

## Supporting Information

### Photoinduced arene-alkyne [3 + 2] cycloaddition cascade of 1-alkynyl-naphthalen-2-ols for tunable synthesis of skeletally diverse bridged hexacycles

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## General Information

<sup>1</sup>H NMR (<sup>13</sup>C NMR) spectra were measured on a Bruker DPX 400 MHz spectrometer in CDCl<sub>3</sub> (DMSO-*d*<sub>6</sub>) with chemical shift ( $\delta$ ) given in ppm relative to TMS as internal standard [(s = singlet, d = doublet, t = triplet, brs = broad singlet, m = multiplet), coupling constant (Hz)]. HRMS (ESI) was determined by using microTOF-QII HRMS/MS instrument (BRUKER). X-Ray crystallographic analysis was performed with a Siemens SMART CCD and a Siemens P4 diffractometer.

### General procedure for the synthesis of compounds 2 and 3

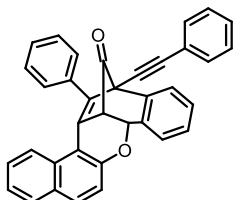
Example for the synthesis of **2**:

In a flame-dried Schlenk tube along with a stir bar under air conditions, 1-(phenylethynyl)naphthalen-2-ol (**1a**, 0.2 mmol, 49 mg) was added into the tube and then dry DMF (2 mL) was injected into the reaction system. Subsequently, the tube was stirred at room temperature under the 10W blue LEDs. After stirring for 12 hours, the reaction mixture was concentrated by vacuum distillation and was purified by flash column chromatography (ethyl acetate/petroleum ether = 1:20 (V/V)) to afford the desired pure product **2a**.

Example for the synthesis of **3**:

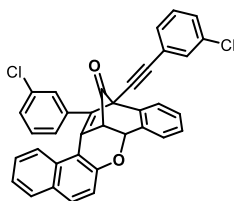
In a flame-dried Schlenk tube along with a stir bar under air conditions, 1-(phenylethynyl)naphthalen-2-ol (**1a**, 0.2 mmol, 49 mg) was added into the tube and then dry THF (2 mL) was injected into the reaction system. Subsequently, the tube was stirred at room temperature under the 10W blue LEDs. After stirring for 12 hours, the reaction mixture was concentrated by vacuum distillation and was purified by flash column chromatography (ethyl acetate/petroleum ether = 1:10 (V/V)) to afford the desired pure product **3a**.

### 15-phenyl-12-(phenylethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2a)



White solid; 69.4 mg, 72% yield; mp: 300-301 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) ( $\delta$ , ppm): 7.74 (d, *J* = 7.6 Hz, 1H), 7.69 (d, *J* = 8.8 Hz, 1H), 7.65-7.59 (m, 3H), 7.44 (d, *J* = 8.0 Hz, 1H), 7.41-7.36 (m, 4H), 7.26 (d, *J* = 8.0 Hz, 1H), 7.23-7.17 (m, 2H), 7.14 (m, 1H), 7.10-7.05 (m, 1H), 7.04-6.97 (m, 3H), 6.86-6.82 (m, 2H), 5.94 (d, *J* = 5.6 Hz, 1H), 3.84 (d, *J* = 5.6 Hz, 1H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) ( $\delta$ , ppm): 201.6, 153.1, 148.1, 137.1, 134.1, 133.1, 132.0, 131.1, 129.8, 128.9, 128.8, 128.7, 128.6, 128.5, 128.4, 128.1, 127.8, 127.7, 126.5, 126.1, 125.9, 124.7, 123.8, 122.6, 118.1, 114.6, 92.0, 81.6, 75.0, 62.1, 51.5. IR (KBr,  $\nu$ , cm<sup>-1</sup>): 2320, 1711, 1644, 1554, 1459, 1380, 1108, 959, 833, 718; HRMS (ESI -TOF) *m/z* calcd for C<sub>36</sub>H<sub>22</sub>NaO<sub>2</sub> [M+Na]<sup>+</sup> 509.1517, found 509.1519;

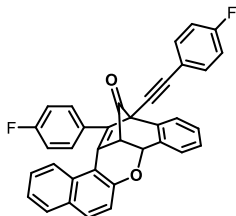
### 15-(3-chlorophenyl)-12-((3-chlorophenyl)ethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2b)



White solid; 70.9 mg, 64% yield; mp: 295-296 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) ( $\delta$ , ppm): 7.77-7.69 (m, 2H), 7.68-7.63 (m, 2H), 7.55-7.51 (m, 1H), 7.43-7.37 (m, 3H), 7.36-7.29 (m, 1H), 7.24 (s, 1H), 7.22-7.14 (m, 4H), 7.12-7.06 (m, 2H),

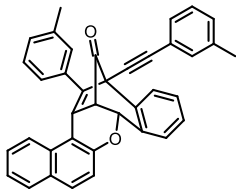
6.84-6.77 (m, 1H), 6.40 (d,  $J = 8.0$  Hz, 1H), 5.94 (d,  $J = 5.6$  Hz, 1H), 3.86 (d,  $J = 5.6$  Hz, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 200.6, 153.1, 145.8, 136.5, 134.7, 134.4, 133.8, 133.7, 132.0, 131.3, 130.2, 130.2, 129.8, 129.3, 129.2, 129.2, 129.0, 128.8, 128.5, 128.4, 128.4, 127.9, 127.8, 126.9, 126.5, 125.7, 124.4, 124.0, 118.1, 114.0, 91.0, 82.7, 74.9, 61.8, 51.5. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 2303, 1715, 1633, 1577, 1442, 1362, 1124, 954, 831, 706; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{36}\text{H}_{20}\text{Cl}_2\text{NaO}_2$   $[\text{M}+\text{Na}]^+$  577.0738, found 577.0736;

**15-(4-fluorophenyl)-12-((4-fluorophenyl)ethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2c)**



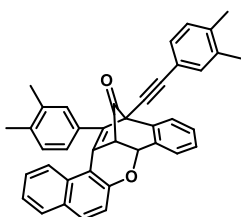
White solid; 75.1 mg, 68% yield; mp: 295-296 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.73 (d,  $J = 7.6$  Hz, 1H), 7.69 (d,  $J = 8.8$  Hz, 1H), 7.64 (d,  $J = 8.0$  Hz, 1H), 7.60-7.56 (m, 2H), 7.41-7.37 (m, 2H), 7.25-7.21 (m, 2H), 7.20-7.15 (m, 2H), 7.11-7.05 (m, 3H), 6.82-6.77 (m, 2H), 6.72-6.66 (m, 2H), 5.93 (d,  $J = 5.6$  Hz, 1H), 3.84 (d,  $J = 5.6$  Hz, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 201.2, 164.1, 163.7, 161.7, 161.2, 153.1, 146.8, 136.8, 135.0, 134.0, 133.9, 131.2, 130.6, 130.5, 130.0, 129.0, 128.8, 128.5, 128.4, 127.9, 127.2, 126.3, 125.7, 124.5, 124.0, 118.1, 115.9, 115.7, 115.1, 115.0, 114.2, 91.0, 81.2, 75.0, 62.0, 51.5. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 2304, 1714, 1622, 1573, 1437, 1355, 1124, 966, 817, 726; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{36}\text{H}_{20}\text{F}_2\text{NaO}_2$   $[\text{M}+\text{Na}]^+$  545.1329, found 545.1329;

**15-(*m*-tolyl)-12-(*m*-tolylethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2d)**



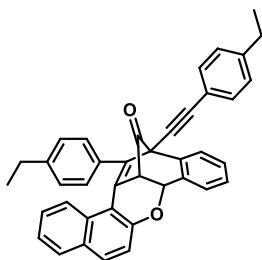
White solid; 80.2 mg, 78% yield; mp: 301-302 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.74 (d,  $J = 7.6$  Hz, 1H), 7.69 (d,  $J = 9.2$  Hz, 1H), 7.64 (d,  $J = 8.10$  Hz, 1H), 7.47-7.42 (m, 3H), 7.40-7.36 (m, 1H), 7.31-7.27 (m, 2H), 7.21 (d,  $J = 8.8$  Hz, 2H), 7.19-7.13 (m, 2H), 7.06-7.02 (m, 1H), 6.90 (d,  $J = 7.2$  Hz, 2H), 6.83-6.78 (m, 1H), 6.47 (d,  $J = 7.6$  Hz, 1H), 5.94 (d,  $J = 5.6$  Hz, 1H), 3.83 (d,  $J = 5.6$  Hz, 1H), 2.39 (s, 3H), 2.09 (s, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 201.7, 153.1, 148.1, 138.1, 137.2, 137.2, 134.0, 133.0, 132.6, 131.1, 129.7, 129.7, 129.4, 129.0, 128.9, 128.8, 128.8, 128.6, 128.5, 128.3, 127.7, 127.6, 126.2, 126.1, 126.0, 125.8, 124.9, 123.7, 122.5, 118.1, 114.8, 92.2, 81.5, 75.0, 62.0, 51.6, 31.7, 22.7, 21.3, 21.3, 14.2. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 2310, 1722, 1630, 1560, 1478, 1376, 1122, 941, 843, 701; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{38}\text{H}_{26}\text{NaO}_2$   $[\text{M}+\text{Na}]^+$  537.1830, found 537.1831;

**15-(3,4-dimethylphenyl)-12-((3,4-dimethylphenyl)ethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2e)**



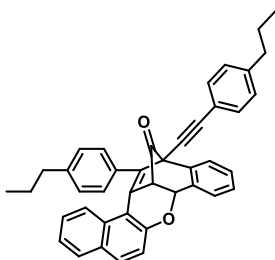
White solid; 80.2 mg, 74% yield; mp: 302-303 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.74-7.66 (m, 2H), 7.64 (d, *J* = 8.0 Hz, 1H), 7.48 (d, *J* = 7.6 Hz, 1H), 7.42 (s, 1H), 7.39-7.34 (m, 2H), 7.31 (d, *J* = 8.4 Hz, 1H), 7.22-7.14 (m, 4H), 7.08-7.02 (m, 1H), 6.92 (s, 1H), 6.65 (d, *J* = 7.6 Hz, 1H), 6.41 (d, *J* = 6.4 Hz, 1H), 5.93 (d, *J* = 5.6 Hz, 1H), 3.80 (d, *J* = 5.6 Hz, 1H), 2.31 (s, 3H), 2.30 (s, 3H), 2.06 (s, 3H), 2.00 (s, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 1978.0, 153.4, 137.6, 136.9, 136.4, 135.7, 135.4, 134.8, 133.2, 133.1, 131.5, 131.0, 130.6, 129.9, 129.7, 129.6, 129.5, 129.4, 128.9, 128.7, 128.3, 127.6, 126.2, 126.0, 125.4, 125.0, 124.9, 123.6, 118.1, 117.7, 79.0, 75.1, 64.8, 51.6, 49.8, 19.9, 19.6, 19.5, 19.5. IR (KBr, ν, cm<sup>-1</sup>): 2312, 1718, 1635, 1560, 1478, 1386, 1102, 953, 843, 711; HRMS (ESI -TOF) *m/z* calcd for C<sub>40</sub>H<sub>30</sub>NaO<sub>2</sub> [M+Na]<sup>+</sup> 565.2143, found 565.2146;

**15-(4-ethylphenyl)-12-((4-ethylphenyl)ethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2f)**



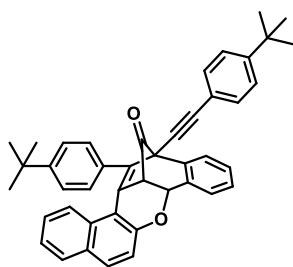
White solid; 77.0 mg, 71% yield; mp: 301-302 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.73-7.61 (m, 3H), 7.54 (d, *J* = 8.0 Hz, 2H), 7.46 (d, *J* = 7.6 Hz, 1H), 7.39-7.34 (m, 1H), 7.25-7.21 (m, 3H), 7.21-7.07 (m, 3H), 7.04-6.99 (m, 1H), 6.83-6.75 (m, 4H), 5.92 (d, *J* = 5.6 Hz, 1H), 3.80 (d, *J* = 5.6 Hz, 1H), 2.73-2.66 (m, 2H), 2.48-2.41 (m, 2H), 1.27 (t, *J* = 7.6 Hz, 3H), 1.06 (t, *J* = 7.6 Hz, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 202.0, 153.1, 148.3, 145.3, 144.0, 137.4, 134.1, 132.1, 131.1, 130.4, 129.7, 128.8, 128.8, 128.7, 128.7, 128.5, 128.0(2), 128.0, 127.7, 127.3, 126.1, 126.0, 125.0, 123.7, 119.9, 118.1, 114.9, 92.1, 81.2, 75.1, 75.1, 62.1(2), 62.1(8), 51.7, 29.0, 28.6, 15.5, 15.2. IR (KBr, ν, cm<sup>-1</sup>): 2319, 1708, 1641, 1552, 1466, 1368, 1121, 953, 844, 717; HRMS (ESI -TOF) *m/z* calcd for C<sub>40</sub>H<sub>30</sub>NaO<sub>2</sub> [M+Na]<sup>+</sup> 565.2143, found 565.2142;

**15-(4-propylphenyl)-12-((4-propylphenyl)ethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2g)**



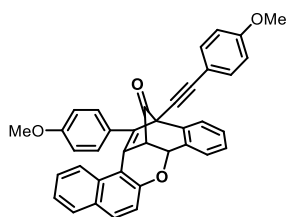
White solid; 73.0 mg, 64% yield; mp: 302-303 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.72 (d, *J* = 7.6 Hz, 1H), 7.68 (d, *J* = 9.2 Hz, 1H), 7.63 (d, *J* = 8.0 Hz, 1H), 7.54 (d, *J* = 8.0 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 1H), 7.39-7.33 (m, 1H), 7.24 (d, *J* = 8.4 Hz, 1H), 7.22-7.17 (m, 4H), 7.16-7.12 (m, 1H), 7.03-6.98 (m, 1H), 6.81-6.75 (m, 4H), 5.93 (d, *J* = 5.6 Hz, 1H), 3.82 (d, *J* = 5.6 Hz, 1H), 2.66-2.61 (m, 2H), 2.46-2.32 (m, 2H), 1.73-1.63 (m, 2H), 1.51-1.41 (m, 2H), 1.00-0.94 (m, 3H), 0.79-0.74 (m, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 201.9, 153.1, 148.3, 143.7, 142.4, 137.4, 134.1, 131.9, 131.0, 130.4, 129.6, 128.8, 128.7(4), 128.7(6), 128.6, 128.5, 127.9, 127.6, 124.9, 123.7, 119.9, 118.1, 114.8, 92.1, 81.1, 75.0, 62.1, 51.1, 38.1, 37.6, 24.5, 24.2, 13.8, 13.5. IR (KBr, ν, cm<sup>-1</sup>): 2318, 1708, 1644, 1552, 1466, 1358, 1122, 953, 844, 722; HRMS (ESI -TOF) *m/z* calcd for C<sub>42</sub>H<sub>34</sub>NaO<sub>2</sub> [M+Na]<sup>+</sup> 593.2457, found 565.2455;

**15-(4-(tert-butyl)phenyl)-12-((4-(tert-butyl)phenyl)ethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2h)**



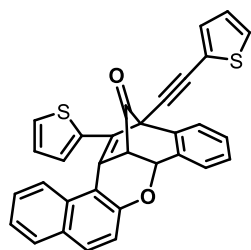
White solid; 74.2 mg, 62% yield; mp: 304-305 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.72 (d, *J* = 7.6 Hz, 1H), 7.68 (d, *J* = 8.8 Hz, 1H), 7.63 (d, *J* = 7.6 Hz, 1H), 7.59-7.55 (m, 2H), 7.50 (d, *J* = 7.6 Hz, 1H), 7.42 (d, *J* = 8.0 Hz, 2H), 7.39-7.35 (m, 1H), 7.22-7.17 (m, 3H), 7.14 (s, 1H), 7.01-6.96 (m, 3H), 6.84-6.79 (m, 2H), 5.92 (d, *J* = 5.6 Hz, 1H), 3.80 (d, *J* = 5.6 Hz, 1H), 1.36 (s, 9H), 1.14 (s, 9H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 201.9, 153.1, 152.1, 150.9, 148.1, 137.4, 134.1, 131.8, 131.1, 130.1, 129.6, 128.8, 128.8, 128.7, 128.5, 128.4, 127.6, 126.0, 125.9, 125.4, 125.0, 124.6, 123.7, 119.8, 118.1, 115.0, 91.9, 81.3, 75.1, 62.0, 51.7, 34.9, 34.5, 31.7, 31.8, 31.2, 22.7, 14.2. IR (KBr, ν, cm<sup>-1</sup>): 2317, 1724, 1635, 1550, 1474, 1374, 1116, 955, 849, 722; HRMS (ESI -TOF) *m/z* calcd for C<sub>44</sub>H<sub>38</sub>NaO<sub>2</sub> [M+Na]<sup>+</sup> 621.2770 found 621.2768;

**15-(4-methoxyphenyl)-12-((4-methoxyphenyl)ethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2i)**



White solid; 83.0 mg, 76% yield; mp: 297-298 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.72 (d, *J* = 7.6 Hz, 1H), 7.68 (d, *J* = 8.8 Hz, 1H), 7.64 (d, *J* = 8.0 Hz, 1H), 7.60-7.54 (m, 2H), 7.46 (m, 1H), 7.37 (m, 1H), 7.30 (m, 1H), 7.20 (d, *J* = 8.8 Hz, 1H), 7.19-7.10 (m, 2H), 7.07 (m, 1H), 6.95-6.89 (m, 2H), 6.85-6.80 (m, 2H), 6.53-6.48 (m, 2H), 5.92 (d, *J* = 5.6 Hz, 1H), 3.85 (s, 3H), 3.81 (d, *J* = 6.0 Hz, 1H), 3.62 (s, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 202.1, 160.0, 159.2, 153.1, 147.8, 137.5, 134.1, 133.5, 131.0, 130.1, 129.6, 128.8, 128.7, 128.6, 128.5, 127.7, 126.3, 125.9, 125.8, 125.5, 124.9, 123.8, 118.1, 114.9, 114.8, 114.1, 113.2, 91.9, 80.4, 75.1, 62.2, 55.4, 55.0, 51.7. IR (KBr, ν, cm<sup>-1</sup>): 2310, 1711, 1640, 1567, 1477, 1380, 1110, 950, 833, 708; HRMS (ESI -TOF) *m/z* calcd for C<sub>38</sub>H<sub>26</sub>NaO<sub>4</sub> [M+Na]<sup>+</sup> 569.1729, found 569.1728;

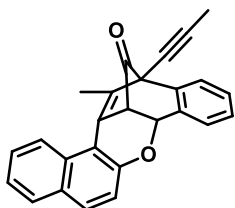
**15-(thiophen-2-yl)-12-(thiophen-2-ylethynyl)-7a,13a-dihydro-12,14-(metheno)dibenzo[a,h]xanthen-13(12H)-one(2j)**



White solid; 65.7 mg, 66% yield; mp: 290-291 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.79-7.74 (m, 2H), 7.67 (d, *J* = 8.8 Hz, 2H), 7.58-7.55 (m, 1H), 7.49-7.46 (m, 1H), 7.39-7.34 (m, 2H), 7.34-7.29 (m, 2H), 7.26-7.22 (m, 1H), 7.20 (d, *J* = 8.8 Hz, 1H), 7.10-7.06 (m, 2H), 7.02-6.99 (m, 1H), 6.72-6.68 (m, 1H), 5.91 (d, *J* = 6.0 Hz, 1H), 3.81 (d, *J* = 6.0 Hz, 1H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 200.5, 153.7, 140.8, 136.7, 133.5, 133.0, 131.4, 130.3, 129.1, 129.1, 129.0, 128.8, 128.6, 128.2, 127.9, 127.5, 127.2, 126.8, 126.5, 125.9, 125.4, 124.2, 124.1, 122.4, 118.3, 118.2, 115.5, 86.1, 85.6, 75.2,

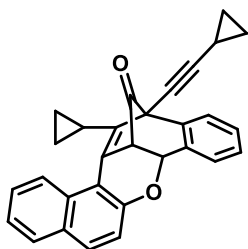
61.5, 52.4. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 2322, 1726, 1636, 1577, 1445, 1336, 1155, 967, 837, 733; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{32}\text{H}_{18}\text{F}_2\text{NaS}_2$   $[\text{M}+\text{Na}]^+$  521.0646, found 521.0644;

**15-methyl-12-(prop-1-yn-1-yl)-7a,13a-dihydro-12,14 (metheno)dibenzo[a,h]xanthen-13(12H)-one(2k)**



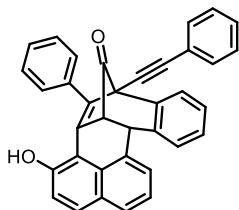
White solid; 49.2 mg, 68% yield; mp: 287-288 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.80 (d,  $J = 8.4$  Hz, 1H), 7.75 (d,  $J = 8.0$  Hz, 1H), 7.72-7.67 (m, 2H), 7.64 (d,  $J = 7.2$  Hz, 1H), 7.51-7.46 (m, 1H), 7.40-7.33 (m, 2H), 7.33-7.28 (m, 1H), 7.14 (d,  $J = 9.2$  Hz, 1H), 5.79 (d,  $J = 5.6$  Hz, 1H), 3.63 (d,  $J = 6.4$  Hz, 1H), 2.14 (s, 3H), 1.73 (s, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 202.8, 152.5, 148.0, 137.1, 134.1, 131.4, 129.8, 129.1, 128.8, 128.7, 128.6, 128.2, 126.6, 125.2, 124.7, 123.8, 118.0, 115.3, 87.1, 75.1, 70.7, 60.8, 50.7, 13.5, 4.2. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 2311, 1727, 1620, 1550, 1481, 1362, 1112, 932, 866, 721; HRMS (ESI-TOF)  $m/z$  calcd for  $\text{C}_{26}\text{H}_{18}\text{NaO}_2$   $[\text{M}+\text{Na}]^+$  385.1204, found 385.1204;

**15-cyclopropyl-12-(cyclopropylethynyl)-7a,13a-dihydro-12,14 (metheno)dibenzo[a,h]xanthen-13(12H)-one(2l)**



White solid; 58.0 mg, 70% yield; mp: 281-282 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.99 (d,  $J = 8.4$  Hz, 1H), 7.75 (d,  $J = 8.0$  Hz, 1H), 7.72-7.67 (m, 2H), 7.64 (d,  $J = 7.2$  Hz, 1H), 7.51-7.46 (m, 1H), 7.40-7.30 (m, 3H), 7.15 (d,  $J = 9.2$  Hz, 1H), 5.75 (d,  $J = 5.6$  Hz, 1H), 3.55 (d,  $J = 5.6$  Hz, 1H), 1.54-1.39 (m, 2H), 1.14-1.06 (m, 1H), 0.99-0.87 (m, 5H), 0.83-0.75 (m, 1H), 0.36-0.27 (m, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 201.9, 152.5, 149.6, 137.5, 134.1, 131.5, 130.2, 129.2, 128.6, 128.6, 128.6, 128.1, 126.4, 125.9, 125.3, 124.2, 123.7, 118.0, 115.4, 93.8, 75.0, 66.9, 58.1, 50.7, 12.5, 8.5, 8.4, 5.5, 5.5. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 2312, 173, 1610, 1547, 1485, 1363, 1104, 922, 866, 721; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{30}\text{H}_{22}\text{NaO}_2$   $[\text{M}+\text{Na}]^+$  437.1517, found 437.1515;

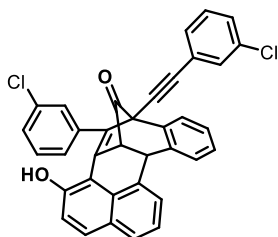
**6-hydroxy-14-phenyl-9-(phenylethynyl)-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one (3a)**



Yellowish solid; 73.9 mg, 76% yield; mp: 193-194 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.78 (d,  $J = 8.4$  Hz, 1H), 7.70-7.67 (m, 2H), 7.57 (m, 2H), 7.46 (m, 2H), 7.39-7.35 (m, 4H), 7.30 (m, 1H), 7.20 (m, 3H), 7.05 (m, 1H), 6.97 (d,  $J = 9.2$  Hz, 1H), 6.88 (d,  $J = 7.6$  Hz, 2H), 4.94 (d,  $J = 4.4$  Hz, 1H), 4.74 (s, 1H), 3.74 (d,  $J = 4.4$  Hz, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 205.8, 147.8, 146.8, 139.5, 135.1, 134.5, 132.5, 132.0, 131.5, 130.7, 130.0, 129.5, 129.4, 129.2, 128.7, 128.7, 128.5, 128.4, 128.0, 127.3, 127.0, 126.4, 123.6, 122.6, 118.3, 111.7, 91.8, 81.8, 62.0, 52.7, 49.0. IR (KBr,

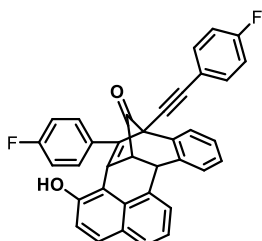
$\nu$ ,  $\text{cm}^{-1}$ ): 3547, 2201, 1720, 1619, 1556, 1459, 1377, 1126, 8121, 717; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{36}\text{H}_{21}\text{O}_2$   $[\text{M}-\text{H}]^-$  485.1542, found 485.1544;

**14-(3-chlorophenyl)-9-((3-chlorophenyl)ethynyl)-6-hydroxy-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3b)**



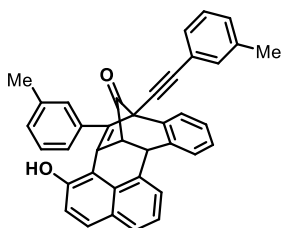
Yellowish solid; 68.7 mg, 62% yield; mp: 201-202 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.79 (d,  $J = 7.6$  Hz, 1H), 7.73-7.68 (m, 2H), 7.60-7.58 (m, 1H), 7.50-7.45 (m, 3H), 7.37-7.34 (m, 1H), 7.33-7.28 (m, 3H), 7.24-7.21 (m, 1H), 7.13-7.10 (m, 1H), 7.08-7.03 (m, 2H), 6.98 (d,  $J = 8.8$  Hz, 1H), 6.55 (d,  $J = 7.6$  Hz, 1H), 4.95 (d,  $J = 4.8$  Hz, 1H), 4.79 (s, 1H), 3.75 (d,  $J = 4.4$  Hz, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 205.1, 147.7, 144.9, 138.8, 134.9, 134.4, 134.3, 134.3, 131.9, 131.4, 130.8, 130.4, 130.3, 130.1, 129.9, 129.7, 129.5, 129.3, 129.2, 128.9, 128.6, 128.2, 127.4, 127.2, 126.6, 126.2, 124.0, 123.7, 118.2, 111.1, 90.7, 83.0, 61.7, 52.7, 48.9. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 3551, 2202, 1726, 1637, 1578, 1455, 1357, 1112, 818, 732; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{36}\text{H}_{19}\text{Cl}_2\text{O}_2$   $[\text{M}-\text{H}]^-$  553.0762, found 553.0761;

**14-(4-fluorophenyl)-9-((4-fluorophenyl)ethynyl)-6-hydroxy-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3c)**



Yellowish solid; 64.7 mg, 62% yield; mp: 201-202 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.79 (d,  $J = 8.0$  Hz, 1H), 7.72-7.67 (m, 2H), 7.55-7.51 (m, 2H), 7.50-7.44 (m, 2H), 7.33-7.30 (m, 1H), 7.25-7.20 (m, 1H), 7.08-7.03 (m, 3H), 6.98 (d,  $J = 8.8$  Hz, 1H), 6.90-6.84 (m, 4H), 4.94 (d,  $J = 4.4$  Hz, 1H), 4.82 (s, 1H), 3.75 (d,  $J = 4.8$  Hz, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 205.7, 164.3, 164.1, 161.8, 161.6, 147.7, 145.6, 139.2, 135.0, 134.4, 133.9, 133.8, 131.4, 130.8, 130.5, 130.4, 130.2, 129.9, 129.5, 128.8, 128.1, 127.4, 127.1, 126.2, 123.7, 118.2, 115.9, 115.9, 115.7, 115.7, 111.4, 90.8, 81.5, 61.9, 52.7, 49.0. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 3556, 2202, 1726, 1641, 1578, 1445, 1326, 1102, 828, 722; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{36}\text{H}_{19}\text{F}_2\text{O}_2$   $[\text{M}-\text{H}]^-$  521.1353, found 521.1354;

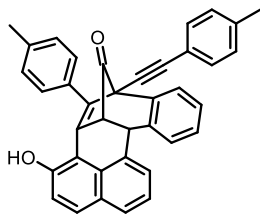
**6-hydroxy-14-(*m*-tolyl)-9-(*m*-tolylethynyl)-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3d)**



Yellowish solid; 78.2 mg, 76% yield; mp: 200-201 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.78 (d,  $J = 7.6$  Hz, 1H), 7.71-7.67 (m, 2H), 7.50-7.44 (m, 2H), 7.42-7.37 (m, 3H), 7.24-7.22 (m, 1H), 7.19 (d,  $J = 8.8$  Hz, 2H), 7.12 (d,  $J = 7.6$  Hz, 1H), 7.08-7.01 (m, 2H), 6.98 (d,  $J = 8.8$  Hz, 1H), 6.90 (s, 1H), 6.51 (d,  $J = 7.6$  Hz, 1H), 4.94 (d,  $J = 4.4$  Hz, 1H), 4.79 (s, 1H), 3.73 (d,  $J = 4.8$  Hz, 1H), 2.37 (s, 3H), 2.21 (s, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 206.0, 147.8, 146.9,

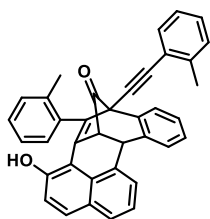
139.6, 138.3, 138.1, 135.1, 134.6, 132.6, 132.4, 131.5, 130.6, 130.0, 129.9, 129.6, 129.5, 129.1, 129.0(3), 129.0(9), 128.6, 128.5, 128.3, 128.0, 127.3, 127.0, 126.4, 125.6, 123.6, 122.5, 118.4, 111.9, 92.0, 81.6, 62.0, 52.7, 49.0, 21.4, 21.3. IR (KBr, v, cm<sup>-1</sup>): 3546, 2211, 1718, 1629, 1588, 1459, 1368, 1126, 811, 726; HRMS (ESI -TOF) m/z calcd for C<sub>38</sub>H<sub>25</sub>O<sub>2</sub> [M-H]<sup>-</sup> 513.1855, found 513.1856;

**6-hydroxy-14-(p-tolyl)-9-(p-tolylolethynyl)-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one (3e)**



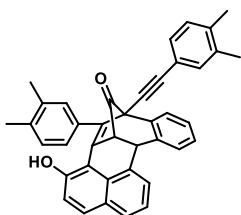
Yellowish solid; 78.2 mg, 76% yield; mp: 193-194 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.77 (d, *J* = 8.0 Hz, 1H), 7.70-7.66 (m, 2H), 7.47 (d, *J* = 8.0 Hz, 3H), 7.44 (d, *J* = 6.4 Hz, 1H), 7.37 (d, *J* = 7.6 Hz, 1H), 7.20 (M, 3H), 7.03 (m, 1H), 6.98 (m, 3H), 6.78 (d, *J* = 8.0 Hz, 2H), 4.92 (d, *J* = 4.4 Hz, 1H), 4.77 (s, 1H), 3.72 (d, *J* = 4.4 Hz, 1H), 2.39 (s, 3H), 2.28 (s, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 206.2, 147.7, 146.9, 139.7, 139.1, 138.8, 135.1, 134.6, 131.9, 131.5, 130.6, 129.9, 129.5, 129.4, 129.1, 129.0, 128.5, 128.4, 128.0, 127.2, 127.0, 126.4, 123.6, 119.6, 118.3, 112.0, 91.8, 81.2, 62.0, 52.8, 49.0, 21.6, 21.5. IR (KBr, v, cm<sup>-1</sup>): 3551, 2216, 1718, 1624, 1549, 1461, 1378, 1127, 8121, 720; HRMS (ESI -TOF) m/z calcd for C<sub>38</sub>H<sub>25</sub>O<sub>2</sub> [M-H]<sup>-</sup> 513.1855, found 513.1855;

**6-hydroxy-14-(o-tolyl)-9-(o-tolylolethynyl)-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3f)**



Yellowish solid; 60.7 mg, 59% yield; mp: 198-199 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.78 (d, *J* = 7.6 Hz, 1H), 7.70-7.66 (m, 2H), 7.45 (m, 4H), 7.37 (m, 1H), 7.21 (m, 1H), 7.18 (d, *J* = 8.0 Hz, 2H), 7.04 (m, 1H), 6.98 (m, 3H), 6.78 (d, *J* = 8.0 Hz, 2H), 4.93 (d, *J* = 4.4 Hz, 1H), 4.76 (s, 1H), 3.72 (d, *J* = 4.4 Hz, 1H), 2.39 (s, 3H), 2.28 (s, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm): 206.2, 147.7, 146.9, 139.7, 139.1, 138.8, 135.1, 134.6, 131.9, 131.5, 130.6, 129.9, 129.5, 129.4, 129.4, 129.1, 129.0, 128.6, 128.4, 128.0, 127.2, 127.0, 126.4, 123.6, 119.6, 118.3, 111.9, 91.8, 81.2, 62.0, 52.8, 49.0, 21.6, 21.5. IR (KBr, v, cm<sup>-1</sup>): 3547, 2211, 1725, 1644, 1569, 1445, 1336, 1104, 816, 732; HRMS (ESI -TOF) m/z calcd for C<sub>38</sub>H<sub>25</sub>O<sub>2</sub> [M-H]<sup>-</sup> 513.1855, found 513.1856;

**14-(3,4-dimethylphenyl)-9-((3,4-dimethylphenyl)ethynyl)-6-hydroxy-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3g)**

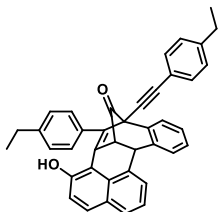


Yellowish solid; 79.2 mg, 73% yield; mp: 196-197 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) (δ, ppm): 7.78 (d, *J* = 8.0 Hz, 1H), 7.72-7.65 (m, 2H), 7.49-7.42 (m, 2H), 7.38 (d, *J* = 10.0 Hz, 2H), 7.32 (d, *J* = 7.2 Hz, 1H), 7.24-7.18 (m, 1H), 7.13 (d, *J* = 7.6 Hz, 1H), 7.06-6.95 (m, 2H), 6.88 (d, *J* = 8.4 Hz, 2H), 6.43 (d, *J* = 5.6 Hz, 1H), 4.93 (d, *J* = 4.0 Hz, 1H), 4.82 (s, 1H), 3.72 (d, *J* = 4.0 Hz, 1H), 2.30 (s, 3H), 2.28 (s, 3H), 2.19 (s, 3H), 2.12 (s, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) (δ, ppm):



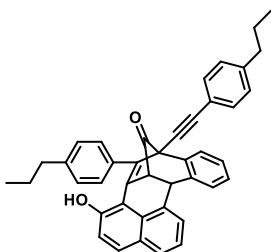
206.3, 147.7, 147.0, 139.9, 137.8, 137.6, 137.0, 136.7, 135.1, 134.7, 133.1, 131.5, 130.6, 120.0, 129.8, 129.7, 129.6, 129.5, 129.4, 128.7, 128.5, 128.0, 127.2, 127.0, 126.5, 125.9, 123.6, 120.0, 118.4, 112.1, 92.1, 81.1, 62.1, 52.8, 49.0, 19.9, 19.8, 19.8, 19.7. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 3546, 2211, 1718, 1629, 1588, 1459, 1368, 1126, 8121, 726; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{40}\text{H}_{29}\text{O}_2$   $[\text{M}-\text{H}]^-$  541.2168, found 541.2166;

**14-(4-ethylphenyl)-9-((4-ethylphenyl)ethynyl)-6-hydroxy-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3h)**



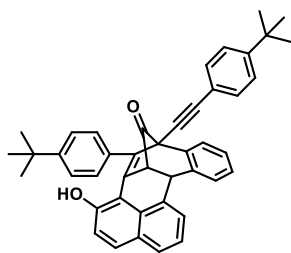
Yellowish solid; 79.2 mg, 73% yield; mp: 197-198 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.78 (d,  $J = 7.6$  Hz, 1H), 7.71-7.66 (m, 2H), 7.51-7.48 (m, 2H), 7.48-7.41 (m, 2H), 7.40-7.36 (m, 1H), 7.20 (d,  $J = 8.0$  Hz, 3H), 7.06-6.97 (m, 4H), 6.81 (d,  $J = 8.4$  Hz, 2H), 4.93 (d,  $J = 4.8$  Hz, 1H), 4.77 (s, 1H), 3.72 (d,  $J = 4.8$  Hz, 1H), 2.72-2.65 (m, 2H), 2.63-2.56 (m, 2H), 1.28-1.24 (m, 3H), 1.21-1.16 (m, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 206.3, 147.8, 146.9, 145.2, 139.8, 135.1, 134.6, 132.0, 131.5, 130.6, 129.9, 129.6, 129.5, 129.0, 128.6, 128.4, 128.2, 128.0, 127.3, 127.0, 126.5, 123.6, 119.9, 118.4, 112.0, 91.8, 81.3, 62.1, 52.8, 49.0, 29.0, 28.6, 15.5, 14.9. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 3541, 2204, 1722, 1616, 1587, 1458, 1368, 1126, 811, 726; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{40}\text{H}_{29}\text{O}_2$   $[\text{M}-\text{H}]^-$  541.2168, found 541.2168;

**6-hydroxy-14-(4-propylphenyl)-9-((4-propylphenyl)ethynyl)-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3i)**



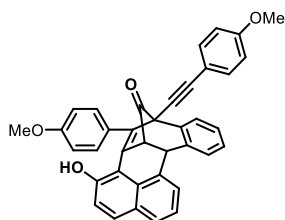
Yellowish solid; 75.3 mg, 66% yield; mp: 198-199 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.78 (d,  $J = 7.6$  Hz, 1H), 7.70-7.66 (m, 2H), 7.51-7.43 (m, 4H), 7.41-7.37 (m, 1H), 7.21-7.17 (m, 3H), 7.06-7.01 (m, 2H), 6.98 (d,  $J = 8.8$  Hz, 2H), 6.81 (d,  $J = 8.0$  Hz, 2H), 4.93 (d,  $J = 4.4$  Hz, 1H), 4.79 (s, 1H), 3.72 (d,  $J = 4.8$  Hz, 1H), 2.64-2.60 (m, 2H), 2.54-2.49 (m, 2H), 1.70-1.64 (m, 2H), 1.62-1.57 (m, 2H), 0.98-0.94 (m, 3H), 0.92-0.88 (m, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 206.3, 147.8, 146.9, 143.7, 143.6, 139.8, 135.1, 134.6, 131.9, 131.5, 130.6, 129.8, 129.7, 129.5, 129.0, 128.7, 128.5, 128.3, 128.0, 127.2, 127.0, 126.4, 123.5, 119.9, 118.4, 91.9, 81.3, 62.1, 52.8, 49.0, 38.1, 37.9, 24.5, 24.1, 13.9, 13.8. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 3544, 2212, 1712, 1616, 1587, 1458, 1378, 1122, 813, 719; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{42}\text{H}_{33}\text{O}_2$   $[\text{M}-\text{H}]^-$  569.2481, found 569.2483;

**14-(4-(tert-butyl)phenyl)-9-((4-(tert-butyl)phenyl)ethynyl)-6-hydroxy-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3j)**

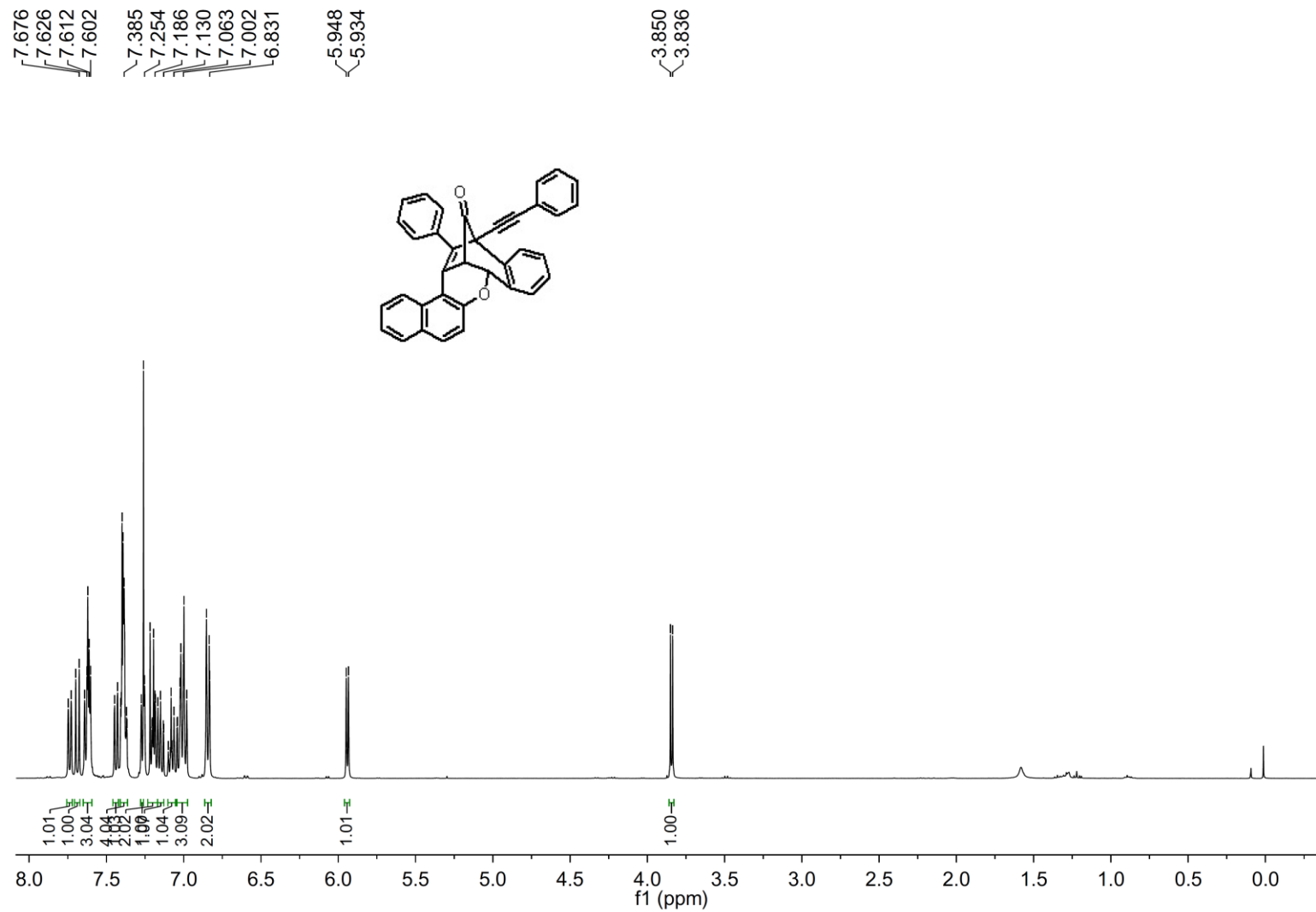


Yellowish solid; 79.0 mg, 66% yield; mp: 197-198 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.78 (d,  $J = 8.0$  Hz, 1H), 7.70-7.66 (m, 2H), 7.53-7.50 (m, 2H), 7.48-7.44 (m, 2H), 7.41-7.38 (m, 3H), 7.22-7.18 (m, 3H), 7.07-7.02 (m, 1H), 6.98 (d,  $J = 9.2$  Hz, 1H), 6.84 (d,  $J = 8.4$  Hz, 2H), 4.92 (d,  $J = 4.4$  Hz, 1H), 4.76 (s, 1H), 3.71 (d,  $J = 4.4$  Hz, 1H), 1.35 (s, 9H), 1.25 (s, 9H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 206.3, 152.1, 152.0, 147.8, 146.9, 139.8, 135.1, 134.7, 131.8, 131.6, 130.6, 129.8, 129.6, 129.4, 129.0, 128.6, 128.1, 128.0, 127.3, 127.0, 126.5, 125.6, 125.4, 123.6, 119.8, 118.6, 112.2, 91.7, 81.5, 62.1, 52.9, 49.0, 34.9, 34.8, 31.3, 31.3. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 3544, 2202, 1723, 1616, 1557, 1458, 1378, 1122, 815, 729; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{44}\text{H}_{37}\text{O}_2$   $[\text{M}-\text{H}]^-$  597.2794, found 597.2793;

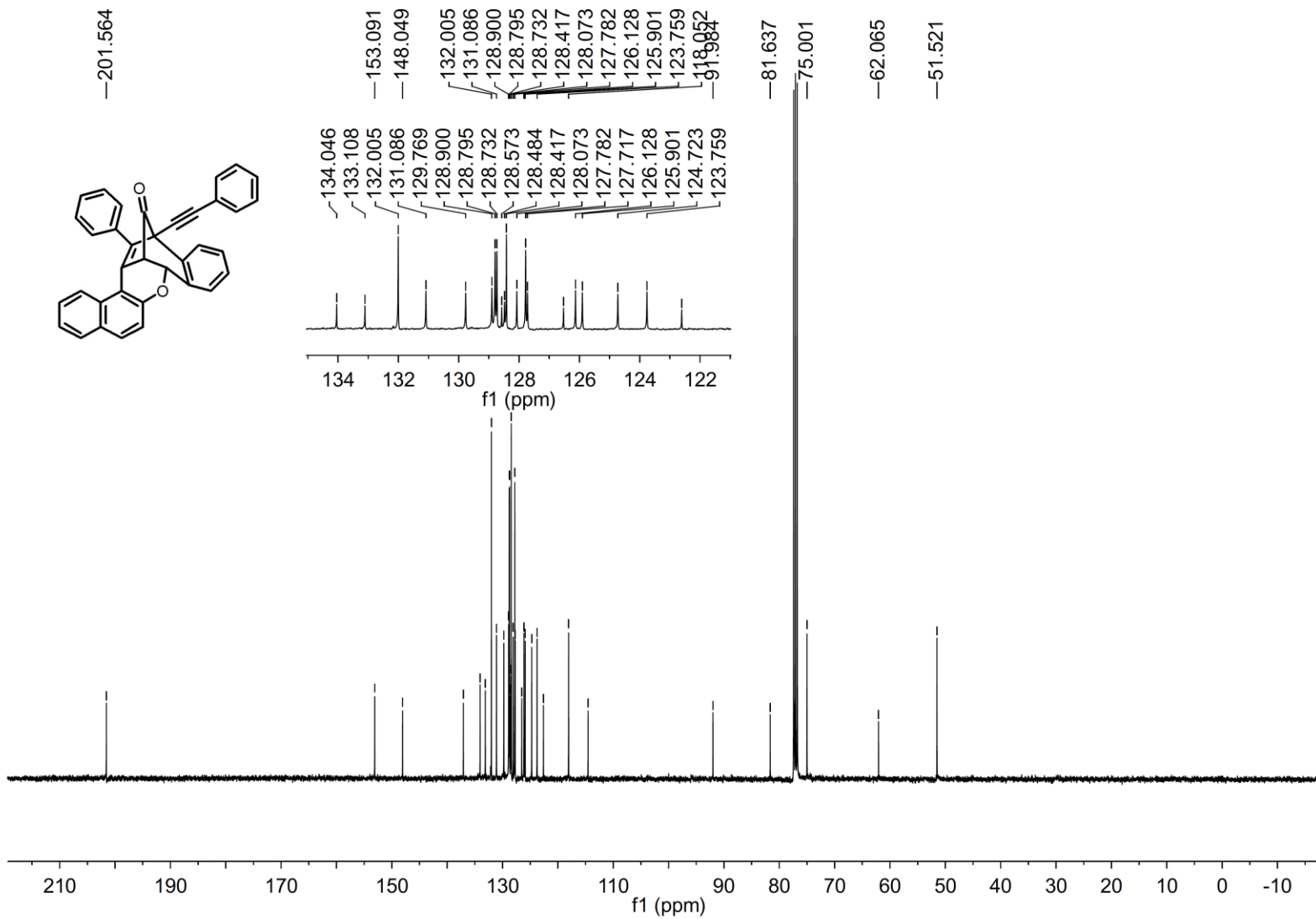
**6-hydroxy-14-(4-methoxyphenyl)-9-((4-methoxyphenyl)ethynyl)-9,13b-dihydro-7,9-(metheno)benzo[no]tetraphen-8(7aH)-one(3k)**



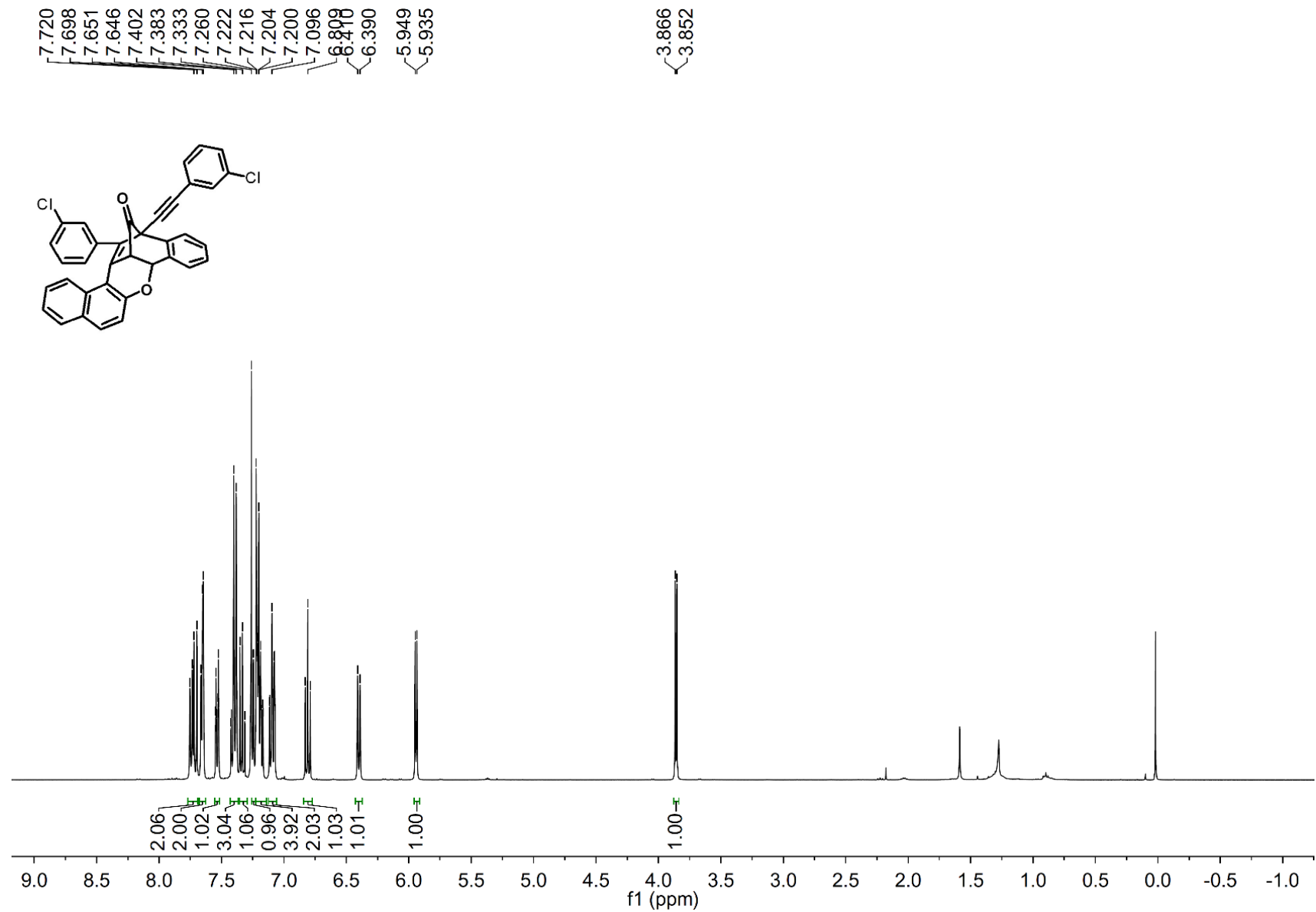
White solid; 74.3 mg, 68% yield; mp: 267-268 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 7.78 (d,  $J = 8.0$  Hz, 1H), 7.68 (m, 2H), 7.54-7.50 (m, 2H), 7.48-7.42 (m, 2H), 7.37 (m, 1H), 7.20 (m, 1H), 7.03 (m, 1H), 6.99 (d,  $J = 9.2$  Hz, 1H), 6.91-6.88 (m, 2H), 6.85-6.81 (m, 2H), 6.72-6.68 (m, 2H), 4.92 (d,  $J = 4.4$  Hz, 1H), 4.81 (s, 1H), 3.85 (s, 3H), 3.73 (s, 3H), 3.72 (d,  $J = 4.4$  Hz, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) ( $\delta$ , ppm): 206.4, 160.1, 159.9, 147.7, 146.5, 139.9, 135.1, 134.6, 133.4, 131.4, 130.6, 129.9, 129.9, 129.5, 128.9, 128.5, 128.0, 127.2, 126.9, 126.3, 124.5, 123.6, 118.3, 114.8, 114.1, 114.0, 112.0, 91.6, 80.5, 62.1, 55.4, 55.1, 52.8, 49.0. IR (KBr,  $\nu$ ,  $\text{cm}^{-1}$ ): 3545, 2208, 1720, 1648, 1578, 1461, 1362, 1120, 811, 730; HRMS (ESI -TOF)  $m/z$  calcd for  $\text{C}_{38}\text{H}_{25}\text{O}_4$   $[\text{M}-\text{H}]^-$  545.1753, found 545.1753;



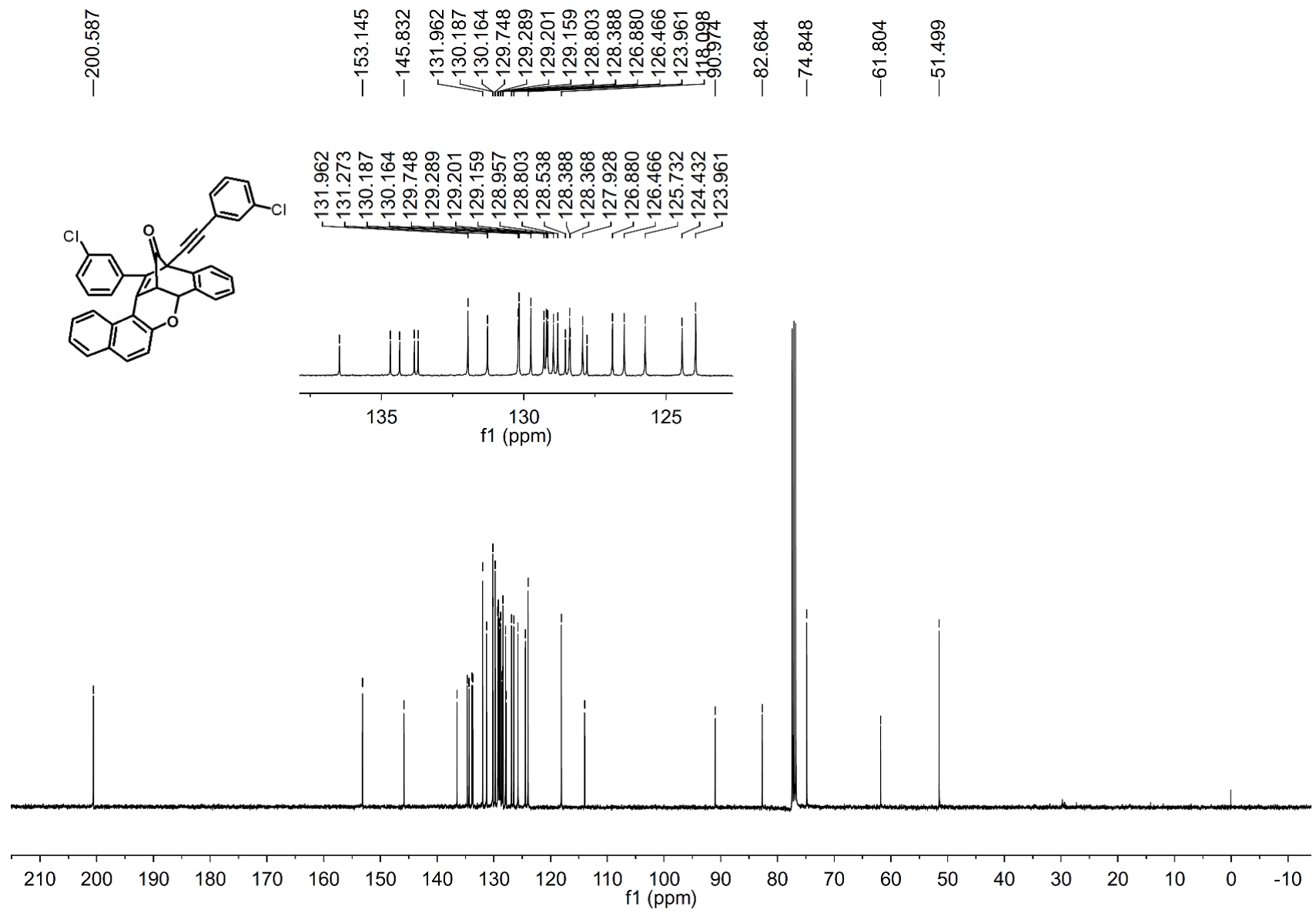
<sup>1</sup>H NMR Spectrum of Compound 2a



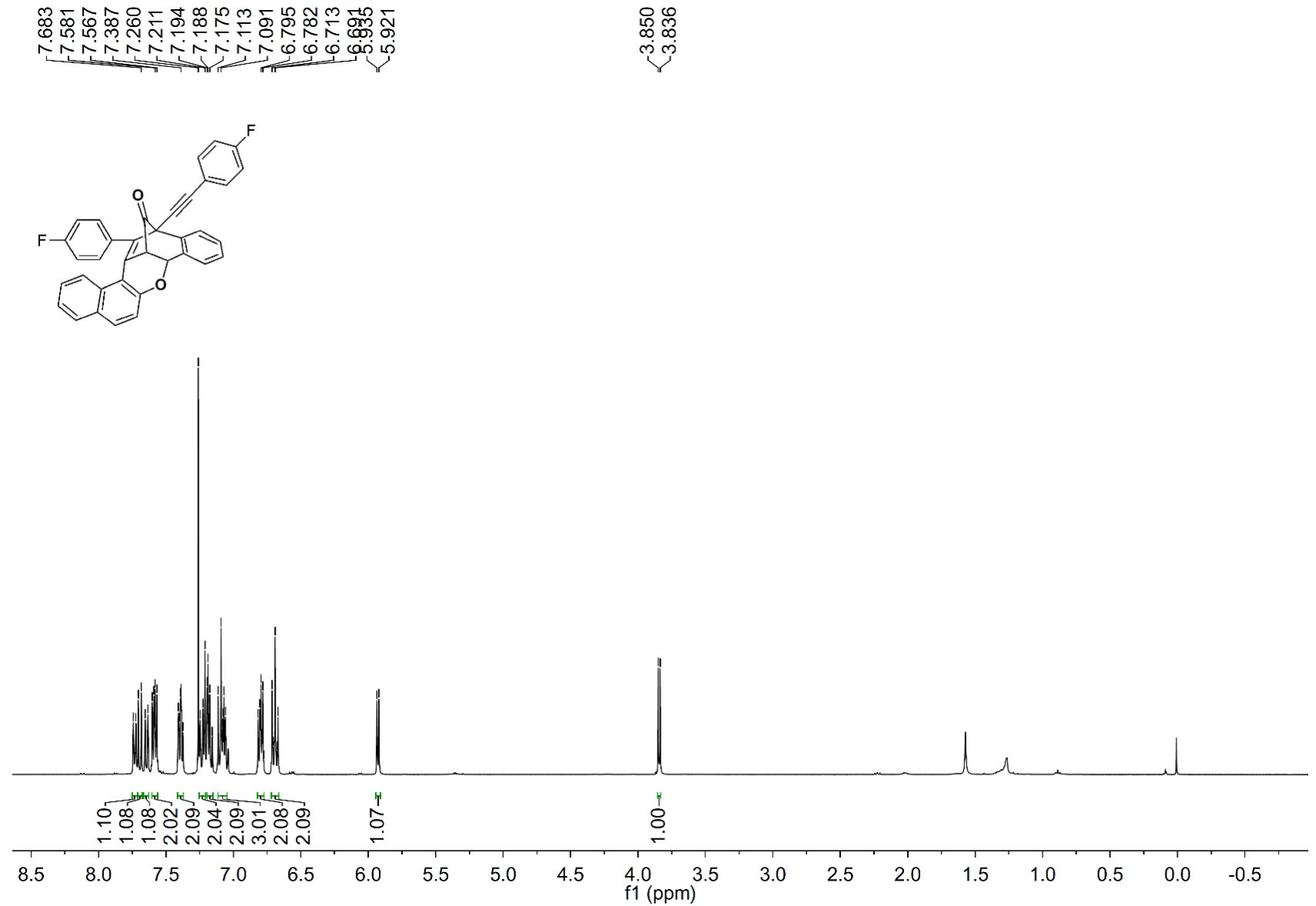
<sup>13</sup>C NMR Spectrum of Compound 2a



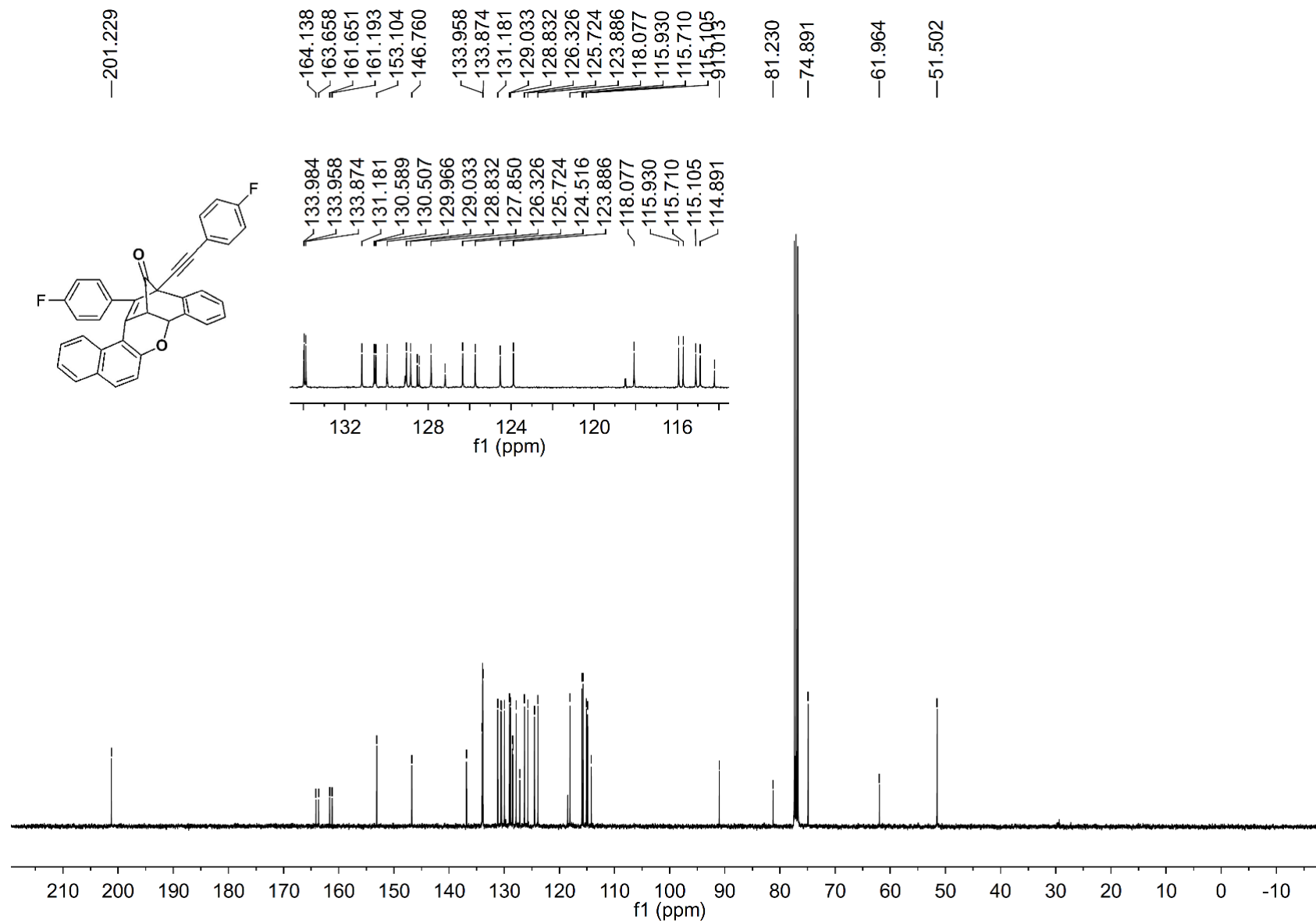
**<sup>1</sup>H NMR Spectrum of Compound 2b**



<sup>13</sup>C NMR Spectrum of Compound 2b

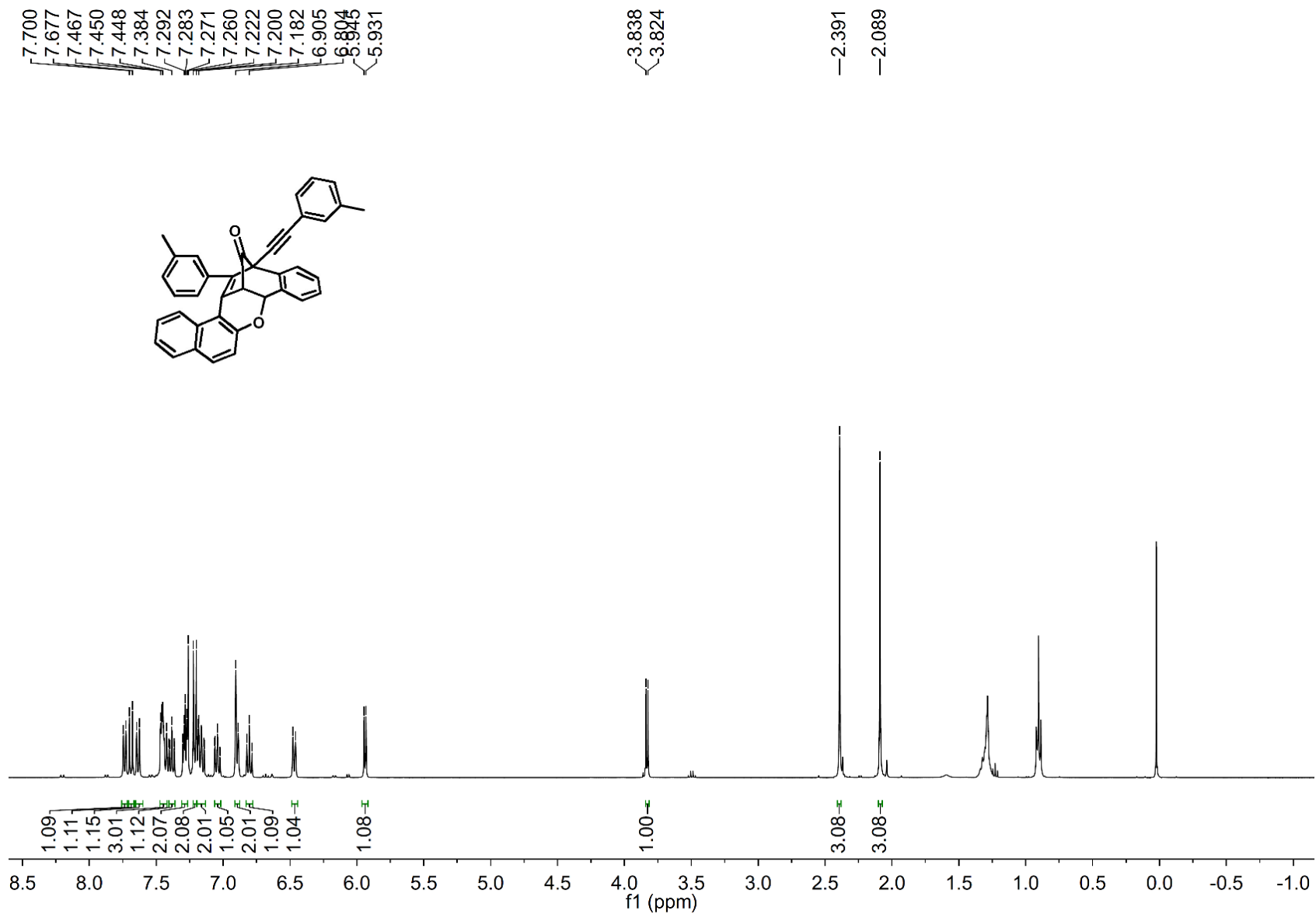


**<sup>1</sup>H NMR Spectrum of Compound 2c**

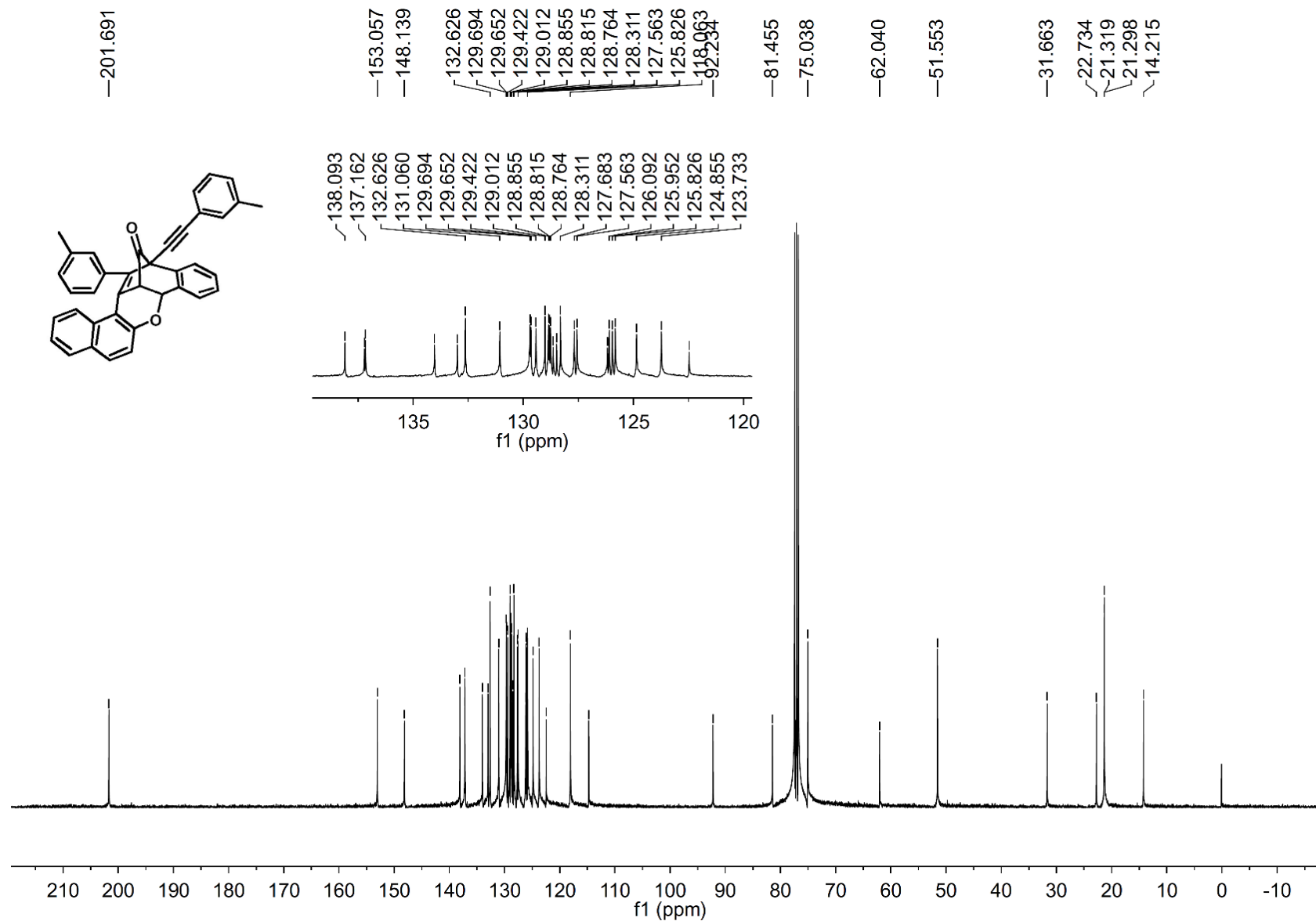


$^{13}\text{C}$  NMR Spectrum of Compound 2c

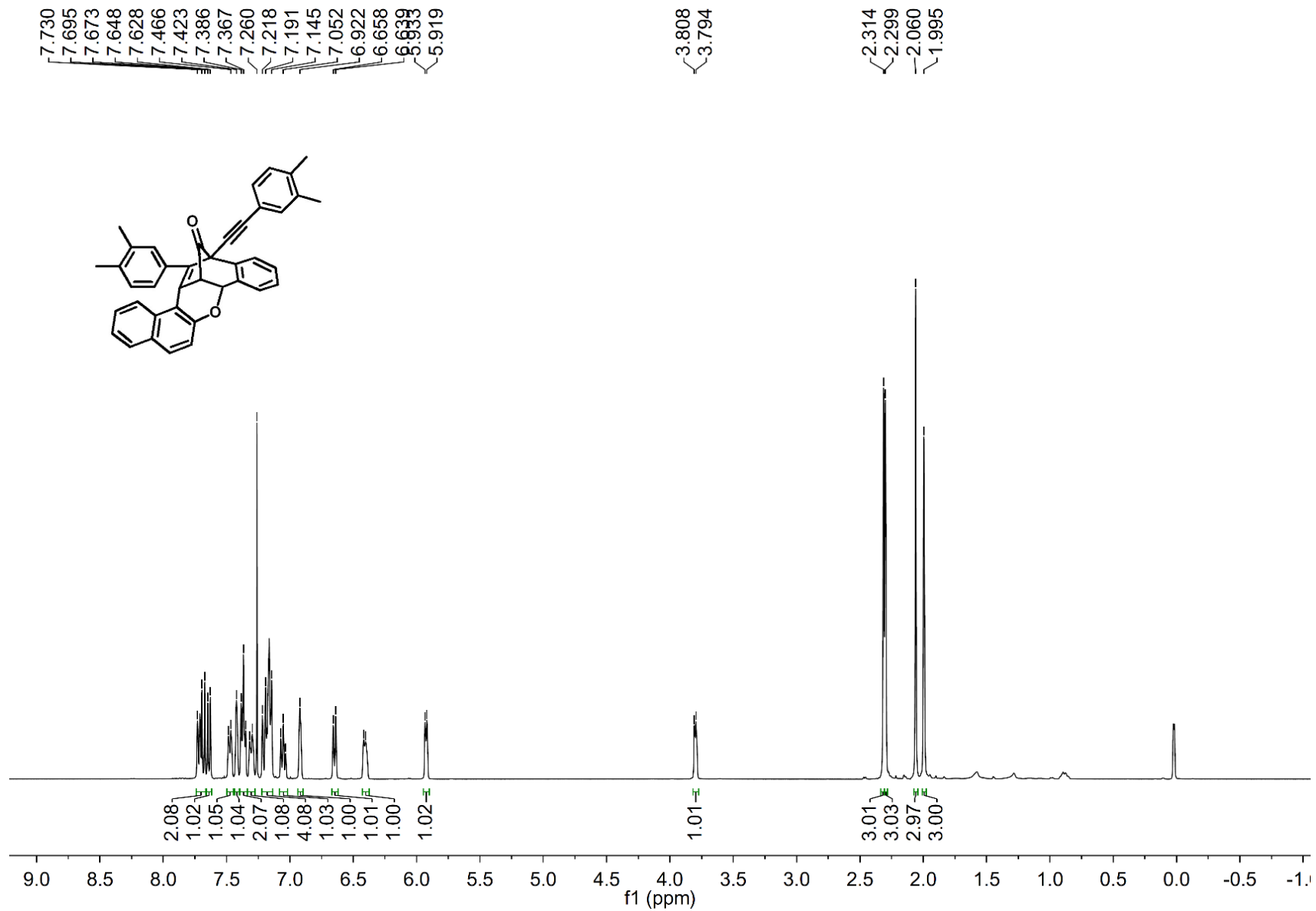




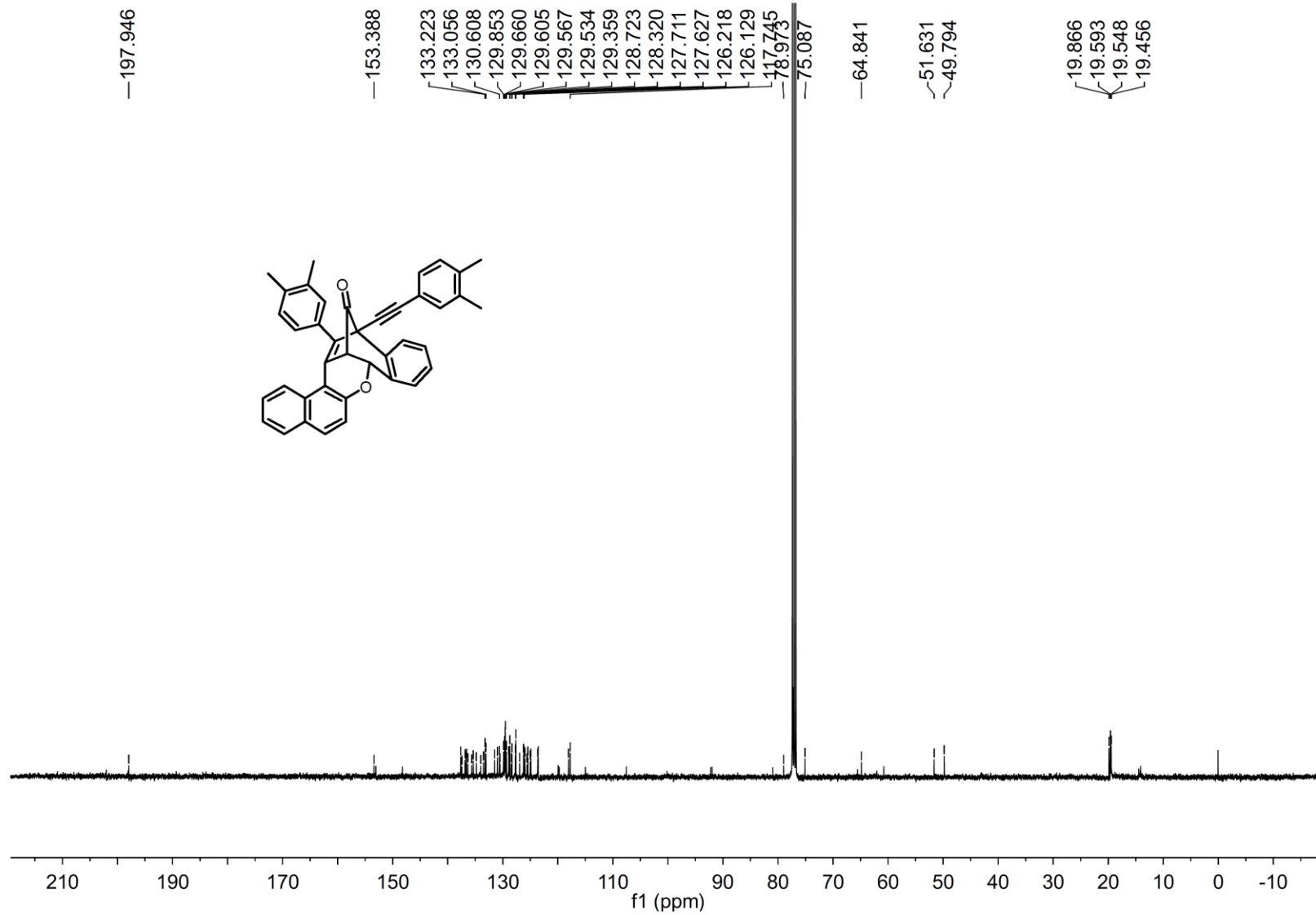
<sup>1</sup>H NMR Spectrum of Compound 2d



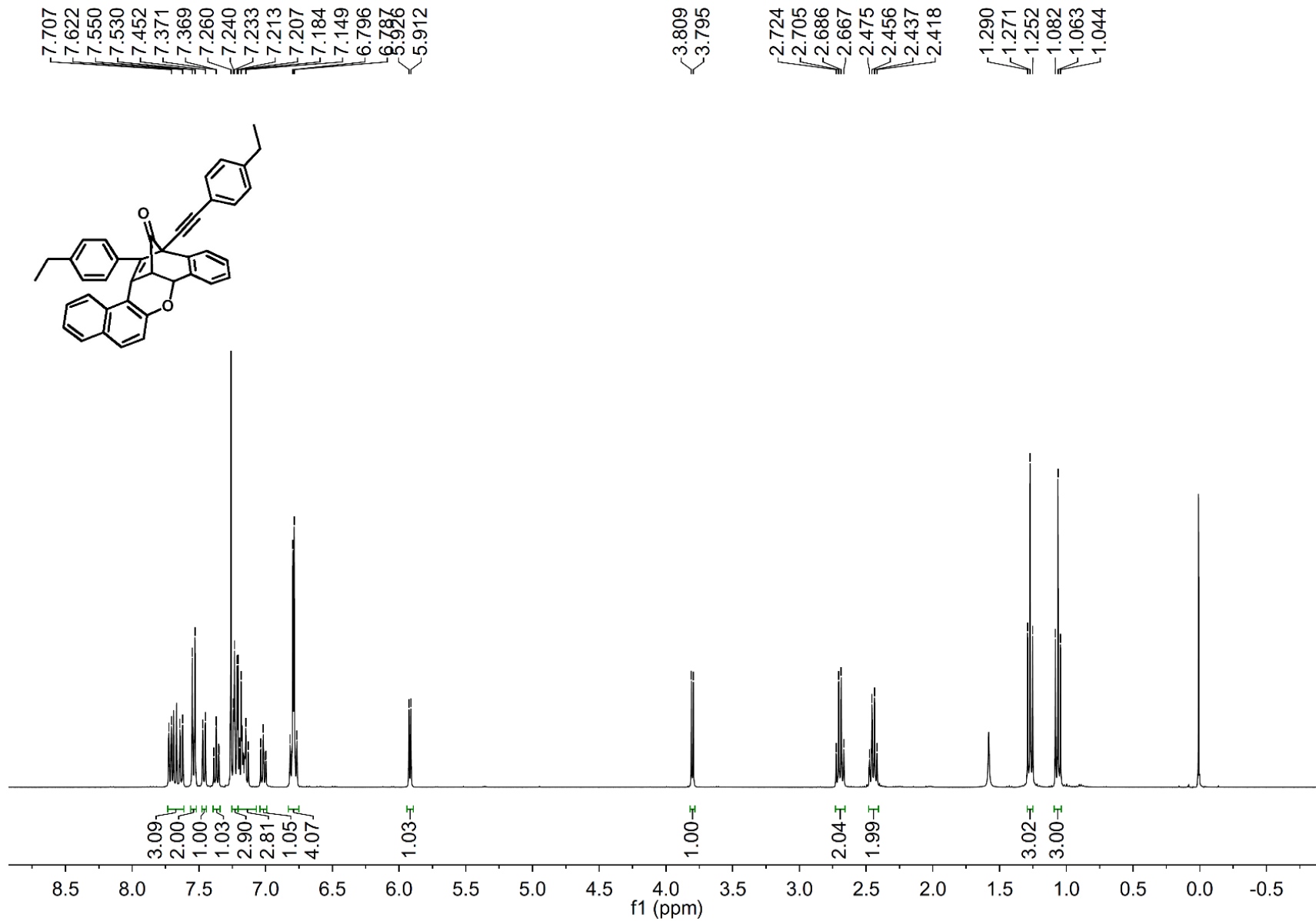
<sup>13</sup>C NMR Spectrum of Compound 2d



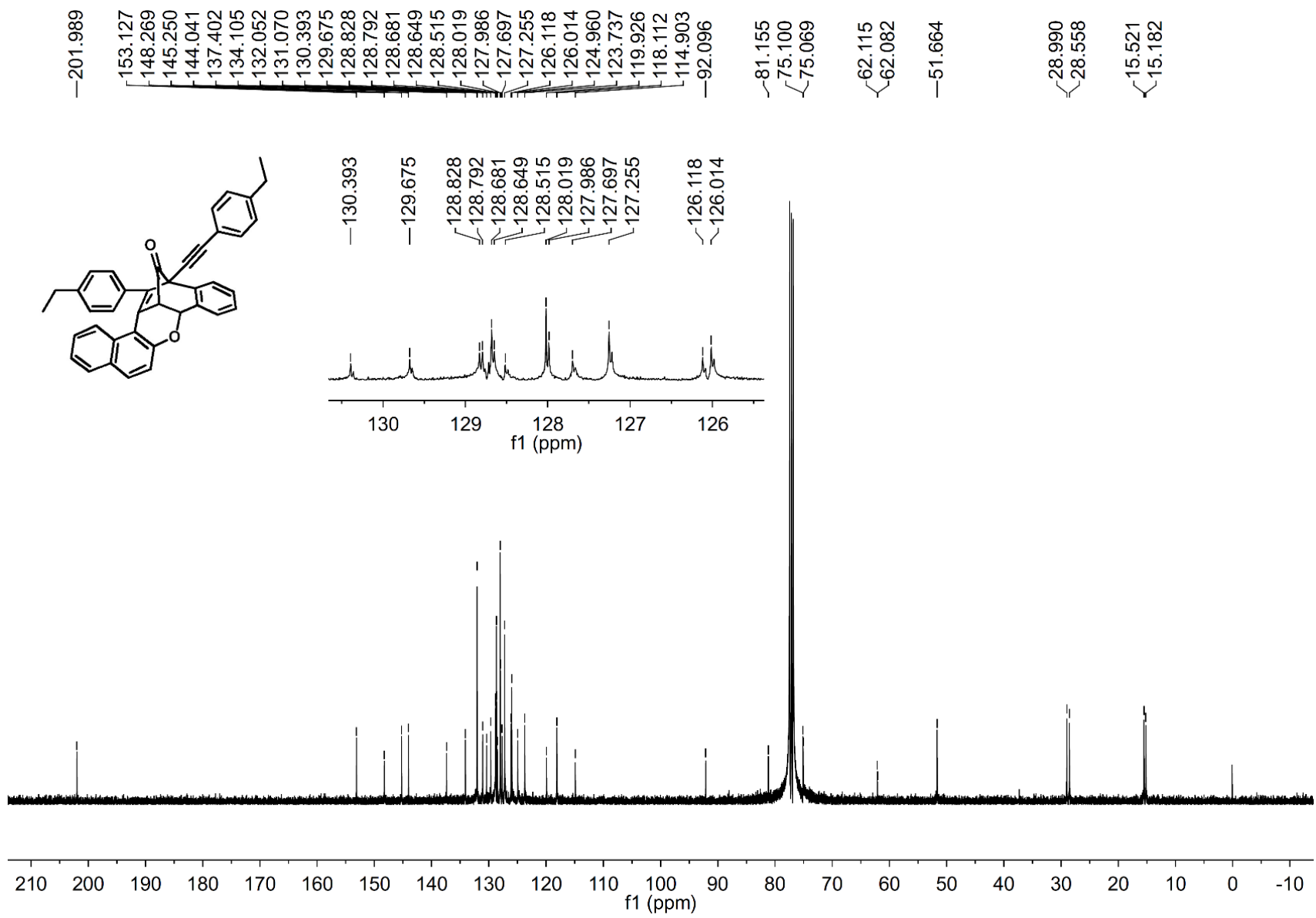
**<sup>1</sup>H NMR Spectrum of Compound 2e**



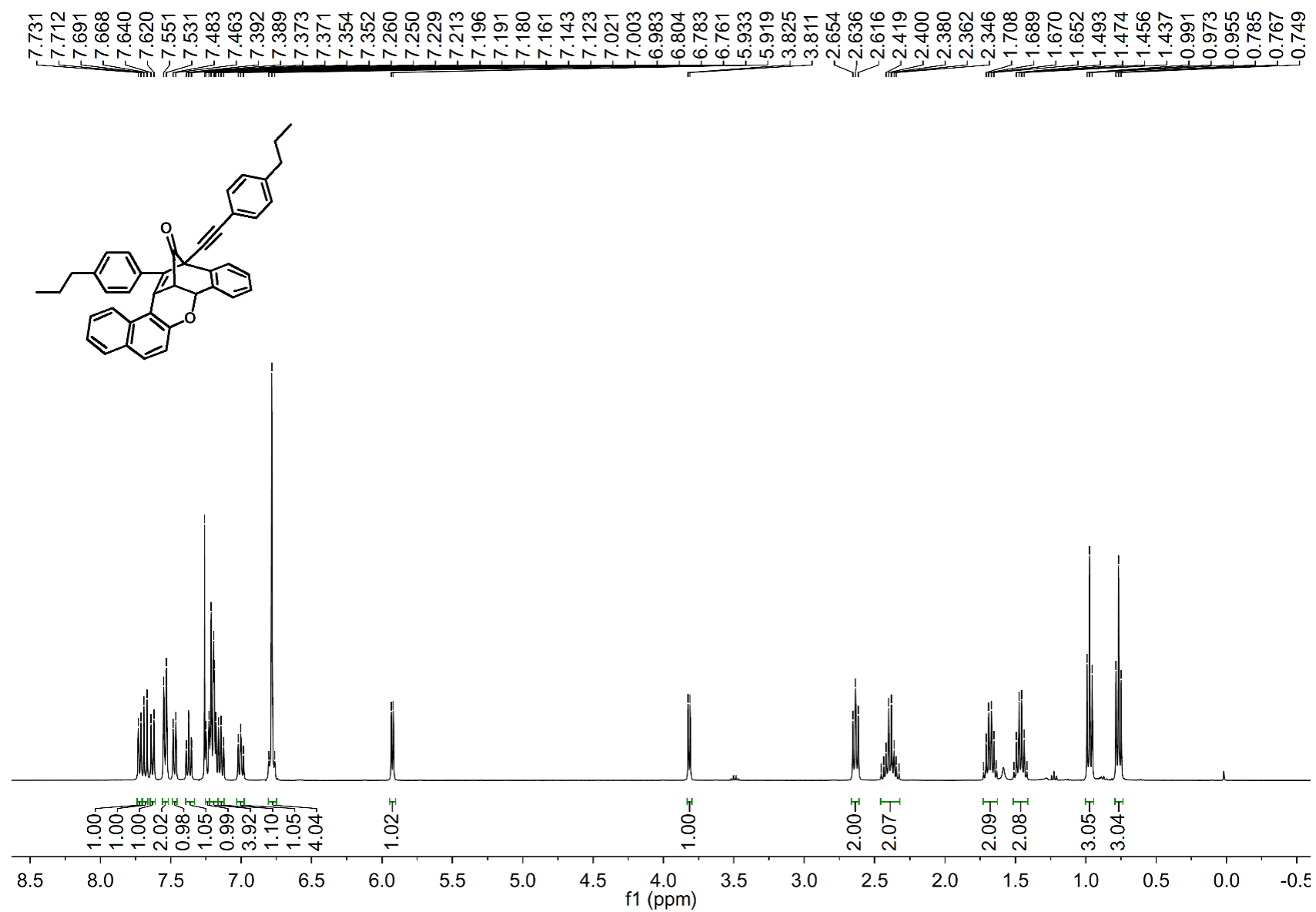
<sup>13</sup>C NMR Spectrum of Compound 2e



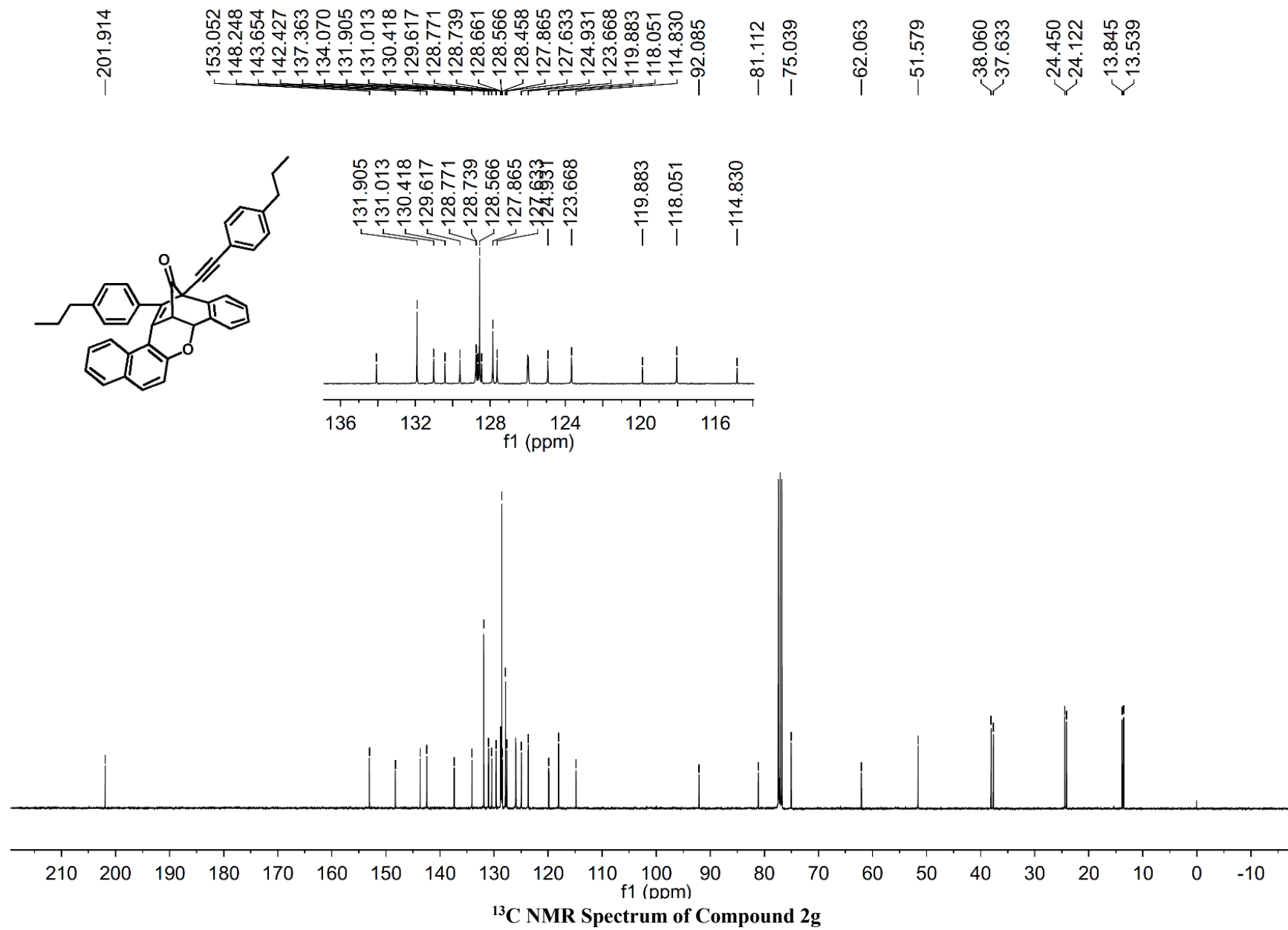
**<sup>1</sup>H NMR Spectrum of Compound 2f**



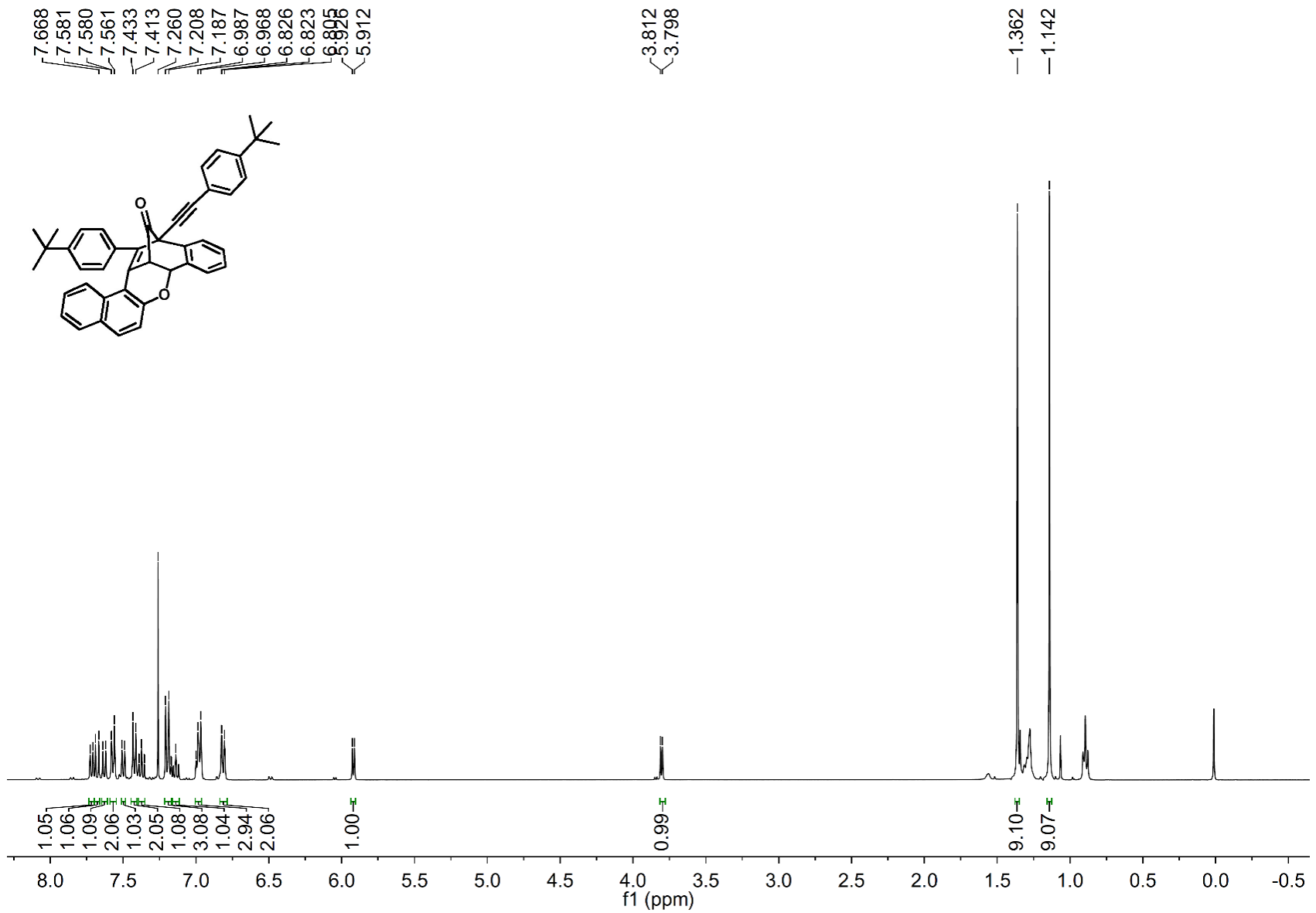
<sup>13</sup>C NMR Spectrum of Compound 2f



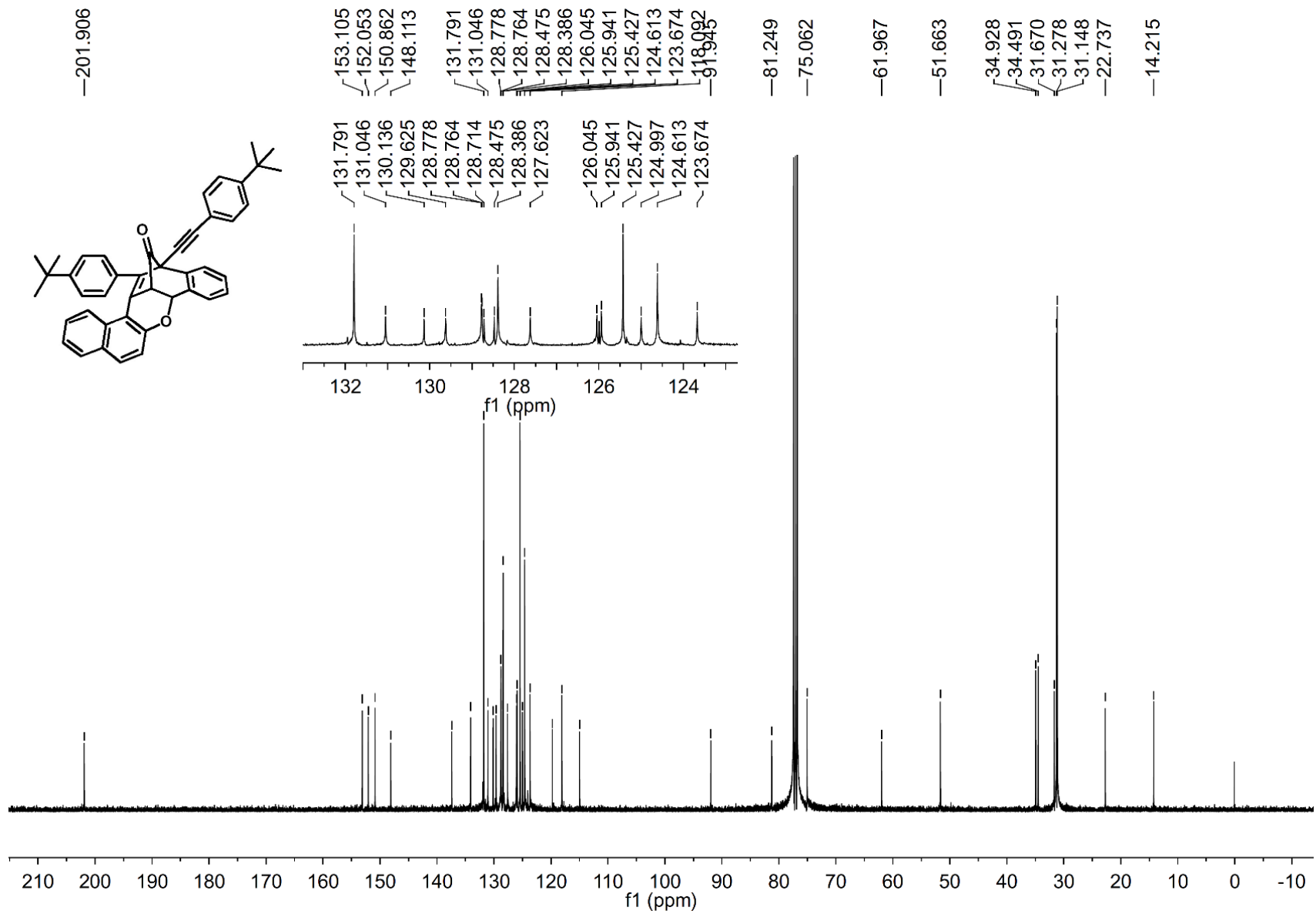
<sup>1</sup>H NMR Spectrum of Compound 2g



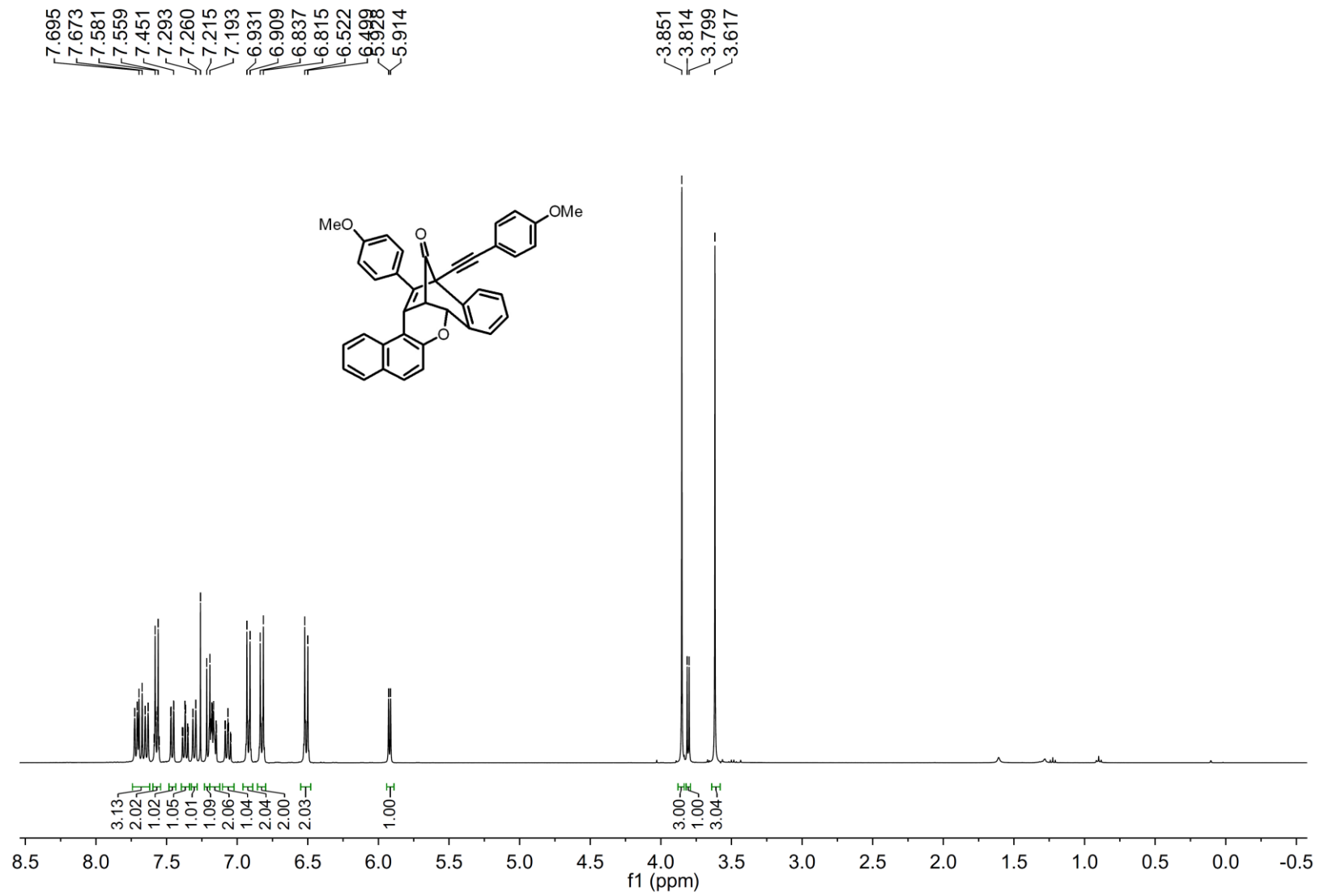




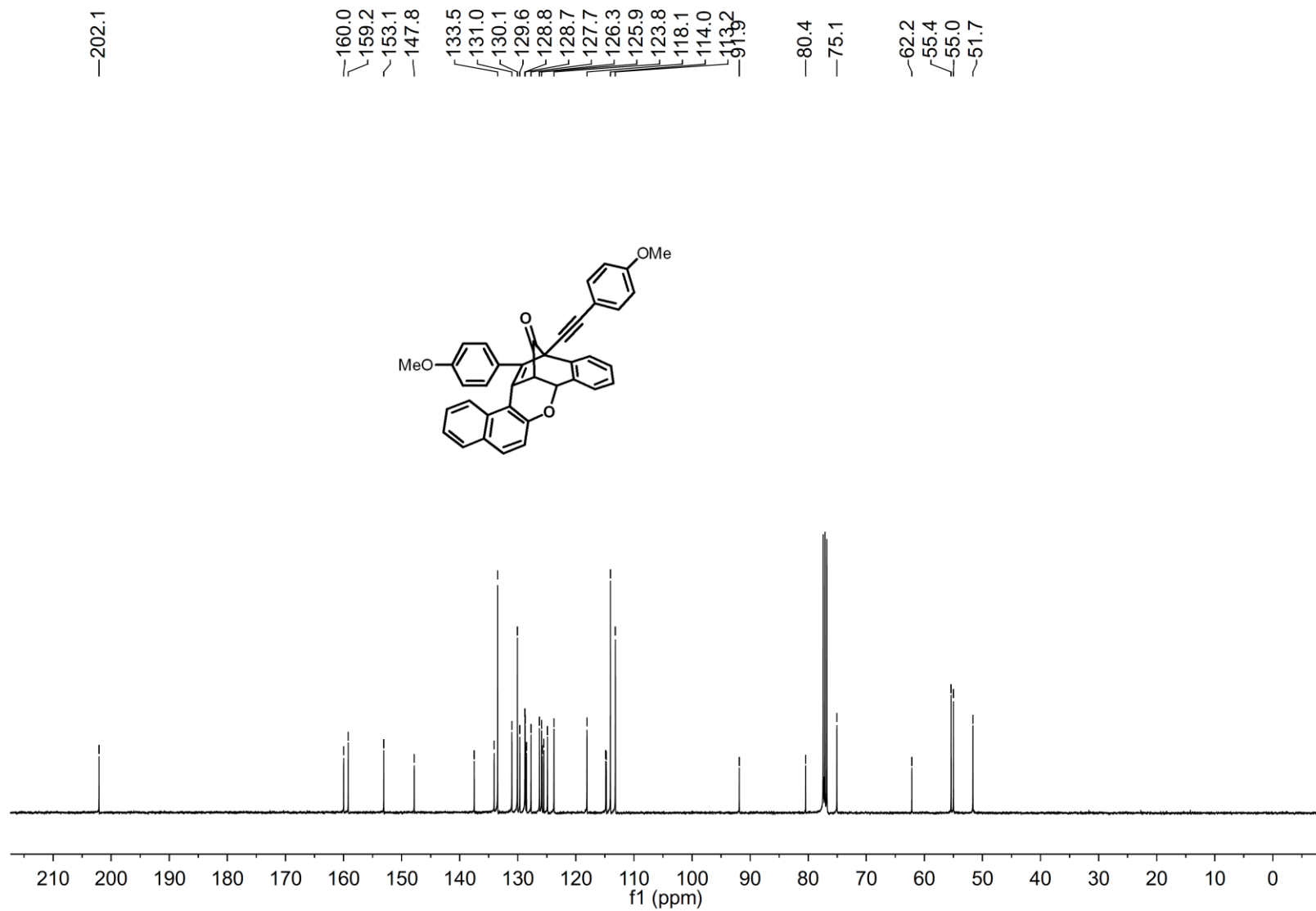
<sup>1</sup>H NMR Spectrum of Compound 2h



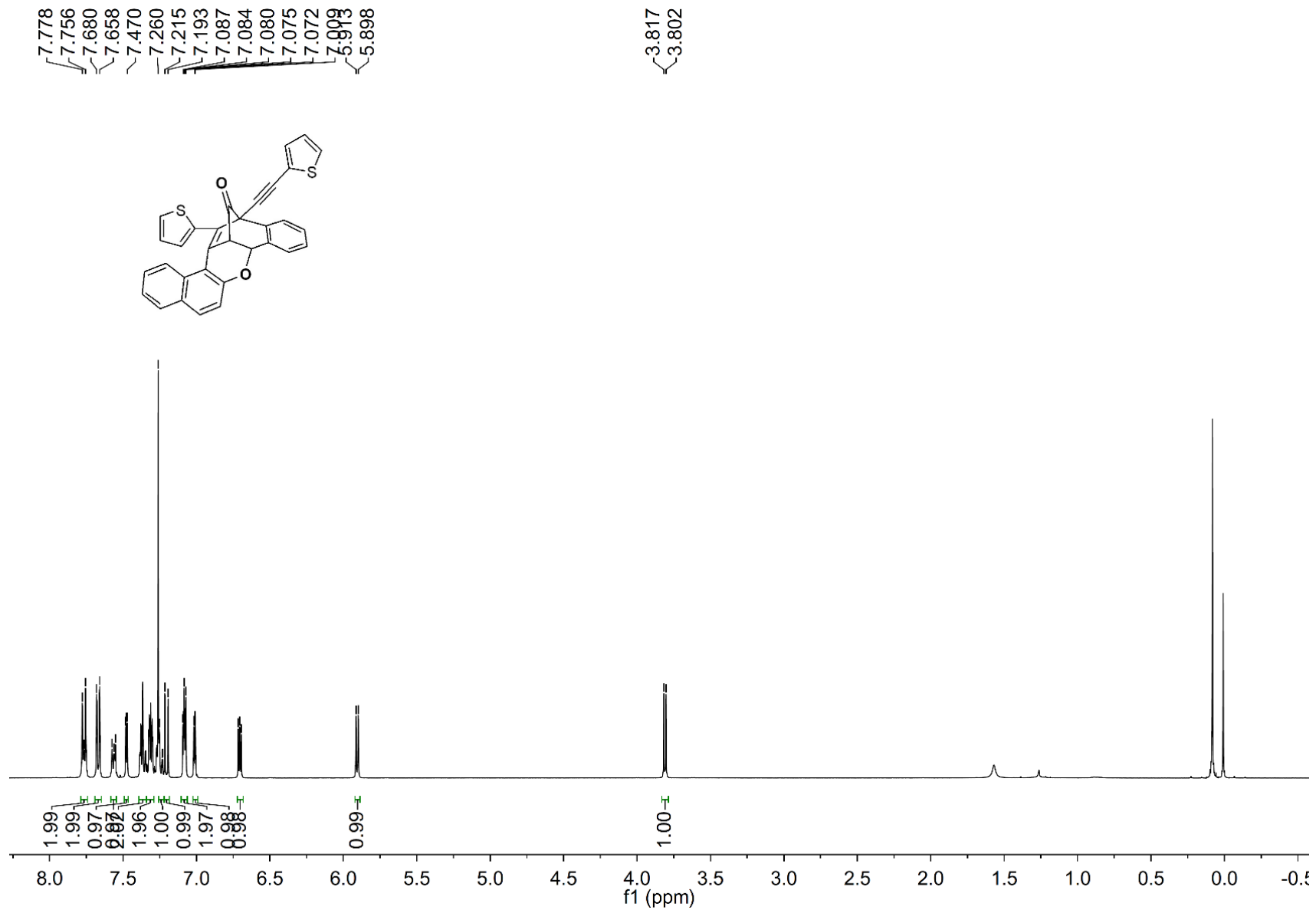
**<sup>13</sup>C NMR Spectrum of Compound 2h**



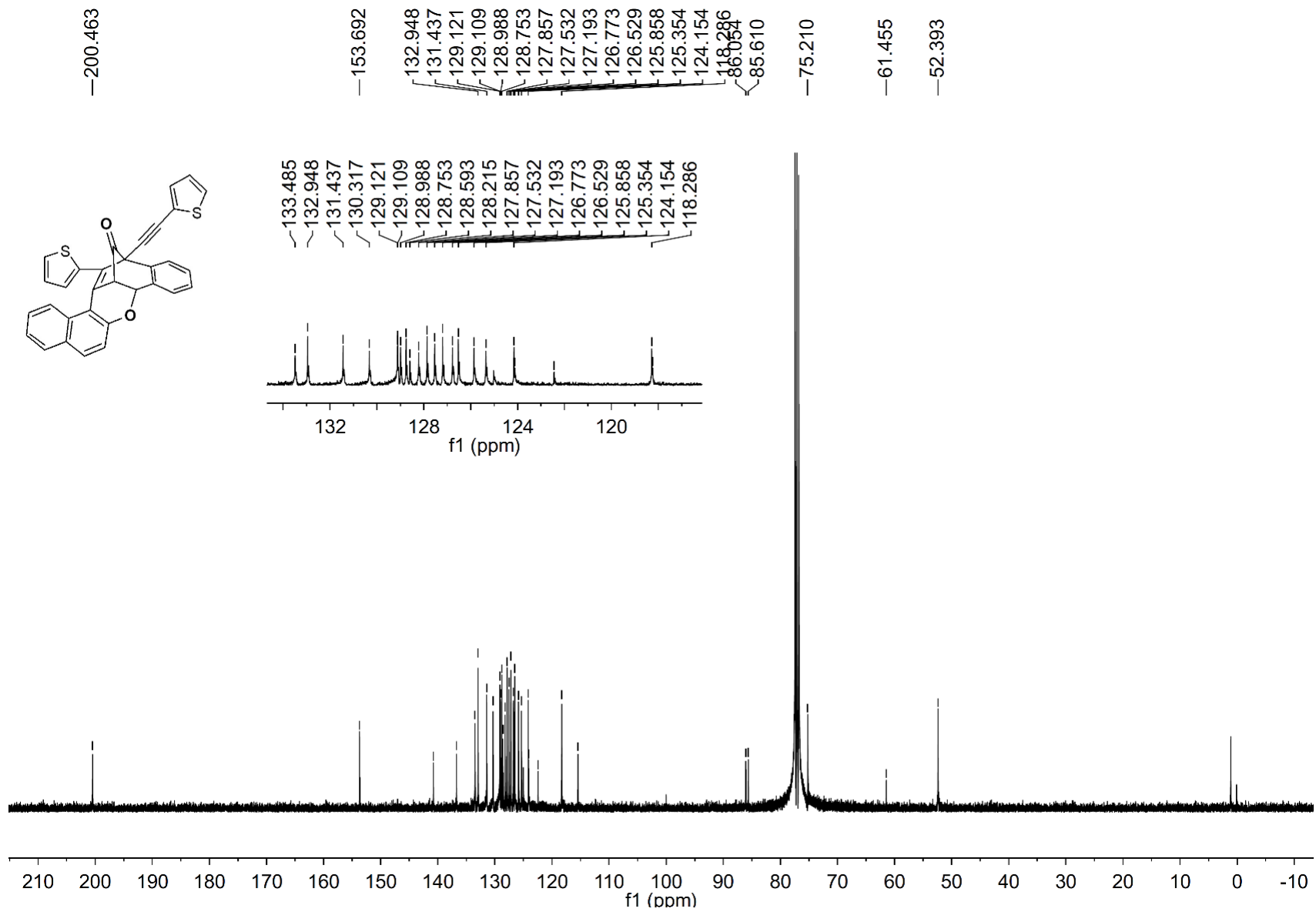
**<sup>1</sup>H NMR Spectrum of Compound 2i**



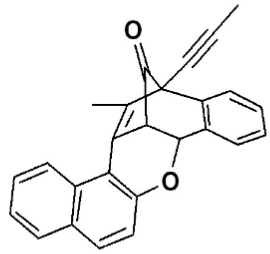
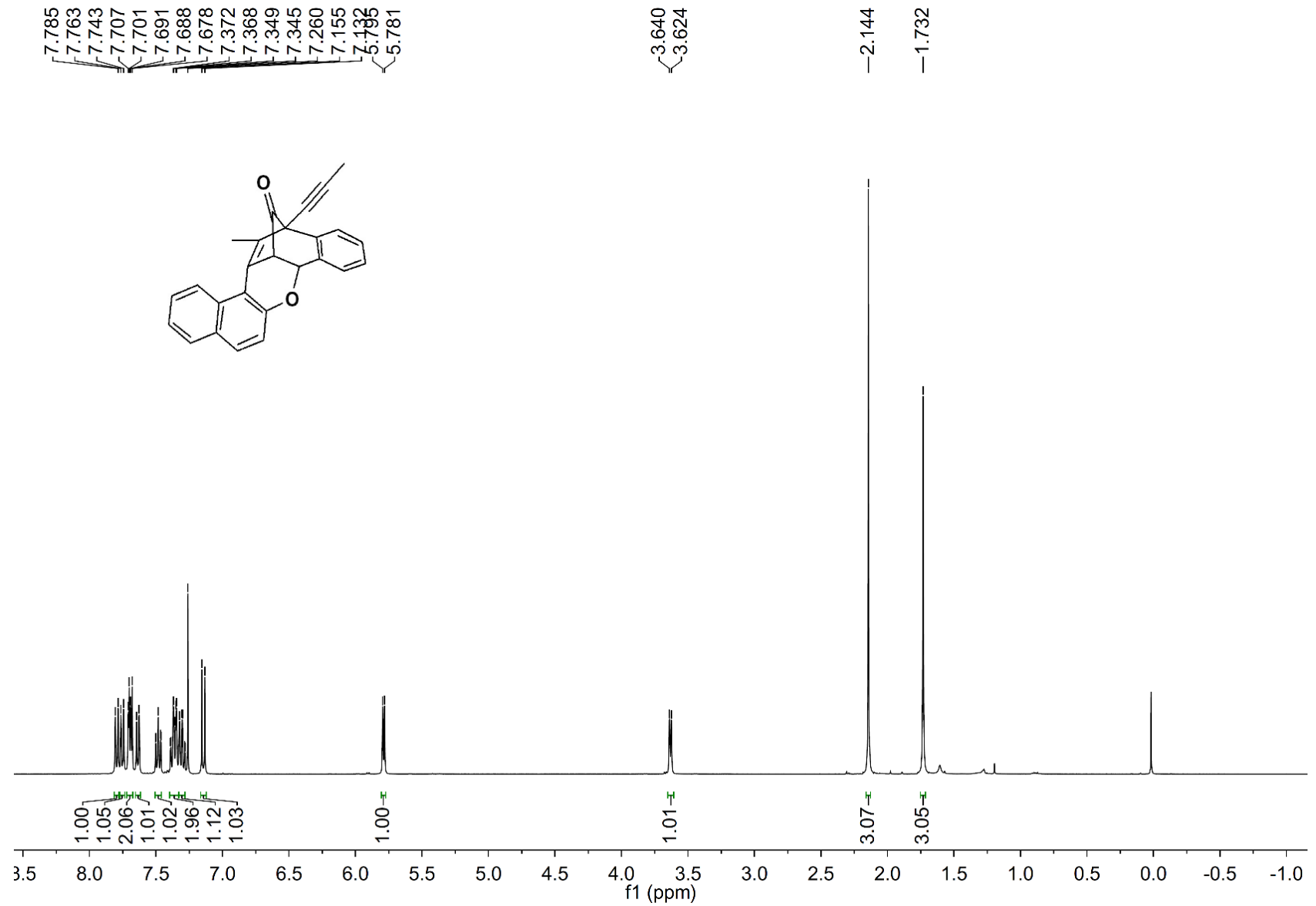
**<sup>13</sup>C NMR Spectrum of Compound 2i**



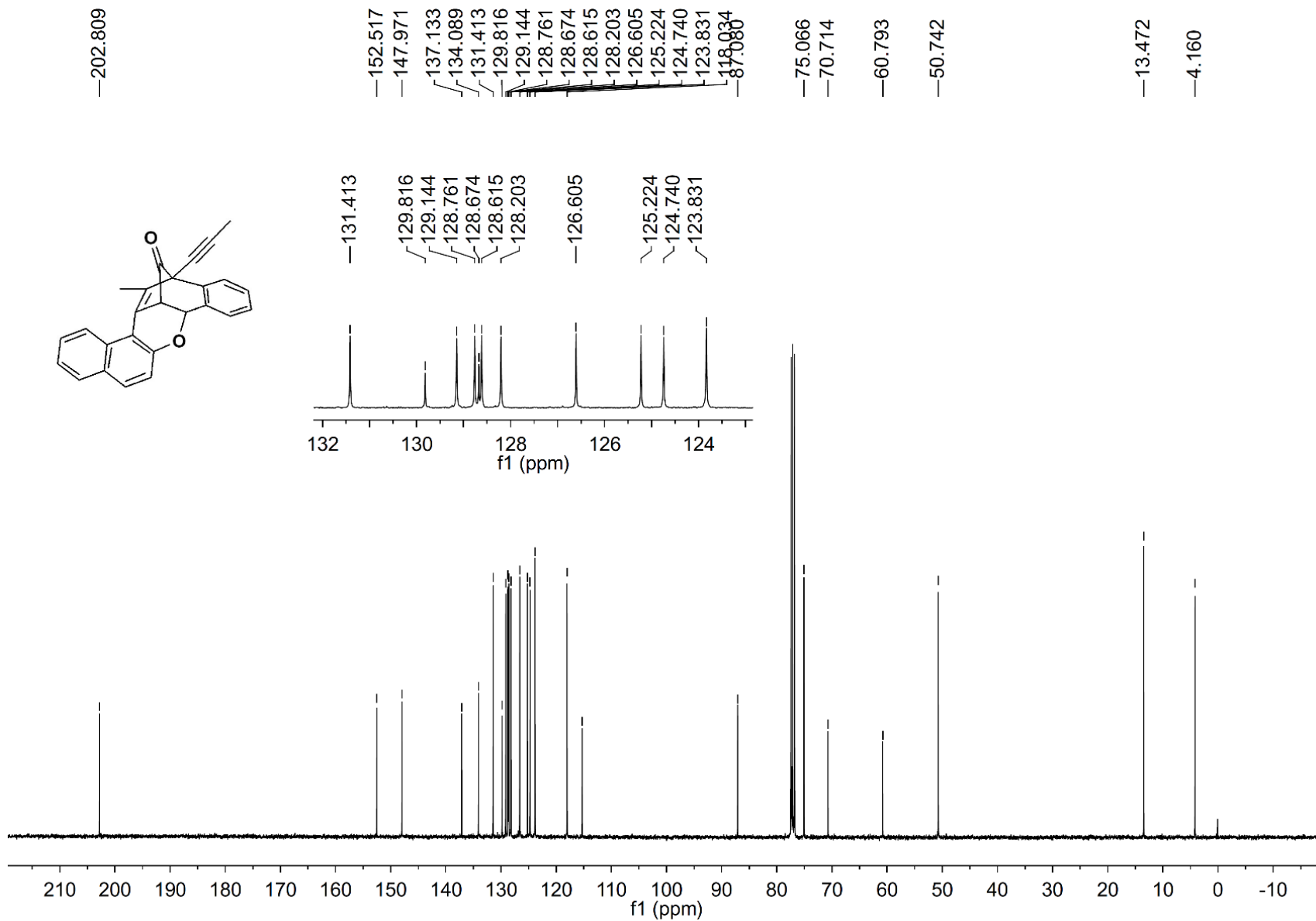
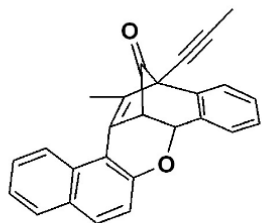
<sup>1</sup>H NMR Spectrum of Compound 2j



<sup>13</sup>C NMR Spectrum of Compound 2j

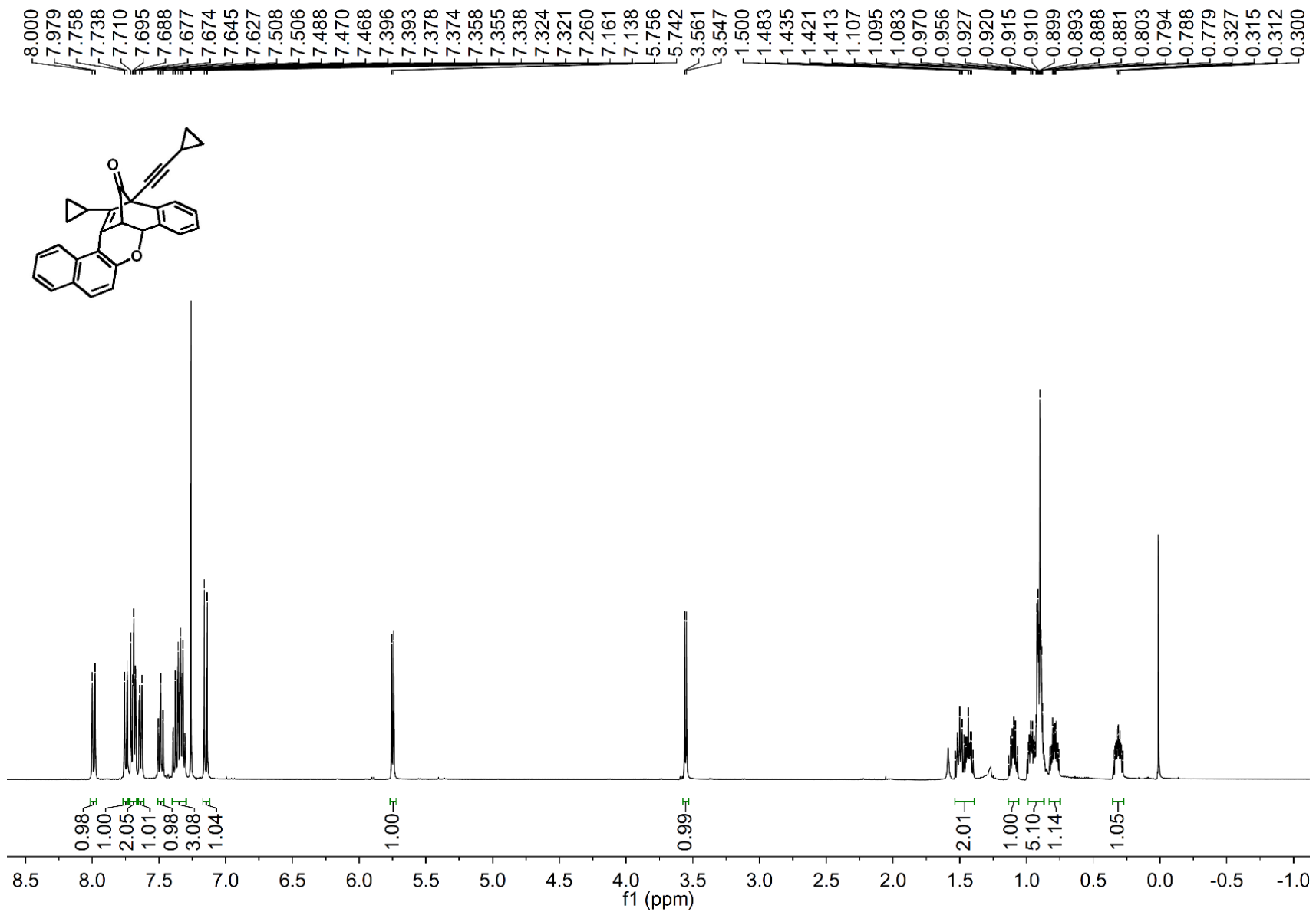


**<sup>1</sup>H NMR Spectrum of Compound 2k**

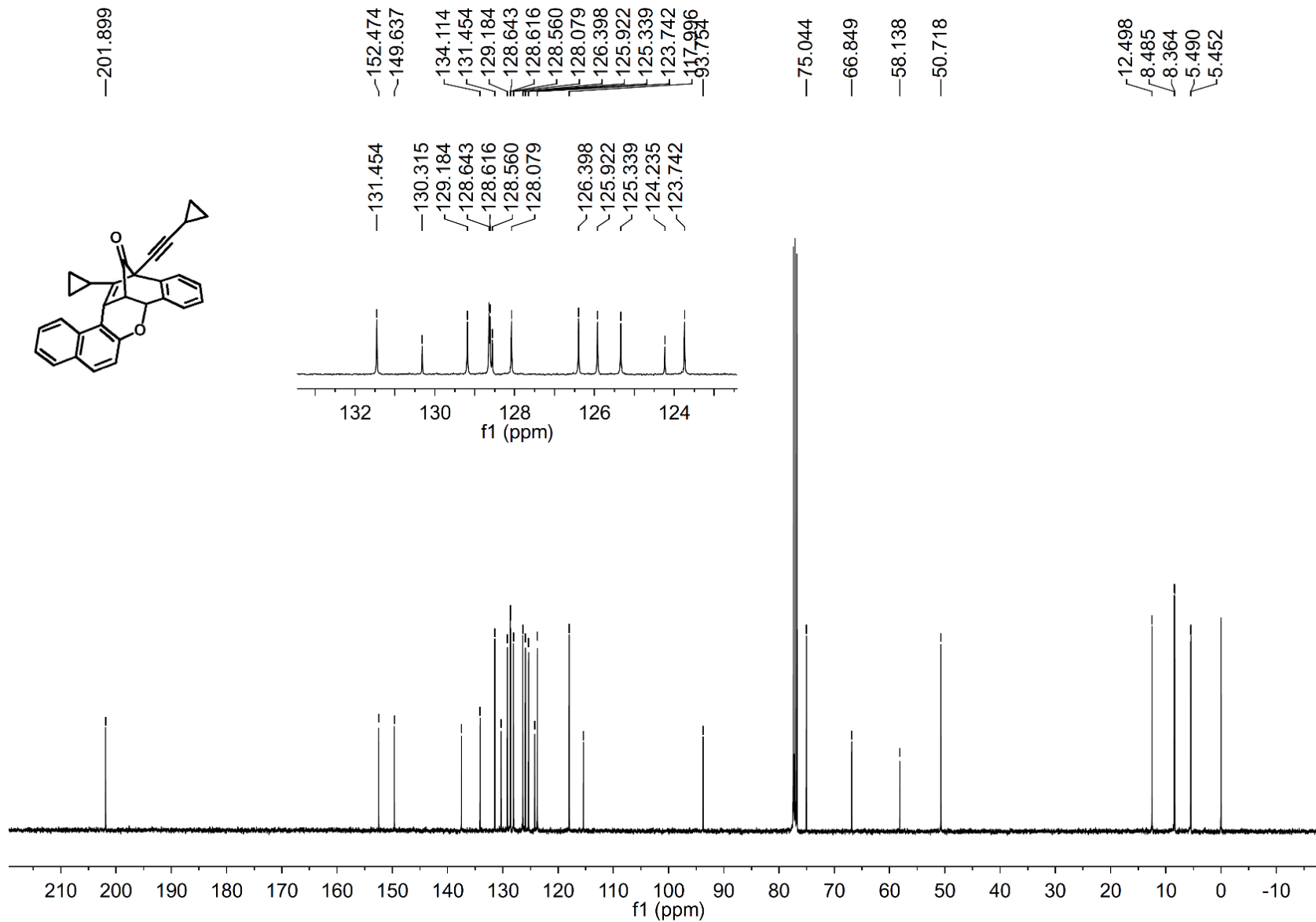
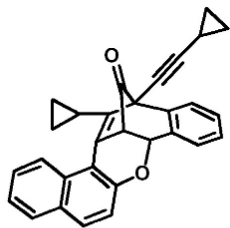


**<sup>13</sup>C NMR Spectrum of Compound 2k**

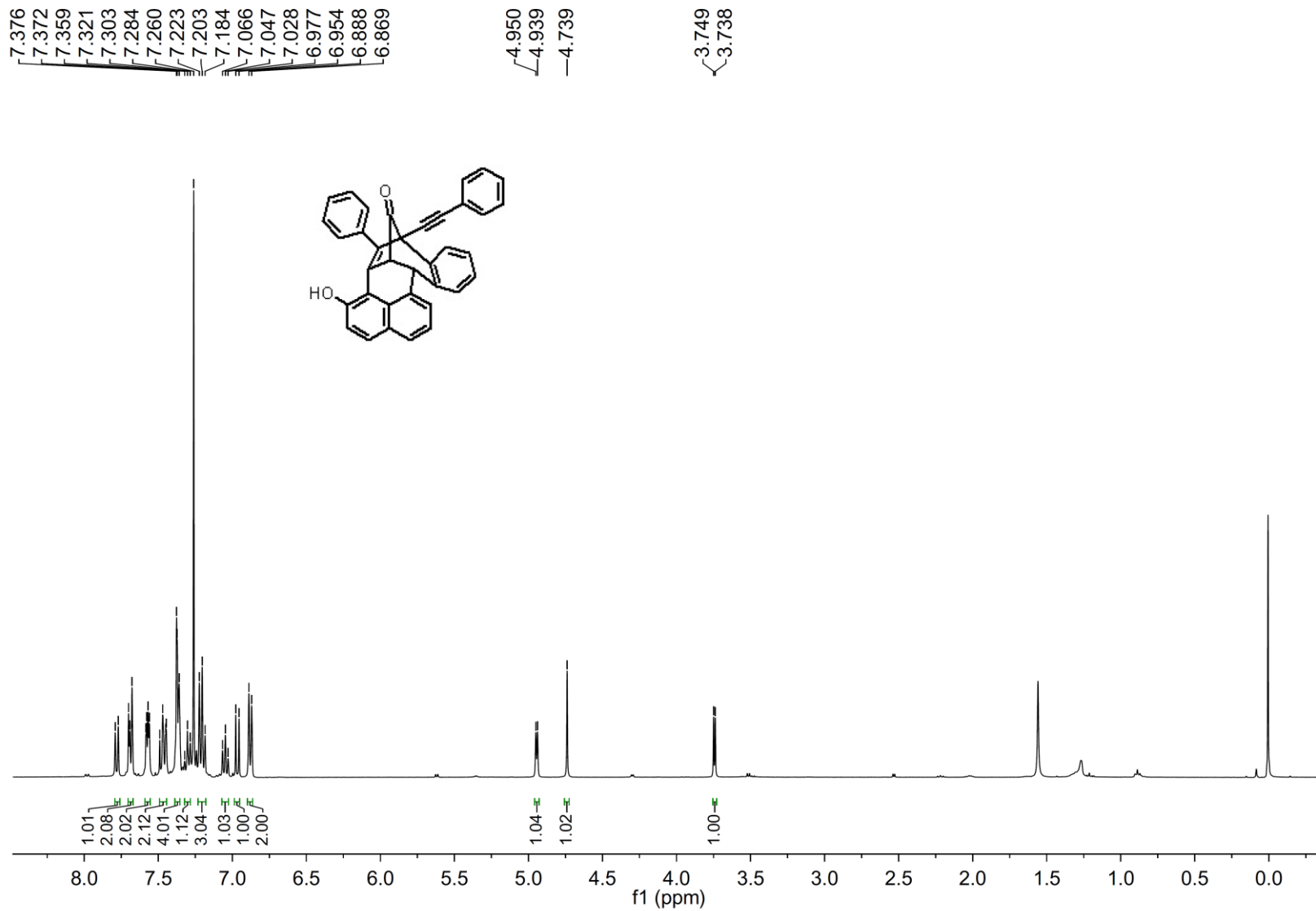




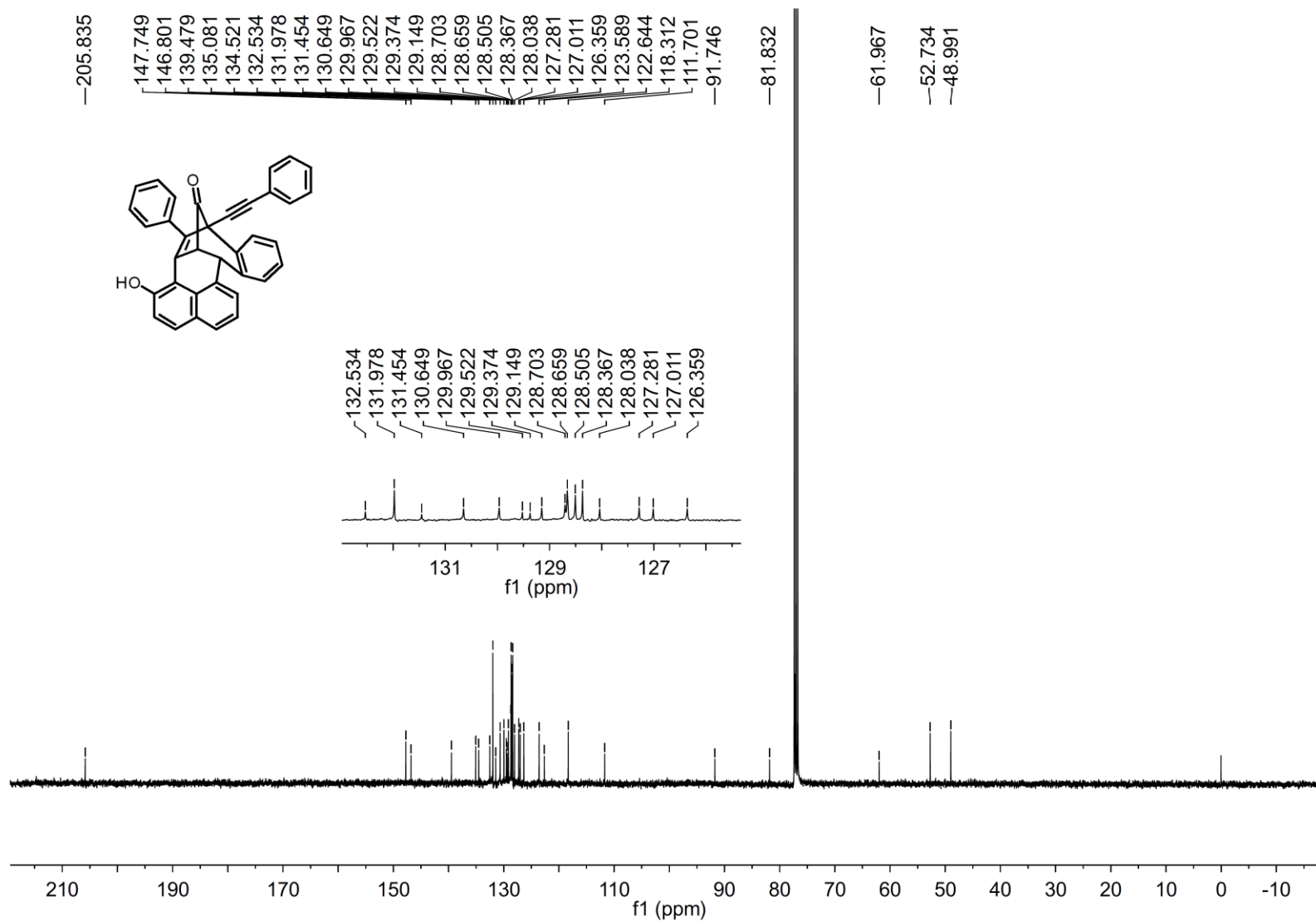
<sup>1</sup>H NMR Spectrum of Compound 2l



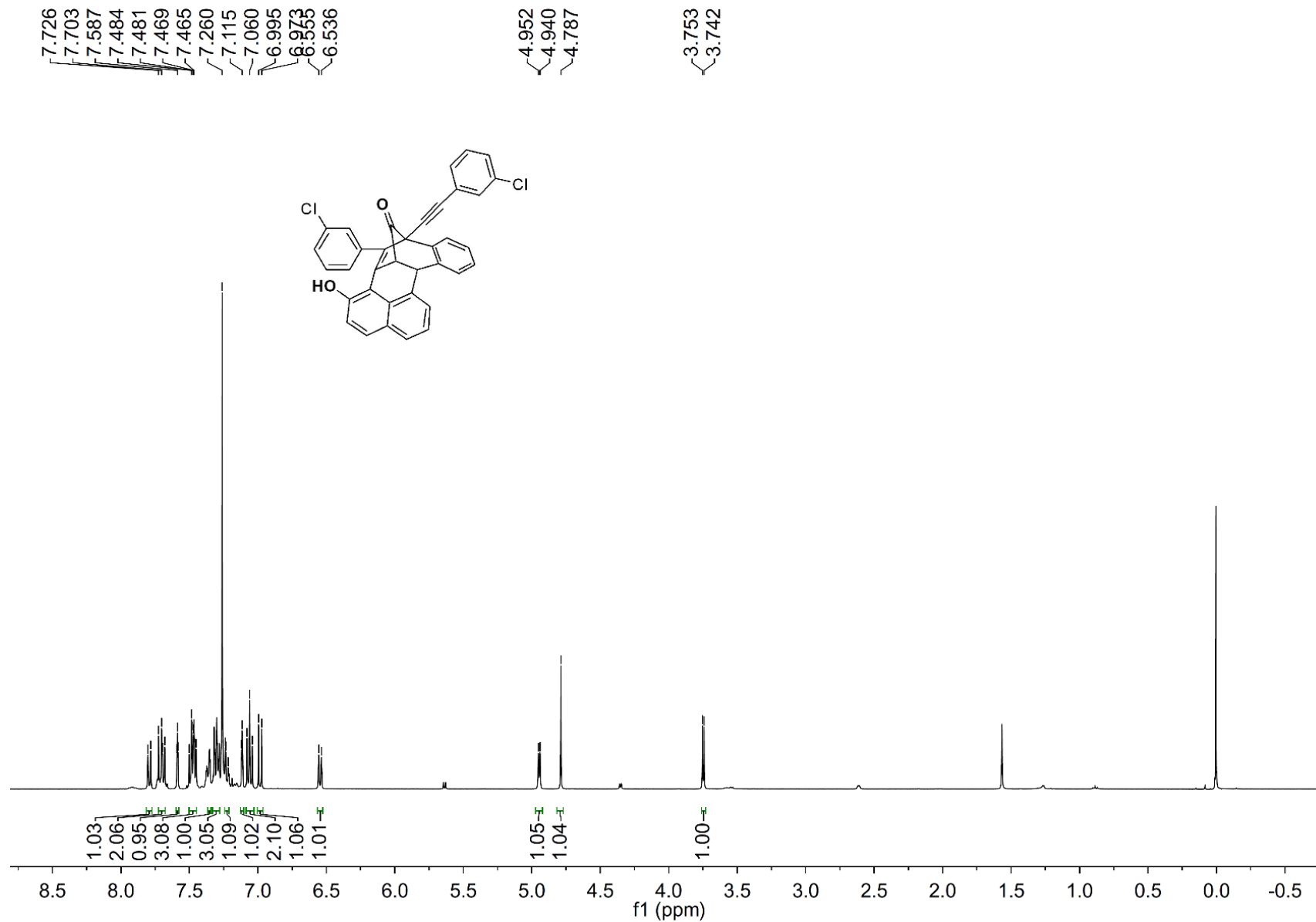
<sup>13</sup>C NMR Spectrum of Compound 21



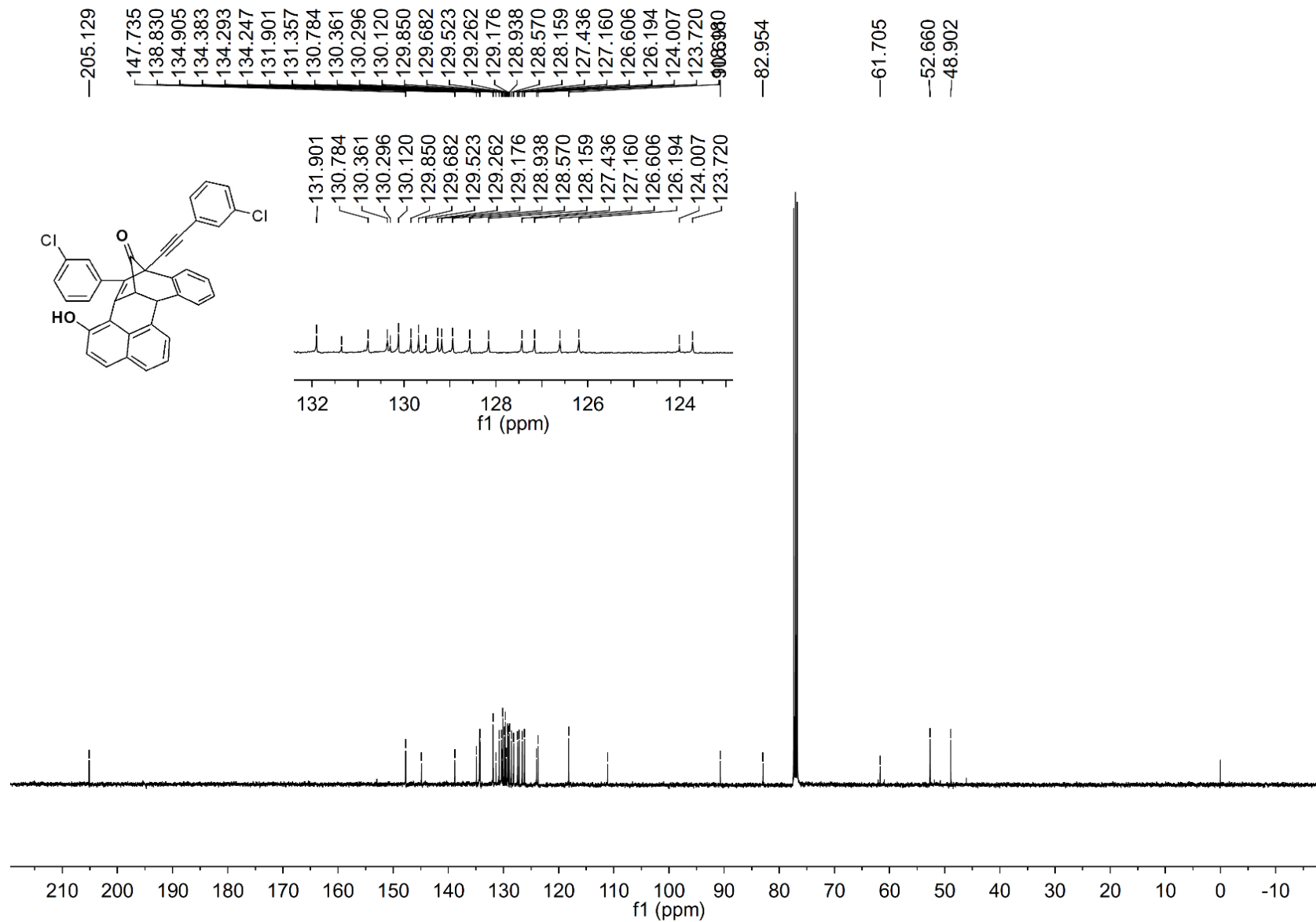
**<sup>1</sup>H NMR Spectrum of Compound 3a**



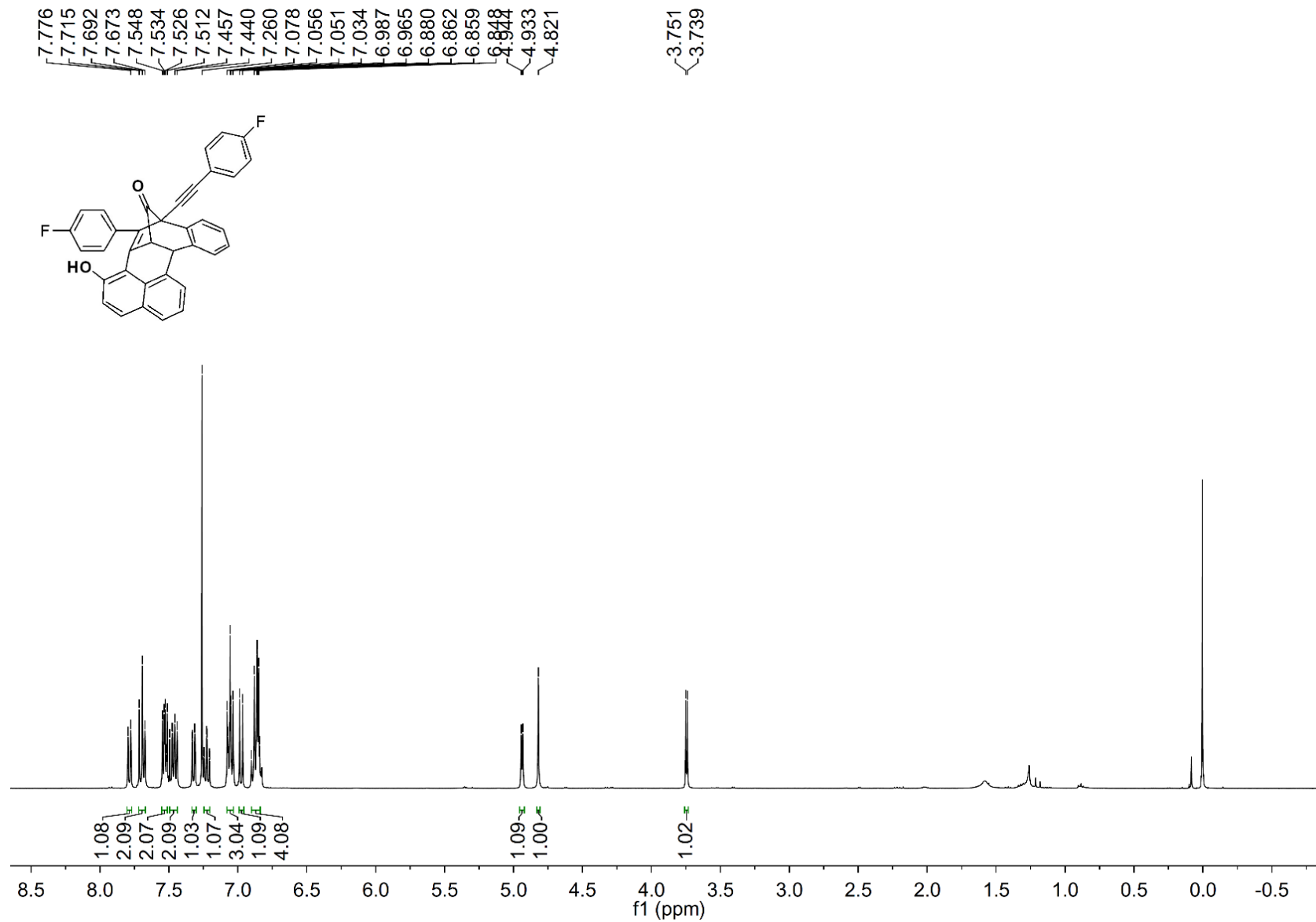
<sup>13</sup>C NMR Spectrum of Compound 3a



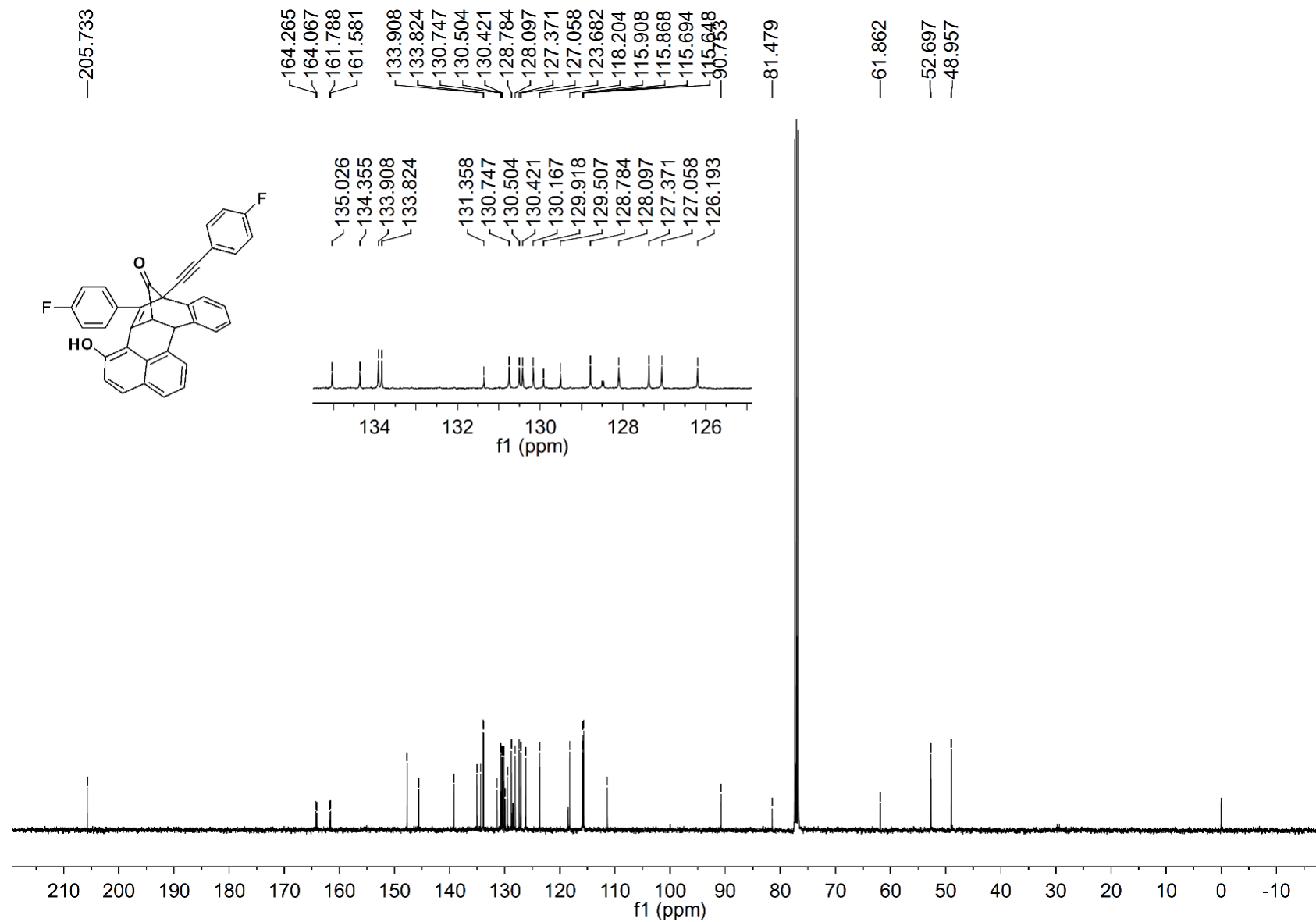
<sup>1</sup>H NMR Spectrum of Compound 3b



<sup>13</sup>C NMR Spectrum of Compound 3b

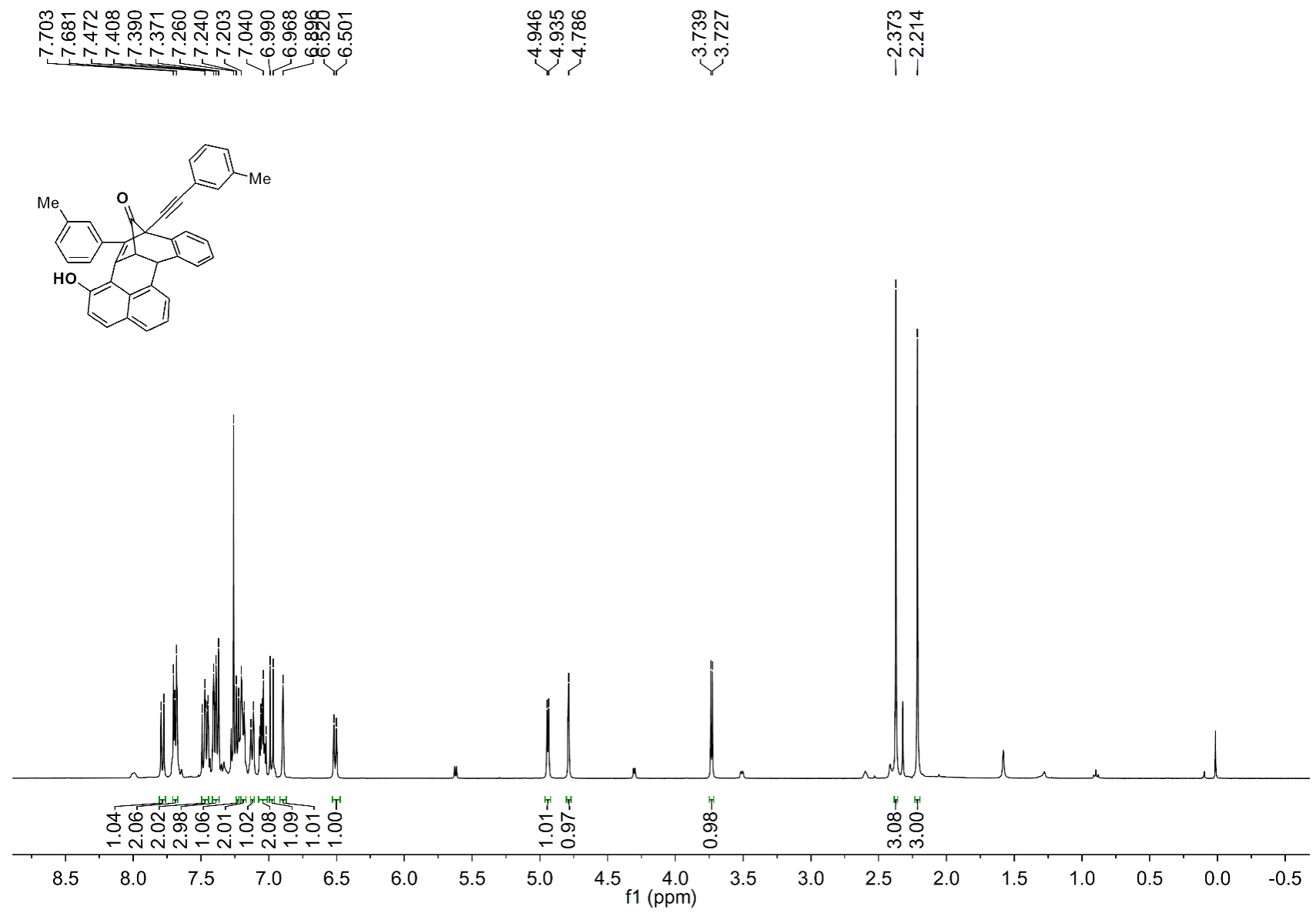


**<sup>1</sup>H NMR Spectrum of Compound 3c**

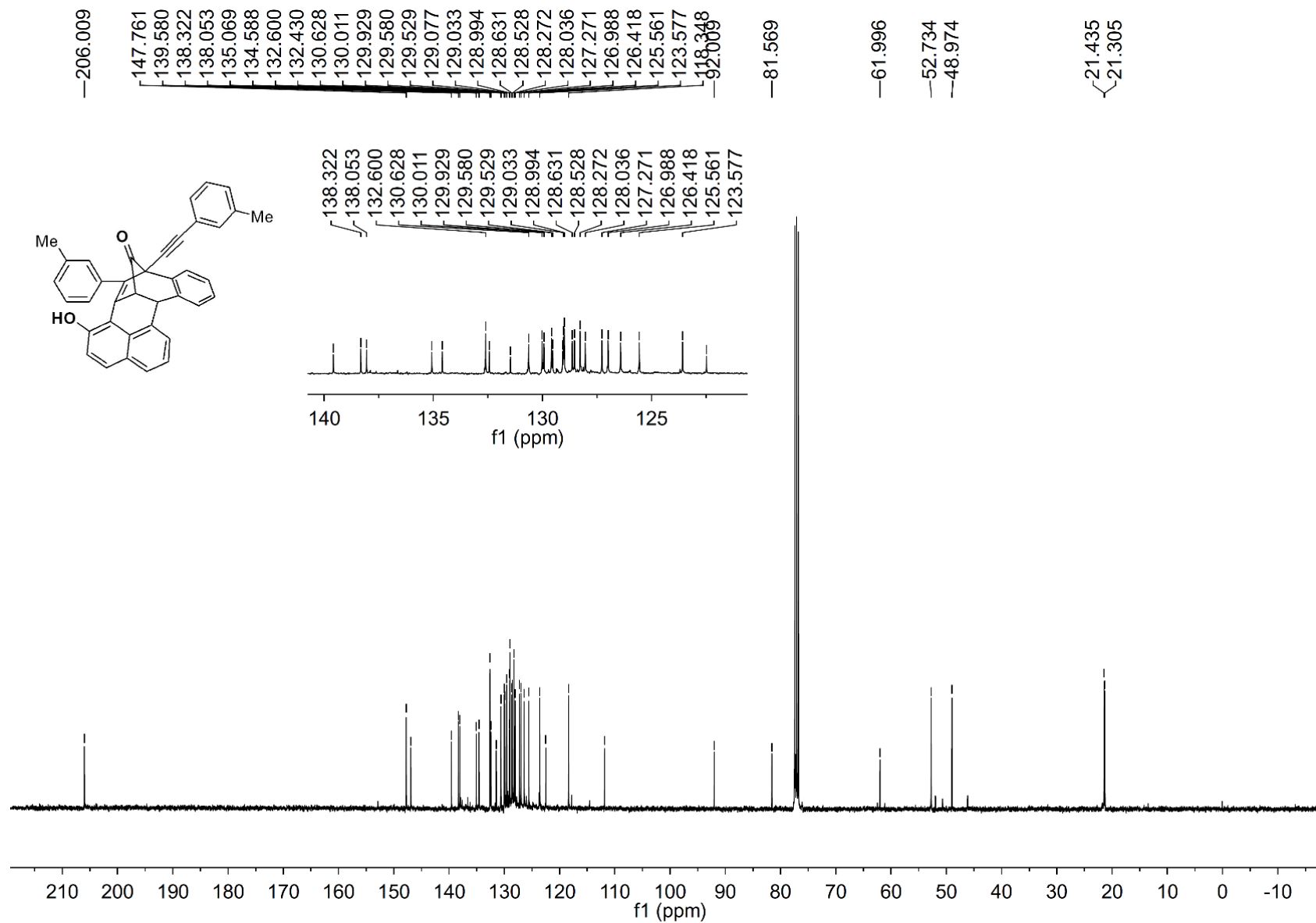


**<sup>13</sup>C NMR Spectrum of Compound 3c**

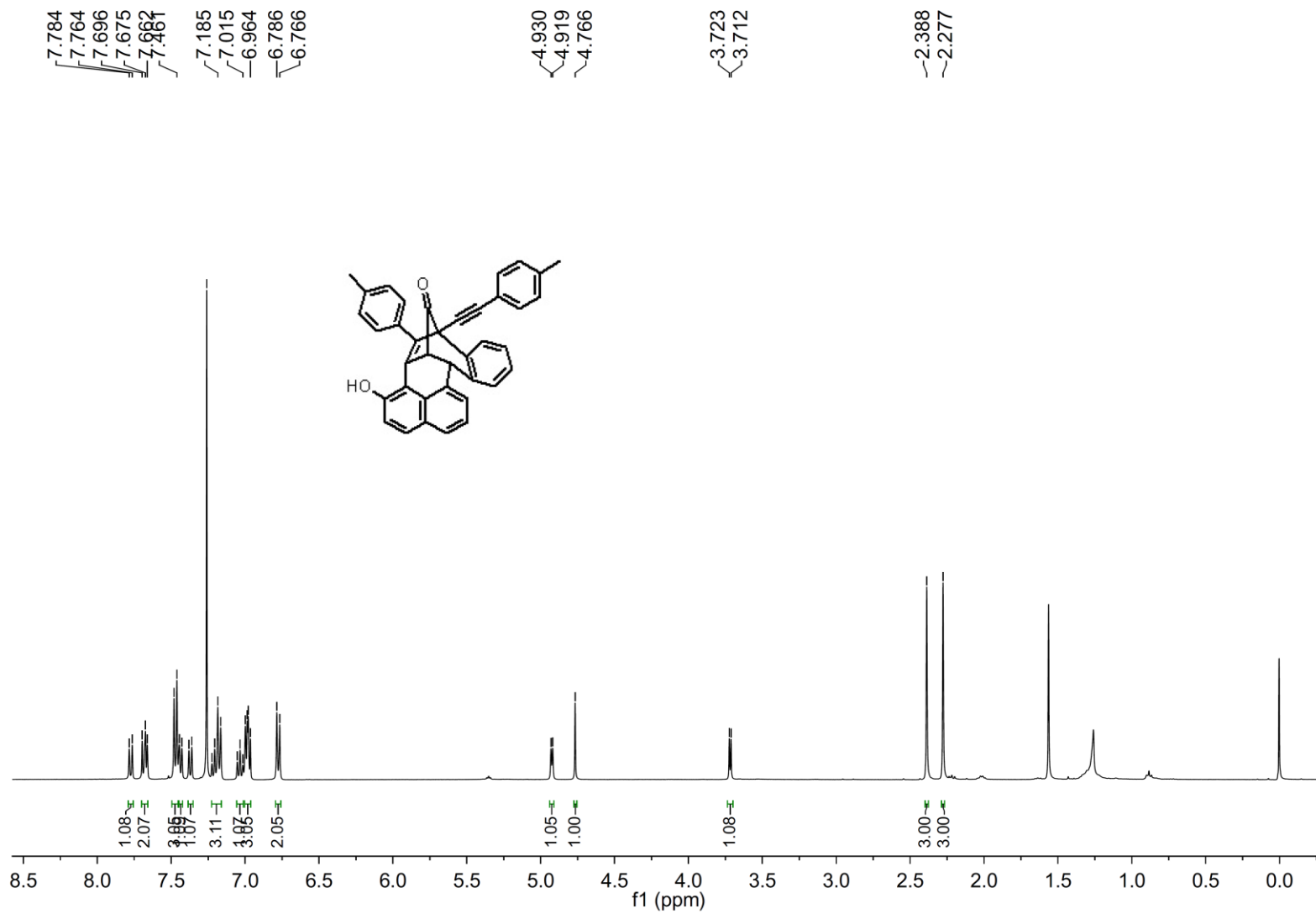




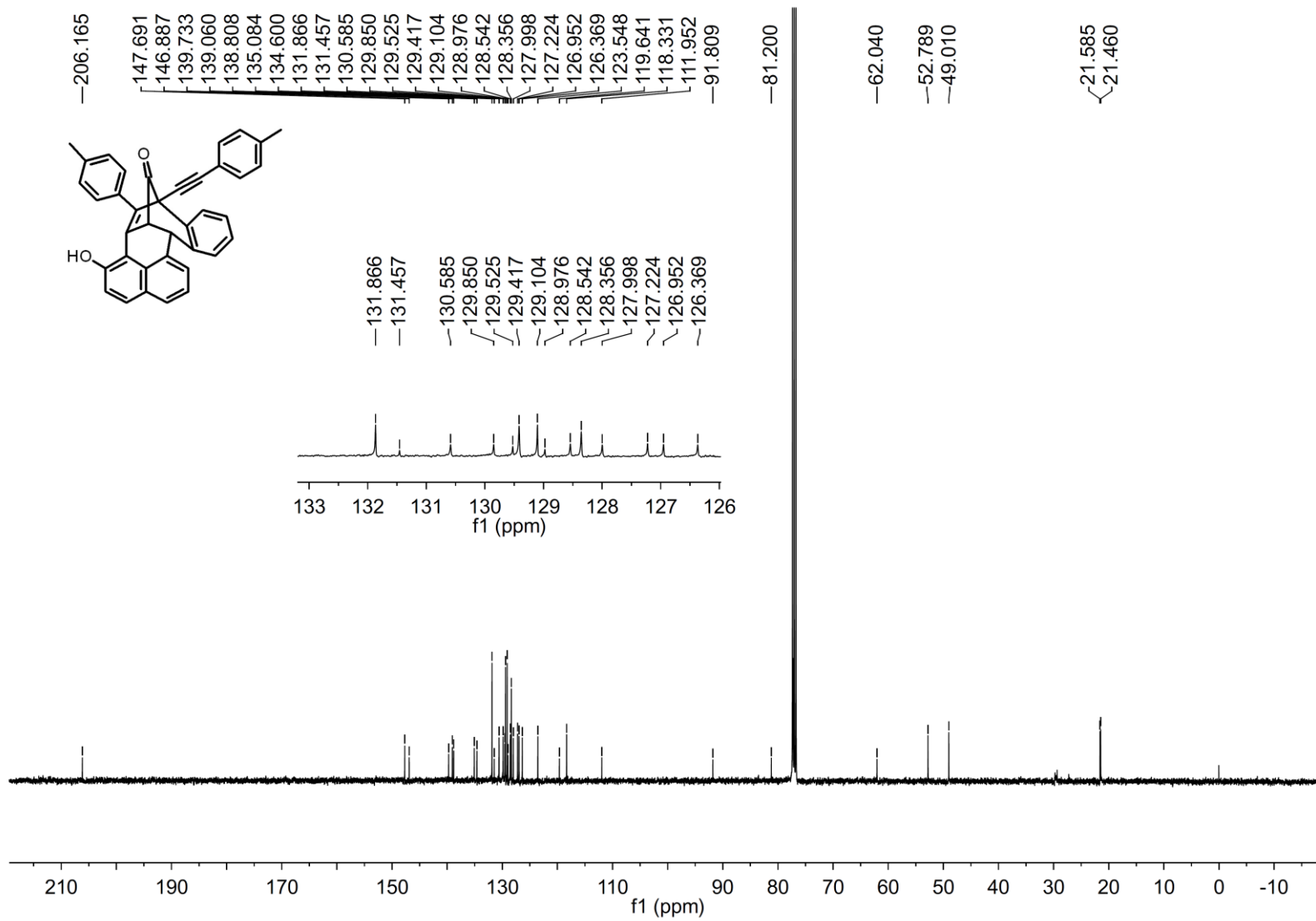
<sup>1</sup>H NMR Spectrum of Compound 3d



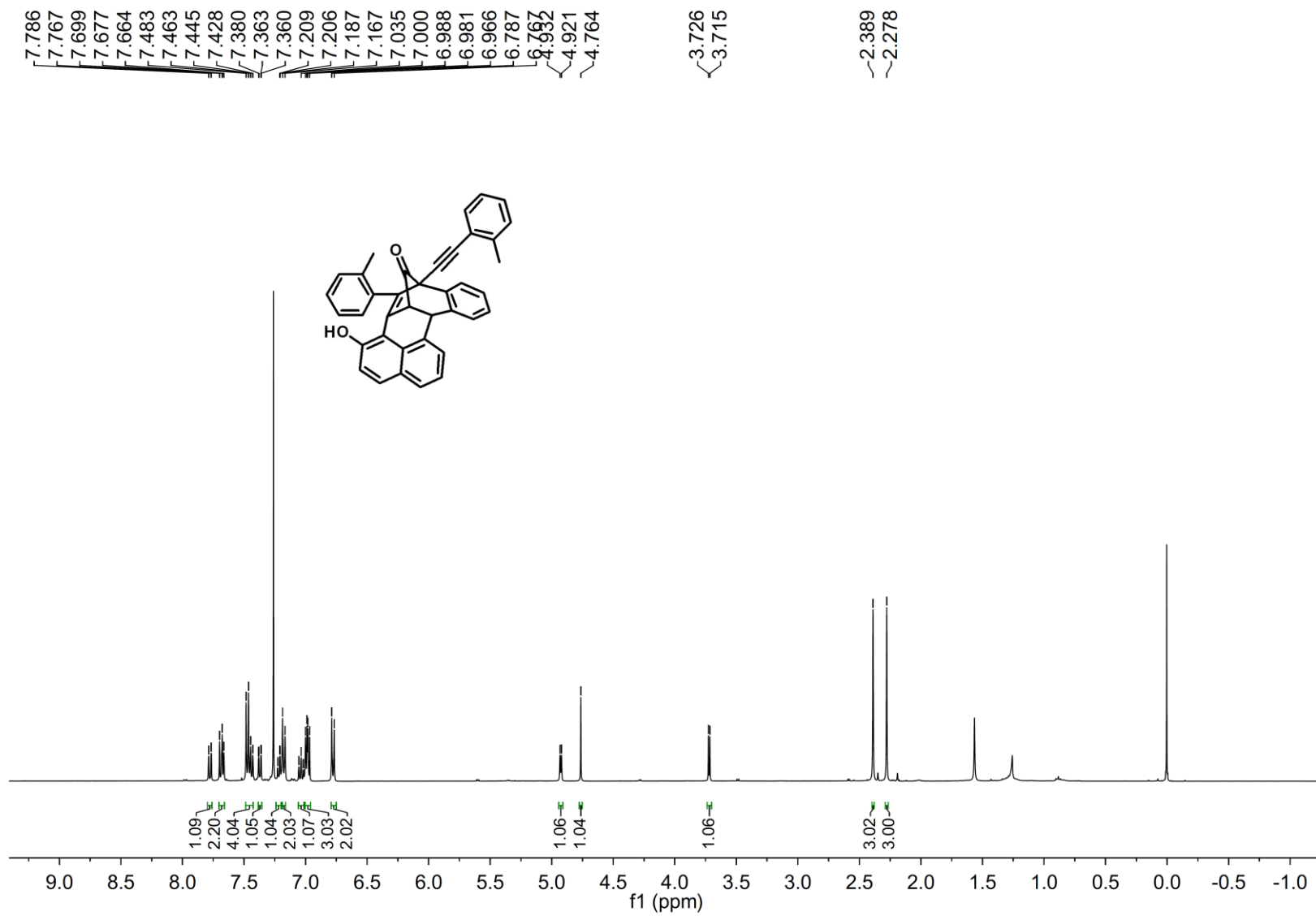
<sup>13</sup>C NMR Spectrum of Compound 3d



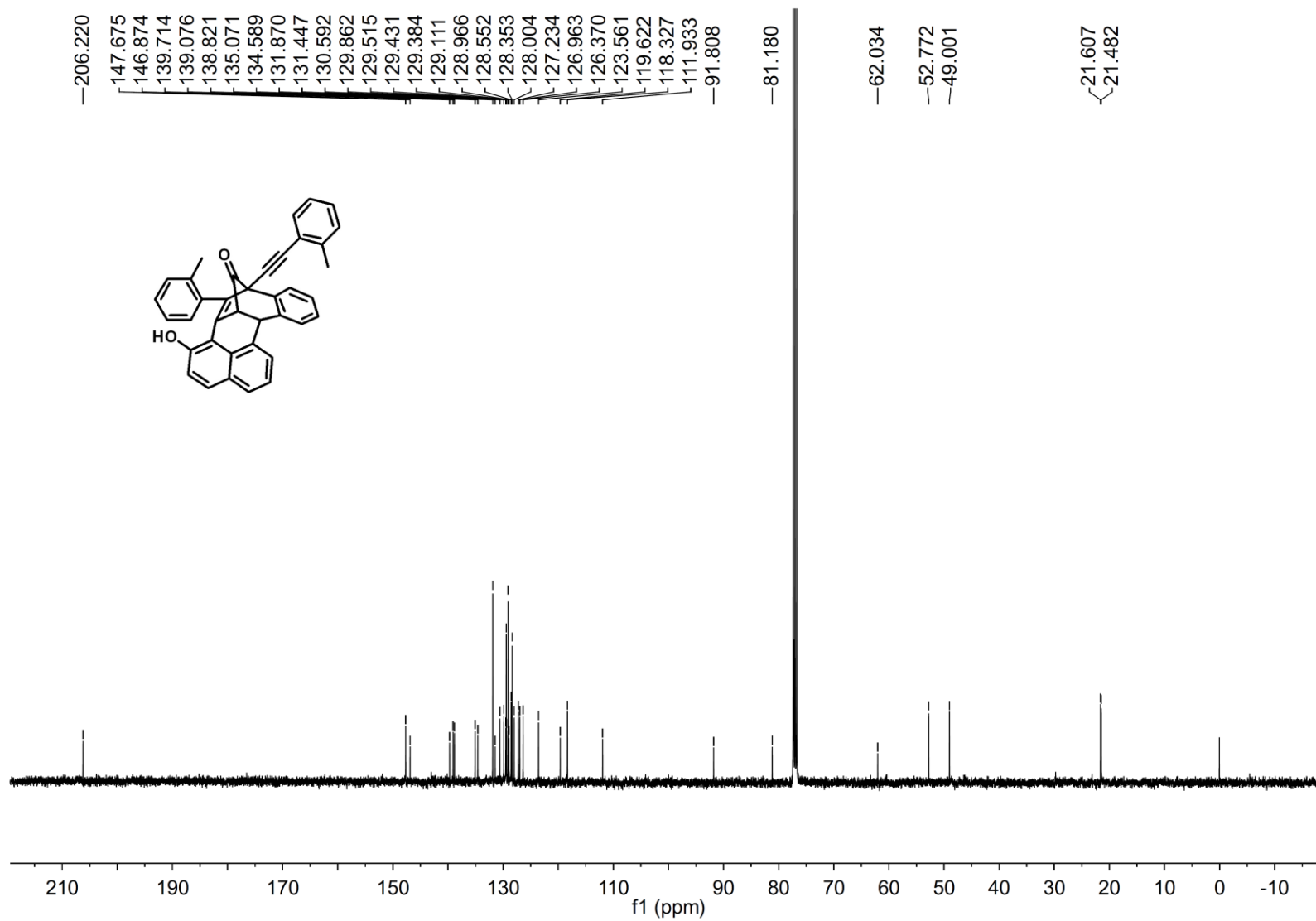
$^1\text{H}$  NMR Spectrum of Compound 3e



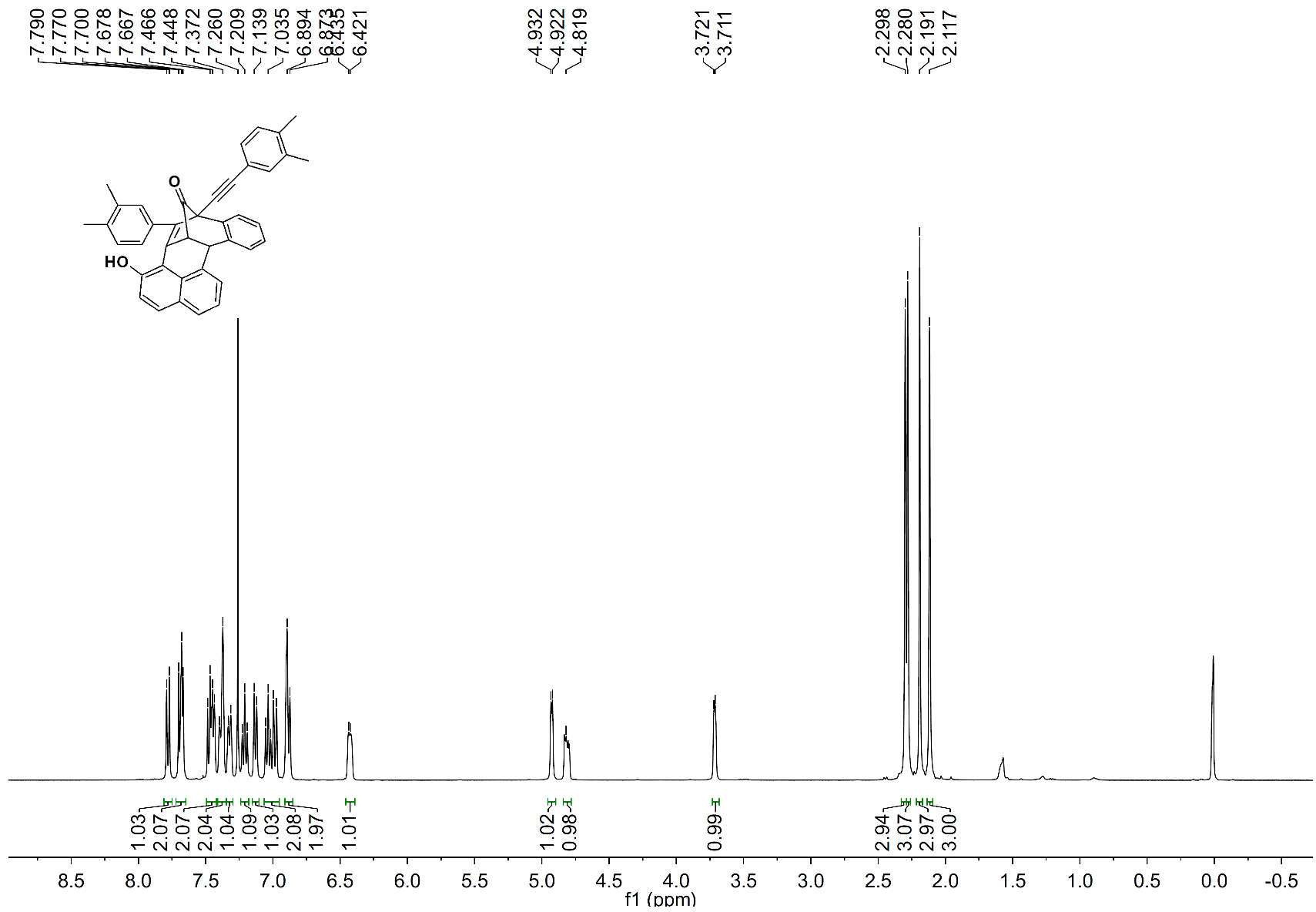
**<sup>13</sup>C NMR Spectrum of Compound 3e**



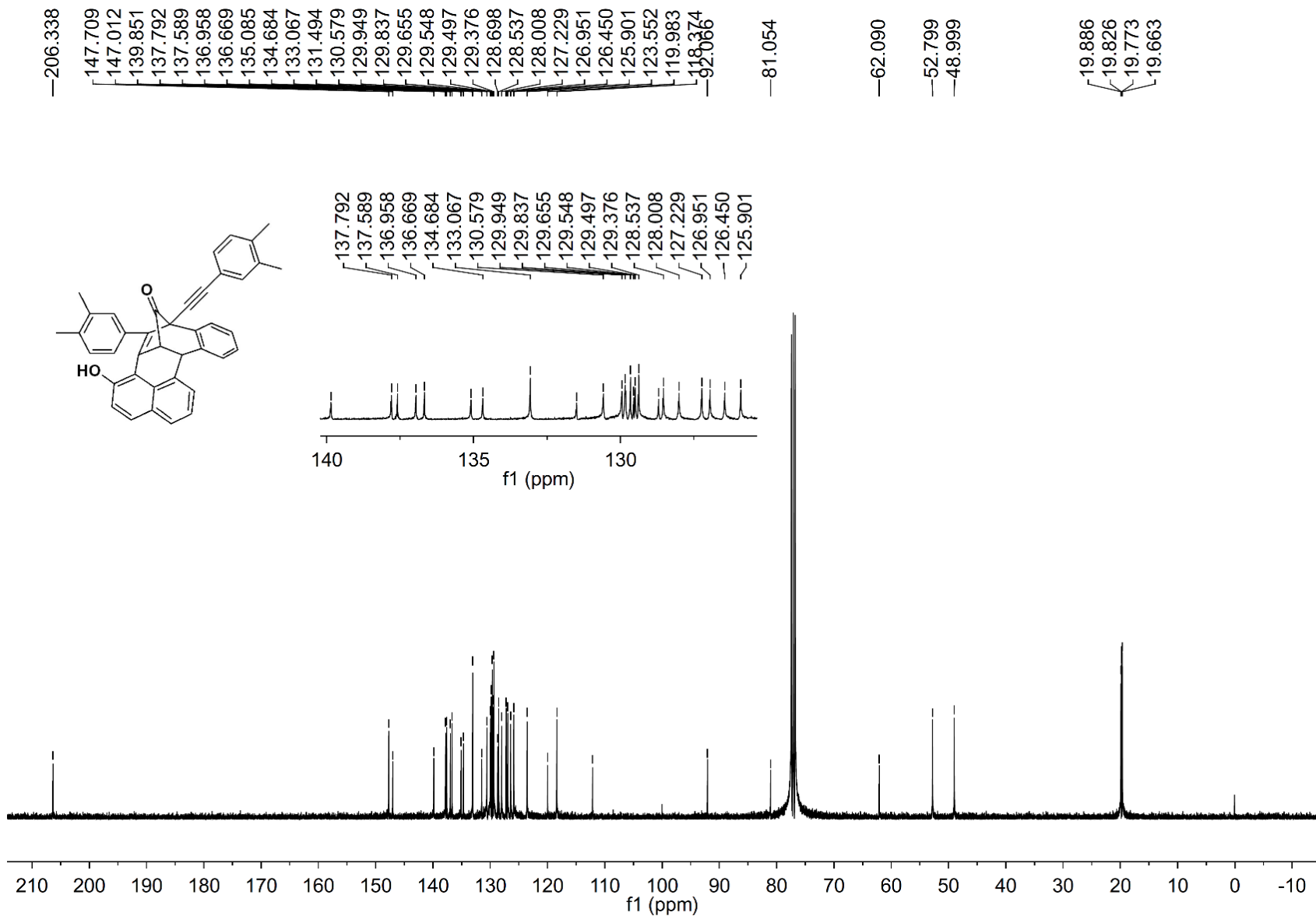
**<sup>1</sup>H NMR Spectrum of Compound 3f**



<sup>13</sup>C NMR Spectrum of Compound 3f

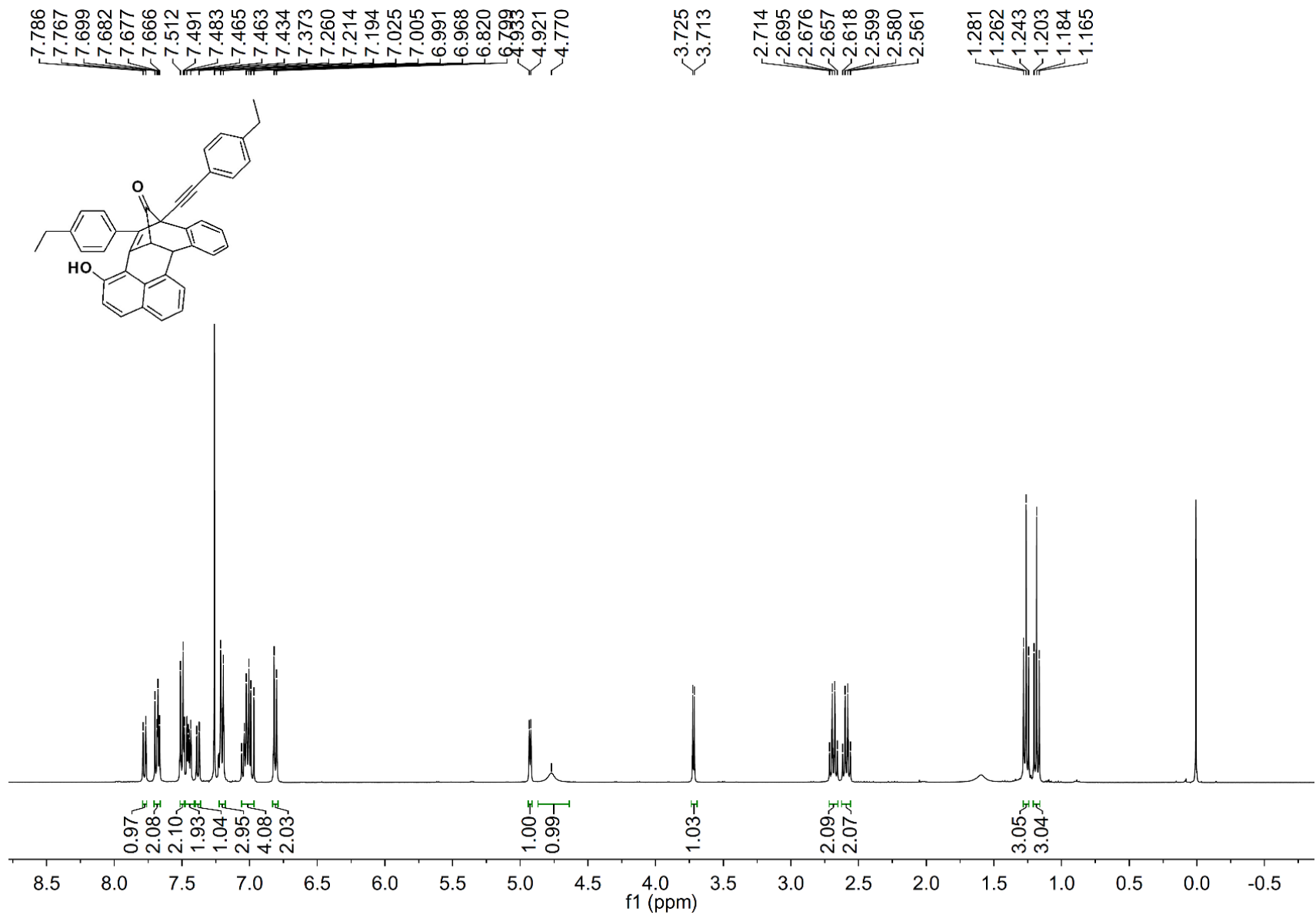


$^1\text{H}$  NMR Spectrum of Compound 3g

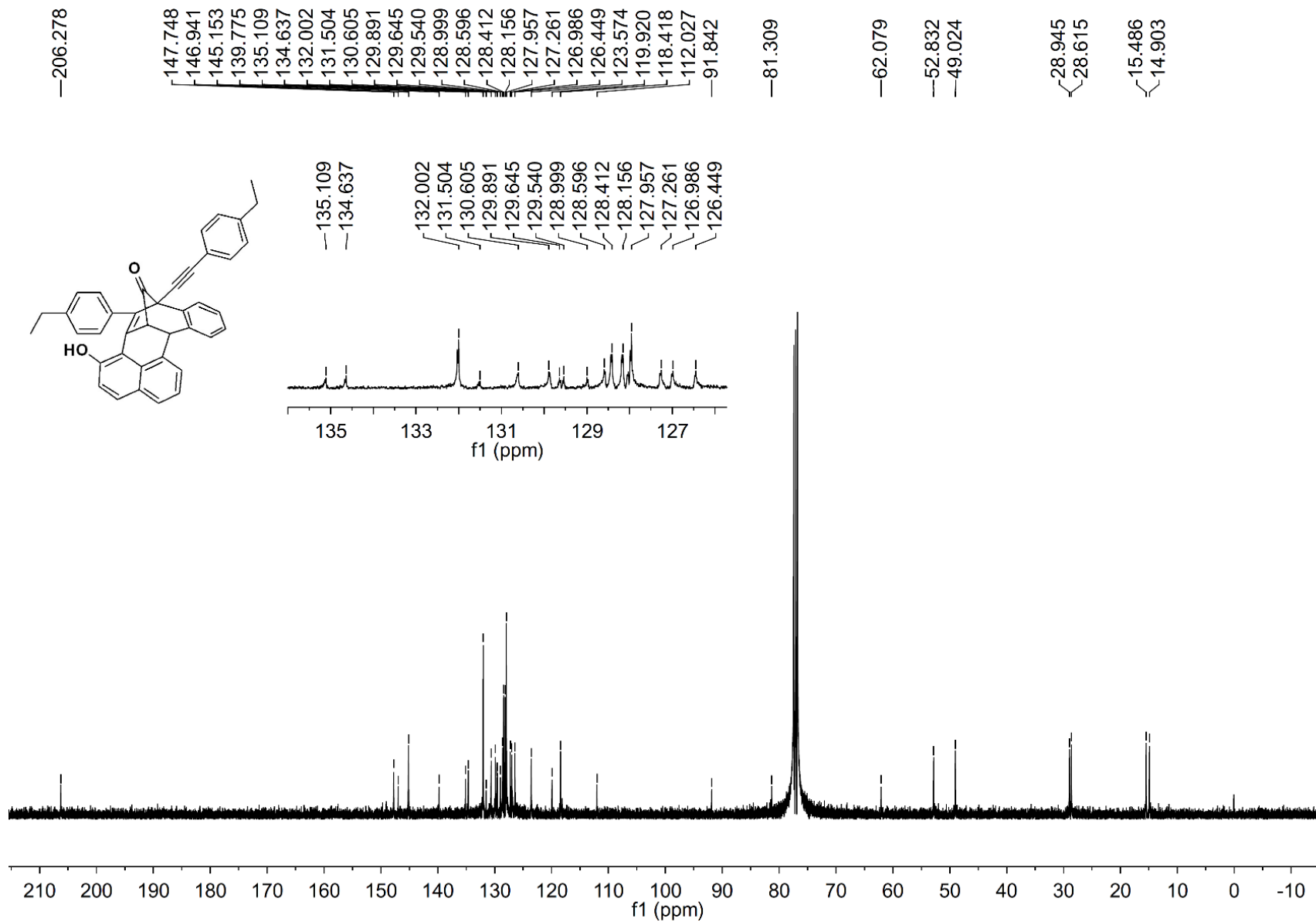


**<sup>13</sup>C NMR Spectrum of Compound 3g**

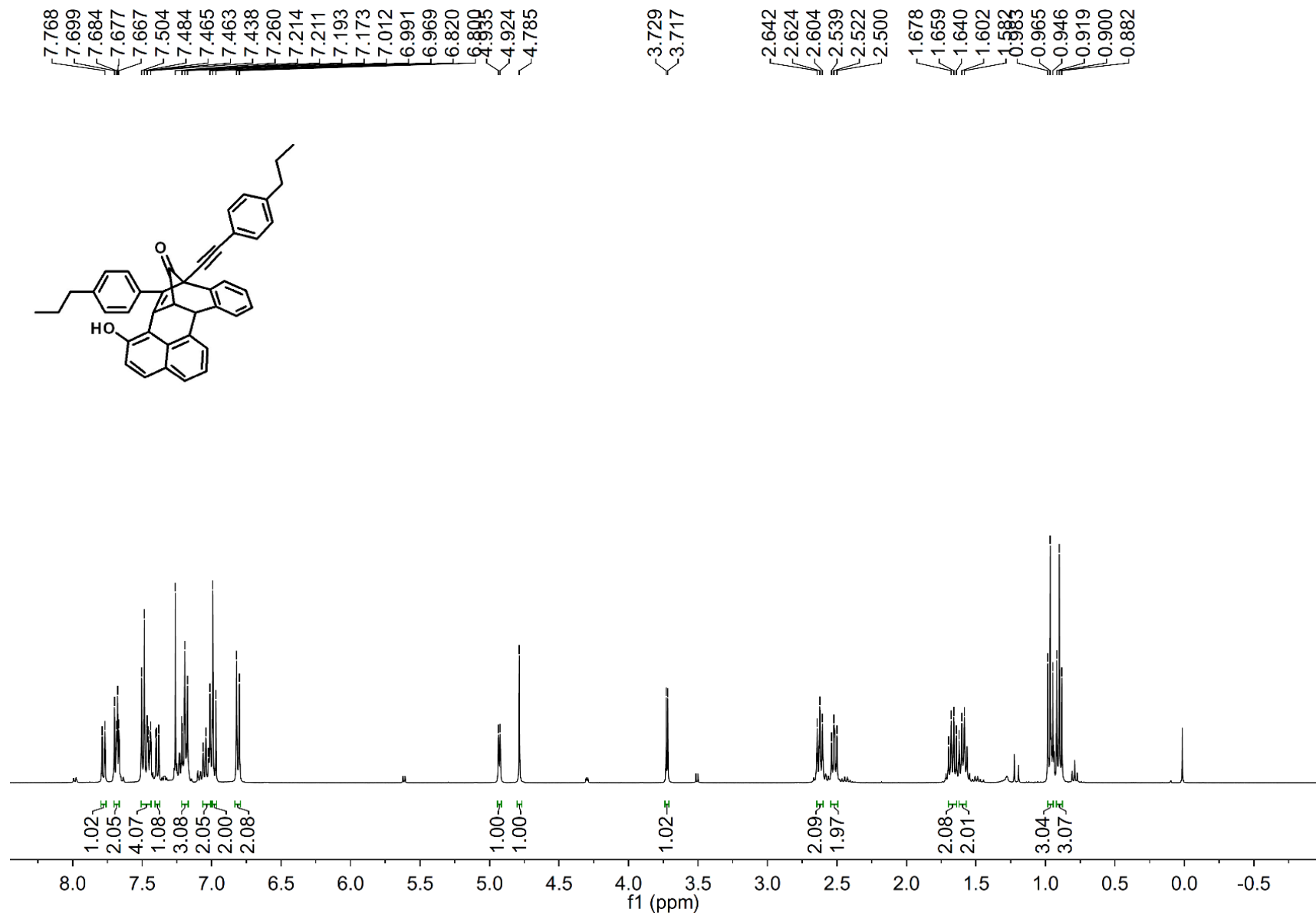




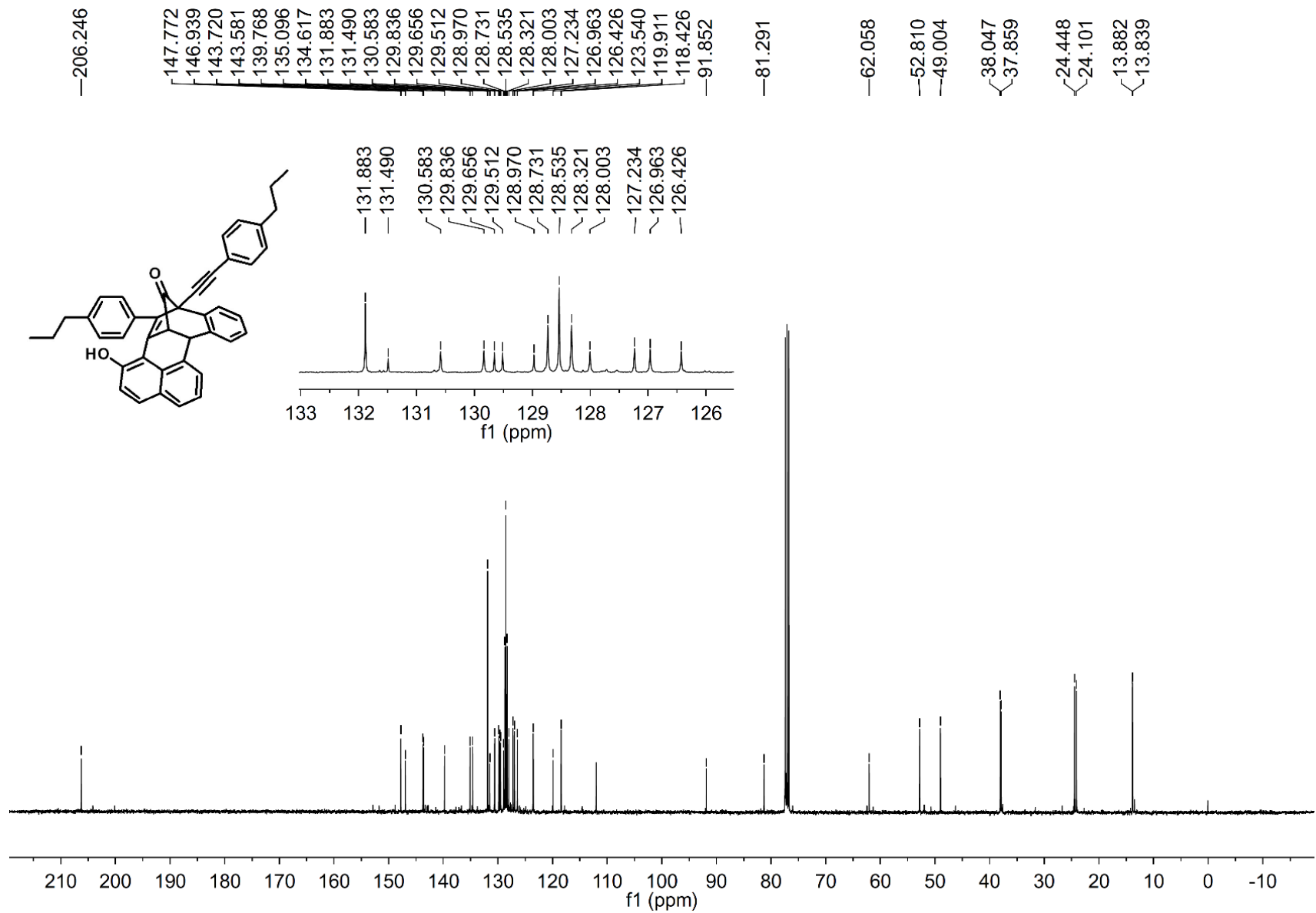
**<sup>1</sup>H NMR Spectrum of Compound 3h**



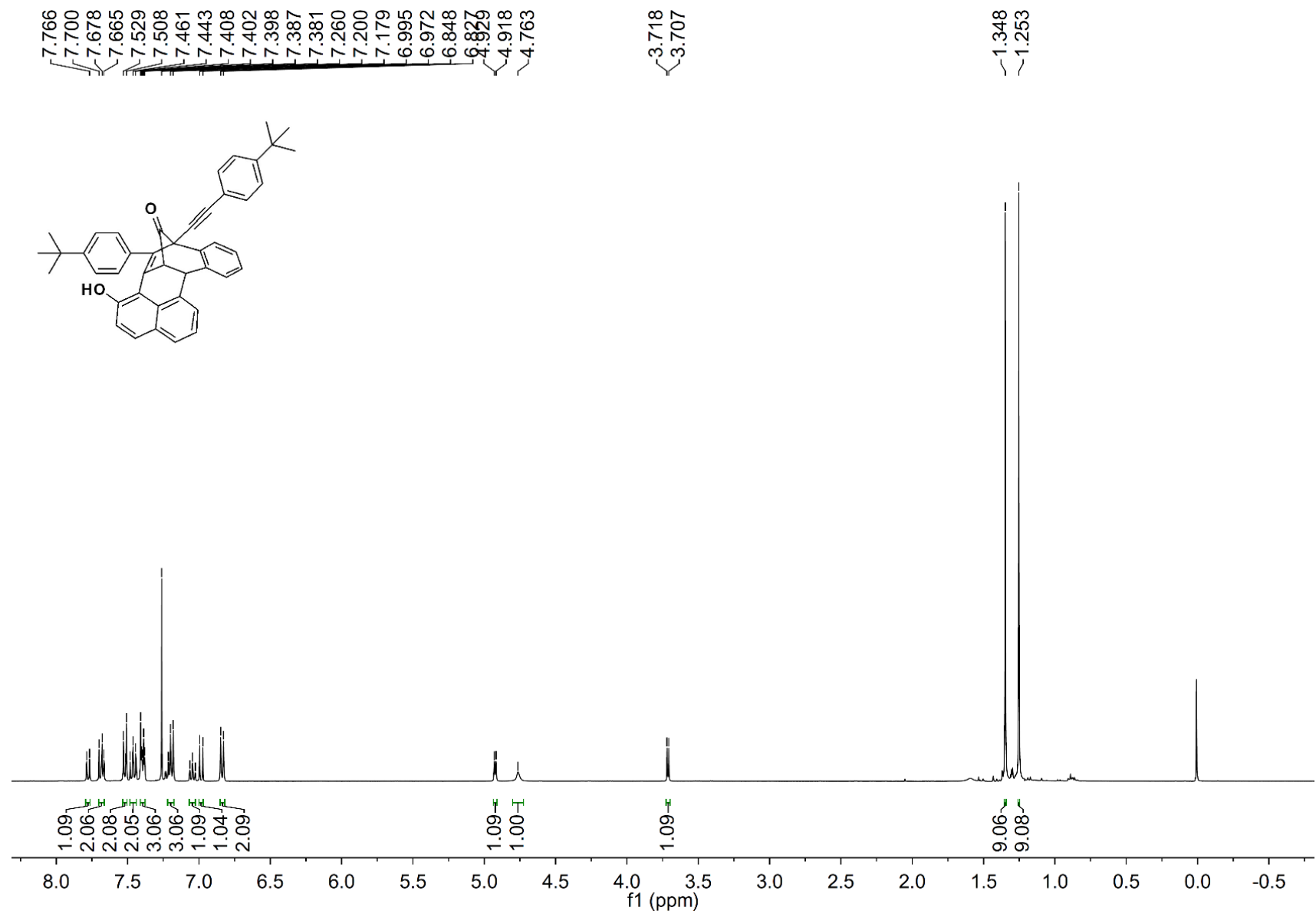
<sup>13</sup>C NMR Spectrum of Compound 3h



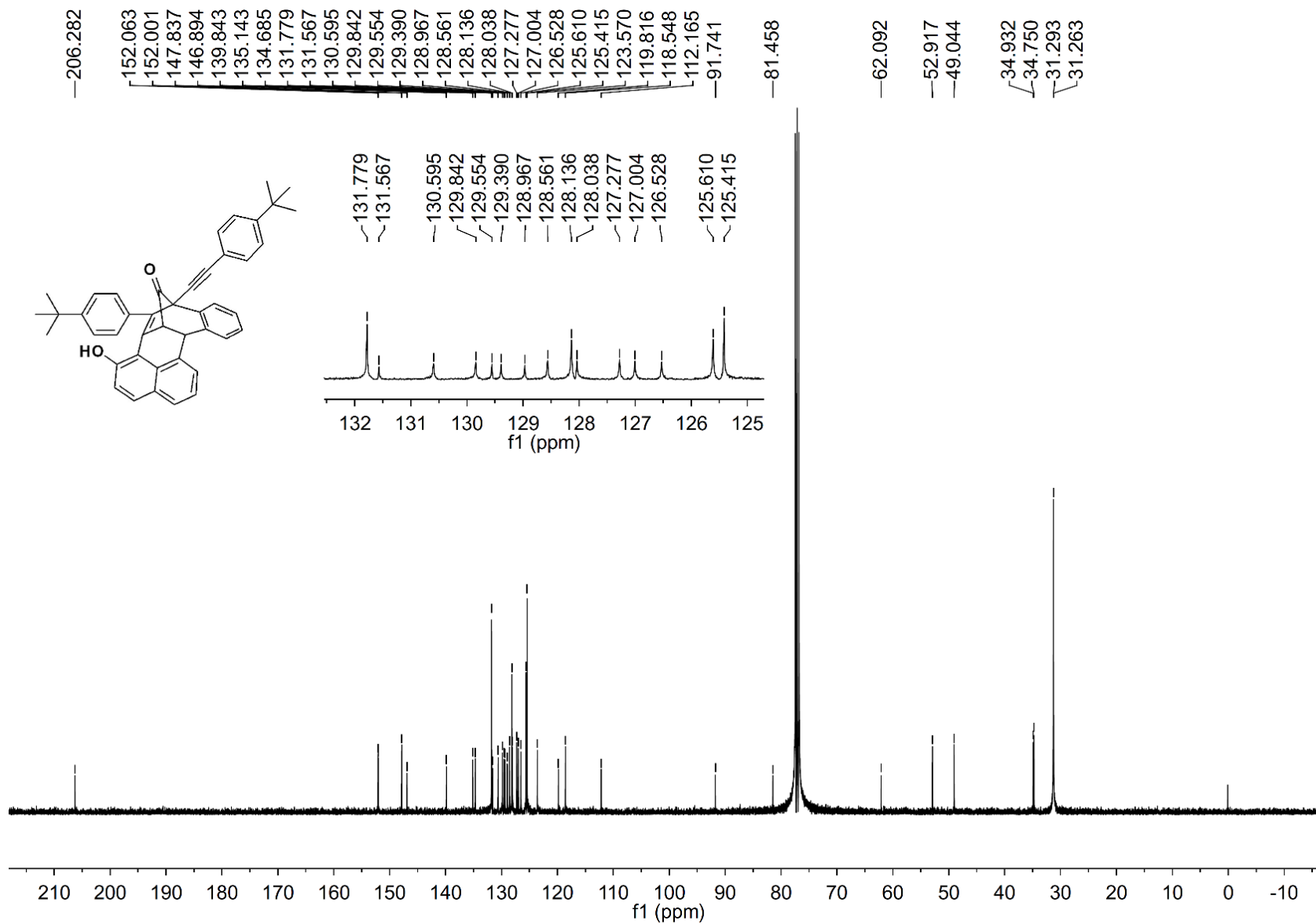
<sup>1</sup>H NMR Spectrum of Compound 3i



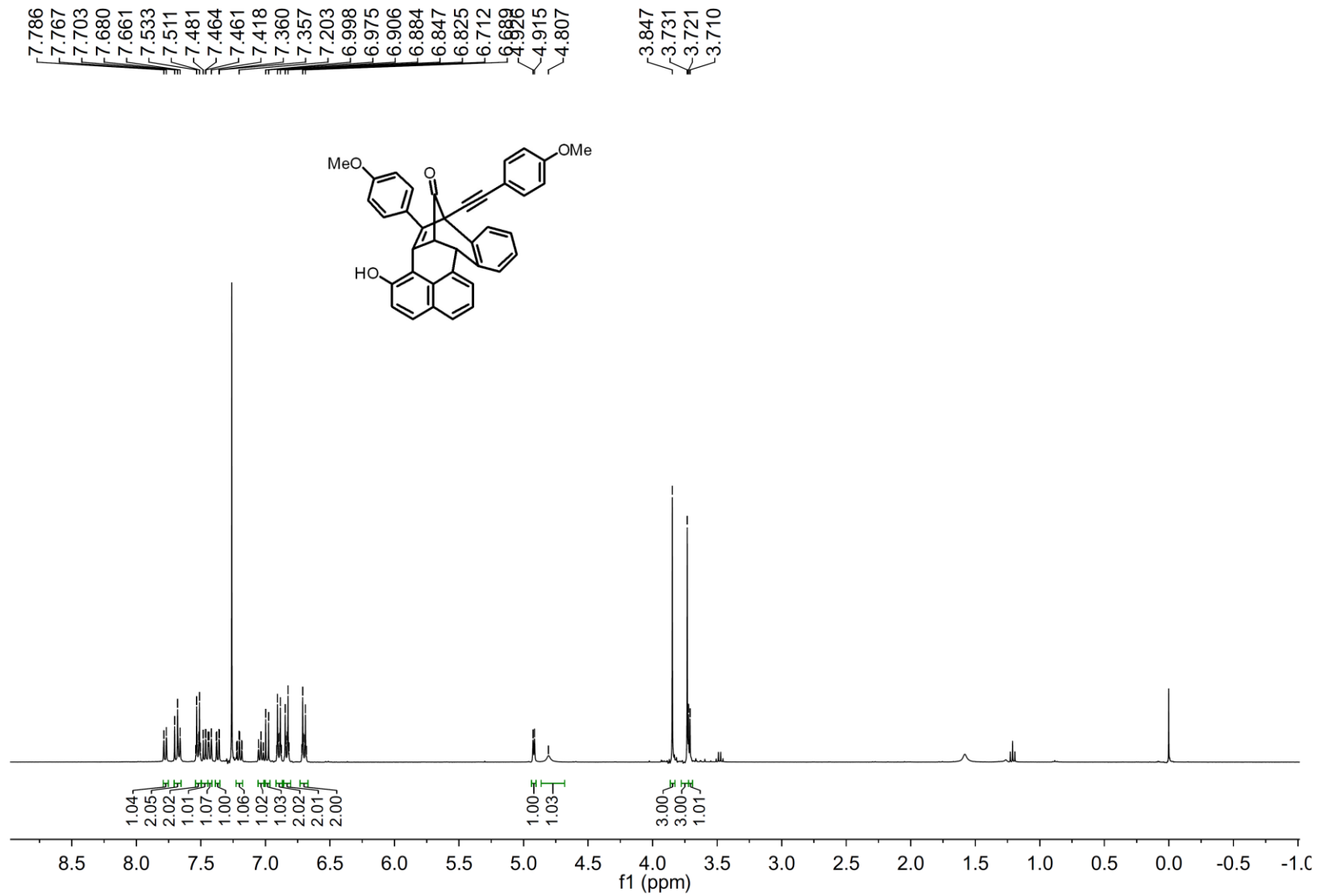
$^{13}\text{C}$  NMR Spectrum of Compound 3i



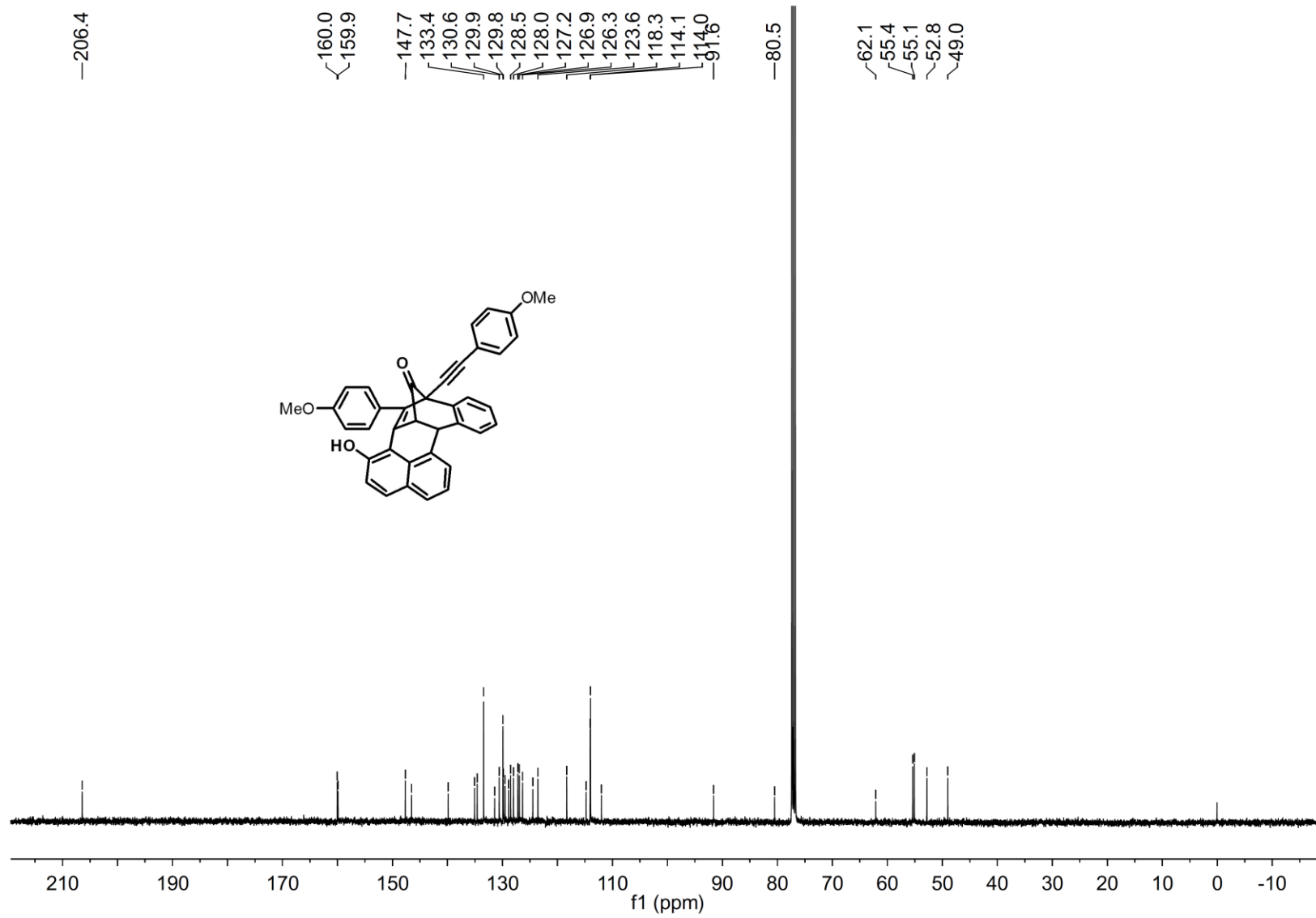
**<sup>1</sup>H NMR Spectrum of Compound 3j**



**<sup>13</sup>C NMR Spectrum of Compound 3j**



<sup>1</sup>H NMR Spectrum of Compound 3k



<sup>13</sup>C NMR Spectrum of Compound 3k