Stramonin-B

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Abstract. $C_{15}H_{18}O_4$, orthorhombic, $P2_12_12_1$, $a = 8.449$ (1), $b = 23.822$ (2), $c = 6.465$ (1) Å, $V = 1301.2$ Å^3, $\rho_{obs} = 1.344$ (by flotation in carbon tetrachloride/benzene), $\rho_{calc} = 1.339$ Mg m^{-3} (for $Z = 4$); $R = 0.049$ for 1388 (out of 1578) observed data measured with Cu radiation. The configurations at the asymmetric centers are $C(1)S$, $C(5)R$, $C(6)R$, $C(7)R$, $C(10)S$ and $C(11)R$. Stramonin-B, with an epoxy group at $C(11)$, is the first such naturally occurring epoxidized α-methylene lactone reported. Its structure was determined in order to establish the chirality of the epoxide group at $C(11)$. Its conformation is marked by *pseudo* diad axes passing through the carbonyl C atom of the lactone ring, $C(10)$ of the seven-membered ring, and the midpoint of $C(6)$–$C(7)$.

Introduction. Stramonin-B (I) was isolated and first characterized by Rodriquez (1977) who found it and a series of closely related sesquiterpene lactones, the stramonins A through E, in chloroform extracts of the medicinal plant *Parthenium tomentosum* var. *stramonium* (Compositae). Preliminary IR, NMR, and mass-spectral characterization of the class of compounds suggested that a unique series of C(15) epoxidized ambrosanolides had been discovered. However, further study by Grieco, Oguri, Burke, Rodriquez, DeTitta & Fortier (1978) suggested that the epoxide was at C(11) on the lactone ring and that stramonin-B possessed the Ambrosia pseudoguaianolide ring system. Spectral methods were unable to establish the relative stereochemistry of C(11) which bonds to the epoxide group. In order to determine the chirality at C(11) and confirm the other spectral assignments, a single-crystal diffraction study was undertaken. Subsequent to our structural study, Grieco *et al.* (1978) synthesized stramonin-B stereospecifically from (−)-damsin, thus establishing the absolute stereochemistry of the molecule.

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(I)
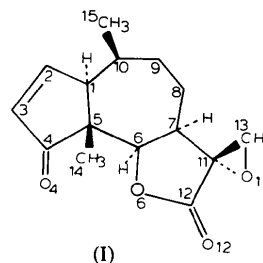
A single crystal of stramonin-B was selected from a sample of natural material supplied by Rodriquez and purified by one of us (PAG). The approximate dimensions of the crystal are $0.12 \times 0.30 \times 0.40$ mm. Crystal quality was checked and the space group was determined by X-ray Weissenberg photography. Intensity data were measured on a CAD-4 diffractometer to a sin θ/λ limit of 0.63 Å^{-1} using a variable scan width of $(0.8 + 0.14 \tan \theta)°$ and a Cu source in the $\theta/2\theta$ scan mode. Of 1578 reflections measured 1388 were considered observed ($I > 2\sigma_I$). The data were corrected for Lorentz and polarization effects but not for absorption ($\mu_{Cu} = 0.802$ mm^{-1}). The stucture was determined by multi-solution tangent-formula techniques (Langs & DeTitta, 1975) and refined by a full-matrix least-squares procedure. The final residuals are $R = 0.049$, $R_w = 0.071$. The e.s.d. of an observation of unit weight is 1.66. The function minimized was $\sum w ||F_o| - |F_c||^2$ where $w = 1/\sigma^2$; σ was given by eq. H.14 of Stout & Jensen (1968) except that the factor 0.01Npk was replaced by 0.06Npk. All 18 H atoms were located by difference Fourier techniques at various stages of structure refinement. Although included in the final cycles of refinement the H atoms were not refined. Scattering factors used throughout the refinement were those of Cromer & Waber (1974) for C and O, and those of Stewart, Davidson & Simpson (1965) for H.

Discussion. A stereoview of stramonin-B is shown in Fig. 1. Nonhydrogen atomic positional parameters are given in Table 1; bond distances, bond angles, and
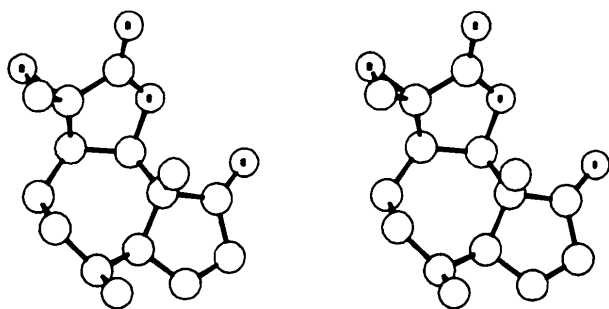
Fig. 1. A stereogram of stramonin-B.

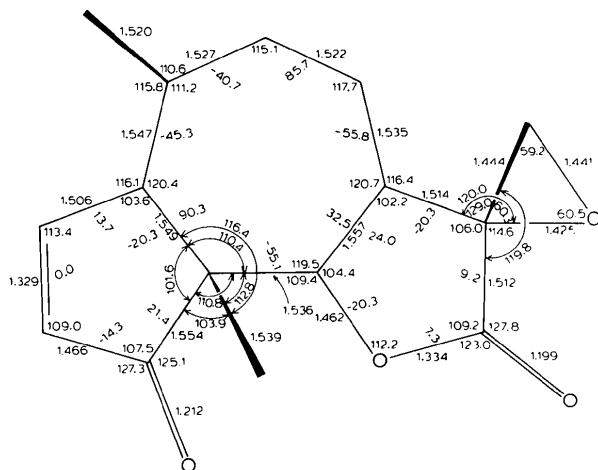Fig. 3. Crystal structure of stramonin-B projected down the crystallographic c axis.

Fig. 2. Bond distances (Å), bond angles (°) and selected torsion angles (°) for stramonin B. Torsion angles are distinguished from bond angles by being drawn off the horizontal. The average e.s.d.'s in distances, angles and torsion angles are 0·003 Å, 0·2° and 0·3° respectively. Positive torsion angles represent a clock wise rotation of a back bond with respect to a stationary front bond when sighted down the middle bond.

Table 1. *Nonhydrogen atomic coordinates for stramonin-B*

	x	y	z
C(1)	0·5357 (3)	0·0794 (1)	−0·4192 (4)
C(2)	0·6068 (3)	0·0216 (1)	−0·4367 (5)
C(3)	0·5316 (3)	−0·0167 (1)	−0·3244 (5)
C(4)	0·3990 (3)	0·0101 (1)	−0·2166 (4)
C(5)	0·4238 (3)	0·0746 (1)	−0·2303 (4)
C(6)	0·2666 (3)	0·1047 (1)	−0·2739 (4)
C(7)	0·2680 (3)	0·1675 (1)	−0·3407 (4)
C(8)	0·4048 (3)	0·1913 (1)	−0·4703 (4)
C(9)	0·5718 (3)	0·1848 (1)	−0·3855 (4)
C(10)	0·6526 (3)	0·1292 (1)	−0·4375 (4)
C(11)	0·2327 (3)	0·1974 (1)	−0·1392 (4)
C(12)	0·1567 (3)	0·1542 (1)	0·0002 (4)
C(13)	0·3103 (3)	0·2457 (1)	−0·0497 (5)
C(14)	0·4948 (3)	0·0902 (1)	−0·0188 (4)
C(15)	0·8066 (3)	0·1232 (1)	−0·3178 (7)
O(4)	0·2885 (3)	−0·0129 (1)	−0·1321 (4)
O(6)	0·1683 (2)	0·1037 (1)	−0·0877 (3)
O(12)	0·0908 (2)	0·1620 (1)	0·1620 (3)
O(13)	0·1554 (2)	0·2506 (1)	−0·1414 (3)

selected torsion angles are shown in Fig. 2. A view of the crystal packing of stramonin-B is shown in Fig. 3.*

The diffraction study confirms the skeletal assignments deduced from spectral techniques and establishes that the epoxide group is bound at C(11) with R stereochemistry; *i.e.* O(13) is on the same side of the lactone ring as the H atoms at C(6) and C(7). Because of our interest in unequivocally establishing the stereochemistry at C(11), a further refinement of the structure was undertaken. Although the H atoms at C(13) were clearly discernible in a difference Fourier map, additional cycles of refinement in which the epoxy O and C atoms were interchanged were calculated. The residual rose from the converged value $R = 0·049$ to

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* Lists of structure factors, anisotropic thermal parameters, H atom positions and a complete list of torsion angles have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 34360 (12 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.
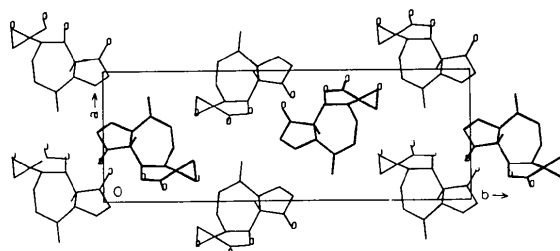
$R = 0·093$, confirming the choice of O and C positions originally suggested by the peak heights of those positions in the first E map. No attempt was made to determine the absolute stereochemistry of the natural product by diffraction techniques given the weak anomalous scattering of the O atoms when Cu radiation is employed, but subsequent synthetic work established the absolute stereochemistry as shown in Fig. 1.

The ring junctions of the pseudoguaianolide nucleus are *trans* at C(1)—C(5) and *cis* at C(6)—C(7) respectively. The α,β-unsaturated keto ring, atoms C(1) through C(5), is envelope shaped with C(5) at the flap. The average torsion-angle magnitude is 13·9° and the ring asymmetry parameter (Duax, Weeks & Rohrer, 1976) ΔC_s at C(5) is 0·9°. The γ-lactone ring, atoms O(6), C(6), C(7), C(11), C(12), is half-chair shaped. A pseudo-diad runs through C(12) and the midpoint of the C(6)—C(7) bond. The average torsion-angle magnitude in the lactone ring is 16·2° and the asymmetry parameter ΔC_2 at C(12) is 1·4°. The seven-membered ring, atoms C(1), C(5) through C(10), is a deformed
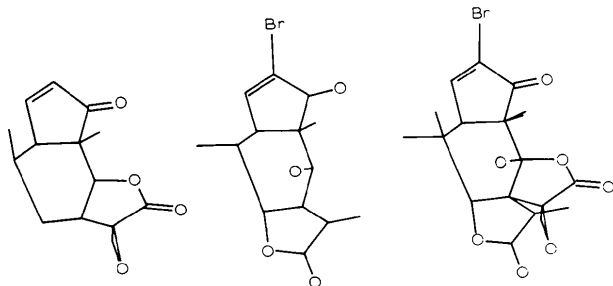
Fig. 4. Stramonin-B (left), bromohelenalin (middle), and the super-position of the two pseudoguaianolides (right). The atoms super-imposed are those of the bicyclic ring system C(1) through C(10) [see (I)] by minimizing $\sum d_i^2$, the sum of the squares of the distances between corresponding atomic positions in the two molecules (see text).

half chair. The average torsion-angle magnitude in the ring is 57·9°. A pseudo diad axis relates ring atoms on either side of the line from C(10) to the midpoint of the C(6)—C(7) bond. The C(15) methyl group is antiperiplanar to C(8).

The pseudoguaianolides are subdivided into two main families. Stramonin-B belongs to the Ambrosia class in which the lactone is cis-attached to C(6) and C(7). The other class is the Helenium family in which the lactone is cis-attached to C(7) and C(8). In addition to differing modes of lactone bonding, the Ambrosia and Helenium classes differ in their stereochemistry at C(10). Bromohelenalin (Mazhar-ul-Haque & Caughlan, 1969) is a representative of the Helenium class and has been compared to the observed structure of stramonin-B, Fig. 4. In spite of their differing stereochemistries, the two pseudoguaianolides have remark-

ably similar conformations. Using a routine similar to one described by Nyburg (1974) which has been used successfully in the comparative analysis of molecular conformation, the structures of stramonin-B and bromohelenalin were fitted together by a least-squares method. Atomic positions fitted in the two molecules were atoms C(1) through C(10). The average separation between corresponding atoms is only 0·06 Å and the maximum separation is 0·1 Å between the atoms C(10) and C(3) in corresponding molecules.

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SHORT COMMUNICATIONS

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Equatorial 2-phenoxy-trans-1-oxadecalin: erratum.
By PETER G. JONES, OLGA KENNARD, SOSALE CHANDRA-SEKHAR and ANTHONY J. KIRBY, University Chemical Laboratory, Lensfield Road, Cambridge CB2 1EW, England

Abstract

An error in the paper by Jones, Kennard, Chandrasekhar & Kirby [Acta Cryst. (1978). B34, 3835–3837] is corrected.

The third sentence of the Discussion of a previous paper (Jones, Kennard, Chandrasekhar & Kirby, 1978) was

omitted. Line 4 of page 3836 should read as follows: Gorenstein & Kar (1977). Similarly the angle O(1)—C(2)—C(3) is 111·5° in (I), compared with 113·1° in the axial isomer. This angle must open to...

Reference

JONES, P. G., KENNARD, O., CHANDRASEKHAR, S. & KIRBY, A. J. (1978). Acta Cryst. B34, 3835–3837.

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