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SYNTHESES IN THE BRAZILIN GROUP BY WAY OF OF INDENO-COUMARINS

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Abstract—The work described in this communication was carried out in 1946–1948.

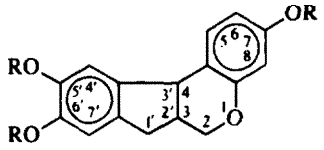
Reductive acetylation of brazilein afforded, in the hands of Herzig and Pollak, a substance $C_{16}H_9O(OAc)_3$. We have found that hydrolysis and methylation of this substance yields the known anhydro-O-trimethylbrazilin.

In 1911[3] the possibility of synthesising a Brazilin derivative from an indeno-coumarin had already been considered and a hydroxyindenocoumarin was synthesised by condensing indan-1-one-2-carboxylic acid with resorcinol and with the help of hydrogen chloride. Some years later[4,5] an indeno coumarin containing the resorcinol hydroxyl as before but with two appropriately situated OMe groups in the catechol nucleus was prepared. The present work carried out in 1946–1948 apart from a recent extension noted in the text, has followed this method and approach.

The O-trimethoxyindenocoumarin (**10**) has been reduced by sodium and amyl alcohol to a phenolic alcohol (**11**), which could be converted into O-trimethylbrazilane (**13**). It is just possible that a mixture of the *cis* and *trans* was obtained. Reduction of the coumarin (**10**) with LAH afforded O-trimethylanhydrobrazilin (**5**).

Nomenclature

In harmony with procedure over more than seven decades the names of Brazilin derivatives may be derived from a fundamental indenochroman ring system bearing, however, the phenolic OH in the positions in which they occur in brazilin. This fundamental structure may be termed brazilane (**1**, R=H). The numbering shown in (**1**) is favoured because it gives the best relation with related substances in other groups. It is easy to memorise because the chroman system is numbered in the same way, e.g. the flavone group. The change now proposed involves the naming of substituents in the brazilin system. The stereoisomeric forms produced by *cis* and *trans* fusion of the chroman and indane nuclei are characterised as such because the use of alpha and beta and iso would lead to confusion in some cases.



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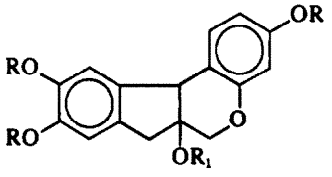
Nevertheless, the names based on the use of Brazaroot such as "Brazilein", "Brazilium", etc are still used to avoid abrupt discontinuity of the record.

In the case of haematoxylin it is obvious that the prefix corresponding to brazil is haematoxyl and this has been used in the past in such names as tetramethylhaematoxylin and tetramethylhaematoxylone. Unfortunately, this system was not carried through logically in the case of the substance now termed haematein. There has always been some danger of confusion with the names of substances connected with 'haem', such as, haematin in the blood-pigment group for the porphyrins. We propose that this confusion should be avoided in the future by re-naming haematoxylein in strict analogy with brazilein. The indenochromylium salts related to haematoxylin should be designated as haematoxylium salts.

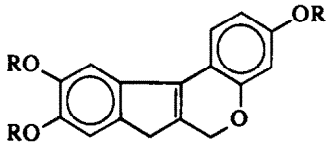
The questions posed by nomenclature of derivatives of trimethylbrazilone will be discussed at a later stage.

Anhydro-O-trimethylbrazilin

In view of the fact that the hydroxyl in position -3 of the pyran nucleus of brazilin (**2**) is tertiary and the adjacent hydrogen in position-4 might be expected to be activated by the two aromatic nuclei of the substituted diphenylmethane group, it seems surprising that dehydration of the molecule itself does not appear to be an extremely facile process. However, we found that anhydro-O-trimethylbrazilin (**5**) can be readily produced by the action of *para*-toluenesulphonyl chloride and pyridine. The *para*-toluenesulphonate (**3**) is first produced and later decomposed. On one occasion when the product was worked up by treatment with ethanol, O-trimethylbrazilin-3-ethyl ether was obtained as a by-product.



2: R = R_1 = H
3: R = Me, R_1 = $-SO_2-C_6H_4-Me-p$
4: R = Me, R_1 = Ac



5: R = Me
6: R = Ac

Anhydro-O-trimethylbrazilin (**5**) has been obtained by G. G. Clarke and W. D. Ollis (Ph.D. Thesis, Bristol 1955) (private communication) (cf Rodd's Chemistry of Carbon Compounds, Vol. IVB, p. 1005, Elsevier 1959 cf[2]). O-Trimethylbrazilin acetate was pyrolysed by passage through a hot tube. Loss of acetic acid and formation of anhydro-O-trimethylbrazilin (**6**) resulted. This was clear evidence of the *cis*-brazilane configuration of brazilin.

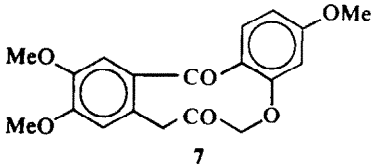
Under conditions described in the Experimental, Herzig and Pollak[7] obtained a substance to which they ascribed composition $C_{16}H_9O(AcO)_3$ from which it may be deduced that it is O-triacetylanhydrobrazilin (triacetyldeoxybrazilone) (**6**). This hypothesis we have confirmed by simultaneous hydrolysis and methylation, whereby the known O-trimethylanhydrobrazilin (**5**), m.p. 167–70°, was obtained.

The possibility that certain indenocoumarins could be used as starting points for synthesis in the brazilin group was realised early. An account of the condensation of indan-1-one-2-carboxylic acid with resorcinol, was published in 1918.[3]

5,6-Dimethoxy-2-carbethoxyindan-1-one[5] (**8**) was condensed with resorcinol with the help of hydrogen chloride. The indeno-coumarin produced (**9**) was O-methylated to (**10**) and reduction by LAH was attempted, but was frustrated by the very sparing solubility of the substance in ether. Reduction of the coumarin (**10**) with sodium and amyl alcohol afforded a phenolic alcohol (**11**) which gave the pyran (**13**) by successive treatment with PBr_3 and base. The other product of the reaction with sodium and amyl alcohol, hydroxy-acid (**12**). This substance (**12**) is more amenable to reduction by LAH and afforded the phenolic alcohol (**11**).

Prolonged reduction of a suspension of the indeno-coumarin (**10**) in ether with excess LAH in boiling ether was found to afford phenolic material, together with O-trimethylanhydrobrazilin O-trimethyldeoxybrazilone) (**5**).

The indeno-coumarin (**10**) was hydrogenated using Adams' catalyst to its 3,4-dihydro derivative (**14**). This dihydro derivative (**14**) was treated with LAH in ethereal solution and the isolated product



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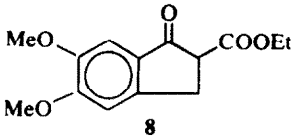

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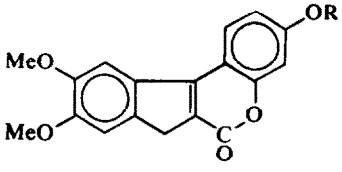
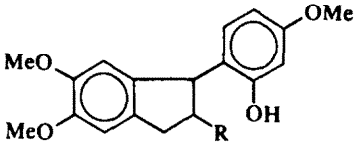
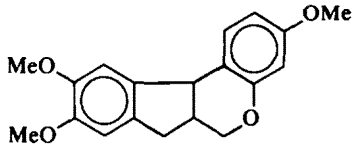


9: R = H
10: R = Me

was reduced with phosphorus tribromide and subsequently with sodium hydroxide solution, under conditions described in the Experimental. After chromatography over alumina the eluted product was found to be almost pure O-trimethyl*cis*-brazilane (**13**).



11: R = CH_2OH
12: R = COOH



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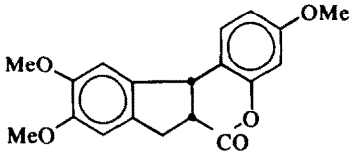

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EXPERIMENTAL

Anhydro-O-trimethylbrazilin (**5**)

(a) In repeating the work of Herzig and Pollak,[7] a mixture of brazilein (10 g), HcOH (100 ml), Ac_2O (100 ml) and Zn dust (50 g) was refluxed for 3 hr. The cooled soln was decanted and diluted with water, and the solid ppt was collected, washed, dried and crystallised from EtOAc in colourless plates, m.p. 193–195° (dec) (2·9 g). This substance was methylated in dioxan soln by means of alternate additions of Me_2SO_4 and 40% NaOHaq. The resulting O-trimethylanhydrobrazilin (**5**), had m.p. 167–70° alone, or mixed with an authentic specimen.

(b) *p*-Toluenesulphonyl chloride (5 g) was gradually added to a mixture of O-trimethylbrazilin (5 g) and pyridine (10 ml). After keeping for 2 days at room temp the mixture was treated with dil HCl aq and the ppt collected and dried. Recrystallisation from EtOH afforded O-trimethylbrazilin *p*-toluenesulphonate (**3**) as colourless plates (1·99 g), m.p. 125°. (Found: C, 64·8; H, 5·6. $C_{26}H_{26}O_7S$ requires: C, 64·7; H, 5·4%). Along with this tri-O-methylbrazilin *p*-toluenesulphonate (**3**), a second substance was produced and slowly separated from the ethanolic mother-liquor (1·1 g). This crystallised from EtOH as colourless needles, m.p. 108°. (Found: C, 71·4; H, 6·55%). This substance is clearly O-trimethyl-O-ethylbrazilin produced by the action of EtOH on tri-O-methylbrazilin *p*-toluenesulphonate. ($C_{21}H_{24}O_5$ requires: C, 70·8; H, 6·7%).

The above tri-O-methylbrazilin *p*-toluenesulphonate was boiled in pyridine solution for 30 min and on adding dil HCl aq it afforded anhydro-O-trimethylbrazilin (**5**; 0·25 g) m.p. 170° alone, or mixed with an authentic specimen.

Ethyl 5,6 - dimethoxyindan - 1 - one - 2 - carboxylate (**8**). A soln of 5,6-dimethoxyindan-1-one (9·6 g) in benzene (50 ml) and ethyl carbonate (50 ml) was added to powdered Na (1·2 g) (protection from moisture). On heating the mixture a vigorous reaction occurred at 100° and a solid separated. The mixture was maintained at 100° (reflux) for 2 hr with occasional shaking, and then the volatile material removed as far as possible, under reduced pressure and at 100°. After acidification with ice-cold, dil HCl aq, the mixture was extracted with ether, the extract was then shaken with successive portions of $CuSO_4$ aq. The grey Cu- salt was collected (11 g) and washed with ether-alcohol. The Cu-salt was decomposed with dil AcOH and the β-ketoester isolated by means of chloroform. It crystallised from alcohol as colourless, felted needles, m.p. 142–143°. Perkin *et al.*[5] give m.p. 138°. Further purification by sublimation did not raise the m.p. (Found: 63·6; H, 6·3. Calc. for $C_{14}H_{16}O_5$: C, 63·6; H, 6·1%).

7 - *Hydroxy - 5',6' - dimethoxyindeno - (2',3',3,4) - coumarin* (**9**). A soln of the above β-ketoester (**8**; 3·5 g) and resorcinol (12 g) in EtOH (60 ml) was saturated at room temp (external cooling) with dry HCl. When the saturation was nearly complete the coumarin began to separate slowly. After 2 days, when much of the coumarin had separated, the mixture was maintained at 50–60° for 4 hr. The product was isolated by the addition of water, collected and washed repeatedly with warm alcohol. It was obtained as a light brown powder (3·8 g) and was almost insoluble in the usual organic solvents. It was crystallised quickly from a mixture of pyridine and alcohol (the product deteriorated on prolonged treatment with pyridine) and was obtained in light brown, microscopic, diamond-shaped prisms. (Found: C, 69·6; H, 4·8. $C_{18}H_{14}O_5$ requires: C, 69·6; H, 4·5%). The compound sintered at 260°, suddenly turned blue at 270° and then carbonised progressively without melting. It dissolved in conc H_2SO_4 with an intense green fluorescence, which disappeared on the addition of water. It dissolved in HNO_3 to a brilliant purple soln, the colour of which faded slowly.

7 - *Methoxy - 5',6' - dimethoxyindeno - (2',3',3,4) - coumarin* (**10**). The above hydroxy-coumarin (**9**; 1·0 g) was stirred with 1% NaOH aq (100 ml), and Me_2SO_4 (5 ml) was slowly added. Excess of Me_2SO_4 was destroyed by further addition of NaOH aq. The product (**10**; 0·8–0·9 g) crystallised from BuOH or AcOH in brownish needles, m.p. 237–239° (dec) after suddenly turning blue at 217°. (Found: C, 70·3, 70·2; H, 5·2, 5·0 $C_{19}H_{16}O_5$ requires: C, 70·4; H, 4·9%). It can be obtained in colourless needles by digesting its soln in AcOH with a little Zn dust, which does not reduce the compound. In BuOH or AcOH it exhibited a pale violet fluorescence. With H_2SO_4 or HNO_3 it behaved in the same way as the parent compound.

A soln of MeMgI in ether was added slowly to a stirred soln of this methylated coumarin (0·5 g) in anisole (100 ml) until a test portion gave a bluish-green colouration with a soln of benzoquinone in ether. A brown ppt formed immediately, and on addition of conc HCl, the aqueous layer turned yellow with the appearance of a strong green fluorescence. The ferrichloride, was obtained as a chocolate-brown, crystalline powder sparingly soluble in hot AcOH. The derivative gave the reaction of O-methylhomobrazilium ferrichloride, described by Crabtree and Robinson.[3] In aqueous soln the fluorescence was green, and in alcohol, bright apple-green. The fluorescence in acetone soln was quenched on the addition of benzene.

Reduction of the coumarin (**10**) *with sodium in amyl alcohol.* A suspension of the coumarin (3 g) in anhyd amyl alcohol (150 ml) was refluxed (bath at 170–175°), while Na (12 g) in small pieces, was quickly added. After 2 hr, the mixture was cooled and traces of unreacted Na destroyed by the addition of alcohol. Water was then added and the solvents removed in a current of steam. The alkaline soln was filtered through glass-wool, acidified with HCl and extracted with ether. The ethereal layer was shaken thrice with a saturated $NaHCO_3$ aq. The acid product was liberated from the aqueous layer and isolated by means of ether (A). The ethereal soln was extracted with 2% NaOH aq (100 ml). The alkaline soln, on acidification, gave the crude phenolic alcohol (**11**, 0·9 g) which was isolated by ether extraction (B).

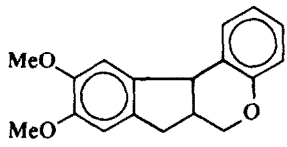
A soln of PBr_3 (0·8 g) in benzene (3 ml) was slowly added to the phenolic alcohol (B, 0·9 g) in the same solvent (20 ml). The brown mixture was kept 12 hr and then heated to 50–60°. A soln of NaOH (0·7 g) in water (20 ml) was added with stirring and the mixture refluxed for 3 hr. After separating the benzene layer the aqueous layer was extracted with more benzene and the combined solns evaporated to give a mixture of substituted chromans (0·15 g), which could not be purified easily. The highly characteristic colour reaction with bromine and acetone, and the quick formation of brazilium salt, was noted.

The crude O-trimethylbrazilane (**13**) was heated with an excess of $FeCl_3$ in AcOH on a steam-bath. The salt that separated was collected and crystallised from AcOH containing a trace of $FeCl_3$. The product crystallised in characteristic ochreous leaflets and had m.p. 206–212° undepressed by admixture with an authentic sample of O-trimethylbrazilium ferrichloride. (Found: C, 44·9; H, 3·7. $C_{19}H_{17}O_4FeCl_4$ requires: C, 44·9; H, 3·4%). The behaviour of the specimen conformed in all respects with the description of Crabtree and Robinson.[3]

5,6-Dimethoxy-3-(2'-hydroxy-4'-methoxyphenyl) indan-2-carbocyclic acid (**12**). The ethereal (A) gave the acid as a gum crystallising from benzene in colourless prisms (1·1 g) which after two crystallisations from benzene, melted at 126–127° with evolution of gas. The product contained benzene of crystallisation and gave a positive Ramsden's test. (Found: C, 70·9; H, 6·2. $C_{19}H_{20}O_6$, C_6H_6 requires: C, 71·1; H, 6·2%). The soln in H_2SO_4 had a green fluorescence.

The above acid (1·0 g) was treated with LAH (1·0 g) in ether (50 ml) with the usual precaution. After 24 hr, crushed ice and dil HCl aq were added. The separated aqueous layer was extracted with a further quantity of ether. The evaporation of the dried extract (Na_2SO_4) afforded a gum which could not be crystallised and was used for the next stage, as mentioned below.

O-Trimethylbrazilane (**13**). The foregoing crude phenolic alcohol in benzene (10 ml) was treated with PBr_3 (0·6 g) dissolved in part of the benzene employed. The mixture was kept at room temp overnight and then heated to 50–60° for ½ hr, NaOH (0·4 g in 4 ml water) having been added, and the mixture was refluxed for 3 hr. A neutral product was isolated in the known manner and purified by column chromatography over alumina. The solvent employed was benzene light petroleum (15:85). Elution was carried out by the same solvent and a non-fluorescent band furnished a substance, m.p. 128–130°. (Found: 75·9, 76·14; H, 6·3, 6·3. $C_{18}H_{18}O_3$ requires: C, 76·6; H, 6·3%). This substance is probably 7-desmethoxy-O-trimethylbrazilane (**15**). The elimination of OMe in the resorcinol nucleus fully accounts for the failure to obtain a fluorescent brazylium salt. Experience in the flavylium salt series has demonstrated that resorcinol derivatives show a strikingly green flourescence in dilute acid solution, whereas corresponding substances based on phenol and phloroglucinol do not exhibit this property.



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A second white band contained very little material of any kind but this was followed by a non-fluorescent band; this was eluted with 600 ml light petroleum/benzene (80:20). After removal of the solvent the substance was crystallised from EtOH in prisms, m.p. 116–118° (Found: C, 72·1, 71·8; H, 6·2, 6·0, $C_{19}H_{20}O_4$ requires; C, 73·1; H, 6·4%). The colour reactions exhibited by this substance when treated with bromine and with concentrated mineral acids closely resembled those of the O-trimethylbrazilanes obtained, respectively, by catalytic reduction of anhydrotrimethylbrazilin and from the Hersiz/Pollak series of reactions.

Approximately equal quantities of this substance m.p. 116·118° with the known trimethylbrazilane m.p. 109° had m.p. 107–114°. This relatively small lowering of the m.p. on admixture suggested that the compound under examination might be impure. As it was convertible into trimethylbrazilium ferrichloride and trimethylbrazilone, it appeared at the time that the substance must be a trimethylbrazilane and, accordingly, trimethyl-*trans*-brazilane. Recent work (R. H. Jaeger, P. M. E. Lewis and R. R.) suggests a different interpretation of the results.

3,4-Dihydro derivative of 7-methoxy-5',6'-dimethoxyindeno-(2',3'-3,4)-coumarin (**14**). A soln of the indeno-coumarin (0·2 g) in AcOH (50 ml) was hydrogenated at the atmospheric pressure with Adams' catalyst (0·15 g) at 60–70°. The absorption of H_2 was very slow and never complete. After 5 hr the violet fluorescent soln was filtered, the bulk of the solvent removed, when the unchanged coumarin (0·1 g) crystallised out. This was filtered, the filtrate treated with water and the precipitated gum dissolved in alcohol (4 ml). Silky needles of the *dihydrocoumarin* (0·05 g) gradually separated which on recrystallisation melted at 129–30°. (Found: C, 69·9; H, 5·6. $C_{19}H_{18}O_5$ requires: C, 70·0; H, 5·5%). With H_2SO_4 the compound gave a greenish soln which became brilliantly fluorescent after several hr.

cis-O-*Trimethylbrazilane* (**13**). A soln of the above dihydrocoumarin (0·1 g) in dry ether (50 ml) was treated with an excess of LAH (0·2 g) and the mixture left over-

night at the room temp. Next day, the mixture was carefully decomposed with dil H_2SO_4 aq, the ether soln separated, dried and the solvent removed. The gummy phenolic intermediate was dissolved in benzene (2 ml), cooled and treated with PBr_3 (0·05 g). An immediate separation of a reddish ppt took place. After 5 hr the mixture was treated with 20% NaOH aq (0·5 ml) and warmed on the waterbath. The benzene soln was separated and passed through an alumina column. On removal of the solvent, *cis*-O-trimethylbrazilane (0·015 g) separated, crystallising from alcohol in colourless plates, m.p. and mixed m.p. 109°.

O-*Trimethylanhydrobrazilin* (*deoxytrimethylbrazilone*) (**5**). A suspension of finely powdered indeno-coumarin (2·0 g) in dry ether (250 ml) was treated with an excess LAH (1·0 g) and the mixture refluxed for 66 hr. After decomposing the mixture with dil H_2SO_4 aq, the ether soln was worked up as before to give a gummy phenolic material which gradually turned brown. This was heated at 270° for 2 min and then dissolved in benzene and passed through an alumina column. Practically all the phenolic material was held on the column and the filtrate on working up gave a small quantity of deoxytrimethylbrazilone (5–6 mg) which crystallised from alcohol in brownish needles, m.p. and mixed m.p. 167–68°. The compound exhibited typical colour reactions with conc HNO_3 and with Br_2 in AcOH.

Oxidation of certain brazilin derivatives by means of lead tetra-acetate. A soln of lead tetra-acetate (0·88 g) in AcOH (30 ml) was added to one of trimethylbrazilin (0·33 g) in AcOH (10 ml). A carmine colouration at first produced rapidly faded after 24 hr at room temp. Trimethylbrazilone (0·3 g) in fairly pure crystalline condition could be obtained after the addition of water. It has also been observed that oxidation of acetyltrimethylbrazilin (**2**; 0·2 g) in AcOH (2 ml) with chromium anhydride (0·12 g) proceeds satisfactorily at room temp. Acetylated brazilins, however, are not oxidised by lead tetra-acetate under similar conditions.

Some substances derived from triacetylbrazilone

Tetra-acetyl-α-anhydrobrazilone. Triacetylbrazilone was refluxed in Ac_2O with a little fused NaOAc for 1 hr. After cooling, water was added and the solid product crystallised from EtOH, slender needles m.p. 245°. (Found: C, 63·9; H, 4·0, Acetyl, 43·4, 44·0, 45·3. $C_{24}H_{18}O_9$ requires: C, 64·0; H, 4·0; Acetyl, 38·2%).

Triacetoxybrazanquinone. The foregoing tetraacetate was dissolved in cold HN_3 aq (*d*, 1·42) at room temp when the formation of the canary yellow ppt appeared to be complete. After a short time, the solid was collected and on dissolving in hot AcOH, oxides of nitrogen were evolved. On cooling the orange coloured needles separated, m.p. 225–235° (dec). (Found: C, 62·2; H, 3·6; N, 0; Acetyl, 41·3. $C_{22}H_{14}O_9$ requires: C, 62·6; H, 3·3; N, 0; Acetyl, 37·1%). The substance was characterised as triacetoxybrazanquinone by conversion into the related phenazine derivative on condensation with O-phenylene-diamine in the usual manner. The dark brown substance is very sparingly soluble in all solvents and was purified by washing with hot AcOH; it did not melt below 300°. (Found: C, 68·7; H, 3·6. $C_{28}H_{18}O_7N_2$ requires: C, 68·0; H, 3·6%). The substance exhibited the anticipated colour reactions, namely a deep blue soln in conc H_2SO_4, and red-violet in HNO_3.

In the series of operations described above, in the first stage, it is simply the nitration of the anhydrobrazilin derivative, and on heating with AcOH the O-nitro derivative is decomposed with formation of the related β-naphthaquinone.

Tripropionylbrazilone. Brazilin (3·0 g) in pyridine (10 ml) was boiled with propionic anhydride (3·9 g) for 30 min. After treatment with dil HCl aq the substance was dissolved in ether and the soln dried (Na_2SO_4). The gum left after removal of the ether was dissolved in the AcOH (15 ml) and was slowly treated at room temp with chromic anhydride (2·5 g) in a little water. On keeping, crystals separated and re-crystallisation from alcohol gave colourless plates, m.p. 144–146°. (Found: C, 64·2; H, 5·1. $C_{16}H_9O_6(CO.C_2H_5)_3$ requires: C, 64·1; H, 5·1. $C_{16}H_8O_6(CO.C_2H_5)_4$ requires; C, 64·1; H, 5·3%).

On heating with propionic anhydride and sodium propionate, tripropionylanhydrobrazilone, m.p. 178° was obtained. (Found: C, 66·1; H, 5·1 $C_{28}H_{26}O_9$ requires: C, 66·4; H, 5·1%). The corresponding brazanquinone was prepared as for the forementioned acetate. The derivative crystallised from AcOH as orange-red prisms m.p. 201–203° (dec). (Found: C, 65·0; H, 4·2. $C_{25}H_{20}O_9$ requires: C, 64·6; H, 4·3%).

Some substances derived from haematoxylin

Penta-acetylhaematoxylin: When haematoxylin was refluxed with excess acetyl chloride for 30 min it was converted into its penta-acetylderivative. After isolation in the known manner the substance crystallised from EtOH, m.p. 171–173°. (Found: C, 60·3; H, 4·9; Acetyl, 46·8 Calc. for $C_{16}H_9O_6(CO.CH_3)_5$: C, 60·9; H, 4·7; Acetyl, 47·4%). The foregoing is a repetition of the method of Reim[8] who, however, gives m.p. 165–166°. Full acetylation of haematoxylin following Reim (refluxing acetyl chloride) and subsequently by crystallisation from EtOH gave colourless needles, m.p. 171–173°, lit.,[8] m.p. 165–166°.

Tetraacetylhaematoxylone and derivatives therefrom. A mixture of haematoxylin (10 g), pyridine (30 ml) and Ac_2O (12·5 g) was kept 24 hr and the product (8·5 g) isolated in the known manner; it could not be crystallised. The whole was dissolved in AcOH (30 ml) and oxidation effected by addition of chromic anhydride (4·5 g) in a little water, at 10–15°. After 2 hr more AcOH (30 ml) was added and on cautious addition of water a crystalline ppt was obtained. Recrystallisation from EtOH afforded a hydrate, m.p. 150–151°. (Found: C, 57·35; H, 4·7. Acetyl, 38·0; $C_{16}H_8O_7(CO.CH_3)_4.H_2O$ requires: C, 57·6; H, 4·4; Acetyl, 34·3.

O-*Penta-acetylanhydrohaematoxylone.* This substance was obtained by refluxing tetraacetylhaematoxylone with Ac_2O in the presence of fused NaOAc for 1·5 hr. The product, isolated in the known manner, crystallised from AcOH in needles m.p. 256° (dec). (Found: C, 61·2; H, 4·4; $C_{26}H_{20}O_{11}$ requires: C, 64·4; H, 3·9.

O-*Tetraacetylbrazanquinone.* This was prepared like the corresponding triacetyl compound by nitration and decomposition of the nitro-naphthol moiety on heating with AcOH. The tetraacetylbrazanquinone formed yellowish orange needles on crystallisation from AcOH, m.p. 260° (dec). (Found: C, 60·0; H, 3·3. $C_{24}H_{16}O_{11}$ requires: C, 60·0; H, 3·3%). This substance condensed with *o*-phenylenediamine to a product which gave the deep blue soln with conc H_2SO_4.

3,4-*Dihydroxy*-8-*methoxy*-O-*trimethylbrazilane.* This substance, named on the system suggested above under nomenclature, is the intramolecular pinacol obtainable by reduction of tetra-methylhaematoxylone. A suspension of finely powdered tetra-methylhaematoxylone (2 g) in

EtOH (300 ml) was heated on the steam bath with occasional shaking, so as to dissolve as much of the solid as possible, then cooled to 45°. Zn dust (25 g) was then added, followed by gradual addition of AcOH (20 ml) over a period of 6 hr. More Zn (25 g) was added in the middle of this period and the mixture was frequently shaken. Next day the solvent was removed under diminished pressure from the filtered soln. On addition of water a small amount of crystalline solid separated, but this has not been investigated. The aqueous soln was extracted with EtOAc. The separated extract (dried over Na_2SO_4) was evaporated and the residue could be crystallised from EtOH as large colourless prisms, m.p. 184° (dec). (Found C, 64·2; H, 5·9. $C_{20}H_{22}O_7$ requires: C, 64·2; H, 5·9%). This pinacol shows the usual colour changes indicating conversion to a tetramethoxybrazilium salt,[6] e.g. it dissolves in HCl aq to a carmine soln, due to the formation of quininoid salt involving a change of the diaryl carbinol system. Treatment with conc H_2SO_4 furnishes the O-tetramethylhaematoxylium hydrogen sulphate, which separates as orange coloured needles.

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