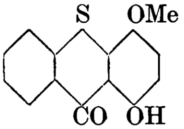
CLXXIII.—1-*Methoxy-derivatives of Thioxanthone.*

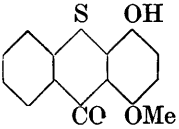
By Kenneth Charles Roberts and Samuel Smiles.

It has been shown (this vol., p. 863) that the basic character of the thioxanthone nucleus as indicated by the stability of the salts is promoted by the presence of methoxyl; this influence does not primarily depend on the number of methoxyl groups but rather on their position. The influence of the 1-methoxyl group is remarkable, the salts formed from 1-methoxy-thioxanthones having characteristic physical properties and being more stable than those yielded by other methoxy-derivatives. Further evidence of this distinctive effect of 1-methoxyl has now been obtained.

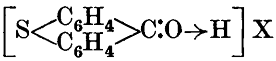
When *p*-methoxyphenol is treated in the usual manner with 2-thiolbenzoic acid, the two possible hydroxymethoxythioxanthones (I and II) are formed. One of these gave a characteristic *diacetoborate*, from which the original material was regenerated by hydrolysis; this substance must therefore be (Dimroth, *Annalen*, 1926, **446**, 97) the 1-*hydroxy*-4-*methoxy*-derivative (I). The isomeride was thus evidently the 4-*hydroxy*-1-*methoxythioxanthone* (II), and accordingly it did not yield a diacetoborate but was merely acetylated by the boroacetic anhydride; also it was easily converted by aqueous alkaline methylation into 1 : 4-dimethoxythioxanthone.



(I.)



(II.)



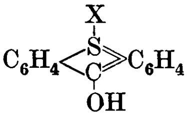
$\left[S{<}\genfrac{}{}{0pt}{}{C_6H_4}{C_6H_4}{>}C{:}O\rightarrow H\right]X$

(III.)

The separation of the two substances was readily effected by hydrochloric acid or by aqueous alkali hydroxide, in both of which the 4-hydroxy-1-methoxy-derivative is soluble. The insolubility of 1-hydroxy-4-methoxythioxanthone in aqueous alkali is noteworthy. The basic character of these isomerides was examined by the methods previously described (*loc. cit.*, p. 867). The results, which are collected below, together with data from the 1 : 4-dihydroxy- and dimethoxy-thioxanthones for comparison, show the distinctive effect of the 1-methoxyl group and amplify the evidence previously adduced.

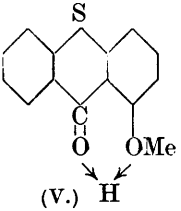
Derivative.	Mols. HCl added.	Colour of salts.	Titration (c.c.).
4-Hydroxy-1-methoxy	2	crimson	28
1-Hydroxy-4-methoxy	none	—	6
1 : 4-Dihydroxy	none	—	4—5
1 : 4-Dimethoxy	2	crimson	28

In expressing the structure of the salts of thioxanthone and its derivatives the views of Pfeiffer ("Organische Molekulverbindungen," Stuttgart, p. 192) on the character of salts and additive products of ketones have been adopted. These lead in the first instance to the formulation (III); expressions involving the *o*-quinonoid (IV) or the corresponding quinocarbonium structures have been avoided, since the salts in question are difficult to reduce and do not exhibit the characteristics usually associated with such systems. The distinctive effect of the 1-methoxyl group on the stability and physical character of the salts is readily explained by the assumption that in these hydrogen, exerting the dicovalence for which Sidgwick (" Electronic Theory of Valency," 1927, p. 72; J., 1924, **125**, 532; also Werner, " Neuere Anschauungen," 1913, p. 259) has adduced ample evidence, plays the part of a chelate member of a ring system (V).

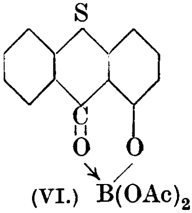


$C_6H_4{<}\genfrac{}{}{0pt}{}{\overset{X}{\overset{|}{S}}}{\underset{OH}{\underset{|}{C}}}{>}C_6H_4$

(IV.)

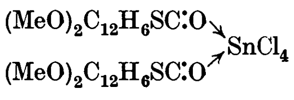


(V.)

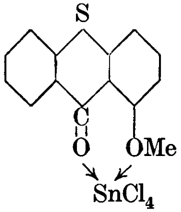


(VI.)

(VII.)



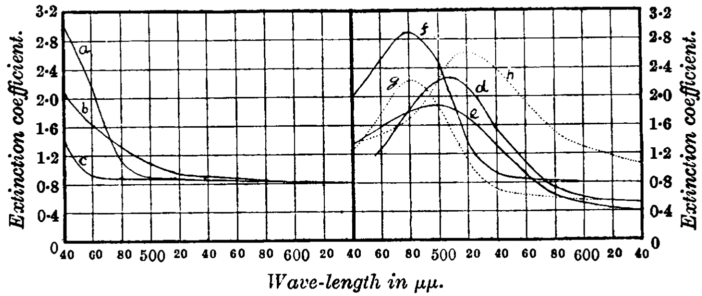
$$\left.\begin{array}{l}(MeO)_2C_{12}H_6SC{:}O\searrow\\(MeO)_2C_{12}H_6SC{:}O\nearrow\end{array}\right.SnCl_4$$



(VIII.)

Evidence in support of this view is forthcoming from independent sources. The absorption curves of the hydrochlorides of 1-methoxy-derivatives are characteristic and differ remarkably from those of the parent substances and from those of the hydrochlorides of other methoxythioxanthones. This is illustrated by the accompanying figures. Fig. 1 shows (*a* and *b*) the absorption curves of the hydrochlorides of 2 : 3-dimethoxy- and 2 : 3 : 4-trimethoxy-thioxanthones with that of 1 : 4-dimethoxythioxanthone taken alone in alcohol (*c*); Fig. 2 illustrates the curves obtained from the hydrochlorides of 1 : 4-dimethoxy-(*d*), 4-hydroxy-1-methoxy-(*e*), and 1-methoxy-4-methyl-(*f*) thioxanthones. It is also remarkable that the diacetoborates of the 1-hydroxy-derivatives show absorption curves which are closely similar to those of the 1-methoxy-hydrochlorides; those obtained from the diacetoborates of 1 : 4-dihydroxy-(*g*) and 1-hydroxy-4-methoxy-(*h*) thioxanthones are shown also in Fig. 2. These diacetoborates undoubtedly possess (Dimroth, *Annalen*, 1926, **446**, 97) a co-ordinate ring (VI) of similar type to that now assigned to the 1-methoxy-hydrochlorides.

FIG. 1. FIG. 2.



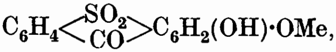
Solid curves: hydrochlorides (except c). *Dotted curves: diacetoborates.*

Moreover Pfeiffer (*loc. cit.*) has shown that the additive compounds of ketones and stannic chloride have the composition $(R_2CO)_2SnCl_4$, in which tin preserves the usual co-ordination number 6. 2 : 3-Dimethoxythioxanthone accords with other ketones in this respect, giving a yellow *stannichloride* of normal composition (VII); but 1 : 4-dimethoxythioxanthone yields a red *stannichloride* containing equimolecular proportions of the reactants. Assuming that in this substance tin preserves the usual co-ordination number (6), it is evident that 1 : 4-dimethoxythioxanthone offers two centres of co-ordination (VIII); this is an essential feature of the structure proposed for the kation of the salts (V). In conclusion, it must be remarked that the structure as expressed is not meant to imply that the sulphur is without influence on the basic character of the thioxanthone nucleus; there is, on the contrary, evidence that this property is profoundly influenced by the state of the sulphur present. For example, the dioxides of the thioxanthones examined do not show basic character in the methods used in these experiments. A similar effect is evident in the character of 1-hydroxy-derivatives of thioxanthone. All those hitherto obtained are insoluble in aqueous alkali hydroxide, whilst the corresponding sulphones yield characteristic red salts with this reagent. Another interesting feature of these 1-methoxy-derivatives of thioxanthone is found in the ease with which they are demethylated. This and other features will be the subject of a future communication.

EXPERIMENTAL.

1-*Hydroxy*-4-*methoxythioxanthone* (I).—*p*-Methoxyphenol (8 g.) was added in portions to a stirred solution of 2-thiolbenzoic acid (3 g.) in sulphuric acid (60 c.c.). After 15 minutes (15°), the mixture was poured into water (800 c.c.). The solid material was then digested with aqueous sodium hydroxide (2*N*), in which the required 1-*hydroxy*-4-*methoxy*-derivative was insoluble and 4-hydroxy-1-methoxythioxanthone and most impurities readily dissolved. The residue (*ca.* 50% of crude material) separated from acetic acid in orange-red needles, m. p. 182° (Found : C, 64·7 ; H, 3·9. $C_{14}H_{10}O_3S$ requires C, 65·1 ; H, 3·8%). The substance was insoluble in warm concentrated hydrochloric acid and did not yield a hydrochloride with the dry reagent. A perchlorate was not formed under the usual conditions. A purple sodium derivative was formed when sodium ethoxide was added to a benzene solution of the substance. The *acetyl* derivative, prepared in the usual way, had m. p. 138° (Found : C, 63·8 ; H, 4·0. $C_{16}H_{12}O_4S$ requires C, 64·0 ; H, 4·0%). The *diacetoborate* separated in deep red needles from a solution of the substance in acetic anhydride containing boroacetic anhydride ; it had m. p. 205° and was decomposed by boiling water, yielding the original material (m. p. 182°). Analysis was made by weighing this product [Found : $C_{14}H_{10}O_3S$, 67·0. $C_{14}H_9O_3S{\cdot}B(O{\cdot}CO{\cdot}CH_3)_2$ requires $C_{14}H_{10}O_3S$, 66·8%].

1-*Hydroxy*-4-*methoxythioxanthone dioxide*,



$$C_6H_4{<}\genfrac{}{}{0pt}{}{SO_2}{CO}{>}C_6H_2(OH){\cdot}OMe,$$

was obtained when acetic acid containing the suspended thioxanthone and hydrogen peroxide (50% excess) was warmed (100° ; 2 hrs.). It separated from the cooled liquid and after purification from acetic acid formed orange needles, m. p. 184° (Found : C, 57·7 ; H, 3·4. $C_{14}H_{10}O_5S$ requires C, 57·9 ; H, 3·4%). The sparingly soluble red sodium salt separated in needles from a hot solution in aqueous sodium hydroxide. The substance was also isolated from the alkylation of 1 : 4-dihydroxythioxanthone dioxide under intense conditions (J., 1928, 3158).

4-*Hydroxy*-1-*methoxythioxanthone* (II) was isolated from the crude material resulting from the condensation of *p*-methoxyphenol and 2-thiolbenzoic acid as described. This was treated with warm concentrated hydrochloric acid until the extract was no longer coloured. The residue contained the isomeric 1-hydroxy-derivative, which was purified by alkali hydroxide as described in a previous paragraph. The cooled acid solution deposited the hydrochloride of the required substance; this was decomposed by hot water, and the resulting material, crystallised from alcohol, formed yellow needles, m. p. 270° (decomp.) (Found: C, 64·9; H, 3·8. $C_{14}H_{10}O_3S$ requires C, 65·1; H, 3·8%). The crimson *dihydrochloride* was obtained by reaction with dry hydrogen chloride (Found: HCl, 22·2. $C_{14}H_{10}O_3S,2HCl$ requires HCl, 22·0%) and the *perchlorate* was isolated by adding perchloric acid to a benzene solution of the substance which had been treated with hydrogen chloride (Found: $HClO_4$, 28·1. $C_{14}H_{10}O_3S,HClO_4$ requires $HClO_4$, 28·0%). Aqueous alkaline methylation readily yielded 1 : 4-dimethoxythioxanthone. A hot solution in acetic anhydride containing boroacetic anhydride deposited yellow needles of the *acetyl* derivative, m. p. 133° (Found: C, 64·0; H, 4·0. $C_{16}H_{14}O_4S$ requires C, 64·0; H, 4·0%); no boroacetate was obtained. Attempts to isolate the corresponding sulphone by oxidising the substance in acetic acid with hydrogen peroxide were unsuccessful, the material being decomposed. This result is in striking contrast to the behaviour of the 1-hydroxy-4-methoxy-derivative described above.

The stannichlorides were obtained by addition of stannic chloride to benzene solutions of the thioxanthone derivatives. The *stannichloride* of 2 : 3-dimethoxythioxanthone (VII) was isolated as yellow needles [Found: Sn, 14·8. $(C_{15}H_{12}O_3S)_2,SnCl_4$ requires Sn, 14·7%]. The *stannichloride* of 1 : 4-dimethoxythioxanthone (VIII) formed crimson needles (Found: Sn, 21·7. $C_{15}H_{12}O_3S,SnCl_4$ requires Sn, 22·3%), which were hydrolysed by water, yielding 1 : 4-dimethoxythioxanthone. Evidently demethylation similar to that effected by Pfeiffer in the case of the analogous stannichloride of alizarin dimethyl ether (*Annalen*, 1913, **398**, 141) had not taken place during the preparation of the substance.

The data referring to the relative stability of the salts of 1-hydroxy-4-methoxy- and 4-hydroxy-1-methoxy-thioxanthones were obtained under the conditions described in a former communication (this vol., p. 863) and are comparable with these.

The absorption spectra of the hydrochlorides (Fig. 1, *a* and *b*; Fig. 2, *d*, *e*, and *f*) were obtained from solutions of the respective thioxanthones in concentrated hydrochloric acid, and the spectra of the diacetoborates (Fig. 2, *g* and *h*) were obtained from solutions in acetic anhydride.

King's College, London. [*Received, May 15th*, 1929.]
