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Dimethyl 4-(4-formylphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,5-dicarboxylate

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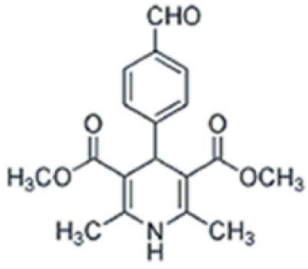
Key indicators: single-crystal X-ray study; T = 298 K; mean σ(C–C) = 0.003 Å; R factor = 0.052; wR factor = 0.140; data-to-parameter ratio = 12.9.

The title compound, $C_{18}H_{19}NO_5$, is a product of the Hantzsch reaction of *p*-phthalaldehyde, methyl acetoacetate, and ammonium acetate. The 1,4-dihydropyridine ring of the molecule adopts a flattened boat conformation. The benzene ring is almost perpendicular to the 1,4-dihydropyridine ring; the plane through the six C atoms of the benzene ring and the plane through the four C atoms that form the base of the boat-shaped 1,4-dihydropyridine ring (excluding the ring N atom and the opposite ring C atom) make a dihedral angle of 87.60 (3)°. Intermolecular N—H···O hydrogen bonds result in the formation of extended chains along the *a* axis.

Related literature

For a related 1,4-dihydropyridine structure, see: Fossheim *et al.* (1982). For the synthesis of 1,4-dihydropyridines, see: Hantzsch & Liebigs (1882). For the biological activity of 1,4-dihydropyridines, see: Janis & Triggle (1983).



Experimental

Crystal data

$C_{18}H_{19}NO_5$
M_r = 329.34
Triclinic, $P\overline{1}$
a = 8.219 (2) Å
b = 10.432 (3) Å
c = 10.979 (3) Å
α = 111.364 (3)°
β = 102.799 (3)°
γ = 101.150 (4)°
V = 815.0 (4) Å^3
Z = 2
Mo $K\alpha$ radiation
μ = 0.10 mm^{-1}
T = 298 (2) K
0.48 × 0.34 × 0.10 mm

Data collection

Bruker SMART CCD area-detector diffractometer
Absorption correction: multi-scan (*SADABS*: Sheldrick, 2004)
T_{min} = 0.954, T_{max} = 0.990
4173 measured reflections
2855 independent reflections
2352 reflections with $I > 2\sigma(I)$
R_{int} = 0.015

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.052
$wR(F^2)$ = 0.140
S = 1.04
2855 reflections
221 parameters
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.25 e Å^{-3}
$\Delta\rho_{min}$ = −0.23 e Å^{-3}

Table 1
Hydrogen-bond geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
N1—H1···O5^{i}	0.86	2.27	3.107 (2)	163

Symmetry code: (i) $-x+1, -y+2, -z+2$.

Data collection: *SMART* (Bruker, 2001); cell refinement: *SAINT* (Bruker, 2001); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1990); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *SHELXTL* (Sheldrick, 2001); software used to prepare material for publication: *SHELXTL*.

The authors are grateful to Dr Jianping Ma of Shandong Normal University for his help with the crystallographic analysis.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: SQ2008).

References

Bruker. (2001). *SMART* and *SAINT*. Bruker AXS Inc., Madison, Wisconsin, USA.
Fossheim, R., Svarteng, K. & Mostad, A. (1982). *J. Med. Chem.* **25**, 126–131.
Hantzsch, A. & Liebigs, J. (1882). *Ann. Chem.* **215**, 1–82.
Janis, R. A. & Triggle, D. J. (1983). *J. Med. Chem.* **25**, 775–785.
Sheldrick, G. M. (1990). *Acta Cryst.* A**46**, 467–473.
Sheldrick, G. M. (1997). *SHELXL97*. University of Göttingen, Germany.
Sheldrick, G. M. (2001). *SHELXTL*. Version 5.0. Bruker AXS Inc., Madison, Wisconsin, USA.
Sheldrick, G. M. (2004). *SADABS*. University of Göttingen, Germany.

supporting information

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Dimethyl 4-(4-formylphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,5-dicarboxylate

Fei Teng, Fanpeng Kong and Qingjian Liu

S1. Comment

It is well known that 1,4-dihydropyridines (DHPs) exhibit a wide range of biological activities, acting as potent vasodilators and antihypertensives (Janis & Triggle, 1983). The classical preparation method of 1,4-dihydropyridines is the Hantzsch reaction (Hantzsch & Liebigs, 1882). We have synthesized a series of 1,4-dihydropyridine compounds by the Hantzsch protocol in water. The structure of (I) was fully characterized by NMR (^{1}H,^{13}C), MS, IR, and elemental analysis and was confirmed by single-crystal X-ray crystallographic analysis (Figure 1).

The bond lengths and angles in (I) show normal values (Table 1) except for the geometry of the 1,4-dihydropyridine ring which adopts a flattened boat conformation with ring distortions at the nitrogen (Nl) and the tetrahedral carbon (C11). Both atoms are displaced to the same side of the ring with distances of 0.17Å and 0.39 Å, respectively, from the plane defined by C3, C4, C7, and C8, and thus form the apices of a boat-type conformation (Fossheim *et al.*, 1982). The phenyl ring is almost perpendicular to the 1,4-dihydropyridine ring (N1—C4—C3—C11—C8—C7) with a dihedral angle of 92.40 (1)°. The bisect plane of the 1,4-dihydropyridine ring defined by N1, C11, and C12 makes a dihedral angle of 35.40 (7)° with the phenyl ring. The intermolecular hydrogen bonds N1—H1···O5^{i} [symmetry code (i): -*x* + 1, -*y* + 2, -*z* + 2] between the pyridine N atom and a neighboring formyl O atom result in the formation of extended chains along the *a* axis (Figure 2).

S2. Experimental

The title compound,(I), was prepared by refluxing a mixture of *p*-phthaldehyde (0.67 g, 5.0 mmol), methyl acetoacetate (1.19 g, 10.25 mmol), and ammonium acetate (0.58 g, 7.5 mmol) for 6 h in water (10 ml), and purified by recrystallization, m.p.479–481 K. Single crystals suitable for X-ray diffraction were obtained by slow evaporation of an ethyl acetate solution.

S3. Refinement

All non-hydrogen atoms were refined with anisotropic displacement parameters. Hydrogen atoms attached to anisotropically refined atoms were placed in geometrically idealized positions and included as riding atoms with C—H = 0.93Å and U_{iso}(H) = 1.2*U_{eq}(C) (aromatic); C—H = 0.96Å and U_{iso}(H) = 1.5*U_{eq}(C) (methyl); C—H = 0.98Å and U_{iso}(H) = 1.2*U_{eq}(C) (tertiary CH).

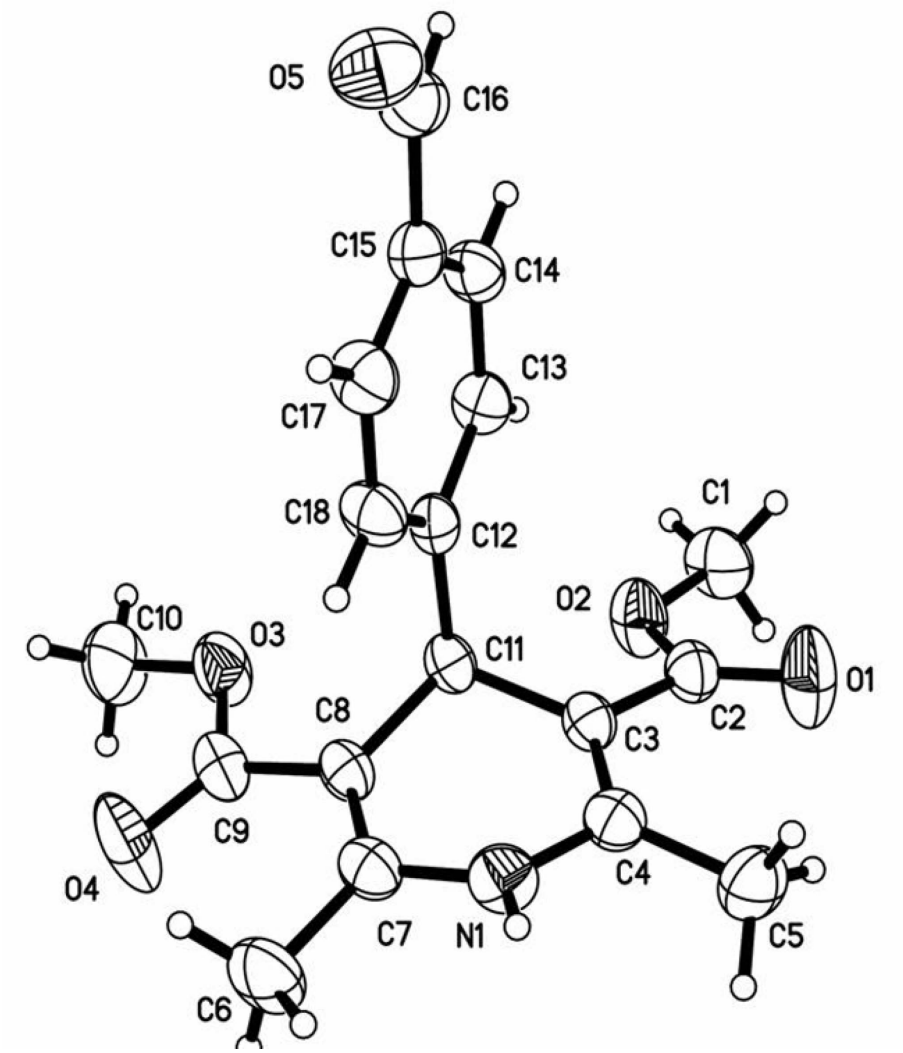

Figure 1

The crystal structure drawing for (I) with the atom-numbering scheme and ellipsoids shown at the 50% probability level.

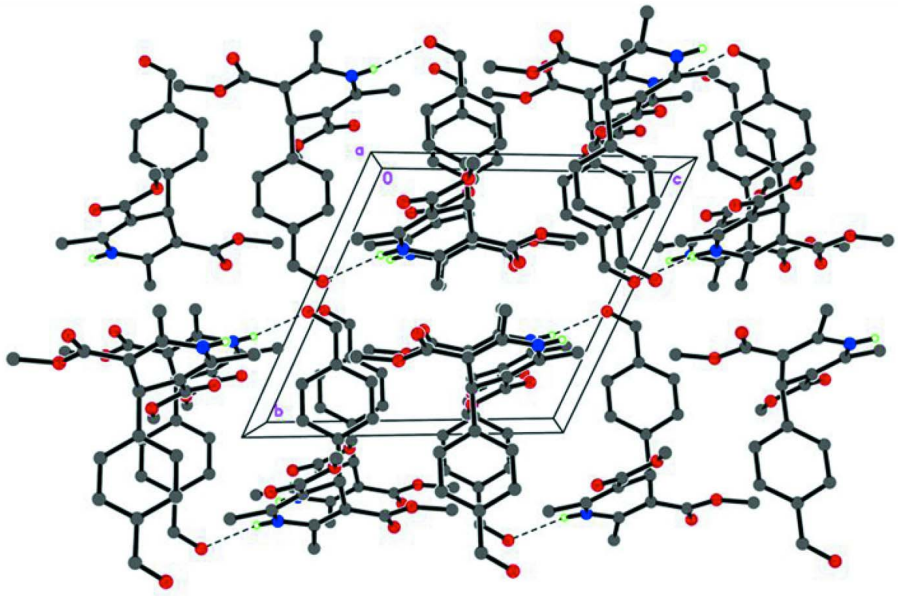

Figure 2

The crystal packing diagram for (I). Hydrogen bonds are shown as dashed lines.

Dimethyl 4-(4-formylphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,5-dicarboxylate

Crystal data

$C_{18}H_{19}NO_5$
$M_r = 329.34$
Triclinic, $P\overline{1}$
Hall symbol: -P 1
$a = 8.219\ (2)$ Å
$b = 10.432\ (3)$ Å
$c = 10.979\ (3)$ Å
$\alpha = 111.364\ (3)°$
$\beta = 102.799\ (3)°$
$\gamma = 101.150\ (4)°$
$V = 815.0\ (4)$ Å^3
$Z = 2$
$F(000) = 348$
$D_x = 1.342$ Mg m^{-3}
Melting point: 479 K
Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Cell parameters from 1572 reflections
$\theta = 2.2–26.7°$
$\mu = 0.10$ mm^{-1}
$T = 298$ K
Plate, colourless
0.48 × 0.34 × 0.10 mm

Data collection

Bruker SMART CCD area-detector diffractometer
Radiation source: fine-focus sealed tube
Graphite monochromator
phi and ω scans
Absorption correction: multi-scan (*SADABS*: Sheldrick, 2004)
$T_{min} = 0.954$, $T_{max} = 0.990$
4173 measured reflections
2855 independent reflections
2352 reflections with $I > 2\sigma(I)$
$R_{int} = 0.015$
$\theta_{max} = 25.1°$, $\theta_{min} = 2.1°$
$h = -7\rightarrow9$
$k = -12\rightarrow12$
$l = -13\rightarrow11$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)] = 0.052$
$wR(F^2) = 0.140$
$S = 1.04$
2855 reflections
221 parameters
0 restraints
Primary atom site location: structure-invariant direct methods

Secondary atom site location: difference Fourier map	$w = 1/[\sigma^2(F_o^2) + (0.0745P)^2 + 0.2263P]$ where $P = (F_o^2 + 2F_c^2)/3$
Hydrogen site location: inferred from neighbouring sites	$(\Delta/\sigma)_{max} < 0.001$
H-atom parameters constrained	$\Delta\rho_{max} = 0.25$ e Å^{-3}
	$\Delta\rho_{min} = -0.23$ e Å^{-3}

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 (Å²)

	x	*y*	*z*	U_{iso}*/U_{eq}
C1	0.0487 (3)	0.7111 (3)	0.2379 (2)	0.0540 (6)
H1A	0.1663	0.7527	0.2429	0.081*
H1B	−0.0263	0.7598	0.2053	0.081*
H1C	0.0087	0.6105	0.1753	0.081*
C2	0.1597 (3)	0.6835 (2)	0.4429 (2)	0.0369 (5)
C3	0.1430 (2)	0.7146 (2)	0.58051 (19)	0.0316 (4)
C4	0.2082 (3)	0.6488 (2)	0.6575 (2)	0.0360 (5)
C5	0.3136 (3)	0.5473 (2)	0.6249 (3)	0.0501 (6)
H5A	0.2939	0.5048	0.5272	0.075*
H5B	0.2792	0.4727	0.6538	0.075*
H5C	0.4355	0.5989	0.6725	0.075*
C6	−0.0172 (3)	0.7028 (3)	0.9224 (3)	0.0562 (6)
H6A	−0.0266	0.7913	0.9853	0.084*
H6B	0.0693	0.6730	0.9707	0.084*
H6C	−0.1282	0.6294	0.8845	0.084*
C7	0.0357 (3)	0.7258 (2)	0.8083 (2)	0.0369 (5)
C8	−0.0337 (2)	0.7922 (2)	0.73481 (19)	0.0326 (4)
C9	−0.1879 (3)	0.8380 (2)	0.7515 (2)	0.0403 (5)
C10	−0.3909 (3)	0.9447 (3)	0.6724 (3)	0.0648 (7)
H10A	−0.4883	0.8609	0.6436	0.097*
H10B	−0.4126	0.9901	0.6110	0.097*
H10C	−0.3759	1.0113	0.7646	0.097*
C11	0.0538 (2)	0.8272 (2)	0.63858 (18)	0.0298 (4)
H11	−0.0369	0.8235	0.5614	0.036*
C12	0.1873 (2)	0.9776 (2)	0.70850 (19)	0.0306 (4)
C13	0.2279 (3)	1.0506 (2)	0.6300 (2)	0.0352 (5)
H13	0.1695	1.0093	0.5356	0.042*
C14	0.3539 (3)	1.1837 (2)	0.6906 (2)	0.0387 (5)
H14	0.3797	1.2310	0.6368	0.046*
C15	0.4421 (2)	1.2473 (2)	0.8316 (2)	0.0360 (5)

C16	0.5802 (3)	1.3855 (2)	0.8933 (2)	0.0443 (5)
H16	0.5943	1.4329	0.8374	0.053*
C17	0.4002 (3)	1.1764 (2)	0.9107 (2)	0.0423 (5)
H17	0.4576	1.2186	1.0054	0.051*
C18	0.2739 (3)	1.0439 (2)	0.8499 (2)	0.0395 (5)
H18	0.2461	0.9981	0.9044	0.047*
O1	0.2601 (3)	0.6284 (2)	0.39502 (18)	0.0686 (5)
O2	0.0449 (2)	0.72623 (17)	0.37188 (14)	0.0483 (4)
O3	−0.23540 (19)	0.90263 (18)	0.66944 (17)	0.0504 (4)
O4	−0.2703 (2)	0.8207 (2)	0.8252 (2)	0.0747 (6)
O5	0.6775 (2)	1.44321 (17)	1.01131 (17)	0.0562 (5)
N1	0.1702 (2)	0.67213 (19)	0.77876 (18)	0.0412 (4)
H1	0.2335	0.6523	0.8389	0.049*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
C1	0.0704 (16)	0.0601 (15)	0.0303 (12)	0.0144 (12)	0.0190 (11)	0.0191 (11)
C2	0.0353 (10)	0.0365 (11)	0.0348 (11)	0.0084 (9)	0.0136 (9)	0.0106 (9)
C3	0.0284 (9)	0.0344 (10)	0.0300 (10)	0.0073 (8)	0.0094 (8)	0.0126 (8)
C4	0.0324 (10)	0.0351 (10)	0.0359 (11)	0.0063 (8)	0.0084 (8)	0.0136 (9)
C5	0.0477 (13)	0.0487 (13)	0.0603 (15)	0.0223 (11)	0.0167 (11)	0.0264 (12)
C6	0.0671 (16)	0.0706 (16)	0.0500 (14)	0.0234 (13)	0.0269 (12)	0.0401 (13)
C7	0.0367 (11)	0.0396 (11)	0.0322 (11)	0.0063 (9)	0.0105 (9)	0.0158 (9)
C8	0.0303 (10)	0.0386 (11)	0.0272 (10)	0.0072 (8)	0.0098 (8)	0.0134 (8)
C9	0.0353 (11)	0.0498 (12)	0.0351 (11)	0.0104 (9)	0.0154 (9)	0.0162 (10)
C10	0.0452 (14)	0.0819 (19)	0.088 (2)	0.0365 (13)	0.0322 (14)	0.0428 (16)
C11	0.0283 (9)	0.0377 (10)	0.0242 (9)	0.0097 (8)	0.0084 (8)	0.0140 (8)
C12	0.0305 (10)	0.0353 (10)	0.0307 (10)	0.0144 (8)	0.0129 (8)	0.0151 (8)
C13	0.0385 (11)	0.0391 (11)	0.0297 (10)	0.0129 (9)	0.0097 (8)	0.0166 (9)
C14	0.0419 (11)	0.0422 (12)	0.0427 (12)	0.0157 (9)	0.0182 (9)	0.0255 (10)
C15	0.0329 (10)	0.0365 (11)	0.0408 (11)	0.0133 (8)	0.0139 (9)	0.0162 (9)
C16	0.0418 (12)	0.0413 (12)	0.0522 (14)	0.0134 (10)	0.0155 (11)	0.0219 (11)
C17	0.0429 (12)	0.0461 (12)	0.0304 (11)	0.0070 (9)	0.0097 (9)	0.0126 (9)
C18	0.0436 (12)	0.0438 (12)	0.0301 (11)	0.0060 (9)	0.0127 (9)	0.0177 (9)
O1	0.0757 (12)	0.0995 (15)	0.0529 (11)	0.0537 (12)	0.0386 (10)	0.0324 (10)
O2	0.0566 (9)	0.0688 (10)	0.0300 (8)	0.0290 (8)	0.0194 (7)	0.0240 (7)
O3	0.0424 (9)	0.0688 (11)	0.0632 (11)	0.0303 (8)	0.0285 (8)	0.0392 (9)
O4	0.0658 (12)	0.1291 (18)	0.0740 (13)	0.0490 (12)	0.0508 (11)	0.0651 (13)
O5	0.0491 (9)	0.0482 (9)	0.0542 (11)	0.0042 (8)	0.0013 (8)	0.0173 (8)
N1	0.0425 (10)	0.0499 (11)	0.0385 (10)	0.0177 (8)	0.0100 (8)	0.0266 (8)

Geometric parameters (Å, º)

C1—O2	1.429 (2)	C9—O4	1.203 (2)
C1—H1A	0.9600	C9—O3	1.344 (2)
C1—H1B	0.9600	C10—O3	1.432 (3)
C1—H1C	0.9600	C10—H10A	0.9600

C2—O1	1.202 (2)	C10—H10B	0.9600
C2—O2	1.337 (3)	C10—H10C	0.9600
C2—C3	1.469 (3)	C11—C12	1.529 (3)
C3—C4	1.355 (3)	C11—H11	0.9800
C3—C11	1.522 (3)	C12—C18	1.390 (3)
C4—N1	1.381 (3)	C12—C13	1.394 (3)
C4—C5	1.489 (3)	C13—C14	1.381 (3)
C5—H5A	0.9600	C13—H13	0.9300
C5—H5B	0.9600	C14—C15	1.389 (3)
C5—H5C	0.9600	C14—H14	0.9300
C6—C7	1.495 (3)	C15—C17	1.386 (3)
C6—H6A	0.9600	C15—C16	1.463 (3)
C6—H6B	0.9600	C16—O5	1.211 (3)
C6—H6C	0.9600	C16—H16	0.9300
C7—C8	1.346 (3)	C17—C18	1.378 (3)
C7—N1	1.381 (3)	C17—H17	0.9300
C8—C9	1.463 (3)	C18—H18	0.9300
C8—C11	1.511 (2)	N1—H1	0.8600

O2—C1—H1A	109.5	O3—C10—H10B	109.5
O2—C1—H1B	109.5	H10A—C10—H10B	109.5
H1A—C1—H1B	109.5	O3—C10—H10C	109.5
O2—C1—H1C	109.5	H10A—C10—H10C	109.5
H1A—C1—H1C	109.5	H10B—C10—H10C	109.5
H1B—C1—H1C	109.5	C8—C11—C3	110.09 (15)
O1—C2—O2	121.76 (19)	C8—C11—C12	112.69 (15)
O1—C2—C3	127.5 (2)	C3—C11—C12	109.55 (15)
O2—C2—C3	110.72 (16)	C8—C11—H11	108.1
C4—C3—C2	121.94 (18)	C3—C11—H11	108.1
C4—C3—C11	119.60 (17)	C12—C11—H11	108.1
C2—C3—C11	118.44 (16)	C18—C12—C13	118.16 (18)
C3—C4—N1	118.15 (18)	C18—C12—C11	121.69 (16)
C3—C4—C5	127.55 (19)	C13—C12—C11	120.14 (16)
N1—C4—C5	114.27 (17)	C14—C13—C12	120.86 (18)
C4—C5—H5A	109.5	C14—C13—H13	119.6
C4—C5—H5B	109.5	C12—C13—H13	119.6
H5A—C5—H5B	109.5	C13—C14—C15	120.34 (18)
C4—C5—H5C	109.5	C13—C14—H14	119.8
H5A—C5—H5C	109.5	C15—C14—H14	119.8
H5B—C5—H5C	109.5	C17—C15—C14	119.14 (19)
C7—C6—H6A	109.5	C17—C15—C16	121.20 (19)
C7—C6—H6B	109.5	C14—C15—C16	119.65 (19)
H6A—C6—H6B	109.5	O5—C16—C15	125.3 (2)
C7—C6—H6C	109.5	O5—C16—H16	117.4
H6A—C6—H6C	109.5	C15—C16—H16	117.4
H6B—C6—H6C	109.5	C18—C17—C15	120.34 (19)
C8—C7—N1	118.71 (17)	C18—C17—H17	119.8
C8—C7—C6	126.71 (19)	C15—C17—H17	119.8

N1—C7—C6	114.59 (18)	C17—C18—C12	121.13 (18)
C7—C8—C9	121.16 (17)	C17—C18—H18	119.4
C7—C8—C11	119.69 (17)	C12—C18—H18	119.4
C9—C8—C11	119.07 (16)	C2—O2—C1	118.39 (17)
O4—C9—O3	121.06 (19)	C9—O3—C10	116.16 (17)
O4—C9—C8	127.2 (2)	C7—N1—C4	123.31 (16)
O3—C9—C8	111.71 (16)	C7—N1—H1	118.3
O3—C10—H10A	109.5	C4—N1—H1	118.3

O1—C2—C3—C4	−18.6 (3)	C8—C11—C12—C18	27.1 (2)
O2—C2—C3—C4	161.80 (17)	C3—C11—C12—C18	−95.8 (2)
O1—C2—C3—C11	159.8 (2)	C8—C11—C12—C13	−154.35 (17)
O2—C2—C3—C11	−19.8 (2)	C3—C11—C12—C13	82.7 (2)
C2—C3—C4—N1	−172.96 (17)	C18—C12—C13—C14	1.6 (3)
C11—C3—C4—N1	8.7 (3)	C11—C12—C13—C14	−177.05 (17)
C2—C3—C4—C5	4.6 (3)	C12—C13—C14—C15	−0.2 (3)
C11—C3—C4—C5	−173.75 (19)	C13—C14—C15—C17	−1.0 (3)
N1—C7—C8—C9	173.70 (18)	C13—C14—C15—C16	177.53 (18)
C6—C7—C8—C9	−6.5 (3)	C17—C15—C16—O5	6.6 (3)
N1—C7—C8—C11	−9.5 (3)	C14—C15—C16—O5	−171.9 (2)
C6—C7—C8—C11	170.29 (19)	C14—C15—C17—C18	0.7 (3)
C7—C8—C9—O4	−1.9 (3)	C16—C15—C17—C18	−177.79 (19)
C11—C8—C9—O4	−178.8 (2)	C15—C17—C18—C12	0.7 (3)
C7—C8—C9—O3	179.69 (18)	C13—C12—C18—C17	−1.8 (3)
C11—C8—C9—O3	2.8 (3)	C11—C12—C18—C17	176.73 (18)
C7—C8—C11—C3	31.4 (2)	O1—C2—O2—C1	−2.8 (3)
C9—C8—C11—C3	−151.73 (17)	C3—C2—O2—C1	176.83 (18)
C7—C8—C11—C12	−91.2 (2)	O4—C9—O3—C10	−1.8 (3)
C9—C8—C11—C12	85.7 (2)	C8—C9—O3—C10	176.73 (19)
C4—C3—C11—C8	−31.0 (2)	C8—C7—N1—C4	−17.3 (3)
C2—C3—C11—C8	150.61 (16)	C6—C7—N1—C4	162.9 (2)
C4—C3—C11—C12	93.5 (2)	C3—C4—N1—C7	17.6 (3)
C2—C3—C11—C12	−84.9 (2)	C5—C4—N1—C7	−160.32 (19)

Hydrogen-bond geometry (Å, º)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
N1—H1···O5^{i}	0.86	2.27	3.107 (2)	163

Symmetry code: (i) −*x*+1, −*y*+2, −*z*+2.