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3-Ethoxycarbonyl-2-hydroxy-6-methoxy-4-methylbenzoic acid

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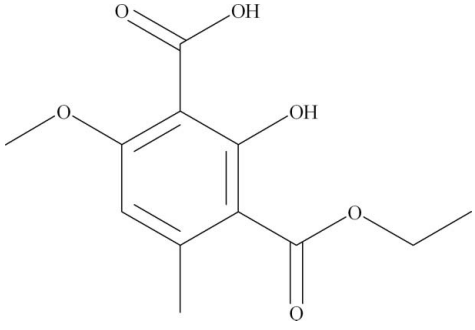
Key indicators: single-crystal X-ray study; T = 293 K; mean σ(C–C) = 0.004 Å; disorder in main residue; R factor = 0.057; wR factor = 0.174; data-to-parameter ratio = 12.7.

The title compound, $C_{12}H_{14}O_6$, a substituted isophthalic acid monoester which was isolated from the lichen *Thamnolia vermicularis* var. *subuliformis*, displays intramolecular carboxyl–methoxy O—H···O and hydroxy–carboxyl O—H···O hydrogen-bonding interactions. The terminal methyl group of the ethyl ester is disordered over two sets of sites with occupancies of 0.599 (19) and 0.401 (19).

Related literature

For general background to the phenol compounds isolated from the lichen *Thamnolia vermicularis* var. *subuliformis*, see: Jiang *et al.* (2002); Milenkovic-Andjelkovic (2010). For applications of analogs of the title compound, see: Huneck (1999).



Experimental

Crystal data

$C_{12}H_{14}O_6$
M_r = 254.23
Triclinic, $P\overline{1}$
a = 6.8460 (14) Å
b = 8.0065 (16) Å
c = 11.469 (2) Å
α = 97.059 (4)°
β = 95.987 (4)°
γ = 98.072 (4)°
V = 612.9 (2) Å^3
Z = 2
Mo $K\alpha$ radiation
μ = 0.11 mm^{-1}
T = 293 K
0.39 × 0.30 × 0.11 mm

Data collection

Bruker SMART CCD area-detector diffractometer
Absorption correction: multi-scan (*SADABS*; Bruker, 2003)
T_{min} = 0.245, T_{max} = 1.000
3352 measured reflections
2359 independent reflections
1379 reflections with $I > 2\sigma(I)$
R_{int} = 0.083

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.057
$wR(F^2)$ = 0.174
S = 0.91
2359 reflections
186 parameters
22 restraints
H atoms treated by a mixture of independent and constrained refinement
$\Delta\rho_{max}$ = 0.32 e Å^{-3}
$\Delta\rho_{min}$ = −0.21 e Å^{-3}

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

D—H···A	D—H	H···A	D···A	D—H···A
O4—H4···O2	0.88 (2)	1.77 (3)	2.535 (3)	144 (4)
O1—H1···O3	0.84 (2)	1.78 (3)	2.524 (3)	146 (4)

Data collection: *SMART* (Bruker, 2003); cell refinement: *SAINT* (Bruker, 2003); 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*.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: ZS2195).

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supplementary materials

Acta Cryst. (2012). E**68**, o1420 [doi:10.1107/S1600536812015012]

3-Ethoxycarbonyl-2-hydroxy-6-methoxy-4-methylbenzoic acid

Yun-Xia Deng, Tao Guo, Hui Xie and Sheng-Li Pan

Comment

The title compound, $C_{12}H_{14}O_6$, a substituted isophthalic acid monoester, is one of the phenol compounds isolated from the lichen *Thamnolia vermicularis* var.*subuliformis* (Jiang *et al.*, 2002; Milenkovic-Andjelkovic, 2010). The X-ray structural analysis of this compound reported here confirms the assignment of its structure determined from experimental spectroscopic data. In the molecule (Fig. 1), intramolecular carboxylic acid O—H···$O_{methoxy}$ and hydroxy O—H···$O_{carboxyl}$ hydrogen -bonding interactions (Table 1) result in the formation of two six-membered rings. In the crystal (Fig. 2), no significant hydrogen-bonding interactions are found. The terminal methyl group of the ethyl ester is disordered over two sites with occupancies 0.599:0.401.

Experimental

Extraction of the title compound. The air-dried and powdered plant materials (5 kg) were extracted by 95% EtOH (3 times, 20*L*) at room temperature and concentrated under vacuum. The residue was partitioned with petroleum ether (PE) and EtOAc,successively. The EtOAc extract (47 g) was chromatographed on a silica gel column eluted successively with PE-EtOAc/ EtOAc–MeOH to afford six major fractions. Fraction 3 eluted with PE-EtOAc (1:3) was further purified by silica gel chromatography [$CHCl_3$-MeOH (15:1)] and then Sephadex LH-20 using MeOH (100%) to yield the title compound (200 mg). The solvent was removed *in vacuo* to give colorless crystals (m.p. 435–437 K). ^{1}*H*-NMR ($CDCl_3$, 400 MHz): 12.6 (1H, s, OH), 11.2 (1H, s, COOH), 6.34 (1H, s), 4.4 (2H, q, CH_2), 4.08 (3H, s, CH_3), 2.37 (3H, s, CH_3), 1.39 (3H, t, CH_3). Crystals suitable for X-ray diffraction were obtained by slow evaporation of a methanol solution.

Refinement

Hydroxy and carboxylic acid H-atoms were located in a difference-Fourier analysis and both positional and isotropic displacement parameters were refined. Other H-atoms were positioned geometrically with C—H = 0.93 Å (for aromatic H) or 0.96 or 0.97 Å (for methyl or methylene H-atoms respectively) and constrained to ride on their parent atoms, with U_{iso}(H) = 1.2 or 1.5 U_{eq}(C). Disorder in the terminal methyl group (C12) of the ethyl ester resulted in the refinement at two sites with occupancies of 0.599 (19) (C12) and 0.401 (19) (C12′).

Computing details

Data collection: *SMART* (Bruker, 2003); cell refinement: *SAINT* (Bruker, 2003); data reduction: *SAINT* (Bruker, 2003); 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).

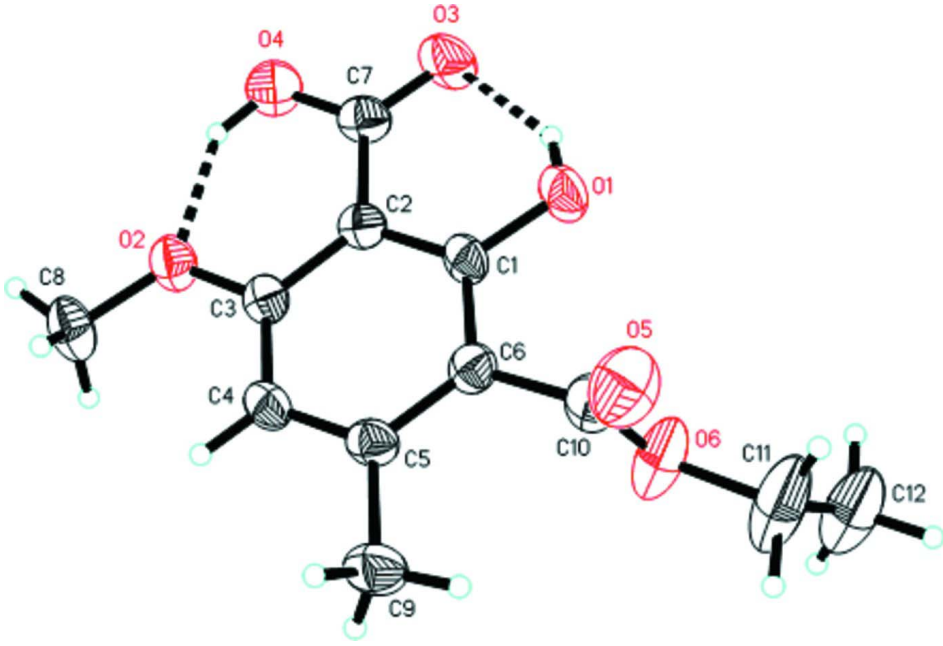

Figure 1

The molecular structure of the title compound, showing 30% probability displacement ellipsoids. The disorder in the ethyl ester group is not shown. Intramolecular hydrogen bonds are shown as dashed lines.

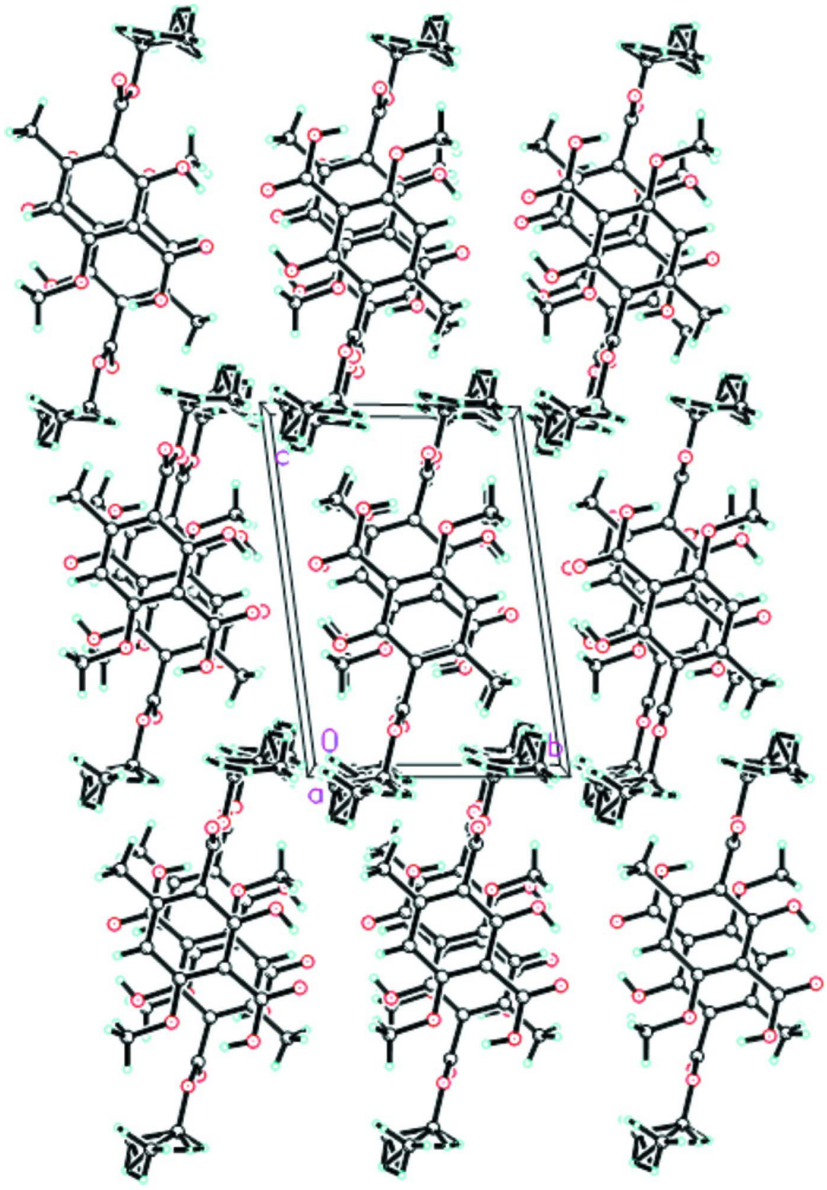

Figure 2

The crystal packing of the title compound viewed down the *a* axis.

3-Ethoxycarbonyl-2-hydroxy-6-methoxy-4-methylbenzoic acid

Crystal data

$C_{12}H_{14}O_6$
$M_r = 254.23$
Triclinic, $P\overline{1}$
Hall symbol: -P 1
$a = 6.8460\ (14)$ Å
$b = 8.0065\ (16)$ Å
$c = 11.469\ (2)$ Å
$\alpha = 97.059\ (4)°$
$\beta = 95.987\ (4)°$
$\gamma = 98.072\ (4)°$
$V = 612.9\ (2)$ Å^3
$Z = 2$
$F(000) = 268$
$D_x = 1.378$ Mg m^{-3}
Melting point = 435–437 K
Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Cell parameters from 969 reflections
$\theta = 5.2–52.9°$

μ = 0.11 mm^{-1}
T = 293 K

Prismatic, colorless
0.39 × 0.30 × 0.11 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*; Bruker, 2003)
T_{min} = 0.245, T_{max} = 1.000

3352 measured reflections
2359 independent reflections
1379 reflections with $I > 2\sigma(I)$
R_{int} = 0.083
θ_{max} = 26.0°, θ_{min} = 1.8°
h = −8→8
k = −9→7
l = −14→13

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)]$ = 0.057
$wR(F^2)$ = 0.174
S = 0.91
2359 reflections
186 parameters
22 restraints
Primary atom site location: structure-invariant direct methods
Secondary atom site location: difference Fourier map

Hydrogen site location: inferred from neighbouring sites
H atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.0955P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max}$ = 0.32 e Å^{-3}
$\Delta\rho_{min}$ = −0.21 e Å^{-3}
Extinction correction: *SHELXL97* (Sheldrick, 2008), $Fc^*=kFc[1+0.001xFc^2\lambda^3/\sin(2\theta)]^{-1/4}$
Extinction coefficient: 0.036 (12)

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}	Occ. (<1)
O1	0.1285 (4)	0.1888 (3)	0.3537 (2)	0.0692 (7)	
O2	0.3292 (3)	0.6477 (3)	0.66405 (18)	0.0640 (7)	
O3	0.1945 (4)	0.1389 (3)	0.5664 (2)	0.0771 (8)	
O4	0.2762 (4)	0.3453 (3)	0.7124 (2)	0.0773 (8)	
O5	−0.0464 (4)	0.3799 (4)	0.1320 (2)	0.0992 (10)	
O6	0.2714 (5)	0.3547 (4)	0.1310 (2)	0.0992 (10)	
C1	0.1806 (4)	0.3544 (3)	0.3938 (3)	0.0501 (8)	
C2	0.2325 (4)	0.4167 (3)	0.5141 (2)	0.0472 (7)	
C3	0.2804 (4)	0.5934 (4)	0.5465 (2)	0.0485 (7)	
C4	0.2788 (4)	0.7035 (3)	0.4632 (3)	0.0518 (8)	
H4A	0.3110	0.8204	0.4867	0.062*	
C5	0.2289 (4)	0.6395 (4)	0.3439 (3)	0.0526 (8)	
C6	0.1793 (4)	0.4666 (4)	0.3092 (2)	0.0519 (8)	

C7	0.2327 (4)	0.2914 (4)	0.5983 (3)	0.0575 (8)	
C8	0.3758 (6)	0.8247 (4)	0.7062 (3)	0.0777 (11)	
H8A	0.4967	0.8708	0.6783	0.117*	
H8B	0.3928	0.8415	0.7912	0.117*	
H8C	0.2696	0.8814	0.6777	0.117*	
C9	0.2292 (6)	0.7624 (4)	0.2541 (3)	0.0742 (10)	
H9A	0.3583	0.8302	0.2612	0.111*	
H9B	0.1317	0.8355	0.2682	0.111*	
H9C	0.1977	0.6999	0.1759	0.111*	
C10	0.1172 (6)	0.3942 (4)	0.1827 (3)	0.0668 (9)	
C11	0.2310 (10)	0.2902 (7)	0.0054 (4)	0.136 (2)	
H11A	0.1002	0.2215	−0.0116	0.164*	0.599 (19)
H11B	0.2327	0.3847	−0.0402	0.164*	0.599 (19)
H11C	0.3379	0.3382	−0.0339	0.164*	0.401 (19)
H11D	0.1099	0.3252	−0.0259	0.164*	0.401 (19)
C12	0.376 (2)	0.1907 (18)	−0.0273 (7)	0.128 (5)	0.599 (19)
H12A	0.3768	0.0993	0.0196	0.192*	0.599 (19)
H12B	0.5047	0.2605	−0.0141	0.192*	0.599 (19)
H12C	0.3461	0.1445	−0.1096	0.192*	0.599 (19)
C12′	0.213 (4)	0.107 (2)	−0.0170 (14)	0.137 (7)	0.401 (19)
H12D	0.2147	0.0720	−0.0999	0.205*	0.401 (19)
H12E	0.0899	0.0571	0.0065	0.205*	0.401 (19)
H12F	0.3219	0.0709	0.0276	0.205*	0.401 (19)
H1	0.144 (7)	0.131 (5)	0.410 (3)	0.113 (16)*	
H4	0.301 (6)	0.457 (3)	0.728 (4)	0.110 (16)*	

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
O1	0.0993 (18)	0.0384 (13)	0.0710 (16)	0.0188 (11)	0.0075 (13)	0.0049 (10)
O2	0.0797 (15)	0.0543 (14)	0.0555 (14)	0.0149 (10)	−0.0031 (10)	0.0023 (9)
O3	0.1013 (19)	0.0482 (15)	0.0865 (18)	0.0195 (12)	0.0037 (13)	0.0254 (12)
O4	0.106 (2)	0.0709 (18)	0.0605 (16)	0.0252 (15)	0.0042 (13)	0.0245 (13)
O5	0.091 (2)	0.126 (3)	0.0735 (18)	0.0161 (17)	−0.0105 (15)	0.0056 (15)
O6	0.124 (2)	0.132 (3)	0.0519 (15)	0.069 (2)	0.0086 (14)	−0.0027 (13)
C1	0.0554 (17)	0.0362 (16)	0.0614 (19)	0.0177 (13)	0.0087 (13)	0.0047 (12)
C2	0.0432 (16)	0.0471 (17)	0.0572 (18)	0.0180 (12)	0.0096 (13)	0.0148 (13)
C3	0.0434 (16)	0.0484 (17)	0.0553 (18)	0.0148 (12)	0.0039 (12)	0.0065 (13)
C4	0.0540 (18)	0.0389 (16)	0.0638 (19)	0.0112 (12)	0.0069 (14)	0.0073 (13)
C5	0.0536 (18)	0.0469 (17)	0.063 (2)	0.0151 (13)	0.0113 (14)	0.0168 (14)
C6	0.0583 (18)	0.0502 (18)	0.0519 (18)	0.0197 (14)	0.0114 (14)	0.0091 (13)
C7	0.0561 (18)	0.055 (2)	0.069 (2)	0.0188 (14)	0.0095 (15)	0.0221 (15)
C8	0.096 (3)	0.056 (2)	0.072 (2)	0.0133 (18)	−0.0136 (19)	−0.0104 (16)
C9	0.093 (3)	0.061 (2)	0.072 (2)	0.0127 (18)	0.0080 (18)	0.0270 (17)
C10	0.086 (3)	0.058 (2)	0.060 (2)	0.0230 (18)	0.0068 (19)	0.0108 (15)
C11	0.199 (5)	0.168 (5)	0.055 (3)	0.097 (5)	0.006 (3)	−0.006 (3)
C12	0.173 (10)	0.159 (9)	0.068 (5)	0.083 (8)	0.021 (5)	0.005 (5)
C12′	0.163 (13)	0.131 (11)	0.107 (9)	0.037 (9)	−0.003 (8)	−0.020 (7)

Geometric parameters (Å, º)

O1—C1	1.334 (3)	C6—C10	1.488 (4)
O1—H1	0.84 (2)	C8—H8A	0.9600
O2—C3	1.357 (3)	C8—H8B	0.9600
O2—C8	1.420 (4)	C8—H8C	0.9600
O3—C7	1.214 (4)	C9—H9A	0.9600
O4—C7	1.316 (4)	C9—H9B	0.9600
O4—H4	0.88 (2)	C9—H9C	0.9600
O5—C10	1.190 (4)	C11—C12	1.411 (10)
O6—C10	1.321 (4)	C11—C12′	1.441 (15)
O6—C11	1.453 (4)	C11—H11A	0.9700
C1—C2	1.399 (4)	C11—H11B	0.9700
C1—C6	1.401 (4)	C11—H11C	0.9580
C2—C3	1.401 (4)	C11—H11D	0.9607
C2—C7	1.475 (4)	C12—H12A	0.9600
C3—C4	1.377 (4)	C12—H12B	0.9600
C4—C5	1.390 (4)	C12—H12C	0.9600
C4—H4A	0.9300	C12′—H12D	0.9600
C5—C6	1.376 (4)	C12′—H12E	0.9600
C5—C9	1.509 (4)	C12′—H12F	0.9600
C1—O1—H1	110 (3)	C5—C9—H9A	109.5
C3—O2—C8	120.1 (2)	C5—C9—H9B	109.5
C7—O4—H4	113 (3)	H9A—C9—H9B	109.5
C10—O6—C11	115.9 (3)	C5—C9—H9C	109.5
O1—C1—C2	122.7 (2)	H9A—C9—H9C	109.5
O1—C1—C6	116.8 (3)	H9B—C9—H9C	109.5
C2—C1—C6	120.5 (3)	O5—C10—O6	123.6 (3)
C1—C2—C3	117.9 (2)	O5—C10—C6	125.6 (3)
C1—C2—C7	117.7 (3)	O6—C10—C6	110.8 (3)
C3—C2—C7	124.5 (3)	C12—C11—O6	109.7 (5)
O2—C3—C4	122.7 (3)	C12′—C11—O6	112.2 (7)
O2—C3—C2	115.7 (2)	C12—C11—H11A	109.7
C4—C3—C2	121.6 (3)	O6—C11—H11A	109.7
C3—C4—C5	119.8 (3)	C12—C11—H11B	109.7
C3—C4—H4A	120.1	O6—C11—H11B	109.7
C5—C4—H4A	120.1	H11A—C11—H11B	108.2
C6—C5—C4	120.1 (2)	C12′—C11—H11C	108.5
C6—C5—C9	121.0 (3)	O6—C11—H11C	108.9
C4—C5—C9	118.9 (3)	C12′—C11—H11D	109.6
C5—C6—C1	120.2 (3)	O6—C11—H11D	108.5
C5—C6—C10	121.5 (3)	H11C—C11—H11D	109.1
C1—C6—C10	118.3 (3)	C11—C12—H12A	109.5
O3—C7—O4	118.1 (3)	C11—C12—H12B	109.5
O3—C7—C2	122.5 (3)	C11—C12—H12C	109.5
O4—C7—C2	119.4 (3)	C11—C12′—H12D	109.5
O2—C8—H8A	109.5	C11—C12′—H12E	109.5
O2—C8—H8B	109.5	H12D—C12′—H12E	109.5
H8A—C8—H8B	109.5	C11—C12′—H12F	109.5

O2—C8—H8C	109.5	H12D—C12′—H12F	109.5
H8A—C8—H8C	109.5	H12E—C12′—H12F	109.5
H8B—C8—H8C	109.5		
O1—C1—C2—C3	−178.6 (2)	C9—C5—C6—C10	−2.2 (5)
C6—C1—C2—C3	0.6 (4)	O1—C1—C6—C5	179.2 (3)
O1—C1—C2—C7	1.4 (4)	C2—C1—C6—C5	−0.1 (4)
C6—C1—C2—C7	−179.4 (2)	O1—C1—C6—C10	1.1 (4)
C8—O2—C3—C4	1.8 (4)	C2—C1—C6—C10	−178.2 (3)
C8—O2—C3—C2	−178.6 (3)	C1—C2—C7—O3	1.7 (4)
C1—C2—C3—O2	179.8 (2)	C3—C2—C7—O3	−178.3 (3)
C7—C2—C3—O2	−0.2 (4)	C1—C2—C7—O4	−178.4 (3)
C1—C2—C3—C4	−0.5 (4)	C3—C2—C7—O4	1.5 (4)
C7—C2—C3—C4	179.5 (2)	C11—O6—C10—O5	−0.3 (6)
O2—C3—C4—C5	179.5 (2)	C11—O6—C10—C6	−177.2 (3)
C2—C3—C4—C5	−0.1 (4)	C5—C6—C10—O5	−83.8 (4)
C3—C4—C5—C6	0.6 (4)	C1—C6—C10—O5	94.2 (4)
C3—C4—C5—C9	−179.7 (3)	C5—C6—C10—O6	93.0 (4)
C4—C5—C6—C1	−0.5 (4)	C1—C6—C10—O6	−88.9 (4)
C9—C5—C6—C1	179.8 (3)	C10—O6—C11—C12	−156.0 (9)
C4—C5—C6—C10	177.5 (3)	C10—O6—C11—C12′	−100.3 (13)

Hydrogen-bond geometry (Å, º)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O4—H4···O2	0.88 (2)	1.77 (3)	2.535 (3)	144 (4)
O1—H1···O3	0.84 (2)	1.78 (3)	2.524 (3)	146 (4)