Supplementary material

(2*R*,6'*R*,*E*)-3'-(1-aminoethylidene)-7-chloro-4,6-dimethoxy-6'-methyl-3*H*-spiro[benzofuran-2,1'-cyclohexane]-2',3,4'-trione

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Figure S1. ^{1}H NMR spectrum (300 MHz) of **3** in DMSO-d_6

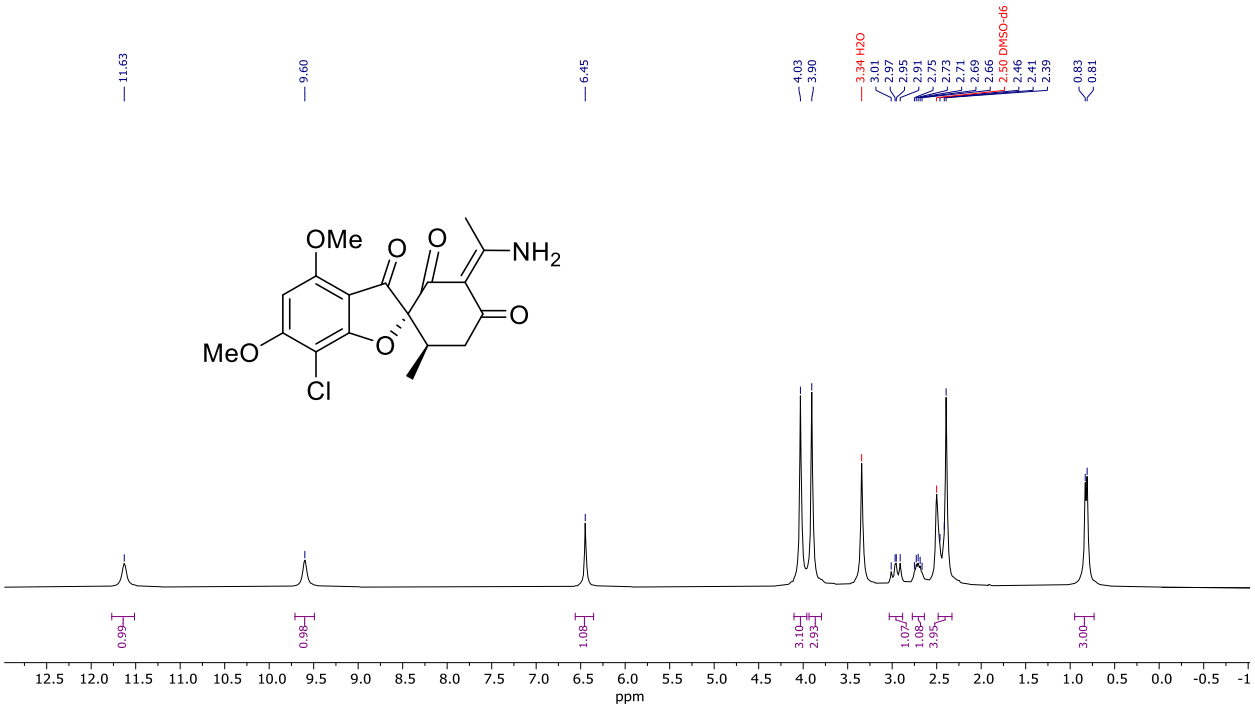


Figure S2. ^{13}C {^{1}H} NMR spectrum (75 MHz) of **3** in DMSO-d_6

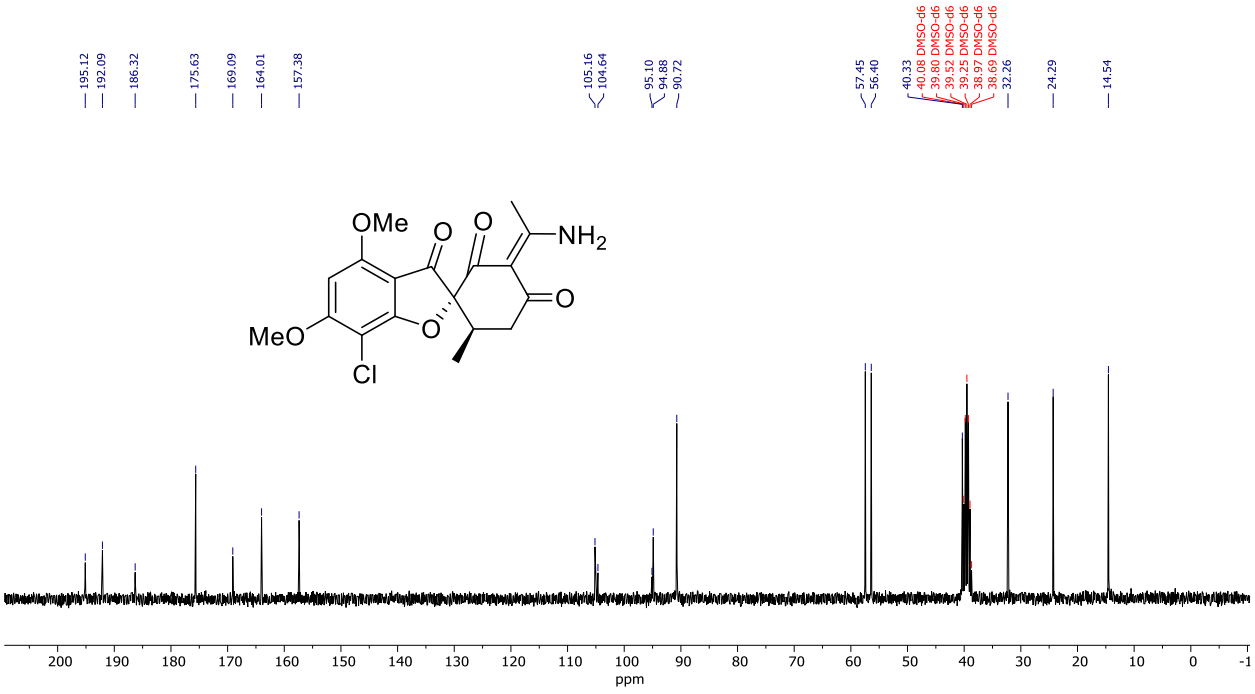
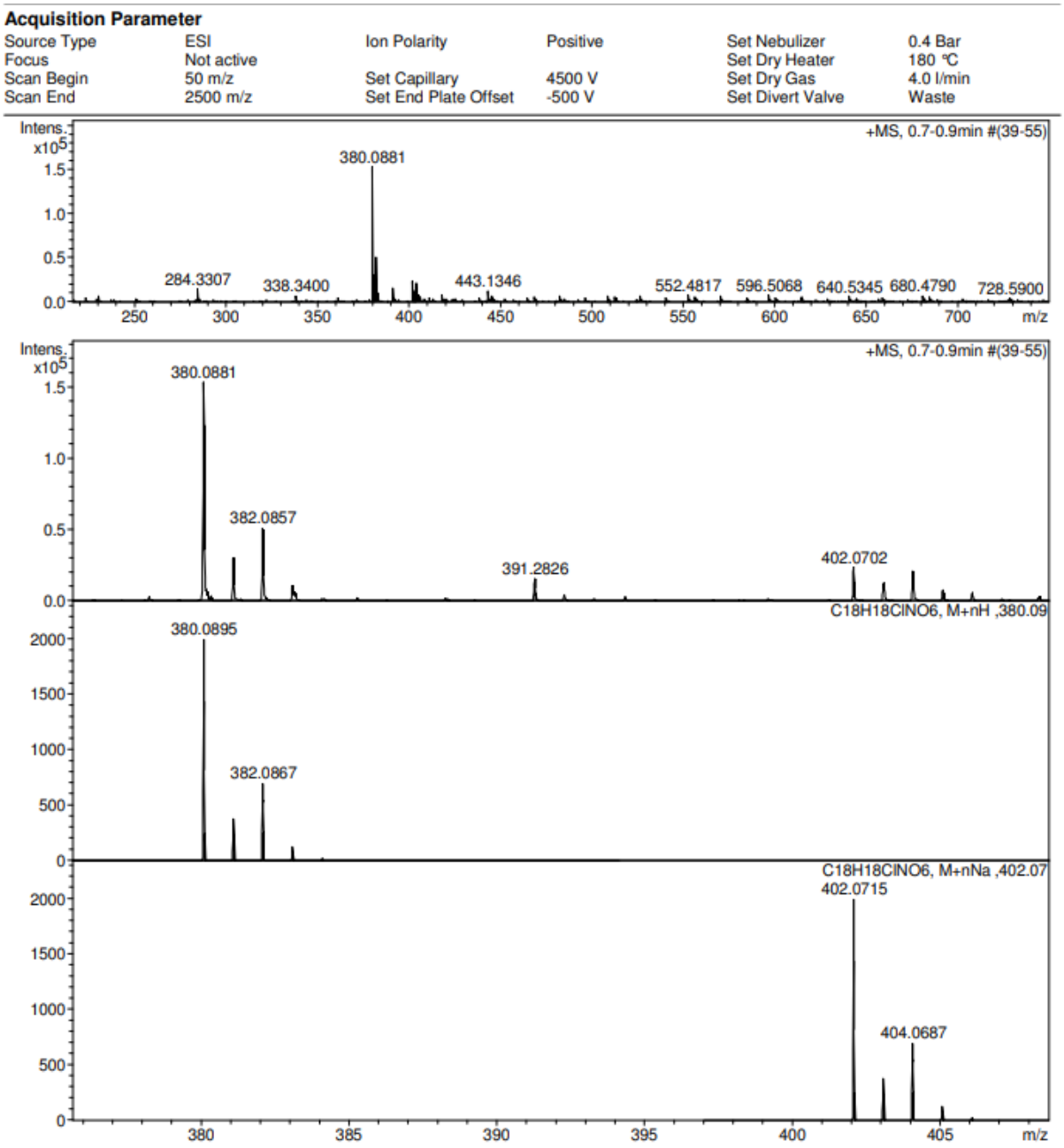


Figure S3. HRMS for compound **3**.



X-ray crystallographic data and refinement details.

X-ray diffraction data were collected at 100K on a four-circle Rigaku Synergy S diffractometer equipped with a HyPix6000HE area-detector (kappa geometry, shutterless ω-scan technique), using graphite monochromatized Cu K_α-radiation. The intensity data were integrated and corrected for absorption and decay by the CrysAlisPro program[19]. The structure was solved by direct methods using SHELXT[20] and refined on F^2 using SHELXL-2018[21] in the OLEX2 program.[22] All non-hydrogen atoms were refined with individual anisotropic displacement parameters. The locations of hydrogen atoms H20A and H20B were found from the electron density-difference map; these hydrogen atoms were refined with individual isotropic displacement parameters. All other hydrogen atoms were placed in ideal calculated positions and refined as riding atoms with relative isotropic displacement parameters. The Mercury program suite[23] was used for molecular graphics.

The crystal contains disordered solvent molecules in the voids with volume of 164 $Å^3$ per independent part of unit cell. A solvent mask was used by OLEX2[4] to remove solvent molecules (51 electrons were found).

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Table S1. Crystal data and structure refinement for **3**

Identification code	**3**	
Empirical formula	C18 H18 Cl N O6	
Formula weight	379.78	
Temperature	99.9(2) K	
Wavelength	1.54184 Å	
Crystal system	Orthorhombic	
Space group	$P2_12_12_1$	
Unit cell dimensions	a = 8.78910(6) Å	α= 90°.
	b = 11.75912(10) Å	β= 90°.
	c = 21.4735(2) Å	γ = 90°.
Volume	2219.33(3) $Å^3$	
Z	4	
Density (calculated)	1.137 g/cm^3	
Absorption coefficient	1.778 mm^{-1}	
F(000)	792	
Crystal size	0.41 x 0.08 x 0.06 mm^3	
Theta range for data collection	4.117 to 77.761°.	
Index ranges	-8<=h<=11, -14<=k<=14, -27<=l<=26	
Reflections collected	24677	
Independent reflections	4705 [R(int) = 0.0358]	
Observed reflections	4638	
Completeness to theta = 67.684°	99.9 %	
Absorption correction	Gaussian	
Max. and min. transmission	1.000 and 0.570	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	4705 / 1 / 248	
Goodness-of-fit on F^2	1.041	
Final R indices [I>2sigma(I)]	R1 = 0.0547, wR2 = 0.1607	
R indices (all data)	R1 = 0.0552, wR2 = 0.1614	
Absolute structure parameter	0.05(2)	
Largest diff. peak and hole	0.550 and -0.572 $e.Å^{-3}$	
CCDC	**2240675**	

Table S2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for **3**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Cl(3)	8410(1)	4195(1)	4272(1)	34(1)
O(6)	1812(3)	3284(2)	4197(1)	28(1)
O(4)	7022(3)	1956(2)	4270(1)	31(1)
O(1)	5817(3)	5866(2)	4269(1)	27(1)
O(14)	5028(4)	6441(2)	3131(1)	44(1)
O(8)	1772(3)	5907(2)	4218(1)	31(1)
O(12)	2903(4)	9845(2)	3891(2)	42(1)
N(20)	4122(5)	9871(3)	2794(2)	41(1)
C(4)	5944(4)	2765(3)	4249(2)	26(1)
C(10)	4381(4)	7406(3)	4723(2)	25(1)
C(5)	4373(4)	2540(3)	4228(2)	26(1)
C(2)	5416(4)	4746(3)	4243(2)	25(1)
C(9)	4440(4)	6538(3)	4197(2)	25(1)
C(6)	3334(4)	3423(3)	4214(2)	22(1)
C(13)	4184(4)	8255(3)	3458(2)	27(1)
C(14)	4566(4)	7072(3)	3545(2)	28(1)
C(17)	4095(4)	6875(3)	5365(2)	29(1)
C(12)	3402(4)	8858(3)	3952(2)	27(1)
C(3)	6478(4)	3889(3)	4247(2)	27(1)
C(16)	1254(4)	2141(3)	4133(2)	29(1)
C(8)	3119(4)	5656(3)	4214(2)	25(1)
C(18)	4579(5)	8819(3)	2896(2)	33(1)
C(15)	6539(4)	793(3)	4321(2)	33(1)
C(11)	3177(4)	8286(3)	4570(2)	26(1)
C(7)	3863(4)	4558(3)	4228(2)	23(1)
C(19)	5538(7)	8300(4)	2395(2)	48(1)

Table S3. Bond lengths [Å] and angles [°] for **3**.

Cl(3)-C(3)	1.737(4)	C(15)-H(15A)	0.9800
O(6)-C(6)	1.348(4)	C(15)-H(15B)	0.9800
O(6)-C(16)	1.437(4)	C(15)-H(15C)	0.9800
O(4)-C(4)	1.343(4)	C(11)-H(11A)	0.9900
O(4)-C(15)	1.437(4)	C(11)-H(11B)	0.9900
O(1)-C(2)	1.364(4)	C(19)-H(19A)	0.9800
O(1)-C(9)	1.453(4)	C(19)-H(19B)	0.9800
O(14)-C(14)	1.227(4)	C(19)-H(19C)	0.9800
O(8)-C(8)	1.220(4)	C(6)-O(6)-C(16)	117.0(3)
O(12)-C(12)	1.248(4)	C(4)-O(4)-C(15)	117.9(3)
N(20)-C(18)	1.320(5)	C(2)-O(1)-C(9)	107.8(2)
N(20)-H(20A)	0.88(5)	C(18)-N(20)-H(20A)	104(4)
N(20)-H(20B)	0.89(5)	C(18)-N(20)-H(20B)	124(5)
C(4)-C(5)	1.406(5)	H(20A)-N(20)-H(20B)	131(6)
C(4)-C(3)	1.403(5)	O(4)-C(4)-C(5)	124.1(3)
C(10)-H(10)	1.0000	O(4)-C(4)-C(3)	115.5(3)
C(10)-C(9)	1.523(5)	C(3)-C(4)-C(5)	120.4(3)
C(10)-C(17)	1.534(5)	C(9)-C(10)-H(10)	107.8
C(10)-C(11)	1.517(5)	C(9)-C(10)-C(17)	113.5(3)
C(5)-H(5)	0.9500	C(17)-C(10)-H(10)	107.8
C(5)-C(6)	1.384(4)	C(11)-C(10)-H(10)	107.8
C(2)-C(3)	1.373(5)	C(11)-C(10)-C(9)	108.7(3)
C(2)-C(7)	1.383(4)	C(11)-C(10)-C(17)	111.0(3)
C(9)-C(14)	1.539(5)	C(4)-C(5)-H(5)	119.7
C(9)-C(8)	1.557(4)	C(6)-C(5)-C(4)	120.5(3)
C(6)-C(7)	1.413(4)	C(6)-C(5)-H(5)	119.7
C(13)-C(14)	1.443(5)	O(1)-C(2)-C(3)	122.2(3)
C(13)-C(12)	1.449(5)	O(1)-C(2)-C(7)	114.2(3)
C(13)-C(18)	1.420(5)	C(3)-C(2)-C(7)	123.6(3)
C(17)-H(17A)	0.9800	O(1)-C(9)-C(10)	108.4(3)
C(17)-H(17B)	0.9800	O(1)-C(9)-C(14)	105.0(3)
C(17)-H(17C)	0.9800	O(1)-C(9)-C(8)	104.9(2)
C(12)-C(11)	1.501(5)	C(10)-C(9)-C(14)	113.8(3)
C(16)-H(16A)	0.9800	C(10)-C(9)-C(8)	113.8(3)
C(16)-H(16B)	0.9800	C(14)-C(9)-C(8)	110.2(3)
C(16)-H(16C)	0.9800	O(6)-C(6)-C(5)	124.4(3)
C(8)-C(7)	1.448(4)	O(6)-C(6)-C(7)	116.2(3)
C(18)-C(19)	1.497(6)	C(5)-C(6)-C(7)	119.4(3)

C(14)-C(13)-C(12)	119.2(3)	C(7)-C(8)-C(9)	104.9(3)
C(18)-C(13)-C(14)	120.3(3)	N(20)-C(18)-C(13)	120.4(4)
C(18)-C(13)-C(12)	120.6(3)	N(20)-C(18)-C(19)	115.7(4)
O(14)-C(14)-C(9)	115.8(3)	C(13)-C(18)-C(19)	123.9(3)
O(14)-C(14)-C(13)	124.4(3)	O(4)-C(15)-H(15A)	109.5
C(13)-C(14)-C(9)	119.7(3)	O(4)-C(15)-H(15B)	109.5
C(10)-C(17)-H(17A)	109.5	O(4)-C(15)-H(15C)	109.5
C(10)-C(17)-H(17B)	109.5	H(15A)-C(15)-H(15B)	109.5
C(10)-C(17)-H(17C)	109.5	H(15A)-C(15)-H(15C)	109.5
H(17A)-C(17)-H(17B)	109.5	H(15B)-C(15)-H(15C)	109.5
H(17A)-C(17)-H(17C)	109.5	C(10)-C(11)-H(11A)	108.8
H(17B)-C(17)-H(17C)	109.5	C(10)-C(11)-H(11B)	108.8
O(12)-C(12)-C(13)	123.1(3)	C(12)-C(11)-C(10)	113.9(3)
O(12)-C(12)-C(11)	117.5(3)	C(12)-C(11)-H(11A)	108.8
C(13)-C(12)-C(11)	119.4(3)	C(12)-C(11)-H(11B)	108.8
C(4)-C(3)-Cl(3)	121.5(3)	H(11A)-C(11)-H(11B)	107.7
C(2)-C(3)-Cl(3)	120.8(3)	C(2)-C(7)-C(6)	118.4(3)
C(2)-C(3)-C(4)	117.7(3)	C(2)-C(7)-C(8)	107.7(3)
O(6)-C(16)-H(16A)	109.5	C(6)-C(7)-C(8)	133.8(3)
O(6)-C(16)-H(16B)	109.5	C(18)-C(19)-H(19A)	109.5
O(6)-C(16)-H(16C)	109.5	C(18)-C(19)-H(19B)	109.5
H(16A)-C(16)-H(16B)	109.5	C(18)-C(19)-H(19C)	109.5
H(16A)-C(16)-H(16C)	109.5	H(19A)-C(19)-H(19B)	109.5
H(16B)-C(16)-H(16C)	109.5	H(19A)-C(19)-H(19C)	109.5
O(8)-C(8)-C(9)	124.3(3)	H(19B)-C(19)-H(19C)	109.5
O(8)-C(8)-C(7)	130.8(3)		

Table S4. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for **3**. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Cl(3)	20(1)	18(1)	64(1)	-2(1)	1(1)	2(1)
O(6)	19(1)	14(1)	50(1)	-2(1)	-4(1)	0(1)
O(4)	25(1)	15(1)	53(1)	2(1)	-3(1)	4(1)
O(1)	22(1)	11(1)	48(1)	1(1)	-1(1)	3(1)
O(14)	66(2)	22(1)	44(2)	-6(1)	11(1)	12(1)
O(8)	21(1)	18(1)	55(2)	-2(1)	-5(1)	1(1)
O(12)	53(2)	16(1)	59(2)	5(1)	3(1)	12(1)
N(20)	53(2)	25(2)	46(2)	12(1)	-2(2)	-5(2)
C(4)	22(2)	20(2)	35(2)	1(1)	-1(1)	6(1)
C(10)	22(2)	15(1)	37(2)	0(1)	-1(1)	-1(1)
C(5)	23(2)	15(1)	39(2)	0(1)	-1(1)	0(1)
C(2)	24(2)	15(1)	34(2)	1(1)	0(1)	-2(1)
C(9)	17(1)	16(1)	41(2)	-3(1)	-2(1)	2(1)
C(6)	19(1)	14(1)	34(2)	0(1)	-2(1)	2(1)
C(13)	25(2)	18(2)	38(2)	-1(1)	-3(1)	-1(1)
C(14)	29(2)	21(2)	33(2)	-2(1)	1(1)	2(1)
C(17)	26(2)	22(2)	38(2)	4(1)	-1(1)	-4(1)
C(12)	25(2)	14(1)	44(2)	2(1)	0(1)	0(1)
C(3)	25(2)	17(1)	39(2)	1(1)	1(2)	2(1)
C(16)	24(2)	14(2)	50(2)	-2(1)	0(1)	-2(1)
C(8)	24(2)	13(1)	38(2)	-1(1)	-2(1)	-1(1)
C(18)	33(2)	26(2)	40(2)	1(1)	-5(2)	-4(1)
C(15)	33(2)	15(1)	51(2)	0(1)	-5(2)	5(1)
C(11)	22(2)	14(1)	42(2)	0(1)	3(1)	4(1)
C(7)	20(1)	13(1)	36(2)	0(1)	-3(1)	1(1)
C(19)	62(3)	42(2)	39(2)	6(2)	10(2)	5(2)

Table S5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$x 10^3) for **3**.

	x	y	z	U(eq)
H(10)	5387	7802	4738	30
H(5)	4023	1776	4223	31
H(17A)	3022	6657	5400	43
H(17B)	4343	7429	5690	43
H(17C)	4736	6199	5415	43
H(16A)	1549	1840	3725	44
H(16B)	143	2140	4169	44
H(16C)	1691	1663	4461	44
H(15A)	5970	578	3947	49
H(15B)	5886	707	4688	49
H(15C)	7433	300	4364	49
H(11A)	2167	7913	4572	31
H(11B)	3174	8873	4900	31
H(19A)	4940	7732	2168	72
H(19B)	6429	7934	2582	72
H(19C)	5874	8895	2106	72
H(20A)	3690(70)	10080(50)	3150(20)	51(16)
H(20B)	4300(80)	10260(60)	2450(30)	70(20)

Table S6. Torsion angles [°] for **3**.

O(6)-C(6)-C(7)-C(2)	-179.7(3)	C(13)-C(12)-C(11)-C(10)	27.8(4)
O(6)-C(6)-C(7)-C(8)	-1.7(6)	C(14)-C(9)-C(8)-O(8)	-73.8(5)
O(4)-C(4)-C(5)-C(6)	179.3(3)	C(14)-C(9)-C(8)-C(7)	106.8(3)
O(4)-C(4)-C(3)-Cl(3)	-0.3(5)	C(14)-C(13)-C(12)-O(12)	-172.9(4)
O(4)-C(4)-C(3)-C(2)	-178.3(3)	C(14)-C(13)-C(12)-C(11)	7.3(5)
O(1)-C(2)-C(3)-Cl(3)	-1.0(5)	C(14)-C(13)-C(18)-N(20)	174.4(4)
O(1)-C(2)-C(3)-C(4)	177.0(3)	C(14)-C(13)-C(18)-C(19)	-6.8(6)
O(1)-C(2)-C(7)-C(6)	-178.7(3)	C(17)-C(10)-C(9)-O(1)	-69.5(3)
O(1)-C(2)-C(7)-C(8)	2.8(4)	C(17)-C(10)-C(9)-C(14)	174.2(3)
O(1)-C(9)-C(14)-O(14)	42.6(4)	C(17)-C(10)-C(9)-C(8)	46.8(4)
O(1)-C(9)-C(14)-C(13)	-136.0(3)	C(17)-C(10)-C(11)-C(12)	178.9(3)
O(1)-C(9)-C(8)-O(8)	173.7(4)	C(12)-C(13)-C(14)-O(14)	169.2(4)
O(1)-C(9)-C(8)-C(7)	-5.6(4)	C(12)-C(13)-C(14)-C(9)	-12.3(5)
O(8)-C(8)-C(7)-C(2)	-177.3(4)	C(12)-C(13)-C(18)-N(20)	-6.0(6)
O(8)-C(8)-C(7)-C(6)	4.5(7)	C(12)-C(13)-C(18)-C(19)	172.7(4)
O(12)-C(12)-C(11)-C(10)	-152.0(3)	C(3)-C(4)-C(5)-C(6)	-1.0(6)
C(4)-C(5)-C(6)-O(6)	-179.6(3)	C(3)-C(2)-C(7)-C(6)	-0.2(6)
C(4)-C(5)-C(6)-C(7)	-0.7(5)	C(3)-C(2)-C(7)-C(8)	-178.6(3)
C(10)-C(9)-C(14)-O(14)	160.9(3)	C(16)-O(6)-C(6)-C(5)	-5.8(5)
C(10)-C(9)-C(14)-C(13)	-17.7(4)	C(16)-O(6)-C(6)-C(7)	175.2(3)
C(10)-C(9)-C(8)-O(8)	55.5(5)	C(8)-C(9)-C(14)-O(14)	-69.9(4)
C(10)-C(9)-C(8)-C(7)	-123.9(3)	C(8)-C(9)-C(14)-C(13)	111.5(3)
C(5)-C(4)-C(3)-Cl(3)	180.0(3)	C(18)-C(13)-C(14)-O(14)	-11.2(6)
C(5)-C(4)-C(3)-C(2)	2.0(5)	C(18)-C(13)-C(14)-C(9)	167.3(3)
C(5)-C(6)-C(7)-C(2)	1.3(5)	C(18)-C(13)-C(12)-O(12)	7.5(6)
C(5)-C(6)-C(7)-C(8)	179.2(4)	C(18)-C(13)-C(12)-C(11)	-172.2(3)
C(2)-O(1)-C(9)-C(10)	129.3(3)	C(15)-O(4)-C(4)-C(5)	-5.0(5)
C(2)-O(1)-C(9)-C(14)	-108.9(3)	C(15)-O(4)-C(4)-C(3)	175.3(3)
C(2)-O(1)-C(9)-C(8)	7.3(3)	C(11)-C(10)-C(9)-O(1)	166.5(3)
C(9)-O(1)-C(2)-C(3)	174.7(3)	C(11)-C(10)-C(9)-C(14)	50.1(4)
C(9)-O(1)-C(2)-C(7)	-6.7(4)	C(11)-C(10)-C(9)-C(8)	-77.3(4)
C(9)-C(10)-C(11)-C(12)	-55.6(4)	C(7)-C(2)-C(3)-Cl(3)	-179.4(3)
C(9)-C(8)-C(7)-C(2)	2.0(4)	C(7)-C(2)-C(3)-C(4)	-1.4(6)
C(9)-C(8)-C(7)-C(6)	-176.1(4)		

Table S7. Hydrogen bonds for **3** [Å and °].

D-H...A	d(D-H)	d(H...A)	d(D...A)	<(DHA)
N(20)-H(20A)...O(12)	0.88(5)	1.76(5)	2.589(5)	155(6)
N(20)-H(20B)...O(14)#1	0.89(5)	1.96(5)	2.812(4)	162(7)

Symmetry transformations used to generate equivalent atoms:

#1 -x+1,y+1/2,-z+1/2