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CIS-9-ACETYL-4a-ETHYL-1,2,3,4,4a,9a-HEXAHYDROCARBAZOLE: DETERMINATION OF STEREOSTRUCTURE BY X-RAY ANALYSIS

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The difficulty of making a rigorous assignment of configuration to *cis-trans* pairs of hexahydrocarbazoles by chemical or spectroscopic methods was recognized when the distinction between certain pairs of isomers became a matter of significance to other studies[1,2]. Since our own interest concerned molecules of general formula I, the compound I (X = H), obtained by platinum-catalyzed hydrogenation of 4a-ethyltetrahydrocarbazolenine[1] in acetic anhydride, has been subjected to single crystal X-ray analysis.

The crystals, mp 63.5-64.5° from hexane, $C_{16}H_{21}NO$ (M.W. = 243 g/mole), are orthorhombic, space group $P2_12_12_1$; $\underline{a}$ = 14.915(6), $\underline{b}$ = 9.901(4), $\underline{c}$ = 9.370(4) Å; D_m = 1.13, D_x (for Z = 4) = 1.14 g/cm³; F(000) = 528. X-ray intensities were measured on an automated Picker four-circle diffractometer using the 2θ-θ scan mode with CuK_α radiation. Of the 1346 non-equivalent reflections, $0 \leq \sin\theta \leq 0.9$, 906 were observed; no corrections were made for extinction or absorption (μ = 6.47 cm^{-1}).

After assignment of phases for four origin- and enantiomorph-determining reflections, two additional reflections of large E were assigned arbitrary phases of 125, 375, 625, and 875 millicycles. The 182 largest E values were used for refinement by the tangent formula[3]. Two of the sets of generated phases had R_{Karle} = 21%, a value significantly lower than those of the remaining sets ($\geq$ 31%). These two sets contained 173 reliable phases and were later shown to differ only in chirality. The E-map revealed 17 of the 18 non-hydrogen atoms, and phasing on these 17 revealed the remaining carbon atom (C16). The hydrogen atoms were located from difference maps computed after anisotropic refinement. The conventional R factor is presently at 7.2% with refinement almost complete.

The Figure shows the molecule in z-projection, from which the important features of the streochemistry are clear. [An arbitrary numbering system is used in the Figure to identify the atoms.] The saturated ring 3 and the heterocyclic ring 2 are cis-fused with the ethyl side chain (C15 and C16) and N equatorial to the six-membered ring, and C7 and the H at C1 axial. Ring 3 is in a chair conformation, slightly flattened by the ring fusion; the torsional angle in C5-C6-C1-C2 is 41°, and that in C7-C6-C1-N is 33°; C1, C2, C4, and C5 are nearly coplanar (maximum deviation 0.02 Å) and the dihedral angle between this plane and those of C5-C6-C1 and C2-C3-C4 are 141° and 121°, respectively. The five-membered ring 2 has an envelope conformation with C1 at the flap and bent away from the ethyl group at C6. The aromatic ring 1 together with C6, N, and the atoms C13, C14, and O of the acetyl group form a closely coplanar system (maximum deviation 0.14 Å at C6) in which the conformation of the acetyl group is that with the oxygen pointing in the direction of the phenylene ring. Bond lengths and angles and intermolecular contacts are normal. A detailed account of the crystal structure will be published elsewhere.

This hydrogenation product, I (X = H), has been related by chemical methods to the other members of the hexahydrocarbazole series, I (X = Br, OAc, OH, etc.), that we described previously[1], and consequently rigorously establishes their configuration. Details of this correlation and an account of its chemical ramifications will be published shortly.

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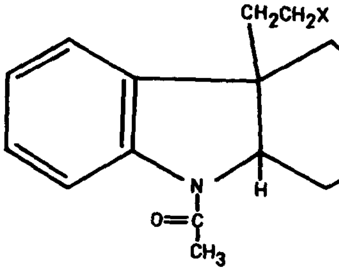
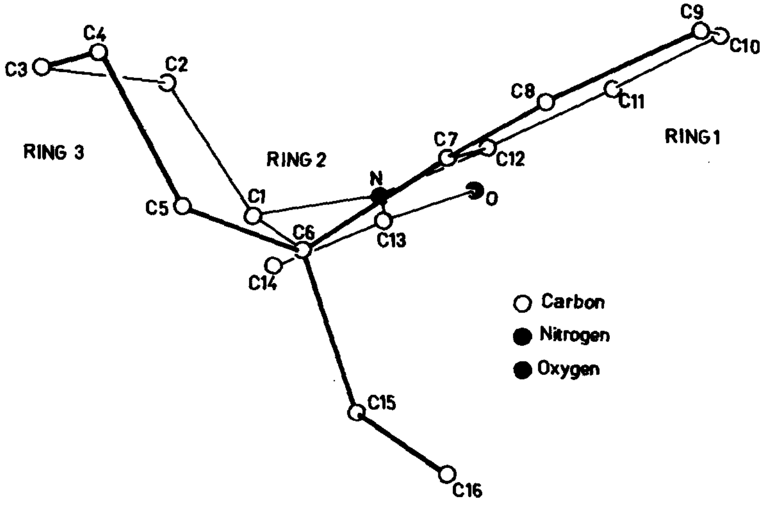

CH2CH2X
N
H
O=C
CH3

I


C9
C10
C4
C3
C2
C8
C11
RING 3
RING 2
C7
C12
RING1
N
C1
O
C5
C6
C13
C14
○ Carbon
● Nitrogen
● Oxygen
C15
C16

FIGURE

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