

Acta Crystallographica Section E

Structure Reports

Online

ISSN 1600-5368

11*H*-Dibenzo[*b,e*]azepine-6-carbonitrileGuo-Dong Fan,^a Yu-Liang Xiao,^b Gui-Rong You^b and Gui-Yun Duan^{b*}

^aCollege of Chemistry and Chemical Engineering, Shaanxi University of Science and Technology, Xi'an 710021, People's Republic of China, and ^bCollege of Pharmaceutical Sciences, Taishan Medical College, Tai'an 271016, People's Republic of China

Correspondence e-mail: duanguiyun@yahoo.cn

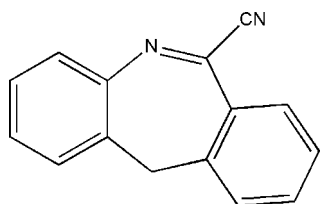
Received 5 October 2008; accepted 13 October 2008

Key indicators: single-crystal X-ray study; $T = 273$ K; mean $\sigma(\text{C}-\text{C}) = 0.002$ Å; R factor = 0.036; wR factor = 0.097; data-to-parameter ratio = 13.3.

The title compound, $\text{C}_{15}\text{H}_{10}\text{N}_2$, crystallizes with two independent molecules in the asymmetric unit. The two benzene rings make dihedral angles of 60.32 (2) and 61.35 (3)°. The crystal packing is stabilized by weak π - π stacking interactions [centroid-to-centroid distances = 3.673 (4) and 3.793 (4) Å].

Related literature

For discussions of the biological activity of the title compound, see: Bakker *et al.* (2000); Bielory & Ghafoor (2005); Schmutz *et al.* (1967). For a similar structure, see: Li *et al.* (2006).



Experimental

Crystal data

$\text{C}_{15}\text{H}_{10}\text{N}_2$
 $M_r = 218.25$
 Triclinic, $P\bar{1}$

$a = 10.125$ (2) Å
 $b = 10.275$ (2) Å
 $c = 12.749$ (3) Å

$\alpha = 105.96$ (3)°
 $\beta = 99.18$ (2)°
 $\gamma = 109.04$ (3)°
 $V = 1159.2$ (6) Å³
 $Z = 4$

Mo $K\alpha$ radiation
 $\mu = 0.08$ mm⁻¹
 $T = 273$ (2) K
 $0.15 \times 0.12 \times 0.10$ mm

Data collection

Bruker SMART CCD area-detector diffractometer
 Absorption correction: multi-scan (SADABS; Sheldrick, 1996)
 $T_{\min} = 0.989$, $T_{\max} = 0.993$

12026 measured reflections
 4084 independent reflections
 3382 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.021$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.036$
 $wR(F^2) = 0.097$
 $S = 1.03$
 4084 reflections

308 parameters
 H-atom parameters constrained
 $\Delta\rho_{\text{max}} = 0.19$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.13$ e Å⁻³

Table 1

Selected interatomic distances (Å).

$Cg1$ is the centroid of the ring C8–C13 and $Cg2$ is the centroid of the ring C23–C28.

$Cg1 \cdots Cg1^i$	3.673 (4)	$Cg2 \cdots Cg2^{ii}$	3.793 (4)
--------------------	-----------	-----------------------	-----------

Symmetry codes: (i) $-x + 2, -y + 1, -z + 1$; (ii) $-x + 1, -y + 1, -z$.

Data collection: SMART (Bruker, 2001); cell refinement: SAINT (Bruker, 2001); data reduction: SAINT; program(s) used to solve structure: SHELXTL (Sheldrick, 2008); program(s) used to refine structure: SHELXTL; molecular graphics: SHELXTL; software used to prepare material for publication: SHELXTL.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: SG2271).

References

- Bakker, R. A., Wieland, K., Timmerman, H. & Leurs, R. (2000). *Eur. J. Pharmacol.* **387**, R5–R7.
 Bielory, L. & Ghafoor, S. (2005). *Curr. Opin. Allergy Clin. Immunol.* **5**, 437–440.
 Bruker (2001). SMART and SAINT. Bruker AXS Inc., Madison, Wisconsin.
 Li, Q.-B., Yang, W.-C., Han, Y.-J. & Zhao, X.-J. (2006). *Acta Cryst.* **E62**, o3021–o3022.
 Schmutz, J., Hunziker, F. & Kunzle, F. (1967). *Helv. Chim. Acta*, **50**, 245–248.
 Sheldrick, G. M. (1996). SADABS. University of Göttingen, Germany.
 Sheldrick, G. M. (2008). *Acta Cryst.* **A64**, 112–122.

supporting information

Acta Cryst. (2008). E64, o2126 [doi:10.1107/S1600536808033072]

11H-Dibenzo[b,e]azepine-6-carbonitrile

Guo-Dong Fan, Yu-Liang Xiao, Gui-Rong You and Gui-Yun Duan

S1. Comment

The title compound, (1), is an intermediate in the synthesis of Epinastine which is an antihistamine agent (Bakker *et al.*, 2000; Bielory & Ghafoor, 2005), and was first synthesized in 1967 (Schmutz *et al.*, 1967).

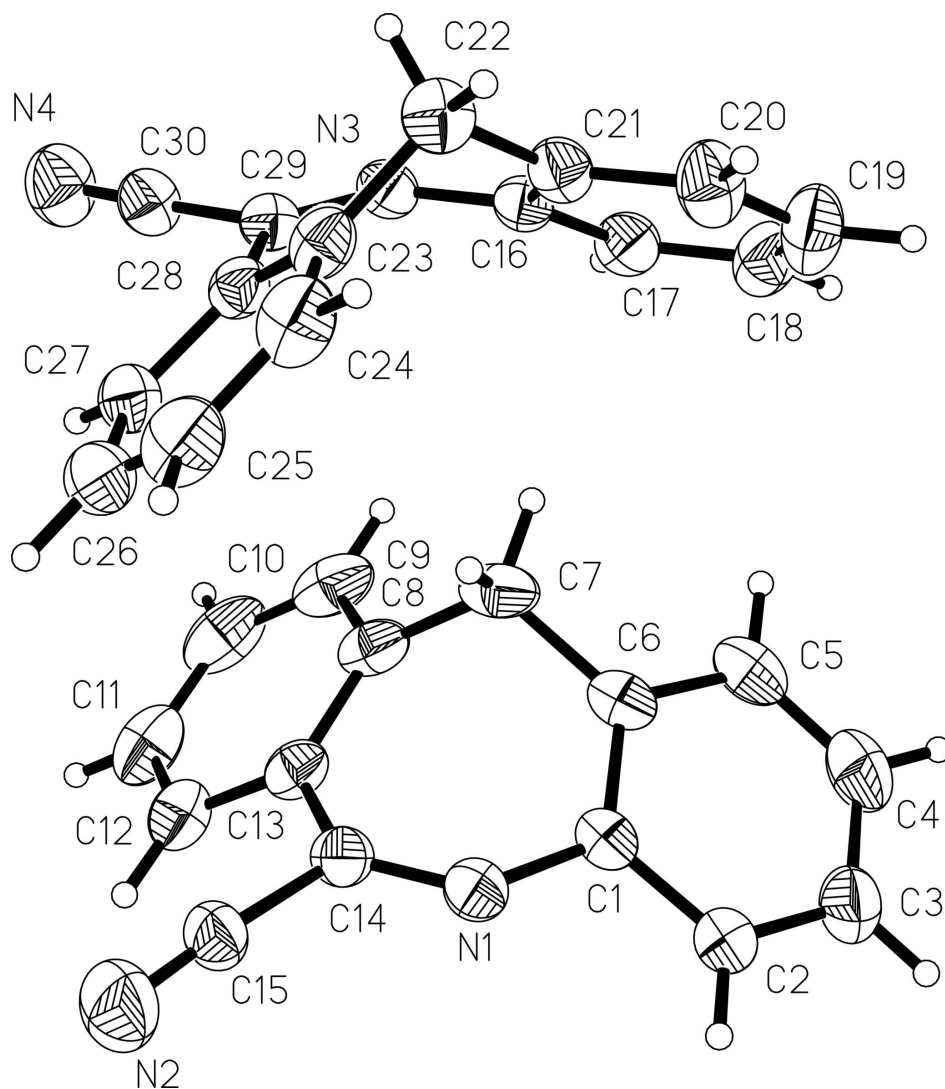
Compound (1) crystallizes with two independent molecules in the asymmetric unit (Fig. 1), all bond lengths and angles are normal and in a good agreement with those reported previously (Li *et al.*, 2006). The dihedral angles between the planes of benzene rings in the two independent molecules are 60.32 (2) and 61.35 (3)°. π - π stacking interactions (Table 1) are present in the structure (*Cg*1: C8–C13; *Cg*2: C23–C28).

S2. Experimental

Compound (1) was synthesized from 6-chlor-11H-dibenzo[b,e]azepine (1 mmol, 0.23 g) and sodium cyanade (1.1 mmol, 0.05 g) in 10 ml DMSO as solvent at 363 K for 5 h to afford the title compound (Yield 73%, 0.16 g). Crystals suitable for X-ray diffraction analysis were obtained by slow evaporation of a methanol solution at room temperature for one week.

S3. Refinement

All H atoms were placed in calculated positions, with C—H = 0.93 or 0.97 Å, and included in the final cycles of refinement using a riding model, with $U_{\text{iso}}(\text{H}) = 1.2$ times $U_{\text{eq}}(\text{C})$.

**Figure 1**

View of the title compound (I), with displacement ellipsoids drawn at the 35% probability level.

11*H*-Dibenzo[b,e]azepine-6-carbonitrile

Crystal data

$C_{15}H_{10}N_2$

$M_r = 218.25$

Triclinic, $P\bar{1}$

Hall symbol: $-P\ 1$

$a = 10.125\ (2)\ \text{\AA}$

$b = 10.275\ (2)\ \text{\AA}$

$c = 12.749\ (3)\ \text{\AA}$

$\alpha = 105.96\ (3)^\circ$

$\beta = 99.18\ (2)^\circ$

$\gamma = 109.04\ (3)^\circ$

$V = 1159.2\ (6)\ \text{\AA}^3$

$Z = 4$

$F(000) = 456$

$D_x = 1.251\ \text{Mg m}^{-3}$

Mo $K\alpha$ radiation, $\lambda = 0.71073\ \text{\AA}$

Cell parameters from 4851 reflections

$\theta = 2.2\text{--}28.0^\circ$

$\mu = 0.08\ \text{mm}^{-1}$

$T = 273\ \text{K}$

Block, brown

$0.15 \times 0.12 \times 0.10\ \text{mm}$

Data collection

Bruker SMART CCD area-detector
diffractometer
Radiation source: fine-focus sealed tube
Graphite monochromator
 φ and ω scans
Absorption correction: multi-scan
(*SADABS*; Sheldrick, 1996)
 $T_{\min} = 0.989$, $T_{\max} = 0.993$

12026 measured reflections
4084 independent reflections
3382 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.021$
 $\theta_{\max} = 25.0^\circ$, $\theta_{\min} = 2.2^\circ$
 $h = -12 \rightarrow 12$
 $k = -12 \rightarrow 12$
 $l = -14 \rightarrow 15$

Refinement

Refinement on F^2
Least-squares matrix: full
 $R[F^2 > 2\sigma(F^2)] = 0.036$
 $wR(F^2) = 0.097$
 $S = 1.03$
4084 reflections
308 parameters
0 restraints
Primary atom site location: structure-invariant
direct methods
Secondary atom site location: difference Fourier
map

Hydrogen site location: inferred from
neighbouring sites
H-atom parameters constrained
 $w = 1/[\sigma^2(F_o^2) + (0.0446P)^2 + 0.1613P]$
where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\max} < 0.001$
 $\Delta\rho_{\max} = 0.19 \text{ e } \text{\AA}^{-3}$
 $\Delta\rho_{\min} = -0.13 \text{ e } \text{\AA}^{-3}$
Extinction correction: *SHELXTL* (Sheldrick,
2008), $F_c^* = kFc[1 + 0.001x \text{Fc}^2 \lambda^3 / \sin(2\theta)]^{-1/4}$
Extinction coefficient: 0.037 (2)

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) *etc.* and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

	x	y	z	$U_{\text{iso}}^*/U_{\text{eq}}$
N1	0.93668 (11)	0.20617 (11)	0.18911 (9)	0.0486 (3)
N2	1.10390 (18)	0.47578 (17)	0.10411 (14)	0.0874 (4)
N3	0.33399 (10)	0.33411 (11)	0.30617 (9)	0.0474 (3)
N4	0.42697 (16)	0.69062 (15)	0.35893 (13)	0.0816 (4)
C1	0.87147 (12)	0.11423 (13)	0.24622 (10)	0.0466 (3)
C2	0.93247 (14)	0.01429 (14)	0.25883 (12)	0.0568 (3)
H2A	1.0096	0.0105	0.2288	0.068*
C3	0.87991 (17)	-0.07883 (16)	0.31523 (14)	0.0699 (4)
H3B	0.9238	-0.1425	0.3261	0.084*
C4	0.76259 (18)	-0.07763 (18)	0.35547 (14)	0.0747 (5)
H4A	0.7275	-0.1399	0.3944	0.090*
C5	0.69679 (16)	0.01499 (17)	0.33859 (13)	0.0679 (4)
H5A	0.6151	0.0122	0.3640	0.082*
C6	0.74956 (13)	0.11314 (15)	0.28418 (11)	0.0532 (3)
C7	0.67936 (14)	0.21544 (17)	0.26432 (13)	0.0644 (4)

H7A	0.6553	0.2013	0.1841	0.077*
H7B	0.5900	0.1936	0.2871	0.077*
C8	0.78013 (14)	0.37191 (16)	0.33094 (11)	0.0549 (3)
C9	0.74955 (18)	0.4600 (2)	0.41954 (13)	0.0707 (4)
H9A	0.6653	0.4210	0.4403	0.085*
C10	0.8421 (2)	0.6044 (2)	0.47717 (14)	0.0800 (5)
H10A	0.8204	0.6615	0.5369	0.096*
C11	0.9659 (2)	0.66483 (19)	0.44740 (13)	0.0732 (4)
H11A	1.0271	0.7630	0.4859	0.088*
C12	0.99953 (16)	0.58006 (15)	0.36048 (12)	0.0596 (4)
H12A	1.0832	0.6213	0.3398	0.071*
C13	0.90890 (13)	0.43261 (14)	0.30305 (10)	0.0486 (3)
C14	0.95118 (13)	0.34087 (14)	0.21488 (10)	0.0469 (3)
C15	1.03427 (15)	0.41783 (15)	0.14911 (12)	0.0549 (3)
C16	0.30864 (12)	0.18357 (13)	0.26934 (11)	0.0457 (3)
C17	0.32200 (14)	0.12481 (16)	0.35496 (12)	0.0570 (3)
H17A	0.3485	0.1854	0.4305	0.068*
C18	0.29646 (18)	-0.02147 (18)	0.32903 (16)	0.0717 (4)
H18A	0.3087	-0.0591	0.3867	0.086*
C19	0.2528 (2)	-0.11204 (18)	0.21765 (17)	0.0804 (5)
H19A	0.2344	-0.2115	0.1997	0.097*
C20	0.23630 (18)	-0.05569 (16)	0.13243 (15)	0.0703 (4)
H20A	0.2060	-0.1184	0.0573	0.084*
C21	0.26371 (13)	0.09205 (14)	0.15582 (11)	0.0508 (3)
C22	0.24469 (15)	0.15472 (15)	0.06392 (11)	0.0577 (4)
H22A	0.1773	0.2029	0.0739	0.069*
H22B	0.2046	0.0762	-0.0095	0.069*
C23	0.38852 (15)	0.26340 (15)	0.06805 (11)	0.0518 (3)
C24	0.45555 (19)	0.23862 (18)	-0.01782 (13)	0.0684 (4)
H24A	0.4114	0.1515	-0.0800	0.082*
C25	0.5865 (2)	0.3412 (2)	-0.01221 (15)	0.0777 (5)
H25A	0.6302	0.3222	-0.0704	0.093*
C26	0.65358 (17)	0.4714 (2)	0.07818 (15)	0.0715 (4)
H26A	0.7420	0.5402	0.0811	0.086*
C27	0.58889 (15)	0.49905 (16)	0.16430 (13)	0.0583 (4)
H27A	0.6326	0.5879	0.2249	0.070*
C28	0.45808 (13)	0.39437 (14)	0.16093 (11)	0.0467 (3)
C29	0.39603 (13)	0.42144 (13)	0.25784 (10)	0.0459 (3)
C30	0.41483 (15)	0.57366 (16)	0.31439 (12)	0.0566 (3)

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
N1	0.0475 (6)	0.0505 (6)	0.0503 (6)	0.0185 (5)	0.0175 (5)	0.0198 (5)
N2	0.0998 (11)	0.0880 (10)	0.0966 (11)	0.0383 (9)	0.0484 (9)	0.0511 (9)
N3	0.0454 (5)	0.0503 (6)	0.0456 (6)	0.0166 (5)	0.0171 (5)	0.0152 (5)
N4	0.0931 (10)	0.0557 (8)	0.0875 (10)	0.0253 (7)	0.0296 (8)	0.0140 (7)
C1	0.0414 (6)	0.0468 (7)	0.0461 (7)	0.0105 (5)	0.0116 (5)	0.0163 (6)

C2	0.0511 (7)	0.0501 (8)	0.0691 (9)	0.0171 (6)	0.0189 (6)	0.0229 (7)
C3	0.0716 (9)	0.0565 (9)	0.0850 (11)	0.0206 (7)	0.0198 (8)	0.0363 (8)
C4	0.0769 (10)	0.0655 (10)	0.0781 (11)	0.0102 (8)	0.0259 (9)	0.0385 (9)
C5	0.0525 (8)	0.0725 (10)	0.0725 (10)	0.0095 (7)	0.0263 (7)	0.0289 (8)
C6	0.0393 (6)	0.0592 (8)	0.0535 (8)	0.0112 (6)	0.0119 (6)	0.0184 (6)
C7	0.0404 (7)	0.0874 (11)	0.0719 (10)	0.0274 (7)	0.0195 (7)	0.0325 (8)
C8	0.0533 (7)	0.0761 (9)	0.0526 (8)	0.0391 (7)	0.0175 (6)	0.0299 (7)
C9	0.0765 (10)	0.1060 (14)	0.0618 (9)	0.0620 (10)	0.0305 (8)	0.0389 (10)
C10	0.1131 (14)	0.1013 (14)	0.0517 (9)	0.0765 (12)	0.0237 (9)	0.0231 (9)
C11	0.1017 (13)	0.0676 (10)	0.0545 (9)	0.0487 (9)	0.0093 (9)	0.0153 (8)
C12	0.0703 (9)	0.0566 (8)	0.0564 (8)	0.0307 (7)	0.0122 (7)	0.0224 (7)
C13	0.0523 (7)	0.0573 (8)	0.0453 (7)	0.0300 (6)	0.0120 (6)	0.0219 (6)
C14	0.0445 (6)	0.0529 (8)	0.0474 (7)	0.0200 (6)	0.0141 (5)	0.0220 (6)
C15	0.0579 (8)	0.0502 (8)	0.0647 (9)	0.0220 (6)	0.0287 (7)	0.0244 (7)
C16	0.0411 (6)	0.0497 (7)	0.0527 (8)	0.0192 (5)	0.0220 (5)	0.0205 (6)
C17	0.0569 (8)	0.0671 (9)	0.0591 (8)	0.0262 (7)	0.0290 (6)	0.0303 (7)
C18	0.0836 (11)	0.0774 (11)	0.0891 (12)	0.0452 (9)	0.0474 (9)	0.0513 (10)
C19	0.1060 (13)	0.0592 (9)	0.1064 (15)	0.0445 (9)	0.0607 (11)	0.0415 (10)
C20	0.0872 (11)	0.0526 (8)	0.0744 (10)	0.0277 (8)	0.0401 (9)	0.0163 (8)
C21	0.0508 (7)	0.0489 (7)	0.0543 (8)	0.0194 (6)	0.0234 (6)	0.0155 (6)
C22	0.0639 (8)	0.0562 (8)	0.0450 (7)	0.0212 (7)	0.0119 (6)	0.0103 (6)
C23	0.0657 (8)	0.0585 (8)	0.0451 (7)	0.0332 (7)	0.0212 (6)	0.0246 (6)
C24	0.0968 (11)	0.0771 (10)	0.0546 (9)	0.0472 (9)	0.0390 (8)	0.0314 (8)
C25	0.1023 (13)	0.1026 (14)	0.0778 (12)	0.0643 (11)	0.0602 (10)	0.0559 (11)
C26	0.0680 (9)	0.0919 (12)	0.0898 (12)	0.0400 (9)	0.0441 (9)	0.0609 (11)
C27	0.0586 (8)	0.0636 (9)	0.0660 (9)	0.0257 (7)	0.0236 (7)	0.0365 (7)
C28	0.0509 (7)	0.0541 (7)	0.0481 (7)	0.0268 (6)	0.0193 (6)	0.0262 (6)
C29	0.0439 (6)	0.0474 (7)	0.0453 (7)	0.0183 (5)	0.0119 (5)	0.0144 (6)
C30	0.0591 (8)	0.0516 (8)	0.0559 (8)	0.0182 (6)	0.0200 (6)	0.0156 (7)

Geometric parameters (Å, °)

N1—C14	1.2833 (16)	C12—H12A	0.9300
N1—C1	1.4082 (16)	C13—C14	1.4728 (18)
N2—C15	1.1062 (17)	C14—C15	1.4805 (19)
N3—C29	1.2804 (16)	C16—C17	1.3940 (19)
N3—C16	1.4077 (16)	C16—C21	1.3956 (19)
N4—C30	1.1348 (18)	C17—C18	1.372 (2)
C1—C2	1.3909 (19)	C17—H17A	0.9300
C1—C6	1.3936 (18)	C18—C19	1.372 (3)
C2—C3	1.373 (2)	C18—H18A	0.9300
C2—H2A	0.9300	C19—C20	1.377 (2)
C3—C4	1.369 (2)	C19—H19A	0.9300
C3—H3B	0.9300	C20—C21	1.386 (2)
C4—C5	1.370 (2)	C20—H20A	0.9300
C4—H4A	0.9300	C21—C22	1.4994 (19)
C5—C6	1.391 (2)	C22—C23	1.5008 (19)
C5—H5A	0.9300	C22—H22A	0.9700

C6—C7	1.500 (2)	C22—H22B	0.9700
C7—C8	1.500 (2)	C23—C24	1.3858 (19)
C7—H7A	0.9700	C23—C28	1.396 (2)
C7—H7B	0.9700	C24—C25	1.374 (2)
C8—C9	1.387 (2)	C24—H24A	0.9300
C8—C13	1.3980 (19)	C25—C26	1.374 (3)
C9—C10	1.375 (3)	C25—H25A	0.9300
C9—H9A	0.9300	C26—C27	1.377 (2)
C10—C11	1.369 (3)	C26—H26A	0.9300
C10—H10A	0.9300	C27—C28	1.3927 (19)
C11—C12	1.373 (2)	C27—H27A	0.9300
C11—H11A	0.9300	C28—C29	1.4735 (18)
C12—C13	1.393 (2)	C29—C30	1.4642 (19)
Cg1...Cg1 ⁱ	3.673 (4)	Cg2...Cg2 ⁱⁱ	3.793 (4)
C14—N1—C1	123.45 (11)	N2—C15—C14	175.67 (16)
C29—N3—C16	123.40 (10)	C17—C16—C21	119.88 (12)
C2—C1—C6	119.79 (12)	C17—C16—N3	115.52 (12)
C2—C1—N1	115.43 (11)	C21—C16—N3	124.48 (12)
C6—C1—N1	124.70 (12)	C18—C17—C16	120.68 (14)
C3—C2—C1	120.61 (14)	C18—C17—H17A	119.7
C3—C2—H2A	119.7	C16—C17—H17A	119.7
C1—C2—H2A	119.7	C17—C18—C19	119.75 (15)
C4—C3—C2	119.76 (15)	C17—C18—H18A	120.1
C4—C3—H3B	120.1	C19—C18—H18A	120.1
C2—C3—H3B	120.1	C18—C19—C20	120.00 (15)
C3—C4—C5	120.23 (14)	C18—C19—H19A	120.0
C3—C4—H4A	119.9	C20—C19—H19A	120.0
C5—C4—H4A	119.9	C19—C20—C21	121.66 (15)
C4—C5—C6	121.38 (14)	C19—C20—H20A	119.2
C4—C5—H5A	119.3	C21—C20—H20A	119.2
C6—C5—H5A	119.3	C20—C21—C16	118.00 (13)
C5—C6—C1	118.08 (14)	C20—C21—C22	122.27 (13)
C5—C6—C7	122.46 (13)	C16—C21—C22	119.73 (12)
C1—C6—C7	119.45 (12)	C21—C22—C23	109.89 (11)
C8—C7—C6	110.19 (11)	C21—C22—H22A	109.7
C8—C7—H7A	109.6	C23—C22—H22A	109.7
C6—C7—H7A	109.6	C21—C22—H22B	109.7
C8—C7—H7B	109.6	C23—C22—H22B	109.7
C6—C7—H7B	109.6	H22A—C22—H22B	108.2
H7A—C7—H7B	108.1	C24—C23—C28	118.32 (13)
C9—C8—C13	118.34 (15)	C24—C23—C22	122.21 (13)
C9—C8—C7	122.16 (14)	C28—C23—C22	119.47 (12)
C13—C8—C7	119.49 (12)	C25—C24—C23	120.81 (16)
C10—C9—C8	120.89 (16)	C25—C24—H24A	119.6
C10—C9—H9A	119.6	C23—C24—H24A	119.6
C8—C9—H9A	119.6	C26—C25—C24	120.87 (14)

C11—C10—C9	120.64 (15)	C26—C25—H25A	119.6
C11—C10—H10A	119.7	C24—C25—H25A	119.6
C9—C10—H10A	119.7	C25—C26—C27	119.47 (15)
C10—C11—C12	119.79 (16)	C25—C26—H26A	120.3
C10—C11—H11A	120.1	C27—C26—H26A	120.3
C12—C11—H11A	120.1	C26—C27—C28	120.16 (15)
C11—C12—C13	120.34 (15)	C26—C27—H27A	119.9
C11—C12—H12A	119.8	C28—C27—H27A	119.9
C13—C12—H12A	119.8	C27—C28—C23	120.32 (12)
C12—C13—C8	119.93 (13)	C27—C28—C29	119.32 (12)
C12—C13—C14	119.64 (12)	C23—C28—C29	120.34 (11)
C8—C13—C14	120.42 (12)	N3—C29—C30	113.12 (11)
N1—C14—C13	131.09 (12)	N3—C29—C28	130.40 (12)
N1—C14—C15	113.18 (11)	C30—C29—C28	116.35 (11)
C13—C14—C15	115.56 (11)	N4—C30—C29	178.61 (15)
C14—N1—C1—C2	-144.10 (13)	C29—N3—C16—C17	144.15 (12)
C14—N1—C1—C6	39.14 (19)	C29—N3—C16—C21	-39.94 (18)
C6—C1—C2—C3	-4.5 (2)	C21—C16—C17—C18	2.36 (19)
N1—C1—C2—C3	178.60 (12)	N3—C16—C17—C18	178.47 (12)
C1—C2—C3—C4	2.7 (2)	C16—C17—C18—C19	-2.1 (2)
C2—C3—C4—C5	0.7 (3)	C17—C18—C19—C20	0.7 (2)
C3—C4—C5—C6	-2.2 (3)	C18—C19—C20—C21	0.4 (3)
C4—C5—C6—C1	0.4 (2)	C19—C20—C21—C16	-0.2 (2)
C4—C5—C6—C7	179.82 (14)	C19—C20—C21—C22	-179.33 (14)
C2—C1—C6—C5	2.86 (19)	C17—C16—C21—C20	-1.19 (18)
N1—C1—C6—C5	179.49 (12)	N3—C16—C21—C20	-176.93 (12)
C2—C1—C6—C7	-176.53 (12)	C17—C16—C21—C22	177.98 (12)
N1—C1—C6—C7	0.1 (2)	N3—C16—C21—C22	2.23 (18)
C5—C6—C7—C8	114.56 (15)	C20—C21—C22—C23	-116.19 (15)
C1—C6—C7—C8	-66.07 (17)	C16—C21—C22—C23	64.68 (15)
C6—C7—C8—C9	-113.97 (14)	C21—C22—C23—C24	113.44 (15)
C6—C7—C8—C13	66.57 (16)	C21—C22—C23—C28	-66.68 (15)
C13—C8—C9—C10	1.2 (2)	C28—C23—C24—C25	-0.7 (2)
C7—C8—C9—C10	-178.22 (14)	C22—C23—C24—C25	179.17 (14)
C8—C9—C10—C11	0.7 (2)	C23—C24—C25—C26	-0.6 (2)
C9—C10—C11—C12	-1.1 (2)	C24—C25—C26—C27	0.2 (2)
C10—C11—C12—C13	-0.5 (2)	C25—C26—C27—C28	1.4 (2)
C11—C12—C13—C8	2.5 (2)	C26—C27—C28—C23	-2.72 (19)
C11—C12—C13—C14	-176.18 (12)	C26—C27—C28—C29	175.55 (12)
C9—C8—C13—C12	-2.84 (19)	C24—C23—C28—C27	2.32 (19)
C7—C8—C13—C12	176.64 (12)	C22—C23—C28—C27	-177.56 (12)
C9—C8—C13—C14	175.83 (12)	C24—C23—C28—C29	-175.94 (12)
C7—C8—C13—C14	-4.68 (18)	C22—C23—C28—C29	4.19 (18)
C1—N1—C14—C13	0.1 (2)	C16—N3—C29—C30	-177.84 (11)
C1—N1—C14—C15	175.05 (11)	C16—N3—C29—C28	-2.2 (2)
C12—C13—C14—N1	142.00 (14)	C27—C28—C29—N3	-139.03 (14)
C8—C13—C14—N1	-36.7 (2)	C23—C28—C29—N3	39.2 (2)

C12—C13—C14—C15	-32.90 (17)	C27—C28—C29—C30	36.50 (17)
C8—C13—C14—C15	148.42 (12)	C23—C28—C29—C30	-145.22 (12)

Symmetry codes: (i) $-x+2, -y+1, -z+1$; (ii) $-x+1, -y+1, -z$.