103. *Experiments on the Synthesis of Substances related to the Sterols. Part XXXVII. Derivatives of Chrysene.*

By L. Golberg and Sir Robert Robinson.

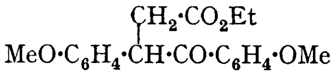
In Part I Ramage and Robinson (J., 1933, 607) described the preparation of stereoisomeric hexahydrochrysenes from the *meso*- and the *r*-form of ββ′-diphenyladipic acid (Oommen and Vogel, J., 1930, 2148). 5 : 14-Dimethoxyhexahydrochrysenes were also synthesised, but the method could only be applied to the preparation of symmetrically constituted substances. Hence it was proposed to achieve greater flexibility by first making suitable 2-phenyltetralones with the object of introducing

the acetic acid residue by the Reformatzky reaction and cyclising the reduced product. This scheme was explained in Part V (Robinson and Young, J., **1935**, 1414) and carried out with the exception of the final ring-closure.

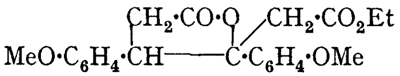
A better method for the preparation of the substituted 2-phenyl-α-tetralones was described by Richardson, Robinson, and Seijo (J., **1937**, 835). The present work describes the natural continuation of this investigation and was completed in 1938. For the conversion of αγ-diarylbutyric acids into 2-aryltetralones we have found phosphoryl chloride an effective condensing agent. In the Reformatzky reaction a *by-product* has been obtained, and its constitution determined. The normal products were reduced, hydrolysed, and cyclised by means of phosphoric oxide. In this way intermediates have been obtained in which it should be possible to modify one only of the terminal benzene nuclei. A novel synthesis of substituted hexahydrochrysenes by cyclodehydration of glycols is also described.

As the yield of diaryladipic esters obtained by the reduction of arylacrylic esters is not favourable, we have studied a synthesis of a different kind but have made little use of it up to the present. Introduction of the carbethoxymethyl group into deoxyanisoin by the ordinary alkylation procedure affords *ethyl* 4 : 4′-*dimethoxydesylacetate* (I), which reacts with zinc and ethyl bromoacetate with formation of the *lactone* (II). The yields obtained offered little prospect of an improvement in the preparation of ββ′-dianisyladipic acid.

(I.)



$$MeO\cdot C_6H_4\cdot \overset{CH_2\cdot CO_2Et}{\overset{|}{CH}}\cdot CO\cdot C_6H_4\cdot OMe$$



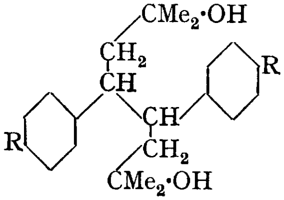
$$MeO\cdot C_6H_4\cdot \overset{CH_2\cdot CO\cdot O}{\overset{|}{CH}}\text{——}\overset{\diagup CH_2\cdot CO_2Et}{\overset{|}{C}}\cdot C_6H_4\cdot OMe$$

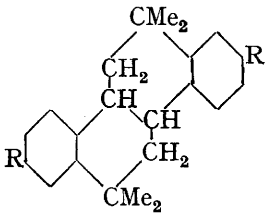
(II.)

Dodds, Golberg, Lawson, and Robinson (*Proc. Roy. Soc.*, 1939, *B*, **127**, 160) have described the glycol (III, R = OMe), the product of the action of methylmagnesium iodide on ethyl ββ′-dianisyladipate-a. The substance was dehydrated by means of potassium hydrogen sulphate with formation of a diene and the latter was reduced to a saturated dianisyldimethyloctane. We have now found that, when the glycol is heated with hydriodic acid, it is rapidly converted into 5 : 14-*dimethoxy*-2 : 2 : 11 : 11-*tetramethyl*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-a (IV, R = OMe). We have also prepared the *glycol* from ethyl dianisyladipate-b : if this undergoes similar ring-closure, it certainly is not facile, and, in fact, has not been achieved.

The *glycol* (III, R = H) from methyl ββ′-diphenyladipate-a affords (IV, R = H), on heating with hydriodic acid, with great readiness and at a lower temperature than was required in the first example.

(III.)

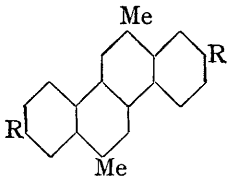




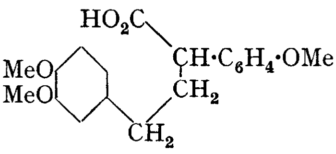
(IV.)

The constitution of the products (IV) was proved by selenium dehydrogenation, whereby substituted chrysenes were obtained.

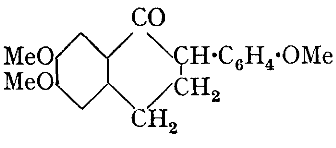
5 : 14-*Dimethoxy*-2 : 11-*dimethylchrysene* (V, R = OMe) so produced from (IV, R = OMe) was synthesised by the action of methylmagnesium iodide on 2 : 11-*diketo*-5 : 14-



(V.)



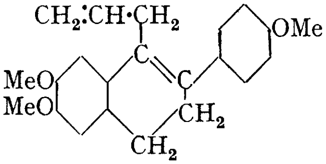
(VI.)

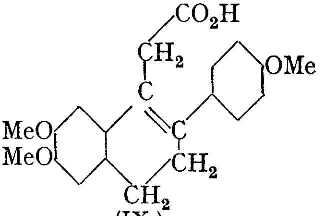


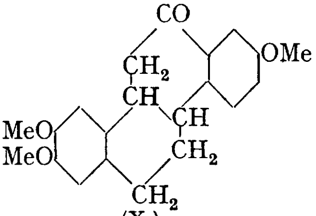
(VII.)

dimethoxy-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-a (Ramage and Robinson, *loc. cit.*). The decahydrochrysene derivative that should be produced undergoes oxidation in the process. The selenium dehydrogenation of (IV, R = H) affords 2 : 11-dimethylchrysene (V, R = H) (Part IV; Lewis, Ramage, and Robinson, J., 1935, 1414).

The methods of Richardson, Robinson, and Seijo (*loc. cit.*) were applied to the preparation of *α-anisyl-β-veratrylpropionic acid* (VI) from anisylideneacetoveratrone (4 : 3′ : 4′-trimethoxychalkone). This acid was easily dehydrated to the *α-tetralone* (VII) by quite short treatment with boiling phosphoryl chloride. The ketone has been reduced, and the resulting *α-tetralol* dehydrated; it has also been converted into 6 : 7-*dimethoxy*-2-*anisyl*-1-*allyl*-3 : 4-*dihydronaphthalene* (VIII), a possible intermediate for construction of the chrysene ring.


(VIII.)

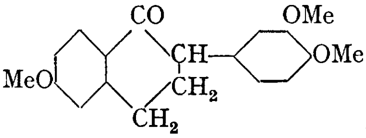

(IX.)

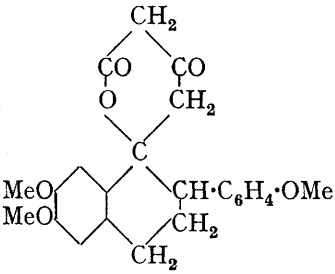

(X.)

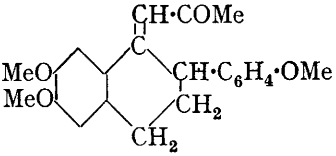
The Reformatzky reaction with (VII) and ethyl bromoacetate affords a yellow substance (below), m. p. 230—234°, and, after hydrolysis, 6 : 7-*dimethoxy*-2-*anisyl*-3 : 4-*dihydro*-1-*naphthylacetic acid* (IX). The bromine–sodium carbonate test indicates the $\Delta^{\beta\gamma}$-structure (cf. Robinson and Young, *loc. cit.*, for a similar observation in a closely related case).

The *dihydro*-derivative of (IX) was dehydrated to (X) by means of phosphoric oxide in boiling moist benzene solution. The reduction of this ketone gave an anomalous result. Another series, starting from *veratrylidene*-m-*methoxyacetophenone* (3 : 4 : 3′-trimethoxychalkone), has been taken as far as 1-*keto*-6 : 3′ : 4′-*trimethoxy*-2-*phenyl*-1 : 2 : 3 : 4-*tetrahydronaphthalene* (XI).

Shortly after this work had been completed Newman (*J. Amer. Chem. Soc.*, 1938, **60,** 2947) published an account of this chrysene synthesis in the simplest case. He has apparently overlooked the papers of Robinson and Young and Richardson, Robinson, and Seijo (*loc. cit.*). The yellow by-product, m. p. 230—234°, mentioned above, is regarded as the *lactone* (XII). It gives a red ferric reaction, can be *O*-methylated (product, ferric negative), and on heating loses carbon dioxide with formation of an unsaturated *ketone* (XIII). The latter can be catalytically reduced to a dihydro-derivative.


(XI.)


(XII.)


(XIII.)

EXPERIMENTAL.

Ethyl 4 : 4′-*Dimethoxydesylacetate* (I).—Deoxyanisoin (25·6 g.) and then ethyl bromoacetate (33·4 g.) were added to a solution of sodium (4·6 g.) in alcohol (80 c.c.) and the mixture was refluxed for 5 hours. The same quantities of alcoholic sodium ethoxide and ethyl bromoacetate were added as before, and the boiling continued for a further 24 hours. The product was isolated in the usual manner and distilled; the first fraction consisted of deoxyanisoin, followed by a very viscous oil, b. p. 220—225°/0·14 mm. On dilution of the oil with ether, deoxyanisoin separated and was collected, the process being repeated after keeping for 24 hours at −10°. The oil was redistilled (15 g.) (Found: C, 70·4; H, 6·4. $C_{20}H_{22}O_5$ requires C, 70·2; H, 6·4%).

4 : 4′-*Dimethoxydesylacetic Acid.*—A mixture of the ester (5 g.), potassium hydroxide (10 g.), water (10 c.c.), and methyl alcohol (20 c.c.) was boiled for 3 hours. The solution was diluted; a crystalline potassium salt was then deposited. The *acid* was obtained as an oil, which crystallised from benzene, forming thick, colourless prisms (3·8 g.), m. p. 103—106°, 110° after recrystallisation (Found : C, 68·6; H, 5·6. $C_{18}H_{18}O_5$ requires C, 68·8; H, 5·7%).

The same acid, together with anisic acid, was isolated from the oily mixture resulting from the oxidation of allyldeoxyanisoin by potassium permanganate in acetone solution.

β-*Hydroxy*-βγ-*dianisyladipolactone* (II).—A crystal of iodine was added to a mixture of ethyl dimethoxydesylacetate (15 g.), ethyl bromoacetate (22 g.), zinc (8·6 g.), and benzene (100 c.c.); on heating, a gentle reaction set in. After refluxing for 3 hours, the mixture was decomposed with water and dilute hydrochloric acid; the benzene solution yielded a brown oil. This was hydrolysed by a boiling solution of potassium hydroxide (20 g.) in methyl alcohol (40 c.c.) and water (20 c.c.) for 3 hours. The *lactone*, isolated in the usual manner, crystallised from benzene in small prisms, m. p. 186° (decomp.) (Found : C, 67·3; H, 5·7. $C_{20}H_{20}O_6$ requires C, 67·4; H, 5·6%).

5 : 14-*Dimethoxy*-2 : 2 : 11 : 11-*tetramethyl*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-a (IV, R = OMe).—A solution of 4 : 5-dianisyl-2 : 7-dimethyloctane-2 : 7-diol-a (III, R = OMe) (Dodds, Golberg, Lawson, and Robinson, *loc. cit.*) (2 g.) in acetic acid (5 c.c.) was mixed with hydriodic acid (25 c.c., *d* 1·7) and heated at 150° until a solid cake appeared on the surface of the liquid. The mixture was cooled and diluted, and the solid collected and dissolved in chloroform. The solution was washed with water, freed from iodine, and concentrated; on addition of light petroleum, thick prisms were deposited. Repeated crystallisation gave colourless prisms (1·6 g.), m. p. 219° (Found : C, 82·3; H, 8·9. $C_{24}H_{30}O_2$ requires C, 82·3; H, 8·6%). The *product* was neutral, saturated, and resistant to hydrogenation in the presence of a platinic oxide catalyst. On boiling with nitric acid (*d* 1·5) and acetic acid, a mixture of compounds resulted, but no picric acid was formed. This was a clear indication of *C*-substitution in the *m*-position to methoxyl.

5 : 14-*Dimethoxy*-2 : 11-*dimethylchrysene* (V, R = OMe).—The above hexahydrochrysene (2 g.) was heated with selenium powder (1 g.) in a current of nitrogen at 295—300° for 24 hours, with the addition of selenium (1 g.) at intervals of 6 hours. The cooled mass was extracted with boiling ether, and the filtered ethereal extract boiled for ½ hour with sodium foil, filtered, and evaporated. The residue partly solidified on trituration with alcohol and the solid was collected and crystallised from chloroform–light petroleum (b. p. 40—60°); it had m. p. 214—216° (unchanged material). The mother-liquor was gently heated and mixed with picric acid; on cooling, it deposited a red, crystalline *picrate*. This was recrystallised twice from alcoholic picric acid and formed ruby-red, elongated prisms, m. p. 190° (after sintering at 169—171°) (Found : N, 7·7. $C_{22}H_{20}O_2,C_6H_3O_7N_3$ requires N, 8·0%).

The picrate (0·3 g.) was shaken with aqueous sodium hydroxide and the solid which separated was collected, washed with alkali and water, and dried. It separated from benzene in long, slender prisms, m. p. 188—190°, and 199° after recrystallisation and sublimation in a vacuum (Found : C, 82·1; H, 6·8. $C_{22}H_{20}O_2$ requires C, 82·3; H, 6·8%).

The same compound was obtained when 2 : 11-diketo-5 : 14-dimethoxy-1 : 2 : 9 : 10 : 11 : 18-hexahydrochrysene-a (3 g.) (Ramage and Robinson, *loc. cit.*) was added slowly to a Grignard solution, prepared from methyl iodide (9·2 g.) and magnesium (1·5 g.) in ether (25 c.c.), to which dry benzene (50 c.c.) had been added. The mixture was boiled for 24 hours and decomposed with ice, and the benzene layer decanted, washed, dried, and evaporated. The pale yellow residue crystallised from benzene in prisms (0·3 g.), m. p. 199°, mixed m. p. with above specimen, 199°. Unchanged starting material (2 g.) was recovered from the mother-liquors.

4 : 5-*Diphenyl*-2 : 7-*dimethyloctane*-2 : 7-*diol*-a (III, R = H).—The Grignard reaction was carried out in the usual manner; methyl ββ′-diphenyladipate-a(*meso*) (7 g.) (Oommen and Vogel, *loc. cit.*) being added with stirring to a solution of a Grignard reagent made from methyl iodide (30·5 g.) and magnesium (5·2 g.) in ether (250 c.c.). The *glycol* crystallised from chloroform–light petroleum in colourless prisms (5·6 g.), m. p. 125° (Found : C, 80·8; H, 9·2. $C_{22}H_{30}O_2$ requires C, 81·0; H, 9·2%).

2 : 2 : 11 : 11-*Tetramethyl*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*-a (IV, R = H).—The cyclisation was carried out as above, with the diol (5 g.) in acetic acid (12·5 c.c.) and hydriodic acid (30 c.c.). When the temperature reached 90°, a solid cake separated. Purification of the product as before gave a *substance* which crystallised from chloroform–light petroleum in long, slender prisms, m. p. 173° (Found : C, 91·0; H, 9·0. $C_{22}H_{26}$ requires C, 91·0; H, 9·0%).

2 : 11-*Dimethylchrysene*.—Dehydrogenation was carried out with selenium as before; the hydrochrysene proved more resistant in this case to dehydrogenation and was heated at 315—320° for 34 hours. A crystalline sublimate was formed, which, together with the product isolated from the reaction mixture, was crystallised from ethyl acetate and had m. p. 220—228°. After two further recrystallisations it was still reddish in tinge and had m. p. 236—237°. It was sublimed in a vacuum; the colourless sublimate, crystallised from benzene, had m. p. 238°, alone or mixed with authentic 2 : 11-dimethylchrysene (Found : C, 93·5; H, 6·3. Calc. for $C_{20}H_{16}$: C, 93·75; H, 6·25%). The reddish-orange *s*-trinitrobenzene compound formed needles, m. p. 222° alone or mixed with an authentic specimen.

4 : 5-*Dianisyl*-2 : 7-*dimethyloctane*-2 : 7-*diol*-b (III, R = OMe).—This was prepared from methyl dianisyladipate-b (Ramage and Robinson, *loc. cit.*) in the usual manner. It was a brown, viscous oil solidifying on trituration and warming with light petroleum (b. p. 40—60°). It crystallised from benzene–light petroleum in small prisms, m. p. 120° (mixed with diol-a, m. p. 85—110°) (Found : C, 74·7; H, 8·8. $C_{24}H_{34}O_4$ requires C, 74·6; H, 8·8%).

4 : 3′ : 4′-*Trimethoxychalkone*.—This compound has been described by Tasaki (*Acta phytochim.*, 1927, **3**, 259), who gives m. p. 137—138°, and by Kuroda and Matsukuma (*Sci. Papers Inst. Phys. Chem. Res.*, 1932, **18**, 51), who number it as 3 : 4 : 4′- and give m. p. 80—81°. Kauffmann and Kieser (*Ber.*, 1913, **46**, 3798) report m. p. 90°. The chalkone was prepared as follows : A solution of acetoveratrone (120 g.) and anisaldehyde (90·7 g.) in alcohol (500 c.c.) was shaken for a few minutes with aqueous sodium hydroxide (100 c.c. of 10%) and kept overnight at room temperature. The yellow crystalline mass which separated was collected, washed with water and a little alcohol, and recrystallised from dilute alcohol, forming thick prisms, m. p. 80°. Dilution of the mother-liquor gave a further quantity (total yield, 190 g.).

γ-*Keto*-α-*cyano*-α-*anisyl*-γ-3 : 4-*dimethoxyphenylpropane*.—A solution of the chalkone (100 g.) in methyl alcohol (350 c.c.) was heated to boiling, and sodium cyanide (47·1 g.) added, together with three drops of a solution of phenolphthalein. The mixture was boiled for 20 minutes, a solution of acetic acid (20 g.) in water (100 c.c.) being added dropwise at a rate such that the mixture remained faintly pink. After 30 minutes, the solution was poured on ice; the white solid that separated crystallised from acetone in colourless prisms (90 g.), m. p. 112—114° (Found : C, 70·3; H, 5·9; N, 4·3. $C_{19}H_{19}O_4N$ requires C, 70·2; H, 5·9; N, 4·3%). A further quantity (10 g.) of pure product was isolated from the mother-liquors of the first crystallisation.

β-*Veratroyl*-α-*anisylpropionamide*.—The above nitrile (85 g.) was suspended in acetic acid (400 c.c.), and concentrated sulphuric acid (80 c.c.) added slowly, with constant shaking, a dark claret-red colour being produced. After keeping for 15 minutes, the mixture was poured on ice (2 kg.). The white solid which separated was taken up in chloroform, and the solution washed with aqueous sodium carbonate and water and dried with sodium sulphate. On evaporation a solid resulted which crystallised from aqueous alcohol in colourless plates (80 g.), m. p. 174—175° (Found : C, 66·7; H, 6·3; N, 4·1. $C_{19}H_{21}O_5N$ requires C, 66·5; H, 6·1; N, 4·1%).

β-*Veratroyl*-α-*anisylpropionic Acid*.—A solution of the amide (76 g.) in alcohol (250 c.c.) was boiled for 10 hours with aqueous sodium hydroxide (750 c.c. of 7%). The solution was diluted with an equal volume of water, filtered, and acidified. The white granular precipitate, crystallised from ethyl acetate and then from acetic acid, had m. p. 184—185° (yield, 69 g.) (Found : C, 66·7; H, 6·1. $C_{19}H_{20}O_6$ requires C, 66·3; H, 5·8%).

α-*Anisyl*-β-*veratrylpropionic Acid* (VI.)—A mixture of the keto-acid (67 g.), toluene (275 c.c.), concentrated hydrochloric acid (350 c.c.), aqueous acetic acid (100 c.c. of 5%), and amalgamated zinc (150 g.) was boiled for 40 hours, with the addition of concentrated hydrochloric acid (50 c.c.) every 10 hours. After cooling, the toluene layer was separated, washed with water, and extracted with aqueous sodium carbonate. The combined extracts were acidified, a milky oil separating. It was extracted with chloroform; on removal of the solvent a yellowish oil remained which crystallised from light petroleum in colourless needles (60 g.), m. p. 77—79° (Found : C, 69·1; H, 6·7. $C_{19}H_{22}O_5$ requires C, 69·1; H, 6·7%).

Methyl ester. The acid (6 g.) was boiled with toluene (50 c.c.), methyl alcohol (25 c.c.), and concentrated sulphuric acid (1 c.c.) for 8 hours. Dilution of the reaction mixture was followed by removal of the alcohol, cooling, and separation of the toluene layer. It was washed with water and aqueous sodium carbonate, and the toluene removed under reduced pressure. The product was a viscous oil, b. p. 220—222°/1 mm., which solidified on keeping. It crystallised from light petroleum or aqueous alcohol in elongated prisms (5·7 g.), m. p. 41—43° (Found : C, 69·9; H, 7·1. $C_{20}H_{24}O_5$ requires C, 69·8; H, 7·0%).

1-*Keto*-6 : 7-*dimethoxy*-2-*anisyl*-1 : 2 : 3 : 4-*tetrahydronaphthalene* (VII).—The reduced acid (60 g.) was boiled with phosphoryl chloride (150 c.c.) for 5 minutes, cooled, and poured on ice. The solid which separated was extracted with chloroform, the extracts washed with aqueous sodium carbonate and dried, and the solvent removed. The light brown residue crystallised from methyl alcohol or ethyl acetate in colourless prisms (56 g.), m. p. 141—142° (Found: C, 73·1; H, 6·5. $C_{19}H_{20}O_4$ requires C, 73·1; H, 6·4%).

The p-*nitrophenylhydrazone* crystallised from acetic acid in orange prisms, m. p. 205—207° after drying in a vacuum (Found: C, 67·0; H, 5·6; N, 9·4. $C_{25}H_{25}O_5N_3$ requires C, 67·1; H, 5·6; N, 9·4%).

6 : 7-*Dimethoxy*-2-*anisyl*-α-*tetralol*.—The ketone (10 g.) was dissolved in propyl alcohol (250 c.c.), and sodium (4 g.) in small pieces added to the boiling solution during 2 hours. The mixture was then poured into water and acidified with acetic acid, and the propyl alcohol removed under diminished pressure. A reddish oil, isolated by means of ether, distilled as a viscous, yellow oil, b. p. 214—215°/0·23 mm. (Found: C, 72·5; H, 7·0. $C_{19}H_{22}O_4$ requires C, 72·6; H, 7·0%).

6 : 7-*Dimethoxy*-2-*anisyl*-3 : 4-*dihydronaphthalene*.—A solution of the tetralol (6·3 g.) in pyridine (15 c.c.) was slowly added to an ice-cold solution of phosphorus tribromide (16·5 g.) in ether (25 c.c.). After 12 hours the mixture was poured on ice. The product, collected by means of ether, crystallised from alcohol or benzene in colourless plates (4 g.), m. p. 155—156° (Found: C, 77·2; H, 6·9. $C_{19}H_{20}O_3$ requires C, 77·0; H, 6·8%). It was free from bromine and was unsaturated.

6 : 7-*Dimethoxy*-2-*anisyl*-1-*allyl*-3 : 4-*dihydronaphthalene*.—A mechanically stirred mixture of 1-keto-6 : 7-dimethoxy-2-anisyl-1 : 2 : 3 : 4-tetrahydronaphthalene (12·5 g.), magnesium (4·9 g.), and dry ether (350 c.c.) was boiled, and a little iodine and methyl iodide added. When reaction set in, allyl bromide (24·4 g.) in ether (200 c.c.) was added very slowly during 1½ hours. Dry benzene (50 c.c.) was added, and the mixture stirred and refluxed for 3 hours and then decomposed with ice and ammonium chloride. The product isolated from the ethereal layer was a brown oil (11 g.), b. p. 207—210°/0·5 mm. It solidified slowly on keeping (Found: C, 78·6; H, 7·2. $C_{22}H_{24}O_3$ requires C, 78·6; H, 7·1%).

6 : 7-*Dimethoxy*-2-*anisyl*-3 : 4-*dihydro*-1-*naphthylacetic Acid* (IX).—Ketodimethoxyanisyltetrahydronaphthalene (30·2 g.), ethyl bromoacetate (33·4 g.), and zinc (13·1 g.) were heated together in dry benzene (100 c.c.). On activation with iodine, a vigorous reaction set in; when this moderated, the mixture was refluxed on the steam-bath for 3 hours. It was decomposed with ice and extracted with benzene and ether, and the combined extracts washed with dilute sulphuric acid and water and dried. The residue on evaporation of the solvents was triturated with ether, and the solid collected (15 g. of recovered ketone). The ether was evaporated from the filtrate, and the residue boiled with potassium hydroxide (20 g.) in water (20 c.c.) and alcohol (40 c.c.) for 3 hours. On dilution, filtration, and acidification, a brown solid separated. This was collected, dried, and on crystallisation from glacial acetic acid afforded a yellow substance (15·6 g.). This was extracted thrice with boiling ethyl acetate, the residue being a yellow solid (5·3 g.), m. p. 230—234°. A pale brown substance crystallised from the ethyl acetate extracts and on recrystallisation afforded an *acid* in colourless needles (5·6 g.), m. p. 169—171° (Found: C, 71·2; H, 6·1. $C_{21}H_{22}O_5$ requires C, 71·2; H, 6·2%).

The acid was unsaturated to permanganate, but gave no turbidity on addition of bromine water to a solution in aqueous sodium carbonate. It is therefore probable that the substance is a βγ- rather than an αβ-unsaturated acid.

6 : 7-*Dimethoxy*-2-*anisyl*-1 : 2 : 3 : 4-*tetrahydro*-1-*naphthylacetic Acid*.—The unsaturated acid (5·6 g.) was dissolved in alcohol (50 c.c.) and shaken at 65° with hydrogen in the presence of a palladised strontium carbonate catalyst (2 g. of 2%) for 6 hours. On filtration and concentration, the saturated *acid* crystallised in colourless prisms (3·8 g.), m. p. 192—194° (Found: C, 70·7; H, 6·7. $C_{21}H_{24}O_5$ requires C, 70·8; H, 6·7%).

A small quantity (0·3 g.) of an acid, m. p. 180—183°, was isolated from the mother-liquors. This may be a stereoisomeride.

2-*Keto*-5 : 14 : 15-*trimethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene* (X).—Phosphoric oxide (10 g.) was added gradually with stirring to a boiling solution of the above acid (1·8 g.), m. p. 192°, in benzene (50 c.c.). The mixture was warmed on the steam-bath for 3 hours, decomposed with ice, and extracted with benzene and ether. A solution of the pale yellow oil, which was isolated in the usual manner, in ethyl acetate deposited a colourless, crystalline substance on dilution with light petroleum. The solid, recrystallised twice, afforded stout prisms, m. p. 166—168° (Found: C, 74·3; H, 6·5. $C_{21}H_{22}O_4$ requires C, 74·6; H, 6·5%). The *ketone* gave a semicarbazone which crystallised from chloroform–light petroleum in elongated, rectangular prisms, m. p. 220° (Found : N, 10·6. $C_{22}H_{25}O_4N_3$ requires N, 10·6%).

Attempted Clemmensen Reduction of 2-*Keto*-5 : 14 : 15-*trimethoxy*-1 : 2 : 9 : 10 : 11 : 18-*hexahydrochrysene*.—The ketone (1 g.) was reduced in the usual manner with zinc amalgam and hydrochloric acid. The product solidified and crystallised from benzene or benzene–light petroleum; m. p. 193° (Found : C, 76·8, 76·8; H, 6·4, 6·3. $C_{21}H_{24}O_3$ requires C, 77·8; H, 7·4%).

The substance is neutral, saturated, and not a ketone or alcohol. It is not phenolic and a determination of the molecular weight (324, cryoscopic in camphor) shows that the molecule has not condensed with itself ($C_{42}H_{42}O_7$ requires C, 76·6; H, 6·4%). Apparently the only assumption that can be reconciled with the analytical figures is that chlorination (about 15% of 1 Cl) and dehydrogenation have occurred, and in any case, the material cannot be homogeneous.

γ-(1-*Hydroxy*-6 : 7-*dimethoxy*-2-*anisyl*-1 : 2 : 3 : 4-*tetrahydro*-1-*naphthyl*)*acetoacetic Acid Lactone* (XII).—The yellow crystalline product of m. p. 230—234° (p. 580) was recrystallised from acetic acid and from chloroform–light petroleum. It had m. p. 237—238° and was soluble in alkali, forming a colourless solution, from which the yellow compound separated on acidification. It gave a red ferric reaction and a beautiful blue fluorescence in chloroform solution (Found : C, 69·1; H, 5·6; OMe, 23·1. $C_{23}H_{24}O_6$ requires C, 69·7; H, 6·1; OMe, 23·5%). A little halogen-containing material was found to be present, but could not be eliminated.

The p-*nitrophenylhydrazone* crystallised from acetic acid in red needles, m. p. 203—205° (Found : N, 7·8. $C_{29}H_{29}O_7N_3$ requires N, 7·9%).

A solution of the yellow compound (3 g.) in hot aqueous sodium hydroxide (20 c.c. of 10%) was cooled, and methyl sulphate (2·5 c.c.) added in small quantities with shaking; a pale yellow solid separated. The mixture was shaken with chloroform, the extract dried and concentrated, and light petroleum added. The pale yellow solid which separated was collected and crystallised several times in the same way. The *methyl* ether thus obtained formed colourless square platelets, m. p. 209—210° (Found : C, 71·0; H, 6·3; OMe, 29·7. $C_{24}H_{26}O_2$ requires C, 71·2; H, 6·3; OMe, 30·2%). The substance no longer gave a ferric reaction. Unchanged material (0·6 g.) was recovered from the original alkaline solution.

6 : 7-*Dimethoxy*-2-*anisyl*-1-*acetonylidene*-1 : 2 : 3 : 4-*tetrahydronaphthalene* (XIII).—The yellow compound (2 g.) was heated in an oil-bath at 250° for 1 hour. A rapid evolution of carbon dioxide occurred; when this ceased, the substance was distilled as a yellow oil (1·3 g.), b. p. 235—240°/0·3 mm., which solidified on cooling. It crystallised from alcohol in colourless, hexagonal plates possessing a faint greenish sheen, m. p. 214—215°, was highly unsaturated, and gave no ferric reaction (Found : C, 75·1; H, 6·7. $C_{22}H_{24}O_4$ requires C, 75·0; H, 6·8%).

The 2 : 4-*dinitrophenylhydrazone* crystallised from alcohol in red, elongated prisms, m. p. 228—230° (Found : N, 10·8. $C_{28}H_{28}O_7N_4$ requires N, 10·5%).

6 : 7-*Dimethoxy*-2-*anisyl*-1-*acetonyl*-1 : 2 : 3 : 4-*tetrahydronaphthalene*.—A solution of the unsaturated ketone (0·2 g.) in ethyl alcohol (50 c.c.) was shaken with hydrogen in presence of palladised strontium carbonate (2 g. of 2%) for 2 hours. On filtering and concentrating the solution an oil separated which solidified on keeping. It crystallised from methyl alcohol (norit) in colourless prisms (0·15 g.), m. p. 142—145° (Found : C, 74·6; H, 7·3. $C_{22}H_{26}O_4$ requires C, 74·6; H, 7·3%).

3 : 4 : 3′-*Trimethoxychalkone*.—A solution of *m*-methoxyacetophenone (30 g.), veratraldehyde (33·3 g.), and sodium hydroxide (30 c.c. of 10%) in alcohol (150 c.c.), on keeping for several days, deposited a greenish-yellow crystalline crust. This was recrystallised several times from aqueous alcohol, forming prisms (30 g.), m. p. 66—68° (Found : C, 72·8; H, 6·1. $C_{18}H_{18}O_4$ requires C, 72·5; H, 6·0%).

β-m-*Methoxybenzoyl*-α-3 : 4-*dimethoxyphenylpropionitrile*.—The chalkone (15 g.) in methyl alcohol (50 c.c.) was converted into the nitrile by means of sodium cyanide (7·1 g.) in the manner described above. The product crystallised from acetone and was washed with alcohol. It formed colourless prismatic needles, m. p. 98—99° (Found : C, 70·2; H, 5·9; N, 4·4. $C_{19}H_{19}O_4N$ requires C, 70·2; H, 5·9; N, 4·3%).

β-m-*Methoxybenzoyl*-α-3 : 4-*dimethoxyphenylpropionamide*.—The nitrile (12·5 g.) was hydrolysed to the *amide* by means of acetic acid (62·5 c.c.) and sulphuric acid (12·5 c.c.) under the usual conditions. The product crystallised from alcohol in needles, m. p. 177—178° (Found : C, 66·6; H, 6·2; N, 4·2. $C_{19}H_{21}O_5N$ requires C, 66·5; H, 6·1; N, 4·1%).

γ-m-*Methoxyphenyl*-α-3 : 4-*dimethoxyphenylbutyric Acid*.—The amide (9·8 g.) was hydrolysed to the keto-acid, and the latter reduced directly by means of toluene (40 c.c.), concentrated hydrochloric acid (50 c.c.), acetic acid (20 c.c. of 5%), and amalgamated zinc (25 g.). The product was an oil which could not be crystallised. It was esterified with methyl alcohol, sulphuric acid and toluene, as described above (p. 579). The *methyl* ester, b. p. 210—213°/0·8 mm., solidified on keeping and crystallised from light petroleum or dilute methyl alcohol in small, colourless needles, m. p. 64—65° (Found : C, 69·8; H, 6·9. $C_{20}H_{24}O_5$ requires C, 69·8; H, 7·0%).

On hydrolysis, the ester yielded an oil which solidified overnight and crystallised from light petroleum in prisms, m. p. 78° (Found : C, 69·1; H, 6·7. $C_{19}H_{22}O_5$ requires C, 69·1; H, 6·7%).

1-*Keto*-6 : 3′ : 4′-*trimethoxy*-2-*phenyl*-1 : 2 : 3 : 4-*tetrahydronaphthalene* (XI).—The acid was cyclised by means of phosphoryl chloride in the usual manner, yielding a red oil. This solidified on trituration with alcohol and was twice crystallised from ethyl acetate. It formed colourless, rectangular plates, m. p. 145—146° (Found : C, 73·1; H, 6·4. $C_{19}H_{20}O_4$ requires C, 73·1; H, 6·4%).

The authors thank the Council of the University of the Witwatersrand for a Post-graduate Scholarship awarded to one of them (L. G.).

DYSON PERRINS LABORATORY, OXFORD UNIVERSITY. [*Received, June* 17*th*, 1941.]