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(±)-9-*exo*-Amino-5,6,7,8-tetrahydro-5,8-methano-9*H*-benzocyclohepten-8-ol Hydrochloride

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Abstract. $C_{12}H_{16}ClNO$, M_r = 225·72, monoclinic, $P2_1/c$, $Z = 4$, a = 11·088 (3), b = 8·540 (2), c = 12·195 (5) Å, β = 97·32 (2)°, D_o = 1·317, D_c = 1·286 g cm^{-3}, λ(Mo $K\alpha$) = 0·7107 Å, μ(Mo $K\alpha$) = 3·117 cm^{-1}, R = 0·036 for 2120 observed reflections. The six-membered ring is in a half-chair conformation.

Introduction. Single crystals of the title compound were obtained as colorless needles upon recrystallization from ethanol solution. X-ray photographs showed monoclinic symmetry and systematic absences consistent with the space group $P2_1/c$ ($0k0$ reflections absent when k odd, $h0l$ absent when l odd). Intensity data were collected using a crystal 0·3 × 0·3 × 0·4 mm, a Syntex $P2_1$ diffractometer, a graphite monochromator, Mo $K\alpha$ radiation, and a θ–2θ scan procedure, the details of which have been reported elsewhere (Seccombe, Lee & Henry, 1975). Intensities were measured for 2635 independent reflections with $2\theta \leq 55°$. The intensity data were reduced to the structure factors by the application of Lorentz and polarization corrections. No absorption or extinction corrections were applied. The structure was determined using a symbolic addition procedure (Karle & Karle, 1966) and refined by a full-matrix least-squares procedure using anisotropic thermal parameters for the non-hydrogen atoms and fixed isotropic thermal parameters for the H atoms (these were 110% of the isotropic equivalent of the anisotropic thermal parameters for the atom to which H was attached). Only the 2120 reflections having $I > 3\sigma(I)$ were used in the refinement. In the last cycle of refinement, parameter shifts were less than 0·1σ, $R = \Sigma||F_o| - |F_c||/\Sigma|F_o|$ = 0·036 and $R' = [\Sigma w(|F_o| - |F_c|)^2/\Sigma w|F_o|^2]^{1/2}$ = 0·050, where $w = 4F_o^2/\sigma^2(F_o^2)$.

The molecular structure and atom-numbering system are shown in Fig. 1. The final atomic coordinates are

Table 1. *Positional parameters and their estimated standard deviations*

The atomic coordinates are given in the fractional crystallographic coordinate system.

	x	y	z
C(1)	0·19772 (13)	0·42703 (17)	0·06366 (12)
C(2)	0·14949 (13)	0·27162 (17)	0·10519 (12)
C(3)	0·24259 (14)	0·14049 (18)	0·12302 (12)
C(4)	0·36232 (14)	0·16714 (18)	0·10250 (13)
C(5)	0·39426 (15)	0·32515 (20)	0·05867 (15)
C(6)	0·33770 (17)	0·34513 (23)	−0·06439 (15)
C(7)	0·21421 (16)	0·42646 (22)	−0·05931 (14)
C(8)	0·32879 (15)	0·45100 (20)	0·11870 (15)
C(9)	0·21039 (15)	−0·00297 (18)	0·16549 (13)
C(10)	0·29650 (17)	−0·12074 (20)	0·18741 (14)
C(11)	0·41497 (17)	−0·09480 (22)	0·16679 (16)
C(12)	0·44790 (16)	0·04745 (22)	0·12538 (15)
Cl	0·12766 (4)	−0·01513 (5)	−0·15753 (3)
O	0·11541 (10)	0·54946 (13)	0·08505 (10)
N	0·03891 (11)	0·21976 (15)	0·02858 (11)
H(C2)	0·1190 (19)	0·2930 (25)	0·1785 (19)
H(C5)	0·4871 (22)	0·3296 (29)	0·0716 (20)
H(C6)	0·3911 (22)	0·4114 (29)	−0·1055 (20)
H′(C6)	0·3287 (23)	0·2400 (30)	−0·1016 (22)
H(C7)	0·2194 (23)	0·5381 (30)	−0·0782 (21)
H′(C7)	0·1477 (22)	0·3825 (28)	−0·1046 (19)
H(C8)	0·3384 (22)	0·4406 (28)	0·1996 (21)
H′(C8)	0·3555 (23)	0·5559 (29)	0·0986 (19)
H(C9)	0·1269 (23)	−0·0191 (27)	0·1831 (21)
H(C10)	0·2745 (21)	−0·2183 (29)	0·2207 (20)
H(C11)	0·4739 (23)	−0·1792 (34)	0·1838 (20)
H(C12)	0·5279 (25)	0·0645 (30)	0·1088 (21)
H(O)	0·1156 (23)	0·5507 (28)	0·1560 (21)
H(N)	0·0593 (20)	0·1623 (27)	−0·0310 (20)
H′(N)	−0·0169 (21)	0·1609 (28)	0·0651 (19)
H″(N)	−0·0114 (20)	0·3103 (28)	0·0014 (19)

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Table 2. *Bond lengths* (Å)

C(1)–C(2)	1·540 (2)	C(6)–H′(C6)	1·00 (3)
C(1)–C(7)	1·534 (2)	C(7)–H(C7)	0·98 (3)
C(1)–C(8)	1·535 (2)	C(7)–H′(C7)	0·94 (2)
C(1)–O	1·433 (2)	C(8)–H(C8)	0·98 (2)
C(2)–C(3)	1·520 (2)	C(8)–H′(C8)	0·98 (2)
C(2)–N	1·510 (2)	C(9)–C(10)	1·389 (3)
C(2)–H(C2)	1·01 (2)	C(9)–H(C9)	0·99 (3)
C(3)–C(4)	1·400 (2)	C(10)–C(11)	1·386 (3)
C(3)–C(9)	1·394 (2)	C(10)–H(C10)	0·97 (2)
C(4)–C(5)	1·510 (2)	C(11)–C(12)	1·382 (3)
C(4)–C(12)	1·398 (2)	C(11)–H(C11)	0·98 (3)
C(5)–C(6)	1·560 (3)	C(12)–H(C12)	0·95 (3)
C(5)–C(8)	1·534 (2)	O–H(O)	0·86 (3)
C(5)–H(C5)	1·02 (2)	N–H(N)	0·93 (2)
C(6)–C(7)	1·544 (2)	N–H′(N)	0·95 (2)
C(6)–H(C6)	1·00 (3)	N–H″(N)	0·99 (2)

Table 3. *Bond angles* (°)

C(2)–C(1)–C(7)	114·1 (1)	C(3)–C(4)–C(12)	118·7 (2)
C(2)–C(1)–C(8)	108·7 (1)	C(5)–C(4)–C(12)	122·7 (1)
C(2)–C(1)–O	108·2 (1)	C(4)–C(5)–C(6)	110·8 (1)
C(7)–C(1)–C(8)	101·8 (1)	C(4)–C(5)–C(8)	108·1 (1)
C(7)–C(1)–O	109·8 (1)	C(6)–C(5)–C(8)	103·0 (1)
C(8)–C(1)–O	114·4 (1)	C(5)–C(6)–C(7)	105·1 (1)
C(1)–C(2)–C(3)	115·1 (1)	C(1)–C(7)–C(6)	104·9 (1)
C(1)–C(2)–N	109·7 (1)	C(1)–C(8)–C(5)	100·2 (1)
C(3)–C(2)–N	110·8 (1)	C(3)–C(9)–C(10)	120·4 (2)
C(2)–C(3)–C(4)	119·8 (1)	C(9)–C(10)–C(11)	119·6 (2)
C(2)–C(3)–C(9)	119·9 (1)	C(10)–C(11)–C(12)	120·5 (2)
C(4)–C(3)–C(9)	120·2 (1)	C(4)–C(12)–C(11)	120·7 (2)
C(3)–C(4)–C(5)	118·6 (1)		

given in Table 1. Bond lengths and angles are listed in Tables 2 and 3 respectively.*

Discussion. As part of our continuing studies on the effect of defined conformation on adrenergic drug action, we were interested in a series of substituted benzobicyclo[2.2.2]octenes and benzobicyclo[3.2.1]-octenes (Grunewald, Ruth, Kroboth, Kamdar, Patil & Salman, 1976). The title compound was prepared by reductive amination of the corresponding ketone as shown in Fig. 2. At least 95% of the isolated amine was a single isomer as determined by liquid chromatography. While there is ample precedent to suggest that hydride will reduce the intermediate imine from the methano-bridged face of the molecule (Borch, Bernstein & Durst, 1971), spectral evidence (IR, PMR, UV, mass spectra) alone did not provide unambiguous proof of the stereochemistry of the major product. The crystal structure determination confirmed that addition of hydride is sterically controlled in this case.

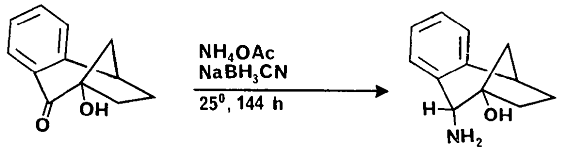

Fig. 2. Synthesis of the title compound.

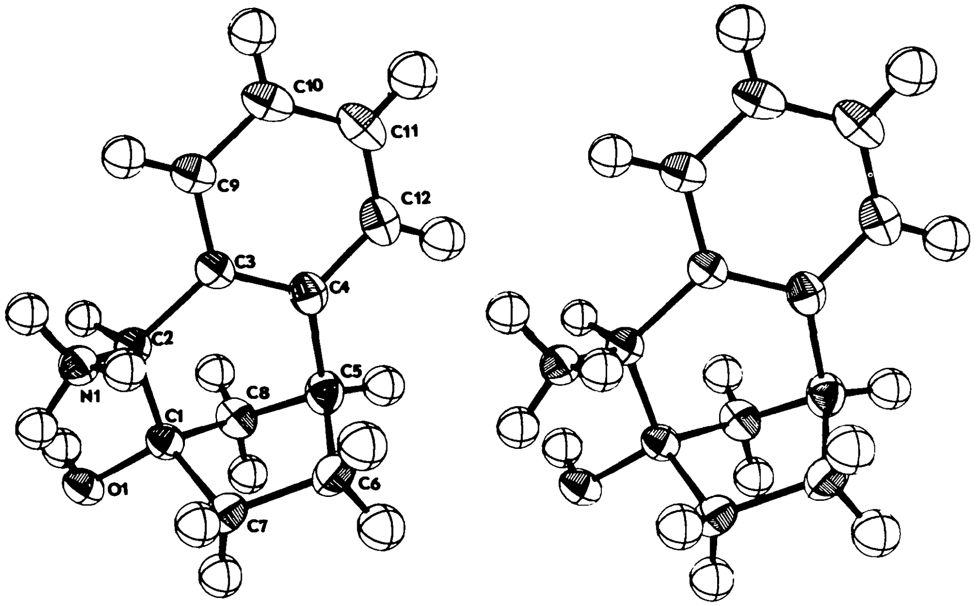

Fig. 1. Stereoview of a molecule of the title compound.

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* Lists of structure factors and anisotropic thermal parameters have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 32961 (16 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 13 White Friars, Chester CH1 1NZ, England.

Table 4. *Hydrogen bonds*

D H *A*	H···*A* (Å)	∠*DHA* (°)
O–H···Cl	2·28 (3)	171 (2)
N–H···O	1·89 (2)	165 (2)
N–H···Cl	2·16 (2)	174 (2)
N–H···Cl	2·36 (2)	170 (2)

The constraints imposed by the two-carbon bridge and the fusion to the aromatic ring force the six-membered ring into a half-chair conformation. In the crystal lattice, the chloride anion appears to be hydrogen-bonded to the hydroxy proton and two of the amino protons of three different neighboring molecules. The third amino proton is hydrogen-bonded to the hydroxy oxygen of an adjacent molecule. Table 4 summarizes the pertinent parameters for the hydrogen bonds.

This paper is the result of a group project completed in partial fulfillment of a graduate-level course offered by the University of Kansas in the Fall semester, 1976. We thank the University of Kansas for making this course possible and Dr K. B. Mertes for allowing us to use the X-ray diffractometer. We also acknowledge support of NIH Training Grant GM-1341, NIH Research Grant GM-22988 and a Grant-in-Aid from the Kansas Heart Association.

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16,18-Dihydroxy-8-oxo-8-demethyl-5α-kolava-3,13-diene-15,17-dioic Acid 15,16:17,18-Dilactone (Desmethyl-marrubiaketone)

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Abstract. $C_{19}H_{22}O_5$, orthorhombic, $P2_12_12_1$, a = 12·825 (2), b = 13·545 (1), c = 9·855 (1) Å, V = 1665·6 (5) Å^3, Z = 4, D_x = 1·317 g cm^{-3}. The stereochemical configuration of a new natural compound which was unclear from chemical and spectroscopic methods has been established unambiguously by X-ray structure analysis. The molecules are held together by packing forces only.

Introduction. The specimen was provided by Professor R. Tschesche and B. Streuff, Institute of Organic Chemistry and Biochemistry, Universität Bonn. For the present investigation a clear crystal of irregular shape with a maximum diameter of 0·2 mm was used. Systematic absences were $h00$, h odd, $0k0$, k odd and $00l$, l odd. Intensities were measured in the θ–2θ mode on an automatic Syntex $P2_1$ four-circle diffractometer with Mo $K\alpha$ radiation (λ = 0·71069 Å) monochromatized by a graphite crystal.

With a 2° plus $(\alpha_1\alpha_2)$-dispersion scan range for positive h, k, l and a maximum 2θ = 45°, 1267 unique reflexions were recorded of which 527 were regarded as unobserved ($I < 3\sigma$) owing to the small sample size and the high overall temperature factor (B = 4·1 Å^2). No absorption correction was applied (μ = 1·0 cm^{-1}).

The structure (24 heavy atoms) was solved with *MULTAN* (Germain, Main & Woolfson, 1971) using 180 $|E|$'s $\geq$ 1·4, 2340 Σ_2 relationships, $|E_hE_kE_{h-k}| \geq$ 3·0. The starting set with the highest CFOM fixed the positions of 23 heavy atoms. The position of the missing methyl group C atom was calculated as well as derived from a difference electron density map at R = 0·27. Refinement was by full-matrix least-squares calculations with anisotropic temperature factors. Except for the methyl group H atoms, which were ignored, all H positions were calculated. The H atoms were allocated the isotropic temperature factors of their carrier atoms, and refined for positional parameters.