IUCrData

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(10*R*,13*R*)-17-(6-Hydroxy-5-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,-16,17-tetradecahydro-1*H*-cyclopenta[*a*]phenanthren-3-ol hemihydrate: a bioactive steroid isolated from the Indian herb *Artemisia reticulata*

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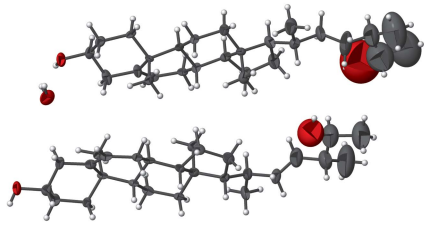
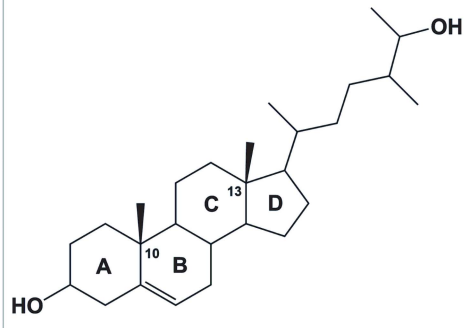
Structural data: full structural data are available from iucrdata.iucr.org

The title tetracyclic steroidal compound, $C_{27}H_{46}O_2\cdot0.5H_2O$, crystallized as a monohydrate with two independent molecules (**1** and **2**) in the asymmetric unit. In both molecules, the conformations of the three cyclohexane rings (*A*, *B* and *C*) are chair, half-chair and chair, respectively. The fourth ring, *D*, has a twisted conformation on the bond linking the *D* and *C* rings. The crystal structure is stabilized by hydrogen bonding with the two independent molecules being linked through the solvent water molecule *via* various O—H···O hydrogen bonds, forming layers parallel to ($\bar{1}$01).

3D view



Chemical scheme



Structure description

The title compound was isolated from a methanol extract of the herb *A. reticulata* (in local dialect *Kirmani aajowan*) by column chromatography (CC) over SiO_2 gel by gradient solvent elution. This herb has been credited with different kinds of pharmacological activities, and has been used as a folklore medicine for conventional therapy against various ailments: malaria (Klayman *et al.*, 1984; Malagon *et al.*, 1997; Newton & White, 1999), cancer (Efferth *et al.*, 2001; Lai & Singh, 1995), cardiovascular (Guantai & Addae-Mensah, 1999), vasodilatory (Walker, 1996), hepatitis (Aniya *et al.*, 2000) and diabetes (Iriadam *et al.*, 2006). It is found as a major constituent in many ayurvedic and herbal drug preparations, such as *forkolin*, *Afsanteen* and others, in Indian traditional

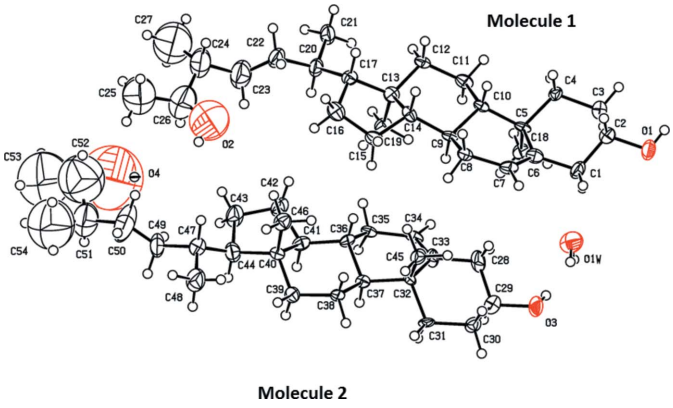


Figure 1
The molecular structure of the title compound, with the atom labelling and displacement ellipsoids drawn at the 50% probability level.

medicinal systems (Nadkarni, 1954; Satyavati *et al.*, 1987; Subramoniam *et al.*, 1996; Drury, 1978). The *Artemisia* species are a rich source of bioactive sesquiterpenenoids (Klayman *et al.*, 1984), such as artemisin and artemisinin, and secondary metabolites isolated from *A. annua* (Klayman, 1985) exhibit antiplasmodial activity (Li *et al.*, 1982). It is also under clinical trials to eradicate malaria.

We are looking for alternative abundant sources of artemisin and artemisinin from other varieties of *Artemisia* species. Unfortunately, phytochemical investigations revealed that the species of *A. reticulata* used by us did not possess the aforesaid terpenoids. Instead of that, a colourless solid substance was isolated as a minor constituent by column chromatographic separation. Herein, we report on the extraction and crystal structure of this minor colourless solid constituent assigned as a tetracyclic steroid based on chemical evidence. This solid substantiated the LB test (Liebermann Burchard Test), and a colour reaction on spraying with 10% aqueous H_2SO_4 onto a micro TLC plate followed by heating at 393 K for 5 min developed a pink-coloured spot on the TLC. These chemical tests revealed that the compound is a steroid. It shows a very close structural resemblance to the cyclopenteno perhydrophenanthreen skeleton *viz.* cholesterol (Craven, 1976; Marc, 1979; Naora *et al.*, 1986), but with different substituents.

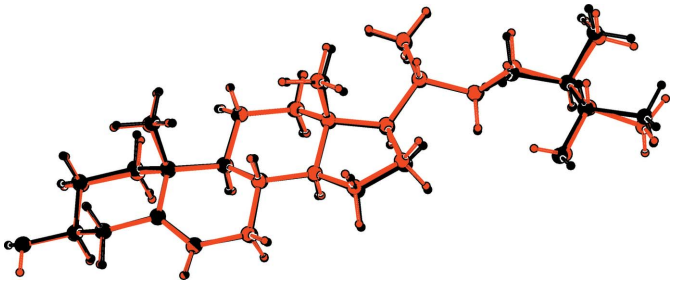


Figure 2
An AutoMolFit view of molecule **2** (red) on molecule **1** (black).

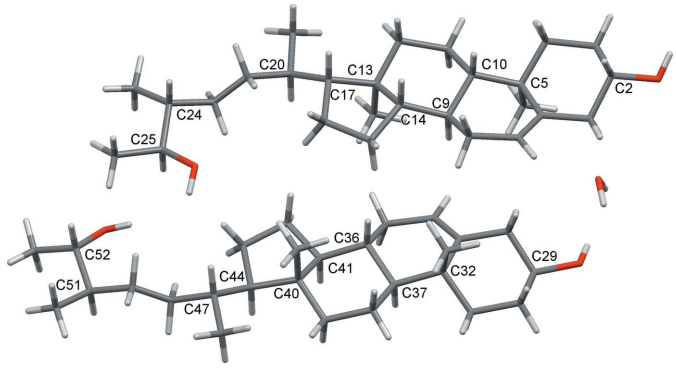


Figure 3
A view of the chiral centres by symmetry equivalence of the two molecules.

The molecular structure of the title compound is illustrated in Fig. 1. It crystallizes as a monohydrate with two independent molecules (**1** and **2**) in the asymmetric unit. The two molecules are almost identical (Fig. 2) and here the geometry will be described for molecule **1** only. It has an alkyl (1-hydroxy-2-isopropylhexyl) side chain located at atom C17 of the cyclopentane *D* ring. This side chain undergoes considerable thermal liberation and bond strain. The molecule is composed of a series of fused rings (*A*, *B*, *C* and *D*). Rings *A* and *C* have chair conformations while ring *B* has a half-chair conformation, and the five-membered ring *D* is twisted on bond C13—C14. In addition to the tetracyclic moiety, two $-CH_3$ groups are present at positions C5 and C13, at ring junctures *A*/*B* and *C*/*D*, respectively. At atom C2 in ring *A* there is an –OH group and in ring *D* the alkyl side chain, (1-hydroxy-2-isopropylhexyl), at atom C17.

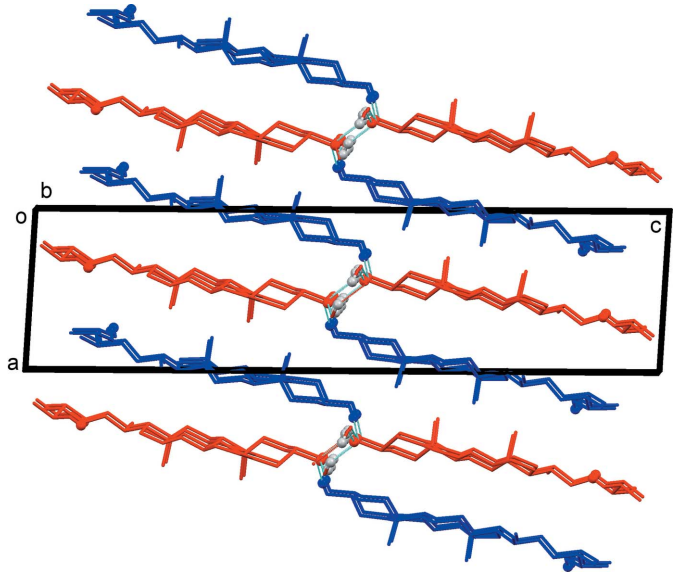


Figure 4
A view along the *b* axis of the crystal packing of the title compound (molecule **1** blue, molecule **2** red). The O—H···O hydrogen bonds are shown as dashed lines (Table 1) and only the water molecule and hydroxy H atoms have been included.

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

D—H···A	D—H	H···A	D···A	D—H···A
O3—H3O···O1W	0.84	2.48	3.282 (11)	161
O1W—H11W···O3	0.91 (8)	2.45 (9)	3.282 (11)	151 (10)
O1W—H12W···O3^{i}	0.87 (7)	2.07 (9)	2.834 (9)	147 (10)
O1—H1O···O3^{ii}	0.84	1.94	2.766 (9)	169

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

There is total of eleven asymmetric centres in the title molecule at various positions, such as C2, C5, C9, C10, C13, C14, C17, C20, C24 and C25. Among them, five asymmetric centres located at carbon atoms C2, C9, C10, C14, C25, and the remaining six chiral centres located at atoms C5, C13, C17, C20, C24, have relative *S* and *R* configurations, respectively; see Fig. 3.

In the crystal, molecules are linked *via* O—H···O_{water}, O_{water}—H···O and other O—H···O hydrogen bonds, forming layers lying parallel to ($\bar{1}$01); see Table 1 and Figs. 4 and 5.

Synthesis and crystallization

The title steroid was isolated as a colourless solid from a methanol extract of *A. reticulata* by means of CC/SiO_2 gel by gradient elution with a mixture of a binary solvent system, hexane and ethyl acetate. The desired compound was purified by reverse-phase high-pressure liquid chromatography. Suitable crystals for X-ray diffraction were obtained after being recrystallized three times from ethyl acetate:hexane (1:4) at room temperature by slow evaporation of the solvents.

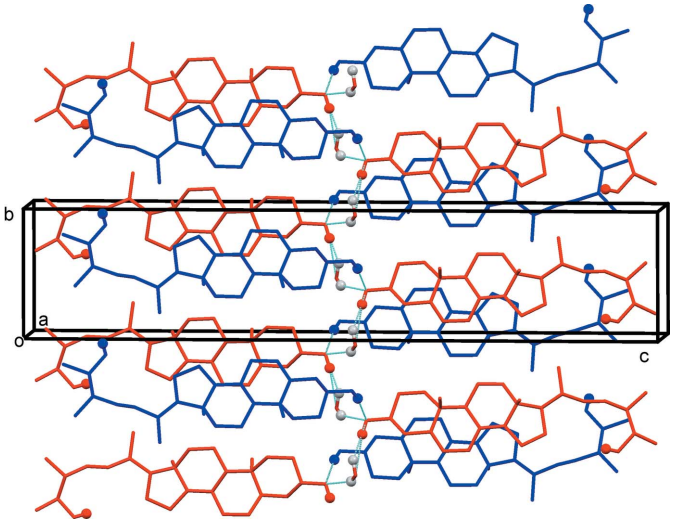


Figure 5
A view along the *a* axis of the crystal packing of the title compound (molecule **1** blue, molecule **2** red). The O—H···O hydrogen bonds are shown as dashed lines (Table 1), and only the water molecule and hydroxy H atoms have been included.

Table 2
Experimental details.

Crystal data	
Chemical formula	$C_{27}H_{46}O_2{\cdot}0.5H_2O$
M_r	411.64
Crystal system, space group	Monoclinic, $P2_1$
Temperature (K)	150
a, b, c (Å)	9.4107 (8), 7.5175 (6), 36.979 (3)
β (°)	93.375 (8)
V (Å^3)	2611.5 (4)
Z	4
Radiation type	Mo $K\alpha$
μ (mm^{-1})	0.06
Crystal size (mm)	0.32 × 0.28 × 0.12
Data collection	
Diffractometer	Oxford Diffraction Xcalibur diffractometer with a Sapphire CCD detector
Absorption correction	Multi-scan (*CrysAlis RED*; Oxford Diffraction, 2009)
T_{min}, T_{max}	0.980, 0.992
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	10852, 6720, 4382
R_{int}	0.048
(sin $\theta/\lambda)_{max}$ (Å^{-1})	0.602
Refinement	
$R[F^2 > 2\sigma(F^2)]$, $wR(F^2)$, S	0.110, 0.319, 1.06
No. of reflections	6720
No. of parameters	538
No. of restraints	70
H-atom treatment	H atoms treated by a mixture of independent and constrained refinement
$\Delta\rho_{max}$, $\Delta\rho_{min}$ (e Å^{-3})	0.86, −0.40
Absolute structure	Flack x determined using 911 quotients $[(I^+)-(I^-)]/[(I^+)+(I^-)]$ (Parsons *et al.*, 2013)
Absolute structure parameter	−0.1 (10)

Computer programs: *CrysAlis CCD* and *CrysAlis RED* (Oxford Diffraction, 2009), *SHELXS2014* (Sheldrick, 2008), *SHELXL2014* (Sheldrick, 2015) and *PLATON* (Spek, 2009).

Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2. In both molecules the alkyl (1-hydroxy-2-isopropylhexyl) side chain located at atom C17 of the cyclopentane *D* ring undergoes considerable thermal liberation and bond strain, and it was necessary to use a number of ISOR, DELU and DFIX restraints during the refinement process. Nevertheless, the final *R* factors are still relatively high: $R[F^2 > 2\sigma(F^2)] = 0.11$ and $wR(F^2) = 0.32$.

Acknowledgements

The authors thank Professor Dr Hartmut, FG Strukturforschung, Material-und Geowissenschaften, Technische Universit at Darmstadt, and Professor Kingston, Department of Chemistry, Virginia Polytechnic Institute and State University, USA, for their kind co-operation to record XRD of the crystal, for providing diffractometer time and for carrying out the antiproliferative bioassay against the cancer cell line.

References

Aniya, Y., Shimabukuro, M., Shimoji, M., Kohatsu, M., Gyamfi, M. A., Miyagi, C., Kunii, D., Takayama, F. & Egashira, T. (2000). *Biol. Pharm. Bull.* **23**, 309–312.

Craven, B. M. (1976). *Nature*, **260**, 727–729.

Drury, C. H. (1978). *The Useful Plants of India* (with notices of their chief value in commerce, medicine & the arts). London: William H. Allen & Co.

Efferth, T., Dunstan, H., Sauerbrey, A., Miyachi, H. & Chitambar, C. R. (2001). *Int. J. Oncol.* **18**, 767–773.

Guantai, A. N. & Addae-Mensah, I. (1999). *Pharm. Biol.* **37**, 351–356.

Iriadam, M., Musa, D., Gumushan, H. & Baba, F. (2006). *J. Cell. Mol. Biol.* **5**, 19–24.

Klayman, D. L. (1985). *Science*, **228**, 1049–1055.

Klayman, D. L., Lin, A., Acton, N., Scovill, J. P., Hoch, J. M., Milhous, W. K., Theoharides, A. D. & Dobek, A. S. (1984). *J. Nat. Prod.* **47**, 715–717.

Lai, H. & Singh, N. P. (1995). *Cancer Lett.* **91**, 41–46.

Li, G., Guo, X., Jin, R., Wang, Z., Jian, H. & Li, Z. (1982). *J. Tradit. Chin. Med.* **2**, 125–130.

Malagon, F., Vazquez, J., Delgado, G. & Ruiz, A. (1997). *Parasitolgia*, **39**, 3–7.

Marc, S. (1979). Ger. Offen. DE2732749 B219790628.

Nadkarni, A. K. (1954). *Indian Materia Medica*, 3rd ed. Bombay: Popular Prakashan.

Naora (nee Namikawa), M., Murae, T., Tsuyuki, T. & Takahashi, T. (1986). *Bull. Chem. Soc. Jpn*, **59**, 1767–1976.

Newton, P. & White, N. (1999). *Annu. Rev. Med.* **50**, 179–192.

Oxford Diffraction (2009). *CrysAlis CCD* and *CrysAlis RED*. Oxford Diffraction Ltd, Abingdon, England.

Parsons, S., Flack, H. D. & Wagner, T. (2013). *Acta Cryst.* B**69**, 249–259.

Satyavati, G. V., Gupta, A. & Tandon, N. (1987). *Medicinal plants of India*. New Delhi: ICMR.

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

Sheldrick, G. M. (2015). *Acta Cryst.* C**71**, 3–8.

Spek, A. L. (2009). *Acta Cryst.* D**65**, 148–155.

Subramoniam, A., Pushpangadan, P., Rajasekharan, S., Evans, D. A., Latha, P. G. & Valsaraj, R. (1996). *J. Ethnopharmacol.* **50**, 13–17.

Walker, A. F. (1996). *Biologist*, **43**, 177–180.

full crystallographic data

IUCrData (2017). **2**, x171086 [https://doi.org/10.1107/S2414314617010860]

(10*R*,13*R*)-17-(6-Hydroxy-5-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1*H*-cyclopenta[*a*]phenanthren-3-ol hemihydrate: a bioactive steroid isolated from the Indian herb *Artemisia reticulata*

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Crystal data

$C_{27}H_{46}O_2 \cdot 0.5H_2O$
M_r = 411.64
Monoclinic, $P2_1$
a = 9.4107 (8) Å
b = 7.5175 (6) Å
c = 36.979 (3) Å
β = 93.375 (8)°
V = 2611.5 (4) Å^3
Z = 4
$F(000)$ = 916
D_x = 1.047 Mg m^{-3}
Mo $K\alpha$ radiation, λ = 0.71073 Å
Cell parameters from 2353 reflections
θ = 2.5–28.0°
μ = 0.06 mm^{-1}
T = 150 K
Prism, colourless
0.32 × 0.28 × 0.12 mm

Data collection

Oxford Diffraction Xcalibur diffractometer with a Sapphire CCD detector
Radiation source: Enhance (Mo) X-ray Source
Rotation method data acquisition using ω scans
Absorption correction: multi-scan (CrysAlis RED; Oxford Diffraction, 2009)
T_{min} = 0.980, T_{max} = 0.992
10852 measured reflections
6720 independent reflections
4382 reflections with $I > 2\sigma(I)$
R_{int} = 0.048
θ_{max} = 25.4°, θ_{min} = 2.5°
h = −11→10
k = −6→9
l = −44→43

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)]$ = 0.110
$wR(F^2)$ = 0.319
S = 1.06
6720 reflections
538 parameters
70 restraints
Primary atom site location: structure-invariant direct methods
Secondary atom site location: difference Fourier map
Hydrogen site location: mixed
H atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.1665P)^2 + 5.0834P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max}$ = 0.86 e Å^{-3}
$\Delta\rho_{min}$ = −0.40 e Å^{-3}
Absolute structure: Flack x determined using 911 quotients $[(I^+)-(I^-)]/[(I^+)+(I^-)]$ (Parsons *et al.*, 2013)
Absolute structure parameter: −0.1 (10)

Special details

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

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²)

	x	*y*	*z*	U_{iso}*/U_{eq}
O1	1.2212 (7)	0.5959 (10)	0.51417 (15)	0.0389 (17)
H1O	1.2907	0.5340	0.5220	0.047*
O2	0.823 (2)	0.891 (3)	0.1325 (4)	0.199 (8)
H2O	0.7706	0.9808	0.1287	0.239*
C1	1.0884 (10)	0.6980 (13)	0.4597 (2)	0.033 (2)
H1A	1.1043	0.8239	0.4667	0.039*
H1B	0.9996	0.6579	0.4703	0.039*
C2	1.2097 (9)	0.5885 (13)	0.4751 (2)	0.030 (2)
H2	1.2999	0.6356	0.4658	0.036*
C3	1.1923 (10)	0.3970 (14)	0.4635 (2)	0.034 (2)
H3A	1.1050	0.3469	0.4732	0.041*
H3B	1.2747	0.3264	0.4733	0.041*
C4	1.1819 (8)	0.3852 (12)	0.4217 (2)	0.022 (2)
H4A	1.1650	0.2597	0.4146	0.027*
H4B	1.2744	0.4214	0.4126	0.027*
C5	1.0630 (8)	0.5016 (11)	0.4032 (2)	0.0200 (18)
C6	1.0707 (9)	0.6856 (13)	0.4193 (2)	0.028 (2)
C7	1.0664 (8)	0.8326 (12)	0.3990 (2)	0.027 (2)
H7	1.0720	0.9437	0.4112	0.032*
C8	1.0535 (9)	0.8360 (12)	0.3582 (2)	0.0228 (19)
H8A	1.1473	0.8651	0.3489	0.027*
H8B	0.9857	0.9305	0.3501	0.027*
C9	1.0025 (8)	0.6589 (12)	0.3425 (2)	0.0208 (18)
H9	0.8990	0.6451	0.3466	0.025*
C10	1.0854 (8)	0.5048 (11)	0.3617 (2)	0.0180 (18)
H10	1.1885	0.5311	0.3594	0.022*
C11	1.0569 (9)	0.3277 (12)	0.3426 (2)	0.027 (2)
H11A	0.9593	0.2885	0.3473	0.033*
H11B	1.1238	0.2380	0.3534	0.033*
C12	1.0716 (8)	0.3307 (12)	0.3014 (2)	0.0228 (19)
H12A	1.0440	0.2135	0.2910	0.027*
H12B	1.1722	0.3533	0.2963	0.027*
C13	0.9762 (8)	0.4771 (13)	0.2835 (2)	0.026 (2)
C14	1.0230 (8)	0.6501 (12)	0.3018 (2)	0.0221 (19)
H14	1.1279	0.6585	0.2992	0.027*
C15	0.9558 (10)	0.7972 (12)	0.2775 (2)	0.030 (2)
H15A	1.0122	0.9083	0.2797	0.036*
H15B	0.8570	0.8223	0.2838	0.036*
C16	0.9591 (11)	0.7173 (14)	0.2386 (3)	0.037 (2)

H16A	0.8641	0.7280	0.2258	0.044*
H16B	1.0288	0.7823	0.2245	0.044*
C17	1.0020 (9)	0.5190 (12)	0.2424 (2)	0.025 (2)
H17	1.1066	0.5105	0.2393	0.030*
C18	0.9162 (8)	0.4185 (14)	0.4110 (2)	0.031 (2)
H18A	0.9097	0.2984	0.4007	0.038*
H18B	0.9070	0.4123	0.4373	0.038*
H18C	0.8397	0.4925	0.4000	0.038*
C19	0.8177 (8)	0.4387 (13)	0.2871 (2)	0.028 (2)
H19A	0.7925	0.3263	0.2749	0.033*
H19B	0.7984	0.4300	0.3127	0.033*
H19C	0.7609	0.5353	0.2758	0.033*
C20	0.9263 (10)	0.4050 (14)	0.2131 (2)	0.033 (2)
H20	0.8222	0.4114	0.2169	0.039*
C21	0.9678 (11)	0.2102 (14)	0.2151 (2)	0.041 (3)
H21A	0.9157	0.1447	0.1956	0.049*
H21B	1.0704	0.1986	0.2123	0.049*
H21C	0.9442	0.1614	0.2385	0.049*
C22	0.9471 (12)	0.4818 (16)	0.1754 (2)	0.045 (3)
H22A	0.9936	0.5989	0.1792	0.054*
H22B	1.0169	0.4042	0.1641	0.054*
C23	0.8380 (15)	0.507 (2)	0.1502 (3)	0.080 (4)
H23A	0.7725	0.5923	0.1610	0.095*
H23B	0.7864	0.3920	0.1483	0.095*
C24	0.8551 (17)	0.569 (2)	0.1118 (3)	0.082 (4)
H24	0.9587	0.5873	0.1084	0.099*
C25	0.778 (2)	0.748 (3)	0.1070 (4)	0.107 (6)
H25	0.6757	0.7237	0.1112	0.129*
C26	0.780 (2)	0.818 (3)	0.0665 (5)	0.146 (8)
H26A	0.7502	0.7218	0.0497	0.175*
H26B	0.7149	0.9186	0.0630	0.175*
H26C	0.8769	0.8555	0.0616	0.175*
C27	0.798 (3)	0.423 (3)	0.0849 (5)	0.195 (11)
H27A	0.8086	0.4623	0.0600	0.234*
H27B	0.8514	0.3123	0.0893	0.234*
H27C	0.6967	0.4010	0.0885	0.234*
O3	0.5647 (7)	0.8560 (10)	0.46662 (15)	0.0392 (17)
H3O	0.5645	0.7492	0.4733	0.047*
O4	0.297 (4)	0.608 (6)	0.0743 (10)	0.45 (2)
H4O	0.3496	0.6316	0.0928	0.535*
C28	0.5988 (11)	0.7558 (14)	0.4054 (2)	0.039 (3)
H28A	0.5939	0.6299	0.4131	0.047*
H28B	0.6994	0.7940	0.4083	0.047*
C29	0.5111 (10)	0.8677 (13)	0.4296 (2)	0.030 (2)
H29	0.4115	0.8209	0.4279	0.036*
C30	0.5077 (10)	1.0581 (13)	0.4164 (2)	0.028 (2)
H30A	0.6050	1.1085	0.4186	0.033*
H30B	0.4466	1.1299	0.4317	0.033*

C31	0.4496 (8)	1.0675 (12)	0.3768 (2)	0.0229 (19)
H31A	0.4499	1.1932	0.3688	0.027*
H31B	0.3495	1.0261	0.3754	0.027*
C32	0.5349 (8)	0.9554 (12)	0.3506 (2)	0.0191 (19)
C33	0.5488 (10)	0.7694 (12)	0.3656 (2)	0.028 (2)
C34	0.5214 (9)	0.6197 (12)	0.3461 (2)	0.027 (2)
H34	0.5325	0.5078	0.3579	0.032*
C35	0.4745 (8)	0.6239 (11)	0.3068 (2)	0.0215 (19)
H35A	0.5243	0.5283	0.2942	0.026*
H35B	0.3712	0.5982	0.3043	0.026*
C36	0.5019 (9)	0.7967 (12)	0.2887 (2)	0.0225 (19)
H36	0.6066	0.8082	0.2861	0.027*
C37	0.4521 (8)	0.9557 (12)	0.3122 (2)	0.0194 (18)
H37	0.3496	0.9340	0.3165	0.023*
C38	0.4590 (9)	1.1335 (12)	0.2924 (2)	0.0233 (19)
H38A	0.4130	1.2260	0.3068	0.028*
H38B	0.5600	1.1676	0.2907	0.028*
C39	0.3867 (10)	1.1291 (13)	0.2544 (2)	0.030 (2)
H39A	0.3986	1.2461	0.2427	0.036*
H39B	0.2835	1.1081	0.2561	0.036*
C40	0.4477 (8)	0.9850 (13)	0.2310 (2)	0.026 (2)
C41	0.4258 (9)	0.8085 (13)	0.2510 (2)	0.027 (2)
H41	0.3216	0.8007	0.2548	0.033*
C42	0.4571 (11)	0.6626 (16)	0.2235 (2)	0.042 (3)
H42A	0.4069	0.5506	0.2288	0.050*
H42B	0.5605	0.6388	0.2232	0.050*
C43	0.3979 (12)	0.7470 (14)	0.1874 (3)	0.046 (3)
H43A	0.3107	0.6834	0.1784	0.056*
H43B	0.4693	0.7369	0.1689	0.056*
C44	0.3630 (10)	0.9462 (15)	0.1939 (2)	0.038 (2)
H44	0.2592	0.9550	0.1980	0.046*
C45	0.6833 (8)	1.0364 (15)	0.3488 (2)	0.032 (2)
H45A	0.6750	1.1574	0.3391	0.038*
H45B	0.7300	1.0402	0.3732	0.038*
H45C	0.7399	0.9636	0.3330	0.038*
C46	0.6025 (9)	1.0197 (14)	0.2246 (2)	0.034 (2)
H46A	0.6386	0.9246	0.2095	0.041*
H46B	0.6113	1.1341	0.2122	0.041*
H46C	0.6580	1.0228	0.2478	0.041*
C47	0.3906 (10)	1.0561 (15)	0.1608 (2)	0.036 (2)
H47	0.4924	1.0380	0.1553	0.044*
C48	0.3685 (15)	1.2558 (16)	0.1667 (3)	0.061 (4)
H48A	0.3877	1.3205	0.1445	0.073*
H48B	0.2700	1.2774	0.1727	0.073*
H48C	0.4336	1.2971	0.1866	0.073*
C49	0.2989 (12)	0.9932 (19)	0.1280 (2)	0.056 (3)
H49A	0.2739	0.8679	0.1329	0.068*
H49B	0.2092	1.0618	0.1281	0.068*

C50	0.3399 (17)	0.998 (3)	0.0938 (3)	0.122 (8)
H50A	0.4325	0.9351	0.0940	0.146*
H50B	0.3598	1.1242	0.0884	0.146*
C51	0.252 (2)	0.927 (3)	0.0612 (4)	0.110 (6)
H51	0.1506	0.9138	0.0676	0.132*
C52	0.306 (4)	0.749 (4)	0.0484 (9)	0.210 (14)
H52	0.4063	0.7621	0.0414	0.253*
C53	0.215 (4)	0.667 (6)	0.0166 (9)	0.30 (2)
H53A	0.2098	0.7493	−0.0039	0.359*
H53B	0.2578	0.5546	0.0094	0.359*
H53C	0.1183	0.6438	0.0243	0.359*
C54	0.259 (3)	1.059 (4)	0.0312 (7)	0.241 (14)
H54A	0.2246	1.1749	0.0392	0.290*
H54B	0.3582	1.0714	0.0246	0.290*
H54C	0.2001	1.0189	0.0101	0.290*
O1W	0.6405 (9)	0.4363 (12)	0.4827 (2)	0.055 (2)
H11W	0.618 (11)	0.552 (11)	0.487 (3)	0.066*
H12W	0.566 (10)	0.385 (14)	0.491 (3)	0.066*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
O1	0.054 (4)	0.043 (5)	0.019 (3)	0.005 (4)	−0.003 (3)	0.000 (3)
O2	0.225 (14)	0.192 (16)	0.179 (13)	0.031 (13)	−0.006 (11)	−0.043 (12)
C1	0.048 (6)	0.030 (6)	0.020 (4)	0.005 (5)	0.003 (4)	−0.006 (4)
C2	0.032 (5)	0.030 (6)	0.028 (5)	−0.001 (4)	0.002 (4)	−0.003 (4)
C3	0.041 (5)	0.034 (6)	0.025 (5)	0.002 (5)	0.001 (4)	0.002 (4)
C4	0.029 (5)	0.019 (5)	0.019 (4)	0.003 (4)	0.004 (3)	0.001 (4)
C5	0.018 (4)	0.010 (4)	0.032 (4)	0.005 (3)	0.001 (3)	−0.001 (4)
C6	0.025 (5)	0.023 (5)	0.035 (5)	0.001 (4)	0.004 (4)	0.000 (4)
C7	0.027 (5)	0.016 (5)	0.039 (5)	0.002 (4)	0.003 (4)	−0.010 (4)
C8	0.020 (4)	0.018 (5)	0.030 (4)	0.002 (4)	−0.001 (3)	−0.004 (4)
C9	0.015 (4)	0.013 (5)	0.035 (5)	0.003 (4)	0.004 (3)	−0.002 (4)
C10	0.014 (4)	0.011 (4)	0.029 (4)	0.001 (3)	−0.001 (3)	−0.001 (4)
C11	0.029 (5)	0.013 (5)	0.039 (5)	0.003 (4)	−0.003 (4)	0.002 (4)
C12	0.020 (4)	0.018 (5)	0.030 (4)	0.006 (4)	0.000 (3)	−0.001 (4)
C13	0.018 (4)	0.030 (6)	0.030 (5)	−0.003 (4)	0.000 (3)	−0.001 (4)
C14	0.014 (4)	0.025 (5)	0.027 (4)	−0.003 (4)	−0.001 (3)	0.007 (4)
C15	0.040 (5)	0.014 (5)	0.035 (5)	0.009 (4)	0.001 (4)	0.004 (4)
C16	0.040 (6)	0.034 (6)	0.037 (5)	0.002 (5)	−0.001 (4)	0.008 (5)
C17	0.022 (4)	0.029 (6)	0.025 (4)	0.000 (4)	0.009 (3)	0.004 (4)
C18	0.026 (5)	0.044 (6)	0.025 (4)	−0.002 (5)	0.009 (3)	0.004 (5)
C19	0.026 (5)	0.029 (5)	0.029 (4)	−0.005 (4)	0.008 (4)	−0.004 (4)
C20	0.036 (5)	0.040 (6)	0.023 (4)	−0.004 (5)	0.000 (4)	−0.003 (4)
C21	0.058 (7)	0.040 (7)	0.023 (5)	0.008 (5)	−0.010 (4)	0.000 (5)
C22	0.074 (7)	0.037 (7)	0.025 (5)	0.012 (6)	0.002 (5)	−0.006 (5)
C23	0.103 (11)	0.090 (12)	0.044 (7)	0.002 (9)	−0.004 (7)	−0.010 (8)
C24	0.096 (8)	0.101 (9)	0.049 (6)	0.007 (8)	−0.011 (6)	0.004 (7)

C25	0.136 (10)	0.112 (11)	0.073 (8)	−0.008 (9)	−0.003 (8)	−0.013 (8)
C26	0.208 (17)	0.143 (17)	0.085 (11)	0.000 (15)	0.002 (11)	0.011 (12)
C27	0.32 (2)	0.19 (2)	0.080 (11)	0.030 (18)	0.003 (14)	−0.006 (14)
O3	0.057 (4)	0.038 (4)	0.022 (3)	0.005 (4)	0.001 (3)	0.010 (3)
O4	0.45 (3)	0.45 (3)	0.43 (3)	−0.03 (2)	0.00 (2)	−0.03 (2)
C28	0.065 (7)	0.021 (6)	0.028 (5)	0.002 (5)	−0.011 (5)	0.009 (4)
C29	0.036 (5)	0.032 (6)	0.023 (4)	−0.009 (4)	0.004 (4)	0.000 (4)
C30	0.035 (5)	0.023 (5)	0.026 (4)	0.003 (4)	0.005 (4)	−0.003 (4)
C31	0.027 (4)	0.014 (5)	0.028 (4)	0.008 (4)	0.009 (3)	−0.004 (4)
C32	0.015 (4)	0.022 (5)	0.020 (4)	0.007 (4)	−0.003 (3)	−0.001 (4)
C33	0.046 (5)	0.017 (5)	0.019 (4)	0.001 (4)	−0.003 (4)	0.007 (4)
C34	0.031 (5)	0.006 (5)	0.042 (5)	0.007 (4)	0.001 (4)	0.004 (4)
C35	0.021 (4)	0.014 (5)	0.030 (4)	0.006 (4)	0.002 (3)	0.000 (4)
C36	0.032 (5)	0.013 (5)	0.023 (4)	0.002 (4)	0.002 (4)	−0.010 (4)
C37	0.017 (4)	0.020 (5)	0.022 (4)	−0.001 (4)	0.008 (3)	0.006 (4)
C38	0.036 (5)	0.013 (5)	0.021 (4)	0.011 (4)	0.005 (3)	0.001 (4)
C39	0.044 (5)	0.022 (5)	0.024 (4)	0.008 (5)	0.004 (4)	0.007 (4)
C40	0.021 (4)	0.032 (6)	0.025 (4)	0.008 (4)	0.001 (3)	−0.002 (4)
C41	0.026 (5)	0.024 (5)	0.031 (5)	−0.001 (4)	0.006 (4)	−0.007 (4)
C42	0.055 (6)	0.040 (7)	0.030 (5)	0.004 (6)	0.001 (4)	−0.012 (5)
C43	0.067 (7)	0.034 (7)	0.036 (5)	0.000 (6)	−0.012 (5)	−0.009 (5)
C44	0.041 (6)	0.039 (6)	0.033 (5)	0.003 (5)	−0.008 (4)	0.004 (5)
C45	0.020 (4)	0.053 (7)	0.023 (4)	−0.001 (5)	0.003 (3)	−0.004 (5)
C46	0.037 (5)	0.034 (6)	0.030 (5)	−0.003 (5)	0.003 (4)	0.000 (4)
C47	0.040 (6)	0.041 (7)	0.029 (5)	0.006 (5)	0.006 (4)	0.002 (5)
C48	0.098 (10)	0.045 (8)	0.039 (6)	0.020 (7)	0.004 (6)	0.007 (6)
C49	0.076 (8)	0.064 (9)	0.027 (5)	0.018 (7)	−0.013 (5)	0.000 (6)
C50	0.109 (12)	0.22 (3)	0.039 (7)	−0.054 (15)	0.007 (7)	−0.017 (11)
C51	0.133 (10)	0.127 (11)	0.068 (8)	0.000 (9)	−0.016 (7)	−0.005 (8)
C52	0.217 (16)	0.211 (17)	0.200 (16)	−0.007 (11)	−0.012 (11)	−0.008 (11)
C53	0.32 (3)	0.30 (3)	0.27 (3)	−0.03 (2)	−0.02 (2)	0.00 (2)
C54	0.33 (2)	0.23 (2)	0.164 (18)	−0.06 (2)	−0.052 (17)	0.005 (18)
O1W	0.069 (5)	0.046 (5)	0.052 (4)	0.006 (5)	0.021 (4)	0.014 (4)

Geometric parameters (Å, º)

O1—C2	1.442 (9)	O3—H3O	0.8400
O1—H1O	0.8400	O4—C52	1.43 (2)
O2—C25	1.479 (17)	O4—H4O	0.8400
O2—H2O	0.8400	C28—C29	1.508 (13)
C1—C2	1.493 (12)	C28—C33	1.520 (11)
C1—C6	1.500 (11)	C28—H28A	0.9900
C1—H1A	0.9900	C28—H28B	0.9900
C1—H1B	0.9900	C29—C30	1.511 (13)
C2—C3	1.510 (13)	C29—H29	1.0000
C2—H2	1.0000	C30—C31	1.534 (11)
C3—C4	1.543 (10)	C30—H30A	0.9900
C3—H3A	0.9900	C30—H30B	0.9900

C3—H3B	0.9900	C31—C32	1.545 (11)
C4—C5	1.548 (11)	C31—H31A	0.9900
C4—H4A	0.9900	C31—H31B	0.9900
C4—H4B	0.9900	C32—C33	1.508 (12)
C5—C6	1.504 (12)	C32—C45	1.528 (11)
C5—C18	1.559 (11)	C32—C37	1.579 (10)
C5—C10	1.561 (11)	C33—C34	1.353 (12)
C6—C7	1.335 (12)	C34—C35	1.495 (11)
C7—C8	1.504 (11)	C34—H34	0.9500
C7—H7	0.9500	C35—C36	1.491 (12)
C8—C9	1.518 (12)	C35—H35A	0.9900
C8—H8A	0.9900	C35—H35B	0.9900
C8—H8B	0.9900	C36—C41	1.531 (11)
C9—C14	1.532 (11)	C36—C37	1.566 (11)
C9—C10	1.546 (11)	C36—H36	1.0000
C9—H9	1.0000	C37—C38	1.528 (11)
C10—C11	1.524 (12)	C37—H37	1.0000
C10—H10	1.0000	C38—C39	1.526 (11)
C11—C12	1.537 (11)	C38—H38A	0.9900
C11—H11A	0.9900	C38—H38B	0.9900
C11—H11B	0.9900	C39—C40	1.519 (12)
C12—C13	1.545 (12)	C39—H39A	0.9900
C12—H12A	0.9900	C39—H39B	0.9900
C12—H12B	0.9900	C40—C46	1.513 (12)
C13—C14	1.519 (13)	C40—C41	1.538 (13)
C13—C19	1.532 (11)	C40—C44	1.574 (11)
C13—C17	1.585 (11)	C41—C42	1.536 (13)
C14—C15	1.537 (11)	C41—H41	1.0000
C14—H14	1.0000	C42—C43	1.553 (13)
C15—C16	1.560 (13)	C42—H42A	0.9900
C15—H15A	0.9900	C42—H42B	0.9900
C15—H15B	0.9900	C43—C44	1.555 (15)
C16—C17	1.549 (13)	C43—H43A	0.9900
C16—H16A	0.9900	C43—H43B	0.9900
C16—H16B	0.9900	C44—C47	1.513 (13)
C17—C20	1.525 (12)	C44—H44	1.0000
C17—H17	1.0000	C45—H45A	0.9800
C18—H18A	0.9800	C45—H45B	0.9800
C18—H18B	0.9800	C45—H45C	0.9800
C18—H18C	0.9800	C46—H46A	0.9800
C19—H19A	0.9800	C46—H46B	0.9800
C19—H19B	0.9800	C46—H46C	0.9800
C19—H19C	0.9800	C47—C49	1.520 (13)
C20—C21	1.516 (14)	C47—C48	1.533 (15)
C20—C22	1.530 (13)	C47—H47	1.0000
C20—H20	1.0000	C48—H48A	0.9800
C21—H21A	0.9800	C48—H48B	0.9800
C21—H21B	0.9800	C48—H48C	0.9800

C21—H21C	0.9800	C49—C50	1.346 (15)
C22—C23	1.358 (15)	C49—H49A	0.9900
C22—H22A	0.9900	C49—H49B	0.9900
C22—H22B	0.9900	C50—C51	1.52 (2)
C23—C24	1.514 (17)	C50—H50A	0.9900
C23—H23A	0.9900	C50—H50B	0.9900
C23—H23B	0.9900	C51—C54	1.496 (19)
C24—C27	1.559 (18)	C51—C52	1.51 (2)
C24—C25	1.54 (2)	C51—H51	1.0000
C24—H24	1.0000	C52—C53	1.54 (2)
C25—C26	1.59 (2)	C52—H52	1.0000
C25—H25	1.0000	C53—H53A	0.9800
C26—H26A	0.9800	C53—H53B	0.9800
C26—H26B	0.9800	C53—H53C	0.9800
C26—H26C	0.9800	C54—H54A	0.9800
C27—H27A	0.9800	C54—H54B	0.9800
C27—H27B	0.9800	C54—H54C	0.9800
C27—H27C	0.9800	O1W—H11W	0.91 (8)
O3—C29	1.435 (10)	O1W—H12W	0.87 (7)

C2—O1—H1O	109.5	C52—O4—H4O	109.5
C25—O2—H2O	109.5	C29—C28—C33	112.7 (8)
C2—C1—C6	112.6 (7)	C29—C28—H28A	109.0
C2—C1—H1A	109.1	C33—C28—H28A	109.0
C6—C1—H1A	109.1	C29—C28—H28B	109.0
C2—C1—H1B	109.1	C33—C28—H28B	109.0
C6—C1—H1B	109.1	H28A—C28—H28B	107.8
H1A—C1—H1B	107.8	O3—C29—C28	111.0 (7)
O1—C2—C1	111.8 (7)	O3—C29—C30	111.4 (7)
O1—C2—C3	108.9 (8)	C28—C29—C30	109.9 (7)
C1—C2—C3	110.4 (8)	O3—C29—H29	108.2
O1—C2—H2	108.6	C28—C29—H29	108.2
C1—C2—H2	108.6	C30—C29—H29	108.2
C3—C2—H2	108.6	C29—C30—C31	110.5 (7)
C2—C3—C4	109.9 (8)	C29—C30—H30A	109.6
C2—C3—H3A	109.7	C31—C30—H30A	109.6
C4—C3—H3A	109.7	C29—C30—H30B	109.6
C2—C3—H3B	109.7	C31—C30—H30B	109.6
C4—C3—H3B	109.7	H30A—C30—H30B	108.1
H3A—C3—H3B	108.2	C30—C31—C32	113.9 (7)
C3—C4—C5	114.3 (7)	C30—C31—H31A	108.8
C3—C4—H4A	108.7	C32—C31—H31A	108.8
C5—C4—H4A	108.7	C30—C31—H31B	108.8
C3—C4—H4B	108.7	C32—C31—H31B	108.8
C5—C4—H4B	108.7	H31A—C31—H31B	107.7
H4A—C4—H4B	107.6	C33—C32—C45	109.0 (7)
C6—C5—C18	108.6 (7)	C33—C32—C31	108.1 (7)
C6—C5—C4	109.2 (7)	C45—C32—C31	108.7 (7)

C18—C5—C4	108.5 (7)	C33—C32—C37	111.1 (7)
C6—C5—C10	111.5 (7)	C45—C32—C37	111.4 (6)
C18—C5—C10	111.1 (6)	C31—C32—C37	108.5 (6)
C4—C5—C10	107.9 (6)	C34—C33—C28	119.8 (8)
C7—C6—C1	120.5 (9)	C34—C33—C32	124.4 (7)
C7—C6—C5	122.7 (8)	C28—C33—C32	115.7 (8)
C1—C6—C5	116.8 (8)	C33—C34—C35	122.5 (8)
C6—C7—C8	125.1 (8)	C33—C34—H34	118.8
C6—C7—H7	117.5	C35—C34—H34	118.8
C8—C7—H7	117.5	C36—C35—C34	114.0 (7)
C7—C8—C9	111.9 (7)	C36—C35—H35A	108.8
C7—C8—H8A	109.2	C34—C35—H35A	108.8
C9—C8—H8A	109.2	C36—C35—H35B	108.8
C7—C8—H8B	109.2	C34—C35—H35B	108.8
C9—C8—H8B	109.2	H35A—C35—H35B	107.7
H8A—C8—H8B	107.9	C35—C36—C41	112.1 (7)
C8—C9—C14	111.1 (7)	C35—C36—C37	110.5 (6)
C8—C9—C10	110.0 (6)	C41—C36—C37	108.8 (7)
C14—C9—C10	109.3 (6)	C35—C36—H36	108.5
C8—C9—H9	108.8	C41—C36—H36	108.5
C14—C9—H9	108.8	C37—C36—H36	108.5
C10—C9—H9	108.8	C38—C37—C36	112.3 (6)
C11—C10—C9	111.8 (6)	C38—C37—C32	113.5 (7)
C11—C10—C5	114.4 (7)	C36—C37—C32	110.5 (6)
C9—C10—C5	111.7 (6)	C38—C37—H37	106.7
C11—C10—H10	106.1	C36—C37—H37	106.7
C9—C10—H10	106.1	C32—C37—H37	106.7
C5—C10—H10	106.1	C39—C38—C37	113.2 (7)
C10—C11—C12	115.0 (7)	C39—C38—H38A	108.9
C10—C11—H11A	108.5	C37—C38—H38A	108.9
C12—C11—H11A	108.5	C39—C38—H38B	108.9
C10—C11—H11B	108.5	C37—C38—H38B	108.9
C12—C11—H11B	108.5	H38A—C38—H38B	107.8
H11A—C11—H11B	107.5	C38—C39—C40	112.1 (7)
C11—C12—C13	110.7 (7)	C38—C39—H39A	109.2
C11—C12—H12A	109.5	C40—C39—H39A	109.2
C13—C12—H12A	109.5	C38—C39—H39B	109.2
C11—C12—H12B	109.5	C40—C39—H39B	109.2
C13—C12—H12B	109.5	H39A—C39—H39B	107.9
H12A—C12—H12B	108.1	C46—C40—C39	111.5 (8)
C14—C13—C19	112.4 (7)	C46—C40—C41	112.5 (7)
C14—C13—C12	105.8 (6)	C39—C40—C41	106.0 (7)
C19—C13—C12	111.9 (8)	C46—C40—C44	109.7 (7)
C14—C13—C17	101.5 (7)	C39—C40—C44	116.0 (7)
C19—C13—C17	109.0 (6)	C41—C40—C44	100.6 (7)
C12—C13—C17	115.8 (7)	C42—C41—C36	117.6 (8)
C13—C14—C9	115.2 (7)	C42—C41—C40	105.2 (7)
C13—C14—C15	104.9 (6)	C36—C41—C40	114.7 (7)

C9—C14—C15	118.2 (7)	C42—C41—H41	106.2
C13—C14—H14	105.9	C36—C41—H41	106.2
C9—C14—H14	105.9	C40—C41—H41	106.2
C15—C14—H14	105.9	C41—C42—C43	101.8 (8)
C14—C15—C16	103.4 (7)	C41—C42—H42A	111.4
C14—C15—H15A	111.1	C43—C42—H42A	111.4
C16—C15—H15A	111.1	C41—C42—H42B	111.4
C14—C15—H15B	111.1	C43—C42—H42B	111.4
C16—C15—H15B	111.1	H42A—C42—H42B	109.3
H15A—C15—H15B	109.1	C42—C43—C44	109.2 (8)
C17—C16—C15	107.9 (7)	C42—C43—H43A	109.8
C17—C16—H16A	110.1	C44—C43—H43A	109.8
C15—C16—H16A	110.1	C42—C43—H43B	109.8
C17—C16—H16B	110.1	C44—C43—H43B	109.8
C15—C16—H16B	110.1	H43A—C43—H43B	108.3
H16A—C16—H16B	108.4	C47—C44—C43	110.6 (8)
C20—C17—C16	111.7 (7)	C47—C44—C40	120.2 (9)
C20—C17—C13	118.6 (7)	C43—C44—C40	102.3 (8)
C16—C17—C13	102.9 (7)	C47—C44—H44	107.7
C20—C17—H17	107.7	C43—C44—H44	107.7
C16—C17—H17	107.7	C40—C44—H44	107.7
C13—C17—H17	107.7	C32—C45—H45A	109.5
C5—C18—H18A	109.5	C32—C45—H45B	109.5
C5—C18—H18B	109.5	H45A—C45—H45B	109.5
H18A—C18—H18B	109.5	C32—C45—H45C	109.5
C5—C18—H18C	109.5	H45A—C45—H45C	109.5
H18A—C18—H18C	109.5	H45B—C45—H45C	109.5
H18B—C18—H18C	109.5	C40—C46—H46A	109.5
C13—C19—H19A	109.5	C40—C46—H46B	109.5
C13—C19—H19B	109.5	H46A—C46—H46B	109.5
H19A—C19—H19B	109.5	C40—C46—H46C	109.5
C13—C19—H19C	109.5	H46A—C46—H46C	109.5
H19A—C19—H19C	109.5	H46B—C46—H46C	109.5
H19B—C19—H19C	109.5	C44—C47—C49	111.0 (9)
C21—C20—C17	113.6 (7)	C44—C47—C48	112.8 (9)
C21—C20—C22	111.3 (8)	C49—C47—C48	110.0 (10)
C17—C20—C22	110.8 (8)	C44—C47—H47	107.6
C21—C20—H20	106.9	C49—C47—H47	107.6
C17—C20—H20	106.9	C48—C47—H47	107.6
C22—C20—H20	106.9	C47—C48—H48A	109.5
C20—C21—H21A	109.5	C47—C48—H48B	109.5
C20—C21—H21B	109.5	H48A—C48—H48B	109.5
H21A—C21—H21B	109.5	C47—C48—H48C	109.5
C20—C21—H21C	109.5	H48A—C48—H48C	109.5
H21A—C21—H21C	109.5	H48B—C48—H48C	109.5
H21B—C21—H21C	109.5	C50—C49—C47	124.1 (12)
C23—C22—C20	123.0 (11)	C50—C49—H49A	106.3
C23—C22—H22A	106.6	C47—C49—H49A	106.3

C20—C22—H22A	106.6	C50—C49—H49B	106.3
C23—C22—H22B	106.6	C47—C49—H49B	106.3
C20—C22—H22B	106.6	H49A—C49—H49B	106.4
H22A—C22—H22B	106.5	C49—C50—C51	124.3 (14)
C22—C23—C24	124.6 (13)	C49—C50—H50A	106.2
C22—C23—H23A	106.2	C51—C50—H50A	106.2
C24—C23—H23A	106.2	C49—C50—H50B	106.2
C22—C23—H23B	106.2	C51—C50—H50B	106.2
C24—C23—H23B	106.2	H50A—C50—H50B	106.4
H23A—C23—H23B	106.4	C54—C51—C52	109 (2)
C27—C24—C23	109.2 (14)	C54—C51—C50	107.9 (18)
C27—C24—C25	113.6 (14)	C52—C51—C50	112 (2)
C23—C24—C25	107.7 (13)	C54—C51—H51	109.2
C27—C24—H24	108.7	C52—C51—H51	109.2
C23—C24—H24	108.7	C50—C51—H51	109.2
C25—C24—H24	108.7	O4—C52—C51	114 (3)
O2—C25—C26	110.1 (17)	O4—C52—C53	99 (3)
O2—C25—C24	116.7 (14)	C51—C52—C53	114 (3)
C26—C25—C24	111.5 (15)	O4—C52—H52	109.6
O2—C25—H25	106.0	C51—C52—H52	109.6
C26—C25—H25	106.0	C53—C52—H52	109.6
C24—C25—H25	106.0	C52—C53—H53A	109.5
C25—C26—H26A	109.5	C52—C53—H53B	109.5
C25—C26—H26B	109.5	H53A—C53—H53B	109.5
H26A—C26—H26B	109.5	C52—C53—H53C	109.5
C25—C26—H26C	109.5	H53A—C53—H53C	109.5
H26A—C26—H26C	109.5	H53B—C53—H53C	109.5
H26B—C26—H26C	109.5	C51—C54—H54A	109.5
C24—C27—H27A	109.5	C51—C54—H54B	109.5
C24—C27—H27B	109.5	H54A—C54—H54B	109.5
H27A—C27—H27B	109.5	C51—C54—H54C	109.5
C24—C27—H27C	109.5	H54A—C54—H54C	109.5
H27A—C27—H27C	109.5	H54B—C54—H54C	109.5
H27B—C27—H27C	109.5	H11W—O1W—H12W	99 (8)
C29—O3—H3O	109.5		

C6—C1—C2—O1	−177.4 (8)	C33—C28—C29—O3	−178.0 (8)
C6—C1—C2—C3	−56.1 (11)	C33—C28—C29—C30	−54.3 (11)
O1—C2—C3—C4	−179.2 (6)	O3—C29—C30—C31	−179.8 (6)
C1—C2—C3—C4	57.7 (10)	C28—C29—C30—C31	56.8 (10)
C2—C3—C4—C5	−55.2 (10)	C29—C30—C31—C32	−57.6 (10)
C3—C4—C5—C6	47.6 (10)	C30—C31—C32—C33	51.7 (9)
C3—C4—C5—C18	−70.6 (9)	C30—C31—C32—C45	−66.6 (9)
C3—C4—C5—C10	169.0 (7)	C30—C31—C32—C37	172.2 (7)
C2—C1—C6—C7	−126.5 (10)	C29—C28—C33—C34	−128.1 (10)
C2—C1—C6—C5	51.6 (11)	C29—C28—C33—C32	52.5 (11)
C18—C5—C6—C7	−109.5 (9)	C45—C32—C33—C34	−110.2 (10)
C4—C5—C6—C7	132.4 (8)	C31—C32—C33—C34	131.8 (9)

C10—C5—C6—C7	13.2 (11)	C37—C32—C33—C34	12.9 (12)
C18—C5—C6—C1	72.4 (9)	C45—C32—C33—C28	69.1 (10)
C4—C5—C6—C1	−45.7 (10)	C31—C32—C33—C28	−48.9 (10)
C10—C5—C6—C1	−164.9 (7)	C37—C32—C33—C28	−167.8 (7)
C1—C6—C7—C8	178.1 (7)	C28—C33—C34—C35	−178.9 (8)
C5—C6—C7—C8	0.1 (13)	C32—C33—C34—C35	0.3 (14)
C6—C7—C8—C9	16.8 (11)	C33—C34—C35—C36	17.4 (12)
C7—C8—C9—C14	−166.8 (6)	C34—C35—C36—C41	−168.3 (7)
C7—C8—C9—C10	−45.6 (9)	C34—C35—C36—C37	−46.9 (9)
C8—C9—C10—C11	−170.0 (7)	C35—C36—C37—C38	−172.1 (7)
C14—C9—C10—C11	−47.8 (9)	C41—C36—C37—C38	−48.7 (9)
C8—C9—C10—C5	60.4 (8)	C35—C36—C37—C32	60.0 (9)
C14—C9—C10—C5	−177.4 (6)	C41—C36—C37—C32	−176.6 (7)
C6—C5—C10—C11	−171.2 (7)	C33—C32—C37—C38	−169.0 (7)
C18—C5—C10—C11	−50.0 (9)	C45—C32—C37—C38	−47.2 (9)
C4—C5—C10—C11	68.8 (9)	C31—C32—C37—C38	72.3 (8)
C6—C5—C10—C9	−43.0 (9)	C33—C32—C37—C36	−41.8 (9)
C18—C5—C10—C9	78.3 (9)	C45—C32—C37—C36	80.0 (9)
C4—C5—C10—C9	−162.9 (6)	C31—C32—C37—C36	−160.5 (7)
C9—C10—C11—C12	49.0 (9)	C36—C37—C38—C39	50.1 (9)
C5—C10—C11—C12	177.3 (6)	C32—C37—C38—C39	176.4 (6)
C10—C11—C12—C13	−54.7 (9)	C37—C38—C39—C40	−56.3 (10)
C11—C12—C13—C14	57.5 (8)	C38—C39—C40—C46	−64.1 (10)
C11—C12—C13—C19	−65.1 (9)	C38—C39—C40—C41	58.7 (9)
C11—C12—C13—C17	169.1 (7)	C38—C39—C40—C44	169.4 (8)
C19—C13—C14—C9	60.0 (9)	C35—C36—C41—C42	−56.5 (11)
C12—C13—C14—C9	−62.3 (8)	C37—C36—C41—C42	−178.9 (8)
C17—C13—C14—C9	176.3 (6)	C35—C36—C41—C40	179.1 (7)
C19—C13—C14—C15	−71.7 (8)	C37—C36—C41—C40	56.7 (9)
C12—C13—C14—C15	166.0 (7)	C46—C40—C41—C42	−69.9 (9)
C17—C13—C14—C15	44.6 (8)	C39—C40—C41—C42	167.9 (7)
C8—C9—C14—C13	179.5 (6)	C44—C40—C41—C42	46.7 (8)
C10—C9—C14—C13	58.0 (8)	C46—C40—C41—C36	60.8 (9)
C8—C9—C14—C15	−55.4 (9)	C39—C40—C41—C36	−61.3 (9)
C10—C9—C14—C15	−176.9 (7)	C44—C40—C41—C36	177.5 (7)
C13—C14—C15—C16	−34.1 (8)	C36—C41—C42—C43	−164.7 (8)
C9—C14—C15—C16	−164.0 (7)	C40—C41—C42—C43	−35.7 (9)
C14—C15—C16—C17	9.8 (9)	C41—C42—C43—C44	10.8 (11)
C15—C16—C17—C20	145.0 (7)	C42—C43—C44—C47	146.2 (9)
C15—C16—C17—C13	16.7 (9)	C42—C43—C44—C40	17.0 (11)
C14—C13—C17—C20	−160.9 (7)	C46—C40—C44—C47	−42.0 (12)
C19—C13—C17—C20	−42.1 (11)	C39—C40—C44—C47	85.5 (11)
C12—C13—C17—C20	85.1 (9)	C41—C40—C44—C47	−160.7 (9)
C14—C13—C17—C16	−37.1 (8)	C46—C40—C44—C43	81.0 (10)
C19—C13—C17—C16	81.6 (9)	C39—C40—C44—C43	−151.6 (9)
C12—C13—C17—C16	−151.1 (8)	C41—C40—C44—C43	−37.7 (9)
C16—C17—C20—C21	178.6 (8)	C43—C44—C47—C49	60.2 (11)
C13—C17—C20—C21	−62.1 (11)	C40—C44—C47—C49	179.0 (9)

C16—C17—C20—C22	52.5 (10)	C43—C44—C47—C48	−175.8 (9)
C13—C17—C20—C22	171.8 (8)	C40—C44—C47—C48	−56.9 (13)
C21—C20—C22—C23	101.2 (14)	C44—C47—C49—C50	−146.9 (16)
C17—C20—C22—C23	−131.5 (13)	C48—C47—C49—C50	87.5 (18)
C20—C22—C23—C24	−175.1 (13)	C47—C49—C50—C51	176.9 (17)
C22—C23—C24—C27	118.7 (18)	C49—C50—C51—C54	137 (2)
C22—C23—C24—C25	−117.5 (17)	C49—C50—C51—C52	−103 (3)
C27—C24—C25—O2	177.7 (17)	C54—C51—C52—O4	−177 (3)
C23—C24—C25—O2	57 (2)	C50—C51—C52—O4	64 (4)
C27—C24—C25—C26	−55 (2)	C54—C51—C52—C53	−64 (3)
C23—C24—C25—C26	−175.8 (14)	C50—C51—C52—C53	177 (2)

Hydrogen-bond geometry (Å, º)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O3—H3*O*···O1*W*	0.84	2.48	3.282 (11)	161
O1*W*—H11*W*···O3	0.91 (8)	2.45 (9)	3.282 (11)	151 (10)
O1*W*—H12*W*···O3^{i}	0.87 (7)	2.07 (9)	2.834 (9)	147 (10)
O1—H1*O*···O3^{ii}	0.84	1.94	2.766 (9)	169

Symmetry codes: (i) −*x*+1, *y*−1/2, −*z*+1; (ii) −*x*+2, *y*−1/2, −*z*+1.