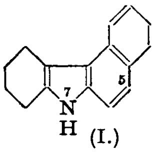
220. *C-Acetylation of α'β'-Naphthindole (4 : 5-Benzindole) Derivatives.*

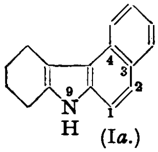
By S. G. P. Plant and M. W. Thompson.

8 : 9-Dimethyl- and 8 : 9-diphenyl-α'β'-naphthindole (2 : 3-dimethyl- and 2 : 3-diphenyl-4 : 5-benzindole) (III) have been converted, by the action of hot acetic anhydride and a catalyst such as sulphuric acid or phosphoric acid, into compounds which contain a *C*-acetyl group. Other derivatives of these indoles have also been prepared, and some of the substances have been oxidised to substituted naphthalenes.

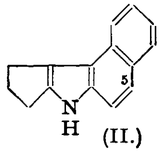
It was found by Oakeshott and Plant (*J.*, 1928, 1840) that 8 : 9 : 10 : 11-tetrahydro-α'β'-naphthacarbazole (I) [5 : 6 : 7 : 8-tetrahydro-3 : 4-benzcarbazole (I*a*)] * was readily converted by hot acetic anhydride in the presence of a few drops of concentrated sulphuric acid first into the *N*-acetyl, and then into a *C* : *N*-diacetyl derivative, the latter of which was hydrolysed to the corresponding *C*-acetyl compound. The point of attachment of the *C*-acetyl group was not determined, but it was later suggested that it occupied the 5-position in an analogous compound obtained similarly from 9 : 10-dihydro-α'β'-naphthapentindole (II) (Bryant and Plant, *J.*, 1931, 93). 8 : 9-Dimethyl-α'β'-naphthindole (III; R = Me) [2 : 3-dimethyl-4 : 5-benzindole (III*a*; R = Me)] has now been similarly converted into its 5 : 7-*diacetyl* derivative and thence into 5-*acetyl*-8 : 9-*dimethyl*-α'β'-*naphthindole* (6-*acetyl*-2 : 3-*dimethyl*-4 : 5-*benzindole*), the nature of which was confirmed by the preparation of its *oxime*. Other substances can be used in the place of sulphuric acid as catalysts in this reaction, and syrupy phosphoric acid has been found to be very convenient.



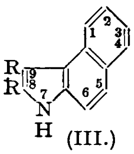
(I.)



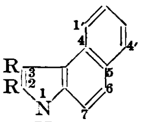
(I*a*.)



(II.)



(III.)



(III*a*.)

(IV.)

The position of the *C*-acetyl group in these compounds has not been rigorously proved, but there is now no reasonable doubt that they are 5-acetyl derivatives of (III) [= 6-acetyl derivatives of (III*a*)] for the following reasons: (i) bromination of the 7-acyl derivatives of (I) has given the 5-bromo-compounds (Plant and Tomlinson, *J.*, 1932, 2192); (ii) the above *C* : *N*-diacetyl compounds have also been obtained from the *N*-acetyl derivatives of (I) and (III; R = Me) with acetyl chloride and aluminium chloride under the conditions of a Friedel–Crafts reaction, a process which has been shown invariably to result in substitution at the corresponding positions in the closely related *N*-acyl derivatives of carbazole, 1 : 2 : 3 : 4-tetrahydrocarbazole, and 2 : 3-dimethylindole (*J.*, 1934, 1142; 1935, 741; 1936, 40; 1947, 1631); (iii) 5-bromo-7-acetyl-8 : 9 : 10 : 11-tetrahydro-α'β'-naphthacarbazole (2-bromo-9-acetyl-5 : 6 : 7 : 8-tetrahydro-3 : 4-benzcarbazole), in which there is already a substituent in the 5-position, was not affected by acetic anhydride under the conditions mentioned above.

Treatment of 8 : 9-diphenyl-α'β'-naphthindole (III; R = Ph) with hot acetic anhydride

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* The " naphtha " names are used to provide a link with earlier publications, but the " benz " names given in parentheses are now preferred. Ed.

and syrupy phosphoric acid resulted in the formation first of a *C*-acetyl compound, which was unaffected by boiling aqueous-alcoholic potassium hydroxide, and then of a *C* : *N*-diacetyl compound under more vigorous conditions. These substances are probably 5-*acetyl*- and 5 : 7-*diacetyl*-8 : 9-*diphenyl*-α'β'-*naphthindole*, and the latter was hydrolysed to the former.

The 7-*acetyl* derivatives of 8 : 9-dimethyl- and 8 : 9-diphenyl-α'β'-naphthindole have been obtained by treating the products from (III; R = Me and Ph respectively) and ethylmagnesium bromide with acetyl chloride. Both were hydrolysed to the original indole by hot alkali, and were converted into their 5-*bromo*-derivatives.

Koelsch (*J. Amer. Chem. Soc.*, 1944, **66**, 1983) found that 6-bromo-1-acetyl-2 : 3-diphenylindole could be oxidised by chromic acid in acetic acid to 5-bromo-2-benzoyl-*N*-acetylbenzanilide (IV), and the process has been extended by Ritchie (*J. Proc. Roy. Soc. N.S.W.*, 1946, **80**, 33) to other derivatives of 2 : 3-diphenylindole and by Gaudion, Hook, and Plant (*J.*, 1947, 1631) to 1-acetyl- and 1 : 6-diacetyl-2 : 3-dimethylindole. It therefore seemed probable that a similar oxidation of some of the above substances would provide a convenient route to certain di- and tri-substituted naphthalenes, and the reaction has been satisfactorily applied to 7-acetyl- and 5 : 7-diacetyl-8 : 9-dimethyl-α'β'-naphthindole, and to 5-bromo-7-acetyl-8 : 9-diphenyl-α'β'-naphthindole. It is surprising that when 7-acetyl-, 5 : 7-diacetyl-, and 5-bromo-7-acetyl-8 : 9 : 10 : 11-tetrahydro-α'β'-naphthacarbazole, in which a cyclic structure is attached at the 2 : 3-position in the indole system, were treated with chromic acid under similar conditions, analogous oxidation products could not be isolated.

EXPERIMENTAL.

8 : 9-*Dimethyl*-α'β'-*naphthindole* (2 : 3-*Dimethyl*-4 : 5-*benzindole*).—2-Naphthylhydrazine hydrochloride [from the amine (50 g.)] in alcohol (500 c.c.) containing sodium acetate (40 g.) at 50° was treated with methyl ethyl ketone (25 c.c.), and the mixture boiled for 10 minutes. After the addition of concentrated sulphuric acid (10 c.c.), the mixture was again boiled for 20 minutes, cooled, and diluted with water (1 l.) When the solid was crystallised from glacial acetic acid, the dimethyl compound was obtained in colourless plates, m. p. 131° (yield, 70%). Wolff (*Ber.*, 1888, **21**, 3360), who prepared the compound from 2-naphthylamine and β-bromolævulic acid, found m. p. 132°.

7-*Acetyl*-8 : 9-*dimethyl*-α'β'-*naphthindole* (1-*Acetyl*-2 : 3-*dimethyl*-4 : 5-*benzindole*).—The above indole (8 g.) was added to a solution of magnesium (2·2 g.) in ether (150 c.c.) containing ethyl bromide (8 c.c.) and, when the reaction was finished, the mixture was treated gradually with acetyl chloride (8 c.c.), with shaking, and the whole boiled for 10 minutes. After the addition of an equal volume of dilute hydrochloric acid and removal of the ether by evaporation, the solid was crystallised from alcohol, and the *acetyl* derivative obtained in colourless needles (yield, 50%), m. p. 119° (Found : N, 6·0. $C_{16}H_{15}ON$ requires N, 5·9%). After a solution of the acetyl compound in aqueous-alcoholic potassium hydroxide had been boiled for ½ hour, addition of water precipitated 8 : 9-dimethyl-α'β'-naphthindole (identified by mixed m. p.). The addition of a molecular proportion of bromine to the acetyl compound in glacial acetic acid, followed by dilution with water, gave 5-*bromo*-7-*acetyl*-8 : 9-*dimethyl*-α'β'-*naphthindole* (6-*bromo*-1-*acetyl*-2 : 3-*dimethyl*-4 : 5-*benzindole*), which separated from acetic acid in needles with a blue tinge (yield, 70%), m. p. 186° (decomp.) (Found : N, 4·7. $C_{16}H_{14}ONBr$ requires N, 4·4%).

When 7-acetyl-8 : 9-dimethyl-α'β'-naphthindole was oxidised with chromic acid as described below, 2-*diacetylamino*-1-*acetylnaphthalene*, colourless needles (40%), m. p. 133°, from alcohol, was obtained (Found : C, 71·3; H, 5·6. $C_{16}H_{15}O_3N$ requires C, 71·4; H, 5·6%).

5 : 7-*Diacetyl*-8 : 9-*dimethyl*-α'β'-*naphthindole* (1 : 6-*Diacetyl*-2 : 3-*dimethyl*-4 : 5-*benzindole*).—(*a*) After 8 : 9-dimethyl-α'β'-naphthindole (10 g.) in acetic anhydride (60 c.c.) containing 5 drops of concentrated sulphuric acid had been refluxed for ¾ hour and poured into water (500 c.c.), the solid which separated was purified by boiling its solution in alcohol (500 c.c.) with charcoal. When recovered from the filtered solution by dilution with water and crystallised from amyl alcohol, it gave 5 : 7-*diacetyl*-8 : 9-*dimethyl*-α'β'-*naphthindole* in pale yellow plates (30%), m. p. 171° (Found : N, 4·9. $C_{18}H_{17}O_2N$ requires N, 5·0%). The use of syrupy phosphoric acid, or sulphanilic acid, as catalyst gave better yields.

(*b*) Aluminium chloride (3·5 g.) was added to 7-acetyl-8 : 9-dimethyl-α'β'-naphthindole (2 g.) and acetyl chloride (1·5 c.c.) in carbon disulphide (50 c.c.), and the whole refluxed for 3 hours. After the carbon disulphide had been distilled off and the residue added to ice–dilute hydrochloric acid, the solid was crystallised twice from alcohol and 5 : 7-diacetyl-8 : 9-dimethyl-α'β'-naphthindole, identical (mixed m. p.) with the above product, was obtained.

5-*Acetyl*-8 : 9-*dimethyl*-α'β'-*naphthindole* (6-*Acetyl*-2 : 3-*dimethyl*-4 : 5-*benzindole*).—After a solution of the above diacetyl compound (0·7 g.) in alcohol (12 c.c.) and water (3 c.c.) containing potassium hydroxide (0·5 g.) had been boiled for ½ hour and diluted with water, 5-*acetyl*-8 : 9-*dimethyl*-α'β'-*naphthindole*, yellow needles (80%), m. p. 237°, from alcohol, was obtained (Found : C, 80·9; H, 6·1. $C_{16}H_{15}ON$ requires C, 81·0; H, 6·3%). Its *oxime*, prepared by boiling a solution of the ketone in alcohol with hydroxylamine hydrochloride and sodium acetate for ½ hour, separated from benzene in colourless rods (90%), m. p. 227° (Found : N, 11·4. $C_{16}H_{16}ON_2$ requires N, 11·1%).

1 : 4-*Diacetyl*-2-*naphthylamine*.—Chromic anhydride (0·8 g.) in water (3 c.c.) was added to 5 : 7-diacetyl-8 : 9-dimethyl-α'β'-naphthindole (2 g.) in glacial acetic acid (100 c.c.), and the mixture left at room temperature for 12 hours and then heated at 70° for 10 minutes. When cold, it was poured into an equal volume of water, and the solution filtered from unchanged diacetyl compound. After the addition of more water (200 c.c.), the product was extracted thrice with benzene (3 × 30 c.c.). The residue obtained when the dried ($CaCl_2$) united extracts were evaporated was crystallised from alcohol

and gave 2-*diacetylamino*-1 : 4-*diacetylnaphthalene* in pale yellow plates (35%), m. p. 168° (Found : C, 69·3; H, 5·5; N, 4·6. $C_{18}H_{17}O_4N$ requires C, 69·5; H, 5·5; N, 4·5%). This substance (0·5 g.) was dissolved in concentrated hydrochloric acid (15 c.c.) just below its b. p., and the solution immediately cooled and treated with aqueous ammonia (*d* 0·880). The product which separated on storage was crystallised from aqueous alcohol, and 2-*acetamido*-1 : 4-*diacetylnaphthalene* isolated in almost colourless needles (75%), m. p. 149—150° (Found : C, 71·1; H, 5·6. $C_{16}H_{15}O_3N$ requires C, 71·4; H, 5·6%). 1 : 4-*Diacetyl*-2-*naphthylamine* was obtained when this acetamido-compound (0·5 g.) was refluxed with dilute hydrochloric acid (10 c.c. of 2N.) for 20 minutes, and the cold solution made alkaline with aqueous ammonia. It separated from aqueous alcohol in yellow prisms (70%), m. p. 83—85° (Found : C, 74·4; H, 5·9. $C_{14}H_{13}O_2N$ requires C, 74·0; H, 5·7%).

8 : 9-*Diphenyl-α′β′-naphthindole* (2 : 3-*Diphenyl*-4 : 5-*benzindole*).—After a solution of equal weights of 2-naphthylhydrazine hydrochloride, crystallised sodium acetate, and phenyl benzyl ketone in alcohol had been refluxed for ½ hour, the ***hydrazone***, colourless needles (yield, 80%), m. p. 156°, from alcohol, separated on cooling (Found : N, 8·2. $C_{24}H_{20}N_2$ requires N, 8·3%). When a solution of this substance (10 g.) in alcohol (500 c.c.) containing concentrated sulphuric acid (5 c.c.) was boiled for ½ hour and then poured into water (500 c.c.), 8 : 9-diphenyl-α′β′-naphthindole was precipitated. It separated from glacial acetic acid in almost colourless prisms (80%), m. p. 166° (Found : N, 4·3. Calc. for $C_{24}H_{17}N$: N, 4·4%). Japp and Murray (*J.*, 1894, **65**, 897), who made this indole by heating benzoin with 2-naphthylamine and zinc chloride, give m. p. 166—167°.

7-*Acetyl*-8 : 9-*diphenyl-α′β′-naphthindole* (1-*Acetyl*-2 : 3-*diphenyl*-4 : 5-*benzindole*) *and its Bromo-derivative.*—Prepared by a process similar to that used for the dimethyl analogue described above, 7-*acetyl*-8 : 9-*diphenyl-α′β′-naphthindole* crystallised from alcohol in colourless needles (yield, 35%), m. p. 227° (Found : N, 3·6. $C_{26}H_{19}ON$ requires N, 3·9%). It was readily hydrolysed to 8 : 9-diphenyl-α′β′-naphthindole by boiling aqueous-alcoholic potassium hydroxide. Bromine (0·4 g.) in glacial acetic acid (2·7 c.c.) was added with stirring to a warm solution of the acetyl compound (0·9 g.) in the same solvent (250 c.c.), and, after ½ hour, water (100 c.c.) was added. The 5-*bromo*-7-*acetyl*-8 : 9-*diphenyl-α′β′-naphthindole* (6-*bromo*-1-*acetyl*-2 : 3-*diphenyl*-4 : 5-*benzindole*) which separated crystallised from acetic acid or alcohol in colourless needles (70%), m. p. 209° (Found : N, 3·1. $C_{26}H_{18}ONBr$ requires N, 3·2%).

4-*Bromo*-2-*benzamido*-1-*benzoylnaphthalene.*—The above bromo-compound (6 g.) in glacial acetic acid (500 c.c.) was treated with chromic anhydride (4 g., in a little water), and the whole left for 4 hours at room temperature and then boiled for one minute. Addition of an equal volume of water to the cold mixture precipitated 4-*bromo*-2-(N-*acetyl*-N-*benzoylamino*)-1-*benzoylnaphthalene*, colourless rods (60%), m. p. 145°, from alcohol (Found : C, 66·7; H, 4·0; N, 2·8. $C_{26}H_{18}O_3NBr$ requires C, 66·1; H, 3·8; N, 3·0%). After a solution of this substance (1 g.) in alcohol (30 c.c.) containing concentrated hydrochloric acid (5 c.c.) had been refluxed for ½ hour, 4-*bromo*-2-*benzamido*-1-*benzoylnaphthalene* separated on cooling. On recrystallisation from alcohol it gave yellow prisms (60%), m. p. 169° (Found : C, 66·8; H, 3·9; N, 3·4. $C_{24}H_{16}O_2NBr$ requires C, 67·0; H, 3·7; N, 3·3%).

5-*Acetyl- and* 5 : 7-*Diacetyl*-8 : 9-*diphenyl-α′β′-naphthindole* (6-*Acetyl- and* 1 : 6-*Diacetyl*-2 : 3-*diphenyl*-4 : 5-*benzindole*).—After a solution of 8 : 9-diphenyl-α′β′-naphthindole (5 g.) in acetic anhydride (30 c.c.) containing 4 drops of syrupy phosphoric acid had been refluxed for ¾ hour, cooled, and poured into water (200 c.c.), the solid was purified by boiling its alcohol solution with charcoal for 20 minutes, and recovered by precipitation with water. When crystallised from alcohol or glacial acetic acid, it gave 5-*acetyl*-8 : 9-*diphenyl-α′β′-naphthindole* in greenish yellow rods (1 g.), m. p. 245—246° (Found : C, 86·3; H, 5·4. $C_{26}H_{19}ON$ requires C, 86·4; H, 5·3%). This was unaffected by boiling with aqueous-alcoholic potassium hydroxide but, when its solution in acetic anhydride (1 g. in 15 c.c.) containing 12 drops of syrupy phosphoric acid was refluxed for ¾ hour and the product isolated and purified as above, 5 : 7-*diacetyl*-8 : 9-*diphenyl-α′β′-naphthindole*, reddish-brown prisms, m. p. 189°, from alcohol, was obtained (Found : C, 83·3; H, 5·3. $C_{28}H_{21}O_2N$ requires C, 83·4; H, 5·2%). It was hydrolysed to 5-acetyl-8 : 9-diphenyl-α′β′-naphthindole by boiling aqueous-alcoholic potassium hydroxide.

5 : 7-*Diacetyl*-8 : 9 : 10 : 11-*tetrahydro-α′β′-naphthacarbazole* (2 : 9-*Diacetyl*-5 : 6 : 7 : 8-*tetrahydro*-3 : 4-*benzcarbazole*).—After 7-acetyl-8 : 9 : 10 : 11-tetrahydro-α′β′-naphthacarbazole in carbon disulphide had been treated with acetyl chloride and aluminium chloride as described for the corresponding derivative of 8 : 9-dimethyl-α′β′-naphthindole, and the product recrystallised from alcohol, 5 : 7-diacetyl-8 : 9 : 10 : 11-tetrahydro-α′β′-naphthacarbazole was obtained in pale yellow prisms, m. p. 182°, identical (mixed m. p.) with the substance described by Oakeshott and Plant (*loc. cit.*).

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