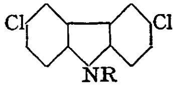
175. *The Friedel–Crafts Reaction in the Carbazole Series. Part III.*

By S. G. P. Plant and (Mrs.) J. F. Powell.

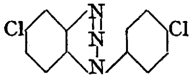
3 : 6-Dichloro- and 3 : 6-dibromo-9-acetylcarbazole were recovered largely unchanged in attempts to apply Friedel–Crafts reactions, but the closely related 6-chloro-9-acetyltetrahydrocarbazole readily gave its 7-*acetyl* derivative under similar conditions. 6-*Bromo*-9-*acetyl*- and 9-acetyl-6-methyl-tetrahydrocarbazole gave analogous products, but several unacetylated tetrahydrocarbazoles proved to be unreactive. 3 : 6-Dichlorocarbazole, which has been prepared synthetically from 5 : 4′-*dichloro*-1-*phenylbenzotriazole*, gave only *N*-acyl derivatives.

It has been established that under the usual conditions for Friedel–Crafts reactions two acyl groups can be readily introduced into carbazole and its 9-alkyl derivatives in the 3- and the

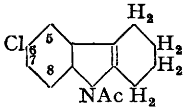
6-position, but with the 9-acylcarbazoles substitution of a single acyl group in the 2-position ensues (*J.*, 1935, 741; 1936, 1295). It seemed possible that these reactions might be extended to the preparation of substances which would be of value as intermediates for dyes by the use of certain substituted carbazoles, *e.g.*, 3 : 6-dichloro-9-acetylcarbazole (I; R = Ac). 3 : 6-Dichlorocarbazole was first prepared by Mazzara and Lamberti-Zanardi (*Gazzetta*, 1896, **26**, 236) by heating carbazole with sulphuryl chloride in chloroform, but the constitution of the product appears never to have been rigidly established. This has now been achieved in the form of an unambiguous synthesis by heating 5 : *4′-dichloro-1-phenylbenzotriazole* (II) (the Graebe–Ullmann reaction), which was obtained from 4 : 4′-dichloro-2-nitrodiphenylamine through the corresponding 2-amino-compound.



(I.)



(II.)



(III.)

3 : 6-Dichloro-9-acetylcarbazole proved to be unreactive towards acetyl bromide and aluminium chloride in boiling carbon disulphide. Similar lack of reactivity was displayed towards phthalic anhydride and aluminium chloride in nitrobenzene, except that in one experiment, after prolonged standing, a very small quantity of 3 : *6-dichlorocarbazole-9-phthaloylic acid* (I; R = $CO \cdot C_6H_4 \cdot CO_2H$), formed by displacement of the acetyl group, was isolated. 3 : 6-Dichlorocarbazole itself reacted with phthalic anhydride, benzoyl chloride, and acetyl chloride in the presence of aluminium chloride with the introduction of the corresponding acyl radical, but the substituent was shown in each case to be attached to nitrogen by the fact that it could readily be removed by warming with alkali, and *C*-acylation was not observed. 3 : 6-Dibromo-9-acetylcarbazole also failed to react with acetyl bromide under similar conditions.

In contrast, it was found that the closely related 6-chloro-9-acetyltetrahydrocarbazole (III) could be easily converted into *6-chloro-7 : 9-diacetyltetrahydrocarbazole*. This was hydrolysed to *6-chloro-7-acetyltetrahydrocarbazole*, the constitution of which was established by reducing it with the Clemmensen reagent. The product, evidently a mixture of 6-chloro-7-ethyltetrahydrocarbazole and 6-chloro-7-ethylhexahydrocarbazole from the fact that it was only partly soluble in dilute acids, was heated with palladised charcoal in an atmosphere of hydrogen with the formation of 2-ethylcarbazole. The result is in harmony with the observations of Plant and Rogers (*J.*, 1936, 40) who found that the 7-acetyl and 7-benzoyl derivatives were obtained when 9-acetyl- and 9-benzoyl-tetrahydrocarbazole were submitted to Friedel–Crafts reactions with acetyl bromide and benzoyl chloride. It was not, however, possible to obtain an analogous phthaloylic acid from 6-chloro-9-acetyltetrahydrocarbazole by the use of phthalic anhydride.

An acetyl group has been similarly introduced into *6-bromo-9-acetyltetrahydrocarbazole* and 9-acetyl-6-methyltetrahydrocarbazole, the products being evidently *6-bromo-7 : 9-diacetyl-* and *7 : 9-diacetyl-6-methyl-tetrahydrocarbazole* respectively. The latter was hydrolysed to *7-acetyl-6-methyltetrahydrocarbazole*.

A surprising observation is that unacetylated tetrahydrocarbazole, and its 6-chloro-, 6-bromo-, 6-methyl, and 6-acetamido-derivatives, were recovered unchanged after treatment with acetyl bromide and aluminium chloride in carbon disulphide, even with prolonged boiling. This is remarkable in view of the ease with which carbazole undergoes substitution.

EXPERIMENTAL.

Synthesis of 3 : 6-Dichlorocarbazole.—After a mixture of 2 : 5-dichloronitrobenzene (16 g.), *p*-chloroaniline (12 g.), and potassium carbonate (12 g.) had been heated at 220° for an hour, unchanged materials were removed in steam and the residue crystallised from alcohol, 4 : 4′-dichloro-2-nitrodiphenylamine being obtained in crimson needles, m. p. 149—150° (cf. Blom, *Helv. Chim. Acta*, 1921, **4**, 1038). The nitro-compound (1·2 g.) in hot glacial acetic acid (20 c.c.) was treated gradually with stannous chloride (6 g.) dissolved in hydrochloric acid (20 c.c. of 28%), and the solution boiled for 10 minutes, cooled, and made alkaline with concentrated aqueous potassium hydroxide. The precipitated amine separated from alcohol in colourless needles, m. p. 137°. Its suspension in glacial acetic acid was treated with aqueous sodium nitrite, and, after the addition of water, the precipitated 5 : *4′-dichloro-1-phenylbenzotriazole* was crystallised from alcohol and obtained in brown needles, m. p. 175° (Found : N, 15·9. $C_{12}H_7N_3Cl_2$ requires N, 15·9%). When this substance was heated for an hour at 360° and the product distilled under reduced pressure, 3 : 6-dichlorocarbazole, colourless prisms, m. p. 202°, from glacial acetic acid, was obtained. It proved to be identical (mixed m. p.) with the material obtained by the chlorination of carbazole as described by Mazzara and Lamberti-Zanardi (*loc. cit.*).

Attempted Friedel–Crafts Reactions with 3 : 6-Dichlorocarbazole.—(*a*) A solution of 3 : 6-dichlorocarbazole (2 g.), phthalic anhydride (2 g.), and aluminium chloride (2 g.) in nitrobenzene (25 c.c.) was left at room temperature for 4 days and then treated with ice–dilute hydrochloric acid, and the solvent removed in steam. After the residue had been dissolved in hot alcohol and poured into dilute ammonia, the filtered aqueous solution was acidified, and 3 : 6-*dichlorocarbazole*-9-*phthaloylic acid*, colourless needles, m. p. 185° (rapid heating), from glacial acetic acid, obtained (Found : Cl, 18·2. $C_{20}H_{11}O_3NCl_2$ requires Cl, 18·5%). When its solution in aqueous ammonia was boiled, a precipitate of 3 : 6-dichlorocarbazole, identified by mixed m. p., soon appeared. Similar results were obtained when the reaction was carried out in nitrobenzene at 60° for 6 hours.

(*b*) Benzoyl chloride (2·5 g.) was added to 3 : 6-dichlorocarbazole (2 g.) and aluminium chloride (2·5 g.) in carbon disulphide (25 c.c.), and the whole refluxed for an hour. After the carbon disulphide had been distilled off, the residue poured into ice–dilute hydrochloric acid, and the excess of benzoyl chloride removed in steam, 3 : 6-*dichloro*-9-*benzoylcarbazole* remained; it separated from glacial acetic acid in almost colourless needles, m. p. 204° (Found : Cl, 20·3. $C_{19}H_{11}ONCl_2$ requires Cl, 20·9%). When its solution in aqueous-alcoholic potassium hydroxide was boiled for 1½ hours and poured into water, 3 : 6-dichlorocarbazole was precipitated.

(*c*) After 3 : 6-dichlorocarbazole had been treated with acetyl chloride and aluminium chloride under conditions similar to those used with benzoyl chloride, 3 : 6-dichloro-9-acetylcarbazole, colourless prisms, m. p. 185°, from glacial acetic acid, was obtained. It was identical (mixed m. p.) with the substance obtained by boiling 3 : 6-dichlorocarbazole with acetic anhydride and a drop of concentrated sulphuric acid under reflux (cf. Mazzara and Lamberti-Zanardi, *loc. cit.*).

6-*Chloro*-7-*acetyltetrahydrocarbazole*.—Aluminium chloride (2 g.) was added to a mixture of 6-chloro-9-acetyltetrahydrocarbazole (2 g., prepared as described by Plant and Rosser, *J.*, 1928, 2454) and acetyl bromide (1·5 c.c.) in carbon disulphide (30 c.c.), and the whole refluxed for 10 minutes. After the solvent had been distilled off, the residue added to ice–dilute hydrochloric acid, and the solid crystallised from alcohol, 6-*chloro*-7 : 9-*diacetyltetrahydrocarbazole* was obtained in colourless needles, m. p. 118° (Found : C, 66·5; H, 5·2. $C_{16}H_{16}O_2NCl$ requires C, 66·3; H, 5·5%). The reaction proceeded less readily when acetyl chloride was used. When a solution of the diacetyl compound (1 g.) in alcohol (10 c.c.) containing potassium hydroxide (0·6 g.) and water (0·5 c.c.) was refluxed for an hour, filtered, and allowed to cool, 6-*chloro*-7-*acetyltetrahydrocarbazole* separated. It was recrystallised from alcohol and isolated in almost colourless prisms, m. p. 171° (Found : C, 68·1; H, 6·0; N, 5·9. $C_{14}H_{14}ONCl$ requires C, 67·9; H, 5·7; N, 5·7%).

Acetyl chloride (0·7 c.c. in a little acetone) was gradually added with constant shaking to the 7-acetyl compound (0·5 g.) dissolved in acetone (10 c.c.) containing aqueous potassium hydroxide (0·45 g. of 66%). Water then precipitated 6-chloro-7 : 9-diacetyltetrahydrocarbazole, which was crystallised from alcohol and found to be identical (mixed m. p.) with the substance described above.

Conversion of 6-*Chloro*-7-*acetyltetrahydrocarbazole into* 2-*Ethylcarbazole*.—6-Chloro-7-acetyltetrahydrocarbazole (2·6 g.) and concentrated hydrochloric acid (50 c.c.) were shaken with amalgamated granulated zinc (200 g.), and the whole was left overnight. After the addition of anisole (5 c.c.) and more concentrated hydrochloric acid (30 c.c.), the mixture was refluxed for 12 hours, the product extracted with ether, the extract evaporated, and anisole removed from the residue by distillation in steam. The less volatile material, which was only partly soluble in dilute acids, was again extracted with ether, and the extract dried (K_2CO_3) and evaporated. When the residue was mixed with 25% of its weight of palladised charcoal and heated at 300—320° for 11 hours in an atmosphere of hydrogen, hydrogen chloride was freely evolved in the early stages. The product was dissolved in warm acetone and recovered from the filtered solution by the addition of water. After it had been distilled under reduced pressure and crystallised from glacial acetic acid, 2-ethylcarbazole was obtained in colourless plates, m. p. 218—220°, identical (mixed m. p.) with the substance prepared by Plant and Williams (*J.*, 1934, 1142).

6-*Bromo*-7 : 9-*diacetyltetrahydrocarbazole*.—After a solution of 6-bromotetrahydrocarbazole (25 g., Borsche, Witte, and Bothe, *Annalen*, 1908, **359**, 53) in acetic anhydride (90 c.c.) containing a few drops of concentrated sulphuric acid had been refluxed for 6 hours, 6-*bromo*-9-*acetyltetrahydrocarbazole* separated on cooling. It was recrystallised from alcohol (charcoal) and obtained in colourless plates (15 g.), m. p. 120° (Found : N, 4·7. $C_{14}H_{14}ONBr$ requires N, 4·8%). Aluminium chloride (4 g.) was added to a mixture of this acetyl compound (2 g.) and acetyl chloride (6 c.c.) in carbon disulphide (25 c.c.), and the whole refluxed for 15 minutes and treated as described for the corresponding chloro-compound. When the product was crystallised from alcohol, 6-*bromo*-7 : 9-*diacetyltetrahydrocarbazole* separated in colourless needles, m. p. 112° (Found : N, 4·2. $C_{16}H_{16}O_2NBr$ requires N, 4·2%). The use of acetyl bromide gave less satisfactory products.

When the diacetyl compound (3 g.) in hot glacial acetic acid (10 c.c.) was treated with concentrated nitric acid (1·2 g.), oxides of nitrogen were evolved, and 6-*bromo*-10 : 11-*dihydroxy*-7 : 9-*diacetylhexahydrocarbazole* separated on cooling. On crystallisation from alcohol, it was obtained in colourless plates, m. p. 210° (decomp.) (Found : C, 52·0; H, 4·9. $C_{16}H_{18}O_4NBr$ requires C, 52·2; H, 4·9%).

7-*Acetyl*-6-*methyltetrahydrocarbazole*.—When treated with acetyl bromide and aluminium chloride as described for the corresponding chloro-compound, 9-acetyl-6-methyltetrahydrocarbazole (Manjunath and Plant, *J.*, 1926, 2260) gave 7 : 9-*diacetyl*-6-*methyltetrahydrocarbazole*, colourless needles, m. p. 136°, from alcohol (Found : C, 75·6; H, 7·1. $C_{17}H_{19}O_2N$ requires C, 75·8; H, 7·1%). Hydrolysis as for the chloro-compound led to 7-*acetyl*-6-*methyltetrahydrocarbazole*, colourless plates, m. p. 207°, from alcohol (Found : C, 78·7; H, 7·4. $C_{15}H_{17}ON$ requires C, 79·3; H, 7·5%).

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DYSON PERRINS LABORATORY, OXFORD UNIVERSITY. [*Received, October* 12*th*, 1946.]