526. 1 : 2 : 3 : 4-*Tetrahydro*-6-*hydroxycarbazole and* 3-*Hydroxycarbazole.*

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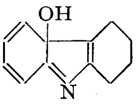
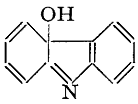
The so-called " 12-hydroxy-1 : 2 : 3 : 4-tetrahydro*iso*carbazole " (Barnes, Pausacker, and Schubert, *J.*, 1949, 1381) has been shown to be identical with the hitherto unrecognised 1 : 2 : 3 : 4-tetrahydro-6-hydroxycarbazole which has now been prepared by demethylating 1 : 2 : 3 : 4-tetrahydro-6-methoxycarbazole. It gives 1 : 2 : 3 : 4-tetrahydro-6-methoxycarbazole on methylation. The compound formerly regarded as 12-hydroxy*iso*carbazole has been shown to be identical with 3-hydroxycarbazole prepared by an unambiguous route. A new compound $C_{12}H_{13}ON$ has been isolated from the bromination products of 1 : 2 : 3 : 4-tetrahydrocarbazole.

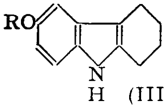
Four isomeric compounds $C_{12}H_{13}ON$ have been obtained from 1 : 2 : 3 : 4-tetrahydrocarbazole and its derivatives in various ways (Perkin and Plant, *J.*, 1923, 676; Plant and Tomlinson, *J.*, 1931, 3324; *J.*, 1933, 298), and the structures originally allotted to these substances have recently been revised (Plant and Robinson, *Nature*, 1950, **165**, 36; Witkop, *J. Amer. Chem. Soc.*, 1950, **72**, 614; Plant, Robinson, and Tomlinson, *Nature*, 1950, **165**, 928; Partick and Witkop, *J. Amer. Chem. Soc.*, 1950, **72**, 634; Plant and Tomlinson, *J.*, 1950, 2127). One of us (M. L. T.) has now obtained, in very small quantity, a fifth isomer as colourless needles, m. p. 243° (decomp.), formed together with 1 : 2 : 3 : 4-tetrahydro-11-hydroxycarbazolenine, by bromination of 1 : 2 : 3 : 4-tetrahydrocarbazole in acetic acid and dilution of the resulting solution with water and ammonia. Its nature has not yet been elucidated. Its infra-red absorption spectrum shows bands at 2·86 and 2·95 μ which probably indicate that both OH and NH groups are present. It appears to be a monomer of $C_{12}H_{13}ON$ because it was dehydrogenated with palladium–charcoal at 280—300° to carbazole. The xylene used to extract the product exhibited no fluorescence, thus showing that no trace of 1 : 9-9′ : 1′-dicarbazolylene (*J.*, 1950, 2127) was formed in the reaction. However, the molecular weight (Rast) was discordant and indicated considerable association. Further investigations are in progress.

Barnes, Pausacker, and Schubert (*J.*, 1949, 1381) have described an isomer of these substances which they obtained as a by-product in the preparation of 8-chloro-1 : 2 : 3 : 4-tetrahydrocarbazole from *cyclo*hexanone *o*-chlorophenylhydrazone by the Fischer method with sulphuric acid. Their compound, $C_{12}H_{13}ON$, which formed colourless needles, m. p. 172°, they considered to be 12-hydroxy-1 : 2 : 3 : 4-tetrahydro*iso*carbazole (I) and they dehydrogenated it with palladium–charcoal to a substance, m. p. 267°, to which they attributed the constitution (II), 12-hydroxy*iso*carbazole. They stated that both of these substances were non-phenolic.

It was of interest to us to prepare a specimen of the compound $C_{12}H_{13}ON$, m. p. 172°, for comparison with our own materials and also to assist in ascertaining whether it might possibly be present in our bromination product. Accordingly we followed these authors' procedure exactly and we obtained a colourless crystalline compound, m. p. 172°, which was a polymorphic mixture of needles and plates. Our product was, however, definitely phenolic. It dissolved in dilute aqueous sodium hydroxide to give a solution that darkened in air and from which it could be reprecipitated by acid. A brownish-purple colour was produced when aqueous ferric chloride was added to its alcoholic solution. It thus appeared to be a tetrahydrohydroxycarbazole, and it seemed to us that the 6-position was the most probable for the hydroxyl group. This structure (III; R = H) was confirmed because


(I)


(II)


(III)

methylation with methyl sulphate and sodium hydroxide afforded 1 : 2 : 3 : 4-tetrahydro-6-methoxycarbazole (III; R = Me) identified by mixed-melting-point determination with an authentic specimen of that substance prepared from *cyclo*hexanone *p*-methoxyphenylhydrazone. In addition 1 : 2 : 3 : 4-tetrahydro-6-methoxycarbazole has now been demethylated by heating it with pyridine hydrochloride (cf. Prey, *Ber.*, 1941, **74**, 1219) to give 1 : 2 : 3 : 4-tetrahydro-6-hydroxycarbazole (III; R = H), m. p. 172°, not depressed on admixture with the substance, m. p. 172°, prepared by the method of Barnes, Pausacker, and Schubert.

In view of these results we repeated the dehydrogenation procedure of these authors, using a specimen prepared by their method, and we obtained a colourless solid that melted to a black liquid at 255°. This too was phenolic. It formed a solution in aqueous sodium hydroxide that darkened in air, and an alcoholic solution treated with aqueous ferric chloride became green. An authentic specimen of 3-hydroxycarbazole, m. p. 260°, was therefore prepared by dehydrogenating and demethylating 1 : 2 : 3 : 4-tetrahydro-6-methoxycarbazole, and the two substances were identical: a mixture melted at 258°, and the infra-red absorption spectra measured for paraffin pastes are in every way identical (both show bands at 2·92 and 3·15μ characteristic of hydrogen-bonded OH and NH respectively). The two specimens also exhibit similar ultra-violet absorption in methanol ($\lambda_{max.}$ 2350, 2650, 3000, and 3450 Å; ε 17,100, 12,500, 17,100, and 3800 respectively). From these results it must be concluded that the so-called 12-hydroxy*iso*carbazole is actually 3-hydroxycarbazole.

3-Hydroxycarbazole has been previously described by Ruff and Stein (*Ber.*, 1901, **34**, 1683) who prepared it in very small yield by diazotising 3-aminocarbazole and give its corrected m. p. as 260—261°. We found their method of preparation rather unsatisfactory, as was diazotisation with nitrosylsulphuric acid in place of nitrous acid. A specimen made this way melted at 245° but the m. p. was raised by 3-hydroxycarbazole. An abstract of a patent (*Chem. Zentr.*, 1931, II, 1761) gives m. p. 256°.

We obtained 3-methoxycarbazole as plates, m. p. 151—152°; Borsche, Witte, and Bothe (*Annalen*, 1908, **359**, 49) give m. p. 138—139°, and the above patent gives m. p. 142°. 1 : 2 : 3 : 4-Tetrahydro-6-methoxycarbazole was first prepared by Borsche *et al.* (*loc. cit.*) who give its m. p. as 94—95°. It melts to a yellow liquid and we have not found the m. p. sharp, it seems to depend on the rate of heating and on the size of the crystals and we have obtained values of 93—98° and 93—105° with different specimens. In light petroleum solution it is rapidly converted into a substance that liberates iodine from acidified potassium iodide and is presumably a peroxide (cf. Beer, McGrath, and Robertson, *J.*, 1950, 2118). 1 : 2 : 3 : 4-Tetrahydro-6-methoxycarbazole is recovered unchanged when treated with methyl sulphate and alkali under the conditions used to methylate the hydroxyl group of 1 : 2 : 3 : 4-tetrahydro-6-hydroxycarbazole. 1 : 2 : 3 : 4-Tetrahydro-6-hydroxycarbazole does not appear to have been previously recognised.

EXPERIMENTAL

Bromination of 1 : 2 : 3 : 4-*Tetrahydrocarbazole.*—The reaction was carried out as described by Plant and Tomlinson (*J.*, 1933, 299). Evaporation of the benzene from which 1 : 2 : 3 : 4-tetrahydro-11-hydroxycarbazolenine (formerly called 10-hydroxy-1 : 2 : 3 : 10-tetrahydrocarbazole) separated, afforded a small quantity of material which, after trituration with ether and recrystallisation from alcohol, yielded a *substance* as colourless needles, m. p. 243° (decomp.) [Found: C, 77·1; H, 7·0; N, 7·45%; *M* (Rast), 285. $C_{12}H_{13}ON$ requires C, 77·0; H, 6·95; N, 7·5%; *M*, 187].

1 : 2 : 3 : 4-*Tetrahydro*-6-*hydroxycarbazole* (12-*Hydroxytetrahydro*iso*carbazole*).—(*a*) This substance was prepared as described by Barnes, Pausacker, and Schubert (*loc. cit.*). It separated from light petroleum (b. p. 100—120°) as a mixture of colourless needles and plates, both of m. p. 172° alone or mixed together (Found: C, 77·0; H, 6·9; N, 7·5. Calc. for $C_{12}H_{13}ON$: C, 77·0; H, 6·95; N, 7·5%). (*b*) 1 : 2 : 3 : 4-Tetrahydro-6-methoxycarbazole (0·5 g.) was heated with freshly distilled pyridine hydrochloride at 200—220° for 2½ hours in an atmosphere of carbon dioxide. The resulting product was washed with dilute hydrochloric acid and quickly extracted with sodium hydroxide (2N). The alkaline extract was rapidly acidified and the product, after drying *in vacuo*, was recrystallised (twice) from light petroleum (b. p. 100—120°) from which it separated as colourless needles, m. p. 172°, alone or mixed with the substance prepared as above.

1 : 2 : 3 : 4-*Tetrahydro*-6-*methoxycarbazole* (cf. Borsche *et al.*, *Annalen*, 1908, **359**, 65).—(*a*) *cyclo*Hexanone *p*-methoxyphenylhydrazone was mixed with dilute sulphuric acid (1 acid : 9 water by volume) and kept at the b. p. for 10—15 minutes. On cooling, the indole crystallised and was obtained, after recrystallisation from alcohol or aqueous alcohol, as needles m. p. 93—105° or 93—98° (Found: C, 77·5; H, 7·4. Calc. for $C_{13}H_{15}ON$: C, 77·6; H, 7·4%). (*b*) The so-called 12-hydroxytetrahydro*iso*carbazole (0·1 g.) was dissolved in acetone (5 c.c.), sodium hydroxide (0·5 g. in a little water) was added, and the mixture was treated with methyl sulphate (1 c.c.) drop by drop with shaking. After 15 minutes water was added and the product crystallised. Recrystallisation from dilute alcohol afforded 1 : 2 : 3 : 4-tetrahydro-6-methoxycarbazole as fine needles, m. p. 93—98° not depressed by admixture with a specimen of the substance prepared as above and recrystallised from dilute alcohol.

3-*Methoxycarbazole.*—1 : 2 : 3 : 4-Tetrahydro-6-methoxycarbazole was heated in an atmosphere of carbon dioxide for 2 hours at 280—300° with palladium–charcoal (containing 10% of palladium and prepared by reduction of palladium chloride with hydrogen at atmospheric pressure in the presence of " Norite "). 3-Methoxycarbazole was extracted with hot alcohol and recrystallised from alcohol as colourless plates, m. p. 151—152° (Found: C, 79·3; H, 5·5. Calc. for $C_{13}H_{11}ON$: C, 79·2; H, 5·6%).

3-*Hydroxycarbazole.*—(*a*) 3-Methoxycarbazole (1·0 g.) was boiled with aqueous hydrobromic acid (2 c.c. of 50%) and acetic acid (10 c.c.) in an inert atmosphere for 2 hours. When the solution cooled, the product crystallised. It was collected and recrystallised first from aqueous alcohol and then from glacial acetic acid from which it separated as almost colourless plates, m. p. 260° (with partial decomp. to a black liquid) (Found: C, 78·8; H, 5·1. Calc. for $C_{12}H_9ON$: C, 78·7; H, 4·9%). (*b*) The so-called 12-hydroxytetrahydro*iso*carbazole was dehydrogenated as described by Barnes, Pausacker, and Schubert, with palladium–charcoal prepared as above, and 3-hydroxycarbazole, m. p. 255° raised by admixture with the above to 258° (black liquids), was obtained.

The authors thank Dr. S. G. P. Plant for much valuable discussion.

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