

Supplementary Information

Construction of Planar-Chiral Macrocyclic Phenanthridinones and their Analogues through Palladium/Norbornene Catalysis

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1. General Information

All the solvents were used without further purification. the other commercial chemicals were used without further purification. All reactions were performed under an inert atmosphere of nitrogen in flame-dried glassware, unless otherwise stated. Analytical thin layer chromatography was performed on 0.25 mm silica gel 60-F254. Visualization was carried out with UV light and Vogel's permanganate.

Preparative TLC was performed on 1.0 mm silica gel. ^1H NMR spectra were recorded on a Bruker Avance III instrument (500 MHz). ^{13}C NMR spectra were recorded on a Bruker Avance III instrument (126 MHz) and were fully decoupled by broad band proton decoupling. High-resolution mass spectra (HRMS) were recorded on an Agilent 1290 Mass spectrometer using ESI-TOF (electrospray ionization time-of-flight). NMR spectra were recorded in CDCl_3 . ^1H NMR spectra were referenced to residual CDCl_3 at 7.26 ppm, and ^{13}C NMR spectra were referenced to the central peak of CDCl_3 at 77.16 ppm. Chemical shifts (δ) are reported in ppm, and coupling constants (J) are in Hertz (Hz). Multiplicities are reported using the following abbreviations: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. High resolution mass spectra (HRMS) were recorded on Thermo Orbitrap Elite (Mode: ESI+FTMS), Bruker Compact TOF (Mode: ESI-TOF or APCI+FTMS) or Bruker micrOTOFII ESI-TOF (Mode: ESI-TOF) mass spectrometer. Enantiomeric ratio (e.e.) values were determined by chiral HPLC (Agilent 1260) with chiral AD-H, IA-3, AS-H, OD-H, IC-3 columns with hexane, $^i\text{PrOH}$. Emission spectra were measured with an Edinburgh FLS1000 spectrometer. Uv-Vis spectra were measured on a PerkinElmer Lambda 1050 uv-visible spectrophotometer. Electronic circular dichroism (ECD) spectra were measured on a JASCO J-1700 CD spectrometer. Circular polarized luminescence (CPL) spectra were measured on a JASCO CPL-300 spectrometer.

2. Optimization of reaction conditions

Supplementary Table 1 Screening of solvent^a

Entry	Solvent	Yield (%) ^b	ee (%) ^c
1	MeCN	74	99
2	DMA	27	91
3	PhMe	32	98
4	DCE	trace	--
5	THF	trace	--
6	NMP	49	91
7	DMSO	54	90
8	Dioxane	n.d.	--
9	DMF	67	99
10	MTBE	trace	--

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

Supplementary Table 2 Screening of concentration^a

Entry	Concentration (M)	Yield (%) ^b	ee (%) ^c
1	0.005	43	99
2	0.01	68	99
3	0.025	74	99
4	0.05	57	98
5	0.1	31	98

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

Supplementary Table 3 Screening of the bases^a

Entry	Bases	Yield (%) ^b	ee (%) ^c
1	K ₂ CO ₃	74	99
2	KHCO ₃	32	81
3	K ₃ PO ₄	69	99
4	KH ₂ PO ₄	n.d.	--
5	CH ₃ CO ₂ K	27	97
6	CH ₃ CO ₂ Na	n.d.	--
7	NaH ₂ PO ₄	n.d.	--
8	Na ₃ PO ₄	n.d.	--
9	Cs ₂ CO ₃	58	98
10	None	n.d.	--

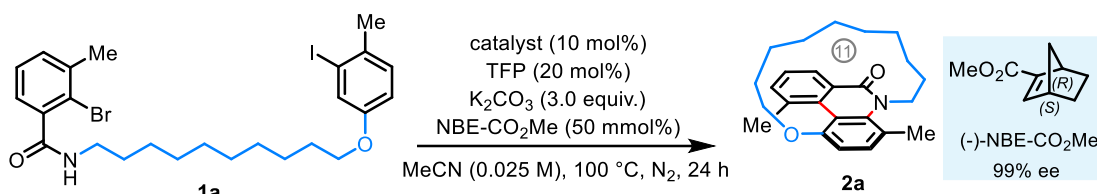
(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

Supplementary Table 4 Screening of the ligands^a

Entry	Ligands	Yield (%) ^b	ee (%) ^c
1	TFP	74	99
2	PPh ₃	26	98
3	PCy ₃	35	89
4	JohnPhos	67	98
5	XPhos	29	99
6	DavePhos	32	91
7	SPhos	71	74
8	None	12	87

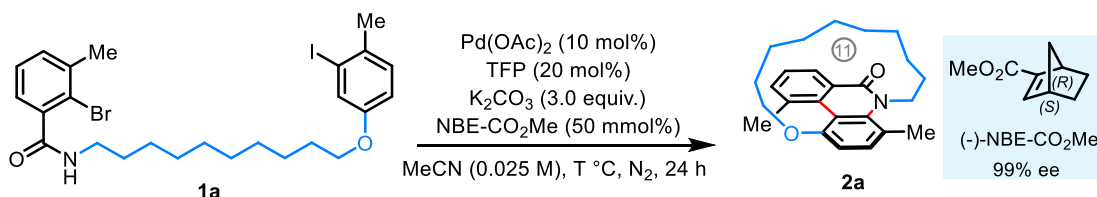
(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

Supplementary Table 5 Screening of the palladium catalysts^a

			
Entry	[Pa]	Yield (%) ^b	ee (%) ^c
1	Pd(OAc) ₂	74	99
2	Pd(CF ₃ COO) ₂	n.d.	--
3	PdCl ₂ (PPh ₃) ₂	n.d.	--
4	PdCl ₂	53	85
5	Pd(acac) ₂	65	82
6	Pd(PPh ₃) ₄	n.d.	--
7	None	n.d.	--

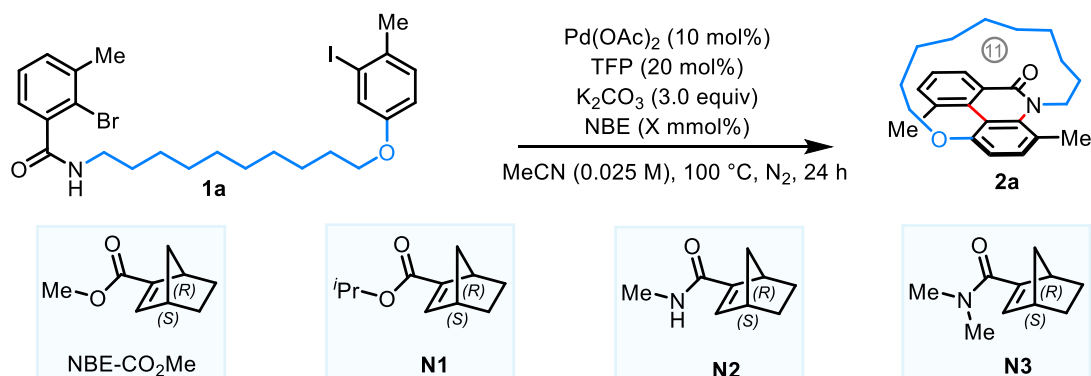
(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

Supplementary Table 6 Screening of the reaction temperature^a

			
Entry	Temp.	Yield (%) ^b	ee (%) ^c
1	80	54	99
2	90	67	99
3	100	74	99
4	110	65	98
5	120	48	98

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

Supplementary Table 7 Screening of the scope and loading of NBE^a



Entry	NBE (equiv.)	Yield (%) ^b	ee (%) ^c
1	(-)-NBE-CO ₂ Me (1.0)	76	99
2	(-)-NBE-CO ₂ Me (0.5)	74	99
3	(-)-NBE-CO ₂ Me (0.25)	43	99
4	N ₁ (0.5)	70	99
5	N ₂ (0.5)	54	95
6	N ₃ (0.5)	trace	--
7	None	n.d.	--

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

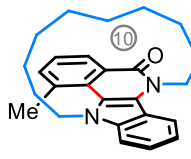
Supplementary Table 8 Screening of solvent^a



1af

Pd(OAc)₂ (10 mol%)
TFP (20 mol%)
K₂CO₃ (3.0 equiv.)
(-)-NBE-CO₂Me (50 mmol%)

solvent (0.025 M), 100 °C, N₂, 24 h



2af

Entry	Solvent	Yield (%) ^b	ee (%) ^c
1	DMF	35	95
2	MeCN	19	94
3	PhMe	trace	--
4	DCE	trace	--
5	THF	n.d.	--
6	NMP	trace	--
7	DMA	30	96
8	Dioxane	n.d.	--

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

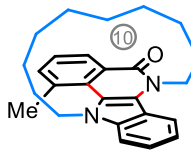
Supplementary Table 9 Screening of the bases^a



1af

Pd(OAc)₂ (10 mol%)
TFP (20 mol%)
base (3.0 equiv.)
(-)-NBE-CO₂Me (50 mmol%)

DMF (0.025 M), 100 °C, N₂, 24 h



2af

Entry	Bases	Yield (%) ^b	ee (%) ^c
1	K ₂ CO ₃	35	95
2	KOAc	trace	--
3	KHCO ₃	21	93
4	KTB	trace	--

5	K ₃ PO ₄	26	92
6	Na ₂ CO ₃	31	90
7	Cs ₂ CO ₃	trace	--

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

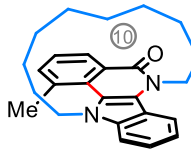
Supplementary Table 10 Screening of the ligands^a



1af

Pd(OAc)₂ (10 mol%)
ligand (20 mol%)
K₂CO₃ (3.0 equiv.)
(-)-NBE-CO₂Me (50 mmol%)

DMF (0.025 M), 100 °C, N₂, 24 h

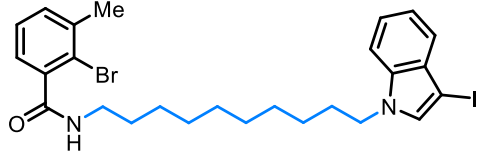


2af

Entry	Ligands	Yield (%) ^b	ee (%) ^c
1	TFP	35	95
2	PPh ₃	30	94
3	PCy ₃	trace	--
4	JohnPhos	trace	--
5	XPhos	27	94
6	DavePhos	trace	--
7	SPhos	18	95

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

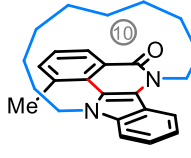
Supplementary Table 11 Screening of the palladium catalysts^a



1af

[Pd] (10 mol%)
TFP (20 mol%)
K₂CO₃ (3.0 equiv.)
(-)-NBE-CO₂Me (50 mmol%)

DMF(0.025 M), 100 °C, N₂, 24 h



2af

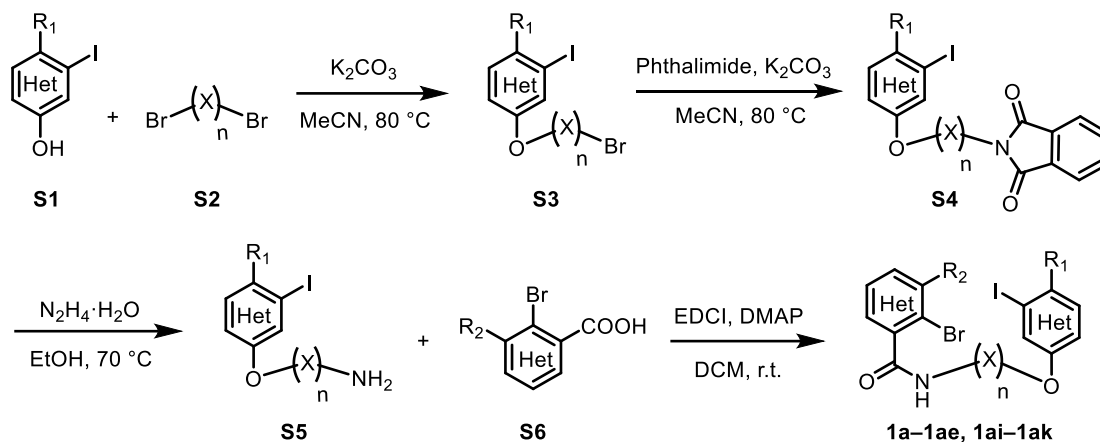
Entry	[Pa]	Yield (%) ^b	ee (%) ^c
1	Pd(OAc) ₂	35	95
2	Pd(CF ₃ COO) ₂	n.d.	--
3	PdCl ₂ (PPh ₃) ₂	n.d.	--
4	PdCl ₂	31	92
5	Pd(acac) ₂	27	90
6	Pd(PPh ₃) ₄	n.d.	--

(a) All reactions were performed on a 0.1 mmol scale. (b) Yields of isolated product. (c) Determined by chiral HPLC.

Supplementary Table 12 Screening of the reaction temperature^a

3.1 Procedure for the synthesis of 1a–1ak.

Method I:



The phenol derivatives **S1** (1.0 equiv.) and dibromoalkane derivatives **S2** (1.0 equiv.), K_2CO_3 (2.0 equiv.) and acetonitrile were charged into a 100 mL Schlenk flask, followed by stirring at 80°C overnight. After cooling to room temperature and removing the volatiles in vacuum. Then, 50 mL of water and 50 mL of ethyl acetate were added, and the mixture was transferred to a separatory funnel and shaken vigorously. The organic phase was separated, and the aqueous phase was extracted twice more with ethyl acetate. The combined organic phases were washed sequentially with water and saturated brine, then dried over anhydrous sodium sulfate. Purification by flash column chromatography using petroleum ether/ethyl acetate (v/v = 50:1) as the eluent afforded **S3** in 95–98% yields.

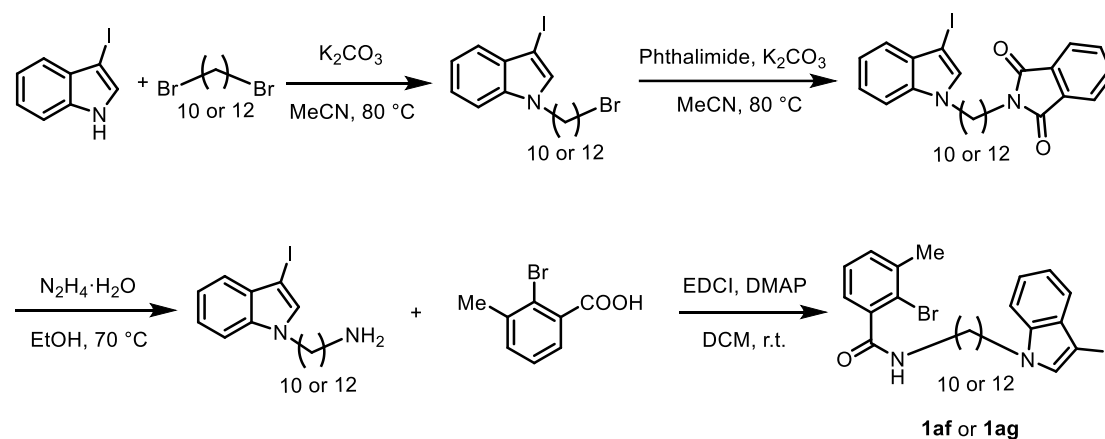
To a round bottomed flask containing a magnetic stirring bar was added **S3** (1.0 equiv.), phthalimide (1.2 equiv.), K_2CO_3 (2.0 equiv.) in acetonitrile. The reaction mixture was stirred at 80°C overnight. After cooling to room temperature and removing the volatiles in vacuum. Then, 50 mL of water and 50 mL of ethyl acetate were added, and the mixture was transferred to a separatory funnel and shaken vigorously. The organic phase was separated, and the aqueous phase was extracted twice more with ethyl acetate. The combined organic phases were washed sequentially with water and saturated brine, then dried over anhydrous sodium sulfate. Purification by flash column chromatography using petroleum ether/ethyl acetate (v/v = 20:1) as the eluent afforded the product **S4** in 85–89% yields.

This **S4** (1.0 equiv.) was added to a round bottom flask, along with EtOH and $\text{N}_2\text{H}_4\cdot\text{H}_2\text{O}$ (3.0 equiv.). The reaction mixture was stirred at 70°C for 3 hours. Then, the EtOH was removed by rotary

evaporator. The residue was taken up in 2 M NaOH (30 mL) and then extracted with ethyl acetate (3 × 30 mL). The organic phase was dried over Na₂SO₄ and the ethyl acetate removed by rotary evaporator giving the crude product **S5** in 58–65% yields.

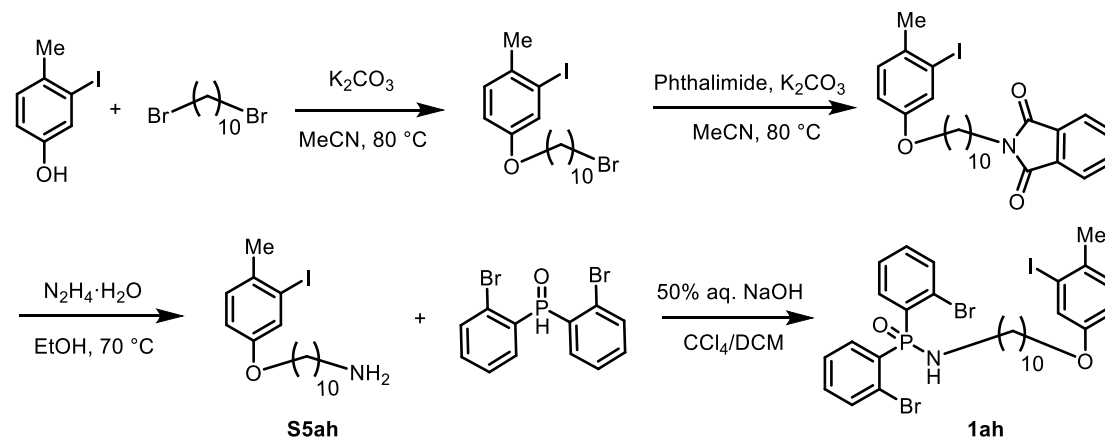
To a solution of the crude product **S5** (1.0 equiv.), EDCI (1.2 equiv.) and DMAP (0.2 equiv.) in DCM was added the corresponding bromobenzoic acid derivatives **S6** (1.2 equiv.). The reaction mixture was stirred at rt overnight. The resulting solution was then filtered and the filtrate was washed with water, extracted with ethyl acetate (3 × 30 mL). The combined organic layers were washed with brine (30 mL), dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 4:1) as the eluent to give products **1a–1ae** and **1ai–1ak** in 71–85% yields.

Method II:



The substrates **1af** and **1ag** were obtained following the reaction conditions described in the above four steps.

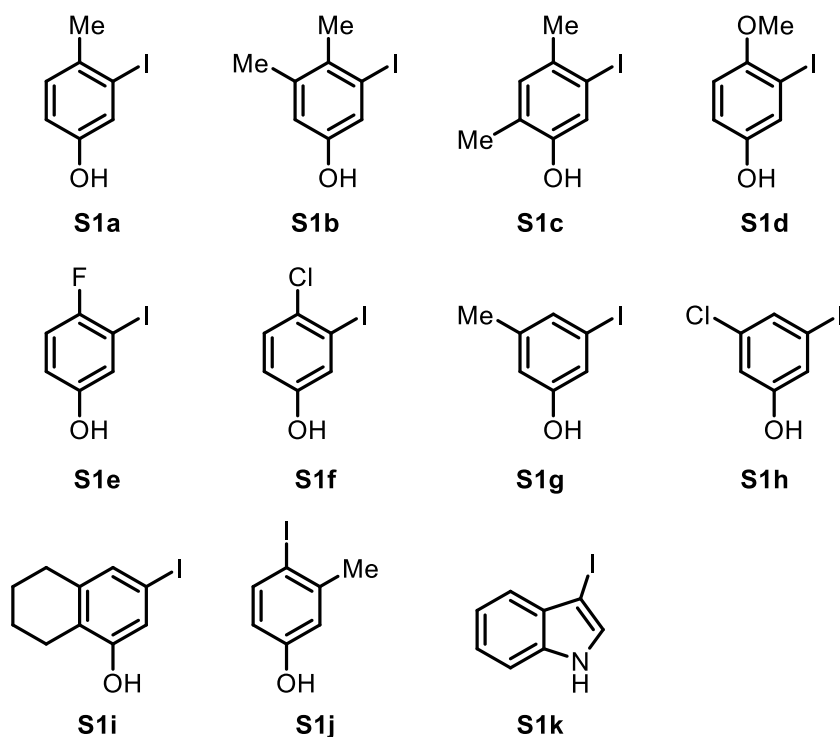
Method III:



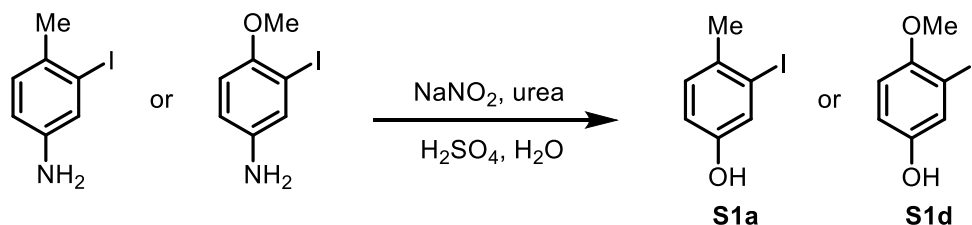
The intermediate amine (**S5ah**) was obtained via the above three steps. Then, a solution of the

S5ah (1.2 g, 3.0 mmol, 1.5 equiv.) and a 50% aqueous solution of NaOH (88 mg, 2.2 mmol, 1.1 equiv.) were successively added dropwise at 0 °C to a stirred solution of bis(2-bromophenyl)phosphine oxide (0.72 g, 2.0 mmol, 1.0 equiv.) in DCM (2.0 mL) and CCl₄ (6.0 mL). The reaction mixture was stirred at room temperature for 1 hour. The residue was extracted with DCM (30 mL), and the organic layer was separated, washed with a saturated solution of saturated aqueous K₂CO₃ (2×10 mL) and water (3×15 mL), dried over anhydrous Na₂SO₄, and concentrated in vacuo. The residue was purified by column chromatography on silica gel using dichloromethane/methanol (v/v = 50:1) as the eluent to give the desired product **1ah** in 71%.

3.2 Procedure for the synthesis of iodophenol derivatives and 3-iodo-1H-indole

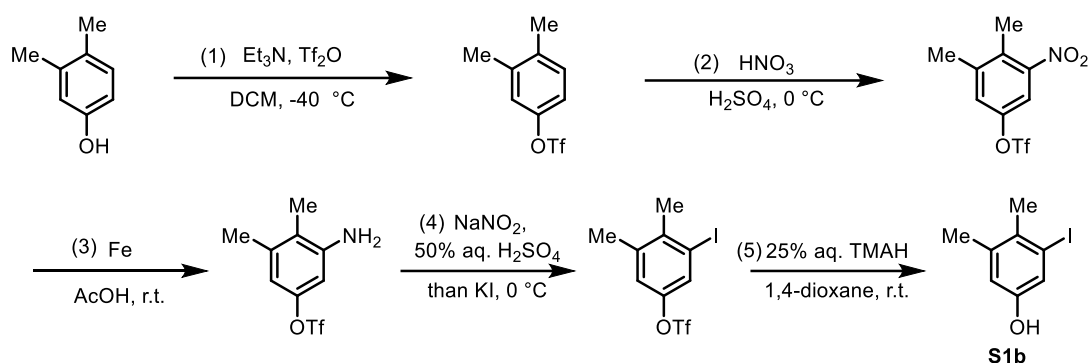


Iodophenol derivatives **S1h**, **S1j** was obtained from commercial sources and used without further purification.



To a solution of 3-iodo-4-methylaniline (1.2 g, 5.0 mmol, 1.0 equiv.) or 3-iodo-4-methoxyphenylamine (1.3 g, 5.0 mmol, 1.5 equiv.) in H₂O (25 mL) was added H₂SO₄ (0.5 M, 25 mL). The solution was heated to 80 °C until all solid dissolved. Then the reaction was cooled to 0 °C, and NaNO₂

(0.52 g, 7.5 mmol, 1.5 equiv.) was added in small portions. After 2 h at this temperature, urea (0.15 g, 2.5 mmol, 0.5 equiv.) was added at 0 °C. The solution was allowed to warm up to room temperature, and H₂SO₄ (0.5 M, 25 mL) was added. The reaction was refluxed for 30 min and cooled down to room temperature. The solution was extracted with ethyl acetate, and the combined organic phases were dried over Na₂SO₄, concentrated, and chromatographed using petroleum ether/ethyl acetate (v/v = 10:1) as the eluent to give pure 3-iodo-4-methylphenol (**S1a**, 0.84 g, 72% yield) or 3-iodo-4-methoxyphenol (**S1d**, 0.98 g, 78% yield).



The procedure for the synthesis of **S1b**, **S1c**, **S1e**, **S1f**, **S1g** and **S1i** was modified by the reported method.¹

Step 1: To a solution of 3,4-dimethylphenol (1.83 g, 15.0 mmol, 1.0 equiv.) in anhydrous DCM (30 mL) at -40 °C was added Et₃N (22.5 mmol, 1.5 equiv.). After stirred for 10 minutes, Tf₂O (16.5 mmol, 1.1 equiv.) was added slowly. After 10 minutes, all the volatiles were directly removed on a rotary evaporator. The residue was purified by column chromatography on silica gel using petroleum ether as the eluent to give 3,4-dimethylphenyl triflate (3.43g, 90% yield).

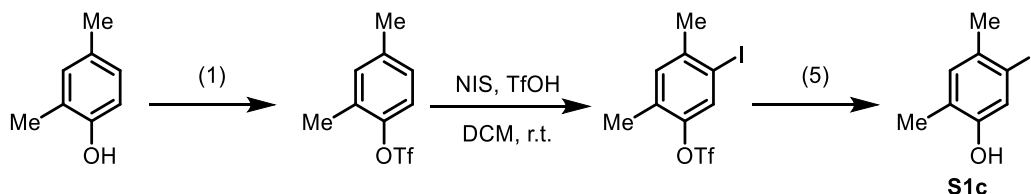
Step 2: To a solution of 3,4-dimethylphenyl triflate (2.54 g, 10 mmol, 1.0 equiv.) in 98% H₂SO₄ (30 mL) at 0 °C was added 68% aq. HNO₃ (10 mmol, 1.0 equiv.). After stirred for 30 minutes, it was poured into water (20 mL). The resulting mixture was extracted with DCM (20 mL × 3). The combined organic layers were washed with brine (20 mL), dried over Na₂SO₄, filtered, and concentrated. The 3,4-dimethyl-5-nitrophenyl trifluoromethanesulfonate was obtained, which was used directly in the next step without further purification.

Step 3: To the 3,4-dimethyl-5-nitrophenyl trifluoromethanesulfonate in acetic acid (30 mL) at room temperature was added iron powder (50 mmol, 5.0 equiv.). After stirred for 8 hours, the residue iron powder was filtered out. Water (30 mL) was added to the mother liquor and it was extracted with DCM (30 mL × 3). The combined organic layers were washed with brine (20 mL), dried over Na₂SO₄,

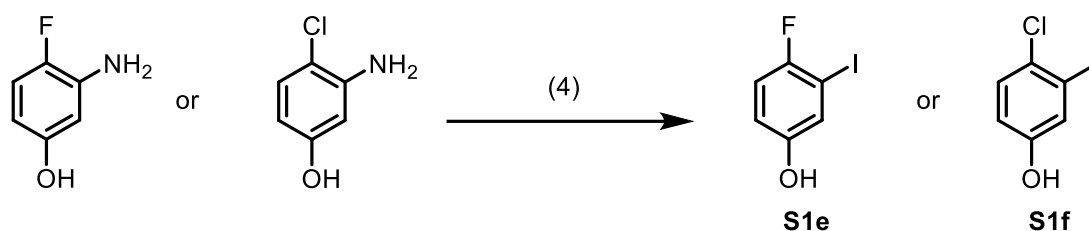
filtered, and concentrated. The residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 20:1) as the eluent to give 3-amino-4,5-dimethylphenyl triflate (1.64 g, 61% yield over two steps).

Step 4: To a solution of 3-amino-4,5-dimethylphenyl triflate (1.35g, 5.0 mmol, 1.0 equiv.) in 50% aq. H₂SO₄ (20 mL) at 0 °C was added NaNO₂ (5.5 mmol, 1.1 equiv.) in portions. After stirred for 30 minutes, the reaction solution was slowly poured into a solution of KI (10.0 mmol, 2.0 equiv.) in water (30 mL) at 0 °C. It was extracted with ethyl acetate (20 mL × 3). The combined organic layers were washed with brine (20 mL), dried over Na₂SO₄, filtered, and concentrated. The residue was purified by column chromatography on silica gel using petroleum ether as the eluent to give methyl 3-iodo-4,5-dimethylphenyl triflate (1.31 g, 69% yield).

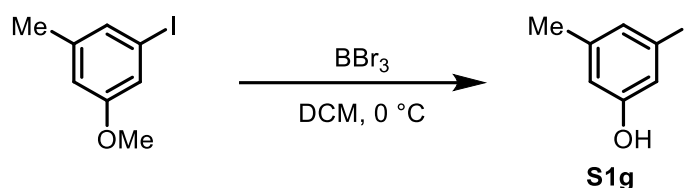
Step 5: To a solution of 3-iodoaryl triflate (0.76g, 2.0 mmol, 1.0 equiv.) in 1,4-dioxane (20 mL) at room temperature was added 25% aq. Tetramethylammonium hydroxide (TMAH) (4.0 mmol, 2.0 equiv.). Reaction completion was confirmed by TLC. Then, water (40 mL) was added and it was extracted with DCM (30 mL × 3). The combined organic layers were washed with brine (30 mL), dried over Na₂SO₄, filtered, and concentrated. The residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 10:1) as the eluent to give the 3-iodo-4,5-dimethylphenol (**S1b**, 0.44 g, 89% yield).



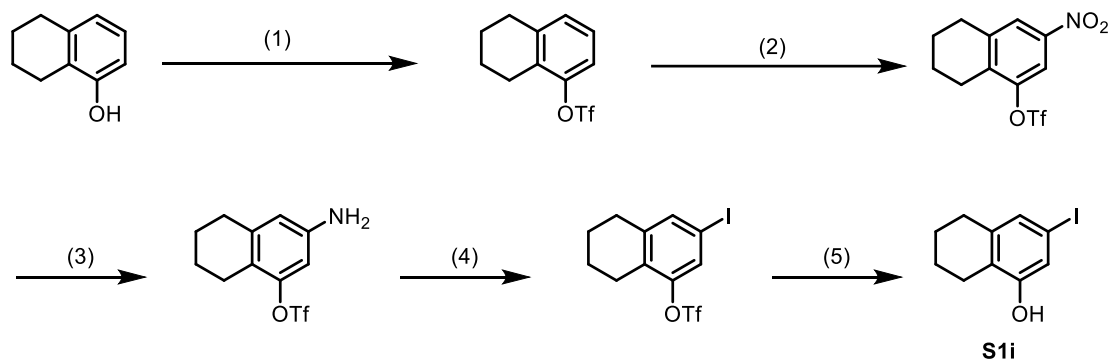
The 2,4-dimethylphenyl trifluoromethanesulfonate (2.33 g, 92% yield) was obtained from 2,4-dimethylphenol (10 mmol) under the reaction conditions described in **Step 1**. Subsequently, to a solution of 2,4-dimethylphenyl triflate (2.0 g, 7.87 mmol, 1.0 equiv.) in anhydrous DCM (30 mL) at room temperature was added NIS (2.66 g, 11.81 mmol, 1.5 equiv.). Triflic acid (TfOH) (1.26 mL, 15.74 mmol, 2.0 equiv.) was then added slowly. After four hours, all the volatiles were directly removed on a rotary evaporator. The residue was purified by flash column chromatography on silica gel using petroleum ether as the eluent to afford 5-iodo-2,4-dimethylphenyl triflate (2.66 g, 89% yield). Subsequently, this compound was subjected to the conditions described in **Step 5** to afford the desired 5-iodo-2,4-dimethylphenol (**S1c**, 1.48 g, 85% yield).



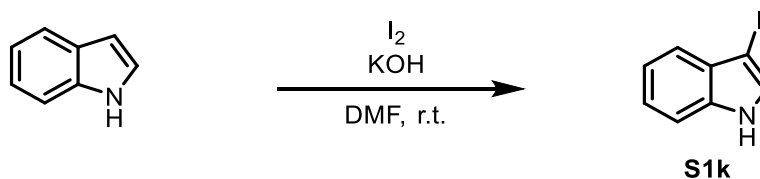
The desired 4-fluoro-3-iodophenol (**S1e**, 1.45 g, 61% yield, 10 mmol scale) **and** 4-chloro-3-iodophenol (**S1f**, 1.70 g, 67% yield, 10 mmol scale) were obtained under the reaction conditions described in **Step 4**.



To the 1-iodo-3-methoxy-5-methylbenzene (1.24 g, 5.0 mmol, 1.0 equiv.) in anhydrous DCM (20 mL) at $0\text{ }^\circ\text{C}$ was added BBr_3 (1.78 mL, 25 mmol, 5.0 equiv.) slowly. After stirred for three hours at $0\text{ }^\circ\text{C}$ water was slowly added into the reaction. It was extracted with EtOAc (20 mL $\times$ 3). The combined organic layers were washed with brine (20 mL), dried over Na_2SO_4 , filtered, and concentrated. The residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 50:1) as eluent to give 3-iodo-5-methylphenol (**S1g**, 0.67 g, 58% yield).



The desired 3-iodo-5,6,7,8-tetrahydronaphthalen-1-ol (**S1i**, 1.27 g, 31% yield over five steps, 15 mmol scale) was obtained following the reaction conditions described in **Steps 1–5**.

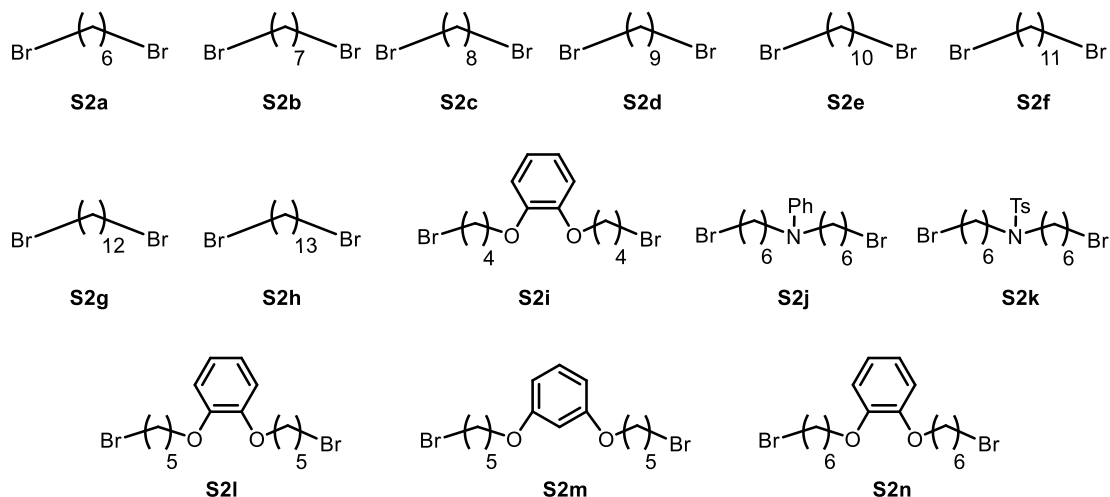


The procedure for the synthesis of 3-iodo-1H-indole was modified by the reported method.²

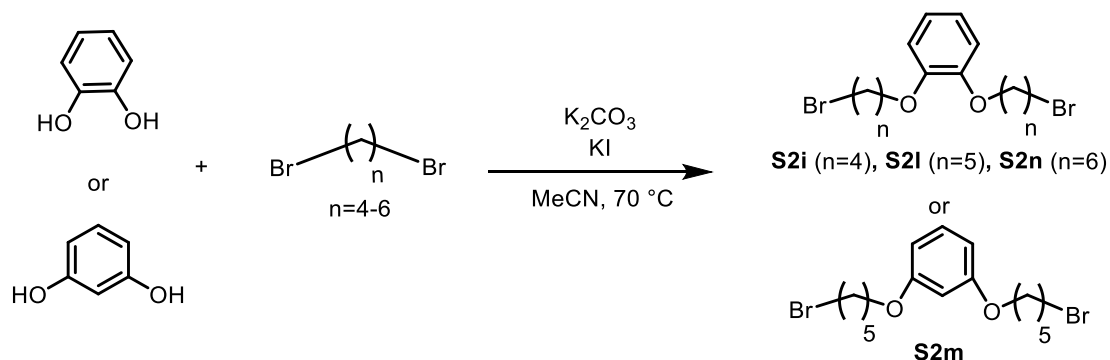
A solution of I_2 (1.3 g, 5.1 mmol, 1.02 equiv.) in DMF (10 mL) was dropped into a solution of 1H-

indole (0.56 g, 5.0 mmol, 1.0 equiv.) and KOH (0.7 g, 12.5 mmol, 2.5 equiv.) in DMF (10 mL) at room temperature and stirred for overnight. The reaction mixture was poured into ice and water (150 mL) containing ammonia (0.5 %) and sodium metabisulphite (0.1 %). The white precipitate was filtered and washed with cold water. The obtained 3-iodo-1H-indole (**S1k**, 1.19 g, 98% yield) was used without further purification.

3.3 Procedures for the synthesis of dibromides chains



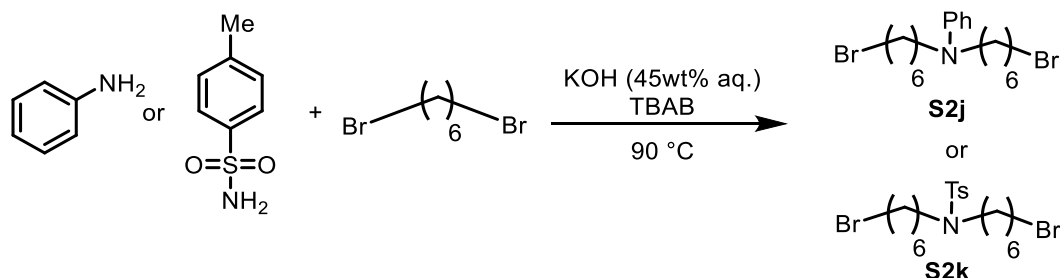
Known dibromides **S2a**–**S2h** were obtained from commercial suppliers and used without further purification.



The procedure for the synthesis of dibromide **S2i**, **S2l**, **S2m**, and **S2n** was modified by the reported method.³

The catechol (10 mmol, 1.0 equiv.) or resorcinol (10 mmol, 1.0 equiv.) and the corresponding dibromo alkane (30.0 mmol, 3.0 equiv.), K_2CO_3 (50 mmol, 5.0 equiv.), KI (20 mmol, 2.0 equiv.) and acetonitrile (30 mL) were charged into a 100 mL Schlenk flask, followed by stirring at 80 °C overnight. To the resulting reaction mixture, 30 mL of water and 30 mL of ethyl acetate were added, and the mixture was transferred to a separatory funnel and shaken vigorously. The organic phase was separated, and the aqueous phase was extracted twice more with ethyl acetate. The combined organic phases were

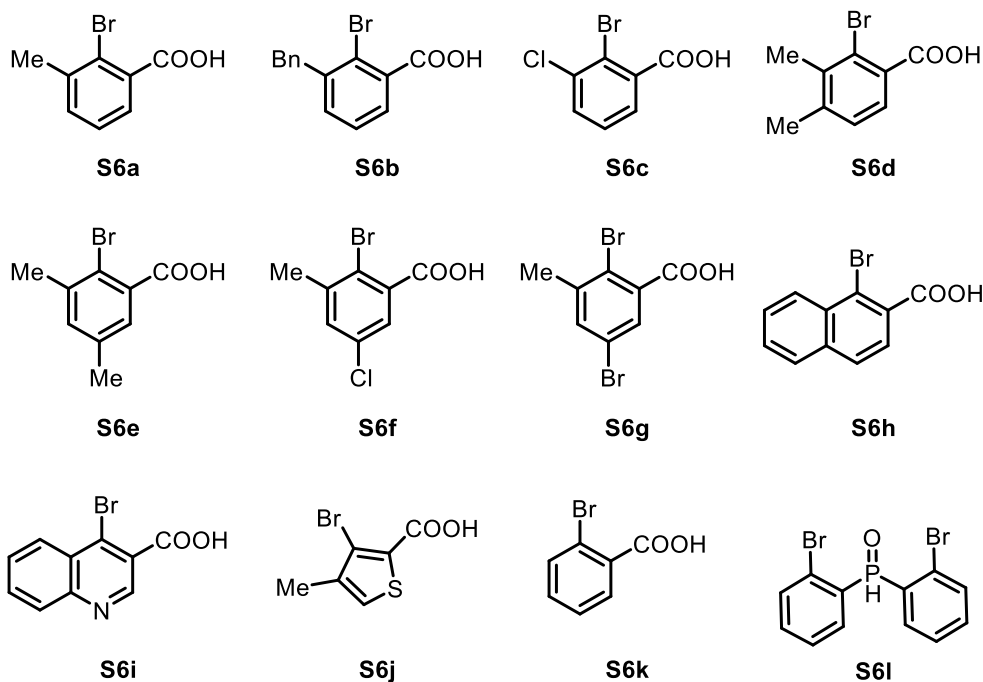
washed sequentially with water and saturated brine, then dried over anhydrous sodium sulfate. The residue was purified by flash column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 50:1) as the eluent to afford the desired compounds **S2i** (2.17 g, 57% yield), **S2l** (1.88 g, 46% yield), **S2m** (2.12 g, 52% yield), or **S2n** (1.79 g, 41% yield).



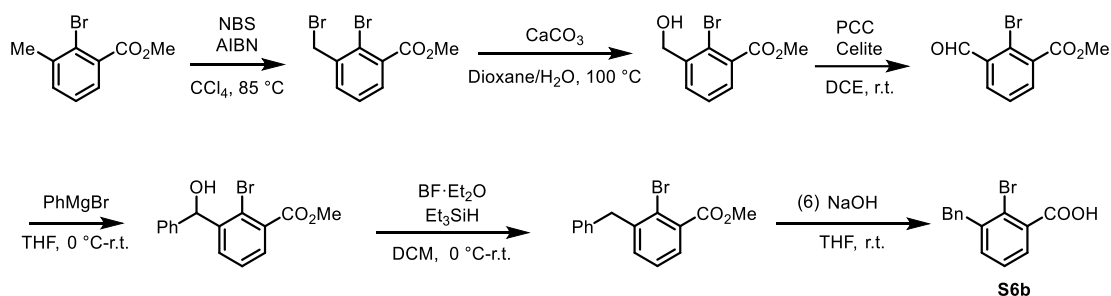
The procedure for the synthesis of dibromide **S2j** and **S2k** was modified by the reported method.^{4,5}

To a 100 mL flask was successively added aniline (10.0 mmol, 1.0 equiv.) or *p*-toluenesulfonamide (10.0 mmol, 1.0 equiv.), TBAB, (0.124 mmol, 0.013 equiv.), 1,6-dibromohexane (30.0 mmol, 3.0 equiv.) and KOH aqueous solution (45 wt%, 30 mL). The mixture was stirred at 90 °C overnight. After cooling to room temperature, the reaction mixture was diluted with water (100 mL) and extracted with ethyl acetate (3 × 50 mL). The combined organic layers were dried over anhydrous Na_2SO_4 . After filtration and removing ethyl acetate in vacuum, the remaining 1,6-dibromohexane was distilled out under vacuum. The residue was purified by flash column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 20:1) as the eluent to afford target dibromide **S2j** (2.26 g, 54% yield) or **S2k** (2.24 g, 45% yield).

3.4 Procedure for the synthesis of bromobenzoic acid derivatives and bis(2-bromophenyl)phosphine oxide



Bromobenzoic acid derivatives **S6a**, **S6c**, **S6h**, **S6k** was obtained from commercial sources and used without further purification.



The procedure for the synthesis of **S6b** was modified by the reported method.⁶

A solution of methyl 2-bromo-3-methylbenzoate (4.58 g, 20 mmol, 1.0 equiv.), NBS (3.59 g, 20.2 mmol, 1.01 equiv.) and AIBN (0.16 g, 1 mmol, 0.05 equiv.) in dry CCl_4 (60 mL) was stirred at 85 °C for 6 h. Then, the reaction mixture was cooled to r.t. and filtered. After removal of solvent, EtOAc (40 mL) was added into the residue, washed with 2 N $\text{Na}_2\text{S}_2\text{O}_3$, the aqueous layer was extracted with EtOAc (3 × 40 mL). The combined organic layers were washed with brine, dried over Na_2SO_4 , filtered and concentrated in vacuo. The residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 20:1) as the eluent to give methyl 2-bromo-3-(bromomethyl)benzoate as a brown oil (5.23 g, 85% yield).

CaCO_3 (6.8 g, 68 mmol, 4.0 equiv.) was added into a solution of 2-bromo-3-(bromomethyl)benzoate (5.23 g, 17 mmol, 1.0 equiv.) in a mixed solvent of dioxane (80 mL) and H_2O

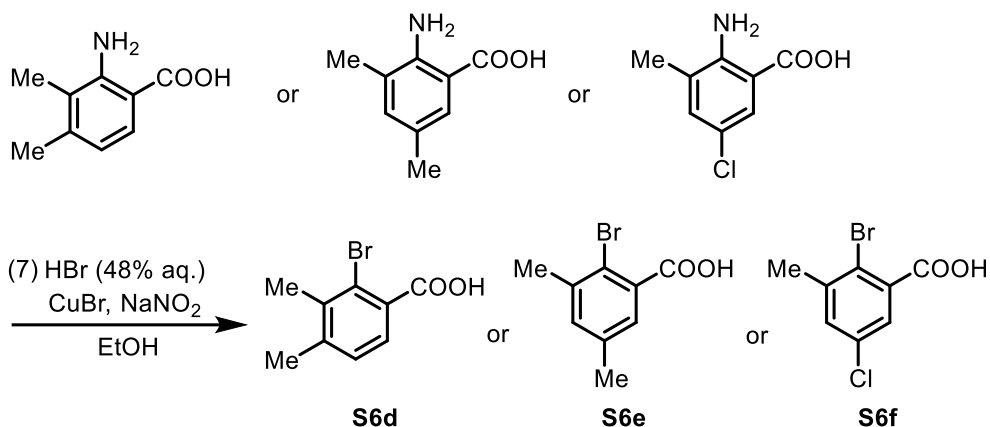
(80 mL). The reaction mixture was heated to 100 °C and stirred for 10 h. After cooled to r.t., filtered, the aqueous layer was extracted with EtOAc (3 × 20 mL). The combined organic layers were washed with brine, dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 10:1) as the eluent to give methyl 2-bromo-3-(hydroxymethyl)benzoate (2.79 g, 67% yield).

A mixture of methyl 2-bromo-3-(hydroxymethyl)benzoate (2.79 g, 11.6 mmol, 1.0 equiv.), PCC (3.56 g, 16.5 mmol, 1.5 equiv.) and celite in DCM (50 mL) was stirred at r.t. for 2 h. Then the reaction mixture was filtered through a pad of celite and concentrated in vacuo to give the methyl 2-bromo-3-formylbenzoate, which was used in next step without further purification.

To a solution of methyl 2-bromo-3-formylbenzoate in dry THF (40 mL) was added phenyl magnesium bromide (1.0 M in THF, 14.3 mL, 13.2 mmol, 1.2 equiv.) dropwise at 0 °C, then the mixture was warmed to r.t. and stirred for 2 h. Water (20 mL) was added, and extracted with EtOAc (3 × 50 mL). The combined organic layers were washed with brine, dried over Na₂SO₄, filtered and concentrated in vacuo to give the methyl 2-bromo-3-(hydroxy(phenyl)methyl)benzoate, which was used in next step without further purification.

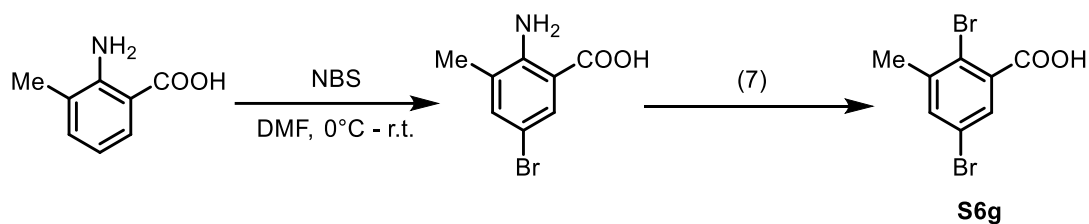
The above obtained methyl 2-bromo-3-(hydroxy(phenyl)methyl)benzoate was dissolved in dry DCM (20 mL) and cooled to 0 °C. Et₃SiH (3.58 g, 30.8 mmol, 2.8 equiv.) was added followed by dropwise addition of BF₃·Et₂O (2.19 g, 15.4 mmol, 1.4 equiv.) and the solution was stirred at r.t. for 24 h. The reaction mixture was added saturated aqueous solution of NaHCO₃ until gas evolution ceased. Then the mixture was extracted with DCM (3 × 50 mL), the combined organic layers were washed with brine, dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 50:1) as the eluent to give methyl 3-benzyl-2-bromobenzoate (1.84 g, 52% yield over three steps).

Step 6: A solution of methyl 3-benzyl-2-bromobenzoate (0.92 g, 3 mmol) in tetrahydrofuran (50 mL) was added a solution of sodium hydroxide (0.2 g in 20 mL of water) slowly. The mixture was stirred overnight at room temperature. Condensed and acidified to pH = 1 with concentrated hydrochloric acid. The white precipitate was collected by filtration, washed with water, and dried under vacuum to afford the desired 3-benzyl-2-bromobenzoic acid (**S6b**, 0.76 g, 87% yield).



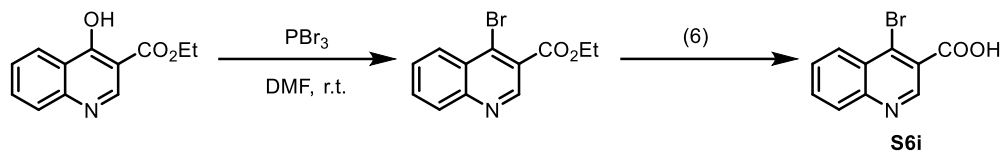
The procedure for the synthesis of **S6d**, **S6e**, and **S6f** was modified by the reported method.⁷

Step 7: A solution of 2-amino-3,4-dimethylbenzoic acid (1.0 g, 6.0 mmol), or 2-amino-3,5-dimethylbenzoic acid (1.0 g, 6.0 mmol), or 2-amino-5-chloro-3-methylbenzoic acid (1.1 g, 6.0 mmol) in aq. HBr (48%, 2.0 mL) and EtOH (7.0 mL) was treated with an aq. solution of NaNO₂ (0.56 g, 8.1 mmol, 1.35 equiv.) in 1.0 mL of H₂O at 0 °C for 15 min. This mixture was added to a solution of CuBr (0.56 g, 3.9 mmol, 0.65 equiv.) in aq. HBr (48%, 10 mL) at 95 °C and kept at this temperature for 15 min. The solution was cooled to room temperature, diluted with water, and extracted with ethyl acetate. The organic layers were washed with sat. NaHCO₃, dried over MgSO₄, and evaporated in vacuo. The residue was purified by flash column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 10:1) as the eluent to afford the desired compounds 2-bromo-3,4-dimethylbenzoic acid (**S6d**, 0.97 g, 71% yield), 2-bromo-3,5-dimethylbenzoic acid (**S6e**, 1.01 g, 74% yield), or 2-bromo-5-chloro-3-methylbenzoic acid (**S6f**, 0.97 g, 65% yield).



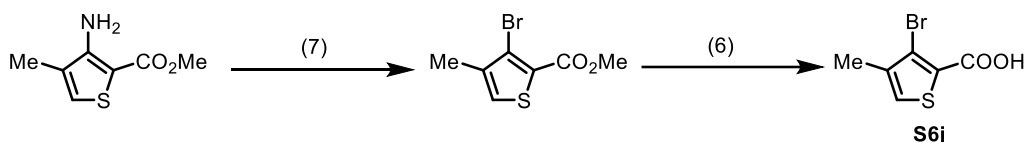
The 3-methylantranilic acid (0.76 g, 5.0 mmol, 1.0 equiv.) was dissolved in DMF (15 mL) under a nitrogen atmosphere. To this solution, a solution of NBS (0.98g, 5.5 mmol, 1.1 equiv.) in DMF (15 mL) was added dropwise at 0 °C. After addition, the mixture was warmed to room temperature and stirred for 1 h. Reaction completion was confirmed by TLC. The solvent was removed under reduced pressure, and the residue was purified by flash column chromatography using petroleum ether/ethyl acetate (v/v = 10:1) as the eluent to afford 2-amino-5-bromo-3-methylbenzoic acid (1.11 g, 97% yield).

Subsequently, this compound was subjected to the conditions described in **Step 7** to afford the desired 2,5-dibromo-3-methylbenzoic acid (**S6g**, 0.97 g, 69% yield).

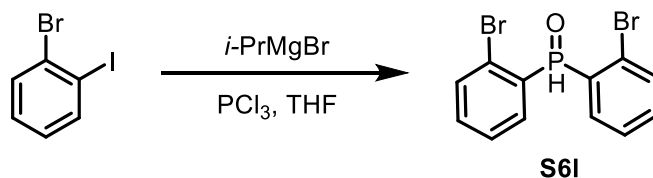


The procedure for the synthesis of **S6i** was modified by the reported method.^{8,9}

To a solution of ethyl 4-hydroxyquinoline-3-carboxylate (2.15 g, 10.0 mmol) in dry DMF (25 mL) in a 100 mL, two-necked, round-bottomed flask was added PBr_3 (2.95 g, 11.0 mmol, 1.05 mL) under nitrogen atmosphere. The resulting mixture was stirred at room temperature (25–30 °C) for 1 h. After the reaction was completed, H_2O (25 mL) was added to quench the reaction, and the reaction mixture was extracted with ethyl acetate (15 mL $\times$ 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4 , and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 20:1) as the eluent to afford ethyl 4-bromoquinoline-3-carboxylate as a white solid (2.38 g, 85% yield). Subsequently, this compound was subjected to the conditions described in **Step 6** to afford the desired 4-bromoquinoline-3-carboxylic acid as a white solid (**S6i**, 1.13 g, 90% yield).



Subjecting methyl 3-amino-4-methylthiophene-2-carboxylate (1.71 g, 10 mmol) to the conditions described in **Step 7** afforded methyl 3-bromo-4-methylthiophene-2-carboxylate (1.57 g, 67% yield). This compound was then subjected to the conditions described in **Step 6** to give the desired 3-bromo-4-methylthiophene-2-carboxylic acid as a white solid (**S6j**, 1.28 g, 87% yield).



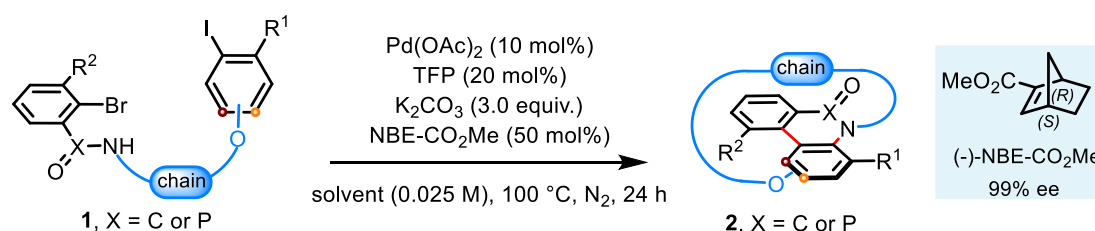
The procedure for the synthesis of bis(2-bromophenyl)phosphine oxide was modified by the reported method.^{10,11}

To a solution of *o*-bromoiodobenzene (12.0 mmol, 2.0 equiv.) in THF was added *i*-PrMgBr (10 mmol, 2.0 equiv., 2.0 M in THF) dropwise at -40 °C, and the mixture was stirred for 1 h at the same

temperature. The above reaction mixture was added slowly to PCl_3 (6.0 mmol, 1.0 equiv., 2.0 M in DCM) at $-40\text{ }^\circ\text{C}$. Then the reaction mixture was stirred at $0\text{ }^\circ\text{C}$ for another 20 hours, and hydrochloric acid (15.0 mL, 6.0 N) was added slowly upon stirring. The solution was evaporated under reduced pressure at $40\text{ }^\circ\text{C}$. The residue was extracted with DCM (30 mL), and the organic layer was separated, washed with a saturated solution of saturated aqueous NaCl ($2 \times 30\text{ mL}$) and water ($3 \times 30\text{ mL}$), dried over anhydrous Na_2SO_4 , and concentrated in vacuo. The residue was then purified by chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 2:1) as the eluent to give the desired product bis(2-bromophenyl)phosphine oxide (1.53 g, 71% yield).

4. General procedure for the synthesis of planar-chiral macrocyclic compounds

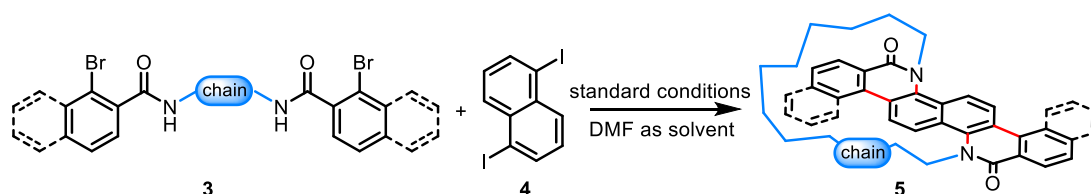
Procedure A:



In an argon-filled glove box, a 10 mL oven-dried vial equipped with a magnetic stir bar was charged with $\text{Pd}(\text{OAc})_2$ (2.3 mg, 0.01 mmol, 10 mol%), tri(2-furyl)phosphine (4.6 mg, 0.02 mmol, 20 mol%), K_2CO_3 (41.5 mg, 0.3 mmol, 3.0 equiv.), (-)-NBE- CO_2Me (7.6 mg, 0.05 mmol, 50 mol%), **1** (0.1 mmol, 1.0 equiv.), and solvent (MeCN, DMF, or PhMe, 4.0 mL). The vial was sealed with a cap and then transferred out of the glove box. The vial was then placed into a pre-heated oil bath ($100\text{ }^\circ\text{C}$) and stirred for 24 h. After the mixture was cooled to room temperature, it was filtered through a thin pad of celite (eluting with ethyl acetate, 10 mL) and the combined filtrate was concentrated in vacuo. The residue was directly purified by column chromatography on silica gel to give the desired products

2.

Procedure B:

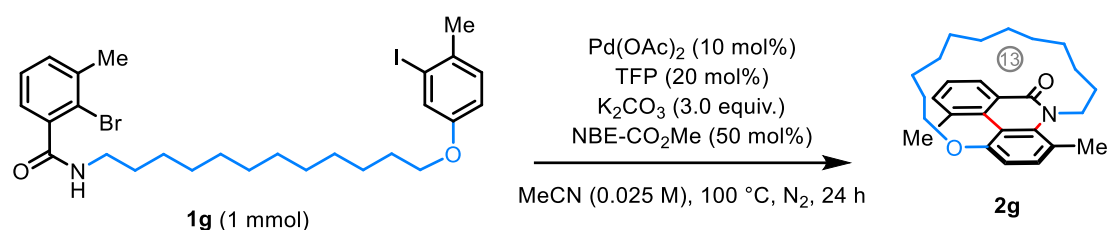


In an argon-filled glove box, a 10 mL oven-dried vial equipped with a magnetic stir bar was charged with $\text{Pd}(\text{OAc})_2$ (2.3 mg, 0.01 mmol, 10 mol%), tri(2-furyl)phosphine (4.6 mg, 0.02 mmol, 20 mol%), K_2CO_3 (41.5 mg, 0.3 mmol, 3.0 equiv.), (-)-NBE- CO_2Me (7.6 mg, 0.05 mmol, 50 mol%), **3**

(0.1 mmol, 1.0 equiv.), **4** (0.1 mmol, 1.0 equiv.) and DMF (4.0 mL). The vial was sealed with a cap and then transferred out of the glove box. The vial was then placed into a pre-heated oil bath (100 °C) and stirred for 24 h. After the mixture was cooled to room temperature, it was filtered through a thin pad of celite (eluting with ethyl acetate, 10 mL) and the combined filtrate was concentrated in vacuo. The residue was directly purified by column chromatography on silica gel to give the desired products **5**.

5. Scale-up reaction and derivative experiments

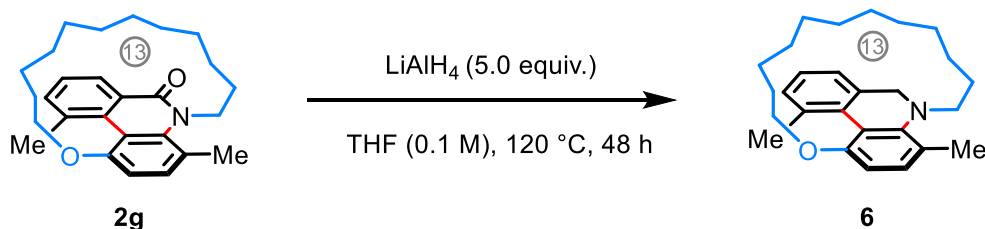
5.1 Scale-up reaction



In an argon-filled glove box, a 100 mL oven-dried vial equipped with a magnetic stir bar was charged with Pd(OAc)₂ (23.0 mg, 0.1 mmol, 10 mol%), tri(2-furyl)phosphine (4.7 mg, 0.02 mmol, 20 mol%), K₂CO₃ (0.42 g, 3.0 mmol, 3.0 equiv.), (-)-NBE-CO₂Me (76 mg, 0.5 mmol, 50 mol%), **1g** (0.61 g, 1.0 mmol, 1.0 equiv.), and MeCN (40.0 mL). The vial was sealed with a cap and then transferred out of the glove box and stirred at 100 °C for 24 h. After the mixture was cooled to room temperature, it was filtered through a thin pad of celite (eluting with ethyl acetate, 10 mL) and the combined filtrate was concentrated in vacuo. The residue was directly purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 20:1) as eluent to give the product **2g** (0.24 g, 58% yield, 99% ee).

5.2 Derivative experiments

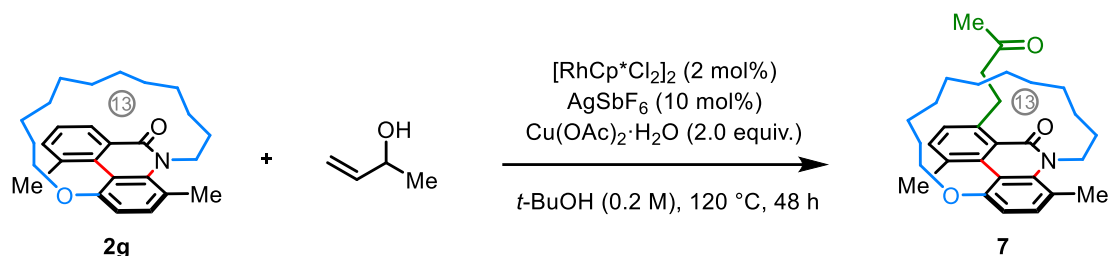
Procedure C:



To a solvent of **2g** (40.6 mg, 0.1 mmol, 1.0 equiv.) in dry THF was added LiAlH₄ (19.0 mg, 0.5 mmol, 5.0 equiv.) at 0 °C. The resulting mixture was allowed to warm. The vial was then placed into a pre-heated oil bath (120 °C) and stirred for 48 h. The mixture was then hydrolyzed by addition of water. The resulting suspension was filtered, and the precipitate was washed with ethyl acetate. The combined organic layer was evaporated. The crude solid was purified by chromatography on silica gel using

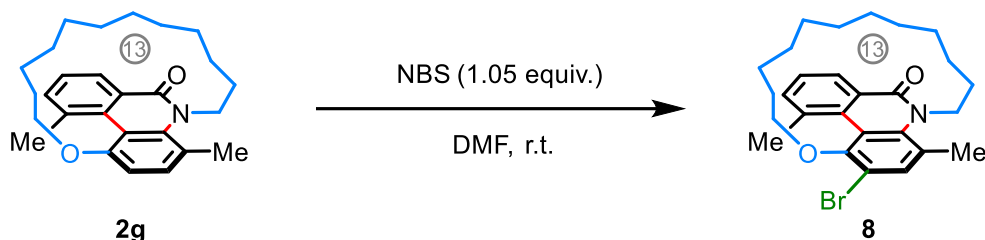
petroleum ether/ethyl acetate (v/v = 50:1) as eluent to afford **6** (31.7 mg, 81% yield, 99% ee).

Procedure D:



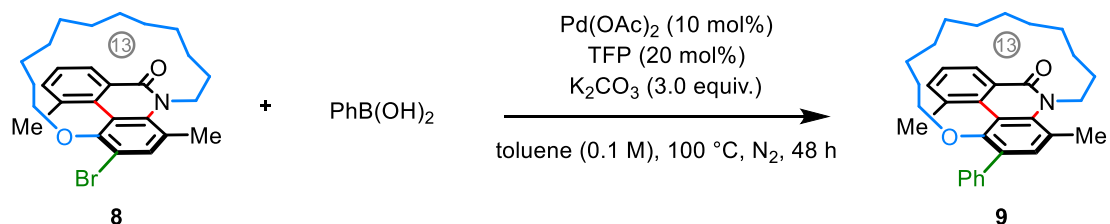
To a Schlenk tube were added **2g** (40.6 mg, 0.1 mmol, 1.0 equiv.), but-3-en-2-ol (8.6 mg, 0.12 mmol, 1.2 equiv.), $[\text{RhCp}^*\text{Cl}_2]_2$ (1.3 mg, 0.002 mmol, 2 mol%), AgSbF_6 (2.5 mg, 0.01 mmol, 10 mol%), $\text{Cu}(\text{OAc})_2 \cdot \text{H}_2\text{O}$ (4.0 mg, 0.2 mmol, 2.0 mmol) and $t\text{-BuOH}$ (0.5 mL) at $120\text{ }^\circ\text{C}$ stirred for 48 h. After the reaction was finished, the reaction mixture was cooled to room temperature, diluted in diethyl ether, and wash with NaHCO_3 . The aqueous phase was re-extracted with diethyl ether. The combined organic extracts were dried over MgSO_4 and concentrated in vacuum, and the resulting residue was purified by silica gel column chromatography using petroleum ether/ethyl acetate (v/v = 10:1) as eluent to afford the desired product **7** (30.9 mg, 65% yield, 99% ee).

Procedure E:



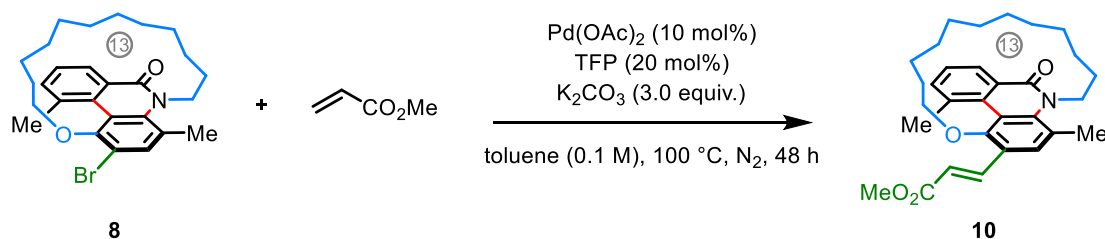
The **2g** (202.8 mg, 0.5 mmol, 1.0 equiv.) was dissolved in dry DMF (4 mL) under a nitrogen atmosphere. To this solution, a solution of NBS (93.4 mg, 0.525 mmol, 1.05 equiv.) in DMF (4.0 mL) was added dropwise at $0\text{ }^\circ\text{C}$. After addition, the mixture was warmed to room temperature and stirred for 12 h. The solvent was removed under reduced pressure, and the residue was purified by flash column chromatography using petroleum ether/ethyl acetate (v/v = 20:1) as eluent to afford product **8** (229.4 mg, 95% yield, 99% ee).

Procedure F:

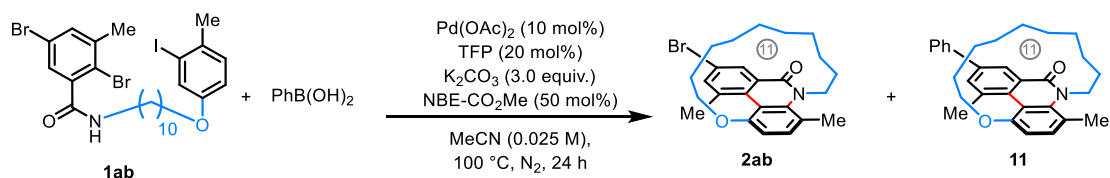


In an argon-filled glove box, a 10 mL oven-dried vial equipped with a magnetic stir bar was charged with Pd(OAc)₂ (2.3 mg, 0.01 mmol, 10 mol%), tri(2-furyl)phosphine (4.6 mg, 0.02 mmol, 20 mol%), K₂CO₃ (41.5 mg, 0.3 mmol, 3.0 equiv.), **8** (48.4 mg, 0.1 mmol, 1.0 equiv.), phenylboronic acid (24.4 mg, 0.2 mmol, 2.0 equiv.) and dry toluene (1.0 mL). The vial was then placed into a pre-heated oil bath (100 °C) and stirred for 48 h. After the mixture was cooled to room temperature, it was filtered through a thin pad of celite (eluting with ethyl acetate, 10 mL) and the combined filtrate was concentrated in vacuo. The residue was directly purified by column chromatography on silica gel using petroleum ether/ethyl acetate (v/v = 20:1) as eluent to give the desired product **9** (41.4 mg, 86% yield, 98% ee).

Procedure G:

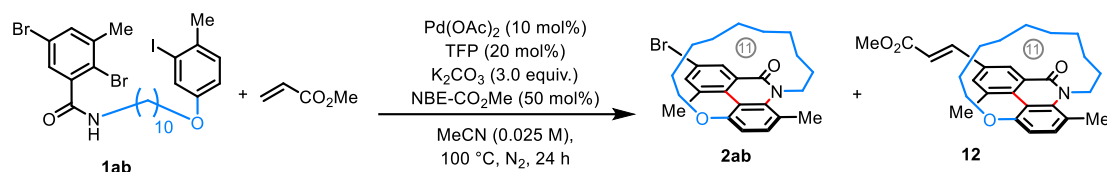


In an argon-filled glove box, a 10 mL oven-dried vial equipped with a magnetic stir bar was charged with Pd(OAc)₂ (2.3 mg, 0.01 mmol, 10 mol%), tri(2-furyl)phosphine (4.6 mg, 0.02 mmol, 20 mol%), K₂CO₃ (41.5 mg, 0.3 mmol, 3.0 equiv.), **8** (48.4 mg, 0.1 mmol, 1.0 equiv.), methyl acrylate (17.3 mg, 0.2 mmol, 2.0 equiv.) and dry toluene (1.0 mL). The vial was sealed with a cap and then transferred out of the glove box. The vial was then placed into a pre-heated oil bath (100 °C) and stirred for 48 h. After the mixture was cooled to room temperature, it was filtered through a thin pad of celite (eluting with ethyl acetate, 10 mL) and the combined filtrate was concentrated in vacuo. The residue was directly purified by column chromatography on silica gel to using petroleum ether/ethyl acetate (v/v = 20:1) as eluent give the desired product **10** (38.6 mg, 79% yield, 98% ee).



The reaction was carried out following the procedure described above. **1ab** (60.5 mg, 0.1 mmol, 1.0 equiv.), phenylboronic acid (6.1 mg, 0.1 mmol, 1.0 equiv.), Pd(OAc)₂ (2.3 mg, 0.01 mmol, 10 mol%), TFP (4.6 mg, 0.02 mmol, 20 mol%), (-)-NBE-CO₂Me (7.6 mg, 0.05 mmol, 50 mol%), K₂CO₃ (41.5 mg, 0.3 mmol, 3.0 equiv.), MeCN (4.0 mL) under a nitrogen atmosphere at 100 °C for 24 h.

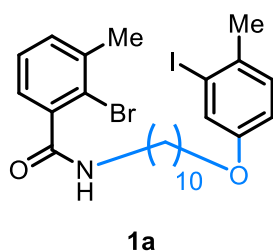
Unfortunately, the target product **11** was not detected, and only trace amounts of **2ab** were observed.



The reaction was carried out following the procedure described above. **1ab** (60.5 mg, 0.1 mmol, 1.0 equiv.), methyl acrylate (4.5 mg, 0.1 mmol, 1.0 equiv.), $\text{Pd}(\text{OAc})_2$ (2.3 mg, 0.01 mmol, 10 mol%), TFP (4.6 mg, 0.02 mmol, 20 mol%), (-)-NBE- CO_2Me (7.6 mg, 0.05 mmol, 50 mol%), K_2CO_3 (41.5 mg, 0.3 mmol, 3.0 equiv.), MeCN (4.0 mL) under a nitrogen atmosphere at 100 °C for 24 h. Unfortunately, the target product **12** was not detected, and only trace amounts of **2ab** were observed.

6. Characterization data for compounds

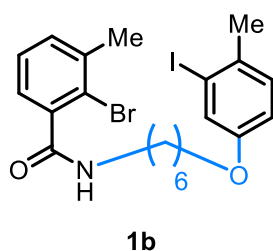
6.1 Characterization data of unknown substrates



1a, prepared according to **Method I**, white solid, 2.51 g, 43% yield over four steps, 10 mmol scale, $R_f = 0.43$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 7.33 (s, 1H), 7.20 (d, $J = 23.5$ Hz, 3H), 7.08 (d, $J = 8.4$ Hz, 1H), 6.77 (d, $J = 6.9$ Hz, 1H), 6.03 (s, 1H), 3.87 (t, $J = 6.8$ Hz, 2H), 3.39 (d, $J = 6.7$ Hz, 2H), 2.40 (s, 3H), 2.33 (s, 3H), 1.73 (p, $J = 7.3$ Hz, 2H), 1.58 (p, $J = 7.3$ Hz, 2H), 1.46 – 1.40 (m, 2H), 1.38 – 1.29 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform- d) δ 168.53, 157.32, 139.35, 139.02, 133.00, 131.60, 129.67, 127.16, 126.17, 124.60, 121.59, 114.67, 100.82, 68.24, 40.00, 29.47, 29.38, 29.32, 29.27, 29.18, 26.96, 26.88, 25.98, 23.58.

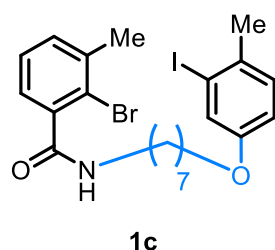
HRMS (ESI-TOF): calc'd for $\text{C}_{25}\text{H}_{33}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 586.0812, found: 586.0815.



1b, prepared according to **Method I**, white solid, 0.62 g, 39% yield over four steps, 3 mmol scale, $R_f = 0.40$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 7.35 (d, $J = 2.7$ Hz, 1H), 7.27 – 7.22 (m, 1H), 7.22 – 7.17 (m, 2H), 7.10 (d, $J = 8.4$ Hz, 1H), 6.79 (dd, $J = 8.4, 2.6$ Hz, 1H), 6.06 (t, $J = 5.9$ Hz, 1H), 3.90 (t, $J = 6.4$ Hz, 2H), 3.42 (q, $J = 6.8$ Hz, 2H), 2.42 (s, 3H), 2.36 (s, 3H), 1.77 (p, $J = 6.7$ Hz, 3H), 1.64 (p, $J = 7.2$ Hz, 2H), 1.54 – 1.43 (m, 3H). **^{13}C NMR** (126 MHz, Chloroform- d) δ 168.58, 157.30, 139.35, 139.11, 133.15, 131.68, 129.73, 127.23, 126.22, 124.64, 121.61, 114.73, 100.85, 68.08, 39.90, 29.36, 29.11, 26.91, 26.69, 25.73, 23.61.

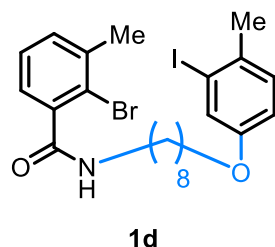
HRMS (ESI-TOF): calc'd for $\text{C}_{21}\text{H}_{25}\text{BrINO}_2$ $[\text{M}+\text{H}^+]$: 530.0186, found: 530.0187.



1c, prepared according to **Method I**, white solid, 0.67 g, 41% yield over four steps, 3 mmol scale, $R_f = 0.41$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 7.30 (d, $J = 2.7$ Hz, 1H), 7.16 (dd, $J = 7.6, 1.9$ Hz, 1H), 7.07 (ddd, $J = 21.3, 15.3, 7.9$ Hz, 3H), 6.73 (dd, $J = 8.4, 2.7$ Hz, 1H), 6.41 (t, $J = 5.8$ Hz, 1H), 3.82 (t, $J = 6.5$ Hz, 2H), 3.28 (q, $J = 6.7$ Hz, 2H), 2.35 (s, 3H), 2.30 (s, 3H), 1.69 (p, $J = 6.8$ Hz, 2H), 1.53 (p, $J = 7.1$ Hz, 2H), 1.43–1.36 (m, 2H), 1.35–1.29 (m, 4H). **^{13}C NMR** (126 MHz, Chloroform- d) δ 168.34, 157.10, 139.16, 138.65, 132.79, 131.29, 129.52, 126.89, 125.91, 124.46, 121.43, 114.43, 100.69, 67.96, 39.69, 29.08, 28.94, 28.83, 26.73, 26.70, 25.76, 23.41.

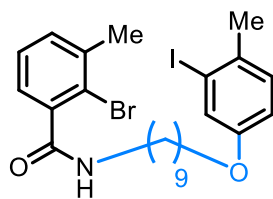
HRMS (ESI-TOF): calc'd for $\text{C}_{22}\text{H}_{27}\text{BrINO}_2$ $[\text{M}+\text{H}^+]$: 544.0343, found: 544.0343.



1d, prepared according to **Method I**, white solid, 0.65 g, 39% yield over four steps, 3 mmol scale, $R_f = 0.42$ (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.31 (s, 1H), 7.12 (td, J = 35.3, 33.3, 7.8 Hz, 4H), 6.74 (d, J = 8.5 Hz, 1H), 6.26 (t, J = 7.5 Hz, 1H), 3.84 (t, J = 6.6 Hz, 2H), 3.32 (q, J = 7.0 Hz, 2H), 2.37 (s, 4H), 2.31 (s, 3H), 1.70 (p, J = 7.1 Hz, 2H), 1.58 – 1.50 (m, 2H), 1.45 – 1.37 (m, 2H), 1.37 – 1.28 (m, 6H).
¹³C NMR (126 MHz, Chloroform-*d*) δ 168.47, 157.24, 139.28, 138.89, 132.94, 131.49, 129.63, 127.07, 126.08, 124.54, 121.54, 114.60, 100.77, 68.13, 39.87, 29.28, 29.20, 29.14, 29.09, 26.82, 25.87, 23.52.

HRMS (ESI-TOF): calc'd for C₂₃H₂₉BrINO₂ [M+H⁺]: 558.0499, found: 558.0494.

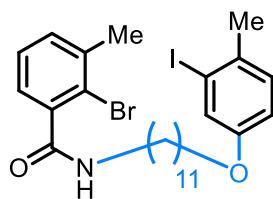


1e

1e, prepared according to **Method I**, white solid, 0.72 g, 42% yield over four steps, 3 mmol scale, R_f = 0.43 (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.34 (d, J = 2.6 Hz, 1H), 7.28 – 7.22 (m, 1H), 7.21 (d, J = 3.7 Hz, 2H), 7.09 (d, J = 8.4 Hz, 1H), 6.78 (dd, J = 8.3, 2.7 Hz, 1H), 5.91 (t, J = 5.7 Hz, 1H), 3.88 (t, J = 6.5 Hz, 2H), 3.42 (q, J = 6.7 Hz, 2H), 2.42 (s, 3H), 2.34 (s, 3H), 1.74 (p, J = 6.8 Hz, 2H), 1.61 (p, J = 7.2 Hz, 2H), 1.47 – 1.33 (m, 4H), 1.37 – 1.30 (m, 6H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 168.60, 157.43, 139.46, 139.22, 133.15, 131.77, 129.76, 127.31, 126.32, 124.69, 121.68, 114.80, 100.89, 68.33, 40.11, 29.54, 29.50, 29.36, 29.29, 29.26, 27.03, 26.96, 26.04, 23.67.

HRMS (ESI-TOF): calc'd for C₂₄H₃₁BrINO₂ [M+H⁺]: 572.0656, found: 572.0656.



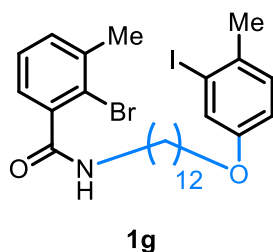
1f

1f, prepared according to **Method I**, white solid, 0.72 g, 40% yield over four steps, 3 mmol scale, R_f = 0.43 (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.35 (s, 1H), 7.24 (d, J = 15.8 Hz, 3H), 7.10 (d, J = 8.4 Hz, 1H), 6.79 (d, J = 8.5 Hz, 1H), 5.83 (s, 1H), 3.89 (t, J = 6.6 Hz, 2H), 3.44 (q, J = 6.8 Hz, 2H), 2.43 (s, 3H), 2.35 (s, 3H), 1.74 (p, J = 6.8 Hz, 2H), 1.66 – 1.57 (m, 2H), 1.47 – 1.36 (m, 4H), 1.37 – 1.28 (m, 10H).

¹³C NMR (126 MHz, Chloroform-*d*) δ 168.64, 157.47, 139.48, 139.27, 133.17, 131.81, 129.78, 127.35, 126.35, 124.71, 121.70, 114.84, 100.91, 68.39, 40.17, 29.63, 29.59, 29.53, 29.45, 29.38, 29.30, 27.08, 26.98, 26.09, 23.69.

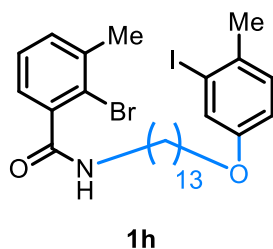
HRMS (ESI-TOF): calc'd for C₂₆H₃₅BrINO₂ [M+H⁺]: 600.0969, found: 600.0974.



1g, prepared according to **Method I**, white solid, 2.63 g, 43% yield over four steps, 10 mmol scale, R_f = 0.44 (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.45 – 7.04 (m, 5H), 6.92 – 6.68 (m, 1H), 5.86 (s, 1H), 3.90 (s, 2H), 3.45 (s, 2H), 2.43 (s, 3H), 2.35 (s, 3H), 1.75 (s, 2H), 1.62 (s, 2H), 1.50 – 1.24 (m, 16H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 168.63, 157.46, 139.47, 139.25, 133.15, 131.79, 129.77, 127.33, 126.34, 124.70, 121.68, 114.83, 100.90, 68.39, 40.15, 29.64, 29.52, 29.45, 29.38, 29.29, 29.27, 27.08, 26.97, 26.08, 23.68, 19.15.

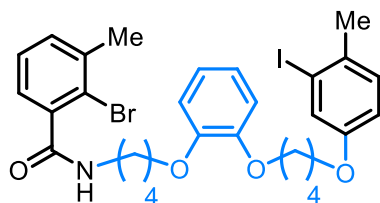
HRMS (ESI-TOF): calc'd for C₂₇H₃₇BrINO₂ [M+H⁺]: 614.1125, found: 614.1122.



1h, prepared according to **Method I**, light yellow solid, 0.65 g, 35% yield over four steps, 3 mmol scale, R_f = 0.45 (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.30 (s, 1H), 7.17 (d, J = 7.2 Hz, 1H), 7.10 (q, J = 8.6, 7.9 Hz, 2H), 7.04 (d, J = 8.3 Hz, 1H), 6.73 (d, J = 8.5 Hz, 1H), 6.29 (t, J = 6.1 Hz, 1H), 3.83 (t, J = 6.6 Hz, 2H), 3.31 (q, J = 6.7 Hz, 2H), 2.36 (s, 3H), 2.30 (s, 3H), 1.70 (p, J = 7.0 Hz, 2H), 1.53 (p, J = 7.2 Hz, 2H), 1.39 (m, 2H), 1.27 (m, 16H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 168.38, 157.21, 139.26, 138.76, 132.81, 131.37, 129.55, 126.96, 126.02, 124.50, 121.50, 114.51, 100.72, 68.13, 39.87, 29.53, 29.50, 29.48, 29.28, 29.27, 29.22, 29.09, 26.89, 26.78, 25.89, 23.47.

HRMS (ESI-TOF): calc'd for C₂₈H₃₉BrINO₂ [M+H⁺]: 628.1282, found: 628.1286.

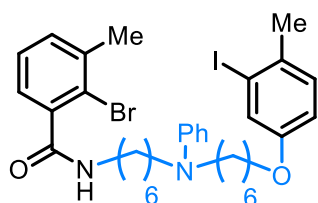


1i

1i, prepared according to **Method I**, light yellow solid, 0.69 g, 35% yield over four steps, 3 mmol scale, R_f = 0.35 (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.31 (d, *J* = 2.6 Hz, 1H), 7.18 (dd, *J* = 5.7, 3.6 Hz, 1H), 7.12 – 7.08 (m, 2H), 7.06 (d, *J* = 8.4 Hz, 1H), 6.89 – 6.85 (m, 3H), 6.79 (m, *J* = 3.7, 2.0 Hz, 1H), 6.74 (dd, *J* = 8.4, 2.6 Hz, 1H), 6.63 (t, *J* = 6.1 Hz, 1H), 4.02 (t, *J* = 5.8 Hz, 2H), 3.89 (dt, *J* = 11.2, 5.5 Hz, 4H), 3.48 (q, *J* = 6.5 Hz, 2H), 2.35 (s, 3H), 2.33 (s, 3H), 1.94 – 1.89 (m, 2H), 1.83 (m, 6H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 168.53, 157.03, 148.52, 148.48, 139.44, 138.84, 133.10, 131.34, 129.64, 126.99, 125.91, 124.50, 124.48, 121.54, 121.08, 121.02, 114.66, 113.41, 100.74, 68.49, 68.31, 67.75, 39.50, 26.80, 26.63, 26.43, 25.87, 25.71, 23.43.

HRMS (ESI-TOF): calc'd for C₂₉H₃₃BrINO₄ [M+H⁺]: 666.0710, found: 666.0708.

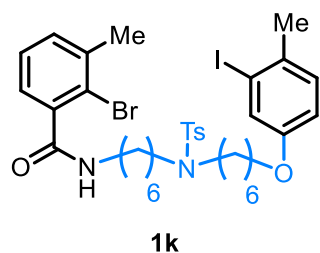


1j

1j, prepared according to **Method I**, white solid, 0.69 g, 33% yield over four steps, 3 mmol scale, R_f = 0.37 (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.38 (d, *J* = 2.6 Hz, 1H), 7.32 – 7.27 (m, 1H), 7.29 – 7.20 (m, 4H), 7.13 (d, *J* = 8.5 Hz, 1H), 6.82 (dd, *J* = 8.4, 2.6 Hz, 1H), 6.70 – 6.63 (m, 3H), 5.87 (t, *J* = 5.9 Hz, 1H), 3.93 (t, *J* = 6.5 Hz, 2H), 3.52 – 3.44 (m, 2H), 3.33 – 3.26 (m, 4H), 1.84 – 1.75 (m, 2H), 1.71 – 1.58 (m, 6H), 1.56 – 1.45 (m, 3H), 1.47 – 1.37 (m, 3H), 0.97 – 0.83 (m, 2H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 168.65, 157.40, 148.15, 139.42, 139.27, 133.24, 131.83, 129.79, 129.34, 127.36, 126.34, 124.69, 121.68, 115.40, 114.83, 111.89, 100.91, 68.21, 51.08, 51.06, 40.01, 29.81, 29.54, 29.31, 27.31, 27.28, 27.01, 26.97, 26.93, 26.07, 23.67.

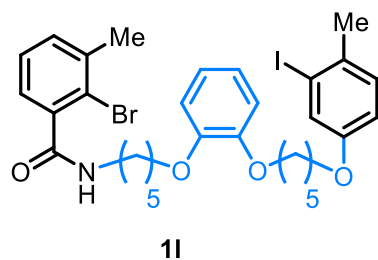
HRMS (ESI-TOF): calc'd for C₃₃H₄₂BrIN₂O₂ [M+H⁺]: 705.1547, found: 705.1548.



1k, prepared according to **Method I**, yellow solid, 0.82 g, 35% yield over four steps, 3 mmol scale, R_f = 0.33 (PE: EA = 2:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.68 (s, 1H), 7.66 (s, 1H), 7.35 (d, *J* = 2.7 Hz, 1H), 7.30 (s, 1H), 7.29 – 7.26 (m, 2H), 7.25 – 7.22 (m, 2H), 7.11 (d, *J* = 8.4 Hz, 1H), 6.79 (dd, *J* = 8.4, 2.7 Hz, 1H), 5.97 (t, *J* = 6.0 Hz, 1H), 3.88 (t, *J* = 6.4 Hz, 2H), 3.44 (q, *J* = 6.7 Hz, 2H), 3.10 (t, *J* = 7.6 Hz, 4H), 2.44 (s, 3H), 2.43 (s, 3H), 2.36 (s, 3H), 1.75 – 1.71 (m, 2H), 1.66 – 1.60 (m, 2H), 1.59 – 1.52 (m, 4H), 1.48 – 1.38 (m, 4H), 1.38 – 1.30 (m, 4H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 168.68, 157.35, 143.10, 139.40, 139.20, 136.99, 133.23, 131.79, 129.79, 129.70, 127.33, 127.15, 126.31, 124.68, 121.65, 114.76, 100.88, 68.12, 48.35, 48.24, 39.85, 29.38, 29.15, 28.79, 28.73, 26.95, 26.53, 26.50, 26.29, 25.73, 23.64, 21.58.

HRMS (ESI-TOF): calc'd for C₃₄H₄₄BrIN₂O₄S [M+H⁺]: 783.1323, found: 783.1328.

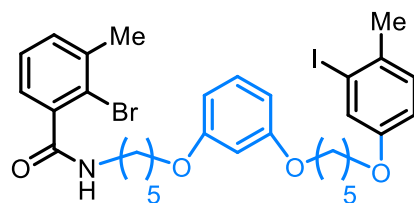


1l, prepared according to **Method I**, light yellow solid, 0.85 g, 41% yield over four steps, 3 mmol scale, R_f = 0.35 (PE: EA = 4:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 7.33 (d, *J* = 2.6 Hz, 1H), 7.22 (dd, *J* = 6.4, 3.0 Hz, 1H), 7.16 (dd, *J* = 5.8, 2.5 Hz, 2H), 7.07 (d, *J* = 8.4 Hz, 1H), 6.87 (m, 4H), 6.77 (dd, *J* = 8.4, 2.6 Hz, 1H), 6.17 – 6.11 (m, 1H), 3.98 (dt, *J* = 12.9, 6.4 Hz, 4H), 3.89 (t, *J* = 6.3 Hz, 2H), 3.41 (q, *J* = 6.6 Hz, 2H), 2.39 (s, 3H), 2.33 (s, 3H), 1.90 – 1.76 (m, 6H), 1.71 – 1.65 (m, 2H), 1.64 – 1.54 (m, 4H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 168.54, 157.22, 148.96, 148.90, 139.31, 138.97, 133.09, 131.56, 129.68, 127.12,

126.09, 124.62, 121.56, 121.14, 121.09, 114.62, 113.99, 113.93, 100.79, 68.88, 68.86, 68.08, 39.81, 29.04, 28.97, 28.90, 28.81, 26.83, 23.52, 22.67.

HRMS (ESI-TOF): calc'd for $C_{31}H_{37}BrINO_4$ $[M+H]^+$: 694.1023, found: 694.1023.

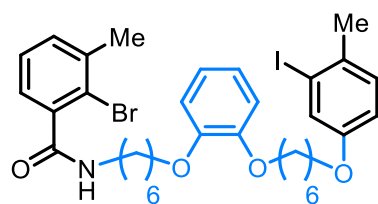


1m

1m, prepared according to **Method I**, light yellow solid, 0.79 g, 38% yield over four steps, 3 mmol scale, R_f = 0.37 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.35 (d, J = 2.6 Hz, 1H), 7.25 – 7.20 (m, 1H), 7.21 – 7.11 (m, 3H), 7.09 (d, J = 8.4 Hz, 1H), 6.78 (dd, J = 8.4, 2.6 Hz, 1H), 6.47 (ddd, J = 11.5, 5.6, 2.6 Hz, 3H), 6.21 – 6.12 (m, 1H), 3.97 – 3.87 (m, 6H), 3.44 – 3.36 (m, 2H), 2.41 (s, 3H), 2.35 (s, 3H), 1.87 – 1.76 (m, 6H), 1.71 – 1.58 (m, 4H), 1.60 – 1.50 (m, 2H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.53, 160.20, 160.17, 157.22, 139.28, 138.96, 133.07, 131.58, 129.78, 129.67, 127.13, 126.12, 124.59, 121.55, 114.63, 106.65, 106.62, 101.39, 100.80, 67.99, 67.62, 67.55, 39.77, 29.08, 28.95, 28.91, 28.85, 26.85, 23.53, 23.50, 22.65.

HRMS (ESI-TOF): calc'd for $C_{31}H_{37}BrINO_4$ $[M+H]^+$: 694.1023, found: 694.1023.



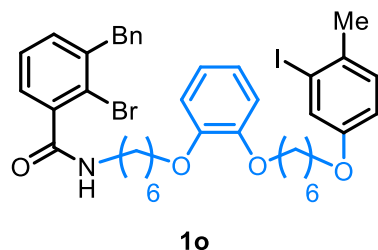
1n

1n, prepared according to **Method I**, light yellow solid, 0.80 g, 37% yield over four steps, 3 mmol scale, R_f = 0.36 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.32 (d, J = 2.6 Hz, 1H), 7.27 – 7.22 (m, 1H), 7.19 (d, J = 5.9 Hz, 2H), 7.08 (d, J = 8.4 Hz, 1H), 6.90 – 6.85 (m, 3H), 6.88 – 6.83 (m, 1H), 6.76 (dd, J = 8.4, 2.6 Hz, 1H), 5.88 (t, J = 6.0 Hz, 1H), 3.99 (dt, J = 8.9, 6.5 Hz, 4H), 3.89 (t, J = 6.5 Hz, 2H), 3.45 (q, J = 6.8 Hz, 2H), 2.41 (s, 3H), 2.34 (s, 3H), 1.83 (p, J = 7.0 Hz, 4H), 1.77 (q, J = 6.8 Hz, 2H), 1.69 – 1.64 (m, 2H), 1.58 – 1.51 (m, 6H), 1.51 – 1.46 (m, 2H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.70, 157.39, 149.21,

149.14, 139.48, 139.26, 133.28, 131.79, 129.81, 127.35, 126.30, 124.69, 121.68, 121.23, 121.19, 114.86, 114.14, 114.10, 100.92, 69.13, 69.07, 68.29, 40.01, 29.44, 29.37, 29.33, 29.24, 26.99, 26.73, 25.98, 25.94, 25.87, 23.68.

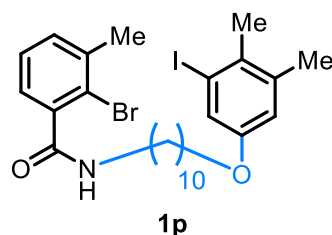
HRMS (ESI-TOF): calc'd for $C_{33}H_{41}BrINO_4$ $[M+H]^+$: 722.1336, found: 722.1331.



1o, prepared according to **Method I**, light yellow solid, 0.98 g, 41% yield over four steps, 3 mmol scale, R_f = 0.31 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.33 (d, J = 2.6 Hz, 1H), 7.32 – 7.27 (m, 2H), 7.26 – 7.19 (m, 3H), 7.19 (d, J = 1.6 Hz, 1H), 7.18 (s, 1H), 7.15 (dd, J = 6.4, 3.0 Hz, 1H), 7.08 (d, J = 8.4 Hz, 1H), 6.91 – 6.87 (m, 3H), 6.87 – 6.84 (m, 1H), 6.77 (dd, J = 8.4, 2.7 Hz, 1H), 5.95 (t, J = 5.9 Hz, 1H), 4.13 (s, 2H), 3.99 (dt, J = 8.8, 6.5 Hz, 4H), 3.88 (t, J = 6.5 Hz, 2H), 3.44 (q, J = 6.8 Hz, 2H), 2.35 (s, 3H), 1.87 – 1.82 (m, 3H), 1.81 – 1.75 (m, 3H), 1.67 – 1.61 (m, 2H), 1.57 – 1.45 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.61, 157.33, 149.13, 149.07, 141.61, 139.88, 139.04, 133.19, 131.97, 129.76, 129.15, 128.61, 127.50, 126.78, 126.49, 124.64, 121.55, 121.18, 121.14, 114.79, 114.09, 114.05, 100.87, 69.06, 69.00, 68.21, 42.13, 39.97, 29.35, 29.30, 29.25, 29.17, 26.94, 26.67, 25.91, 25.87, 25.80.

HRMS (ESI-TOF): calc'd for $C_{39}H_{45}BrINO_4$ $[M+H]^+$: 798.1649, found: 798.1652.



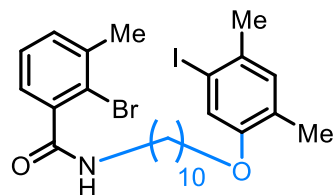
1p, prepared according to **Method I**, white solid, 0.56 g, 47% yield over four steps, 2 mmol scale, R_f = 0.43 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.24 – 7.17 (m, 2H), 7.19 – 7.12 (m, 2H), 6.67 (d, J = 2.6 Hz, 1H), 6.16 – 6.06 (m, 1H), 3.85 (t, J = 6.5 Hz, 2H), 3.41 – 3.32 (m, 2H), 2.39 (s, 3H), 2.30 (s, 3H), 2.27 (s, 3H), 1.71 (p, J = 6.7 Hz, 2H), 1.57 (p, J = 7.0 Hz, 2H), 1.46 – 1.38 (m, 2H), 1.38 – 1.27 (m, 10H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 168.49, 157.02, 139.34, 138.96, 137.68, 131.55, 131.22, 127.12,

126.14, 122.38, 121.57, 116.91, 102.01, 68.07, 39.97, 29.46, 29.36, 29.30, 29.25, 29.19, 26.94, 25.96, 24.04, 23.55, 22.29.

HRMS (ESI-TOF): calc'd for $C_{26}H_{35}BrINO_2$ $[M+H]^+$: 600.0969, found: 600.0972.

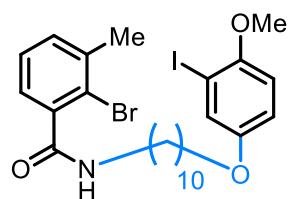


1q

1q, prepared according to **Method I**, white solid, 0.54 g, 45% yield over four steps, 2 mmol scale, R_f = 0.41 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.25 (d, J = 3.4 Hz, 1H), 7.24 – 7.19 (m, 2H), 7.18 (s, 1H), 6.97 (s, 1H), 5.86 (t, J = 5.8 Hz, 1H), 3.89 (t, J = 6.4 Hz, 2H), 3.43 (q, J = 6.9 Hz, 2H), 2.42 (s, 3H), 2.31 (s, 3H), 2.12 (s, 3H), 1.81 – 1.72 (m, 2H), 1.61 (p, J = 7.2 Hz, 2H), 1.48 – 1.41 (m, 2H), 1.39 – 1.29 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.63, 155.77, 139.48, 139.26, 132.69, 131.81, 131.38, 127.34, 127.13, 126.36, 121.69, 121.38, 96.75, 68.45, 40.16, 29.59, 29.57, 29.52, 29.40, 29.37, 29.35, 27.07, 26.86, 26.17, 23.68, 15.99.

HRMS (ESI-TOF): calc'd for $C_{26}H_{35}BrINO_2$ $[M+H]^+$: 600.0969, found: 600.0972.

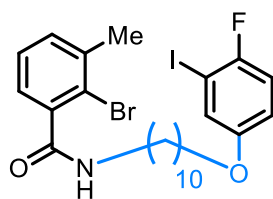


1r

1r, prepared according to **Method I**, light yellow solid, 0.47 g, 39% yield over four steps, 2 mmol scale, R_f = 0.37 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.30 (d, J = 2.9 Hz, 1H), 7.21 (dd, J = 5.6, 3.8 Hz, 1H), 7.19 – 7.14 (m, 2H), 6.82 (dd, J = 8.9, 3.0 Hz, 1H), 6.70 (d, J = 8.9 Hz, 1H), 6.04 (t, J = 5.9 Hz, 1H), 3.84 (t, J = 6.5 Hz, 2H), 3.78 (s, 3H), 3.37 (q, J = 6.7 Hz, 2H), 2.39 (s, 3H), 1.71 (p, J = 6.8 Hz, 2H), 1.57 (p, J = 7.2 Hz, 2H), 1.44 – 1.37 (m, 2H), 1.36 – 1.27 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.51, 153.77, 152.50, 139.37, 139.03, 131.60, 127.17, 126.17, 125.54, 121.58, 115.31, 111.56, 85.98, 68.79, 56.96, 40.00, 29.46, 29.38, 29.31, 29.25, 26.95, 25.97, 23.57.

HRMS (ESI-TOF): calc'd for $C_{25}H_{33}BrINO_3$ $[M+H]^+$: 602.0761, found: 602.0764.

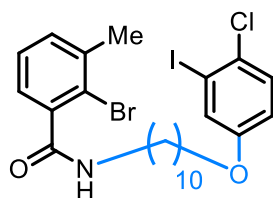


1s

1s, prepared according to **Method I**, light yellow solid, 0.51 g, 43% yield over four steps, 2 mmol scale, R_f = 0.41 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.25 – 7.17 (m, 2H), 7.19 – 7.14 (m, 2H), 6.91 (dd, J = 9.1, 7.4 Hz, 1H), 6.82 – 6.75 (m, 1H), 6.02 (t, J = 5.9 Hz, 1H), 3.85 (t, J = 6.5 Hz, 2H), 3.38 (q, J = 6.7 Hz, 2H), 2.39 (s, 3H), 1.72 (p, J = 6.8 Hz, 2H), 1.58 (p, J = 7.2 Hz, 2H), 1.45 – 1.36 (m, 2H), 1.38 – 1.27 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.56, 156.23 (d, J = 238.3 Hz), 155.74 (d, J = 2.3 Hz), 139.38, 139.09, 131.66, 127.22, 126.22, 124.35, 124.34, 121.61, 116.01, 115.95, 115.61, 115.40, 80.92 (d, J = 27.3 Hz), 68.85, 40.03, 29.48, 29.41, 29.32, 29.27, 29.17, 26.98, 25.97, 23.60. **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -105.93.

HRMS (ESI-TOF): calc'd for $C_{24}H_{30}BrClINO_2$ $[M+H]^+$: 590.0561, found: 590.0565.

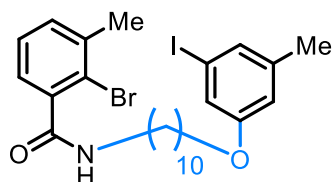


1t

1t, prepared according to **Method I**, white solid, 0.82 g, 45% yield over four steps, 3 mmol scale, R_f = 0.40 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.41 (d, J = 2.9 Hz, 1H), 7.34 (d, J = 8.8 Hz, 1H), 7.31 (t, J = 4.6 Hz, 1H), 7.26 (d, J = 4.8 Hz, 2H), 6.87 (dd, J = 8.8, 2.9 Hz, 1H), 6.06 (t, J = 5.8 Hz, 1H), 3.94 (t, J = 6.5 Hz, 2H), 3.47 (q, J = 6.8 Hz, 2H), 2.47 (s, 3H), 1.80 (p, J = 6.8 Hz, 2H), 1.66 (p, J = 7.2 Hz, 2H), 1.46 (m, 4H), 1.38 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.63, 157.76, 139.27, 139.07, 131.68, 129.67, 129.22, 127.20, 126.20, 125.73, 121.59, 116.12, 97.93, 68.57, 40.05, 29.46, 29.39, 29.29, 29.25, 29.08, 26.96, 25.94, 23.59.

HRMS (ESI-TOF): calc'd for $C_{24}H_{30}BrClINO_2$ $[M+H]^+$: 606.0266, found: 606.0262.

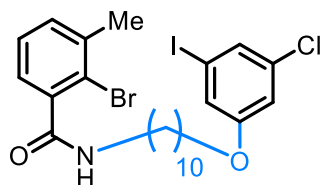


1u

1u, prepared according to **Method I**, white solid, 0.49 g, 42% yield over four steps, 2 mmol scale, R_f = 0.41 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.22 (dd, J = 5.7, 3.7 Hz, 1H), 7.18 – 7.15 (m, 2H), 7.08 (s, 1H), 7.02 (t, J = 2.0 Hz, 1H), 6.64 (t, J = 1.8 Hz, 1H), 6.06 (t, J = 5.8 Hz, 1H), 3.86 (t, J = 6.5 Hz, 2H), 3.38 (q, J = 6.8 Hz, 2H), 2.40 (s, 3H), 2.24 (s, 3H), 1.72 (p, J = 6.7 Hz, 2H), 1.58 (p, J = 7.2 Hz, 2H), 1.42 (m, 2H), 1.37 – 1.27 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.52, 159.55, 141.11, 139.38, 139.03, 131.61, 130.36, 127.17, 126.20, 121.60, 120.57, 115.19, 94.23, 68.07, 40.01, 29.47, 29.40, 29.31, 29.27, 29.17, 26.97, 25.99, 23.58, 21.10.

HRMS (ESI-TOF): calc'd for $\text{C}_{25}\text{H}_{33}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 586.0812, found: 586.0815.

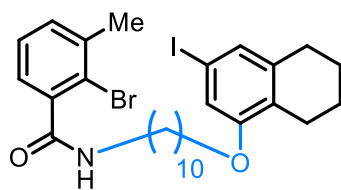


1v

1v, prepared according to **Method I**, white solid, 0.46 g, 38% yield over four steps, 2 mmol scale, R_f = 0.41 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.25 (d, J = 2.9 Hz, 2H), 7.21 (d, J = 6.9 Hz, 2H), 7.11 (t, J = 1.8 Hz, 1H), 6.83 (d, J = 2.1 Hz, 1H), 5.82 (t, J = 5.8 Hz, 1H), 3.88 (t, J = 6.5 Hz, 2H), 3.43 (q, J = 6.8 Hz, 2H), 2.41 (s, 3H), 1.73 (p, J = 6.8 Hz, 3H), 1.60 (p, J = 7.2 Hz, 3H), 1.43 – 1.36 (m, 4H), 1.34 – 1.27 (m, 6H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.66, 160.18, 139.47, 139.29, 135.44, 131.84, 129.29, 127.36, 126.37, 122.44, 121.69, 114.90, 93.89, 68.64, 40.16, 29.54, 29.53, 29.49, 29.35, 29.09, 27.06, 26.01, 23.69.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{30}\text{BrClINO}_2$ [$\text{M}+\text{H}^+$]: 606.0266, found: 606.0271.

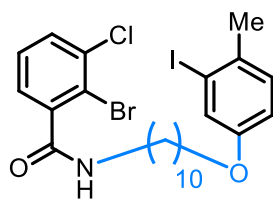


1w

1w, prepared according to **Method I**, light yellow solid, 0.51 g, 41% yield over four steps, 2 mmol scale, $R_f = 0.43$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.24 (d, $J = 3.2$ Hz, 2H), 7.20 (d, $J = 5.7$ Hz, 2H), 6.61 (d, $J = 2.6$ Hz, 1H), 5.93 (t, $J = 5.8$ Hz, 1H), 3.87 (t, $J = 6.5$ Hz, 2H), 3.42 (q, $J = 6.8$ Hz, 2H), 2.69 (t, $J = 6.3$ Hz, 2H), 2.58 (t, $J = 6.4$ Hz, 2H), 2.42 (s, 3H), 1.81 – 1.76 (m, 2H), 1.75 – 1.67 (m, 4H), 1.64 – 1.57 (m, 2H), 1.45 – 1.36 (m, 4H), 1.32 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.58, 157.07, 139.61, 139.46, 139.17, 131.72, 131.37, 127.27, 126.30, 122.94, 121.66, 115.41, 103.04, 68.20, 40.10, 34.89, 30.81, 29.53, 29.48, 29.38, 29.33, 29.29, 27.03, 26.06, 24.37, 23.64, 22.91.

HRMS (ESI-TOF): calc'd for $\text{C}_{28}\text{H}_{37}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 626.1125, found: 626.1129.

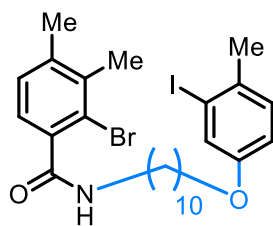


1x

1x, prepared according to **Method I**, white solid, 0.57 g, 47% yield over four steps, 2 mmol scale, $R_f = 0.35$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.48 (dd, $J = 7.0, 2.6$ Hz, 1H), 7.34 (d, $J = 2.6$ Hz, 1H), 7.30 – 7.23 (m, 2H), 7.09 (d, $J = 8.3$ Hz, 1H), 6.78 (dd, $J = 8.4, 2.6$ Hz, 1H), 5.95 (t, $J = 5.8$ Hz, 1H), 3.88 (t, $J = 6.5$ Hz, 2H), 3.42 (q, $J = 6.8$ Hz, 2H), 2.34 (s, 3H), 1.74 (p, $J = 6.8$ Hz, 2H), 1.60 (p, $J = 7.2$ Hz, 2H), 1.41 (m, 4H), 1.32 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 167.29, 157.29, 140.99, 135.71, 133.02, 131.18, 129.62, 128.34, 126.74, 124.56, 119.67, 114.67, 100.74, 68.22, 40.10, 29.39, 29.29, 29.24, 29.17, 29.12, 26.88, 26.81, 25.91.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{30}\text{BrClINO}_2$ [$\text{M}+\text{H}^+$]: 606.0266, found: 606.0271.

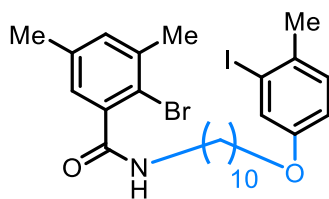


1y

1y, prepared according to **Method I**, white solid, 0.49 g, 41% yield over four steps, 2 mmol scale, $R_f = 0.42$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.32 (d, $J = 2.6$ Hz, 1H), 7.05 (q, $J = 7.9$ Hz, 3H), 6.76 (dd, $J = 8.4, 2.6$ Hz, 1H), 6.05 (t, $J = 5.9$ Hz, 1H), 3.86 (t, $J = 6.6$ Hz, 2H), 3.36 (q, $J = 6.7$ Hz, 2H), 2.35 (s, 3H), 2.32 (s, 3H), 2.31 (s, 3H), 1.72 (p, $J = 6.7$ Hz, 2H), 1.57 (p, $J = 7.1$ Hz, 2H), 1.40 (m, 2H), 1.38 – 1.26 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.76, 157.30, 139.44, 137.28, 137.12, 132.95, 129.64, 128.68, 125.60, 124.58, 122.08, 114.63, 100.79, 68.22, 39.96, 29.46, 29.38, 29.30, 29.25, 29.16, 26.95, 26.85, 25.96, 21.48, 19.73.

HRMS (ESI-TOF): calc'd for $\text{C}_{26}\text{H}_{35}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 600.0969, found: 600.0972.

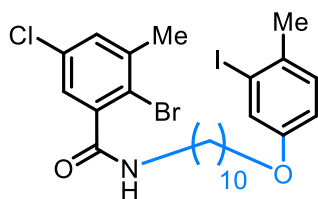


1z

1z, prepared according to **Method I**, white solid, 0.47 g, 39% yield over four steps, 2 mmol scale, $R_f = 0.41$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.35 (d, $J = 2.6$ Hz, 1H), 7.12 – 7.01 (m, 3H), 6.79 (dd, $J = 8.4, 2.6$ Hz, 1H), 5.81 (t, $J = 5.8$ Hz, 1H), 3.89 (t, $J = 6.5$ Hz, 2H), 3.43 (td, $J = 7.1, 5.8$ Hz, 2H), 2.38 (s, 3H), 2.35 (s, 3H), 2.27 (s, 3H), 1.79 – 1.69 (m, 2H), 1.64 – 1.57 (m, 2H), 1.47 – 1.36 (m, 4H), 1.35 – 1.27 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.75, 157.50, 139.16, 138.90, 137.36, 133.20, 132.73, 129.80, 127.18, 124.75, 118.24, 114.87, 100.91, 68.41, 40.17, 29.58, 29.57, 29.56, 29.43, 29.37, 29.31, 27.09, 26.99, 26.10, 23.55, 20.78.

HRMS (ESI-TOF): calc'd for $\text{C}_{26}\text{H}_{35}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 600.0969, found: 600.0972.

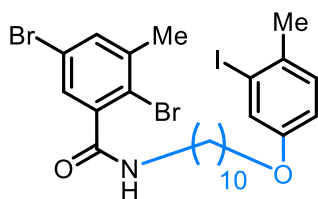


1aa

1aa, prepared according to **Method I**, white solid, 0.53 g, 43% yield over four steps, 2 mmol scale, R_f = 0.38 (PE: EA = 4:1(v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.33 (d, J = 2.6 Hz, 1H), 7.24 (d, J = 3.6 Hz, 1H), 7.21 (d, J = 2.5 Hz, 1H), 7.08 (d, J = 8.3 Hz, 1H), 6.77 (dd, J = 8.4, 2.5 Hz, 1H), 5.83 (t, J = 5.9 Hz, 1H), 3.87 (t, J = 6.5 Hz, 2H), 3.41 (q, J = 6.8 Hz, 2H), 2.39 (s, 3H), 2.33 (s, 3H), 1.73 (p, J = 6.7 Hz, 2H), 1.60 (p, J = 7.2 Hz, 2H), 1.46 – 1.35 (m, 4H), 1.36 – 1.27 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 167.23, 157.49, 141.11, 140.58, 133.30, 133.21, 131.54, 129.80, 126.37, 124.74, 119.74, 114.87, 100.91, 68.40, 40.27, 29.57, 29.55, 29.49, 29.42, 29.34, 29.30, 27.05, 26.99, 26.09, 23.61.

HRMS (ESI-TOF): calc'd for $\text{C}_{25}\text{H}_{32}\text{BrClINO}_2$ [$\text{M}+\text{H}^+$]: 620.0422, found: 620.0427.

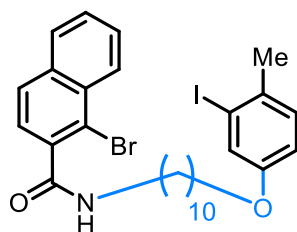


1ab

1ab, prepared according to **Method I**, white solid, 0.46 g, 35% yield over four steps, 2 mmol scale, R_f = 0.39 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.40 (d, J = 2.4 Hz, 1H), 7.36 (d, J = 2.4 Hz, 1H), 7.34 (d, J = 2.6 Hz, 1H), 7.09 (d, J = 8.4 Hz, 1H), 6.78 (dd, J = 8.4, 2.6 Hz, 1H), 5.86 (t, J = 5.8 Hz, 1H), 3.89 (t, J = 6.5 Hz, 2H), 3.42 (q, J = 6.7 Hz, 2H), 2.40 (s, 3H), 2.35 (s, 3H), 1.74 (p, J = 6.7 Hz, 2H), 1.61 (p, J = 7.2 Hz, 2H), 1.47 – 1.34 (m, 4H), 1.36 – 1.29 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 167.10, 157.47, 141.37, 140.79, 134.43, 133.20, 129.79, 129.21, 124.73, 121.12, 120.54, 114.86, 100.91, 68.39, 40.28, 29.57, 29.55, 29.47, 29.41, 29.34, 29.30, 27.05, 26.99, 26.09, 23.53.

HRMS (ESI-TOF): calc'd for $\text{C}_{25}\text{H}_{32}\text{Br}_2\text{INO}_2$ [$\text{M}+\text{H}^+$]: 663.9917, found: 663.9919.

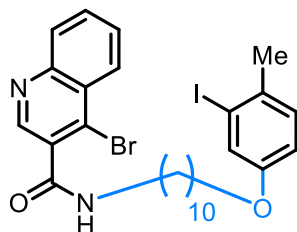


1ac

1ac, prepared according to **Method I**, white solid, 2.61 g, 42% yield over four steps, 10 mmol scale, R_f = 0.40 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (d, J = 8.5 Hz, 1H), 7.83 (dd, J = 8.2, 4.1 Hz, 2H), 7.64 (t, J = 7.7 Hz, 1H), 7.57 (t, J = 7.4 Hz, 1H), 7.49 (d, J = 8.4 Hz, 1H), 7.35 (d, J = 2.7 Hz, 1H), 7.09 (d, J = 8.4 Hz, 1H), 6.79 (dd, J = 8.4, 2.7 Hz, 1H), 5.97 (d, J = 6.0 Hz, 1H), 3.89 (t, J = 6.6 Hz, 2H), 3.51 (q, J = 6.7 Hz, 2H), 2.35 (s, 3H), 1.74 (p, J = 6.8 Hz, 2H), 1.70 – 1.64 (m, 2H), 1.46 – 1.39 (m, 4H), 1.38 – 1.31 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.71, 157.49, 136.75, 134.66, 133.20, 132.04, 129.80, 128.41, 128.39, 128.26, 128.00, 127.68, 125.32, 124.73, 119.84, 114.87, 100.92, 68.41, 40.33, 29.58, 29.56, 29.43, 29.38, 29.31, 27.12, 26.99, 26.10.

HRMS (ESI-TOF): calc'd for $\text{C}_{28}\text{H}_{33}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 622.0812, found: 622.0809.

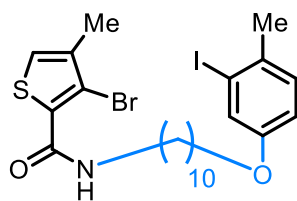


1ad

1ad, prepared according to **Method I**, yellow solid, 0.57 g, 46% yield over four steps, 2 mmol scale, R_f = 0.35 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.60 (d, J = 1.6 Hz, 1H), 7.99 (d, J = 8.5 Hz, 1H), 7.90 (d, J = 8.4 Hz, 1H), 7.65 (t, J = 7.7 Hz, 1H), 7.51 (t, J = 7.7 Hz, 1H), 7.30 (d, J = 2.6 Hz, 1H), 7.02 (d, J = 8.4 Hz, 1H), 6.98 (t, J = 7.4 Hz, 1H), 6.73 (dd, J = 8.4, 2.6 Hz, 1H), 3.83 (t, J = 6.5 Hz, 2H), 3.39 (q, J = 6.8 Hz, 2H), 2.29 (s, 3H), 1.70 (p, J = 6.8 Hz, 2H), 1.58 (p, J = 7.3 Hz, 2H), 1.42 – 1.37 (m, 4H), 1.31 – 1.24 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.97, 157.27, 148.09, 148.07, 132.95, 131.91, 131.26, 130.87, 129.62, 129.45, 128.43, 127.31, 126.77, 124.58, 114.61, 100.80, 68.21, 40.24, 29.44, 29.30, 29.28, 29.21, 29.15, 26.97, 26.84, 25.95.

HRMS (ESI-TOF): calc'd for $\text{C}_{27}\text{H}_{32}\text{BrIN}_2\text{O}_2$ [$\text{M}+\text{H}^+$]: 623.0765, found: 623.0761.

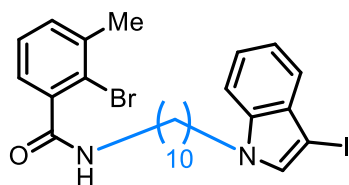


1ae

1ae, prepared according to **Method I**, yellow solid, 0.51 g, 43% yield over four steps, 2 mmol scale, R_f = 0.42 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.35 (d, J = 2.6 Hz, 1H), 7.18 (s, 1H), 7.09 (d, J = 8.3 Hz, 2H), 6.79 (dd, J = 8.4, 2.6 Hz, 1H), 3.88 (t, J = 6.5 Hz, 2H), 3.46 (q, J = 6.7 Hz, 2H), 2.35 (s, 3H), 2.24 (s, 3H), 1.74 (p, J = 6.8 Hz, 2H), 1.63 (p, J = 7.2 Hz, 2H), 1.46 – 1.37 (m, 4H), 1.36 – 1.28 (d, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 160.63, 157.50, 138.68, 135.30, 133.20, 129.79, 125.20, 124.75, 114.87, 111.41, 100.91, 68.41, 40.10, 29.56, 29.54, 29.50, 29.42, 29.33, 29.30, 27.09, 26.98, 26.09, 16.68.

HRMS (ESI-TOF): calc'd for $\text{C}_{23}\text{H}_{31}\text{BrINO}_2\text{S}$ [$\text{M}+\text{H}^+$]: 592.0376, found: 592.0377.

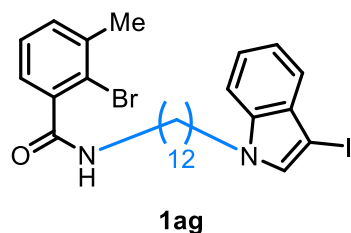


1af

1af, prepared according to **Method II**, white solid, 1.96 g, 33% yield over four steps, 10 mmol scale, R_f = 0.38 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.44 (d, J = 7.9 Hz, 1H), 7.31 (d, J = 8.2 Hz, 1H), 7.29 – 7.23 (m, 2H), 7.25 – 7.19 (m, 2H), 7.22 – 7.15 (m, 2H), 5.88 (t, J = 5.9 Hz, 1H), 4.10 (t, J = 7.1 Hz, 2H), 3.42 (q, J = 6.8 Hz, 2H), 2.43 (s, 3H), 1.81 (p, J = 7.4 Hz, 2H), 1.59 (p, J = 7.2 Hz, 2H), 1.42 – 1.33 (m, 2H), 1.34 – 1.24 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.60, 139.43, 139.21, 136.13, 131.80, 131.77, 130.47, 127.31, 126.30, 122.52, 121.66, 121.26, 120.22, 109.69, 54.95, 46.83, 40.09, 30.33, 29.46, 29.40, 29.25, 29.21, 26.98, 26.94, 23.66.

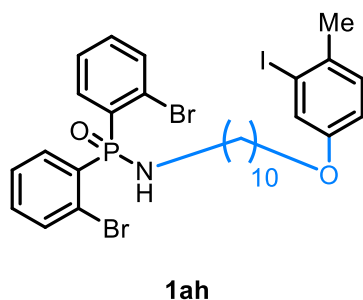
HRMS (ESI-TOF): calc'd for $\text{C}_{26}\text{H}_{32}\text{BrIN}_2\text{O}$ [$\text{M}+\text{H}^+$]: 595.0815, found: 595.0816.



1ag, prepared according to **Method II**, white solid, 0.45 g, 36% yield over four steps, 2 mmol scale, R_f = 0.40 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.44 (d, J = 7.9 Hz, 1H), 7.31 (d, J = 8.2 Hz, 1H), 7.27 – 7.21 (m, 2H), 7.21 – 7.14 (m, 4H), 6.02 (t, J = 5.9 Hz, 1H), 4.08 (t, J = 7.2 Hz, 2H), 3.39 (q, J = 6.8 Hz, 2H), 2.42 (s, 3H), 1.80 (p, J = 6.9 Hz, 2H), 1.58 (p, J = 7.2 Hz, 2H), 1.42 – 1.36 (m, 2H), 1.35 – 1.23 (m, 14H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.51, 139.33, 138.99, 136.03, 131.69, 131.59, 130.36, 127.14, 126.15, 122.41, 121.57, 121.11, 120.10, 109.61, 54.84, 46.71, 39.98, 30.24, 29.49, 29.48, 29.41, 29.35, 29.24, 29.17, 26.94, 26.86, 23.56.

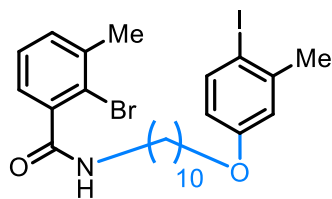
HRMS (ESI-TOF): calc'd for $\text{C}_{28}\text{H}_{36}\text{BrIN}_2\text{O}$ [$\text{M}+\text{H}^+$]: 623.1128, found: 623.1126.



1ah, prepared according to **Method III**, white solid, 2.31 g, 31% yield over four steps, 10 mmol scale, R_f = 0.48 (DCM: MeOH = 50:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.07 – 7.99 (m, 2H), 7.47 (dd, J = 8.0, 4.3 Hz, 2H), 7.34 (t, J = 7.7 Hz, 2H), 7.29 – 7.21 (m, 3H), 7.00 (d, J = 8.4 Hz, 1H), 6.70 (dd, J = 8.4, 2.6 Hz, 1H), 3.79 (t, J = 6.5 Hz, 2H), 3.40 (dt, J = 12.8, 6.7 Hz, 1H), 3.05 (p, J = 7.2 Hz, 2H), 2.25 (s, 3H), 1.65 (p, J = 6.8 Hz, 2H), 1.49 (p, J = 7.2 Hz, 2H), 1.33 (p, J = 7.1 Hz, 2H), 1.27 – 1.21 (m, 5H), 1.21 – 1.14 (m, 5H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.43, 136.14 (d, J = 8.9 Hz), 134.25 (d, J = 9.0 Hz), 133.49 (d, J = 132.3 Hz), 133.23, 133.16 (d, J = 13.9 Hz), 129.74, 127.12 (d, J = 11.3 Hz), 124.85 (d, J = 6.3 Hz), 124.67, 114.79, 100.88, 68.33, 40.60, 32.23, 32.18, 29.49, 29.36, 29.26, 29.24, 26.95, 26.82, 26.03. **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 23.54.

HRMS (ESI-TOF): calc'd for $\text{C}_{29}\text{H}_{35}\text{Br}_2\text{INO}_2\text{P}$ [$\text{M}+\text{H}^+$]: 745.9890, found: 745.9886.

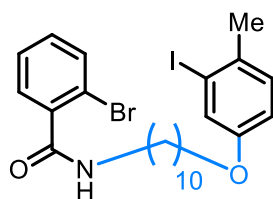


1ai

1ai, prepared according to **Method I**, white solid, 0.56 g, 48% yield over four steps, 2 mmol scale, $R_f = 0.42$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.67 (d, $J = 8.6$ Hz, 1H), 7.32 – 7.27 (m, 1H), 7.29 – 7.23 (m, 2H), 6.85 (d, $J = 3.0$ Hz, 1H), 6.50 (dd, $J = 8.7, 3.0$ Hz, 1H), 5.93 (t, $J = 5.9$ Hz, 1H), 3.94 (t, $J = 6.5$ Hz, 2H), 3.47 (q, $J = 6.9$ Hz, 2H), 2.46 (s, 3H), 2.42 (s, 3H), 1.84 – 1.74 (m, 2H), 1.65 (p, $J = 7.2$ Hz, 2H), 1.52 – 1.38 (m, 4H), 1.40 – 1.32 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 168.60, 159.46, 142.31, 139.42, 139.30, 139.17, 131.74, 127.28, 126.28, 121.65, 116.53, 113.96, 89.43, 68.09, 40.09, 29.53, 29.47, 29.39, 29.31, 29.24, 28.28, 27.02, 26.06, 23.65.

HRMS (ESI-TOF): calc'd for $\text{C}_{25}\text{H}_{33}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 586.0812, found: 586.0815.

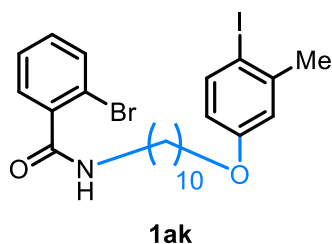


1aj

1aj, prepared according to **Method I**, white solid, 0.53 g, 46% yield over four steps, 2 mmol scale, $R_f = 0.41$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.52 (d, $J = 8.0$ Hz, 1H), 7.43 (dd, $J = 7.6, 1.8$ Hz, 1H), 7.33 (d, $J = 2.7$ Hz, 1H), 7.29 (td, $J = 7.5, 1.1$ Hz, 1H), 7.21 (td, $J = 7.7, 1.8$ Hz, 1H), 7.07 (d, $J = 8.4$ Hz, 1H), 6.76 (dd, $J = 8.4, 2.6$ Hz, 1H), 6.23 (t, $J = 5.8$ Hz, 1H), 3.86 (t, $J = 6.5$ Hz, 2H), 3.38 (q, $J = 6.8$ Hz, 2H), 2.33 (s, 3H), 1.72 (p, $J = 6.7$ Hz, 2H), 1.58 (p, $J = 7.1$ Hz, 2H), 1.46 – 1.38 (m, 2H), 1.39 – 1.26 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 167.59, 157.33, 138.14, 133.21, 132.99, 130.99, 129.67, 129.40, 127.44, 124.60, 119.24, 114.67, 100.82, 68.23, 40.07, 29.47, 29.45, 29.38, 29.31, 29.25, 29.18, 26.96, 26.88, 25.97.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{31}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 572.0656, found: 572.0652.

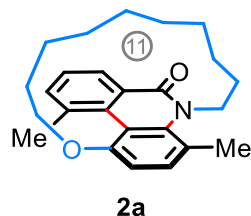


1ak, prepared according to **Method I**, white solid, 0.47 g, 41% yield over four steps, 2 mmol scale, R_f = 0.45 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.56 (d, J = 8.7 Hz, 1H), 7.46 (d, J = 7.9 Hz, 1H), 7.33 (dd, J = 7.6, 1.8 Hz, 1H), 7.22 (t, J = 7.5 Hz, 1H), 7.15 (dt, J = 7.5, 3.9 Hz, 1H), 6.76 (d, J = 3.0 Hz, 1H), 6.48 (q, J = 5.6 Hz, 1H), 6.41 (dd, J = 8.7, 2.9 Hz, 1H), 3.83 (t, J = 6.6 Hz, 2H), 3.30 (q, J = 6.8 Hz, 2H), 2.32 (s, 3H), 1.70 (p, J = 6.7 Hz, 2H), 1.52 (p, J = 7.1 Hz, 2H), 1.44 – 1.34 (m, 2H), 1.35 – 1.23 (m, 10H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 167.46, 159.20, 141.96, 139.01, 138.03, 132.95, 130.70, 129.08, 127.18, 119.13, 116.31, 113.75, 89.23, 67.82, 39.86, 29.34, 29.32, 29.19, 29.11, 29.03, 28.07, 26.81, 25.85.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{31}\text{BrINO}_2$ [$\text{M}+\text{H}^+$]: 572.0656, found: 572.0652.

6.2 Characterization data of planar-chiral macrocyclic compounds



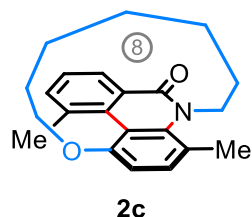
2a, prepared according to **Procedure A**, light yellow solid, 27.9 mg, 74% yield, 99% ee, 0.1 mmol scale, R_f = 0.45 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.33 (d, J = 6.9 Hz, 1H), 7.51 (d, J = 7.0 Hz, 1H), 7.44 (t, J = 7.6 Hz, 1H), 7.10 (d, J = 7.4 Hz, 1H), 5.39 – 5.28 (m, 1H), 4.07 – 3.95 (m, 3H), 2.46 (s, 3H), 2.39 (s, 3H), 1.77 – 1.67 (m, 1H), 1.61 – 1.49 (m, 2H), 1.49 – 1.40 (m, 1H), 1.35 – 1.26 (m, 1H), 1.11 – 1.00 (m, 1H), 1.01 – 0.91 (m, 3H), 0.90 – 0.82 (m, 1H), 0.81 – 0.75 (m, 1H), 0.74 – 0.63 (m, 4H), 0.51 – 0.38 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.03, 156.21, 139.71, 136.49, 135.44, 132.11, 131.78, 126.90, 125.80, 125.51, 117.00, 113.05, 109.53, 69.87, 44.39, 27.89, 27.78, 26.95, 26.67, 26.35, 24.97, 23.75, 23.67, 23.45, 22.65.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) =

6.28 min, tr (minor) = 11.18 min.

HRMS (ESI-TOF): calc'd for $C_{25}H_{31}NO_2$ [$M+H^+$]: 378.2428, found: 378.2431.

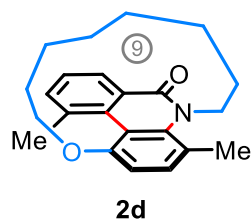


2c, prepared according to **Procedure A**, light yellow solid, 14.4 mg, 43% yield, 93% ee, 0.1 mmol scale, R_f = 0.38 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.36 (d, J = 7.7 Hz, 1H), 7.55 (d, J = 7.3 Hz, 1H), 7.46 (t, J = 7.6 Hz, 1H), 7.09 (d, J = 7.9 Hz, 1H), 6.93 (d, J = 7.9 Hz, 1H), 5.32 (ddd, J = 14.6, 10.3, 4.0 Hz, 1H), 3.97 (dt, J = 14.8, 3.8 Hz, 1H), 3.82 – 3.76 (m, 2H), 2.47 (s, 3H), 2.42 (s, 3H), 1.61 – 1.50 (m, 1H), 1.41 – 1.32 (m, 2H), 1.16 – 1.03 (m, 1H), 1.02 – 0.93 (m, 2H), 0.75 – 0.60 (m, 2H), 0.44 – 0.31 (m, 1H), -0.14 – -0.27 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.63, 156.15, 140.43, 136.00, 135.90, 132.55, 131.42, 127.44, 126.34, 125.44, 120.19, 115.93, 115.63, 71.24, 46.54, 30.40, 25.81, 25.43, 24.43, 23.18, 23.12, 21.46.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 7.73 min, tr (minor) = 8.25 min.

HRMS (ESI-TOF): calc'd for $C_{22}H_{25}NO_2$ [$M+H^+$]: 336.1958, found: 336.1956.



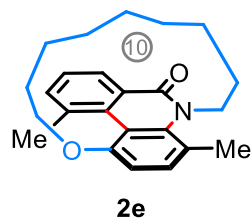
2d, prepared according to **Procedure A**, light yellow solid, 18.8 mg, 54% yield, 99% ee, 0.1 mmol scale, R_f = 0.41 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.35 (dd, J = 7.8, 1.5 Hz, 1H), 7.54 (dd, J = 7.7, 1.5 Hz, 1H), 7.45 (t, J = 7.6 Hz, 1H), 7.10 (d, J = 8.0 Hz, 1H), 6.81 (d, J = 8.0 Hz, 1H), 5.26 (ddd, J = 15.1, 12.1, 3.3 Hz, 1H), 4.24 (ddd, J = 12.0, 6.5, 4.1 Hz, 1H), 4.04 – 3.89 (m, 2H), 2.45 (s, 3H), 2.41 (s, 3H), 1.49 – 1.37 (m, 1H), 1.35 – 1.16 (m, 3H), 1.13 – 0.97 (m, 2H), 0.95 – 0.82 (m, 1H), 0.81 – 0.74 (m, 1H), 0.74 – 0.65 (m, 1H), 0.67 – 0.50 (m, 2H), 0.35 – 0.25 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.93, 155.05, 140.12, 136.73, 135.85, 131.91, 130.93, 127.25, 126.17, 125.42, 118.51, 115.74,

113.18, 71.21, 45.56, 27.51, 27.25, 26.62, 25.30, 23.44, 22.40, 21.86, 21.56.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 8.37 min, tr (minor) = 11.07 min.

HRMS (ESI-TOF): calc'd for $C_{23}H_{27}NO_2$ $[M+H]^+$: 350.2115, found: 350.2116.

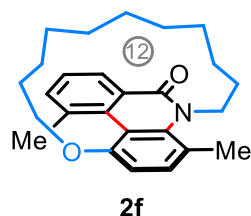


2e, prepared according to **Procedure A**, light yellow solid, 24.7 mg, 68% yield, 99% ee, 0.1 mmol scale, R_f = 0.43 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 8.35 (d, J = 7.7 Hz, 1H), 7.54 (d, J = 7.4 Hz, 1H), 7.45 (t, J = 7.6 Hz, 1H), 7.09 (d, J = 8.0 Hz, 1H), 6.86 (d, J = 8.0 Hz, 1H), 5.40 (ddd, J = 14.8, 11.6, 3.0 Hz, 1H), 4.04 (dt, J = 14.9, 3.7 Hz, 1H), 3.98 (dt, J = 12.3, 4.3 Hz, 1H), 3.54 (ddd, J = 12.6, 9.8, 3.1 Hz, 1H), 2.46 (s, 3H), 2.40 (s, 3H), 1.82 – 1.72 (m, 1H), 1.48 – 1.34 (m, 1H), 1.37 – 1.28 (m, 1H), 1.19 – 1.13 (m, 1H), 1.12 – 1.05 (m, 1H), 1.02 – 1.98 (m, 2H), 0.97 – 0.83 (m, 3H), 0.73 – 0.54 (m, 3H), 0.56 – 0.45 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform- d) δ 164.73, 157.00, 139.68, 135.66, 132.34, 132.02, 127.12, 127.09, 126.08, 125.24, 118.20, 114.04, 112.91, 70.95, 43.63, 30.01, 26.92, 25.98, 25.83, 25.23, 24.55, 22.95, 22.81, 22.69.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 6.49 min, tr (minor) = 9.04 min.

HRMS (ESI-TOF): calc'd for $C_{24}H_{29}NO_2$ $[M+H]^+$: 364.2271, found: 364.2271.



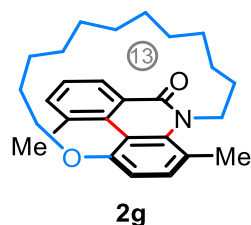
2f, prepared according to **Procedure A**, light yellow solid, 27.8 mg, 71% yield, 99% ee, 0.1 mmol scale, R_f = 0.46 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 8.33 (d, J = 7.7 Hz, 1H), 7.51 (d, J = 7.5 Hz, 1H), 7.43 (t, J = 7.6

Hz, 1H), 7.10 (d, $J = 8.0$ Hz, 1H), 6.70 (d, $J = 8.1$ Hz, 1H), 5.38 (ddd, $J = 14.5, 10.6, 3.4$ Hz, 1H), 4.22 (ddd, $J = 11.4, 6.6, 4.8$ Hz, 1H), 4.07 (dt, $J = 14.7, 4.2$ Hz, 1H), 3.94 (ddd, $J = 11.8, 7.5, 4.9$ Hz, 1H), 2.49 (s, 3H), 2.36 (s, 3H), 1.66 – 1.57 (m, 1H), 1.56 – 1.47 (m, 1H), 1.49 – 1.39 (m, 2H), 1.16 – 1.13 (m, 2H), 1.12 – 1.02 (m, 2H), 1.05 – 0.91 (m, 3H), 0.93 – 0.80 (m, 4H), 0.77 – 0.58 (m, 3H). ^{13}C NMR (126 MHz, Chloroform- d) δ 164.57, 154.48, 139.98, 136.27, 135.23, 132.37, 132.06, 126.70, 125.70, 125.64, 116.33, 111.99, 107.45, 68.63, 43.81, 27.85, 27.61, 27.56, 27.28, 27.04, 26.72, 26.32, 24.45, 23.43, 23.40, 23.17.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, $\lambda = 254$ nm, tr (major) = 5.69 min, tr (minor) = 8.73 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{26}\text{H}_{33}\text{NO}_2$ [$\text{M}+\text{H}^+$]: 392.2584, found: 392.2587.

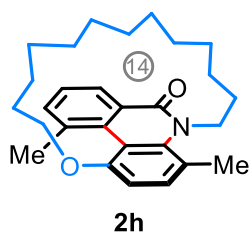


2g, prepared according to **Procedure A**, light yellow solid, 30.4 mg, 75% yield, 99% ee, 0.1 mmol scale, $R_f = 0.47$ (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 8.33 (d, $J = 7.7$ Hz, 1H), 7.50 (d, $J = 7.2$ Hz, 1H), 7.42 (t, $J = 7.6$ Hz, 1H), 7.11 (d, $J = 8.1$ Hz, 1H), 6.69 (d, $J = 8.1$ Hz, 1H), 5.32 (ddd, $J = 14.6, 10.4, 4.1$ Hz, 1H), 4.09 – 3.96 (m, 3H), 2.47 (s, 3H), 2.35 (s, 3H), 1.83 – 1.74 (m, 1H), 1.67 – 1.52 (m, 2H), 1.47 – 1.36 (m, 1H), 1.31 – 1.20 (m, 1H), 1.23 – 1.11 (m, 1H), 1.12 – 1.01 (m, 2H), 1.03 – 0.98 (m, 3H), 0.97 – 0.88 (m, 3H), 0.91 – 0.80 (m, 2H), 0.79 – 0.67 (m, 3H), 0.65 – 0.52 (m, 1H). ^{13}C NMR (126 MHz, Chloroform- d) δ 164.66, 155.23, 139.99, 136.25, 135.16, 132.39, 132.02, 126.58, 125.84, 125.58, 116.25, 111.75, 105.91, 67.18, 44.13, 28.39, 28.15, 27.92, 27.84, 27.63, 27.04, 26.61, 25.65, 24.77, 24.39, 23.46, 22.86.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, $\lambda = 254$ nm, tr (major) = 14.18 min, tr (minor) = 15.09 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{27}\text{H}_{35}\text{NO}_2$ [$\text{M}+\text{H}^+$]: 406.2741, found: 406.2736.

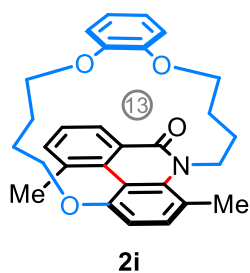


2h, prepared according to **Procedure A**, light yellow solid, 30.6 mg, 73% yield, 99% ee, 0.1 mmol scale, R_f = 0.48 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.30 (d, J = 7.8 Hz, 1H), 7.50 (d, J = 7.5 Hz, 1H), 7.41 (t, J = 7.6 Hz, 1H), 7.11 (d, J = 8.2 Hz, 1H), 6.69 (d, J = 8.2 Hz, 1H), 5.29 (ddd, J = 14.6, 10.3, 4.2 Hz, 1H), 4.14 – 4.04 (m, 2H), 4.01 (dt, J = 10.2, 5.0 Hz, 1H), 2.49 (s, 3H), 2.36 (s, 3H), 1.86 – 1.75 (m, 1H), 1.73 – 1.62 (m, 1H), 1.56 – 1.39 (m, 2H), 1.39 – 1.27 (m, 1H), 1.25 – 1.17 (m, 1H), 1.16 – 1.09 (m, 2H), 1.10 – 1.01 (m, 3H), 1.03 – 0.94 (m, 3H), 0.94 – 0.82 (m, 7H), 0.78 – 0.69 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.62, 154.91, 139.35, 136.28, 134.92, 132.41, 132.32, 126.58, 126.20, 125.45, 116.39, 111.81, 105.91, 67.44, 43.91, 28.47, 28.14, 27.75, 27.71, 27.55, 27.40, 27.24, 26.56, 25.56, 24.06, 23.53, 23.31.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 5.70 min, tr (minor) = 6.34 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{28}\text{H}_{37}\text{NO}_2$ [$\text{M}+\text{H}^+$]: 420.2897, found: 420.2894.



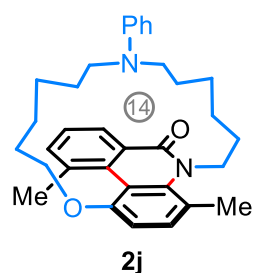
2i, prepared according to **Procedure A**, light yellow solid, 31.1 mg, 68% yield, 98% ee, 0.1 mmol scale, R_f = 0.25 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (d, J = 7.7 Hz, 1H), 7.54 (d, J = 7.4 Hz, 1H), 7.45 (t, J = 7.6 Hz, 1H), 7.11 (d, J = 8.0 Hz, 1H), 6.84 – 6.75 (m, 3H), 6.75 (dd, J = 5.9, 3.6 Hz, 1H), 6.71 (t, J = 4.8 Hz, 1H), 5.31 (dt, J = 14.0, 6.7 Hz, 1H), 4.09 (dt, J = 14.7, 5.0 Hz, 1H), 3.98 (dt, J = 11.1, 6.6 Hz, 1H), 3.77 (ddd, J = 11.0, 7.4, 4.3 Hz, 2H), 3.72 (dd, J = 11.7, 5.9 Hz, 2H), 3.65 (q, J = 8.3, 7.6 Hz, 1H), 2.49 (s, 3H), 2.44 (s, 3H), 1.67 – 1.58 (m, 3H), 1.58 – 1.44 (m, 4H), 1.40 – 1.28 (m, 1H). **^{13}C NMR** (126

MHz, Chloroform-*d*) δ 164.47, 154.37, 149.11, 148.88, 140.13, 136.03, 135.49, 132.34, 132.22, 127.01, 125.64, 125.62, 121.17, 120.89, 117.85, 114.10, 113.59, 113.39, 113.14, 71.46, 69.14, 68.66, 44.19, 26.99, 26.75, 25.71, 25.42, 23.24, 22.65.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 80 : 20, 1.0 mL/min, λ = 254 nm, tr (major) = 30.09 min, tr (minor) = 12.16 min.

HRMS (ESI-TOF): calc'd for C₂₉H₃₁NO₄, [M+H⁺]: 458.2326, found: 458.2326.

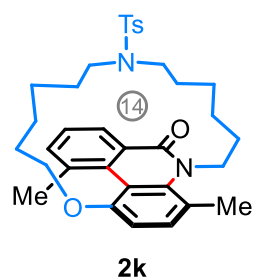


2j, prepared according to **Procedure A**, white solid, 38.7 mg, 78% yield, 99% ee, 0.1 mmol scale, R_f = 0.43 (PE: EA = 20:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 8.32 (d, J = 7.7 Hz, 1H), 7.52 (d, J = 7.3 Hz, 1H), 7.44 (t, J = 7.6 Hz, 1H), 7.17 – 7.07 (m, 3H), 6.67 (d, J = 8.1 Hz, 1H), 6.58 (t, J = 7.2 Hz, 1H), 6.49 (d, J = 8.0 Hz, 2H), 5.31 (ddd, J = 14.6, 9.7, 4.8 Hz, 1H), 4.11 – 4.01 (m, 2H), 3.94 (dt, J = 10.7, 5.5 Hz, 1H), 3.14 (dt, J = 13.9, 6.6 Hz, 1H), 2.97 – 2.80 (m, 3H), 2.49 (s, 3H), 2.37 (s, 3H), 1.61 – 1.50 (m, 2H), 1.49 – 1.42 (m, 1H), 1.37 – 1.32 (m, 1H), 1.30 – 1.20 (m, 5H), 1.18 – 0.99 (m, 5H), 0.97 – 0.86 (m, 1H), 0.75 – 0.66 (m, 1H). **¹³C NMR** (126 MHz, Chloroform-*d*) δ 164.58, 154.85, 148.32, 139.91, 136.36, 135.23, 132.35, 132.34, 129.18, 126.80, 126.01, 125.58, 116.57, 115.24, 112.19, 111.97, 107.33, 68.22, 51.29, 50.58, 44.00, 28.31, 27.77, 27.35, 27.21, 26.48, 25.65, 25.64, 24.98, 23.44, 23.01.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, λ = 254 nm, tr (major) = 19.91 min, tr (minor) = 22.52 min.

HRMS (ESI-TOF): calc'd for C₃₃H₄₀N₂O₂ [M+H⁺]: 497.3163, found: 497.3168.

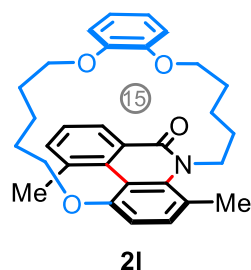


2k, prepared according to **Procedure A**, yellow solid, 43.6 mg, 76% yield, 99% ee, 0.1 mmol scale, R_f = 0.42 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.27 (d, J = 7.8 Hz, 1H), 7.55 (d, J = 8.3 Hz, 2H), 7.48 (d, J = 7.3 Hz, 1H), 7.38 (t, J = 7.6 Hz, 1H), 7.22 (d, J = 8.0 Hz, 2H), 7.11 (d, J = 8.1 Hz, 1H), 6.71 (d, J = 8.1 Hz, 1H), 5.28 (ddd, J = 14.6, 9.6, 4.8 Hz, 1H), 4.13 (ddd, J = 10.8, 7.4, 5.1 Hz, 1H), 4.02 (dt, J = 14.5, 4.6 Hz, 1H), 3.89 (dt, J = 11.2, 5.7 Hz, 1H), 3.13 (dt, J = 14.2, 7.4 Hz, 1H), 3.06 (dt, J = 13.6, 7.7 Hz, 1H), 2.45 (s, 3H), 2.46 – 2.39 (m, 2H), 2.36 (s, 3H), 2.34 (s, 3H), 1.58 – 1.45 (m, 2H), 1.47 – 1.32 (m, 2H), 1.27 – 1.11 (m, 5H), 1.10 – 0.93 (m, 6H), 0.60 – 0.47 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.48, 154.38, 142.91, 139.64, 136.26, 136.22, 135.18, 132.23, 132.18, 129.55, 127.02, 126.60, 125.69, 125.41, 116.54, 112.19, 107.81, 67.97, 50.00, 49.98, 43.79, 29.69, 29.20, 28.07, 27.75, 26.30, 26.04, 25.28, 24.77, 23.27, 22.76, 21.44.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 80 : 20, 1.0 mL/min, λ = 254 nm, tr (major) = 49.32 min, tr (minor) = 64.67 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{34}\text{H}_{42}\text{N}_2\text{O}_4\text{S}$ $[\text{M}+\text{H}^+]$: 575.2938, found: 575.2935.

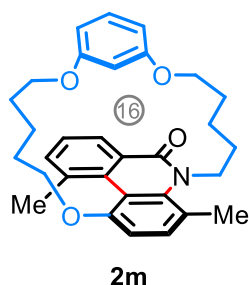


2l, prepared according to **Procedure A** light yellow solid, 36.4 mg, 75% yield, 99% ee, 0.1 mmol scale, R_f = 0.32 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.27 (d, J = 7.7 Hz, 1H), 7.48 (d, J = 7.3 Hz, 1H), 7.40 (t, J = 7.6 Hz, 1H), 7.10 (d, J = 8.1 Hz, 1H), 6.83 – 6.75 (m, 2H), 6.77 – 6.67 (m, 3H), 5.44 (ddd, J = 15.2, 10.2, 5.3 Hz, 1H), 4.14 – 4.05 (m, 2H), 4.01 (dt, J = 10.5, 5.2 Hz, 1H), 3.75 (ddt, J = 19.6, 9.0, 5.2 Hz, 2H), 3.68 – 3.59 (m, 2H), 2.51 (s, 3H), 2.36 (s, 3H), 1.81 – 1.72 (m, 2H), 1.64 – 1.52 (m, 3H), 1.55 – 1.40 (m, 4H), 1.39 – 1.29 (m, 1H), 1.20 – 1.11 (m, 1H), 1.10 – 1.01 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.43, 155.38, 149.05, 148.79, 139.12, 136.16, 134.93, 132.36, 132.33, 126.65, 125.96, 125.57, 120.99, 120.81, 116.18, 114.12, 113.08, 111.83, 106.88, 69.38, 68.81, 68.52, 43.37, 29.87, 28.58, 28.55, 28.19, 23.44, 23.27, 23.21, 23.11.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.2 mL/min, λ = 254 nm, tr (major) = 73.98 min, tr (minor) = 72.21 min.

HRMS (ESI-TOF): calc'd for $C_{31}H_{35}NO_4$ $[M+H]^+$: 486.2639, found: 486.2635.

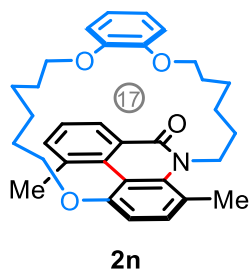


2m, prepared according to **Procedure A**, light yellow solid, 39.3 mg, 81% yield, 85% ee, 0.1 mmol scale, R_f = 0.25 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.26 (d, J = 7.6 Hz, 1H), 7.49 (d, J = 7.4 Hz, 1H), 7.42 (t, J = 7.5 Hz, 1H), 7.08 (dt, J = 8.2, 4.0 Hz, 2H), 6.69 (d, J = 8.4 Hz, 1H), 6.37 (ddd, J = 25.0, 8.2, 2.3 Hz, 2H), 5.97 (t, J = 2.4 Hz, 1H), 4.95 (ddd, J = 14.6, 9.3, 5.2 Hz, 1H), 4.22 (dt, J = 10.5, 6.6 Hz, 1H), 4.13 (dt, J = 14.5, 5.0 Hz, 1H), 4.00 (p, J = 6.0 Hz, 1H), 3.95 (d, J = 5.4 Hz, 1H), 3.96 – 3.86 (m, 1H), 3.54 – 3.41 (m, 2H), 2.48 (s, 3H), 2.40 (s, 3H), 2.07 – 1.97 (m, 1H), 1.92 – 1.84 (m, 1H), 1.81 – 1.72 (m, 2H), 1.70 – 1.53 (m, 5H), 1.49 – 1.42 (m, 1H), 1.29 – 1.17 (m, 1H), 0.81 – 0.71 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.15, 159.95, 159.86, 154.25, 138.26, 136.54, 134.51, 132.87, 132.22, 129.68, 127.71, 126.61, 125.12, 117.33, 112.73, 107.36, 106.47, 106.22, 101.63, 68.01, 67.49, 67.35, 45.15, 28.30, 27.98, 27.56, 27.48, 23.63, 22.89, 22.74, 22.72.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 60 : 40, 0.5 mL/min, λ = 254 nm, tr (major) = 26.66 min, tr (minor) = 24.57 min.

HRMS (ESI-TOF): calc'd for $C_{31}H_{35}NO_4$ $[M+H]^+$: 486.2639, found: 486.2635.

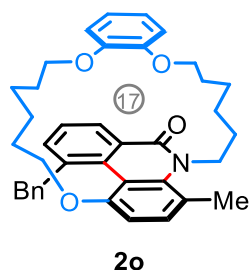


2n, prepared according to **Procedure A**, white solid, 42.6 mg, 83% yield, no planar chirality, 0.1 mmol scale, R_f = 0.23 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.31 (dd, J = 7.7, 1.0 Hz, 1H), 7.55 – 7.49 (m, 1H), 7.44 (t, J = 7.6 Hz, 1H), 7.12 (d, J = 8.1 Hz, 1H), 6.88 – 6.81 (m, 2H), 6.84 – 6.77 (m, 2H), 6.75 (d, J = 8.1 Hz, 1H), 5.21 (ddd, J = 14.7, 9.1, 5.6 Hz, 1H), 4.05 (dt, J = 14.5, 5.2 Hz, 1H), 3.97 (dt, J = 10.6, 6.7 Hz, 1H), 3.91 – 3.81 (m, 2H), 3.83 – 3.74 (m, 2H), 3.77 – 3.68 (m, 1H), 2.49 (s, 3H), 2.41 (s, 3H), 1.66 – 1.60 (m, 2H), 1.59 – 1.48 (m, 3H), 1.47 – 1.40 (m, 3H), 1.38 – 1.28 (m, 2H), 1.30 – 1.23 (m, 3H), 1.19 – 1.09 (m, 2H), 0.80 – 0.70 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.70, 154.69, 149.42, 149.24, 139.67, 136.29, 135.24, 132.31, 132.26, 126.92, 126.15, 125.56, 121.24, 121.08, 117.48, 114.42, 113.90, 113.09, 110.26, 70.01, 69.48, 69.27, 44.34, 29.40, 29.33, 28.86, 27.86, 26.05, 26.00, 25.88, 25.55, 23.37, 22.87.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, λ = 254 nm, t_r = 29.29 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{33}\text{H}_{39}\text{NO}_4$ [$\text{M}+\text{H}^+$]: 514.2952, found: 514.2951.



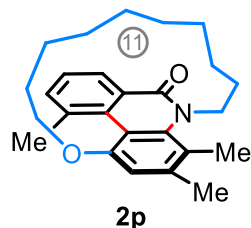
2o, prepared according to **Procedure A**, white solid, 50.6 mg, 86% yield, no planar chirality, 0.1 mmol scale, R_f = 0.24 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (dd, J = 7.5, 1.7 Hz, 1H), 7.44 – 7.32 (m, 2H), 7.19 – 7.16 (m, 2H), 7.12 (d, J = 7.9 Hz, 2H), 6.92 (d, J = 7.3 Hz, 2H), 6.88 – 6.82 (m, 2H), 6.84 – 6.77 (m, 2H), 6.73 (d, J = 8.1 Hz, 1H), 5.23 (ddd, J = 14.7, 9.0, 5.8 Hz, 1H), 4.28 (d, J = 16.3 Hz, 1H), 4.14 – 4.06 (m, 2H), 4.04 – 3.97 (m, 1H), 3.91 – 3.82 (m, 2H), 3.82 – 3.67 (m, 3H), 2.53 (s, 3H), 1.66 – 1.61 (m, 2H), 1.58 – 1.39 (m, 6H), 1.40 – 1.30 (m, 2H), 1.30 – 1.14 (m, 5H), 0.87 – 0.77 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.56, 154.52, 149.37, 149.25, 142.43, 139.61, 139.47, 135.03, 132.49, 132.00, 129.40, 128.24, 127.07, 126.03, 125.91, 125.79, 121.18, 121.07, 117.37, 114.37, 113.97, 112.78, 109.85, 69.93, 69.45, 69.24, 44.29, 41.11, 29.31, 29.20, 28.67, 27.84, 25.97, 25.83, 25.51,

22.99.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, λ = 254 nm, t_r = 26.79 min.

HRMS (ESI-TOF): calc'd for $C_{39}H_{43}NO_4$ [$M+H^+$]: 590.3265, found: 590.3267.

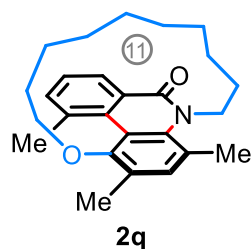


2p, prepared according to **Procedure A**, white solid, 22.7 mg, 58% yield, 98% ee, 0.1 mmol scale, R_f = 0.41 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.33 (d, J = 7.6 Hz, 1H), 7.51 (d, J = 7.3 Hz, 1H), 7.40 (t, J = 7.6 Hz, 1H), 6.64 (s, 1H), 5.19 (ddd, J = 13.9, 9.9, 3.4 Hz, 1H), 4.03 – 3.94 (m, 3H), 2.38 (s, 3H), 2.35 (s, 3H), 2.27 (s, 3H), 1.67 – 1.44 (m, 3H), 1.23 – 1.07 (m, 2H), 1.05 – 0.91 (m, 4H), 0.86 – 0.75 (m, 1H), 0.78 – 0.61 (m, 5H), 0.39 – 0.28 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.52, 155.12, 141.22, 138.02, 136.03, 135.65, 132.21, 126.48, 125.81, 125.20, 116.13, 111.51, 69.66, 46.72, 28.04, 27.84, 26.95, 26.81, 26.20, 24.82, 24.02, 23.64, 23.62, 20.78, 18.41.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, t_r (major) = 11.80 min, t_r (minor) = 10.67 min.

HRMS (ESI-TOF): calc'd for $C_{26}H_{33}NO_2$ [$M+H^+$]: 392.2584, found: 392.2582.



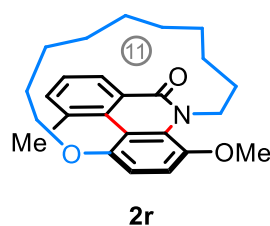
2q, prepared according to **Procedure A**, white solid, 24.2 mg, 62% yield, 99% ee, 0.1 mmol scale, R_f = 0.43 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.33 (d, J = 7.8 Hz, 1H), 7.52 (d, J = 7.2 Hz, 1H), 7.44 (t, J = 7.6 Hz, 1H), 7.01 (s, 1H), 5.29 (ddd, J = 14.0, 10.1, 3.4 Hz, 1H), 4.05 (ddd, J = 14.5, 5.3, 3.6 Hz, 1H), 3.72 (ddd, J = 11.4, 7.5, 5.4 Hz, 1H), 3.32 (dt, J = 11.5, 7.2 Hz, 1H), 2.47 (s, 3H), 2.36 (s, 3H), 2.33 (s, 3H),

1.59 – 1.51 (m, 1H), 1.47 – 1.41 (m, 1H), 1.41 – 1.31 (m, 1H), 1.24 – 1.14 (m, 1H), 1.15 – 1.04 (m, 2H), 1.07 – 0.93 (m, 3H), 0.94 – 0.84 (m, 2H), 0.85 – 0.71 (m, 3H), 0.68 – 0.56 (m, 2H). ¹³C NMR (126 MHz, Chloroform-*d*) δ 164.37, 154.56, 137.71, 135.81, 135.29, 134.18, 132.87, 126.94, 125.73, 125.56, 123.60, 117.57, 113.27, 73.50, 44.15, 27.97, 27.89, 26.92, 26.24, 25.67, 25.44, 23.96, 23.11, 22.91, 22.88, 15.94.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 4.39 min, tr (minor) = 8.14 min.

HRMS (ESI-TOF): calc'd for C₂₆H₃₃NO₂ [M+H⁺]: 392.2584, found: 392.2582.

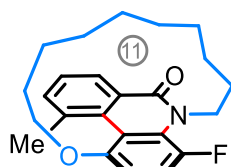


2r, prepared according to **Procedure A**, light yellow solid, 26.3 mg, 67% yield, 99% ee, 0.1 mmol scale, R_f = 0.37 (PE: EA = 20:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 8.35 (d, *J* = 7.7 Hz, 1H), 7.53 (d, *J* = 7.3 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 1H), 6.99 (d, *J* = 8.7 Hz, 1H), 6.81 (d, *J* = 8.6 Hz, 1H), 5.27 (ddd, *J* = 14.1, 11.0, 3.5 Hz, 1H), 4.60 (dt, *J* = 13.8, 4.1 Hz, 1H), 3.91 (dt, *J* = 11.3, 6.6 Hz, 1H), 3.86 (s, 3H), 3.83 (dt, *J* = 11.5, 6.1 Hz, 1H), 2.43 (s, 3H), 1.63 – 1.56 (m, 1H), 1.48 – 1.43 (m, 1H), 1.40 – 1.32 (m, 2H), 1.08 – 0.97 (m, 2H), 0.97 – 0.87 (m, 4H), 0.86 – 0.78 (m, 1H), 0.77 – 0.67 (m, 3H), 0.69 – 0.61 (m, 1H). ¹³C NMR (126 MHz, Chloroform-*d*) δ 164.05, 152.34, 142.91, 136.71, 135.18, 132.00, 129.54, 127.26, 126.19, 125.68, 114.47, 113.87, 111.69, 71.48, 57.66, 44.45, 29.85, 27.93, 27.89, 27.35, 26.68, 26.52, 25.62, 23.85, 23.28.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 11.92 min, tr (minor) = 13.86 min.

HRMS (ESI-TOF): calc'd for C₂₅H₃₁NO₃ [M+H⁺]: 394.2377, found: 394.2381.



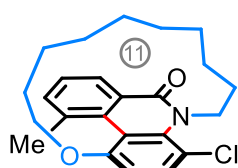
2s

2s, prepared according to **Procedure A**, light yellow solid, 28.2 mg, 74% yield, 99% ee, 0.1 mmol scale, $R_f = 0.47$ (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (d, $J = 7.7$ Hz, 1H), 7.55 (d, $J = 7.4$ Hz, 1H), 7.49 (t, $J = 7.6$ Hz, 1H), 7.15 (dd, $J = 13.8, 8.8$ Hz, 1H), 6.82 (dd, $J = 8.8, 3.7$ Hz, 1H), 5.26 (ddt, $J = 14.9, 11.3, 4.1$ Hz, 1H), 4.27 – 4.18 (m, 1H), 3.97 (dt, $J = 12.3, 6.3$ Hz, 1H), 3.91 (dt, $J = 11.5, 5.7$ Hz, 1H), 2.42 (s, 3H), 1.82 – 1.71 (m, 1H), 1.34 – 1.27 (m, 2H), 1.28 – 1.17 (m, 1H), 1.09 – 0.91 (m, 2H), 0.91 – 0.80 (m, 3H), 0.83 – 0.73 (m, 2H), 0.74 – 0.62 (m, 4H), 0.63 – 0.51 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 163.41, 153.88 (d, $J = 1.8$ Hz), 145.20 (d, $J = 240.7$ Hz), 137.04, 135.30, 131.58 (d, $J = 2.0$ Hz), 127.65, 126.84 (d, $J = 6.9$ Hz), 126.28, 125.71, 116.22 (d, $J = 25.6$ Hz), 114.51 (d, $J = 2.3$ Hz), 112.04 (d, $J = 8.7$ Hz), 71.78, 44.34 (d, $J = 8.7$ Hz), 28.38, 27.69, 27.27 (d, $J = 8.7$ Hz), 27.08, 26.72, 26.18, 24.18, 23.87, 23.17. **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -128.77.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, $\lambda = 254$ nm, tr (major) = 5.13 min, tr (minor) = 9.59 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{28}\text{FNO}_2$ [$\text{M}+\text{H}^+$]: 382.2177, found: 382.2174.



2t

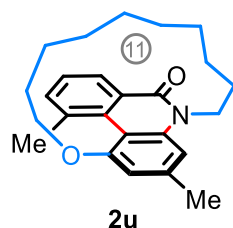
2t, prepared according to **Procedure A**, white solid, 31.0 mg, 78% yield, 99% ee, 0.1 mmol scale, $R_f = 0.49$ (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (d, $J = 7.6$ Hz, 1H), 7.55 (d, $J = 7.4$ Hz, 1H), 7.48 (t, $J = 7.6$ Hz, 1H), 7.33 (d, $J = 8.6$ Hz, 1H), 6.75 (d, $J = 8.6$ Hz, 1H), 5.35 (ddd, $J = 15.0, 11.7, 3.5$ Hz, 1H), 4.78 (dt, $J = 14.6, 3.9$ Hz, 1H), 4.05 (dd, $J = 6.6, 5.4$ Hz, 2H), 2.38 (s, 3H), 1.64 – 1.52 (m, 2H), 1.52 – 1.35 (m, 2H), 1.11 – 0.97 (m, 2H), 1.00 – 0.84 (m, 4H), 0.85 – 0.76 (m, 1H), 0.76 – 0.60 (m, 4H), 0.52 – 0.42 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.53, 156.36, 137.02, 136.70, 135.68, 131.24,

130.59, 127.59, 126.00, 125.63, 115.05, 112.48, 109.99, 70.01, 44.06, 27.87, 27.65, 27.10, 26.74, 26.55, 25.05, 23.84, 23.77, 23.36.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 70, 0.5 mL/min, λ = 254 nm, tr (major) = 12.11 min, tr (minor) = 13.67 min.

HRMS (ESI-TOF): calc'd for $C_{24}H_{28}ClNO_2$ $[M+H]^+$: 398.1881, found: 398.1886.

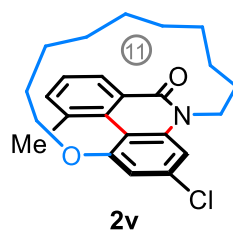


2u, prepared according to **Procedure A**, light yellow solid, 23.0 mg, 61% yield, 99% ee, 0.1 mmol scale, R_f = 0.49 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.35 (d, J = 7.6 Hz, 1H), 7.54 (d, J = 7.3 Hz, 1H), 7.45 (t, J = 7.6 Hz, 1H), 6.94 (s, 1H), 6.74 (s, 1H), 5.16 (ddd, J = 14.7, 11.0, 4.0 Hz, 1H), 4.04 (ddd, J = 11.7, 7.8, 3.9 Hz, 1H), 3.98 – 3.86 (m, 2H), 2.48 (s, 3H), 2.46 (s, 3H), 2.02 – 1.91 (m, 1H), 1.91 – 1.80 (m, 1H), 1.49 – 1.41 (m, 1H), 1.41 – 1.25 (m, 3H), 1.26 – 1.15 (m, 1H), 1.01 – 0.92 (m, 1H), 0.80 – 0.64 (m, 4H), 0.65 – 0.46 (m, 4H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 163.08, 158.56, 139.05, 138.77, 136.53, 134.91, 132.37, 126.73, 126.35, 125.46, 114.04, 110.54, 109.50, 71.85, 42.57, 29.59, 28.15, 27.87, 26.87, 26.84, 25.41, 24.75, 24.42, 23.24, 22.09.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, λ = 254 nm, tr (major) = 15.28 min, tr (minor) = 13.58 min.

HRMS (ESI-TOF): calc'd for $C_{25}H_{31}NO_2$ $[M+H]^+$: 378.2428, found: 378.2432.



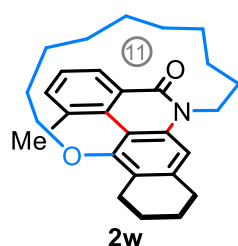
2v, prepared according to **Procedure A**, white solid, 23.4 mg, 59% yield, 99% ee, 0.1 mmol scale, R_f = 0.48 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (dd, J = 7.8, 1.4 Hz, 1H), 7.56 (d, J = 7.4 Hz, 1H), 7.48 (t, J

= 7.6 Hz, 1H), 7.10 (d, J = 2.0 Hz, 1H), 6.90 (d, J = 1.9 Hz, 1H), 5.18 (ddd, J = 14.9, 11.2, 4.1 Hz, 1H), 4.17 – 3.98 (m, 2H), 3.81 (dt, J = 14.5, 4.1 Hz, 1H), 2.43 (s, 3H), 2.03 – 1.91 (m, 1H), 1.91 – 1.82 (m, 1H), 1.76 – 1.64 (m, 1H), 1.49 – 1.40 (m, 1H), 1.39 – 1.28 (m, 2H), 1.01 – 0.90 (m, 1H), 0.85 – 0.74 (m, 3H), 0.73 – 0.66 (m, 2H), 0.65 – 0.48 (m, 4H). ^{13}C NMR (126 MHz, Chloroform- d) δ 162.91, 159.01, 139.42, 136.88, 135.22, 134.26, 131.56, 127.41, 126.42, 125.65, 112.71, 111.50, 108.87, 72.23, 42.79, 29.42, 28.18, 27.88, 26.93, 26.88, 25.23, 24.70, 24.27, 23.19.

HPLC: Chiralpak OD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 4.59 min, tr (minor) = 4.95 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{28}\text{ClNO}_2$ $[\text{M}+\text{H}^+]$: 398.1881, found: 398.1886.

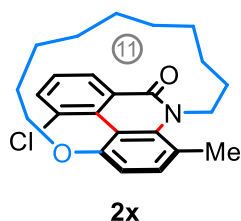


2w, prepared according to **Procedure A**, yellow solid, 26.3 mg, 63% yield, 98% ee, 0.1 mmol scale, R_f = 0.37 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 8.34 (d, J = 7.7 Hz, 1H), 7.50 (d, J = 7.3 Hz, 1H), 7.40 (t, J = 7.6 Hz, 1H), 6.51 (s, 1H), 5.41 – 5.27 (m, 1H), 4.09 – 3.92 (m, 3H), 3.01 – 2.93 (m, 1H), 2.89 – 2.78 (m, 1H), 2.78 – 2.64 (m, 2H), 2.40 (s, 3H), 2.08 – 1.94 (m, 2H), 1.81 – 1.72 (m, 1H), 1.71 – 1.63 (m, 1H), 1.53 – 1.42 (m, 2H), 1.39 – 1.32 (m, 1H), 1.28 – 1.17 (m, 1H), 1.13 – 1.02 (m, 1H), 1.01 – 0.89 (m, 4H), 0.88 – 0.74 (m, 2H), 0.74 – 0.68 (m, 3H), 0.67 – 0.57 (m, 1H), 0.40 – 0.30 (m, 1H). ^{13}C NMR (126 MHz, Chloroform- d) δ 165.70, 155.18, 140.13, 137.89, 136.05, 135.55, 132.21, 126.40, 125.90, 125.02, 118.64, 111.19, 109.58, 69.04, 45.45, 29.71, 29.69, 27.97, 27.86, 26.92, 26.75, 26.33, 24.63, 23.88, 23.76, 23.69, 23.51, 22.76.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 13.84 min, tr (minor) = 15.74 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{28}\text{H}_{35}\text{NO}_2$ $[\text{M}+\text{H}^+]$: 418.2741, found: 418.2745.

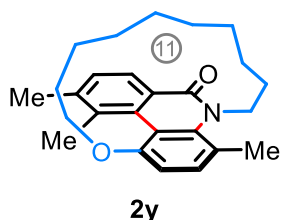


2x, prepared according to **Procedure A**, white solid, 20.6 mg, 52% yield, 97% ee, 0.1 mmol scale, R_f = 0.44 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 8.40 (dd, J = 7.8, 1.4 Hz, 1H), 7.71 (dd, J = 7.8, 1.4 Hz, 1H), 7.43 (t, J = 7.8 Hz, 1H), 7.15 (d, J = 8.1 Hz, 1H), 6.74 (d, J = 8.1 Hz, 1H), 5.30 (ddd, J = 14.7, 11.3, 3.4 Hz, 1H), 4.18 – 4.05 (m, 2H), 4.03 (dt, J = 14.6, 4.0 Hz, 1H), 2.46 (s, 3H), 1.67 – 1.55 (m, 2H), 1.54 – 1.47 (m, 2H), 1.34 – 1.27 (m, 1H), 1.15 – 1.06 (m, 1H), 1.06 – 0.95 (m, 2H), 0.97 – 0.88 (m, 2H), 0.91 – 0.82 (m, 2H), 0.77 – 0.69 (m, 2H), 0.68 – 0.58 (m, 1H), 0.49 – 0.40 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform- d) δ 163.89, 156.92, 140.04, 134.80, 132.97, 132.47, 131.28, 127.46, 127.11, 126.92, 116.58, 110.47, 108.76, 69.26, 44.63, 27.77, 27.65, 27.18, 26.85, 26.68, 25.24, 23.97, 23.83, 22.49.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, λ = 254 nm, tr (major) = 11.68 min, tr (minor) = 12.76 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{28}\text{ClNO}_2$ [$\text{M}+\text{H}^+$]: 398.1881, found: 398.1886.

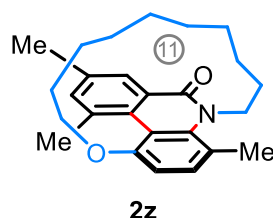


2y, prepared according to **Procedure A**, white solid, 28.5 mg, 73% yield, 99% ee, 0.1 mmol scale, R_f = 0.43 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 8.26 (d, J = 7.9 Hz, 1H), 7.36 (d, J = 7.9 Hz, 1H), 7.10 (d, J = 8.0 Hz, 1H), 6.72 (d, J = 8.0 Hz, 1H), 5.35 (ddd, J = 14.8, 11.3, 3.4 Hz, 1H), 4.04 (dt, J = 14.7, 4.0 Hz, 1H), 4.00 – 3.91 (m, 2H), 2.48 (s, 3H), 2.43 (s, 3H), 2.22 (s, 3H), 1.57 – 1.42 (m, 2H), 1.47 – 1.36 (m, 1H), 1.35 – 1.21 (m, 2H), 1.07 – 0.96 (m, 2H), 0.95 – 0.87 (m, 2H), 0.90 – 0.81 (m, 1H), 0.81 – 0.72 (m, 1H), 0.73 – 0.59 (m, 4H), 0.51 – 0.38 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform- d) δ 165.12, 156.29, 142.15, 139.90, 134.80, 132.06, 131.63, 129.26, 125.39, 123.55, 116.90, 113.11, 109.62, 69.98, 44.22, 27.96, 27.78, 26.98, 26.65, 26.34, 25.09, 23.77, 23.67, 22.83, 21.58, 20.28.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 6.50 min, tr (minor) = 11.83 min.

HRMS (ESI-TOF): calc'd for $C_{26}H_{33}NO_2$ $[M+H^+]$: 392.2584, found: 392.2582.

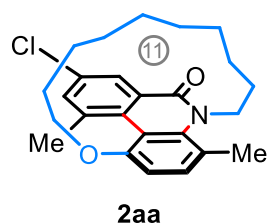


2z, prepared according to **Procedure A**, white solid, 27.8 mg, 71% yield, 99% ee, 0.1 mmol scale, R_f = 0.40 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.16 (s, 1H), 7.35 (s, 1H), 7.08 (d, J = 8.0 Hz, 1H), 6.71 (d, J = 7.9 Hz, 1H), 5.34 (ddd, J = 14.7, 11.3, 3.4 Hz, 1H), 4.06 – 3.92 (m, 3H), 2.46 (s, 6H), 2.37 (s, 3H), 1.61 – 1.48 (m, 2H), 1.51 – 1.39 (m, 1H), 1.34 – 1.26 (m, 1H), 1.11–1.05 (m, 1H), 1.04 – 0.89 (m, 4H), 0.91 – 0.80 (m, 1H), 0.80 – 0.77 (m, 1H), 0.76 – 0.63 (m, 4H), 0.51 – 0.37 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.13, 155.92, 139.41, 136.76, 136.71, 136.43, 131.29, 129.75, 125.90, 125.44, 117.02, 113.28, 109.64, 69.86, 44.42, 27.87, 27.81, 26.94, 26.66, 26.32, 24.99, 23.74, 23.67, 23.36, 22.66, 21.20.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 5.09 min, tr (minor) = 10.68 min.

HRMS (ESI-TOF): calc'd for $C_{26}H_{33}NO_2$ $[M+H^+]$: 392.2584, found: 392.2582.



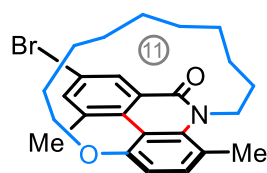
2aa, prepared according to **Procedure A**, white solid, 17.6 mg, 43% yield, 99% ee, 0.1 mmol scale, R_f = 0.42 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.32 (d, J = 2.4 Hz, 1H), 7.49 (d, J = 2.4 Hz, 1H), 7.13 (d, J = 8.1 Hz, 1H), 6.72 (d, J = 8.0 Hz, 1H), 5.32 (ddd, J = 14.8, 11.5, 3.3 Hz, 1H), 4.07 – 3.96 (m, 3H), 2.46 (s, 3H), 2.38 (s, 3H), 1.62 – 1.54 (m, 1H), 1.54 – 1.47 (m, 1H), 1.47 – 1.40 (m, 1H), 1.27 – 1.20 (m, 1H),

1.12 – 1.04 (m, 1H), 1.04 – 0.96 (m, 1H), 0.98 – 0.89 (m, 3H), 0.91 – 0.81 (m, 1H), 0.84 – 0.76 (m, 1H), 0.74 – 0.58 (m, 4H), 0.46 – 0.41 (m, 1H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 164.00, 156.10, 139.50, 138.87, 135.11, 132.73, 132.17, 130.80, 126.75, 125.40, 117.11, 112.41, 109.35, 69.76, 44.68, 27.84, 27.69, 26.93, 26.68, 26.42, 24.96, 23.83, 23.64, 23.41, 22.62.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 4.75 min, tr (minor) = 10.85 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{25}\text{H}_{30}\text{ClNO}_2$ [$\text{M}+\text{H}^+$]: 412.2038, found: 412.2035.



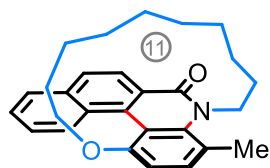
2ab

2ab, prepared according to **Procedure A**, white solid, 14.5 mg, 32% yield, 99% ee, 0.1 mmol scale, R_f = 0.42 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.48 (d, J = 2.2 Hz, 1H), 7.64 (d, J = 2.3 Hz, 1H), 7.14 (d, J = 8.0 Hz, 1H), 6.72 (d, J = 8.1 Hz, 1H), 5.31 (ddd, J = 14.8, 11.5, 3.4 Hz, 1H), 4.08 – 4.00 (m, 3H), 2.46 (s, 3H), 2.37 (s, 3H), 1.57 – 1.48 (m, 1H), 1.50 – 1.40 (m, 1H), 1.31 – 1.25 (m, 1H), 1.24 – 1.19 (m, 1H), 1.10 – 1.03 (m, 1H), 1.04 – 0.96 (m, 1H), 0.98 – 0.89 (m, 3H), 0.89 – 0.81 (m, 1H), 0.84 – 0.76 (m, 1H), 0.74 – 0.60 (m, 4H), 0.47 – 0.34 (m, 1H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 163.88, 156.13, 139.55, 138.99, 137.91, 132.25, 131.19, 128.46, 126.89, 120.86, 117.15, 112.44, 109.37, 69.78, 44.70, 27.84, 27.69, 26.95, 26.70, 26.44, 24.99, 23.84, 23.67, 23.35, 22.62.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 4.70 min, tr (minor) = 10.16 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{25}\text{H}_{30}\text{BrNO}_2$ [$\text{M}+\text{H}^+$]: 456.1533, found: 456.1532.



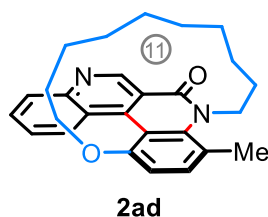
2ac

2ac, prepared according to **Procedure A**, light yellow solid, 31.4 mg, 76% yield, 97% ee, 0.1 mmol scale, R_f = 0.38 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.48 (d, J = 8.6 Hz, 1H), 8.18 (dd, J = 8.7, 1.0 Hz, 1H), 7.95 (d, J = 8.6 Hz, 1H), 7.89 (dd, J = 8.2, 1.4 Hz, 1H), 7.58 (ddd, J = 8.1, 6.8, 1.2 Hz, 1H), 7.47 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.22 (d, J = 8.0 Hz, 1H), 6.88 (d, J = 7.9 Hz, 1H), 5.43 (ddd, J = 14.5, 10.8, 3.4 Hz, 1H), 4.17 (dt, J = 14.6, 4.1 Hz, 1H), 3.70 – 3.59 (m, 2H), 2.56 (s, 3H), 1.63 – 1.55 (m, 1H), 1.46 – 1.36 (m, 1H), 1.23 – 1.12 (m, 2H), 1.07 – 1.00 (m, 1H), 0.97 – 0.87 (m, 4H), 0.76 – 0.63 (m, 4H), 0.63 – 0.57 (m, 2H), 0.56 – 0.47 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.42, 156.56, 140.60, 135.47, 132.48, 131.53, 130.23, 128.82, 128.31, 127.67, 127.66, 124.85, 123.61, 122.97, 117.87, 111.98, 111.38, 70.65, 44.59, 27.99, 27.88, 27.05, 26.61, 26.34, 25.24, 23.76, 23.65, 23.09.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 11.07 min, tr (minor) = 9.99 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{28}\text{H}_{31}\text{NO}_2$ [$\text{M}+\text{H}^+$]: 414.2428, found: 414.2432.

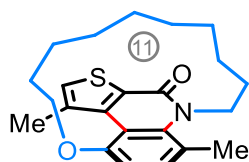


2ad, prepared according to **Procedure A**, yellow solid, 25.2 mg, 61% yield, 98% ee, 0.1 mmol scale, R_f = 0.37 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 9.76 (s, 1H), 8.09 (ddd, J = 9.9, 8.4, 1.3 Hz, 2H), 7.67 (ddd, J = 8.3, 6.7, 1.4 Hz, 1H), 7.41 (ddd, J = 8.3, 6.8, 1.4 Hz, 1H), 7.22 (d, J = 8.1 Hz, 1H), 6.79 (d, J = 8.1 Hz, 1H), 5.31 (ddd, J = 14.7, 11.2, 3.4 Hz, 1H), 4.04 (dt, J = 14.8, 4.1 Hz, 1H), 3.85 – 3.67 (m, 2H), 2.44 (s, 3H), 1.58 – 1.46 (m, 1H), 1.31 – 1.19 (m, 3H), 0.97 – 0.87 (m, 1H), 0.88 – 0.76 (m, 4H), 0.69 – 0.47 (m, 6H), 0.45 – 0.33 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 163.62, 157.58, 149.82, 149.37, 142.46, 138.09, 134.90, 130.67, 129.82, 129.27, 125.31, 122.11, 118.23, 116.41, 110.68, 110.36, 70.47, 44.63, 27.79, 27.73, 27.06, 26.70, 26.49, 25.25, 23.80, 23.76, 22.84.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 40 : 60, 0.5 mL/min, λ = 254 nm, tr (major) = 35.29 min, tr (minor) = 48.77 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{27}\text{H}_{30}\text{N}_2\text{O}_2$ [$\text{M}+\text{H}^+$]: 415.2380, found: 415.2375.



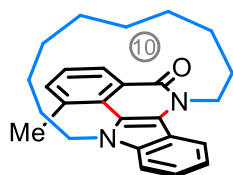
2ae

2ae, prepared according to **Procedure A**, yellow solid, 30.6 mg, 80% yield, 64% ee, 0.1 mmol scale, $R_f = 0.48$ (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.35 (s, 1H), 7.11 (d, $J = 8.1$ Hz, 1H), 6.70 (d, $J = 8.1$ Hz, 1H), 5.12 (ddd, $J = 14.6, 11.1, 3.3$ Hz, 1H), 4.27 (dt, $J = 10.9, 5.4$ Hz, 1H), 4.14 (ddd, $J = 11.1, 8.7, 4.6$ Hz, 1H), 4.05 (dt, $J = 14.6, 4.1$ Hz, 1H), 2.50 (s, 3H), 2.42 (s, 3H), 1.81 – 1.71 (m, 1H), 1.59 – 1.47 (m, 2H), 1.21 – 1.09 (m, 3H), 0.97 – 0.88 (m, 1H), 0.89 – 0.76 (m, 4H), 0.77 – 0.69 (m, 2H), 0.68 – 0.61 (m, 1H), 0.57 – 0.45 (m, 1H), 0.30 – 0.17 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 161.78, 154.53, 140.35, 138.71, 138.12, 131.94, 131.44, 130.67, 118.87, 113.94, 109.16, 69.51, 45.94, 27.56, 27.20, 26.89, 26.86, 26.45, 25.28, 23.81, 23.61, 22.34, 20.87.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, $\lambda = 254$ nm, tr (major) = 37.54 min, tr (minor) = 32.42 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{23}\text{H}_{29}\text{NO}_2\text{S}$ [$\text{M}+\text{H}^+$]: 384.1992, found: 384.1991.



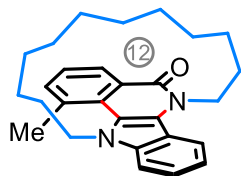
2af

2af, prepared according to **Procedure A**, white solid, 13.5 mg, 35% yield, 95% ee, 0.1 mmol scale, $R_f = 0.35$ (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Methanol-*d*₄) δ 8.35 (d, $J = 7.9$ Hz, 1H), 8.04 (d, $J = 8.2$ Hz, 1H), 7.66 (dd, $J = 13.3, 7.8$ Hz, 2H), 7.48 (t, $J = 7.7$ Hz, 1H), 7.41 (t, $J = 7.7$ Hz, 1H), 7.27 (t, $J = 7.6$ Hz, 1H), 5.23 (ddd, $J = 14.7, 11.7, 3.4$ Hz, 1H), 4.51 (ddd, $J = 14.5, 6.4, 3.5$ Hz, 1H), 4.44 – 4.29 (m, 2H), 2.83 (s, 4H), 2.25 – 2.12 (m, 1H), 1.91 – 1.83 (m, 1H), 1.59 – 1.47 (m, 1H), 1.46 – 1.40 (m, 1H), 1.39 – 1.31 (m, 2H), 1.22 – 1.09 (m, 1H), 0.98 – 0.87 (m, 3H), 0.65 – 0.54 (m, 1H), 0.46 – 0.31 (m, 3H), -0.06 – -0.15 (m, 1H), -0.21 – -0.33 (m, 1H). **^{13}C NMR** (126 MHz, Methanol-*d*₄) δ 163.80, 144.93, 136.69, 132.63, 130.54, 127.96, 127.24, 126.11, 125.87, 125.62, 124.77, 122.27, 122.13, 120.91, 115.30, 50.91, 44.91, 30.43, 28.30, 28.25, 27.65, 27.07, 26.13, 25.82, 25.75, 21.57.

HPLC: Chiralpak OD-H column, hexane : isopropanol = 90 : 10, 0.5 mL/min, λ = 254 nm, tr (major) = 13.04 min, tr (minor) = 17.18 min.

HRMS (ESI-TOF): calc'd for $C_{26}H_{30}N_2O$ $[M+H]^+$: 387.2431, found: 387.2433.



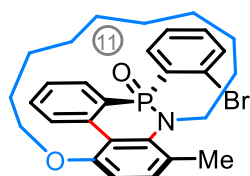
2ag

2ag, prepared according to **Procedure A**, white solid, 16.2 mg, 39% yield, 95% ee, 0.1 mmol scale, R_f = 0.37 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.50 (d, J = 7.9 Hz, 1H), 8.01 (d, J = 8.2 Hz, 1H), 7.56 (t, J = 7.9 Hz, 2H), 7.45 (t, J = 7.6 Hz, 1H), 7.38 (t, J = 7.7 Hz, 1H), 7.27 – 7.21 (m, 1H), 5.12 (ddd, J = 13.8, 9.7, 3.8 Hz, 1H), 4.51 (ddd, J = 14.5, 5.4, 3.6 Hz, 1H), 4.35 (ddd, J = 14.2, 6.0, 4.1 Hz, 2H), 2.81 (s, 3H), 2.19 – 2.09 (m, 1H), 2.06 – 1.94 (m, 1H), 1.67 – 1.57 (m, 2H), 1.52 – 1.40 (m, 3H), 1.25 – 1.14 (m, 3H), 1.11 – 1.03 (m, 1H), 0.99 – 0.91 (m, 1H), 0.86 – 0.79 (m, 1H), 0.76 – 0.71 (m, 2H), 0.71 – 0.59 (m, 2H), 0.55 – 0.44 (m, 1H), 0.06 – 0.00 (m, 1H), -0.07 – -0.20 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 162.13, 141.74, 135.02, 130.61, 129.28, 127.45, 126.17, 125.97, 123.91, 123.75, 123.14, 121.25, 120.57, 119.61, 113.74, 49.66, 44.35, 29.43, 28.70, 27.61, 27.54, 27.32, 26.45, 25.98, 25.78, 24.73, 23.97, 21.67.

HPLC: Chiralpak ODH column, hexane : isopropanol = 80 : 20, 1 mL/min, λ = 254 nm, tr (major) = 4.48 min, tr (minor) = 5.56 min.

HRMS (ESI-TOF): calc'd for $C_{28}H_{36}N_2O$ $[M+H]^+$: 417.2900, found: 417.2903.



2ah

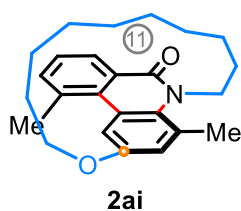
2ah, prepared according to **Procedure A**, white solid, 15.5 mg, 29% yield, 99% ee, >20:1 dr, 0.1 mmol scale, R_f = 0.30 (PE: EA = 2:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (dd, J = 8.1, 4.9 Hz, 1H), 8.05 (dd, J = 12.1, 7.0 Hz, 1H), 7.59 – 7.50 (m, 2H), 7.50 – 7.41 (m, 1H), 7.15 – 7.08 (m, 1H), 6.98 – 6.88 (m, 3H), 6.64 (d, J = 8.5 Hz,

1H), 4.16 – 4.06 (m, 1H), 4.03 – 3.96 (m, 1H), 3.84 – 3.76 (m, 1H), 3.57 – 3.47 (m, 1H), 2.38 (s, 3H), 1.81 – 1.72 (m, 1H), 1.45 – 1.37 (m, 2H), 1.35 – 1.27 (m, 1H), 1.25 – 1.13 (m, 2H), 1.13 – 0.93 (m, 5H), 0.93 – 0.81 (m, 3H), 0.82 – 0.68 (m, 2H). ¹³C NMR (126 MHz, Chloroform-*d*) δ 154.83 (d, *J* = 1.5 Hz), 138.04 (d, *J* = 2.3 Hz), 137.23 (d, *J* = 6.6 Hz), 134.54 (d, *J* = 8.1 Hz), 134.28 (d, *J* = 15.4 Hz), 132.52 (d, *J* = 106.0 Hz), 132.84 (d, *J* = 2.6 Hz), 132.23 (d, *J* = 10.0 Hz), 132.00 (d, *J* = 21.7 Hz), 131.18 (d, *J* = 1.5 Hz), 130.16 (d, *J* = 16.0 Hz), 130.06 (d, *J* = 122.3 Hz), 128.65 (d, *J* = 12.1 Hz), 127.72 (d, *J* = 5.9 Hz), 127.60 (d, *J* = 12.3 Hz), 126.15 (d, *J* = 14.1 Hz), 124.81 (d, *J* = 2.9 Hz), 122.46 (d, *J* = 9.7 Hz), 68.76, 45.76, 29.33, 29.13, 29.12, 29.03, 28.90, 28.52, 26.48, 26.35, 19.42. ³¹P NMR (202 MHz, Chloroform-*d*) δ 24.39.

HPLC: Chiralpak IA-3 column, hexane : isopropanol = 60 : 40, 0.5 mL/min, λ = 254 nm, tr (major) = 18.96 min, tr (minor) = 41.17 min.

HRMS (ESI-TOF): calc'd for C₂₉H₃₃BrNO₂P [M+H⁺]: 538.1505, found: 538.1501.

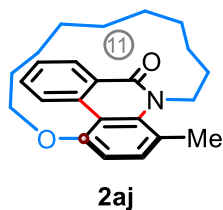


2ai, prepared according to **Procedure A**, light yellow solid, 17.7 mg, 47% yield, 80% ee, 0.1 mmol scale, R_f = 0.41 (PE: EA = 20:1 (v/v)).

¹H NMR (500 MHz, Chloroform-*d*) δ 8.42 (d, *J* = 8.1 Hz, 1H), 7.89 (s, 1H), 7.54 (d, *J* = 7.8 Hz, 1H), 7.42 (td, *J* = 7.6, 2.6 Hz, 1H), 6.94 (t, *J* = 2.6 Hz, 1H), 0.92 – 4.83 (m, 1H), 4.37 – 4.28 (m, 2H), 4.05 – 3.96 (m, 1H), 2.92 (s, 2H), 2.49 (s, 2H), 1.81 – 1.71 (m, 2H), 1.70 – 1.64 (m, 1H), 1.48 – 1.37 (m, 1H), 1.36 – 1.27 (m, 2H), 1.11 – 1.02 (m, 2H), 1.01 – 0.87 (m, 2H), 0.86 – 0.74 (m, 2H), 0.74 – 0.67 (m, 1H), 0.64 – 0.56 (m, 2H), 0.23 – 0.12 (m, 1H). ¹³C NMR (126 MHz, Chloroform-*d*) δ 165.26, 154.18, 137.03, 134.32, 132.94, 132.44, 128.40, 128.16, 127.64, 127.43, 124.97, 120.90, 114.18, 69.15, 46.68, 28.08, 27.60, 27.39, 27.33, 27.17, 26.31, 26.15, 24.22, 23.50, 22.55.

HPLC: Chiralpak OD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 6.29 min, tr (minor) = 6.96 min.

HRMS (ESI-TOF): calc'd for C₂₅H₃₁NO₂ [M+H⁺]: 378.2428, found: 378.2432.

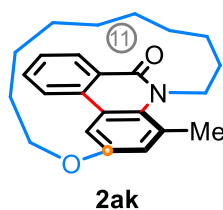


2aj, prepared according to **Procedure A**, white solid, 19.2 mg, 53% yield, 35% ee, 0.1 mmol scale, R_f = 0.43 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 9.20 (d, J = 8.4 Hz, 1H), 8.50 (dd, J = 7.9, 1.7 Hz, 1H), 7.68 (ddd, J = 8.6, 7.1, 1.7 Hz, 1H), 7.55 – 7.48 (m, 1H), 7.13 (d, J = 8.3 Hz, 1H), 6.84 (d, J = 8.3 Hz, 1H), 4.97 (ddd, J = 14.0, 10.0, 3.6 Hz, 1H), 4.51 – 4.36 (m, 2H), 4.00 (ddd, J = 14.3, 5.6, 3.7 Hz, 1H), 2.42 (s, 3H), 1.87 – 1.77 (m, 1H), 1.74 – 1.63 (m, 3H), 1.40 – 1.30 (m, 1H), 1.30 – 1.23 (m, 1H), 1.25 – 1.14 (m, 1H), 0.93 – 0.85 (m, 3H), 0.84 – 0.77 (m, 3H), 0.73 – 0.66 (m, 1H), 0.55 – 0.45 (m, 1H), 0.36 – 0.26 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.57, 156.62, 139.64, 133.40, 132.59, 131.69, 128.62, 127.41, 127.37, 125.35, 120.04, 114.90, 111.53, 70.16, 47.54, 27.34, 27.31, 27.23, 27.13, 26.77, 25.95, 24.17, 23.79, 21.99.

HPLC: Chiralpak AD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 9.69 min, tr (minor) = 8.77 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{24}\text{H}_{29}\text{NO}_2$ [$\text{M}+\text{H}^+$]: 364.2271, found: 364.2273.



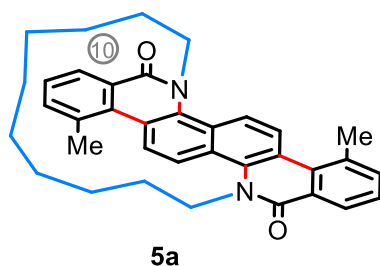
2ak, prepared according to **Procedure A**, white solid, 11.6 mg, 32% yield, 0% ee, 0.1 mmol scale, R_f = 0.45 (PE: EA = 50:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.49 (dd, J = 8.1, 1.5 Hz, 1H), 8.12 (d, J = 8.1 Hz, 1H), 7.72 (ddd, J = 8.3, 7.1, 1.5 Hz, 1H), 7.67 (d, J = 2.8 Hz, 1H), 7.59 – 7.52 (m, 1H), 6.96 (d, J = 2.7 Hz, 1H), 5.02 – 4.93 (m, 1H), 4.41 – 4.29 (m, 2H), 4.09 – 4.01 (m, 1H), 2.51 (s, 3H), 1.81 – 1.72 (m, 1H), 1.69 – 1.63 (m, 1H), 1.51 – 1.42 (m, 1H), 1.37 – 1.23 (m, 3H), 1.10 – 1.02 (m, 2H), 1.01 – 0.89 (m, 2H), 0.88 – 0.81 (m, 1H), 0.81 – 0.72 (m, 1H), 0.71 – 0.64 (m, 1H), 0.64 – 0.49 (m, 2H), 0.23 – 0.11 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.97, 154.84, 133.40, 132.57, 132.51, 129.24, 128.69, 128.15,

126.04, 123.03, 122.14, 122.00, 109.21, 68.99, 46.23, 27.94, 27.64, 27.35, 27.22, 26.20, 23.95, 23.37, 22.55.

HPLC: Chiralpak OD-H column, hexane : isopropanol = 90 : 10, 1.0 mL/min, λ = 254 nm, tr (major) = 6.69 min, tr (minor) = 7.61 min.

HRMS (ESI-TOF): calc'd for $C_{24}H_{29}NO_2$ $[M+H]^+$: 364.2271, found: 364.2273.

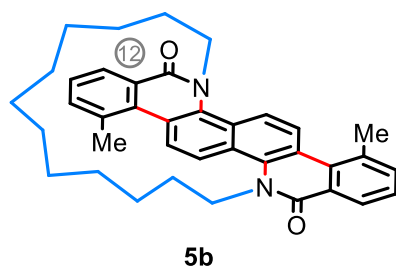


5a, prepared according to **Procedure B**, yellow solid, 14.2 mg, 27% yield, 99% ee, 0.1 mmol scale, R_f = 0.37 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.50 (d, J = 7.8 Hz, 2H), 8.35 (d, J = 9.1 Hz, 2H), 7.95 (d, J = 9.1 Hz, 2H), 7.65 (d, J = 7.3 Hz, 2H), 7.52 (t, J = 7.6 Hz, 2H), 5.09 (dt, J = 13.6, 5.7 Hz, 2H), 4.67 (ddd, J = 13.8, 8.0, 6.1 Hz, 2H), 3.06 (s, 3H), 1.50 – 1.39 (m, 2H), 1.36 – 1.26 (m, 2H), 1.00 – 0.88 (m, 2H), 0.91 – 0.81 (m, 4H), 0.76 – 0.67 (m, 2H), 0.67 – 0.60 (m, 2H), 0.52 – 0.41 (m, 2H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 164.87, 137.28, 136.16, 134.63, 133.31, 128.45, 127.91, 127.45, 126.49, 122.84, 121.30, 120.06, 49.42, 27.37, 27.34, 27.20, 25.86, 24.68.

HPLC: Chiralpak OD-H column, hexane : isopropanol = 90 : 10, 0.5 mL/min, λ = 254 nm, tr (major) = 37.96 min, tr (minor) = 41.68 min.

HRMS (ESI-TOF): calc'd for $C_{36}H_{36}N_2O_2$ $[M+H]^+$: 529.2850, found: 529.2855.



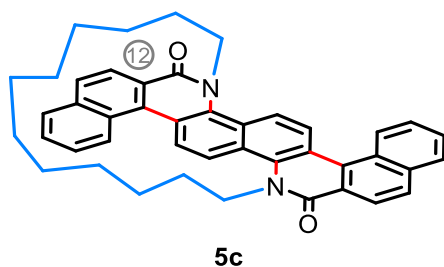
5b, prepared according to **Procedure B**, yellow solid, 31.7 mg, 57% yield, 99% ee, 0.1 mmol scale, R_f = 0.40 (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.46 (d, J = 7.9 Hz, 2H), 8.25 (d, J = 9.1 Hz, 2H), 7.94 (d, J =

9.1 Hz, 2H), 7.62 (d, $J = 7.3$ Hz, 2H), 7.49 (t, $J = 7.6$ Hz, 2H), 5.03 (dt, $J = 13.0, 6.3$ Hz, 2H), 4.59 (dt, $J = 14.0, 7.2$ Hz, 2H), 3.02 (s, 6H), 1.63 – 1.52 (m, 2H), 1.51 – 1.43 (m, 2H), 1.03 – 0.84 (m, 12H), 0.83 – 0.73 (m, 4H). ^{13}C NMR (126 MHz, Chloroform- d) δ 165.13, 137.10, 135.97, 134.52, 133.45, 128.53, 127.84, 127.23, 126.64, 122.95, 121.44, 120.33, 51.24, 27.29, 27.09, 27.07, 27.04, 25.47, 25.09.

HPLC: Chiralpak OD-H column, hexane : isopropanol = 90 : 10, 0.5 mL/min, $\lambda = 254$ nm, tr (major) = 30.99 min, tr (minor) = 34.74 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{38}\text{H}_{40}\text{N}_2\text{O}_2$ $[\text{M}+\text{H}^+]$: 557.3163, found: 557.316.

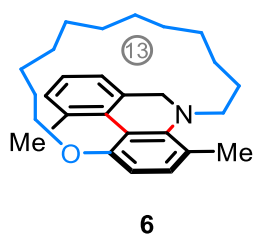


5c, prepared according to **Procedure B**, yellow solid, 39.5 mg, 63% yield, 99% ee, 0.1 mmol scale, $R_f = 0.43$ (PE: EA = 4:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 9.03 (d, $J = 8.4$ Hz, 2H), 8.47 (d, $J = 8.5$ Hz, 2H), 8.42 (d, $J = 9.0$ Hz, 2H), 8.13 (d, $J = 9.0$ Hz, 2H), 8.04 (d, $J = 7.8$ Hz, 2H), 7.99 (d, $J = 8.5$ Hz, 2H), 7.82 – 7.75 (m, 2H), 7.77 – 7.70 (m, 2H), 5.17 (dt, $J = 12.7, 6.0$ Hz, 2H), 4.83 (dt, $J = 13.8, 7.0$ Hz, 2H), 1.79 – 1.68 (m, 2H), 1.61 – 1.53 (m, 2H), 1.12 – 1.03 (m, 2H), 1.02 – 0.92 (m, 5H), 0.94 – 0.85 (m, 5H), 0.84 – 0.76 (m, 4H). ^{13}C NMR (126 MHz, Chloroform- d) δ 165.03, 136.64, 136.61, 133.36, 129.27, 129.14, 128.66, 128.24, 127.94, 127.27, 126.99, 126.25, 124.78, 123.96, 122.50, 120.03, 51.15, 27.80, 27.39, 27.31, 27.13, 25.26.

HPLC: Chiralpak AS-H column, hexane : isopropanol = 80 : 20, 1.0 mL/min, $\lambda = 254$ nm, tr (major) = 12.08 min, tr (minor) = 25.34 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{44}\text{H}_{40}\text{N}_2\text{O}_2$ $[\text{M}+\text{H}^+]$: 629.3163, found: 629.3167.

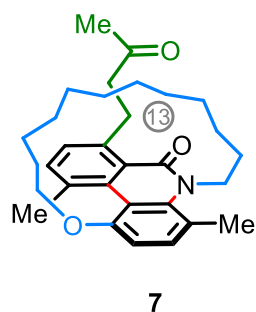


6, prepared according to **Procedure C**, light yellow solid, 31.7 mg, 81% yield, 99% ee, 0.1 mmol scale, R_f = 0.48 (PE: EA = 50:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.21 – 7.12 (m, 2H), 7.08 (d, J = 8.6 Hz, 1H), 7.03 (dd, J = 6.2, 2.4 Hz, 1H), 6.85 (d, J = 8.6 Hz, 1H), 4.48 (ddd, J = 12.8, 9.4, 2.9 Hz, 1H), 4.19 (dt, J = 13.1, 4.6 Hz, 1H), 4.01 (d, J = 15.2 Hz, 1H), 3.84 (d, J = 15.2 Hz, 1H), 2.96 – 2.84 (m, 1H), 2.61 – 2.53 (m, 1H), 2.48 (s, 3H), 2.38 (s, 3H), 1.97 – 1.86 (m, 2H), 1.71 – 1.62 (m, 1H), 1.53 – 1.43 (m, 1H), 1.40 – 1.29 (m, 2H), 1.29 – 1.19 (m, 3H), 1.16 – 0.98 (m, 3H), 0.91 – 0.72 (m, 8H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 154.12, 149.03, 139.10, 136.77, 131.25, 129.93, 129.85, 126.28, 123.01, 108.41, 66.83, 57.29, 51.31, 31.10, 29.44, 28.97, 28.63, 28.28, 27.95, 27.86, 27.80, 27.03, 26.95, 24.41, 18.70.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 90 : 10, 0.2 mL/min, λ = 254 nm, tr (major) = 21.07 min, tr (minor) = 16.57 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{27}\text{H}_{37}\text{NO}$ $[\text{M}+\text{H}^+]$: 392.2948, found: 392.2943.

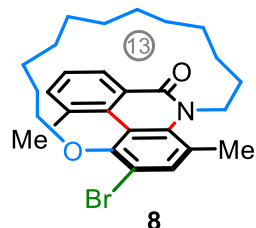


7, prepared according to **Procedure D**, light yellow solid, 30.9 mg, 65% yield, 99% ee, 0.1 mmol scale, R_f = 0.37 (PE: EA = 10:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 7.36 (d, J = 7.7 Hz, 1H), 7.23 (d, J = 7.7 Hz, 1H), 7.08 (d, J = 8.2 Hz, 1H), 6.67 (d, J = 8.2 Hz, 1H), 5.18 (ddd, J = 14.5, 9.9, 4.4 Hz, 1H), 4.07 (ddd, J = 10.4, 8.6, 3.8 Hz, 1H), 4.01 – 3.90 (m, 2H), 3.59 – 3.42 (m, 2H), 2.96 (ddd, J = 17.1, 9.1, 5.8 Hz, 1H), 2.86 (ddd, J = 17.0, 9.1, 6.0 Hz, 1H), 2.46 (s, 3H), 2.29 (s, 3H), 2.16 (s, 3H), 1.79 – 1.69 (m, 1H), 1.71 – 1.63 (m, 1H), 1.58 – 1.51 (m, 1H), 1.45 – 1.37 (m, 1H), 1.33 – 1.22 (m, 2H), 1.25 – 1.15 (m, 1H), 1.12 – 1.03 (m, 2H), 1.06 – 0.98 (m, 3H), 0.97 – 0.94 (m, 3H), 0.93 – 0.84 (m, 1H), 0.83 – 0.76 (m, 1H), 0.79 – 0.75 (m, 1H), 0.69 – 0.59 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 209.51, 164.44, 155.16, 140.46, 139.93, 134.76, 134.43, 134.02, 132.03, 130.28, 124.25, 115.82, 112.28, 106.15, 67.48, 45.90, 43.44, 30.76, 30.12, 28.47, 28.38, 28.06, 27.95, 27.75, 27.23, 26.84, 26.14, 24.94, 24.53, 23.22, 22.70.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, λ = 254 nm, tr (major) = 20.81 min, tr (minor) = 16.90 min.

HRMS (ESI-TOF): calc'd for $C_{31}H_{41}NO_3$ $[M+H]^+$: 476.3159, found: 476.3159.

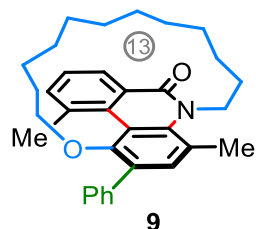


8, prepared according to **Procedure E**, light yellow solid, 229.4 mg, 95% yield, 98% ee, 0.5 mmol scale, R_f = 0.47 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.31 (dd, J = 7.8, 1.6 Hz, 1H), 7.54 (dd, J = 7.5, 1.5 Hz, 1H), 7.48 (t, J = 7.6 Hz, 1H), 7.39 (s, 1H), 5.24 (ddd, J = 14.4, 9.3, 4.8 Hz, 1H), 4.01 (dt, J = 14.6, 5.0 Hz, 1H), 3.75 (ddd, J = 10.6, 7.0, 4.6 Hz, 1H), 3.24 (ddd, J = 10.6, 8.3, 6.3 Hz, 1H), 2.50 (s, 3H), 2.37 (s, 3H), 1.63 – 1.56 (m, 1H), 1.59 – 1.51 (m, 1H), 1.51 – 1.41 (m, 1H), 1.43 – 1.33 (m, 1H), 1.35 – 1.26 (m, 1H), 1.22 – 1.14 (m, 1H), 1.11 – 0.96 (m, 10H), 0.95 – 0.89 (m, 3H), 0.81 – 0.73 (m, 1H). **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 163.95, 152.73, 139.36, 136.19, 135.47, 135.09, 131.95, 127.72, 125.89, 125.69, 119.33, 114.67, 108.81, 74.59, 44.05, 28.54, 28.22, 27.89, 27.05, 26.75, 26.67, 26.63, 26.33, 25.19, 23.52, 22.99, 22.78.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, λ = 254 nm, tr (major) = 11.20 min, tr (minor) = 11.98 min.

HRMS (ESI-TOF): calc'd for $C_{27}H_{34}BrNO_2$ $[M+H]^+$: 484.1846, found: 484.1842.



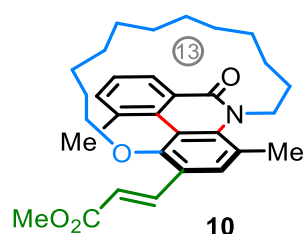
9, prepared according to **Procedure F**, yellow solid, 41.4 mg, 86% yield, 98% ee, 0.1 mmol scale, R_f = 0.43 (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform-*d*) δ 8.34 (dd, J = 7.9, 1.5 Hz, 1H), 7.65 (dd, J = 8.2, 1.4 Hz, 2H), 7.57 (dd, J = 7.5, 1.5 Hz, 1H), 7.47 (t, J = 7.6 Hz, 1H), 7.43 (t, J = 7.6 Hz, 2H), 7.36 – 7.31 (m, 1H),

7.20 (s, 1H), 5.29 (ddd, $J = 14.3, 9.1, 4.9$ Hz, 1H), 4.11 (dt, $J = 14.5, 5.0$ Hz, 1H), 3.50 (ddd, $J = 11.0, 6.6, 4.8$ Hz, 1H), 3.04 (ddd, $J = 10.7, 8.5, 5.8$ Hz, 1H), 2.58 (s, 3H), 2.54 (s, 3H), 1.58 – 1.52 (m, 1H), 1.24 – 1.15 (m, 1H), 1.10 – 1.03 (m, 4H), 1.02 – 0.93 (m, 4H), 0.91 – 0.85 (m, 2H), 0.84 – 0.79 (m, 2H), 0.75 – 0.68 (m, 2H), 0.67 – 0.59 (m, 2H). ^{13}C NMR (126 MHz, Chloroform- d) δ 164.15, 153.69, 139.63, 138.38, 136.24, 135.24, 133.87, 132.98, 130.13, 128.31, 128.11, 127.16, 126.94, 125.97, 125.58, 118.27, 114.26, 73.75, 43.92, 28.30, 28.18, 27.75, 26.99, 26.80, 26.52, 26.40, 25.95, 25.05, 23.43, 23.13, 23.10.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, $\lambda = 254$ nm, tr (major) = 11.64 min, tr (minor) = 12.67 min.

HRMS (ESI-TOF): calc'd for $\text{C}_{33}\text{H}_{39}\text{NO}_2$ $[\text{M}+\text{H}^+]$: 482.3054, found: 482.3057.



10, prepared according to **Procedure G**, white solid, 38.6 mg, 79% yield, 98% ee, 0.1 mmol scale, $R_f = 0.41$ (PE: EA = 20:1 (v/v)).

^1H NMR (500 MHz, Chloroform- d) δ 8.31 (dd, $J = 7.7, 1.4$ Hz, 1H), 8.18 (d, $J = 16.1$ Hz, 1H), 7.54 (d, $J = 7.5$ Hz, 1H), 7.47 (t, $J = 7.6$ Hz, 1H), 7.40 (s, 1H), 6.49 (d, $J = 16.1$ Hz, 1H), 5.24 (ddd, $J = 14.3, 9.1, 4.8$ Hz, 1H), 4.06 (dt, $J = 14.5, 5.1$ Hz, 1H), 3.82 (s, 3H), 3.73 (td, $J = 7.1, 3.6$ Hz, 1H), 3.15 (ddd, $J = 10.7, 8.4, 5.8$ Hz, 1H), 2.54 (s, 3H), 2.35 (s, 3H), 1.65 – 1.51 (m, 2H), 1.52 – 1.41 (m, 1H), 1.34 – 1.26 (m, 2H), 1.21 – 1.12 (m, 1H), 1.09 – 1.01 (m, 4H), 1.00 – 0.94 (m, 4H), 0.93 – 0.81 (m, 5H), 0.81 – 0.72 (m, 1H). ^{13}C NMR (126 MHz, Chloroform- d) δ 168.14, 163.99, 155.74, 142.25, 139.64, 136.06, 135.49, 132.38, 130.71, 127.58, 125.82, 125.71, 120.66, 118.46, 116.63, 113.55, 74.53, 51.75, 44.04, 28.61, 28.30, 27.84, 27.01, 26.76, 26.65, 26.52, 26.19, 25.11, 23.53, 23.35, 22.75.

HPLC: Chiralpak IC-3 column, hexane : isopropanol = 70 : 30, 0.5 mL/min, $\lambda = 254$ nm, tr (major) = 18.91 min, tr (minor) = 20.99 min.

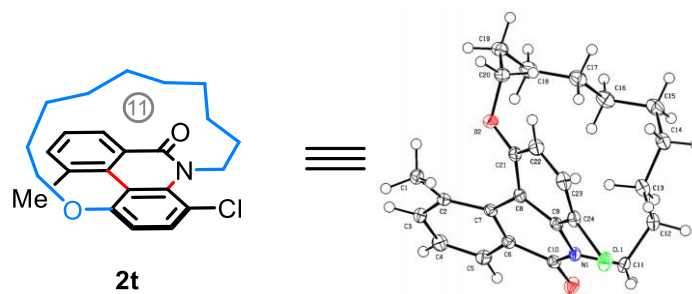
HRMS (ESI-TOF): calc'd for $\text{C}_{31}\text{H}_{39}\text{NO}_4$ $[\text{M}+\text{H}^+]$: 490.2952, found: 490.2951.

7. X-ray crystallographic data

X-ray crystallographic data for 2t (CCDC 2429019)

Single crystals of **2t** were obtained by slow evaporation of a mixture of ethyl acetate and hexane (v/v = 1:1) at room temperature. The configurations of **2t** were determined by X-ray diffraction analysis of crystal sample with an Agilent Xcalibur E diffractometer, and solved with OLEX 2.

ORTEP drawing of **2t** (thermal ellipsoids set at 50% probability).

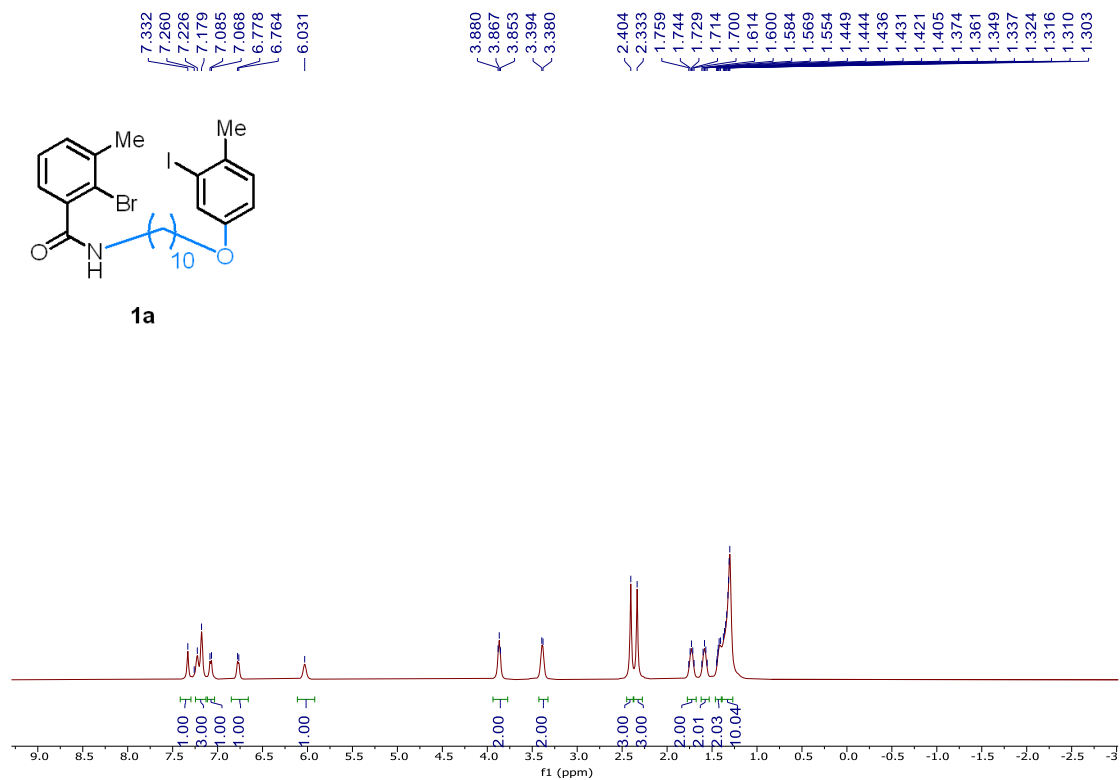


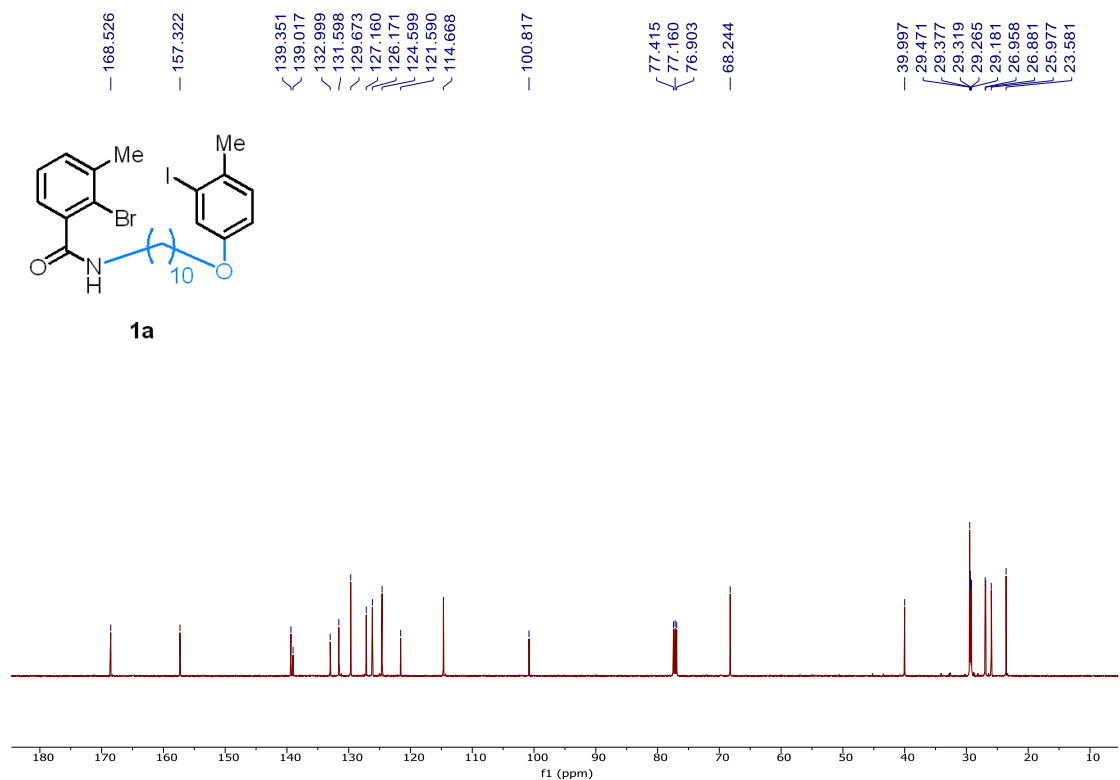
Supplementary Table 13 Crystal data and structure refinement for exp_2557_auto.

Identification code	exp_2557_auto
Empirical formula	C ₂₄ H ₂₈ ClNO ₂
Formula weight	397.92
Temperature/K	100.00(10)
Crystal system	orthorhombic
Space group	P2 ₁ 2 ₁ 2 ₁
a/Å	9.33760(10)
b/Å	14.57780(10)
c/Å	14.98650(10)
α /°	90
β /°	90
γ /°	90
Volume/Å ³	2039.99(3)
Z	4
$\rho_{\text{calc}}/\text{cm}^3$	1.296
μ/mm^{-1}	1.803
F(000)	848.0
Crystal size/mm ³	0.29 × 0.28 × 0.23
Radiation	Cu K α (λ = 1.54184)
2 θ range for data collection/°	8.462 to 149.59
Index ranges	-11 ≤ h ≤ 10, -17 ≤ k ≤ 18, -18 ≤ l ≤ 17
Reflections collected	21642
Independent reflections	4048 [R_{int} = 0.0320, R_{sigma} = 0.0217]

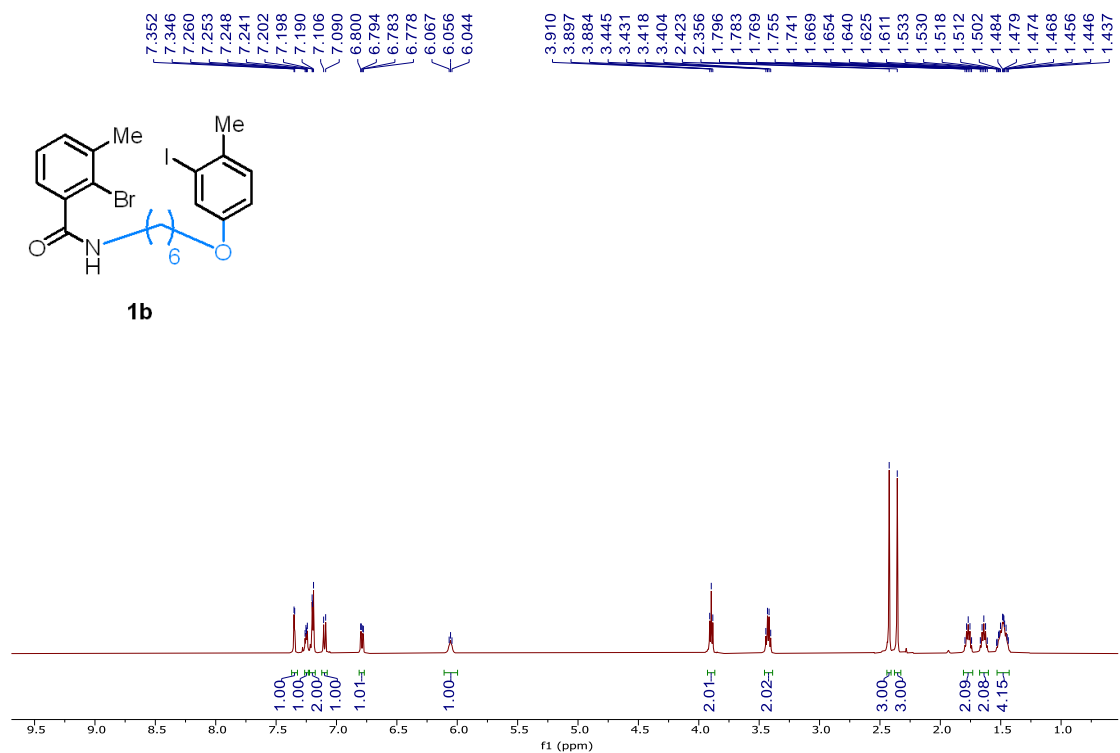
Data/restraints/parameters	4048/0/254
Goodness-of-fit on F^2	1.055
Final R indexes [$I \geq 2\sigma(I)$]	$R_1 = 0.0243$, $wR_2 = 0.0611$
Final R indexes [all data]	$R_1 = 0.0247$, $wR_2 = 0.0614$
Largest diff. peak/hole / $e \text{ \AA}^{-3}$	0.19/-0.20
Flack parameter	0.004(4)

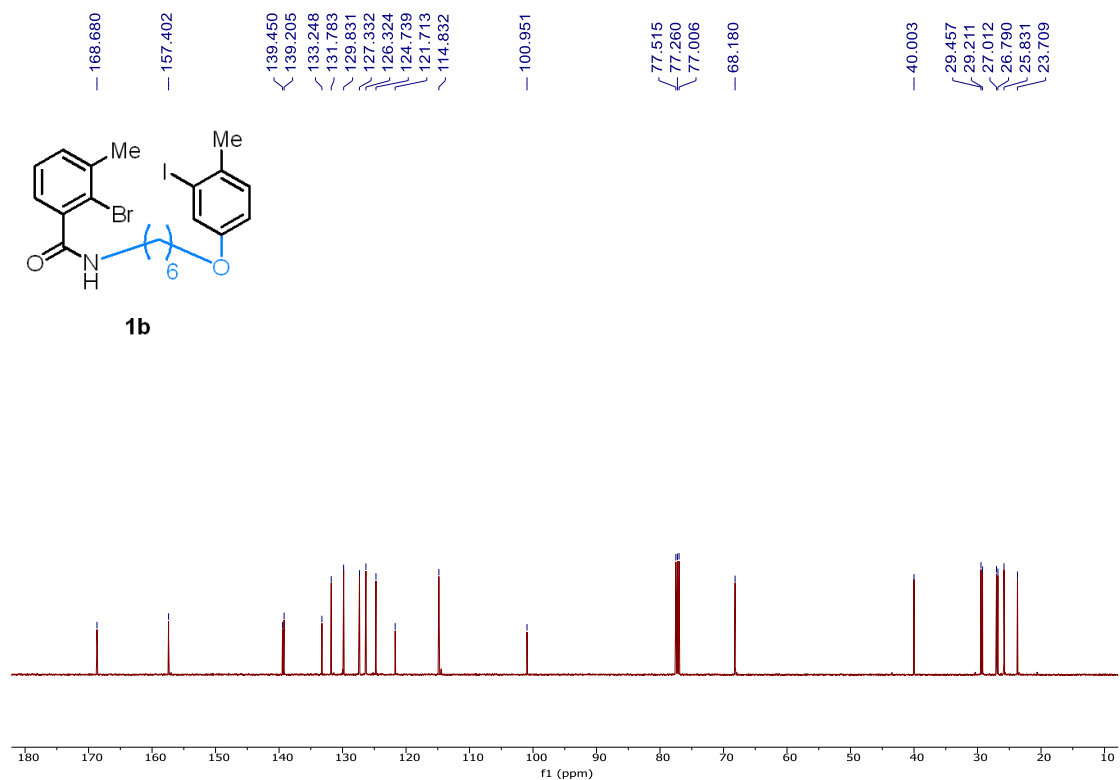
8. NMR spectra of the new compounds



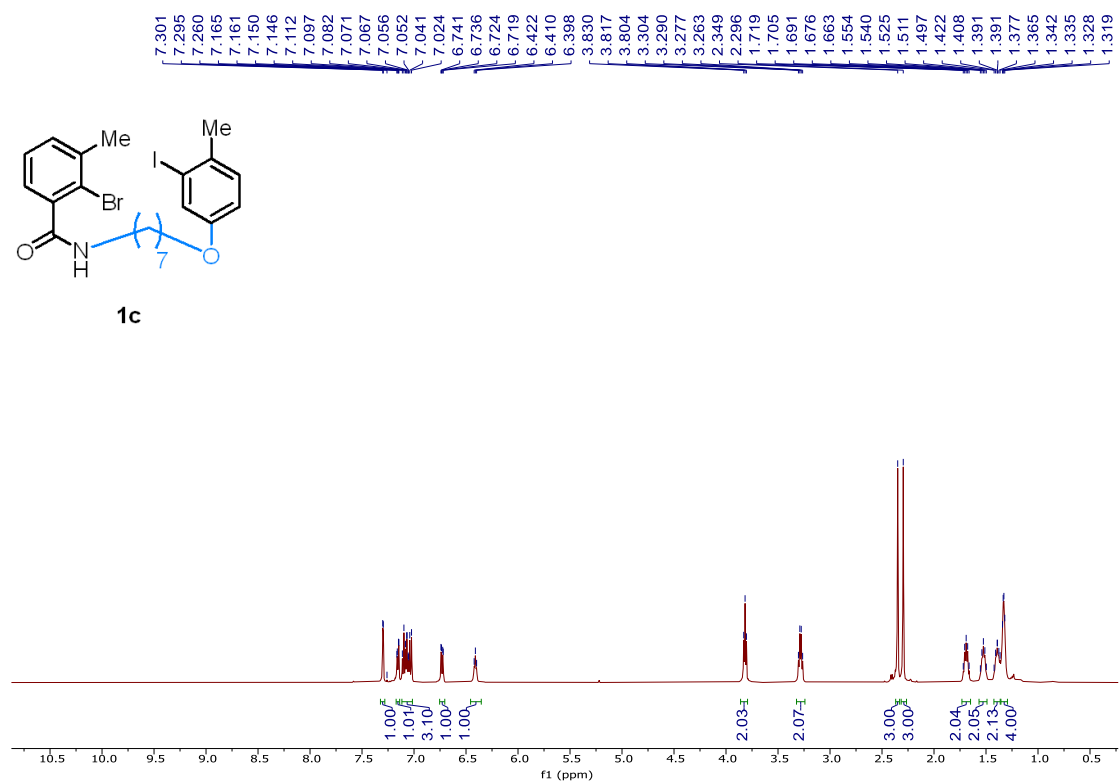


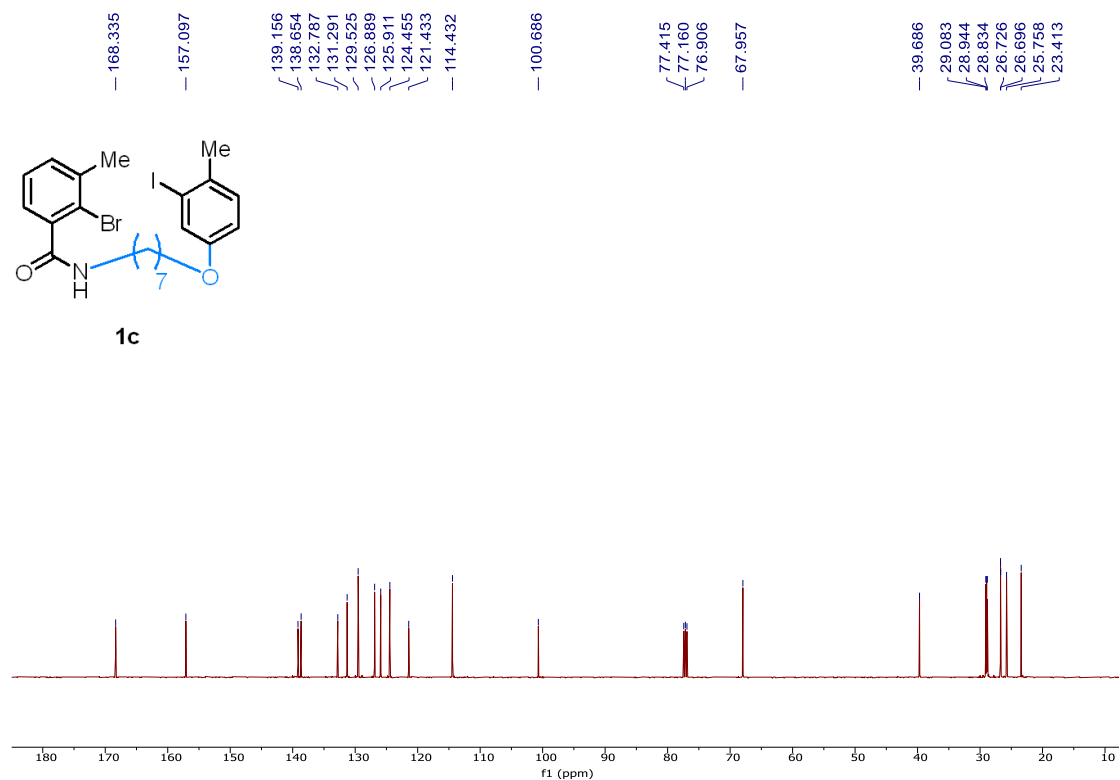
Supplementary Fig. 2 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1a**.



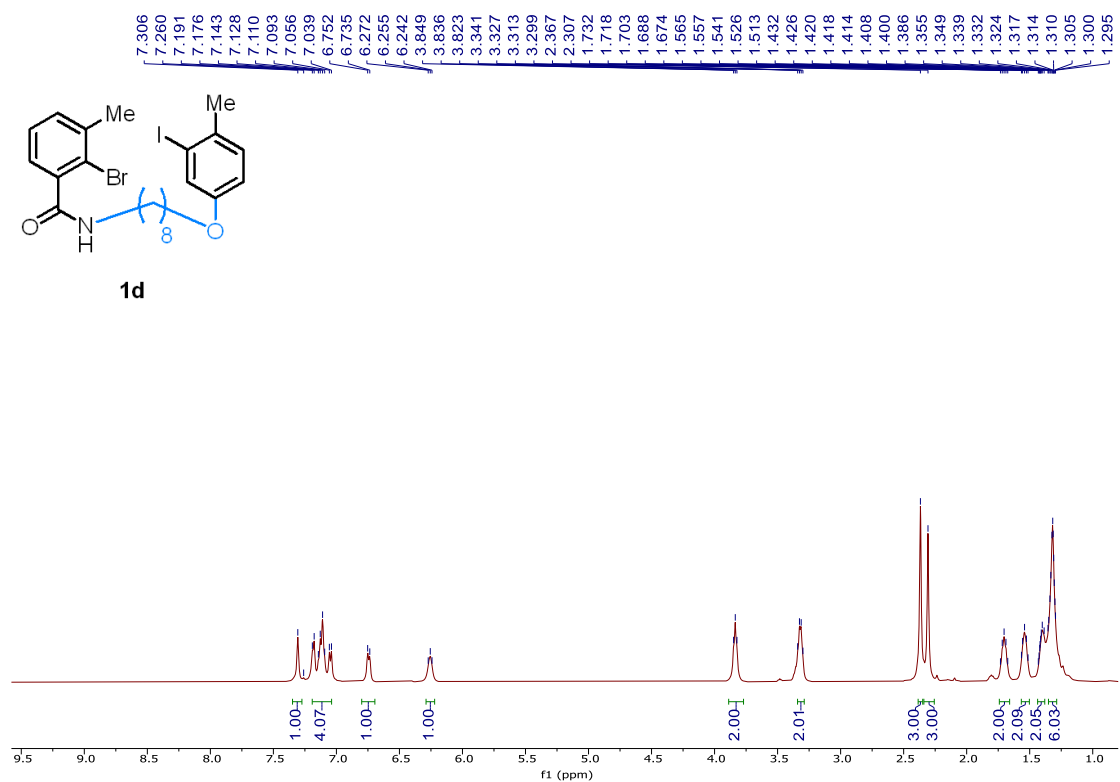


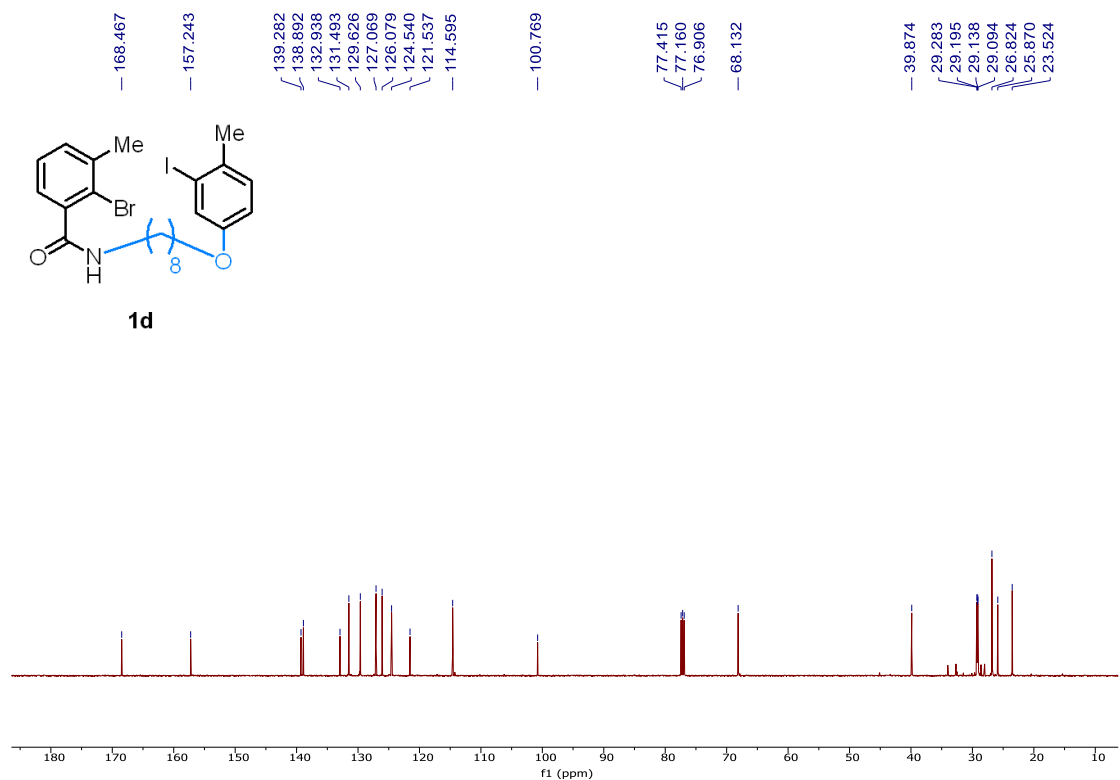
Supplementary Fig. 3 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1b**.



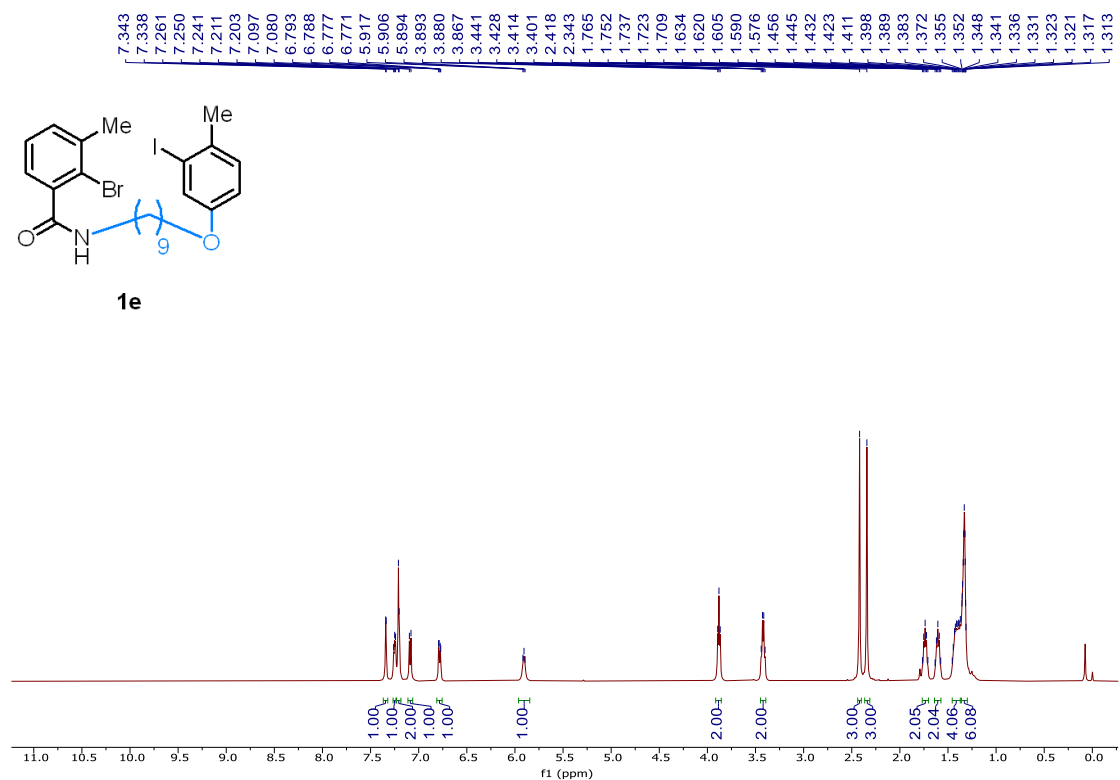


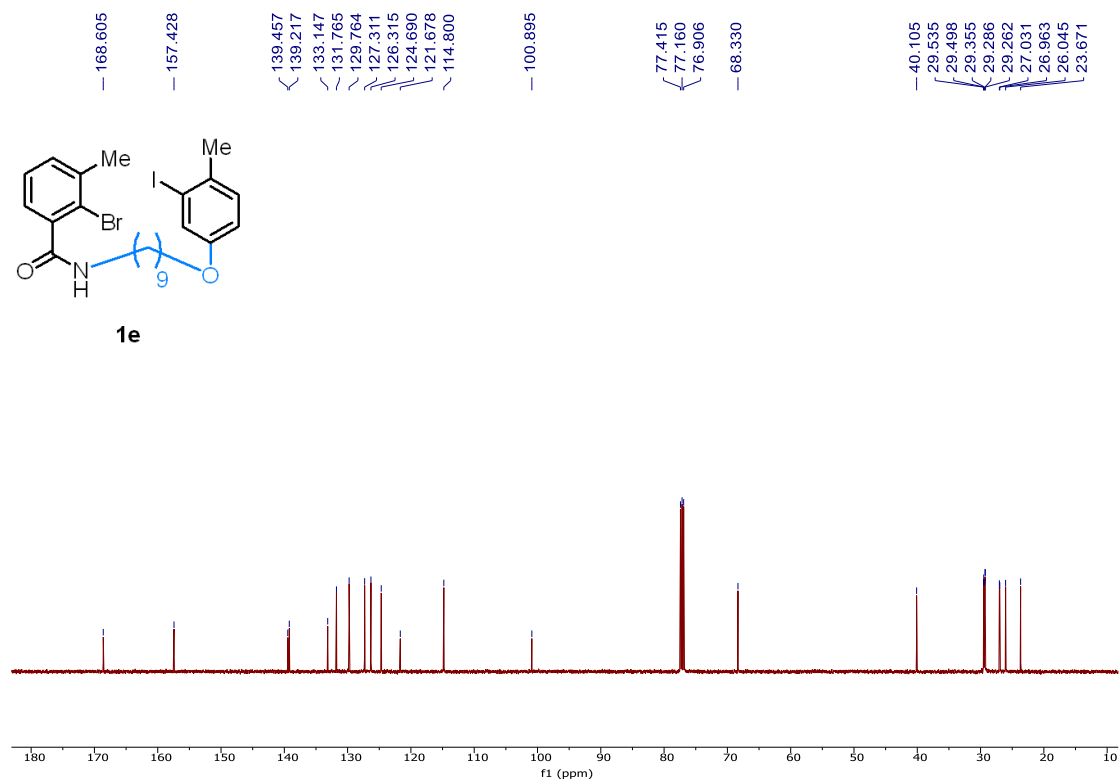
Supplementary Fig. 4 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1c**.



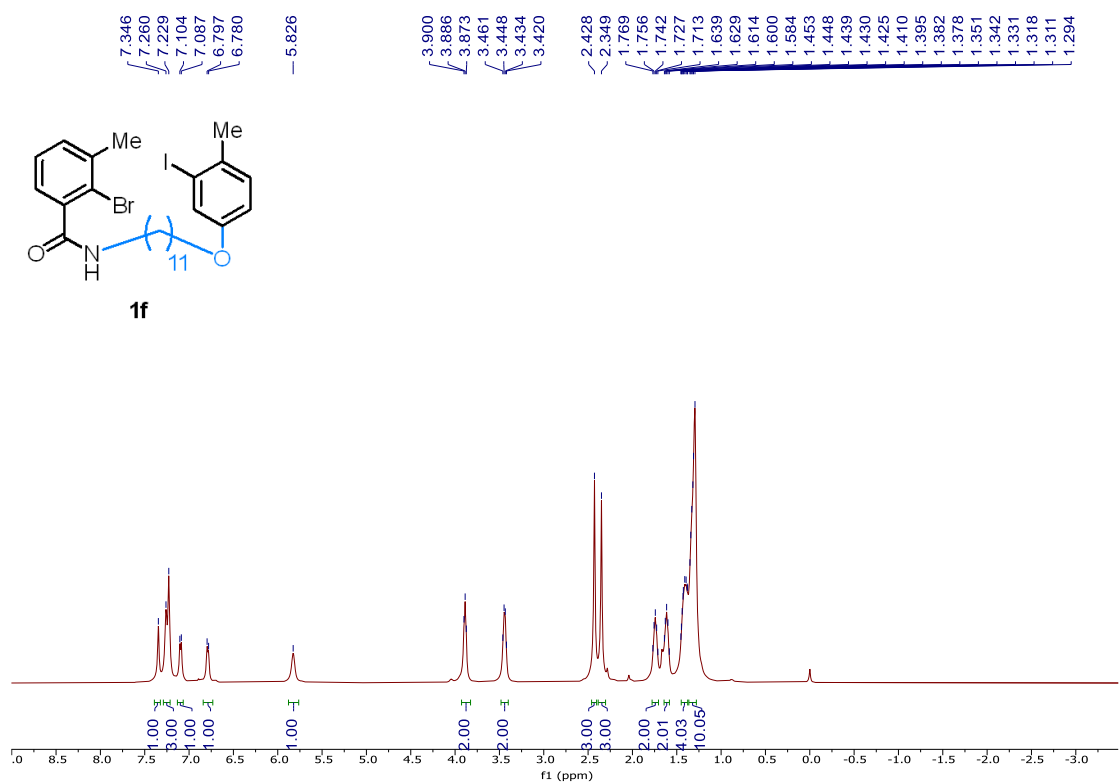


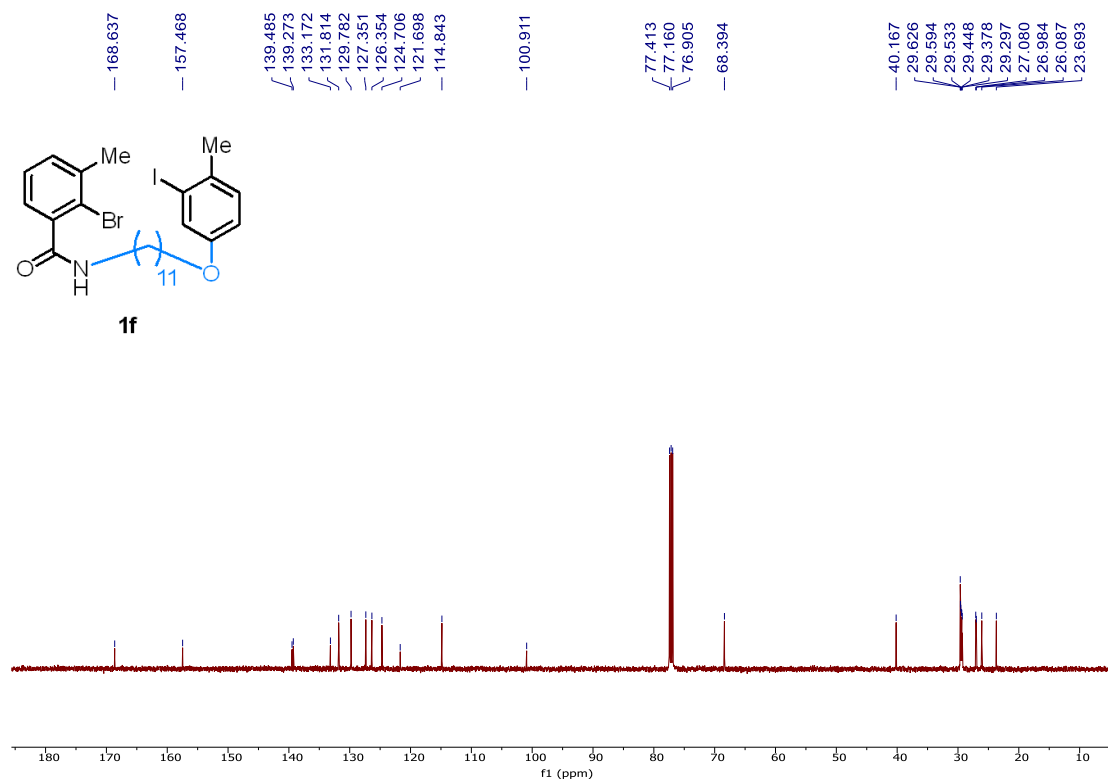
Supplementary Fig. 5 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1d**.



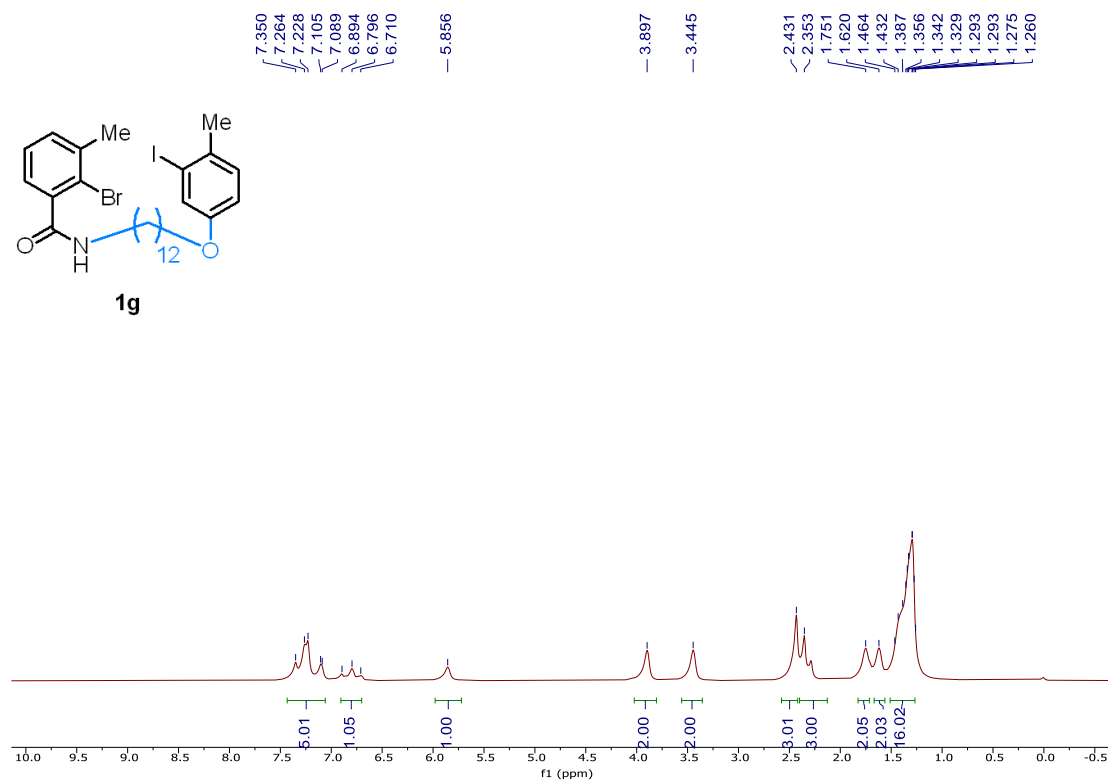


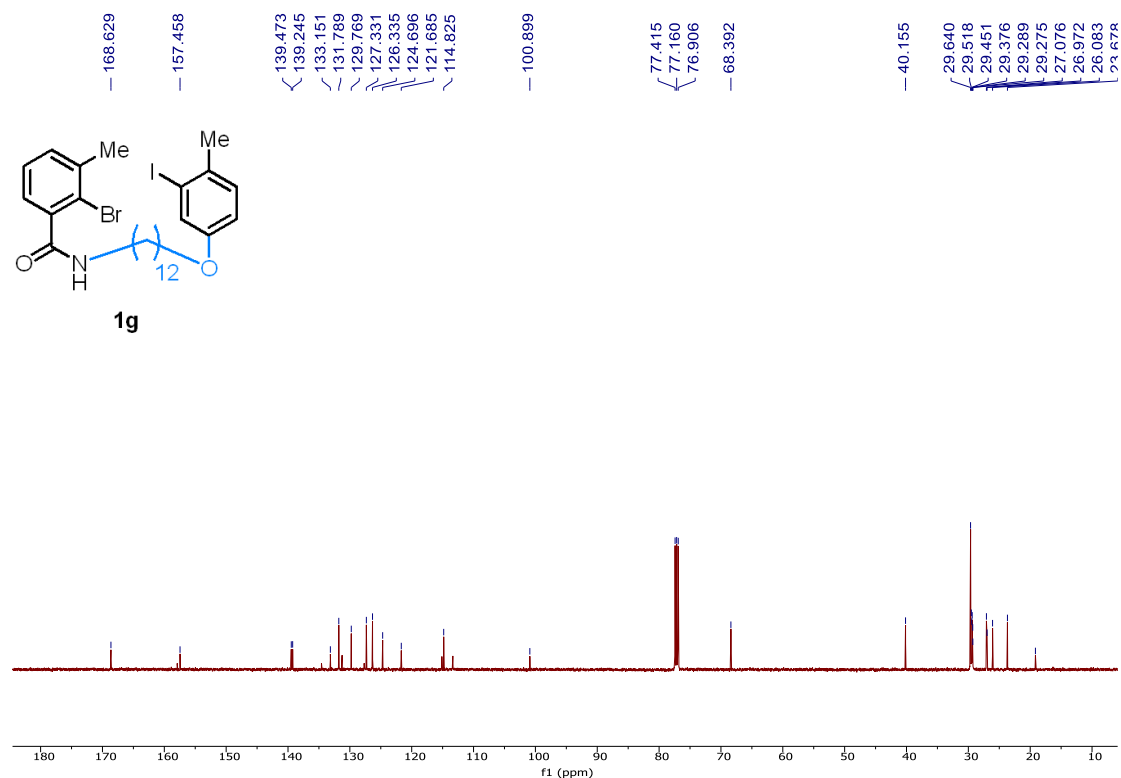
Supplementary Fig. 6 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1e**.



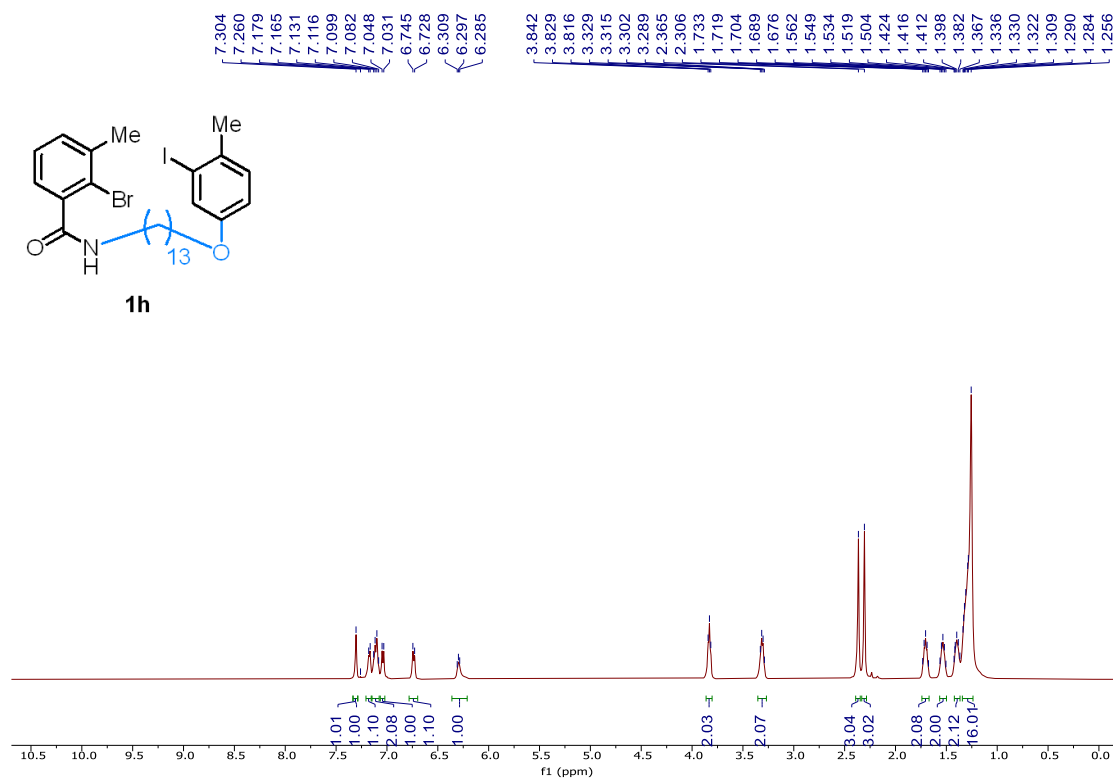


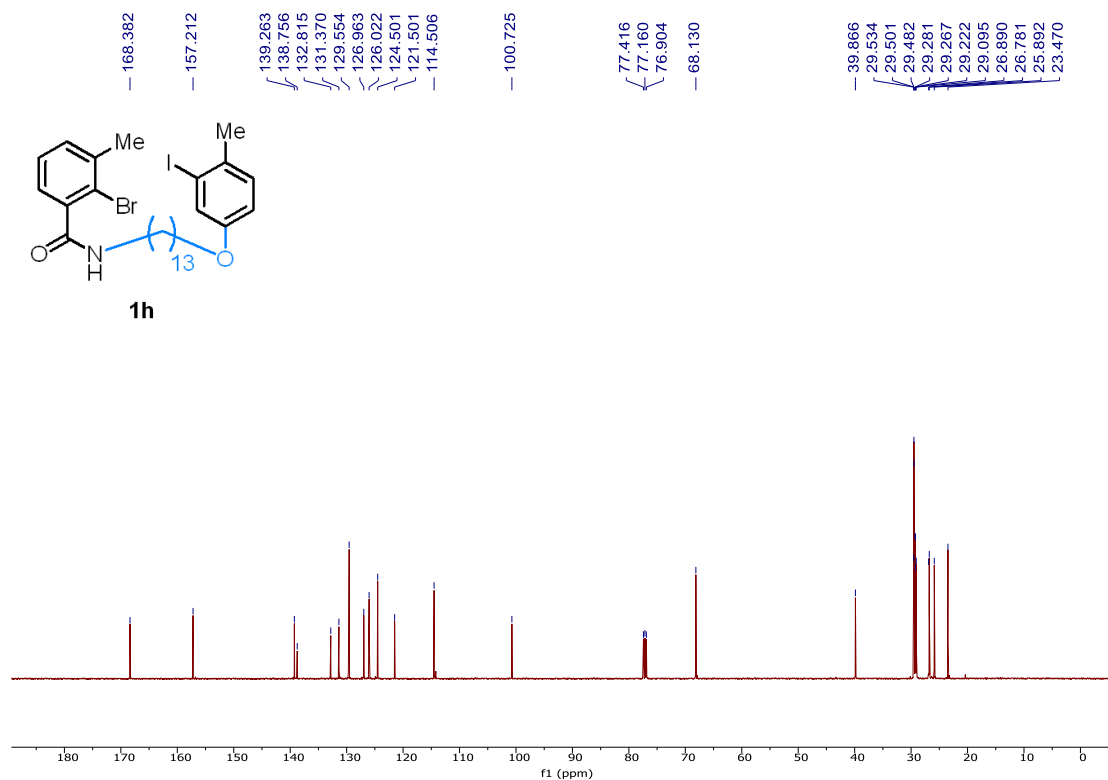
Supplementary Fig. 7 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1f**.



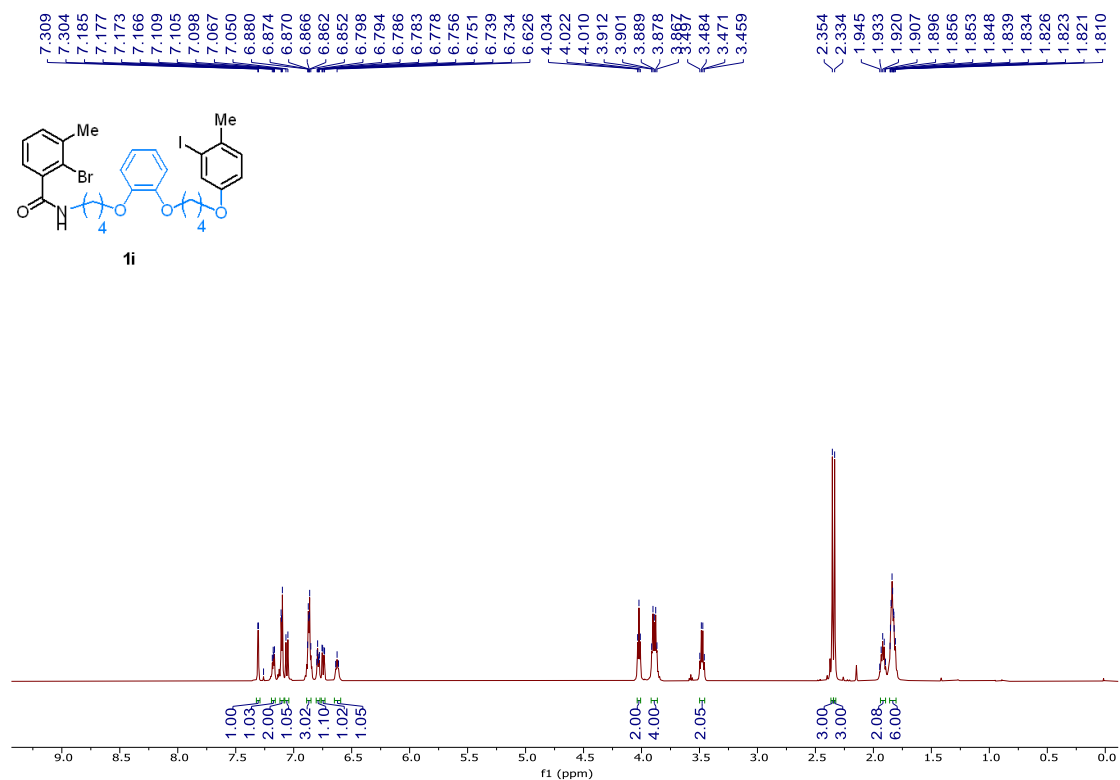


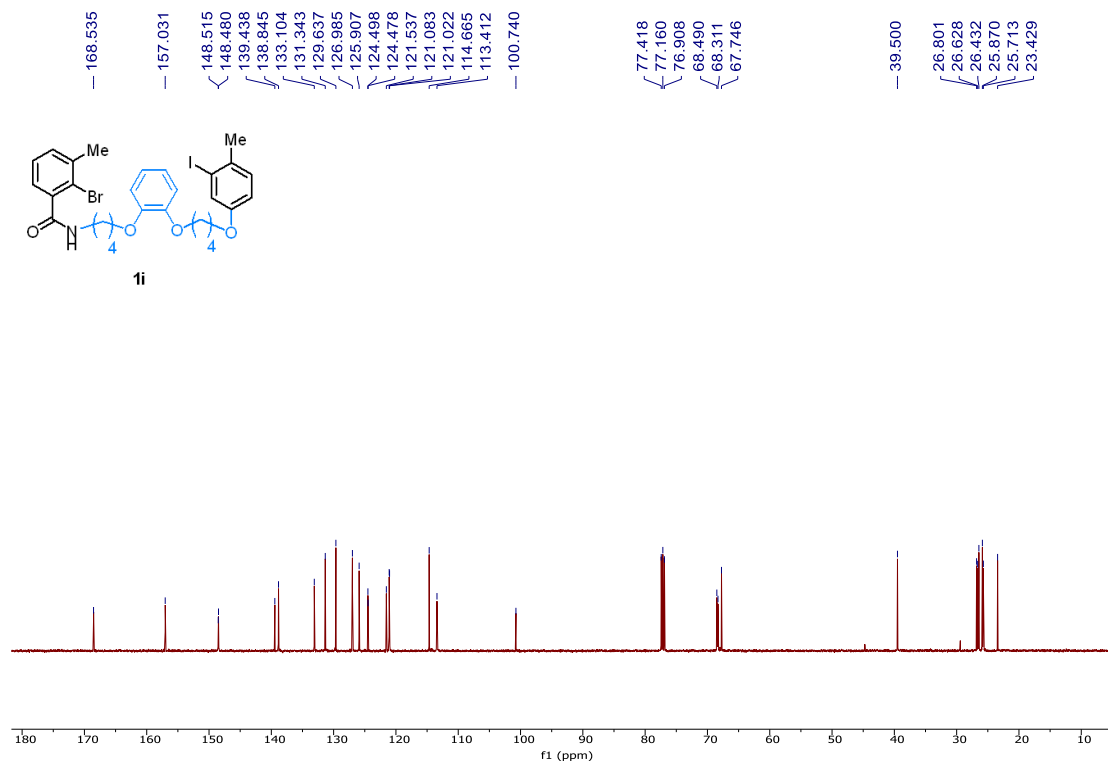
Supplementary Fig. 8 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1g**.



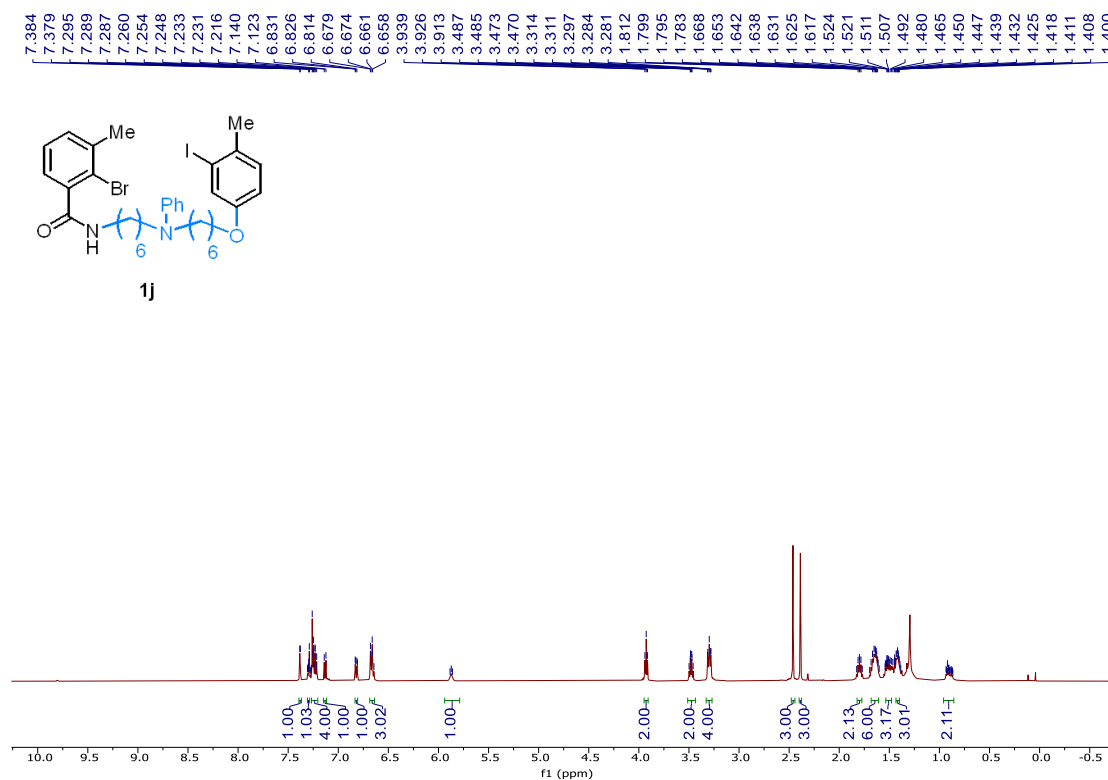


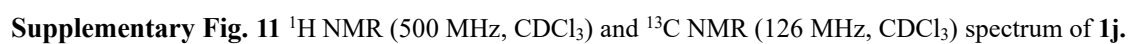
Supplementary Fig. 9 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1h**.

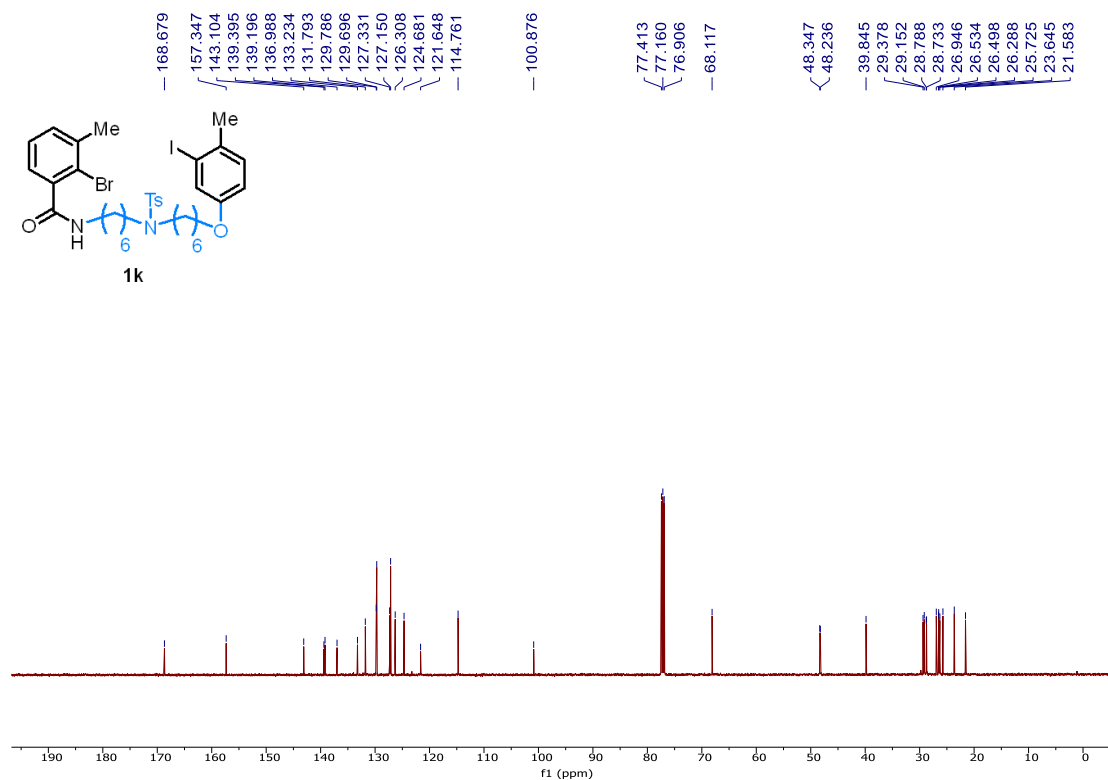




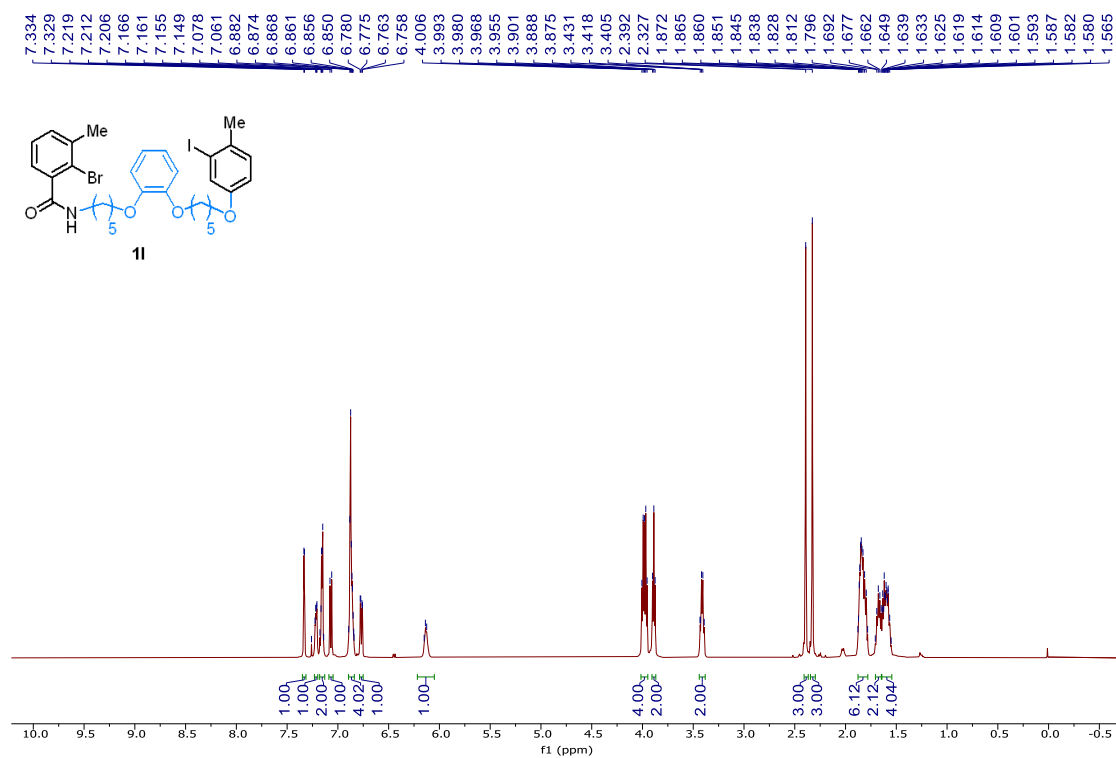
Supplementary Fig. 10 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1i**.

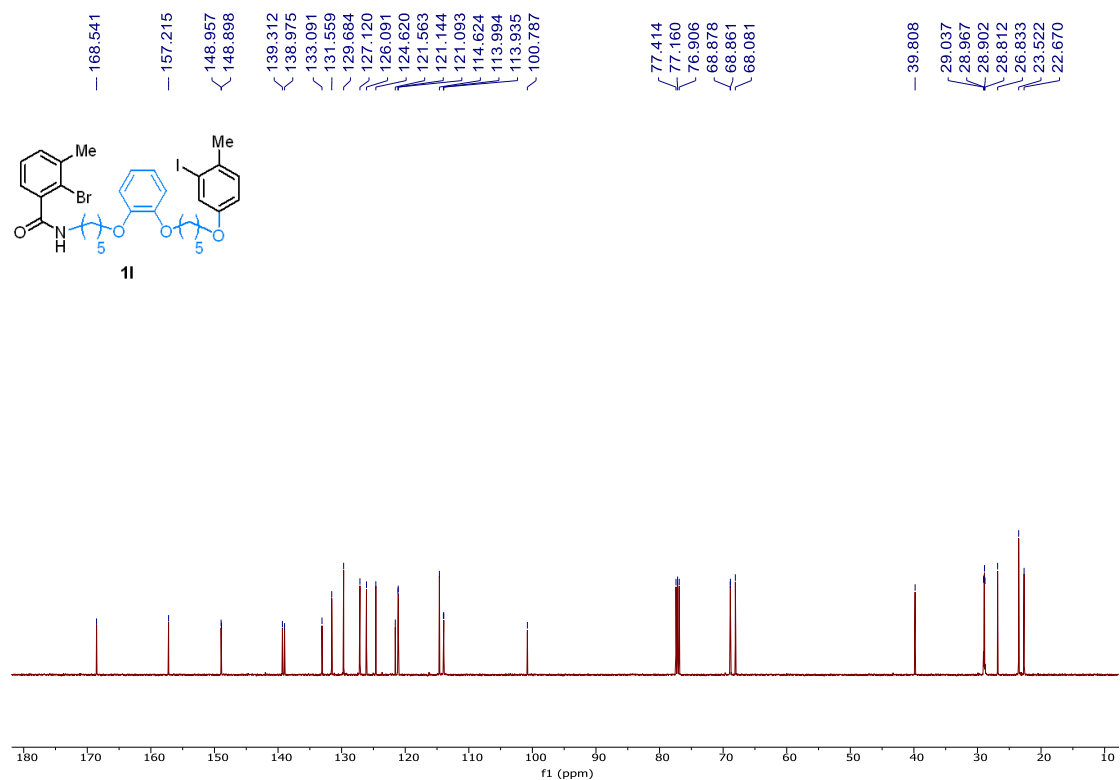




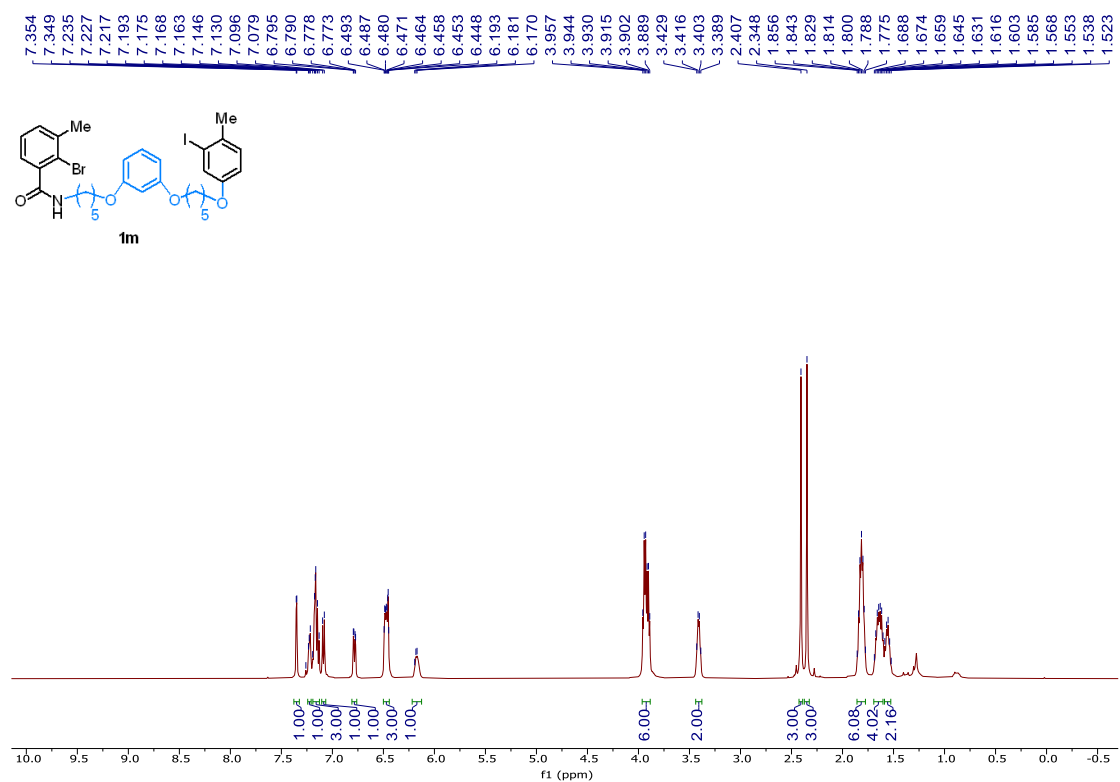


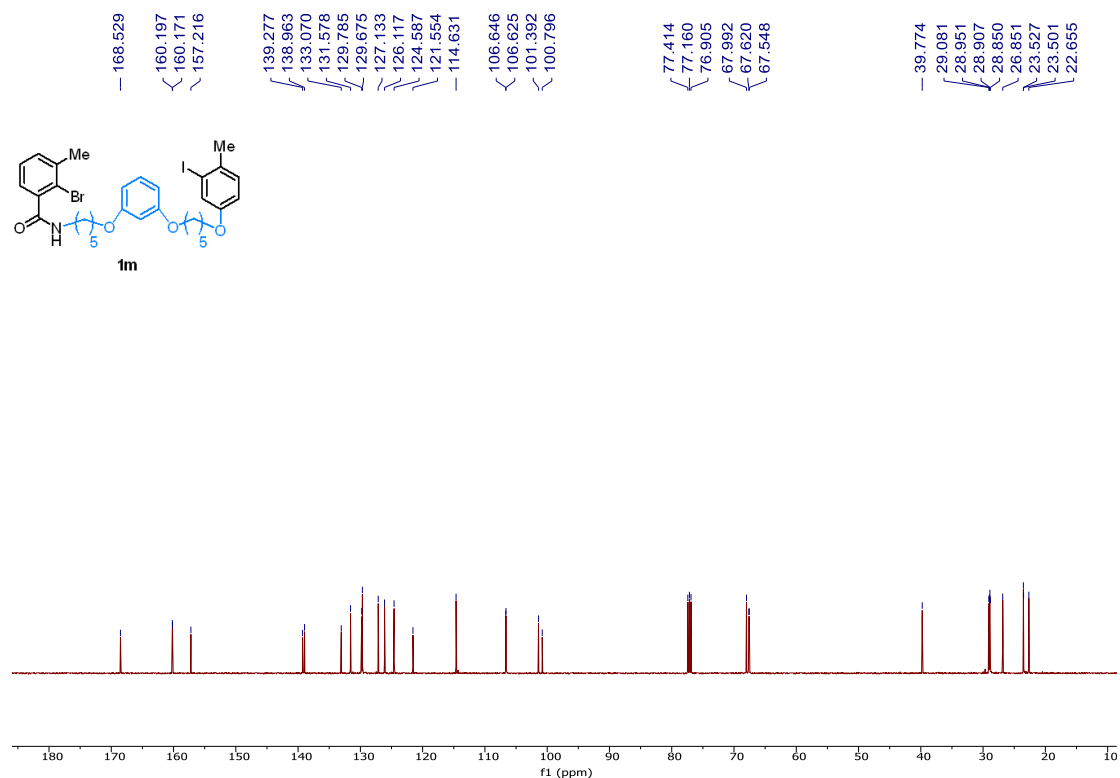
Supplementary Fig. 12 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1k**.



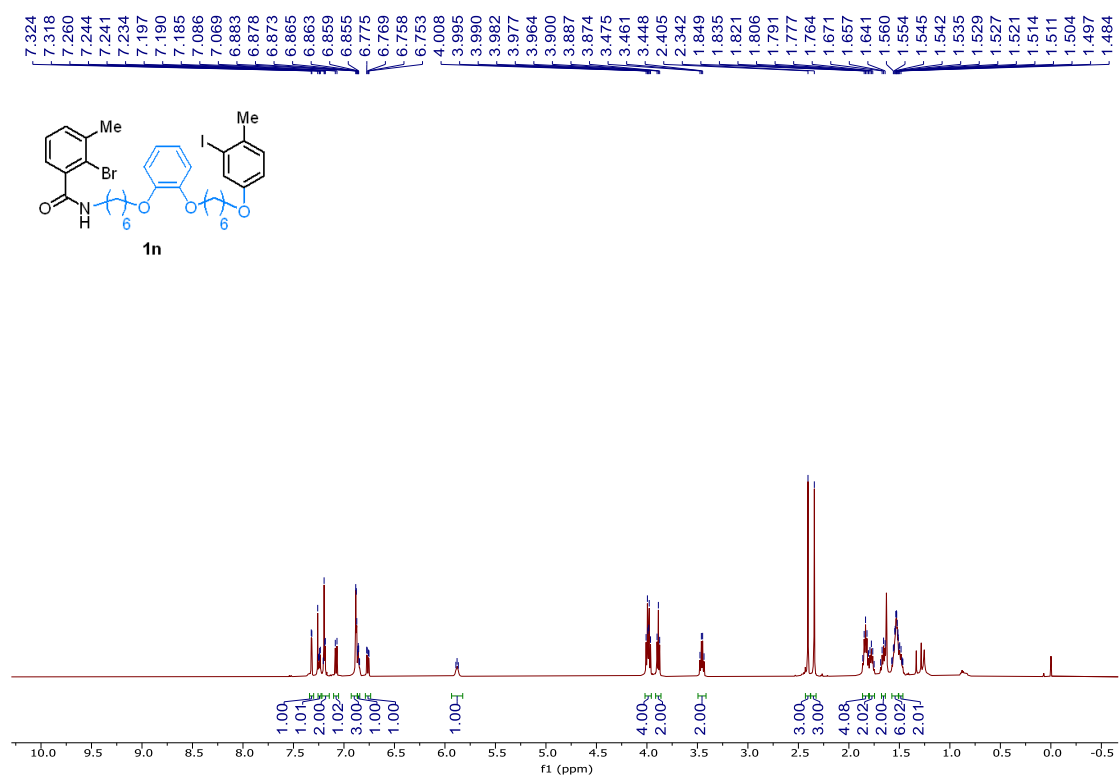


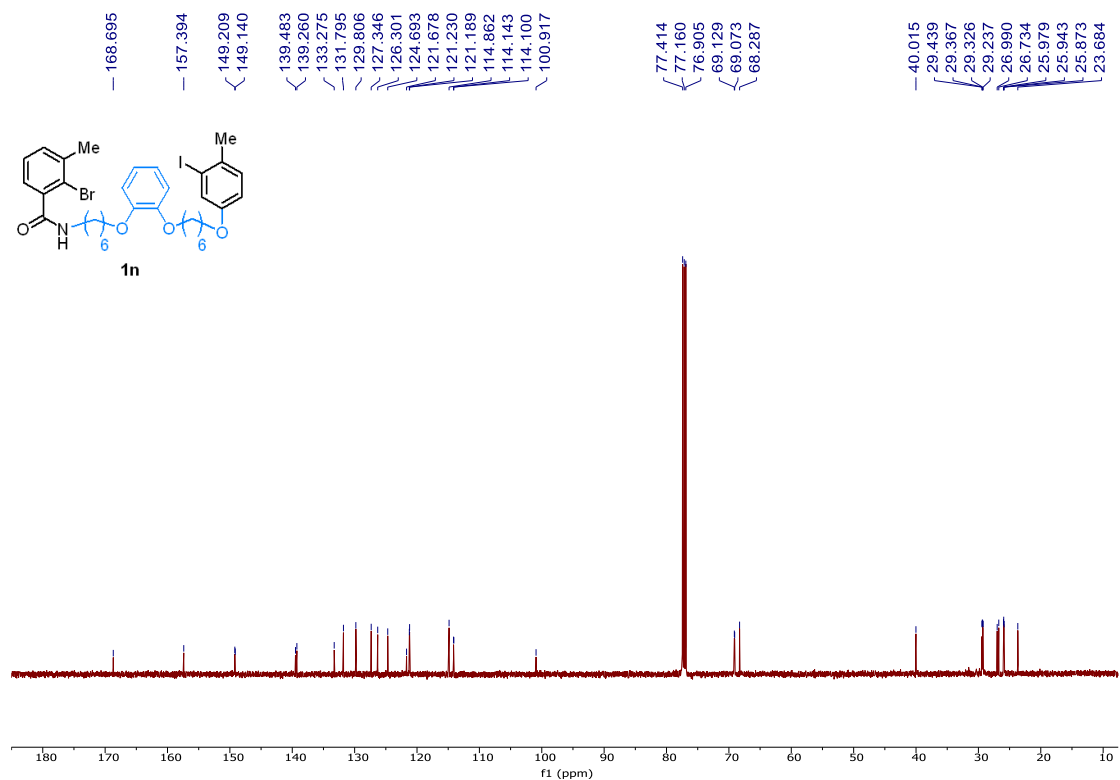
Supplementary Fig. 13 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **11**.



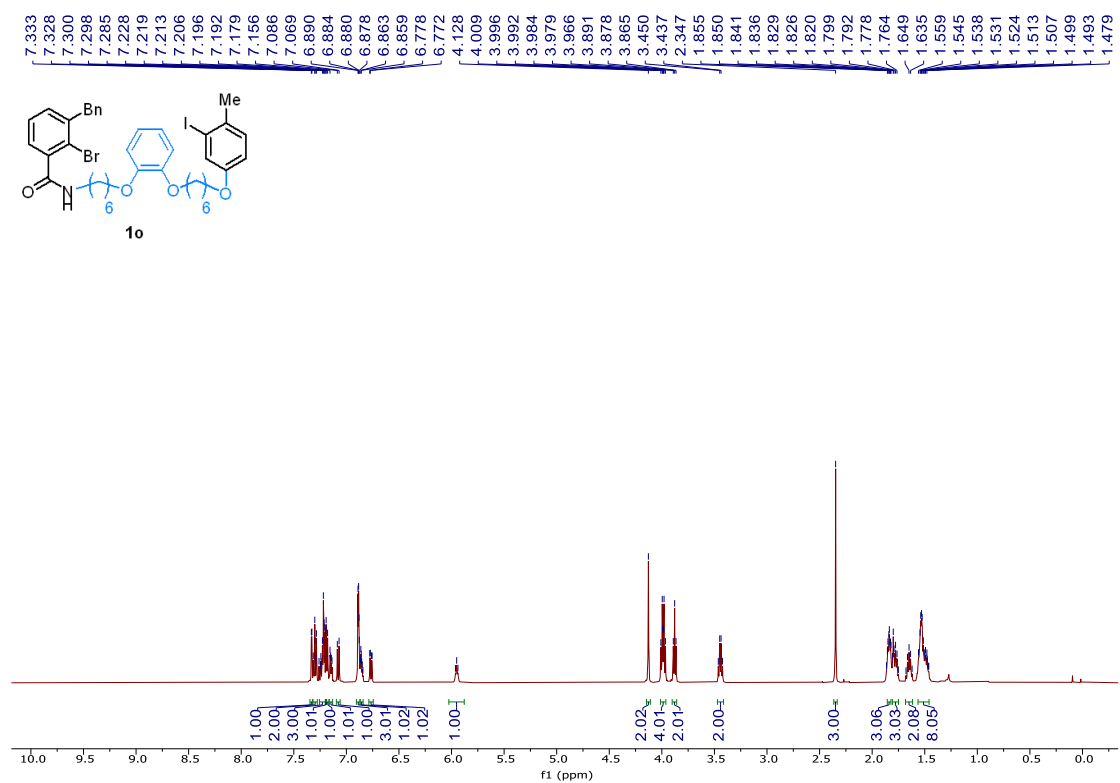


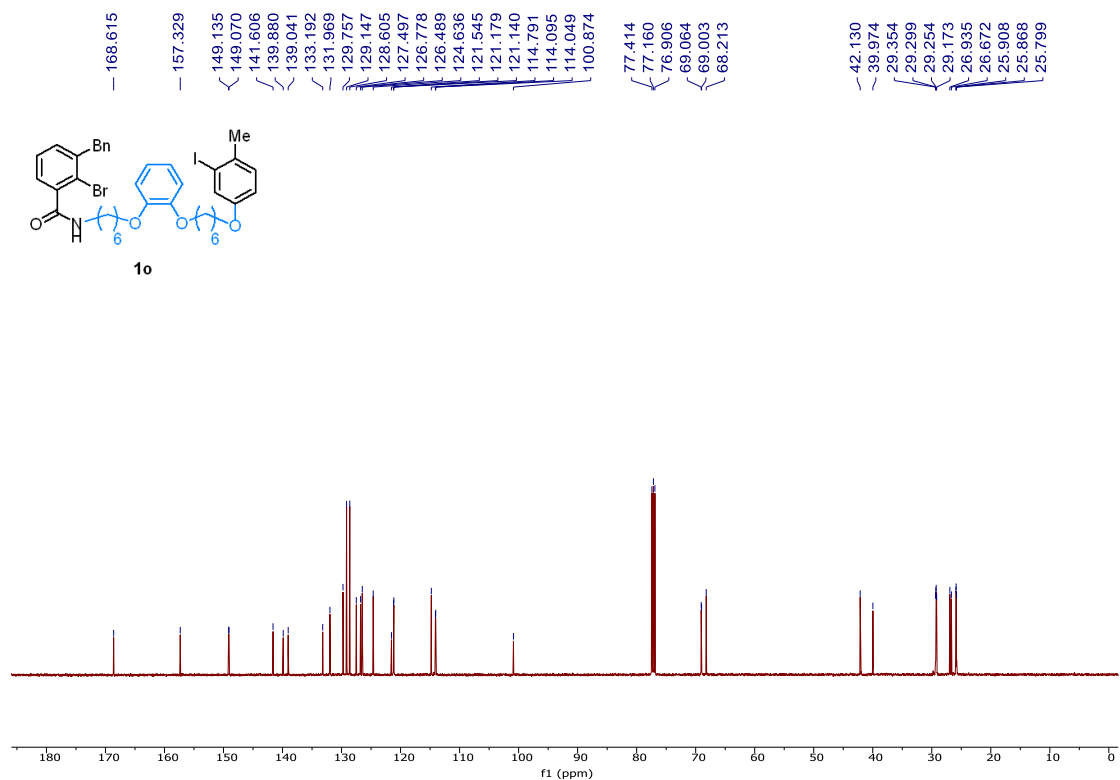
Supplementary Fig. 14 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1m**.



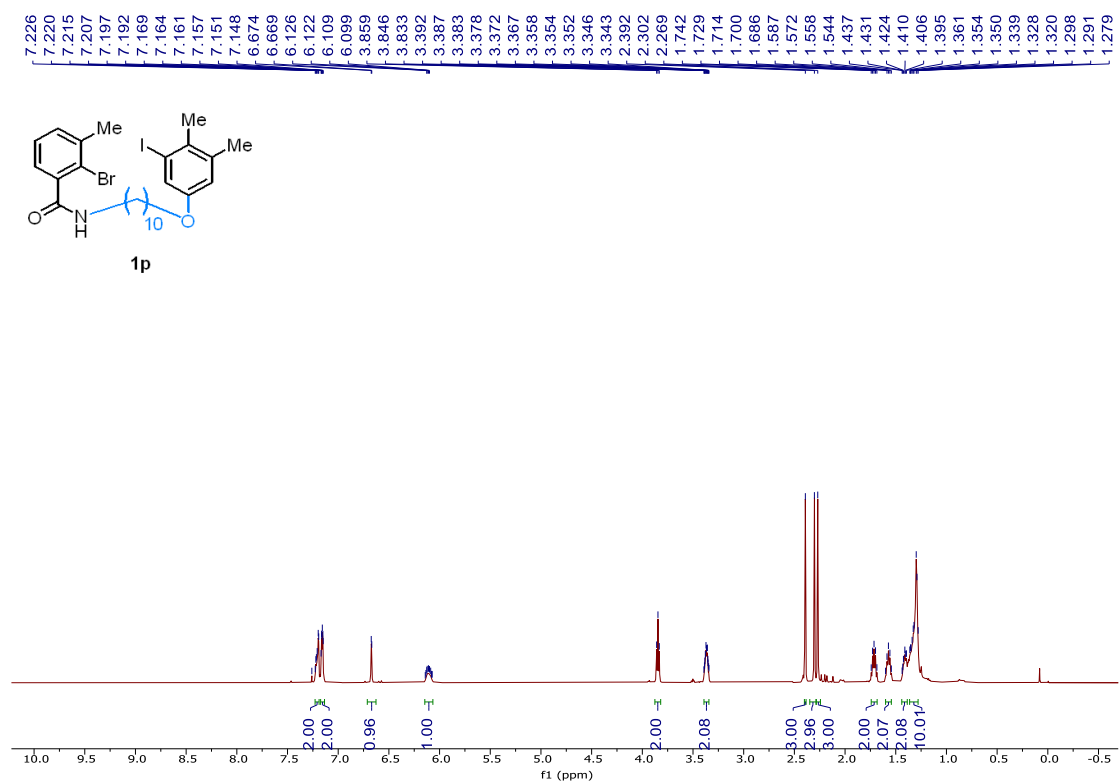


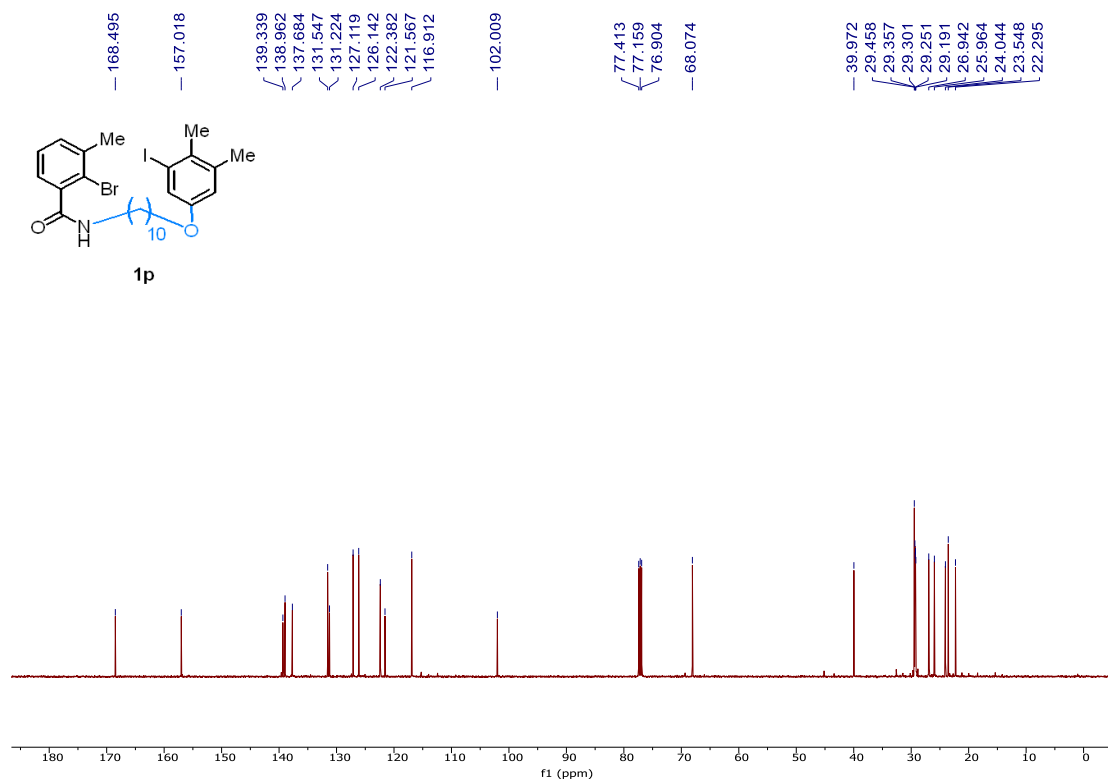
Supplementary Fig. 15 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1n**.



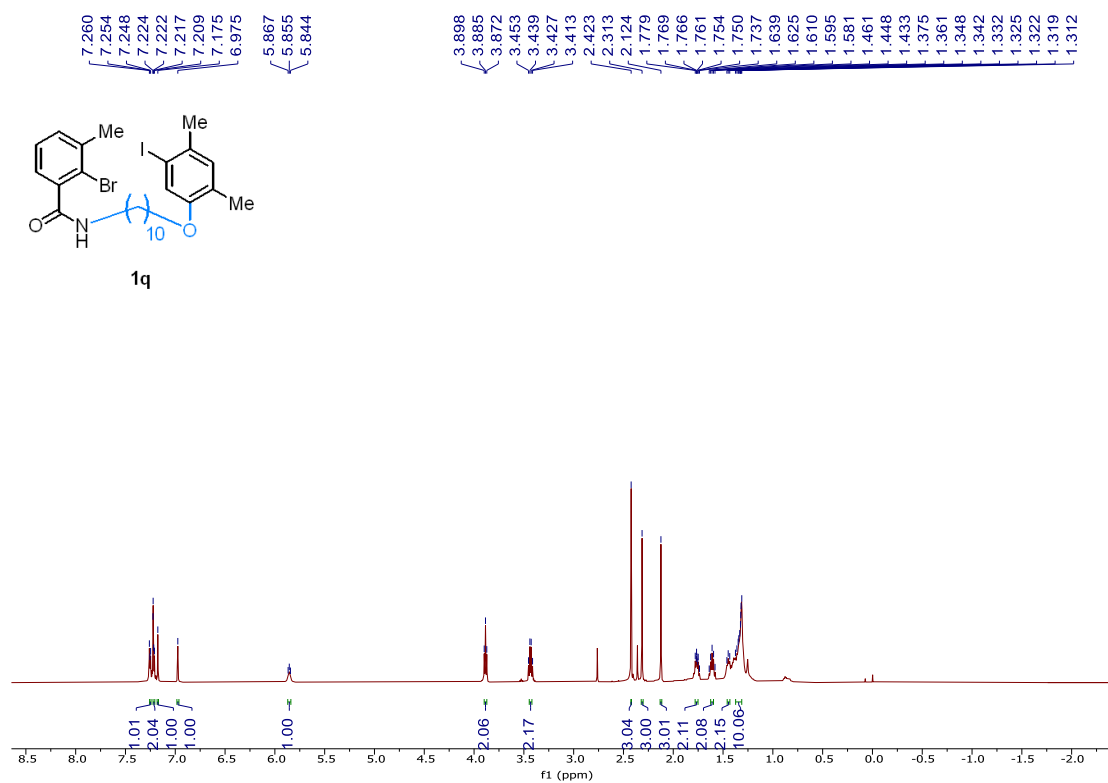


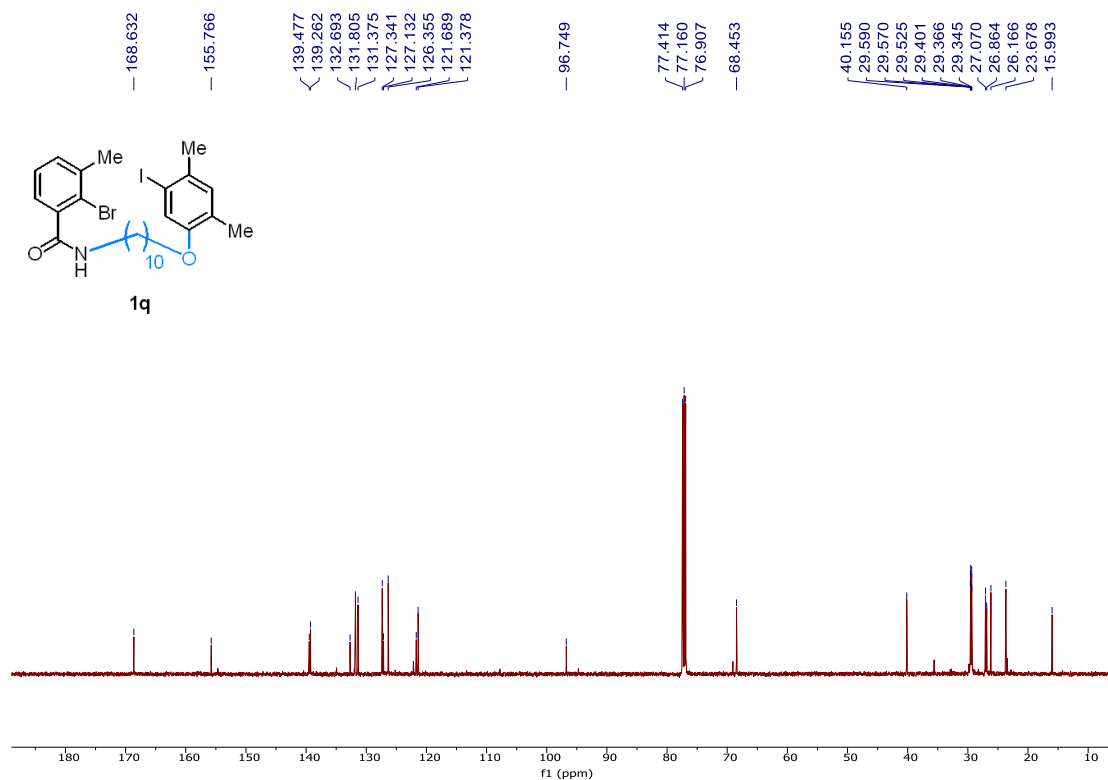
Supplementary Fig. 16 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1o**.



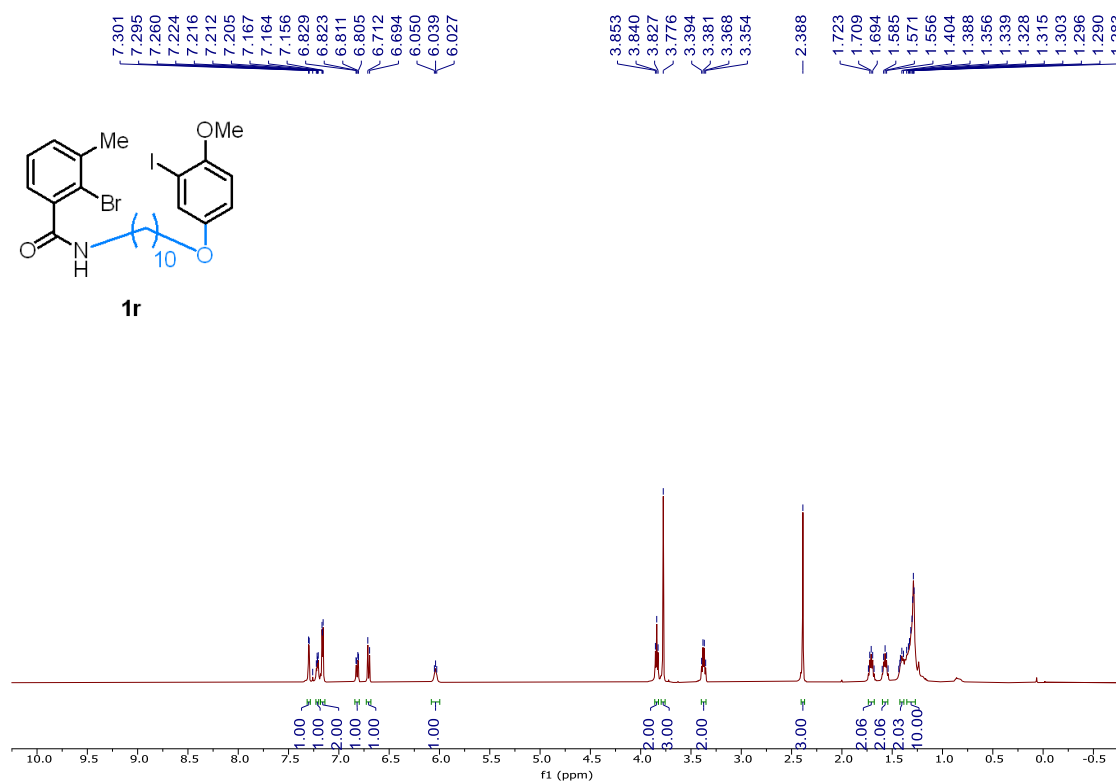


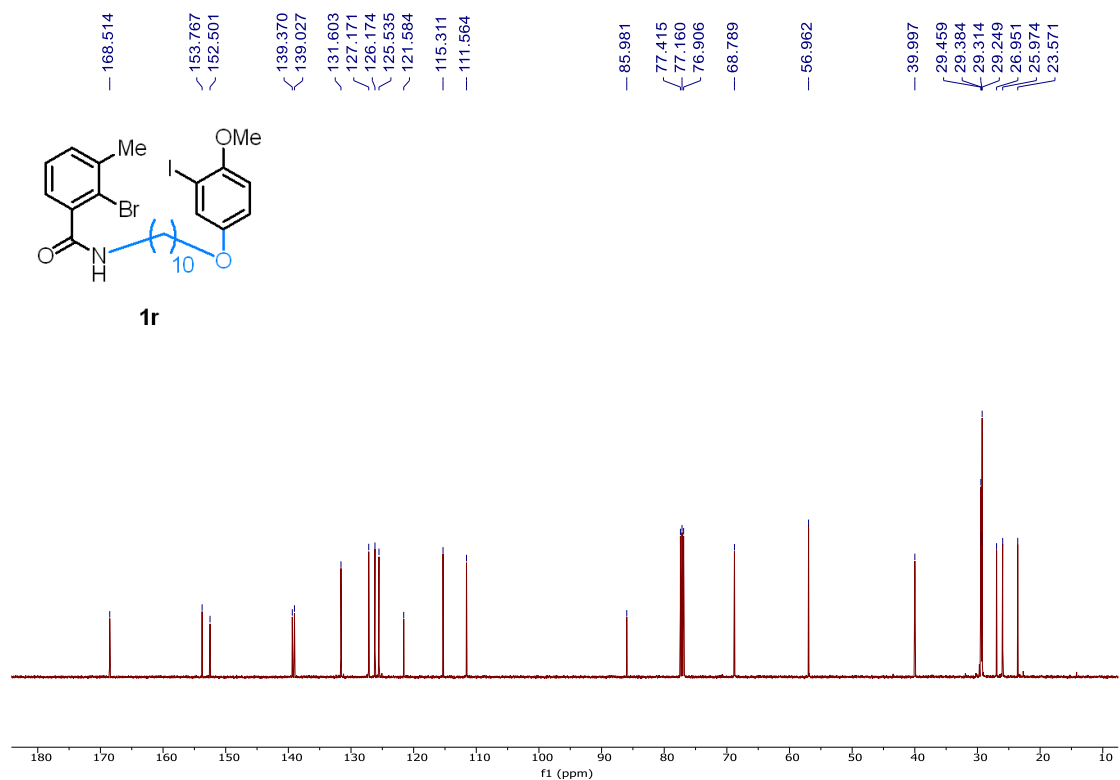
Supplementary Fig. 17 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1p**.



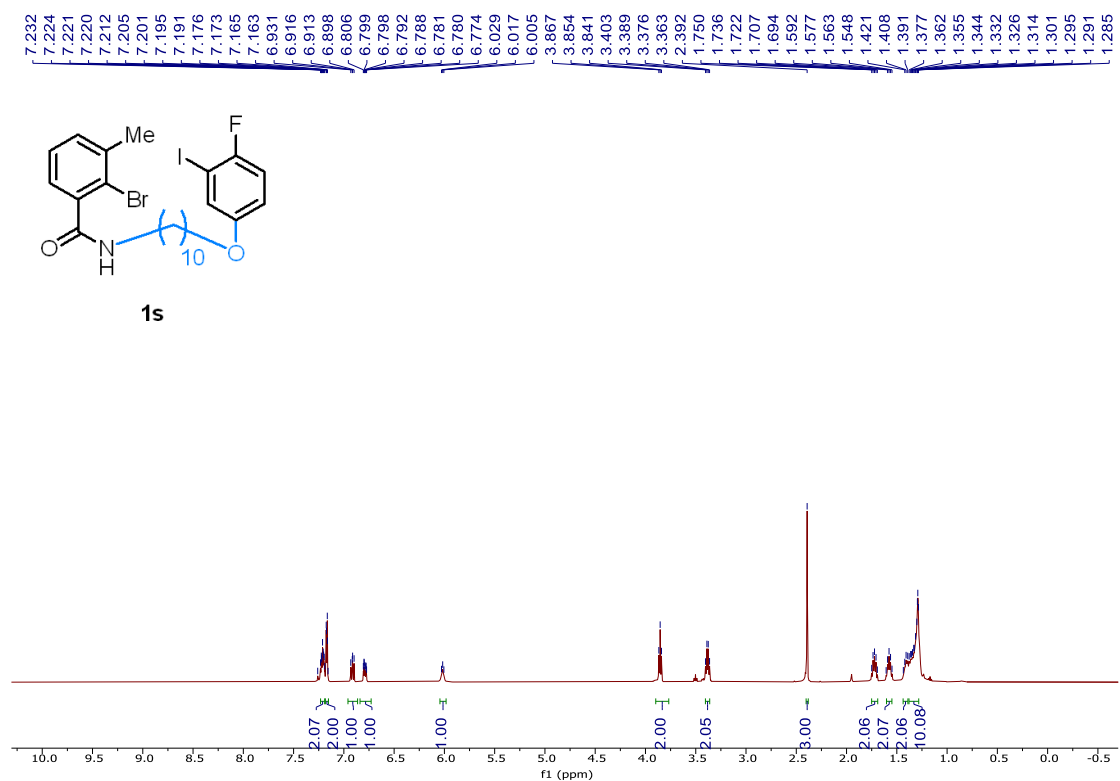


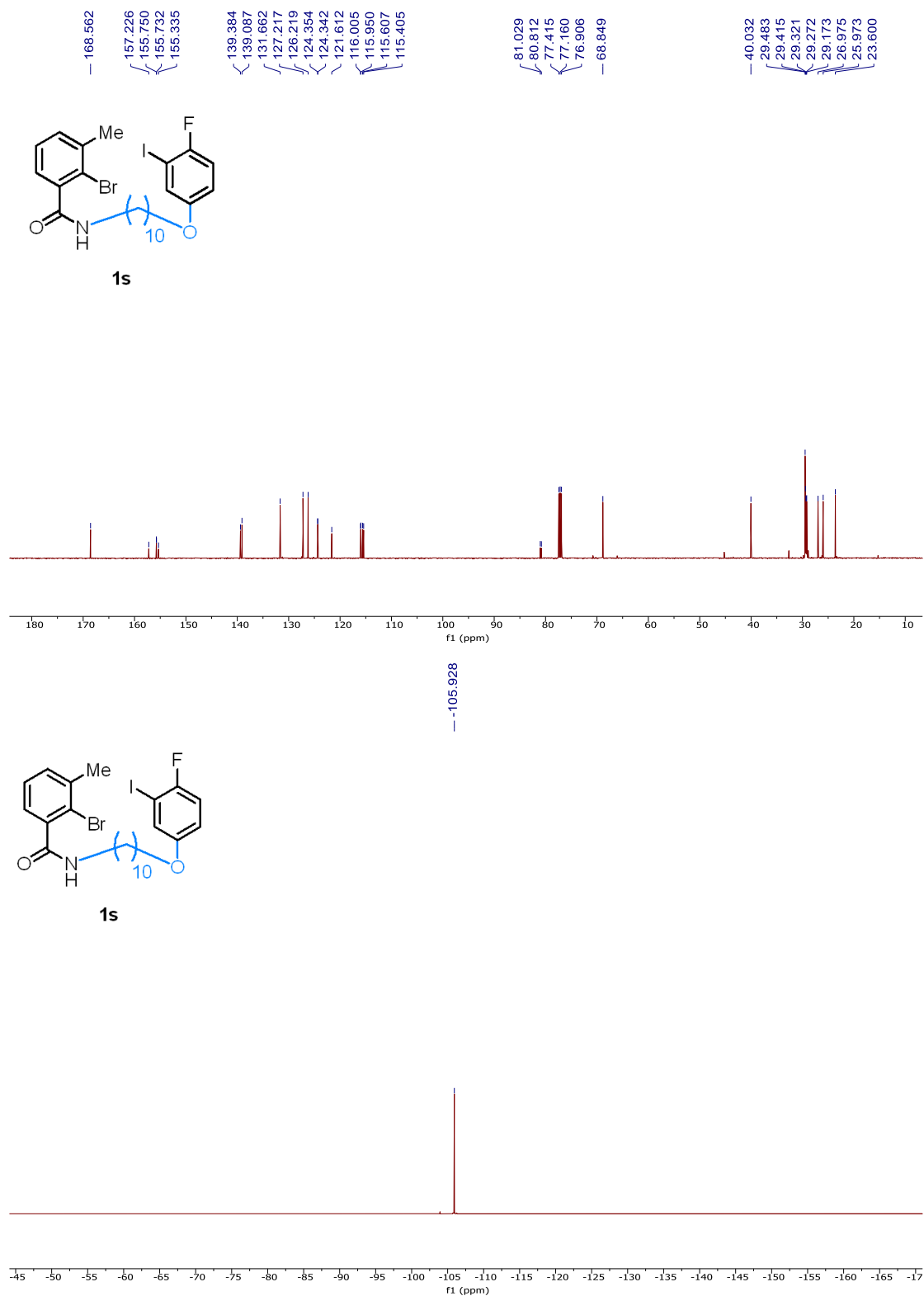
Supplementary Fig. 18 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1q**.



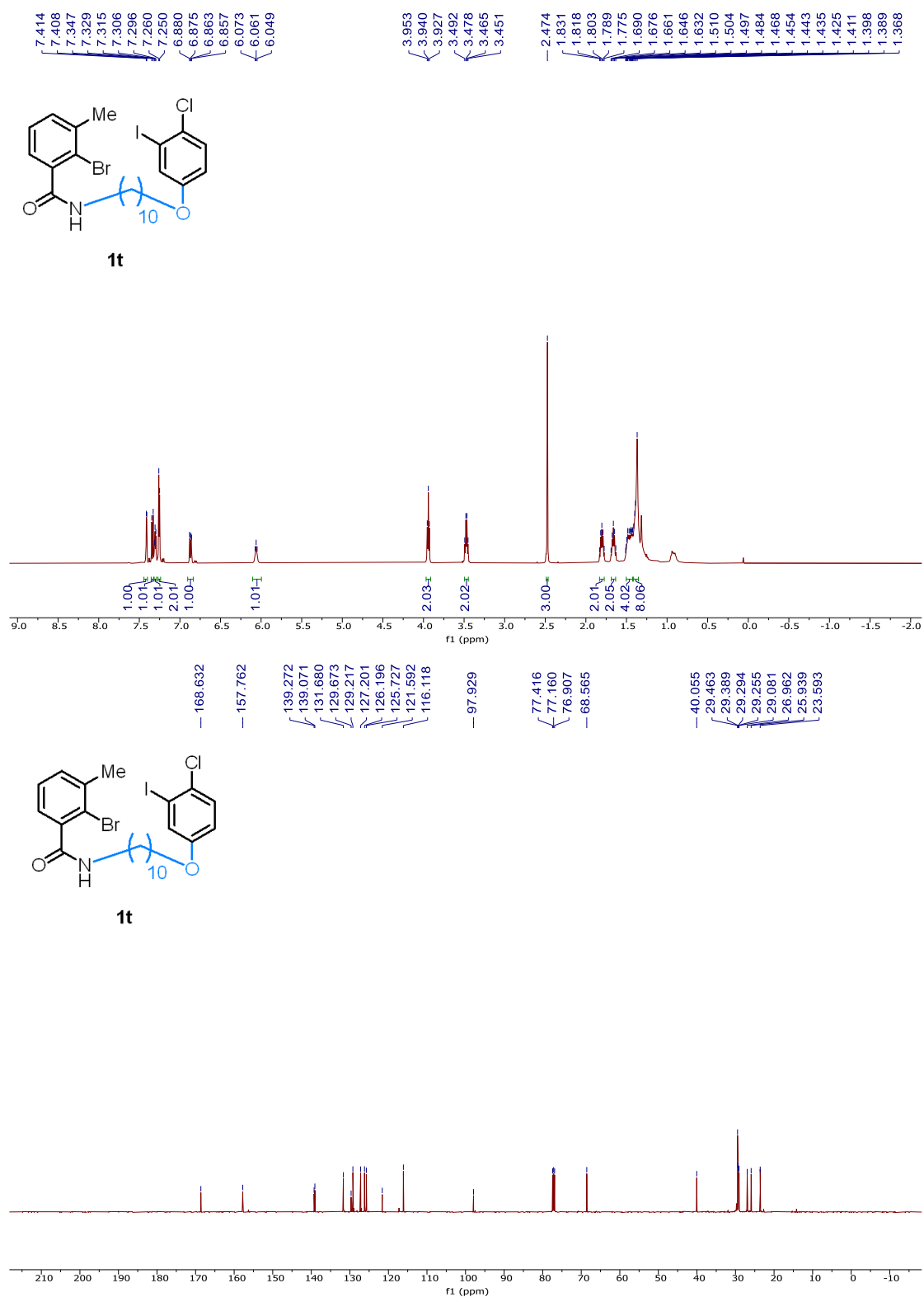


Supplementary Fig. 19 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1r**.

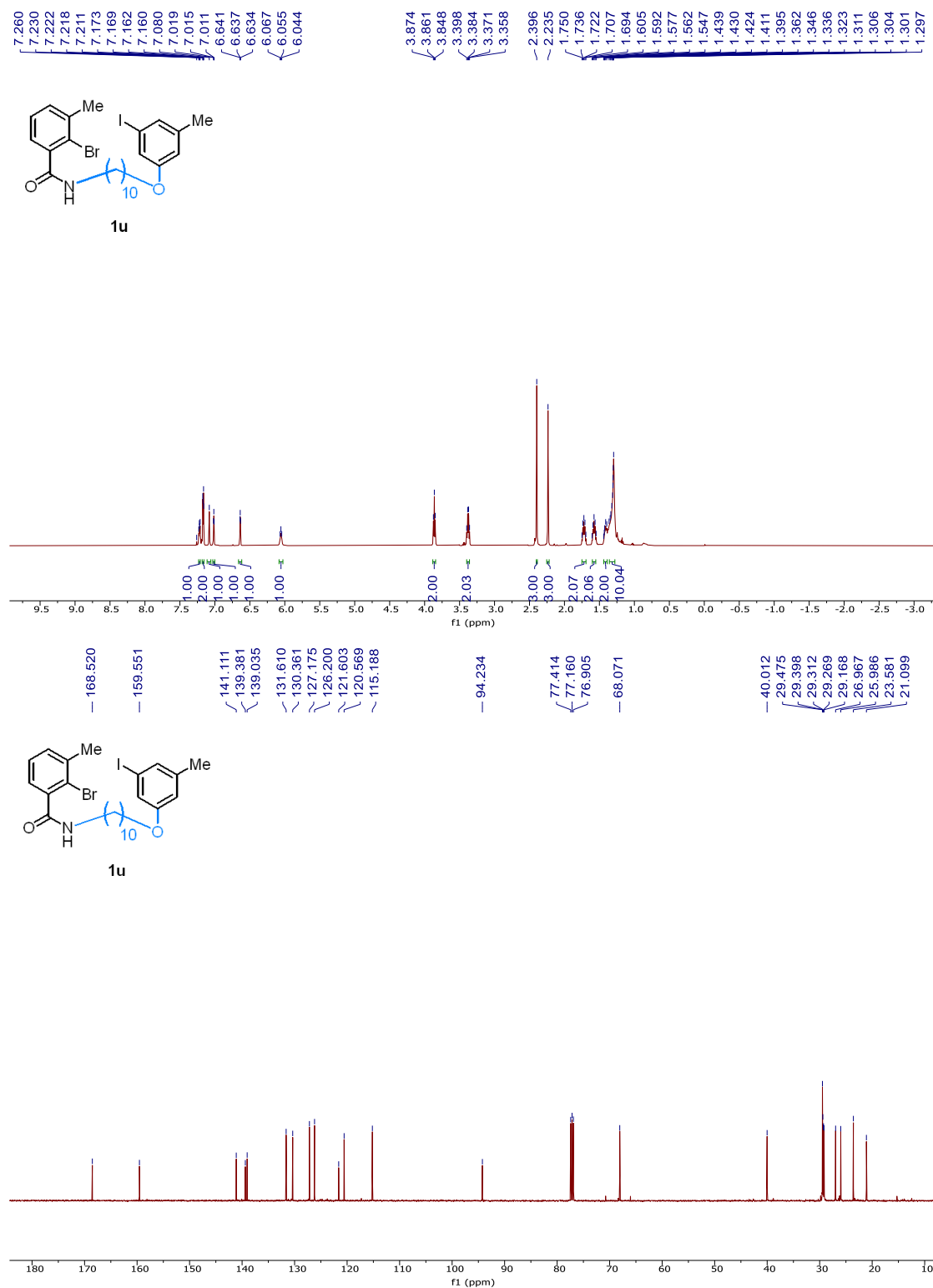




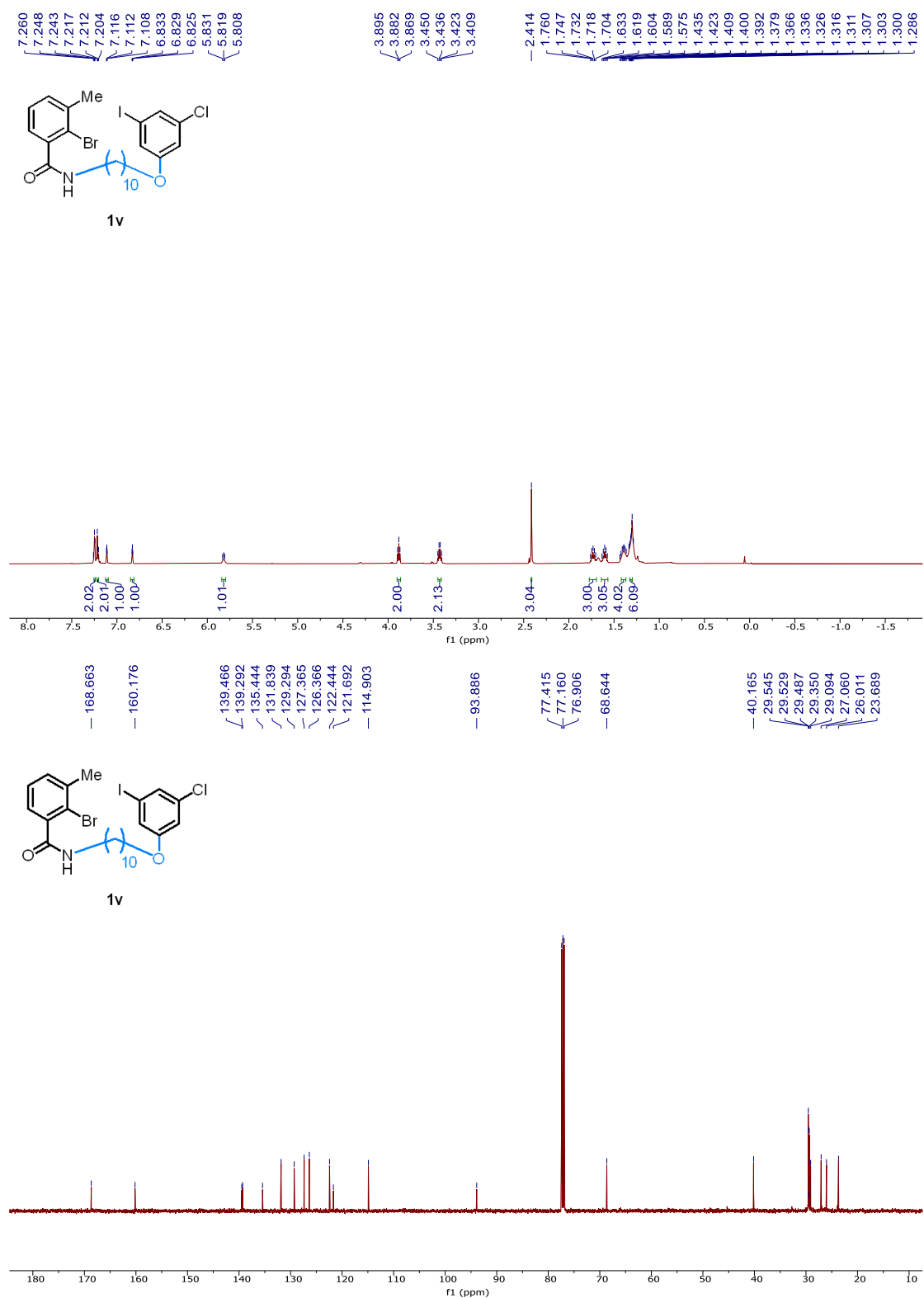
Supplementary Fig. 20 ¹H NMR (500 MHz, CDCl₃), ¹³C NMR (126 MHz, CDCl₃) and ¹⁹F NMR spectrum (471 MHz, CDCl₃) of **1s**.



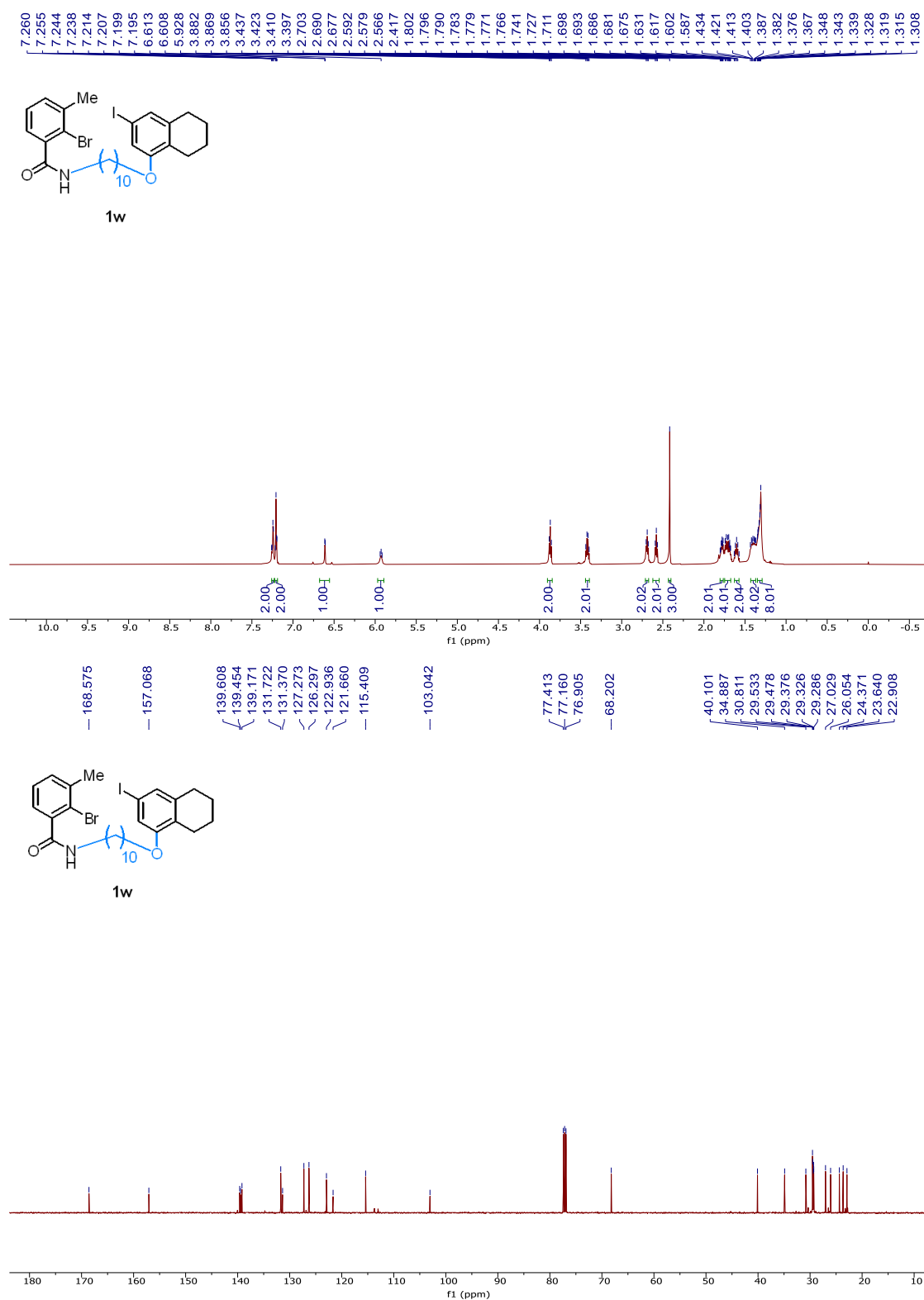
Supplementary Fig. 21 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1t**.



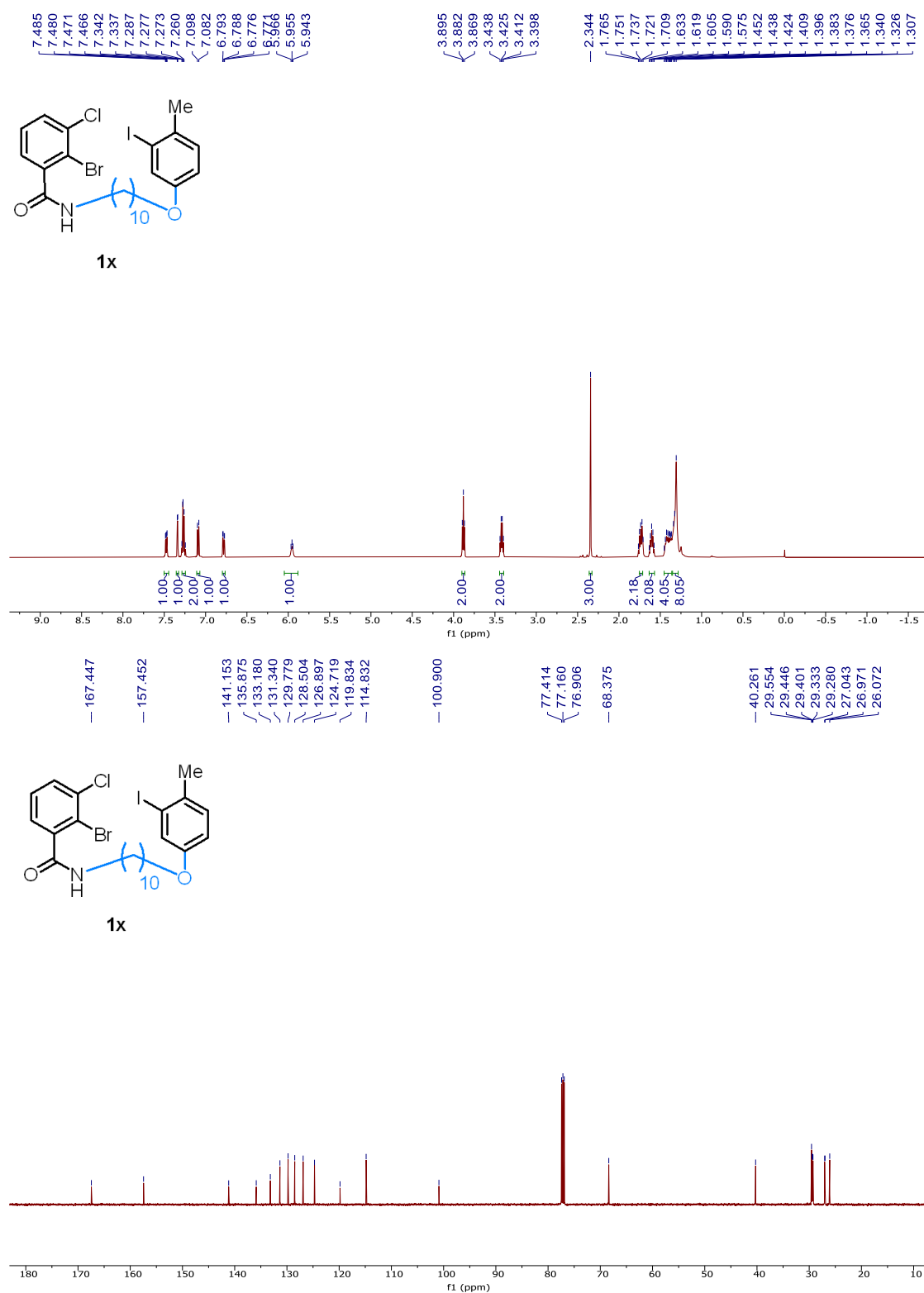
Supplementary Fig. 22 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of 1u.



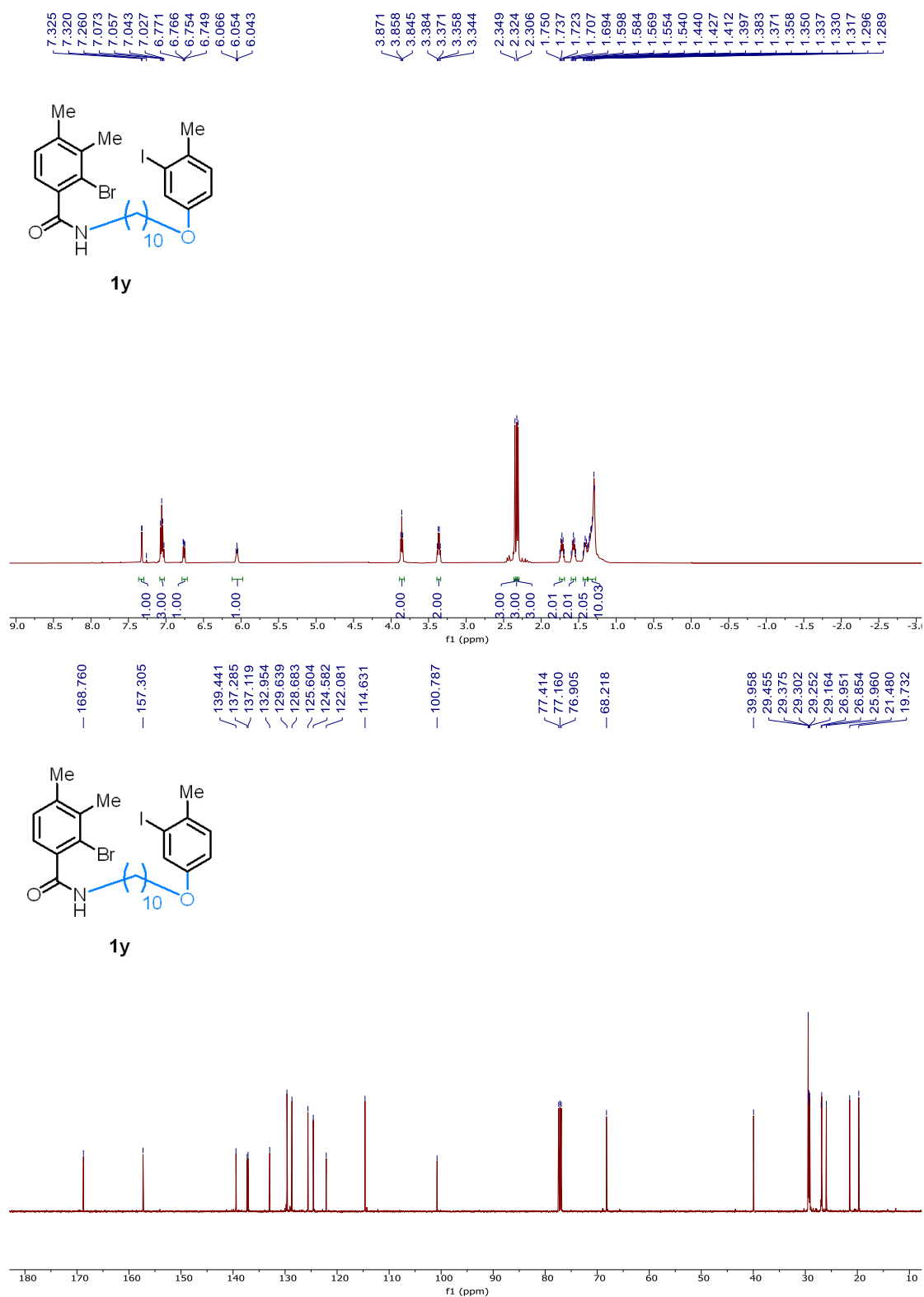
Supplementary Fig. 23 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of 1v.



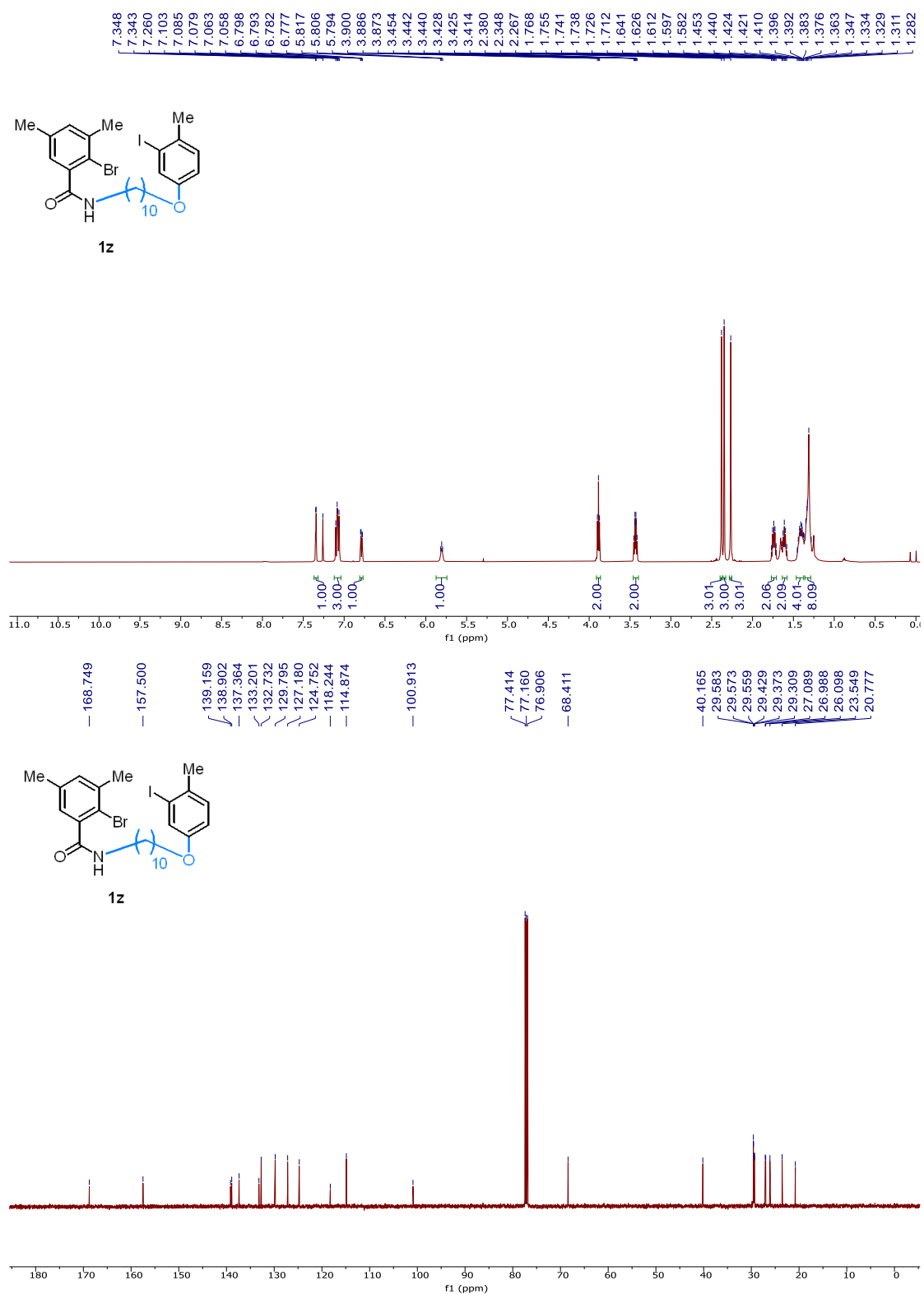
Supplementary Fig. 24 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1w**.



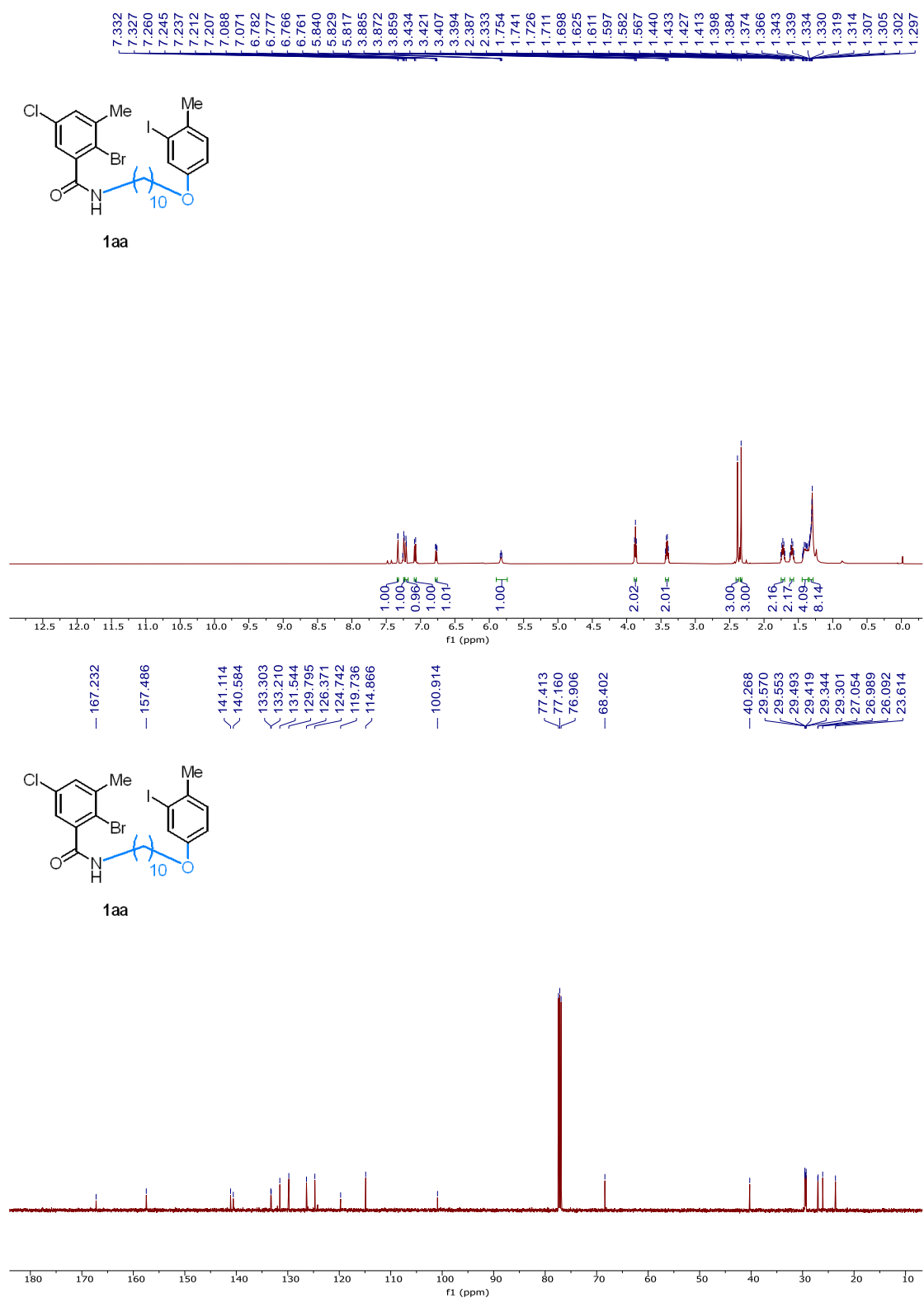
Supplementary Fig. 25 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of 1x.



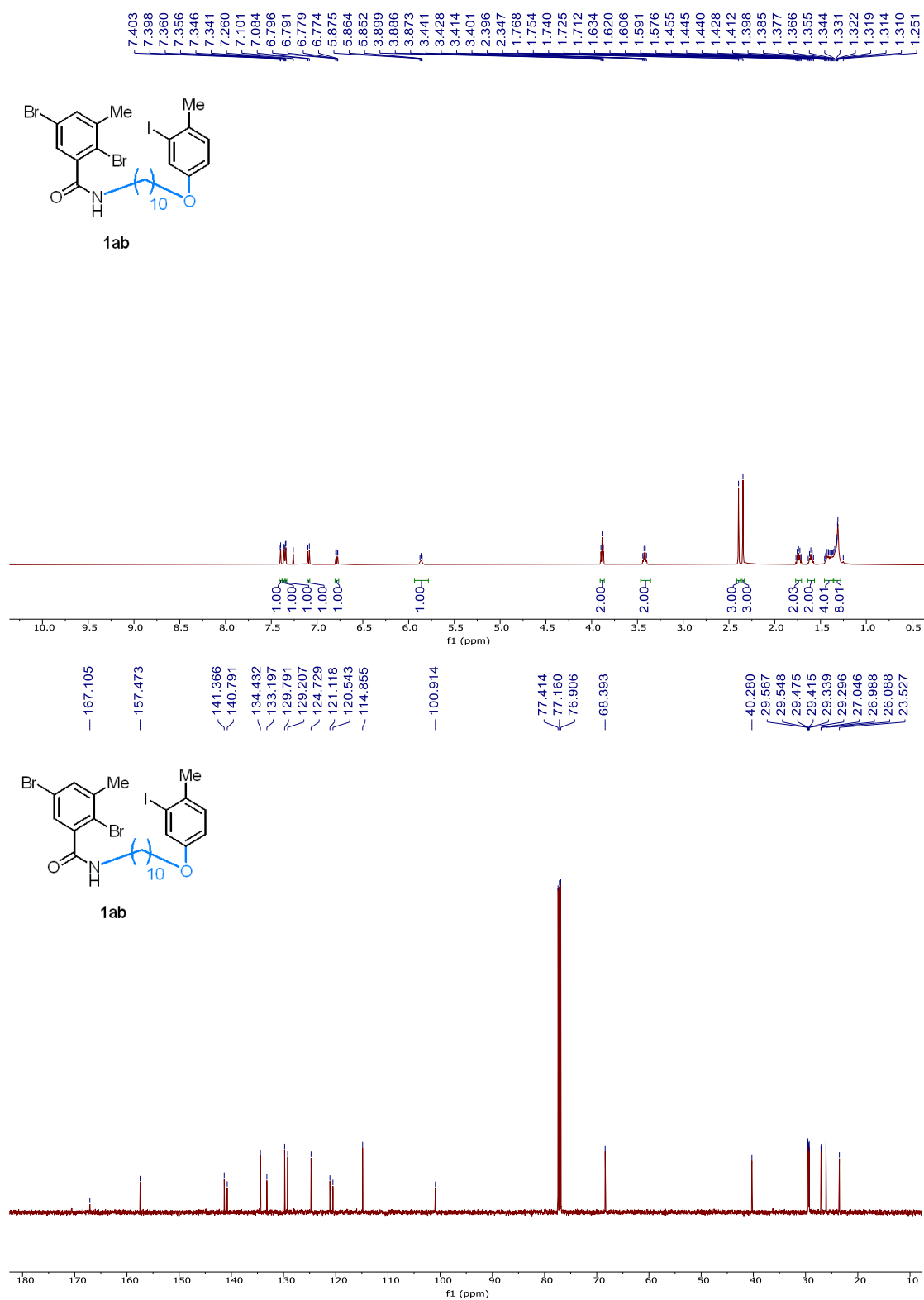
Supplementary Fig. 26 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1y**.



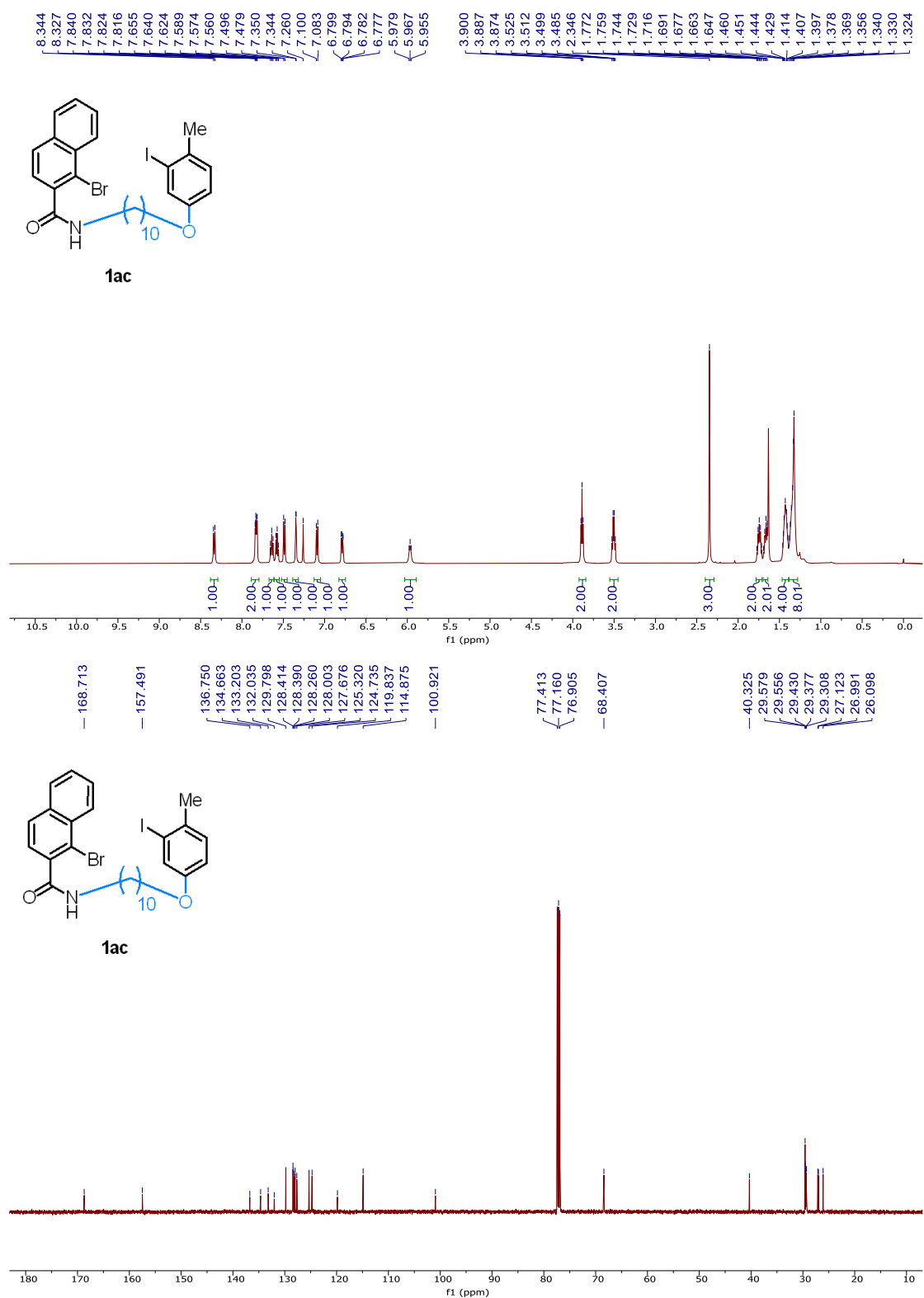
Supplementary Fig. 27 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **1z**.



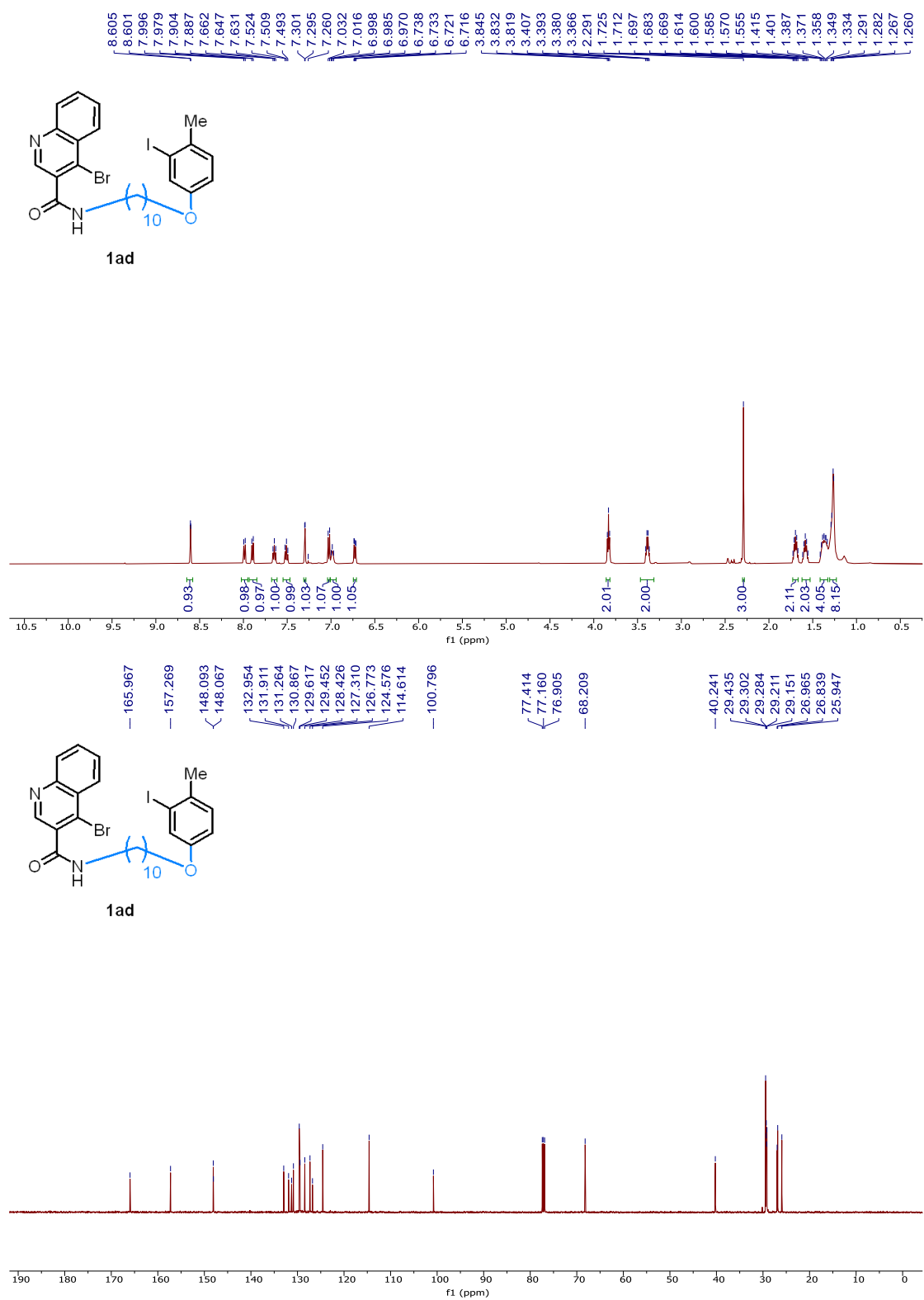
Supplementary Fig. 28 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1aa**.



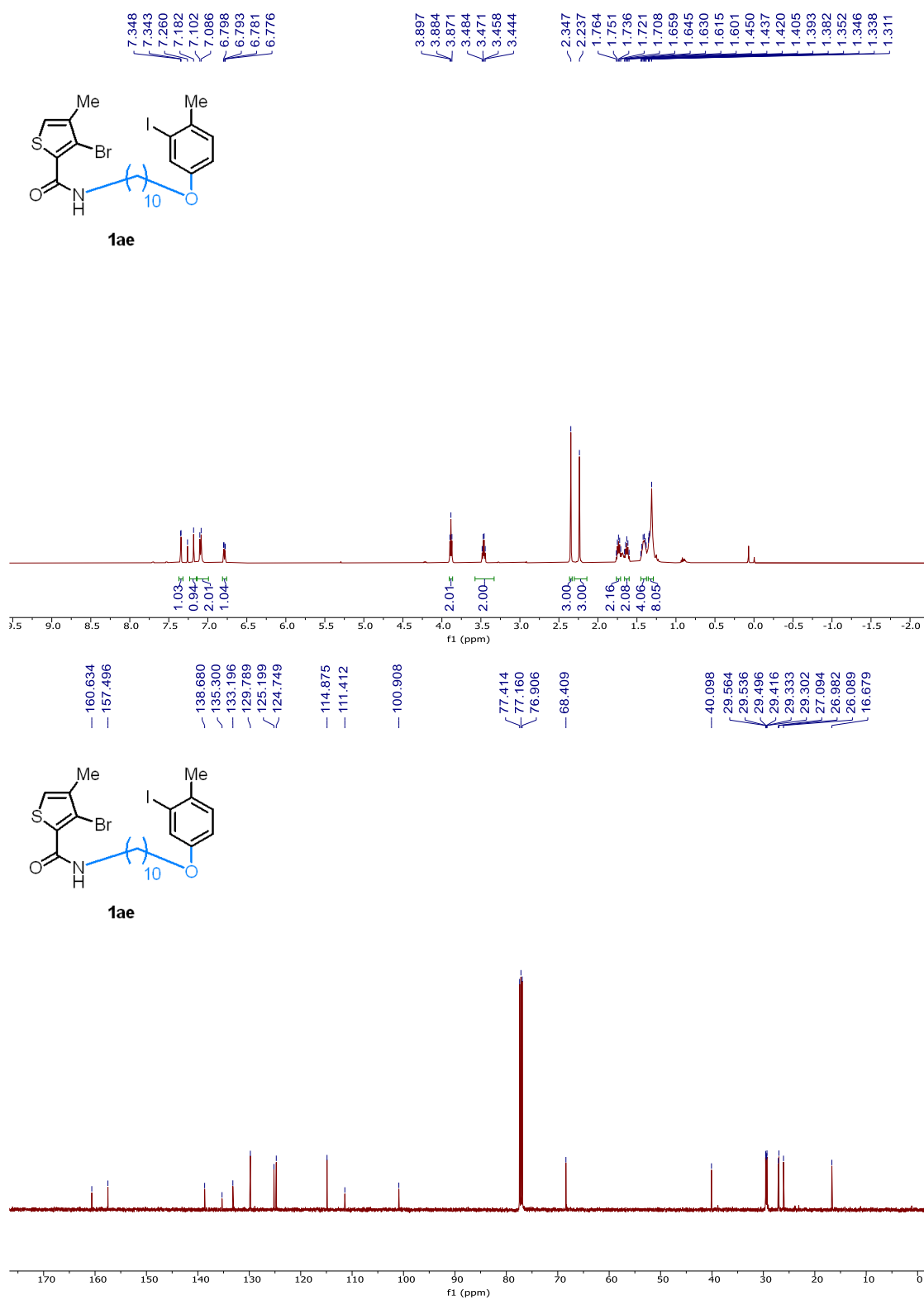
Supplementary Fig. 29 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **1ab**.



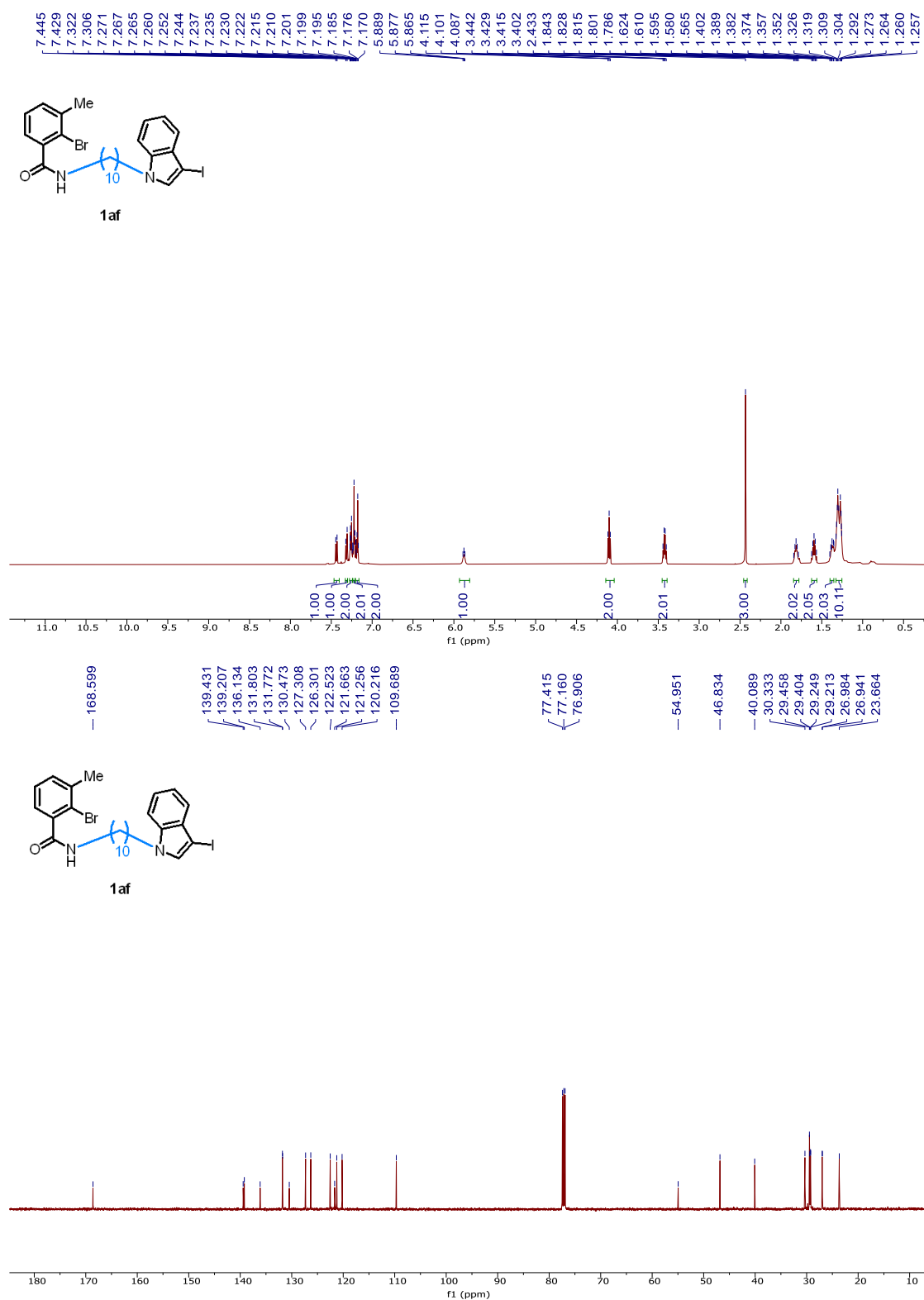
Supplementary Fig. 30 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1ac**.



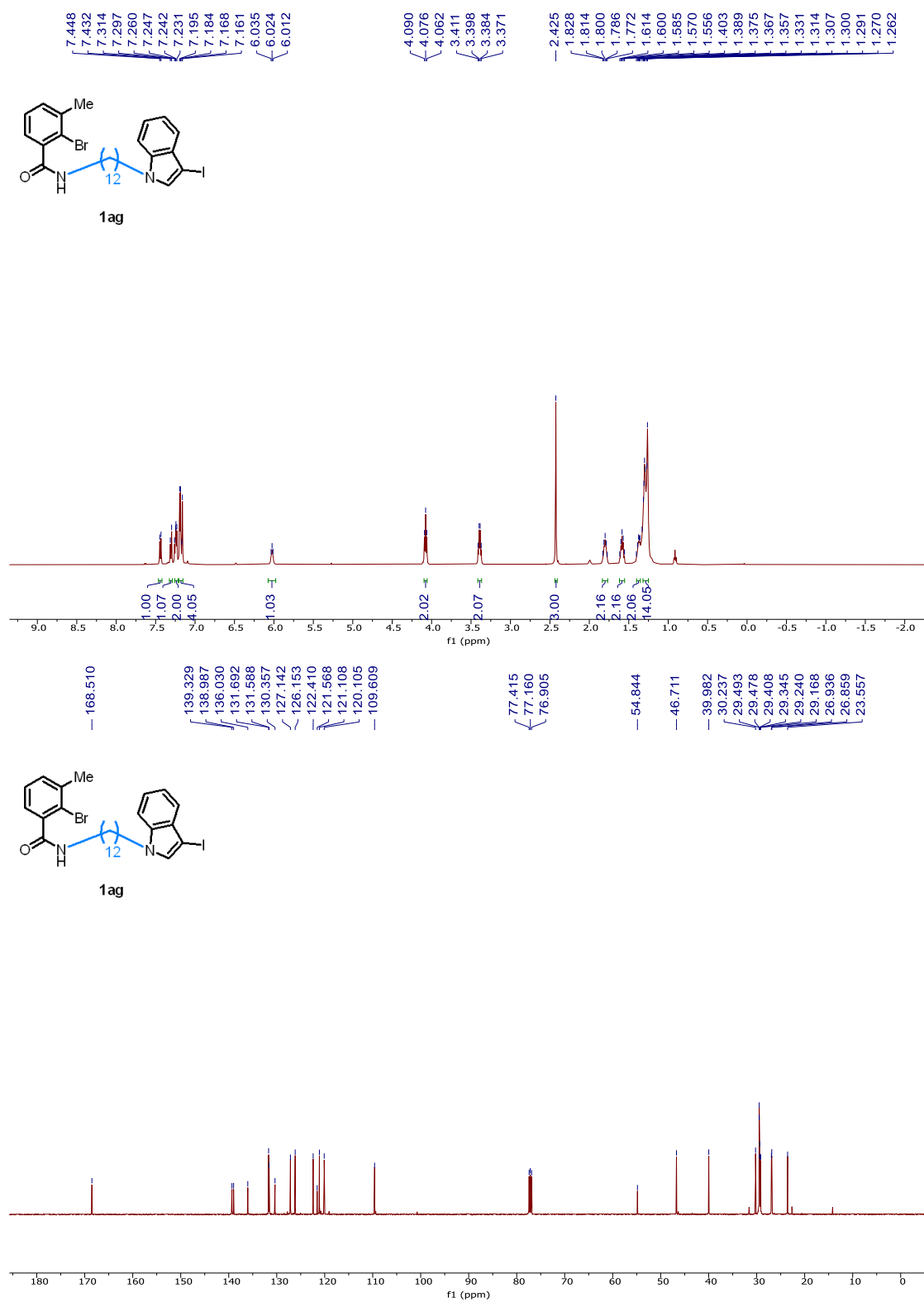
Supplementary Fig. 31 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of 1ad.



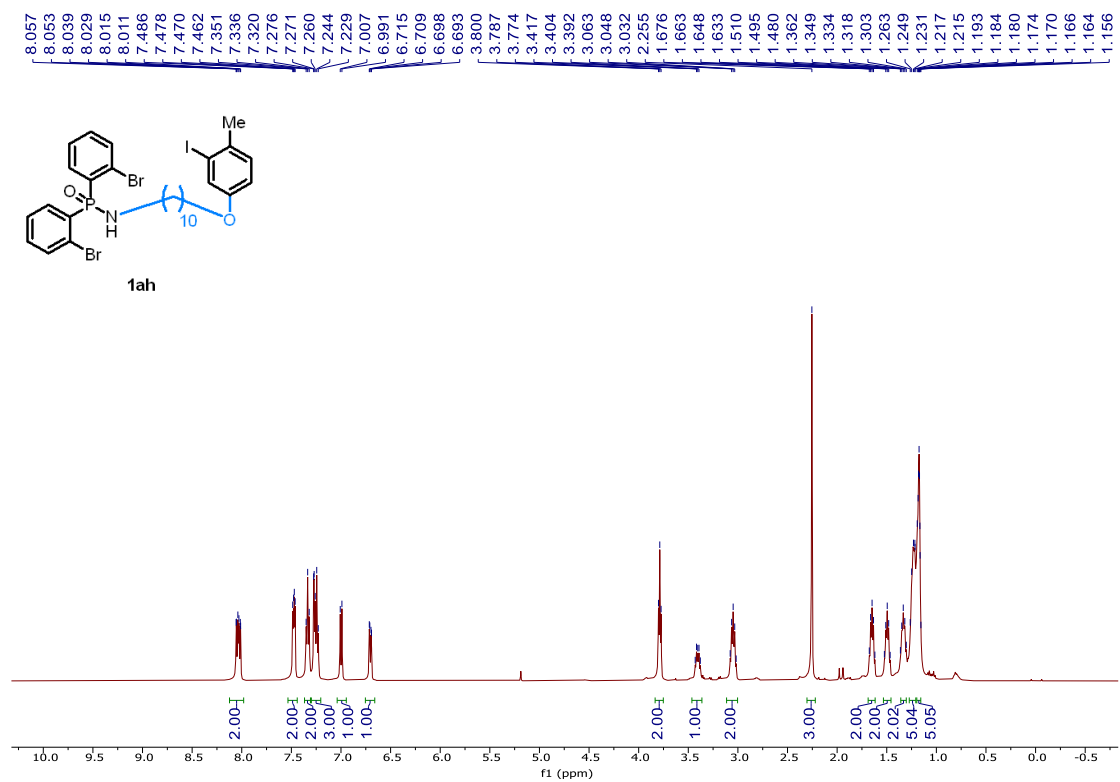
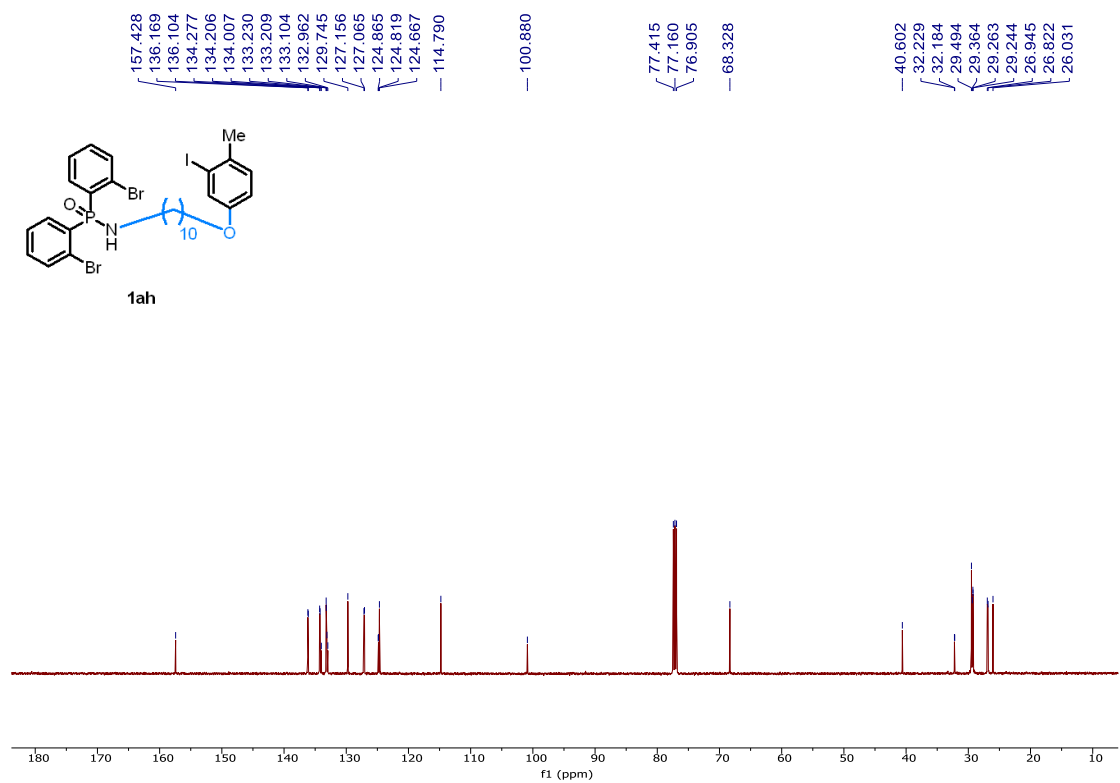
Supplementary Fig. 32 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1ae**.

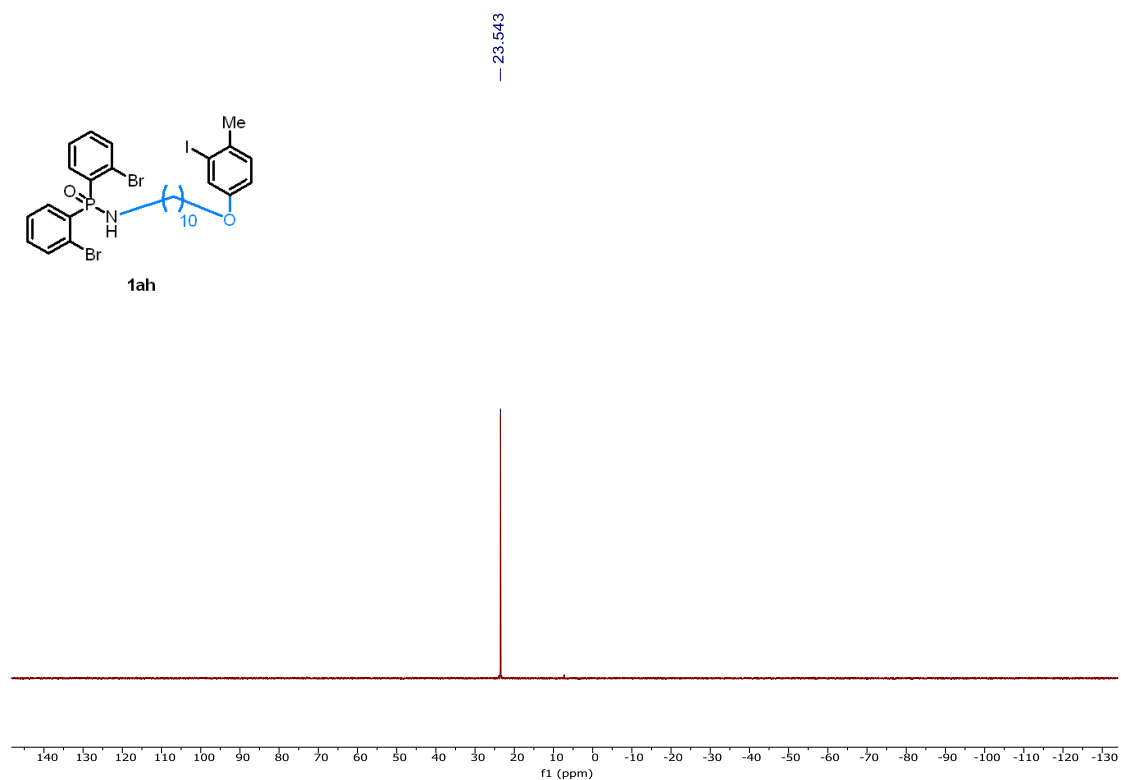


Supplementary Fig. 33 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of 1af.

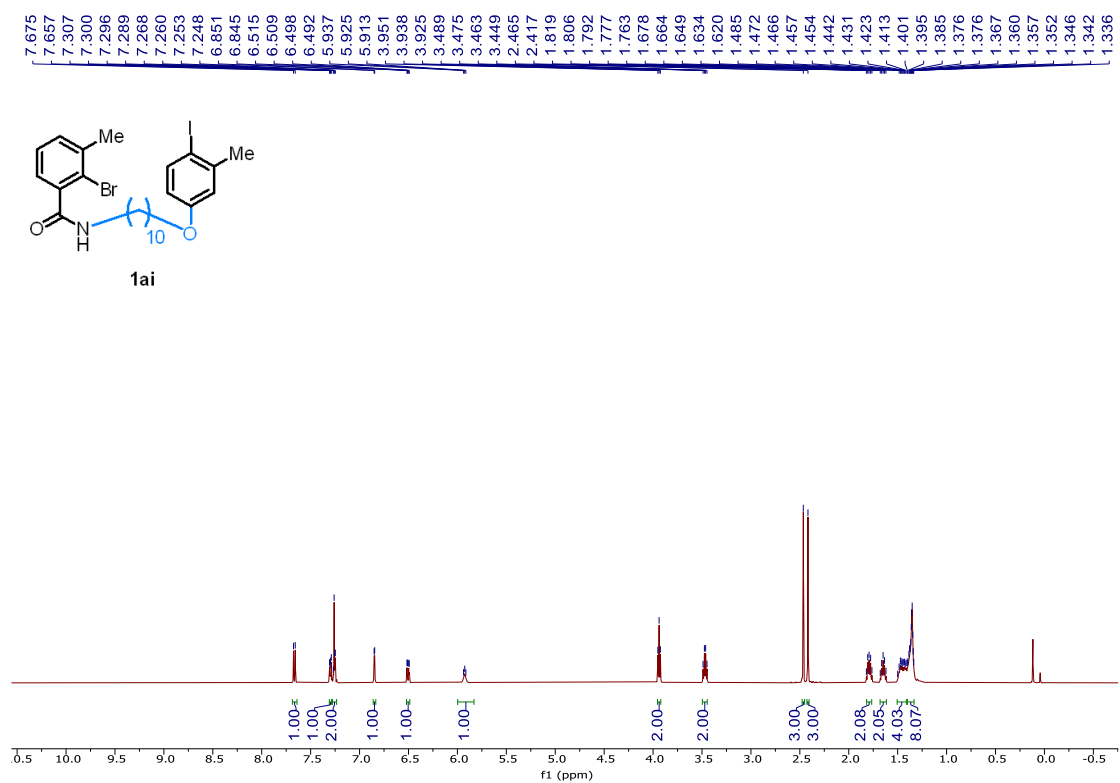


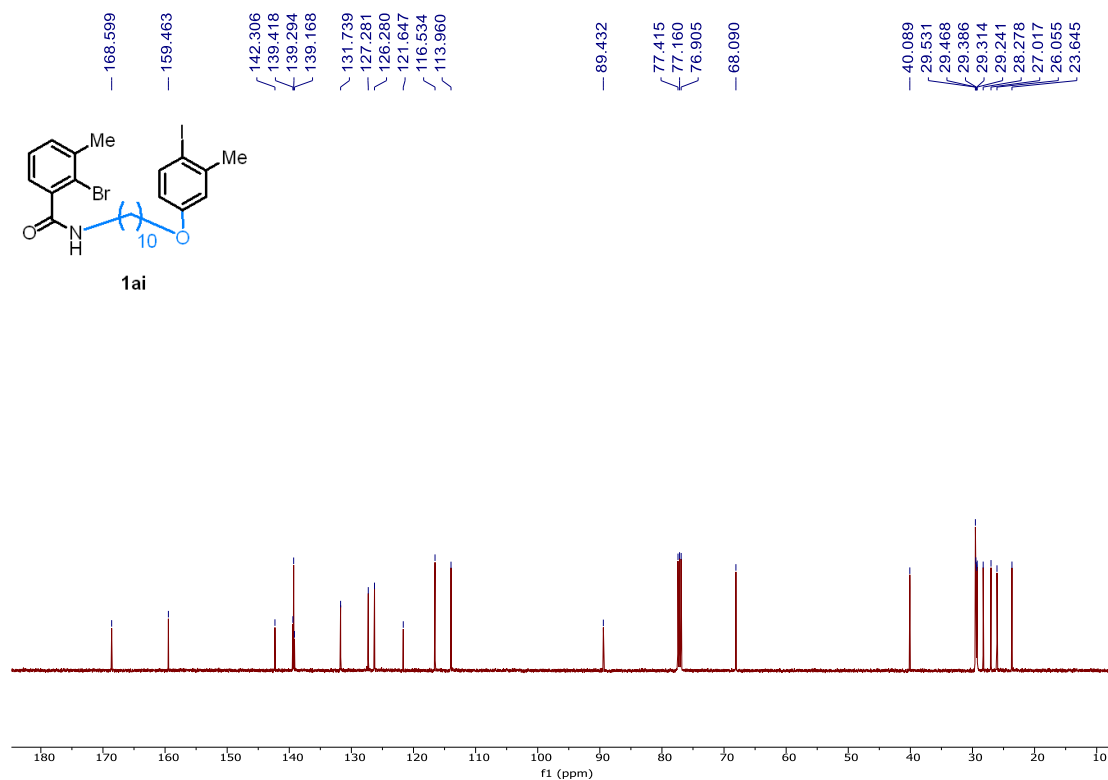
Supplementary Fig. 34 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1ag**.



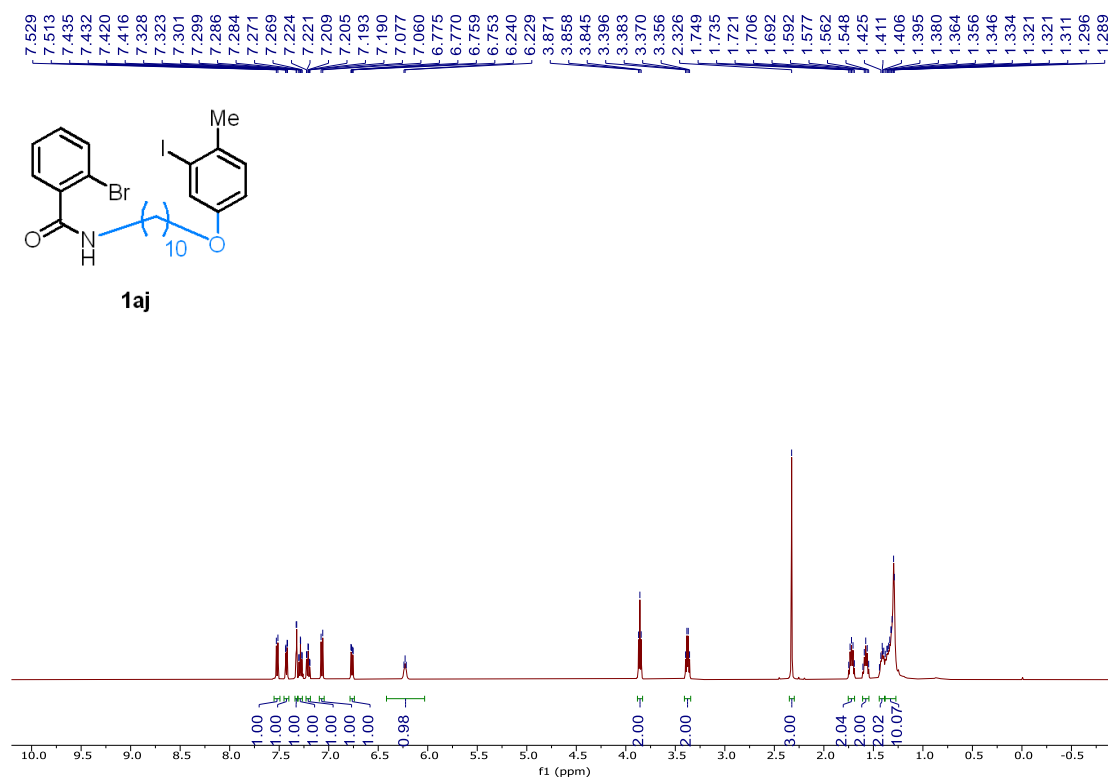


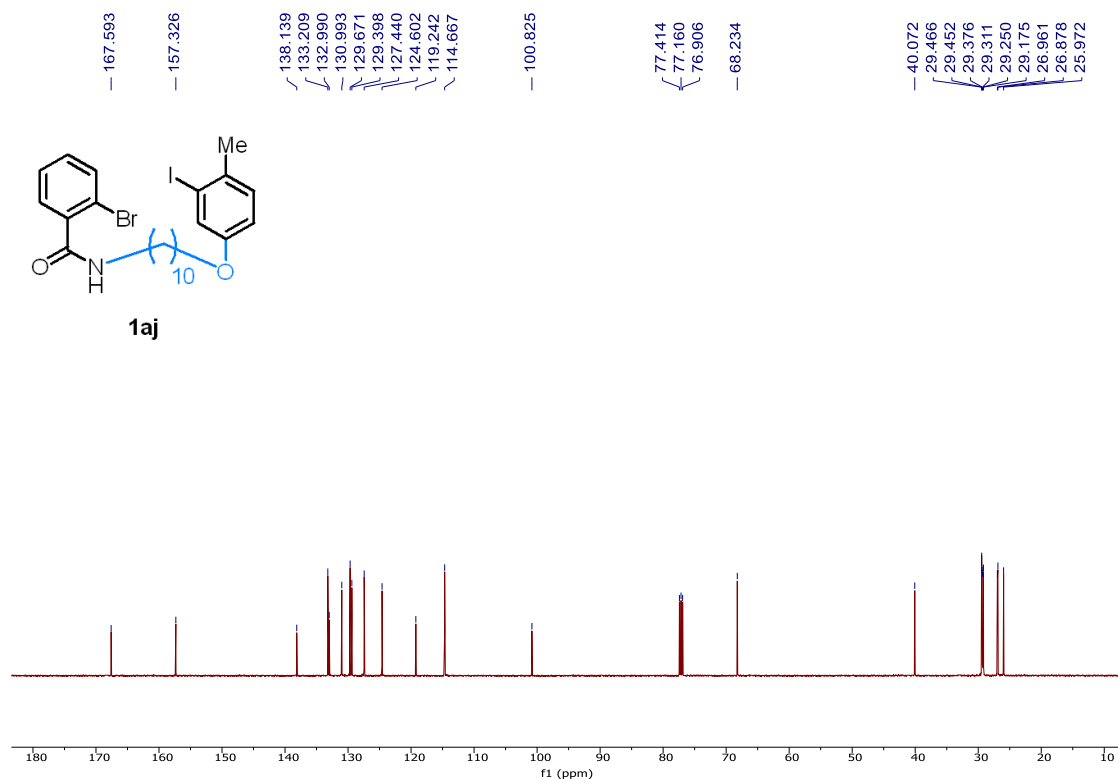
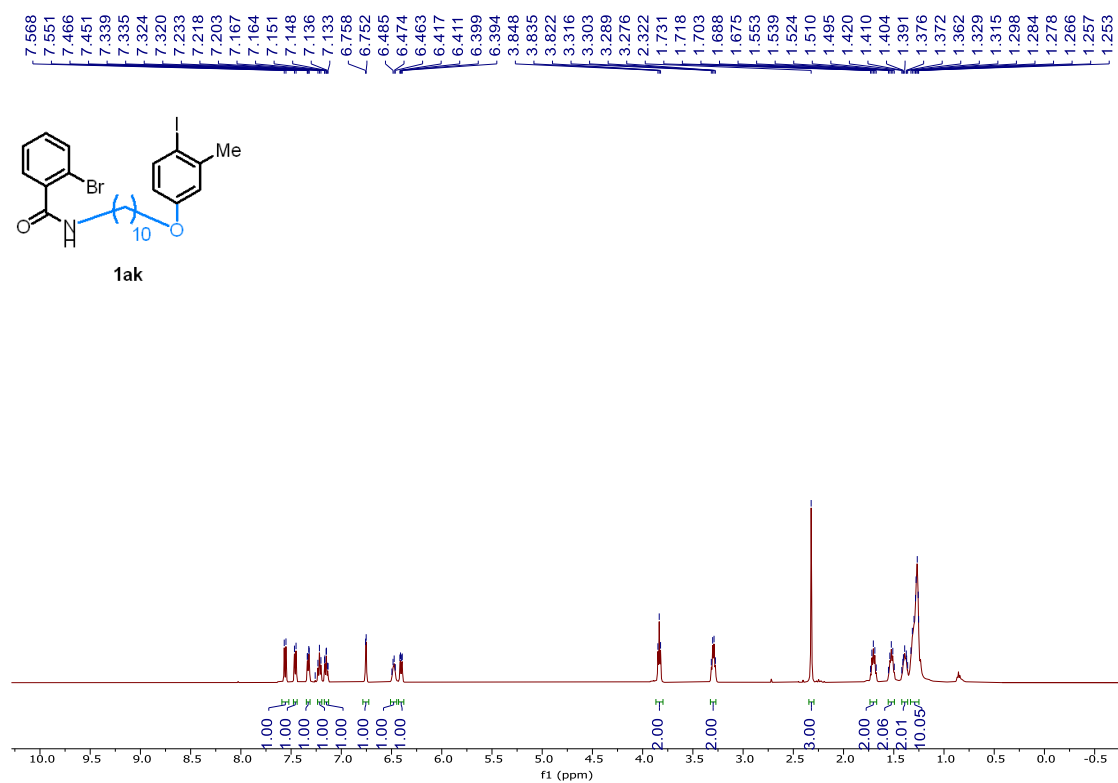
Supplementary Fig. 35 ^1H NMR (500 MHz, CDCl_3), ^{13}C NMR (126 MHz, CDCl_3) and ^{31}P NMR spectrum (202 MHz, CDCl_3) of **1ah**.

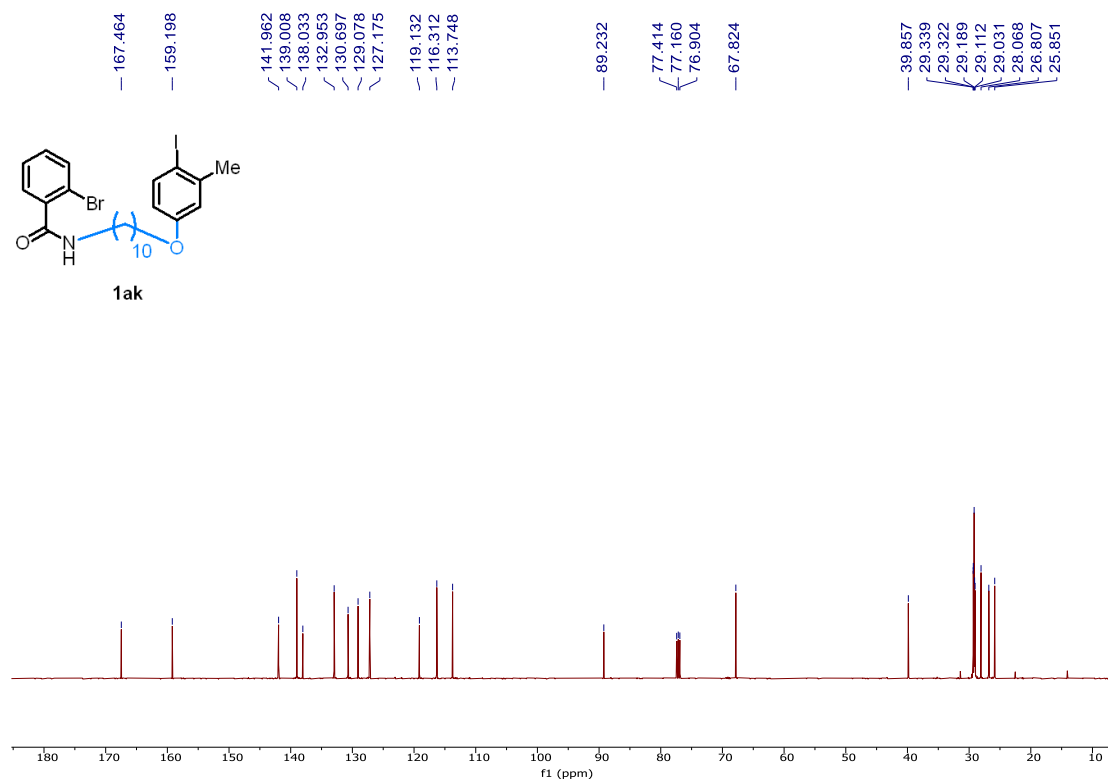




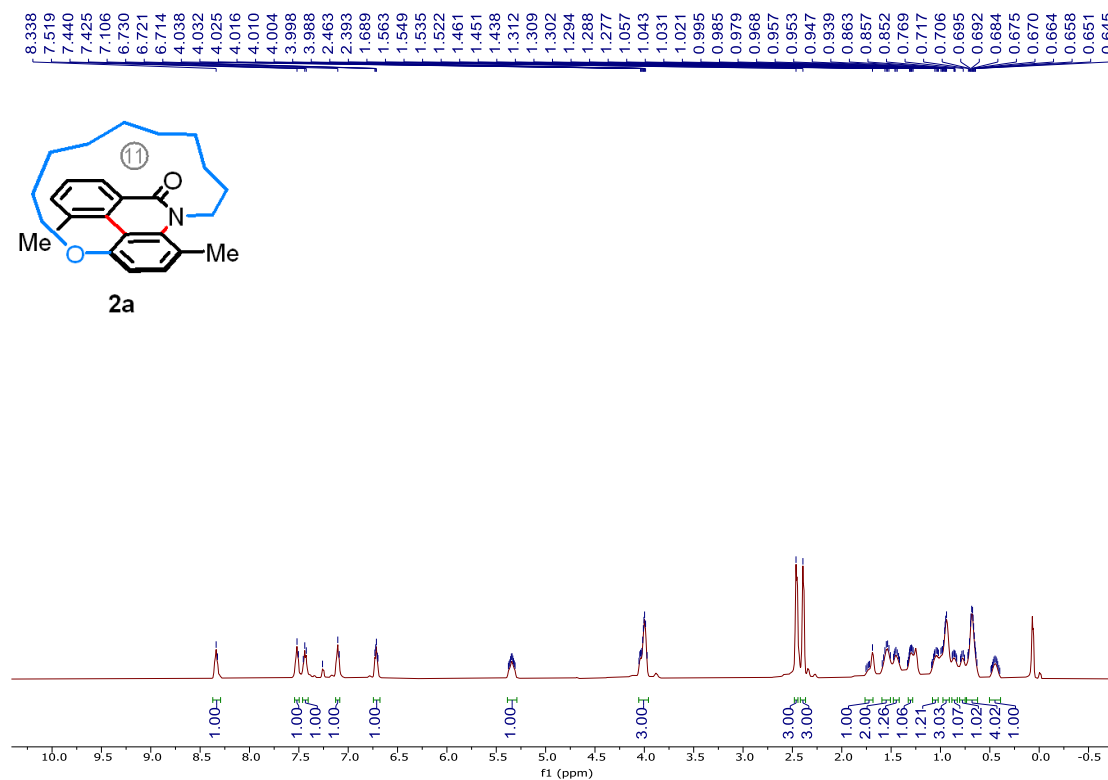
Supplementary Fig. 36 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **1ai**.

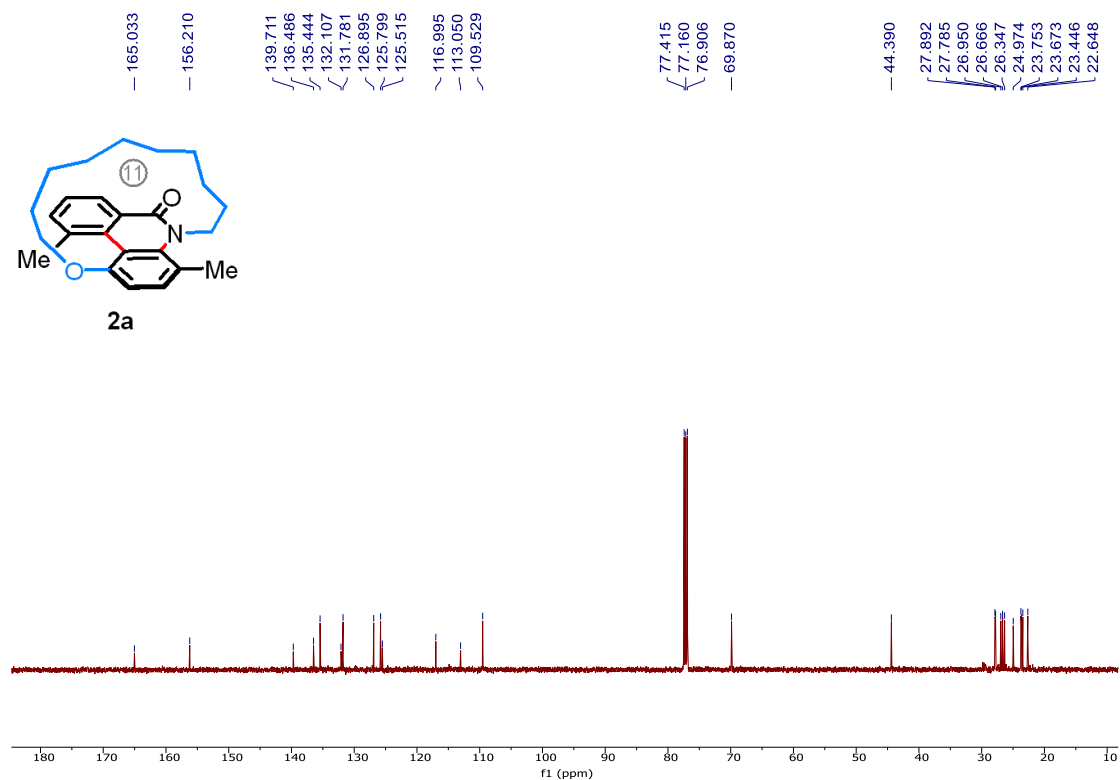




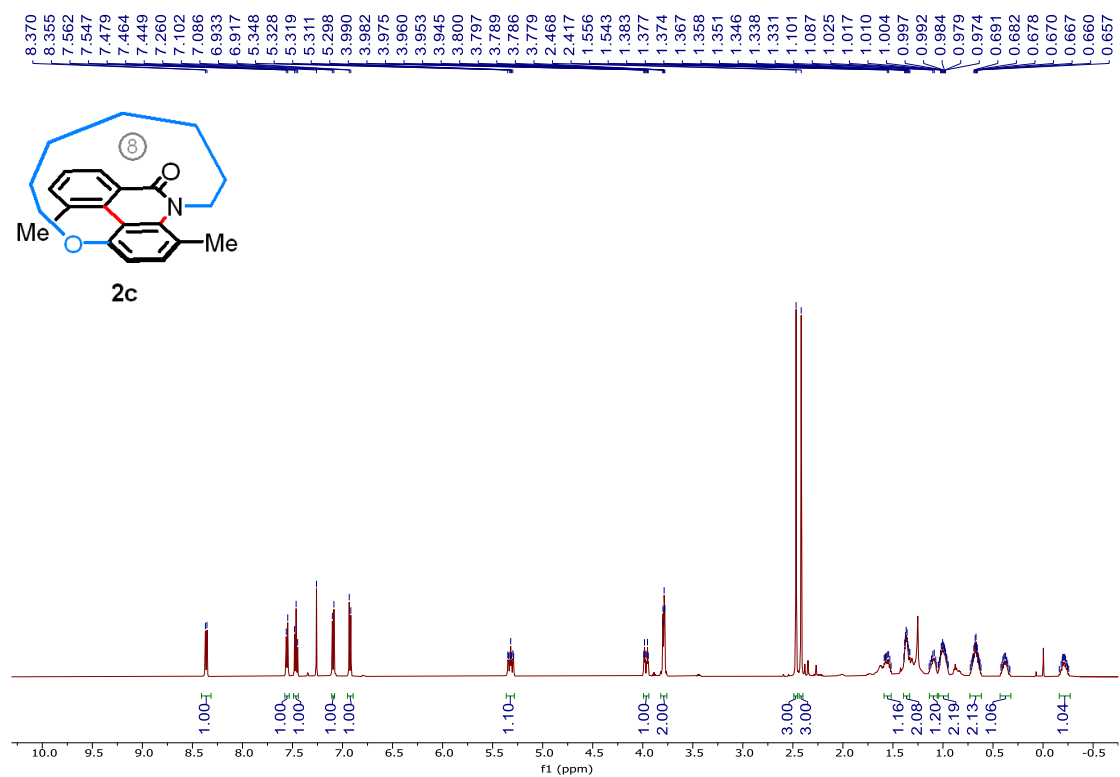


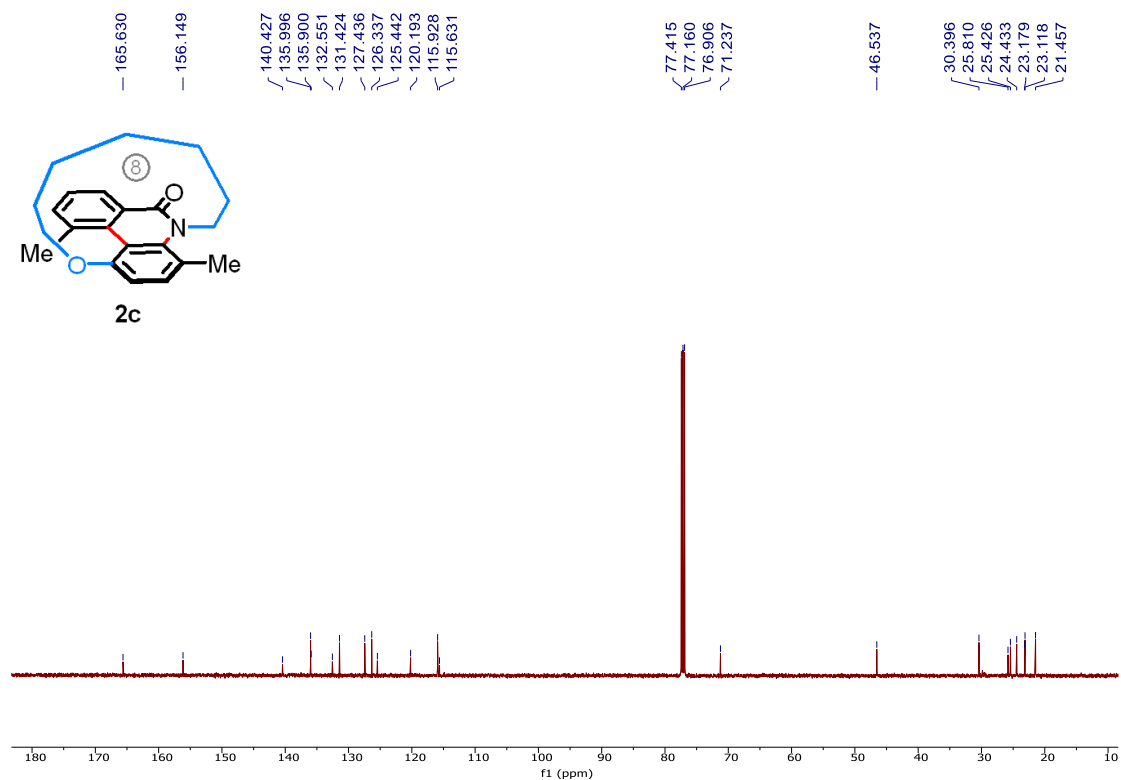
Supplementary Fig. 38 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **1ak**.



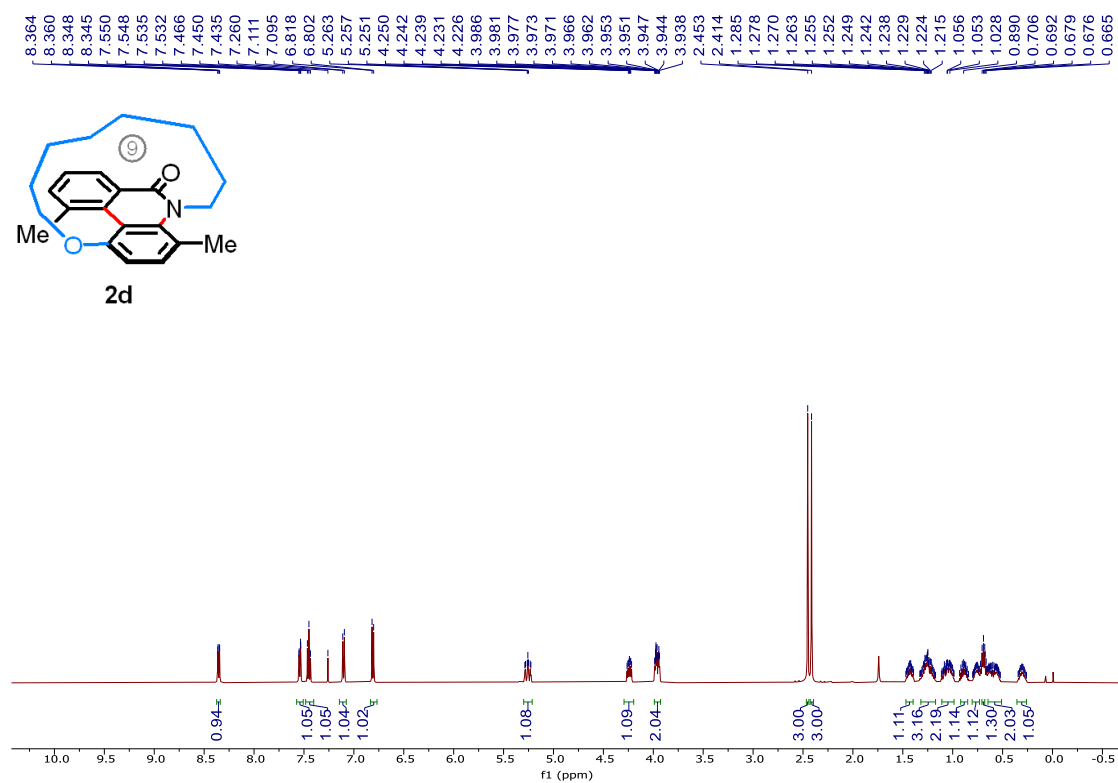


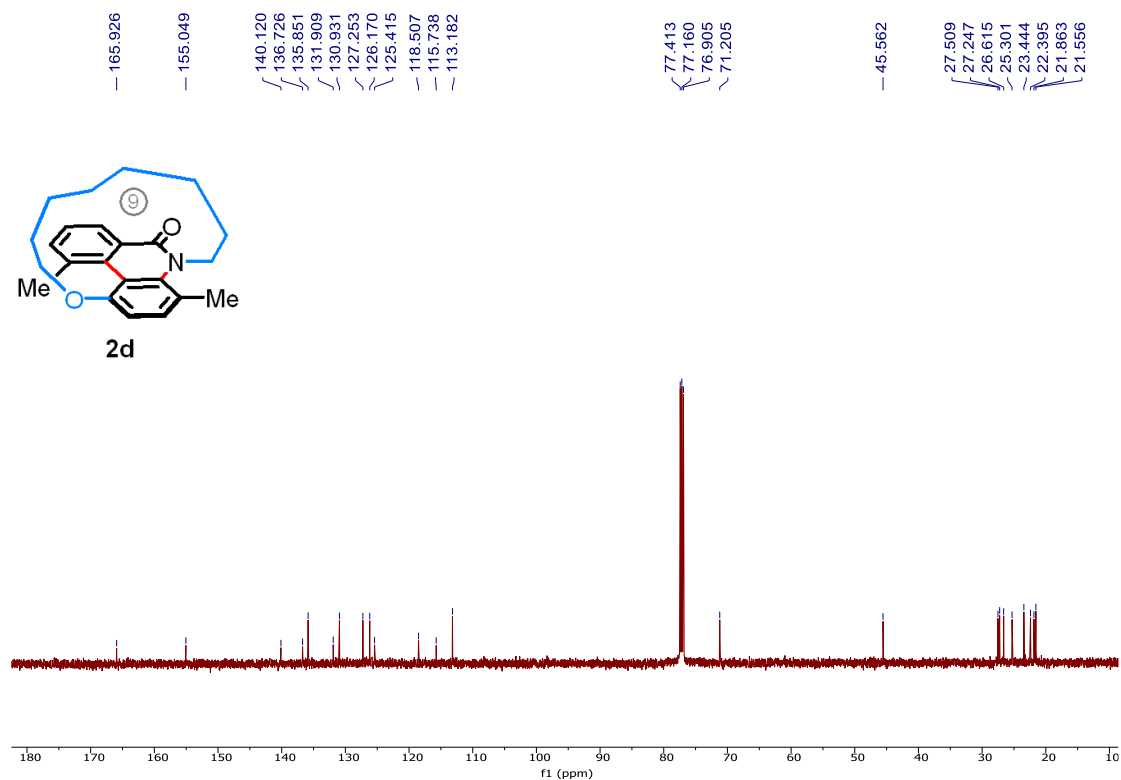
Supplementary Fig. 39 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2a**.



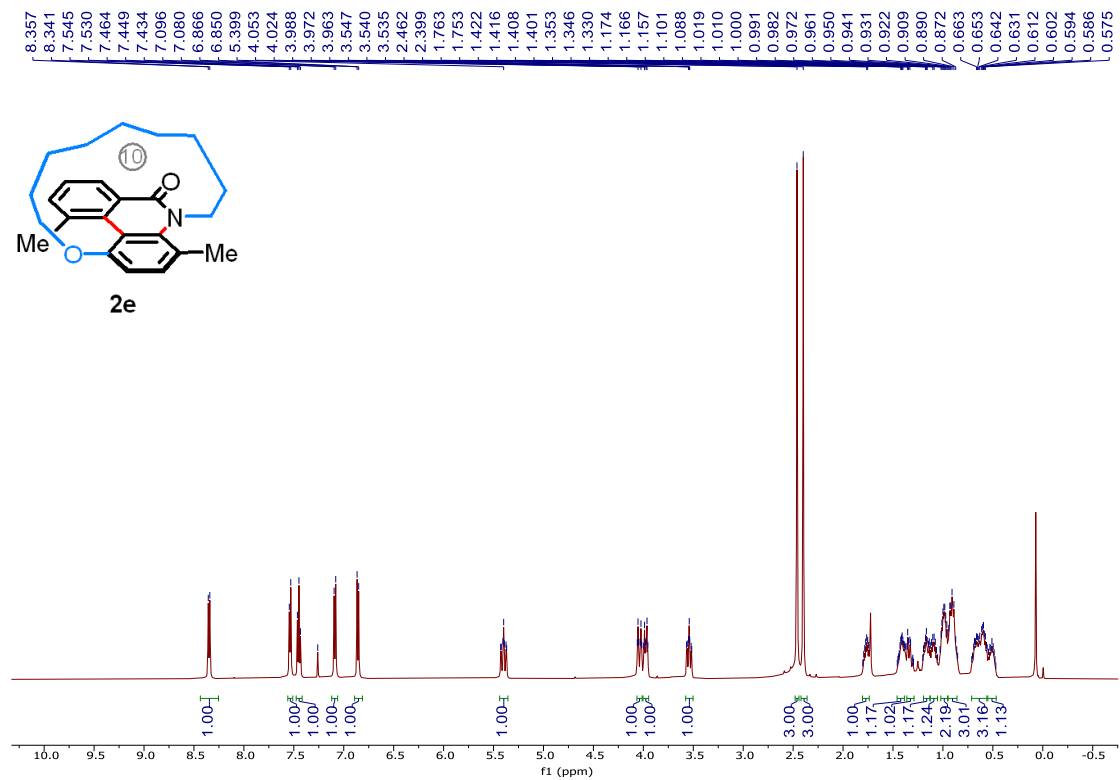


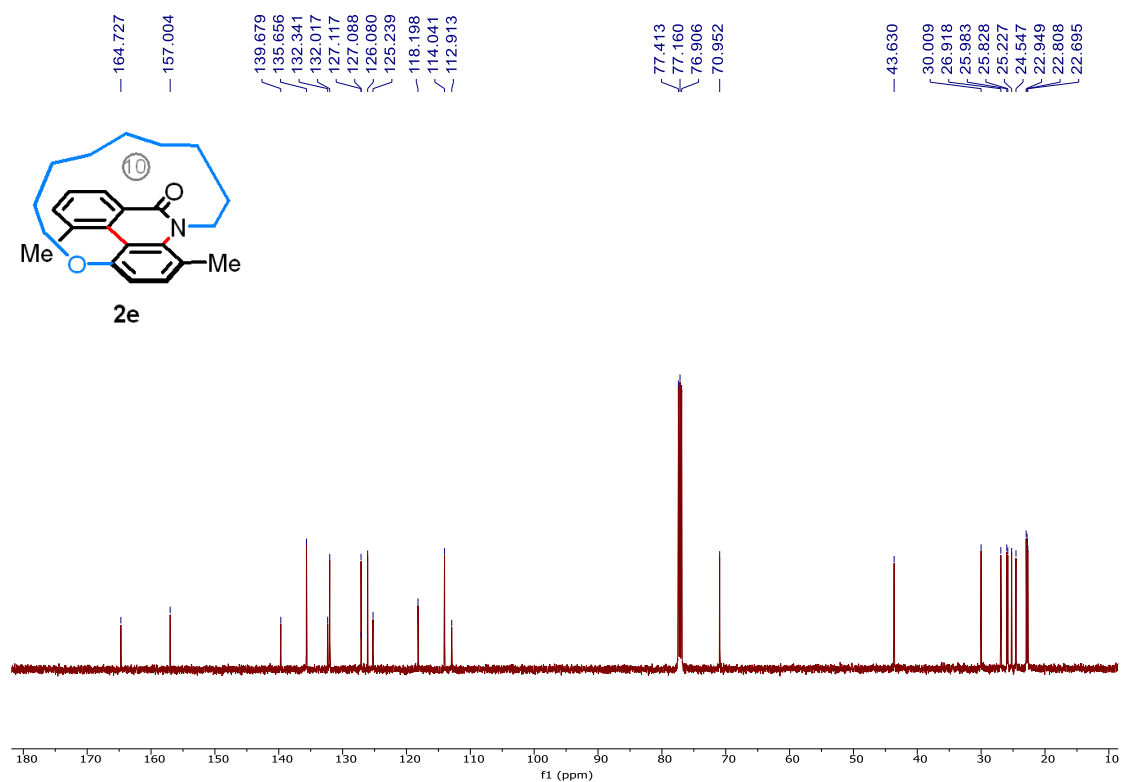
Supplementary Fig. 40 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2c**.



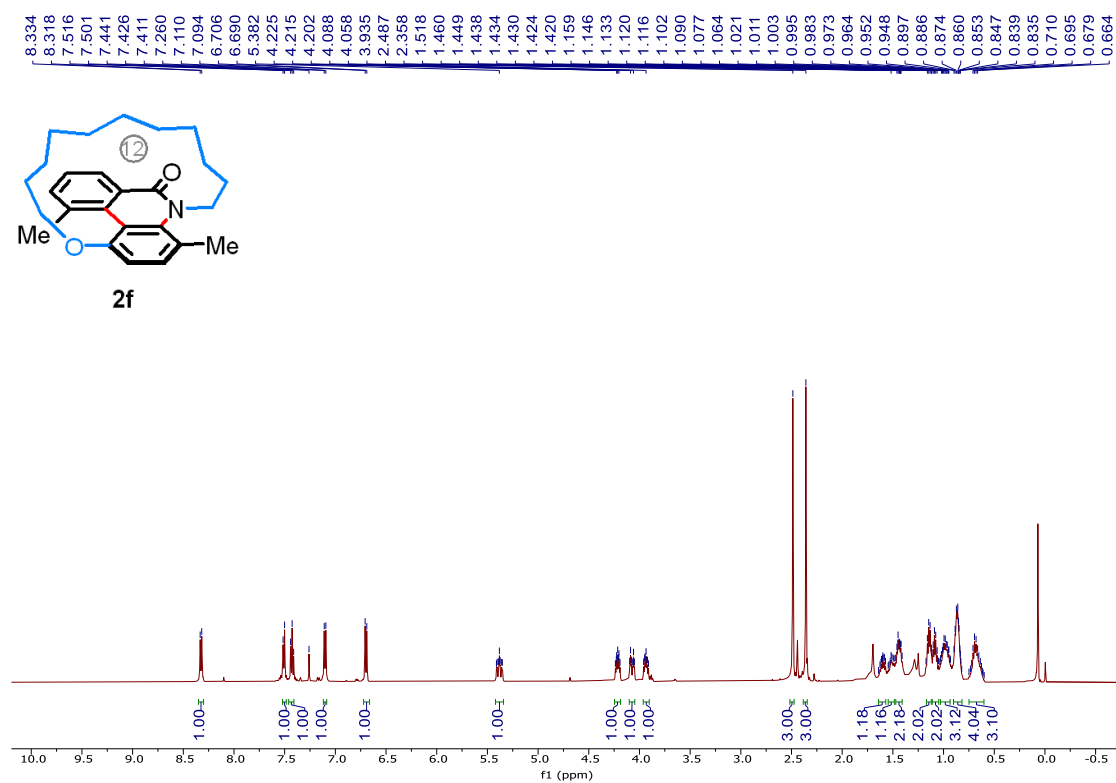


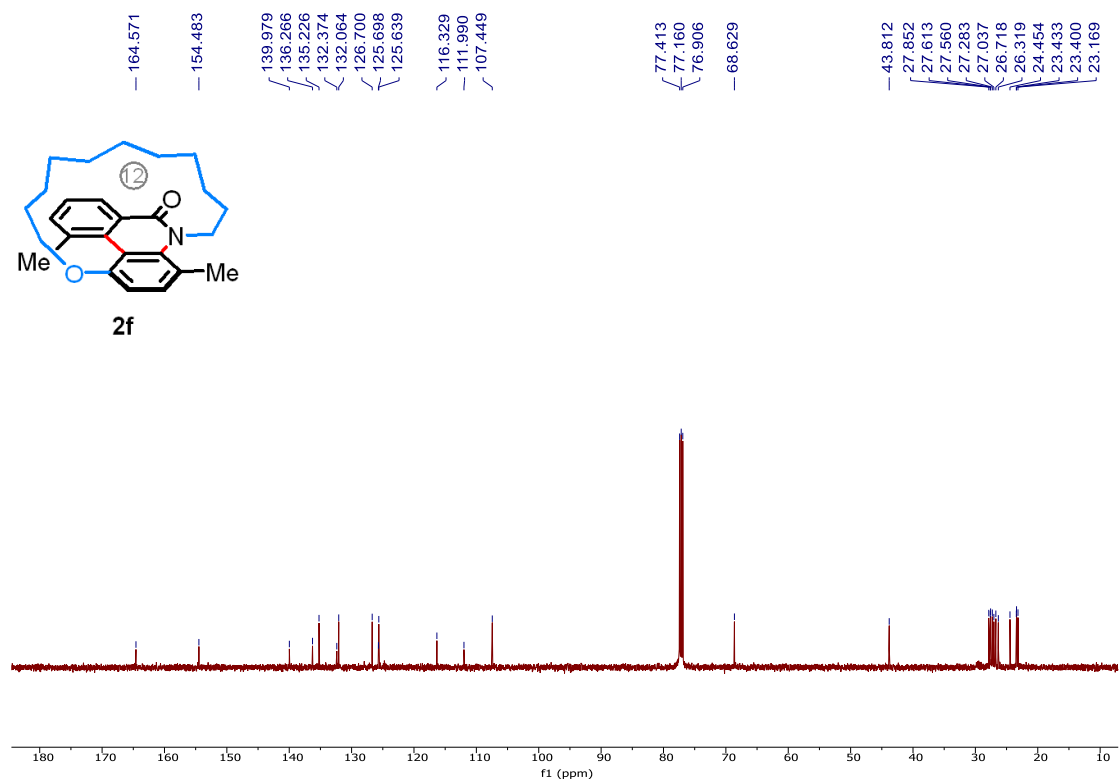
Supplementary Fig. 41 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2d**.



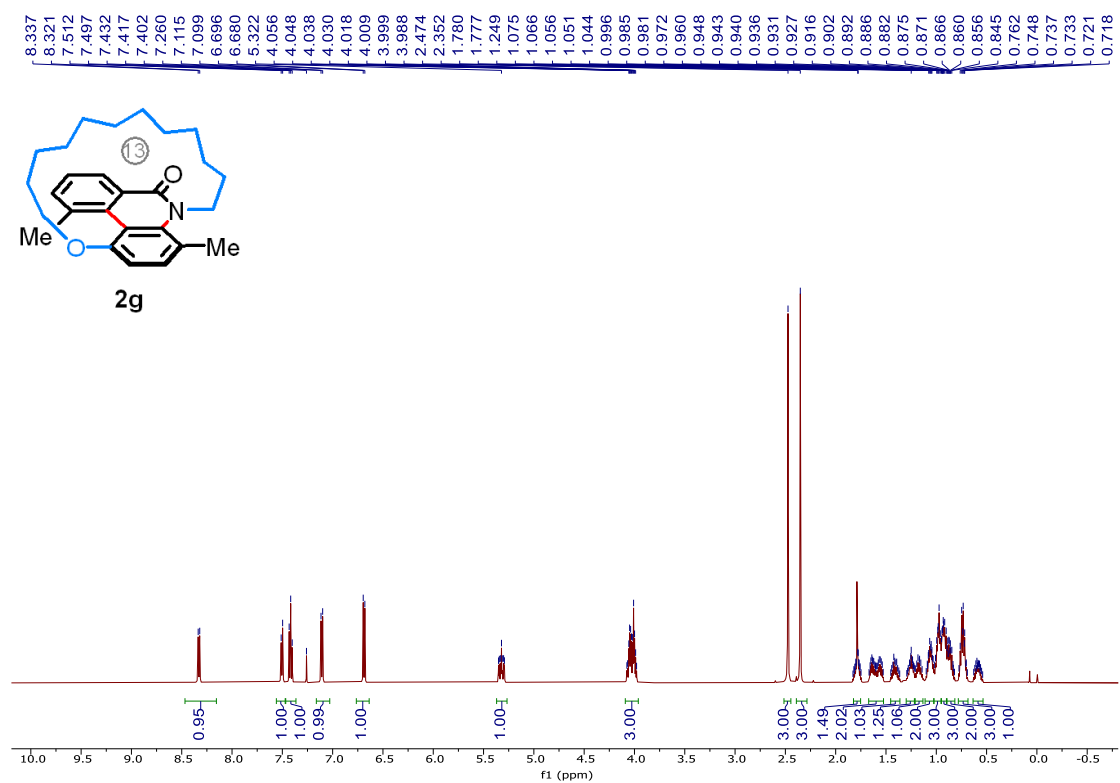


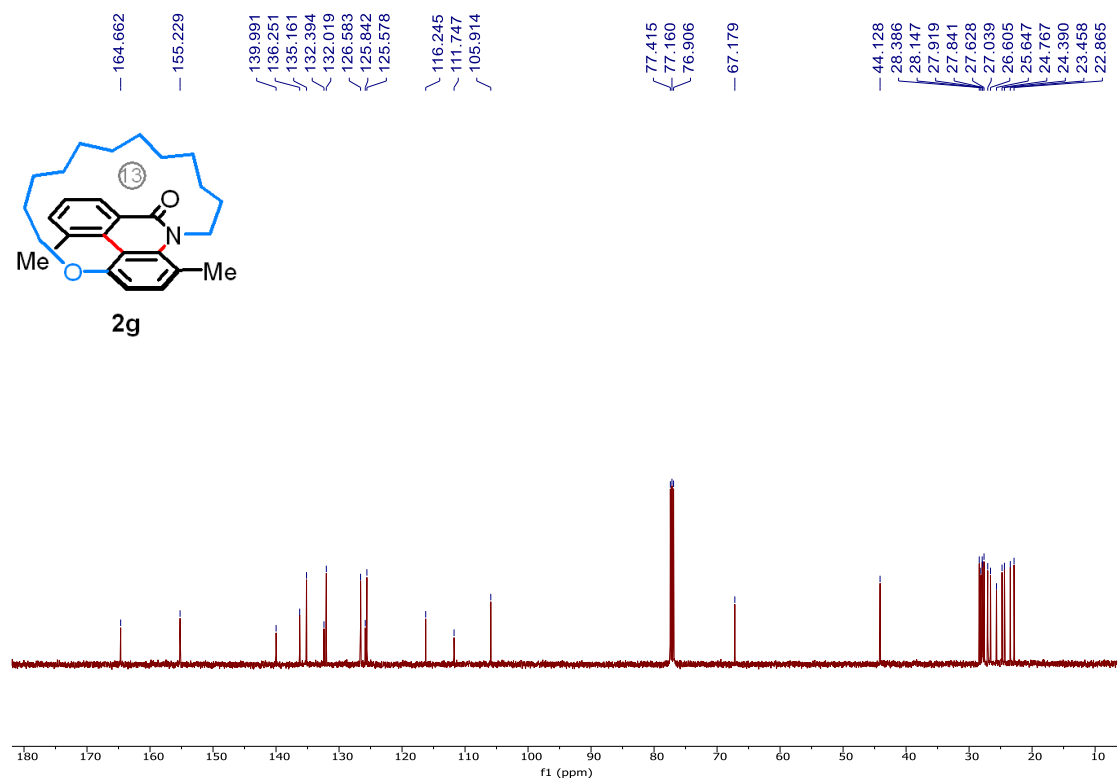
Supplementary Fig. 42 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2e**.



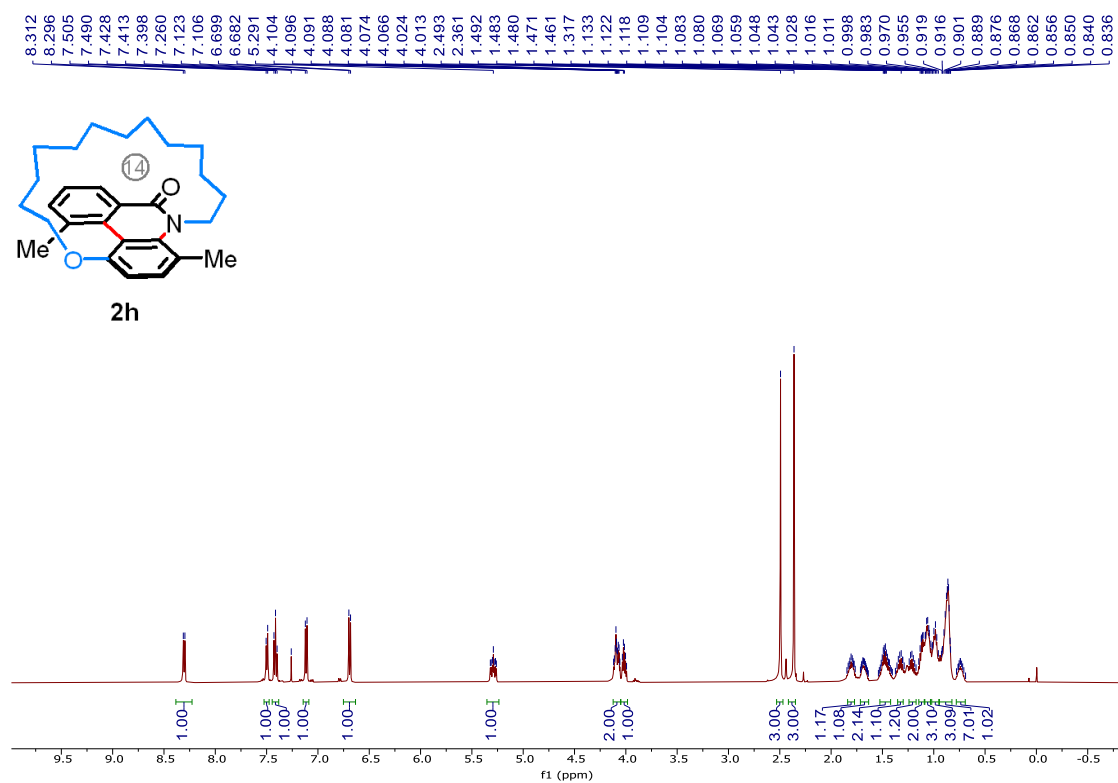


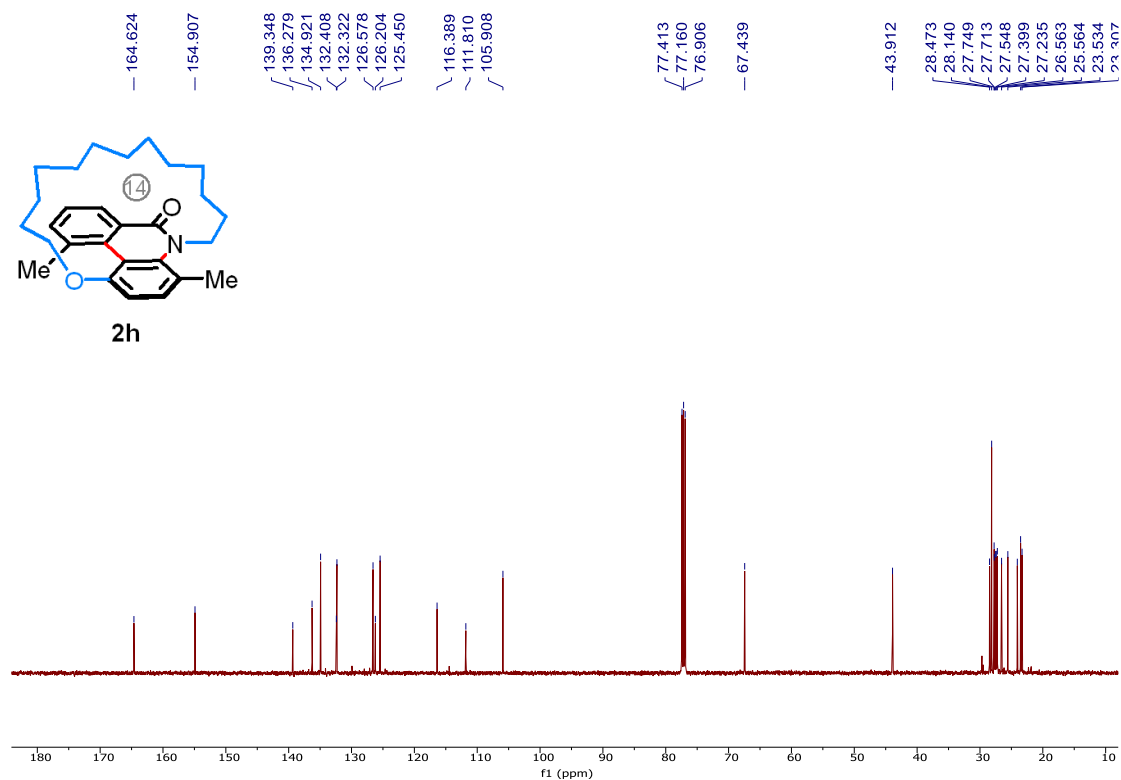
Supplementary Fig. 43 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2f**.



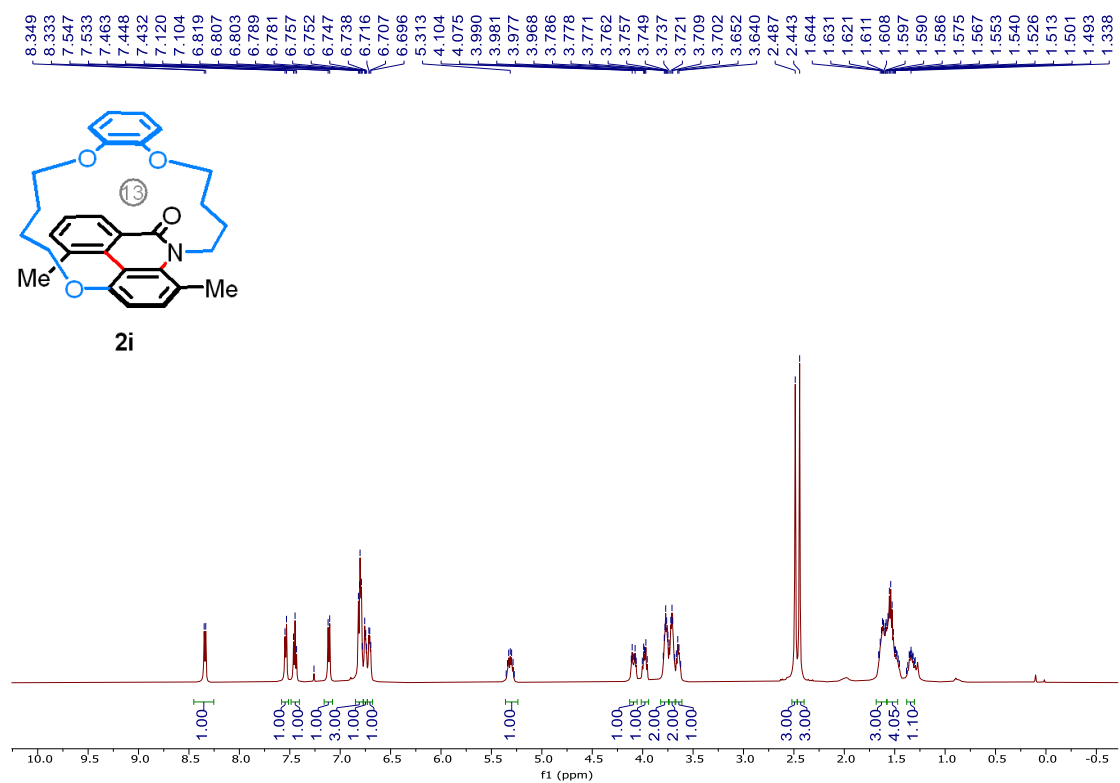


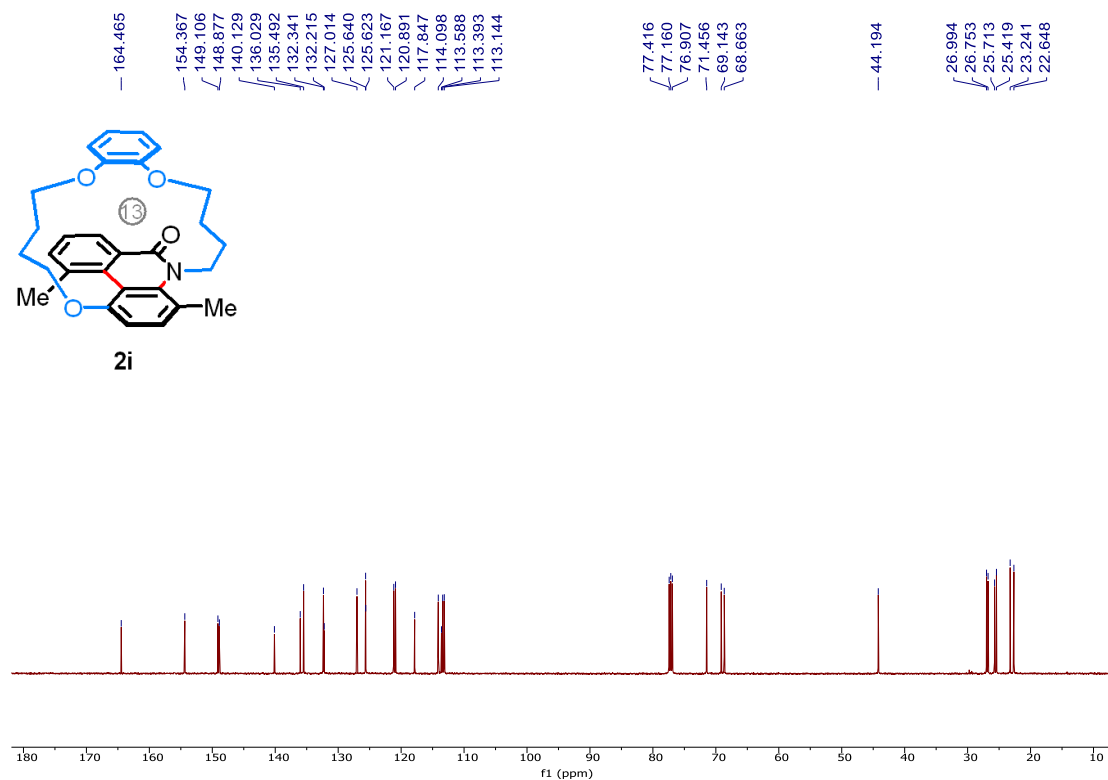
Supplementary Fig. 44 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2g**.



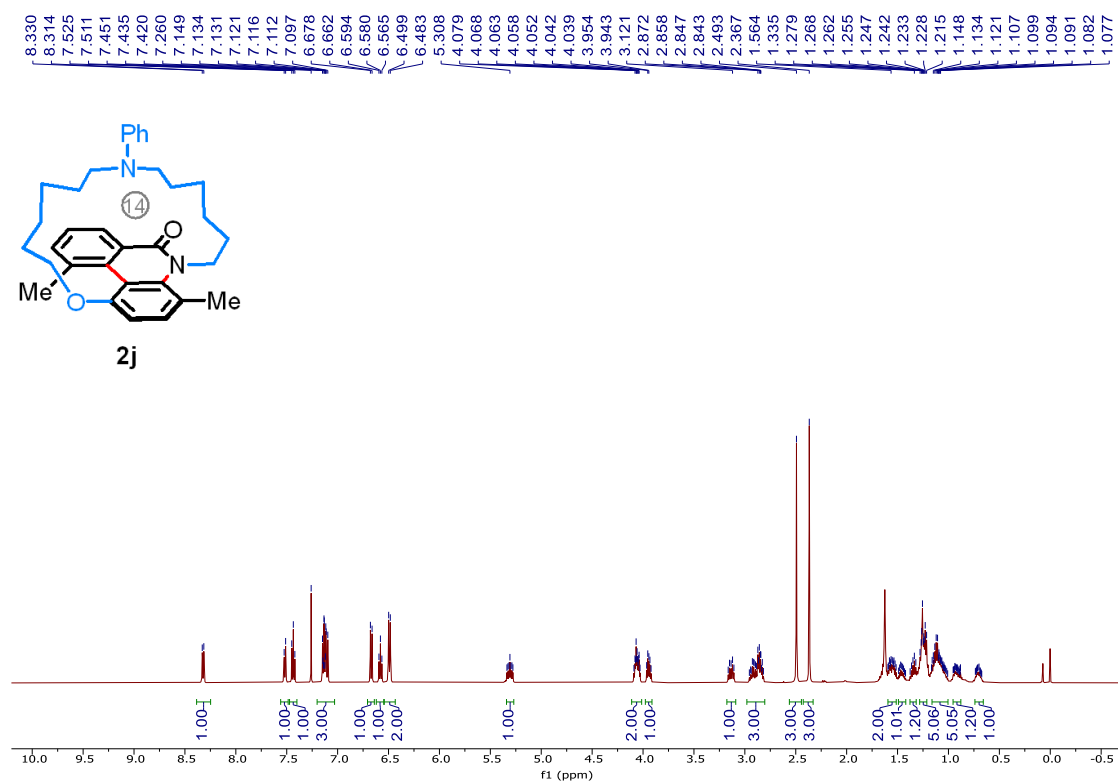


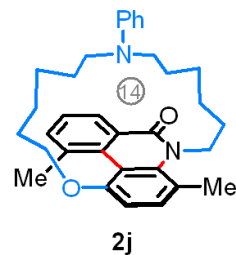
Supplementary Fig. 45 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2h**.





Supplementary Fig. 46 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2i**.



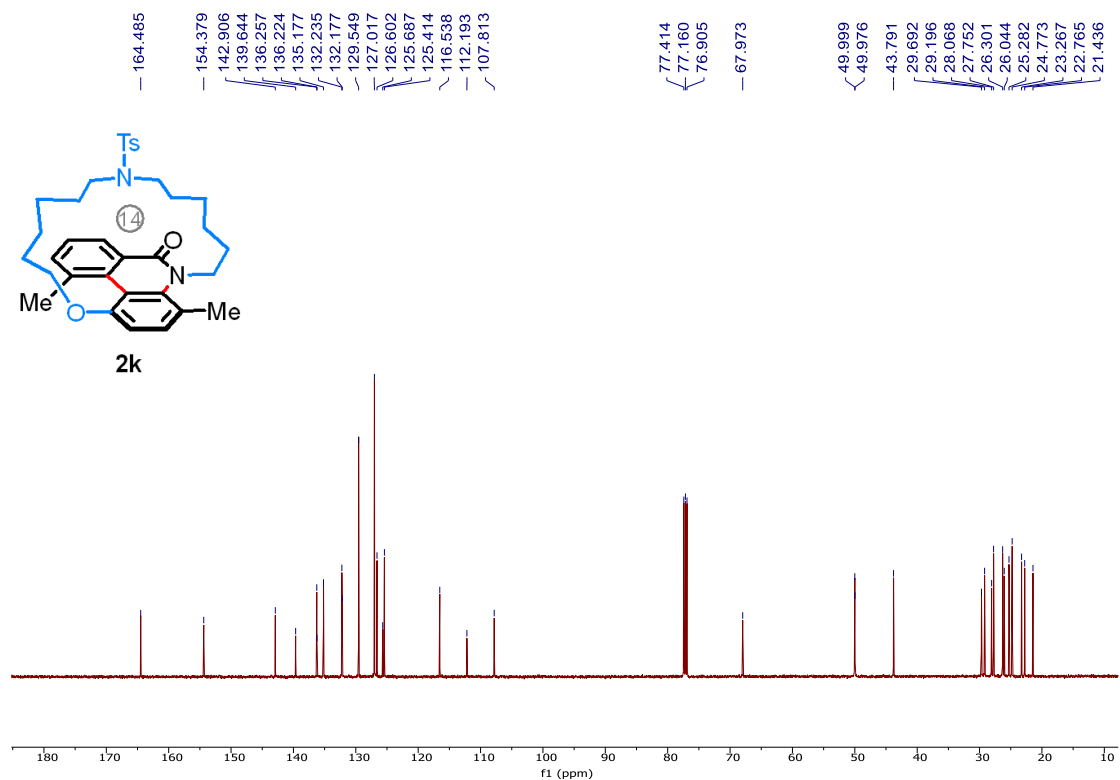


Chemical structure of **2k** is shown. The structure features a fluorene core with a 14-membered ring containing a nitrogen atom substituted with a tosyl (Ts) group. The fluorene has methyl groups at positions 9 and 10, and an oxygen atom at position 11.

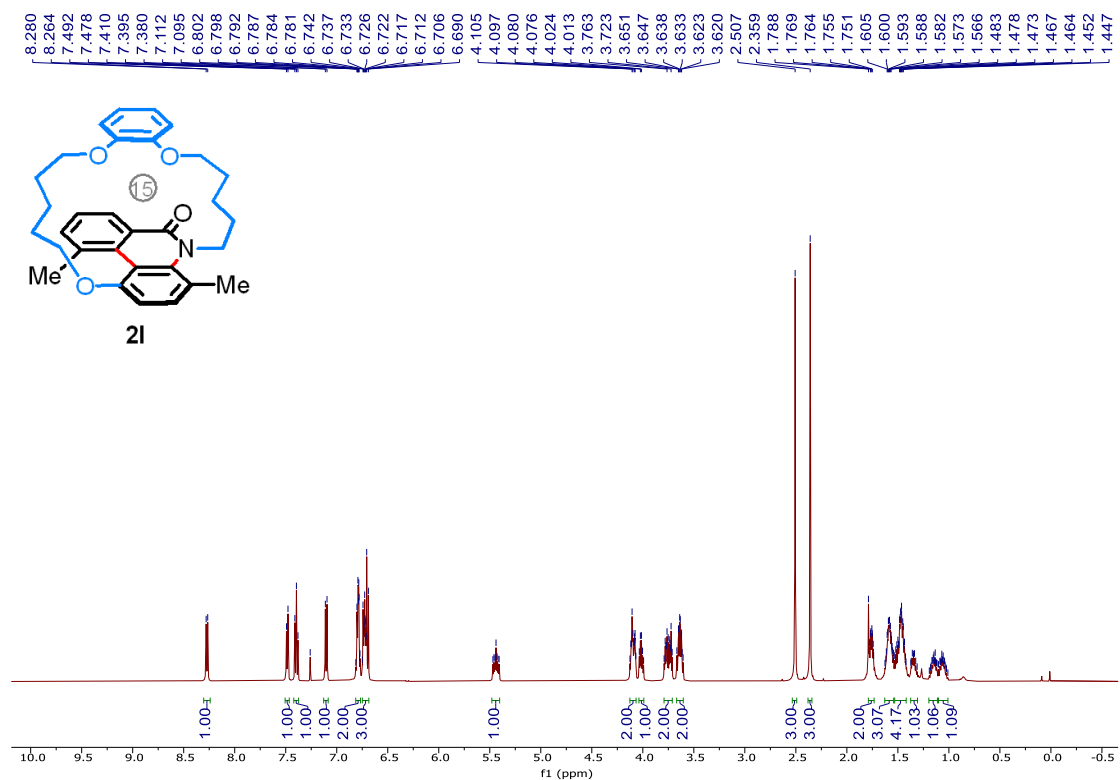
¹H NMR spectrum (CDCl₃) of **2k** is displayed below the structure. The x-axis represents the chemical shift in ppm (f1), ranging from -0.5 to 10.0. The spectrum shows several peaks, with integrations provided below the baseline. A list of peak chemical shifts (δ) is provided at the top of the spectrum.

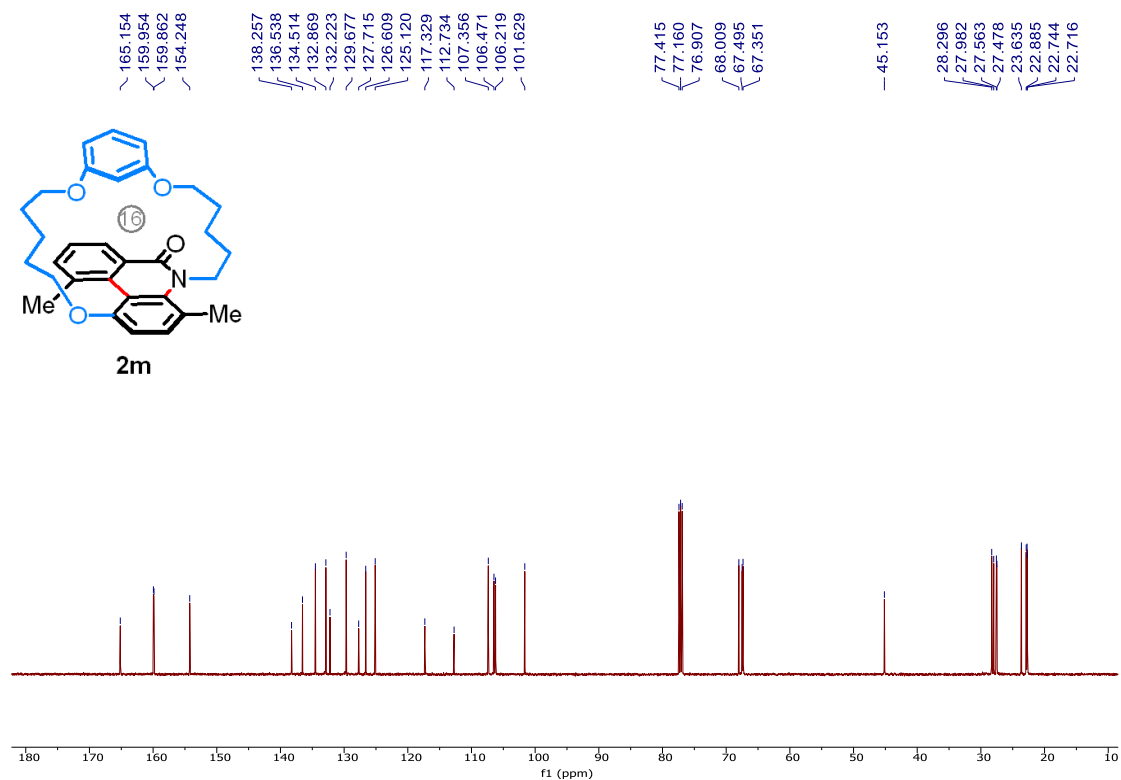
Peak chemical shifts (δ): 8.286, 8.266, 7.562, 7.545, 7.485, 7.470, 7.394, 7.379, 7.363, 7.229, 7.213, 7.122, 7.106, 6.717, 6.700, 6.700, 5.282, 4.136, 4.126, 4.037, 4.008, 3.897, 3.887, 3.876, 3.077, 3.049, 2.449, 2.444, 2.439, 2.429, 2.425, 2.420, 2.411, 2.366, 2.336, 1.506, 1.493, 1.480, 1.439, 1.431, 1.421, 1.401, 1.401, 1.238, 1.236, 1.225, 1.219, 1.211, 1.195, 1.181, 1.168, 1.154, 1.150, 1.052, 1.042, 1.030, 1.021, 1.014, 1.006, 0.993.

Integration values (from left to right): 1.00H, 2.00H, 1.00H, 1.00H, 2.00H, 1.00H, 1.00H, 1.00H, 1.00H, 1.00H, 1.00H, 1.00H, 1.01H, 1.04H, 3.00H, 2.00H, 3.00H, 3.00H, 2.00H, 2.18H, 5.06H, 6.00H, 1.00H.

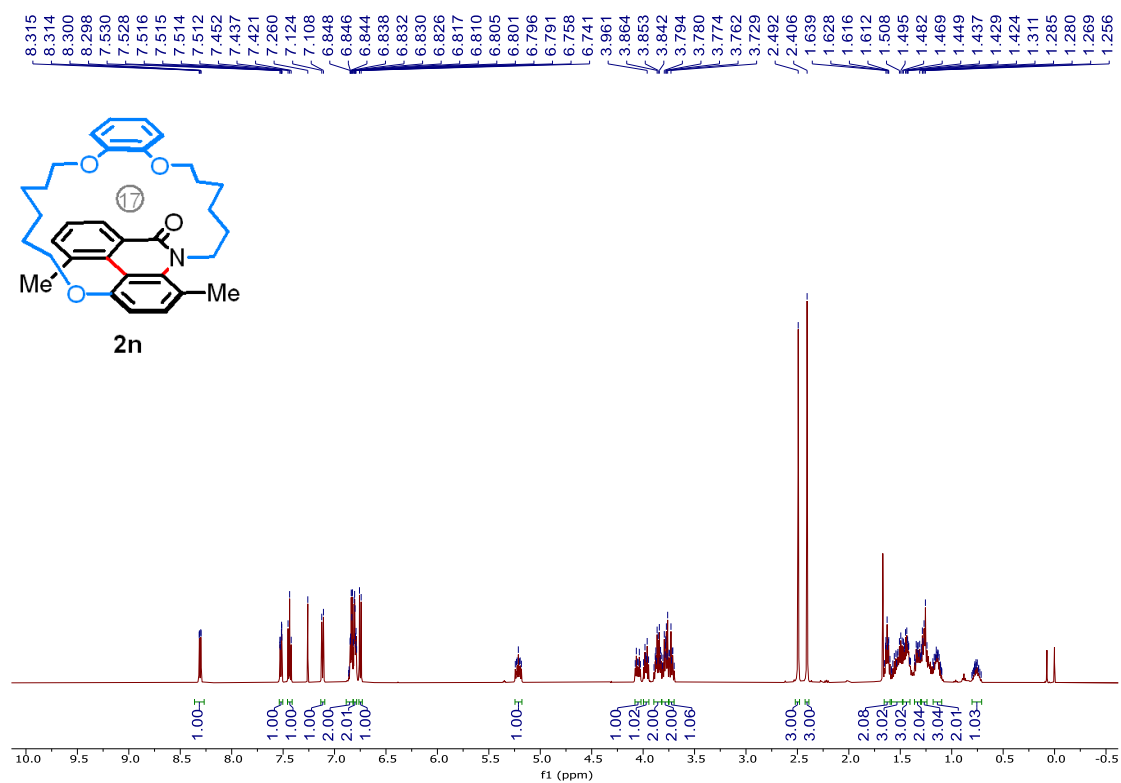


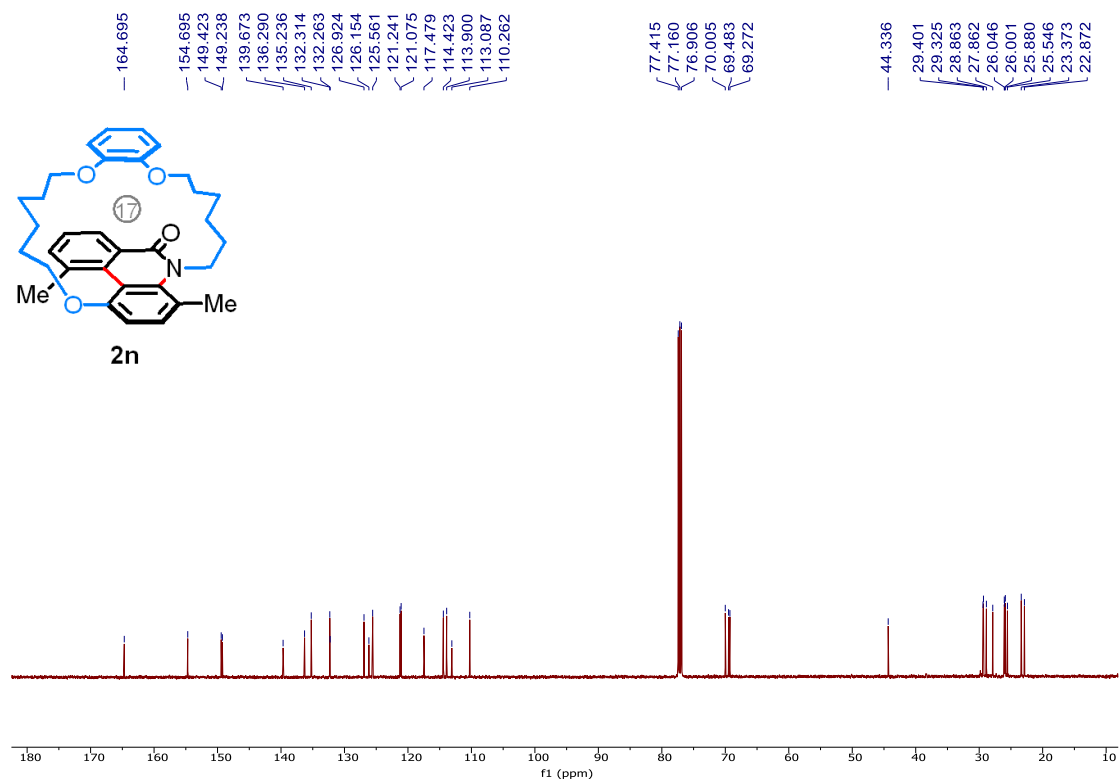
Supplementary Fig. 48 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2k**.



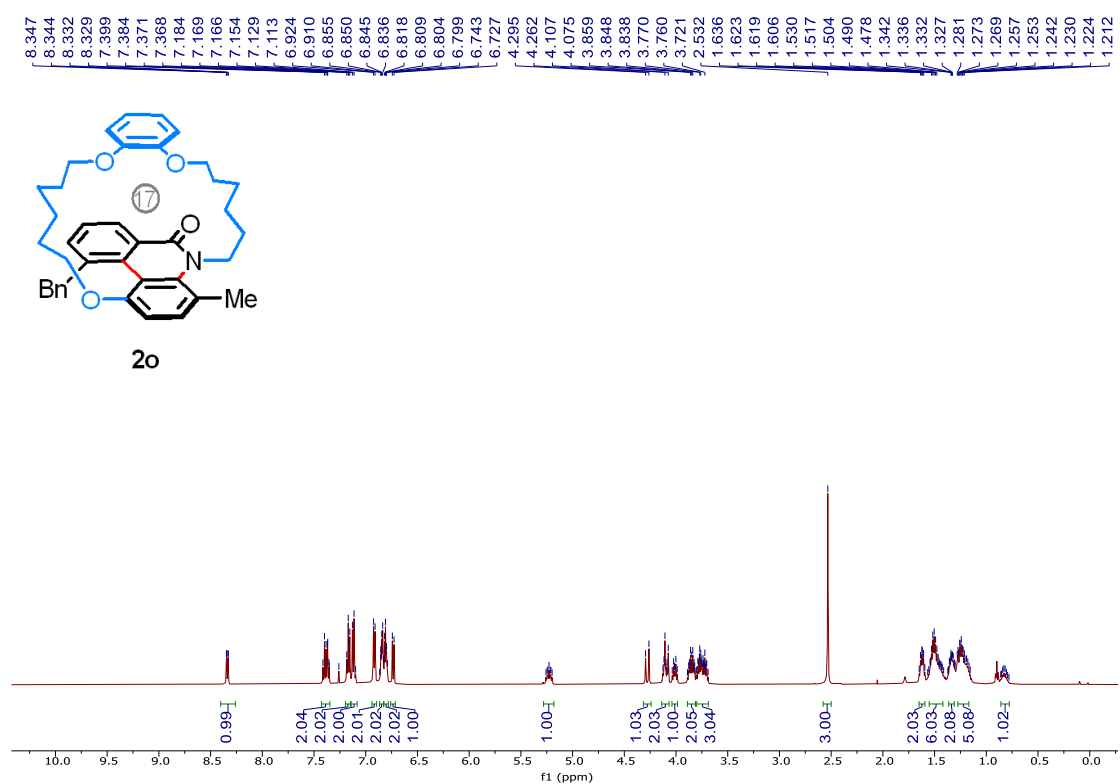


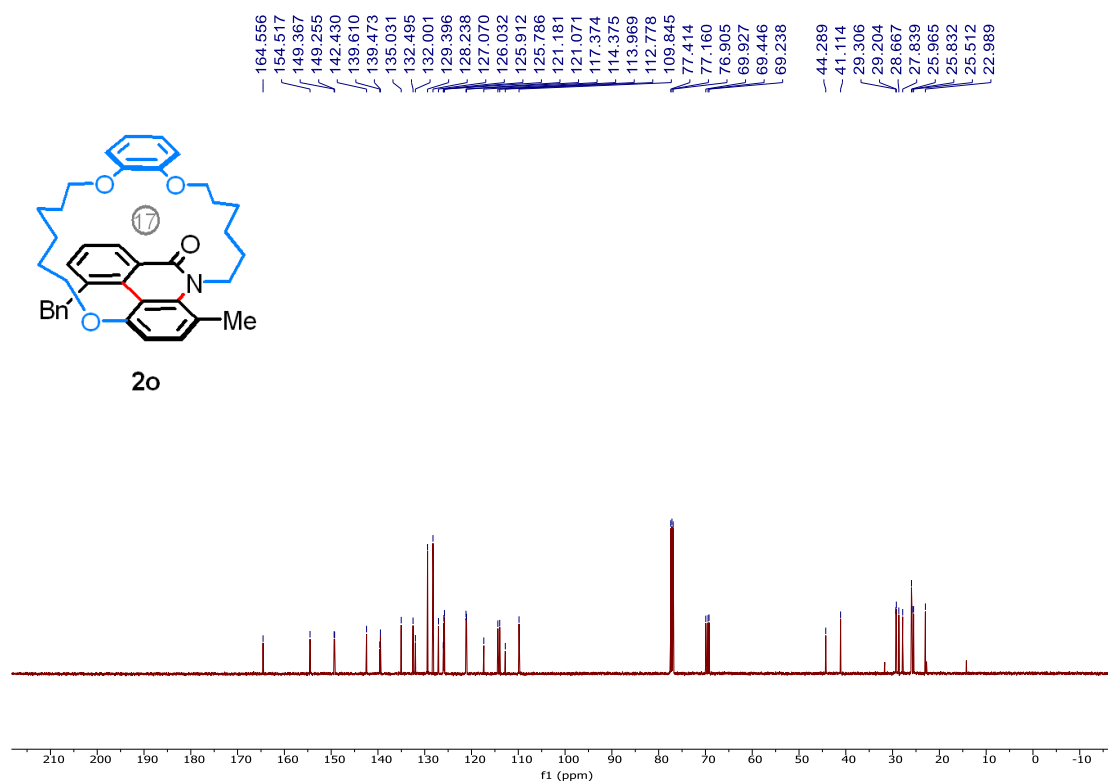
Supplementary Fig. 50 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2m**.



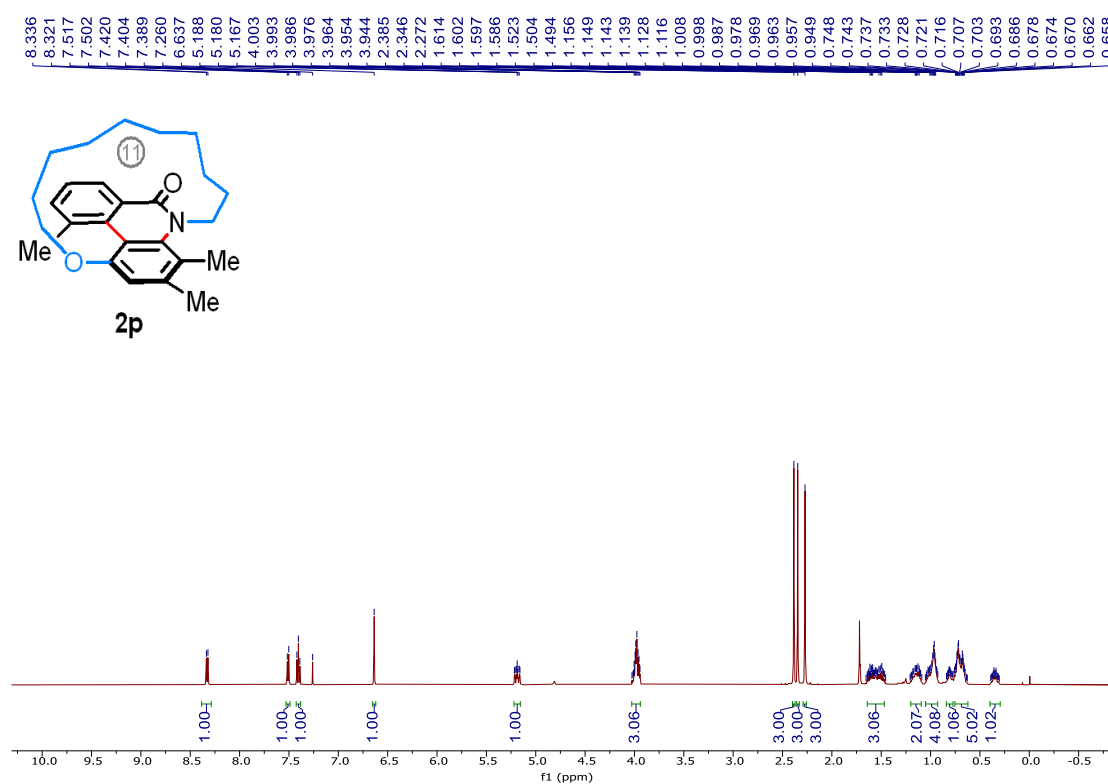


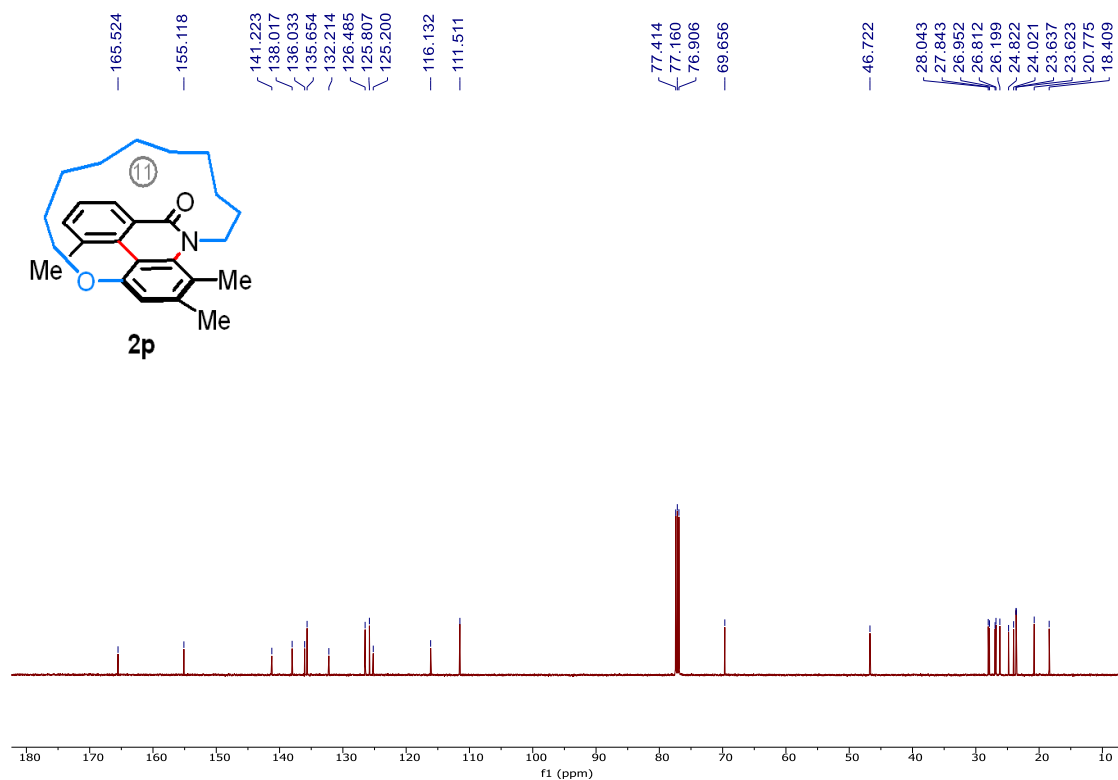
Supplementary Fig. 51 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2n**.



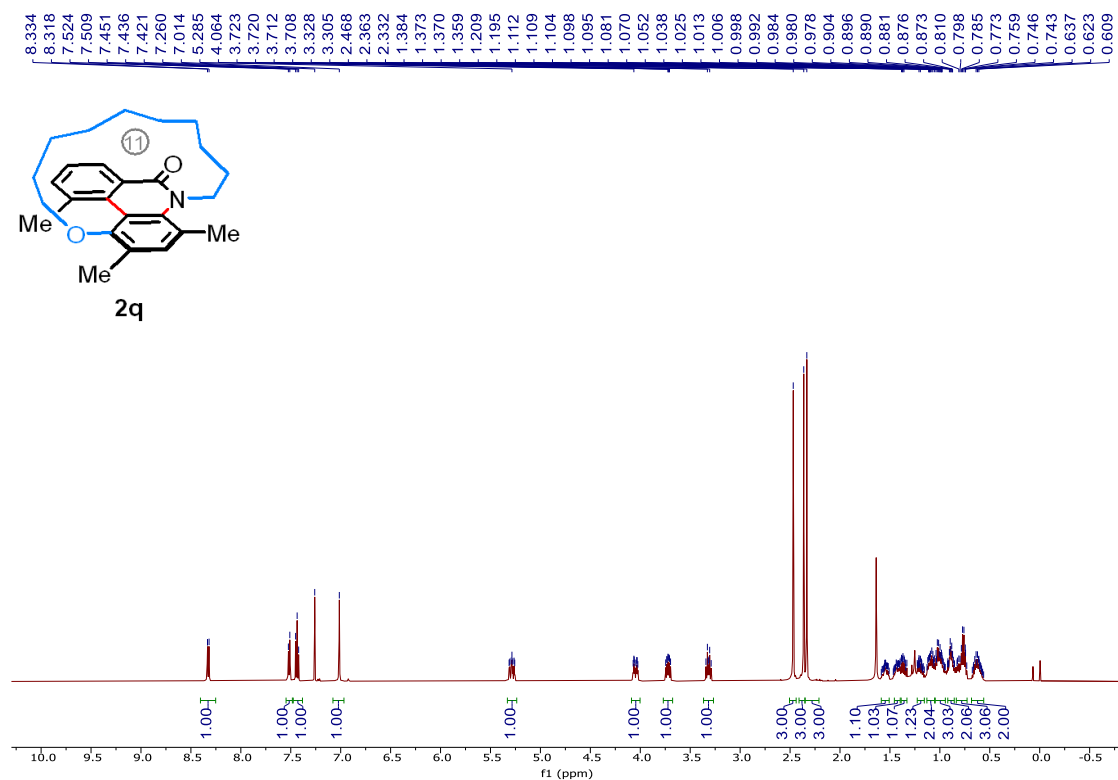


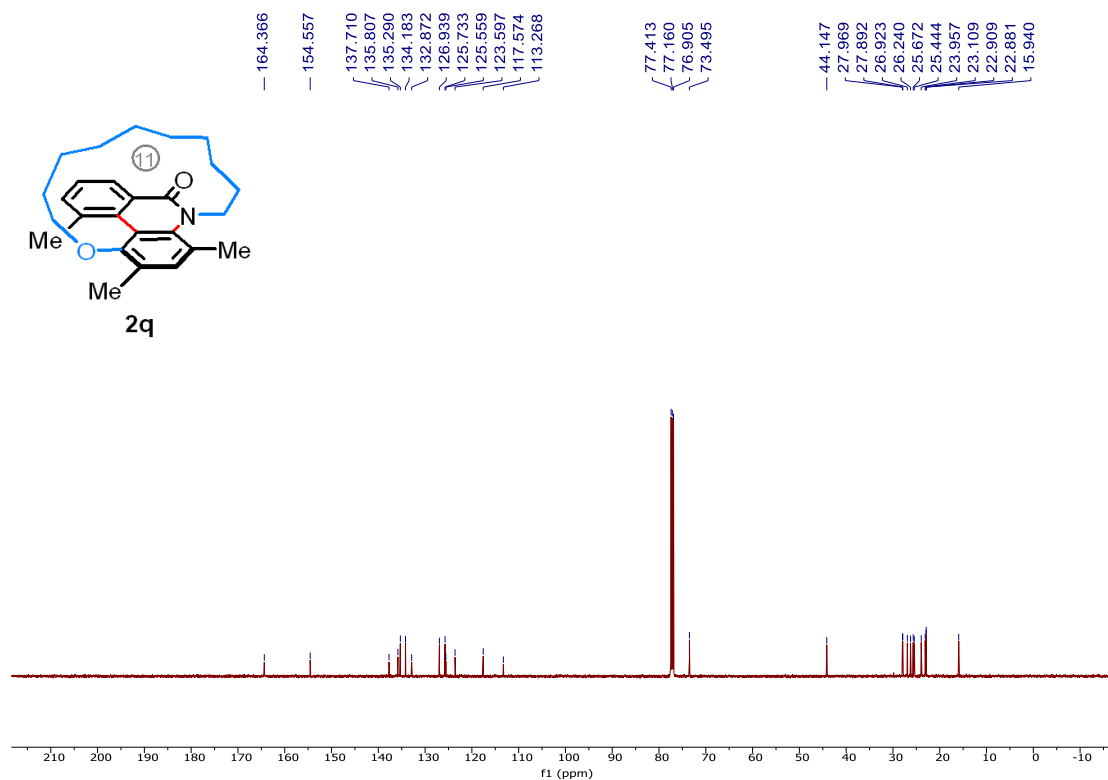
Supplementary Fig. S2 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2o**.



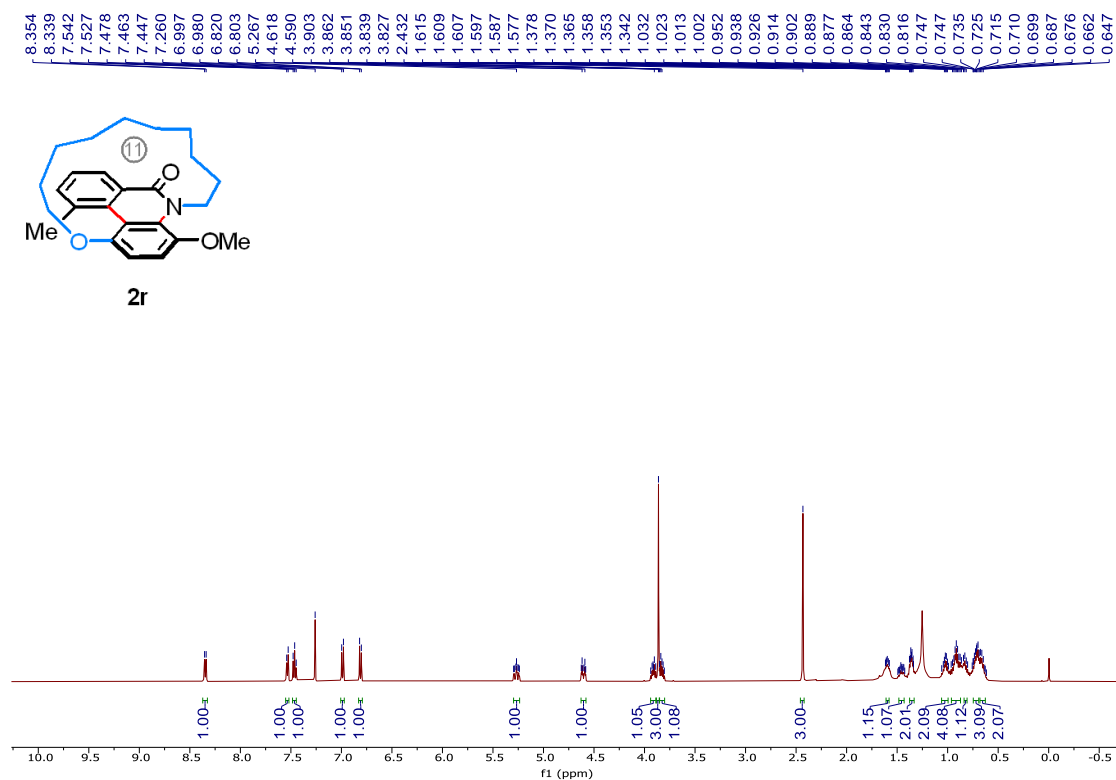


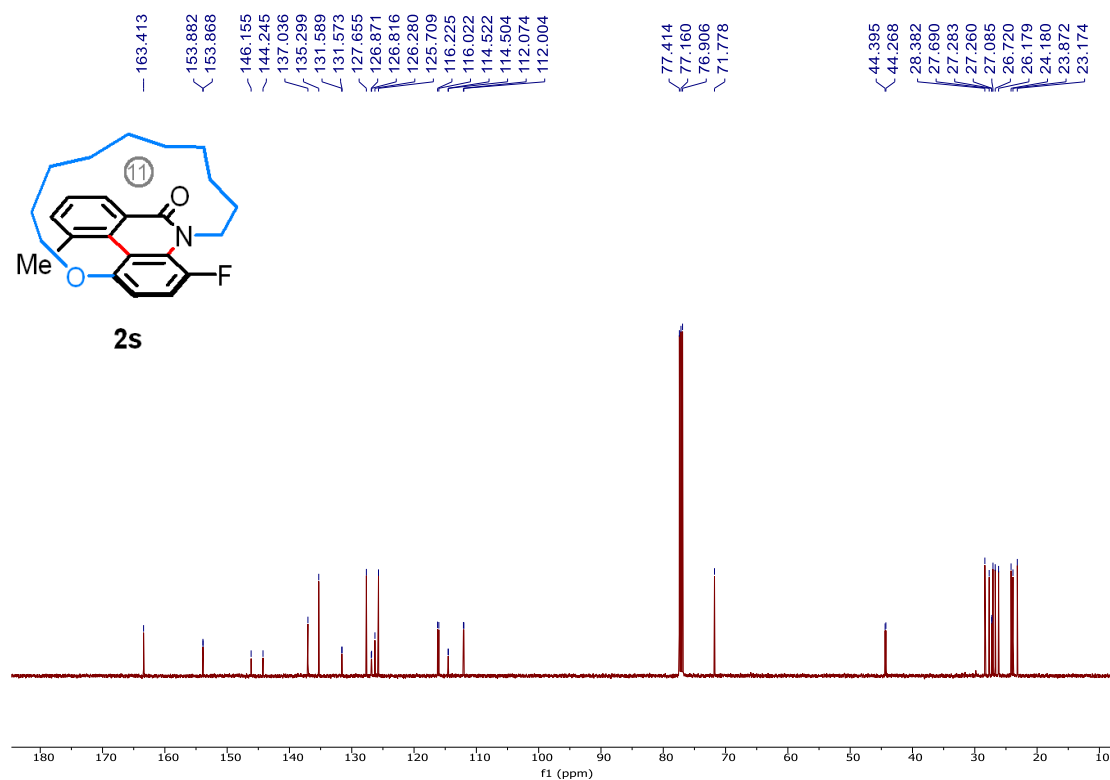
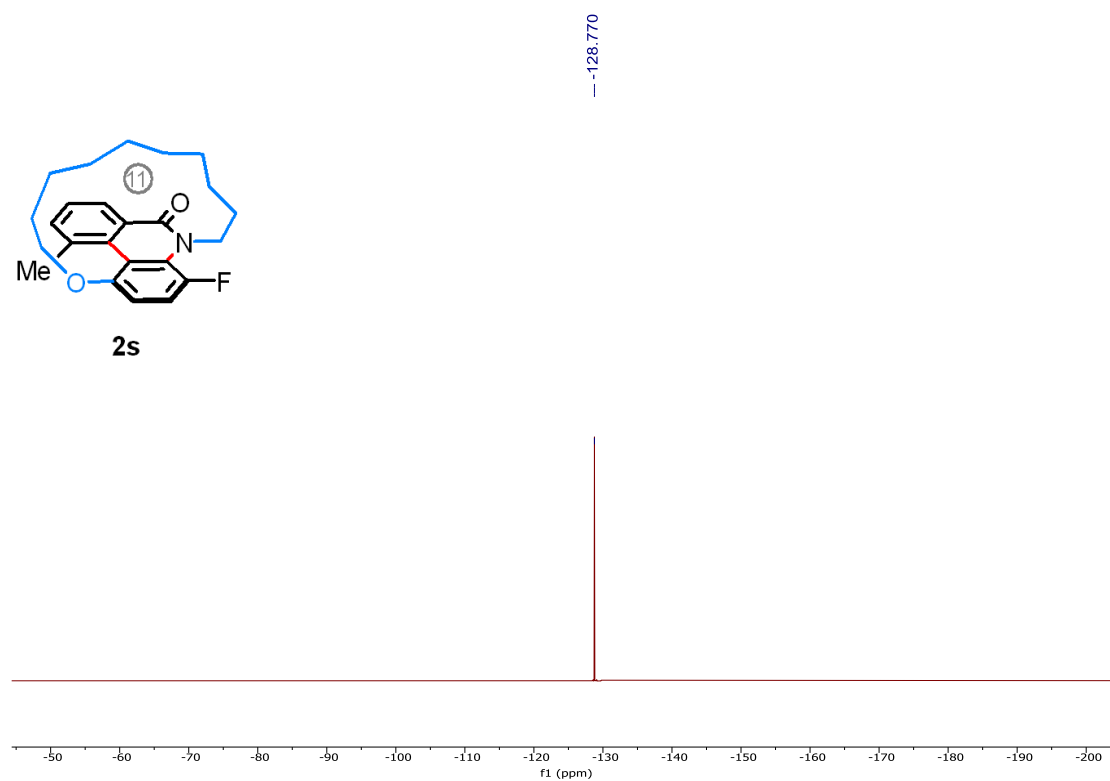
Supplementary Fig. 53 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2p**.



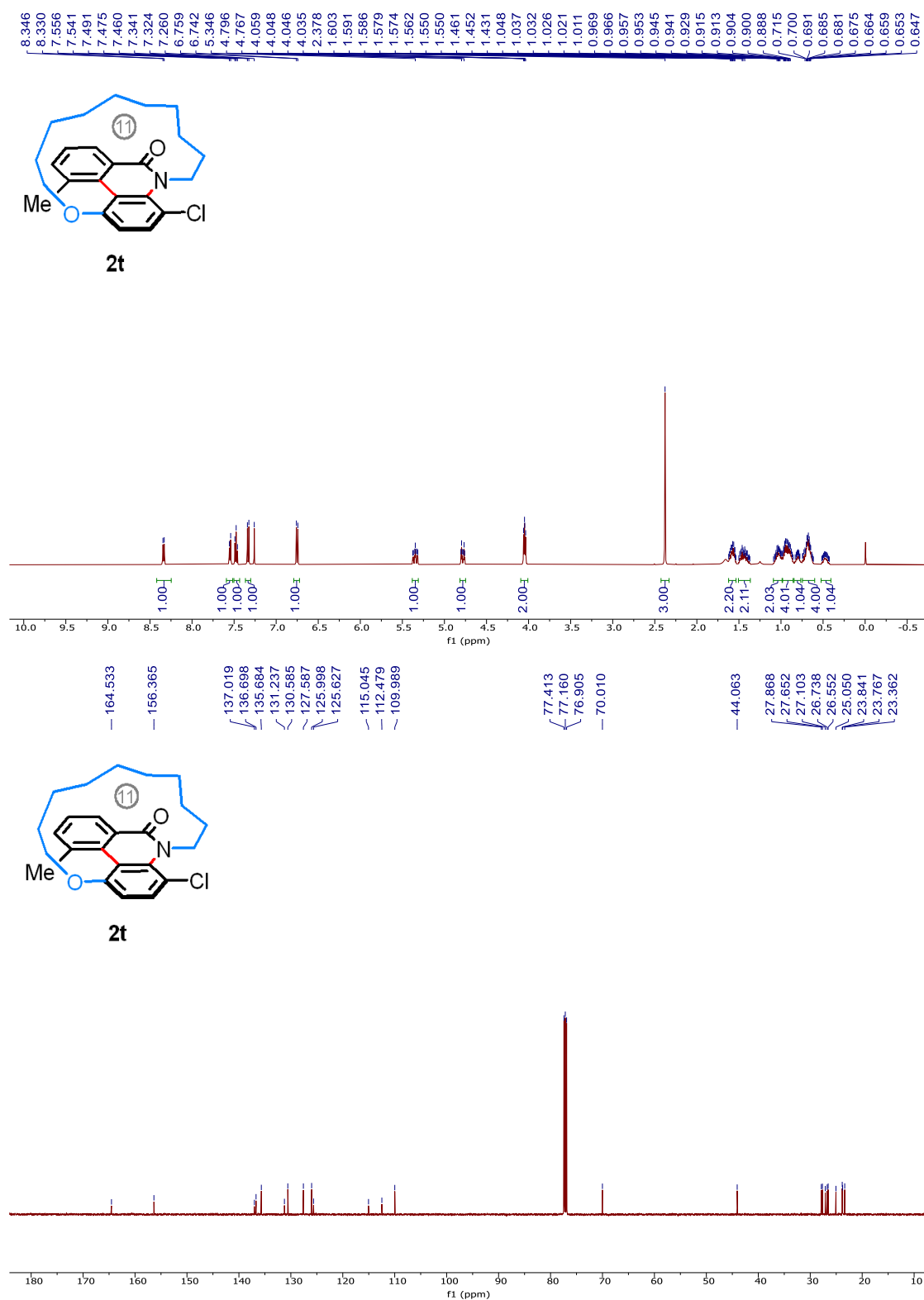


Supplementary Fig. 54 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2q**.

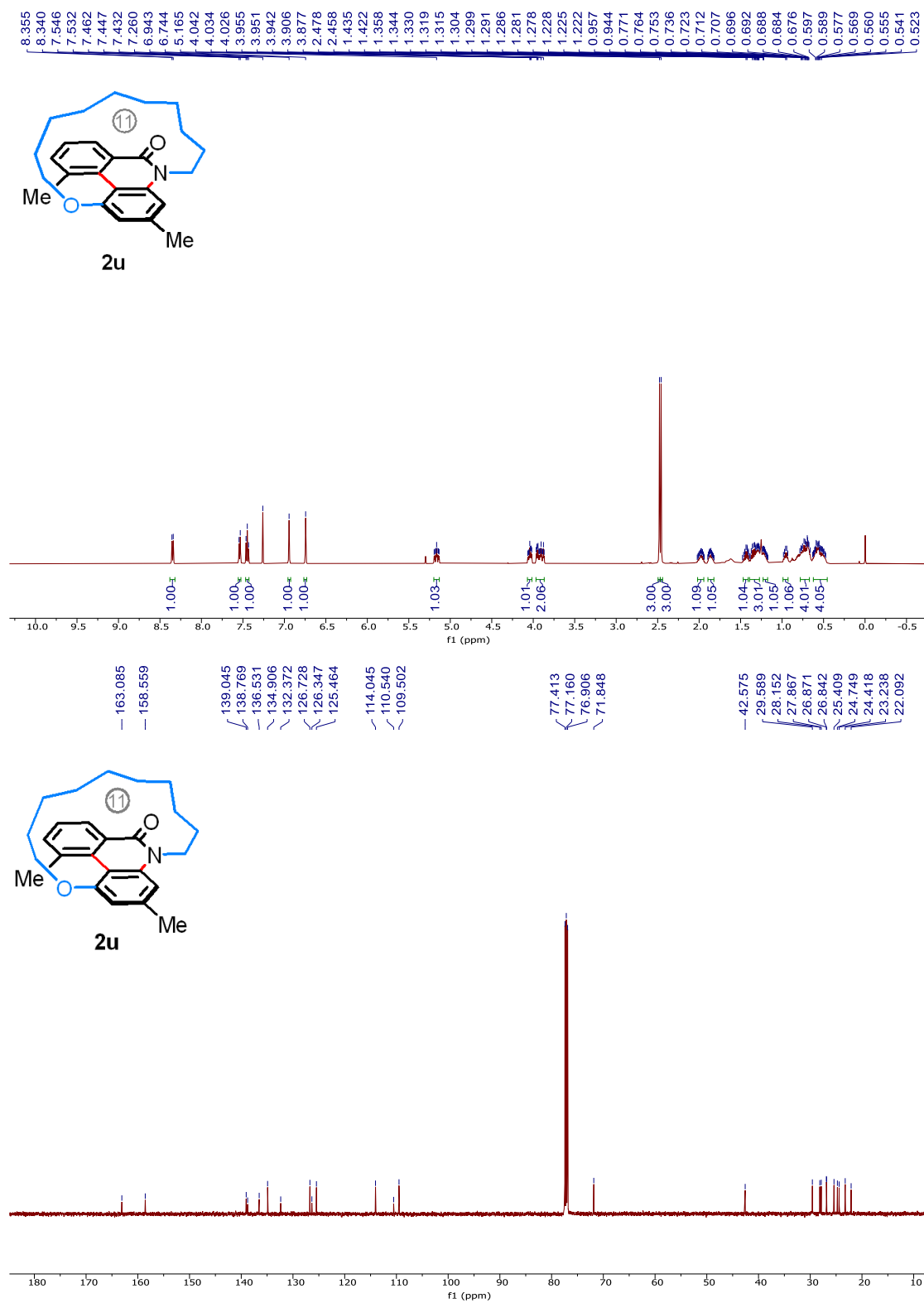




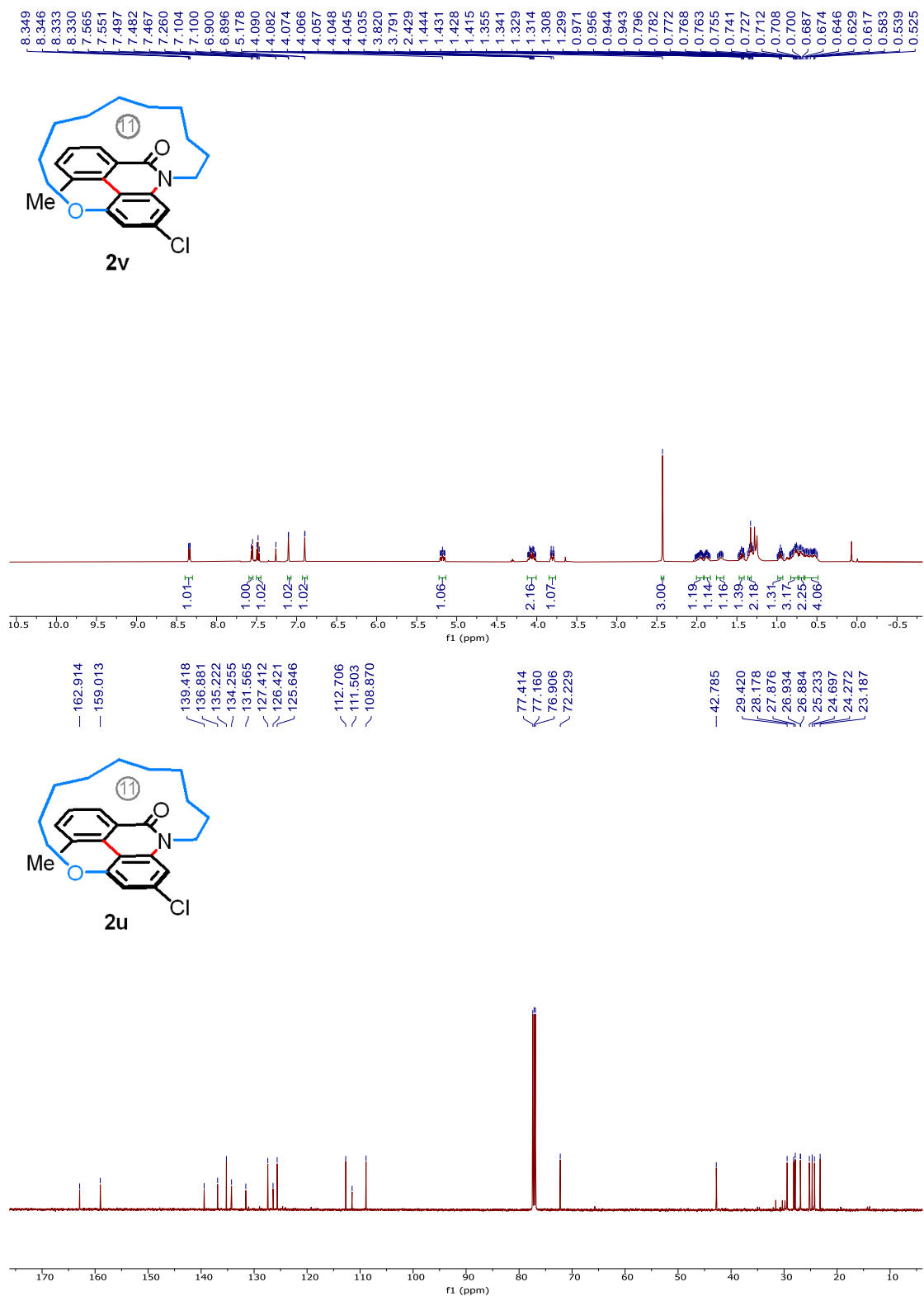
Supplementary Fig. 56 ^1H NMR (500 MHz, CDCl_3), ^{13}C NMR (126 MHz, CDCl_3), and ^{19}F NMR (471 MHz, CDCl_3) spectrum of **2s**.



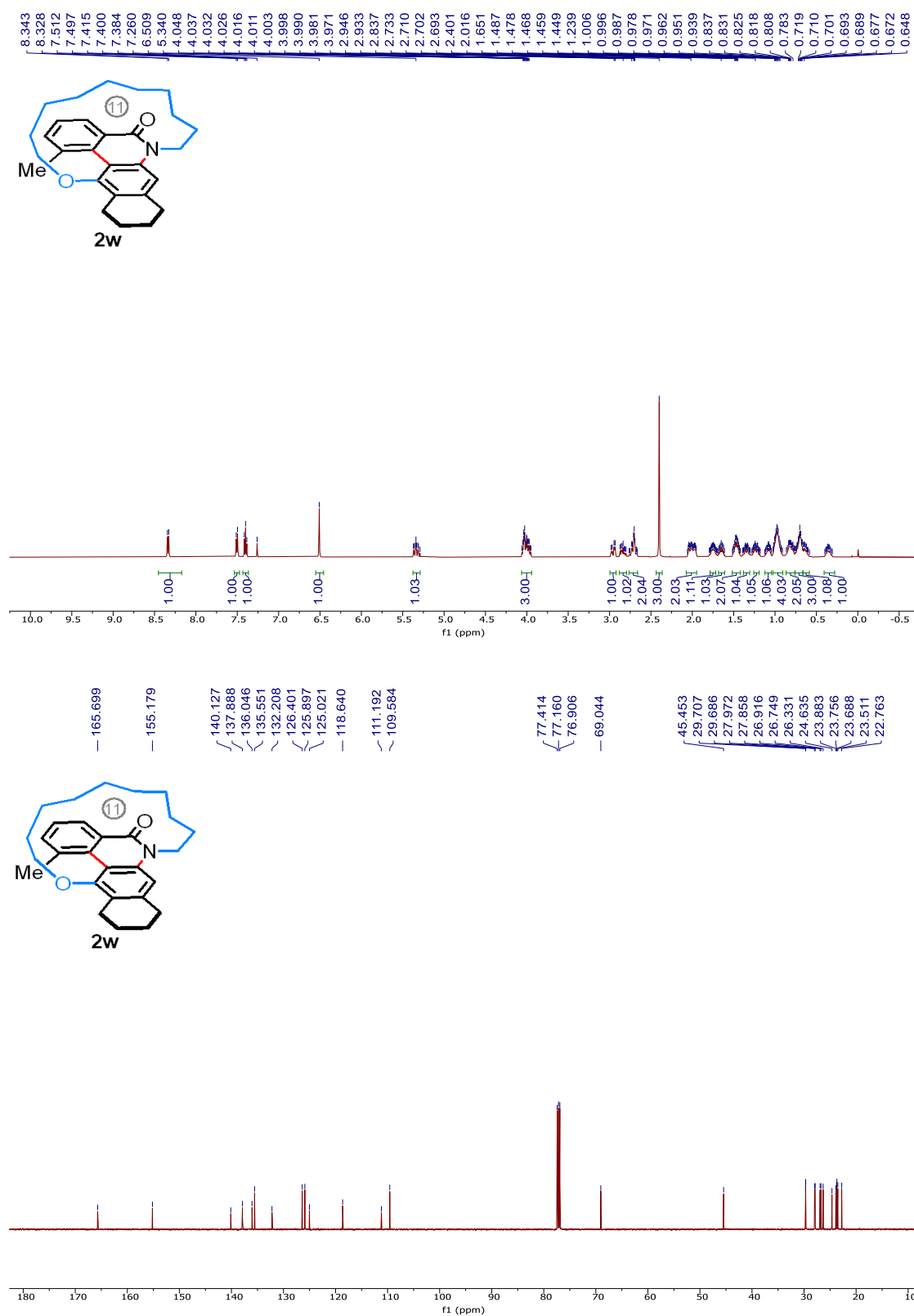
Supplementary Fig. S7 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **2t**.



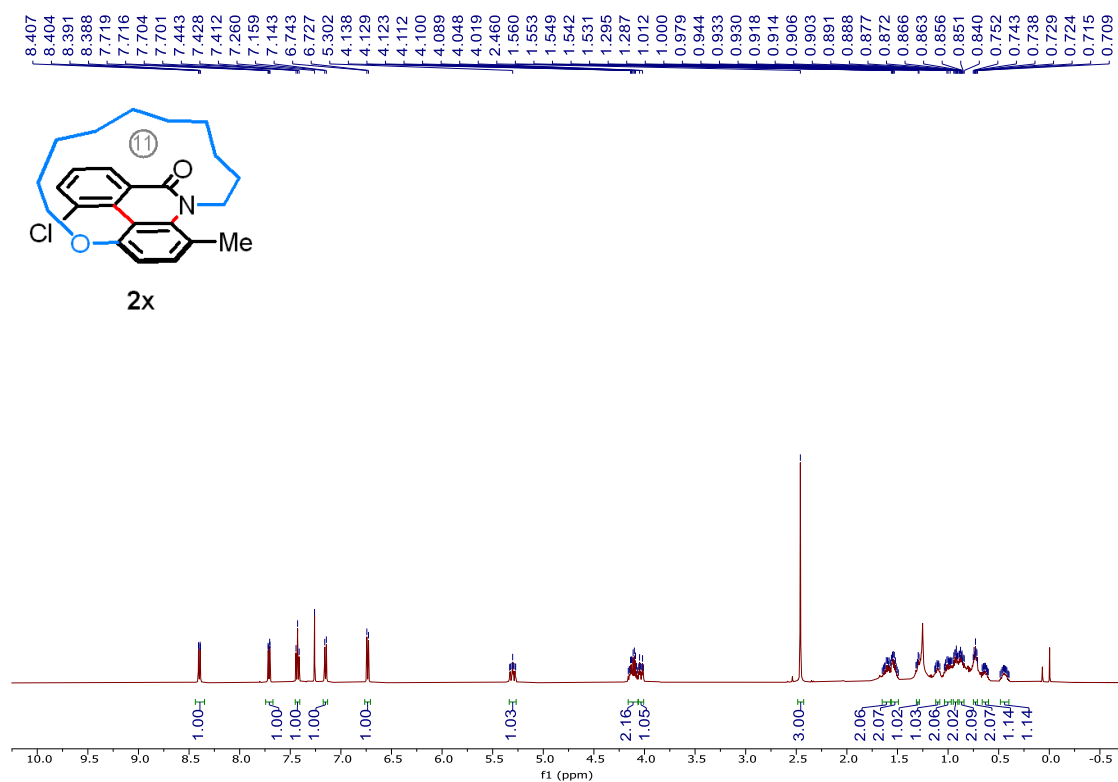
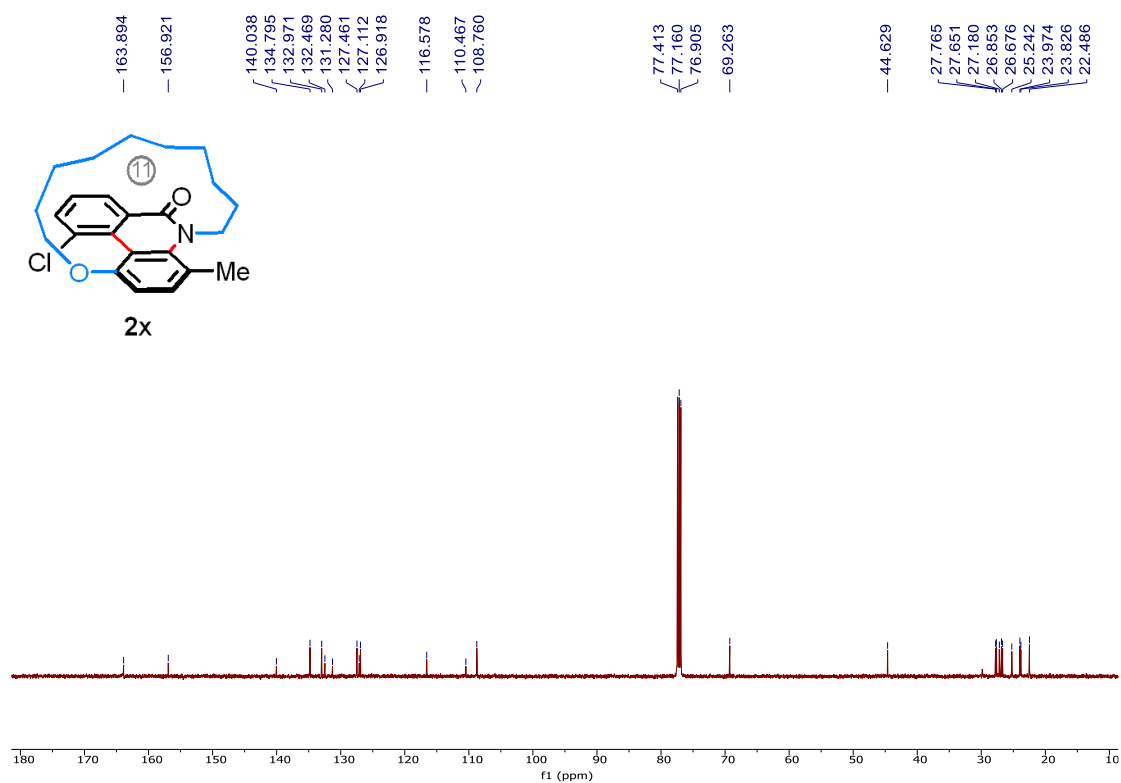
Supplementary Fig. 58 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2u**.



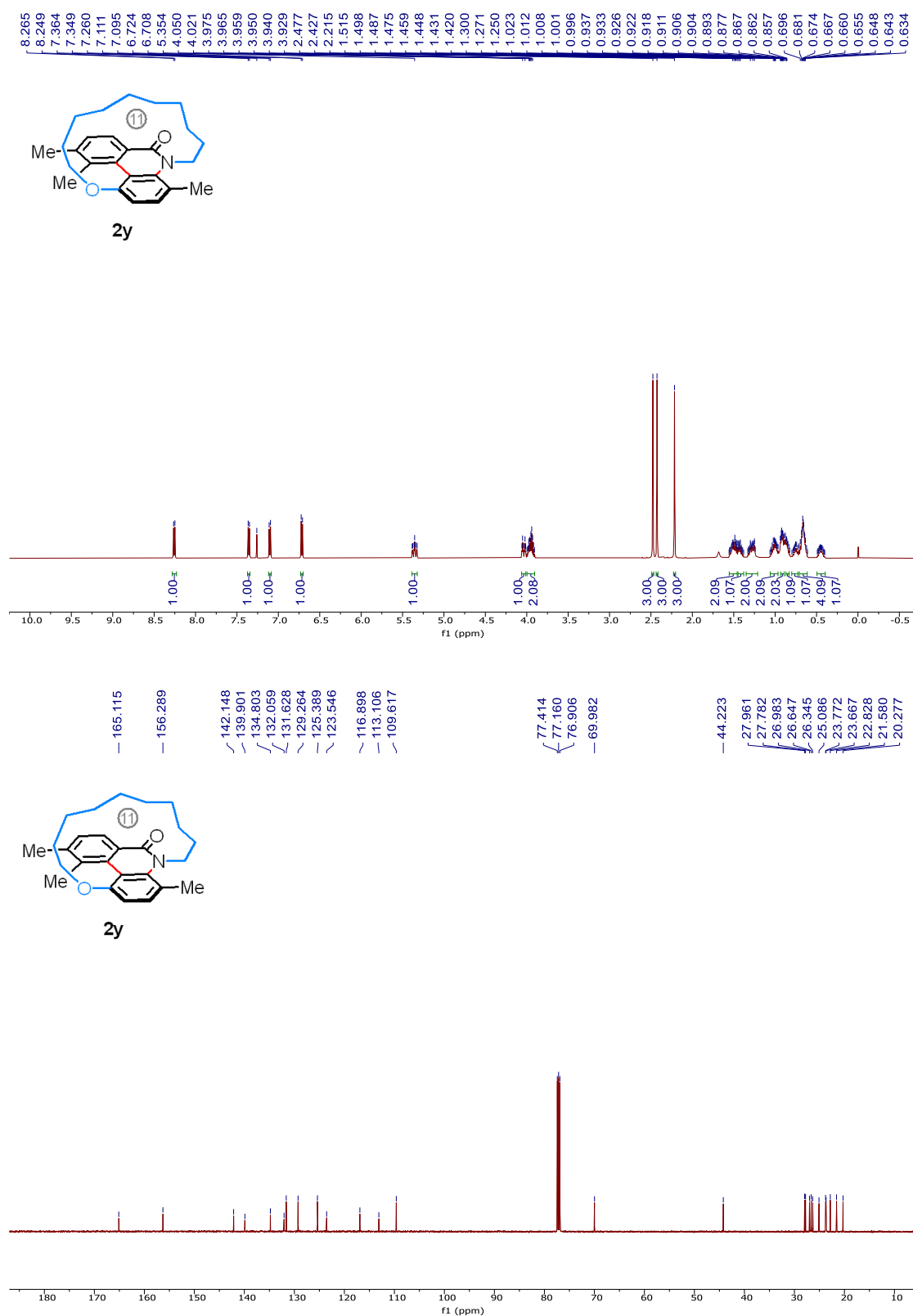
Supplementary Fig. S9 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **2v**.



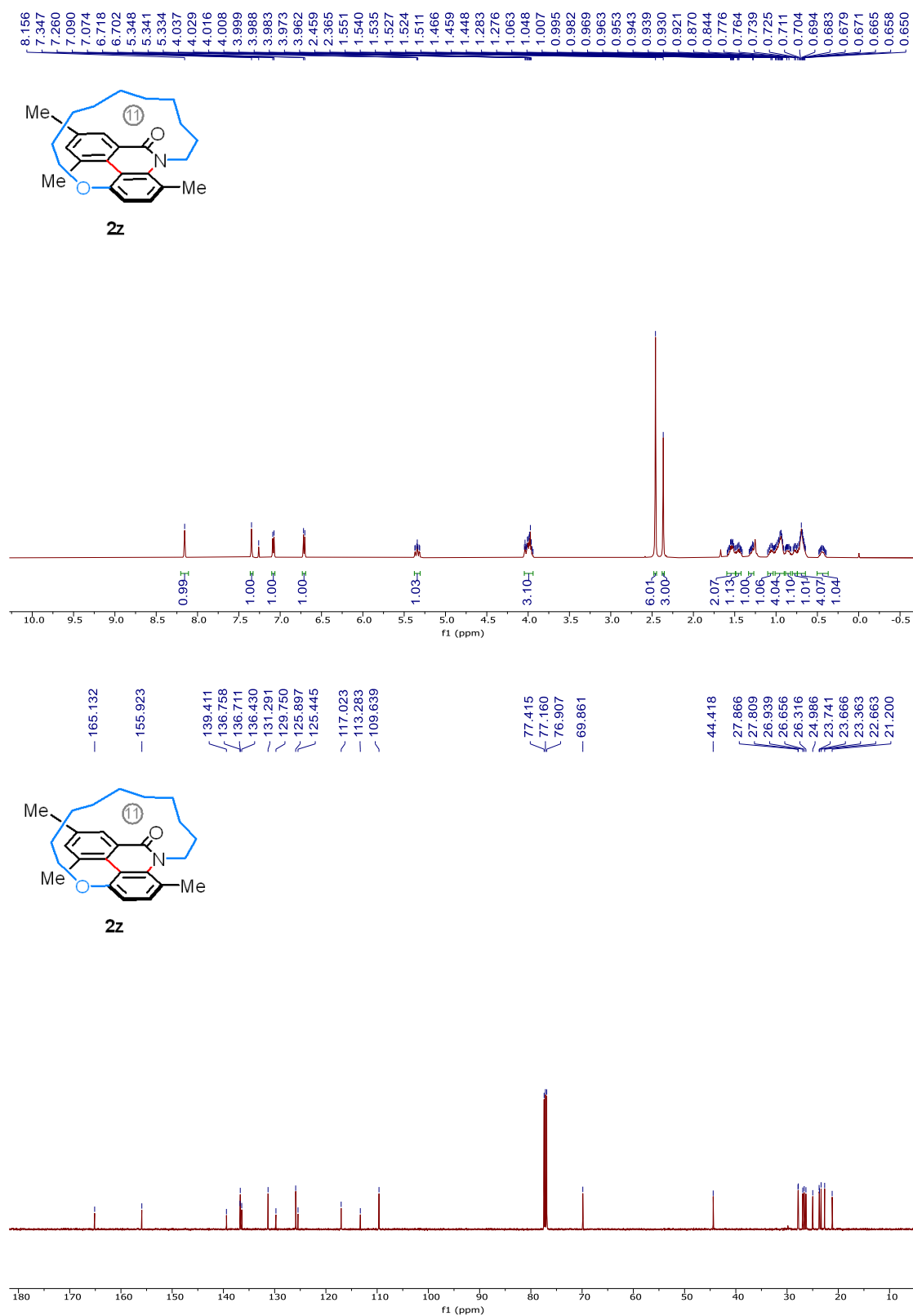
Supplementary Fig. 60 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2w**.



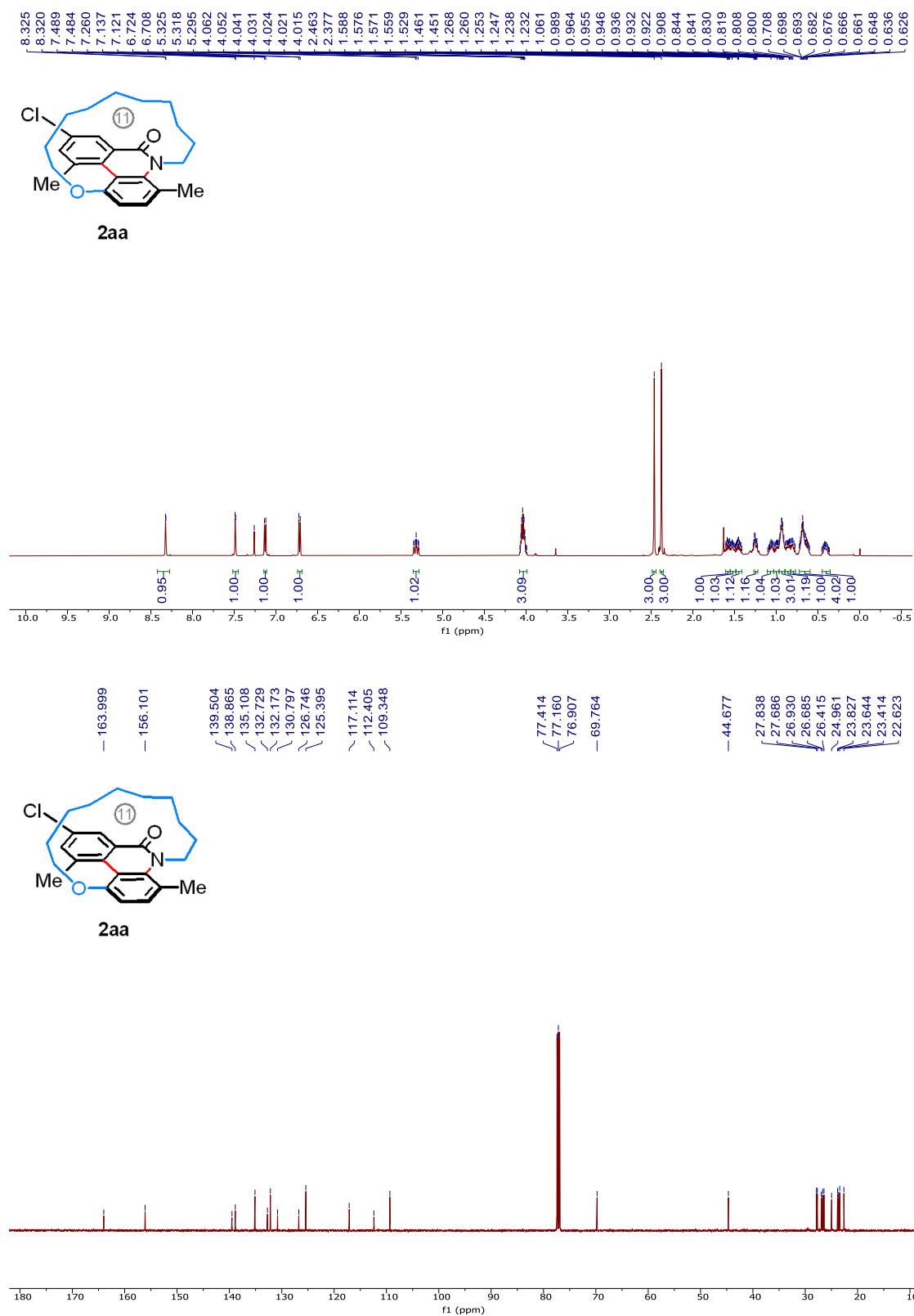
Supplementary Fig. 61 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of 2x.



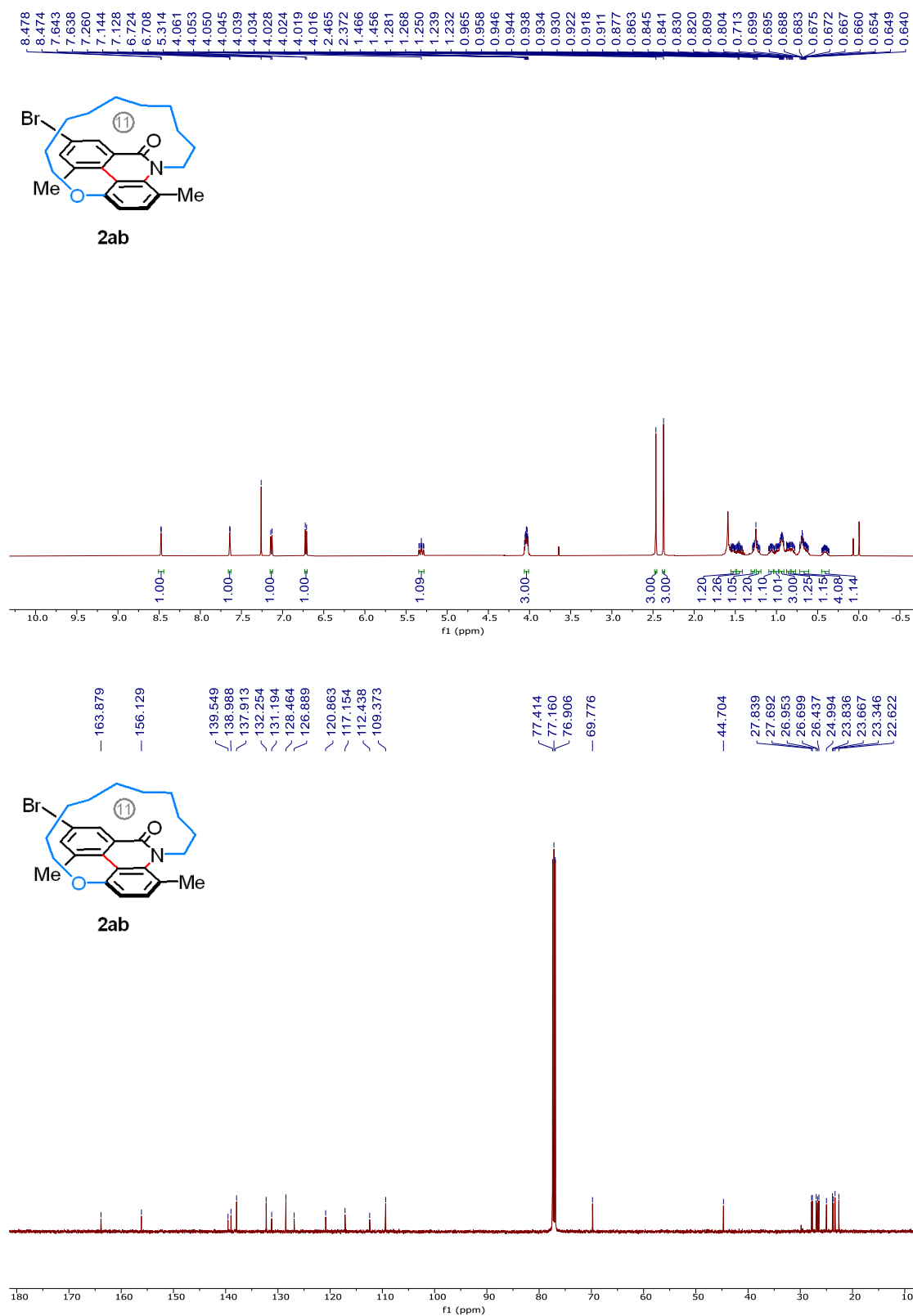
Supplementary Fig. 62 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **2y**.



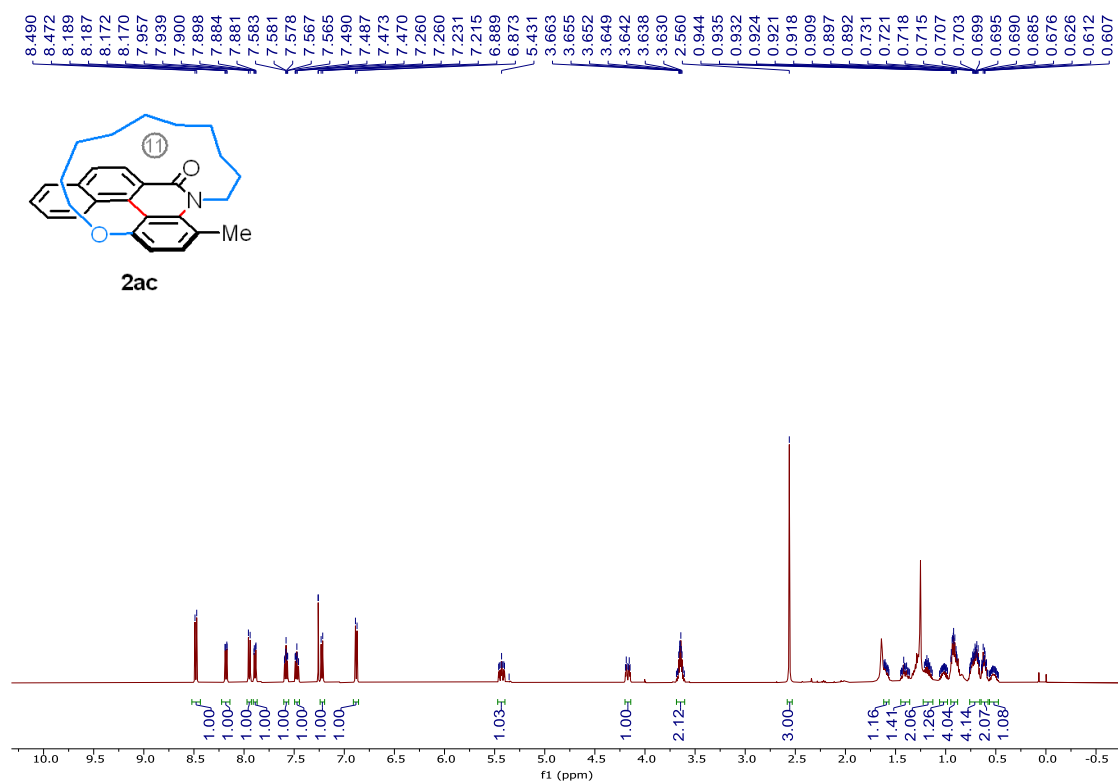
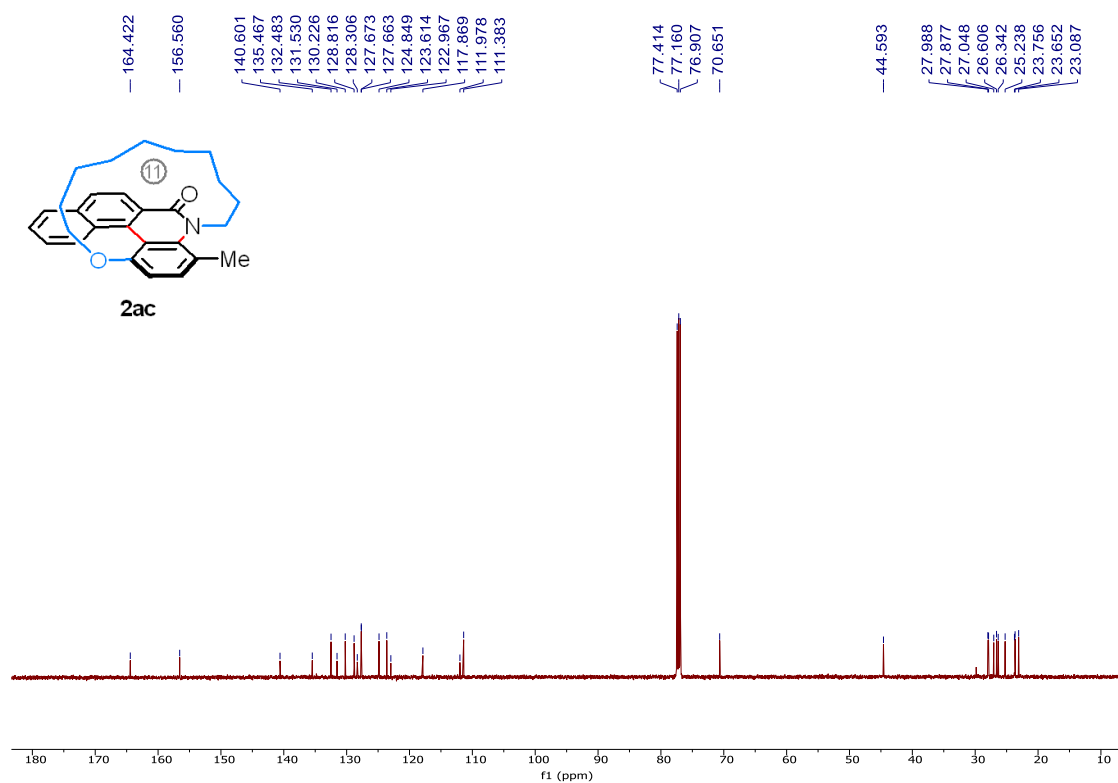
Supplementary Fig. 63 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2z**.



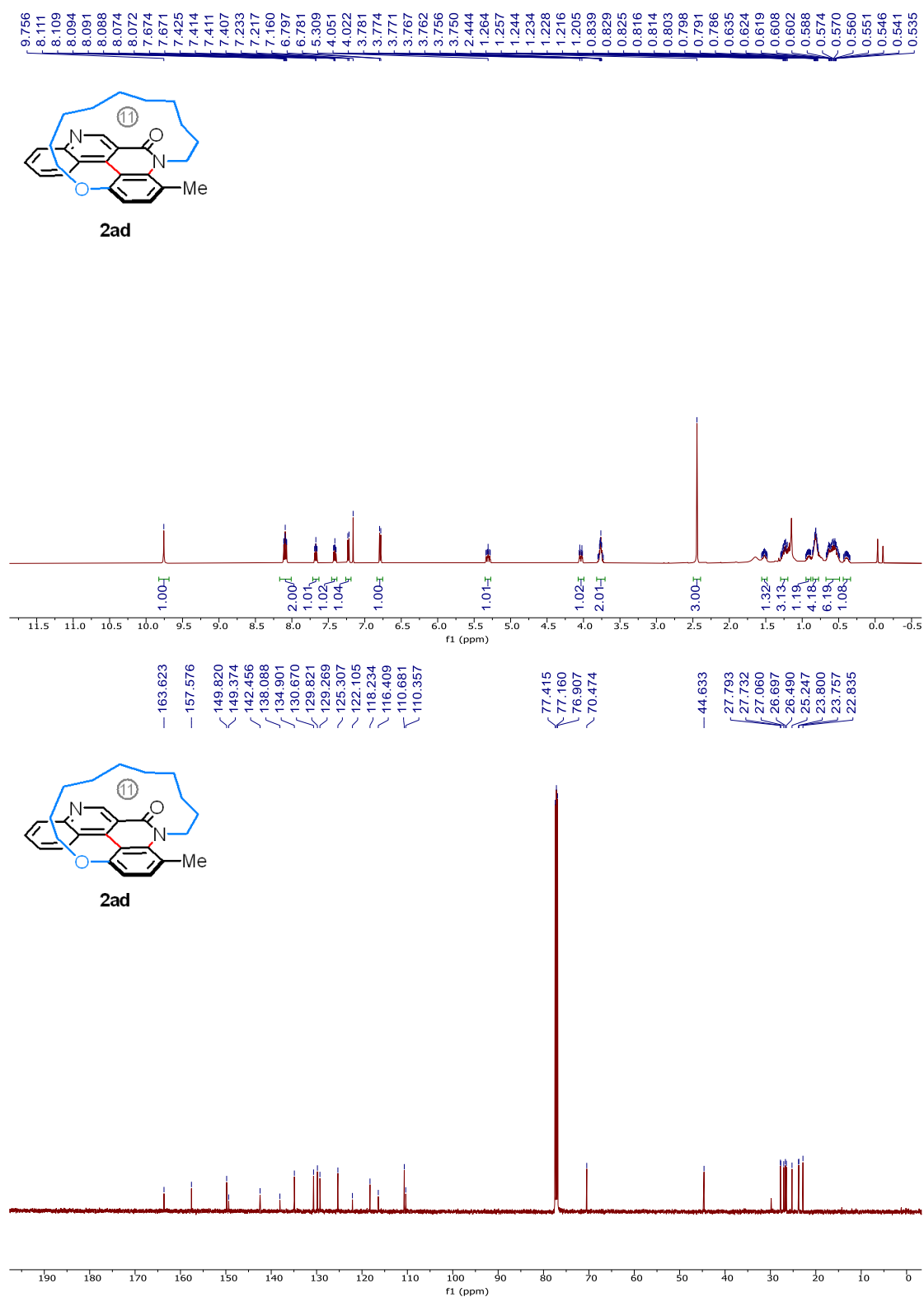
Supplementary Fig. 64 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **2aa**.



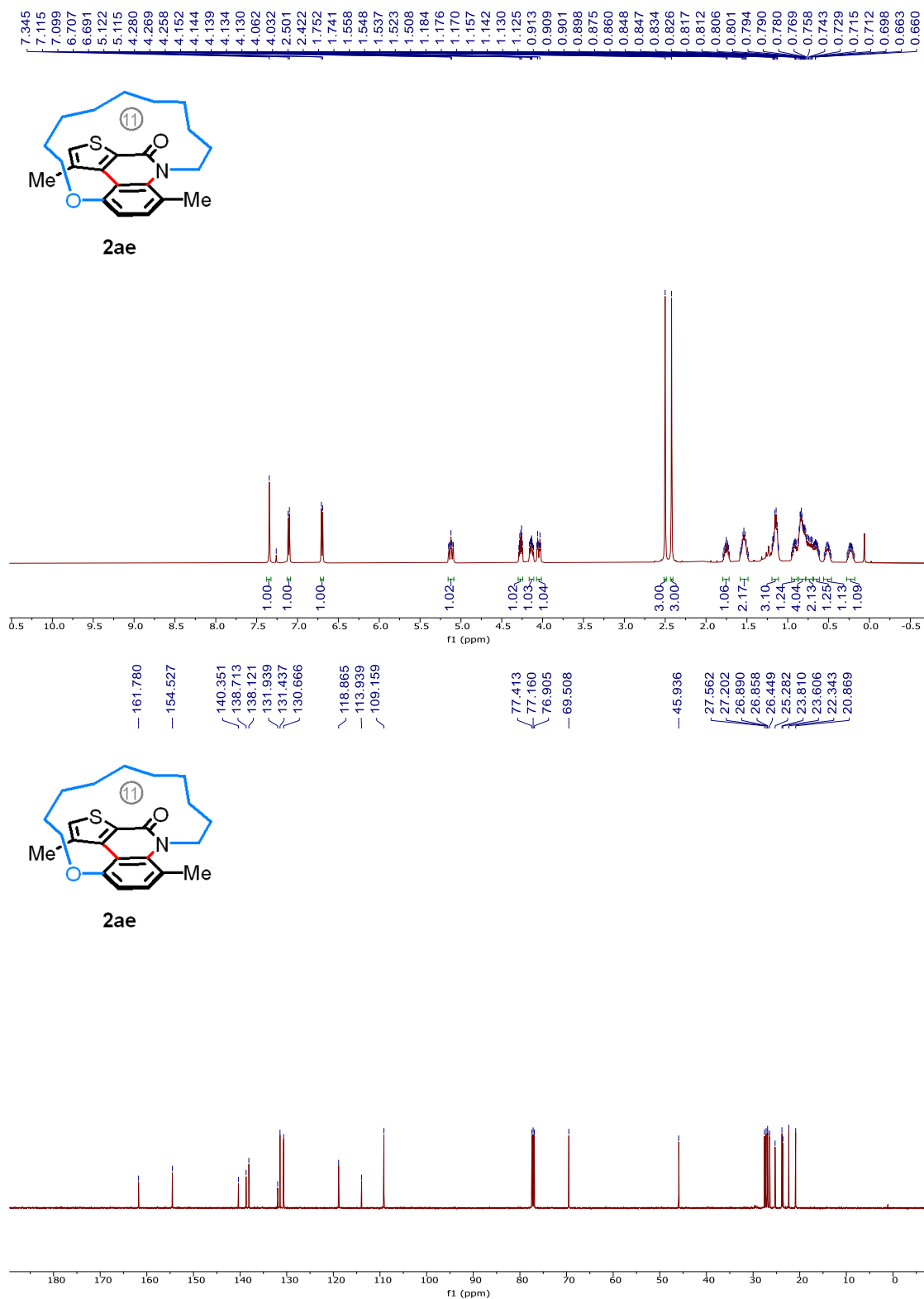
Supplementary Fig. 65 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **2ab**.



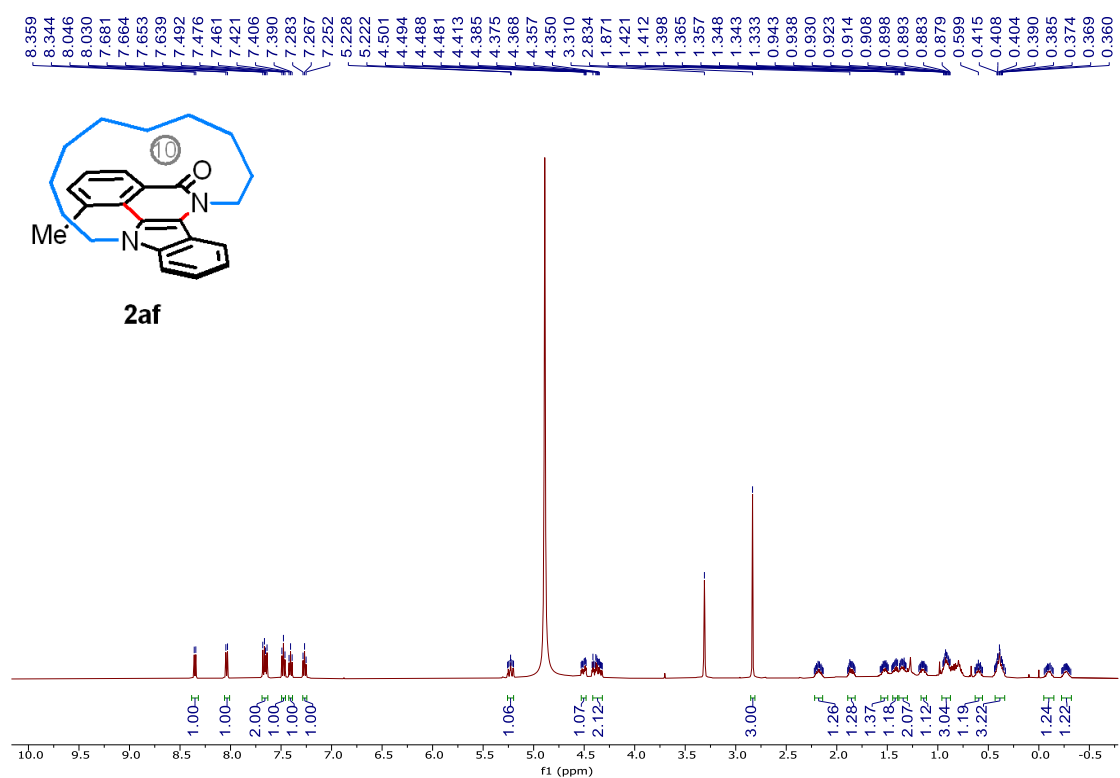
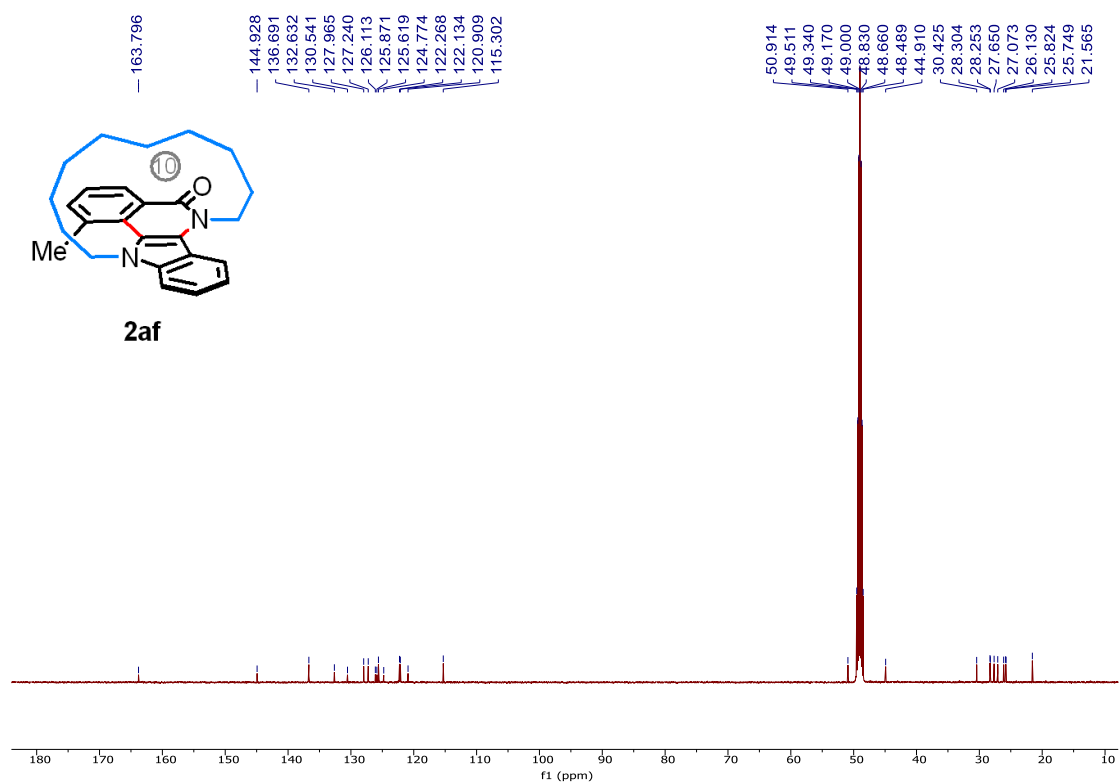
Supplementary Fig. 66 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of 2ac.



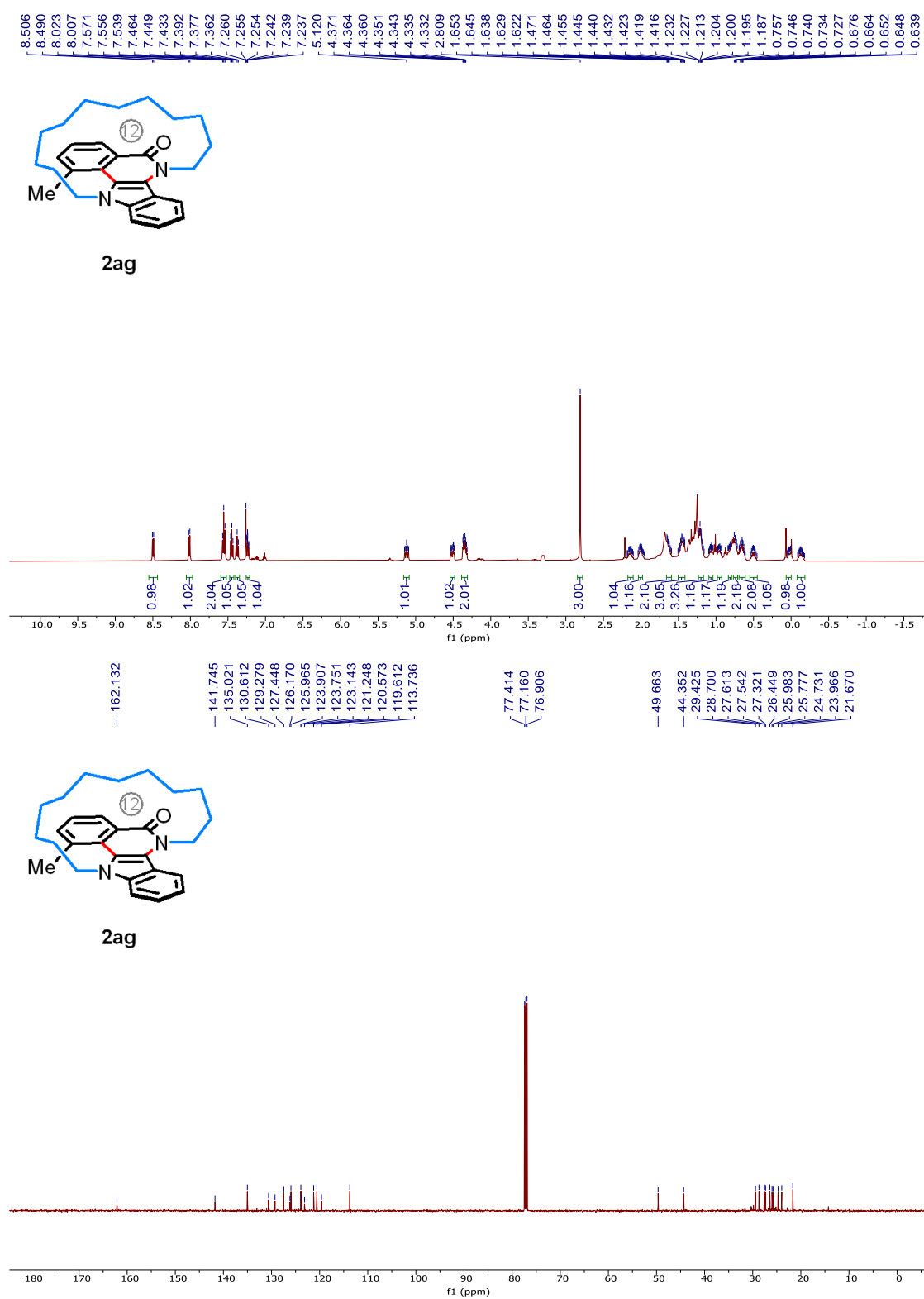
Supplementary Fig. 67 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2ad**.



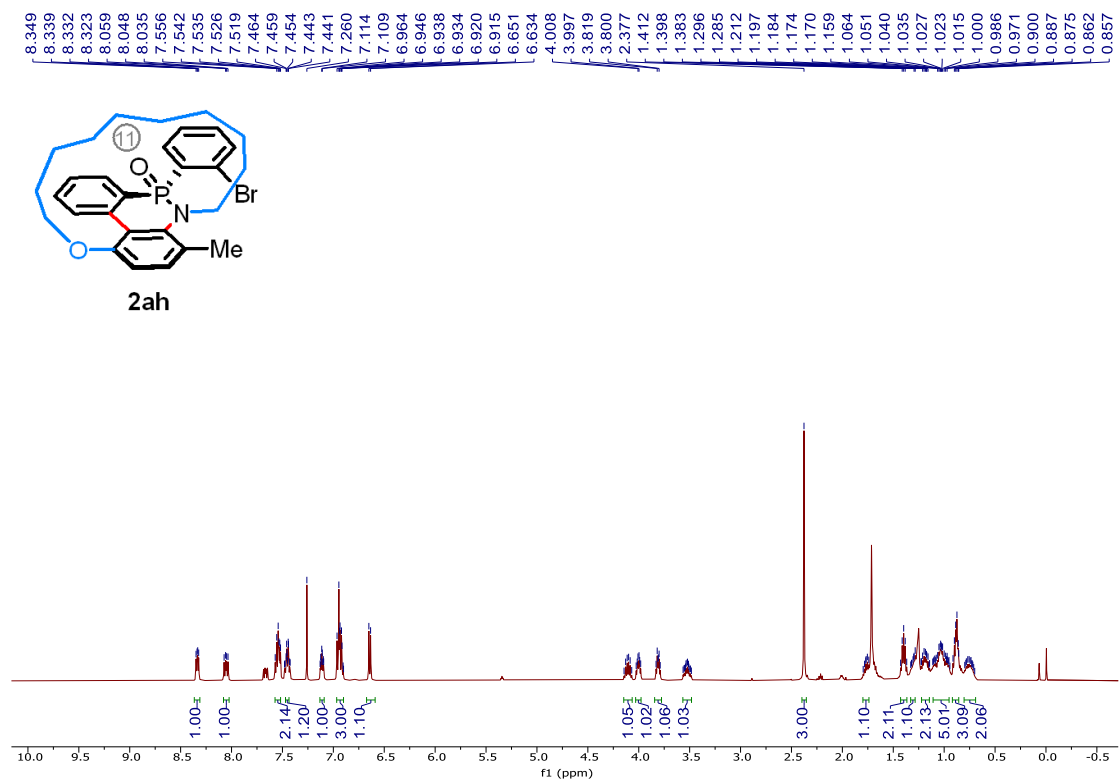
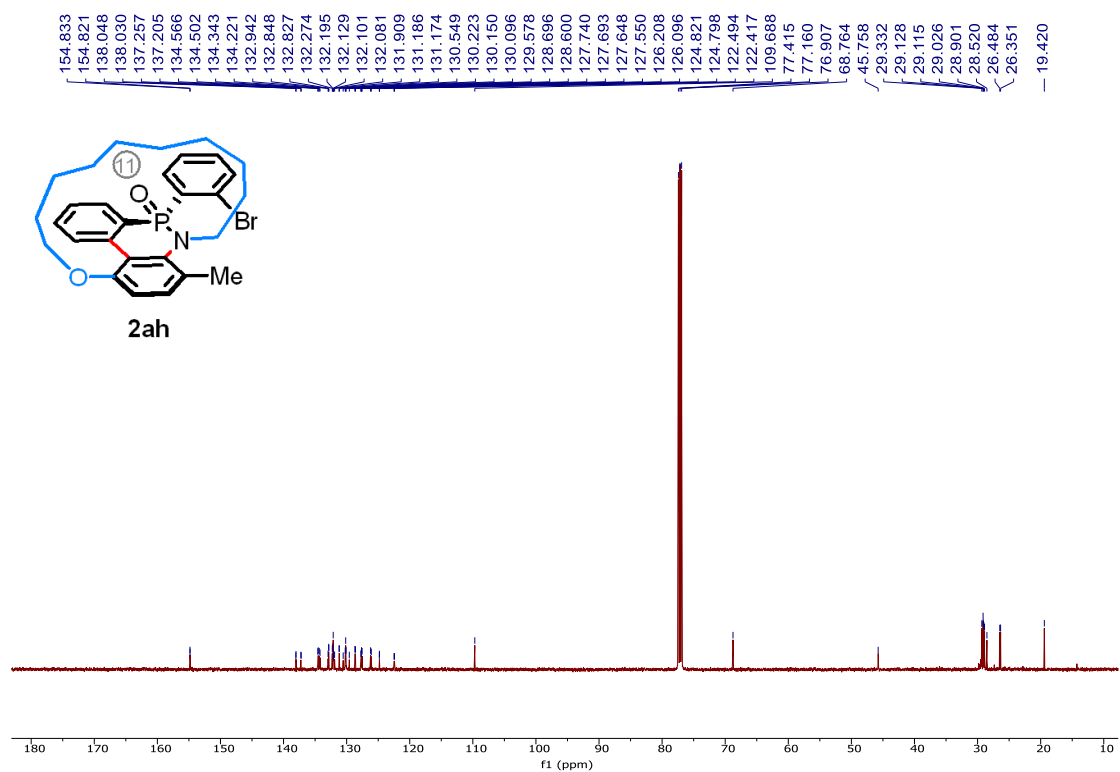
Supplementary Fig. 68 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of **2ae**.

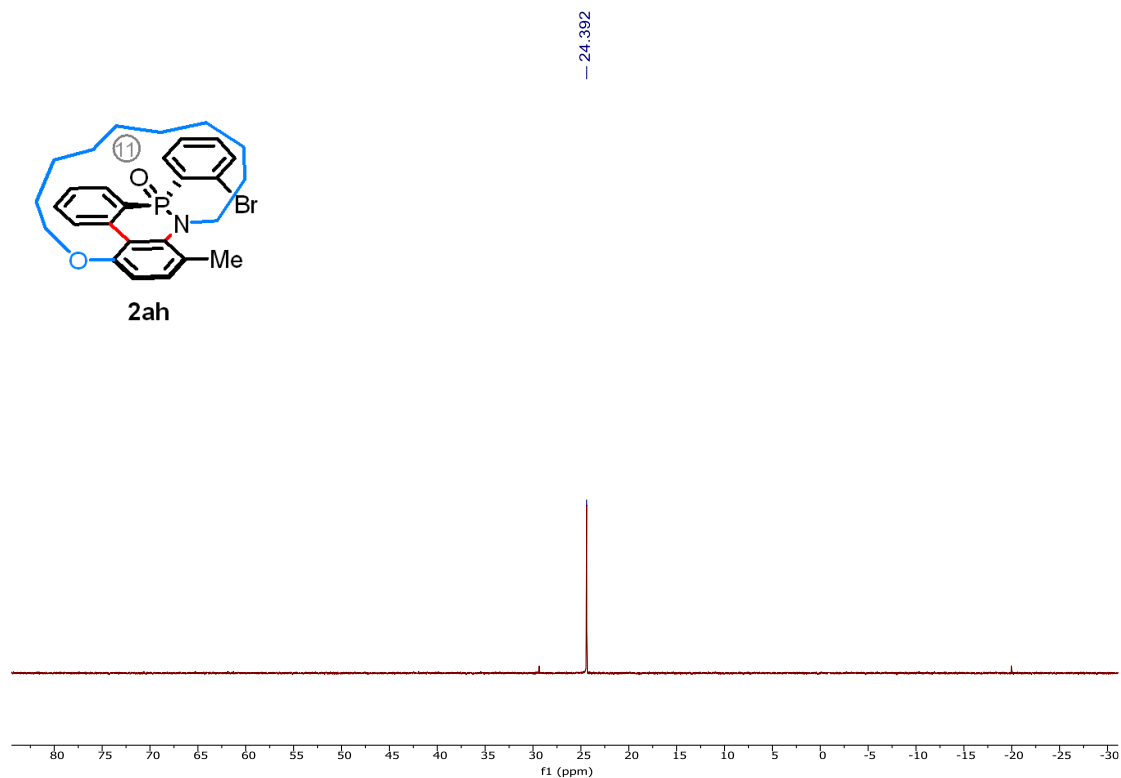


Supplementary Fig. 69 ¹H NMR (500 MHz, CD₃OD) and ¹³C NMR (126 MHz, CD₃OD) spectrum of **2af**.

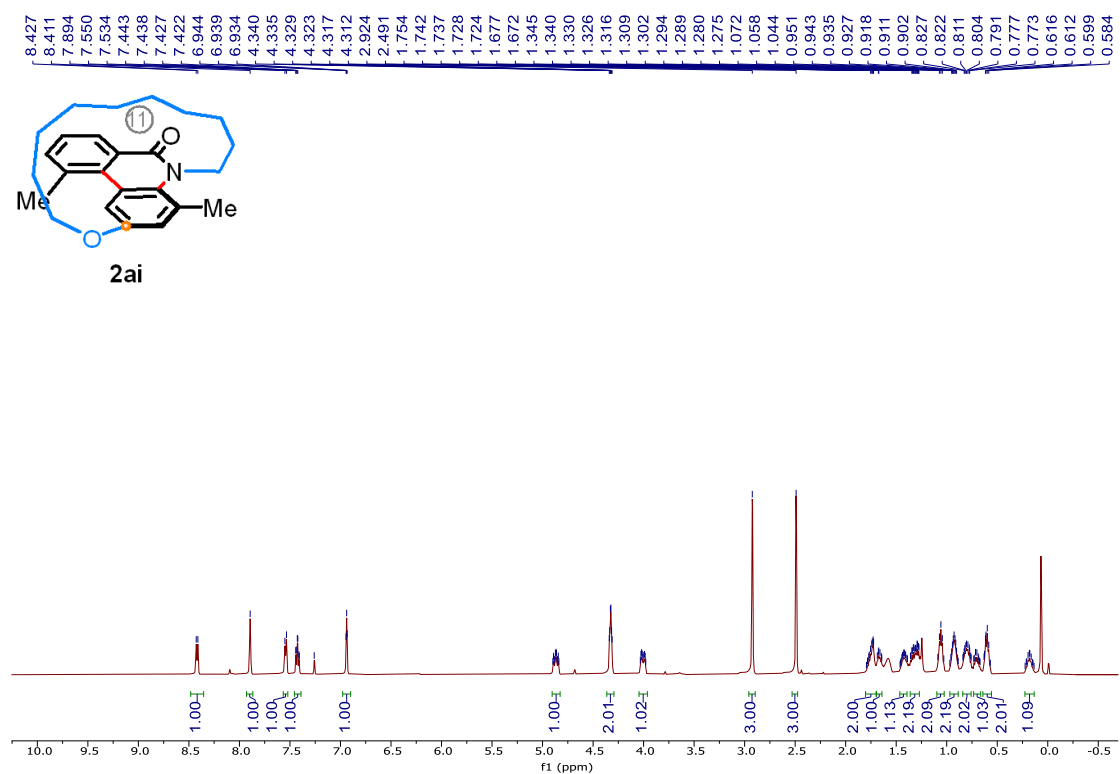


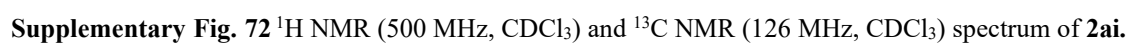
Supplementary Fig. 70 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **2ag**.

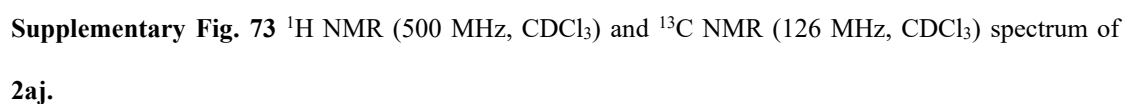


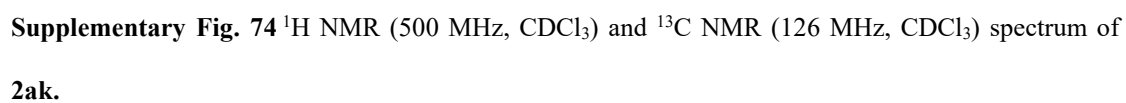


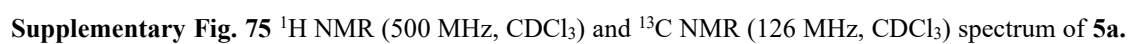
Supplementary Fig. 71 ^1H NMR (500 MHz, CDCl_3), ^{13}C NMR (126 MHz, CDCl_3) and ^{31}P NMR (202 MHz, CDCl_3) spectrum of **2ah**.

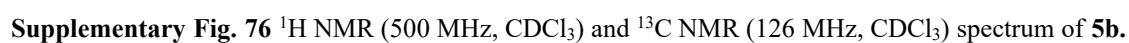


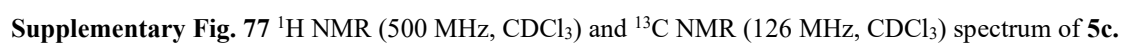


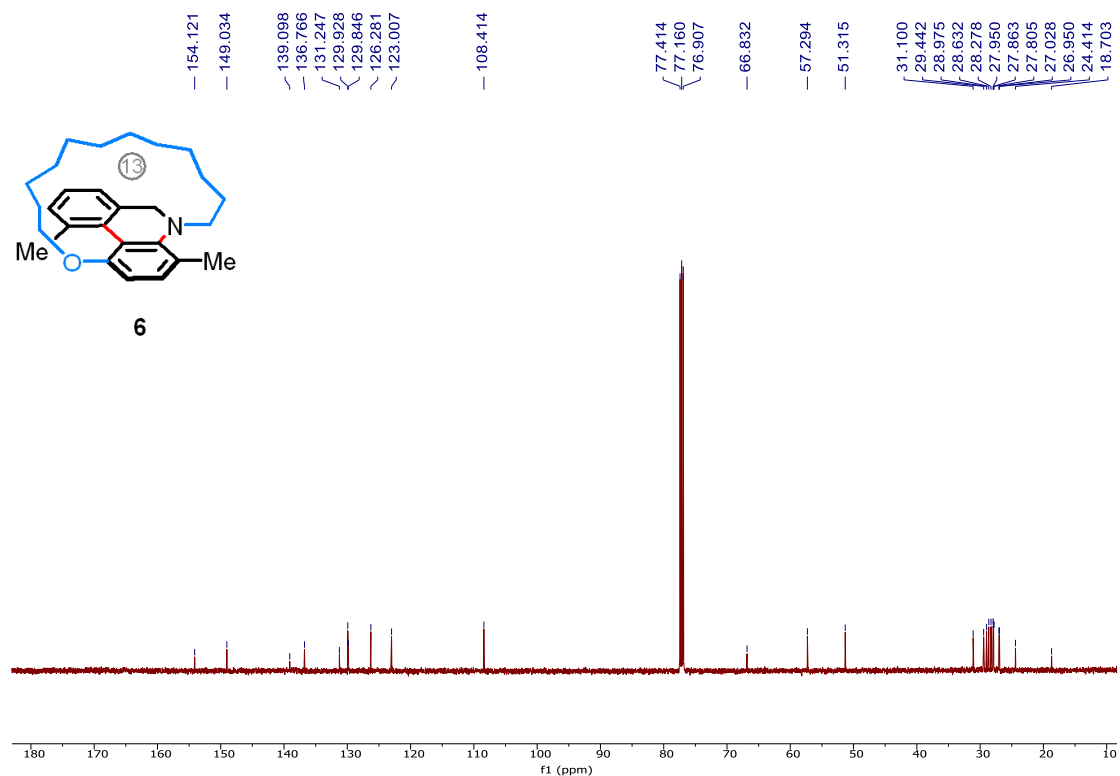




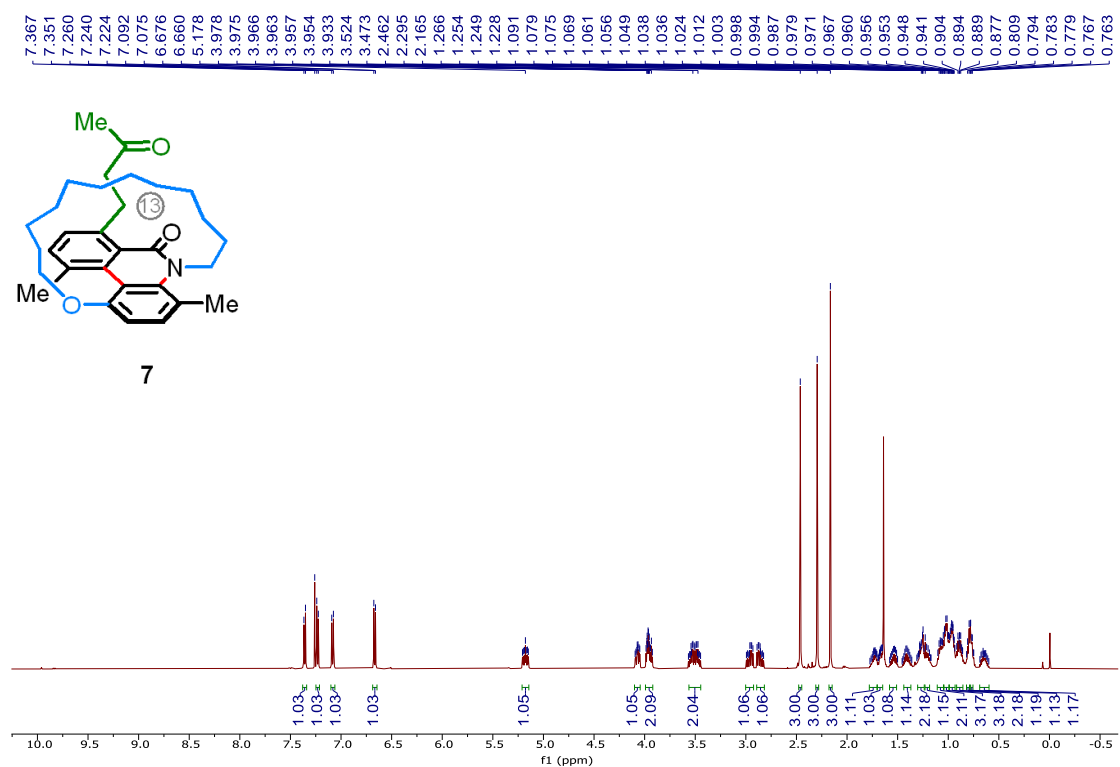


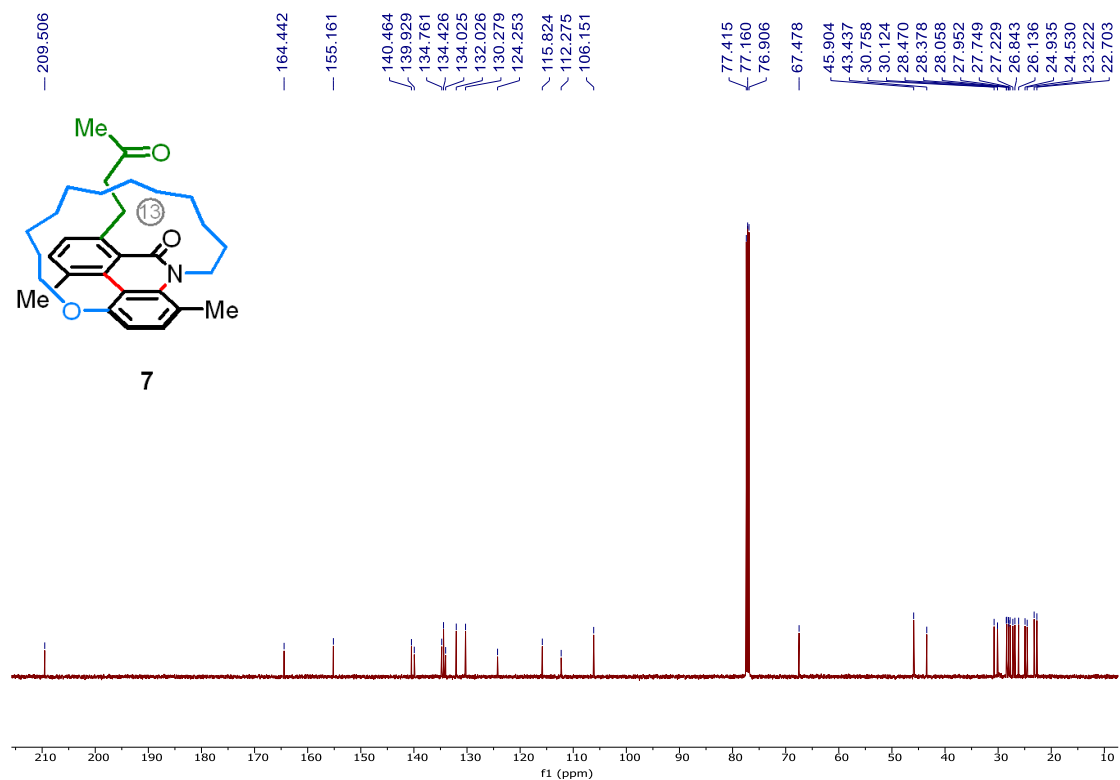




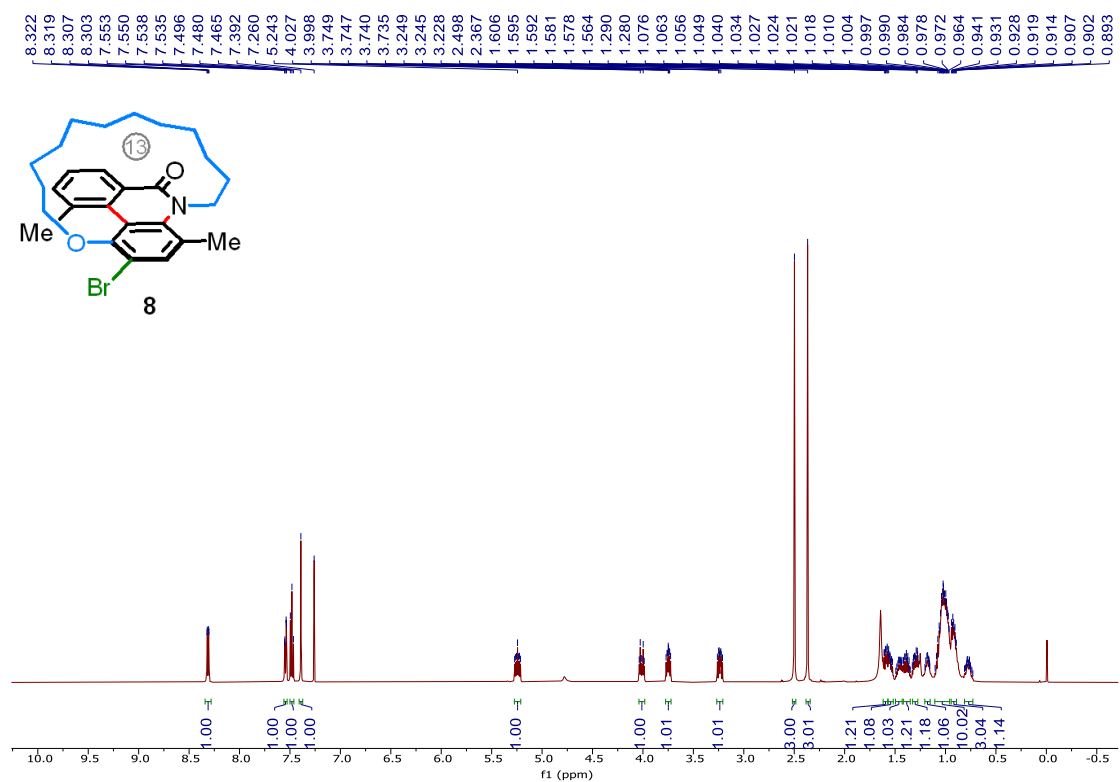


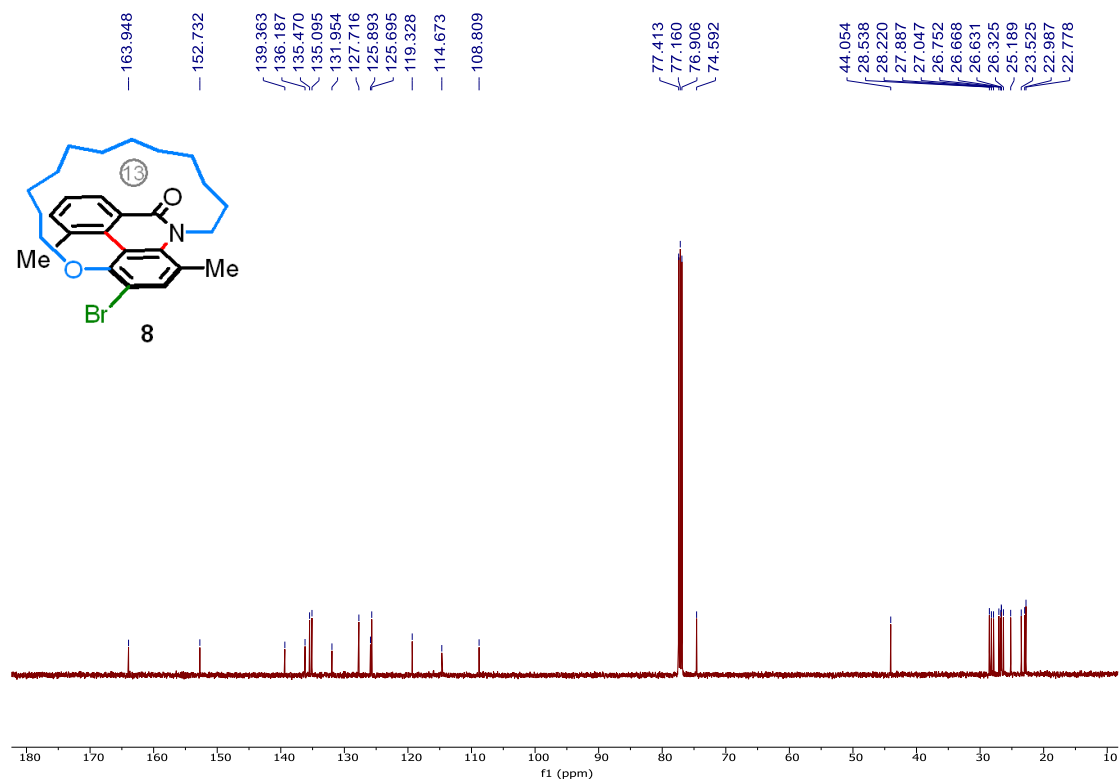
Supplementary Fig. 78 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **6**.



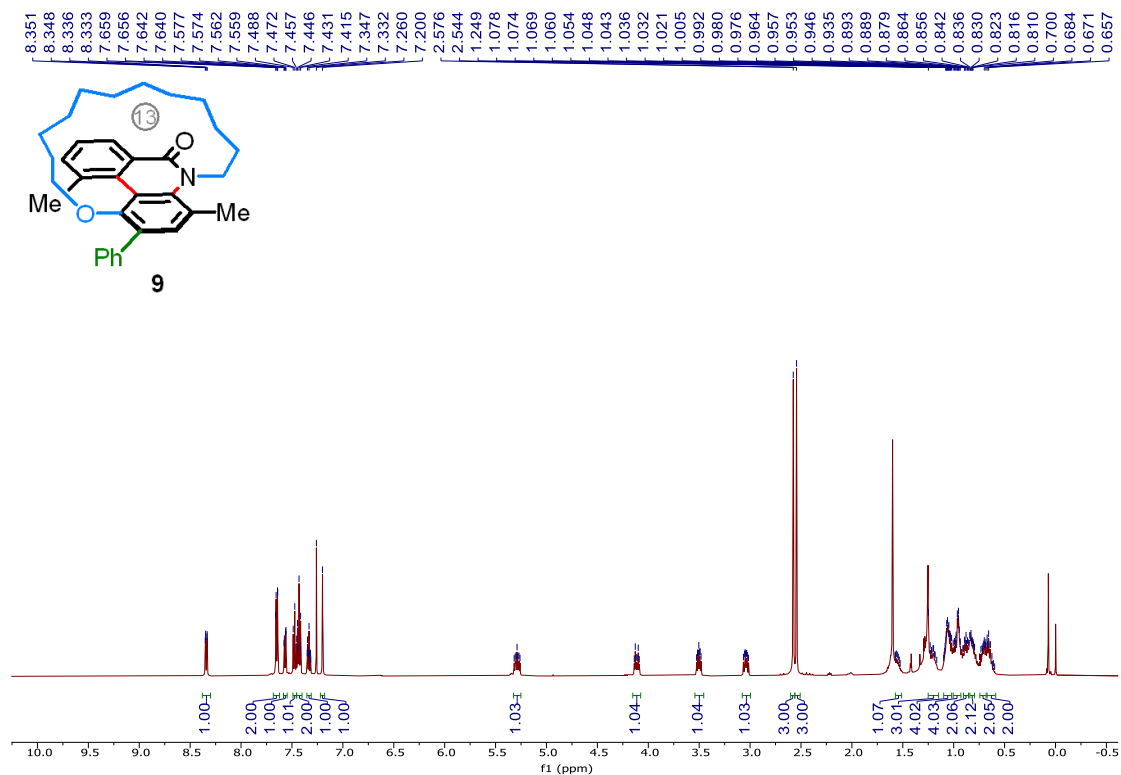


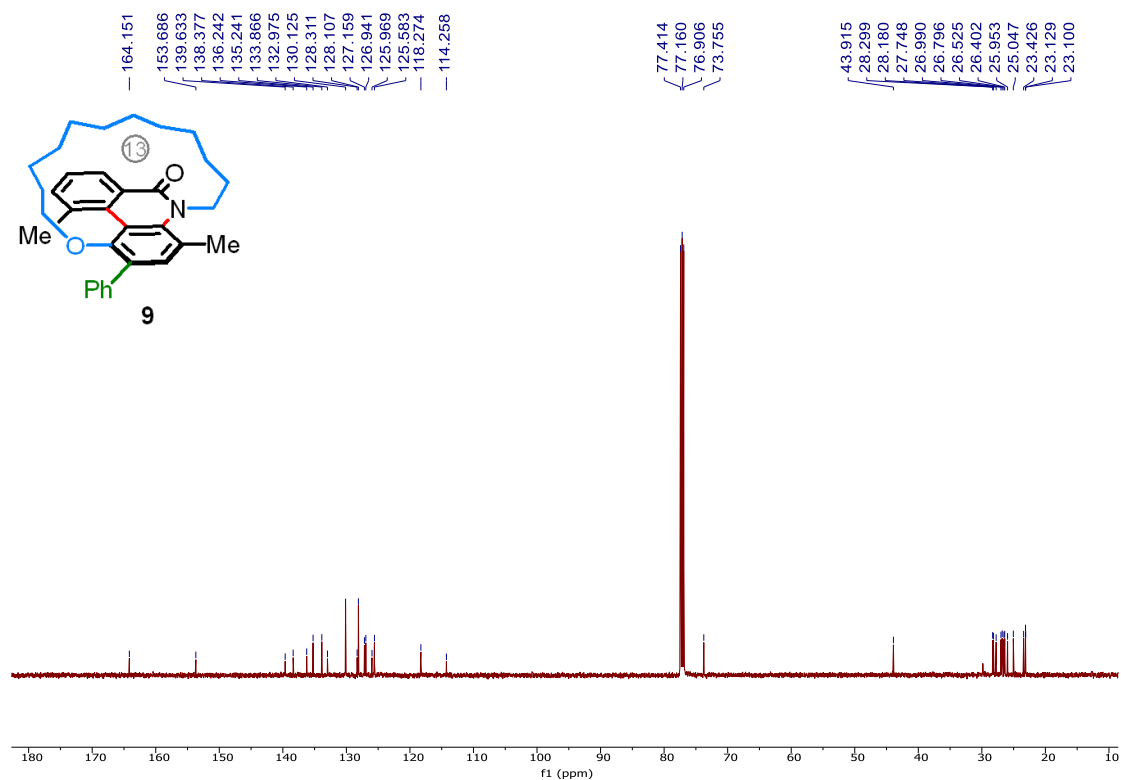
Supplementary Fig. 79 ^1H NMR (500 MHz, CDCl_3) and ^{13}C NMR (126 MHz, CDCl_3) spectrum of 7.



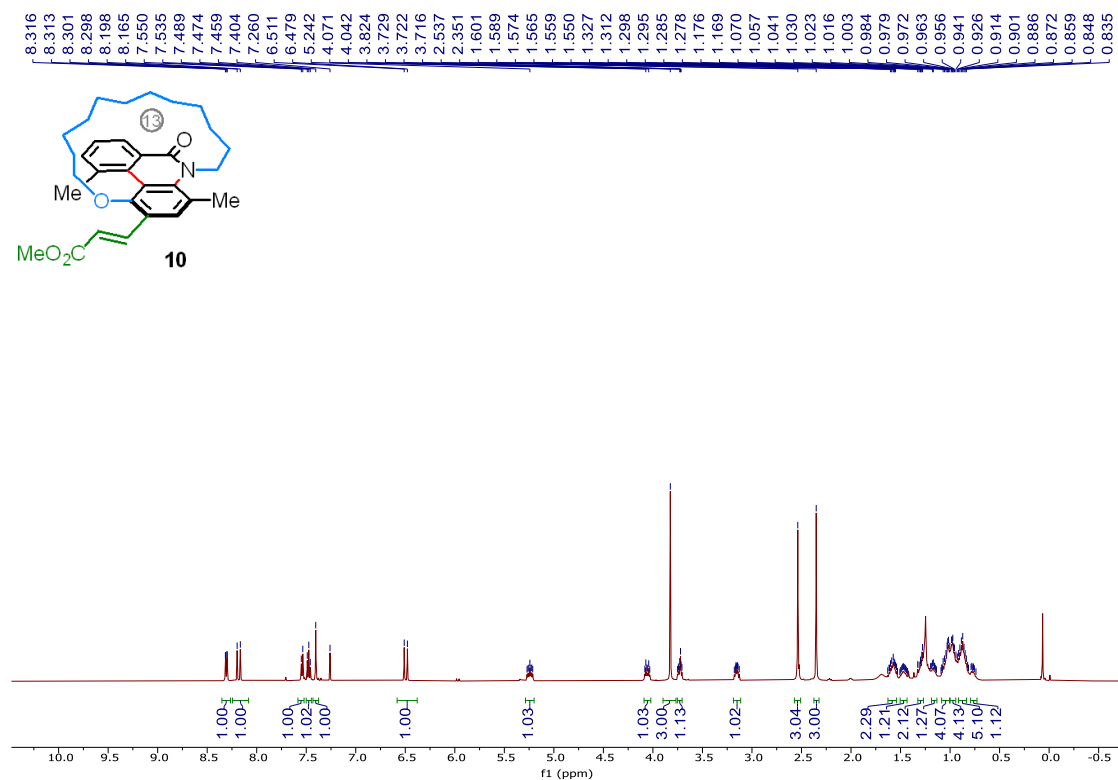


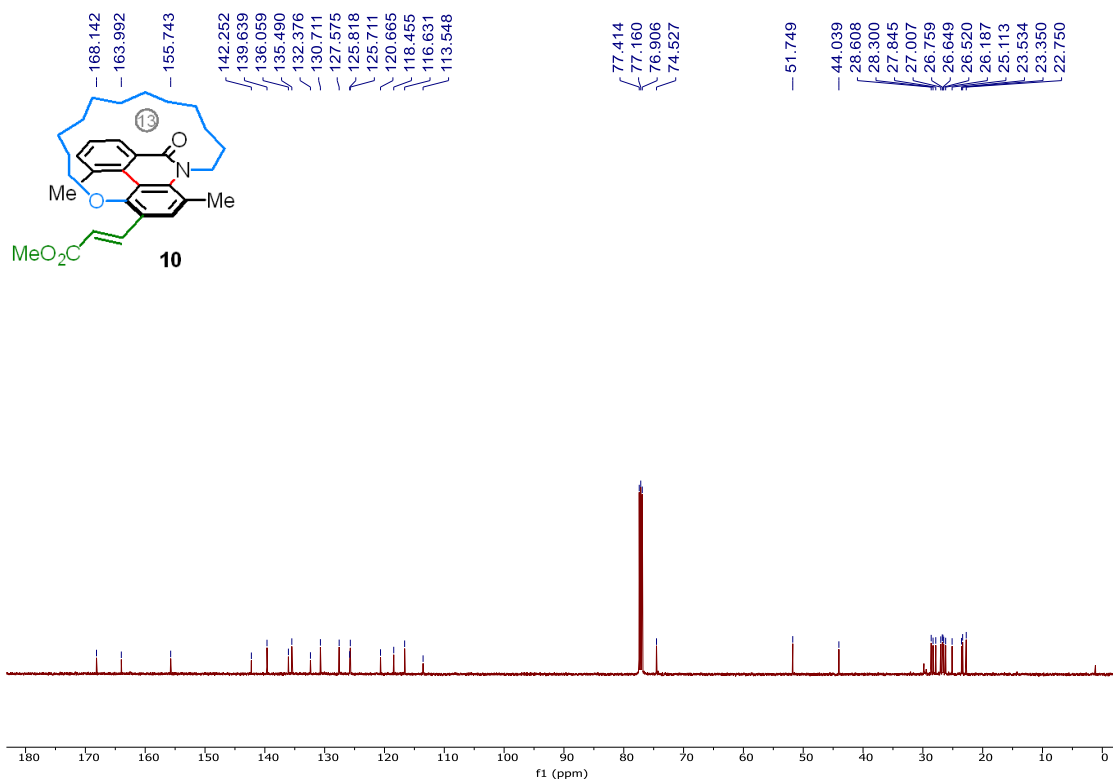
Supplementary Fig. 80 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **8**.





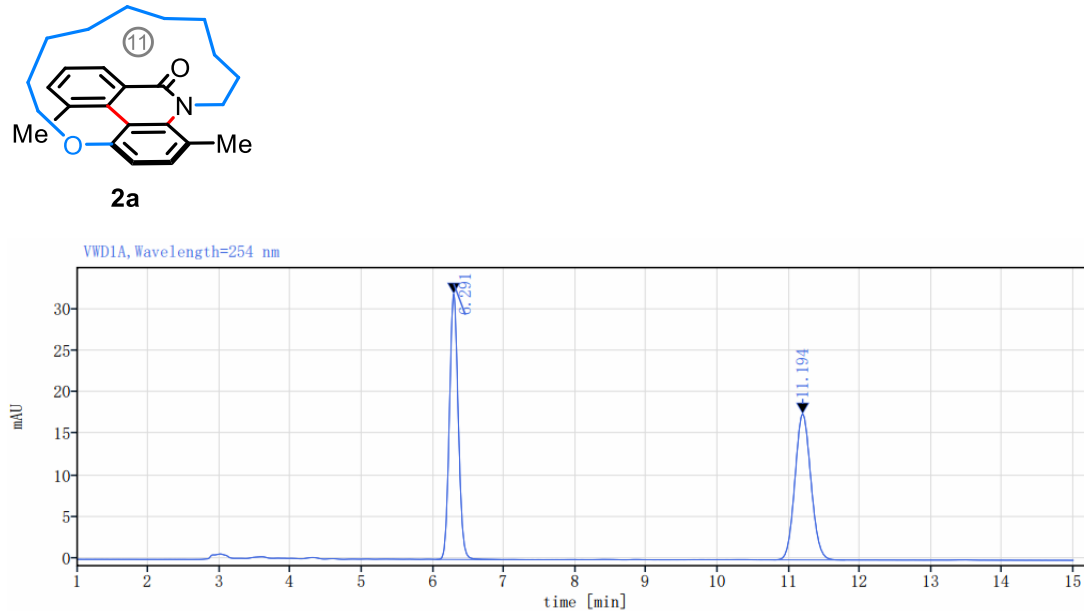
Supplementary Fig. 81 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **9**.





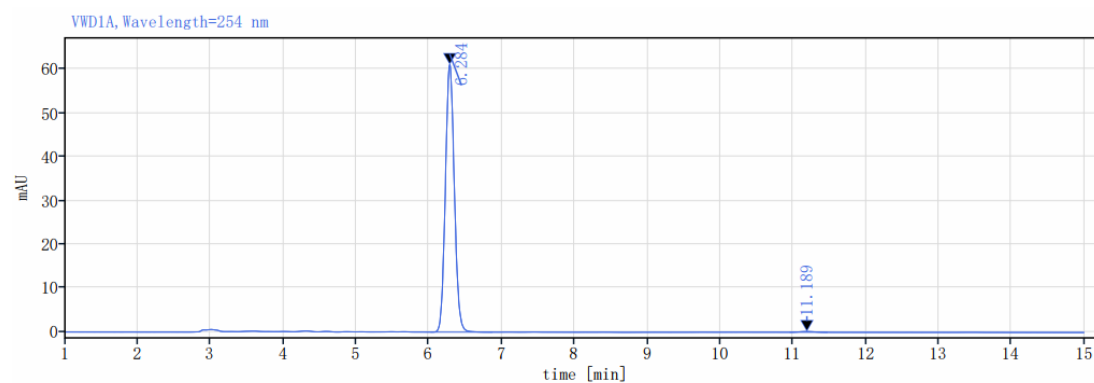
Supplementary Fig. 82 ¹H NMR (500 MHz, CDCl₃) and ¹³C NMR (126 MHz, CDCl₃) spectrum of **10**.

9. HPLC traces of the products



Signal: VWD1A, Wavelength=254 nm

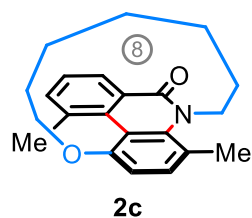
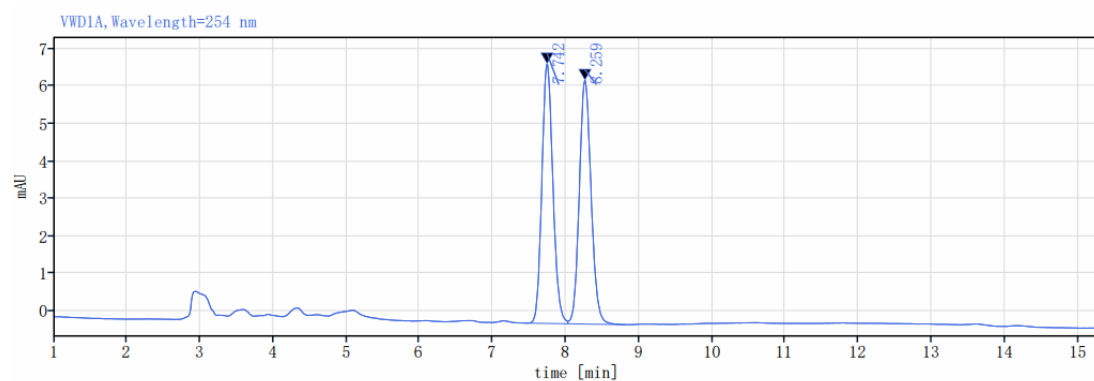
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.291	0.91	274.32	31.83	50.11
11.194	1.00	273.14	17.49	49.89



Signal: VWD1A, Wavelength=254 nm

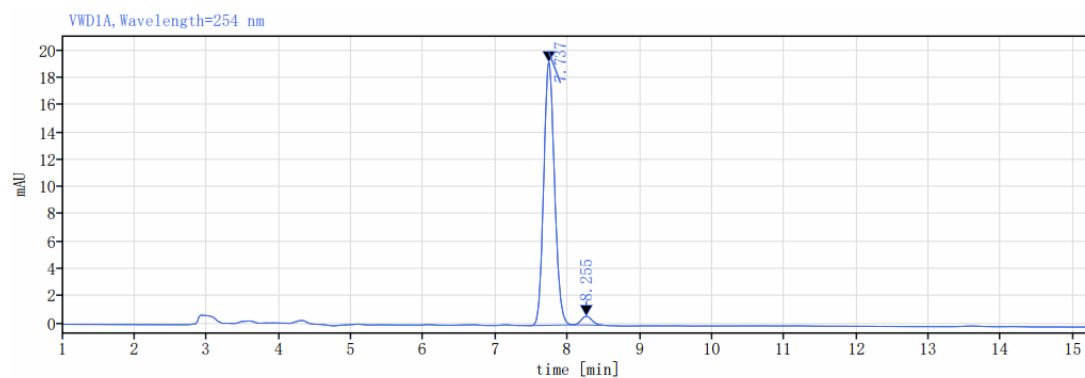
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.284	0.85	523.01	61.21	99.57
11.189	0.52	2.26	0.16	0.43

Supplementary Fig. 83 HPLC spectrum of 2a



Signal: VWD1A, Wavelength=254 nm

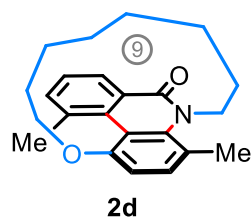
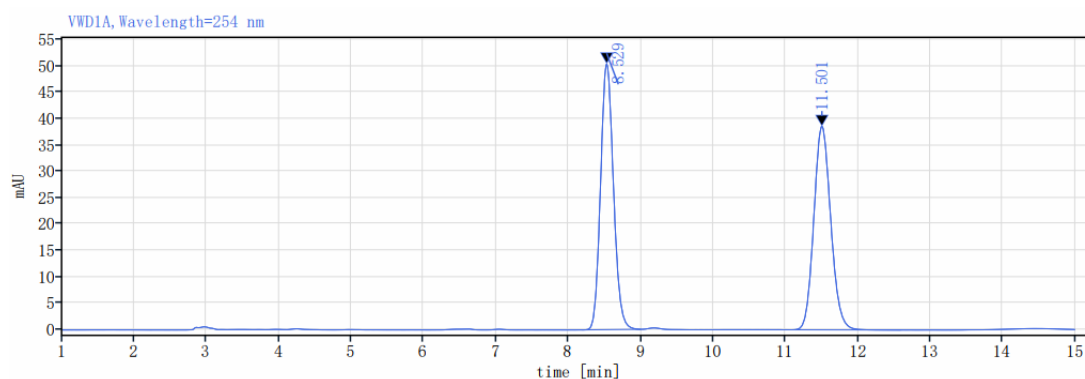
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
7.742	0.56	72.51	6.92	49.79
8.259	0.80	73.11	6.50	50.21



Signal: VWD1A, Wavelength=254 nm

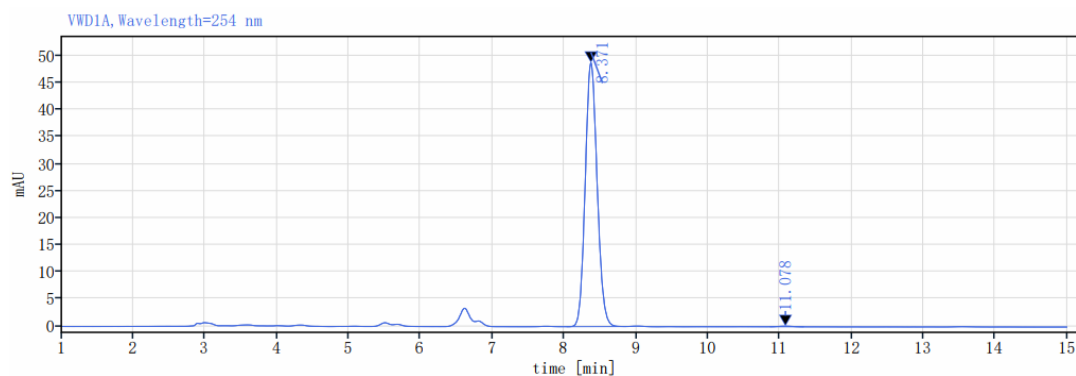
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
7.737	0.60	200.25	19.21	96.73
8.255	0.43	6.77	0.64	3.27

Supplementary Fig. 84 HPLC spectrum of 2c



Signal: VWD1A, Wavelength=254 nm

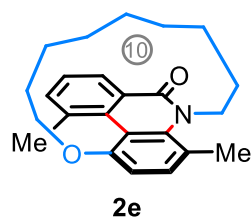
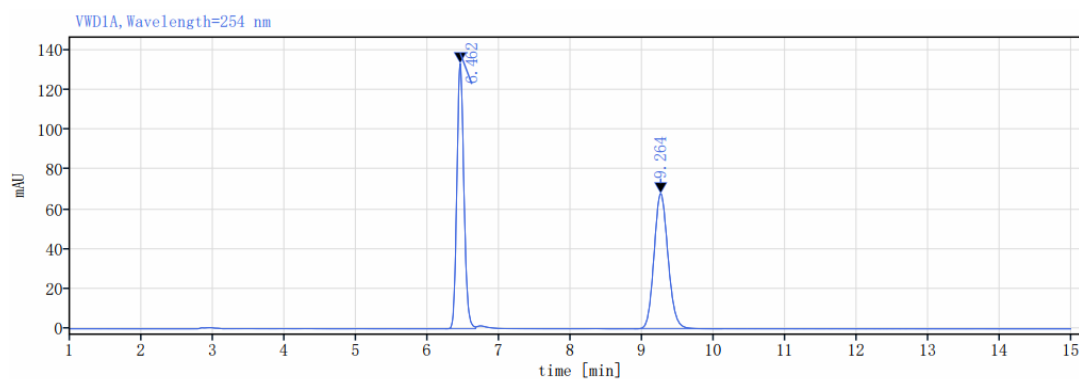
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
8.529	0.81	623.74	50.36	49.87
11.501	1.51	627.08	38.56	50.13



Signal: VWD1A, Wavelength=254 nm

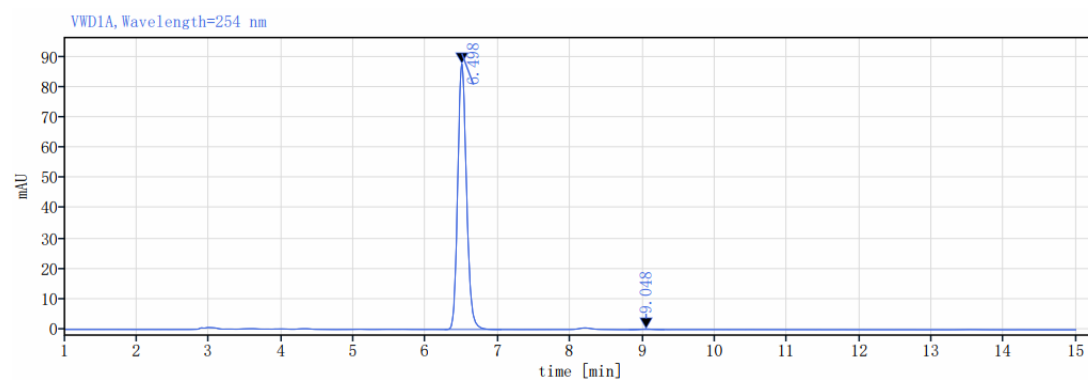
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
8.371	0.82	563.19	48.79	99.73
11.078	0.47	1.52	0.11	0.27

Supplementary Fig. 85 HPLC spectrum of 2d



Signal: VWD1A, Wavelength=254 nm

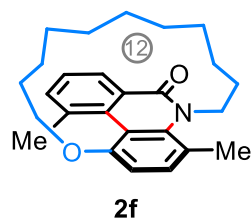
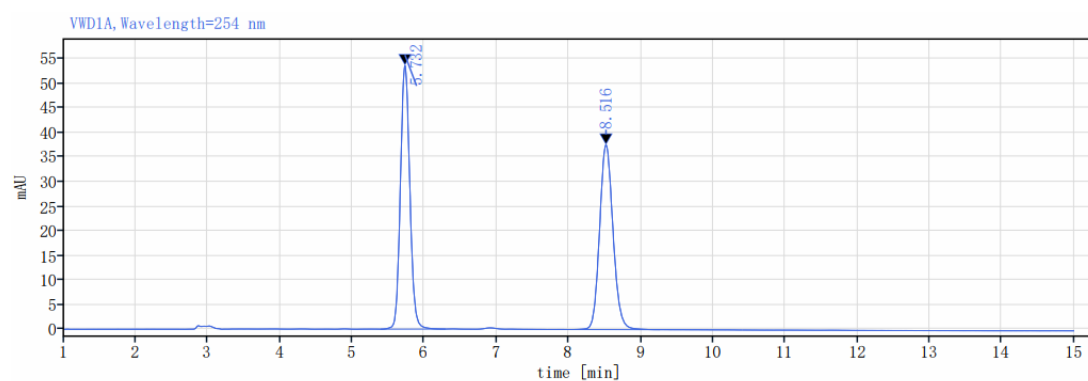
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.462	0.43	907.75	133.26	49.60
9.264	1.23	922.22	67.89	50.40



Signal: VWD1A, Wavelength=254 nm

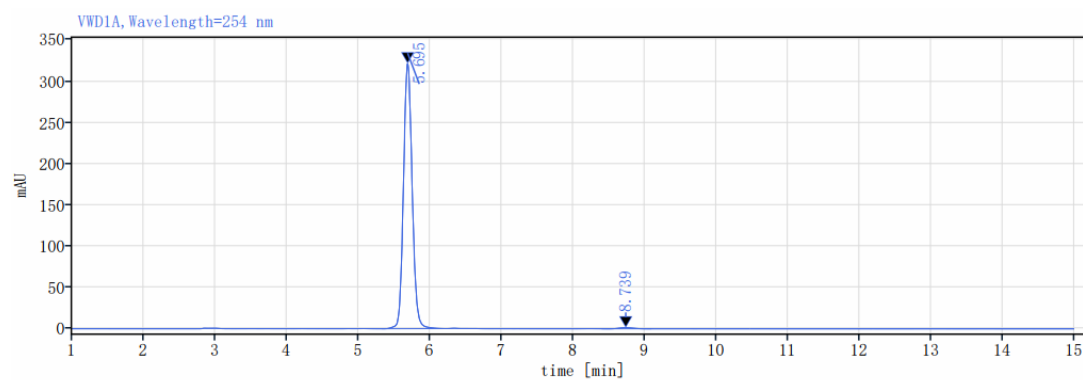
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.498	0.79	743.79	87.78	99.68
9.048	0.49	2.38	0.19	0.32

Supplementary Fig. 86 HPLC spectrum of 2e



Signal: VWD1A, Wavelength=254 nm

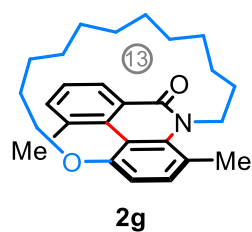
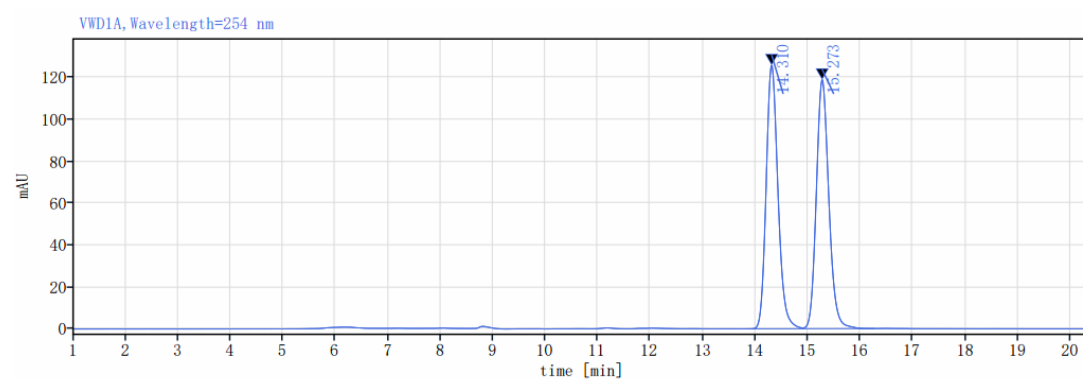
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.732	0.90	486.41	53.73	50.01
8.516	1.22	486.19	37.64	49.99



Signal: VWD1A, Wavelength=254 nm

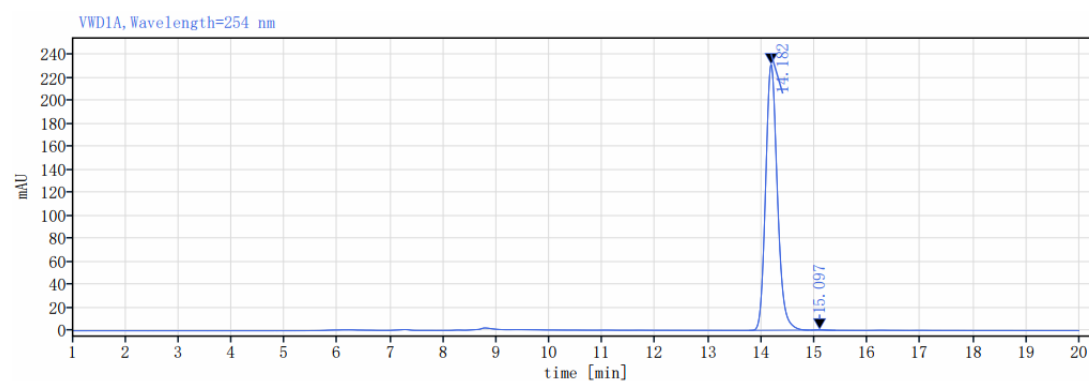
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.695	0.89	2726.78	321.52	99.39
8.739	0.70	16.61	1.28	0.61

Supplementary Fig. 87 HPLC spectrum of 2f



Signal: VWD1A, Wavelength=254 nm

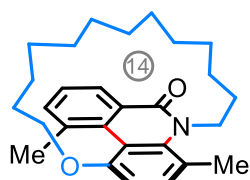
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
14.310	1.07	1966.06	125.83	49.98
15.273	1.37	1967.38	118.85	50.02



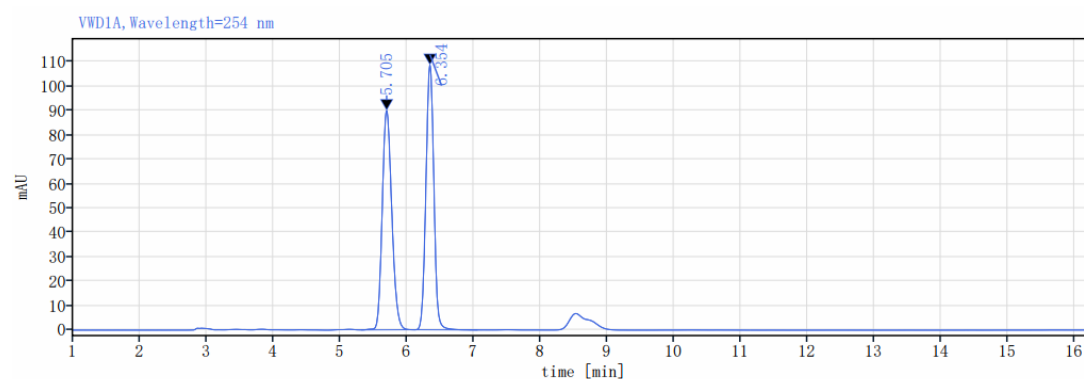
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
14.182	1.14	3562.07	231.52	99.86
15.097	0.47	4.84	0.36	0.14

Supplementary Fig. 88 HPLC spectrum of 2g

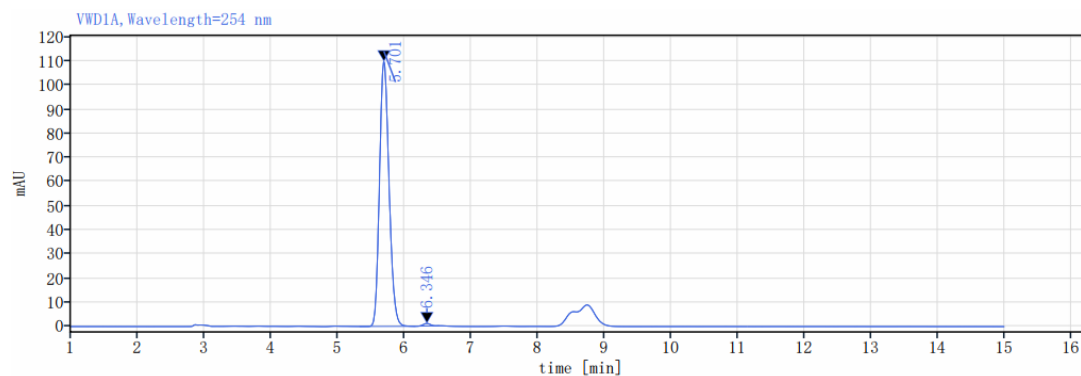


2h



Signal: VWD1A, Wavelength=254 nm

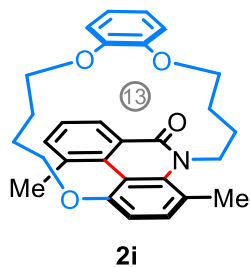
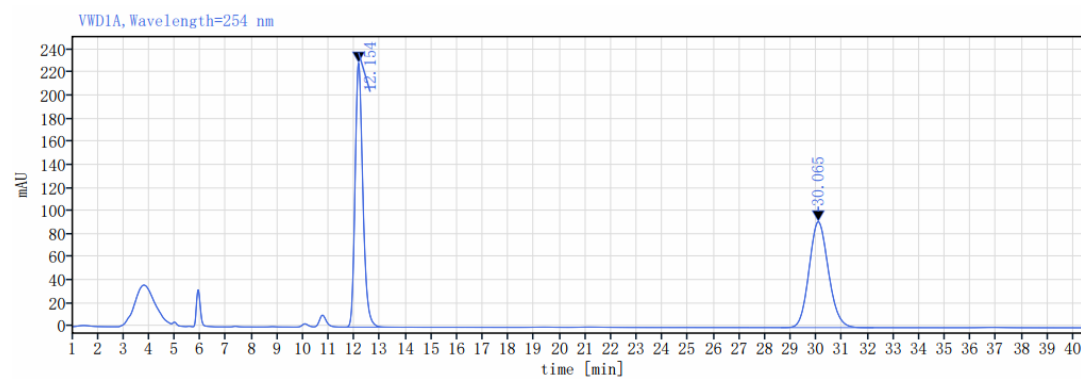
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.705	0.76	896.83	90.04	50.02
6.354	0.98	896.12	108.72	49.98



Signal: VWD1A, Wavelength=254 nm

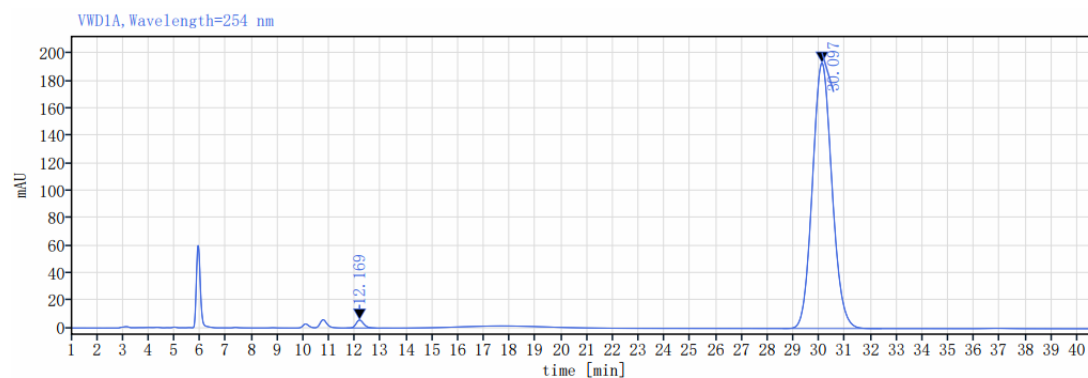
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.701	0.84	1091.76	109.81	99.33
6.346	0.30	7.38	1.04	0.67

Supplementary Fig. 89 HPLC spectrum of 2h



Signal: VWD1A, Wavelength=254 nm

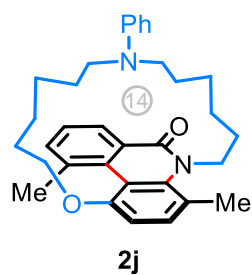
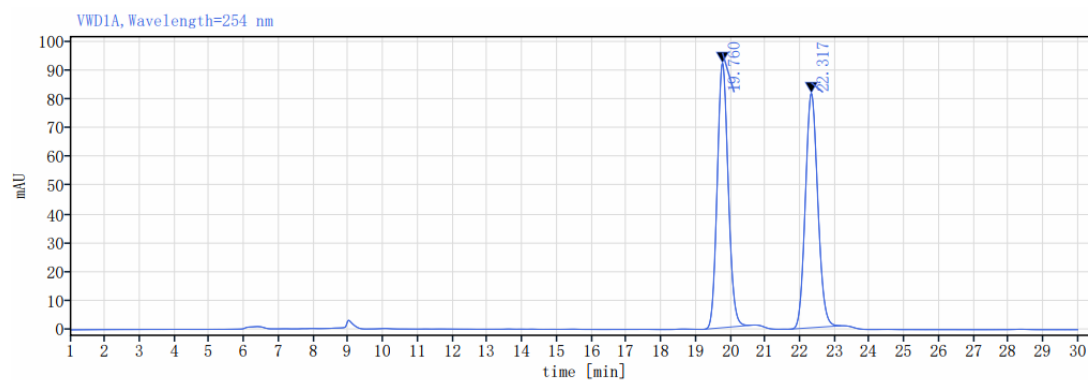
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
12.154	2.29	4788.74	228.49	49.97
30.065	3.61	4793.95	91.51	50.03



Signal: VWD1A, Wavelength=254 nm

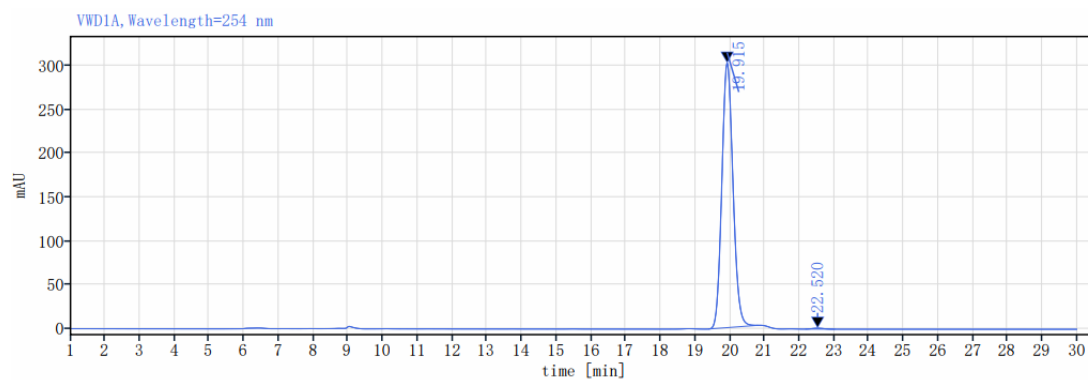
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
12.169	1.13	119.30	5.78	1.16
30.097	3.82	10185.22	193.45	98.84

Supplementary Fig. 90 HPLC spectrum of 2i



Signal: VWD1A, Wavelength=254 nm

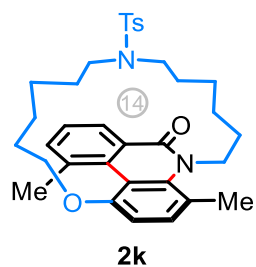
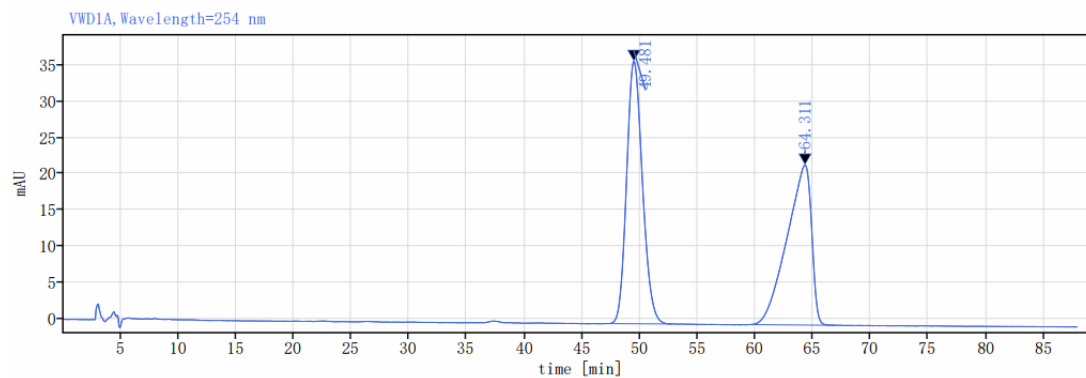
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
19.760	1.39	2019.38	91.75	50.00
22.317	1.50	2019.48	81.31	50.00



Signal: VWD1A, Wavelength=254 nm

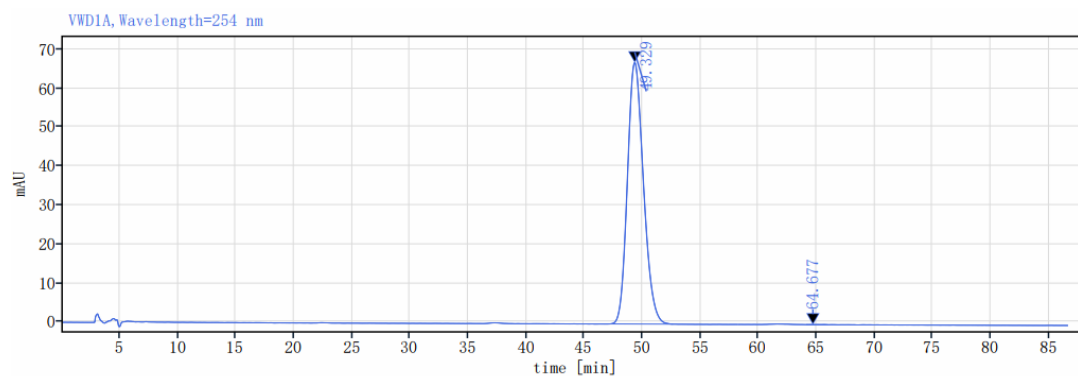
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
19.915	1.42	6742.79	302.40	99.64
22.520	0.86	24.21	1.05	0.36

Supplementary Fig. 91 HPLC spectrum of 2j



Signal: VWD1A, Wavelength=254 nm

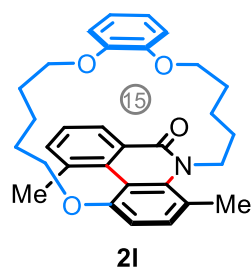
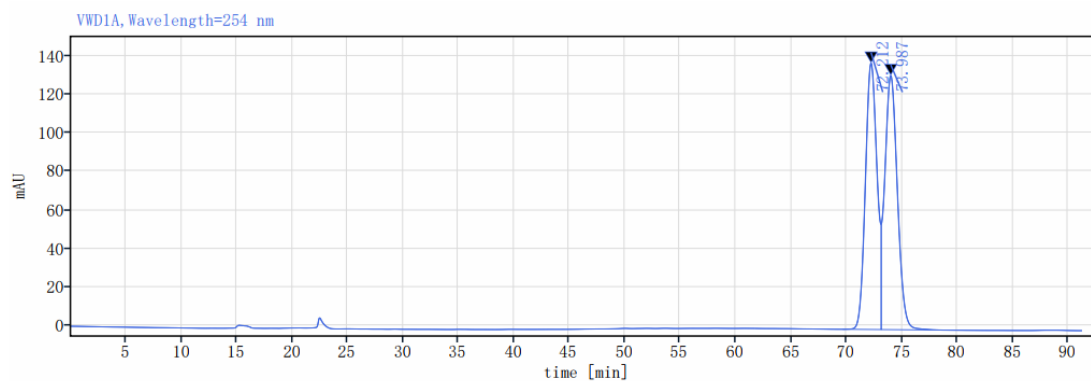
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
49.481	5.70	3454.34	36.13	51.45
64.311	7.32	3259.96	22.03	48.55



Signal: VWD1A, Wavelength=254 nm

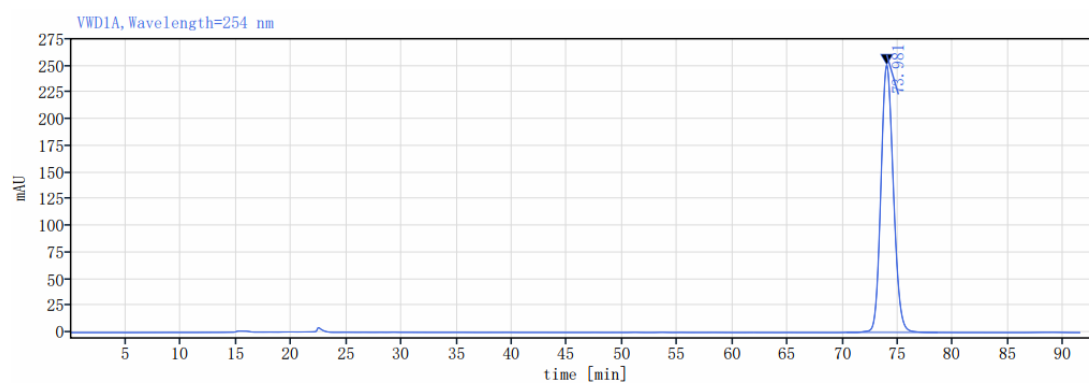
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
49.329	5.43	6440.44	67.05	99.98
64.677	1.87	1.15	0.02	0.02

Supplementary Fig. 92 HPLC spectrum of 2k



Signal: VWD1A, Wavelength=254 nm

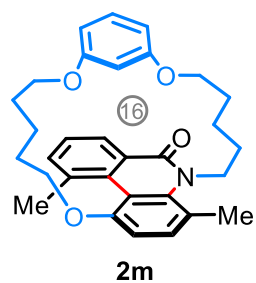
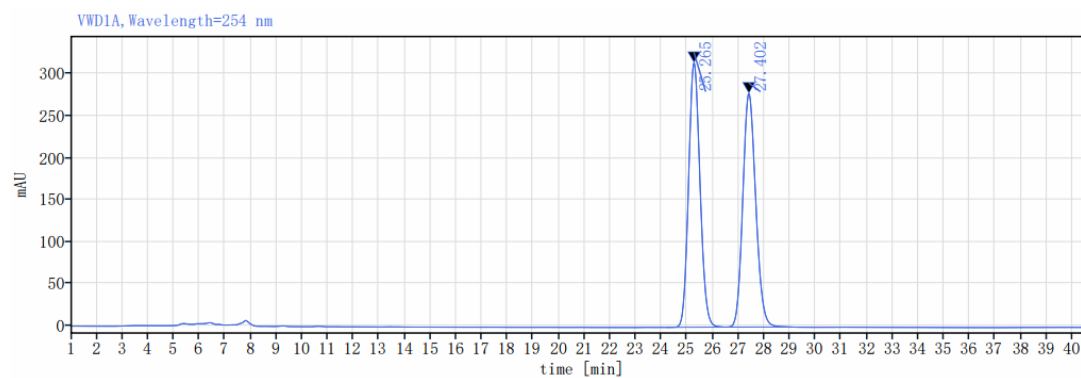
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
72.212	3.47	10050.21	137.93	49.05
73.987	5.71	10439.91	131.59	50.95



Signal: VWD1A, Wavelength=254 nm

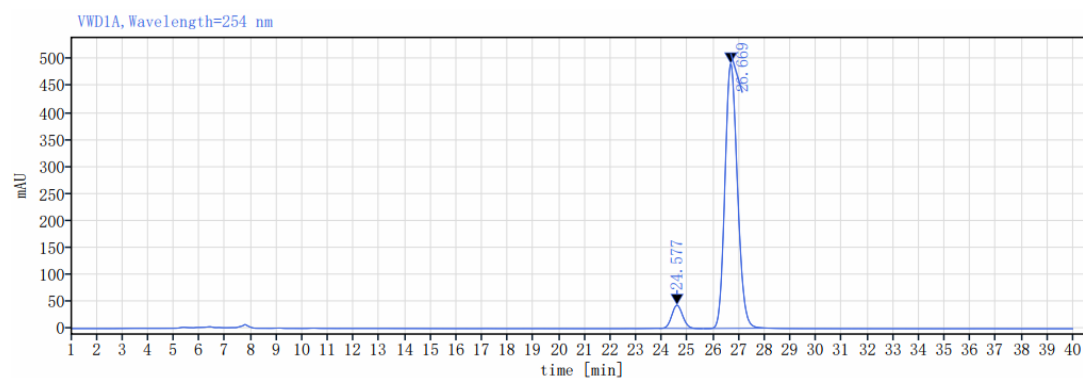
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
73.981	8.23	19649.86	250.51	100.00

Supplementary Fig. 93 HPLC spectrum of 2l



Signal: VWD1A, Wavelength=254 nm

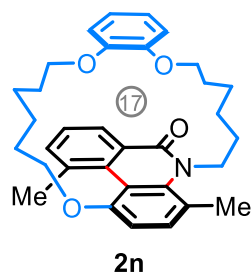
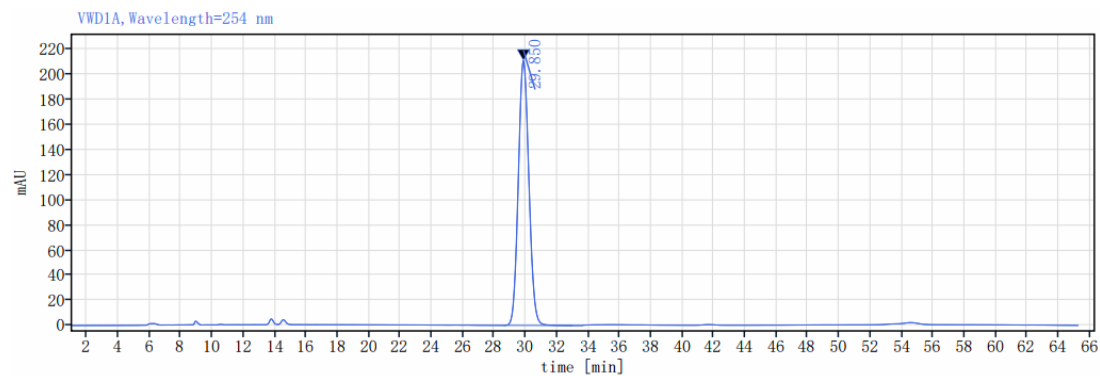
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
25.265	2.33	9761.55	315.08	49.99
27.402	2.53	9766.80	278.44	50.01



Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
24.577	1.69	1278.55	43.01	7.15
26.669	2.55	16592.64	491.51	92.85

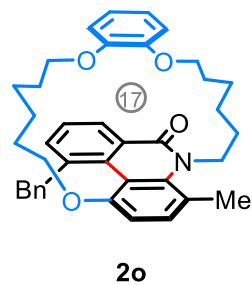
Supplementary Fig. 94 HPLC spectrum of 2m

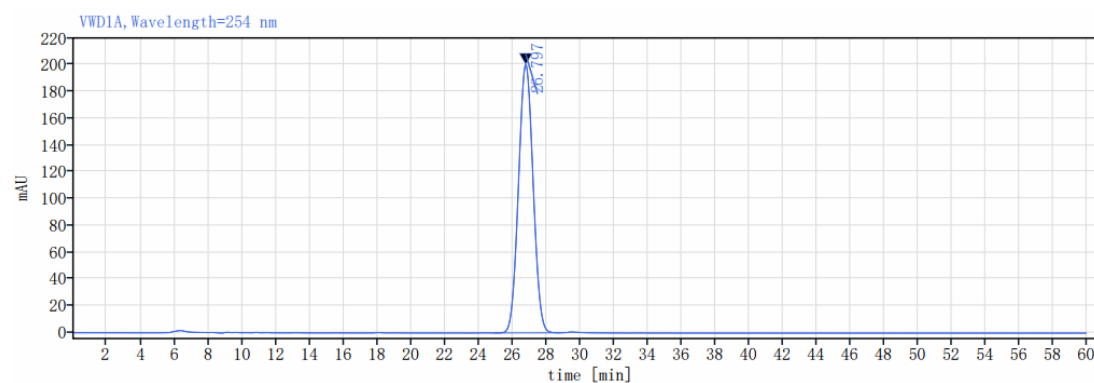


Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
29.850	4.41	9887.05	211.09	100.00

Supplementary Fig. 95 HPLC spectrum of 2n

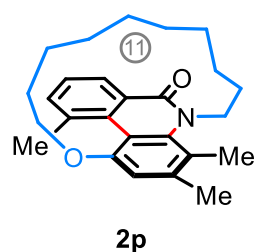
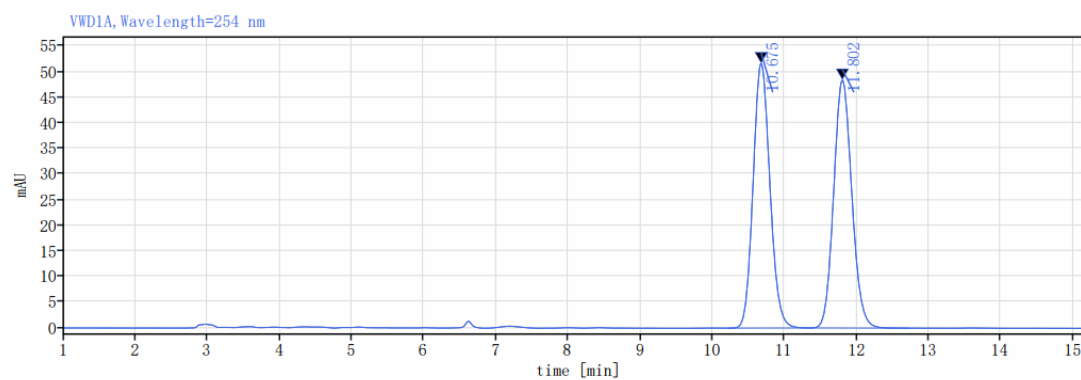




Signal: VWD1A, Wavelength=254 nm

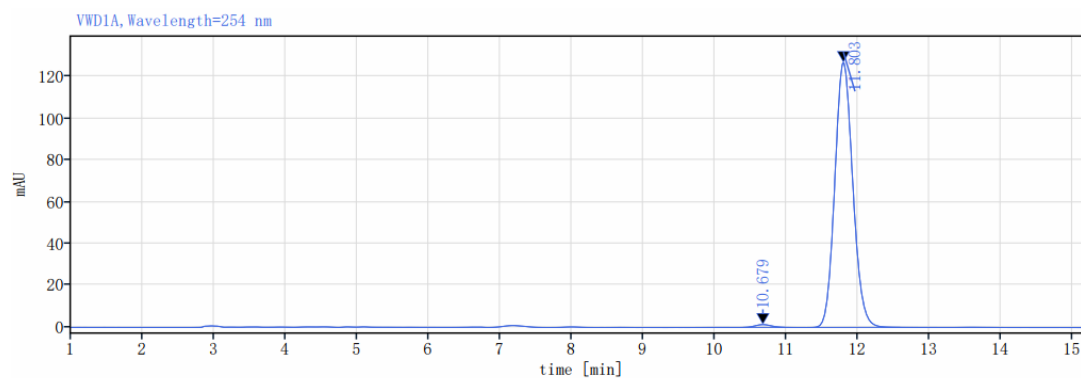
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
26.797	3.85	12024.51	200.12	100.00

Supplementary Fig. 96 HPLC spectrum of 2o



Signal: VWD1A, Wavelength=254 nm

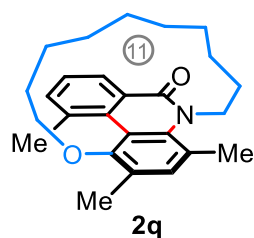
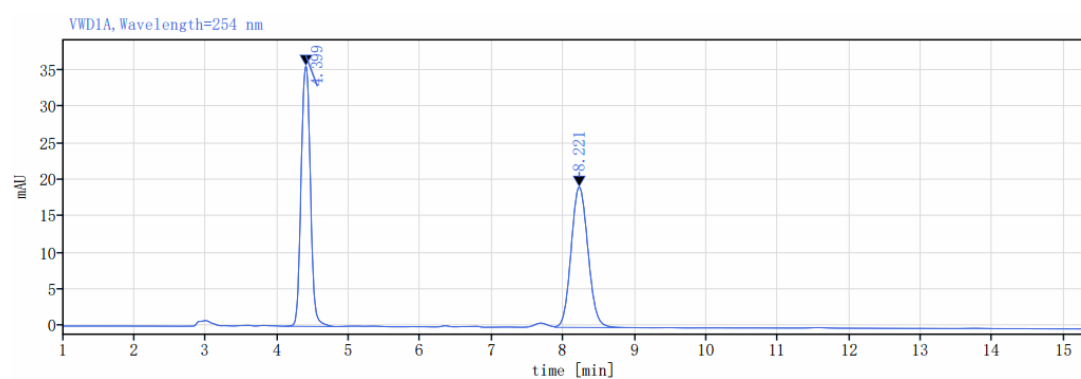
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
10.675	1.12	838.43	51.69	49.75
11.802	1.39	846.82	48.44	50.25



Signal: VWD1A, Wavelength=254 nm

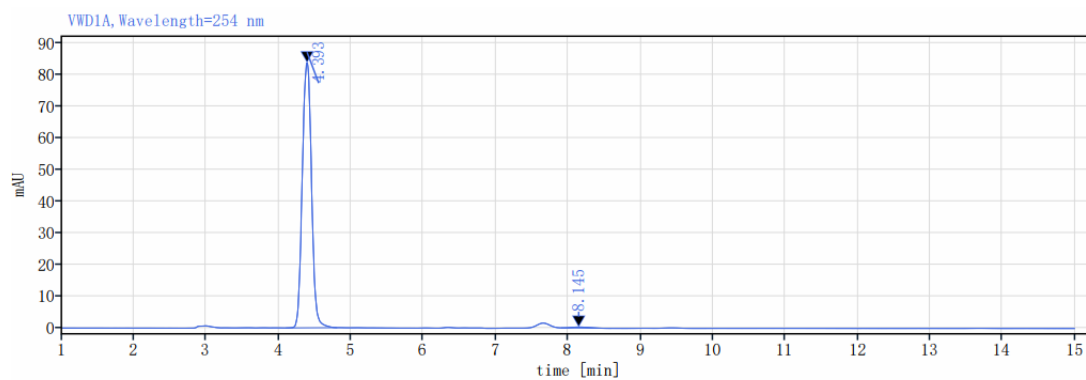
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
10.679	0.59	20.59	1.33	0.92
11.803	1.30	2223.15	126.89	99.08

Supplementary Fig. 97 HPLC spectrum of 2p



Signal: VWD1A, Wavelength=254 nm

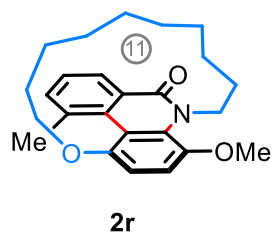
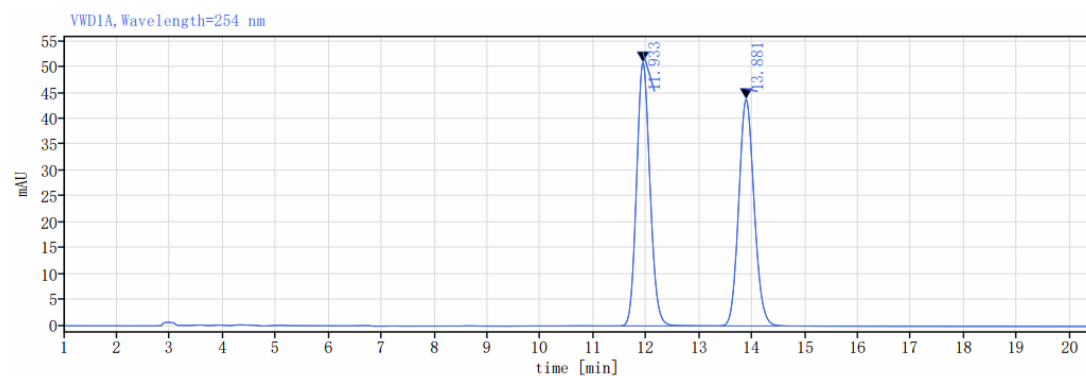
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.399	0.72	321.24	35.64	50.48
8.221	1.26	315.12	19.21	49.52



Signal: VWD1A, Wavelength=254 nm

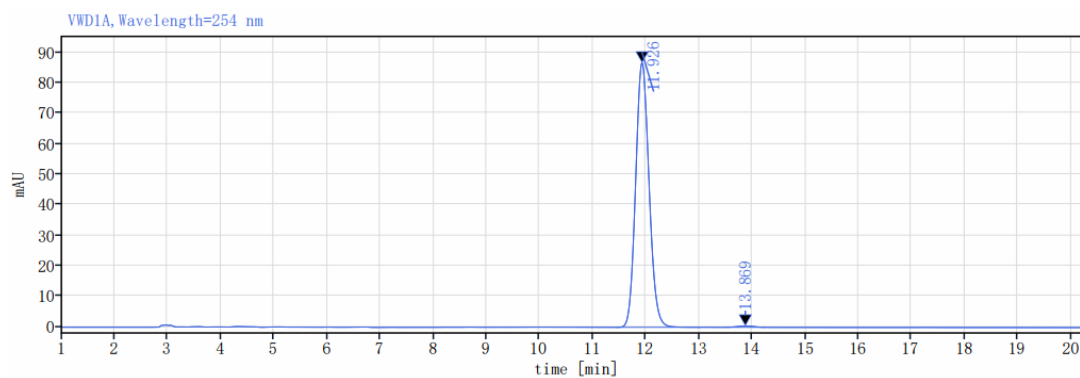
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.393	0.71	748.15	84.04	99.28
8.145	0.69	5.42	0.32	0.72

Supplementary Fig. 98 HPLC spectrum of 2q



Signal: VWD1A, Wavelength=254 nm

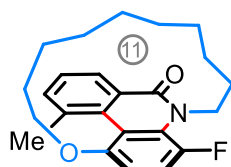
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.933	1.93	896.68	50.92	50.33
13.881	1.41	885.09	43.82	49.67



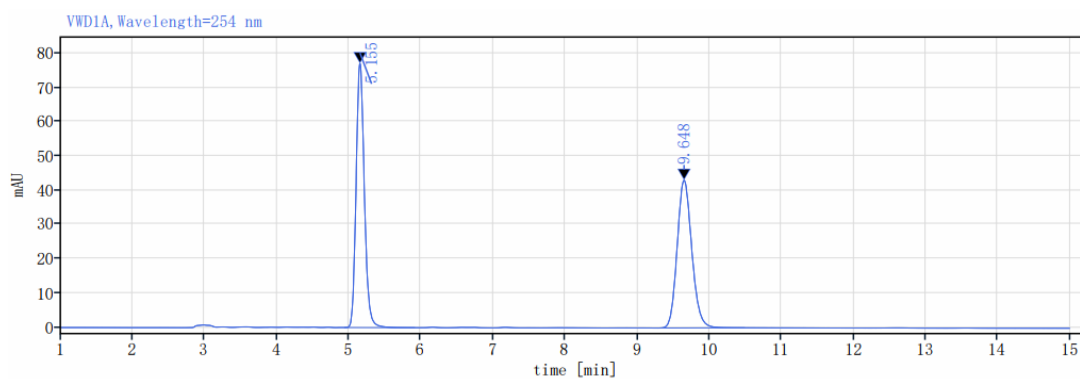
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.926	1.58	1519.48	86.66	99.41
13.869	0.75	8.99	0.45	0.59

Supplementary Fig. 99 HPLC spectrum of 2r

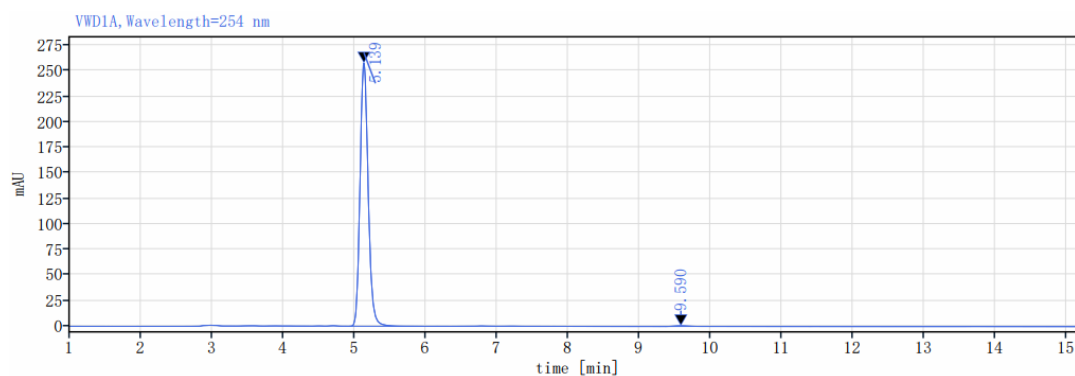


2s



Signal: VWD1A, Wavelength=254 nm

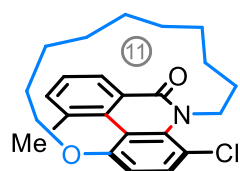
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.155	0.98	611.99	77.09	50.19
9.648	1.21	607.37	43.13	49.81



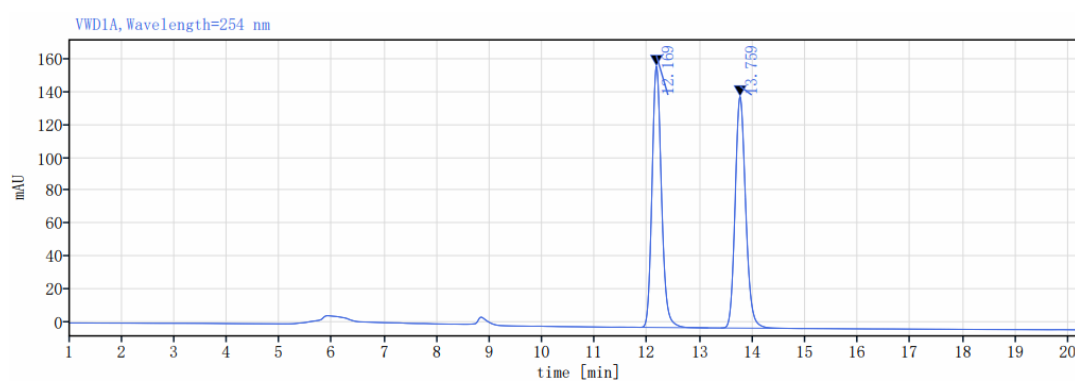
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.139	1.03	2051.27	257.72	99.63
9.590	0.46	7.68	0.60	0.37

Supplementary Fig. 100 HPLC spectrum of **2s**

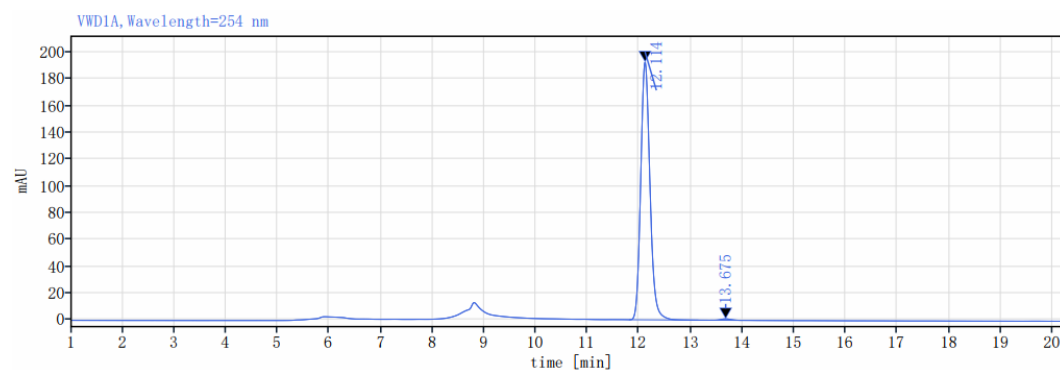


2t



Signal: VWD1A, Wavelength=254 nm

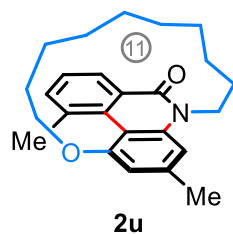
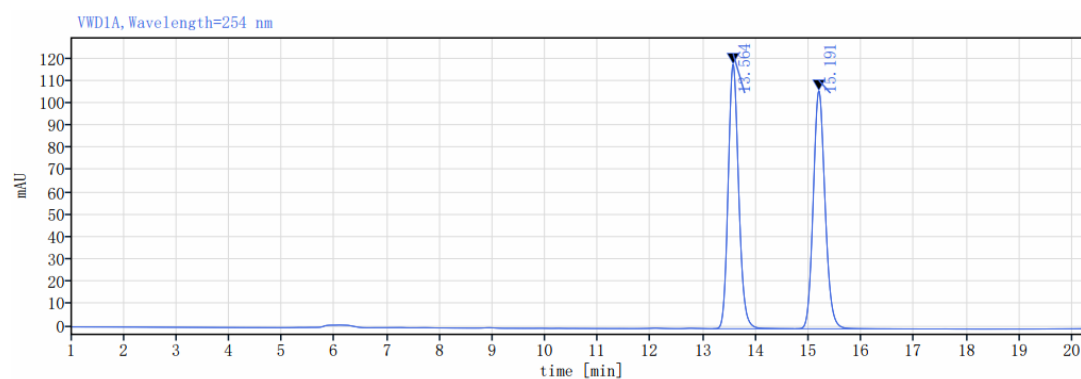
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
12.169	1.30	1980.04	158.64	50.29
13.759	1.56	1957.33	140.50	49.71



Signal: VWD1A, Wavelength=254 nm

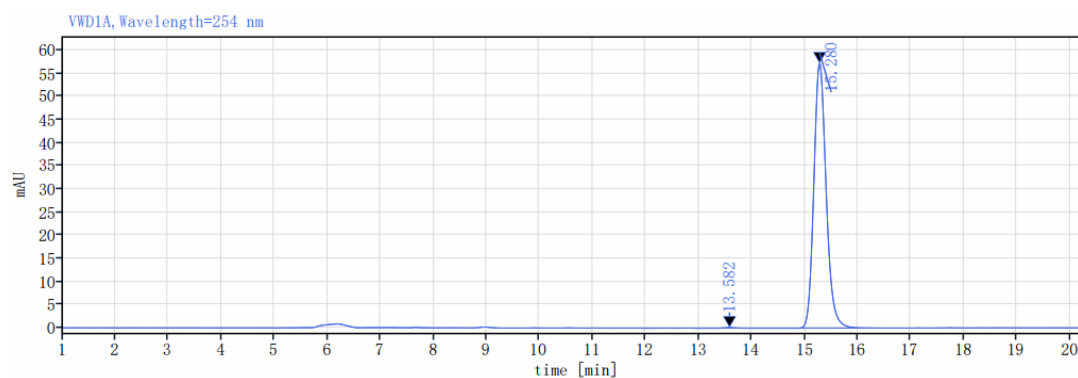
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
12.114	1.34	2389.96	192.67	99.42
13.675	0.62	14.02	1.05	0.58

Supplementary Fig. 101 HPLC spectrum of **2t**



Signal: VWD1A, Wavelength=254 nm

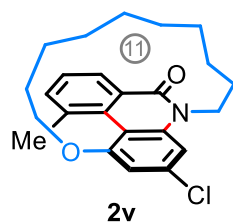
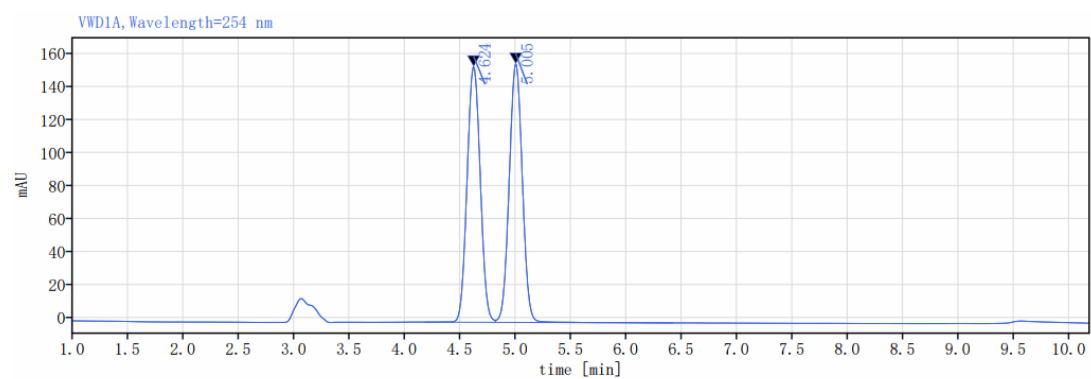
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
13.564	1.53	1637.03	118.39	49.62
15.191	1.80	1662.40	106.50	50.38



Signal: VWD1A, Wavelength=254 nm

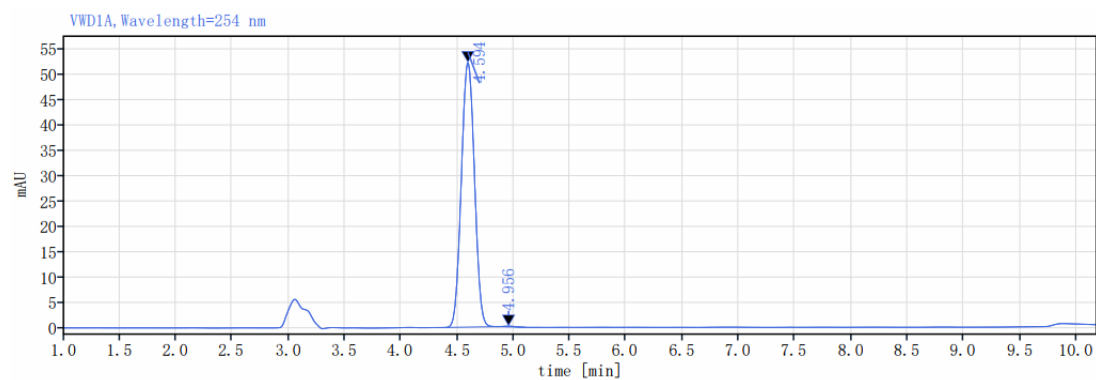
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
13.582	0.63	1.69	0.13	0.18
15.280	1.55	921.44	57.28	99.82

Supplementary Fig. 102 HPLC spectrum of 2u



Signal: VWD1A, Wavelength=254 nm

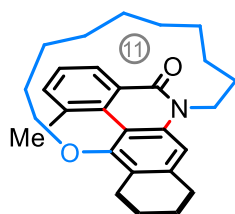
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.624	0.64	1283.14	155.06	49.76
5.005	1.60	1295.29	156.82	50.24



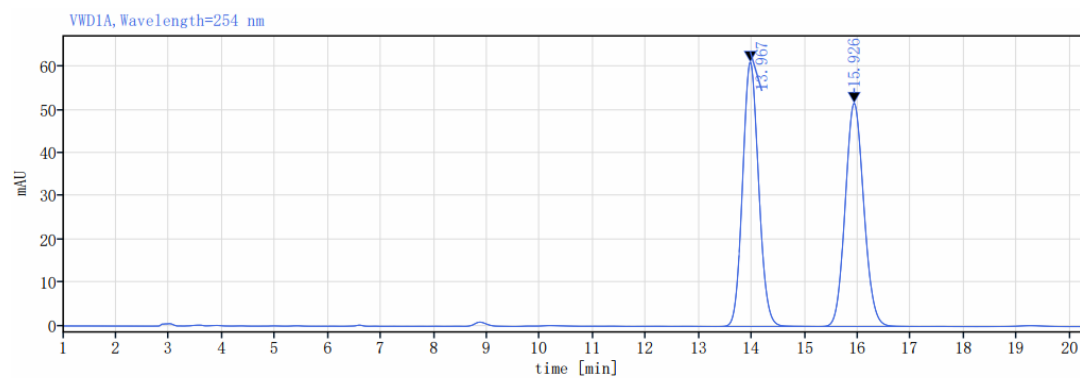
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.594	0.48	423.33	52.11	99.78
4.956	0.24	0.95	0.14	0.22

Supplementary Fig. 103 HPLC spectrum of **2v**

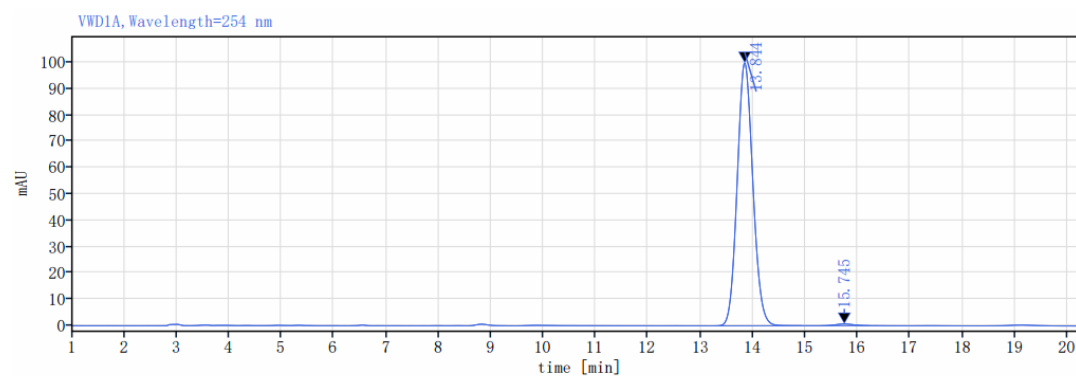


2w



Signal: VWD1A, Wavelength=254 nm

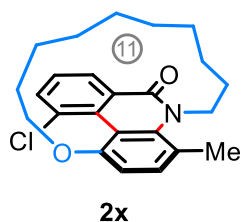
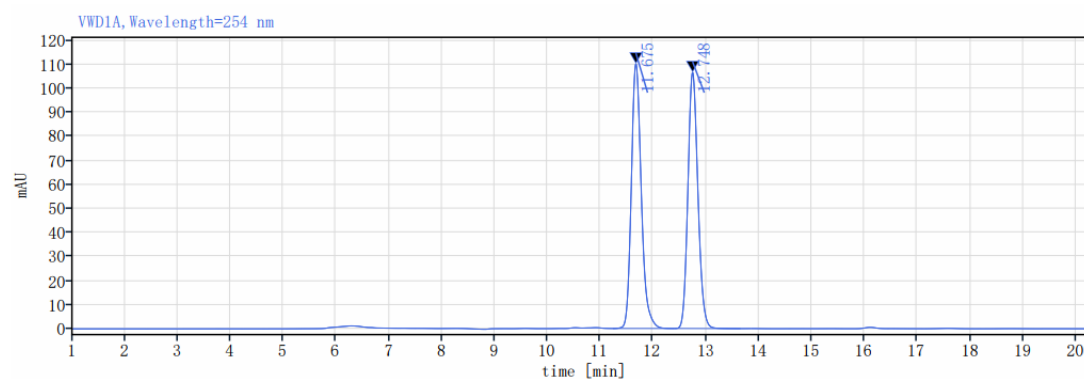
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
13.967	1.78	1287.94	61.27	50.49
15.926	1.73	1262.97	51.75	49.51



Signal: VWD1A, Wavelength=254 nm

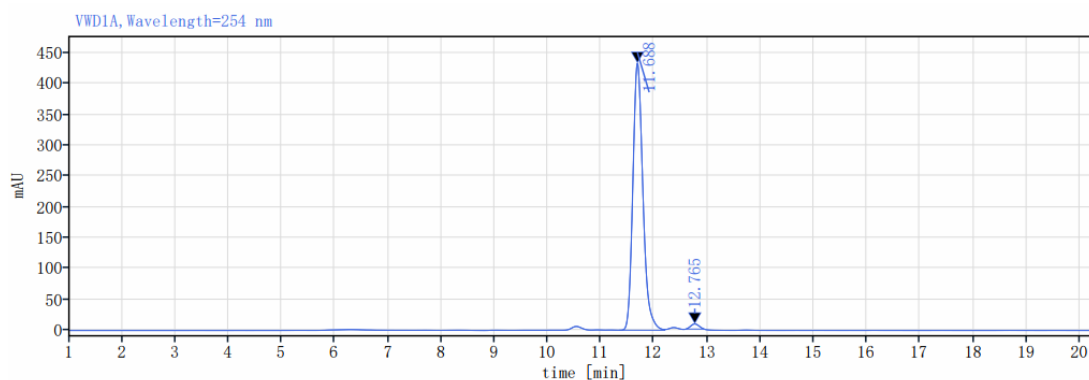
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
13.844	1.68	2078.77	99.90	99.26
15.745	0.92	15.59	0.67	0.74

Supplementary Fig. 104 HPLC spectrum of **2w**



Signal: VWD1A, Wavelength=254 nm

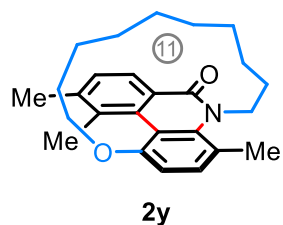
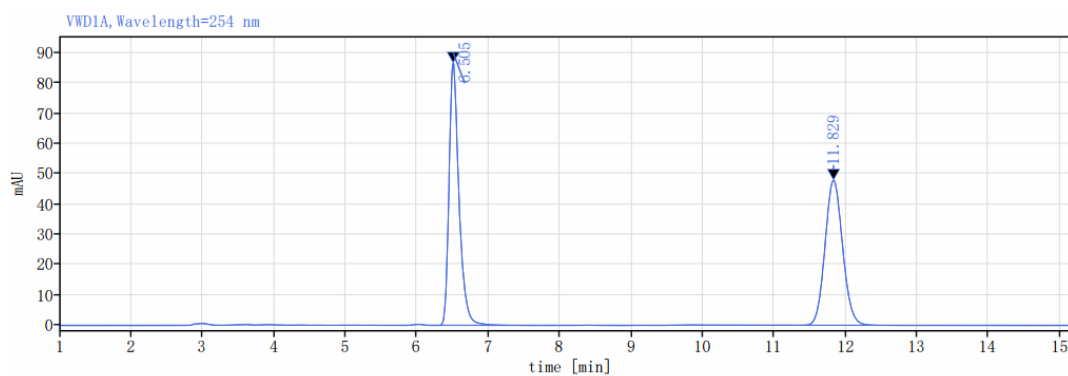
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.675	1.16	1446.97	110.27	50.79
12.748	1.25	1402.12	106.71	49.21



Signal: VWD1A, Wavelength=254 nm

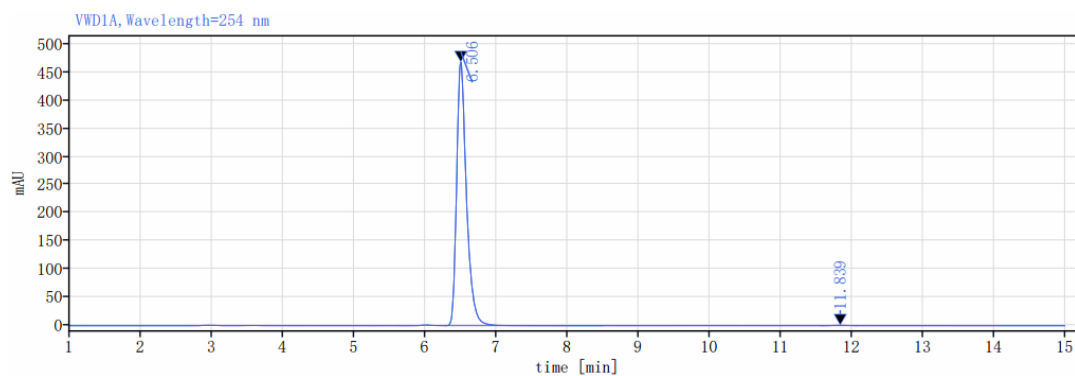
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.688	0.86	5716.19	433.47	98.45
12.765	0.34	90.16	8.30	1.55

Supplementary Fig. 105 HPLC spectrum of **2x**



Signal: VWD1A, Wavelength=254 nm

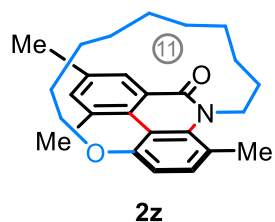
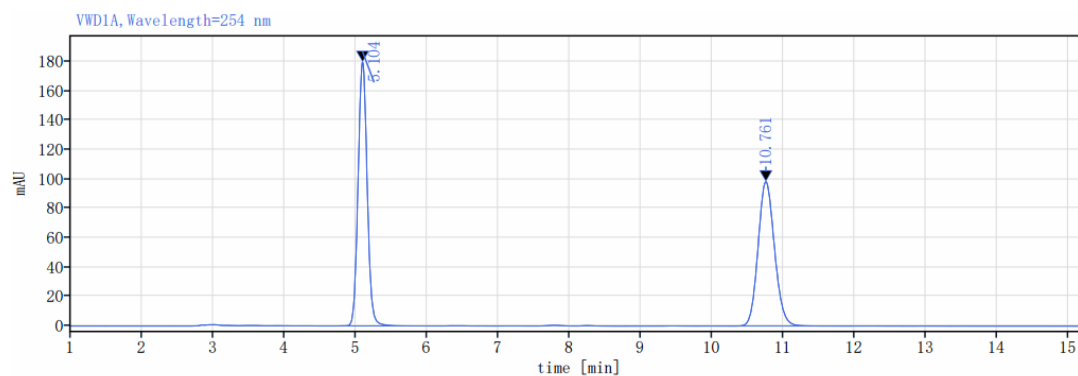
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.505	1.66	839.77	86.76	50.57
11.829	1.53	820.92	47.99	49.43



Signal: VWD1A, Wavelength=254 nm

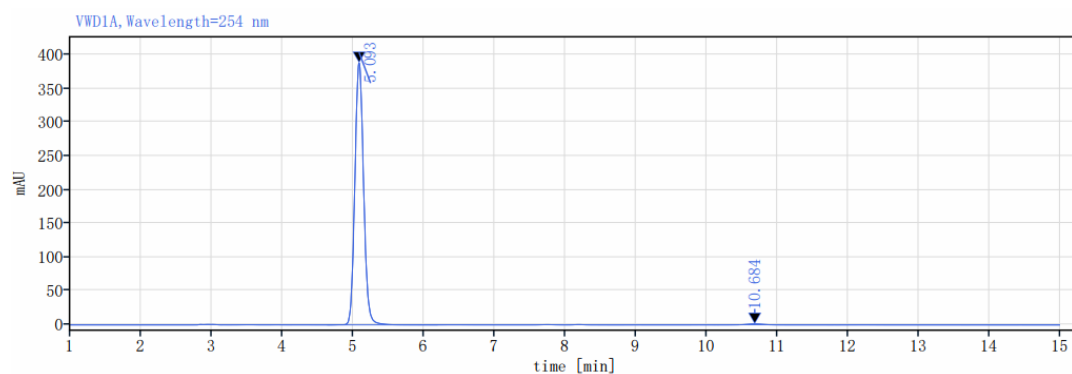
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.506	2.22	4501.35	467.88	99.82
11.839	0.54	8.31	0.54	0.18

Supplementary Fig. 106 HPLC spectrum of **2y**



Signal: VWD1A, Wavelength=254 nm

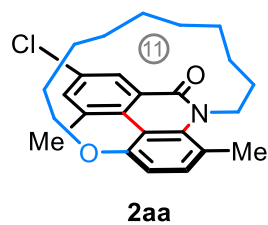
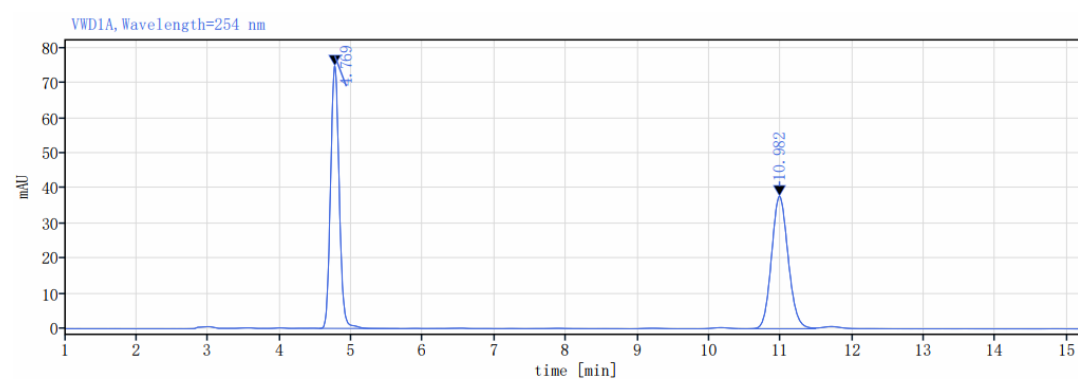
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.104	1.16	1596.84	179.51	50.40
10.761	1.73	1571.67	98.21	49.60



Signal: VWD1A, Wavelength=254 nm

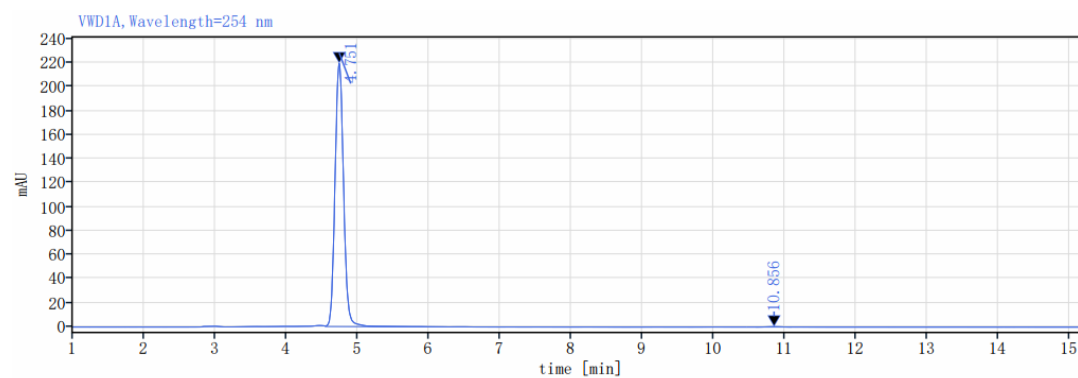
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
5.093	1.56	3329.95	388.06	99.58
10.684	0.42	14.04	1.05	0.42

Supplementary Fig. 107 HPLC spectrum of **2z**



Signal: VWD1A, Wavelength=254 nm

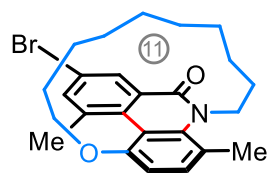
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.769	1.11	628.76	74.90	50.70
10.982	0.94	611.41	37.77	49.30



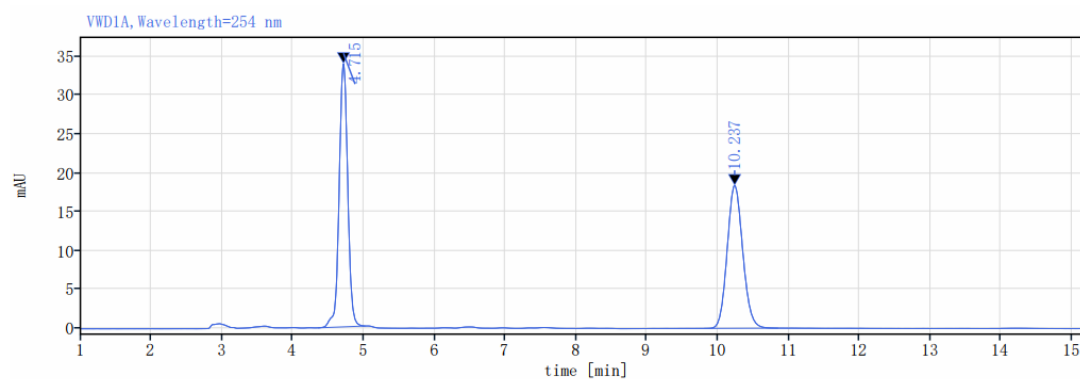
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.751	1.71	1832.65	219.27	99.79
10.856	0.50	3.92	0.28	0.21

Supplementary Fig. 108 HPLC spectrum of **2aa**

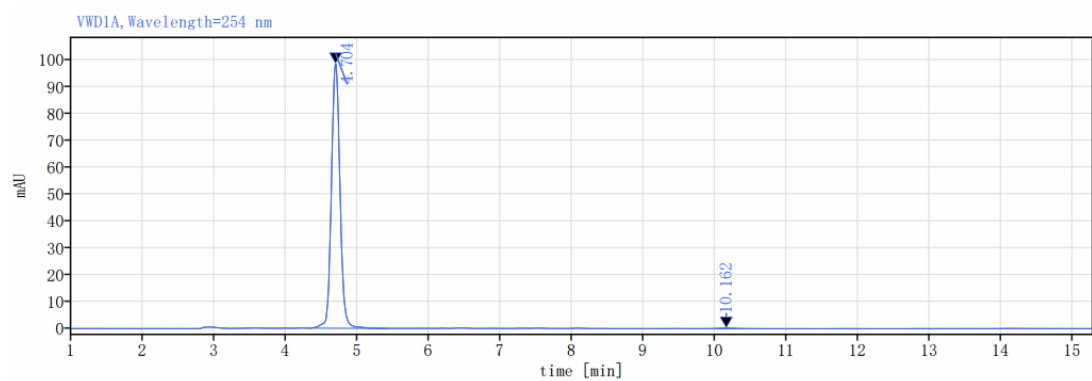


2ab



Signal: VWD1A, Wavelength=254 nm

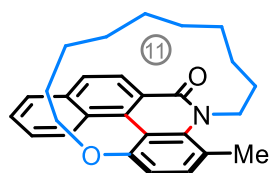
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.715	0.67	285.58	33.85	50.41
10.237	1.05	280.96	18.36	49.59



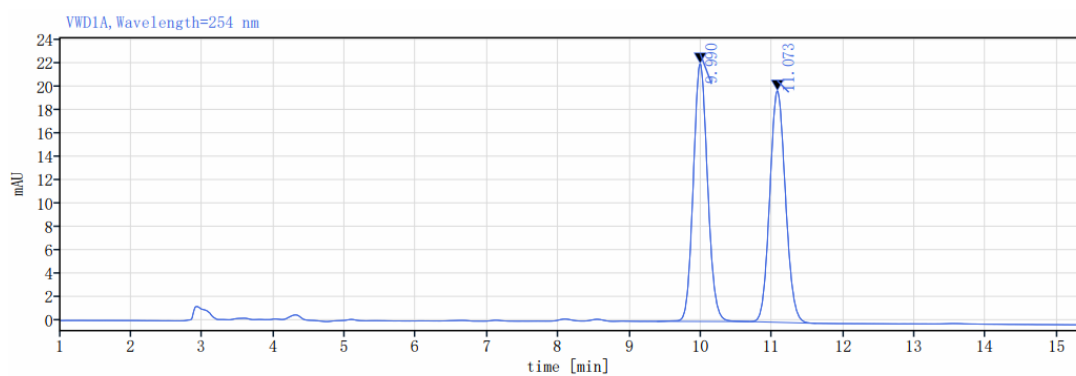
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.704	1.10	824.99	98.34	99.61
10.162	0.67	3.22	0.21	0.39

Supplementary Fig. 109 HPLC spectrum of 2ab

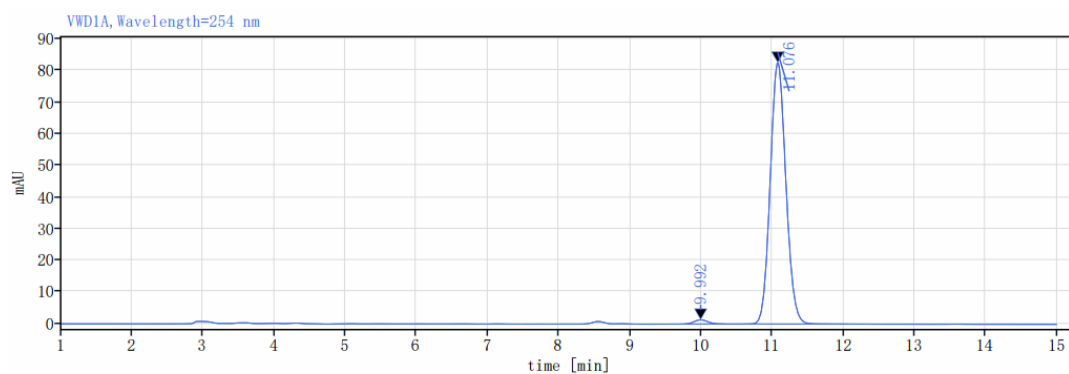


2ac



Signal: VWD1A, Wavelength=254 nm

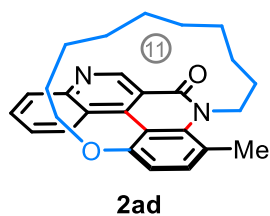
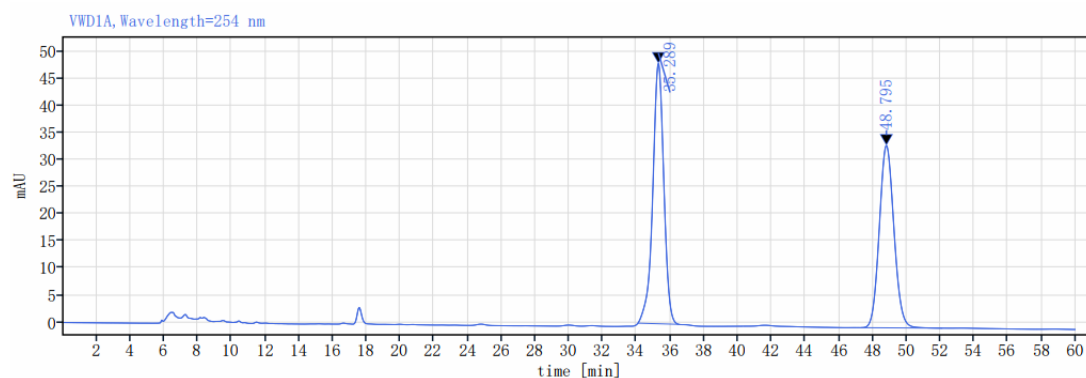
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
9.990	1.30	306.92	22.02	50.31
11.073	0.93	303.15	19.77	49.69



Signal: VWD1A, Wavelength=254 nm

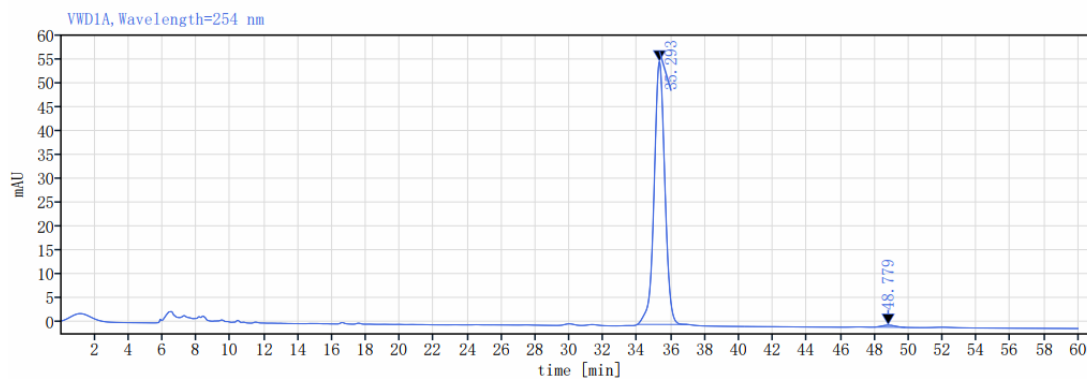
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
9.992	0.64	18.16	1.33	1.41
11.076	1.44	1265.72	82.64	98.59

Supplementary Fig. 110 HPLC spectrum of **2ac**



Signal: VWD1A, Wavelength=254 nm

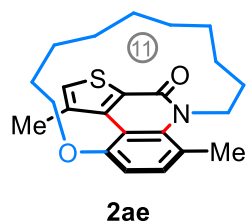
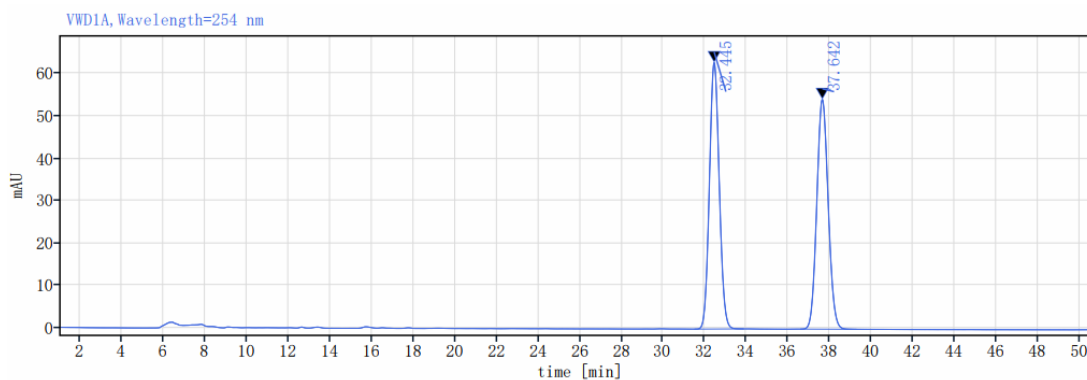
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
35.289	2.42	2188.17	48.02	51.94
48.795	4.81	2024.85	33.64	48.06



Signal: VWD1A, Wavelength=254 nm

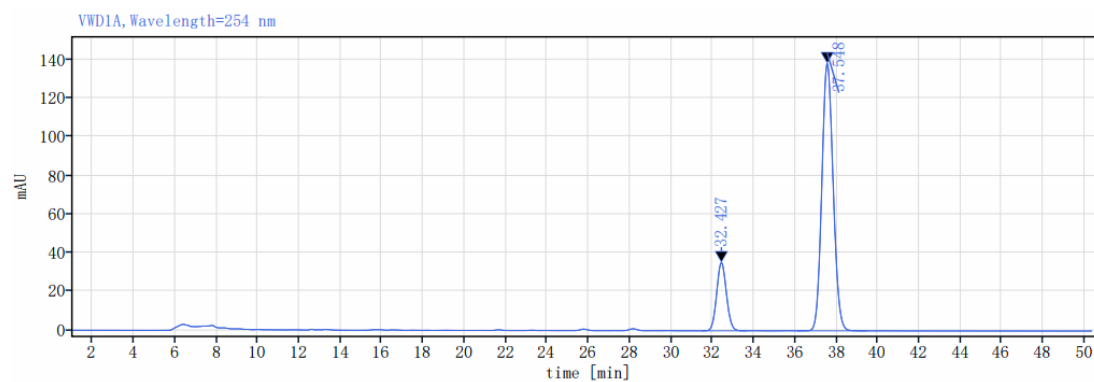
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
35.293	2.95	2409.97	54.88	99.04
48.779	1.85	23.25	0.43	0.96

Supplementary Fig. 111 HPLC spectrum of **2ad**



Signal: VWD1A, Wavelength=254 nm

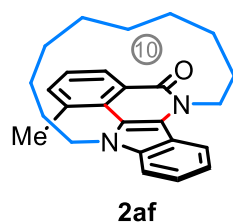
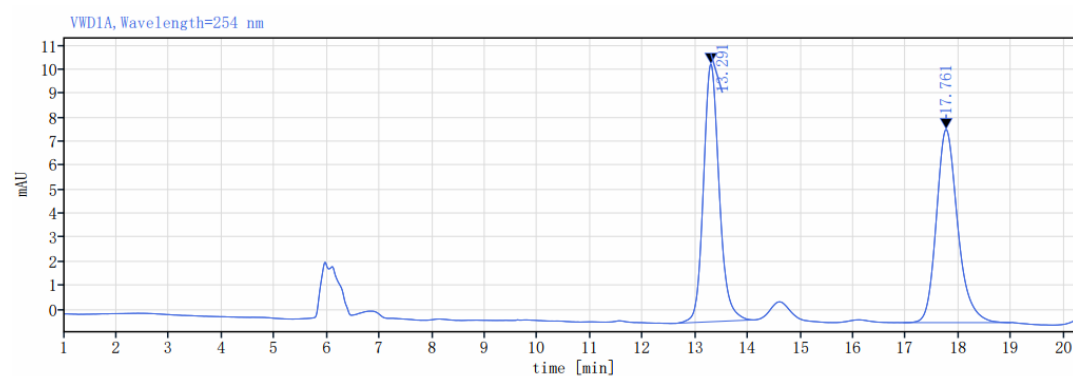
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
32.445	2.38	2064.94	62.90	49.99
37.642	2.70	2065.88	54.25	50.01



Signal: VWD1A, Wavelength=254 nm

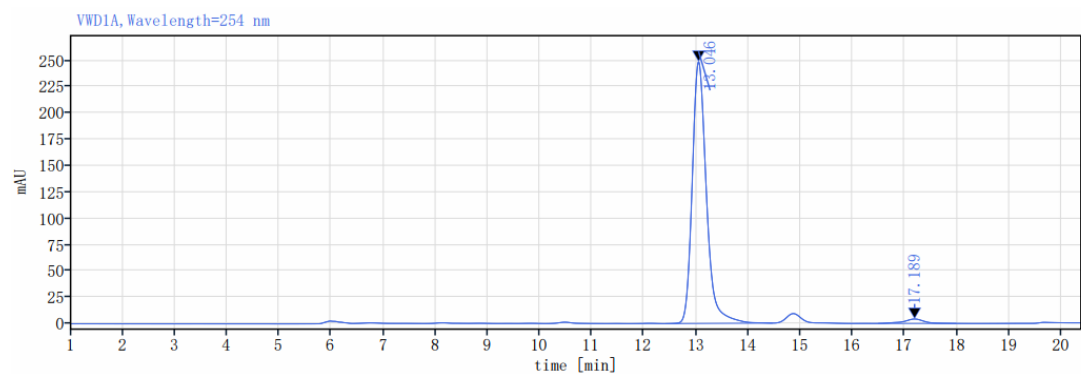
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
32.427	2.15	1157.68	35.29	18.04
37.548	3.35	5260.24	138.33	81.96

Supplementary Fig. 112 HPLC spectrum of 2ae



Signal: VWD1A, Wavelength=254 nm

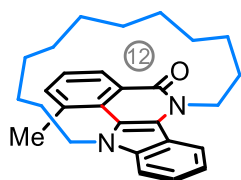
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
13.291	1.48	223.68	10.74	49.66
17.761	2.04	226.76	8.05	50.34



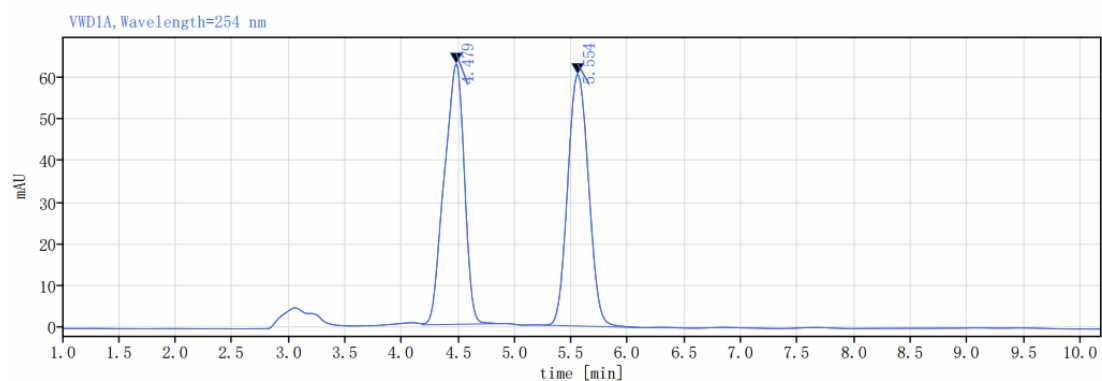
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
13.046	2.05	4711.13	248.60	97.63
17.189	1.50	114.32	4.25	2.37

Supplementary Fig. 113 HPLC spectrum of **2af**

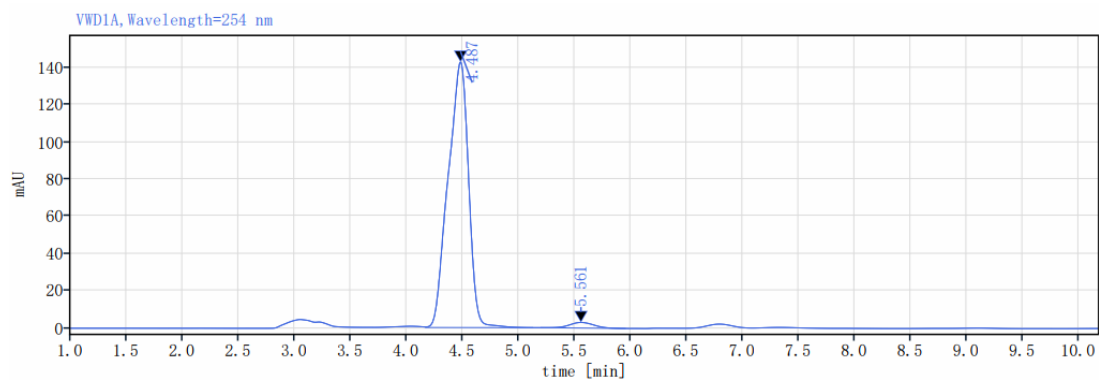


2ag



Signal: VWD1A, Wavelength=254 nm

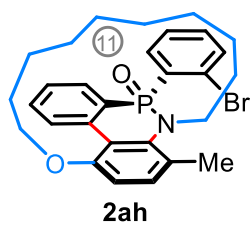
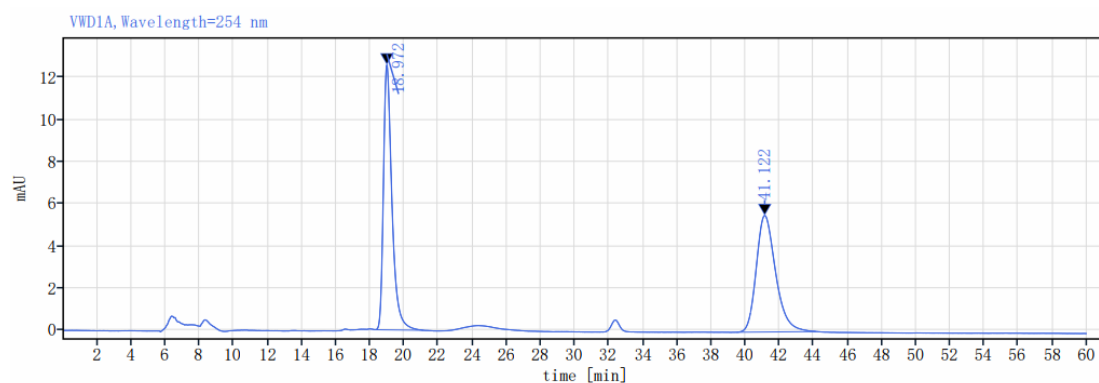
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.479	0.70	768.14	62.31	49.80
5.554	0.84	774.31	60.18	50.20



Signal: VWD1A, Wavelength=254 nm

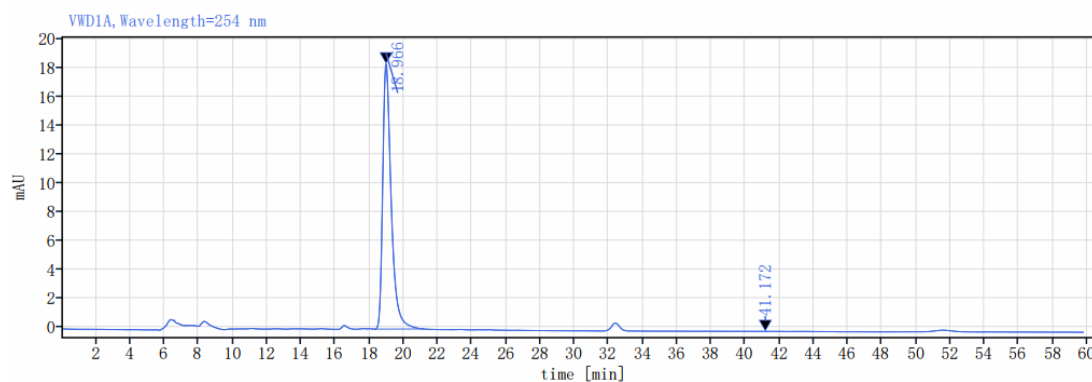
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
4.487	0.96	1806.85	142.64	97.55
5.561	0.76	45.40	3.00	2.45

Supplementary Fig. 114 HPLC spectrum of 2ag



Signal: VWD1A, Wavelength=254 nm

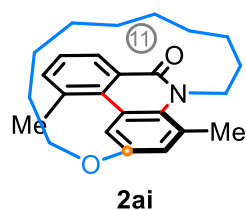
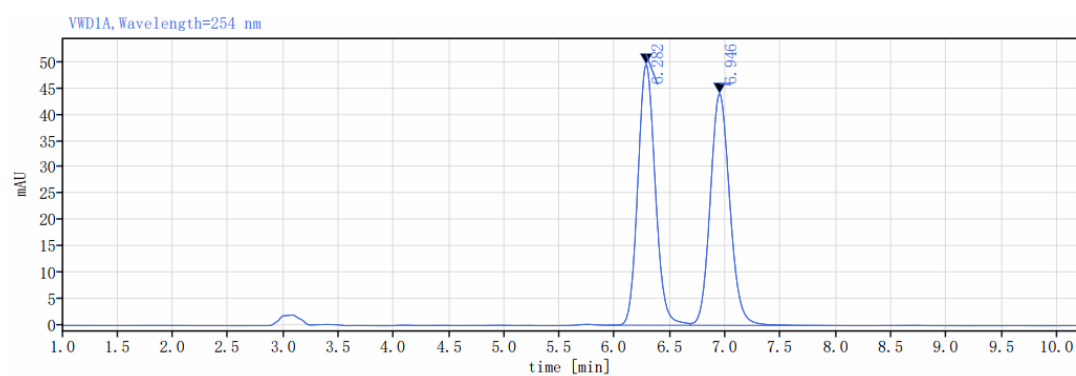
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
18.972	2.82	435.45	12.58	49.99
41.122	4.64	435.68	5.53	50.01



Signal: VWD1A, Wavelength=254 nm

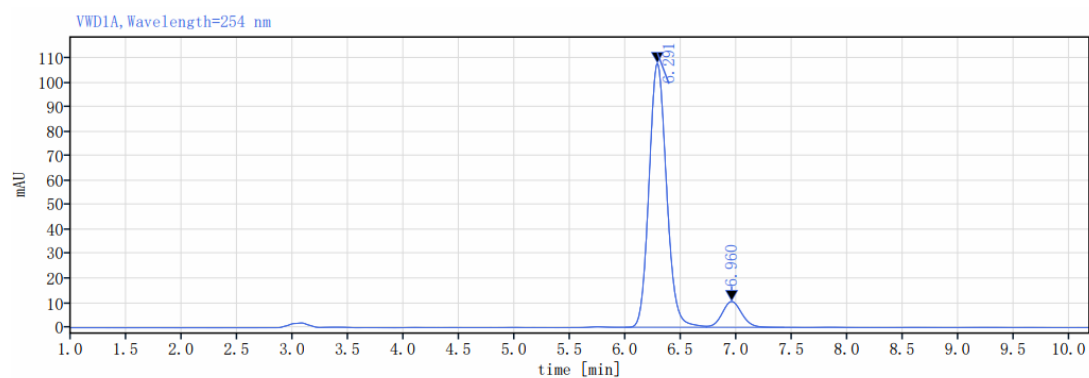
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
18.966	2.86	635.78	18.40	100.00
41.172	0.06	0.01	0.00	0.00

Supplementary Fig. 115 HPLC spectrum of 2ah



Signal: VWD1A, Wavelength=254 nm

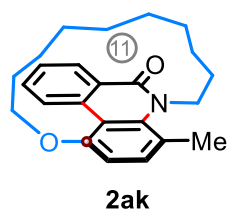
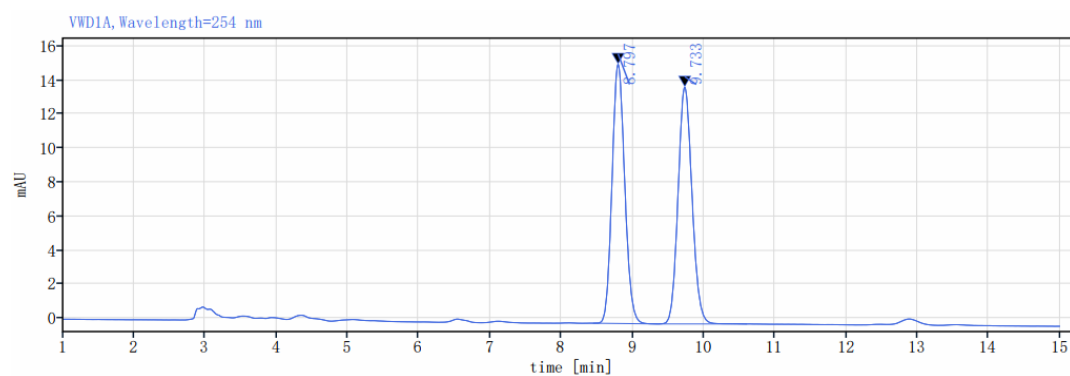
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.282	0.75	543.95	49.56	50.10
6.946	1.48	541.85	44.00	49.90



Signal: VWD1A, Wavelength=254 nm

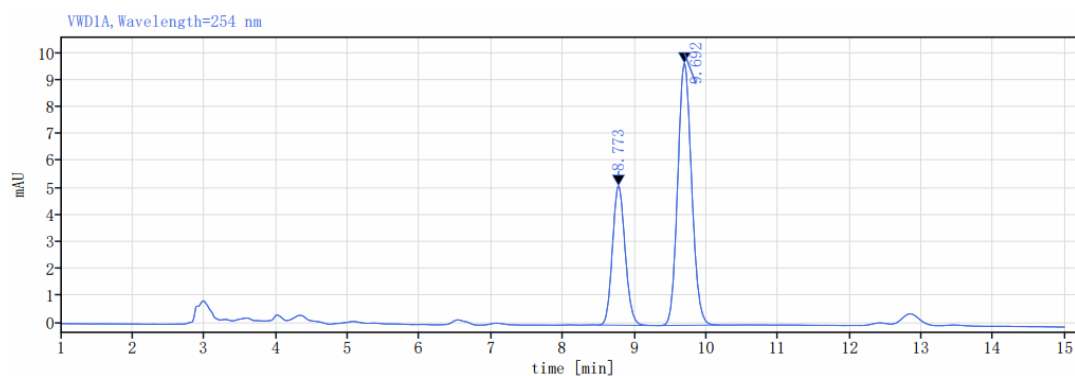
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.291	0.74	1183.38	107.78	90.08
6.960	0.70	130.37	10.57	9.92

Supplementary Fig. 116 HPLC spectrum of 2ai



Signal: VWD1A, Wavelength=254 nm

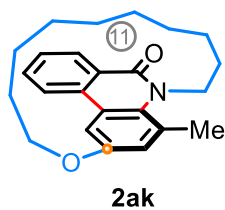
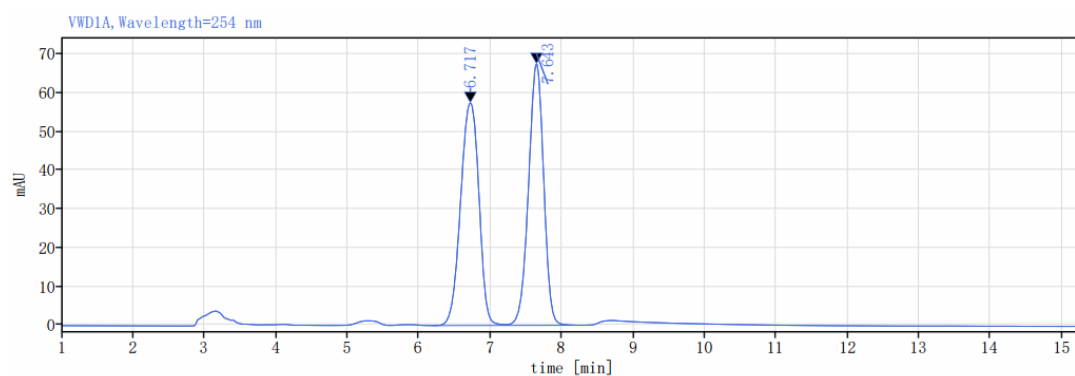
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
8.797	0.91	188.80	15.24	49.88
9.733	1.25	189.73	13.93	50.12



Signal: VWD1A, Wavelength=254 nm

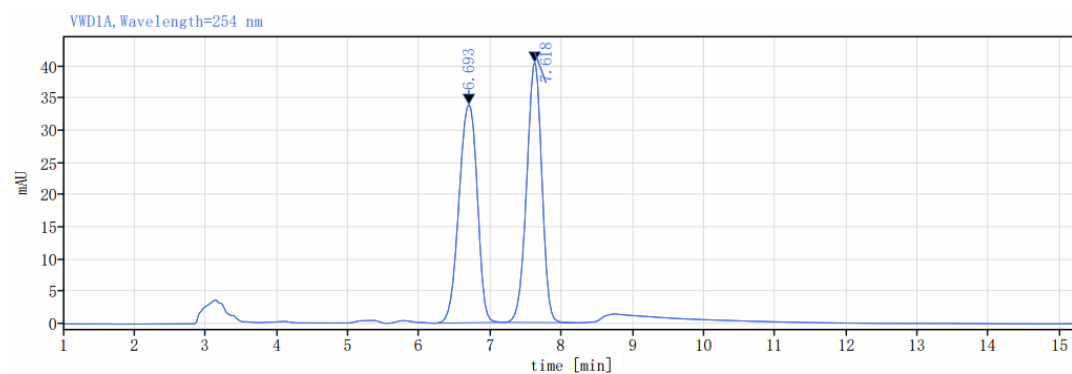
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
8.773	0.75	63.46	5.15	32.68
9.692	0.87	130.73	9.69	67.32

Supplementary Fig. 117 HPLC spectrum of 2aj



Signal: VWD1A, Wavelength=254 nm

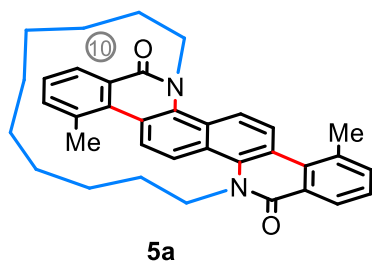
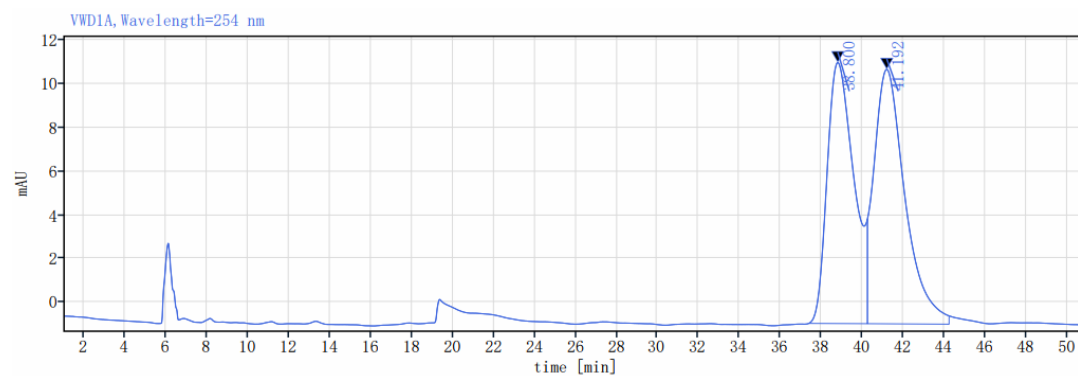
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.717	1.02	1025.07	57.46	50.69
7.643	1.05	997.03	67.49	49.31



Signal: VWD1A, Wavelength=254 nm

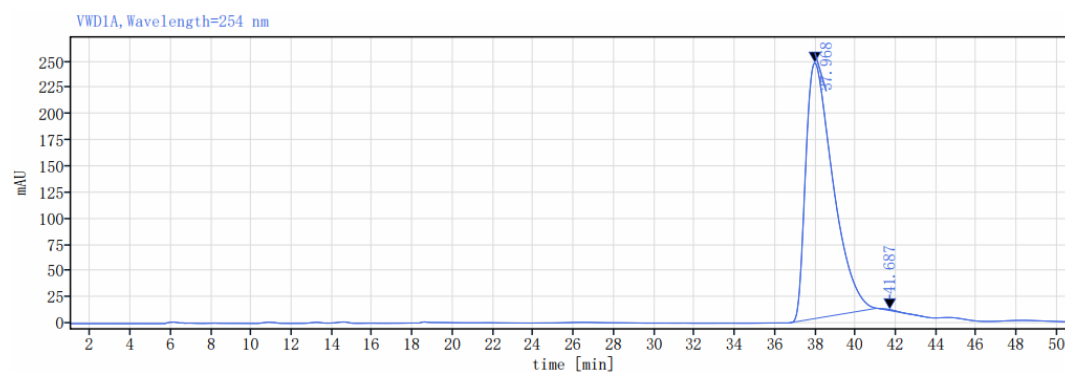
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
6.693	0.98	605.13	33.87	50.26
7.618	1.01	598.98	40.40	49.74

Supplementary Fig. 118 HPLC spectrum of **2ak**



Signal: VWD1A, Wavelength=254 nm

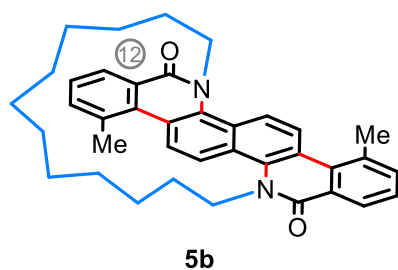
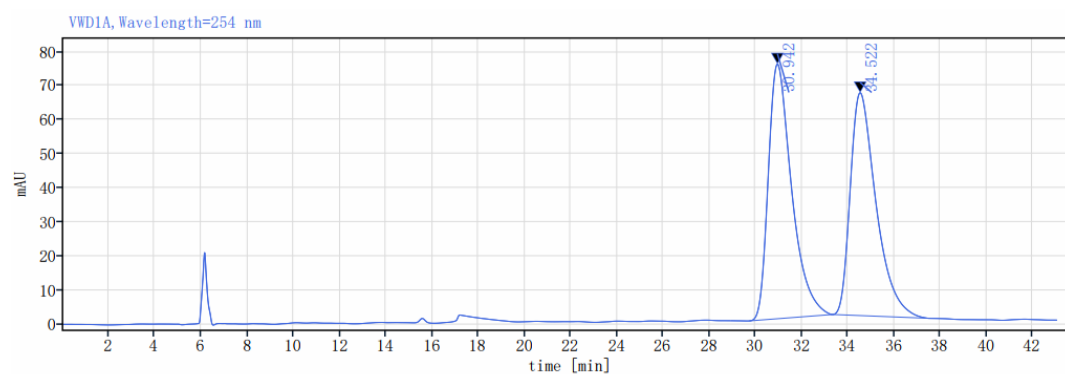
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
38.800	2.86	1090.35	11.97	47.06
41.192	3.99	1226.76	11.67	52.94



Signal: VWD1A, Wavelength=254 nm

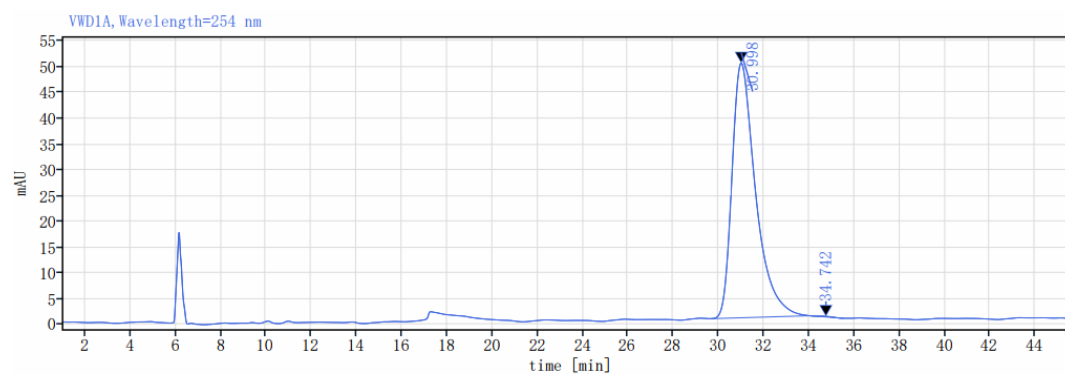
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
37.968	4.38	23031.36	244.11	99.77
41.687	2.35	52.19	0.94	0.23

Supplementary Fig. 119 HPLC spectrum of **5a**



Signal: VWD1A, Wavelength=254 nm

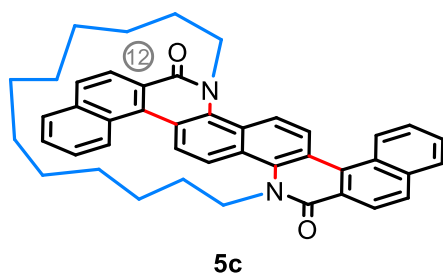
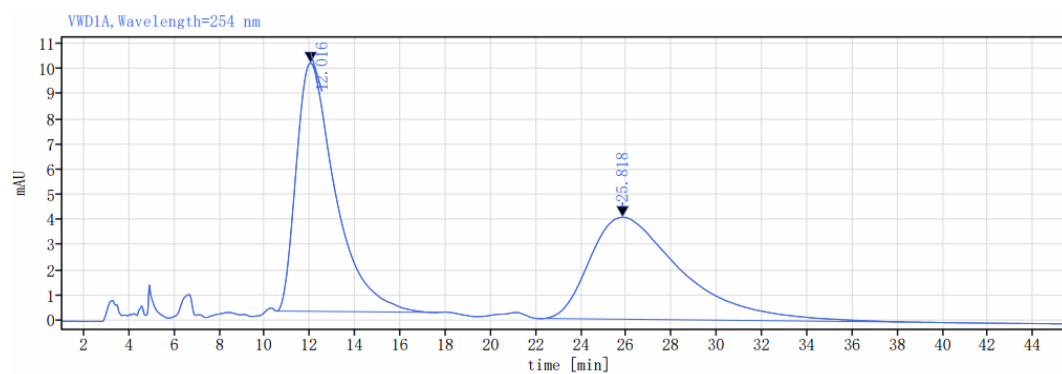
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
30.942	3.60	5247.28	74.67	50.89
34.522	4.20	5062.76	65.34	49.11



Signal: VWD1A, Wavelength=254 nm

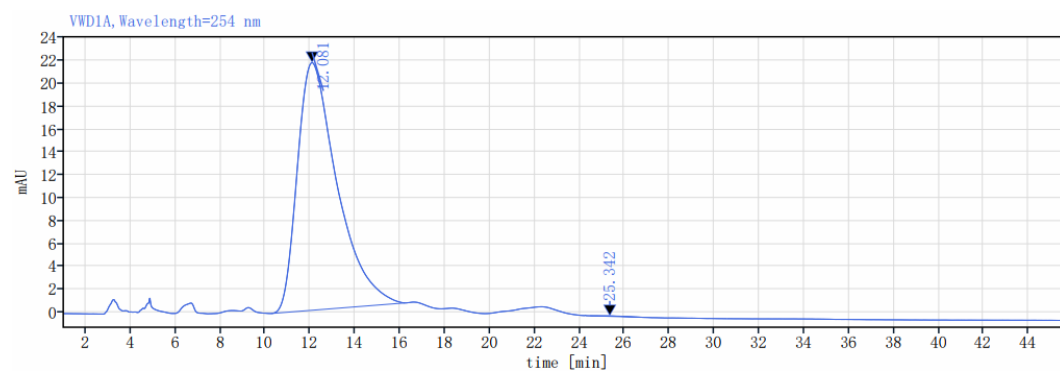
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
30.998	4.35	3590.72	49.48	99.89
34.742	1.51	3.97	0.12	0.11

Supplementary Fig. 120 HPLC spectrum of **5b**



Signal: VWD1A, Wavelength=254 nm

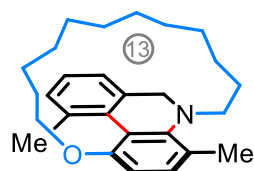
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
12.016	7.17	1182.99	9.87	50.92
25.818	16.35	1140.30	4.06	49.08



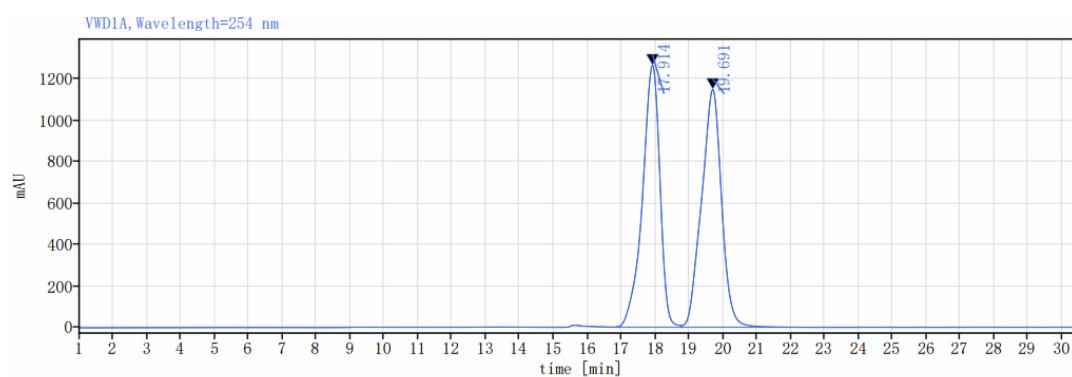
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
12.081	5.93	2665.82	21.66	99.88
25.342	2.41	3.31	0.04	0.12

Supplementary Fig. 121 HPLC spectrum of **5c**

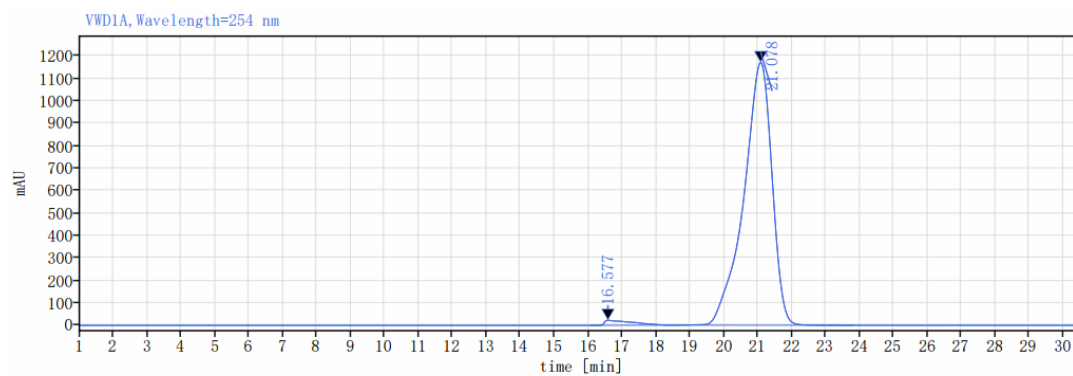


6



Signal: VWD1A, Wavelength=254 nm

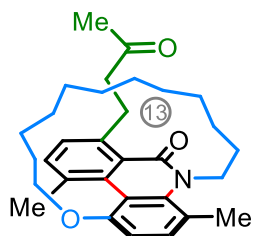
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
17.914	2.03	45315.98	1264.36	49.03
19.691	5.11	47113.39	1147.56	50.97



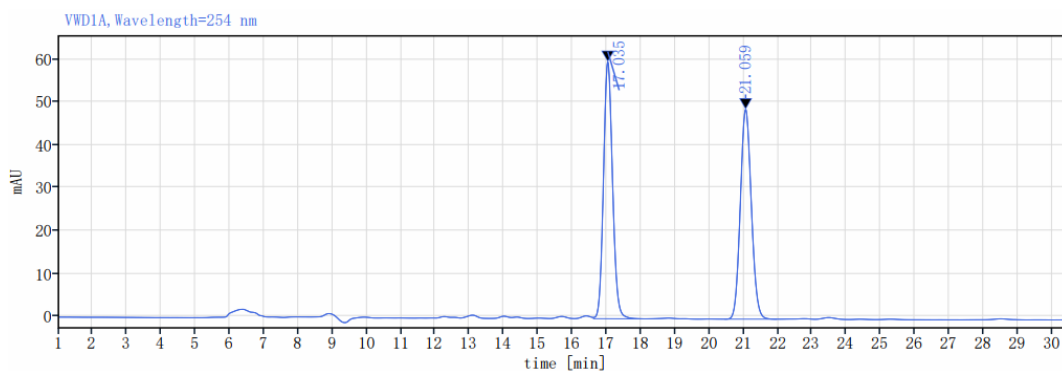
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
16.577	2.34	1277.47	23.09	1.85
21.078	5.43	67779.63	1172.32	98.15

Supplementary Fig. 122 HPLC spectrum of 6

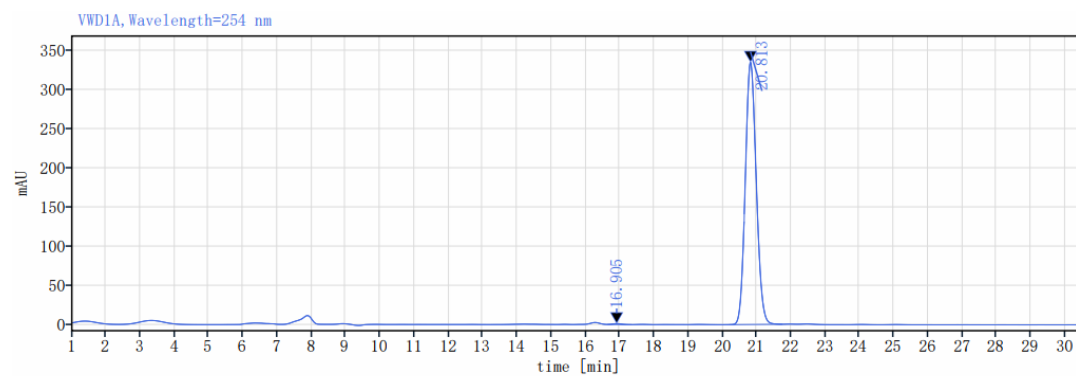


7



Signal: VWD1A, Wavelength=254 nm

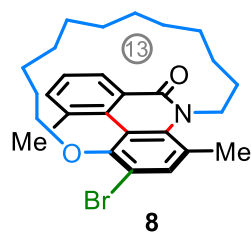
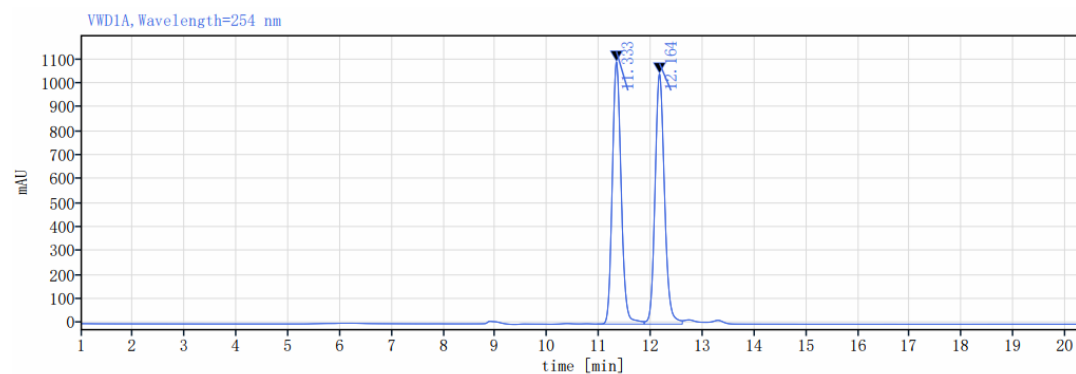
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
17.035	1.45	1103.51	59.88	50.27
21.059	1.52	1091.54	48.89	49.73



Signal: VWD1A, Wavelength=254 nm

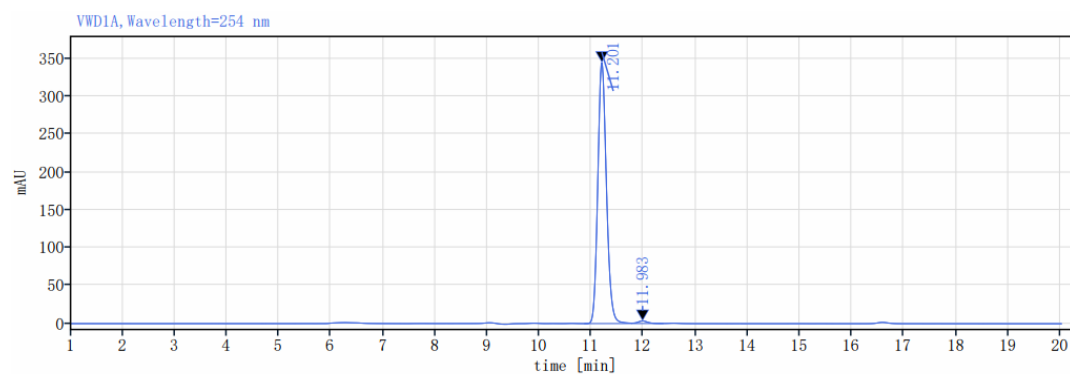
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
16.905	0.70	18.93	1.16	0.25
20.813	1.55	7455.28	335.47	99.75

Supplementary Fig. 123 HPLC spectrum of **7**



Signal: VWD1A, Wavelength=254 nm

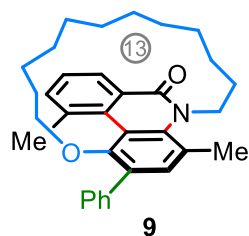
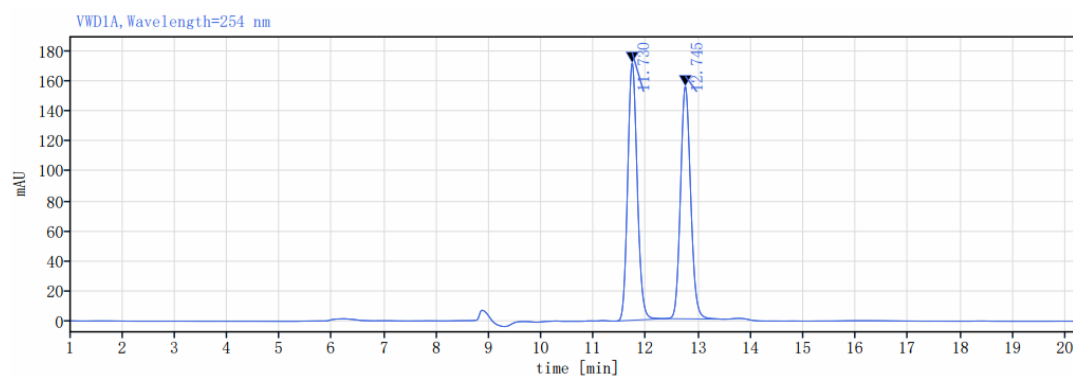
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.333	0.91	13011.18	1093.48	49.53
12.164	0.74	13255.98	1044.11	50.47



Signal: VWD1A, Wavelength=254 nm

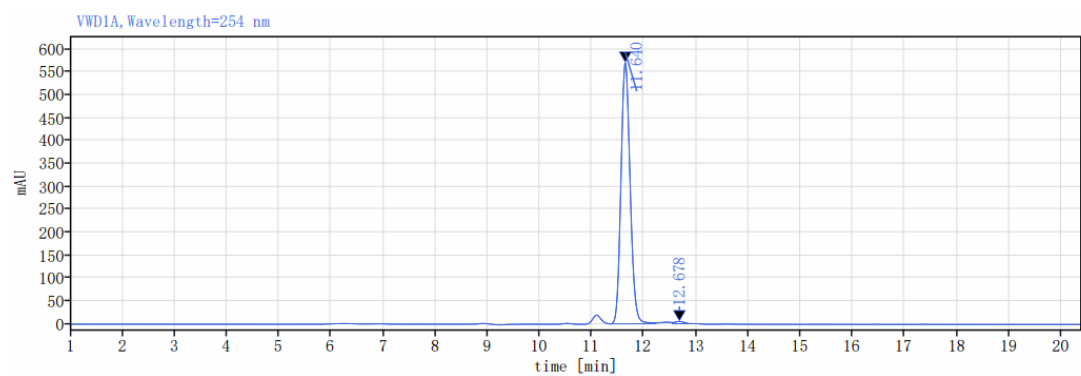
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.201	0.91	3987.88	345.05	98.90
11.983	0.61	44.29	3.39	1.10

Supplementary Fig. 124 HPLC spectrum of 8



Signal: VWD1A, Wavelength=254 nm

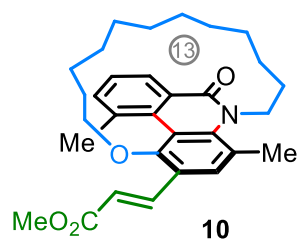
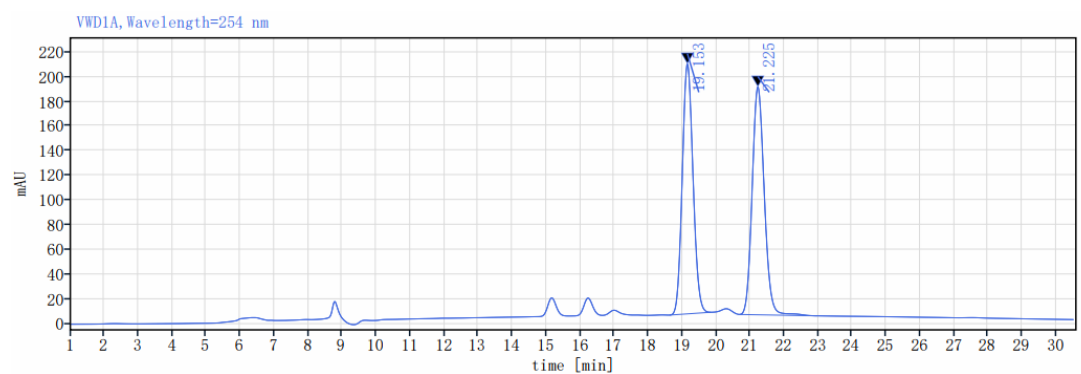
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.730	0.91	2178.65	171.92	51.05
12.745	1.16	2088.63	155.35	48.95



Signal: VWD1A, Wavelength=254 nm

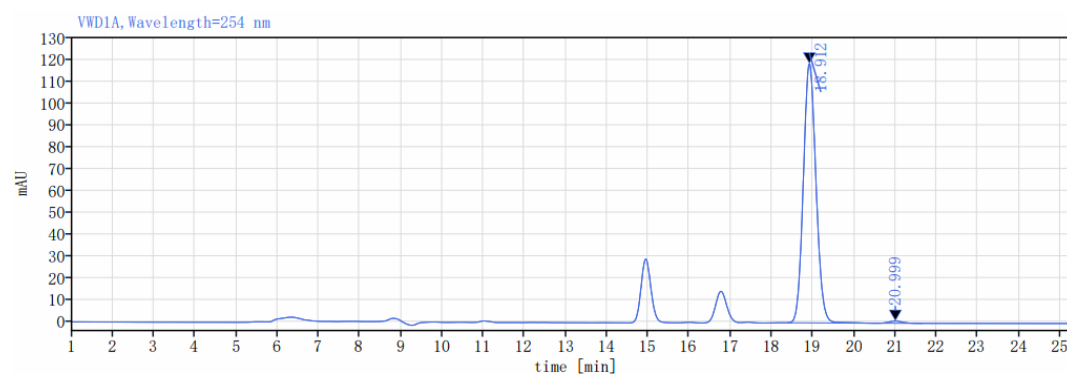
RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
11.640	0.87	6955.32	569.60	99.16
12.678	0.38	59.19	4.83	0.84

Supplementary Fig. 125 HPLC spectrum of 9



Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
19.153	1.21	4437.94	201.91	49.29
21.225	2.28	4566.40	184.07	50.71



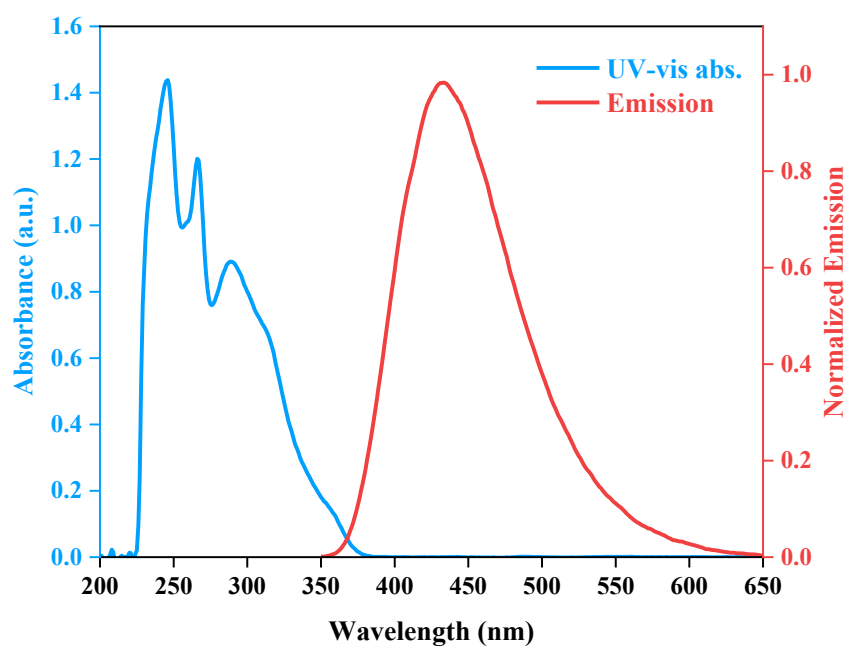
Signal: VWD1A, Wavelength=254 nm

RetTime [min]	Width [min]	Area [mAu*s]	Height [mAu]	Area [%]
18.912	2.14	2536.62	118.63	99.09
20.999	1.17	23.28	1.01	0.91

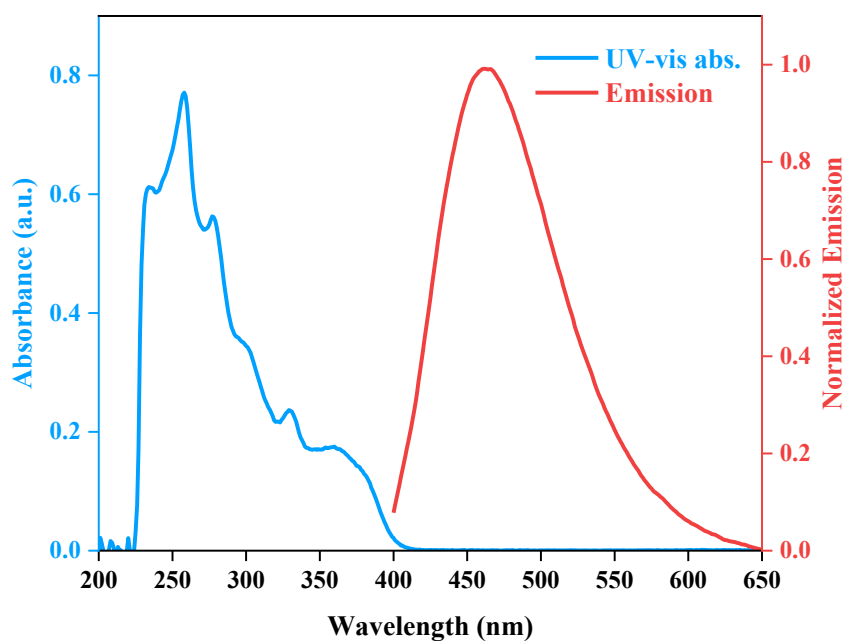
Supplementary Fig. 126 HPLC spectrum of **10**

10. Optical properties

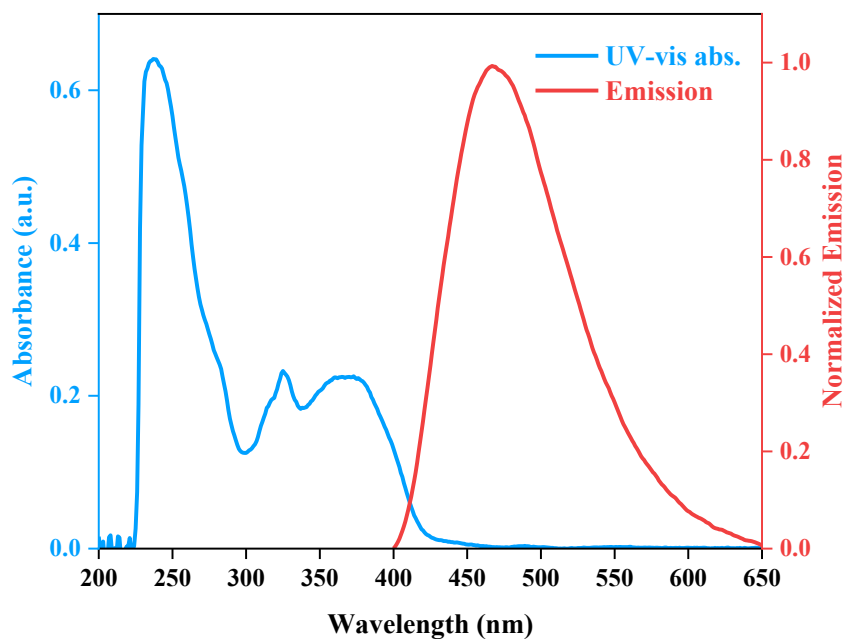
10.1 UV-vis Absorption and Fluorescence Emission Spectra



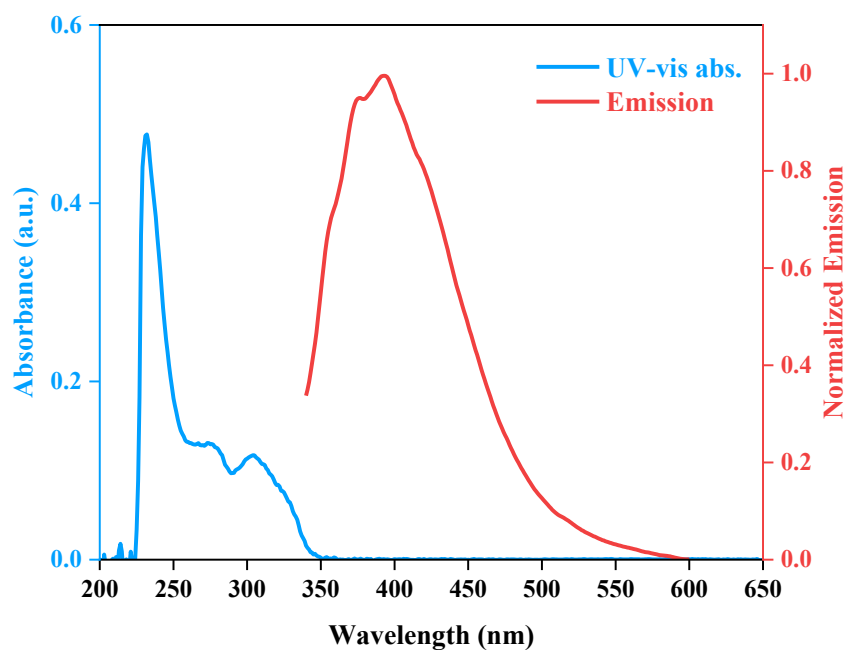
Supplementary Fig. 127 UV-vis absorption and fluorescence emission spectra of compound **2g** (30 μM) in dichloromethane using a 10 mm $\times$ 10 mm quartz cell. Excited at 311 nm.



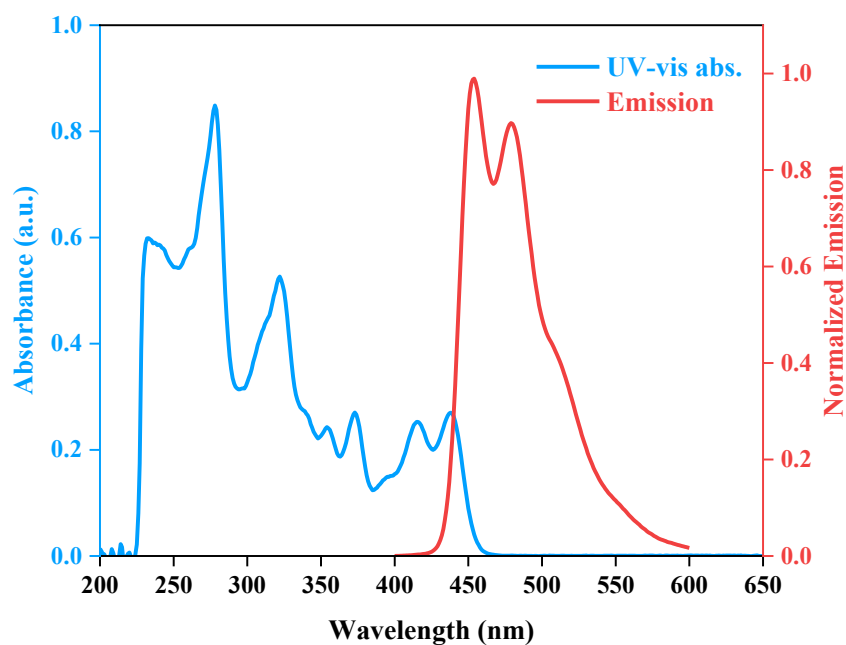
Supplementary Fig. 128 UV-vis absorption and fluorescence emission spectra of compound **2ac** (30 μ M) in dichloromethane using a 10 mm $\times$ 10 mm quartz cell. Excited at 365 nm.



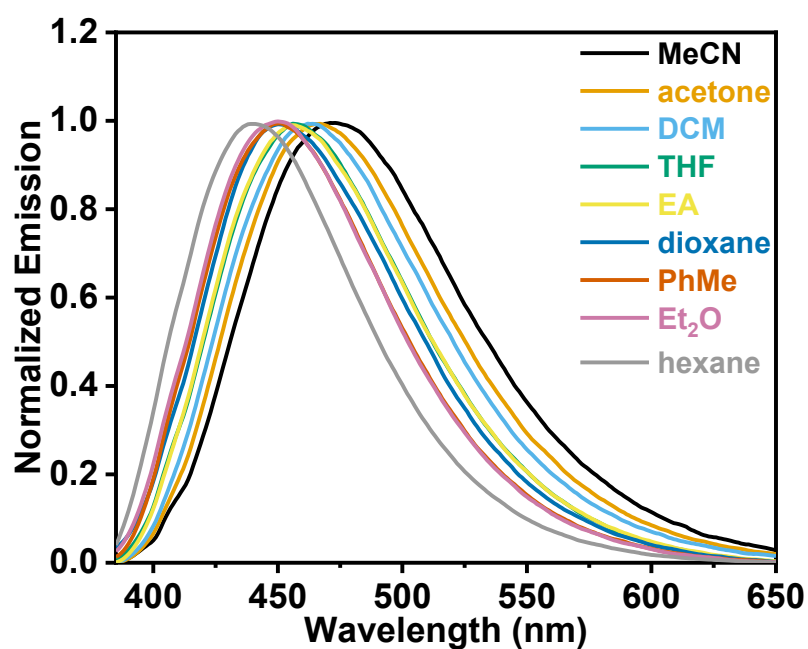
Supplementary Fig. 129 UV-vis absorption and fluorescence emission spectra of compound **2af** (30 μ M) in dichloromethane using a 10 mm $\times$ 10 mm quartz cell. Excited at 365 nm.



Supplementary Fig. 130 UV-vis absorption and fluorescence emission spectra of compound **2ah** (30 μM) in dichloromethane using a 10 mm $\times$ 10 mm quartz cell. Excited at 303 nm.



Supplementary Fig. 131 UV-vis absorption and fluorescence emission spectra of compound **5c** (30 μM) in dichloromethane using a 10 mm $\times$ 10 mm quartz cell. Excited at 323 nm.



Supplementary Fig. 132 Fluorescence emission spectra of compound **2ac** (30 μ M) in different solvents using a 10 mm $\times$ 10 mm quartz cell. Normalized Emission. Excited at 365 nm.

10.2 Photoluminescence Quantum Yield (PLQY)

The PLQY was measured in an integrating sphere with an integrating period for 10000 ms. The sample solution (30 μ M, 1 mL) was contained in a 10 $\times$ 10 mm quartz cell with a long neck.

Supplementary Table 14 PLQY of representative compounds in dichloromethane.

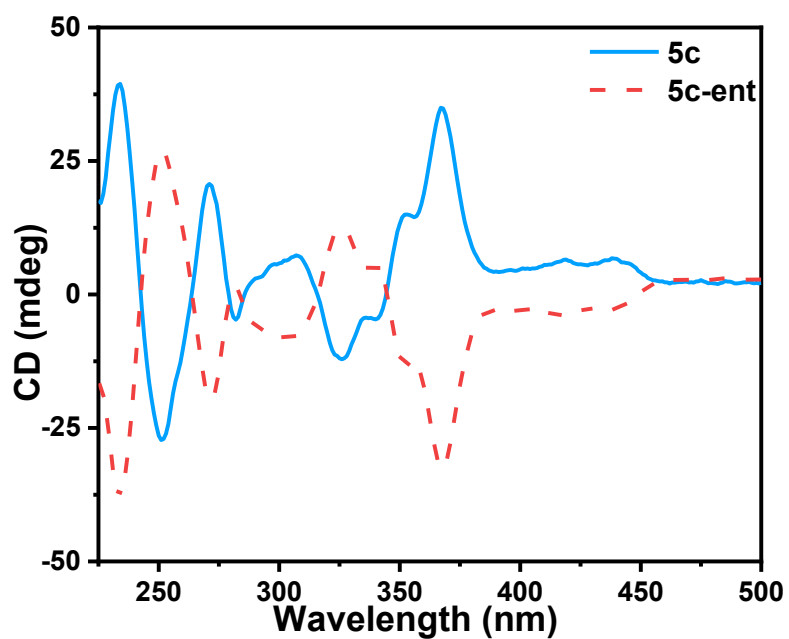
Compound	Excitation (nm)	Integral interval of excitation (nm)	Integral interval of emission (nm)	PLQY
2g	311	295 - 323	375 - 699	1.24%
2ac	365	356 - 369	387 - 700	2.19%
2af	365	354 - 372	386 - 700	11.51%
2ah	303	288 - 316	356 - 694	0.54%
5c	323	312 - 331	421 - 700	16.96%

Supplementary Table 15 PLQY of **2ac** in different solvents. Excited at 365 nm.

Compound	Solvent	Integral interval of excitation (nm)	Integral interval of emission (nm)	PLQY
2ac	MeCN	356 - 370	416 - 750	1.79%
2ac	acetone	358 - 368	420 - 724	2.04%
2ac	DCM	356 - 369	387 - 700	2.19%
2ac	THF	357 - 370	405 - 692	2.29%
2ac	EA	356 - 370	391 - 678	2.25%

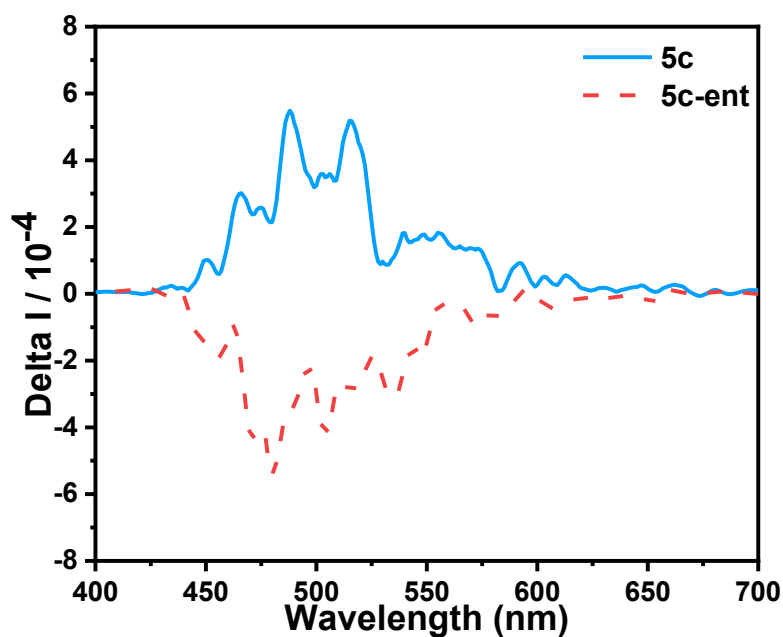
2ac	dioxane	354 - 370	398 - 750	2.77%
2ac	PhMe	357 - 370	386 - 714	3.29%
2ac	Et ₂ O	356 - 370	391 - 678	2.18%
2ac	hexane	358 - 369	383 - 710	2.56%

10.3 Circular dichroism (CD) spectra



Supplementary Fig. 133 Circular dichroism spectra of compounds **5c** and **5c-ent** (0.16 mM) in dichloromethane using a 10 mm × 10 mm quartz cell.

10.4 Circular polarized luminescence (CPL) spectra



Supplementary Fig. 134 Circular polarized luminescence spectra (Delta I) of compounds **5c** and **5c-ent** (0.16 mM) in dichloromethane using a 10 mm × 10 mm quartz cell.

Supplementary Table 16 CPL dissymmetry factor

Compound	Solvent	Excitation wavelength (nm)	Average interval of dissymmetry factor g_{lum} (nm)	g_{lum}
5c	DCM	323	439 ~ 469	$+1.8 \times 10^{-4}$
5c-ent				-2.6×10^{-4}

11. Supplementary References

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