

## Structure of 1-Benzyl-7-methyl-1-azaspiro[5.5]undecan-9-one, C<sub>18</sub>H<sub>25</sub>NO

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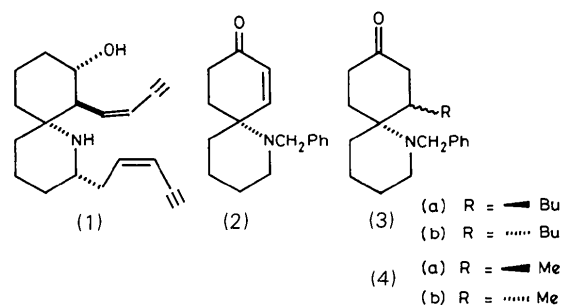
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(Received 26 April 1983; accepted 19 July 1983)

**Abstract.**  $M_r = 271.39$ , orthorhombic,  $Pca2_1$ ,  $a = 9.705$  (2),  $b = 19.413$  (4),  $c = 8.164$  (2) Å,  $Z = 4$ ,  $V = 1538$  (1) Å<sup>3</sup>,  $D_x = 1.16$  Mg m<sup>-3</sup>,  $\lambda(\text{Cu } K\alpha) = 1.5418$  Å,  $\mu = 0.56$  mm<sup>-1</sup>,  $F(000) = 592$ ,  $T = 293$  K.  $R = 0.045$  for 1254 unique observed reflections. Bond lengths and angles are normal.

**Introduction.** We are currently studying the total synthesis of molecules related to histrionicotoxin (1), an azaspirocyclic compound isolated from the skins of the Columbian frog *Dendrobates histrionicus* (Witkop, 1971). Our starting point was the azaspirocyclic enone (2), available in multigram quantities using organoiron chemistry developed in our laboratories (Pearson, Ham & Rees, 1982), and the projected strategy required the conjugate addition of an alkyl group to the enone moiety and *trans* to the amino function. Addition of lithium di-*n*-butyl cuprate to (2) gave rise to two oily diastereoisomers (3) in a ratio of *ca* 2:1, the major product being the more polar compound on TLC (silica gel, 50% ether in hexane). It was not possible to assign the relative stereochemistries of these compounds using the usual spectroscopic methods, although it may be noted that in the <sup>1</sup>H NMR spectrum the benzyl group shows a greater difference in chemical shift of the two protons in one compound than in the other. Since these compounds were not crystalline, and since it was essential to know the stereochemistry for future synthetic planning, the methyl adducts (4) were prepared by reaction of (2) with lithium dimethyl cuprate. These compounds were obtained in similar ratio and showed similar differences in polarity (TLC) and NMR spectra, suggesting a correlation between the relative stereochemistries of (3) and (4). The major methyl adduct was obtained crystalline and was

subjected to the analysis described in this paper, which shows it to correspond to the isomer (4b).



**Experimental.** Good quality crystals grown by slow evaporation of a water/methanol solution; crystal dimensions 0.35 × 0.14 × 0.11 mm. Preliminary X-ray photographs unambiguously established space group to be  $Pca2_1$  ( $Pbcn$ , also consistent with systematic absences, discounted as  $Z = 4$ ). Philips PW1100 diffractometer, Ni-filtered Cu  $K\alpha$  radiation.  $6 < 2\theta < 124^\circ$ . Cell dimensions from setting angles of 19 independent reflexions. 2786 reflexions in one quadrant (including systematically absent reflexions) measured. Three reference reflexions monitored throughout data-collection process showed no significant variations in intensity. Lorentz, polarization and empirical absorption corrections (transmission factors 0.85–1.0) applied, reflexion data merged to give 1309 reflexions,  $R_{int} = 0.03$ . Structure solved with direct methods. Full-matrix least-squares refinement on  $F$  using 1254 reflexions with  $F > 3\sigma(F)$ , index range  $h$  0–11,  $k$  0–22,  $l$  0–9, unit weights, anisotropic thermal parameters for all non-H atoms, idealized H-atom coordinates calculated after each least-squares cycle

Table 1. Atomic coordinates and equivalent isotropic thermal parameters ( $\text{\AA}^2$ ) for the non-H atoms

$B_{eq} = \frac{1}{3}$  (trace of the orthogonalized  $U_{ij}$  matrix).

	x	y	z	$B_{eq}$
N(1)	0.5214 (3)	0.7405 (1)	0.2934	0.041 (1)
C(2)	0.6044 (4)	0.6956 (2)	0.4016 (7)	0.057 (2)
C(3)	0.5459 (6)	0.6881 (2)	0.5740 (8)	0.078 (2)
C(4)	0.5186 (6)	0.7579 (3)	0.6498 (7)	0.077 (2)
C(5)	0.4380 (4)	0.8073 (2)	0.5356 (7)	0.058 (1)
C(6)	0.5032 (4)	0.8114 (2)	0.3635 (7)	0.040 (1)
C(7)	0.4121 (4)	0.8550 (2)	0.2483 (7)	0.046 (1)
C(8)	0.4034 (4)	0.9310 (2)	0.3074 (8)	0.061 (2)
C(9)	0.5449 (4)	0.9623 (2)	0.3192 (8)	0.065 (2)
C(10)	0.6461 (4)	0.9217 (2)	0.4190 (8)	0.061 (2)
C(11)	0.6493 (4)	0.8449 (2)	0.3690 (7)	0.050 (1)
C(12)	0.4568 (5)	0.8530 (2)	0.0693 (7)	0.060 (2)
C(13)	0.3894 (4)	0.7066 (2)	0.2504 (7)	0.052 (1)
C(14)	0.4112 (4)	0.6406 (2)	0.1547 (7)	0.046 (1)
C(15)	0.3225 (4)	0.5857 (2)	0.1806 (8)	0.061 (2)
C(16)	0.3373 (6)	0.5254 (2)	0.0911 (9)	0.078 (2)
C(17)	0.4410 (6)	0.5196 (2)	-0.0253 (9)	0.081 (2)
C(18)	0.5306 (5)	0.5743 (2)	-0.0530 (8)	0.073 (2)
C(19)	0.5142 (5)	0.6345 (2)	0.0366 (7)	0.059 (1)
O(20)	0.5742 (3)	1.0167 (2)	0.2532 (7)	0.096 (2)

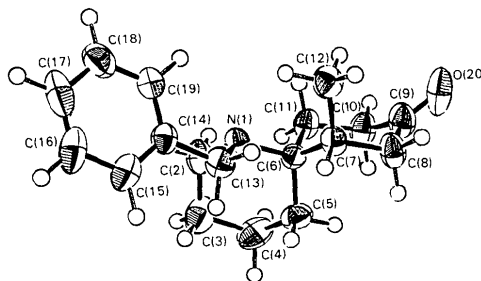


Fig. 1. Molecular geometry and atom labelling scheme.

and a common-variable isotropic temperature factor for all H atoms gave a final  $R$  of 0.045,  $S = 15.02$ . In final refinement cycle  $\Delta/\sigma_{\max} = 0.05$ . Max. peaks and holes in final difference map *ca*  $0.2 \text{ e \AA}^{-3}$ . Complex neutral-atom scattering factors from *International Tables for X-ray Crystallography* (1974). All calculations performed with *SHELX76* (Sheldrick, 1976) at the Cambridge University Computing Service.

Table 2. Bond lengths ( $\text{\AA}$ ) and angles ( $^\circ$ )

Numbers in parentheses are e.s.d.'s associated with the least significant digits.

N(1)—C(2)	1.479 (5)	C(2)—C(3)	1.525 (7)
C(3)—C(4)	1.513 (6)	C(4)—C(5)	1.549 (6)
C(5)—C(6)	1.543 (5)	C(6)—N(1)	1.502 (4)
C(6)—C(7)	1.544 (5)	C(7)—C(12)	1.525 (6)
C(7)—C(8)	1.554 (5)	C(8)—C(9)	1.506 (5)
C(9)—O(20)	1.219 (5)	C(9)—C(10)	1.500 (6)
C(10)—C(11)	1.547 (5)	C(11)—C(6)	1.560 (5)
N(1)—C(13)	1.483 (4)	C(13)—C(14)	1.515 (4)
C(14)—C(15)	1.387 (5)	C(15)—C(16)	1.386 (6)
C(16)—C(17)	1.388 (8)	C(17)—C(18)	1.392 (6)
C(18)—C(19)	1.386 (6)	C(19)—C(14)	1.394 (6)
C(6)—N(1)—C(13)	113.3 (3)	C(13)—N(1)—C(2)	110.5 (3)
C(6)—N(1)—C(2)	112.1 (3)	N(1)—C(2)—C(3)	113.9 (4)
C(2)—C(3)—C(4)	111.0 (4)	C(3)—C(4)—C(5)	113.3 (4)
C(4)—C(5)—C(6)	111.9 (4)	C(5)—C(6)—N(1)	110.3 (3)
C(5)—C(6)—C(7)	110.4 (3)	N(1)—C(6)—C(11)	106.6 (3)
C(5)—C(6)—C(11)	111.6 (3)	C(11)—C(6)—C(7)	108.1 (3)
C(7)—C(6)—N(1)	109.8 (3)	C(6)—C(7)—C(8)	111.2 (3)
C(8)—C(7)—C(12)	109.7 (4)	C(12)—C(7)—C(6)	114.0 (3)
C(7)—C(8)—C(9)	110.7 (3)	C(8)—C(9)—C(10)	114.8 (4)
C(10)—C(9)—O(20)	122.9 (4)	O(20)—C(9)—C(8)	122.3 (4)
C(9)—C(10)—C(11)	112.1 (4)	C(10)—C(11)—C(6)	113.0 (3)
N(1)—C(13)—C(14)	112.1 (3)	C(13)—C(14)—C(19)	122.0 (3)
C(19)—C(14)—C(15)	118.9 (4)	C(15)—C(14)—C(13)	119.0 (4)
C(14)—C(15)—C(16)	120.3 (5)	C(15)—C(16)—C(17)	120.3 (4)
C(16)—C(17)—C(18)	120.1 (5)	C(17)—C(18)—C(19)	119.0 (5)
C(18)—C(19)—C(14)	121.3 (4)		

**Discussion.** Table 1 lists the atom coordinates and equivalent isotropic thermal parameters,\* Table 2 lists selected bond lengths and angles. Fig. 1, drawn with *ORTEP* (Johnson, 1965), illustrates the molecular geometry and atom labelling scheme. The structure displays no unusual features.

\* Lists of structure factors, anisotropic thermal parameters and H-atom parameters have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 38724 (11 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

## References

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