Tetrahedron, 1964, Vol. 20, pp. 515 to 517. Pergamon Press Ltd. Printed in Northern Ireland

THE PILOTY CYCLIZATION OF BISCYCLOHEXANONE AZINE AND THE METHYLATION OF 1,2,3,4,5,6,7,8,-OCTAHYDROCARBAZOLE

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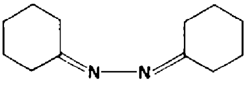
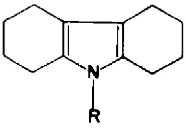
(*Received* 13 *November* 1963)

Abstract—1,2,3,4,5,6,7,8-Octahydrocarbazole is methylated on C-1a, not on N as previously assumed.

By application of the Piloty pyrrole synthesis[1] to biscyclohexanone azine (I) using hydrogen chloride as catalyst, Perkin and Plant[2] obtained a product which they formulated as 1,2,3,4,5,6,7,8-octahydrocarbazole (II, R = H). As methylation of this product yielded a compound which was not identical with a compound obtained previously by von Braun and Ritter[3] by catalytic hydrogenation of N-methylcarbazole and formulated by them as II (R = CH_3), their product[3] was reformulated as III or IV.[2] After further work, this was rejected by von Braun *et al.*[4] who in turn suggested V (R = H) as a possible structure for the product obtained by Perkin and Plant.[2]



I



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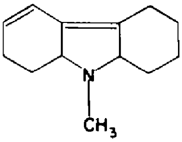

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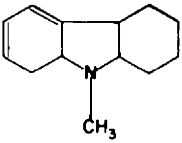

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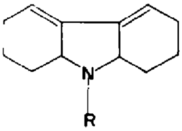

V

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[1] For a review see: B. Robinson, *Chem. Rev.* **63**, 397 (1963).

[2] W. H. Perkin jun. and S. G. P. Plant, *J. Chem. Soc.* **125**, 1503 (1924).

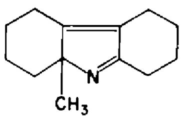
[3] J. von Braun and H. Ritter, *Ber. Dtsch. Chem. Ges.* **55**, 3792 (1922).

[4] J. von Braun and O. Bayer, *Ber. Dtsch. Chem. Ges.* **58**, 387 (1925); J. von Braun and L. Schörnig, *Ibid.* **58**, 2156 (1925).

Only after further counter argument had been advanced,[5] Plant[6] synthesized II (R = CH_3) unambiguously and found this product to be identical with that of von Braun and Ritter[3] and therefore concluded that the Piloty cyclization of biscyclohexanone azine yields not the pyrrole II (R = H) but an isometric product of probable structure V (R = H), as had been suggested previously.[4] Later,[7] using chloroacetyl chloride and acetyl chloride, biscyclohexanone azine was converted to compounds which, by analogy with the work of Plant,[6] were formulated as V (R = $Cl{\cdot}CH_2{\cdot}CO$ and $CH_3{\cdot}CO$ respectively), and recently[8] the original cyclization[2] was repeated using anhydrous zinc chloride instead of hydrogen chloride as catalyst, the product being given the pyrrole structure II (R = H) without experimental verification.

Using both hydrogen chloride[2] and anhydrous zinc chloride[8] the cyclization of biscyclohexanone azine to octahydrocarbazole has now been repeated. In both cases, the same product was obtained as white prisms from ethanol, m.p. 95–97° (Lit., m.p. 102°[2], 96°[8]), which from the following spectral data has been shown to have structure II (R = H). ν_{max} (in nujol) 3390 ± 5 cm^{-1} (s) (pyrrolic N—H stretching); λ_{max} 212–215 mμ (log ε = 3·81 in ethanol) (tetra-alkyl pyrrole); λ_{max} 209–212, 274 mμ (log = 3·63, 3·77 respectively, in ethanolic hydrochloric acid) (tetra-alkyl 2H-pyrolinium cation); the PMR spectrum (in chloroform) shows no ethylenic protons (which would arise from the other possible isomeric structures) but shows two multiplets of equal intensity between 8·52 and 7·90τ and 7·71 and 7·08τ, that at lower field being due to the eight protons of the four methylene groups adjacent to the pyrrole ring, and the higher field multiplet being due to the eight protons of the other four methylene groups.

In view of the above spectral data, which definitely establishes structure II (R = H) for the product from the Piloty synthesis, and since the structure of the octahydro-N-methylcarbazole obtained by von Braun and Ritter[3] has also been firmly established[6] as II (R = CH_3), the attempt by Perkin and Plant[2] to N-methylate II (R = H) did not proceed as they expected. The product from this reaction, purified via the picrate as greenish-yellow plates from ethanol, m.p. 147° (Lit., m.p. 147°),[2] has now been shown by the following spectral measurements to have structure VI, and thus C_2-alkylation, the occurrence of which is well established[9] in 2,3,4,5-tetra-alkylated pyrroles, has occurred instead of N-alkylation as expected by Perkin and Plant.[2]



VI

VI, b.p. 148–150°/16 mm (Lit., b.p. 139–140°/14 mm),[2] shows ν_{max} (liquid film) 1658 ± 5 cm^{-1} (m) (C═N stretching) and 1563 ± 5 cm^{-1} (m) (C═C stretching), and λ_{max} 247 mμ (log ε = 3·62 in ethanol), 274 mμ (log ε = 3·78 in ethanolic hydrochloric acid) (2,2,3,4,5-penta-alkyl 2H-pyrrole and 2H-pyrrolinium cation respectively).[9] The PMR spectrum (in benzene) has a sharp singlet at 8·77τ (intensity 3) $(\text{—}\overset{|}{\underset{|}{C}}\text{—}CH_3$

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[5] W. H. Perkin jun. and S. G. P. Plant, *J. Chem. Soc.* **127**, 1138 (1925).

[6] S. G. P. Plant, *J. Chem. Soc.* 1595 (1930).

[7] E. Benary, *Ber. Dtsch. Chem. Ges.* **67**, 708 (1934).

[8] A. N. Kost and I. I. Grandberg, *J. Gen. Chem. U.S.S.R.* **26**, 607 (1956).

[9] H. Booth, A. W. Johnson, E. Markham and R. Price, *J. Chem. Soc.* 1587 (1959).

protons) and a multiplet between 8·74 and 7·08τ (intensity 15·7) (16 methylene protons). The methiodide of VI, white prisms from acetone, m.p. 194–195° (Lit., m.p. 194°),[2] shows ν_{max} (in nujol) 1652 ± 5 cm^{-1} (m) (C=N stretching) and 1580 ± 5 cm^{-1} (m) (C=C stretching), λ_{max} 275–277 mμ (log ε = 3·83 in ethanol), 295 mμ (log ε = 3·88 in ethanolic sodium hydroxide) (1,2,2,3,4,5-hexa-alkyl pyrrolinium cation and 1,3,4,5,5-penta-alkyl 2-alkylidene-Δ^3-pyrrolidine respectively).[9]

EXPERIMENTAL

The m.ps. (determined on a Kofler block) and b.ps. are uncorrected. UV and IR spectra were recorded using a Perkin-Elmer 137 UV spectrophotometer and a Unicam SP. 200 spectrophotometer respectively. PMR spectra were determined on an A.E.I. spectrometer R.S. II operating at 60 Mc; tetramethylsilane was used as internal standard and intensities were measured using a planimeter.