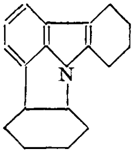
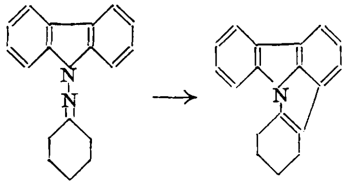
175. Attempts to prepare Optically Active Tervalent Nitrogen Compounds. Part II. 1 : 9-(2′ : 3′ : 4′ : 5′-Tetrahydrophenylene)carbazole.

By Robert W. G. Preston and S. Horwood Tucker.

Diphenylenehydrazones of *cyclo*hexanone, acetone, pyruvic acid, methyl pyruvate, ethyl acetoacetate, and ethyl oxaloacetate have been prepared. The first has been indolised to *tetrahydrophenylenecarbazole*, which has been dehydrogenated to 1 : 9-phenylenecarbazole. This has also been synthesised from 1-nitrocarbazole, thus corroborating its synthesis from carbazole.

Manjunath (*J. Indian Chem. Soc.*, 1927, **4**, 271), by reduction of 9-nitrosohexahydrocarbazole with zinc and acetic acid in presence of *cyclo*hexanone, the solution then being heated, prepared a substance, $C_{18}H_{21}N$, to which he gave an obviously incorrect structural formula. This was rectified by Lions and Ritchie (*J. Roy. Soc. N.S.W.*, 1939, **73**, 127), and the compound correctly represented by (I)—" 8 : 9-(1 : 2-*cyclo*hexylene)tetrahydrocarbazole."


(I.)



(II.) (III.)

Manjunath (*loc. cit.*, p. 280) also prepared *cyclo*hexanone diphenylenehydrazone (II), but failed to indolise it into 1 : 9-(2′ : 3′ : 4′ : 5′-*tetrahydrophenylene*)*carbazole* (III). We have been able to effect this indolisation (yield, 21%) by heating the hydrazone (II) with dry hydrogen chloride in tetralin maintained at 160° for ¾ hour (cf. Robinson and Robinson, J., 1918, **113**, 639, 644; Perkin and Plant, J., 1924, **125**, 1503, 1509). The tetrahydrophenylenecarbazole (III) was readily dehydrogenated to 1:9-phenylenecarbazole (Dunlop and Tucker, J., 1939, 1945) by heating with sulphur in quinoline. Manjunath failed to dehydrogenate " 8 : 9-(1 : 2-*cyclo*hexylene)tetrahydrocarbazole " (I) by heating with sulphur, but by means of heated lead monoxide a dehydrogenation product, m. p. 140°, was obtained in too small quantity for investigation. It may have been 1 : 9-phenylenecarbazole (m. p. 136·5—138·5°, corr.).

The above synthesis of 1 : 9-phenylenecarbazole supports the previous formulation : a conclusive synthesis has now been carried out by the reaction of 1-nitrocarbazole (Preston, Tucker, and Cameron, J., 1942, 500) and iodobenzene to give 1-*nitro*-9-*phenylcarbazole*, which by reduction to 1-*amino*-9-*phenylcarbazole*, followed by diazotisation in acetic–sulphuric acid solution, cyclised to give 1 : 9-phenylenecarbazole (see Dunlop and Tucker, *loc. cit.*).

Formerly we endeavoured to rigidify a non-planar configuration of the nitrogen bonds by having benzene rings fused to two pyrrole rings, as in 1 : 9-phenylenecarbazole (Dunlop and Tucker, *loc. cit.*) : we do not expect to be able to obtain compounds of the constrained type from reduced phenylenecarbazoles, since reduced rings are mobile, and accordingly will relieve strain instead of imposing it.

We have prepared *diphenylenehydrazones* of acetone, pyruvic acid, methyl pyruvate, ethyl acetoacetate and ethyl oxaloacetate. Attempts to indolise these have been discouraging but are to be continued.

EXPERIMENTAL.

9-Aminocarbazole (Wieland, Süsser, and Fressel, *Annalen*, 1912, **392**, 183) forms colourless crystals from carbon tetrachloride : it gives an orange-red *picrate*, m. p. 136—138° (Found : C, 52·9; H, 3·2; N, 16·8. $C_{12}H_{10}N_2,C_6H_3O_7N_3$ requires C, 52·6; H, 3·1; N, 17·0%).

cyclo*Hexanone Diphenylenehydrazone*.—A mixture of 9-aminocarbazole (4·55 g.) and *cyclo*hexanone (freshly distilled, 5 g.; 2 mols.) was gently warmed over a free flame until reaction set in. After the reaction had subsided, the mixture was boiled (½ min.), and the product dissolved in carbon tetrachloride; carbazole separated on cooling. The filtrate was evaporated, and the residue crystallised from ethanol. More carbazole at first separated (total yield, 0·85 g.; 20%), then the hydrazone, m. p. 96° (4·25 g.; yield, 65%). The hydrazone grew out of solution slowly and so facilitated the troublesome removal of carbazole.

When reaction was brought about by heating (2½ hours) in alcohol (Manjunath, *loc. cit.*, p. 280), the yields of hydrazone and of carbazole were both slightly lower.

Attempts to prepare the hydrazone from 9-nitrosocarbazole without isolation of 9-aminocarbazole (cf. Manjunath, *loc. cit.*, p. 280; Lions and Ritchie, *loc. cit.*, p. 136) gave greatly reduced yields (~25%).

1 : 9-(2′ : 3′ : 4′ : 5′-*Tetrahydrophenylene*)*carbazole*.—A solution of *cyclo*hexanone diphenylenehydrazone (2 g.) in tetralin (distilled over sodium; 20 ml.) was added in small amounts during 30 mins. to tetralin (10 ml.) heated in a metal bath (160°), dry hydrogen chloride being continuously bubbled through during this period and a subsequent 30 minutes' heating. After removal of a mustard-coloured precipitate (0·9 g.) the tetralin was removed in steam, and the pale yellow residue dissolved in boiling carbon tetrachloride. After cooling, carbazole (0·2 g.) was removed, the solution evaporated, and the residue crystallised from methanol–acetone (1 : 1) to give colourless needles of 1 : 9-(2′ : 3′ : 4′ : 5′-*tetrahydrophenylene*)*carbazole*, m. p. 99—100° (0·4 g.; yield, 21%) (Found : C, 88·0; H, 6·2; N, 5·7. $C_{18}H_{15}N$ requires C, 88·2; H, 6·1; N, 5·7%).

When the hydrazone (2 g.) was added all at once to the tetralin (25 ml.) through which hydrogen chloride was passing at 160°, and the mixture maintained at this temperature for ¾ hour, the yield was slightly less.

Addition of anhydrous zinc chloride (1 g.) was without appreciable effect.

Whenever reagents containing water were used (Hughes, Lions, and Ritchie, *J. Roy. Soc. N.S.W.*, 1938, **72**, 213) a high yield of carbazole was obtained; boiling the hydrazone in glacial acetic acid gave rise to 9-acetamidocarbazole, m. p. 247°.

The s-*trinitrobenzene* compound was prepared in and crystallised from ethanol, forming orange-red needles, m. p. 164—166° (Found : C, 62·8; H, 4·1; N, 12·3. $C_{18}H_{15}N,C_6H_3O_6N_3$ requires C, 62·9; H, 3·9; N, 12·2%).

The *picrate* was prepared in and crystallised from ethanol, forming bronze-coloured needles, m. p. 159—160° (Found : C, 60·6; H, 3·8; N, 12·0. $C_{18}H_{15}N,C_6H_3O_7N_3$ requires C, 60·8; H, 3·8; N, 11·8%).

1 : 9-*Phenylenecarbazole*.—Dehydrogenation of 1 : 9-(2′ : 3′ : 4′ : 5′-tetrahydrophenylene)carbazole (0·1 g.) was effected by boiling its solution in quinoline (2 ml.) containing sulphur (0·026 g.) for 2 hours. The mixture was treated with excess of dilute hydrochloric acid and extracted with ether; the residue obtained on evaporation of the ether sublimed at 260—270°/12 mm. The product crystallised from methanol–acetone (1 : 1) in colourless, silky needles having alone or admixed with 1 : 9-phenylenecarbazole (Dunlop and Tucker, *loc. cit.*) m. p. 136·5—138·5° (corr.). The identity was confirmed by means of the *s*-trinitrobenzene compound.

Pyruvic Acid Diphenylenehydrazone.—A solution of pyruvic acid (4·5 g.) and 9-aminocarbazole (4·5 g.) in ethanol (15 ml.) was boiled for 15 minutes. On cooling, the hydrazone separated in flat, yellow needles, m. p. 157—160° (decomp.) (5·35 g.; yield, 85%) (Found : C, 71·4; H, 4·8; N, 11·0. Calc. : C, 71·4; H, 4·8; N, 11·1%) [Barger and Dyer, *J. Amer. Chem. Soc.*, 1938, **60**, 2414, give m. p. 148—150° (decomp.)].

Methyl pyruvate diphenylenehydrazone, prepared by the action of diazomethane (ether) on the acid in the usual way, separated from methanol in stumpy, lemon-yellow crystals, m. p. 89—90° (Found : C, 72·2; H, 5·4; N, 10·4. $C_{16}H_{14}O_2N_2$ requires C, 72·2; H, 5·3; N, 10·5%).

Ethyl acetoacetate diphenylenehydrazone, prepared similarly to the pyruvic acid hydrazone above, or by heating 9-aminocarbazole in excess of ethyl acetoacetate on a boiling water-bath for 15 minutes, separated from methanol in colourless, craggy crystals, m. p. 113°, after softening at 108° (yield, nearly 100%) (Found : C, 73·7; H, 6·0; N, 9·7. $C_{18}H_{18}O_2N_2$ requires C, 73·5; H, 6·1; N, 9·5%).

Ethyl oxaloacetate diphenylenehydrazone was prepared, as for the acetoacetate hydrazone, in good yield from 9-aminocarbazole and ethyl oxaloacetate. It was obtained in pale green prisms from methanol and recrystallised from light petroleum (b. p. 60—80°); m. p. 85—87° (Found : C, 68·3; H, 5·8; N, 8·1. $C_{20}H_{20}O_4N_2$ requires C, 68·2; H, 5·7; N, 8·0%).

Acetone diphenylenehydrazone, obtained by boiling a solution of 9-aminocarbazole in excess of acetone for 1½—2 hours, crystallised from light petroleum (b. p. 40—60°) in colourless, fluffy balls of needles, m. p. 78—81° (yield, 85%) (Found : C, 80·9; H, 6·3; N, 12·7. $C_{15}H_{14}N_2$ requires C, 81·1; H, 6·3; N, 12·6%).

1-*Nitro*-9-*phenylcarbazole*.—A mixture of 1-nitrocarbazole (1·2 g.), iodobenzene (6 ml.), anhydrous potassium carbonate (1·2 g.), and copper bronze (0·01 g.) was boiled (metal bath) for 6 hours. More potassium carbonate (0·5 g.) was added (there was effervescence and the colour of the liquid changed from yellow to red) and heating was continued for 2 hours. The excess of iodobenzene was removed by distillation, and the residue treated with dilute hydrochloric acid, washed with water, and extracted with boiling light petroleum (b. p. 80—100°). From the filtered extract, nearly pure product separated on cooling. Recrystallisation from methanol or from benzene–light petroleum (b. p. 80—100°) gave stout yellow prisms of 1-*nitro*-9-*phenylcarbazole*, m. p. 130—132° (1·1—1·2 g.; yield, >70%) (Found : C, 75·0; H, 4·3; N, 9·9. $C_{18}H_{12}O_2N_2$ requires C, 75·0; H, 4·2; N, 9·7%).

1-*Amino*-9-*phenylcarbazole*.—A mixture of 1-nitro-9-phenylcarbazole (0·8 g.) and sodium sulphide ($Na_2S,9H_2O$, 2 g.) in ethanol (10 ml.) was boiled for 3 hours. Water was added to the boiling solution until turbidity was produced. The material which separated on cooling was extracted with boiling light petroleum (b. p. 60—80°) and crystallised from this solvent, then from ethanol (+ drop of water), giving pale brown laminæ of 1-*amino*-9-*phenylcarbazole*, m. p. 96—98° (0·33 g.; yield, 46%) (Found : C, 83·9; H, 5·6; N, 10·7. $C_{18}H_{14}N_2$ requires C, 83·7; H, 5·4; N, 10·8%).

1 : 9-*Phenylenecarbazole*.—To a solution of 1-amino-9-phenylcarbazole (0·33 g.) in glacial acetic acid (3·5 ml.), concentrated sulphuric acid (0·7 ml.) was added, followed by a solution of sodium nitrite (0·09 g.) in water (2 ml.). The colour of the paste changed from brown to red. After 15 minutes the mixture was gently warmed until effervescence ceased; it was finally boiled for 15 minutes. The material which separated on cooling was washed with dilute acetic acid (1 : 1), then with water, dried, and extracted with ethanol. The product (0·25 g.) obtained by concentration was sublimed in a vacuum and crystallised from methanol–acetone (2 : 1). The needles obtained had the characteristic appearance of 1 : 9-phenylenecarbazole (0·11 g.; yield, 36%), m. p. 136·5—138·5° (corr.), alone or mixed with a specimen synthesised by Dunlop and Tucker's method.

The following were prepared for comparison with the above : 3-*Nitro*-9-*phenylcarbazole* was prepared as 1-nitro-9-phenylcarbazole, above. Extraction with hot benzene, followed by crystallisation from methanol–benzene (1 : 2), gave yellow rosettes, m. p. 140—142° (1·8 g.; yield, 44%) (Found : C, 75·1; H, 4·2; N, 9·7. $C_{18}H_{12}O_2N_2$ requires C, 75·0; H, 4·2; N, 9·7%).

9-(2′-*Aminophenyl*)*carbazole* (Dunlop and Tucker, *loc. cit.*, p. 1950).—This was obtained by reduction of 9-(2′-nitrophenyl)carbazole in a manner similar to that used above for 1-amino-9-phenylcarbazole. Crystallisation from ethanol took place extremely slowly : an improvement was effected by boiling the crude amine (yield ~75%) in methanol solution with a few shavings of magnesium, and, after filtration, keeping the solution in a refrigerator for several days.

We thank the Carnegie Trustees for the award of a Research Scholarship (to R. W. G. P.); and Mr. J. M. L. Cameron for carrying out micro-analyses.

THE UNIVERSITY, GLASGOW. [*Received, June* 30*th*, 1943.]