

3 β -(1-Allyl-1-pyrrolidinio)-16-(2-pyridylmethylene)androst-5-en-17 β -ol bromide hemihydrate

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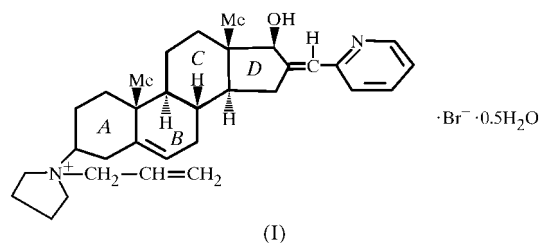
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The title compound, C₃₂H₄₅N₂O⁺·Br⁻·0.5H₂O, has the outer two six-membered rings in chair conformations, while the central ring is in an 8 β ,9 α -half-chair conformation. The five-membered ring of the steroid nucleus adopts a slightly deformed 14 α -envelope conformation. The pyridylmethylene moiety has an *E* configuration with respect to the hydroxyl group at position 17. The structure is stabilized by a network of O—H···Br-type intermolecular hydrogen bonds.

Comment

The present X-ray investigation of the title compound, (I), was undertaken as part of our study of the structure and conformation of new synthetic steroid derivatives (Vasuki *et al.*, 2001; Vasuki, Parthasarathi, Ramamurthi, Jindal & Dubey, 2002; Vasuki, Parthasarathi, Ramamurthi, Dubey & Jindal, 2002; Vasuki, Thamotharan *et al.*, 2002). It is well known that minor changes in the basic composition of steroids significantly alter their biological activities (Duax & Norton, 1975). We are particularly interested in studying the conformational flexibilities of steroids due to various possible substitutions at the C3, C16 and C17 positions.



The puckering parameters in (I) [ring A: $Q = 0.576$ (5) Å, $\theta = 10.1$ (5)° and $\varphi = 84$ (3)°; ring C: $Q = 0.562$ (5) Å, $\theta = 8.9$ (5)° and $\varphi = 251$ (3)°; Cremer & Pople, 1975] show that rings A and C adopt chair conformations. The presence of the pyrrolidine moiety bonded to C3 does not disturb the usual chair

conformation of ring A of the steroid nucleus. The C5—C6 (Csp^2 — Csp^2) distance of 1.331 (6) Å confirms the localization of a double bond at this position. Due to this double bond, the environment of atom C5 is planar, and hence ring B adopts an 8 β ,9 α -half-chair conformation [$Q = 0.498$ (5) Å, $\theta = 50.9$ (6)° and $\varphi = 217.5$ (7)°]. Similar observations have been reported by Caira *et al.* (1995), Andrade *et al.* (2001) and Hema *et al.* (2002).

Ring D adopts a slightly deformed 14 α -envelope conformation, with pseudo-rotation parameters $\Delta = 12.6^\circ$ and $\varphi_m = 46.0^\circ$ (Altona *et al.*, 1968). The pyrrolidine ring at C3 exhibits a slightly distorted β envelope conformation, with $\Delta = 18^\circ$ and $\varphi_m = 42.6$ (3)°. The C17—C16—C20—C21 torsion angle of -171.9 (5)° indicates that the 2-pyridyl ring has an *E* configuration with respect to the hydroxyl group at position 17. The larger exocyclic angle at C15—C16—C20 [129.3 (4)°] compared with C17—C16—C20 [123.1 (4)°] might be a consequence of repulsion between the lone pair of electrons on atom N26 of the pyridine ring and atom H15B on C15 (N26···H15B 2.573 Å).

The C19—C10···C13—C18 pseudo-torsion angle is 7.5 (4)°. The equatorially substituted pyrrolidine moiety is oriented at an angle of 78.5 (3)° with respect to the central steroid nucleus. The dihedral angle between the plane of the pyridine

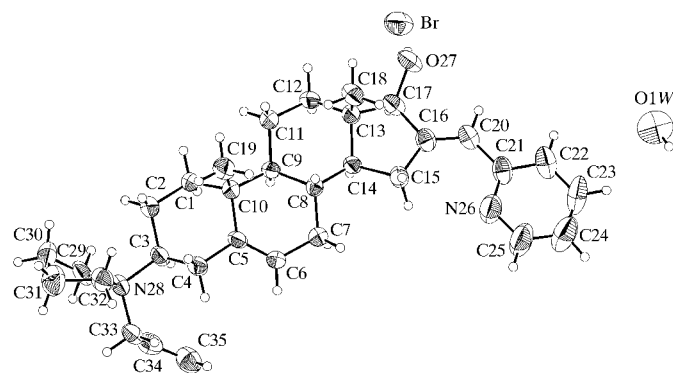


Figure 1

The molecular structure of (I), showing 50% probability displacement ellipsoids and the atom-numbering scheme. All H atoms have been omitted for clarity.

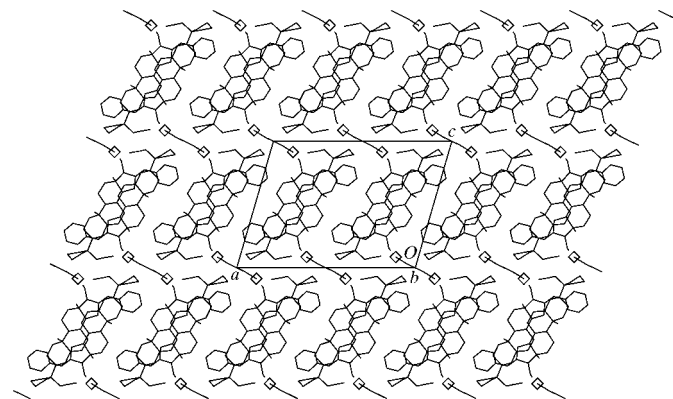


Figure 2

The packing of molecules of (I) viewed down the *b* axis.

ring and the average molecular plane comprising rings *A*, *B*, *C* and *D* is 11.4 (2)°. The dihedral angle between the pyridine and pyrrolidine rings is 59.6 (3)°. The valency angles C8—C14—C15 [119.2 (4)°] and C14—C13—C17 [99.5 (3)°] are close to the expected values of 121.2° and 101.4°, respectively (Duax & Norton, 1975). The geometries of the rings are *trans* at the *B/C* and *C/D* ring junctions.

The structure of (I) is stabilized by an O—H...Br network which involves both the hydroxyl group of the steroid and the water molecules included in the lattice, and a projection down the *b* axis is shown in Fig. 2.

Experimental

The title compound was prepared by dissolving 16-(2-pyridylmethylene)-3 β -pyrrolidinoandrost-5-en-17 β -ol (500 mg, 1.15 mmol) in dried dichloromethane (50 ml) and adding allyl bromide (1 ml, 7.04 mol). The reaction mixture was stirred for a few minutes and kept at room temperature overnight. The solid residues were filtered and washed with dichloromethane to afford crystals of (I) (yield: 0.45 g, 68.36%; m.p. 517–521 K).

Crystal data

C ₃₂ H ₄₅ N ₂ O ⁺ ·Br ⁻ ·0.5H ₂ O	$D_x = 1.277 \text{ Mg m}^{-3}$
$M_r = 562.61$	Mo $K\alpha$ radiation
Monoclinic, C2	Cell parameters from 25 reflections
$a = 21.054 (4) \text{ \AA}$	$\theta = 10\text{--}15^\circ$
$b = 9.3083 (18) \text{ \AA}$	$\mu = 1.43 \text{ mm}^{-1}$
$c = 15.551 (4) \text{ \AA}$	$T = 293 (2) \text{ K}$
$\beta = 106.15 (2)^\circ$	Plate, white
$V = 2927.4 (11) \text{ \AA}^3$	$0.20 \times 0.17 \times 0.17 \text{ mm}$
$Z = 4$	

Data collection

Enraf–Nonius CAD-4 diffractometer	$R_{\text{int}} = 0.013$
$\omega/2\theta$ scans	$\theta_{\text{max}} = 25^\circ$
Absorption correction: ψ scan (North <i>et al.</i> , 1968)	$h = 0 \rightarrow 24$
$T_{\text{min}} = 0.763$, $T_{\text{max}} = 0.793$	$k = 0 \rightarrow 11$
2835 measured reflections	$l = -18 \rightarrow 17$
2751 independent reflections	2 standard reflections
2100 reflections with $I > 2\sigma(I)$	frequency: 120 min
	intensity decay: none

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0413P)^2 + 2.1207P]$
$R[F^2 > 2\sigma(F^2)] = 0.034$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.089$	$(\Delta/\sigma)_{\text{max}} < 0.001$
$S = 1.08$	$\Delta\rho_{\text{max}} = 0.29 \text{ e \AA}^{-3}$
2751 reflections	$\Delta\rho_{\text{min}} = -0.23 \text{ e \AA}^{-3}$
336 parameters	Absolute structure: Flack (1983);
H atoms treated by a mixture of independent and constrained refinement	Friedel equivalents merged
	Flack parameter = $-0.002 (12)$

Table 1

Hydrogen-bonding geometry (Å, °).

<i>D</i> —H... <i>A</i>	<i>D</i> —H	H... <i>A</i>	<i>D</i> ... <i>A</i>	<i>D</i> —H... <i>A</i>
O27—H27...Br	0.81 (3)	2.38 (3)	3.194 (4)	178 (6)
O1W—H1W...Br ⁱ	0.88 (4)	2.53 (4)	3.405 (5)	172 (3)

Symmetry code: (i) $\frac{1}{2} + x, \frac{1}{2} + y, z$.

The structure was solved with *DIRDIF99* (Beurskens *et al.*, 1999) using the *TRACOR* option, with the Br atom at the origin. All H

atoms, except the hydroxyl H atom and the water H atom, were treated as riding, with C—H distances in the range 0.93–0.98 Å and $U_{\text{iso}}(\text{H}) = 1.5U_{\text{eq}}(\text{C})$ for methyl H atoms and $1.2U_{\text{eq}}(\text{C})$ for all others. The hydroxyl H atom was located from a difference Fourier map and refined using the *DFIX* option in *SHELXL97* (Sheldrick, 1997), with H27—O27 = 0.81 (2) Å. It was included in the structure-factor calculations with $U_{\text{iso}}(\text{H27}) = 1.1U_{\text{eq}}(\text{O27})$. At this stage, the maximum residual electron density of 2.87 e \AA^{-3} indicated the presence of a possible atom site in a special position with half occupancy. This peak was found near Br, at a distance of 3.40 Å. This was assumed to be the O atom of a water molecule and was refined. One of the H atoms of the water molecule was located from a difference Fourier map and, using the *DFIX* option in *SHELXL97*, the coordinates of atom H1W were refined, with O1W—H1W restrained to 0.88 (2) Å, and H1W...H1W (symmetry equivalent) restrained to 1.44 (1) Å, and included in the structure-factor calculations with $U_{\text{iso}}(\text{H1W}) = 1.1U_{\text{eq}}(\text{O1W})$.

Data collection: *CAD-4 EXPRESS* (Enraf–Nonius, 1994); cell refinement: *CAD-4 EXPRESS*; data reduction: *MolEN* (Fair, 1990); program(s) used to solve structure: *DIRDIF99* (Beurskens *et al.*, 1999); program(s) used to refine structure: *SHELXL97*; molecular graphics: *ZORTEP* (Zsolnai, 1997); software used to prepare material for publication: *SHELXL97*.

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Supplementary data for this paper are available from the IUCr electronic archives (Reference: DE1189). Services for accessing these data are described at the back of the journal.

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