Supporting Information

Deaminative Ring Contraction for the Synthesis of Polycyclic Heteroaromatics: A Concise Total Synthesis of Toddaquinoline

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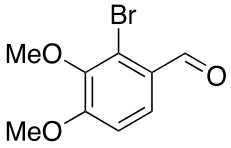
Miscellaneous Synthetic Procedures

*2-bromo-3,4-dimethoxybenzaldehyde (**S1**)*

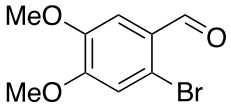


To a solution of KOH (15.6 mmol) in water (10 ml) at 50 °C was added 2-bromo-3-hydroxy-4-methoxybenzaldehyde (8.6 mmol) with aggressive stirring. To this solution, dimethyl sulfate (13.8 mmol) was added dropwise over 10 minutes, followed by an additional 10 minutes of stirring. The reaction mixture was cooled to room temperature and the precipitate was filtered, washed twice with 1 M NaOH, twice with water, then dissolved in dichloromethane. Solvent was removed *in vacuo* and **S1** was isolated as a white solid (1.37 g, 5.62 mmol, 65%). Spectroscopic data for **S1** match those previously reported.[1]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 10.25 (d, *J* = 0.9 Hz, 1H), 7.74 (d, *J* = 8.7 Hz, 1H), 6.96 (d, *J* = 8.7 Hz, 1H), 3.96 (s, 3H), 3.88 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 188.4, 156.1, 143.8, 124.8, 123.9, 120.6, 108.4, 58.1, 53.7.

*2-bromo-4,5-dimethoxybenzaldehyde (**S2**)*



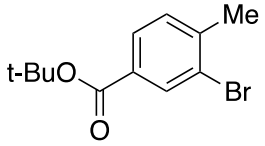
To a stirred solution of 3,4-dimethoxybenzaldehyde (18.1 mmol) in methanol (30 mL) was added Br_2 dropwise over the course of 30 minutes, followed by an additional hour of stirring. The reaction mixture was then concentrated under reduced pressure, and the residue was washed with cold water and pet. ether. **S2** was isolated as a tan solid (4.01 g, 16.8 mmol, 91%). Spectroscopic data for **S2** match those previously reported.[2]

^{1}H NMR ^{1}H NMR (500 MHz, Chloroform-*d*) δ 10.17 (s, 1H), 7.40 (s, 1H), 7.04 (s, 1H), 3.95 (s, 3H), 3.91 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 190.89, 154.45, 148.83, 126.49, 120.36, 115.41, 110.39, 56.48, 56.13.

HRMS (ESI^{+}): *Calcd*. for $C_9H_{10}O_3Br$ [M+H]+: 244.9813 found 244.9820.

*tert-butyl 3-bromo-4-methylbenzoate (**S3**)*

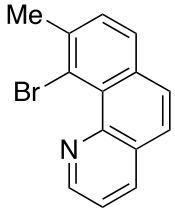


Prepared according to a literature procedure used for similar molecules.[3] To a solution of 21.80 mmol t-BuOK in 17.5 mL Et_2O was added a solution of 4.36 mmol methyl 3-bromo-4-methylbenzoate in 1 mL Et_2O, dropwise. The reaction was stirred for 10 minutes, by which time it appeared to be complete based on analysis by TLC. The reaction was quenched by slowly pouring the mixture into ice water. The aqueous layer was extracted with EtOAc (20 mL × 3). Combined organic extracts were washed with brine, dried over anhydrous $MgSO_4$, filtered, and evaporated to yield **S3** as an orange oil (831 mg, 3.06 mmol, 70%). Spectroscopic data for **S3** closely match those previously reported.[4]

TLC R_f = 0.61 (9:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.11 (d, *J* = 1.70 Hz, 1H), 7.79 (dd, *J* = 7.86, 1.76 Hz, 1H), 7.27 (d, *J* = 7.87 Hz, 1H), 2.44 (s, 3H), 1.58 (s, 9H).

*10-bromo-9-methylbenzo[h]quinoline (**S4**)*



To a pressure tube was added palladium(II) acetate (0.029 mmol) and N-bromosuccinimide (0.60 mmol). The tube was purged with nitrogen, followed by addition of **17** (0.57 mmol) dissolved in 4.8 mL acetonitrile. The tube was sealed and heated to 100ºC for 40 hrs. The solution was evaporated, and residue was purified by column chromatography using a gradient of 100% hexanes to 95:5 Hex:EtOAc to yield **S4** as white crystals (96 mg, 0.35 mmol, 62%). Spectroscopic data for **S4** closely match those previously reported.[5]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.09 (dd, *J* = 4.3, 1.8 Hz, 1H), 8.17 (dd, *J* = 8.0, 1.9 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.74 (d, *J* = 8.7 Hz, 1H), 7.65 (d, *J* = 8.7 Hz, 1H), 7.54-7.58 (m, 2H), 2.76 (s, 3H).

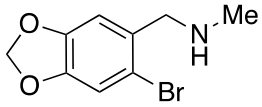
^{13}C NMR (126 MHz, Chloroform-*d*) δ 146.5, 146.2, 140.4, 135.6, 134.5, 130.4, 128.8, 128.0, 127.6, 127.51, 126.0, 121.7, 121.6, 26.1.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{11}NBr$ $[M+H]^+$: 272.0075, found 272.0082.

General procedure A for the synthesis of secondary amines

Methylamine hydrochloride (3 equiv.) and potassium carbonate (3 equiv.) were stirred in methanol (0.2 M) in a round bottom flask for 30 min. Aldehyde (1 equiv.) was added to the flask and the mixture stirred for an additional 2 hr. The reaction mixture was cooled to 0 ºC and sodium borohydride (1.2 equiv.) was added in portions. The solution was allowed to reach room temperature while stirring for an additional 2 hr. The reaction mixture was filtered, then the solvent was removed under reduced pressure, and the crude material was partitioned into water and EtOAc. The aqueous layer was extracted three times with EtOAc (20 mL), then the combined organic extracts were washed with brine (15 mL) and dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure to give the desired secondary amine which was used without further purification.

*1-(6-bromobenzo[d][1,3]dioxol-5-yl)-N-methylmethanamine (**32**)*



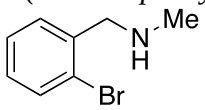
Reaction performed following general procedure **A** with 10.9 mmol of 6-bromobenzo[d][1,3]dioxole-5-carbaldehyde. **32** was isolated as a colorless oil (2.66 g, 10.9 mmol, 99%). Spectroscopic data for **32** match those previously reported.[6]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.00 (s, 1H), 6.89 (s, 1H), 5.97 (s, 2H), 3.74 (s, 2H), 2.44 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 147.3, 132.4, 114.2, 112.76, 112.75, 110.2, 101.7, 55.6, 35.8.

HRMS (ESI$^+$): *Calcd.* for $C_9H_{11}NO_2Br$ $[M+H]^+$: 243.9973, found 243.9978.

*1-(2-bromophenyl)-N-methylmethanamine (**S5**)*



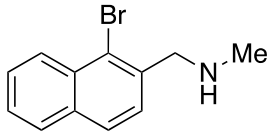
Reaction performed following general procedure **A** with 16.2 mmol of 2-bromobenzaldehyde. **S5** was isolated as a colorless oil (2.617 g, 13.1 mmol, 81%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.56 (dt, *J* = 8.0, 1.7 Hz, 1H), 7.38 (dt, *J*= 7.7, 2.0 Hz, 1H), 7.32 –7.27 (m, 1H), 7.16 –7.11 (m, 1H), 3.83 (s, 2H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 139.0, 132.7, 130.2, 128.5, 127.3, 123.9, 55.6, 35.8.

HRMS (ESI$^+$): *Calcd.* for $C_8H_{11}NBr$ $[M+H]^+$: 200.0075, found 200.0078.

*1-(1-bromonaphthalen-2-yl)-N-methylmethanamine (**S6**)*



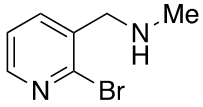
Reaction performed following general procedure **A** with 12.8 mmol of 1-bromo-2- naphthaldehyde. **S6** was isolated as an orange oil (2.943 g, 11.8 mmol, 92%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.33 (d, *J* = 8.6 Hz, 1H), 7.84 – 7.76 (m, 2H), 7.59 (ddd , *J* = 8.4, 6.8, 1.3 Hz, 1H), 7.55 – 7.47 (m, 2H), 4.08 (s, 2H), 2.50 (s, 3H)

^{13}C NMR (126 MHz, Chloroform-*d*) δ 137.0, 133.8, 128.04, 128.03, 127.7, 127.6, 127.4, 127.2, 126.3, 123.9, 56.5, 35.8.

HRMS (ESI$_{+}$): *Calcd*. for $C_{12}H_{12}NBr$ $[M+H]^+$: 250.0231, found 250.0207

*1-(2-bromopyridin-3-yl)-N-methylmethanamine (**S7**)*



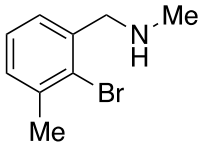
Reaction performed following general procedure **A** with 53.8 mmol of 2-bromonicotinaldehyde. To effectively extract product, extractions were performed 7x with 5:1 $CHCl_3$:iPrOH instead of 3x with EtOAc. **S7** was isolated as a light yellow liquid (10.453 g, 52.0 mmol, 97%). Spectroscopic data for **S7** match those previously reported.[6]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.26 (dd, *J* = 4.8, 2.0 Hz, 1H), 7.71 (ddd, *J* = 7.5, 2.0, 0.9 Hz, 1H), 7.25 (dd, *J* = 7.4, 4.6 Hz, 1H), 3.80 (s, 2H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.6, 143.7, 138.2, 136.3, 123.0, 54.6, 36.0.

HRMS (ESI^{+}): *Calcd.* for $C_7H_{10}N_2Br$ $[M+H]^+$: 201.0027, found 201.0029.

*1-(2-bromo-3-methylphenyl)-N-methylmethanamine (**S8**)*



Reaction performed following general procedure **A** with 2.51 mmol of 2-bromo-3-methylbenzaldehyde. **S8** was isolated as an opaque oil (505 mg, 2.36 mmol, 94%).

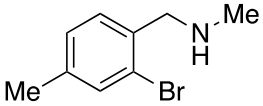
TLC R_f = 0.10 (2:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.20 – 7.13 (m, 3H), 3.84 (s, 2H), 2.45 (s, 3H), 2.42 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 139.4, 138.7, 129.6, 127.8, 126.9, 126.7, 56.5, 35.9, 23.8.

HRMS (ESI$^+$): *Calcd.* for $C_9H_{13}NBr$ $[M+H]^+$: 214.0231, found 214.0227.

*1-(2-bromo-4-methylphenyl)-N-methylmethanamine (**S9**)*



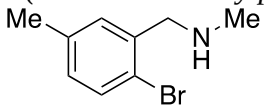
Reaction performed following general procedure **A** with 6.17 mmol of 2-bromo-4-methylbenzaldehyde. **S9** was isolated as a colorless oil (1.128 g, 5.26 mmol, 86%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.36 (s, 1H), 7.22 (d, *J* = 7.72 Hz, 1H), 7.06 (d, *J* = 7.64 Hz, 1H), 3.77 (s, 2H), 2.42 (s, 3H), 2.30 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 138.7, 136.0, 133.3, 130.2, 128.2, 123.9, 55.5, 35.9, 20.7.

HRMS (ESI$^+$): *Calcd.* for $C_9H_{13}NBr$ $[M+H]^+$: 214.0231, found 214.0235.

*1-(2-bromo-5-methylphenyl)-N-methylmethanamine (**S10**)*



Reaction performed following general procedure **A** with 2.51 mmol of 2-bromo-5-methylbenzaldehyde. **S10** was isolated as an opaque oil (499 mg, 2.33 mmol, 93%).

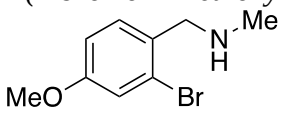
TLC R_f = 0.13 (2:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.40 (d, *J* = 8.1 Hz, 1H), 7.18 (d, *J* = 2.3 Hz, 1H), 6.93 (dd, *J* = 8.2, 2.2 Hz, 1H), 3.78 (s, 2H), 2.46 (s, 3H), 2.30 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 138.6, 137.4, 132.6, 131.3, 129.5, 120.7, 55.8, 36.0, 21.0.

HRMS (ESI$^+$): *Calcd.* for $C_9H_{13}NBr$ $[M+H]^+$: 214.0231, found 214.0227.

*1-(2-bromo-4-methoxylphenyl)-N-methylmethanamine (**S11**)*



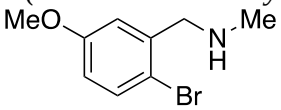
Reaction performed following general procedure **A** with 9.30 mmol of 2-bromo-5-methoxybenzaldehyde. **S11** was isolated as a tan solid (1.500 g, 6.52 mmol, 70%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.31 (d, *J* = 8.45 Hz, 1H), 7.11 (d, *J* = 2.60 Hz, 1H), 6.83 (dd, *J* = 8.46, 2.60 Hz, 1H), 3.82 (s, 2H), 3.79 (s, 3H), 2.44 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.5, 131.4, 129.9, 124.6, 118.2, 113.5, 55.6, 54.6, 35.2.

HRMS (ESI^{+}): *Calcd.* for $C_9H_{13}NOBr$ $[M+H]^+$: 230.0181, found 230.0186.

*1-(2-bromo-5-methoxylphenyl)-N-methylmethanamine (**S12**)*



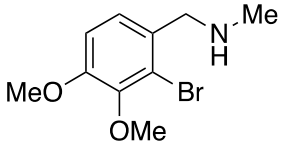
Reaction performed following general procedure **A** with 6.98 mmol of 2-bromo-5-methoxybenzaldehyde. **S12** was isolated as a colorless oil (1.093 g, 4.75 mmol, 68%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.41 (dd, *J* = 8.68, 1.32 Hz, 1H), 6.95 (dd, *J* = 3.19, 1.30 Hz, 1H), 6.69 (ddd, *J* = 8.69, 3.13, 1.31 Hz, 1H), 3.79 (d, *J* = 1.31 Hz, 3H), 3.78 (d, *J* = 1.31 Hz, 2H), 2.46 (d, *J* = 1.31 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.1, 140.1, 133.4, 115.9, 114.44, 114.35, 55.9, 55.6, 36.0.

HRMS (ESI^{+}): *Calcd.* for $C_9H_{13}NOBr$ $[M+H]^+$: 230.0181, found 230.0188.

*1-(2-bromo-3,4-dimethoxylphenyl)-N-methylmethanamine (**S13**)*



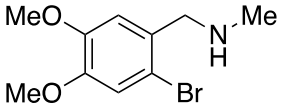
Reaction performed following general procedure **A** with 5.59 mmol of **S1. S13** was isolated as a pale yellow liquid (1.263 g, 4.86 mmol, 87%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.07 (d, *J* = 8.4 Hz, 1H), 6.83 (d, *J* = 8.5 Hz, 1H), 3.85 (d, *J* = 7.0 Hz, 6H), 3.77 (s, 2H), 2.42 (s, 3H), 1.80 (s, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 152.6, 146.5, 131.8, 125.2, 119.6, 110.9, 60.4, 56.0, 55.5, 35.6.

HRMS (ESI^{+}): *Calcd.* for $C_{10}H_{14}NO_2Br$ $[M+H]^{+}$: 260.0286, found 260.0291.

*1-(2-bromo-4,5-dimethoxylphenyl)-N-methylmethanamine (**S14**)*



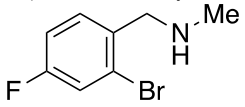
Reaction performed following general procedure **A** with 3.56 mmol of **S2**. **S14** was isolated as a pale yellow liquid (0.907 g, 3.49 mmol, 98%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.00 (s, 1H), 6.92 (s, 1H), 3.86 (d, *J* = 9.5 Hz, 6H), 3.75 (s, 2H), 2.45 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.5, 148.3, 131.0, 115.4, 113.7, 112.9, 56.1, 56.0, 55.4, 35.9.

HRMS (ESI^{+}): *Calcd.* for $C_{10}H_{14}NO_2Br$ $[M+H]^{+}$: 260.0286, found 260.0293.

*1-(2-bromo-4-fluorophenyl)-N-methylmethanamine (**S15**)*



Reaction performed following general procedure **A** with 9.85 mmol of 2-bromo-4-fluorobenzaldehyde. **S15** was isolated as a yellow oil (1.267 g, 5.81 mmol, 59%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.36 (dd, *J* = 8.5, 6.1 Hz, 1H), 7.30 (dd, *J* = 8.2, 2.6 Hz, 1H), 7.00 (td, *J* = 8.3, 2.6 Hz, 1H), 3.80 (s, 2H), 2.44 (s, 3H), 1.81 (s, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 162.5, 160.5, 131.2 (d, J_{CF} = 8.5 Hz), 123.9 (d, J_{CF} = 9.5 Hz), 120.1 (dd, J_{CF} = 24.3, 1.0 Hz), 114.5 (d, J_{CF} = 20.6 Hz), 55.0, 35.9.

HRMS (ESI^{+}): *Calcd.* for $C_8H_{10}NBrF$ $[M+H]^+$: 217.9981, found 217.9986.

General procedure B for the synthesis of tertiary amines

To a round bottom flask was added aldehyde (1 equiv.) and benzylamine (1.2 equiv.), dissolved in 1,2-dichloroethane (0.3 M). AcOH (1 equiv.) was added dropwise and stirred at room temperature for 10 min. $NaBH(OAc)_3$ (2 equiv.) was added portion wise and stirred at 40 °C for 18 hr. The reaction mixture was cooled to room temperature, washed with $NaHCO_3$ (10 mL × 3), and brine (10 mL). The organic layer was dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The crude material was purified by flash column chromatography, using a gradient of 100% hexane to 9:1 Hex:EtOAc to afford the desired tertiary amine.

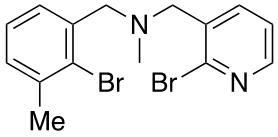
General procedure C for the synthesis of tertiary amines

To a round bottom flask was added secondary amine (1 equiv.), benzyl halide (1.1 equiv.), and Hünig's base (1.5 equiv.) dissolved in acetonitrile (0.2 M). The reaction mixture was stirred at room temperature for 2 hr. After cooling to room temperature, solvent was removed under reduced pressure. The crude material was purified by flash column chromatography, using a gradient of 100% hexane to 9:1 Hex:EtOAc to afford the desired tertiary amine.

General procedure D for synthesis of tertiary amines

To a round bottom flask was added methyl arene (1 equiv.), *N*-bromosuccinimide (1 equiv.), benzoyl peroxide (0.05 equiv.) dissolved in benzene (0.2 M). The reaction mixture was refluxed at 80 °C for 6 hr. The mixture was cooled to room temperature followed by addition of substituted benzylamine (1 equiv.) dissolved in THF (0.6 M). The solution was stirred overnight at room temperature and quenched with 2M NH_4OH (10 mL), followed by extraction three times with EtOAc (20 mL). Combined organic layers were washed with brine (15 mL), dried over $MgSO_4$, filtered, and concentrated under reduced pressure. The crude material was purified by flash column chromatography, using a gradient of 100% hexane to 9:1 Hex:EtOAc to afford the desired tertiary amine.

*N-(2-bromo-3-methylbenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22a**)*



Reaction performed following general procedure **D** with 2.36 mmol of 3-bromo-2-methylpyridine and 2.36 mmol of secondary amine **S8**. **22a** was isolated as a yellow oil (532 mg, 1.39 mmol, 59%).

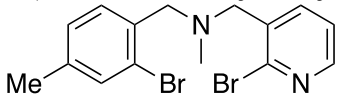
TLC R_f = 0.35 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.23 (dd, *J* = 4.7, 2.3 Hz, 1H), 7.89 (d, *J* = 7.6 Hz, 1H), 7.33 (d, *J* = 7.4 Hz, 1H), 7.24 (dd, *J* = 7.6, 4.7 Hz, 1H), 7.21 – 7.11 (m, 2H), 3.73 (s, 2H), 3.69 (s, 2H), 2.42 (s, 3H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.3, 143.8, 138.7, 138.7, 138.3, 136.1, 129.6, 128.0, 127.2, 126.8, 122.9, 62.3, 60.1, 42.4, 23.9.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2Br_2$ $[M+H]^+$: 382.9767, found 382.9752.

*N-(2-bromo-4-methylbenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22b**)*



Reaction performed following general procedure **D** with 3.5 mmol of 3-bromo-2-methylpyridine and 3.5 mmol of secondary amine **S9**. **22b** was isolated as a yellow oil (778 mg, 2.0 mmol, 58%). Spectroscopic data for **22b** match those previously reported.[7]

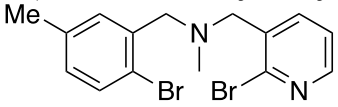
TLC R_f = 0.41 (7:3 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.23 (dd, *J* = 4.7, 2.0 Hz, 1H), 7.88 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.39 – 7.34 (m, 2H), 7.24 (dd, *J* = 7.6, 4.7 Hz, 1H), 7.08 (dd, *J* = 7.8, 1.8 Hz, 1H), 3.68 (s, 2H), 3.66 (s, 2H), 2.30 (s, 3H), 2.25 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.4, 143.9, 138.9, 138.8, 136.2, 134.9, 133.4, 130.7, 128.2, 124.6, 123.0, 61.4, 60.0, 42.4, 20.8.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2Br_2$ $[M+H]^+$: 382.9767, found 382.9764.

*N-(2-bromo-5-methylbenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22c**)*



Reaction performed following general procedure **D** with 2.33 mmol of 3-bromo-2-methylpyridine and 2.33 mmol of secondary amine **S10**. **22c** was isolated as a yellow oil (492 mg, 1.28 mmol, 55%).

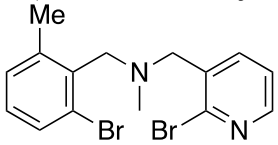
TLC R_f = 0.31 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.24 (d, *J* = 4.7 Hz, 1H), 7.87 (d, *J* = 7.7 Hz, 1H), 7.40 (d, *J* = 8.1 Hz, 1H), 7.29 (s, 1H), 7.24 (dd, *J* = 7.5, 4.8 Hz, 1H), 6.92 (d, *J* = 8.2 Hz, 1H), 3.67 (s, 4H), 2.30 (s, 3H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.3, 143.8, 138.8, 137.4, 137.2, 136.0, 132.6, 131.6, 129.5, 122.9, 121.3, 61.5, 60.0, 42.4, 21.0.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2Br_2$ $[M+H]^+$: 382.9767, found 382.9752.

*N-(2-bromo-6-methylbenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22d**)*

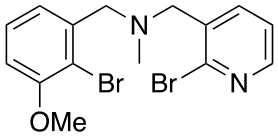


Reaction performed following general procedure **C** with 10.4 mmol of secondary amine **S7** and 11.4 mmol of 2-bromo-6-methylbenzyl bromide. **22d** was isolated as a yellow oil (2.74 g, 7.6 mmol, 73%). Spectroscopic data for **22d** match those previously reported.[6]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.24 (dd, *J* = 4.8, 2.0 Hz, 1H), 7.89 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.34 (dd, *J* = 7.4, 2.0 Hz, 1H), 7.24 (dd, *J* = 7.6, 4.7, 1H), 7.20 – 7.14 (m, 2H), 3.74 (s, 2H), 3.69 (s, 2H), 2.43 (s, 3H), 2.28 (s, 3H).

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2Br_2$ $[M+H]^+$: 382.9767, found 382.9765.

*N-(2-bromo-3-methoxybenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22e**)*



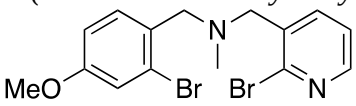
Reaction performed following general procedure **D** with 5.00 mmol of 2-bromo-3-methylanisole and 5.00 mmol of secondary amine **S7**. **22e** was isolated as an colorless oil (1.139 g, 2.85 mmol, 57%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.23 (dd, *J* = 4.70, 1.98 Hz, 1H), 7.89 (d, *J* = 7.44 Hz, 1H), 7.23-7.25 (m, 2H), 7.13 (d, *J* = 7.67 Hz, 1H), 6.82 (dd, *J* = 8.23, 1.49 Hz, 1H), 3.90 (s, 3H), 3.75 (s, 2H), 3.68 (s, 2H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 156.1, 148.4, 143.8, 139.8, 138.8, 136.2, 127.8, 123.0, 122.7, 114.1, 110.6, 61.9, 60.1, 56.5, 42.5.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{17}N_2OBr_2$ $[M+H]^{+}$: 398.9708, found 398.9716.

*N-(2-bromo-4-methoxybenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22f**)*



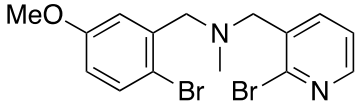
Reaction performed following general procedure **D** with 2.91 mmol of 2-bromo-3-methylpyridine and 2.91 mmol of secondary amine **S11**. **22f** was isolated as an colorless oil (550 mg, 1.38 mmol, 47%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.23 (dd, *J* = 4.7, 2.0 Hz, 1H), 7.86 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.36 (d, *J* = 8.5 Hz, 1H), 7.24 (dd, *J* = 7.6, 4.7 Hz, 1H), 7.10 (d, *J* = 2.6 Hz, 1H), 6.83 (dd, *J* = 8.5, 2.6 Hz, 1H), 3.78 (s, 3H), 3.65 (s, 2H), 3.64 (s, 2H), 2.24 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.2, 148.4, 143.9, 138.9, 136.2, 131.6, 129.9, 125.1, 123.0, 118.1, 113.5, 61.0, 59.9, 55.6, 42.3.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{17}N_2OBr_2$ $[M+H]^{+}$: 398.9708, found 398.9713.

*N-(2-bromo-5-methoxybenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22g**)*

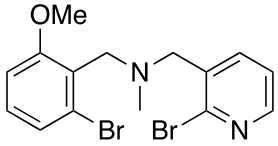


Reaction performed following general procedure **D** with 5.00 mmol of 2-bromo-3-methylpyridine and 5.00 mmol of secondary amine **S12**. **22g** was isolated as a pale yellow oil (687 mg, 1.72 mmol, 59%). Spectroscopic data for **22g** match those previously reported.[6]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.24 (dd, *J* = 4.7, 2.0 Hz, 1H), 7.86 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.42 (d, *J* = 8.7 Hz, 1H), 7.25 (dd, *J* = 7.6, 4.7 Hz, 1H), 7.11 (d, *J* = 3.1 Hz, 1H), 6.68 (dd, *J* = 8.7, 3.2 Hz, 1H), 3.78 (s, 3H), 3.68 (s, 2H), 3.67 (s, 2H), 2.29 (s, 3H).

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{17}N_2OBr_2$ $[M+H]^+$: 398.9708, found 398.9709.

*N-(2-bromo-6-methoxybenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22h**)*



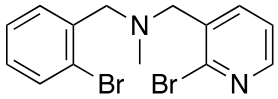
Reaction performed following general procedure **D** with 2.49 mmol of 3-bromo-2-methylanisole and 2.49 mmol of secondary amine **S7**. **22h** was isolated as a pale yellow oil (656 mg, 1.64 mmol, 66%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.19 (dd, *J* = 4.7, 1.7 Hz, 1H), 7.86 (dd, *J* = 7.5, 1.4 Hz, 1H), 7.20-7.17 (m, 2H), 7.07 (t, *J* = 8.1 Hz, 1H), 6.79 (d, *J* = 8.2 Hz, 1H), 3.81 (s, 3H), 3.80 (s, 2H), 3.67 (s, 2H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.3, 148.2, 143.8, 139.3, 136.6, 129.4, 127.6, 126.9, 125.4, 122.8, 109.8, 60.0, 56.0, 54.9, 42.5.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{17}N_2OBr_2$ $[M+H]^+$: 398.9708, found 398.9718.

*N-(2-bromobenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**22i**)*



Reaction performed following general procedure **B** with 20.9 mmol of 2-bromonicotinaldehyde and 23 mmol of secondary amine **S5**. **22i** was isolated as a white solid (5.94 g, 16.1 mmol, 77%). Spectroscopic data for **22i** match those previously reported.[6]

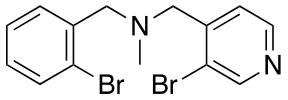
TLC R_f = 0.67 (4:6 Hex:EtOAc)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.24 (d, *J* = 4.47 Hz,1H), 7.88 (d, *J* = 7.53 Hz, 1H), 7.55 (d, *J* = 7.95, 1H), 7.50 (d, *J* = 7.65, 1H), 7.30 – 7.23 (m, 2H), 7.12 (t, *J* = 7.84 Hz, 1H), 3.73 (s, 2H), 3.69 (s, 2H), 2.28 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.5, 143.9, 138.8, 138.0, 136.1, 133.0, 130.8, 128.8, 127.5, 124.8, 123.0, 61.6, 60.2, 42.5.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{15}N_2Br_2$ $[M+H]^+$: 368.9602, found 368.9607.

*N-(2-bromobenzyl)-1-(3-bromopyridin-4-yl)-N-methylmethanamine (**22j**)*



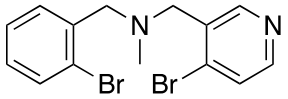
Reaction performed following general procedure **B** with 4.0 mmol of 3-bromopyridine-4-carbaldehyde and 4.8 mmol of secondary amine **S5**. **22j** was isolated as a light tan oil (979 mg, 2.6 mmol, 66%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.64 (s, 1H), 8.46 (d, *J* = 5.0 Hz, 1H), 7.59 – 7.53 (m, 2H), 7.51 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.29 (td, *J* = 7.6, 1.2 Hz, 1H), 7.12 (td, *J* = 7.7, 1.8 Hz, 1H), 3.73 (s, 2H), 3.68 (s, 2H), 2.29 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 151.8, 148.4, 147.8, 137.9, 133.0, 130.7, 128.8, 127.5, 125.0, 124.8, 122.6, 61.7, 60.2, 42.7.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{15}N_2Br_2$ $[M+H]^+$: 368.9602, found 368.9611.

*N-(2-bromobenzyl)-1-(4-bromopyridin-3-yl)-N-methylmethanamine (**22k**)*



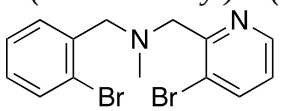
Reaction performed following general procedure **B** with 4.0 mmol of 4-bromonicotinaldehyde and 4.8 mmol of secondary amine **S5**. **22k** was isolated as a light tan oil (793 mg, 2.1 mmol, 53%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.67 (s, 1H), 8.27 (d, *J* = 5.3 Hz, 1H), 7.53 (d, *J* = 7.9 Hz, 2H), 7.48 (d, *J* = 5.3 Hz, 1H), 7.28 (t, *J* = 7.6 Hz, 1H), 7.11 (td, *J* = 7.7, 1.7 Hz, 1H), 3.72 (s, 4H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 152.0, 149.0, 138.0, 135.2, 134.5, 132.9, 131.0, 128.7, 127.9, 127.5, 124.7, 61.4, 59.0, 42.3.

HRMS (ESI^{+}): *Calcd.* for $C_{14}H_{15}N_2Br_2$ $[M+H]^+$: 368.9602, found 368.9610.

*N-(2-bromobenzyl)-1-(3-bromopyridin-2-yl)-N-methylmethanamine (**22l**)*



Reaction performed following general procedure **D** with 17.4 mmol of 3-bromo-2-methylpyridine and 17.4 mmol of secondary amine **S5**. **22l** was isolated as a white solid (2.088 g, 8.7 mmol, 50%).

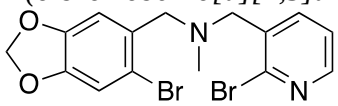
TLC R_f = 0.28 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.53 (dd, *J* = 4.7, 1.5 Hz, 1H), 7.85 (dd, *J* = 8.1, 1.5 Hz, 1H), 7.57 (d, *J* = 7.7 Hz, 1H), 7.50 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.26 (td, *J* = 8.0, 1.3 Hz, 1H), 7.10 – 7.06 (m, 2H), 3.91 (s, 2H), 3.77 (s, 2H), 2.34 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 156.8, 147.6, 140.7, 138.1, 132.6, 131.2, 128.4, 127.2, 124.6, 123.5, 122.6, 62.5, 60.9, 42.4.

HRMS (ESI^{+}): *Calcd.* for $C_{14}H_{15}N_2Br_2$ $[M+H]^+$: 368.9602, found 368.9596.

*1-(6-bromobenzo[d][1,3]dioxol-5-yl)-N-((2-bromopyridin-3-yl)methyl)-N-methylmethanamine (**22m**)*



Reaction performed following general procedure **D** with 2.9 mmol of 2-bromo-3-methylpyridine and 2.9 mmol of secondary amine **31**. **22m** was isolated as a colorless oil (756 mg, 1.8 mmol, 63%). Spectroscopic data for **22m** match those previously reported.[6]

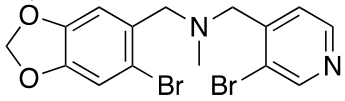
TLC R_f = 0.27 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.24 (dd, *J* = 4.8, 2.0 Hz, 1H), 7.85 (dd, *J* = 7.6, 2.1 Hz, 1H), 7.25 (dd, *J* = 7.4, 4.6 Hz, 1H), 7.02 (s, 1H), 6.99 (d, *J* = 1.3 Hz, 1H), 5.96 (d, *J* = 1.2 Hz, 2H), 3.65 (s, 1H), 3.62 (s, 1H), 2.25 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.5, 147.53, 147.50, 144.0, 138.8, 136.1, 131.3, 123.0, 114.8, 112.8, 110.4, 101.8, 61.3, 60.1, 42.3.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{15}Br_2N_2O_2$ $[M+H]^+$: 412.9500, found 412.9502.

*1-(6-bromobenzo[d][1,3]dioxol-5-yl)-N-((3-bromopyridin-4-yl)methyl)-N-methylmethanamine (**22n**)*



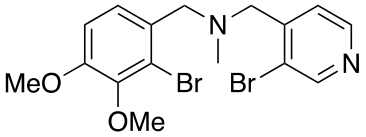
Reaction performed following general procedure **B** with 4.03 mmol of 3-bromopyridine-4-carbaldehyde and 4.84 mmol of secondary amine **31**. **22n** was isolated as a white solid (1.510 g, 3.65 mmol, 90%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.64 (s, 1H), 8.46 (d, *J* = 4.9 Hz, 1H) 7.52 (d, *J* = 5.2 Hz, 1H), 7.03 (s, 1H), 6.99 (s, 1H), 5.96 (s, 2H), 3.64 (s, 2H), 3.62 (s, 2H), 2.26 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 151.8, 148.4, 147.7, 147.6, 147.5, 131.1, 124.9, 122.6, 114.8, 112.8, 110.3, 101.8, 61.4, 60.0, 42.5.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{15}N_2O_2Br_2$ $[M+H]^+$: 412.9500, found 412.9510.

*N-(2-bromo-3,4-dimethoxybenzyl)-1-(3-bromopyridin-4-yl)-N-methylmethanamine (**22o**)*



Reaction performed following general procedure **B** with 4.05 mmol of 3-bromopyridine-4-carbaldehyde and 4.85 mmol of secondary amine **S13**. **22o** was isolated as a white solid (1.292 g, 3.00 mmol, 74%).

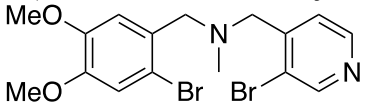
TLC R_f = 0.56 (1:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.62 (s, 1H), 8.44 (d, *J* = 4.9 Hz, 1H), 7.54 (d, *J* = 5.0 Hz, 1H), 7.19 (d, *J* = 8.5 Hz, 1H), 6.84 (d, *J* = 8.5 Hz, 1H), 3.85 (d, *J* = 6.9 Hz, 6H), 3.66 (d, *J* = 13.3 Hz, 4H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 152.6, 151.6, 148.2, 147.8, 146.4, 130.6, 125.5, 124.8, 122.3, 120.4, 110.9, 61.4, 60.4, 59.8, 56.0, 42.5.

HRMS (ESI$^+$): *Calcd.* for $C_{16}H_{18}N_2O_2Br_2$ $[M+H]^+$: 428.9813, found 428.9823.

*N-(2-bromo-4,5-dimethoxybenzyl)-1-(3-bromopyridin-4-yl)-N-methylmethanamine (**22p**)*



Reaction performed following general procedure **B** with 7.03 mmol of 3-bromopyridine-4-carbaldehyde and 8.44 mmol of secondary amine **S14**. **22p** was isolated as a white solid (1.740 g, 4.05 mmol, 58%).

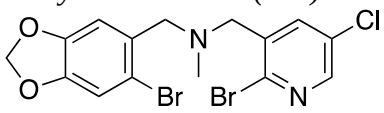
TLC R_f = 0.44 (1:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.63 (s, 1H), 8.45 (d, *J* = 4.9 Hz, 1H), 7.50 (d, *J* = 4.9 Hz, 1H), 7.04 (s, 1H), 6.98 (s, 1H), 3.84 (d, *J* = 1.6 Hz, 6H), 3.64 (d, *J* = 11.2 Hz, 4H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 151.7, 148.5, 148.3, 148.1, 147.6, 129.7, 124.7, 122.5, 115.3, 114.2, 113.0, 61.0, 59.8, 56.1, 56.0, 42.4.

HRMS (ESI$^+$): *Calcd.* for $C_{16}H_{18}N_2O_2Br_2$ $[M+H]^+$: 428.9813, found 428.9822.

*1-(2-bromo-5-chloropyridin-3-yl)-N-((6-bromobenzo[d][1,3]dioxol-5-yl)methyl)-N-methylmethanamine (**29a**)*



Reaction performed following general procedure **D** with 3.8 mmol of 2-bromo-5-chloro-3-methylpyridine and 3.8 mmol of secondary amine **32**. **29a** was isolated as a colorless oil (995 mg, 2.2 mmol, 59%).

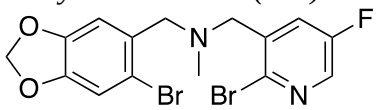
TLC R_f = 0.50 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.21 (d, *J* = 2.7 Hz, 1H), 7.85 (d, *J* = 2.3 Hz, 1H), 6.99 (s, 1H), 6.97 (s, 1H), 5.96 (s, 2H), 3.63 (s, 2H), 3.61 (s, 2H), 2.26 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 147.6, 147.5, 147.0, 140.9, 138.2, 137.5, 131.8, 130.9, 115.0, 112.9, 110.5, 101.8, 61.5, 59.6, 42.5.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{14}N_2O_2ClBr_2$ $[M+H]^+$: 446.9111, found 446.9124.

*1-(2-bromo-5-fluoropyridin-3-yl)-N-((6-bromobenzo[d][1,3]dioxol-5-yl)methyl)-N-methylmethanamine (**29b**)*



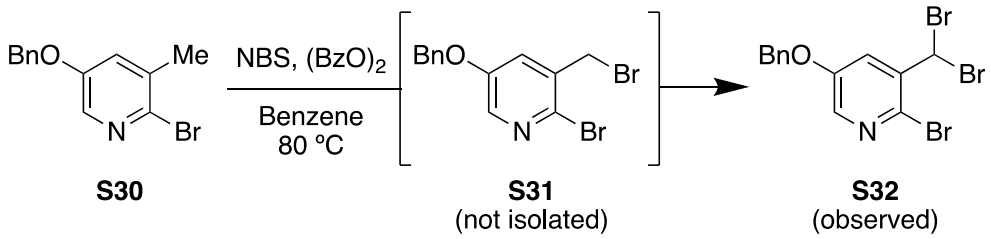
Reaction performed following general procedure **D** with 3.4 mmol of 2-bromo-5-fluoro-3-methylpyridine and 3.5 mmol of secondary amine **32**. **29b** was isolated as a white solid (820 mg, 1.90 mmol, 56%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.14 (d, *J* = 3.01 Hz, 1H), 7.68 (dd, *J* = 8.81, 3.01 Hz, 1H), 7.01 (s, 1H), 6.98 (s, 1H), 3.64 (s, 2H), 3.62 (s, 2H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 160.7, 158.7, 147.6 (d, J_{CF} = 10.5 Hz), 138.2 (d, J_{CF} = 3.5 Hz), 136.9 (d, J_{CF} = 1.9 Hz), 136.4 (d, J_{CF} = 25.3 Hz), 130.9, 125.8 (d, J_{CF} = 20.4 Hz), 115.0, 112.9, 110.4, 101.9, 61.5, 59.5, 42.5.

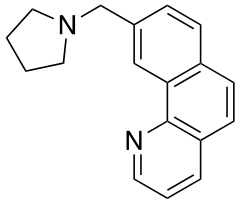
HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{14}N_2O_2FBr_2$ $[M+H]^+$: 430.9406, found 430.9408.

Note: Attempts to prepare **S31** to be used *en route* to access **29c** (R = OBn) following general procedure **D** were met with overhalogenation (confer **S32**). Accordingly, we pursued strategies where **29a** (R = Cl) and **29b** (R = F) could be converted into the required C3-OH functionality present in **3**.



S30 **S31** (not isolated) **S32** (observed)

*9-(pyrrolidin-1-ylmethyl)benzo[h]quinoline (**36**)*



Reaction performed following general procedure **D** with 0.26 mmol of **17** and 0.39 mmol of pyrrolidine. The crude material was purified by flash column chromatography, using Et_3N neutralized silica using a gradient of 100% $CHCl_3$ to 96:4 $CHCl_3$:MeOH. **36** was isolated as a light yellow semisolid (50 mg, 0.19 mmol, 74%).

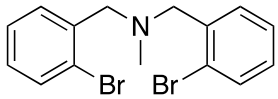
TLC R_f = 0.45 (9:1 $CHCl_3$:MeOH, Et_3N treated plate)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.17 (dt, *J* = 1.7, 0.9 Hz, 1H), 9.00 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.19 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.91 (d, *J* = 7.9 Hz, 1H), 7.85 (d, *J* = 8.5 Hz, 1H), 7.82 (d, *J* = 8.8 Hz, 1H), 7.67 (dd, *J* = 8.8, 1.6 Hz, 1H), 7.55 – 7.50 (m, 1H), 3.99 (s, 2H), 2.68 (s, 4H), 1.84 (d, *J* = 4.0 Hz, 4H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 146.2, 143.9, 133.4, 130.3, 128.7, 127.0, 125.6, 125.0, 124.0, 122.6, 121.8, 119.2, 58.2, 51.5, 20.9.

HRMS (ESI$^+$): *Calcd.* for $C_{18}H_{19}N_2$ $[M+H]^+$: 263.1548, found 263.1555.

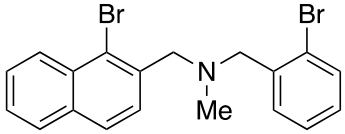
*N-(2-bromobenzyl)-1-(2-bromophenyl)-N-methylmethanamine (**S16**)*



Reaction performed following general procedure **C** with 10 mmol of secondary amine **S5**. **S16** was isolated as a colorless oil (3.08 g, 8.3 mmol, 83%). Spectroscopic data for **S16** match those previously reported.[6]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.59 (d, *J* = 7.7 Hz, 2H), 7.55 (dt, *J* = 8.0, 1.4 Hz, 2H) 7.30 (tt, *J* = 7.6, 1.6 Hz, 2H), 7.11 (tt, *J* = 7.6, 2.0 Hz, 2H), 3.74 (s, 4H), 2.29 (s, 3H).

*N-(2-bromobenzyl)-1-(1-bromonaphthalen-2-yl)-N-methylmethanamine (**S17**)*



Reaction performed following general procedure **C** with 1.72 mmol 2-bromobenzylbromide and 1.57 mmol of secondary amine **S6**. **S17** was isolated as a yellow oil (340 mg, 0.81 mmol, 54%).

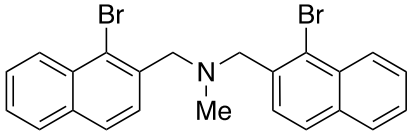
TLC R_f = 0.51 (8:1 Hex:EtOAc)

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.31 (d, J = 8.6 Hz, 1H), 7.86 – 7.67 (m, 3H), 7.66 – 7.33 (m, 5H), 7.33 – 7.20 (m, 1H), 7.07 (td, J = 7.7, 2.0 Hz, 1H), 3.94 (s, 1H), 3.73 (s, 2H), 2.26 (s, 3H).

^{13}C NMR (125 MHz, Chloroform-*d*): δ 138.5, 136.9, 134.0, 132.9, 132.5, 131.0, 128.6, 128.2, 128.1, 127.6, 127.5, 127.39, 127.35, 126.4, 124.8, 124.3, 62.2, 61.6, 42.4.

HRMS (ESI+): *Calcd.* for $C_{19}H_{18}NBr_2$ $[M+H]^+$: 417.9806, found 417.9812.

*1-(1-bromonaphthalen-2-yl)-N-((1-bromonaphthalen-2-yl)methyl)-N-methylmethanamine (**S18**)*



Reaction performed following general procedure **D** with 1.54 mmol of 1-bromo-2-methylnaphthalene and 1.54 mmol of secondary amine **S6**. **S18** was isolated as a yellow oil (448 mg, 0.95 mmol, 62%). Spectroscopic data for **S18** match those previously reported.[8]

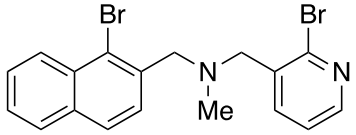
TLC R_f = 0.49 (9:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.36 (d, *J* = 8.5 Hz, 2H), 7.83 – 7.73 (m, 6H), 7.62 – 7.57 (m, 2H), 7.53 – 7.47 (m, 2H), 4.02 (s, 4H), 2.34 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 136.7, 134.0, 132.5, 128.2, 127.6, 127.5, 127.4, 126.4, 124.4, 62.2, 42.5.

HRMS (ESI$^+$): *Calcd.* for $C_{23}H_{20}NBr_2$ $[M+H]^+$: 467.9963, found 467.9973.

*1-(1-bromonaphthalen-2-yl)-N-((2-bromopyridin-3-yl)methyl)-N-methylmethanamine (**S19**)*



Reaction performed following general procedure **D** with 3.0 mmol of 2-bromo-3-methylpyridine and 3.0 mmol of secondary amine **S6**. **S19** was isolated as an orange oil (634 mg, 1.5 mmol, 50%). Spectroscopic data for **S19** match those previously reported.[6]

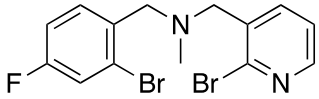
TLC R_f = 0.40 (7:3 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.34 (d, *J* = 8.6 Hz, 1H), 8.25 (dd, *J* = 4.8, 2.0 Hz, 1H), 7.89 (dd, *J* = 7.6, 1.9 Hz, 1H), 7.81 (d, *J* = 8.1 Hz, 1H), 7.78 (d, *J* = 8.4 Hz, 1H), 7.67 (d, *J* = 8.4 Hz, 1H), 7.59 (t, *J* = 7.7 Hz, 1H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.24 (dd, *J* = 7.4, 4.5 Hz, 1H), 3.99 (s, 2H), 3.73 (s, 2H), 2.31 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.5, 144.0, 138.9, 136.3, 136.1, 134.0, 132.6, 128.2, 127.9, 127.7, 127.5, 127.5, 126.5, 124.5, 123.0, 62.4, 60.3, 42.6.

HRMS (ESI+): *Calcd.* for $C_{18}H_{17}Br_2N_2$ $[M+H]^+$: 418.9758, found 418.9761.

*N-(2-bromo-4-fluorobenzyl)-1-(2-bromopyridin-3-yl)-N-methylmethanamine (**S20**)*



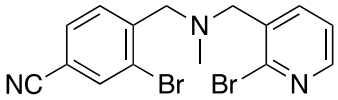
Reaction performed following general procedure **D** with 2.75 mmol of 2-bromo-3-methylpyridine and 2.75 mmol of secondary amine **S15**. **S20** was isolated as a yellow oil (526 mg, 1.36 mmol, 49%). Spectroscopic data for **S20** match those previously reported.[6]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.25 (dd, *J* = 4.8, 2.0 Hz, 1H), 7.84 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.46 (dd, *J* = 8.6, 6.2 Hz, 1H), 7.32 – 7.22 (m, 2H), 7.01 (d, *J* = 2.6 Hz, 0H), 3.67 (d, *J* = 4.9 Hz, 4H), 2.25 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 162.5, 160.5, 148.46 144.0, 138.8, 135.9, 133.9 (d, J_{CF} = 3.4 Hz), 131.7 (d, J_{CF} = 8.4 Hz), 124.5 (d, J_{CF} = 9.4 Hz), 123.0, 120.1 (d, J_{CF} = 24.4 Hz), 114.5 (d, J_{CF} = 20.8 Hz), 60.9, 60.1, 42.3.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{13}N_2FBr_2$ $[M+H]^+$: 386.9515, found 386.9508.

*3-bromo-4-((((2-bromopyridin-3-yl)methyl)(methyl)amino)methyl)benzonitrile (**S21**)*



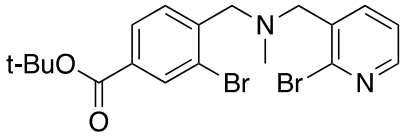
Reaction performed following general procedure **C** with 4.76 mmol of 3-bromo-4-formylbenzonitrile and 5.71 mmol of secondary amine **S7**. **S21** was isolated as a yellow oil (1.768 g, 4.47 mmol, 94%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.26 (dd, *J* = 4.8, 1.7 Hz, 1H), 7.82-7.80 (m, 2H), 7.68 (d, *J* = 7.9 Hz, 1H), 7.58 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.26 (dd, *J* = 7.5, 4.7 Hz, 1H), 3.75 (s, 2H), 3.71 (s, 2H), 2.28 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.8, 144.11, 144.06, 138.7, 136.1, 135.5, 131.0, 130.9, 124.6, 123.0, 117.5, 112.6, 61.3, 60.6, 42.6.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{14}N_3Br_2$ $[M+H]^+$: 394.9554, found 394.9551.

*tert-butyl 3-bromo-4-((((2-bromopyridin-3-yl)methyl)(methyl)amino)methyl)benzoate (**S22**)*



Reaction performed following general procedure **D** with 3.06 mmol of **S3** and 3.06 mmol of secondary amine **S7**. **S22** was isolated as a yellow oil (803 mg, 1.71 mmol, 56%).

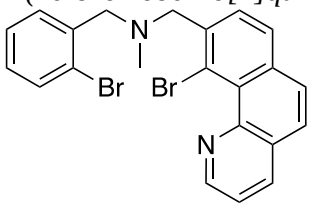
TLC R_f = 0.11 (9:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.25 (dd, *J* = 4.8, 2.1 Hz, 1H), 8.14 (d, *J* = 1.7 Hz, 1H), 7.90 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.86 (d, *J* = 7.6 Hz, 1H), 7.58 (d, *J* = 8.0 Hz, 1H), 7.25 (dd, *J* = 7.2, 5.1 Hz, 1H), 3.75 (s, 2H), 3.68 (s, 2H), 2.28 (s, 3H), 1.58 (s, 9H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 164.5, 148.6, 143.9, 142.6, 138.7, 135.8, 133.9, 132.6, 130.3, 128.4, 124.3, 123.1, 81.8, 61.5, 60.2, 42.5, 28.3.

HRMS (ESI$^+$): *Calcd.* for $C_{19}H_{23}N_2O_2Br_2$ $[M+H]^+$: 469.0126, found 469.0130.

*1-(10-bromobenzo[h]quinolin-9-yl)-N-(2-bromobenzyl)-N-methylmethanamine (**S23**)*



Reaction performed following general procedure **D** with 2.0 mmol of 10-bromo-9-methylbenzo[h]quinoline **S4** and 2.0 mmol of secondary amine **S5**. **S23** was isolated as a pale yellow oil (422 mg, 0.90 mmol, 45%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.09 (dd, *J* = 4.3, 1.8 Hz, 1H), 8.17 (dd, *J* = 8.0, 1.5 Hz, 1H), 8.02 (d, *J* = 8.1 Hz, 1H), 7.85 (d, *J* = 8.2 Hz, 1H), 7.75 (d, *J* = 8.7 Hz, 1H), 7.67 (d, *J* = 8.7 Hz, 1H), 7.63 (d, *J* = 8.7 Hz, 1H), 7.56 (d, *J* = 3.8 Hz, 1H), 7.54 (d, *J* = 3.8 Hz, 1H), 7.30 (t, *J* = 7.4 Hz, 1H), 7.11 (t, *J* = 7.4 Hz, 1H), 4.11 (s, 2H), 3.82 (s, 2H), 2.35 (s, 3H).

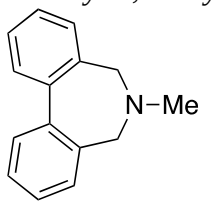
^{13}C NMR (126 MHz, Chloroform-*d*) δ 146.6, 140.9, 138.6, 135.8, 135.4, 132.9, 130.9, 129.6, 128.8, 128.5, 128.1, 127.9, 127.8, 127.4, 126.3, 124.7, 121.8, 121.3, 63.0, 61.8, 42.7.

HRMS (ESI$^+$): *Calcd.* for $C_{22}H_{19}N_2Br_2$ $[M+H]^+$: 468.9915, found 468.9909.

General procedure E for the synthesis of biaryl-linked dihydroazepines

To a flame dried round bottom flask charged with a magnetic stir bar was added Et_4NI (1 equiv), activated Zn powder (10 equiv.) and $NiBr_2(PPh_3)_2$ (1 equiv.). The flask was evacuated and back filled with N_2 three times, followed by the addition of anhydrous THF (0.05 M). The green reaction solution was allowed to stir for ten minutes in which time the color changed to a dark red. Tertiary amine (1 equiv) dissolved in anhydrous THF was added and the resulting mixture was stirred at 50 °C for 30 minutes to 24 hours, followed by TLC. Following complete consumption of starting material, the reaction was cooled to room temperature and quenched with 2M NH_3 (aq.) (10 mL). After stirring for 15 minutes, the crude reaction mixture was filtered through a pad of Celite and transferred to a separatory funnel. The solution was extracted with EtOAc (20 mL × 3). The combined organic extracts were washed with brine (20 mL), dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The crude material was purified by flash column chromatography using a gradient of 1:1 Hex:EtOAc to 1:1 EtOAc:MeOH to afford the desired biaryl-linked dihydroazepine.

*6-methyl-6,7-dihydro-5H-dibenzo[c,e]azepine (**7**)*



Reaction performed following general procedure **E** with 1.35 mmol of tertiary amine **S16**. The reaction required 18 hours to go to completion instead of the standard 30 minutes. **7** was isolated as a viscous, pale yellow oil (204 mg, 0.98 mmol, 72%). Spectroscopic data for **7** match those previously reported.[6]

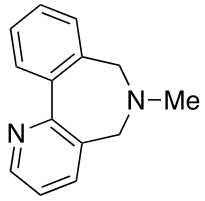
TLC R_f = 0.50 (9:1 EtOAc:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.52 – 7.50 (m, 2H), 7.45 (ddd, *J* = 8.75, 5.94, 2.84 Hz, 2H), 7.37 – 7.36 (m, 4H), 3.38 (s, 4H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 141.2, 134.5, 129.9, 128.2, 127.82, 127.81 57.3, 43.1.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{16}N$ $[M+H]^+$: 210.1283, found 210.1288.

*6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**11**)*



Reaction performed following general procedure **E** with 8.1 mmol of tertiary amine **22i**. **11** was isolated as a yellow oil (1.569 g, 7.5 mmol, 92%). Spectroscopic data for **11** match those previously reported.[6]

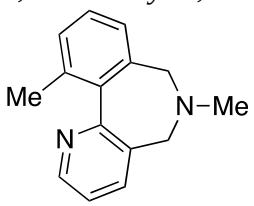
TLC R_f = 0.20 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.61 (dd, *J* = 5.0, 1.8 Hz, 1H), 7.80 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.57 (dd, *J* = 7.6, 1.8 Hz, 1H), 7.41 (td, *J* = 7.5, 1.4 Hz, 1H), 7.33 (td, *J* = 7.4, 1.4 Hz, 1H), 7.25 (dd, *J* = 7.4, 1.4 Hz, 1H), 7.16 (dd, *J* = 7.6, 4.8 Hz, 1H), 3.36 (s, 2H), 3.27 (s, 2H), 2.39 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.4, 149.0, 140.0, 137.4, 134.0, 130.0, 129.6, 128.9, 128.2, 128.1, 122.1, 56.7, 56.0, 42.7.

HRMS(ESI$^+$): *Calcd.* for $C_{14}H_{15}N_2$ $[M+H]^+$: 211.1235, found 211.1234.

*6,11-dimethyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23a**)*



Reaction performed following general procedure **E** with 1.4 mmol of tertiary amine **22a**. **23a** was isolated as a brown oil (217 mg, 0.97 mmol, 69%).

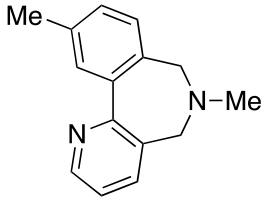
TLC R_f = 0.29 (6:4 EtOAc:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.67 (dd, *J* = 4.9, 1.7 Hz, 1H), 7.66 (dd, *J* = 7.6, 1.8 Hz, 1H), 7.32 – 7.26 (m, 2H), 7.23 (dt, *J* = 7.5, 4.3 Hz, 1H), 7.13 (dd, *J* = 6.8, 1.9 Hz, 1H), 3.49 (d, *J* = 12.5 Hz, 1H), 3.46 (d, *J* = 12.5 Hz, 1H), 3.16 (d, *J* = 12.5 Hz, 1H), 3.07 (d, *J* = 12.5 Hz, 1H), 2.48 (s, 3H), 2.40 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.7, 148.1, 137.8, 137.0, 136.9, 134.0, 130.93, 130.90, 128.4, 127.2, 121.9, 57.0, 55.8, 42.8, 20.5.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2$ $[M+H]^+$: 225.1392, found 225.1394.

*6,10-dimethyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23b**)*



Reaction performed following general procedure **E** with 1.93 mmol of tertiary amine **22a**. **23b** was isolated as a light brown oil (320 mg, 1.43 mmol, 74%). Spectroscopic data for **23b** match those previously reported.[6]

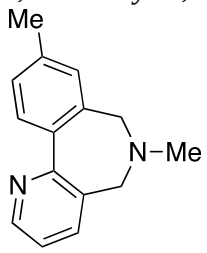
TLC R_f = 0.36 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.72 – 8.71 (m, 1H), 7.72 (s, 1H), 7.68 (d, *J* = 7.6 Hz, 1H), 7.30 – 7.25 (m, 3H), 3.43 (d, *J* = 2.1 Hz, 2H), 3.37 (d, *J* = 2.2 Hz, 2H), 2.49 (s, 3H), 2.47 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.0, 149.1, 140.1, 138.1, 137.6, 131.7, 130.5, 129.84, 129.80, 128.8, 122.3, 56.8, 56.6, 43.2, 21.4.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2$ $[M+H]^+$: 225.1392, found 225.1397.

*6,9-dimethyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23c**)*



Reaction performed following general procedure **E** with 1.3 mmol of tertiary amine **22c**. **23c** was isolated as a pale orange solid (175 mg, 0.79 mmol, 61%).

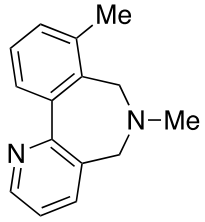
TLC R_f = 0.27 (6:4 EtOAc:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.69 (dd, *J* = 4.9, 1.6 Hz, 1H), 7.77 (d, *J* = 7.8 Hz, 1H), 7.67 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.32 (d, *J* = 7.8 Hz, 1H), 7.26 – 7.23 (m, 1H), 7.16 (s, 1H), 3.43 (s, 2H), 3.37 (s, 2H), 2.50 (s, 3H), 2.43 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.7, 149.1, 139.1, 137.6, 137.4, 133.9, 130.5, 130.0, 129.1, 128.2, 122.0, 57.0, 56.4, 43.0, 21.4.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2$ $[M+H]^+$: 225.1392, found 225.1397.

*6,8-dimethyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23d**)*



Reaction performed following general procedure **E** with 1.76 mmol of tertiary amine **22d**. **23d** was isolated as a light tan oil (316 mg, 1.41 mmol, 80%). Spectroscopic data for **23d** match those previously reported.[6]

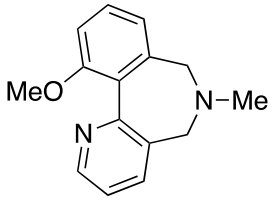
TLC R_f = 0.22 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.63 (dd, *J* = 4.9, 1.8 Hz, 1H), 7.61 (dd, *J* = 7.6, 1.8 Hz, 1H), 7.28 – 7.23 (m, 2H), 7.19 (dd, *J* = 7.6, 4.9 Hz, 1H), 7.10 (dd, *J* = 6.9, 1.9 Hz, 1H), 3.43 (t, *J* = 13.8 Hz, 2H), 3.11 (d, *J* = 12.9 Hz, 1H), 3.04 (d, *J* = 12.3 Hz, 1H), 2.45 (s, 3H), 2.35 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.6, 148.0, 137.8, 136.9, 136.8, 134.1, 130.9, 130.8, 128.3, 127.2, 121.8, 57.0, 55.8, 42.8, 20.5.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2$ $[M+H]^+$: 225.1392, found 225.1397.

*11-methoxy-6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23e**)*



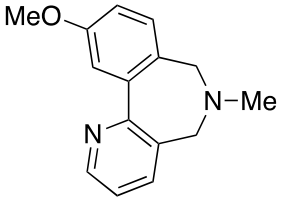
Reaction performed following general procedure **E** with 1.25 mmol of tertiary amine **22e**. **23e** was isolated as an off-white solid (170 mg, 0.71 mmol, 57%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.74 (dd, *J* = 4.9, 1.74 Hz, 1H), 7.68 (dd, *J* = 7.6, 1.75 Hz, 1H), 7.37-7.41 (m, 1H), 7.24-7.27 (m, 1H), 7.06 (d, *J* = 8.5 Hz, 1H), 6.94 (d, *J* = 7.3 Hz, 1H), 3.87 (s, 3H), 3.52 (d, *J* = 12.2 Hz, 1H), 3.47 (d, *J* = 12.8 Hz, 1H), 3.19 (d, *J* = 12.9 Hz, 1H), 3.12 (d, *J* = 12.1 Hz, 1H), 2.42 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 156.8, 156.5, 148.4, 137.1, 135.7, 131.1, 129.8, 127.4, 122.1, 111.4, 56.7, 56.2, 56.1, 43.0.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2O$ $[M+H]^+$: 241.1341, found 241.1348.

*10-methoxy-6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23f**)*



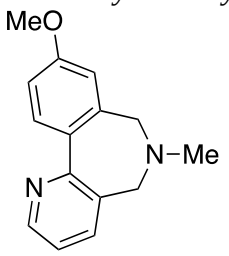
Reaction performed following general procedure **E** with 2.50 mmol of tertiary amine **22f**. **23f** was isolated as a clear oil (250 mg, 1.89 mmol, 42%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.70 (dt, *J* = 4.9, 1.7 Hz, 1H), 7.67 (dt, *J* = 7.5, 1.6 Hz, 1H), 7.45 – 7.42 (m, 1H), 7.29 – 7.24 (m, 2H), 6.97 (dt, *J* = 8.2, 2.0 Hz, 1H), 3.89 (d, *J* = 1.3 Hz, 3H), 3.37 (d, *J* = 12.0 Hz, 4H), 2.46 (d, *J* = 1.3 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.7, 158.6, 149.0, 141.4, 137.6, 130.9, 130.3, 126.8, 122.3, 115.6, 112.6, 56.3, 56.2, 55.5, 42.8.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{17}N_2O$ $[M+H]^{+}$: 241.1341, found 241.1347.

*9-methoxy-6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23g**)*



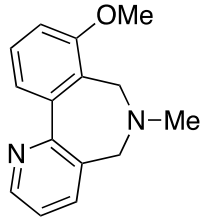
Reaction performed following general procedure **E** with 1.25 mmol of tertiary amine **22g**. **23g** was isolated as an off-white solid (172 mg, 0.72 mmol, 58%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.67 (d, *J* = 4.6, 1H), 7.83 (d, *J* = 8.5 Hz, 1H), 7.66 (d, *J* = 7.5 Hz, 1H), 7.24 (dd, *J* = 7.6, 5.1 Hz, 1H), 7.04 (dd, *J* = 8.6, 2.5 Hz, 1H), 6.89 (d, *J* = 2.5 Hz, 1H), 3.89 (s, 3H), 3.44 (s, 2H), 3.37 (s, 2H), 2.51 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 160.2, 158.6, 148.9, 137.5, 136.1, 132.8, 130.1, 129.6, 121.7, 115.2, 113.5, 57.4, 56.7, 55.4, 43.3.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{17}N_2O$ $[M+H]^{+}$: 241.1341, found 241.1343.

*8-methoxy-6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**23h**)*



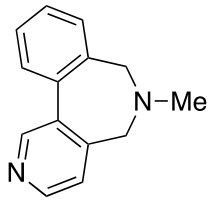
Reaction performed following general procedure **E** with 1.14 mmol of tertiary amine **22h**. **23h** was isolated as an orange solid (138 mg, 0.57 mmol, 50%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.69 (dd, *J* = 4.9, 1.7 Hz, 1H), 7.67 (dd, *J* = 7.6, 1.7 Hz, 1H), 7.42-7.47 (m, 2H), 7.26-7.29 (m, 1H), 7.01 (dd, *J* = 7.5, 1.8 Hz, 1H), 3.89 (s, 3H), 3.57 (s, 2H), 3.35 (s, 2H), 2.48 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.7, 157.5, 149.2, 142.0, 137.6, 130.7, 128.9, 122.5, 120.5, 111.0, 56.8, 55.9, 48.3, 43.4.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{17}N_2O$ $[M+H]^{+}$: 241.1341, found 241.1346.

*6-methyl-6,7-dihydro-5H-benzo[c]pyrido[3,4-e]azepine (**23j**)*



Reaction performed following general procedure **E** with 2.65 mmol of tertiary amine **22j**. **23j** was isolated as a tan oil (234 mg, 1.11 mmol, 42%).

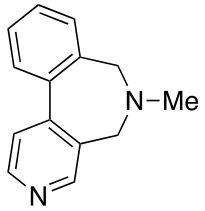
TLC R_f = 0.28 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.73 (s, 1H), 8.60 (d, *J* = 4.8 Hz, 1H), 7.52 (dd, *J* = 7.5, 1.5 Hz, 1H), 7.47 (td, *J* = 7.3, 1.7 Hz, 1H), 7.42 (td, *J* = 7.2, 1.5 Hz, 1H), 7.38 (dd, *J* = 7.4, 1.6 Hz, 1H), 7.28 (d, *J* = 4.9 Hz, 1H), 3.37 (s, 4H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.2, 148.1, 142.6, 137.5, 136.7, 135.0, 130.2, 128.7, 128.5, 127.6, 124.3, 57.3, 56.5, 43.5.

HRMS (ESI^{+}): *Calcd.* for $C_{14}H_{15}N_2$ $[M+H]^{+}$: 211.1235, found 211.1240.

*6-methyl-6,7-dihydro-5H-benzo[c]pyrido[4,3-e]azepine (**23k**)*



Reaction performed following general procedure **E** with 1.34 mmol of tertiary amine **22k**. **23k** was isolated as a light yellow oil (226 mg, 50%).

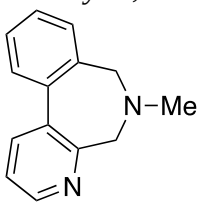
TLC R_f = 0.28 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.68 (d, *J* = 5.0 Hz, 1H), 8.58 (s, 1H), 7.52 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.49 (td, *J* = 7.3, 1.6 Hz, 1H), 7.45 (td, *J* = 7.2, 1.6 Hz, 1H), 7.42 – 7.39 (m, 2H), 3.39 (s, 2H), 3.38 (s, 2H), 2.47 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 150.2, 149.8, 149.0, 138.5, 135.1, 130.3, 129.9, 129.3, 128.5, 127.8, 121.8, 57.2, 54.4, 43.3.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{15}N_2$ $[M+H]^+$: 211.1235, found 211.1239.

*6-methyl-6,7-dihydro-5H-benzo[c]pyrido[3,2-e]azepine (**23l**)*



Reaction performed following general procedure **E** with 1.34 mmol of tertiary amine **22l**. **23l** was isolated as a tan oil (23 mg, 0.1 mmol, 8%).

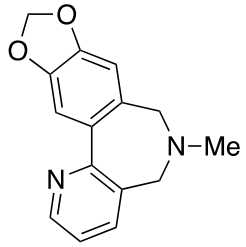
TLC R_f = 0.20 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.60 (dd, *J* = 4.9, 1.6 Hz, 1H), 7.80 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.48 – 7.44 (m, 2H), 7.44 – 7.40 (m, 2H), 7.38 (dd, *J* = 5.0, 1.3 Hz, 1H), 3.61 (s, 2H), 3.39 (s, 2H), 2.53 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 154.6, 148.7, 139.1, 136.2, 135.2, 135.0, 130.1, 128.6, 128.4, 127.8, 123.2, 59.2, 57.6, 43.8.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{15}N_2$ $[M+H]^+$: 211.1235, found 211.1238.

*6-methyl-6,7-dihydro-5H-[1,3]dioxolo[4',5':4,5]benzo[1,2-c]pyrido[2,3-e]azepine (**23m**)*



Reaction performed following general procedure **E** with 1.81 mmol of tertiary amine **22m**. **23m** was isolated as a light tan solid (304 mg, 66%). Spectroscopic data for **23m** match those previously reported.[6]

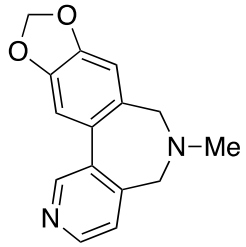
TLC R_f = 0.19 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.66 (d, *J* = 4.5 Hz, 1H), 7.65 (d, *J* = 7.5 Hz, 1H), 7.37 (d, *J* = 1.2 Hz, 1H), 7.24 – 7.22 (m, 1H), 6.82 (s, 1H), 6.03 (s, 2H), 3.33 (s, 2H), 3.32 (s, 2H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.5, 148.9, 148.2, 147.7, 137.5, 134.2, 130.4, 128.9, 121.9, 109.9, 108.6, 101.3, 56.8, 56.5, 43.0.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{15}N_2O_2$ $[M+H]^+$: 255.1134, found 255.1138.

*6-methyl-6,7-dihydro-5H-[1,3]dioxolo[4',5':4,5]benzo[1,2-c]pyrido[3,4-e]azepine (**23n**)*



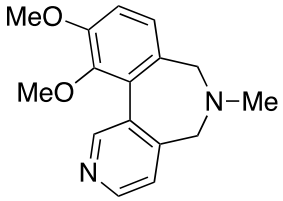
Reaction performed following general procedure **E** with 1.45 mmol of tertiary amine **22n**. The reaction required 18 hours to go to completion instead of the standard 30 minutes. **23n** was isolated as an off-white solid (200 mg, 0.79 mmol, 54%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.62 (s, 1H), 8.52 (d, *J* = 4.8 Hz, 1H), 7.22 (d, *J* = 4.9 Hz, 1H), 6.96 (s, 1H), 6.84 (s, 1H), 6.00 (s, 2H), 3.30 (s, 2H), 3.22 (s, 2H), 2.39 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.7, 147.9, 147.7, 147.7, 142.6, 136.6, 131.0, 129.0, 124.2, 110.5, 107.9, 101.5, 57.0, 56.5, 43.3.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{17}N_2O$ $[M+H]^+$: 241.1341, found 241.1346.

*10,11-dimethoxy-6-methyl-6,7-dihydro-5H-benzo[c]pyrido[3,4-e]azepine (**23o**)*



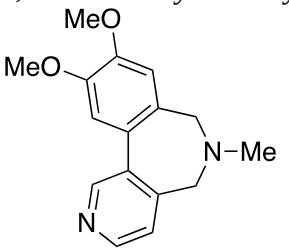
Reaction performed following general procedure **E** with 2.33 mmol of tertiary amine **22o**. The reaction required 14 hours to go to completion instead of the standard 30 minutes. **23o** was isolated as an off-white solid (443 mg, 1.64 mmol, 70%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.92 (s, 1H), 8.57 (d, *J* = 4.9 Hz, 1H), 7.27 (d, *J* = 7.7 Hz, 1H), 7.08 (d, *J* = 8.2 Hz, 1H), 6.95 (d, *J* = 8.3 Hz, 1H), 3.93 (s, 3H), 3.64 (s, 3H), 3.46 (dd, *J* = 12.5, 8.0 Hz, 2H), 3.23 (d, *J* = 12.2 Hz, 1H), 3.00 (d, *J* = 12.8 Hz, 1H), 2.40 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 152.8, 150.6, 148.6, 145.8, 142.3, 132.4, 130.3, 128.1, 125.4, 124.1, 111.9, 60.8, 56.6, 56.1, 55.9, 43.0.

HRMS (ESI^{+}): *Calcd.* for $C_{16}H_{18}N_2O_2$ $[M+H]^+$: 274.1447, found 274.1455.

*9,10-dimethoxy-6-methyl-6,7-dihydro-5H-benzo[c]pyrido[3,4-e]azepine (**23p**)*



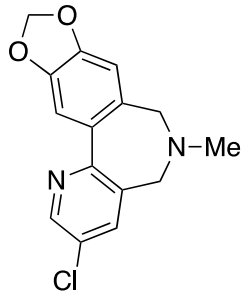
Reaction performed following general procedure **E** with 2.33 mmol of tertiary amine **22p**. The reaction required 14 hours to go to completion instead of the standard 30 minutes. **23p** was isolated as an off-white solid (254 mg, 0.94 mmol, 40%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.73 (s, 1H), 8.60 – 8.55 (m, 1H), 7.28 (d, *J* = 4.8 Hz, 1H), 7.03 (d, *J* = 2.0 Hz, 1H), 6.94 (d, *J* = 1.9 Hz, 1H), 3.96 (dd, *J* = 5.2, 2.1 Hz, 6H), 3.40 (s, 2H), 3.32 (s, 2H), 2.48 (d, *J* = 2.0 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.0, 148.9, 148.6, 147.8, 142.1, 136.6, 129.6, 127.6, 124.3, 113.1, 110.6, 56.9, 56.4, 56.13, 56.08, 43.2.

HRMS (ESI^{+}): *Calcd.* for $C_{16}H_{18}N_2O_2$ $[M+H]^+$: 274.1447, found 274.1454.

*3-chloro-6-methyl-6,7-dihydro-5H-[1,3]dioxolo[4',5':4,5]benzo[1,2-c]pyrido[2,3- e]azepine (**33a**)*



Reaction performed at 0 °C for 3h following general procedure **E** with 0.566 mmol of tertiary amine **26a**. **33a** was isolated as a light yellow oil (74 mg, 45%).

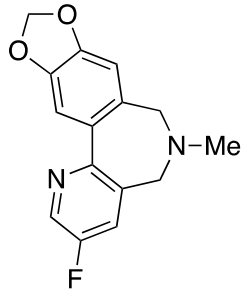
TLC R_f = 0.28 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.61 (d, *J* = 2.4 Hz, 1H), 7.65 (d, *J* = 2.4 Hz, 1H), 7.32 (s, 1H), 6.82 (s, 1H), 6.03 (s, 2H), 3.34 (s, 2H) 3.33 (s, 2H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 156.8, 148.6, 148.0, 147.9, 137.2, 133.3, 131.2, 130.2, 128.9, 110.2, 108.7, 101.6, 56.8, 56.1, 42.9.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{14}N_2O_2Cl$ $[M+H]^+$: 289.0744, found 289.0751.

*3-fluoro-6-methyl-6,7-dihydro-5H-[1,3]dioxolo[4',5':4,5]benzo[1,2-c]pyrido[2,3- e]azepine (**33b**)*



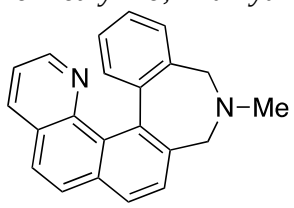
Reaction performed following general procedure **E** with 2.13 mmol of tertiary amine **26b**. **33b** was isolated as a light brown oil (337 mg, 1.23 mmol, 58%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.51 (d, *J* = 2.77 Hz, 1H), 7.40 (dd, *J* = 8.20, 2.81 Hz, 1H), 7.30 (s, 1H), 6.81 (s, 1H), 6.03 (s, 2H), 3.32 (s, 4H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.4, 157.4, 154.8 (d, J_{CF} = 4.0 Hz), 148.0 (d, J_{CF} = 57.8 Hz) 137.0 (d, J_{CF} = 23.4 Hz), 133.4, 131.8 (d, J_{CF} = 3.7 Hz), 128.8, 124.3 (d, J_{CF} = 17.7 Hz), 110.0, 108.7, 101.5, 57.0, 56.4, 43.2.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{14}N_2O_2F$ $[M+H]^+$: 273.1039, found 273.1046.

*10-methyl-10,11-dihydro-9H-benzo[5',6']azepino[4',3':3,4]benzo[1,2-h]quinoline (**39**)*



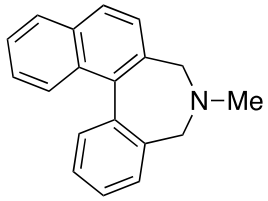
Reaction performed following general procedure **E** with 0.79 mmol of tertiary amine **S22**. **39** was isolated as a light brown solid (123 mg, 0.40 mmol, 50%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.41 (dd, *J* = 4.2, 1.8 Hz, 1H), 8.10 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.93 (d, *J* = 7.8 Hz, 1H), 7.86 (d, *J* = 8.7 Hz, 1H), 7.71 (d, *J* = 8.7 Hz, 1H), 7.66 (d, *J* = 7.8 Hz, 1H), 7.50 (dt, *J* = 7.6, 0.7 Hz, 1H), 7.37 (td, *J* = 7.5, 1.2 Hz, 1H), 7.34 (dd, *J* = 7.9, 4.2 Hz, 1H), 7.22 (td, *J* = 7.5, 1.2 Hz, 1H), 7.12 (dd, *J* = 7.6, 1.2 Hz, 1H), 3.79 (d, *J* = 12.4 Hz, 1H), 3.72 (d, *J* = 12.9 Hz, 1H), 3.64 (d, *J* = 11.9 Hz, 1H), 3.34 (d, *J* = 12.9 Hz, 1H), 2.53 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 147.1, 146.8, 142.9, 138.4, 135.3, 135.2, 134.2, 133.0, 131.1, 129.8, 128.8, 128.5, 128.2, 128.1, 127.5, 126.6, 126.0, 121.4, 57.6, 57.4, 42.8.

HRMS (ESI^{+}): *Calcd.* for $C_{22}H_{19}N_2$ $[M+H]^+$: 311.1548, found 311.1552.

*6-methyl-6,7-dihydro-5H-benzo[c]naphtho[1,2-e]azepine (**S24**)*



Reaction performed following general procedure **E** with 0.67 mmol of tertiary amine **S17**. **S24** was isolated as a yellow oil (0.12 g, 0.46 mmol, 68%).

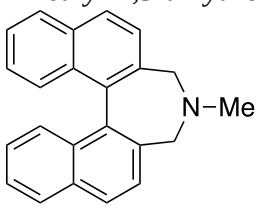
TLC Rf = 0.25 (5:1 EtOAc:MeOH).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 – 8.09 (m, 1H), 7.91 – 7.88 (m, 1H), 7.84 (d, J = 8.2 Hz, 1H), 7.62 (dd, J = 7.6, 1.5 Hz, 1H), 7.51 – 7.39 (m, 8H), 3.65 (d, *J* = 12.6 Hz, 1H), 3.59 (d, *J* = 12.2 Hz, 1H), 3.28 (d, *J* = 12.6 Hz, 1H), 3.21 (d, *J* = 12.2 Hz, 1H), 2.44 (s, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.3, 136.7, 133.8, 132.7, 132.3, 130.8, 128.4, 128.0, 127.9, 127.4, 127.3, 127.24, 127.20, 126.2, 124.6, 124.1, 62.0, 61.4, 42.2.

HRMS (ESI^{+}): *Calcd*. for $C_{19}H_{18}N$ $[M+H]^+$: 260.1339, found 260.1440.

*4-methyl-4,5-dihydro-3H-dinaphtho[2,1-c:1',2'-e]azepine (**S25**)*



Reaction performed following general procedure **E** with 1.07 mmol of tertiary amine **S18**. **S25** was isolated as a yellow crystalline solid (162 mg, 0.52 mmol, 49%). Spectroscopic data for **S25** closely match those previously reported.[9]

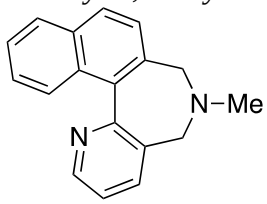
TLC R_f = 0.31 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.97 (dd, *J* = 8.2, 2.0 Hz, 4H), 7.59 (d, *J* = 8.2 Hz, 2H), 7.49 – 7.46 (m, 4H), 7.29 – 7.26 (m, 2H), 3.67 (d, *J* = 12.3 Hz, 2H), 3.30 (d, *J* = 12.3 Hz, 2H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 135.0, 133.5, 133.3, 131.6, 128.5, 127.9, 127.6, 125.9, 125.6, 57.4, 43.2.

HRMS (ESI$^+$): *Calcd.* for $C_{23}H_{20}N$ $[M+H]^+$: 310.1596, found 310.1599.

*6-methyl-6,7-dihydro-5H-naphtho[2,1-c]pyrido[2,3-e]azepine (**S26**)*



Reaction performed following general procedure **E** with 1.44 mmol of tertiary amine **S19**. **S26** was isolated as a light brown oil (278 mg, 1.07 mmol, 74%). Spectroscopic data for **S26** match those previously reported.[6]

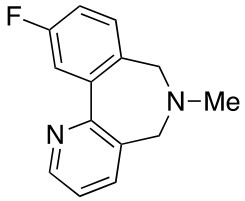
TLC R_f = 0.36 (9:1 $CHCl_3$:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.83 – 8.81 (m, 1H), 8.46 – 8.44 (m, 1H), 7.94 – 7.90 (m, 2H), 7.77 (dt, *J* = 7.6, 1.7 Hz, 1H), 7.53 – 7.44 (m, 2H), 7.45 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.34 (ddd, *J* = 7.6, 4.9, 1.5 Hz, 1H), 3.64 (dd, *J* = 13.0, 1.3 Hz, 1H), 3.55 (dd, *J* = 12.0, 1.4 Hz, 1H), 3.35 (dd, *J* = 13.0, 1.5 Hz, 1H), 3.11 (d, *J* = 12.0 Hz, 1H), 2.46 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.3, 148.5, 137.5, 135.2, 133.9, 132.4, 132.3, 131.0, 129.4, 128.3, 127.8, 126.9, 126.4, 125.9, 122.2, 57.4, 56.2, 43.1.

HRMS (ESI$^+$): *Calcd.* for $C_{18}H_{17}N_2$ $[M+H]^+$: 261.1392, found 261.1396.

*10-fluoro-6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine (**S27**)*



Reaction performed following general procedure **E** with 5.2 mmol of tertiary amine **S20**. **S27** was isolated as a grey oil (500 mg, 2.2 mmol, 42%). Spectroscopic data for **S27** match those previously reported.[6]

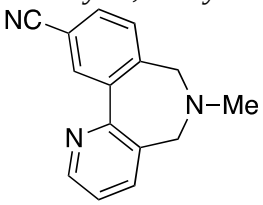
TLC R_f = 0.28 (9:1 EtOAc:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.67 (dd, *J* = 4.9, 1.7 Hz, 1H), 7.66 (d, *J* = 7.5 Hz, 1H), 7.56 (dd, *J* = 9.4, 2.7 Hz, 1H), 7.28 (dt, *J* = 7.7, 5.1 Hz, 2H), 7.09 (dt, *J* = 8.9, 4.4 Hz, 1H), 3.36 (d, *J* = 16.7 Hz, 4H), 2.45 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 162.7 (d, J_{CF} = 246.4 Hz), 157.6, 149.0 (d, J_{CF} = 2.8 Hz), 142.2 (d, J_{CF} = 7.9 Hz), 137.6, 131.2 (d, J_{CF} = 8.2 Hz), 130.4, 128.6 (d, J_{CF} = 11.7 Hz), 122.6, 115.6 (d, J_{CF} = 21.5 Hz), 115.1 (d, J_{CF} = 22.5 Hz), 56.3, 56.2, 42.9.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{14}N_2F$ $[M+H]^+$: 229.1141, found 229.1145.

*6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine-10-carbonitrile (**S28**)*



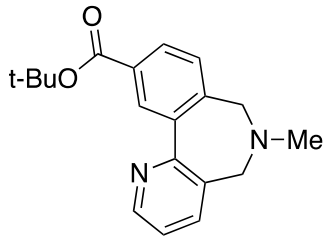
Reaction performed following general procedure **E** with 1.50 mmol of tertiary amine **S21**. **S28** was isolated as an orange oil (228 mg, 0.97 mmol, 65%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.72 (dd, *J* = 4.8, 1.6 Hz, 1H), 8.20 (d, *J* = 1.9 Hz, 1H), 7.70 (d, *J* = 7.7 Hz, 2H), 7.45 (d, *J* = 7.8 Hz, 1H), 7.34 (dd, *J* = 7.3, 4.8 Hz, 1H), 3.46 (s, 2H), 3.36 (s, 2H), 2.48 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 156.5, 149.5, 141.6, 139.6, 137.9, 132.4, 132.2, 130.8, 130.6, 123.4, 118.7, 112.6, 57.0, 56.3, 43.4.

HRMS (ESI$^+$): *Calcd.* for $C_{15}H_{14}N_3$ $[M+H]^+$: 236.1188, found 236.1189.

*tert-butyl 6-methyl-6,7-dihydro-5H-benzo[c]pyrido[2,3-e]azepine-10-carboxylate (**S29**)*



Reaction performed following general procedure **E** with 1.67 mmol of tertiary amine **S22**. **S29** was isolated as a yellow oil (378 mg, 1.22 mmol, 73%).

TLC R_f = 0.41 (9:1 EtOAc:MeOH)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.73 (dd, *J* = 4.8, 1.7 Hz, 1H), 8.46 (d, *J* = 1.8 Hz, 1H), 8.07 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.69 (dd, *J* = 7.6, 1.7 Hz, 1H), 7.40 (d, *J* = 7.8 Hz, 1H), 7.30 (dd, *J* = 7.5, 4.8 Hz, 1H), 3.48 (s, 2H), 3.36 (s, 2H), 2.49 (s, 3H), 1.61 (s, 9H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 165.4, 157.9, 149.2, 140.2, 138.4, 137.5, 132.3, 130.3, 129.9, 129.7, 129.3, 122.6, 81.2, 56.8, 56.3, 43.1, 28.2.

HRMS (ESI$^+$): *Calcd.* for $C_{19}H_{23}N_2O_2$ $[M+H]^+$: 311.1760, found 311.1768.

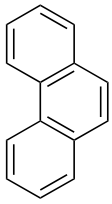
General procedure F for deaminative contractions

To a round bottom flask was added biaryl-linked dihydroazepine (1 equiv.), trimethyl phosphate (5 equiv.), and lithium iodide (1 equiv.) dissolved in anhydrous THF (0.1M). The reaction mixture was purged with nitrogen and heated to 65 °C for 16 hr. The mixture was allowed to cool to room temperature, followed by addition of 18-crown-6 (3 equiv.) and dropwise 1M *t*-BuOK in THF (6 equiv.). The mixture was again heated to 65 °C and stirred for an additional 6 hr. After cooling to room temperature, the reaction was quenched with 2M NH_3 (aq.) (5 mL) and extracted with EtOAc (15 mL × 3). Combined organic layers were washed with brine (10 mL), dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The crude material was purified by column chromatography using a gradient of 100% hexanes to 95:5 Hex:EtOAc to afford the desired polycyclic aromatic.

phenanthrene (**8**); *N,N-dimethyl-9,10-dihydrophenanthren-9-amine* (**10**)

Reaction performed following general procedure **F** with 0.50 mmol of azepine **7**. Purified by column chromatography using a gradient of 100% hexanes to 95:5 Hex:EtOAc, followed by a gradient of 100% EtOAc to 9:1 EtOAc:MeOH. **8** was isolated as a white solid (9 mg, 0.05 mmol, 10%). **10** was isolated as a beige oil (86 mg, 0.39 mmol, 77%). Spectroscopic data for **8** and **10** match those previously reported.[6]

*phenanthrene (**8**)*

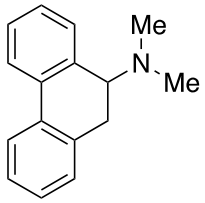


TLC R_f = 0.61 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.71 (dd, *J* = 8.3, 1.4 Hz, 2H), 7.91 (dd, *J* = 7.7, 1.5 Hz, 2H), 7.76 (s, 2H), 7.67 (ddd, *J* = 8.3, 7.0, 1.5 Hz, 2H), 7.61 (ddd, *J* = 7.4, 6.9, 1.3 Hz, 2H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 129.5, 127.7, 126.0, 124.4, 124.0, 120.1.

*N,N-dimethyl-9,10-dihydrophenanthren-9-amine (**10**)*

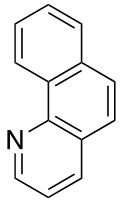


^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.80 (d, *J* = 7.3 Hz, 1H), 7.79 (d, *J* = 7.8 Hz, 1H) 7.43 (dd, *J* = 7.5, 1.5 Hz, 1H), 7.39 (td, *J* = 7.6, 1.5 Hz, 1H), 7.33 – 7.29 (m, 2H), 7.27 – 7.25 (m, 2H), 3.61 (t, *J* = 5.5 Hz, 1H), 3.12 (dd, *J* = 15.9, 6.0 Hz, 1H), 3.00 (dd, *J* = 15.4, 4.8 Hz, 1H), 2.26 (s, 6H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 135.0, 133.8, 129.8, 128.7, 128.6, 128.2, 127.5, 127.4, 126.7, 124.2, 123.7, 122.8, 62.4, 42.1, 30.5.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{18}N$ $[M+H]^{+}$: 224.1433, found 224.1434.

*benzo[h]quinoline (**13**)*



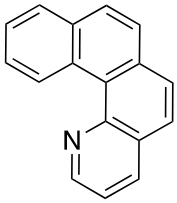
Reaction performed following general procedure **F** with 0.50 mmol of azepine **11**. Purified by column chromatography using a gradient of 100% hexanes to 95:5 Hex:EtOAc. **13** was isolated as a colorless oil (74 mg, 0.42 mmol, 83%). Spectroscopic data for **13** match those previously reported.[6]

TLC R_f = 0.40 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.31 (dd, *J* = 8.1, 1.6 Hz, 1H), 9.01 (dd, *J* = 4.4, 1.8 Hz, 1H), 8.18 (dd, *J* = 8.0, 1.8 Hz, 1H), 7.92 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.82 (d, *J* = 8.8 Hz, 1H), 7.78 – 7.67 (m, 3H), 7.53 (dd, *J* = 8.0, 4.4 Hz, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 146.3, 144.0, 133.3, 131.1, 128.9, 125.7, 125.3, 125.2, 124.5, 123.9, 122.8, 121.8, 119.3.

*naphtho[2,1-h]quinoline (**14**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **S26**. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **14** was isolated as a white solid (100 mg, 87%). Spectroscopic data for **14** match those previously reported.[6]

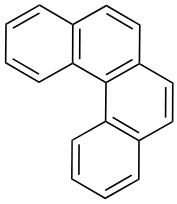
TLC R_f = 0.50 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 11.21 (d, *J* = 8.9 Hz, 1H), 9.23 (dt, *J* = 3.3, 1.6 Hz, 1H), 8.31 (ddd, *J* = 8.0, 3.4, 1.9 Hz, 1H), 8.06 – 8.00 (m, 2H), 7.97 (d, *J* = 8.5 Hz, 1H), 7.93 – 7.82 (m, 3H), 7.69 (ddd, *J* = 8.0, 6.7, 1.3 Hz, 1H), 7.57 (ddd, *J* = 8.1, 4.2, 1.4 Hz, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.6, 148.5, 136.6, 134.1, 133.8, 131.8, 130.8, 120.0, 128.8, 128.6, 128.0, 127.5, 127.0, 126.7, 126.5, 126.4, 120.7.

HRMS (ESI$^+$): *Calcd.* for $C_{17}H_{12}N$ $[M+H]^+$: 230.0970, found 230.0973.

*[4]helicene (**15**)*

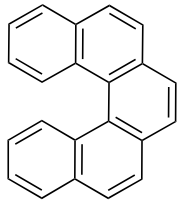


Reaction performed following general procedure **F** with 0.50 mmol of azepine **S24**. Purified by column chromatography using 100% hexanes. **15** was isolated as a white solid (67 mg, 0.29 mmol, 59%). Spectroscopic data for **15** match those previously reported.[10]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.16 (d, *J* = 8.5 Hz, 2H), 8.04 (d, *J* = 7.9 Hz, 2H), 7.92 (d, *J* = 8.5 Hz, 2H), 7.84 (d, *J* = 8.5 Hz, 2H), 7.70 (ddd, *J* = 8.4, 6.8, 1.6 Hz, 2H), 7.64 (ddd, *J* = 7.9, 6.9, 1.2 Hz, 2H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 133.6, 131.1, 130.5, 128.7, 128.0, 127.6, 127.5, 127.0, 126.3, 126.0.

*[5]helicene (**16**)*

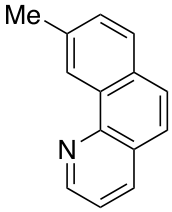


Reaction performed following general procedure **F** with 0.50 mmol of azepine **S25**. Purified by column chromatography using a gradient of 100% hex to 99:1 Hex:EtOAc. **16** was isolated as a white solid (121 mg, 0.44 mmol, 87%). Spectroscopic data for **16** match those previously reported.[10]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.53 (d, *J* = 8.5 Hz, 2H), 7.94-7.99 (m, 4H), 7.89-7.91 (m, 4H), 7.52-7.56 (td, *J* = 6.8, 1.2 Hz, 2H), 7.27-7.31 (m, 2H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 132.7, 132.4, 130.9, 129.1, 128.0, 127.6, 127.4, 127.1, 126.5, 126.4, 124.5.

*9-methylbenzo[h]quinoline (**17**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **23b**. Purified by column chromatography using 1:1 Hex:EtOAc. **17** was isolated as a colorless oil (90 mg, 0.47 mmol, 93%). Spectroscopic data for **17** match those previously reported.[6]

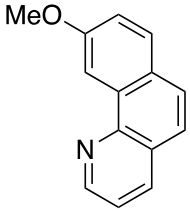
TLC R_f = 0.39 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.09 (s, 1H), 9.00 (dt, *J* = 4.1, 1.9 Hz, 1H), 8.17 (dd, *J* = 8.0, 2.1 Hz, 1H), 7.80 (ddd, *J* = 16.6, 8.5, 1.7 Hz, 2H), 7.62 (dd, *J* = 8.9, 1.8 Hz, 1H), 7.57 – 7.49 (m, 2H), 2.66 (d, *J* = 1.9 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.7, 146.5, 137.3, 136.0, 131.8, 131.6, 130.1, 127.9, 127.8, 126.7, 124.5, 124.0, 121.8, 22.1.

HRMS (ESI^{+}): *Calcd.* for $C_{14}H_{12}N$ $[M+H]^{+}$: 194.0970, found 194.0973.

*9-methoxybenzo[h]quinoline (**18**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **23f**. Purified by column chromatography using a gradient of 100% hexanes to 95:5 Hex:EtOAc. **18** was isolated as an opaque oil (85 mg, 0.41 mmol, 81%).

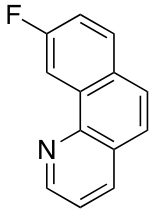
TLC R_f = 0.37 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.00 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.71 (d, *J* = 2.7 Hz, 1H), 8.16 (dd, *J* = 8.1, 1.8 Hz, 1H), 7.82 (d, *J* = 8.7 Hz, 1H), 7.76 (d, *J* = 8.7 Hz, 1H), 7.55 (d, *J* = 8.7 Hz, 1H), 7.51 (dd, *J* = 8.0, 4.3 Hz, 1H), 7.35 (dd, *J* = 8.7, 2.7 Hz, 1H), 4.11 – 4.08 (m, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 156.4, 145.8, 143.4, 133.4, 130.4, 126.8, 125.8, 124.9, 124.3, 120.2, 119.2, 117.0, 101.3, 53.1.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{12}NO$ $[M+H]^+$: 210.0919, found 210.0921.

*9-fluorobenzo[h]quinoline (**19**); 9-methoxybenzo[h]quinoline (**18**)*



Reaction performed following general procedure **F** with 0.21 mmol of azepine **S27**. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **19** was isolated as a white solid (27 mg, 0.14 mmol, 65%). **18** was isolated as an opaque oil (3 mg, 0.04 mmol, 7%). Spectroscopic data for **19** match those previously reported.[6]

TLC R_f = 0.62 (8:2 Hex:EtOAc)

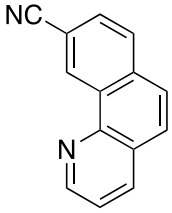
^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.99 (dd, *J* = 4.4, 1.8 Hz, 1H), 8.92 (dd, *J* = 10.7, 2.7 Hz, 1H), 8.18 (dd, *J* = 8.0, 1.8 Hz, 1H), 7.89 (dd, *J* = 8.7, 5.5 Hz, 1H), 7.79 (d, *J* = 8.8 Hz, 1H), 7.64 (d, *J* = 8.8 Hz, 1H), 7.55 (dd, *J* = 7.9, 4.3 Hz, 1H), 7.44 (td, *J* = 8.4, 2.7 Hz, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 161.8 (d, J_{CF} = 246.6 Hz), 148.8, 146.0 (d, J_{CF} = 4.7 Hz), 135.9, 133.3 (d, J_{CF} = 8.7 Hz), 130.3 (d, J_{CF} = 2.2 Hz), 129.9 (d, J_{CF} = 8.7 Hz), 127.1, 126.7, 124.5 (d, J_{CF} = 2.8 Hz), 122.3, 117.3 (d, J_{CF} = 24.3 Hz), 109.3 (d, J_{CF} = 22.9 Hz).

^{19}F NMR (471 MHz, Chloroform-*d*) δ -112.38.

HRMS (ESI$^+$): *Calcd.* for $C_{13}H_9NF$ $[M+H]^+$: 198.0719, found 198.0719.

*benzo[h]quinoline-9-carbonitrile (**20**)*



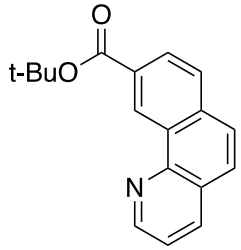
Reaction performed following general procedure **F** with 0.50 mmol of azepine **S28**. Purified by column chromatography using a gradient of 100% Hex to 4:1 Hex:EtOAc. **20** was isolated as a white solid (67 mg, 0.32 mmol, 66%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.68-9.67 (m, 1H), 9.05 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.23 (dd, *J* = 8.1, 1.7 Hz, 1H), 7.98 (d, *J* = 8.2 Hz, 1H), 7.87-7.84 (m, 3H), 7.62 (dd, *J* = 8.1, 4.4 Hz, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 150.0, 145.7, 136.2, 135.6, 131.4, 130.4, 129.6, 128.9, 127.0, 126.9, 123.1, 119.5, 110.5.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_9N_2$ $[M+H]^+$: 205.0766, found 205.0770.

*tert-butyl benzo[h]quinoline-9-carboxylate (**21**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **S29**. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **21** was isolated as a white solid (63 mg, 0.22 mmol, 45%).

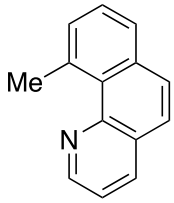
TLC R_f = 0.36 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.93 (s, 1H), 9.05 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.28 (dd, *J* = 8.3, 1.8 Hz, 1H), 8.20 (dd, *J* = 8.0, 1.8 Hz, 1H), 7.93 (d, *J* = 8.3 Hz, 1H), 7.84 (d, *J* = 8.8 Hz, 1H), 7.78 (d, *J* = 8.8 Hz, 1H), 7.56 (dd, *J* = 8.0, 4.4 Hz, 1H), 1.69 (s, 9H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 166.2, 149.5, 146.9, 136.08, 136.05, 131.2, 130.6, 128.4, 128.0, 127.7, 127.4, 126.64, 126.60, 122.3, 81.4, 28.5.

HRMS (ESI$^+$): *Calcd.* for $C_{18}H_{18}NO_2$ $[M+H]^+$: 280.1338, found 280.1342.

*10-methylbenzo[h]quinoline (**24a**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **23a**. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **24a** was isolated as a white solid (56 mg, 58%). Spectroscopic data for **24a** match those previously reported.[7]

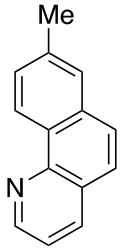
TLC R_f = 0.63 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.04 (dd, *J* = 4.3, 1.9 Hz, 1H), 8.16 (dd, *J* = 8.0, 1.9 Hz, 1H), 7.80 (dd, *J* = 9.0, 4.3 Hz, 2H), 7.66 (d, *J* = 8.7 Hz, 1H), 7.61 – 7.55 (m, 2H), 7.48 (dd, *J* = 8.0, 4.3 Hz, 1H), 3.37 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.1, 147.3, 138.9, 135.5, 135.3, 131.3, 130.1, 128.9, 127.6, 127.4, 126.9, 125.6, 120.7, 27.4.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{12}N$ $[M+H]^+$: 194.0970, found 194.0973.

*8-methylbenzo[h]quinoline (**24c**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **23c**. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **24c** was isolated as a colorless oil (83 mg, 86%).

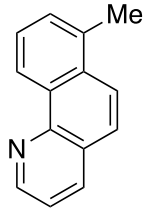
TLC R_f = 0.44 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.18 (d, *J* = 8.4 Hz, 1H), 8.98 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.15 (dt, *J* = 7.9, 1.6 Hz, 1H), 7.74 (d, *J* = 8.8 Hz, 1H), 7.69 (s, 1H), 7.65 (dd, *J* = 8.8, 1.3 Hz, 1H), 7.58 (dd, *J* = 8.5, 1.8 Hz, 1H), 7.49 (ddd, *J* = 7.9, 4.4, 1.1 Hz, 1H), 2.60 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.9, 146.8, 138.3, 135.9, 133.9, 129.5, 129.1, 127.7, 127.5, 126.2, 125.5, 124.4, 121.5, 21.8.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{12}N$ $[M+H]^+$: 194.0970, found 194.0972.

*7-methylbenzo[h]quinoline (**24d**)*



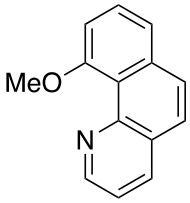
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23d**. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **24d** was isolated as a white solid (37 mg, 38%). Spectroscopic data for **24d** match those previously reported.[6]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.04 (dd, *J* = 4.3, 1.9 Hz, 1H), 8.17 (dd, *J* = 8.0, 1.9 Hz, 1H), 7.80 (dd, *J* = 8.9, 5.4 Hz, 2H), 7.66 (d, *J* = 8.7 Hz, 1H), 7.60 – 7.55 (m, 2H), 7.49 (dd, *J* = 8.0, 4.3 Hz, 1H), 3.37 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.1, 147.3, 138.9, 135.5, 135.3, 131.3, 130.0, 129.0, 127.6, 127.4, 126.9, 125.6, 120.7, 27.4.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{12}N$ $[M+H]^+$: 194.0970, found 194.0967.

*10-methoxybenzo[h]quinoline (**24e**)*



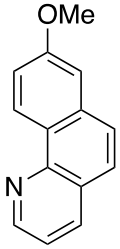
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23e**. Purified by column chromatography using 1:1 Hex:EtOAc. **24e** was isolated as a brown solid (95 mg, 0.46 mmol, 91%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.16 (br s, 1H), 8.18 (dd, *J* = 8.0, 1.9 Hz, 1H), 7.79 (d, *J* = 8.8 Hz, 1H), 7.68 (d, *J* = 8.8 Hz, 1H), 7.64 (t, *J* = 8.0 Hz, 1H), 7.55 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.51 (dd, *J* = 8.0, 4.4 Hz, 1H), 7.27 (d, *J* = 8.0 Hz, 1H), 4.20 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.3, 148.8, 136.6, 136.1, 128.6, 128.6, 127.4, 126.5, 121.4, 120.9, 109.9, 57.1.

HRMS (ESI^{+}): *Calcd.* for $C_{14}H_{12}NO$ $[M+H]^{+}$: 210.0919, found 210.0922.

*8-methoxybenzo[h]quinoline (**24g**)*



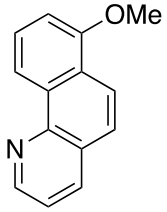
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23g**. Purified by column chromatography using 1:1 Hex:EtOAc. **24g** was isolated as a white solid (80 mg, 0.38 mmol, 77%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.21 (d, *J* = 9.1 Hz, 1H), 8.97 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.12-8.16 (m, 1H), 7.72-7.72 (m, 1H), 7.65-7.68 (m, 1H), 7.44-7.48 (m, 1H), 7.38 (dd, *J* = 9.0, 2.6 Hz, 1H), 3.99 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.8, 149.0, 146.7, 136.0, 135.3, 127.4, 126.20, 126.0, 125.4, 121.0, 117.7, 108.0, 55.6.

HRMS (ESI^{+}): *Calcd.* for $C_{14}H_{12}NO$ $[M+H]^{+}$: 210.0919, found 210.0925.

*7-methoxybenzo[h]quinoline (**24h**)*



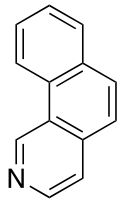
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23h**. Purified by column chromatography using 1:1 Hex:EtOAc. **24h** was isolated as a white solid (65 mg, 0.31 mmol, 62%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.00 (dd, *J* = 4.4, 1.8 Hz, 1H), 8.88 (d, *J* = 8.3 Hz, 1H), 8.30 (d, *J* = 9.1 Hz, 1H), 8.20 (dd, *J* = 8.1, 1.8 Hz, 1H), 7.69 (d, *J* = 9.3 Hz, 1H), 7.66 (d, *J* = 8.4 Hz, 1H), 7.53 (dd, *J* = 8.1, 4.4 Hz, 1H), 7.12 (d, *J* = 7.9 Hz, 1H), 4.06 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 152.9, 146.2, 143.7, 133.4, 130.0, 124.7, 124.0, 122.2, 121.9, 119.3, 118.9, 113.9, 104.8, 53.2.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{12}NO$ $[M+H]^+$: 210.0919, found 210.0919.

*benzo[h]isoquinoline (**24j**)*



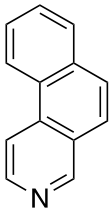
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23j**. Purified by column chromatography using 1:1 Hex:EtOAc. **24j** was isolated as a yellow solid (87 mg, 0.49 mmol, 97%). Spectroscopic data for **24j** match those previously reported.[11]

TLC R_f = 0.29 (2:8 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 10.06 (s, 1H), 8.81 (d, *J* = 8.1 Hz, 1H), 8.72 (d, *J* = 5.5 Hz, 1H), 7.98 – 7.91 (m, 2H), 7.78 – 7.65 (m, 4H).

HRMS (ESI$^+$): *Calcd.* for $C_{13}H_{10}N$ $[M+H]^+$: 180.0813, found 180.0818.

*benzo[f]isoquinoline (**24k**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **23k**. Purified by column chromatography using 1:1 Hex:EtOAc. **24k** was isolated as a tan solid (74 mg, 83%). Spectroscopic data for **24k** match those previously reported.[11]

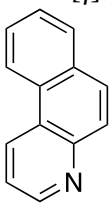
TLC R_f = 0.29 (2:8 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.26 (s, 1H), 8.77 (d, *J* = 5.8 Hz, 1H), 8.73 – 8.66 (m, 1H), 8.44 (d, *J* = 5.8 Hz, 1H), 8.00 – 7.93 (m, 1H), 7.91 – 7.80 (m, 2H), 7.77 – 7.71 (m, 2H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 151.8, 145.2, 135.1, 133.7, 129.0, 128.9, 128.64, 128.59, 127.4, 127.2, 124.9, 123.4, 116.3.

HRMS (ESI$^+$): *Calcd.* for $C_{13}H_{10}N$ $[M+H]^+$: 180.0813, found 180.0816.

*benzo[f]quinoline (**24l**)*



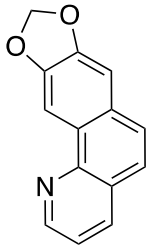
Reaction performed following general procedure **F** with 0.10 mmol of azepine **23l**. Purified by column chromatography using 1:1 Hex:EtOAc. **24k** was isolated as a tan solid (13 mg, 0.07 mmol, 70%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.97-8.94 (m, 2H), 8.62 (d, *J* = 8.2 Hz, 1H), 8.01 (d, *J* = 9.3 Hz, 1H), 7.98 (d, *J* = 9.0 Hz, 1H), 7.94 (d, *J* = 7.8 Hz, 1H), 7.72-7.64 (m, 2H), 7.56 (dd, 8.27, 4.39 Hz, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.8, 148.3, 131.9, 131.1, 130.9, 129.8, 128.9, 128.3, 127.5, 127.3, 125.6, 122.7, 121.5.

HRMS (ESI$^+$): *Calcd.* for $C_{13}H_{10}N$ $[M+H]^+$: 180.0813, found 180.0814.

*[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline (desoxytoddaquinoline) (**24m**)*



Reaction performed following general procedure **F** with 0.50 mmol of azepine **23m**. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **24m** was isolated as a white solid (95 mg, 0.43 mmol, 85%). Spectroscopic data for **24m** match those previously reported.[6]

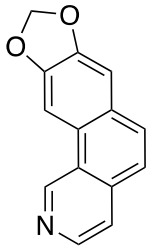
TLC R_f = 0.48 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.94 (dd, *J* = 4.4, 1.8 Hz, 1H), 8.65 (s, 1H), 8.13 (dd, *J* = 8.0, 1.8 Hz, 1H), 7.68 (d, *J* = 8.8 Hz, 1H), 7.57 (d, *J* = 8.8 Hz, 1H), 7.45 (dd, *J* = 8.0, 4.3 Hz, 1H), 7.23 (s, 1H), 6.13 (s, 2H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.1, 148.7, 148.5, 146.2, 136.0, 130.5, 128.3, 127.2, 125.8, 123.9, 121.2, 105.1, 102.5, 101.6.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{10}NO_2$ $[M+H]^+$: 224.0712, found 224.0712.

*[1,3]dioxolo[4',5':4,5]benzo[1,2-h]isoquinoline (**24n**)*



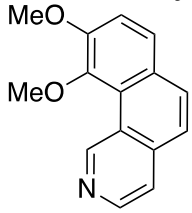
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23n**. Product purified by recrystallization from EtOAc. **24n** was isolated as off-white crystals (93 mg, 0.42 mmol, 83%). Spectroscopic data for **24n** match those previously reported.[12]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.85 (s, 1H), 8.63 (d, *J* = 5.4 Hz, 1H), 8.12 (s, 1H), 7.81 (d, *J* = 8.8 Hz, 1H), 7.66 (d, *J* = 5.4 Hz, 1H), 7.59 (d, *J* = 8.8 Hz, 1H), 7.25 (s, 1H), 6.14 (s, 2H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.2, 148.4, 146.9, 144.1, 135.1, 131.2, 129.0, 125.9, 125.1, 123.3, 121.2, 106.2, 101.8, 100.3.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{10}NO_2$ $[M+H]^+$: 224.0712, found 224.0717.

*9,10-dimethoxybenzo[h]isoquinoline (**24o**)*



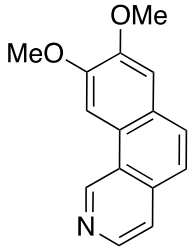
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23o**. Purified by column chromatography using a gradient of 1:1 Hex:EtOAc to 9:1 EtOAc:MeOH. **24o** was isolated as an orange oil (33 mg, 0.14 mmol, 28%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 10.82 (s, 1H), 8.67 (d, *J* = 5.3 Hz, 1H), 7.79 (d, 8.8 Hz, 1H), 7.65 (d, *J* = 8.7 Hz, 1H), 7.64 (d, *J* = 5.3 Hz, 1H), 7.47 (d, *J* = 8.8 Hz, 1H), 7.35 (d, *J* = 8.7 Hz, 1H), 4.03 (s, 3H), 4.01 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 152.4, 151.36, 146.7, 144.9, 137.1, 131.8, 128.3, 125.5, 125.3, 123.8, 123.4, 121.2, 113.6, 59.9, 56.5.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{14}NO_2$ $[M+H]^{+}$: 240.1025, found 240.1026.

*8,9-dimethoxybenzo[h]isoquinoline (**24p**)*



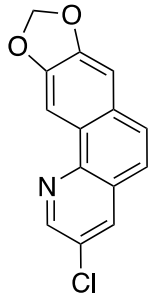
Reaction performed following general procedure **F** with 0.50 mmol of azepine **23p**. Product purified by recrystallization from EtOAc. **24p** was isolated as tan crystals (65 mg, 0.27 mmol, 54%).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 9.92 (s, 1H), 8.64 (d, *J* = 5.5 Hz, 1H), 8.11 (s, 1H), 7.86 (d, *J* = 8.7 Hz, 1H), 7.70 (d, *J* = 5.4 Hz, 1H), 7.61 (d, *J* = 8.7 Hz, 1H), 7.29 (s, 1H), 4.15 (s, 3H), 4.06 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 150.5, 150.1, 146.3, 143.7, 137.0, 135.2, 131.0, 127.7, 124.2, 123.2, 121.5, 108.7, 102.4, 56.3, 56.2.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{14}NO_2$ $[M+H]^{+}$: 240.1025, found 240.1029.

*3-chloro-[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline (**34a**)*



Reaction performed following general procedure **F** with 0.43 mmol of azepine **33a**. After addition of *t*-BuOK, the reaction was heated to 40 °C. Purified by column chromatography using a gradient of 100% Hex to 95:5 Hex:EtOAc. **34a** was isolated as a white solid (57 mg, 51%).

TLC R_f = 0.51 (8:2 Hex:EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.83 (d, *J* = 2.4 Hz, 1H), 8.57 (s, 1H), 8.11 (d, *J* = 2.5 Hz, 1H), 7.71 (d, *J* = 8.8 Hz, 1H), 7.50 (d, *J* = 8.8 Hz, 1H), 7.22 (s, 1H), 6.14 (s, 2H).

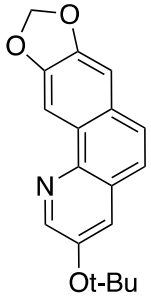
^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.3, 148.8, 147.7, 144.2, 134.2, 130.4, 128.7, 128.6, 128.1, 126.3, 122.9, 105.2, 102.5, 101.7.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_9NO_2Cl$ $[M+H]^+$: 258.0322, found 258.0329.

3-(tert-butoxy)-[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline (**34b**); *3-methoxy-[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline* (**34c**); *3-fluoro-[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline* (**34d**)

Reaction performed following general procedure **F** with 0.37 mmol of azepine **33b**. Purified by column chromatography using a gradient of 100% hexanes to 4:1 Hex:EtOAc. In order of elution from the column, **34d** was isolated as a white solid (11 mg, 0.05mmol, 12%), **34b** as a colorless oil (33 mg, 0.11 mmol, 30%), and **34c** as a white solid (35 mg, 0.14 mmol, 37%).

*3-(tert-butoxy)-[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline (**34b**)*

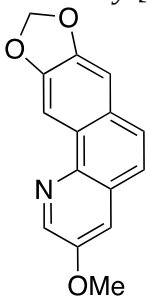


^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.68 (d, *J* = 2.7 Hz, 1H), 8.56 (s, 1H), 7.70 (d, *J* = 2.7 Hz, 1H), 7.66 (d, *J* = 8.8 Hz, 1H), 7.52 (d, *J* = 8.8 Hz, 1H), 7.21 (s, 1H), 6.12 (s, 2H), 1.44 (s, 9H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 149.3, 148.6, 148.6, 147.1, 142.2, 129.6, 128.2, 128.0, 127.6, 126.2, 123.6, 105.1, 102.2, 101.5, 80.1, 28.9.

HRMS (ESI^{+}): *Calcd.* for $C_{18}H_{18}NO_3$ $[M+H]^+$: 296.1281, found 296.1281.

*3-methoxy-[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline (**34c**)*

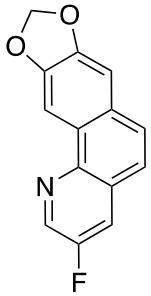


^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.68 (d, *J* = 2.9 Hz, 1H), 8.54 (s, 1H), 7.67 (d, *J* = 8.7 Hz, 1H), 7.53 (d, *J* = 8.8 Hz, 1H), 7.46 (d, *J* = 2.9 Hz, 1H), 7.21 (s, 1H), 6.11 (s, 2H), 3.98 (s, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 153.7, 148.6, 148.2, 141.1, 129.7, 129.0, 127.9, 126.4, 123.4, 116.9, 114.4, 105.0, 102.0, 101.5, 55.8.

HRMS (ESI^{+}): *Calcd.* for $C_{15}H_{12}NO_3$ $[M+H]^+$: 254.0811, found 254.0809.

*3-fluoro-[1,3]dioxolo[4',5':4,5]benzo[1,2-h]quinoline (**34d**)*

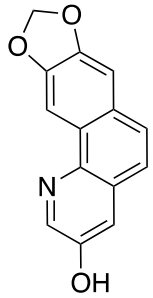


^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.80 (d, *J* = 2.9 Hz, 1H), 8.56 (s, 1H), 7.76 (dd, *J* = 8.8, 2.9 Hz, 1H), 7.70 (d, *J* = 8.8 Hz, 1H), 7.52 (d, *J* = 8.8 Hz, 1H), 7.21 (s, 1H), 6.12 (s, 2H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.2, 146.2, 148.8 (d, J_{CF} = 15.4 Hz), 143.0 (d, J_{CF} = 2.4 Hz), 138.6 (d, J_{CF} = 25.8 Hz), 129.8 (d, J_{CF} = 1.7 Hz), 128.7, 128.3, 126.4 (d, J_{CF} = 5.1 Hz), 123.2 (d, J_{CF} = 3.8 Hz), 119.3 (d, J_{CF} = 17.1 Hz), 105.1, 102.5, 101.7.

HRMS (ESI^{+}): *Calcd.* for $C_{14}H_9NO_2F$ $[M+H]^{+}$: 242.0611, found 242.0612.

*toddaquinoline (**3**)*



From 34a: To a disposable tube with a Teflon septum screw top cap was added Pd_2dba_3 (0.0012 mmol, 0.01 equiv.), Me4*t*-ButylXPhos (0.0050 mmol, 0.04 equiv.), and KOH (0.373 mmol, 3 equiv.). The tube was evacuated and backfilled three times with N_2, followed by addition of **34a** (0.124 mmol, 1 equiv.) dissolved in dioxane and degassed H_2O. The reaction was stirred at 100 °C overnight. The mixture was cooled to room temperature, then carefully acidified with dilute HCl, and extracted with EtOAc (5 mL × 3). Combined organics were dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Crude reaction mixture was purified using preparative TLC (1:1 Hex:EtOAc) to yield **3** as a white solid (6 mg, 21%).

From 34b: To a solution of **34b** (26 mg) in 1.5 mL CH_2Cl_2 was added 650 µL trifluoroacetic acid. The reaction mixture was stirred overnight. The solvent was evaporated under a stream of nitrogen to yield **3** as an off-white solid (21 mg, quant.).

Spectroscopic data for **3** closely matches those previously reported.[13]

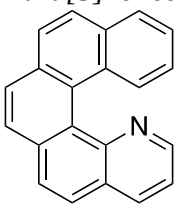
TLC R_f = 0.49 (1:1 Hex:EtOAc)

^{1}H NMR (500 MHz, Methanol-*d4*) δ 8.50 (d, *J* = 2.8 Hz, 1H), 8.13 (s, 1H), 7.94 (d, *J* = 8.8 Hz, 1H), 7.77 (d, *J* = 2.8 Hz, 1H), 7.58 (d, *J* = 8.7 Hz, 1H), 7.30 (s, 1H), 6.13 (s, 2H).

^{13}C NMR (126 MHz, Methanol-*d4*) δ 153.6, 151.1, 150.9, 136.4, 135.6, 131.6, 130.8, 129.8, 125.8, 124.0, 123.7, 106.9, 103.7, 101.0.

HRMS (ESI$^+$): *Calcd.* for $C_{14}H_{10}NO_3$ $[M+H]^+$: 240.0661, found 240.0667.

*1-aza[5]helicene (**40**)*



Reaction performed following general procedure **F** with 0.39 mmol of azepine **39**. Purified by column chromatography using a gradient of 100% hexanes to 9:1 Hex:EtOAc. **40** was isolated as pale yellow crystals (9 mg, 0.03 mmol, 25%). Spectroscopic data for **40** closely match those previously reported.[14]

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.71 (dd, *J* = 4.3, 1.8 Hz, 1H), 8.29 (dd, *J* = 8.0, 1.7 Hz, 1H), 8.17 (dd, *J* = 8.4, 1.0 Hz, 1H), 8.00 (d, *J* = 1.1 Hz, 1H), 7.99 (d, *J* = 1.3 Hz, 1H), 7.97 (d, *J* = 8.4 Hz, 1H), 7.94 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.92 (d, *J* = 8.1 Hz, 1H), 7.90 (d, *J* = 8.4 Hz, 1H), 7.87 (d, *J* = 8.4 Hz, 1H), 7.54 (ddd, *J* = 7.8, 6.8, 1.0 Hz, 1H), 7.51 (dd, *J* = 8.0, 4.1 Hz, 1H), 7.27 (ddd, *J* = 8.3, 6.7, 1.3 Hz, 1H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 146.6, 135.9, 134.3, 132.8, 132.7, 131.2, 130.5, 129.0, 128.6, 127.7, 127.4, 126.7, 126.5, 126.3, 126.1, 125.6, 123.3, 121.8.

HRMS (ESI^{+}): *Calcd.* for $C_{21}H_{14}N$ $[M+H]^{+}$: 280.1126, found 280.1128.

References

(1) Zheng, Y.; Liu, Y.; Wang, Q. Collective Asymmetric Synthesis of (−)-Antofine, (−)-Cryptopleurine, (−)-Tylophorine, and (−)-Tylocrebrine with Tert-Butanesulfinamide as a Chiral Auxiliary. *J. Org. Chem.* **2014**, *79* (8), 3348–3357. https://doi.org/10.1021/jo500013e.

(2) Chandrasekhar, S.; Reddy, N. R.; Rao, Y. S. Synthetic Studies on Ecteinascidin-743: Synthesis of Building Blocks through Sharpless Asymmetric Dihydroxylation and Aza-Michael Reactions. *Tetrahedron* **2006**, *62* (51), 12098–12107. https://doi.org/10.1016/j.tet.2006.09.056.

(3) Vasin, V. A.; Razin, V. V. Mild and Efficient Method for Preparation of Tert-Butyl Esters. *Synlett* **2001**, *2001* (05), 0658–0660. https://doi.org/10.1055/s-2001-13356.

(4) Numasawa, K.; Hanaoka, K.; Ikeno, T.; Echizen, H.; Ishikawa, T.; Morimoto, M.; Komatsu, T.; Ueno, T.; Ikegaya, Y.; Nagano, T.; Urano, Y. A Cytosolically Localized Far-Red to near-Infrared Rhodamine-Based Fluorescent Probe for Calcium Ions. *Analyst* **2020**, *145* (23), 7736–7740. https://doi.org/10.1039/D0AN01739F.

(5) Takenaka, N.; Sarangthem, R. S.; Captain, B. Helical Chiral Pyridine N-Oxides: A New Family of Asymmetric Catalysts. *Angew. Chem. Int. Ed.* **2008**, *47* (50), 9708–9710. https://doi.org/10.1002/anie.200803338.

(6) McFadden, T. P.; Nwachukwu, C. I.; Roberts, A. G. An Amine Template Strategy to Construct Successive C–C Bonds: Synthesis of Benzo[h]Quinolines by a Deaminative Ring Contraction Cascade. *Org. Biomol. Chem.* **2022**, *20* (7), 1379–1385. https://doi.org/10.1039/D1OB02245H.

(7) Yang, Q.-L.; Liu, Y.; Liang, L.; Li, Z.-H.; Qu, G.-R.; Guo, H.-M. Facilitating Rh-Catalyzed C–H Alkylation of (Hetero)Arenes and 6-Arylpurine Nucleosides (Nucleotides) with Electrochemistry. *J. Org. Chem.* **2022**, *87* (9), 6161–6178. https://doi.org/10.1021/acs.joc.2c00391.

(8) Bouwkamp, M.; van Leusen, D.; Meetsma, A.; Hessen, B. Highly Electron-Deficient Neutral and Cationic Zirconium Complexes with Bis(σ-Aryl)Amine Dianionic Tridentate Ligands. *Organometallics* **1998**, *17* (17), 3645–3647. https://doi.org/10.1021/om980358s.

(9) Page, P. C. B.; Bordogna, C.; Strutt, I.; Chan, Y.; Buckley, B. R. Asymmetric Aziridination of Chalcone Promoted by Binaphthalene-Based Chiral Amines. *Synlett* **2013**, *24* (16), 2067–2072. https://doi.org/10.1055/s-0033-1339643.

(10) Mamane, V.; Hannen, P.; Fürstner, A. Synthesis of Phenanthrenes and Polycyclic Heteroarenes by Transition-Metal Catalyzed Cycloisomerization Reactions. *Chem. – Eur. J.* **2004**, *10* (18), 4556–4575. https://doi.org/10.1002/chem.200400220.

(11) Mamane, V.; Louërat, F.; Iehl, J.; Abboud, M.; Fort, Y. A General and Efficient Method for the Synthesis of Benzo-(Iso)Quinoline Derivatives. *Tetrahedron* **2008**, *64* (47), 10699–10705. https://doi.org/10.1016/j.tet.2008.09.015.

(12) Cho, E. K.; Quach, P. K.; Zhang, Y.; Sim, J. H.; Lambert, T. H. Polycyclic Heteroaromatics via Hydrazine-Catalyzed Ring-Closing Carbonyl–Olefin Metathesis. *Chem. Sci.* **2022**, *13* (8), 2418–2422. https://doi.org/10.1039/D1SC06234D.

(13) Harrowven, D. C.; Nunn, M. I. T.; Blumire, N. J.; Fenwick, D. R. The First Total Synthesis of Toddaquinoline, an Alkaloid from Toddalia Asiatica. *Tetrahedron* **2001**, *57* (20), 4447–4454. https://doi.org/10.1016/S0040-4020(01)00336-2.

(14) Abbate, S.; Bazzini, C.; Caronna, T.; Fontana, F.; Gambarotti, C.; Gangemi, F.; Longhi, G.; Mele, A.; Sora, I. N.; Panzeri, W. Monoaza[5]Helicenes. Part 2: Synthesis, Characterisation and Theoretical Calculations. *Tetrahedron* **2006**, *62* (1), 139–148. https://doi.org/10.1016/j.tet.2005.09.132.

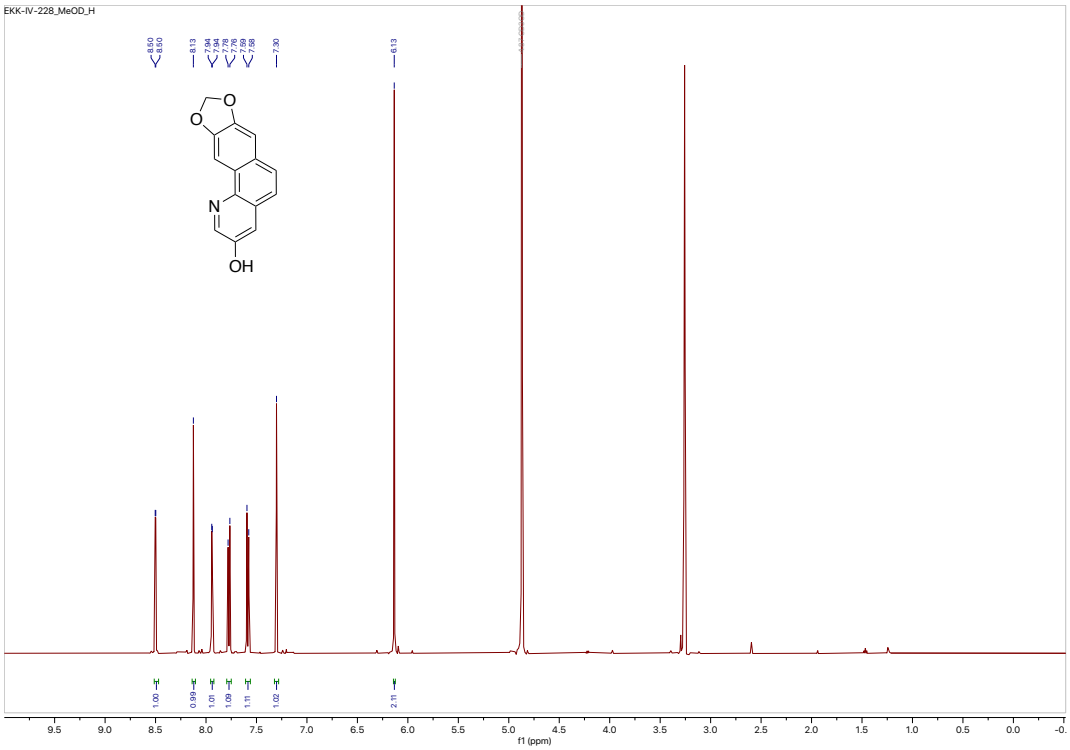


Figure S1. ^{1}H NMR (500 MHz, CD_3OD) spectrum of compound **3.**

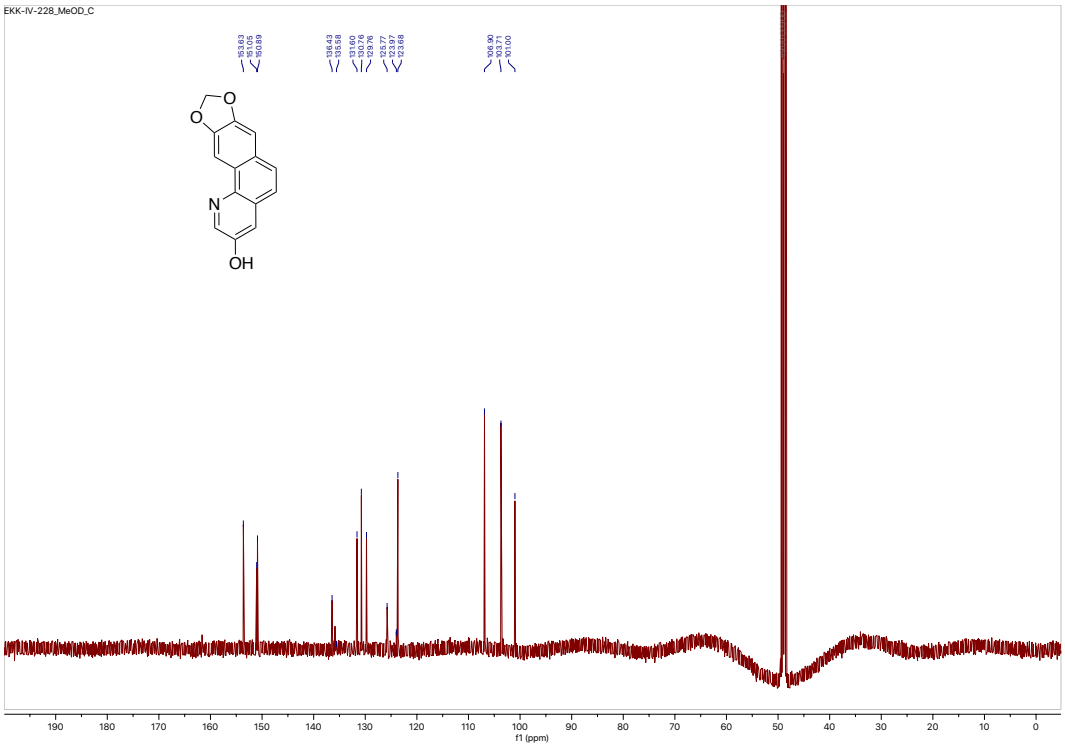


Figure S2. ^{13}C NMR (126 MHz, CD_3OD) spectrum of compound **3.**

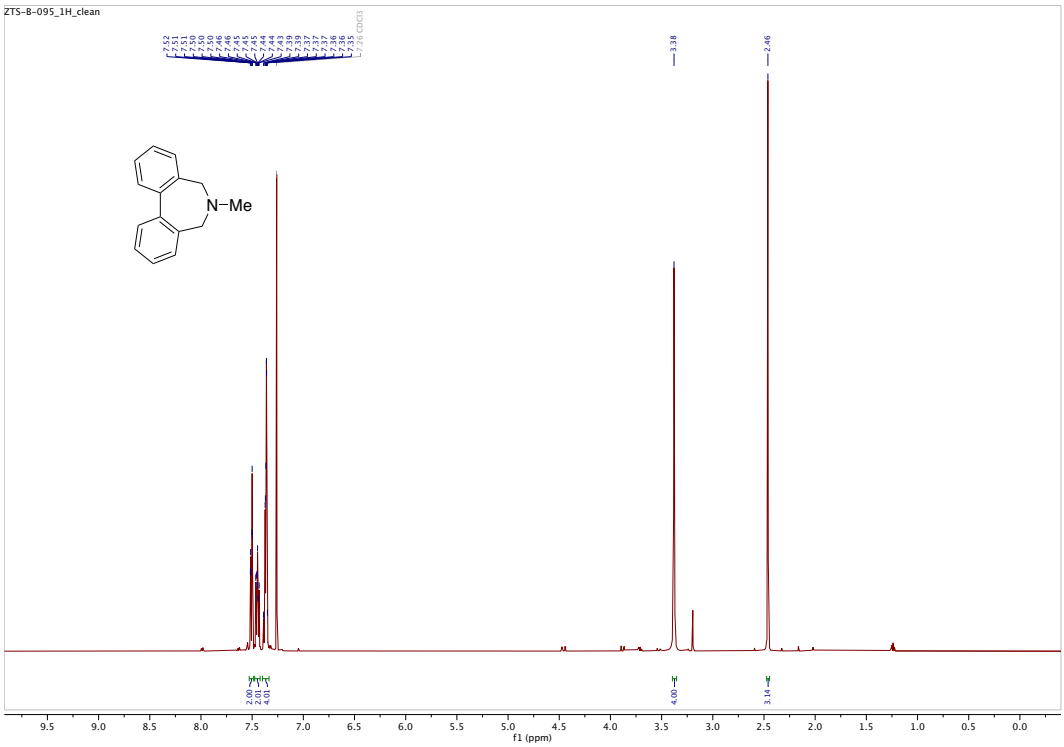


Figure S3. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **7.**

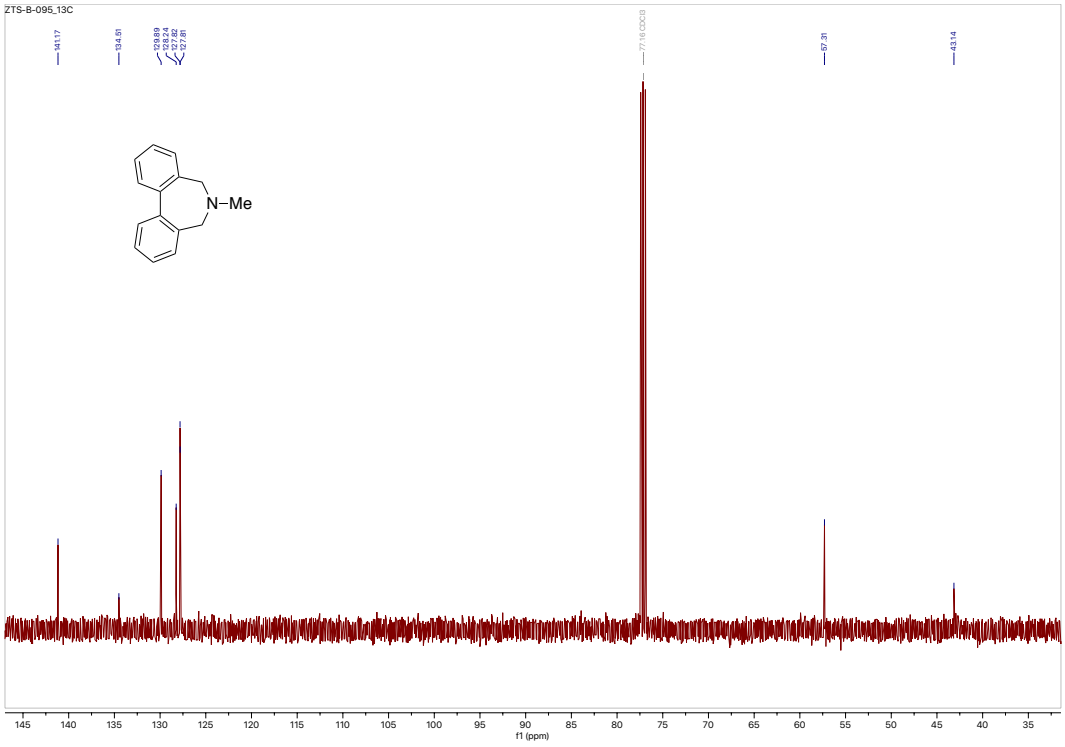


Figure S4. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **7.**

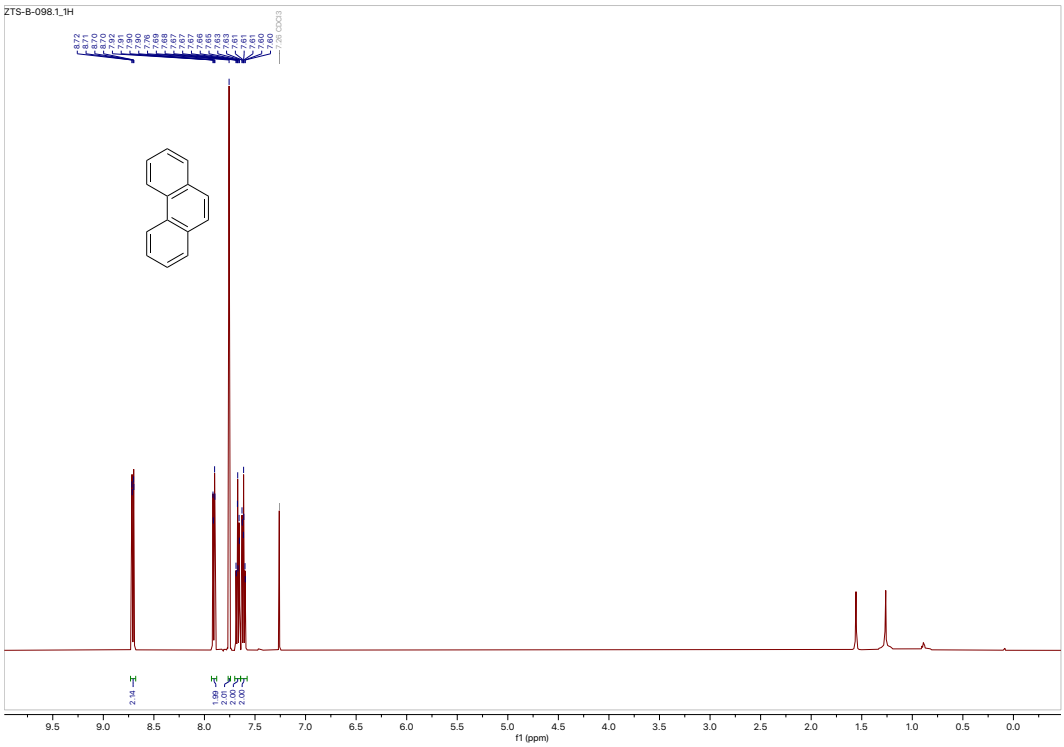


Figure S5. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **8.**

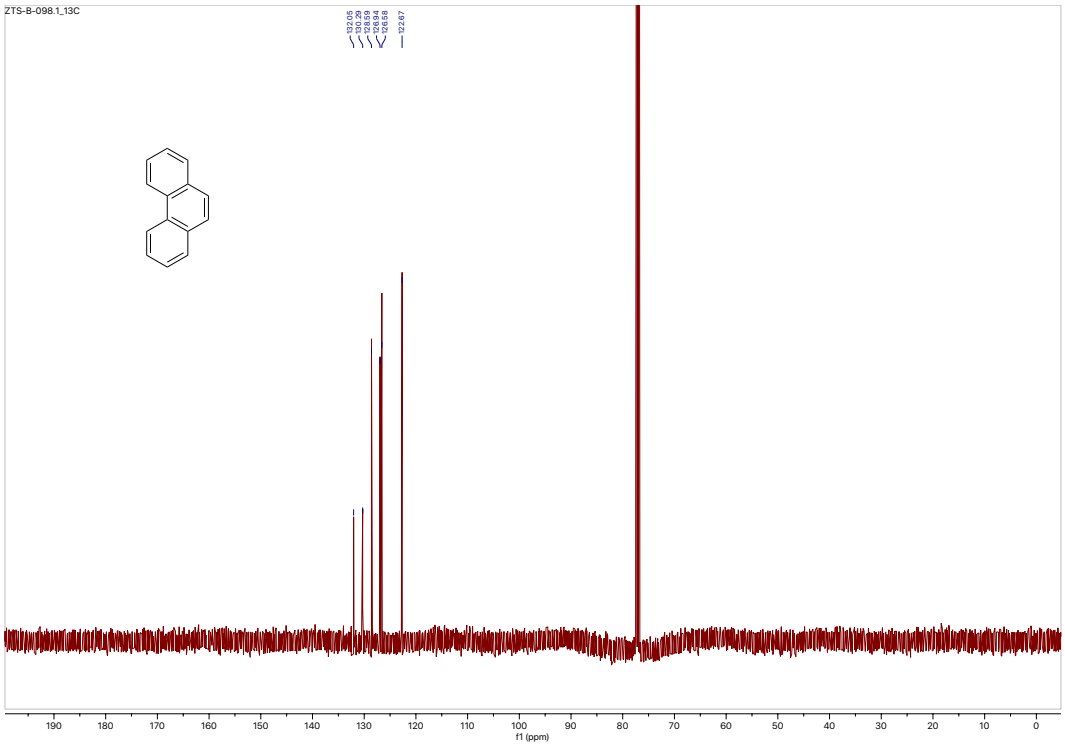


Figure S6. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **8.**

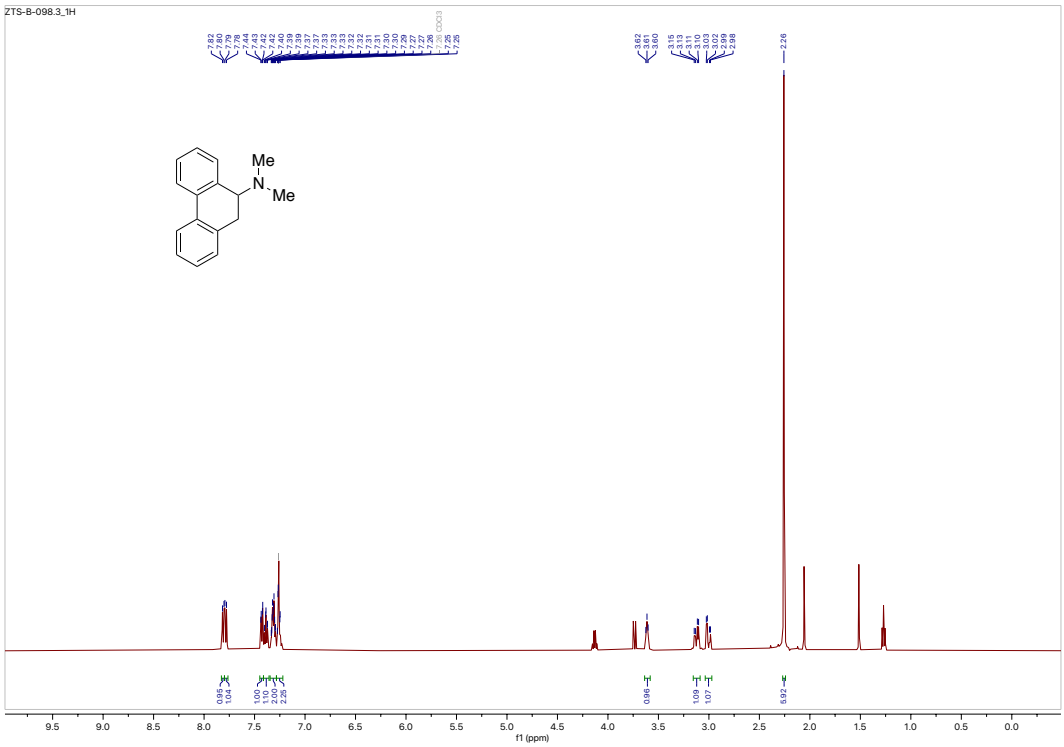


Figure S7. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **10.**

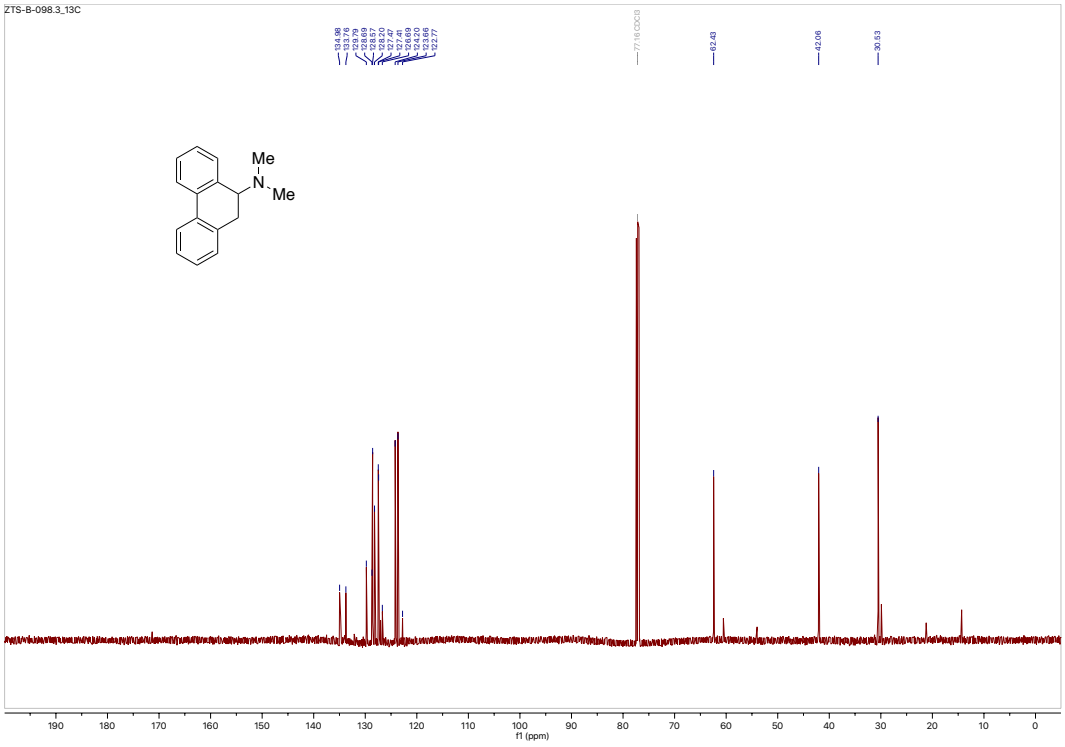


Figure S8. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **10.**

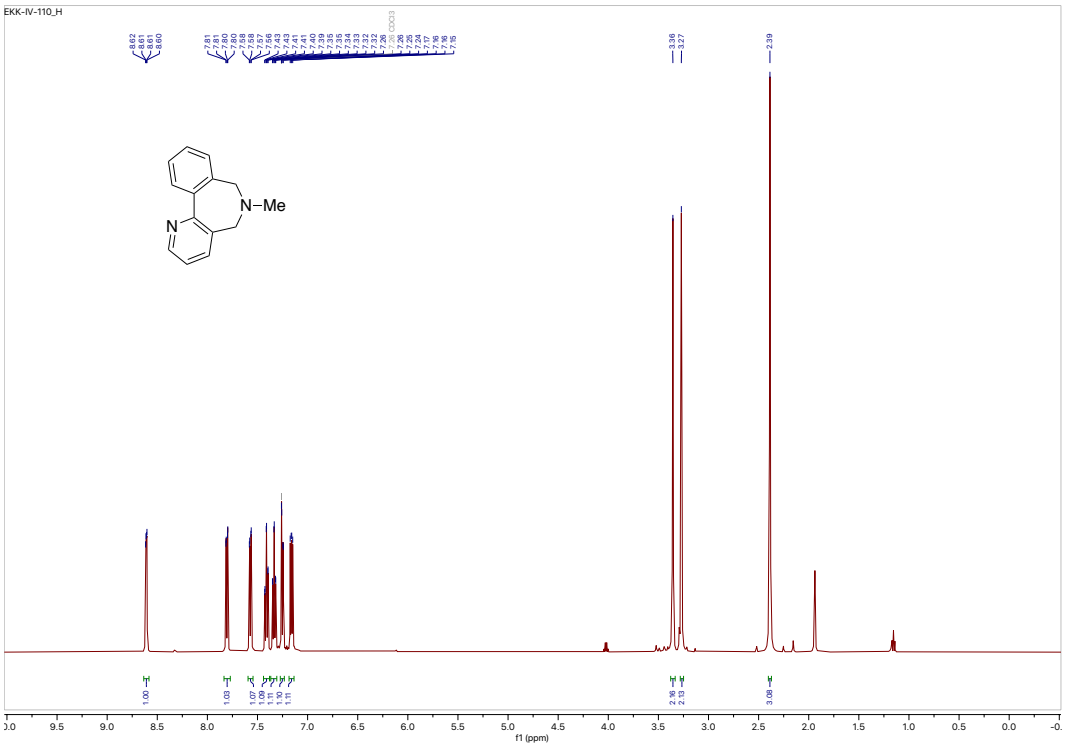


Figure S9. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **11.**

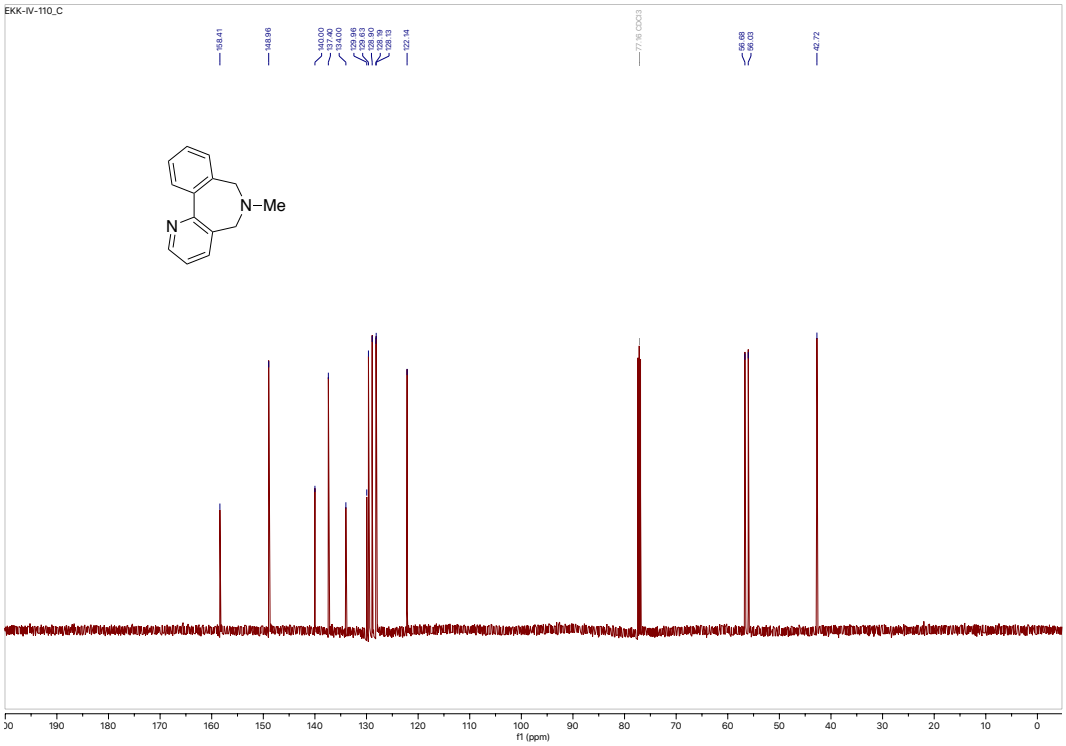


Figure S10. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **11.**

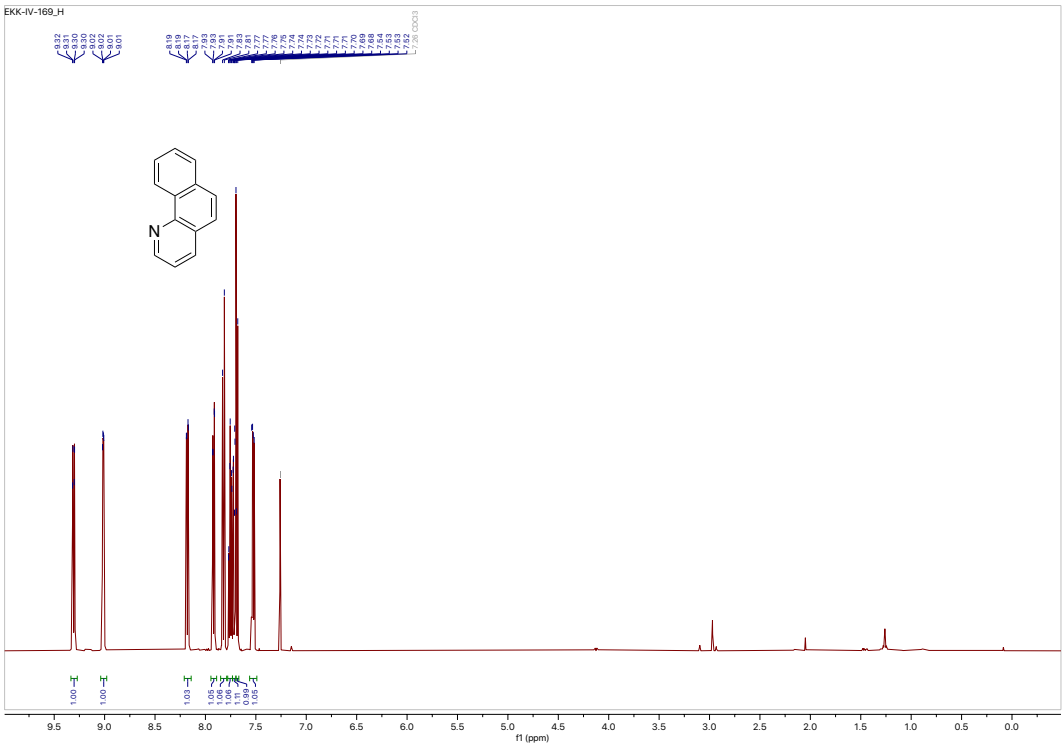


Figure S11. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **13.**

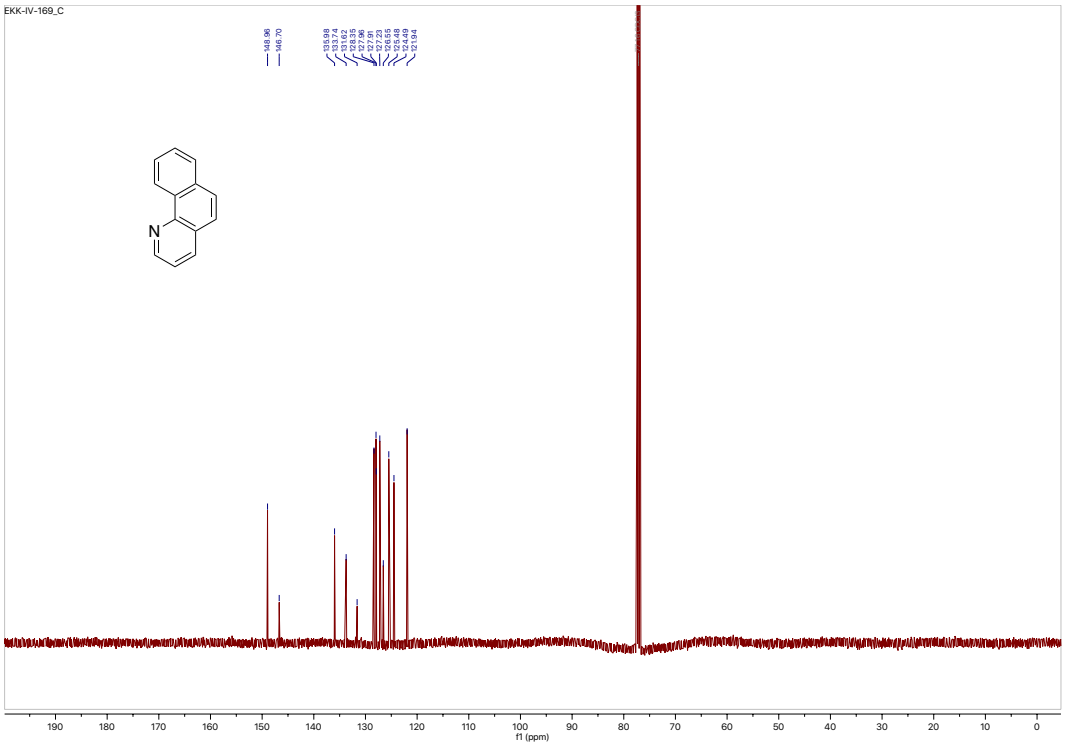


Figure S12. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **13.**

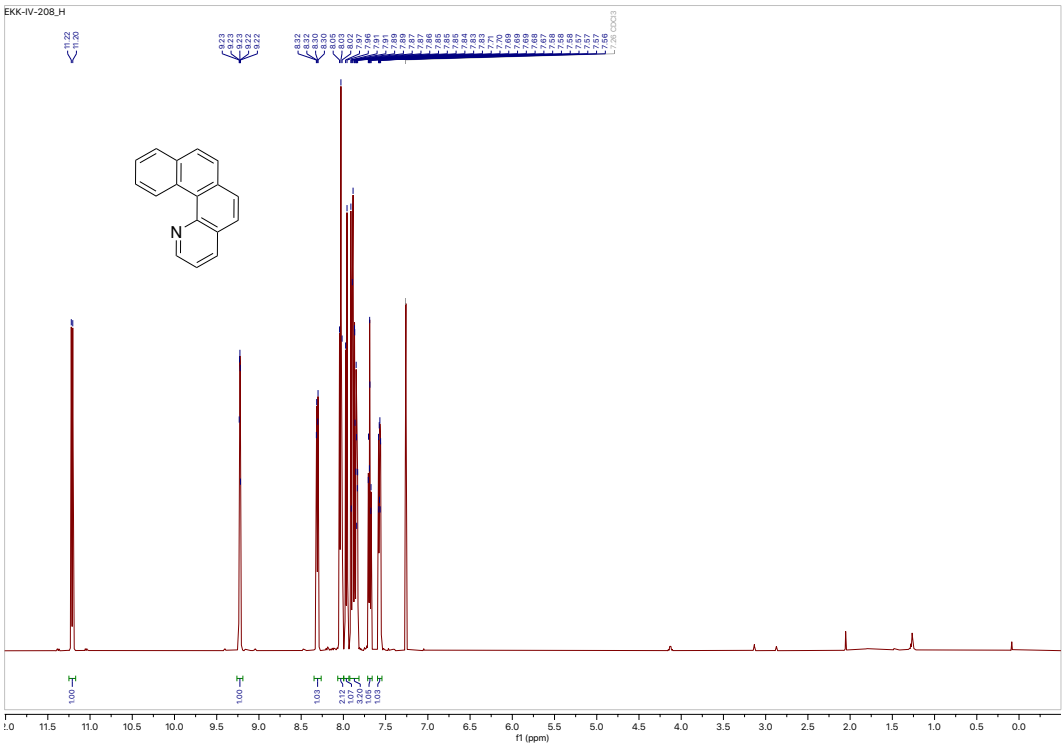


Figure S13. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **14.**

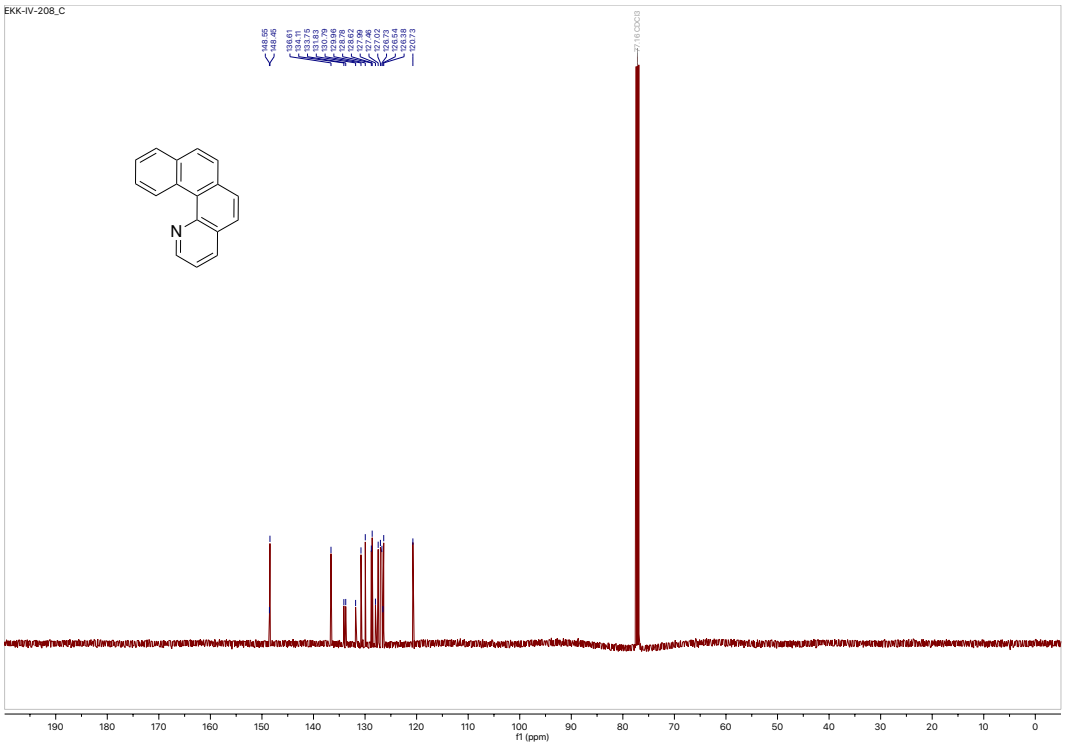


Figure S14. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **14.**

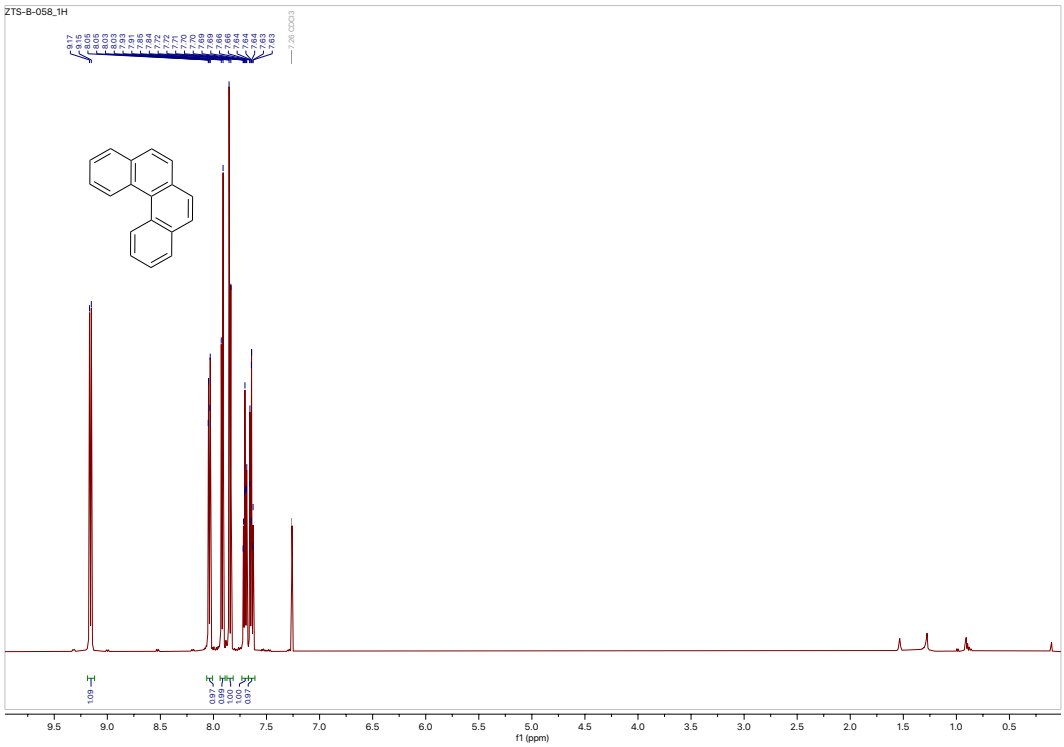


Figure S15. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **15.**

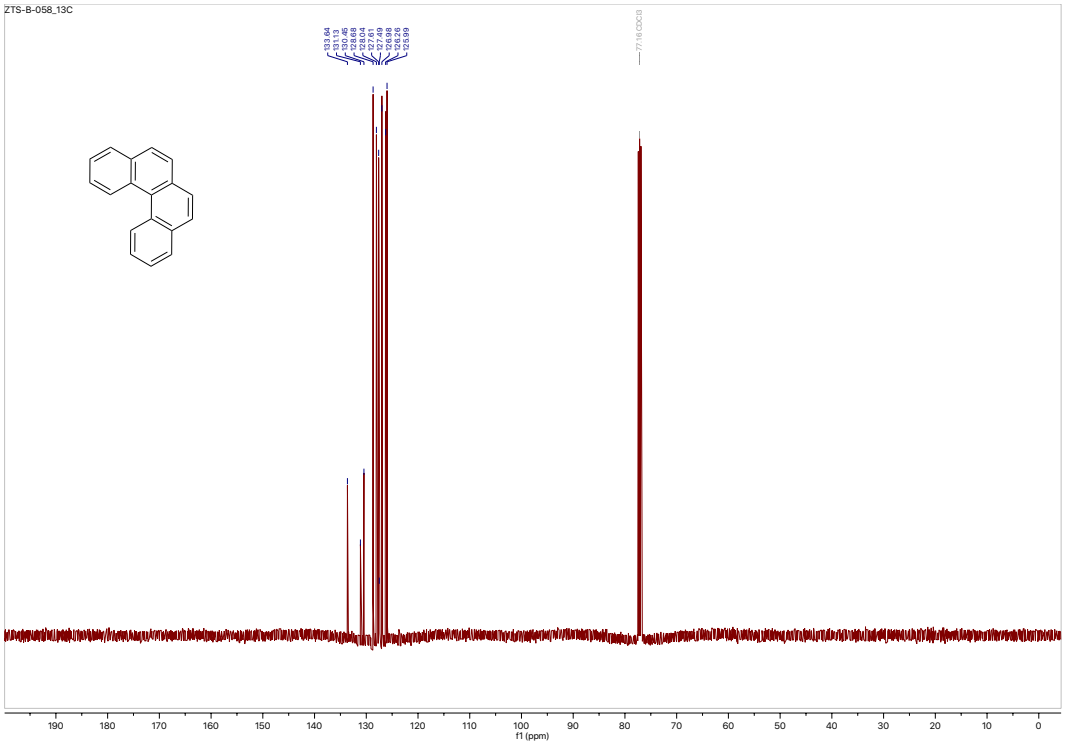


Figure S16. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **15.**

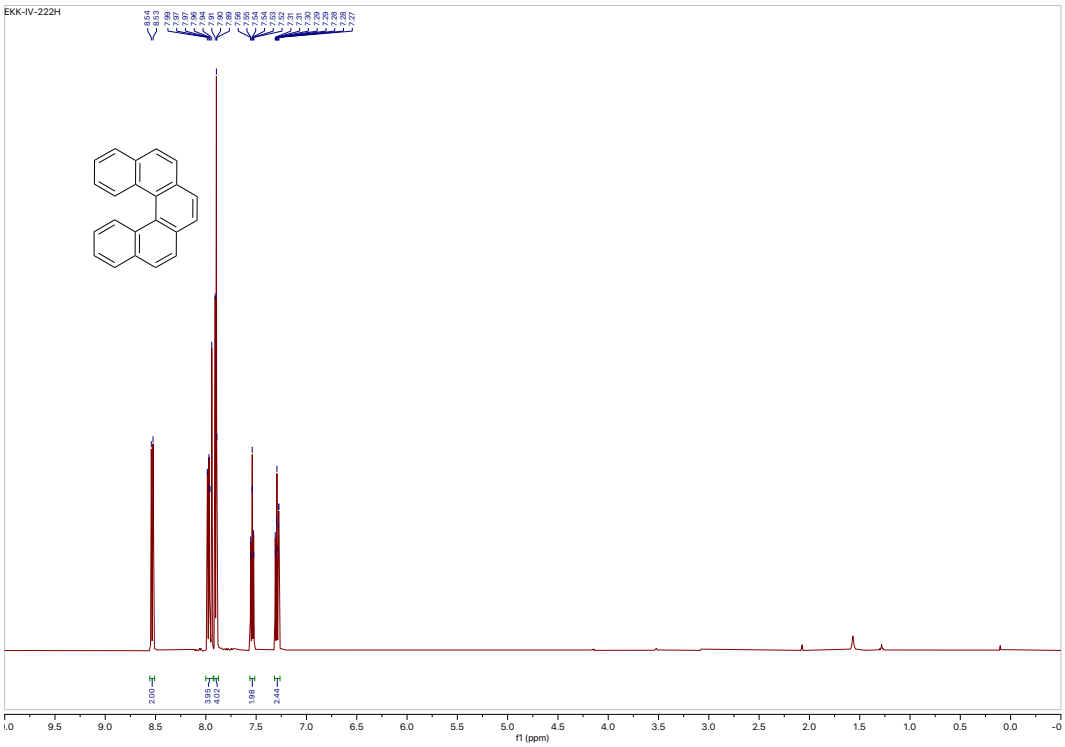


Figure S17. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **16.**

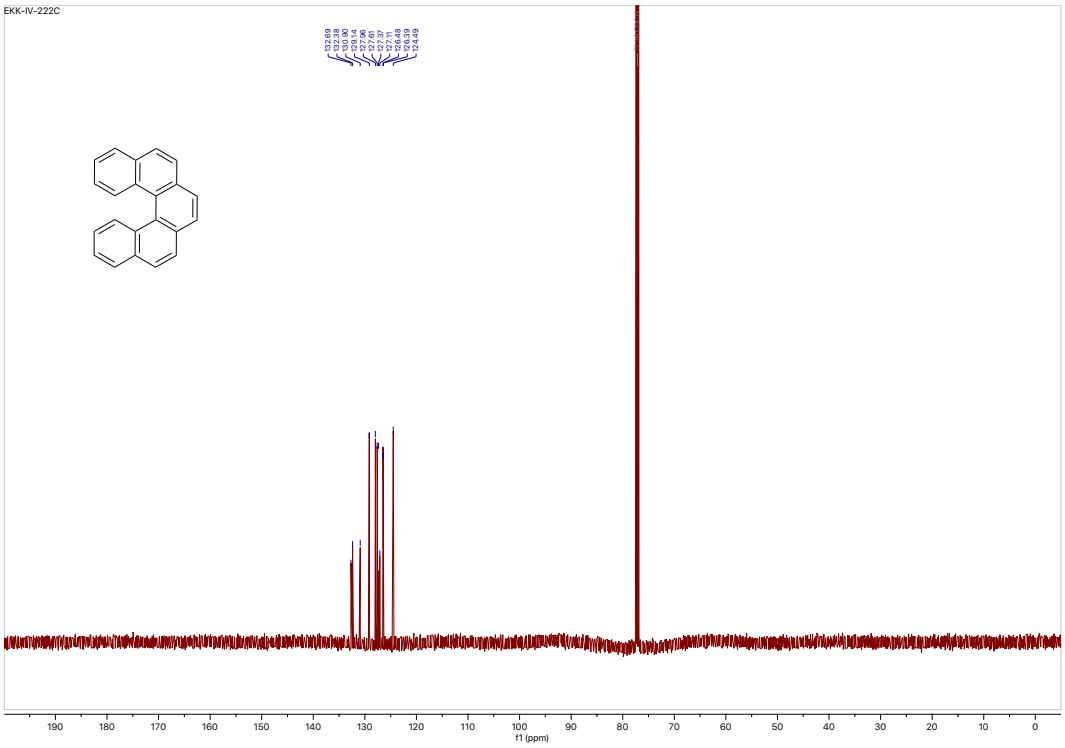


Figure S18. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **16.**

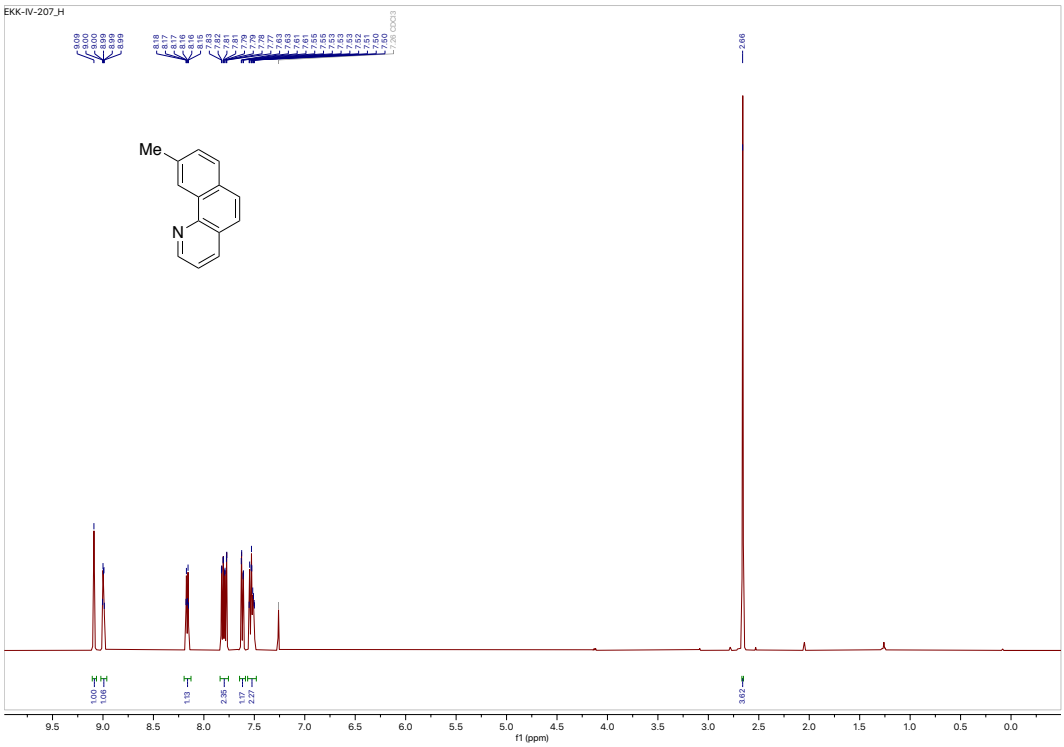


Figure S19. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **17.**

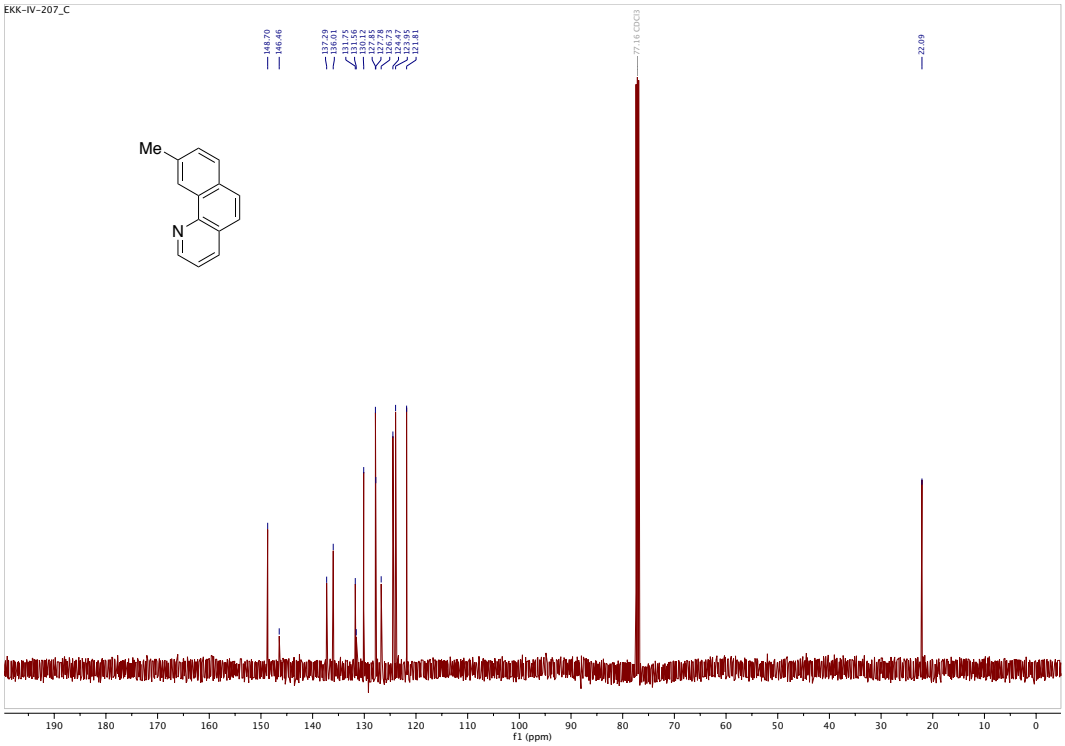


Figure S20. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **17.**

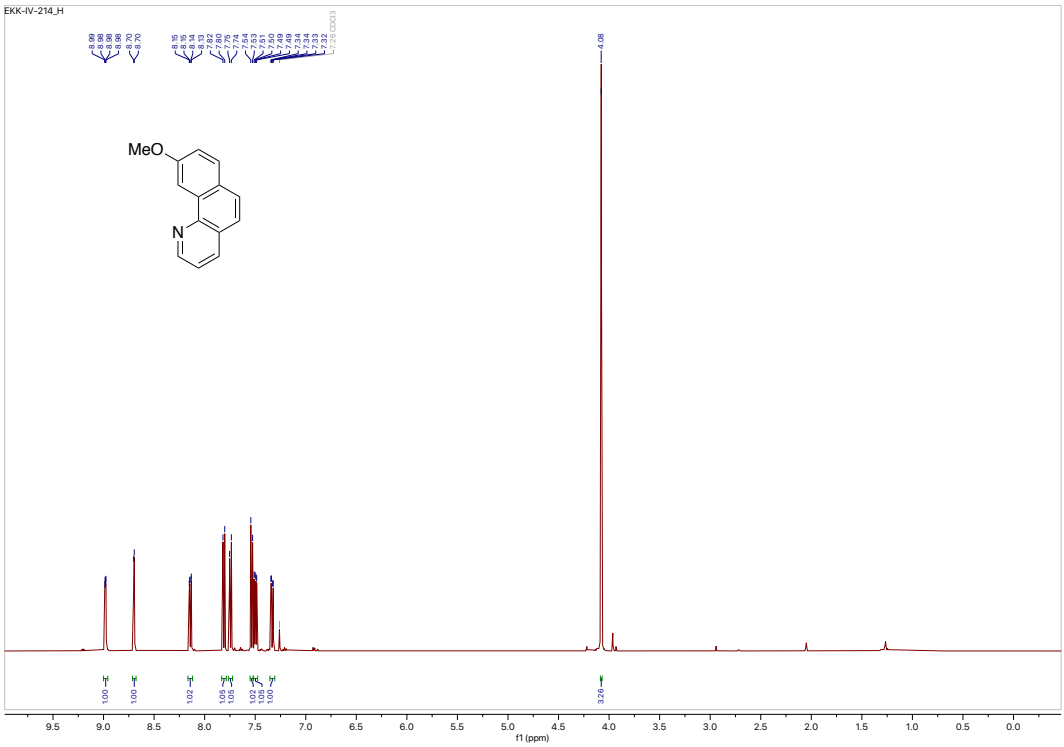


Figure S21. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **18.**

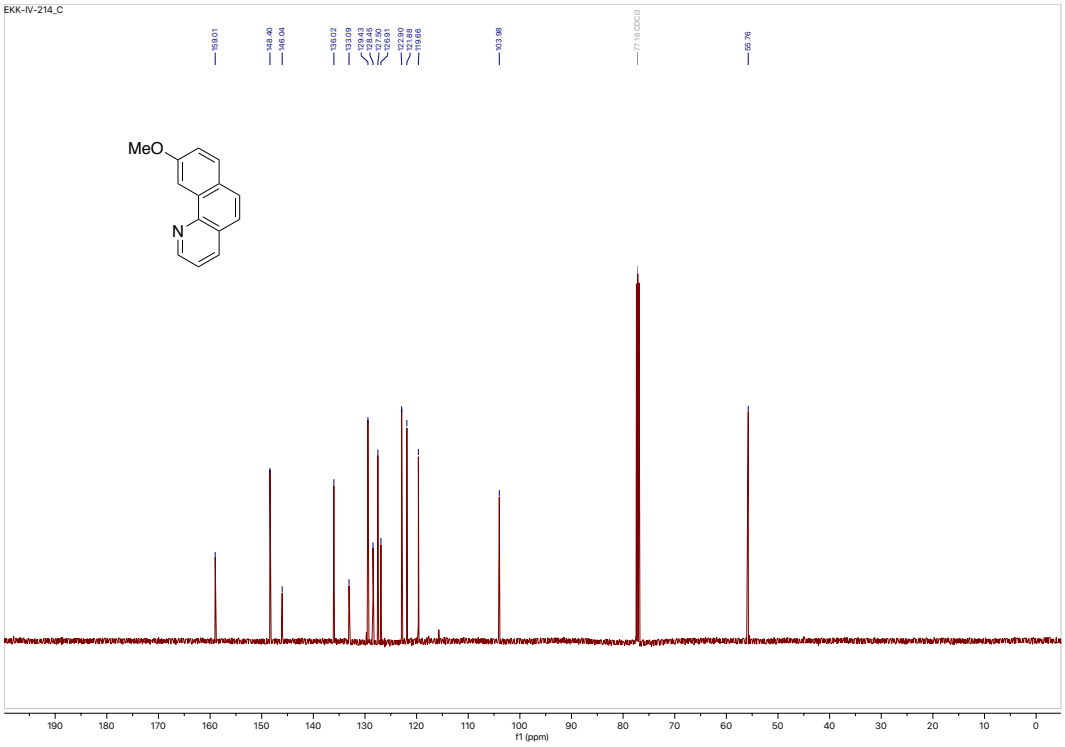


Figure S22. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **18.**

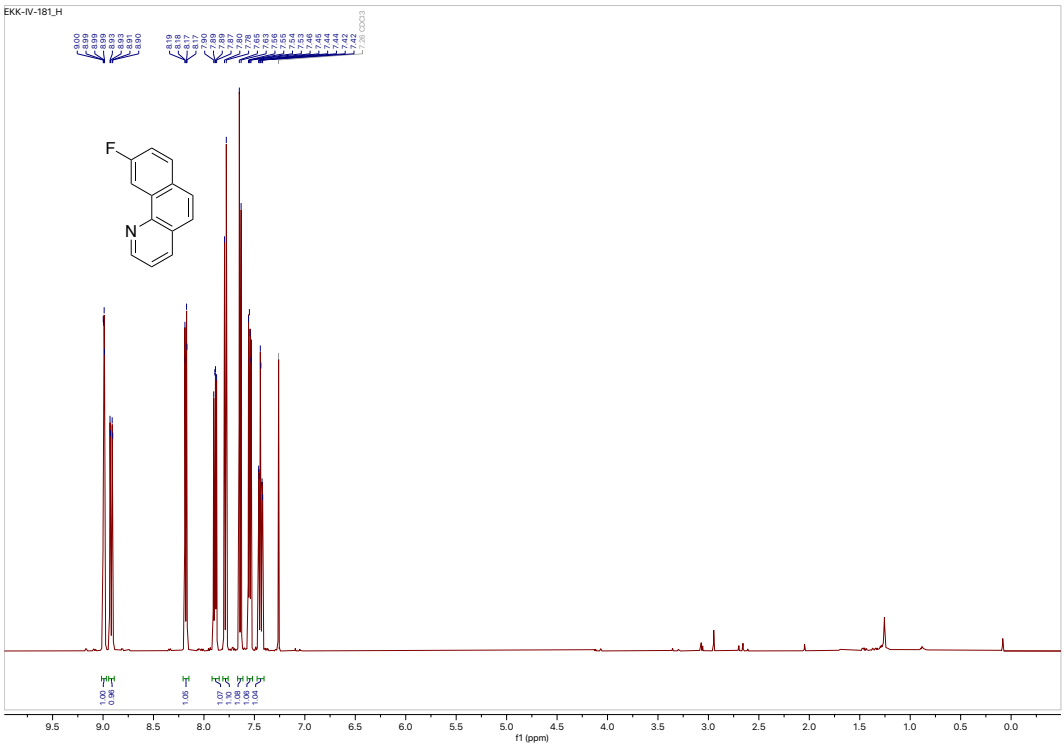


Figure S23. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **19.**

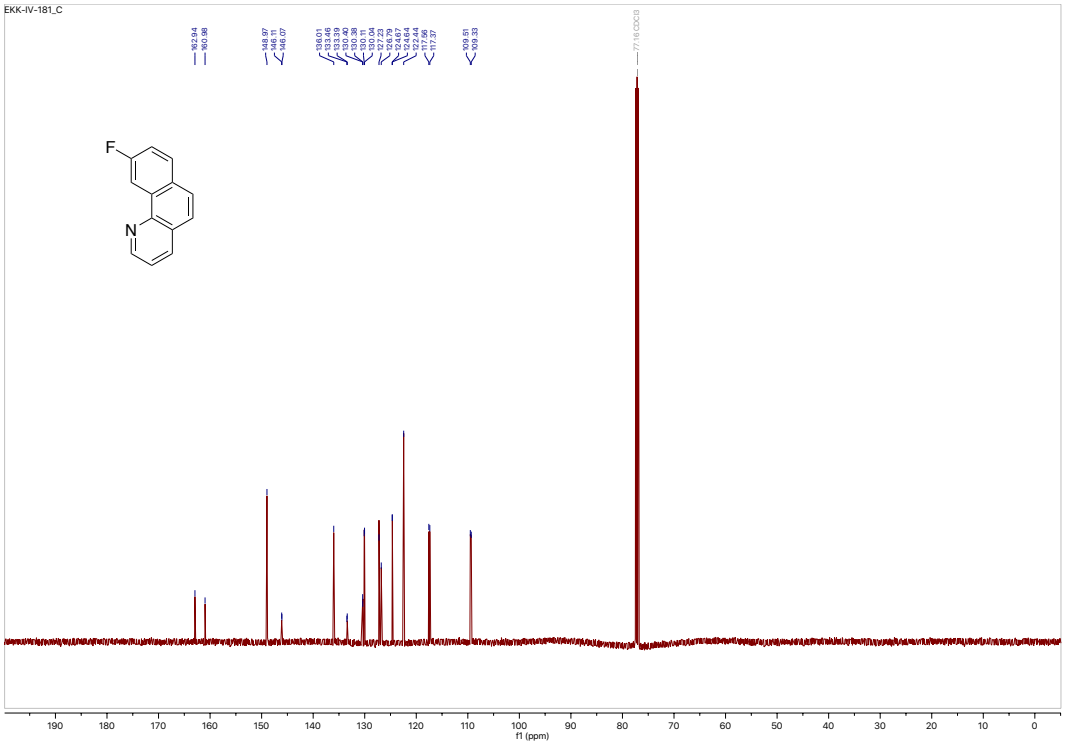


Figure S24. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **19.**

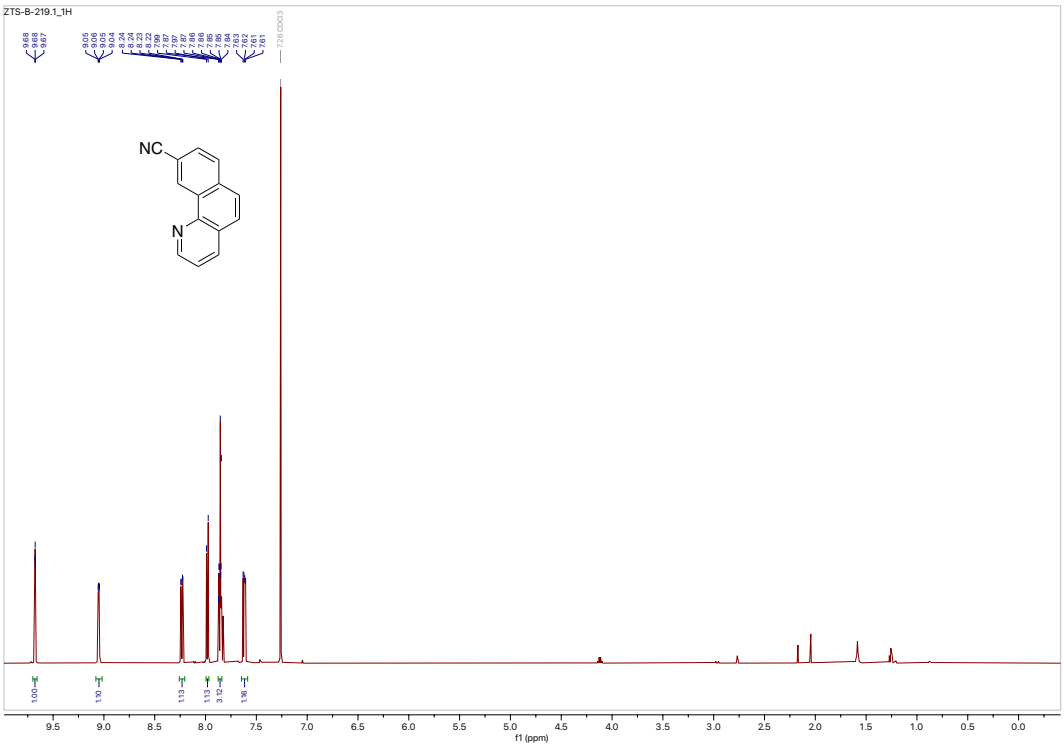


Figure S25. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **20.**

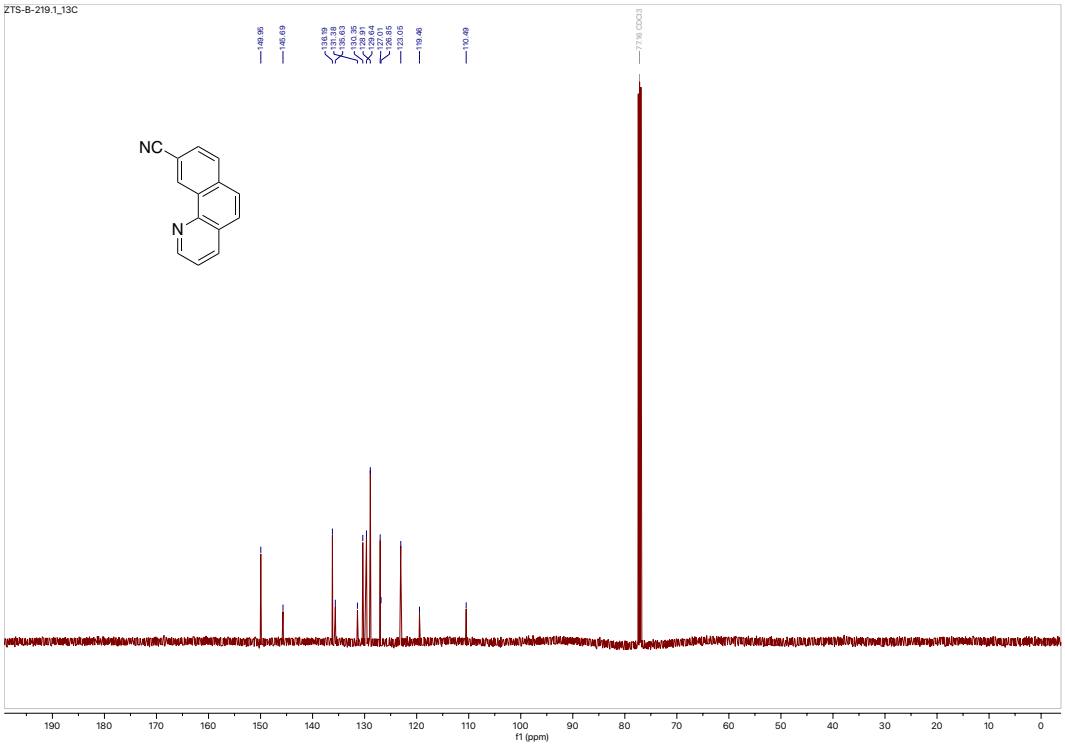


Figure S26. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **20.**

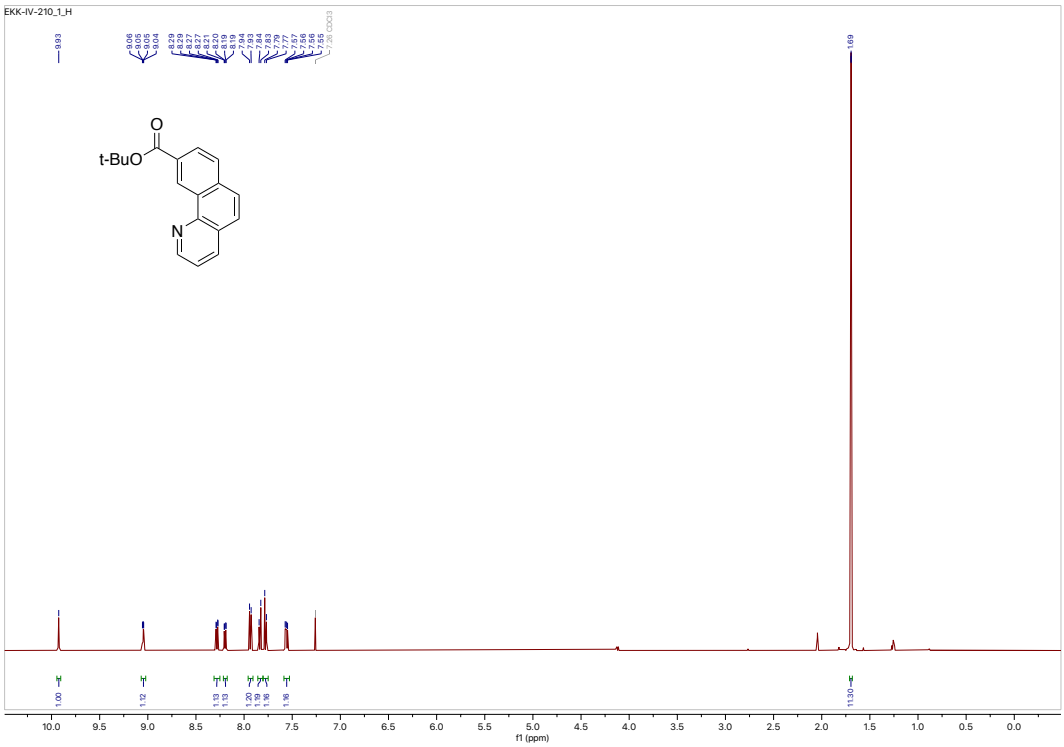


Figure S27. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **21.**

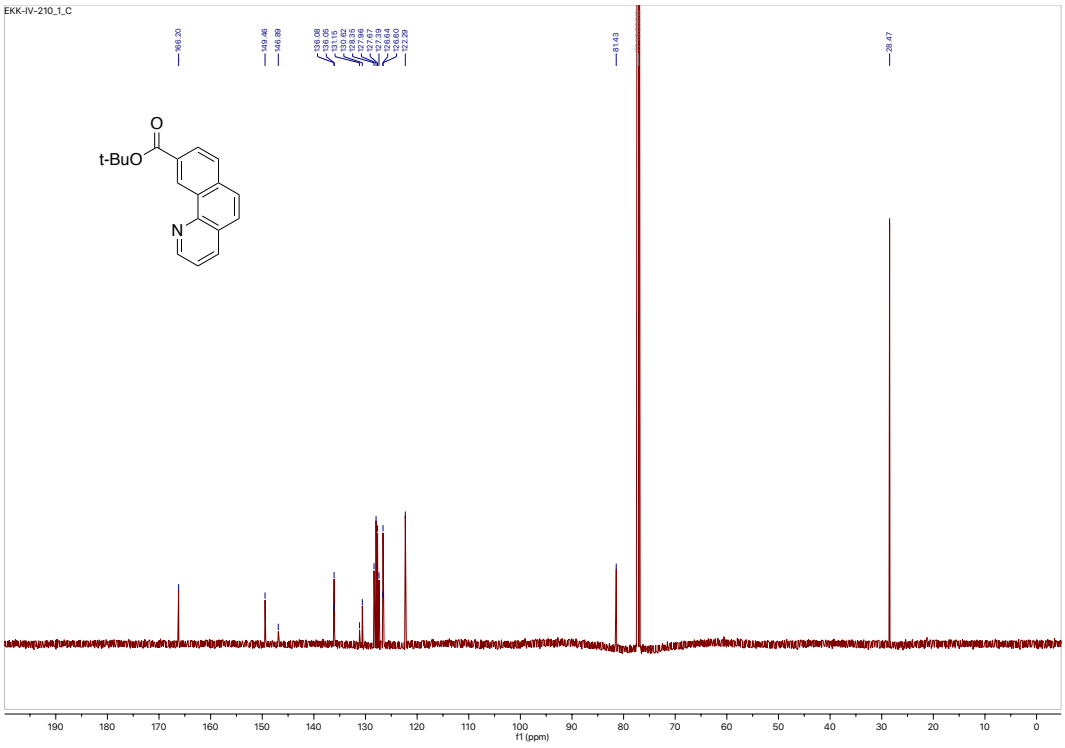


Figure S28. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **21.**

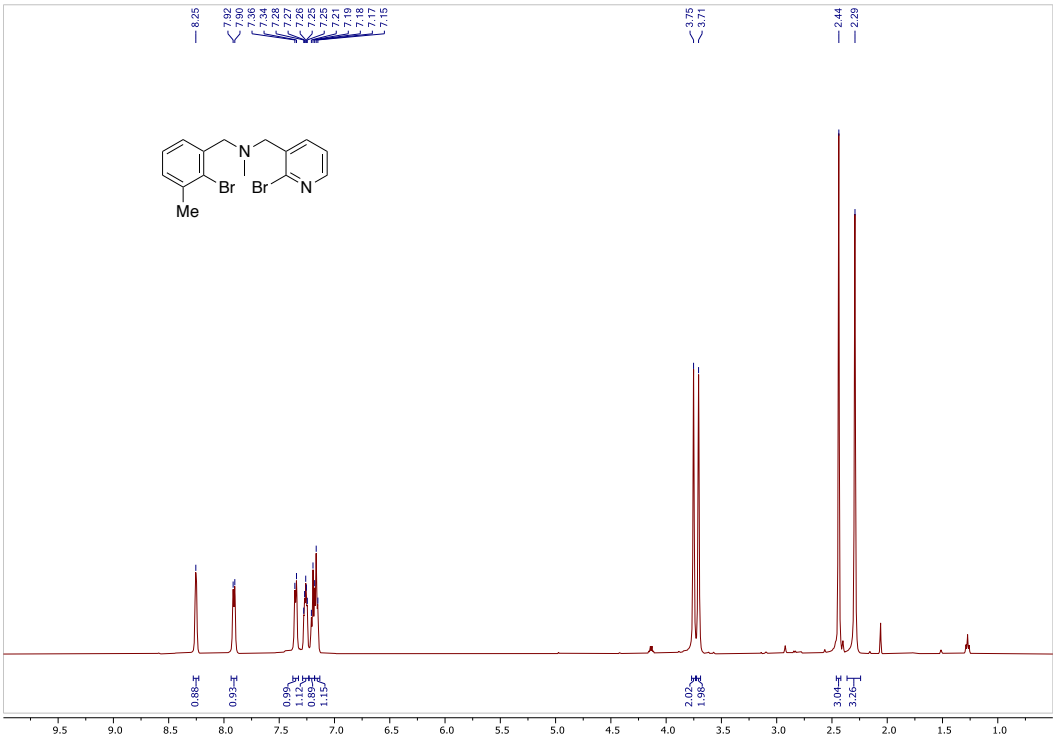


Figure S29. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22a.**

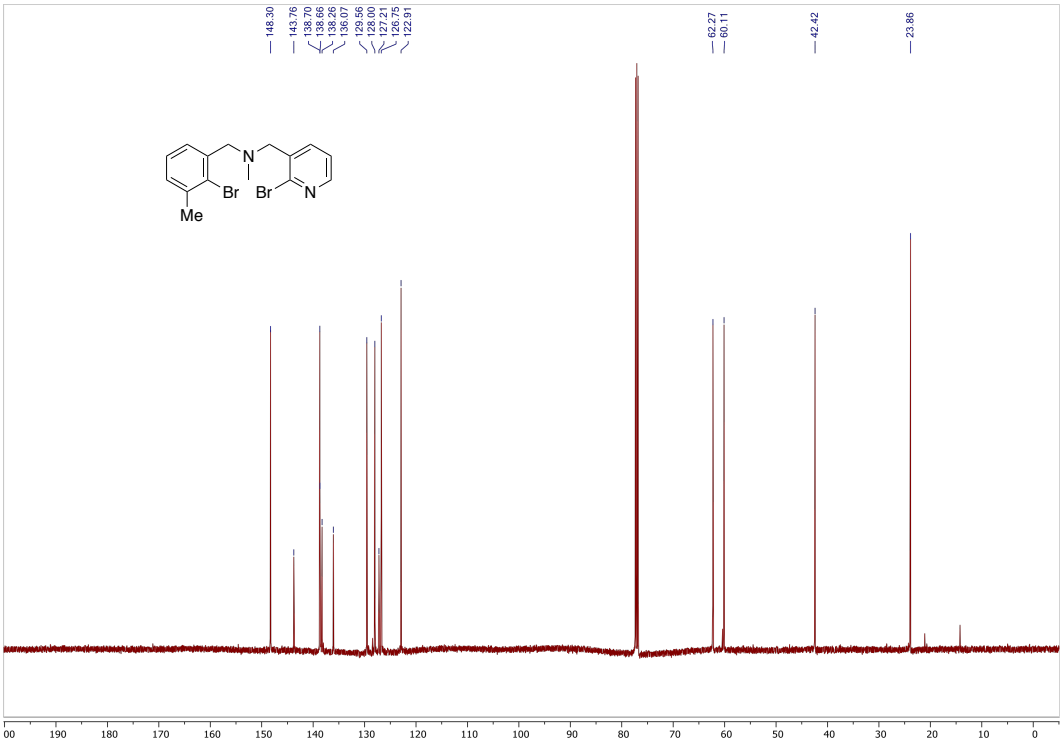


Figure S30. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22a.**

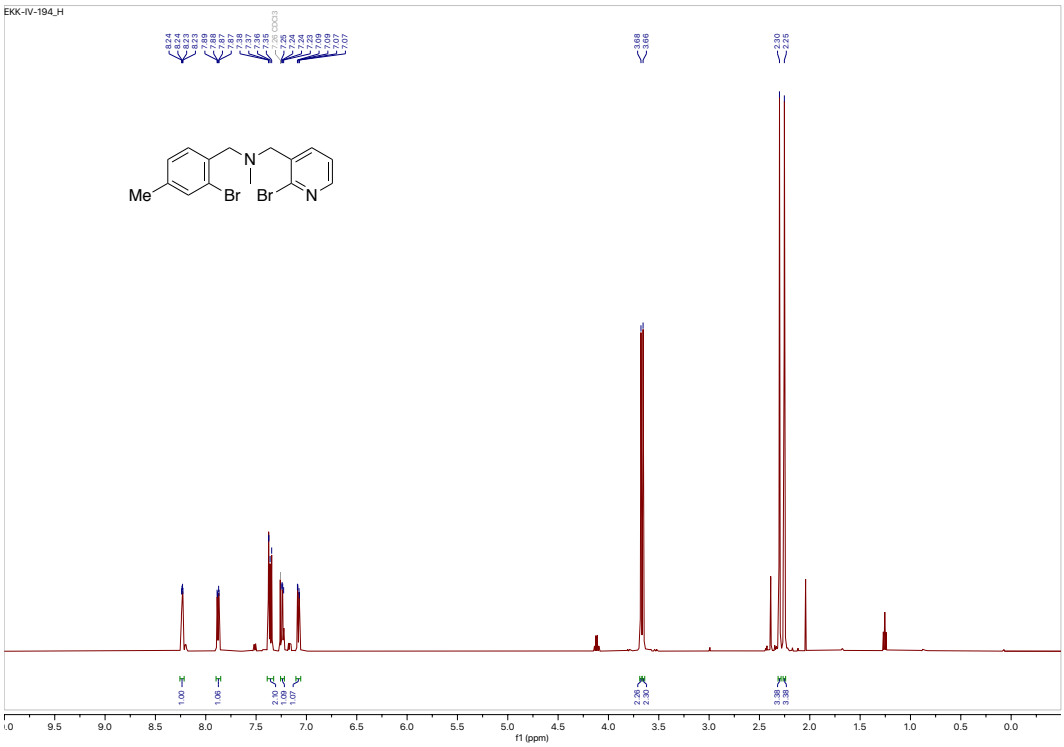


Figure S31. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22b.**

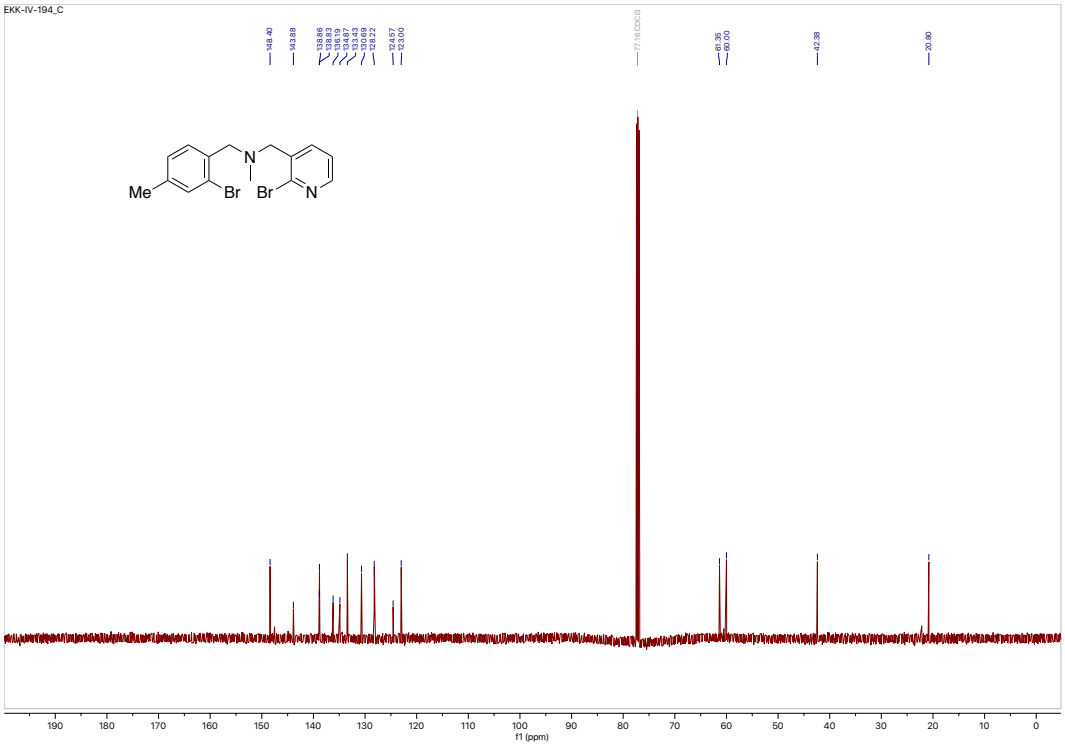


Figure S32. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22b.**

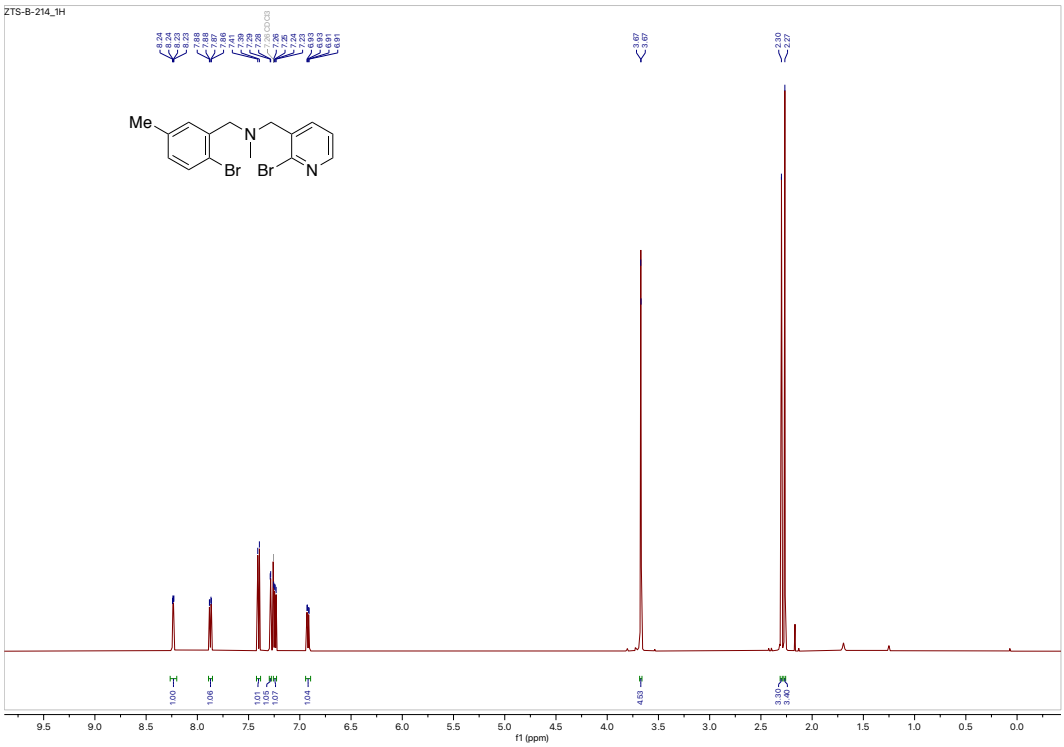


Figure S33. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22c.**

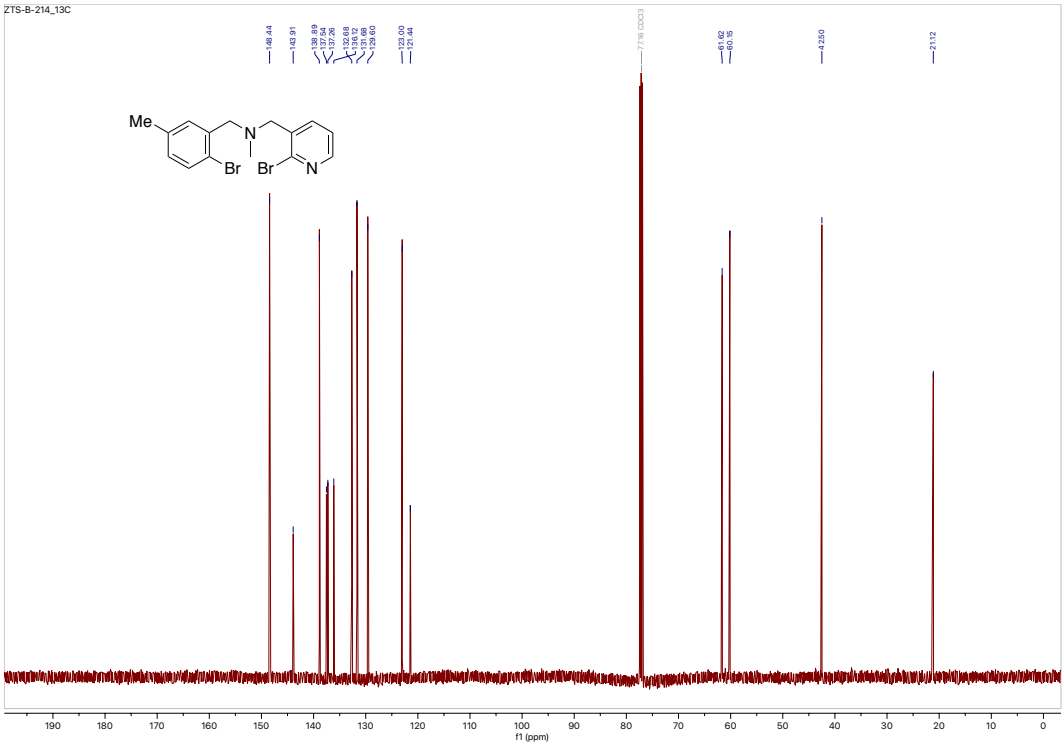


Figure S34. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22c.**

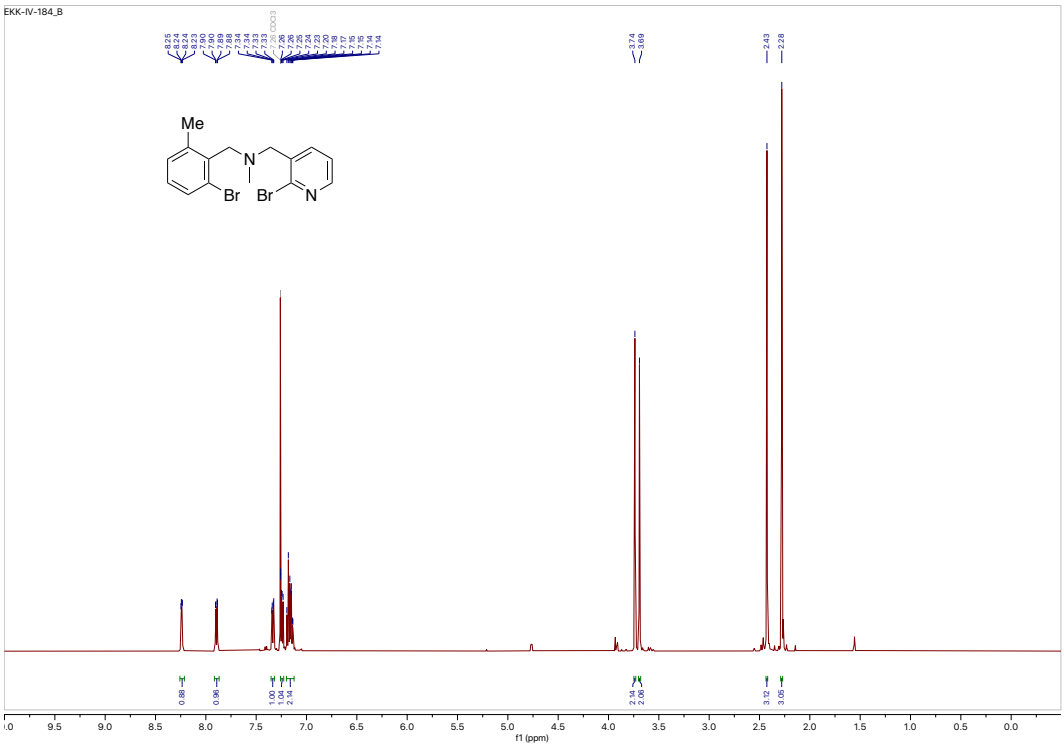


Figure S35. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22d.**

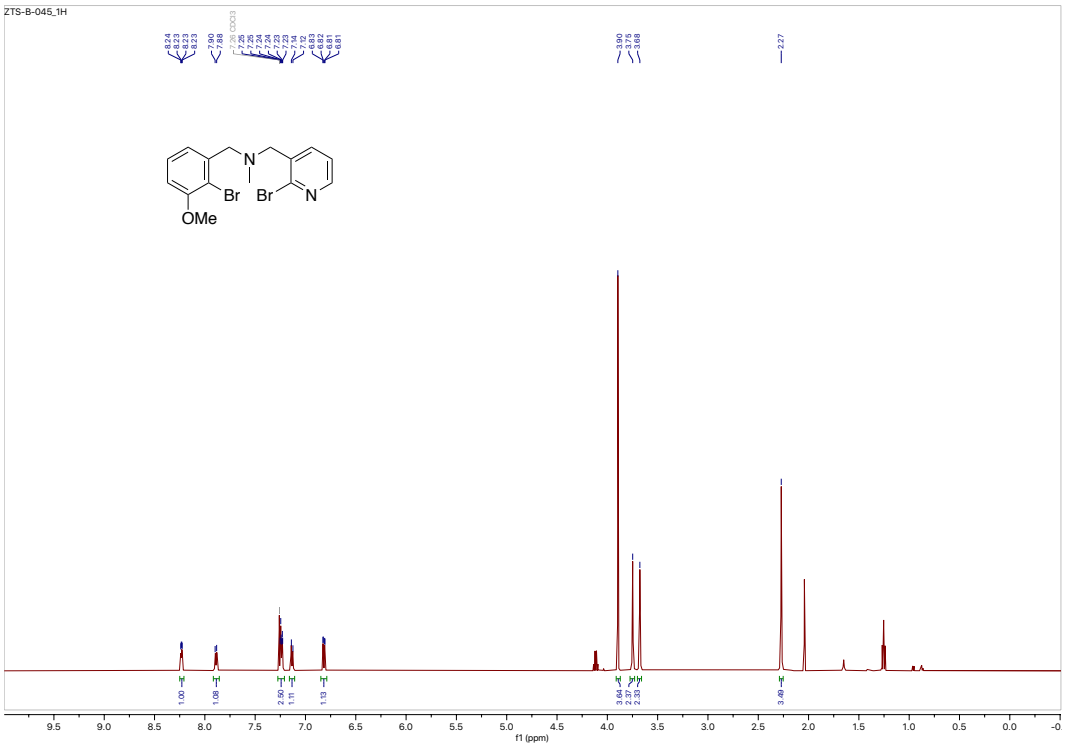


Figure S36. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22e.**

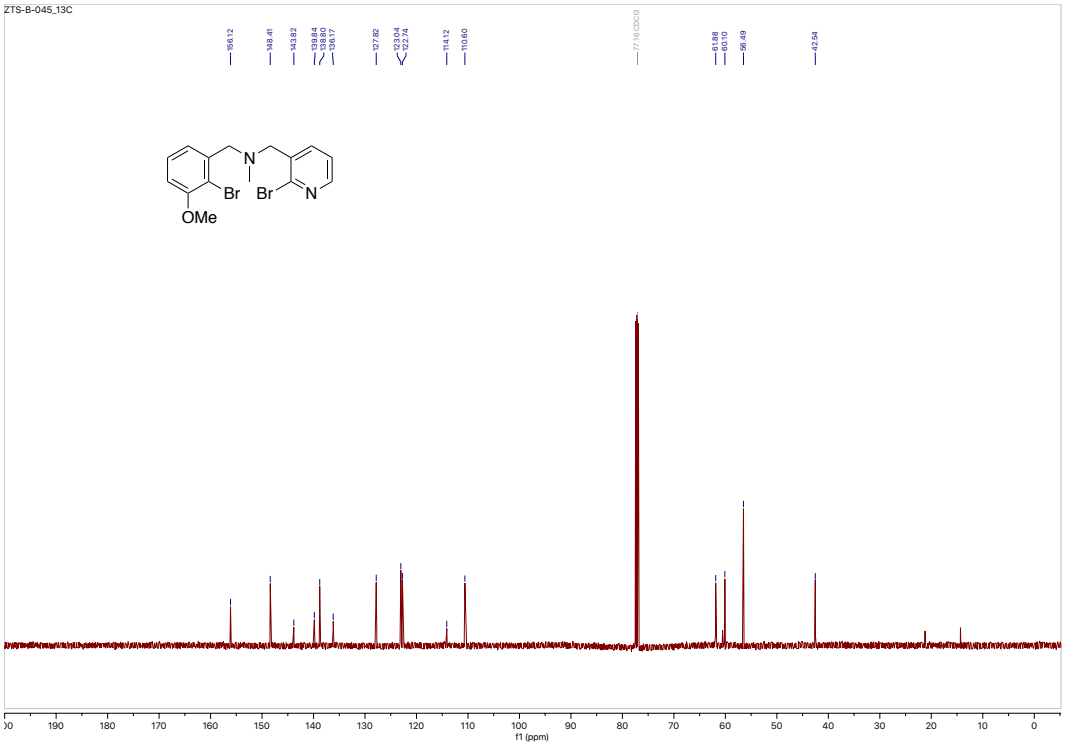


Figure S37. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22e.**

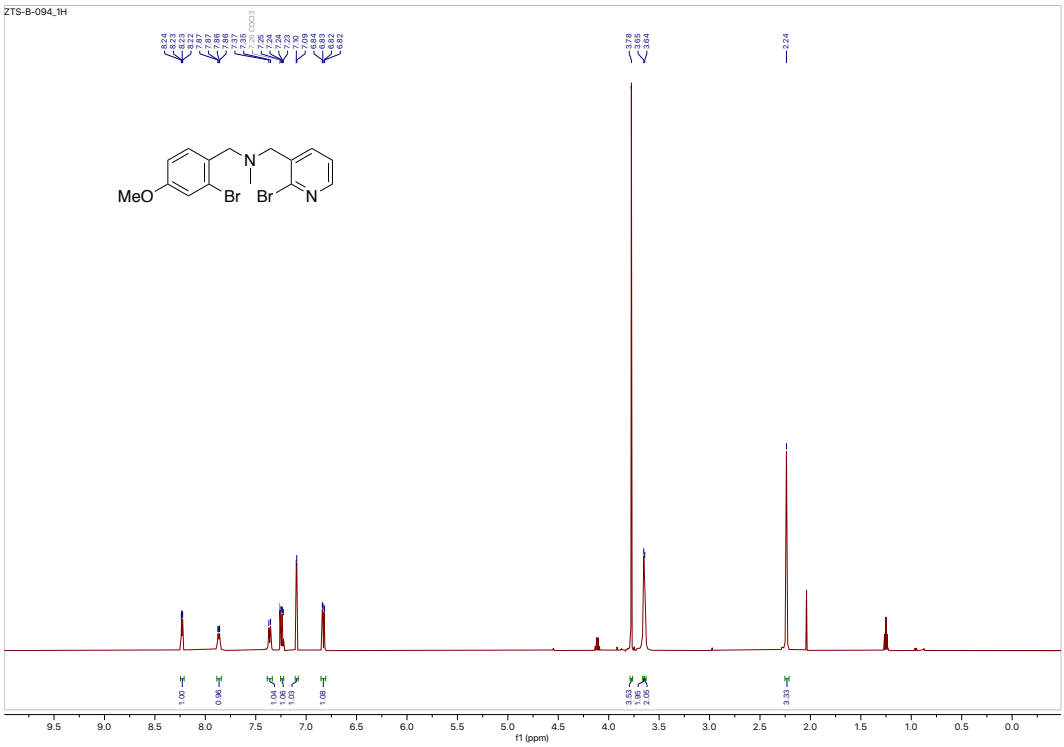


Figure S38. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22f.**

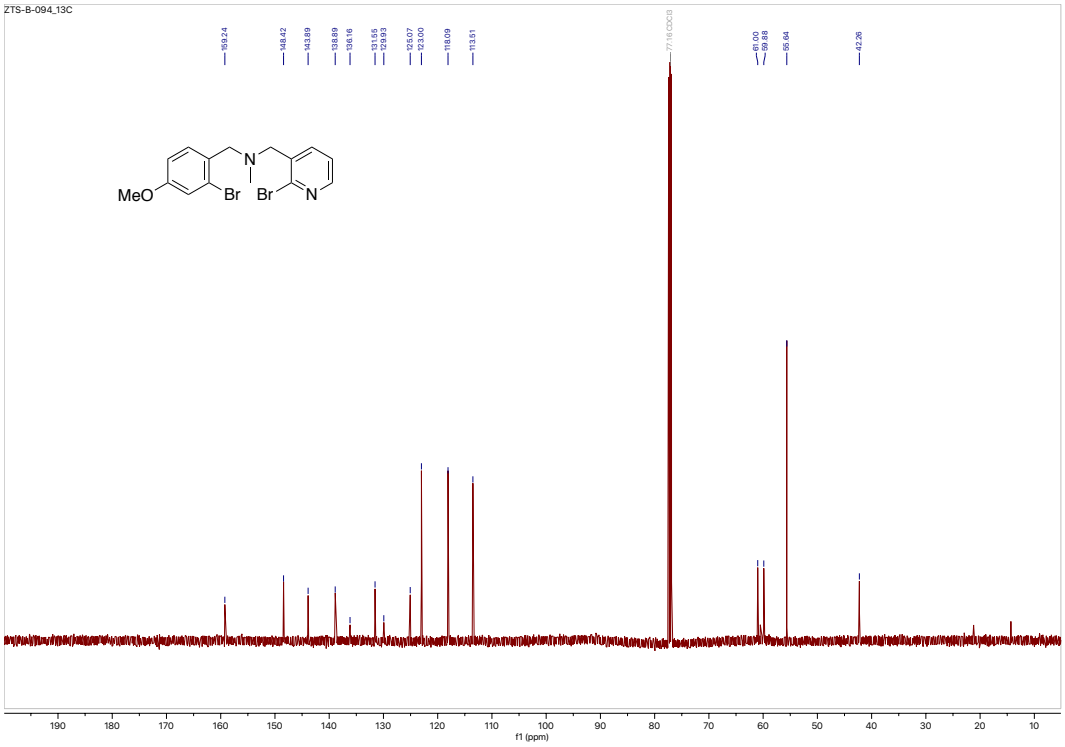


Figure S39. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22f.**

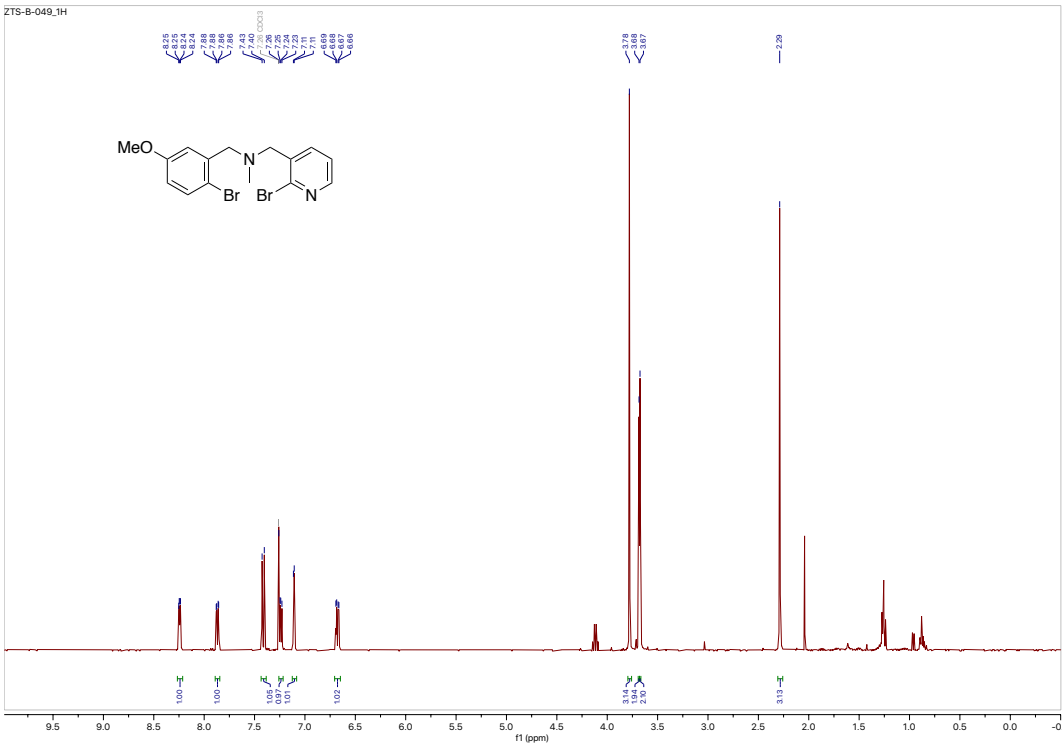


Figure S40. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22g.**

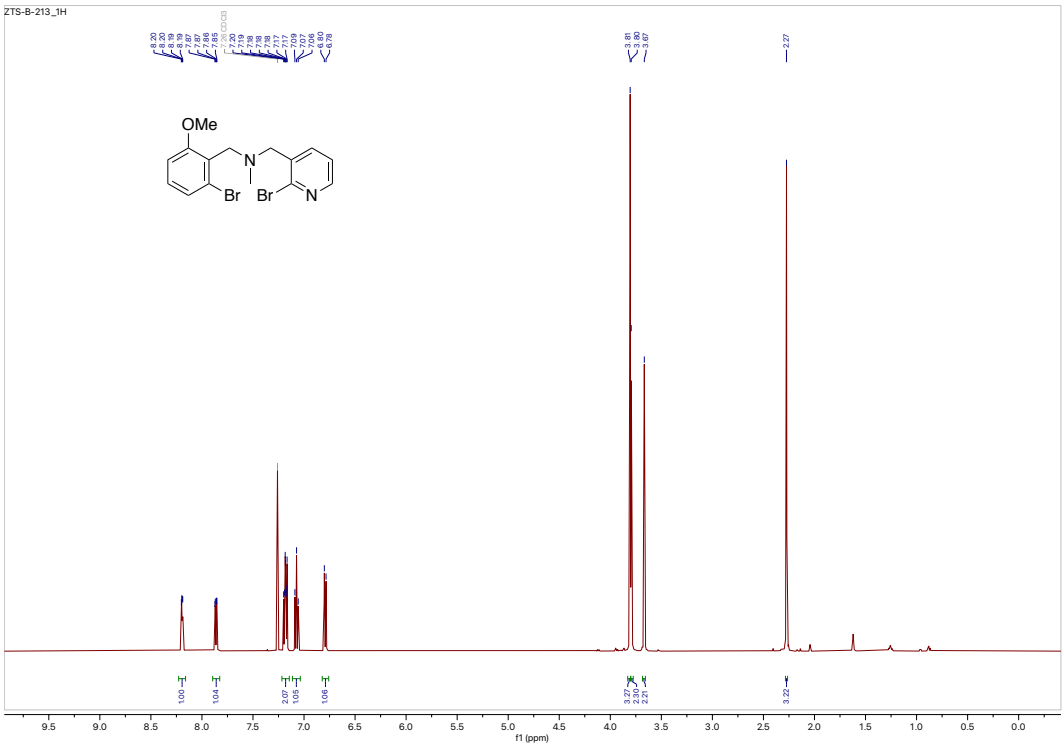


Figure S41. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22h.**

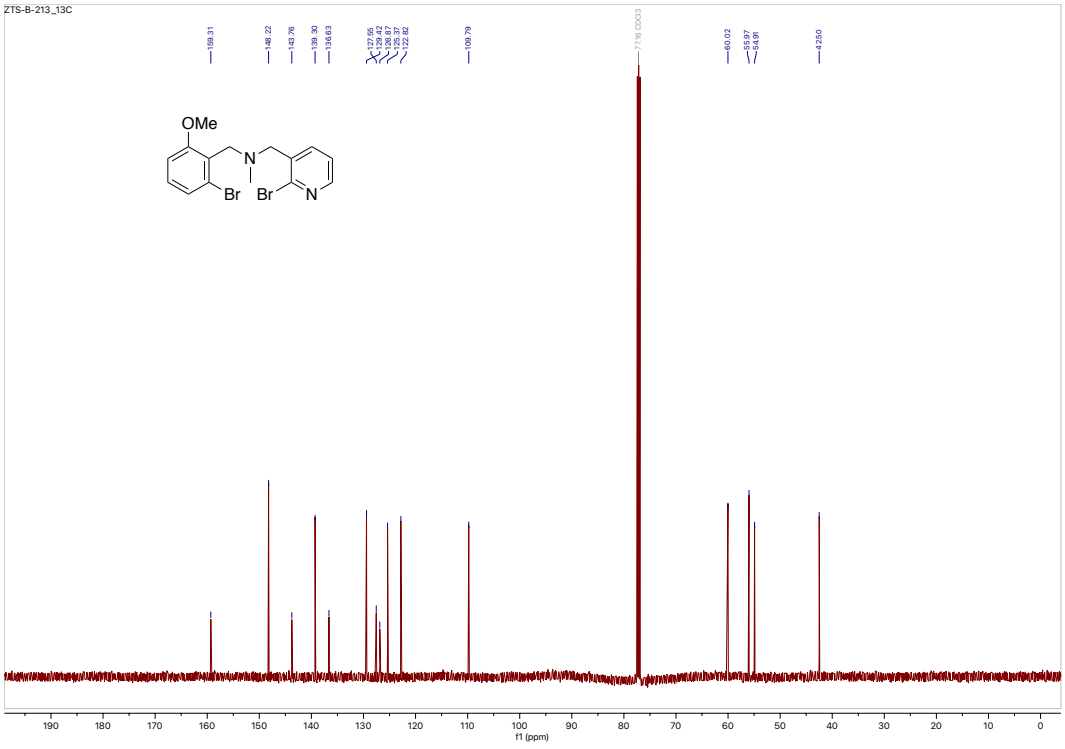


Figure S42. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22h.**

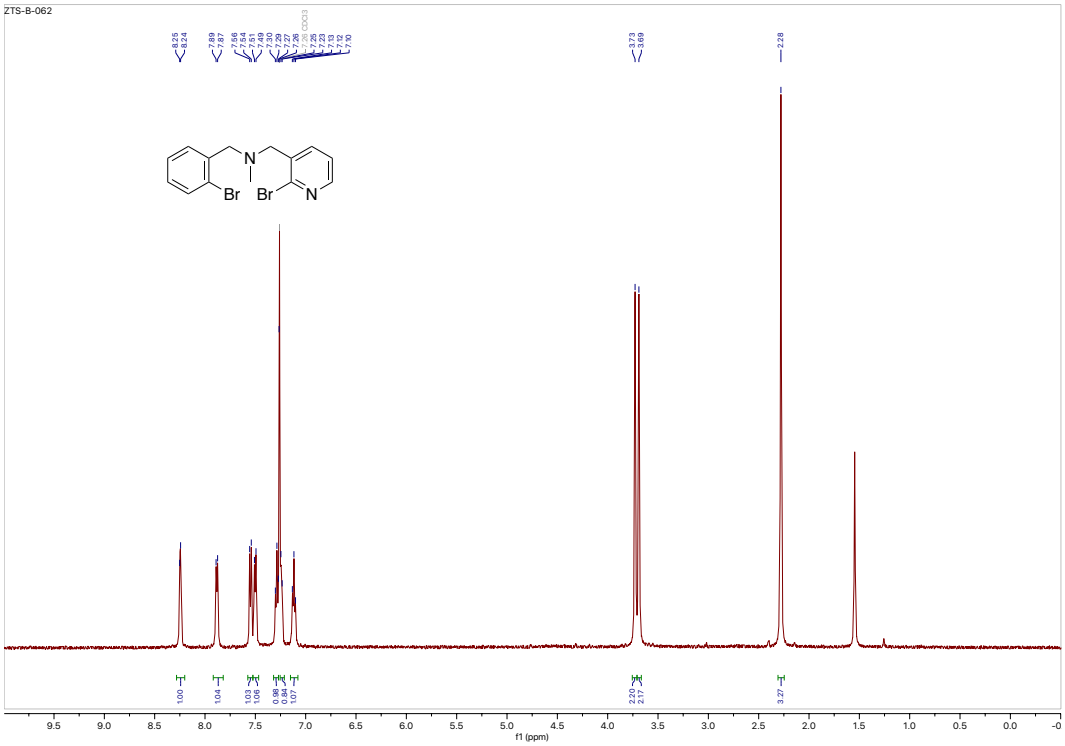


Figure S43. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22i.**

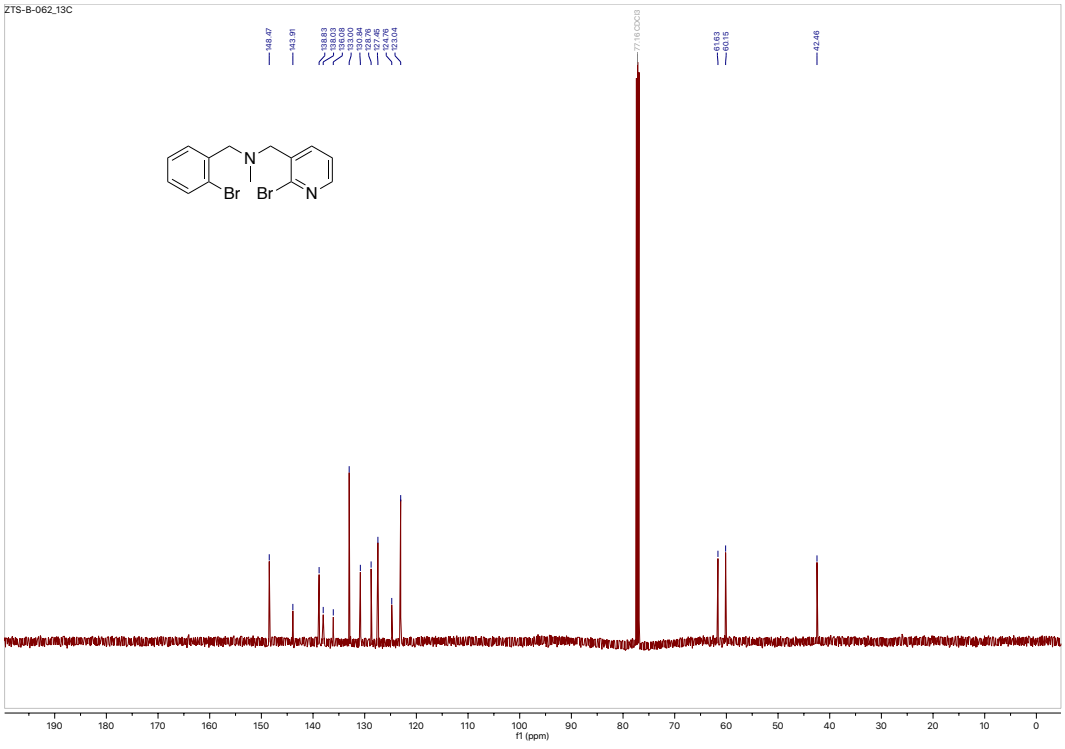


Figure S44. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22i.**

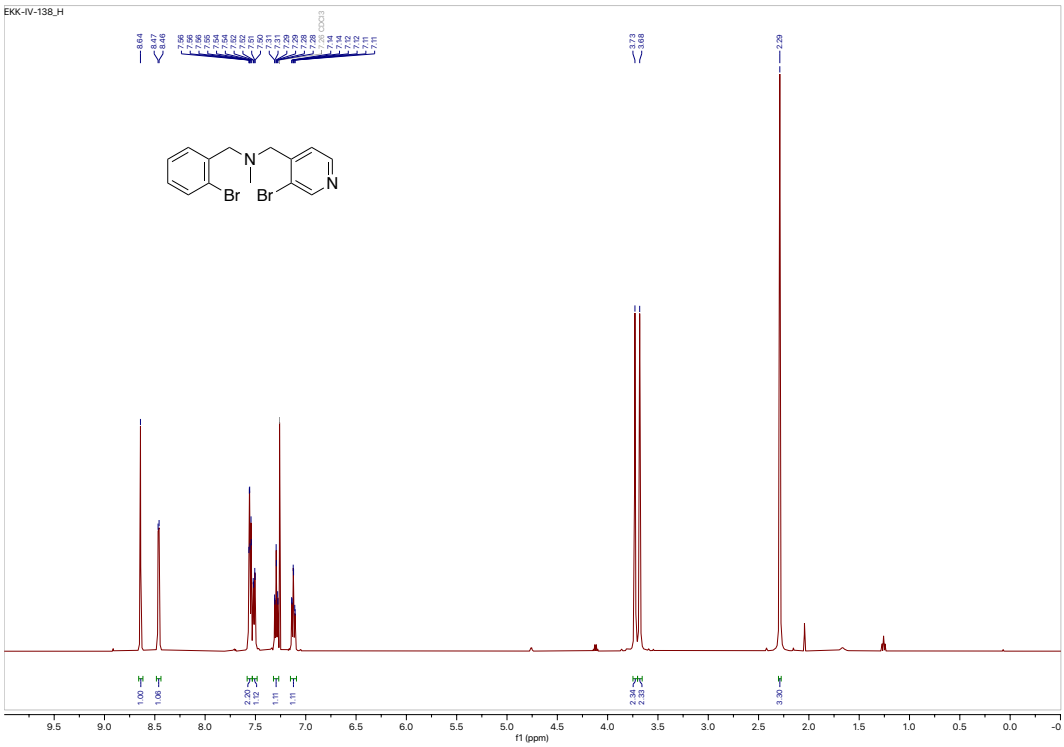


Figure S45. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22j.**

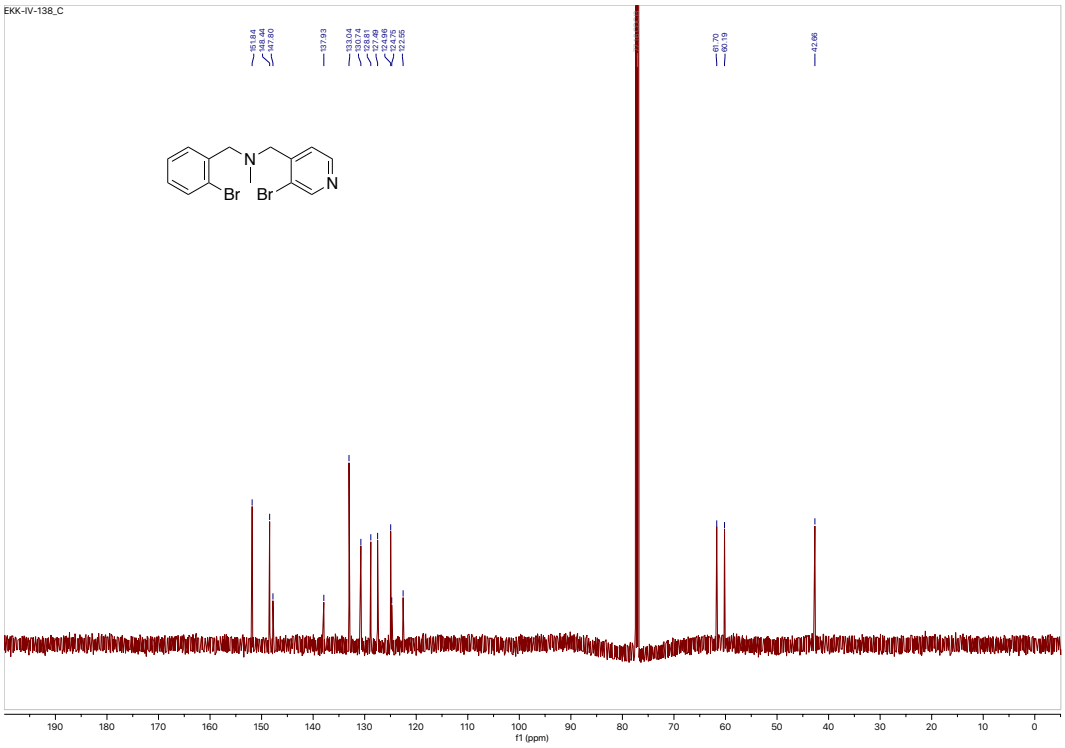


Figure S46. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22j.**

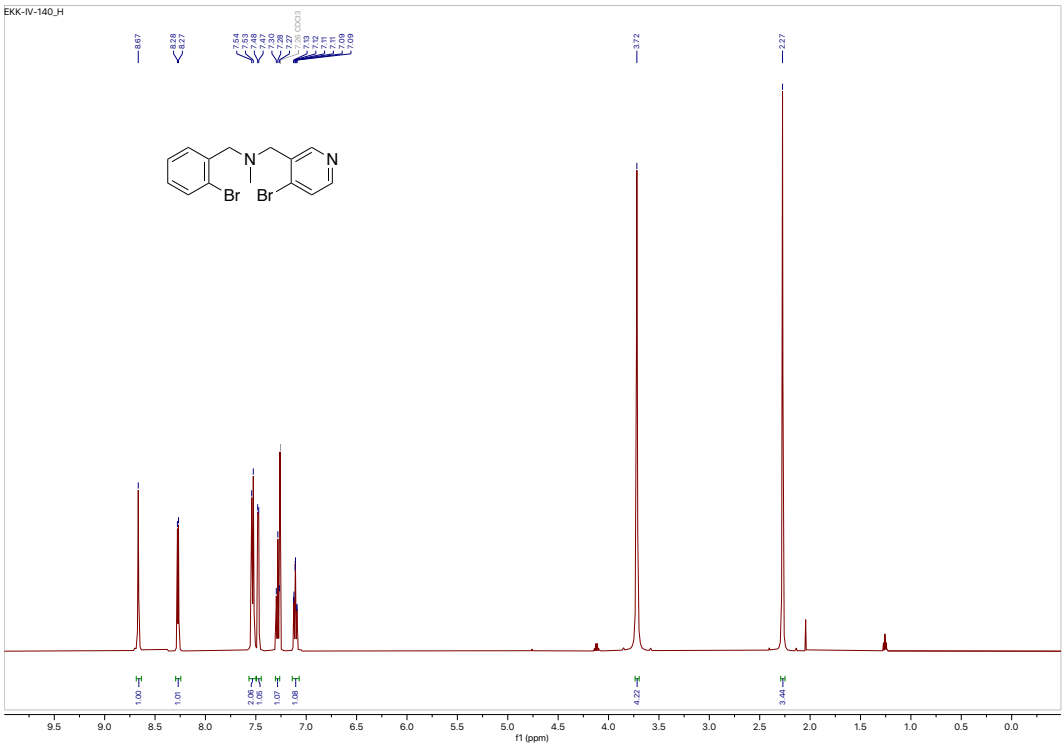


Figure S47. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22k.**

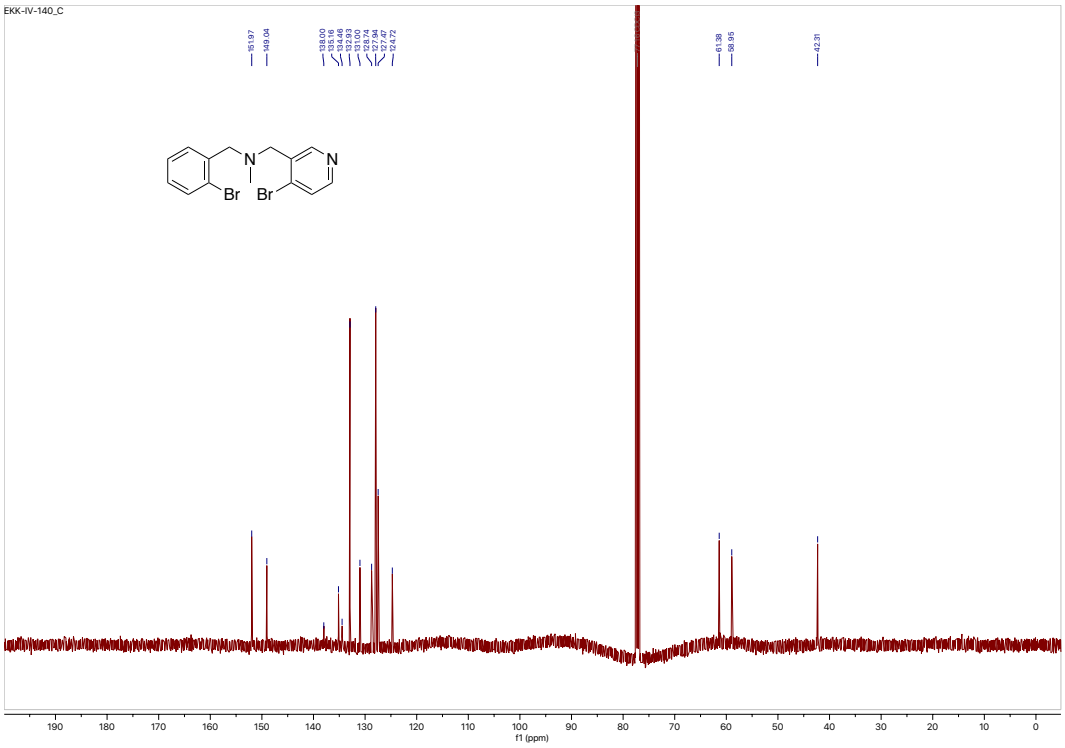


Figure S48. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22k.**

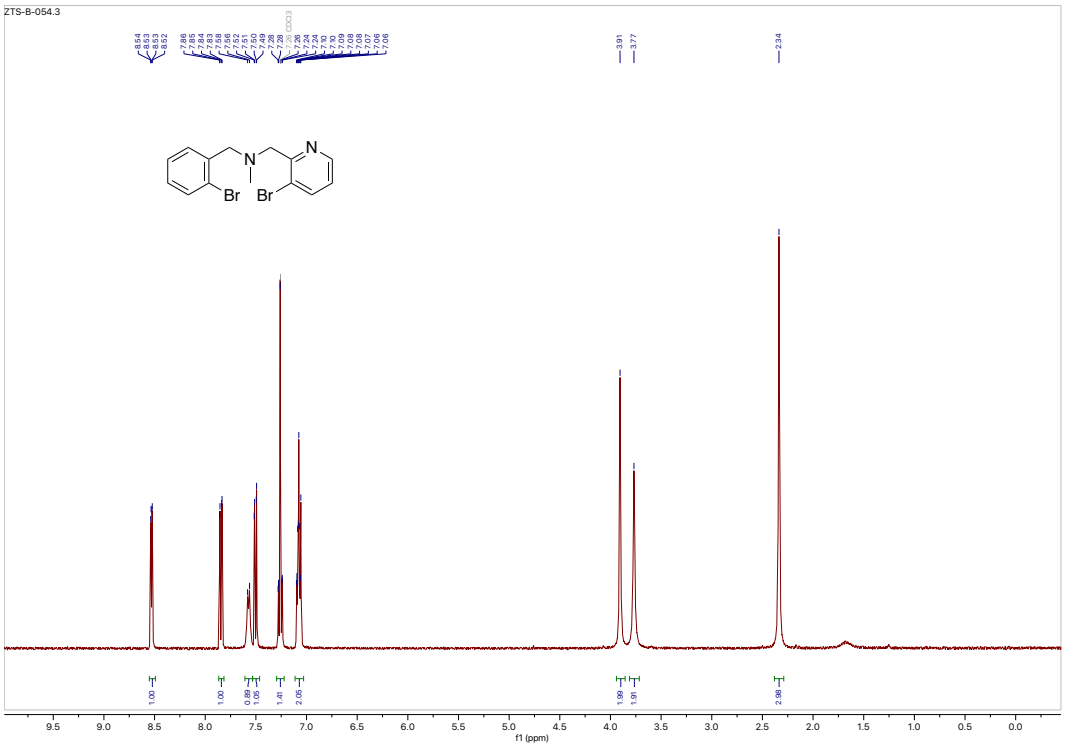


Figure S49. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22l.**

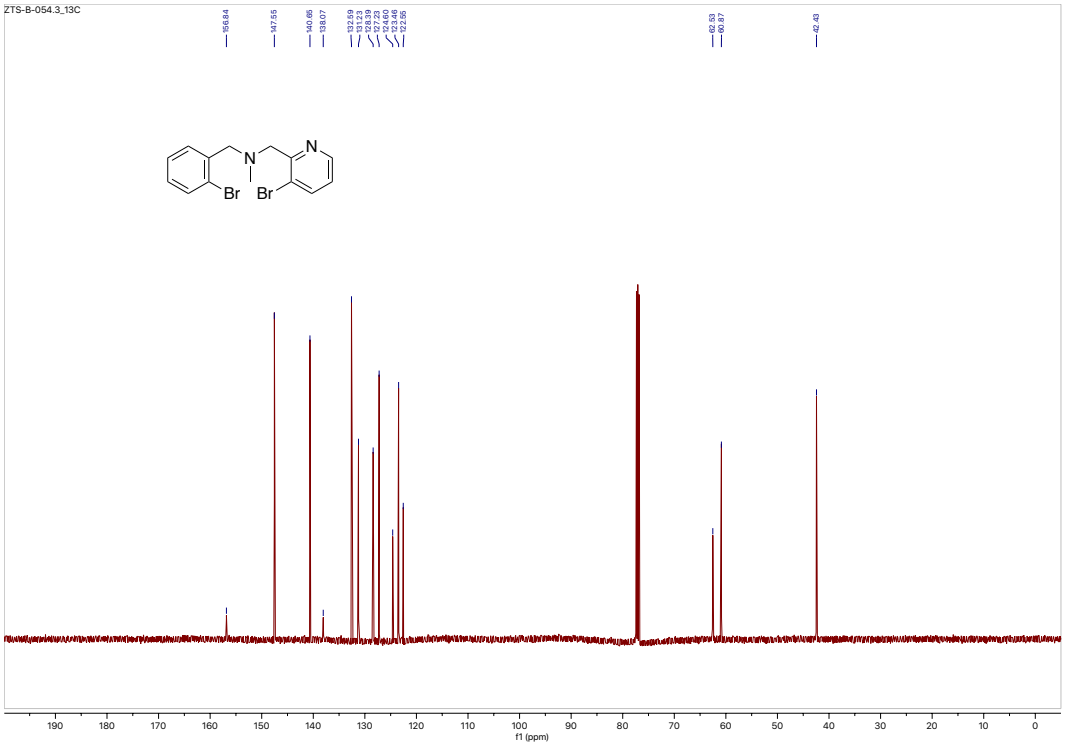


Figure S50. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22l.**

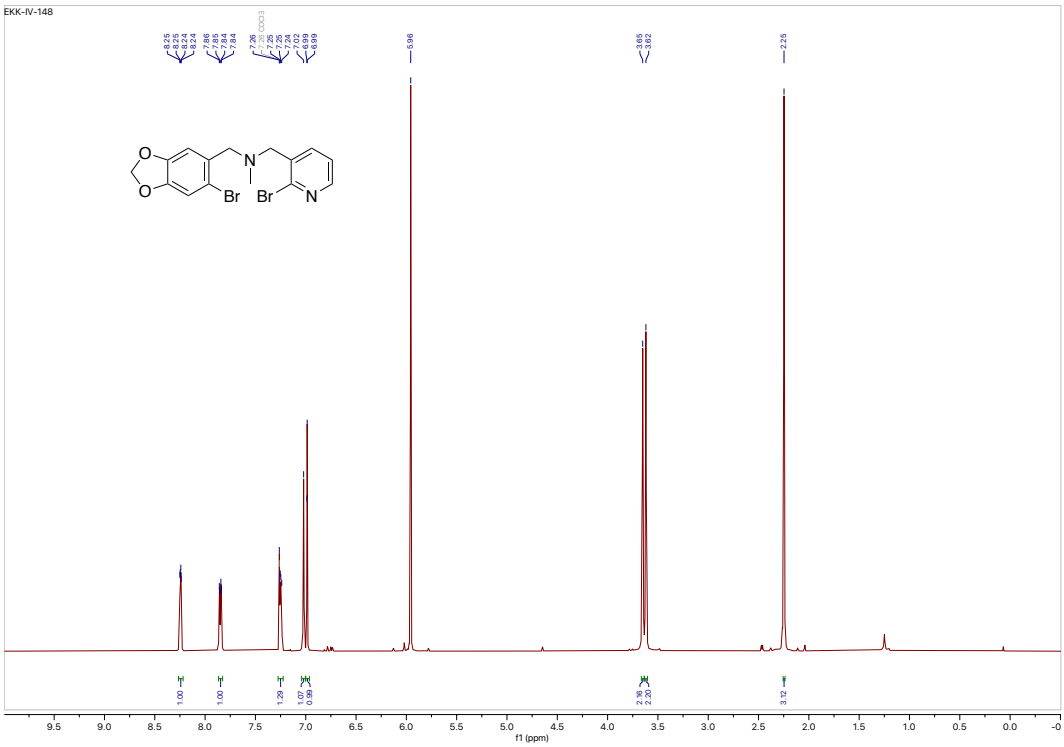


Figure S51. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22m.**

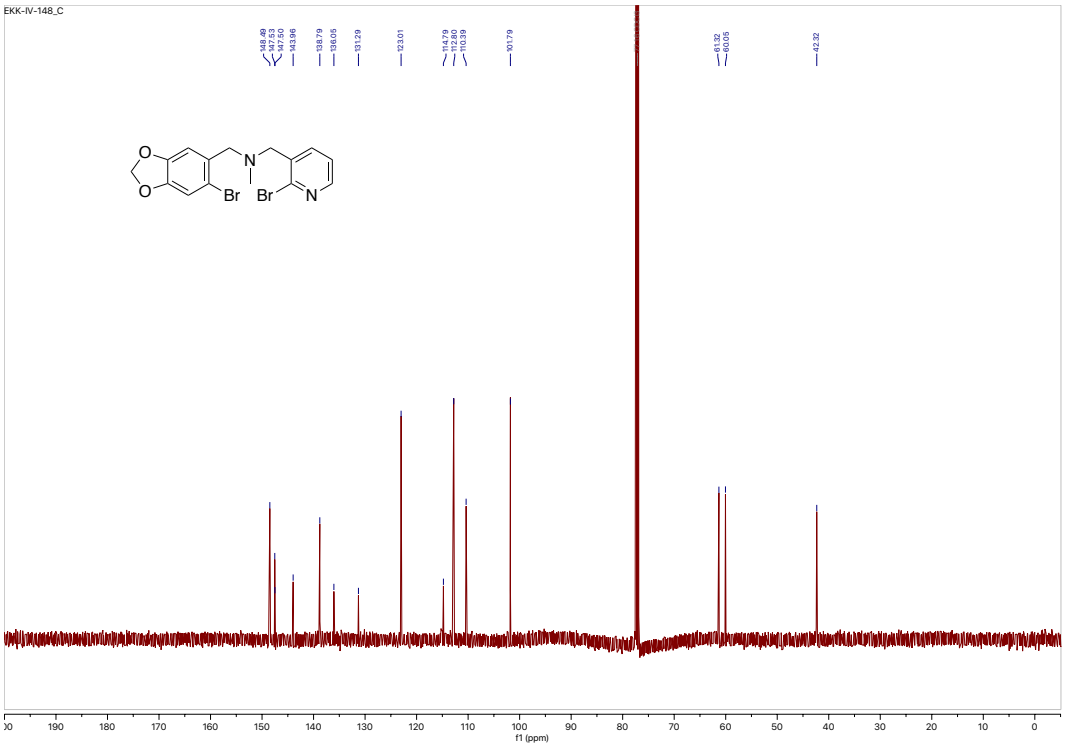


Figure S52. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22m.**

*EtOAc

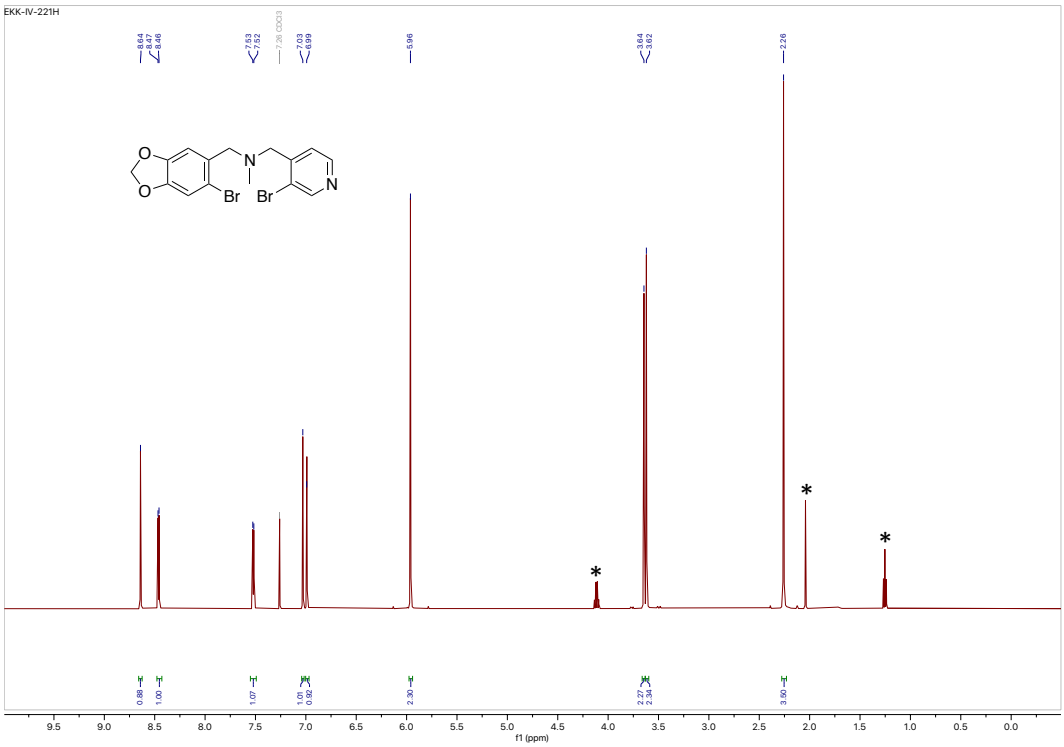


Figure S53. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22n.**

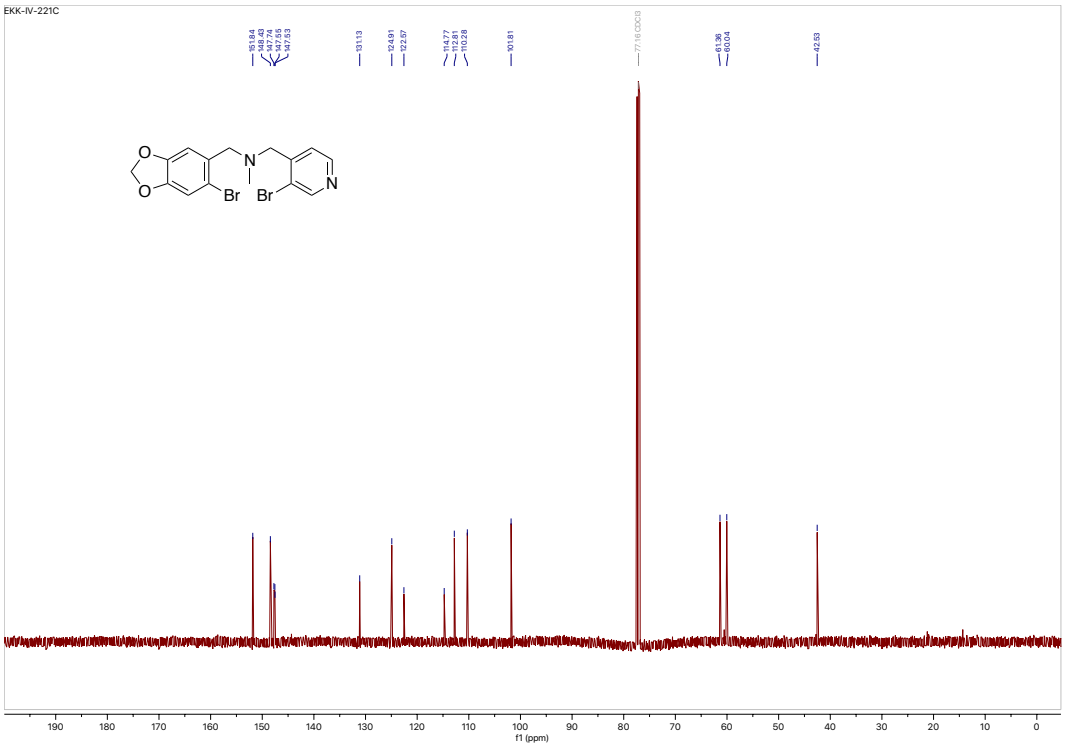


Figure S54. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22n.**

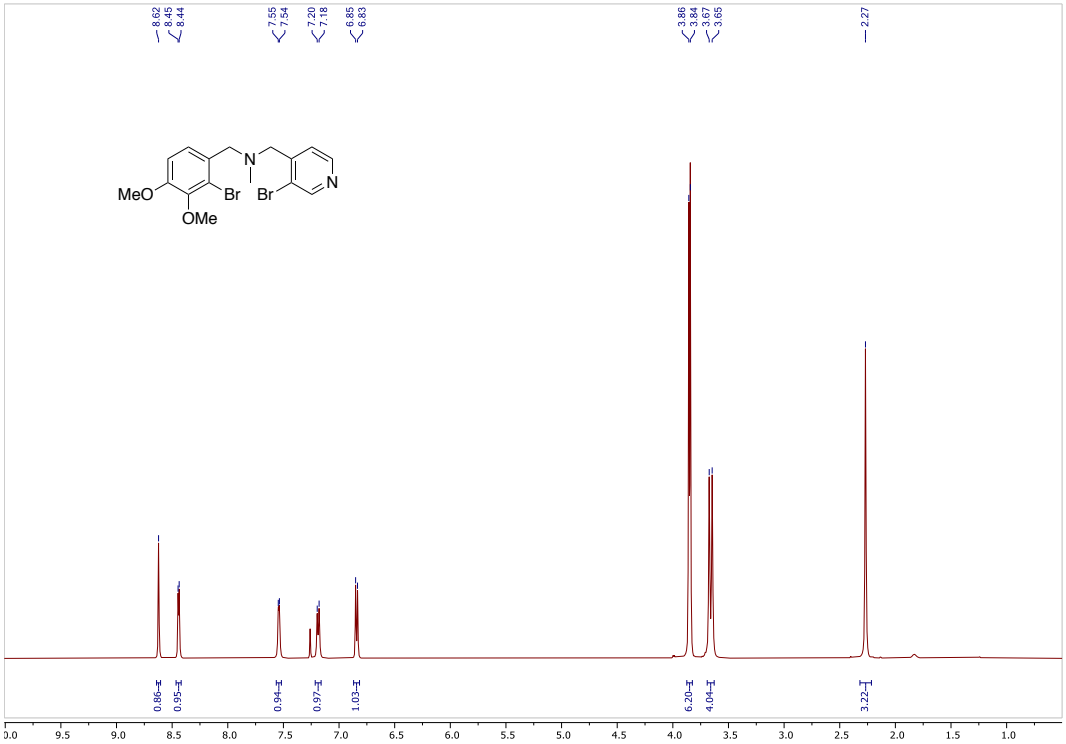


Figure S55. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22o.**

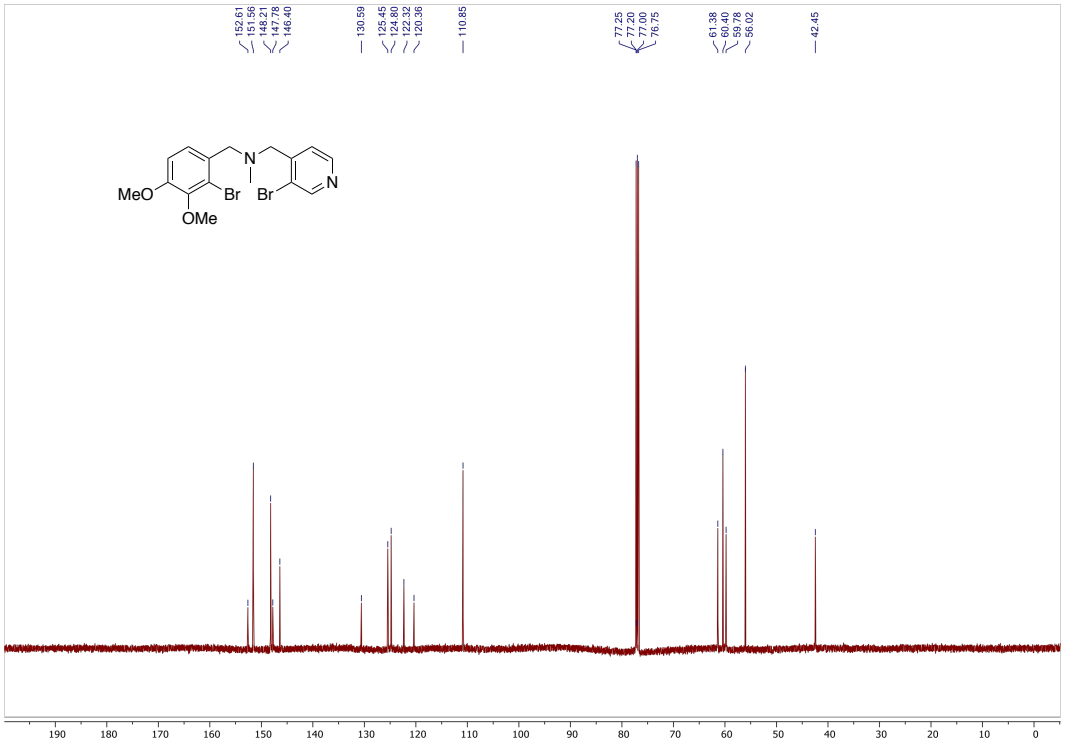


Figure S56. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22o.**

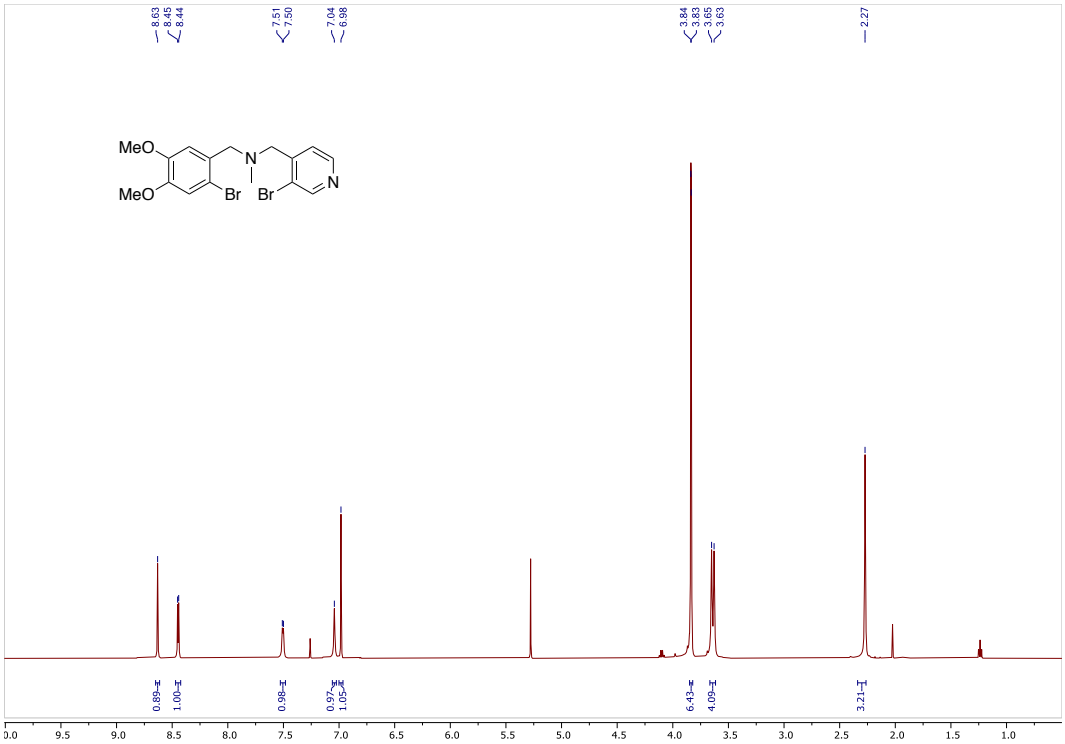


Figure S57. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **22p.**

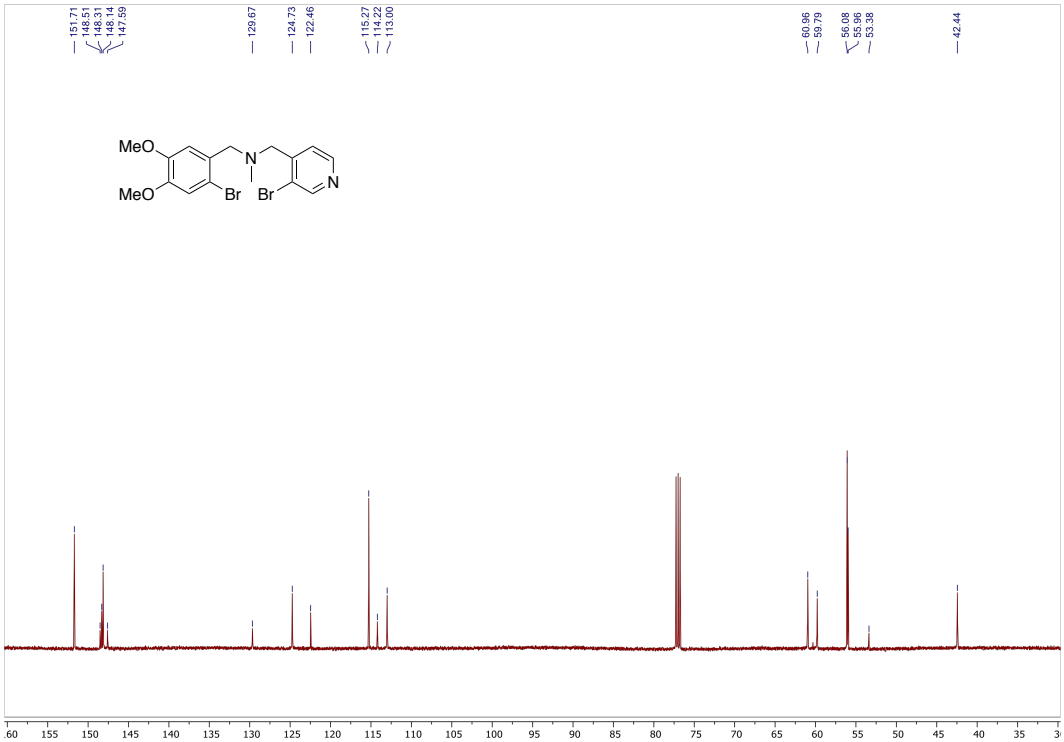


Figure S58. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **22p.**

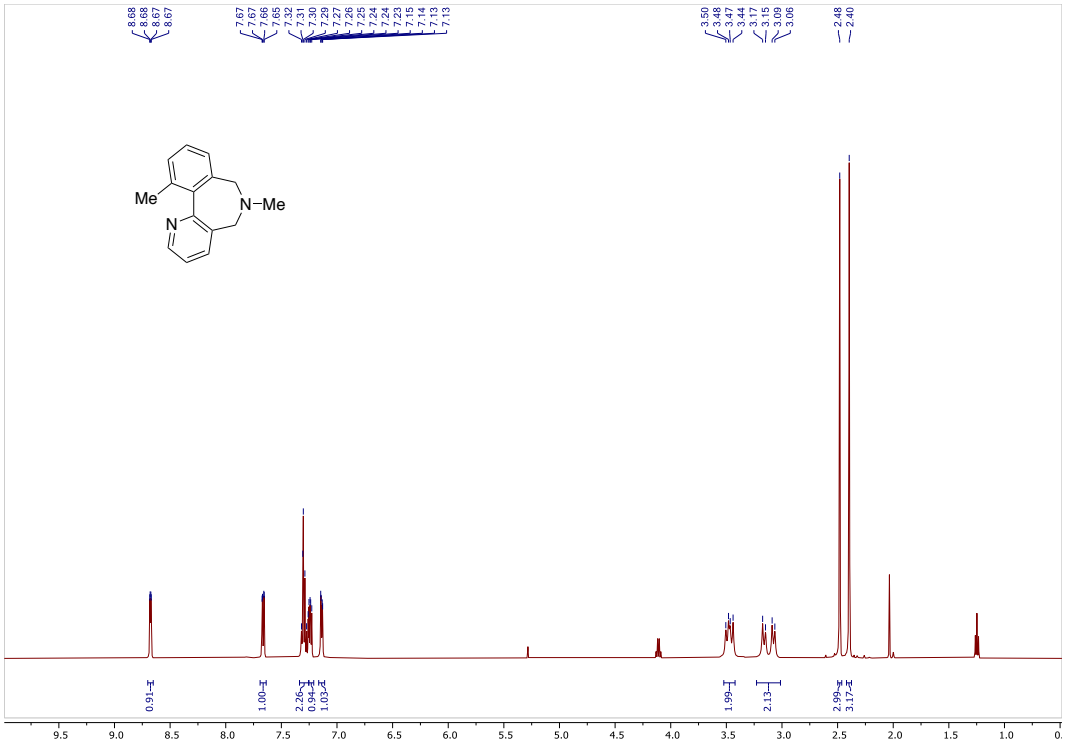


Figure S59. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23a.**

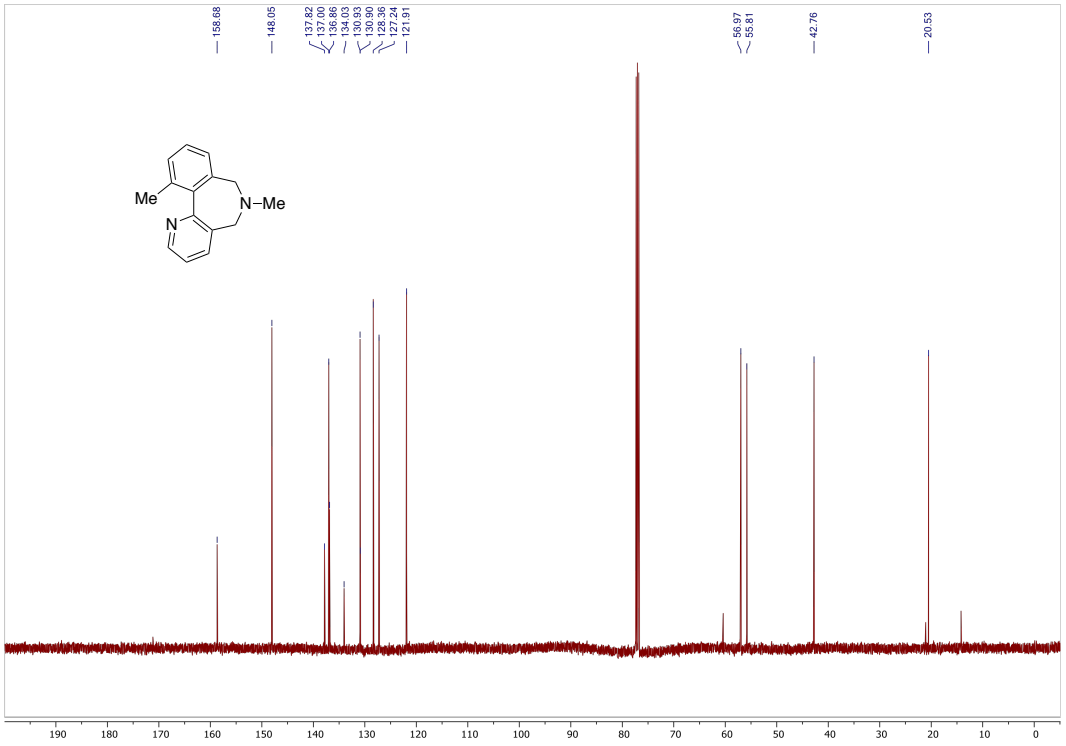


Figure S60. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23a.**

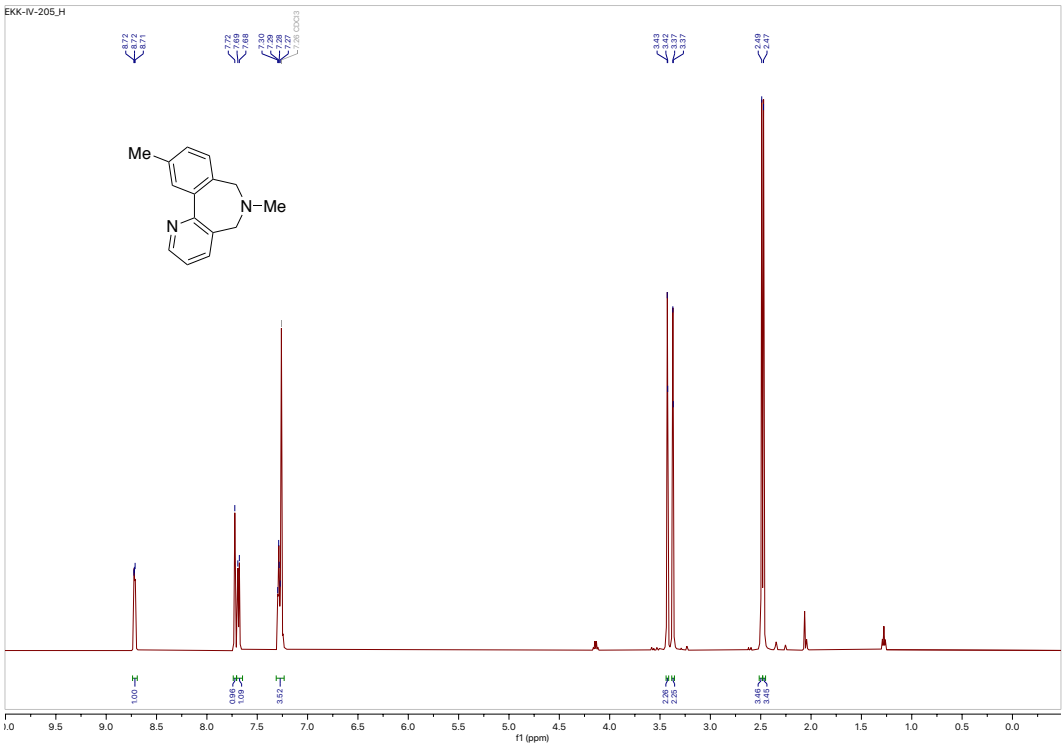


Figure S61. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23b.**

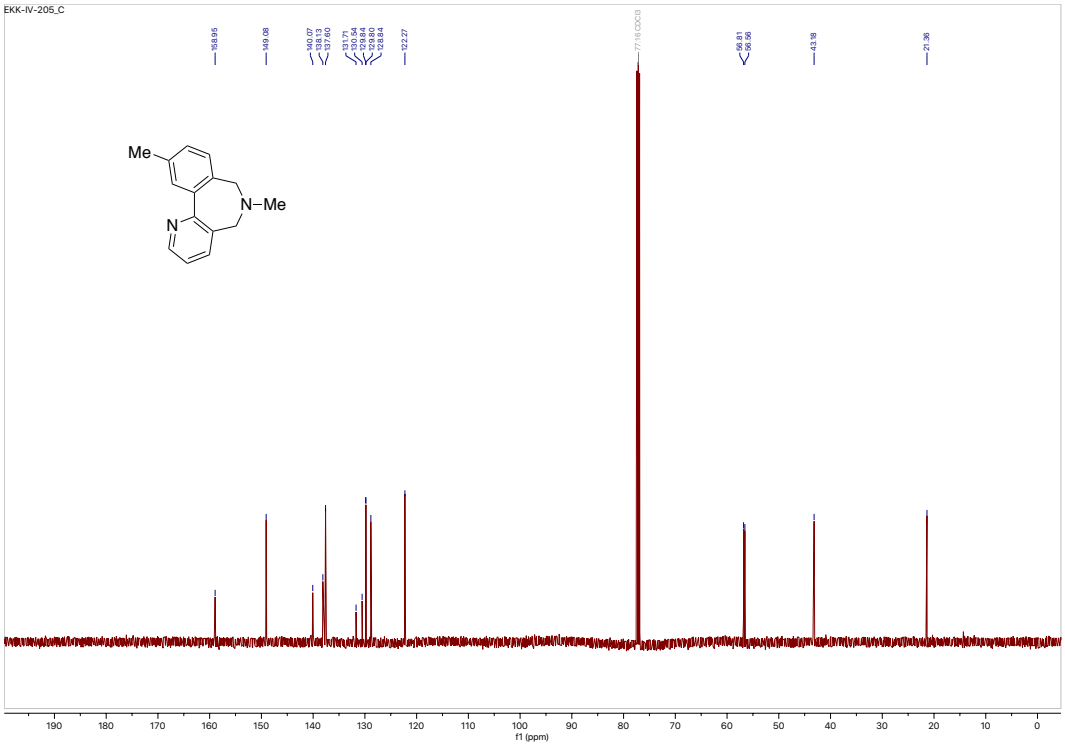


Figure S62. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23b.**

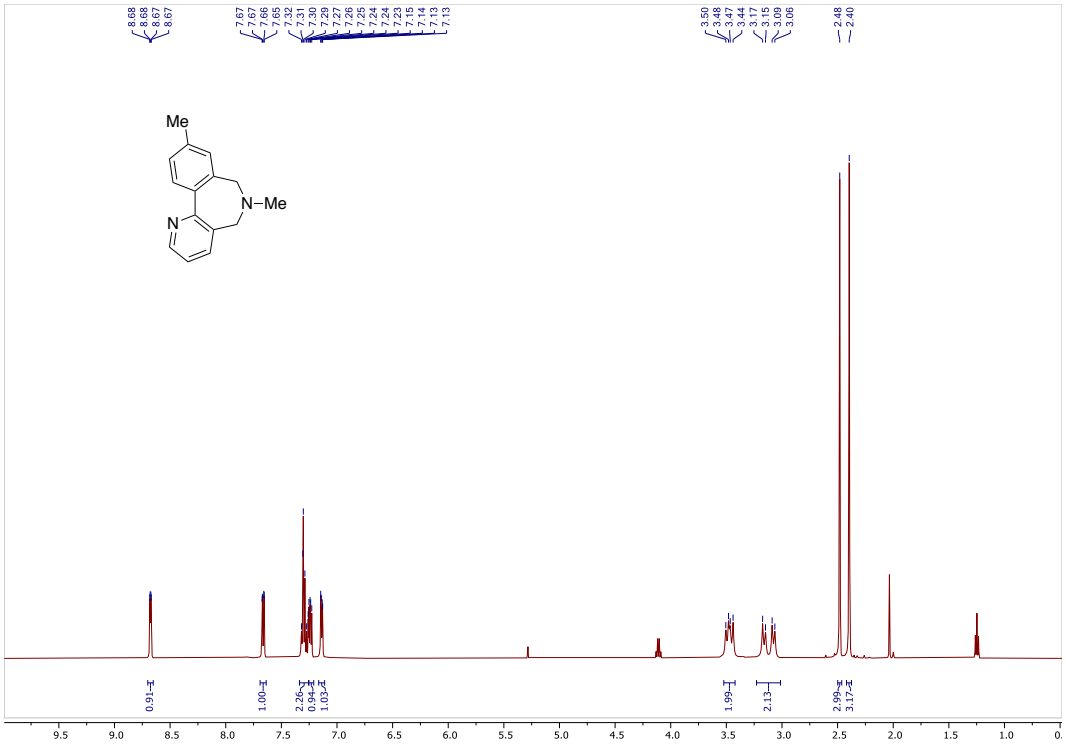


Figure S63. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23c.**

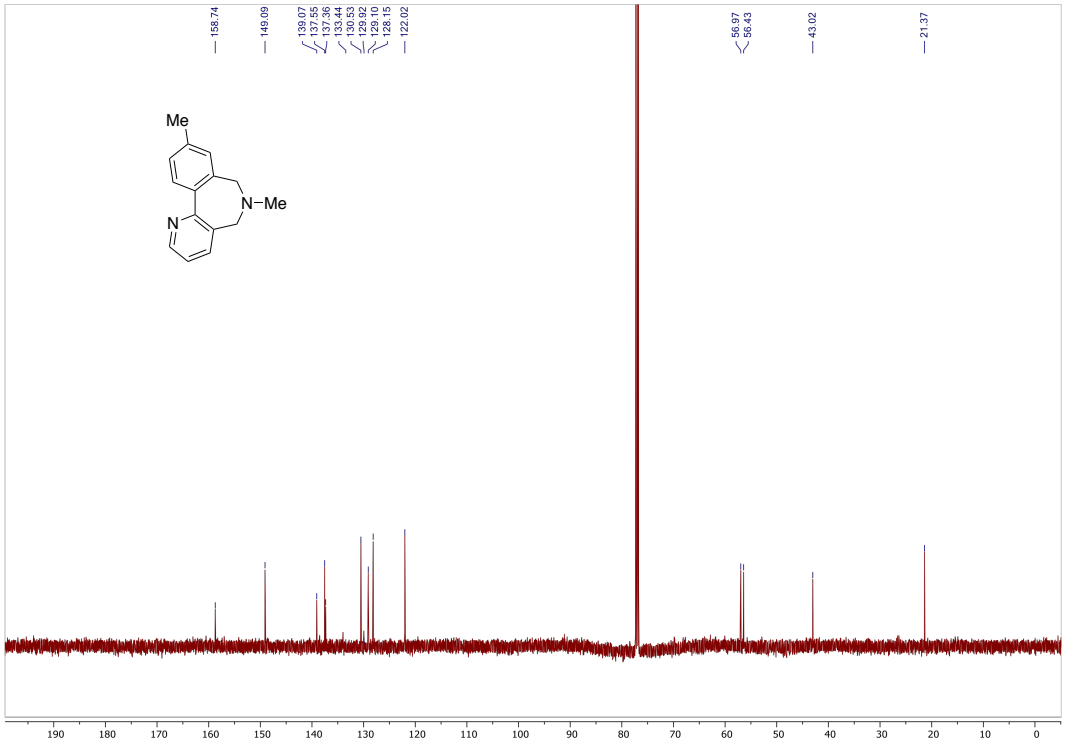


Figure S64. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23c.**

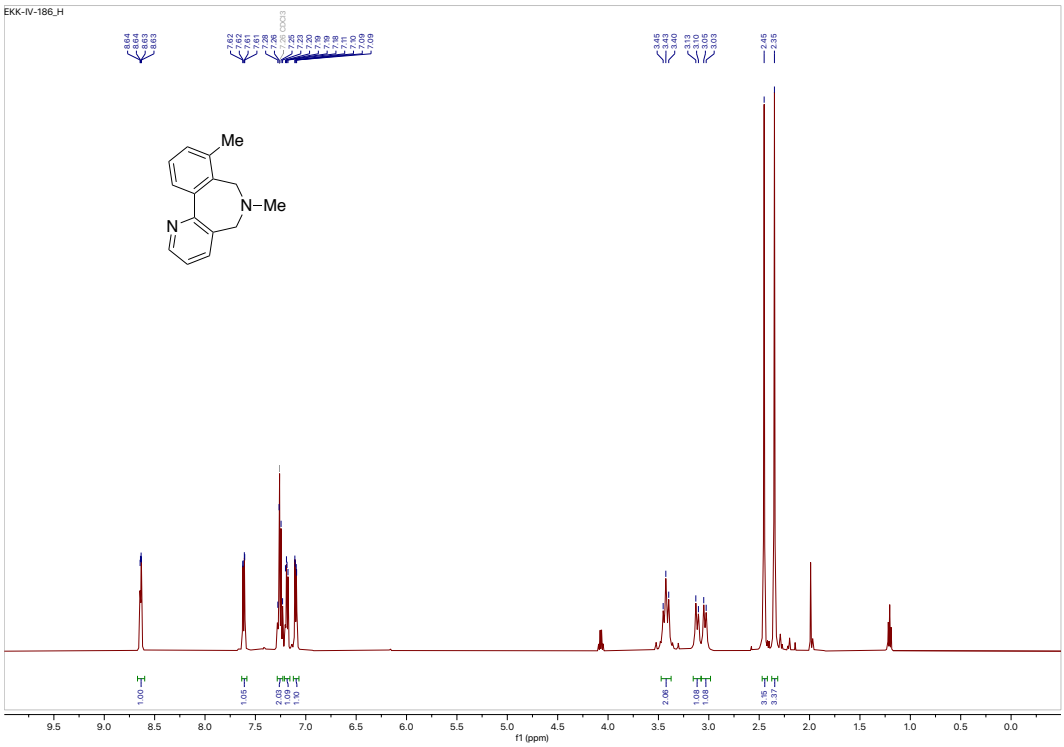


Figure S65. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23d.**

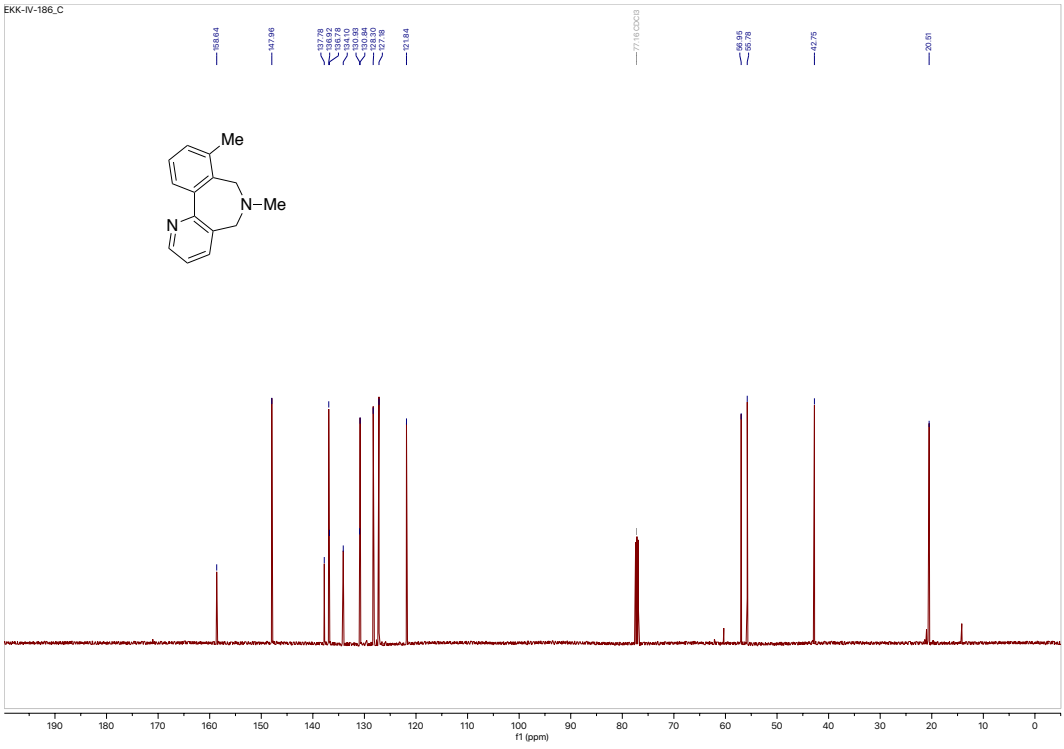


Figure S66. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23d.**

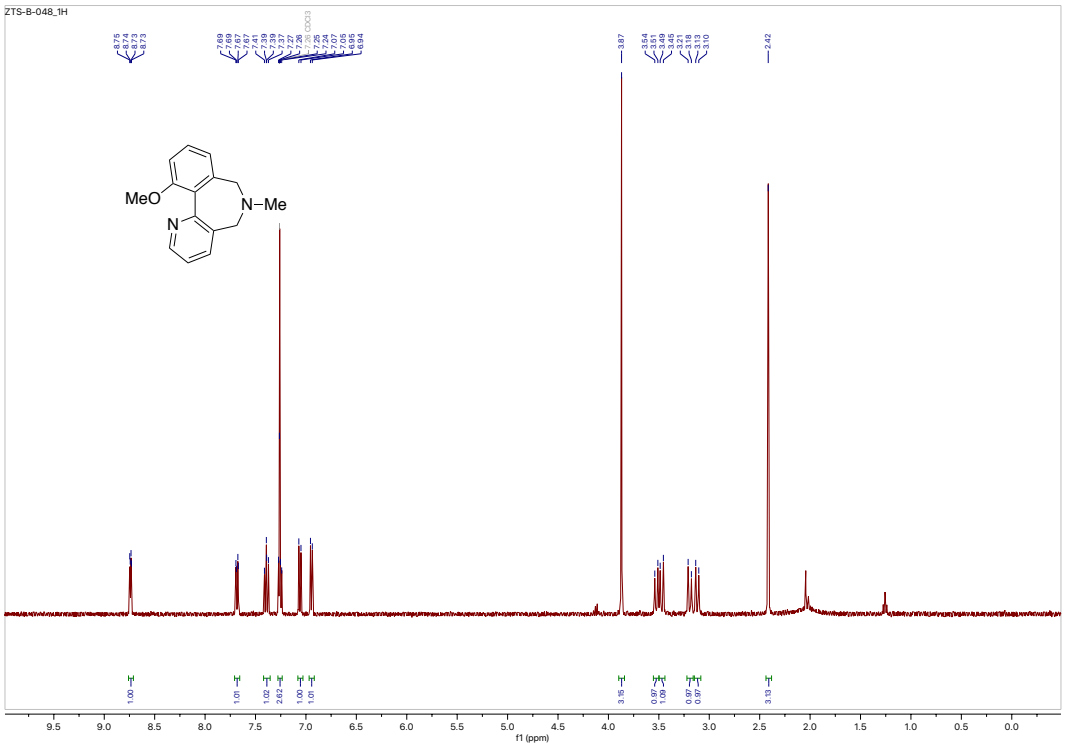


Figure S67. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23e.**

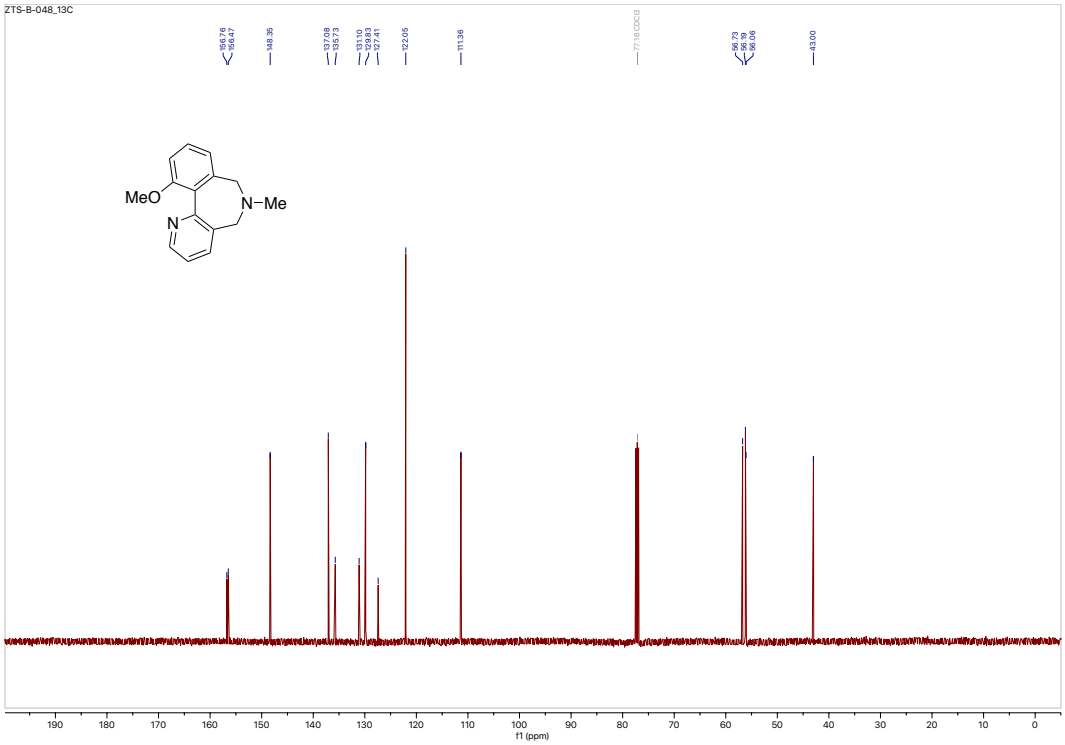


Figure S68. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23e.**

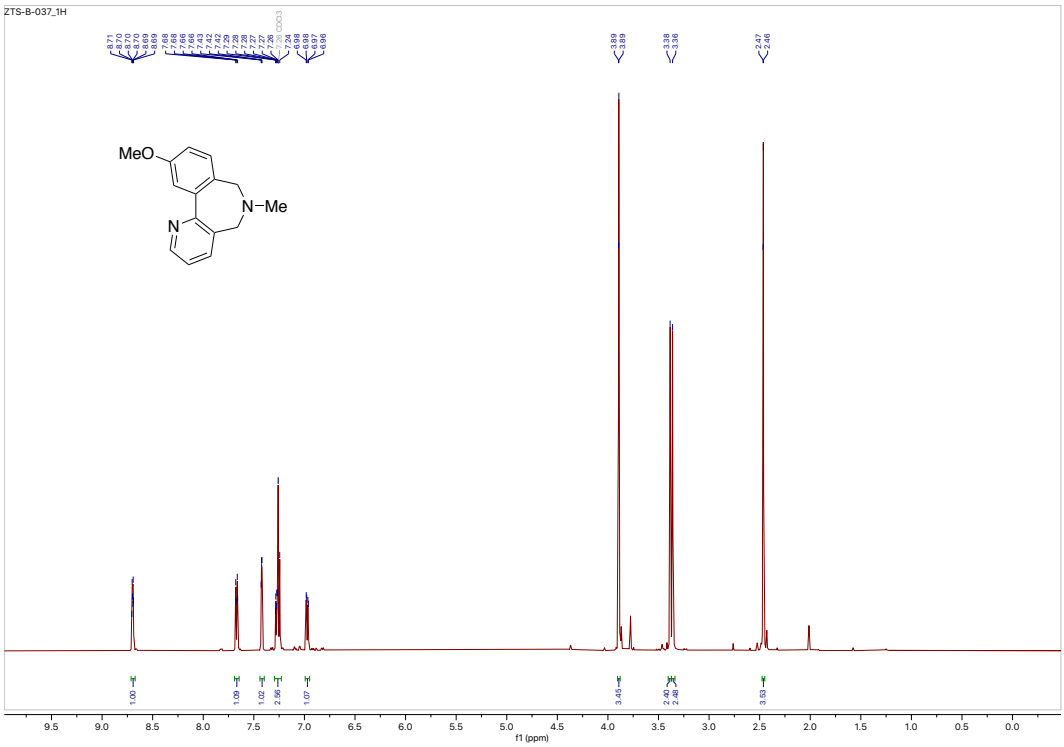


Figure S69. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23f.**

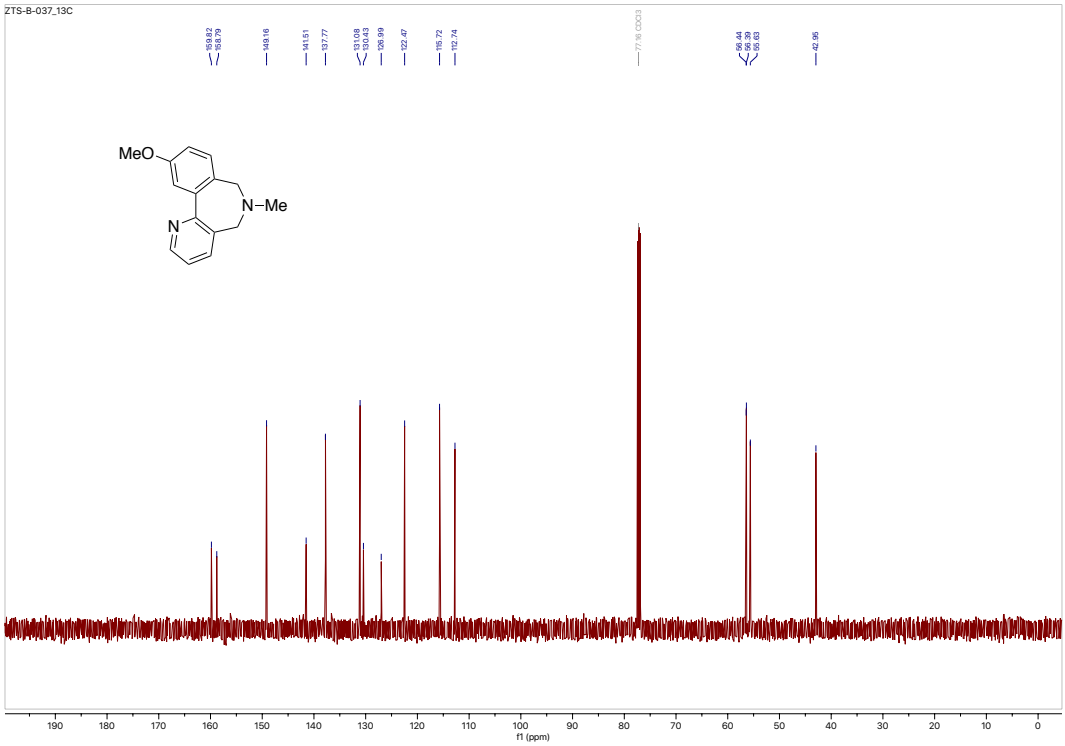


Figure S70. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23f.**

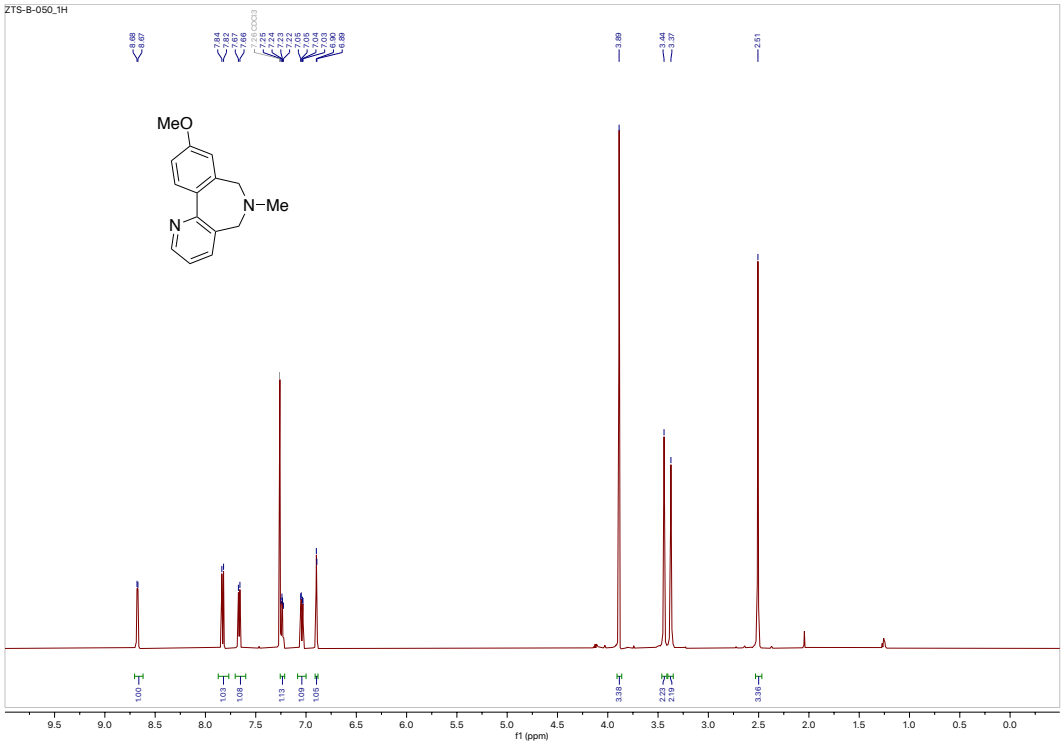


Figure S71. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23g.**

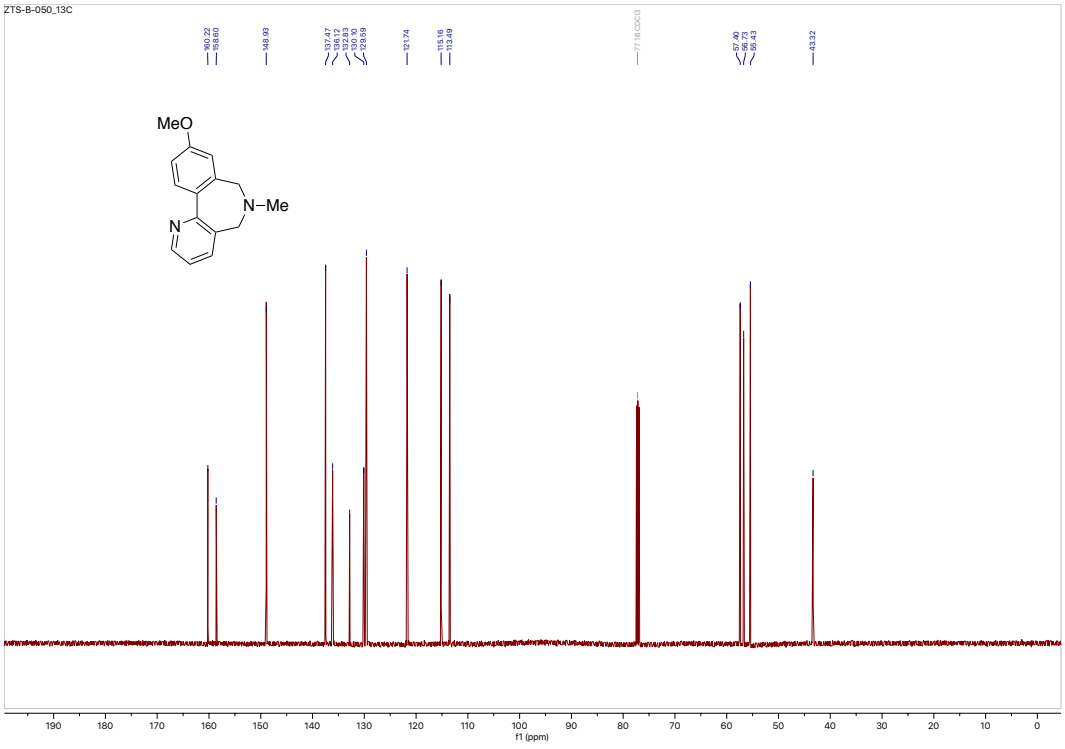


Figure S72. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23g.**

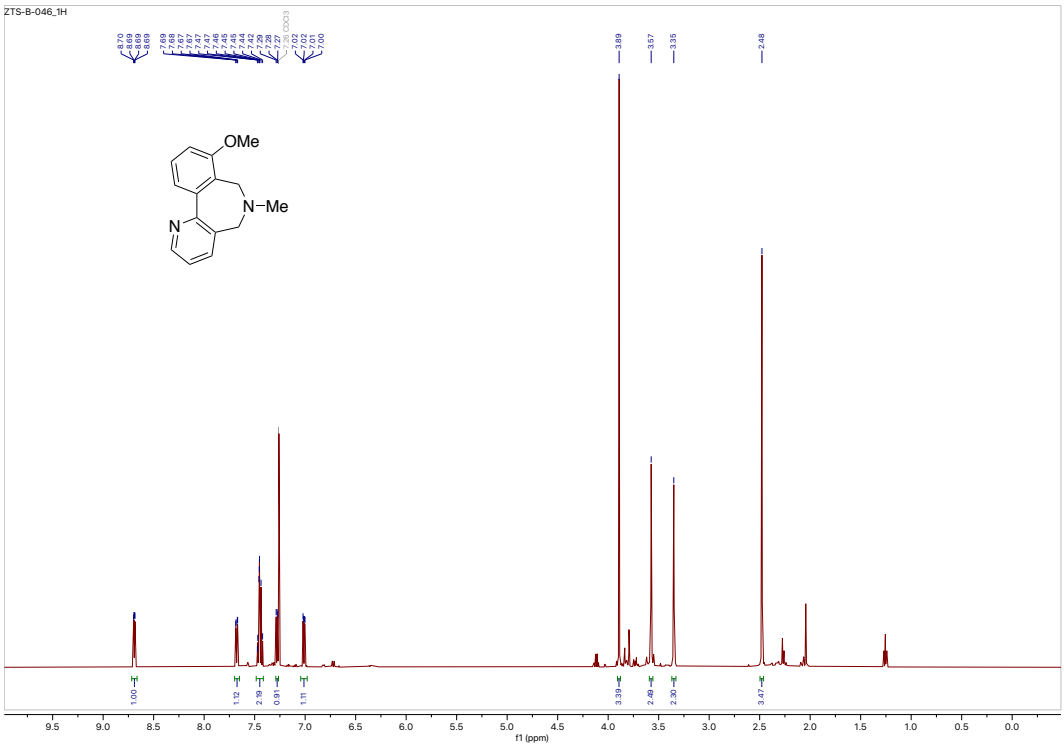


Figure S73. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23h.**

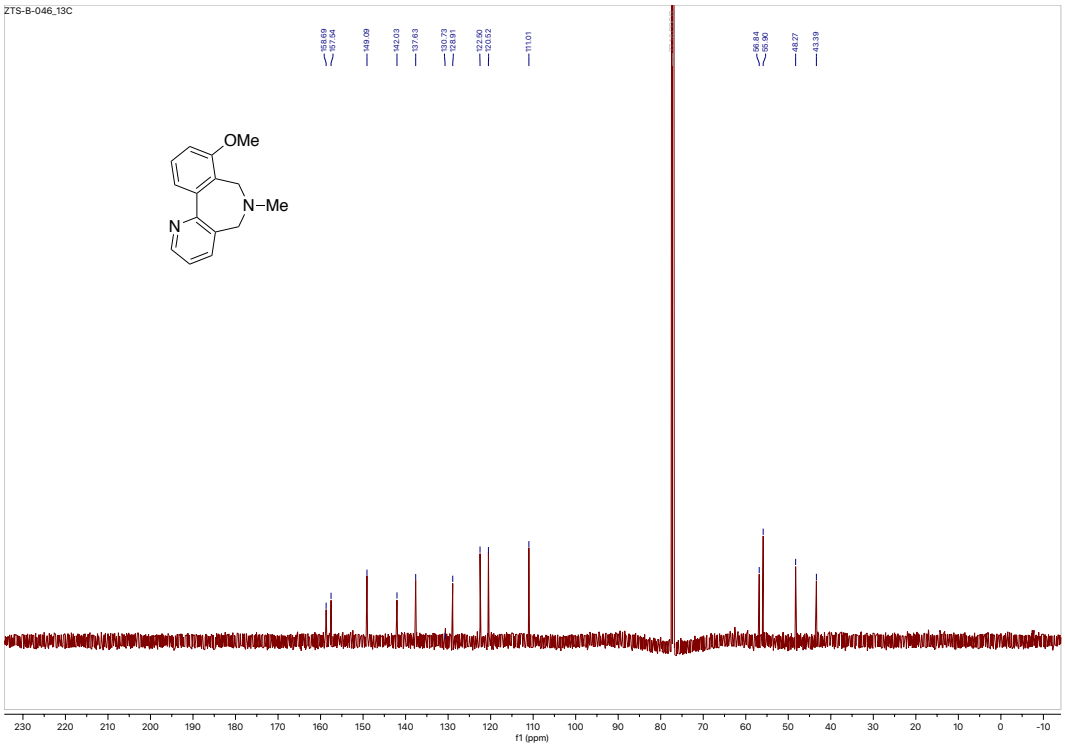


Figure S74. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23h.**

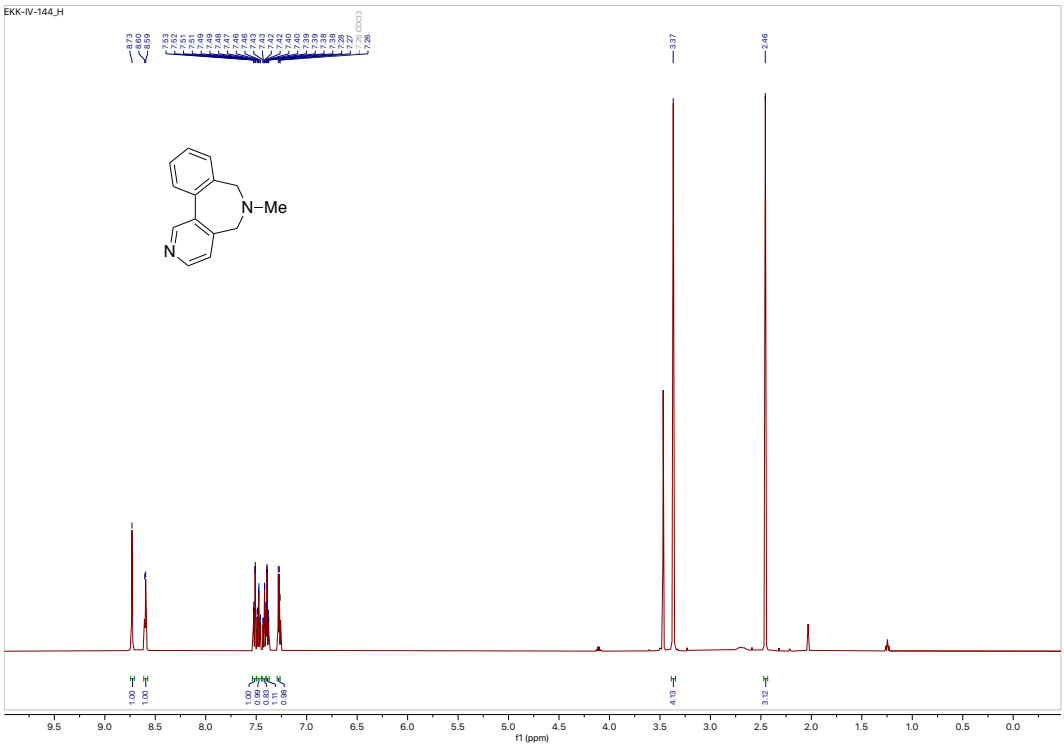


Figure S75. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23j.**

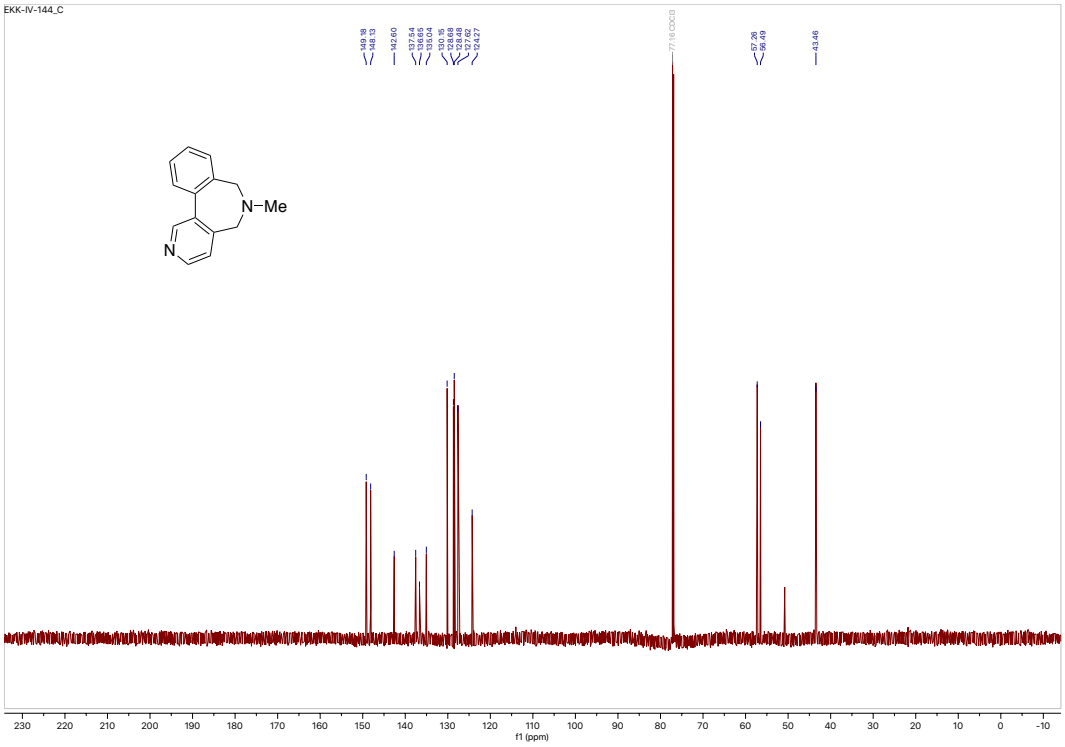


Figure S76. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23j.**

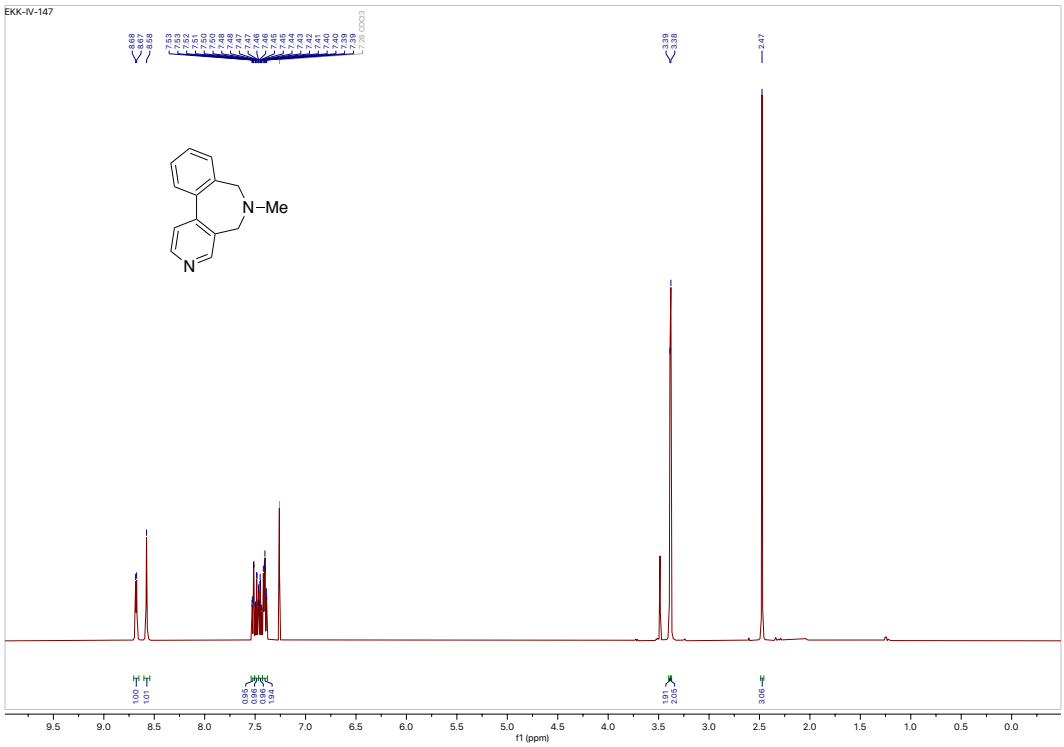


Figure S77. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23k.**

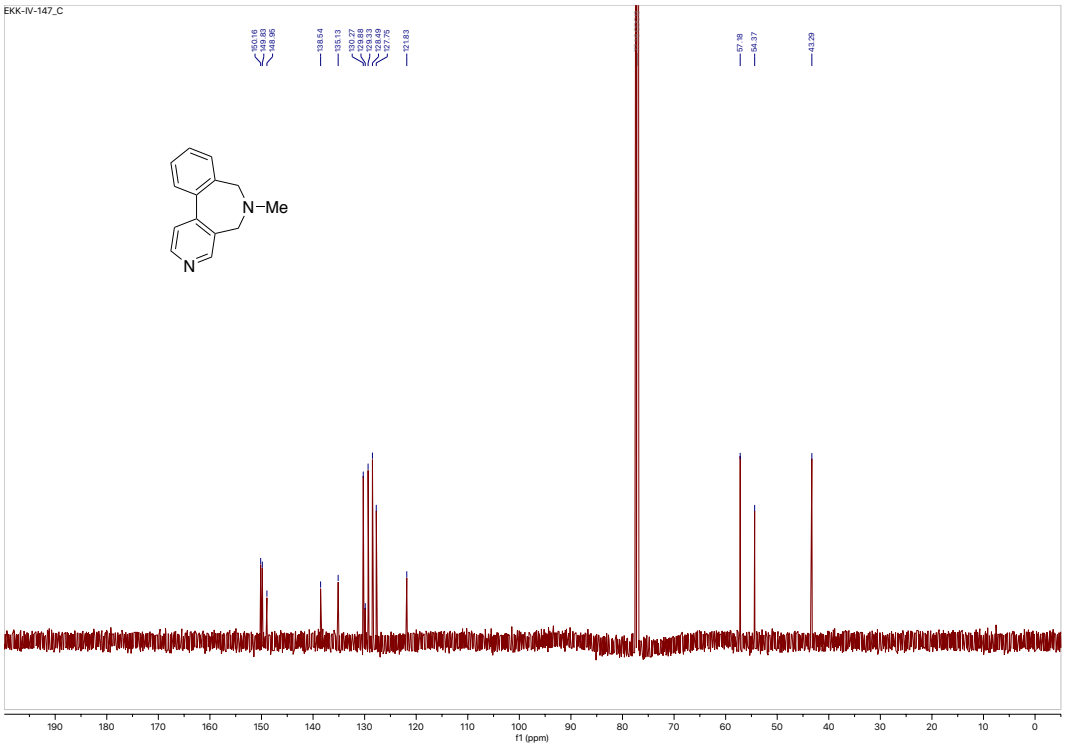


Figure S78. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23k.**

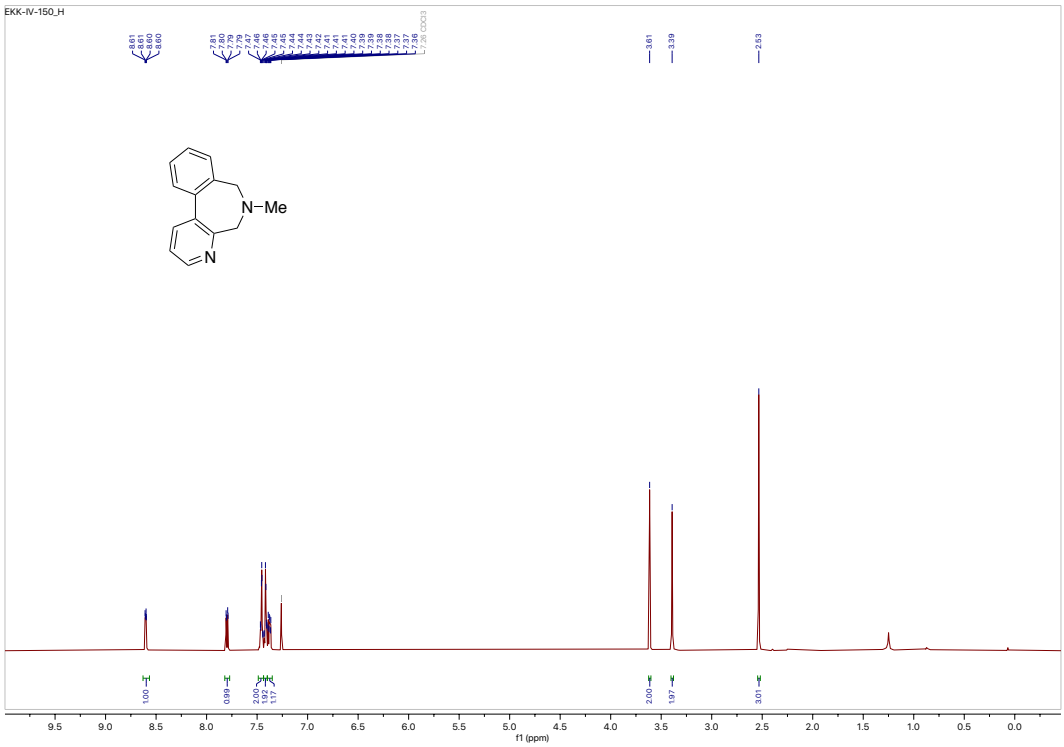


Figure S79. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23l.**

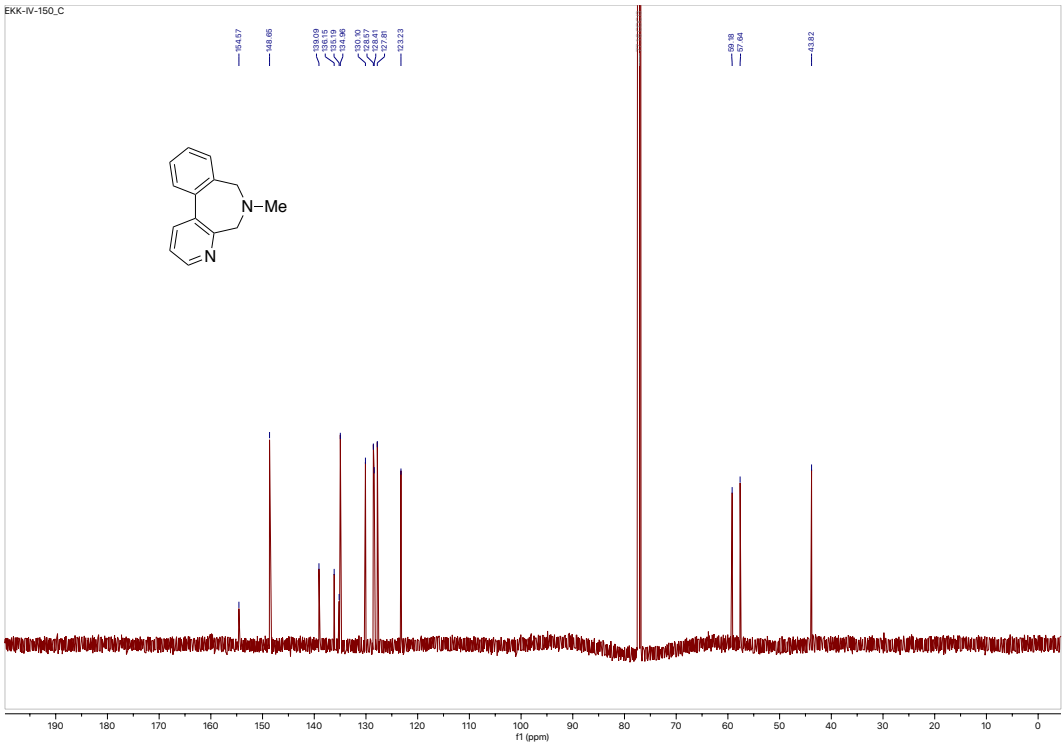


Figure S80. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23l.**

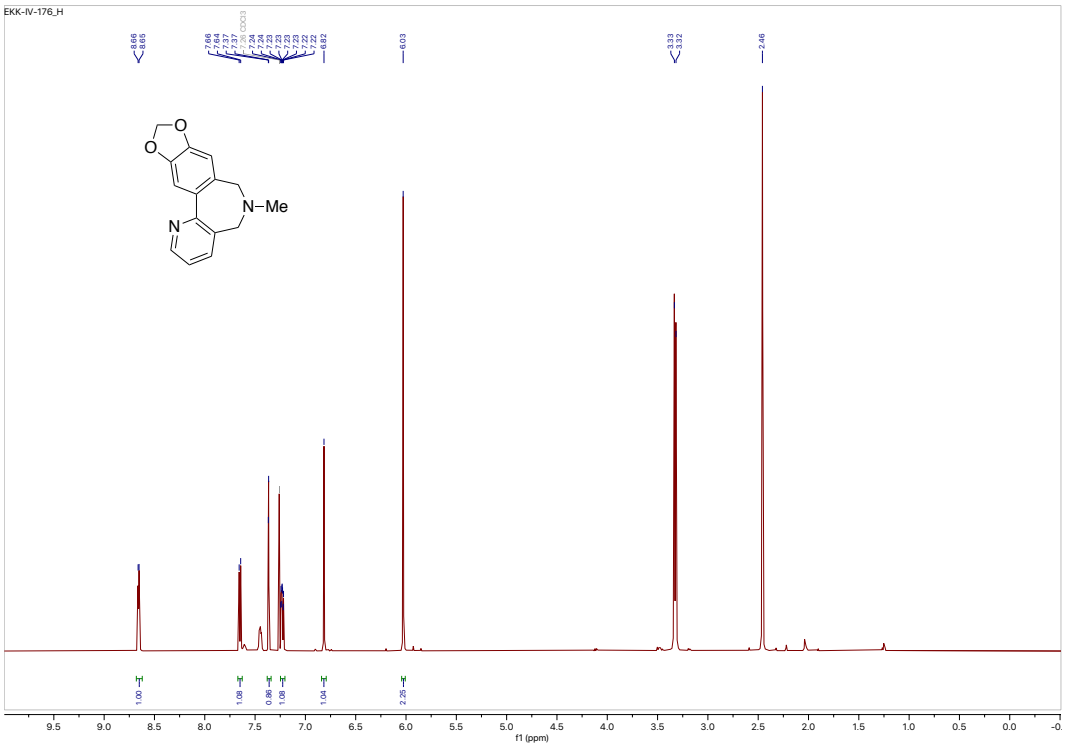


Figure S81. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23m.**

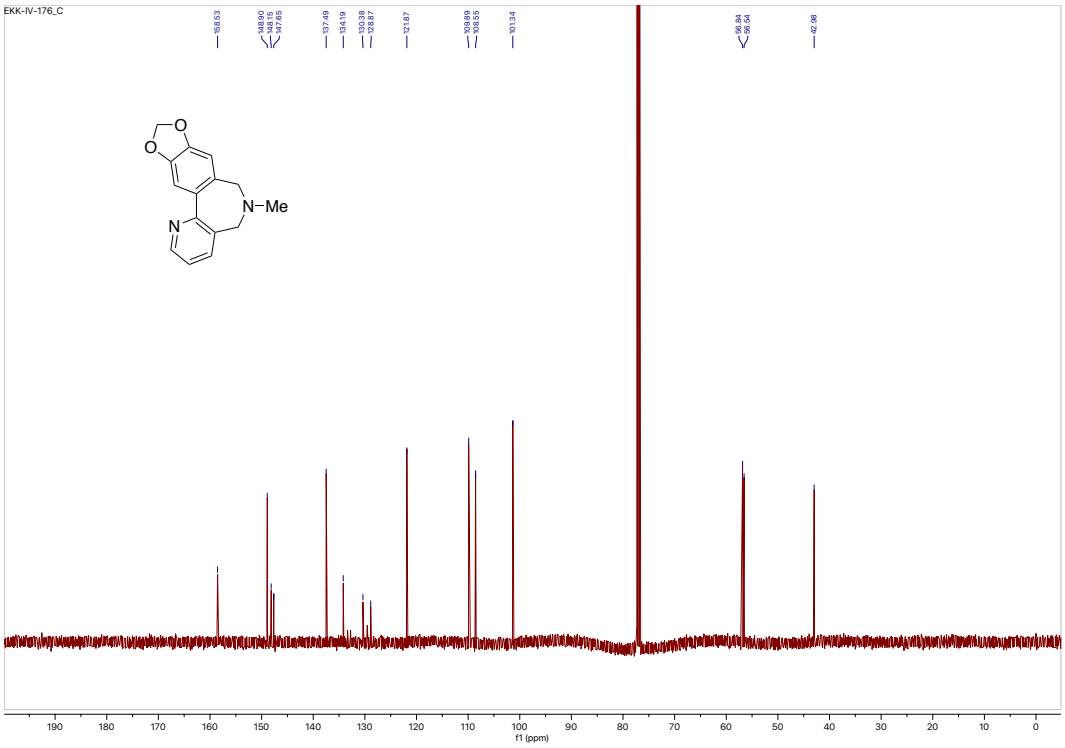


Figure S82. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23m.**

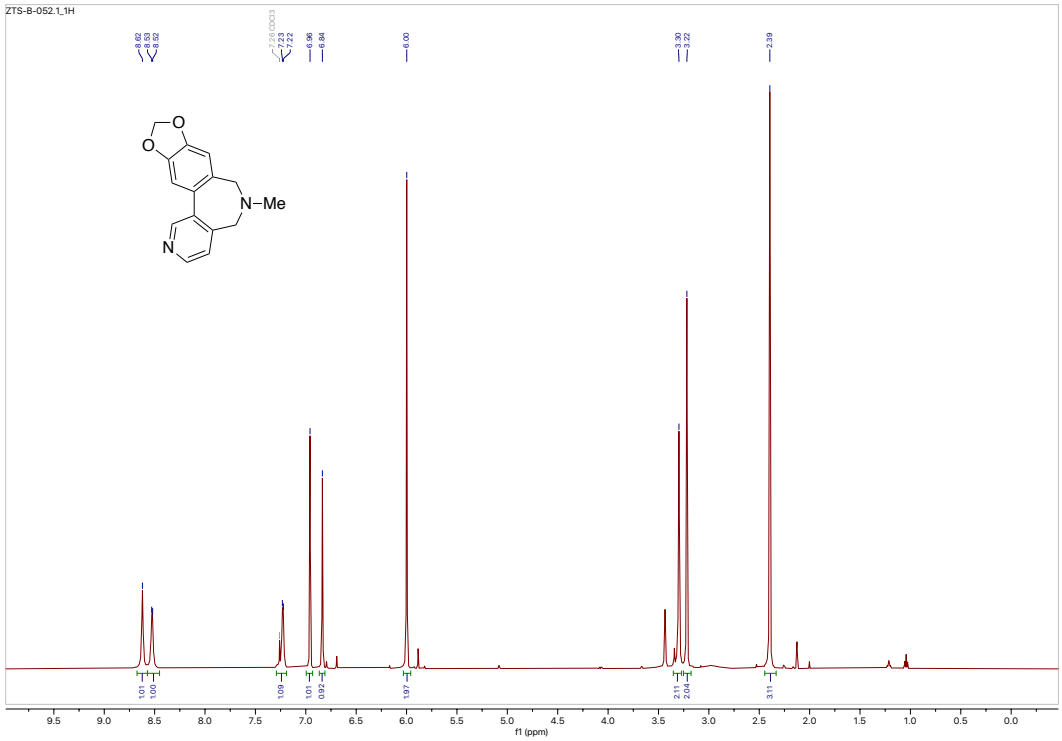


Figure S83. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23n.**

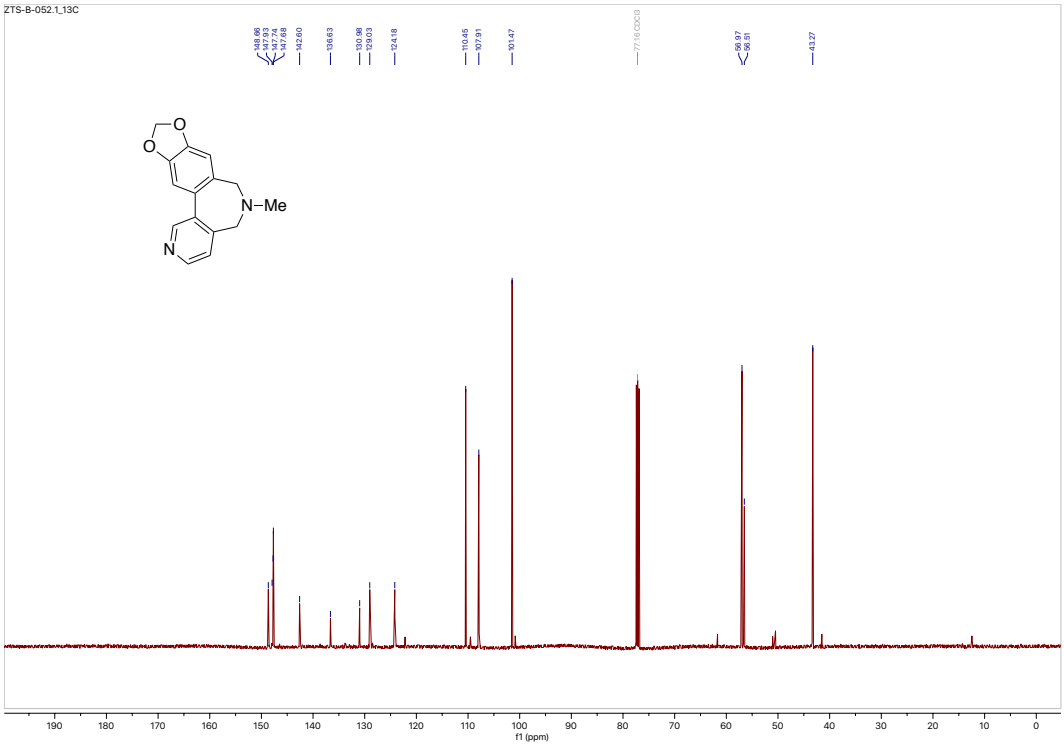


Figure S84. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23n.**

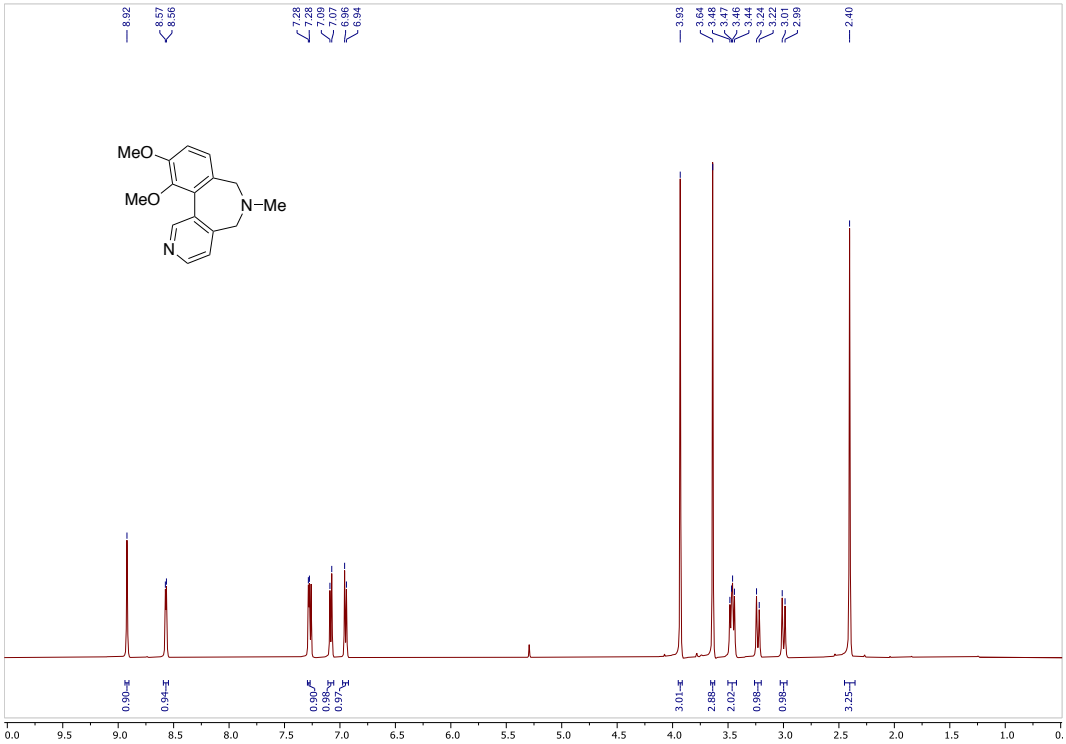


Figure S85. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23o.**

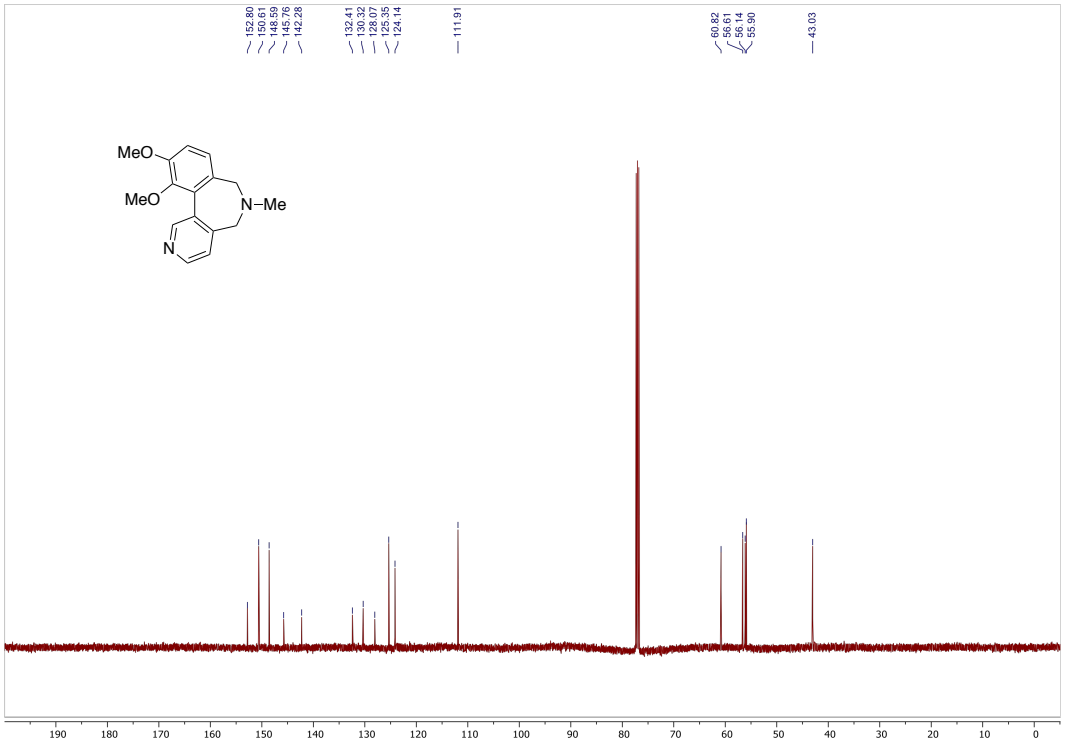


Figure S86. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23o.**

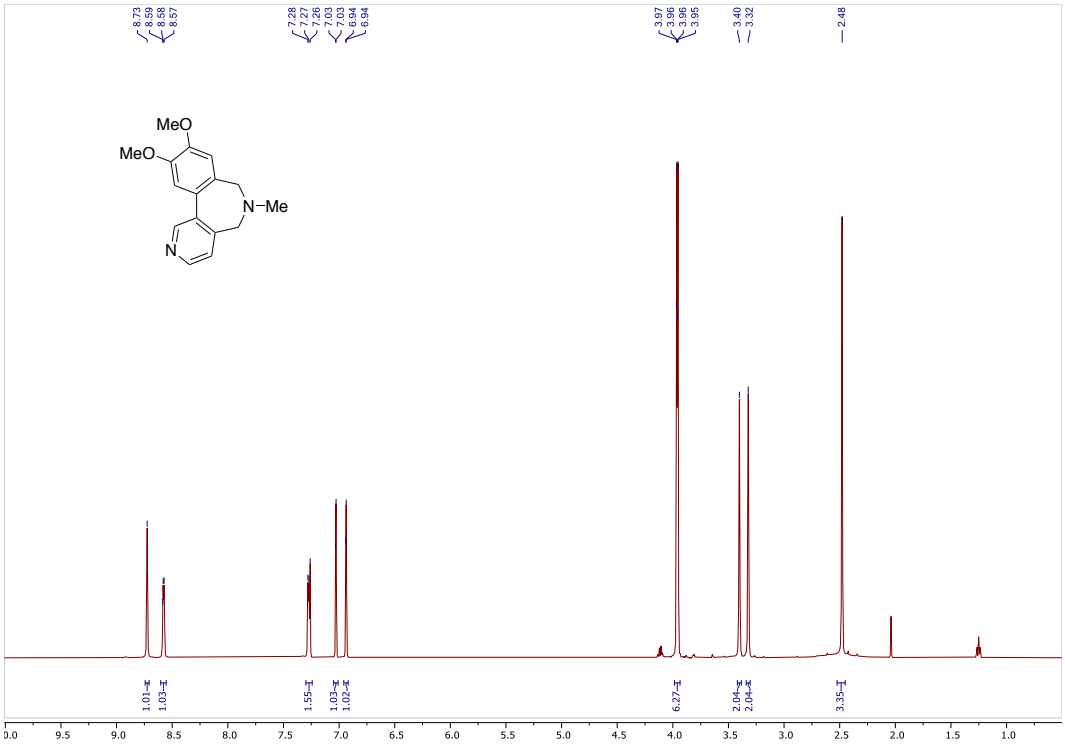


Figure S87. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **23p.**

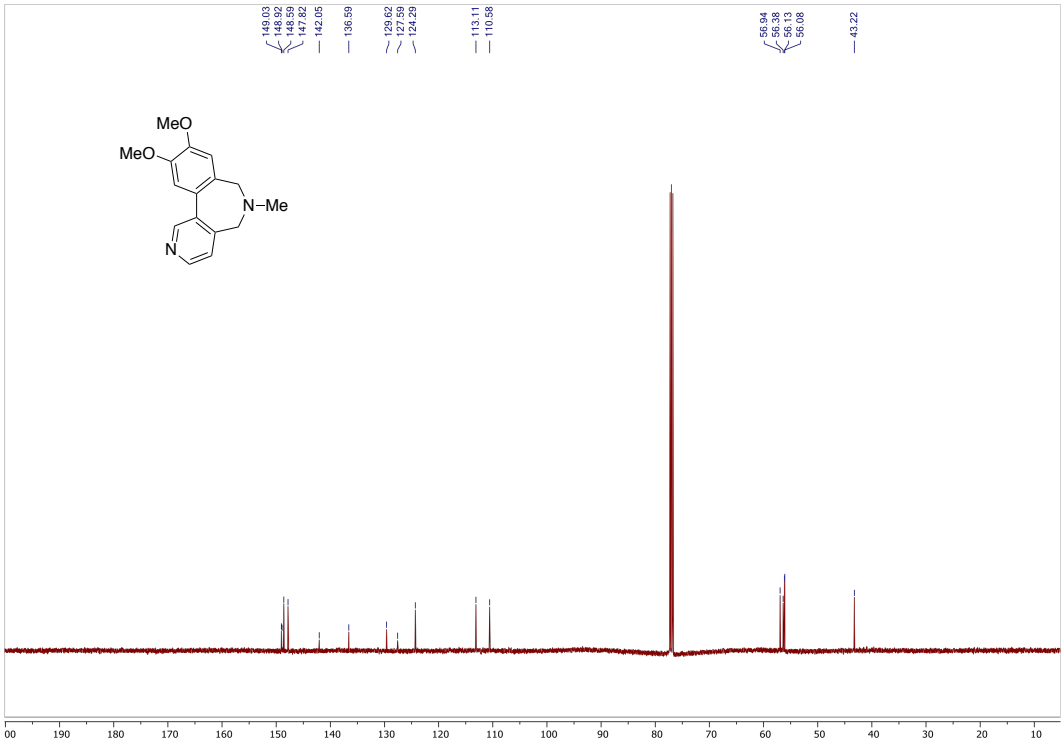


Figure S88. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **23p.**

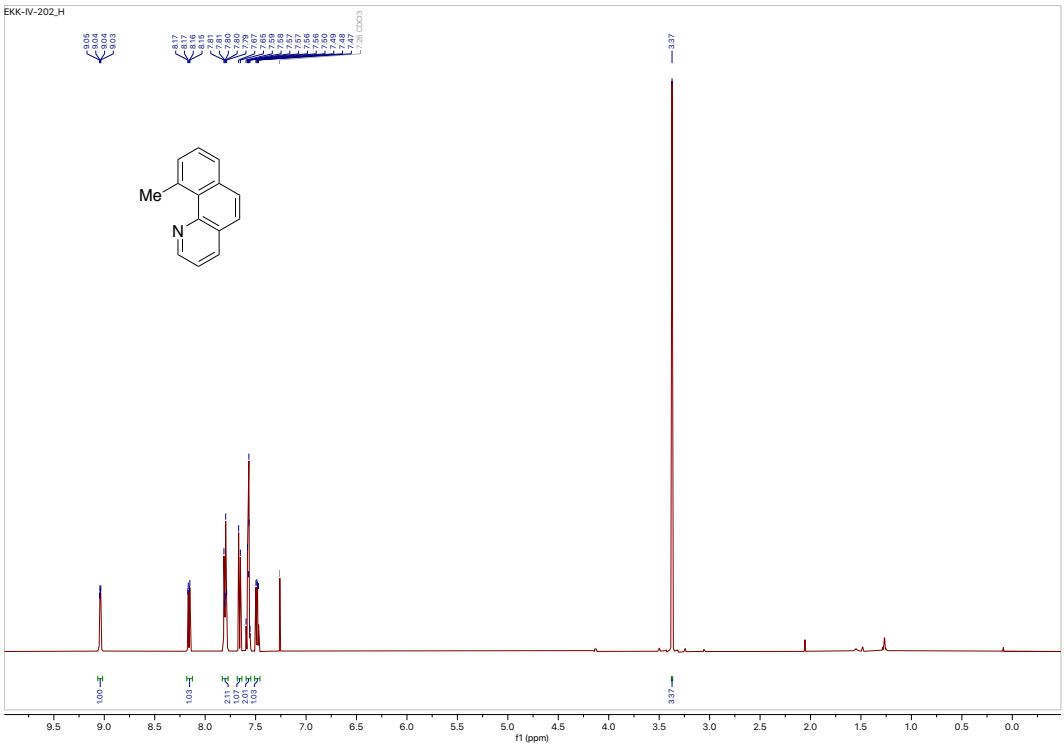


Figure S89. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24a.**

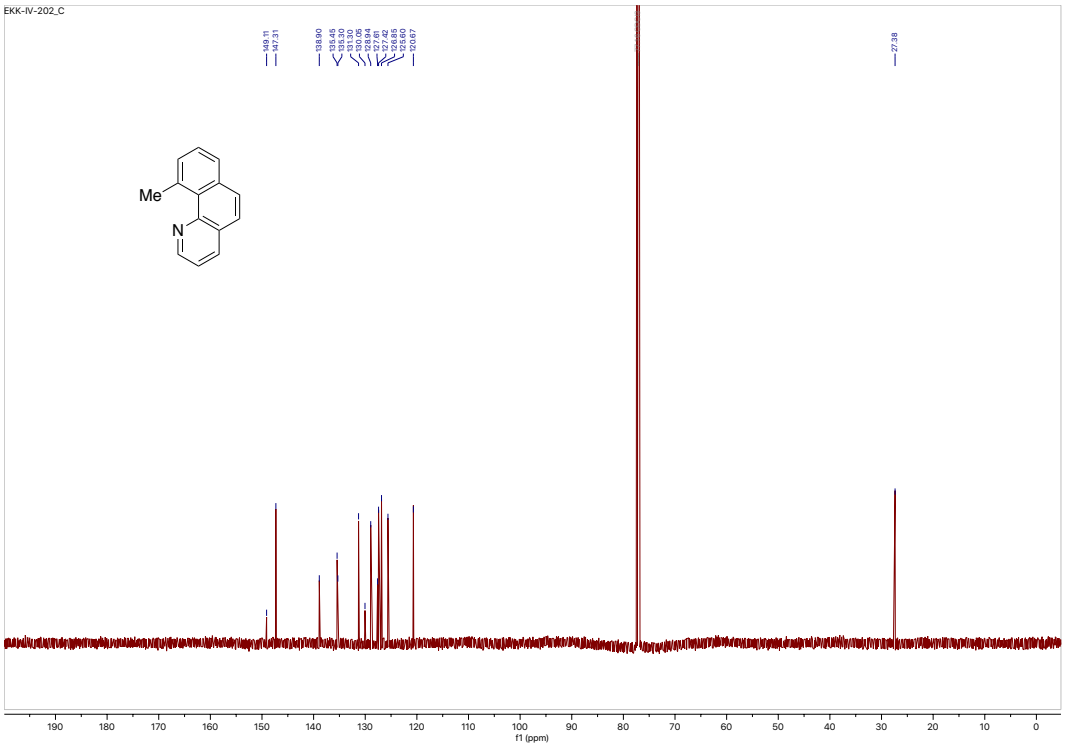


Figure S90. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24a.**

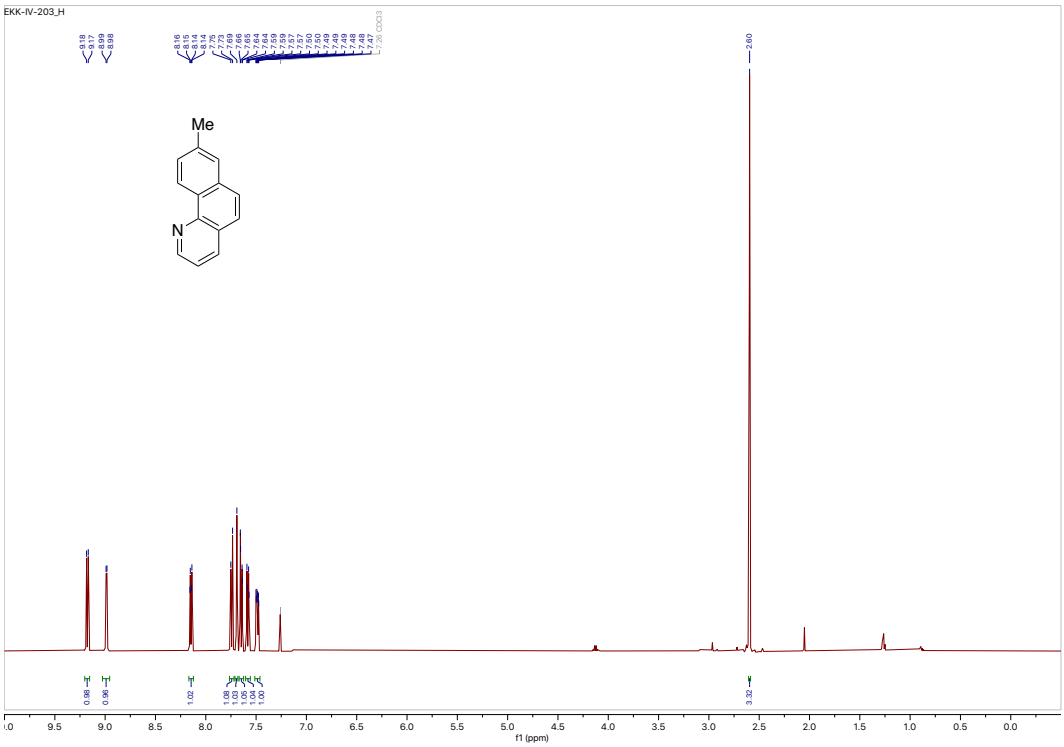


Figure S91. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24c.**

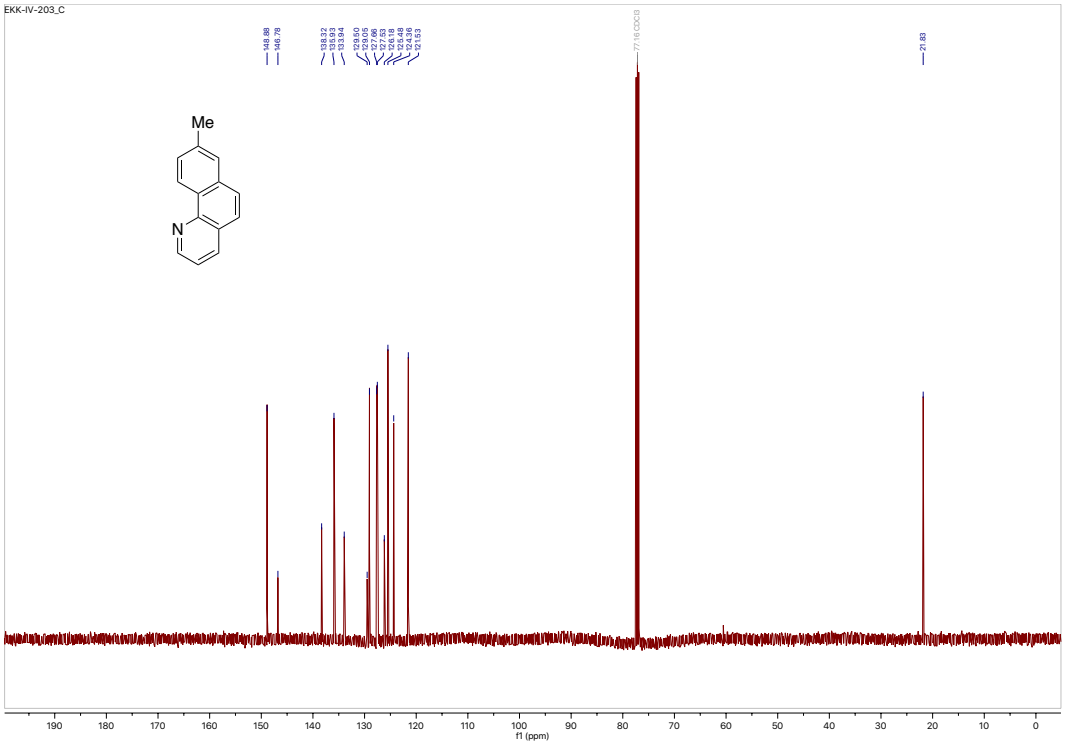


Figure S92. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24c.**

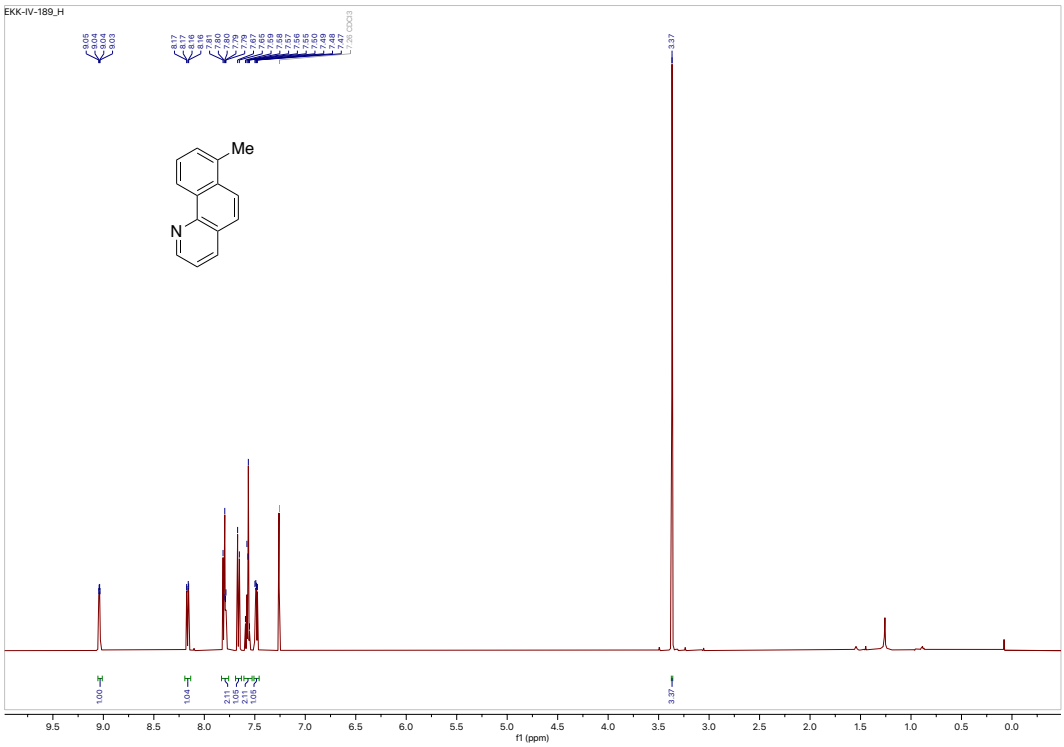


Figure S93. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24d.**

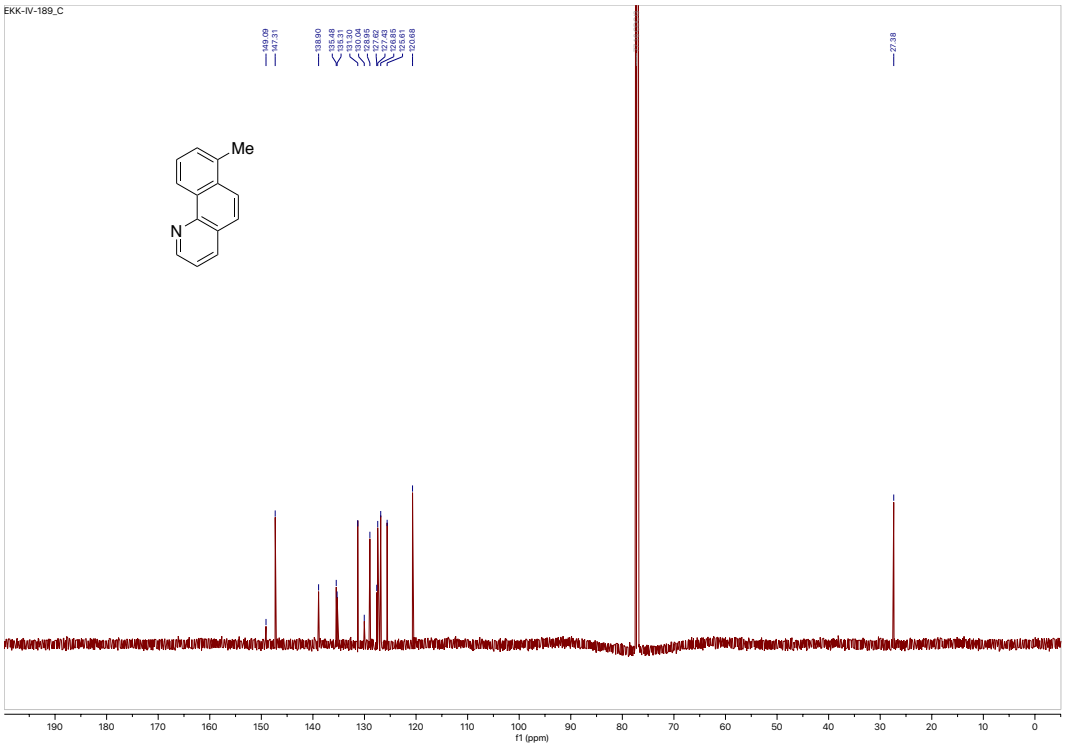


Figure S94. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24d.**

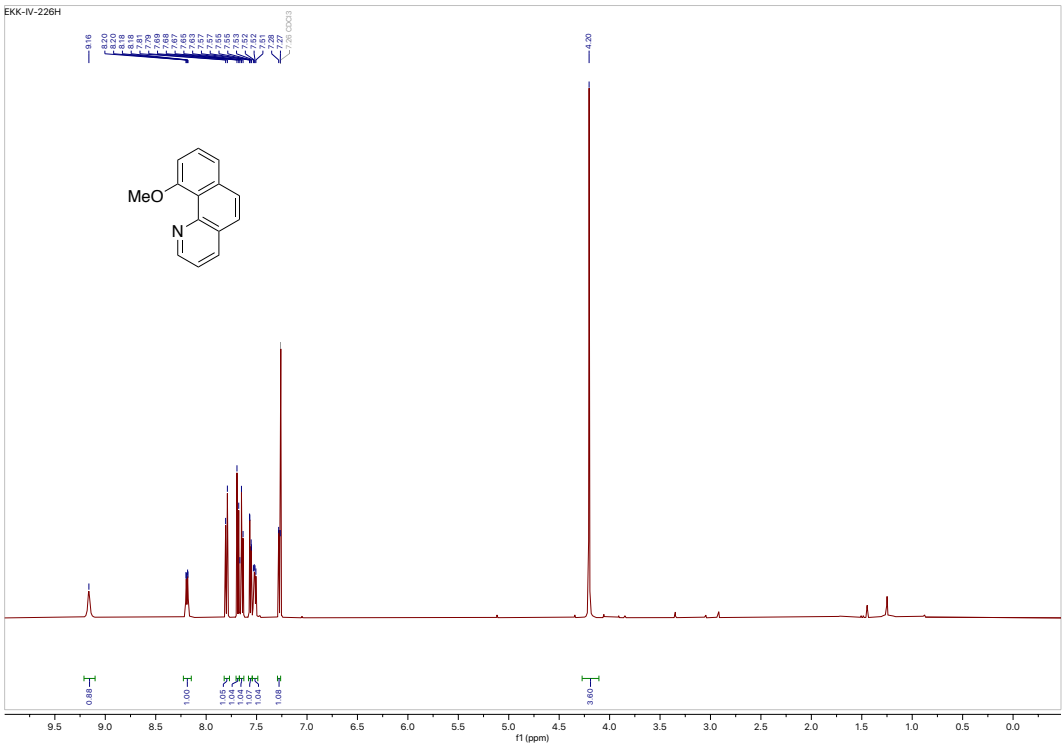


Figure S95. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24e.**

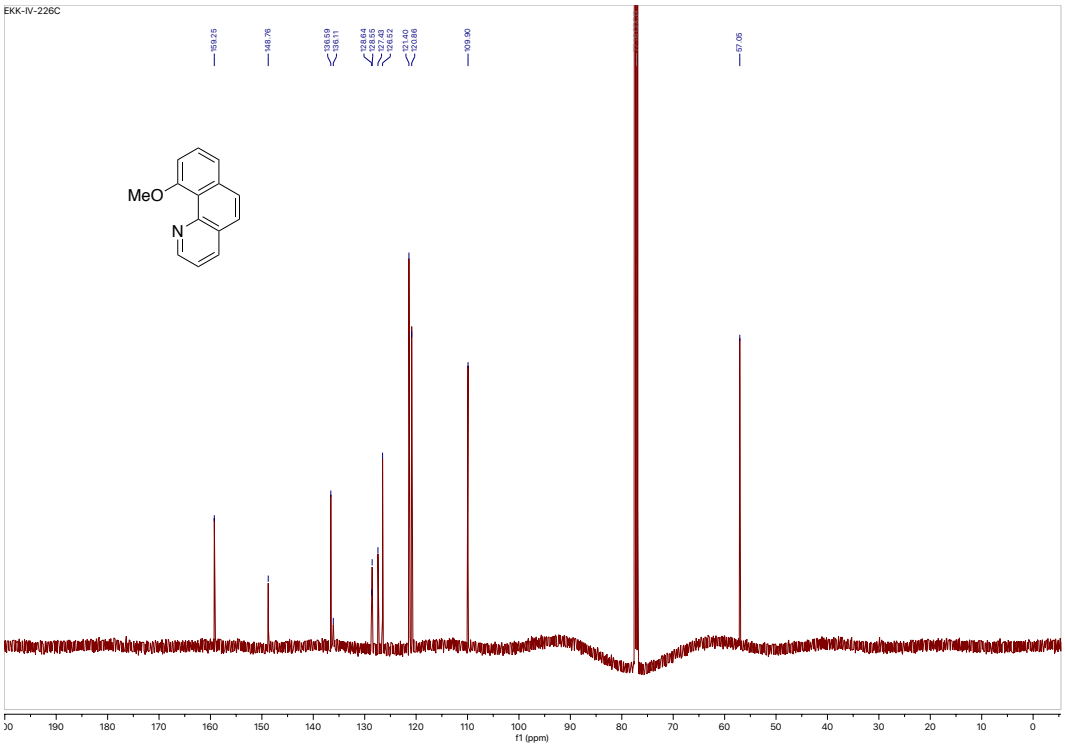


Figure S96. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24e.**

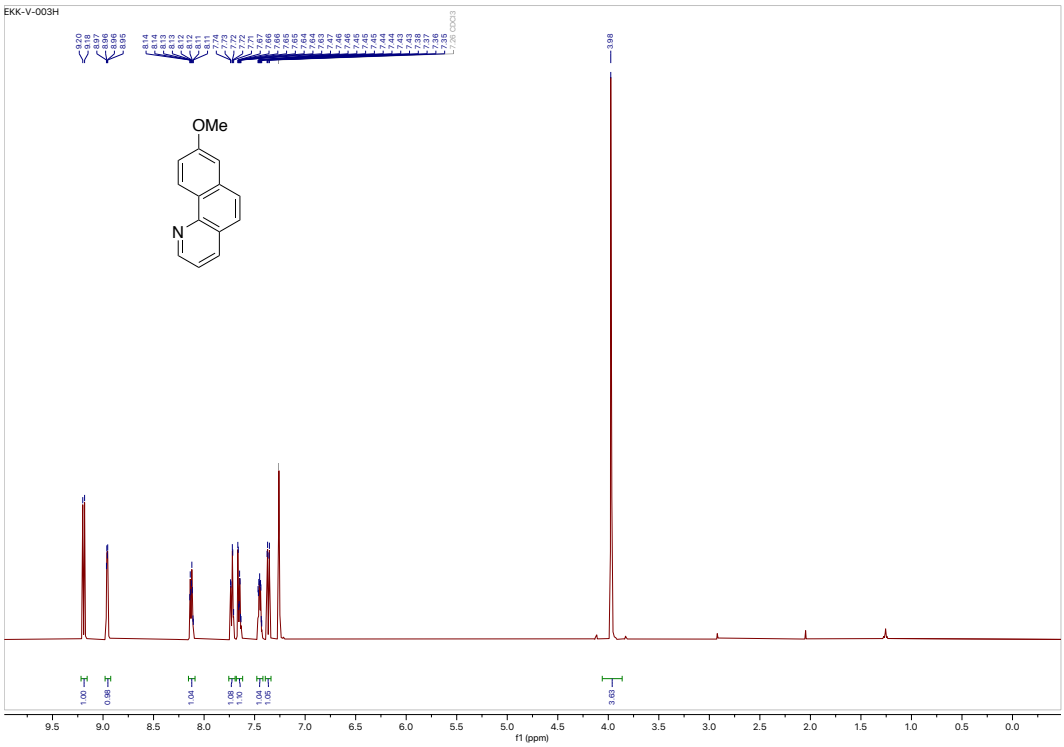


Figure S97. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24g.**

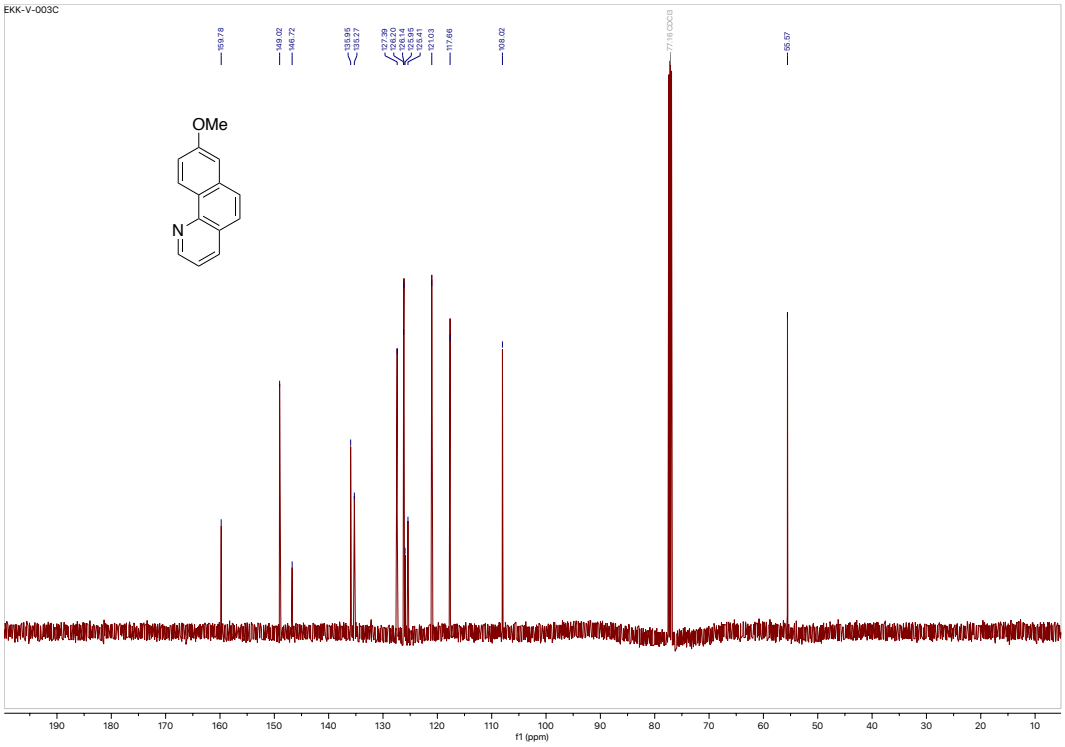


Figure S98. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24g.**

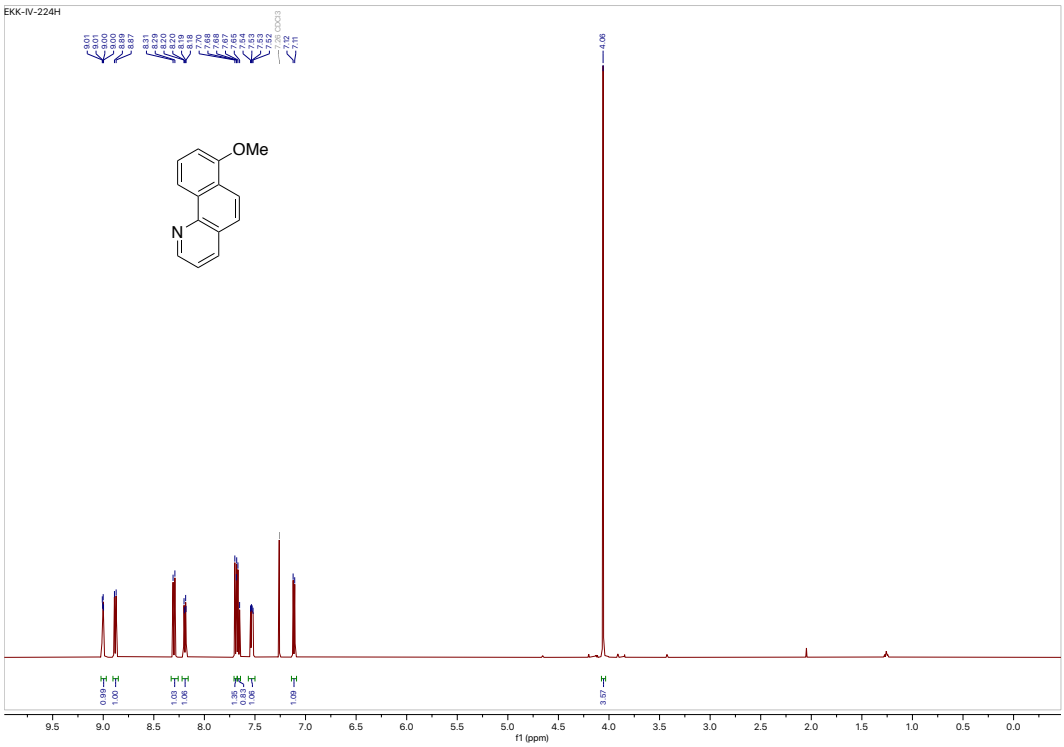


Figure S99. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24h.**

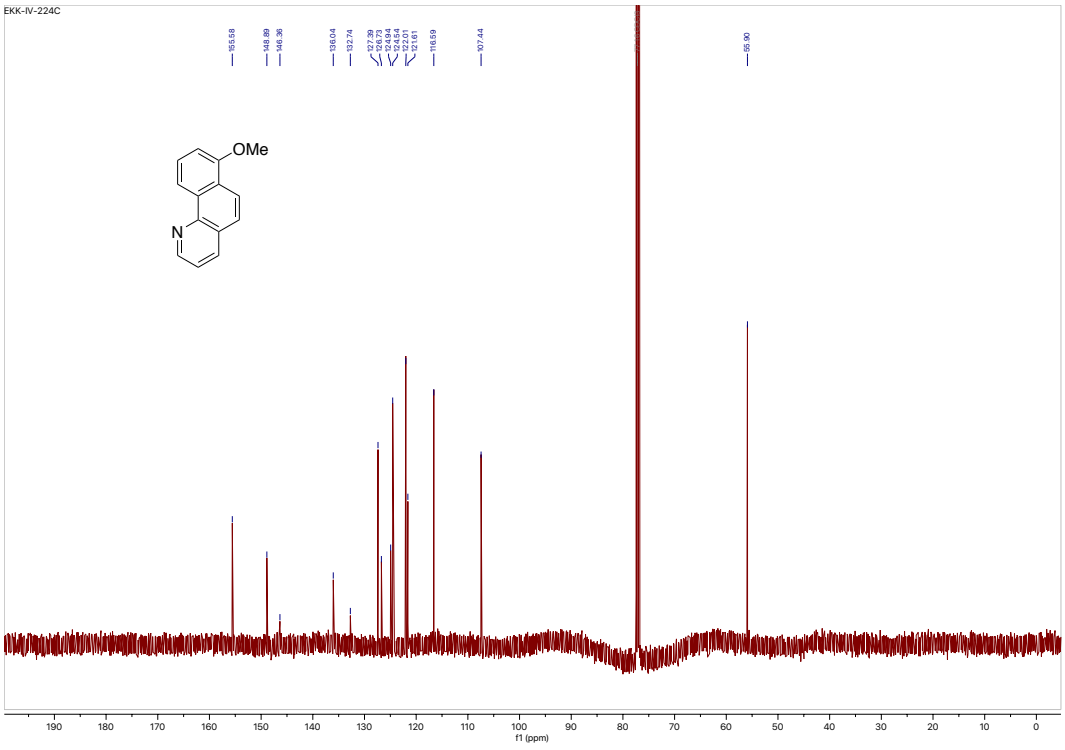


Figure S100. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24h.**

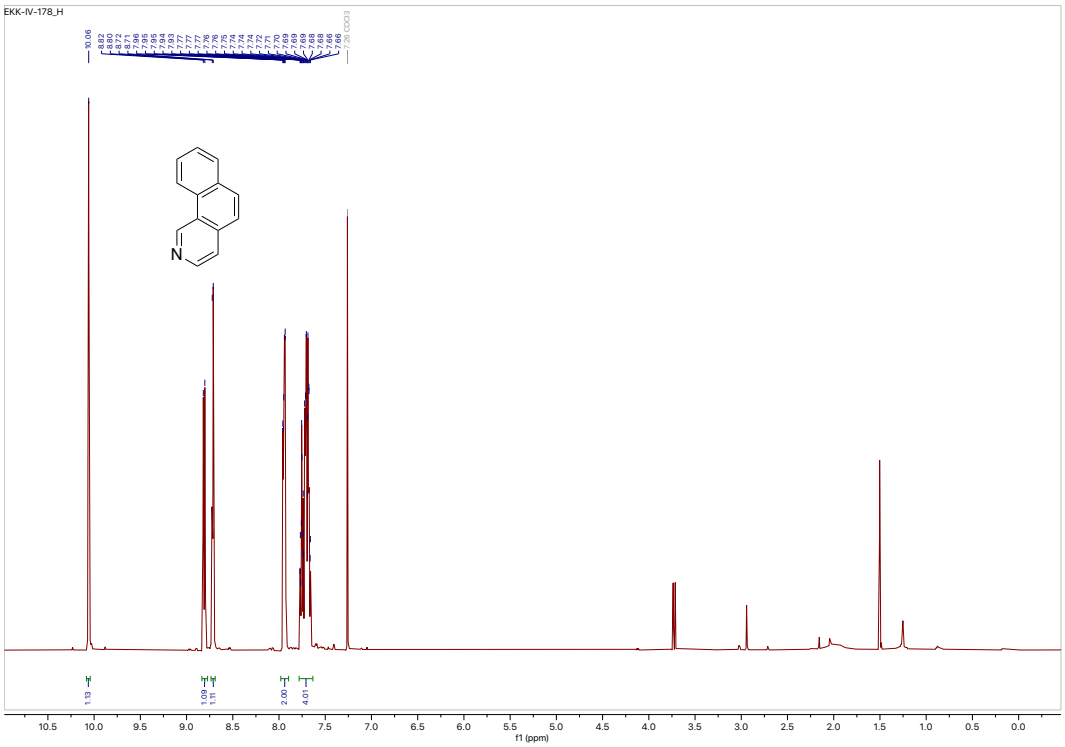


Figure S101. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24j.**

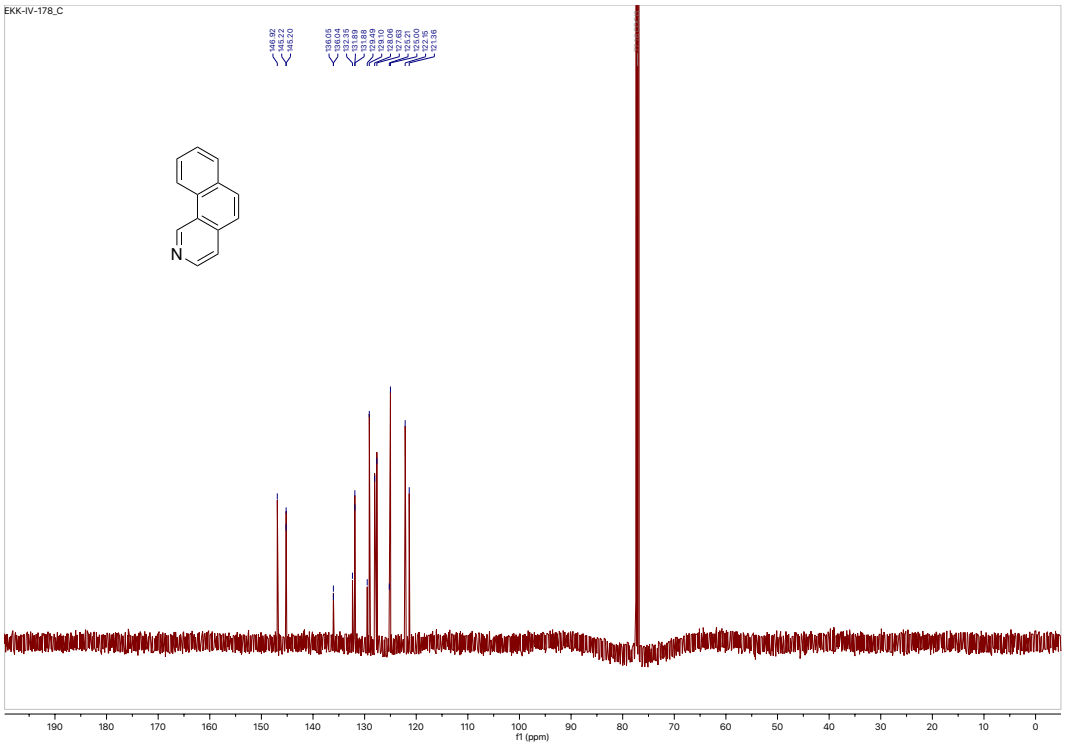


Figure S102. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24j.**

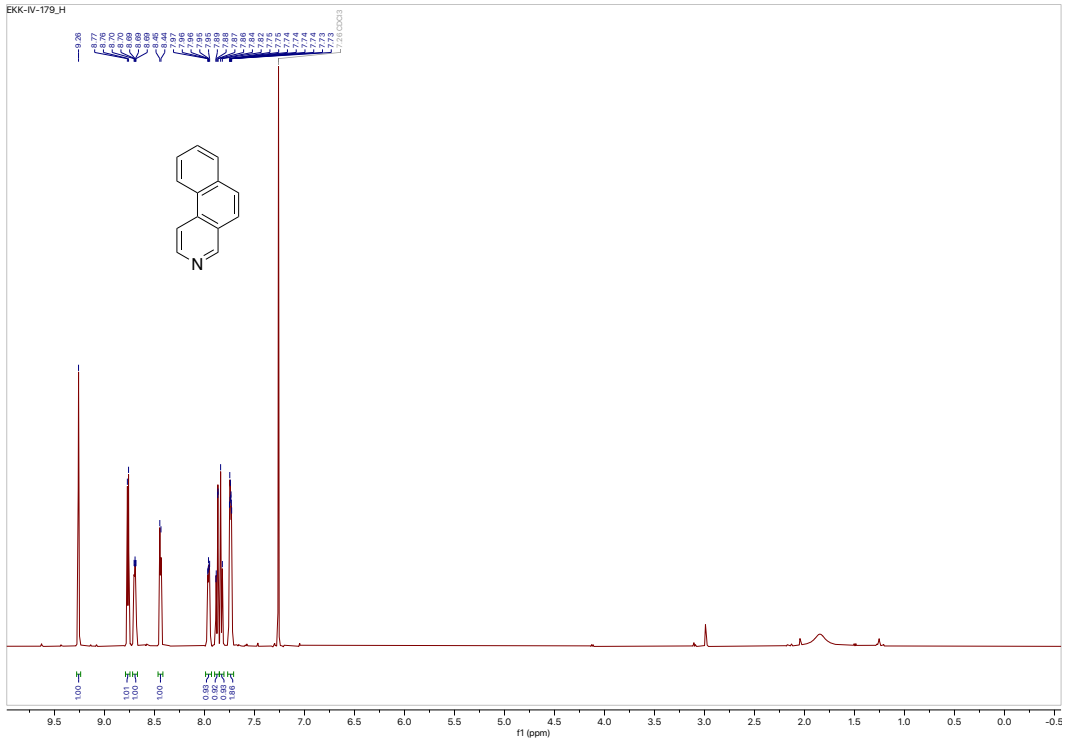


Figure S103. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24k.**

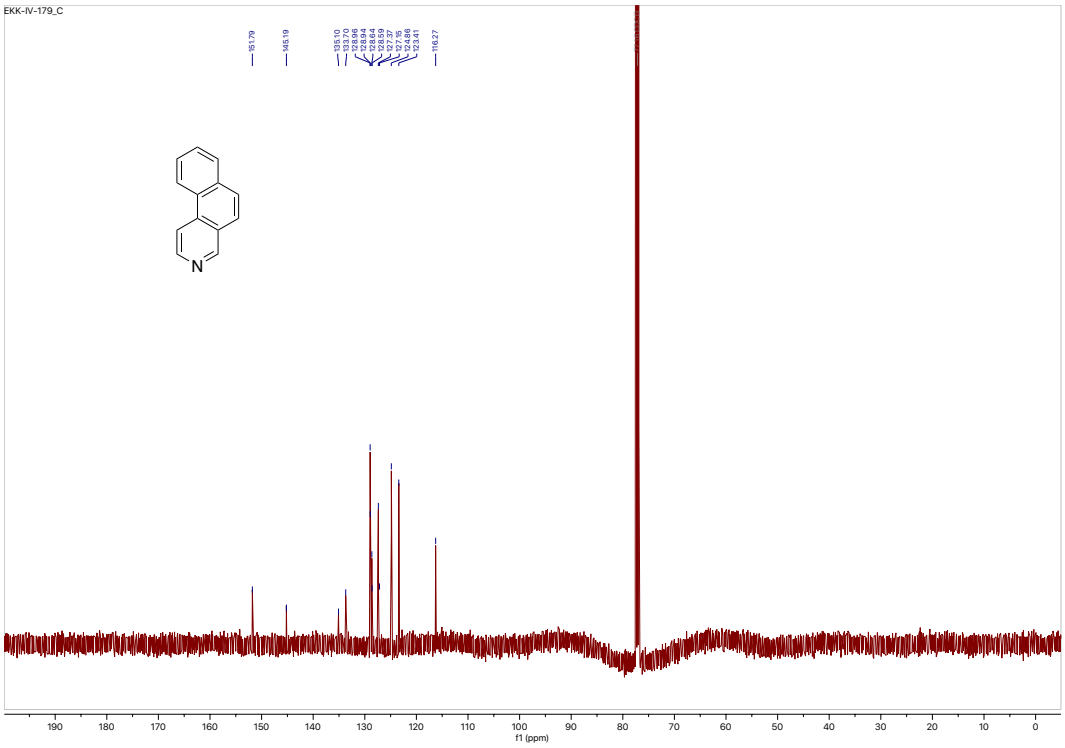


Figure S104. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24k.**

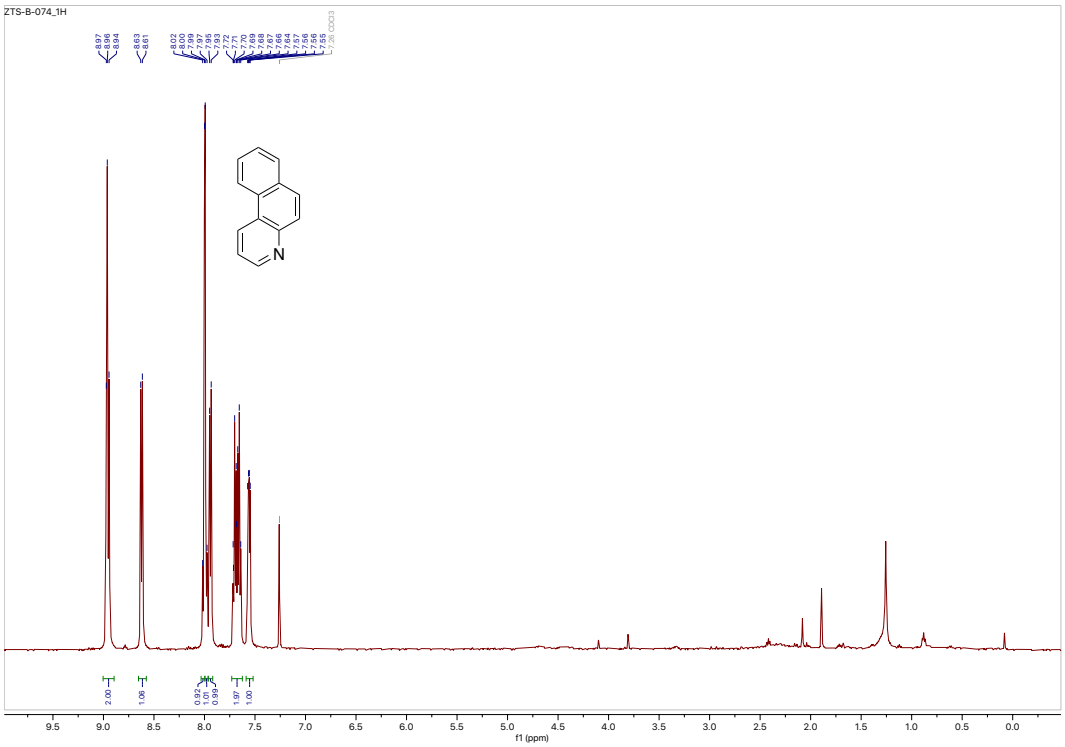


Figure S105. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24l.**

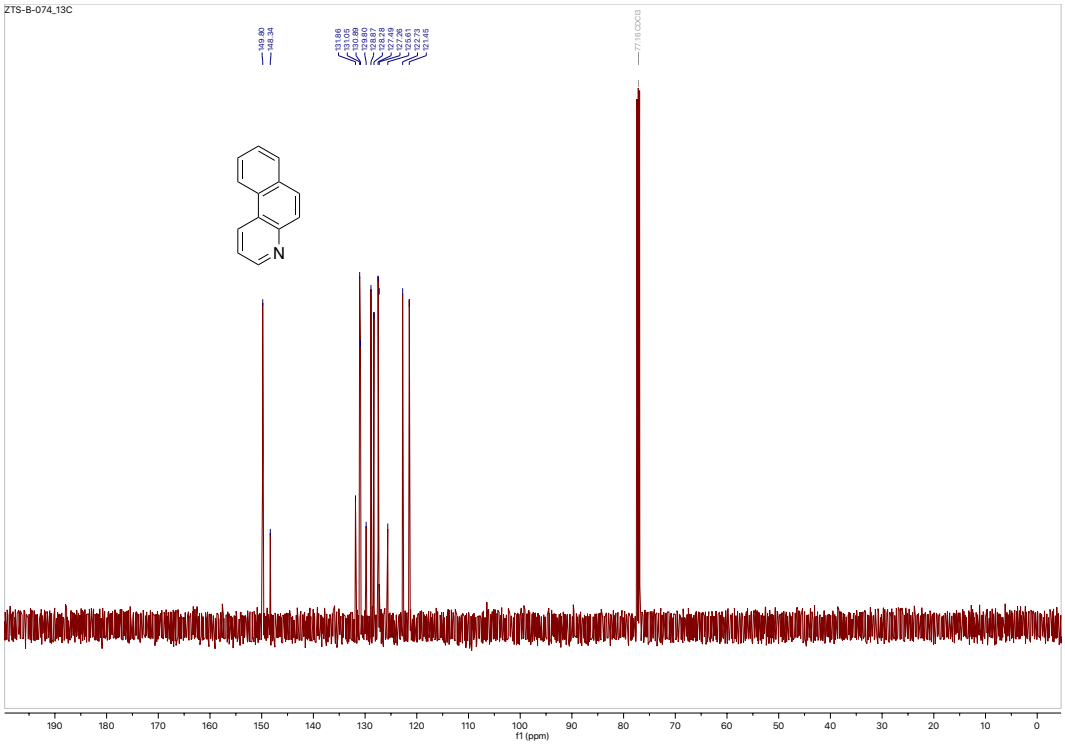


Figure S106. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24l.**

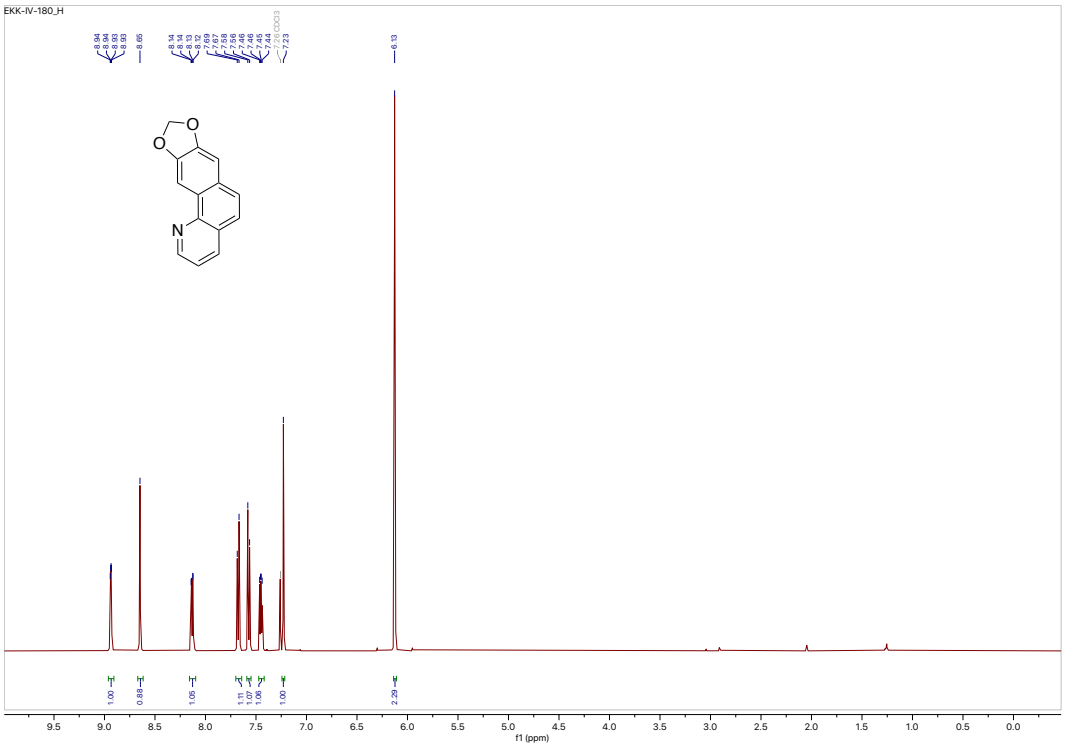


Figure S107. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24m.**

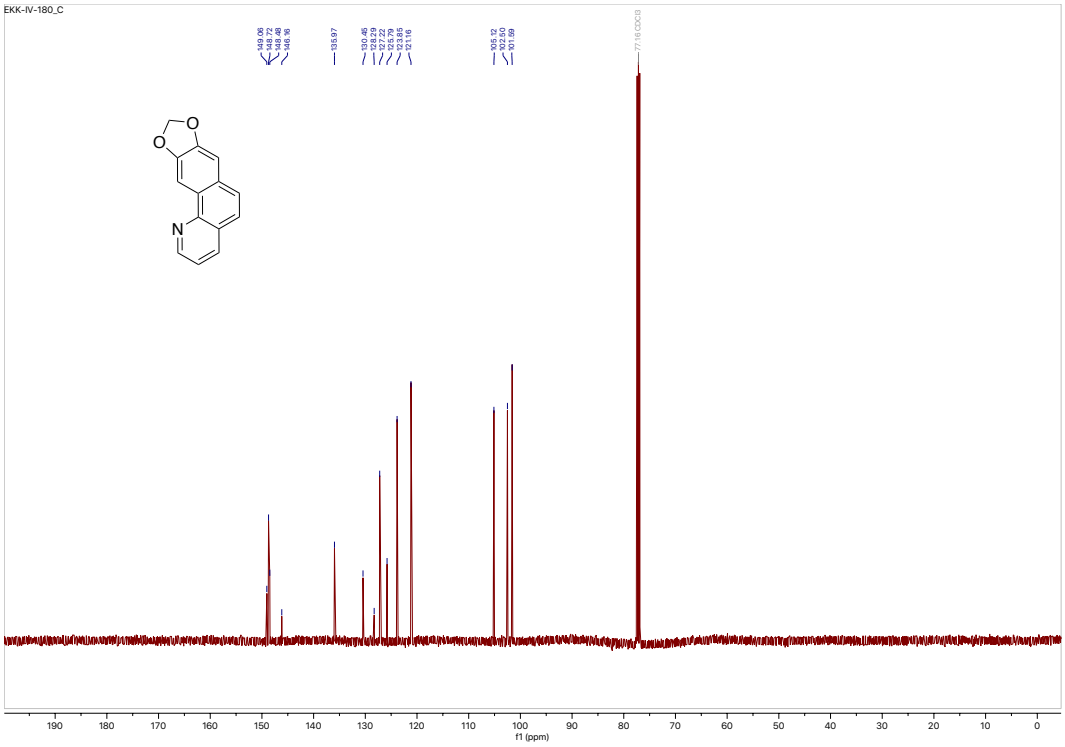


Figure S108. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24m.**

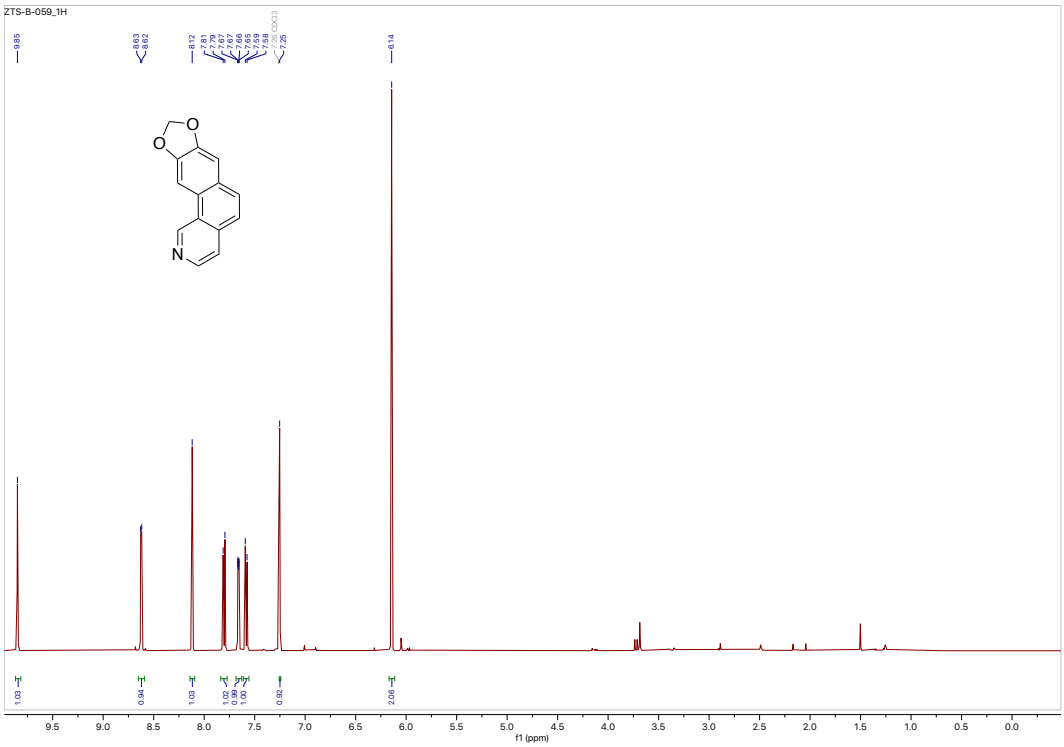


Figure S109. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24n.**

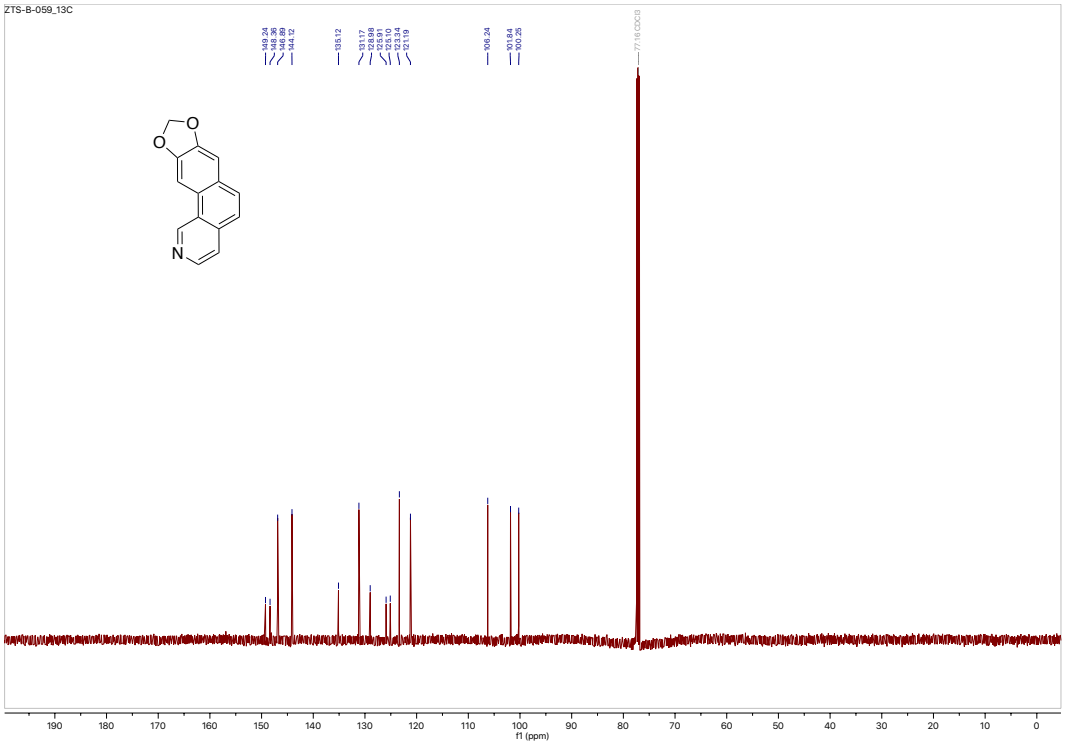


Figure S110. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24n.**

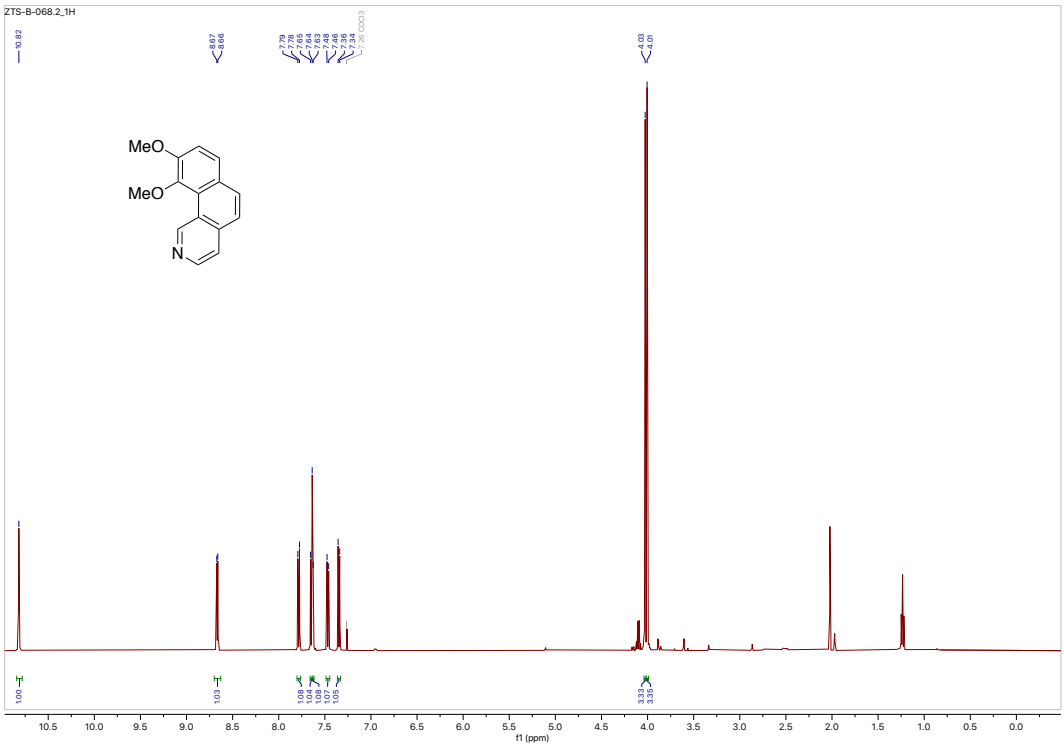


Figure S111. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24o.**

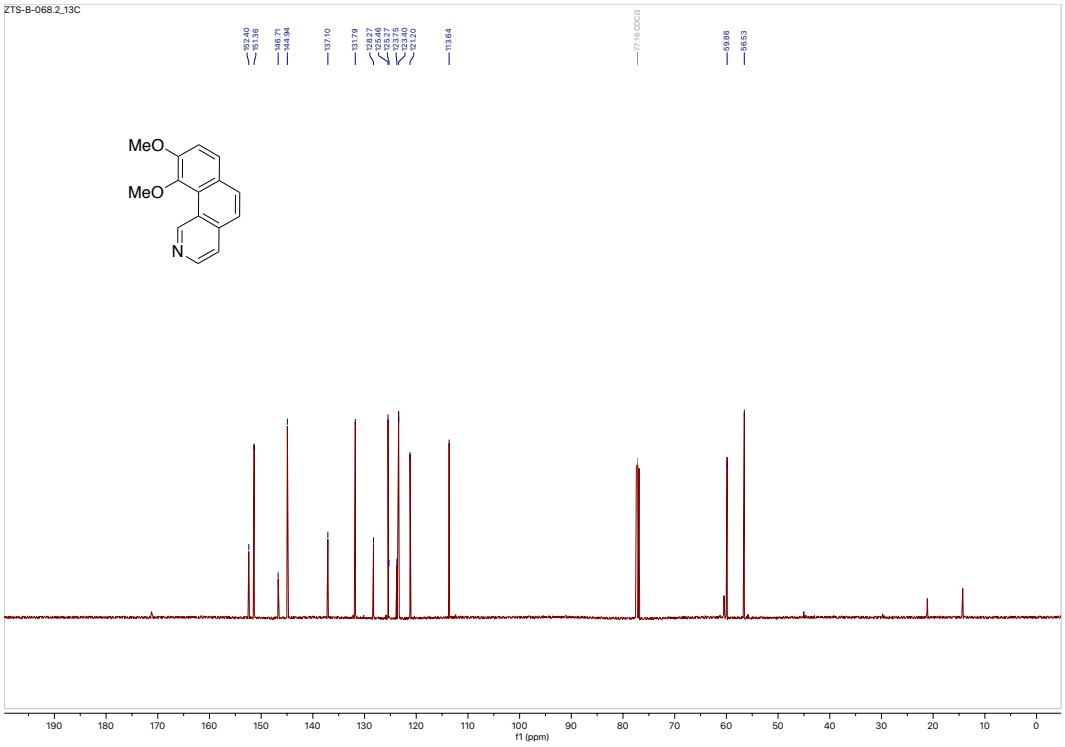


Figure S112. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24o.**

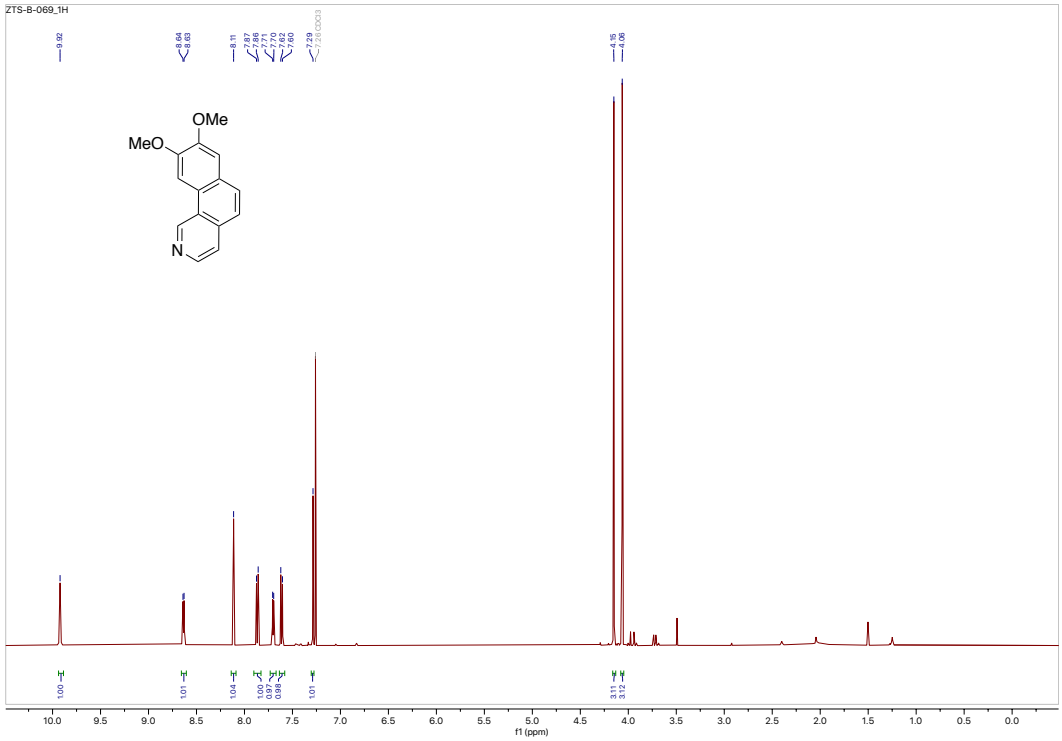


Figure S113. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **24p.**

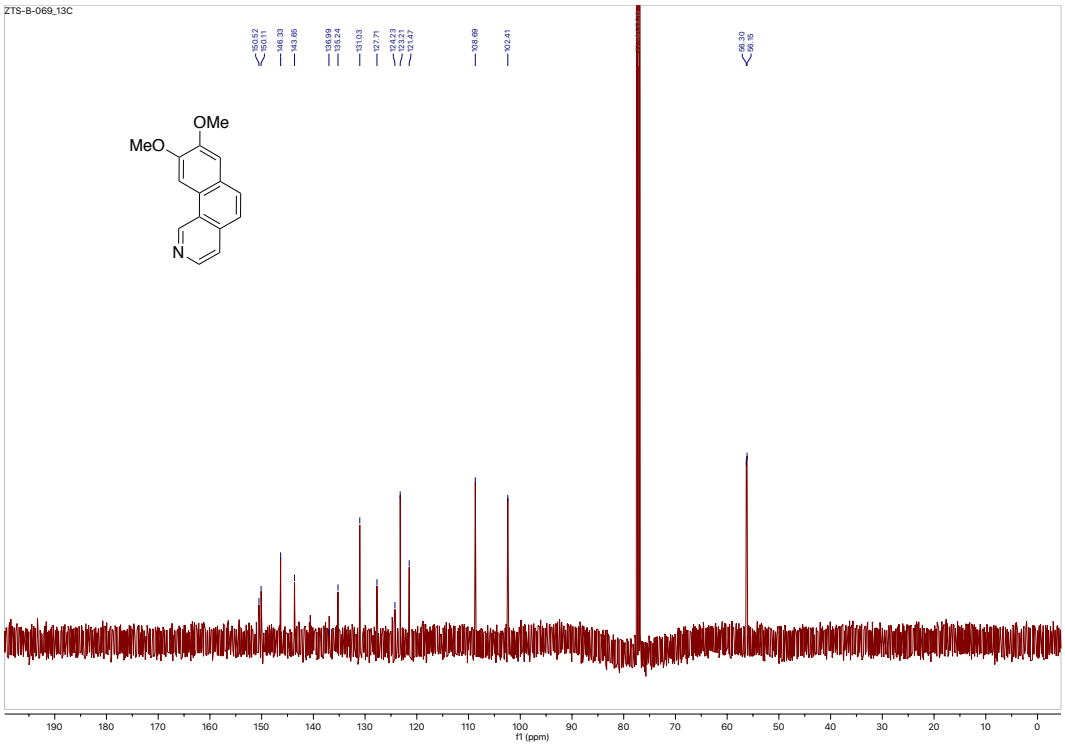


Figure S114. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **24p.**

*EtOAc

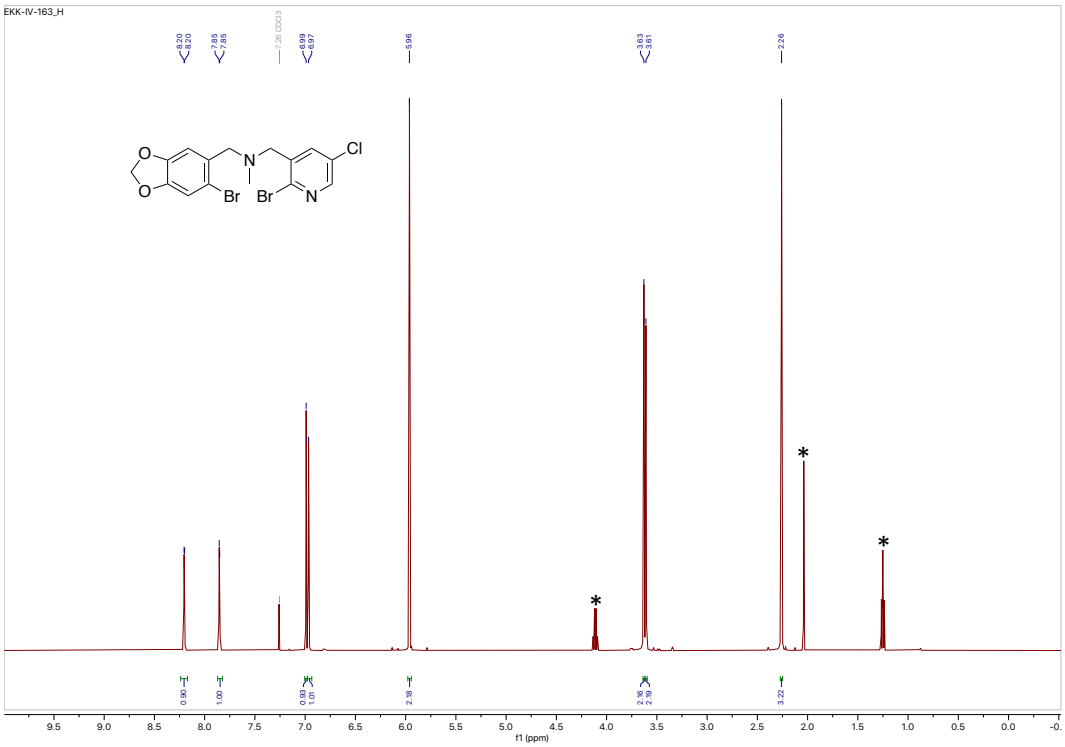


Figure S115. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **29a.**

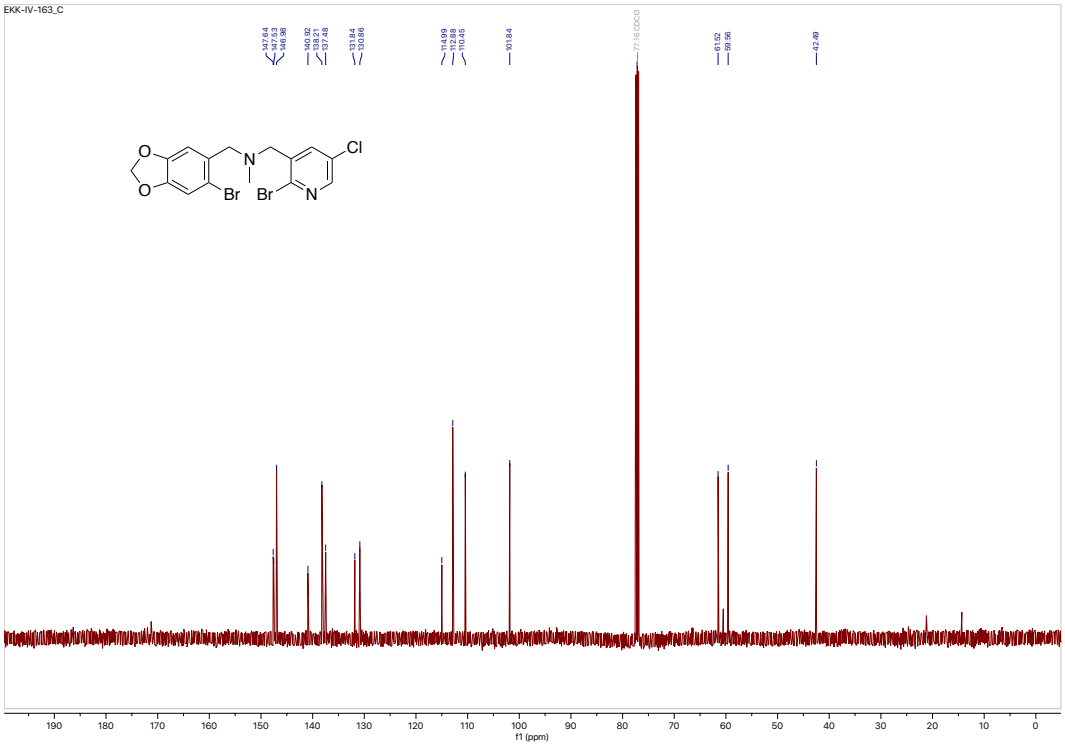


Figure S116. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **29a.**

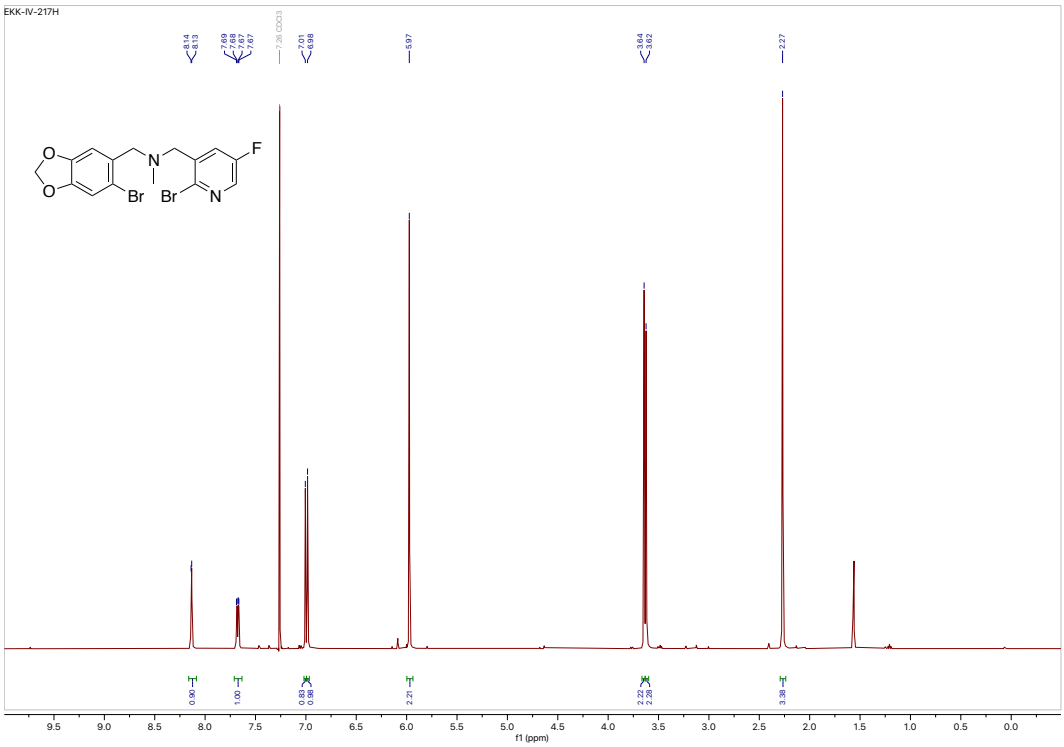


Figure S117. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **29b.**

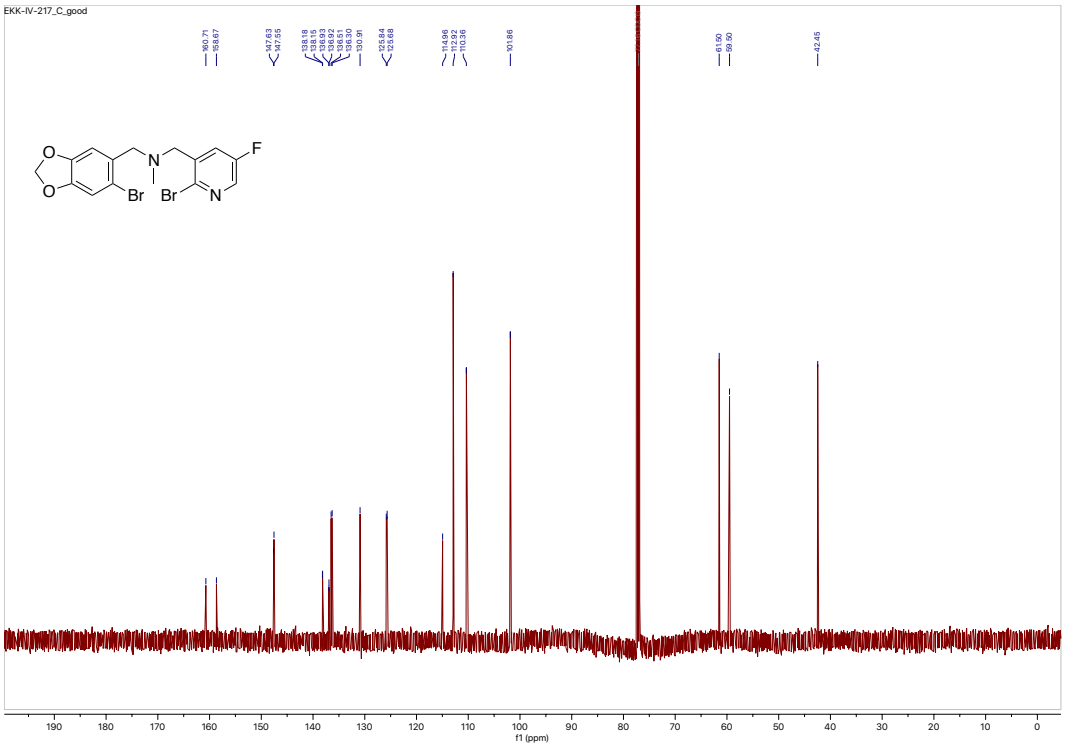


Figure S118. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **29b.**

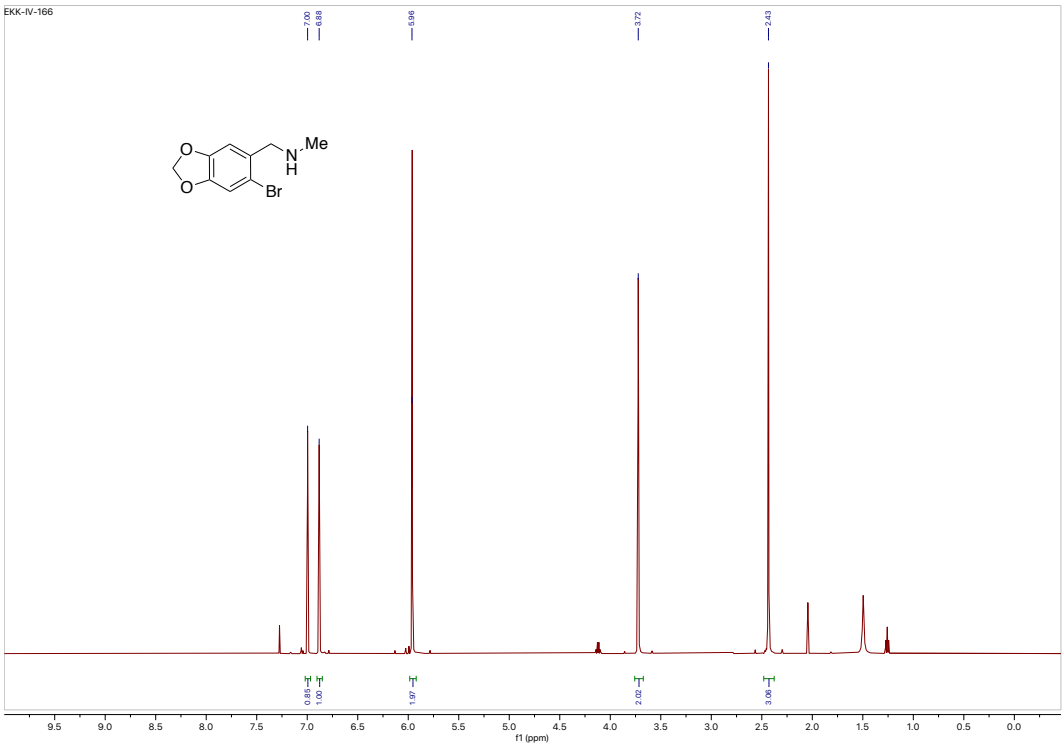


Figure S119. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **32.**

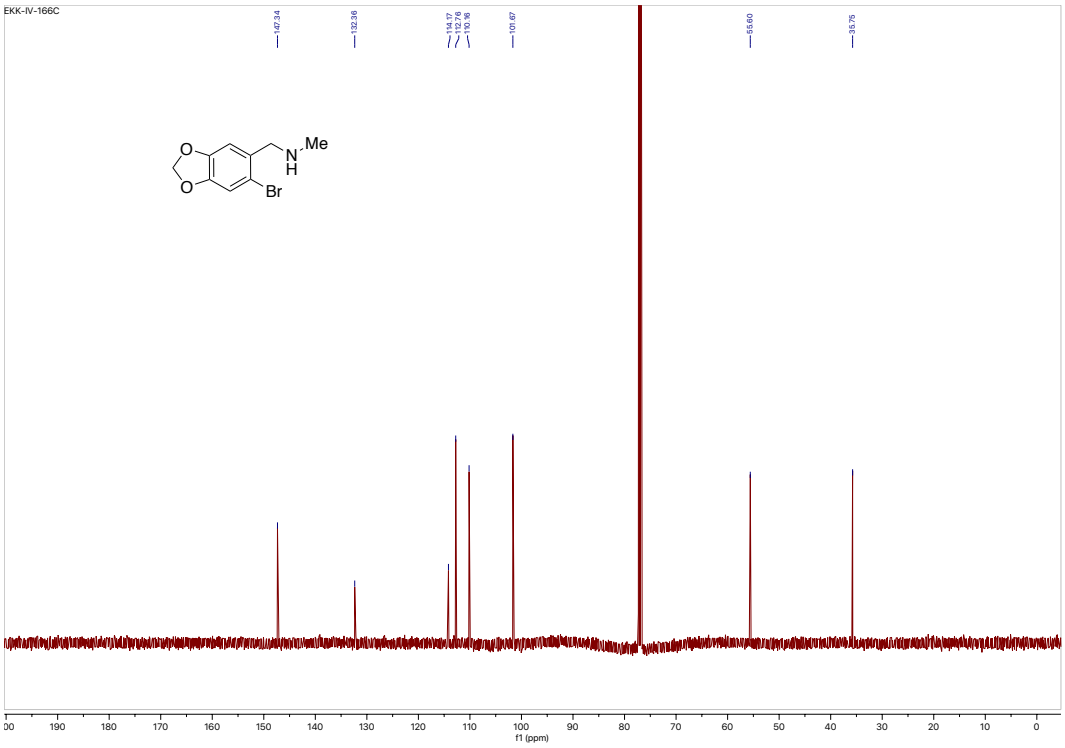


Figure S120. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **32.**

*EtOAc

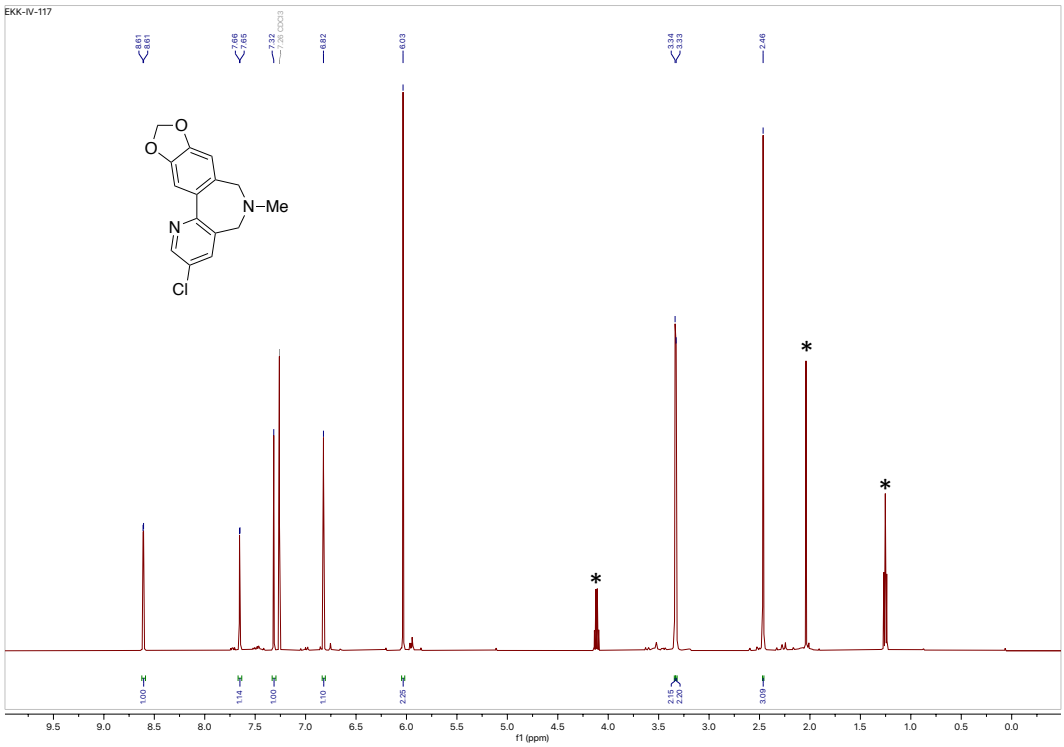


Figure S121. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **33a.**

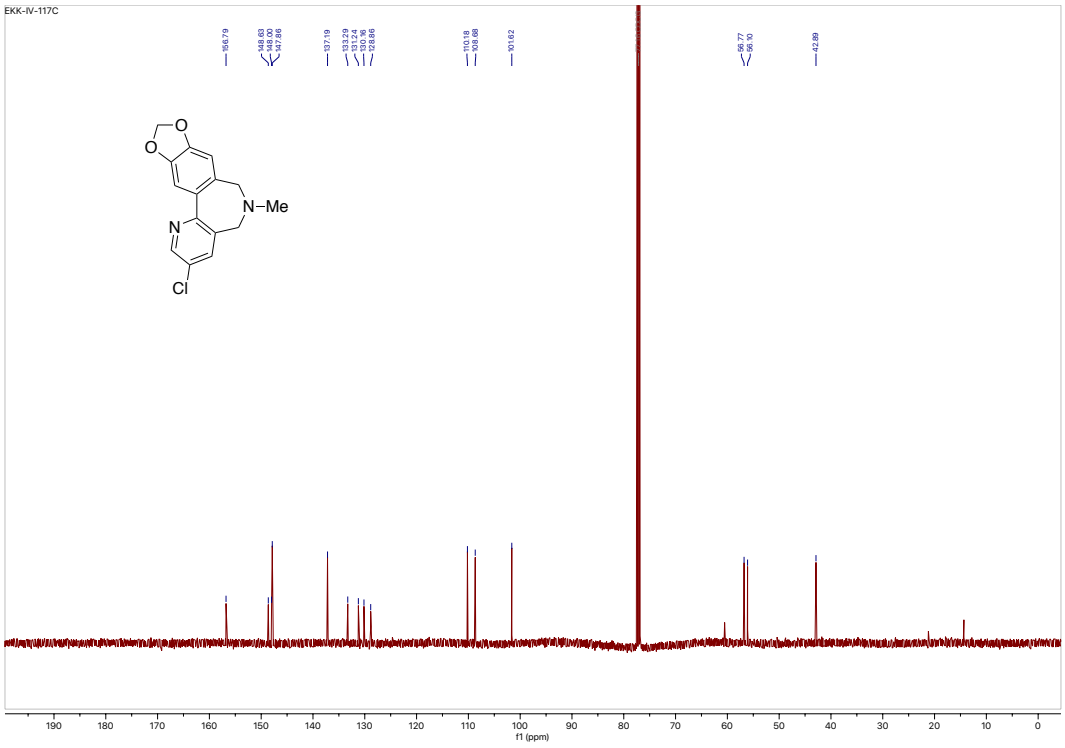


Figure S122. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **33a.**

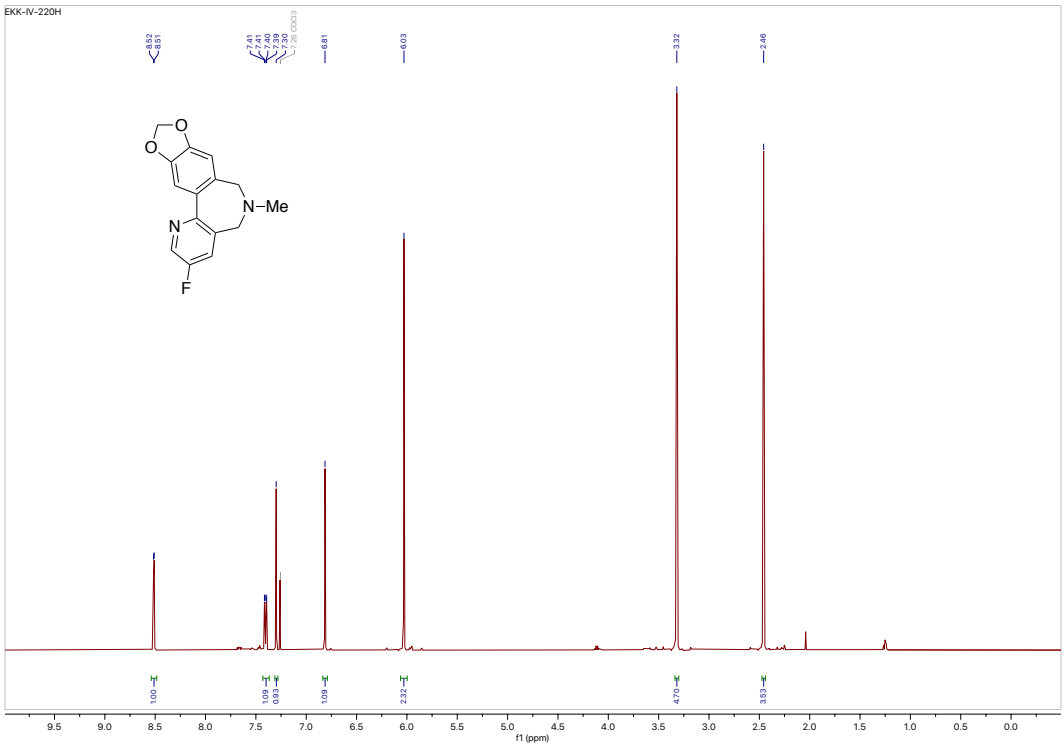


Figure S123. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **33b.**

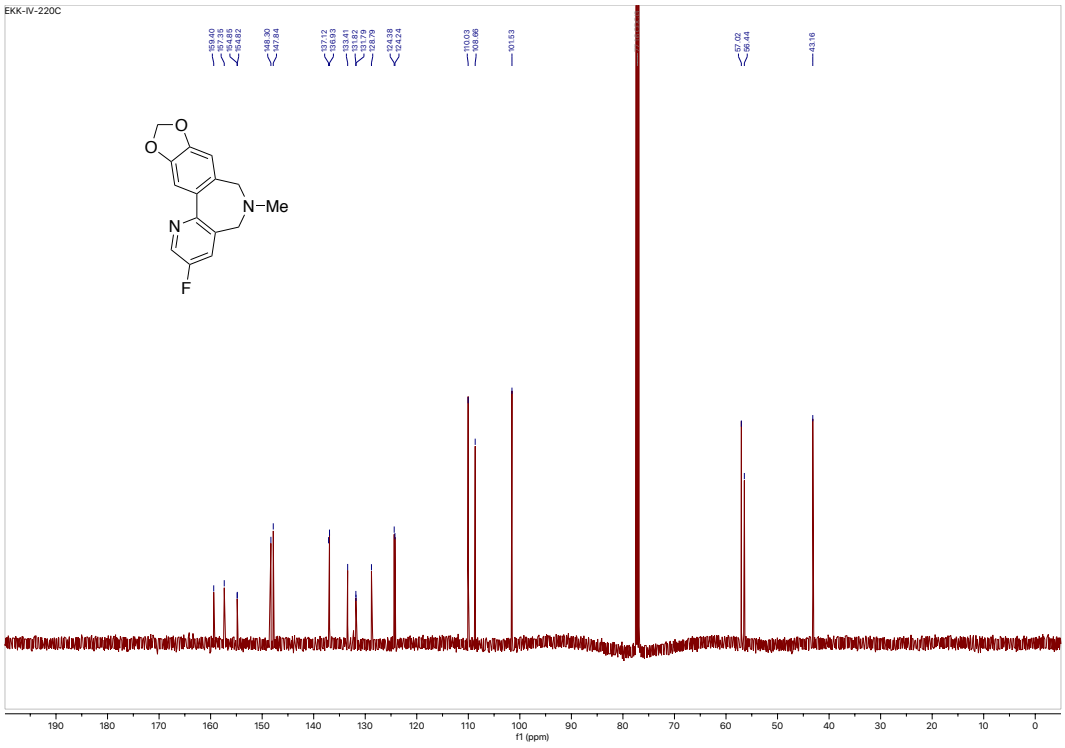


Figure S124. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **33b.**

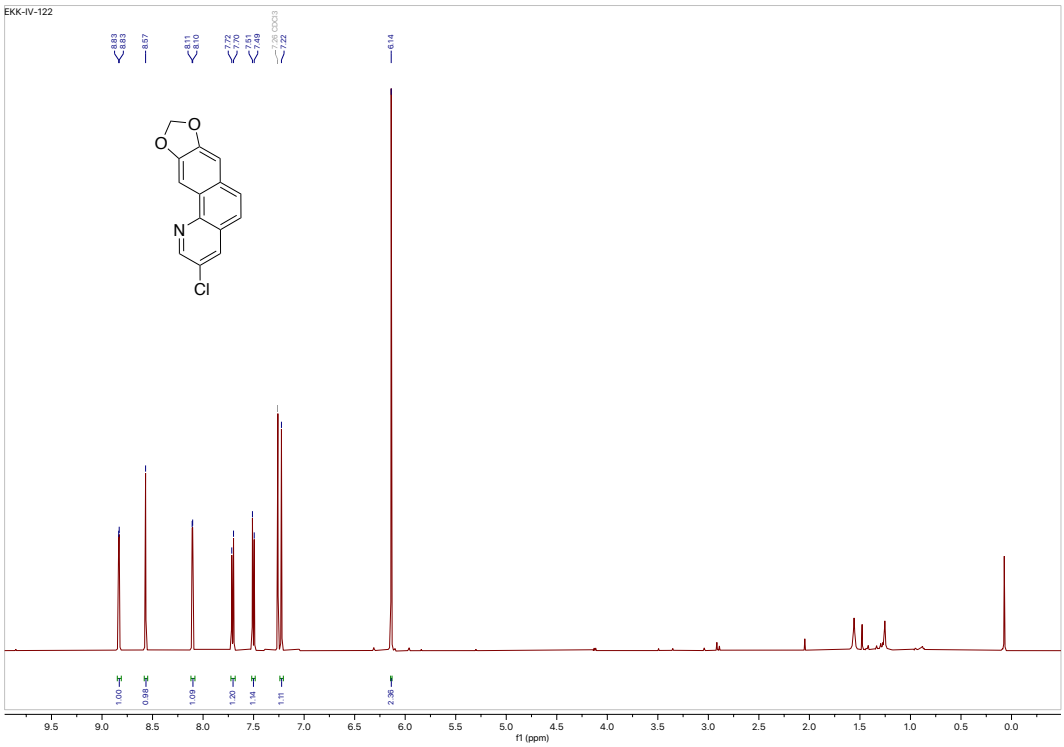


Figure S125. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **34a.**

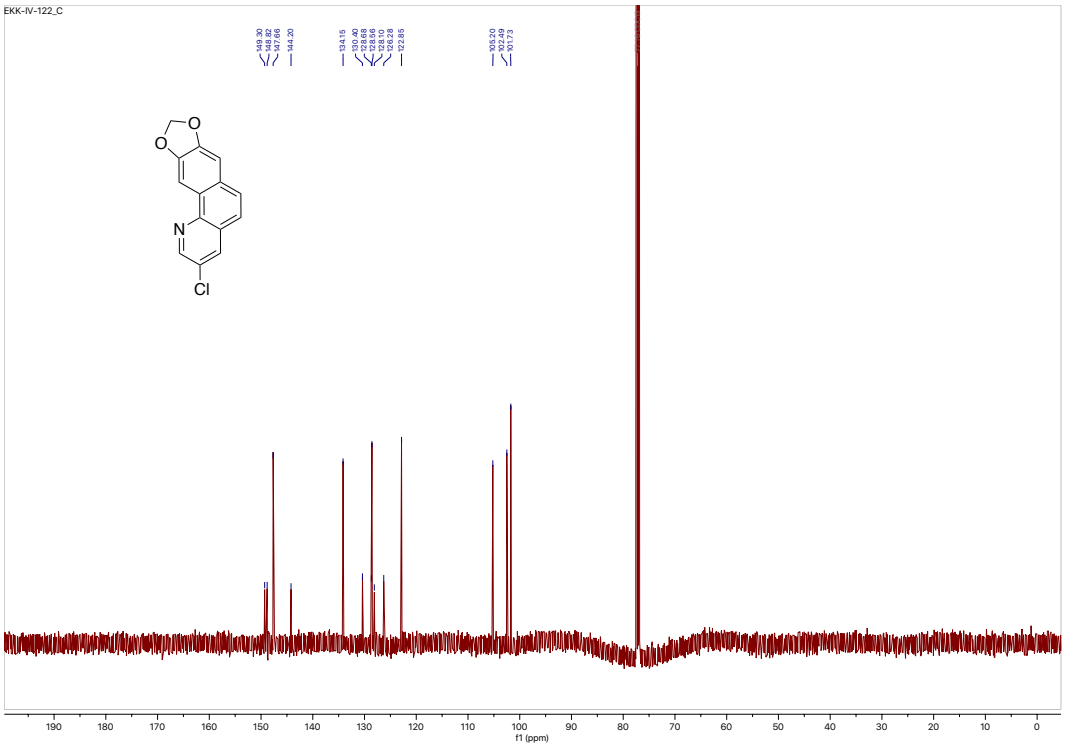


Figure S126. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **34a.**

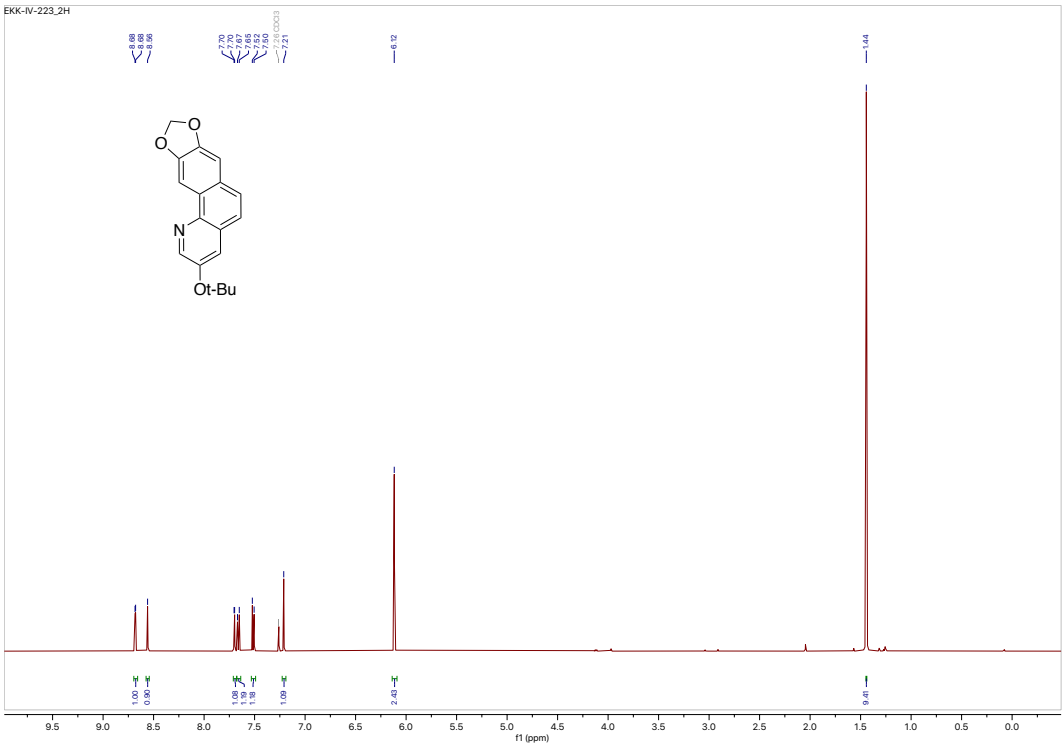


Figure S127. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **34b.**

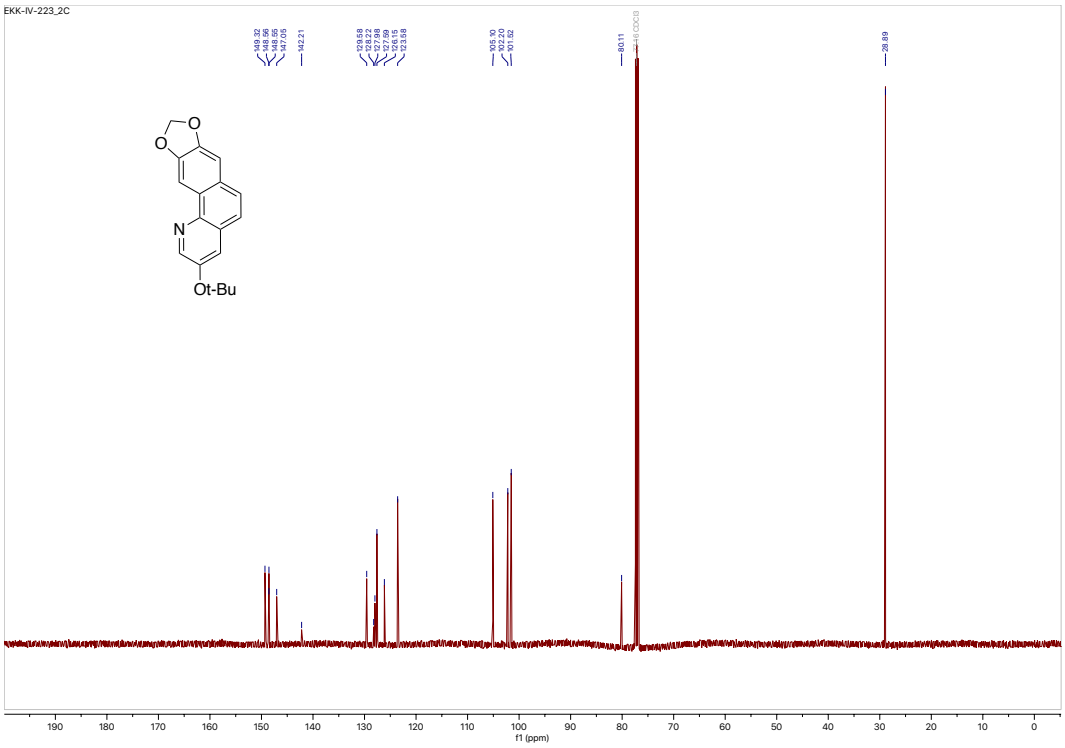


Figure S128. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **34b.**

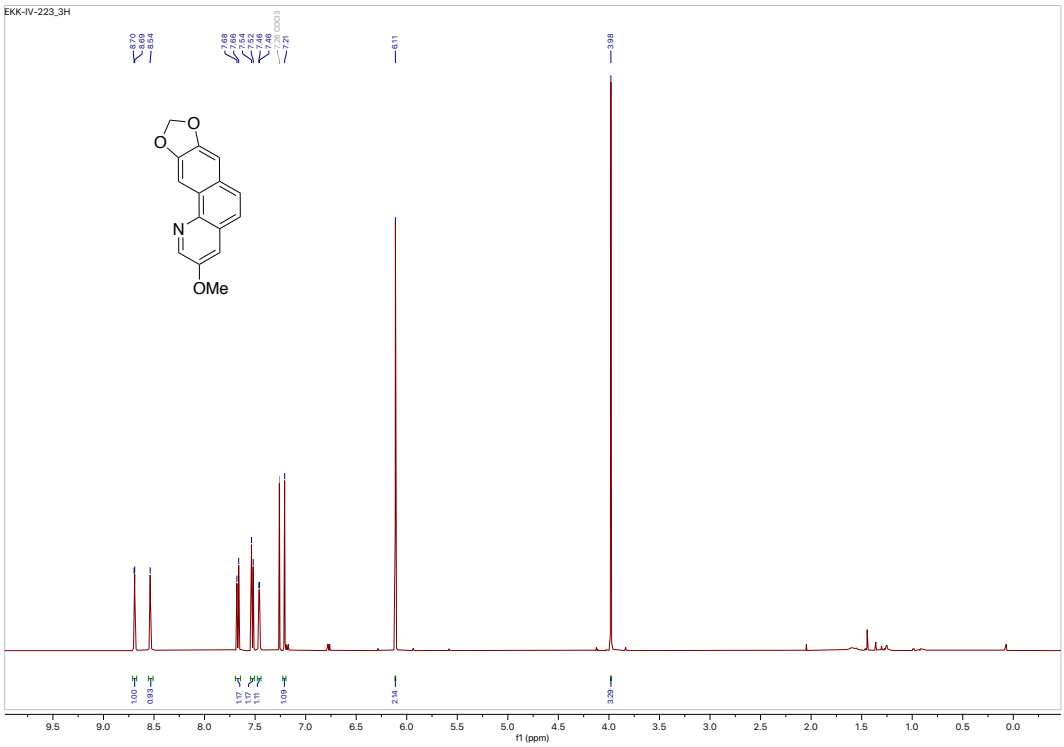


Figure S129. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **34c.**

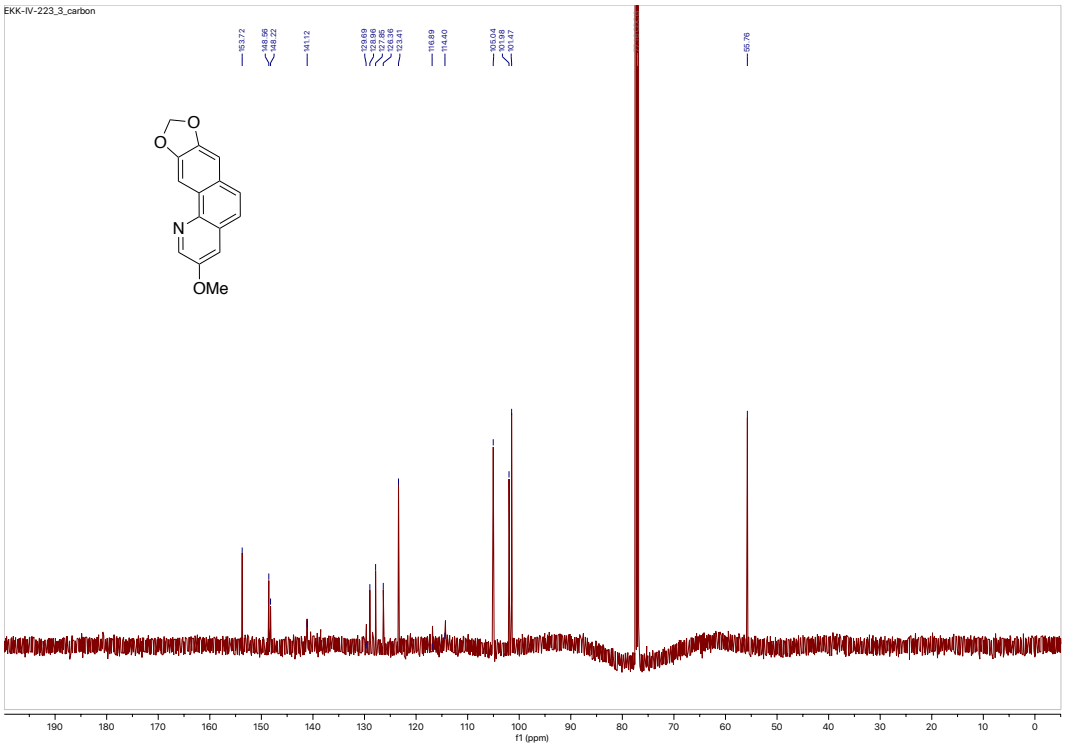


Figure S130. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **34c.**

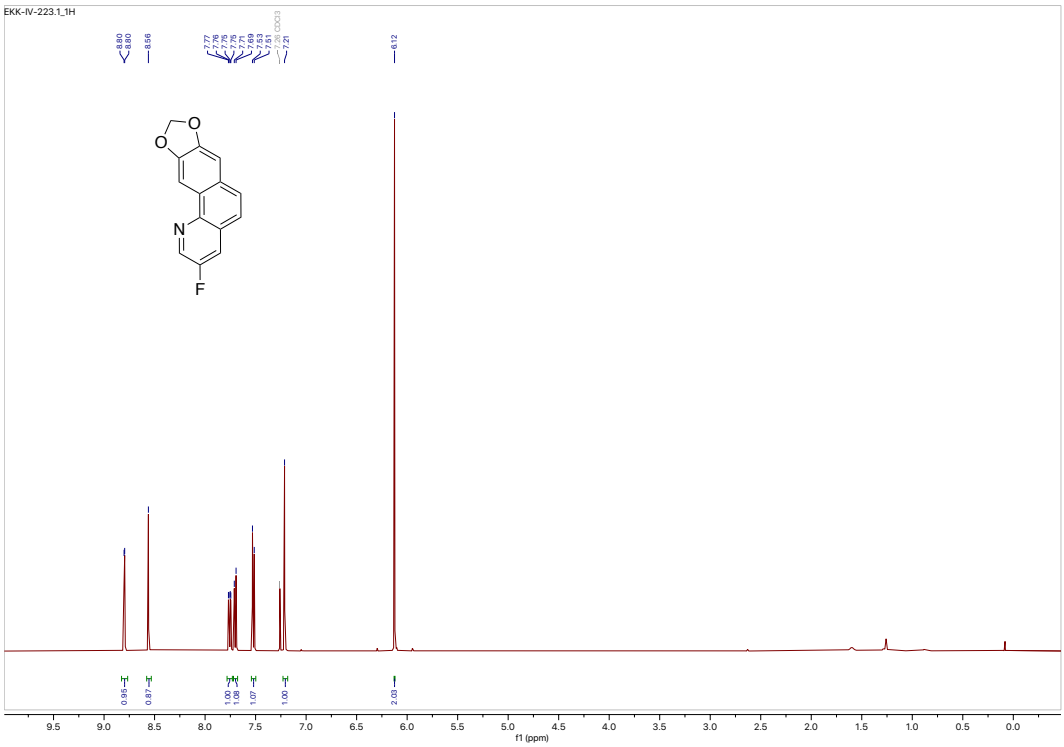


Figure S131. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **34d.**

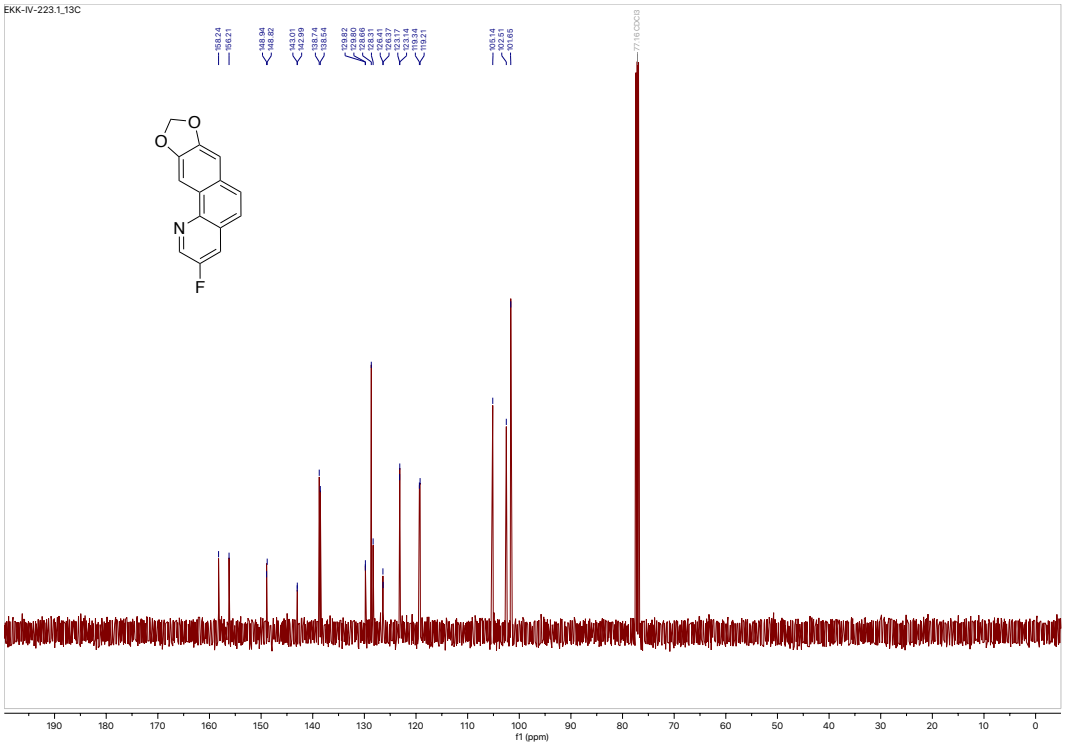


Figure S132. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **34d.**

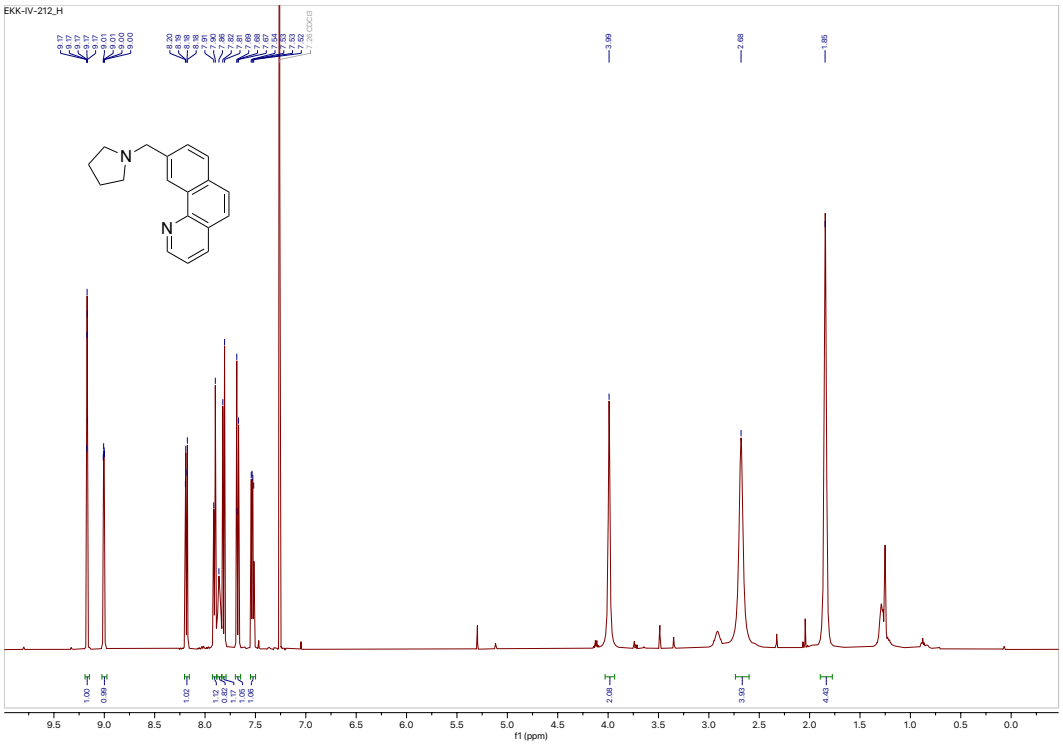


Figure S133. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **36.**

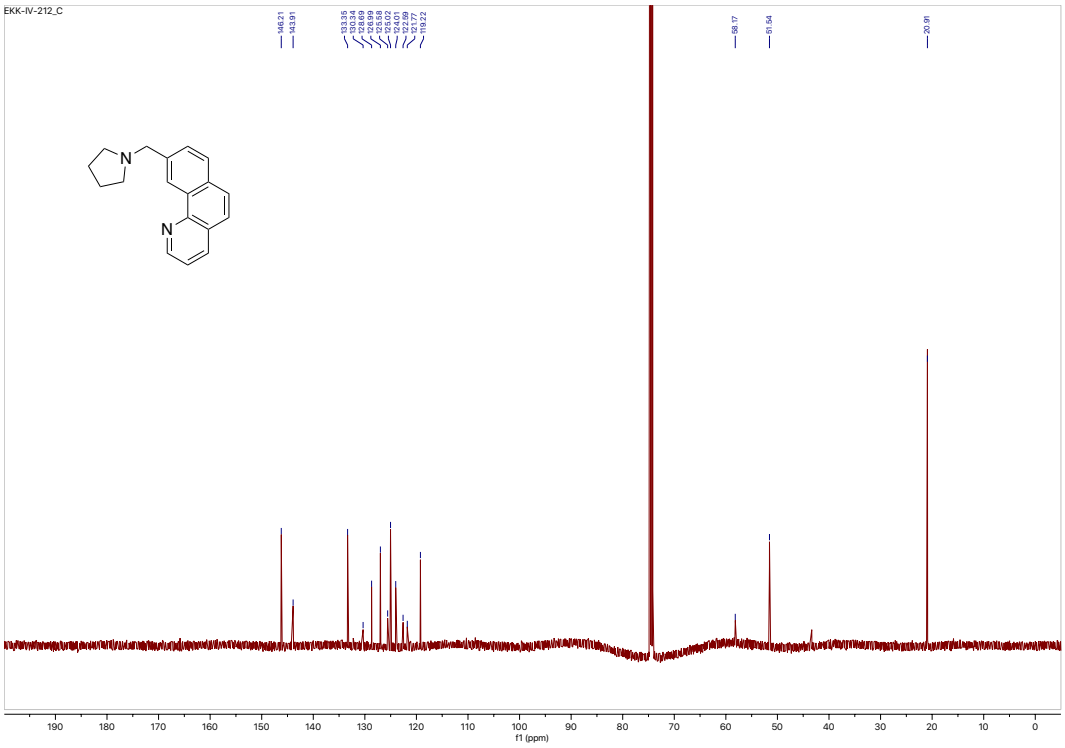


Figure S134. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **36.**

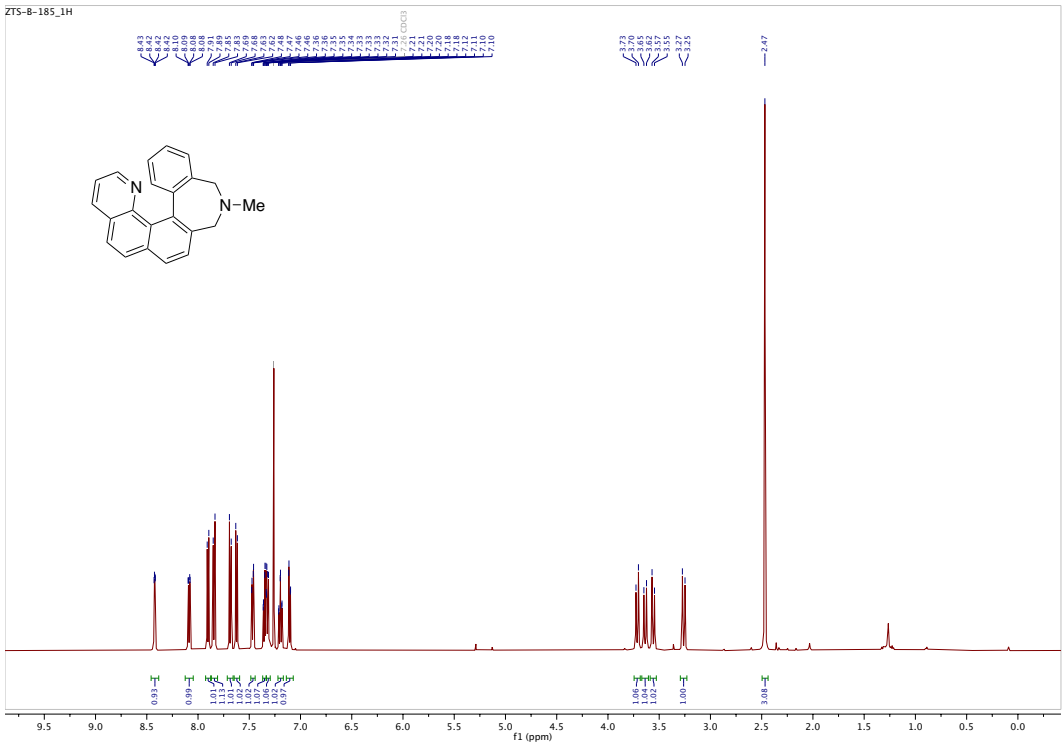


Figure S135. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **39.**

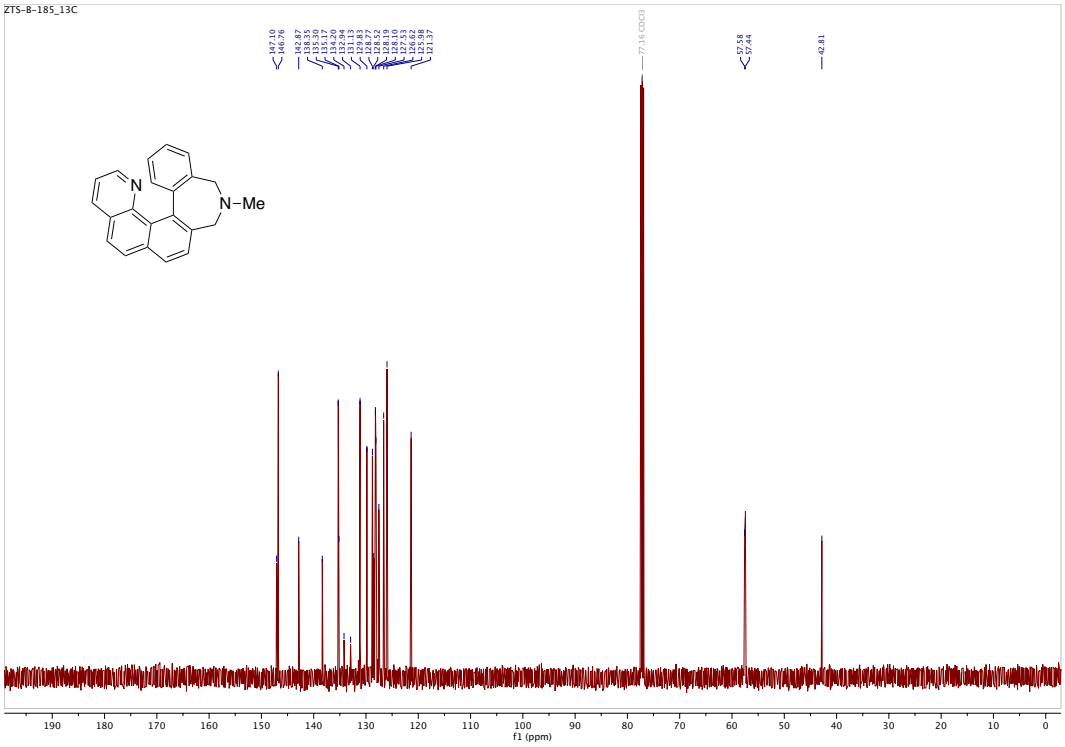


Figure S136. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **39.**

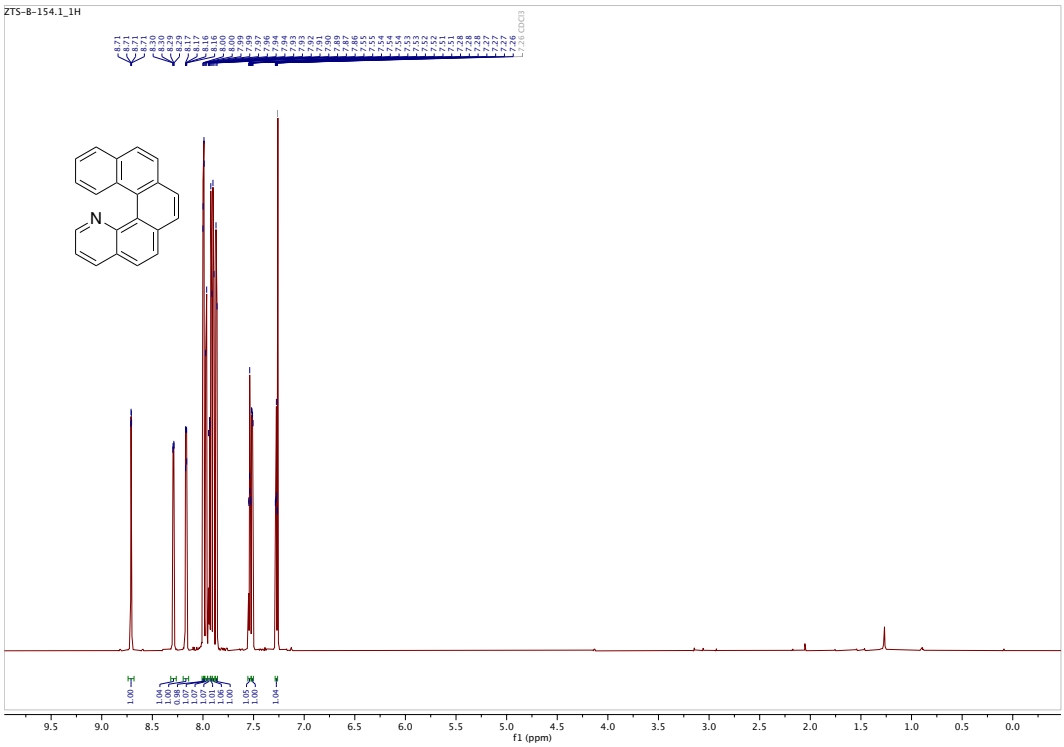


Figure S137. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **40.**

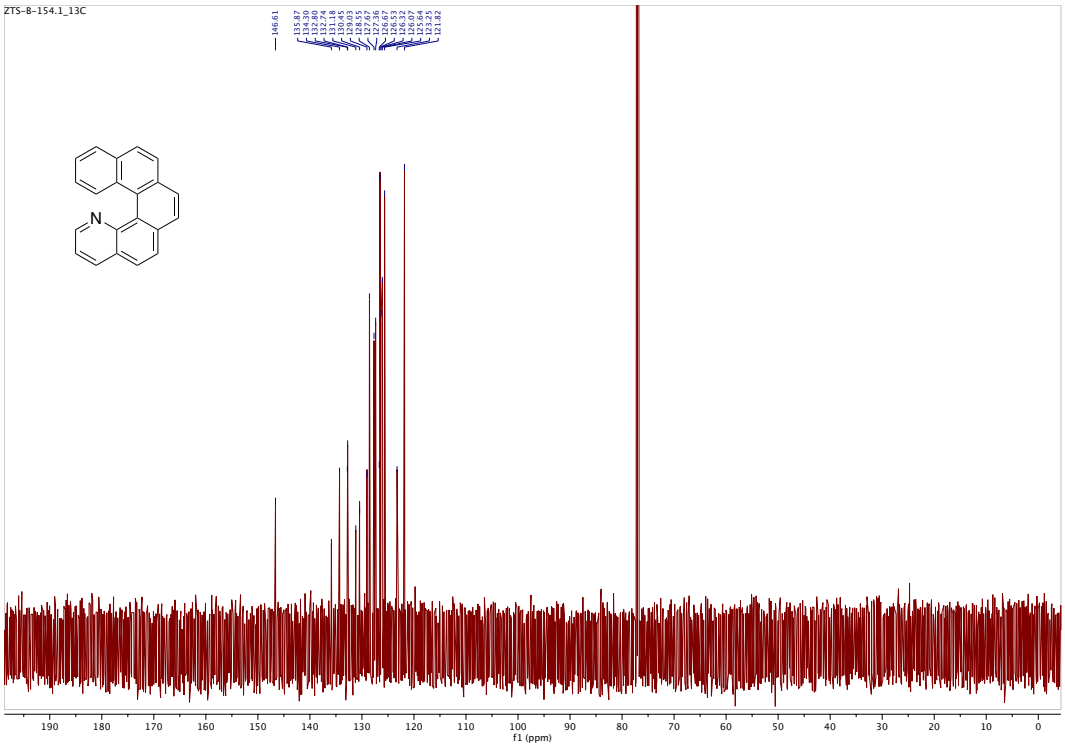


Figure S138. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **40.**

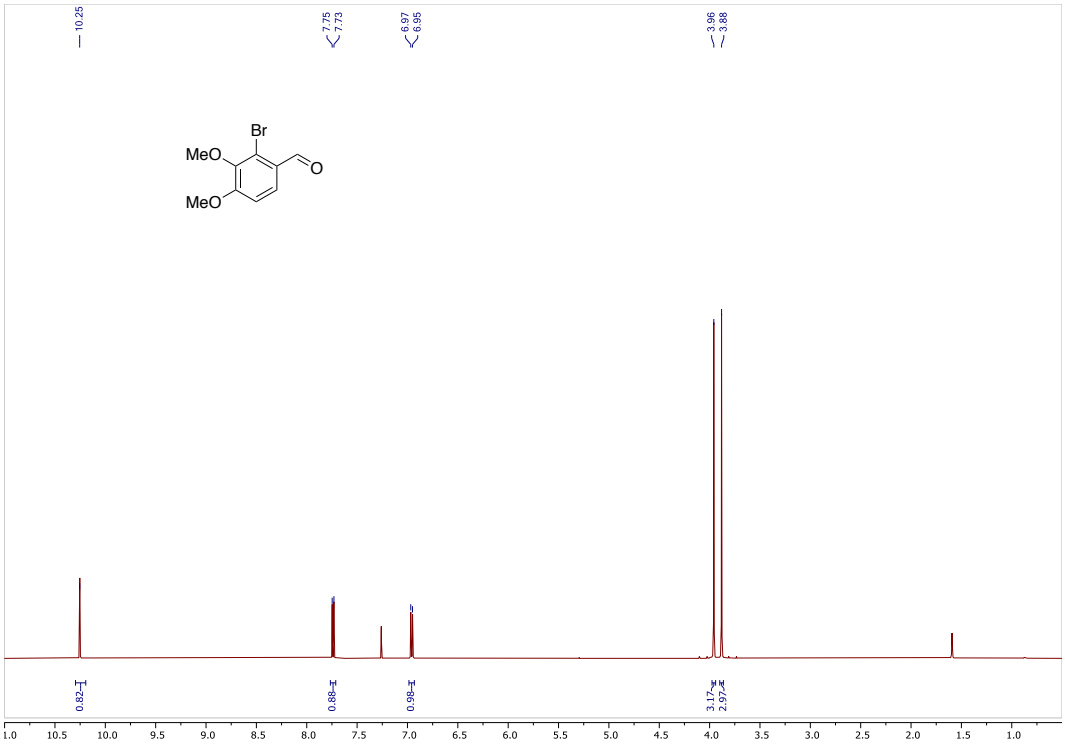


Figure S139. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S1.**

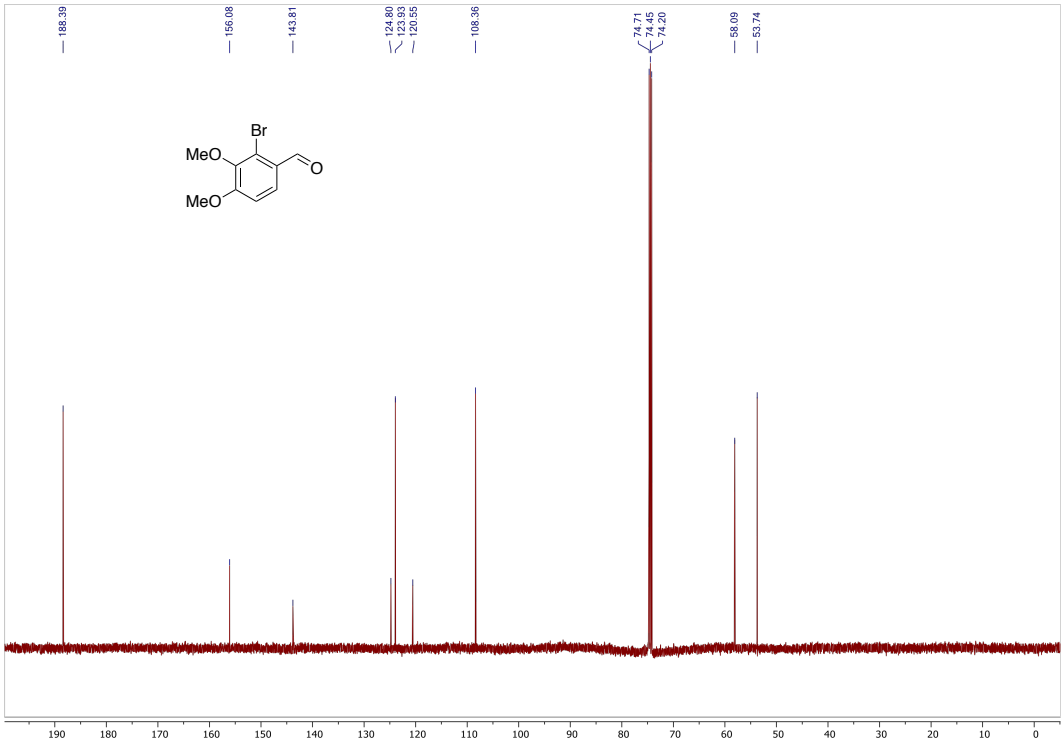


Figure S140. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S1.**

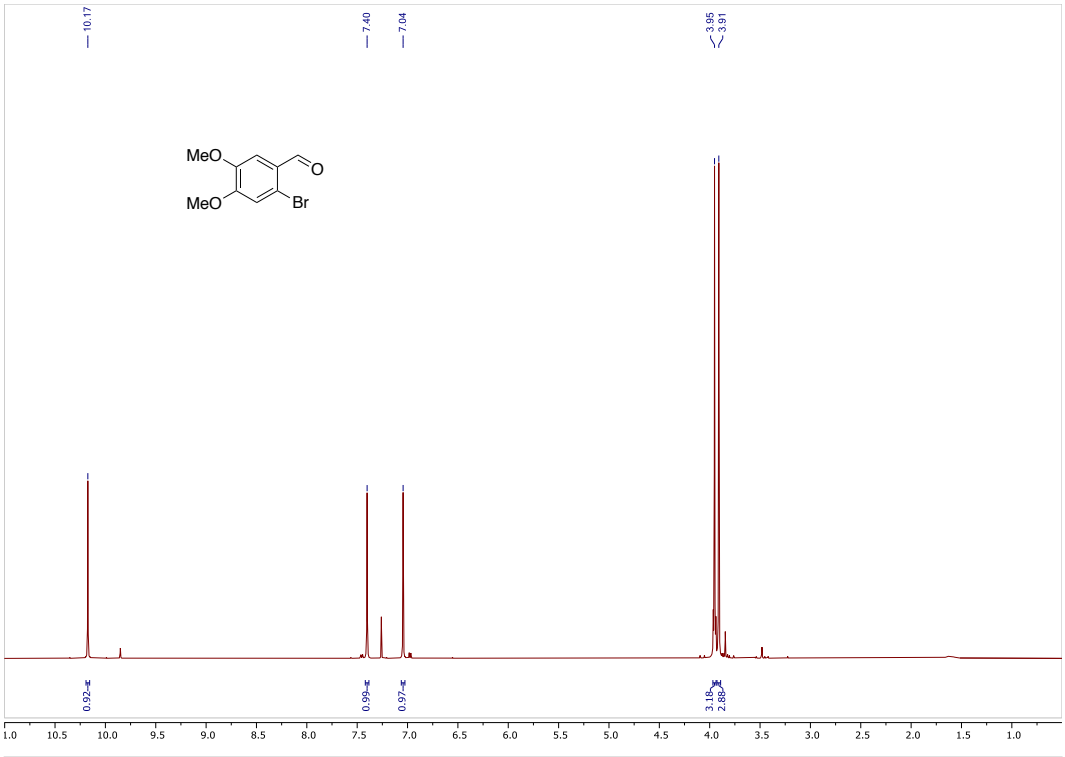


Figure S141. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S2.**

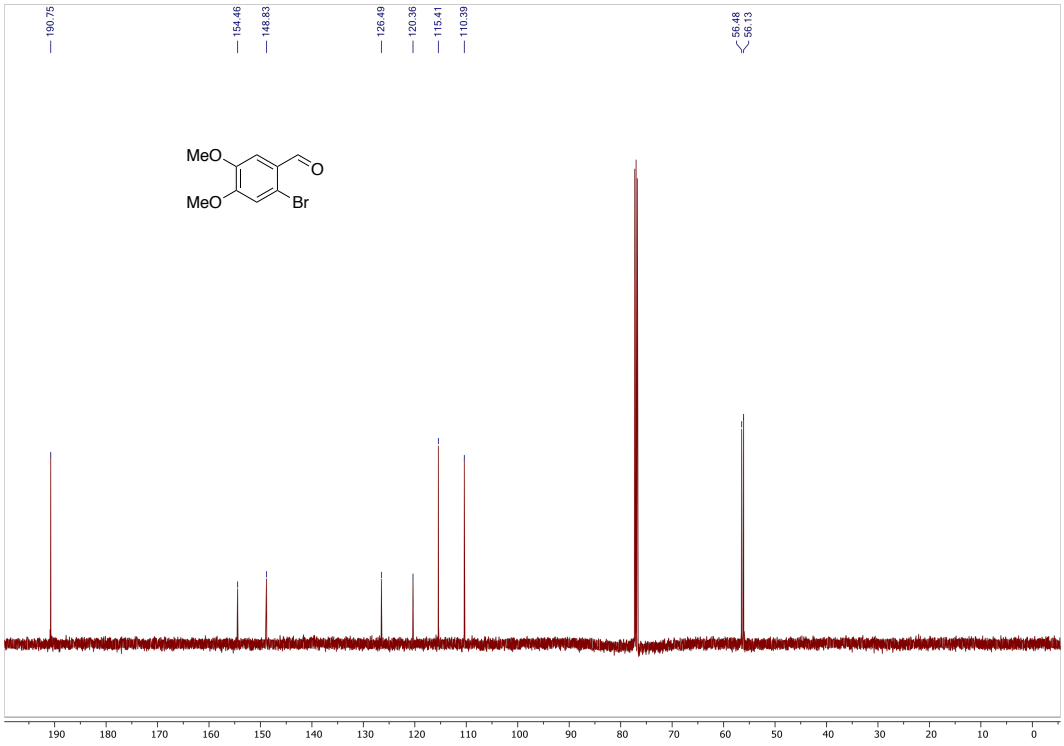


Figure S142. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S2.**

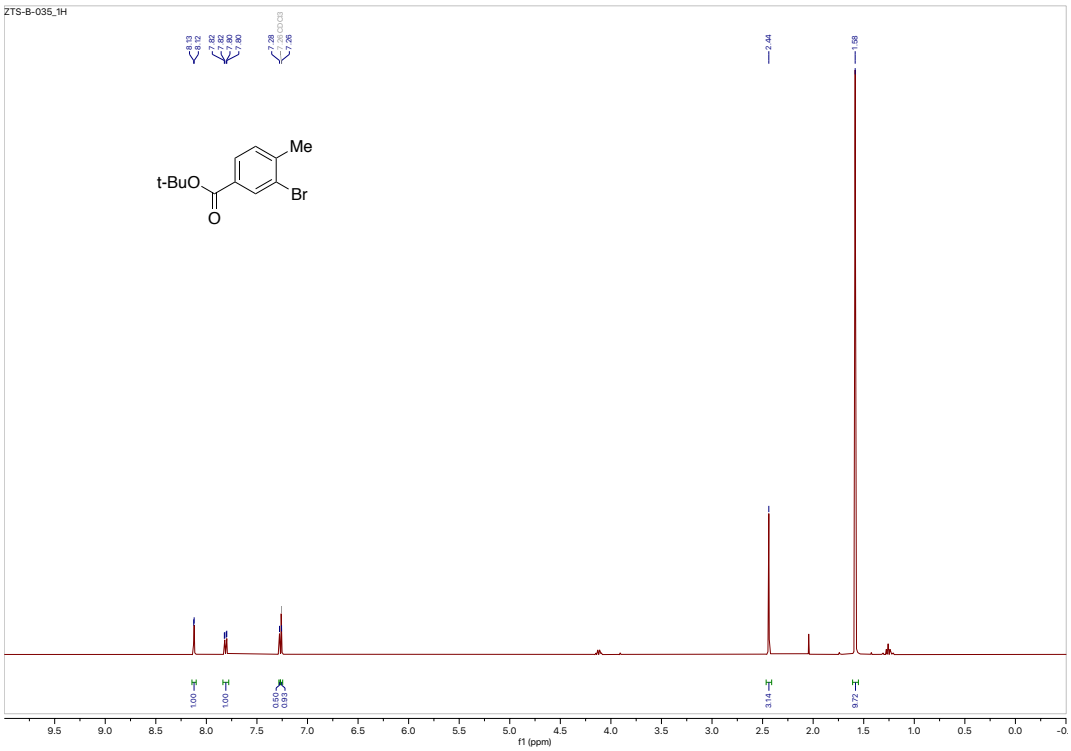


Figure S143. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S3.**

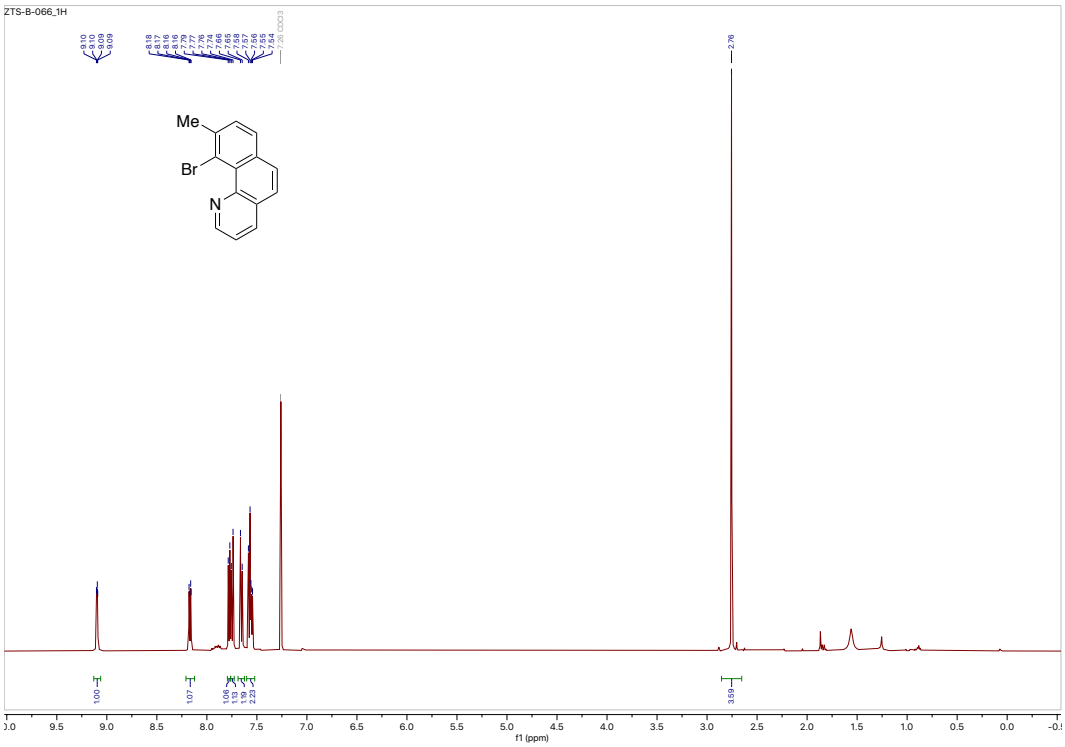


Figure S144. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S4.**

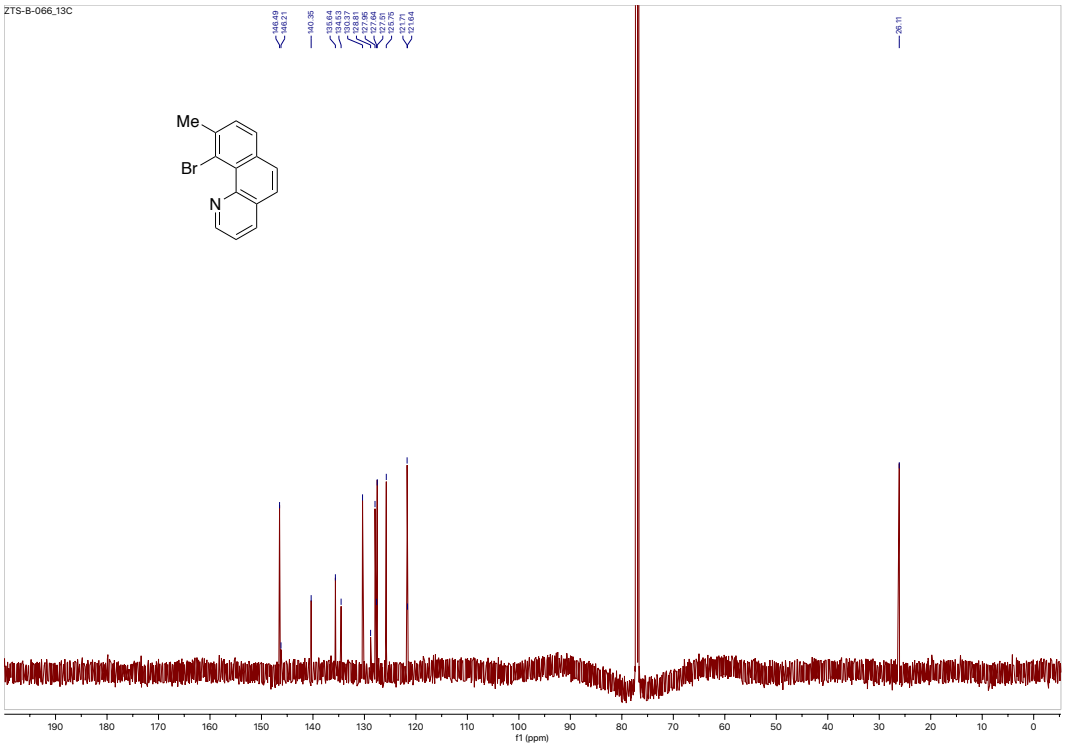


Figure S145. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S4.**

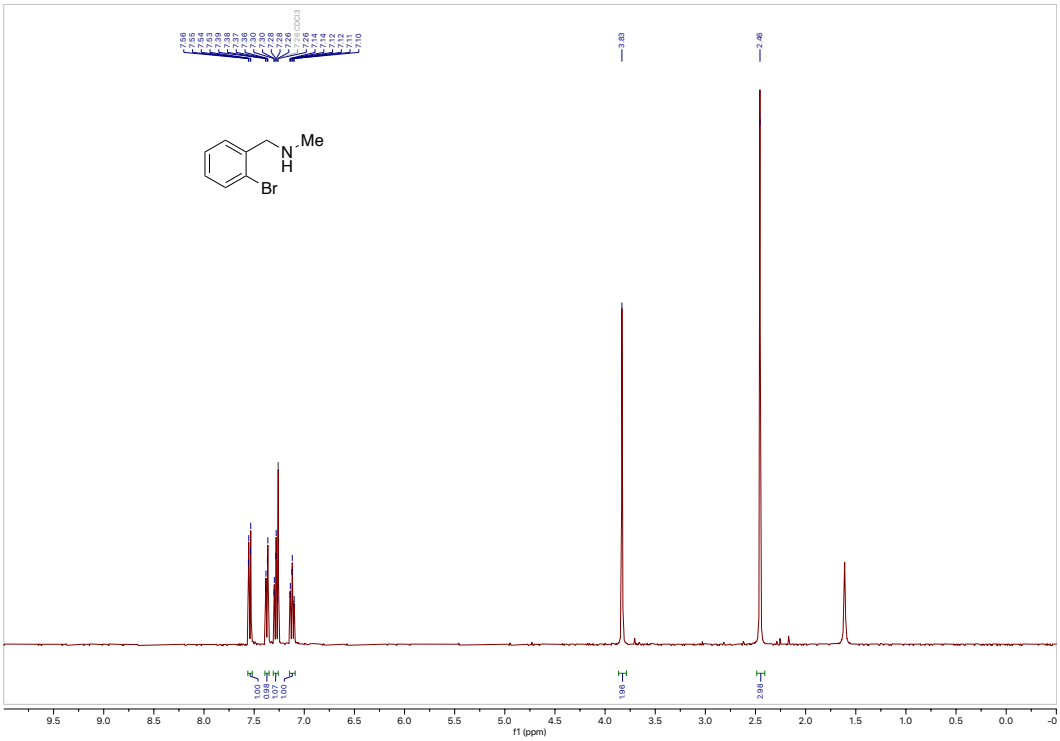


Figure S146. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S5.**

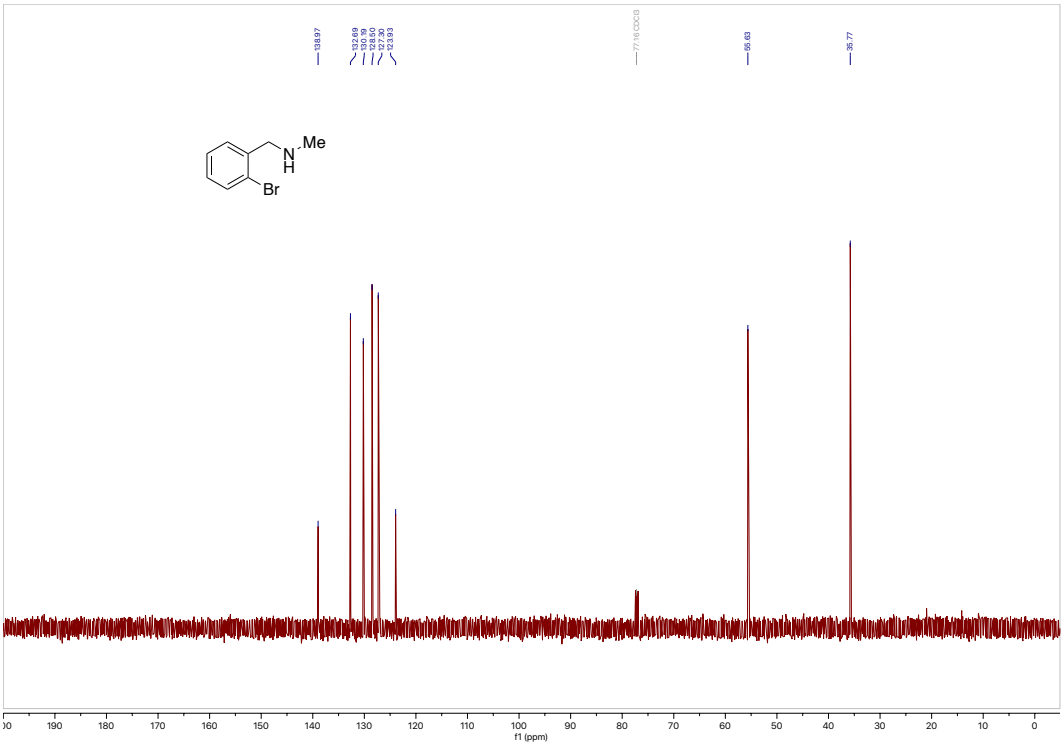


Figure S147. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S5.**

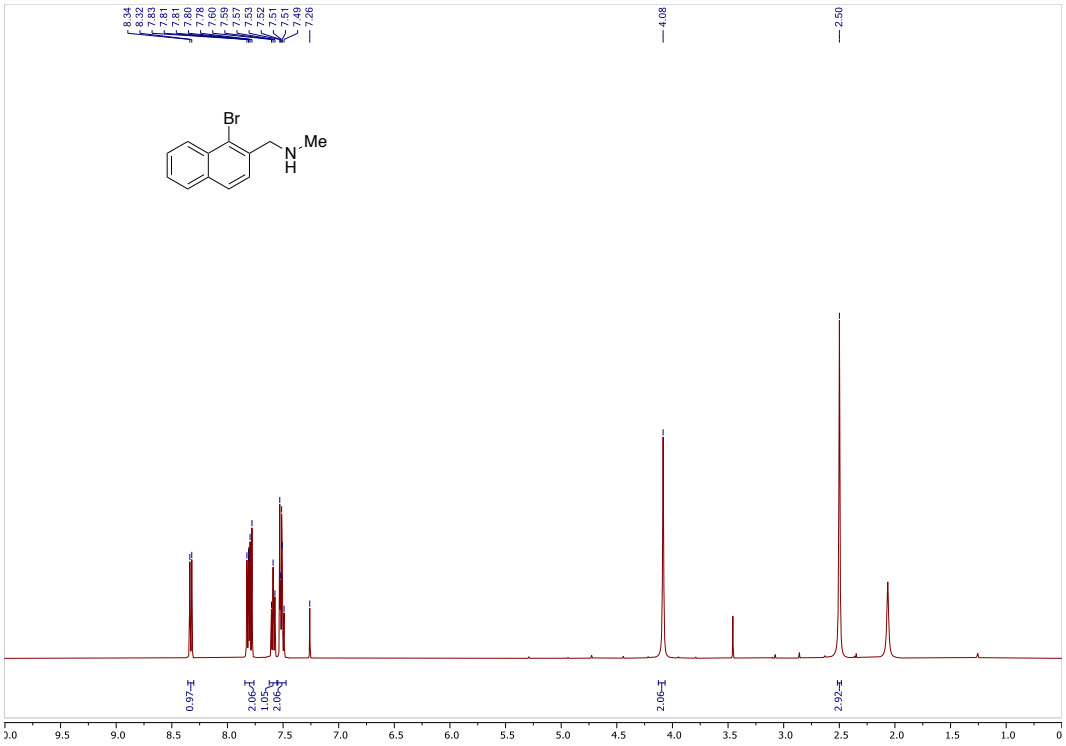


Figure S148. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S6.**

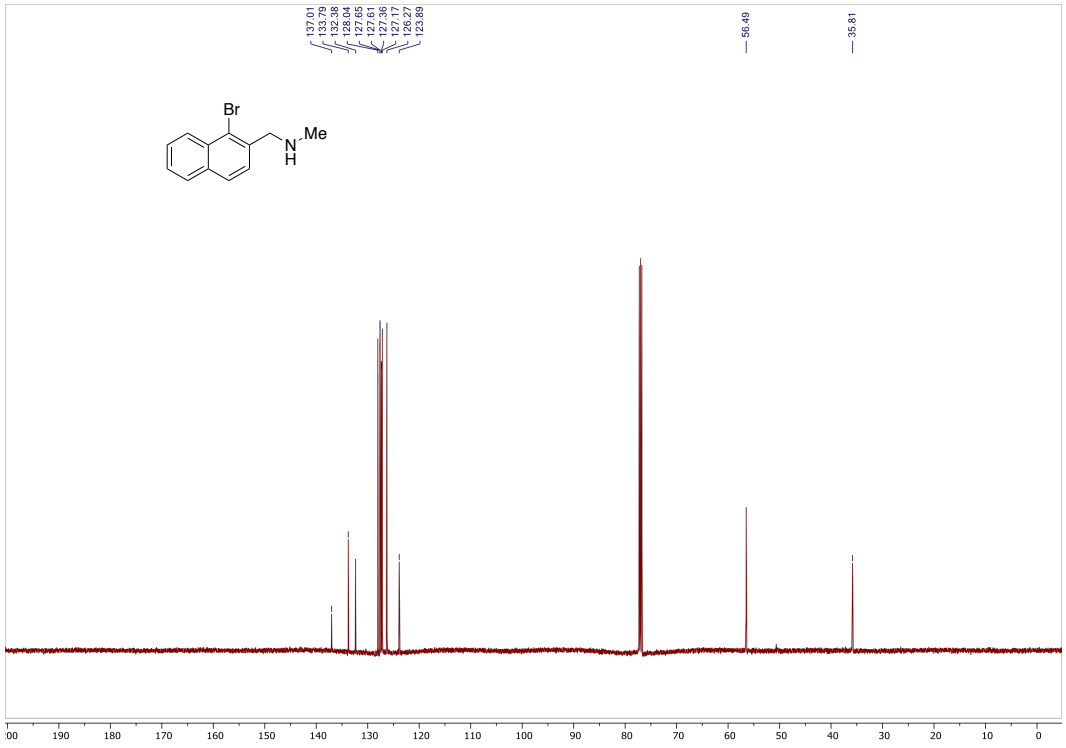


Figure S149. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S6.**

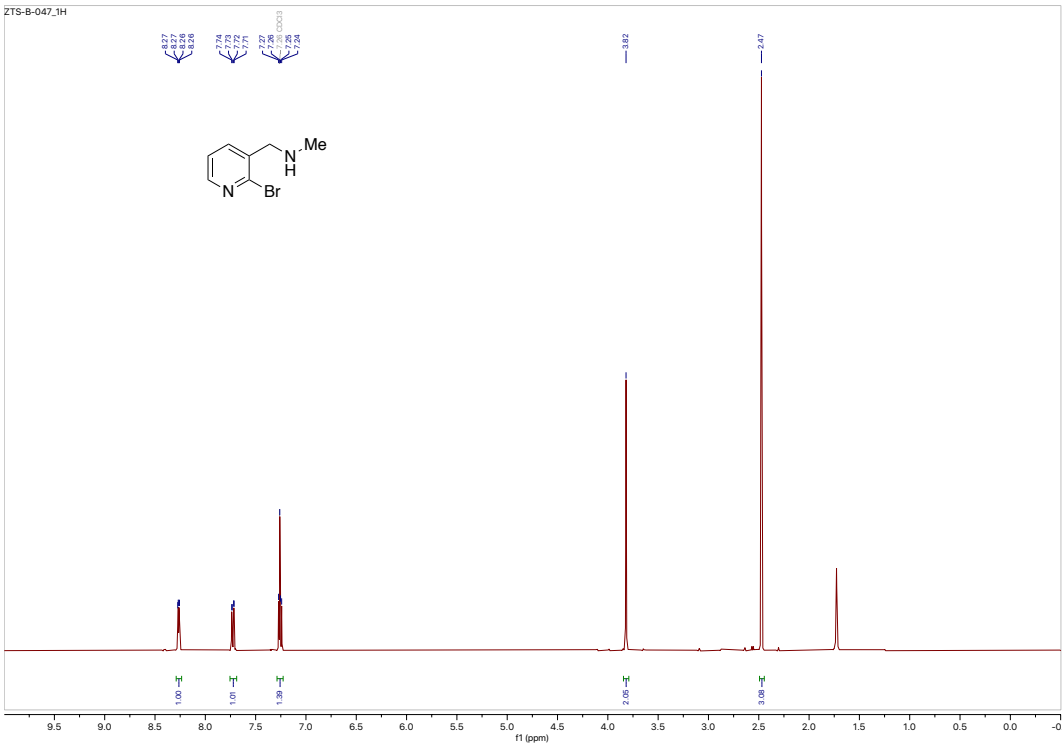


Figure S150. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S7.**

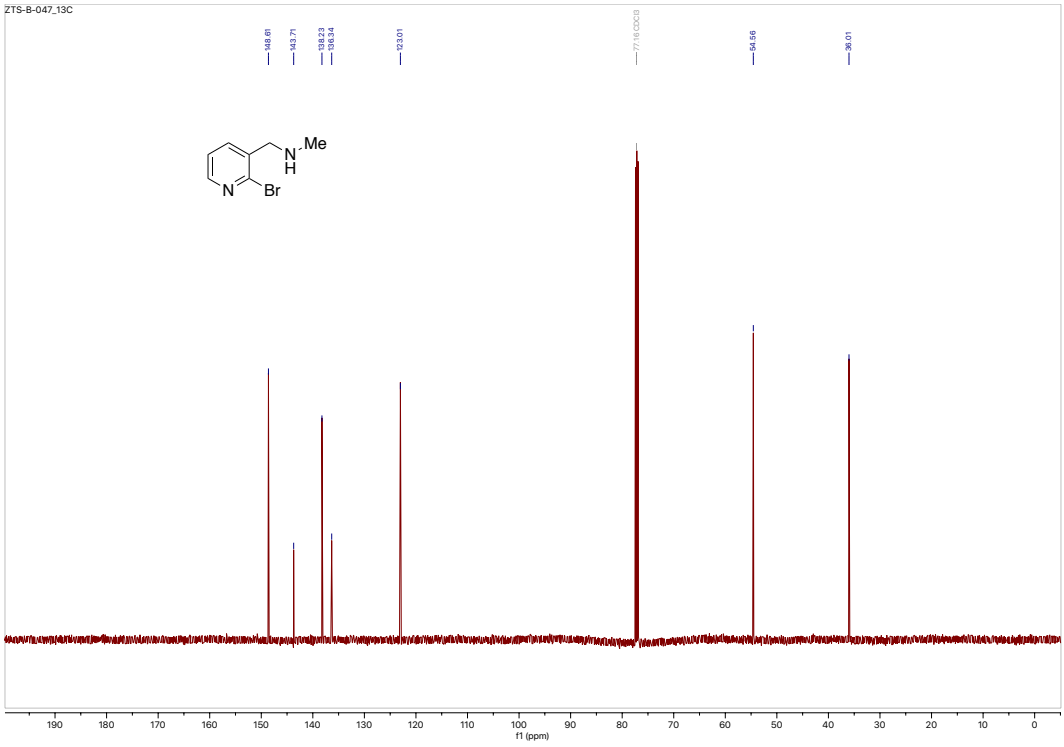


Figure S151. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S7.**

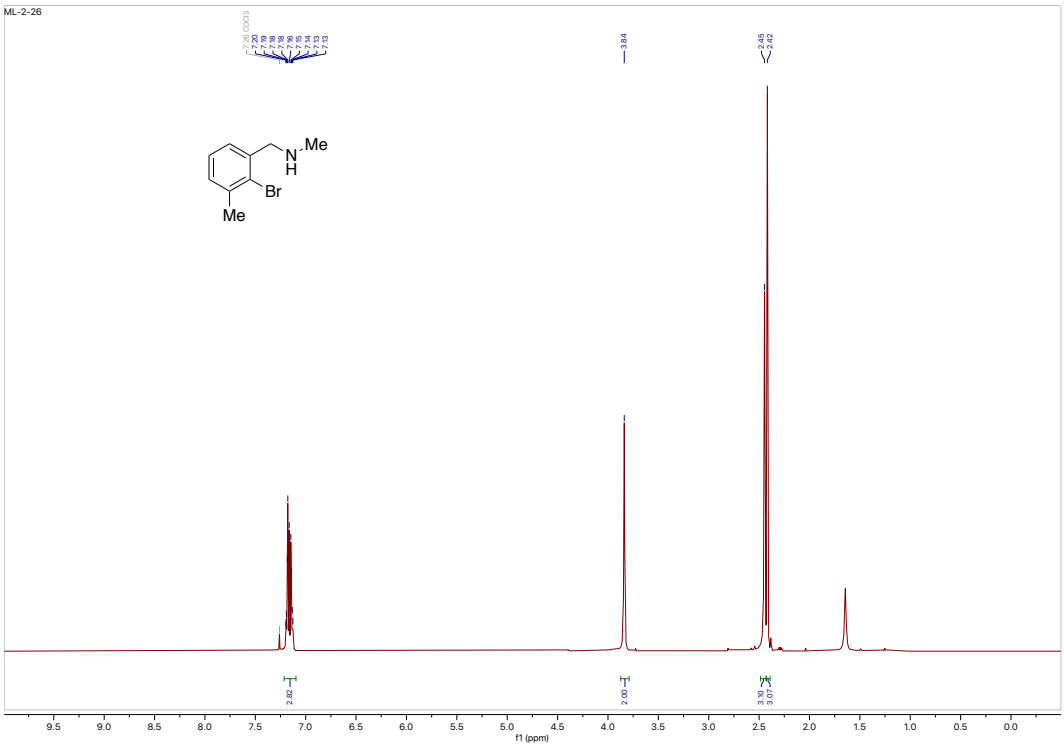


Figure S152. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S8.**

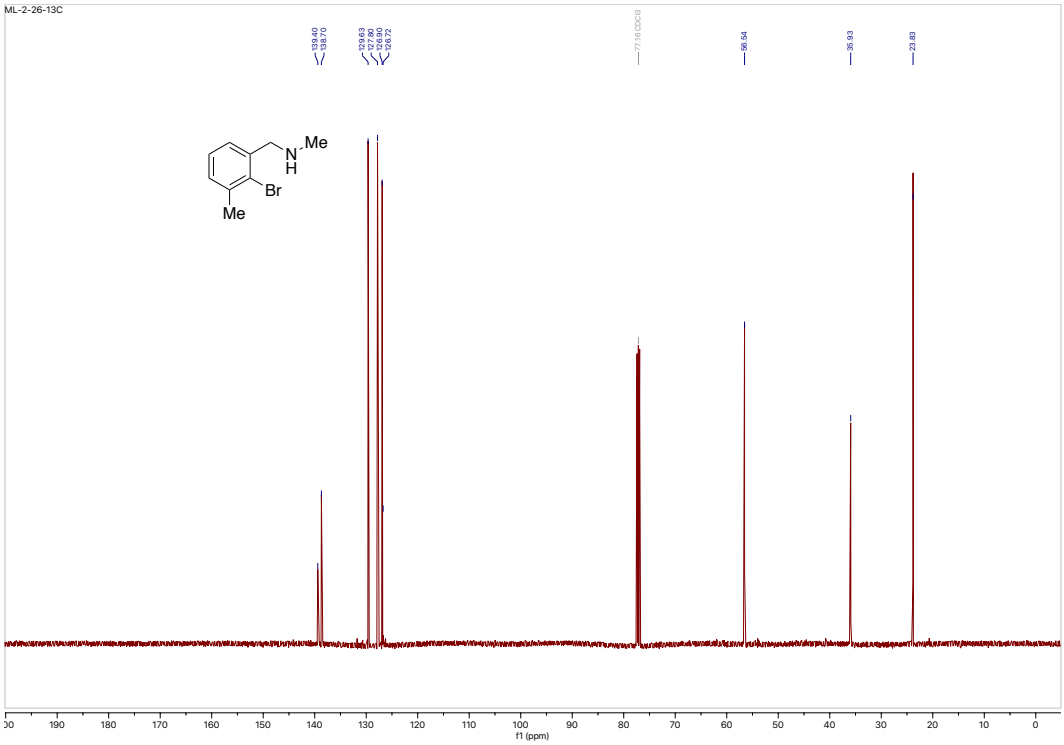


Figure S153. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S8.**

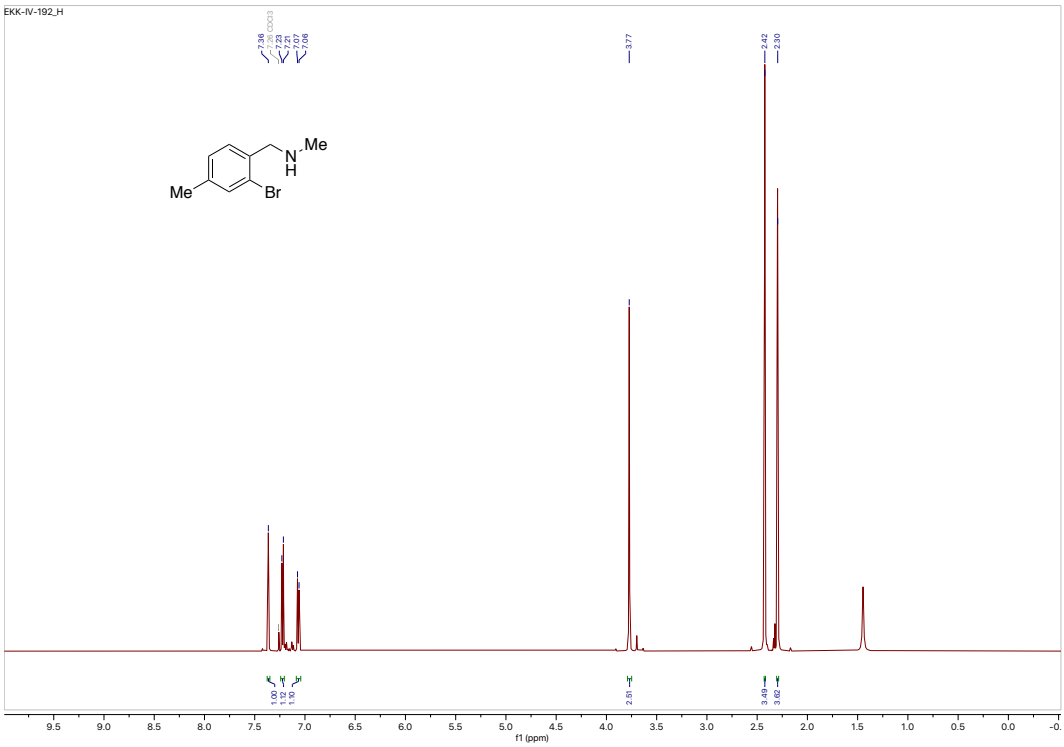


Figure S154. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S9.**

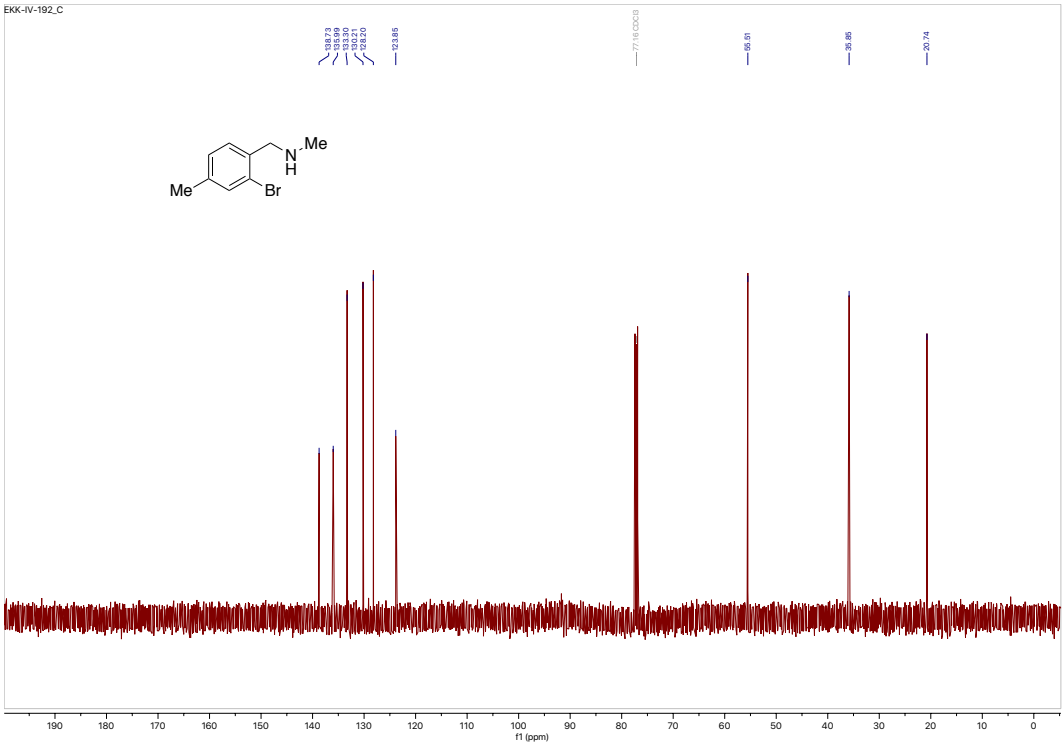


Figure S155. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S9.**

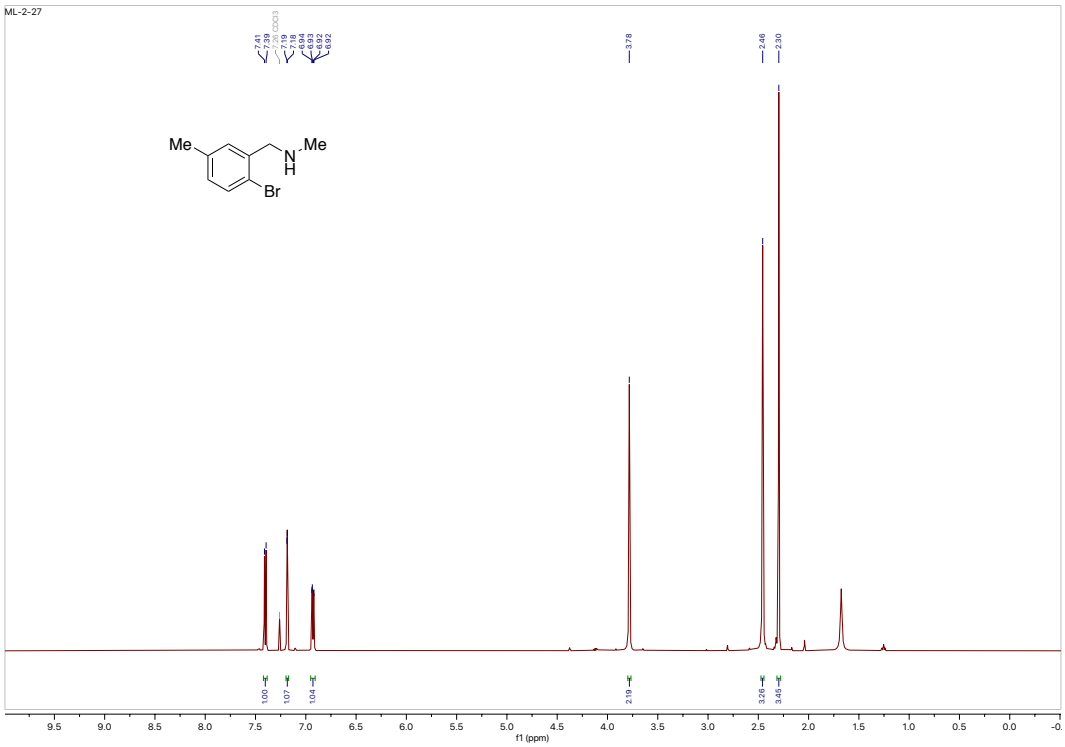


Figure S156. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S10.**

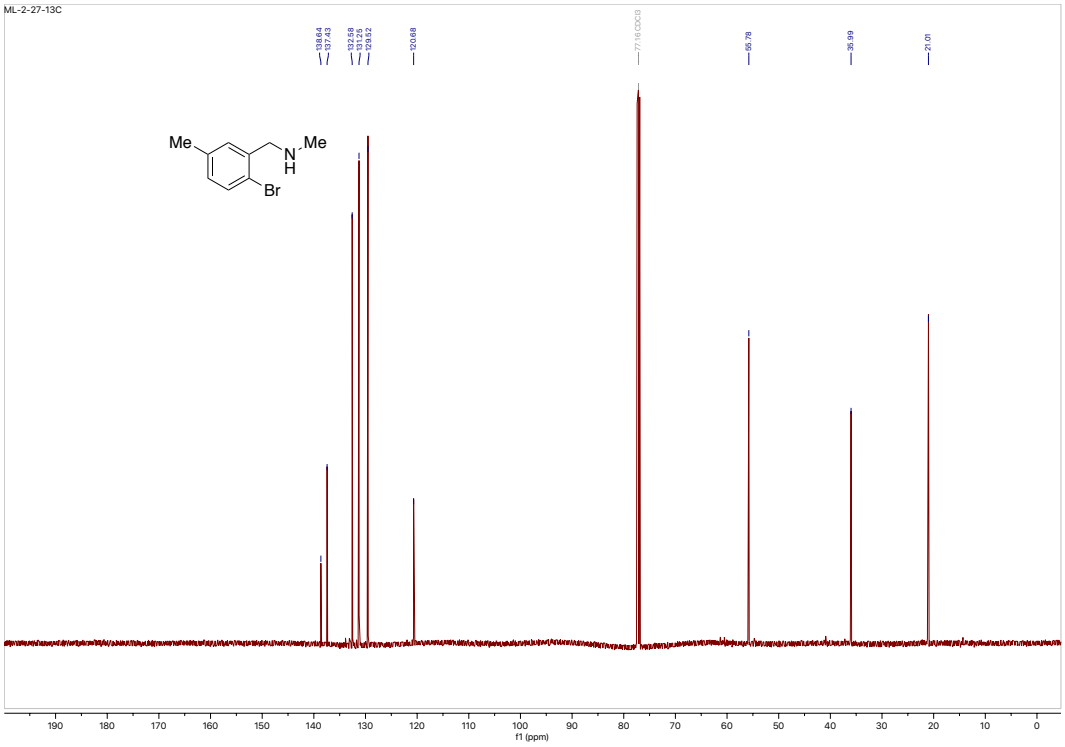


Figure S157. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S10.**

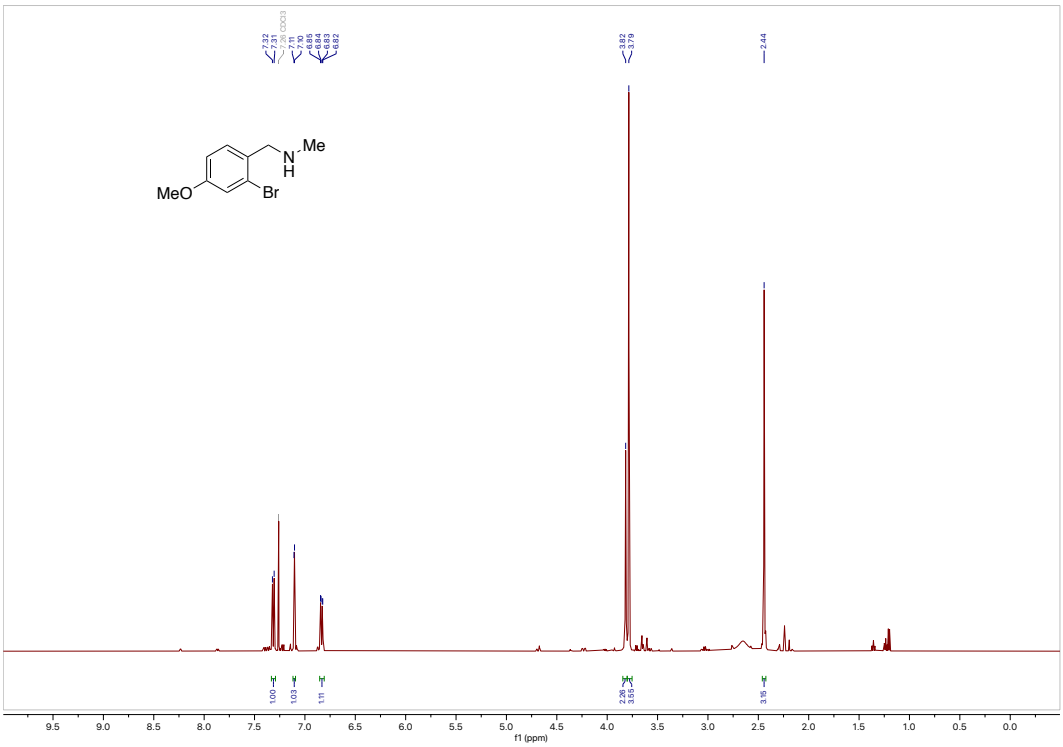


Figure S158. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S11.**

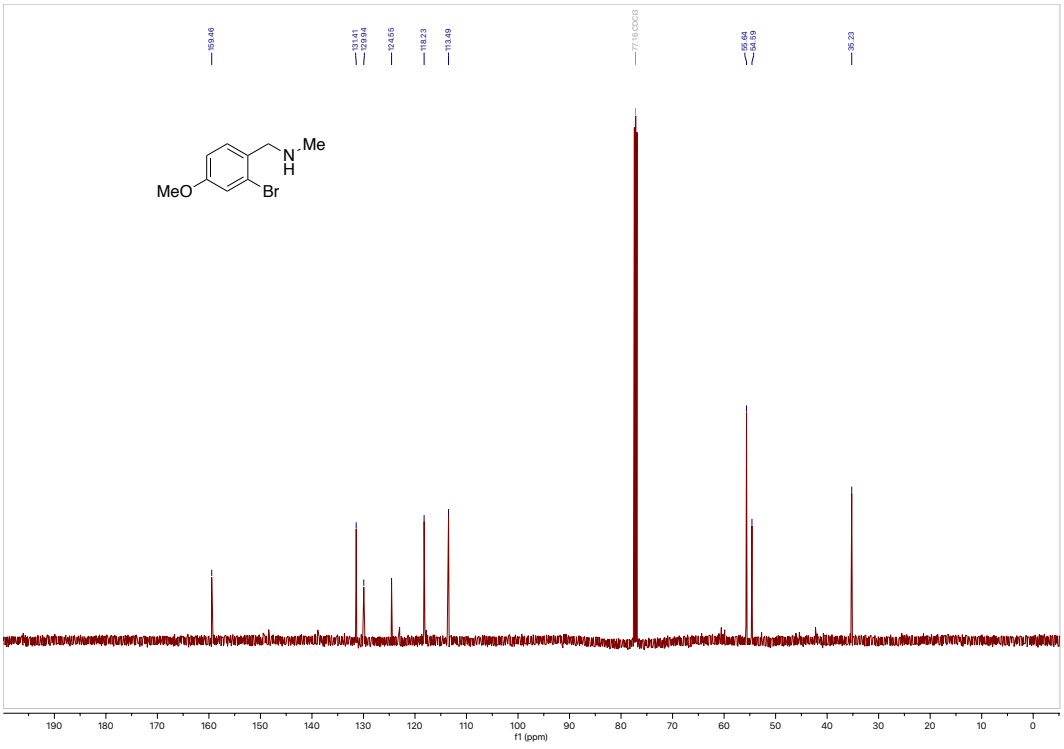


Figure S159. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S11.**

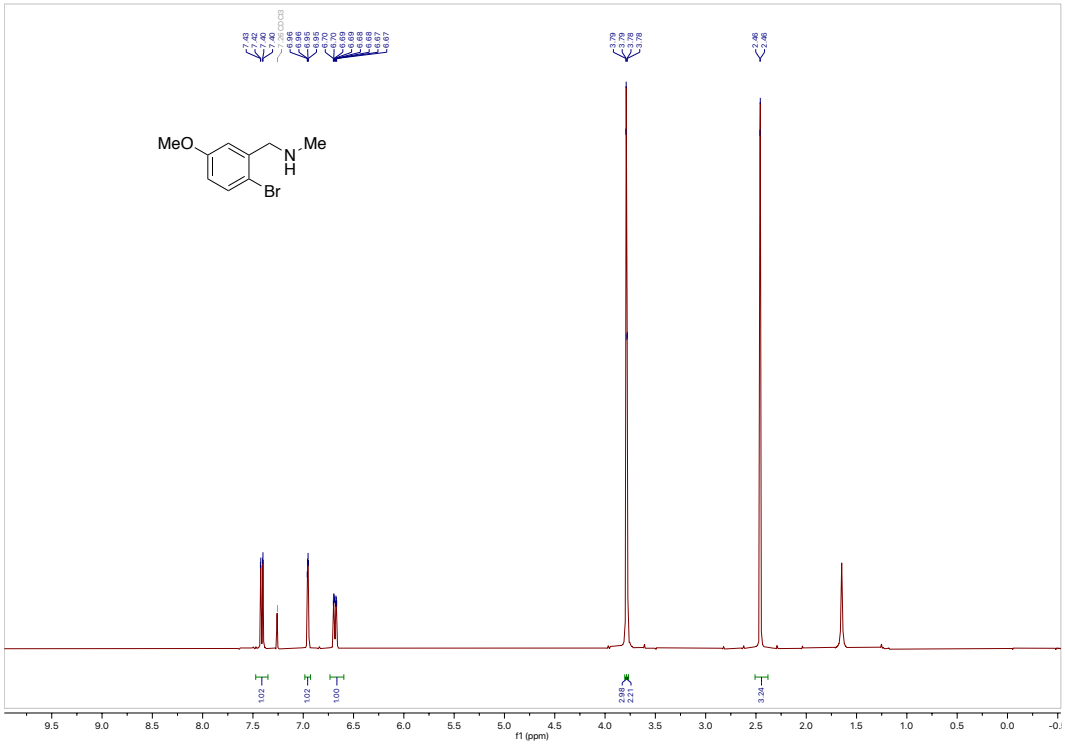


Figure S160. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S12.**

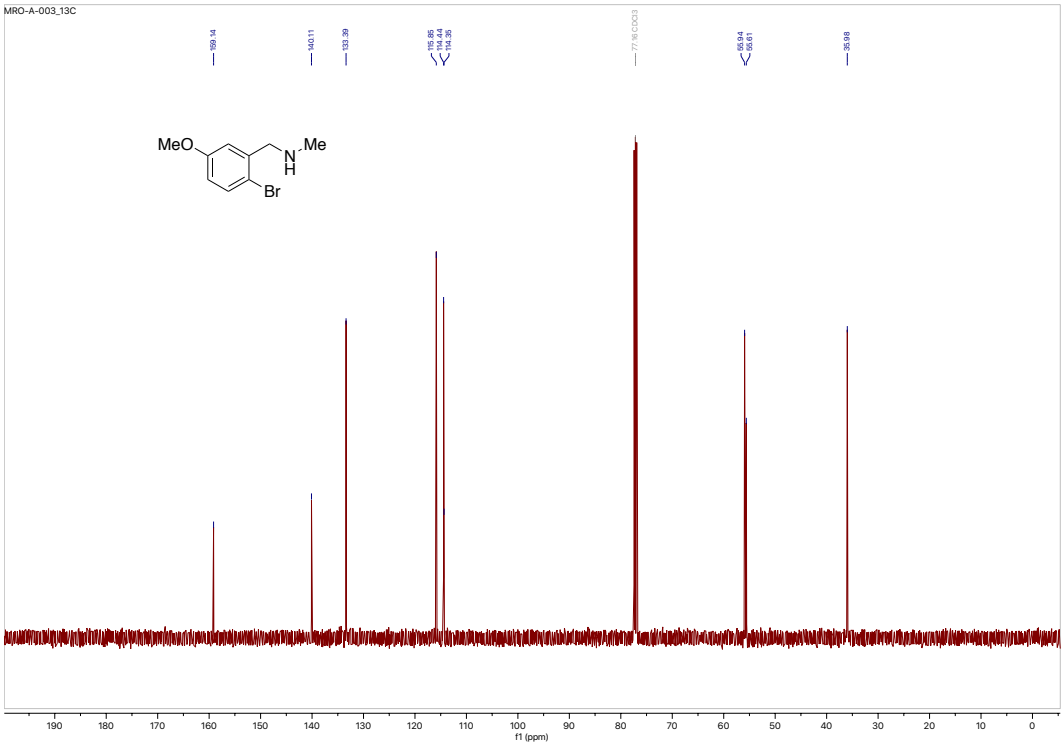


Figure S161. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S12.**

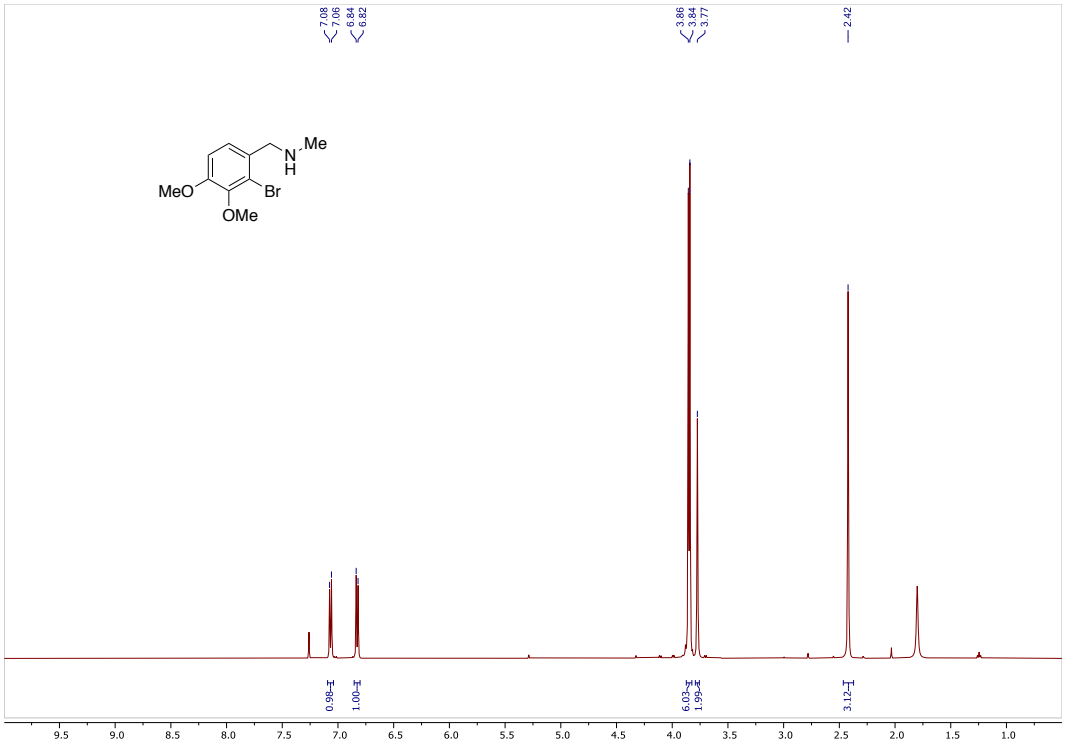


Figure S162. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S13.**

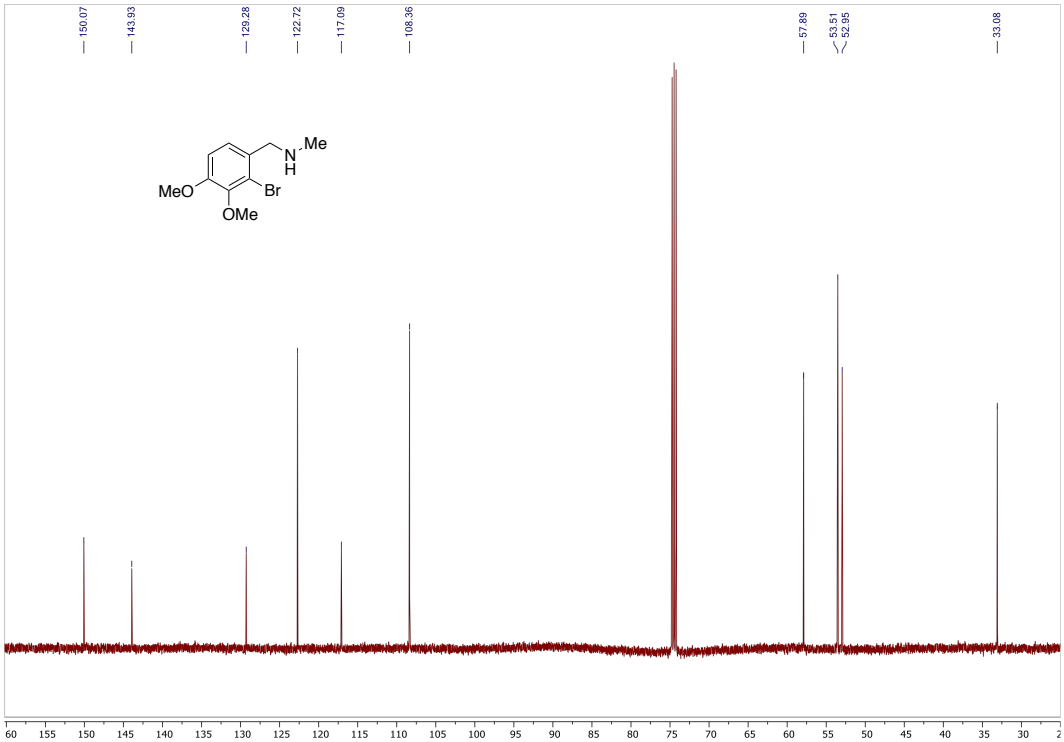


Figure S163. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S13.**

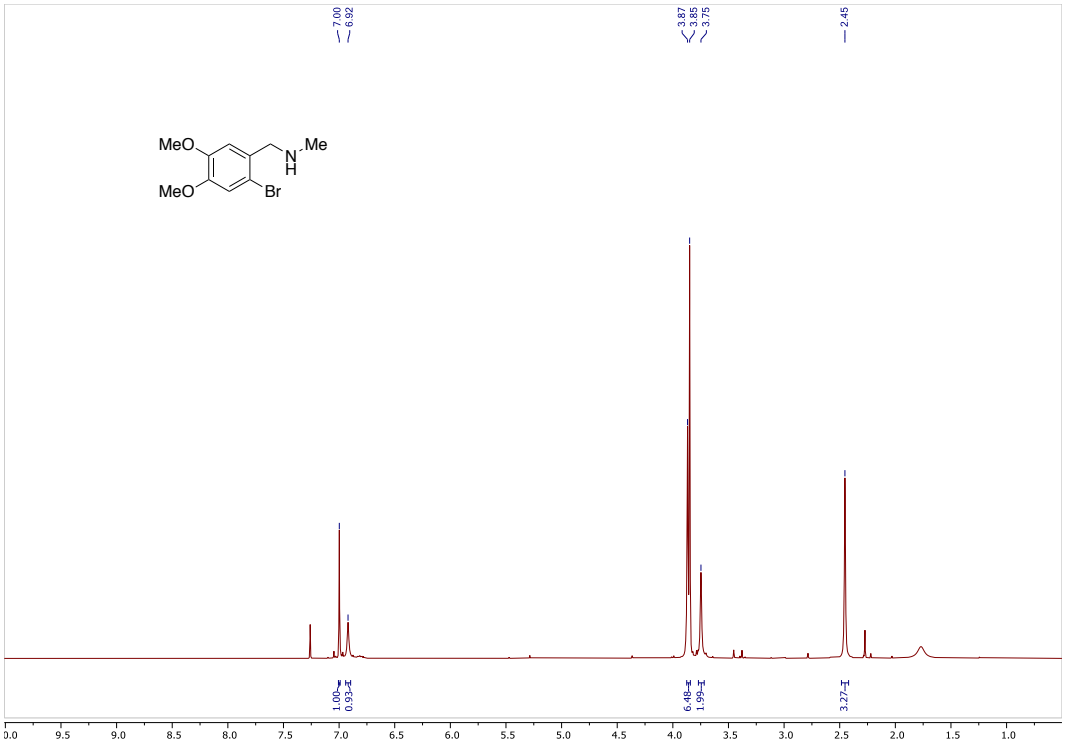


Figure S164. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S14.**

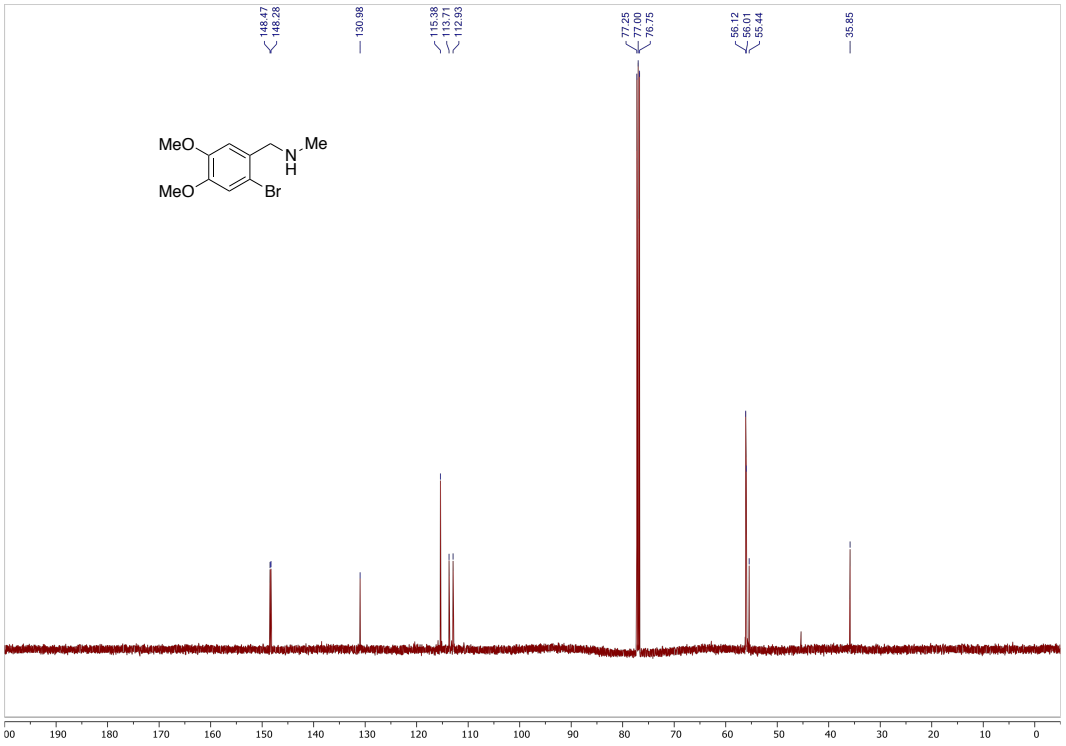


Figure S165. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S14.**

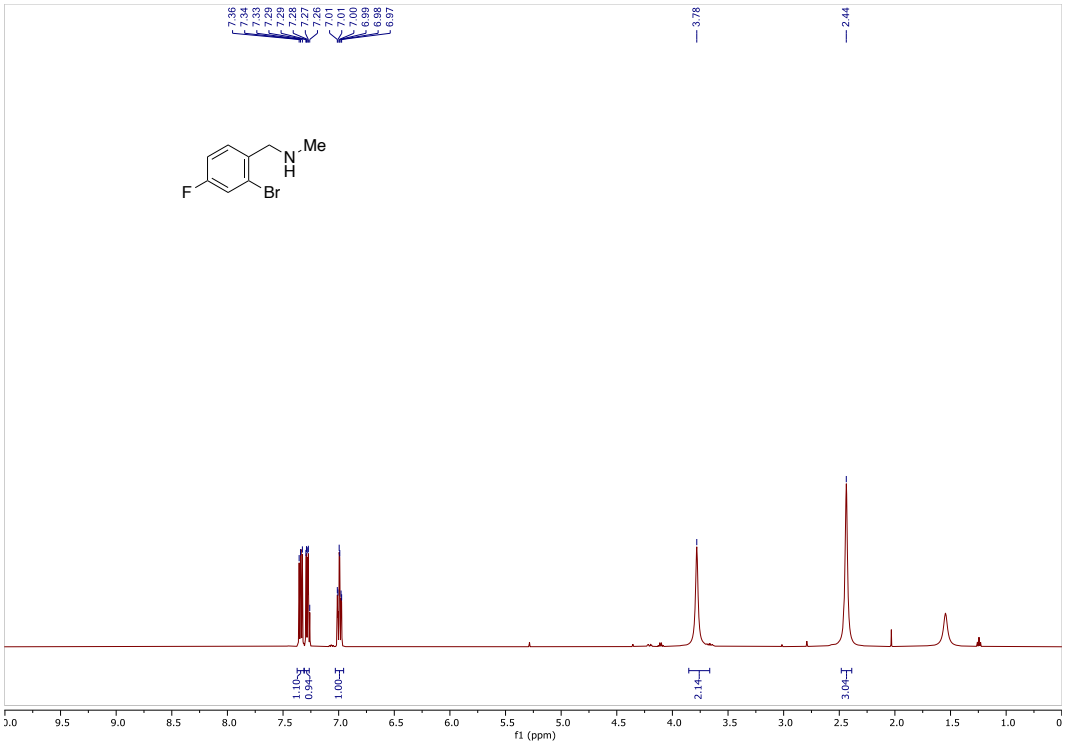


Figure S166. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S15.**

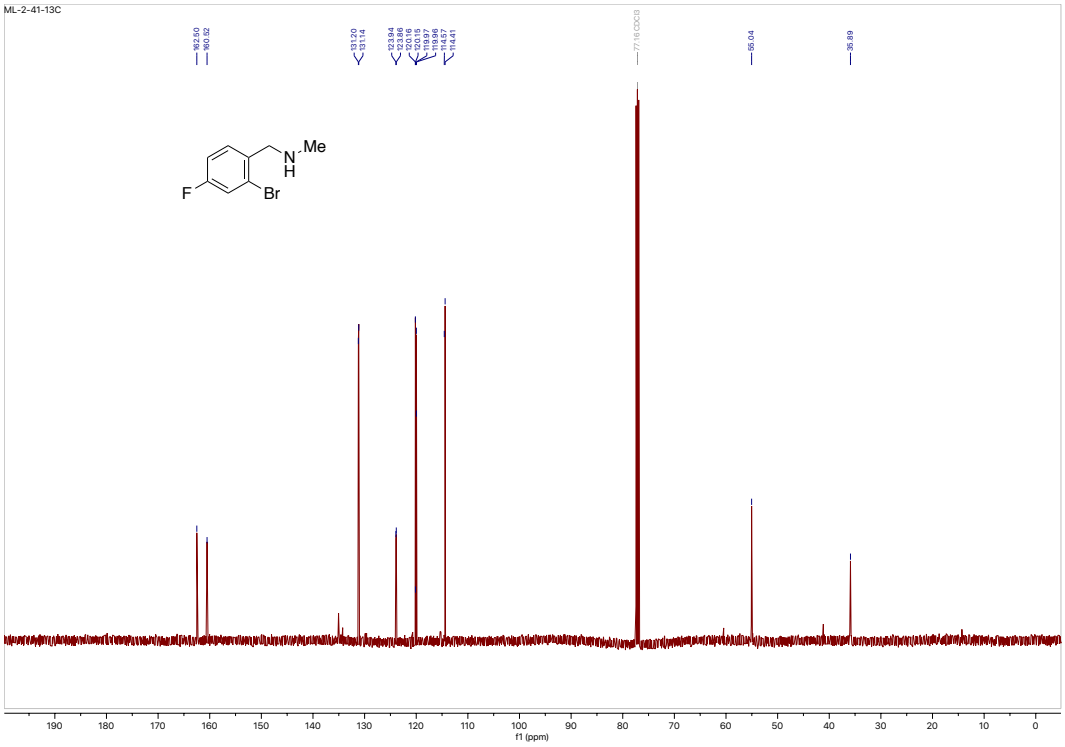


Figure S167. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S15.**

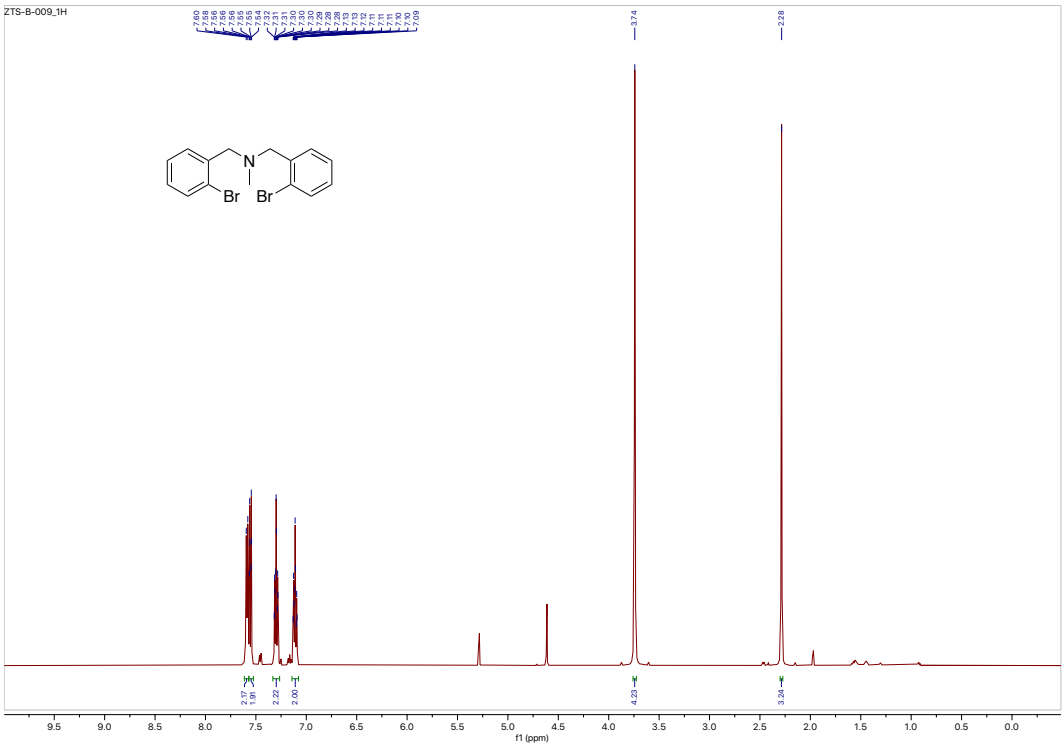


Figure S168. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S16.**

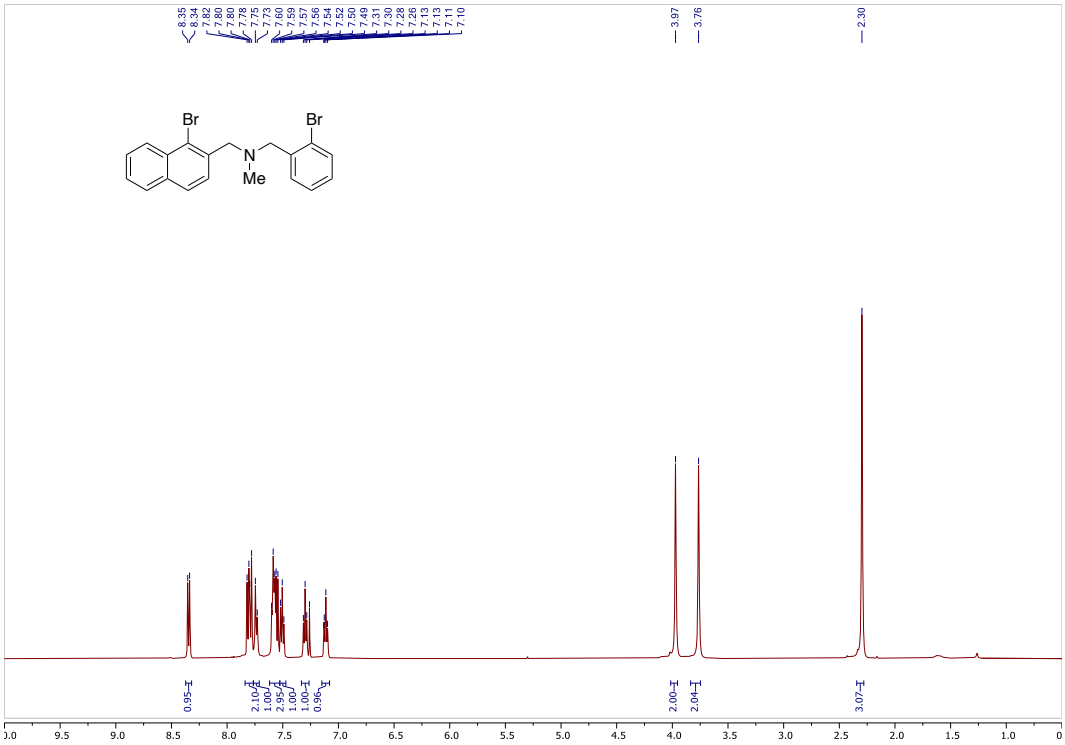


Figure S169. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S17.**

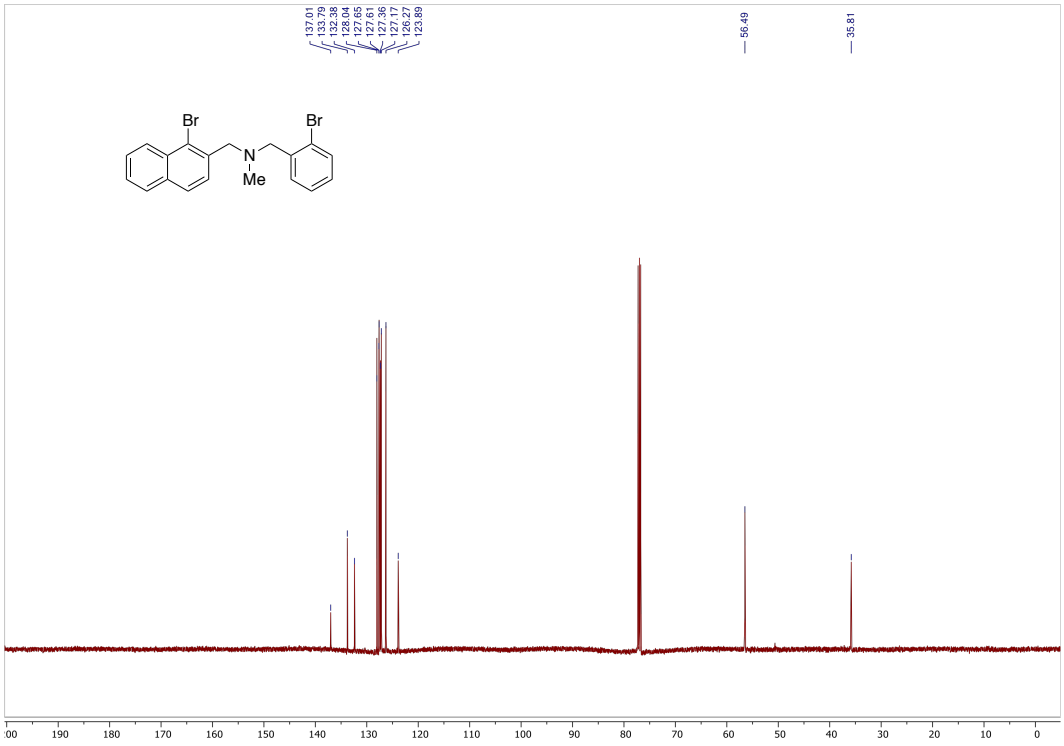


Figure S170. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S17.**

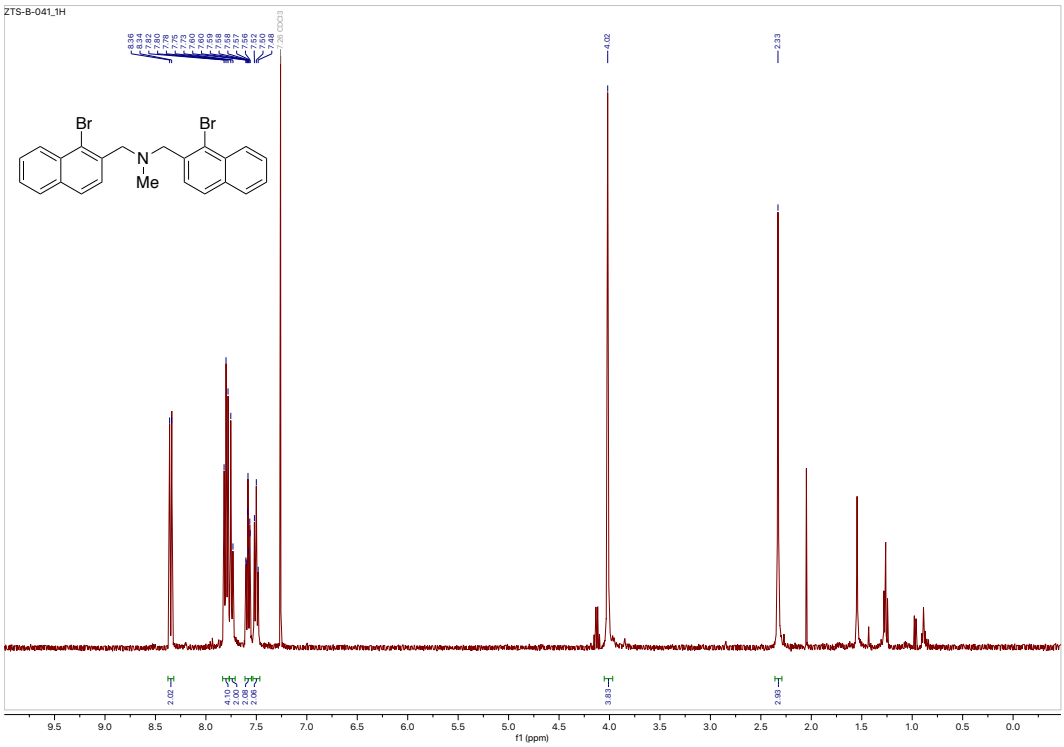


Figure S171. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S18.**

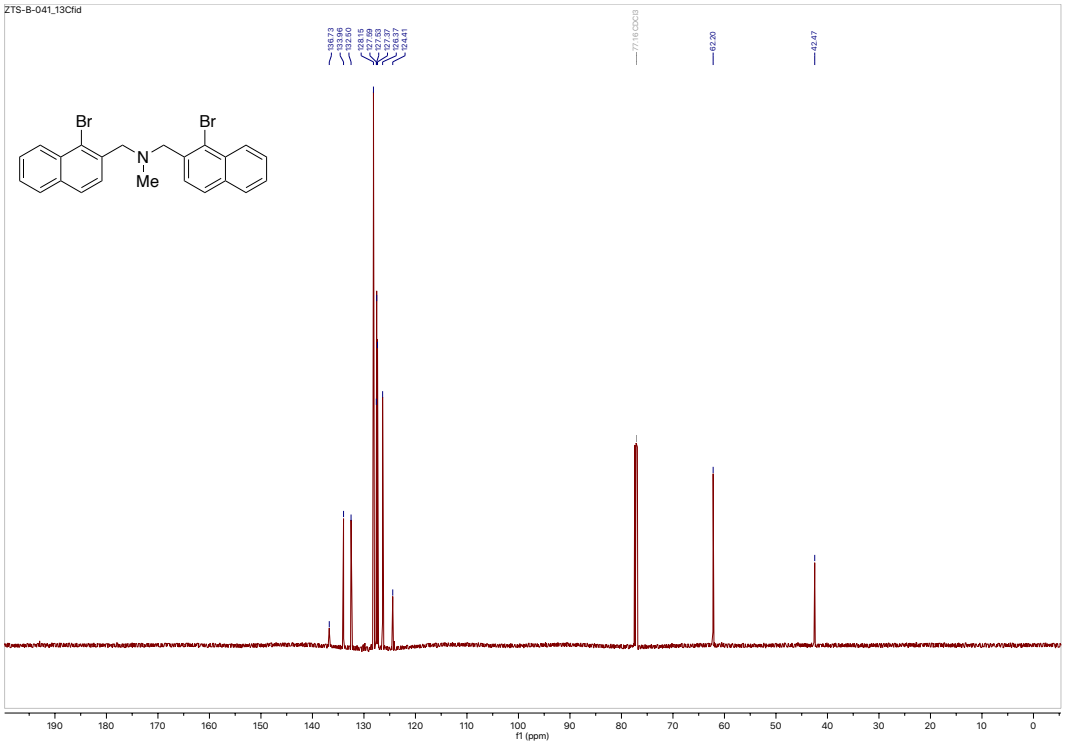


Figure S172. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S18.**

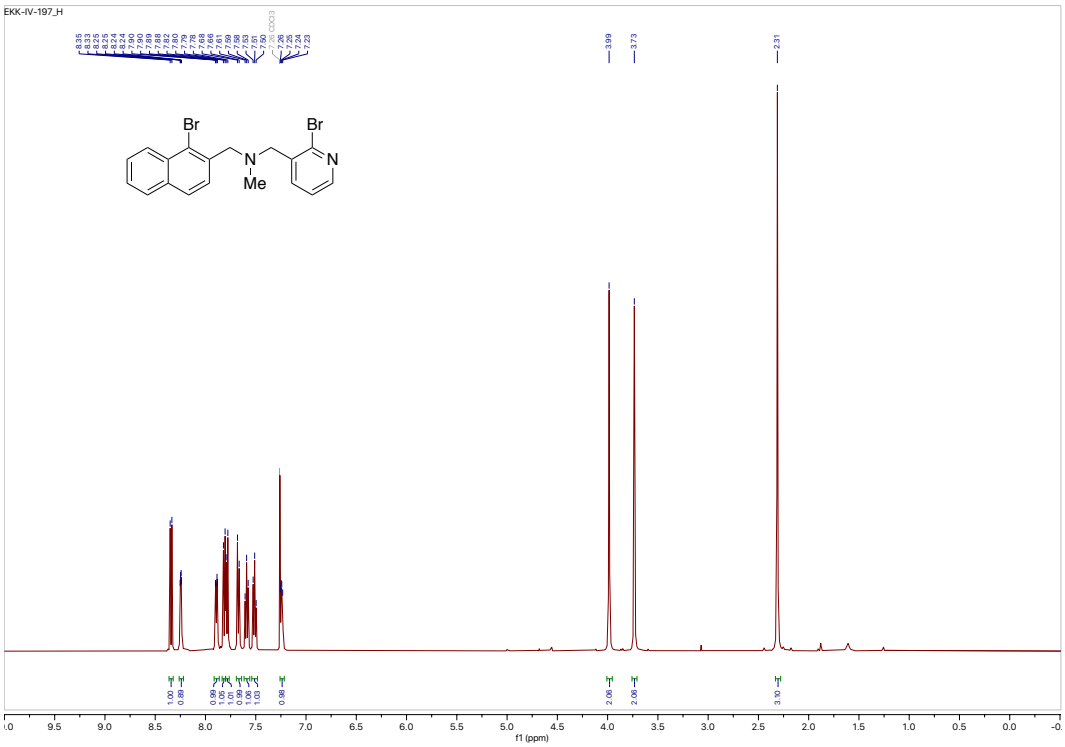


Figure S173. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S19.**

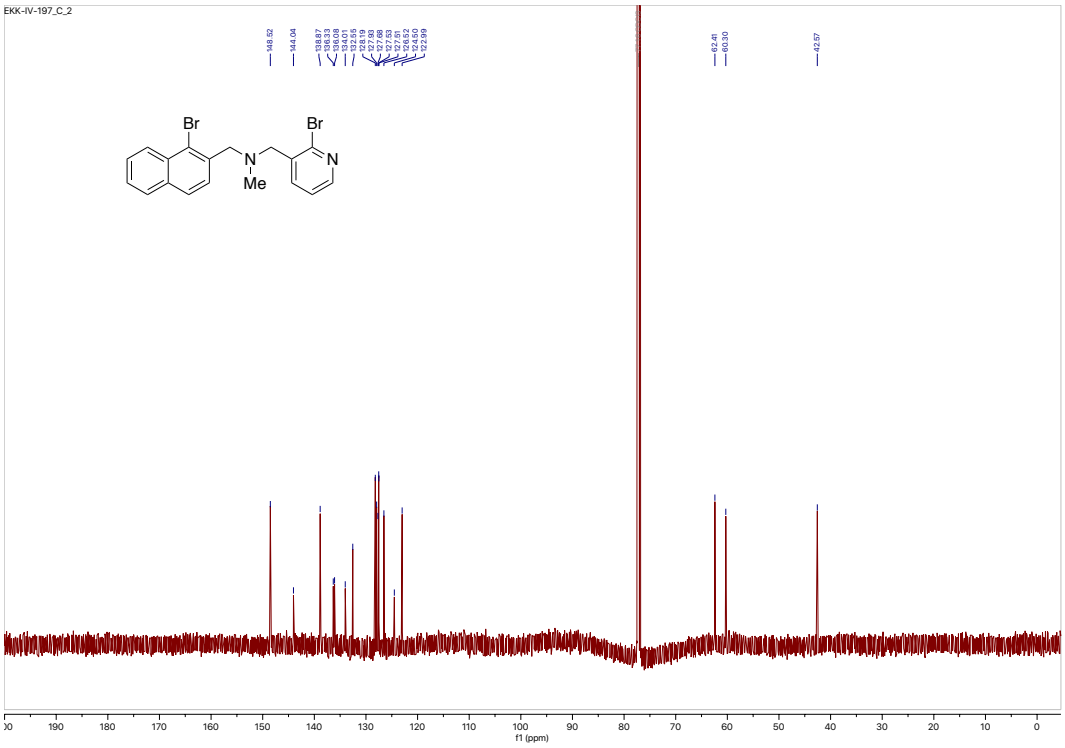


Figure S174. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S19.**

*EtOAc

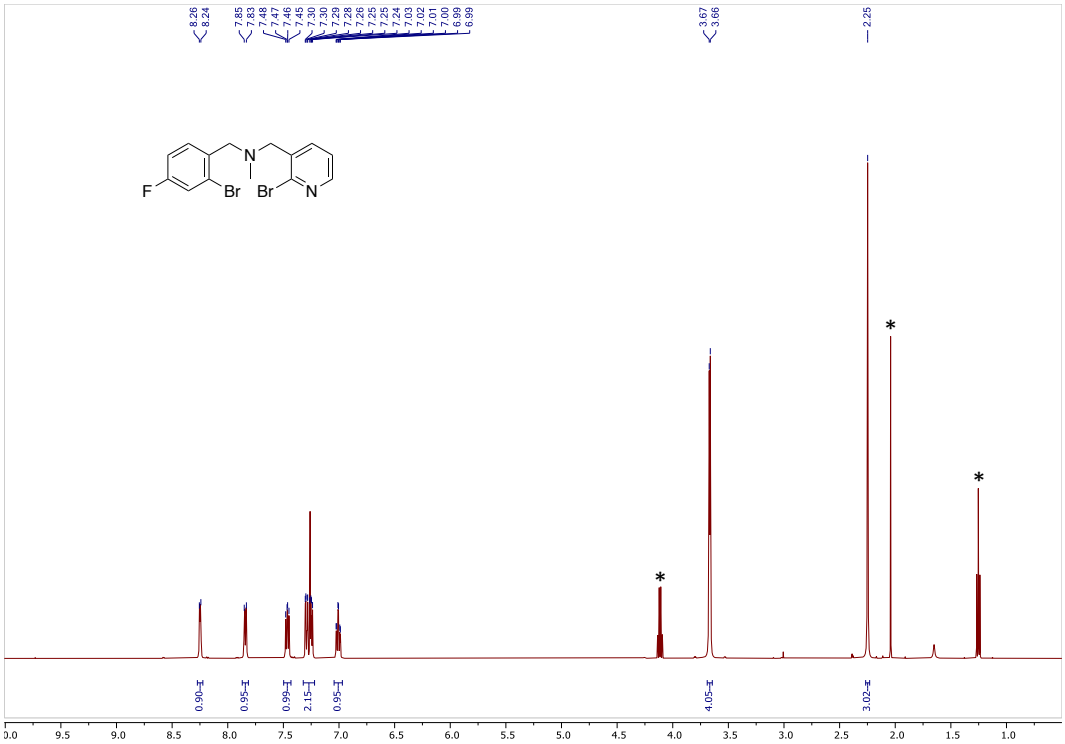


Figure S175. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S20.**

*EtOAc

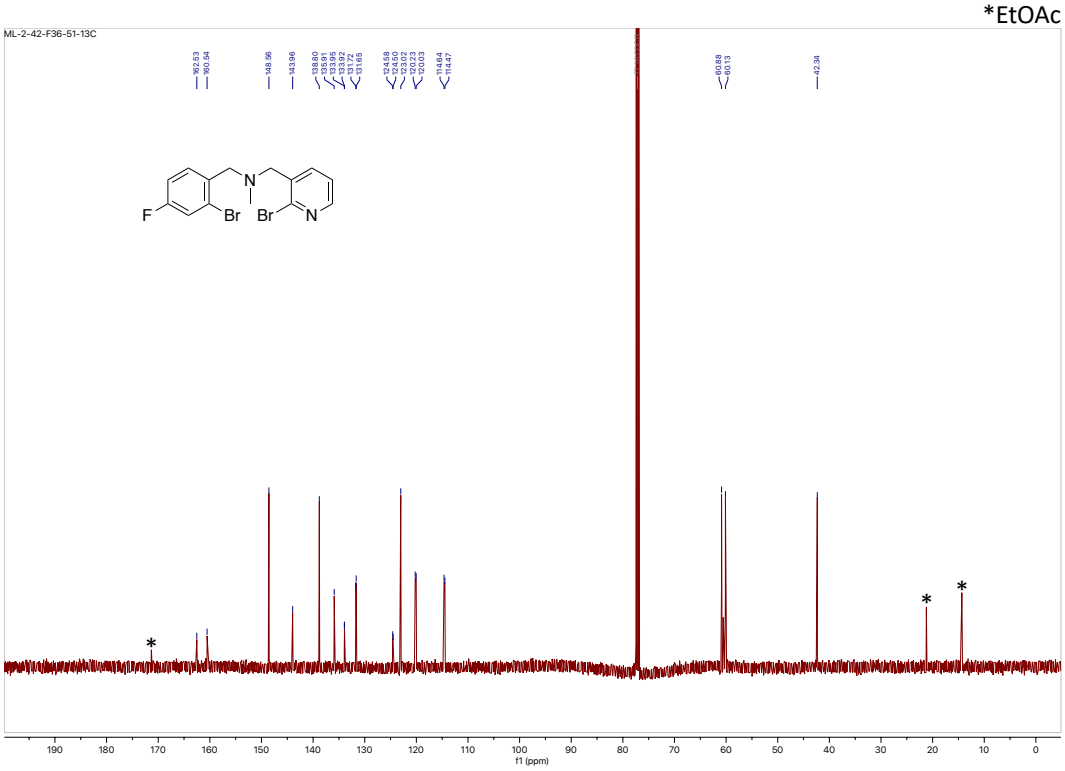


Figure S176. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S20.**

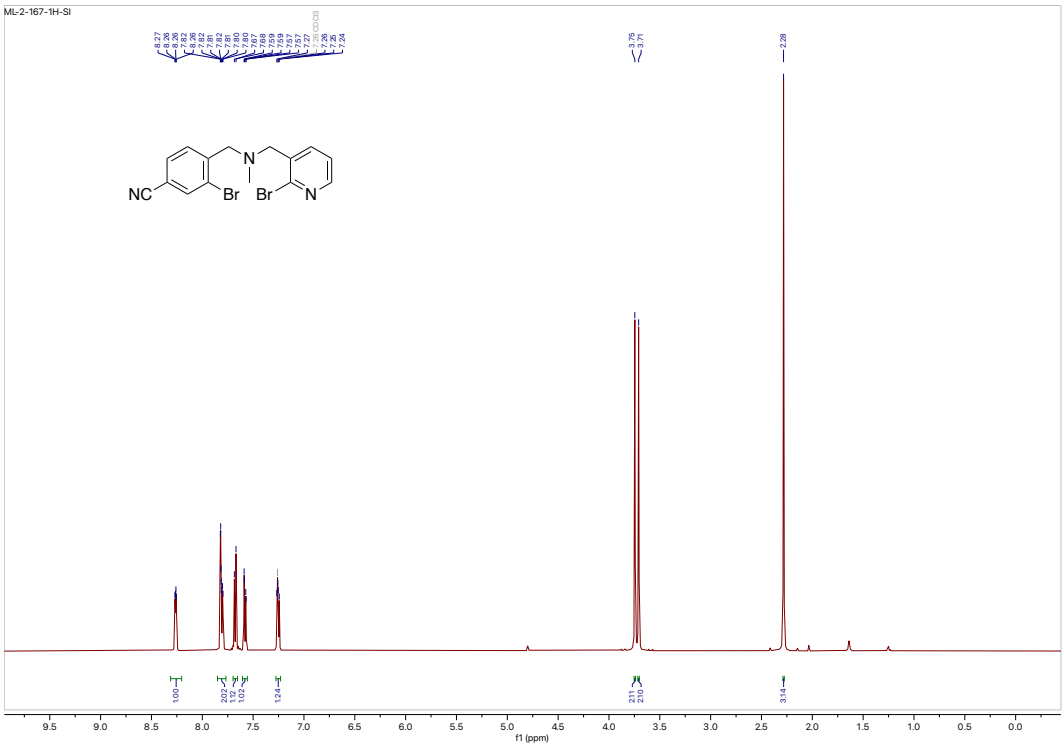


Figure S177. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S21.**

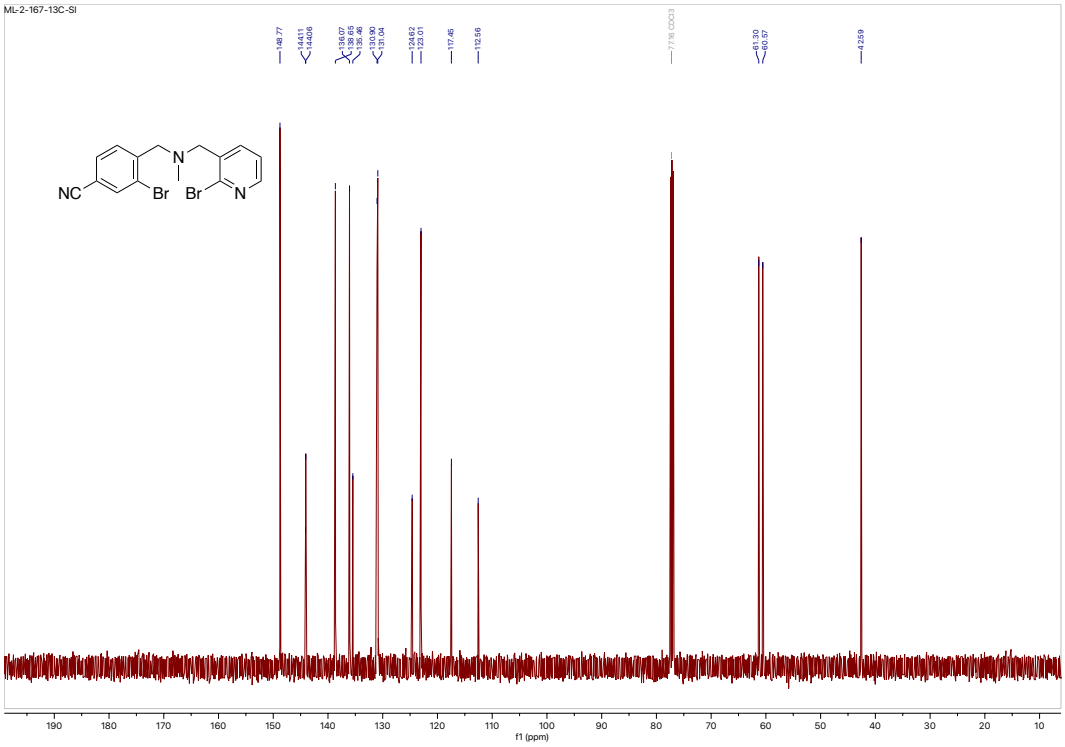


Figure S178. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S21.**

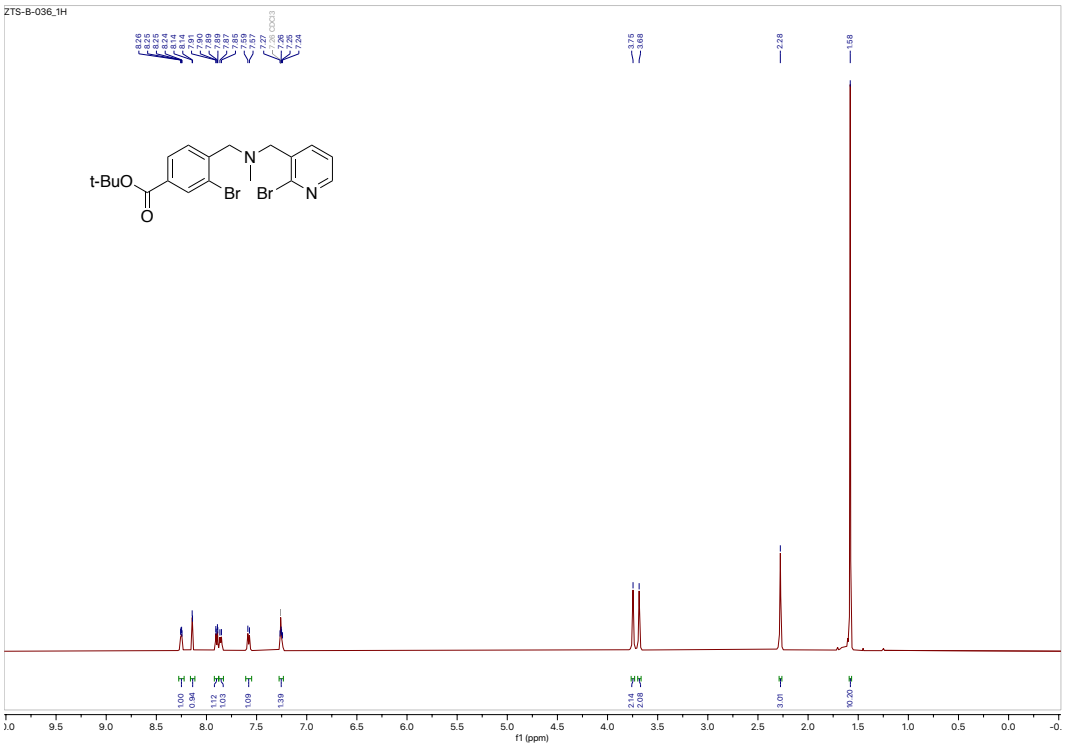


Figure S179. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S22.**

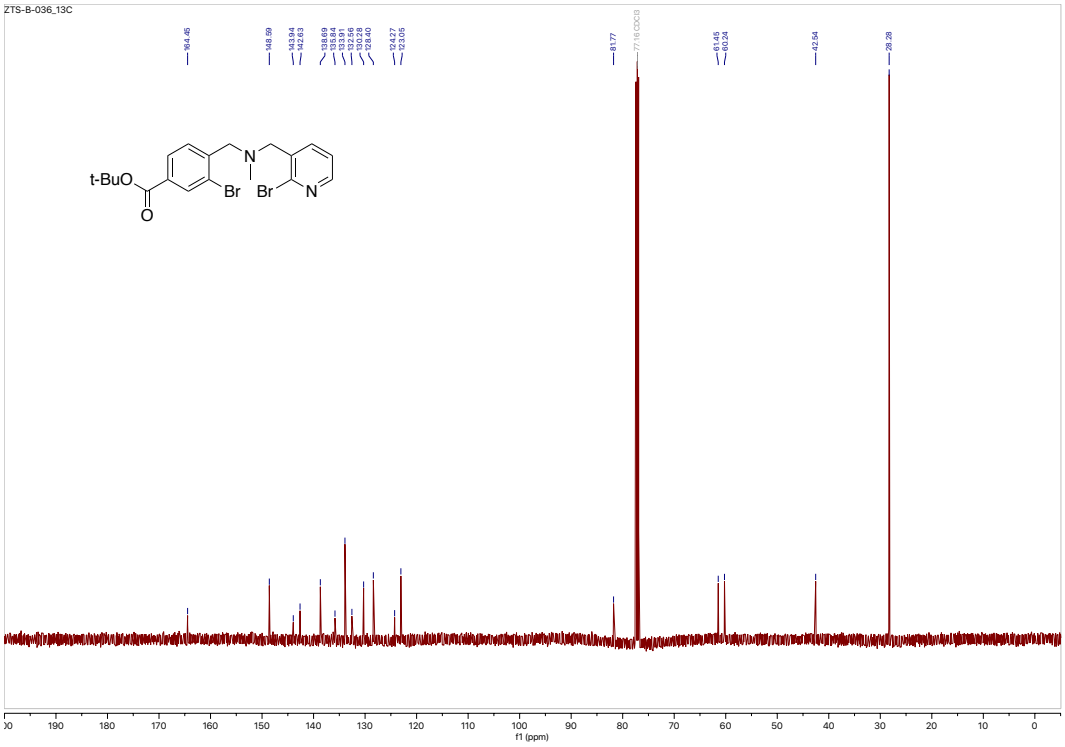


Figure S180. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S22.**

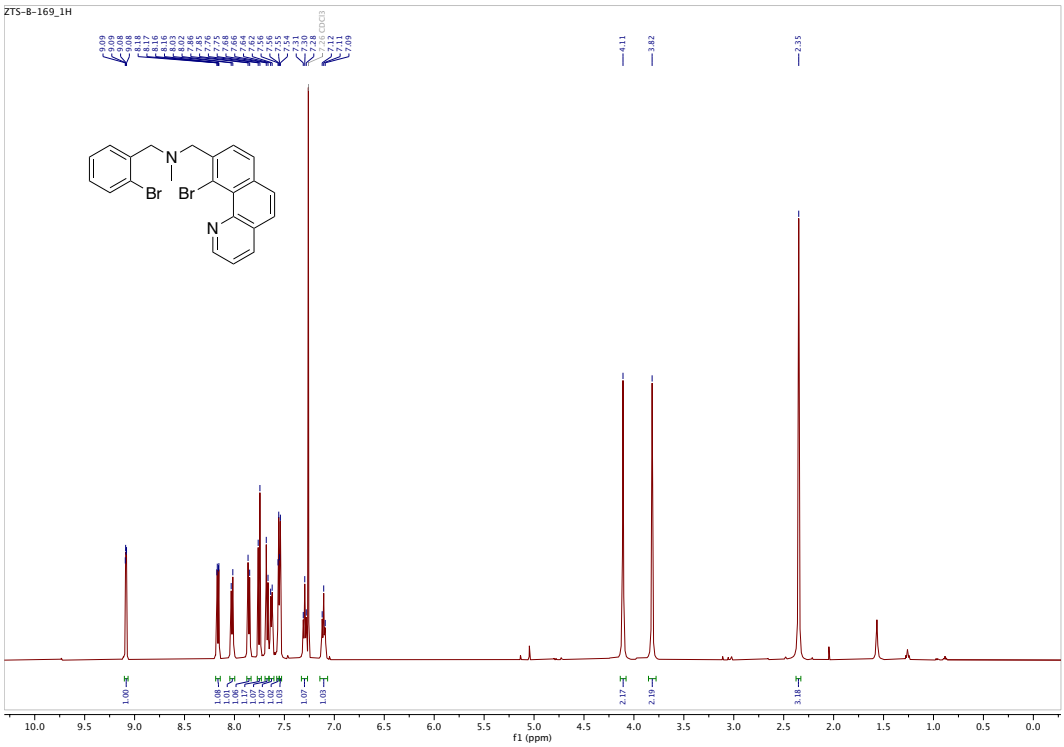


Figure S181. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S23.**

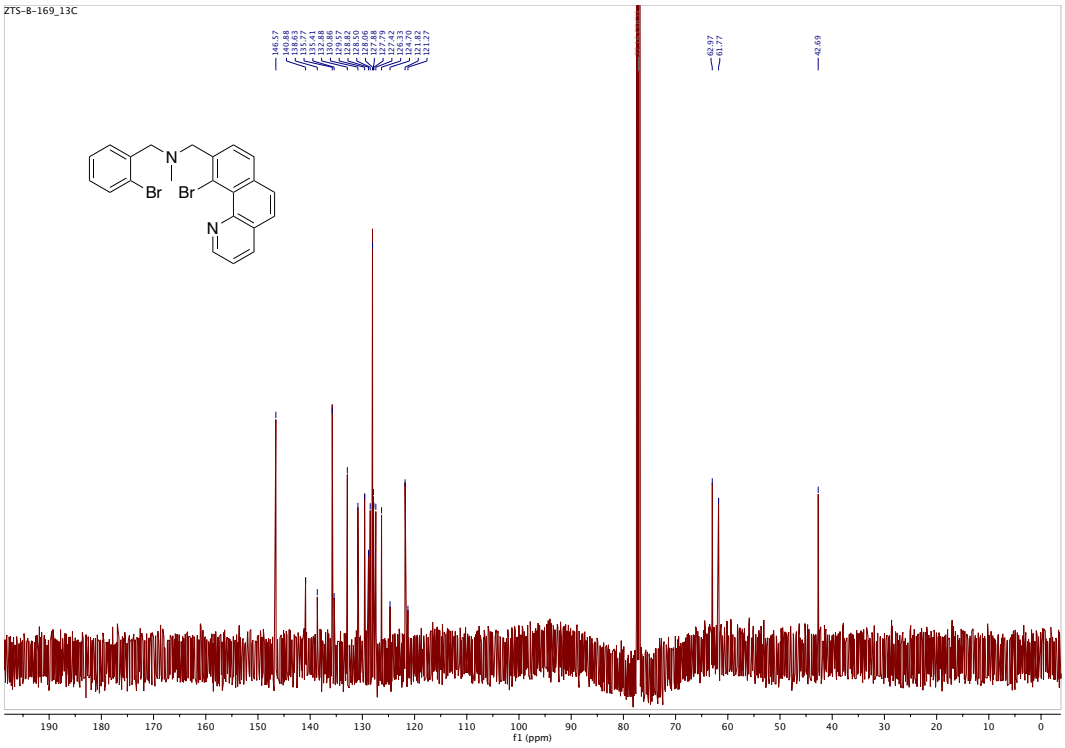


Figure S182. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S23.**

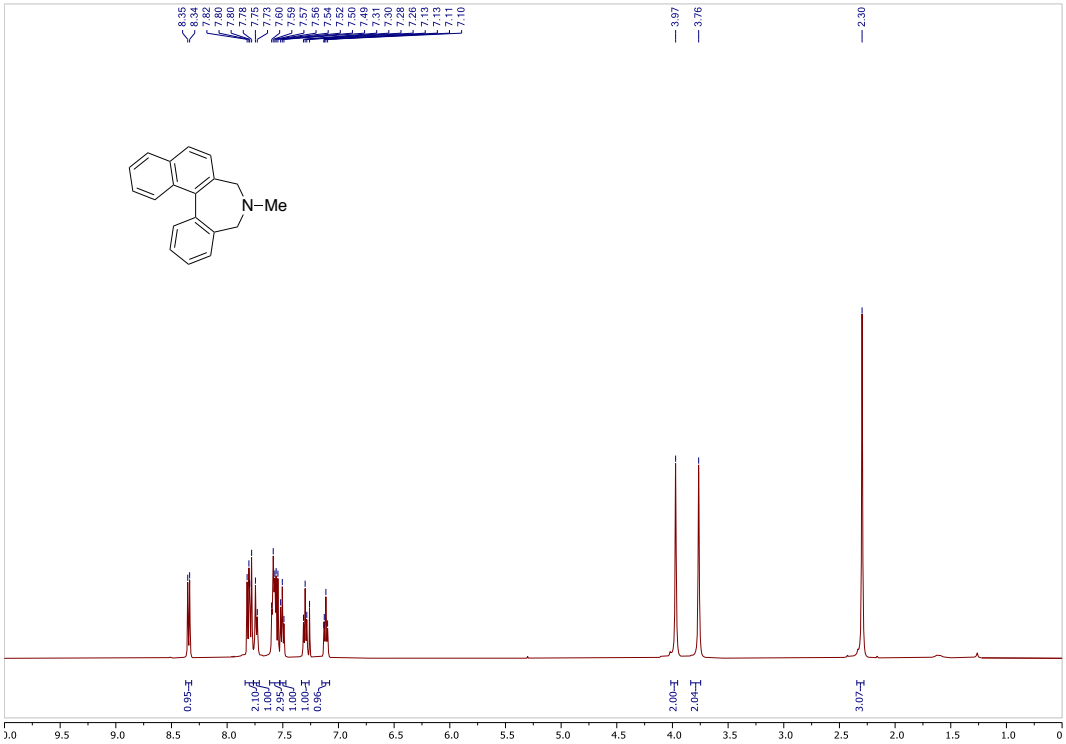


Figure S183. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S24.**

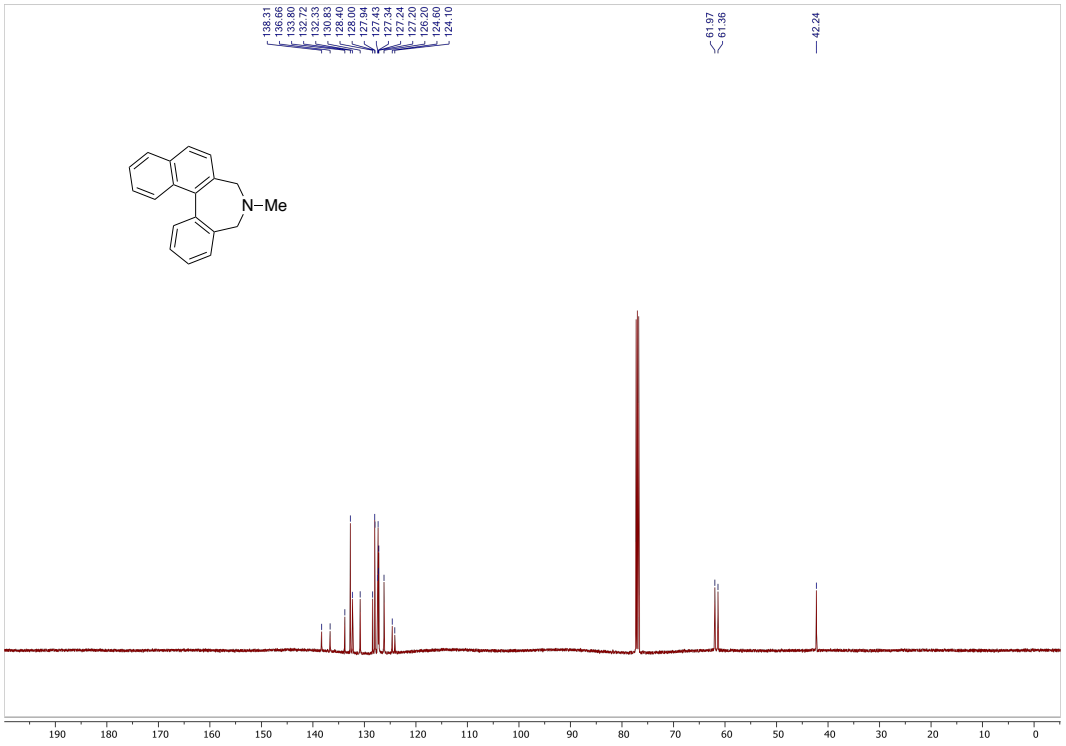


Figure S184. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S24.**

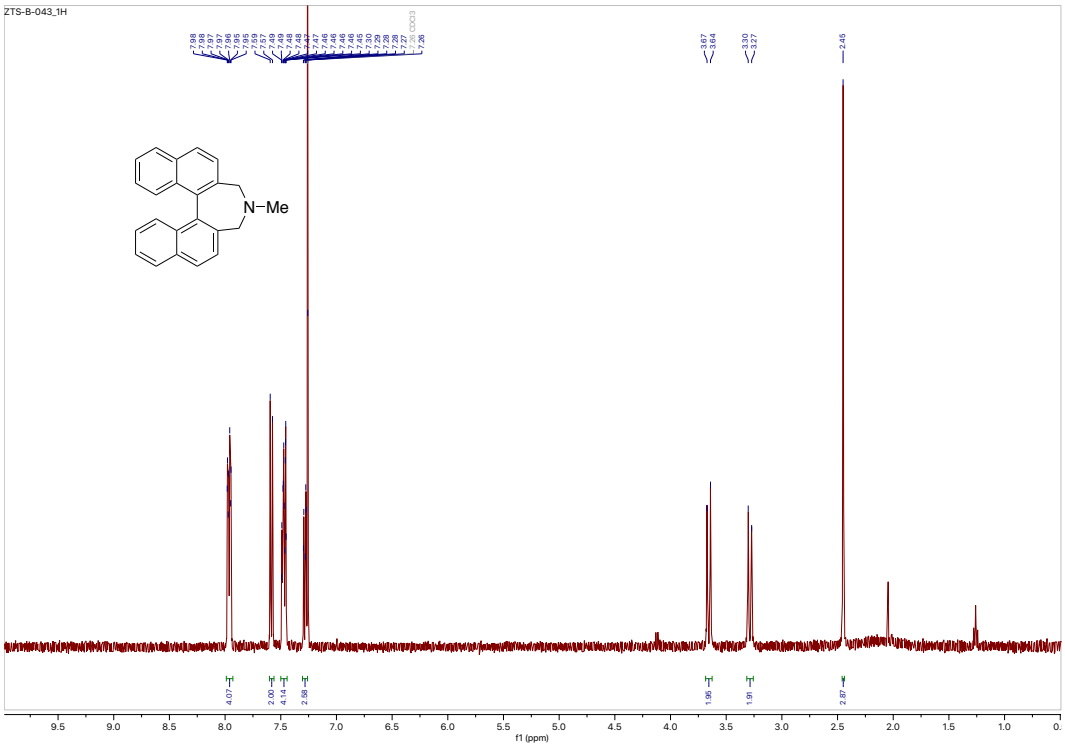


Figure S185. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S25.**

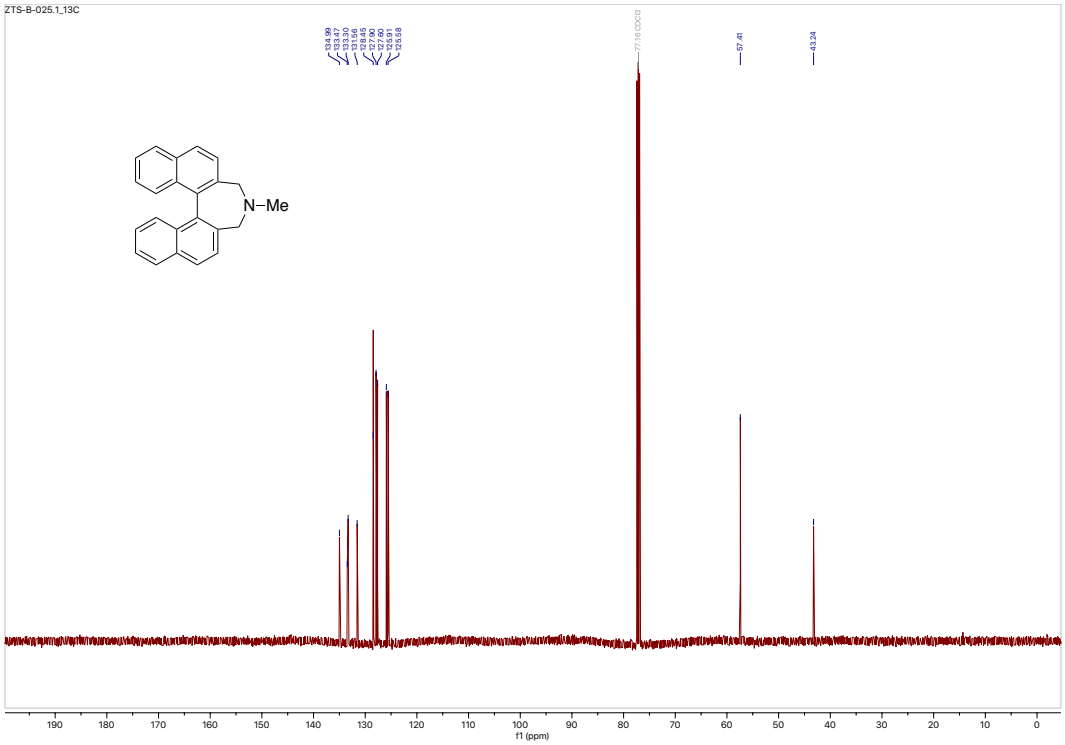


Figure S186. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S25.**

*EtOAc

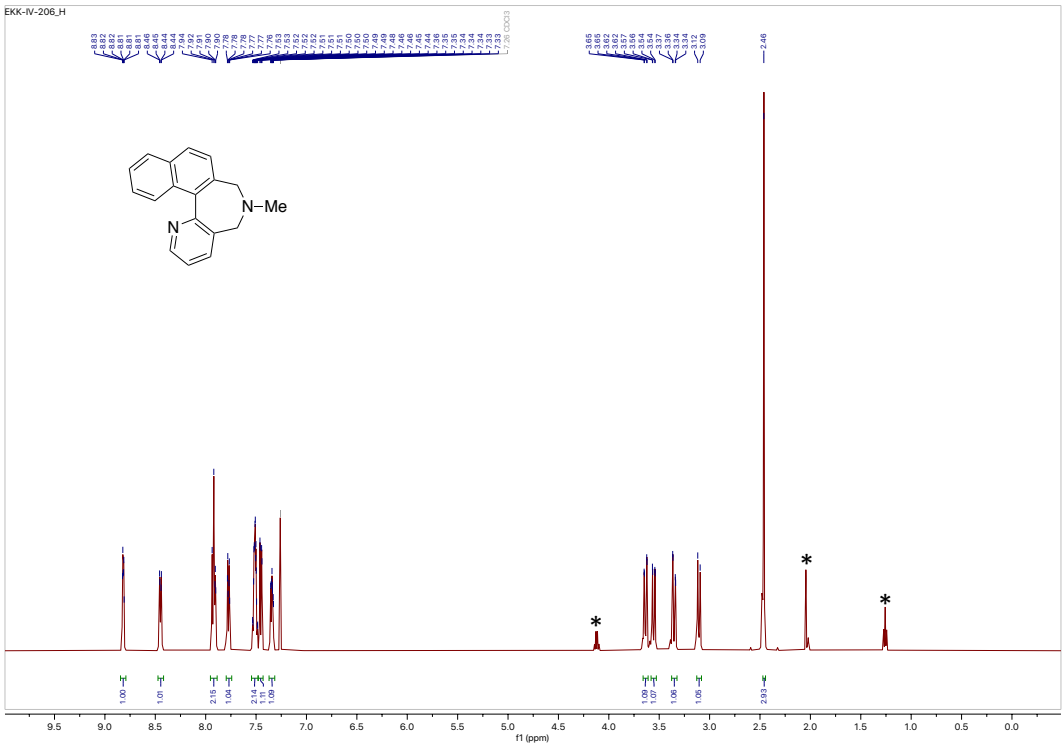


Figure S187. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S26.**

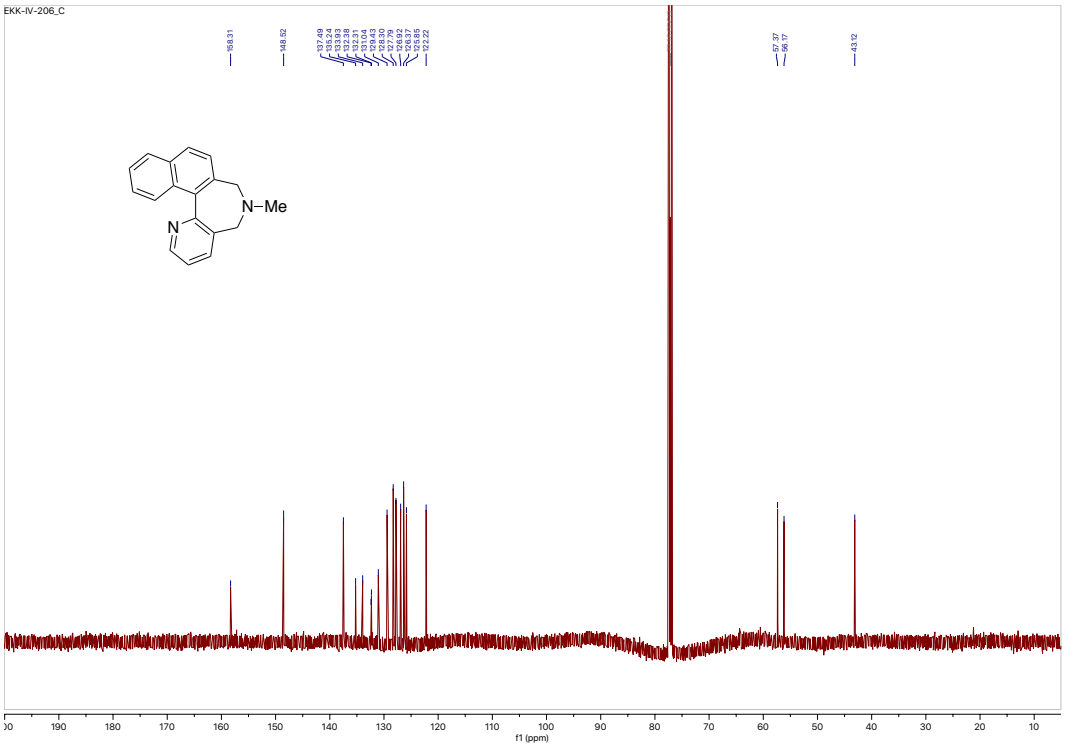


Figure S188. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S26.**

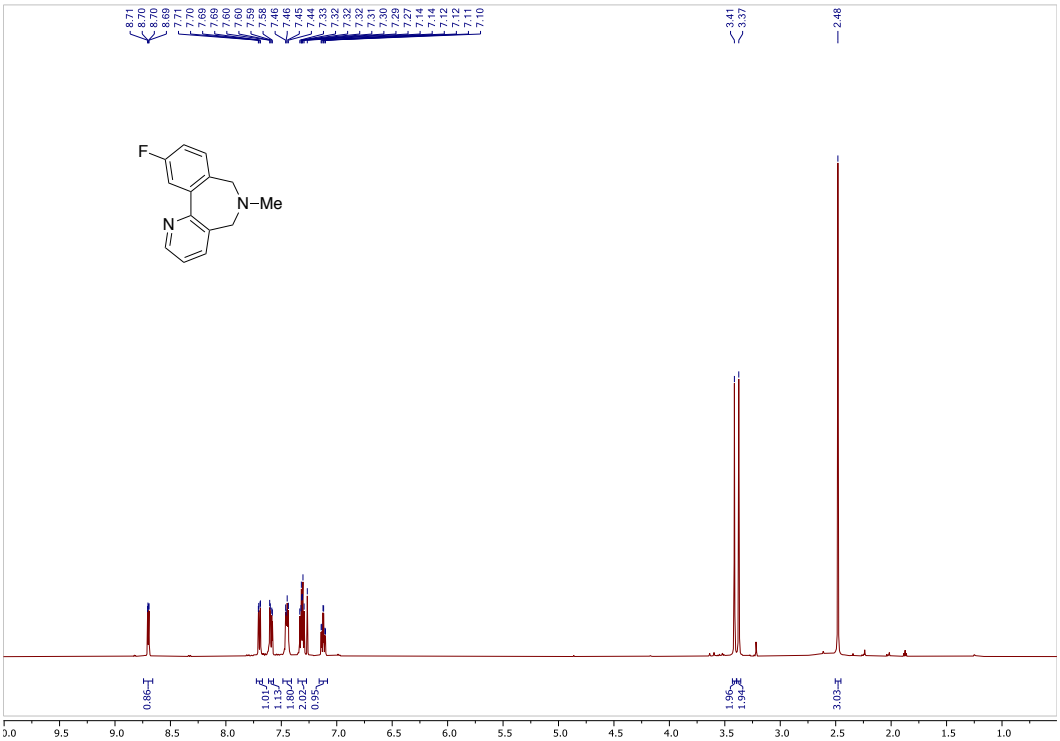


Figure S189. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S27.**

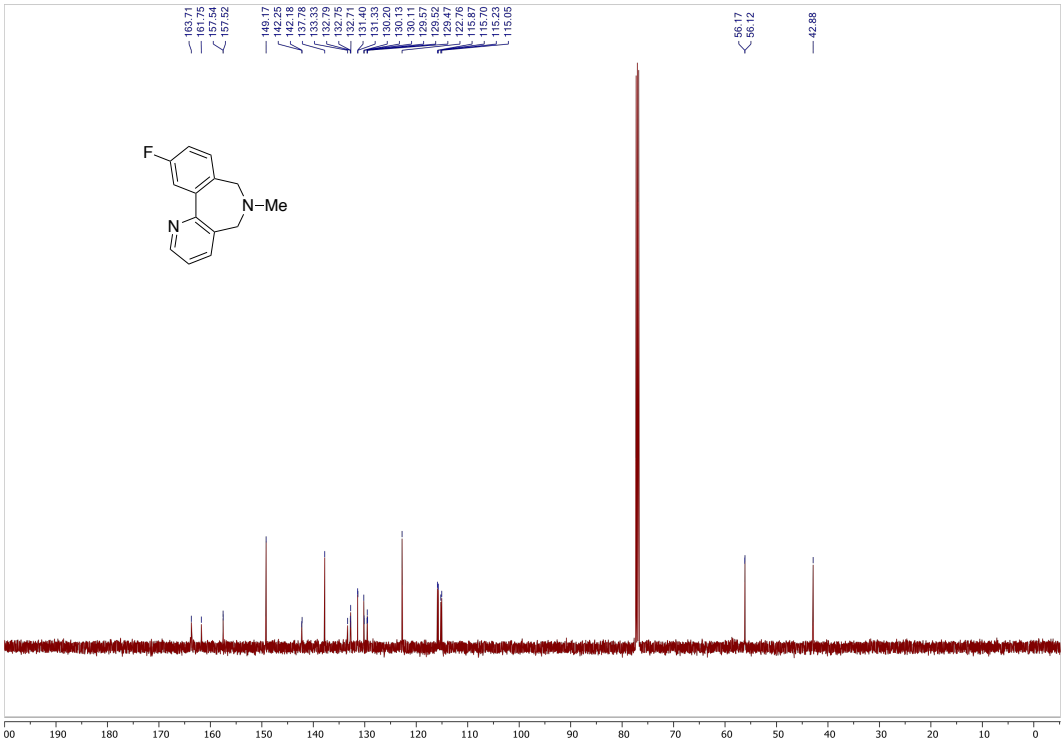


Figure S190. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S27.**

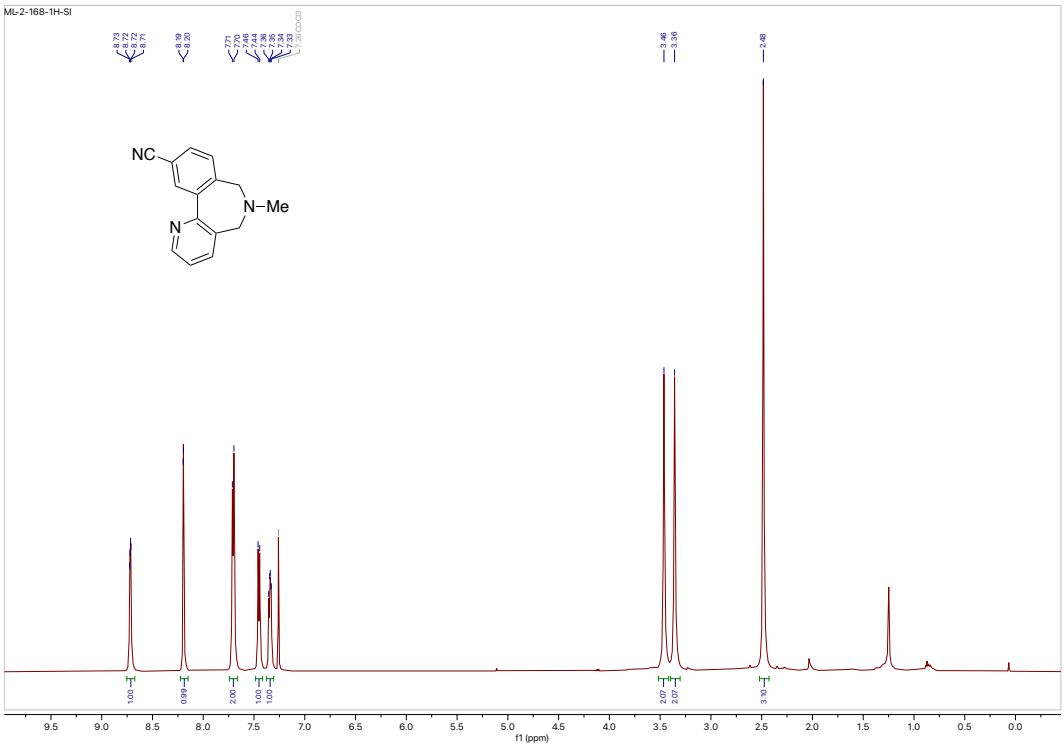


Figure S191. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S28.**

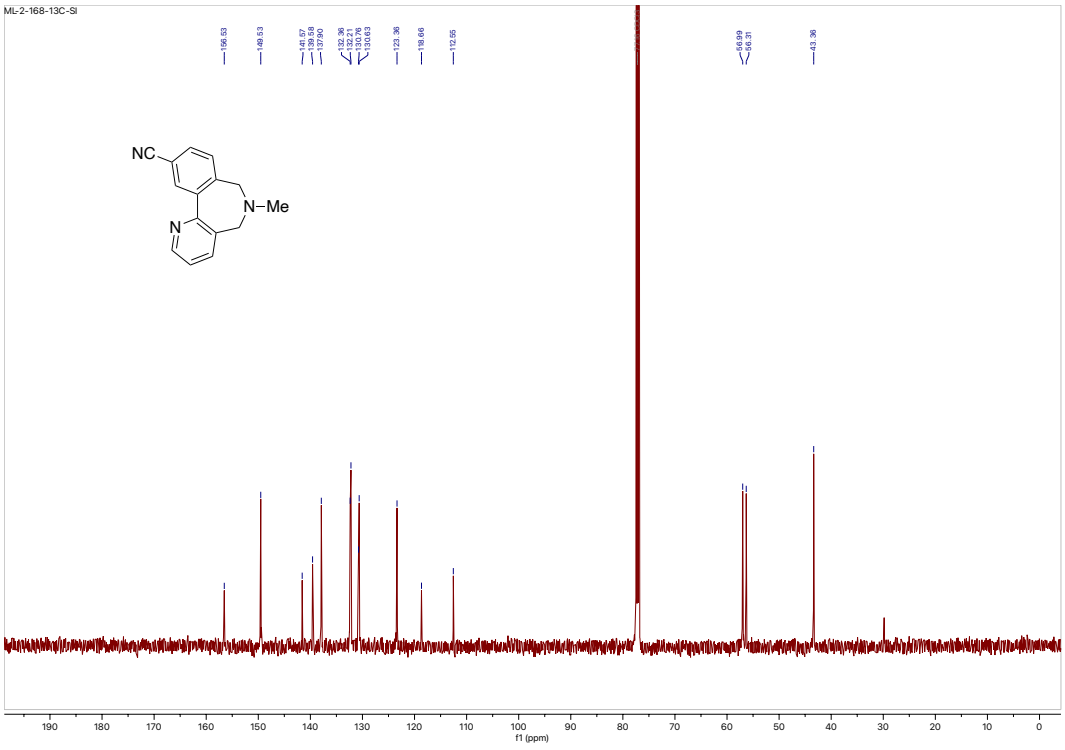


Figure S192. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S28.**

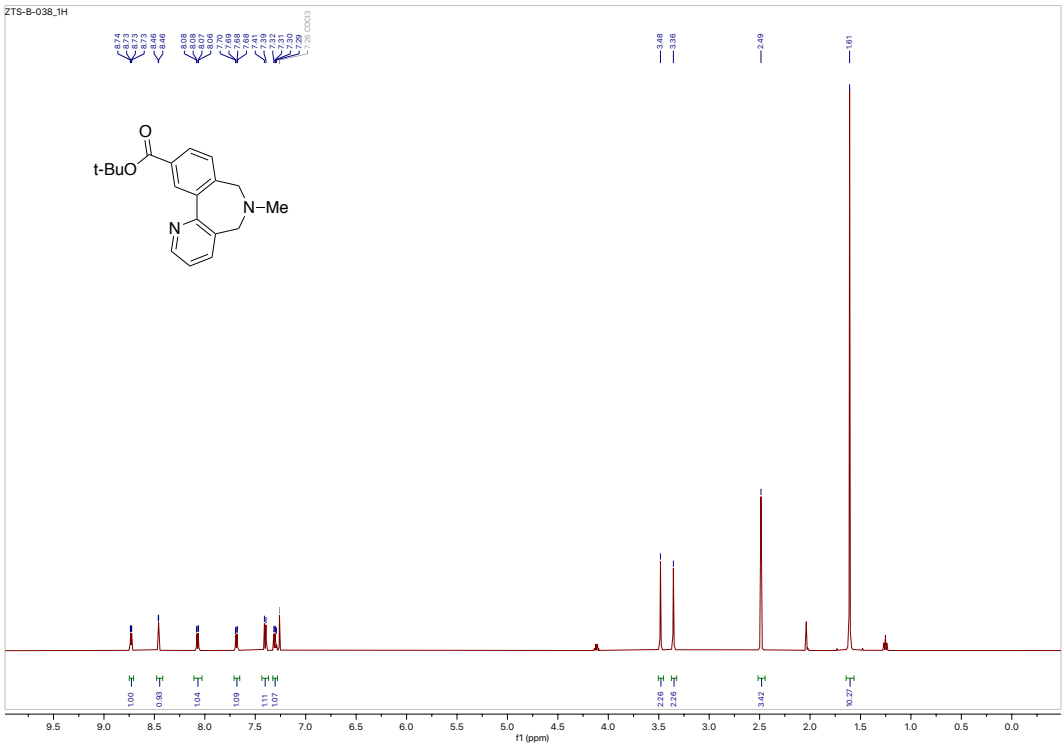


Figure S193. ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **S28.**

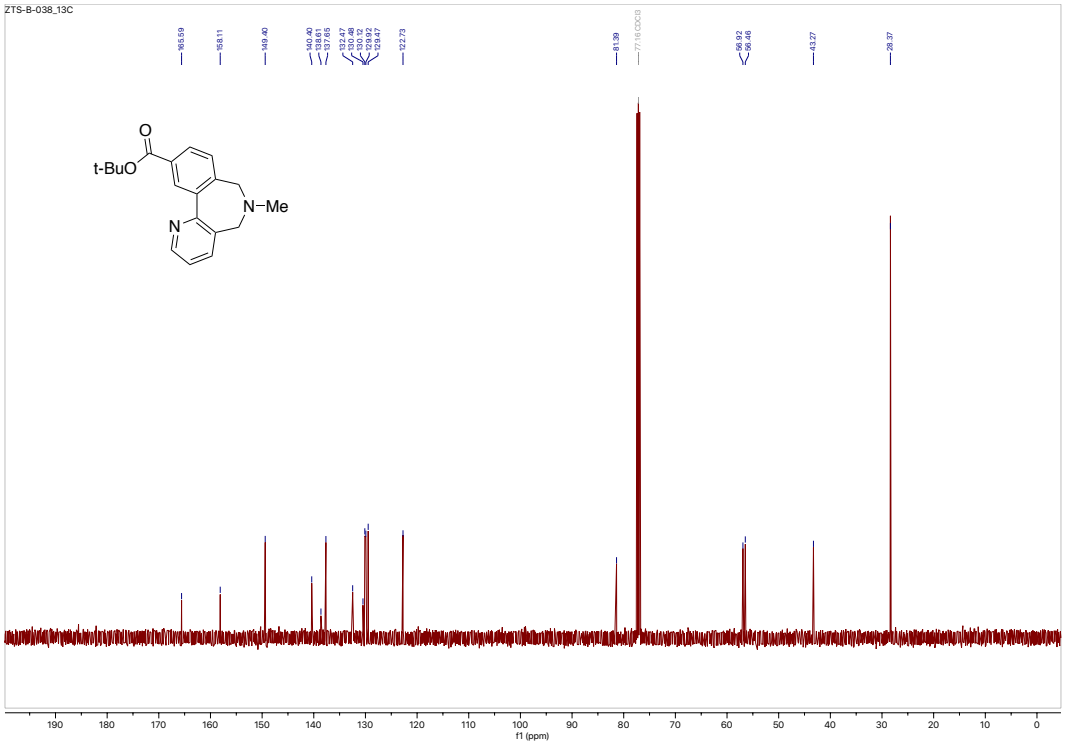


Figure S194. ^{13}C NMR (126 MHz, $CDCl_3$) spectrum of compound **S29.**