CCLXXXV.—*Comparison of the Directive Powers of Elements having Consecutive Atomic Numbers. Part II. The Mononitrations of 2-Phenylquinoline and its Methosulphate.*

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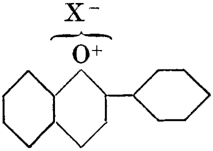
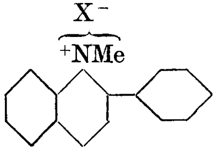
The work here described is complementary to that (J., 1929, 2771) on the nitration of 2-phenylbenzopyrylium salts. The aim of this series is to ascertain whether the changes in the nuclear charges in a series of elements have a specific influence on the effective positive fields exerted over the aromatic nuclei in which they are substituted although the net *ionic* charges are formally identical. The nitrations of analogously constituted pairs of substances containing oxonium oxygen and ammonium nitrogen are therefore being examined, these elements being chosen as poles because they were the simplest pair collaterally adjacent in the periodic table readily available in the "onium" condition. They were thus the pair in which one would expect differences of total positivity due to the respective specific nuclear charges to be most easily perceived, since complications arising from unequal atomic volumes, numbers of unshared electrons, etc. (compare Ingold, Shaw, and Wilson, J., 1928, 1280; Challenger and Peters, J., 1929, 2610), would be at a minimum.

Suitable compounds containing them were accessible among the salts of 2-phenylbenzopyrylium (I) and 1-methyl-2-phenylquinolinium (II). Nitration of the ferrichloride and perchlorate of (I) gave the 2-*m*-nitrophenylbenzopyrylium salts in such high yields that the fear was expressed (*loc. cit.*, p. 2772) that the related quinolinium salts might similarly be nitrated predominantly in the *m*-position to such an extent that accurate comparison would be impossible.


(I.)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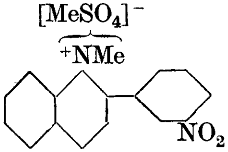
(III.)

The present communication verifies this and shows that, when occurrence of the equilibrium $[NR_3H]X \rightleftharpoons NR_3 + HX$ is repressed as much as possible by substituting an alkyl group for the hydrogen atom, the resulting quaternary ammonium salt is attacked only with difficulty by nitric acid, giving exclusively the *m*-nitro-derivative.

Thus the *methosulphate* of (II) gave after 24 hours' nitration in fuming nitric acid a 97% crude yield of 2-m-*nitrophenylquinolinium methosulphate* (III), the constitution of which was established by preparation of the corresponding *methochloride* (*via* the *methopicrate*) and examination of the solid product of its thermal decomposition. That the latter consisted almost entirely of the 2-*m*-nitrophenylquinoline of Kinkelin and Miller (*Ber.*, 1885, **18**, 1902) was proved, not only by its m. p. and undepressed mixed m. p. with a specimen prepared by the methods of these authors, but also by the considerable depression of m. p. resulting from admixture with 2-o- or with 2-p-*nitrophenylquinoline,* which we synthesised, in order to complete the comparison, from *o*- or *p*-nitrocinnamaldehyde, aniline, and hydrochloric acid.

Experiments on the nitration of 2-phenylquinoline directly with nitric acid indicate that little *o*-nitro-compound is produced (none was isolated) but that *p*- and *m*-derivatives are formed to the extent of about 60% and 30% respectively, in agreement with such analogous cases as the sulphonation of 2-phenylquinoline (Murmann, *Monatsh.*, 1892, **13**, 59) and the nitration of 2-phenylpyridine (Forsyth and Pyman, J., 1926, 2912).

With the similar case of 4-phenylquinoline, since the phenyl group is farther from the salt-forming nitrogen, it would be justifiable to forecast a slightly greater yield of *o*-, along with somewhat less *m*-, nitro-derivative than is obtained from 2-phenylquinoline. Königs and Nef (*Ber.*, 1887, **20**, 624), however, state that 4-phenylquinoline gives, by nitration in fuming nitric acid at 0°, three mononitro-derivatives: α-, m. p. 187°; β-, m. p. 117—118°; and γ-, m. p. 135°, in yields of about 50%, 40%, and 5% respectively. By analogy with our results, therefore, we regard these respectively as the *p*-, *m*-, and *o*-nitro-4-phenylquinolines, thus placing the nitration of 4-phenylquinoline among the class of anomalous nitrations in which substitution occurs predominantly in the *m*- and *p*-, rather than in the *o*- and *p*-, positions.

Final proof by synthesis was unsuccessful, for we tested the two most obvious syntheses of these nitro-compounds by applying them to the preparation of 4-phenylquinoline itself, but without result.

EXPERIMENTAL.

Preparation of 2-Phenylquinoline.—The methods described by Döbner (*Ber.*, 1883, **16**, 1665), Murmann (*Monatsh.*, 1904, **24**, 621), Grimaux (*Compt. rend.*, 1883, **96**, 584), Pictet and Barbier (*Bull. Soc. chim.*, 1895, **13**, 26), and Miller (*Ber.*, 1891, **24**, 1720) for the preparation of 2-phenylquinoline gave much less satisfactory results than did that of Döbner and Giesecke (*Annalen*, 1887, **242**, 291), by which most of the material used in the present work was prepared. Many crystallisations from dilute alcohol failed to raise the m. p. above 84° (Knorr, *Annalen*, 1888, **245**, 379, gives 86°).

2-*Phenylquinoline methosulphate.* To 2-phenylquinoline (5 g.), dissolved in dry benzene (30 c.c.), freshly distilled methyl sulphate (12 g.) was added. The mixture was refluxed for 2 hours, then cooled, and the resulting white crystalline solid separated and dried (crude yield 93%; m. p. 137—141°). After recrystallisation from absolute alcohol and dry ether it formed stout white needles, m. p. 142—143·5° (Found: C, 61·6; H, 5·4; N, 4·4. $C_{17}H_{17}O_4NS$ requires C, 61·6; H, 5·1; N, 4·2%) (pure yield 85%). The *methosulphate* is soluble in water and in the common organic solvents.

2-*Phenylquinoline methopicrate.* The foregoing methosulphate (1 g.) was dissolved in dilute aqueous alcohol, and an excess of cold saturated aqueous picric acid added; 1·33 g. of crystalline *metho-*

picrate (air-dried) were obtained. After two crystallisations from water containing picric acid, it formed long yellow needles, m. p. 138—139° (Found: C, 59·2; H, 3·6; N, 12·6. $C_{22}H_{16}O_7N_4$ requires C, 59·2; H, 3·6; N, 12·5%). The substance resembles the methosulphate in its solubilities.

Nitration of 2-Phenylquinoline Methosulphate.—After various attempts to nitrate the methosulphate under a great variety of conditions, it was found that the following method afforded the best results: The methosulphate (5 g.) was dissolved in nitric acid (50 c.c., *d* 1·5) at 0°, and the solution left in the ice-chest for 24 hours. It was then poured on crushed ice, and the resulting solution (about 1 litre) partly neutralised by ammonia. A saturated aqueous solution of picric acid was gradually added until no further change in colour was noticed. After 12 hours' standing at 0°, filtration, washing, and air-drying gave 7·15 g. (97% yield) of crude picrate, m. p. 162—176°. After 3 crystallisations, each from 550 c.c. of 95% alcohol, 5·7 g. of pure 2-m-*nitrophenylquinoline methopicrate*, m. p. 181—182° (Found: C, 53·2; H, 3·88; N, 14·2. $C_{22}H_{15}O_9N_5$ requires C, 53·5; H, 3·05; N, 14·2%), were obtained.

2-m-*Nitrophenylquinoline methochloride*. The above methopicrate (3 g.) was boiled with concentrated hydrochloric acid for ½ hour. After cooling, picric acid was removed by filtration, followed by extraction of the acid solution with benzene. Evaporation of the aqueous portion to dryness then yielded 1·93 g. of crude *methochloride* in a hydrated form. It softened at 48°, melted to a viscous mass at 52°, and gave off water between 120° and 130°; with further heating it resolidified, to soften again at 180° and melt with darkening and effervescence at 203—204°.

The salt was obtained in a pure condition by three recrystallisations from absolute alcohol and dry ether. It thus formed cream-coloured needles, m. p. 204—205° (Found: C, 63·8; H, 4·44; Cl, 11·6. $C_{16}H_{13}O_2N_2Cl$ requires C, 63·9; H, 4·32; Cl, 11·5%). It is soluble in water, and in methyl and ethyl alcohols, but not in benzene, ether, chloroform, etc.

2-m-*Nitrophenylquinoline*. 1 G. quantities of the above methochloride were maintained at their m. p. in an oil-bath for ½ hour. On cooling, dark solids, m. p. 122—123°, were obtained. After crystallisation from aqueous ethyl alcohol they yielded light yellow needles, m. p. 123—124°, identical (m. p. and mixed m. p.) with the 2-*m*-nitrophenylquinoline prepared by Kinkelin and Miller's method (*loc. cit.*). Mixed m. p. determinations with the synthetic 2-*o*- and -*p*-nitrophenylquinolines (see later) showed considerable depression.

Nitration of 2-Phenylquinoline.—2-Phenylquinoline (5 g.) was dissolved in nitric acid (*d* 1·5; 50 c.c.) at 0° and left for 24 hours in the ice-chest. It was then poured on crushed ice, and the resulting solution (about 500 c.c.) kept over-night. The solid was filtered off, washed, and dried (4·1 g.; product A; yield about 66%).

The filtrate on further dilution gave no more precipitate; it was therefore made alkaline with ammonia. After 12 hours the precipitate so obtained was separated and dried (2 g.; product B; yield about 33%).

Product A. The crude material softened at 100° and melted at 110—115°. After 3 crystallisations from aqueous methyl alcohol, 3·5 g. of light yellow crystals were obtained, m. p. 129—131° (Found: C, 71·8; H, 3·9; N, 11·4. $C_{15}H_{10}O_2N_2$ requires C, 72·0; H, 4·0; N, 11·2%). This substance was identical (m. p. and mixed m. p.) with 2-*p*-nitrophenylquinoline synthesised as described below.

Product B. This melted at 103—112° and crystallised from aqueous methyl alcohol as straw-coloured, silky needles (yield pure, 26%), m. p. 123—125°. The identity of this nitration product with 2-*m*-nitrophenylquinoline was demonstrated as already described (p. 2237).

Syntheses of 2-p- *and* -o-*Nitrophenylquinolines.*—*p*-Nitrocinnamaldehyde (25 g.), aniline (15 g.), and concentrated hydrochloric acid (50 g.) were heated in an oil-bath at 150° for 5 hours. The resulting mass was extracted with alcoholic–aqueous hydrochloric acid (1 : 1 by vol.), and the aqueous solution concentrated to one quarter of its volume; by addition of an equal volume of water and rapid filtration from black tars, a clear solution was obtained. This was basified by ammonia and again acidified by acetic acid. After standing, 7 g. of 2-p-*nitrophenylquinoline* separated; it was crystallised from light petroleum (b. p. 40—60°) and finally from aqueous methyl alcohol, from which it separated as light yellow needles, m. p. 129—131° (Found: C, 71·7; H, 4·2; N, 11·4. $C_{15}H_{10}O_2N_2$ requires C, 72·0; H, 4·0; N, 11·2%).

2-o-*Nitrophenylquinoline*, similarly synthesised from *o*-nitrocinnamaldehyde, formed silky needles, m. p. 121—123°, from aqueous methyl alcohol (Found: N, 11·2. $C_{15}H_{10}O_2N_2$ requires N, 11·2%).

Attempted Syntheses of 4-*Phenylquinoline.*—As an exploration of possible preparative methods for the 4-nitrophenylquinolines the following experiments were performed: (1) Benzoylacetaldehyde (prepared by the method of Claisen and Fischer, *Ber.*, 1887, **20**, 2192) was converted into its anil, m. p. 141°; attempts to effect dehydration and cyclisation of this substance (to produce 4-phenylquinoline directly), by using sulphuric acid at 100° or at 140°, or by treating acetic or anhydrous formic acid solutions with dry hydrogen chloride (compare Bülow and Issler, *Ber.*, 1903, **36**, 4013) were all unsuccessful, the anil being recovered unchanged in each case. (2) Acetophenoneoxalic ester (Beyer and Claisen, *Ber.*, 1887, **20**, 2181) condensed with aniline when heated either directly or in boiling acetic acid solution to form an anil as a bright yellow viscous liquid, but no ring closure was observed when this was heated with concentrated sulphuric acid in the usual way. (3) The same ester was dissolved in excess of acetic acid, and the solution treated with concentrated aqueous hydrochloric acid until a turbidity was just produced. After 24 hours, hydrolysis was complete and the acetophenoneoxalic acid was separated. The anil from this acid (Bromme and Claisen, *Ber.*, 1888, **21**, 1134) was similarly recovered unchanged from treatments with (*a*) hot sulphuric acid, (*b*) acetic acid and dry hydrogen chloride at the ordinary temperature, or (*c*) boiling xylene containing phosphorus pentoxide for 3 hours.

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