340. *Experiments on the Synthesis of Substances Related to the Sterols. Part IV. Some Derivatives of Chrysene* (contd.).

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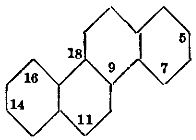

The aims of this part of the investigation have been already explained in Part I (J., 1933, 607). The new material comprises (1) the isolation of 5 : 14-dimethoxyhexahydrochrysene and its diketo-derivatives in the stereoisomeric series-*b*, (2) the preparation of 6 : 15-dimethoxyhexahydrochrysene and 5 : 6 : 14 : 15-tetramethoxyhexahydrochrysene, and (3) the preparation of 2 : 11-dimethylchrysene by aerial oxidation of the product of interaction of *cis*-2 : 11-diketo-1 : 2 : 9 : 10 : 11 : 18-hexahydrochrysene and methylmagnesium iodide.

Owing to the fact that the yields of bimolecular reduction products of substituted cinnamic esters in the new examples were uniformly poor, the stereoisomeric series could not be examined and the investigation was directed into other channels.

Experimental.

Methyl βγ-Dianisyladipate-b.—Methyl 4-methoxycinnamate (50 g.) was reduced as described in Part I (*loc. cit.*), the *methyl βγ-dianisyladipate*-b being present with other products (13 g.) in the ether-soluble viscous material. The ester could not be induced to crystallise, but about half of the product could be distilled, b. p. 285°/14 mm., and this fraction crystallised from a solution in a little methyl alcohol. On recrystallisation methyl βγ-dianisyladipate-*b* (3·0 g.) was obtained as long colourless prisms, m. p. 67° (Found: C, 68·5; H, 6·8. $C_{22}H_{26}O_6$ requires C, 68·4; H, 6·7%). Hydrolysis gave *βγ-dianisyladipic*-b *acid*, which crystallised from aqueous methyl alcohol (1 : 1) in colourless prisms, m. p. 180° (Found: C, 67·0; H, 6·2. $C_{20}H_{22}O_6$ requires C, 67·1; H, 6·15%).

2 : 11-*Diketo*-5 : 14-*dimethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-b.—Dianisyladipic-*b* acid (3·0 g.) was ring-closed by means of a Friedel–Crafts reaction in tetrachloroethane solution, under conditions already described for the isomeride-*a*, with cooling at first, and then at 60° for 12 hours. The solvent was removed in a current of steam and, on cooling, the brown oil solidified; it was collected and digested with hot aqueous sodium hydroxide (10%) in order to remove acids. Crystallisation from butyl alcohol gave the *diketone* (1·9 g.) as plates, m. p. 220° (Found: C, 74·4; H, 5·7. $C_{20}H_{18}O_4$ requires C, 74·5; H, 5·6%), moderately readily soluble in anisole and in hot butyl alcohol.

In view of the difficulty of separating the methyl βγ-dianisyladipate-*b* from the viscous unidentified substances that are also formed in the reduction, the preparation of the diketone was modified in that the crude mixture was hydrolysed and, after drying, the crude acid (12 g.) was treated with thionyl chloride and ring-closed as above; the pure diketone (3·5 g.) was then isolated.

5 : 14-*Dimethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-b.—A mixture of the above diketone (1·2 g.), amalgamated zinc (50 g.), and concentrated hydrochloric acid (10 c.c.) was refluxed for 36 hours, a further quantity (15 c.c.) of hydrochloric acid being added during this period. The resulting oil was collected in benzene, the solvent removed, and the distilled product (reduced pressure) crystallised first from butyl alcohol and then from ethyl alcohol, forming irregular plates (0·5 g.), m. p. 140—141° (Found: C, 81·2; H, 7·5. $C_{20}H_{22}O_2$ requires C, 81·6; H, 7·5%).

βγ-Di-3-*methoxyphenyladipic*-a *Acid*.—Methyl 3-methoxycinnamate (50 g.) was reduced in ethereal solution (1500 c.c.) by means of aluminium amalgam (from 100 g. of aluminium foil) under conditions similar to those employed in other cases by Oommen and Vogel (J., 1930, 2150). The main product was *methyl* β-3-*methoxyphenylpropionate*, b. p. 146°/12 mm. (Found: C, 68·2; H, 7·2. $C_{11}H_{14}O_3$ requires C, 68·1; H, 7·2%), but the viscous residue from this, when dissolved in ether and kept in the ice-chest, afforded crystals of *methyl* βγ-*di*-3-*methoxyphenyladipate*-a (1·7 g.) (4 g. of viscous oil left in the ether probably contained some of the isomeride-*b*). The ester crystallised from ethyl alcohol in colourless prisms, m. p. 139·5° (Found: C, 68·4; H, 7·0. $C_{22}H_{26}O_6$ requires C, 68·4; H, 6·7%). It was hydrolysed by refluxing with aqueous-alcoholic potassium hydroxide. βγ-*Di*-3-*methoxyphenyladipic*-a *acid* crystallised from methyl alcohol in minute prisms, m. p. 247—248° (Found: C, 66·7; H, 6·4. $C_{20}H_{22}O_6$ requires C, 67·0; H, 6·1%).

2 : 11-*Diketo*-6 : 15-*dimethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-a.—A mixture of di-3-methoxyphenyladipic acid (0·5 g.) and sulphuric acid (5 c.c. of 90%) was heated at 100° for 2·5 hours. The *product* was freed from acids (yield, 0·3 g.); it crystallised from boiling acetic anhydride in rectangular plates, m. p. *ca*. 350° (Found: C, 73·9, 74·2; H, 5·8, 5·7. $C_{20}H_{18}O_4$ requires C, 74·5; H, 5·6%).

6 : 15-*Dimethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*.—The crude diketone (1·2 g.) was reduced by amalgamated zinc (60 g.) and hydrochloric acid (15 c.c. of 30% + 6 c.c. after 12 hours) in the presence of anisole (30 c.c.) at the b. p. of the liquid during 24 hours. The hot anisole layer was separated, the zinc extracted with fresh anisole, and the solvent removed by distillation under diminished pressure. Alcohol (10 c.c.) was added to the residue, and the substance then separated in a crude condition (0·3 g.). It crystallised from acetic acid in stout prisms, m. p. 159° (Found: C, 81·4; H, 7·6. $C_{20}H_{22}O_2$ requires C, 81·6; H, 7·5%).

Methyl 3 : 4-*Methylenedioxycinnamate*.—A 90% yield of this *ester* was obtained by the condensation of piperonal (50 g.) and dry methyl acetate (200 c.c.) by means of finely granulated sodium (8 g.); the reaction was completed by refluxing for 1 hour. The ester crystallised from methyl alcohol in plates, m. p. 133—134° (Found: C, 64·2; H, 4·8. $C_{11}H_{10}O_4$ requires C, 64·1; H, 4·8%). Presumably this substance is not identical with the methyl 3 : 4-methylenedioxycinnamate, m. p. 68—69°, obtained by Feuerstein and Heimann (*Ber.*, 1901, **34**, 1469) by esterification of the acid, but we have not yet examined this form of lower m. p. On reduction with amalgamated aluminium in ethyl acetate solution the ester, m. p. 133°, gave *methyl* β-3 : 4-*methylenedioxyphenylpropionate* as the sole product; b. p. 165—170°/13 mm., m. p. 34—35° (prisms from alcohol) (Found: C, 63·8; H, 5·8. $C_{11}H_{12}O_4$ requires C, 63·5; H, 5·8%).

$\beta\gamma$-*Di*-3 : 4-*dimethoxyphenyladipic*-a *Acid*.—The condensation of veratraldehyde (50 g.) and dry methyl acetate (150 c.c.) with the help of granulated sodium (7 g.) afforded 60 g. of methyl 3 : 4-dimethoxycinnamate, b. p. 200°/20 mm.

On reduction of this ester (50 g.) in ethereal solution (1500 c.c.) by means of amalgamated aluminium (100 g.), there were obtained *methyl* β-3 : 4-*dimethoxyphenylpropionate* (37 g.), b. p. 175—180°/12 mm., plates, m. p. 37° (Found : C, 64·5; H, 7·1. $C_{12}H_{16}O_4$ requires C, 64·3; H, 7·1%), and a viscous residue (4·5 g.) from the distillation. An ethereal solution of the latter deposited crystals (0·6 g.) on keeping in the ice-chest; the substance separated from hot *n*-butyl alcohol in microscopic prisms, m. p. 184° (Found : C, 64·7; H, 6·9. $C_{24}H_{30}O_8$ requires C, 64·6; H, 6·7%).

This *methyl* $\beta\gamma$-*di*-3 : 4-*dimethoxyphenyladipate*-a was isolated in larger amount (6 g.) from the alumina sludge; it was hydrolysed by means of boiling aqueous-alcoholic potassium hydroxide and the *acid*, crystallised five times from acetic acid, was obtained in microscopic prisms, m. p. 255° (Found : C, 63·0; H, 6·4. $C_{22}H_{26}O_8$ requires C, 63·2; H, 6·2%).

2 : 11-*Diketo*-5 : 6 : 13 : 14-*tetramethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-a.—A mixture of $\beta\gamma$-di-3 : 4-dimethoxyphenyladipic-*a* acid (0·5 g.) and sulphuric acid (3 c.c. of 80%) was heated on the steam-bath for 30 minutes (yield, 0·3 g.). The substance was very sparingly soluble in organic solvents; it crystallised from boiling acetic anhydride in plates, m. p. 330° (decomp.) (Found : C, 69·0; H, 5·7. $C_{22}H_{22}O_6$ requires C, 69·1; H, 5·8%).

5 : 6 : 13 : 14-*Tetramethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-a.—The reduction was carried out in presence of boiling anisole as in similar cases; a somewhat improved yield was obtained when the finely powdered diketone was slowly added to the reducing agents and solvent over a period of hours. The product crystallised from acetic acid in rhomboidal plates, m. p. 204° (Found : C, 74·4; H, 7·4. $C_{22}H_{26}O_4$ requires C, 74·6; H, 7·3%).

2 : 11-*Dimethylchrysene*.—A Grignard reagent was prepared in dry ether (10 c.c.) from methyl iodide (4·5 g.) and magnesium (0·75 g.) and diluted with dry benzene (30 c.c.). To the hot solution, dry powdered *cis*-diketohexahydrochrysene (2·0 g.) was slowly added, and the mixture refluxed for 3 hours. After decomposition with dilute sulphuric acid, a precipitate remained which could not be purified, but when the benzene solution was exposed to the air and allowed to evaporate slowly, oxidation occurred and *dimethylchrysene* separated in stout prisms, m. p. 237° (Found : C, 93·7; H, 6·4. $C_{20}H_{26}$ requires C, 93·75; H, 6·25%). The same compound was obtained, but not so readily, by employing the less soluble *trans*-diketone in the above preparation.

The 1 : 3 : 5-*trinitrobenzene compound* of dimethylchrysene was prepared in benzene solution; it crystallised from this solvent as reddish-orange needles, m. p. 222° (Found : C, 66·5; H, 4·1. $C_{20}H_{26},C_6H_3O_6N_3$ requires C, 66·6; H, 4·1%).

The styphnate crystallised from benzene in orange needles, m. p. 207° (decomp.). Both these derivatives are much more stable than the corresponding chrysene compounds; the picrate, however, could not be isolated.

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