277. *Synthesis of Diaminoxanthones.*

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1 : 5-, 1 : 6-, 1 : 7-, 2 : 5-, 2 : 6-, 2 : 7-, 3 : 5-, and 3 : 6-Diaminoxanthone have been synthesised (for examination for activity against *M. tuberculosis*) by two routes : (i) cyclodehydration of *o*-phenoxybenzoic acids bearing a nitro- or acetamido-group in each nucleus, followed by reduction or deacetylation of the resulting dinitro- or bisacetamido-xanthone; and (ii) nitration of a nitroxanthone and reduction of the dinitroxanthone thus obtained.

The influence of electron-attracting and electron-repelling groups in the 3′-position on the direction of cyclisation of *o*-phenoxybenzoic acids has been investigated. 3′-Nitro-derivatives cyclise principally upon the 2′-position whereas with 3′-acetamido-derivatives ring closure takes place exclusively at the 6′-position.

Nitrating agents attack 1-, 2-, 3-, and 4-nitroxanthone at the same position, giving respectively 1 : 7-, 2 : 7-, 2 : 6- and 2 : 5-dinitroxanthone. Nitration of xanthone leads successively to 2-nitro-, 2 : 7-dinitro-, and 2 : 4 : 7-trinitroxanthone. It has been shown that " α-dinitroxanthone," described in the literature as " 1 : 8- " and " 2 : 4- "dinitroxanthone, is actually 2 : 4 : 7-trinitroxanthone.

During the search for functional derivatives and spatial analogues of 4-aminosalicylic acid active against *Mycobacterium tuberculosis* a number of amino- and diaminoxanthones has been prepared. 3-Amino- and 3 : 6-diamino-xanthone bear formal resemblance to 4-aminosalicylic acid and the antimycobacterial diphenyl ethers described by Barry (*Proc. Roy. Irish Acad.*, 1950, **53**, *B*, 55). It is of interest that various dialkylaminoalkyl derivatives of 1-aminoxanthone have of recent years attained chemotherapeutic value on account of their schistosomicidal properties (Mauss, *Chem. Ber.*, 1948, **81**, 19).

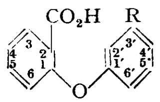
Of the ten theoretically possible heteronuclear diaminoxanthones only one—the 2 : 7-isomeride—is recorded in the literature. The present communication describes the synthesis of 1 : 5-, 1 : 6-, 1 : 7-, 2 : 5-, 2 : 6-, 2 : 7-, 3 : 5-, and 3 : 6-diaminoxanthone and new routes to 1- and 4-monoaminoxanthone.

Two general methods have been employed for the preparation of the diaminoxanthones, *viz.*; (i) cyclodehydration of *o*-phenoxybenzoic acids bearing a nitro- or acetamido-substituent in each nucleus, followed by reduction or deacetylation of the resulting dinitro- or bisacetamido-xanthone; and (ii) nitration of a nitroxanthone and reduction of the dinitroxanthone thus obtained. The orientations have been established either by unequivocal synthesis or by establishing an identity between the products obtained by the two different synthetic routes each of which fixes the position of one substituent.

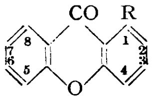
m-Nitrophenol condensed readily with the 3-, 4-, 5-, and 6-nitro-derivatives of *o*-chlorobenzoic acid, giving respectively 2-carboxy-6 : 3′-, -5 : 3′-, -4 : 3′-, and -3 : 3′-dinitrodiphenyl ether. These on reduction and acetylation yielded the bisacetamido-derivatives; the corresponding diamino-acids were too unstable for isolation in satisfactory yield. Both *o*- and *p*-nitrophenol, however, failed to condense with the nitro- and acetamido-derivatives of *o*-chlorobenzoic acid. This is apparently due to the weak anionoid properties of these phenols caused by lowering of electron availability on the phenolic oxygen atom by the *o*- or *p*-nitro-group. (Compare the reluctance of *o*- and *p*-nitroaniline, and the readiness of *m*-nitroaniline, to condense with *o*-chlorobenzoic acids : Bogert and Hirschfelder, *Coll. Trav. chim. Czeckoslov.*, 1930, **5—6**, 382; Albert and Linnell, *J.*, 1936, 1614; Goldberg and Kelly, *J.*, 1946, 102; Goldberg, *J.*, 1952, 4368.) *o*-*p*′-Nitrophenoxybenzoic acids may be easily obtained, however, by nitrating *o*-phenoxybenzoic acids (see below).

On the other hand, *o*- and *p*-acetamidophenol reacted smoothly with 2-chloro-5-nitrobenzoic acid to yield respectively 2′- and 4′-acetamido-2-carboxy-4-nitrodiphenyl ether which, on cyclisation and subsequent deacetylation, gave 5- and 7-amino-2-nitroxanthone; reduction of these yielded 2 : 5- and 2 : 7-diaminoxanthone. With 2-chloro-4-nitrobenzoic acid both *o*- and *p*-acetamidophenol at 120° in amyl alcohol effected reductive dehalogenation with production of *p*-nitrobenzoic acid in high yield (cf. the hydrogenolysis of the

2-chloro-group in 2-chloro-4-nitrobenzoic acid by *p*-phenylenediamine; Goldberg and Kelly, *loc. cit.*). 2-Chloro-3-nitrobenzoic acid condensed with *p*-hydroxyacetanilide to give 4′-acetamido-2-carboxy-6-nitrodiphenyl ether which by cyclisation, deacetylation, and reduction was converted into 2 : 5-diaminoxanthone. Reaction of 3-acetamido-2-chlorobenzoic acid with *o*- and *p*-acetamidophenol gave only 3-acetamidobenzoic acid.



(I)



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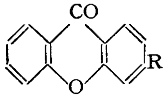
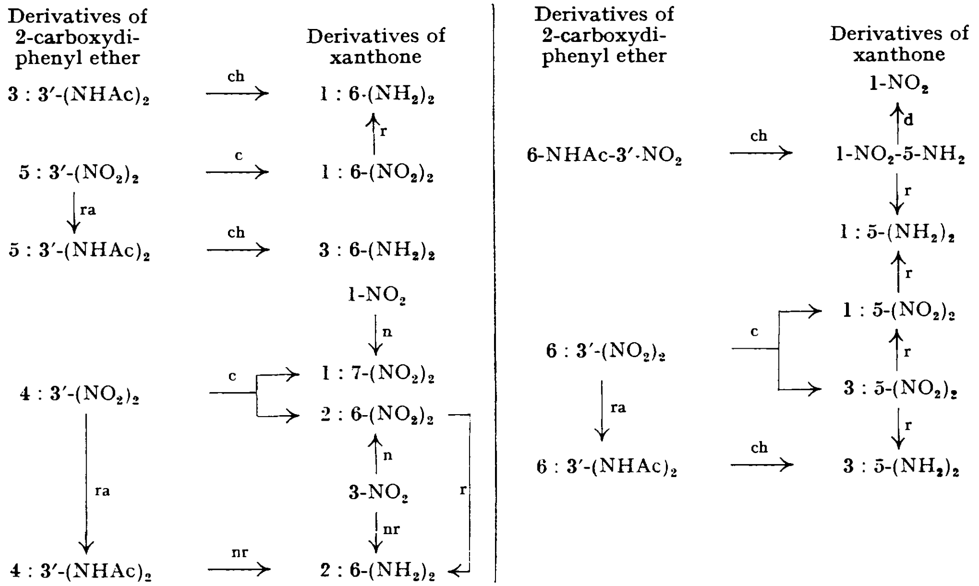


(III)

Cyclodehydration of Substituted o-*Phenoxybenzoic Acids.*—While 2′- and 4′-substituted *o*-phenoxybenzoic acids can undergo cyclodehydration with formation in each case of only one product, the 3′-substituted acids (I) may give 1- or 3-substituted xanthones according to whether ring closure proceeds upon the 2′- (II) (*ortho*-closure) or the 6′-position (III) (*para*-closure). There are no records of the influence of 3′-substituents in this reaction other than that by Dhar (*J.*, 1920, 1064) who obtained 1-nitroxanthone by cyclodehydration of *o*-*m*′-nitrophenoxybenzoic acid.

The present communication describes the cyclodehydration of a series of 3′-nitro- and 3′-acetamido-derivatives and in all cases *ortho*-closure predominates with the 3′-nitro-series, but with the 3′-acetamido-series *para*-closure takes place almost exclusively.



a = acetylation.
r = reduction.
c = cyclisation.
h = hydrolysis.
d = deamination.
n = nitration.

Thus 2-carboxy-4 : 3′-dinitrodiphenyl ether gave a product containing *ca.* 85% of 1 : 7- and *ca.* 15% of 2 : 6-dinitroxanthone. These were separable by their different solubilities in toluene and their structures established by their respective identities with the dinitroxanthones obtained by the nitration of 1- and 3-nitroxanthone (see scheme). Reduction with stannous chloride yielded 1 : 7- and 2 : 6-diaminoxanthone. Cyclodehydration of 4 : 3′-bisacetamido-2-carboxydiphenyl ether followed by hydrolysis yielded 2 : 6-diaminoxanthone as sole product.

Cyclisation of 2-carboxy-5 : 3′-dinitrodiphenyl ether gave a product which was apparently not completely homogeneous but from which only 1 : 6-dinitroxanthone could be isolated, the yield being of the order of 80%. This was reduced to 1 : 6-diaminoxanthone, the structure of which was proved by its identity with the diaminoxanthone obtained by cyclisation of 3 : 3′-bisacetamido-2-carboxydiphenyl ether followed by hydrolysis. Cyclisation of 5 : 3′-bisacetamido-2-carboxydiphenyl ether acid yielded one product only which, being different from the foregoing 1 : 6-diaminoxanthone, must be 3 : 6-diaminoxanthone. Both 2-carboxy-3 : 3′-dinitro- and 3-acetamido-2-carboxy-3′-nitro-diphenyl ether resisted cyclisation with sulphuric acid or phosphoryl chloride or by Gottesmann's method (*Ber.*, 1933, **66**, 1168) (compare the inability 3-acetamido-2-carboxy-3′-nitrodiphenylamine to cyclise; Goldberg and Kelly, *J.*, 1947, 596).

Treatment of 2-carboxy-6 : 3′-dinitrodiphenyl ether with sulphuric acid gave a product separable by crystallisation from pyridine into the less soluble 1 : 5-dinitroxanthone, m. p. 304°, and the more soluble 3 : 5-isomer, m. p. 234°, in the ratio of *ca.* 80 : 20; reduction of these yielded 1 : 5- and 3 : 5-diaminoxanthone, m. p. 266° and 270° respectively. Cyclisation of 6 : 3′-bisacetamido-2-carboxydiphenyl ether and deacetylation of the product gave 3 : 5-diaminoxanthone, m. p. 270°, in quantitative yield, identical with the compound obtained by reduction of the more soluble dinitroxanthone. Authentic 1 : 5-diaminoxanthone was obtained by condensation of 3-acetamido-2-chlorobenzoic acid with *m*-nitrophenol to give 6-acetamido-2-carboxy-3′-nitrodiphenyl ether which on cyclodehydration yielded a compound which must be 5-amino-1-nitroxanthone, and not the 3 : 5-isomer, since on deamination it was converted into 1-nitroxanthone. Reduction of this 5-amino-1-nitroxanthone yielded 1 : 5-diaminoxanthone.

Nitration of Mononitroxanthones.—The mononitroxanthones were obtained by condensation of the four nitro-derivatives of *o*-chlorobenzoic acid with phenol and cyclisation of the resulting nitrophenoxybenzoic acid with phosphoryl chloride; this constitutes a novel route to 1- and 4-nitroxanthones. Treatment of 1-, 2-, 3-, and 4-nitroxanthone in sulphuric acid with 1·1 mol. of nitric acid in all cases effected nitration in the same position with production respectively of 1 : 7-, 2 : 7-, 2 : 6-, and 2 : 5-dinitroxanthone. A more expeditious route to 2 : 6-dinitroxanthone was found to be nitration of 2-carboxy-5-nitrodiphenyl ether and cyclisation of the resulting 5 : 4′-dinitro-acid with sulphuric acid.

Nitration of Xanthone.—The literature on this subject is confusing. Graebe (*Annalen*, 1889, **254**, 285) treated xanthone with nitric acid at 100° and obtained the benzene-insoluble " β-dinitroxanthone," m. p. 260°, together with a small amount of a benzene-soluble compound, m. p. 190°, which he termed " α-dinitroxanthone " (cf. Perkin, *J.*, 1883, 193; Richter, *J. pr. Chem.*, 1883, **28**, 273). Bayer (*Annalen*, 1910, **372**, 80) nitrated xanthone in sulphuric acid, obtaining a 90% yield of β-dinitroxanthone which he proved to be the 2 : 7-isomeride. Dhar (*loc. cit.*) nitrated xanthone in cold sulphuric acid and recorded the production of the alcohol-insoluble 2 : 7-dinitroxanthone together with an alcohol-soluble mixture of 3-nitroxanthone and unchanged xanthone. Das Gupta (*J. Indian Chem. Soc.*, 1932, **9**, 393) converted " α-dinitroxanthone " into a nitroxanthonylarsinic acid for which he gave, without evidence, the structural formula of 1-nitroxanthone-8-arsinic acid (*Chem. Abs.*, 1933, **27**, 498, accordingly referred to the " α "-compound as 1 : 8-dinitroxanthone). Le Fèvre (*J.*, 1937, 200) nitrated xanthone with excess of cold fuming nitric acid and obtained a high yield of the " α "-compound, m. p. 180—187° (for which carbon and hydrogen, but no nitrogen, analyses were recorded), and from dipole moment measurements concluded that it was " impure 2 : 4-dinitroxanthone."

During the present work xanthone has been nitrated with an excess of cold fuming nitric acid for 4 days by Le Fèvre's method. The product consisted of *ca.* 50% of the benzene-insoluble 2 : 7-dinitroxanthone and *ca.* 50% of the benzene-soluble " α "-compound, m. p. 180—186°, raised to 204° by crystallisation with little loss in yield. Reduction of the nitration time increased the yield of the 2 : 7-dinitroxanthone and decreased that of the " α "-compound. No other compounds could be isolated from the reaction product. The m. p. of the " α "-compound was considerably depressed by authentic 2 : 4-dinitroxanthone (m. p. 204°); analysis showed it to be, in fact, a trinitroxanthone. The production of the same substance both by mononitration of 2 : 7-dinitroxanthone and by dinitration of 4-nitroxanthone established its identity as 2 : 4 : 7-trinitroxanthone. The " α "-compound obtained in small yield by nitrating xanthone in cold sulphuric acid by Perkin's or Bayer's method has also been shown to be 2 : 4 : 7-trinitroxanthone. It appears that this is the substance obtained by Dhar (*loc. cit.*) by nitration of 2-nitroxanthone and termed by him 2 : 3 : 7-trinitroxanthone.

Nitration of xanthone in sulphuric acid solution with the theoretical amount of fuming nitric acid yielded principally 2-nitroxanthone. Small amounts of 2 : 7-dinitroxanthone together with unchanged xanthone, but no 3-nitroxanthone, could be isolated from the reaction product (cf. Dhar, *loc. cit.*).

It is accordingly apparent that the nitration of a nitroxanthone leads invariably to a heteronuclear dinitroxanthone and that the 2- and the 7-position in the xanthone molecule are the positions predominantly activated towards attack by nitrating agents. The 4- and the 5-position are reactive but less so than the 2- and the 7-position, as shown by the fact that there is little nitration at the 4(or 5)-position unless the 2- and the 7-position are already occupied.

EXPERIMENTAL

General Procedure for the Condensation of o-*Chlorobenzoic acids with Phenols.*—The condensation between an *o*-halogenobenzoic acid and a phenol takes place less readily than that between the former and an arylamine (cf. Goldberg and Kelly, *J.*, 1946, 104; Goldberg, *J.*, 1952, 4368); for the higher temperature needed, nitrobenzene, hexyl alcohol, and anisole are suitable solvents since these, being volatile in steam, are easily removed from the reaction mixture. In some cases no solvent is necessary. The *o*-chlorobenzoic acid was normally dissolved in *ca.* 4 times its weight of nitrobenzene, and the catalyst and potassium carbonate (1·0—1·5 mol.) were added portionwise to the solution stirred at *ca.* 80° in order to obtain the salt in a voluminous state. After addition of the requisite phenol, stirring was continued at the stated temperature; water formed during the reaction was allowed to distil off. The mixture was diluted with water, the solvent removed in steam, and the residual aqueous solution filtered from tar. Acidification to pH 6 often precipitated more tar; after removal of this, the filtrate was adjusted to pH 2 and the carboxydiphenyl ether collected. The most economical method of purification was found to be dissolution in water and *ca.* 3 mols. of potassium carbonate, evaporation to small volume, collection of the salt, and its reconversion into the free acid. In some cases purification *via* the calcium salt was more effective.

Series from 2-chloro-4-nitrobenzoic acid.

2-Carboxy-5 : 3′-dinitrodiphenyl Ether.—2-Chloro-4-nitrobenzoic acid (40·2 g., 0·2 mol.) was stirred with nitrobenzene (250 c.c.), anhydrous potassium carbonate (42 g., 0·3 mol.), copper bronze (1 g.), cuprous iodide (1 g.), and *m*-nitrophenol (31 g., 0·22 mol.) at 155° (internal) for 6 hours. The crude *2-carboxy-5 : 3′-dinitrodiphenyl ether* (40 g.) had m. p. 176—180°; a sample crystallised from 60% alcohol in yellow needles, m. p. 188—190° (Found: *M*, 302; N, 9·4. $C_{13}H_8O_7N_2$ requires *M*, 304; N, 9·2%).

1 : 6-Dinitroxanthone.—A solution of the foregoing acid (50 g.) in concentrated sulphuric acid (300 c.c.) was heated on the water-bath for 1 hour and poured on powdered ice (3 kg.). Extraction of the precipitate with boiling 2½% sodium carbonate solution left a residue of crude *1 : 6-dinitroxanthone* (47 g., m. p. 242°) which crystallised from dilute pyridine in fawn-coloured leaves, m. p. 250—252° (Found: C, 54·6; H, 2·2; N, 10·0. $C_{13}H_6O_6N_2$ requires C, 54·5; H, 2·1; N, 9·8%).

1 : 6-Diaminoxanthone.—Crude 1 : 6-dinitroxanthone (30 g.) was added during ¾ hour to a solution of stannous chloride dihydrate (300 g.) in 10N-hydrochloric acid (300 c.c.) stirred at 100°. Stirring was continued at this temperature for a further 2¼ hours, the mixture kept in the refrigerator overnight, and the yellow magma drained at the pump on sintered glass. The solid was stirred for ½ hour with cold 5N-sodium hydroxide (1 l.), and the insoluble material collected, washed with cold water and dried; the yield of crude *1 : 6-diaminoxanthone* was 17 g. (m. p. 240—250°). A sample crystallised from dilute pyridine in glittering yellow tablets, m. p. 254—256° alone and in admixture with the material prepared by cyclisation and deacetylation of 3 : 3′-bisacetamido-2-carboxydiphenyl ether (Found: C, 68·6; H, 4·3; N, 12·6. $C_{13}H_{10}O_2N_2$ requires C, 69·0; H, 4·4; N, 12·4%).

5 : 3′-Bisacetamido-2-carboxydiphenyl Ether.—A solution of 2-carboxy-5 : 3′-dinitrodiphenyl ether (50 g.) in aqueous ammonia (500 c.c.; *d* 0·880) was saturated with hydrogen sulphide, kept overnight, then heated at 80° for 4 hours during which hydrogen sulphide was passed in. The mixture was boiled to remove ammonia, filtered from sulphur, and chilled, and sodium carbonate (50 g.) and then acetic anhydride (40 c.c.) were added dropwise with stirring at 20°; after a further 2 hours' stirring at this temperature, the solution was acidified with 5N-hydrochloric acid and the precipitate collected. Recrystallisation from dilute alcohol gave *5 : 3′-bisacetamido-2-carboxydiphenyl ether* (30 g.) in colourless nacreous plates, m. p. 274—276° (decomp.) (Found: *M*, 327; N, 8·7. $C_{17}H_{16}O_5N_2$ requires *M*, 328; N, 8·6%).

3 : 6-*Diaminoxanthone.*—The foregoing bisacetamido-acid (25 g.) was heated at 100° with concentrated sulphuric acid (150 c.c.) for 2 hours. The solution was cooled and, after the addition of water (40 c.c.), heated on the water-bath for ½ hour to effect deacetylation, and poured on crushed ice (1500 g.). The precipitate was extracted with dilute aqueous ammonia and crystallised from dilute pyridine; 3 : 6-*diaminoxanthone* (12 g.) was obtained in lemon-coloured needles, m. p. 324—326° (Found : C, 68·8; H, 4·6; N, 12·5. $C_{13}H_{10}O_2N_2$ requires C, 69·0; H, 4·4; N, 12·4%).

Series from 2-chloro-5-nitrobenzoic acid.

2-*Carboxy*-4 : 3′-*dinitrodiphenyl Ether.*—2-Chloro-5-nitrobenzoic acid (65 g., 0·32 mol.), *m*-nitrophenol (46 g., 0·33 mol.), anhydrous potassium carbonate (42 g., 0·32 mol.), copper bronze (0·5 g.), and nitrobenzene (200 c.c.) were stirred together at 160° for 4½ hours. The crude 4 : 3′-*dinitro-acid* (68 g.) had m. p. 200° and crystallised from 75% alcohol in prisms, m. p. 206° (Found : *M*, 306; N, 9·4. $C_{13}H_8O_7N_2$ requires *M*, 304; N, 9·2%).

1 : 7- *and* 2 : 6-*Dinitroxanthone.*—A solution of the foregoing acid (20 g.) in sulphuric acid (100 c.c.; *d* 1·84) was heated at 100° for 2 hours and poured on ice (500 g.). The precipitate was washed with dilute aqueous sodium carbonate and dried (yield, 17·5 g.; m. p. 235—250°). Extraction with boiling benzene (2 × 100 c.c.) left nearly pure 1 : 7-*dinitroxanthone* (12·5 g.), m. p. 260°, which on crystallisation from toluene gave the pure compound in pale yellow plates, m. p. 264° alone and admixed with material prepared by mononitration of 1-nitroxanthone (Found : C, 54·5; H, 2·0; N, 9·9. $C_{13}H_6O_6N_2$ requires C, 54·5; H, 2·1; N, 9·8%). By a tedious fractional crystallisation from toluene of the material extracted by the benzene there was obtained 0·6 g. of 2 : 6-dinitroxanthone, m. p. 268° (Found : N, 10·0%). This m. p. was strongly depressed by admixture with the foregoing 1 : 7-dinitroxanthone but not by 2 : 6-dinitroxanthone obtained by nitration of 3-nitroxanthone. The solubilities of 1 : 7- and 2 : 6-dinitroxanthone were too similar for easy separation of the latter; after reduction, however, the mixture of 1 : 7- and 2 : 6-diaminoxanthone was easily separable.

1 : 7- *and* 2 : 6-*Diaminoxanthone.*—The foregoing crude precipitate of 1 : 7- and 2 : 6-dinitroxanthones (14 g.) was added during ½ hour to a solution of hydrated stannous chloride (80 g.) in 10N-hydrochloric acid (80 c.c.) stirred at 100°. Stirring was continued at this temperature for a further 3 hours, and the slurry chilled and then drained at the pump; the filtrate was kept for the isolation of the 2 : 6-diaminoxanthone. The precipitate, after extraction with cold dilute sodium hydroxide, consisted of 1 : 7-*diaminoxanthone* (9·2 g.; m. p. 260°); crystallisation from acetone gave the pure compound in bright yellow needles, m. p. 276° alone and in admixture with a sample prepared by nitration of 1-nitroxanthone and reduction of the product (Found : C, 68·8; H, 4·9; N, 12·5. $C_{13}H_{10}O_2N_2$ requires C, 69·0; H, 4·4; N, 12·4%).

The above acid stannous chloride filtrate was added to 5N-sodium hydroxide, the yellow precipitate collected and redissolved in 5N-hydrochloric acid (50 c.c.), and the filtered solution basified with dilute aqueous ammonia. The precipitate of 2 : 6-*diaminoxanthone* (1·0 g.; m. p. 282—286°) crystallised from aqueous pyridine in yellow needles, m. p. 318° alone and admixed with material obtained by nitration of 3-nitroxanthone and reduction of the product (Found : C, 68·9; H, 4·7; N, 12·2%).

4 : 3′-*Bisacetamido-2-carboxydiphenyl Ether.*—A solution of 2-carboxy-4 : 3′-dinitrodiphenyl ether (10 g.) in aqueous ammonia (100 c.c.; *d* 0·880) was saturated with hydrogen sulphide and then refluxed for 1 hour. The precipitate of sulphur was removed, acetic anhydride (40 c.c.) added during 1 hour to the filtrate stirred at 40°, and the precipitate of 4 : 3′-*bisacetamido*-2-*carboxydiphenyl ether* (8·6 g.) collected. Recrystallisation from aqueous alcohol gave the pure compound (6 g.) in colourless needles, m. p. 260° (Found : *M*, 327; N, 8·8. $C_{17}H_{16}O_5N_2$ requires *M*, 328; N, 8·6%).

2 : 6-*Diaminoxanthone.*—Cyclodehydration of the foregoing 4 : 3′-bisacetamido-acid (20 g.) followed by deacetylation yielded crude 2 : 6-diaminoxanthone (12 g.; m. p. 296—300°) which separated from dilute pyridine in yellow needles, m. p. 318° (Found : N, 12·6%). This m. p. was not depressed by admixture with a sample prepared as above or by nitration of 3-nitroxanthone followed by reduction; admixture with 1 : 7-diaminoxanthone depressed the m. p. of the latter.

4′-*Acetamido-2-carboxy-4-nitrodiphenyl Ether.*—A mixture of 2-chloro-5-nitrobenzoic acid (20 g., 0·1 mol.), *p*-hydroxyacetanilide (15 g., 0·1 mol.), anhydrous potassium carbonate (14 g., 0·1 mol.), copper bronze (0·1 g.), cuprous iodide (0·1 g.), and amyl alcohol (150 c.c.) was stirred at the b. p. for 3 hours. The resulting *diphenyl ether* (25 g.; m. p. 244°) separated from acetic acid in golden prisms, m. p. 248° (Found : M, 313; N, 8·9. $C_{15}H_{12}O_6N_2$ requires M, 316; N, 8·9%).

2 : 7-*Diaminoxanthone*.—A solution of the foregoing crude acetamido-nitro-acid (5 g.) in concentrated sulphuric acid (40 c.c.) was heated at 100° for 2 hours; after cooling, water (10 c.c.) was added and the heating continued for a further 1 hour at 90°. The solution was poured on ice, and the precipitate stirred with a solution of hydrated stannous chloride (30 g.) in 10N-hydrochloric acid (30 c.c.) for 3 hours at 100°. Isolation in the usual way gave 2 : 7-diaminoxanthone (3 g.) which crystallised from dilute pyridine in long yellow prisms, m. p. 272° alone and in admixture with a sample prepared by direct nitration of xanthone and reduction of the product (Found : N, 12·5%).

2′-*Acetamido-2-carboxy-4-nitrodiphenyl Ether*.—Condensation of 2-chloro-5-nitrobenzoic acid (20 g.) with *o*-hydroxyacetanilide (16 g.), by the method used for the *p*-isomer, yielded the *diphenyl ether* (6 g.) as pale yellow plates, m. p. 254° (from aqueous alcohol) (Found : M, 316; N, 9·1%).

2 : 5-*Diaminoxanthone*.—Cyclisation of the foregoing acid (5 g.) followed by deacetylation and reduction of the product yielded 2 : 5-*diaminoxanthone* (2·5 g.) which crystallised from alcohol in yellow needles, m. p. 258—260° (Found : C, 69·2; H, 4·6; N, 12·4%).

Series from 2-chloro-3-nitrobenzoic acid.

2 : 5-*Diaminoxanthone*.—A finely ground mixture of 2-chloro-3-nitrobenzoic acid (10 g.), *p*-hydroxyacetanilide (8 g.), anhydrous potassium carbonate (7 g.), copper bronze (0·1 g.), and cuprous iodide (0·1 g.) was heated at 170—175° (oil-bath) for 1 hour. The dark solid mass was extracted with boiling water (100 c.c.), and the filtered solution acidified with hydrochloric acid. The precipitated 4′-acetamido-2-carboxy-6-nitrodiphenyl ether was heated in concentrated sulphuric acid (40 c.c.) at 100° for 1 hour; after cooling and addition of water (10 c.c.) the solution was heated on the water-bath for a further 1 hour and poured on ice (200 g.). The precipitate was heated for 4 hours at 100° with hydrated stannous chloride (30 g.) and 10N-hydrochloric acid (30 c.c.), then poured into 5N-sodium hydroxide. The precipitate of 2 : 5-diaminoxanthone (4·6 g.) crystallised from alcohol in yellow needles, m. p. 254° alone and admixed with that obtained from the 2′-acetamido-4-nitro-acid (Found : N, 12·5%).

2-*Carboxy*-6 : 3′-*dinitrodiphenyl Ether*.—2-Chloro-3-nitrobenzoic acid (20 g., 0·1 mol.), *m*-nitrophenol (14 g., 0·1 mol.), anhydrous potassium carbonate (14 g., 0·1 mol.), and copper bronze (0·5 g.) were stirred with nitrobenzene (120 c.c.) for 4 hours at 160—165° (internal). Treatment in the usual manner gave the crude *diphenyl ether* (20 g.) as pale yellow prisms, m. p. 180—182°, from aqueous alcohol (Found : M, 304; N, 9·4. $C_{13}H_8O_7N_2$ requires M, 304; N, 9·2%).

1 : 5- *and* 3 : 5-*Dinitroxanthone*.—Cyclodehydration of the foregoing crude acid (20 g.) at 100° with concentrated sulphuric acid (160 c.c.) for 2 hours yielded a mixture of 1 : 5- and 3 : 5-dinitroxanthones (16 g.; m. p. 255—275°). This was dissolved in boiling pyridine (150 c.c.); the chilled solution deposited pure 1 : 5-*dinitroxanthone* (8·4 g.), m. p. 304° not raised by further crystallisation (Found : C, 55·0; H, 2·3; N, 10·0. $C_{13}H_6O_6N_2$ requires C, 54·5; H, 2·1; N, 9·8%).

The pyridine filtrate was heated to the b. p., an equal volume of boiling water added, and the solution cooled. The precipitate, on recrystallisation twice from 50% pyridine, gave 3 : 5-*dinitroxanthone* (2·8 g.) in plates, m. p. 234° (Found : C, 54·7; H, 2·3; N, 10·1%).

1 : 5- *and* 3 : 5-*Diaminoxanthone*.—Heating the foregoing 1 : 5-dinitroxanthone (7 g.) with stannous chloride (50 g.) and 10N-hydrochloric acid (50 c.c.) for 3 hours at 100° gave 1 : 5-*diaminoxanthone* (4·2 g.), yellow needles (from aqueous pyridine), m. p. 266° (Found : C, 69·5; H, 4·5; N, 12·5%).

Reduction of the 3 : 5-dinitroxanthone (3 g.) in like manner yielded 3 : 5-*diaminoxanthone* (1·5 g.) which separated from aqueous pyridine in yellow needles, m. p. 268—270°, strongly depressed by admixture of the foregoing 1 : 5-isomeride (Found : C, 68·8; H, 4·3; N, 12·5%).

6 : 3′-*Bisacetamido-2-carboxydiphenyl Ether*.—A solution of 2-carboxy-6 : 3′-dinitrodiphenyl ether (18 g.) in water (100 c.c.) and aqueous ammonia (300 c.c.; *d* 0·880) was saturated with hydrogen sulphide and then refluxed for 3 hours. The solution was cooled, the sulphur removed, and the solution adjusted to pH 4·5 with acetic acid. Acetic anhydride (70 c.c.) was added dropwise to the stirred solution which was then cautiously warmed until spontaneous reaction had ceased. After being heated on the water-bath for a further ½ hour the mixture was kept overnight on ice and the precipitate of *bisacetamido-ether* (18 g.; m. p. 240—242°) collected (Found : M, 326; N, 8·6. $C_{17}H_{16}O_5N_2$ requires M, 328; N, 8·6%).

3 : 5-*Diaminoxanthone*.—Cyclodehydration and deacetylation of the foregoing bisacetamido-acid (15 g.) gave 3 : 5-diaminoxanthone (9·0 g.) which crystallised from 30% aqueous pyridine in fine yellow needles, m. p. 268—270° alone and in admixture with a sample obtained by reduction of 3 : 5-dinitroxanthone (Found : C, 69·3; H, 4·2; N, 12·6%). The m. p. was strongly depressed by admixture with 1 : 5-diaminoxanthone.

6-*Acetamido*-2-*carboxy*-3′-*nitrodiphenyl Ether*.—3-Acetamido-2-chlorobenzoic acid (36 g., 0·16 mol.), *m*-nitrophenol (25 g., 0·18 mol.), potassium carbonate (22 g., 0·16 mol.), copper bronze (0·25 g.), and cuprous iodide (0·25 g.) were stirred with nitrobenzene (200 c.c.) for 5 hours at 155° (internal). The crude product was dissolved in excess of 2·5N-sodium carbonate (100 c.c.), the solution stirred at 50°, and acetic anhydride (25 c.c.) added dropwise during ½ hour. Adjustment to pH 4 with dilute hydrochloric acid effected precipitation of 6-*acetamido*-2-*carboxy*-3′-*nitrodiphenyl ether* (10 g.; m. p. 224°). A sample crystallised from alcohol in colourless needles, m. p. 227° (Found : *M*, 314; N, 9·0. $C_{15}H_{12}O_6N_2$ requires *M*, 316; N, 8·9%).

5-*Amino*-1-*nitroxanthone* : 1 : 5-*Diaminoxanthone*.—The foregoing acid (8 g.) was heated with sulphuric acid (40 c.c.) at 100° for ½ hour, the solution diluted with water (20 c.c.), and heating continued for a further ½ hour at the same temperature. 5-*Amino*-1-*nitroxanthone* (1·5 g.) was obtained which separated from pyridine in short red needles, m. p. 236° (Found : N, 11·0. $C_{13}H_8O_4N_2$ requires N, 11·0%). Reduction of this (1·0 g.) with stannous chloride (4 g.) and 10N-hydrochloric acid (4 c.c.) for 3 hours yielded 1 : 5-diaminoxanthone which separated from pyridine in yellow needles, m. p. 264—266° alone and in admixture with a sample prepared as above (Found : N, 12·5%).

Deamination of 5-*Amino*-1-*nitroxanthone* : 1-*Nitroxanthone*.—A solution of sodium nitrite (0·28 g.) in concentrated sulphuric acid (2 c.c.) was added dropwise to a solution of 5-amino-1-nitroxanthone (1 g.) in glacial acetic acid (5 c.c.) and sulphuric acid (8 c.c.) stirred at 5°. The solution, after a further 2 hours' stirring, was added dropwise to a stirred suspension of cuprous oxide (1·0 g.; obtained by alkaline reduction of copper sulphate with glucose) in methanol (10 c.c.) at 0°. The mixture was stirred for a further 2 hours at room temperature and poured into water (50 c.c.). Collection of the precipitate, extraction with N-hydrochloric acid (100 c.c.), and crystallisation of the residue three times from toluene gave 1-nitroxanthone (0·2 g.) in pale yellow needles, m. p. 200° alone and in admixture with the compound prepared by cyclisation of 2-carboxy-3-nitrodiphenyl ether (Found : N, 5·9. Calc. for $C_{13}H_7O_4N$: N, 5·8%).

Series from 2-*chloro*-6-*nitro*- *or* 6-*acetamido*-2-*chloro*-*benzoic acid.*

2-*Carboxy*-3 : 3′-*dinitrodiphenyl Ether*.—2-Chloro-6-nitrobenzoic acid (10 g., 0·05 mol.), *m*-nitrophenol (10 g., 0·07 mol.), potassium carbonate (7 g., 0·05 mol.), copper bronze (0·1 g.), and cuprous iodide (0·1 g.) were intimately mixed and heated at 170—175° (oil-bath) for 1 hour. The solidified melt was extracted with boiling water (100 c.c.) and the aqueous extract adjusted to pH 3. The precipitated *dinitro-acid* (10 g.) crystallised from aqueous alcohol in colourless plates, m. p. 178—180° (Found : *M*, 304; N, 9·4. $C_{13}H_8O_7N_2$ requires *M*, 304; N, 9·2%). Attempts to cyclise this acid with sulphuric acid, acetic anhydride containing sulphuric acid, phosphoryl chloride, and sulphuric–phosphoric acid failed.

3-*Acetamido*-2-*carboxy*-3′-*nitrodiphenyl Ether*.—A finely ground mixture of 6-acetamido-2-chlorobenzoic acid (11 g., 0·05 mol.), *m*-nitrophenol (8 g., 0·06 mol.), anhydrous potassium carbonate (7·0 g., 0·05 mol.), copper bronze (0·1 g.), and cuprous iodide (0·1 g.) was heated at 170—175° (oil-bath) for 2 hours. Extraction with boiling water (200 c.c.) and acidification of the extract yielded 3-*acetamido*-2-*carboxy*-3′-*nitrodiphenyl ether* (13 g.) which crystallised from alcohol in golden tablets, m. p. 170—172° (Found : *M*, 315; N, 9·1. $C_{15}H_{12}O_6N_2$ requires *M*, 316; N, 8·8%). This could not be cyclodehydrated with sulphuric acid or acetic anhydride–sulphuric acid.

3 : 3′-*Bisacetamido*-2-*carboxydiphenyl Ether*.—Reduction and acetylation of 2-carboxy-3 : 3′-dinitrodiphenyl ether (10 g.) as for the 6 : 3′-isomer yielded 3 : 3′-*bisacetamido*-2-*carboxydiphenyl ether* (8 g.), m. p. 164° (Found : *M*, 326; N, 8·6. $C_{17}H_{16}O_5N_2$ requires *M*, 328; N, 8·6%).

1 : 6-*Diaminoxanthone*.—Cyclisation of the foregoing acid (4 g.) with sulphuric acid (25 c.c.) followed by deacetylation yielded 1 : 6-diaminoxanthone (1·0 g.) in slender yellow needles, m. p. 254° (Found : N, 12·5%).

Nitroxanthones.

2-*Carboxynitrodiphenyl Ethers*.—These were prepared by stirring the requisite nitro-derivative of *o*-chlorobenzoic acid (80 g.), phenol (100 g.), potassium carbonate (56 g.), nitrobenzene (100 c.c.), copper bronze (0·5 g.), and copper iodide (0·5 g.) at 155° for the time given in parentheses after the yield. Thus were obtained: 2-Carboxy-4-nitrodiphenyl ether (70 g.; 4 hours), colourless needles, m. p. 172° (from toluene) (Found: *M*, 256; N, 5·6. Calc. for $C_{13}H_9O_5N$: *M*, 259; N, 5·4%) (cf. Purgotti, *Gazzetta*, 1914, **44**, 641). 5-Nitro-acid (72 g.; 7 hours) leaves, m. p. 158° (from aqueous alcohol) (Found: *M*, 258; N, 5·8%) (cf. Ullmann and Wagner, *Annalen*, 1907, **355**, 363). 6-*Nitro-acid* (50 g.; 4 hours), prisms, m. p. 152° (from toluene, (Found: *M*, 259; N, 5·7%).

The following amino-2-carboxydiphenyl ethers were obtained by passing hydrogen sulphide into a solution of the corresponding nitro-acid (20 g.) in aqueous ammonia (*d* 0·880; 100 c.c.) for 2 hours at 20° and then refluxing the solution for 1 hour. After removal of the sulphur the pH of the filtrate was adjusted to pH 4·0 in order to precipitate the amino-acid. The yields were 55—65%.

4-*Amino-*, colourless glistening plates (from water), m. p. 164° (Found: *M*, 225; N, 6·4. $C_{13}H_{11}O_3N$ requires *M*, 229; N, 6·1%). 5-*Amino-*, tablets (from aqueous methanol), m. p. 152° (Found: *M*, 231; N, 6·3%). 6-*Amino-*, golden plates (from aqueous alcohol), m. p. 176° (Found: *M*, 227; N, 6·2%). 3'-*Amino-*, golden plates (from aqueous alcohol), m. p. 150° (Found: *M*, 228; N, 6·2%).

1-*Nitroxanthone*.—2-Carboxy-3-nitrodiphenyl ether (20 g.; Goldberg and Walker, unpublished) was refluxed with phosphoryl chloride (200 c.c.) for 1 hour. Excess of solvent was pumped off, the residual oil poured on ice (250 g.), and the precipitate extracted with dilute sodium carbonate solution. Recrystallisation from aqueous alcohol gave 1-nitroxanthone (10 g.) in colourless plates, m. p. 202° (Found: N, 6·0%). The compound is more accessible by the following route.

o-Chlorobenzoic acid (64 g.), *m*-nitrophenol (56 g.), potassium carbonate (56 g.), and copper bronze were heated together at 160° (bath-temp.) for 4 hours. Isolation *via* the potassium salt yielded *o*-*m'*-nitrophenoxybenzoic acid (55 g.) which crystallised from 80% alcohol in rhombs, m. p. 138° (Found: *M*, 256; N, 5·5. Calc. for $C_{13}H_9O_5N$: *M*, 259; N, 5·4%) (cf. Dhar, *loc. cit.*). Cyclodehydration of the crude acid (30 g.) with sulphuric acid (150 c.c.) at 100° for 2 hours gave crude 1-nitroxanthone (27 g.) containing *ca.* 10% of the 3-isomeride. Crystallisation from 90% pyridine yielded pure 1-nitroxanthone (22 g.) in pale yellow needles, m. p. 202° alone and in admixture with a sample prepared from 2-carboxy-3-nitrodiphenyl ether (Found: C, 64·4; H, 2·9; N, 6·0%). The pyridine filtrate from the crystallisation was diluted with water and the precipitate crystallised several times from benzene and then aqueous alcohol; 3-nitroxanthone (1·4 g.) was obtained in pale yellow plates, m. p. 170—172° alone and admixed with material obtained by cyclisation of 2-carboxy-5-nitrodiphenyl ether (Found: N, 5·9%).

The following nitroxanthones were prepared by refluxing the crude 2-carboxynitrodiphenyl ether (50 g.) with phosphoryl chloride (400 c.c.) for the time stated after the yield and isolation by the method described for 1-nitroxanthone.

2-Nitroxanthone (41 g.; 8 hours), plates, m. p. 204° (from benzene) (Found: N, 5·9%) (cf. Purgotti and Dhar, *locc. cit.*). 3-Nitroxanthone (40 g.; 7 hours); fawn-coloured needles, m. p. 174° (from aqueous pyridine) (Found: N, 5·8%) (cf. Ullmann and Wagner, *loc. cit.*). 4-Nitroxanthone (38 g.; 4 hours), pale yellow needles, m. p. 190° (from toluene) (Found: N, 6·0, 6·0%) (cf. Dhar, *loc. cit.*, who records m. p. 127°).

4-Nitroxanthone was obtained in the same yield by refluxing 2-carboxy-6-nitrodiphenyl ether (20 g.) in acetic anhydride (100 c.c.) and sulphuric acid (4 c.c.) for 1 hour and pouring the mixture on ice. 2-Carboxy-4-nitrodiphenyl ether by the same method, with a reflux time of 4 hours, gave 2-nitroxanthone in 80% yield. Cyclisation of 2-carboxymononitrodiphenyl ethers, in which the nitro-group is in the carboxylated nucleus, with sulphuric acid at 100° leads to considerable loss of yield by sulphonation. By dissolving 3-carboxy-2-nitrodiphenyl ether (5 g.) in cold sulphuric acid (25 c.c.) and keeping the mixture at room temperature overnight there were obtained 2·4 g. of 2-nitroxanthone.

Aminoxanthones.—The following aminoxanthones were obtained by adding the nitroxanthone (20 g.) during ½ hour to a solution of hydrated stannous chloride (120 g.) in 10N-hydrochloric acid (120 c.c.) stirred at 95—100°. Stirring was continued for 3 hours at this temperature, the mixture kept overnight at 0°, and the magma drained at the pump. The solid was stirred for ½ hour with cold 5N-sodium hydroxide (750 c.c.), and the aminoxanthone collected, washed, and crystallised. The yields in all cases were *ca.* 80%.

1-*Aminoxanthone*, yellow plates (from alcohol), m. p. 148° (Found: C, 73·6; H, 4·3; N, 6·8. Calc. for $C_{13}H_9O_2N$: C, 73·8; H, 4·3; N, 6·6%). 2-Aminoxanthone, yellow needles (from alcohol), m. p. 212° (Found: C, 74·2; H, 4·3; N, 6·8%) (cf. Purgotti, *loc. cit.*; F.P. 821,275). 3-Aminoxanthone, golden prisms (from alcohol), m. p. 230° (Found: N, 6·8%) (cf. Ullmann and

Wagner, *loc. cit.*). 4-Aminoxanthone, pale yellow needles (from toluene), m. p. 202° (Found : C, 73·9; H, 4·3; N, 6·8%) (cf. F.P. 821,275 and 839,698).

Nitration of 4-*Nitroxanthone* : 2 : 5-*Dinitro- and* 2 : 5-*Diamino-xanthone*.—A solution of nitric acid (9 c.c.; *d* 1·5; 1·1 mol.) in sulphuric acid (30 c.c.; *d* 1·84) was added dropwise to a stirred solution of 4-nitroxanthone (45 g.) in sulphuric acid (200 c.c.) initially at room temperature, that at the end of the addition (30 minutes) being 40°. The solution was heated at 65—70° for a further 1½ hours, then poured on ice, and the precipitate (46 g.; m. p. 200—206°) collected and washed with dilute sodium carbonate and water. Recrystallisation from pyridine gave 2 : 5-*dinitroxanthone* in colourless needles, m. p. 218° (Found : N, 9·9%).

This compound (5 g.) on reduction with hydrated stannous chloride (50 g.) and 10N-hydrochloric acid (50 c.c.) yielded 2 : 5-diaminoxanthone (3 g.) which separated from aqueous pyridine in elongated yellow needles, m. p. 258—260° alone and mixed with the previous sample (Found : N, 12·6%).

Nitration of 3-*Nitroxanthone* : 2 : 6-*Dinitro- and* 2 : 6-*Diamino-xanthone*.—To 3-nitroxanthone (24·1 g., 0·1 mol.), dissolved in sulphuric acid (100 c.c.; *d* 1·84) stirred at 10°, nitric acid (4·83 c.c.; *d* 1·5; 0·115 mol.) in sulphuric acid (25 c.c.) was added during ½ hour. The solution was kept at room temperature for a further 2 hours, then heated to 80° during ½ hour, stirred at this temperature for ½ hour, and poured on ice (600 g.). The precipitate was extracted with boiling 2% aqueous sodium carbonate and washed with water (yield, 24 g.; m. p. 230—240°). Crystallisation from aqueous pyridine yielded 2 : 6-dinitroxanthone, m. p. 268°, alone or mixed with the previous sample (Found : C, 54·6; H, 2·0; N, 10·1%).

Reduction gave 2 : 6-diaminoxanthone (15 g.), lemon-coloured needles (from dilute pyridine), m. p. and mixed m. p. 320° (Found : C, 68·8; H, 4·6; N, 12·3%).

2-*Carboxy*-5 : 4′-*dinitrodiphenyl Ether* : 2 : 6-*Dinitroxanthone*.—To nitric acid (280 c.c. of *d* 1·42 plus 120 c.c. of *d* 1·50), stirred at 10°, 2-carboxy-5-nitrodiphenyl ether (40 g.) was added during ½ hour, stirring was continued for 5 hours at 15°, and the solution poured on ice (600 g.). The precipitate was washed, boiled with water (1500 c.c.) and calcium carbonate (15 g.) for ½ hour, filtered, evaporated to small volume, and chilled. The crystalline precipitate of the calcium salt was collected (filtrate, 110 c.c.) and stirred on the water-bath for ½ hour with water (250 c.c.) and 10N-hydrochloric acid (50 c.c.) and the 2-*carboxy*-5 : 4′-*dinitrodiphenyl ether* (36 g.; m. p. 148°) collected. This crystallised from toluene in cubes, m. p. 152° (Found : *M*, 304; N, 9·3. $C_{13}H_8O_7N_2$ requires *M*, 304; N, 9·2%). A solution of the crude acid (35 g.) in concentrated sulphuric acid (210 c.c.) was heated on the water-bath for 4 hours, then poured on ice (1 kg.), the precipitate extracted with aqueous sodium carbonate, and the 2 : 6-dinitroxanthone (25 g.) collected. A sample separated from dilute pyridine in almost colourless needles, m. p. and mixed m. p. 274° (Found : C, 54·0; H, 2·0; N, 9·9%).

The most rapid route to 2 : 6-dinitroxanthone was the following. 2-Carboxy-5-nitrodiphenyl ether (25·9 g., 0·1 mol.) was dissolved in concentrated sulphuric acid (100 c.c.), stirred at 10—15°; a mixture of nitric acid (4·83 c.c.; *d* 1·5; 0·115 mol.) and sulphuric acid (25 c.c.) was added during ½ hour, the temperature being kept at 10°. Stirring was continued at room temperature for 3 hours, then at 95° for a further 2 hours, the solution poured on ice (400 g.), and the precipitate filtered off. After extraction with dilute potassium carbonate the insoluble crude 2 : 6-dinitroxanthone (23 g.) was collected. Recrystallisation from dilute pyridine gave the pure compound, m. p. and mixed m. p. 274° (Found : N, 10·0%).

Nitration of 1-*Nitroxanthone* : 1 : 7-*Dinitroxanthone*.—Nitration of 1-nitroxanthone (9 g.) as described for the 4-isomer yielded crude 1 : 7-dinitroxanthone (9·8 g.), m. p. 210—220°. This was extracted with a boiling mixture of alcohol (100 c.c.) and pyridine (40 c.c.); the insoluble residue of 1 : 7-dinitroxanthone (6 g.) on crystallisation from xylene was obtained in yellow plates, m. p. and mixed m. p. 264—266° (Found : C, 54·6; H, 2·0; N, 10·1%).

Reduction of this (10 g.) with stannous chloride (70 g.) and 10N-hydrochloric acid (70 c.c.) gave 1 : 7-diaminoxanthone (6·5 g.), yellow needles (from acetone), m. p. 276° (Found : N, 12·5%).

Mononitration of Xanthone : 2-*Nitroxanthone*.—Xanthone (19·6 g., 0·1 mol.) was dissolved in sulphuric acid (150 c.c.; *d* 1·84) at 0°. Nitric acid (4·5 c.c.; *d* 1·5; 0·1 mol.) in sulphuric acid (25 c.c.) was added dropwise during ½ hour to the solution stirred at 5°. After a further 2 hours at room temperature the solution was poured on ice (1000 g.), and the precipitate extracted with dilute aqueous sodium carbonate. Extraction with boiling 60% alcohol (150 c.c.) and crystallisation of the insoluble residue from dilute pyridine gave 2-nitroxanthone (15 g.), m. p. and mixed m. p. 204° (Found : N, 5·9%).

Dinitration of Xanthone : 2 : 7-*Dinitroxanthone* (cf. Graebe, and Perkin, *locc. cit.*).—Xanthone

(30 g.) was added portionwise during ½ hour to nitric acid (90 c.c.; *d* 1·5) stirred at 70°. The solution was stirred for a further ½ hour at this temperature, then for 1 hour at 95°, and poured on ice (2 kg.). The colourless solid was washed with boiling water, dried, and extracted for ½ hour with boiling benzene (250 c.c.). The insoluble residue of 2 : 7-dinitroxanthone became crystalline when boiled with methanol (200 c.c.) and pyridine (20 c.c.) (yield, 27 g.; m. p. 262—264°) (Found : C, 54·0; H, 2·0; N, 10·0%).

The benzene extracts from two such nitrations were evaporated and the first fraction (3·5 g.) was removed. The filtrate on evaporation to 150 c.c. and cooling deposited 16 g. of colourless crystals, m. p. 170—182°. Crystallisation from benzene–alcohol–ligroin yielded 2 : 4 : 7-trinitroxanthone (4 g.), m. p. 202—204° (Found : N, 12·7. Calc. for $C_{13}H_5O_8N_3$: N, 12·7%) and a mixture of di- and tri-nitroxanthones (9 g.), m. p. 165—175°.

2 : 7-*Diaminoxanthone*.—Reduction of 2 : 7-dinitroxanthone (50 g.) as described for the 2 : 6-isomeride gave 2 : 7-diaminoxanthone (33 g.; m. p. 272°). Crystallisation from dilute pyridine gave amber-yellow needles, m. p. and mixed m. p. 276° (Found : C, 68·6; H, 4·8; N, 12·6%).

Trinitration of Xanthone : 2 : 4 : 7-*Trinitroxanthone* ("*α-Dinitroxanthone*") (cf. Le Fèvre, *loc. cit.*).—Xanthone (11 g.) was added portionwise during ½ hour to nitric acid (110 c.c.; *d* 1·5), stirred at −5° to 0°, and the solution kept at room temperature for 96 hours and poured into ice-water (500 g.). The colourless precipitate (13·5 g.) was washed, dried, boiled with benzene (400 c.c.), and filtered off at the b. p.; the insoluble residue (6·0 g.) was pure 2 : 7-dinitroxanthone, m. p. 260—262° alone and mixed with that obtained by Graebe's method (*loc. cit.*) (Found : N, 10·0%). The benzene extract on chilling deposited a first crop (3·0 g.), m. p. 202—206° (Found : N, 12·5%); further concentration gave a crop (6·5 g.), m. p. 200° (Found : N, 12·6%). The second crop was shown to be homogeneous by dissolution in benzene and separation into two fractions : 1·8 g., m. p. 198—200° (Found : N, 12·5%), and 4·0 g., m. p. 200—204° (Found : N, 12·5%). Thus, 11 g. of xanthone gave 6·0 g. of 2 : 7-dinitroxanthone and 9·5 g. of 2 : 4 : 7-*trinitroxanthone*. Recrystallisation of the latter from benzene gave leaves, m. p. 202—204°, depressed on admixture with 2 : 4-dinitroxanthone (Ullmann, *Annalen*, 1909, **366**, 86) obtained by cyclisation of 2-carboxy-4 : 6-dinitrodiphenyl ether (Found : C, 47·3; H, 1·6; N, 12·7. $C_{13}H_5O_8N_3$ requires C, 47·2; H, 1·5; N, 12·7%). The m. p. was not depressed by admixture of the trinitroxanthone obtained by mononitration of 2 : 7-dinitroxanthone or dinitration of 4-nitroxanthone.

Nitration of xanthone (11 g.) as above but for 48 hours gave 2 : 7-dinitroxanthone (6·8 g.), m. p. 264°, a mixture (2·0 g.), m. p. 206—224°, and 2 : 4 : 7-trinitroxanthone (4·5 g.), m. p. 202—204° (Found : N, 12·6%). Nitration for 8 hours then gave 2 : 7-dinitroxanthone (10·5 g.), m. p. 264°, a mixture (1 g.), and 2 : 4 : 7-trinitroxanthone (1·8 g.), m. p. 202° (Found : N, 12·6%).

Mononitration of 2 : 7-*Dinitroxanthone*.—2 : 7-Dinitroxanthone (6 g.) in nitric acid (25 c.c.; *d* 1·5) was heated on the water-bath for 2 hours and poured on ice. The precipitate was dried and boiled with benzene (150 c.c.), and the insoluble residue removed. The filtrate was chilled and the precipitate recrystallised from benzene (150 c.c.); 2 : 4 : 7-trinitroxanthone (3·8 g.) was obtained in colourless leaves, m. p. and mixed m. p. 202—204° (Found : N, 12·6%).

Dinitration of 4-*Nitroxanthone*.—4-Nitroxanthone (6·0 g.) and nitric acid (18 c.c.; *d* 1·5) at 70° (1 hour) and 100° (1 hour) gave a product which was extracted with boiling benzene; the insoluble residue (3 g.) on crystallisation from aqueous pyridine gave 2 : 5-dinitroxanthone (1·6 g.), needles, m. p. 216° (Found : N, 10·0%). The benzene extract on evaporation and chilling yielded material which on recrystallisation from the same solvent gave 2 : 4 : 7-trinitroxanthone (1·0 g.), m. p. 202—204° (Found : N, 12·8%).

2 : 4 : 7-*Triaminoxanthone*.—2 : 4 : 7-Trinitroxanthone (5 g.), stannous chloride dihydrate (60 g.), and 10N-hydrochloric acid (60 c.c.) were heated on the water-bath for 3 hours. The solution was kept at room temperature overnight, then poured into ice (200 g.) and 10N-sodium hydroxide (150 c.c.), and the mixture stirred for 1 hour. The precipitate was washed and crystallised from dilute pyridine, giving 2 : 4 : 7-*triaminoxanthone* (3 g.) as ochre needles, m. p. 252—254° (Found : C, 64·2; H, 4·5; N, 17·4. $C_{13}H_{11}O_2N_3$ requires C, 64·8; H, 4·6; N, 17·4%).

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