

THE CRYSTAL AND MOLECULAR STRUCTURE OF
THE 0,0'-DI-PARA-BROMOBENZOATE OF BRUNSVIGINE,
AN AMARYLLIDACEAE ALKALOID FROM BRUNSVIGIA COOPERII

Michael Laing,*

(Chemistry Department, University of Natal, Durban, South Africa)

Richard C. Clark,

(National Chemical Research Laboratory, CSIR, Pretoria, South Africa)

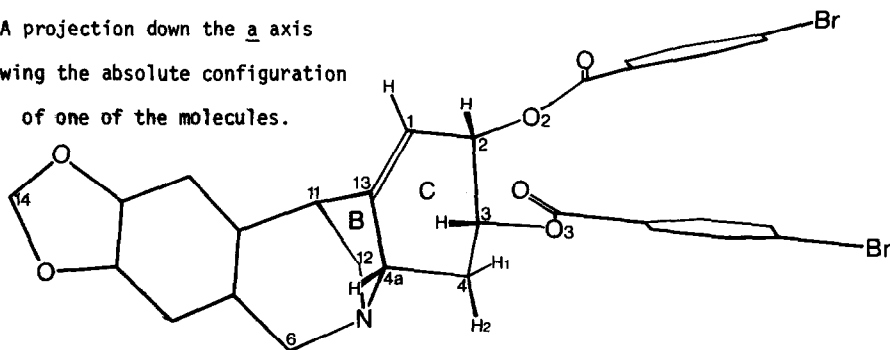
(Received in UK 19 November 1973; accepted for publication 11 January 1974)

Early work¹ on brunsvigine, $C_{16}H_{17}NO_4$, established that it was isomeric with lycorine and contained two vicinal hydroxyl groups. It was subsequently formulated² as the 2,3 dihydroxy analog of montanine. A detailed chemical study³ threw doubt on this assignment but did not lead to an unequivocal identification. An elegant study⁴ of the n.m.r. and mass spectra of pancracine and its derivatives showed that it in fact had the structure previously attributed to brunsvigine. To resolve the uncertainties, a crystal structure determination was undertaken.

Suitable crystals of the 0,0'-di-parabromobenzoate, $C_{30}H_{23}NO_6Br_2$, were obtained with difficulty by recrystallization from ethanol. They were triclinic, space group $P1$, $a = 7.460$, $b = 12.213$, $c = 16.303 (\pm 0.005 \text{ \AA})$, $\alpha = 87.49$, $\beta = 98.38$, $\gamma = 106.95 (\pm 0.05^\circ)$; $V_0 = 1405.7 \text{ \AA}^3$, $Z = 2$, $D_{\text{obs}} = 1.59 \text{ g cm}^{-3}$, $D_{\text{calc}} = 1.57 \text{ g cm}^{-3}$. Three-dimensional intensity data were collected on a Philips four-circle diffractometer with graphite monochromated Mo-K α radiation to $\theta = 20^\circ$. Of 2028 measured data, 1660 were judged to be above background. The positions of the four bromine atoms were readily deduced from a three-dimensional Patterson map and the remaining atoms were located in the subsequent Fourier maps. The presence of a molecule of ethanol solvent was clearly observable in the 78-atom observed Fourier map. The three atoms were included and the structure was refined isotropically by block diagonal least squares to $R = 0.070$ (bromine atoms anisotropic). The absolute configuration was determined by including the anomalous contribution of the bromine atoms ($\Delta f'' = 2.55$).

Both molecules in the asymmetric unit are remarkably similar. The two parabromo-benzoate groups on ring C are cis oriented, hence brunsvigine has the same skeleton as β -isocrinamine and manthidine² with the two hydroxyl groups cis oriented. The absolute stereochemistry confirms earlier assignments based on both degradative and X-ray techniques⁵.

A projection down the a axis
showing the absolute configuration
of one of the molecules.



The bond lengths and angles are normal; average Br-C(ph) = 1.92, C(1)-C(13) = 1.35Å. The atoms of the methylenedioxyphenyl system are coplanar within 0.02Å except for C(14) which deviates from the plane by 0.15Å. The small bond angle C(13)-C(11)-C(12) = 93° implies that ring B is moderately strained which may account for previously unexplained³ aspects of the chemistry.

The conformation of ring C is of particular interest. Deviations from the mean plane are: C(1) 0.07, C(2) -0.07, C(3) -0.02, C(4) -0.83, C(4a) 0.01, C(13) 0.06, O(2) -1.40, O(3) -0.68, C(11) -0.07, N -0.62, C(12) -1.16Å. The torsion angle O(2)-C(2)-C(3)-O(3) is 48°; O(2)···O(3) = 2.72Å. The observed torsion angles between the hydrogen atoms on ring C are consistent with the coupling constants derived from the observed n.m.r. spectrum: $\phi(1,2) = 50^\circ$, $\phi(2,3) = 50^\circ$, $\phi(3,4.1) = 167^\circ$, $\phi(3,4.2) = 65^\circ$, $\phi(4.1,4a) = 177^\circ$, $\phi(4.2,4a) = 52^\circ$, implying that there is no significant difference between the conformation of the C ring of the acetate in solution and that of the di-parabromobenzoate in the solid state.

Acknowledgement. We thank Dr. Gert Kruger, National Physical Research Laboratory, CSIR, Pretoria, who collected the intensity data.

References.

1. L. Dry, M. Poynton, M.E. Thompson and F.L. Warren, J. Chem. Soc. 4701 (1958).
2. Y. Inubushi, H.M. Fales, E.W. Warnhoff and W.C. Wildman, J. Org. Chem. 25, 2153 (1960).
3. R.C. Clark, Ph.D.Thesis, University of Natal, 1962.
4. W.C. Wildman and C.L. Brown, J. Amer. Chem. Soc., 90, 6439 (1968).
5. J. Karle, J.A. Estlin and I.L. Karle, J. Amer. Chem. Soc., 89, 6510 (1967),
J. Clardy, F.M. Hauser, D. Dahm, R.A. Jacobson and W.C. Wildman, *ibid*, 92, 6337 (1970),
J. Clardy, J.A. Chan and W.C. Wildman, J. Org. Chem., 37, 49 (1972).