436. *The Action of Nitric Acid on the* 1-*Acyl*-2 : 3-*diphenylindoles.*

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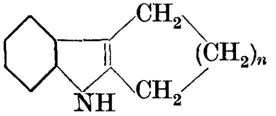
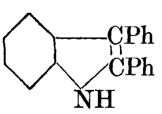
Previous work (for references, see footnote, J., 1931, 93) has shown that, although the *N*-acyl derivatives of tetrahydrocarbazole (I; $n = 2$) and of dihydropentindole (I; $n = 1$) readily form products during nitration by the addition of 2OH, or OH and NO_2, to the double linkage, the tendency to form similar compounds is enormously diminished when the indole nucleus is contained in more complex polycyclic systems with four rings fused together. The present investigation was instituted to discover how far these additive reactions can be realised with the simple indole nucleus, and, to avoid substitution in the 3-position, the acyl derivatives of the readily accessible 2 : 3-diphenylindole (II) were selected for the purpose.

(I.)





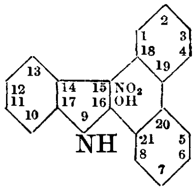
(II.)

In order to identify substitution products Fischer's reaction has been applied to the *m*-nitrophenylhydrazone of phenyl benzyl ketone and a mixture of the two possible nitrodiphenylindoles has been obtained: 4(or 6)-*nitro*-2 : 3-*diphenylindole*, m. p. 227—228°, and 6(or 4)-*nitro*-2 : 3-*diphenylindole*, m. p. 205°. By a similar process 5-*nitro*-2 : 3-*diphenylindole* has been prepared, but it has not been possible to remove ammonia from the o-*nitrophenylhydrazone* of phenyl benzyl ketone.

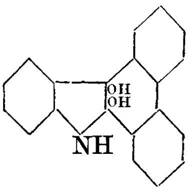
The action of nitric acid on 1-*acetyl*-2 : 3-*diphenylindole* was complex and yielded a number of products under different conditions. The simplest of these was 4(or 6)-*nitro*-1-*acetyl*-2 : 3-*diphenylindole*; and one of the most readily accessible was a substance, $C_{20}H_{14}O_3N_2$, which is doubtless 15-*nitro*-16-*hydroxy*-15 : 16-*dihydrophenanthracarbazole* (III), since, like the simpler nitric acid addition compounds previously described, it is colourless and melts with evolution of oxides of nitrogen. In boiling acetic acid, this product was converted into a red isomeric *compound*, which does not decompose on melting.

Another colourless compound, $C_{20}H_{13}O_4N_3$, m. p. 170° (decomp.), isolated under other conditions, is probably the 9-*nitroso*-derivative of (III). Two further products, $C_{20}H_{14}O_4N_2$ and $C_{20}H_{13}O_6N_3$, have been characterised, and, like the simpler dihydroxy-addition compounds, they melt without decomposition. It is probable that these are a *mononitro*- and a *dinitro*-derivative respectively of 15 : 16-*dihydroxy*-15 : 16-*dihydrophenanthracarbazole* (IV).

(III.)



(IV.)



Since the formation of most of the above substances involves the removal of the acetyl group, it appeared probable that some of them would result from the nitration of other acyl derivatives of 2 : 3-diphenylindole. Preliminary experiments with the 1-*benzoyl*- and the 1-*carbethoxy*-compound showed that the simple 4(or 6)-*nitro*-derivatives were the main products under the conditions employed, but 1-*cinnamoyl*-2 : 3-*diphenylindole* has yielded not only its 4(or 6)-*nitro*-derivative but also the compound (III) and a small quantity of the nitroso-product, m. p. 170° (decomp.). The latter result strongly supports the structures advanced for the compounds derived from 1-acetyl-2 : 3-diphenylindole.

Since the formation of these derivatives involves an additive reaction, hydrolysis of the acyl group, and production of the phenanthrene ring by oxidation, in unknown order, this field is clearly unsuitable for the study outlined at the beginning.

EXPERIMENTAL.

Benzoin (32 g.), $PhNH_2$ (48 g.), and $PhNH_2,HCl$ (20 g.) were heated under a fractionating column so that H_2O and a very little $PhNH_2$ distilled. When H_2O ceased to be evolved (1 hr.), the mixture was stirred with dil. HCl until it solidified. The 2 : 3-diphenylindole, after being washed with dil. HCl and with EtOH, crystallised from EtOH in colourless prisms (31 g.), m. p. 123° (cf. Japp and Murray, J., 1894, **65**, 889).

Its 1-*acetyl* derivative, obtained by shaking in acetone with conc. KOH aq. and AcCl, followed by dilution with H_2O, separated from AcOH in almost colourless needles, m. p. 138° (Found: N, 4·6. $C_{22}H_{17}ON$ requires N, 4·5%).

5-*Nitro*-1-*acetyl*-2 : 3-*diphenylindole*.—*p*-Nitrophenylhydrazine (5 g.) and phenyl benzyl ketone (7 g.) were heated together at 135° for ½ hr.; the *hydrazone* formed separated from EtOH in orange-red plates, m. p. 158—160° (Found: N, 12·7. $C_{20}H_{17}O_2N_3$ requires N, 12·7%). A solution of the latter (1 g.) in AcOH (25 c.c.) and conc. HCl (15 c.c.) was refluxed for 8 hr., diluted with H_2O, and extracted with Et_2O. The extract, after being shaken with dil. Na_2CO_3 aq., was dried with $CaCl_2$ and evaporated; the residual 5-nitro-2 : 3-diphenylindole separated from AcOH containing a little H_2O in golden-yellow plates, m. p. 211° (previous sintering). When this substance was acetylated by the method described above, 5-*nitro*-1-*acetyl*-2 : 3-*diphenylindole* was obtained; brownish-yellow plates, m. p. 158°, from EtOH (Found: C, 74·2; H, 4·4. $C_{22}H_{16}O_3N_2$ requires C, 74·2; H, 4·5%).

4(or 6)-*Nitro- and* 6(or 4)-*Nitro*-2 : 3-*diphenylindole*.—Prepared like the corresponding *p*-nitro-compound, the *m*-nitrophenylhydrazone of phenyl benzyl ketone separated from petroleum (b. p. 100—120°) in red needles, m. p. 157—158°. A solution of this hydrazone (2 g.) in AcOH (50 c.c.) and conc. HCl (30 c.c.) was boiled for 16 hr., and, when the product (m. p. 170—180°) which separated on cooling was crystallised from EtOH, 4(or 6)-*nitro*-2 : 3-*diphenylindole* was obtained in golden-brown plates, m. p. 227—228° (Found: N, 8·6. $C_{20}H_{14}O_2N_2$ requires N, 8·9%). The alc. mother-liquor from the crystn. of this compound yielded, on concn., a product, m. p. about 180°; when twice recryst. from C_6H_6, this gave 6(or 4)-*nitro*-2 : 3-*diphenylindole* in yellow needles, m. p. 205° (Found: N, 9·0%), the 1-*acetyl* derivative of which formed yellow needles, m. p. 187°, from EtOH (Found: C, 74·1; H, 4·5%).

The *o-nitrophenylhydrazone* of phenyl benzyl ketone, prepared like the *p*-nitro-compound, separated from much EtOH in red needles, m. p. 143° (Found: N, 12·5%).

Nitration of 1-*Acetyl*-2 : 3-*diphenylindole*.—(A) When a solution of this compound (1·2 g.) in AcOH (5 c.c.) at 80° was treated with HNO_3 (0·3 g., *d* 1·5, in 1·5 c.c. AcOH) and allowed to cool, 4(or 6)-*nitro*-1-*acetyl*-2 : 3-*diphenylindole*, yellow needles, m. p. 210°, from EtOH, separated (Found: C, 74·3; H, 4·6%). The product was refluxed for ½ hr. with aq.-alc. KOH, and the 4(or 6)-nitro-2 : 3-diphenylindole which separated on cooling (m. p. 228°, after crystn. from EtOH) was shown by mixed m. p. to be identical with the synthetical specimen.

(B) When a solution of 1-acetyl-2 : 3-diphenylindole (10 g.) in AcOH (40 c.c.) at 80° was treated with HNO_3 (2·5 c.c., *d* 1·5, in 7 c.c. AcOH) and then boiled for 5 min., oxides of N were evolved and 15-*nitro*-16-*hydroxy*-15 : 16-*dihydrophenanthracarbazole* (III) (3·5 g.), colourless needles, m. p. 262° (decomp.), from acetone, separated (Found: C, 72·7, 72·9; H, 4·4, 4·2; N, 8·5. $C_{20}H_{14}O_3N_2$ requires C, 72·7; H, 4·2; N, 8·5%). After the AcOH mother-liquor had been concentrated, a small amount of 4(or 6)-nitro-1-acetyl-2 : 3-diphenylindole (purified by crystn. from EtOH) was obtained.

After a solution of the compound (III) (2 g.) in AcOH (70 c.c.) had been refluxed for 12 hr., H_2O pptd. the isomeric ?-*nitro*-16-*hydroxy*-15 : 16-*dihydro*-

phenanthracarbazole, red prisms, m. p. 227°, from EtOH (Found: C, 72·6, 72·2; H, 4·1, 4·1; N, 8·3%), a *monoacetyl* derivative of which crystallised from EtOH in yellow prisms, m. p. 175—176° (Found: C, 71·3; H, 4·1; N, 7·5. $C_{22}H_{16}O_4N_2$ requires C, 71·0; H, 4·3; N, 7·5%).

(C) HNO_3 (2 g., *d* 1·5, in a little AcOH) was slowly stirred into a suspension of 1-acetyl-2 : 3-diphenylindole (5 g.) in AcOH (30 c.c.), the temp. being maintained carefully at 50°. The clear cooled solution deposited after 12 hr. a small amount of 4(or 6)-nitro-1-acetyl-2 : 3-diphenylindole, m. p. 209° (after crystn. from EtOH). After a further 12 hr., a yellow product separated; on crystn. from acetone and then MeOH, this gave 15-*nitro*-9-*nitroso*-16-*hydroxy*-15 : 16-*dihydrophenanthracarbazole* in colourless plates, m. p. 170° (decomp.) (Found: C, 66·7, 67·1; H, 3·6, 3·9; N, 11·9, 11·6. $C_{20}H_{13}O_4N_3$ requires C, 66·9; H, 3·6; N, 11·7%). The AcOH mother-liquor was then left for a further 24 hr., during which yellow crystals, m. p. 170—180°, were obtained. On crystn. twice from a relatively large volume of EtOH, these gave ?-*nitro*-15 : 16-*dihydroxy*-15 : 16-*dihydrophenanthracarbazole* in yellow needles, m. p. 192° (Found: C, 69·3, 69·5; H, 4·0, 4·2; N, 8·2, 8·3. $C_{20}H_{14}O_4N_2$ requires C, 69·4; H, 4·0; N, 8·1%). The AcOH mother-liquor finally deposited after 1—2 weeks a small quantity of a fluffy product, m. p. 170—190°; on crystn. from EtOH and then acetone, this gave ? ?-*dinitro*-15 : 16-*dihydroxy*-15 : 16-*dihydrophenanthracarbazole* in almost colourless needles, m. p. 215° (Found: C, 61·6, 61·6; H, 3·4, 3·5; N, 10·6, 10·5. $C_{20}H_{13}O_6N_3$ requires C, 61·4; H, 3·3; N, 10·7%).

Nitration of 1-*Benzoyl*-2 : 3-*diphenylindole*.—The *benzoyl* compound, prepared in a similar way to the acetyl derivative, was a gum which crystallised only after extraction with Et_2O and subsequent grinding with EtOH. It then separated from EtOH in lemon-yellow needles, m. p. 153° (Found: N, 3·5. $C_{27}H_{19}ON$ requires N, 3·7%). A solution of the benzoyl compound (2 g.) in AcOH (10 c.c.) at 80° was treated with HNO_3 (0·8 g., *d* 1·5, in a little AcOH), and the mixture boiled for 5 min. On cooling and stirring, 4(or 6)-*nitro*-1-*benzoyl*-2 : 3-*diphenylindole* (1·2 g.), yellow needles, m. p. 215°, from acetone, was obtained (Found: N, 6·5. $C_{27}H_{18}O_3N_2$ requires N, 6·7%). Hydrolysed under the same conditions as the acetyl compound, it gave (mixed m. p.) 4(or 6)-nitro-2 : 3-diphenylindole.

Nitration of Ethyl 2 : 3-*Diphenylindole*-1-*carboxylate*.—Prepared in the same way as the benzoyl derivative, ethyl chloroformate being used, this *ester* separated from EtOH in colourless prisms, m. p. 110° (Found: N, 4·0. $C_{23}H_{19}O_2N$ requires N, 4·1%). When it was nitrated under the conditions used for the benzoyl derivative, *ethyl* 4(or 6)-*nitro*-2 : 3-*diphenylindole*-1-*carboxylate*, yellow needles, m. p. 184°, from acetone, separated (Found: N, 7·3. $C_{23}H_{18}O_4N_2$ requires N, 7·2%), the identity of which was established by hydrolysis to 4(or 6)-nitro-2 : 3-diphenylindole (mixed m. p.).

The same nitro-derivative crystallised from the solution when the ester was treated in AcOH with fuming HNO_3 at 50° as described for the acetyl compound.

Nitration of 1-*Cinnamoyl*-2 : 3-*diphenylindole*.—Prepared like the corresponding acetyl derivative, cinnamoyl chloride being used, this *cinnamoyl* compound separated from AcOH in yellow prisms, m. p. 192° (Found: C, 87·1; H, 5·2; N, 3·5. $C_{29}H_{21}ON$ requires C, 87·2; H, 5·3; N, 3·5%).

After its solution in AcOH (2·5 g. in 60 c.c.) at 80° had been treated with HNO_3 (0·6 g., *d* 1·5 and boiled for 5 min., the substance (III) separated on standing. The identity of the latter was established by conversion into the isomeric compound, m. p. 227°, as described above.

A suspension of the cinnamoyl compound (1·5 g.) in AcOH (20 c.c.) at 50° was treated with HNO_3 (0·4 g., *d* 1·5, in 2 c.c. AcOH) and mechanically stirred for an hour, AcOH being added at intervals to replace that lost by evaporation. After a short time, 4(or 6)-*nitro*-1-*cinnamoyl*-2 : 3-*diphenylindole*, yellow needles, m. p. 254°, from xylene, separated (Found : N, 6·3. $C_{29}H_{20}O_3N_2$ requires N, 6·3%). The constitution of the latter was established by hydrolysis with aq.-alc. KOH to 4(or 6)-nitro-2 : 3-diphenylindole (mixed m. p.). When the AcOH mother-liquor was left for a further 2 days, a mixture containing a small quantity of colourless plates crystallised. The plates, removed by hand and washed, melted, alone or mixed with 15-nitro-9-nitroso-16-hydroxy-15 : 16-dihydrophenanthracarbazole, at 165° (decomp.).

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