191. *Chemistry of the* Coprosma *Genus. Part III. A Synthesis of Areolatin and an Isomer,* 3 : 5 : 6 : 7-*Tetrahydroxy*-2-*methylanthraquinone.*

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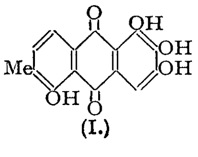
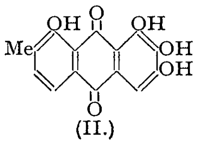
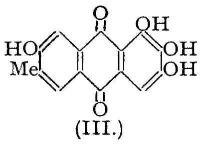
The constitution of areolatin as 1 : 5 : 6 : 7-tetrahydroxy-2-methylanthraquinone suggested in Part II (this vol., p. 568) has been confirmed synthetically by condensation of 2-hydroxy-*p*-toluic acid with gallic acid in the presence of concentrated sulphuric acid. 3 : 5 : 6 : 7-Tetrahydroxy-2-methylanthraquinone has been isolated as a by-product and characterised.

In Part II (*loc. cit.*) evidence was adduced for the formulation of areolatin, a new anthraquinone colouring matter from the bark of *Coprosma areolata*, as 1 : 5 : 6 : 7-tetrahydroxy-2-methylanthraquinone (I) although the alternative structure (II) was not rigidly excluded.


(I.)


(II.)


(III.)

It should be possible for condensation of 2-hydroxy-*p*-toluic and gallic acids in the presence of concentrated sulphuric acid to yield compounds corresponding to structures (I) and/or (III) but not (II), so that if by this means a compound is obtained having the properties of areolatin it must have the structure (I). This has proved to be the case.

Self condensation of 2-hydroxy-*p*-toluic acid has been shown (Jowett and Potter, *J.*, 1903, **83**, 1331) to produce the three isomers 1 : 5-dihydroxy-, 3 : 5-dihydroxy-, and 3 : 7-dihydroxy-2 : 6-dimethylanthraquinone, and self condensation of gallic acid yields rufigallic acid (1 : 2 : 3 : 5 : 6 : 7-hexahydroxyanthraquinone) (Robiquet, *Annalen*, 1837, **19**, 204). Condensation of equimolecular quantities of 2-hydroxy-*p*-toluic acid with gallic acid in the presence of concentrated sulphuric acid could therefore give no fewer than six products. The product of this reaction for one hour at 140° was indeed a mixture which could be conveniently separated, however, by chromatographing an acetone solution of it on a magnesium oxide column. Three main bands were obtained, a top purple lake, a middle greyish-green lake, and a lower narrow orange band.

The product from the purple lake was fractionally crystallised from glacial acetic acid to yield areolatin, which must therefore have the structure (I).

The greyish-green lake on decomposition with acid furnished a product which proved to be isomeric with areolatin and must therefore be 3 : 5 : 6 : 7-*tetrahydroxy*-2-*methylanthraquinone* (III). It was characterised as its *tetra-acetate, tetrabenzoate*, and *tetramethyl ether*. With mordanted wool it produces similar colours to those of anthragallol.

The lowest orange band by similar treatment and crystallisation from glacial acetic acid yielded golden yellow needles, m. p. > 330°, which agrees in m. p. and colour reactions with 3 : 5-dihydroxy-2 : 6-dimethylanthraquinone (see above).

By condensation of *m*-hydroxybenzoic acid with gallic acid Noah (*Ber.*, 1886, **19**, 2337) obtained two isomeric products, 1 : 2 : 3 : 5- and 1 : 2 : 3 : 7-tetrahydroxyanthraquinone, one red and the other yellow, but he was unable to distinguish between the two. By analogy with the similar compounds obtained above we suggest that the red and the yellow compound are the 1 : 2 : 3 : 5- and the 1 : 2 : 3 : 7-isomer respectively. We hope to report later on these compounds.

EXPERIMENTAL.

A solution of 2-hydroxy-*p*-toluic acid (3 g., 1 mol.; Meldrum and Perkin, *J.*, 1908, **93**, 1416) and gallic acid (3·36 g., 1 mol.) in concentrated sulphuric acid (20 g., 10 mol.) was heated at 140° for 1 hour. The initial straw colour rapidly changed to red and then to purple which gradually increased in intensity. The dark brown precipitate formed on pouring the reaction mixture into water (300 c.c.) was allowed to settle, collected, washed free from acid, and dried (3·42 g.). It was then extracted with acetone and the black insoluble portion discarded. The acetone solution after being chromatographed on freshly ignited magnesium oxide and developed with the same solvent formed two main bands—a top purple lake and a greyish-green lake—and a narrow orange band at the bottom. The column was extruded and sectioned, and the water-insoluble anthraquinones liberated by dilute hydrochloric acid.

1 : 5 : 6 : 7-*Tetrahydroxy*-2-*methylanthraquinone* (*Areolatin*).—The product (350 mg.) from the purple band was not homogeneous and contained material from the middle band. This was not unexpected since the first two bands are lakes of magnesium salts which cannot be eluted with organic solvents. The mixture was separated by fractional crystallisation from glacial acetic acid, the sparingly soluble material being identical with that obtained from the second band. The product obtained on concentrating the acetic acid mother liquors, after recrystallisation from glacial acetic acid or better from aqueous acetic acid (charcoal), formed red plates (180 mg.) indistinguishable in its characteristic shrinking point and colour reactions from those of areolatin (Part II). No alteration to the shrinking point occurred on admixture. The tetra-acetate (prepared as in Part II) had m. p. 239° undepressed by an authentic specimen.

3 : 5 : 6 : 7-*Tetrahydroxy*-2-*methylanthraquinone*.—The dirty brown material (470 mg.) from the greyish-green band, after repeated crystallisation from 60% alcohol, formed orange needles which darkened at high temperatures without melting below 400° (Found : C, 61·8; H, 3·9. $C_{15}H_{10}O_6$ requires C, 63·0; H, 3·5%). In 10% sodium hydroxide solution this 3 : 5 : 6 : 7-*tetrahydroxy*-2-*methylanthraquinone* gives a green colour changing to reddish-brown on standing in air. The solution in concentrated ammonia is first brown, changing through green to bluish-green. Concentrated sulphuric acid with or without the addition of boric acid gives a deep crimson coloration, and ferric chloride solution gives a dark brown precipitate. When applied to wool mordanted with potassium dichromate, ferric alum, potassium titanium oxalate, stannous chloride, lead acetate, zinc sulphate, or cadmium chloride it produces colours almost identical with those from anthragallol. The *tetra-acetate*, formed by interaction with acetic anhydride in pyridine solution for 2 hours at the boiling point and pouring into water, was crystallised from glacial acetic acid, forming spherical aggregates of light yellow needles of constant m. p. 231—233° (Found : C, 60·4; H, 3·9. $C_{23}H_{18}O_{10}$ requires C, 60·8; H, 4·0%). The *tetrabenzoate*, prepared as for areolatin tetrabenzoate (Part II), crystallised from glacial acetic acid (charcoal) in pale cream prisms of constant m. p. 218—222° (Found : C, 73·5; H, 3·6. $C_{43}H_{26}O_{10}$ requires C, 73·5; H, 3·7%). The *tetramethyl ether*, also prepared as for the tetramethyl ether of areolatin, formed citron-yellow needles from acetone, m. p. 206·5—207° (Found : C, 66·1; H, 5·5. $C_{19}H_{18}O_6$ requires C, 66·7; H, 5·3%).

3 : 5-*Dihydroxy*-2 : 6-*dimethylanthraquinone*.—The yellow substance from the orange band crystallised from a large volume of glacial acetic acid (yield, 12 mg.) in minute golden yellow needles, m. p. 330°, which agreed in m. p. and colour reactions with those of 3 : 5-dihydroxy-2 : 6-dimethylanthraquinone, one of the products formed by the self-condensation of 2-hydroxy-*p*-toluic acid (Jowett and Potter, *loc. cit.*).

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