C11	−0.2214 (10)	1.0318 (7)	−0.2976 (5)	0.0341 (13)
C12	−0.0221 (10)	0.9369 (7)	−0.2927 (6)	0.0369 (14)
C13	0.0969 (10)	0.9147 (6)	−0.1894 (6)	0.0346 (13)
C14	−0.3474 (11)	1.0573 (9)	−0.4128 (6)	0.050 (2)
C15	0.2966 (8)	1.0527 (6)	0.3031 (5)	0.0249 (12)
C16	0.5894 (9)	1.2495 (6)	0.2720 (5)	0.0304 (12)
C17	0.5988 (9)	1.3531 (6)	0.1416 (6)	0.0310 (13)
C18	0.7802 (12)	1.4614 (8)	0.0971 (7)	0.050 (2)
C19	0.7933 (15)	1.5640 (9)	−0.0208 (7)	0.064 (2)
C20	0.6258 (13)	1.5558 (7)	−0.0965 (7)	0.050 (2)
C21	0.4426 (12)	1.4465 (8)	−0.0515 (7)	0.050 (2)
C22	0.4281 (11)	1.3468 (7)	0.0665 (7)	0.043 (2)

Table 4. *Selected geometric parameters* (Å, °) *for* (3)

S—C8	1.782 (6)	O5—C16	1.455 (7)
S—C1	1.783 (5)	N—C15	1.348 (7)
O1—C1	1.208 (6)	N—C2	1.434 (7)
O2—C5	1.416 (7)	N—H1	0.79 (6)
O2—C4	1.419 (7)	C1—C2	1.528 (7)
O3—C5	1.429 (7)	C2—C3	1.549 (7)
O3—C3	1.438 (7)	C3—C4	1.544 (7)
O4—C15	1.214 (6)	C5—C7	1.518 (9)
O5—C15	1.351 (6)	C5—C6	1.524 (9)
C8—S—C1	101.1 (2)	O3—C3—C4	104.0 (4)
C5—O2—C4	106.0 (4)	O3—C3—C2	108.0 (4)
C5—O3—C3	108.3 (4)	C4—C3—C2	115.1 (4)
C15—O5—C16	116.1 (4)	O2—C4—C3	103.4 (4)
C15—N—C2	120.9 (4)	O2—C5—O3	105.7 (4)
C2—N—H1	119 (4)	O2—C5—C7	108.3 (5)
C15—N—H1	120 (4)	O3—C5—C7	107.7 (5)
O1—C1—C2	122.9 (5)	O2—C5—C6	112.3 (5)
O1—C1—S	124.2 (4)	O3—C5—C6	109.1 (5)
C2—C1—S	112.9 (4)	C7—C5—C6	113.5 (6)
N—C2—C1	114.3 (4)	O4—C15—N	125.4 (5)
N—C2—C3	112.8 (4)	O4—C15—O5	124.4 (5)
C1—C2—C3	108.1 (4)	N—C15—O5	110.2 (4)
C8—S—C1—O1	5.4 (5)	C5—O2—C4—C3	33.4 (5)
C8—S—C1—C2	−173.8 (3)	O3—C3—C4—O2	−18.8 (5)
O1—C1—C2—C3	54.4 (6)	C2—C3—C4—O2	99.2 (5)
S—C1—C2—C3	−126.3 (4)	C4—O2—C5—O3	−36.0 (5)
C5—O3—C3—C4	−2.4 (5)	C3—O3—C5—O2	23.1 (5)
C5—O3—C3—C2	−125.2 (4)	C1—S—C8—C13	−114.9 (4)
C1—C2—C3—O3	−168.5 (4)	C1—S—C8—C9	67.8 (5)
C1—C2—C3—C4	75.8 (5)		

The measured data set for (2) consisted of an octant, a complete set of Friedel opposites and a further octant equivalent to the first, thus producing the overall index limits given. For (3), the measured data set consisted of a complete sphere of reflections to the specified angle limit.

Isotropic H atoms were refined with a riding model for both compounds, including a parameter for rotation of each methyl group about the C—C bond.

For both compounds, data collection: *DIF*4 (Stoe & Cie, 1990); cell refinement: *DIF*4; data reduction: local programs; program(s) used to solve structures: *SHELXTL* (Sheldrick, 1990, 1994); program(s) used to refine structures: *SHELXL*93 (Sheldrick, 1993); molecular graphics: *SHELXTL*; software used to prepare material for publication: *SHELXL*93 and local programs.

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Lists of structure factors, anisotropic displacement parameters and H-atom coordinates have been deposited with the IUCr (Reference: BM1008). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

References

Ashwell, M., Jackson, R. F. W. & Kirk, J. M. (1990). *Tetrahedron*, **21**, 7429–7442.

Clegg, W. (1981). *Acta Cryst.* A**37**, 22–28.

Flack, H. D. (1983). *Acta Cryst.* A**39**, 876–881

Jackson, R. F. W., Palmer, N. J., Wythes, M. J., Clegg, W. & Elsegood, M. R. J. (1995). *J. Org. Chem.* Submitted.

Sheldrick, G. M. (1990). *SHELXTL*. Version 4. Siemens Analytical X-ray Instruments Inc., Madison, Wisconsin, USA.

Sheldrick, G. M. (1993). *SHELXL*93. *Program for the Refinement of Crystal Structures*. Univ. of Göttingen, Germany.

Sheldrick, G. M. (1994). *SHELXTL*. Version 5. Siemens Analytical X-ray Instruments Inc., Madison, Wisconsin, USA.

Stoe & Cie (1990). *DIF*4. *Diffractometer Control Program*. Version 7.04. Stoe & Cie, Darmstadt, Germany.

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p-(4,6-Diamino-*s*-triazin-2-yl)aminophenylarsonic Acid Dihydrate

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Abstract

The structure of the title compound, $C_9H_{11}AsN_6O_3.2H_2O$, contains a planar organic moiety bonded to pentavalent arsenic. The lattice is stabilized by a combination of aromatic stacking interactions and by a hydrogen-bonding network involving water molecules of crystallization.

Comment

Melarsamine hydrochloride (trade name Cymelarsen) is a water-soluble trivalent arsenical drug which finds use in the treatment of trypanosomal infection in some animals (Zweygarth & Kaminsky, 1990). A study of the properties of the drug in aerobic aqueous solution indicates that the compound is unstable, with a complex mode of dissociation (Berger & Fairlamb, 1994). This analysis was undertaken to identify the structure of a

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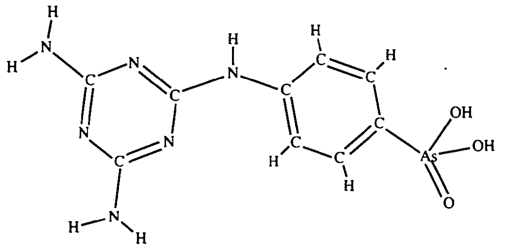
crystalline product resulting from the decomposition of a 10 m*M* aqueous solution of melarsamine hydrochloride and confirms the identification by Berger & Fairlamb (1994) of the pentavalent arsenic compound, melarsen, (I), as one of the products (Fig. 1).



(I)

The molecule is planar with a mean deviation of 0.019 (9) Å from the best plane derived from the atomic positions of the organic moiety and the As atom. Bond lengths and angles determined in the present study are comparable with those of related studies (Dhubhghaill & Sadler, 1991) and those identified from a search of the Cambridge Structural Database (Allen *et al.*, 1987).

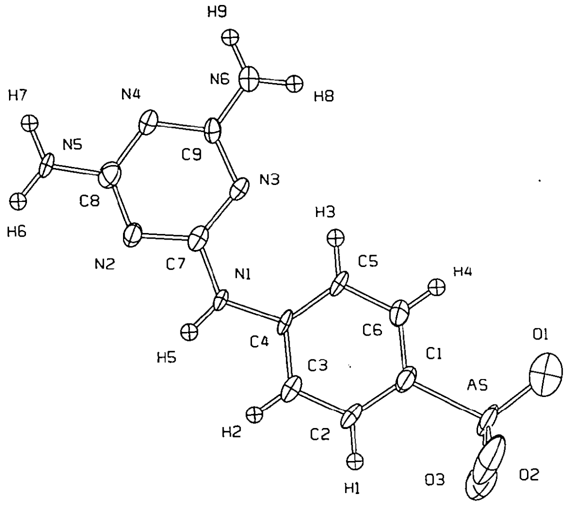


Fig. 1. *ORTEP* (Johnson, 1965) drawing of *p*-(4,6-diamino-*s*-triazin-2-yl)aminophenylarsonic acid showing the numbering scheme used. Ellipsoids are represented at the 50% probability level.

The molecules pack, utilizing the stacking of heterocyclic aromatic systems, parallel to the *b* unit-cell edge. Two waters of crystallization stabilize the lattice by forming a hydrogen-bonding network linking the N1 secondary amine and N6 primary amine with the arsenic groups of symmetry-related molecules.

Experimental

Crystals of the title compound were obtained by evaporation of an aqueous solution.

Crystal data

$C_9H_{11}AsN_6O_3.2H_2O$
$M_r = 362.16$
Monoclinic
$C2/c$
$a = 17.862\ (4)$ Å
$b = 6.849\ (2)$ Å
$c = 23.065\ (2)$ Å
$\beta = 102.14\ (1)°$
$V = 2758\ (1)$ Å^3
$Z = 8$
$D_x = 1.744$ Mg m^{-3}
Cu $K\alpha$ radiation
$\lambda = 1.5418$ Å
Cell parameters from 25 reflections
$\theta = 29.6–35.5°$
$\mu = 0.367$ mm^{-1}
$T = 299\ (1)$ K
Block
0.23 × 0.12 × 0.08 mm
Straw coloured

Data collection

Rigaku AFC-5 diffractometer
$\omega/2\theta$ scans
Absorption correction: three ψ scans (North, Phillips & Mathews, 1968)
$T_{\min} = 0.85$, $T_{\max} = 1.00$
2332 measured reflections
2248 independent reflections
1629 observed reflections [$I > 3\sigma(I)$]
$R_{\rm int} = 0.062$
$\theta_{\max} = 60°$
$h = -19 \rightarrow 20$
$k = -3 \rightarrow 6$
$l = -25 \rightarrow 24$
3 standard reflections monitored every 150 reflections intensity decay: 2%

Refinement

Refinement on F
$R = 0.075$
$wR = 0.098$
$S = 2.98$
1629 reflections
190 parameters
All H-atom parameters refined
$w = 1/\sigma^2(F)$
$(\Delta/\sigma)_{\max} < 0.06$
$\Delta\rho_{\max} = 1.18$ e Å^{-3}
$\Delta\rho_{\min} = -0.88$ e Å^{-3}
Extinction correction: none
Atomic scattering factors from Cromer & Waber (1974)

Table 1. *Fractional atomic coordinates and equivalent isotropic displacement parameters* (Å^2)

$$B_{\rm eq} = (8\pi^2/3)\Sigma_i\Sigma_jU_{ij}a_i^*a_j^*\mathbf{a}_i.\mathbf{a}_j.$$

	x	y	z	$B_{\rm eq}$
As	0.28473 (6)	0.1959 (2)	0.68092 (5)	3.18 (6)
O1	0.2035 (5)	0.240 (1)	0.6428 (4)	6.6 (5)
O2	0.2949 (5)	−0.026 (1)	0.7150 (4)	6.4 (5)
O3	0.3119 (4)	0.359 (1)	0.7373 (4)	5.5 (4)
O4	0.6831 (4)	0.148 (1)	0.6485 (3)	5.6 (4)
O5	0.3960 (4)	0.681 (1)	0.7238 (3)	3.9 (3)
N1	0.5530 (4)	0.233 (1)	0.5550 (3)	2.2 (3)
N2	0.6338 (4)	0.258 (1)	0.4906 (3)	1.8 (3)
N3	0.4964 (4)	0.268 (1)	0.4552 (3)	1.9 (3)
N4	0.5797 (4)	0.289 (1)	0.3886 (3)	2.2 (3)
N5	0.7101 (4)	0.279 (1)	0.4226 (3)	3.1 (4)
N6	0.4498 (4)	0.303 (1)	0.3552 (3)	3.1 (4)
C1	0.3654 (5)	0.206 (1)	0.6388 (4)	2.3 (4)
C2	0.4402 (6)	0.204 (2)	0.6696 (4)	3.8 (5)
C3	0.5006 (5)	0.212 (2)	0.6409 (4)	3.3 (4)
C4	0.4862 (5)	0.225 (1)	0.5792 (4)	1.8 (3)
C5	0.4115 (5)	0.230 (1)	0.5468 (4)	2.2 (4)
C6	0.3516 (5)	0.221 (1)	0.5776 (4)	2.3 (4)
C7	0.5599 (5)	0.255 (1)	0.4976 (4)	1.7 (3)
C8	0.6411 (5)	0.276 (1)	0.4349 (4)	2.3 (4)
C9	0.5084 (5)	0.285 (1)	0.3999 (4)	2.2 (4)

Table 2. *Selected geometric parameters* (Å, °)

As—O1	1.560 (9)	N4—C8	1.36 (1)
As—O2	1.705 (8)	N4—C9	1.35 (1)
As—O3	1.708 (8)	N5—C8	1.32 (1)
As—C1	1.901 (8)	N6—C9	1.31 (1)
N1—C4	1.42 (1)	C1—C2	1.38 (1)
N1—C7	1.37 (1)	C1—C6	1.38 (1)
N2—C7	1.36 (1)	C2—C3	1.38 (1)
N2—C8	1.32 (1)	C3—C4	1.39 (1)
N3—C7	1.33 (1)	C4—C5	1.39 (1)
N3—C9	1.34 (1)	C5—C6	1.41 (1)
O1—As—O2	115.4 (5)	N1—C4—C3	114.4 (7)
O1—As—O3	112.6 (5)	N1—C4—C5	125.4 (8)
O1—As—C1	114.8 (4)	C3—C4—C5	120.3 (8)
O2—As—O3	104.4 (5)	C4—C5—C6	118.3 (8)
O2—As—C1	104.4 (4)	C1—C6—C5	121.8 (8)
O3—As—C1	103.9 (4)	N1—C7—N2	113.7 (7)
C4—N1—C7	129.8 (7)	N1—C7—N3	118.8 (7)
C7—N2—C8	114.2 (7)	N2—C7—N3	127.4 (8)
C7—N3—C9	114.9 (7)	N2—C8—N4	122.6 (8)
C8—N4—C9	118.9 (7)	N2—C8—N5	119.8 (8)
AS—C1—C2	119.6 (7)	N4—C8—N5	117.6 (8)
AS—C1—C6	122.1 (7)	N3—C9—N4	121.9 (8)
C2—C1—C6	118.2 (8)	N3—C9—N6	119.7 (8)
C1—C2—C3	121.7 (9)	N4—C9—N6	118.4 (8)
C2—C3—C4	119.7 (9)		

Although the waters are quite ordered, we were dissatisfied with the refinement of the H atoms associated with them and these H atoms were thus excluded from the final stage of the analysis. The protons required for electroneutrality have not been located. Anomalous-dispersion effects were derived from Ibers & Hamilton (1964).

Computer programs used: *TEXSAN* (Molecular Structure Corporation, 1992), *DIRDIF* (Beurskens, 1984), *MITHRIL* (Gilmore, 1984), *SHELXS*86 (Sheldrick, 1985) and *ORTEP* (Johnson, 1965).

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Lists of structure factors, anisotropic displacement parameters, H-atom coordinates and complete geometry have been deposited with the IUCr (Reference: HU1147). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

References

Allen, F. H., Kennard, O., Watson, D. G., Brammer, L., Orpen, A. G. & Taylor, R. (1987). *J. Chem. Soc. Perkin Trans.* 2, pp. S1–S19.

Berger, B. J. & Fairlamb, A. H. (1994). *Antimicrob. Agents Chemother.* **38**, 1298–1302.

Beurskens, P. T. (1984). *The DIRDIF Program System.* Technical Report 1984/1. Crystallography Laboratory, Toernooiveld, 6525 ED Nijmegen, The Netherlands.

Cromer, D. T. & Waber, J. T. (1974). *International Tables for X-ray Crystallography*, Vol. IV, Table 2.2A. Birmingham: Kynoch Press. (Present distributor Kluwer Academic Publishers, Dordrecht.)

Dhubhghaill, O. M. N. & Sadler, P. J. (1991). *The Structure and Reactivity of Arsenic Compounds; Biological Activity and Drug Design. Structure and Bonding*, pp. 130–190. Berlin: Springer-Verlag.

Gilmore, C. J. (1984). *J. Appl. Cryst.* **17**, 42–46.

Ibers, J. A. & Hamilton, W. C. (1964). *Acta Cryst.* **17**, 781–782.

Johnson, C. K. (1965). *ORTEP*. Report ORNL-3794. Oak Ridge National Laboratory, Tennessee, USA.

Molecular Structure Corporation (1992). *TEXSAN. Single Crystal Structure Analysis Software*. MSC, 3200 Research Forest Drive, The Woodlands, TX 77381, USA.

North, A. C. T., Phillips, D. C. & Mathews, F. S. (1968). *Acta Cryst.* A**24**, 351–359.

Sheldrick, G. M. (1985). *SHELXS*86. *Crystallographic Computing* 3, edited by G. M. Sheldrick, C. Krüger & R. Goddard, pp. 175–189. Oxford Univ. Press.

Zweygarth, E. & Kaminsky, R. (1990). *Trop. Med. Parasitol.* **41**, 208–212.

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8-(Noradamantan-3-yl)-1,3-dipropylxanthine

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Abstract

The title compound, KW-3902 {1,3-dipropyl-8-(3-tricyclo[3.3.1.0^{3,7}]nonyl)-3,7-dihydro-1*H*-purine-2,6-dione, $C_{20}H_{28}N_4O_2$}, is a selective adenosine A1-receptor antagonist. In the crystal of KW-3902, the mirror plane of the 3-noradamantyl group is nearly in the plane of the xanthine moiety. The two propyl side chains have fully extended conformations and are on the same side of the xanthine plane.

Comment

Xanthine derivatives block adenosine receptors and exhibit varied pharmacological activities. Because these compounds act as antagonists, it is obvious that their three-dimensional structures are very important in the process of binding to the receptors. To elucidate the structure–activity relationships of xanthine derivatives, we have undertaken the X-ray analysis of a series of these derivatives (Hirayama, Nagahara, Shimada & Suzuki, 1993). The title compound, KW-3902, displays

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