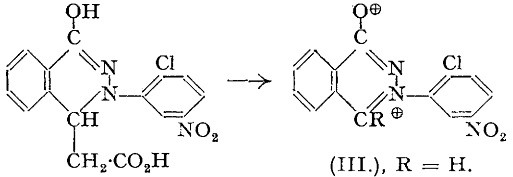
51. *A Reaction of Certain Diazosulphonates derived from* β-*Naphthol*-1-*sulphonic Acid. Part XXII. Derivatives of* 2′-*Chloro*-5′-*nitrobenzene*-2-*naphthol*-1-*diazosulphonate.*

By (the late) F. M. Rowe, A. T. Peters, and Y. I. Rangwala.

The presence of the *o*-chloro-substituent in sodium 1-(2′-chloro-5′-nitrobenzeneazo)-β-naphthaquinone-1-sulphonate causes such an increase in its resistance to fission in presence of aqueous sodium hydroxide that after reaction for 40 seconds only 5% of *sodium hydrogen* 3-(2′-*chloro*-5′-*nitrophenyl*)-3 : 4-*dihydrophthalazine*-1-*sulphonate*-4-*acetate* (I) is formed, with 90% of 2′-chloro-5′-nitrobenzeneazo-β-naphthol. With analogues containing no chlorine, the respective yields under similar conditions are 80% of the corresponding sodium salt and 9% of the azo-β-naphthol derivative. The properties of 1-*hydroxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-3 : 4-*dihydrophthalazine*-4-*acetic acid* (II) are compared with those of the unchlorinated analogue.

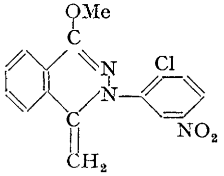
Acid hydrolysis of the sodium salt (I) gave the hydroxy-compound (II) which was converted by a mixture of boiling sulphuric and acetic acid or by acid dichromate into 2′-*chloro*-5′-*nitro*-3-*phenylphthalaz*-1-*one* (III) or the 4-*methyl* derivative (IV) of (III), in yields of 48·2% or 80·2%, respectively. The corresponding yields of the *m*-nitro-analogues were 56·5% and 59·1%

(cf. *J.*, 1928, 2556; 1931, 1918). Both (III) and (IV) possessed the expected properties. Methylation of (III) gave a product which combined with alcohols in varying proportions, like the analogous 2′ : 6′-dihalogeno-4′-nitro- and 2′-nitro-phenyl derivatives (cf. *J.*, 1931, 1073; 1935, 1796). With methyl sulphate in nitrobenzene, (IV) gave 74·7% of 1-*methoxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-4-*methylene*-3 : 4-*dihydrophthalazine* (V), although the corresponding derivative could not be prepared in the *m*-nitro-series. (V) gave water-soluble salts with mineral acids, and condensed with 2 : 4-dinitrochlorobenzene to yield 1-*methoxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-4-(2″ : 4″-*dinitrobenzylidene*)-3 : 4-*dihydrophthalazine.*

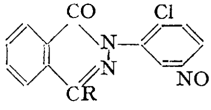


(II.)

(III.), R = H.
(IV.), R = Me.



(V.)



(VIII.), R = H.
(IX.), R = Me.

Oxidation of (II) with boiling aqueous potassium permanganate gave 1 : 4-*diketo*-3-(2′-*chloro*-5′-*nitrophenyl*)*tetrahydrophthalazine* (VI) in 40·4% yield, compared with a yield of 67% in the case of the *m*-nitro-analogue (cf. *J.*, 1935, 1808). Compound (VI) could not be methylated, but the methylene base (V) and *p*-nitrosodimethylaniline afforded 4-*keto*-1-*methoxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-3 : 4-*dihydrophthalazine*, demethylated by hydrobromic acid (*d* 1·7) at 130° to (VI). Reduction of the nitro-compound (II) by iron powder and boiling aqueous-acetic acid gave 1-*hydroxy*-3-(2′-*chloro*-5′-*aminophenyl*)-3 : 4-*dihydrophthalazine*-4-*acetic acid* (VII), which was converted by a mixture of boiling sulphuric and acetic acid into 2′-*chloro*-5′-*amino*-3-*phenylphthalaz*-1-*one*. The corresponding 4-methyl derivative could not be obtained by acid dichromate oxidation of the amine (VII).

For comparison with the above phthalaz-1-ones, (III) and (IV), the isomeric 2′-*chloro*-5′-*nitro*-3-*phenylphthalaz*-4-*one* and its 1-*methyl* derivative, *viz.*, (VIII) and (IX), were synthesised in the usual manner (cf. *J.*, 1936, 311), and they possessed the expected properties; they did not form salts with mineral acids, and could not be methylated. Compound (III) and aqueous hydrochloric acid at 135° gave a substance, probably 1 : 4-*dihydroxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-3 : 4-*dihydrophthalazine*, converted by the same reagent at 200° into a product of undetermined constitution. Isomerisation of 2′-chloro-5′-nitro-3-phenyl-4-methylphthalaz-1-one (IV) into 2′-chloro-5′-nitro-3-phenyl-1-methylphthalaz-4-one was effected by aqueous hydrochloric acid at 200°, but at 145° the reaction afforded 1 : 4-*dihydroxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-4-*methyl*-3 : 4-*dihydrophthalazine* (X), which was also obtained in one experiment by the action of acid dichromate on (II). Compound (X) is insoluble in aqueous mineral acids and alkalis, and could not be methylated, but aqueous hydrochloric acid at 180°, or warm concentrated sulphuric acid, converted it into 2′-chloro-5′-nitro-3-phenyl-1-methylphthalaz-4-one.

EXPERIMENTAL.

Sodium Hydrogen 3-(2′-*Chloro*-5′-*nitrophenyl*)-3 : 4-*dihydrophthalazine*-1-*sulphonate*-4-*acetate* (I).—A filtered solution of commercial 50% sodium β-naphthol-1-sulphonate (150 g.) in water (400 c.c.) was stirred rapidly at 0° into a solution of diazotised 2-chloro-5-nitroaniline, prepared by adding sodium nitrite (30 g.) to a cold suspension of the base (52 g.) in concentrated sulphuric acid (150 c.c.), and pouring the mixture on ice. The bright orange 2′-chloro-5′-nitrobenzene-2-naphthol-1-diazosulphonate, which separated immediately, was filtered off, washed with brine, mixed with cold water (100 c..), and sodium carbonate (100 g.) added quickly, with good stirring; a yellowish-brown suspension of sodium 1-(2′-chloro-5′-nitrobenzeneazo)-β-naphthaquinone-1-sulphonate was thus obtained. After 20 minutes, the suspension was added to a cold solution of sodium hydroxide (60 g.) in water (140 c.c.), with rapid stirring; the mixture became violet and then reddish-brown. After 48 hours it was acidified with hydrochloric acid, then made alkaline with sodium carbonate, and 2′-chloro-5′-nitrobenzeneazo-β-naphthol (6·8 g.) removed; the filtrate was reacidified and saturated with sodium chloride, and the acid *sodium* salt separated as an orange precipitate. Slow crystallisation (1 week) from alcohol gave orange prisms (32 g.; 23·8%, calc. on 2-chloro-5-nitroaniline) (Found: Cl, 8·35; S, 6·35. $C_{16}H_{11}O_7N_3ClSNa$ requires Cl, 7·9; S, 7·15%), readily soluble in water with a deep orange colour.

1-*Hydroxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-3 : 4-*dihydrophthalazine*-4-*acetic Acid* (II).—A solution of the preceding sodium salt (5 g.) in water (500 c.c.) was boiled, and concentrated hydrochloric acid (20 c.c.) added gradually until evolution of sulphur dioxide had ceased. The *acid* (II) crystallised from acetic acid in colourless needles, m. p. 274° (3·5 g.; 86·6%) (Found: C, 53·4; H, 3·6; N, 11·8; Cl, 9·6. $C_{16}H_{12}O_5N_3Cl$ requires C, 53·1; H, 3·3; N, 11·6; Cl, 9·7%).

Derivatives of (II).—The *methyl* ester crystallised from methyl alcohol in pale yellow plates, m. p.

206° (Found: C, 54·1; H, 3·8; Cl, 9·6. $C_{17}H_{14}O_5N_3Cl$ requires C, 54·3; H, 3·7; Cl, 9·45%), insoluble in aqueous sodium carbonate. The *N*-methyl ether, *viz.*, 1-*keto*-3-(2'-*chloro*-5'-*nitrophenyl*)-2-*methyltetrahydrophthalazine*-4-*acetic acid*, crystallised from alcohol in pale yellow, rectangular plates, m. p. 267° (Found: C, 54·1; H, 4·05; N, 11·35; Cl, 9·25. $C_{17}H_{14}O_5N_3Cl$ requires C, 54·3; H, 3·7; N, 11·2; Cl, 9·45%), soluble in warm aqueous alkalis with a yellow colour. The *acetyl* derivative separated from alcohol in colourless prisms, m. p. 194° (Found: C, 53·4; H, 3·6; N, 10·5; Cl, 9·2. $C_{18}H_{14}O_6N_3Cl$ requires C, 53·5; H, 3·5; N, 10·4; Cl, 8·8%), and the *anilide* from aqueous acetic acid in irregular yellow prisms, m. p. 282° (Found: N, 12·7; Cl, 8·5. $C_{22}H_{17}O_4N_4Cl$ requires N, 12·8; Cl, 8·1%).

1-*Hydroxy*-3-(2'-*chloro*-5'-*aminophenyl*)-3 : 4-*dihydrophthalazine*-4-*acetic Acid* (VII).—Iron powder (5 g.) was added to a suspension of the nitro-compound (II) (5 g.) in boiling acetic acid (30 c.c.) and water (20 c.c.). After refluxing for 1 hour, the mixture was filtered and the filtrate added to cold water (300 c.c.); the precipitate was collected, extracted with warm aqueous sodium carbonate, the extract acidified, and the resulting *amine* crystallised from acetic acid in colourless prisms, m. p. 232—233° (decomp.) (1·8 g.; 36%) (Found: C, 57·5; H, 4·6; N, 11·7; Cl, 9·6. $C_{16}H_{14}O_3N_3Cl,0{\cdot}5C_2H_4O_2$ requires C, 56·5; H, 4·4; N, 11·6; Cl, 9·8%), soluble in mineral acids and alkalis.

2'-*Chloro*-5'-*amino*-3-*phenylphthalaz*-1-*one*.—A solution of the above amine (VII) (5 g.) in concentrated sulphuric acid (10 c.c.) and acetic acid (10 c.c.) was boiled for 2 minutes, poured into cold water (100 c.c.), the mixture made alkaline with aqueous sodium hydroxide, and the *phthalaz*-1-*one* crystallised from pyridine in yellow prisms, m. p. 258° (decomp.) (3·1 g.; 75·7%) (Found: C, 61·8; H, 3·6; N, 15·1; Cl, 12·8. $C_{14}H_{10}ON_3Cl$ requires C, 61·9; H, 3·7; N, 15·4; Cl, 13·1%), soluble in dilute hydrochloric acid to give a colourless solution. The *acetyl* derivative crystallised from acetic acid in colourless prisms, m. p. 309—310° (decomp.) (Found: C, 61·3; H, 3·8; N, 13·4. $C_{16}H_{12}ON_3Cl$ requires C, 61·3; H, 3·8; N, 13·4%).

2'-*Chloro*-5'-*nitro*-3-*phenylphthalaz*-1-*one* (III).—A solution of 1-hydroxy-3-(2'-chloro-5'-nitrophenyl)-3 : 4-dihydrophthalazine-4-acetic acid (15 g.) in acetic acid (30 c.c.) and concentrated sulphuric acid (40 c.c.) was boiled for 2 minutes, added to water (250 c.c.), and the precipitated sulphate basified with aqueous ammonia. 2'-*Chloro*-5'-*nitro*-3-*phenylphthalaz*-1-*one* crystallised from methyl alcohol in pale yellow needles, m. p. 255° (6 g.; 48·2%) (Found: C, 55·6; H, 3·0; N, 13·9; Cl, 11·8. $C_{14}H_8O_3N_3Cl$ requires C, 55·7; H, 2·65; N, 13·9; Cl, 11·8%), which formed water-soluble salts with mineral acids. The *picrate* crystallised from alcohol in yellow prisms, m. p. 222° (Found: C, 45·6; H, 2·4; N, 15·9. $C_{20}H_{11}O_{10}N_6Cl$ requires C, 45·2; H, 2·1; N, 15·8%). Attempted reduction of the nitro-compound (II) with aqueous sodium sulphide gave a resin.

Compound (II), alone or in nitrobenzene, was heated with excess of methyl sulphate at 100° for 1 hour, giving a product which combined with alcohols in indefinite proportions, and crystallised from ethyl alcohol in yellow prisms, m. p. 198° (decomp.), or from methyl alcohol in greenish-yellow prisms, m. p. 192° (decomp.).

2'-*Chloro*-5'-*nitro*-3-*phenyl*-4-*methylphthalaz*-1-*one* (IV).—(*a*) A solution of powdered (II) (10 g.) in concentrated sulphuric acid (100 c.c.) was added to a cold solution of potassium dichromate (4 g.) in water (400 c.c.), and the mixture heated to 80°; after 1 hour at this temperature, the precipitate was collected, basified with aqueous ammonia, and crystallised from methyl alcohol in pale yellow, rectangular prisms, m. p. 244° (7 g.; 80·2%) (Found: C, 57·1; H, 3·4; N, 13·3; Cl, 11·1. $C_{15}H_{10}O_3N_3Cl$ requires C, 57·05; H, 3·2; N, 13·3; Cl, 11·2%). 2'-*Chloro*-5'-*nitro*-3-*phenyl*-4-*methylphthalaz*-1-*one* forms water-soluble salts with mineral acids, and the *picrate* separated from alcohol in yellow prismatic needles, m. p. 234° (Found: C, 46·5; H, 2·3; N, 15·7. $C_{21}H_{13}O_{10}N_6Cl$ requires C, 46·3; H, 2·4; N, 15·4%).

(*b*) Compound (II) (2 g.) and nitric acid (*d* 1·5; 5 c.c.) at 0° for 5 minutes gave (IV), m. p. and mixed m. p. 244° (1 g.; 57·2%).

1-*Methoxy*-3-(2'-*chloro*-5'-*nitrophenyl*)-4-*methylene*-3 : 4-*dihydrophthalazine* (V) *and its Derivatives*.—Methylation of the phthalazone (IV) (4·5 g.) in nitrobenzene (30 c.c.) with methyl sulphate (3 g.), at 110—115° for 1 hour, gave the *methylene* compound (V), which crystallised from alcohol in orange-red rectangular plates, with a coppery reflex, m. p. 142° (3·9 g.; 74·7%) (Found: C, 58·6; H, 3·7; Cl, 10·9; OMe, 9·65. $C_{16}H_{12}O_3N_3Cl$ requires C, 58·3; H, 3·6; Cl, 10·8; OMe, 9·4%). The *perchlorate* crystallised from dilute acetic acid containing a little perchloric acid in colourless needles, m. p. 224° (Found: Cl, 16·9. $C_{16}H_{13}O_7N_3Cl_2$ requires Cl, 16·5%).

The methylene base (1 g.) and *p*-nitrosodimethylaniline (0·5 g.), refluxed in alcohol (30 c.c.) for 1 hour, gave 4-*keto*-1-*methoxy*-3-(2'-*chloro*-5'-*nitrophenyl*)-3 : 4-*dihydrophthalazine*, which crystallised from alcohol in sand-coloured prisms, m. p. 170° (0·6 g.; 59·4%) (Found: C, 54·0; H, 3·0; N, 12·8; Cl, 10·5. $C_{15}H_{10}O_4N_3Cl$ requires C, 54·3; H, 3·0; N, 12·7; Cl, 10·7%), insoluble in aqueous mineral acids and alkalis and demethylated by hydrobromic acid (*d* 1·7) at 130° to 1 : 4-diketo-3-(2'-chloro-5'-nitrophenyl)tetrahydrophthalazine (VI), m. p. 282° (see later). Compound (V) (1 g.) condensed with 2 : 4-dinitrochlorobenzene (0·7 g.) in boiling alcohol (50 c.c.) in presence of potassium acetate (2 g.) (1·5 hours) to yield 1-*methoxy*-3-(2'-*chloro*-5'-*nitrophenyl*)-4-(2'' : 4''-*dinitrobenzylidene*)-3 : 4-*dihydrophthalazine*, which crystallised from alcohol in cherry-red needles, m. p. 285° (1 g.; 66·5%) (Found: C, 52·8; H, 3·0; N, 14·4. $C_{22}H_{14}O_7N_5Cl$ requires C, 53·3; H, 2·8; N, 14·1%), and formed a colourless solution with dilute hydrochloric acid.

1 : 4-*Diketo*-3-(2'-*chloro*-5'-*nitrophenyl*)*tetrahydrophthalazine* (VI).—Powdered potassium permanganate (15 g.) was added gradually during 10 minutes to a suspension of (II) (20 g.) in water (300 c.c.) at 80°. The mixture was then boiled for 1 minute, filtered, the filtrate acidified with hydrochloric acid, and the precipitate crystallised from acetic acid in colourless prisms, m. p. 282°, of the *diketo*-compound (7·1 g.; 40·4%) (Found: C, 52·8; H, 3·0; N, 13·1. $C_{14}H_8O_4N_3Cl$ requires C, 52·9; H, 2·5; N, 13·2%), which could not be methylated by the action of methyl iodide on its silver salt in dry methyl alcohol or benzene.

2'-*Chloro*-5'-*nitro*- *and* -5'-*amino*-3-*phenylphthalaz*-4-*one*.—On refluxing a solution of phthalaldehydic acid (1·5 g.) and 2-chloro-5-nitrophenylhydrazine (1·5 g.) in alcohol (50 c.c.) for 10 minutes, orange needles of o-*carboxybenzaldehyde* 2-*chloro*-5-*nitrophenylhydrazone*, m. p. 252°, separated (2·2 g.; 86·3%) (Found: C, 52·5; H, 3·2; N, 12·9. $C_{14}H_{10}O_4N_3Cl$ requires C, 52·6; H, 3·1; N, 13·1%), soluble in warm aqueous alkalis with a yellow colour. Warm concentrated sulphuric acid converted the carboxylic acid into 2′-*chloro*-5′-*nitro*-3-*phenylphthalaz*-4-*one* (95% yield), which crystallised from aqueous alcohol in colourless prisms, m. p. 164° (softens from 150°) (Found: C, 56·1; H, 2·7; N, 13·6; Cl, 11·4. $C_{14}H_8O_3N_3Cl$ requires C, 55·7; H, 2·65; N, 13·9; Cl, 11·8%), insoluble in dilute mineral acids and alkalis. It was reduced by boiling aqueous-alcoholic sodium sulphide to the corresponding *amine* (43·6% yield), which crystallised from alcohol–light petroleum in colourless needles, m. p. 160° (Found: N, 15·3. $C_{14}H_{10}ON_3Cl$ requires N, 15·5%); the *acetyl* derivative crystallised from the same solvent in colourless rhombs, m. p. 247° (Found: N, 13·4. $C_{16}H_{12}O_2N_3Cl$ requires N, 13·4%).

2′-*Chloro*-5′-*nitro*- and -*amino*-3-*phenyl*-1-*methylphthalaz*-4-*one*.—Alcoholic solutions of acetophenone-*o*-carboxylic acid (4 g.) and 2-chloro-5-nitrophenylhydrazone (4 g.), refluxed for 10 minutes, gave o-*carboxyacetophenone* 2-*chloro*-5-*nitrophenylhydrazone*, which separated in yellow cubes, m. p. 160° (4·5 g.; 63·2%) (Found: C, 53·6; H, 3·4; N, 12·3. $C_{15}H_{12}O_4N_3Cl$ requires C, 54·0; H, 3·6; N, 12·6%). On being heated at 135°, or more conveniently by being refluxed with acetic acid (40 c.c.) for 1 hour, the hydrazone (1 g.) was converted into 2′-*chloro*-5′-*nitro*-3-*phenyl*-1-*methylphthalaz*-4-*one*, which separated from aqueous acetic acid in colourless rhombs, m. p. 163° (0·8 g.; 83·1%) (Found: C, 56·6; H, 3·0; N, 13·6; Cl, 11·3. $C_{15}H_{10}O_3N_3Cl$ requires C, 57·05; H, 3·2; N, 13·3; Cl, 11·2%). It was also obtained in 67% yield by heating 2′-chloro-5′-nitro-3-phenyl-4-methylphthalaz-1-one with aqueous hydrochloric acid (8 : 1) in a sealed tube at 200° for 6 hours. Reduction with boiling aqueous-alcoholic sodium sulphide for 20 minutes afforded 2′-*chloro*-5′-*amino*-3-*phenyl*-1-*methylphthalaz*-4-*one* (27·5%), which crystallised from aqueous alcohol in colourless cubes, m. p. 145° (Found: C, 62·8; H, 4·2; N, 14·4; Cl, 12·5. $C_{15}H_{12}ON_3Cl$ requires C, 63·0; H, 4·2; N, 14·7; Cl, 12·4%). The *acetyl* derivative crystallised from aqueous alcohol in colourless cubes, m. p. 238° (Found: N, 12·6. $C_{17}H_{14}O_2N_3Cl$ requires N, 12·8%).

Action of Dilute Hydrochloric Acid on 2′-*Chloro*-5′-*nitro*-3-*phenylphthalaz*-1-*one*.—The phthalaz-1-one (1·5 g.) was heated with dilute hydrochloric acid (1 : 8; 18 c.c.) in a sealed tube at 135° for 3 hours. The product, probably 1 : 4-*dihydroxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-3 : 4-*dihydrophthalazine*, crystallised from aqueous alcohol in yellow needles, m. p. 225—227° (1·1 g.; 69·3%) (Found: C, 54·4; H, 3·2; N, 12·9; Cl, 10·8. $C_{14}H_{10}O_4N_3Cl$ requires C, 52·6; H, 3·1; N, 13·1; Cl, 11·1%), and was converted (as also was 2′-chloro-5′-nitro-3-phenylphthalaz-1-one) by dilute hydrochloric acid (1 : 8) in a sealed tube at 200° into a *product*, which crystallised from methyl alcohol in colourless rhombs, m. p. 156° (Found: C, 56·1; H, 2·9; N, 13·5; Cl, 11·7. $C_{14}H_8O_3N_3Cl$ requires C, 55·7; H, 2·65; N, 13·9; Cl, 11·8%). The constitution of this is uncertain, and, on admixture with 2′-chloro-5′-nitro-3-phenylphthalaz-4-one, the m. p. was depressed.

1 : 4-*Dihydroxy*-3-(2′-*chloro*-5′-*nitrophenyl*)-4-*methyl*-3 : 4-*dihydrophthalazine*.—2′-Chloro-5′-nitro-3-phenyl-4-methylphthalaz-1-one (1·5 g.) was heated with dilute hydrochloric acid (1 : 8; 18 c.c.) in a sealed tube at 145° for 5 hours. The *dihydroxy*-compound crystallised from methyl alcohol in pale yellow prismatic needles, m. p. 238° (1·3 g.; 83%) (Found: C, 53·7; H, 3·6; N, 12·4; Cl, 10·6. $C_{15}H_{12}O_4N_3Cl$ requires C, 54·0; H, 3·6; N, 12·6; Cl, 10·6%), converted by heating with dilute hydrochloric acid (1 : 8) in a sealed tube at 180° for 3 hours, or by warming with concentrated sulphuric acid for 10 minutes, into 2′-chloro-5′-nitro-3-phenyl-1-methylphthalaz-4-one, m. p. and mixed m. p. 163°.

The authors thank Imperial Chemical Industries Ltd., Dyestuffs Division, for gifts of chemicals.

CLOTHWORKERS' RESEARCH LABORATORY,
THE UNIVERSITY, LEEDS.

[*Received, March* 20*th*, 1947.