neighboring molecule at x, $0{\cdot}5-y$, $1{\cdot}5-z$, through H(4*b*) [N(4)···O(3′) 3·070 (2) Å; H(4*b*)···O(3′) 2·42 (3) Å], and H(2*b*) participates in a bifurcated donation to both O(3′) and O(4′) of a neighboring molecule at $1-x$, $0{\cdot}5+y$, $1{\cdot}5-z$ [N(2)···O(3′) 3·098 (2) Å; N(2)···O(4′) 3·196 (2) Å; H(2*b*)···O(3′) 2·34 (3) Å; H(2*b*)···O(4′) 2·44 (3) Å].

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Structure of Ethyl 6-(*p*-Chlorophenyl)-3-phenylimidazo[2,1-*b*]thiazol-2-ylacetate

By Prem C. Jain

Department of Chemistry, Kurukshetra University, Kurukshetra 132119, *India*

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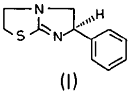
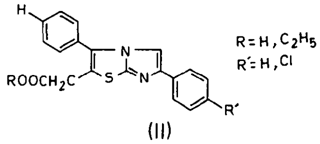
Abstract. $C_{21}H_{17}ClN_2O_2S$, $M_r = 396{\cdot}95$, monoclinic, $P2_1/a$, $a = 21{\cdot}022$ (7), $b = 8{\cdot}301$ (1), $c = 10{\cdot}823$ (3) Å, $\beta = 99{\cdot}14$ (2)°, $V = 1864{\cdot}7$ (9) Å^3, $Z = 4$, $D_x = 1{\cdot}414$, D_m(flotation) $= 1{\cdot}43$ g cm^{-3}, λ(Cu $K\alpha$) $= 1{\cdot}54178$ Å, $\mu = 29{\cdot}80$ cm^{-1}, $F(000) = 824$, $R = 0{\cdot}037$ for 2020 unique observed reflections. The compound is of a class which on hydrolysis yields an acid that is anti-inflammatory. The molecule consists of two fused five-membered rings which form an approximately coplanar configuration with the *p*-chlorophenyl ring. The 3-phenyl is oriented at about 64° to this plane. The ethoxycarbonylmethyl group has an extended configuration. The S—C average distance (1·756 Å) is shorter than for a single bond.

Introduction. Following the discovery of levamisol (I), the *S*-(−) isomer of tetramisol, and its ability to potentiate the immune system in man, as a potent anthelmintic drug (Raeymakers, Roevens & Janssen, 1967; Wilkins & Olkowski, 1977) and as an anti-inflammatory and anti-arthitic agent (Lambardino, 1978), many compounds with imidazo[2,1-*b*]thiazole and imidazo[2,1-*b*]benzothiazole moieties have been synthesized by Abignente, Arena, de Capariis & Parente (1976). Degradation of (±)-2,3,5,6-tetrahydro-6-phenylimidazo[2,1-*b*]thiazole was shown by a single-crystal X-ray diffraction study to give 1-(2′-*p*-bromobenzylthio)ethyl-4-phenylimidazole by Fibiger, Banks, Jones, Haltiwanger & Watt (1978). Sawhney, Kodali, Dhindsa & Singh (1982) prepared some arylimidazo-[2,1-*b*]thiazole compounds for the evaluation of their activities as potential anti-inflammatory agents. The parent compound (II, R = H, R' = H) showed the highest activity in the series but substitution on either of the aryl groups was not found favourable and further esterification resulted in the loss of activity (II, $R = C_2H_5$, R' = Cl).



(I)



(II)

So far crystal and molecular structure determinations of few such adversely affected compounds have been undertaken by X-ray diffraction studies. The present molecule consists of a system of fused heterocyclic rings and is different from the one reported by Cameron, Cameron & Duncanson (1981). Therefore the desire for a comparison and contrast in the molecular geometry and stereochemistry of substitution with other imidazothiazoles led to an X-ray investigation of the title compound.

Experimental. A pale crystal of approximate size $0{\cdot}16 \times 0{\cdot}20 \times 0{\cdot}22$ mm of well defined shape was mounted along the *c* axis on a Syntex $P2_1$ diffractometer, and data collected using a θ:2θ scan, $2\theta_{\max} = 114{\cdot}2°$, variable scan rate, graphite-monochromated Cu $K\alpha$ ($\lambda = 1{\cdot}54178$ Å), lattice parameters from least-squares refinement of 15 reflections, $10{\cdot}9 \le \theta \le 27{\cdot}16°$, approximate density $1{\cdot}43$ g cm^{-3} measured by flotation method, systematic absences ($h = 2n+1$ for $h00$, $h = 2n+1$ for $h0l$, $k = 2n+1$ for $0k0$) consistent with the space group $P2_1/a$, monitored reflection (321) showed no intensity variation greater than 1·5%, 2362 independent reflections measured ($0 \le h \le 22$, $0 \le k \le 9$, $-11 \le l \le 11$) with 2020 intensities greater than $2\sigma(I)$, accurate measurement of 50 equivalent reflections ($R_{\rm int} = 0{\cdot}015$), consideration of crystal shape, transmission factors and $R_{\rm int}$ enabled neglect of absorption. Lorentz–polarization corrections, extinction corrections, real and imaginary contributions to the anomalous dispersion applied (*International Tables for X-ray Crystallography*, 1974); direct methods (*MULTAN*78: Main, Hull, Lessinger, Germain, Declercq & Woolfson, 1978) revealed initially positions of 15 atoms, subsequent weighted Fourier synthesis yielded the remaining non-H atoms; least-squares refinement followed by difference Fourier synthesis enabled location of all H atoms; further refinement with all atoms (H atoms isotropic) reduced R to 0·037, $wR = 0{\cdot}035$, $S = 0{\cdot}759$, $(\Delta/\sigma)_{\rm ave} = 0{\cdot}011$, $(\Delta/\sigma)_{\max} = 0{\cdot}22$ and a largest peak in the final difference map of $|0{\cdot}18|$ e Å^{-3}; $w(F_o - F_c)^2$ minimized, $w = 1/\sigma^2(F_o)$ from counting statistics, 245 parameters refined using 2020 reflections; all calculations carried out using *XRAY*76 (Stewart, Machin, Dickinson, Ammon, Heck & Flack, 1976); atomic scattering factors for C, O, N, S and Cl those of Cromer & Mann (1968), those for H from Stewart, Davidson & Simpson (1965). The positional coordinates and $U_{\rm eq}$ are given in Table 1.* Fig. 1 shows the contents of the unit cell viewed along the *c* axis. Bond lengths, valence angles and selected torsion angles are given in Table 2.

Discussion. Fig. 2 is an *ORTEP* plot (Johnson, 1971) showing the relative configuration of the title compound. The torsion angles (Table 2) show that the five-membered rings and the *p*-chlorophenyl group form an approximately planar configuration whilst the 3-phenyl ring is oriented at ~64° to it. The ethoxycarbonylmethyl group exhibits an extended conformation. The molecules lie in parallel rows inclined to the *a* axis and have the shape of an open oval (Fig. 1). Thermal motion of the terminal CH_3 group is large (Table 1); similarly Cl pointing out from the main molecule also occupies a large thermal cavity. C—C

Table 1. *Fractional atomic coordinates* (× 10⁴) *for non-*H *atoms and their equivalent isotropic thermal parameters* (Å² × 10³)

$$U_{\rm eq} = \tfrac{1}{3}[U_{11}(aa^*)^2 + U_{22}(bb^*)^2 + U_{33}(cc^*)^2 + 2U_{12}aba^*b^*\cos\gamma + 2U_{13}aca^*c^*\cos\beta + 2U_{23}bcb^*c^*\cos\alpha].$$

	x	y	z	$U_{\rm eq}$
C(1)	1509 (1)	1205 (4)	3263 (3)	54 (2)
C(2)	2086 (2)	1170 (5)	2764 (3)	71 (2)
C(3)	2623 (2)	1929 (5)	3389 (4)	75 (3)
C(4)	2600 (2)	2736 (5)	4486 (3)	71 (2)
C(5)	2028 (1)	2817 (5)	4987 (3)	61 (2)
C(6)	1487 (1)	1998 (4)	4382 (3)	41 (2)
C(7)	891 (1)	2010 (4)	4946 (3)	45 (2)
N(8)	888 (1)	1296 (3)	6098 (2)	42 (1)
C(9)	305 (1)	1273 (4)	6510 (2)	43 (2)
S(10)	−273 (0)	2266 (1)	5439 (1)	54 (0)
C(11)	304 (1)	2617 (3)	4448 (2)	41 (2)
C(12)	1307 (1)	475 (4)	6982 (3)	47 (2)
C(13)	950 (1)	2 (4)	7878 (3)	45 (2)
N(14)	314 (1)	536 (3)	7574 (2)	45 (1)
C(15)	1170 (1)	−900 (4)	9022 (3)	45 (2)
C(16)	1816 (1)	−1379 (4)	9381 (3)	54 (2)
C(17)	2008 (1)	−2261 (4)	10443 (3)	57 (2)
C(18)	1560 (2)	−2728 (4)	11179 (3)	56 (2)
C(19)	920 (1)	−2240 (4)	10886 (3)	55 (2)
C(20)	730 (1)	−1357 (4)	9806 (3)	48 (2)
Cl(21)	1796 (4)	−3893 (1)	12512 (1)	77 (1)
C(22)	177 (1)	3408 (4)	3201 (3)	52 (2)
C(23)	−458 (1)	4300 (4)	2890 (3)	48 (2)
O(24)	−885 (1)	4288 (3)	3489 (2)	68 (2)
O(25)	−471 (1)	5053 (3)	1791 (2)	55 (1)
C(26)	−1081 (1)	5788 (4)	1270 (3)	59 (2)
C(27)	−985 (2)	6629 (4)	89 (3)	69 (2)

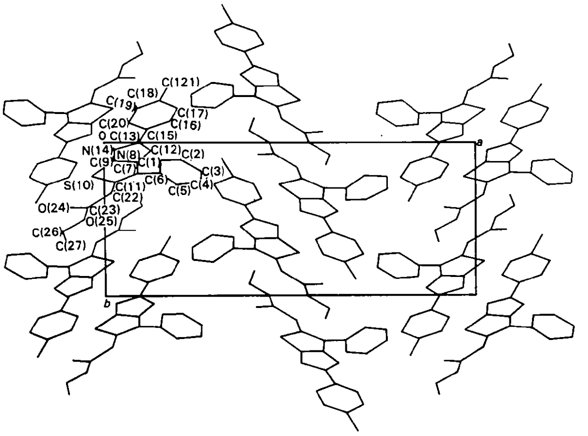


Fig. 1. Projection of the structure onto the (001) plane. Non-H atoms of one molecule are labelled.

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* Lists of H-atom coordinates, anisotropic thermal parameters, least-squares planes and structure factors have been deposited with the British Library Document Supply Centre as Supplementary Publication No. SUP 44308 (24 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

distances in the two phenyl rings range from 1·368 (5) to 1·410 (4) Å, reflecting relatively small anisotropic thermal motion; the valence angles are within 3σ of the ideal value 120° except in the case of angles at C(5) and C(15). S—C distances are shorter than the usual single bond and larger than a double owing to conjugation of the system (Mathew & Palenik, 1974; Kornis, Marks & Chidester, 1980; Foresti, Sanseverino & Sabatino, 1985). The difference of 6σ between the two C—S bonds is similar to that found in 2-(2,6-dimethylphenyl)iminothiazolidine (Argay, Kálmán, Lazar, Ribár & Tóth, 1977) and in 2,5-diamino-3*H*-1,3,4-thiadiazolinium chloride monohydrate (Senda, Matsuoka & Maruha, 1986). C(6)—C(7), 1·477 (4), as well as C(13)—C(15), 1·458 (4) Å, are shorter than a typical C—C bond. Similar behaviour has also been noticed in 2-(5-amino-1,3,4-thiadiazol-2-yl)benzenesulfonamide (Foresti, Sanseverino & Sabatino, 1985) and in 1-(2′-*p*-bromobenzylthio)ethyl-4-phenylimidazole (Fibiger, Banks, Jones, Haltiwanger & Watt, 1978). C(9)—N(14), 1·302 (4) Å, is larger by 4σ than the corresponding bond length in 6-*β*-(1-ethyl-1-hydroxypropyl)-5-phenyl-2,3,5,6-tetrahydroimidazo-[2,1-*b*]thiazole (Cameron, Cameron & Duncanson, 1981). Cl(21) is symmetrically placed about C(17) and C(19), C(17)···Cl(21), 2·714 (4), and C(19)···Cl(21), 2·710 (3) Å, are nearly equal. In the ethoxycarbonylmethyl group C—C and C—O bond distances are within the commonly found range of values in simple organic compounds.

Table 2. *Interatomic distances* (Å), *valence angles* (°) *and selected torsion angles* (°)

C(1)—C(2)	1·405 (5)	C(12)—C(13)	1·375 (4)
C(1)—C(6)	1·389 (4)	C(13)—N(14)	1·397 (4)
C(2)—C(3)	1·373 (5)	C(13)—C(15)	1·458 (4)
C(3)—C(4)	1·370 (6)	C(15)—C(16)	1·410 (4)
C(4)—C(5)	1·396 (5)	C(15)—C(20)	1·403 (5)
C(5)—C(6)	1·396 (4)	C(16)—C(17)	1·368 (5)
C(6)—C(7)	1·477 (4)	C(17)—C(18)	1·382 (5)
C(7)—C(11)	1·364 (4)	C(18)—C(19)	1·393 (5)
C(7)—N(8)	1·381 (4)	C(18)—Cl(21)	1·742 (3)
N(8)—C(9)	1·369 (4)	C(19)—C(20)	1·383 (4)
N(8)—C(12)	1·374 (4)	C(22)—C(23)	1·517 (4)
C(9)—N(14)	1·302 (4)	C(23)—O(24)	1·188 (4)
C(9)—S(10)	1·747 (3)	C(23)—O(25)	1·340 (4)
C(11)—S(10)	1·766 (3)	O(25)—C(26)	1·451 (4)
C(11)—C(22)	1·486 (4)	C(26)—C(27)	1·498 (3)

C(2)—C(1)—C(6)	119·8 (3)	N(8)—C(12)—C(13)	105·8 (2)
C(1)—C(2)—C(3)	119·5 (3)	C(12)—C(13)—C(15)	127·6 (3)
C(2)—C(3)—C(4)	120·8 (3)	C(12)—C(13)—N(14)	110·6 (2)
C(3)—C(4)—C(5)	120·8 (3)	N(14)—C(13)—C(15)	121·7 (3)
C(4)—C(5)—C(6)	118·8 (3)	C(9)—N(14)—C(13)	103·7 (2)
C(1)—C(6)—C(5)	120·3 (3)	C(13)—C(15)—C(16)	122·8 (3)
C(1)—C(6)—C(7)	120·8 (2)	C(13)—C(15)—C(20)	120·1 (3)
C(5)—C(6)—C(7)	118·9 (3)	C(16)—C(15)—C(20)	117·1 (3)
C(6)—C(7)—C(11)	127·8 (3)	C(15)—C(16)—C(17)	121·6 (3)
C(6)—C(7)—N(8)	119·8 (2)	C(16)—C(17)—C(18)	119·9 (3)
N(8)—C(7)—C(11)	112·4 (3)	C(17)—C(18)—C(19)	120·6 (3)
C(7)—N(8)—C(9)	115·7 (2)	C(18)—C(19)—C(20)	119·0 (3)
C(7)—N(8)—C(12)	138·3 (2)	C(15)—C(20)—C(19)	121·7 (3)
C(9)—N(8)—C(12)	105·9 (2)	C(17)—C(18)—Cl(21)	120·2 (2)
N(8)—C(9)—N(14)	114·0 (2)	C(19)—C(18)—Cl(21)	119·2 (2)
S(10)—C(9)—N(8)	110·0 (2)	C(11)—C(22)—C(23)	116·2 (3)
S(10)—C(9)—N(14)	136·0 (2)	C(22)—C(23)—O(24)	126·1 (3)
C(9)—S(10)—C(11)	90·5 (1)	C(22)—C(23)—O(25)	108·5 (3)
C(7)—C(11)—C(22)	122·8 (3)	O(24)—C(23)—O(25)	125·3 (3)
S(10)—C(11)—C(7)	111·4 (2)	C(23)—O(25)—C(26)	115·7 (2)
S(10)—C(11)—C(22)	125·7 (2)	O(25)—C(26)—C(27)	107·3 (3)

C(6)C(1)C(2)C(3)	−0·3 (5)	C(12)C(13)C(15)C(16)	2·1 (5)
C(1)C(2)C(3)C(4)	−0·8 (6)	C(12)C(13)C(15)C(20)	−176·6 (3)
C(2)C(3)C(4)C(5)	−0·6 (6)	C(13)N(14)C(9)N(8)	−1·2 (3)
C(3)C(4)C(5)C(6)	2·9 (6)	C(13)N(14)C(9)S(10)	178·7 (3)
C(4)C(5)C(6)C(1)	3·1 (6)	C(9)N(14)C(13)C(15)	−179·9 (3)
C(5)C(6)C(1)C(2)	2·7 (5)	C(13)C(15)C(16)C(17)	−178·3 (3)
C(4)C(5)C(6)C(7)	176·8 (3)	C(13)C(15)C(20)C(19)	−178·8 (3)
C(5)C(6)C(7)N(8)	−63·9 (4)	C(20)C(15)C(13)N(14)	4·7 (5)
C(5)C(6)C(7)C(11)	118·3 (4)	C(20)C(15)C(13)C(12)	−176·6 (3)
C(6)C(7)N(8)C(12)	−0·8 (5)	C(15)C(16)C(17)C(18)	1·2 (5)
C(6)C(7)C(11)C(22)	−0·5 (5)	C(16)C(17)C(18)C(19)	−3·3 (5)
C(7)N(8)C(12)C(13)	−175·4 (3)	C(16)C(17)C(18)Cl(21)	178·4 (3)
C(7)N(8)C(9)S(10)	−2·5 (3)	C(17)C(18)C(19)C(20)	3·7 (5)
N(8)C(9)S(10)C(11)	1·7 (2)	Cl(21)C(18)C(19)C(20)	−178·0 (3)
N(8)C(9)N(14)C(13)	−1·2 (3)	C(18)C(19)C(20)C(15)	−2·1 (5)
C(9)S(10)C(11)C(7)	−0·6 (2)	C(19)C(20)C(15)C(16)	0·0 (5)
C(9)S(10)C(11)C(22)	177·1 (3)	C(19)C(20)C(15)C(13)	178·8 (3)
S(10)C(11)C(7)C(6)	177·2 (3)	C(11)C(22)C(23)O(24)	−8·0 (5)
S(10)C(11)C(7)N(8)	−0·7 (3)	C(11)C(22)C(23)O(25)	174·7 (2)
S(10)C(11)C(22)C(23)	14·0 (4)	C(22)C(23)O(25)C(26)	172·0 (2)
N(8)C(12)C(13)N(14)	−0·8 (3)	O(24)C(23)O(25)C(26)	−5·3 (5)
N(8)C(12)C(13)C(15)	−179·6 (3)	C(23)O(25)C(26)C(27)	177·1 (3)
C(12)C(13)N(14)C(9)	1·2 (3)		

The angle C(6)—C(7)—C(11), 127·8 (3)°, facing the 3-phenyl ring is significantly large owing to the steric effect of the ester group. N(8)—C(9)—S(10), 110·0 (2)°, in the thiazole ring is normal but C(7)—N(8)—C(9), 115·7 (2)°, is small for a substituent linked by a single bond. The increasing deformation of C(13)—C(15)—C(16), 122·8 (3)°, is a logical consequence of the packing effects to retain the planarity of the system of five-membered rings and *p*-chlorophenyl group. The shorter bond distance of C(13)—C(15) and small torsion angle about it point to conjugation between the imidazole and *p*-chlorophenyl groups. The remaining distances and valence angles around the five- and six-membered rings can be rationalized in terms of conformational geometry and substitution pattern. The least-squares planes fitted to the six atoms of each of the phenyl rings show maximum deviation (0·019 Å) for C(5) and C(18). N(8) of the thiazole ring points up (0·013) and C(9) points down (−0·013 Å) from the mean thiazole plane; other atoms have smaller deviations. The imidazole ring is planar and the sum of the internal angles is 540·0°. The ethoxycarbonylmethyl is tilted by 7·8 (2)° to the fused-ring system.

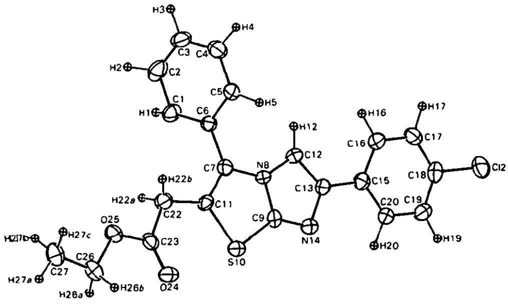

Fig. 2. *ORTEP* drawing (Johnson, 1971) of the title compound (relative configuration). Thermal ellipsoids are drawn at the 35% probability level. H atoms are drawn as spheres of arbitrary radius.

The short intermolecular contact (C—)H(3)···O(24), 2·47 (5) Å [$\frac{1}{2}+x, \frac{1}{2}-y, z$], with $d = 0{\cdot}23$ Å (Taylor & Kennard, 1982) probably forms a weak hydrogen bond; otherwise intermolecular distances correspond to or are greater than the relevant van der Waals radii.

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Structures of Two Isomeric Phenylethanolamine Analogs Containing the Benzobicyclo[3.2.1]octane Skeleton

BY GARY L. GRUNEWALD AND QIZHUANG YE

Department of Medicinal Chemistry, University of Kansas, Lawrence, Kansas 66045, *USA*

AND FUSAO TAKUSAGAWA

Department of Chemistry, University of Kansas, Lawrence, Kansas 66045, *USA*

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Abstract. *endo*-8-Amino-6,7,8,9-tetrahydro-5,8-methano-5*H*-benzocyclohepten-9-ol hydrochloride, $C_{12}H_{16}NO^+.Cl^-$, $M_r = 225{\cdot}72$, tetragonal, $I4_1/a$, $a = b = 24{\cdot}641$ (3), $c = 7{\cdot}709$ (1) Å, $V = 4681$ (1) Å^3, $Z = 16$, $D_x = 1{\cdot}281$ Mg m^{-3}, λ(Mo $K\alpha$) = 0·71069 Å, $\mu = 0{\cdot}3032$ mm^{-1}, $F(000) = 1920$, $T = 297$ K. $R = 0{\cdot}0324$ for 1543 independent reflections collected. *exo*-8-Amino-6,7,8,9-tetrahydro-5,8-methano-5*H*-benzocyclohepten-9-ol, $C_{12}H_{15}NO$, $M_r = 189{\cdot}26$, monoclinic, $P2_1/c$, $a = 13{\cdot}863$ (3), $b = 6{\cdot}910$ (2), $c = 13{\cdot}437$ (3) Å, $V = 1018{\cdot}2$ (5) Å^3, $Z = 4$, $D_x = 1{\cdot}235$ Mg m^{-3}, λ(Mo $K\alpha$) = 0·71069 Å, $\mu = 0{\cdot}08456$ mm^{-1}, $F(000) = 408$, $T = 297$ K. $R = 0{\cdot}0378$ for 1340 independent reflections collected. The torsion angles N—C(8)—C(9)—C(9a) of the two isomers are 174·0 (2) and 173·4 (1)°, respectively, which are very close to those observed for epinephrine (172°) and norepinephrine (179°) with the side chain in a fully extended conformation. The cyclohexene moiety has a half-chair conformation as found in tetralols.

Introduction. In the continuation of our effort in studying the relationship between conformation and biological activities in phenylethanolamine analogs (Grunewald, Reitz, Hallett, Rutledge, Vollmer, Archuleta & Ruth, 1980; Rafferty & Grunewald, 1982; Grunewald, Pleiss & Rafferty, 1982), we obtained *endo*- and *exo*-8-amino-6,7,8,9-tetrahydro-5,8-methano-5*H*-benzocyclohepten-9-ols (1) and (2). They are both conformationally defined analogs of phenyl-

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