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(3*R*,4*S*)-1-(4-Methoxyphenyl)-2-oxo-4-(3-vinylphenyl)azetidin-3-yl acetate

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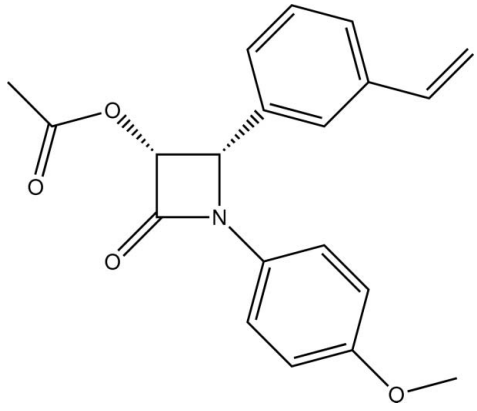
Key indicators: single-crystal X-ray study; T = 124 K; mean σ(C–C) = 0.002 Å; R factor = 0.026; wR factor = 0.069; data-to-parameter ratio = 10.4.

In the title compound, $C_{20}H_{19}NO_4$, the absolute configuration (3*R*,4*S*) for the two chiral centres of the molecule has been determined.

Related literature

For the preparation of the title compound, an intermediate in the synthesis of C-4 to C-3′ bridged paclitaxel analogues, see: Ganesh *et al.* (2007).



Experimental

Crystal data

$C_{20}H_{19}NO_4$
M_r = 337.36
Monoclinic, $C2$
a = 20.7448 (4) Å
b = 6.3930 (1) Å
c = 15.7434 (3) Å
β = 124.309 (1)°
V = 1724.64 (5) Å^3
Z = 4
Cu $K\alpha$ radiation
μ = 0.74 mm^{-1}
T = 124 K
0.20 × 0.18 × 0.11 mm

Data collection

Bruker APEXII CCD diffractometer
Absorption correction: multi-scan (*SADABS*; Bruker, 2010)
T_{min} = 0.866, T_{max} = 0.923
6072 measured reflections
2374 independent reflections
2330 reflections with $I > 2\sigma(I)$
R_{int} = 0.024

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.026
$wR(F^2)$ = 0.069
S = 1.06
2374 reflections
228 parameters
1 restraint
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.18 e Å^{-3}
$\Delta\rho_{min}$ = −0.15 e Å^{-3}
Absolute structure: Flack (1983), 730 Friedel pairs
Flack parameter: 0.01 (15)

Data collection: *APEX2* (Bruker, 2010); cell refinement: *SAINT* (Bruker, 2010); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008); software used to prepare material for publication: *SHELXTL*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: MW2104).

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Sheldrick, G. M. (2008). *Acta Cryst.* A**64**, 112–122.

supplementary materials

Acta Cryst. (2013). E**69**, o601 [doi:10.1107/S1600536813007897]

(3*R*,4*S*)-1-(4-Methoxyphenyl)-2-oxo-4-(3-vinylphenyl)azetidin-3-yl acetate

Xiao-Dong Hao, Cheng Xie, Yun-Peng Hao, Jun Chang and Xun Sun

Comment

In our research on the conformation of a novel fluorinated, tubulin-bound, docetaxel analogue, one of the key intermediate products, the title compound (3*R*,4*S*)-1-(4-methoxyphenyl)-2-oxo-4-(3-vinylphenyl)azetidin-3-yl acetate $C_{20}H_{19}NO_4$ (I) (Fig. 1) was separated from the racemic 1-(4-methoxyphenyl)-2-oxo-4-(3-vinylphenyl)azetidin-3-yl acetate (Ganesh *et al.*, 2007). The reaction scheme is shown in Fig. 2. The absolute configuration (3*R*,4*S*) for the two chiral centres of the molecule has been determined.

Experimental

Lipase PS (Amano) (2.25 g) was added to a solution of racemic 1-(4-methoxyphenyl)-2-oxo-4-(3-vinylphenyl)azetidin-3-yl acetate (2.26 g, 6.7 mmol) in 60 mL of CH_3CN and pH 7.0 phosphate buffer (1:9), and the resulting solution was stirred at r.t. for 120 h. The reaction mixture was filtered and extracted with EtOAc (200 mL × 2), the organic layers were combined and solvent was removed under reduced pressure. The residue was purified by flash column chromatography using petroleum ether/EtOAc (4/1) to furnish the title compound (3*R*,4*S*)-1-(4-Methoxyphenyl)-2-oxo-4-(3-vinylphenyl)-azetidin-3-yl acetate (1 g, 49%) as a white solid. Suitable crystals were obtained by recrystallization from hexane and DCM (m.p. 391.8–392.9 K). ^{1}H NMR (400 MHz, $CDCl_3$): δ 1.71 (s, 3H), 3.88 (s, 3H), 5.28 (d, 1H, J = 10.96 Hz), 5.35 (d, 1H, J = 4.69 Hz), 5.75 (d, 1H, J = 17.61 Hz), 5.95 (d, 1H, J = 4.70 Hz), 6.62–6.76 (m, 1H), 6.81 (d, 2H, J = 9 Hz), 7.18–7.42 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 19.85, 55.45, 61.42, 76.32, 114.45, 114.80, 118.82, 125.86, 126.46, 127.28, 128.72, 130.31, 132.73, 136.20, 137.88, 156.66, 161.32, 169.24; ESIMS m/z 338.0 $[M + H]^+$.

Refinement

All hydrogen atoms were positioned geometrically and treated as riding with C—H = 0.95–1.00Å and U_{iso}(H) = 1.2 or 1.5U_{eq}(C). The title compound was identified as (3*R*,4*S*)-1-(4-methoxyphenyl)-2-oxo-4-(3-vinylphenyl)azetidin-3-yl acetate.

Computing details

Data collection: *APEX2* (Bruker, 2010); cell refinement: *SAINT* (Bruker, 2010); data reduction: *SAINT* (Bruker, 2010); program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008); software used to prepare material for publication: *SHELXTL* (Sheldrick, 2008).

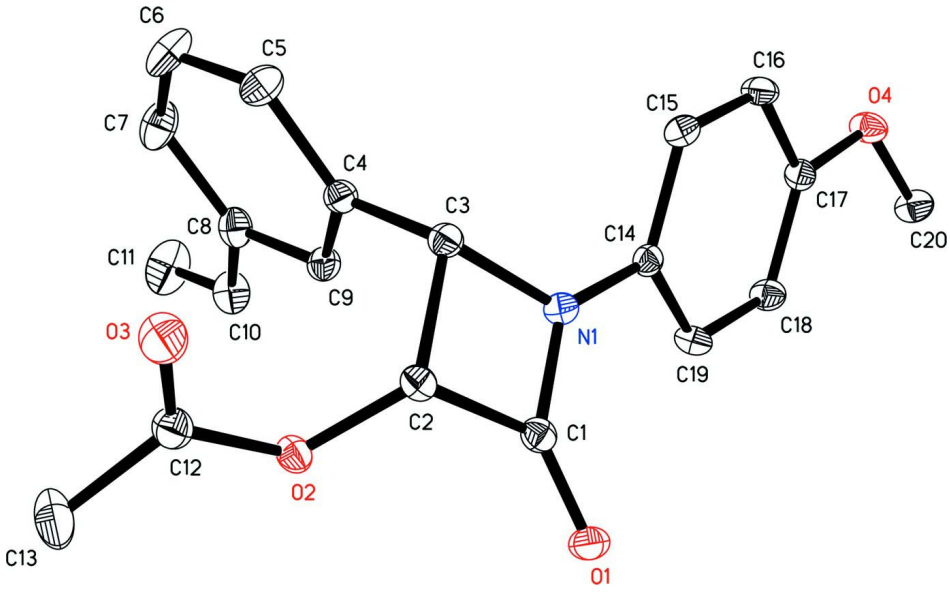

Figure 1

Molecular configuration and atom numbering scheme for (I).

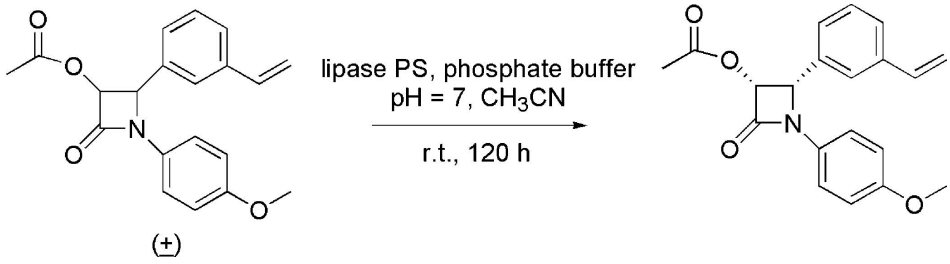

Figure 2

Reaction scheme for the synthesis of (I).

(3*R*,4*S*)-1-(4-Methoxyphenyl)-2-oxo-4-(3-vinylphenyl)azetidin-3-yl acetate

Crystal data

$C_{20}H_{19}NO_4$
$M_r = 337.36$
Monoclinic, *C*2
Hall symbol: C 2y
$a = 20.7448$ (4) Å
$b = 6.3930$ (1) Å
$c = 15.7434$ (3) Å
$\beta = 124.309$ (1)°
$V = 1724.64$ (5) Å^3
$Z = 4$
$F(000) = 712$
$D_x = 1.299$ Mg m^{-3}
Cu $K\alpha$ radiation, $\lambda = 1.54178$ Å
Cell parameters from 4349 reflections
$\theta = 3.4$–66.0°
$\mu = 0.74$ mm^{-1}
$T = 124$ K
Block, colourless
0.20 × 0.18 × 0.11 mm

Data collection

Bruker APEXII CCD diffractometer
Radiation source: fine-focus sealed tube
Graphite monochromator
φ and ω scans
Absorption correction: multi-scan (*SADABS*; Bruker, 2010)
$T_{min} = 0.866$, $T_{max} = 0.923$
6072 measured reflections
2374 independent reflections

2330 reflections with $I > 2\sigma(I)$
$R_{int} = 0.024$
$\theta_{max} = 66.3°$, $\theta_{min} = 3.4°$
$h = -24 \rightarrow 24$
$k = -7 \rightarrow 6$
$l = -18 \rightarrow 18$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)] = 0.026$
$wR(F^2) = 0.069$
$S = 1.06$
2374 reflections
228 parameters
1 restraint
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
$w = 1/[\sigma^2(F_o^2) + (0.0432P)^2 + 0.3527P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} = 0.024$
$\Delta\rho_{max} = 0.18$ e Å^{-3}
$\Delta\rho_{min} = -0.15$ e Å^{-3}
Absolute structure: Flack (1983), 730 Friedel pairs
Flack parameter: 0.01 (15)

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 (Å^2)

	x	*y*	*z*	U_{iso}*/U_{eq}
N1	0.01643 (6)	0.3030 (2)	0.64077 (8)	0.0200 (3)
O1	−0.02784 (6)	0.65258 (18)	0.59931 (8)	0.0270 (2)
O2	−0.06828 (5)	0.45389 (17)	0.74357 (7)	0.0222 (2)
O3	−0.15201 (7)	0.2201 (2)	0.73583 (9)	0.0383 (3)
O4	0.26072 (6)	0.13686 (18)	0.59965 (8)	0.0273 (2)
C1	−0.02761 (7)	0.4753 (3)	0.62602 (10)	0.0211 (3)
C2	−0.07416 (7)	0.3539 (2)	0.65865 (10)	0.0211 (3)
H2	−0.1292	0.3251	0.6003	0.025*
C3	−0.01748 (7)	0.1671 (2)	0.68246 (10)	0.0207 (3)
H3	−0.0451	0.0426	0.6380	0.025*
C4	0.03811 (7)	0.1098 (2)	0.79424 (10)	0.0211 (3)
C5	0.02826 (8)	−0.0778 (3)	0.82961 (12)	0.0296 (3)
H5	−0.0121	−0.1714	0.7832	0.035*
C6	0.07760 (9)	−0.1290 (3)	0.93339 (12)	0.0390 (4)
H6	0.0704	−0.2572	0.9576	0.047*
C7	0.13680 (9)	0.0046 (3)	1.00140 (12)	0.0360 (4)
H7	0.1695	−0.0314	1.0722	0.043*
C8	0.14908 (8)	0.1925 (3)	0.96712 (11)	0.0269 (3)
C9	0.09860 (8)	0.2431 (3)	0.86306 (11)	0.0229 (3)
H9	0.1057	0.3711	0.8387	0.028*
C10	0.21420 (9)	0.3354 (3)	1.03509 (12)	0.0332 (4)

H10	0.2162	0.4619	1.0050	0.040*
C11	0.26974 (10)	0.3070 (4)	1.13267 (14)	0.0499 (5)
H11A	0.2706	0.1832	1.1667	0.060*
H11B	0.3090	0.4102	1.1692	0.060*
C12	−0.11309 (8)	0.3737 (3)	0.77324 (12)	0.0272 (3)
C13	−0.10664 (12)	0.5031 (4)	0.85648 (14)	0.0436 (5)
H13A	−0.1589	0.5291	0.8408	0.065*
H13B	−0.0816	0.6367	0.8613	0.065*
H13C	−0.0752	0.4286	0.9221	0.065*
C14	0.07884 (7)	0.2651 (2)	0.63024 (9)	0.0191 (3)
C15	0.09304 (7)	0.0624 (2)	0.61245 (10)	0.0224 (3)
H15	0.0609	−0.0497	0.6071	0.027*
C16	0.15445 (8)	0.0252 (2)	0.60258 (11)	0.0244 (3)
H16	0.1643	−0.1127	0.5902	0.029*
C17	0.20168 (8)	0.1904 (2)	0.61088 (10)	0.0210 (3)
C18	0.18780 (8)	0.3919 (3)	0.62910 (11)	0.0239 (3)
H18	0.2203	0.5038	0.6353	0.029*
C19	0.12576 (8)	0.4292 (3)	0.63829 (10)	0.0236 (3)
H19	0.1156	0.5673	0.6501	0.028*
C20	0.30559 (8)	0.3045 (3)	0.59786 (13)	0.0295 (3)
H20A	0.2707	0.4030	0.5431	0.044*
H20B	0.3433	0.2482	0.5850	0.044*
H20C	0.3335	0.3771	0.6642	0.044*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
N1	0.0204 (5)	0.0178 (6)	0.0214 (5)	−0.0002 (5)	0.0116 (4)	0.0004 (5)
O1	0.0313 (5)	0.0195 (6)	0.0351 (5)	0.0038 (4)	0.0218 (5)	0.0041 (5)
O2	0.0229 (4)	0.0220 (6)	0.0253 (5)	−0.0024 (4)	0.0159 (4)	−0.0037 (4)
O3	0.0451 (6)	0.0320 (7)	0.0505 (7)	−0.0147 (6)	0.0347 (6)	−0.0096 (6)
O4	0.0284 (5)	0.0215 (6)	0.0406 (5)	−0.0004 (4)	0.0247 (4)	−0.0021 (5)
C1	0.0200 (6)	0.0215 (8)	0.0202 (6)	0.0002 (5)	0.0105 (5)	−0.0017 (6)
C2	0.0210 (6)	0.0212 (8)	0.0206 (6)	0.0000 (6)	0.0116 (5)	−0.0020 (6)
C3	0.0210 (6)	0.0193 (8)	0.0238 (6)	−0.0015 (5)	0.0138 (5)	−0.0010 (6)
C4	0.0207 (6)	0.0206 (8)	0.0245 (7)	0.0014 (5)	0.0143 (5)	0.0010 (6)
C5	0.0266 (7)	0.0272 (9)	0.0322 (7)	−0.0042 (6)	0.0149 (6)	0.0028 (7)
C6	0.0380 (8)	0.0379 (11)	0.0357 (8)	−0.0049 (8)	0.0176 (7)	0.0149 (9)
C7	0.0289 (8)	0.0483 (12)	0.0268 (7)	0.0004 (7)	0.0133 (6)	0.0107 (8)
C8	0.0217 (7)	0.0350 (10)	0.0245 (7)	0.0005 (6)	0.0133 (6)	0.0001 (7)
C9	0.0230 (6)	0.0228 (8)	0.0260 (7)	0.0000 (6)	0.0156 (6)	0.0013 (6)
C10	0.0278 (7)	0.0408 (11)	0.0300 (7)	−0.0045 (7)	0.0157 (6)	−0.0031 (8)
C11	0.0360 (9)	0.0674 (15)	0.0308 (8)	−0.0154 (9)	0.0094 (7)	−0.0001 (10)
C12	0.0281 (7)	0.0256 (9)	0.0331 (7)	−0.0024 (7)	0.0204 (6)	−0.0017 (7)
C13	0.0543 (10)	0.0499 (13)	0.0450 (9)	−0.0151 (9)	0.0392 (9)	−0.0142 (9)
C14	0.0195 (6)	0.0203 (8)	0.0170 (6)	0.0018 (5)	0.0099 (5)	0.0019 (6)
C15	0.0236 (6)	0.0186 (8)	0.0251 (7)	−0.0012 (6)	0.0138 (6)	0.0021 (6)
C16	0.0281 (7)	0.0167 (8)	0.0308 (7)	0.0020 (6)	0.0180 (6)	−0.0006 (6)
C17	0.0201 (6)	0.0219 (8)	0.0215 (6)	0.0016 (5)	0.0119 (5)	0.0008 (6)
C18	0.0230 (6)	0.0198 (8)	0.0295 (7)	−0.0030 (6)	0.0153 (6)	−0.0013 (7)

C19	0.0244 (6)	0.0178 (8)	0.0282 (7)	0.0004 (6)	0.0147 (6)	−0.0037 (6)
C20	0.0267 (7)	0.0256 (8)	0.0433 (8)	0.0009 (6)	0.0240 (7)	0.0048 (7)

Geometric parameters (Å, º)

N1—C1	1.365 (2)	C8—C10	1.475 (2)
N1—C14	1.4157 (17)	C9—H9	0.9500
N1—C3	1.4834 (18)	C10—C11	1.313 (2)
O1—C1	1.208 (2)	C10—H10	0.9500
O2—C12	1.3547 (18)	C11—H11A	0.9500
O2—C2	1.4237 (17)	C11—H11B	0.9500
O3—C12	1.194 (2)	C12—C13	1.491 (2)
O4—C17	1.3760 (16)	C13—H13A	0.9800
O4—C20	1.4300 (19)	C13—H13B	0.9800
C1—C2	1.535 (2)	C13—H13C	0.9800
C2—C3	1.566 (2)	C14—C19	1.387 (2)
C2—H2	1.0000	C14—C15	1.392 (2)
C3—C4	1.5077 (19)	C15—C16	1.388 (2)
C3—H3	1.0000	C15—H15	0.9500
C4—C5	1.385 (2)	C16—C17	1.396 (2)
C4—C9	1.393 (2)	C16—H16	0.9500
C5—C6	1.392 (2)	C17—C18	1.385 (2)
C5—H5	0.9500	C18—C19	1.394 (2)
C6—C7	1.379 (3)	C18—H18	0.9500
C6—H6	0.9500	C19—H19	0.9500
C7—C8	1.398 (3)	C20—H20A	0.9800
C7—H7	0.9500	C20—H20B	0.9800
C8—C9	1.397 (2)	C20—H20C	0.9800
C1—N1—C14	133.38 (13)	C11—C10—H10	116.4
C1—N1—C3	96.24 (11)	C8—C10—H10	116.4
C14—N1—C3	130.15 (13)	C10—C11—H11A	120.0
C12—O2—C2	116.20 (12)	C10—C11—H11B	120.0
C17—O4—C20	116.91 (12)	H11A—C11—H11B	120.0
O1—C1—N1	133.42 (13)	O3—C12—O2	123.08 (14)
O1—C1—C2	135.29 (13)	O3—C12—C13	126.19 (15)
N1—C1—C2	91.28 (12)	O2—C12—C13	110.73 (14)
O2—C2—C1	110.50 (12)	C12—C13—H13A	109.5
O2—C2—C3	117.53 (11)	C12—C13—H13B	109.5
C1—C2—C3	86.35 (10)	H13A—C13—H13B	109.5
O2—C2—H2	113.2	C12—C13—H13C	109.5
C1—C2—H2	113.2	H13A—C13—H13C	109.5
C3—C2—H2	113.2	H13B—C13—H13C	109.5
N1—C3—C4	114.66 (11)	C19—C14—C15	120.34 (12)
N1—C3—C2	85.81 (11)	C19—C14—N1	120.06 (14)
C4—C3—C2	116.23 (12)	C15—C14—N1	119.60 (13)
N1—C3—H3	112.5	C16—C15—C14	119.60 (14)
C4—C3—H3	112.5	C16—C15—H15	120.2
C2—C3—H3	112.5	C14—C15—H15	120.2
C5—C4—C9	119.27 (13)	C15—C16—C17	119.98 (14)

C5—C4—C3	119.38 (13)	C15—C16—H16	120.0
C9—C4—C3	121.34 (14)	C17—C16—H16	120.0
C4—C5—C6	119.86 (15)	O4—C17—C18	124.20 (13)
C4—C5—H5	120.1	O4—C17—C16	115.37 (13)
C6—C5—H5	120.1	C18—C17—C16	120.42 (13)
C7—C6—C5	120.61 (16)	C17—C18—C19	119.50 (14)
C7—C6—H6	119.7	C17—C18—H18	120.2
C5—C6—H6	119.7	C19—C18—H18	120.2
C6—C7—C8	120.59 (14)	C14—C19—C18	120.15 (15)
C6—C7—H7	119.7	C14—C19—H19	119.9
C8—C7—H7	119.7	C18—C19—H19	119.9
C9—C8—C7	118.18 (14)	O4—C20—H20A	109.5
C9—C8—C10	118.85 (15)	O4—C20—H20B	109.5
C7—C8—C10	122.94 (14)	H20A—C20—H20B	109.5
C4—C9—C8	121.45 (15)	O4—C20—H20C	109.5
C4—C9—H9	119.3	H20A—C20—H20C	109.5
C8—C9—H9	119.3	H20B—C20—H20C	109.5
C11—C10—C8	127.16 (19)		

C14—N1—C1—O1	−0.2 (3)	C6—C7—C8—C9	1.7 (2)
C3—N1—C1—O1	174.55 (16)	C6—C7—C8—C10	−176.31 (17)
C14—N1—C1—C2	−179.17 (13)	C5—C4—C9—C8	−0.6 (2)
C3—N1—C1—C2	−4.44 (11)	C3—C4—C9—C8	178.51 (13)
C12—O2—C2—C1	173.69 (12)	C7—C8—C9—C4	−0.9 (2)
C12—O2—C2—C3	−89.52 (15)	C10—C8—C9—C4	177.16 (14)
O1—C1—C2—O2	−56.7 (2)	C9—C8—C10—C11	−175.47 (18)
N1—C1—C2—O2	122.26 (11)	C7—C8—C10—C11	2.5 (3)
O1—C1—C2—C3	−174.77 (17)	C2—O2—C12—O3	4.6 (2)
N1—C1—C2—C3	4.19 (10)	C2—O2—C12—C13	−175.14 (14)
C1—N1—C3—C4	−112.63 (13)	C1—N1—C14—C19	24.9 (2)
C14—N1—C3—C4	62.36 (19)	C3—N1—C14—C19	−148.25 (14)
C1—N1—C3—C2	4.37 (11)	C1—N1—C14—C15	−155.51 (14)
C14—N1—C3—C2	179.35 (13)	C3—N1—C14—C15	31.4 (2)
O2—C2—C3—N1	−115.12 (12)	C19—C14—C15—C16	−0.1 (2)
C1—C2—C3—N1	−3.86 (10)	N1—C14—C15—C16	−179.71 (12)
O2—C2—C3—C4	0.37 (19)	C14—C15—C16—C17	0.2 (2)
C1—C2—C3—C4	111.62 (13)	C20—O4—C17—C18	−5.7 (2)
N1—C3—C4—C5	−151.25 (14)	C20—O4—C17—C16	174.20 (12)
C2—C3—C4—C5	110.90 (16)	C15—C16—C17—O4	−179.83 (12)
N1—C3—C4—C9	29.63 (19)	C15—C16—C17—C18	0.1 (2)
C2—C3—C4—C9	−68.22 (17)	O4—C17—C18—C19	179.39 (12)
C9—C4—C5—C6	1.4 (2)	C16—C17—C18—C19	−0.5 (2)
C3—C4—C5—C6	−177.79 (14)	C15—C14—C19—C18	−0.3 (2)
C4—C5—C6—C7	−0.6 (3)	N1—C14—C19—C18	179.28 (12)
C5—C6—C7—C8	−0.9 (3)	C17—C18—C19—C14	0.6 (2)