Acta Crystallographica Section E
Structure Reports Online
ISSN 1600-5368

(1*R**,3*S**,8*S**)-2,2-Difluoro-3,8-dihydroxy-5,5-dimethylcyclooct-4(*Z*)-en-1-yl *N*,*N*-diethylcarbamate

John Fawcett,[a] Jonathan M Percy,[a] Stéphane Pintat,[b] Clive A. Smith[c] and Emi Uneyama[a]*

[a]Department of Chemistry, University of Leicester, Leicester LE1 7RH, England, [b]GlaxoSmithKline Pharmaceuticals, New Frontiers Science Park, Third Avenue, Harlow CM19 5AW, England, and [c]Chroma Therapeutics Ltd, 93 Milton Park, Abingdon, Oxon OX14 4RY, England

Correspondence e-mail: jmp29@leicester.ac.uk

Received 11 July 2005
Accepted 3 August 2005
Online 21 September 2005

Key indicators

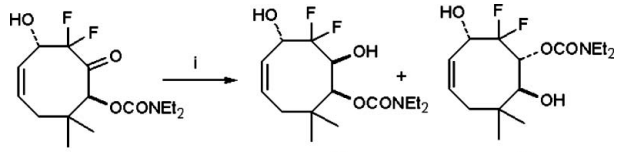
Single-crystal X-ray study
T = 150 K
Mean σ(C–C) = 0.002 Å
R factor = 0.039
wR factor = 0.095
Data-to-parameter ratio = 13.7

For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

The structure of the title compound, $C_{15}H_{25}F_2NO_4$, is presented. Comparison of this minor product with the isomeric major product of the synthesis is made in the previous paper.

Comment

The pseudorotational relationship between the ring conformations of the title compound, (2), and diol (1), which was presented in the previous paper (Fawcett *et al.*, 2005), are discussed in the *Comment* of that paper.



(1) (2)

Hydrogen bonding (Table 1) links molecules of (2) into sheets perpendicular to the *c* axis.

Experimental

Compound (2) was obtained as the minor product during the preparation of diol (1), as described in the previous paper (Fawcett *et al.*, 2005). A sample was recrystallized by vapour diffusion (ethyl acetate/light petroleum) to afford colourless crystals.

Crystal data

$C_{15}H_{25}F_2NO_4$
M_r = 321.36
Monoclinic, $P2_1/c$
a = 20.062 (14) Å
b = 6.433 (4) Å
c = 12.424 (9) Å
β = 97.346 (12)°
V = 1590.4 (19) Å^3
Z = 4
D_x = 1.342 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 3558 reflections
θ = 3.1–28.1°
μ = 0.11 mm^{-1}
T = 150 (2) K
Block, colourless
0.28 × 0.22 × 0.15 mm

Data collection

Bruker APEX CCD area-detector diffractometer
φ and ω scans
Absorption correction: none
10968 measured reflections
2805 independent reflections
2413 reflections with $I > 2\sigma(I)$
R_{int} = 0.068
θ_{max} = 25.0°
$h = -23 \rightarrow 23$
$k = -7 \rightarrow 7$
$l = -14 \rightarrow 14$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.039
$wR(F^2)$ = 0.095
S = 1.05
2805 reflections
205 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.045P)^2 + 0.1172P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.003
$\Delta\rho_{max}$ = 0.22 e Å^{-3}
$\Delta\rho_{min}$ = −0.21 e Å^{-3}

© 2005 International Union of Crystallography
Printed in Great Britain – all rights reserved

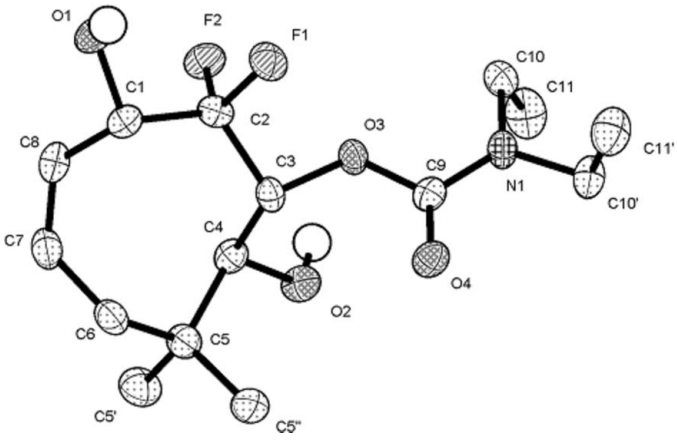


Figure 1
The molecular structure of (2), showing the atom-numbering scheme and 50% displacement ellipsoids. H atoms have been omitted.

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

D—H···A	D—H	H···A	D···A	D—H···A
O1—H1···O4^{i}	0.84	1.92	2.7598 (19)	173
O2—H2···O1^{ii}	0.84	2.01	2.827 (2)	163

Symmetry codes: (i) $x, -y+\frac{3}{2}, z+\frac{1}{2}$; (ii) $x, -y+\frac{1}{2}, z-\frac{1}{2}$.

H atoms were positioned geometrically, with C—H = 0.95–1.00 Å and O—H = 0.84 Å, and treated as riding, with U_{iso}(H) = 1.2 or 1.5 (methyl and OH) times U_{eq} of the parent atom.

Data collection: *SMART* (Bruker, 1997); cell refinement: *SAINT* (Bruker, 1999); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *SHELXTL* (Sheldrick, 2000); software used to prepare material for publication: *SHELXTL*.

The authors thank the Universities of Birmingham and Leicester, the EPSRC (project prant GR/K84882 for SP), GlaxoSmithKline (CASE studentship for SP) and Universities UK (ORS Award for EU).

References

Bruker (1997). *SMART*. Version 5.622. Bruker AXS Inc., Madison, Wisconsin, USA.
Bruker (1999). *SAINT*. Version 6.02. Bruker AXS Inc., Madison, Wisconsin, USA.
Fawcett, J., Percy, J. M., Pintat, S., Smith, C. A. & Uneyama, E. (2005). *Acta Cryst.* E**61**, o3319–o3321.
Sheldrick, G. M. (1997). *SHELXS97* and *SHELXL97*. University of Göttingen, Germany.
Sheldrick, G. M. (2000). *SHELXTL*. Version 6.10. Bruker AXS Inc., Madison, Wisconsin, USA.

supporting information

Acta Cryst. (2005). E**61**, o3322–o3323 [doi:10.1107/S1600536805024840]

(1*R**,3*S**,8*S**)-2,2-Difluoro-3,8-dihydroxy-5,5-dimethylcyclooct-4(*Z*)-en-1-yl *N*,*N*-diethylcarbamate

John Fawcett, Jonathan M Percy, Stéphane Pintat, Clive A. Smith and Emi Uneyama

S1. Comment

The pseudorotational relationship between the ring conformations of the title compound, (2), and diol (1), which was presented in the previous paper (Fawcett *et al.*, 2005), are discussed in the Comment of that paper.

Hydrogen bonding (Table 1) links molecules of (2) into sheets perpendicular to the *c* axis.

S2. Experimental

Compound (2) was obtained as the minor product during the preparation of diol (1), as described in the previous paper (Fawcett *et al.*, 2005). A sample was recrystallized by vapour diffusion (ethyl acetate/light petroleum) to afford colourless crystals.

S3. Refinement

H atoms were positioned geometrically, with C—H = 0.95–1.00 Å and O—H = 0.84 Å, and treated as riding, with U_{iso}(H) = 1.2 or 1.5 (methyl and OH) times U_{eq} of the parent atom.

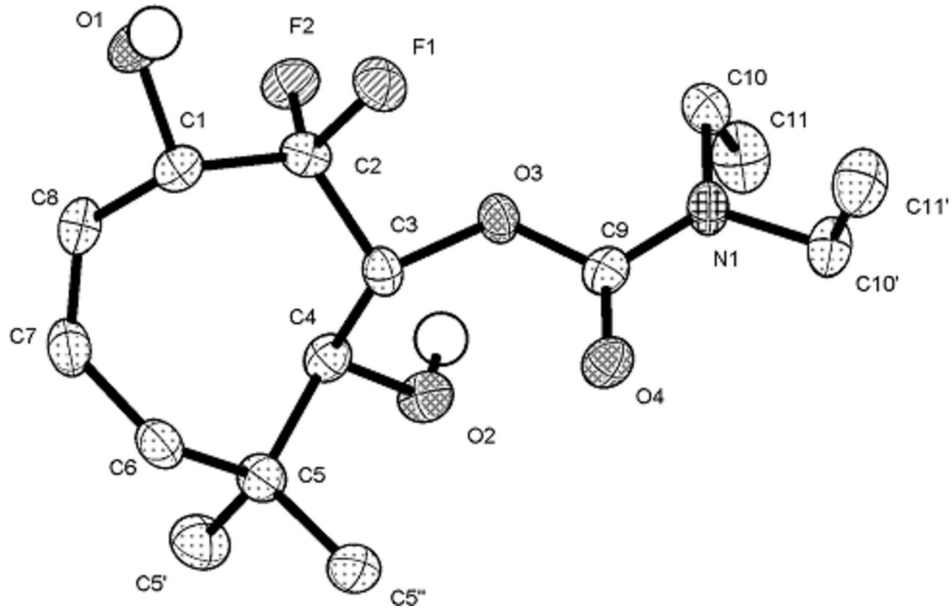


Figure 1

The molecular structure of (2), showing the atom-numbering scheme and 50% displacement ellipsoids.

(1*R,3*S**,8*S**)-2,2-Difluoro-3,8-dihydroxy-5,5-dimethylcyclooct-4(*Z*)-en-1-yl *N*,*N*-diethylcarbamate**

Crystal data

$C_{15}H_{25}F_2NO_4$
$M_r = 321.36$
Monoclinic, $P2_1/c$
Hall symbol: -P 2ybc
$a = 20.062$ (14) Å
$b = 6.433$ (4) Å
$c = 12.424$ (9) Å
$\beta = 97.346$ (12)°
$V = 1590.4$ (19) Å^3
$Z = 4$
$F(000) = 688$
$D_x = 1.342$ Mg m^{-3}
Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Cell parameters from 3558 reflections
$\theta = 3.1$–$28.1°$
$\mu = 0.11$ mm^{-1}
$T = 150$ K
Block, colourless
0.28 × 0.22 × 0.15 mm

Data collection

Bruker APEX CCD area-detector diffractometer
Radiation source: fine-focus sealed tube
Graphite monochromator
φ and ω scans
10968 measured reflections
2805 independent reflections
2413 reflections with $I > 2\sigma(I)$
$R_{int} = 0.068$
$\theta_{max} = 25.0°$, $\theta_{min} = 2.1°$
$h = -23 \rightarrow 23$
$k = -7 \rightarrow 7$
$l = -14 \rightarrow 14$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)] = 0.039$
$wR(F^2) = 0.095$
$S = 1.05$
2805 reflections
205 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
$w = 1/[\sigma^2(F_o^2) + (0.045P)^2 + 0.1172P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} = 0.003$
$\Delta\rho_{max} = 0.22$ e Å^{-3}
$\Delta\rho_{min} = -0.21$ 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 (Å^2)

	x	*y*	*z*	U_{iso}*/U_{eq}
F1	0.17709 (4)	0.50429 (15)	0.94617 (7)	0.0317 (3)
F2	0.23221 (4)	0.25700 (13)	0.87715 (7)	0.0289 (2)
N1	0.11443 (6)	0.73451 (19)	0.64634 (10)	0.0253 (3)
O1	0.25363 (6)	0.30397 (16)	1.10013 (8)	0.0279 (3)
H1	0.2329	0.3768	1.1410	0.042*

O2	0.30629 (6)	0.58984 (17)	0.66659 (8)	0.0274 (3)
H2	0.2857	0.4869	0.6370	0.041*
O3	0.19811 (5)	0.58723 (15)	0.75457 (8)	0.0234 (3)
O4	0.19503 (5)	0.93651 (16)	0.73795 (8)	0.0269 (3)
C1	0.28505 (8)	0.4356 (2)	1.02965 (12)	0.0228 (4)
H1A	0.2908	0.5774	1.0625	0.027*
C2	0.23950 (7)	0.4496 (2)	0.92154 (12)	0.0220 (3)
C3	0.25589 (7)	0.6030 (2)	0.83486 (11)	0.0205 (3)
H3	0.2589	0.7468	0.8657	0.025*
C4	0.31992 (8)	0.5554 (2)	0.78015 (12)	0.0226 (3)
H4	0.3315	0.4054	0.7923	0.027*
C5	0.38220 (7)	0.6860 (2)	0.82212 (12)	0.0247 (4)
C6	0.39729 (8)	0.6690 (3)	0.94646 (12)	0.0272 (4)
H6A	0.4400	0.7420	0.9708	0.033*
H6B	0.3612	0.7399	0.9797	0.033*
C7	0.40263 (8)	0.4506 (3)	0.98573 (13)	0.0295 (4)
H7	0.4447	0.3823	0.9870	0.035*
C8	0.35268 (8)	0.3461 (3)	1.01882 (12)	0.0269 (4)
H8	0.3601	0.2038	1.0371	0.032*
C9	0.17114 (8)	0.7665 (2)	0.71366 (12)	0.0213 (3)
C10	0.09080 (8)	0.5314 (2)	0.60752 (13)	0.0302 (4)
H10C	0.0413	0.5259	0.6044	0.036*
H10D	0.1101	0.4239	0.6594	0.036*
C11	0.10994 (10)	0.4840 (3)	0.49671 (15)	0.0404 (5)
H11D	0.0923	0.5928	0.4457	0.061*
H11E	0.0910	0.3494	0.4718	0.061*
H11F	0.1590	0.4789	0.5006	0.061*
C5"	0.37228 (8)	0.9155 (2)	0.79324 (13)	0.0313 (4)
H5"1	0.4109	0.9954	0.8274	0.047*
H5"2	0.3312	0.9661	0.8194	0.047*
H5"3	0.3684	0.9323	0.7143	0.047*
C5′	0.44161 (8)	0.6016 (3)	0.77064 (14)	0.0362 (4)
H5′1	0.4334	0.6213	0.6918	0.054*
H5′2	0.4471	0.4531	0.7870	0.054*
H5′3	0.4826	0.6760	0.8000	0.054*
C10′	0.07636 (8)	0.9164 (3)	0.60459 (13)	0.0293 (4)
H10A	0.0514	0.8827	0.5328	0.035*
H10B	0.1080	1.0308	0.5945	0.035*
C11′	0.02753 (9)	0.9882 (3)	0.67924 (15)	0.0388 (4)
H11A	−0.0045	0.8765	0.6883	0.058*
H11B	0.0032	1.1105	0.6480	0.058*
H11C	0.0521	1.0243	0.7501	0.058*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
F1	0.0218 (5)	0.0425 (6)	0.0322 (5)	0.0031 (4)	0.0085 (4)	0.0033 (4)
F2	0.0379 (6)	0.0228 (5)	0.0260 (5)	−0.0057 (4)	0.0036 (4)	−0.0032 (4)

N1	0.0254 (7)	0.0247 (7)	0.0240 (7)	0.0031 (5)	−0.0035 (6)	0.0010 (5)
O1	0.0360 (7)	0.0256 (6)	0.0239 (6)	0.0017 (5)	0.0103 (5)	0.0029 (5)
O2	0.0351 (7)	0.0288 (6)	0.0183 (6)	−0.0051 (5)	0.0033 (5)	−0.0025 (5)
O3	0.0223 (6)	0.0212 (6)	0.0245 (6)	−0.0004 (4)	−0.0047 (4)	−0.0001 (4)
O4	0.0336 (6)	0.0208 (6)	0.0256 (6)	−0.0015 (5)	0.0014 (5)	−0.0010 (5)
C1	0.0275 (9)	0.0207 (8)	0.0206 (8)	−0.0006 (6)	0.0048 (6)	0.0007 (6)
C2	0.0207 (8)	0.0200 (8)	0.0261 (8)	−0.0004 (6)	0.0059 (6)	−0.0043 (6)
C3	0.0194 (8)	0.0209 (8)	0.0198 (8)	0.0015 (6)	−0.0026 (6)	−0.0022 (6)
C4	0.0272 (9)	0.0217 (8)	0.0187 (8)	−0.0001 (6)	0.0030 (6)	0.0000 (6)
C5	0.0229 (8)	0.0267 (9)	0.0246 (8)	−0.0010 (7)	0.0029 (6)	−0.0002 (7)
C6	0.0201 (8)	0.0337 (9)	0.0267 (9)	−0.0033 (7)	−0.0011 (7)	0.0005 (7)
C7	0.0231 (9)	0.0373 (10)	0.0268 (9)	0.0054 (7)	−0.0010 (7)	0.0035 (7)
C8	0.0301 (9)	0.0272 (9)	0.0224 (8)	0.0062 (7)	0.0000 (7)	0.0036 (7)
C9	0.0249 (8)	0.0229 (9)	0.0170 (7)	0.0022 (6)	0.0058 (6)	0.0006 (6)
C10	0.0259 (9)	0.0295 (9)	0.0329 (9)	−0.0039 (7)	−0.0049 (7)	0.0017 (7)
C11	0.0435 (11)	0.0362 (10)	0.0392 (11)	0.0071 (9)	−0.0028 (9)	−0.0101 (8)
C5"	0.0304 (9)	0.0305 (9)	0.0316 (9)	−0.0067 (7)	−0.0004 (7)	0.0028 (7)
C5′	0.0285 (9)	0.0458 (11)	0.0357 (10)	−0.0012 (8)	0.0098 (8)	0.0024 (8)
C10′	0.0305 (9)	0.0324 (9)	0.0242 (9)	0.0080 (7)	0.0008 (7)	0.0038 (7)
C11′	0.0407 (11)	0.0425 (11)	0.0342 (10)	0.0126 (9)	0.0087 (8)	0.0031 (8)

Geometric parameters (Å, º)

F1—C2	1.3722 (18)	C6—H6A	0.990
F2—C2	1.3564 (18)	C6—H6B	0.990
N1—C9	1.339 (2)	C7—C8	1.316 (2)
N1—C10	1.451 (2)	C7—H7	0.950
N1—C10′	1.456 (2)	C8—H8	0.950
O1—C1	1.4220 (18)	C10—C11	1.507 (3)
O1—H1	0.840	C10—H10C	0.990
O2—C4	1.420 (2)	C10—H10D	0.990
O2—H2	0.840	C11—H11D	0.980
O3—C9	1.3458 (19)	C11—H11E	0.980
O3—C3	1.4329 (18)	C11—H11F	0.980
O4—C9	1.2167 (19)	C5"—H5"1	0.980
C1—C8	1.496 (2)	C5"—H5"2	0.980
C1—C2	1.528 (2)	C5"—H5"3	0.980
C1—H1A	1.000	C5′—H5′1	0.980
C2—C3	1.527 (2)	C5′—H5′2	0.980
C3—C4	1.559 (2)	C5′—H5′3	0.980
C3—H3	1.000	C10′—C11′	1.505 (2)
C4—C5	1.540 (2)	C10′—H10A	0.990
C4—H4	1.000	C10′—H10B	0.990
C5—C5′	1.523 (2)	C11′—H11A	0.980
C5—C5"	1.526 (2)	C11′—H11B	0.980
C5—C6	1.540 (2)	C11′—H11C	0.980
C6—C7	1.487 (2)		

C9—N1—C10	124.15 (13)	C6—C7—H7	118.0
C9—N1—C10′	117.66 (13)	C7—C8—C1	124.56 (15)
C10—N1—C10′	118.09 (13)	C7—C8—H8	117.7
C1—O1—H1	109.5	C1—C8—H8	117.7
C4—O2—H2	109.5	O4—C9—N1	124.71 (14)
C9—O3—C3	116.91 (12)	O4—C9—O3	123.38 (14)
O1—C1—C8	107.74 (13)	N1—C9—O3	111.89 (13)
O1—C1—C2	108.30 (13)	N1—C10—C11	112.04 (14)
C8—C1—C2	113.03 (13)	N1—C10—H10C	109.2
O1—C1—H1A	109.2	C11—C10—H10C	109.2
C8—C1—H1A	109.2	N1—C10—H10D	109.2
C2—C1—H1A	109.2	C11—C10—H10D	109.2
F2—C2—F1	105.72 (12)	H10C—C10—H10D	107.9
F2—C2—C3	108.99 (12)	C10—C11—H11D	109.5
F1—C2—C3	106.05 (12)	C10—C11—H11E	109.5
F2—C2—C1	108.96 (12)	H11D—C11—H11E	109.5
F1—C2—C1	106.22 (12)	C10—C11—H11F	109.5
C3—C2—C1	119.96 (13)	H11D—C11—H11F	109.5
O3—C3—C2	102.53 (12)	H11E—C11—H11F	109.5
O3—C3—C4	108.72 (12)	C5—C5"—H5"1	109.5
C2—C3—C4	116.38 (12)	C5—C5"—H5"2	109.5
O3—C3—H3	109.6	H5"1—C5"—H5"2	109.5
C2—C3—H3	109.6	C5—C5"—H5"3	109.5
C4—C3—H3	109.6	H5"1—C5"—H5"3	109.5
O2—C4—C5	107.23 (12)	H5"2—C5"—H5"3	109.5
O2—C4—C3	109.75 (12)	C5—C5′—H5′1	109.5
C5—C4—C3	115.04 (12)	C5—C5′—H5′2	109.5
O2—C4—H4	108.2	H5′1—C5′—H5′2	109.5
C5—C4—H4	108.2	C5—C5′—H5′3	109.5
C3—C4—H4	108.2	H5′1—C5′—H5′3	109.5
C5′—C5—C5"	109.39 (13)	H5′2—C5′—H5′3	109.5
C5′—C5—C6	109.39 (13)	N1—C10′—C11′	112.35 (14)
C5"—C5—C6	107.91 (13)	N1—C10′—H10A	109.1
C5′—C5—C4	107.92 (14)	C11′—C10′—H10A	109.1
C5"—C5—C4	111.86 (13)	N1—C10′—H10B	109.1
C6—C5—C4	110.35 (12)	C11′—C10′—H10B	109.1
C7—C6—C5	113.14 (13)	H10A—C10′—H10B	107.9
C7—C6—H6A	109.0	C10′—C11′—H11A	109.5
C5—C6—H6A	109.0	C10′—C11′—H11B	109.5
C7—C6—H6B	109.0	H11A—C11′—H11B	109.5
C5—C6—H6B	109.0	C10′—C11′—H11C	109.5
H6A—C6—H6B	107.8	H11A—C11′—H11C	109.5
C8—C7—C6	124.04 (15)	H11B—C11′—H11C	109.5
C8—C7—H7	118.0		

O1—C1—C2—F2	−61.47 (15)	C3—C4—C5—C5"	−66.51 (17)
C8—C1—C2—F2	57.83 (16)	O2—C4—C5—C6	176.01 (12)
O1—C1—C2—F1	52.00 (15)	C3—C4—C5—C6	53.64 (17)

C8—C1—C2—F1	171.30 (12)	C5′—C5—C6—C7	−65.68 (17)
O1—C1—C2—C3	172.00 (12)	C5"—C5—C6—C7	175.41 (13)
C8—C1—C2—C3	−68.70 (18)	C4—C5—C6—C7	52.91 (17)
C9—O3—C3—C2	134.44 (12)	C5—C6—C7—C8	−95.27 (19)
C9—O3—C3—C4	−101.78 (14)	C6—C7—C8—C1	−4.8 (3)
F2—C2—C3—O3	60.55 (14)	O1—C1—C8—C7	−160.47 (15)
F1—C2—C3—O3	−52.85 (14)	C2—C1—C8—C7	79.9 (2)
C1—C2—C3—O3	−172.94 (12)	C10—N1—C9—O4	172.08 (14)
F2—C2—C3—C4	−57.97 (16)	C10′—N1—C9—O4	−4.1 (2)
F1—C2—C3—C4	−171.36 (11)	C10—N1—C9—O3	−9.8 (2)
C1—C2—C3—C4	68.55 (18)	C10′—N1—C9—O3	174.05 (12)
O3—C3—C4—O2	22.24 (16)	C3—O3—C9—O4	3.3 (2)
C2—C3—C4—O2	137.32 (13)	C3—O3—C9—N1	−174.85 (12)
O3—C3—C4—C5	143.24 (12)	C9—N1—C10—C11	−97.16 (18)
C2—C3—C4—C5	−101.68 (16)	C10′—N1—C10—C11	78.99 (18)
O2—C4—C5—C5′	−64.51 (16)	C9—N1—C10′—C11′	−87.16 (18)
C3—C4—C5—C5′	173.12 (13)	C10—N1—C10′—C11′	96.43 (18)
O2—C4—C5—C5"	55.86 (16)		

Hydrogen-bond geometry (Å, º)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O1—H1···O4^{i}	0.84	1.92	2.7598 (19)	173
O2—H2···O1^{ii}	0.84	2.01	2.827 (2)	163

Symmetry codes: (i) x, $-y+3/2$, $z+1/2$; (ii) x, $-y+1/2$, $z-1/2$.