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Supporting Information

69451 Weinheim, Germany

Synthesis of 3-Oxaterpenoids and Its Application in the Total Synthesis of (±)-Moluccanic Acid Methyl Ester**

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1 General Information

Reagents and solvents were purified prior to use by the following procedures:

$InBr_3$ was purchased from Sigma-Aldrich and used as obtained.

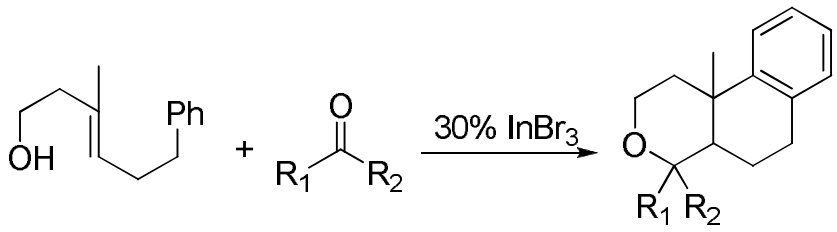
CH_2Cl_2 (Reagent grade, Merck) was distilled over CaH_2.

4Å molecular sieves were purchased from Alfa Aesar and activated at 250 ^oC for 10 h prior to use.

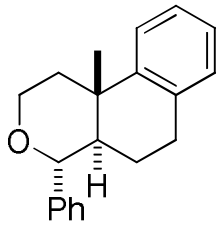
Analytical thin layer chromatography (TLC) was performed using Merck 60 F254 precoated silica gel plate (0.2 mm thickness). Subsequent to elution, plates were visualized using UV radiation (254 nm) on Spectroline Model ENF-24061/F 254 nm. Further visualization was possible by staining with basic solution of potassium permanganate or acidic solution of ceric molybdate, followed by heating on a hot plate. Flash chromatography was performed using Merck silica gel 60 with distilled solvents. Columns were typically packed as slurry and equilibrated with hexane prior to use.

Proton nuclear magnetic resonance (^1H NMR) and carbon nuclear magnetic resonance (^{13}C NMR) spectroscopy were performed on Bruker Advance 300, 400 and 500 NMR spectrometers. Chemical shifts of ^1H NMR spectra are reported as d in units of parts per million (ppm) downfield from $SiMe_4$ (d = 0.0) and relative to the signal of chloroform-*d* (d = 7.264, singlet). Multiplicities were given as: s (singlet); d (doublet); t (triplet); q (quartet); dd (doublet of doublets); ddd (doublet of doublets of doublets); m (multiplets) and etc. The number of protons for a given resonance is indicated by nH. Coupling constants are reported as *J* values in Hz. Carbon nuclear magnetic resonance spectra (^{13}C NMR) are reported as d in units of parts per million (ppm) downfield from $SiMe_4$ (d 0.0) and relative to the signal of chloroform-*d* (d = 77.23, triplet). High-resolution mass spectral analysis (HRMS) was performed on Q-Tof Premier mass spectrometer (Waters Corporation).

2 General Procedure for Prins-Polyene Cyclization Reaction

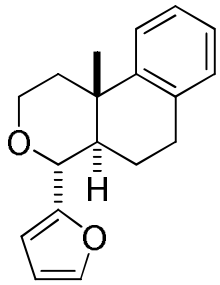


An oven-dried round bottom flask (10 mL) equipped with a magnetic stir bar was charged with 4Å molecular sieves (100 mg), indium bromide (0.06 mmol) and sealed with a rubber septum. Then alcohol (0.20 mmol) and aldehyde (0.24 mmol, 1.2 equiv) were dissolved in dry CH_2Cl_2 (2 mL) and added via syringe. The solution was allowed to stir at room temperature for 24-96 h. The reaction was quenched with Sat. $NaHCO_3$ (5 mL) and extracted with CH_2Cl_2 (3 x 20 mL). The combined organic layers were washed with brine (30 mL), dried over Na_2SO_4 and concentrated *in vacuo.* The crude product was purified by flash column chromatography on silica gel using appropriate solvents (hexane/EtOAc mixture) to provide the title compounds.



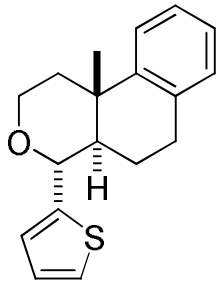
10b-Methyl-4-phenyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3a for Table 1)

The title compound prepared following the General Procedure described above. Yield: 88%, white solid, mp: 83.9-84.8 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.16-1.22 (m, 1H), 1.33 (s, 3H), 1.51 (ddt, J_1 = 8.1 Hz, J_2 = 10.1 Hz, J_3 = 13.3 Hz, 1H), 1.89 (ddd, J_1 = 3.3 Hz, J_2 = 10.3 Hz, J_3 = 13.3 Hz, 1H), 2.04 (dt, J_1 = 5.1 Hz, J_2 = 12.8 Hz, 1H), 2.14 (d, J = 13.1 Hz, 1H), 2.70-2.77 (m, 2H), 4.03 (dt, J_1 = 2.5 Hz, J_2 = 12.2 Hz, 1H), 4.12 (dd, J_1 = 5.1 Hz, J_2 = 11.9 Hz, 1H), 4.36 (d, J = 10.3 Hz, 1H), 7.02 (d, J = 7.4 Hz, 1H), 7.10 (t, J = 7.3 Hz, 1H), 7.16 (t, J = 7.4 Hz, 1H), 7.24 (d, J = 7.7 Hz, 1H), 7.25-7.33 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.70, 21.89, 27.91, 35.72, 37.97, 46.74, 64.38, 80.38, 123.92, 125.82, 125.87, 127.46, 127.94, 128.43, 129.36, 135.13, 141.21, 147.02. HRMS (ESI$^+$) exact mass calcd for $C_{20}H_{22}ONa$ $[M+Na]^+$ requires *m/z* 301.1568, found *m/z* 301.1564.



4-(Furan-2-yl)-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3b for Table 1)

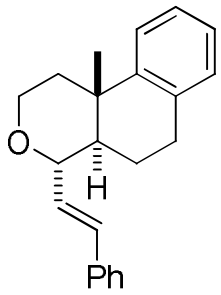
The title compound prepared following the General Procedure described above. Yield: 79%, yellow solid, mp: 75.4-76.2 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.26-1.33 (m, 1H), 1.29 (s, 3H), 1.47-1.58 (m, 1H), 2.01 (dt, J_1 = 5.2 Hz, J_2 = 12.8 Hz, 1H), 2.11 (d, J = 13.1 Hz, 1H), 2.18 (ddd, J_1 = 3.3 Hz, J_2 = 10.8 Hz, J_3 = 13.7 Hz, 1H), 2.83-2.87 (m, 2H), 4.02 (dt, J_1 = 2.5 Hz, J_2 = 12.2 Hz, 1H), 4.10 (ddd, J_1 = 1.6 Hz, J_2 = 5.2 Hz, J_3 = 12.0 Hz, 1H), 4.49 (d, J = 10.7 Hz, 1H), 6.32-6.35 (m, 2H), 7.06 (d, J = 7.3 Hz, 1H), 7.12 (t, J = 7.1 Hz, 1H), 7.17 (t, J = 1.5 Hz, 1H), 7.23 (d, J = 7.5 Hz, 1H), 7.39 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.66, 21.68, 27.97, 35.55, 37.57, 44.15, 64.39, 72.88, 108.19, 110.06, 123.88, 125.80, 125.89, 129.35, 134.98, 142.31, 146.63, 153.78. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{21}O_2$ $[M+H]^+$ requires *m/z* 269.1542, found *m/z* 269.1533.



10b-Methyl-4-(thiophen-2-yl)-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3c for Table 1)

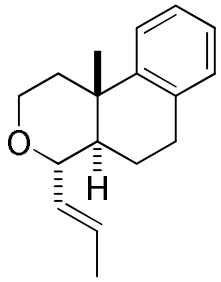
The title compound prepared following the General Procedure described above. Yield: 71%, yellow solid, mp: 84.0-85.2 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.32 (s, 3H), 1.37 (tdd, J_1 = 3.3 Hz, J_2 = 6.9 Hz, J_3 = 13.6 Hz, 1H), 1.47-1.58 (m, 1H), 1.90 (ddd, J_1 = 3.3 Hz, J_2 = 10.4 Hz, J_3 = 13.5 Hz, 1H), 2.03 (dt, J_1 = 5.2 Hz, J_2 = 12.8 Hz, 1H), 2.13 (d, J = 13.1 Hz, 1H), 2.75-2.87 (m, 2H), 4.04 (dt, J_1 = 2.5 Hz, J_2 = 12.2 Hz, 1H), 4.12 (ddd, J_1 = 1.7 Hz, J_2 = 5.2 Hz, J_3 = 12.0 Hz, 1H), 4.70 (d, J = 10.4 Hz, 1H), 6.97 (dd, J_1 = 3.5 Hz, J_2 = 5.0 Hz, 1H), 7.01 (dd, J_1 = 1.1 Hz, J_2 = 3.4 Hz, 1H), 7.05 (d, J = 7.3 Hz, 1H), 7.12 (dt, J_1 = 1.5 Hz, J_2 = 7.3 Hz, 1H), 7.17 (t, J = 7.3 Hz, 1H), 7.24 (d, J = 8.3 Hz, 1H), 7.27 (d, J = 5.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$):

d 19.79, 21.93, 27.98, 35.86, 37.68, 47.97, 64.45, 75.59, 123.90, 125.13, 125.49, 125.83, 125.90, 126.16, 129.34, 135.05, 144.59, 146.65. HRMS (ESI^+) exact mass calcd for $C_{18}H_{20}OSNa$ $[M+Na]^+$ requires *m/z* 307.1133, found *m/z* 307.1126.



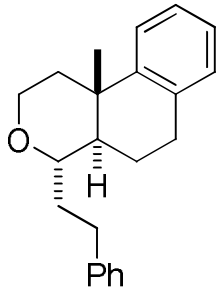
10b-Methyl-4-((*E*)-styryl)-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3d for Table 1)

The title compound prepared following the General Procedure described above. Yield: 87%, colorless oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.28 (s, 3H), 1.55-1.61 (m, 1H), 1.69-1.79 (m, 2H), 1.94 (dt, J_1 = 5.2 Hz, J_2 = 12.8 Hz, 1H), 2.10 (d, J = 13.1 Hz, 1H), 2.88 (dd, J_1 = 4.8 Hz, J_2 = 8.8 Hz, 2H), 3.98 (dt, J_1 = 2.3 Hz, J_2 = 12.3 Hz, 1H), 4.03-4.09 (m, 2H), 6.17 (dd, J_1 = 7.8 Hz, J_2 = 15.9 Hz, 1H), 6.65 (d, J = 15.9 Hz, 1H), 7.06 (d, J = 7.3 Hz, 1H), 7.10-7.18 (m, 2H), 7.21-7.26 (m, 2H), 7.31 (t, J = 7.5 Hz, 2H), 7.41 (d, J = 7.3 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.83, 21.95, 28.06, 35.30, 37.77, 45.65, 63.79, 78.29, 123.89, 125.78, 125.83, 126.60, 127.75, 128.57, 1229.25, 129.35, 133.25, 135.04, 136.75, 146.87. HRMS (ESI^+) exact mass calcd for $C_{22}H_{25}O$ $[M+H]^+$ requires *m/z* 305.1905, found *m/z* 305.1920.



10b-Methyl-4-((*E*)-prop-1-en-1-yl)-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3e for Table 1)

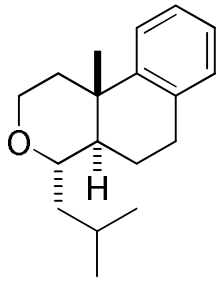
The title compound prepared following the General Procedure described above. Yield: 90%, colorless oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.23 (s, 3H), 1.50 (ddt, J_1 = 8.0 Hz, J_2 = 10.1 Hz, J_3 = 13.3 Hz, 1H), 1.54-1.62 (m, 1H), 1.68-1.73 (m, 4H), 1.88 (dt, J_1 = 5.2 Hz, J_2 = 12.8 Hz, 1H), 2.05 (d, J = 13.1 Hz, 1H), 2.88 (dd, J_1 = 5.0 Hz, J_2 = 8.7 Hz, 2H), 3.82 (t, J_1 = 9.2 Hz, 1H), 3.92 (dt, J_1 = 2.3 Hz, J_2 = 12.3 Hz, 1H), 4.00 (ddd, J_1 = 1.6 Hz, J_2 = 5.3 Hz, J_3 = 11.8 Hz, 1H), 5.43 (dd, J_1 = 8.1 Hz, J_2 = 15.3 Hz, 1H), 5.76 (qd, J_1 = 6.5 Hz, J_2 = 15.1 Hz, 1H), 7.08 (t, J = 7.4 Hz, 1H), 7.12 (dd, J_1 = 1.8 Hz, J_2 = 7.3 Hz, 1H), 7.16 (d, J = 5.5 Hz, 1H), 7.20 (d, J = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 17.89, 19.77, 21.94, 28.14, 35.17, 37.76, 45.25, 63.63, 78.30, 123.88, 125.70, 125.73, 129.31, 130.11, 131.15, 135.11, 147.03. HRMS (ESI^+) exact mass calcd for $C_{17}H_{22}ONa$ $[M+Na]^+$ requires *m/z* 265.1568, found *m/z* 265.1566.



10b-Methyl-4-phenethyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3f for Table 1)

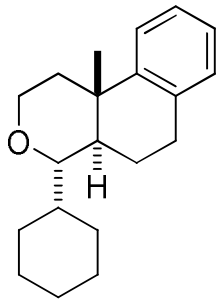
The title compound prepared following the General Procedure described above. Yield: 94%, colorless oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.19 (s, 3H), 1.46-1.55 (m, 1H), 1.56-1.61 (m, 1H), 1.65-1.75 (m, 1H), 1.77-1.82 (m, 1H), 1.85-1.93 (dt, J_1 = 5.1 Hz,

J_2 = 13.0 Hz, 1H), 1.93-2.01 (m, 1H), 2.06 (d, J = 13.0 Hz, 1H), 2.66 (ddd, J_1 = 6.2 Hz, J_2 = 10.6 Hz, J_3 = 13.6 Hz, 1H), 2.83-2.91 (m, 3H), 3.45 (dt, J_1 = 2.7 Hz, J_2 = 9.2 Hz, 1H), 3.87 (dt, J_1 = 2.3 Hz, J_2 = 12.6 Hz, 1H), 4.04 (ddd, J_1 = 1.4 Hz, J_2 = 5.0 Hz, J_3 = 11.8 Hz, 1H), 7.06 (d, J = 7.0 Hz, 1H), 7.11 (dt, J_1 = 1.5 Hz, J_2 = 7.0 Hz, 1H), 7.15-7.30 (m, 7H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.39, 21.83, 27.96, 31.58, 35.37, 35.44, 38.10, 45.29, 63.87, 75.40, 123.86, 125.70, 125.75, 128.36, 128.54, 129.19, 134.91, 142.79, 147.24. HRMS (ESI$^+$) exact mass calcd for $C_{22}H_{26}ONa$ $[M+Na]^+$ requires *m/z* 329.1881, found *m/z* 329.1869.



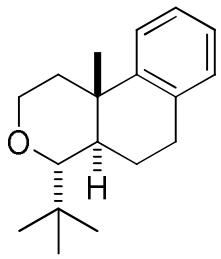
4-Isobutyl-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3g for Table 1)

The title compound prepared following the General Procedure described above. Yield: 81%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 0.92 (t, J = 6.6 Hz, 6H), 1.22 (s, 3H), 1.35-1.38 (m, 2H), 1.49-1.55 (m, 2H), 1.79-1.93 (m, 3H), 2.04 (d, J = 13.0 Hz, 1H), 2.89-2.92 (m, 2H), 3.45 (dd, J_1 = 9.0 Hz, J_2 = 12.8 Hz, 1H), 3.83 (dt, J_1 = 2.2 Hz, J_2 = 12.4 Hz, 1H), 3.98 (ddd, J_1 = 1.5 Hz, J_2 = 5.0 Hz, J_3 = 11.8 Hz, 1H), 7.07 (d, J = 7.1 Hz, 1H), 7.11 (t, J = 7.0 Hz, 1H), 7.16 (t, J = 7.0 Hz, 1H), 7.19 (d, J = 7.3 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.42, 21.56, 21.93, 24.12, 24.17, 28.02, 35.40, 38.08, 42.69, 46.06, 63.80, 74.12, 123.83, 125.69, 125.70, 129.16, 134.97, 147.37. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{26}ONa$ $[M+Na]^+$ requires *m/z* 281.1881, found *m/z* 281.1871.



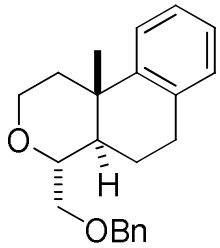
4-Cyclohexyl-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3h for Table 1)

The title compound prepared following the General Procedure described above. Yield: 88%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.16-1.26 (m, 3H), 1.20 (s, 3H), 1.47-1.58 (m, 6H), 1.63-1.65 (m, 1H), 1.70-1.86 (m, 5H), 2.01 (d, J = 13.0 Hz, 1H), 2.90 (dd, J_1 = 5.0 Hz, J_2 = 8.9 Hz, 2H), 3.27 (d, J = 10.0 Hz, 1H), 3.79 (dt, J_1 = 2.3 Hz, J_2 = 12.4 Hz, 1H), 3.98 (ddd, J_1 = 1.5 Hz, J_2 = 5.0 Hz, J_3 = 11.8 Hz, 1H), 7.06 (d, J = 7.0 Hz, 1H), 7.10 (t, J = 6.9 Hz, 1H), 7.15 (t, J = 7.0 Hz, 1H), 7.19 (d, J = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 18.90, 21.62, 24.71, 26.64, 26.69, 27.06, 27.96, 30.87, 35.41, 38.20, 38.79, 41.57, 64.15, 79.93, 123.92, 125.66, 125.68, 129.13, 135.00, 147.64. HRMS (ESI$^+$) exact mass calcd for $C_{20}H_{28}ONa$ $[M+Na]^+$ requires *m/z* 307.2038, found *m/z* 307.2029.



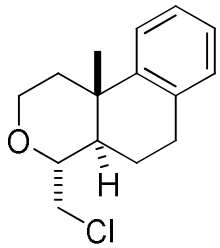
4-(*tert*-Butyl)-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3i for Table 1)

The title compound prepared following the General Procedure described above. Yield: 79%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.00 (s, 9H), 1.25 (s, 3H), 1.56-1.66 (m, 1H), 1.77 (ddd, J_1 = 3.4 Hz, J_2 = 9.6 Hz, J_3 = 12.8 Hz, 1H), 1.83 (dd, J_1 = 5.3 Hz, J_2 = 12.9 Hz, 1H), 2.02 (d, J = 12.9 Hz, 1H), 2.06-2.08 (m, 1H), 2.86-2.90 (m, 2H), 3.05 (d, J = 9.5 Hz, 1H), 3.78 (dt, J_1 = 2.3 Hz, J_2 = 12.8 Hz, 1H), 3.99 (dd, J_1 = 5.2 Hz, J_2 = 11.8 Hz, 1H), 7.05 (d, J = 7.0 Hz, 1H), 7.10 (t, J = 7.1 Hz, 1H), 7.16 (t, J = 7.0 Hz, 1H), 7.21 (d, J = 7.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 20.85, 22.21, 27.79, 28.31, 35.10, 36.36, 38.60, 44.24, 64.60, 83.54, 124.38, 125.64, 125.73, 128.90, 134.65, 147.52. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{26}ONa$ $[M+Na]^+$ requires *m/z* 281.1881, found *m/z* 281.1875.



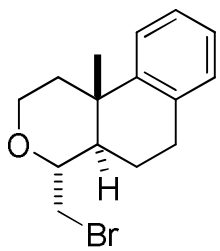
4-((Benzyloxy)methyl)-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3j for Table 1)

The title compound prepared following the General Procedure described above. Yield: 66%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.21 (s, 3H), 1.48-1.59 (m, 1H), 1.63-1.70 (m, 1H), 1.83-1.94 (m, 2H), 2.04 (d, J = 13.1 Hz, 1H), 2.86-2.90 (m, 2H), 3.55 (dd, J_1 = 4.8 Hz, J_2 = 10.1 Hz, 1H), 3.60-3.64 (m, 1H), 3.68 (dd, J_1 = 2.3 Hz, J_2 = 10.1 Hz, 1H), 3.91 (dt, J_1 = 2.4 Hz, J_2 = 12.4 Hz, 1H), 4.06 (ddd, J_1 = 1.6 Hz, J_2 = 5.1 Hz, J_3 = 11.8 Hz, 1H), 4.53 (d, J = 12.3 Hz, 1H), 4.65 (d, J = 12.3 Hz, 1H), 7.07 (d, J = 6.9 Hz, 1H), 7.10 (dt, J_1 = 1.7 Hz, J_2 = 7.0 Hz, 1H), 7.16 (t, J = 7.0 Hz, 1H), 7.19 (d, J = 7.4 Hz, 1H), 7.26-7.35 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.18, 21.71, 27.88, 35.07, 37.70, 41.89, 63.98, 71.46, 73.54, 75.83, 123.87, 125.72, 125.74, 127.61, 127.83, 128.34, 129.19, 134.83, 138.30, 146.97. HRMS (ESI$^+$) exact mass calcd for $C_{22}H_{26}O_2Na$ $[M+Na]^+$ requires *m/z* 345.1831, found *m/z* 345.1842.



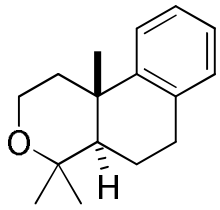
4-(Chloromethyl)-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3k for Table 1)

The title compound prepared following the General Procedure described above. Yield: 69%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.23 (s, 3H), 1.55-1.66 (m, 1H), 1.75-1.82 (m, 1H), 1.90 (ddd, J_1 = 4.3 Hz, J_2 = 11.6 Hz, J_3 = 13.3 Hz, 2H), 2.07 (d, J = 13.1 Hz, 1H), 2.93-2.97 (m, 2H), 3.65-3.70 (m, 2H), 3.81-3.84 (m, 1H), 3.93 (dt, J_1 = 2.4 Hz, J_2 = 12.4 Hz, 1H), 4.08 (ddd, J_1 = 1.6 Hz, J_2 = 5.1 Hz, J_3 = 11.9 Hz, 1H), 7.08 (d, J = 6.8 Hz, 1H), 7.12 (dd, J_1 = 1.8 Hz, J_2 = 6.9 Hz, 1H), 7.15 (d, J = 5.9 Hz, 1H), 7.19 (t, J = 6.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.14, 21.74, 27.59, 35.08, 37.51, 42.34, 47.02, 64.02, 75.48, 123.83, 125.85, 125.92, 129.23, 134.62, 146.54. HRMS (ESI$^+$) exact mass calcd for $C_{15}H_{19}ClONa$ $[M+Na]^+$ requires *m/z* 273.1022, found *m/z* 273.1016.



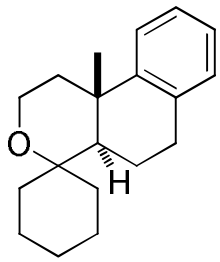
4-(Bromomethyl)-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3l for Table 1)

The title compound prepared following the General Procedure described above. Yield: 58%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.24 (s, 3H), 1.56-1.62 (m, 1H), 1.7 (ddd, J_1 = 3.4 Hz, J_2 = 7.0 Hz, J_3 = 13.8 Hz, 1H), 1.81-1.89 (m, 1H), 1.93 (dd, J_1 = 5.1 Hz, J_2 = 12.9 Hz, 1H), 2.06 (d, J = 13.2 Hz, 1H), 2.93-2.97 (m, 2H), 3.52 (dd, J_1 = 4.9 Hz, J_2 = 10.9 Hz, 1H), 3.61 (ddd, J_1 = 2.2 Hz, J_2 = 4.9 Hz, J_3 = 9.7 Hz, 1H), 3.70 (dd, J_1 = 2.2 Hz, J_2 = 10.9 Hz, 1H), 3.93 (dt, J_1 = 2.4 Hz, J_2 = 12.4 Hz, 1H), 4.08 (ddd, J_1 = 1.5 Hz, J_2 = 5.1 Hz, J_3 = 11.9 Hz, 1H), 7.08 (d, J = 6.9 Hz, 1H), 7.13 (dd, J_1 = 2.0 Hz, J_2 = 7.0 Hz, 1H), 7.15 (d, J = 5.9 Hz, 1H), 7.19 (d, J = 7.3 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.18, 21.92, 27.61, 35.12, 36.29, 37.55, 43.61, 64.02, 74.84, 123.84, 125.87, 125.94, 129.24, 134.64, 146.52. HRMS (ESI$^+$) exact mass calcd for $C_{15}H_{19}BrONa$ $[M+Na]^+$ requires *m/z* 317.0517, found *m/z* 317.0526.



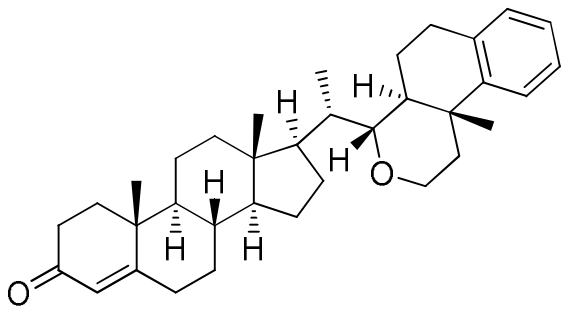
4,4,10b-Trimethyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (3m for Table 1)

The title compound prepared following the General Procedure described above. Yield: 73%, white solid, mp: 73.2-74.5 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.24 (s, 3H), 1.26 (s, 3H), 1.29 (s, 3H), 1.67-1.78 (m, 3H), 1.83 (dt, J_1 = 4.9 Hz, J_2 = 12.7 Hz, 1H), 2.07 (td, J_1 = 2.2 Hz, J_2 = 13.0 Hz, 1H), 2.91-2.95 (m, 2H), 3.82 (ddd, J_1 = 2.2 Hz, J_2 = 4.9 Hz, J_3 = 12.3 Hz, 1H), 3.96 (dt, J_1 = 2.3 Hz, J_2 = 12.3 Hz, 1H), 7.05 (d, J = 7.3 Hz, 1H), 7.09 (dt, J_1 = 1.7 Hz, J_2 = 6.7 Hz, 1H), 7.14 (t, J = 6.4 Hz, 1H), 7.17 (d, J = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 20.04, 20.47, 24.26, 29.34, 31.67, 35.49, 38.20, 49.11, 58.45, 74.88, 123.91, 125.56, 125.85, 129.12, 134.62, 148.78. HRMS (ESI$^+$) exact mass calcd for $C_{16}H_{22}ONa$ $[M+Na]^+$ requires *m/z* 253.1568, found *m/z* 253.1567.



10b-Methyl-1,2,4a,5,6,10b-hexahydrospiro[benzo[*f*]isochromene-4,1'-cyclohexane]

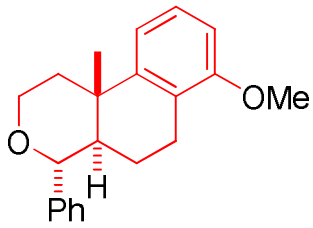
The title compound prepared following the General Procedure described above. Yield: 75%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.16 (td, J_1 = 4.2 Hz, J_2 = 13.7 Hz, 1H), 1.29 (s, 3H), 1.33-1.35 (m, 1H), 1.47-1.61 (m, 4H), 1.65-1.87 (m, 7H), 2.08 (td, J_1 = 2.1 Hz, J_2 = 13.0 Hz, 1H), 2.21 (d, J = 14.2 Hz, 1H), 2.84-2.99 (m, 2H), 3.79-3.89 (m, 2H), 7.04 (d, J = 7.2 Hz, 1H), 7.08 (dt, J_1 = 1.8 Hz, J_2 = 6.7 Hz, 1H), 7.13 (t, J = 6.2 Hz, 1H), 7.17 (d, J = 7.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 20.12, 21.18, 21.66, 25.40, 26.02, 27.11, 29.58, 35.64, 37.91, 38.22, 49.66, 57.49, 75.24, 123.82, 125.50, 125.79, 129.07, 134.64, 149.26. HRMS (ESI$^+$) exact mass calcd for $C_{19}H_{27}O$ $[M+H]^+$ requires *m/z* 271.2062, found *m/z* 271.2055.



(8*S*,9*S*,10*R*,13*S*,14*S*,17*R*)-10,13-Dimethyl-17-((*S*)-1-((4*R*,4a*S*,10b*R*)-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-

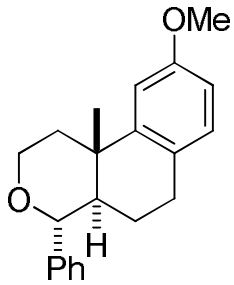
benzo[*f*]isochromen-4-yl)ethyl)-6,7,8,9,10,11,12,13,14,15,16,17-dodecahydro-1*H*-cyclopenta[*a*]phenanthren-3(2*H*)-one (3n for Scheme 2)

The title compound prepared following the General Procedure described above. Yield: 74%, white solid, mp: 149.5-151.0 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 0.73 (s, 3H), 0.90 (d, J = 6.1 Hz, 3H), 0.93-0.97 (m, 1H), 1.18 (s, 3H), 1.20 (s ,3H), 1.01-1.27 (m, 5H), 1.38-1.72 (m, 10H), 1.77-1.86 (m, 2H), 1.93-2.04 (m, 4H), 2.24-2.46 (m, 4H), 2.91 (dd, J_1 = 5.2 Hz, J_2 = 8.7 Hz, 2H), 3.42 (d, J = 9.8 Hz, 1H), 3.76 (t, J = 11.3 Hz, 1H), 3.98 (dd, J_1 = 3.9 Hz, J_2 = 11.7 Hz, 1H), 5.72 (s, 1H), 7.07 (d, J = 7.0 Hz, 1H), 7.11 (t, J = 6.8 Hz, 1H), 7.14 (t, J = 6.8 Hz, 1H), 7.19 (d, J = 7.3 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 11.92, 11.96, 17.41, 18.86, 21.09, 21.64, 24.04, 27.56, 27.80, 32.02, 32.96, 34.00, 35.52, 35.67, 35.73, 36.14, 38.16, 38.61, 39.64, 41.46, 42.20, 52.13, 53.76, 55.73, 64.23, 123.80, 123.86, 125.69, 125.71, 129.13, 134.94, 147.66, 171.63, 199.64. HRMS (ESI$^+$) exact mass calcd for $C_{35}H_{49}O_2$ $[M+H]^+$ requires *m/z* 501.3733, found *m/z* 501.3719.



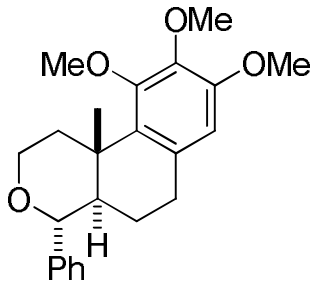
7-Methoxy-10b-methyl-4-phenyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (4b for Table 2)

The title compound prepared following the General Procedure described above. Yield: 94%, white solid, mp: 96.5-97.8 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.22-1.26 (m, 1H), 1.34 (s, 3H), 1.46 (ddt, J_1 = 7.8 Hz, J_2 = 10.6 Hz, J_3 = 13.3 Hz, 1H), 1.88 (ddd, J_1 = 3.0 Hz, J_2 = 10.3 Hz, J_3 = 13.3 Hz, 1H), 2.03 (dt, J_1 = 5.2 Hz, J_2 = 12.8 Hz, 1H), 2.13 (d, J = 13.1 Hz, 1H), 2.45-2.54 (m, 1H), 2.68 (dd, J_1 = 7.5 Hz, J_2 = 18.5 Hz, 1H), 3.77 (s, 3H), 4.02 (dt, J_1 = 2.5 Hz, J_2 = 12.2 Hz, 1H), 4.11 (ddd, J_1 = 1.6 Hz, J_2 = 5.1 Hz, J_3 = 11.9 Hz, 1H), 4.36 (d, J = 10.3 Hz, 1H), 6.68 (d, J = 8.0 Hz, 1H), 6.89 (d, J = 8.0 Hz, 1H), 7.17 (t, J = 8.0 Hz, 1H), 7.26-7.34 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.05, 21.95, 22.06, 35.63, 38.15, 46.29, 55.23, 64.37, 80.37, 107.07, 116.05, 123.99, 126.20, 127.46, 127.89, 128.39, 141.21, 148.26, 157.29. HRMS (ESI$^+$) exact mass calcd for $C_{21}H_{25}O_2$ $[M+H]^+$ requires *m/z* 309.1855, found *m/z* 309.1859.



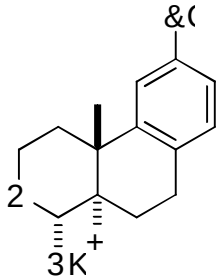
9-Methoxy-10b-methyl-4-phenyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (4c for Table 2)

The title compound prepared following the General Procedure described above. Yield: 82%, white solid, mp: 89.0-91.2 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.14-1.21 (m, 1H), 1.34 (s, 3H), 1.49 (ddt, J_1 = 8.1 Hz, J_2 = 10.2 Hz, J_3 = 13.2 Hz, 1H), 1.87 (ddd, J_1 = 3.3 Hz, J_2 = 10.3 Hz, J_3 = 13.3 Hz, 1H), 2.04-2.09 (m, 2H), 2.64-2.70 (m, 1H), 2.73 (dd, J_1 = 7.1 Hz, J_2 = 16.4 Hz, 1H), 3.80 (s, 3H), 4.03 (dt, J_1 = 3.2 Hz, J_2 = 11.9 Hz, 1H), 4.12 (ddd, J_1 = 1.9 Hz, J_2 = 4.8 Hz, J_3 = 11.9 Hz, 1H), 4.36 (d, J = 10.3 Hz, 1H), 6.69 (dd, J_1 = 2.6 Hz, J_2 = 8.4 Hz, 1H), 6.80 (d, J = 2.6 Hz, 1H), 6.95 (d, J = 8.4 Hz, 1H), 7.26-7.34 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.76, 21.76, 27.06, 35.90, 37.91, 46.70, 55.32, 64.33, 80.35, 109.92, 111.08, 127.18, 127.42, 127.90, 128.39, 130.11, 141.16, 148.25, 157.76. HRMS (ESI$^+$) exact mass calcd for $C_{21}H_{25}O_2$ $[M+H]^+$ requires *m/z* 261.1855, found *m/z* 309.1854.



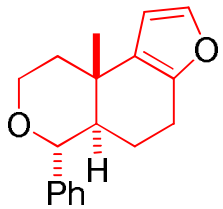
8,9,10-Trimethoxy-10b-methyl-4-phenyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (4d for Table 2)

The title compound prepared following the General Procedure described above. Yield: 86%, white solid, mp: 131.8-133.3 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.05-1.10 (m, 1H), 1.38 (t, J = 5.8 Hz, 1H), 1.46 (s, 3H), 1.88 (ddd, J_1 = 2.1 Hz, J_2 = 10.4 Hz, J_3 = 12.6 Hz, 1H), 1.98 (td, J_1 = 9.2 Hz, J_2 = 13.4 Hz, 1H), 2.58-2.72 (m, 2H), 2.83 (d, J = 13.4 Hz, 1H), 3.80 (s, 3H), 3.83 (s, 3H), 3.92 (s, 3H), 4.03 (d, J = 7.9 Hz, 2H), 4.46 (d, J = 10.3 Hz, 1H), 6.32 (s, 1H), 7.25-7.35 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.29, 19.77, 30.67, 36.74, 38.04, 49.05, 55.73, 60.50, 60.60, 64.35, 79.76, 107.59, 127.46, 127.82, 128.39, 131.73, 131.90, 140.60, 141.51, 151.50, 153.29. HRMS (ESI$^+$) exact mass calcd for $C_{23}H_{29}O_4$ $[M+H]^+$ requires *m/z* 369.2066, found *m/z* 369.2061.



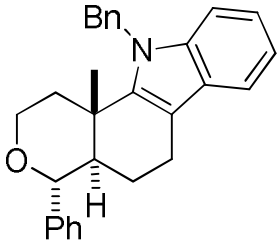
9-Chloro-10b-methyl-4-phenyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (4e for Table 2)

The title compound prepared following the General Procedure described above. Yield: 81%, yellow solid, mp: 123.6-125.0 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.16-1.23 (m, 1H), 1.32 (s, 3H), 1.49 (ddt, J_1 = 8.0 Hz, J_2 = 10.1 Hz, J_3 = 13.3 Hz, 1H), 1.84 (ddd, J_1 = 3.3 Hz, J_2 = 10.3 Hz, J_3 = 13.3 Hz, 1H), 1.99-2.11 (m, 2H), 2.67 (dd, J_1 = 9.2 Hz, J_2 = 14.0 Hz, 1H), 2.75 (ddd, J_1 = 2.1 Hz, J_2 = 10.4 Hz, J_3 = 12.6 Hz, 1H), 4.02 (dt, J_1 = 3.0 Hz, J_2 = 12.0 Hz, 1H), 4.13 (ddd, J_1 = 1.9 Hz, J_2 = 4.9 Hz, J_3 = 12.0 Hz, 1H), 4.35 (d, J = 10.3 Hz, 1H), 6.95 (d, J = 8.2 Hz, 1H), 7.07 (dd, J_1 = 2.2 Hz, J_2 = 8.2 Hz, 1H), 7.20 (d, J = 2.2 Hz, 1H), 7.25-7.35 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.46, 21.75, 27.30, 35.90, 37.77, 46.42, 64.19, 80.21, 124.15, 125.93, 127.37, 127.98, 128.42, 130.66, 131.36, 133.51, 140.91, 148.80. HRMS (ESI$^+$) exact mass calcd for $C_{20}H_{21}ClONa$ $[M+Na]^+$ requires *m/z* 335.1179, found *m/z* 335.1177.



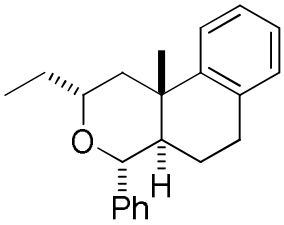
9a-Methyl-6-phenyl-5,5a,6,8,9,9a-hexahydro-4*H*-furo[3,2-*f*]isochromene (4f for Table 2)

The title compound prepared following the General Procedure described above. Yield: 63%, yellow solid, mp: 73.5-75.5 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.19-1.26 (m, 1H), 1.33 (s, 3H), 1.48-1.57 (m, 1H), 1.82-1.89 (m, 2H), 1.93-2.01 (m, 1H), 2.41-2.57 (m, 2H), 4.01-4.05 (m, 2H), 4.40 (d, J = 10.4 Hz, 1H), 6.24 (d, J = 1.8 Hz, 1H), 7.24 (s, 1H), 7.27-7.37 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.87, 20.82, 23.08, 32.55, 37.81, 49.00, 63.79, 79.35, 106.78, 127.22, 127.78, 127.91, 128.44, 140.91, 141.17, 149.01. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{20}O_2Na$ $[M+Na]^+$ requires *m/z* 291.1361, found *m/z* 291.1365.



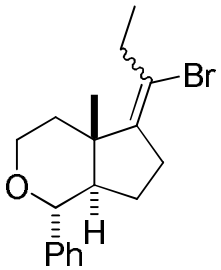
11-Benzyl-11b-methyl-4-phenyl-1,2,4,4a,5,6,11,11b-octahydropyrano[4,3-*a*]carbazole (4g for Table 2)

The title compound prepared following the General Procedure described above. Yield: 82%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.20-1.27 (m, 1H), 1.47-1.56 (m, 1H), 1.50 (s, 3H), 2.01-2.05 (m, 2H), 2.18 (t, J = 11.6 Hz, 1H), 2.60 (ddd, J_1 = 6.7 Hz, J_2 = 11.5 Hz, J_3 = 16.0 Hz, 1H), 2.73 (dd, J_1 = 5.6 Hz, J_2 = 16.0 Hz, 1H), 3.89-3.95 (m, 2H), 4.48 (d, J = 10.5 Hz, 1H), 5.49 (s, 2H), 6.97 (d, J = 7.1 Hz, 2H), 7.05-7.10 (m, 3H), 7.21-7.38 (m, 8H), 7.45 (d, J = 7.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.30, 20.08, 21.41, 35.61, 37.49, 48.46, 50.28, 63.27, 79.32, 109.40, 109.43, 118.07, 119.30, 121.63, 125.67, 127.01, 127.13, 127.43, 128.02, 128.50, 128.76, 137.76, 138.23, 141.23, 142.61. HRMS (ESI$^+$) exact mass calcd for $C_{29}H_{30}NO$ $[M+H]^+$ requires *m/z* 408.2327, found *m/z* 408.2331.



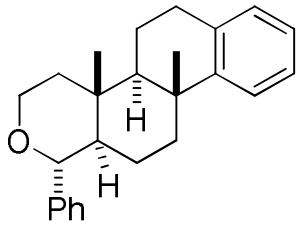
2-Ethyl-10b-methyl-4-phenyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (4i for Table 2)

The title compound prepared following the General Procedure described above. Yield: 75%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 0.98 (t, J = 7.5 Hz, 3H), 1.16-1.22 (m, 1H), 1.32 (s, 3H), 1.45-1.54 (m, 1H), 1.56-1.69 (m, 3H), 1.77 (ddd, J_1 = 3.2 Hz, J_2 = 10.3 Hz, J_3 = 13.3 Hz, 1H), 2.21 (dd, J_1 = 1.9 Hz, J_2 = 12.9 Hz, 1H), 2.69-2.77 (m, 2H), 3.84 (dtd, J_1 = 1.9 Hz, J_2 = 5.9 Hz, J_3 = 7.8 Hz, 1H), 4.40 (d, J = 10.2 Hz, 1H), 7.02 (d, J = 7.4 Hz, 1H), 7.10 (t, J = 7.4 Hz, 1H), 7.16 (t, J = 7.2 Hz, 1H), 7.26 (d, J = 6.2 Hz, 1H), 7.25-7.33 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 9.87, 19.62, 22.71, 27.98, 29.51, 36.09, 42.79, 46.85, 74.20, 80.09, 123.88, 125.72, 125.77, 127.54, 127.68, 128.30, 129.33, 135.19, 141.71, 147.29. HRMS (ESI$^+$) exact mass calcd for $C_{22}H_{26}ONa$ $[M+Na]^+$ requires *m/z* 329.1881, found *m/z* 329.1827.



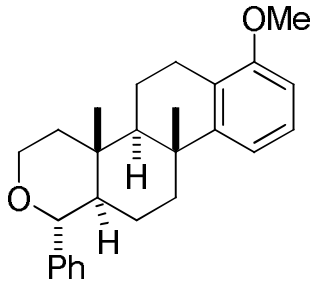
5-(1-Bromopropylidene)-4a-methyl-1-phenyloctahydrocyclopenta[*c*]pyran (4h for Table 2)

The title compound prepared following the General Procedure described above using 1.0 equiv. $InBr_3$. Yield: 68%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.16 (t, J = 7.3 Hz, 3H), 1.16 (s, 3H), 1.29-1.36 (m, 1H), 1.73-1.90 (m, 2H), 2.01-2.14 (m, 2H), 2.17-2.27 (m, 1H), 2.37 (d, J = 9.0 Hz, 1H), 2.49 (q, J = 7.3 Hz, 1H), 2.67 (q, J = 7.3 Hz, 1H), 3.88 (dt, J_1 = 3.3 Hz, J_2 = 12.1 Hz, 1H), 4.05 (ddd, J_1 = 1.8 Hz, J_2 = 5.0 Hz, J_3 = 12.2 Hz, 1H), 4.41 (d, J = 10.3 Hz, 1H), 7.27-7.35 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 14.31, 16.74, 23.03, 30.90, 34.42, 39.04, 44.89, 55.71, 63.66, 78.92, 123.11, 126.34, 127.28, 127.77, 128.37, 140.94, 147.38. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{23}BrO_2Na$ $[M+Na]^+$ requires *m/z* 357.0830, found *m/z* 357.0823.



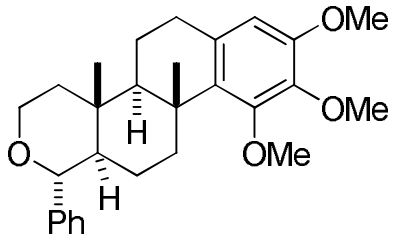
4a,10b-Dimethyl-1-phenyl-3,4,4a,4b,5,6,10b,11,12,12a-decahydro-1*H*-naphtho[2,1-*f*]isochromene (4j for Table 3)

The title compound prepared following the General Procedure described above. Yield: 81%, white solid, mp: 184.5-186.2 ºC. ^{1}H NMR (300 MHz, $CDCl_3$): d 0.92-0.96 (m, 1H), 1.12 (s, 3H), 1.21 (s, 3H), 1.35-1.43 (m, 3H), 1.47-1.55 (m, 2H), 1.70 (d, *J* = 13.0 Hz, 1H), 1.74-1.82 (m, 1H), 1.85-1.90 (m, 1H), 2.19-2.25 (m, 1H), 2.84-3.01 (m, 2H), 3.99-4.03 (m, 2H), 4.27 (d, *J* = 10.1 Hz, 1H), 7.02-7.11 (m, 3H), 7.14-7.16 (m, 1H), 7.27-7.34 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 13.55, 17.71, 20.28, 26.03, 30.28, 35.91, 37.74, 39.07, 39.67, 52.68, 52.97, 63.90, 79.23, 124.21, 125.33, 125.78, 127.23, 127.70, 128.33, 128.92, 134.87, 141.37, 149.96. HRMS (ESI$^+$) exact mass calcd for $C_{25}H_{31}O$ $[M+H]^+$ requires *m/z* 347.2375, found *m/z* 347.2368.



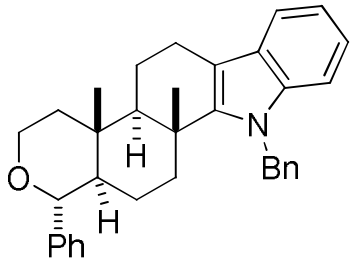
7-Methoxy-4a,10b-dimethyl-1-phenyl-3,4,4a,4b,5,6,10b,11,12,12a-decahydro-1*H*-naphtho[2,1-*f*]isochromene (4k for Table 3)

The title compound prepared following the General Procedure described above. Yield: 87%, white solid, mp: 198.3-200.5 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 0.93 (d, *J* = 7.8Hz, 1H), 1.14 (s, 3H), 1.21 (s, 3H), 1.31-1.41 (m, 3H), 1.46-1.56 (m, 2H), 1.64-1.73 (m, 2H), 1.88-1.93 (m, 1H), 2.19 (dd, J_1 = 3.0 Hz, J_2 = 9.7 Hz, 1H), 2.57-2.69 (m, 1H), 2.92 (dd, J_1 = 6.5 Hz, J_2 = 18.2 Hz, 1H), 3.80 (s, 3H), 3.93-4.06 (m, 2H), 4.26 (d, *J* = 10.1 Hz, 1H), 6.63 (d, *J* = 8.0 Hz, 1H), 6.80 (d, *J* = 8.0 Hz, 1H), 7.09 (t, *J* = 8.0 Hz, 1H), 7.26-7.34 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 13.52, 17.09, 20.33, 24.47, 25.93, 35.84, 37.72, 39.29, 39.66, 52.30, 52.90, 55.23, 63.93, 79.22, 106.44, 116.38, 123.95, 126.17, 127.23, 127.68, 128.32, 141.40, 151.36, 156.99. HRMS (ESI$^+$) exact mass calcd for $C_{26}H_{33}O_2$ $[M+H]^+$ requires *m/z* 377.2481, found *m/z* 377.2488.



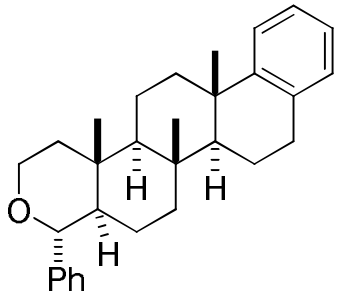
8,9,10-Trimethoxy-4a,10b-dimethyl-1-phenyl-3,4,4a,4b,5,6,10b,11,12,12a-decahydro-1*H*-naphtho[2,1-*f*]isochromene (4l for Table 3)

The title compound prepared following the General Procedure described above. Yield: 82%, white solid, mp: 208.5-210.9. ^{1}H NMR (400 MHz, $CDCl_3$): d 0.84-0.97 (m, 1H), 1.13 (s, 3H), 1.30 (s, 3H), 1.26-1.36 (m, 2H), 1.46-1.64 (m, 5H), 1.69 (d, *J* = 13.2 Hz, 1H), 1.78-1.81 (m, 1H), 2.83-2.86 (m, 2H), 3.76 (s, 3H), 3.79 (s, 3H), 3.80 (s, 3H), 3.98-4.05 (m, 2H), 4.23 (d, *J* = 10.1 Hz, 1H), 6.34 (s, 1H), 7.24-7.34 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): d 13.83, 17.73, 20.53, 22.82, 32.89, 36.20, 37.86, 39.56, 39.80, 53.06, 55.05, 55.68, 60.32, 60.44, 63.89, 79.14, 107.28, 127.19, 127.62, 128.27, 131.72, 134.71, 140.78, 141.39, 151.14, 153.14. HRMS (ESI$^+$) exact mass calcd for $C_{28}H_{37}O_4$ $[M+H]^+$ requires *m/z* 437.2692, found *m/z* 437.2689.



13-Benzyl-6a,13b-dimethyl-3-phenyl-1,2,2a,3,5,6,6a,6b,7,8,13,13b-dodecahydroisochromeno[6,5-*a*]carbazole (4m for Table 3)

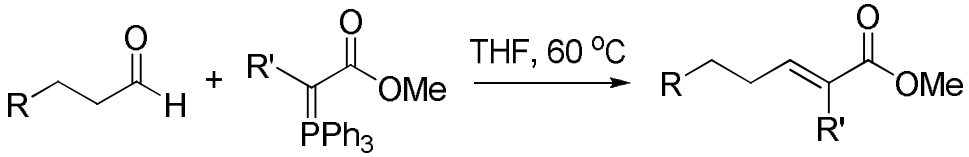
The title compound prepared following the General Procedure described above. Yield: 66%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 0.74 (dd, J_1 = 3.1 Hz, J_2 = 13.5 Hz, 1H), 1.15 (s, 3H), 1.34 (s, 3H), 1.39-1.62 (m, 4H), 1.68-1.75 (m, 3H), 1.97-2.01 (m, 1H), 2.14 (td, J_1 = 3.1 Hz, J_2 = 12.6 Hz, 1H), 2.69-2.77 (m, 1H), 2.94 (dd, J_1 = 4.8 Hz, J_2 = 15.0 Hz, 1H), 4.02-4.05 (m, 2H), 4.21 (d, J = 10.0 Hz, 1H), 5.34 (d, J = 17.7 Hz, 1H), 5.46 (d, J = 17.7 Hz, 1H), 6.89 (d, J = 6.8 Hz, 2H), 6.95-6.97 (m, 1H), 7.03-7.09 (m, 2H), 7.14-7.30 (m, 8H), 7.48-7.50 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 13.77, 18.11, 19.88, 22.32, 22.89, 36.13, 37.46, 38.22, 39.73, 48.68, 53.04, 56.09, 63.80, 78.92, 109.19, 109.50, 117.87, 119.12, 121.34, 125.59, 126.89, 127.11, 127.65, 128.28, 128.61, 138.18, 141.17, 144.53. HRMS (ESI$^+$) exact mass calcd for $C_{34}H_{38}NO$ $[M+H]^+$ requires *m/z* 476.2953, found *m/z* 476.2948.



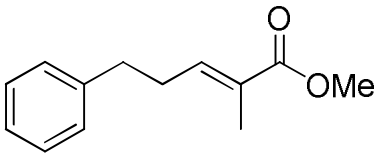
6a,12b,14b-Trimethyl-4-phenyl-2,4,4a,5,6,6a,6b,7,8,12b,13,14,14a,14b-tetradecahydro-1*H*-phenanthro[2,1-*f*]isochromene (4n for Table 3)

The title compound prepared following the General Procedure described above. Yield: 59%, white solid, mp: 134.0-136.1 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): d 0.75-0.90 (m, 3H), 0.95 (s, 3H), 1.07 (s, 3H), 1.20 (s, 3H), 1.26-1.34 (m, 2H), 1.36-1.47 (m, 3H), 1.56-1.77 (m, 6H), 2.40-2.44 (m, 1H), 2.77 (ddd, J_1 = 7.4 Hz, J_2 = 11.6 Hz, J_3 = 16.8 Hz, 1H), 2.89 (dd, J_1 = 4.9 Hz, J_2 = 17.2 Hz, 1H), 3.96-4.00 (m, 2H), 4.21 (d, J = 10.2 Hz, 1H), 7.00 (d, J = 7.3 Hz, 1H), 7.05 (dt, J_1 = 1.3 Hz, J_2 = 7.0 Hz, 1H), 7.12 (t, J = 7.2 Hz, 1H), 7.24-7.33 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$): d 13.39, 17.70, 17.76, 17.90, 19.52, 26.18, 30.87, 35.73, 37.63, 38.16, 39.59, 40.27, 40.54, 53.32, 55.51, 58.64, 63.91, 79.23, 124.66, 125.20, 125.73, 127.20, 127.62, 128.85, 135.03, 141.45, 150.08. HRMS (ESI$^+$) exact mass calcd for $C_{30}H_{38}O$ $[M+Na]^+$ requires *m/z* 437.2820, found *m/z* 437.2803.

3 Experimental Procedure and Data for Prins-Polyene Cyclization Precusors

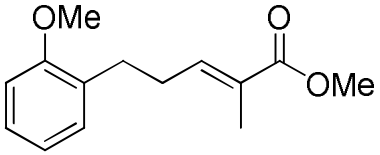


To an oven-dried round bottom flask (100 mL) equipped with a magnetic stir bar, aldehyde (10 mmol) and wittg reagent (12 mmol, 1.2 equiv) was dissolved in THF (50 mL). After the reaction was stirred at 60 ^{o}C for 10h, solvent was removed *in vacuo*. The crude product was purified by flash column chromatography on silica gel using appropriate solvents (hexane/EtOAc mixture) to provide the title compounds.



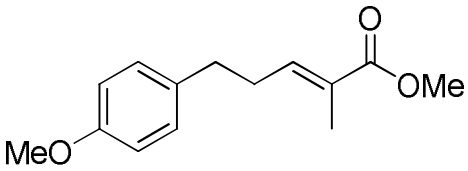
(*E*)-Methyl 2-methyl-5-phenylpent-2-enoate

Yield: 92%, yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$): d 1.78 (s, 3H), 2.49 (q, *J* = 7.6 Hz, 2H), 2.75 (t, *J* = 7.8 Hz, 2H), 3.73 (s, 3H), 6.81 (t, *J* = 7.4 Hz, 1H), 7.18-7.22 (m, 3H), 7.26-7.31 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): d 12.37, 30.57, 34.71, 51.75, 126.11, 128.19, 128.36, 128.47, 141.20, 141.28, 168.63. HRMS (ESI^+) exact mass calcd for $C_{13}H_{17}O_2$ $[M+H]^+$ requires *m/z* 205.1229, found *m/z* 205.1232.



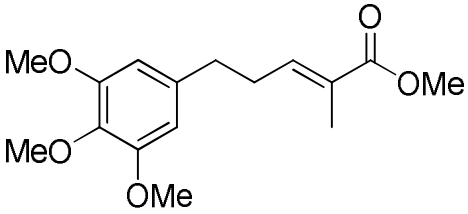
(*E*)-Methyl 5-(2-methoxyphenyl)-2-methylpent-2-enoate

Yield: 95%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.78 (s, 3H), 2.47 (q, *J* = 7.6 Hz, 2H), 2.73 (t, *J* = 7.6 Hz, 2H), 3.73 (s, 3H), 3.83 (s, 3H), 6.83-6.90 (m, 3H), 7.12 (d, *J* = 7.6 Hz, 1H), 7.19 (t, *J* = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.26, 28.98, 29.39, 51.67, 55.20, 110.23, 120.42, 127.39, 127.78, 129.60, 129.82, 142.11, 157.47, 168.76. HRMS (ESI^+) exact mass calcd for $C_{14}H_{19}O_3$ $[M+H]^+$ requires *m/z* 235.1334, found *m/z* 235.1325.



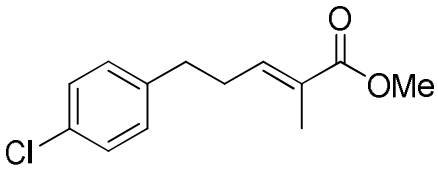
(*E*)-Methyl 5-(4-methoxyphenyl)-2-methylpent-2-enoate

Yield: 93%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.55 (s, 3H), 1.95-2.04 (m, 2H), 2.69 (t, *J* = 7.6 Hz, 2H), 3.78 (s, 3H), 3.84 (s, 3H), 4.78 (t, *J* = 5.3 Hz, 1H), 6.82 (d, *J* = 8.6 Hz, 2H), 7.10 (d, *J* = 8.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.39, 30.82, 33.80, 51.74, 55.27, 113.86, 128.09, 129.27, 133.28, 141.41, 157.96, 168.64. HRMS (ESI^+) exact mass calcd for $C_{14}H_{18}O_3Na$ $[M+Na]^+$ requires *m/z* 257.1154, found *m/z* 257.1143.



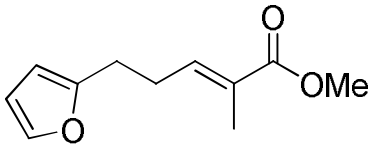
(*E*)-Methyl 2-methyl-5-(3,4,5-trimethoxyphenyl)pent-2-enoate

Yield: 79%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.81 (s, 3H), 2.49 (q, *J* = 7.5 Hz, 2H), 2.70 (t, *J* = 7.7 Hz, 2H), 3.74 (s, 3H), 3.83 (s, 3H), 3.85 (s, 6H), 6.40 (s, 2H), 6.80 (t, *J* = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.44, 30.55, 35.10, 51.76, 56.08, 60.88, 105.27, 128.21, 136.33, 136.93, 141.17, 153.16, 168.59. HRMS (ESI^+) exact mass calcd for $C_{16}H_{22}O_5Na$ $[M+Na]^+$ requires *m/z* 317.1365, found *m/z* 317.1363.



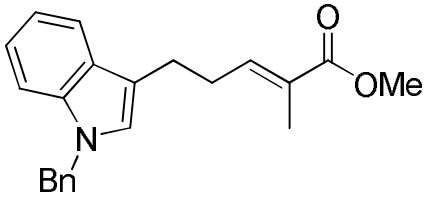
(*E*)-Methyl 5-(4-chlorophenyl)-2-methylpent-2-enoate

Yield: 84%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.77 (s, 3H), 2.47 (q, *J* = 7.6 Hz, 2H), 2.72 (t, *J* = 7.7 Hz, 2H), 3.73 (s, 3H), 6.76 (t, *J* = 7.6 Hz, 1H), 7.11 (d, *J* = 8.5 Hz, 2H), 7.25 (d, *J* = 7.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.39, 30.34, 34.02, 51.77, 128.54, 129.71, 130.90, 131.86, 139.56, 140.69, 168.50. HRMS (ESI^+) exact mass calcd for $C_{13}H_{16}ClO_2$ $[M+H]^+$ requires *m/z* 239.0839, found *m/z* 239.0848.



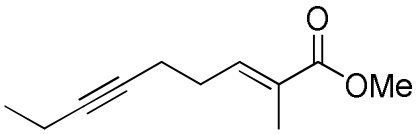
(*E*)-Methyl 5-(furan-2-yl)-2-methylpent-2-enoate

Yield: 76%, yellow oil. ^{1}H NMR (300 MHz, $CDCl_3$): d 1.80 (s, 3H), 2.51 (q, *J* = 7.4 Hz, 2H), 2.75 (t, *J* = 7.5 Hz, 2H), 3.71 (s, 3H), 5.99 (d, *J* = 3.1 Hz, 1H), 6.26 (dd, J_1 = 1.9 Hz, J_2 = 3.1 Hz, 1H), 6.75 (t, *J* = 7.3 Hz, 1H), 7.29 (d, *J* = 1.7 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$): d 12.35, 26.93, 27.23, 51.74, 105.33, 110.19, 128.51, 140.68, 141.13, 154.76, 168.50. HRMS (ESI^+) exact mass calcd for $C_{11}H_{14}O_3Na$ $[M+Na]^+$ requires *m/z* 217.0841, found *m/z* 217.0843.



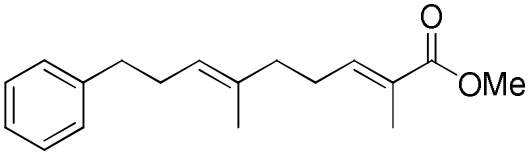
(*E*)-Methyl 5-(1-benzyl-1*H*-indol-3-yl)-2-methylpent-2-enoate

Yield: 85%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.79 (s, 3H), 2.59 (q, *J* = 7.5 Hz, 2H), 2.90 (t, *J* = 7.6 Hz, 2H), 3.72 (s, 3H), 5.27 (s, 2H), 6.87 (t, *J* = 7.3 Hz, 1H), 6.91 (s, 1H), 7.08-7.10 (m, 3H), 7.17 (t, *J* = 7.5 Hz, 2H), 7.23-7.31 (m, 3H), 7.60 (d, *J* = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.48, 24.19, 29.41, 49.86, 51.72, 109.71, 114.79, 118.95, 118.99, 121.81, 125.54, 126.76, 127.55, 127.90, 127.98, 128.74, 136.73, 137.73, 142.18, 168.69. HRMS (ESI^+) exact mass calcd for $C_{22}H_{24}NO_2$ $[M+H]^+$ requires *m/z* 334.1807, found *m/z* 334.1805.



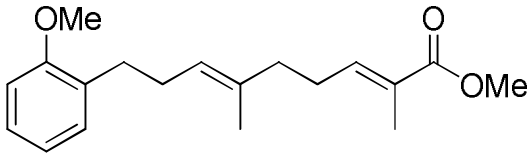
(*E*)-Methyl 2-methylnon-2-en-6-ynoate

Yield: 85%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.11 (t, *J* = 7.5 Hz, 3H), 1.86 (s, 3H), 2.15 (tq, J_1 = 2.2 Hz, J_2 = 7.5 Hz, 2H), 2.26-2.30 (m, 2H), 2.37 (q, *J* = 7.0 Hz, 2H), 3.74 (s, 3H), 6.78 (t, *J* = 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.38, 12.53, 14.20, 18.12, 28.45, 51.74, 78.14, 82.50, 128.55, 140.54, 168.54. HRMS (ESI^+) exact mass calcd for $C_{11}H_{16}O_2Na$ $[M+Na]^+$ requires *m/z* 203.1048, found *m/z* 203.1047.



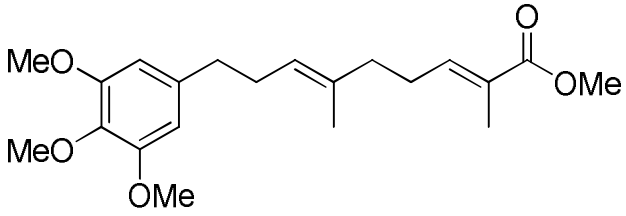
(2*E*,6*E*)-Methyl 2,6-dimethyl-9-phenylnona-2,6-dienoate

Yield: 99%, yellow oil, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.55 (s, 3H), 1.83 (s, 3H), 2.07-2.10 (m, 2H), 2.26 (q, *J* = 8.6 Hz, 2H), 2.31 (q, *J* = 7.6 Hz, 2H), 2.62-2.65 (m, 2H), 3.73 (s, 3H), 5.20 (t, *J* = 7.1 Hz, 1H), 6.74 (t, *J* = 7.3 Hz, 1H), 7.16-7.19 (m, 3H), 7.25-7.28 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.43, 15.92, 27.28, 29.96, 36.04, 38.23, 51.70, 124.45, 125.72, 127.51, 128.24, 128.49, 134.67, 142.27, 168.70. HRMS (ESI^+) exact mass calcd for $C_{18}H_{25}O_2$ $[M+H]^+$ requires *m/z* 273.1855, found *m/z* 273.1844.



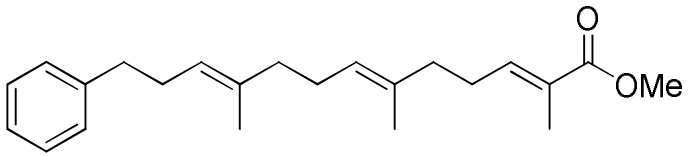
(2*E*,6*E*)-Methyl 9-(2-methoxyphenyl)-2,6-dimethylnona-2,6-dienoate

Yield: 89%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.57 (s, 3H), 1.83 (s, 3H), 2.05-2.11 (m, 2H), 2.23-2.30 (m, 4H), 2.61-2.65 (m, 2H), 3.73 (s, 3H), 3.82 (s, 3H), 5.24 (t, *J* = 7.1 Hz, 1H), 6.75 (t, *J* = 7.3 Hz, 1H), 6.85 (t, *J* = 8.0 Hz, 1H), 6.87 (d, *J* = 7.4 Hz, 1H), 7.11 (d, *J* = 7.3 Hz, 1H), 7.17 (t, *J* = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.42, 15.86, 27.36, 28.18, 30.50, 38.23, 51.69, 55.22, 110.14, 120.27, 124.97, 126.96, 127.44, 129.88, 130.60, 134.37, 142.40, 157.49, 168.73. HRMS (ESI^+) exact mass calcd for $C_{19}H_{26}O_3Na$ $[M+Na]^+$ requires *m/z* 325.1780, found *m/z* 325.1778.



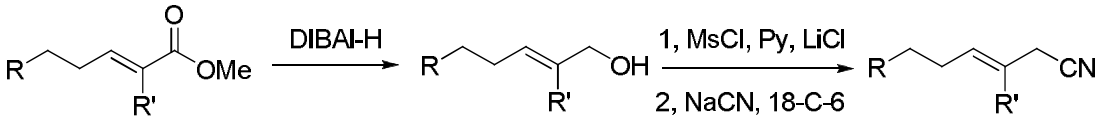
(2*E*,6*E*)-Methyl 2,6-dimethyl-9-(3,4,5-trimethoxyphenyl)nona-2,6-dienoate

Yield: 83%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.60 (s, 3H), 1.83 (s, 3H), 2.11 (t, *J* = 7.6 Hz, 2H), 2.24-2.33 (m, 4H), 2.56-2.60 (m, 2H), 3.73 (s, 3H), 3.83 (s, 3H), 3.86 (s, 6H), 5.21 (t, *J* = 7.0 Hz, 1H), 6.41 (s, 2H), 6.75 (t, *J* = 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.42, 16.02, 27.30, 29.99, 36.41, 38.22, 51.72, 56.05, 60.88, 105.29, 124.39, 127.54, 134.74, 136.05, 138.09, 142.15, 153.03, 168.70. HRMS (ESI^+) exact mass calcd for $C_{21}H_{30}O_5Na$ $[M+Na]^+$ requires *m/z* 385.1991, found *m/z* 385.2006.



(2*E*,6*E*,10*E*)-methyl 2,6,10-trimethyl-13-phenyltrideca-2,6,10-trienoate

Yield: 98%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.58 (s, 3H), 1.64 (s, 3H), 1.86 (s, 3H), 2.00-2.03 (m, 2H), 2.08-2.13 (m, 4H), 2.27-2.35 (m, 4H), 2.65-2.68 (m, 2H), 3.76 (s, 3H), 5.16 (t, *J* = 6.5 Hz, 1H), 5.22 (t, *J* = 6.7 Hz, 1H), 6.78 (t, *J* = 7.3 Hz, 1H), 7.19-7.23 (m, 3H), 7.29-7.32 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.43, 15.99, 26.60, 27.37, 29.96, 36.15, 38.23, 39.60, 51.69, 123.71, 125.10, 125.67, 127.46, 128.22, 128.47, 133.86, 135.65, 142.32, 142.39, 168.77. HRMS (ESI^+) exact mass calcd for $C_{23}H_{32}O_2Na$ $[M+Na]^+$ requires *m/z* 363.2300, found *m/z* 363.205.

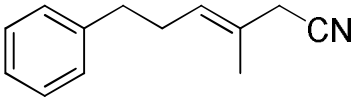


An oven-dried round bottom flask (100 mL) equipped with a magnetic stir bar, ester was dissolved in 40 mL CH_2Cl_2 and cooled to 0 ^{o}C. DIBAl-H (1.0M solution in heptane, 2.2 equiv) was added dropwisely. Then the reaction was allowed to stir at ambient temperature for 2 h. The reaction mixture was poured into cool sat. NH_4Cl, filtered through celight and extracted the filtrated with EtOAc (3 x 50 mL). The combined organic phase was washed with brine (100 mL), dried with Na_2SO_4 and concentrated *in vacuo* to give the alcohol. The product was used for the next step without further purification.

An oven-dried round bottom flask (100 mL) equipped with a magnetic stir bar, alcohol, pyridine (1.2 equiv) and LiCl (0.2 equiv) were dissolved in DMF (50 mL). Cooled the solution to 0 ^{o}C, MsCl (1.2 equiv) was added. The reaction was allowed to stir at ambient temperature overnight. Poured the mixture to water, extracted with diethyl ether (3 x 50 mL) and washed with

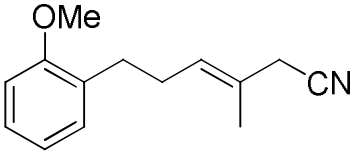
brine. Dried with Na_2SO_4 and concentrated *in vacuo* to give the chloro-product.

The crude chloro product was dissolved in CH_3CN, NaCN (2.0 equiv) and 18-crown-6 (1.0 equiv) were added. The mixture was stirred overnight at room temperature. The reaction mixture was poured into water and extracted with EtOAc (3 x 50 mL). The combined organic layer was washed with H_2O (2 x 100 mL) and brine (2 x 100 mL), dried over Na_2SO_4 and concentrated *in vacuo*. The crude product was purified by flash column chromatography on silica gel using appropriate solvents (hexane/EtOAc mixture) to provide the title compounds.



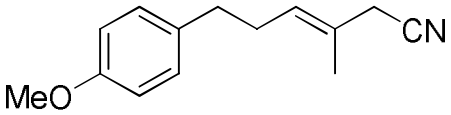
(*E*)-3-Methyl-6-phenylhex-3-enenitrile

Yield: 87%, yellow oil. 1.64 (s, 3H), 2.36 (q, *J* = 7.6 Hz, 2H), 2.67 (t, *J* = 7.7 Hz, 2H), 3.00 (s, 2H), 5.53 (t, *J* = 7.2 Hz, 1H), 7.16-7.21 (m, 3H), 7.27-7.30 (m, 2H); ^{13}C NMR (125 MHz, CDCl3): d 15.97, 27.22, 29.94, 35.41, 117.74, 124.96, 125.99, 128.39, 128.45, 128.81, 141.48. HRMS (ESI^+) exact mass calcd for $C_{13}H_{16}N$ $[M+H]^+$ requires *m/z* 186.1283, found *m/z* 186.1287.



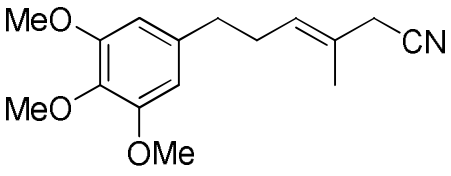
(*E*)-6-(2-Methoxyphenyl)-3-methylhex-3-enenitrile

Yield: 93%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.65 (s, 3H), 2.32 (q, *J* = 7.5 Hz, 2H), 2.66 (t, *J* = 7.2 Hz, 2H), 2.99 (s, 2H), 3.82 (s, 3H), 5.55 (t, *J* = 7.3 Hz, 1H), 6.84 (d, *J* = 8.2 Hz, 1H), 6,88 (t, *J* = 7.7 Hz, 1H), 7.10 (d, *J* = 7.4 Hz, 1H), 7.19 (t, *J* = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.85, 27.21, 28.29, 30.00, 55.22, 110.20, 117.88, 120.36, 124.53, 127.27, 129.40, 129.86, 129.90, 157.46. HRMS (ESI^+) exact mass calcd for $C_{14}H_{18}NO$ $[M+H]^+$ requires *m/z* 216.1388, found *m/z* 216.1383.



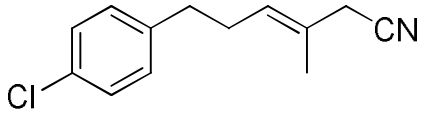
(*E*)-6-(4-Methoxyphenyl)-3-methylhex-3-enenitrile

Yield: 64%, yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$): d 1.67 (s, 3H), 2.35 (q, *J* = 7.5 Hz, 2H), 2.64 (t, *J* = 7.6 Hz, 2H), 3.03 (s, 2H), 3.82 (s, 3H), 5.55 (t, *J* = 7.8 Hz, 1H), 6.86 (d, *J* = 8.6 Hz, 2H), 7.12 (d, *J* = 8.6 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): d 15.99, 27.22, 30.18, 34.49, 55.28, 113.79, 117.77, 124.86, 128.89, 129.33, 133.57, 157.89. HRMS (ESI^+) exact mass calcd for $C_{14}H_{18}NO$ $[M+H]^+$ requires *m/z* 216.1388, found *m/z* 216.1379.



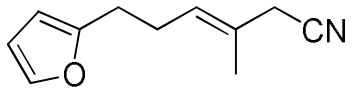
(*E*)-3-Methyl-6-(3,4,5-trimethoxyphenyl)hex-3-enenitrile

Yield: 79%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.69 (s, 3H), 2.36 (q, *J* = 7.4 Hz, 2H), 2.62 (t, *J* = 7.7 Hz, 2H), 3.02 (s, 2H), 3.83 (s, 3H), 3,86 (s, 6H), 5.55 (t, *J* = 6.5 Hz, 1H), 6.40 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 16.10, 27.16, 29.93, 35.77, 56.08, 60.87, 105.28, 117.72, 125.01, 128.66, 136.17, 137.31, 153.11. HRMS (ESI^+) exact mass calcd for $C_{16}H_{21}NO_3Na$ $[M+Na]^+$ requires *m/z* 298.1419, found *m/z* 298.1418.



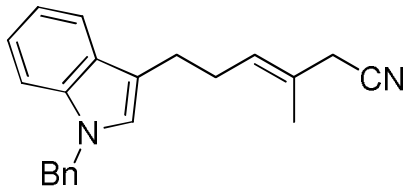
(*E*)-6-(4-Chlorophenyl)-3-methylhex-3-enenitrile

Yield: 86%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.64 (s, 3H), 2.33 (q, *J* = 7.5 Hz, 2H), 2.64 (t, *J* = 7.6 Hz, 2H), 3.00 (s, 2H), 5.50 (t, *J* = 7.2 Hz, 1H), 7.10 (d, *J* = 8.3 Hz, 2H), 7.25 (d, *J* = 8.3 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 16.02, 27.16, 29.76, 34.72, 117.64, 125.32, 128.31, 128.46, 129.79, 131.72, 139.87. HRMS (ESI$^+$) exact mass calcd for $C_{13}H_{15}ClN$ $[M+H]^+$ requires *m/z* 220.0893, found *m/z* 220.0891.



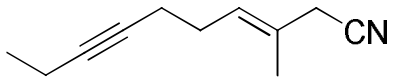
(*E*)-6-(Furan-2-yl)-3-methylhex-3-enenitrile

Yield: 67%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.69 (s, 3H), 2.38 (q, *J* = 7.3 Hz, 2H), 2.68 (t, *J* = 7.5 Hz, 2H), 3.01 (s, 2H), 5.50 (t, *J* = 7.2 Hz, 1H), 5.98 (d, *J* = 3.0 Hz, 1H), 6.27 (s, 1H), 7.30 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.94, 26.63, 27.22, 27.55, 105.24, 110.18, 117.68, 125.35, 128.34, 141.02, 155.12. HRMS (ESI$^+$) exact mass calcd for $C_{11}H_{14}NO$ $[M+H]^+$ requires *m/z* 176.1075, found *m/z* 176.1075.



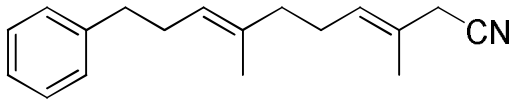
(*E*)-6-(1-Benzyl-1*H*-indol-3-yl)-3-methylhex-3-enenitrile

Yield: 77%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.56 (s, 3H), 1.64 (s, 3H), 2.44 (q, *J* = 7.2 Hz, 2H), 2.82 (t, *J* = 7.6 Hz, 2H), 2.98 (s, 2H), 5.27 (s, 2H), 5.59 (t, *J* = 7.2 Hz, 1H), 6.90 (s, 1H), 7.09-7.12 (m, 3H), 7.17 (t, *J* = 7.6 Hz, 2H), 7.25-7.32 (m, 4H), 7.60 (d, *J* = 7.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 16.06, 24.77, 27.23, 28.81, 49.85, 109.66, 115.05, 117.85, 118.92, 118.99, 121.74, 124.60, 125.51, 126.82, 127.56, 128.06, 128.74, 129.60, 136.70, 137.79. HRMS (ESI$^+$) exact mass calcd for $C_{22}H_{22}N_2Na$ $[M+Na]^+$ requires *m/z* 337.1681, found *m/z* 337.1685.



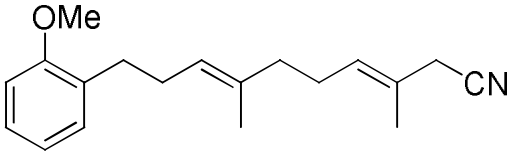
(*E*)-3-Methyldec-3-en-7-ynenitrile

Yield: 75%. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.14 (t, *J* = 7.6 Hz, 3H), 1.76 (s, 3H), 2.13-2.26 (m, 6H), 3.05 (s, 2H), 5.54 (t, *J* = 7.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.38, 14.25, 16.13, 18.69, 27.25, 27.75, 78.45, 82.30, 117.69, 125.40, 128.30. HRMS (ESI$^+$) exact mass calcd for $C_{11}H_{15}NNa$ $[M+Na]^+$ requires *m/z* 184.1102, found *m/z* 184.1098.



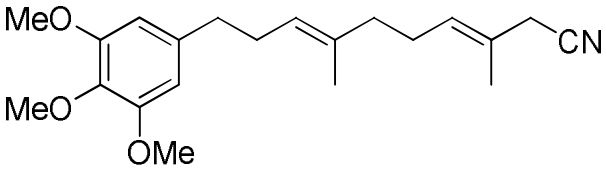
(3*E*,7*E*)-3,7-Dimethyl-10-phenyldeca-3,7-dienenitrile

Yield: 87%, yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$): d 1.55 (s, 3H), 1.71 (s, 3H), 2.00-2.03 (m, 2H), 2.12 (q, *J* = 7.3 Hz, 2H), 2.31 (q, *J* = 7.4 Hz, 2H), 2.63-2.66 (m, 2H), 2.99 (s, 2H), 5.18 (t, *J* = 7.2 Hz, 1H), 5.43 (t, *J* = 7.0 Hz, 1H), 7.18-7.19 (m, 3H), 7.25-7.29 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): d 15.95, 16.01, 26.55, 27.25, 29.86, 36.04, 38.94, 117.87, 124.08, 124.28, 125.71, 128.24, 128.48, 129.57, 134.92, 142.29. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{24}N$ $[M+H]^+$ requires *m/z* 254.1909, found *m/z* 254.1913.



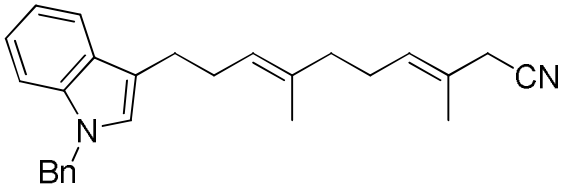
(3*E*,7*E*)-10-(2-Methoxyphenyl)-3,7-dimethyldeca-3,7-dienenitrile

Yield: 79%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.56 (s, 3H), 1.72 (s, 3H), 1.99-2.03 (m, 2H), 2.12 (q, *J* = 7.3 Hz, 2H), 2.27 (q, *J* = 7.4 Hz, 2H), 2.61-2.65 (m, 2H), 3.00 (s, 2H), 3.83 (s, 3H), 5.20 (t, *J* = 7.1 Hz, 1H), 5.44 (t, *J* = 7.1 Hz, 1H), 6.84 (d, *J* = 8.3 Hz, 1H), 6.87 (t, *J* = 7.4 Hz, 1H), 7.12 (d, *J* = 7.4 Hz, 1H), 7.17 (t, *J* = 7.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.88, 16.00, 26.63, 27.25, 28.13, 30.50, 38.96, 55.25, 110.16, 117.91, 120.27, 124.02, 124.78, 126.96, 129.68, 129.84, 130.63, 134.63, 157.51. HRMS (ESI$^+$) exact mass calcd for $C_{19}H_{26}NO$ $[M+H]^+$ requires *m/z* 284.2014, found *m/z* 284.2018.



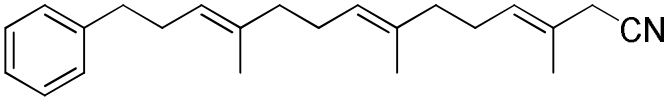
(3*E*,7*E*)-3,7-Dimethyl-10-(3,4,5-trimethoxyphenyl)deca-3,7-dienenitrile

Yield: 60%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.59 (s, 3H), 1.72 (s, 3H), 2.01-2.05 (m, 2H), 2.13 (q, *J* = 7.3 Hz, 2H), 2.31 (q, *J* = 7.4 Hz, 2H), 2.57-2.61 (m, 2H), 3.01 (s, 2H), 3.83 (s, 3H), 3.85 (s, 6H), 5.19 (t, *J* = 7.0 Hz, 1H), 5.45 (t, *J* = 7.0 Hz, 1H), 6.41 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 16.03, 26.58, 27.21, 29.90, 36.39, 38.95, 56.07, 60.88, 105.31, 117.85, 124.15, 124.21, 129.44, 134.99, 136.03, 138.12, 153.01. HRMS (ESI$^+$) exact mass calcd for $C_{21}H_{29}NO_3Na$ $[M+Na]^+$ requires *m/z* 366.2054, found *m/z* 366.2052.



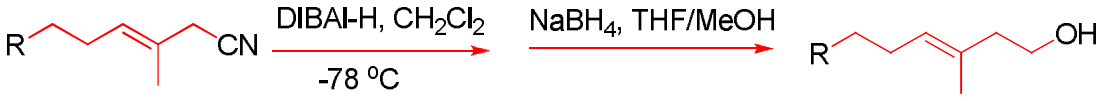
(3*E*,7*E*)-10-(1-Benzyl-1*H*-indol-3-yl)-3,7-dimethyldeca-3,7-dienenitrile

Yield: 75%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.52 (s, 3H), 1.66 (s, 3H), 1.95-1.98 (m, 2H), 2.04-2.07 (m, 2H), 2.36 (q, *J* = 7.3 Hz, 2H), 2.81 (t, *J* = 8.2 Hz, 2H), 2.92 (s, 2H), 5.24 (t, *J* = 7.1 Hz, 1H), 5.34 (s, 2H), 5.39 (t, *J* = 6.8 Hz, 1H), 7.04-7.15 (m, 5H), 7.17-7.27 (m, 4H), 7.54-7.56 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 16.00, 16.06, 24.43, 26.56, 27.22, 28.37, 38.99, 46.86, 109.62, 111.94, 117.96, 118.53, 119.80, 121.92, 123.30, 124.09, 124.31, 126.46, 127.05, 127.48, 128.74, 129.65, 135.07, 135.44, 137.37. HRMS (ESI$^+$) exact mass calcd for $C_{27}H_{30}N_2K$ $[M+K]^+$ requires *m/z* 421.2046, found *m/z* 421.2044.



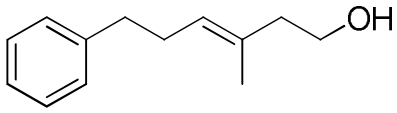
(3*E*,7*E*,11*E*)-3,7,11-Trimethyl-14-phenyltetradeca-3,7,11-trienenitrile

Yield: 80%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.56 (s, 3H), 1.60 (s, 3H), 1.72 (s, 3H), 1.97-2.08 (m, 6H), 2.13 (q, *J* = 7.2 Hz, 2H), 2.31 (q, *J* = 7.6 Hz, 2H), 2.62-2.66 (m, 2H), 3.01 (s, 2H), 5.11 (t, *J* = 6.7 Hz, 1H), 5.19 (t, *J* = 7.0 Hz, 1H), 5.46 (t, *J* = 7.0 Hz, 1H), 7.18-7.20 (m, 3H), 7.26-7.29 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.98, 26.61, 26.67, 27.26, 29.97, 36.16, 38.97, 39.65, 117.85, 123.66, 124.03, 124.89, 125.68, 128.22, 128.48, 129.66, 134.14, 135.71, 142.39. HRMS (ESI$^+$) exact mass calcd for $C_{23}H_{32}N$ $[M+H]^+$ requires *m/z* 322.2535, found *m/z* 322.2542.



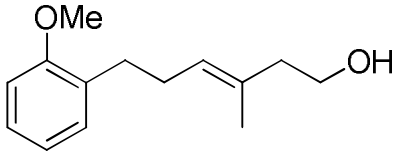
To an oven-dried round bottom flask (50 mL) equipped with a magnetic stir bar, the cyanide (1.0 mmol) was dissolved in dry

CH_2Cl_2 (10 mL) and cooled to -78 ºC. DIBAl-H (1.1 mL of a 1.0M solution in heptane, 1.1 mmol, 1.1 equiv) was added dropwisely. The solution was allowed to stir at -78 ºC for 1h and then EtOH (0.1 mL) was added, the reaction mixture was diluted with EtOAc (10 mL) and poured into Sat. NH_4Cl (10 mL). After stirred for 10 mins, potassium sodium tartrate (2.0 equiv) was added and stirred for 2h. Separated the organic layer, and exacted the aqueous with EtOAc (2 x 30mL). The combined organic layers were washed with brine (50 mL), dried over Na_2SO_4, and concentrated *in vacuo*. The crude product was dissolved in 10 mL MeOH/THF (1/4) and cooled to 0 ºC. $NaBH_4$ (1.0 equiv.) was added and the mixture was stirred for 1 h at 0 ºC. The reaction was quenched with 1 M HCl solution and extracted with EtOAc (3 x 20 mL). The combined organic layer was washed with brine (30 mL), dried with MgSO4 and concentrated *in vacuo*. The crude product was purified by flash chromatography on silica gel using EtOAc in hexane to provide the title compound.



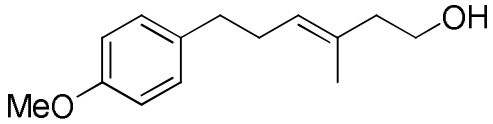
(*E*)-3-Methyl-6-phenylhex-3-en-1-ol (1a for Table 1)

Yield: 84%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.55 (s, 3H), 2.22 (t, *J* = 6.0 Hz, 2H), 2.36 (q, *J* = 7.2 Hz, 2H), 2.68 (t, *J* = 7.2 Hz, 2H), 3.58-3.63 (m, 2H), 5.27 (t, *J* = 7.2 Hz, 1H), 7.17-7.20 (m, 3H), 7.26-7.30 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.62, 29.88, 35.87, 42.66, 59.93, 125.86, 127.19, 128.32, 128.45, 132.04, 142.01. HRMS (ESI$^+$) exact mass calcd for $C_{13}H_{18}ONa$ $[M+Na]^+$ requires *m/z* 213.1255, found *m/z* 213.1260.



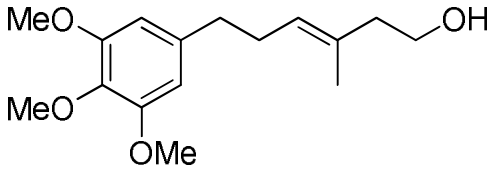
(*E*)-6-(2-Methoxyphenyl)-3-methylhex-3-en-1-ol (1b for Table 2)

Yield: 80%, colorless oil. H NMR (400 MHz, $CDCl_3$): d 1.53 (s, 3H), 2.20 (t, *J* = 6.1 Hz, 2H), 2.33 (q, *J* = 7.4 Hz, 2H), 2.67 (t, *J* = 7.6 Hz, 2H), 3.59 (t, *J* = 6.2 Hz, 2H), 3.81 (s, 3H), 5.29 (t, *J* = 7.2 Hz, 1H), 6.83 (d, *J* = 8.2 Hz, 1H), 6.87 (t, *J* = 7.4 Hz, 1H), 7.10 (d, *J* = 7.4 Hz, 1H), 7.17 (t, *J* = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.52, 28.26, 30.34, 42.66, 55.32, 59.96, 110.36, 120.38, 127.13, 127.66, 129.96, 130.40, 131.71, 157.51. HRMS (ESI$^+$) exact mass calcd for $C_{14}H_{20}O_2Na$ $[M+Na]^+$ requires *m/z* 243.1361, found *m/z* 243.1358.



(*E*)-6-(4-Methoxyphenyl)-3-methylhex-3-en-1-ol (1c for Table 2)

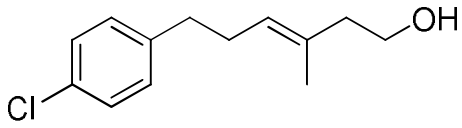
Yield: 87%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.55 (s, 3H), 2.22 (t, *J* = 6.2 Hz, 2H), 2.31 (q, *J* = 7.4 Hz, 2H), 2.61 (t, *J* = 7.6 Hz, 2H), 3.60 (t, *J* = 6.2 Hz, 2H), 3.78 (s, 3H), 5.26 (t, *J* = 7.1 Hz, 1H), 6.82 (d, *J* = 8.6 Hz, 2H), 7.09 (d, *J* = 8.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.68, 30.14, 34.97, 42.67, 55.26, 60.02, 113.72, 127.19, 129.31, 131.96, 134.12, 157.77. HRMS (ESI$^+$) exact mass calcd for $C_{14}H_{20}O_2Na$ $[M+Na]^+$ requires *m/z* 243.1361, found *m/z* 243.1364.



(*E*)-3-Methyl-6-(3,4,5-trimethoxyphenyl)hex-3-en-1-ol (1d for Table 2)

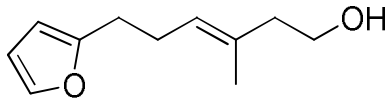
Yield: 88%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.59 (s, 3H), 2.24 (t, *J* = 6.2 Hz, 2H), 2.35 (q, *J* = 7.4 Hz, 2H), 2.61 (t, *J* = 7.6 Hz, 2H), 3.63 (t, *J* = 6.3 Hz, 2H), 3.82 (s, 3H), 3.85 (s, 6H), 5.27 (t, *J* = 6.5 Hz, 1H), 6.40 (s, 2H); ^{13}C NMR (100 MHz,

$CDCl_3$): d 15.79, 29.94, 36.29, 42.65, 56.05, 60.06, 60.85, 105.32, 126.86, 132.20, 136.11, 137.87, 153.05. HRMS (ESI^+) exact mass calcd for $C_{16}H_{24}O_4Na$ $[M+Na]^+$ requires *m/z* 303.1572, found *m/z* 303.1571.



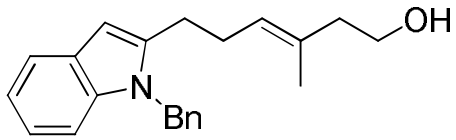
(*E*)-6-(4-Chlorophenyl)-3-methylhex-3-en-1-ol (1e for Table 2)

Yield: 79%, colorless oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.55 (s, 3H), 2.22 (t, *J* = 6.2 Hz, 2H), 2.32 (q, *J* = 7.3 Hz, 2H), 2.63 (t, *J* = 7.6 Hz, 2H), 3.62 (t, *J* = 6.2 Hz, 2H), 5.24 (t, *J* = 7.1 Hz, 1H), 7.10 (d, *J* = 8.4 Hz, 2H), 7.24 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.70, 29.77, 35.22, 42.63, 60.05, 126.61, 128.37, 129.80, 131.53, 132.44, 140.43. HRMS (ESI^+) exact mass calcd for $C_{13}H_{17}ClONa$ $[M+Na]^+$ requires *m/z* 247.0866, found *m/z* 247.0870.



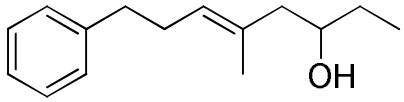
(*E*)-6-(Furan-2-yl)-3-methylhex-3-en-1-ol (1f for Table 2)

Yield: 76%, yellow oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.58 (s, 3H), 2.23 (t, *J* = 6.1 Hz, 2H), 2.38 (q, *J* = 7.3 Hz, 2H), 2.68 (t, *J* = 7.3 Hz, 2H), 3.62 (t, *J* = 6.1 Hz, 2H), 5.26 (t, *J* = 7.2 Hz, 1H), 5.98 (d, *J* = 2.7 Hz, 1H), 6.28 (dd, J_1 = 1.9 Hz, J_2 = 2.9 Hz, 1H), 7.30 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.51, 26.74, 28.00, 42.62, 59.87, 105.08, 110.14, 126.70, 132.47, 140.96, 155.80. HRMS (ESI^+) exact mass calcd for $C_{11}H_{16}O_2Na$ $[M+Na]^+$ requires *m/z* 203.1048, found *m/z* 203.1040.



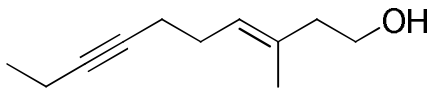
(*E*)-6-(1-Benzyl-1*H*-indol-2-yl)-3-methylhex-3-en-1-ol (1g for Table 2)

Yield: 83%, yellow oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.56 (s, 3H), 2.21 (t, *J* = 6.2 Hz, 2H), 2.44 (q, *J* = 7.3 Hz, 2H), 2.81 (t, *J* = 7.5 Hz, 2H), 3.59 (t, *J* = 6.2 Hz, 2H), 5.24 (s, 2H), 5.33 (t, *J* = 7.0 Hz, 1H), 6.88 (s, 1H), 7.08-7.11 (m, 3H), 7.15 (t, *J* = 7.6 Hz, 1H), 7.22-7.30 (m, 4H), 7.61 (d, *J* = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.83, 25.28, 28.85, 42.70, 49.85, 60.05, 109.67, 115.63, 118.90, 119.13, 121.72, 125.45, 126.84, 127.54, 127.93, 128.23, 128.75, 131.75, 136.76, 137.90. HRMS (ESI^+) exact mass calcd for $C_{22}H_{25}NONa$ $[M+Na]^+$ requires *m/z* 342.1834, found *m/z* 342.1845.



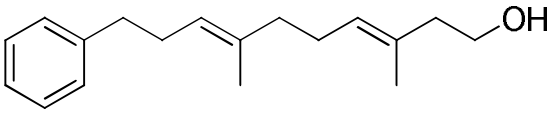
(*E*)-5-Methyl-8-phenyloct-5-en-3-ol (1i for Table 2)

The aldehyde was dissolved in 10 mL THF and cooled to 0 ºC. EtMgCl (1.2 equiv.) was added and the mixture was stirred for 1 h at 0 ºC. The reaction was quenched with 1 M HCl solution and extracted with EtOAc (3 x 20 mL). The combined organic layer was washed with brine (30 mL), dried with MgSO4 and concentrated *in vacuo*. The crude product was purified by flash chromatography on silica gel to provide the title compound. Yield: 75%, colorless oil. ^1H NMR (400 MHz, $CDCl_3$): d 0.87 (t, *J* = 7.5 Hz, 3H), 1.34-1.42 (m, 2H), 1.47 (s, 3H), 1.88 (dd, J_1 = 9.5 Hz, J_2 = 13.4 Hz, 1H), 2.10 (d, *J* = 13.4 Hz, 1H), 2.29 (q, *J* = 7.5 Hz, 2H), 2.54-2.64 (m, 2H), 3.43-3.49 (m, 1H), 5.19 (t, *J* = 7.1 Hz, 1H), 7.09-7.12 (m, 3H), 7.17-7.22 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 10.03, 16.02, 29.71, 29.89, 35.87, 47.55, 69.78, 125.88, 127.61, 128.34, 128.44, 132.92, 141.97. HRMS (ESI^+) exact mass calcd for $C_{15}H_{22}ONa$ $[M+H]^+$ requires *m/z* 241.1568, found *m/z* 241.1567.



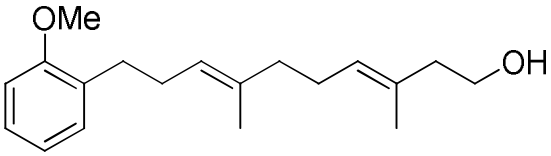
(*E*)-3-Methyldec-3-en-7-yn-1-ol (1h for Table 2)

Yield: 68%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.10 (t, *J* = 7.5 Hz, 3H), 1.66 (s, 3H), 2.12-2.18 (m, 2H), 2.21-2.23 (m, 4H), 2.27 (t, *J* = 6.1 Hz, 2H), 3.65 (t, *J* = 6.1 Hz, 2H), 5.28 (t, *J* = 6.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.35, 14.23, 15.78, 19.13, 27.56, 42.61, 59.76, 79.03, 82.04, 126.64, 132.61. HRMS (ESI$^+$) exact mass calcd for $C_{11}H_{18}ONa$ $[M+Na]^+$ requires *m/z* 189.1255, found *m/z* 189.1250.



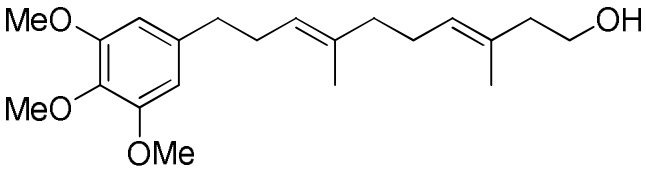
(3*E*,7*E*)-3,7-Dimethyl-10-phenyldeca-3,7-dien-1-ol (1j for Table 3)

Yield: 81%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.55 (s, 3H), 1.62 (s, 3H), 2.01 (t, *J* = 7.1 Hz, 2H), 2.12 (q, *J* = 7.3 Hz, 2H), 2.23 (t, *J* = 6.1 Hz, 2H), 2.30 (q, *J* = 7.3 Hz, 2H), 2.63 (t, *J* = 7.6 Hz, 2H), 3.63 (t, *J* = 6.2 Hz, 2H), 5.16-5.21 (m, 2H), 7.15-7.19 (m, 2H), 7.25-7.29 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.73, 15.88, 26.49, 29.95, 36.10, 39.56, 42.63, 59.93, 124.03, 125.69, 127.85, 128.23, 128.49, 131.22, 135.51, 142.36. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{26}ONa$ $[M+Na]^+$ requires *m/z* 281.1881, found *m/z* 281.1888.



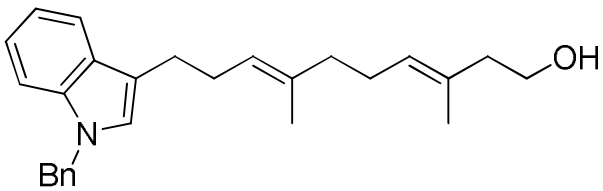
(3*E*,7*E*)-10-(2-Methoxyphenyl)-3,7-dimethyldeca-3,7-dien-1-ol (1k for Table 3)

Yield: 88%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.56 (s, 3H), 1.63 (s, 3H), 2.03 (t, *J* = 7.4 Hz, 2H), 2.12 (q, *J* = 7.3 Hz, 2H), 2.22-2.27 (m, 4H), 2.63 (t, *J* = 7.5 Hz, 2H), 3.64 (t, *J* = 6.0 Hz, 2H), 3.82 (s, 3H), 5.21 (t, *J* = 7.0 Hz, 2H), 6.84 (d, *J* = 8.2 Hz, 1H), 6.87 (t, *J* = 7.4 Hz, 1H), 7.12 (d, *J* = 7.4 Hz, 1H), 7.16 (t, *J* = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.74, 15.81, 26.56, 28.21, 30.54, 39.59, 42.67, 55.24, 59.96, 110.16, 120.29, 124.55, 126.93, 127.91, 129.86, 130.72, 131.18, 135.19, 157.51. HRMS (ESI$^+$) exact mass calcd for $C_{19}H_{28}O_2Na$ $[M+Na]^+$ requires *m/z* 311.1987, found *m/z* 311.1984.



(3*E*,7*E*)-3,7-Dimethyl-10-(3,4,5-trimethoxyphenyl)deca-3,7-dien-1-ol (1l for Table 3)

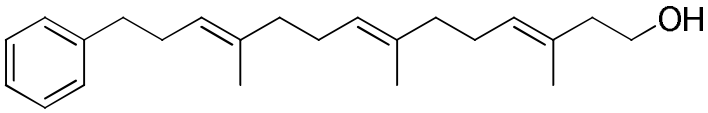
Yield: 86%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.57 (s, 3H), 1.62 (s, 3H), 2.01-2.05 (m, 2H), 2.11-2.16 (m, 2H), 2.23 (t, *J* = 6.2 Hz, 2H), 2.30 (q, *J* = 7.3 Hz, 2H), 2.57-2.61 (m, 2H), 3.63 (t, *J* = 6.2 Hz, 2H), 3.82 (s, 3H), 3.85 (s, 6H), 5.18 (t, *J* = 7.5 Hz, 2H), 6.41 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.70, 15.93, 26.41, 29.86, 36.39, 39.52, 42.62, 56.04, 59.90, 60.86, 105.31, 123.96, 127.65, 131.28, 135.56, 135.97, 138.17, 152.97. HRMS (ESI$^+$) exact mass calcd for $C_{21}H_{32}O_4Na$ $[M+Na]^+$ requires *m/z* 371.2198, found *m/z* 371.2201.



(3*E*,7*E*)-10-(1-Benzyl-1*H*-indol-3-yl)-3,7-dimethyldeca-3,7-dien-1-ol (1m for Table 3)

Yield: 79%, yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.50 (s, 3H), 1.60 (s, 3H), 1.97-2.00 (m, 2H), 2.06-2.10 (m, 2H), 2.22 (t, *J* = 6.1 Hz, 2H), 2.37 (q, *J* = 7.4 Hz, 2H), 2.81 (t, *J* = 7.4 Hz, 2H), 3.62 (t, *J* = 6.2 Hz, 2H), 5.19 (t, *J* = 7.1 Hz, 1H), 5.25 (t, *J* = 7.2 Hz, 1H), 5.36 (s, 2H), 7.05-7.09 (m, 2H), 7.10-7.15 (m, 3H), 7.18-7.28 (m, 4H), 7.54-7.57 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.71, 15.93, 24.45, 26.48, 28.39, 39.58, 42.64, 46.84, 59.91, 109.55, 111.99, 118.52, 121.85, 123.27, 124.10,

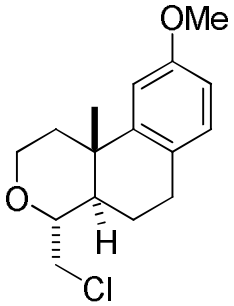
126.43, 127.01, 127.42, 127.97, 128.71, 131.17, 135.41, 135.59, 137.35. HRMS (ESI^+) exact mass calcd for $C_{27}H_{34}NO$ $[M+H]^+$ requires *m/z* 388.2640, found *m/z* 388.2642.



(3*E*,7*E*,11*E*)-3,7,11-Trimethyl-14-phenyltetradeca-3,7,11-trien-1-ol (1n for Table 3)

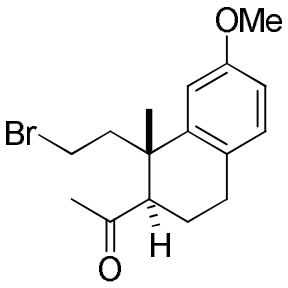
Yield: 83%, colorless oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.55 (s, 3H), 1.59 (s, 3H), 1.63 (s, 3H), 1.96-2.16 (m, 8H), 2.24 (t, *J* = 6.0 Hz, 2H), 2.30 (q, *J* = 7.6 Hz, 2H), 2.63 (t, *J* = 7.6 Hz, 2H), 3.64 (q, *J* = 6.0 Hz, 2H), 5.11 (t, *J* = 6.8 Hz, 1H), 5.17-5.23 (m, 2H), 7.18-7.20 (m, 3H), 7.25-7.29 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): d 15.69, 15.89, 15.98, 26.52, 26.61, 29.98, 36.16, 39.57, 39.67, 42.64, 59.84, 123.64, 124.67, 125.66, 127.98, 128.21, 128.47, 131.13, 134.70, 135.74, 142.43. HRMS (ESI^+) exact mass calcd for $C_{23}H_{34}ONa$ $[M+Na]^+$ requires *m/z* 349.2507, found *m/z* 349.2510.

4 Total Synthesis of (±)Moluccanic acid methyl ester



4-(Chloromethyl)-9-methoxy-10b-methyl-2,4,4a,5,6,10b-hexahydro-1*H*-benzo[*f*]isochromene (5 for Scheme 3)

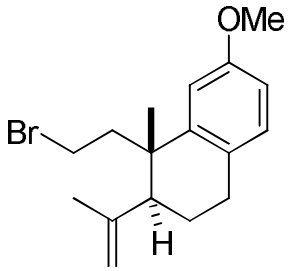
Yield: 64%, colorless oil. ^1H NMR (400 MHz, $CDCl_3$): d 1.23 (s, 3H), 1.55-1.61 (m, 1H), 1.73-1.80 (m, 1H), 1.83-1.89 (m, 1H), 1.93 (dd, J_1 = 5.0 Hz, J_2 = 12.8 Hz, 1H), 2.02 (d, *J* = 13.1 Hz, 1H), 2.86-2.90 (m, 2H), 3.64-3.70 (m, 2H), 3.79 (s, 3H), 3.78-3.84 (m, 1H), 3.91 (dt, J_1 = 2.5 Hz, J_2 = 12.3 Hz, 1H), 4.07 (ddd, J_1 = 1.6 Hz, J_2 = 5.0 Hz, J_3 = 11.9 Hz, 1H), 6.71 (dd, J_1 = 2.6 Hz, J_2 = 8.3 Hz, 1H), 6.74 (d, *J* = 2.6 Hz, 1H), 7.00 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 19.26, 21.65, 26.79, 35.30, 37.51, 42.40, 47.02, 55.30, 64.00, 75.52, 109.92, 111.14, 126.71, 130.03, 147.81, 157.79. HRMS (ESI^+) exact mass calcd for $C_{16}H_{21}ClO_2Na$ $[M+Na]^+$ requires *m/z* 303.1128, found *m/z* 303.1133.



1-(1-(2-Bromoethyl)-7-methoxy-1-methyl-1,2,3,4-tetrahydronaphthalen-2-yl)ethanone (6 for Scheme 3)

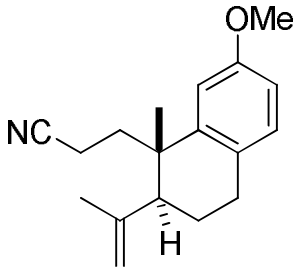
Prepared by the following procedure: To a round bottom flask equipped with a magnetic stir, sodium hydride (0.16 g, 60% dispersion in mineral oil, 4.0 mmol) was dissolved in N,N-dimethylformamide (5 mL). Aftering cooling to 0 ^oC, compound **5** (0.28 g, 1.0 mmol) was added slowly, the mixture was stirred for 10 h at 130 ^oC. Then the reaction mixture was poured into ice-water, extracted with diethyl ether (3 x 20 mL). The combined organic layer was washed with water (2 x 30 mL) and brine (30 mL), dried over Na_2SO_4, and concentrated *in vacuo*. The crude product was dissolved in 10 mL acetone and followed 2mL 40% HBr acetic solution was added. The reaction mixture was stirred for 1 h at room temperature. After that, the reaction mixture was poured into ice-water, extracted with diethyl ether (3 x 20 mL). The combined organic layer was washed with water (2 x 30 mL) and brine (30 mL), dried over Na_2SO_4, and concentrated *in vacuo*. The crude product was purified by flash

chromatography on silica gel using 5% EtOAc in hexane to provide the title compound as colorless oil. Yield: 55%. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.30 (s, 3H), 1.96-2.03 (m, 2H), 2.22 (s, 3H), 2.33-2.42 (m, 2H), 2.67-2.82 (m, 3H), 3.04 (ddd, J_1 = 5.5 Hz, J_2 = 9.7 Hz, J_3 = 11.3 Hz, 1H), 3.36 (J_1 = 6.1 Hz, J_2 = 9.7 Hz, J_3 = 10.7 Hz, 1H), 3.78 (s, 3H), 6.70 (dd, J_1 = 2.6 Hz, J_2 = 8.4 Hz, 1H), 6.78 (d, J = 2.5 Hz, 1H), 6.98 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 22.24, 27.09, 28.20, 29.70, 30.98, 41.55, 44.29, 53.62, 55.30, 111.29, 111.81, 127.97, 130.13, 142.76, 158.30, 210.84. HRMS (ESI$^+$) exact mass calcd for $C_{16}H_{22}BrO_2$ $[M+H]^+$ requires *m/z* 325.0803, found *m/z* 325.0797.



1-(2-Bromoethyl)-7-methoxy-1-methyl-2-(prop-1-en-2-yl)-1,2,3,4-tetrahydronaphthalene (7 for Scheme 3)

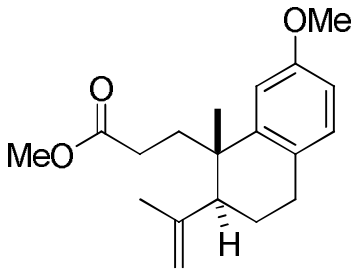
Prepared by the following procedure: To a round bottom flask equipped with a magnetic stir, compound **6** (240 mg, 0.74 mmol) and pyridine (0.06 mL, 0.22 mmol) were dissolved in toluene (6 mL) and cooled to -55 ^{o}C. Tebbe reagent (4.4 mL, 0.5M in toluene, 2.2 mmol) was added dropwisely and the reaction mixture was stirred for 1 h at -55 ^{o}C. Then the reaction mixture was quenched with Sat. $NaHCO_3$. The aqueous layer was extracted with EtOAc (3 x 20 mL). The combined organic layer was washed with Sat. $NaHCO_3$ (2 x 30 mL) and brine (30 mL), dried over Na_2SO_4 and concentrated under reduce pressure. The crude product was purified by flash chromatography on silica gel using 5% EtOAc in hexane to provide the title compound as colorless oil. Yield: 71%, colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.21 (s, 3H), 1.79 (s, 3H), 1.84-1.92 (m, 2H), 2.25-2.48 (m, 3H), 2.71-2.76 (m, 2H), 3.00 (ddd, J_1 = 5.1 Hz, J_2 = 9.6 Hz, J_3 = 12.0 Hz, 1H), 3.28 (J_1 = 4.9 Hz, J_2 = 9.6 Hz, J_3 = 12.6 Hz, 1H), 3.79 (s, 3H), 4.72 (s, 1H), 4.99 (s, 1H), 6.69 (dd, J_1 = 2.7 Hz, J_2 = 8.4 Hz, 1H), 6.81 (d, J = 2.5 Hz, 1H), 6.97 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 22.85, 24.63, 27.73, 29.04, 29.33, 42.85, 43.70, 47.41, 55.30, 111.52, 111.89, 114.62, 129.06, 130.05, 143.74, 146.35, 158.13. HRMS (ESI$^+$) exact mass calcd for $C_{17}H_{24}BrO_2$ $[M+H]^+$ requires *m/z* 323.1011, found *m/z* 323.1007.



3-(7-Methoxy-1-methyl-2-(prop-1-en-2-yl)-1,2,3,4-tetrahydronaphthalen-1-yl)propanenitrile (8 for Scheme 3)

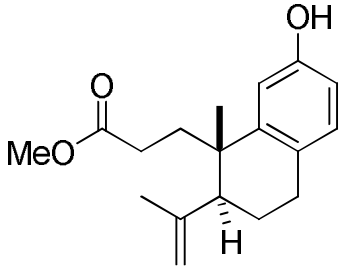
Prepared by the following procedure: To a round bottom flask equipped with a magnetic stir, sodium cyanide (47 mg, 0.96 mmol), 18-crown-6 (127 mg, 0.048 mmol) and compound **7** (155 mg, 0.48 mmol) were dissolved in acetonitrile (5 mL). The mixture was stirred at room temperature for 8 h. Then the reaction mixture was poured into water, extracted with diethyl ether (3 x 20 mL). The combined organic layer was washed with brine (2 x 30 mL), dried over Na_2SO_4, and concentrated *in vacuo.* The crude product was purified by flash chromatography on silica gel using 6% EtOAc in hexane to provide the title compound as colorless oil. Yield: 67%. ^{1}H NMR (400 MHz, $CDCl_3$): d 1.23 (s, 3H), 1.79 (s, 3H), 1.81-1.85 (m, 1H), 1.87-2.00 (m, 2H), 2.05-2.13 (m, 2H), 2.17-2.37 (m, 2H), 2.70-2.80 (m, 2H), 3.79 (s, 3H), 4.72 (s, 1H), 4.99 (s, 1H), 6.68-6.73 (m, 2H), 6.98 (d, J = 8.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 12.51, 22.50, 24.52, 27.54, 29.32, 35.42, 41.42, 47.08, 55.30, 111.70, 111.82, 114.93, 120.21, 129.38, 130.28, 142.94, 146.04, 158.26. HRMS (ESI$^+$) exact mass calcd for $C_{18}H_{23}NONa$

$[M+Na]^+$ requires *m/z* 292.1677, found *m/z* 292.1682.



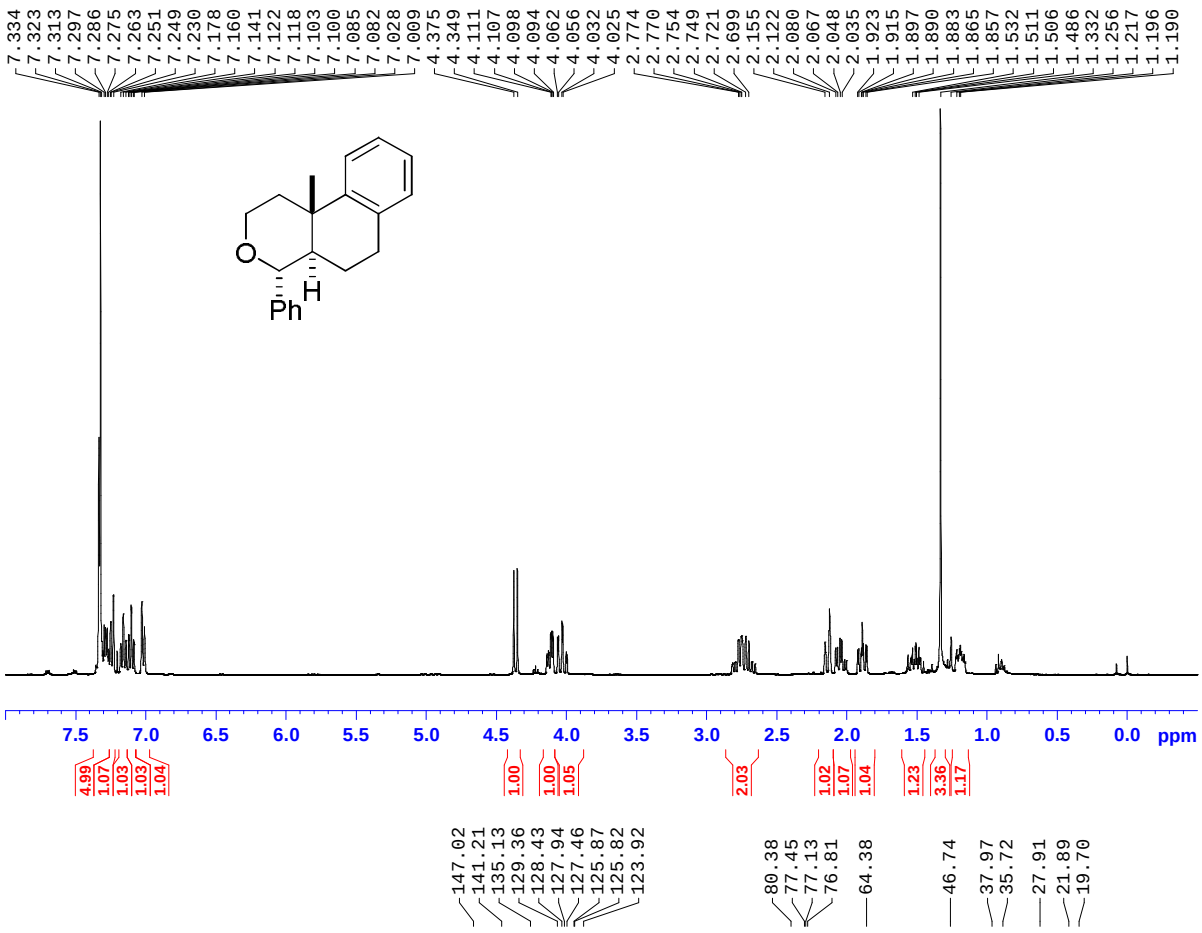
Methyl-3-(7-hydroxy-1-methyl-2-(prop-1-en-2-yl)-1,2,3,4-tetrahydronaphthalen-1-yl)propanoate (9 for Scheme 3)

Prepared by the following procedure: To a round bottom flask equipped with a magnetic stir, compound **8** (46 mg, 0.17 mmol) was dissolved in MeOH/H_2O (10 mL, MeOH/H_2O: 4/1). Then KOH (224 mg, 4 mmol) was added and the mixture was stirred overnight at 60 ^oC. The reaction mixture was poured into water and adjusted the pH value to 2 with 1M HCl, extracted with CH_2Cl_2 (3 x 20 mL). The combined organic layer was washed with brine (2 x 30 mL), dried over Na_2SO_4, and concentrated *in vacuo*. The crude product was dissolved in 5 mL THF, DCC (2.0 equiv.) and MeOH (0.1 mL) were added. The mixture was stirred for 10 h. The solvent was removed under reduce pressure and purified by flash chromatography on silica gel using 5% EtOAc in hexane to provide the title compound as colorless oil. Yield: 58% over two steps. ^1H NMR (400 MHz, $CDCl_3$): d 1.22 (s, 3H), 1.78 (s, 3H), 1.80-1.83 (m, 1H), 1.86-1.98 (m, 2H), 2.04-2.14 (m, 2H), 2.18-2.28 (m, 1H), 2.41 (dd, J_1 = 2.8 Hz, J_2 = 11.2 Hz, 1H), 2.72-2.75 (m, 2H), 3.60 (s, 3H), 3.78 (s, 3H), 4.70 (s, 1H), 4.95 (s, 1H), 6.67 (d, J = 8.4 Hz, 1H), 6.79 (s, 1H), 6.96 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 22.86, 24.74, 27.79, 29.43, 29.52, 34.67, 41.16, 47.12, 51.51, 55.24, 111.48, 111.89, 114.31, 129.30, 129.84, 144.40, 146.65, 158.00, 174.42. HRMS (ESI^+) exact mass calcd for $C_{19}H_{27}O_3$ $[M+H]^+$ requires *m/z* 303.1960, found *m/z* 303.1964.



(±)Moluccanic acid methyl ester (10 for Scheme 3)

Prepared by the following procedure: To a round bottom flask equipped with a magnetic stir, compound **9** (22.2 mg, 0.074 mmol) and tetra-butyl ammonium iodide (35.5 mg, 0.096 mmol) were dissolved in 5 mL CH_2Cl_2. Then BCl_3 (0.19 mL, 1.0 M in CH_2Cl_2, 0.19 mmol) was added to the mixture slowly at 0 ^oC. After 2 h, the reaction mixture was poured into sat. $NaHCO_3$, extracted with CH_2Cl_2 (3 x 20 mL). The combined organic layer was washed with brine (2 x 30 mL), dried over Na_2SO_4, and concentrated *in vacuo.* The crude product was purified by flash chromatography on silica gel using 5% EtOAc in hexane to provide the title compound as colorless oil. Yield: 71%. ^1H NMR (400 MHz, $CDCl_3$): d 1.21 (s, 3H), 1.78 (s, 3H), 1.80-1.83 (m, 1H), 1.84-1.99 (m, 2H), 2.00-2.16 (m, 2H), 2.21-2.29 (m, 1H), 2.40 (dd, J_1 = 3.1 Hz, J_2 = 11.3 Hz, 1H), 2.70-2.75 (m, 2H), 3.61 (s, 3H), 4.70 (s, 1H), 4.82 (brs, 1H), 4.95 (s, 1H), 6.67 (d, J = 8.4 Hz, 1H), 6.79 (s, 1H), 6.96 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): d 22.84, 24.74, 27.79, 29.46, 29.50, 34.64, 41.06, 47.05, 51.58, 112.92, 113.25, 114.34, 129.29, 130.12, 144.61, 146.61, 153.90, 174.60. HRMS (ESI^+) exact mass calcd for $C_{18}H_{25}O_3$ $[M+H]^+$ requires *m/z* 289.1804, found *m/z* 289.1805.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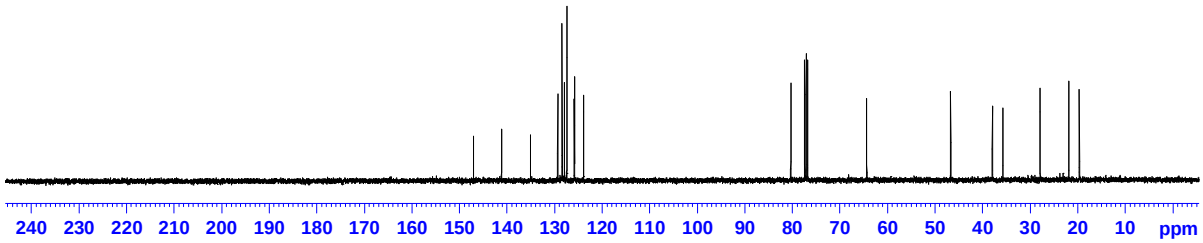
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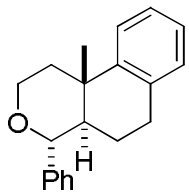
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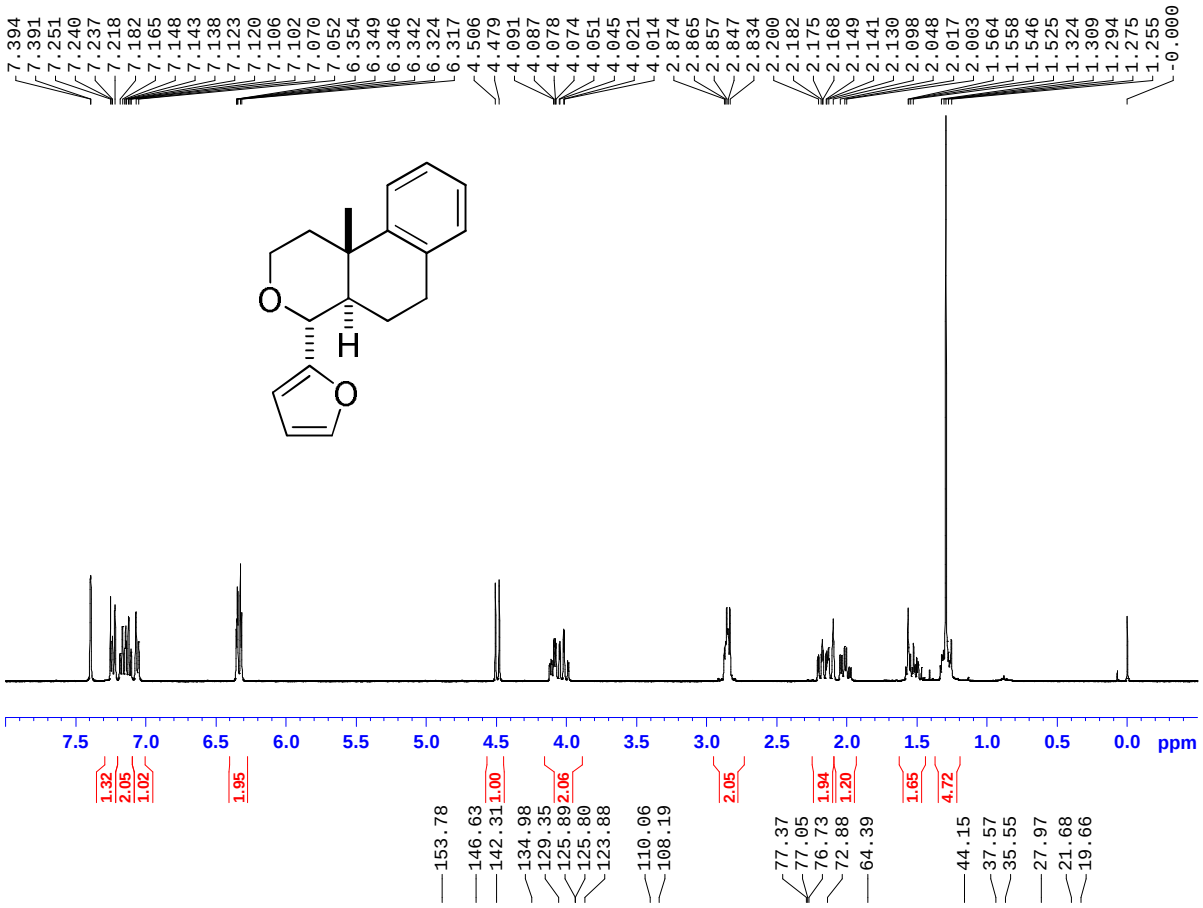
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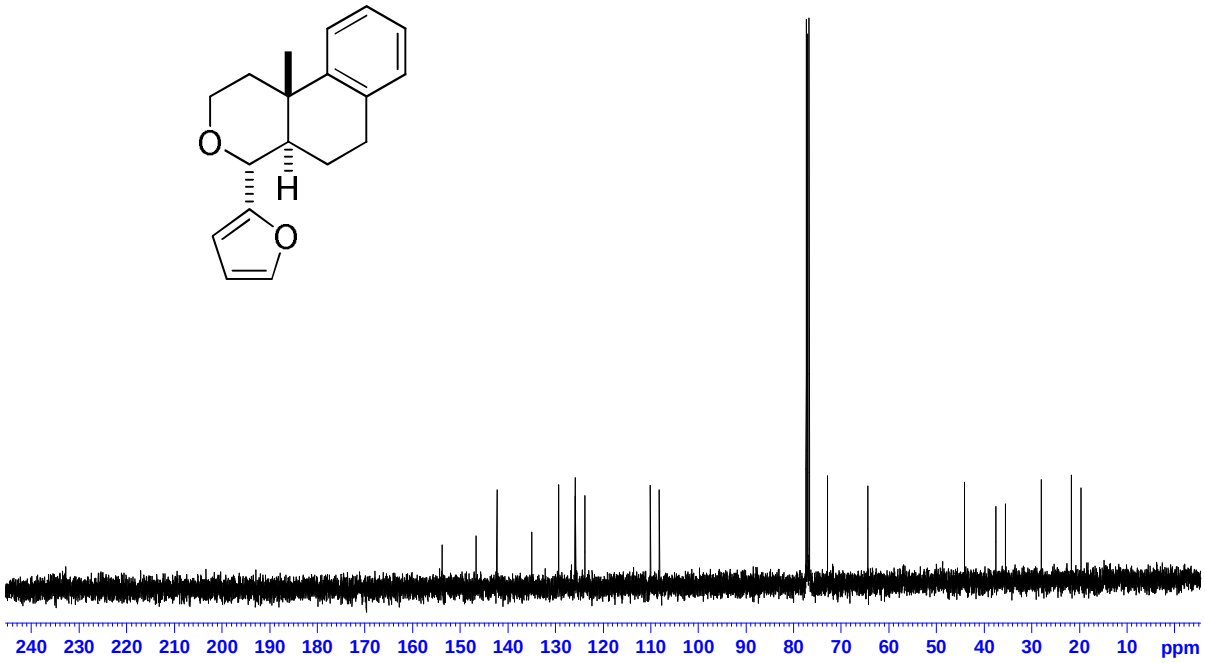
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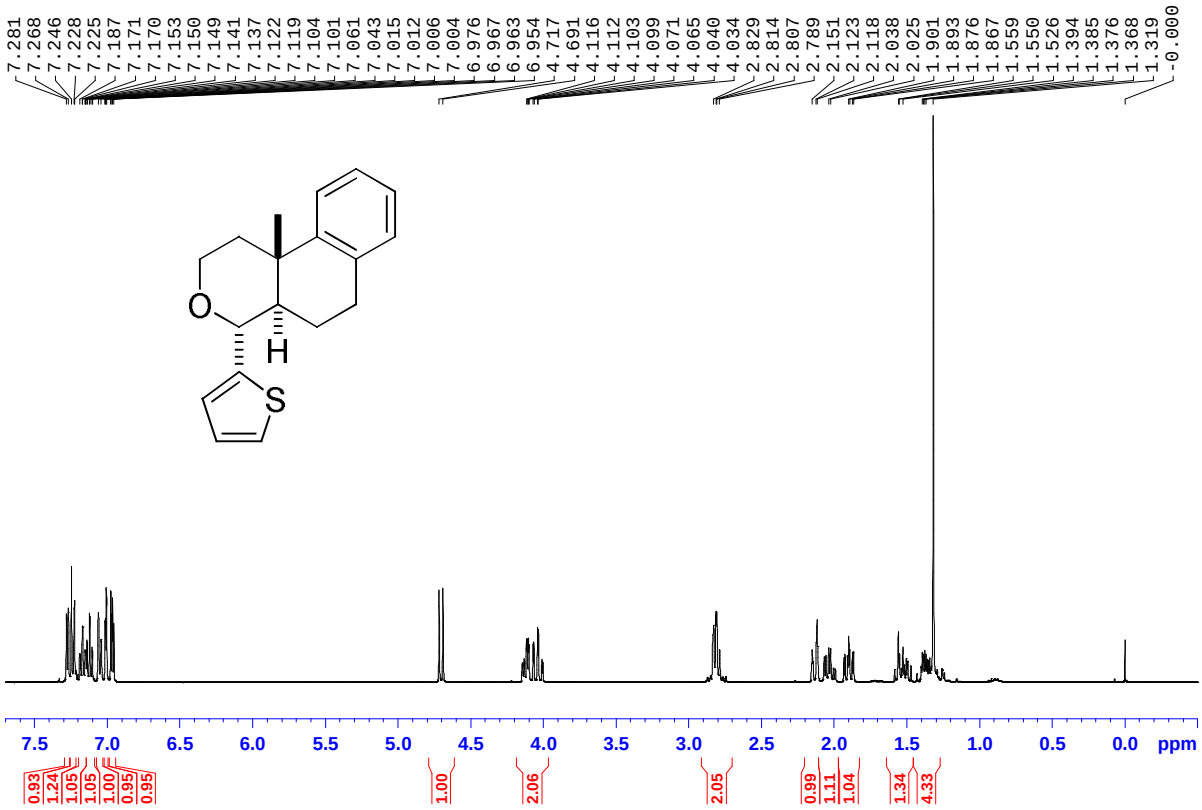
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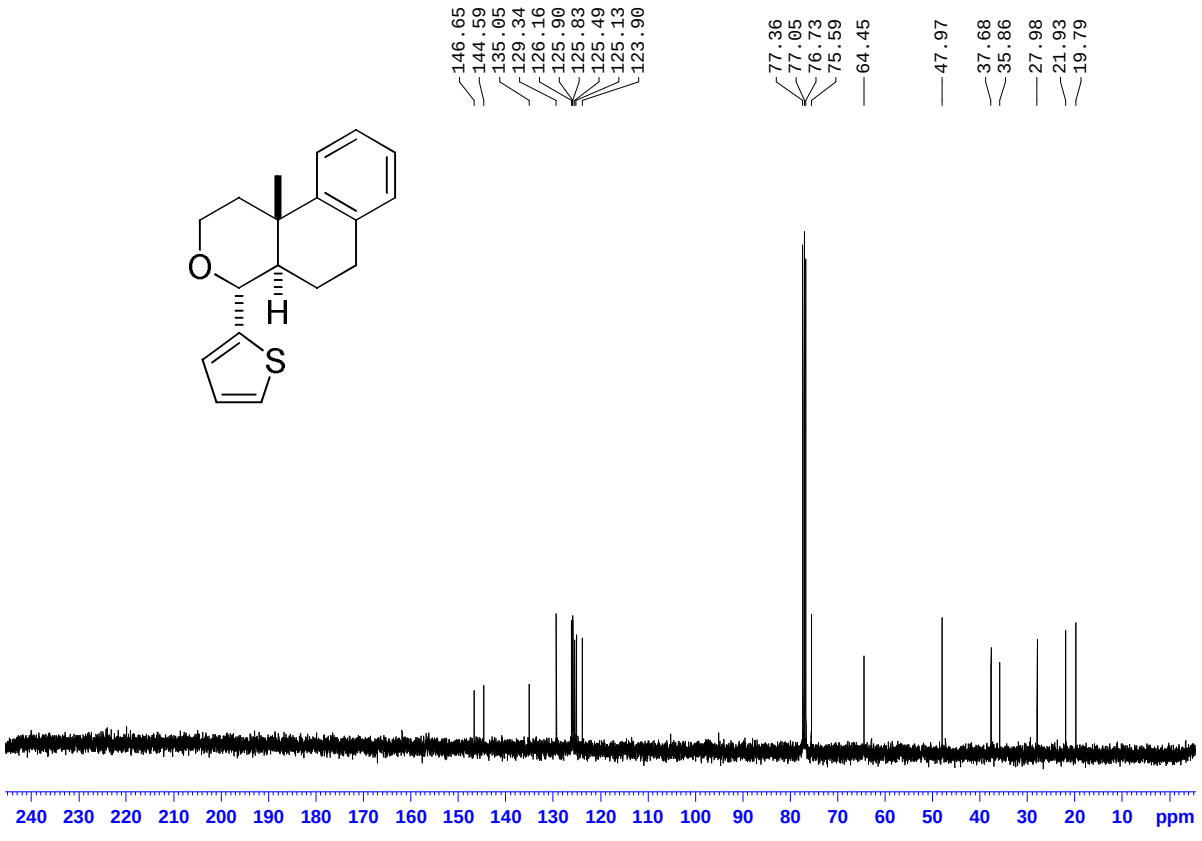
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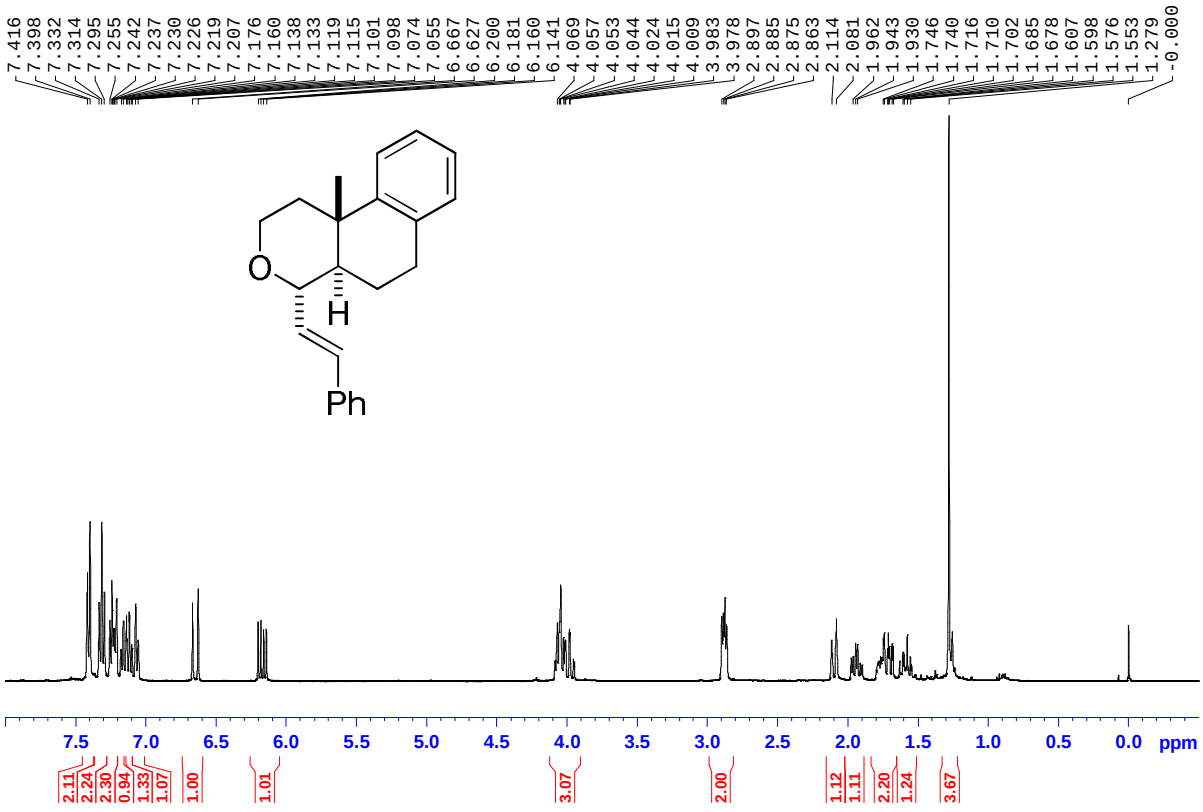
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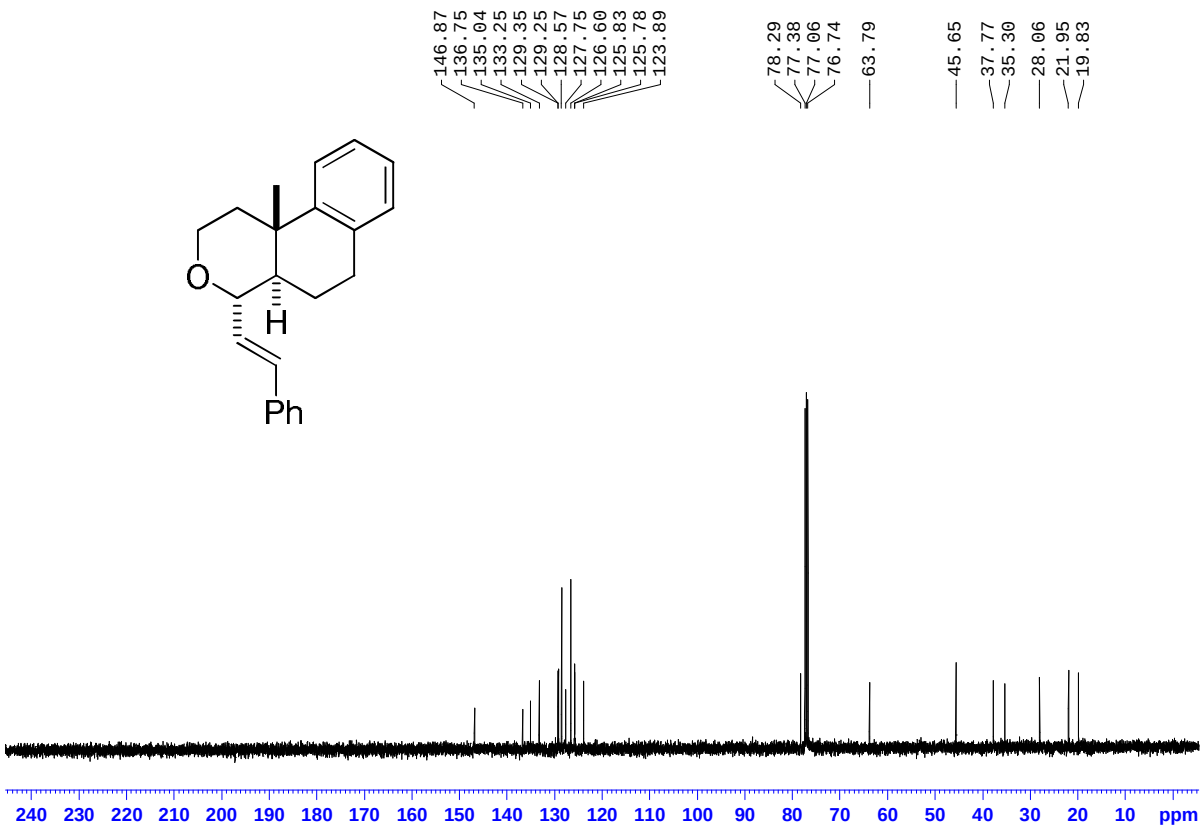
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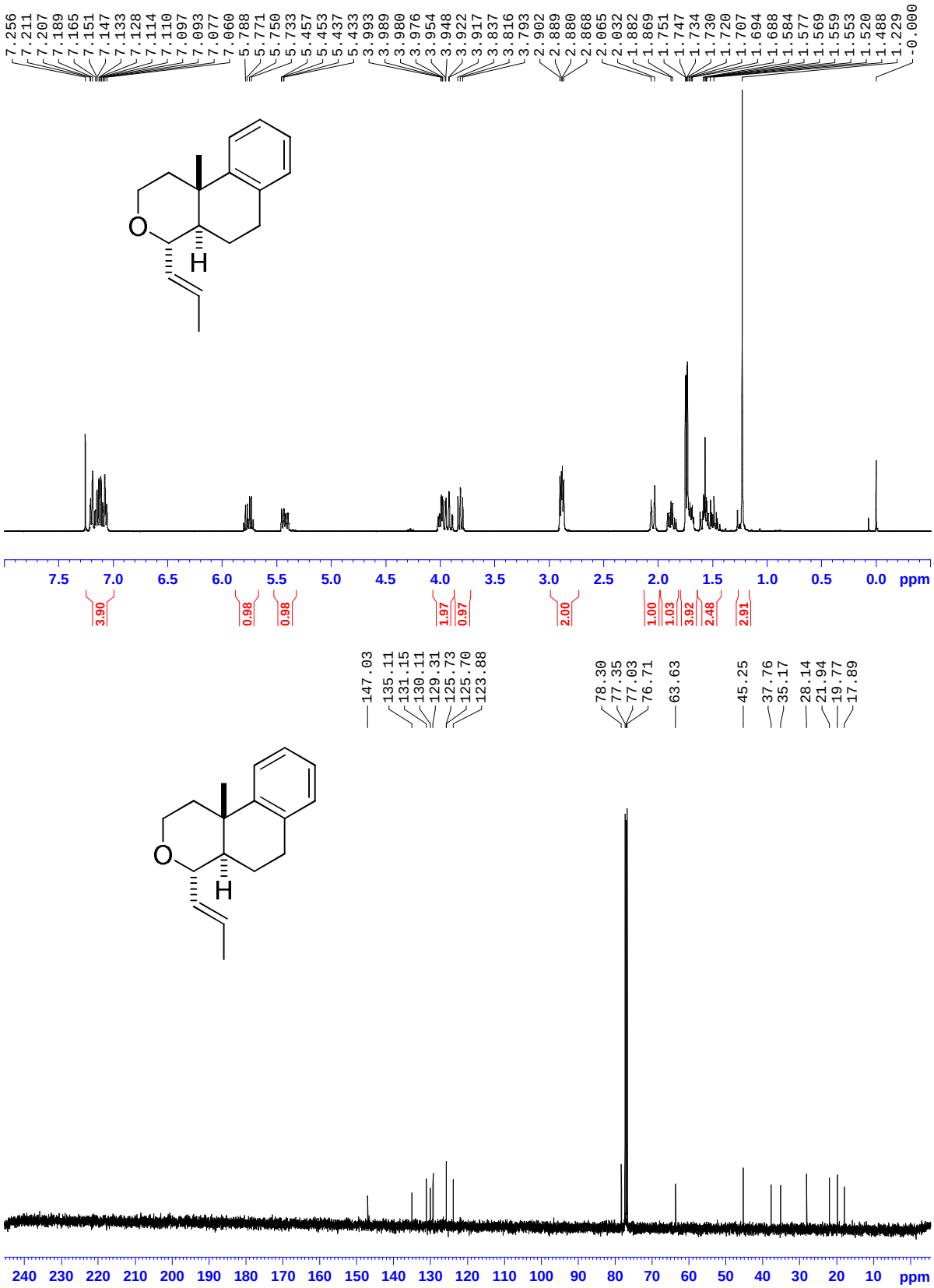
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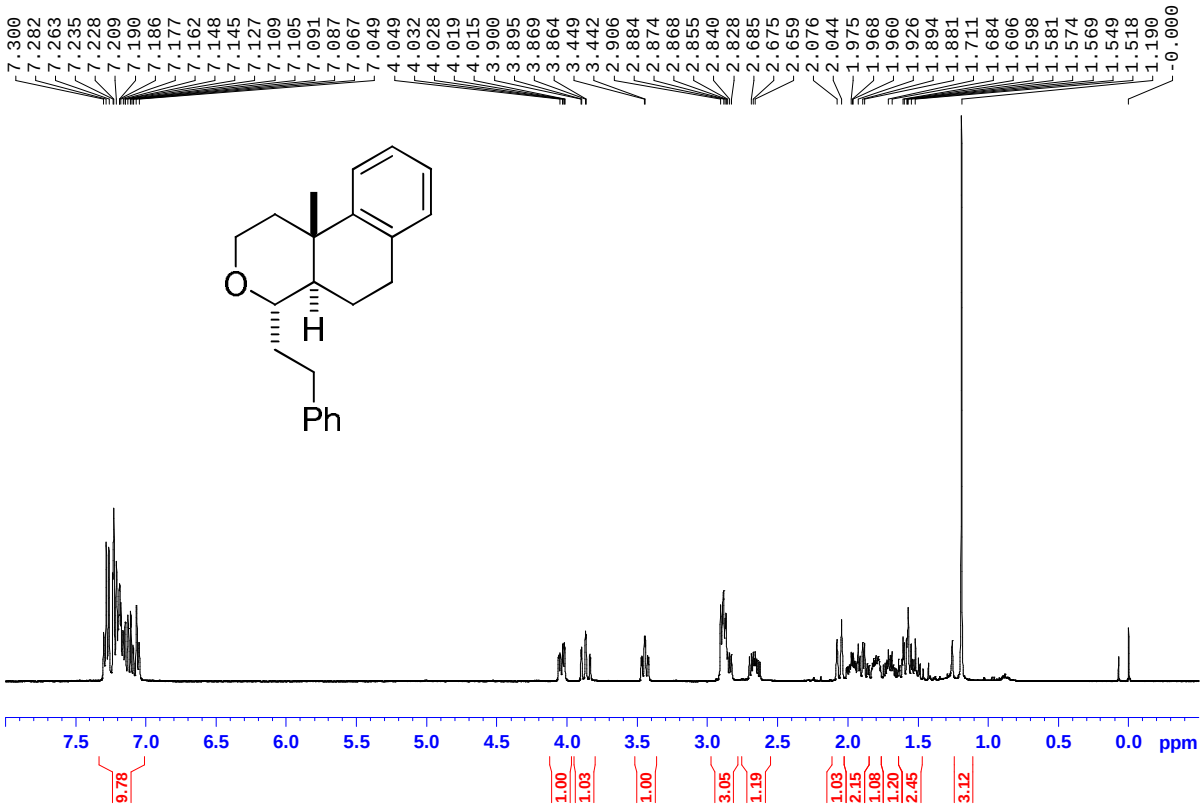
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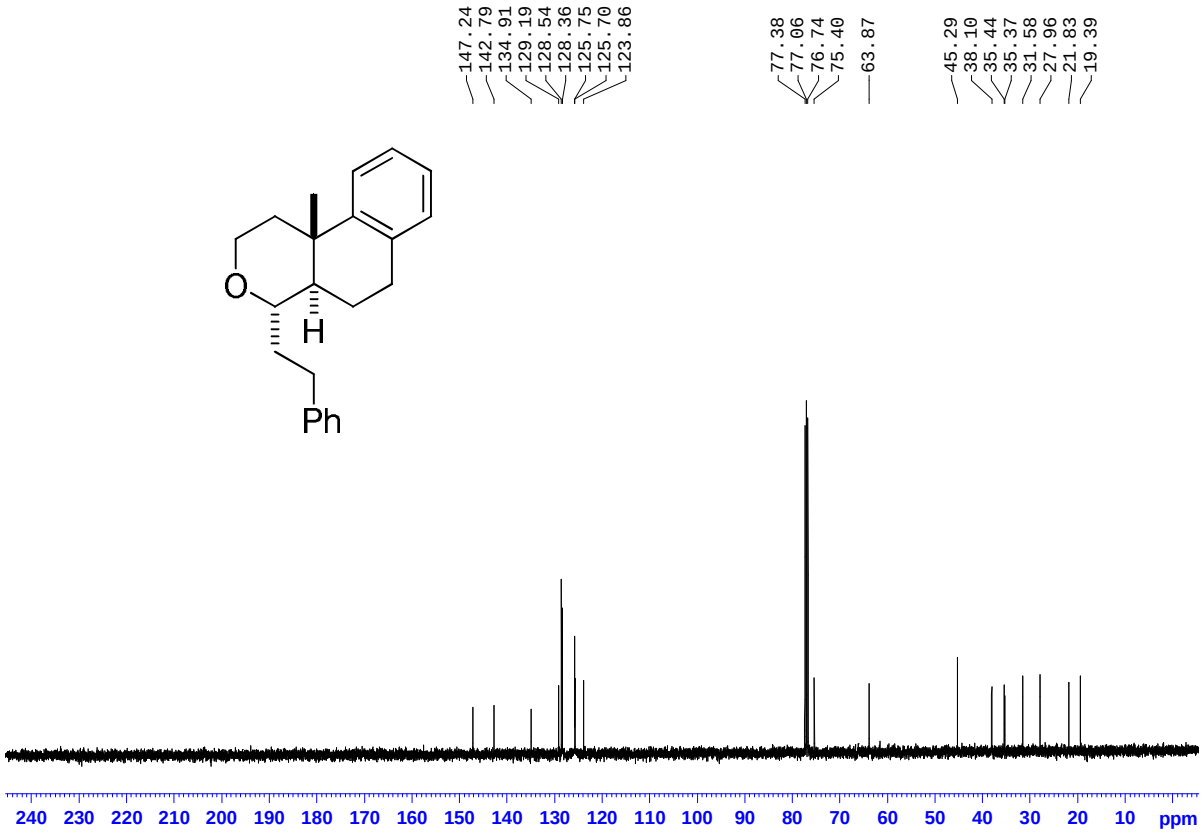
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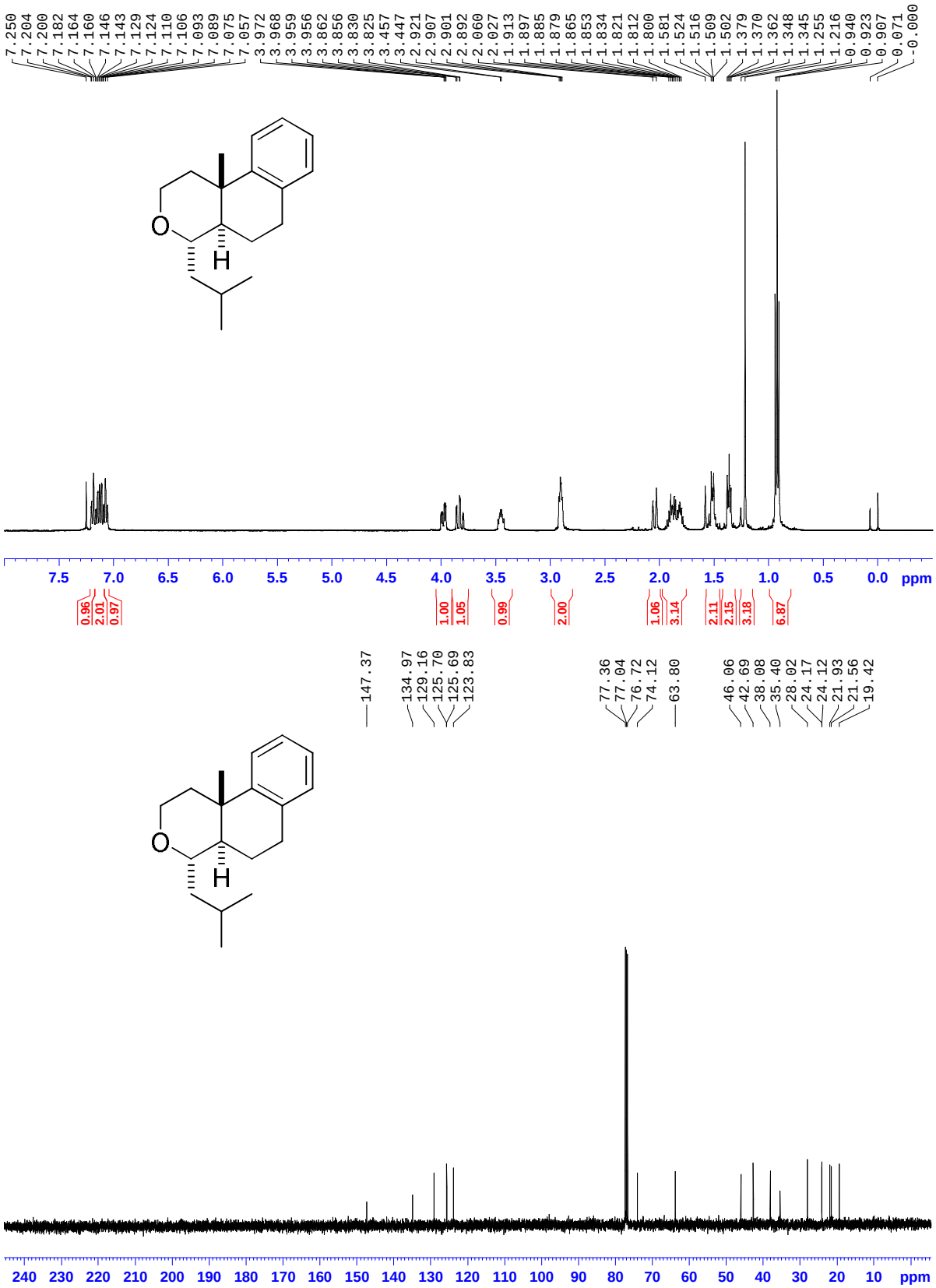
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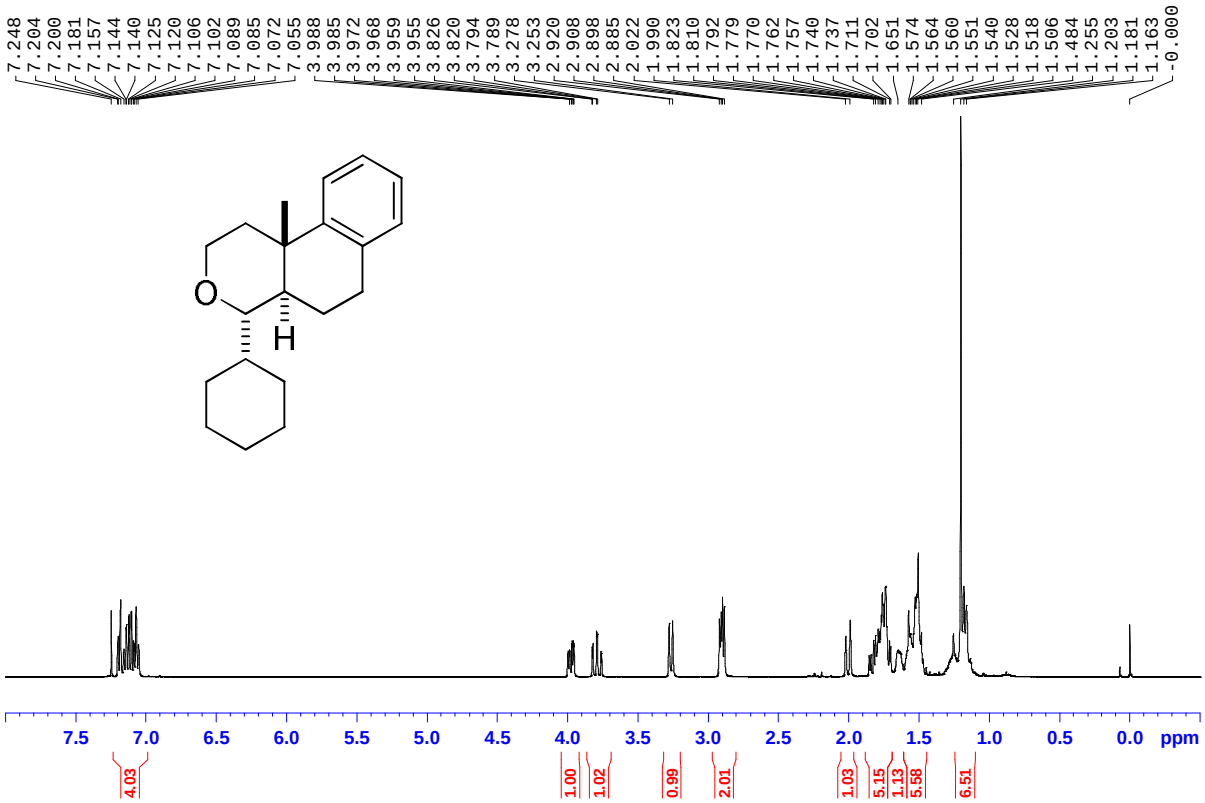
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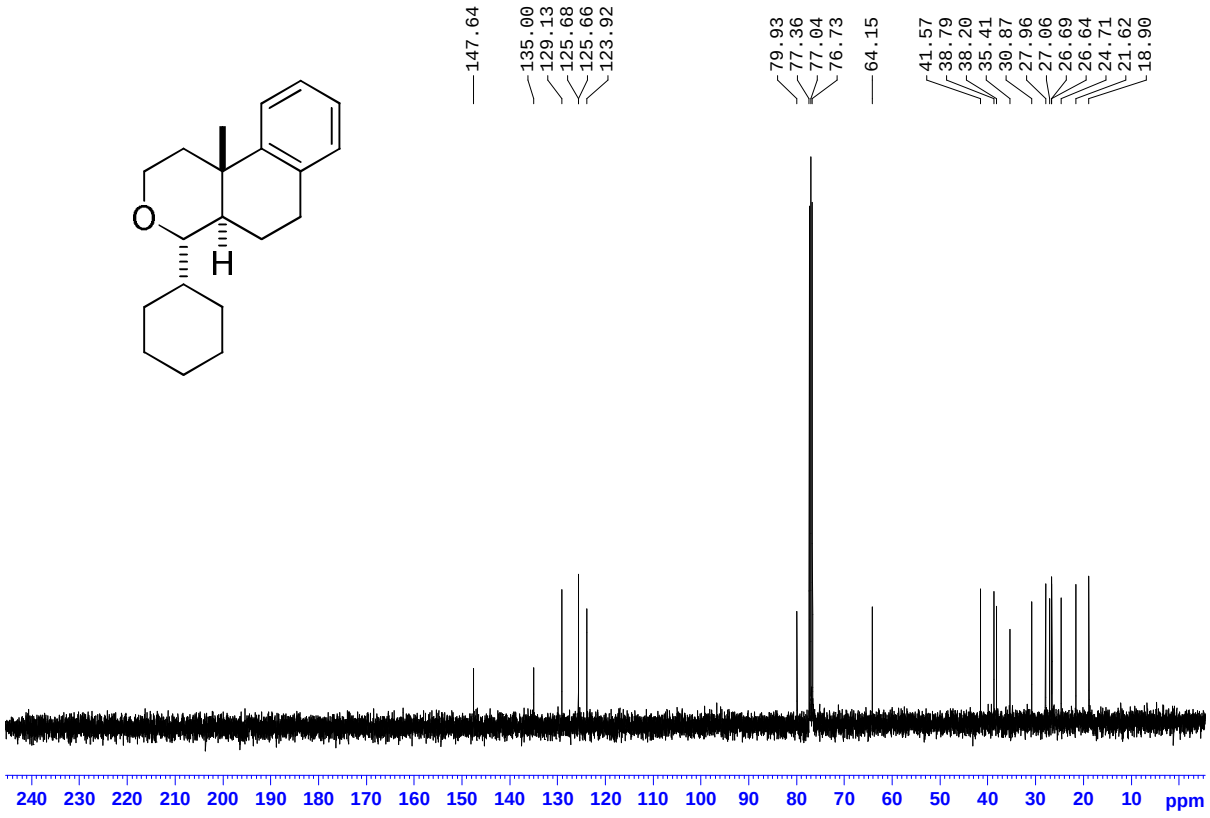
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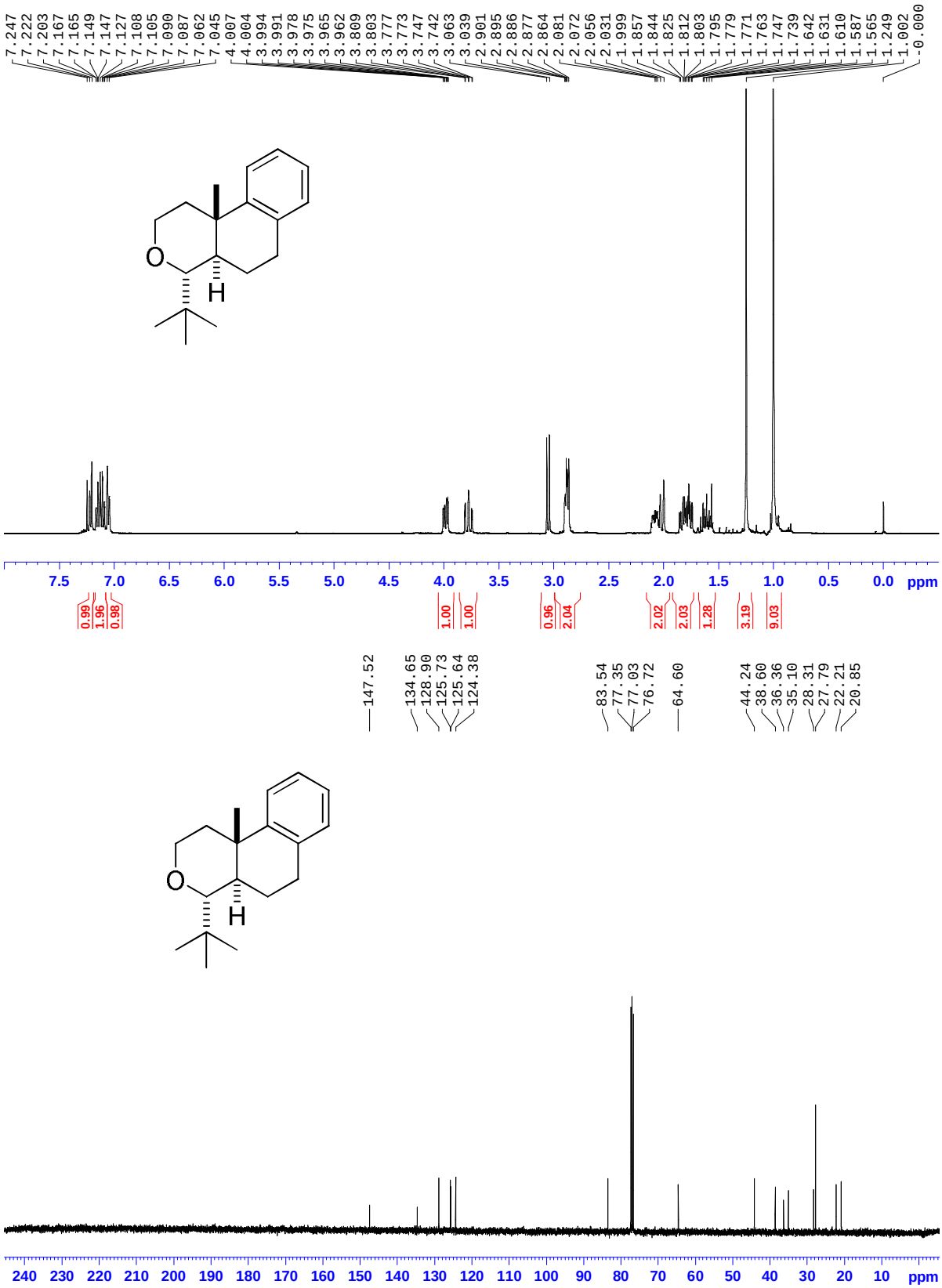
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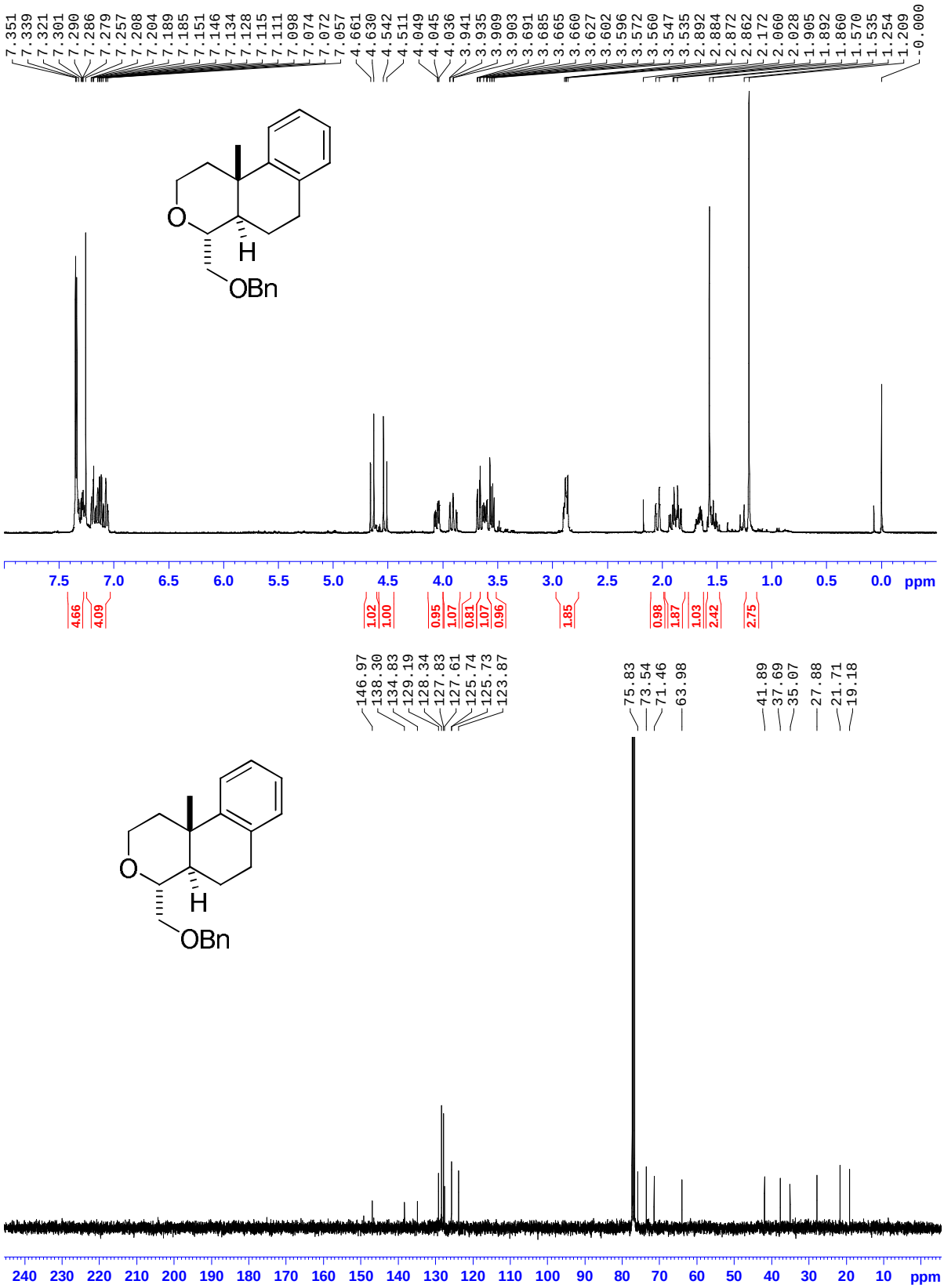
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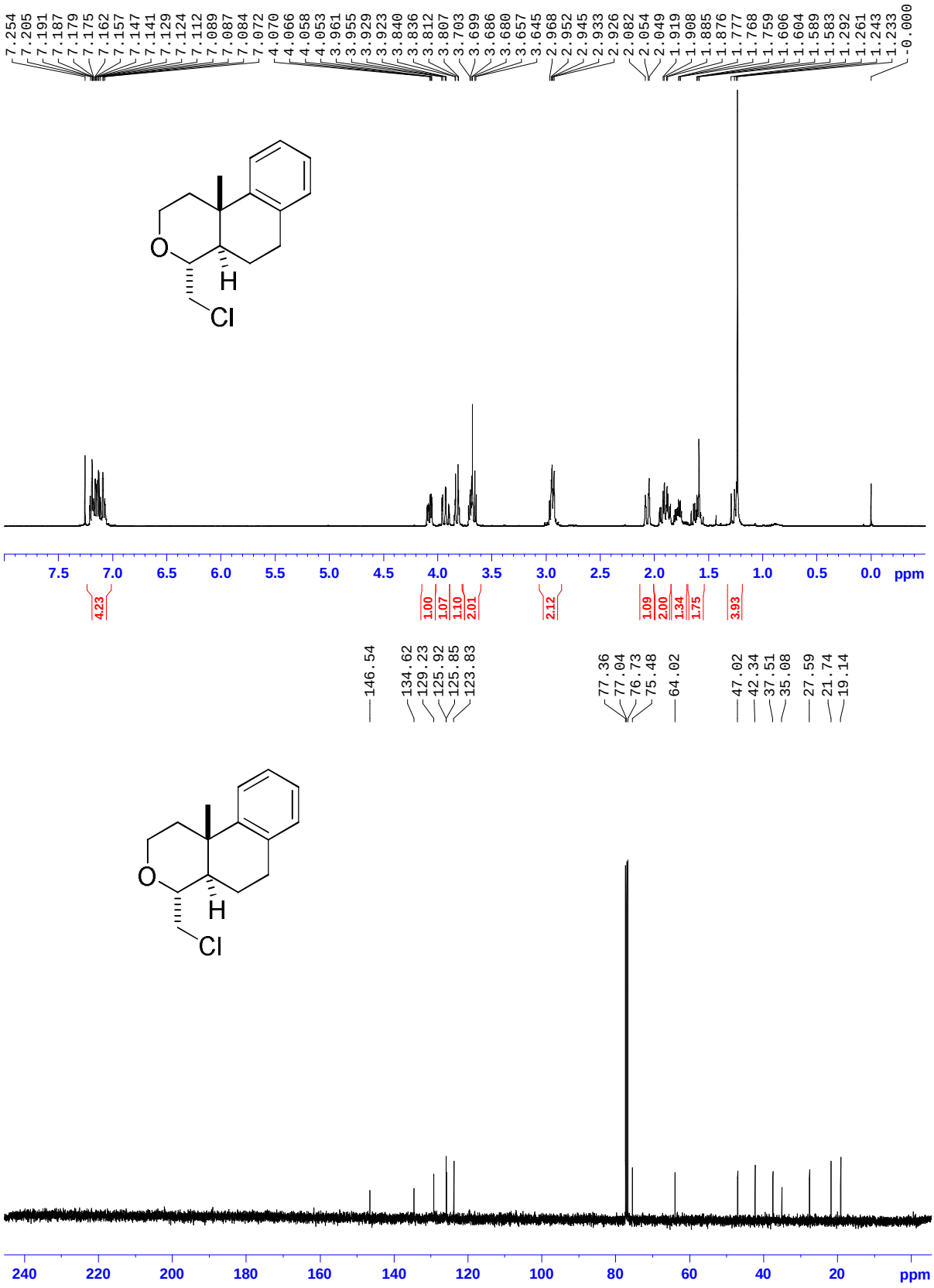
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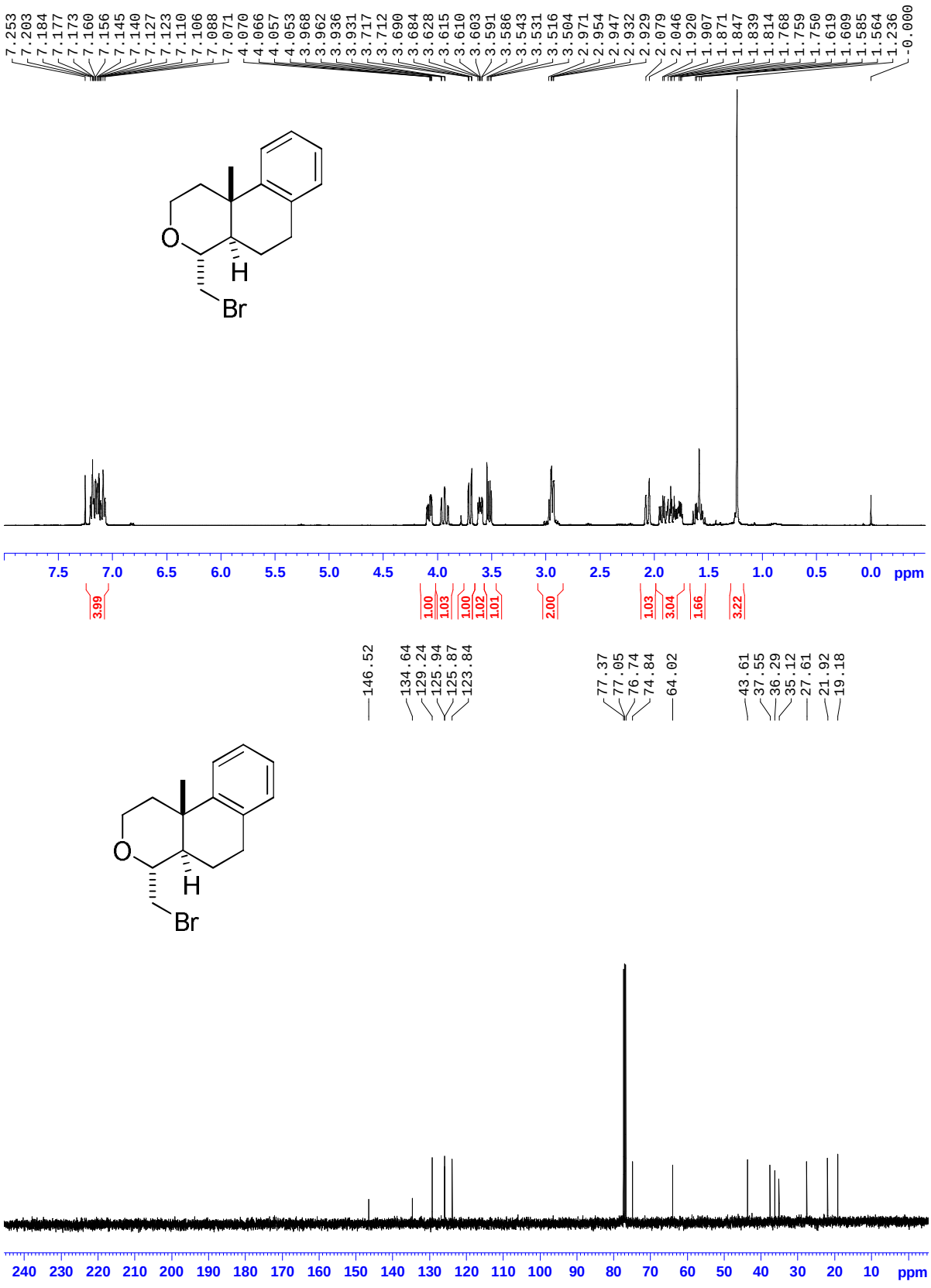
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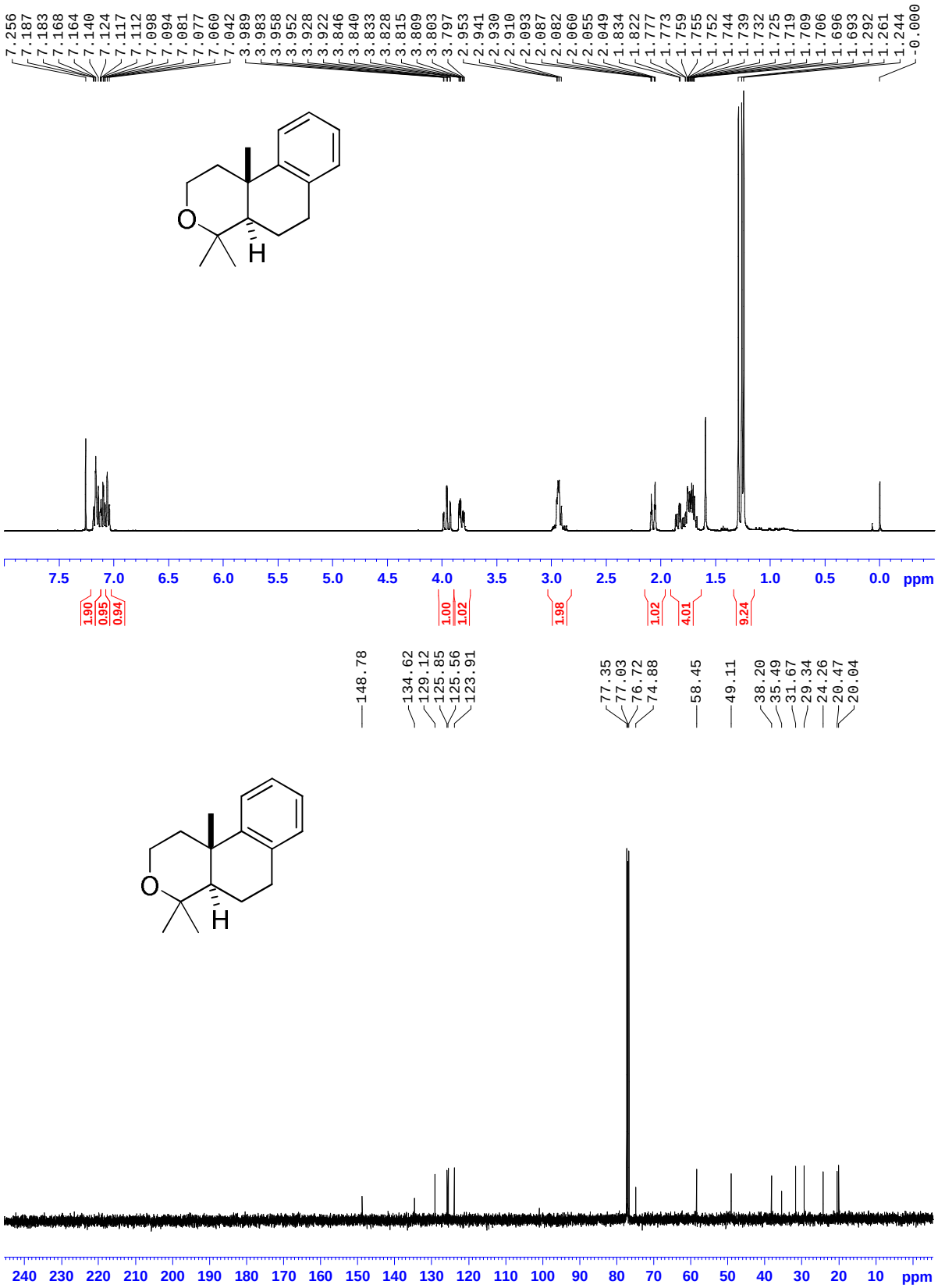
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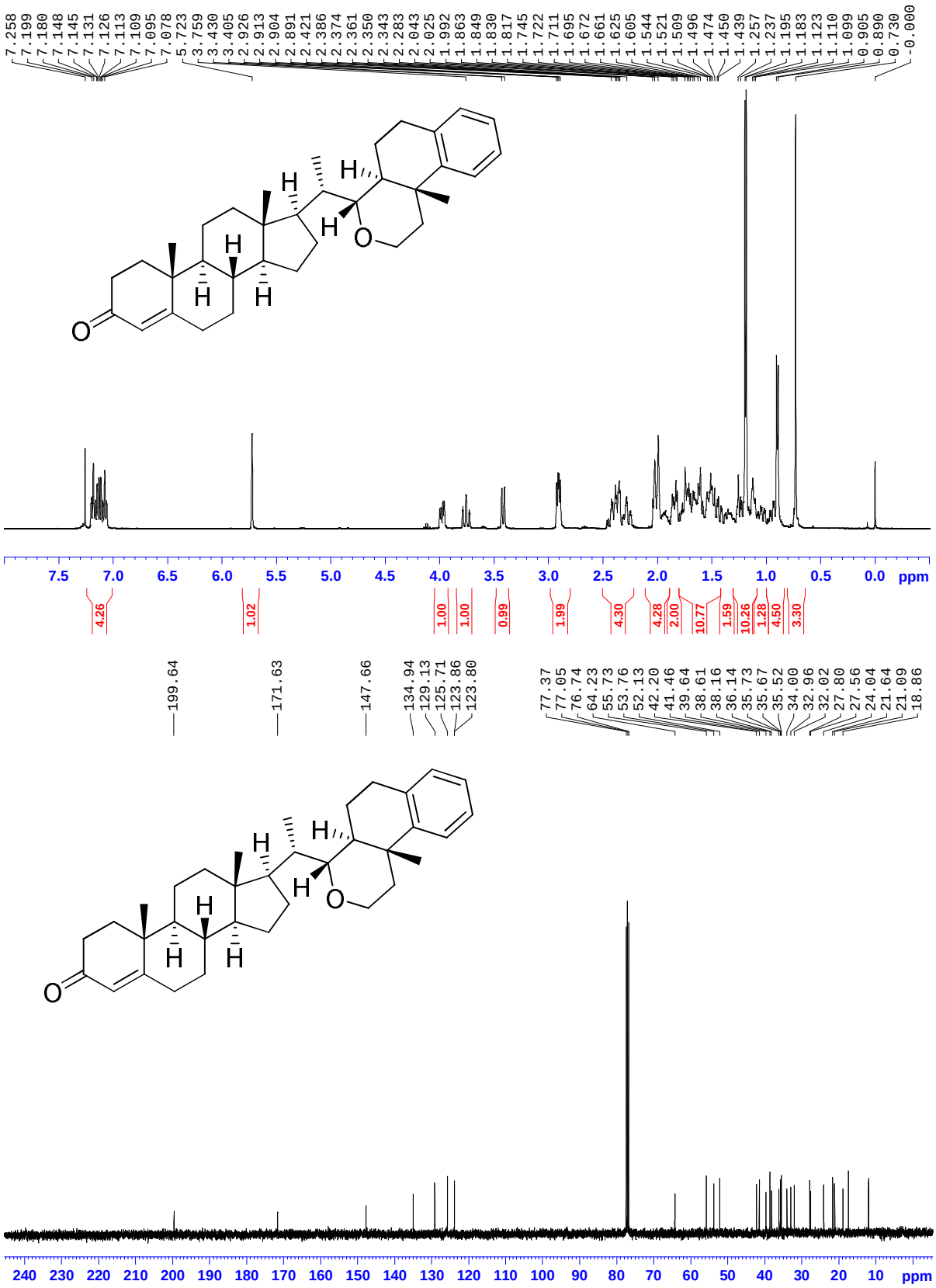
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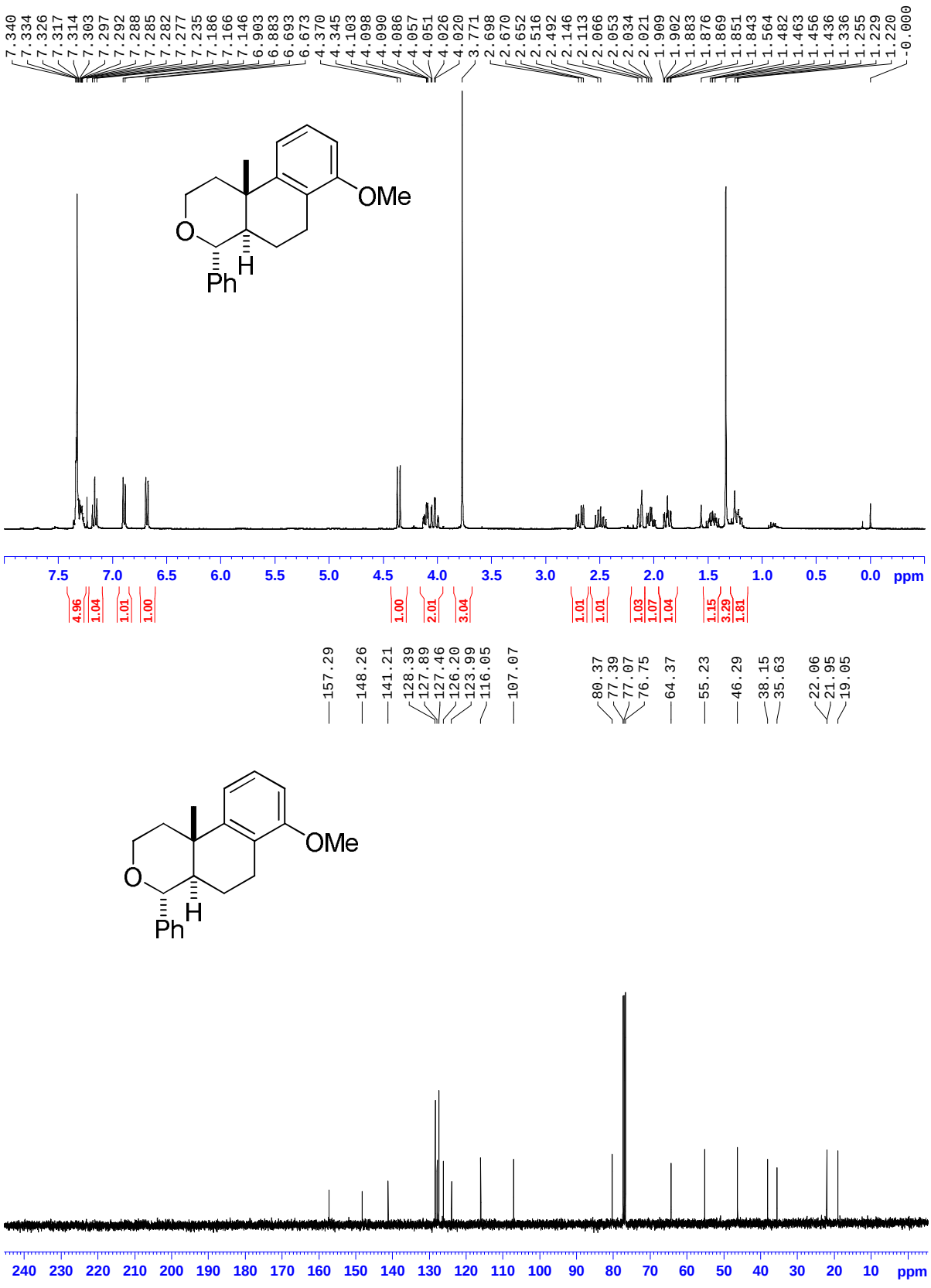
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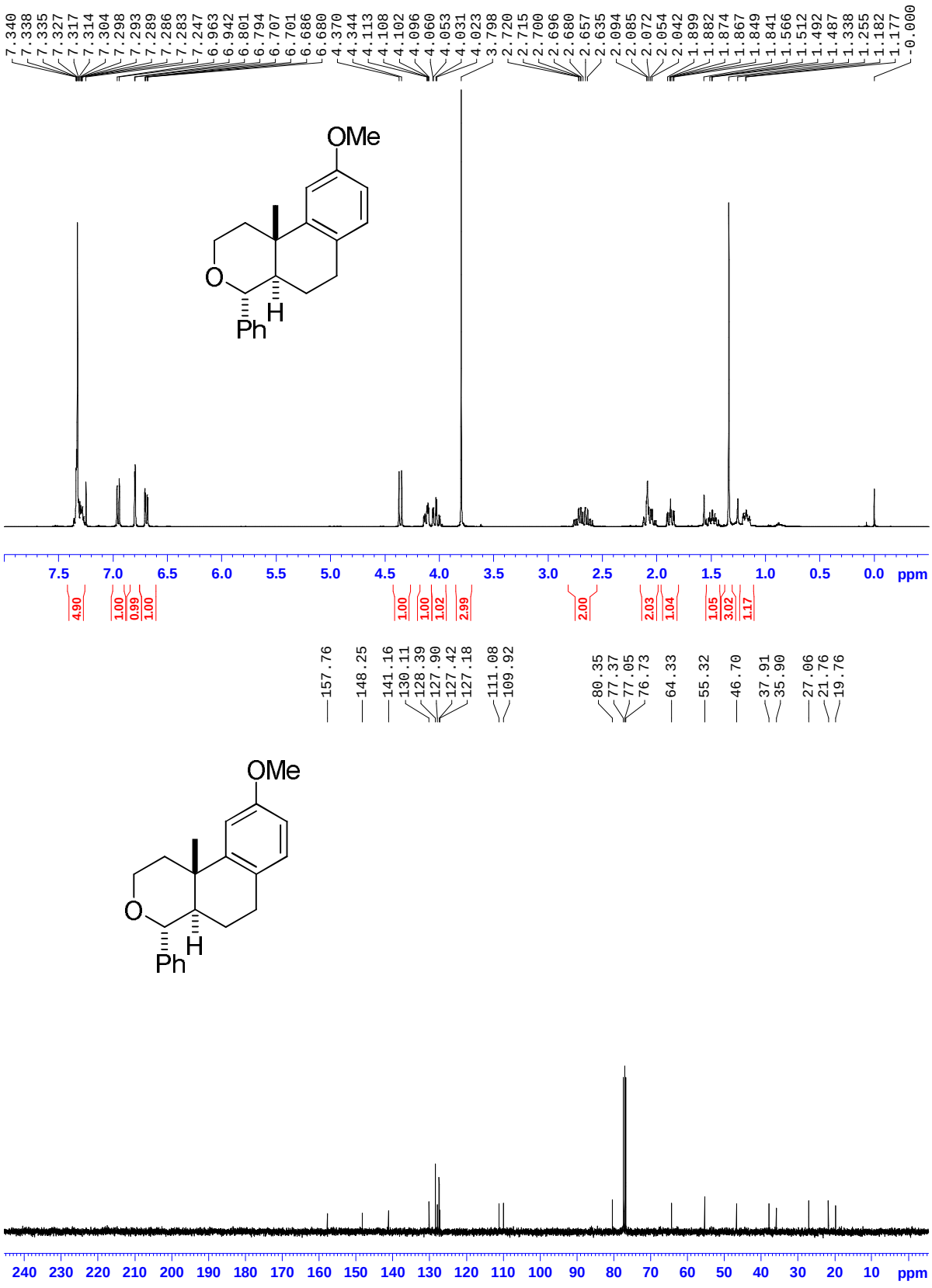
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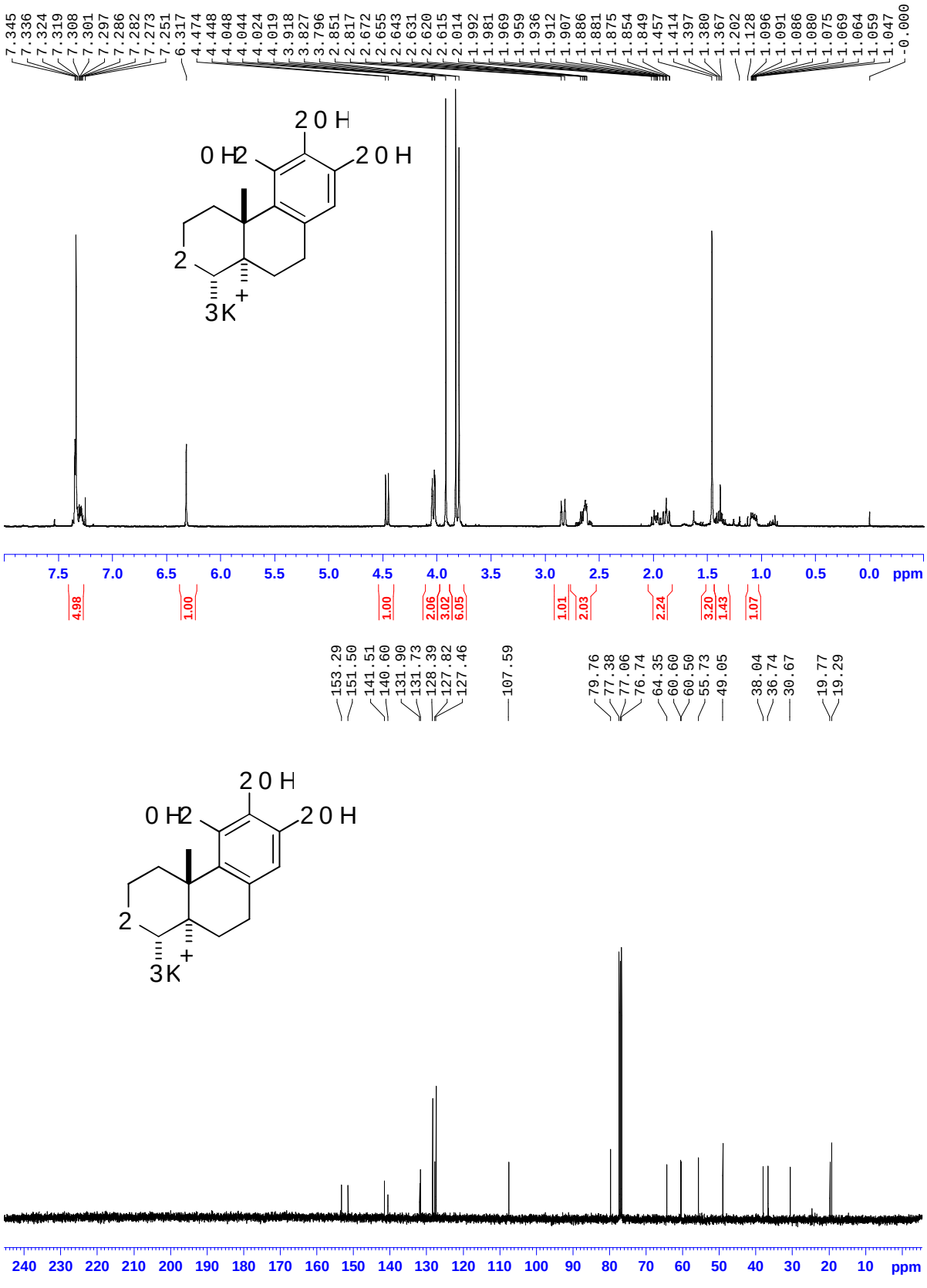
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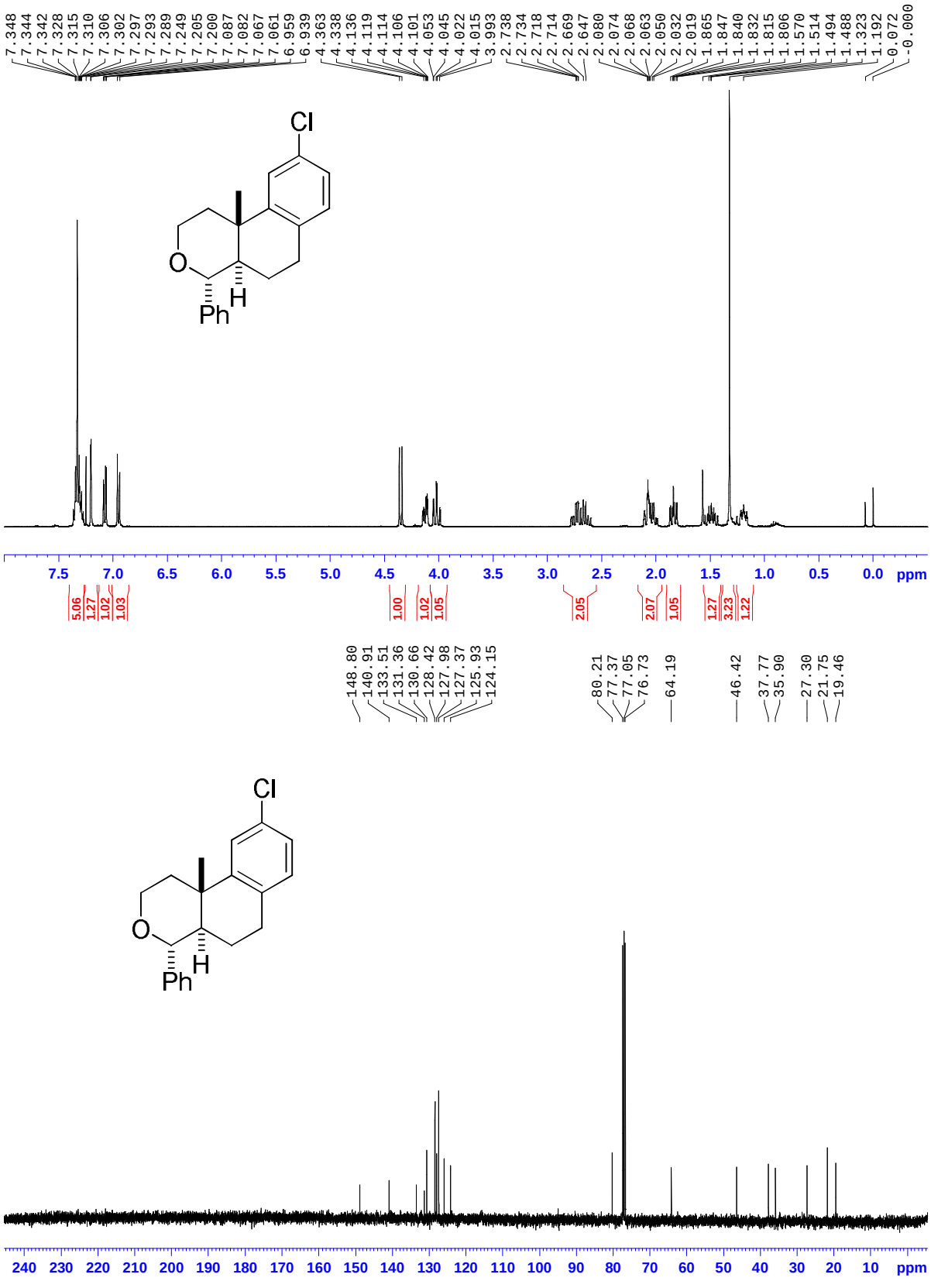
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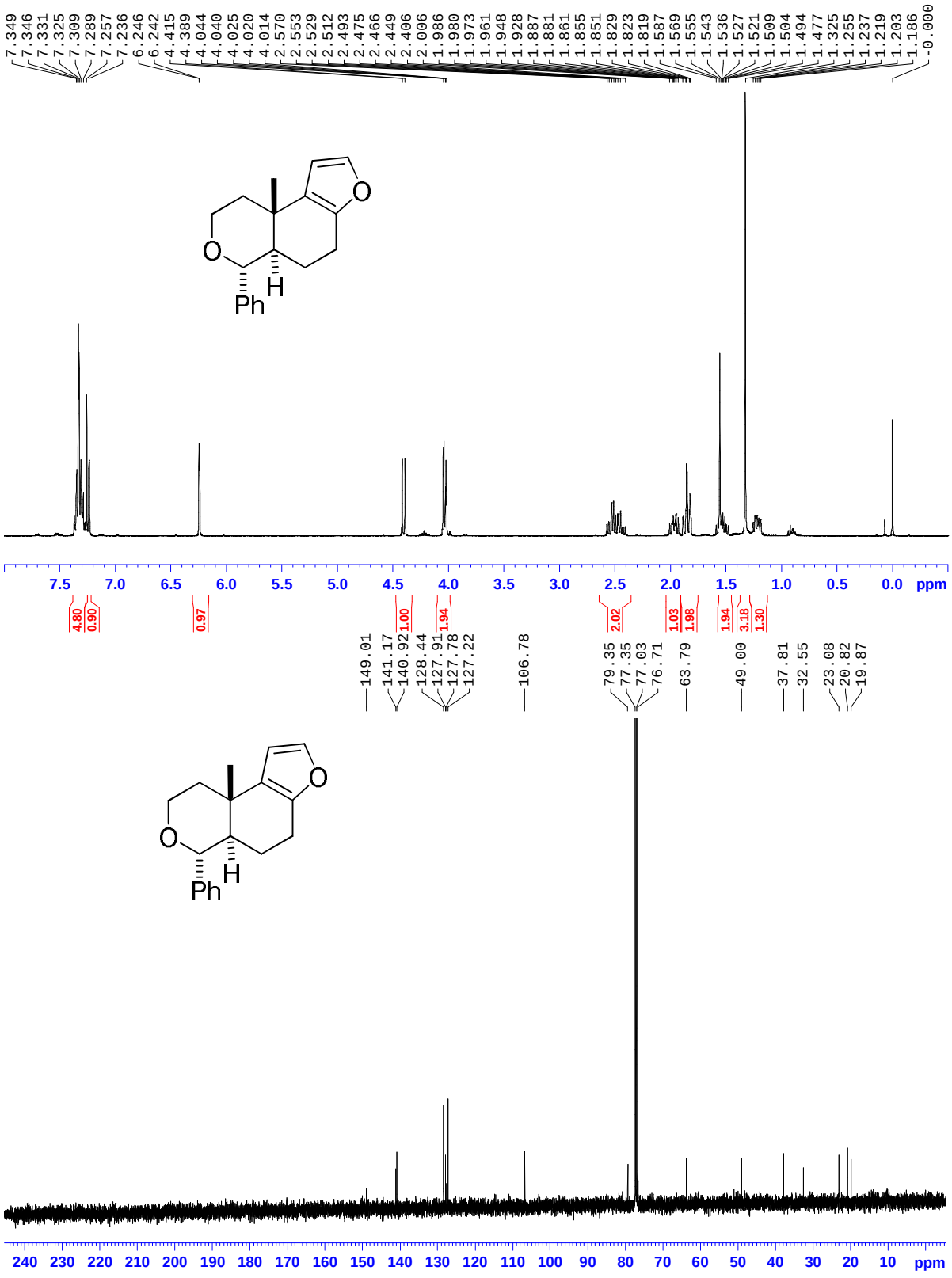
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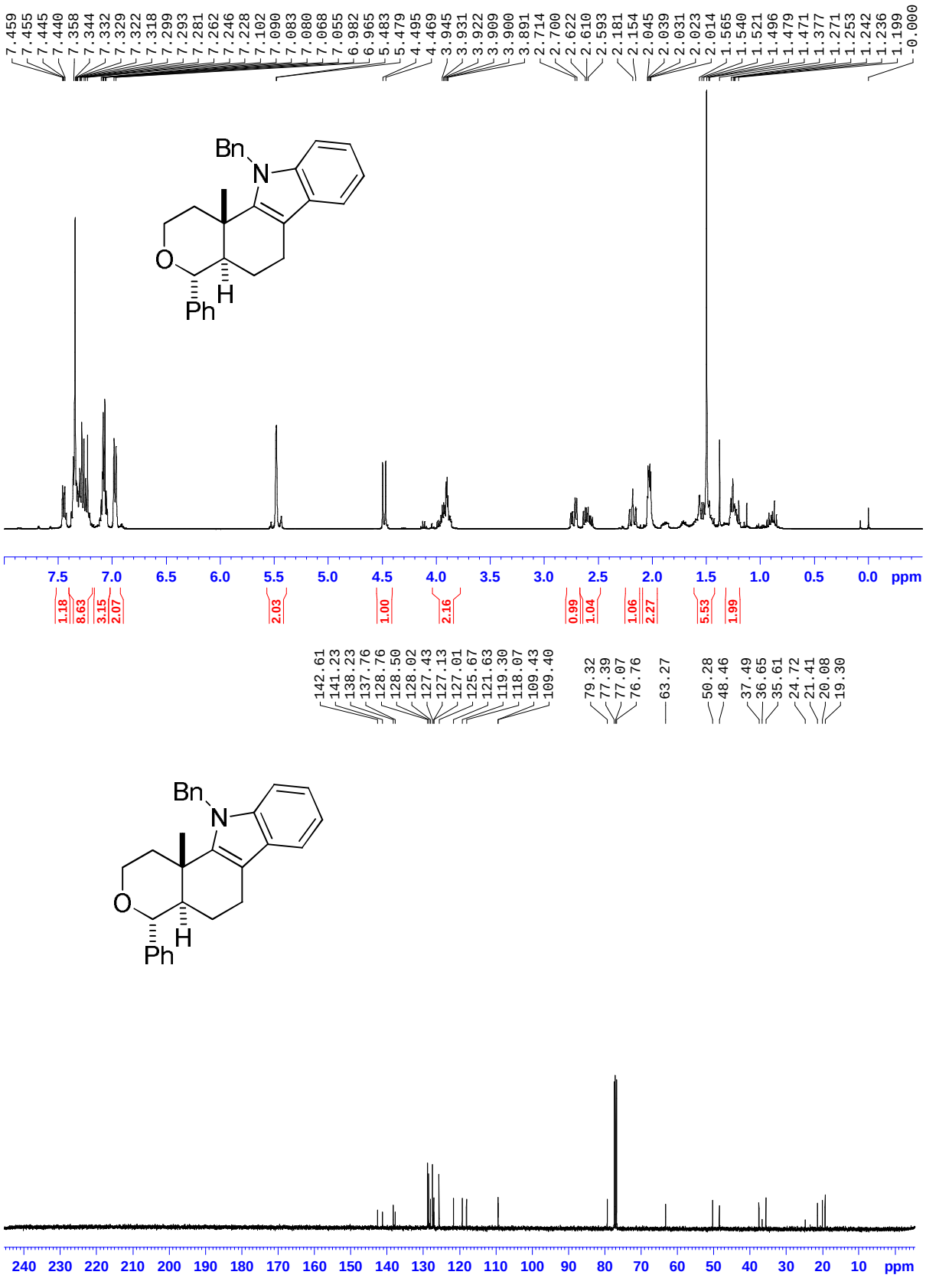
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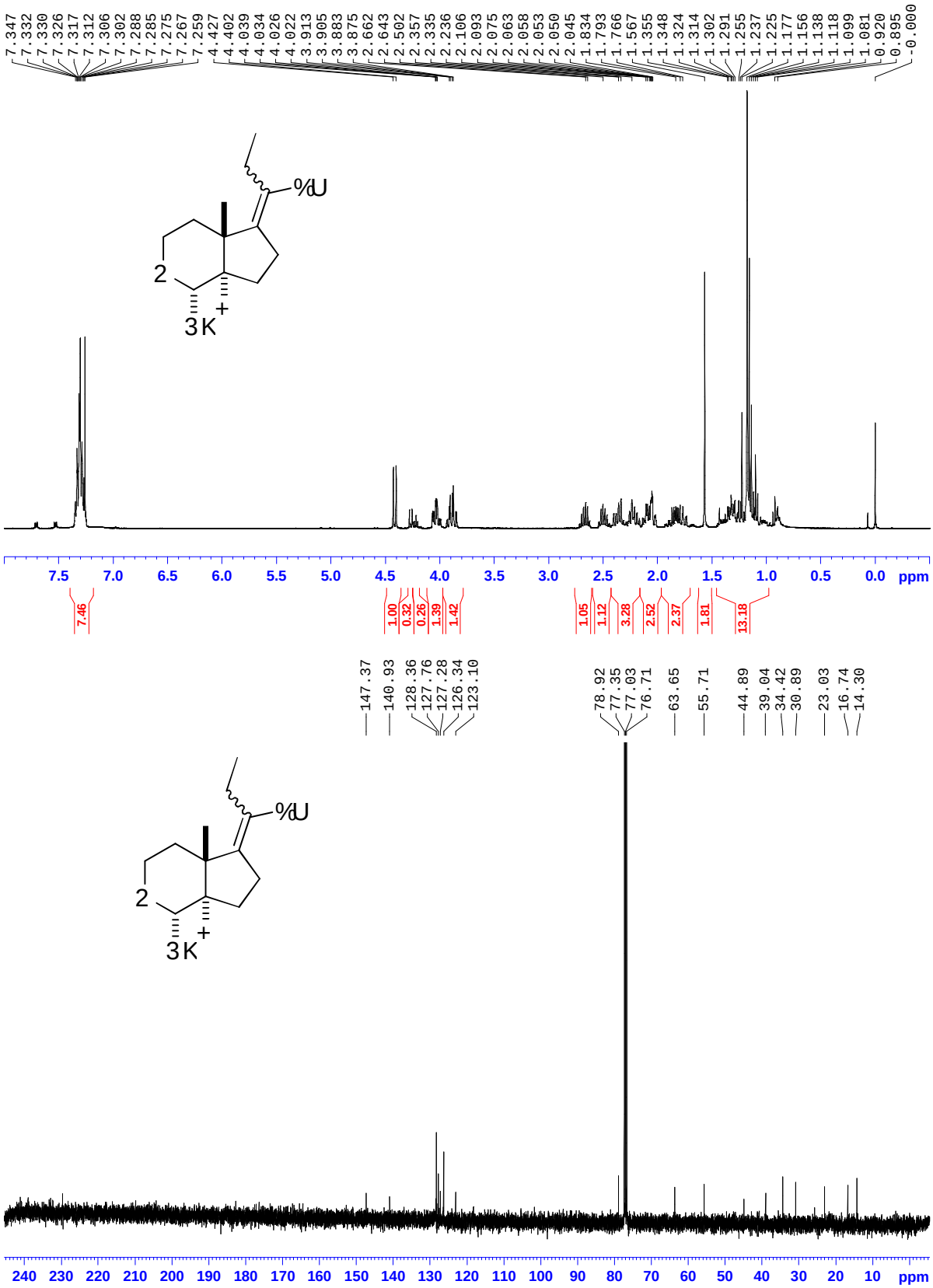
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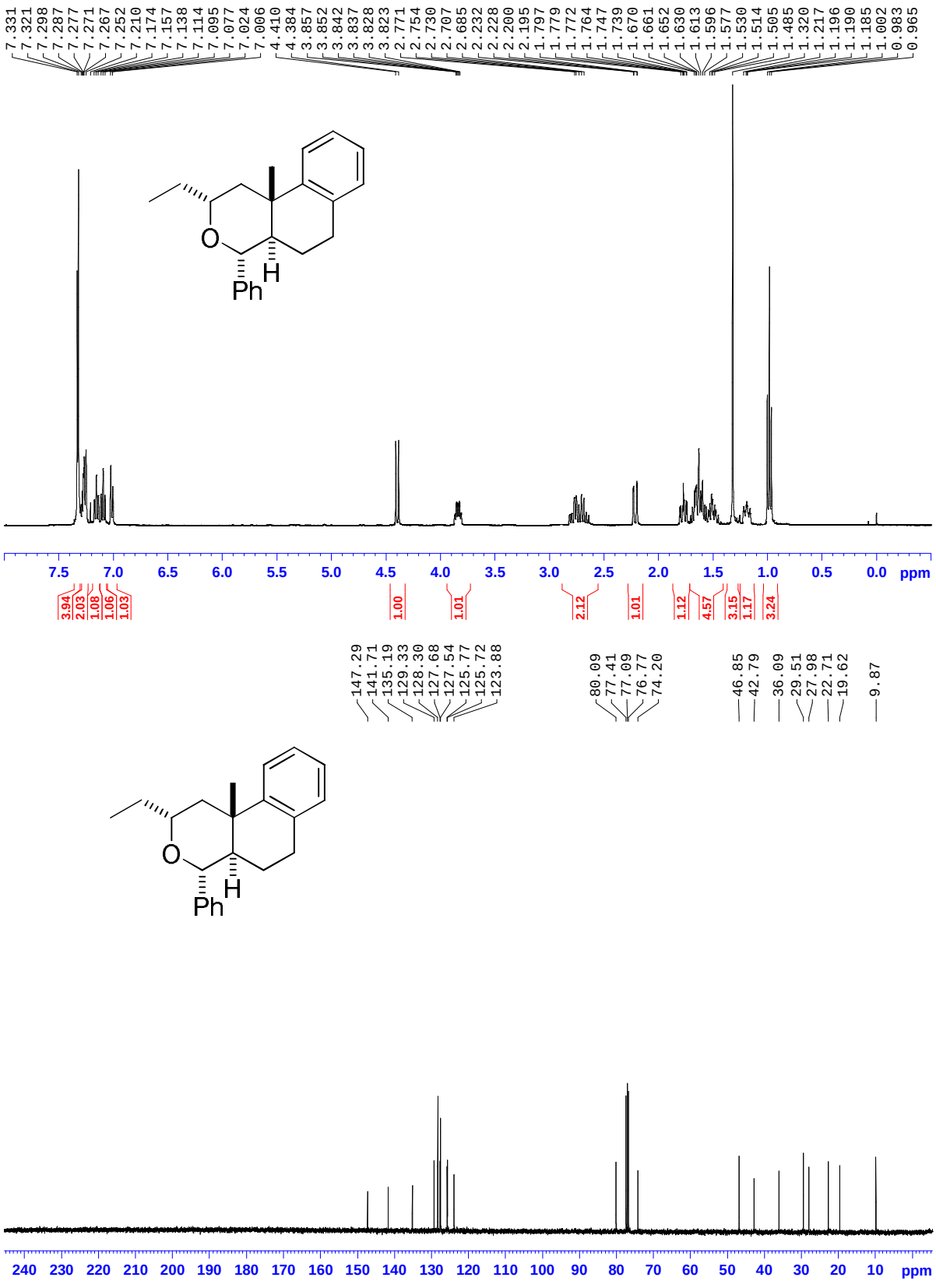
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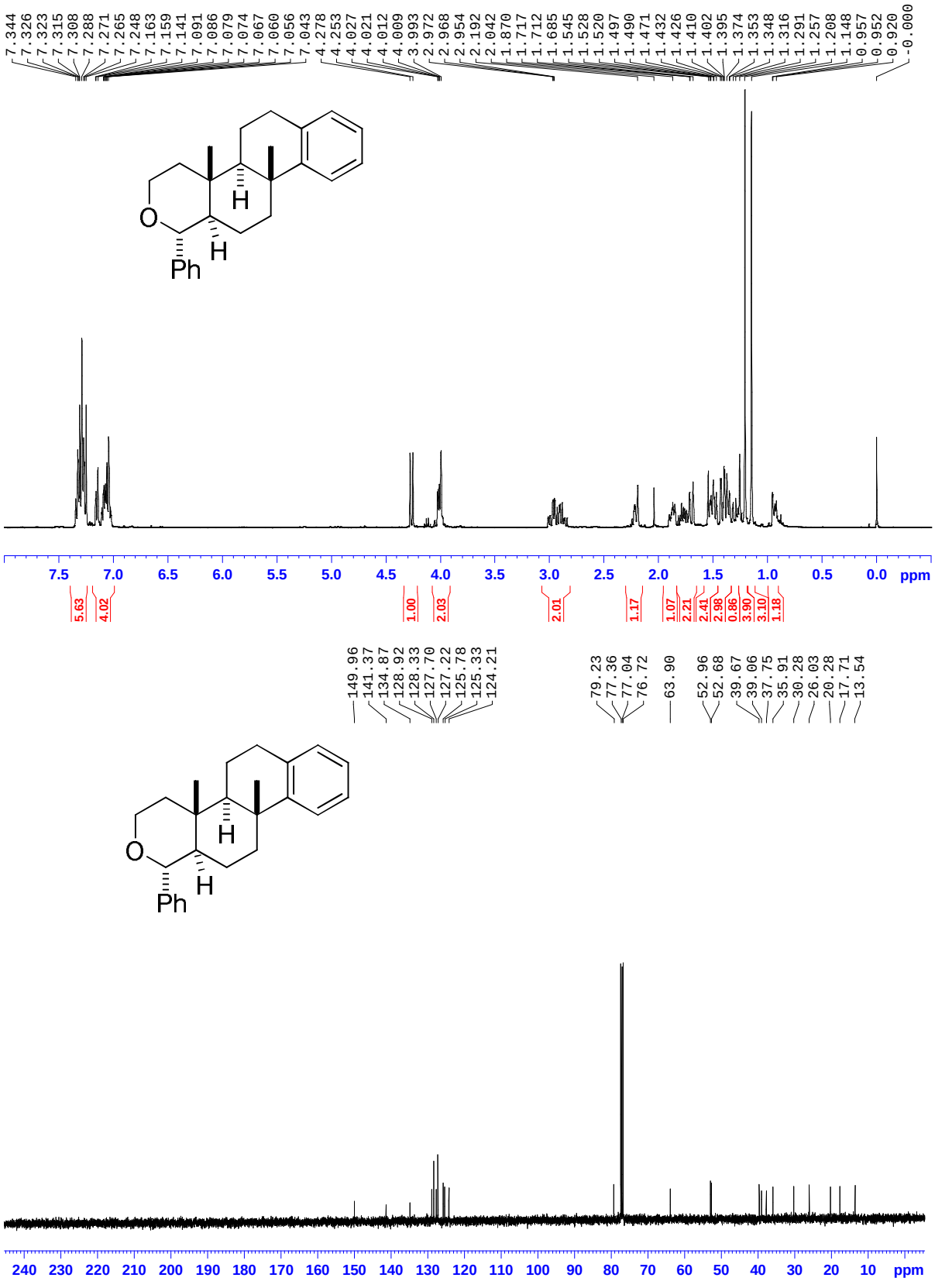
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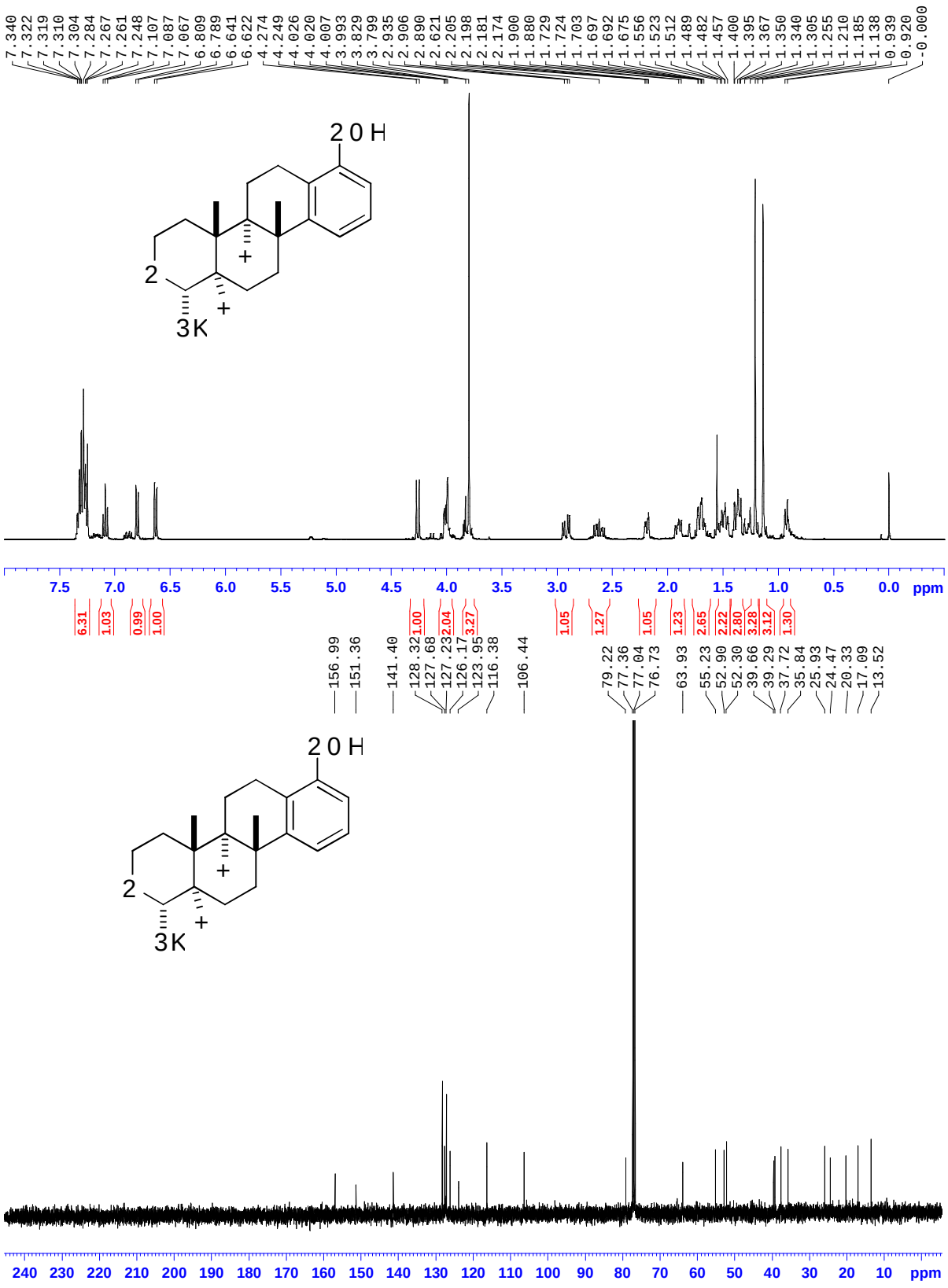
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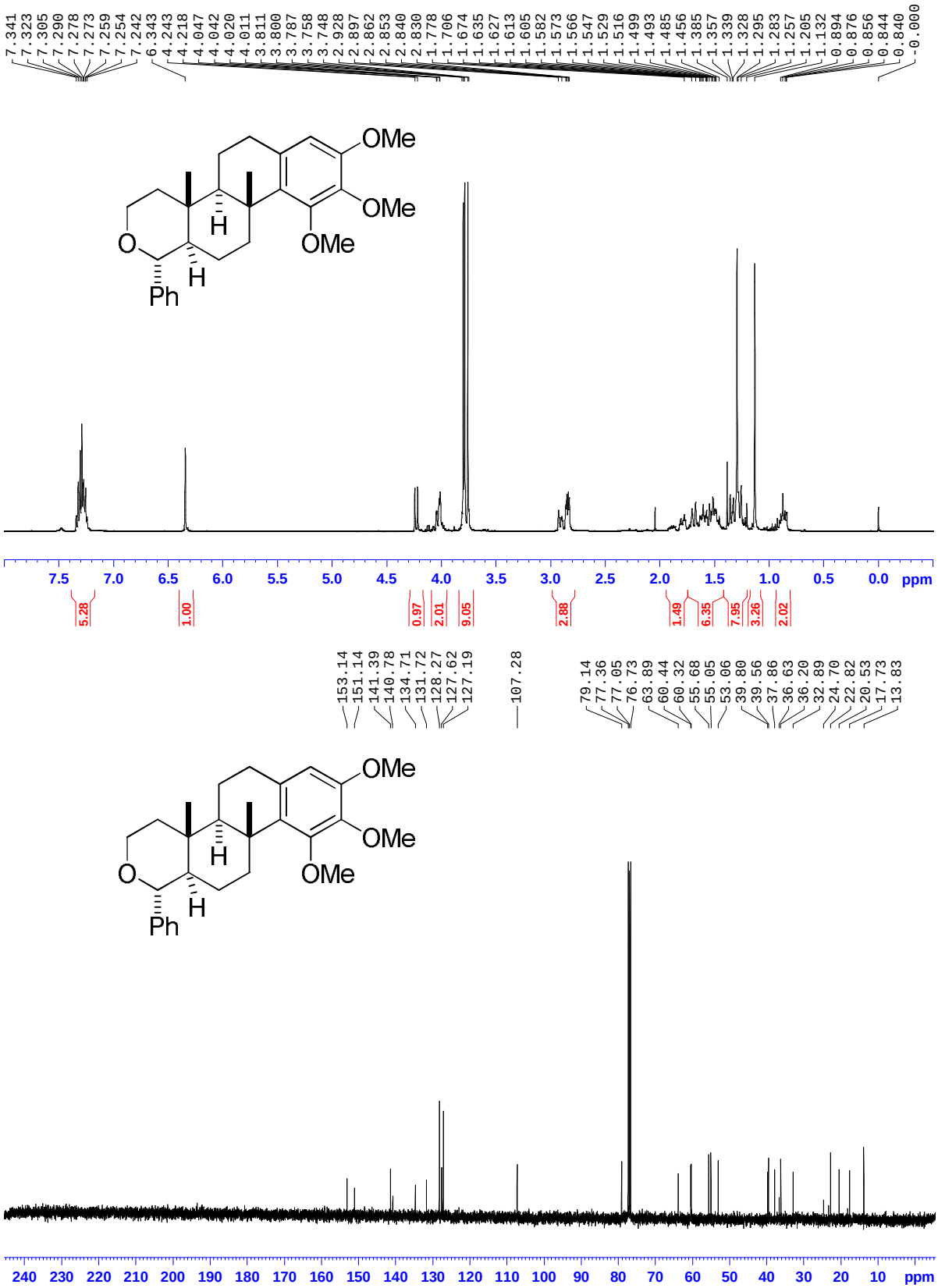
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OMe
OMe
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O
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Ph
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OMe
OMe
OMe
H
O
H
Ph
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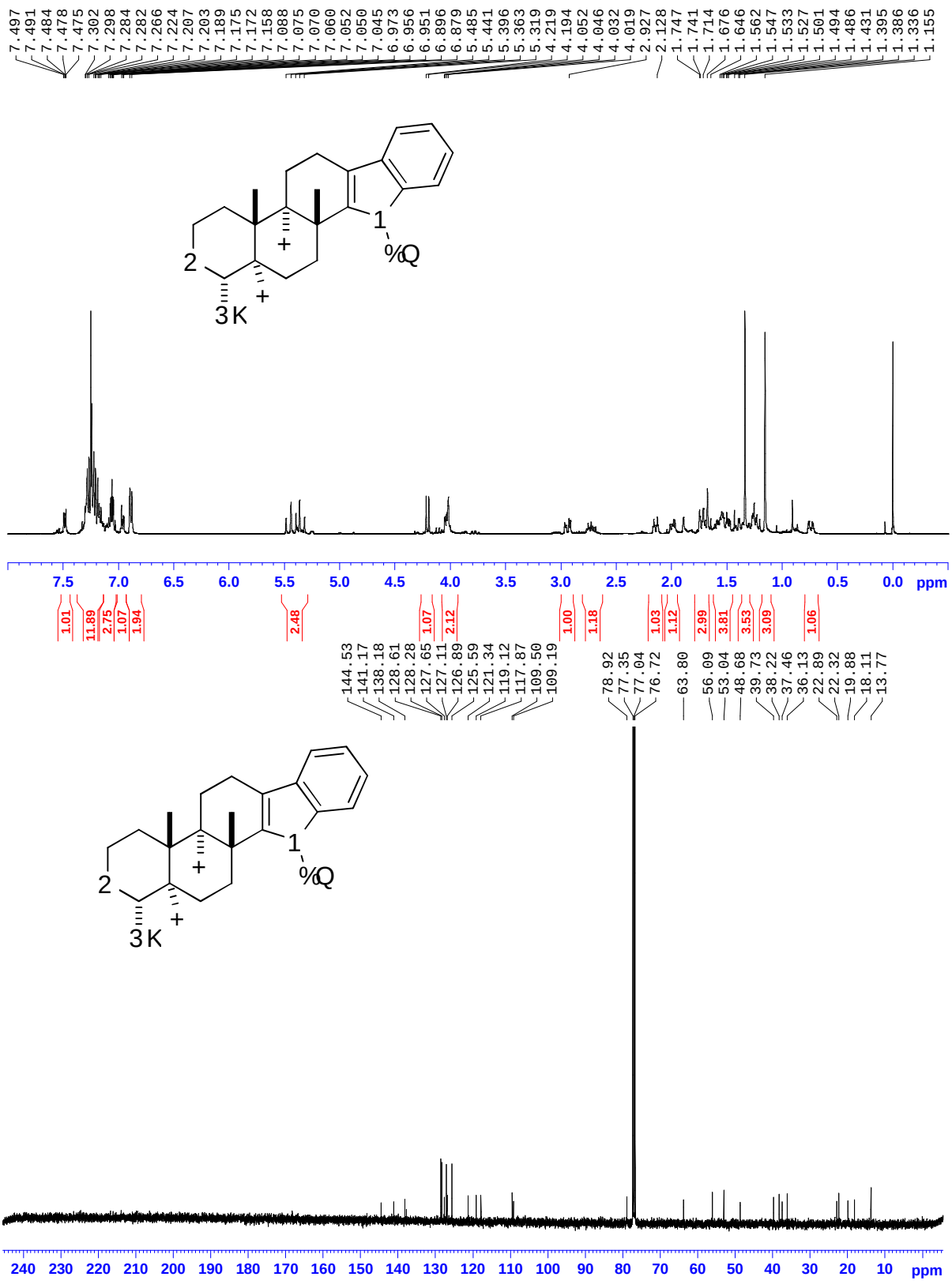
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Q
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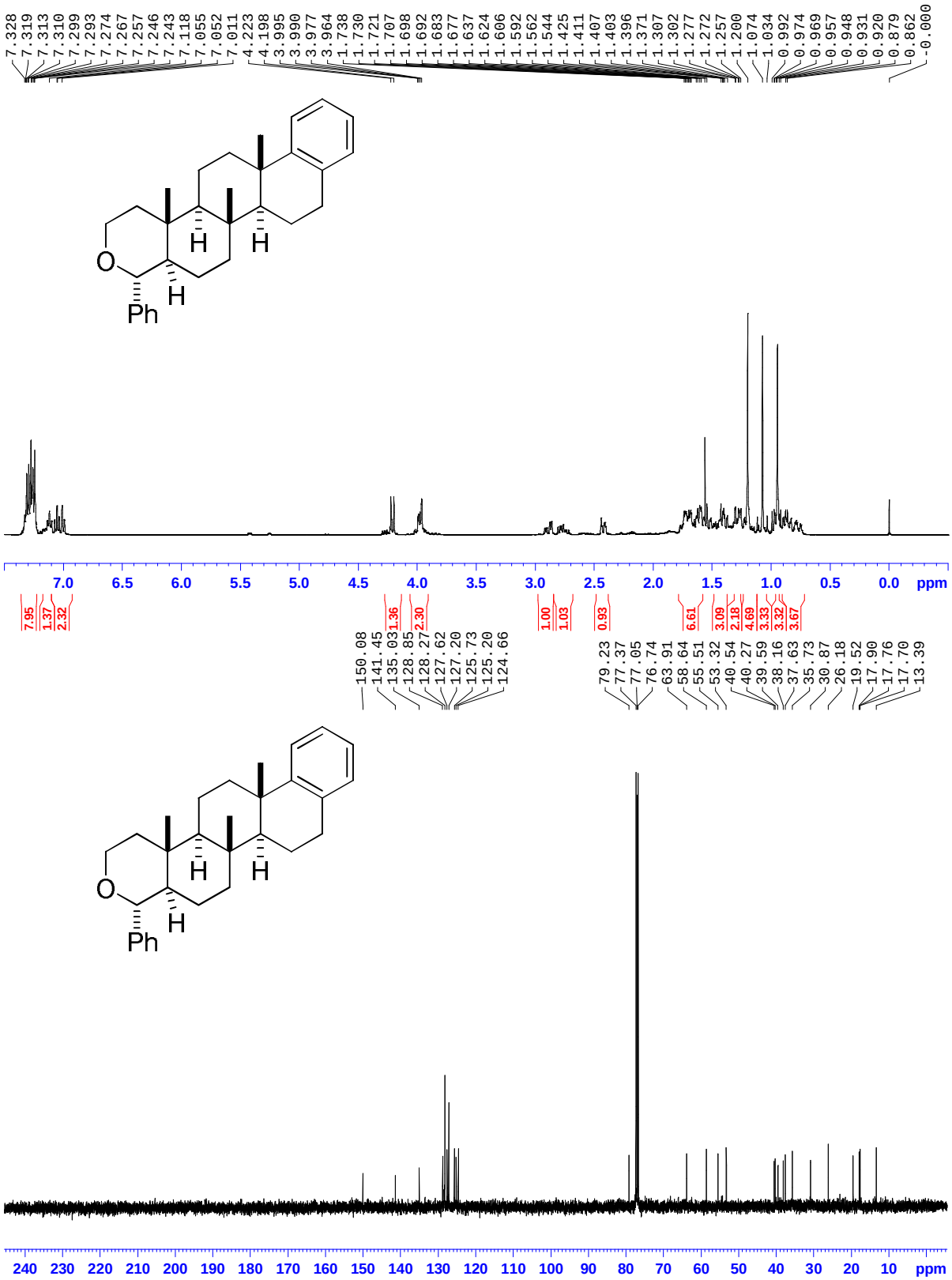
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1.707
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1.544
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-0.000
O
H
H
H
Ph
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6.0
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5.0
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4.0
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1.5
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19.52
17.90
17.76
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13.39
O
H
H
H
Ph
240
230
220
210
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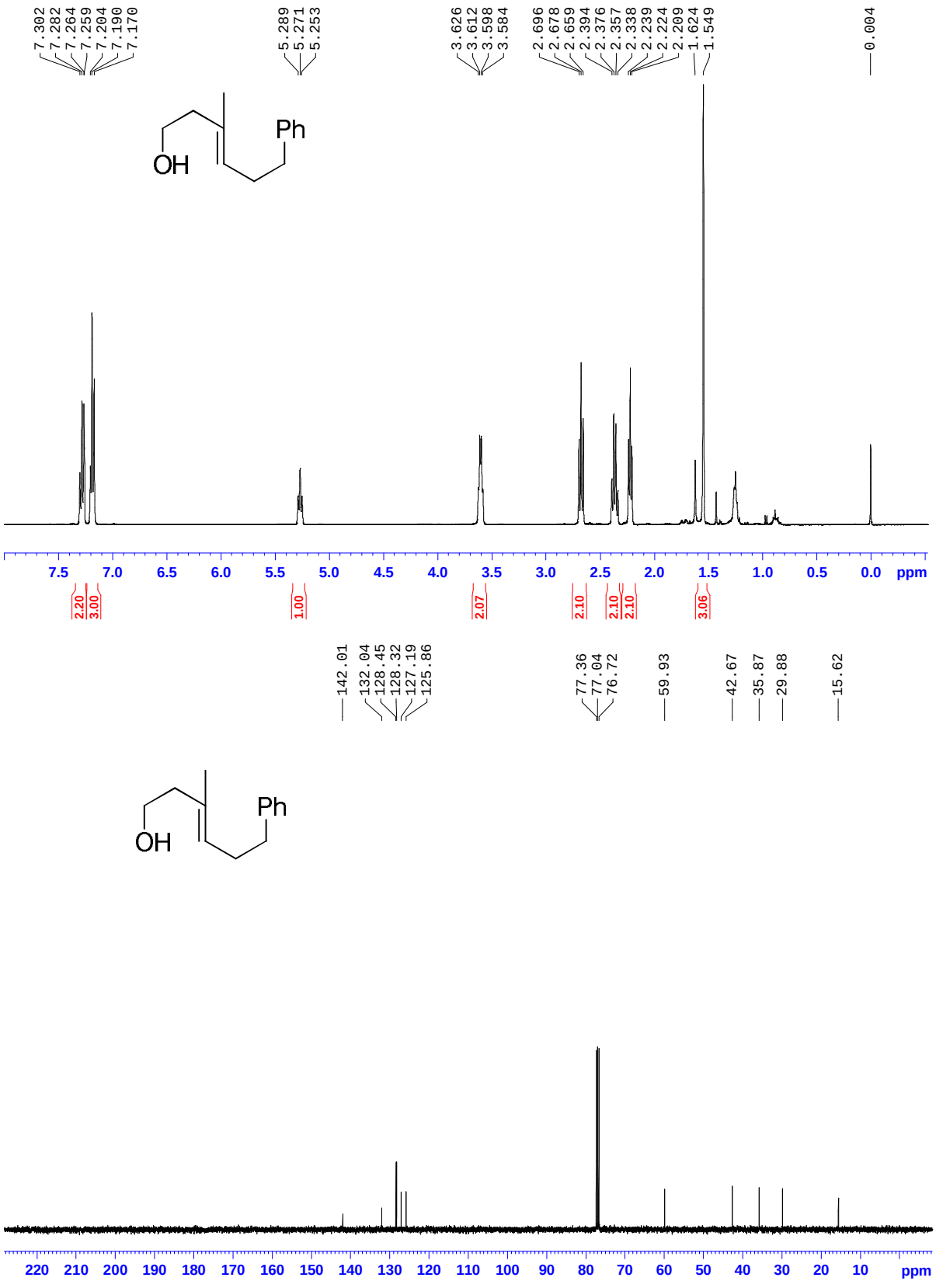
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3.584
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2.678
2.659
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2.376
2.357
2.338
2.239
2.224
2.209
1.624
1.549
0.004
Ph
OH
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1.00
2.07
2.10
2.10
2.10
3.06
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132.04
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128.32
127.19
125.86
77.36
77.04
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15.62
Ph
OH
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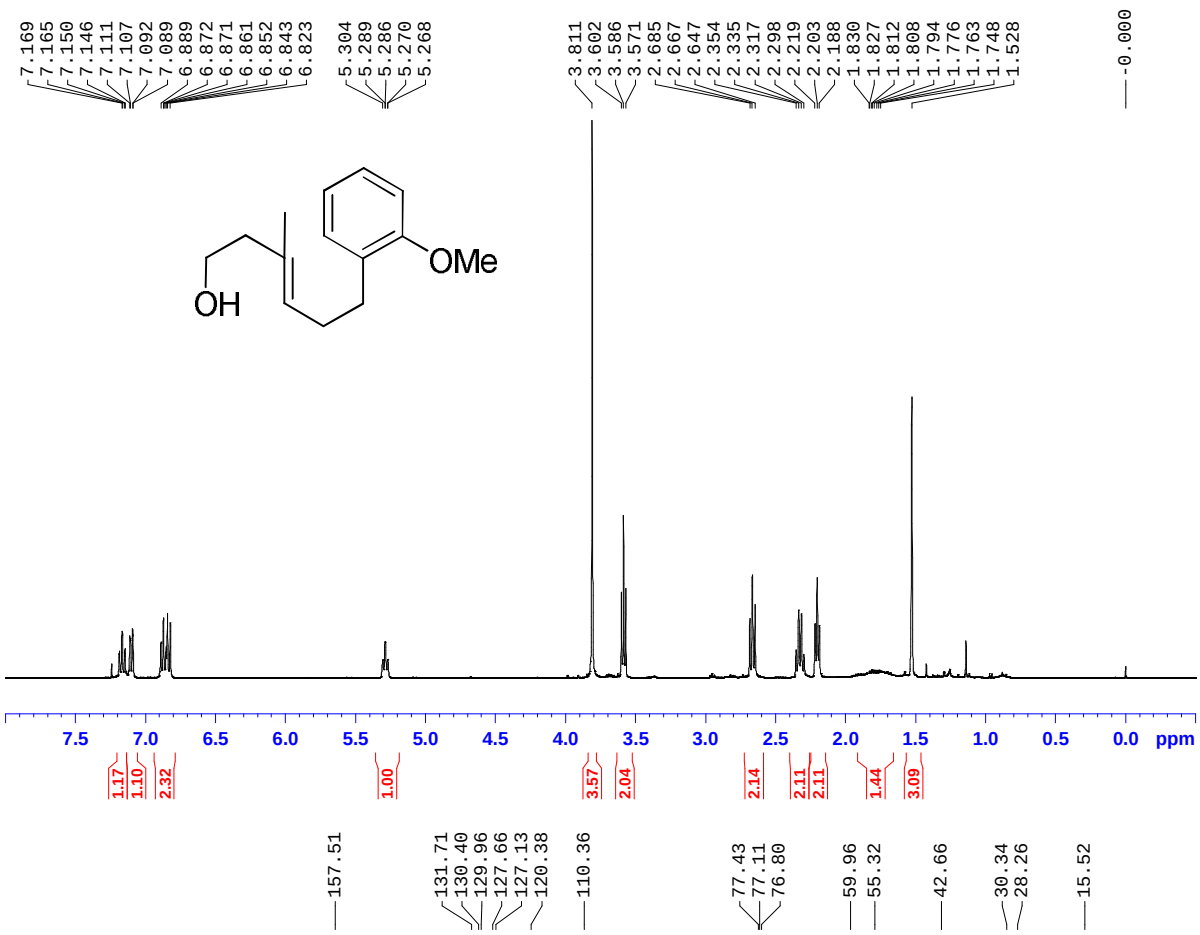
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6.852
6.843
6.823
5.304
5.289
5.286
5.270
5.268
3.811
3.602
3.586
3.571
2.685
2.667
2.647
2.354
2.335
2.317
2.298
2.219
2.203
2.188
1.830
1.827
1.812
1.808
1.794
1.776
1.763
1.748
1.528
-0.000
OMe
OH
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6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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2.0
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1.0
0.5
0.0
ppm
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2.04
2.14
2.11
2.11
1.44
3.09

157.51
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130.40
129.96
127.66
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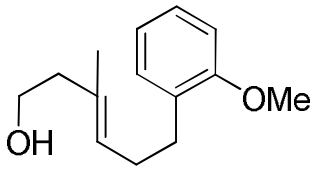
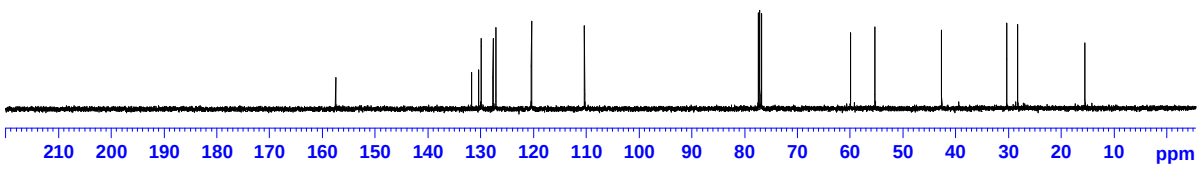

OMe
OH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200
190
180
170
160
150
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130
120
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100
90
80
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40
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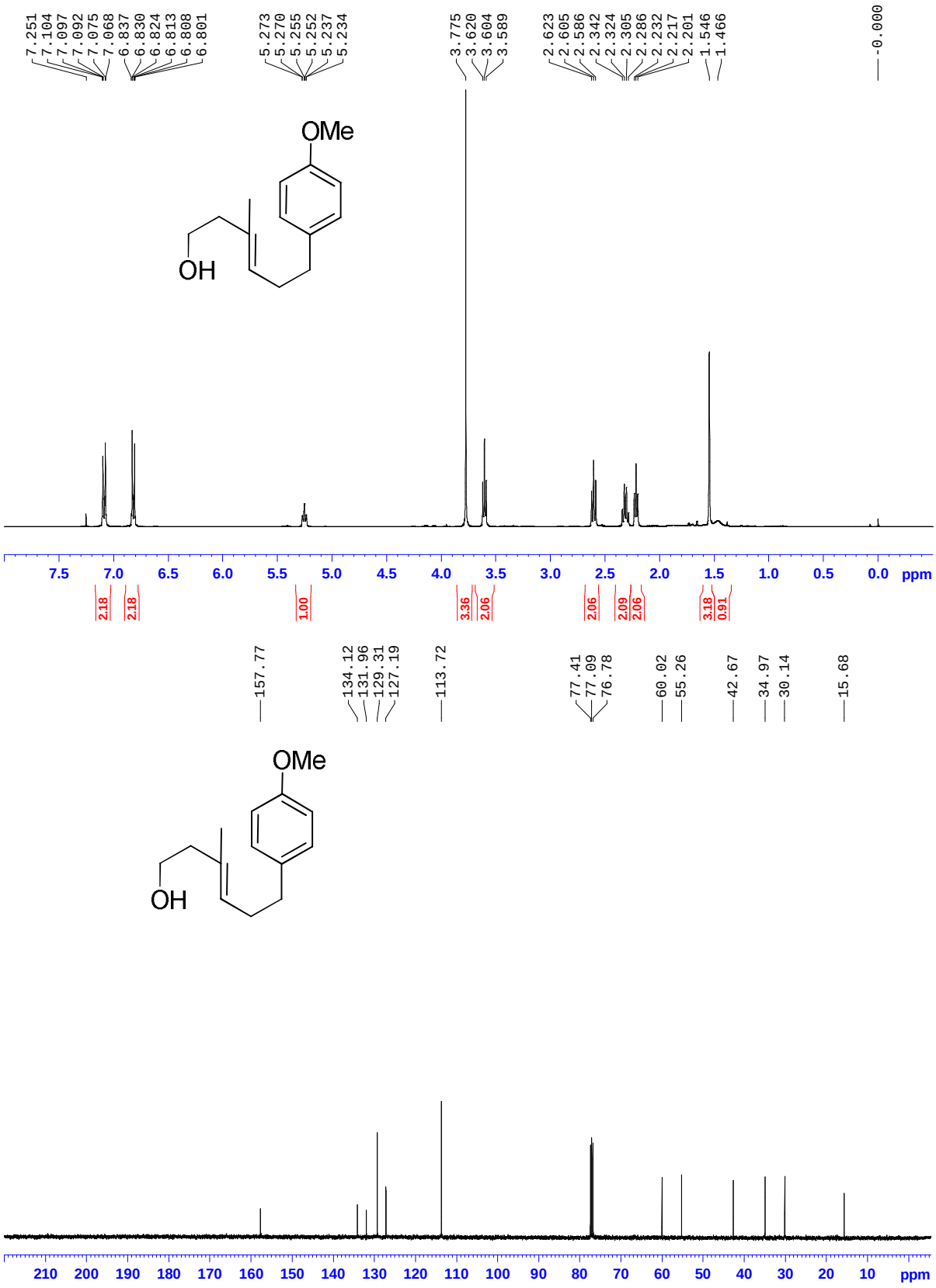
20
10
ppm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5.270
5.255
5.252
5.237
5.234
3.775
3.620
3.604
3.589
2.623
2.605
2.586
2.342
2.324
2.305
2.286
2.232
2.217
2.201
1.546
1.466
-0.000
OMe
OH
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7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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2.18
1.00
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2.06
2.09
2.06
3.18
0.91

157.77
134.12
131.96
129.31
127.19
113.72
77.41
77.09
76.78
60.02
55.26
42.67
34.97
30.14
15.68
OMe
OH
210
200
190
180
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150
140
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120
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70
60
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30
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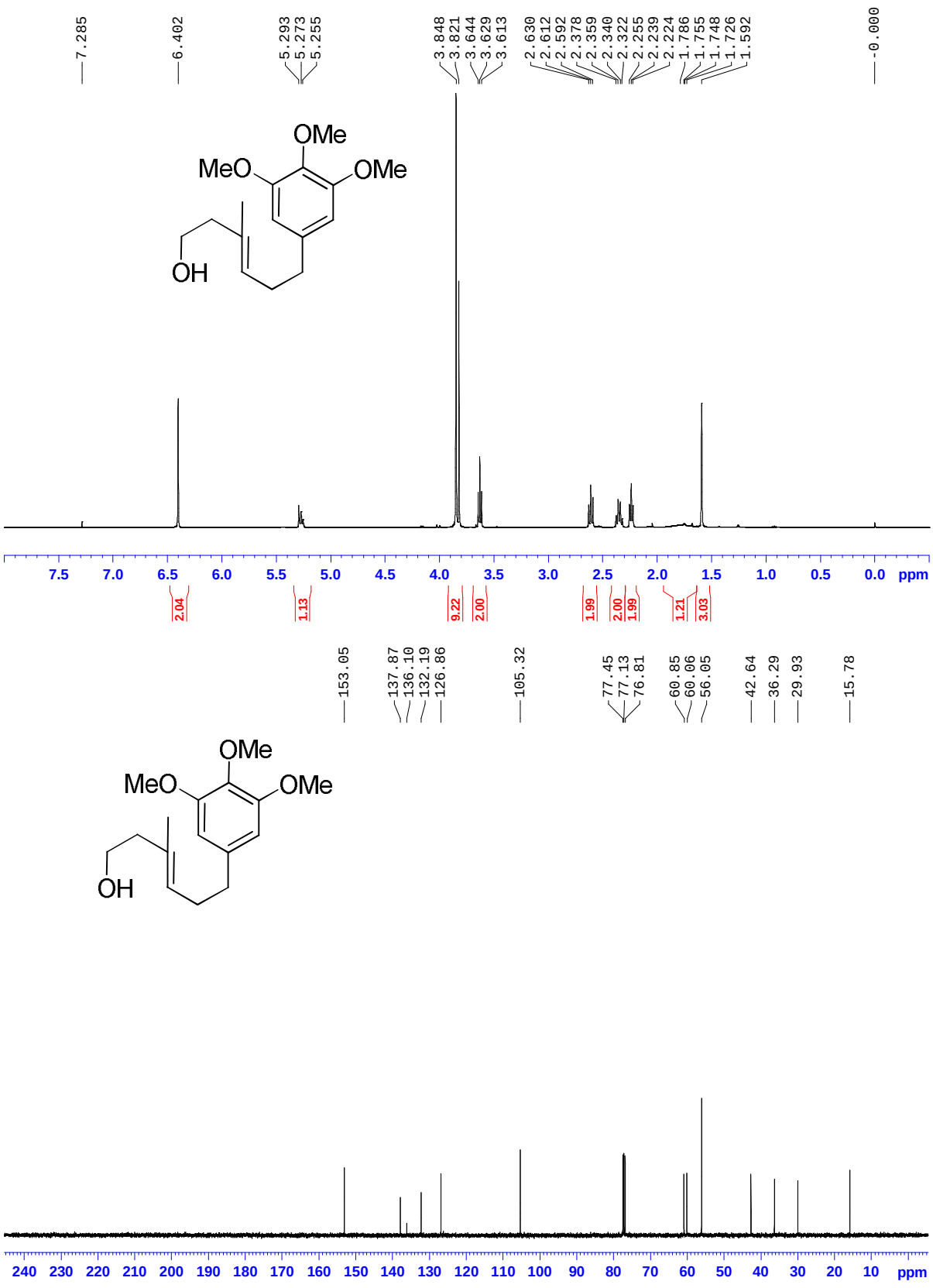
10
ppm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2.359
2.340
2.322
2.255
2.239
2.224
1.786
1.755
1.748
1.726
1.592
-0.000
OMe
MeO
OMe
OH
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2.04
1.13
9.22
2.00
1.99
2.00
1.99
1.21
3.03
153.05
137.87
136.10
132.19
126.86
105.32
77.45
77.13
76.81
60.85
60.06
56.05
42.64
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15.78
OMe
MeO
OMe
OH
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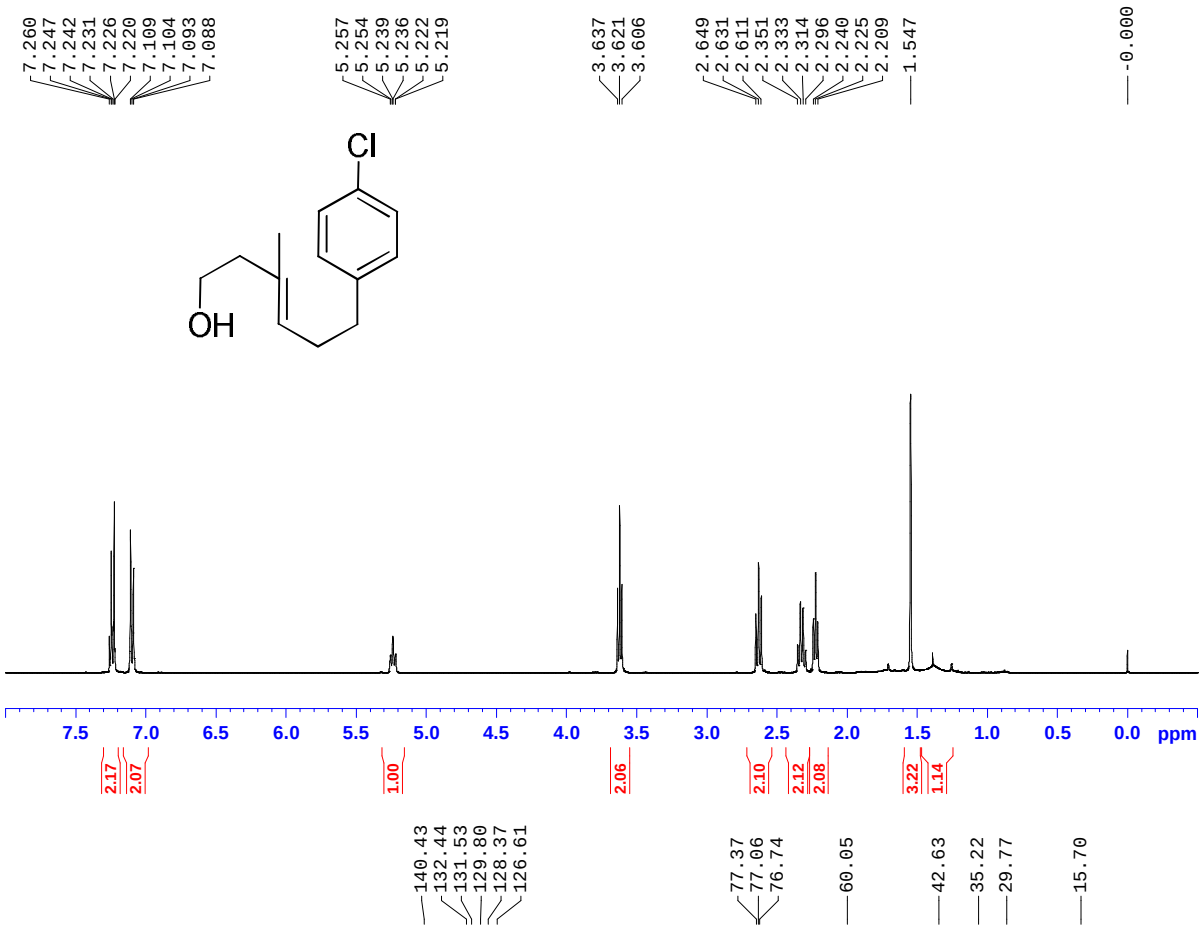
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5.236
5.222
5.219
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3.621
3.606
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2.631
2.611
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2.333
2.314
2.296
2.240
2.225
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Cl
OH
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4.0
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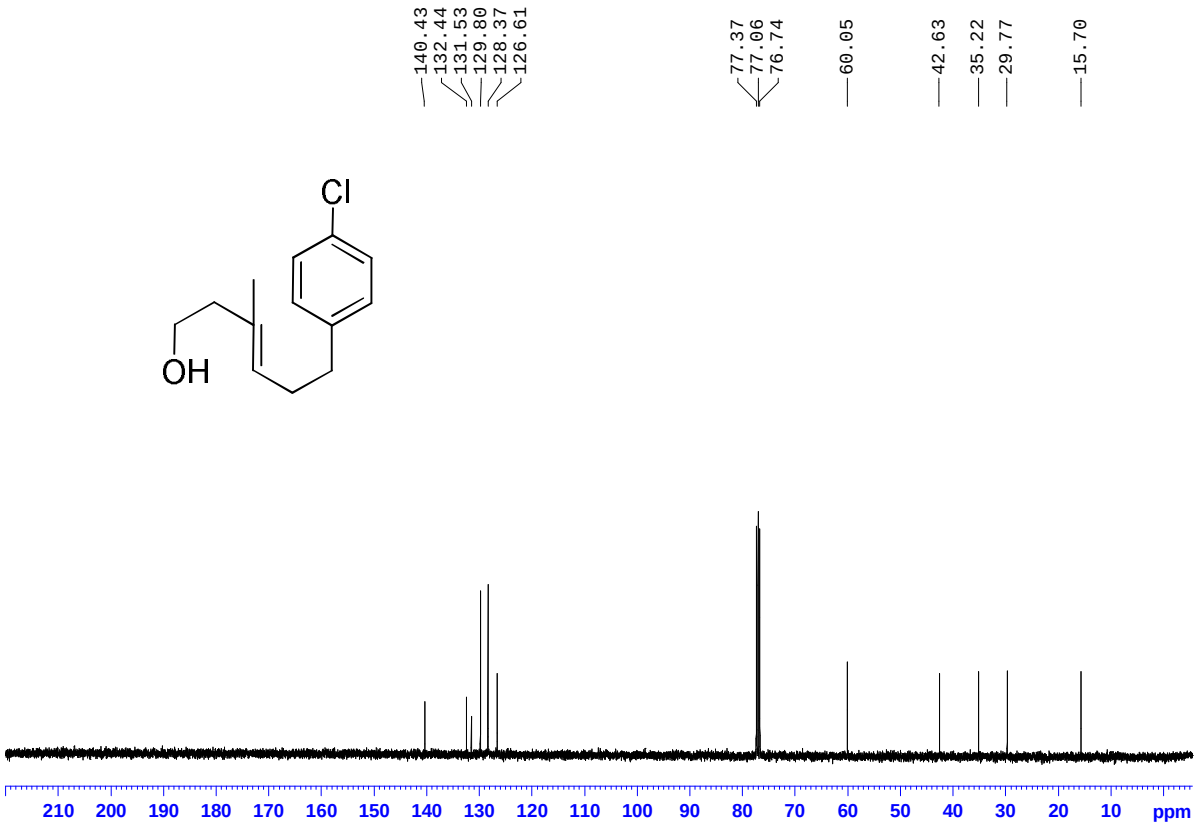
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35.22
29.77
15.70
Cl
OH
210
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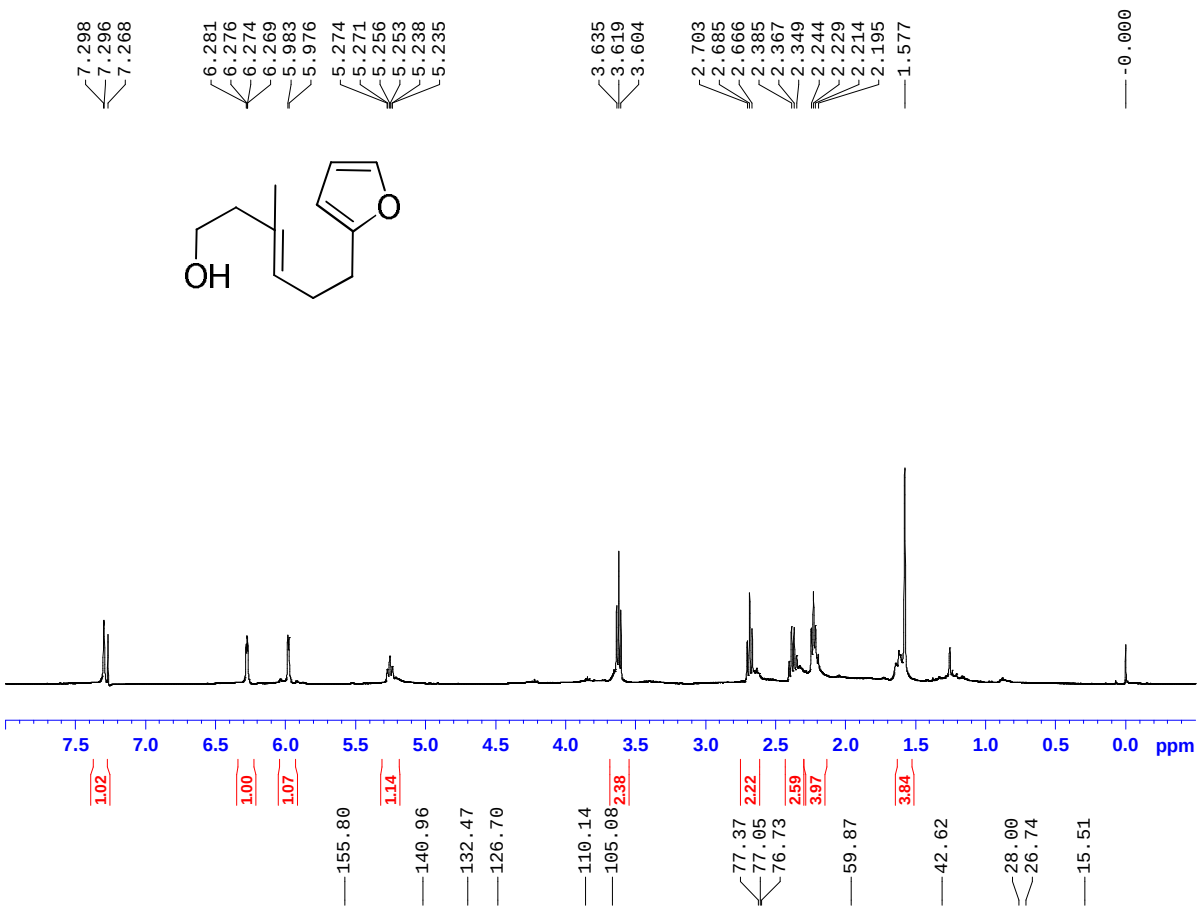
20
10
ppm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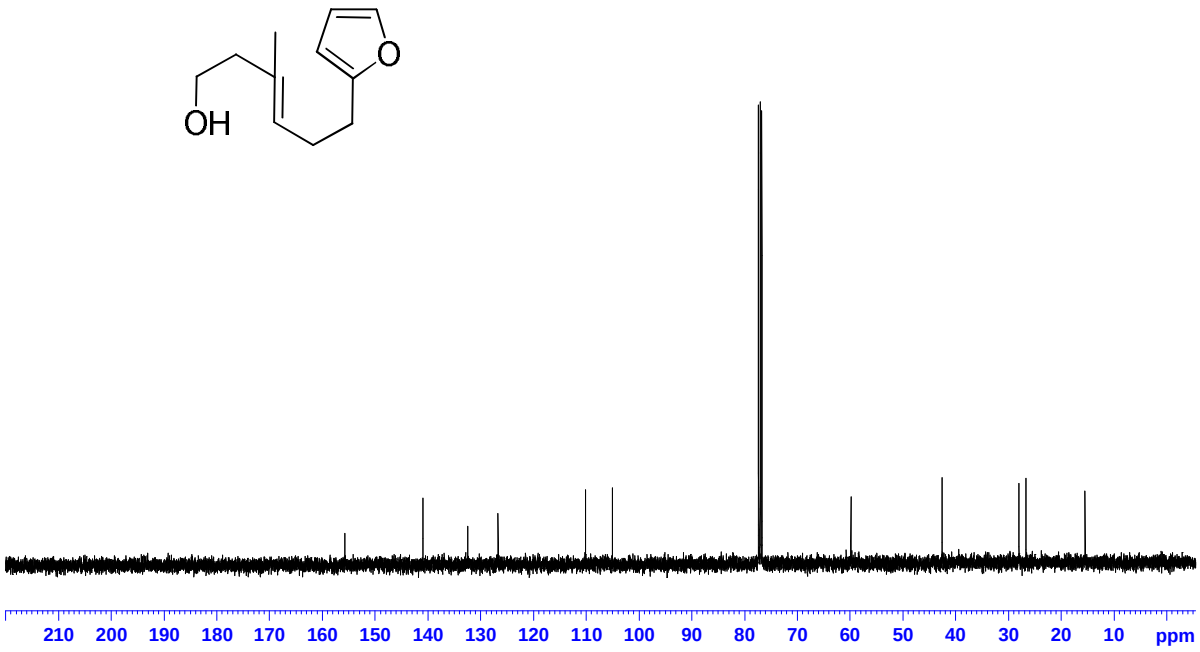
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OH
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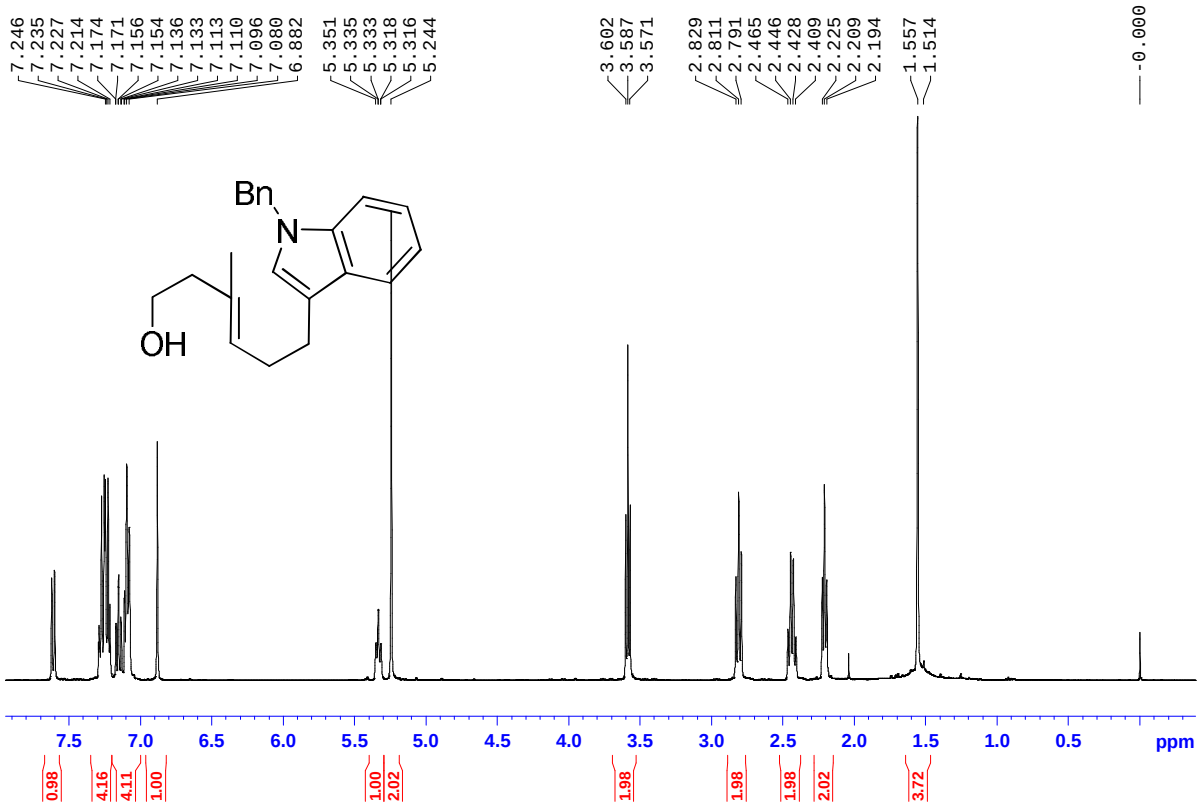
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Bn
N
OH
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4.0
3.5
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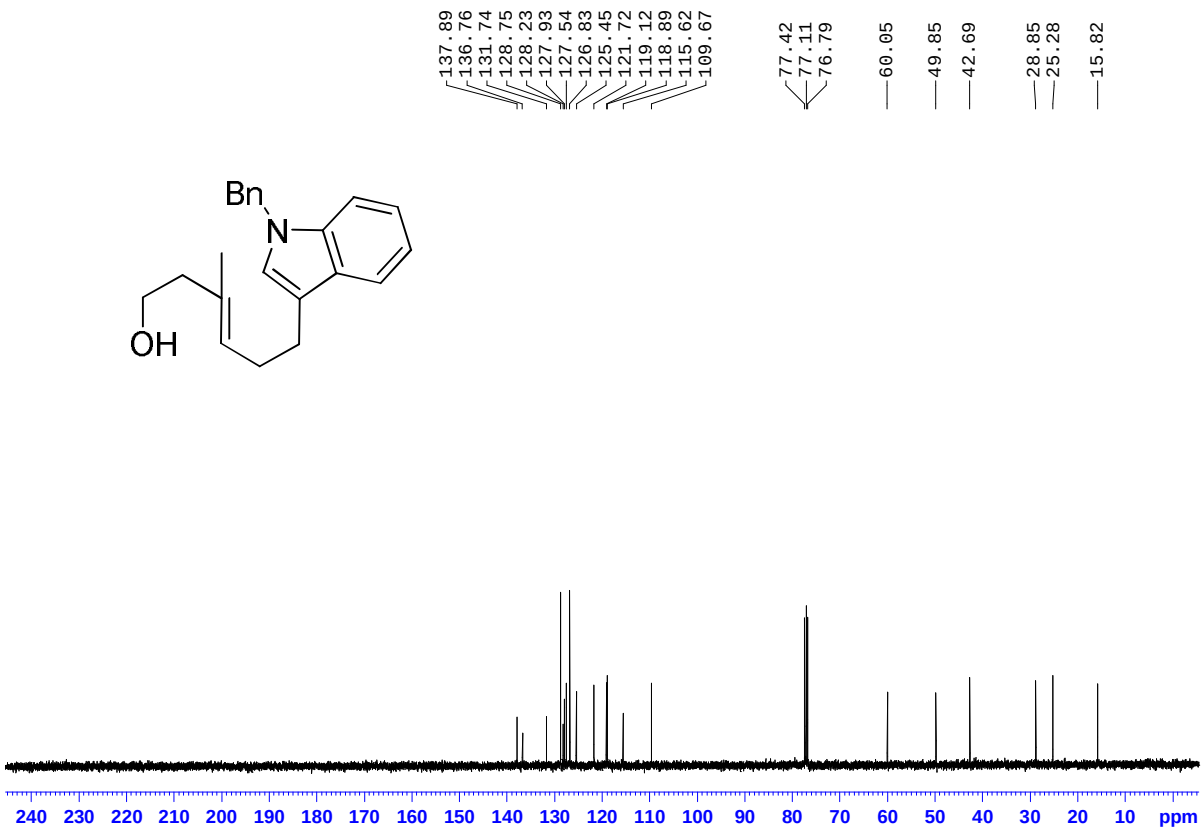
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25.28
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Bn
N
OH
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230
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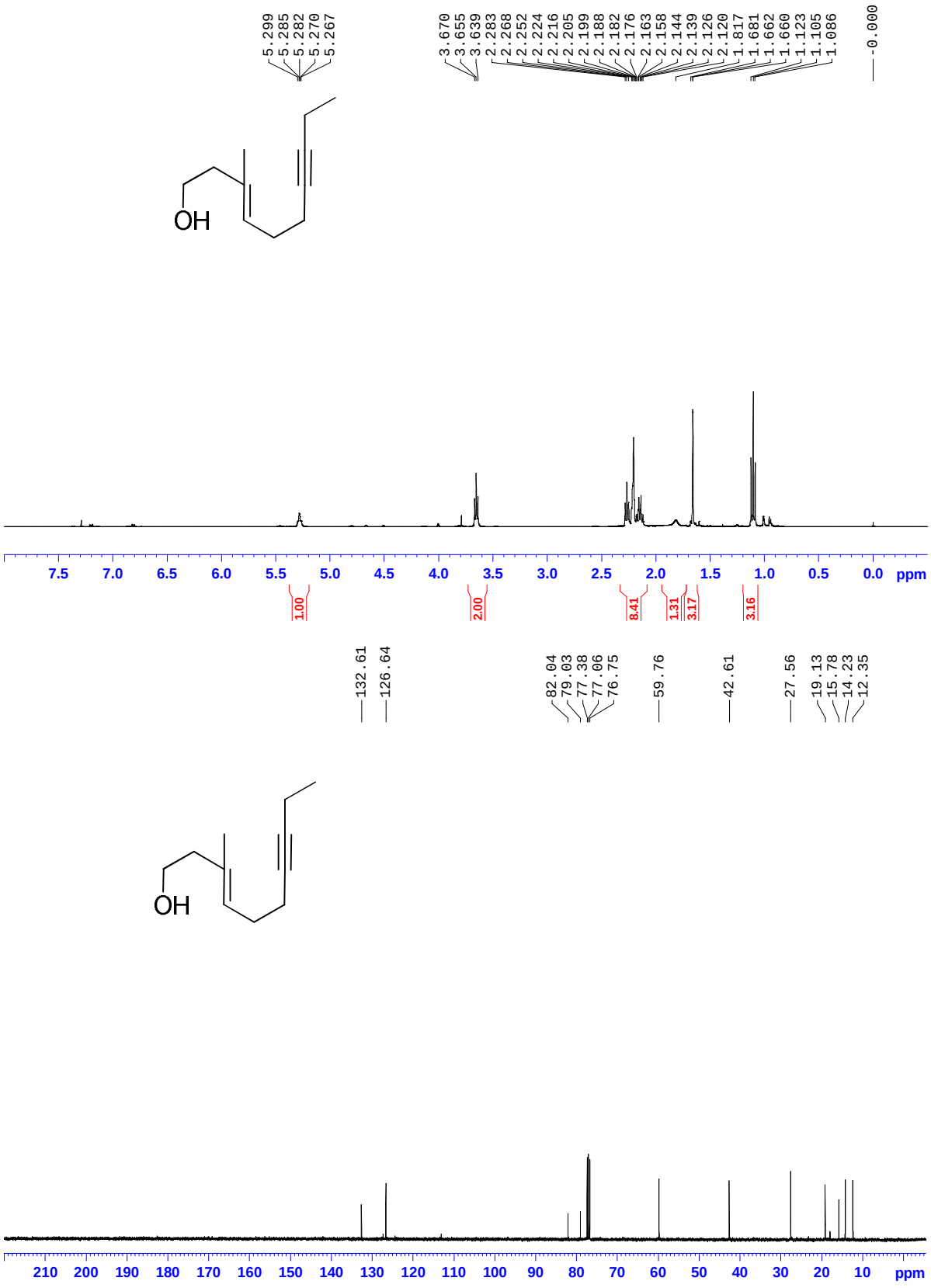
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2.205
2.199
2.188
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2.176
2.163
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2.139
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1.660
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2.00
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3.16
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79.03
77.38
77.06
76.75
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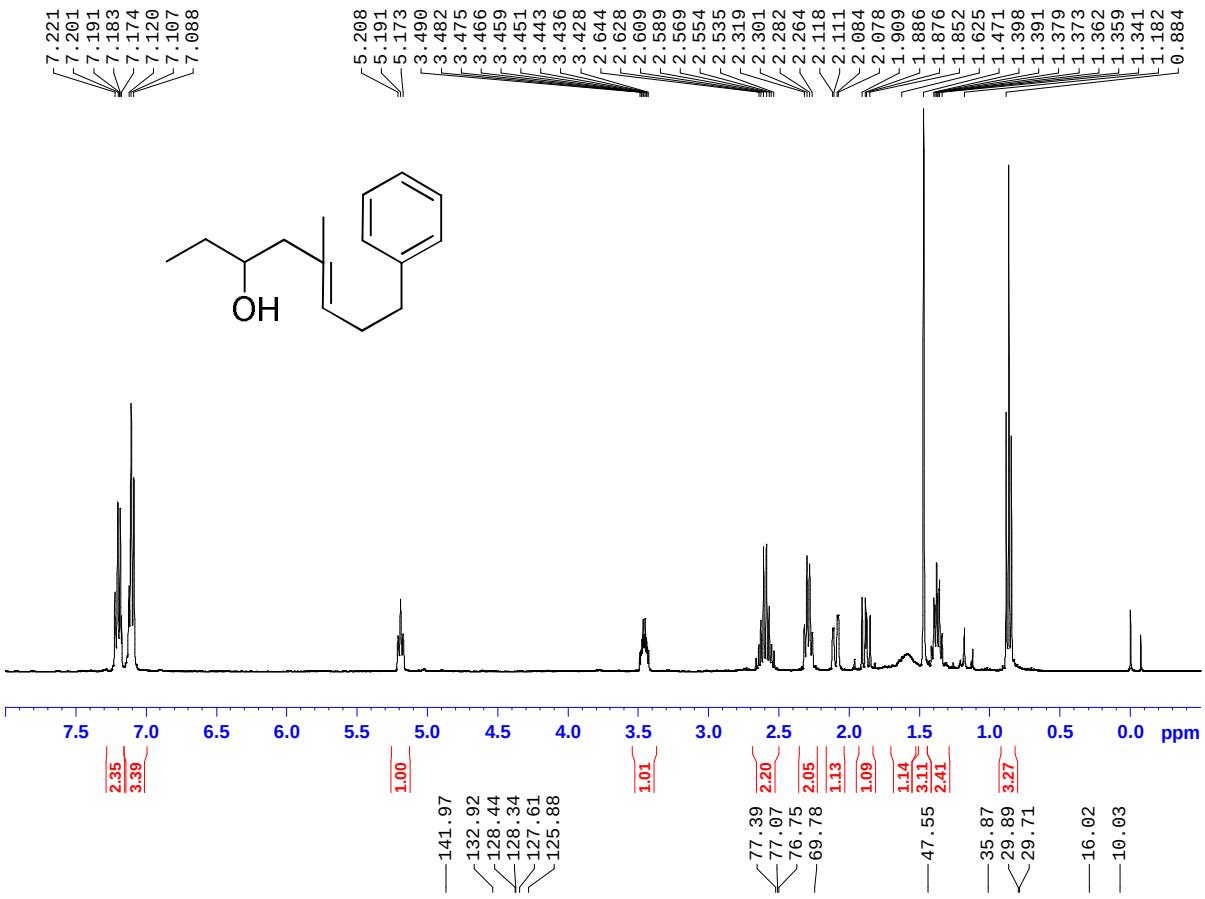
OH
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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3.459
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3.436
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2.554
2.535
2.319
2.301
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4.0
3.5
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1.09
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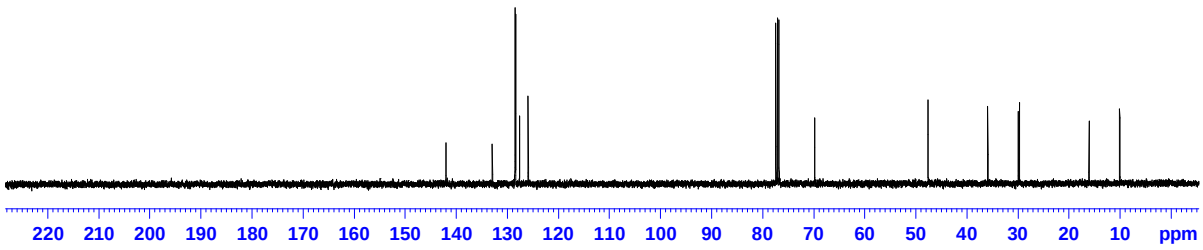
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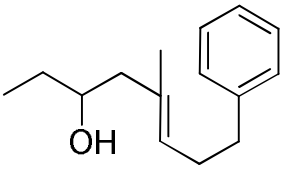
16.02
10.03


OH

220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

7.285
7.266
7.248
7.192
7.188
7.172

5.211
5.197
5.179
5.164
5.162

3.643
3.628
3.612
2.653
2.634
2.614
2.327
2.309
2.289
2.271
2.246
2.231
2.216
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2.110
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2.042
2.033
2.014
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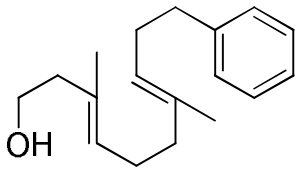
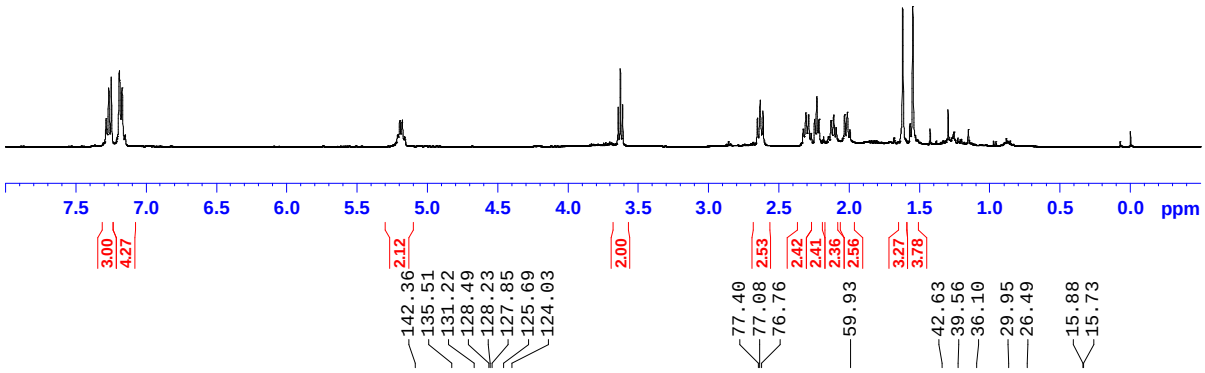
1.620
1.548

-0.000





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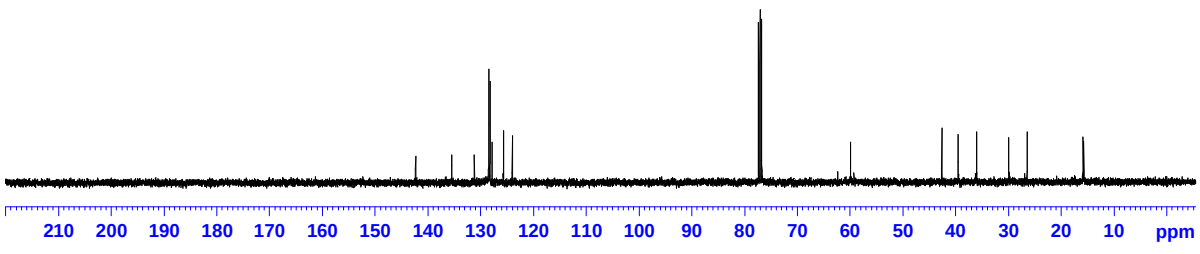
135.51
131.22
128.49
128.23
127.85
125.69
124.03

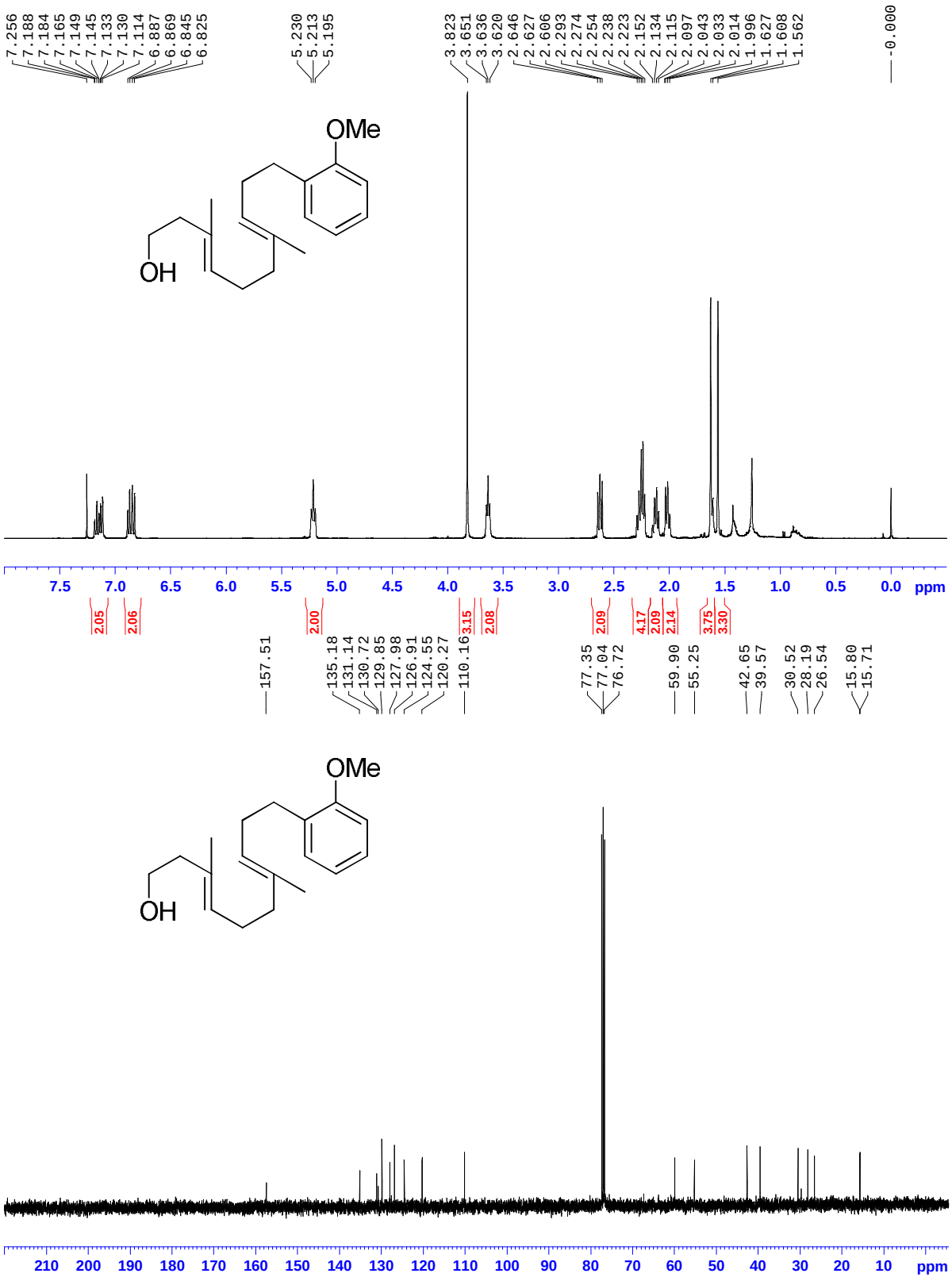
77.40
77.08
76.76

59.93

42.63
39.56
36.10
29.95
26.49

15.88
15.73

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7.184
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7.145
7.133
7.130
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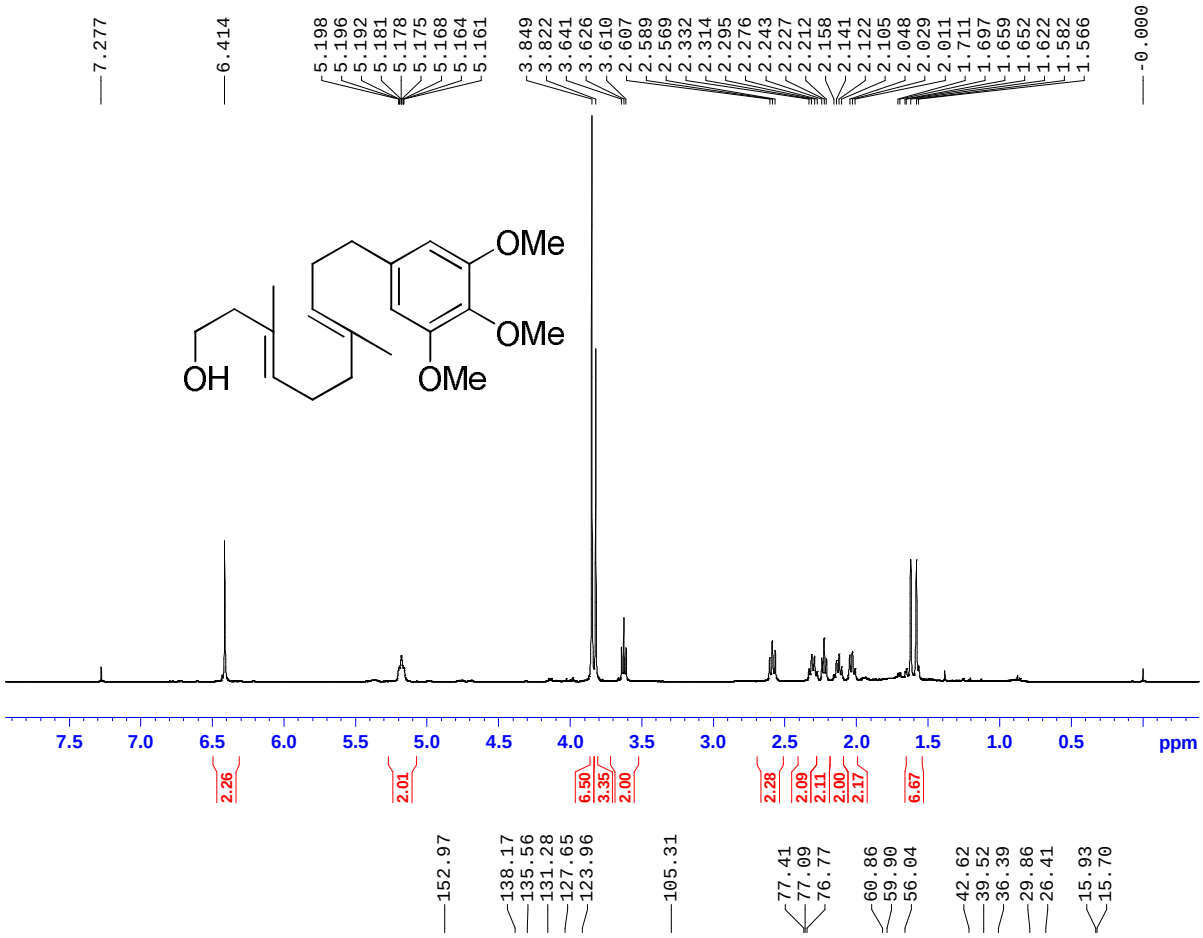
6.869
6.845
6.825
5.230
5.213
5.195
3.823
3.651
3.636
3.620
2.646
2.627
2.606
2.293
2.274
2.254
2.238
2.223
2.152
2.134
2.115
2.097
2.043
2.033
2.014
1.996
1.627
1.608
1.562
-0.000
OMe
OH
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.05
2.06
2.00
3.15
2.08
2.09
4.17
2.09
2.14
3.75
3.30
157.51
135.18
131.14
130.72
129.85
127.98
126.91
124.55
120.27
110.16
77.35
77.04
76.72
59.90
55.25
42.65
39.57
30.52
28.19
26.54
15.80
15.71
OMe
OH
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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5.196
5.192
5.181
5.178
5.175
5.168
5.164
5.161
3.849
3.822
3.641
3.626
3.610
2.607
2.589
2.569
2.332
2.314
2.295
2.276
2.243
2.227
2.212
2.158
2.141
2.122
2.105
2.048
2.029
2.011
1.711
1.697
1.659
1.652
1.622
1.582
1.566
-0.000
OMe
OMe
OMe
OH
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
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6.50
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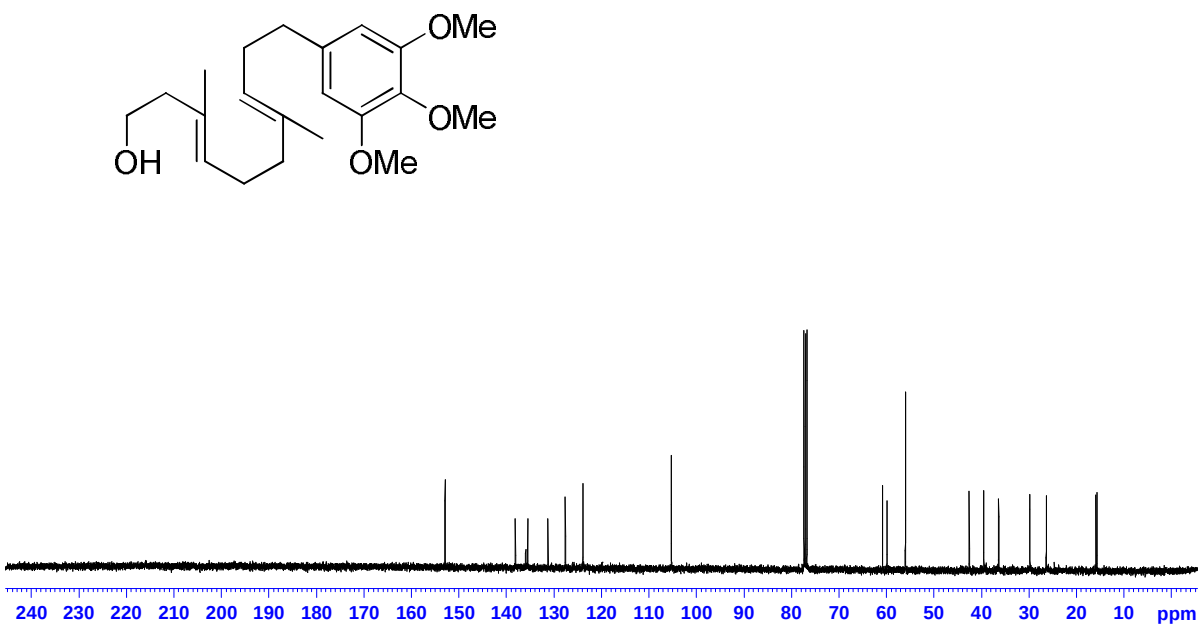
2.00
2.28
2.09
2.11
2.00
2.17
6.67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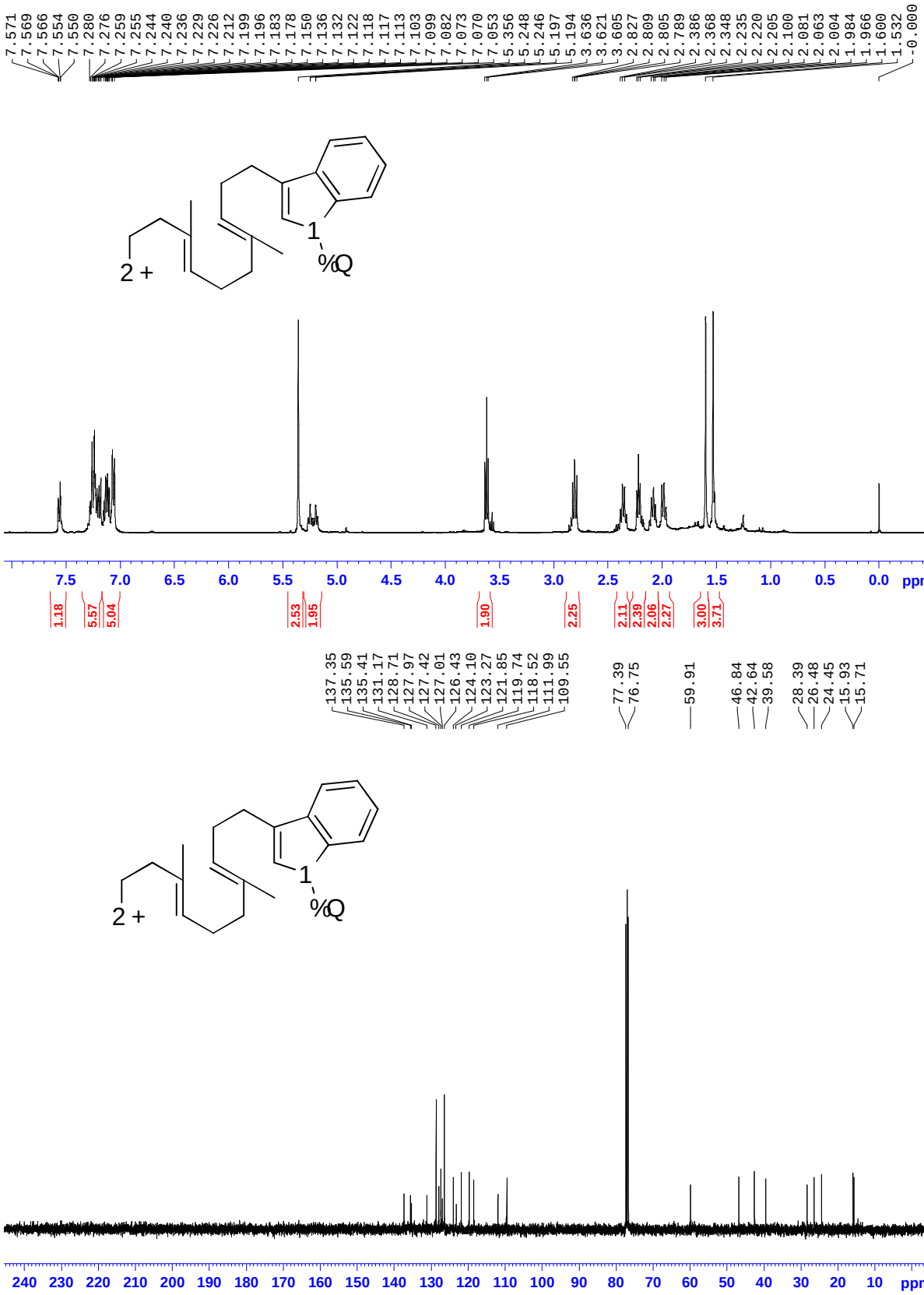
138.17
135.56
131.28
127.65
123.96
105.31
77.41
77.09
76.77
60.86
59.90
56.04
42.62
39.52
36.39
29.86
26.41
15.93
15.70
OMe
OMe
OMe
OH
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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7.569
7.566
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7.550
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7.259
7.255
7.244
7.240
7.236
7.229
7.226
7.212
7.199
7.196
7.183
7.178
7.150
7.136
7.132
7.122
7.118
7.117
7.113
7.103
7.099
7.082
7.073
7.070
7.053
5.356
5.248
5.246
5.197
5.194
3.636
3.621
3.605
2.827
2.809
2.805
2.789
2.386
2.368
2.348
2.235
2.220
2.205
2.100
2.081
2.063
2.004
1.984
1.966
1.600
1.532
0.000
1
2 +
%Q
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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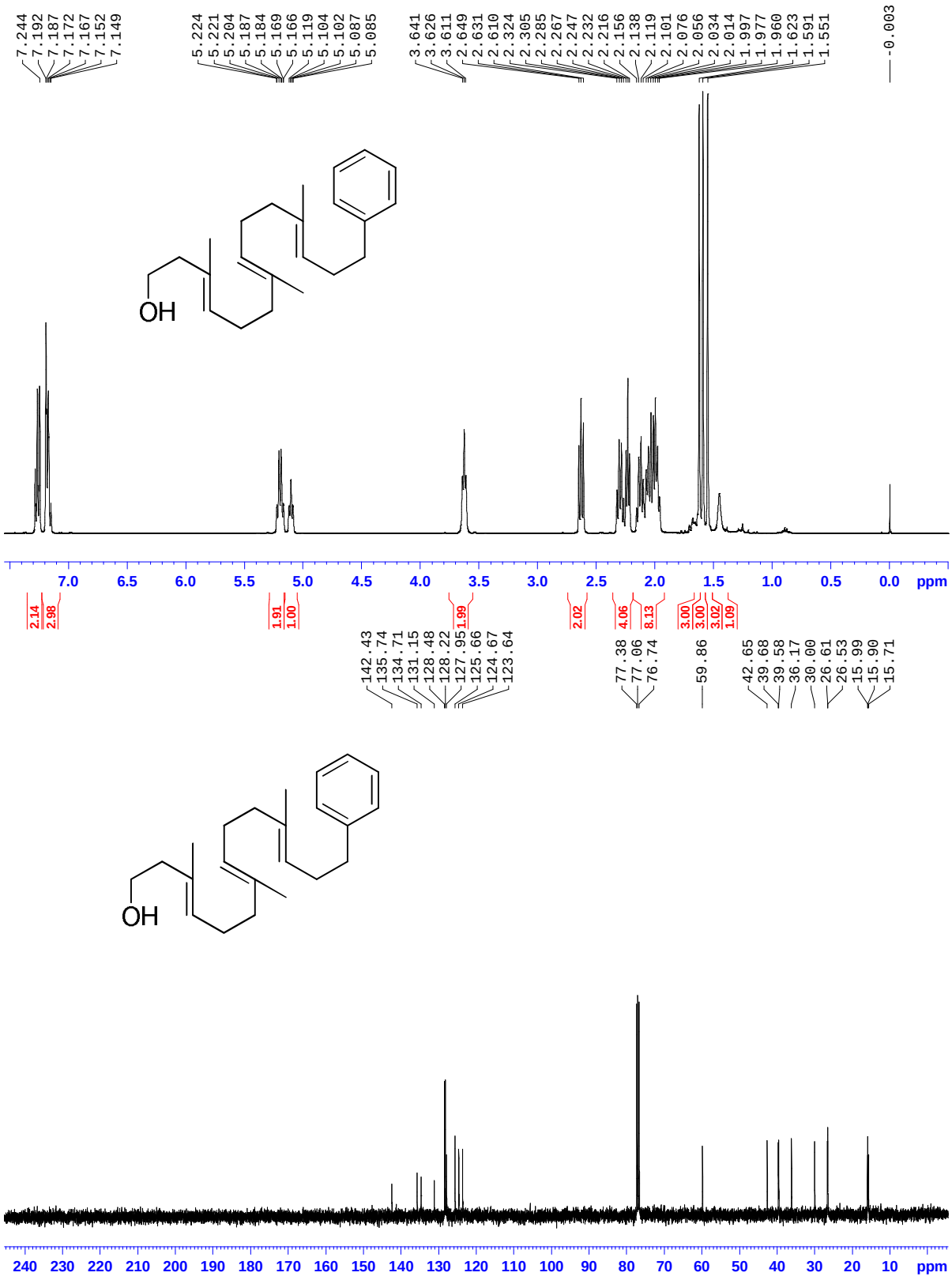
5.57
5.04
2.53
1.95
1.90
2.25
2.11
2.39
2.06
2.27
3.00
3.71
137.35
135.59
135.41
131.17
128.71
127.97
127.42
127.01
126.43
124.10
123.27
121.85
119.74
118.52
111.99
109.55
77.39
76.75
59.91
46.84
42.64
39.58
28.39
26.48
24.45
15.93
15.71
1
2 +
%Q
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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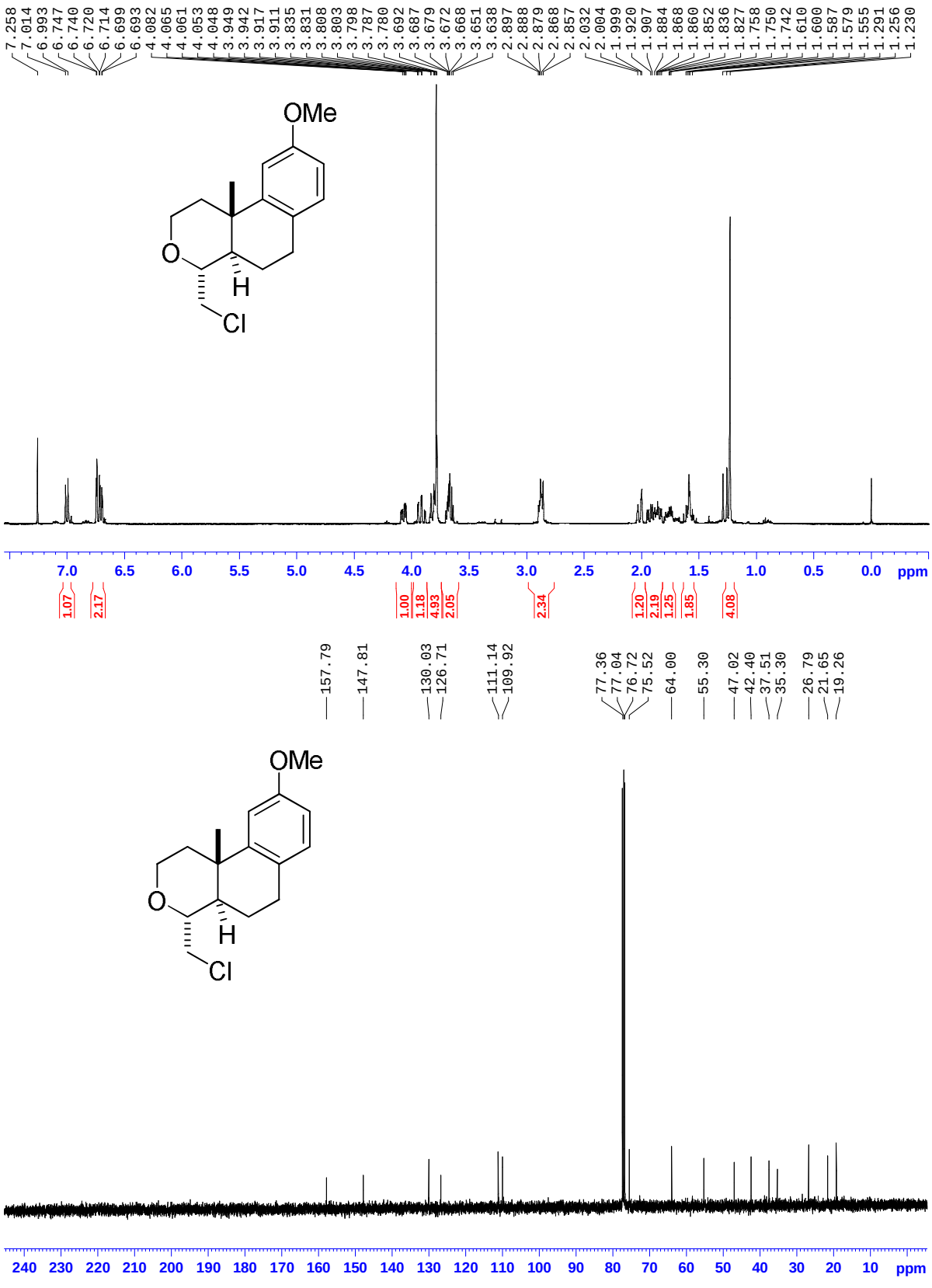
7.172
7.167
7.152
7.149
5.224
5.221
5.204
5.187
5.184
5.169
5.166
5.119
5.104
5.102
5.087
5.085
3.641
3.626
3.611
2.649
2.631
2.610
2.324
2.305
2.285
2.267
2.247
2.232
2.216
2.156
2.138
2.119
2.101
2.076
2.056
2.034
2.014
1.997
1.977
1.960
1.623
1.591
1.551
-0.003
OH
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.14
2.98
1.91
1.00
1.99
2.02
4.06
8.13
3.00
3.00
3.02
1.09
142.43
135.74
134.71
131.15
128.48
128.22
127.95
125.66
124.67
123.64
77.38
77.06
76.74
59.86
42.65
39.68
39.58
36.17
30.00
26.61
26.53
15.99
15.90
15.71
OH
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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6.714
6.699
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4.082
4.065
4.061
4.053
4.048
3.949
3.942
3.917
3.911
3.835
3.831
3.808
3.803
3.798
3.787
3.780
3.692
3.687
3.679
3.672
3.668
3.651
3.638
2.897
2.888
2.879
2.868
2.857
2.032
2.004
1.999
1.920
1.907
1.884
1.868
1.860
1.852
1.836
1.827
1.758
1.750
1.742
1.610
1.600
1.587
1.579
1.555
1.291
1.256
1.230
OMe
O
H
Cl
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.07
2.17
1.00
1.18
4.93
2.05
2.34
1.20
2.19
1.25
1.85
4.08
157.79
147.81
130.03
126.71
111.14
109.92
77.36
77.04
76.72
75.52
64.00
55.30
47.02
42.40
37.51
35.30
26.79
21.65
19.26
OMe
O
H
Cl
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230
220
210
200
190
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170
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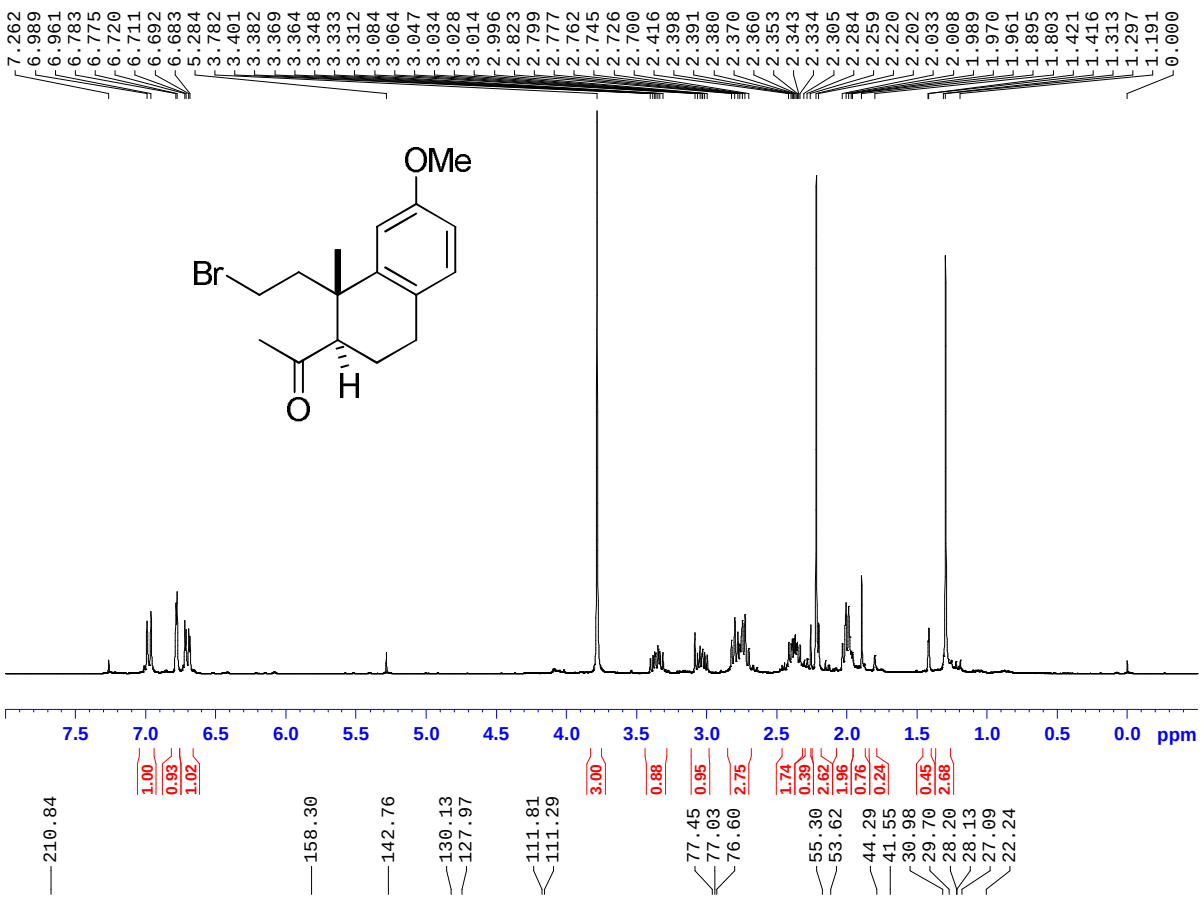
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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6.692
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5.284
3.782
3.401
3.382
3.369
3.364
3.348
3.333
3.312
3.084
3.064
3.047
3.034
3.028
3.014
2.996
2.823
2.799
2.777
2.762
2.745
2.726
2.700
2.416
2.398
2.391
2.380
2.370
2.360
2.353
2.343
2.334
2.305
2.284
2.259
2.220
2.202
2.033
2.008
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1.970
1.961
1.895
1.803
1.421
1.416
1.313
1.297
1.191
0.000
OMe
Br
O
H
7.5
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6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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1.02
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0.95
2.75
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1.96
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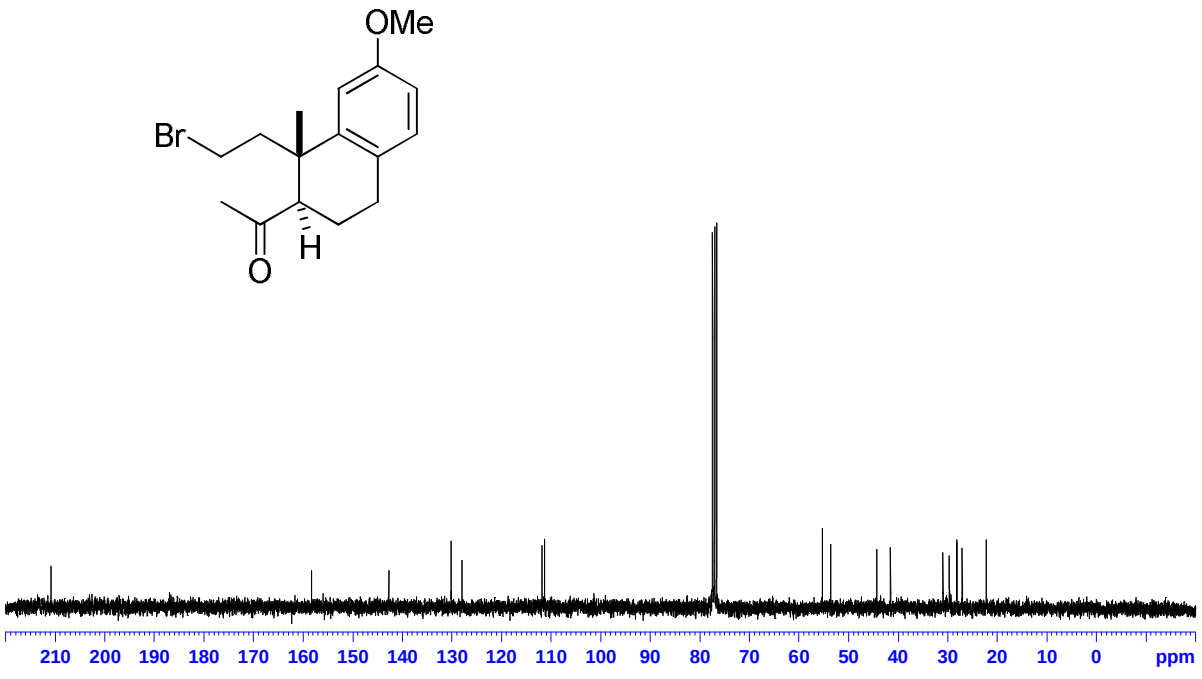
0.24
0.45
2.68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111.29
77.45
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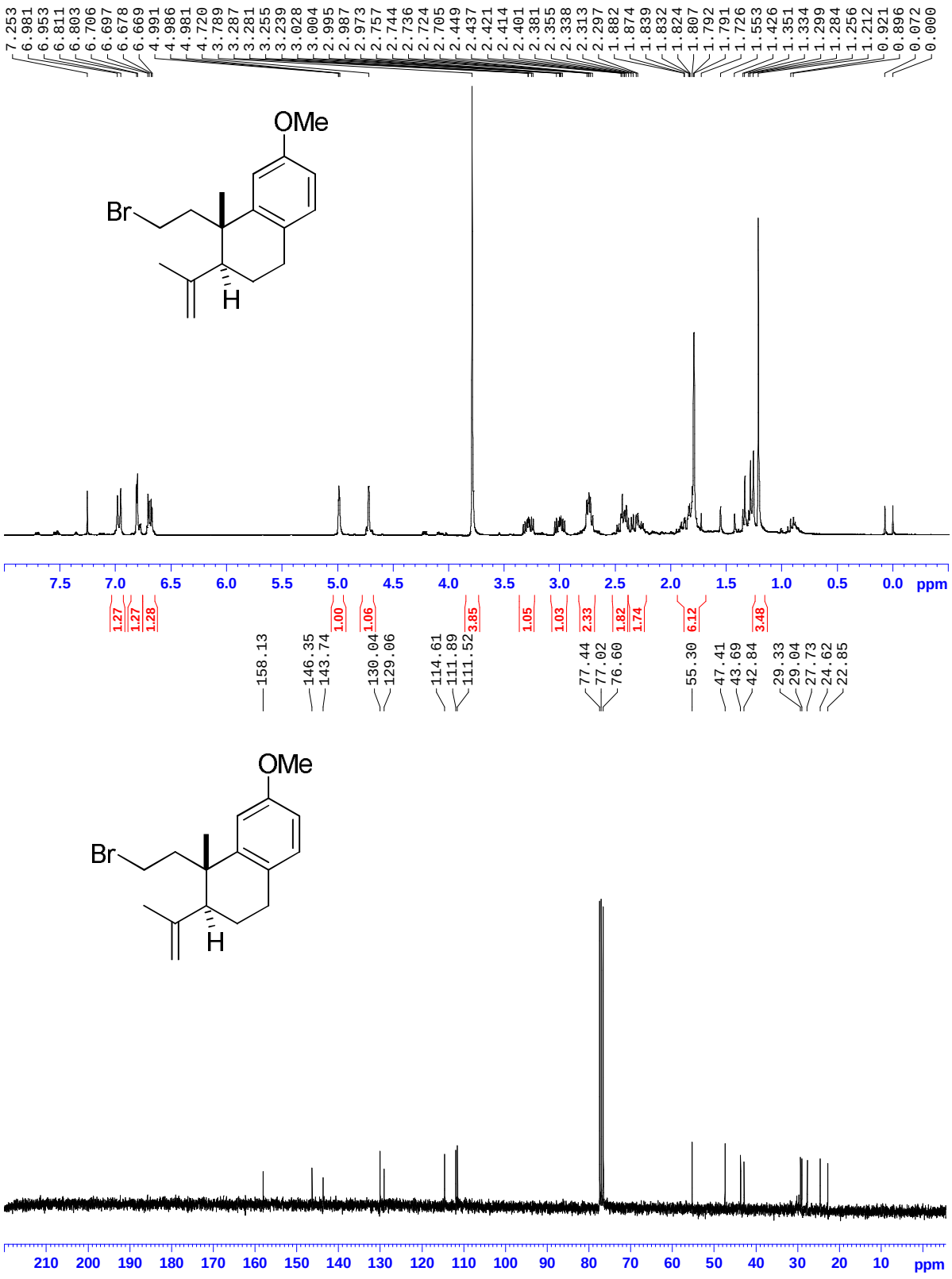
76.60
55.30
53.62
44.29
41.55
30.98
29.70
28.20
28.13
27.09
22.24

OMe
Br
O
H

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm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4.981
4.720
3.789
3.287
3.281
3.255
3.239
3.028
3.004
2.995
2.987
2.973
2.757
2.744
2.736
2.724
2.705
2.449
2.437
2.421
2.414
2.401
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2.355
2.338
2.313
2.297
1.882
1.874
1.839
1.832
1.824
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1.792
1.791
1.726
1.553
1.426
1.351
1.334
1.299
1.284
1.256
1.212
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0.896
0.072
0.000
OMe
Br
H
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7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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1.27
1.28
1.00
1.06
3.85
1.05
1.03
2.33
1.82
1.74
6.12
3.48
158.13
146.35
143.74
130.04
129.06
114.61
111.89
111.52
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77.02
76.60
55.30
47.41
43.69
42.84
29.33
29.04
27.73
24.62
22.85
OMe
Br
H
210
200
190
180
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150
140
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120
110
100
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70
60
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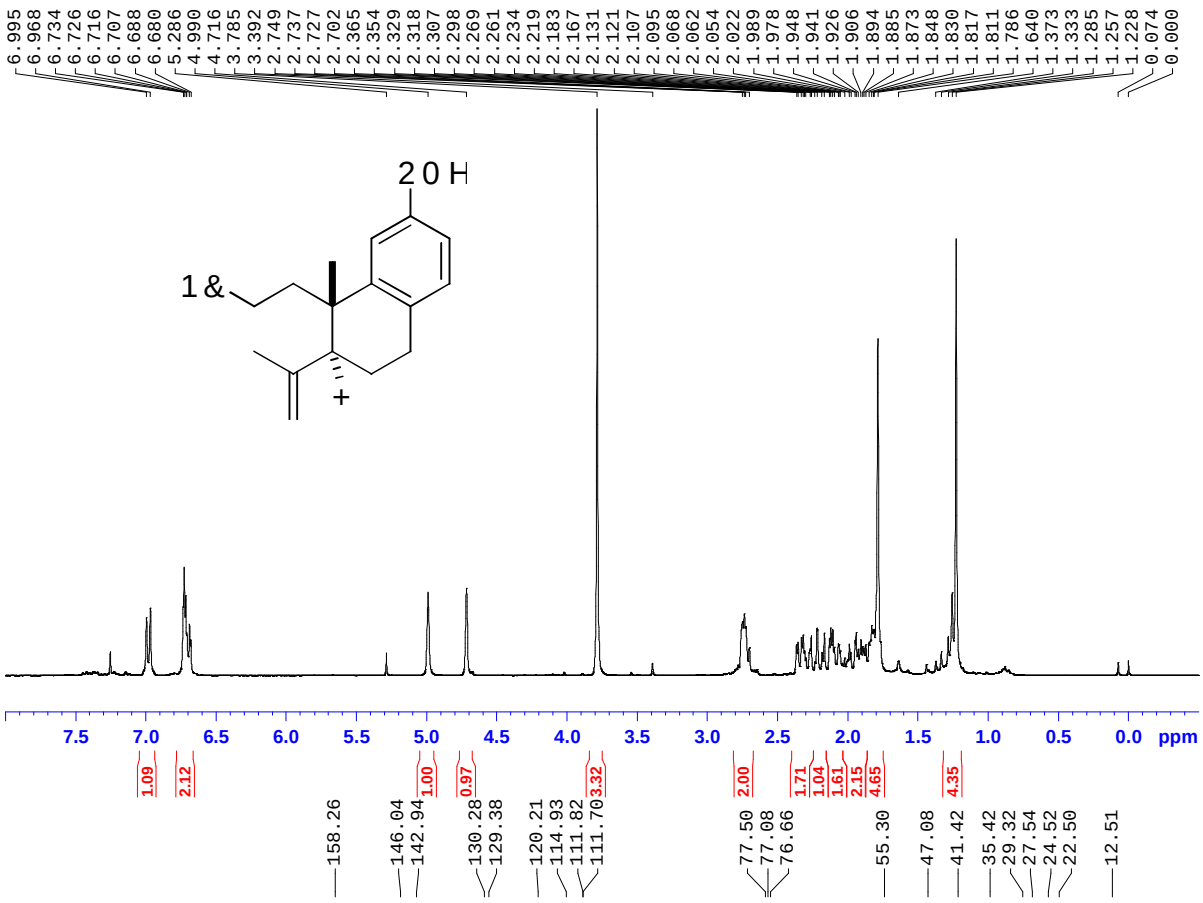
30
20
10
ppm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3.392
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2.737
2.727
2.702
2.365
2.354
2.329
2.318
2.307
2.298
2.269
2.261
2.234
2.219
2.183
2.167
2.131
2.121
2.107
2.095
2.068
2.062
2.054
2.022
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1.941
1.926
1.906
1.894
1.885
1.873
1.848
1.830
1.817
1.811
1.786
1.640
1.373
1.333
1.285
1.257
1.228
0.074
0.000
20H
1&
+
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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2.12
1.00
0.97
3.32
2.00
1.71
1.04
1.61
2.15
4.65
4.35
158.26
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129.38
120.21
114.93
111.82
111.70
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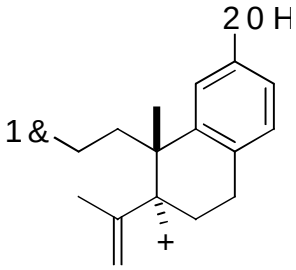
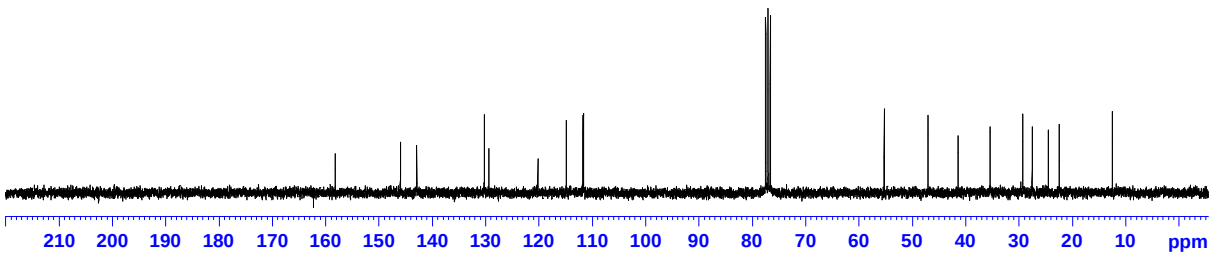
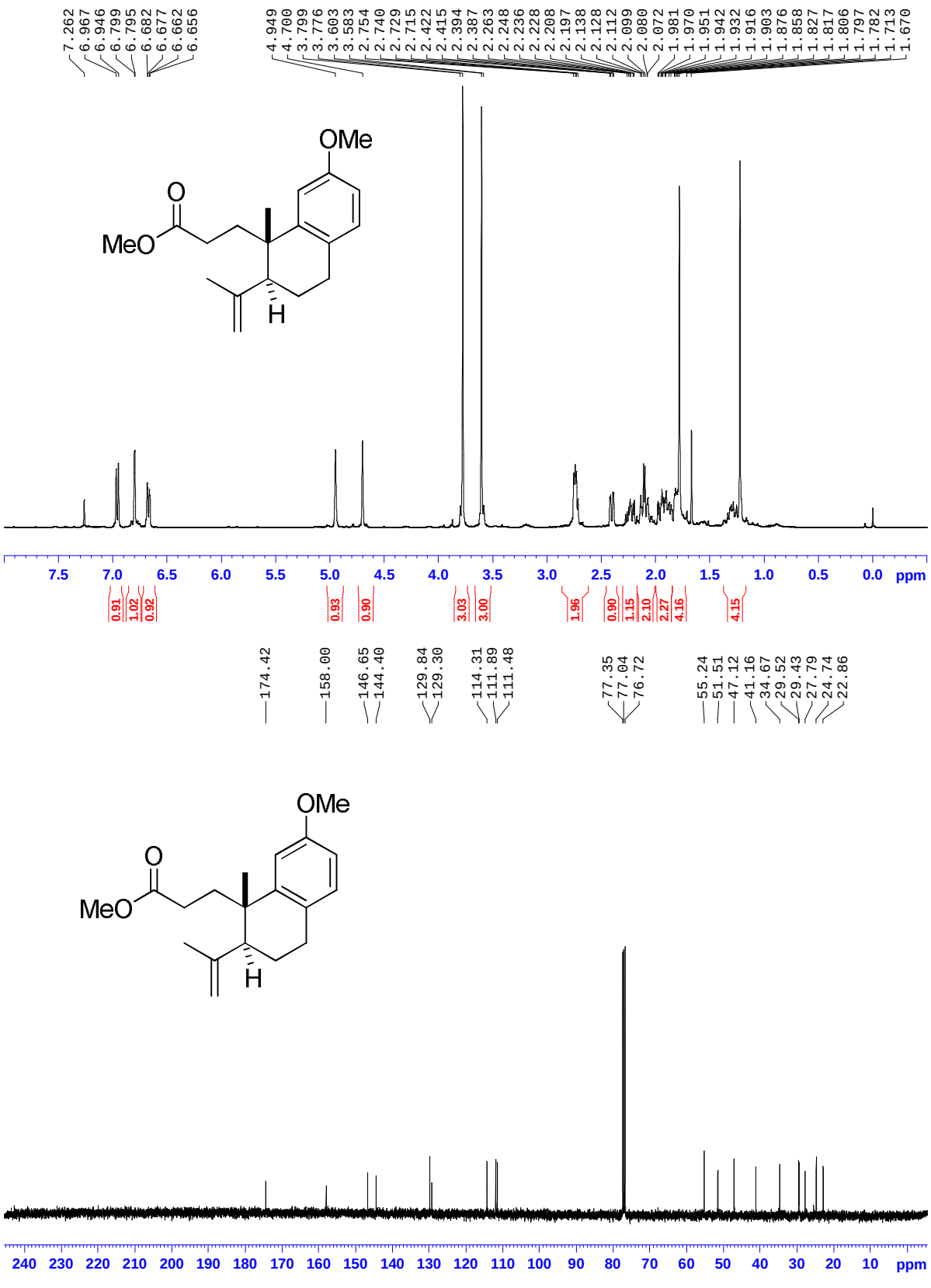
12.51


20H
1&
+


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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6.662
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4.700
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3.776
3.603
3.583
2.754
2.740
2.729
2.715
2.422
2.415
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2.263
2.248
2.236
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2.197
2.138
2.128
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2.072
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1.817
1.806
1.797
1.782
1.713
1.670
OMe
O
MeO
H
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
0.91
1.02
0.92
0.93
0.90
3.03
3.00
1.96
0.90
1.15
2.10
2.27
4.16
4.15
174.42
158.00
146.65
144.40
129.84
129.30
114.31
111.89
111.48
77.35
77.04
76.72
55.24
51.51
47.12
41.16
34.67
29.52
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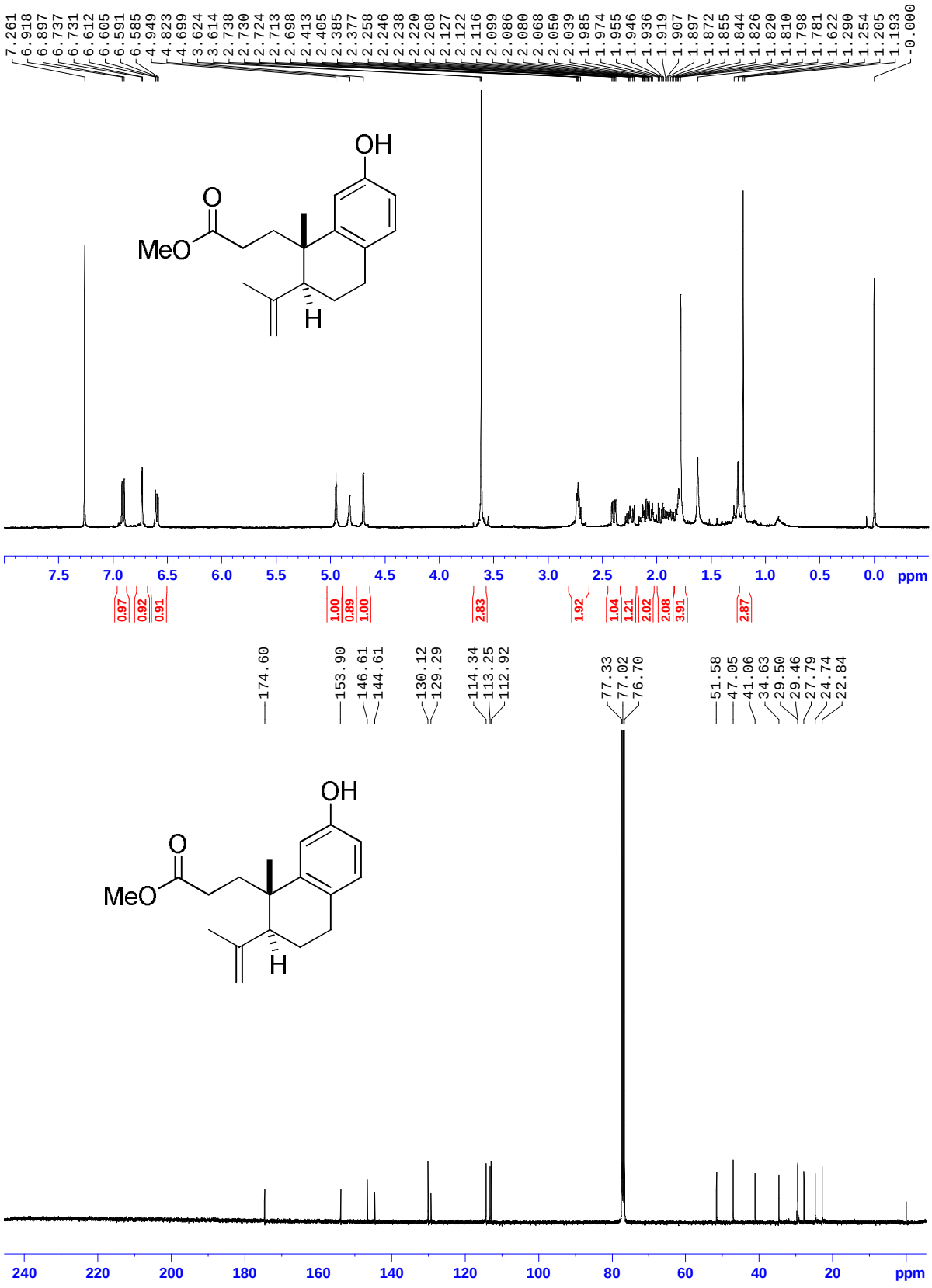
22.86
OMe
O
MeO
H
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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6.591
6.585
4.949
4.823
4.699
3.624
3.614
2.738
2.730
2.724
2.713
2.698
2.413
2.405
2.385
2.377
2.258
2.246
2.238
2.220
2.208
2.127
2.122
2.116
2.099
2.086
2.080
2.068
2.050
2.039
1.985
1.974
1.955
1.946
1.936
1.919
1.907
1.897
1.872
1.855
1.844
1.826
1.820
1.810
1.798
1.781
1.622
1.290
1.254
1.205
1.193
-0.000
OH
O
MeO
H
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
0.97
0.92
0.91
1.00
0.89
1.00
2.83
1.92
1.04
1.21
2.02
2.08
3.91
2.87
174.60
153.90
146.61
144.61
130.12
129.29
114.34
113.25
112.92
77.33
77.02
76.70
51.58
47.05
41.06
34.63
29.50
29.46
27.79
24.74
22.84
OH
O
MeO
H
240
220
200
180
160
140
120
100
80
60
40
20
ppm