Supporting Information

Rhodium-Catalyzed C–H Activation of 3-(Indolin-1-yl)-3-oxopropanenitriles with Diazo Compounds and Tandem Cyclization Leading to Hydrogenated Azepino[3,2,1-*hi*]indoles

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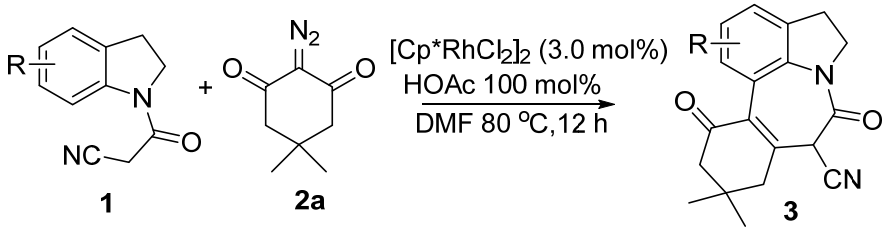
Experimental Section:

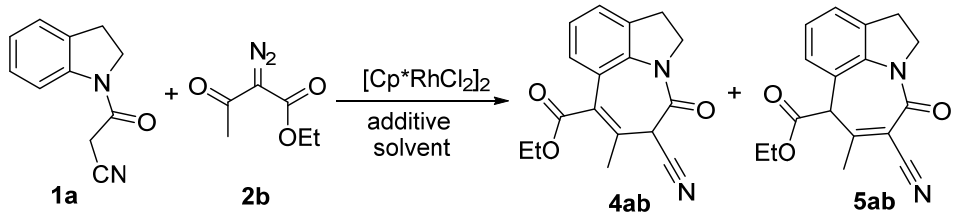
General Considerations. All reactions were carried out under argon atmosphere using standard Schlenk technique. ^{1}H NMR (400 MHz), ^{19}F (376 MHz), and ^{13}C NMR (100MHz) were recorded on Bruker AV400 NMR spectrometer with $CDCl_3$ as solvent. Chemical shifts of ^{1}H, ^{19}F, and ^{13}C NMR spectra are reported in parts per million (ppm). The residual solvent signals were used as references and the chemical shifts converted to the TMS scale ($CDCl_3$: δ_H = 7.26 ppm, δ_C = 77.00 ppm). All coupling constants (*J* values) were reported in Hertz (Hz). Multiplicities are reported as follows: singlet (s), doublet (d), doublet of doublets (dd), triplet (t), quartet (q), and multiplet (m). Column chromatography was performed on silica gel 200–300 mesh. Analytical thin-layer chromatography (TLC) was performed on pre-coated, glass-backed silica gel plates. Visualization of the developed chromatogram was performed by UV absorbance (254 nm). IR spectra were recorded as KBr disks on a Nicolet 380 FT-IR spectrometer. High-resolution mass spectrometry (HRMS) were done on Varian 7.0 T FTICR-mass spectrometer. $[Cp^*RhCl_2]_2$ was prepared from $RhCl_3.xH_2O$ following a literature procedure.[1] The substrates **1a-1l** was prepared according to the literature we reported before.[2] Unless otherwise noted below, all other compounds have been reported in the literature or are commercially available from Alfa Aesar China (Tianjin) Chemical Co., Ltd. without any further purification.

General Procedure for the Rh(III)-Catalyzed Cascade Synthesis (A)



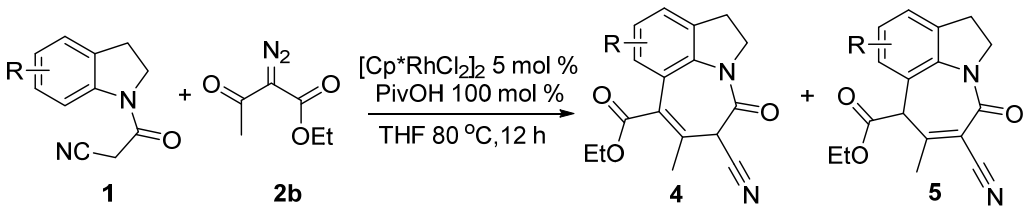
A mixture of substituted 3-(indolin-1-yl)-3-oxopropanenitrile (**1**) (0.2 mmol, 1.0 equiv), 2-diazo-5,5-dimethylcyclohexane-1,3-dione (**2**) (0.3 mmol, 1.5 equiv), $[Cp^*RhCl_2]_2$ (6.2 mg, 0.01 mmol, 5.0 mol %), and HOAc (12 mg, 0.2 mmol, 1.0 equiv) were weighted in a Schlenk tube equipped with a stir bar. Dry dioxane (1.0 mL) was added and the mixture was stirred at 80 °C for 12 h under Ar atmosphere. Afterwards, it was diluted with CH_2Cl_2 and transferred to a round bottom flask. Silica was added to the flask and volatiles were evaporated under reduced pressure. The purification was performed by flash column chromatography on silica gel with EtOAc/petroleum ether.

Table1 S1 Optimization studies[a]



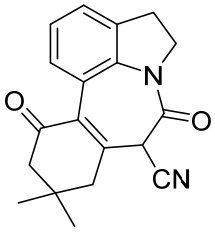
Entry	Temp (°C)	Solvent	Additive	Yield **4ab** (%)[b]	Yield **5ab** (%)[b]
1	80	diaxane	HOAc	25	45
2	80	dioxane	none	12	21
3	80	THF	HOAc	19	62
4	80	MeOH	HOAc	15	58
5	80	CH_3CN	HOAc	16	75
6	80	DMF	HOAc	21	63
7	80	DCE	HOAc	22	71
8	80	CF_3CH_2OH	HOAc	trace	44
9	**80**	**CH_3CN**	**PivOH**	**19**	**80**
10	80	CH_3CN	AgOAc	trace	33
11	60	CH_3CN	PivOH	14	68
12	100	CH_3CN	PivOH	32	56

General Procedure for the Rh(III)-Catalyzed Cascade Synthesis (B)



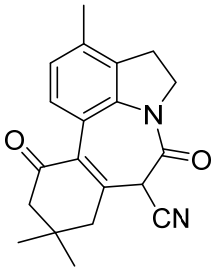
A mixture of substituted 3-(indolin-1-yl)-3-oxopropanenitrile (**1**) (0.2 mmol, 1.0 equiv), ethyl 2-diazo-3-oxobutanoate (**2**) (0.4 mmol, 1.0 equiv), $[Cp^*RhCl_2]_2$ (6.2 mg, 0.01 mmol, 5.0 mol %), and PivOH (20.4 mg, 0.2 mmol, 1.0 equiv) were weighted in a Schlenk tube equipped with a stir bar. Dry DMF (0.5 mL) was added and the mixture was stirred at 100 °C for 12 h under Ar atmosphere. Afterwards, it was diluted with CH_2Cl_2 and transferred to a round bottom flask. Silica was added to the flask and volatiles were evaporated under reduced pressure. The purification was performed by flash column chromatography on silica gel with EtOAc/petroleum ether.

Characterization of Products 3, 4, 5, and 6



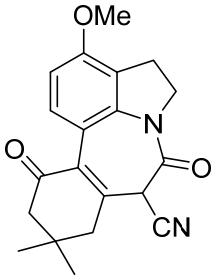
7,7-Dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3aa)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 84% yield（51.5 mg, 0.168mmol）following the general procedure A. Mp: 185–187 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.57 (d, *J* = 8.0 Hz, 1H), 7.33 (d, *J* = 7.3 Hz, 1H), 7.19 (t, *J* = 7.7 Hz, 1H), 4.82 – 4.55 (m, 1H), 4.02 (s, 1H), 3.96 – 3.77 (m, 1H), 3.43 – 3.23 (m, 1H), 3.14 – 2.90 (m, 2H), 2.73 – 2.52 (m, 2H), 2.39 (d, *J* = 15.1 Hz, 1H), 1.22 (s, 3H), 0.96 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.93, 161.18, 142.24, 140.05, 133.71, 131.54, 129.35, 125.56, 124.13, 120.12, 113.67, 51.65, 49.57, 45.10, 43.37, 33.09, 29.90, 28.39, 25.95. **HRMS (ESI):** Calcd for $C_{19}H_{19}N_2O_2$ $[M+H]^+$ 307.1441, found: 307.1440.



7,7,12-Trimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ba)

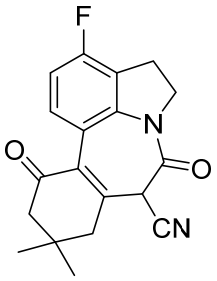
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 76% yield (48.7mg, 0.152 mmol) following the general procedure A. Mp: 158–160 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.46 (d, *J* = 8.1 Hz, 1H), 7.00 (d, *J* = 8.1 Hz, 1H), 4.67 (t, *J* = 10.3 Hz, 1H), 4.01 (s, 1H), 3.84 (d, *J* = 10.5 Hz, 1H), 3.24 – 3.12 (m, 1H), 3.04 – 2.88 (m, 2H), 2.66 – 2.52 (m, 2H), 2.37 (s, 1H), 2.30 (s, 3H), 1.20 (s, 3H), 0.93 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 196.08, 161.10, 141.28, 139.73, 135.57, 131.98, 131.48, 129.18, 125.42, 117.44, 113.74, 51.55, 49.28, 44.99, 43.16, 33.03, 29.88, 27.12, 25.80, 18.55. **HRMS (ESI):** Calcd for $C_{20}H_{21}N_2O_2$ $[M+H]^+$ 321.1598, found: 321.1602.



12-Methoxy-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ca)

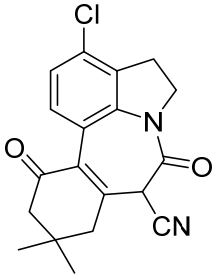
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/1) as a yellow solid in 68% yield (45.4 mg, 0.136 mmol) following the general procedure A. Mp: 168–169 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.57 (d, *J* = 8.9 Hz, 1H), 6.79 (d, *J* = 8.9 Hz, 1H), 4.64 (t, *J* =

10.0 Hz, 1H), 4.07 (s, 1H), 3.89 (s, 3H), 3.87 – 3.75 (m, 1H), 3.18 – 3.07 (m, 1H), 3.06 – 2.87 (m, 2H), 2.70 – 2.49 (m, 2H), 2.35 (d, *J* = 15.1 Hz, 1H), 1.19 (s, 3H), 0.94 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 196.32, 161.11, 156.20, 141.49, 140.35, 131.38, 131.15, 119.67, 113.76, 112.86, 107.43, 55.63, 51.60, 49.88, 45.07, 43.14, 33.03, 29.89, 25.83, 25.30. **HRMS (ESI):** Calcd for $C_{20}H_{21}N_2O_3$ $[M+H]^+$ 337.1547, found: 337.1546.



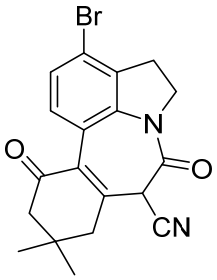
12-Fluoro-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3da)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 91% yield (58.9 mg, 0.182mmol) following the general procedure A. Mp: 74–76 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.59 (dd, *J* = 8.9, 5.4 Hz, 1H), 6.93 (t, *J* = 8.5 Hz, 1H), 4.70 (d, *J* = 10.1 Hz, 1H), 4.06 (s, 1H), 3.93 (d, *J* = 10.6 Hz, 1H), 3.26 (s, 1H), 3.17 (d, *J* = 9.2 Hz, 1H), 2.97 (d, *J* = 19.4 Hz, 1H), 2.69 – 2.55 (m, 2H), 2.38 (d, *J* = 15.3 Hz, 1H), 1.22 (s, 3H), 0.97 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.89, 161.03, 160.05, 157.56, 142.38, 141.67, 131.72, 131.64, 130.98, 119.22, 119.00, 116.16, 113.45, 112.05, 111.84, 51.43, 49.98, 45.07, 43.19, 33.00, 29.76, 25.83, 24.68. **^{19}F NMR ($CDCl_3$, 376 MHz):** δ −115.61. **HRMS (ESI):** Calcd for $C_{19}H_{18}FN_2O_2$ $[M+H]^+$ 325.1347, found: 325.1348.



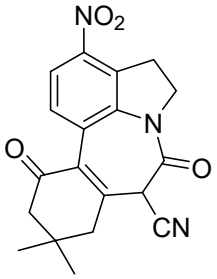
12-Chloro-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ea)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 84% yield (57.1 mg, 0.168 mmol) following the general procedure A. Mp: 100–102 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.52 (d, *J* = 8.6 Hz, 1H), 7.15 (d, *J* = 8.6 Hz, 1H), 4.68 (t, *J* = 10.2 Hz, 1H), 4.01 (s, 1H), 3.96 – 3.84 (m, 1H), 3.34 – 3.22 (m, 1H), 3.16 – 3.07 (m, 1H), 2.95 (d, *J* = 19.5 Hz, 1H), 2.67 – 2.53 (m, 2H), 2.41 (d, *J* = 16.4 Hz, 1H), 1.20 (s, 3H), 0.94 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.75, 161.06, 142.32, 141.01, 132.01, 131.53, 131.00, 130.80, 124.28, 118.30, 113.38, 51.45, 49.26, 45.09, 43.30, 33.06, 29.82, 27.81, 25.88. **HRMS (ESI):** Calcd for $C_{19}H_{18}ClN_2O_2$ $[M+H]^+$ 341.1051, found: 341.1053.



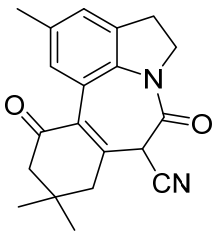
12-Bromo-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3fa)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 74% yield (56.8 mg 0.148 mmol) following the general procedure C. Mp: 108–110 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.44 (d, *J* = 8.6 Hz, 1H), 7.29 (d, *J* = 8.6 Hz, 1H), 4.66 (t, *J* = 10.2 Hz, 1H), 4.00 (s, 1H), 3.94 – 3.82 (m, 1H), 3.33 – 3.18 (m, 1H), 3.12 – 3.02 (m, 1H), 2.94 (d, *J* = 19.5 Hz, 1H), 2.68 – 2.49 (m, 2H), 2.36 (d, *J* = 15.3 Hz, 1H), 1.20 (s, 3H), 0.94 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.64, 161.13, 142.39, 140.70, 134.34, 131.03, 130.82, 127.03, 120.36, 118.79, 113.35, 51.42, 48.88, 45.07, 43.29, 33.03, 29.80, 25.88. **HRMS (ESI):** Calcd for $C_{19}H_{18}BrN_2O_2$ $[M+H]^+$ 385.0546, found: 385.0542.



7,7-Dimethyl-12-nitro-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ga)

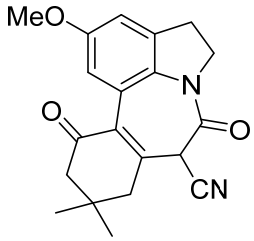
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 78% yield (54.5 mg, 0.156 mmol) following the general procedure B. Mp: 215–217 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.97 (d, *J* = 8.8 Hz, 1H), 7.74 (d, *J* = 8.8 Hz, 1H), 4.76 (s, 1H), 4.10 – 3.87 (m, 2H), 3.68 (d, *J* = 8.4 Hz, 2H), 3.00 (d, *J* = 19.7 Hz, 1H), 2.73 – 2.53 (m, 2H), 2.41 (d, *J* = 15.4 Hz, 1H), 1.23 (s, 3H), 0.97 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.11, 160.92, 145.27, 144.62, 141.99, 131.59, 131.10, 130.62, 124.84, 118.60, 112.92, 51.30, 49.63, 45.14, 43.52, 33.09, 29.69, 26.01. **HRMS (ESI):** Calcd for $C_{19}H_{18}N_3O_4$ $[M+H]^+$ 352.1292, found: 352.1292.



7,7,11-Trimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ha)

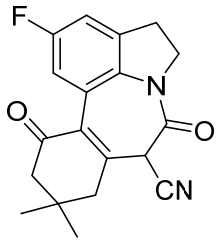
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 83% yield (52.9 mg, 0.186 mmol) following the general procedure A. Mp: 88–90 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.37 (s, 1H), 7.16 (s, 1H), 4.76 – 4.59 (m, 1H), 4.03 (s, 1H), 3.85 (d, *J* = 9.7 Hz, 1H),

3.29 (d, *J* = 9.0 Hz, 1H), 3.08 – 2.92 (m, 2H), 2.70 – 2.54 (m, 2H), 2.40 (s, 4H), 1.22 (s, 3H), 0.97 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.97, 160.98, 141.95, 137.95, 133.88, 133.66, 131.35, 129.12, 126.61, 119.71, 113.77, 51.61, 49.56, 45.04, 43.28, 32.97, 29.79, 28.26, 25.82, 21.17. **HRMS (ESI):** Calcd for $C_{20}H_{21}N_2O_2$ $[M+H]^+$ 321.1598, found: 321.1599.



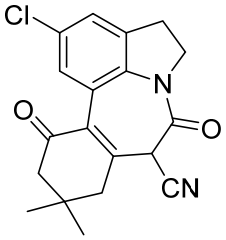
11-Methoxy-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ia)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 86% yield (57.7 mg, 0.172 mmol) following the general procedure A. Mp: 83–84 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.07 (d, *J* = 1.6 Hz, 1H), 6.92 (s, 1H), 4.64 (t, *J* = 10.2 Hz, 1H), 4.00 (s, 1H), 3.80 (s, 4H), 3.33 – 3.21 (m, 1H), 3.05 – 2.90 (m, 2H), 2.68 – 2.52 (m, 2H), 2.36 (d, *J* = 15.2 Hz, 1H), 1.19 (s, 3H), 0.94 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 196.00, 160.69, 156.21, 142.33, 135.21, 134.08, 131.04, 120.58, 113.99, 113.77, 111.97, 55.73, 51.65, 49.69, 45.09, 43.32, 32.91, 29.73, 28.56, 25.90. **HRMS (ESI):** Calcd for $C_{20}H_{21}N_2O_3$ $[M+H]^+$ 337.1547, found: 337.1547.



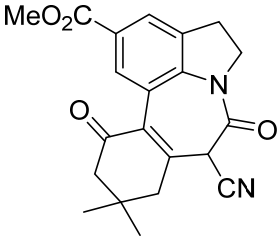
11-Fluoro-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ja)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 75% yield (48.9 mg, 0.150 mmol) following the general procedure A. Mp: 188–190 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.30 (dd, *J* = 10.4, 1.7 Hz, 1H), 7.07 (d, *J* = 6.7 Hz, 1H), 4.69 (t, *J* = 10.3 Hz, 1H), 4.00 (s, 1H), 3.94 – 3.81 (m, 1H), 3.40 – 3.24 (m, 1H), 3.10 – 2.90 (m, 2H), 2.69 – 2.51 (m, 2H), 2.38 (d, *J* = 15.4 Hz, 1H), 1.20 (s, 3H), 0.95 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.51, 160.88, 160.14, 157.72, 143.15, 136.39, 135.95, 135.86, 130.65, 121.00, 120.90, 115.34, 115.09, 113.97, 113.72, 113.47, 51.45, 49.92, 45.09, 43.38, 32.95, 29.73, 28.51, 25.93. **^{19}F NMR ($CDCl_3$, 376 MHz):** δ −116.95 (t，*J* = 9.2 Hz). **HRMS (ESI):** Calcd for $C_{19}H_{18}FN_2O_2$ $[M+H]^+$ 325.1347, found: 325.1351.



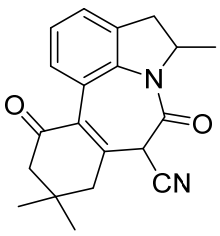
11-Chloro-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ka)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 80% yield (54.2 mg, 0.160 mmol) following the general procedure A. Mp: 199–200 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.56 (s, 1H), 7.28 (s, 1H), 4.67 (s, 1H), 3.99 (s, 1H), 3.87 (d, *J* = 10.2 Hz, 1H), 3.39 – 3.24 (m, 1H), 3.10 – 2.90 (m, 2H), 2.68 – 2.51 (m, 2H), 2.37 (d, *J* = 15.2 Hz, 1H), 1.20 (s, 3H), 0.95 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.45, 160.85, 143.12, 138.70, 135.59, 130.58, 129.61, 128.84, 125.85, 120.86, 113.38, 51.43, 49.79, 45.10, 43.39, 33.00, 29.72, 28.23, 25.95. **HRMS (ESI):** Calcd for $C_{19}H_{18}ClN_2O_2$ $[M+H]^+$ 341.1051, found: 341.1052.



Methyl 5-cyano-7,7-dimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-11-carboxylate (3la)

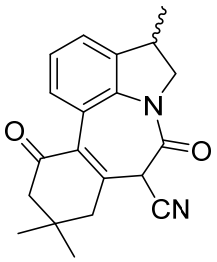
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 93% yield (67.7 mg, 0.186 mmol) following the general procedure A. Mp: 132–133 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 8.26 (s, 1H), 7.97 (s, 1H), 4.69 (t, *J* = 9.9 Hz, 1H), 4.02–3.91 (m, 5H), 3.41 – 3.27 (m, 1H), 3.16 – 3.04 (m, 1H), 2.98 (d, *J* = 19.4 Hz, 1H), 2.72 – 2.54 (m, 2H), 2.40 (d, *J* = 15.1 Hz, 1H), 2.16 (s, 1H), 1.22 (s, 3H), 0.97 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.55, 166.22, 160.94, 143.28, 142.80, 134.19, 131.88, 126.21, 126.12, 119.45, 113.29, 52.35, 51.44, 49.93, 45.20, 43.38, 33.14, 30.90, 29.78, 27.92, 26.04. **HRMS (ESI):** Calcd for $C_{21}H_{21}N_2O_4$ $[M+H]^+$ 365.1496, found: 365.1501.



2,7,7-Trimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile (3ma)

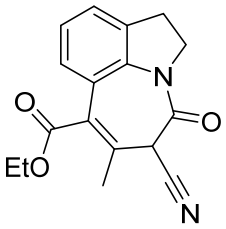
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 74% yield (47.2 mg, 0.148 mmol) following the general procedure A. Mp: 145–147 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.61 (d, *J* = 8.0 Hz, 1H), 7.31 (d, *J* = 7.2 Hz, 1H), 7.22 – 7.14 (m, 1H), 5.03 – 4.93 (m, 1H), 3.96 (s, 1H), 3.49 (dd, *J* = 16.0, 8.6 Hz, 1H), 2.97 (d, *J* = 19.4 Hz, 1H), 2.67 (s, 1H), 2.63 (s, 1H), 2.57 (d, *J* = 15.4 Hz, 1H), 2.38 (dd, *J* = 15.4, 1.5 Hz, 1H), 1.21

(s, 6H), 0.92 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.91, 160.56, 142.18, 138.51, 132.53, 131.41, 129.40, 125.92, 124.07, 120.29, 113.68, 57.66, 51.62, 45.16, 43.32, 35.88, 33.01, 29.86, 25.50, 20.71. **HRMS (ESI):** Calcd for $C_{20}H_{21}N_2O_2$ $[M+H]^+$ 321.1598, found: 321.1600.



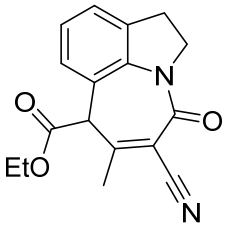
1,7,7-Trimethyl-4,9-dioxo-1,2,4,5,6,7,8,9-octahydrobenzo[4,5]azepino[3,2,1-hi]indole-5-carbonitrile(3na)

The title compounds were isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 84% yield (54.1 mg, 0.168 mmol) following the general procedure A. Mp: 145–147 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.56 (d, *J* = 7.9 Hz, 1H), 7.29 (d, *J* = 7.6 Hz, 1H), 7.23 – 7.16 (m, 1H), 4.79-4.74 (m, 0.63H), 4.25-4.23 (m, 0.37H), 4.11 – 3.90 (m, 1.26H), 3.70 – 3.53 (m, 0.74H), 3.45 – 3.28 (m, 1H), 2.96 (d, *J* = 19.4 Hz, 1H), 2.69 – 2.52 (m, 2H), 2.43 – 2.33 (m, 1H), 1.38 (d, *J* = 6.6 Hz, 2H), 1.30 (d, *J* = 6.7 Hz, 1H), 1.20 (s, 3H), 0.95 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 195.98, 160.75, 142.28, 142.14, 139.86, 138.64, 131.41, 129.41, 129.21, 124.81, 124.15, 123.99, 119.92, 119.87, 113.68, 57.25, 56.57, 51.54, 50.38, 44.97, 44.88, 43.30, 35.35, 35.17, 33.00, 29.84, 28.24, 25.84, 21.24, 17.09. **HRMS (ESI):** Calcd for $C_{20}H_{21}N_2O_2Na$ $[M+Na]^+$ 343.1417, found: 343.1420.



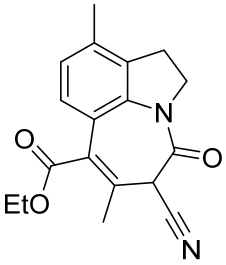
Ethyl 3-cyano-2-methyl-4-oxo-3,4,6,7-tetrahydroazepino[3,2,1-hi]indole-1-carboxylate (4ab)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 19% yield (11.2 mg, 0.038 mmol) following the general procedure B. Mp: 159–161 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.31 (d, *J* = 7.1 Hz, 1H), 7.21 (d, *J* = 7.9 Hz, 1H), 7.15 – 7.10 (m, 1H), 4.58 – 4.50 (m, 1H), 4.32 (q, *J* = 7.1 Hz, 2H), 4.05 – 3.97 (m, 1H), 3.89 (s, 1H), 3.34 – 3.22 (m, 1H), 3.16 – 3.07 (m, 1H), 2.30 (s, 3H), 1.33 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.21, 160.59, 139.39, 134.36, 131.03, 129.06, 126.57, 125.49, 124.50, 121.81, 113.90, 61.81, 49.59, 44.54, 28.27, 20.23, 14.11. **HRMS (ESI):** Calcd for $C_{17}H_{17}N_2O_3$ $[M+H]^+$ 297.1234, found: 297.1234.



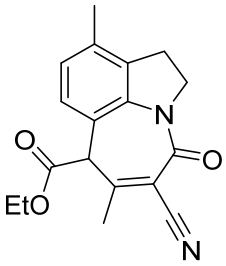
Ethyl 3-cyano-2-methyl-4-oxo-1,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (5ab)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 80% yield (47.2 mg, 0.160 mmol) following the general procedure B. Mp: 155–156 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.27 – 7.23 (m, 1H), 7.10 (t, *J* = 7.5 Hz, 1H), 6.98 (d, *J* = 7.6 Hz, 1H), 4.68 (ddd, *J* = 12.0, 9.8, 2.1 Hz, 1H), 4.28 (s, 1H), 4.13 – 4.06 (m, 2H), 3.91 (dd, *J* = 11.9, 10.1 Hz, 1H), 3.28 – 3.20 (m, 1H), 3.07 – 2.98 (m, 1H), 2.54 (s, 3H), 1.18 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.35, 160.08, 159.08, 139.01, 133.94, 127.73, 125.67, 125.51, 120.78, 115.52, 111.70, 62.44, 55.25, 49.10, 27.36, 27.13, 13.86. **HRMS (ESI):** Calcd for $C_{17}H_{17}N_2O_3$ $[M+H]^+$ 297.1234, found: 297.1238.



Ethyl 3-cyano-2,8-dimethyl-4-oxo-3,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (4bb)

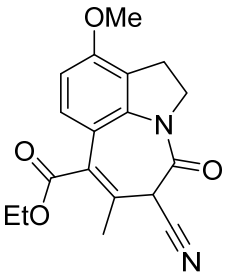
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 24% yield (14.8mg, 0.048 mmol) following the general procedure B. Mp: 122–124 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.12 (d, *J* = 8.1 Hz, 1H), 6.96 (d, *J* = 8.2 Hz, 1H), 4.59 – 4.51 (m, 1H), 4.32 (q, *J* = 7.1 Hz, 2H), 4.05 – 3.96 (m, 1H), 3.88 (s, 1H), 3.20 – 3.11 (m, 1H), 3.07 – 2.99 (m, 1H), 2.31 (s, 3H), 2.28 (s, 3H), 1.32 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.33, 160.60, 139.10, 135.58, 132.58, 131.03, 128.12, 126.60, 125.93, 119.36, 114.00, 61.74, 49.36, 44.54, 27.10, 20.11, 18.63, 14.12. **HRMS (ESI):** Calcd for $C_{18}H_{19}N_2O_3$ $[M+H]^+$ 311.1390, found: 311.1397.



Ethyl 3-cyano-2,8-dimethyl-4-oxo-1,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (5bb)

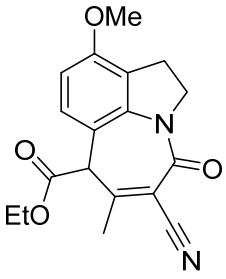
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 76% yield (47.1 mg, 0.152 mmol) following the general procedure B. Mp: 120–122 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 6.93 (d, *J* = 7.8 Hz, 1H), 6.89 (d, *J* = 7.8 Hz, 1H), 4.72–4.66 (m,

1H), 4.24 (s, 1H), 4.13–4.07 (m, 2H), 3.96–3.89 (m, 9.9 Hz, 1H), 3.15–3.06 (m, 1H), 2.99–2.92 (m, 1H), 2.53 (s, 3H), 2.26 (s, 3H), 1.18 (t, J = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.58, 160.21, 159.13, 138.61, 135.50, 132.53, 127.70, 126.50, 118.07, 115.59, 111.58, 62.39, 55.05, 48.89, 27.09, 26.26, 18.37, 13.87. **HRMS (ESI):** Calcd for $C_{18}H_{19}N_2O_3$ $[M+H]^+$ 311.1390, found: 311.1394.



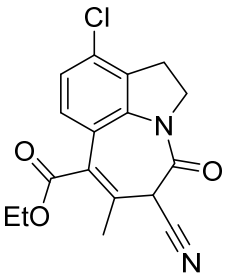
Ethyl 3-cyano-8-methoxy-2-methyl-4-oxo-3,4,6,7-tetrahydroazepino [3,2,1-hi]indole-1-carboxylate (4cb)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 20% yield (13.2 mg, 0.04 mmol) following the general procedure B. Mp: 117–118 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.20 (d, J = 8.8 Hz, 1H), 6.73 (d, J = 8.8 Hz, 1H), 4.56 – 4.48 (m, 1H), 4.32 (q, J = 7.1 Hz, 2H), 4.01 (d, J = 10.5 Hz, 1H), 3.93 (s, 1H), 3.89 (s, 3H), 3.16 – 3.04 (m, 2H), 2.26 (s, 3H), 1.35 – 1.30 (m, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.49, 160.63, 156.21, 140.85, 130.83, 128.51, 126.92, 120.26, 114.99, 114.02, 107.85, 61.71, 55.66, 49.95, 44.57, 25.25, 20.05, 14.13. **HRMS (ESI):** Calcd for $C_{18}H_{19}N_2O_4$ $[M+H]^+$ 327.1339, found: 327.1347.



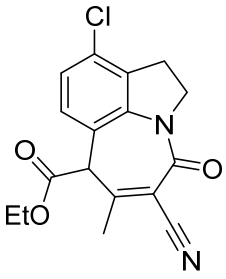
Ethyl 3-cyano-8-methoxy-2-methyl-4-oxo-1,4,6,7-tetrahydroazepino [3,2,1-hi]indole-1-carboxylate (5cb)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 74% yield (48.1 mg, 0.148 mmol) following the general procedure B. Mp: 153–155 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 6.95 (d, J = 8.4 Hz, 1H), 6.63 (d, J = 8.4 Hz, 1H), 4.69–4.63 (m, J = 12.1, 9.3, 2.9 Hz, 1H), 4.22 (s, 1H), 4.10 (q, J = 7.0 Hz, 2H), 3.98 – 3.89 (m, 1H), 3.84 (s, 3H), 3.11 – 2.94 (m, 2H), 2.53 (s, 3H), 1.18 (t, J = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.77, 160.27, 159.10, 156.46, 140.15, 129.08, 120.85, 115.62, 113.40, 111.68, 107.50, 62.38, 55.56, 54.82, 49.47, 27.12, 24.45, 13.90. **HRMS (ESI):** Calcd for $C_{18}H_{19}N_2O_4$ $[M+H]^+$ 327.1339, found: 327.1342.



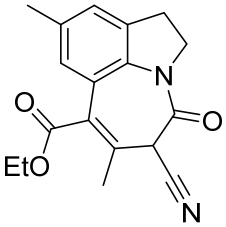
Ethyl 8-chloro-3-cyano-2-methyl-4-oxo-3,4,6,7-tetrahydroazepino [3,2,1-hi]indole-1-carboxylate (4eb)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 24% yield (15.9 mg, 0.142 mmol) following the general procedure B. Mp: 120–122 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.18 (d, *J* = 8.6 Hz, 1H), 7.11 (d, *J* = 8.6 Hz, 1H), 4.61 – 4.51 (m, 1H), 4.32 (q, *J* = 7.1 Hz, 2H), 4.11 – 4.01 (m, 1H), 3.89 (s, 1H), 3.31 – 3.13 (m, 2H), 2.30 (s, 3H), 1.33 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 166.85, 160.52, 140.37, 132.56, 131.49, 130.42, 129.72, 128.18, 124.75, 120.15, 113.57, 61.96, 49.29, 44.63, 27.75, 20.35, 14.10. **HRMS (ESI):** Calcd for $C_{17}H_{16}ClN_2O_3$ $[M+H]^+$ 331.0844, found: 331.0846.



Ethyl 8-chloro-3-cyano-2-methyl-4-oxo-1,4,6,7-tetrahydroazepino [3,2,1-hi]indole-1-carboxylate (5eb)

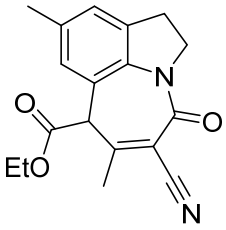
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 76% yield (50.2 mg, 0.152 mmol) following the general procedure B. Mp: 94–96 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.06 (d, *J* = 8.2 Hz, 1H), 6.95 (d, *J* = 8.1 Hz, 1H), 4.71 – 4.60 (m, 1H), 4.28 (s, 1H), 4.09 (q, *J* = 7.0 Hz, 2H), 3.99 – 3.90 (m, 1H), 3.23 – 3.13 (m, 1H), 3.13 – 3.03 (m, 1H), 2.53 (s, 3H), 1.17 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.02, 160.28, 158.95, 140.05, 132.19, 131.38, 129.19, 125.20, 118.91, 115.23, 111.57, 62.55, 54.58, 48.73, 27.11, 26.74, 13.79. **HRMS (ESI):** Calcd for $C_{17}H_{16}ClN_2O_3$ $[M+H]^+$ 331.0844, found: 331.0847.



Ethyl 3-cyano-2,9-dimethyl-4-oxo-3,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (4hb)

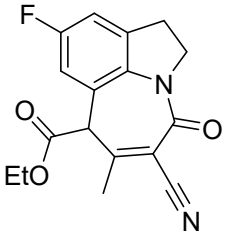
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 17% yield (10.8 mg, 0.034 mmol) following the general procedure B. Mp: 131–134°C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.13 (s, 1H), 6.98 (s, 1H), 4.56 – 4.48 (m, 1H), 4.33 (q, *J* = 7.1 Hz, 2H), 4.04 – 3.95 (m, 1H), 3.88 (s, 1H), 3.28 – 3.18 (m, 1H), 3.09–3.02 (m, 1H), 2.34 (s, 3H), 2.28 (s, 3H), 1.34

(t, J = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.33, 160.34, 137.29, 134.45, 134.41, 131.07, 128.44, 126.69, 126.37, 121.44, 113.99, 61.75, 49.67, 44.50, 28.22, 21.11, 20.23, 14.12. **HRMS (ESI):** Calcd for $C_{18}H_{19}N_2O_3$ $[M+H]^+$ 311.1390, found: 311.1393.



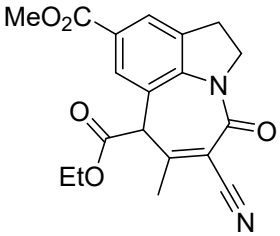
Ethyl 3-cyano-2,9-dimethyl-4-oxo-1,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (5hb)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 64% yield (39.8 mg, 0.128 mmol) following the general procedure B. Mp: 90–92 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.06 (s, 1H), 6.78 (s, 1H), 4.69 – 4.59 (m, 1H), 4.22 (s, 1H), 4.09 (q, J = 7.1 Hz, 2H), 3.89 (d, J = 11.4 Hz, 1H), 3.24 – 3.15 (m, 1H), 2.96 (dd, J = 15.9, 9.3 Hz, 1H), 2.52 (s, 3H), 2.31 (s, 3H), 1.17 (t, J = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 164.31, 151.26, 141.72, 141.30, 136.54, 135.89, 133.47, 133.33, 130.33, 130.29, 129.45, 128.40, 127.86, 127.47, 127.31, 124.22, 123.66, 122.70, 120.07, 59.01, 58.05, 35.33, 20.86. **HRMS (ESI):** Calcd for $C_{18}H_{19}N_2O_3$ $[M+H]^+$ 311.1390, found: 311.1397.



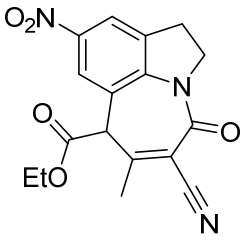
Ethyl 3-cyano-9-fluoro-2-methyl-4-oxo-1,4,6,7-tetrahydroazepino [3,2,1-hi]indole-1-carboxylate (5jb)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 90% yield (56.8mg, 0.180 mmol) following the general procedure B. Mp: 159–161°C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 6.98 (d, J = 7.4 Hz, 1H), 6.73 (dd, J = 8.7, 2.1 Hz, 1H), 4.75–4.64 (m, 1H), 4.22 (s, 1H), 4.17–4.07 (m, 2H), 4.00–3.89 (m, 1H), 3.32–3.19 (m, 1H), 3.02 (dd, J = 16.3, 9.5 Hz, 1H), 2.54 (s, 3H), 1.24–1.15 (m, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 166.87, 161.43, 159.58, 158.99, 158.68, 136.16, 136.07, 135.38, 121.79, 121.71, 115.34, 114.37, 114.12, 113.23, 113.00, 111.71, 62.66, 54.69, 49.54, 27.71, 27.15, 13.86. **^{19}F NMR ($CDCl_3$, 376 MHz):** δ −117.02 (d, J = 8.4 Hz). **HRMS (ESI):** Calcd for $C_{17}H_{16}FN_2O_3$ $[M+H]^+$ 315.1139, found: 315.1144.



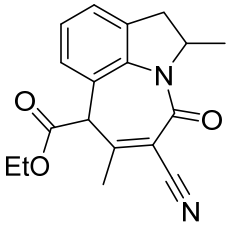
1-Ethyl-9-methyl 3-cyano-2-methyl-4-oxo-1,4,6,7-tetrahydroazepino[3,2,1-hi]indole-1,9-dicarboxylate (5lb)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 84% yield (51.9 mg, 0.168 mmol) following the general procedure B. Mp: 104–106 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.91 (s, 1H), 7.73 (s, 1H), 4.74 – 4.63 (m, 1H), 4.35 (s, 1H), 4.11 (q, *J* = 7.1 Hz, 2H), 3.99 (d, *J* = 11.9 Hz, 1H), 3.90 (s, 3H), 3.31 – 3.21 (m, 1H), 3.13 – 3.03 (m, 1H), 2.56 (s, 3H), 1.18 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.00, 165.90, 160.19, 159.16, 142.83, 134.31, 130.21, 127.19, 126.88, 120.25, 115.19, 111.80, 62.69, 55.13, 52.27, 49.56, 27.16, 26.90, 13.87. **HRMS (ESI):** Calcd for $C_{19}H_{19}N_2O_5$ $[M+H]^+$ 355.1288, found: 355.1291.



Ethyl 3-cyano-2-methyl-9-nitro-4-oxo-1,4,6,7-tetrahydroazepino [3,2,1-hi]indole-1-carboxylate (5pb)

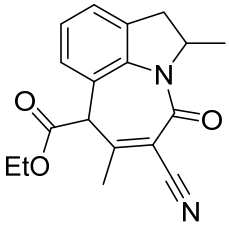
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 77% yield (52.3mg, 0.154 mmol) following the general procedure B. Mp: 184–186 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 8.13 (s, 1H), 7.98 (d, *J* = 1.9 Hz, 1H), 4.79 – 4.70 (m, 1H), 4.40 (s, 1H), 4.15 (q, *J* = 7.0 Hz, 2H), 4.11-4.03 (m, 1H), 3.38-3.29 (m, 1H), 3.21-3.13 (m, 1H), 2.60 (s, 3H), 1.22 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 166.57, 160.14, 159.13, 144.90, 144.48, 135.66, 124.78, 121.37, 120.59, 114.92, 112.01, 63.22, 54.93, 50.09, 27.37, 26.97, 13.99. **HRMS (ESI):** Calcd for $C_{17}H_{15}N_3O_5Na$ $[M+H]^+$ 364.0904, found: 364.0910.



Ethyl 3-cyano-2,6-dimethyl-4-oxo-3,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (4mb)

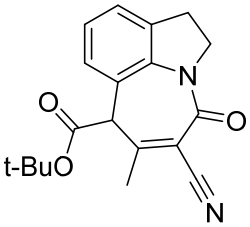
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 10% yield (6.2 mg, 0.020 mmol) following the general procedure B. Mp: 74–76 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.33 – 7.28 (m, 1H), 7.23 (d, *J* = 7.9 Hz, 1H), 7.17 – 7.10 (m, 1H), 5.02 – 4.92 (m, 1H), 4.33 (q, *J* = 7.1 Hz, 2H), 3.76 (s, 1H), 3.49 (dd, *J* = 16.0, 8.8 Hz, 1H), 2.67 (d, *J* = 16.1

Hz, 1H), 2.33 (s, 3H), 1.34 (t, *J* = 7.1 Hz, 3H), 1.27 (d, *J* = 6.6 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.23, 160.66, 138.10, 133.19, 130.86, 129.23, 126.75, 125.85, 124.44, 122.18, 114.20, 61.78, 57.94, 44.77, 35.96, 20.77, 19.84, 14.12. **HRMS (ESI):** Calcd for $C_{18}H_{18}N_2O_3Na$ $[M+Na]^+$ 333.1215, found: 333.1214.



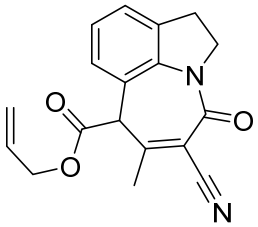
Ethyl 3-cyano-2,6-dimethyl-4-oxo-1,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (5mb)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 80% yield (49.6 mg, 0.160 mmol) following the general procedure B. Mp: 123–125 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.27 (d, *J* = 6.7 Hz, 1H), 7.12 (t, *J* = 7.5 Hz, 1H), 7.00 (d, *J* = 7.6 Hz, 1H), 5.10 – 5.00 (m, 1H), 4.29 (s, 1H), 4.16 – 4.05 (m, 2H), 3.41 (dd, *J* = 16.0, 8.6 Hz, 1H), 2.61 (d, *J* = 16.1 Hz, 1H), 2.55 (s, 3H), 1.28 (d, *J* = 6.5 Hz, 3H), 1.18 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.34, 160.33, 158.49, 137.83, 132.74, 127.70, 126.05, 125.54, 121.41, 111.73, 62.40, 57.31, 55.20, 35.10, 27.11, 20.02, 13.90. **HRMS (ESI):** Calcd for $C_{18}H_{18}N_2O_3Na$ $[M+Na]^+$ 333.1215, found: 333.1213.



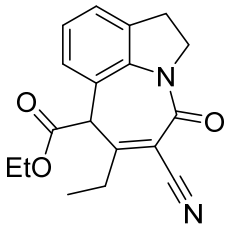
***tert*-Butyl 3-cyano-2-methyl-4-oxo-1,4,6,7-tetrahydroazepino [3,2,1-hi]indole-1-carboxylate (5ac)**

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 70% yield (49.4 mg, 0.182 mmol) following the general procedure B. Mp: 137–138 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.25 (d, *J* = 7.1 Hz, 1H), 7.10 (t, *J* = 7.5 Hz, 1H), 6.97 (d, *J* = 7.6 Hz, 1H), 4.74 – 4.63 (m, 1H), 4.20 (s, 1H), 3.96 – 3.85 (m, 1H), 3.31 – 3.16 (m, 1H), 3.02 (dd, *J* = 16.0, 9.5 Hz, 1H), 2.53 (s, 3H), 1.38 – 1.32 (m, 9H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 166.43, 160.96, 160.88, 159.18, 139.05, 133.83, 127.73, 125.52, 125.46, 121.47, 115.62, 111.22, 111.19, 83.52, 56.50, 49.13, 27.59. **HRMS (ESI):** Calcd for $C_{19}H_{21}N_2O_3$ $[M+H]^+$ 325.1547, found: 325.1554.



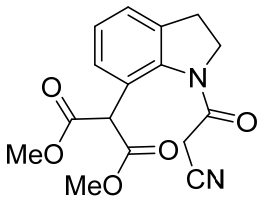
Allyl 3-cyano-2-methyl-4-oxo-1,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (5ad)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 57% yield (35.2 mg, 0.114 mmol) following the general procedure B. Mp: 102–104 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.27 (d, *J* = 6.8 Hz, 1H), 7.11 (t, *J* = 7.5 Hz, 1H), 7.00 (d, *J* = 7.6 Hz, 1H), 5.87 – 5.71 (m, 1H), 5.26 – 5.11 (m, 2H), 4.72 – 4.64 (m, 1H), 4.59 – 4.47 (m, 2H), 4.33 (s, 1H), 3.97 – 3.86 (m, 1H), 3.30 – 3.18 (m, 1H), 3.08 – 2.97 (m, 1H), 2.56 (s, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.04, 159.86, 159.00, 139.02, 133.96, 130.85, 127.74, 125.73, 125.54, 120.60, 119.11, 115.46, 111.88, 66.69, 55.10, 49.10, 27.33, 27.14. **HRMS (ESI):** Calcd for $C_{19}H_{17}N_2O_3$ $[M+H]^+$ 309.1234, found:309.1235.



Ethyl 3-cyano-2-ethyl-4-oxo-1,4,6,7-tetrahydroazepino[3,2,1-hi] indole-1-carboxylate (5af)

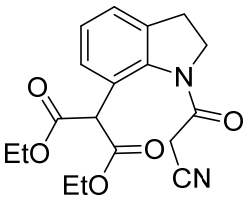
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a yellow solid in 59% yield (36.4mg, 0.118 mmol) following the general procedure D. Mp: 98–100 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.25 (d, *J* = 7.7 Hz, 1H), 7.10 (t, *J* = 7.5 Hz, 1H), 7.00 (d, *J* = 7.6 Hz, 1H), 4.70–4.64 (m, 1H), 4.35 (s, 1H), 4.13 – 4.05 (m, 2H), 3.95 – 3.87 (m, 1H), 3.28–3.19 (m, 1H), 3.06 – 2.97 (m, 1H), 2.83 – 2.76 (m, 2H), 1.26 (t, *J* = 7.6 Hz, 3H), 1.16 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 167.53, 162.24, 159.68, 156.93, 151.39, 145.68, 145.56, 125.52, 125.43, 116.09, 115.87, 114.42, 113.66, 113.43, 112.89, 108.61, 65.94, 48.00, 37.22, 30.30, 24.07, 18.88, 13.51. **^{19}F NMR ($CDCl_3$, 376 MHz):** δ −108.95. **HRMS (ESI):** Calcd for $C_{18}H_{19}N_2O_3$ $[M+H]^+$ 311.1390, found: 311.1396.



Dimethyl 2-(1-(2-cyanoacetyl)indolin-7-yl)malonate (6ah)

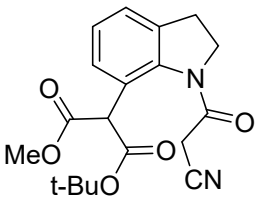
The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a white solid in 95% yield (60.0mg, 0.190 mmol) following the general procedure B. Mp: 202–204 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.38 – 7.33 (m, 1H), 7.25 – 7.20 (m, 2H), 4.83

(s, 1H), 4.08 (t, J = 7.5 Hz, 2H), 3.77 (s, 6H), 3.50 (s, 2H), 3.13 (t, J = 7.5 Hz, 2H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 168.94, 160.83, 140.18, 134.83, 128.95, 126.78, 124.78, 123.66, 113.51, 54.90, 52.86, 51.09, 29.74, 26.70. **HRMS (ESI):** Calcd for $C_{16}H_{17}N_2O_5$ $[M+H]^+$ 317.1132, found:317.1136.



Diethyl 2-(1-(2-cyanoacetyl)indolin-7-yl)malonate (6ai)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a white solid in 85% yield (54.2mg, 0.170 mmol) following the general procedure B. Mp: 137–139 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.35 – 7.30 (m, 1H), 7.22 – 7.16 (m, 2H), 4.70 (s, 1H), 4.26–4.17 (m, 4H), 3.97 (t, J = 7.5 Hz, 2H), 3.29 (s, 2H), 3.07 (t, J = 7.4 Hz, 2H), 1.27 (t, J = 7.1 Hz, 6H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 168.75, 161.43, 140.41, 135.23, 128.70, 126.49, 124.79, 123.66, 113.98, 61.74, 55.36, 50.83, 29.60, 26.42, 14.07. **HRMS (ESI):** Calcd for $C_{18}H_{21}N_2O_5$ $[M+H]^+$ 345.1445, found: 345.1449.



1-(*tert*-Butyl) 3-methyl 2-(1-(2-cyanoacetyl)indolin-7-yl)malonate (6aj)

The title compound was isolated by column chromatography (eluent: EtOAc/petroleum ether = 1/5 to 1/2) as a white solid in 47% yield (33.7 mg, 0.094 mmol) following the general procedure B. Mp: 123–124 °C. **^{1}H NMR ($CDCl_3$, 400 MHz):** δ 7.36 (dd, J = 5.8, 3.1 Hz, 1H), 7.21 (d, J = 6.0 Hz, 2H), 4.70 (s, 1H), 4.05 (t, J = 7.4 Hz, 2H), 3.76 (s, 3H), 3.58 – 3.43 (m, 2H), 3.17 – 3.04 (m, 2H), 1.47 (s, 9H). **^{13}C NMR ($CDCl_3$, 100 MHz):** δ 169.53, 167.54, 161.16, 140.37, 135.02, 128.76, 126.51, 124.65, 124.10, 113.89, 82.32, 56.19, 52.64, 50.91, 29.72, 27.88, 26.63. **HRMS (ESI):** Calcd for $C_{19}H_{22}N_2NaO_5$ $[M+H]^+$ 381.1421, found: 381.1418.

X-ray crystallography:

CCDC-1498693 (**3la**) and 1498694 (**5ab**), contain the supplementary crystallographic data. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

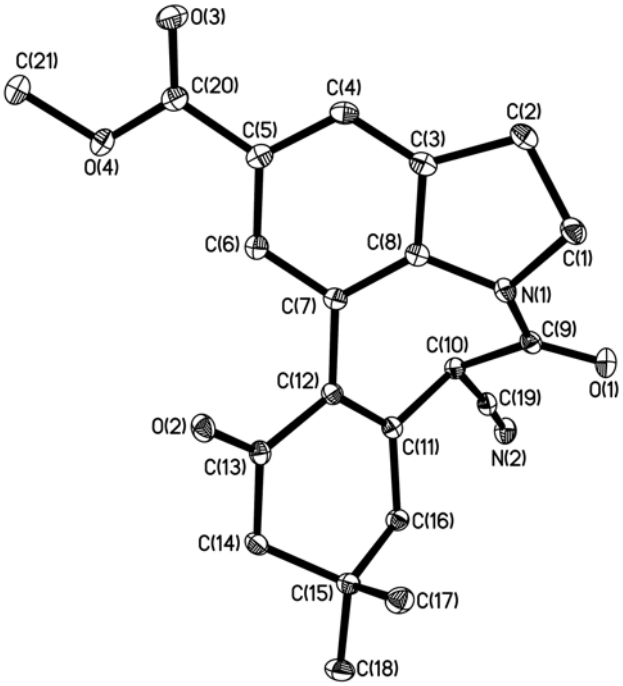


Figure S1. The molecular structure of **3la**. Thermal ellipsoids are shown at the 30% level. Hydrogen atoms have been omitted for clarity.

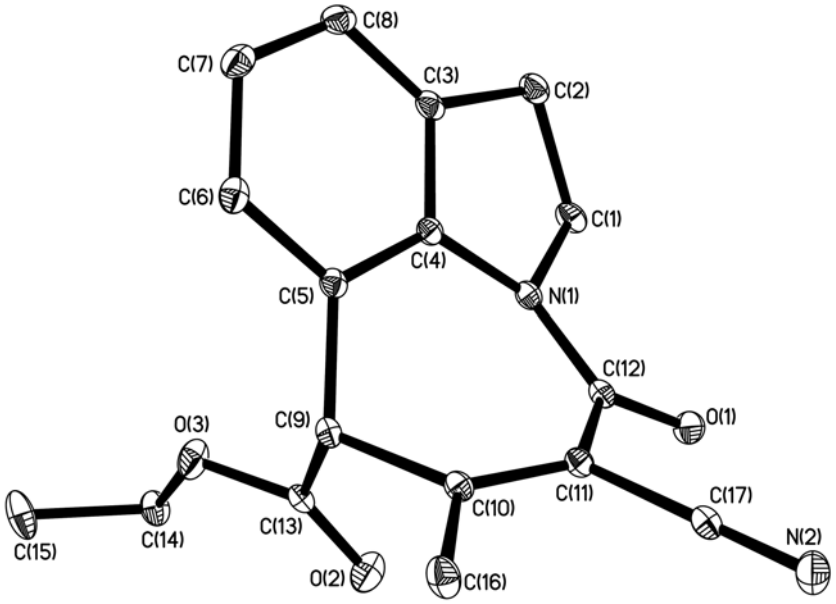
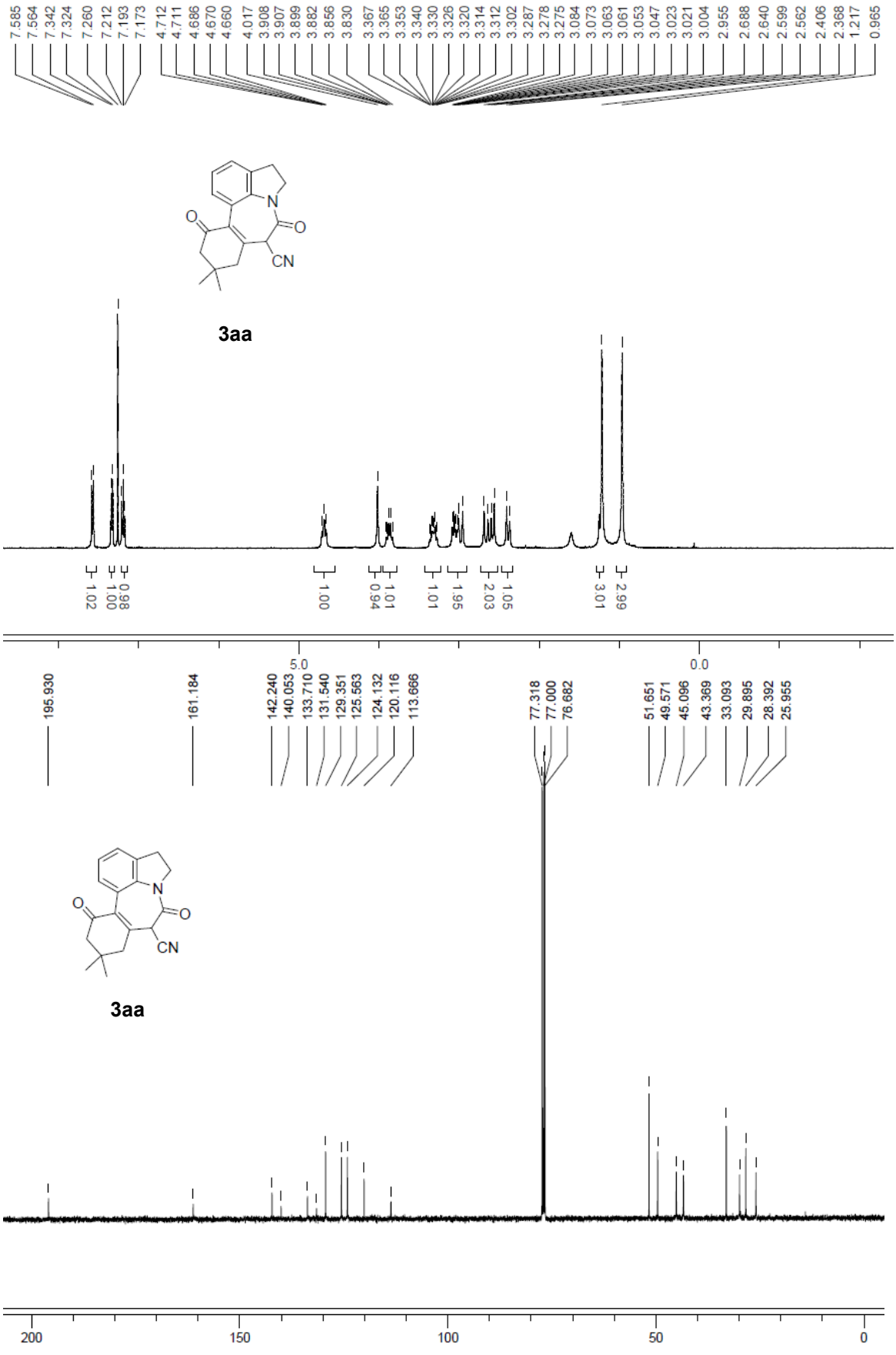
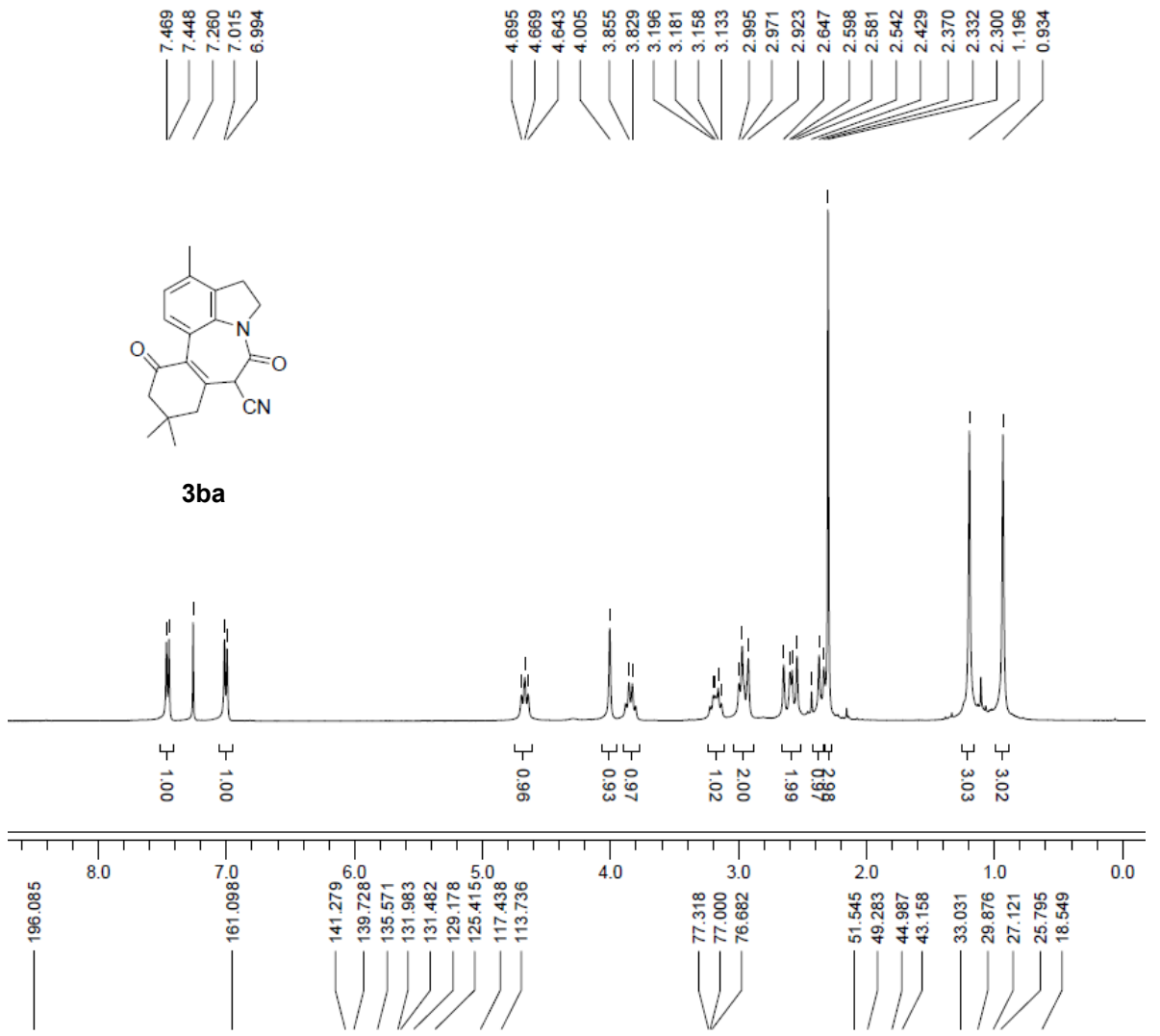


Figure S2. The molecular structure of **5ab**. Thermal ellipsoids are shown at the 30% level. Hydrogen atoms have been omitted for clarity.

Spectral Copies of ^{1}H, ^{13}C, and ^{19}F NMR of Compounds Obtained in This Study

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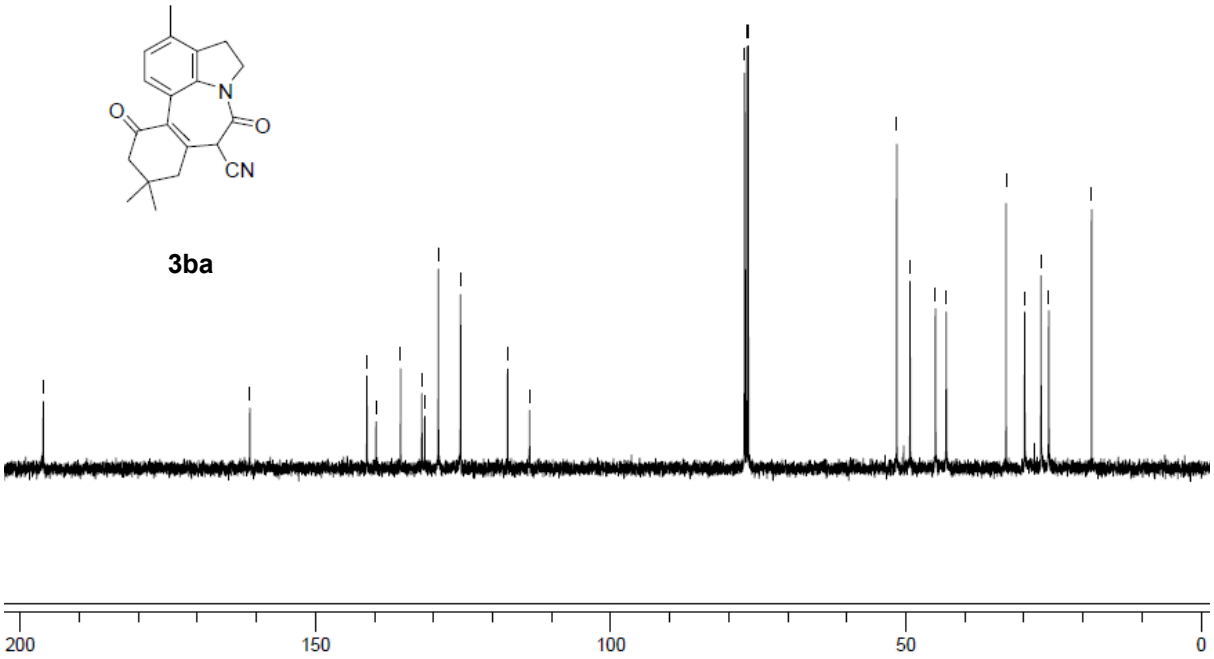
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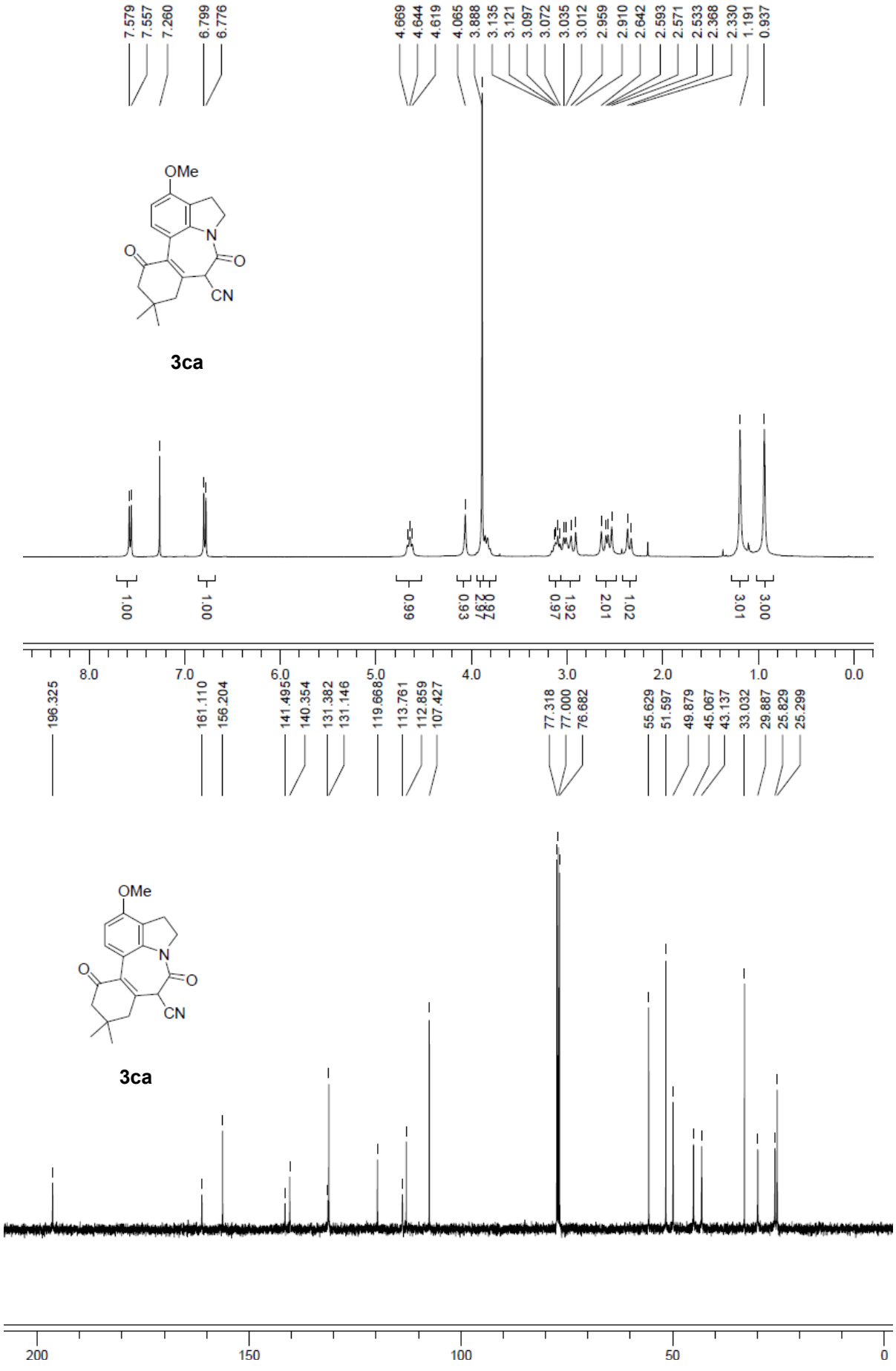
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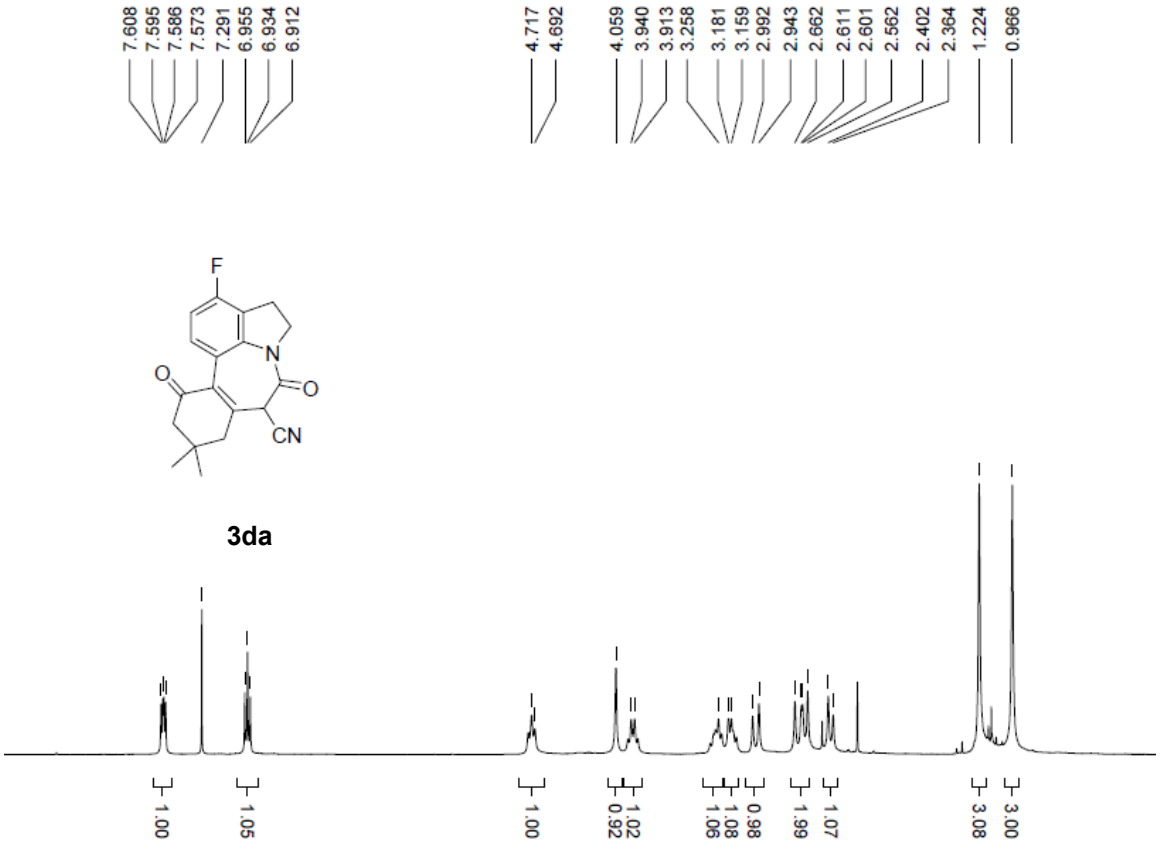
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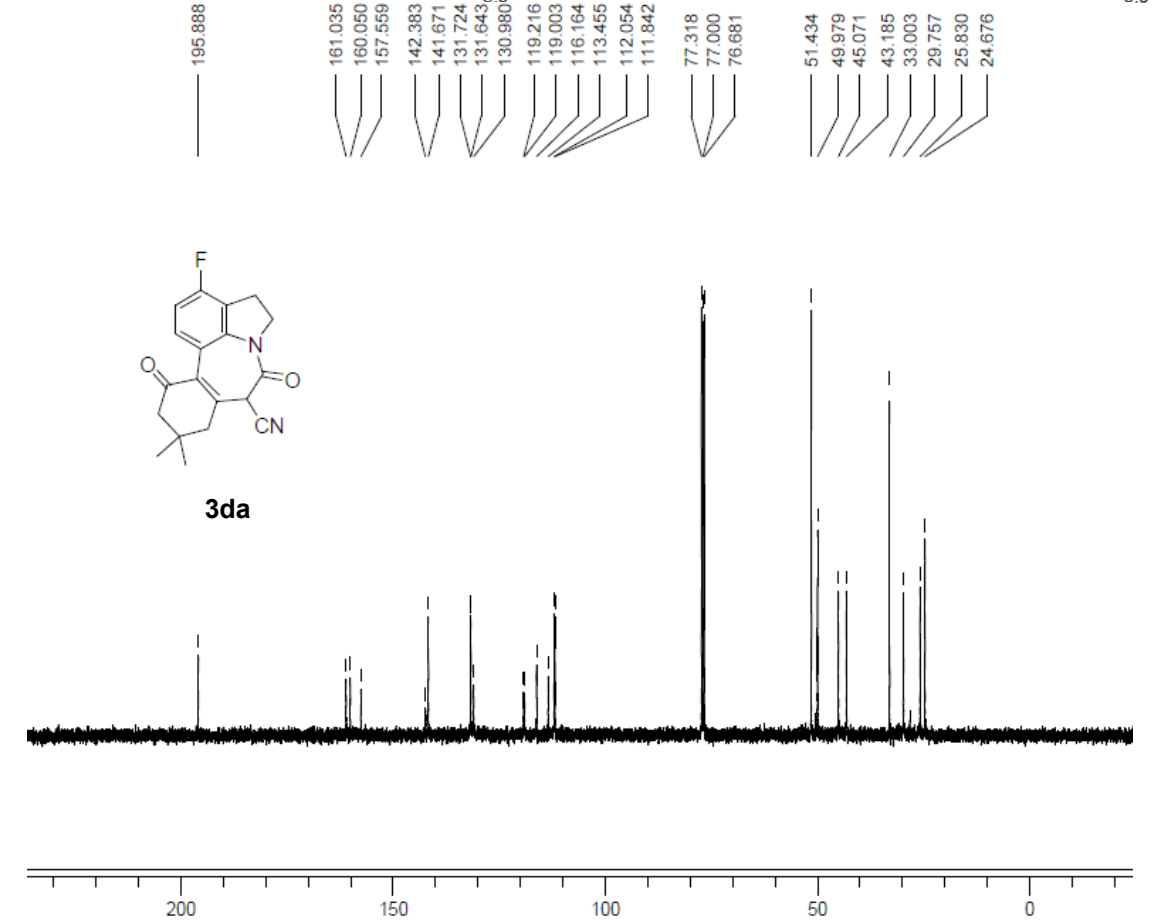
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77.000
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45.071
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O
CN
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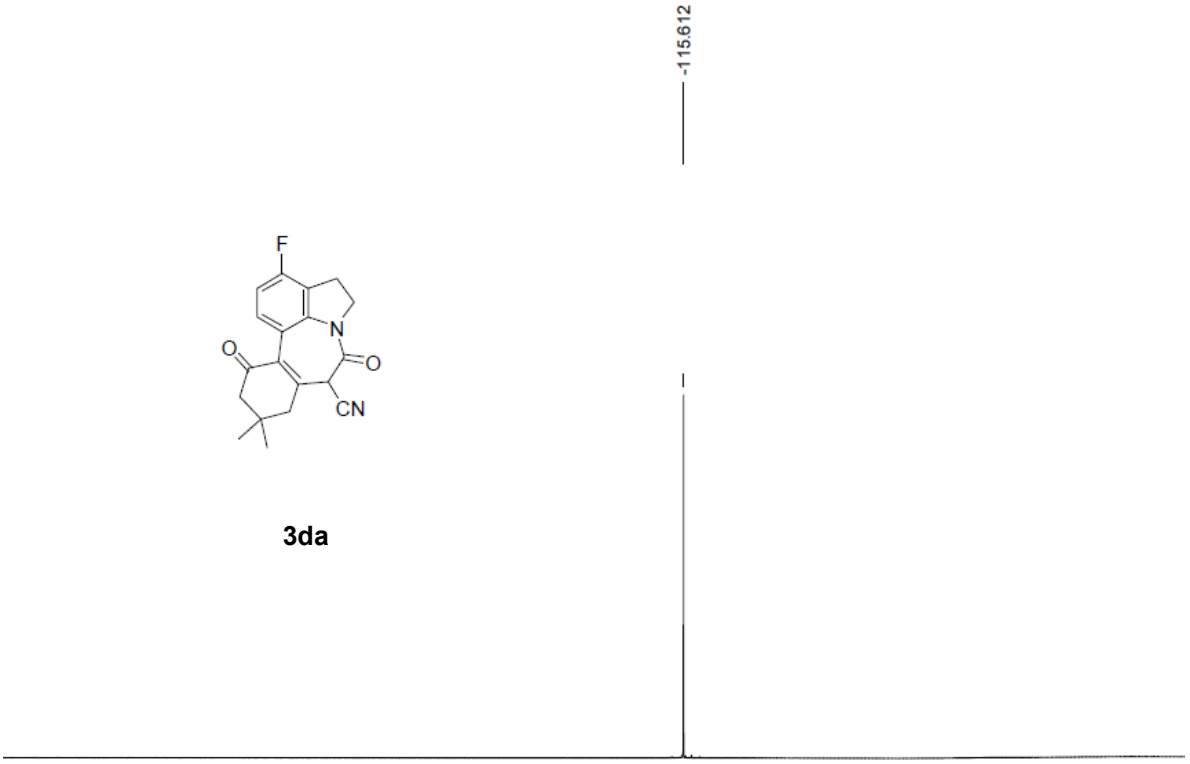
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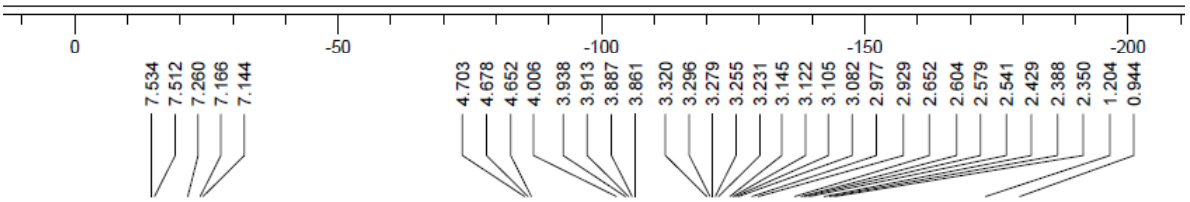
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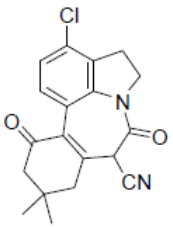
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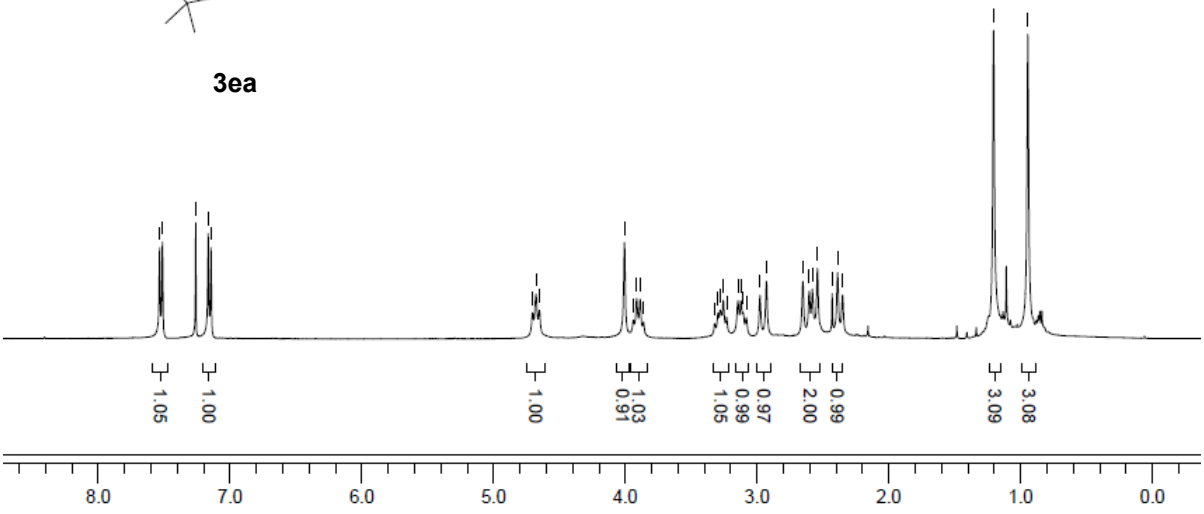
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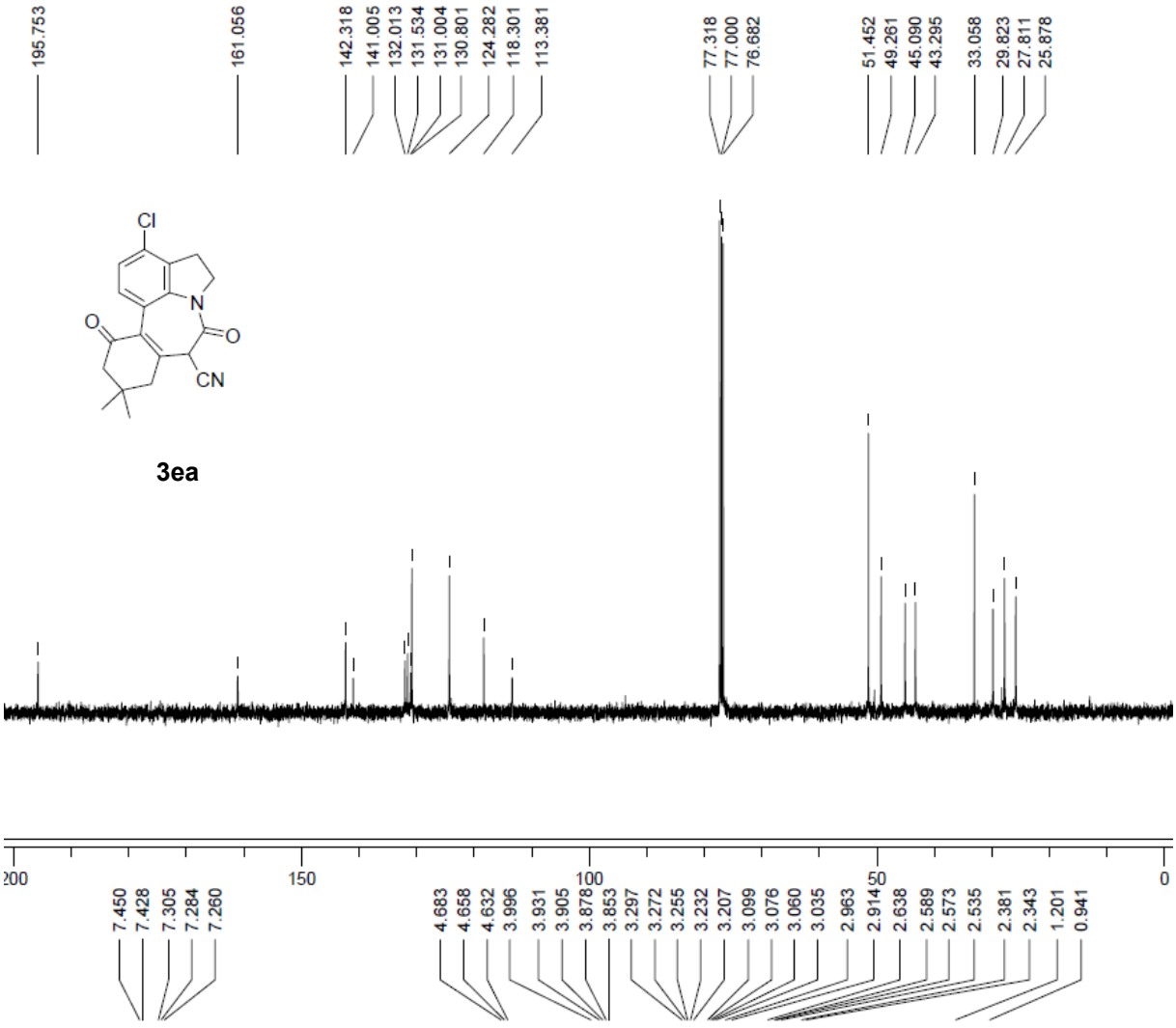
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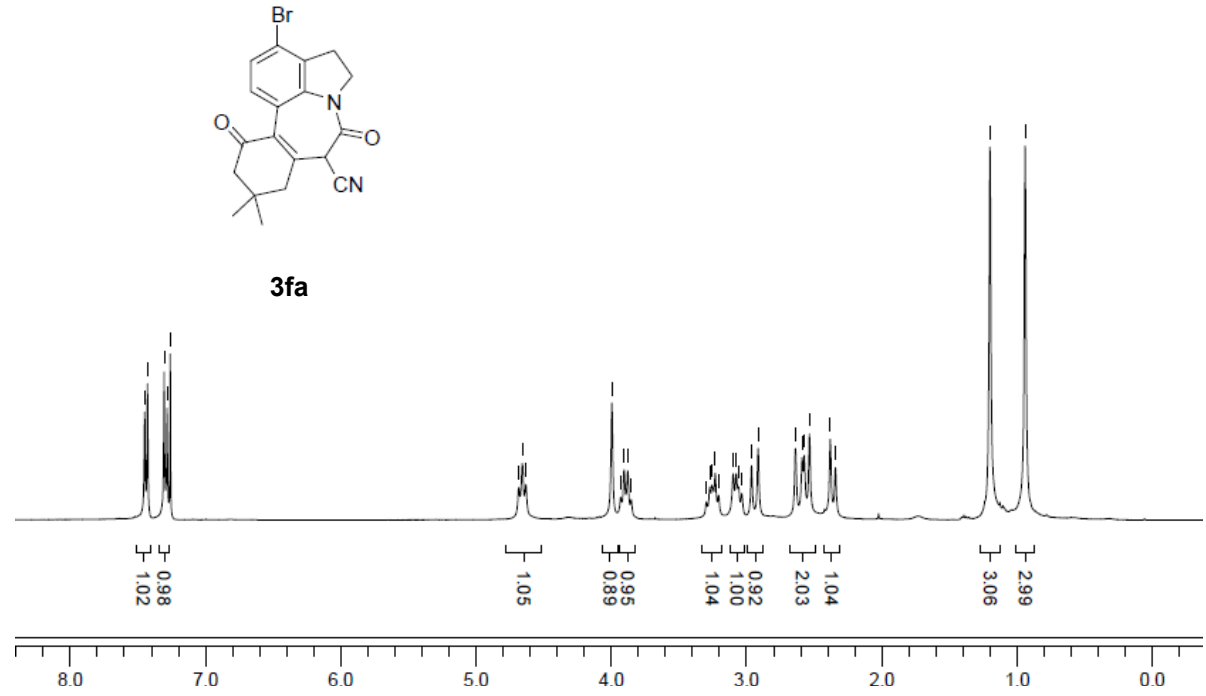
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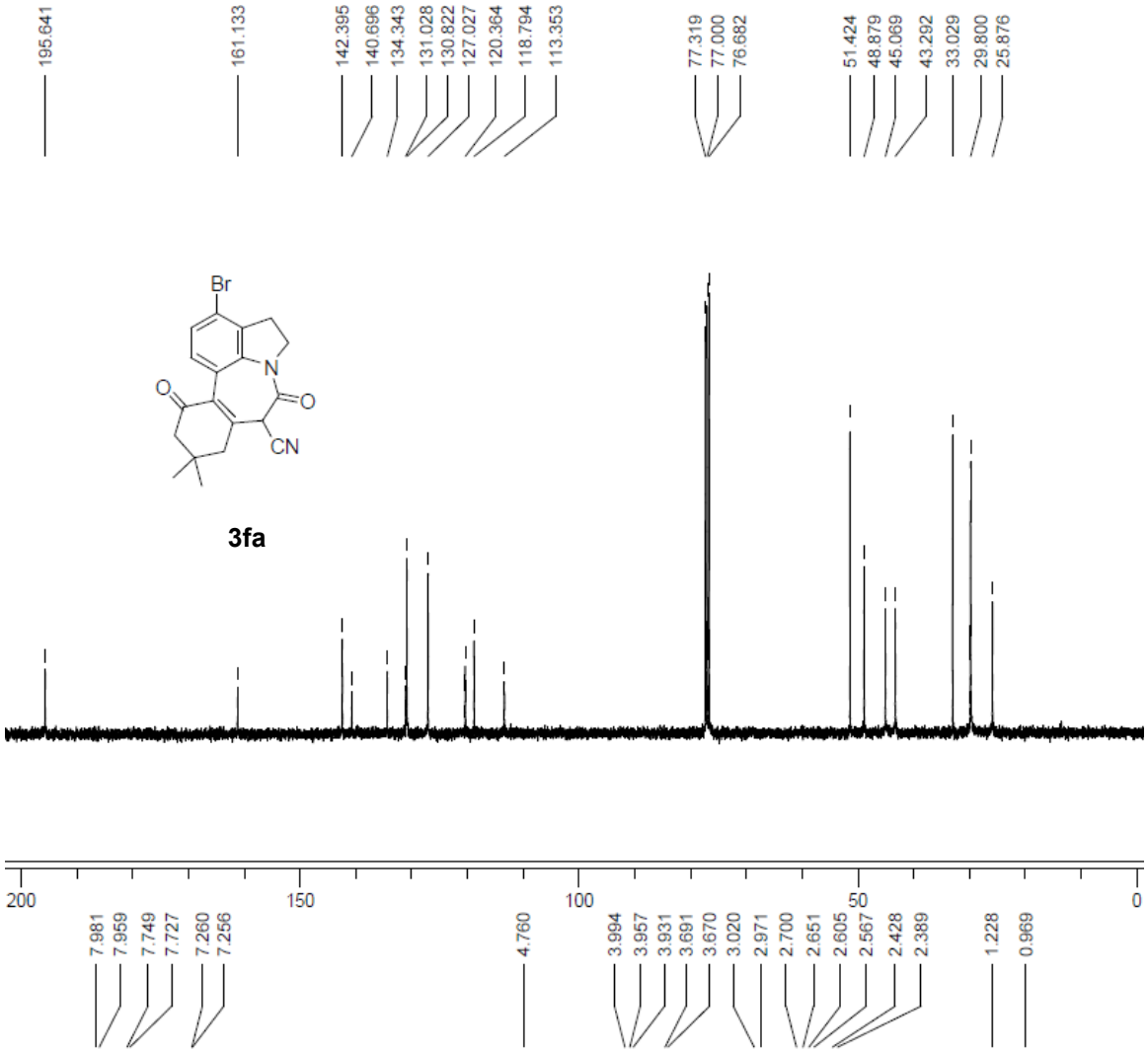
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7.959
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7.727
7.260
7.256
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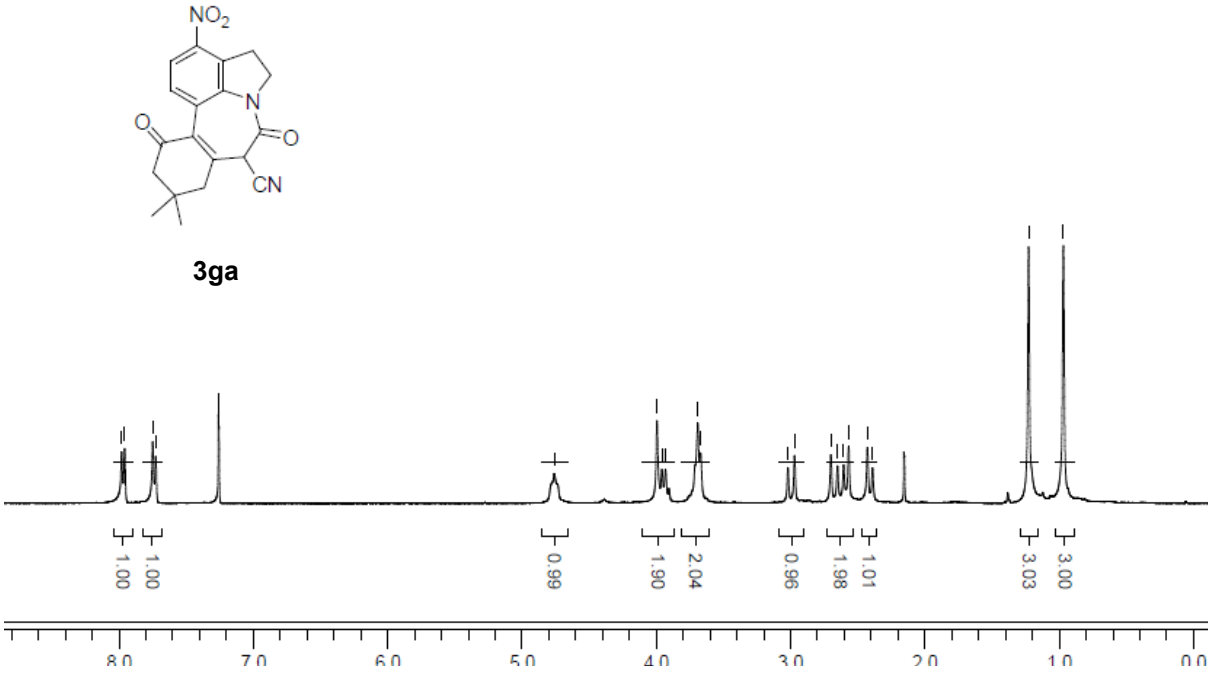
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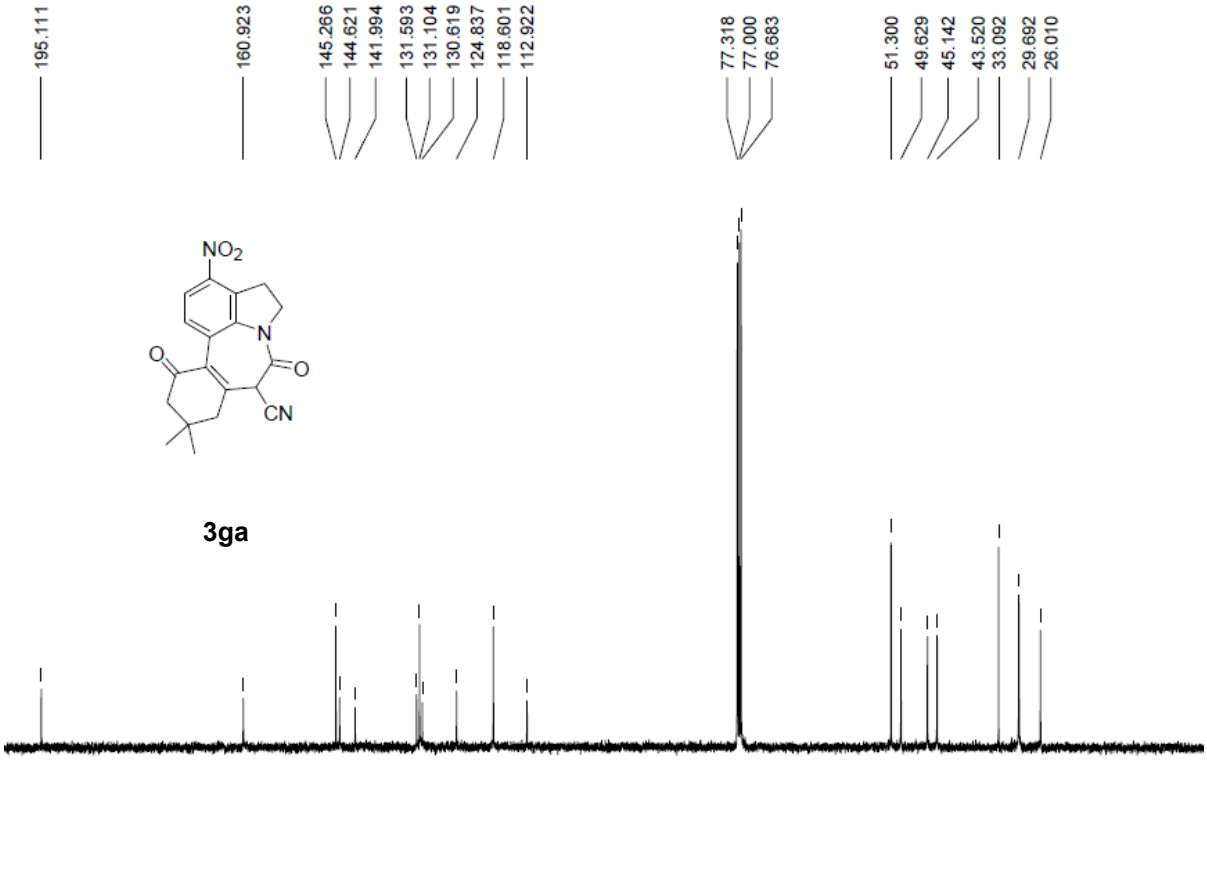
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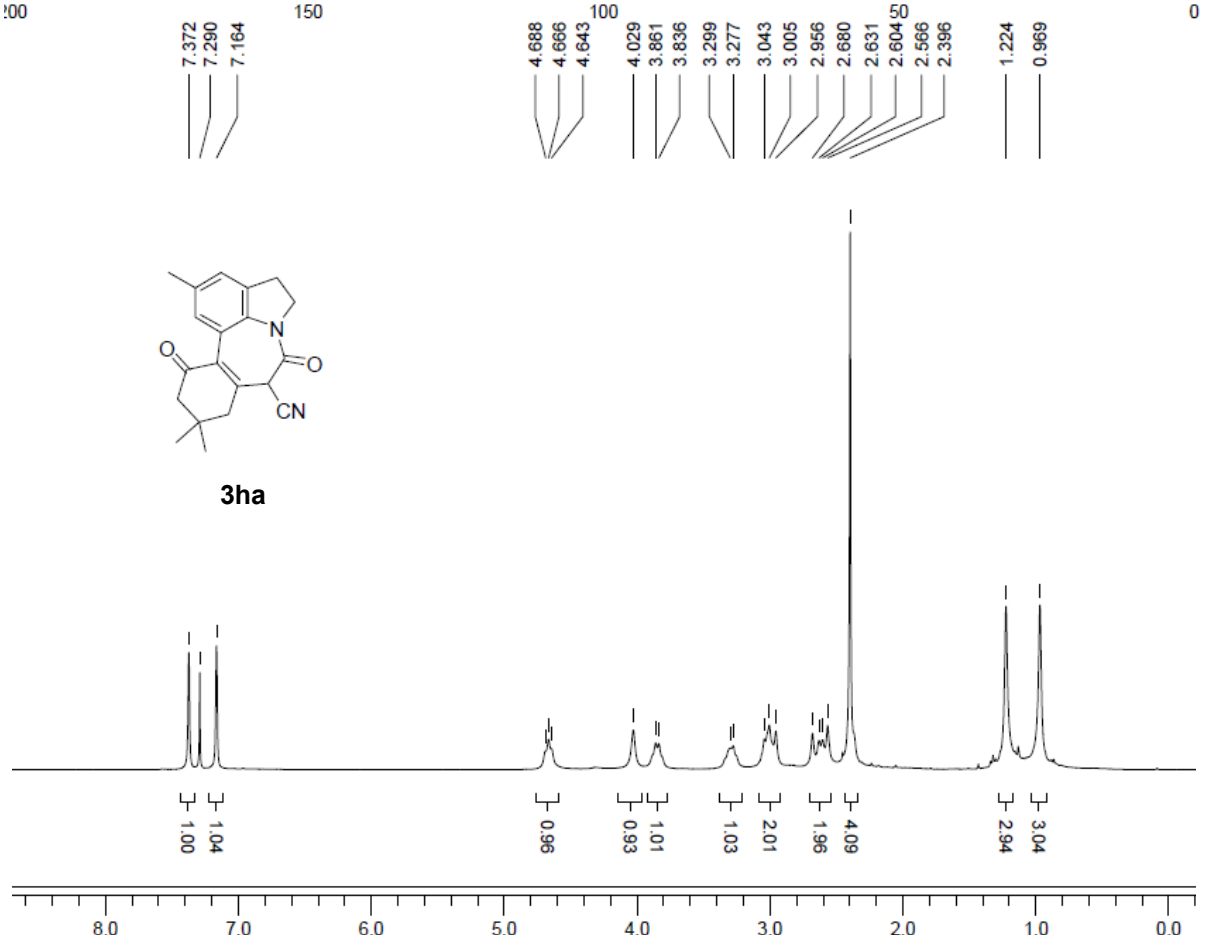
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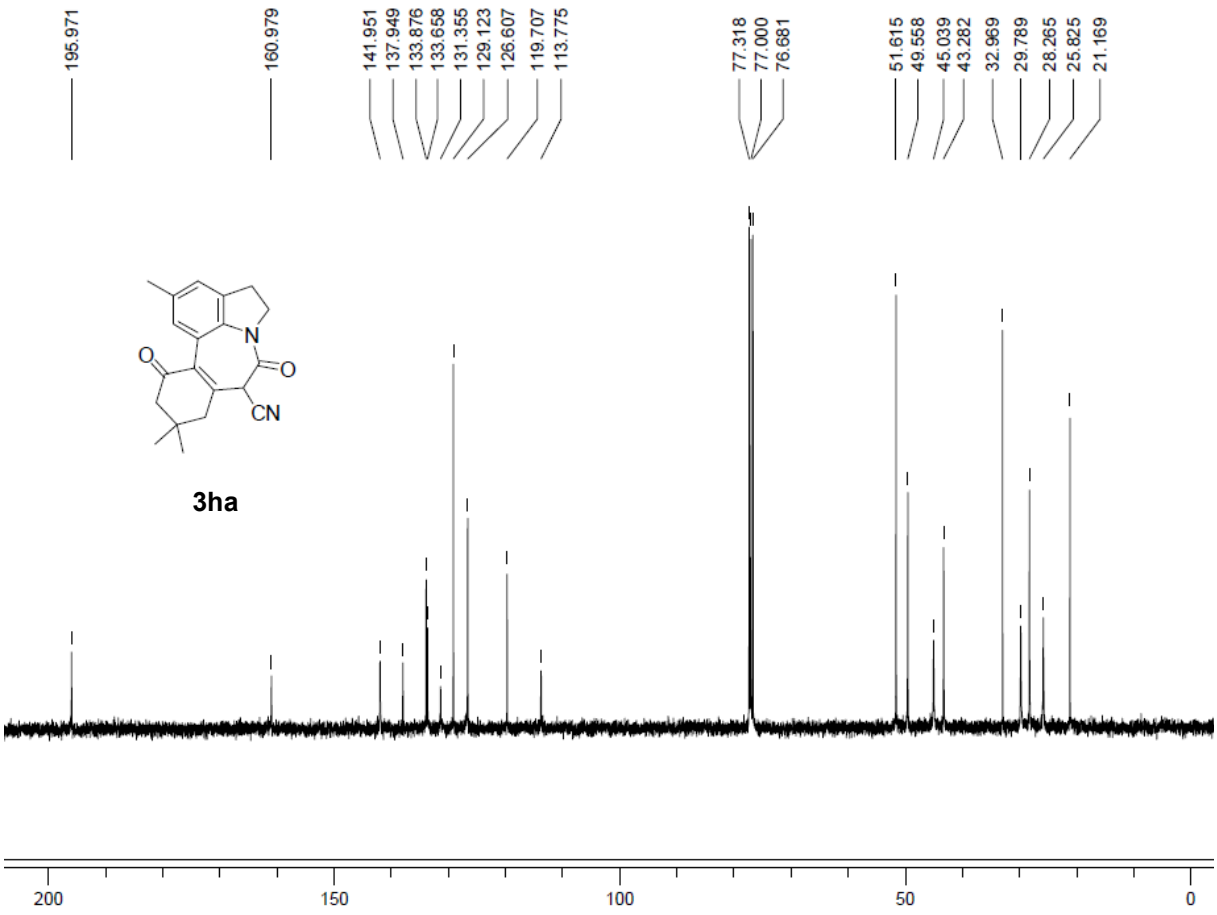
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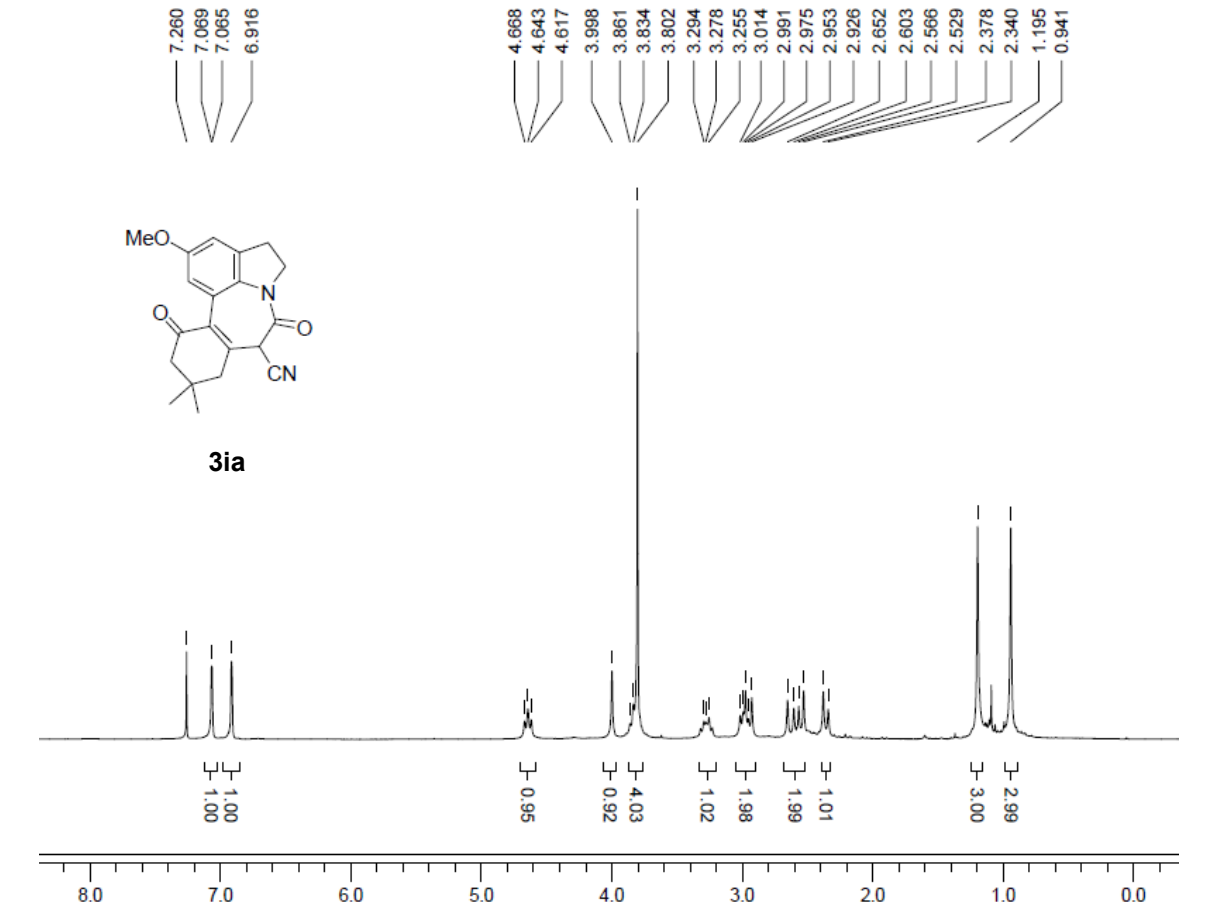
3ha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3.255
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CN
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1.99
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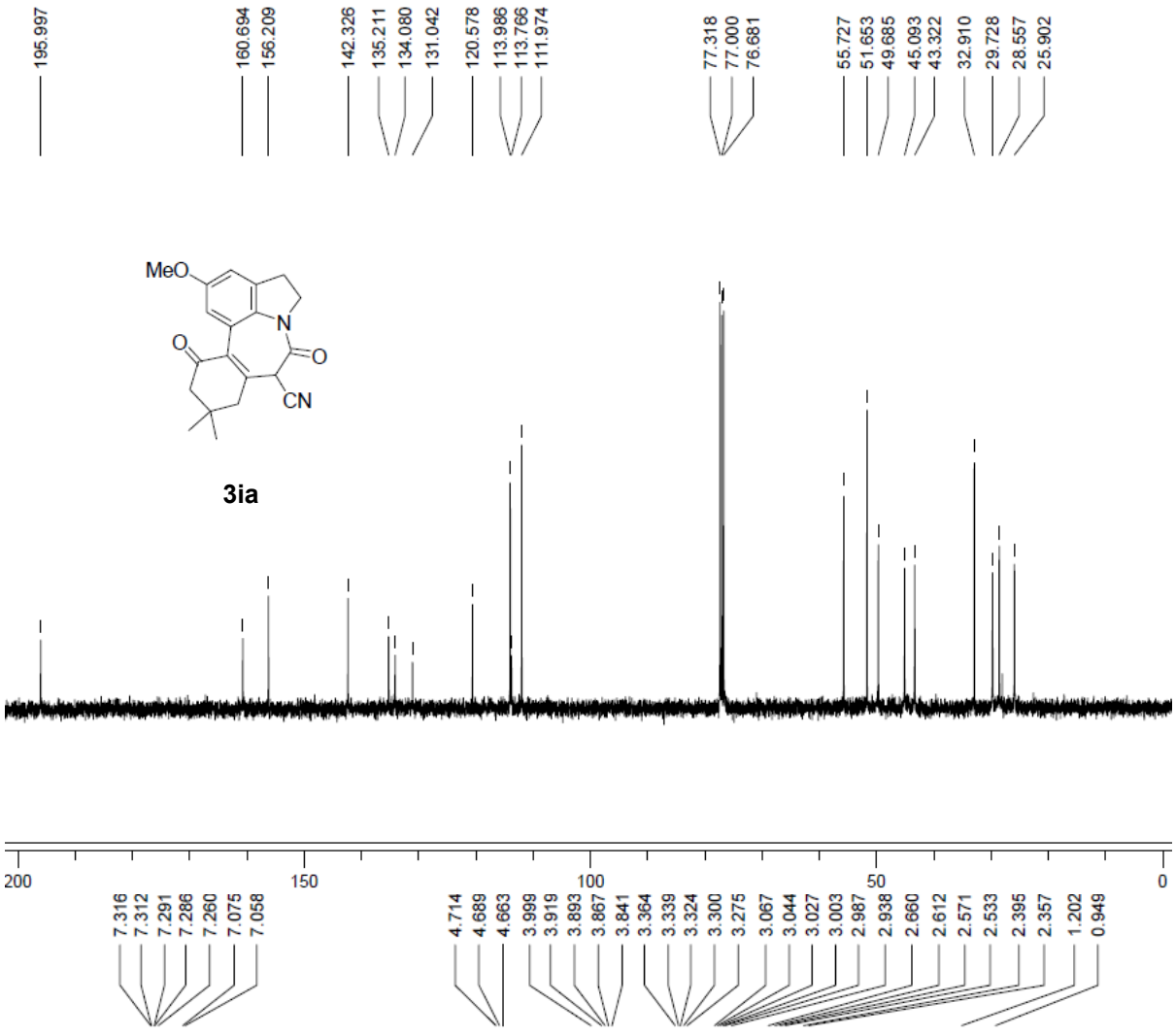
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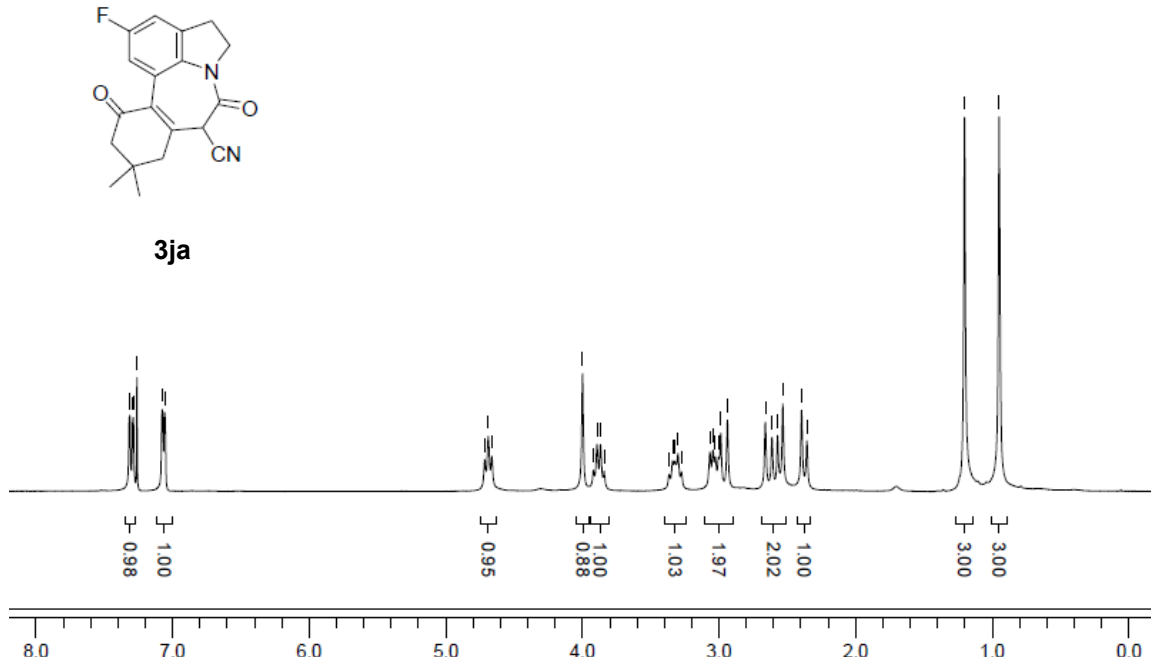
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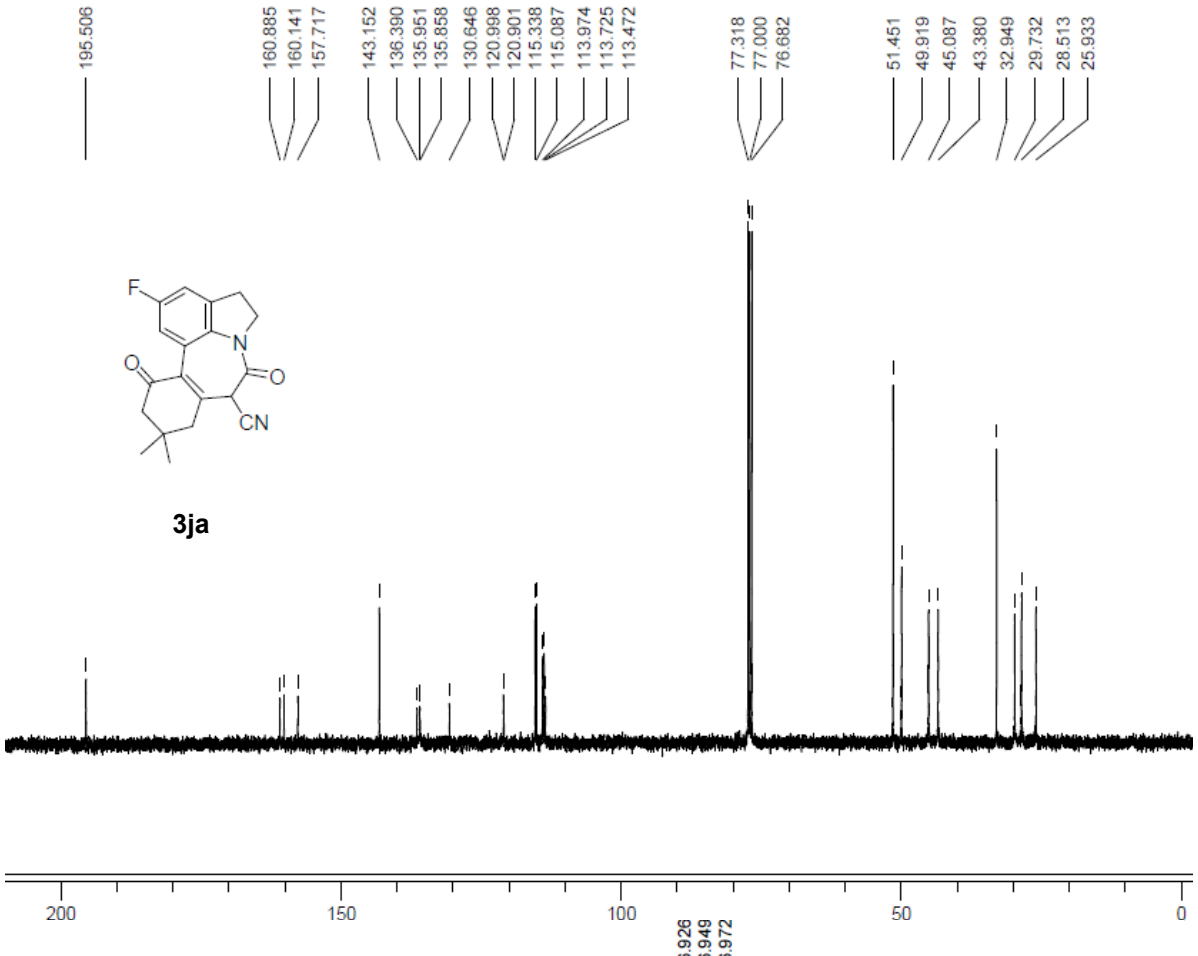
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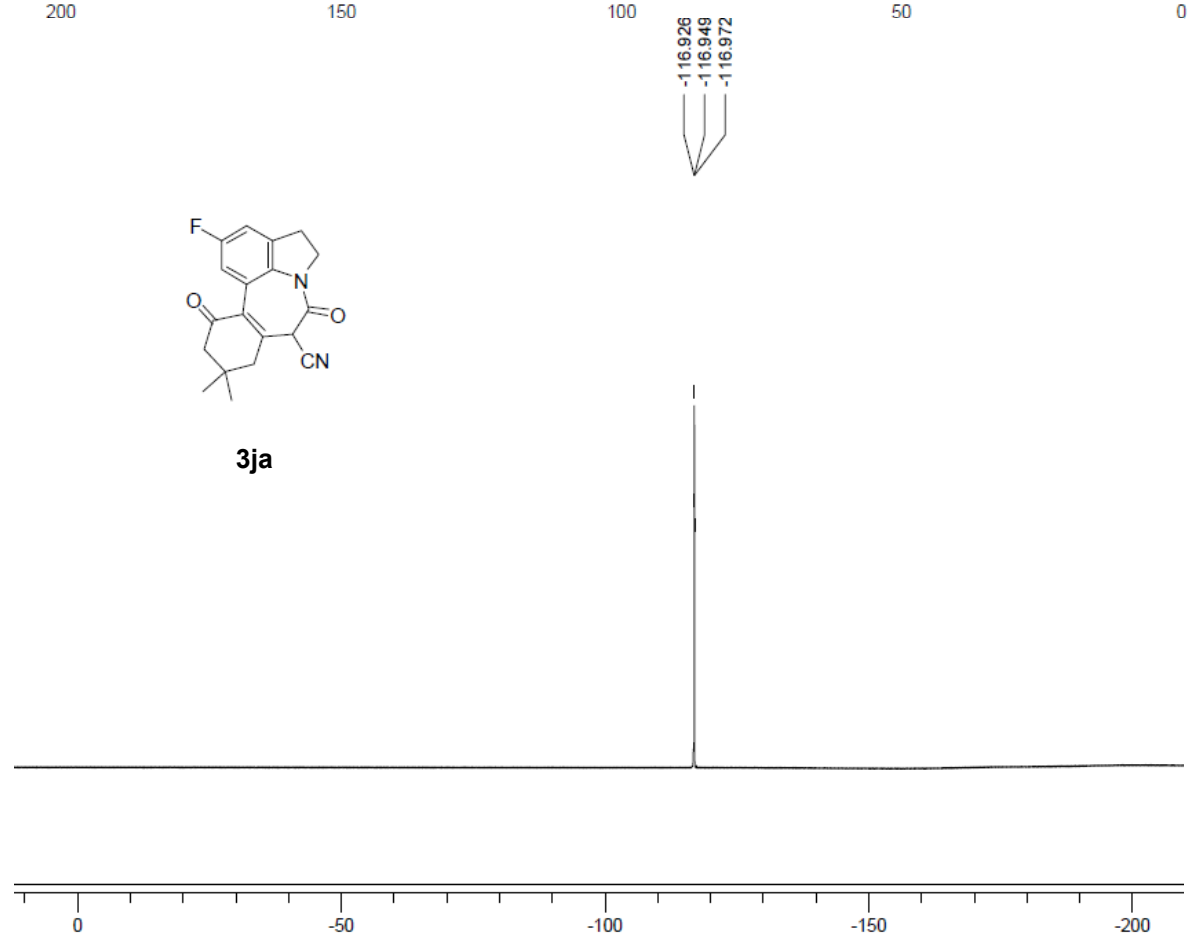
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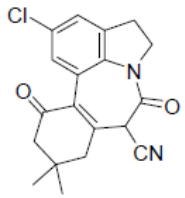
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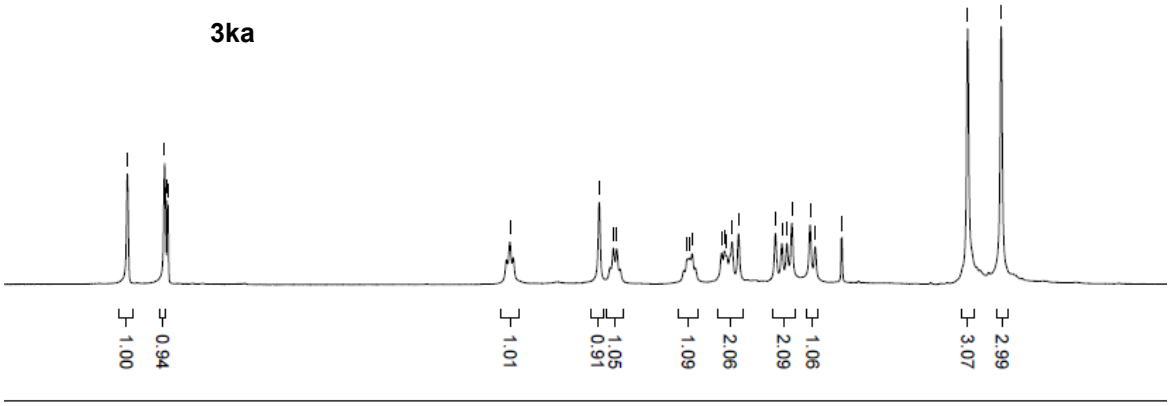
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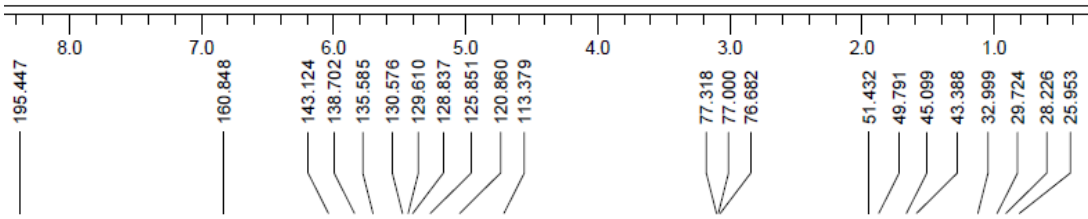
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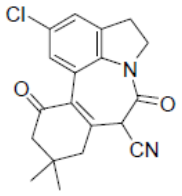
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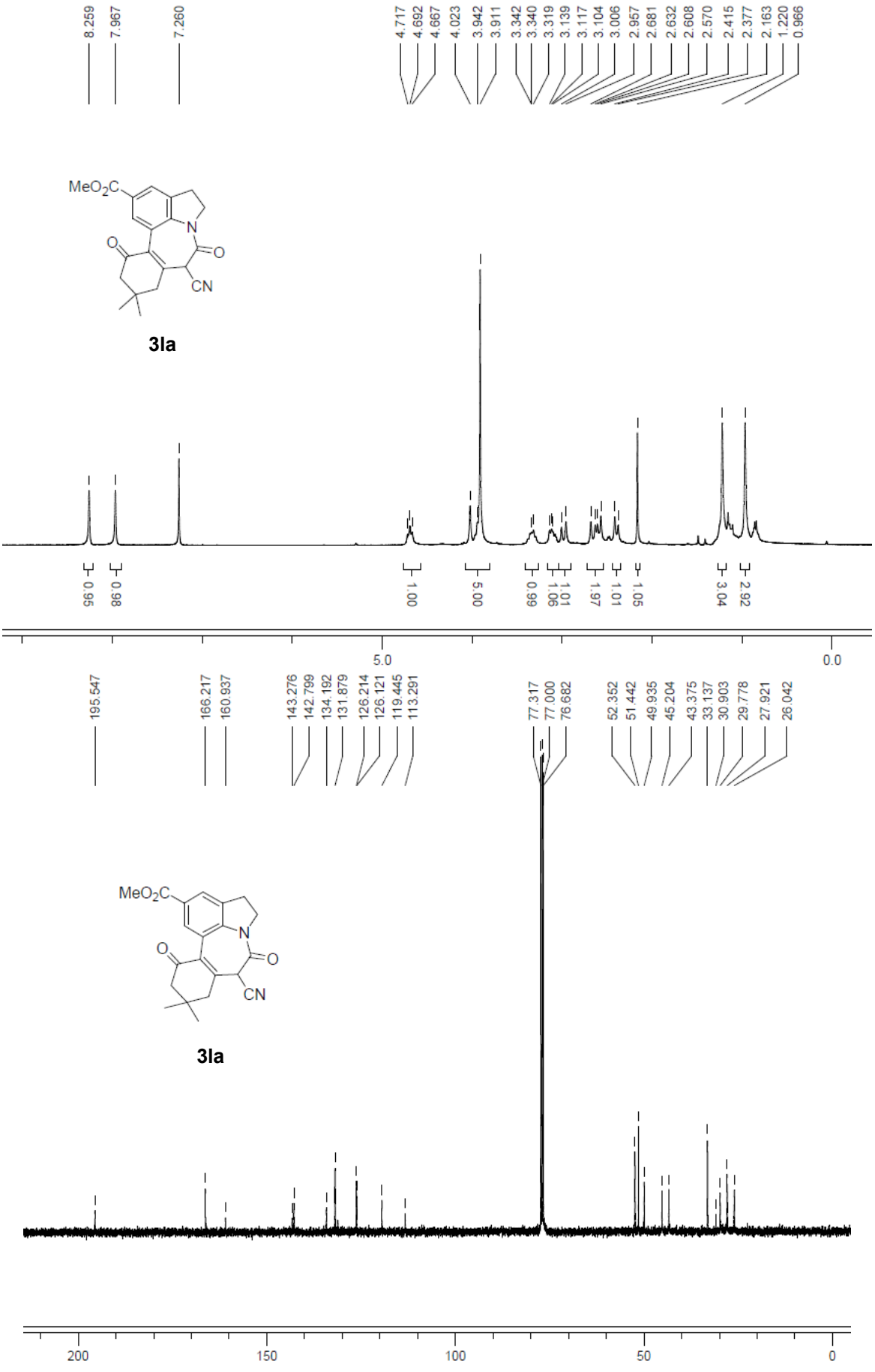
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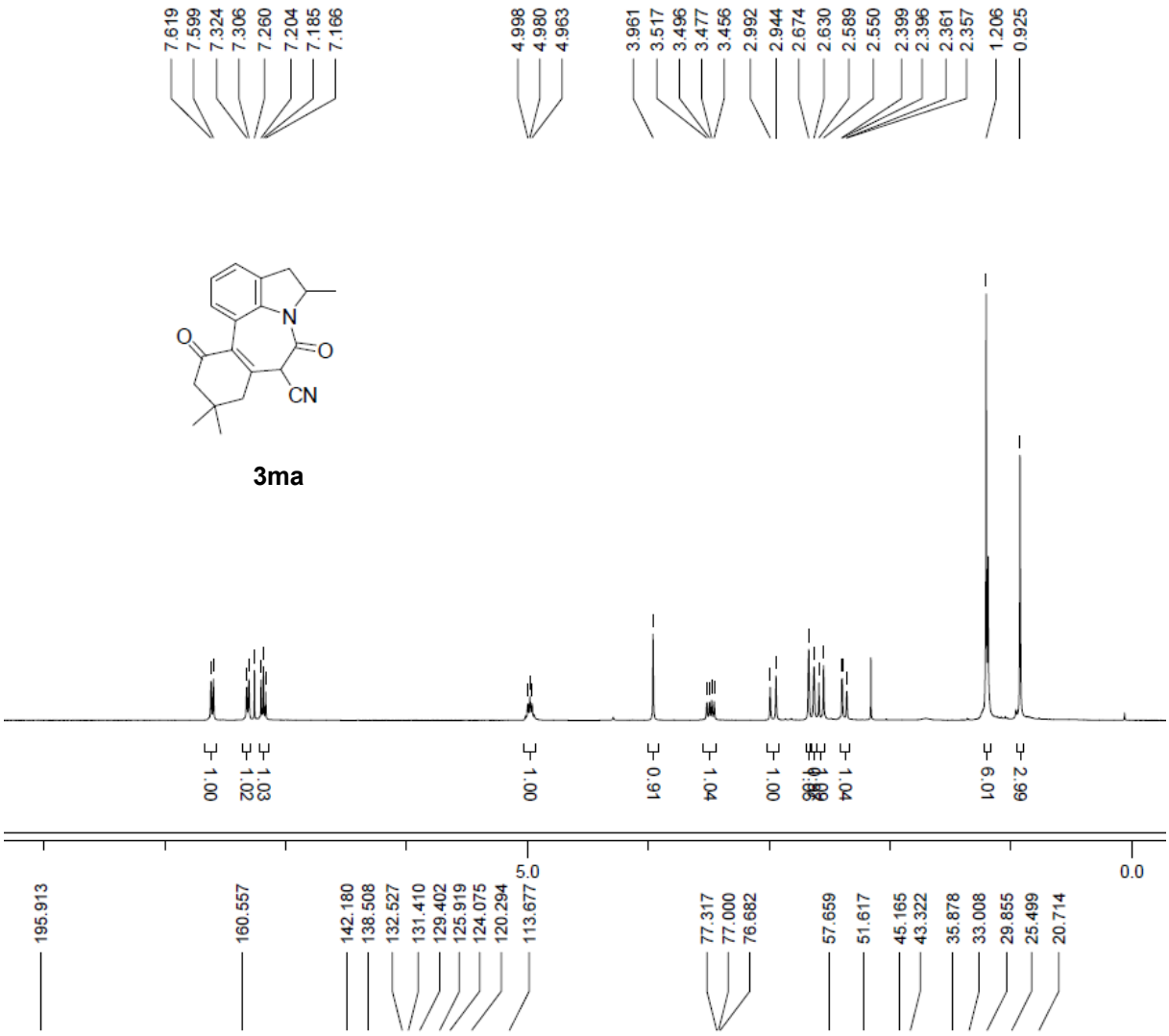
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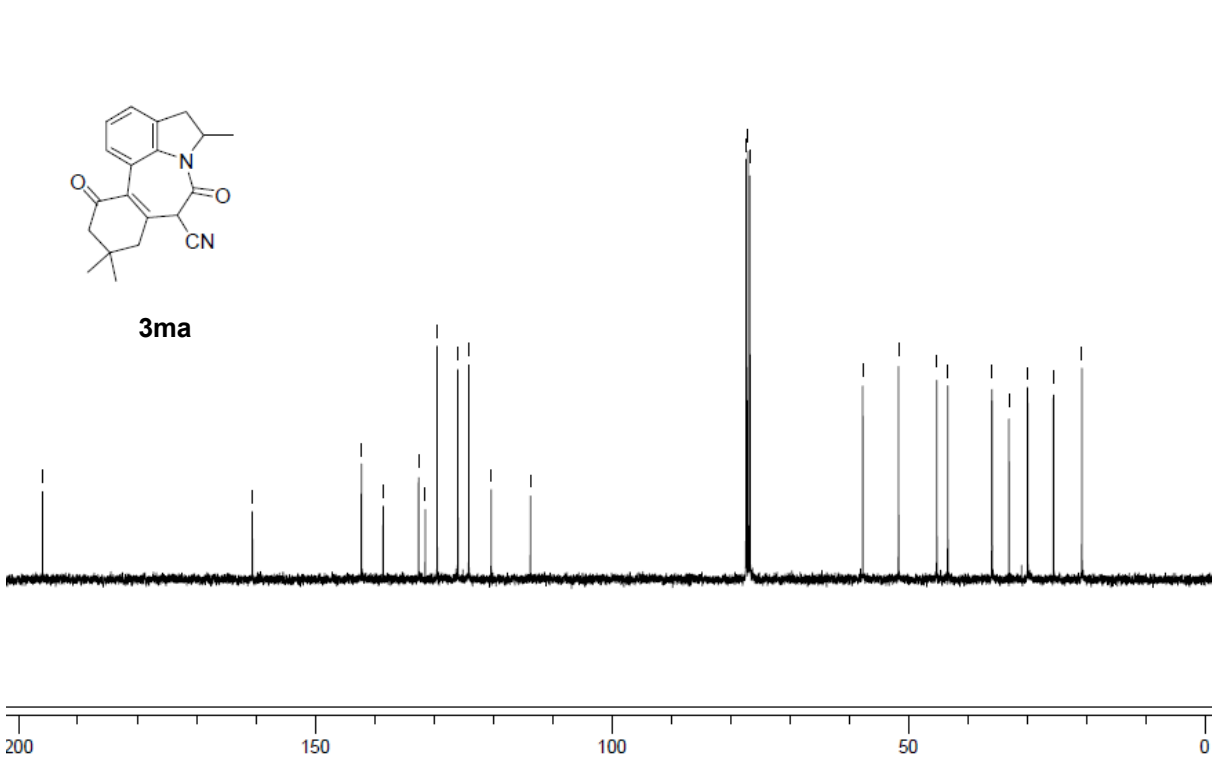
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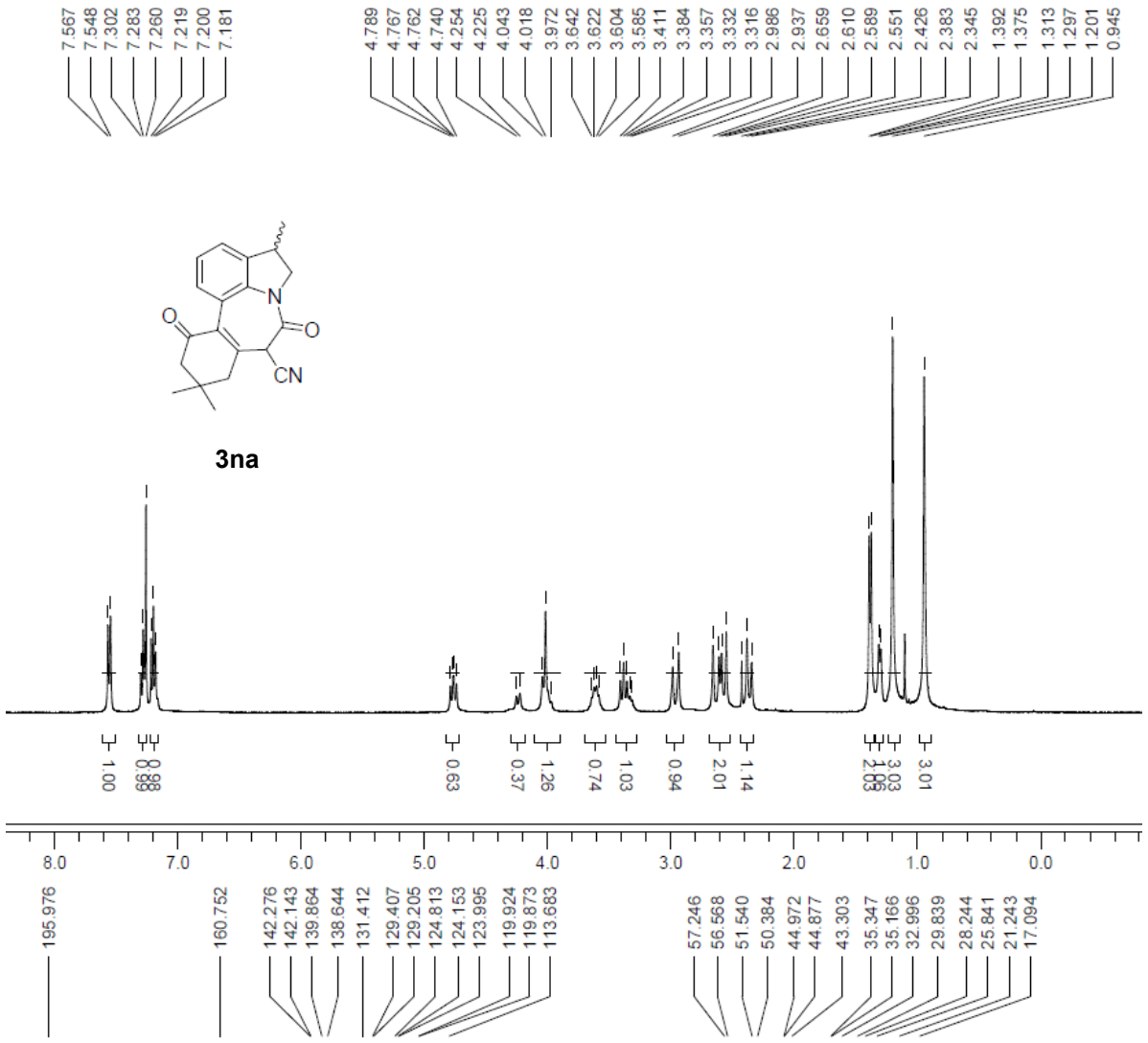
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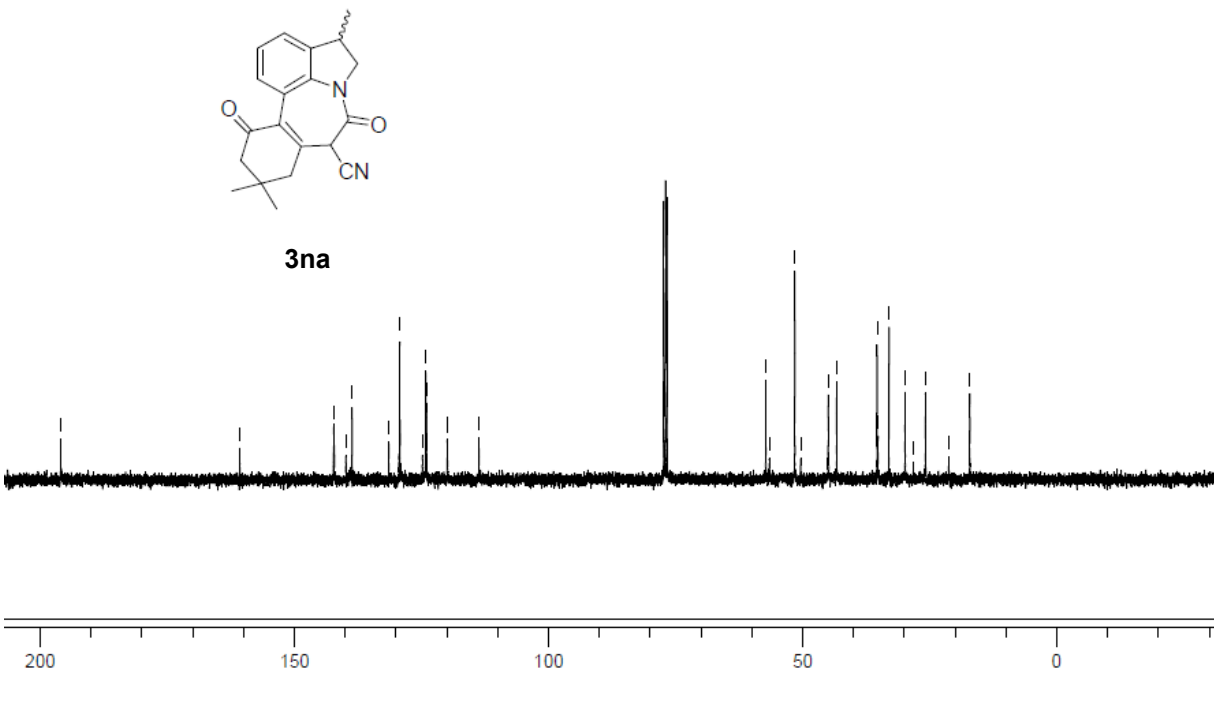
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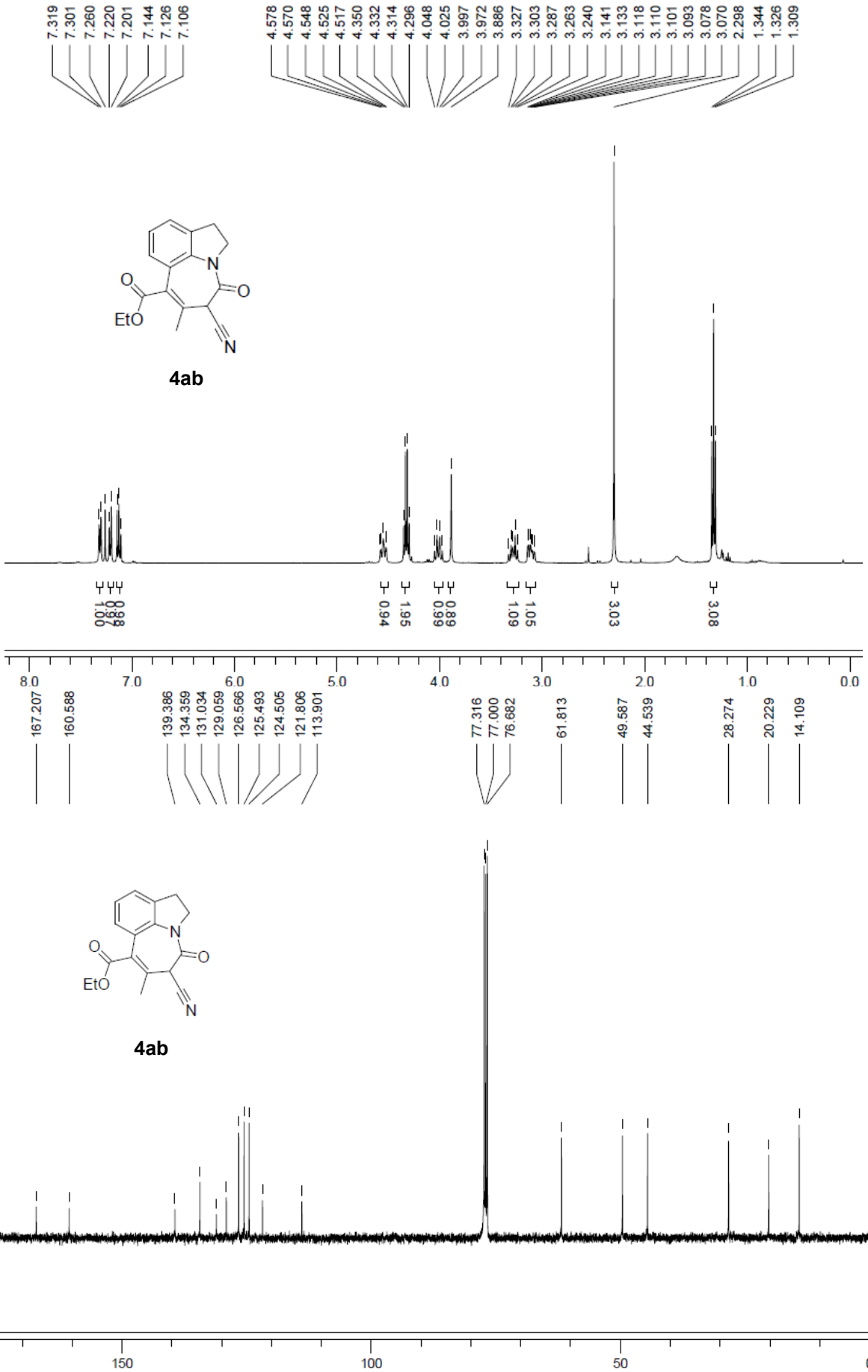
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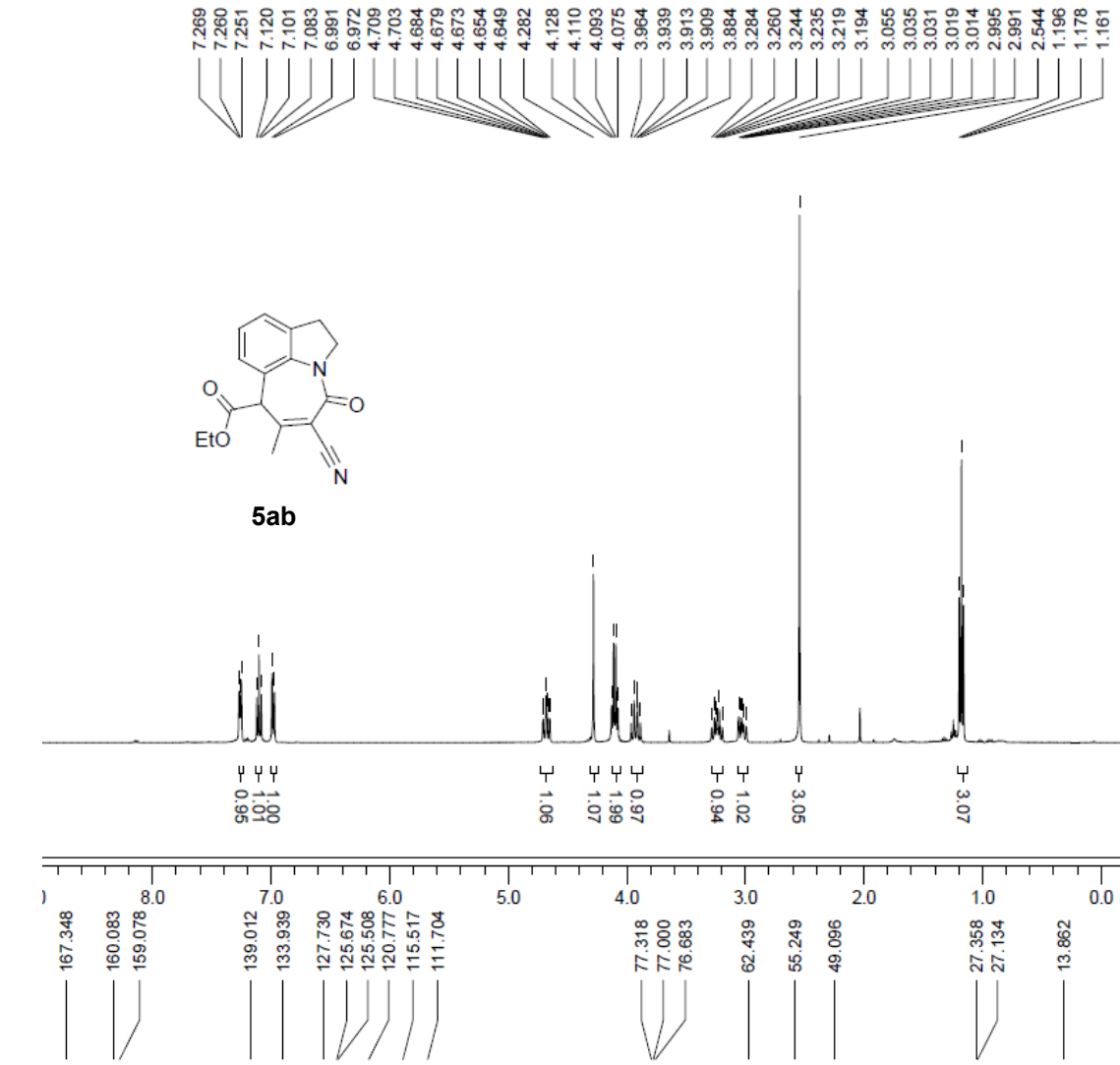
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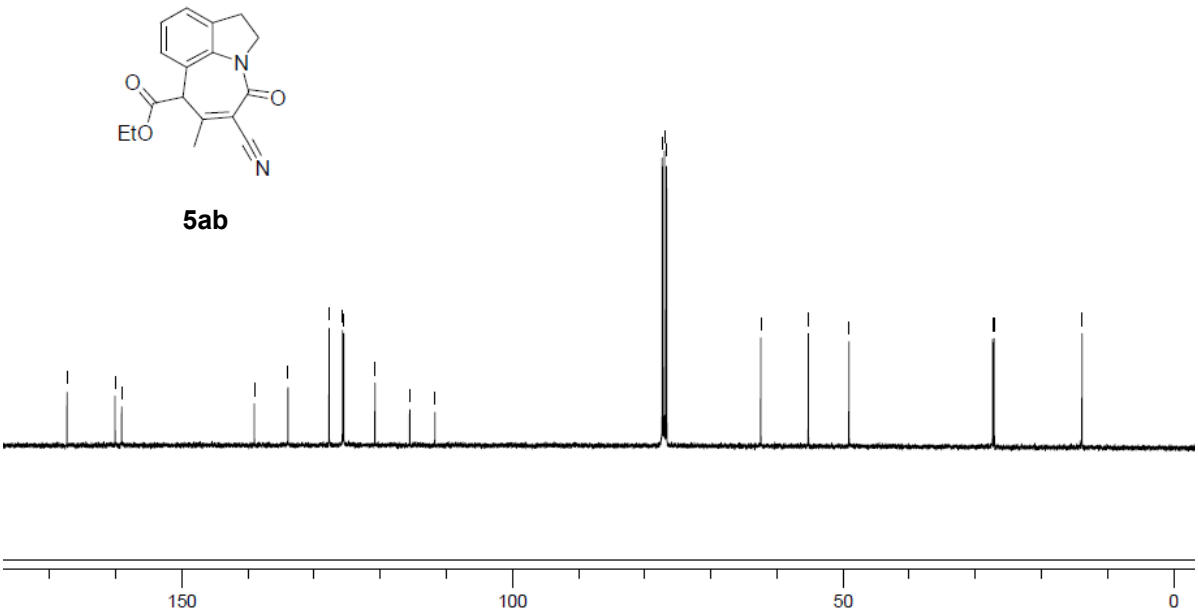
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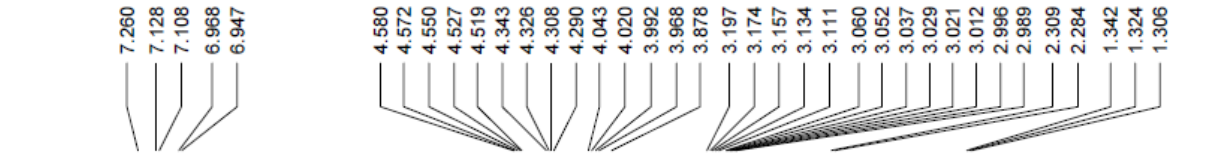
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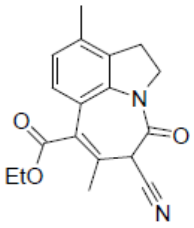
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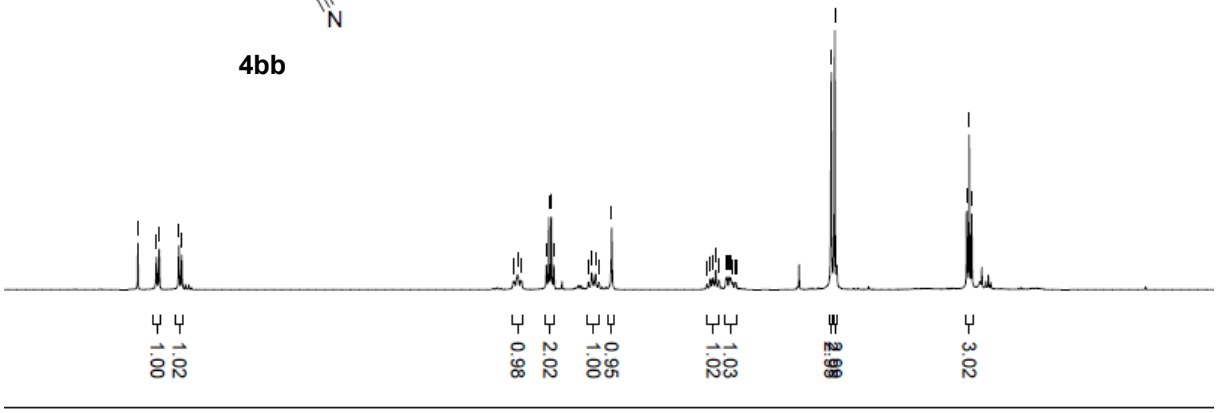
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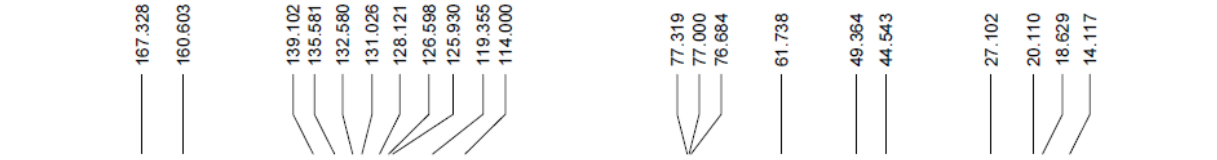
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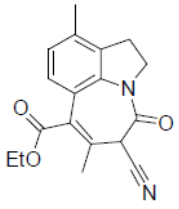
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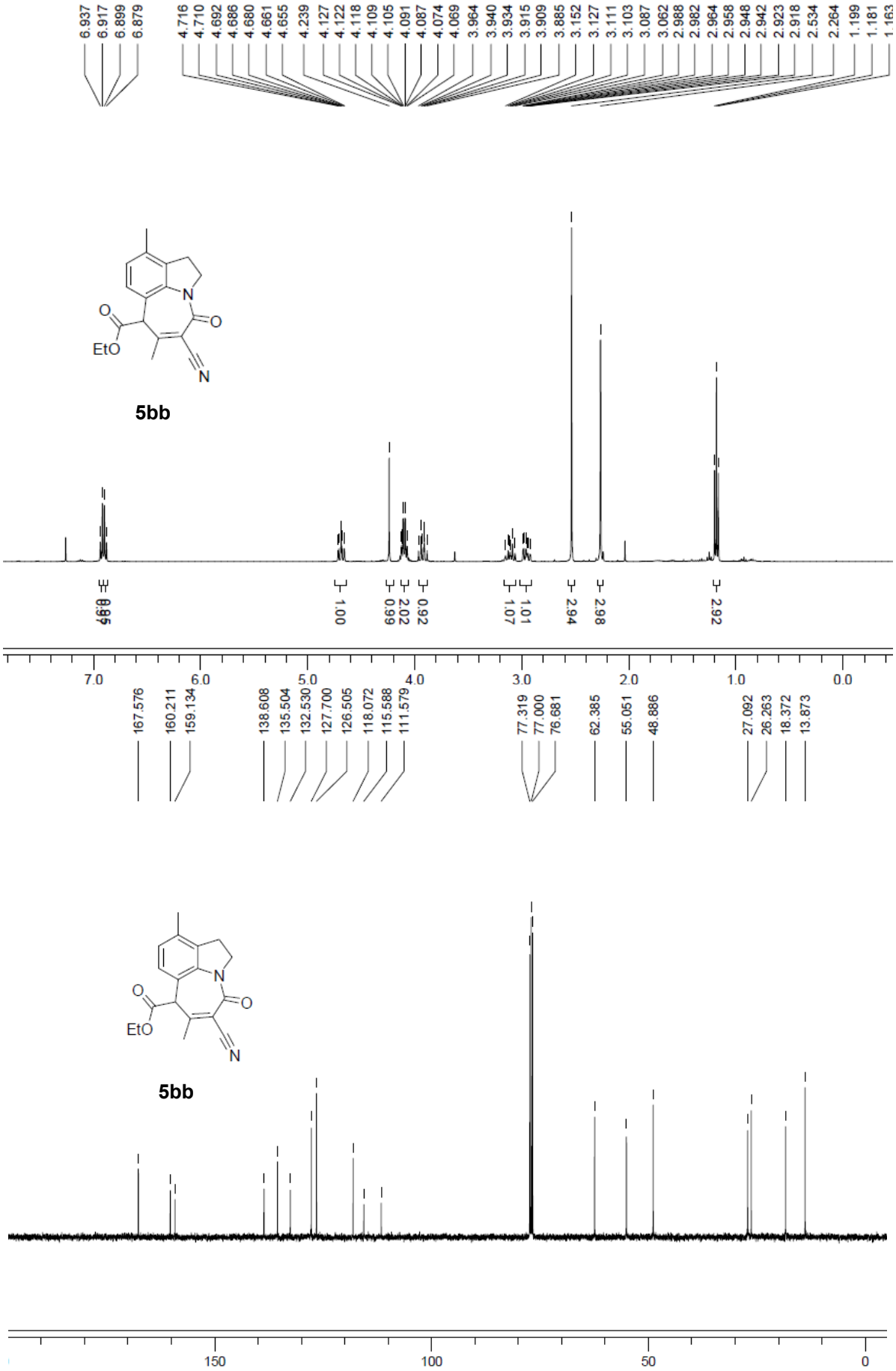
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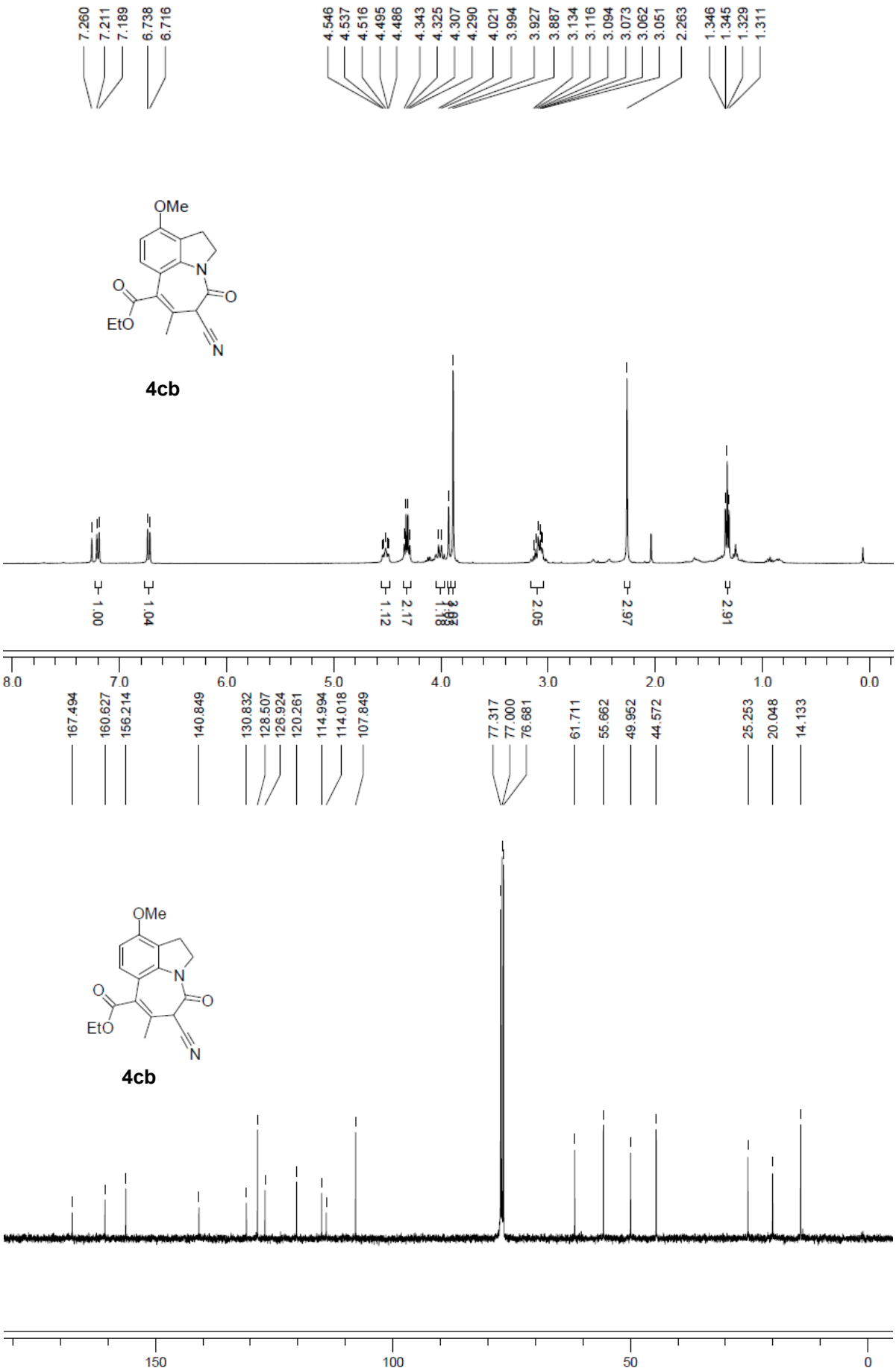
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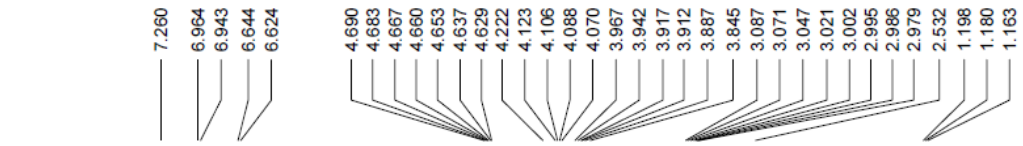
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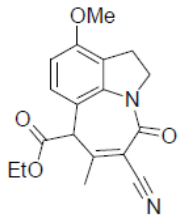
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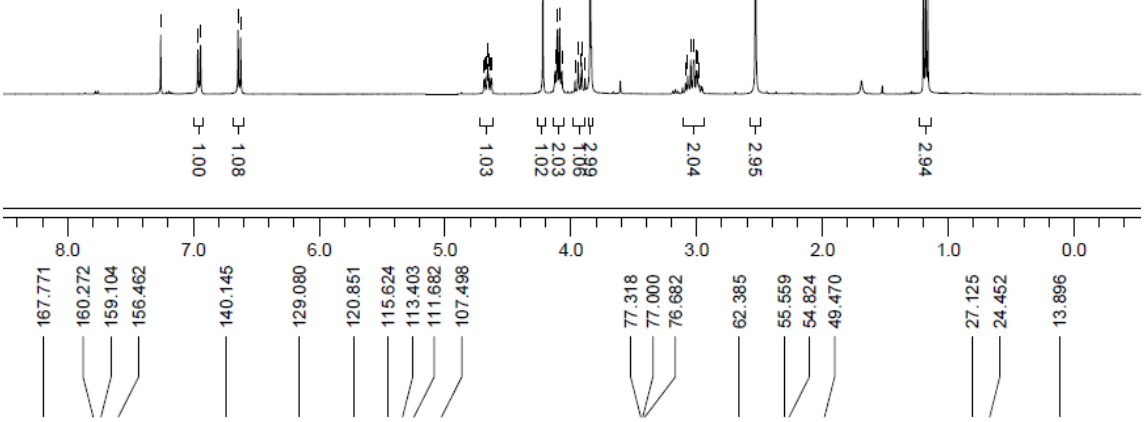
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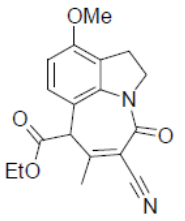
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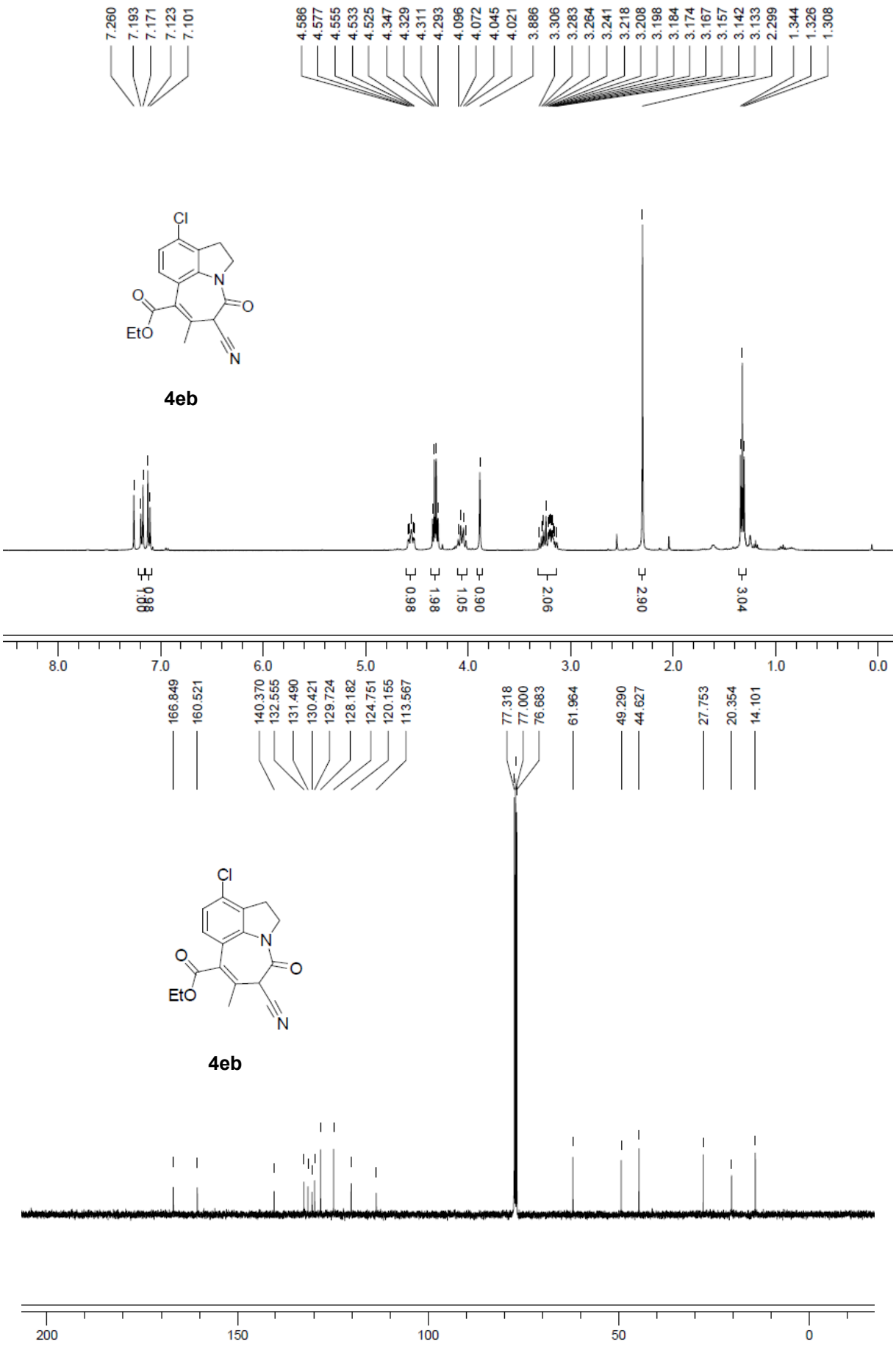
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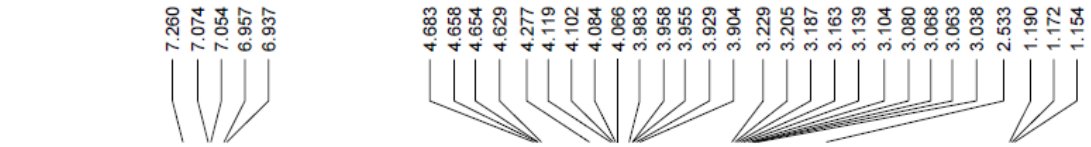
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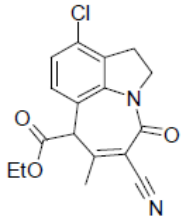
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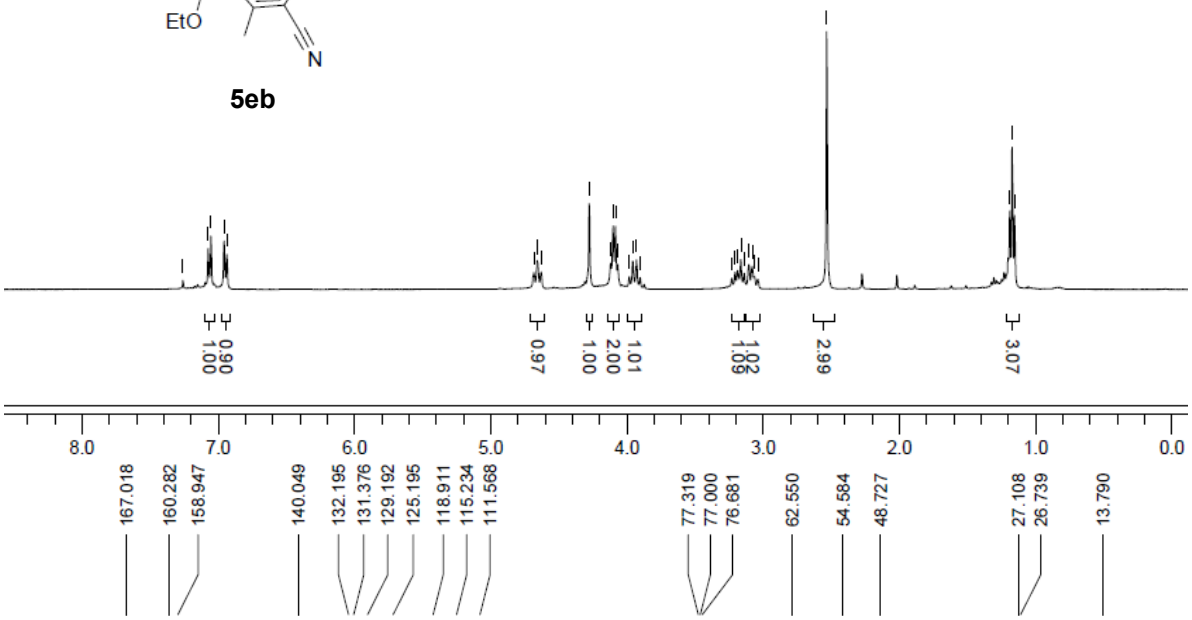
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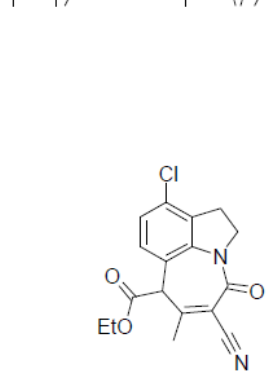
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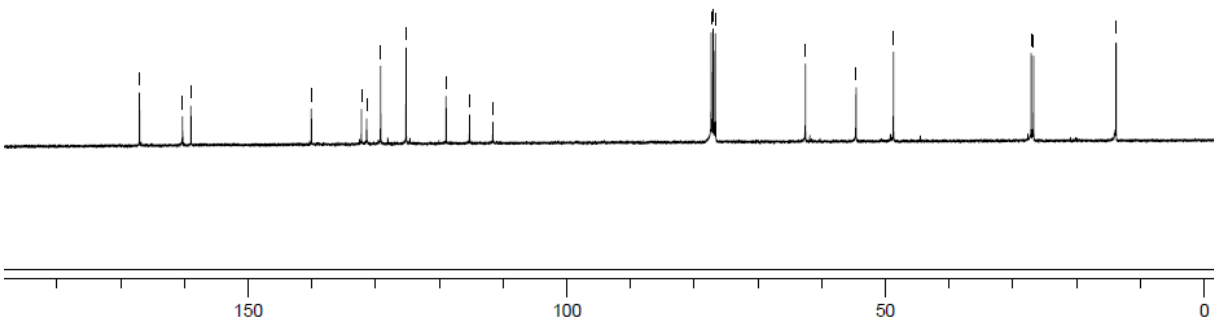
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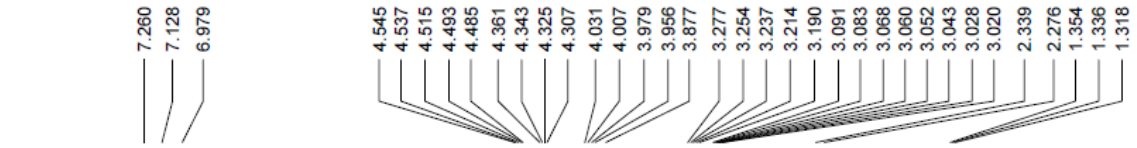
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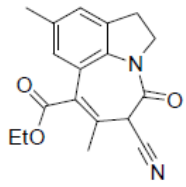
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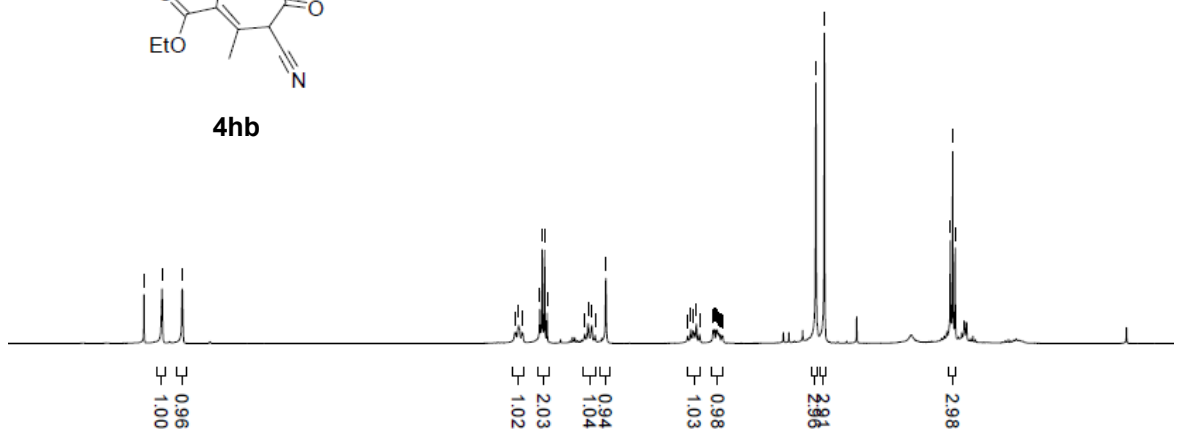
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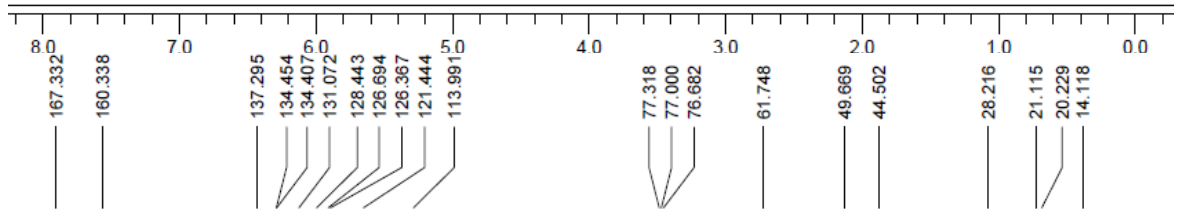
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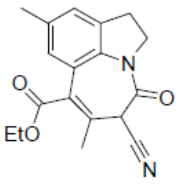
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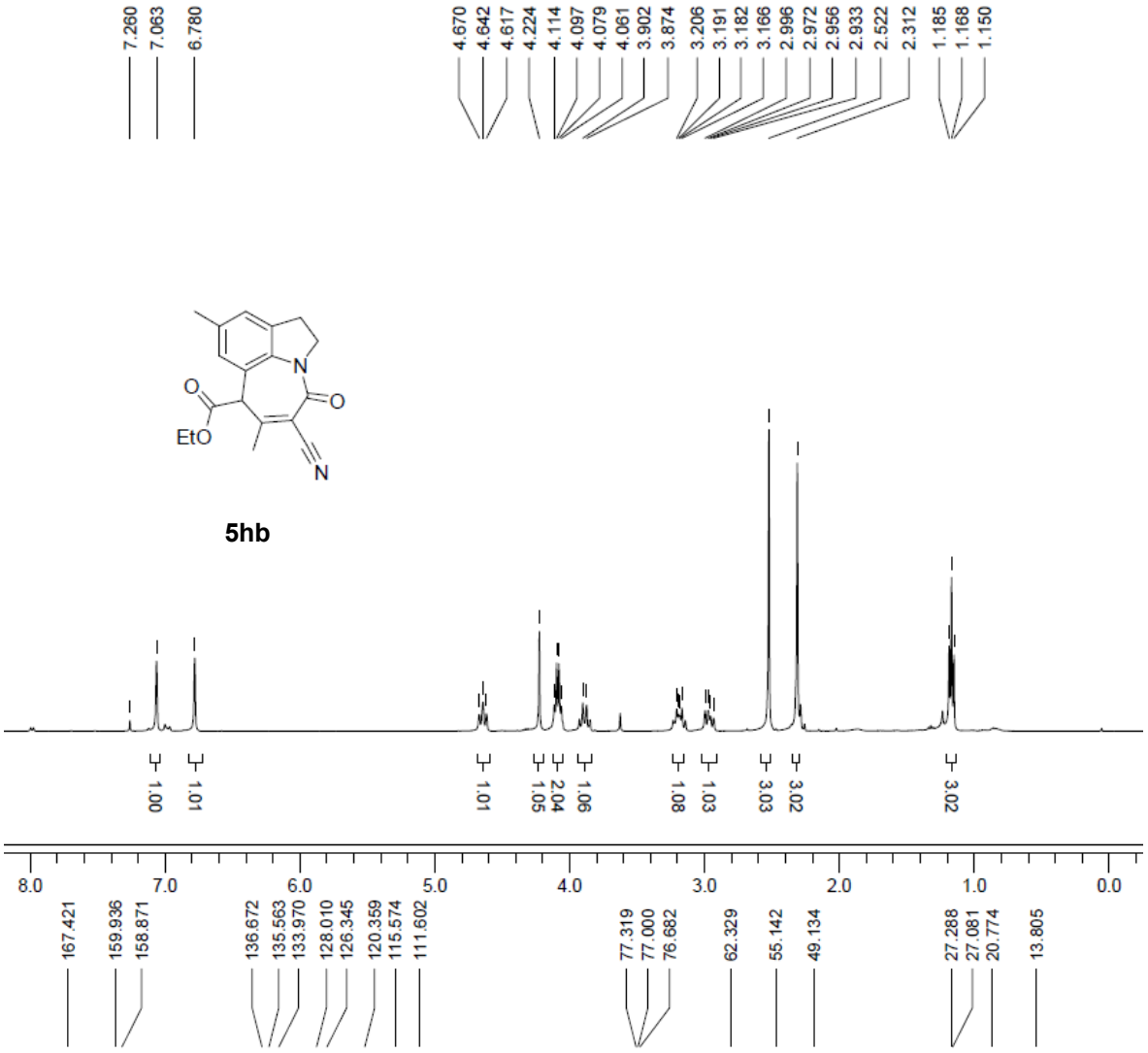
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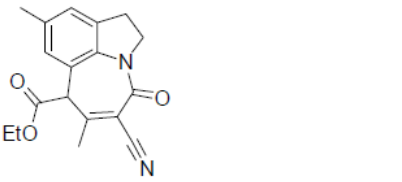
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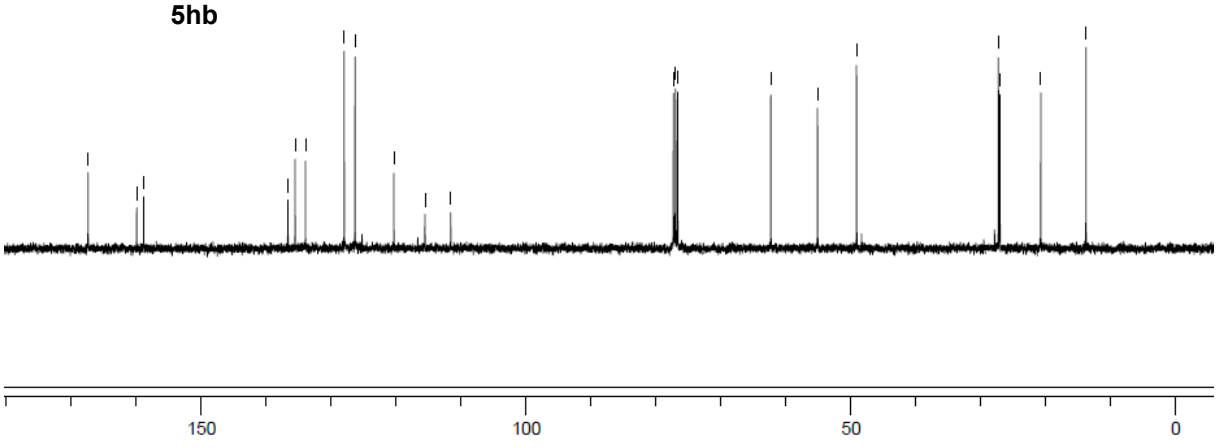
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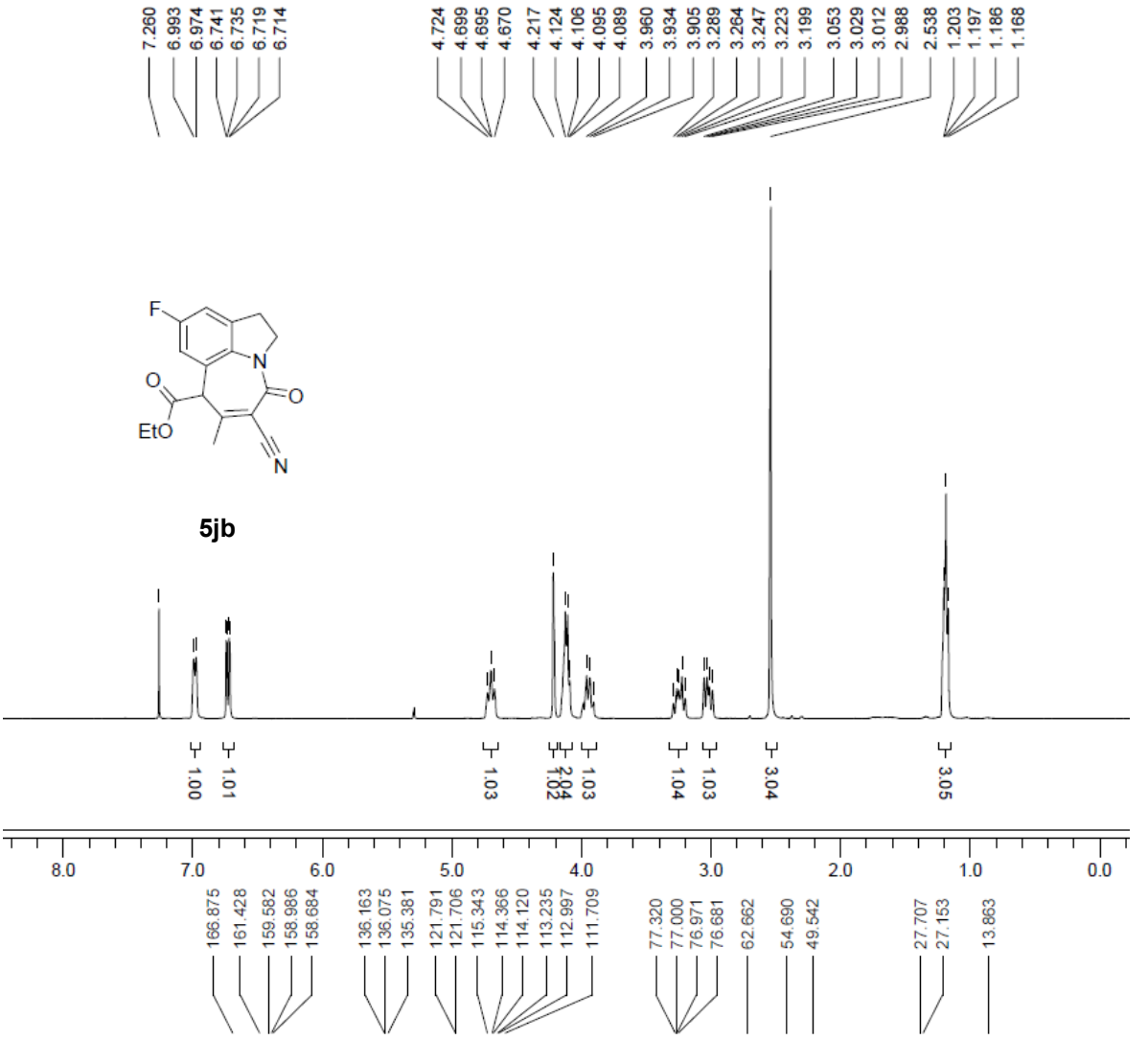
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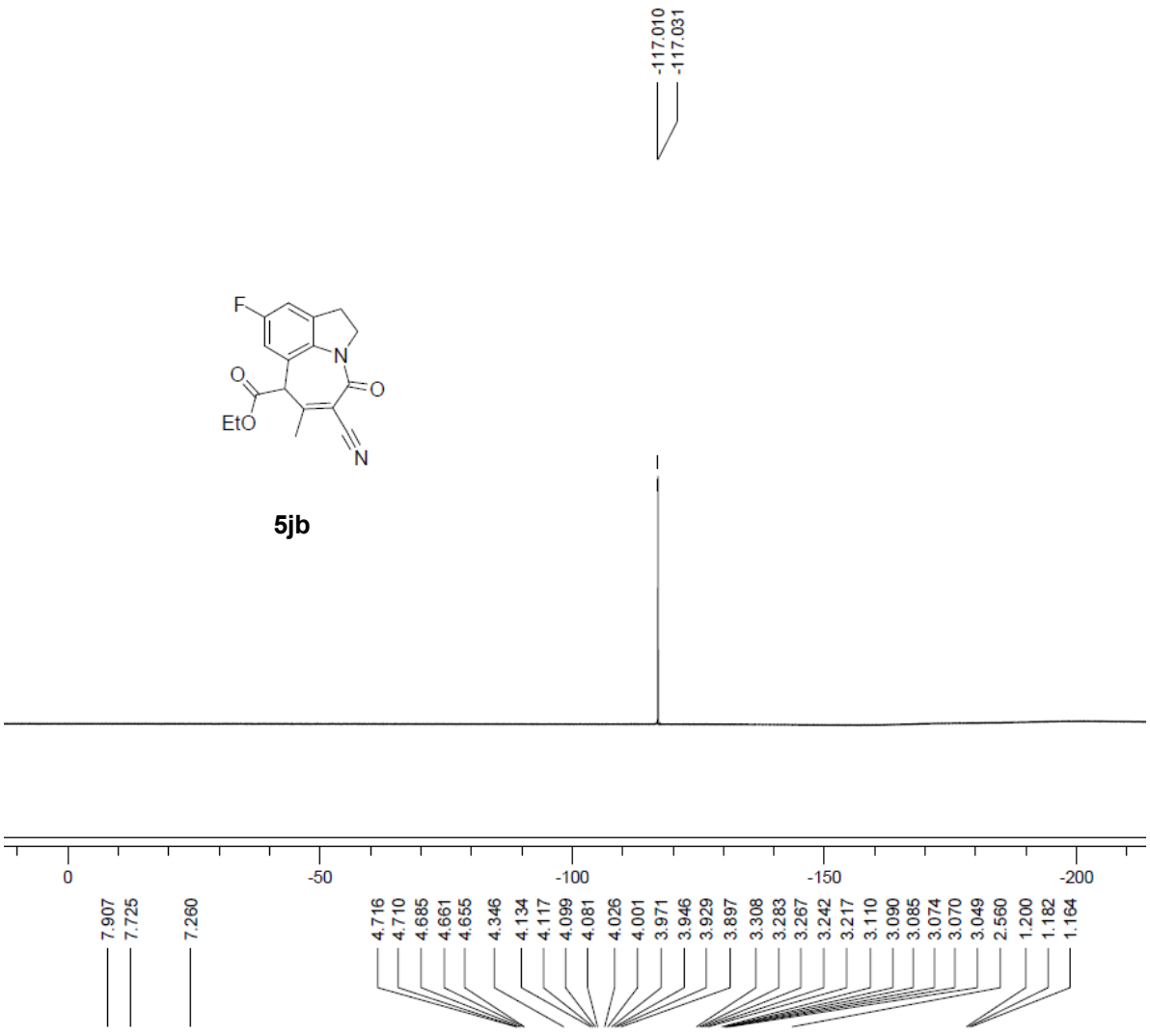
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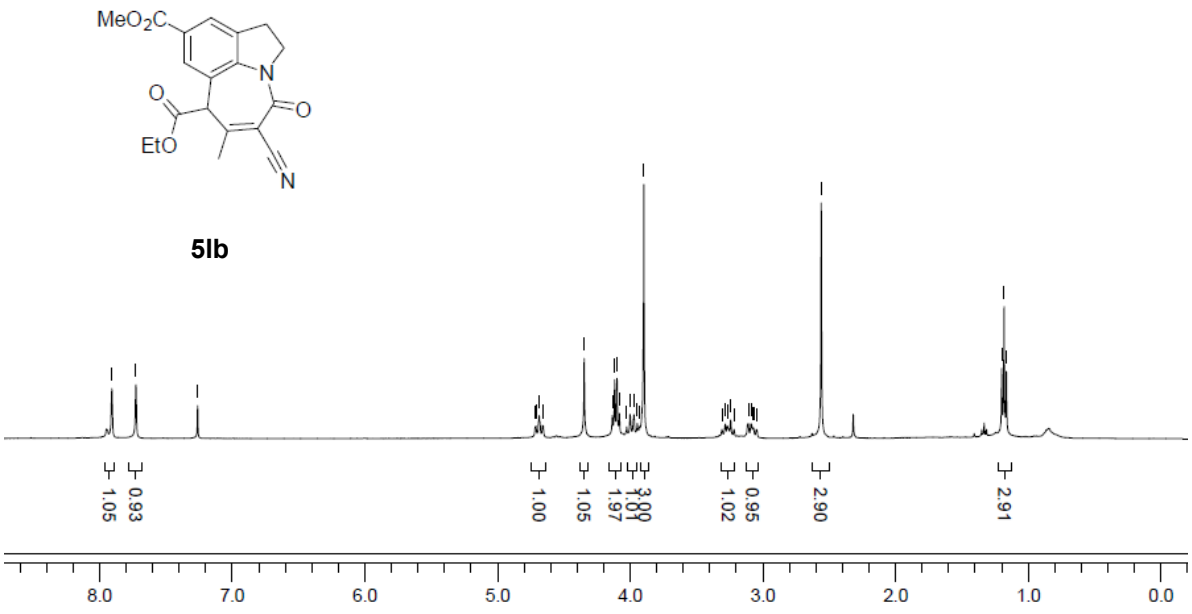
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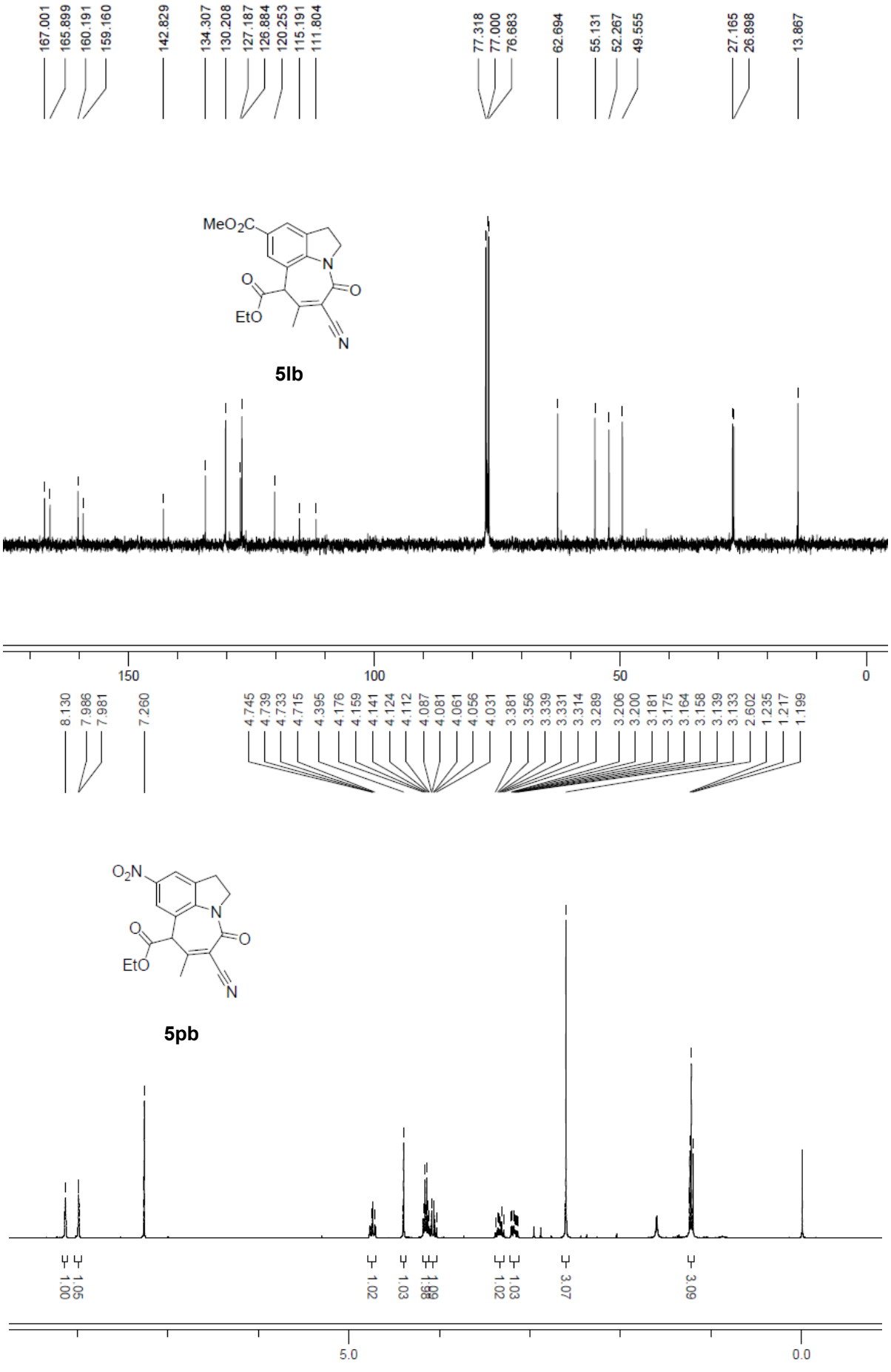
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100
50
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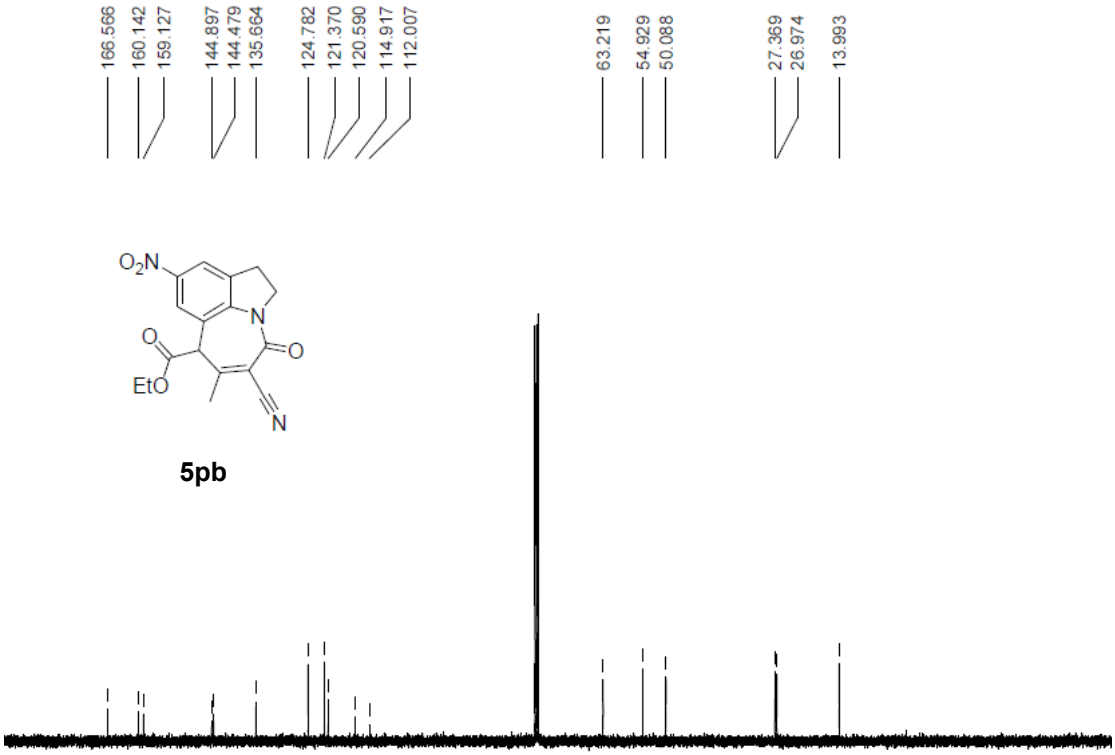
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EtO
N
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100
50
0

5pb

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7.130
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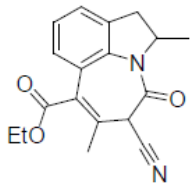
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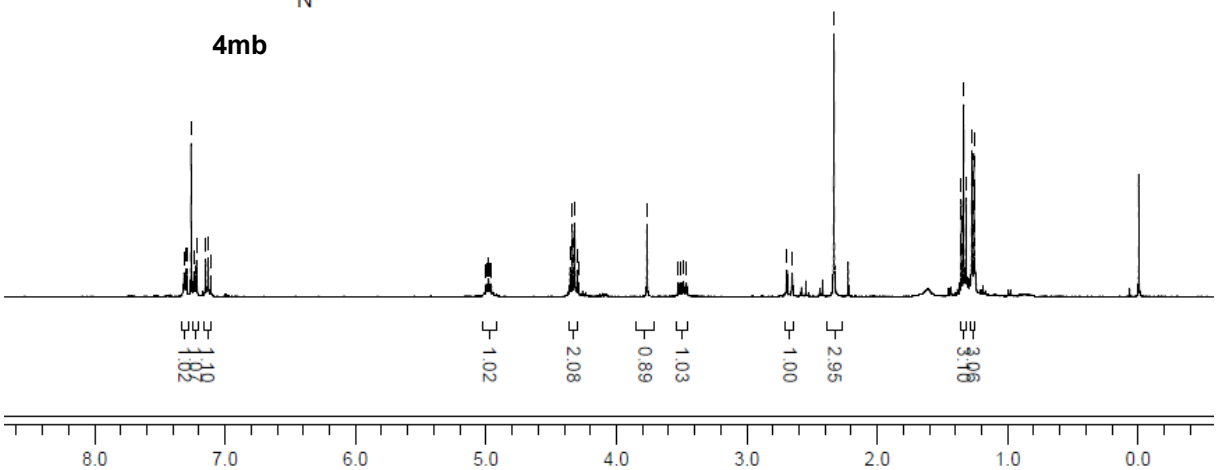
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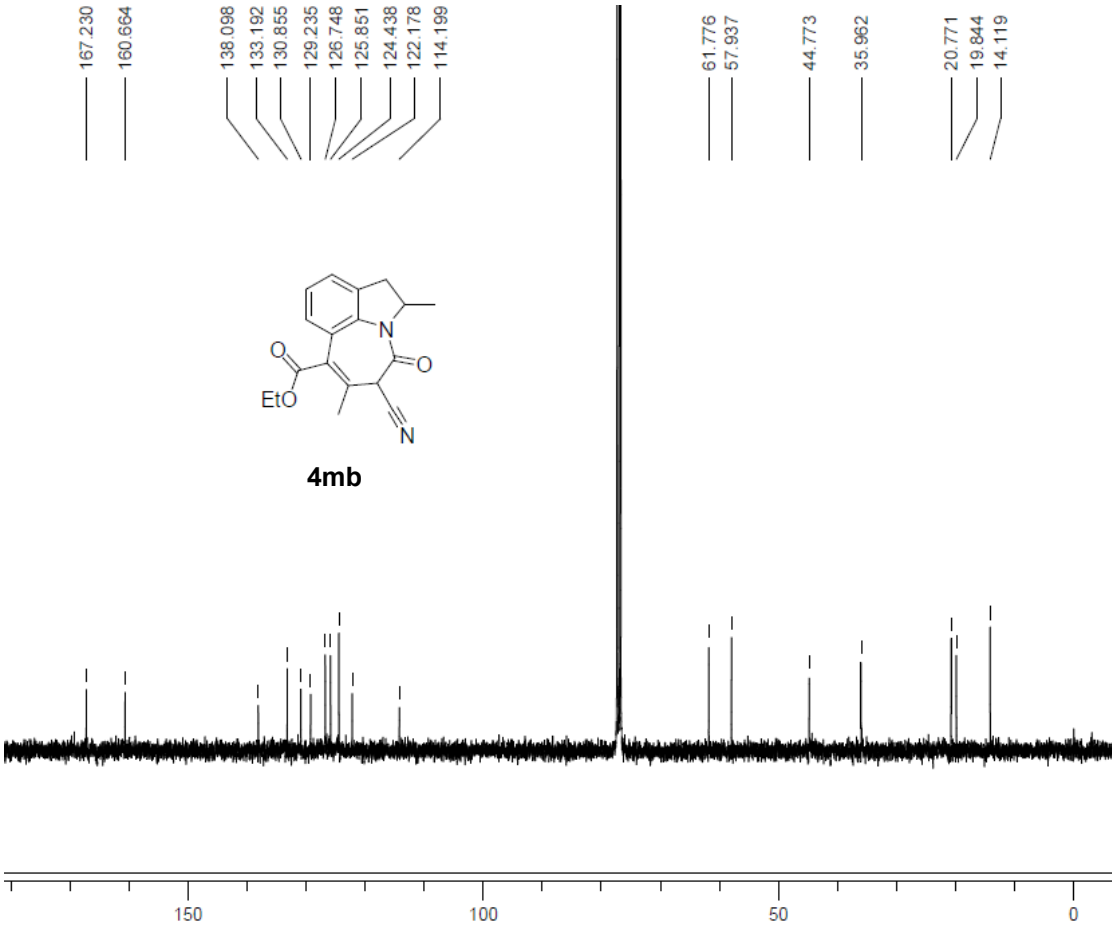
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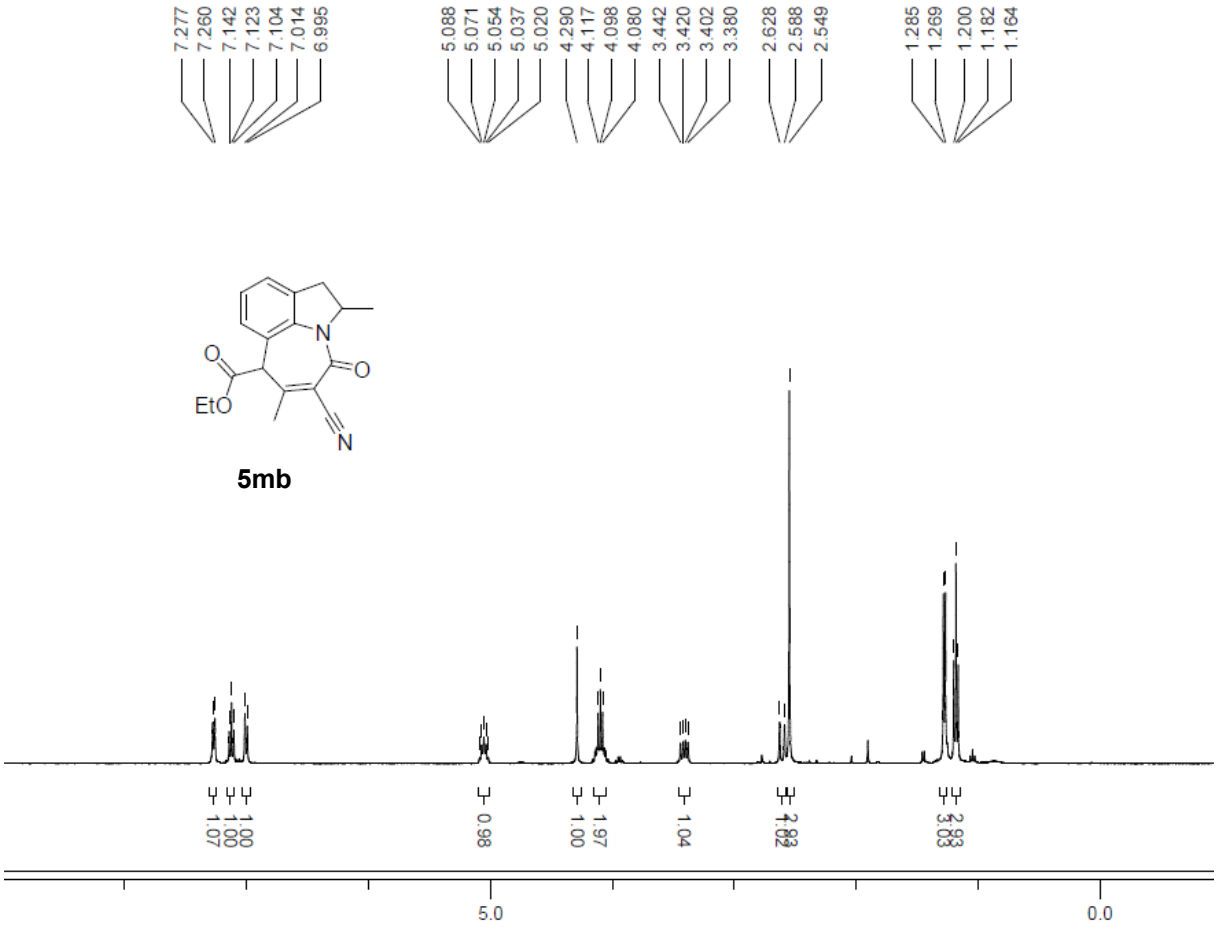
4mb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4.098
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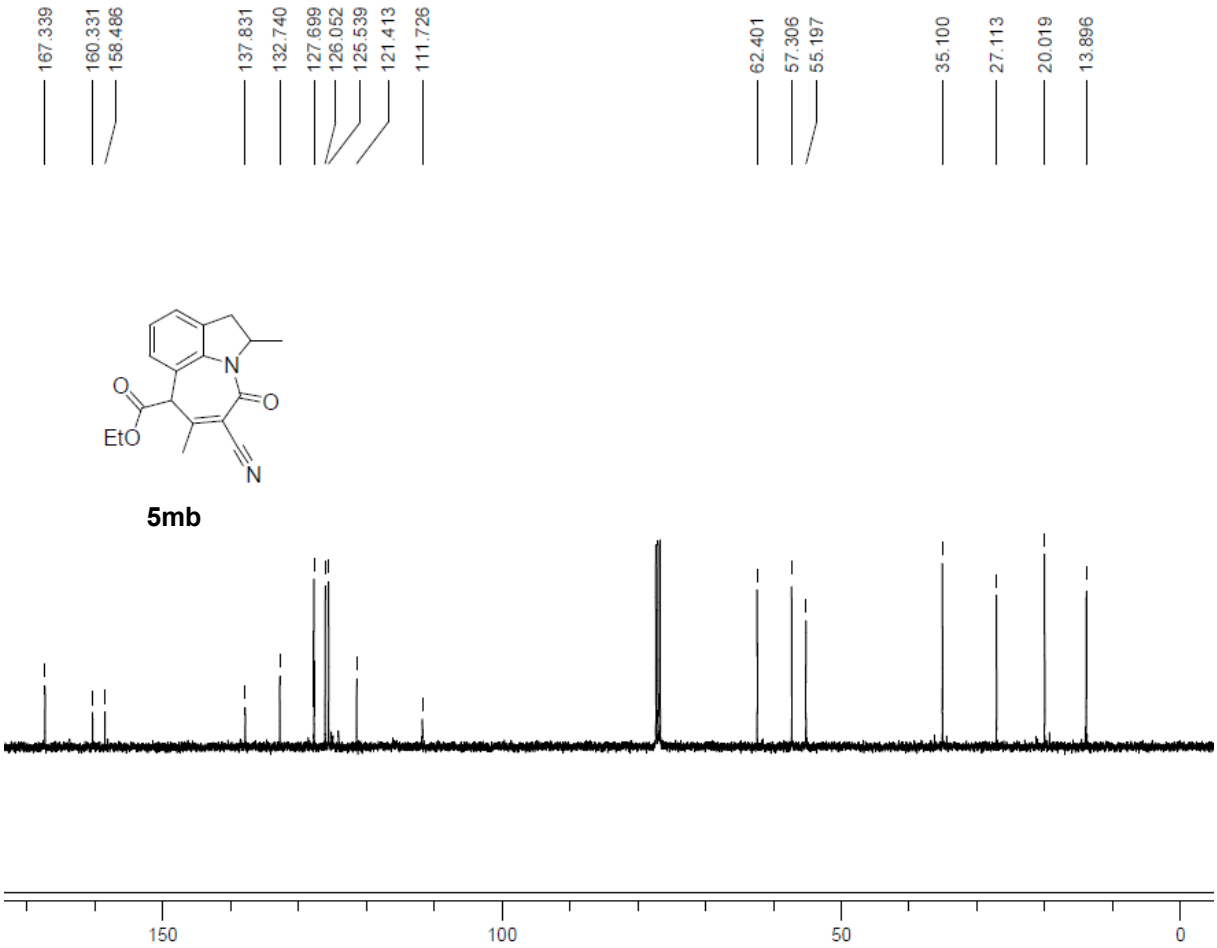
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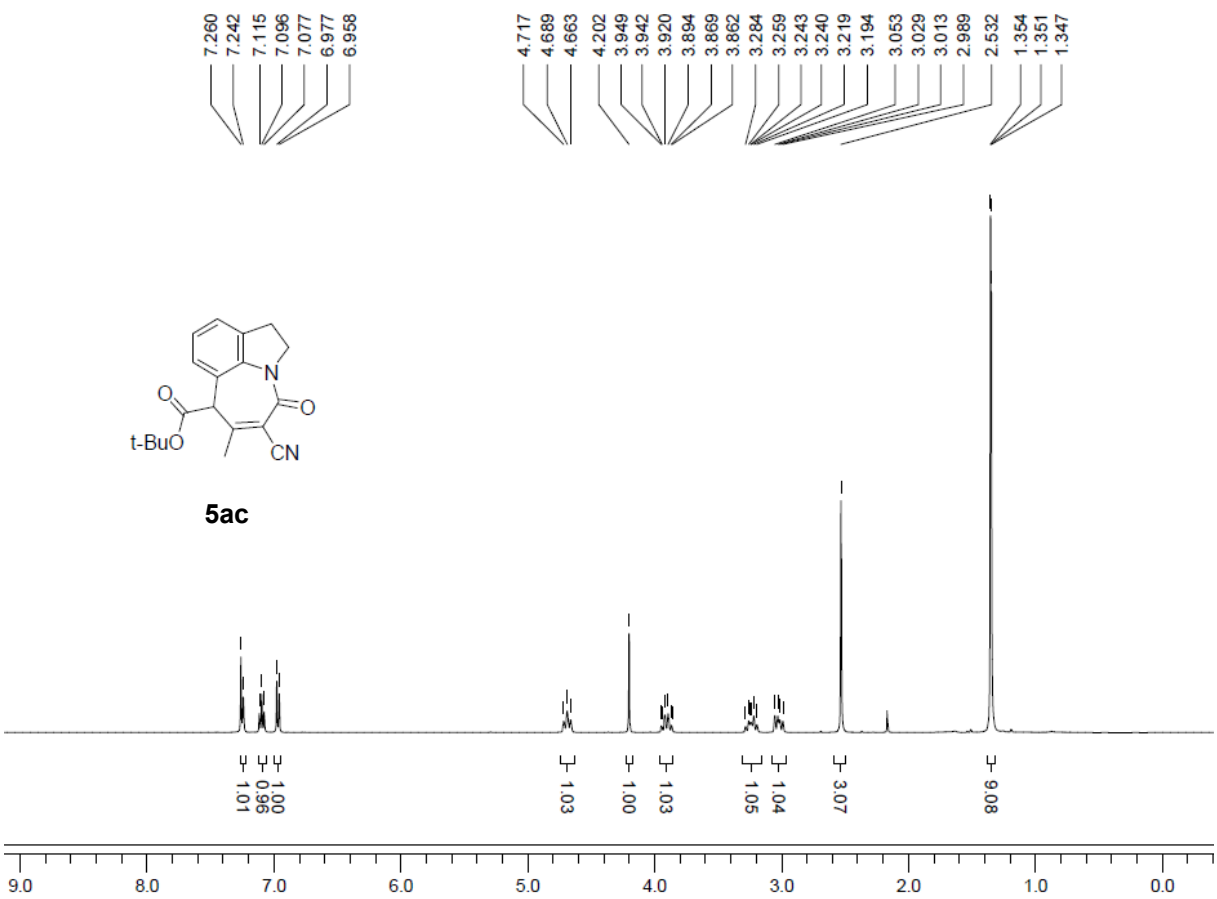
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O
t-BuO
CN
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1.00
1.03
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1.04
3.07
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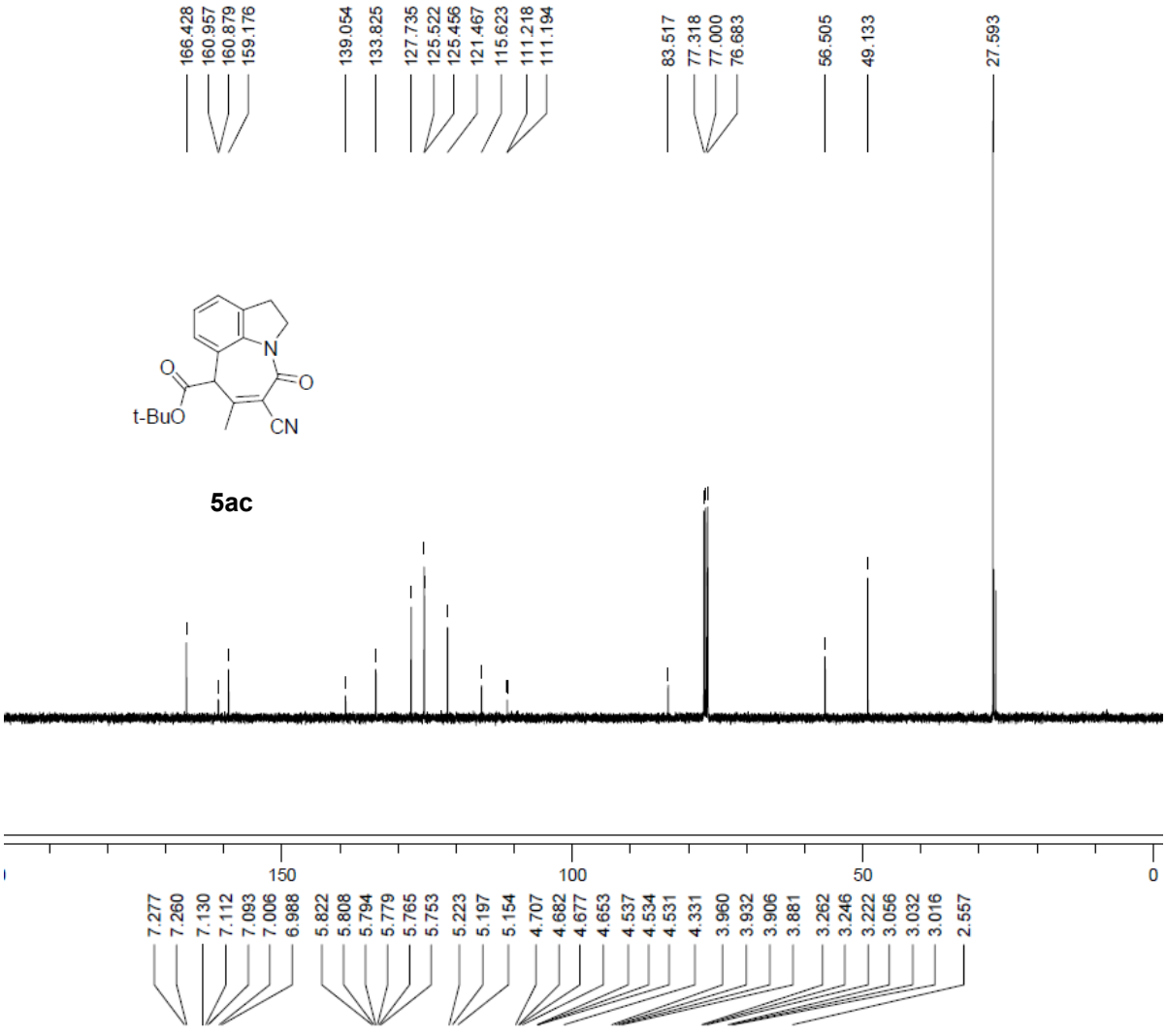
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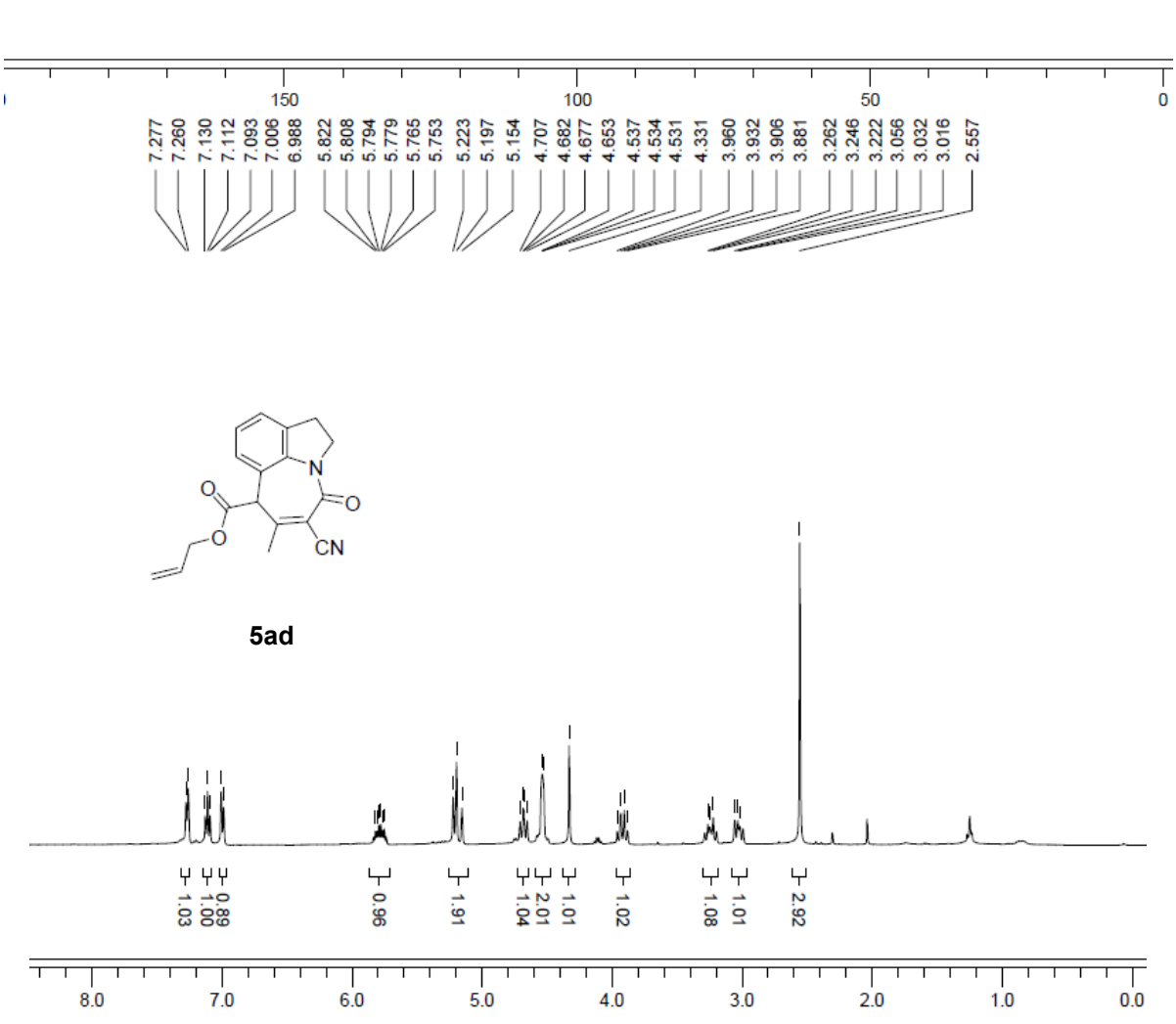
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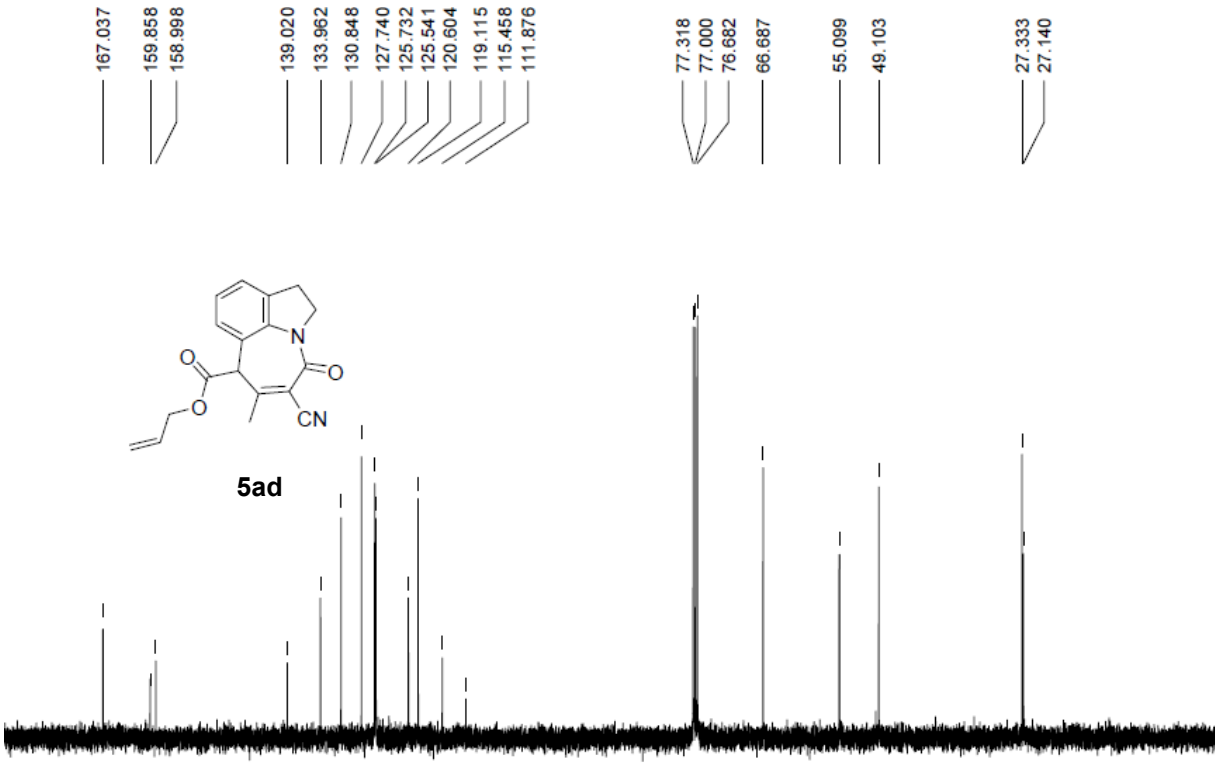
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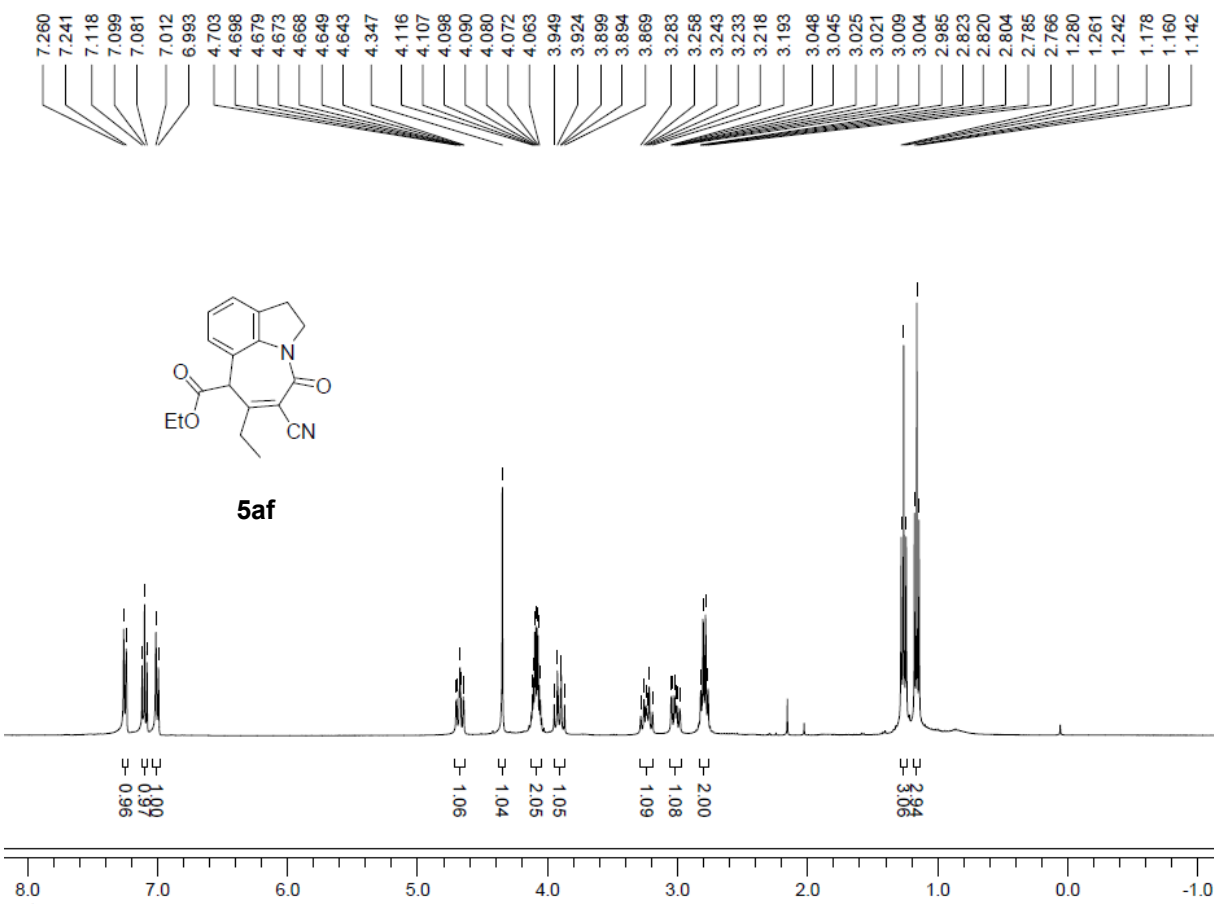
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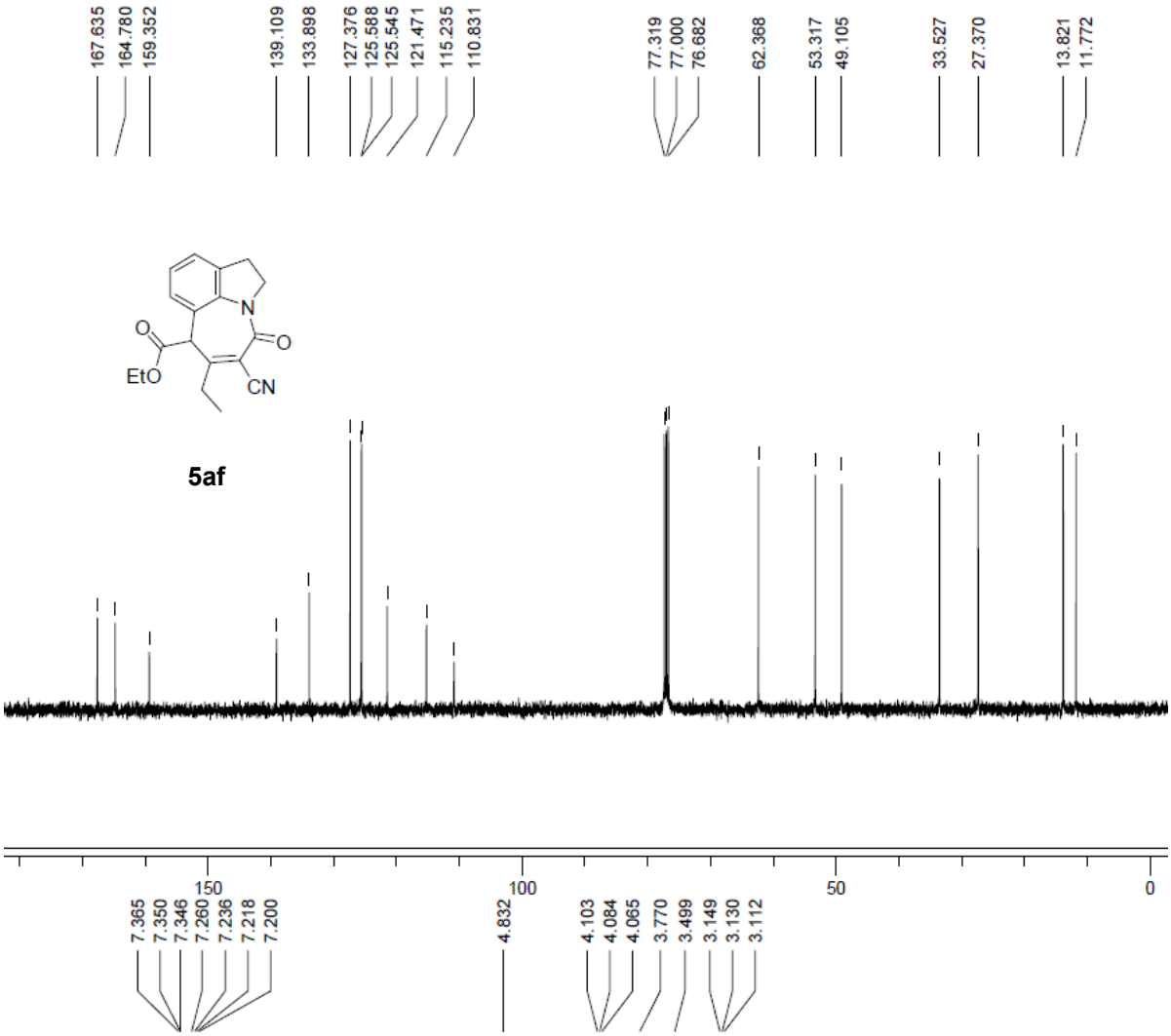
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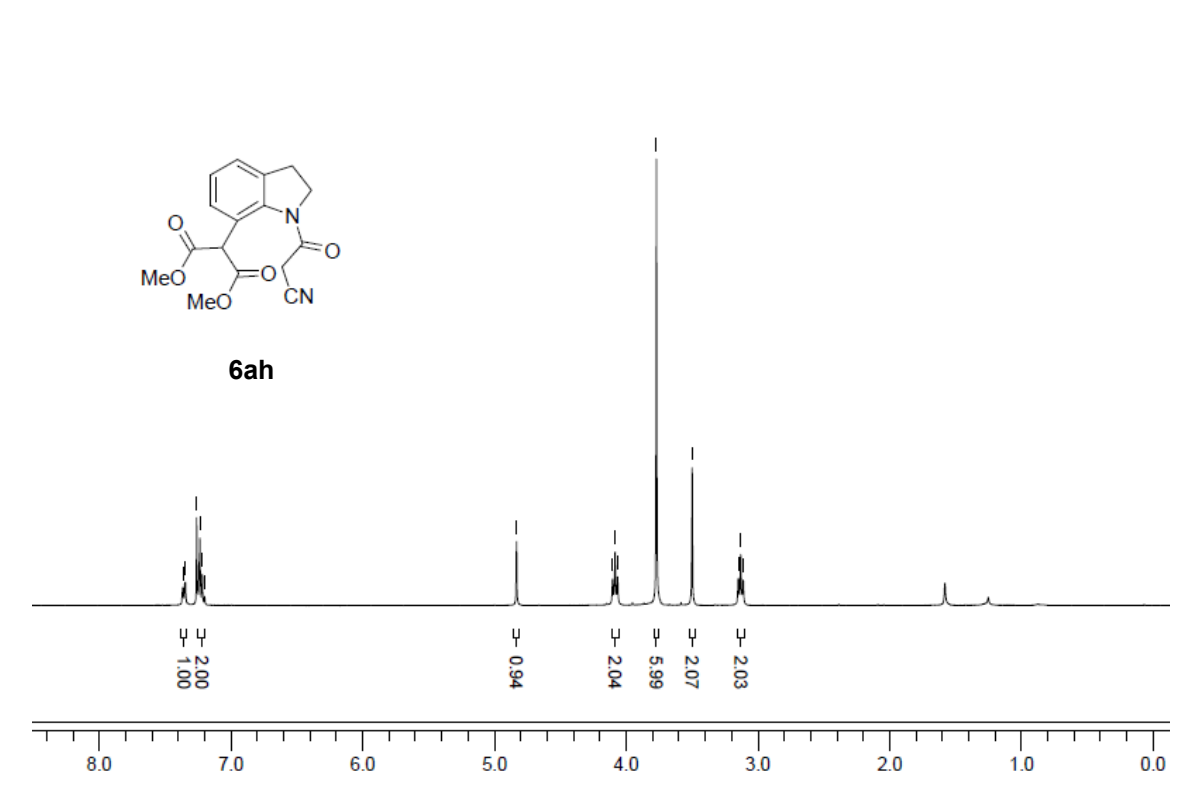
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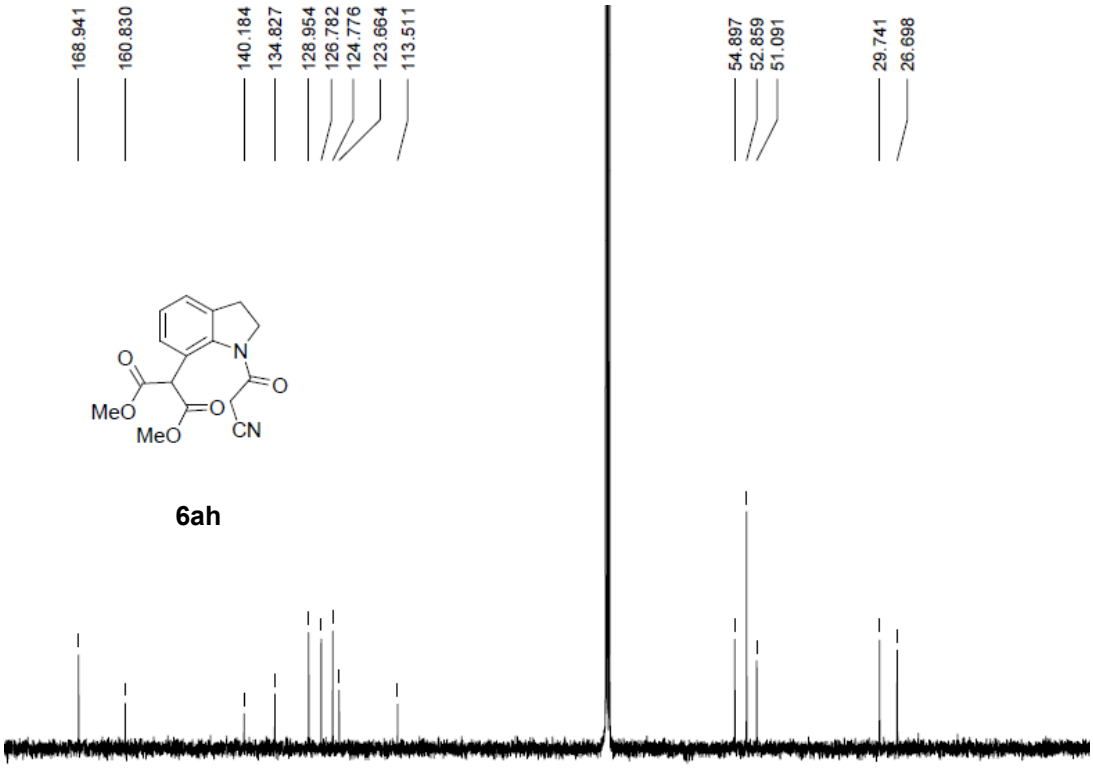
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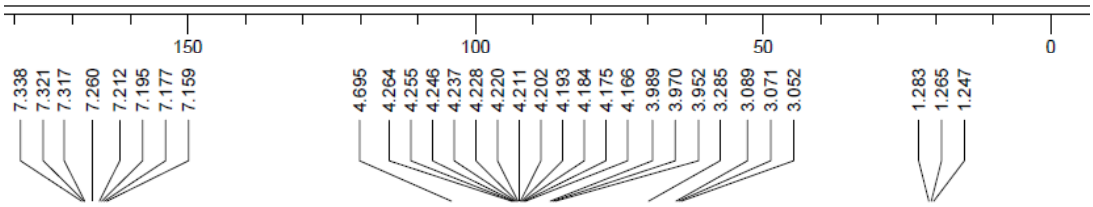
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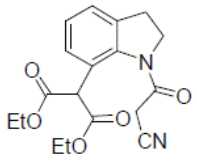
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6ai

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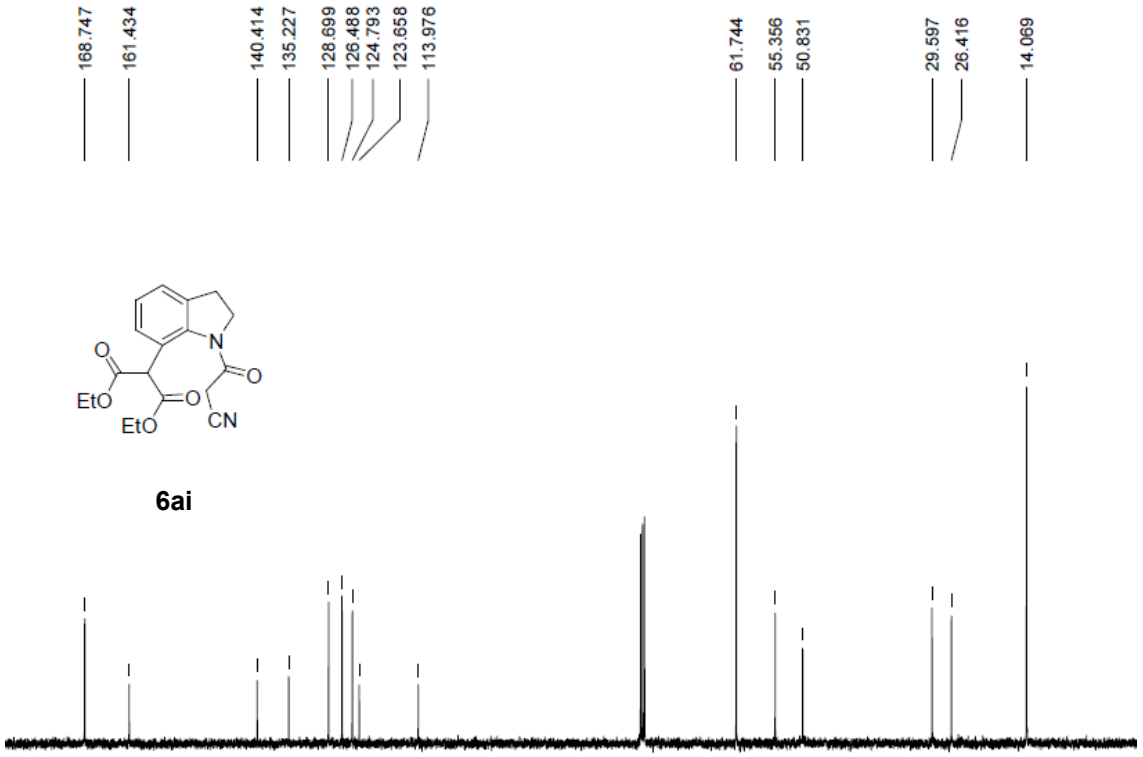
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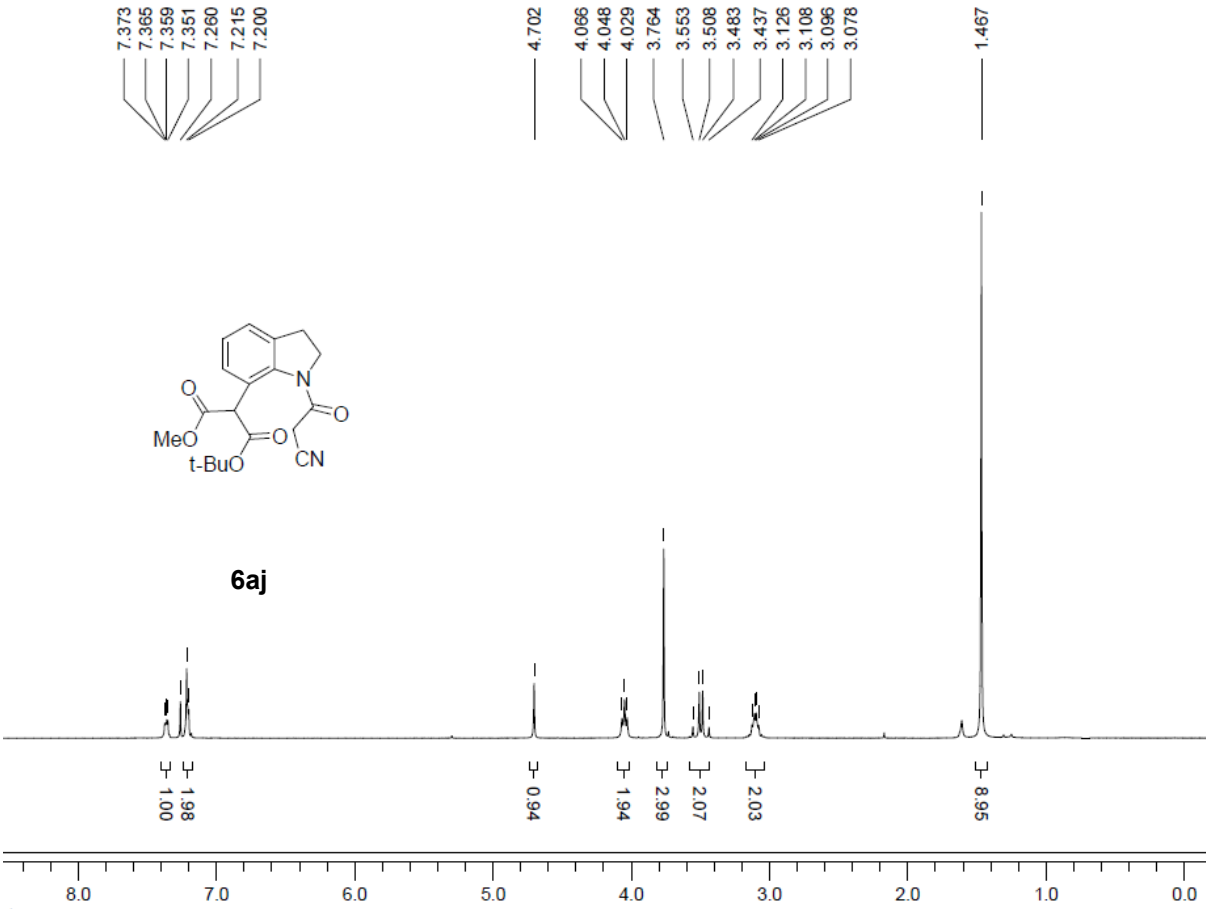
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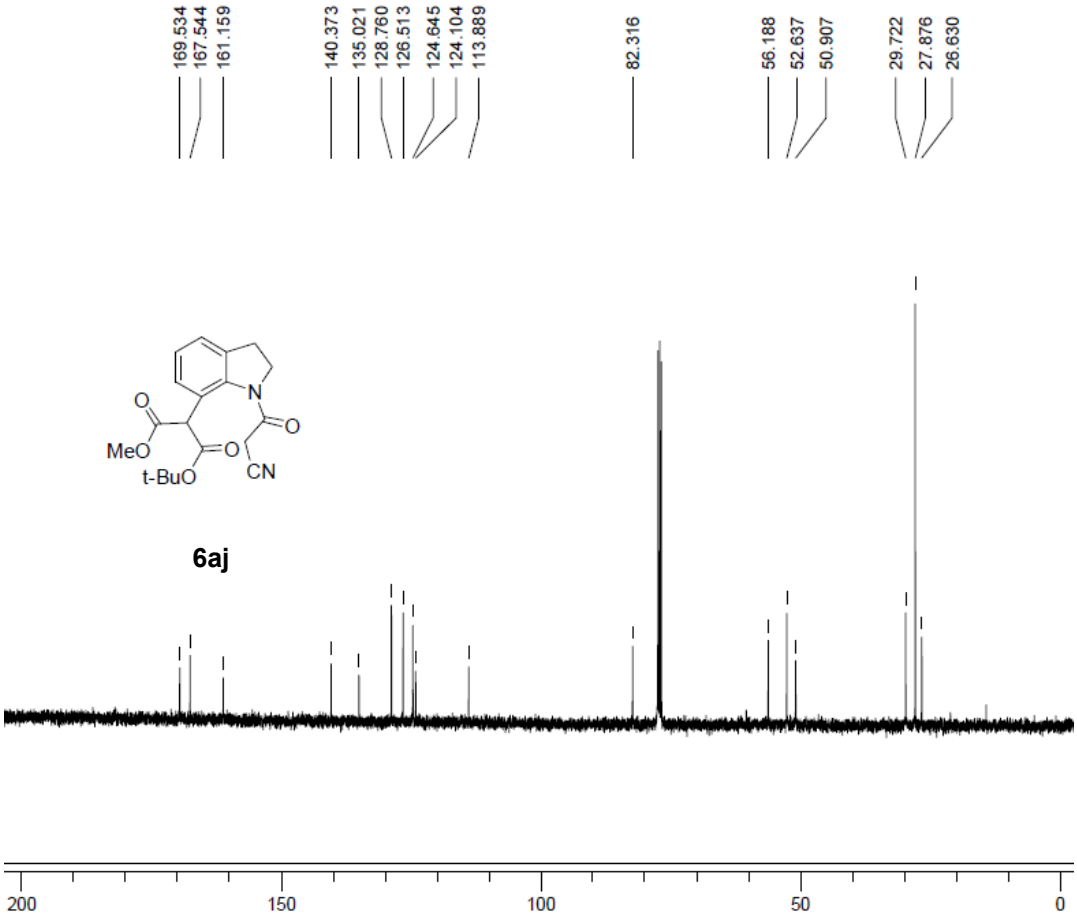

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1. C. White, A. Yates and P. M. Maitlis, *Inorg. Synth.* 1992, **29**, 228.
2. T. Zhou, Y. Wang, B. Li and B. Wang, *Org. Lett.* 2016, **18**, 5066.