Electronic Supplementary Information

Selective Construction of Fused Heterocycles by Iridium-catalyzed Reductive Three-Component Annulation Reaction

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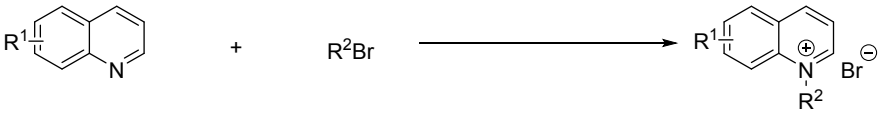
Table of Contents

General Information

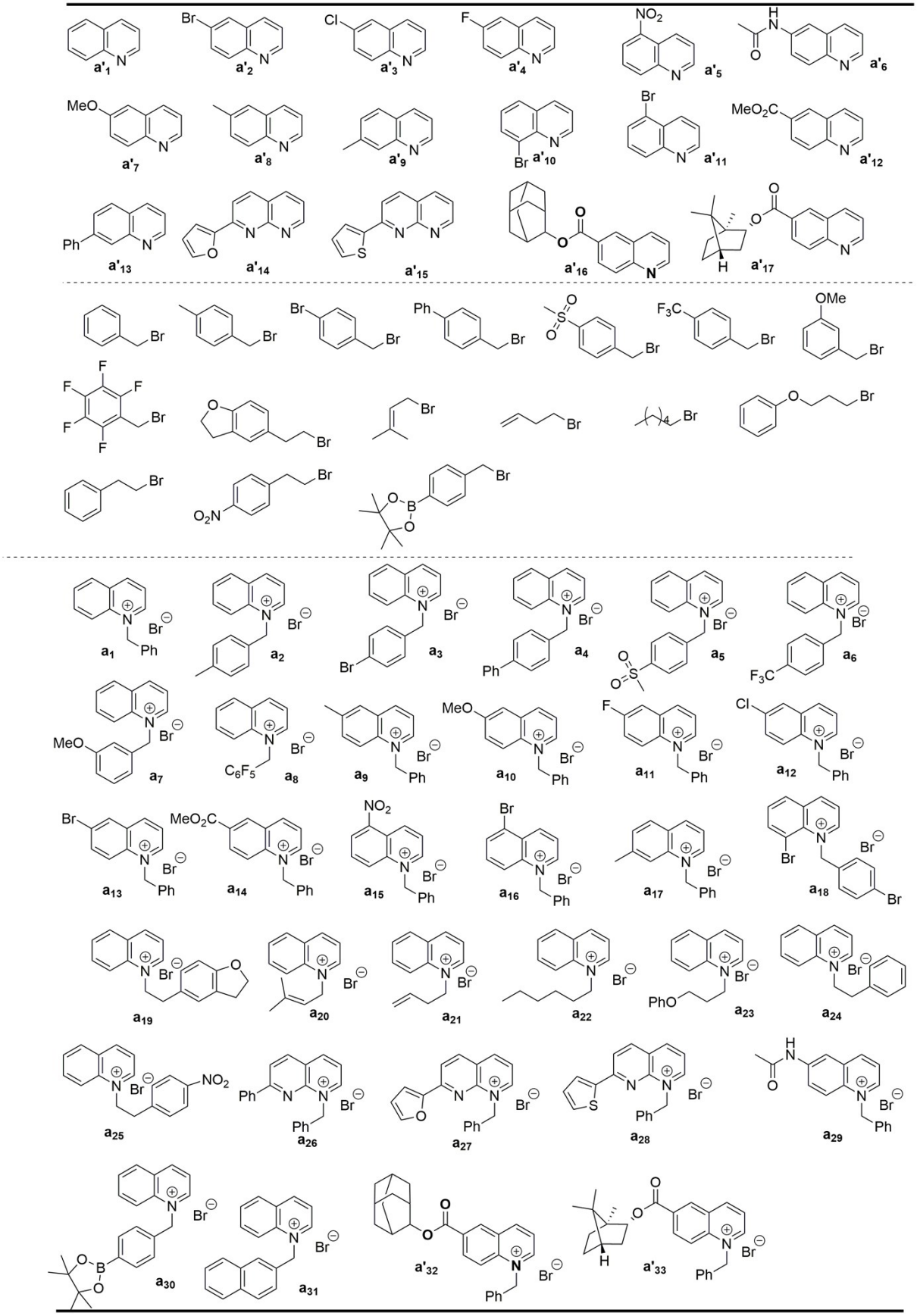
All the obtained products were characterized by melting points (m.p.), ^{1}H-NMR, ^{13}C-NMR, and mass spectra (MS), the NMR spectra of the known compounds were found to be identical with the ones reported in the literatures. Additionally, all the new compounds were further characterized by high resolution mass spectra (HRMS). Melting points were measured on an Electrothemal SGW-X4 microscopy digital melting point apparatus and are uncorrected; ^{1}H-NMR, ^{13}C-NMR spectra were obtained on Bruker-500 or 400; Mass spectra were recorded on Trace DSQ GC/MS，High-resolution mass spectra (HRMS) were recorded on a JEOL JMS-600 spectrometer. Chemical shifts were reported in parts per million (ppm, δ) downfield from tetramethylsilane. Proton coupling patterns are described as singlet (s), doublet (d), triplet (t), multiplet (m); TLC was performed using commercially prepared 100-400 mesh silica gel plates (GF254), and visualization was effected at 254 nm; All the reagents were purchased from commercial sources (J&KChemic, TCI, Fluka, Acros, SCRC), and used without further purification.

Substrate preparation



Method 1: quinoline (3 mmol), benzyl bromide (6 mmol) and acetone (5 mL) were introduced in a flask (50 mL). The resulting mixture was then stirred at room temperature for 24 hours. Then, the solvent was removed. The reaction mixture was washed with small amount of diethyl ether and finally dried under vacuum to get the salt $\mathbf{a_1}$-$\mathbf{a_{18}}$ and $\mathbf{a_{26}}$-$\mathbf{a_{33}}$.

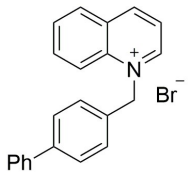
Method 2: quinoline (3 mmol), benzyl bromide (3 mmol) and toluene (3 mL) were introduced in a flask (50 mL). The resulting mixture was stirred at 110 ºC for 24 hours. Then, the solvent was removed. The reaction mixture was washed with small amount of diethyl ether and finally dried under vacuum to get the salt $\mathbf{a_{19}}$-$\mathbf{a_{25}}$.



Scheme S1. Substrates employed for the transformation

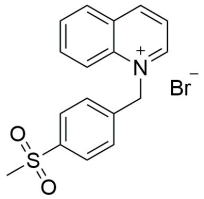
he spectro-
s c o p i c d a t a o f 12 were identical to those of the previous report.
The spectro-
s c o p i c d a t a o f 12 were identical to those of the previous report.

(1) 1-([1,1'-biphenyl]-4-ylmethyl)quinolin-1-ium bromide (a_4)



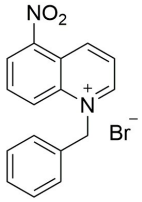
Method 1; White solid, ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.09 (d, J = 5.0 Hz, 1H), 9.51 (d, J = 10.0 Hz, 1H), 8.71 (d, J = 5.0 Hz, 1H), 8.59 (d, J = 5.0 Hz, 1H), 8.40 (dd, J = 10.0, 5.0 Hz, 1H), 8.30 – 8.21 (m, 1H), 8.12 – 7.99 (m, 1H), 7.71 (d, J = 5.0 Hz, 2H), 7.64 (d, J = 5.0 Hz, 2H), 7.61 (d, J = 10.0 Hz, 2H), 7.49 – 7.42 (m, 2H), 7.40 – 7.34 (m, 1H), 6.62 (s, 2H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 150.9, 148.6, 141.0, 139.6, 138.0, 136.3, 133.5, 131.4, 130.4, 130.4, 129.4, 128.6, 128.2, 127.7, 127.1, 123.0, 119.9, 60.0. HRMS (ESI): Calcd. for $C_{22}H_{18}N$ [M-Br]$^+$: 296.1434; found: 296.1429.

(2) 1-(4-(methylsulfonyl)benzyl)quinolin-1-ium bromide (a_5)



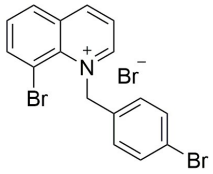
Method 1; White solid, ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.99 – 9.88 (m, 1H), 9.48 (d, J = 5.0 Hz, 1H), 8.67 – 8.53 (m, 1H), 8.49 (d, J = 10.0 Hz, 1H), 8.37 (dd, J = 10.0, 5.0 Hz, 1H), 8.28 – 8.16 (m, 1H), 8.10 – 8.00 (m, 1H), 7.99 – 7.90 (m, 2H), 7.67 (d, J = 5.0 Hz, 2H), 6.62 (s, 2H), 3.23 (s, 3H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 151.4, 149.0, 141.4, 140.1, 138.0, 136.5, 131.5, 130.5, 130.5, 128.6, 128.1, 123.1, 119.6, 59.6, 43.8. HRMS (ESI): Calcd. for $C_{17}H_{16}SO_2N$ [M-Br]$^+$: 298.0896; found: 298.0890.

(3) 1-benzyl-5-nitroquinolin-1-ium bromide (a_{15})



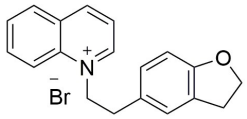
Method 1; Yellow solid, ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.10 – 9.98 (m, 1H), 9.62 (d, J = 10.0 Hz, 1H), 8.96 (d, J = 10.0 Hz, 1H), 8.75 (d, J = 5.0 Hz, 1H), 8.53 (dd, J = 10.0, 5.0 Hz, 1H), 8.43 – 8.29 (m, 1H), 7.49 – 7.43 (m, 2H), 7.45 – 7.33 (m, 3H), 6.55 (s, 2H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 152.5, 147.1, 143.8, 138.1, 134.7, 134.0, 129.6, 129.4, 128.0, 127.6, 125.9, 125.5, 123.1, 61.5. HRMS (ESI): Calcd. for $C_{16}H_{13}N_2O_2$ [M-Br]$^+$: 265.0977; found: 265.0969.

(4) 8-bromo-1-(4-bromobenzyl)quinolin-1-ium bromide(a_{18})



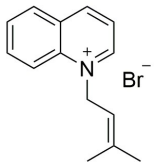
Method 1; Yellow solid ,^{1}H NMR (500 MHz, DMSO-d_6) δ 9.96 (d, J = 5.0 Hz, 1H), 9.40 (d, J = 5.0 Hz, 1H), 8.91 (d, J = 2.0 Hz, 1H), 8.52 (d, J = 10.0 Hz, 1H), 8.42 – 8.33 (m, 2H), 7.61 (d, J = 5.0 Hz, 2H), 7.43 (d, J = 5.0 Hz, 2H), 6.49 (s, 2H). ^{13}C NMR (126 MHz, DMSO) δ 151.5, 147.7, 138.7, 136.9, 133.5, 133.1, 132.4, 131.6, 130.3, 124.2, 123.7, 122.6, 122.0, 59.8. HRMS (ESI): Calcd. for $C_{16}H_{12}NBr_2$ [M-Br]$^+$:375.9331; found: 375.9324.

(5) 1-(2-(2,3-dihydrobenzofuran-5-yl)ethyl)quinolin-1-ium bromide (a_{19})



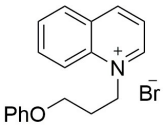
Method 2; Yellow solid ,^{1}H NMR (500 MHz, DMSO-d_6) δ 9.41 – 9.27 (m, 2H), 8.70 (d, J = 10.0 Hz, 1H), 8.52 (d, J = 5.0 Hz, 1H), 8.35 – 8.21 (m, 1H), 8.18 – 8.04 (m, 2H), 7.10 (s, 1H), 6.82 (d, J = 5.0 Hz, 1H), 6.62 (d, J = 5.0 Hz, 1H), 5.40 – 5.23 (m, 2H), 4.49 (t, J = 10.0 Hz, 2H), 3.27 – 3.19 (m, 2H), 3.14 – 3.06 (m, 2H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 159.3, 150.1, 148.0, 137.8, 136.19, 131.2, 130.4, 130.1, 128.8, 128.3, 128.1, 126.2, 122.3, 119.5, 109.2, 71.3, 58.9, 35.2, 29.4. HRMS (ESI): Calcd. for $C_{19}H_{18}ON$ [M-Br]$^+$: 276.1383; found:276.1380.

(6) **1-(3-methylbut-2-en-1-yl)quinolin-1-ium bromide** (**a_{20}**)



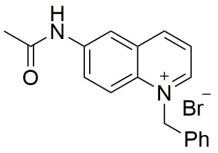
Method 2; White solid, ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.76 (dd, J = 5.8, 1.5 Hz, 1H), 9.40 (d, J = 8.3 Hz, 1H), 8.55 – 8.49 (m, 2H), 8.30 – 8.26 (m, 1H), 8.22 (dd, J = 8.4, 5.8 Hz, 1H), 8.03 (t, J = 7.6 Hz, 1H), 5.78 (d, J = 6.9 Hz, 2H), 5.51 (t, J = 8.0 Hz, 1H), 1.91 (s, 3H), 1.73 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 149.6, 147.8, 141.4, 137.9, 136.0, 131.1, 130.3, 130.1, 122.8, 119.6, 117.3, 56.1, 25.9, 19.0. HRMS (ESI): Calcd. for $C_{14}H_{16}N$ [M–Br]$^+$: 198.1277; found: 198.1273.

(7) 1-(3-phenoxypropyl)quinolin-1-ium bromide(a_{23})



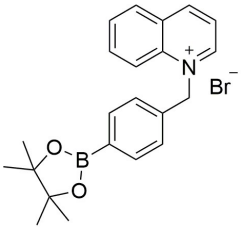
Method 2; Brown solid, ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.73 (d, J = 5.0 Hz, 1H), 9.37 (d, J = 10.0 Hz, 1H), 8.71 (d, J = 10.0 Hz, 1H), 8.55 (d, J = 5.0 Hz, 1H), 8.31 – 8.26 (m, 1H), 8.23 – 8.18 (m, 1H), 8.07 (t, J = 10.0 Hz, 1H), 7.32 – 7.22 (m, 2H), 6.97 – 6.87 (m, 1H), 6.76 (d, J = 10.0 Hz, 2H), 5.38 – 5.24 (m, 2H), 4.23 – 4.15 (m, 2H), 2.53 – 2.49 (m, 2H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 158.3, 150.6, 148.0, 138.1, 136.1, 131.3, 130.3, 130.2, 129.9, 122.6, 121.2, 119.4, 114.7, 65.2, 55.7, 29.3. HRMS (ESI): Calcd. for $C_{18}H_{18}ON$ [M-Br]$^+$: 264.1388; found: 264.1377.

(8) 6-acetamido-1-benzylquinolin-1-ium bromide (a_{29})



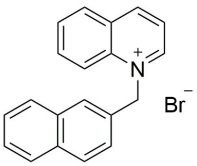
Method 1; White solid, ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.91 (s, 1H), 9.71 (dd, J = 5.8, 1.3 Hz, 1H), 9.30 (d, J = 8.4 Hz, 1H), 8.85 (d, J = 2.4 Hz, 1H), 8.56 (d, J = 9.6 Hz, 1H), 8.26 – 8.21 (m, 2H), 7.45 – 7.35 (m, 5H), 6.41 (s, 2H), 2.20 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 170.1, 148.5, 147.6, 140.4, 134.4, 131.5, 129.5, 129.2, 128.9, 127.9, 123.1, 120.7, 116.2, 60.2, 24.6. HRMS (ESI): Calcd. for $C_{18}H_{17}N_2O$ [M–Br]$^+$: 277.1335; found: 277.1329.

(9) 1-(4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzyl)quinolin-1-ium bromide(a_{30})



Method 1; White solid, ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.86 (d, J = 5.0 Hz, 1H), 9.44 (d, J = 5.0 Hz, 1H), 8.55 (d, J = 5.0 Hz, 1H), 8.47 (d, J = 10.0 Hz, 1H), 8.35 (dd, J = 10.0, 5.0 Hz, 1H), 8.25 – 8.17 (m, 1H), 8.11 – 8.00 (m, 1H), 7.68 (d, J = 5.0 Hz, 2H), 7.40 (d, J = 5.0 Hz, 2H), 6.48 (s, 2H), 1.27 (s, 12H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 151.1, 148.8, 138.0, 137.6, 136.3, 135.5, 131.4, 130.5, 130.4, 127.2, 123.0, 119.8, 84.3, 60.4, 25.1. HRMS (ESI): Calcd. for $C_{22}H_{25}BO_2N$ [M-Br]$^+$: 346.1973; found: 346.1966.

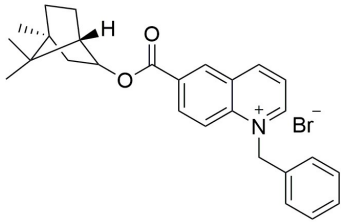
(10) 1-(naphthalen-1-ylmethyl)quinolin-1-ium bromide(a_{31})



Method 1;Yellow solid ,^{1}H NMR (500 MHz, DMSO-d_6) δ 9.95 – 9.90 (m, 1H), 9.46 (d, J = 10.0 Hz, 1H), 8.61 (d, J = 10.0 Hz, 1H), 8.56 (d, J = 10.0 Hz, 1H), 8.43 – 8.32 (m, 1H), 8.21 (t, J = 10.0 Hz, 1H), 8.07 – 8.01 (m, 1H), 8.00 – 7.95 (m, 2H), 7.95 – 7.90 (m, 1H), 7.90 – 7.82 (m, 1H), 7.59 – 7.50 (m, 3H), 6.61 (s, 2H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 151.0, 148.7, 138.1, 136.2, 133.1, 133.1, 131.9, 131.4, 130.4, 129.4,

128.4, 128.1, 127.3, 127.3, 127.0, 125.3, 123.0, 119.8, 60.5 HRMS (ESI): Calcd. for $C_{20}H_{16}N$ $[M-Br]^+$: 270.1277; found: 270.1272.

(11) 1-benzyl-6-((((1S,4S)-4,7,7-trimethylbicyclo[2.2.1]heptan-2-yl)oxy)carbonyl)quinolin-1-ium bromide (a_{33})



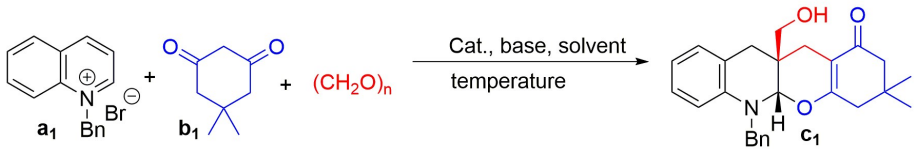
Method 2; Yellow solid , ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.97 (d, J = 5.0 Hz, 1H), 9.66 (d, J = 10.0 Hz, 1H), 9.17 (s, 1H), 8.67 (d, J = 5.0 Hz, 1H), 8.61 – 8.55 (m, 1H), 8.47 – 8.38 (m, 1H), 7.47 – 7.35 (m, 5H), 6.47 (s, 2H), 5.26 – 5.06 (m, 1H), 2.46 – 2.38 (m, 1H), 2.21 – 2.10 (m, 1H), 1.83 – 1.68 (m, 2H), 1.48 – 1.37 (m, 1H), 1.36 – 1.26 (m, 1H), 1.20 – 1.11 (m, 1H), 0.94 (s, 3H), 0.90 (s, 6H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 164.7, 152.8, 150.1, 139.9, 134.6, 134.2, 133.2, 131.2, 130.2, 129.6, 129.3, 127.9, 124.0, 120.9, 81.6, 60.7, 49.3, 48.1, 44.8, 36.7, 28.1, 27.4, 20.0, 19.1, 13.9. HRMS (ESI): Calcd. for $C_{27}H_{30}NO_2$ [M-Br]+:400.2276; found:400.2265.

Optimization of reaction conditions

Typical Procedure for the Synthesis of product c_1

Under N_2 atmosphere, $[Cp^*IrCl_2]_2$ (1 mol %), *t*-BuONa (2.0 equiv.), $(CH_2O)_n$ (10.0 equiv, 60 mg), 1-benzylquinolin-1-ium bromide $\mathbf{a_1}$ (0.2 mmol), 5,5-dimethylcyclohexane-1,3-dione $\mathbf{b_1}$ (0.30 mmol) and MeOH (1.5 mL) were introduced in a Schlenk tube (50 mL), successively. Then, the Schlenk tube was closed and the resulting mixture was stirred at 85 ºC for 16 h. After cooling down to room temperature, the reaction mixture was purified by preparative TLC on silica, eluting with petroleum ether (60-90 ºC): ethyl acetate (3 : 1) to give product $\mathbf{c_1}$ as yellow solid.

Table S1 Screening of optimal reaction conditions. [a]



Entry	Catalyst	Base(1.0 eq.)	Solvent	Yield% of $\mathbf{c_1}$ [b]
1	$[Ru(p\text{-cymene})Cl_2]_2$	*t*-BuONa	MeOH	45
2	$[Cp^*IrCl_2]_2$	*t*-BuONa	MeOH	70
3	$Ru_3(CO)_{12}$, Xantphos	*t*-BuONa	MeOH	44
4	$Ru_3(CO)_{12}$	*t*-BuONa	MeOH	38
5	$RuHCl(CO)(PPh_3)_3$	*t*-BuONa	MeOH	45
6	$Cp^*RuCl_2(COD)$	*t*-BuONa	MeOH	46
7	$[RuCl_2(COD)]_m$	*t*-BuONa	MeOH	40
8	$[Cp^*IrCl_2]_2$	Na_2CO_3	MeOH	56
9	$[Cp^*IrCl_2]_2$	$Mg(OMe)_2$	MeOH	28

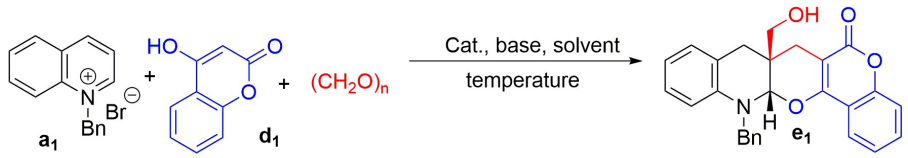
10	$[Cp^*IrCl_2]_2$	DBU	MeOH	/
11	$[Cp^*IrCl_2]_2$	MeONa	MeOH	35
12	$[Cp^*IrCl_2]_2$	K_3PO_4	MeOH	65
13	$[Cp^*IrCl_2]_2$	*t*-BuONa	MeOH	(55, 75) [c]
14	$[Cp^*IrCl_2]_2$	*t*-BuONa	MeOH	(62,74) [d]
15	$[Cp^*IrCl_2]_2$	*t*-BuONa	*t*-amyl alcohol	65
16	$[Cp^*IrCl_2]_2$	*t*-BuONa	toluene	25
17	$[Cp^*IrCl_2]_2$	*t*-BuONa	EtOH	55
18	-	*t*-BuONa	MeOH	trace
19	$[Cp^*IrCl_2]_2$	*t*-BuONa	MeOH	(30, 75, **83**, 79) [e]
20	$[Cp^*IrCl_2]_2$	*t*-BuONa	MeOH	(53, 65) [f]

[a]Conditions: unless otherwise stated, all the reactions were performed with $\mathbf{a_1}$ (0.20 mmol), $\mathbf{b_1}$ (0.30 mmol), catalyst (1 mol %), paraformaldehyde (10.0 equiv.), base (1.0 equiv.), solvent (1.5 mL) at 85 °C for 16 h under N_2 protection; [b]Isolated yield. [c]Yields obtained at 65 ºC, 100 ºC. [d]Yields obtained at 12 h and 20 h. [e]Yields obtained with 0.5, 1.5, 2.0 and 2.5 equiv. *t*-BuONa. [f]Yields obtained with 8.0 and 12.0 equiv. paraformaldehyde.

Typical Procedure for the Synthesis of product $\mathbf{e_1}$

Under N_2 atmosphere, $[Cp^*IrCl_2]_2$ (1 mol %), KOH (1.0 equiv.), $(CH_2O)_n$ (10.0 equiv, 60 mg), 1-benz-ylquinolin-1-ium bromide $\mathbf{a_1}$ (0.2 mmol), 4-hydroxy-2H-chromen-2-one $\mathbf{d_1}$ (0.30 mmol) and 1,4-dioxane (1.5 mL) were introduced in a Schlenk tube (50 mL), successively. Then, the Schlenk tube was closed and the resulting mixture was stirred at 85 ºC for 16 h. After cooling down to room temperature, the reaction mixture was purified by preparative TLC on silica, eluting with petroleum ether (60-90 ºC): ethyl acetate (3 : 1) to give product $\mathbf{e_1}$ as yellow solid.

Table S2 Screening of optimal reaction conditions. [a]



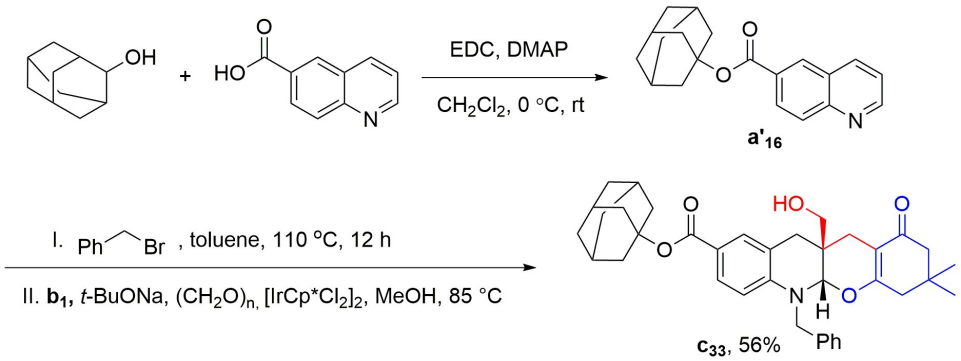
Entry	Catalyst	Base(1.0 eq.)	Solvent	Yield% of $\mathbf{e_1}$ [b]
1	$[Ru(p\text{-cymene})Cl_2]_2$	K_3PO_4	MeOH	25
2	$[Cp^*IrCl_2]_2$	K_3PO_4	MeOH	40
3	$Ru_3(CO)_{12}$, Xantphos	K_3PO_4	MeOH	38
4	$RuHCl(CO)(PPh_3)_3$	K_3PO_4	MeOH	<10
5	$[Cp^*IrCl_2]_2$	KOH	MeOH	45
6	$[Cp^*IrCl_2]_2$	Na_2CO_3	MeOH	<10
7	$[Cp^*IrCl_2]_2$	MeONa	MeOH	<10
8	$[Cp^*IrCl_2]_2$	Cs_2CO_3	MeOH	43
9	$[Cp^*IrCl_2]_2$	DBU	MeOH	trace
10	$[Cp^*IrCl_2]_2$	Et_3N	MeOH	trace

11	$[Cp^*IrCl_2]_2$	KOH	EtOH	<10
12	$[Cp^*IrCl_2]_2$	KOH	t-amyl alcohol	50
13	$[Cp^*IrCl_2]_2$	KOH	toluene	43
14	$[Cp^*IrCl_2]_2$	KOH	THF	trace
15	**$[Cp^*IrCl_2]_2$**	**KOH**	**1,4-dioxane**	**81**
16	$[Cp^*IrCl_2]_2$	KOH	DMSO	<10
17	$[Cp^*IrCl_2]_2$	KOH	DMF	25
18	$[Cp^*IrCl_2]_2$	KOH	1,4-dioxane	(77, 35) [c]
19	$[Cp^*IrCl_2]_2$	KOH	1,4-dioxane	(76, 81) [d]
20	$[Cp^*IrCl_2]_2$	KOH	1,4-dioxane	(75,78) [e]

[a]Conditions: unless otherwise stated, all the reactions were performed with $\mathbf{a_1}$ (0.20 mmol), $\mathbf{d_1}$ (0.30 mmol), catalyst (1 mol %), paraformaldehyde (10.0 equiv.), additive (1.0 equiv.), solvent (1.5 mL) at 85 °C for 16 h; [b]Isolated yields; [c] Yields obtained at 100 °C, 65 °C. [d] Yields obtained at 12 h and 18 h. [e] Yields obtained with 0.8 and 1.2 equiv. KOH.

Synthetic Utility

Synthesis of Compound

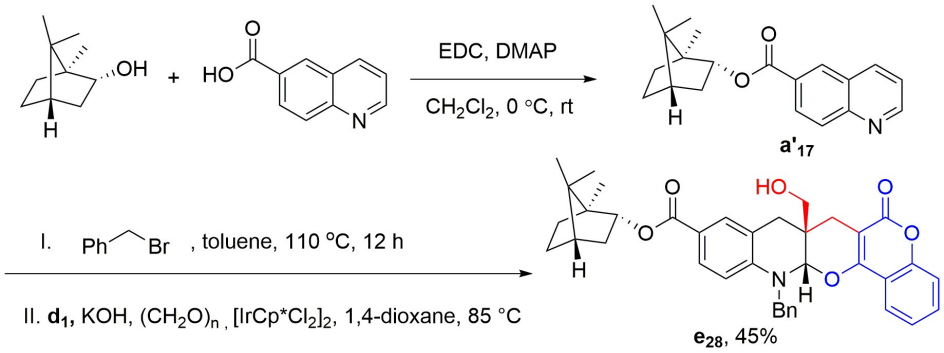


To a suspension of quinoline-6-carboxylic acid (5.0 mmol) in CH_2Cl_2 was added DMAP (4-(dimethylamino)-pyridine, 10.0 mmol) in one portion at room temperature. The reaction mixture was stirred for 10 min at room temperature. N-(3-(Dimethylamino)propyl)-N'-ethylcarbodiimide hydrochloride (EDC, 5.0 mmol) was added at 0 ºC. Then the resultant suspension was stirred for 10 min at 0 ºC. A solution of 2-Adamantanol (4.0 mmol) in CH_2Cl_2 was added at 0 °C. The cooling bath was removed, and the reaction mixture was stirred at room temperature for 16 h. The solution was diluted by the addition of saturated aqueous NH_4Cl solution and CH_2Cl_2 at room temperature. The organic phase was dried with anhydrous sodium sulfate, and then concentrated by removing the solvent under vacuum. Finally, the residue was purified by preparative TLC on silica to give a white solid $\mathbf{a'_{16}}$ (1174.0 mg, 91 % yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.93 (s, 1H), 8.46 (s, 1H), 8.20 (t, J = 12.5, 9.6 Hz, 2H), 8.07 (d, J = 8.6 Hz, 1H), 7.47-7.34(m, 1H), 2.27 (s, 6H), 2.20 (s, 3H), 1.73 – 1.63 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.6, 152.0, 149.7, 137.1, 130.4, 129.9, 129.3, 128.9, 127.2, 121.5, 81.4, 41.3, 36.1, 30.8. HRMS (ESI): Calcd. for $C_{20}H_{22}NO_2$ $[M+H]^+$: 308.1645; found: 308.1642.

$\mathbf{a'_{16}}$ (3.2 mmol), (bromomethyl)benzene (3.2 mmol), and toluene (5.0 mL) were introduced in a Schlenk tube, successively. And it was stirred at 110 °C for 12 h. Then, the solvent was removed. The reaction mixture was washed with small amount of diethyl ether and finally dried under vacuum to get $\mathbf{a_{32}}$(1221.1 mg, 80% yield)**.** Under N_2 atmosphere, $[IrCp^*Cl_2]_2$ (1 mol %), *t*-BuONa(2.0 equiv.), 5,5-dimethylcyclohexane-1,3-dione $\mathbf{b_1}$ (0.3 mmol), $\mathbf{a_{32}}$(0.2 mmol), Paraformaldehyde (10 equiv.) and

MeOH(1.5 mL) were introduced in a Schlenk tube, successively. Then the Schlenk tube was closed and the resulting mixture was stirred at 85 ºC for 16 h. After cooling down to room temperature, the reaction mixture was purified by preparative TLC on silica, eluting with petroleum ether (60-90 ºC): ethyl acetate (3 : 1) to give product **c_{33}** (56% yield).

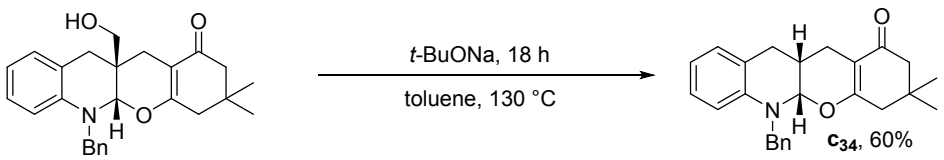
Synthesis of Compound e_{28}



To a suspension of quinoline-6-carboxylic acid (5.0 mmol) in CH_2Cl_2 was added DMAP (4-(dimethylamino)-pyridine, 10.0 mmol) in one portion at room temperature. The reaction mixture was stirred for 10 min at room temperature. N-(3-(Dimethylamino)propyl)-N'-ethylcarbodiimide hydrochloride (EDC, 5.0 mmol) was added at 0 ºC. Then the resultant suspension was stirred for 10 min at 0 ºC. A solution of (-)-Bomeol (4.0 mmol) in CH_2Cl_2 was added at 0 °C. The cooling bath was removed, and the reaction mixture was stirred at room temperature for 16 h. The solution was diluted by the addition of saturated aqueous NH_4Cl solution and CH_2Cl_2 at room temperature. The organic phase was dried with anhydrous sodium sulfate, and then concentrated by removing the solvent under vacuum. Finally, the residue was purified by preparative TLC on silica to give a white solid **a'_{17}** (1174.2 mg, 95% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.03 (d, J = 3.0 Hz, 1H), 8.61 (s, 1H), 8.33 (dd, J = 12.5, 9.0 Hz, 2H), 8.18 (d, J = 8.8 Hz, 1H), 7.50 (dd, J = 8.2, 4.2 Hz, 1H), 5.22 (d, J = 9.6 Hz, 1H), 2.54 (td, J = 10.0, 5.0 Hz, 1H), 2.27 – 2.17 (m, 1H), 1.91 – 1.77 (m, 2H), 1.48 (t, J = 12.6 Hz, 1H), 1.42 – 1.33 (m, 1H), 1.20 (dd, J = 13.8, 3.0 Hz, 1H), 1.01 (s, 3H), 0.97 (s, 3H), 0.96 (s, 3H). ^{13}C NMR (101 MHz, CDCl3) δ 166.34, 152.44, 150.07, 137.37, 130.79, 129.79, 129.00, 128.88, 127.44, 121.82, 81.07, 49.19, 47.97, 45.01, 36.96, 28.15, 27.49, 19.76, 18.96, 13.70. HRMS (ESI): Calcd. for $C_{20}H_{24}NO_2$ $[M+H]^+$: 310.1801; found: 310.1800.

a'_{17} (4.0 mmol), (bromomethyl)benzene (4.0 mmol), and toluene (5.0 mL) were introduced in a Schlenk tube, successively. And it was stirred at 110 ºC for 12 h. Then, the solvent was removed. The reaction mixture was washed with small amount of diethyl ether and finally dried under vacuum to get **a_{33}**(1628.6 mg, 85% yield)**.** Under N_2 atmosphere, $[IrCp^*Cl_2]_2$ (1 mol %), 4-hydroxy-2H-chromen-2-one **d_1** (0.3 mmol), KOH (1.0 equiv.), paraformaldehyde (10.0 equiv.) and 1,4-dioxane (1.5 mL) were introduced in a Schlenk tube, successively. Then the Schlenk tube was closed and the resulting mixture was stirred at 85 ºC for 16 h. After cooling down to room temperature, the reaction mixture was purified by preparative TLC on silica, eluting with petroleum ether (60-90 ºC): ethyl acetate (3 : 1) to give product **e_{28}** (45% yield).

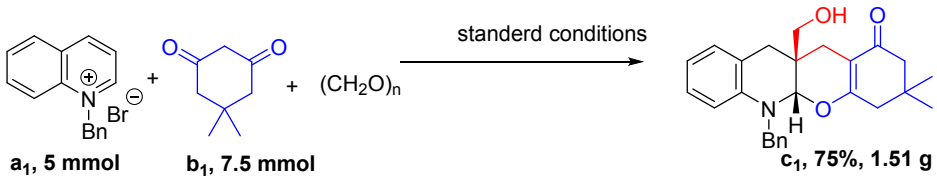
Dehydroxymethyl of compound c_1



Under N_2 atmosphere, **c_1** (0.20 mmol), *t*-BuONa (0.75 equive) and toluene (1.0 mL) were introduced in a Schlenk tube (50 mL), successively. Then, the Schlenk tube was closed and the resulting mixture was

stirred at 130 ˚C for 18 h. After cooling down to room temperature, the reaction mixture was concentrated by removing the solvent under vacuum, and the residue was purified by flash column chromatography, eluting with petroleum ether (60-90 ˚C): ethyl acetate (3 : 1) to give product **c$_{34}$**(60% yield) as white solid.

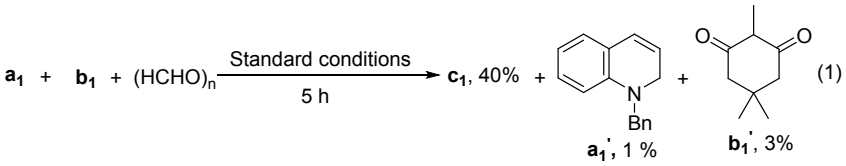
Gram-scale synthesis of compound c$_1$



Under N_2 atmosphere, $[Cp^*IrCl_2]_2$ (1 mol %), *t*-BuONa (2.0 equiv.), $(CH_2O)_n$ (10.0 equiv.), 1-benzylquinolin-1-ium bromide **a$_1$** (5.00 mmol), 5,5-dimethylcyclohexane-1,3-dione **b$_1$** (7.50 mmol) and MeOH (10 mL) were introduced in a Schlenk tube (100 mL), successively. Then, the Schlenk tube was closed and the resulting mixture was stirred at 85 ˚C for 16 h. After cooling down to room temperature, the reaction mixture was purified by preparative TLC on silica, eluting with petroleum ether (60-90 ˚C): ethyl acetate (2 : 1) to give product **c$_1$** (75% yield) as yellow solid.

Control experiment

The interruption of the model reaction



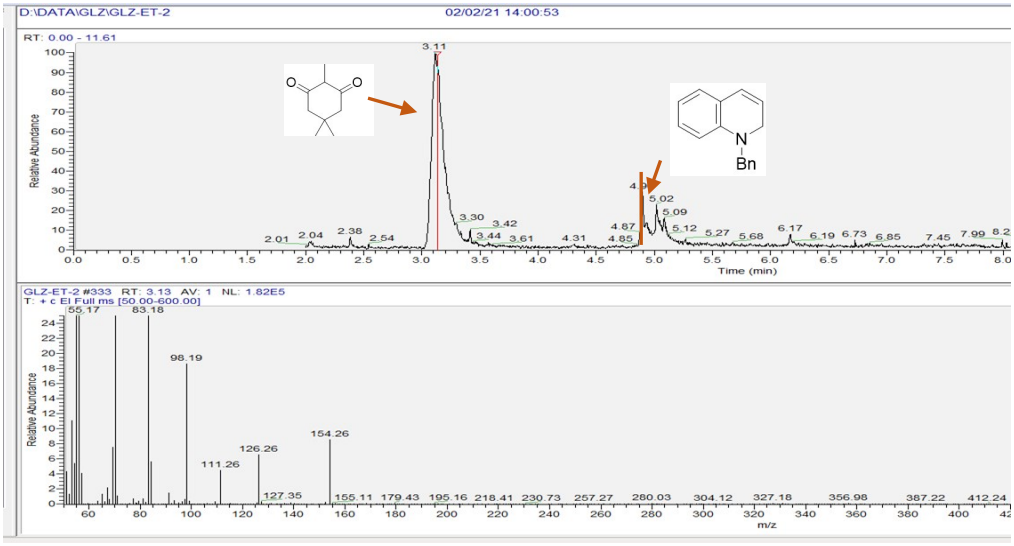
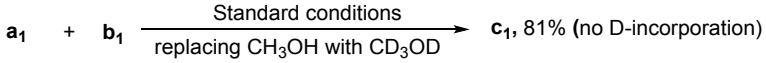


Fig. S1 GC-MS spectrum of the interrupted model reaction at 5 h.

Deuterium labeling experiment



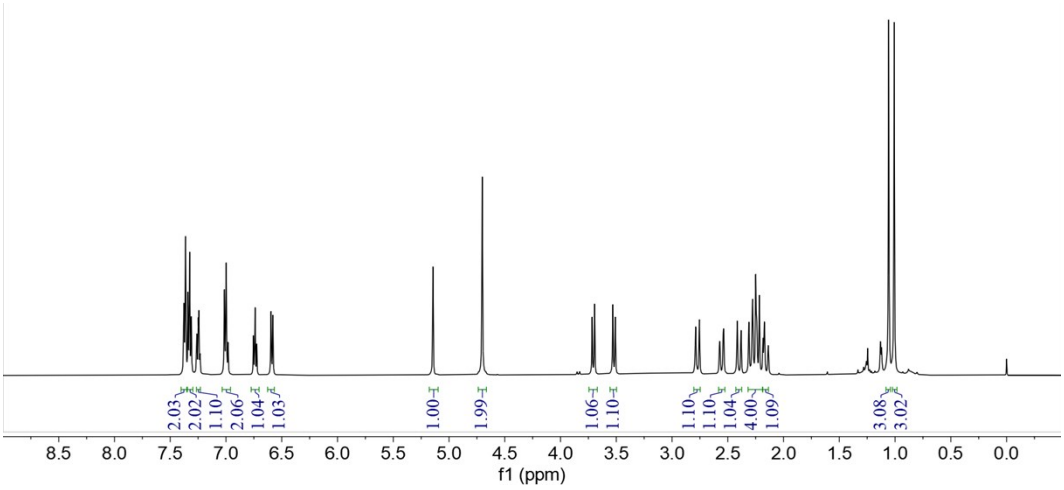


Fig. S2 ^{1}H-NMR spectrum of deuterated $\mathbf{c_1}$ with CD_3OD.

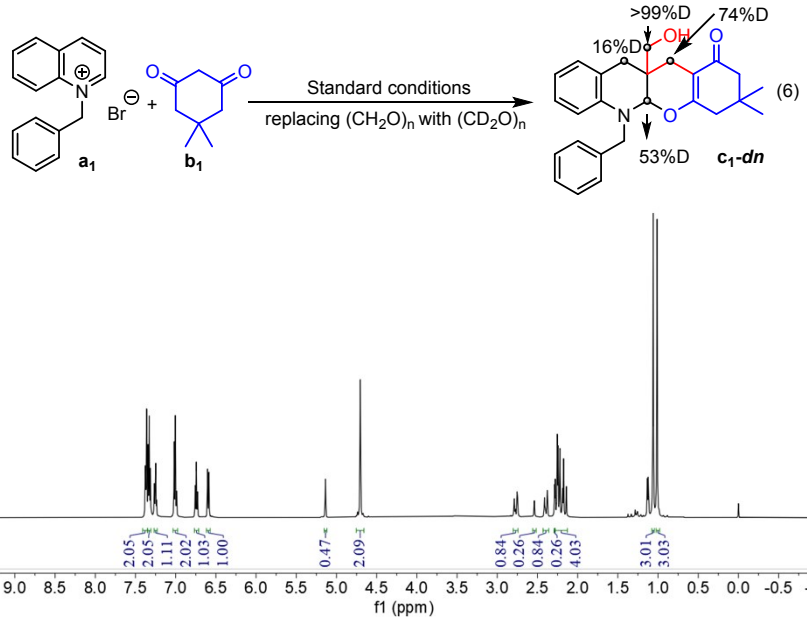
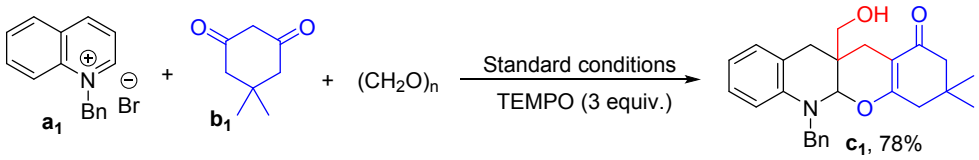


Fig. S3 ^{1}H-NMR spectrum of deuterated $\mathbf{c_1}$ with $(CD_2O)_n$.



Scheme S2. Radical verification experiments.

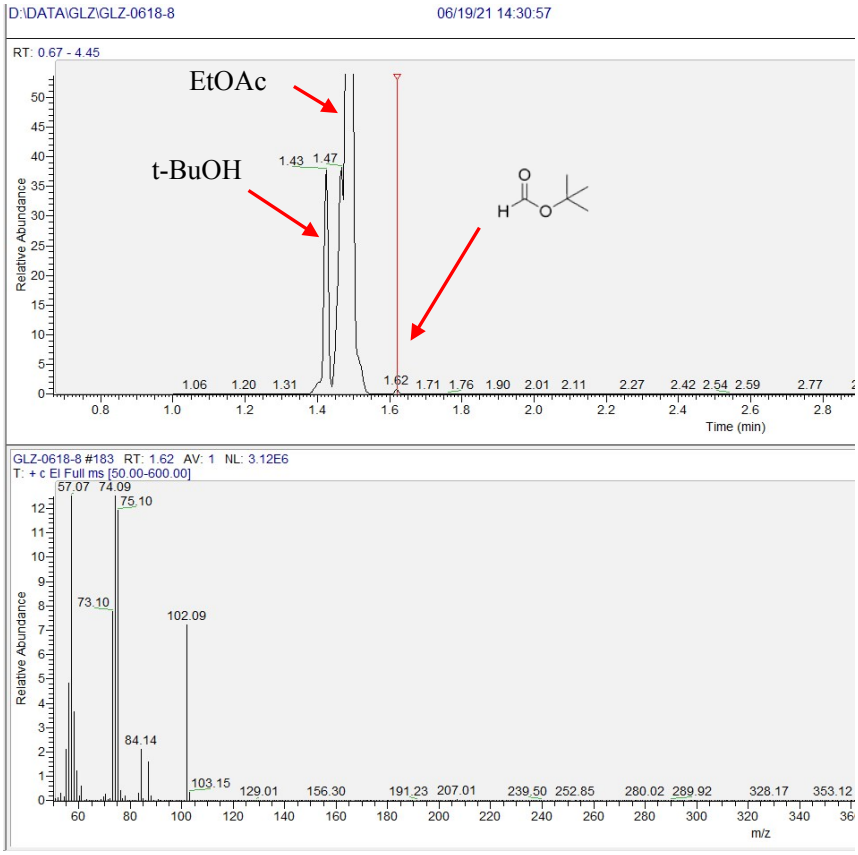
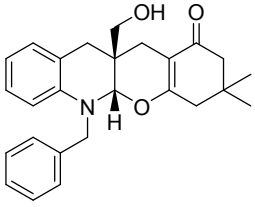


Fig. S4 GC-MS analysis of the model reaction using *t*-BuOH as solvent, tert-butyl formate detected.

The GC-MS analysis of the model reaction (synthesis of product $\mathbf{c_1}$) using *t*-BuOH instead of methanol as solvent was conducted, the detection of tert-butyl formate revealed that there is addition of alcohol to formaldehyde, then followed by Ir-catalyzed *β*-hydride elimination of the acetal forms metal hydride species [IrH].

Analytical Data of the Obtained Compounds

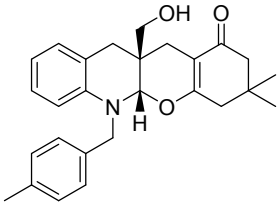
(1) *cis*-6-benzyl-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one ($\mathbf{c_1}$)



Yellow solid (66.9 mg, 0.166 mmol, 83% yield); m.p.: 141.5-142.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.33 (m, 4H), 7.31 – 7.27 (m, 1H), 7.04 (d, J = 8.0 Hz, 2H), 6.78 (d, J = 8.0 Hz, 1H), 6.63 (d, J = 8.0 Hz, 1H), 5.18 (s, 1H), 4.83 – 4.64 (m, 2H), 3.75 (d, J = 8.0 Hz, 1H), 3.56 (d, J = 8.0 Hz, 1H), 2.82 (d, J = 16.0 Hz, 1H), 2.59 (d, J = 16.0 Hz, 1H), 2.43 (d, J = 20.0 Hz, 1H), 2.38 – 2.24 (m, 4H), 2.19 (d, J = 16.0 Hz, 1H), 1.10 (s, 3H), 1.05 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 167.3, 141.1, 138.6, 129.8, 128.8, 127.3, 127.2, 126. 6, 120.8, 119.1, 112.8, 108.2, 90.9, 66.1, 55.0, 50.6, 41.9, 34.2, 32.4, 29.6, 29.5, 27.3, 26.6. HRMS (ESI): Calcd. for $C_{26}H_{30}NO_3$ $[M+H]^+$: 404.2220; found: 404.2219.

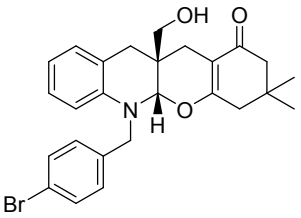
(2) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-(4-methylbenzyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chr

omeno[2,3-*b*]quinolin-1-one (c_2)



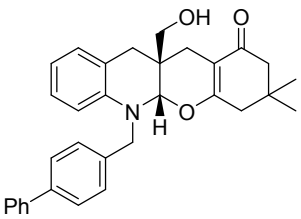
Yellow solid (69.3 mg, 0.166 mmol, 83% yield); m.p.: 159.5-160.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (d, *J* = 8.0 Hz, 2H), 7.18 (d, *J* = 8.0 Hz, 2H), 7.07 – 7.01 (m, 2H), 6.78 (t, *J* = 8.0 Hz, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 5.16 (s, 1H), 4.76 – 4.63 (m, 2H), 3.73 (d, *J* = 8.0 Hz, 1H), 3.54 (d, *J* = 12.0 Hz, 1H), 2.81 (d, *J* = 16.0 Hz, 1H), 2.59 (d, *J* = 16.0 Hz, 1H), 2.43 (d, *J* = 16.0 Hz, 1H), 2.37 (s, 3H), 2.35 – 2.29 (m, 2H), 2.29 – 2.25 (m, 2H), 2.19 (d, *J* = 20.0 Hz, 1H), 1.10 (s, 3H), 1.05 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.6, 167.4, 141.1, 136.8, 135.4, 129.8, 129.5, 127.3, 126.6, 120.8, 119.0, 112.7, 108.2, 90.9, 66.1, 54.7, 50.6, 42.0, 34.2, 32.4, 29.6, 29.5, 27.3, 26.7, 21.1. HRMS (ESI): Calcd. for $C_{27}H_{32}NO_3$ $[M+H]^+$:418.2376; found:418.2368.

(3) *cis*-6-(4-bromobenzyl)-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_3)



Yellow solid (59.6 mg, 0.124 mmol, 62% yield); m.p.: 159.6-160.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, *J* = 8.0 Hz, 2H), 7.31 – 7.24 (m, 2H), 7.04 – 6.91 (m, 2H), 6.80 – 6.68 (m, 1H), 6.48 (d, *J* = 8.0 Hz, 1H), 5.17 (s, 1H), 4.74 – 4.54 (m, 2H), 3.70 (d, *J* = 8.0 Hz, 1H), 3.50 (d, *J* = 8.0 Hz, 1H), 3.23 (s, 1H), 2.77 (d, *J* = 16.0 Hz, 1H), 2.61 (d, *J* = 20.0 Hz, 1H), 2.36 (d, *J* = 16.0 Hz, 1H), 2.31 – 2.18 (m, 4H), 2.14 (d, *J* = 20.0 Hz, 1H), 1.05 (s, 3H), 1.00 (s, 3 H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.8, 167.5, 140.7, 137.8, 131.8, 129.8, 128.4, 127.3, 120.9, 120.8, 119.2, 112.7, 108.3, 91.3, 65.9, 54.9, 50.6, 42.0, 34.2, 32.4, 29.6, 29.5, 27.3, 26.6. HRMS (ESI): Calcd. for $C_{26}H_{29}BrNO_3$ $[M+H]^+$: 482.1325; found: 482.1316.

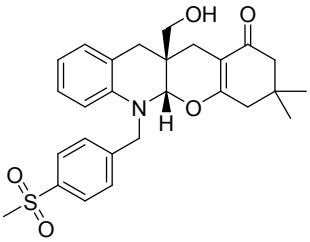
(4) *cis*-6-([1,1'-biphenyl]-4-ylmethyl)-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_4)



Yellow soild (52.8 mg, 0.110 mmol, 55% yield); m.p.: 116.0-117.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 – 7.55 (m, 4H), 7.45 – 7.40 (m, 4H), 7.34 – 7.30 (m, 1H), 7.02 (t, *J* = 5.0 Hz, 2H), 6.78 – 6.73 (m, 1H), 6.63 (d, *J* = 10.0 Hz, 1H), 5.17 (s, 1H), 4.74 (s, 2H), 3.74 (d, *J* = 10.0 Hz, 1H), 3.54 (d, *J* = 10.0 Hz, 1H), 2.79 (d, *J* = 20.0 Hz, 1H), 2.57 (d, *J* = 20.0 Hz, 1H), 2.41 (d, *J* = 15.0 Hz, 1H), 2.33 – 2.26 (m, 2H), 2.25 – 2.22 (m, 2H), 2.18 – 2.14 (m, 1H), 1.06 (s, 3H), 1.01 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.6, 167.3, 141.0, 140.8, 140.1, 137.7, 129.8, 128.8, 127.5, 127.3, 127.0, 127.0, 120.9, 119.1, 112.8, 108.3, 91.0, 66.1, 54.9, 50.6, 41.9, 34.2, 32.4, 29.6,

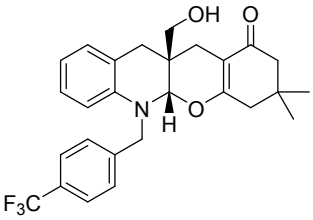
29.5, 27.3, 26.7. HRMS (ESI): Calcd. for $C_{32}H_{34}NO_3$ $[M+H]^+$: 480.2533; found: 480.2526.

(5) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-(4-(methylsulfonyl)benzyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_5)



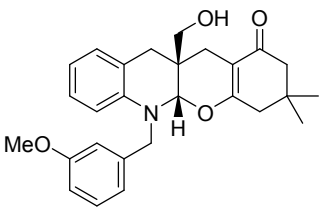
White solid (67.4 mg, 0.140 mmol, 70% yield); m.p.: 179.6-180.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 – 7.83 (m, 2H), 7.72 – 7.57 (m, 2H), 6.99 (d, *J* = 12.0 Hz, 2H), 6.82 – 6.69 (m, 1H), 6.40 (d, *J* = 8.0 Hz, 1H), 5.27 (s, 1H), 4.92 – 4.69 (m, 2H), 3.76 (d, *J* = 8.0 Hz, 1H), 3.53 (d, *J* = 8.0 Hz, 2H), 3.04 (s, 3H), 2.80 (d, *J* = 20.0 Hz, 1H), 2.68 (d, *J* = 16.0 Hz, 1H), 2.36 (d, *J* = 16.0 Hz, 1H), 2.32 – 2.20 (m, 4H), 2.17 (d, *J* = 16.0 Hz, 1H), 1.07 (s, 3H), 1.02 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.8, 167.4, 145.6, 140.5, 139.2, 129.9, 127.9, 127.5, 127.3, 121.0, 119.4, 112.6, 108.4, 91.4, 65.7, 55.2, 50.5, 44.5, 41.9, 34.2, 32.4, 29.6, 29.5, 27.3, 26.6. HRMS (ESI): Calcd. for $C_{27}H_{32}SNO_5$ $[M+H]^+$:482.1996; found: 482.1986.

(6) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-(4-(trifluoromethyl)benzyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_6)



White solid (75.4 mg, 0.160 mmol, 80% yield); m.p.: 182.6-183.6 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58 (d, *J* = 10.0 Hz, 2H), 7.52 (d, *J* = 5.0 Hz, 2H), 7.03 – 6.96 (m, 2H), 6.77 – 6.72 (m, 1H), 6.44 (d, *J* = 5.0 Hz, 1H), 5.22 (s, 1H), 4.83 – 4.69 (m, 2H), 3.74 (d, *J* = 10.0 Hz, 1H), 3.53 (d, *J* = 10.0 Hz, 1H), 2.79 (d, *J* = 15.0 Hz, 1H), 2.64 (d, *J* = 15.0 Hz, 1H), 2.38 (d, *J* = 15.0 Hz, 1H), 2.30 – 2.20 (m, 4H), 2.18 – 2.13 (m, 1H), 1.05 (s, 3H), 1.01 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.8, 167.4, 143.0, 140.7, 129.9, 129.4 (q, *J* = 32.3 Hz), 127.3, 126.8, 125.7 (q, *J* = 3.5 Hz), 124.2 (q, *J* = 272.0 Hz), 120.9, 119.3, 112.7, 108.4, 91.4, 65.9, 55.2, 50.6, 41.9, 34.2, 32.4, 29.6, 29.5, 27.3, 26.6. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.26. HRMS (ESI): Calcd. for $C_{27}H_{29}F_3NO_3$ $[M+H]^+$:472.2094; found: 472.2085.

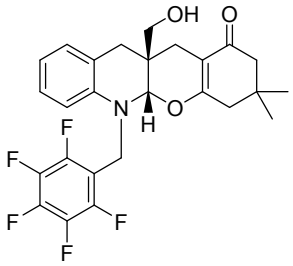
(7) *cis*-11a-(hydroxymethyl)-6-(3-methoxybenzyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_7)



Yellow solid (69.3 mg, 0.160 mmol, 80% yield); m.p.: 165.5-166.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28

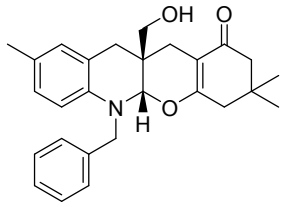
– 7.24 (m, 1H), 7.03 – 6.98 (m, 2H), 6.96 (d, *J* = 4.0 Hz, 2H), 6.82 – 6.72 (m, 2H), 6.60 (d, *J* = 8.0 Hz, 1H), 5.16 (s, 1H), 4.73 – 4.61 (m, 2H), 3.77 (s, 3H), 3.74 (d, *J* = 12.0 Hz, 1H), 3.53 (d, *J* = 12.0 Hz, 1H), 2.79 (d, *J* = 20.0 Hz, 1H), 2.57 (d, *J* = 16.0 Hz, 1H), 2.38 (d, *J* = 16.0 Hz, 1H), 2.30 (d, *J* = 4.0 Hz, 1H), 2.27 – 2.21 (m, 3H), 2.16 (d, *J* = 16.0 Hz, 1H), 1.07 (s, 3H), 1.02 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.5, 167.3, 160.1, 141.1, 140.5, 129.8, 129.7, 127.3, 120.8, 119.1, 118.7, 112.8, 112.6, 112.1, 108.3, 91.0, 66.1, 55.2, 55.1, 50.6, 41.9, 34.2, 32.4, 29.6, 29.5, 27.3, 26.6. HRMS (ESI): Calcd. for $C_{27}H_{32}NO_4$ $[M+H]^+$:434.2326; found: 434.2317.

(8) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-((perfluorophenyl)methyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_8)



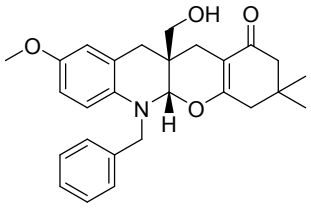
White solid (78.9 mg, 0.158 mmol, 80% yield); m.p.: 146.9-147.9 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (t, *J* = 8.0 Hz, 1H), 7.05 (d, *J* = 8.0 Hz, 1H), 6.94 (d, *J* = 8.0 Hz, 1H), 6.87 – 6.80 (m, 1H), 5.08 (s, 1H), 4.87 (d, *J* = 16.0 Hz, 1H), 4.72 (d, *J* = 12.0 Hz, 1H), 3.55 (d, *J* = 12.0 Hz, 1H), 3.42 (d, *J* = 8.0 Hz, 1H), 2.73 (d, *J* = 20.0 Hz, 1H), 2.54 – 2.40 (m, 2H), 2.32 – 2.19 (m, 4H), 2.17 (d, *J* = 20.0 Hz, 1H), 1.09 (s, 3H), 1.02 (s, 3H). ^{13}C NMR (126 MHz, CDCl3) δ 198.6, 167.1, 146.7-146.9(m), 144.6-144.9(m), 140.2, 138.4-138.8(m), 136.4-136.7(m), 130.3, 127.4, 121.4, 119.8, 111.7, 111.6 (d, J = 17.6 Hz), 108.4, 89.3, 65.7, 50.5, 41.7, 41.7, 34.1, 32.3, 29.4, 29.2, 27.2, 26.8. ^{19}F NMR (471 MHz, $CDCl_3$) δ -140.32 – -141.37 (m), -154.0 (dq, *J* = 43.1, 20.6 Hz), -161.5 (q, *J* = 20.4 Hz). HRMS (ESI): Calcd. for $C_{26}H_{25}F_5NO_3$ $[M+H]^+$:494.1749; found:494.1740.

(9) *cis*-6-benzyl-11a-(hydroxymethyl)-3,3,9-trimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_9)



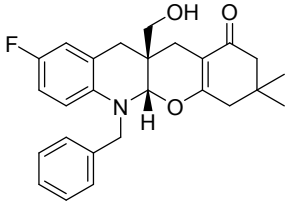
White solid (51.7 mg, 0.124 mmol, 62% yield); m.p.: 167.0-168.0 °C;^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (d, *J* = 8.0 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.25 (d, *J* = 8.0 Hz, 1H), 6.87 – 6.78 (m, 2H), 6.50 (d, *J* = 8.0 Hz, 1H), 5.11 (s, 1H), 4.72 – 4.62 (m, 2H), 3.71 (d, *J* = 12.0 Hz, 1H), 3.52 (d, *J* = 12.0 Hz, 1H), 2.75 (d, *J* = 16.8 Hz, 1H), 2.54 (d, *J* = 16.0 Hz, 1H), 2.36 (d, *J* = 20.0 Hz, 1H), 2.32 – 2.21 (m, 4H), 2.20 (s, 3H), 2.17 – 2.12 (m, 1H), 1.06 (s, 3H), 1.00 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 167.5, 138.8, 138.7, 130.4, 128.8, 128.3, 127.7, 127.1, 126.6, 120.8, 112.8, 108.2, 91.2, 66.2, 55.1, 50.6, 42.0, 34.3, 32.4, 29.5, 29.5, 27.3, 26.7, 20.3. HRMS (ESI): Calcd. for $C_{27}H_{32}NO_3$ $[M+H]^+$: 418.2377; found: 418.2368.

(10) *cis*-6-benzyl-11a-(hydroxymethyl)-9-methoxy-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{10})



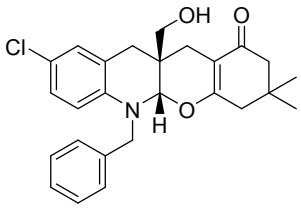
Yellow solid (52.8 mg, 0.122 mmol, 61% yield); m.p.: 146.6-147.6 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.31 (m, 4H), 7.27 – 7.25 (m, 1H), 6.62 (d, *J* = 5.0 Hz, 1H), 6.60 – 6.56 (m, 1H), 6.51 (d, *J* = 10.0 Hz, 1H), 5.10 (s, 1H), 4.72 – 4.63 (m, 2H), 3.72 (d, *J* = 10.0 Hz, 1H), 3.70 (s, 3H), 3.54 (d, *J* = 10.0 Hz, 1H), 2.76 (d, *J* = 15.0 Hz, 1H), 2.52 (d, *J* = 15.0 Hz, 1H), 2.40 (d, *J* = 15.0 Hz, 1H), 2.32 – 2.27 (m, 2H), 2.28 – 2.20 (m, 2H), 2.17 (d, *J* = 20.0 Hz, 1H), 1.06 (s, 3H), 1.02 (s, 3H).^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 167.6, 152.8, 138.8, 135.0, 128.8, 127.2, 126.6, 122.2, 115.5, 113.6, 112.5, 108.1, 91.4, 66.3, 55.6, 55.2, 50.6, 42.0, 34.5, 32.4, 29.8, 29.5, 27.3, 26.8. HRMS (ESI): Calcd. for $C_{27}H_{32}NO_4$ $[M+H]^+$:434.2326; found: 434.2318.

(11) *cis*-6-benzyl-9-fluoro-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{11})



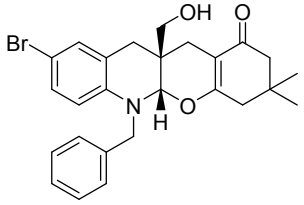
Yellow solid (67.5 mg, 0.160 mmol, 80% yield); m.p.: 143.0-144.0 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.34 (m, 4H), 7.29 (d, *J* = 8.0 Hz, 1H), 6.79 – 6.74 (m, 1H), 6.74 – 6.67 (m, 1H), 6.53 – 6.47 (m, 1H), 5.15 (s, 1H), 4.75 – 4.64 (m, 2H), 3.72 (d, *J* = 12.0 Hz, 1H), 3.56 (d, *J* = 8.0 Hz, 1H), 2.77 (d, *J* = 16.0 Hz, 1H), 2.58 (d, *J* = 16.0 Hz, 1H), 2.42 (d, *J* = 16.0 Hz, 1H), 2.35 – 2.27 (m, 3H), 2.25 – 2.17 (m, 2H), 1.09 (s, 3H), 1.05 (s, 3H). ^{13}C NMR (101 MHz, CDCl3) δ 198.7, 167.5, 156.38 (d, J = 237.6 Hz), 138.4, 137.2 (d, J = 1.7 Hz), 128.8, 127.3, 126.5, 122.6(d, J = 7.1 Hz), 116.2 (d, J = 22.2 Hz), 113.6, 113.50 (d, J = 28.3 Hz), 108.2, 91.2, 66.0, 55.5, 50.5, 41.9, 34.3, 32.4, 29.7, 29.4, 27.3, 26.6. ^{19}F NMR (376 MHz, $CDCl_3$) δ -126.2. HRMS (ESI): Calcd. for $C_{26}H_{29}FNO_3$ $[M+H]^+$:422.2126; found:422.2117.

(12) *cis*-6-benzyl-9-chloro-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{12})



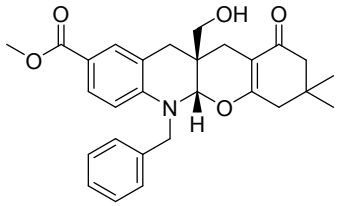
Yellow solid (74.3 mg, 0.170 mmol, 85% yield); m.p.: 163.5-164.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.33 (m, 4H), 7.29 (d, *J* = 8.0 Hz, 1H), 7.00 (s, 1H), 6.95 (d, *J* = 8.0 Hz, 1H), 6.50 (d, *J* = 8.0 Hz, 1H), 5.17 (s, 1H), 4.77 – 4.64 (m, 2H), 3.69 (d, *J* = 12.0 Hz, 1H), 3.54 (d, *J* = 12.0 Hz, 1H), 2.75 (d, *J* = 16.0 Hz, 1H), 2.58 (d, *J* = 20.0 Hz, 1H), 2.41 (d, *J* = 16.0 Hz, 1H), 2.35 – 2.23 (m, 4H), 2.19 (d, *J* = 16.0 Hz, 1H), 1.09 (s, 3H), 1.05 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.8, 167.4, 139.7, 138.1, 129.3, 128.9, 127.3, 127.0, 126.5, 123.8, 122.8, 114.0, 108.3, 91.0, 65.8, 55.4, 50.5, 41.9, 34.2, 32.4, 29.5, 29.4, 27.3, 26.6. HRMS (ESI): Calcd. for $C_{26}H_{29}ClNO_3$ $[M+H]^+$:438.1830; found:438.1823.

(13) *cis*-6-benzyl-9-bromo-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{13})



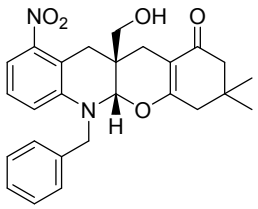
Yellow solid (72.2 mg, 0.150 mmol, 75% yield); m.p.: 183.0-184.0 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.30 (m, 4H), 7.27 – 7.24 (m, 1H), 7.11 (s, 1H), 7.06 (d, *J* = 8.0 Hz, 1H), 6.44 (d, *J* = 8.0 Hz, 1H), 5.13 (s, 1H), 4.73 – 4.59 (m, 2H), 3.67 (d, *J* = 12.0 Hz, 1H), 3.51 (d, *J* = 8.0 Hz, 1H), 2.73 (d, *J* = 16.0 Hz, 1H), 2.55 (d, *J* = 16.0 Hz, 1H), 2.37 (d, *J* = 16.0 Hz, 1H), 2.32 – 2.21 (m, 4H), 2.15 (d, *J* = 20.0 Hz, 1H), 1.06 (s, 3H), 1.02 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 167.1, 140.2, 138.0, 132.2, 129.9, 128.9, 127.3, 126.5, 123.2, 114.5, 111.1, 108.2, 90.7, 65.9, 55.3, 50.5, 41.9, 34.2, 32.4, 29.5, 29.3, 27.3, 26.5. HRMS (ESI): Calcd. for $C_{26}H_{29}BrNO_3$ $[M+H]^+$:482.1325; found:482.1316.

(14) methyl-(*cis*-6-benzyl-11a-(hydroxymethyl)-3,3-dimethyl-1-oxo-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinoline)-9-carboxylate (c_{14})



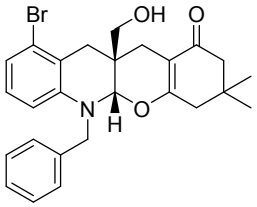
Yellow solid (53.5 mg, 0.116 mmol, 58% yield); m.p.: 188.3-189.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 – 7.67 (m, 2H), 7.40 – 7.32 (m, 4H), 7.29 – 7.27 (m, 1H), 6.61 (d, *J* = 8.0 Hz, 1H), 5.21 (s, 1H), 4.84 – 4.73 (m, 2H), 3.83 (s, 3H), 3.66 (d, *J* = 12.0 Hz, 1H), 3.52 (d, *J* = 8.0 Hz, 1H), 3.21 (s, 1H), 2.78 (d, *J* = 16.0 Hz, 1H), 2.62 (d, *J* = 20.0 Hz, 1H), 2.46 (d, *J* = 16.0 Hz, 1H), 2.35 – 2.23 (m, 4H), 2.20 – 2.13 (m, 1H), 1.08 (s, 3H), 1.03 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 167.1, 166.8, 145.2, 137.7, 131.3, 129.4, 128.9, 127.4, 126.5, 120.5, 120.3, 112.2, 108.4, 90.4, 65.6, 55.3, 51.7, 51.7, 50.5, 41.8, 34.0, 32.4, 29.4, 27.3, 26.3. HRMS (ESI): Calcd. for $C_{28}H_{32}NO_5$ $[M+H]^+$:462.2275; found:462.2265.

(15) *cis*-6-benzyl-11a-(hydroxymethyl)-3,3-dimethyl-10-nitro-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{15})



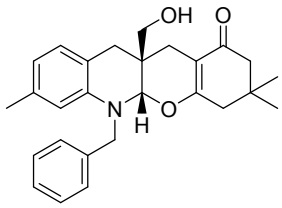
Yellow solid (43.0 mg, 0.096 mmol, 48% yield); m.p.: 180.9-181.9°C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.34 (m, 4H), 7.31 – 7.27 (m, 2H), 7.10 (t, *J* = 8.0 Hz, 1H), 6.81 (d, *J* = 8.0 Hz, 1H), 5.22 (s, 1H), 4.85 – 4.70 (m, 2H), 3.66 (d, *J* = 12.0 Hz, 1H), 3.50 (d, *J* = 12.0 Hz, 1H), 2.91 (d, *J* = 20.0 Hz, 1H), 2.64 (d, *J* = 4.0 Hz, 1H), 2.60 (d, *J* = 8.0 Hz, 1H), 2.32 (d, *J* = 16.0 Hz, 1H), 2.27 – 2.17 (m, 4H), 1.08 (s, 3H), 1.06 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.5, 166.7, 150.6, 142.6, 137.4, 129.0, 127.6, 127.4, 126.4, 116.9, 115.9, 114.9, 108.4, 89.9, 65.8, 56.2, 50.5, 41.8, 33.7, 32.4, 29.2, 27.7, 26.5, 26.5. HRMS (ESI): Calcd. for $C_{26}H_{29}N_2O_5$ $[M+H]^+$:449.2071; found:449.2065.

(16) *cis*-6-benzyl-10-bromo-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{16})



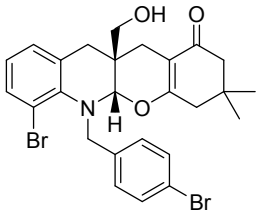
Yellow solid (67.4 mg, 0.140 mmol, 70% yield); m.p.: 134.0-135.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 – 7.31 (m, 4H), 7.28 – 7.24 (m, 1H), 7.00 (d, *J* = 10.0 Hz, 1H), 6.86 – 6.81 (m, 1H), 6.54 (d, *J* = 5.0 Hz, 1H), 5.18 (s, 1H), 4.77 – 4.62 (m, 2H), 3.69 (d, *J* = 15.0 Hz, 1H), 3.51 (d, *J* = 10.0 Hz, 1H), 2.62 (d, *J* = 15.0 Hz, 2H), 2.51 (d, *J* = 20.0 Hz, 1H), 2.33 (d, *J* = 20.0 Hz, 1H), 2.29 – 2.21 (m, 3H), 2.18 (d, *J* = 20.0 Hz, 1H), 1.06 (s, 3H), 1.03 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.8, 167.4, 142.7, 138.1, 128.9, 128.0, 127.3, 126.5, 126.0, 123.2, 120.7, 112.0, 108.4, 90.7, 66.1, 55.7, 50.6, 41.9, 34.4, 32.4, 30.9, 29.4, 27.5, 26.6. HRMS (ESI): Calcd. for $C_{26}H_{29}BrNO_3$ $[M+H]^+$:482.1325; found:482.1314.

(17) *cis*-6-benzyl-11a-(hydroxymethyl)-3,3,8-trimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{17})



Yellow solid (58.5 mg, 0.140 mmol, 70% yield); m.p.: 138.4-139.4 °C;^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, *J* = 8.0 Hz, 2H), 7.32 (t, *J* = 8.0 Hz, 2H), 7.27 – 7.23 (m, 1H), 6.89 (d, *J* = 8.0 Hz, 1H), 6.56 (d, *J* = 4.0 Hz, 1H), 6.44 (s, 1H), 5.11 (s, 1H), 4.74 – 4.62 (m, 2H), 3.68 (d, *J* = 12.0 Hz, 1H), 3.49 (d, *J* = 12.0 Hz, 1H), 2.72 (d, *J* = 16.0 Hz, 1H), 2.54 (d, *J* = 16.0 Hz, 1H), 2.35 (d, *J* = 20.0 Hz, 1H), 2.30 – 2.18 (m, 4H), 2.16 (s, 3H), 2.15 – 2.00 (m, 1H), 1.04 (s, 3H), 0.99 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.7, 167.6, 141.0, 138.7, 136.9, 129.7, 128.8, 127.1, 126.7, 119.9, 117.9, 113.4, 108.3, 91.1, 66.0, 54.9, 50.6, 42.0, 34.3, 32.4, 29.5, 29.2, 27.3, 26.7, 21.6. HRMS (ESI): Calcd. for $C_{27}H_{32}NO_3$ $[M+H]^+$:418.2377; found:418.2368.

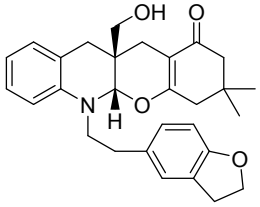
(18) *cis*-7-bromo-6-(4-bromobenzyl)-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{18})



Yellow solid (78.3 mg, 0.140 mmol, 70% yield); m.p.: 161.9-162.9 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.0 Hz, 2H), 7.26 – 7.23 (m, 2H), 7.11 (s, 1H), 7.05 (d, *J* = 8.0 Hz, 1H), 6.34 (d, *J* = 8.0 Hz, 1H), 5.15 (s, 1H), 4.72 – 4.52 (m, 2H), 3.66 (d, *J* = 12.0 Hz, 1H), 3.49 (d, *J* = 12.0 Hz, 1H), 2.73 (d, *J* = 16.0 Hz, 1H), 2.59 (d, *J* = 16.0 Hz, 1H), 2.34 (d, *J* = 16.0 Hz, 1H), 2.30 – 2.19 (m, 4H), 2.15 (d, *J* = 16.0 Hz, 1H), 1.06 (s, 3H), 1.01 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.8, 167.3, 139.9, 137.2, 132.2, 131.9, 129.9,

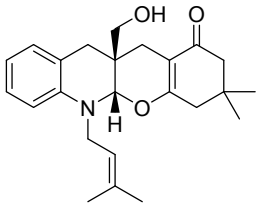
128.3, 123.3, 121.0, 114.4, 111.3, 108.3, 91.0, 65.7, 55.0, 50.5, 41.9, 34.1, 32.4, 29.5, 29.4, 27.3, 26.5. HRMS (ESI): Calcd. for $C_{26}H_{28}Br_2NO_3$ $[M+H]^+$:560.0430; found: 560.0418.

(19) *cis*-6-(2-(2,3-dihydrobenzofuran-5-yl)ethyl)-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{19})



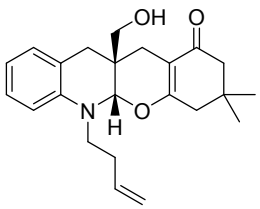
Yellow solid (73.5 mg, 0.160 mmol, 80% yield); m.p.: 122.9-123.9 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.11 – 7.05 (m, 1H), 7.01 (s, 1H), 6.94 – 6.86 (m, 2H), 6.74 (d, *J* = 5.0 Hz, 1H), 6.71 – 6.62 (m, 2H), 4.95 (s, 1H), 4.50 – 4.40 (m, 2H), 3.65 – 3.55 (m, 2H), 3.38 (d, *J* = 10.0 Hz, 1H), 3.24 (d, *J* = 10.0 Hz, 1H), 3.10 (t, *J* = 10.0 Hz, 2H), 2.94 – 2.82 (m, 2H), 2.61 (d, *J* = 20.0 Hz, 1H), 2.44 (d, *J* = 20.0 Hz, 1H), 2.21 (d, *J* = 20.0 Hz, 1H), 2.19 – 2.08 (m, 4H), 2.06 (d, *J* = 15.0 Hz, 1H), 0.98 (s, 3H), 0.91 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.5, 167.3, 158.8, 140.3, 131.2, 130.1, 128.2, 127.5, 127.3, 125.3, 120.8, 118.7, 111.5, 109.3, 108.2, 91.2, 71.3, 66.0, 53.2, 50.6, 42.0, 33.8, 33.7, 32.4, 29.8, 29.6, 29.5, 27.2, 26.5. HRMS (ESI): Calcd. for $C_{29}H_{34}NO_4$ $[M+H]^+$:460.2482; found: 460.2476.

(20) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-(3-methylbut-2-en-1-yl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{20})



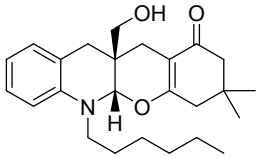
Yellow solid (39.6 mg, 0.104 mmol, 52% yield); m.p.: 128.3-129.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.10 (t, *J* = 8.0 Hz, 1H), 6.99 (d, *J* = 8.0 Hz, 1H), 6.74 (t, *J* = 8.0 Hz, 1H), 6.69 (d, *J* = 8.0 Hz, 1H), 5.33 – 5.26 (m, 1H), 5.09 (s, 1H), 4.16 – 4.00 (m, 2H), 3.55 (d, *J* = 12.0 Hz, 1H), 3.41 (d, *J* = 12.0 Hz, 1H), 2.70 (d, *J* = 16.0 Hz, 1H), 2.52 (d, *J* = 20.0 Hz, 1H), 2.35 (d, *J* = 20.0 Hz, 1H), 2.31 – 2.20 (m, 4H), 2.15 (d, *J* = 16.0 Hz, 1H), 1.75 (s, 6H), 1.06 (s, 3H), 1.00 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 167.6, 140.8, 135.1, 129.8, 127.1, 121.5, 121.0, 118.7, 112.1, 108.1, 90.5, 66.2, 50.5, 48.7, 42.0, 33.8, 32.4, 29.5, 27.2, 26.7, 25.8, 18.1. HRMS (ESI): Calcd. for $C_{24}H_{32}NO_3$ $[M+H]^+$:382.2377; found: 382.2369.

(21) *cis*-6-(but-3-en-1-yl)-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{21})



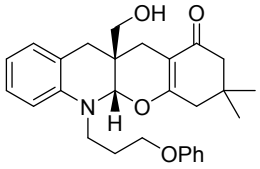
Yellow oil (36.8 mg, 0.100 mmol, 50% yield); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.14 (t, *J* = 10.0 Hz, 1H), 7.00 (d, *J* = 5.0 Hz, 1H), 6.78 – 6.72 (m, 2H), 5.95 – 5.84 (m, 1H), 5.18 – 5.09 (m, 2H), 5.07 (s, 1H), 3.59 (d, *J* = 5.0 Hz, 2H), 3.57 (d, *J* = 5.0 Hz, 1H), 3.40 (d, *J* = 10.0 Hz, 1H), 2.72 (d, *J* = 20.0 Hz, 1H), 2.57 – 2.50 (m, 2H), 2.49 – 2.45 (m, 1H), 2.31 (d, *J* = 15.0 Hz, 1H), 2.29 – 2.22 (m, 4H), 2.15 (d, *J* = 15.0 Hz, 1H), 1.07 (s, 3H), 1.00 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.4, 167.1, 140.3, 136.0, 130.0, 127.3, 120.7, 118.7, 116.9, 111.5, 108.1, 90.8, 66.2, 50.6, 50.4, 42.0, 33.7, 32.6, 32.4, 29.6, 29.5, 27.2, 26.6. HRMS (ESI): Calcd. for $C_{23}H_{30}NO_3$ $[M+H]^+$:368.2220; found: 368.2213.

(22) *cis*-6-hexyl-11a-(hydroxymethyl)-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{21})



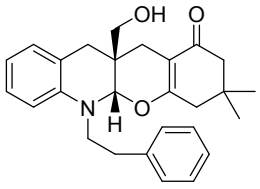
Yellow oil (42.1 mg, 0.106 mmol, 53% yield); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.16 – 7.07 (m, 1H), 6.98 (d, *J* = 5.0 Hz, 1H), 6.77 – 6.64 (m, 2H), 5.09 (s, 1H), 3.55 (d, *J* = 10.0 Hz, 1H), 3.52 – 3.42 (m, 2H), 3.41 (d, *J* = 15.0 Hz, 1H), 2.70 (d, *J* = 20.0 Hz, 1H), 2.55 (d, *J* = 15.0 Hz, 1H), 2.32 (d, *J* = 20.0 Hz, 1H), 2.29 – 2.22 (m, 3H), 2.21 – 2.11 (m, 2H), 1.77 – 1.66 (m, 2H), 1.41 – 1.30 (m, 6H), 1.06 (s, 3H), 1.00 (s, 3H), 0.95 – 0.88 (m, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.5, 167.5, 140.5, 129.9, 127.2, 120.6, 118.3, 111.5, 108.0, 91.1, 66.1, 51.2, 50.6, 42.1, 33.6, 32.4, 31.7, 29.6, 29.5, 28.0, 27.2, 26.8, 26.6, 22.7, 14.1. HRMS (ESI): Calcd. for $C_{25}H_{36}NO_3$ $[M+H]^+$:398.2690; found:398.2682.

(23) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-(3-phenoxypropyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{23})



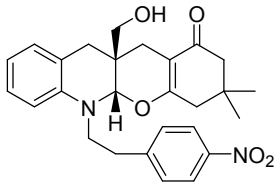
Yellow oil (53.7 mg, 0.120 mmol, 60% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.25 (m, 2H), 7.10 (t, *J* = 8.0 Hz, 1H), 6.99 (d, *J* = 8.0 Hz, 1H), 6.97 – 6.90 (m, 3H), 6.79 (d, *J* = 8.0 Hz, 1H), 6.74 (t, *J* = 8.0 Hz, 1H), 5.11 (s, 1H), 4.10 (t, *J* = 4.0 Hz, 2H), 3.81 – 3.65 (m, 2H), 3.56 (d, *J* = 12.0 Hz, 1H), 3.40 (d, *J* = 8.0 Hz, 1H), 2.71 (d, *J* = 16.0 Hz, 1H), 2.55 (d, *J* = 20.0 Hz, 1H), 2.33 – 2.25 (m, 2H), 2.23 – 2.18 (m, 4H), 2.15 (d, *J* = 12.0 Hz, 2H), 1.04 (s, 3H), 0.98 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.6, 167.4, 158.8, 140.4, 130.0, 129.5, 127.3, 120.9, 120.7, 118.6, 114.6, 111.6, 108.1, 91.2, 66.1, 65.3, 50.6, 47.9, 42.0, 33.7, 32.3, 29.6, 29.5, 28.0, 27.2, 26.6. HRMS (ESI): Calcd. for $C_{28}H_{34}NO_4$ $[M+H]^+$:448.2482; found: 448.2475.

(24) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-phenethyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{24})



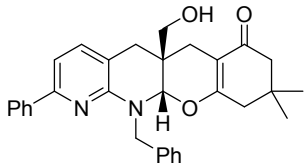
Yellow solid (47.5 mg, 0.114 mmol, 57% yield); m.p.: 131.2-132.2 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.34 (m, 2H), 7.31 – 7.28 (m, 3H), 7.20 (t, *J* = 8.0 Hz, 1H), 7.04 (d, *J* = 8.0 Hz, 1H), 6.87 (d, *J* = 8.0 Hz, 1H), 6.81 (t, *J* = 8.0 Hz, 1H), 5.04 (s, 1H), 3.83 – 3.76 (m, 2H), 3.46 (d, *J* = 12.0 Hz, 1H), 3.32 (d, *J* = 12.0 Hz, 1H), 3.15 – 3.02 (m, 2H), 2.73 (d, *J* = 16.0 Hz, 1H), 2.54 (d, *J* = 16.0 Hz, 1H), 2.35 – 2.30 (m, 2H), 2.27 (d, *J* = 8.0 Hz, 2H), 2.23 (d, *J* = 8.0 Hz, 1H), 2.18 (d, *J* = 20.0 Hz, 1H), 1.09 (s, 3H), 1.02 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.5, 167.2, 140.3, 139.4, 130.1, 128.8, 128.7, 127.3, 126.6, 120.9, 118.7, 111.6, 108.2, 91.3, 66.0, 52.8, 50.6, 42.0, 34.5, 33.8, 32.4, 29.6, 29.5, 27.2, 26.5. HRMS (ESI): Calcd. for $C_{27}H_{32}NO_3$ $[M+H]^+$:418.2377; found: 418.2369.

(25) *cis*-11a-(hydroxymethyl)-3,3-dimethyl-6-(4-nitrophenethyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{25})



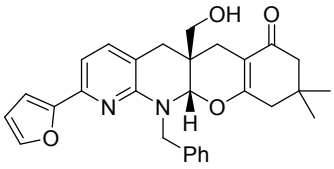
White solid (53.6 mg, 0.116 mmol, 58% yield); m.p.: 174.2-175.2 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (d, *J* = 8.0 Hz, 2H), 7.45 (d, *J* = 8.0 Hz, 2H), 7.16 (t, *J* = 8.0 Hz, 1H), 7.02 (d, *J* = 8.0 Hz, 1H), 6.82 – 6.72 (m, 2H), 5.14 (s, 1H), 3.88 – 3.79 (m, 1H), 3.78 – 3.67 (m, 1H), 3.52 (d, *J* = 12.0 Hz, 1H), 3.40 (d, *J* = 8.0 Hz, 1H), 3.20 – 3.11 (m, 2H), 2.73 (d, *J* = 16.0 Hz, 1H), 2.57 (d, *J* = 16.0 Hz, 1H), 2.32 (d, *J* = 16.0 Hz, 1H), 2.29 – 2.21 (m, 4H), 2.18 – 2.12 (m, 1H), 1.07 (s, 3H), 1.01 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.7, 167.3, 147.2, 146.7, 139.8, 130.2, 129.7, 127.4, 123.9, 120.9, 119.0, 111.3, 108.2, 91.0, 65.9, 52.1, 50.5, 42.0, 34.5, 33.7, 32.4, 29.6, 29.5, 27.2, 26.5. HRMS (ESI): Calcd. for $C_{27}H_{31}N_2O_5$ $[M+H]^+$:463.2227; found: 463.2219.

(26) *cis*-12-benzyl-5a-(hydroxymethyl)-9,9-dimethyl-2-phenyl-5,5a,6,8,9,10,11a,12-octahydro-7*H*-chromeno[2,3-*b*][1,8]naphthyridin-7-one (c_{26})



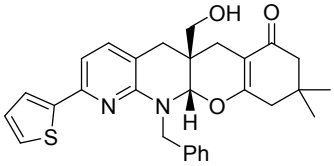
Yellow solid (81.6 mg, 0.170 mmol, 85% yield); m.p.: 165.9-166.9 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 10.0 Hz, 2H), 7.43 (d, *J* = 5.0 Hz, 2H), 7.41 – 7.37 (m, 2H), 7.36 – 7.29 (m, 4H), 7.28 (d, *J* = 5.0 Hz, 1H), 7.18 (d, *J* = 5.0 Hz, 1H), 5.92 (d, *J* = 15.0 Hz, 1H), 5.11 (s, 1H), 4.45 (d, *J* = 15.0 Hz, 1H), 3.47 (d, *J* = 10.0 Hz, 1H), 3.35 (d, *J* = 10.0 Hz, 1H), 2.73 (d, *J* = 15.0 Hz, 1H), 2.49 – 2.37 (m, 2H), 2.30 – 2.18 (m, 4H), 2.15 (d, *J* = 20.0 Hz, 1H), 1.51 (s, 1H), 1.07 (s, 3H), 1.02 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.3, 166.8, 153.3, 151.9, 139.6, 139.4, 138.0, 128.7, 128.5, 128.1, 127.4, 126.5, 114.3, 111.3, 108.3, 88.2, 65.9, 50.6, 49.9, 41.8, 33.7, 32.4, 29.5, 28.9, 27.3, 26.3 HRMS (ESI): Calcd. for $C_{31}H_{33}N_2O_3$ $[M+H]^+$:481.2486; found: 481.2477.

(27) *cis*-12-benzyl-2-(furan-2-yl)-5a-(hydroxymethyl)-9,9-dimethyl-5,5a,6,8,9,10,11a,12-octahydro-7*H*-chromeno[2,3-*b*][1,8]naphthyridin-7-one (c_{27})



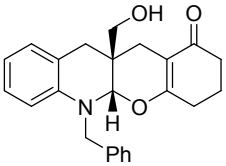
Brown solid (65.8 mg, 0.140 mmol, 70% yield); m.p.: 166.2-167.2 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (d, *J* = 5.0 Hz, 3H), 7.32 (t, *J* = 5.0 Hz, 2H), 7.27 (d, *J* = 5.0 Hz, 2H), 7.12 (d, *J* = 5.0 Hz, 1H), 6.89 (d, *J* = 5.0 Hz, 1H), 6.50 – 6.40 (m, 1H), 5.78 (d, *J* = 15.0 Hz, 1H), 5.10 (s, 1H), 4.42 (d, *J* = 15.0 Hz, 1H), 3.44 (d, *J* = 15.0 Hz, 1H), 3.33 (d, *J* = 10.0 Hz, 1H), 2.70 (d, *J* = 15.0 Hz, 1H), 2.43 (d, *J* = 15.0 Hz, 1H), 2.37 (d, *J* = 15.0 Hz, 1H), 2.30 – 2.20 (m, 4H), 2.18 – 2.12 (m, 1H), 1.66 (s, 1H), 1.07 (s, 3H), 1.01 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.3, 166.7, 154.5, 151.8, 145.8, 142.6, 139.5, 137.8, 128.6, 128.2, 127.4, 114.3, 111.8, 109.6, 108.3, 107.7, 88.1, 65.9, 50.6, 50.0, 41.8, 33.7, 32.3, 29.5, 29.0, 27.3, 26.2. HRMS (ESI): Calcd. for $C_{29}H_{31}N_2O_4$ $[M+H]^+$:471.2278; found: 471.2269.

(28) *cis*-12-benzyl-5a-(hydroxymethyl)-9,9-dimethyl-2-(thiophen-2-yl)-5,5a,6,8,9,10,11a,12-octahydro-7*H*-chromeno[2,3-*b*][1,8]naphthyridin-7-one (c_{28})



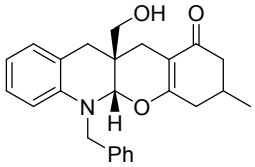
Brown solid (77.8 mg, 0.160 mmol, 80% yield); m.p.: 171.5-172.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 – 7.43 (m, 3H), 7.34 – 7.28 (m, 2H), 7.27 (d, *J* = 5.0 Hz, 1H), 7.27 – 7.19 (m, 2H), 7.08 – 7.01 (m, 2H), 5.78 – 5.68 (m, 1H), 5.11 (s, 1H), 4.51 – 4.39 (m, 1H), 3.41 (d, *J* = 10.0 Hz, 1H), 3.32 (d, *J* = 10.0 Hz, 1H), 2.67 (d, *J* = 15.0 Hz, 1H), 2.44 (d, *J* = 20.0 Hz, 1H), 2.36 (d, *J* = 15.0 Hz, 1H), 2.29 – 2.15 (m, 4H), 2.12 (d, *J* = 20.0 Hz, 1H), 1.06 (s, 3H), 1.00 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.4, 166.8, 151.7, 148.8, 145.8, 139.4, 137.9, 128.6, 128.4, 127.8, 127.4, 126.6, 123.6, 114.1, 109.7, 108.3, 88.1, 65.8, 50.6, 50.1, 41.8, 33.7, 32.3, 29.5, 28.8, 27.3, 26.3 HRMS (ESI): Calcd. for $C_{29}H_{31}SN_2O_3$ $[M+H]^+$:487.2050; found: 487.2041

(29) *cis*-6-benzyl-11a-(hydroxymethyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{29})



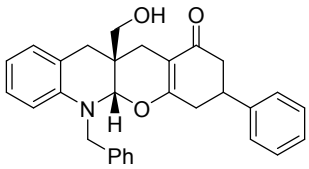
White solid (50.3 mg, 0.134 mmol, 67% yield); m.p.: 183.6-184.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.30 (m, 4H), 7.28 – 7.25 (m, 1H), 7.04 – 6.97 (m, 2H), 6.78 – 6.71 (m, 1H), 6.60 (d, *J* = 8.0 Hz, 1H), 5.13 (s, 1H), 4.77 – 4.65 (m, 2H), 3.71 (d, *J* = 12.0 Hz, 1H), 3.52 (d, *J* = 12.0 Hz, 1H), 2.81 (d, *J* = 16.0 Hz, 1H), 2.55 (d, *J* = 16.0 Hz, 1H), 2.42 – 2.34 (m, 3H), 2.33 – 2.26 (m, 3H), 1.98 – 1.88 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.8, 169.0, 141.0, 138.6, 129.7, 128.8, 127.2, 127.2, 126.6, 120.8, 119.1, 112.8, 109.6, 90.9, 66.2, 55.0, 36.7, 34.3, 29.5, 28.3, 26.8, 21.0. HRMS (ESI): Calcd. for $C_{24}H_{26}NO_3$ $[M+H]^+$:376.1907; found: 376.1899.

（30） *cis*-6-benzyl-11a-(hydroxymethyl)-3-methyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{30})



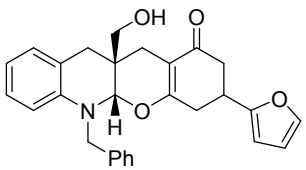
Yellow solid (54.5 mg, 0.140 mmol, 70% yield); m.p.: 169.2-170.2 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 – 7.30 (m, 4H), 7.28 – 7.24 (m, 1H), 7.03 – 6.96 (m, 2H), 6.77 – 6.71 (m, 1H), 6.60 (d, *J* = 10.0 Hz, 1H), 5.16 (s, 0.4H), 5.12 (s, 0.6H), 4.75 – 4.64 (m, 2H), 3.72 (d, *J* = 5.0 Hz, 0.4H), 3.69 (d, *J* = 5.0 Hz, 0.6H), 3.52 (d, *J* = 10.0 Hz, 1H), 2.81 (d, *J* = 20.0 Hz, 0.6H), 2.76 (d, *J* = 15.0 Hz, 0.4H), 2.56 (d, *J* = 12.0 Hz, 1H), 2.50 – 2.40 (m, 2H), 2.39 – 2.24 (m, 3H), 2.10 – 2.01 (m, 2H), 1.04 (d, *J* = 5.0 Hz, 1.8H), 1.02 (d, *J* = 5.0 Hz, 1.2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.9, 198.6, 168.6, 168.2, 141.0, 138.7, 138.6, 129.7, 128.8, 127.3, 127.2, 127.2, 127.2, 126.6, 126.5, 120.9, 120.8, 119.1, 119.1, 112.8, 112.8, 109.2, 108.9, 91.0, 66.2, 55.1, 55.0, 45.1, 44.8, 36.5, 36.2, 34.3, 34.1, 29.6, 29.4, 28.8, 28.4, 26.9, 26.6, 21.1, 20.8. HRMS (ESI): Calcd. for $C_{25}H_{28}NO_3$ $[M+H]^+$: 390.2064; found: 390.2054.

(31) *cis*-6-benzyl-11a-(hydroxymethyl)-3-phenyl-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{31})



Yellow solid (65.0 mg, 0.144 mmol, 72% yield); m.p.: 143.9-144.9 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39 – 7.28 (m, 6H), 7.28 – 7.22 (m, 2H), 7.24 – 7.17 (m, 2H), 7.06 – 6.98 (m, 2H), 6.80 – 6.72 (m, 1H), 6.64 – 6.58 (m, 1H), 5.22 (s, 0.4H), 5.16 (s, 0.6H), 4.76 – 4.64 (m, 2H), 3.79 – 3.69 (m, 1H), 3.55 (d, *J* = 5.0 Hz, 0.6H), 3.53 (d, *J* = 5.0 Hz, 0.4H), 3.42 – 3.32 (m, 0.4H), 3.33 – 3.24 (m, 0.6H), 2.90 (d, *J* = 20.0 Hz, 0.6H), 2.77 (d, *J* = 15.0 Hz, 0.4H), 2.75 – 2.61 (m, 2H), 2.62 – 2.53 (m, 3H), 2.47 – 2.39 (m, 1H), 2.39 – 2.29 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 197.8, 197.5, 168.0, 167.9, 142.8, 142.8, 141.0, 138.6, 138.5, 129.8, 129.8, 128.8, 128.8, 128.7, 127.3, 127.3, 127.2, 127.0, 127.0, 126.7, 126.7, 126.6, 126.5, 120.8, 120.7, 119.2, 119.2, 112.9, 112.8, 109.4, 109.3, 91.1, 66.2, 55.0, 54.9, 43.8, 43.6, 39.2, 39.0, 36.0, 35.5, 34.4, 34.2, 29.6, 29.5, 27.0, 26.5. HRMS (ESI): Calcd. for $C_{30}H_{30}NO_3$ $[M+H]^+$:452.2220; found: 452.2212.

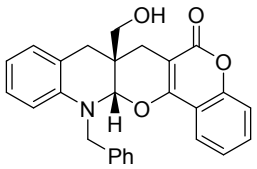
(32) *cis*-6-benzyl-3-(furan-2-yl)-11a-(hydroxymethyl)-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-1-one (c_{32})



White solid (52.9 mg, 0.120 mmol, 60% yield); m.p.: 155.3-156.3 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38 – 7.29 (m, 5H), 7.27 – 7.24 (m, 1H), 7.04 – 6.97 (m, 2H), 6.79 – 6.72 (m, 1H), 6.65 – 6.59 (m, 1H), 6.32 –

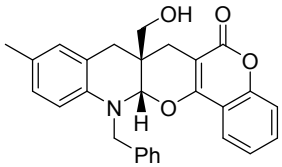
6.28 (m, 0.6H), 6.28 – 6.25 (m, 0.4H), 6.03 (d, *J* = 5.0 Hz, 0.6H), 6.00 (d, *J* = 5.0 Hz, 0.4H), 5.19 (s, 0.4H), 5.15 (s,0.6H), 4.76 – 4.64 (m, 2H), 3.73 (d, *J* = 10.0 Hz, 0.4H), 3.71 (d, *J* = 10.0 Hz, 0.6H), 3.53 (d, *J* = 10.0 Hz, 0.6H), 3.51 (d, *J* = 10.0 Hz, 0.4H), 3.49 – 3.43 (m, 0.4H), 3.41 – 3.35 (m, 0.6H), 2.85 (d, *J* = 15.0 Hz, 0.6H), 2.78 – 2.75 (m, 0.4H), 2.74 – 2.72 (m, 0.6H), 2.71 – 2.68 (m, 0.4H), 2.67 – 2.64 (m, 1H), 2.64 – 2.57 (m, 2H), 2.57 – 2.54 (m, 0.6H), 2.54 – 2.52 (m, 0.4H), 2.49 – 2.36 (m, 1H), 2.34 – 2.28 (m, 1H), 2.10 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 197.0, 196.7, 167.4, 167.1, 156.0, 141.6, 141.5, 141.0, 140.9, 138.6, 138.5, 129.8, 128.8, 127.3, 127.3, 126.6, 126.5, 120.8, 120.7, 119.3, 119.2, 112.8, 112.8, 110.1, 109.5, 109.4, 104.8, 104.5, 91.1, 66.2, 55.0, 54.9, 41.1, 40.8, 34.4, 34.2, 33.1, 32.8, 32.7, 32.5, 29.5, 29.4, 26.9, 26.6. HRMS (ESI): Calcd. for $C_{28}H_{28}NO_4$ $[M+H]^+$:442.2013; found: 442.2005.

(33) *cis*-13-benzyl-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_1)



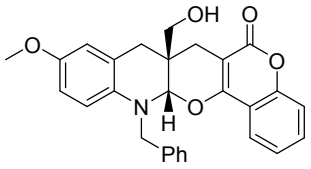
Yellow solid (68.9 mg, 0.162 mmol, 81% yield); m.p.: 117.1-118.1 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.0 Hz, 1H), 7.52 – 7.45 (m, 3H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.32 (d, J = 8.0 Hz, 1H), 7.29 (d, J = 4.0 Hz, 1H), 7.23 (t, *J* = 8.0 Hz, 1H), 7.11 – 7.02 (m, 2H), 6.80 (t, *J* = 8.0 Hz, 1H), 6.75 (d, *J* = 8.0 Hz, 1H), 5.48 (s, 1H), 4.94 (d, *J* = 16.0 Hz, 1H), 4.86 (d, *J* = 16.0 Hz, 1H), 3.86 (d, *J* = 8.0 Hz, 1H), 3.65 (d, *J* = 12.0 Hz, 1H), 3.06 (d, *J* = 20.0 Hz, 1H), 2.96 (d, *J* = 16.0 Hz, 1H), 2.59 (d, *J* = 16.0 Hz, 1H), 2.51 (d, *J* = 20.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 157.6, 152.8, 140.7, 138.4, 131.5, 129.9, 128.8, 127.4, 127.4, 126.7, 123.8, 122.8, 120.5, 119.5, 116.6, 115.5, 112.9, 99.40, 92.0, 65.9, 55.0, 34.5, 29.79, 28.5. HRMS (ESI): Calcd. for $C_{27}H_{24}NO_4$ $[M+H]^+$: 426.1700; found: 426.1697.

(34) *cis*-13-benzyl-7a-(hydroxymethyl)-10-methyl-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_2)



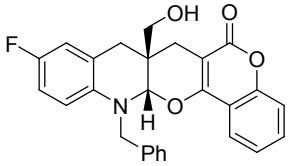
Yellow solid (61.5 mg, 0.140 mmol, 70% yield); m.p.: 161.3-162.3 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 – 7.59 (m, 1H), 7.48 – 7.40 (m, 3H), 7.38 – 7.31 (m, 2H), 7.30 – 7.23 (m, 2H), 7.21 – 7.15 (m, 1H), 6.87 – 6.81 (m, 2H), 6.60 (d, *J* = 10.0 Hz, 1H), 5.42 (s, 1H), 4.91 – 4.76 (m, 2H), 3.82 (d, *J* = 10.0 Hz, 1H), 3.61 (d, *J* = 10.0 Hz, 1H), 3.01 (d, *J* = 20.0 Hz, 1H), 2.89 (d, *J* = 15.0 Hz, 1H), 2.54 (d, *J* = 15.0 Hz, 1H), 2.44 (d, *J* = 20.0 Hz, 1H), 2.19 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.5, 157.8, 152.7, 138.6, 138.3, 131.5, 130.5, 128.8, 128.7, 127.9, 127.3, 126.7, 123.7, 122.8, 120.4, 116.5, 115.6, 112.9, 99.3, 92.3, 66.0, 55.1, 34.6, 29.7, 28.6, 20.3. HRMS (ESI): Calcd. for $C_{28}H_{26}NO_4$ $[M+H]^+$: 440.1856; found: 440.1847.

(35) *cis*-13-benzyl-7a-(hydroxymethyl)-10-methoxy-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_3)



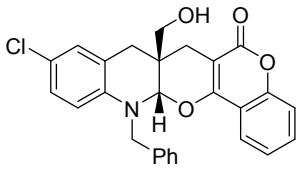
Yellow solid (mg, 0.160 mmol, 80% yield); m.p.: 130.0-131.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (d, *J* = 10.0 Hz, 1H), 7.49 – 7.45 (m, 1H), 7.42 (d, *J* = 5.0 Hz, 2H), 7.38 – 7.34 (m, 2H), 7.28 (d, *J* = 5.0 Hz, 1H), 7.26 (d, *J* = 5.0 Hz, 1H), 7.22 – 7.17 (m, 1H), 6.65 – 6.60 (m, 3H), 5.41 (s, 1H), 4.88 – 4.75 (m, 2H), 3.84 (d, *J* = 15.0 Hz, 1H), 3.69 (s, 3H), 3.63 (d, *J* = 10.0 Hz, 1H), 3.00 (d, *J* = 20.0 Hz, 1H), 2.91 (d, *J* = 20.0 Hz, 1H), 2.55 (d, *J* = 15.0 Hz, 1H), 2.47 (d, *J* = 20.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 157.9, 153.0, 152.7, 138.6, 134.5, 131.5, 128.8, 127.3, 126.7, 123.7, 122.8, 121.8, 116.6, 115.6, 115.5, 113.8, 112.7, 99.3, 92.4, 66.1, 55.6, 55.2, 34.8, 30.0, 28.6. HRMS (ESI): Calcd. for $C_{28}H_{26}NO_5$ $[M+H]^+$: 456.1805; found: 456.1794.

(36) *cis*-13-benzyl-10-fluoro-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6] pyrano[2,3-*b*]quinolin-6-one (e_4)



White solid (73.5 mg, 0.166 mmol, 83% yield); m.p.: 161.2-162.2 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (d, *J* = 5.0 Hz, 1H), 7.50 – 7.44 (m, 1H), 7.42 (d, *J* = 5.0 Hz, 2H), 7.39 – 7.33 (m, 2H), 7.30 – 7.25 (m, 2H), 7.22 – 7.17 (m, 1H), 6.79 – 6.66 (m, 2H), 6.62 – 6.55 (m, 1H), 5.43 (s, 1H), 4.88 (d, *J* = 15.0 Hz, 1H), 4.78 (d, *J* = 15.0 Hz, 1H), 3.82 (d, *J* = 10.0 Hz, 1H), 3.63 (d, *J* = 10.0 Hz, 1H), 3.03 (d, *J* = 20.0 Hz, 1H), 2.90 (d, *J* = 15.0 Hz, 1H), 2.56 (d, *J* = 15.0 Hz, 1H), 2.47 (d, *J* = 15.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 157.7, 156.6 (d, *J* = 238.2 Hz), 152.7, 138.1, 136.9 (d, *J* = 1.5 Hz), 131.6, 128.9, 127.4, 126.6, 123.8, 122.7, 122.2 (d, *J* = 6.9 Hz), 116.6, 116.2 (d, *J* = 22.5 Hz), 115.5, 113.8(d, *J* = 2.5 Hz), 113.7 (d, *J* = 26.4 Hz), 113.6, 99.3, 92.2, 65.9, 55.5, 34.6, 29.8, 28.5. ^{19}F NMR (471 MHz, $CDCl_3$) δ -125.65. HRMS (ESI): Calcd. for $C_{27}H_{23}FNO_4$ $[M+H]^+$: 444.1606; found: 444.1596.

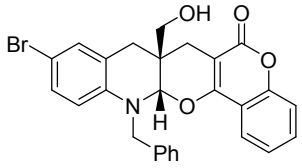
(37) *cis*-13-benzyl-10-chloro-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6] pyrano[2,3-*b*]quinolin-6-one (e_5)



White solid (78.0 mg, 0.170 mmol, 85% yield); m.p.: 139.5-140.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, *J* = 10.0 Hz, 1H), 7.50 – 7.44 (m, 1H), 7.41 (d, *J* = 5.0 Hz, 2H), 7.38 – 7.33 (m, 2H), 7.32 – 7.25 (m, 2H), 7.22 – 7.15 (m, 1H), 6.97 (d, *J* = 5.0 Hz, 2H), 6.65 – 6.57 (m, 1H), 5.43 (s, 1H), 4.89 (d, *J* = 15.0 Hz, 1H), 4.79 (d, *J* = 15.0 Hz, 1H), 3.80 (d, *J* = 10.0 Hz, 1H), 3.61 (d, *J* = 10.0 Hz, 1H), 3.03 (d, *J* = 20.0 Hz, 1H), 2.88 (d, *J* = 20.0 Hz, 1H), 2.55 (d, *J* = 20.0 Hz, 1H), 2.45 (d, *J* = 15.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.3, 157.5, 152.7, 139.3, 137.9, 131.6, 129.4, 128.9, 127.5, 127.2, 126.6, 124.2, 123.9, 122.7,

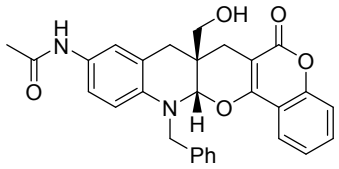
122.3, 116.6, 115.4, 114.2, 99.3, 91.8, 65.7, 55.3, 34.5, 29.5, 28.4. HRMS (ESI): Calcd. for $C_{27}H_{23}ClNO_4$ $[M+H]^+$: 460.1310; found: 460.1298.

(38) *cis*-13-benzyl-10-bromo-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6] pyrano[2,3-*b*]quinolin-6-one (e_6)



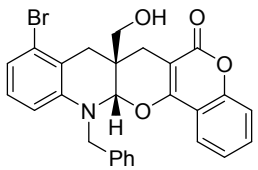
Brown solid (mg, 0.150 mmol, 75% yield); m.p.: 133.0-134.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (d, *J* = 5.0 Hz, 1H), 7.50 – 7.44 (m, 1H), 7.41 (d, *J* = 10.0 Hz, 2H), 7.38 – 7.32 (m, 2H), 7.31 – 7.25 (m, 2H), 7.22 – 7.17 (m, 1H), 7.10 (d, *J* = 5.0 Hz, 2H), 6.55 (d, *J* = 10.0 Hz, 1H), 5.43 (s, 1H), 4.89 (d, *J* = 20.0 Hz, 1H), 4.78 (d, *J* = 20.0 Hz, 1H), 3.79 (d, *J* = 10.0 Hz, 1H), 3.60 (d, *J* = 15.0 Hz, 1H), 3.03 (d, *J* = 15.0 Hz, 1H), 2.88 (d, *J* = 15.0 Hz, 1H), 2.54 (d, *J* = 15.0 Hz, 1H), 2.45 (d, *J* = 15.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.3, 157.5, 152.7, 139.8, 137.8, 132.2, 131.7, 130.1, 128.9, 127.5, 126.6, 123.9, 122.8, 122.7, 116.6, 115.4, 114.6, 111.5, 99.4, 91.7, 65.7, 55.3, 34.4, 29.4, 28.4. HRMS (ESI): Calcd. for $C_{27}H_{23}BrNO_4$ $[M+H]^+$:504.0805; found:504.0796.

(39) N-(7a-*cis*-13-benzyl-7a-(hydroxymethyl)-6-oxo-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5, 6]pyrano[2,3-*b*]quinolin-10-yl)acetamide (e_7)



Yellow solid (57.9 mg, 0.120 mmol, 60% yield); m.p.: 167.5-168.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (s, 1H), 7.55 (d, *J* = 8.0 Hz, 1H), 7.43 (t, *J* = 8.0 Hz, 1H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.35 – 7.26 (m, 2H), 7.26 – 7.19 (m, 2H), 7.20 – 7.11 (m, 3H), 6.58 (d, *J* = 8.0 Hz, 1H), 5.36 (s, 1H), 4.89 – 4.69 (m, 2H), 3.69 (d, *J* = 8.0 Hz, 1H), 3.50 (d, *J* = 12.0 Hz, 1H), 3.22 (s, 1H), 2.93 (d, *J* = 20.0 Hz, 1H), 2.78 (d, *J* = 16.0 Hz, 1H), 2.48 (d, *J* = 16.0 Hz, 1H), 2.37 (d, *J* = 20.0 Hz, 1H), 2.05 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.9, 163.5, 157.7, 152.6, 138.2, 137.5, 131.6, 130.1, 128.8, 127.3, 126.7, 123.9, 122.7, 122.4, 121.0, 120.2, 116.5, 115.5, 113.1, 99.3, 92.2, 65.6, 55.1, 34.5, 29.6, 28.5, 24.2 HRMS (ESI): Calcd. for $C_{29}H_{27}N_2O_5$ $[M+H]^+$: 483.1914; found: 483.1910.

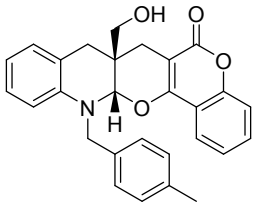
(40) *cis*-13-benzyl-9-bromo-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]p yrano[2,3-*b*]quinolin-6-one (e_8)



White solid (65.4 mg, 0.130 mmol, 65% yield); m.p.: 139.3-140.3 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, *J* = 10.0 Hz, 1H), 7.50 – 7.40 (m, 3H), 7.40 – 7.33 (m, 2H), 7.30 – 7.25 (m, 2H), 7.

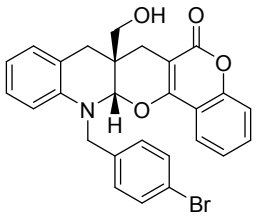
22 – 7.15 (m, 1H), 7.02 (d, *J* = 10.0 Hz, 1H), 6.91 – 6.82 (m, 1H), 6.66 (d, *J* = 5.0 Hz, 1H), 5.47 (s, 1H), 4.93 (d, *J* = 20.0 Hz, 1H), 4.81 (d, *J* = 20.0 Hz, 1H), 3.81 (d, *J* = 10.0 Hz, 1H), 3.61 (d, *J* = 10.0 Hz, 1H), 3.09 (d, *J* = 15.0 Hz, 1H), 2.73 (d, *J* = 20.0 Hz, 1H), 2.65 (d, *J* = 20.0 Hz, 1H), 2.61 (d, *J* = 15.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.3, 157.6, 152.8, 14 2.3, 137.9, 131.6, 128.9, 128.2, 127.5, 126.6, 126.0, 123.8, 123.6, 122.7, 120.3, 116.6, 115.4, 112. 2, 99.4, 91.5, 66.1, 55.6, 34.7, 30.9, 28.5. HRMS (ESI): Calcd. for $C_{27}H_{23}BrNO_4$ $[M+H]^+$:504.0805; found: 504.0794.

(41) *cis*-7a-(hydroxymethyl)-13-(4-methylbenzyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6] pyrano[2,3-*b*]quinolin-6-one (e_9)



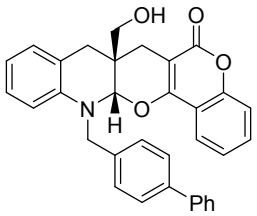
White solid (74.7 mg, 0.170 mmol, 85% yield); m.p.: 169.5.3-170.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63 (d, *J* = 10.0 Hz, 1H), 7.48 – 7.43 (m, 1H), 7.31 (d, *J* = 5.0 Hz, 2H), 7.26 (d, *J* = 5.0 Hz, 1H), 7.21 – 7.17 (m, 1H), 7.16 (d, *J* = 10.0 Hz, 2H), 7.07 – 7.02 (m, 1H), 7.00 (d, *J* = 5.0 Hz, 1H), 6.78 – 6.72 (m, 2H), 5.42 (s, 1H), 4.86 – 4.77 (m, 2H), 3.80 (d, *J* = 10.0 Hz, 1H), 3.59 (d, *J* = 10.0 Hz, 1H), 3.01 (d, *J* = 20.0 Hz, 1H), 2.91 (d, *J* = 20.0 Hz, 1H), 2.55 (d, *J* = 15.0 Hz, 1H), 2.47 (d, *J* = 20.0 Hz, 1H), 2.33 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 157.6, 152.7, 140.8, 137.0, 135.2, 131.5, 129.8, 129.5, 127.4, 126.7, 123.8, 122.8, 120.5, 119.4, 116.6, 115.6, 112.9, 99.4, 91.8, 66.0, 54.6, 34.5, 29.7, 28.5, 21.1. HRMS (ESI): Calcd. for $C_{28}H_{26}NO_4$ $[M+H]^+$: 440.1856; found: 440.1848.

(42) *cis*-13-(4-bromobenzyl)-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6] pyrano[2,3-*b*]quinolin-6-one (e_{10})



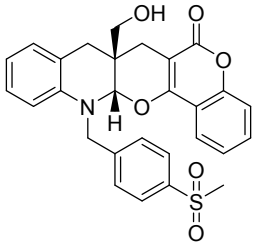
Brown solid (90.5 mg, 0.180 mmol, 90% yield); m.p.: 145.0-146.0 °C; ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.65 – 7.55 (m, 3H), 7.53 (d, *J* = 10.0 Hz, 1H), 7.45 (d, *J* = 10.0 Hz, 2H), 7.38 (d, *J* = 5.0 Hz, 1H), 7.33 – 7.23 (m, 1H), 7.08 – 6.96 (m, 2H), 6.75 – 6.66 (m, 1H), 6.59 (d, *J* = 10.0 Hz, 1H), 5.65 (s, 1H), 5.17 (t, *J* = 5.0 Hz, 1H), 4.95 (d, *J* = 20.0 Hz, 1H), 4.76 (d, *J* = 15.0 Hz, 1H), 3.59 – 3.49 (m, 1H), 3.49 – 3.40 (m, 1H), 2.85 (d, *J* = 15.0 Hz, 1H), 2.70 (d, *J* = 20.0 Hz, 1H), 2.56 (d, *J* = 20.0 Hz, 1H), 2.42 (d, *J* = 15.0 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 162.4, 157.1, 152.7, 140.6, 139.2, 132.2, 131.8, 130.2, 129.4, 127.5, 124.4, 122.8, 121.2, 120.3, 119.4, 116.7, 115.6, 113.0, 99.7, 92.9, 64.4, 54.4, 34.4, 29.1, 28.9. HRMS (ESI): Calcd. for $C_{27}H_{23}BrNO_4$ $[M+H]^+$:504.0805; found: 504.0791.

(43) *cis*-13-([1,1'-biphenyl]-4-ylmethyl)-7a-(hydroxymethyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-ch romeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{11})



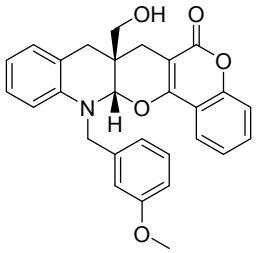
Yellow solid (80.2 mg, 0.160 mmol, 80% yield); m.p.: 183.3-184.3 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63 – 7.53 (m, 5H), 7.49 (d, *J* = 5.0 Hz, 2H), 7.45 – 7.39 (m, 3H), 7.35 – 7.30 (m, 1H), 7.27 – 7.24 (m, 1H), 7.18 – 7.13 (m, 1H), 7.06 (t, *J* = 10.0 Hz, 1H), 7.01 (d, *J* = 10.0 Hz, 1H), 6.81 – 6.71 (m, 2H), 5.47 (s, 1H), 4.95 (d, *J* = 15.0 Hz, 1H), 4.84 (d, *J* = 15.0 Hz, 1H), 3.84 (d, *J* = 10.0 Hz, 1H), 3.62 (d, *J* = 10.0 Hz, 1H), 3.04 (d, *J* = 20.0 Hz, 1H), 2.92 (d, *J* = 20.0 Hz, 1H), 2.56 (d, *J* = 15.0 Hz, 1H), 2.48 (d, *J* = 20.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 157.6, 152.7, 140.7, 140.7, 140.3, 137.5, 131.5, 129.9, 128.8, 127.5, 127.5, 127.4, 127.2, 127.0, 123.8, 122.8, 120.5, 119.5, 116.6, 115.5, 113.0, 99.4, 92.1, 65.9, 54.9, 34.5, 29.7, 28.5. HRMS (ESI): Calcd. for $C_{33}H_{28}NO_4$ $[M+H]^+$:502.2013; found: 502.2002.

（44）*cis*-7a-(hydroxymethyl)-13-(4-(methylsulfonyl)benzyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one（e_{12})



Yellow solid (80.5 mg, 0.160 mmol, 80% yield); m.p.: 145.0-146.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (d, *J* = 10.0 Hz, 2H), 7.69 (d, *J* = 10.0 Hz, 2H), 7.58 (d, *J* = 10.0 Hz, 1H), 7.50 – 7.43 (m, 1H), 7.27 (d, *J* = 5.0 Hz, 1H), 7.23 – 7.18 (m, 1H), 7.03 (t, *J* = 6.9 Hz, 2H), 6.82 – 6.76 (m, 1H), 6.52 (d, *J* = 10.0 Hz, 1H), 5.55 (s, 1H), 5.04 (d, *J* = 15.0 Hz, 1H), 4.88 (d, *J* = 15.0 Hz, 1H), 3.88 (d, *J* = 10.0 Hz, 1H), 3.65 (d, *J* = 10.0 Hz, 1H), 3.11 (d, *J* = 20.0 Hz, 1H), 3.06 (s, 3H), 2.95 (d, *J* = 20.0 Hz, 1H), 2.78 (s, 1H), 2.55 (d, *J* = 15.0 Hz, 1H), 2.47 (d, *J* = 15.0 Hz, 1H).^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 157.5, 152.7, 145.4, 140.2, 139.4, 131.7, 130.0, 127.9, 127.6, 127.5, 123.9, 122.5, 120.6, 119.9, 116.6, 115.4, 112.7, 99.5, 92.3, 65.7, 55.2, 44.6, 34.6, 29.8, 28.4. HRMS (ESI): Calcd. for $C_{28}H_{26}SNO_6$ $[M+H]^+$:504.1475; found: 504.1465.

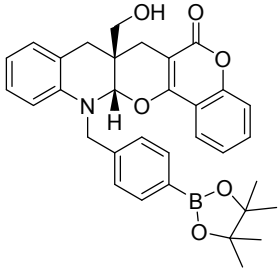
(45) *cis*-7a-(hydroxymethyl)-13-(3-methoxybenzyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one（e_{13}）



Yellow solid (47.3 mg, 0.104 mmol, 52% yield); m.p.: 162.5-163.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 10.0 Hz, 1H), 7.49 – 7.43 (m, 1H), 7.30 – 7.26 (m, 2H), 7.22 – 7.16 (m, 1H), 7.08 – 6.98 (m, 4H), 6.81 (d, *J* = 10.0 Hz, 1H), 6.78 – 6.74 (m, 1H), 6.70 (d, *J* = 5.0 Hz, 1H), 5.45 (s, 1H), 4.89 – 4.76 (m, 2H),

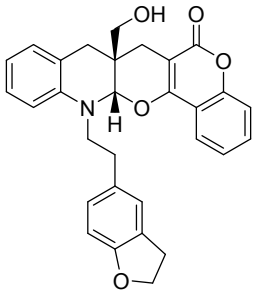
3.85 (d, *J* = 10.0 Hz, 1H), 3.78 (s, 3H), 3.61 (d, *J* = 10.0 Hz, 1H), 3.04 (d, *J* = 20.0 Hz, 1H), 2.93 (d, *J* = 15.0 Hz, 1H), 2.55 (d, *J* = 20.0 Hz, 1H), 2.46 (d, *J* = 15.0 Hz, 1H), 2.26 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 160.1, 157.6, 152.7, 140.7, 140.2, 131.5, 129.9, 129.8, 127.4, 123.8, 122.8, 120.4, 119.5, 118.8, 116.6, 115.5, 113.0, 112.6, 112.4, 99.4, 92.0, 65.9, 55.3, 55.0, 34.5, 29.7, 28.5. HRMS (ESI): Calcd. for $C_{28}H_{26}NO_5$ $[M+H]^+$:456.1805; found: 456.1800.

(46) cis-7a-(hydroxymethyl)-13-(4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzyl)-7a,8,13,13a-tetrahydro-6H,7H-chromeno[3',4':5,6]pyrano[2,3-b]quinolin-6-one (e_{14})



Yellow solid (63.8 mg, 0.116 mmol, 58% yield); m.p.: 196.2-197.2 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, *J* = 10.0 Hz, 2H), 7.62 (d, *J* = 10.0 Hz, 1H), 7.50 – 7.43 (m, 3H), 7.26 (d, *J* = 5.0 Hz, 1H), 7.21 – 7.16 (m, 1H), 7.04 – 6.97 (m, 2H), 6.77 – 6.72 (m, 1H), 6.66 (d, *J* = 10.0 Hz, 1H), 5.44 (s, 1H), 4.91 (d, *J* = 20.0 Hz, 1H), 4.83 (d, *J* = 15.0 Hz, 1H), 3.81 (d, *J* = 10.0 Hz, 1H), 3.60 (d, *J* = 10.0 Hz, 1H), 3.03 (d, *J* = 15.0 Hz, 1H), 2.91 (d, *J* = 20.0 Hz, 1H), 2.55 (d, *J* = 15.0 Hz, 1H), 2.47 (d, *J* = 20.0 Hz, 1H), 1.34 (s, 12H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 157.6, 152.7, 141.7, 140.6, 135.3, 131.5, 129.8, 127.4, 126.1, 123.8, 122.8, 120.5, 119.5, 116.5, 115.5, 112.9, 99.4, 92.1, 83.9, 65.8, 55.3, 34.5, 29.7, 28.5, 24.9. HRMS (ESI): Calcd. for $C_{33}H_{35}BNO_6$ $[M+H]^+$: 552.2552; found:552.2542.

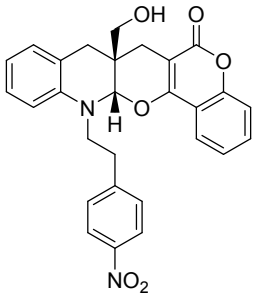
(47) *cis*-13-(2-(2,3-dihydrobenzofuran-5-yl)ethyl)-7a-(hydroxymethyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{15})



Yellow solid (83.7 mg, 0.174 mmol, 87% yield); m.p.: 152.3-153.3 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 – 7.62 (m, 1H), 7.48 – 7.43 (m, 1H), 7.26 (d, *J* = 5.0 Hz, 1H), 7.23 – 7.16 (m, 2H), 7.14 (s, 1H), 7.06 – 6.98 (m, 2H), 6.91 (d, *J* = 10.0 Hz, 1H), 6.82 – 6.77 (m, 1H), 6.75 (d, *J* = 10.0 Hz, 1H), 5.33 (s, 1H), 4.58 – 4.51 (m, 2H), 3.90 – 3.78 (m, 2H), 3.59 (d, *J* = 10.0 Hz, 1H), 3.42 (d, *J* = 10.0 Hz, 1H), 3.23 – 3.15 (m, 2H), 3.15 – 3.04 (m, 2H), 2.99 (d, *J* = 15.0 Hz, 1H), 2.84 (d, *J* = 15.0 Hz, 1H), 2.48 (d, *J* = 15.0 Hz, 1H), 2.39 (d, *J* = 20.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.4, 158.9, 157.6, 152.7, 140.0, 131.5, 131.0, 130.1, 128.2, 127.6, 127.5, 125.3, 123.8, 122.7, 120.6, 119.2, 116.6, 115.5, 111.8, 109.4, 99.4, 92.4, 71.3, 65.9, 53.4, 34.2, 34.1, 29.8, 29.7, 28.4. HRMS (ESI): Calcd. for $C_{30}H_{28}NO_5$ $[M+H]^+$:482.1962; found: 482.1952.

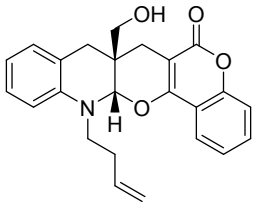
(48) *cis*-7a-(hydroxymethyl)-13-(4-nitrophenethyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3

',4':5,6]pyrano[2,3-*b*]quinolin-6-one（e_{16}）



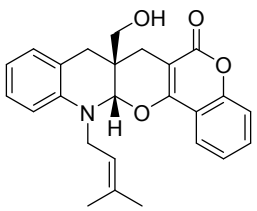
Yellow solid (67.8 mg, 0.140 mmol, 70% yield); m.p.: 152.0-153.0 °C; ^{1}H NMR (500 MHz, DMSO-d_6) δ 8.20 (d, J = 10.0 Hz, 2H), 7.71 (d, J = 10.0 Hz, 2H), 7.67 – 7.61 (m, 1H), 7.62 – 7.54 (m, 1H), 7.39 (d, J = 10.0 Hz, 1H), 7.33 – 7.26 (m, 1H), 7.19 – 7.12 (m, 1H), 7.00 (d, J = 5.0 Hz, 1H), 6.95 (d, J = 5.0 Hz, 1H), 6.74 (t, J = 5.0 Hz, 1H), 5.65 – 5.59 (m, 1H), 5.01 (t, J = 5.0 Hz, 1H), 3.99 – 3.89 (m, 1H), 3.88 – 3.76 (m, 1H), 3.32 – 3.20 (m, 4H), 2.79 (d, J = 20.0 Hz, 1H), 2.63 (d, J = 15.0 Hz, 1H), 2.53 (d, J = 10.0 Hz, 1H), 2.40 (d, J = 20.0 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 162.4, 157.3, 152.7, 148.1, 146.6, 140.0, 132.2, 130.7, 130.4, 127.8, 124.5, 124.0, 122.9, 121.0, 119.1, 116.7, 115.6, 112.1, 99.6, 92.4, 64.2, 51.4, 34.4, 34.1, 29.0, 28.9. HRMS (ESI): Calcd. for $C_{28}H_{25}N_2O_6$ $[M+H]^+$:485.1707; found: 485.1696.

(49) *cis*-13-(but-3-en-1-yl)-7a-(hydroxymethyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{17})



Yellow solid (62.1 mg, 0.154 mmol, 77% yield); m.p.: 133.0-134.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 – 7.63 (m, 1H), 7.50 – 7.46 (m, 1H), 7.32 – 7.28 (m, 1H), 7.25 – 7.20 (m, 1H), 7.20 – 7.16 (m, 1H), 7.00 (d, J = 10.0 Hz, 1H), 6.83 – 6.76 (m, 2H), 6.01 – 5.87 (m, 1H), 5.39 (s, 1H), 5.24 – 5.17 (m, 1H), 5.15 (d, J = 10.0 Hz, 1H), 3.83 – 3.62 (m, 3H), 3.50 (d, J = 10.0 Hz, 1H), 3.03 (d, J = 15.0 Hz, 1H), 2.86 (d, J = 15.0 Hz, 1H), 2.68 – 2.58 (m, 2H), 2.53 (d, J = 15.0 Hz, 1H), 2.41 (d, J = 15.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.3, 157.6, 152.8, 140.0, 135.8, 131.5, 130.1, 127.4, 123.8, 122.7, 120.5, 119.1, 117.2, 116.6, 115.5, 111.8, 99.3, 92.1, 66.0, 50.6, 34.1, 32.8, 29.6, 28.5. HRMS (ESI): Calcd. for $C_{24}H_{24}NO_4$ $[M+H]^+$:390.1700; found: 390.1694.

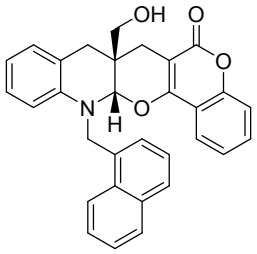
(50) *cis*-7a-(hydroxymethyl)-13-(3-methylbut-2-en-1-yl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{18})



Yellow solid (52.4 mg, 0.130 mmol, 65% yield); m.p.: 145.5-146.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64

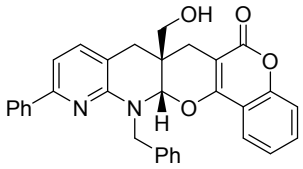
(d, *J* = 5.0 Hz, 1H), 7.49 – 7.41 (m, 1H), 7.26 (d, *J* = 10.0 Hz, 1H), 7.21 – 7.16 (m, 1H), 7.15 – 7.09 (m, 1H), 6.98 (d, *J* = 10.0 Hz, 1H), 6.81 – 6.72 (m, 2H), 5.48 – 5.42 (m, 2H), 5.42 (s, 1H), 4.34 – 4.26 (m, 1H), 4.19 – 4.11 (m, 1H), 3.69 (d, *J* = 10.0 Hz, 1H), 3.52 (d, *J* = 10.0 Hz, 1H), 3.00 (d, *J* = 20.0 Hz, 1H), 2.83 (d, *J* = 20.0 Hz, 1H), 2.53 (d, *J* = 20.0 Hz, 1H), 2.45 (d, *J* = 15.0 Hz, 1H), 1.79 (s, 3H), 1.77 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.6, 157.9, 152.7, 140.4, 135.1, 131.5, 129.9, 127.3, 123.8, 122.8, 121.4, 120.7, 119.1, 116.5, 115.6, 112.3, 99.2, 91.8, 66.0, 48.9, 34.2, 29.7, 28.6, 25.9, 18.1. HRMS (ESI): Calcd. for $C_{25}H_{26}NO_4$ $[M+H]^+$: 404.1856; found: 404.1848.

(51) *cis*-7a-(hydroxymethyl)-13-(naphthalen-1-ylmethyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{19})



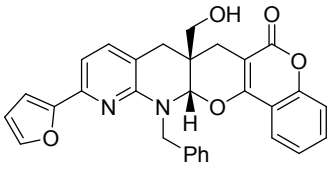
White solid (63.7 mg, 0.134 mmol, 67% yield); m.p.: 165.3-166.3 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.98 (s, 1H), 7.91 (t, *J* = 8.0 Hz, 2H), 7.83 (d, *J* = 8.0 Hz, 1H), 7.65 (d, *J* = 8.0 Hz, 1H), 7.57 – 7.51 (m, 2H), 7.51 – 7.43 (m, 2H), 7.35 (d, *J* = 8.0 Hz, 1H), 7.17 (t, *J* = 8.0 Hz, 1H), 7.03 – 6.91 (m, 2H), 6.69 (d, *J* = 4.0 Hz, 2H), 5.68 (s, 1H), 5.22 (s, 1H), 5.12 (d, *J* = 16.0 Hz, 1H), 4.93 (d, *J* = 16.0 Hz, 1H), 3.66 – 3.48 (m, 2H), 2.88 (d, *J* = 20.0 Hz, 1H), 2.73 (d, *J* = 16.0 Hz, 1H), 2.57 (d, *J* = 16.0 Hz, 1H), 2.51 – 2.42 (m, 1H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 162.4, 157.1, 152.7, 140.9, 137.3, 133.5, 132.8, 132.2, 130.1, 128.6, 128.1, 128.0, 127.5, 126.7, 126.1, 125.8, 125.4, 124.3, 122.8, 121.2, 119.3, 116.7, 115.6, 113.0, 99.7, 93.0, 64.5, 55.2, 34.5, 29.2, 28.9. HRMS (ESI): Calcd. for $C_{31}H_{26}NO_4$ $[M+H]^+$: 476.1856; found: 476.1846.

(52) *cis*-13-benzyl-7a-(hydroxymethyl)-11-phenyl-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*][1,8]naphthyridin-6-one (e_{20})



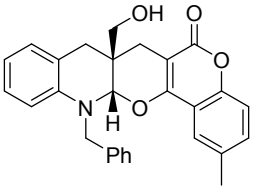
Yellow solid (67.3 mg, 0.134 mmol, 67% yield); m.p.: 156.0-157.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (d, *J* = 10.0 Hz, 2H), 7.51 – 7.45 (m, 4H), 7.44 – 7.40 (m, 2H), 7.39 – 7.30 (m, 5H), 7.28 (d, *J* = 10.0 Hz, 1H), 7.22 (d, *J* = 5.0 Hz, 1H), 7.20 – 7.15 (m, 1H), 5.75 (d, *J* = 15.0 Hz, 1H), 5.45 (s, 1H), 4.92 (d, *J* = 15.0 Hz, 1H), 3.62 (d, *J* = 10.0 Hz, 1H), 3.46 (d, *J* = 10.0 Hz, 1H), 2.96 (d, *J* = 20.0 Hz, 1H), 2.89 (d, *J* = 15.0 Hz, 1H), 2.52 (d, *J* = 15.0 Hz, 1H), 2.48 (d, *J* = 15.0 Hz, 1H), 1.48 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.1, 157.3, 153.5, 152.7, 151.6, 139.6, 139.2, 138.2, 131.6, 128.8, 128.7, 128.6, 128.3, 127.5, 126.5, 123.8, 122.8, 116.5, 115.4, 113.9, 111.6, 99.4, 89.2, 65.8, 50.2, 34.0, 29.0, 28.1. HRMS (ESI): Calcd. for $C_{32}H_{27}N_2O_4$ $[M+H]^+$:503.1965; found: 503.1953.

(53) *cis*-13-benzyl-11-(furan-2-yl)-7a-(hydroxymethyl)-6a,7a,8,13,13a,14a-hexahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*][1,8]naphthyridin-6-one (e_{21})



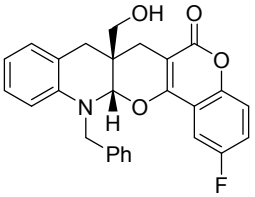
Yellow solid (78.7 mg, 0.160 mmol, 80% yield); m.p.: 129.5-130.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 – 7.43 (m, 5H), 7.36 – 7.32 (m, 2H), 7.31 – 7.26 (m, 3H), 7.19 – 7.13 (m, 2H), 6.96 (d, *J* = 5.0 Hz, 1H), 6.52 – 6.46 (m, 1H), 5.61 (d, *J* = 15.0 Hz, 1H), 5.44 (s, 1H), 4.89 (d, *J* = 15.0 Hz, 1H), 3.59 (d, *J* = 15.0 Hz, 1H), 3.45 (d, *J* = 10.0 Hz, 1H), 2.95 (d, *J* = 15.0 Hz, 1H), 2.85 (d, *J* = 15.0 Hz, 1H), 2.51 (d, *J* = 20.0 Hz, 1H), 2.45 (d, *J* = 15.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.2, 157.3, 154.3, 152.7, 151.6, 145.9, 142.7, 139.5, 138.0, 131.6, 128.8, 128.5, 127.5, 123.8, 122.8, 116.5, 115.3, 114.0, 111.9, 110.0, 107.8, 99.3, 89.3, 65.7, 50.4, 34.0, 29.1, 28.1. HRMS (ESI): Calcd. for $C_{30}H_{25}N_2O_5$ $[M+H]^+$: 493.1758; found: 493.1749.

(54) *cis*-13-benzyl-7a-(hydroxymethyl)-2-methyl-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{22})



White solid (61.5 mg, 0.140 mmol, 70% yield); m.p.: 165.5-166.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (d, *J* = 5.0 Hz, 2H), 7.40 – 7.34 (m, 3H), 7.32 – 7.24 (m, 2H), 7.16 (d, *J* = 10.0 Hz, 1H), 7.10 – 7.03 (m, 1H), 7.02 (d, *J* = 10.0 Hz, 1H), 6.81 – 6.74 (m, 1H), 6.73 (d, *J* = 10.0 Hz, 1H), 5.44 (s, 1H), 4.95 (d, *J* = 20.0 Hz, 1H), 4.83 (d, *J* = 15.0 Hz, 1H), 3.83 (d, *J* = 15.0 Hz, 1H), 3.61 (d, *J* = 10.0 Hz, 1H), 3.02 (d, *J* = 20.0 Hz, 1H), 2.93 (d, *J* = 20.0 Hz, 1H), 2.55 (d, *J* = 20.0 Hz, 1H), 2.48 (d, *J* = 15.0 Hz, 1H), 2.35 (s, 3H), 2.08 (s, 1H).^{13}C NMR (126 MHz, $CDCl_3$) δ 163.5, 157.5, 150.9, 140.6, 138.4, 133.4, 132.5, 129.9, 128.8, 127.4, 127.3, 126.8, 122.5, 120.4, 119.4, 116.3, 115.1, 112.8, 99.2, 91.9, 66.0, 55.1, 34.4, 29.7, 28.5, 20.9. HRMS (ESI): Calcd. for $C_{28}H_{26}NO_4$ $[M+H]^+$:440.1856; found: 440.1849.

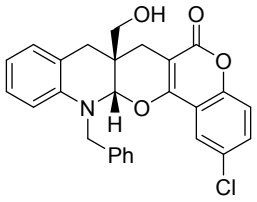
(55) *cis*-13-benzyl-2-fluoro-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{23})



Yellow solid (43.2 mg, 0.100 mmol, 50% yield); m.p.: 108.5-109.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 (d, *J* = 5.0 Hz, 2H), 7.39 – 7.35 (m, 2H), 7.32 – 7.26 (m, 2H), 7.25 – 7.23 (m, 1H), 7.20 – 7.15 (m, 1H), 7.10 – 7.04 (m, 1H), 7.02 (d, *J* = 10.0 Hz, 1H), 6.82 – 6.77 (m, 1H), 6.75 (d, *J* = 5.0 Hz, 1H), 5.46 (s, 1H), 4.92 (d, *J* = 15.0 Hz, 1H), 4.83 (d, *J* = 15.0 Hz, 1H), 3.83 (d, *J* = 10.0 Hz, 1H), 3.61 (d, *J* = 10.0 Hz, 1H), 3.03 (d, *J* = 15.0 Hz, 1H), 2.91 (d, *J* = 15.0 Hz, 1H), 2.56 (d, *J* = 15.0 Hz, 1H), 2.49 (d, *J* = 20.0 Hz, 1H), 1.97 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.0, 158.6 (d, *J* = 243.6 Hz), 156.7(d, *J* = 2.4 Hz), 148.8, 140.5, 138.3, 129.9, 128.9, 127.6, 127.5, 126.7, 120.2, 119.6, 118.9 (d, *J* = 24.4 Hz), 118.1 (d, *J* = 8.2 Hz),

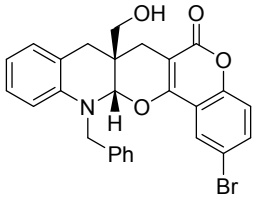
116.4(d, *J* = 8.9 Hz), 112.9, 108.5 (d, *J* = 25.4 Hz), 100.2, 92.2, 65.9, 54.9, 34.5, 29.7, 28.5. ^{19}F NMR (471 MHz, $CDCl_3$) δ -117.54. HRMS (ESI): Calcd. for $C_{27}H_{23}FNO_4$ $[M+H]^+$:444.1606; found: 444.1599.

(56) *cis*-13-benzyl-2-chloro-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{24})



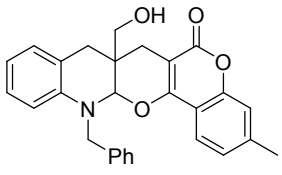
Yellow solid (78.0 mg, 0.170 mmol, 85% yield); m.p.: 149.0-150.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54 (d, *J* = 5.0 Hz, 1H), 7.44 (d, *J* = 5.0 Hz, 2H), 7.41 – 7.36 (m, 3H), 7.32 – 7.28 (m, 1H), 7.20 (d, *J* = 10.0 Hz, 1H), 7.10 – 7.05 (m, 1H), 7.02 (d, *J* = 10.0 Hz, 1H), 6.82 – 6.77 (m, 1H), 6.75 (d, *J* = 5.0 Hz, 1H), 5.46 (s, 1H), 4.94 (d, *J* = 15.0 Hz, 1H), 4.82 (d, *J* = 15.0 Hz, 1H), 3.83 (d, *J* = 10.0 Hz, 1H), 3.61 (d, *J* = 10.0 Hz, 1H), 3.02 (d, *J* = 15.0 Hz, 1H), 2.91 (d, *J* = 15.0 Hz, 1H), 2.55 (d, *J* = 20.0 Hz, 1H), 2.49 (d, *J* = 15.0 Hz, 1H), 1.97 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 162.7, 156.5, 151.1, 140.4, 138.3, 131.5, 129.9, 129.3, 128.8, 127.6, 127.5, 126.7, 122.4, 120.2, 119.6, 118.0, 116.6, 112.9, 100.2, 92.3, 65.9, 55.0, 34.4, 29.7, 28.5. HRMS (ESI): Calcd. for $C_{27}H_{23}ClNO_4$ $[M+H]^+$:460.1310; found: 460.1299.

(57) *cis*-13-benzyl-2-bromo-7a-(hydroxymethyl)-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{25})



Yellow solid (65.4 mg, 0.130 mmol, 65% yield); m.p.: 149.5-150.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 5.0 Hz, 1H), 7.53 – 7.49 (m, 1H), 7.44 (d, *J* = 10.0 Hz, 2H), 7.39 – 7.36 (m, 2H), 7.31 – 7.28 (m, 1H), 7.11 (d, *J* = 10.0 Hz, 1H), 7.08 – 7.04 (m, 1H), 7.01 (d, *J* = 10.0 Hz, 1H), 6.80 – 6.76 (m, 1H), 6.74 (d, *J* = 5.0 Hz, 1H), 5.47 (s, 1H), 4.95 (d, *J* = 15.0 Hz, 1H), 4.81 (d, *J* = 20.0 Hz, 1H), 3.82 (d, *J* = 10.0 Hz, 1H), 3.60 (d, *J* = 10.0 Hz, 1H), 3.02 (d, *J* = 15.0 Hz, 1H), 2.89 (d, *J* = 20.0 Hz, 1H), 2.53 (d, *J* = 15.0 Hz, 1H), 2.48 (d, *J* = 15.0 Hz, 1H), 2.33 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 162.8, 156.5, 151.5, 140.4, 138.3, 134.29, 129.9, 128.8, 127.6, 127.5, 126.7, 125.4, 120.2, 119.6, 118.3, 117.1, 116.7, 112.9, 100.2, 92.6, 65.8, 55.1, 34.4, 29.7, 28.5. HRMS (ESI): Calcd. for $C_{27}H_{23}BrNO_4$ $[M+H]^+$:504.0805; found: 504.0793.

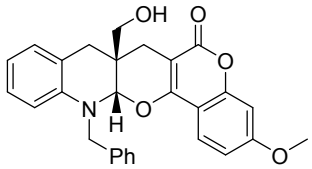
(58) *cis*-13-benzyl-7a-(hydroxymethyl)-3-methyl-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{26})



Yellow solid (61.5 mg, 0.140 mmol, 70% yield); m.p.: 159.5-160.5 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48

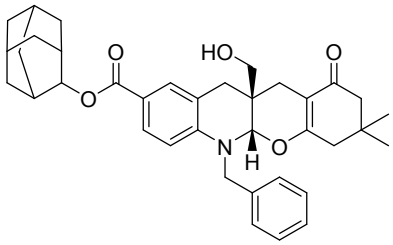
(d, *J* = 5.0 Hz, 1H), 7.43 (d, *J* = 5.0 Hz, 2H), 7.35 (t, *J* = 10.0 Hz, 2H), 7.30 – 7.25 (m, 1H), 7.08 – 6.98 (m, 4H), 6.78 – 6.73 (m, 1H), 6.70 (d, *J* = 5.0 Hz, 1H), 5.43 (s, 1H), 4.90 (d, *J* = 15.0 Hz, 1H), 4.82 (d, *J* = 15.0 Hz, 1H), 3.81 (d, *J* = 10.0 Hz, 1H), 3.60 (d, *J* = 10.0 Hz, 1H), 3.01 (d, *J* = 20.0 Hz, 1H), 2.91 (d, *J* = 20.0 Hz, 1H), 2.53 (d, *J* = 15.0 Hz, 1H), 2.47 (d, *J* = 15.0 Hz, 1H), 2.39 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.7, 157.9, 152.8, 142.6, 140.7, 138.4, 129.8, 128.8, 127.4, 127.3, 126.7, 125.0, 122.5, 120.5, 119.4, 116.7, 113.0, 112.9, 98.3, 92.0, 65.9, 55.1, 34.5, 29.7, 28.5, 21.7. HRMS (ESI): Calcd. for $C_{28}H_{26}NO_4$ $[M+H]^+$:440.1856; found: 440.1845.

(59) *cis*-13-benzyl-7a-(hydroxymethyl)-3-methoxy-7a,8,13,13a-tetrahydro-6*H*,7*H*-chromeno[3',4':5,6]pyrano[2,3-*b*]quinolin-6-one (e_{27})



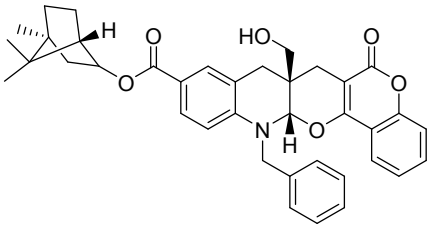
Yellow solid (80.1 mg, 0.176 mmol, 86% yield); m.p.: 163.0-164.0 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 – 7.49 (m, 1H), 7.43 (d, *J* = 5.0 Hz, 2H), 7.38 – 7.34 (m, 2H), 7.31 – 7.26 (m, 1H), 7.07 – 7.00 (m, 2H), 6.79 – 6.75 (m, 3H), 6.71 (d, *J* = 10.0 Hz, 1H), 5.42 (s, 1H), 4.89 (d, *J* = 15.0 Hz, 1H), 4.82 (d, *J* = 20.0 Hz, 1H), 3.83 (s, 3H), 3.81 (d, *J* = 5.0 Hz, 1H), 3.60 (d, *J* = 10.0 Hz, 1H), 2.99 (d, *J* = 15.0 Hz, 1H), 2.93 (d, *J* = 15.0 Hz, 1H), 2.53 (d, *J* = 15.0 Hz, 1H), 2.47 (d, *J* = 15.0 Hz, 1H), 2.02 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.7, 162.6, 158.0, 154.5, 140.7, 138.4, 129.8, 128.8, 127.4, 127.3, 126.7, 123.8, 120.5, 119.4, 112.9, 112.0, 108.8, 100.4, 96.6, 91.8, 66.0, 55.7, 55.0, 34.5, 29.7, 28.4. HRMS (ESI): Calcd. for $C_{28}H_{26}NO_5$ $[M+H]^+$: 456.1804; found: 456.1795.

（60）adamantan-2-yl-*cis*-6-benzyl-11a-(hydroxymethyl)-3,3-dimethyl-1-oxo-2,3,4,5a,6,11,11a,12-octahydro-1*H*-chromeno[2,3-*b*]quinoline-9-carboxylate (c_{33})



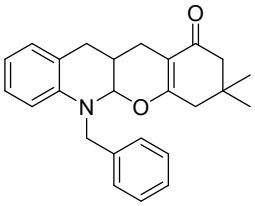
Yellow solid (65.1 mg, 0.112 mmol, 56% yield); m.p.: 125.0-126.0 °C;^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 – 7.62 (m, 2H), 7.37 – 7.31 (m, 4H), 7.29 – 7.26 (m, 1H), 6.59 (d, *J* = 10.0 Hz, 1H), 5.18 (s, 1H), 4.80 – 4.72 (m, 2H), 3.66 (d, *J* = 10.0 Hz, 1H), 3.51 (d, *J* = 10.0 Hz, 1H), 2.78 (d, *J* = 20.0 Hz, 1H), 2.58 (d, *J* = 15.0 Hz, 1H), 2.44 (d, *J* = 20.0 Hz, 1H), 2.31 (d, *J* = 20.0 Hz, 2H), 2.26 – 2.23 (m, 2H), 2.20 – 2.12 (m, 10H), 1.72 – 1.64 (m, 6H), 1.07 (s, 3H), 1.02 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.5, 166.8, 165.5, 144.7, 137.8, 131.1, 129.2, 128.9, 127.4, 126.5, 122.5, 120.2, 112.1, 108.3, 90.4, 80.3, 65.8, 55.2, 50.5, 41.8, 41.5, 36.3, 34.0, 32.4, 30.9, 29.5, 29.4, 27.3, 26.4. HRMS (ESI): Calcd. for $C_{37}H_{44}NO_5$ $[M+H]^+$:582.3214; found: 582.3206.

(61) (1S,4S)-4,7,7-trimethylbicyclo[2.2.1]heptan-2-yl 13-benzyl-7a-(hydroxymethyl)-6-oxo-7a,8,13,13a-tetrahydro-6H,7H-chromeno[3',4':5,6]pyrano[2,3-b]quinoline-10-carboxylate (e_{28})



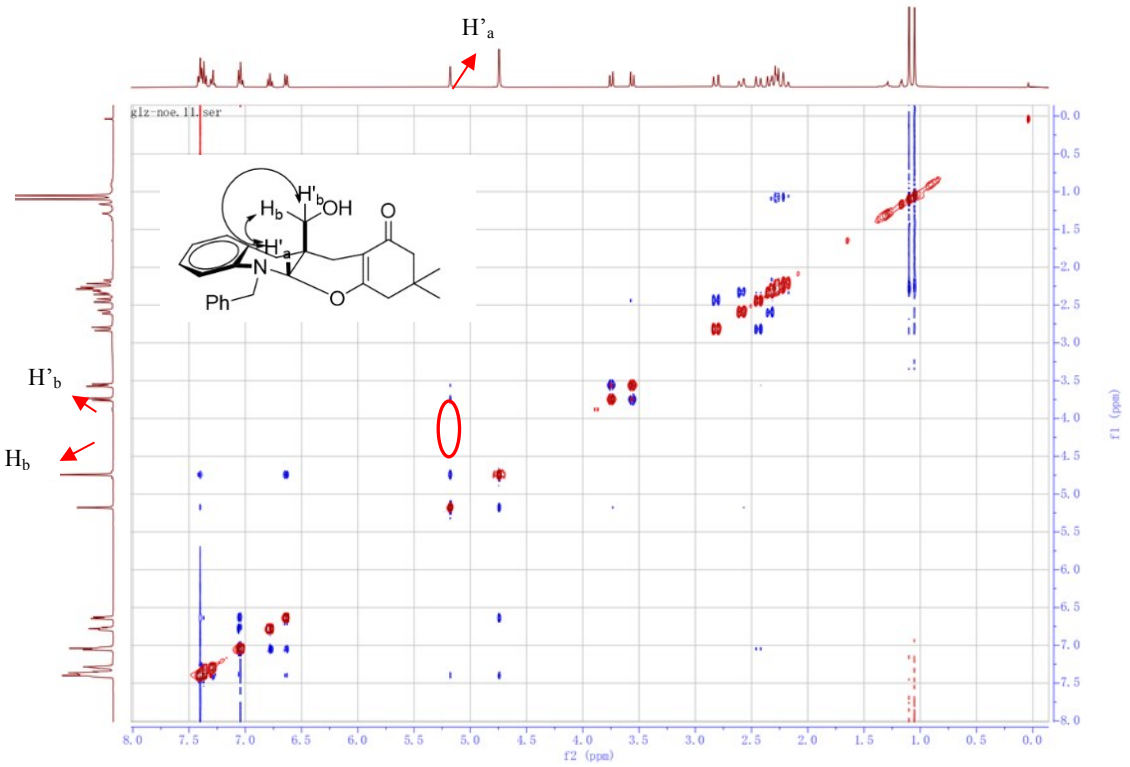
Yellow solid (54.5 mg, 0.09 mmol, 45% yield); m.p.: 150.2-151.2 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.77 (d, *J* = 10.0 Hz, 1H), 7.72 (s, 1H), 7.59 (d, *J* = 10.0 Hz, 1H), 7.51 – 7.41 (m, 3H), 7.40 – 7.34 (m, 2H), 7.33 – 7.25 (m, 2H), 7.23 – 7.16 (m, 1H), 6.75 (d, *J* = 5.0 Hz, 1H), 5.51 (s, 1H), 5.06 – 5.00 (m, 1H), 4.99 (d, *J* = 15.0 Hz, 1H), 4.88 (d, *J* = 20.0 Hz, 1H), 3.80 (d, *J* = 10.0 Hz, 1H), 3.63 (d, *J* = 10.0 Hz, 1H), 3.09 (d, *J* = 20.0 Hz, 1H), 2.97 (d, *J* = 15.0 Hz, 1H), 2.62 – 2.53 (m, 2H), 2.45 – 2.36 (m, 1H), 2.10 – 2.02 (m, 1H), 1.80 – 1.71 (m, 1H), 1.71 – 1.65 (m, 1H), 1.39 – 1.30 (m, 1H), 1.28 – 1.21 (m, 1H), 1.08 – 0.99 (m, 1H), 0.93 (s, 3H), 0.88 (s, 3H), 0.85 (d, *J* = 10.0 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 166.7, 163.2, 157.2, 152.7, 144.7, 137.6, 131.7, 131.3, 129.5, 128.9, 127.6, 126.6, 123.9, 122.6, 121.7, 120.1, 116.6, 115.3, 112.4, 99.5, 91.5, 80.0, 65.6, 55.4, 49.1, 49.0, 47.8, 45.0, 37.0, 36.9, 34.4, 29.6, 28.3, 28.1, 27.4, 19.7, 18.9, 13.6, 13.6. HRMS (ESI): Calcd. for $C_{38}H_{40}NO_6$ $[M+H]^+$:606.2850; found: 606.2843.

(62) cis-6-benzyl-3,3-dimethyl-2,3,4,5a,6,11,11a,12-octahydro-1H-chromeno[2,3-b]quinolin-1-one (c_{34})



Yellow solid (44.8 mg, 0.120 mmol, 60% yield); m.p.: 164.5-165.5 °C;^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.28 (m, 4H), 7.29 – 7.23 (m, 1H), 7.05 (d, *J* = 5.0 Hz, 1H), 7.04 – 6.97 (m, 1H), 6.77 – 6.70 (m, 1H), 6.55 (d, *J* = 5.0 Hz, 1H), 5.19 (s, 1H), 4.81 – 4.69 (m, 2H), 2.79 – 2.69 (m, 1H), 2.65 – 2.53 (m, 2H), 2.50 – 2.46 (m, 2H), 2.31 – 2.13 (m, 4H), 1.07 (s, 3H), 1.03 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.2, 167.2, 141.3, 138.1, 129.2, 128.8, 127.4, 127.1, 126.3, 122.0, 118.6, 112.3, 107.5, 89.2, 54.1, 50.7, 42.2, 32.4, 29.6, 28.7, 27.5, 27.2, 23.8. HRMS (ESI): Calcd. for $C_{25}H_{28}NO_2$ $[M+H]^+$:374.2114; found: 374.2111.

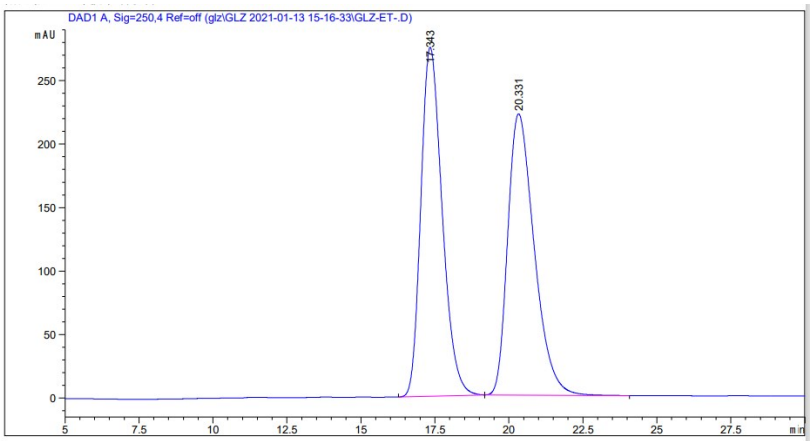
NOESY spectrum of c_1



Coupling between H_a and H_b, and $H_{b'}$ indicates a *cis*-configuration of the C−H bond at the α-site and hydroxymethyl at the β-site of quinoline. As depicted, the coupling signal between H_a and H_b is a little bit stronger than H_a and $H_{b'}$.

HPLC analysis for partial obtained compounds

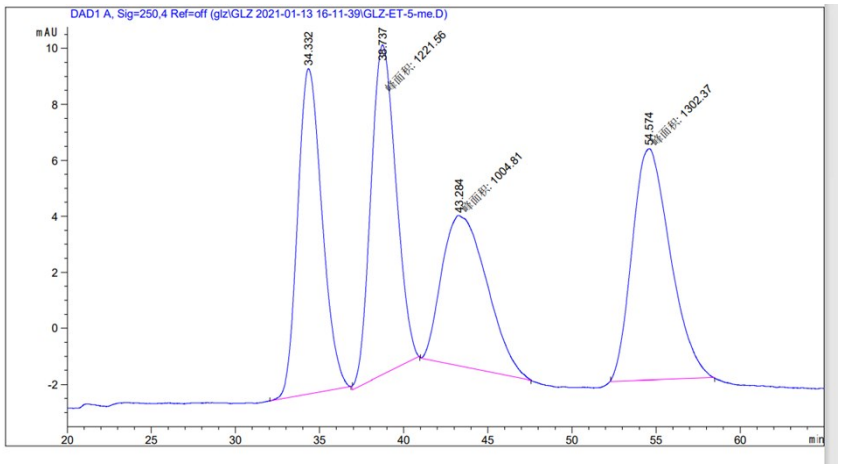
(1) Chromatogram of **c_1**



峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	17.343	BB	0.7754	1.37407e4	274.76080	49.9247
2	20.331	BB	0.9582	1.37821e4	221.42526	50.0753

For $\mathbf{c_1}$, conditions: CHIRALPAK IA (4.6 mm × 250 mm), hexane : IPA = 90 : 10, Flow: 0.8 mL/min, UV: 250 nm.

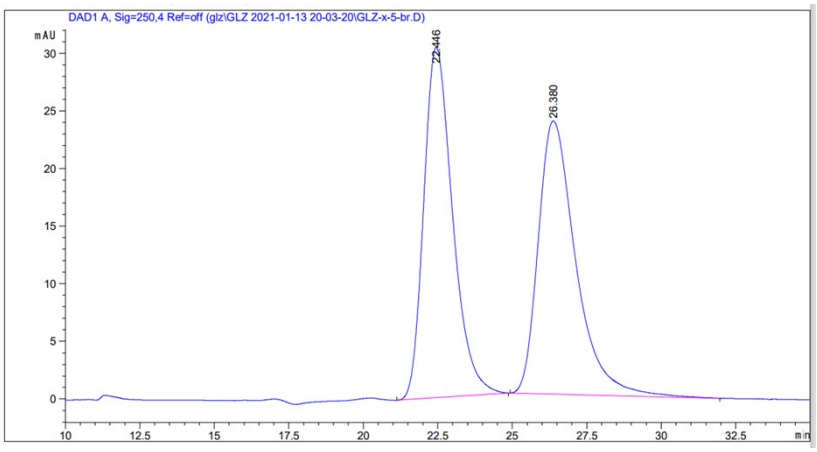
(2) Chromatogram of $\mathbf{c_{30}}$



峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	34.332	BB	1.2825	1167.26587	11.61492	24.8566
2	38.737	MM	1.7281	1221.56055	11.78149	26.0128
3	43.284	MM	3.1194	1004.81067	5.36860	21.3971
4	54.574	MM	2.6279	1302.36780	8.25972	27.7335

For $\mathbf{c_{30}}$, conditions: CHIRALPAK IA (4.6 mm × 250 mm), hexane : IPA = 95 : 5, Flow: 0.8 mL/min, UV: 250 nm.

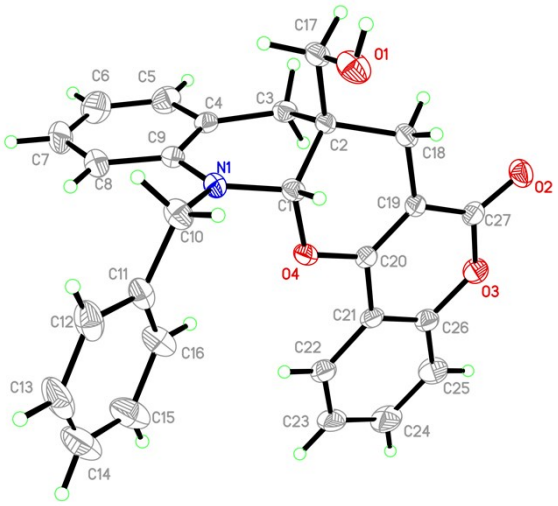
(3) Chromatogram of $\mathbf{e_8}$



峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	3.094	BB	0.1814	25.21510	2.42314	0.6078
2	22.446	BB	1.0194	2047.36743	30.41279	49.3481
3	26.380	BB	1.2734	2076.24609	23.71560	50.0442

For $\mathbf{e_8}$, conditions: CHIRALPAK IA (4.6 mm × 250 mm), hexane : IPA = 90 : 10, Flow: 0.8 mL/min, UV: 250 nm.

Crystallographic data of compound $\mathbf{e_1}$



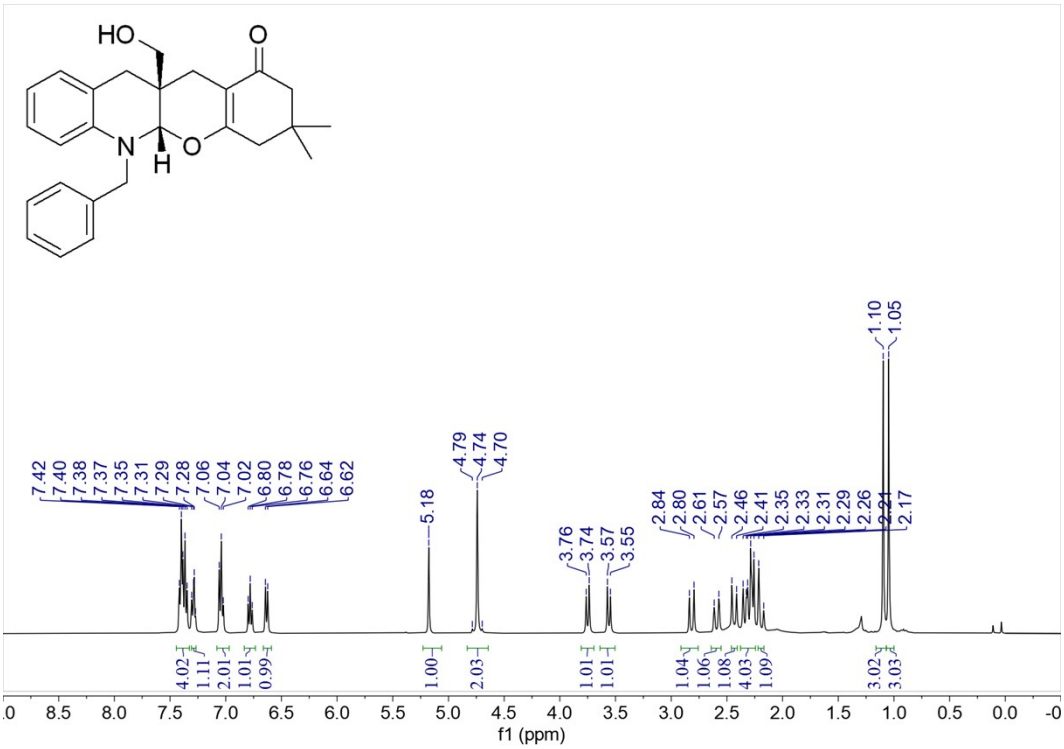
Yellow and transparent block-like single crystals of $\mathbf{e_1}$ were grown by layering a dichloromethane and n-hexane solution at ambient temperature. X-Ray diffraction data of one these crystals were collected on a Bruker P4 diffractometer. The measurements were performed with Mo-Kα radiation (λ = 0.71073 Å). Data were collected at 293 K, using the ω- and φ- scans to a maximum θ value of 29.383°. The data were refined by full-matrix least-squares techniques on F^2 with SHELXTL-2014. And the structures were solved by direct methods SHELXS-2014. All the non-hydrogen atoms were refined anisotropically. The hydrogen atoms were included at geometrically idealized positions. An ORTEP representation of the structure is shown below.

Table 1. Crystal data and structure refinement for $\mathbf{e_1}$.

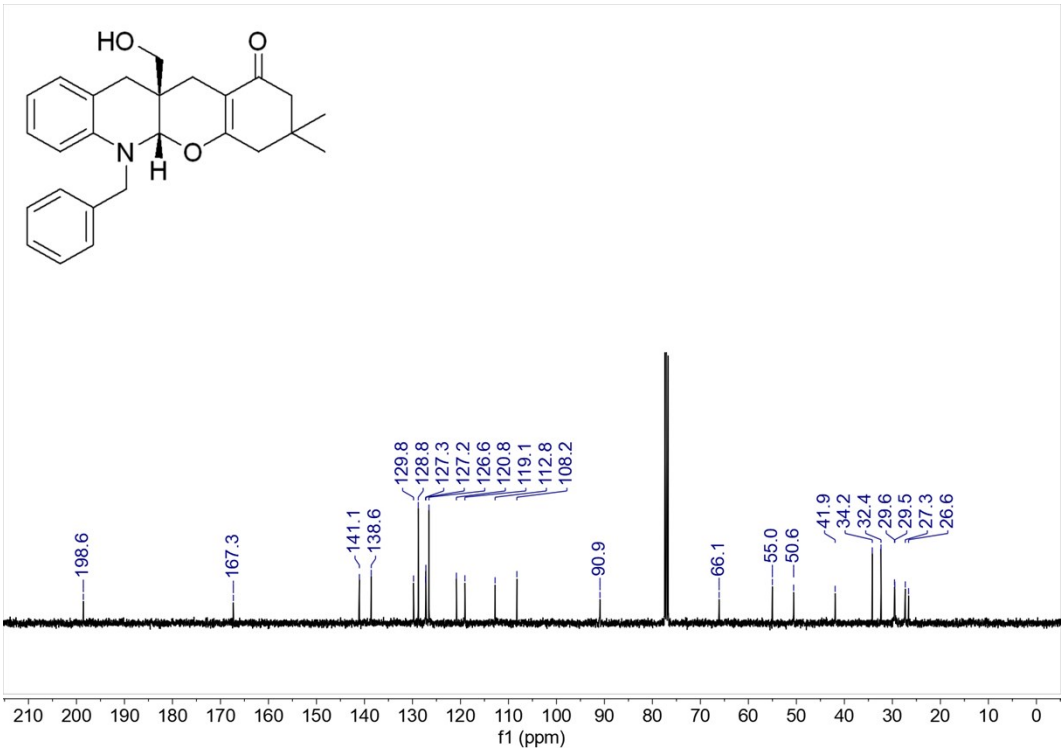
Identification code	$\mathbf{e_1}$	
Empirical formula	$C_{27}H_{23}NO_4$	
Formula weight	425.46	
Temperature	293(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	$P2_1/c$	
Unit cell dimensions	a = 6.2206(6) Å	a= 90°.
	b = 18.2032(13) Å	b= 94.680(7)°.

	c = 18.9733(15) Å g = 90°.
Volume	2141.3(3) $Å^3$
Z	4
Density (calculated)	1.320 Mg/m^3
Absorption coefficient	0.089 mm^{-1}
F(000)	896
Crystal size	0.12 x 0.11 x 0.1 mm^3
Theta range for data collection	2.154 to 29.383°.
Index ranges	-3<=h<=8, -23<=k<=22, -23<=l<=25
Reflections collected	9648
Independent reflections	4919 [R(int) = 0.0313]
Completeness to theta = 25.242°	99.9 %
Absorption correction	NONE
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	4919 / 0 / 289
Goodness-of-fit on F^2	1.022
Final R indices [I>2sigma(I)]	R1 = 0.0705, wR2 = 0.1265
R indices (all data)	R1 = 0.1267, wR2 = 0.1507
Extinction coefficient	n/a
Largest diff. peak and hole	0.162 and -0.225 $e.Å^{-3}$

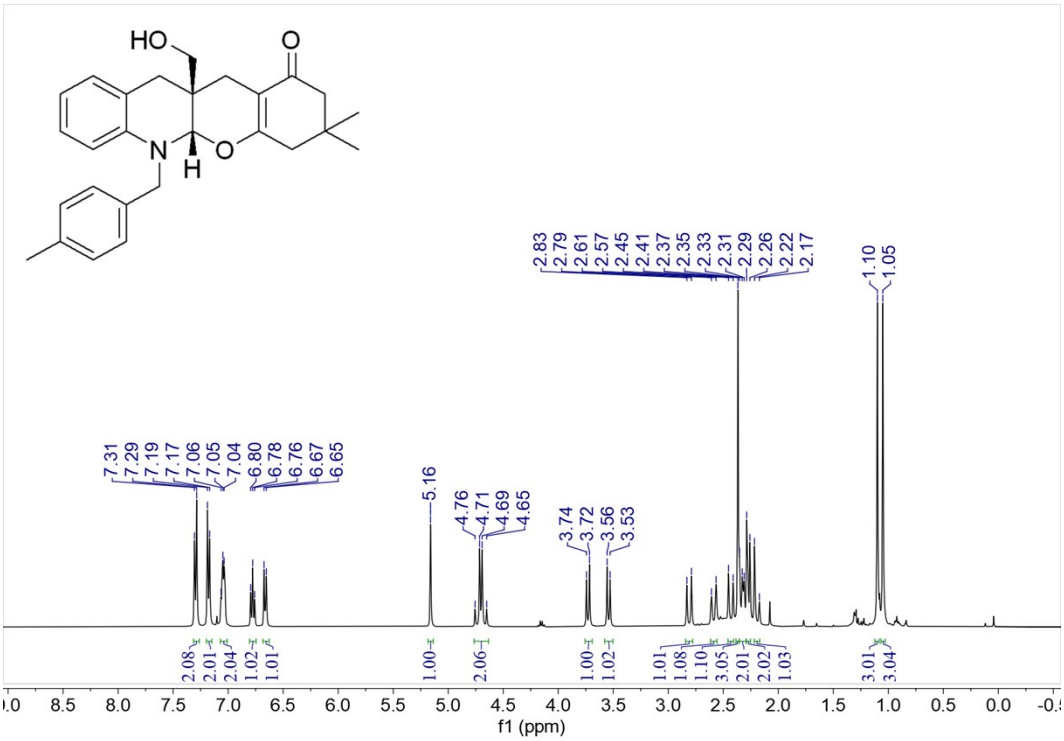
NMR spectra of the Obtained Compounds



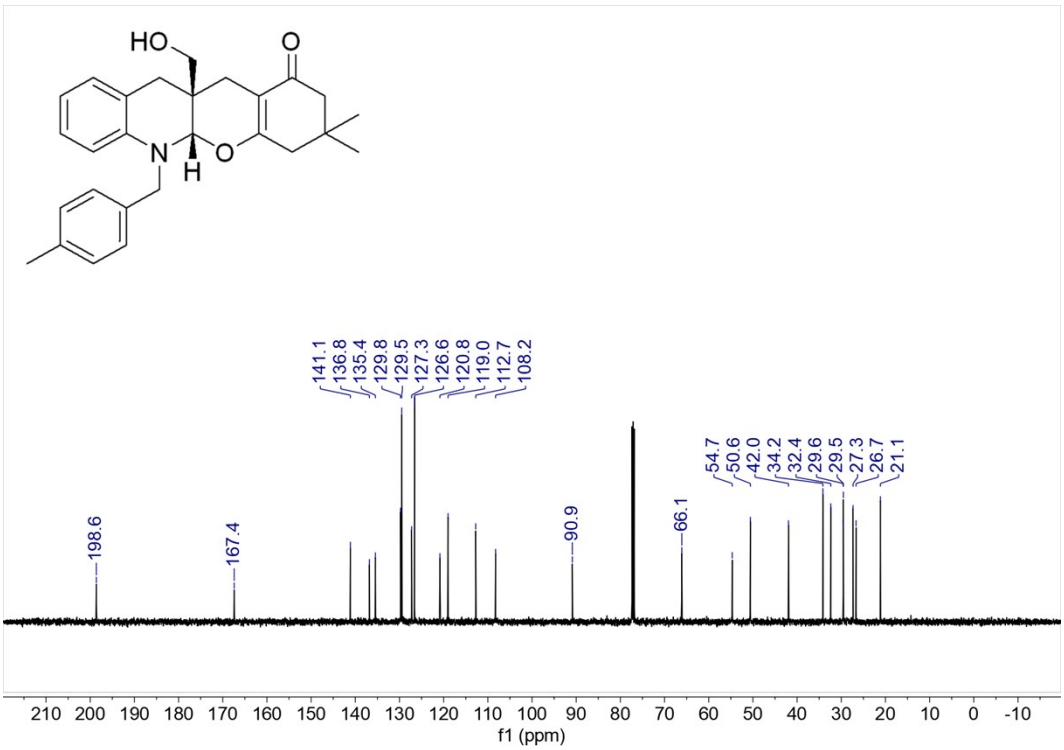
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_1



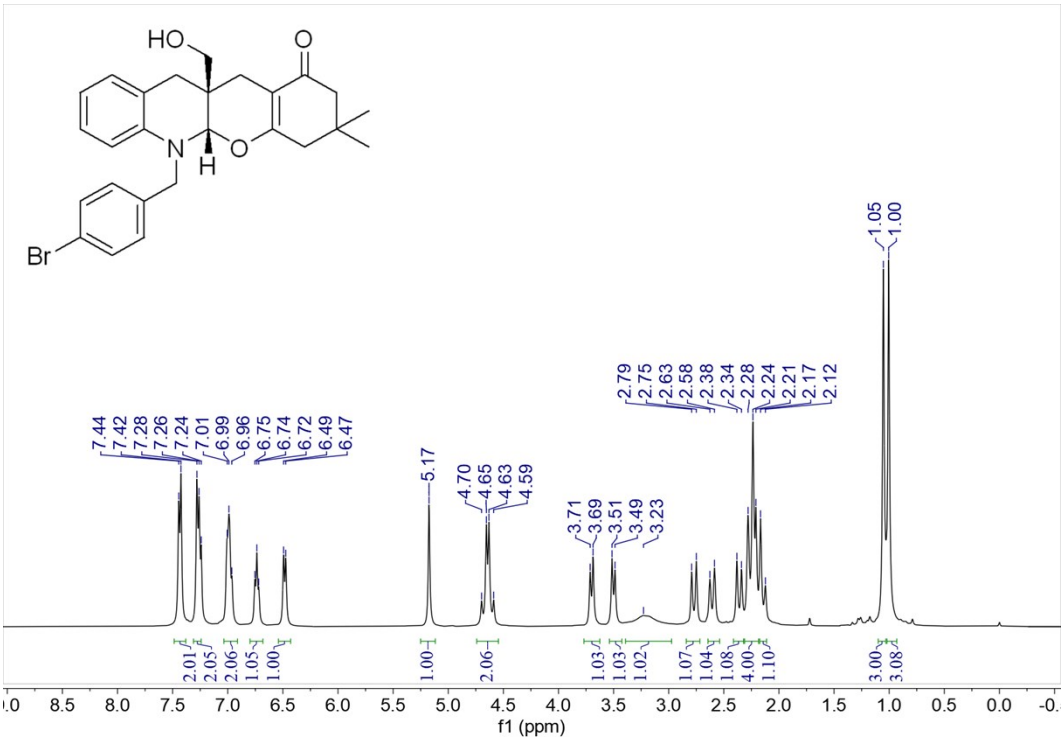
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_1



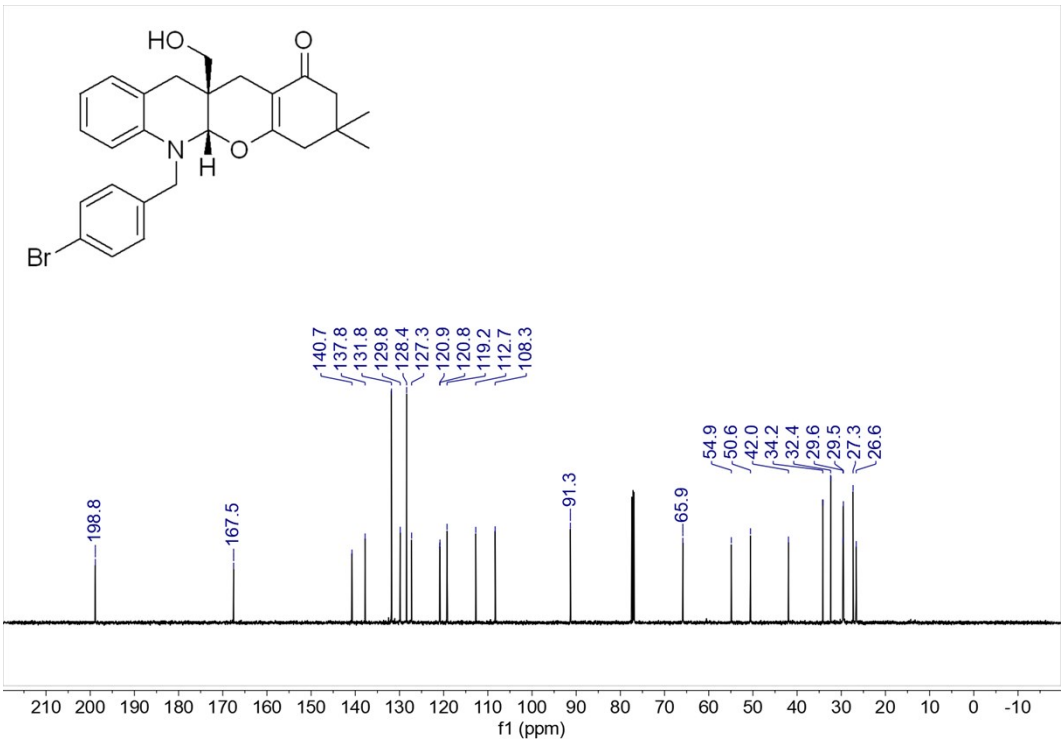
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_2



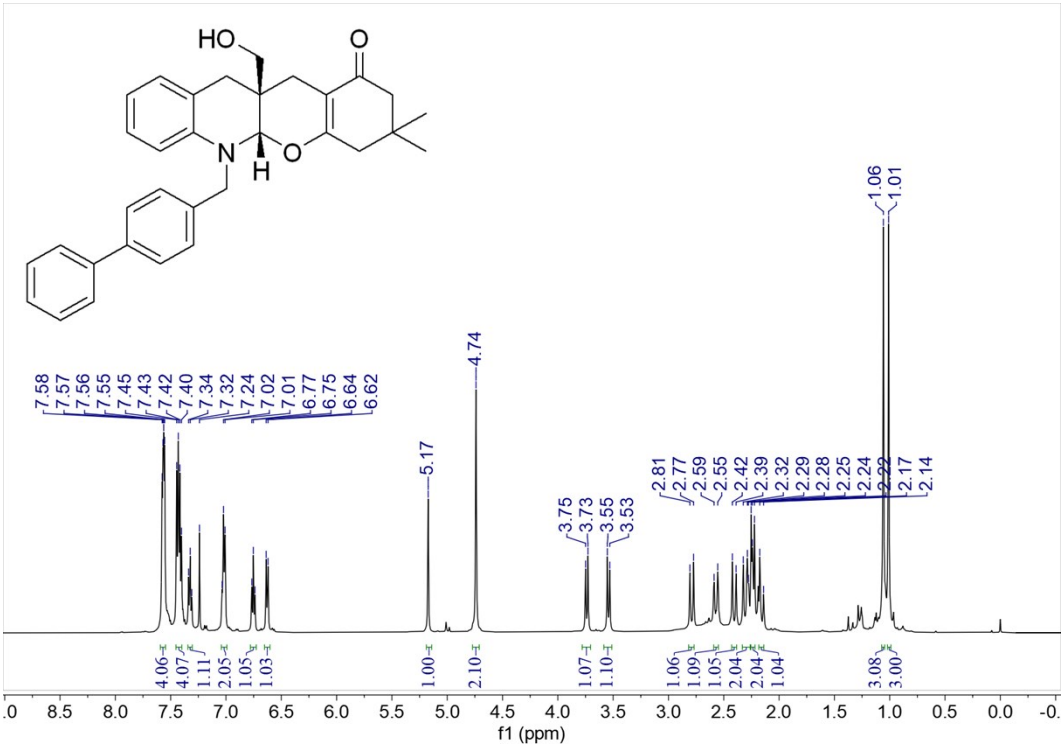
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_2



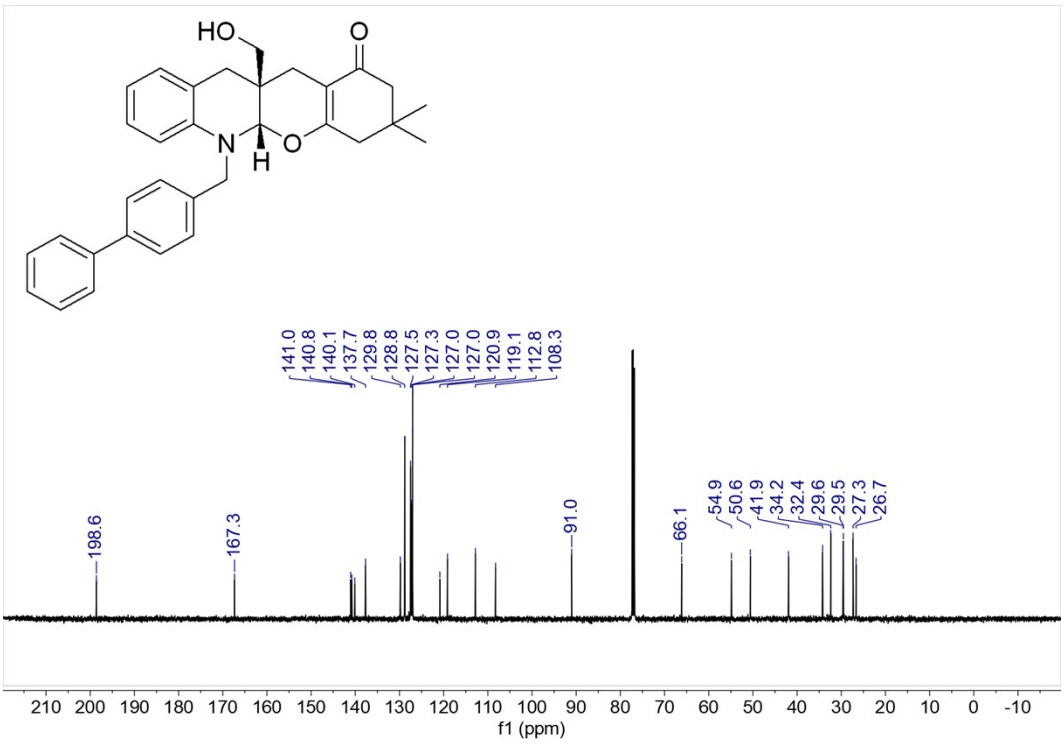
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_3



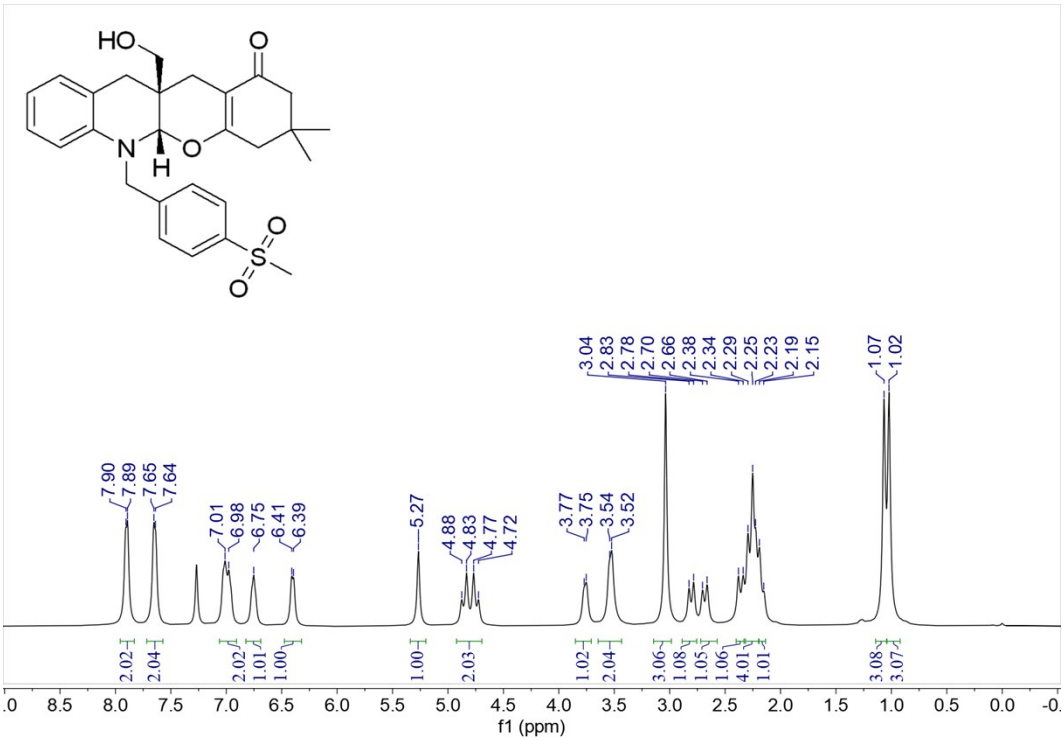
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_3



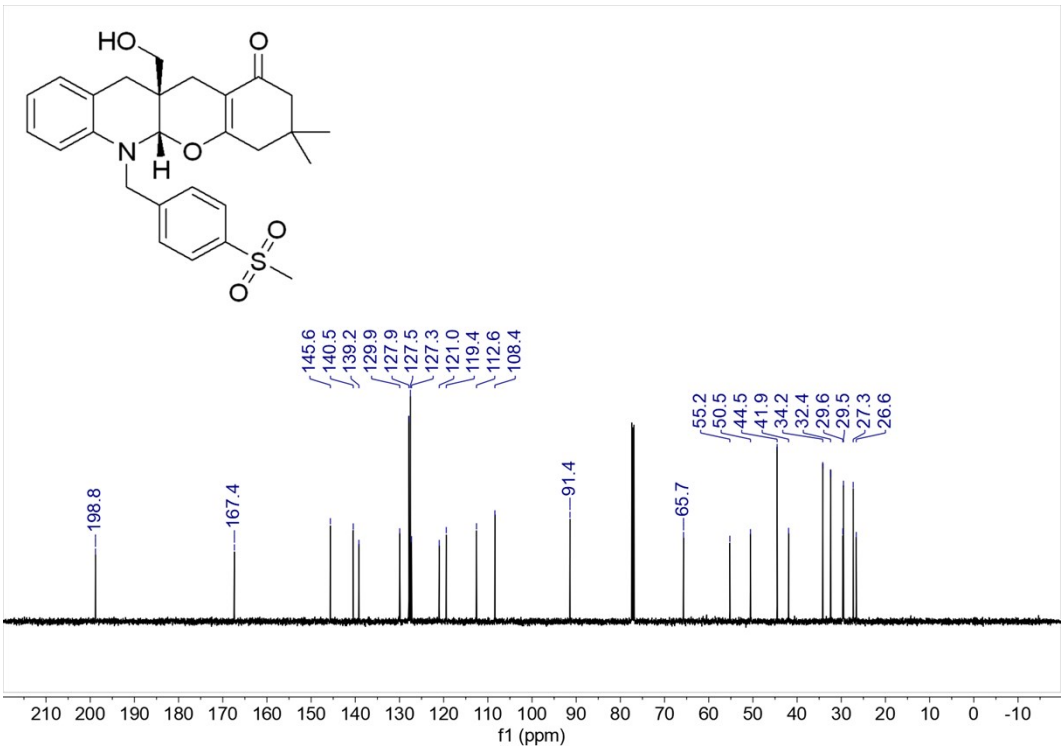
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_4



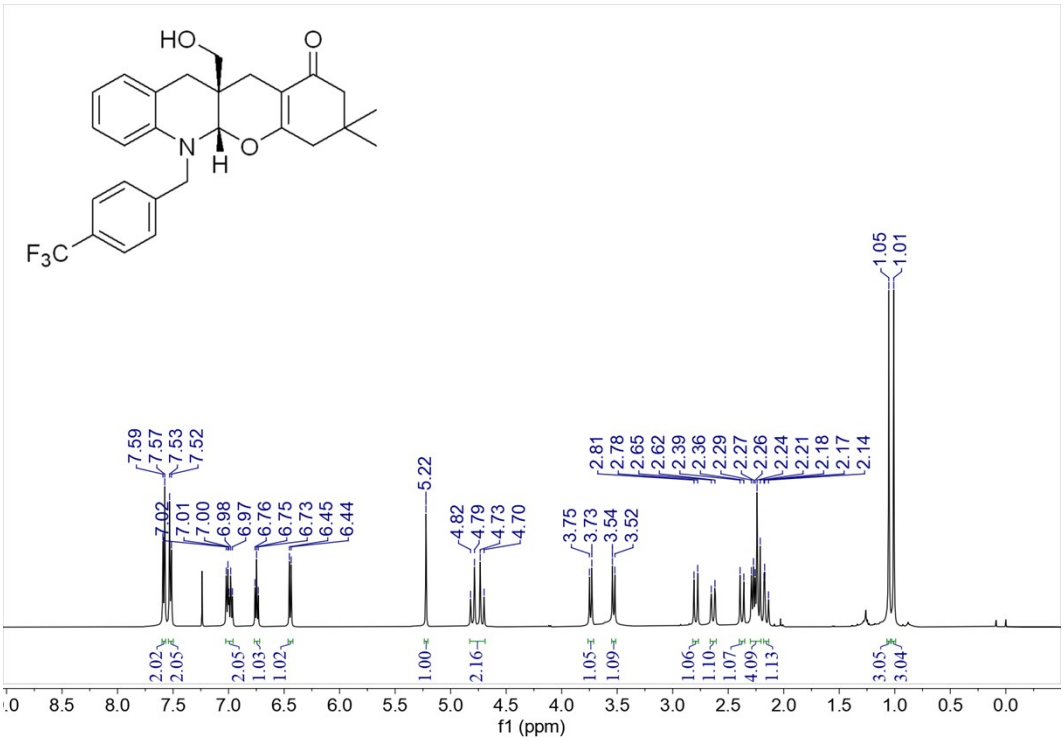
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_4



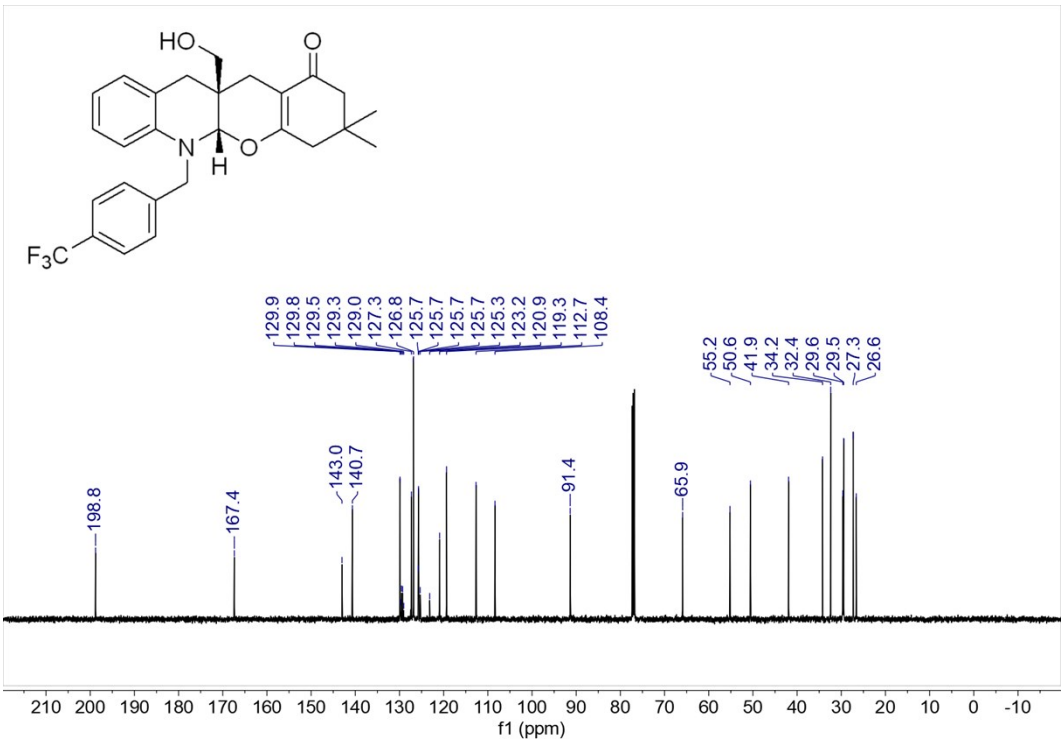
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_5



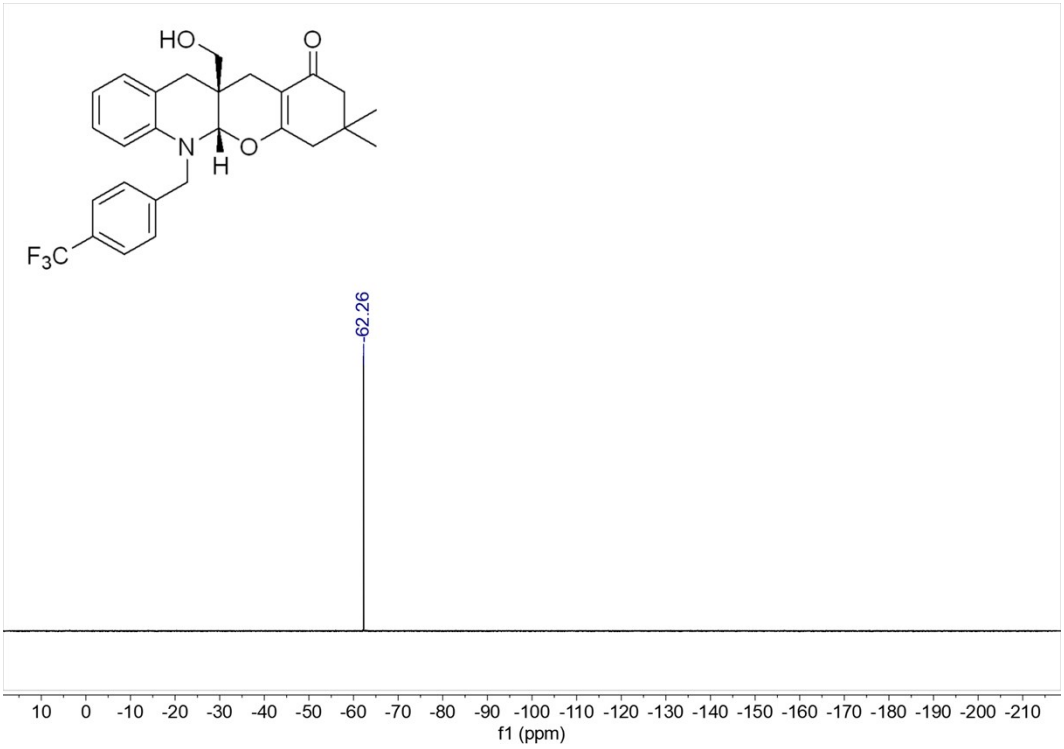
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_5



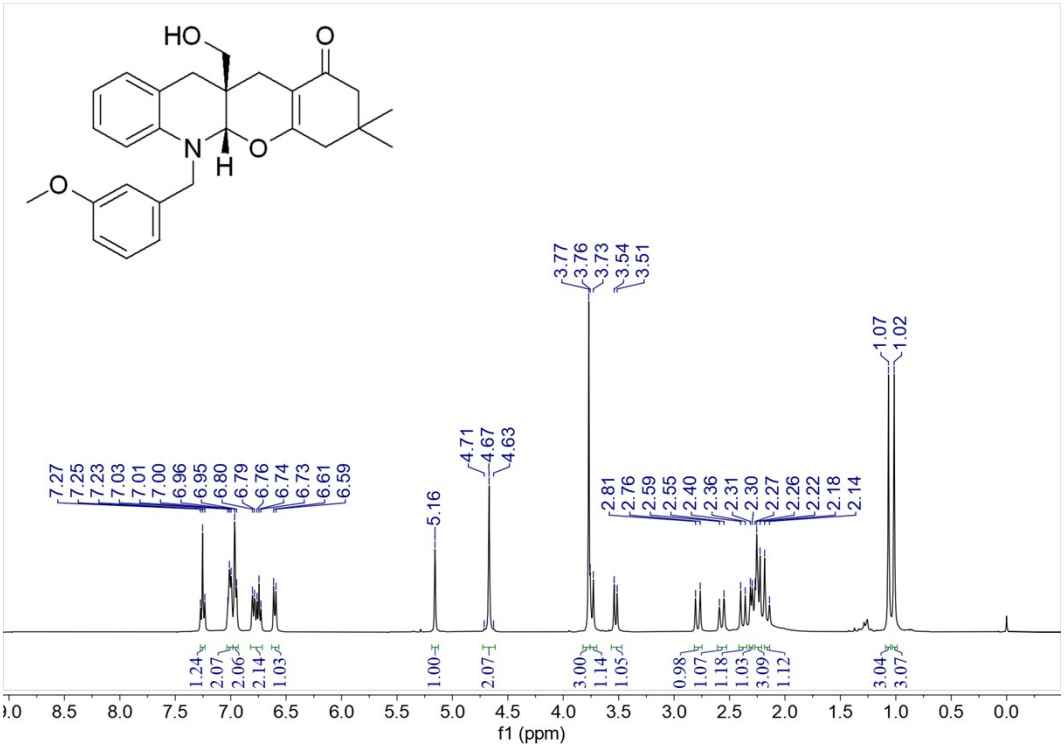
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_6



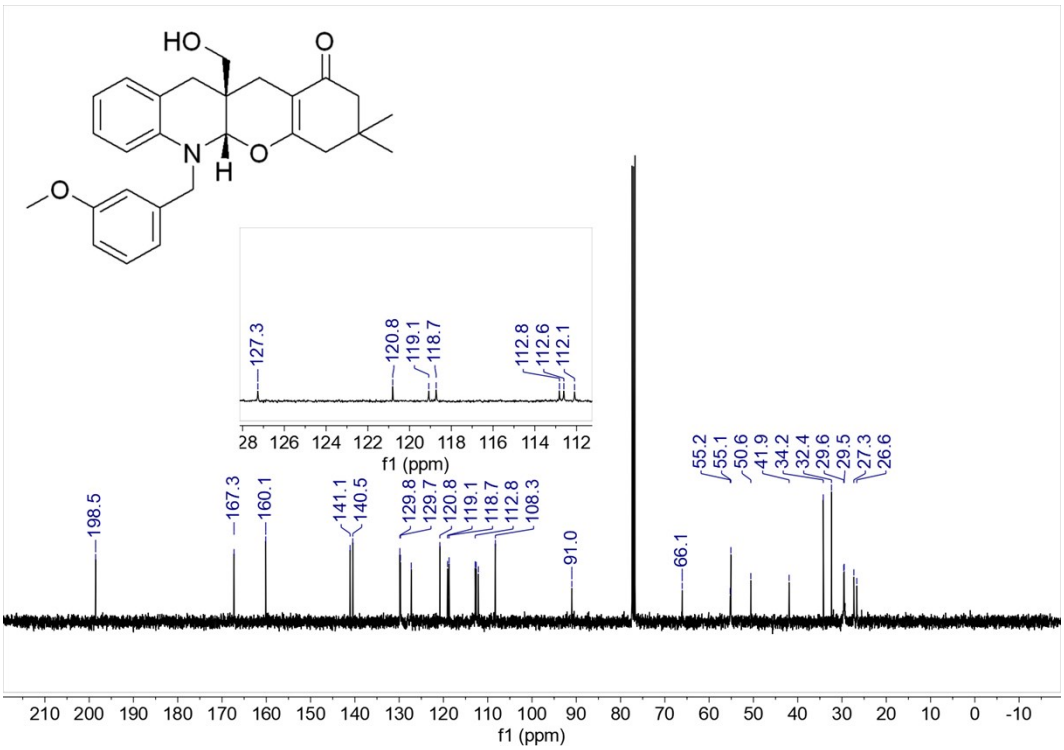
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_6



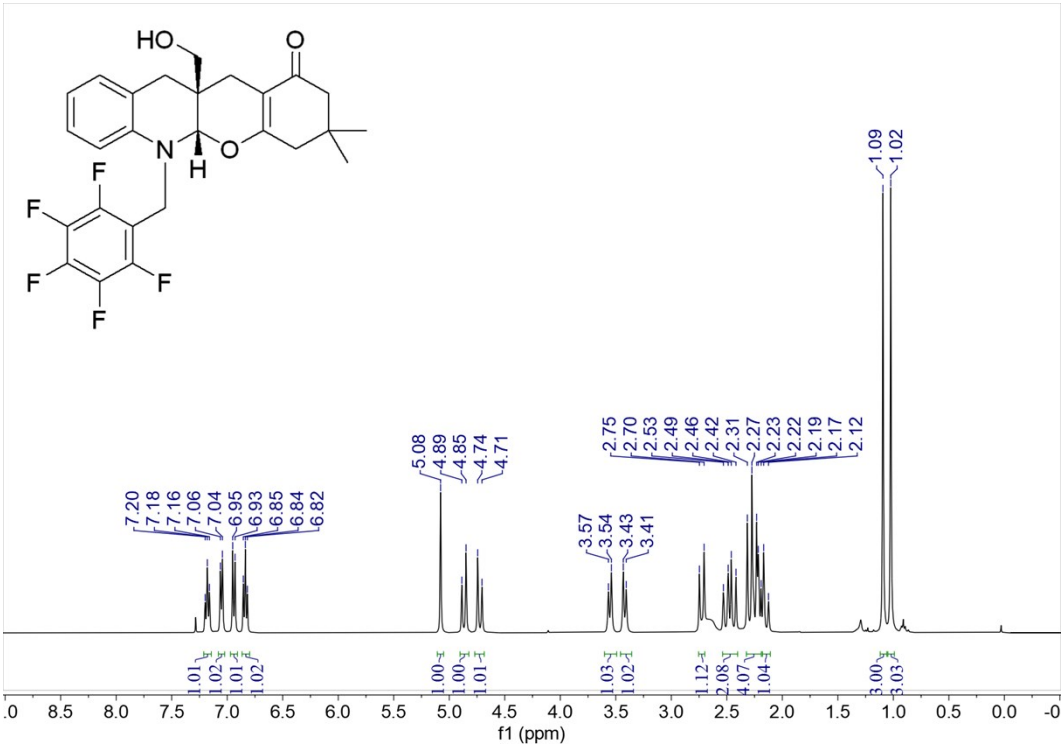
^{19}F NMR (376 MHz, $CDCl_3$) spectrum of c_6



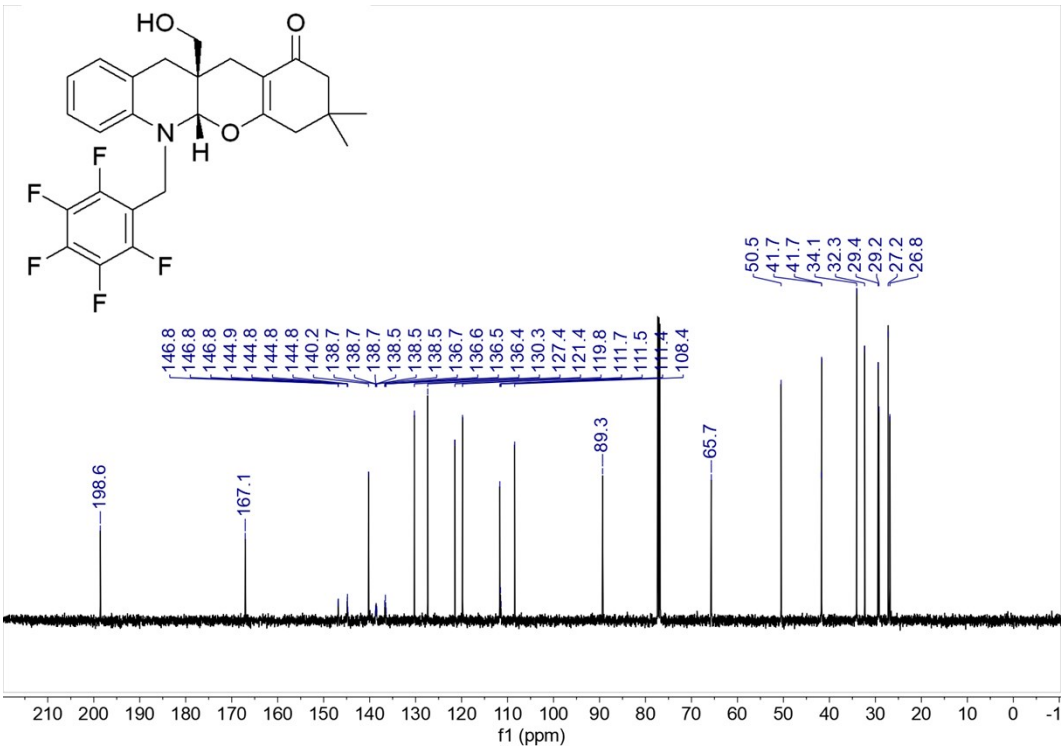
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_7



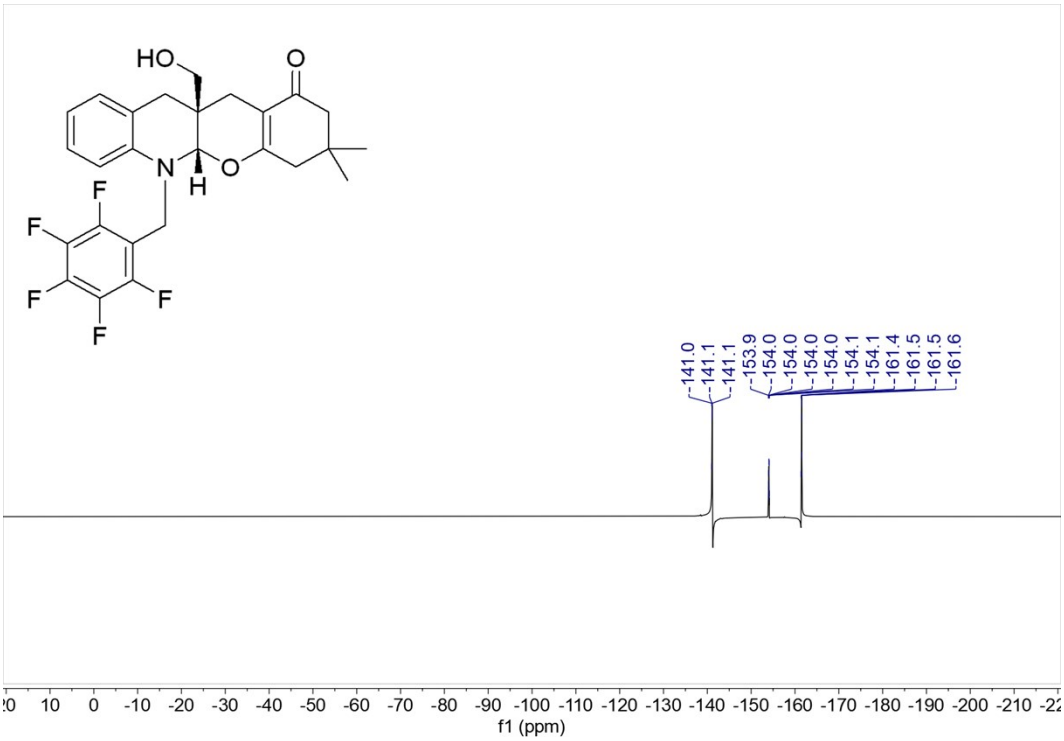
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_7



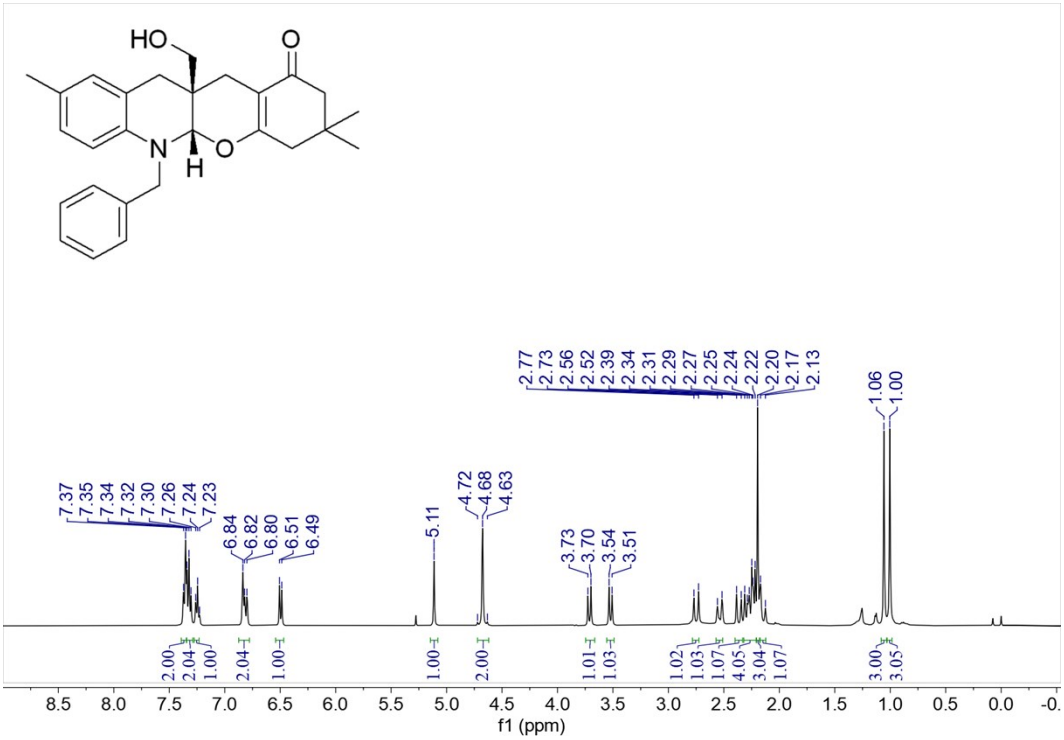
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_8



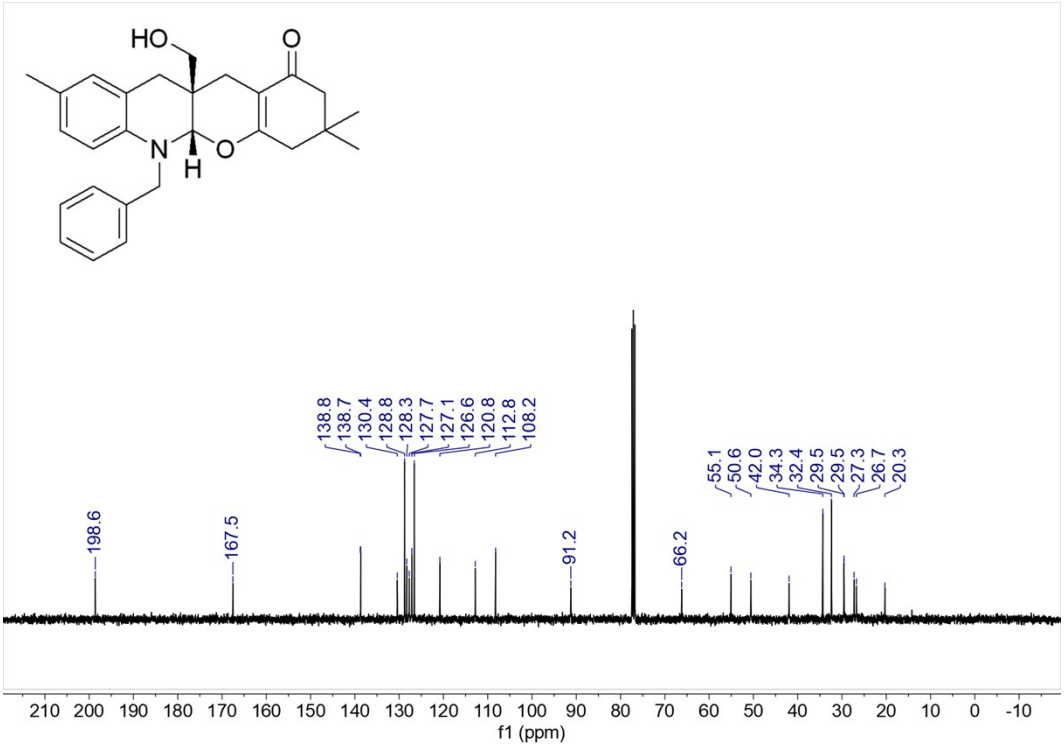
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_8



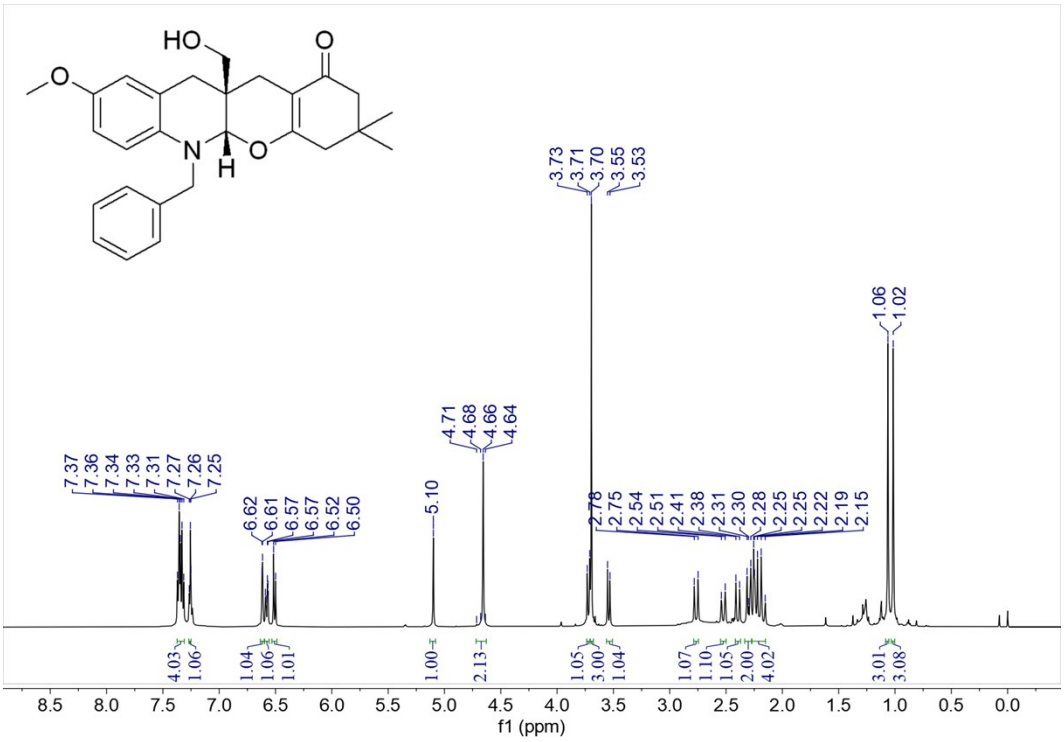
^{19}F NMR (471 MHz, $CDCl_3$) spectrum of c_8



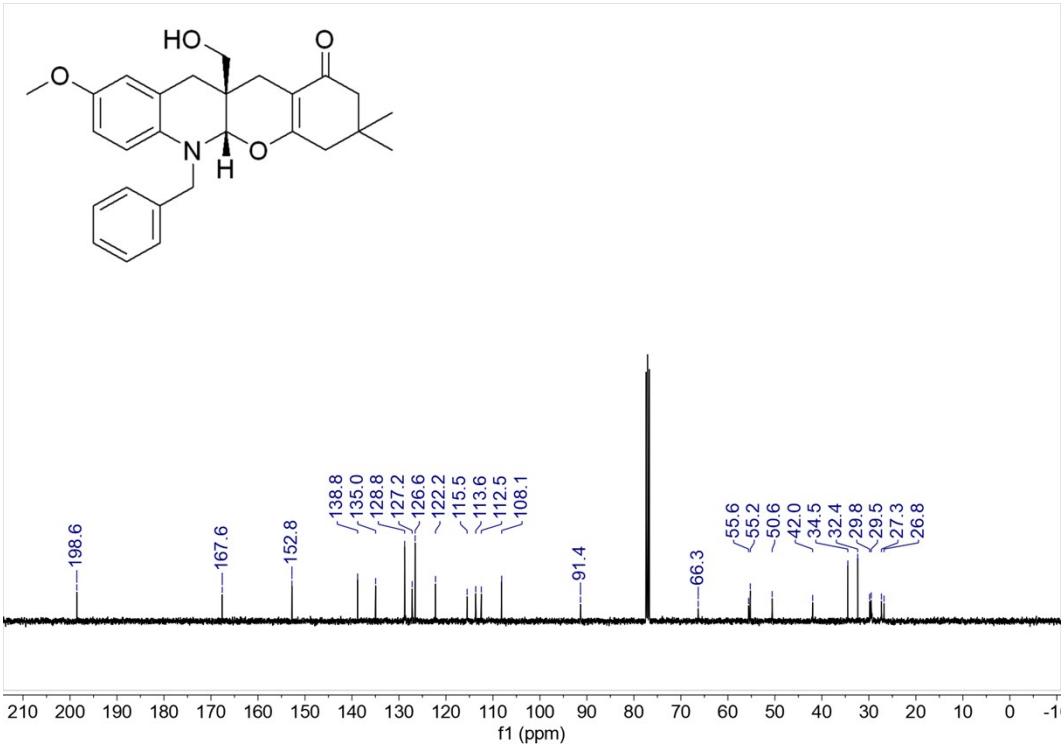
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_9



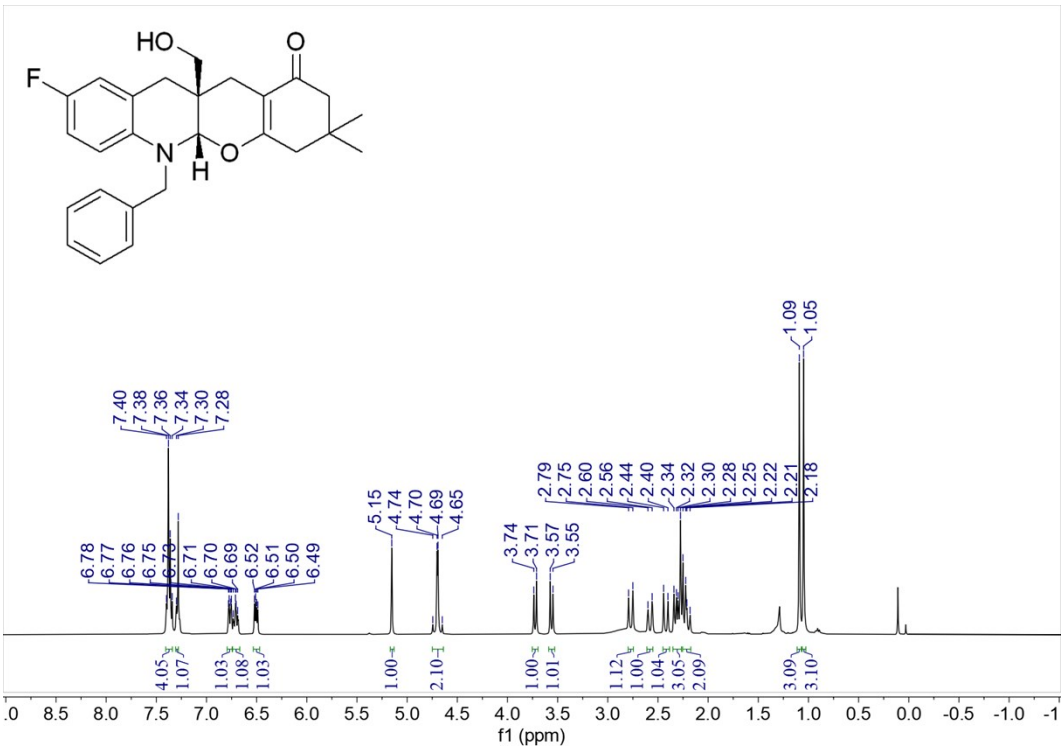
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_9



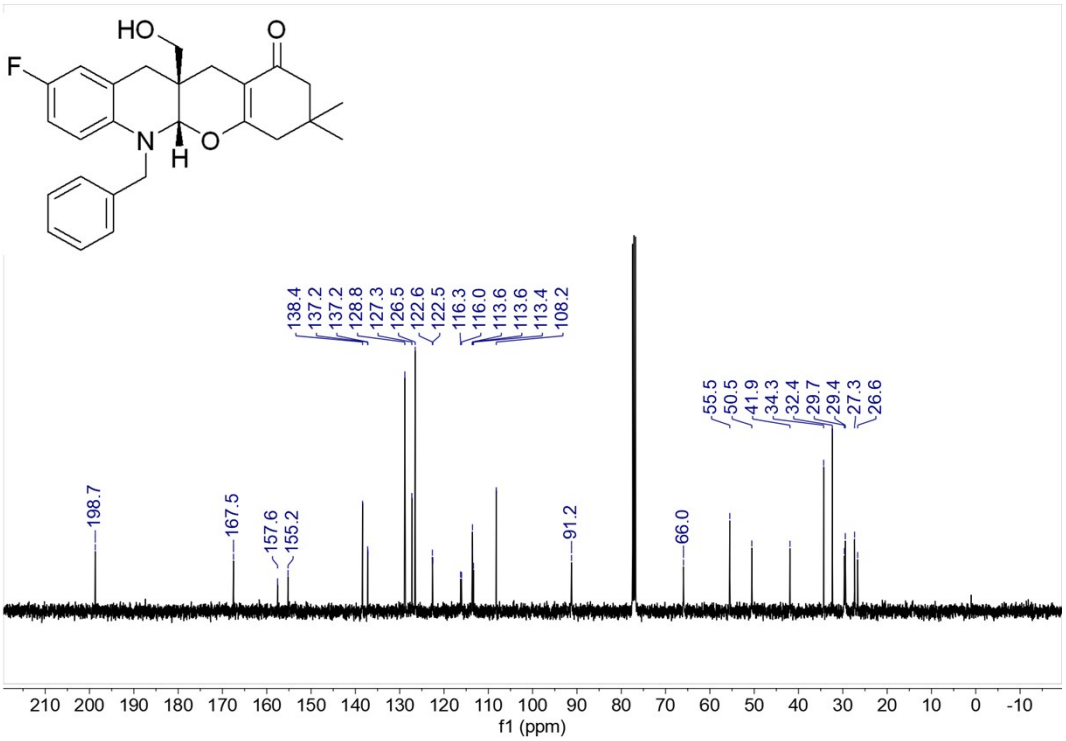
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{10}



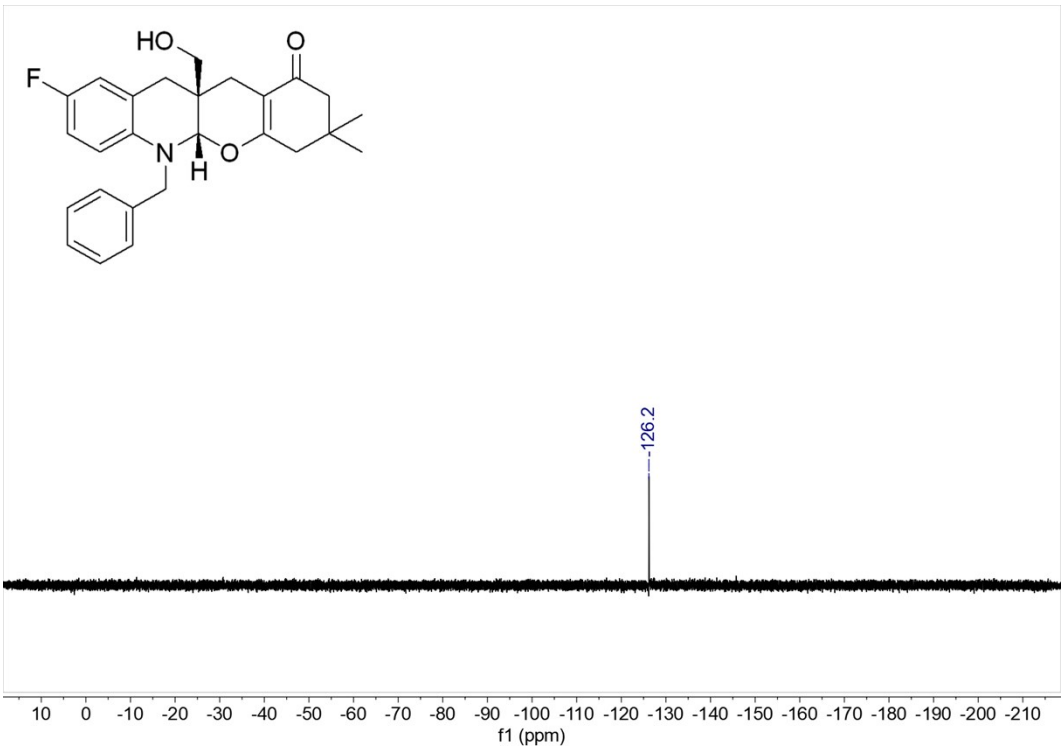
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{10}



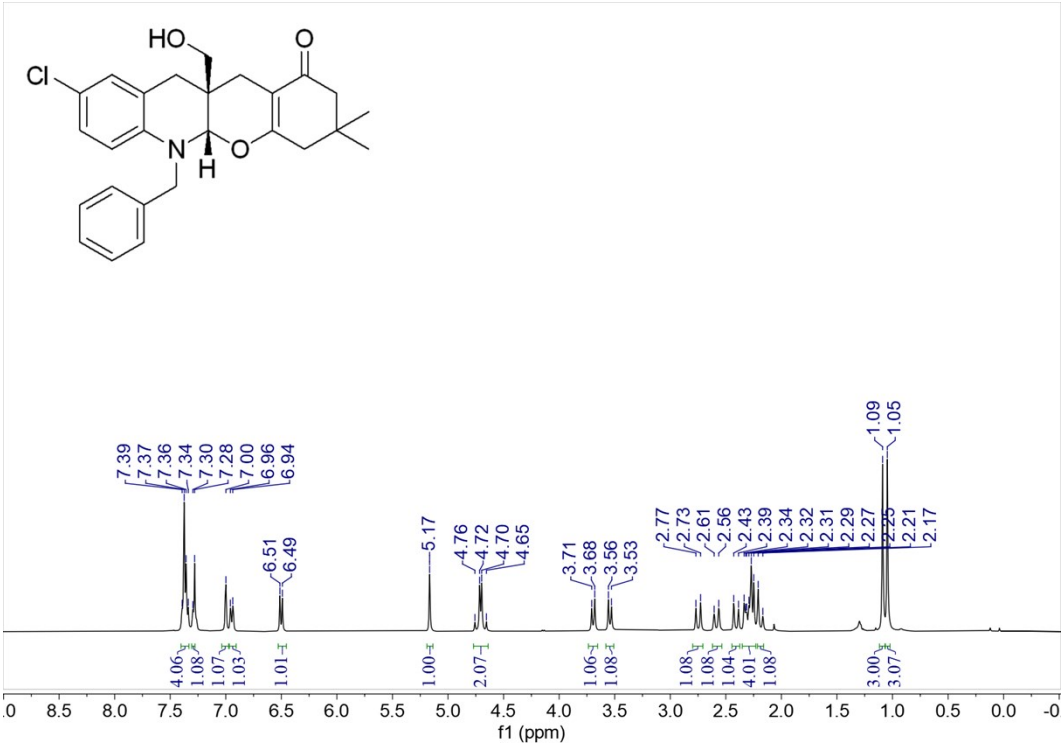
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{11}



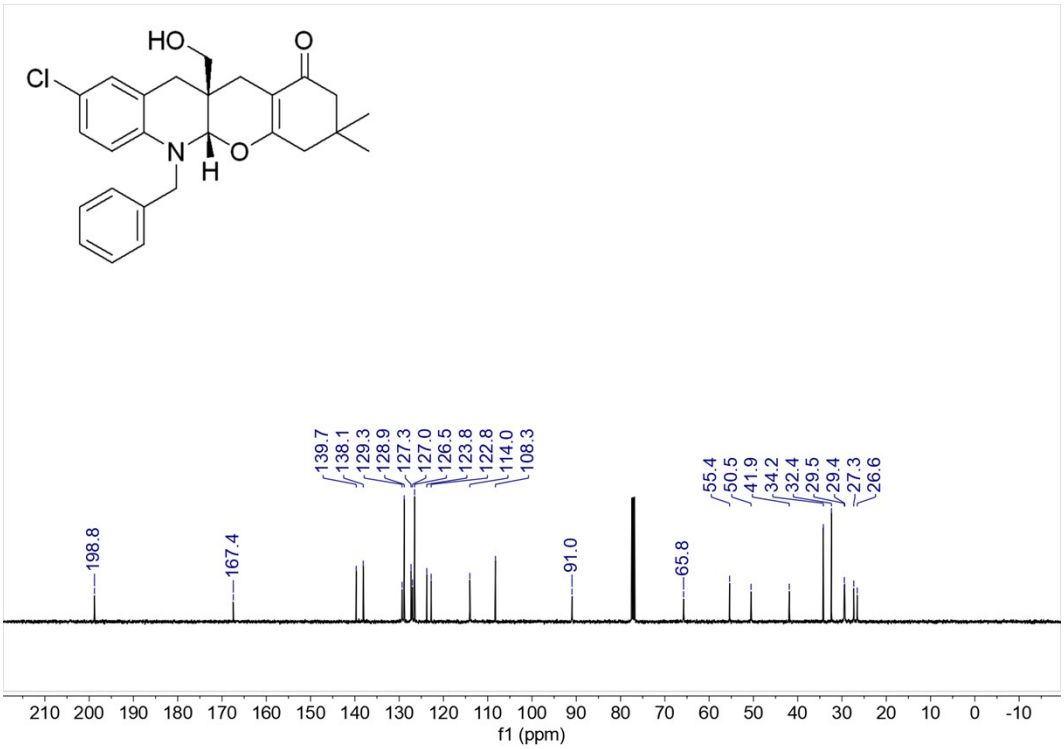
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{11}



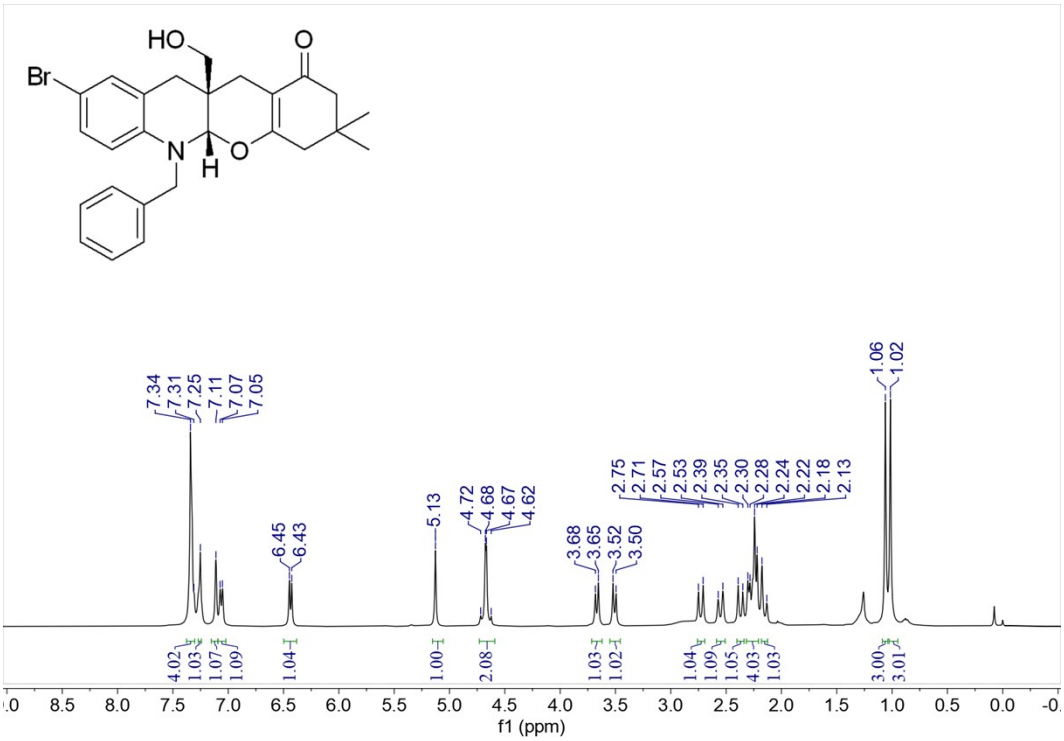
^{19}F NMR (376 MHz, $CDCl_3$) spectrum of c_{11}



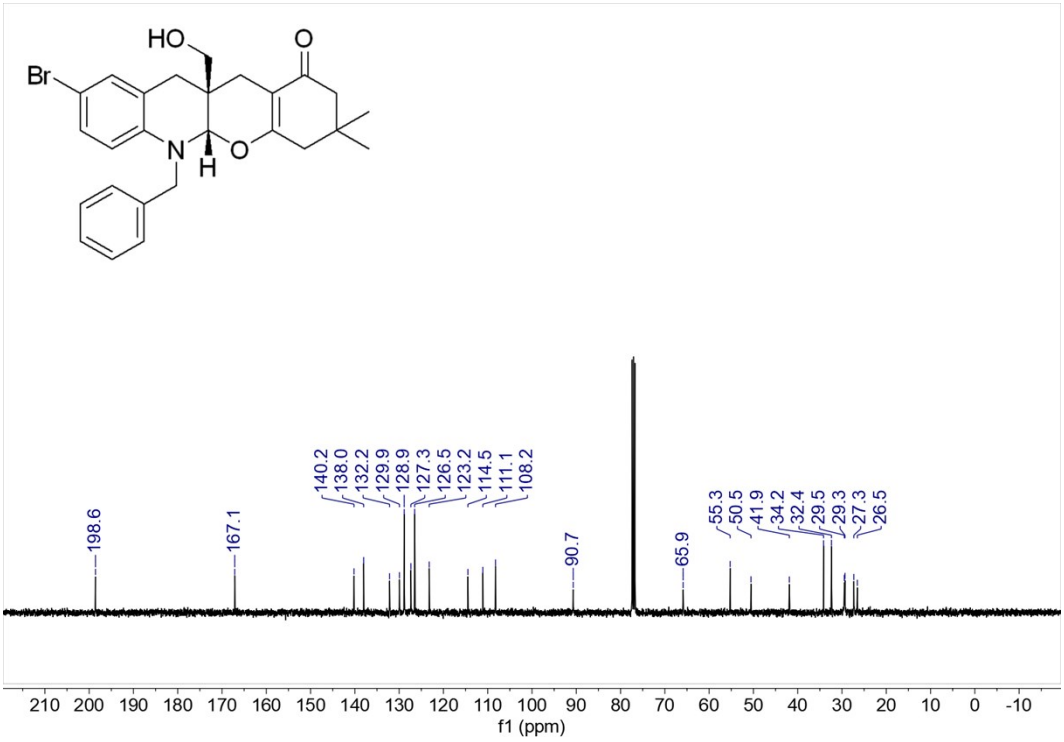
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{12}



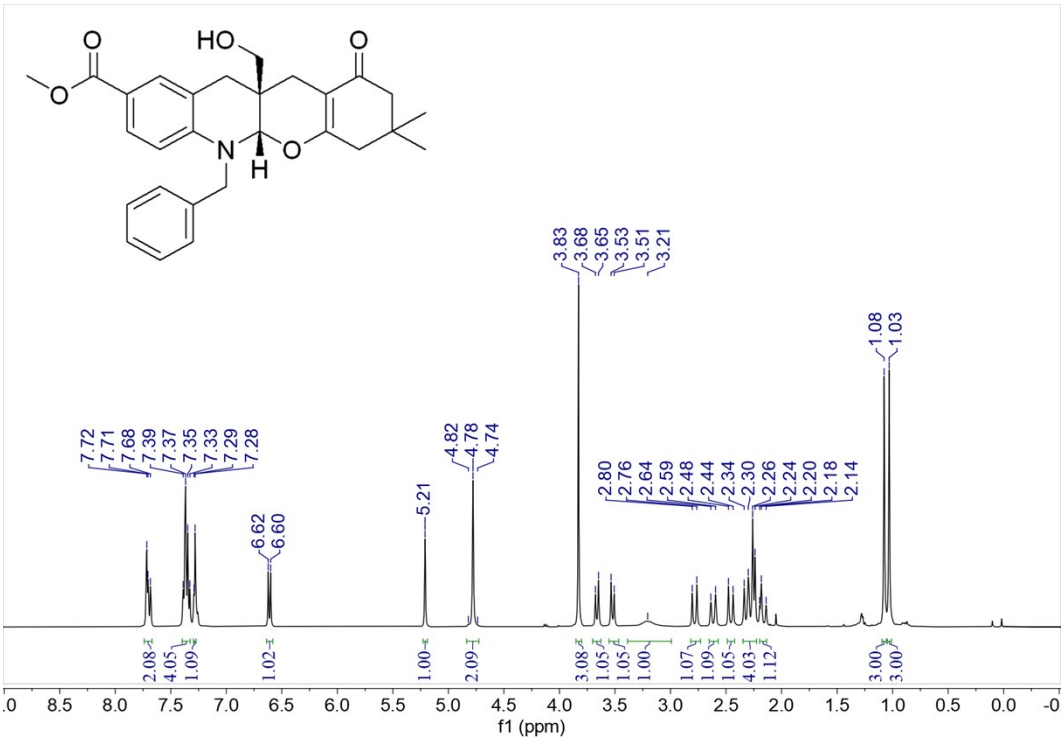
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{12}



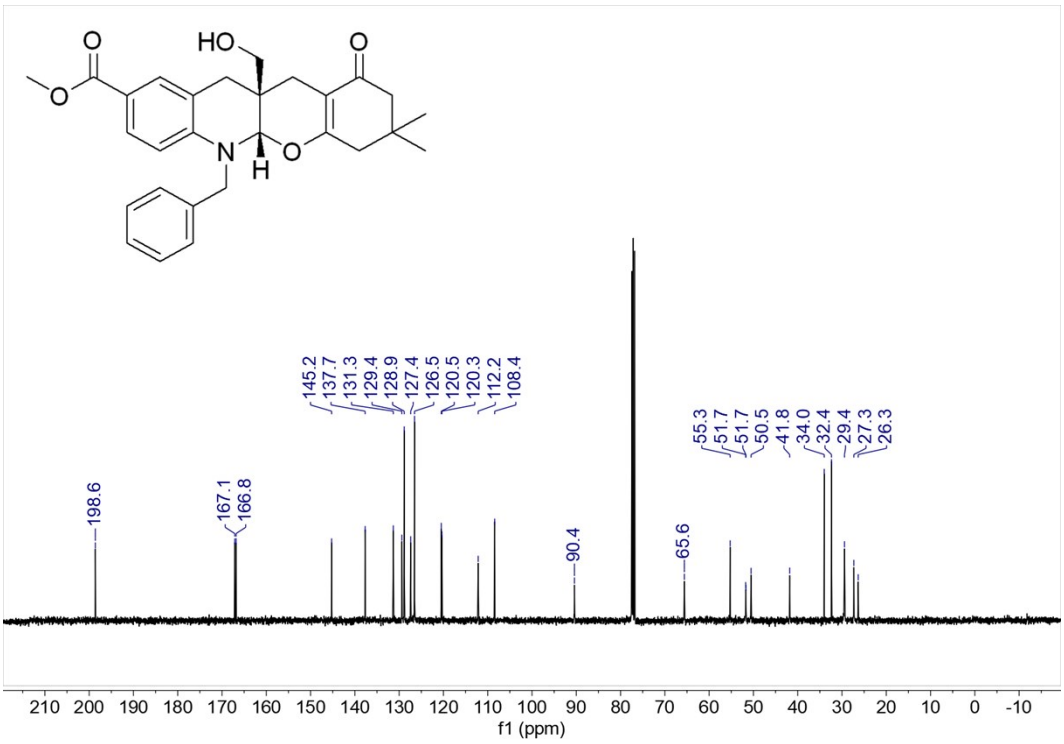
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{13}



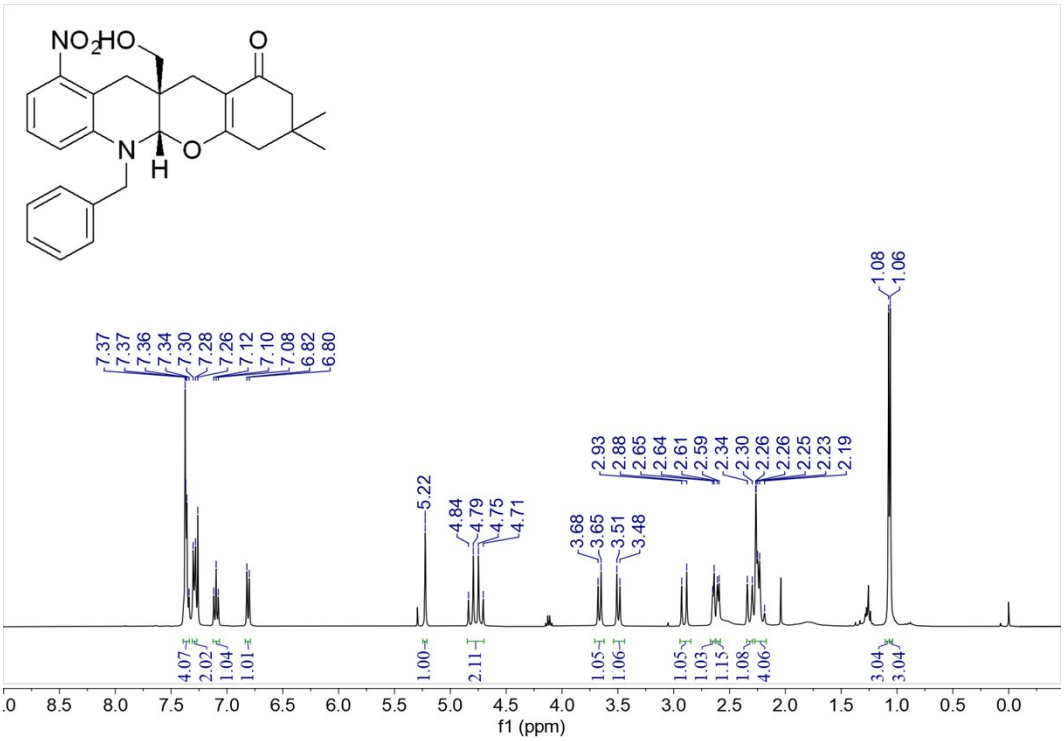
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{13}



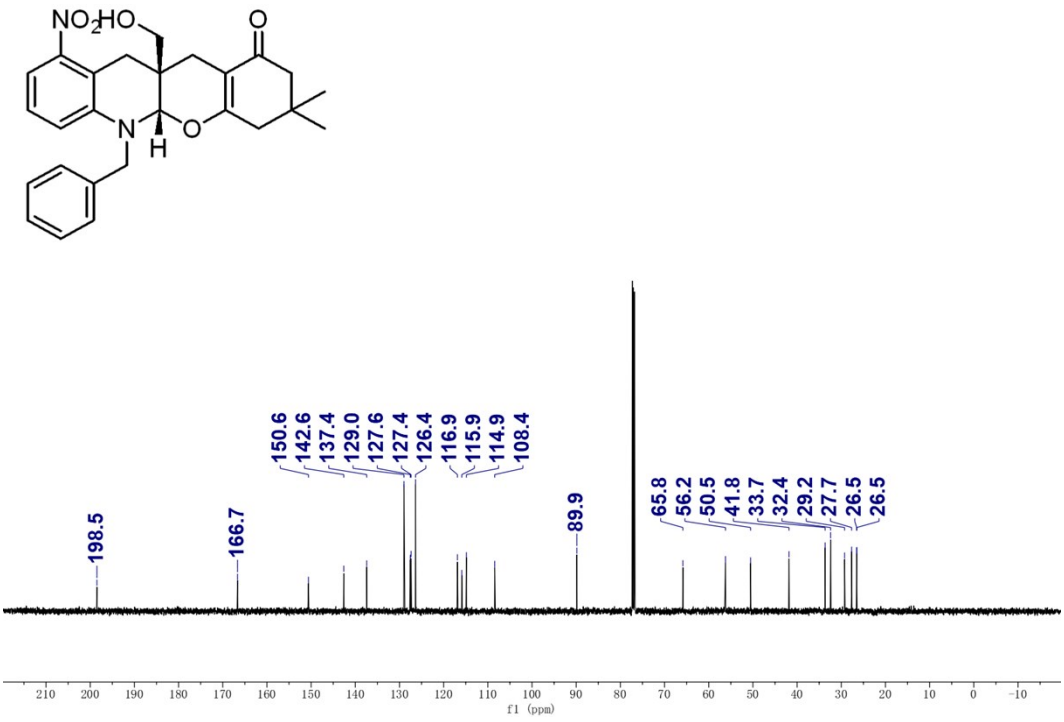
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{14}



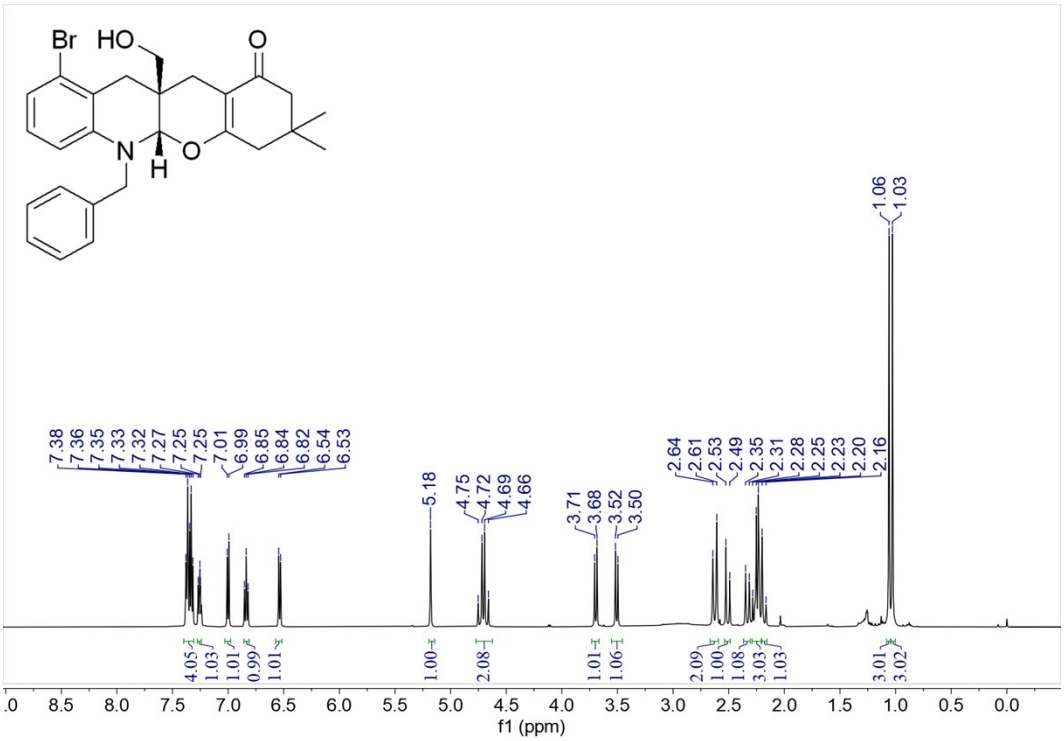
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{14}



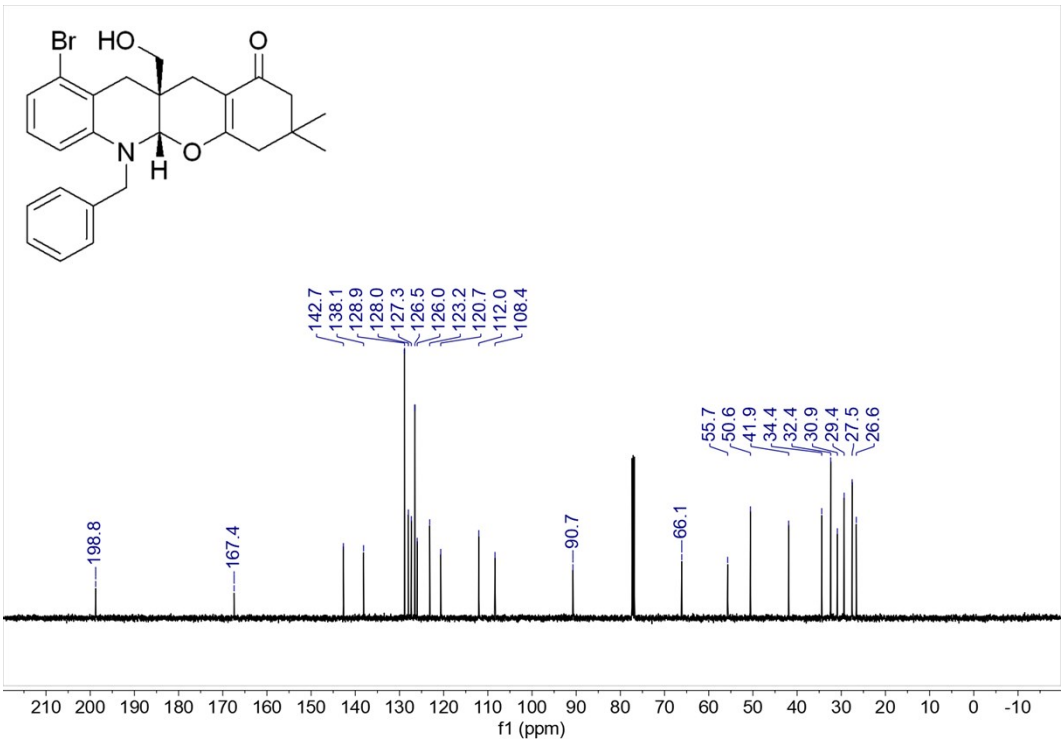
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{15}



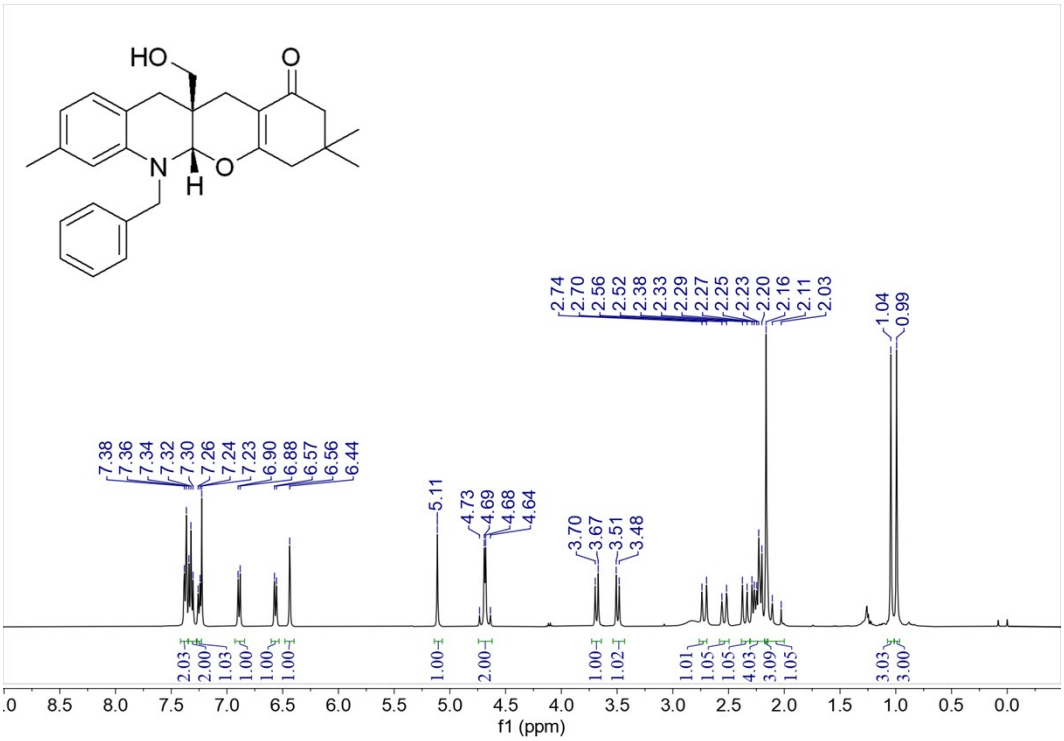
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{15}



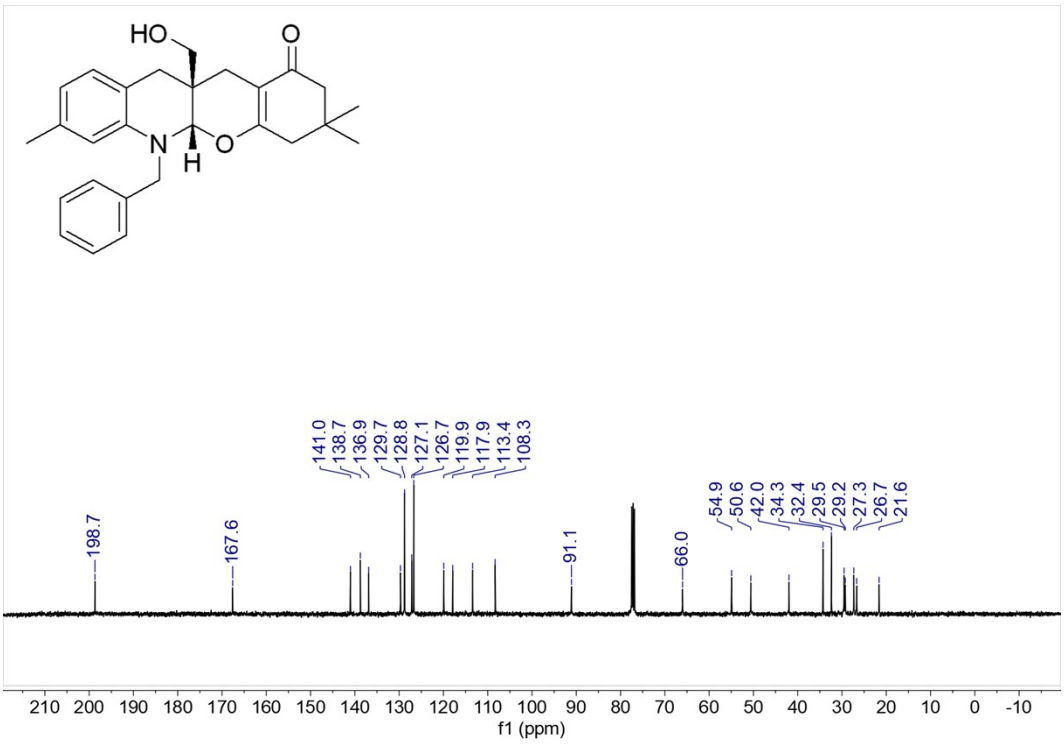
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{16}



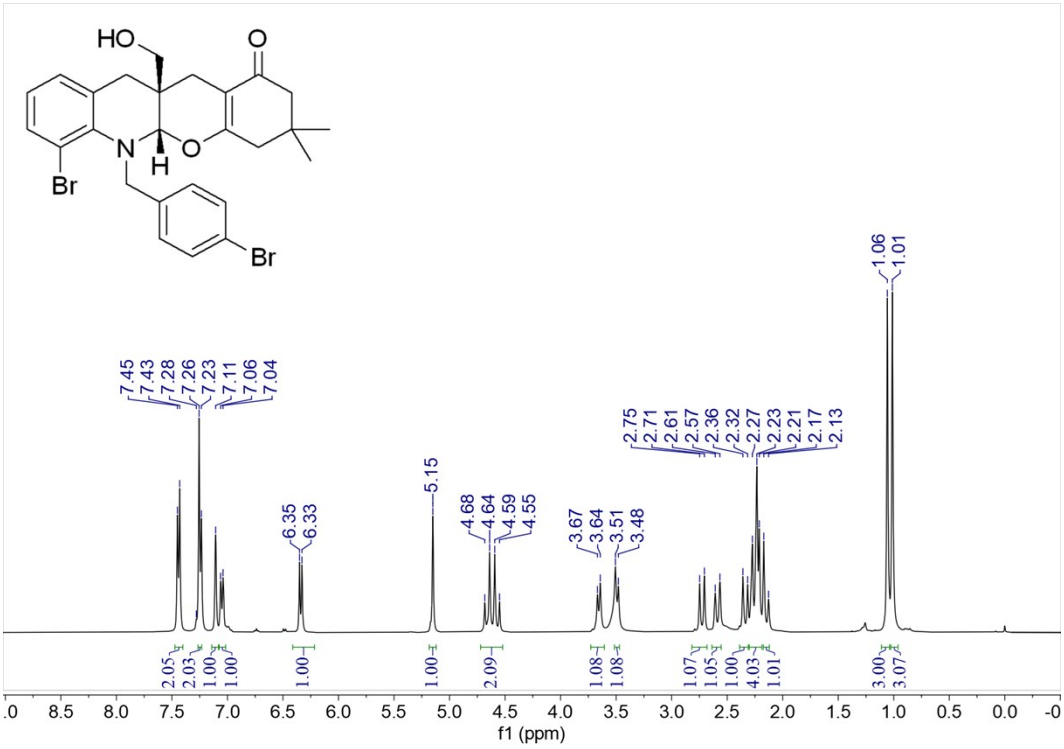
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{16}



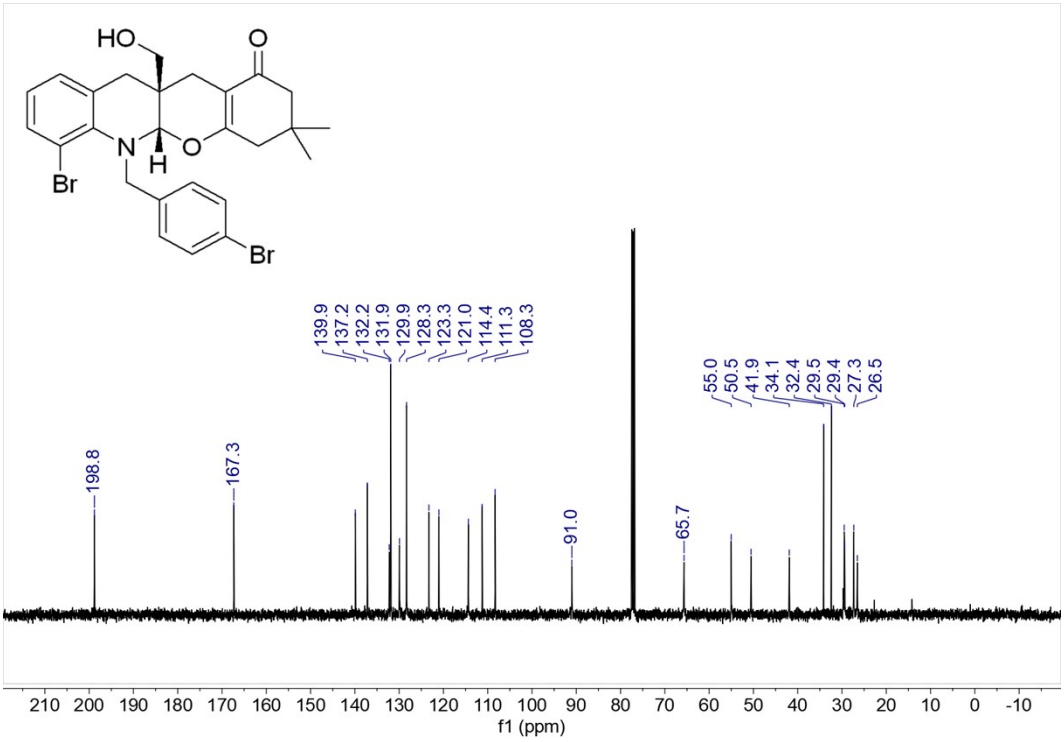
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{17}



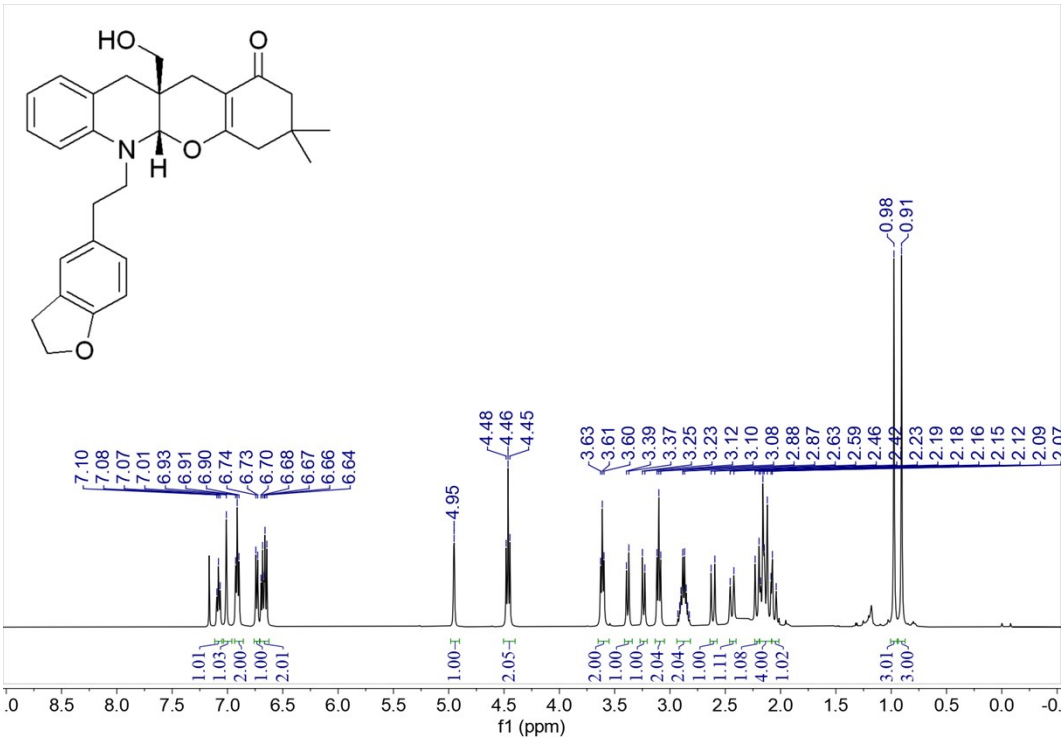
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{17}



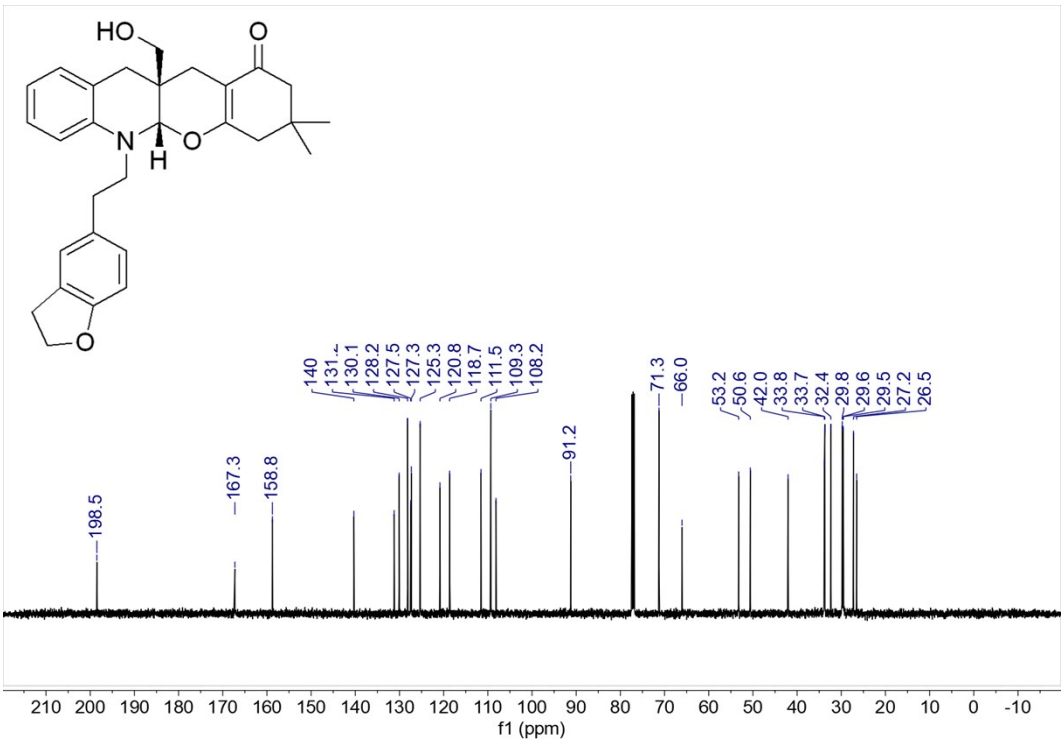
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{18}



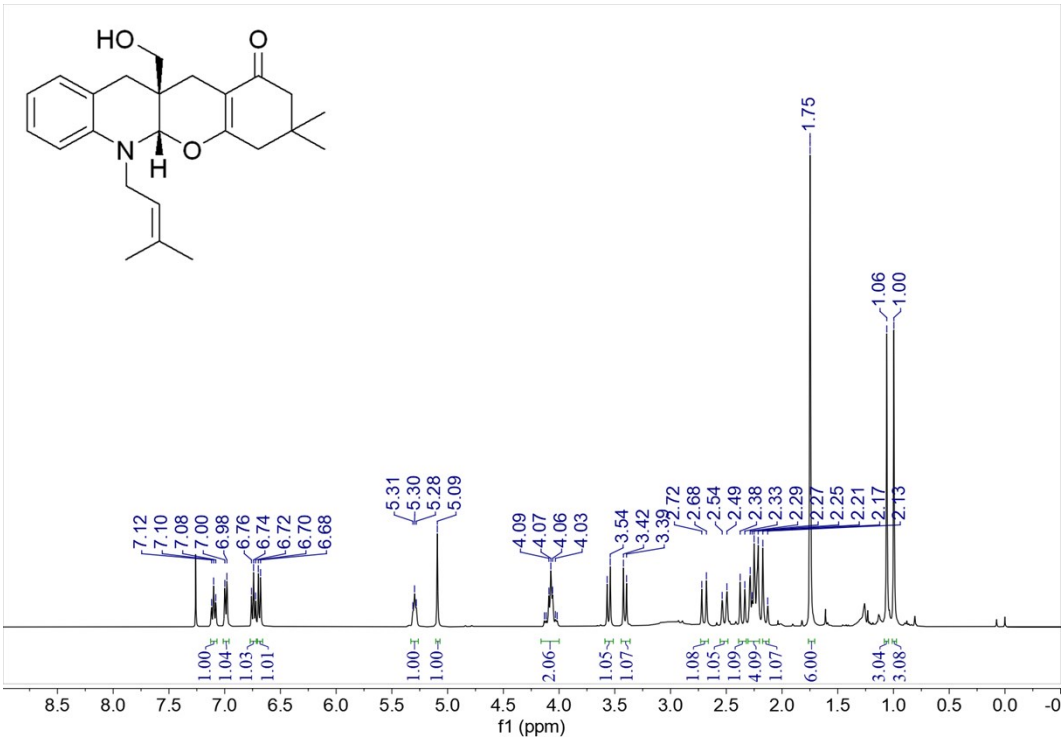
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{18}



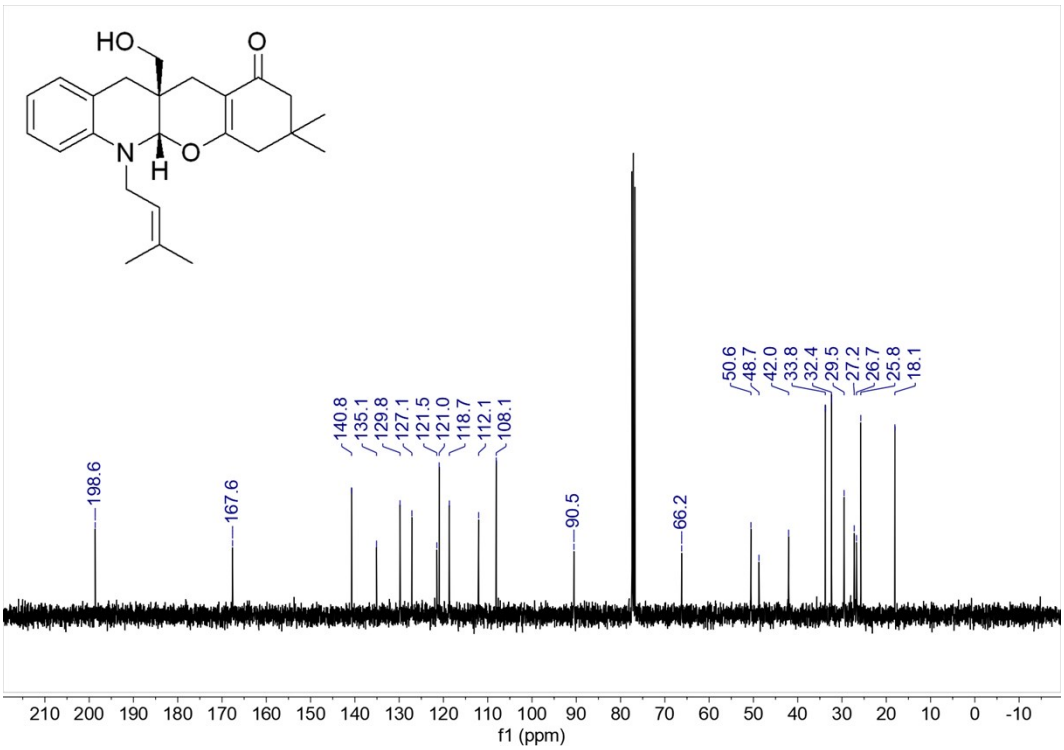
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{19}



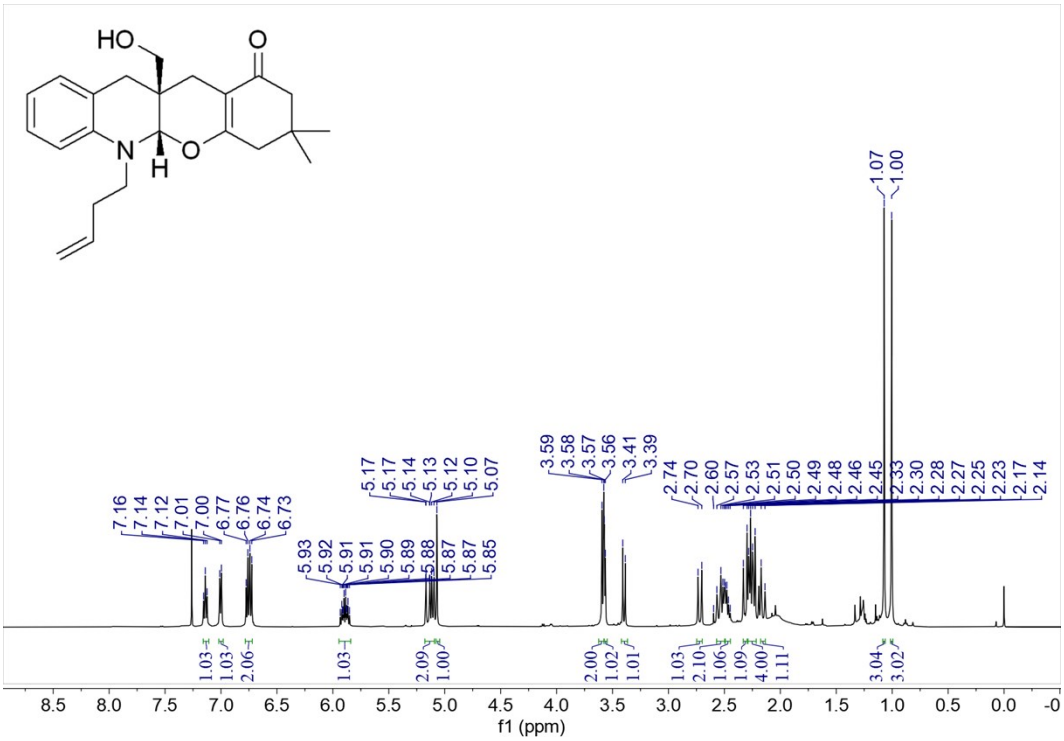
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{19}



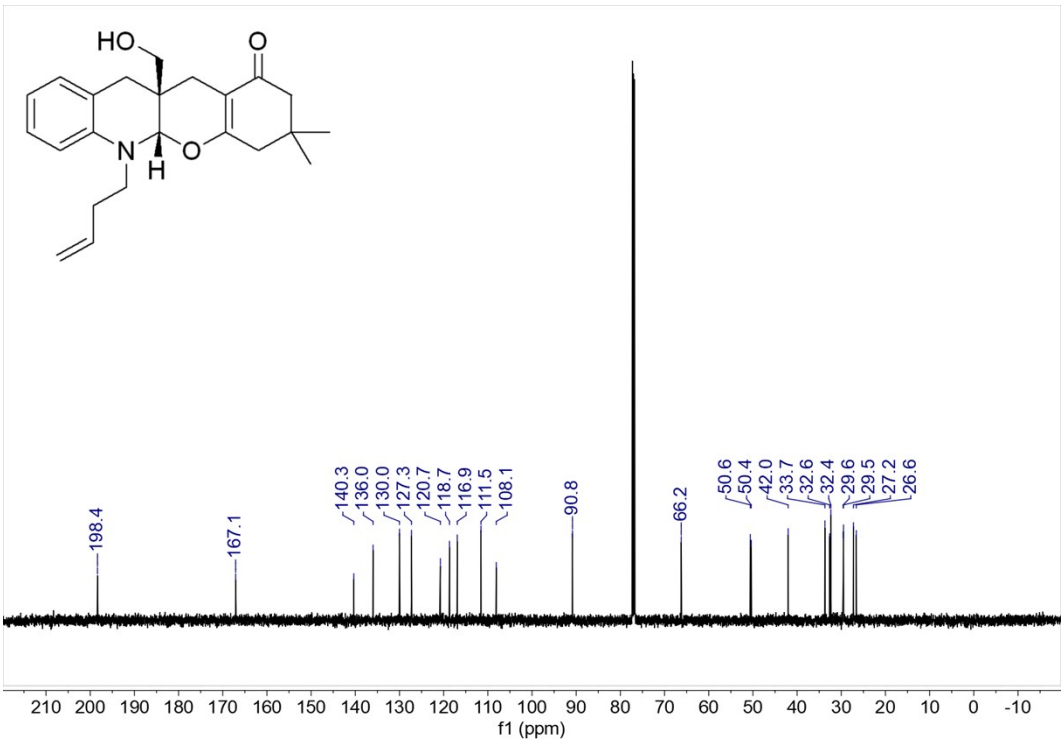
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{20}



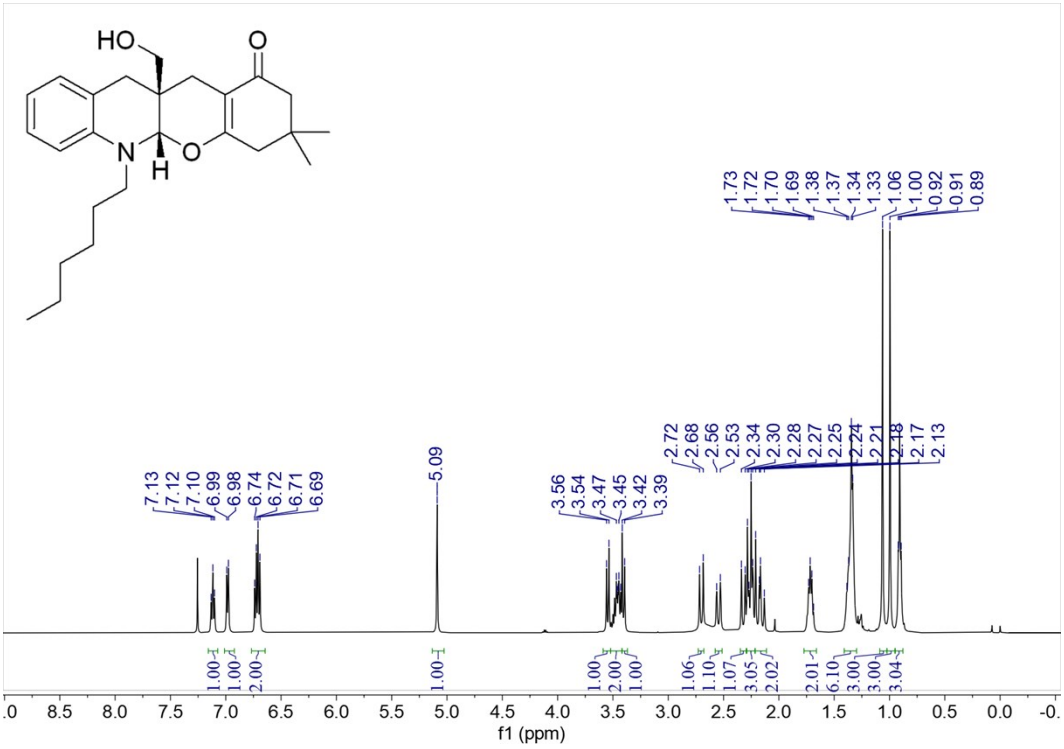
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{20}



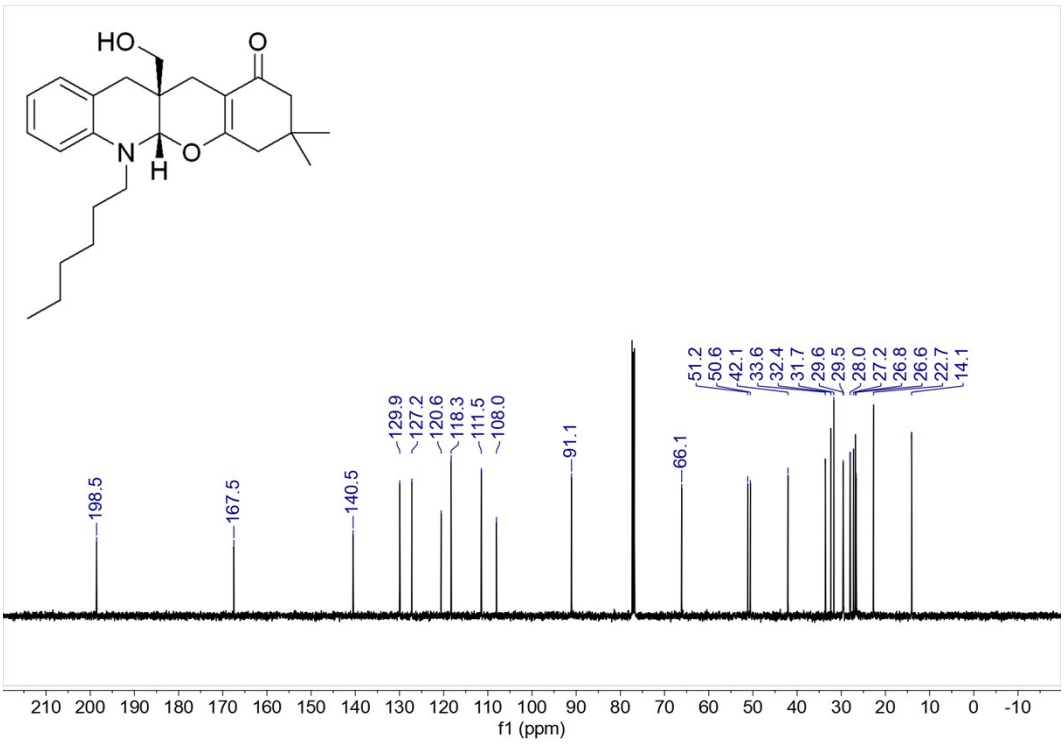
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{21}



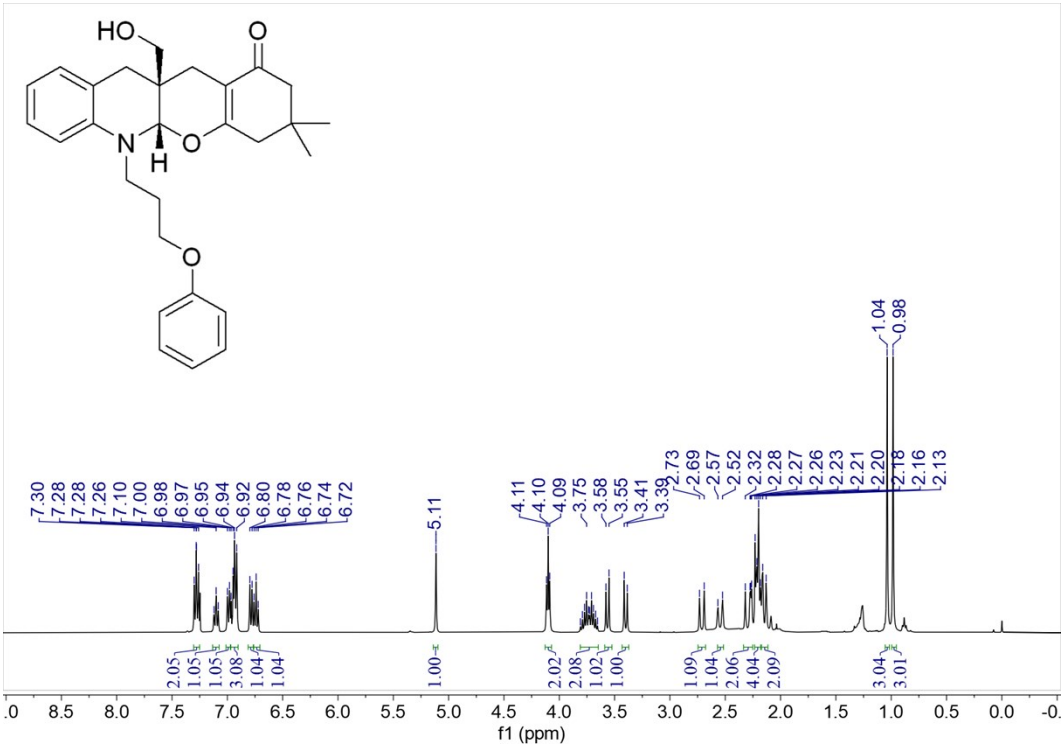
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{21}



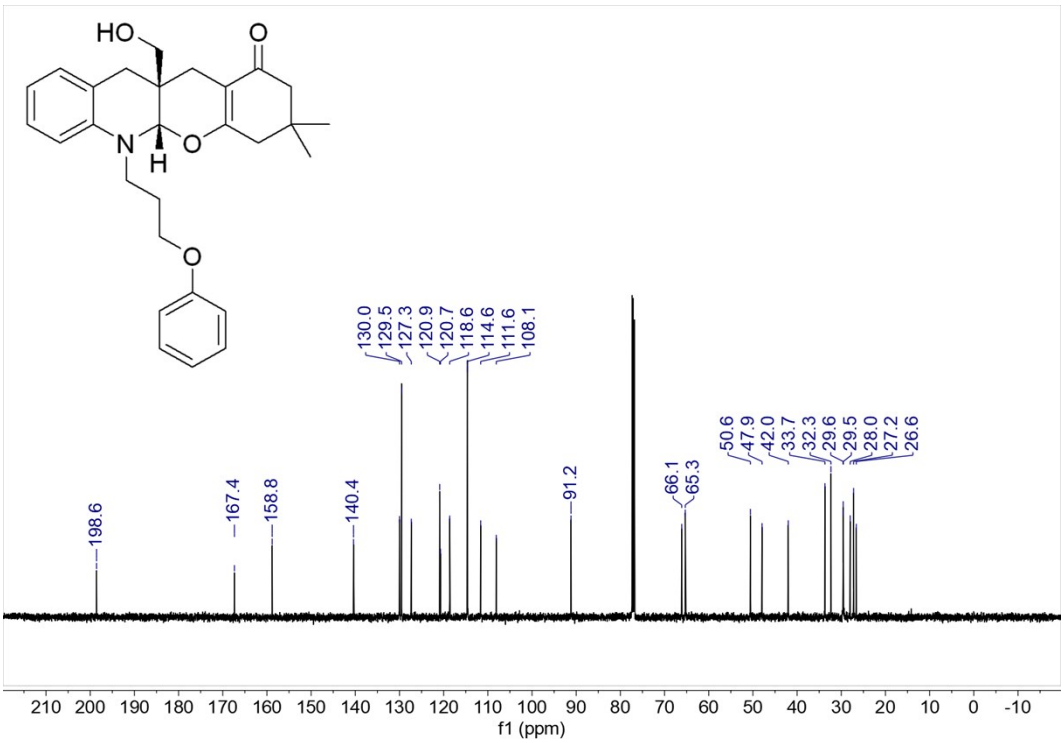
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{22}



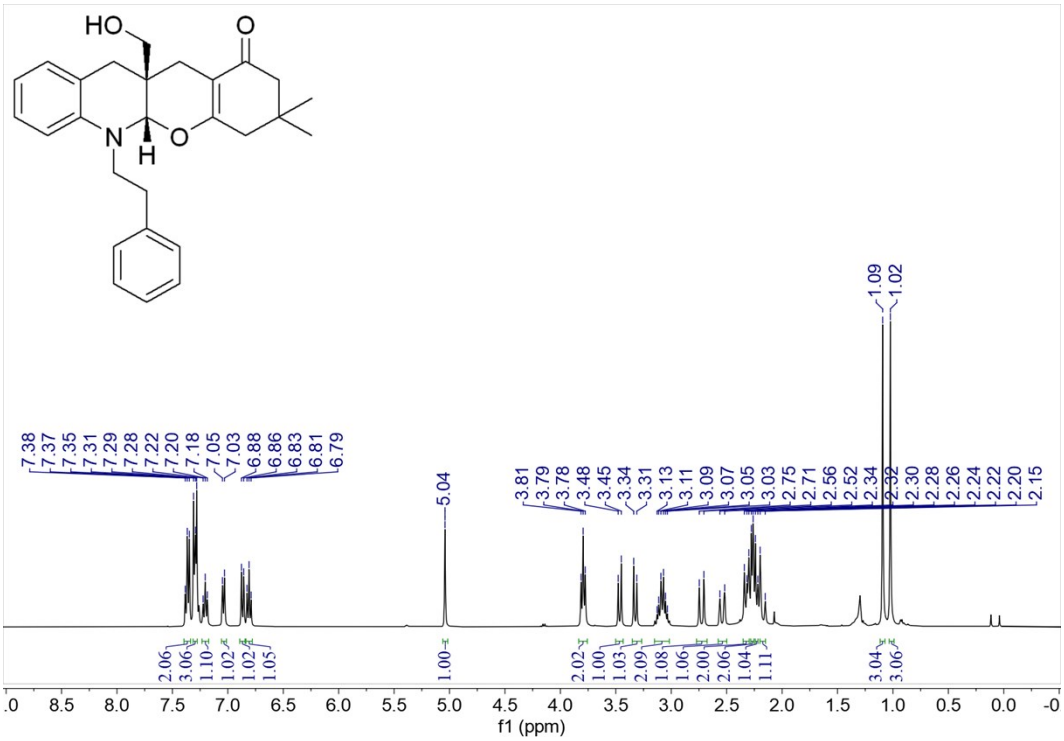
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{22}



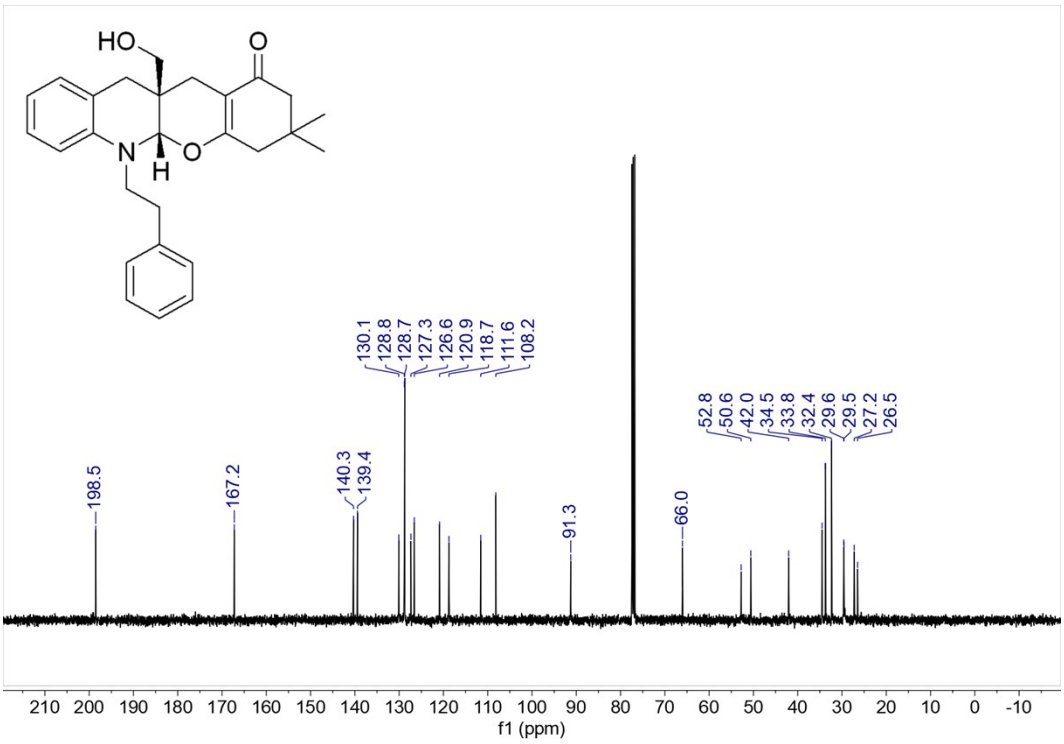
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{23}



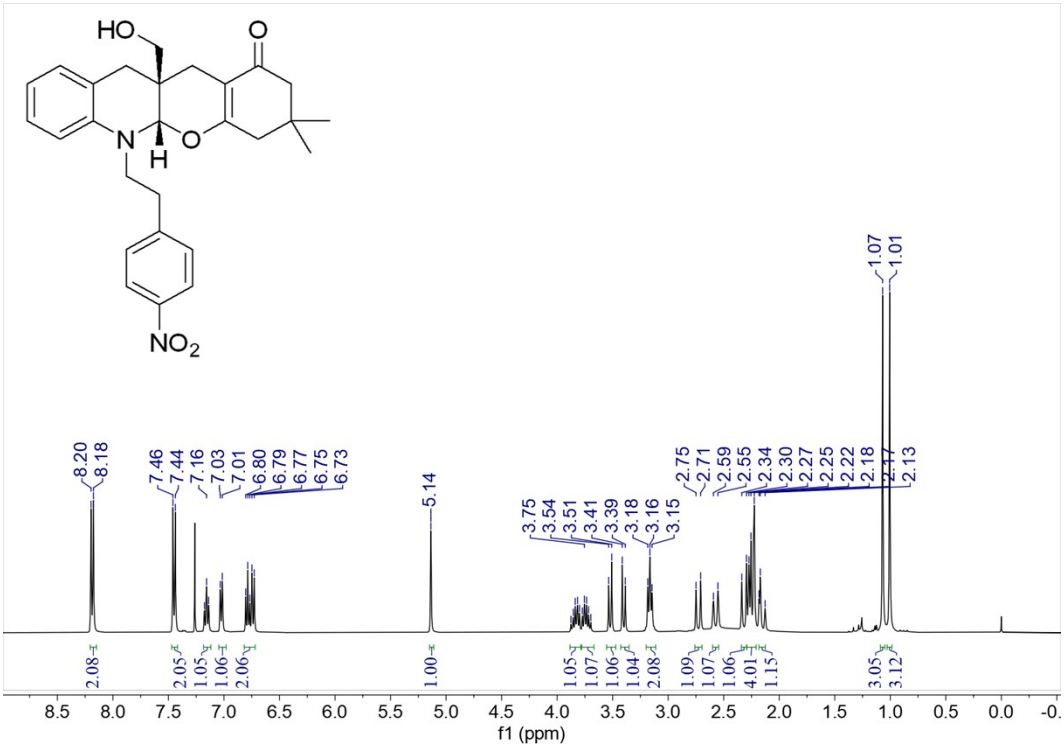
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{23}



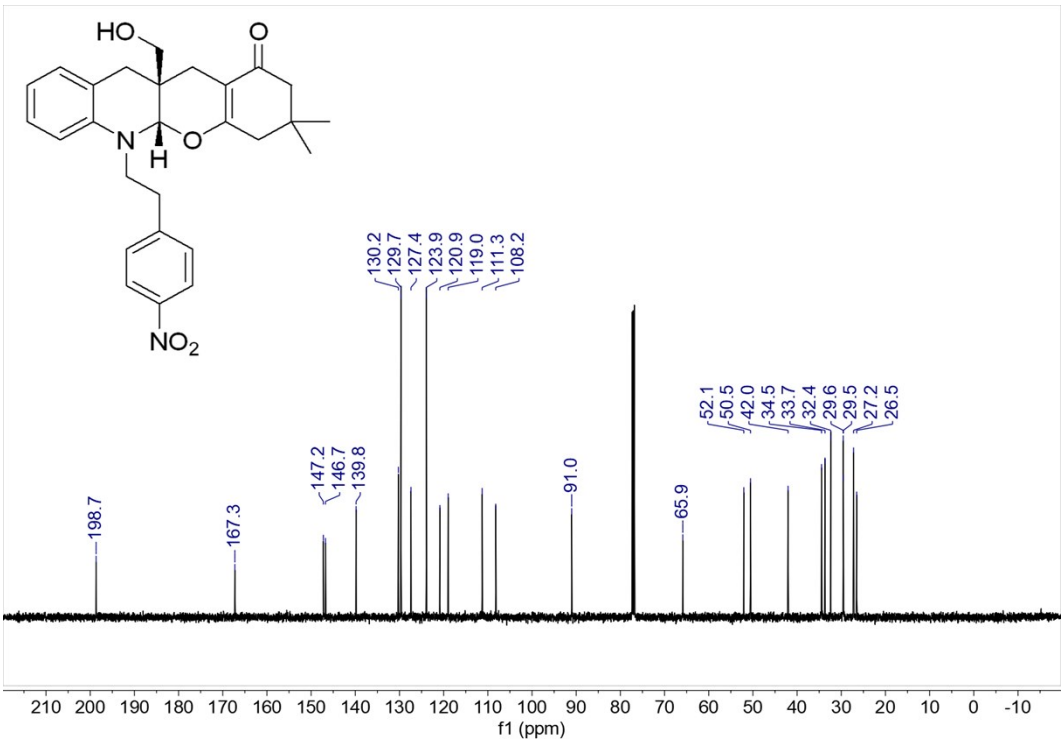
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{24}



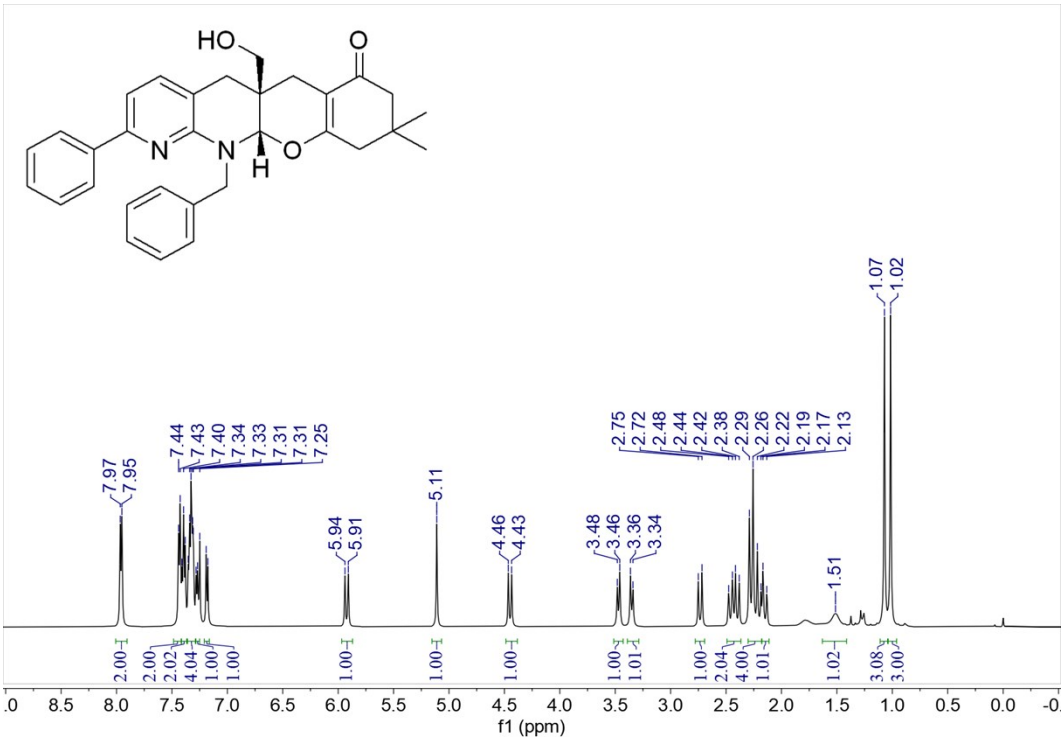
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of c_{24}



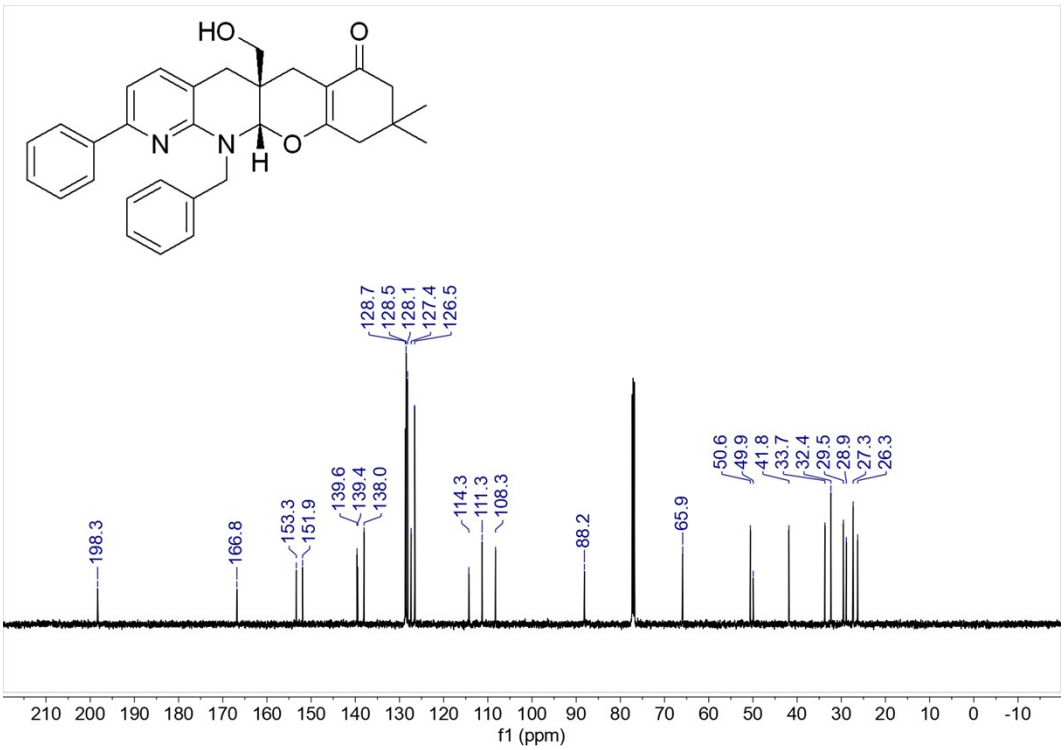
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{25}



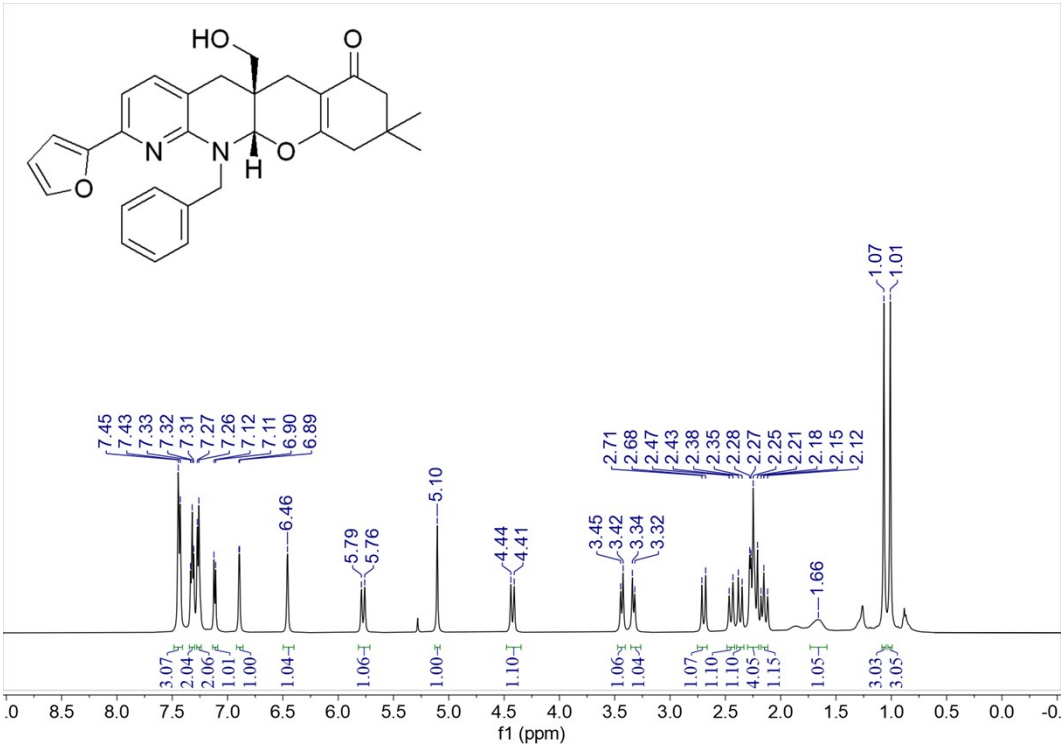
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{25}



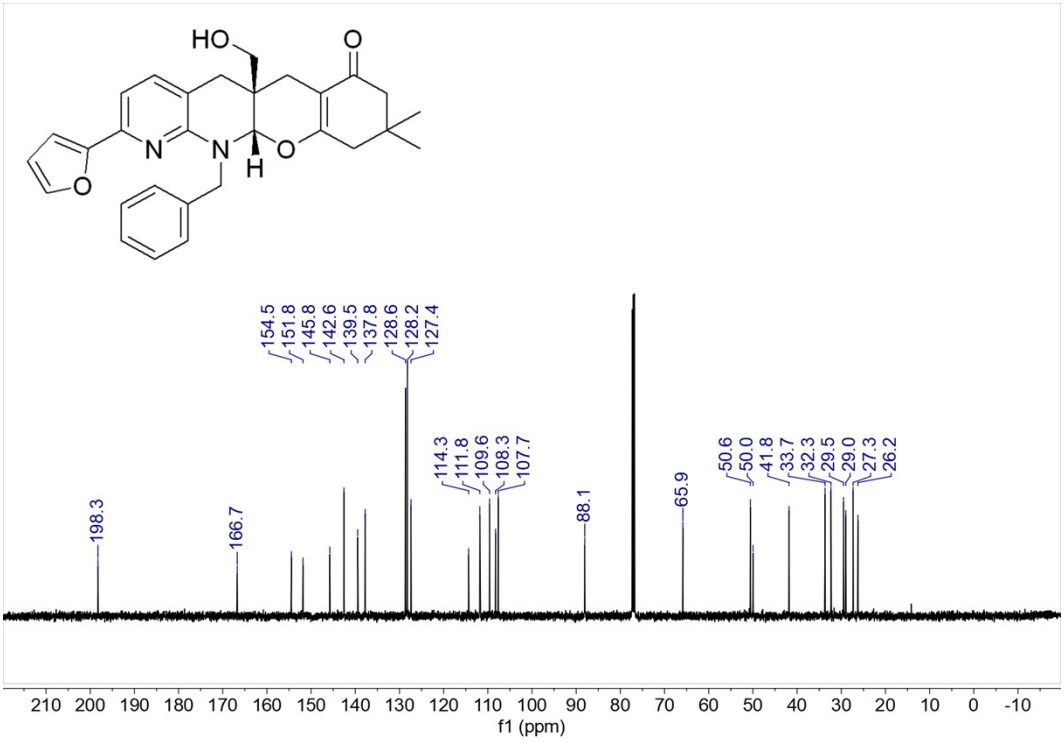
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{26}



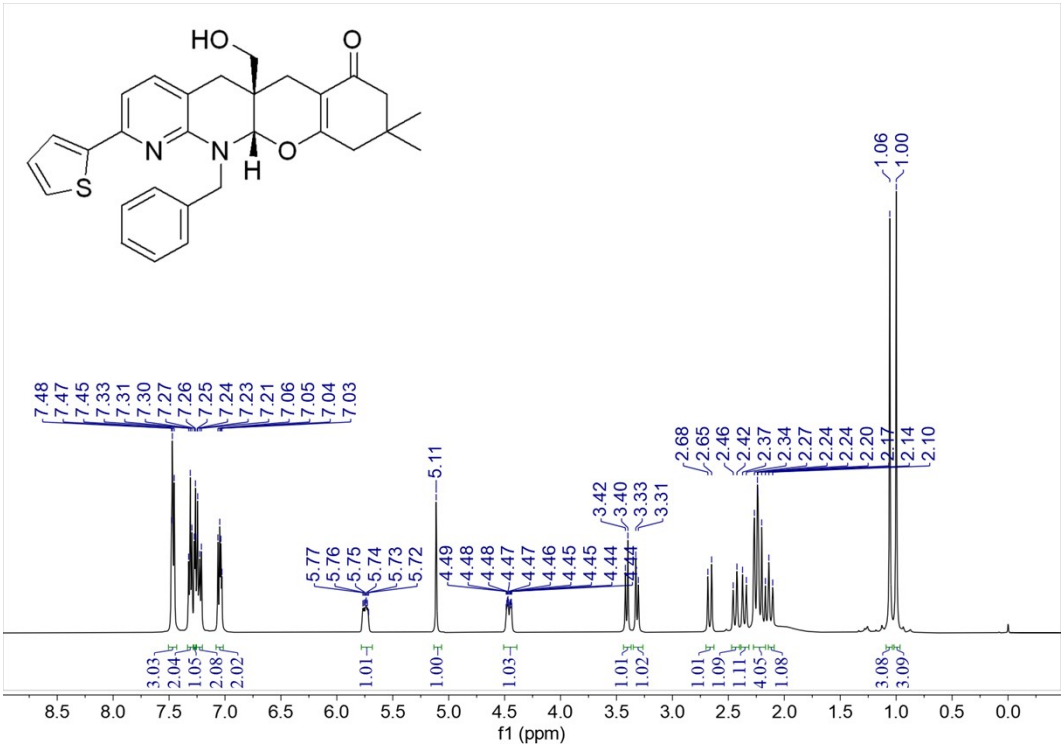
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{26}



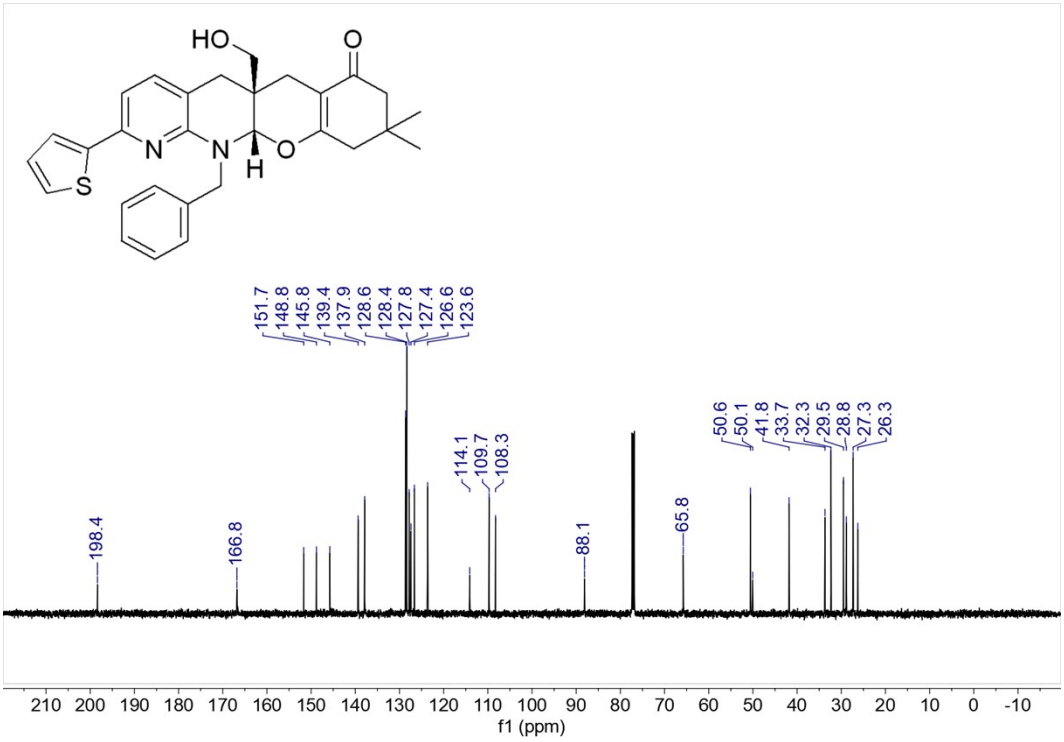
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{27}



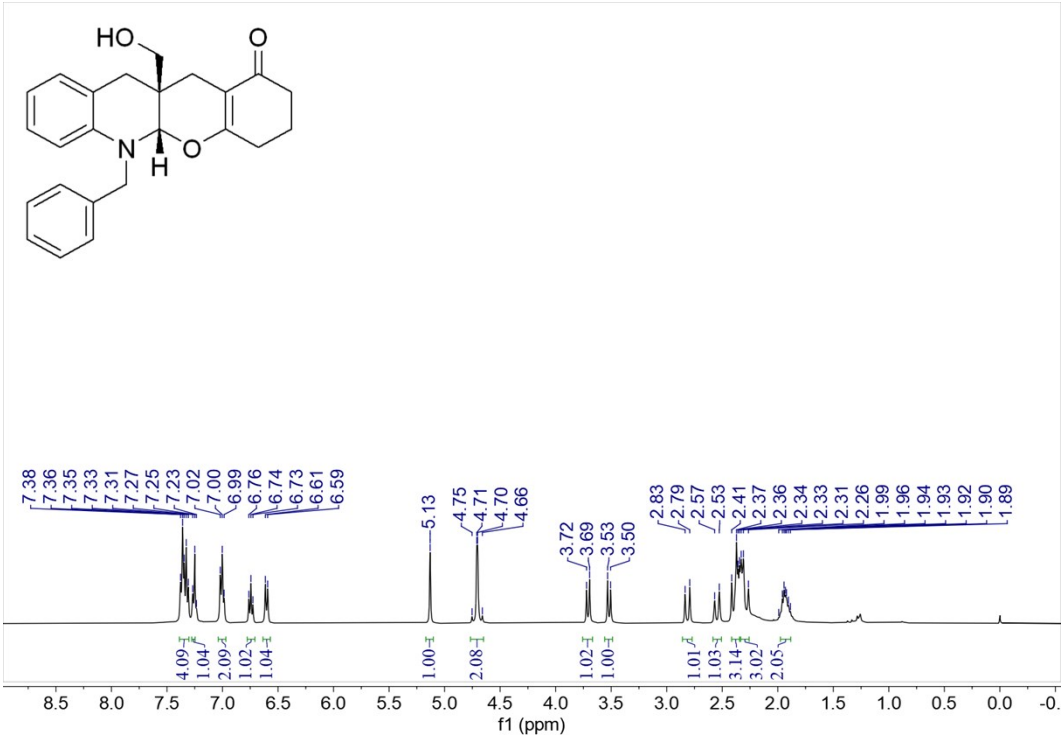
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{27}



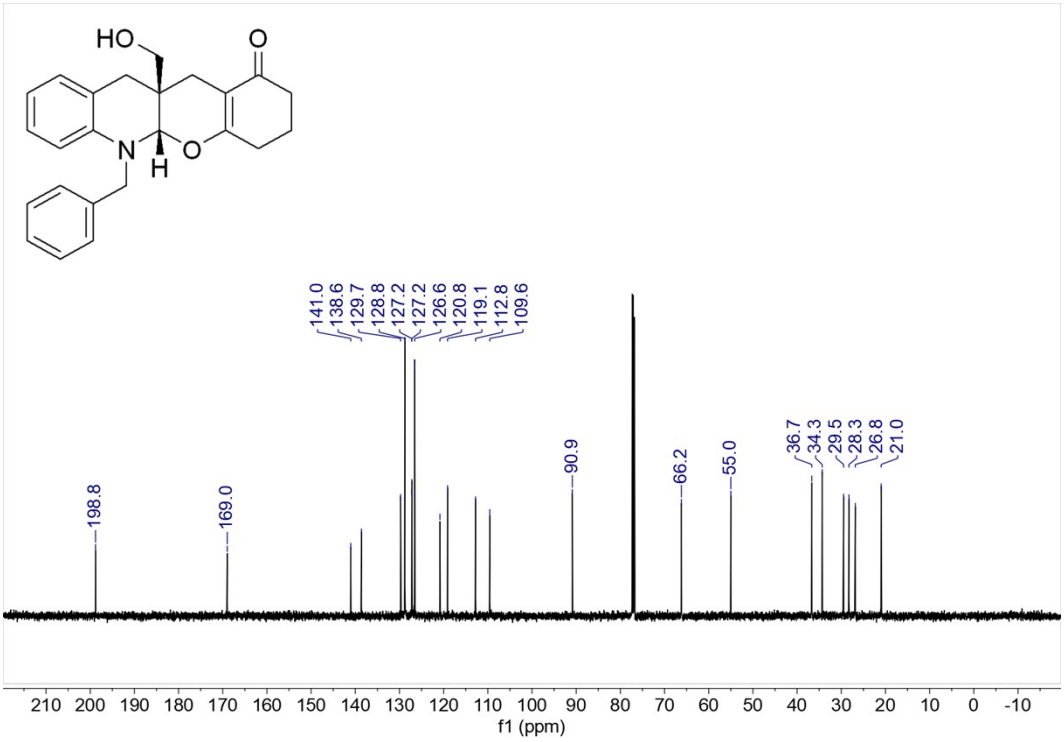
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{28}



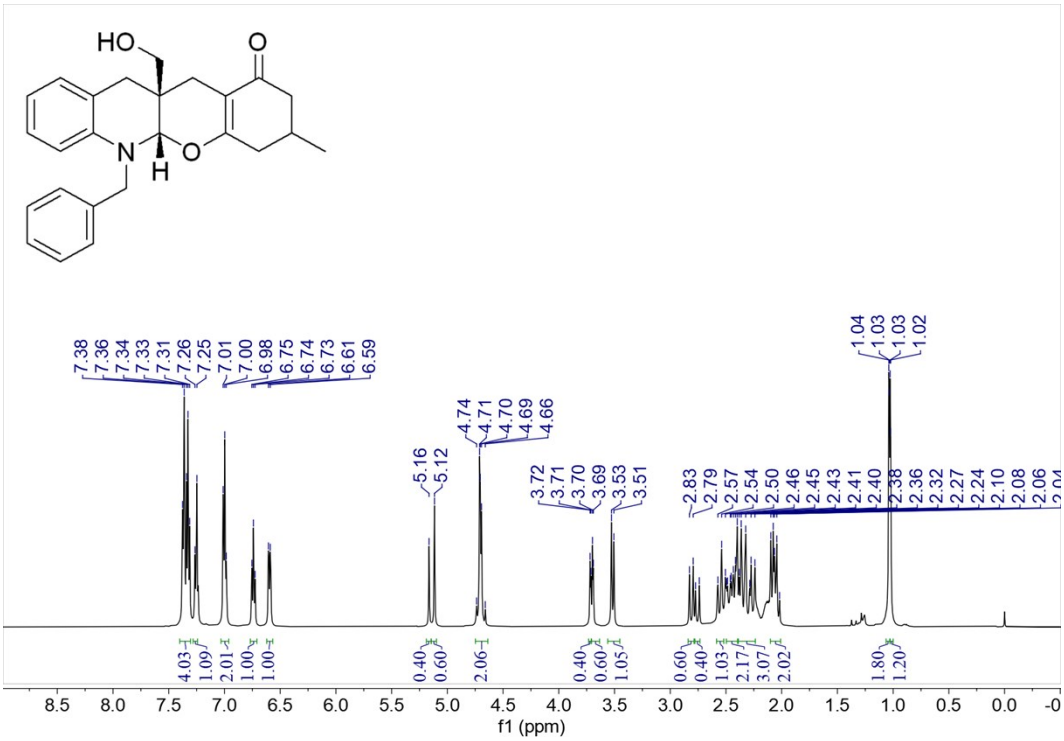
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{28}



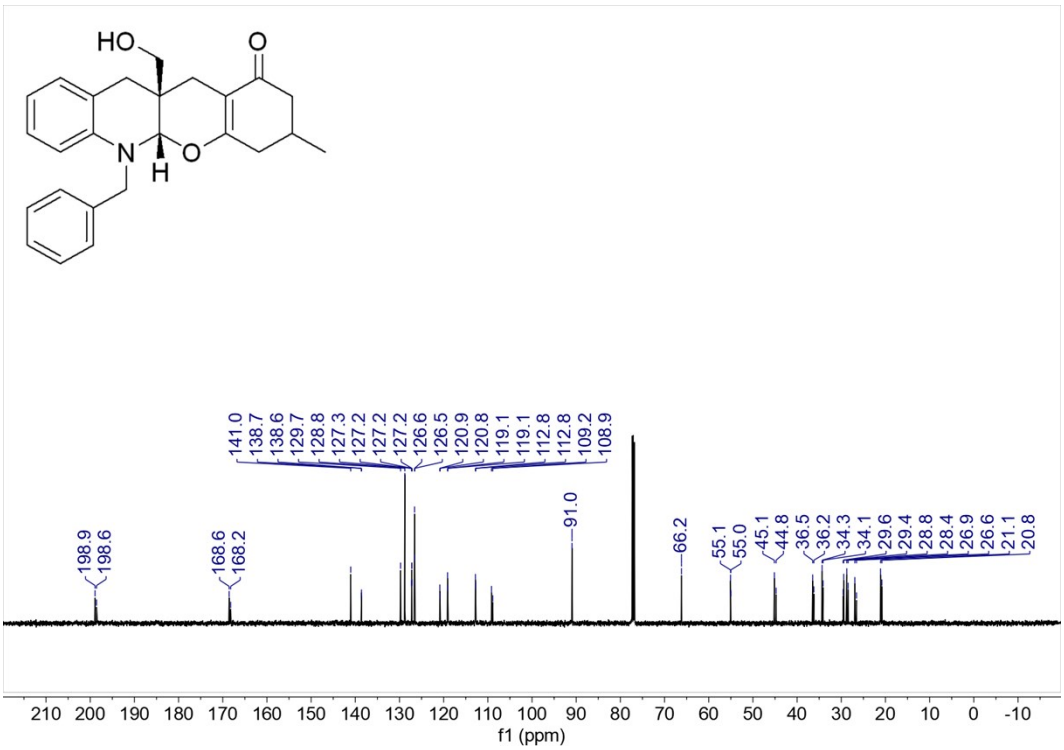
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of c_{29}



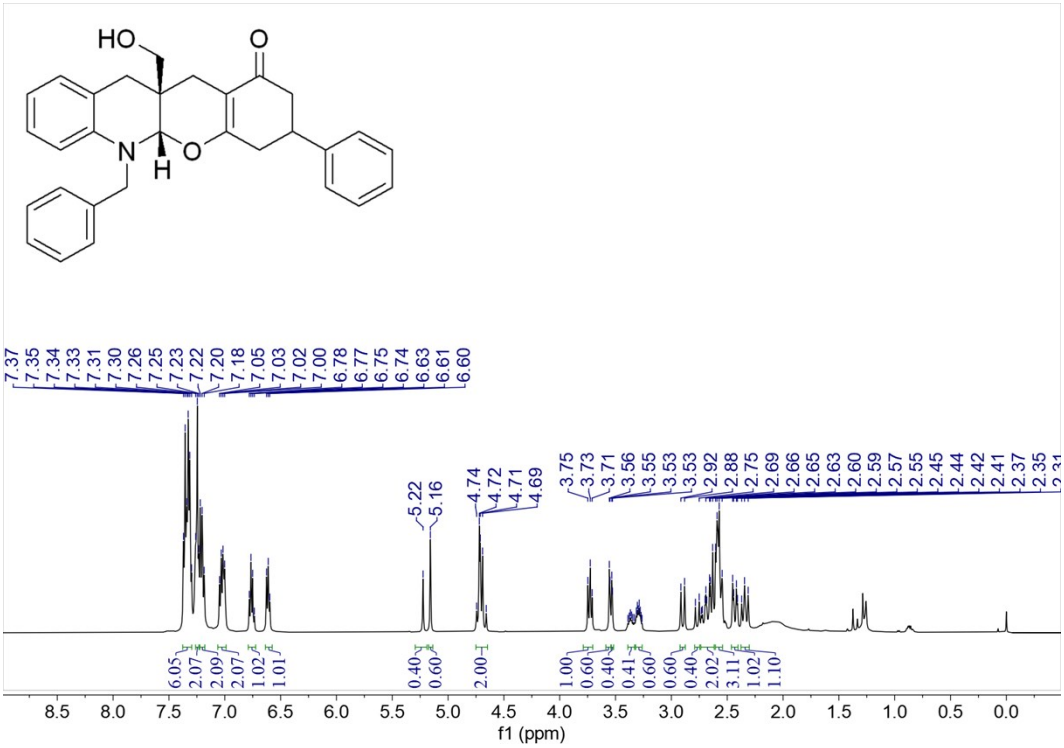
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{29}



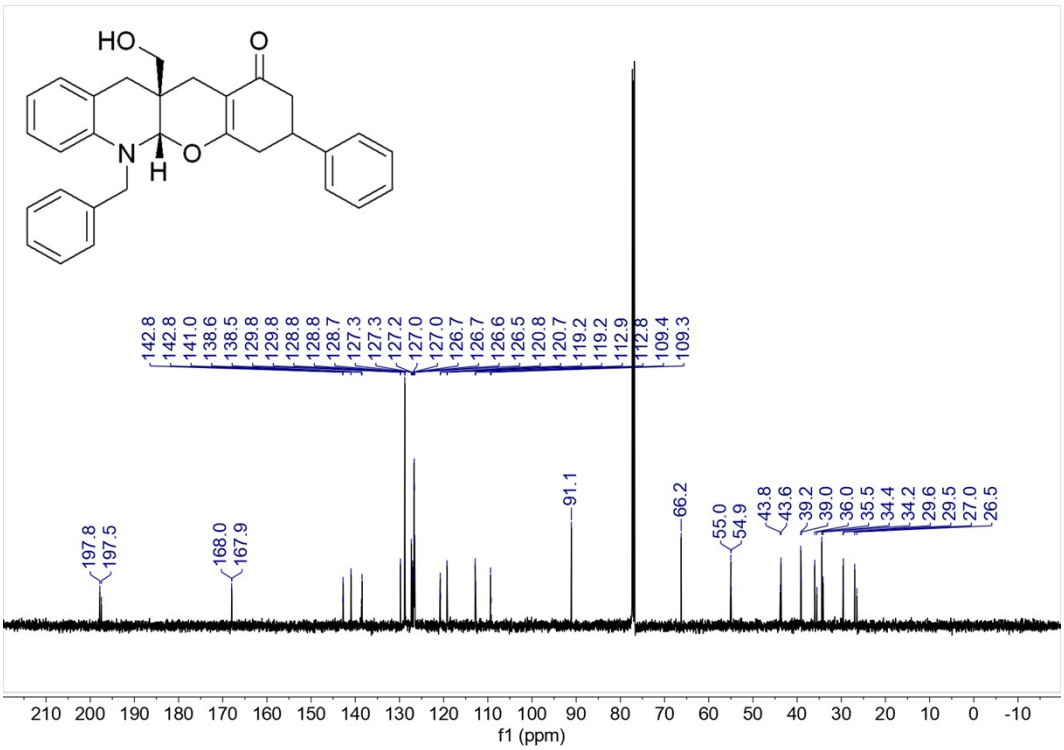
^{1}H-NMR spectrum of c_{30}



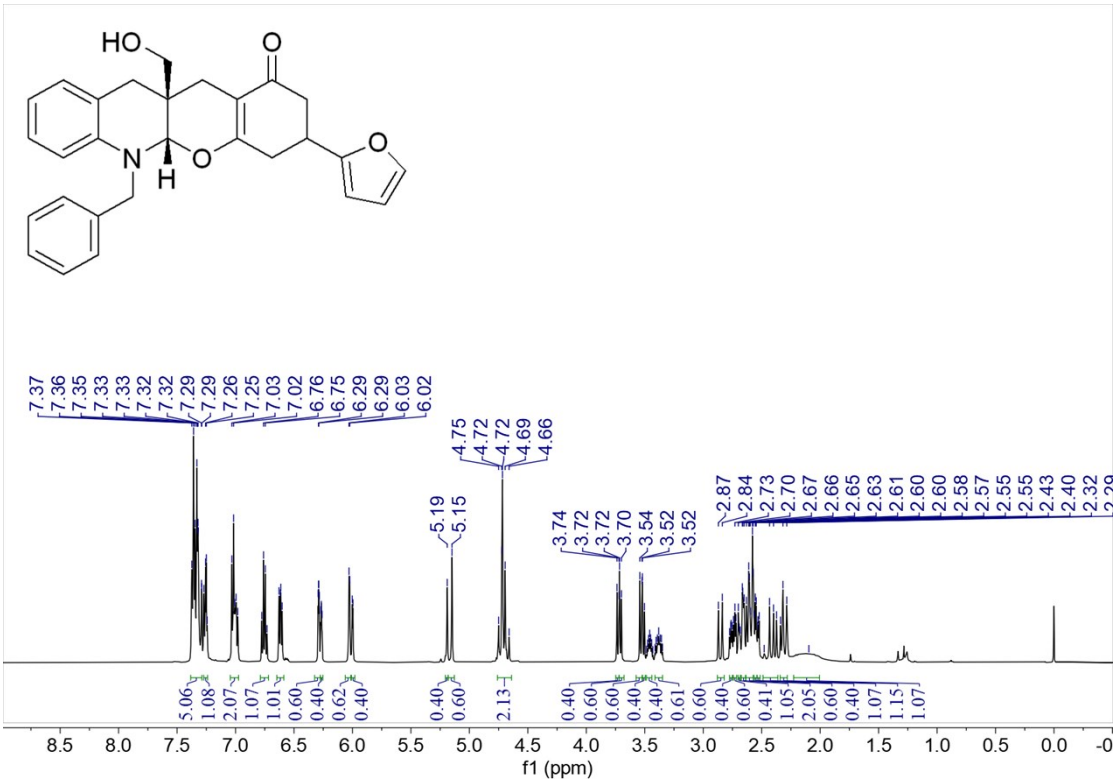
^{13}C-NMR spectrum of c_{30}



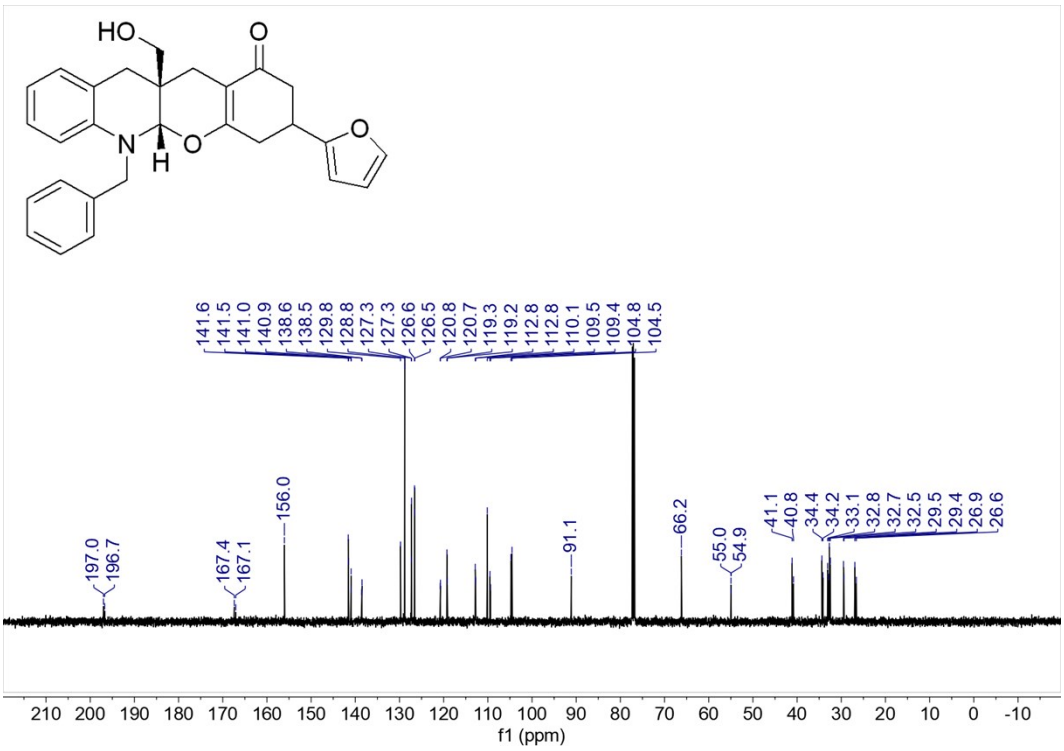
^{1}H-NMR spectrum of c_{31}



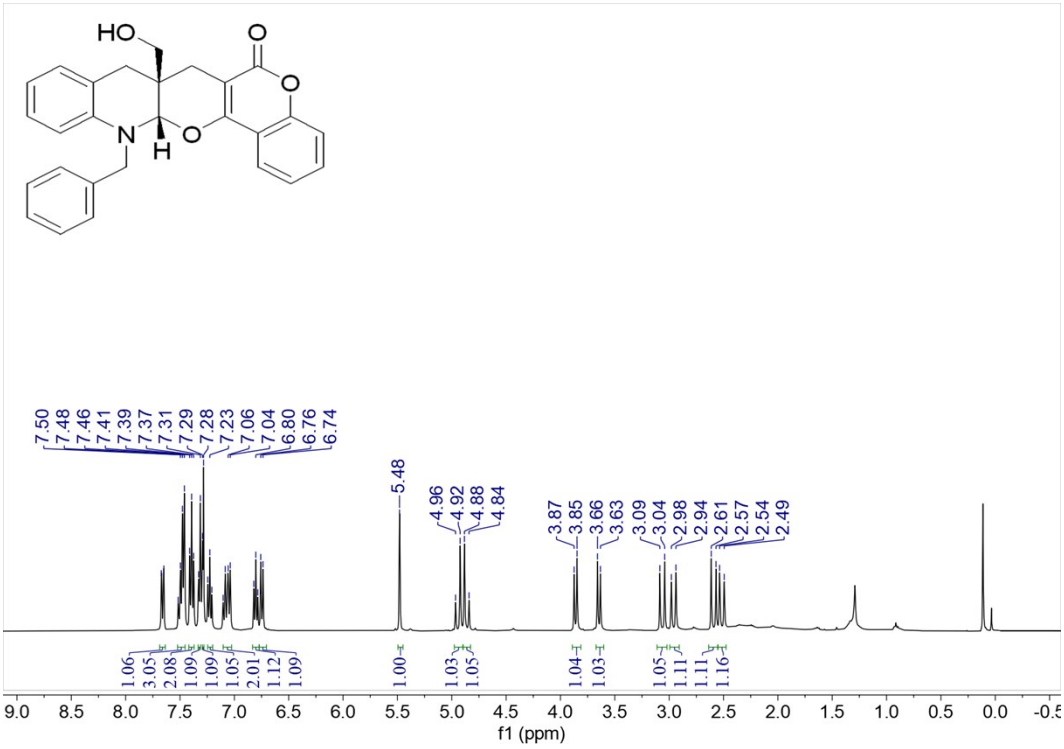
^{13}C-NMR spectrum of c_{31}



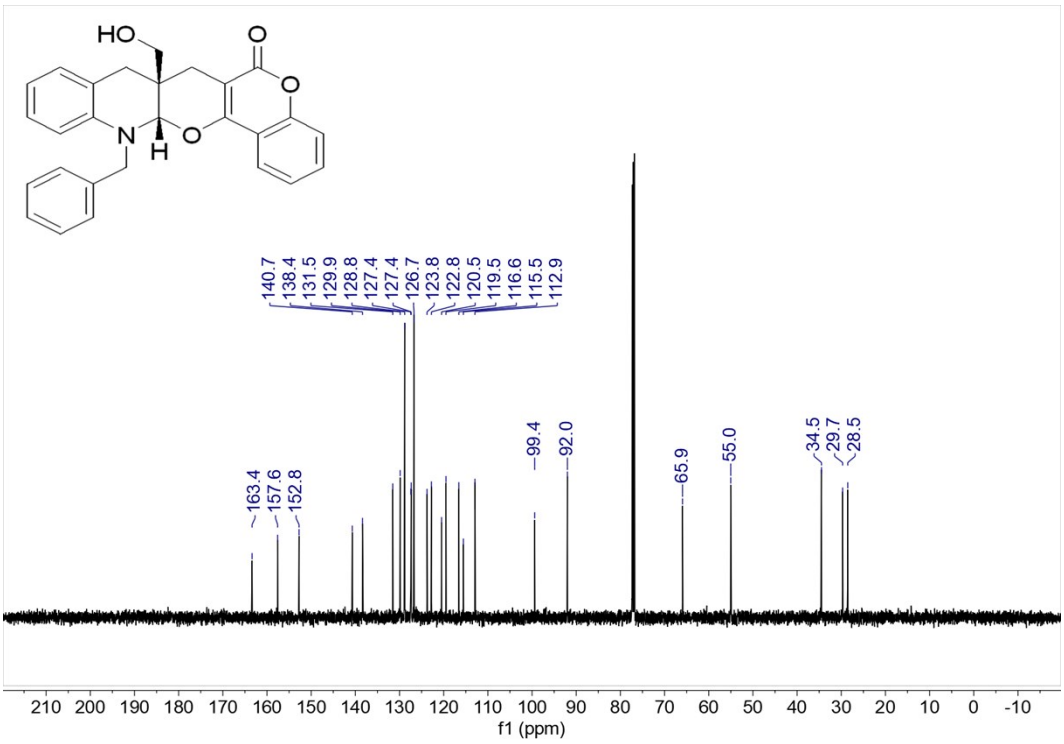
^{1}H-NMR spectrum of c_{32}



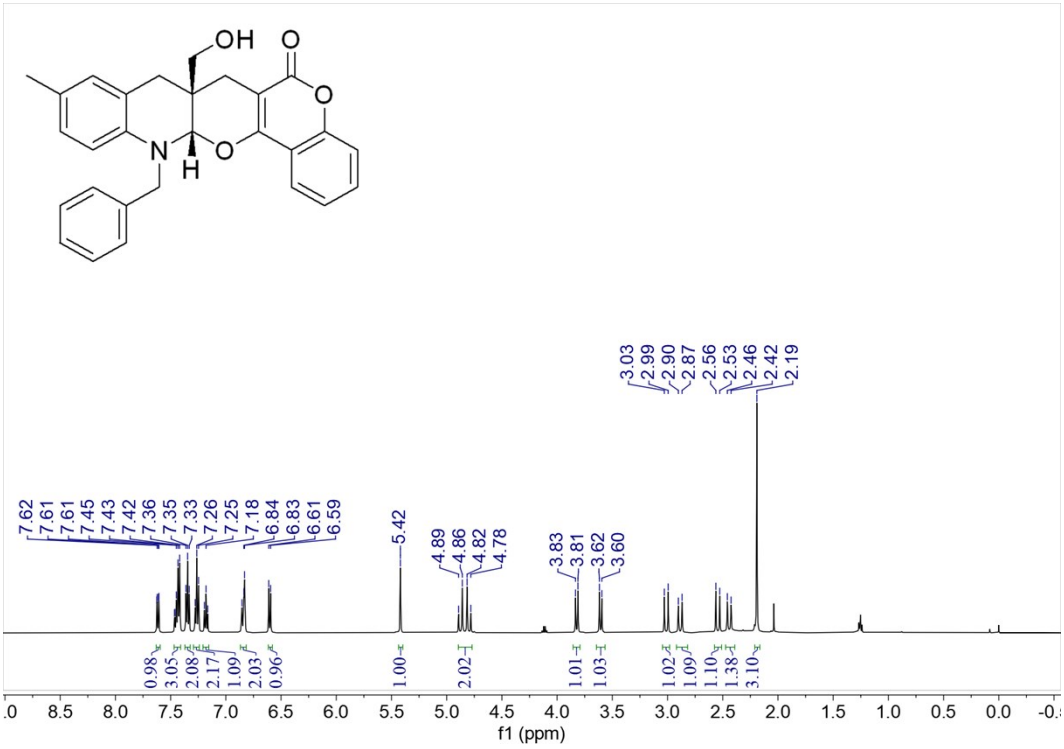
^{13}C-NMR spectrum of c_{32}



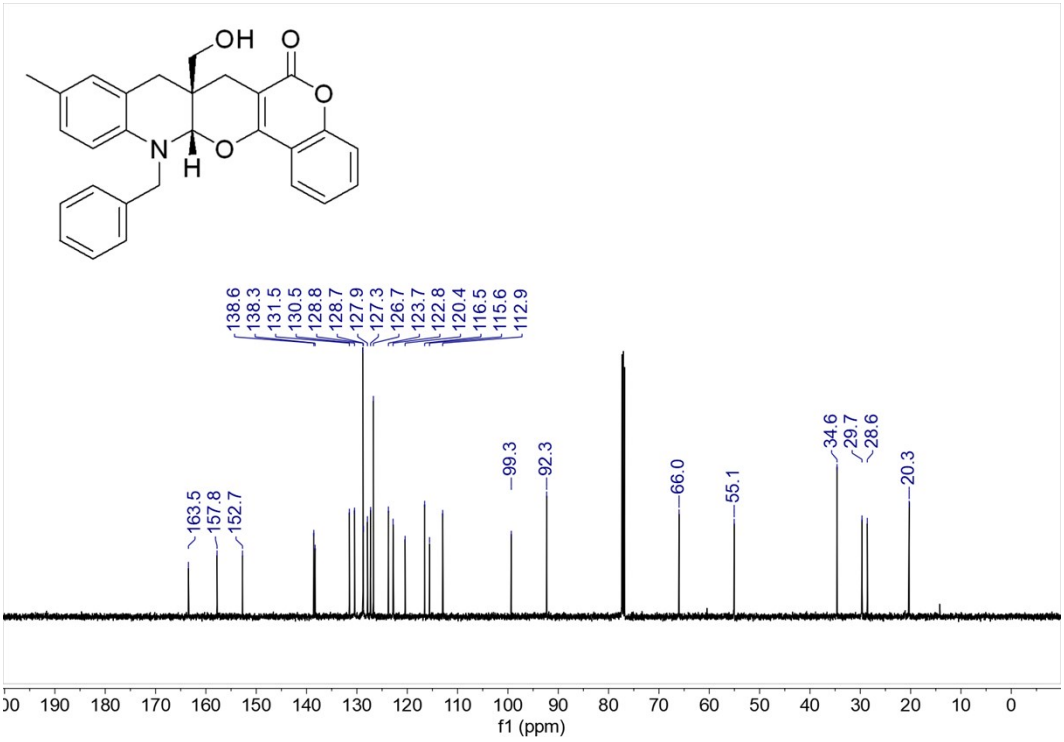
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of e_1



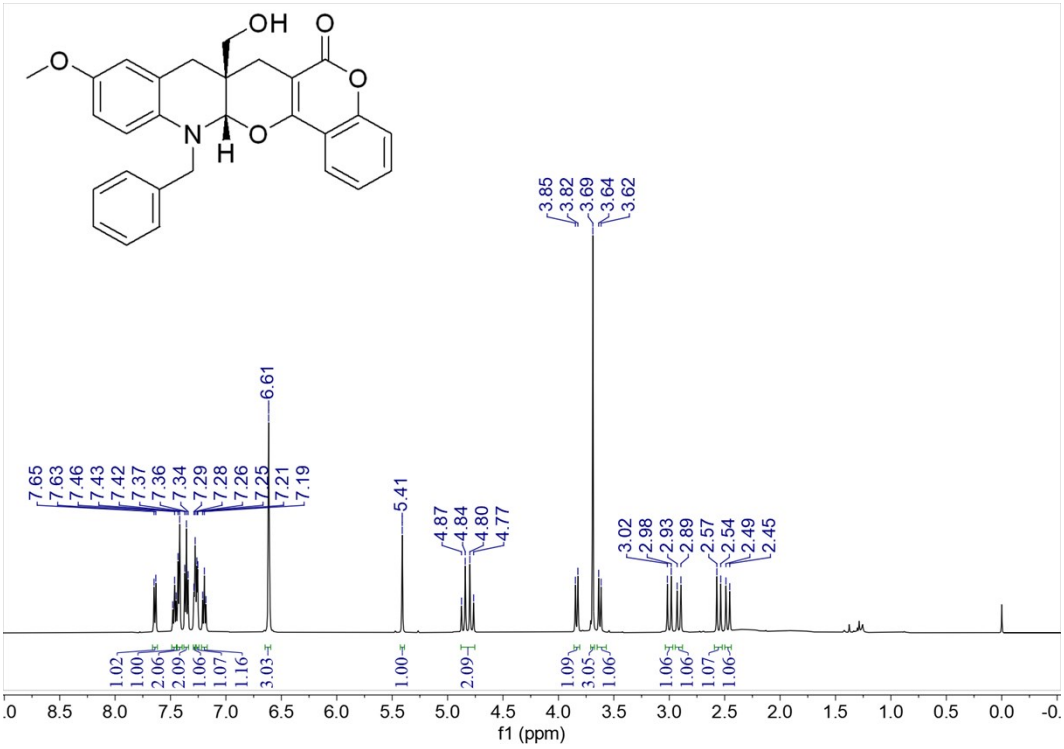
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_1



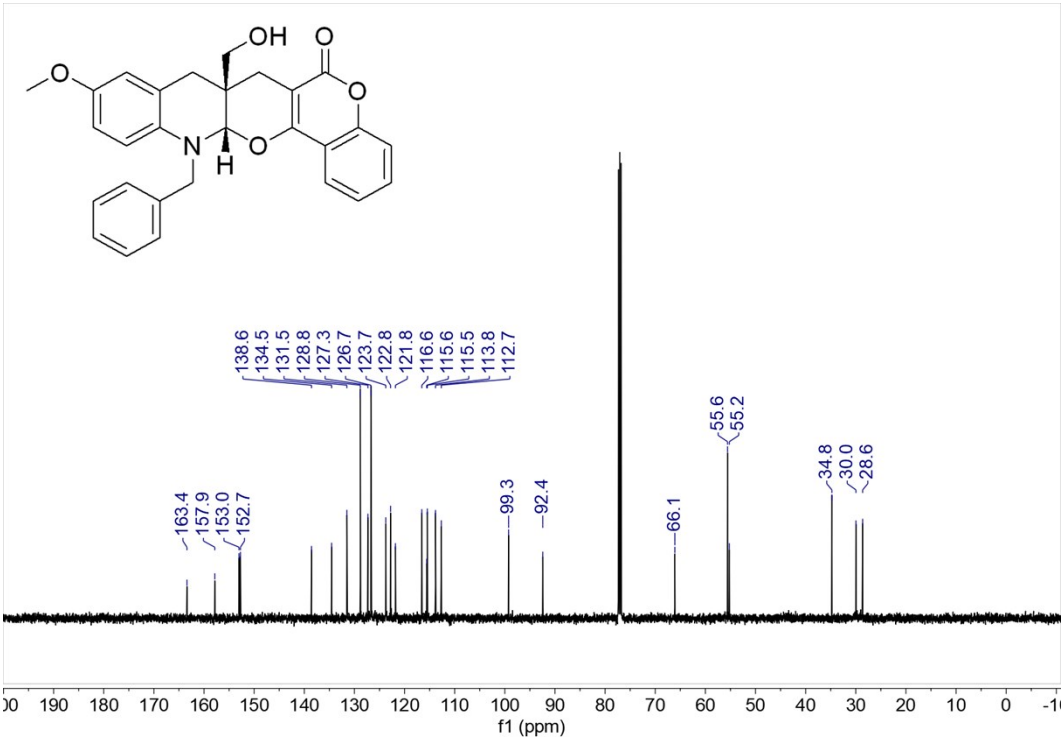
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_2



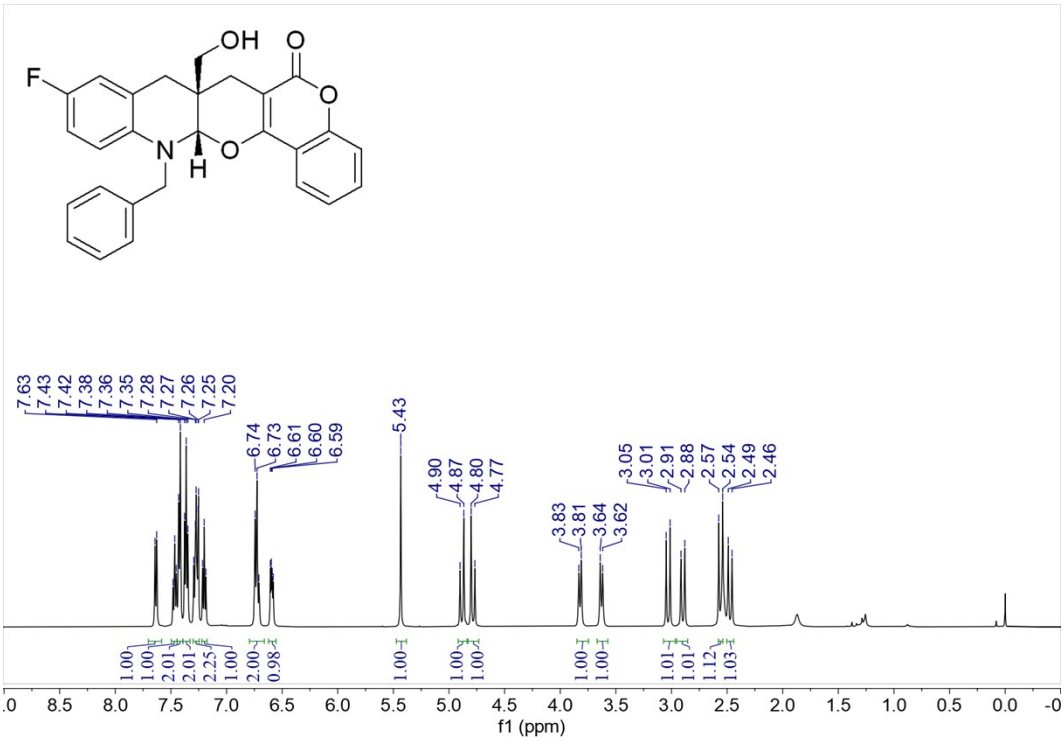
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_2



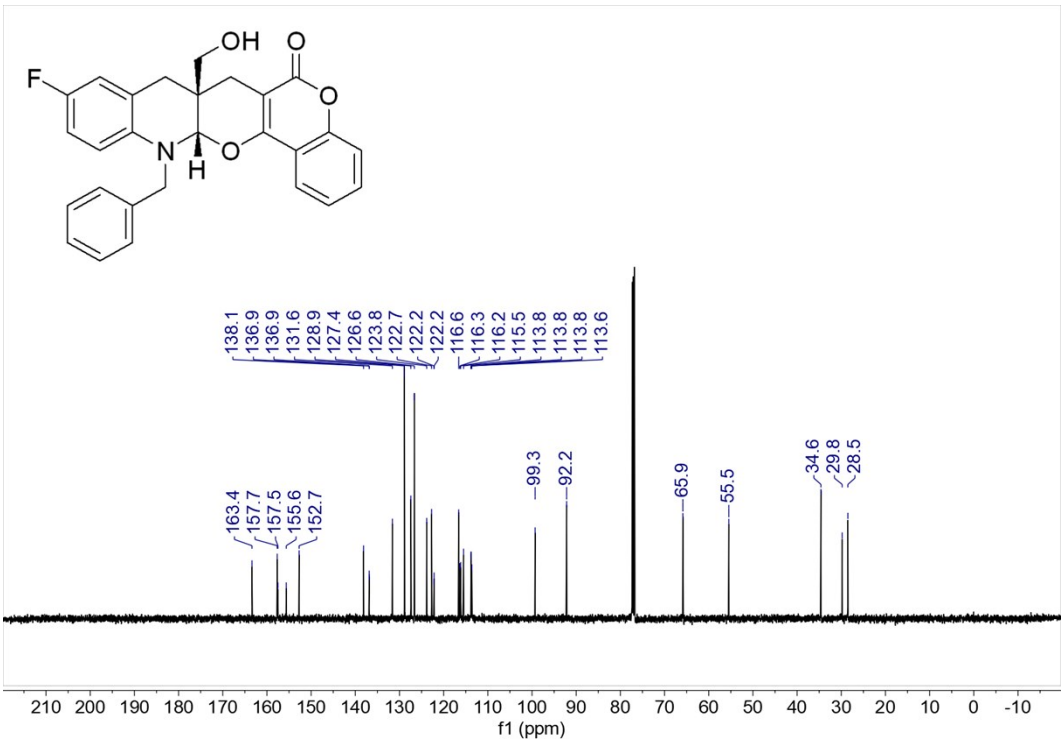
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_3



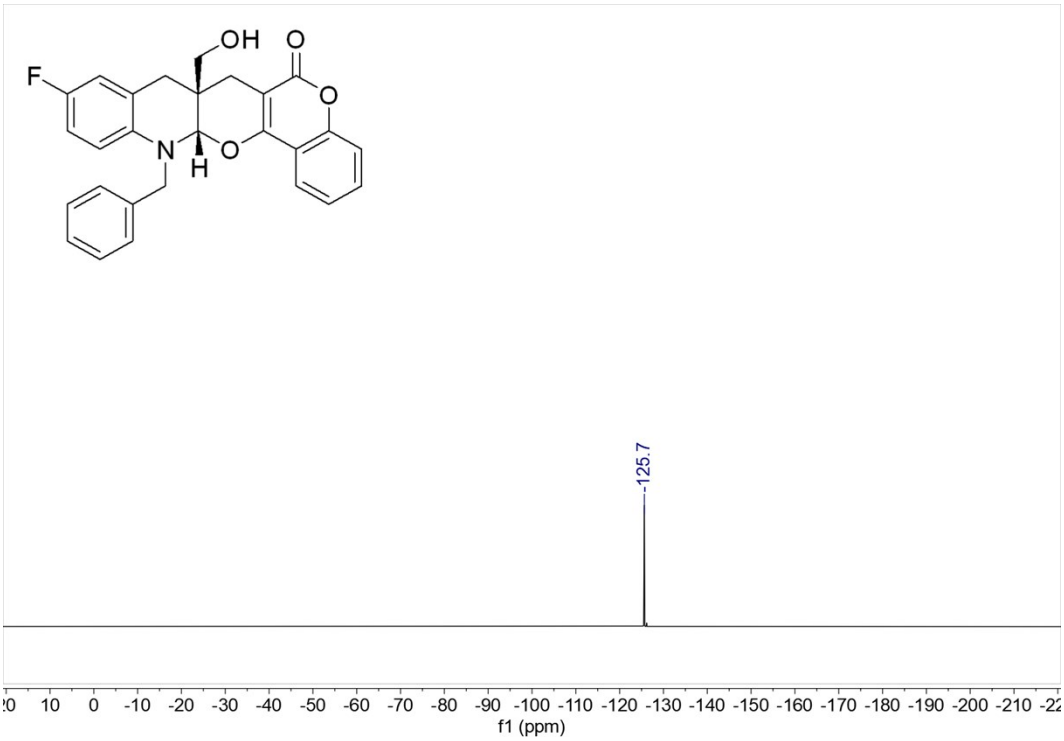
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_3



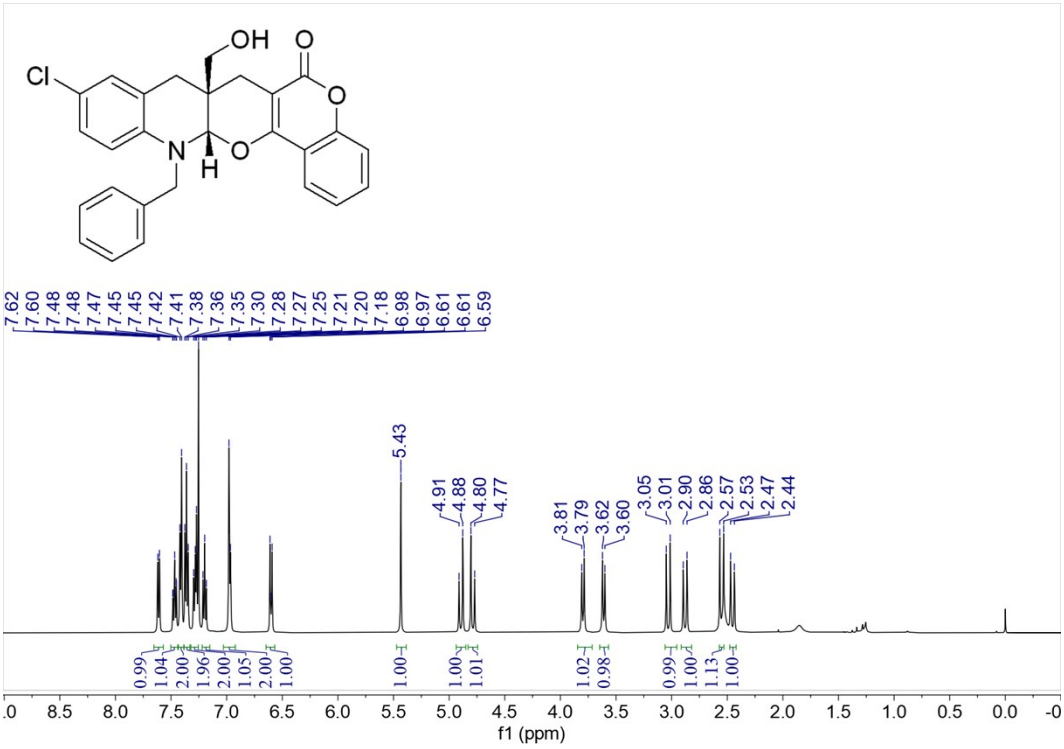
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_4



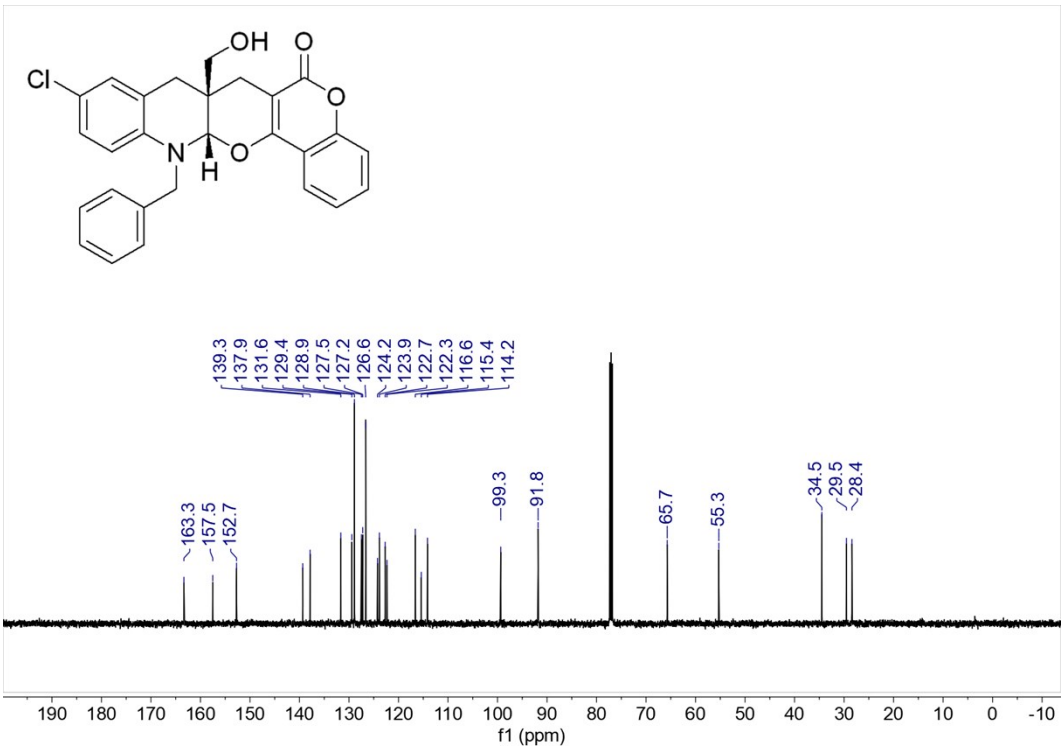
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_4



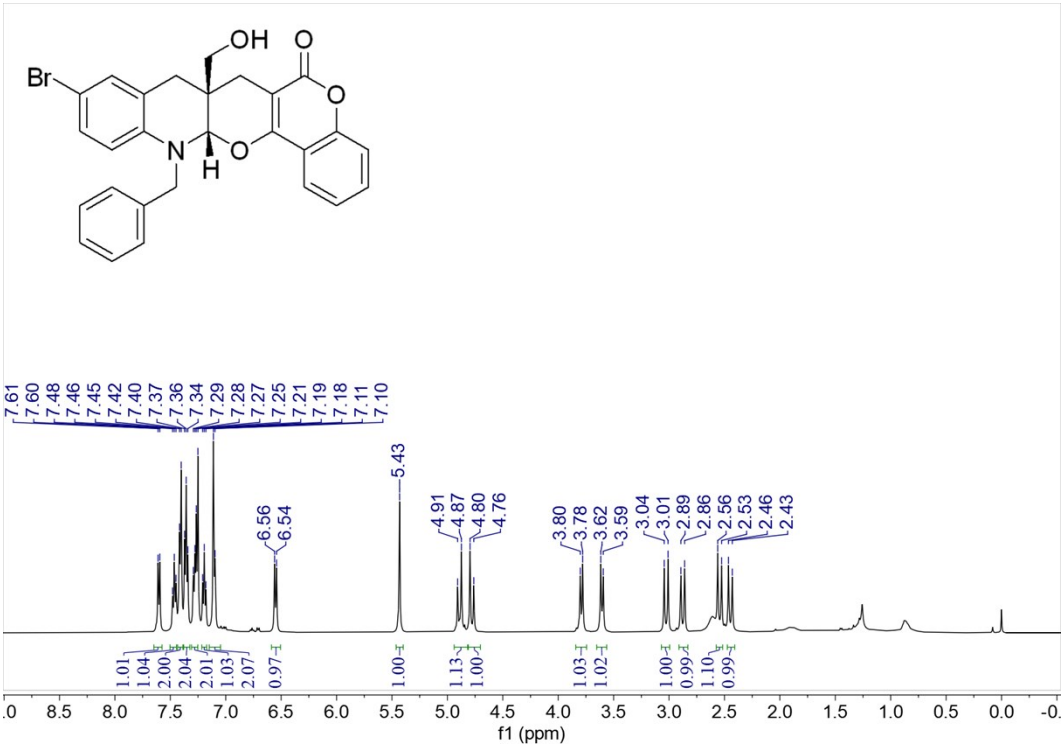
^{19}F NMR (471 MHz, $CDCl_3$) spectrum of e_4



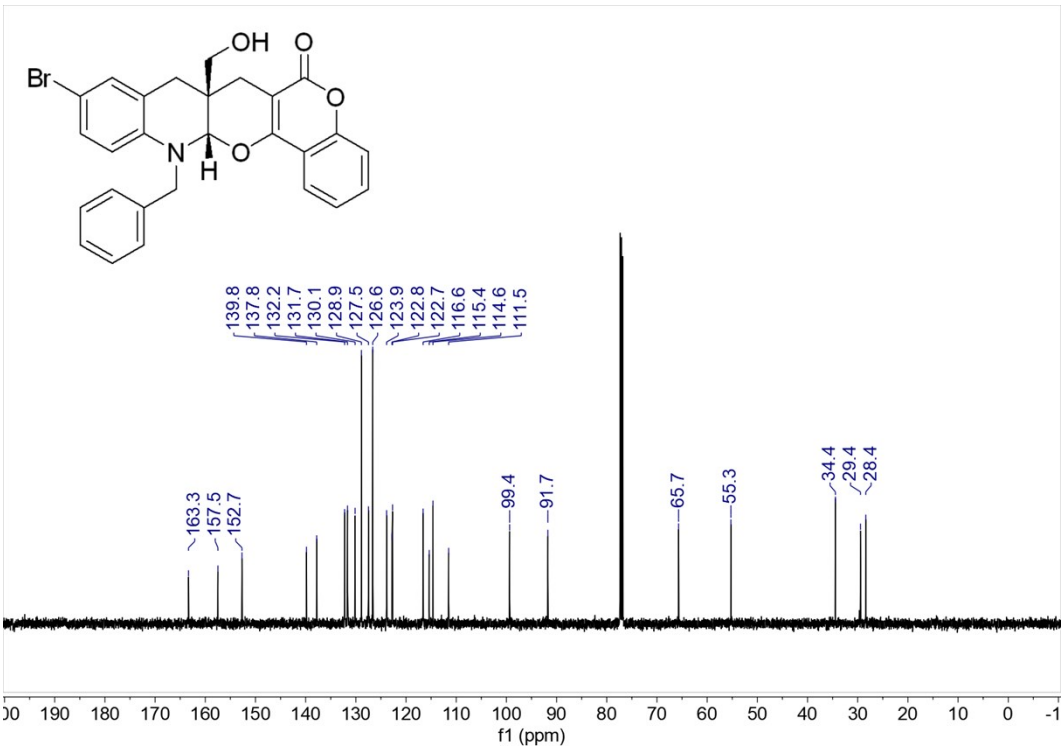
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_5



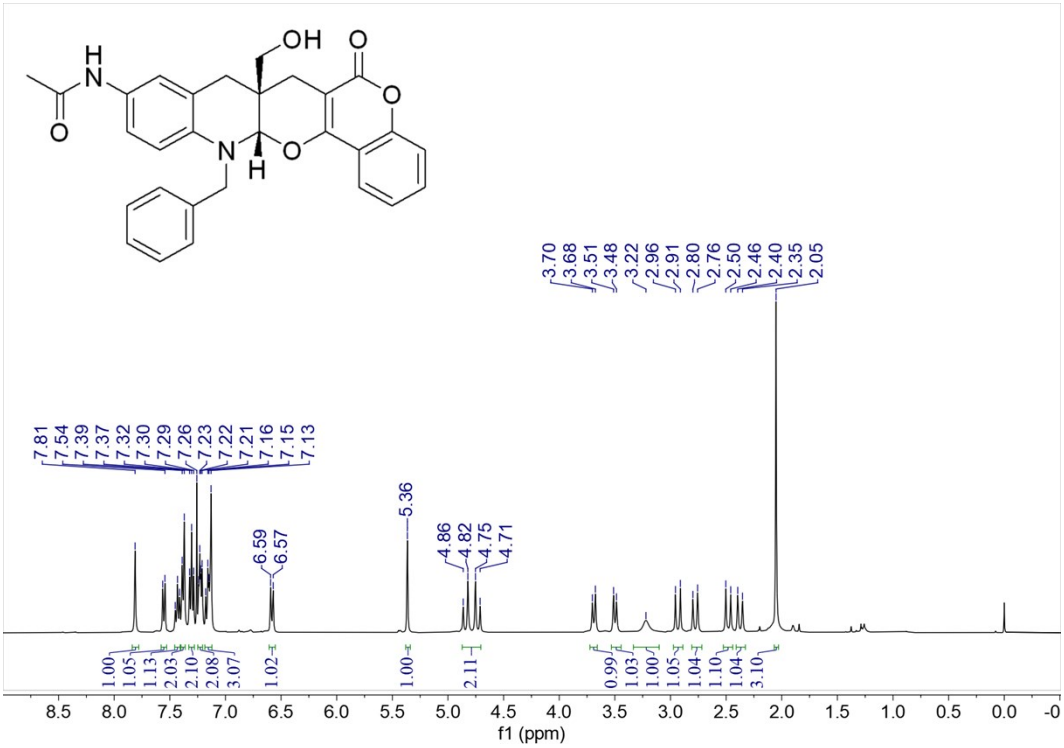
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_5



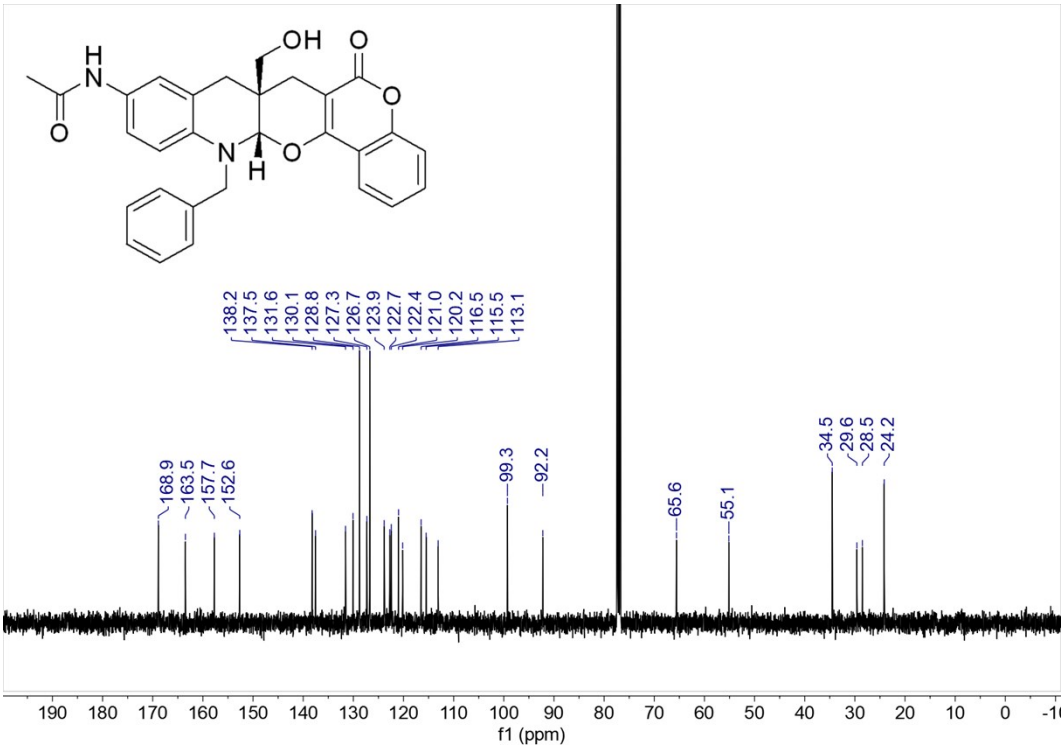
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_6



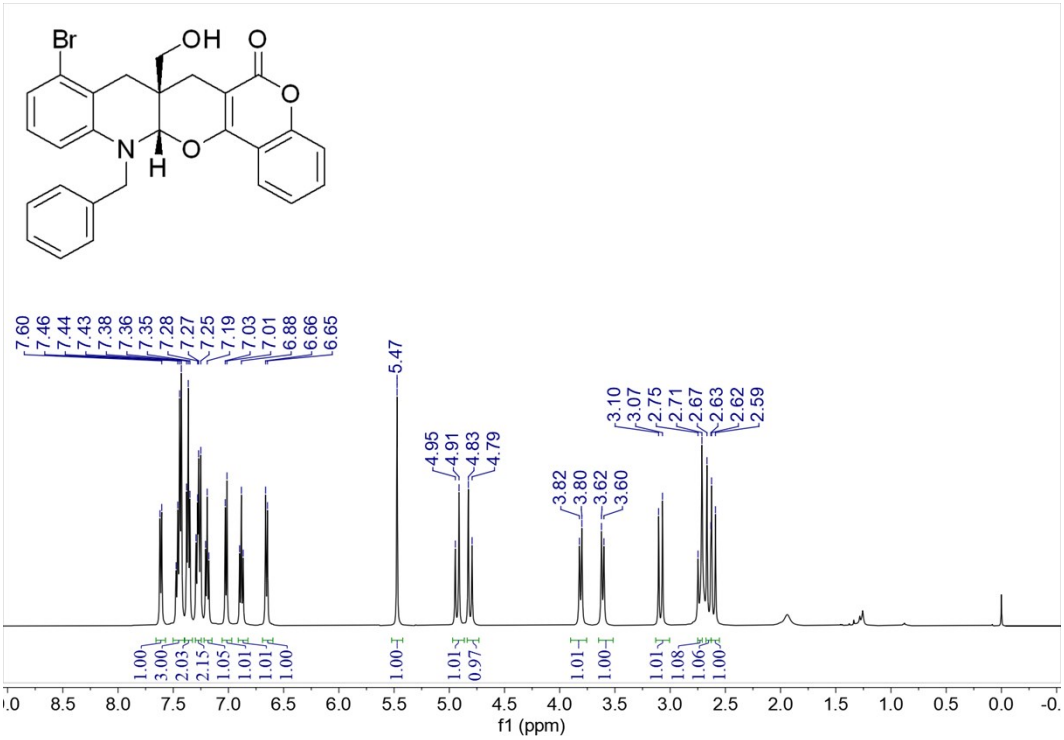
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_6



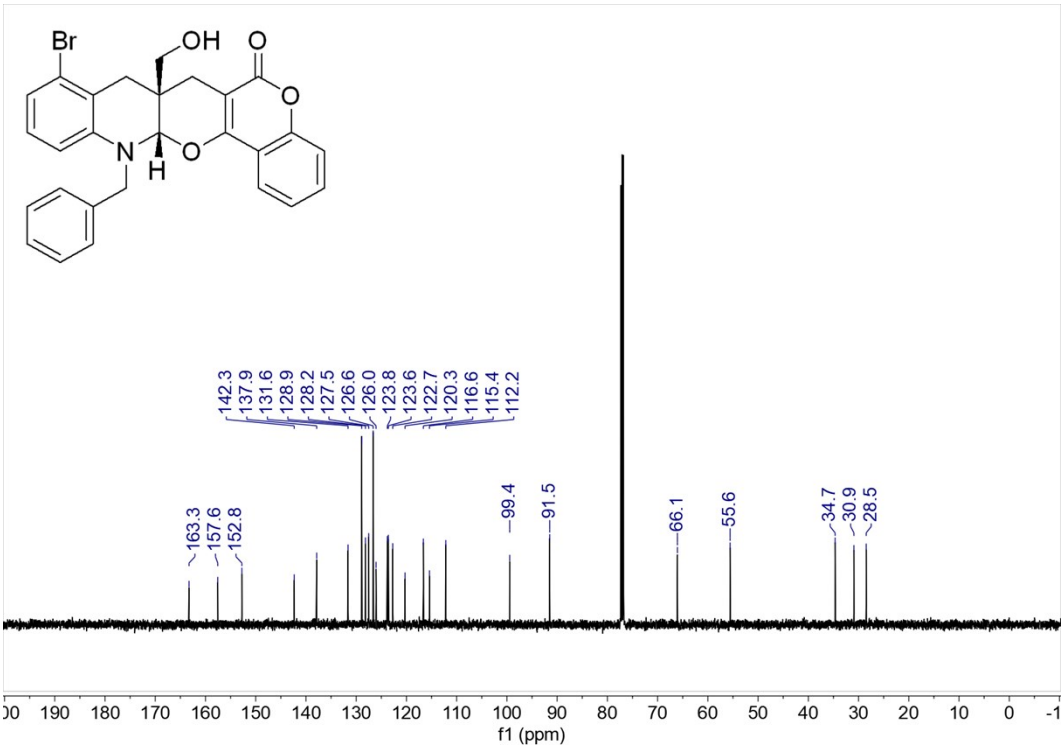
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of e_7



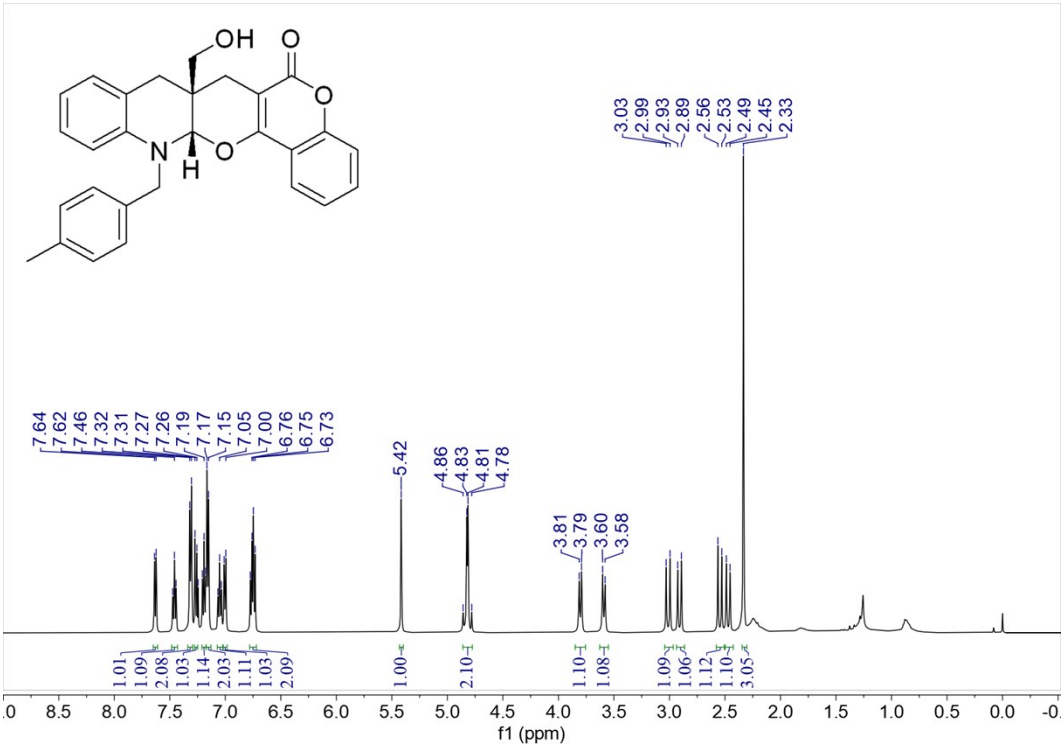
^{13}C NMR (101 MHz, $CDCl_3$) spectrum of e_7



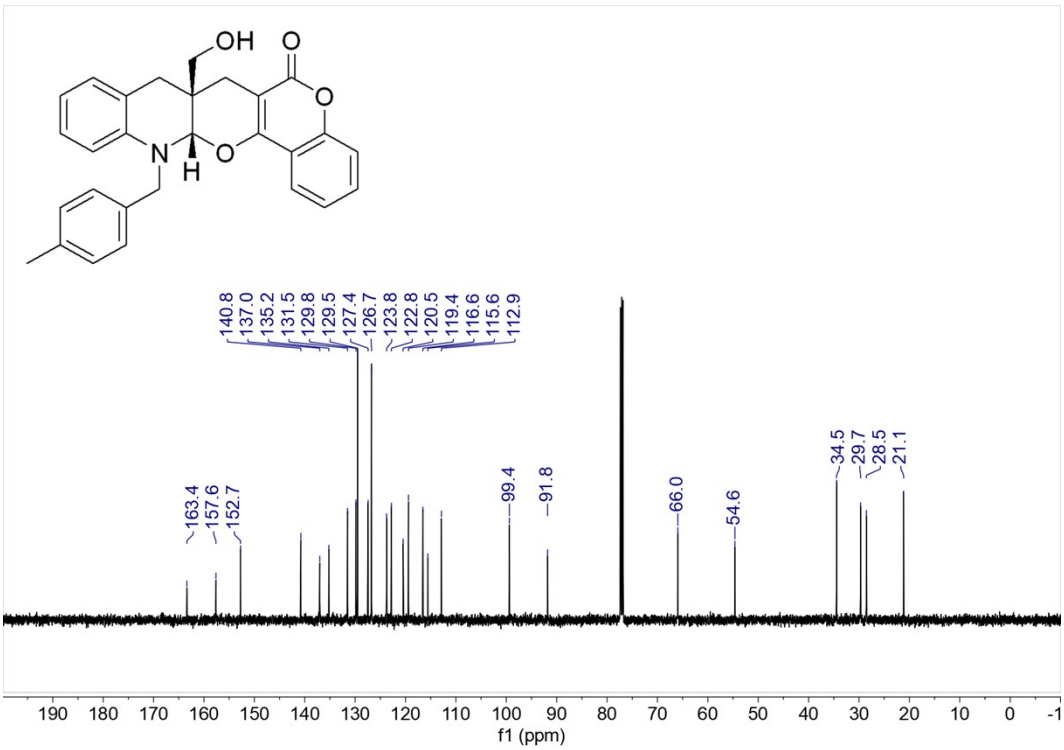
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_8



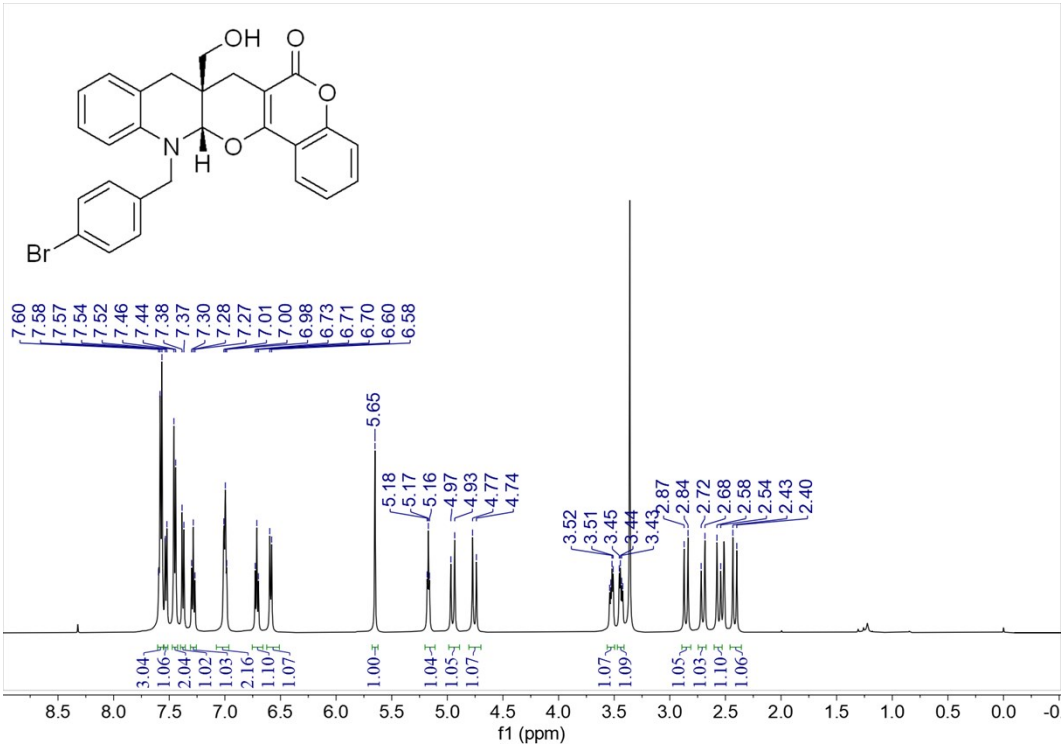
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_8



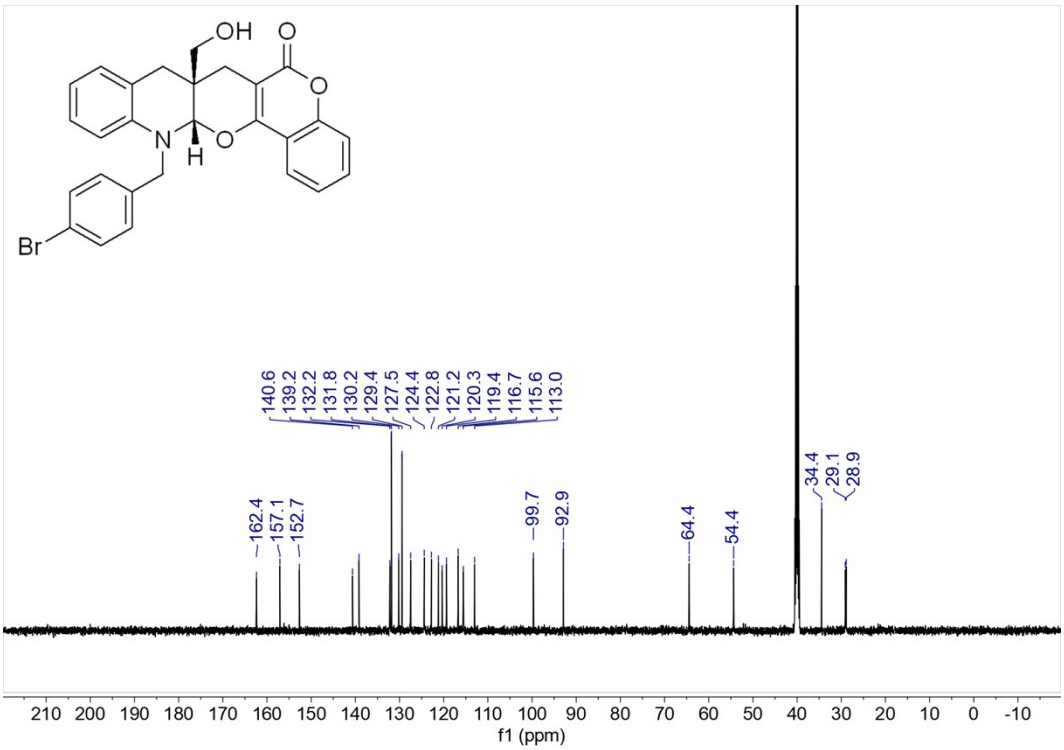
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_9



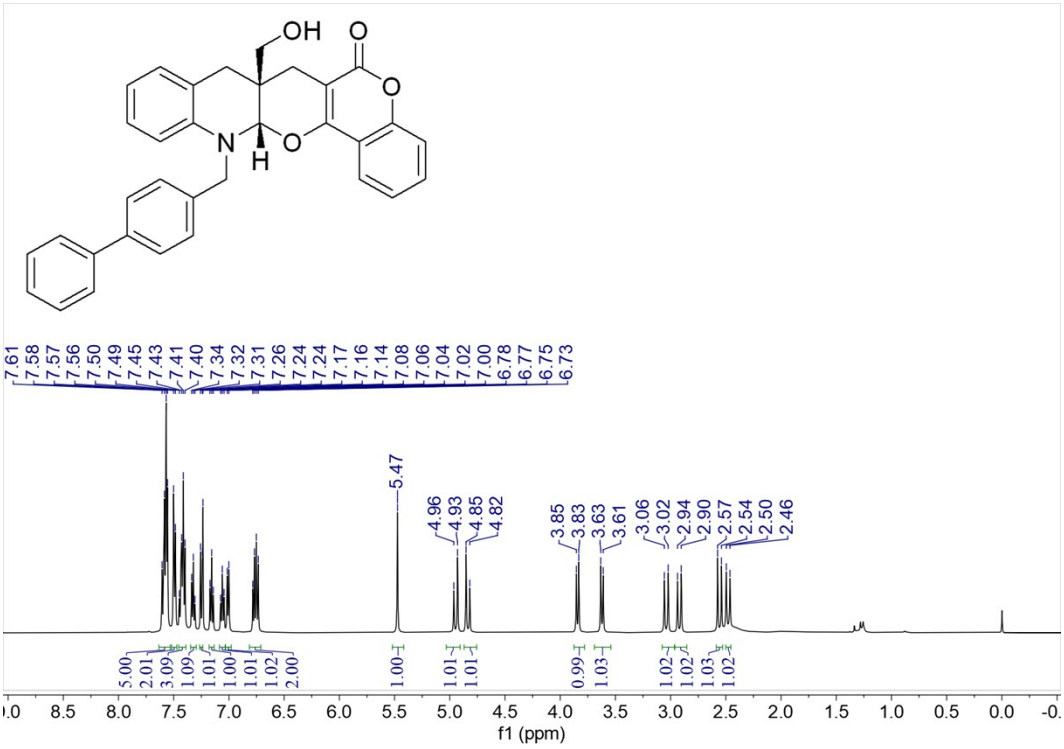
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_9



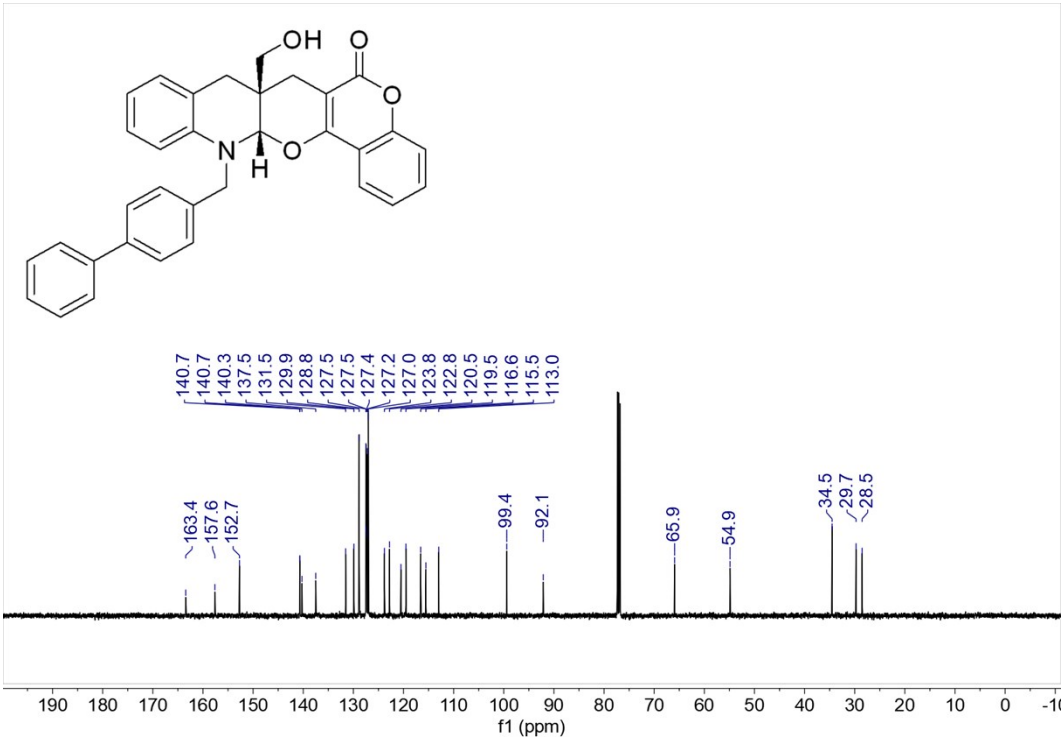
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{10}



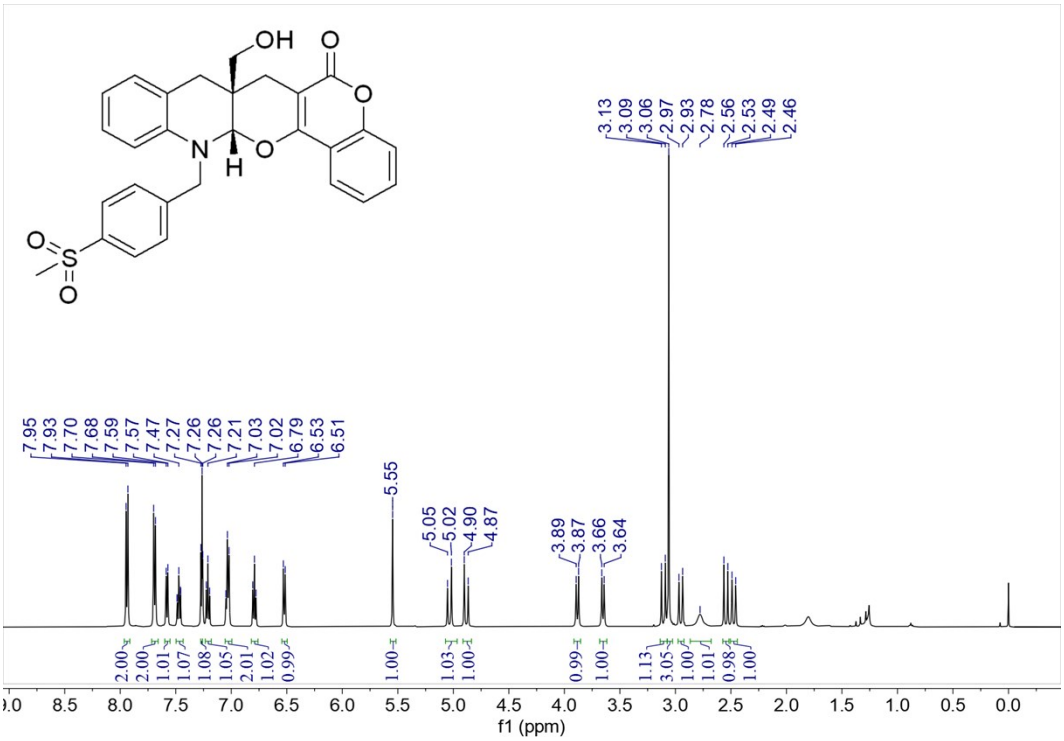
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{10}



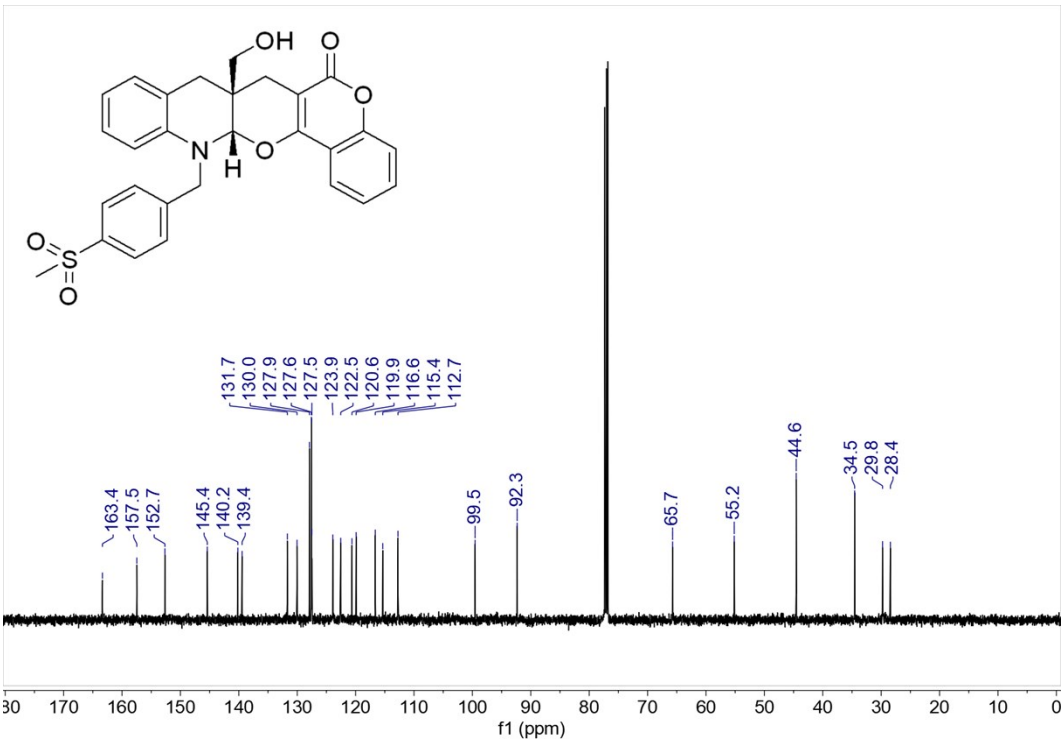
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{11}



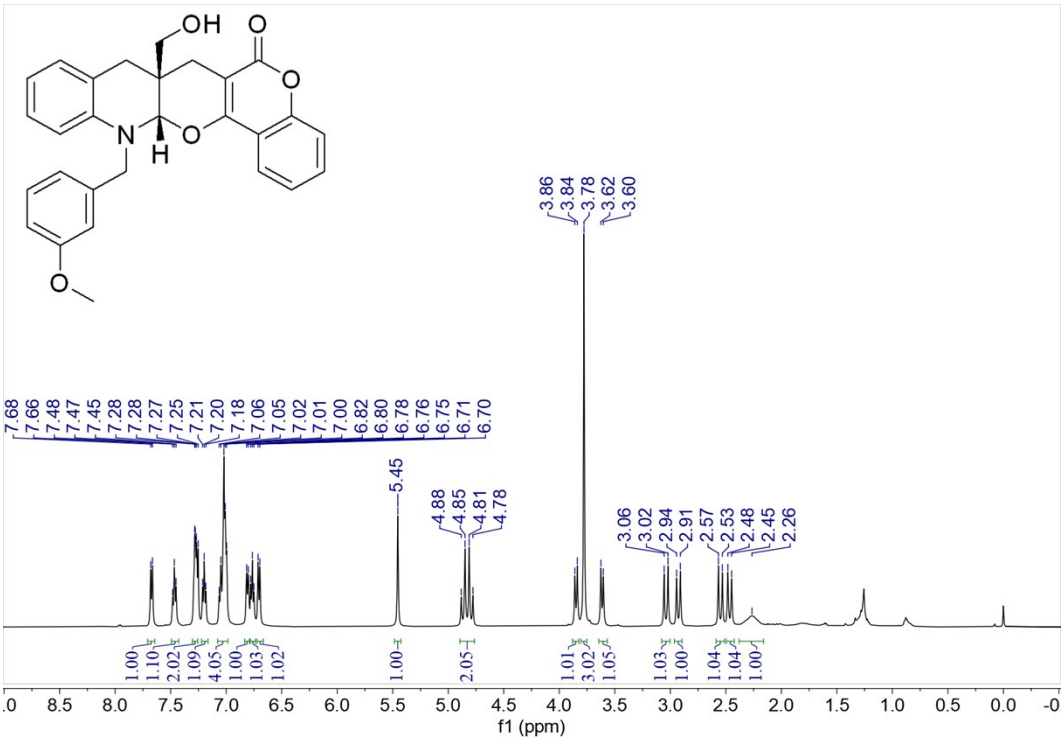
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{11}



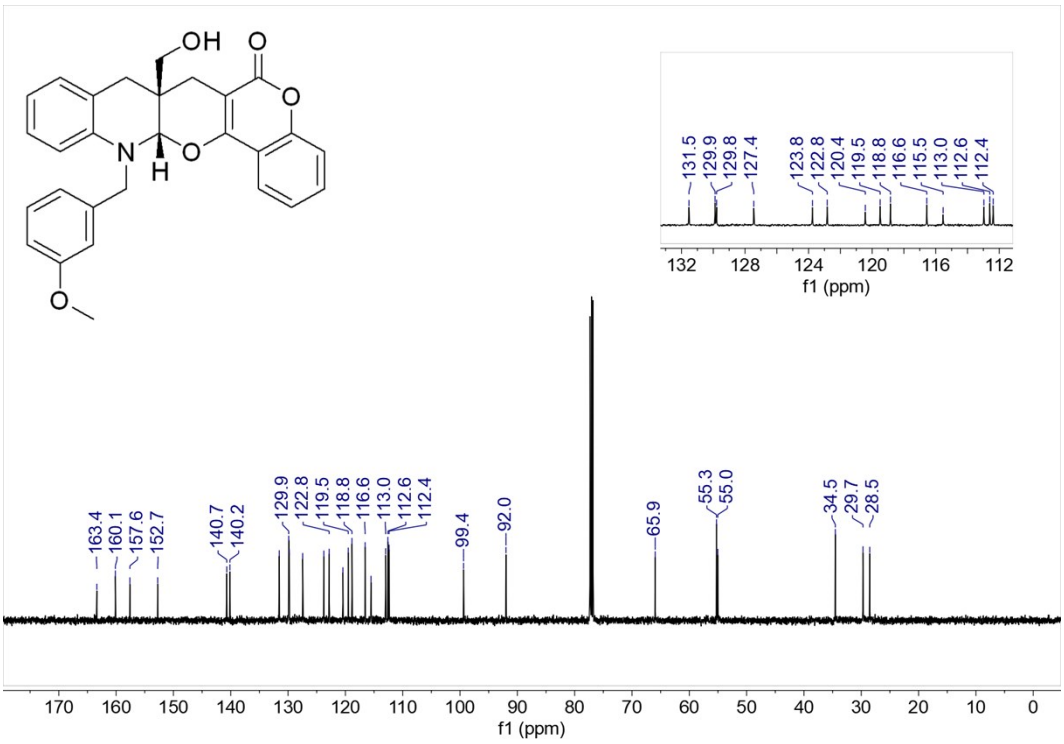
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{12}



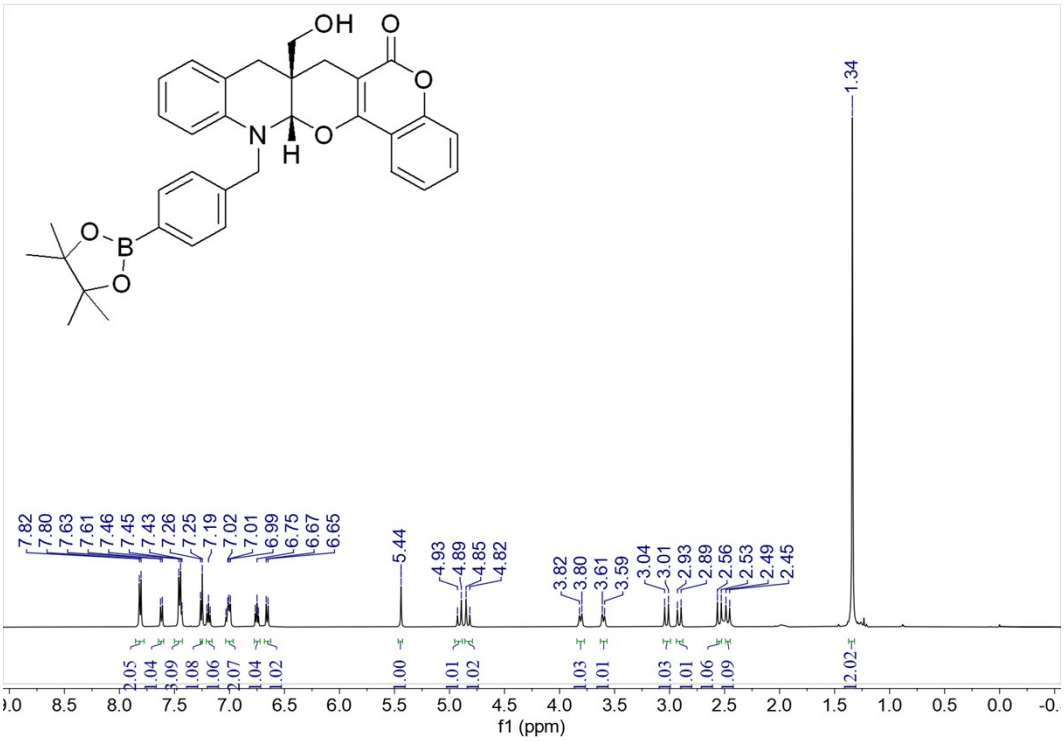
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{12}



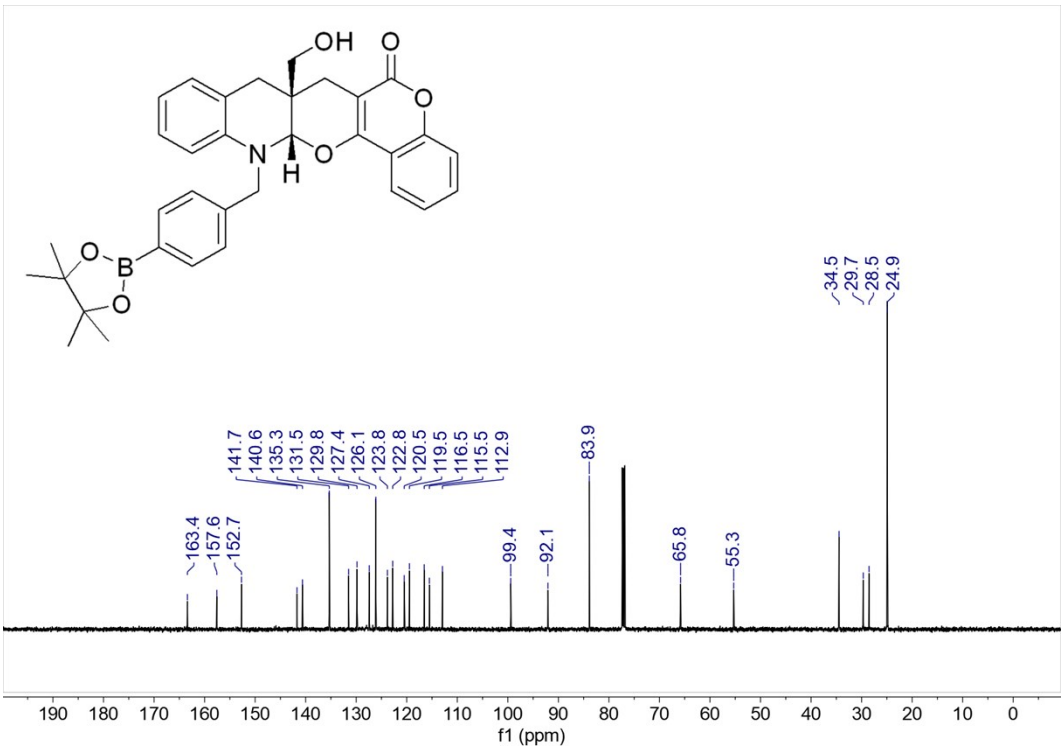
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{13}



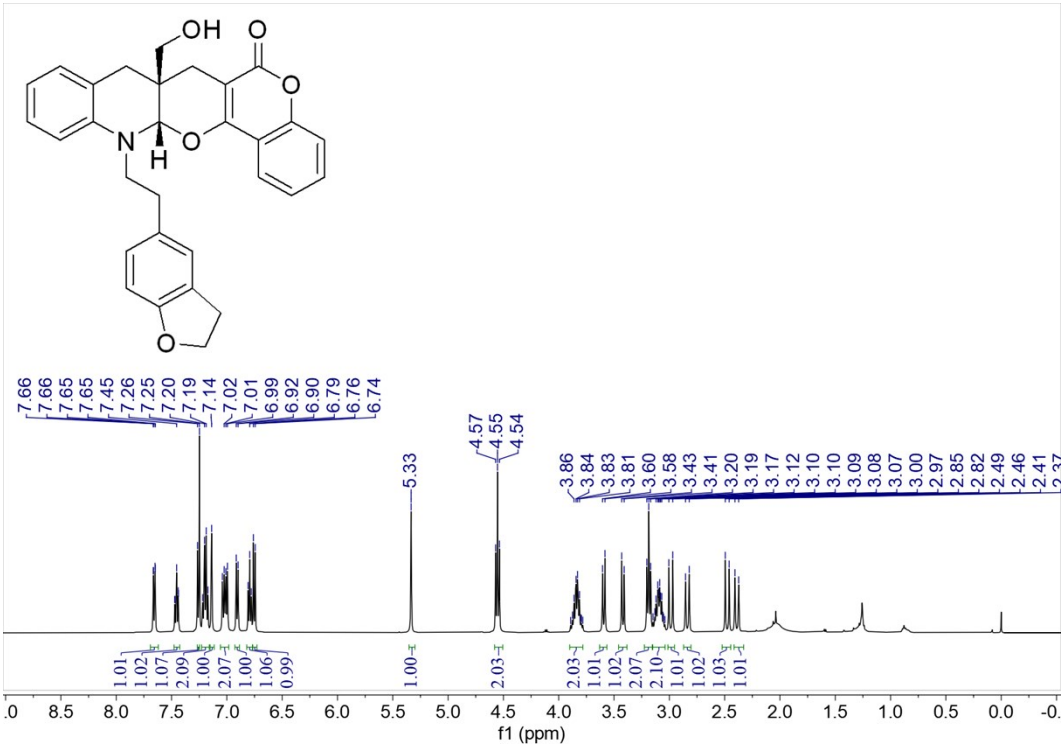
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{13}



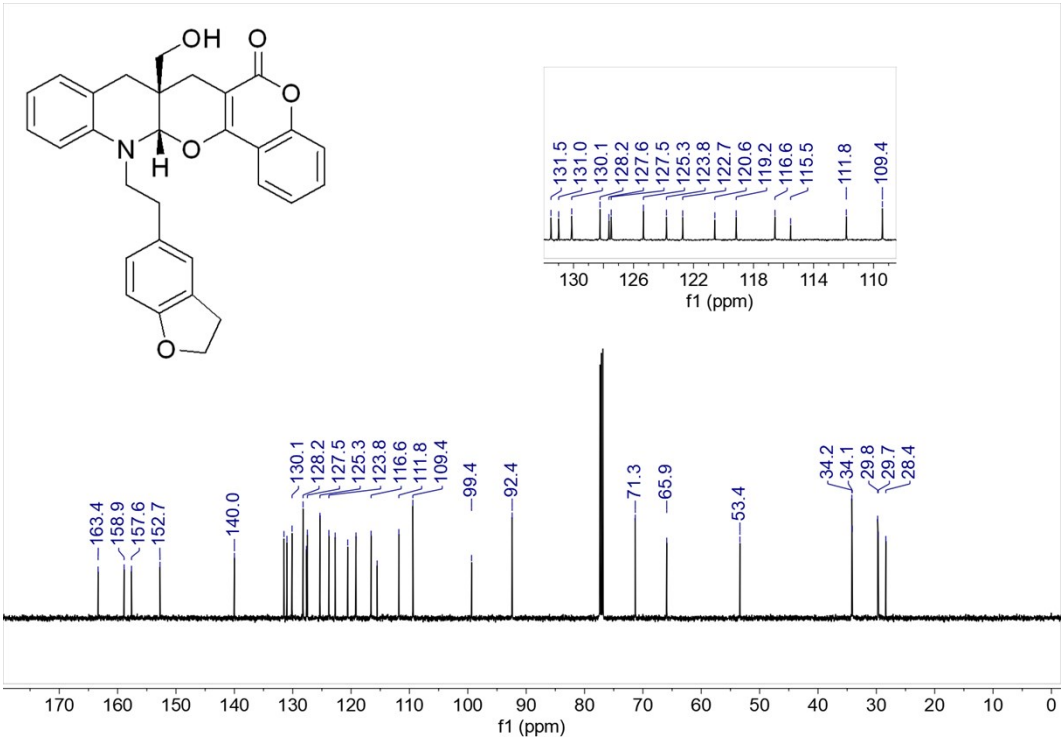
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{14}



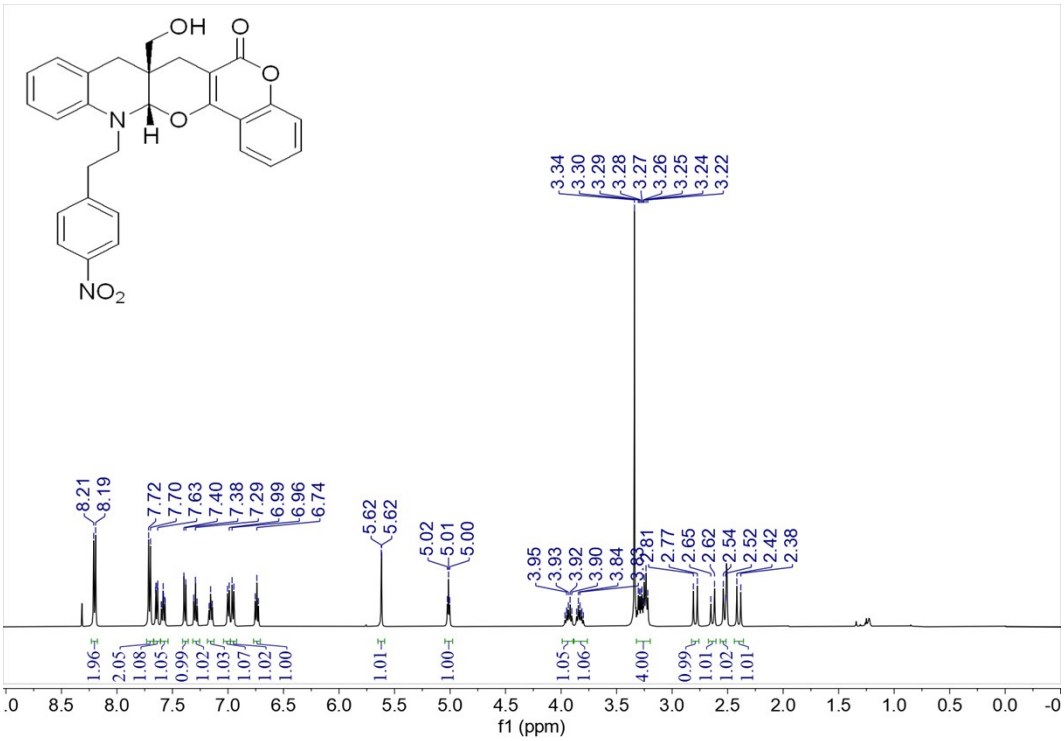
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{14}



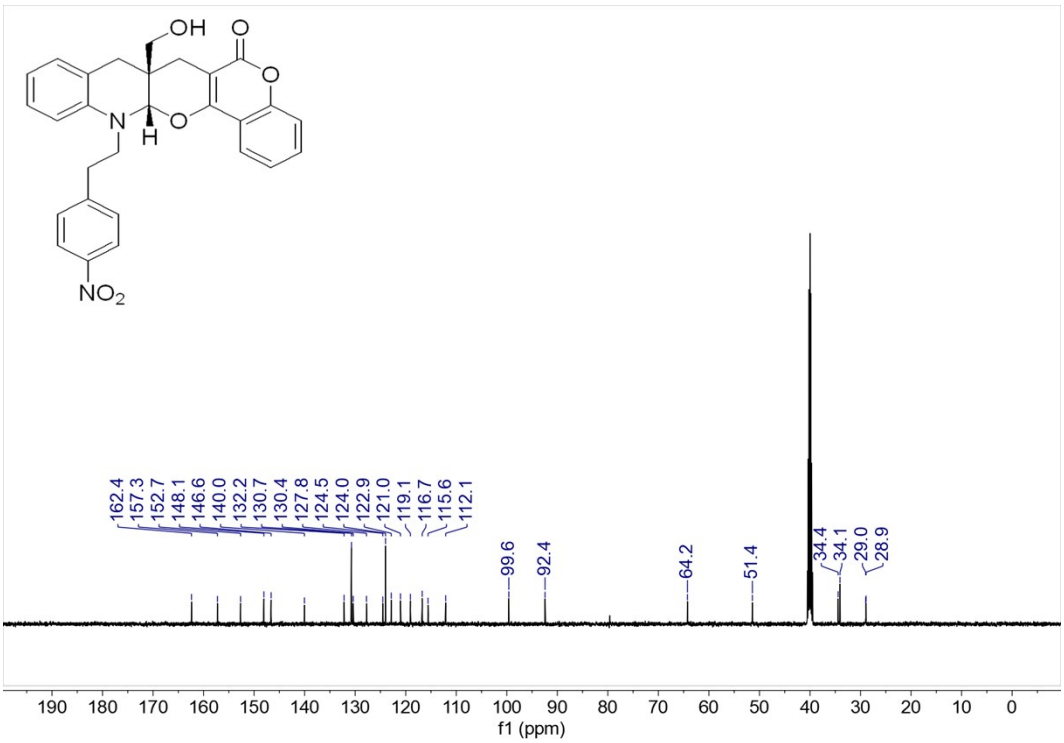
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{15}



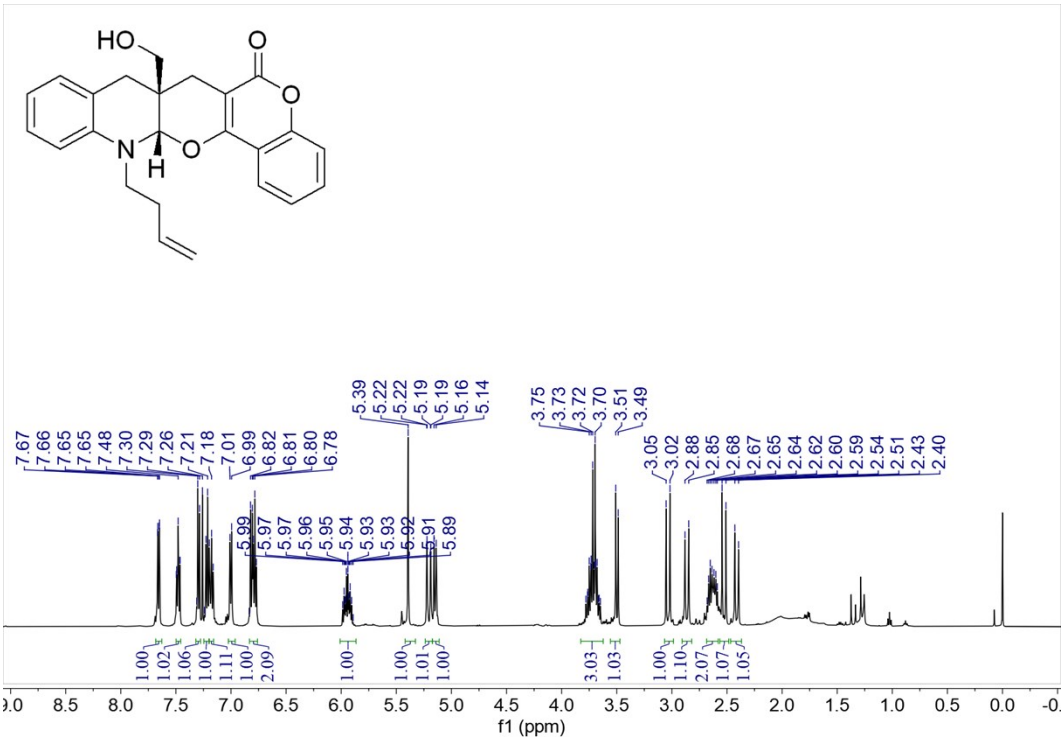
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{15}



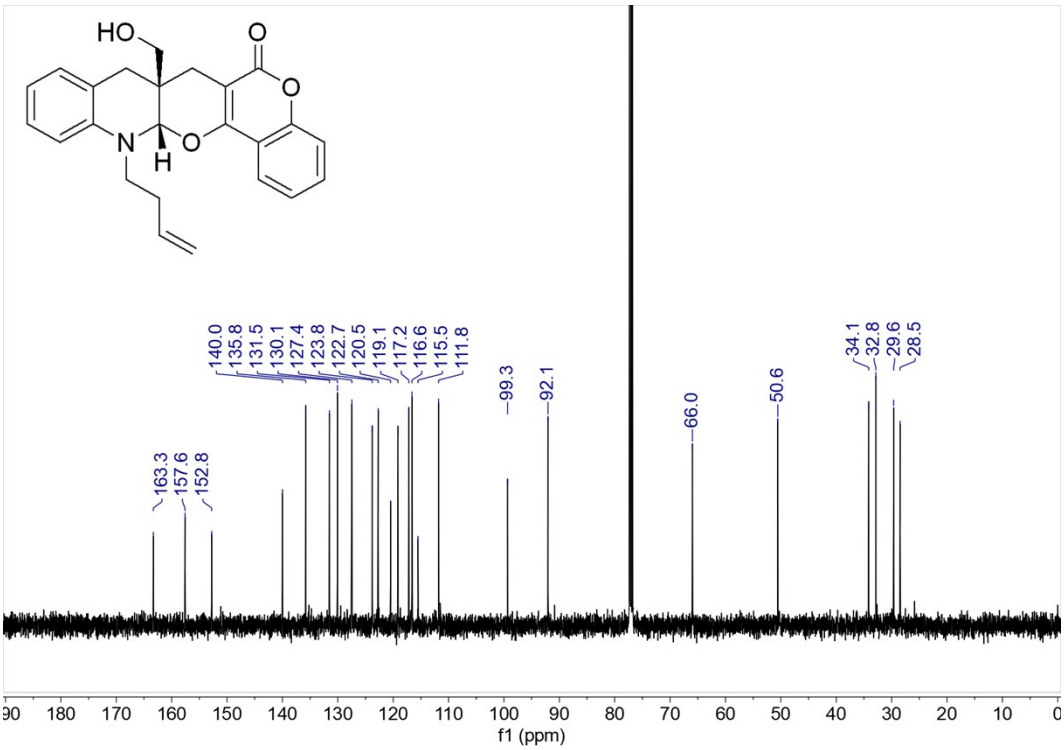
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{16}



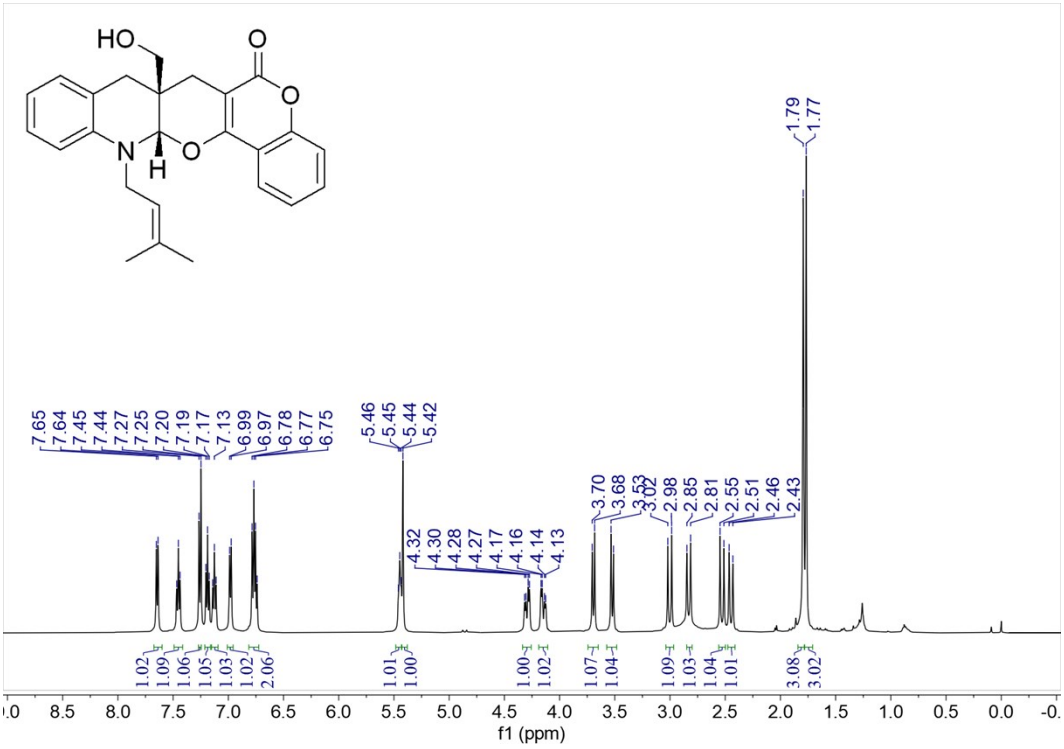
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{16}



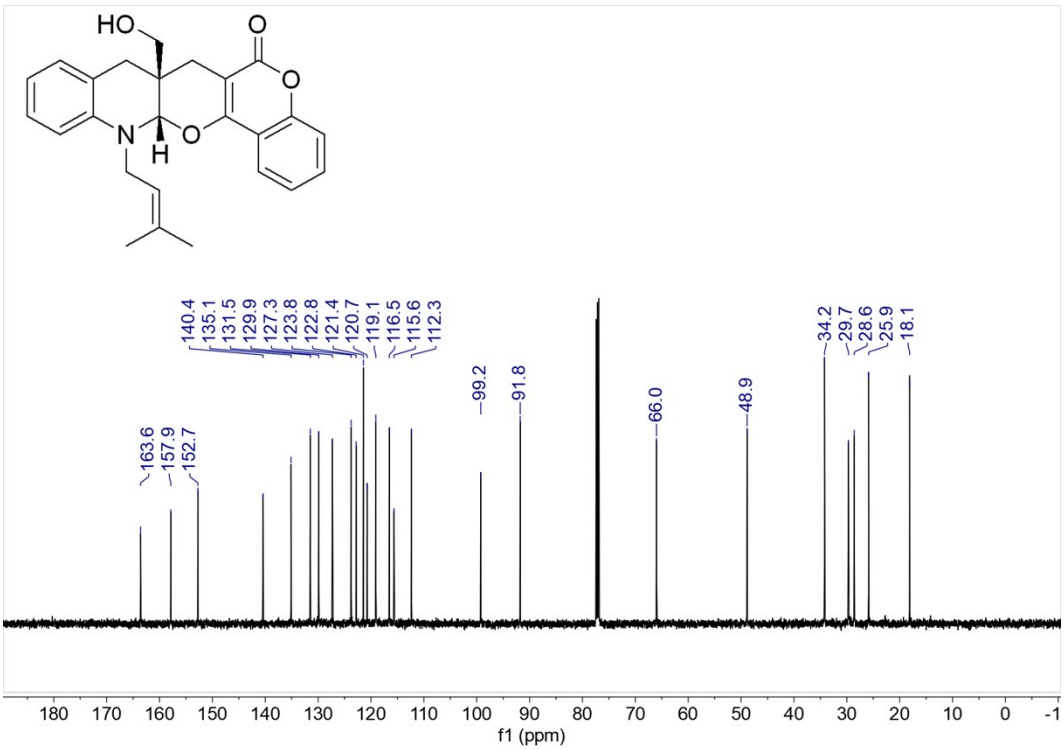
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{17}



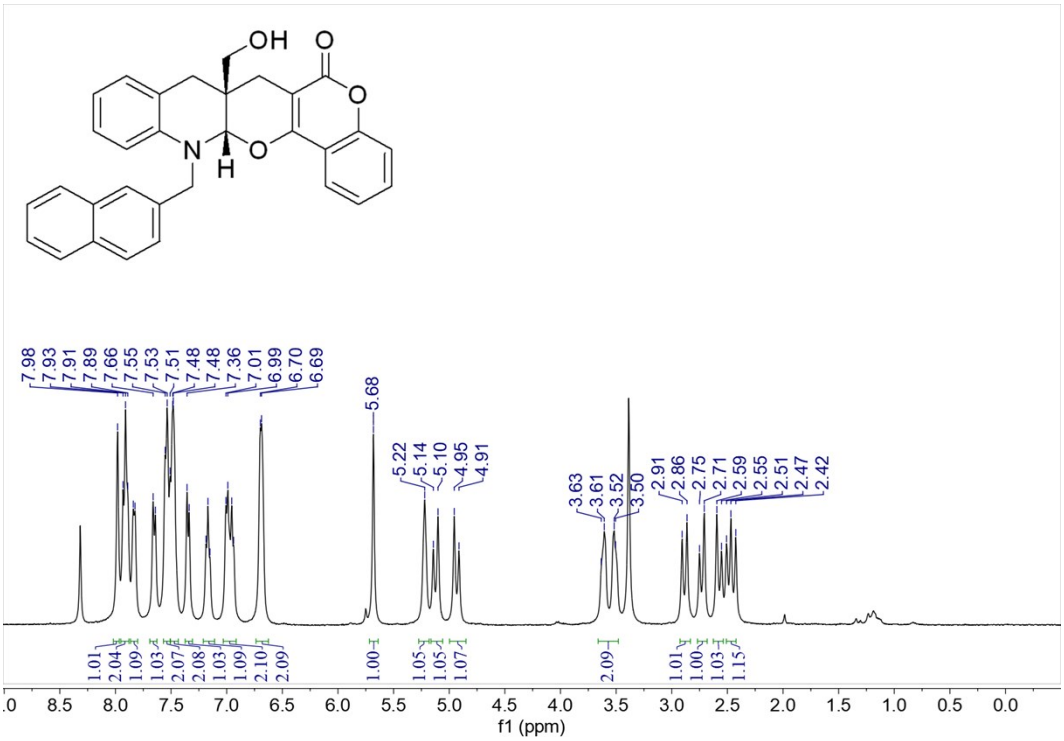
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{17}



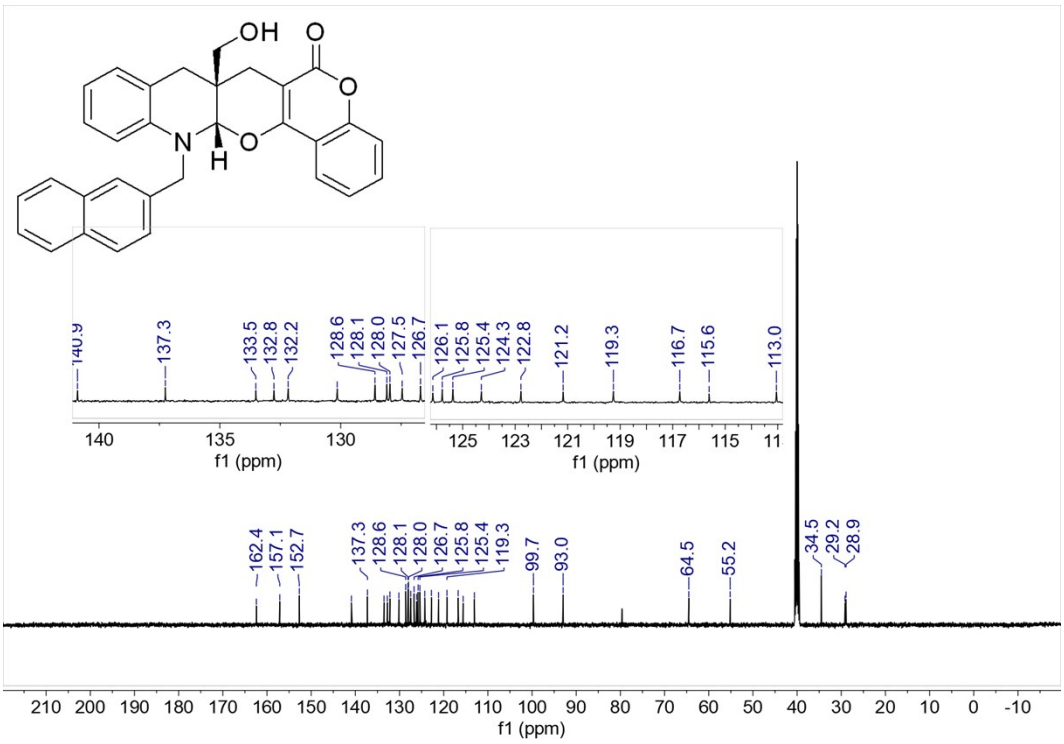
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{18}



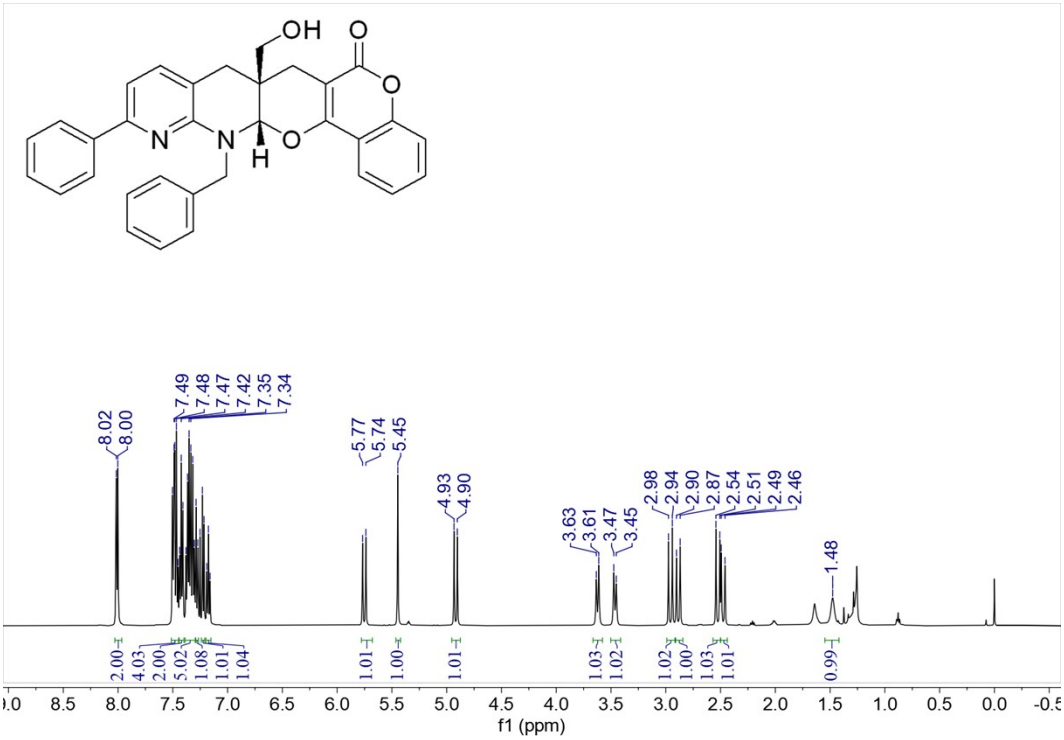
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{18}



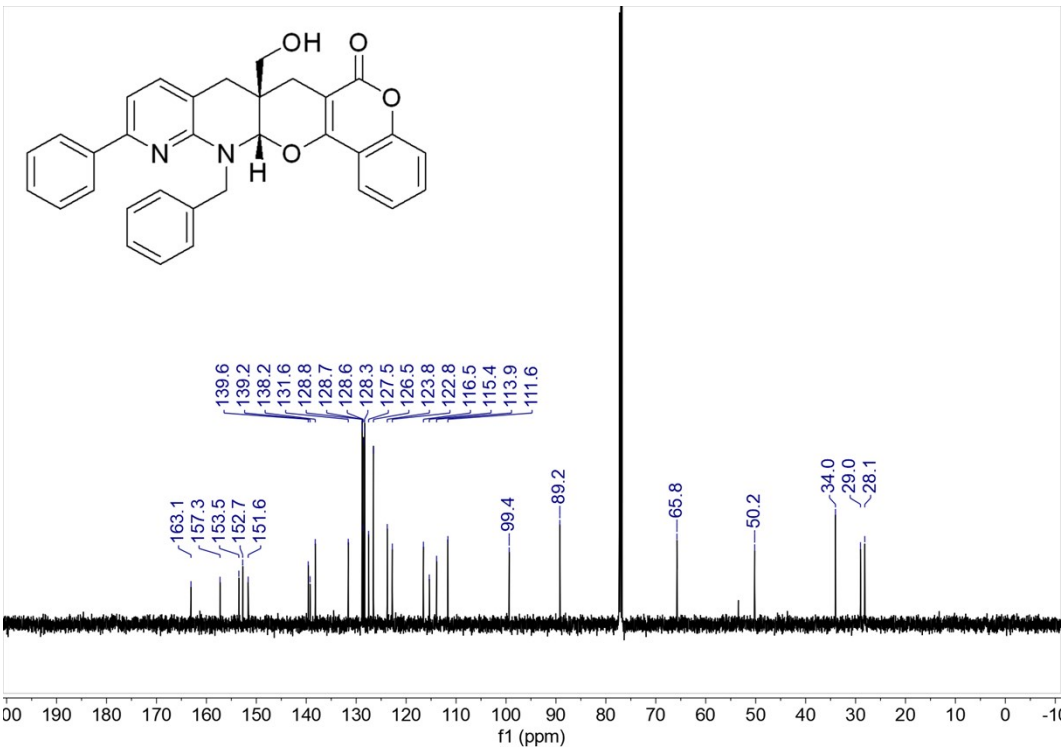
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of e$_{19}$



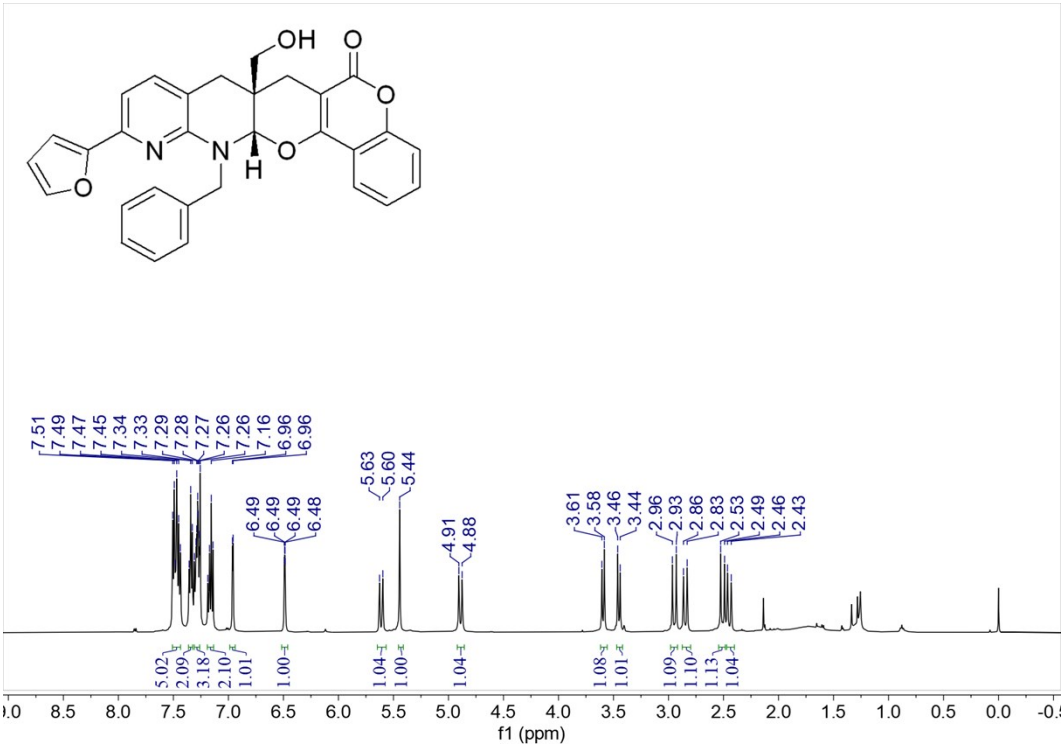
^{13}C NMR (126 MHz, DMSO-d_6) spectrum of e$_{19}$



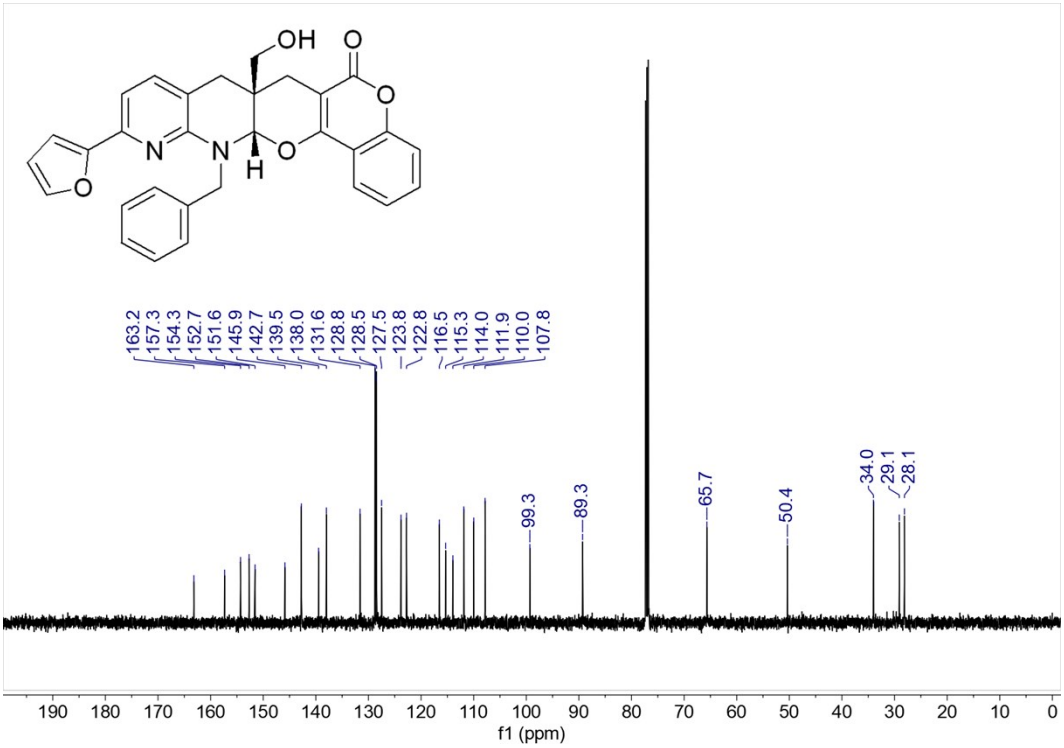
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{20}



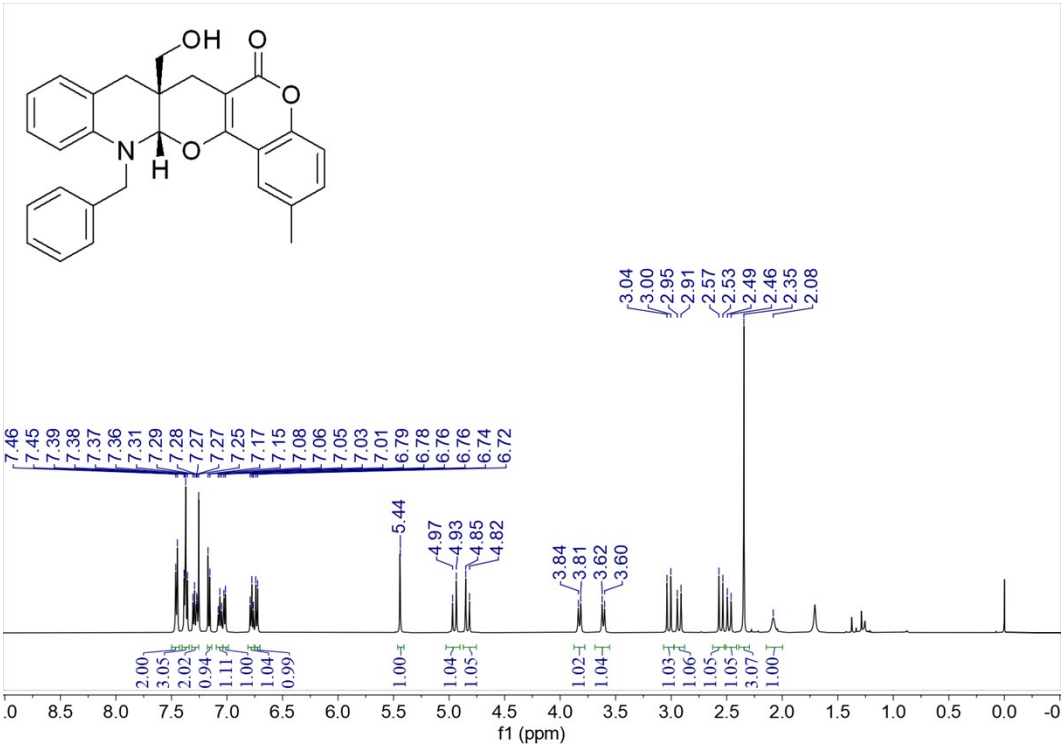
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{20}



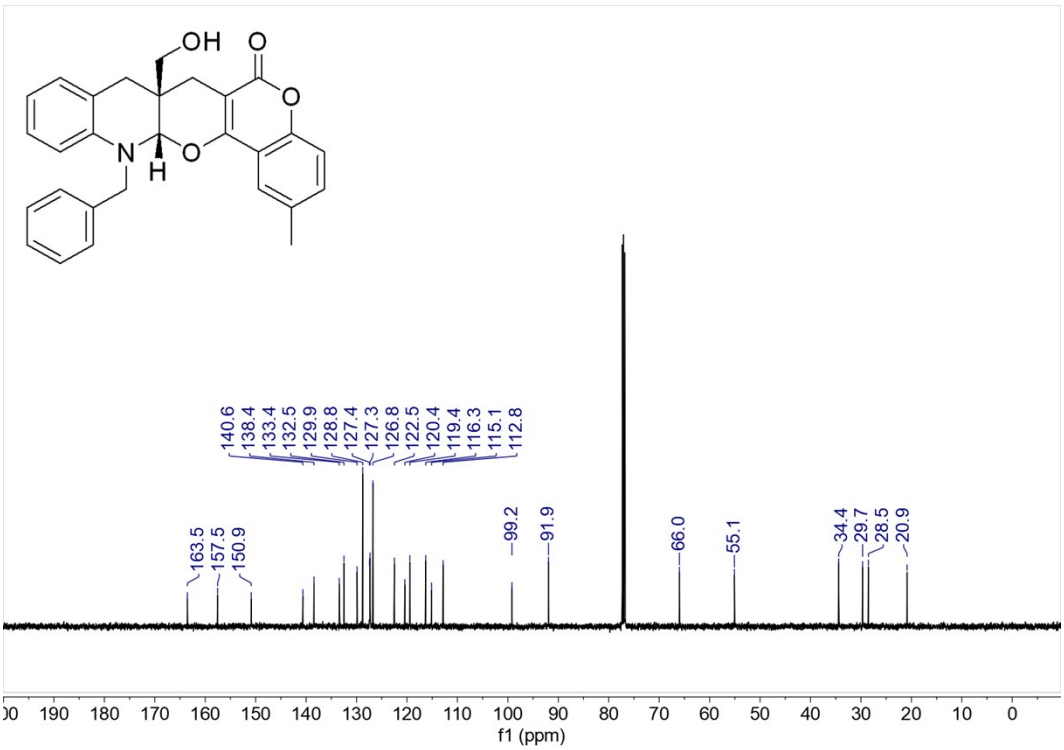
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{21}



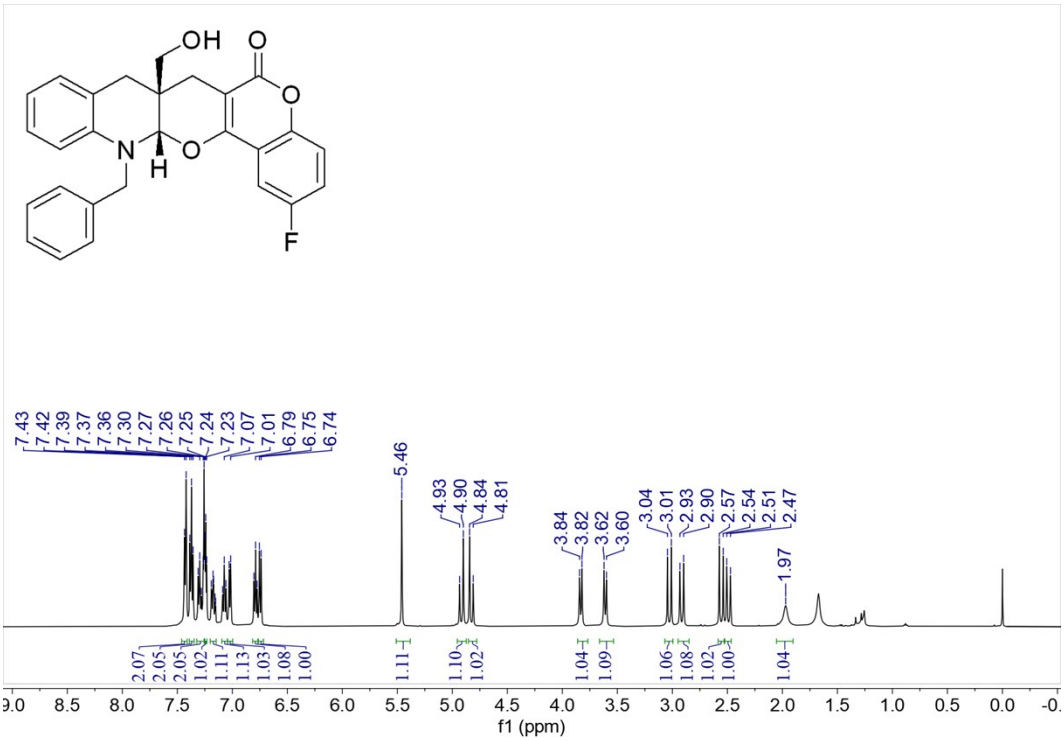
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{21}



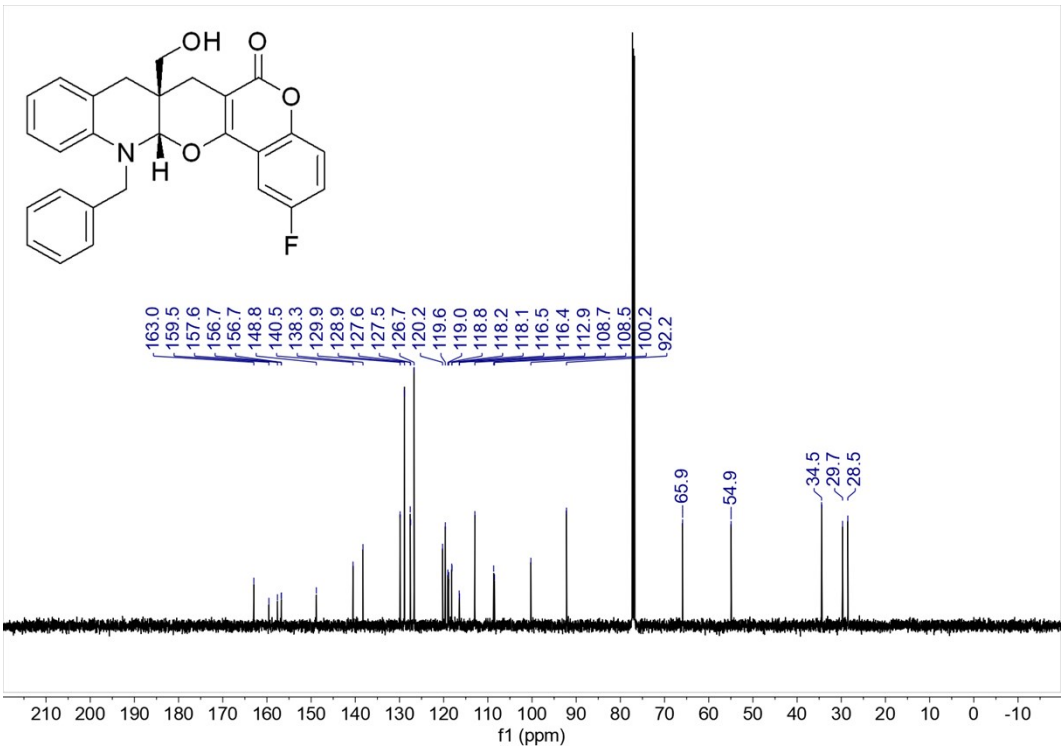
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{22}



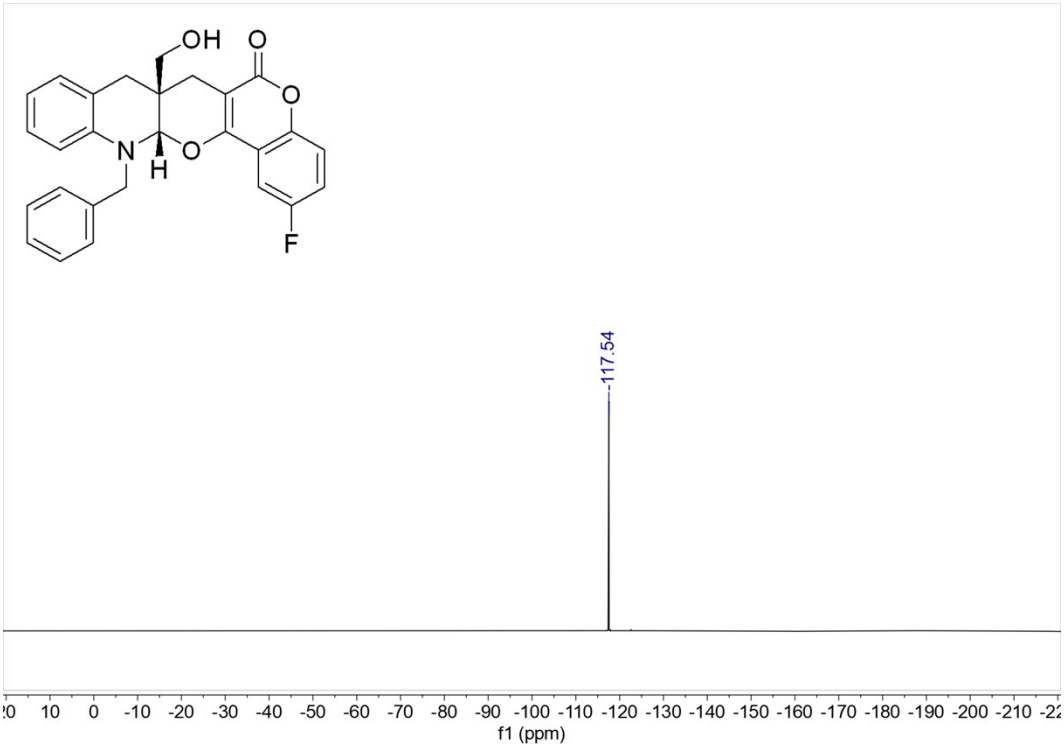
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{22}



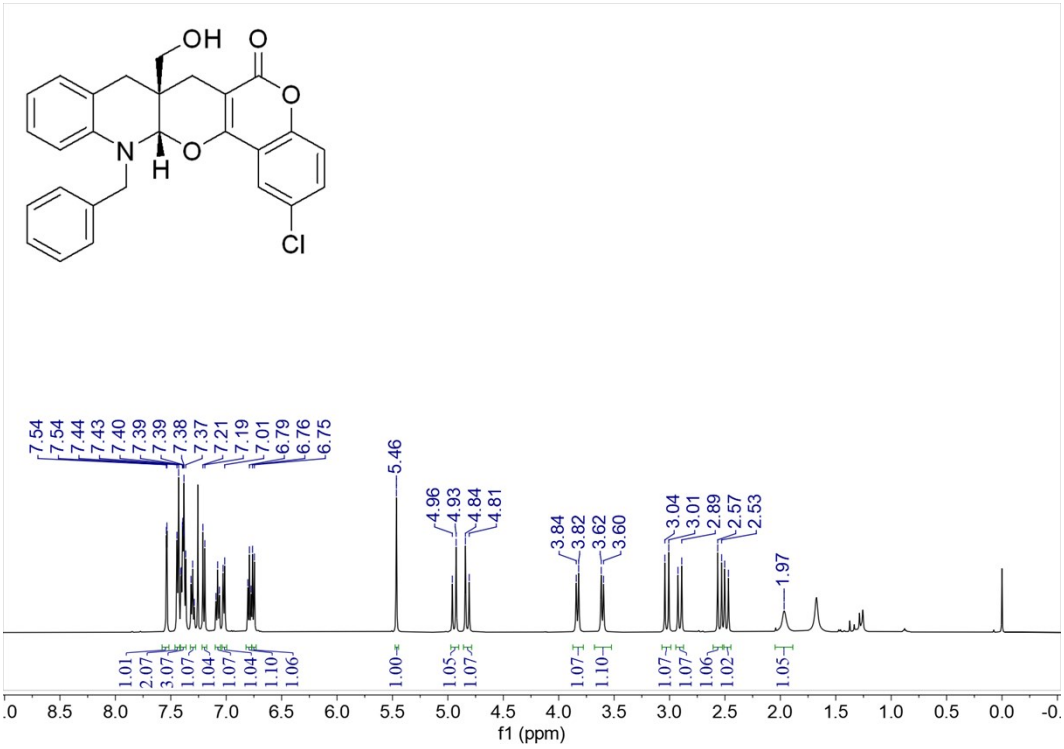
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{23}



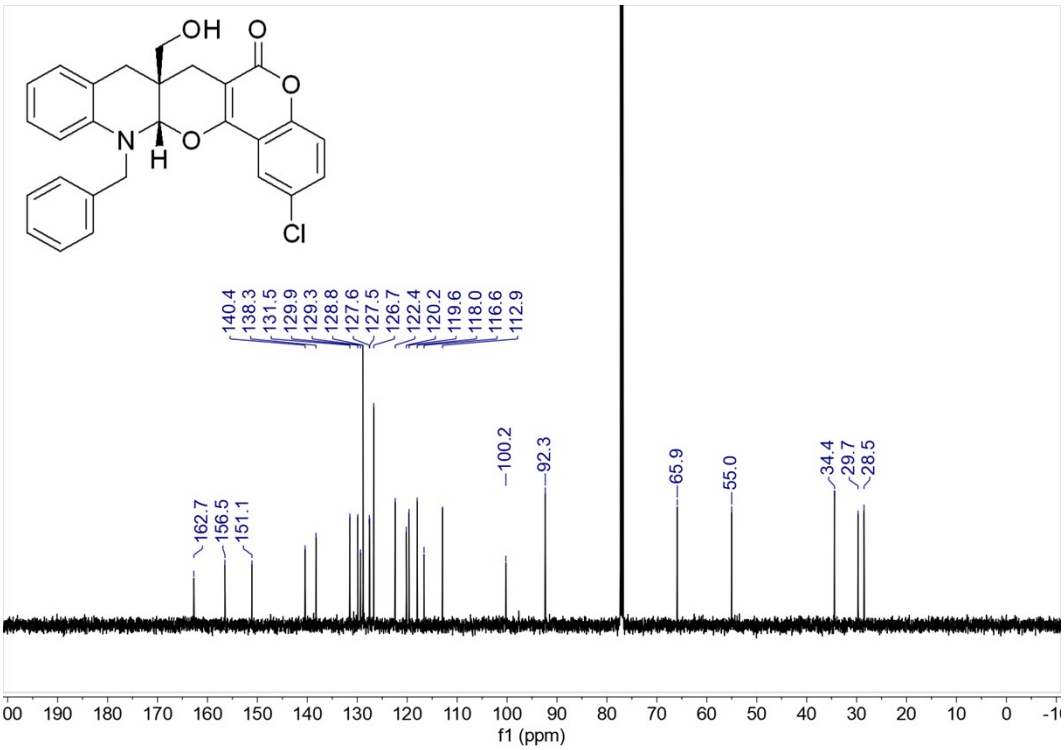
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{23}



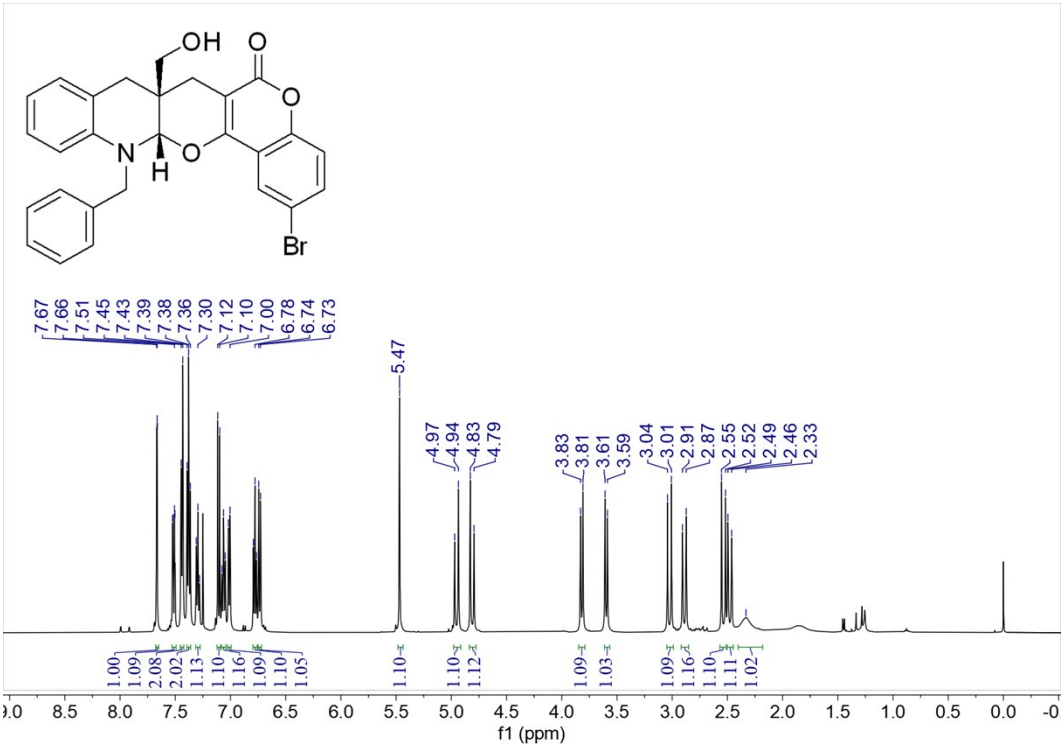
^{19}F NMR (471 MHz, $CDCl_3$) spectrum of e_{23}



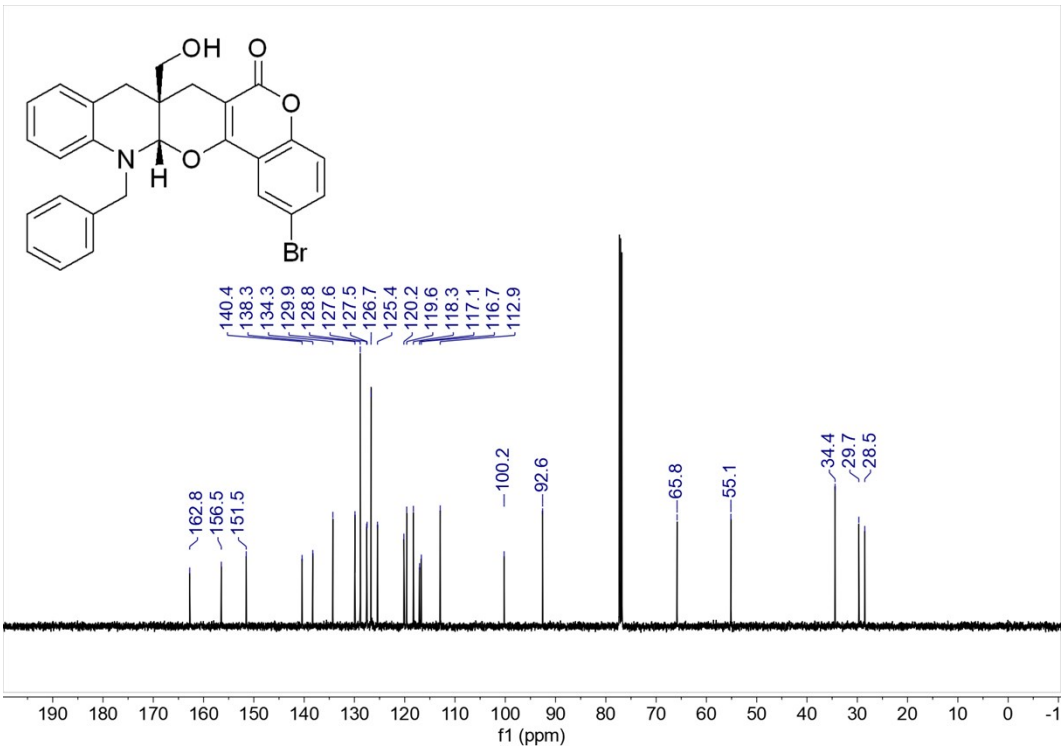
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{24}



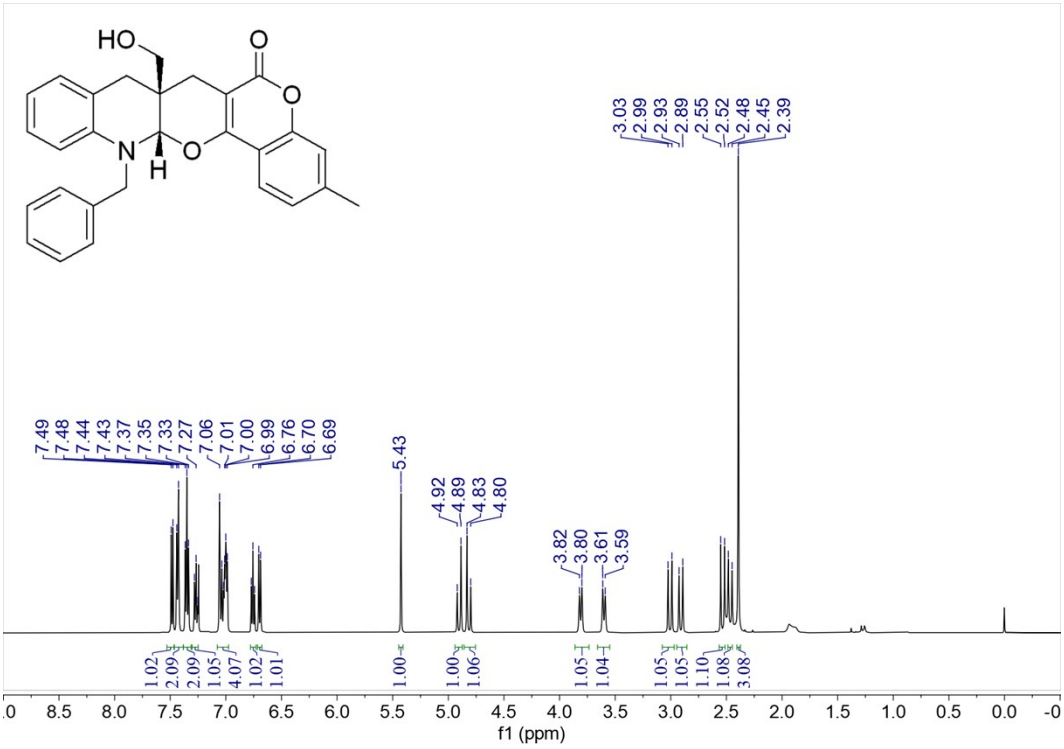
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{24}



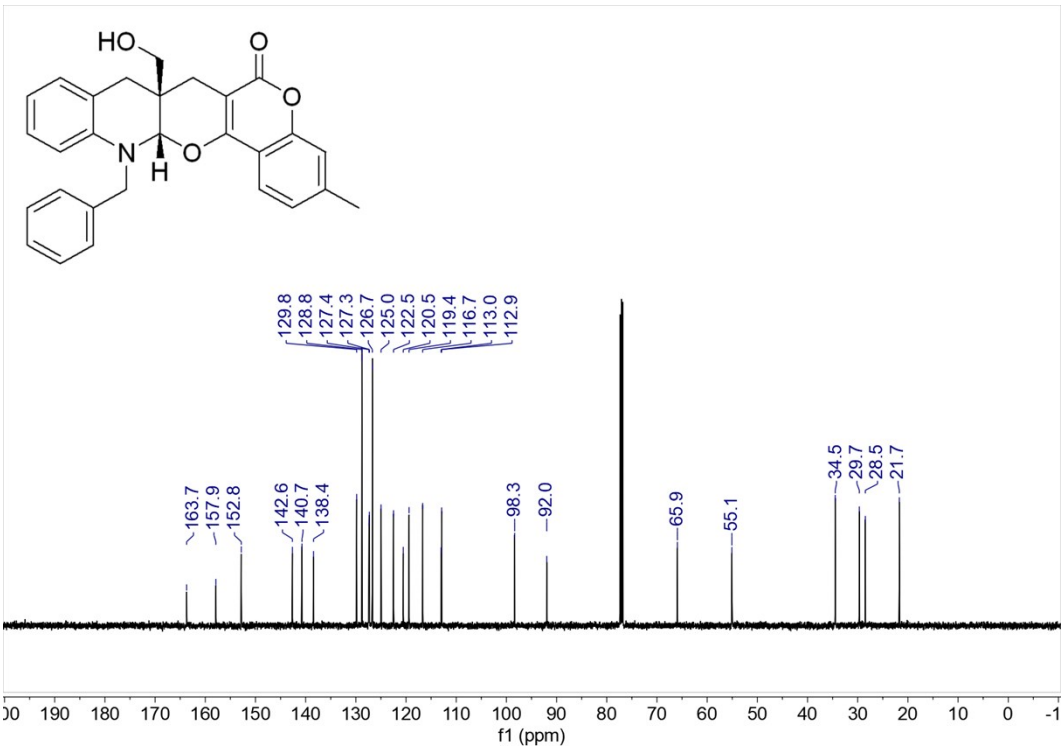
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{25}



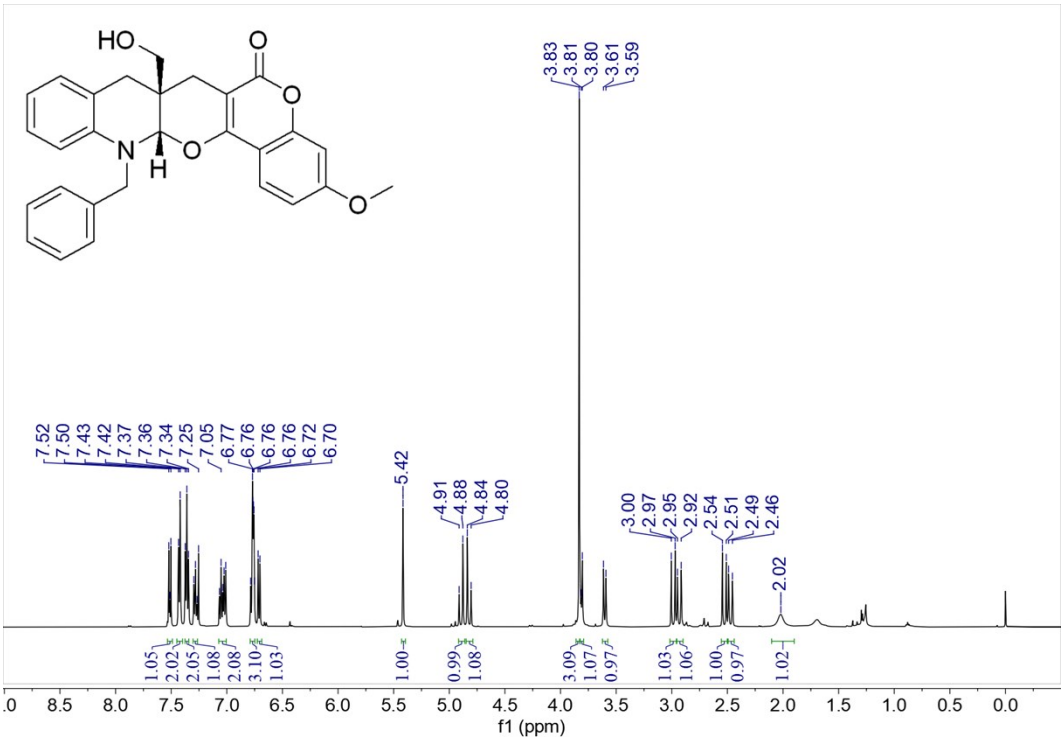
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{25}



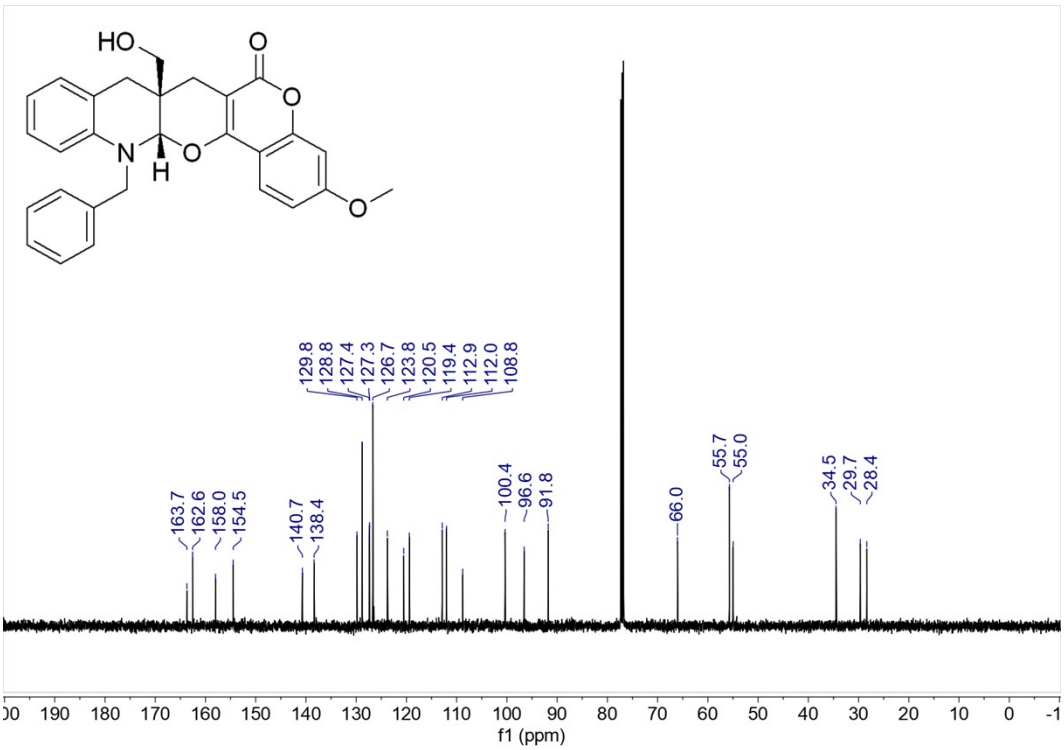
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{26}



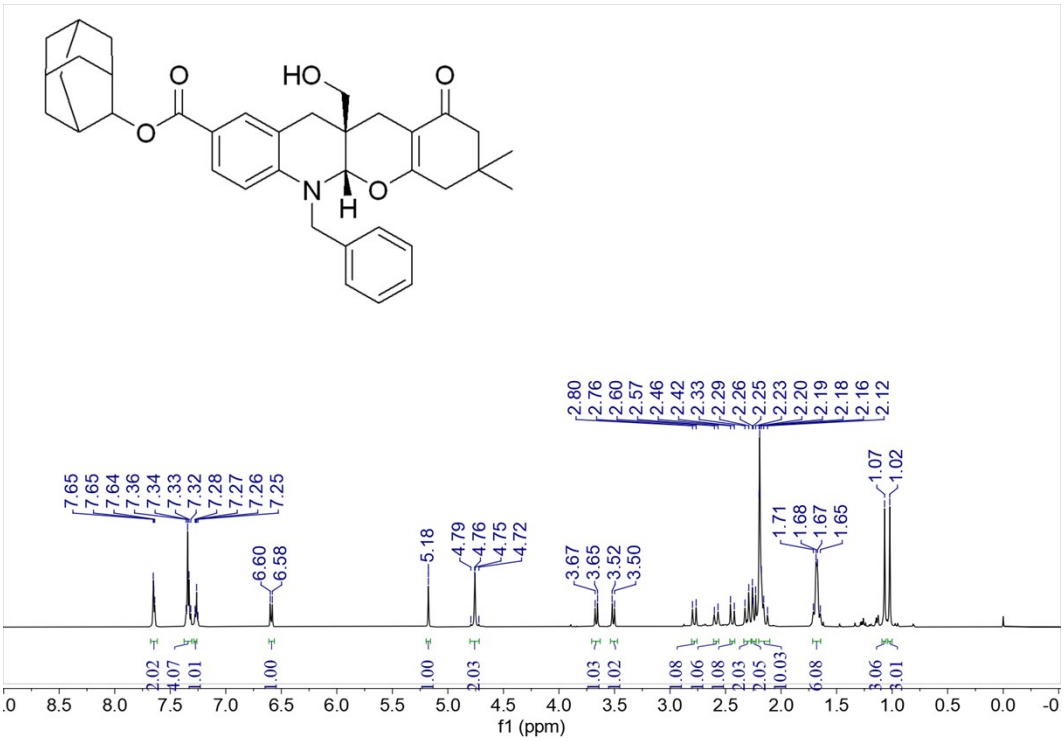
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{26}



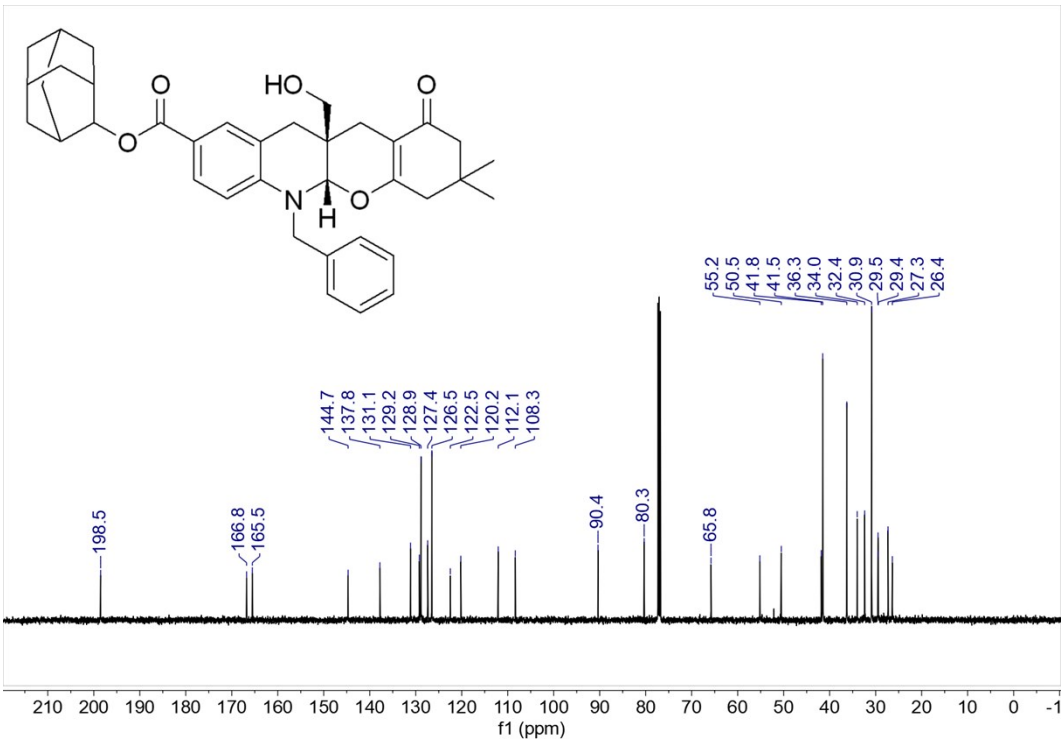
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{27}



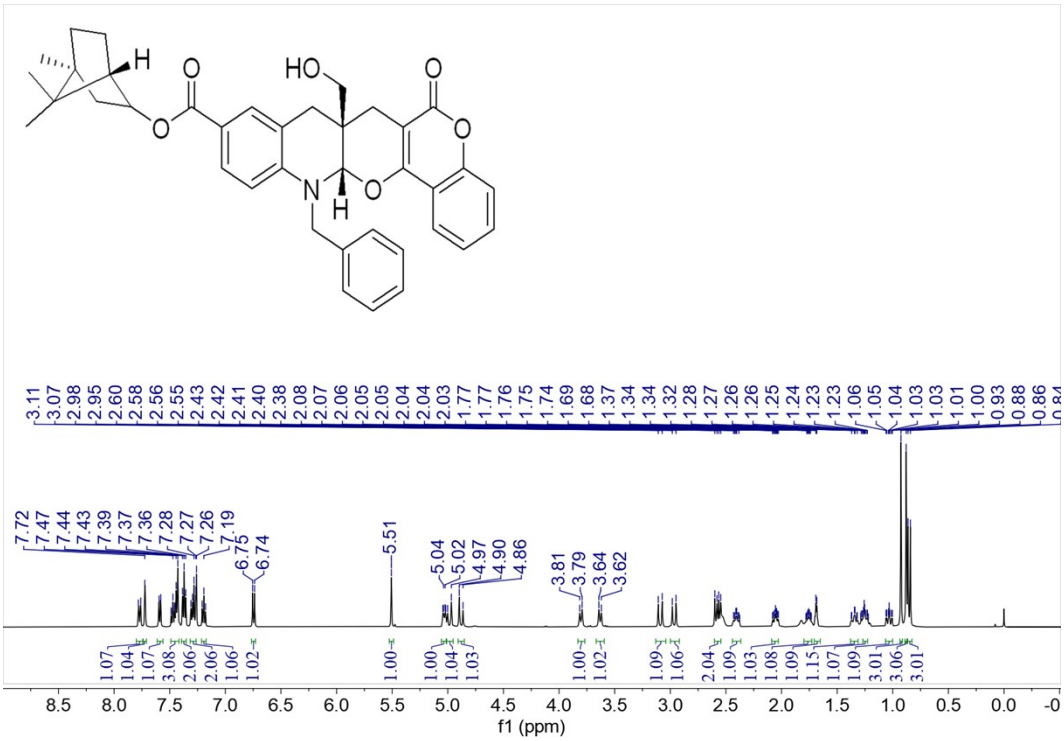
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{27}



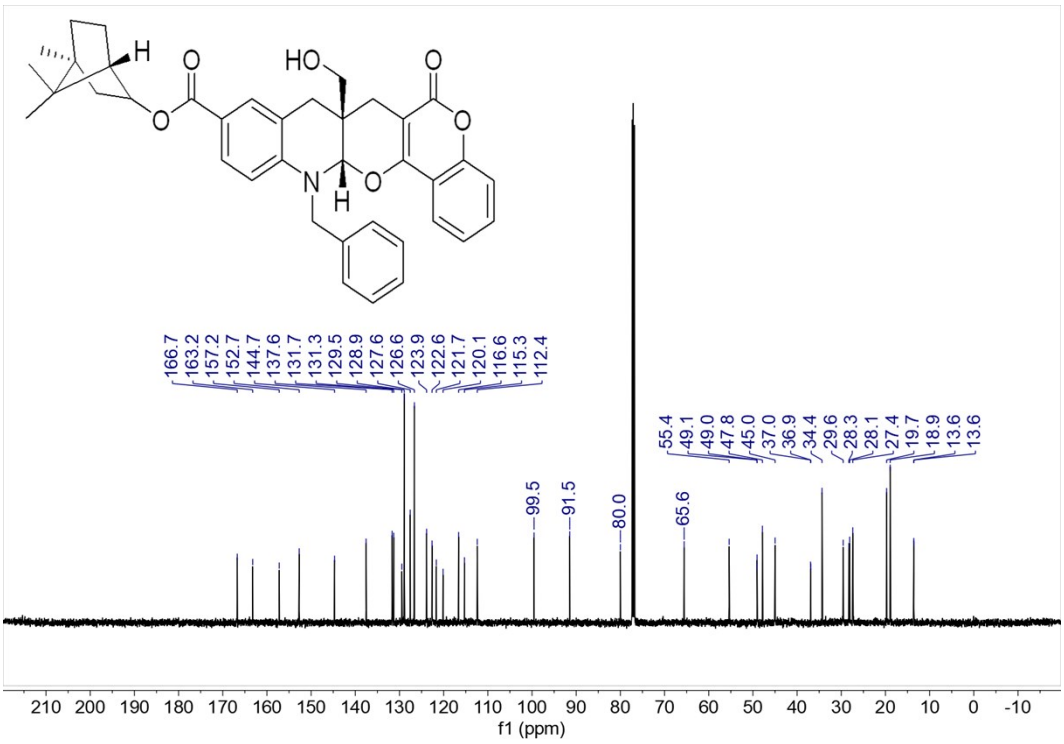
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{33}



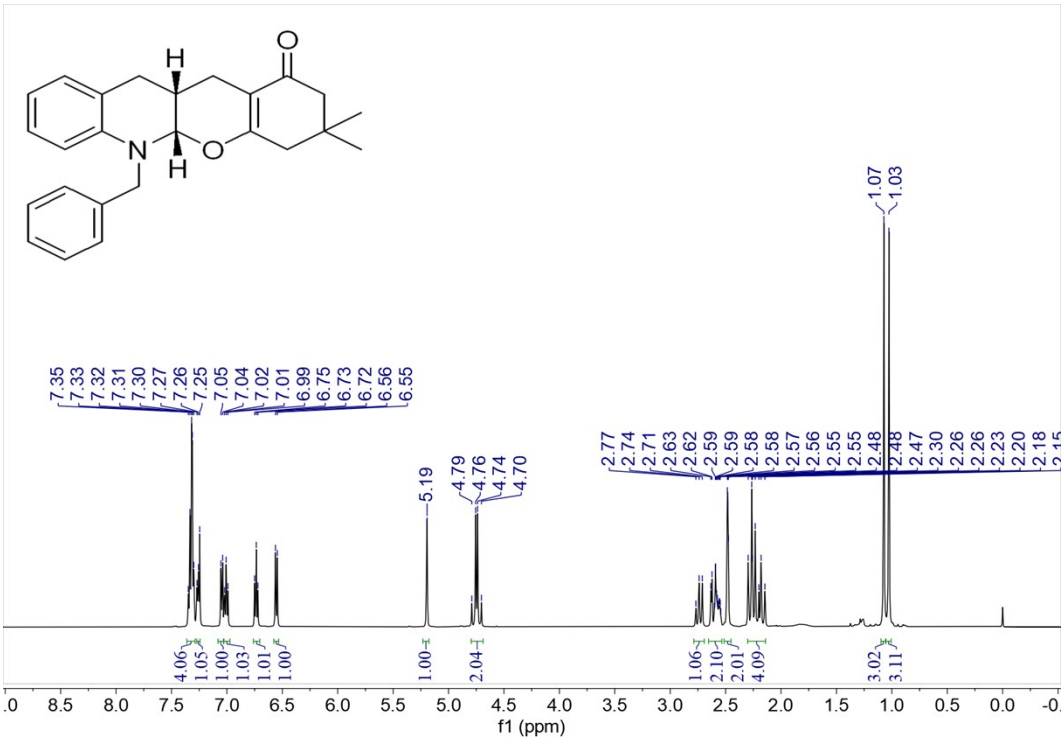
^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{33}



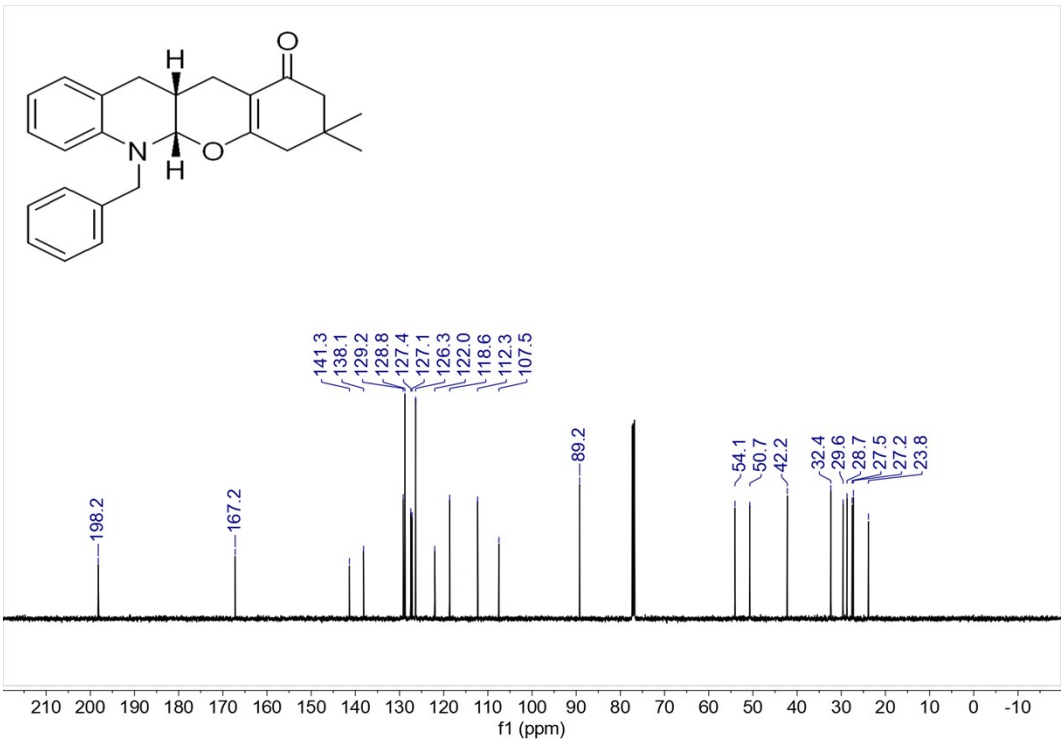
^{1}H NMR (500 MHz, $CDCl_3$) spectrum of e_{28}



^{13}C NMR (126 MHz, $CDCl_3$) spectrum of e_{28}



^{1}H NMR (500 MHz, $CDCl_3$) spectrum of c_{34}



^{13}C NMR (126 MHz, $CDCl_3$) spectrum of c_{34}

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2 Grozavu A.; Hepburn H. B.; Smith P. J., et al. Nature Chemistry, 2019, 11, 242-247.

3 Tan Z.; Ci C.; Yang J., et al. ACS Catalysis, 2020, 10(9), 5243-5249.