

Crystal and Molecular Structure of Sceletium Alkaloid A₄ by X-Ray Analysis

By P. A. Luhan and A. T. McPhail,* Paul M. Gross Chemical Laboratory, Duke University, Durham, North Carolina 27706, U.S.A.

Sceletium Alkaloid A₄. (1). C₂₀H₂₄N₂O₂, isolated from *Sceletium namaquense* L. Bolus crystallizes in the monoclinic system, space group $P2_1$, with $a = 8.33(2)$, $b = 14.74(3)$, $c = 7.18(2)$ Å, $\beta = 95.04(20)^\circ$, and $Z = 2$. The structure was solved from photographic X-ray data by direct phase-determining methods and refined by full-matrix least-squares calculations to R 0.100 over 1523 observed reflexions. The alkaloid which contains a 2,3-disubstituted pyridine moiety is representative of a third structure variant in *Sceletium* species.

DURING the course of their studies on the alkaloid constituents of *Sceletium* species (family Aizoaceae) Jeffs¹ and his co-workers isolated from *Sceletium namaquense* a minor alkaloid of composition C₂₀H₂₄N₂O₂. Comparison of the properties of this alkaloid with those of 'Sceletium A₄', an alkaloid of unknown constitution reported by Popelak and Lettenbauer,² proved them to

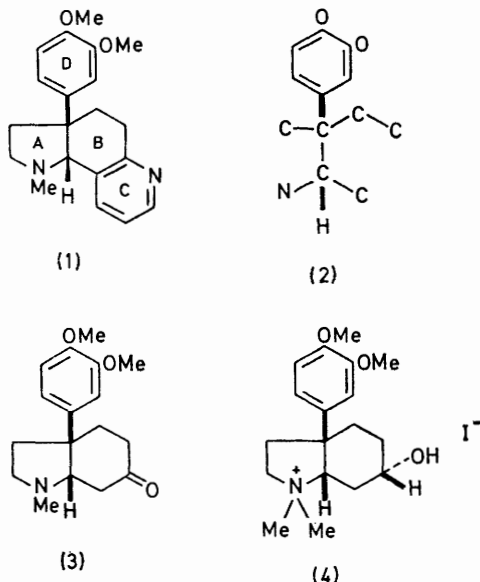
be identical. Mass spectral, n.m.r., i.r., and u.v. data indicated that the alkaloid was a representative of a new structural type of sceletium alkaloid containing a 2,3-disubstituted pyridine ring, and the number of probable structures for the alkaloid could be reduced to four of which (1) seemed the most probable on biogenetic grounds.³ Since only a small amount of alkaloid was available we undertook a single-crystal X-ray analysis

¹ P. W. Jeffs, personal communication.

² A. Popelak and G. Lettenbauer, in 'The Alkaloids,' vol. IX, ed. R. H. F. Manske, Academic Press, New York, 1967, p. 467.

³ P. W. Jeffs, P. A. Luhan, A. T. McPhail, and N. H. Martin, *Chem. Comm.*, 1971, 1466.

in order to establish its structure and stereochemistry unambiguously. Independent investigations by Wiechers⁴ and his associates in South Africa have led



to the isolation and characterization of the same alkaloid from *Scelletium tortuosum* N.E.Br.

EXPERIMENTAL

Crystals {m.p. 153.5–154.5 °C, $[\alpha]_D$ (MeOH) +131°} were obtained from ethyl acetate as prisms.

Crystal Data.— $C_{20}H_{24}N_2O_2$, $M = 324.4$. Monoclinic, $a = 8.33(2)$, $b = 14.74(3)$, $c = 7.18(2)$ Å, $\beta = 95.04(20)^\circ$, $U = 878$ Å³, $D_m = 1.23$, $Z = 2$, $D_c = 1.227$, $F(000) = 348$. Cu- $K\alpha$ X-rays, $\lambda = 1.542$ Å; μ (Cu- $K\alpha$) = 6.4 cm⁻¹. Space group $P2_1(C_2^2)$ from systematic absences: $0k0$ when $k \neq 2n$; *Scelletium Alkaloid A₄* is a chiral molecule.

Crystallographic Measurements.—Oscillation, rotation, and Weissenberg photographs were taken with Cu- $K\alpha$ radiation; precession photographs were recorded with Mo- $K\alpha$ ($\lambda = 0.7107$ Å) radiation. The unit-cell dimensions were evaluated from precession, rotation, and $h0l$ Weissenberg photographs. Intensities were estimated visually from equi-inclination multiple-film Weissenberg photographs of the $h0-13l$ layers by comparison with a calibrated intensity strip. Spot-shape corrections and the usual Lorentz and polarization factors were applied, but absorption was neglected. In all, 1523 independent non-zero structure amplitudes were derived.

Structure Analysis.—Normalized structure factor magnitudes $|E_H|$ were computed from the relationship $|E_H|^2 = |F_H|^2/\epsilon \sum_{j=1}^N f_{jH}^2$ where N is the number of atoms in the unit cell, f_{jH} is the atomic scattering factor of the j^{th} atom. For the space group $P2_1$, $\epsilon = 1$ except for $0k0$ reflexions where $\epsilon = 2$. The $|F_H|^2$ values were those from which the effects of thermal motion were removed by assuming an overall isotropic temperature factor $B = 3.5$ Å².

The initial phases for a selected set of reflexions with

large $|E|$ values were determined by the symbolic addition procedure⁶ for non-centrosymmetric crystals. The formula for starting the phase determination was $\phi_H \simeq \langle \phi_K + \phi_{H-K} \rangle$, where ϕ_H were the phase associated with $|E_H|$ and the average was taken over those K corresponding to the larger $|E|$ values. Phases, ϕ_H , were assigned to three linearly independent reflexions (207, $|E| = 3.63$, $\phi = 0$; 294, $|E| = 2.37$, $\phi = \pi/2$; 582, $|E| = 2.28$, $\phi = 0$) in order to specify the origin of the space group $P2_1$. Two other reflexions (482, $|E| = 2.61$, and 544, $|E| = 2.61$) which entered into a number of Σ_2 combinations were assigned symbols a and b , and a set of phases for 22 reflexions for which $E_H \cdot E_K \cdot E_{H-K} > 10.0$ were derived in terms of the five starting phase angles. The values of a ($0 \leq a \leq \pi$) and b ($0 \leq b \leq 2\pi$) were then allowed to vary by increments of $\pi/4$ and these were input to the tangent formula:⁶

$$\tan \phi_H \simeq \frac{[\Sigma_K |E_K \cdot E_{H-K}| \cdot \sin(\phi_K + \phi_{H-K})]}{[\Sigma_K |E_K \cdot E_{H-K}| \cdot \cos(\phi_K + \phi_{H-K})]} \simeq A/B$$

the restriction on a being equivalent to specifying the enantiomorph. For these calculations we employed a local version of the iterative program originally written by Drew⁷ and amended by Larson and Motherwell.⁸ The largest 58 $|E|$ values were included with the original 22 in the iterations for the first 5 cycles, 250 were refined during the next 5 cycles, and 498 were refined for the final 5 cycles. A phase assignment was rejected in any cycle if the consistency index, $t = \sqrt{A^2 + B^2}/\Sigma_K |E_K| \cdot |E_{H-K}|$ was < 0.40 , and the value of $\alpha = |E_H|/\sqrt{A^2 + B^2}$ was < 6.0 . At the end of the tangent refinement cycles, inspection of the R_K [$= \Sigma_H |E_H|_{\text{obs}} - |E_H|_{\text{calc}}|/\Sigma_H |E_H|_{\text{obs}}$] values revealed that one of the lowest ($R_K = 16.0$) was for the starting set $a = 3\pi/4$, $b = \pi$, which also used a large number of the Σ_2 values and assigned phases to a larger number of reflexions than the other sets. An E -map was computed using the phase values derived from this set, and a seven-atom $[C(1')-(6'), C(3a)]$ partial structure was recognized. These atoms were then used to calculate structure factors. 84 Reflexions with $|E| > 1.0$ and for which, summing over those atoms not included in the structure-factors calculation, $\tanh(F_o \cdot F_c/\Sigma f_j^2)$ exceeded 0.60, were used as input to the tangent formula which generated phases for 385 reflexions with $|E| > 1.0$. A second E -map was computed and a further eight atoms were located to give partial structure (4). Positional and isotropic thermal parameters of these fifteen atoms were refined by four cycles of full-matrix least-squares calculations to R 0.37. A three-dimensional F_o Fourier synthesis was then evaluated, and the positions of the remaining non-hydrogen atoms were revealed clearly in the electron-density distribution. Atomic positional and anisotropic thermal parameters were refined by seven cycles of least-squares calculations which reduced R to 0.130. During these and all subsequent calculations the y coordinate of N(1) was held constant to define the origin of the space group. The pyridine nitrogen atom was identified during the calculations from its relatively low thermal parameter when treated as a carbon atom and from the values of the diagonal elements of the normal-equation matrix. A three-dimensional difference electron density map was evaluated, and this contained significant density

⁷ See e.g., M. G. B. Drew, D. H. Templeton, and A. Zalkin, *Acta Cryst.*, 1969, **B**, 25, 261.

⁸ See e.g., O. Kennard, D. L. Wampler, J. C. Coppola, W. D. S. Motherwell, D. G. Watson, and A. C. Larson, *Acta Cryst.*, 1971, **B**, 27, 1116.

⁴ F. O. Snyckers, F. Strelow, and A. Wiechers, *Chem. Comm.*, 1971, 1467.

⁵ J. Karle and I. L. Karle, *Acta Cryst.*, 1966, **21**, 849.

⁶ J. Karle and H. Hauptmann, *Acta Cryst.*, 1956, **9**, 635.

at all positions calculated for the hydrogen atoms (assuming C-H 1.07 Å). Inclusion of twenty-four hydrogen atoms with $B = 5.0 \text{ \AA}^2$ in the next structure-factor calculation reduced R to 0.113. Four further least-squares iterations to adjust the non-hydrogen atom parameters brought the refinement to convergence with R 0.100. For all structure-factor calculations, scattering factors for neutral atoms were taken from ref. 9. The weighting scheme used in the least-squares calculations was $\sqrt{w} = 1$ for $|F_o| \leq 6.0$ and $\sqrt{w} = |F_o|/6.0$ for $|F_o| > 6.0$; this showed no systematic dependence of $\langle w\Delta^2 \rangle$ when analysed in ranges of $|F_o|$ and $\sin \theta$.†

RESULTS AND DISCUSSION

This X-ray analysis establishes the structure of Sceletium Alkaloid A₄ as (1) or its mirror image. We assume that (1) also represents the absolute stereochemistry in accord with those assigned previously to (–)-mesembrine¹⁰ (3) and to 6-epimesembranol methiodide¹¹ (4). Final atomic positional and thermal parameters are given in Tables 1–3, and the interatomic

TABLE 1

Fractional atomic co-ordinates and their estimated standard deviations

Atom	x/a	y/b	z/c
N(1)	0.2058(5)	–0.0929(0)	0.2103(7)
C(2)	0.1294(7)	–0.0067(6)	0.1627(10)
C(3)	0.2529(7)	0.0505(6)	0.0667(11)
C(3a)	0.4152(6)	–0.0009(4)	0.1162(7)
C(4)	0.4568(6)	–0.0600(4)	–0.0527(7)
C(5)	0.6050(7)	–0.1191(5)	–0.0032(8)
C(6)	0.5990(6)	–0.1689(4)	–0.1803(7)
C(7)	0.4878(6)	–0.1453(4)	0.3072(7)
C(7a)	0.3722(6)	–0.0665(4)	0.2729(7)
C(8)	0.1236(8)	–0.1446(7)	0.3466(11)
N(9)	0.7097(7)	–0.2332(4)	0.2100(8)
C(10)	0.7147(8)	–0.2779(5)	0.3765(10)
C(11)	0.6092(10)	–0.2614(6)	0.5056(11)
C(12)	0.4957(8)	–0.1926(5)	0.4760(8)
C(1') [†]	0.5919(7)	0.1318(5)	0.0509(9)
C(2')	0.7271(8)	0.1890(5)	0.0864(8)
C(3')	0.8272(6)	0.1772(4)	0.2469(8)
C(4')	0.7896(6)	0.1081(4)	0.3746(7)
C(5')	0.6563(6)	0.0539(4)	0.3347(7)
C(6')	0.5562(6)	0.0638(4)	0.1689(7)
O(13)	0.9632(5)	0.2258(3)	0.2955(6)
C(14)	1.0138(8)	0.2901(5)	0.1661(11)
O(15)	0.8930(5)	0.1025(4)	0.5322(5)
C(16)	0.8576(9)	0.0401(7)	0.6706(9)

distances and valency angles are in Table 4. Figure 1 shows the conformation adopted by the molecule in the crystal. Torsion angles¹² for rings A and B are shown in Figure 2, and the displacements of some atoms from selected mean planes through groups of atoms are presented in Table 5.

The atoms of the pyridine ring are coplanar within the accuracy of the analysis, but the substituent atoms, C(5) and C(7a), are displaced significantly by 0.041 and 0.105 Å, respectively, to the same side of the ring plane. Ring B adopts a half-chair conformation with C(3a) and C(4) displaced by 0.406 and –0.387 Å from the mean

† Observed and calculated structure factors are listed in Supplementary Publication No. SUP 20471 (10 pp., 1 microfiche). For details see Notice to Authors No. 7 in *J. Chem. Soc. (A)*, 1970, Issue No. 20.

TABLE 2

Calculated hydrogen-atom fractional co-ordinates, numbered according to their bonded carbon atoms

Atom	x/a	y/b	z/c
H(2 α)	0.024	–0.016	0.069
H(2 β)	0.098	0.028	0.286
H(3 α)	0.224	0.052	–0.081
H(3 β)	0.259	0.118	0.121
H(4 α)	0.356	–0.103	–0.093
H(4 β)	0.479	–0.016	–0.166
H(5 α)	0.613	–0.168	–0.112
H(5 β)	0.709	–0.076	0.005
H(7a)	0.374	–0.030	0.402
H(8 α)	0.180	–0.209	0.382
H(8 β)	0.003	–0.164	0.301
H(8 γ)	0.125	–0.102	0.468
H(10)	0.802	–0.331	0.400
H(11)	0.615	–0.298	0.636
H(12)	0.413	–0.179	0.578
H(1')	0.514	0.142	–0.074
H(2')	0.754	0.241	–0.009
H(5')	0.628	0.002	0.431
H(14 α)	1.137	0.333	0.194
H(14 β)	0.917	0.337	0.149
H(14 γ)	1.021	0.253	0.039
H(16 α)	0.935	0.032	0.797
H(16 β)	0.853	–0.024	0.598
H(16 γ)	0.741	0.058	0.706

TABLE 3

Anisotropic thermal parameters* ($\times 10^4$) with estimated standard deviations

Atom	b_{11}	b_{22}	b_{33}	b_{12}	b_{13}	b_{23}
N(1)	67(5)	36(3)	140(8)	–17(6)	32(10)	–5(8)
C(2)	83(7)	51(4)	213(14)	43(10)	–34(16)	–16(13)
C(3)	70(6)	40(4)	244(14)	–1(9)	–40(16)	–7(13)
C(3a)	81(6)	24(3)	127(9)	–15(7)	–16(12)	–20(8)
C(4)	103(7)	27(3)	118(9)	–23(8)	5(13)	2(8)
C(5)	118(7)	35(5)	146(9)	8(9)	71(14)	–23(10)
C(6)	78(6)	22(3)	147(9)	–31(7)	–38(12)	–40(8)
C(7)	95(6)	25(3)	141(9)	–38(7)	7(13)	–5(9)
C(7a)	71(6)	27(3)	131(9)	–13(7)	29(12)	–32(8)
C(8)	109(8)	63(5)	249(11)	–60(10)	97(17)	17(10)
N(9)	132(7)	27(3)	227(11)	4(8)	–65(15)	–32(9)
C(10)	153(9)	20(3)	288(15)	9(10)	–143(20)	12(12)
C(11)	172(10)	37(4)	219(13)	–48(11)	–122(20)	68(11)
C(12)	139(8)	37(3)	140(10)	–37(9)	–11(15)	29(10)
C(1')	106(7)	21(3)	179(11)	–4(8)	–25(15)	25(9)
C(2')	115(8)	18(3)	154(9)	–14(8)	–4(14)	35(9)
C(3')	98(7)	15(3)	166(10)	–6(8)	35(14)	–12(9)
C(4')	79(6)	23(3)	123(8)	7(7)	–6(12)	–4(8)
C(5')	97(7)	23(3)	116(8)	–1(8)	10(12)	–1(8)
C(6')	80(6)	14(3)	127(8)	3(7)	3(12)	–2(7)
O(13)	116(5)	30(2)	196(8)	–72(5)	10(11)	14(7)
C(14)	113(8)	43(4)	305(16)	–50(9)	–1(19)	90(13)
O(15)	120(5)	46(3)	136(7)	–55(6)	–76(10)	14(7)
C(16)	185(10)	90(6)	171(11)	–109(13)	–142(18)	93(14)

* These are the values of b_{ij} in the expression:

$$B \sin^2 \theta / \lambda^2 = (b_{11}h^2 + b_{22}k^2 + b_{33}l^2 + b_{12}hk + b_{13}hl + b_{23}kl).$$

plane through C(5)–(7a). The five-membered ring A is in a half-chair conformation with N(1) 0.362 below and C(7a) 0.351 Å above the C(2), C(3), C(3a) plane. The C₂ axis of this half-chair conformation has C(3) on the axis which bisects the N(1)–C(7a) bond whereas in (4), where the nitrogen atom is quaternized, C(3a) lies on the approximate C₂ axis which bisects the N(1)–C(2) bond.

⁹ 'International Tables for X-Ray Crystallography,' vol. III, Kynoch Press, Birmingham, 1962.

¹⁰ P. W. Jeffs, R. L. Hawks, and D. S. Farrier, *J. Amer. Chem. Soc.*, 1969, **91**, 3831.

¹¹ P. Coggon, D. S. Farrier, P. W. Jeffs, and A. T. McPhail, *J. Chem. Soc. (B)*, 1970, 1267.

¹² W. Klyne and V. Prelog, *Experientia*, 1960, **16**, 521.

With this different conformation of the five-membered ring in (1), the C(3a)–C(6') bond does not approximately eclipse the C(7a)–H(7a) bond as it does in (4), and

TABLE 4

Interatomic distances (Å) and angles (deg.), standard deviations in parentheses

(a) Intramolecular distances

N(1)–C(2)	1.449(9)	N(9)–C(10)	1.363(9)
N(1)–C(7a)	1.471(7)	C(10)–C(11)	1.355(11)
N(1)–C(8)	1.458(9)	C(11)–C(12)	1.390(11)
C(2)–C(3)	1.539(10)	C(1')–C(2')	1.412(9)
C(3)–C(3a)	1.563(9)	C(1')–C(6')	1.362(9)
C(3a)–C(4)	1.557(8)	C(2')–C(3')	1.372(8)
C(3a)–C(7a)	1.549(8)	C(3')–C(4')	1.424(7)
C(3a)–C(6')	1.534(8)	C(3')–O(13)	1.360(7)
C(4)–C(5)	1.527(8)	C(4')–C(5')	1.377(7)
C(5)–C(6)	1.513(8)	C(4')–O(15)	1.363(6)
C(6)–C(7)	1.399(7)	C(5')–C(6')	1.400(7)
C(6)–N(9)	1.327(8)	O(13)–C(14)	1.417(9)
C(7)–C(7a)	1.515(8)	O(15)–C(16)	1.404(10)
C(7)–C(12)	1.394(8)		
C(3) ... C(1')	3.08	C(8) ... C(12)	3.23
C(4) ... C(1')	3.11	C(7a) ... C(5')	2.96
C(5) ... C(5')	3.52		

H(1') ... H(3 α)	2.75	H(5') ... H(7a)	2.17
H(1') ... H(3 β)	2.67	H(8 α) ... H(12)	2.33
H(1') ... H(4 β)	2.43	H(8 γ) ... H(12)	2.71
H(5') ... H(5 β)	3.39		

(b) Valency angles

C(2)–N(1)–C(7a)	102.8(4)	N(1)–C(7a)–C(7)	114.5(4)
C(2)–N(1)–C(8)	113.2(5)	C(3a)–C(7a)–C(7)	114.4(4)
C(7a)–N(1)–C(8)	114.8(5)	C(6)–N(9)–C(10)	117.0(6)
N(1)–C(2)–C(3)	106.8(5)	N(9)–C(10)–C(11)	122.8(7)
C(2)–C(3)–C(3a)	103.3(6)	C(10)–C(11)–C(12)	120.0(7)
C(3)–C(3a)–C(4)	110.0(5)	C(7)–C(12)–C(11)	118.5(6)
C(3)–C(3a)–C(7a)	102.6(4)	C(2')–C(1')–C(6')	122.8(6)
C(3)–C(3a)–C(6')	112.5(5)	C(1')–C(2')–C(3')	119.5(6)
C(4)–C(3a)–C(7a)	107.3(5)	C(2')–C(3')–C(4')	118.6(5)
C(4)–C(3a)–C(6')	108.8(4)	C(2')–C(3')–O(13)	125.4(5)
C(7a)–C(3a)–C(6')	115.5(4)	C(4')–C(3')–O(13)	115.9(5)
C(3a)–C(4)–C(5)	111.6(4)	C(3')–C(4')–C(5')	120.0(5)
C(4)–C(5)–C(6)	113.0(4)	C(3')–C(4')–O(15)	114.8(4)
C(5)–C(6)–C(7)	121.4(5)	C(5')–C(4')–O(15)	125.2(4)
C(5)–C(6)–N(9)	114.2(5)	C(4')–C(5')–C(6')	121.7(5)
C(7)–C(6)–N(9)	124.3(5)	C(3a)–C(6')–C(1')	120.6(5)
C(6)–C(7)–C(7a)	122.1(5)	C(3a)–C(6')–C(5')	122.0(5)
C(6)–C(7)–C(12)	117.3(5)	C(1')–C(6')–C(5')	117.3(5)
C(7a)–C(7)–C(12)	120.3(5)	C(3')–O(13)–C(14)	118.2(5)
N(1)–C(7a)–C(3a)	102.4(4)	C(4')–O(15)–C(16)	118.0(5)

(c) Intermolecular distances ≤ 3.60 Å

O(13) ... C(8 ^{II})	3.33	C(1') ... N(9 ^I)	3.60
C(14) ... N(1 ^I)	3.57		

The superscripts refer to the following co-ordinate transformations:

$$\text{I } -x, \frac{1}{2} + y, 1 - z \quad \text{II } 1 - x, \frac{1}{2} + y, 1 - z$$

TABLE 5

Displacements (Å) of the atoms from various planes.

Atoms not included in the derivation of the plane are italicized

Plane A: C(2) 0.0, C(3) 0.0, C(3a) 0.0, N(1) <i>-0.362</i> , C(7a) <i>0.351</i>
Plane B: C(5) <i>-0.005</i> , C(6) 0.011, C(7) <i>-0.011</i> , C(7a) 0.005, C(3a) <i>0.406</i> , C(4) <i>-0.387</i>
Plane C: C(6) <i>-0.004</i> , C(7) <i>-0.001</i> , N(9) <i>-0.003</i> , C(10) 0.014, C(11) <i>-0.019</i> , C(12) 0.012, C(5) <i>0.041</i> , C(7a) <i>0.105</i>
Plane D: C(1') 0.012, C(2') 0.019, C(3') 0.004, C(4') 0.001, C(5') <i>-0.003</i> , C(6') <i>-0.025</i> , O(13) <i>-0.027</i> , O(15) 0.018, C(14) <i>-0.142</i> , C(16) <i>0.110</i> , C(3a) <i>-0.139</i> , C(3) <i>0.930</i>

consequently there is an increased degree of rotational freedom about the C(3a)–C(6') bond in order to reduce non-bonded H ... H interactions, although free rotation is still restricted by such interactions. The H(5') ... H(7a) distance in (1) is 2.17 Å whereas the corresponding estimated separation in (4) is 1.76 Å. A consequence of the reduced non-bonded interaction in (1) is that the exocyclic angles at C(6') are equal in contrast to the large observed difference (116.8, 125.2°) in (4). The dihedral angle between the plane through C(7a), C(3a), and C(6'), and the phenyl ring plane is 10°.

The phenyl ring atoms and the substituent oxygen atoms are approximately coplanar (plane D), but C(3a)

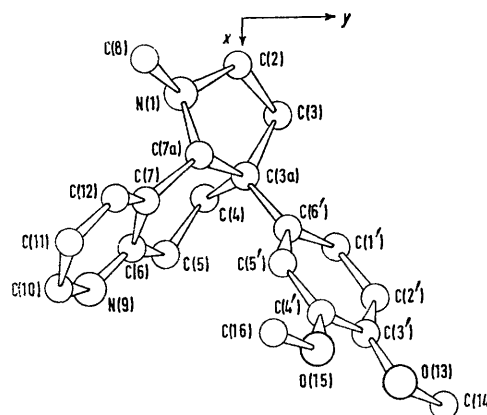


FIGURE 1 Atomic arrangement

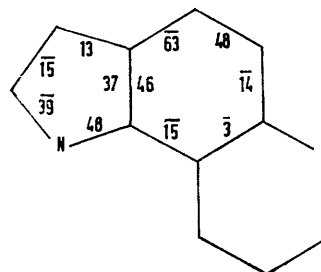


FIGURE 2 Torsion angles in A and B rings of (1)

is significantly displaced (0.118 Å) from the mean plane calculated through C(1')–(6'), O(13), and O(15). This displacement may be ascribed to the bending back of the phenyl ring at the C(3a)–C(6') bond in order to reduce non-bonded intramolecular interactions between the phenyl ring, and H(3), and H(7a). In accord with our earlier observation¹¹ on the geometries of adjacently bonded methoxy-groups in dimethoxyphenyl moieties, the C(Ph) ... O vectors are bent toward each other in (1) to reduce the intramolecular non-bonded H(Me) ... H(Ph) interactions. The methyl groups are rotated co-operatively by small amounts about their C(Ph)–O bonds so that C(14) and C(16) are displaced 0.142 and 0.110 Å to opposite sides of plane D (Table 5). The torsion angles about the C(3')–O(13) and C(4')–O(15) bonds are -5.4 and -7.8° . Similar rotations are present¹¹ in (4).

The mean $C(sp^3)-C(sp^3)$ bond length (1.549 Å) is close to the accepted value¹³ [1.537(5) Å]. The $C(Ph)-C(sp^3)$ single-bond distance [$C(3a)-C(6')$ 1.534 Å] is probably significantly longer ($\Delta/\sigma \simeq 3$) than the accepted value¹³ [1.505(5) Å] for such bonds, the increase being due to

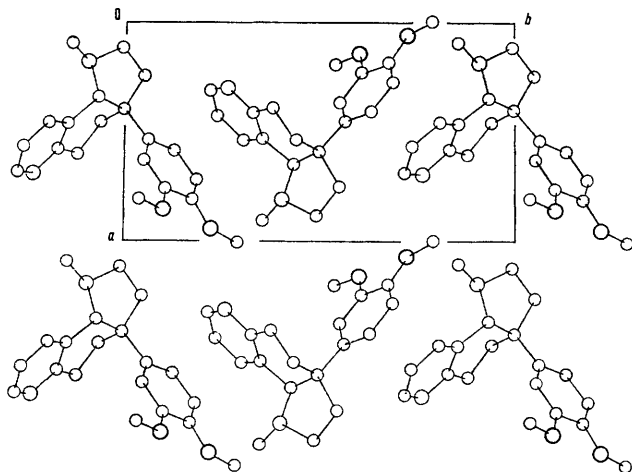


FIGURE 3 The crystal structure, as viewed in projection down c^*

steric overcrowding in this region of the molecule. The $C(sp^2)-C(sp^3)$ bonds from the pyridine ring average 1.514 Å. The mean $C(Ph)-O$ and $C(Me)-O$ lengths (1.362 and 1.411 Å) agree satisfactorily with the corresponding mean distances (1.359 and 1.440 Å) in re-

serpine¹⁴ and cryptopine (1.371 and 1.426 Å).¹⁵ In the phenyl ring, the mean $C-C$ length (1.391 Å) is in good agreement with the accepted value¹³ [1.394(5) Å]. There is, however, an alternation of bond lengths in the phenyl ring and the methyl groups of the methoxy-substituents are *cis* to two of the shorter bonds. Similar *cis* orientations of methyl groups to short bonds have been noted elsewhere for other molecules.¹⁶ In the pyridine ring, the mean $C-C$ and $C-N$ distances are 1.385 and 1.345 Å, $C-N-C$ is 117.0°, and the mean angles at the α -carbon atoms are 123.5°. These dimensions are in excellent agreement with those reported for pyridine¹⁷ [$C-C$ 1.395(5) and $C-N$ 1.340(5) Å; $C-N-C$ 116.7° and $C-C-C = 124.0^\circ$ at the α -carbon atoms]. The mean $C(sp^3)-N$ distance (1.456 Å) is satisfactorily close to the standard value¹³ [1.472(5) Å].

The molecular packing in the crystal, viewed down the c^* axis is shown in Figure 3. There are no abnormally short intermolecular distances.

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