-2 : 3-[7′-*methoxychromeno*(4′ : 3′)]*quinoline* (VII) (*Picrate*).—An alcoholic solution of 7-methoxychromanone and 6-aminopiperonal, together with a small relative volume of 20% aqueous potassium hydroxide, was refluxed for 8 hours; acetic acid in excess was then added, and the boiling continued for 3 hours. The base was isolated as the *picrate*, which crystallised from acetone in slender needles, m. p. *ca.* 244° (Found in material dried at 80° in

a vacuum: C, 54·0; H, 3·4; N, 10·5. $C_{18}H_{13}O_4N,C_6H_3O_7N_3$ requires C, 53·8; H, 3·0; N, 10·5%). The hydrochloride was prepared for physiological investigation by decomposition of the picrate in methyl-alcoholic hydrogen chloride and precipitation with ether; its solutions exhibit a bright blue fluorescence.

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[*Received, August* 1*st,* 1934.]