Tetrahedron Letters No.30, pp. 2645-2648, 1970. Pergamon Press. Printed in Great Britain.

THE STRUCTURE OF THE NON-PEROXIDIC AUTOXIDATION PRODUCT OF 2,3-DIMETHYLINDOLE

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(Received in USA 26 March 1970; received in UK for publication 29 May 1970)

Very recently Berti, Da Settimo, Di Colo and Nannipieri (1) reported on their investigation of the structure of the non-peroxidic autoxidation product of 2,3-dimethylindole which had been described a number of years ago by Beer, Donavanik, and Robertson (2). Their spectroscopic and degradative evidence led them to propose the dimeric structure in Figure 1 for the product; because the ir spectrum indicated that the OH group was hydrogen-bonded to the ether oxygen, they considered that the stereochemistry of the product was most probably represented by Ia or Ib, and, of these, they favoured Ia.

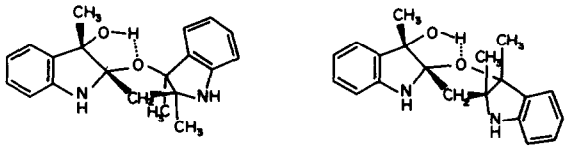
The cause of our interest in this compound, our initial approach to its investigation, the conclusions we drew from chemical and spectroscopic data and, apparently, our reservations about them have been very similar to those of Berti *et al*. We recognized that the appearance in the nmr spectrum of a methylene singlet at τ 7.60, the multiplicity of which did not change in a variety of solvents or over a range of temperature, was difficult to accommodate to structure I (or, indeed, to any chemically reasonable structure) without invoking a persistent accidental coincidence of the chemical shifts of the two non-equivalent protons. Moreover, it was necessary to treat degradative evidence particularly critically since compounds of this class are notoriously prone to rearrangements. Because of these reservations and because the stereochemical question still remained, we turned to X-ray analysis by direct methods.

Crystals, mp 226°, $C_{20}H_{22}N_2O_2$ (M.W. = 322 g/mole), were monoclinic, space group $P2_1/c$; $\underline{a}$ = 10.24, $\underline{b}$ = 11.25, $\underline{c}$ = 15.47 Å; β = 101.5°; D_m = 1.25, D_x (for Z = 4) = 1.24 g/cm^3; F(000) = 688. The intensities were measured on an automated four-circle diffractometer in the 2θ-θ scan mode, using Cu K_α radiation. Of the 2997 non-equivalent reflections, 2166 were significantly above background; no corrections were made for extinction or absorption (μ = 7.65 cm^{-1}).

After assignment of signs to three origin-determining reflections, three additional reflections were given phases of either 0 or π, and signs were generated from the tangent formula for the 267 largest E values. Of the eight possible sets of generated phases, one had R_{Karle} = 16% (3), lower than any others (≥27%) and the E-map revealed all non-hydrogen atoms. A perspective view of the structure is given in Figure 2. All hydrogen atoms were found from difference maps after anisotropic refinement. The conventional R factor is now at 7.5% with refinement virtually complete.

The structure assigned to the molecule previously (1) is thus confirmed, the stereochemistry, however, being that represented by Ib. The appearance of the methylene protons as a singlet in the nmr spectrum remains surprising, and we can only conclude that the coincidence in their chemical shift must be accidental. The existence of an intramolecular hydrogen bond, O-H...O, is confirmed. In addition there is in the crystal an intramolecular hydrogen bond, N1-H1...N2, whose geometry is shown in Figure 3. The hydrogen atoms attached to the nitrogen atoms are displaced as a consequence. Thus, whereas the angle C1-N1-H1 is larger than ∠C2-N1-H1, ∠C3-N2-H2 is smaller than ∠C5-N2-H2. There are no intermolecular hydrogen bonds. Hydrogen atom H2 does not take part in hydrogen bonding presumably because it is effectively screened by H1, by the hydrogen on C4, and two of the hydrogens on the methyl group (C6).

Both indolic five-membered rings have envelope conformations, and the oxygen-containing ring has a half-chair conformation.



I a I b

FIGURE 1.

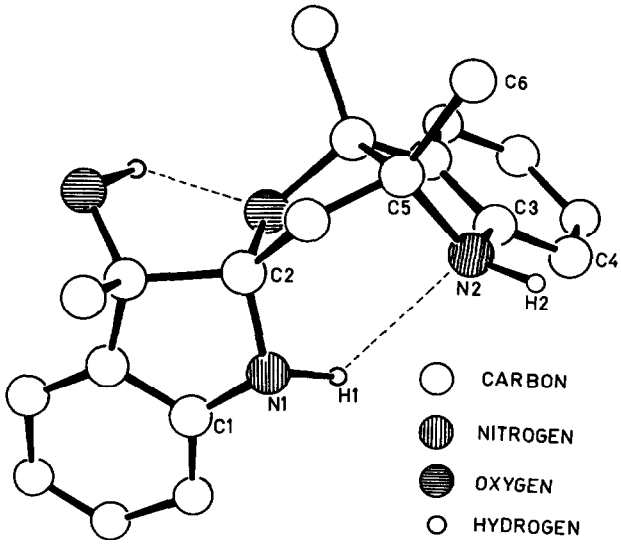


FIGURE 2.

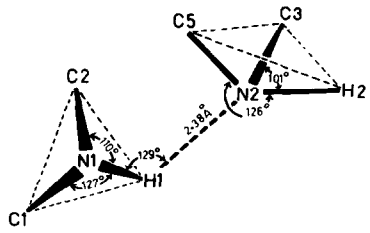


FIGURE 3.

Acknowledgement: We thank the National Research Council (Canada) for support of this work.

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