

XL.—*The Nature of the Alternating Effect in Carbon Chains. Part X. The Nitration of Some Derivatives of β -Phenylethylamine.**

By FRANK ROBERT GOSS, WALTHER HANHART, and CHRISTOPHER KELK INGOLD.

To facilitate the development of the theory of reactivity-transmission by the Lewis electron-displacement mechanism, Goss, Ingold, and Wilson's quantitative study of the substitution of benzylamine derivatives (J., 1926, 2440) has now been supplemented by a similar study of the nitration of some derivatives of β -phenylethylamine. Here the electron-attracting centre is separated from the nucleus by an additional methylene group, and its *m*-directive effect should accordingly be weaker.

Experience having shown that the replacement of one alkyl group by another in a secondary, a tertiary, or a quaternary benzylamine has a relatively small influence on the degree of *m*-substitution observed in each class (*loc. cit.*), we have restricted the present investigation of β -phenylethylamine derivatives to an examination of the primary base, and one secondary, one tertiary, and one quaternary derivative. The results are in the following table, in which the data for the corresponding derivatives of benzylamine also are set forth for comparison.

Nitration of Derivatives of Benzylamine and β -Phenylethylamine in Nitric Acid (d 1.5) at -10° to 0° .

Benzylamine bases.		β -Phenylethylamine bases.	
Side chain.	Proportion of <i>m</i> -substitution.	Side chain.	Proportion of <i>m</i> -substitution.
$-\text{CH}_2\cdot\text{NH}_2$	49%	$-\text{CH}_2\cdot\text{CH}_2\cdot\text{NH}_2$	12%
$-\text{CH}_2\cdot\text{NHMe}$	69 "	$-\text{CH}_2\cdot\text{CH}_2\cdot\text{NHMe}$	15 "
$-\text{CH}_2\cdot\text{NMe}_2$	58 "	$-\text{CH}_2\cdot\text{CH}_2\cdot\text{NMe}_2$	13 "
$-\text{CH}_2\cdot\text{NMe}_3^+$	88 " †	$-\text{CH}_2\cdot\text{CH}_2\cdot\text{NMe}_3^+$	19 " †

† Picrate used.

* These experiments and a corresponding series on γ -phenylpropylamine derivatives were completed in all essentials at the date of the appearance of Ing and Robinson's statement (J., 1926, 1656) that they were investigating a compound of each class.

From these figures, it will be evident that the effect originating in the positively charged nitrogen atom suffers such loss by transmission through the additional carbon atom that the resulting *m*-substitution is diminished in ratios of approximately 1/4—1/5.

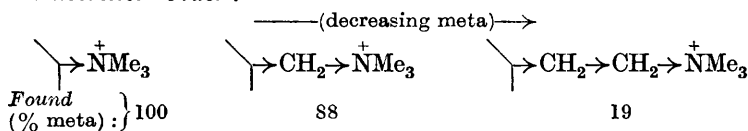
β -Phenylethylamine has been previously nitrated by Ehrlich and Pistschimuka (*Ber.*, 1912, 45, 2428), who isolated the *p*-nitro-compound and one other product which they regarded as the *m*-derivative (yield 18%; m. p. of hydrochloride "gegen 160°"). We think, however, that this could not have been the pure *m*-compound, since our specimen of its hydrochloride melts 45° higher. On the other hand, the m. p. and properties of Ehrlich and Pistschimuka's product agree almost exactly with those of our *o*-compound. Further, the quantity of "meta-" derivative obtained by Ehrlich and Pistschimuka is $1\frac{1}{2}$ times as great as the total amount (12%) estimated to be contained in our nitration products, and experience of the separation of the three isomerides has left us with the impression that it would be difficult to isolate in the pure condition more than a moderate fraction of the quantity of *m*-derivative actually present. On the other hand, the proportion of the *o*-compound formed on nitration under our conditions is considerably greater (25%), and therefore it might be possible to isolate as much as 18% of this substance. Methyl- β -phenylethylamine does not appear to have been nitrated previously. Dimethyl- β -phenylethylamine was nitrated by Barger (*J.*, 1909, 95, 2195), who obtained the *p*-compound; we have also separated some of the *m*-isomeride, and have isolated all three isomerides from the nitration product of trimethyl- β -phenylethylammonium picrate.

The figures in the last column of the table are based on the weights of unrecrystallised *m*-nitrobenzoic acid separated as previously described (Baker and Ingold, *J.*, 1926, 2462) from the mixtures of nitrobenzoic acids formed by oxidation, either of the original mononitration products or of the residues remaining after partial separations of pure isomerides. The oxidation yields were mostly quantitative and the separation of the acids was again checked on artificial mixtures and was shown to give results correct to about 1.5%. Also by oxidation of the pure *o*-, *m*-, and *p*-isomerides it was shown that each gave the same (generally quantitative) yield of the corresponding nitrobenzoic acid; further, by oxidation of artificial mixtures of isomeric nitro-bases of similar composition to the nitration products, and subsequent separation of the acids, the proportions of the isomerides were satisfactorily estimated; it is therefore hoped that the figures submitted are not seriously in error.

Summarising these results, then, it appears that the work now

described provides the first clear proof of the formation of *m*-derivatives by direct nuclear substitution of β -phenylethylammonium compounds, and we can recall no other example of *m*-substitution in which the *m*-directing group is separated from the nucleus by two saturated carbon atoms. Further, the new results combined with those obtained by Vorländer and Siebert (*Ber.*, 1919, 52, 294) for quaternary derivatives of aniline provide the first experimental evidence that the directive effect of the ionic centre situated in a side-chain consisting otherwise of saturated carbon atoms does not alternate, but diminishes continuously with increasing distance from the nucleus* :

Theoretical Order :



The lower values for the primary, secondary, and tertiary β -phenylethylamine salts, as compared with that obtained for the quaternary salt, are attributed to partial compensation by the negative end of the dipolar group (Goss, Ingold, and Wilson, *loc. cit.*; and following paper).

EXPERIMENTAL.

(A) Nitration of β -Phenylethylamine.

(i) *Qualitative Separation of Isomerides.*—The base (10 g.) was run in the course of 1.5 hours into nitric acid (50 c.c.; d^{15} 1.50) at -10° . Nitration appeared to follow almost instantaneously, but the mixture was warmed to 0° before being mixed with ice and basified with sodium hydroxide. The products then extracted with ether were isolated as their hydrochlorides by re-extracting the ethereal solution with sufficient dilute hydrochloric acid and evaporating this solution to dryness (Found: Cl, 17.4. $\text{C}_8\text{H}_{10}\text{O}_2\text{N}_2\cdot\text{HCl}$ requires Cl, 17.5%).

A single crystallisation from the minimal quantity of boiling 95% alcohol yielded 8.7 g. of almost colourless plates, m. p. $209-210^\circ$. This is the recorded m. p. of *p*-nitro- β -phenylethylammonium chloride. On oxidation by permanganate, *p*-nitrobenzoic acid was formed (yield 99%; m. p. $230-231^\circ$; mixed m. p. $232-233^\circ$). A further 1.0 g. of the same hydrochloride was obtained from the residue remaining on evaporation of the alcoholic mother-liquor by

* Mr. I. S. Wilson has obtained the approximate value $5 \pm 2\%$ for $\begin{array}{c} \diagup \\ | \\ \diagdown \end{array} \text{---CH}_2\text{---CH}_2\text{---CH}_2\text{---}^{\oplus} \text{NMe}_3$ by nitration of the picrate under similar conditions.

diluting its solution in the minimal quantity of boiling absolute alcohol with 800 c.c. of chloroform and allowing 24 hours for crystallisation; in another otherwise identical experiment the same result was achieved by extracting the residue with a warm alcohol-chloroform mixture (1:4), in which the *p*-compound remains undissolved. Total yield, 58%.

The *o*-derivative was next isolated by evaporating the chloroform and alcohol, and crystallising the residue from a small quantity of absolute alcohol at 0°. The crystals obtained were washed with alcohol-chloroform and the undissolved portion was crystallised 2—3 times from ethyl acetate containing the minimal quantity of alcohol necessary for solution (yields, up to 9%). *o*-Nitro- β -phenylethylammonium chloride crystallises as flattened needles or leaflets, m. p. 162—163° (Found: C, 47.1; H, 5.9. $C_8H_{11}O_2N_2Cl$ requires C, 47.4; H, 5.4%). On oxidation with potassium permanganate, it gives *o*-nitrobenzoic acid. (Yield of unpurified acid, 100%; m. p. 140—141°; mixed m. p. with genuine *o*-acid 141—144°, and with genuine *m*-acid 100—110°; after crystallisation from water, m. p. 141°; after crystallisation from chloroform, m. p. 144—145° and mixed m. p.'s with the *o*- and *m*-acids 144—145° and 105—110°, respectively. These particulars are recorded because Ehrlich and Pistschimuka, by oxidising their "meta" salt, obtained an acid which, after crystallisation from water, had m. p. 140°. This is the m. p. of pure *m*-nitrobenzoic acid, but it is also that of the *o*-nitrobenzoic acid obtained by us by oxidation and crystallised from water.)

The genuine *m*-derivative was isolated as its *oxalate* by basifying the residue from the combined mother-liquors with sodium hydroxide, extracting it with ether, precipitating the salt with anhydrous oxalic acid in dry ethereal solution, and crystallising it from 90% alcohol until the m. p. rose to and remained constant at 200° (decomp.) (Found: C, 46.7; H, 4.8. $C_{10}H_{12}O_6N_2$ requires C, 46.9; H, 4.7%). *m*-Nitro- β -phenylethylammonium chloride, which separates from alcohol in platelets or flattened needles, has m. p. 204—205° (Found: C, 47.5; H, 5.5; N, 13.6. $C_8H_{11}O_2N_2Cl$ requires C, 47.4; H, 5.4; N, 13.8%). On oxidation by permanganate, *m*-nitrobenzoic acid was obtained. (Yield, before purification, 102%; m. p. 131—135°; mixed m. p. with genuine *m*-acid 138—140°, and with *o*-acid 100—110°; after one crystallisation from ethyl acetate-ligroin, m. p. 139—140°, mixed m. p. with *m*-acid, 139—140°, and with *o*-acid 105—115°.)

(ii) *Estimation of Isomerides*.—Since the three isomerides can be oxidised practically quantitatively to the readily separable nitrobenzoic acids, it was decided to employ that method (Baker

and Ingold, *loc. cit.*) for the estimation of the proportions, although, preliminary experiments having shown that the *o*- and *p*-derivatives do not lose their side chains on reduction and subsequent bromination, it is probable that this method also would have worked (Goss, Ingold, and Wilson, *loc. cit.*).

(a) The base (10.00 g.) was nitrated as described above, and the main quantity of *p*-nitro-derivative removed as hydrochloride (7.68 g. = 46%). The residues (7.48 g. = 45%) were intimately ground and 2.00 g. were oxidised by gradually adding the theoretical quantity of 3% permanganate solution to a boiling solution of the salt in 200 g. of water, the addition being timed to keep pace with decolorisation. The yield of mixed acids was 1.60 g. (=97%) (Found: *M*, 167. Calc.: *M*, 167. Benzoic acid, by sublimation, 0.25%). The separation was performed with 1.512 g. after the removal of the benzoic acid. The *p*-acid (21%) * had m. p. 232°, mixed m. p. 233—235°; the *m*-acid (26%) * had m. p. 130°, mixed m. p. 136—138°, and, after one crystallisation from ligroin-ethyl acetate, m. p. 139—140°. Hence the original nitration product is estimated to have contained, *para* = $(46 + 0.21 \times 45)/91 = 61\%$; *meta* = $0.26 \times 45/91 = 13\%$; *ortho* (by difference only) = 26%.

An artificial mixture of the *p*-, *m*-, and *o*-hydrochlorides in the respective proportions 62.3%, 14.1%, 23.6%, on oxidation gave nitrobenzoic acids (yield 99%), which on separation yielded 61.7% of *p*-acid, m. p. 230—234°, mixed m. p. 234—235°, and 13.0% of *m*-acid, m. p. 132—133°, mixed m. p. 137—139°.

(b) The base (10.00 g.) was nitrated, and the diluted acid solution was extracted with ether, basified with alkali, and then again extracted. The second extract was dried with sodium sulphate, precipitated with dry hydrogen chloride, and then completely evaporated. The residue (16.3 g. = 97%) after grinding was oxidised (2.00 g.) as before (yield 1.61 g. = 98%; *M*, 168; benzoic acid, nil), and the isomeric acids were separated. The *p*-acid (65%) had m. p. 229—234°, mixed m. p. 232—235°; and the *m*-acid (11%) had m. p. 129—133°, mixed m. p. 138—140°.

(c) A portion (10.00 g.) of the mixed hydrochlorides obtained in experiment (b) was separated into 5.01 g. of *p*-nitro- β -phenylethylammonium chloride and 4.97 g. of residues (0.02 g. lost). The residues were oxidised as usual (yield 4.03 g. = 98.5%; *M*, 166, 166; benzoic acid 0.35%), and the acids separated. The *p*-acid (28%) had m. p. 234—235°, mixed m. p. 234—235°; the *m*-acid (26%) had m. p. 133—136°, mixed m. p. 139—140°. Hence the

* These and the other percentages of *p*- and *m*-nitrobenzoic acids given in this section are already corrected for the solubility of the *p*-acid and the *m*-barium salt (Baker and Ingold, *loc. cit.*).

original mixture is estimated to have contained, *para* = $(50.1 + 49.7 \times 0.28)/99.8 = 64\%$; *meta* = $49.7 \times 0.26/99.8 = 13\%$; *ortho* (by difference) 23%.

(B) *Nitration of Methyl-β-phenylethylamine.*

(d) The base (4.5 g.) was nitrated at -10° to -5° with 30 g. of nitric acid (*d* 1.5), the conditions being otherwise as described for experiment (a); the product (yield 97.5%) was isolated as hydrochlorides, as in experiment (b), and oxidised in the usual way. The mixed nitrobenzoic acids (yield 101%; *M*, 167, 168; benzoic acid, nil) on separation contained *p*-nitrobenzoic acid (61%) having m. p. 233–234°, mixed m. p. 234–235°, and *m*-nitrobenzoic acid (15%), m. p. 125–135°, mixed m. p. 139–140°, m. p. after one crystallisation 140°.

(e) The picrate (m. p. 140–141°; Johnson and Guest, *Amer. Chem. J.*, 1909, 42, 340) of the base was nitrated in 7.5 parts of nitric acid (*d* 1.50) at -10° to -5° and the product was mixed with ice, extracted with benzene, basified and extracted with ether. The residue from the ether on precipitation in benzene solution with picric acid gave 93.2% of mixed picrates. These were oxidised as usual (excepting that permanganate sufficient to destroy the picrate ions was added rapidly, and only the remaining quantity cautiously) and gave 97.6% of mixed acids (*M*, 166, 167. Benzoic acid, nil). The separated *p*-acid (65%) had m. p. 230–235°, mixed m. p. 233–235°, and the *m*-acid (15%) m. p. 125–135°, mixed m. p. 139–140°.

(C) *Nitration of Dimethyl-β-phenylethylamine.*

(i) *Qualitative Separation of Isomerides.*—The base was nitrated in the form of its picrate (7.5 g.) with nitric acid (45 g.; *d* 1.50) at -10° , and at the end of the process the temperature was allowed to rise to 0° ; ice was then added, and, after extraction of the picric acid and any neutral by-products with benzene, the nitro-bases were liberated with sodium hydroxide and extracted with ether. In one experiment, the product (yield 90%) was isolated as picrates, and in another as oxalates, by precipitation in each case with the appropriate acid in dry benzene and ether respectively.

Dimethyl-*p*-nitrophenylethylammonium oxalate (Barger, *J.*, 1909, 95, 2195) may be obtained from the mixed oxalates, but owing to the sparing solubility of the *m*-oxalate, this method is less satisfactory than the separation of the *p*-nitro-picrate from the mixed picrates, by crystallisation from acetone–benzene (1 : 6) or acetone–alcohol. *Dimethyl-p-nitro-β-phenylethylammonium picrate* crystallises both in well-defined needles and in cubes, the

latter modification being apparently the more stable, m. p. 162° (Found : C, 45.1; H, 4.1. $C_{16}H_{17}O_9N_5$ requires C, 45.4; H, 4.0%). Oxidation with permanganate gave *p*-nitrobenzoic acid (yield 100%; m. p. 234—235°).

The same compounds were prepared from the primary salts as follows. *p*-Nitro- β -phenylethylammonium chloride (8 g.) and 38% aqueous formaldehyde (16 c.c.) were heated together at 135° for 3 hours, and the bases liberated by the addition of sodium hydroxide to the cooled solution extracted with ether. The oxalate, m. p. 154°, precipitated by the addition of dry ethereal oxalic acid was identical with the separated oxalate (above), and the similarly prepared picrate with the separated picrate.

Dimethyl-m-nitro- β -phenylethylammonium oxalate was isolated from the oxalate mixture by repeatedly crystallising it from 95% alcohol and diluting the filtrates of the later crystallisations with 100% alcohol; needles, m. p. 186°, then separated (Found : C, 50.5; H, 5.7. $C_{12}H_{16}O_6N_2$ requires C, 50.7; H, 5.7%). The *picrate*, prepared by precipitation of an alcoholic solution of the oxalate with picric acid, formed stout needles or prisms, m. p. 166—167° (Found : C, 45.4; H, 4.4. $C_{16}H_{17}O_9N_5$ requires C, 45.4; H, 4.0%). On oxidation of the oxalate with nitric acid, *m*-nitrobenzoic acid was obtained, and the same acid (m. p. 134—138°, mixed m. p. 139—140°) was obtained in 99% yield by the action of permanganate on the picrate.

We did not encounter the *o*-nitro-salts in the course of the above separations, but in order to study its behaviour on oxidation, we prepared *dimethyl-o-nitro- β -phenylethylammonium picrate* from the hydrochloride of the primary *o*-nitro-base by the formaldehyde method described above. The salt crystallised from alcohol-acetone in yellow prisms, m. p. 160—161° (Found : C, 45.8; H, 4.1. $C_{16}H_{17}O_9N_5$ requires C, 45.4; H, 4.0%). On oxidation with permanganate by the usual method, it gave *o*-nitrobenzoic acid. (Yield, unpurified, 102%; m. p. 138—142°, mixed m. p. 140—143°; crystallised from chloroform, m. p. 146°, mixed m. p. 146°.) Although the three isomeric picrates melt at not very different temperatures, they depress each other's m. p. by 15—30°.

(ii) *Estimation of Isomerides.*—(f) The nitration product isolated in the form of picrates (yield 93%; Found : C, 45.5; H, 4.3. Calc. : C, 45.4; H, 4.0%), on oxidation as usual, gave nitrobenzoic acids in 101% yield (*M*, 168; benzoic acid, nil). A sample of the mixture on separation was found to contain 70% of *p*-nitrobenzoic acid (m. p. 234—235°, mixed m. p. 234—235°) and 12% of *m*-nitrobenzoic acid (m. p. 120—130°, mixed m. p. 133—136°; crystallised once, m. p. 139—140°, mixed m. p. 140°).

(g) By crystallisation from acetone-benzene the mixed picrates were divided into two portions constituting 66% and 34% of the whole. The first, on oxidation, gave acids (yield 100%; benzoic acid, nil) which, on separation, contained *p*-nitrobenzoic acid (yield 85%) having m. p. 232—233°, and mixed m. p. 233—238°, and *m*-nitrobenzoic acid (yield 11%) having m. p. 128—133°, mixed m. p. 136—138°. The second gave acids (yield 101%; benzoic acid 1.2%; *M*, 165, 166) which contained the *p*-acid (30%), m. p. 220—232°, mixed m. p. 225—235°, and the *m*-acid (19%), m. p. 130—137°, mixed m. p. 139—140°. The original mixture is therefore estimated to have contained *para* 66%, *meta* 14%, *ortho* (by difference) 20%.

(D) Nitration of Trimethyl- β -phenylethylammonium Picrate.

(i) *Qualitative Separation of Isomerides*.—Trimethyl- β -phenylethylammonium picrate (Decker and Becker, *Ber.*, 1912, **45**, 2404) was nitrated in nitric acid at $-1-0^\circ$, and the nitric acid solution was warmed to 15° , mixed with ice (picric acid separated), just basified with concentrated sodium hydroxide solution, and cooled to -10° ; the nitro-picrates then separated (α ; yield 92%). The filtrate, on saturation with sodium picrate, yielded a further small quantity of crystalline material (β), and more was obtained from the mother-liquor by concentration and extraction with ethyl acetate (γ). The aqueous solution was finally evaporated to dryness, and the residue extracted with alcohol (δ).

The mixture (α), on crystallising twice from boiling alcohol, yielded pure trimethyl-*p*-nitro- β -phenylethylammonium picrate as yellow leaflets, m. p. 144—145° (yield 50%) (Found: C, 46.4; H, 4.5. $C_{17}H_{19}O_9N_5$ requires C, 46.7; H, 4.4%). The corresponding iodide forms pale yellow needles, m. p. 206° (Found: I, 37.5. $C_{11}H_{17}O_2N_2I$ requires I, 37.8%). This was prepared by boiling a benzene solution of dimethyl-*p*-nitrophenylethylamine (from 1.5 g. of oxalate) with sodium carbonate (2 g.) and methyl iodide (2.3 c.c.) for 3 hours, washing the salts with hot benzene, and extracting the quaternary iodide with hot alcohol, from which it separated on cooling. The above picrate was also prepared from *p*-nitrophenylethylammonium chloride (0.75 g.) by boiling its solution in absolute alcohol (20 c.c.) for 2 hours with methyl sulphate (2.5 c.c.) and sodium carbonate (2 g.). After water had been added, and the alcohol boiled off, the solution was extracted with ether, and the quaternary picrate precipitated by addition of a solution of sodium picrate to the aqueous solution (yield 55%). On oxidation by permanganate *p*-nitrobenzoic acid was formed (yield 100%; m. p. 230—235°; mixed m. p. 232—235°).

The mixtures (β), (γ), and (δ) contained sodium salts, from the bulk of which they were freed by washing with cold water. The products thus partly purified were crystallised *slowly* from boiling alcohol or water, and the three isomerides separated by mechanical means. The *p*-picrate was the only one which separated in plates; the other two formed needles, but those of the *o*-compound were of a paler yellow colour than those of the *m*-isomeride.

Trimethyl-m-nitro- β -phenylethylammonium picrate separates from alcohol in short needles (especially when slightly impure), and when pure, in felted masses of flexible, hair-like crystals, m. p. 147—148° (Found: C, 46.7; H, 4.5. $C_{17}H_{19}O_9N_5$ requires C, 46.7; H, 4.4%). Mixtures with the *o*- and *p*-isomerides melted at about 125°. The same substance was prepared from *m*-nitro- β -phenylethylammonium chloride by methylation with methyl sulphate as described above. On oxidation by permanganate *m*-nitrobenzoic acid was obtained in 100% yield (m. p. 135—136°; mixed m. p. 139—140°).

The *trimethyl-o-nitro- β -phenylethylammonium picrate* obtained as described above was identical with the picrate obtained from the product of the action of the alcoholic methyl sulphate and sodium carbonate on *o*-nitro- β -phenylethylammonium chloride, and with the picrate which was precipitated when *o*-nitro- β -phenylethyldimethylamine was mixed with *s*-trinitroanisole in benzene solution. Crystallised from alcohol, it formed bright yellow, brittle needles, m. p. 146—147° (Found: C, 46.7; H, 4.5. $C_{17}H_{19}O_9N_5$ requires C, 46.7; H, 4.4%). The yield of *o*-nitrobenzoic acid (m. p. 145—147°; mixed m. p. 145—147°; mixed m. p. with *m*-nitrobenzoic acid 110—120°) obtained on oxidation by permanganate was 100%.

(ii) *Estimation of Isomerides.*—(h) The quaternary picrate (8.00 g.) was added to 60 g. of nitric acid (d^{16} 1.50) at -5° during 10 minutes, and the product was warmed to 10° during 5 minutes, kept at 10° for 15 minutes, and then mixed with ice and worked up for the *p*-compound as described above. The pure *p*-compound isolated weighed 4.75 g., and the combined residues, when freed from sodium salts, etc., 3.94 g. The total yield was therefore 97.5%, the *p*-isomeride constituting 55% and the residues 45% of this isolated material. On oxidation by the customary method, nitrobenzoic acids (*M*, 166, 165, 166; benzoic acid, nil) were obtained in 89% yield, and this mixture contained 33% of *p*-nitrobenzoic acid (m. p. 230—235°) and 38% of *m*-nitrobenzoic acid (m. p. 120—135°, mixed m. p. 137—140°; after one crystallisation from ethyl acetate, m. p. 138—140°, mixed m. p. 139—140°). The original nitration product

is therefore estimated to have contained: *para*, $55 + 0.33 \times 45 = 70\%$; *meta*, $0.38 \times 45 = 17\%$; *ortho* (by difference), 13% .

An artificial mixture of *p*-, *m*-, and *o*-picrates in the respective proportions, 68.4%, 19.9%, 11.7%, on oxidation gave a 97% yield of nitrobenzoic acids, which on separation gave 67.0% of *p*-acid, m. p. 233—234°, mixed m. p. 235°, and 19.1% of *m*-acid, m. p. 128—133°, mixed m. p. 136—139°.

(i) Another oxidation of the same mixture yielded 91% of mixed nitrobenzoic acids (*M*, 167, 168; benzoic acid, nil), and the mixture, on separation, was found to contain 24% of *p*-acid (m. p. 200—230°; mixed m. p. 225—235°) and 46% of *m*-acid (m. p. 115—130°; mixed m. p. 133—138°; m. p. after one crystallisation from ethyl acetate-ligroin, 137—140°). For the original nitration product this gives: *para*, 66%; *meta*, 21%; *ortho* (by difference) 13%. In view of the fact that in this and the previous experiment the mixed nitrobenzoic acids were obtained in only $90 \pm 1\%$ yield, these figures are regarded as rather less accurate than the others given in this paper.

(E) Nitration of Trimethylbenzylammonium Picrate.

For the sake of the numerical comparison on p. 250 this substance was prepared and nitrated under the conditions employed in example (D) and in the case of triethylbenzylammonium picrate (Goss, Ingold, and Wilson, *loc. cit.*), and the proportions of the isomerides were estimated. Ing and Robinson (*loc. cit.*) nitrated trimethylbenzylammonium nitrate and isolated 73.6% of pure *m*-derivative.

Benzyl dimethylamine and trinitroanisole (1 mol.) were heated together in benzene solution at 70—75° for 0.5 hour, and the *trimethylbenzylammonium picrate* was collected and crystallised from alcohol, from which it separated in clusters of yellow prisms, m. p. 168—169° (Found: C, 51.2; H, 5.1. $C_{16}H_{18}O_7N_4$ requires C, 50.8; H, 4.8%).

The bulk of the nitration product was precipitated with gaseous ammonia (*loc. cit.*), the neutral filtrate evaporated to dryness, and the residue, after grinding with a little cold water, crystallised from boiling water. Total yield 93.6% (Found: C, 45.6; H, 3.7. $C_{16}H_{17}O_9N_5$ requires C, 45.4; H, 4.0%).

Separation.—The principle employed was that crystallisation from or extraction with concentrated alcohol favours the isolation of the *m*-compound, whilst in dilute alcohol or water this isomeride is relatively easily soluble. The well-ground and mixed nitration product (10.00 g.) was boiled with a large bulk of absolute alcohol, the solution filtered while still hot, and the residue crystallised from

50% alcohol (7.30 g. of meta, m. p. 179.5—180.5°). The aqueous-alcoholic solution was concentrated and alcohol was added (0.67 g. of meta, m. p. 179—180°), and the combined aqueous and alcoholic solutions were then evaporated to dryness and the residue was extracted with successive portions of hot absolute alcohol until the m. p. of the undissolved portion rose above 175°. This portion was then crystallised from 50% alcohol (0.42 g. of meta, m. p. 179—180°) and the filtrate was concentrated and mixed with alcohol as before (0.17 g. of meta, m. p. 178—179.5°). All liquors were now combined and evaporated and the residue was crystallised from water (0.23 g. of para, m. p. 193—194°), the filtrate being concentrated (0.12 g. of para, m. p. 192—194°) and mixed with alcohol (0.02 g. of meta, m. p. 178—179°). The totals separated are therefore : para 3.5%, meta 85.8% (total 89.3%). The mother-liquors were now distilled completely from a water-bath under slightly diminished pressure and the distillate was treated with sodium picrate prepared from 0.5 g. of picric acid, and with 0.67 g. of *m*-nitrobenzyltrimethylammonium picrate. The undissolved portion weighed 0.44 g., so that the saturated solution contained 0.23 g., and 0.62 g. of picrate ions. The quantity of picrate ions contained in the solution before the distillation was 0.59 g.

The residue from the distillation, on oxidation with 240 c.c. of 3% permanganate and 200 c.c. of water, gave 0.305 g. of acids, from which 0.201 g. of *p*-nitrobenzoic acid (m. p. 230—233°; mixed m. p. 232—234°) was obtained by digestion with chloroform (solubility correction, 0.026 g.), but the separation of *m*-nitrobenzoic acid through the barium salt was spoiled by the presence of oxalic acid. *p*-Nitrobenzyltrimethylammonium picrate (1.50 g.), on oxidation under the same conditions, gave 0.55 g. of *p*-nitrobenzoic acid (m. p. 234—235°)—that is, 90% of the theoretical—so that the *p*-nitrobenzoic acid isolated by oxidation of the residues may be taken to correspond with 0.64 g. of the *p*-picrate.

Hence, for the original nitration product, we have :

	Separation.	Solubility.	Oxidation.	Total.
Ortho-	—	—	—	—*
Meta-	85.8	2.3	—	88%
Para-	3.5	—	0.4	10 „

* The figure, 2%, obtained by difference is without significance.

For use in identifying the separated products, the *m*- and *p*-nitro-compounds were prepared from the appropriate tertiary base and trinitroanisole. *m*-Nitrobenzyltrimethylammonium picrate separates from water in pyramid-capped prisms or stout rhombs, m. p. 180—180.5° (Found : C, 45.7; H, 4.2. C₁₆H₁₇O₉N₅ requires

C, 45.4; H, 4.0%). It is very sparingly soluble in boiling methyl or ethyl alcohol. *p*-Nitrobenzyltrimethylammonium picrate separates from water or ethyl alcohol in fern-like aggregates of leaflets or flattened needles, m. p. 194° (Found : C, 45.8; H, 4.1%).

THE UNIVERSITY, LEEDS.

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