Supporting Information

Tandem [5+2]/[4+2] cycloadditions to construct the [6-7-6] tricyclic skeleton of icetexane diterpenes: Total synthesis of euolutchuol E, przewalskine E and brussonol

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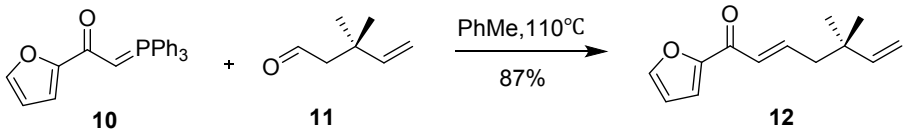
I Experimental Procedures and Spectroscopic Data of Compounds General Procedures. All reactions involving air or moisture sensitive reagents or intermediates were carried out under an argon atmosphere with dry solvents under anhydrous conditions, unless otherwise noted. Reagents were purchased at the highest commercial quality and used without further purification, unless otherwise stated. Solvents purification was conducted according to Purification of Laboratory Chemicals, 8th Edition (W. L. F. Armarego). Tetrahydrofuran and toluene were distilled from sodium/ benzophenone. Dichloromethane and acetonitrile were distilled from calcium hydride. Yields refer to isolated compounds, unless otherwise stated. Reactions were monitored by using thin-layer chromatography (TLC) carried out on 0.25 mm Tsingdao silica gel plates (60F-254) using Tsingdao silica gel (60, particle size 0.040–0.063 mm). The silica gel from the same company was also used for flash column chromatography. NMR spectra were recorded on a Brüker AVANCE 400 (^{1}H: 400 MHz) or a Brüker AVANCE 500 (^{1}H: 500 MHz, ^{13}C: 125 MHz) instrument. Chemical shifts were reported in parts per million (ppm) with respect to the residual solvent signal $CDCl_3$ (^{1}H NMR: δ = 7.26; ^{13}C NMR: δ = 77.16). Peak multiplicities were reported as follows: s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, td = triplet of doublets, dt = doublet of triplets, ddd = doublet of doublet of doublets, m = multiplet, br = broad signal. High resolution mass spectra (HRMS) were recorded on an Agilent Mass spectrometer using ESI-TOF (electrospray ionization-time of flight).

Synthesis of compound (12)



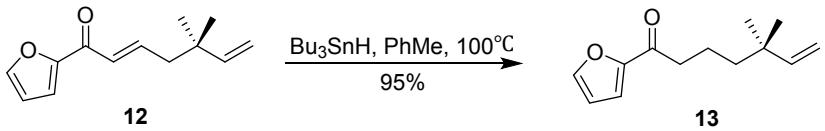
To a solution of phosphonium ylide **10** (54.3 g, 146.6 mmol, 1.0 equiv) in toluene (730 mL, 0.2 M) was added **11** (24.7 g, 219.9 mmol, 1.5 equiv) and the resulting solution was stirred at 110°C with oil bath for overnight. The solution was cooled to room temperature and concentrated in vacuo. Diethyl ether (150 mL) was added to precipitate most of the triphenylphosphine oxide. The filtrate was concentrated in vacuo and the process was repeated twice. The product was purified by using chromatography (PE/EA, 15:1) to afford **12** (26.0 g, 87%) as a pale yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (dd, *J* = 1.7, 0.8 Hz, 1H), 7.22 (dd, *J* = 3.6, 0.8 Hz, 1H), 7.10 (dt, *J* = 15.4, 7.7 Hz, 1H), 6.77 (dt, *J* = 15.3, 1.4 Hz, 1H), 6.54 (dd, *J* = 3.6, 1.7 Hz, 1H), 5.87 – 5.75 (m, 1H), 4.98 (s, 1H), 4.96 – 4.90 (m, 1H), 2.28 (dd, *J* = 7.7, 1.4 Hz, 2H), 1.05 (s, 6H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 178.0, 153.5, 147.3, 146.6, 146.2, 127.2, 117.6, 112.4,

111.5, 45.9, 37.4, 26.9.
HRMS (ESI) m/z: $[M - H]^-$ Calcd for $C_{13}H_{15}O_2$ 203.1078; Found 203.1083.

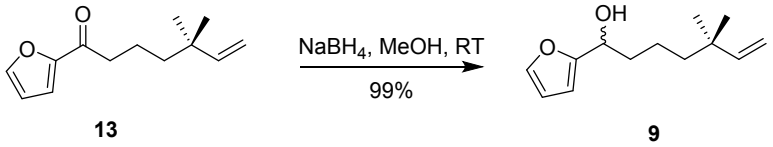
Synthesis of compound (13)



12 **13**

To a stirred solution of the aryl vinyl ketone **12** (20.0 g, 97.9 mmol, 1.0 equiv) in dry toluene (330 mL, 0.3 M) was added tributyltin hydride (52.5 mL, 195.8 mmol, 2.0 equiv) under nitrogen. The reaction mixture was subsequently heated to 100°C with oil bath overnight. Upon completion the reaction, the mixture was concentrated in vacuo and purified by using column chromatography (PE/EA, 30:1) to give the reduction product **13** (19.2 g, 95%) as a pale yellow oil.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (dd, *J* = 1.7, 0.8 Hz, 1H), 7.16 (dd, *J* = 3.6, 0.8 Hz, 1H), 6.52 (dd, *J* = 3.5, 1.7 Hz, 1H), 5.76 (dd, *J* = 17.9, 10.4 Hz, 1H), 4.92 (t, *J* = 1.6 Hz, 1H), 4.90 – 4.85 (m, 1H), 2.77 (t, *J* = 7.5 Hz, 2H), 1.69 – 1.62 (m, 2H), 1.38 – 1.29 (m, 2H), 0.99 (s, 6H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 189.8, 153.0, 148.2, 146.3, 116.9, 112.2, 110.7, 42.4, 39.2, 36.7, 26.8, 19.7.
HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{19}O_2$ 207.1380; Found 207.1377.

Synthesis of compound (9)



13 **9**

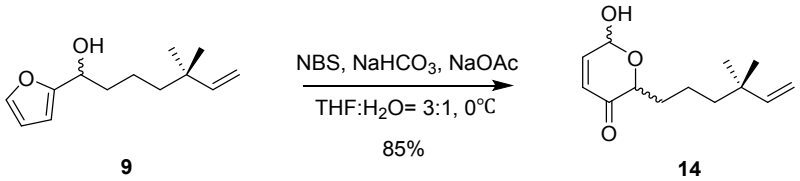
To a stirred solution of ketone **13** (1.433 g, 6.9 mmol, 1.0 equiv) in methanol (35 mL, 0.2 M) was slowly added sodium borohydride (0.315 g, 8.337 mmol, 1.2 equiv) at room temperature. After stirring for 5 minutes, the resulting mixture was quenched with saturated aqueous NH_4Cl solution (10 mL) at 0°C. The reaction mixture was concentrated under reduced pressure in order to remove methanol, and the aqueous layer was extracted with EtOAc (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure to provide crude product **9** (1.439 g, 99%) as a pale yellow oil, which was directly used for the next step without purification.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (dd, *J* = 1.9, 0.9 Hz, 1H), 6.32 (dd, *J* = 3.2, 1.8 Hz, 1H), 6.21 (d, *J* = 3.3 Hz, 1H), 5.80 – 5.68 (m, 1H), 4.91 (s, 1H), 4.89 – 4.82 (m, 1H), 4.66 (td, *J* = 6.8, 4.7 Hz, 1H), 1.87 (d, *J* = 5.0 Hz, 1H), 1.80 (dt, *J* = 7.9, 6.7 Hz, 2H),

1.29 (ddd, J = 12.9, 9.1, 5.1 Hz, 3H), 0.97 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 157.0, 148.5, 142.0, 110.5, 110.3, 105.8, 67.9, 42.6, 36.7, 36.4, 26.8, 20.8.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{21}O_2$ 209.1536; Found 209.1534.

Synthesis of compound (14)



9 **14**

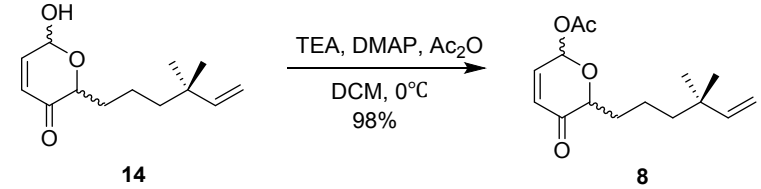
To a solution of compound **9** (1.359 g, 6.525 mmol, 1.0 equiv) in THF (16.5 mL) and H_2O (5.5 mL) were added $NaHCO_3$ (1.135 g, 13.507 mmol, 2.07 equiv), NaOAc (557 mg, 6.786 mmol, 1.04 equiv) and NBS (1.324 g, 7.439 mmol,1.14 equiv) sequentially at 0°C, and the mixture was stirred at the same temperature for 5 min. The reaction was quenched by the addition of water (22.0 mL), followed by extraction with EtOAc (3 × 20 mL). The combined organic layers were washed with brine (20 mL), and then dried over with Na_2SO_4. The solvents were removed under vacuum, and the residue was purified by using flash column chromatography on silica gel (PE/EA, 6:1) to give product **14** (1.248 g, 85%) as a pale yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.90 (ddd, J = 13.6, 10.2, 2.5 Hz, 1H), 6.17 – 6.04 (m, 1H), 5.82 – 5.70 (m, 1H), 5.64 (t, J = 4.1 Hz, 1H), 4.91 (s, 1H), 4.89 – 4.83 (m, 1H), 4.54 (dd, J = 8.2, 3.8 Hz, 1H), 3.04 (d, J = 4.6 Hz, 1H), 1.96 – 1.82 (m, 1H), 1.80 – 1.65 (m, 1H), 1.31 (dddd, J = 13.1, 7.2, 5.3, 3.7 Hz, 3H), 0.98 (d, J = 1.1 Hz, 6H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 196.6, 196.3, 148.6, 148.6, 147.7, 144.3, 128.9, 127.8, 110.5, 110.5, 91.0, 87.8, 79.2, 74.4, 42.7, 42.6, 36.7, 31.5, 30.5, 26.9, 26.9, 20.5, 20.3.

HRMS (ESI) m/z: $[M - H]^-$ Calcd for $C_{13}H_{19}O_3$ 223.1340; Found 223.1339.

Synthesis of compound (8)



14 **8**

To a solution of compound **14** (1.248 g, 5.564 mmol, 1.0 equiv), TEA (1.55 mL, 11.128 mmol, 2.0 equiv) and DMAP (68 mg, 0.556 mmol, 0.1 equiv) in DCM (19 mL, 0.3 M) was added Ac_2O (1.05 mL, 11.128 mmol, 2.0 equiv) dropwise at 0°C. The mixture was stirred at the same temperature for 10 min. The reaction was quenched by the addition of saturated aqueous NH_4Cl solution (10 mL), followed by extraction

with EtOAc (3 × 20 mL). The combined organic layers were dried over by Na_2SO_4. The solvents were removed under vacuum, and the residue was purified by using flash column chromatography on silica gel (PE/EA, 10:1) to give the product **8** (1.459 g, 98%) as a pale yellow oil with a dr value 3:2.

8a: ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.87 (dd, *J* = 10.2, 3.7 Hz, 1H), 6.49 (d, *J* = 3.7 Hz, 1H), 6.20 (d, *J* = 10.2 Hz, 1H), 5.80 – 5.67 (m, 1H), 4.91 (s, 1H), 4.88 – 4.83 (m, 1H), 4.46 (dd, *J* = 7.6, 3.9 Hz, 1H), 2.13 (s, 3H), 1.93 – 1.82 (m, 1H), 1.76 – 1.65 (m, 1H), 1.39 – 1.22 (m, 4H), 0.96 (s, 6H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 195.8, 169.7, 148.5, 141.6, 128.8, 110.5, 87.3, 76.0, 42.5, 36.6, 30.4, 26.9, 26.8, 21.1, 19.8.

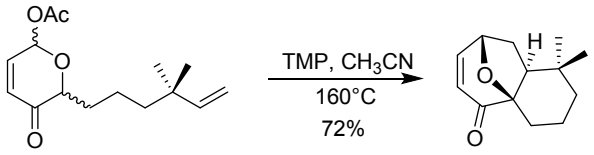
HRMS (ESI) m/z: $[M - AcO]^+$ Calcd for $C_{13}H_{19}O_2$ 207.1380; Found 207.1378.

8b: ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.83 (dd, *J* = 10.4, 2.8 Hz, 1H), 6.54 (dd, *J* = 2.7, 1.2 Hz, 1H), 6.21 (dd, *J* = 10.4, 1.2 Hz, 1H), 5.79 – 5.69 (m, 1H), 4.92 (s, 1H), 4.89 (dd, *J* = 6.6, 1.4 Hz, 1H), 4.21 (dd, *J* = 9.2, 4.9 Hz, 1H), 2.13 (s, 3H), 1.87 – 1.70 (m, 2H), 1.51 – 1.37 (m, 1H), 1.33 (qt, *J* = 7.8, 2.6 Hz, 2H), 1.26 (ddd, *J* = 12.0, 8.9, 4.3 Hz, 2H), 0.98 (s, 6H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 195.9, 169.5, 148.3, 142.8, 128.4, 110.7, 87.7, 79.8, 42.5, 36.7, 33.8, 26.8, 26.8, 21.2, 20.7.

HRMS (ESI) m/z: $[M - H]^-$ Calcd for $C_{15}H_{21}O_4$ 265.1445; Found 265.1452.

Synthesis of compound (15)



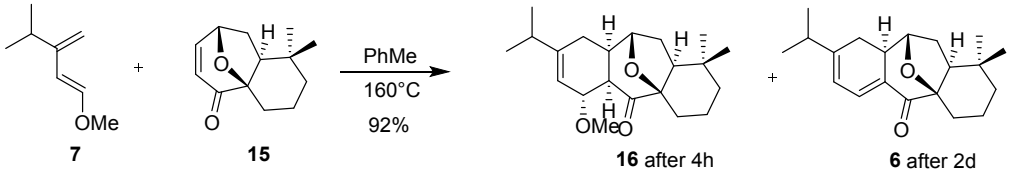
8 **15**

To a solution of precursor **8** (1.0 g, 3.75 mmol, 1.0 equiv) in MeCN (200 mL, <0.02 M) was added TMP (0.95 mL, 5.63 mmol, 1.5 equiv) dropwise at room temperature, and the mixture was stirred at 160°C with oil bath in a sealed tube for 16 h. The reaction mixture was cooled to room temperature, and quenched by the addition of water (30 mL). The mixture was concentrated under reduced pressure in order to remove MeCN, and the aqueous layer was extracted with EtOAc (3 × 15 mL). The combined organic layers were washed with brine (15 mL), and then dried over with Na_2SO_4. The solvents were removed under vacuum, and the residue was purified by using flash column chromatography on silica gel (PE/EA, 15:1) to give the product **15** (554 mg, 72%) as a pale yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (dd, *J* = 9.7, 4.6 Hz, 1H), 5.93 (d, *J* = 9.7 Hz, 1H), 4.67 (dd, *J* = 7.4, 4.6 Hz, 1H), 2.45 (dt, *J* = 15.0, 9.2 Hz, 1H), 2.13 (ddd, *J* = 12.5, 7.4,

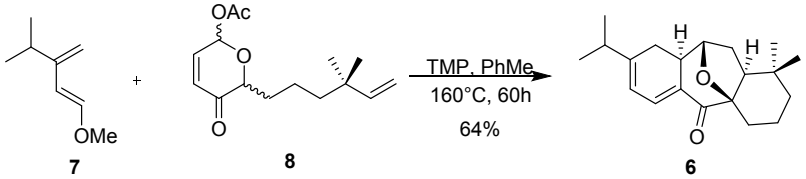
5.2 Hz, 1H), 1.85 (ddd, *J* = 12.5, 8.7, 1.2 Hz, 1H), 1.79 – 1.61 (m, 4H), 1.49 (dt, *J* = 12.8, 6.3 Hz, 1H), 1.21 (dd, *J* = 13.7, 6.9 Hz, 1H), 0.96 (s, 3H), 0.91 (s, 3H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 199.1, 154.3, 125.6, 89.1, 71.7, 45.4, 34.5, 33.1, 31.9, 31.2, 25.9, 23.0, 15.7.
HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{19}O_2$ 207.1380; Found 207.1375.

Synthesis of compound (16) and (6)



The solution of dienophile **15** (1.68 g, 8.144 mmol, 1.0 equiv) and diene **7** (3.08 g, 24.432 mmol, 3.0 equiv) in PhMe (81 mL, 0.1 M) was stirred at 160°C with oil bath in a sealed tube. Upon completion of the reaction, the mixture was concentrated in vacuo and purified by using column chromatography (PE/EA, 25:1) to give product **16** or **6** (92%) depending on the reaction time.

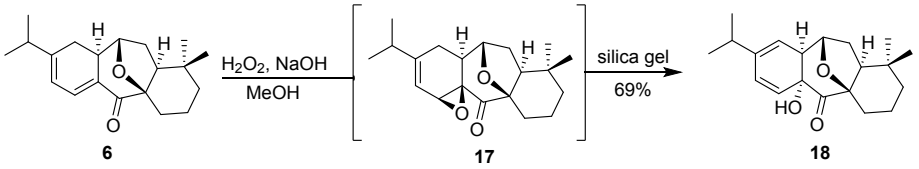
Synthesis of compound (6)



To a solution of precursor **8** (50 mg, 0.188 mmol, 1.0 equiv) and diene **7** (71 mg, 0.563 mmol, 3.0 equiv) in PhMe (4 mL, 0.05 M) was added TMP (40 mg, 0.282 mmol, 1.5 equiv) dropwise at room temperature, and the mixture was stirred at 160°C with oil bath in a sealed tube for 60 h. The reaction mixture was cooled to room temperature, and quenched by the addition of water (2.0 mL), and the aqueous layer was extracted with EtOAc (3 × 5 mL). The combined organic layers were washed with brine (5 mL), and then dried over with Na_2SO_4. The solvents were removed under vacuum, and the residue was purified by using flash column chromatography on silica gel (PE/EA, 25:1) to give the product **6** (36 mg, 64%) as a pale yellow oil.
^{1}H NMR (400 MHz, $CDCl_3$) δ 6.80 (dd, *J* = 5.4, 2.3 Hz, 1H), 5.89 (ddd, *J* = 5.2, 2.5, 1.2 Hz, 1H), 4.20 (dd, *J* = 8.4, 3.6 Hz, 1H), 2.55 – 2.29 (m, 3H), 2.24 (dd, *J* = 13.9, 8.3 Hz, 1H), 2.20 – 2.06 (m, 2H), 1.80 (dd, *J* = 8.5, 1.4 Hz, 1H), 1.78 – 1.70 (m, 1H), 1.64 (ddd, *J* = 14.0, 4.9, 3.6 Hz, 1H), 1.58 (dd, *J* = 5.3, 3.8 Hz, 1H), 1.56 – 1.48 (m, 1H), 1.48 – 1.41 (m, 1H), 1.27 (tt, *J* = 10.4, 3.5 Hz, 2H), 1.07 (dd, *J* = 6.8, 3.0 Hz, 6H), 0.92 (s, 3H), 0.85 (s, 4H);

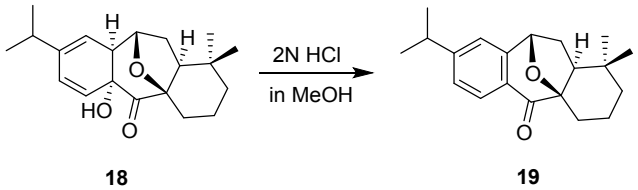
^{13}C NMR (126 MHz, $CDCl_3$) δ 204.4, 154.5, 134.2, 129.0, 117.5, 88.7, 75.5, 50.0, 42.8, 39.0, 35.3, 33.4, 32.0, 31.7, 31.4, 26.3, 22.5, 21.5, 20.5, 17.1.
HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{29}O_2$ 301.2162; Found 301.2168.

Synthesis of compound (18)



To a solution of **6** (300 mg, 0.998 mmol, 1.0 equiv) in MeOH (18 mL) was added aqueous NaOH (10%, 0.18 mL, 0.499 mmol, 0.5 equiv) and 50% H_2O_2 (0.6 mL, 5.991 mmol, 6.0 equiv). The reaction mixture was stirred at room temperature for 30 min and diluted with EtOAc (50 mL). The organic phase was washed with water (2 × 10 mL) and then dried over with Na_2SO_4. The solvent was evaporated in vacuo. The residue was purified by using flash chromatography on silica gel (PE/EA, 20:1) to give the product **18** (218 mg, 69%), and a 2h residence time in silica gel is needed.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.12 (dd, *J* = 9.5, 1.3 Hz, 1H), 5.59 – 5.50 (m, 1H), 5.14 (d, *J* = 9.6 Hz, 1H), 4.31 (dd, *J* = 8.6, 3.8 Hz, 1H), 4.01 (s, 1H), 2.37 (t, *J* = 6.2 Hz, 2H), 2.23 (dd, *J* = 14.2, 8.6 Hz, 1H), 1.88 (td, *J* = 14.0, 5.4 Hz, 1H), 1.81 – 1.72 (m, 2H), 1.70 – 1.55 (m, 3H), 1.49 – 1.39 (m, 2H), 1.31 – 1.23 (m, 2H), 1.08 (dd, *J* = 18.1, 6.8 Hz, 6H), 0.83 (d, *J* = 6.1 Hz, 6H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 217.8, 138.5, 129.2, 122.8, 119.6, 89.7, 78.8, 72.9, 51.0, 50.8, 39.0, 33.0, 33.0, 31.7, 31.5, 28.4, 21.9, 21.0, 16.9.
HRMS (ESI) m/z: $[M - OH]^+$ Calcd for $C_{20}H_{27}O_2$ 299.2006; Found 299.1999.

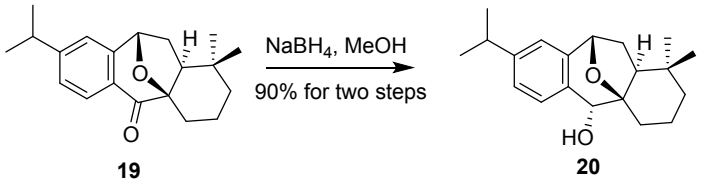
Synthesis of compound (19)



To a solution of 2N HCl in MeOH (20 mL) was added alcohol **18** (750 mg, 2.370 mmol, 1.0 equiv). The reaction mixture was stirred at room temperature overnight and then diluted with EtOAc (60 mL). The organic phase was sequentially washed with water (15 mL), saturated aqueous $NaHCO_3$ solution (15 mL), brine (15 mL) and dried over Na_2SO_4. The solvent was evaporated in vacuo to give product **19**. The crude product was directly used for the next step without purification.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.0 Hz, 1H), 7.21 (dd, *J* = 8.0, 1.7 Hz, 1H),

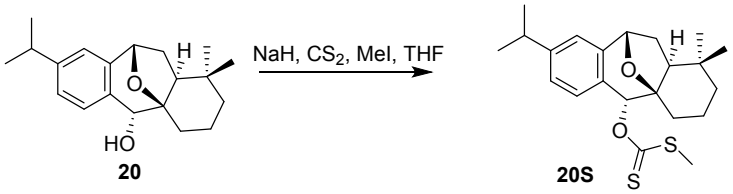
7.04 (d, *J* = 1.7 Hz, 1H), 5.08 (dd, *J* = 7.6, 1.6 Hz, 1H), 2.94 (hept, *J* = 6.9 Hz, 1H), 2.55 (ddd, *J* = 15.1, 11.1, 7.8 Hz, 1H), 2.45 – 2.33 (m, 1H), 1.89 – 1.79 (m, 2H), 1.75 (dd, *J* = 8.7, 4.1 Hz, 1H), 1.68 (dddd, *J* = 12.7, 8.4, 5.8, 3.5 Hz, 2H), 1.54 (dt, *J* = 13.5, 5.3 Hz, 1H), 1.34 – 1.28 (m, 1H), 1.26 (d, *J* = 6.9 Hz, 7H), 0.96 (s, 3H), 0.94 (s, 3H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 198.1, 155.4, 149.4, 128.1, 126.7, 126.0, 120.9, 89.2, 75.7, 46.1, 36.1, 35.7, 34.7, 32.0, 31.5, 24.9, 24.3, 23.8, 23.8, 16.2.
HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{27}O_2$ 299.2006; Found 299.2010.

Synthesis of compound (20)



To a stirred solution of the aryl ketone **19** from the above reaction in methanol (12 mL) was slowly added sodium borohydride (108 mg, 2.844 mmol, 1.2 equiv) at room temperature. After stirring for 5 minutes, the resulting mixture was quenched with saturated aqueous NH_4Cl solution (5 mL) at 0°C. The mixture was concentrated under reduced pressure and the aqueous layer was extracted with EtOAc (3 × 15 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by using flash chromatography on silica gel (PE/EA, 10:1) to provide crude product **20** (635 mg, 90% for two steps).
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41 (d, *J* = 7.9 Hz, 1H), 7.13 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.82 (d, *J* = 1.9 Hz, 1H), 4.91 – 4.81 (m, 1H), 4.65 (s, 1H), 2.86 (hept, *J* = 6.9 Hz, 1H), 2.20 (dt, *J* = 14.5, 9.2 Hz, 1H), 2.15 – 2.03 (m, 2H), 1.91 – 1.63 (m, 6H), 1.55 (dt, *J* = 13.8, 8.6 Hz, 1H), 1.23 (dd, *J* = 6.9, 1.8 Hz, 6H), 1.20 – 1.13 (m, 1H), 1.02 (s, 3H), 0.92 – 0.84 (m, 1H), 0.82 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 148.1, 140.7, 133.8, 127.1, 125.8, 121.3, 83.6, 76.4, 74.9, 43.1, 38.9, 34.0, 31.2, 29.9, 29.7, 28.4, 25.9, 24.1, 24.1, 15.3.
HRMS (ESI) m/z: $[M - H]^-$ Calcd for $C_{20}H_{27}O_2$ 299.2017; Found 299.2016.

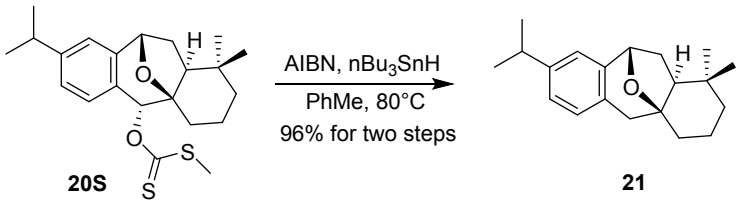
Synthesis of compound (20S)



To a solution of **20** (630 mg, 2.097 mmol, 1.0 equiv) in dry THF (21 mL, 0.1 M) was added NaH (60% in mineral oil, 252 mg, 6.291 mmol, 3.0 equiv). After the mixture

was stirred at rt for about 30 min, CS_2 (760 μL, 12.582 mmol, 6.0 equiv) was added and the stirring was continued for 1 h. MeI (1.57 mL, 25.164 mmol, 12.0 equiv) was then added. The resultant mixture was stirred at rt overnight, quenched with saturated $NaHCO_3$ solution (20 mL), and extracted with EtOAc (3 × 20 mL). The combined organic layers were washed with brine (20 mL), dried over Na_2SO_4, filtered, and concentrated to give product **20S**. The crude product was directly used for the next step without purification.

Synthesis of compound (21)



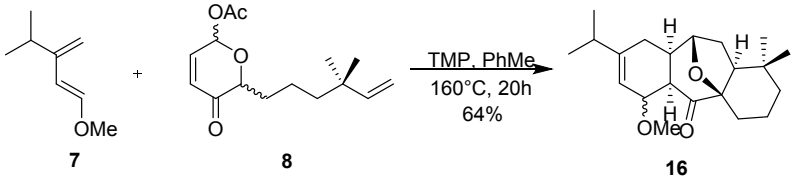
The crude xantate **20S** from the above reaction was dissolved in dry toluene (50 mL) and heated to 80°C. A solution of *n*Bu_3SnH (2.18 mL, 10.485 mmol, 5.0 equiv) and AIBN (76 mg, 0.461 mmol, 0.22 equiv) in toluene (50 mL) was added dropwise. The mixture was stirred at 80°C with oil bath overnight, cooled to rt, and then concentrated under reduced pressure. The residue was purified by using flash chromatography (PE/EA, 40:1) to give product **21** (576 mg, 96% for two steps) as a white solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.05 – 6.95 (m, 2H), 6.86 (d, *J* = 1.8 Hz, 1H), 4.89 (d, *J* = 6.7 Hz, 1H), 2.93 (d, *J* = 16.4 Hz, 1H), 2.85 (p, *J* = 6.9 Hz, 1H), 2.51 (d, *J* = 16.4 Hz, 1H), 2.14 (dt, *J* = 12.0, 6.9 Hz, 1H), 2.04 – 1.96 (m, 1H), 1.92 (dd, *J* = 12.1, 8.3 Hz, 1H), 1.81 (ddd, *J* = 16.7, 6.4, 3.3 Hz, 2H), 1.67 – 1.62 (m, 1H), 1.53 (dt, *J* = 14.1, 7.3 Hz, 1H), 1.38 – 1.34 (m, 1H), 1.32 – 1.28 (m, 1H), 1.23 (dd, *J* = 6.9, 2.0 Hz, 6H), 0.96 (s, 3H), 0.85 (s, 3H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 146.3, 141.8, 130.5, 129.0, 124.9, 121.8, 80.7, 76.5, 50.9, 44.0, 39.8, 33.9, 32.4, 32.0, 30.8, 30.7, 28.0, 27.0, 26.9, 24.3, 24.2, 17.7, 16.3, 13.7.

HRMS (ESI) m/z: $[M - H]^-$ Calcd for $C_{20}H_{27}O$ 283.2067; Found 283.2052.

Synthesis of compound (16)



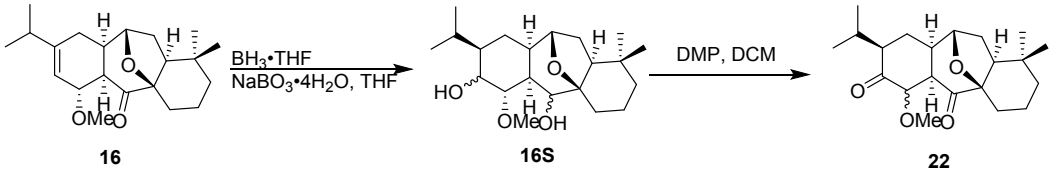
To a solution of precursor **8** (50 mg, 0.188 mmol, 1.0 equiv) in PhMe (4 mL, 0.05 M)

was added TMP (48 μL, 0.282 mmol, 1.5 equiv) dropwise at room temperature, and the mixture was stirred at 160°C with oil bath in a sealed tube for 16 h. The reaction mixture was cooled to room temperature, and then **7** (71 mg, 0.563 mmol, 3.0 equiv) was added. The reaction reaction was stirred at 160°C again for 4 h before it was cooled to room temperature. After the reaction was quenched by the addition of water (2.0 mL), the aqueous layer was extracted with EtOAc (3 × 5 mL). The combined organic layers were washed with brine (5 mL), and then dried over with Na_2SO_4. The solvent were removed under vacuum, and the residue was purified by using flash column chromatography on silica gel (PE/EA, 25:1) to give the product **16** (40 mg, 64%) with a dr value 4:1.

16a: ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.63 – 5.54 (m, 1H), 4.29 (dd, *J* = 4.0, 2.1 Hz, 1H), 4.25 (d, *J* = 7.7 Hz, 1H), 3.35 (s, 3H), 2.84 (dd, *J* = 6.3, 2.1 Hz, 1H), 2.24 (dddd, *J* = 21.1, 14.7, 8.9, 2.7 Hz, 5H), 2.08 (ddd, *J* = 13.7, 9.1, 1.9 Hz, 1H), 1.98 (q, *J* = 10.8 Hz, 1H), 1.81 (dd, *J* = 9.0, 3.4 Hz, 1H), 1.71 – 1.64 (m, 1H), 1.48 (dddd, *J* = 16.6, 11.5, 6.5, 3.5 Hz, 2H), 1.14 (ddt, *J* = 14.4, 8.4, 3.8 Hz, 1H), 1.00 (dd, *J* = 6.9, 3.5 Hz, 6H), 0.94 (s, 3H), 0.91 (s, 3H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 207.8, 147.5, 116.7, 88.0, 77.5, 72.2, 56.4, 49.5, 46.6, 40.3, 37.3, 35.2, 32.6, 31.7, 31.3, 27.7, 24.7, 24.2, 21.3, 20.9, 16.6.
HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{21}H_{32}O_3Na$ 355.2244; Found 355.2239.

16b: ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.76 (dd, *J* = 5.9, 2.8 Hz, 1H), 4.16 – 4.07 (m, 2H), 3.11 (s, 3H), 2.59 (ddd, *J* = 14.7, 12.2, 2.9 Hz, 1H), 2.51 (dd, *J* = 10.5, 5.1 Hz, 1H), 2.32 (p, *J* = 6.9 Hz, 1H), 2.16 (dd, *J* = 13.8, 8.5 Hz, 1H), 2.07 (dd, *J* = 14.2, 5.9 Hz, 1H), 1.95 (ddd, *J* = 14.7, 13.4, 5.2 Hz, 1H), 1.90 – 1.78 (m, 2H), 1.69 (tdd, *J* = 13.4, 4.6, 2.8 Hz, 1H), 1.62 (d, *J* = 8.3 Hz, 1H), 1.53 – 1.40 (m, 3H), 1.30 – 1.22 (m, 1H), 1.03 (dd, *J* = 6.8, 2.4 Hz, 6H), 0.91 (s, 3H), 0.82 (s, 3H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 216.6, 154.8, 118.2, 89.7, 76.4, 76.1, 56.2, 50.4, 48.4, 39.8, 39.6, 35.3, 32.0, 31.9, 31.7, 30.5, 26.0, 22.2, 21.0, 20.6, 17.1.
HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{21}H_{32}O_3Na$ 355.2244; Found 355.2238.

Synthesis of compound (22)



To a solution of **16** (371 mg, 1.116 mmol, 1.0 equiv) in dry THF (11 mL, 0.1 M) was added BH_3·THF (1.0 M in THF, 2.8 mL, 2.790 mmol, 2.5 equiv) at 0°C. After the

mixture was stirred at 0°C for about 10 min, the reaction mixture was heated to 35°C with oil bath and stirred for 2 h. The reaction mixture was cooled to 0°C and quenched by the addition of water (11 mL). $NaBO_3 \cdot 4H_2O$ (343 mg, 2.232 mmol, 2.0 equiv) was then added. The resultant mixture was stirred at rt for 4 h, diluted with water (11 mL), and extracted with EtOAc (3 × 20 mL). The combined organic layers were washed with brine (20 mL), and dried over Na_2SO_4, filtered, and concentrated to give product **16S**.

To a solution of crude product **16S** in DCM (11 mL, 0.1 M) was slowly added DMP (1.136 g, 2.678 mmol, 2.4 equiv) at room temperature. After stirring for 30 minutes, the resulting mixture was quenched with saturated aqueous Na_2SO_3 solution (2 mL) and water (10 mL), and extracted with DCM (3 × 15 mL). The combined organic layers were washed with brine (15 mL), and dried over by Na_2SO_4, filtered, and concentrated to give product **22** with a dr value 4:1. The crude product was directly used for the next step without purification.

22a: ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.28 – 4.18 (m, 2H), 3.41 (s, 3H), 2.75 (t, *J* = 8.2 Hz, 1H), 2.44 (dt, *J* = 9.5, 6.1 Hz, 1H), 2.28 (ddd, *J* = 14.0, 8.4, 2.1 Hz, 1H), 2.24 – 2.16 (m, 2H), 2.11 (dq, *J* = 10.9, 5.2 Hz, 1H), 2.08 – 2.02 (m, 1H), 1.87 (ddd, *J* = 14.1, 9.2, 5.1 Hz, 1H), 1.84 – 1.78 (m, 2H), 1.63 (ddd, *J* = 12.0, 8.9, 3.0 Hz, 3H), 1.52 (dq, *J* = 10.7, 3.2 Hz, 1H), 1.49 – 1.42 (m, 1H), 1.25 (dd, *J* = 12.7, 3.9 Hz, 1H), 0.96 (d, *J* = 6.8 Hz, 3H), 0.89 (d, *J* = 6.4 Hz, 6H), 0.86 (s, 3H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 212.2, 209.4, 90.3, 82.4, 78.3, 58.9, 52.5, 51.1, 49.1, 41.8, 38.3, 34.1, 31.9, 31.6, 30.9, 27.7, 27.1, 23.0, 21.1, 19.1, 16.9.

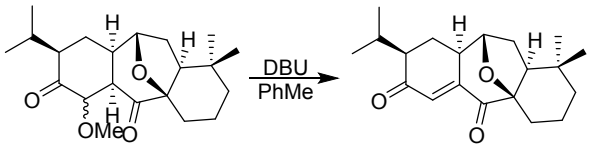
HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{33}O_4$ 349.2373; Found 349.2380.

22b: ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.20 (dd, *J* = 8.6, 3.7 Hz, 1H), 3.63 (d, *J* = 4.9 Hz, 1H), 3.25 (s, 3H), 2.80 (dd, *J* = 10.1, 5.0 Hz, 1H), 2.57 (q, *J* = 13.2 Hz, 1H), 2.40 – 2.34 (m, 1H), 2.23 (dd, *J* = 14.0, 8.4 Hz, 1H), 1.99 (ddt, *J* = 18.5, 13.3, 7.4 Hz, 3H), 1.88 – 1.81 (m, 1H), 1.78 (dt, *J* = 13.0, 4.7 Hz, 1H), 1.68 – 1.63 (m, 3H), 1.47 (dd, *J* = 21.3, 10.4 Hz, 4H), 0.98 (d, *J* = 7.0 Hz, 3H), 0.92 (s, 4H), 0.84 (s, 6H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 213.2, 208.7, 90.6, 84.3, 76.3, 59.0, 53.9, 49.9, 46.1, 40.5, 39.3, 32.2, 31.9, 31.7, 29.8, 29.0, 26.5, 25.8, 22.3, 20.8, 18.9, 16.9.

HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{21}H_{32}O_4Na$ 371.2193; Found 371.2189.

Synthesis of compound (23)



22 **23**

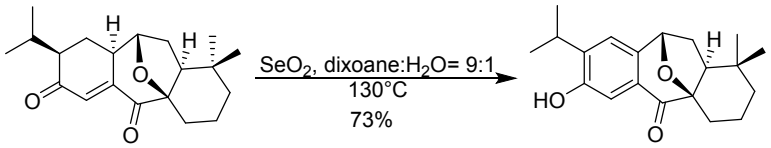
To a solution of crude **22** from the above reaction in PhMe (22 mL, 0.05 M) was added DBU (334 μL, 2.232 mmol, 2.0 equiv) at rt. After stirring for 30 minutes, the resulting mixture was quenched with saturated aqueous NH_4Cl solution (5 mL), and extracted with EtOAc (3 × 15 mL). The combined organic layers were washed with 1N HCl solution (10 mL), saturated aqueous $NaHCO_3$ solution (10 mL) and then brine (10 mL). After drying over Na_2SO_4, the solvent was removed under vacuum, and the residue was purified by using flash column chromatography on silica gel (PE/EA, 15:1) to give the product **23** (219 mg, 62% for 3 steps).

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.25 (d, *J* = 68.7 Hz, 1H), 4.22 (ddd, *J* = 43.6, 8.6, 3.4 Hz, 1H), 2.54 (t, *J* = 8.1 Hz, 1H), 2.39 (dd, *J* = 14.1, 8.5 Hz, 1H), 2.32 – 2.25 (m, 2H), 2.16 – 2.10 (m, 1H), 2.03 – 1.89 (m, 2H), 1.86 – 1.76 (m, 2H), 1.62 (dd, *J* = 8.8, 4.3 Hz, 2H), 1.48 (d, *J* = 12.8 Hz, 1H), 1.28 (dd, *J* = 15.6, 11.6 Hz, 2H), 1.01 (dd, *J* = 30.2, 6.8 Hz, 3H), 0.95 – 0.90 (m, 3H), 0.91 – 0.78 (m, 6H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 207.3, 201.8, 154.2, 129.3, 90.9, 76.1, 52.8, 49.2, 41.9, 38.7, 34.7, 33.7, 31.9, 31.6, 26.9, 26.6, 22.5, 21.6, 21.2, 16.8.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{29}O_3$ 317.2111; Found 317.2107.

Synthesis of compound (24)



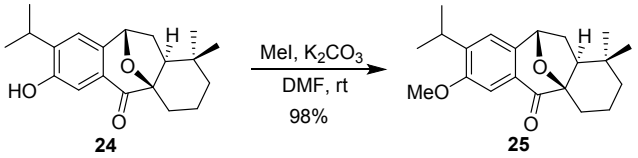
23 **24**

A solution of **23** (208 mg, 0.657 mmol, 1.0 equiv) in dioxane (12 mL) and H_2O (1.4 mL) was added SeO_2 (218 mg, 1.971 mmol, 3.0 equiv) at room temperature, and the mixture was stirred at 130°C with oil bath in a sealed tube overnight. The reaction mixture was cooled to room temperature, diluted with Et_2O (25 mL) and filtered through a pad of Celite^R. The organic solvents were evaporated under reduced pressure and the residue was purified by using flash column chromatography (PE/EA, 15:1) to give product **24** (163 mg, 73%).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (s, 1H), 7.03 (s, 1H), 5.90 (s, 1H), 5.07 (dd, *J* = 7.4, 1.4 Hz, 1H), 3.32 (hept, *J* = 6.9 Hz, 1H), 2.53 (ddd, *J* = 15.1, 10.7, 8.1 Hz, 1H), 2.36 (ddd, *J* = 12.2, 7.5, 4.5 Hz, 1H), 1.88 – 1.77 (m, 2H), 1.73 (dd, *J* = 8.7, 4.4 Hz, 2H), 1.54 (dt, *J* = 13.4, 5.7 Hz, 1H), 1.32 – 1.27 (m, 2H), 1.25 (dd, *J* = 7.0, 1.3 Hz,

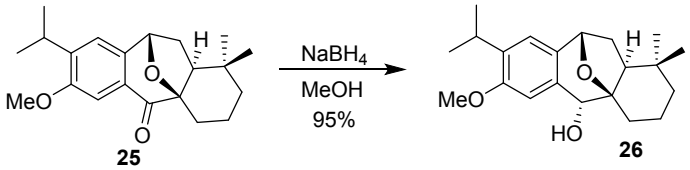
6H), 0.95 (d, J = 3.3 Hz, 6H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 198.7, 152.8, 142.3, 142.0, 127.1, 121.3, 113.4, 88.7, 75.4, 46.0, 35.6, 35.5, 32.0, 31.4, 27.6, 25.3, 24.0, 22.5, 22.3, 16.0.
HRMS (ESI) m/z: $[M - H]^-$ Calcd for $C_{20}H_{25}O_3$ 313.1809; Found 313.1814.

Synthesis of compound (25)



Compound **24** (44 mg, 0.140 mmol, 1.0 equiv) was dissolved in DMF (1 mL) followed by the addition of anhydrous K_2CO_3 (48 mg, 0.350 mmol, 2.5 equiv) and MeI (18 μL, 0.280 mmol, 2.0 equiv). After 4 hours, the solution was diluted with diethyl ether (3 mL) and aqueous HCl (1 mL, 1.0 M) was carefully added. The aqueous phase was extracted with diethyl ether (2 × 4 mL), and the combined organic phases were sequentially washed with aqueous HCl (2 mL, 1.0 M), saturated aqueous $NaHCO_3$ (2 mL), water (2 mL), brine (2 mL) and then dried over anhydrous Na_2SO_4. After removal of the solvent under reduced pressure, the crude product was purified by using flash chromatography on silica gel (PE/EA, 20:1) to give compound **25** (45 mg, 98%) as a pale yellow oil.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39 (s, 1H), 7.03 (s, 1H), 5.07 (d, J = 7.3 Hz, 1H), 3.85 (d, J = 1.8 Hz, 3H), 3.41 – 3.29 (m, 1H), 2.56 (ddd, J = 15.6, 10.5, 8.4 Hz, 1H), 2.36 (ddd, J = 13.5, 6.7, 2.8 Hz, 1H), 1.89 – 1.78 (m, 2H), 1.71 (ddd, J = 29.4, 10.4, 4.9 Hz, 3H), 1.31 – 1.24 (m, 2H), 1.21 (d, J = 6.9 Hz, 6H), 0.95 (t, J = 2.4 Hz, 6H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 198.1, 156.5, 143.9, 142.3, 127.1, 120.9, 108.3, 88.7, 75.4, 55.8, 46.0, 35.7, 35.6, 32.0, 31.4, 27.3, 25.3, 24.1, 22.6, 22.5, 16.1.
HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{29}O_3$ 329.2111; Found 329.2115.

Synthesis of compound (26)



To a stirred solution of aryl ketone **25** (40 mg, 0.122 mmol, 1.0 equiv) in methanol (1 mL) was slowly added sodium borohydride (5.5 mg, 0.146 mmol, 1.2 equiv) at room temperature. After stirring for 5 minutes, the resulting mixture was quenched with saturated aqueous NH_4Cl solution (1 mL) at 0°C. The mixture was concentrated under reduced pressure to remove methanol, and the aqueous layer was extracted with

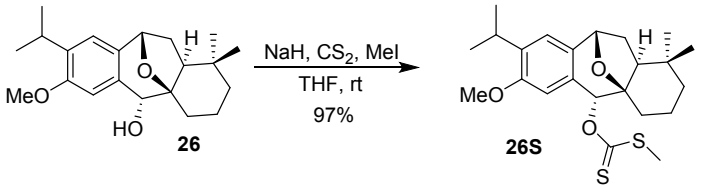
EtOAc (3 × 3 mL). Then the combined organic layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by using flash chromatography on silica gel (PE/EA, 10:1) to provide crude product **26** (38 mg, 95%) as a white solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.98 (s, 1H), 6.79 (d, *J* = 1.9 Hz, 1H), 4.91 – 4.80 (m, 1H), 4.63 (d, *J* = 8.4 Hz, 1H), 3.82 (s, 3H), 3.27 (p, *J* = 6.9 Hz, 1H), 2.20 (dt, *J* = 15.0, 9.2 Hz, 1H), 2.13 – 2.03 (m, 2H), 1.89 – 1.76 (m, 3H), 1.76 – 1.64 (m, 2H), 1.53 (m, 1H), 1.18 (dd, *J* = 6.9, 1.8 Hz, 6H), 1.03 (d, *J* = 1.8 Hz, 3H), 0.82 (d, *J* = 1.9 Hz, 3H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 156.5, 136.2, 134.3, 132.8, 121.2, 109.0, 83.3, 76.1, 75.2, 55.7, 43.2, 39.1, 31.2, 29.7, 29.7, 28.5, 26.7, 25.8, 22.9, 22.7, 15.2.

HRMS (ESI) m/z: $[M - H]^-$ Calcd for $C_{21}H_{29}O_3$ 329.2122; Found 329.2125.

Synthesis of compound (26S)



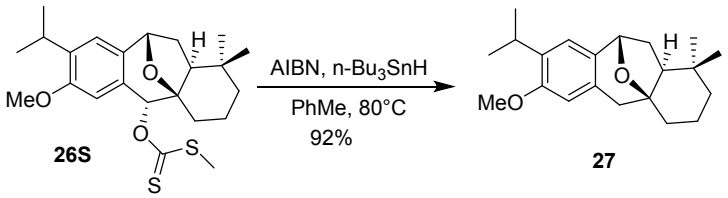
To a solution of **26** (38 mg, 0.155 mmol, 1.0 equiv) in dry THF (1.2 mL, 0.1 M) was added NaH (60% in mineral oil, 28 mg, 0.690 mmol, 6.0 equiv). After the mixture was stirred at rt for about 30 min, CS_2 (83 μL, 1.380 mmol, 12.0 equiv) was added and the stirring was continued for 1 h. MeI (172 μL, 2.760 mmol, 24.0 equiv) was then added. The resultant mixture was stirred at rt overnight, quenched with saturated $NaHCO_3$ solution (2 mL), and extracted with EtOAc (3 × 3 mL). The combined organic layers were washed with brine (2 mL), and dried over by Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by using flash chromatography on silica gel (PE/EA, 50:1) to give product **26S** (47 mg, 97%) as a pale yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.01 (s, 1H), 6.84 (s, 1H), 6.69 (s, 1H), 4.94 (d, *J* = 6.1 Hz, 1H), 3.74 (s, 3H), 3.26 (hept, *J* = 6.9 Hz, 1H), 2.67 (s, 3H), 2.42 (q, *J* = 8.5 Hz, 1H), 2.12 (ddd, *J* = 11.7, 9.0, 6.3 Hz, 1H), 1.94 (ddt, *J* = 13.1, 11.4, 6.7 Hz, 2H), 1.79 (dtd, *J* = 16.9, 8.7, 2.6 Hz, 2H), 1.63 (dddd, *J* = 18.9, 13.3, 8.5, 2.2 Hz, 1H), 1.54 – 1.49 (m, 1H), 1.18 (dd, *J* = 6.9, 1.3 Hz, 6H), 1.17 – 1.13 (m, 1H), 1.05 (s, 3H), 0.84 (s, 3H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 218.3, 156.3, 137.0, 133.5, 130.0, 121.4, 109.2, 84.9, 82.5, 76.4, 55.7, 44.7, 38.9, 31.5, 29.9, 29.5, 28.4, 26.8, 26.1, 22.9, 22.7, 19.6, 15.0.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{23}H_{33}O_3S_2$ 421.1866; Found 421.1861.

Synthesis of compound (27)



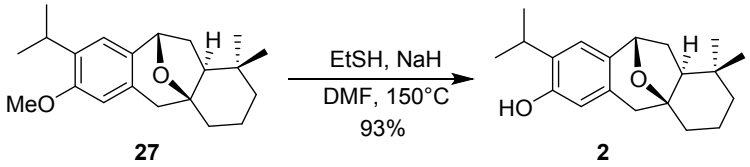
The crude xantate **26S** (42 mg, 0.100 mmol, 1.0 equiv) was dissolved in dry toluene (2.5 mL) and heated to 80°C. A solution of nBu_3SnH (134 µL, 0.500 mmol, 5.0equiv) and AIBN (3.6 mg, 0.022 mmol, 0.22 equiv) in toluene (2.5 mL) was added dropwise while the solution of the crude xantate was heated at 80°C with oil bath. Then the mixture was heated overnight, cooled to rt, and concentrated under reduced pressure. The residue was purified by flash chromatography (PE/EA, 50:1) to give the product **27** (29 mg, 92%; 89% from **26**) as a pale yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.83 (s, 1H), 6.54 (s, 1H), 4.87 (d, *J* = 6.5 Hz, 1H), 3.78 (s, 3H), 3.25 (p, *J* = 7.0 Hz, 1H), 2.93 (d, *J* = 16.3 Hz, 1H), 2.48 (d, *J* = 16.3 Hz, 1H), 2.11 (dt, *J* = 12.6, 6.9 Hz, 1H), 2.01 – 1.93 (m, 1H), 1.90 (dd, *J* = 11.9, 8.2 Hz, 1H), 1.86 – 1.72 (m, 3H), 1.62 (dt, *J* = 12.7, 6.8 Hz, 1H), 1.54 – 1.47 (m, 1H), 1.36 (q, *J* = 7.6 Hz, 1H), 1.21 – 1.16 (m, 6H), 0.97 (s, 3H), 0.84 (s, 3H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 155.8, 134.5, 133.9, 131.1, 121.6, 111.1, 80.4, 76.2, 55.6, 50.8, 44.4, 40.1, 32.0, 30.7, 30.5, 27.1, 26.7, 23.1, 22.8, 16.2.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{31}O_2$ 315.2319; Found 315.2314.

Synthesis of euolutchuol E (2)

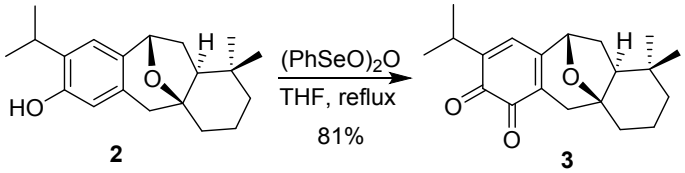


Ethanethiol (97 µL, 1.134 mmol, 18.0 equiv) was added to a suspension of **27** (23 mg, 0.073 mmol, 1.0 equiv) and sodium hydride (60% in mineral oil, 36 mg, 0.878 mmol, 12.0 equiv) in dry DMF (2.5 mL) in a Schlenk tube. The tube was sealed and heated to 150 °C with oil bath overnight. After cooling to rt, the mixture was acidified with aqueous HCl (5 mL, 1.0 M) and extracted with Et_2O (3 x 5 mL). The combined organic layers were washed with brine (5 mL + water, 5 mL), passed through a short plug of silica gel and then concentrated. The crude product was immediately purified by using flash chromatography (PE/EA, 12:1) to give compound **2** (20.4 mg, 93%) as a white solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.80 (s, 1H), 6.40 (s, 1H), 4.98 (s, 1H), 4.88 (d, *J* = 6.5 Hz, 1H), 3.15 (hept, *J* = 7.0 Hz, 1H), 2.84 (d, *J* = 16.3 Hz, 1H), 2.39 (d, *J* = 16.5 Hz, 1H), 2.11 (dt, *J* = 12.4, 6.9 Hz, 1H), 2.02 – 1.92 (m, 1H), 1.89 (dd, *J* = 11.9, 8.5 Hz,

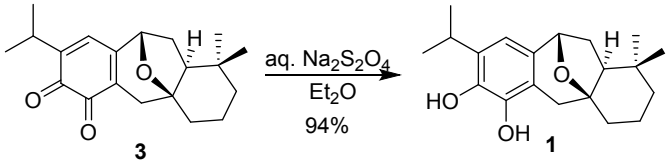
1H), 1.85 – 1.73 (m, 3H), 1.63 – 1.55 (m, 1H), 1.55 – 1.49 (m, 1H), 1.23 (d, *J* = 4.2 Hz, 3H), 1.22 (d, *J* = 4.5 Hz, 3H), 1.18 – 1.13 (m, 1H), 0.96 (s, 3H), 0.84 (s, 3H);
^{13}C NMR (126 MHz, $CDCl_3$) δ 151.8, 134.2, 131.9, 131.4, 121.7, 115.7, 80.5, 76.2, 50.8, 43.9, 40.1, 32.0, 32.0, 30.7, 30.4, 27.0, 27.0, 22.9, 22.7, 16.2.
HRMS (ESI) m/z: [M - H]$^-$ Calcd for $C_{20}H_{27}O_2$ 299.2017; Found 299.2021.

Synthesis of przewalskine E (3)



$(PhSeO)_2O$ (5.3 mg, 0.015 mmol, 1.0 equiv) was added to a solution of phenol **2** (4.4 mg, 0.015 mmol, 1.0 equiv) in anhydrous THF (1.0 mL) under an argon atmosphere, and the reaction mixture was stirred at reflux with oil bath for 20 min. The solvents were evaporated under reduced pressure and the residue was purified by using flash column chromatography (PE/EA, 15:1) to give product **3** (3.8 mg, 81%) as a brown foam.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.46 (s, 1H), 4.47 (d, *J* = 6.8 Hz, 1H), 2.98 – 2.92 (m, 1H), 2.48 (d, *J* = 18.6 Hz, 1H), 2.18 (d, *J* = 18.6 Hz, 1H), 2.15 – 2.08 (m, 1H), 2.08 – 2.02 (m, 1H), 1.99 – 1.91 (m, 1H), 1.81 – 1.72 (m, 3H), 1.65 – 1.61 (m, 1H), 1.52 – 1.45 (m, 1H), 1.19 – 1.14 (m, 1H), 1.12 (d, *J* = 2.2 Hz, 3H), 1.10 (d, *J* = 2.3 Hz, 3H), 0.96 (s, 3H), 0.85 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 180.7, 179.9, 153.1, 148.1, 132.0, 129.7, 80.6, 75.1, 51.7, 38.3, 38.0, 32.2, 31.8, 30.5, 30.0, 27.4, 26.9, 21.7, 21.6, 16.0.
HRMS (ESI) m/z: [M - H]$^-$ Calcd for $C_{20}H_{25}O_3$ 313.1809; Found 313.1806.

Synthesis of brussonol (1)



To a solution of **3** (3.8 mg, 12.09 μmol) in Et_2O (7.5 mL) was added a solution of $Na_2S_2O_4$ (10% aq., 7.5 mL) and the mixture was stirred vigorously until the bright yellow solution became almost colorless. The reaction was monitored using TLC. The organic phase was then separated, dried over Na_2SO_4 and all solvents were removed under reduced pressure. The residue was then purified by using flash chromatography (PE/EA, 6:1) to yield pure brussonol **1** (3.6 mg, 94%) as a yellow foam.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.45 (s, 1H), 5.13 (s, 1H), 5.06 (s, 1H), 4.85 (d, *J* = 6.6 Hz, 1H), 3.16 – 3.06 (m, 1H), 2.72 (d, *J* = 16.0 Hz, 1H), 2.39 (d, *J* = 16.2 Hz, 1H), 2.15 – 2.08 (m, 1H), 2.02 – 1.95 (m, 1H), 1.92 – 1.86 (m, 1H), 1.85 – 1.74 (m, 3H), 1.61 – 1.56 (m, 1H), 1.55 – 1.48 (m, 1H), 1.23 (d, *J* = 3.7 Hz, 3H), 1.22 (d, *J* = 4.3 Hz, 3H), 1.19 – 1.13 (m, 1H), 0.95 (s, 3H), 0.84 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 141.7, 139.7, 134.4, 132.1, 116.7, 112.9, 80.2, 76.3, 51.3, 39.9, 39.0, 32.4, 32.0, 30.9, 30.8, 27.3, 26.8, 22.9, 22.7, 16.3.

HRMS (ESI) m/z: $[M - 2H]^{2-}$ Calcd for $C_{20}H_{26}O_3$ 314.1893; Found 314.1889.

II References

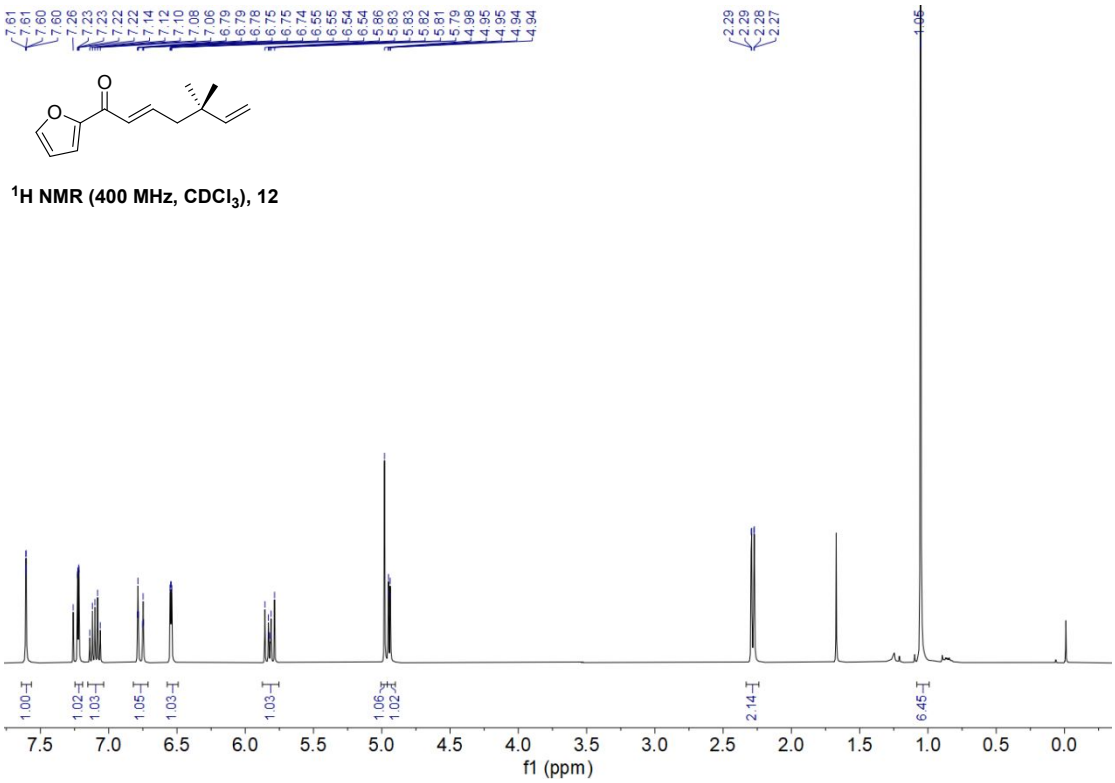
[1] Xu, B.; Wang, B.-Y.; Xun, W.; Qiu, F. G. *Angew. Chem. Int. Ed.* **2019**, *58*, 5754-5757.

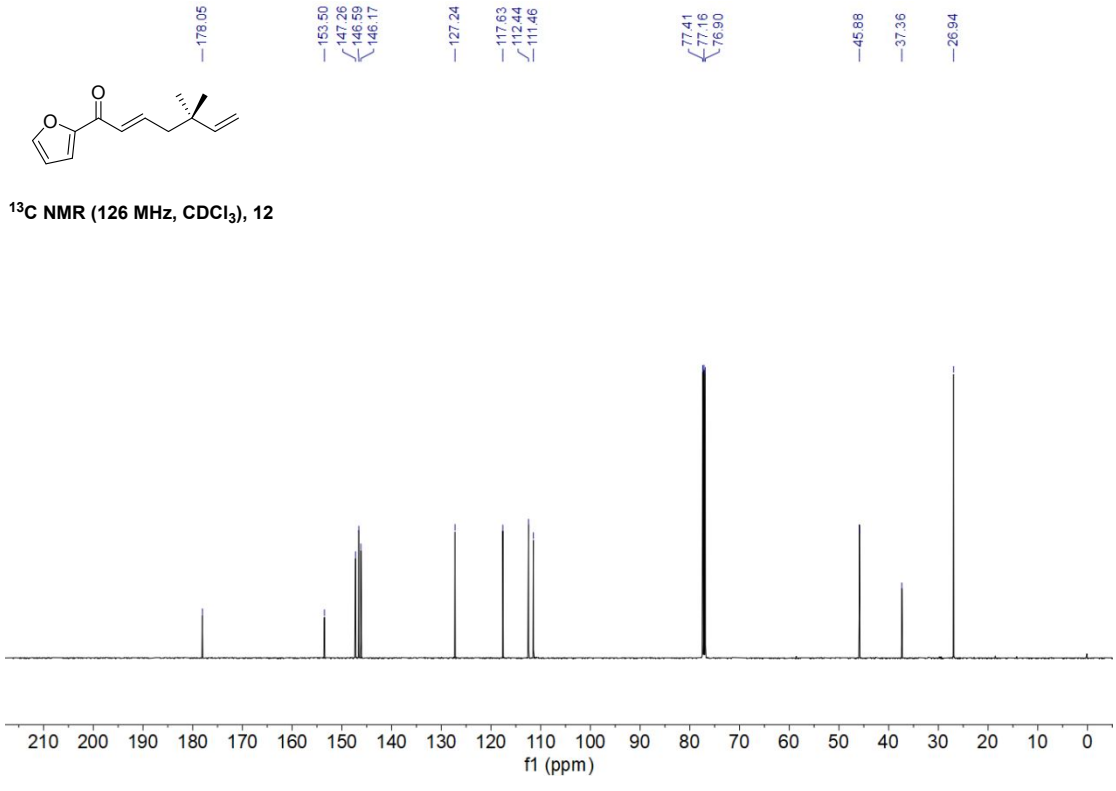
[2] Jia, Z.; Hu, X.; Zhao, Y.; Qiu, F. G.; Chan, A. S. C.; Zhao, J. *Org. Lett.* **2019**, *21*, 9584-9588.

[3] Jiao, Z.-W.; Tu, Y.-Q.; Zhang, Q.; Liu, W.-X.; Zhang, S.-Y.; Wang, S.-H.; Zhang, F.-M.; Jiang, S. *Nat. Commun.* **2015**, *6*, 7332-7338.

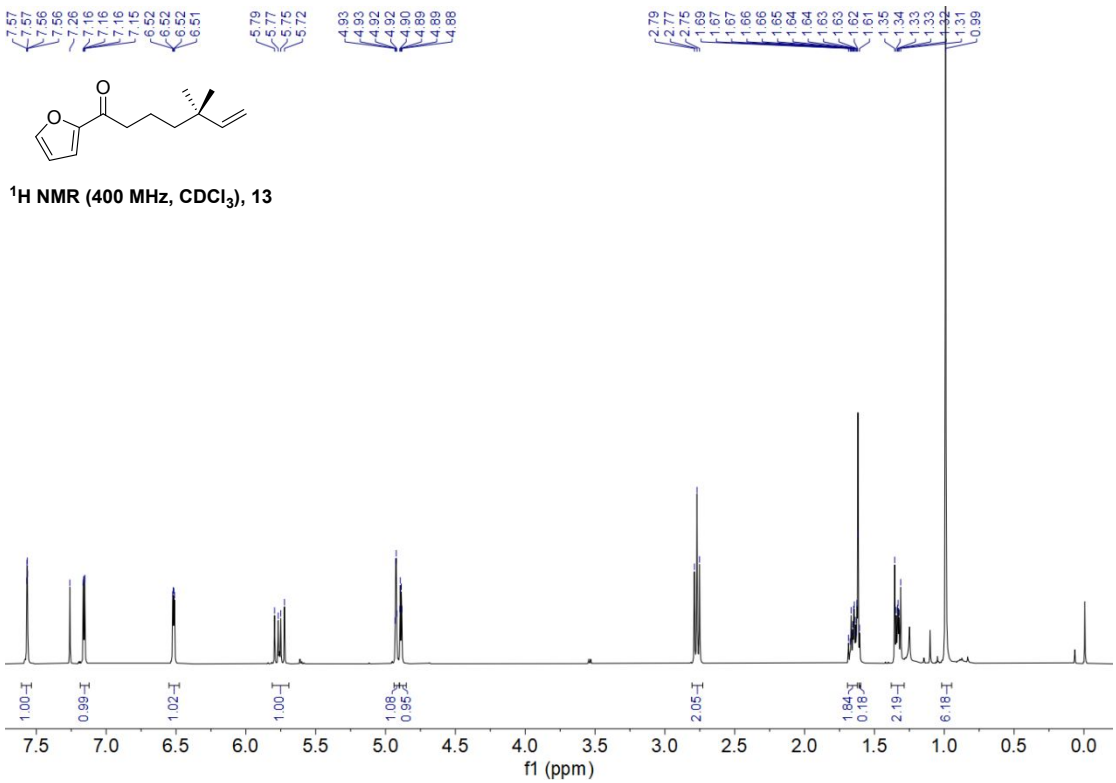
[4] Ahmad, A.; Burtoloso, A. C. B. *Org. Lett.* **2019**, *21*, 6079-6083.

III ^{1}H and ^{13}C NMR Spectra of Compounds

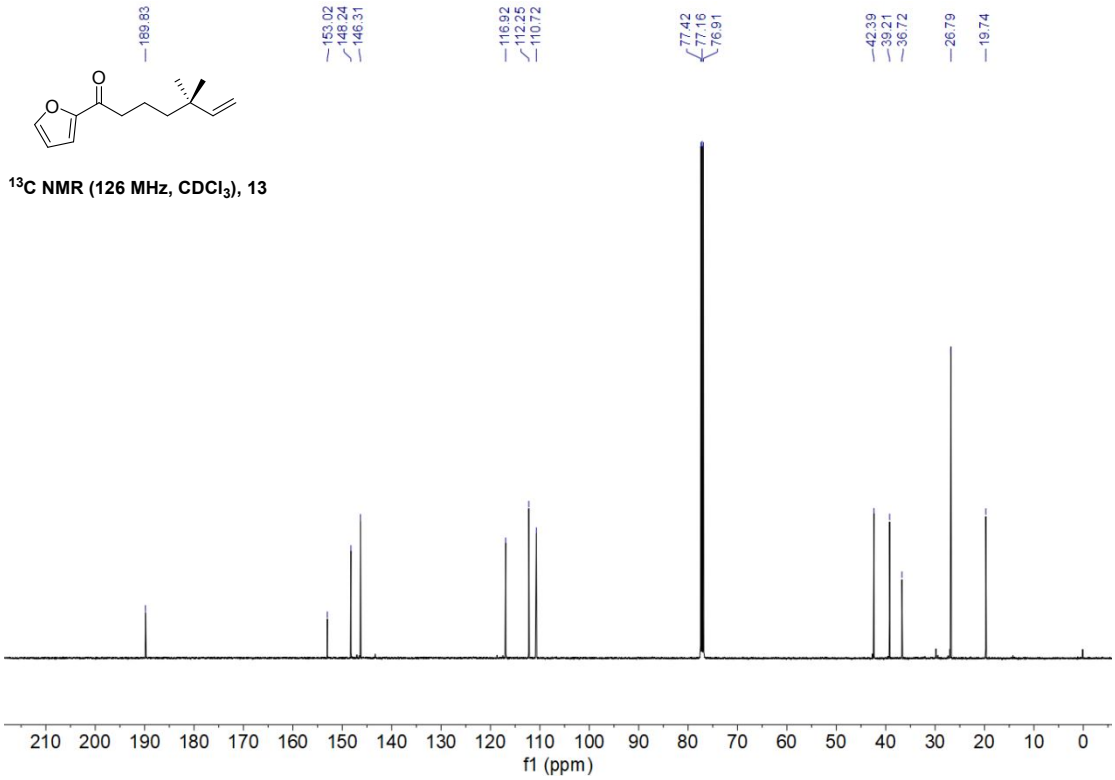




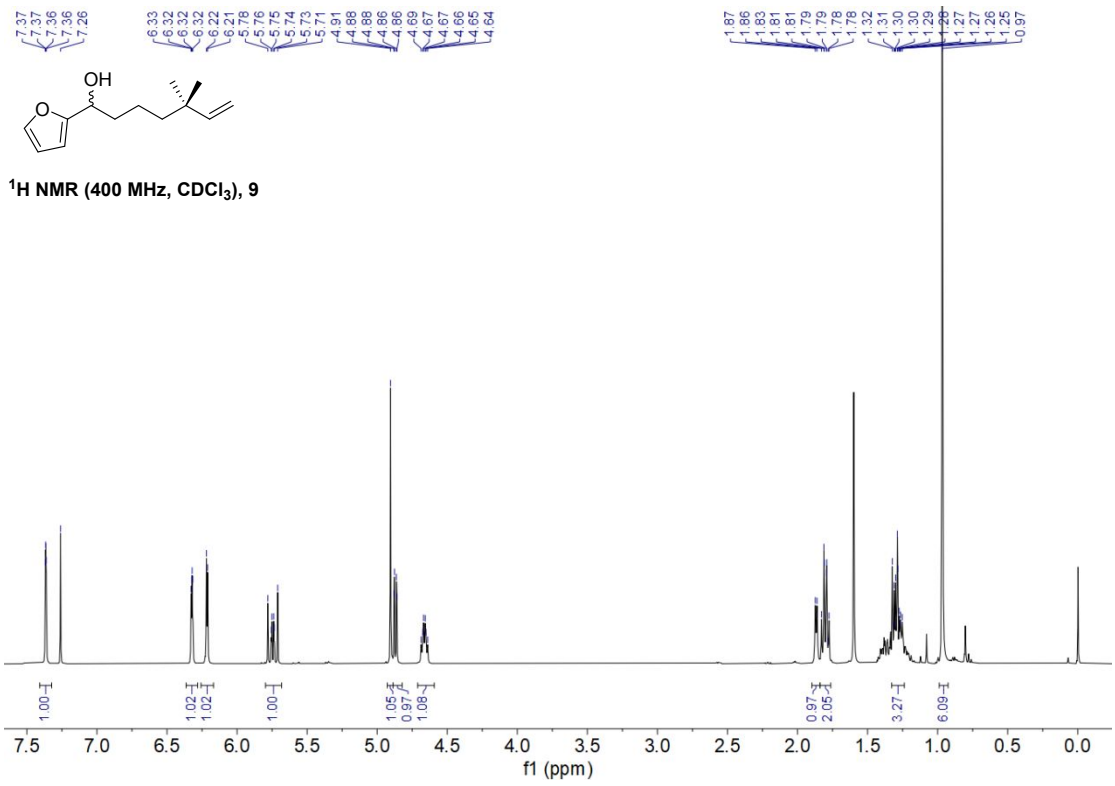
^{13}C NMR (126 MHz, $CDCl_3$), 12



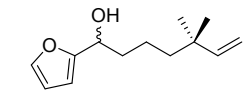
^{1}H NMR (400 MHz, $CDCl_3$), 13



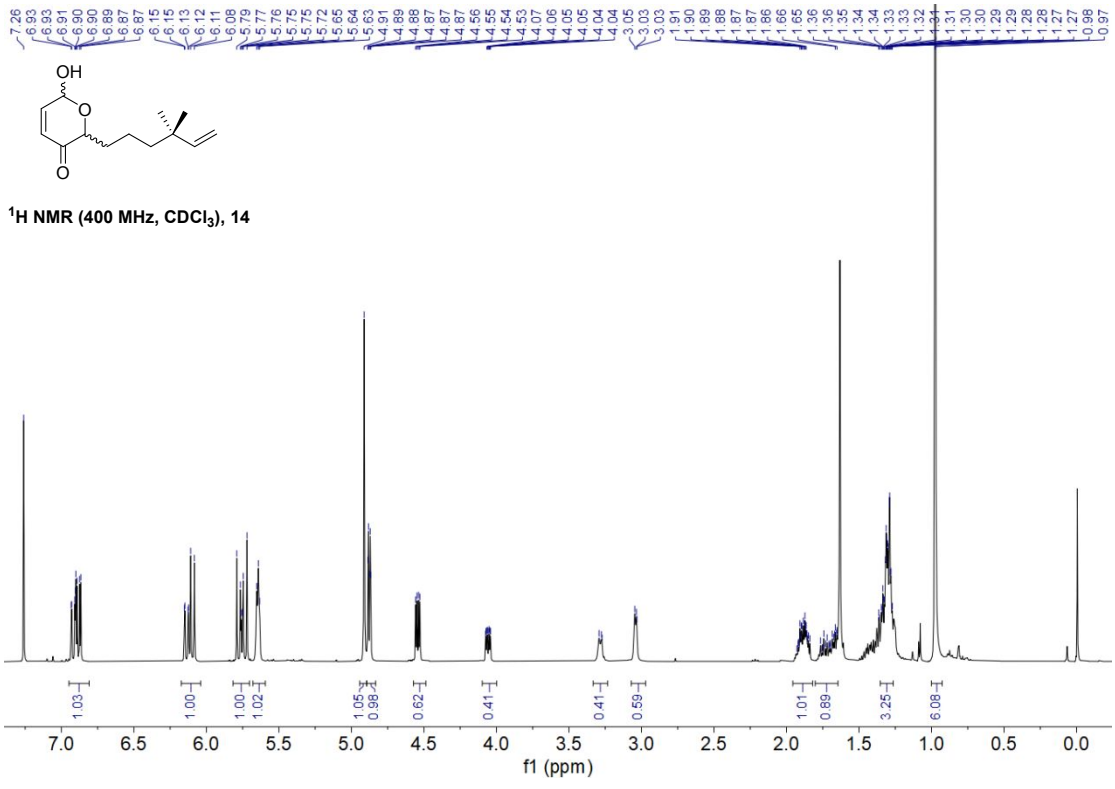
^{13}C NMR (126 MHz, $CDCl_3$), 13



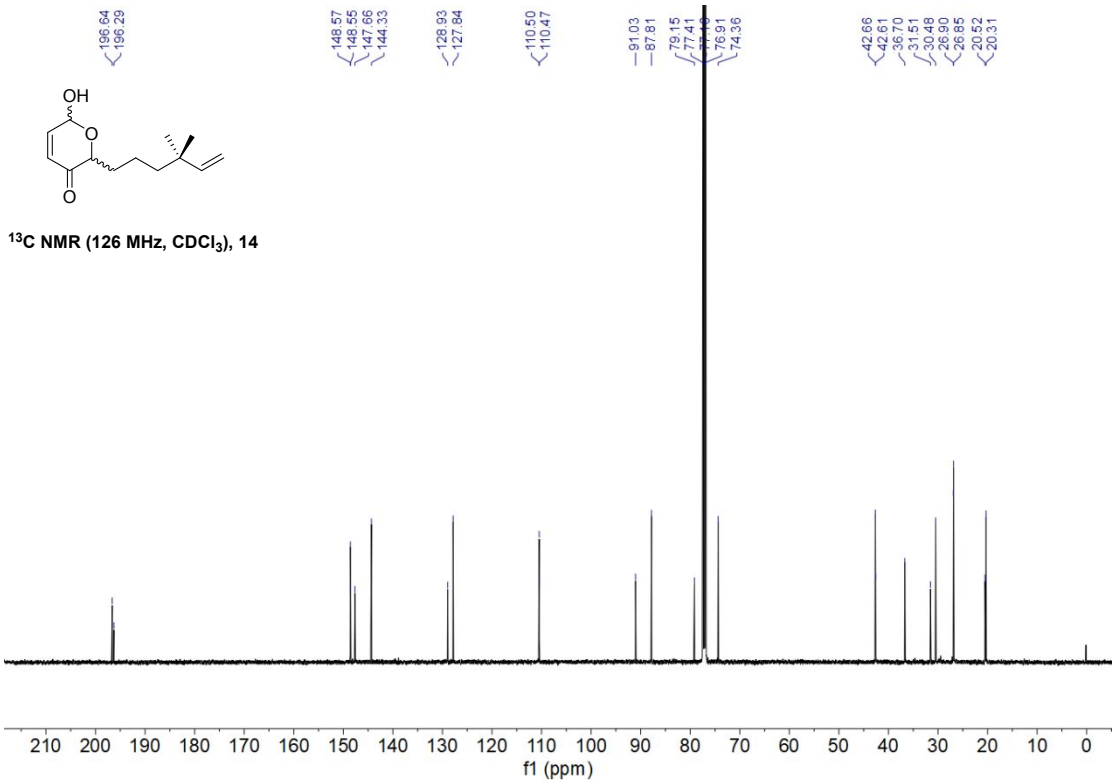
^{1}H NMR (400 MHz, $CDCl_3$), 9



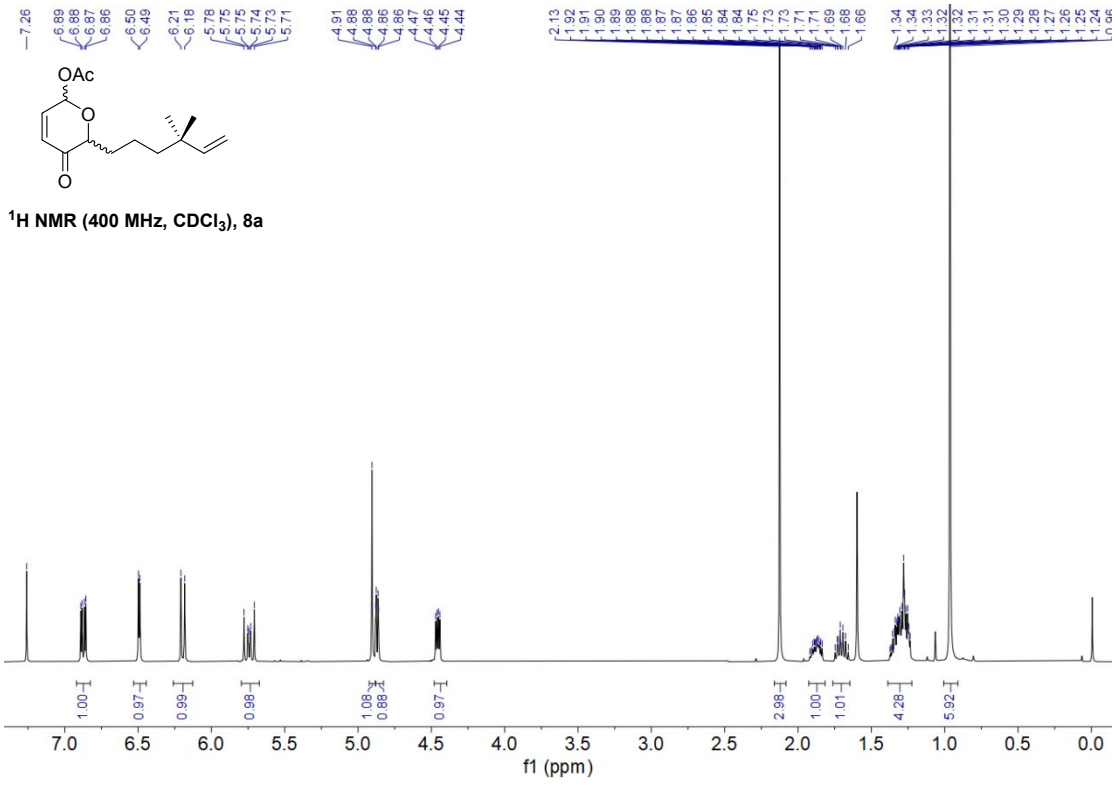
^{13}C NMR (126 MHz, $CDCl_3$), 9



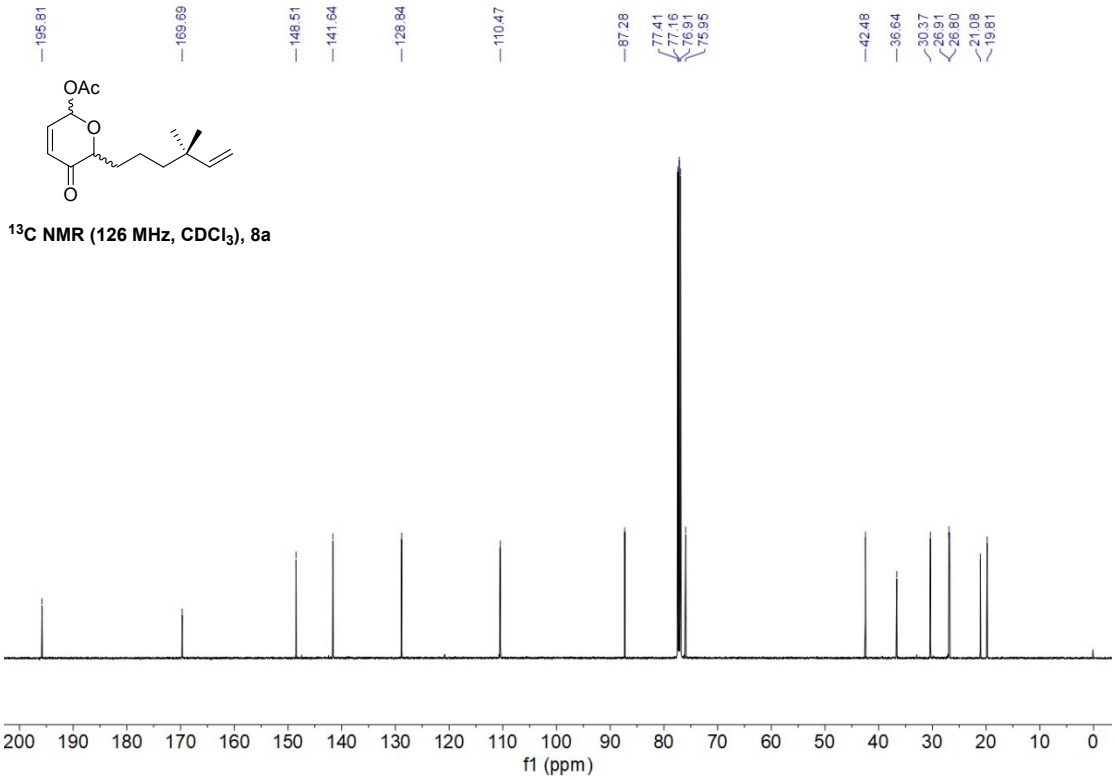
^{1}H NMR (400 MHz, $CDCl_3$), 14



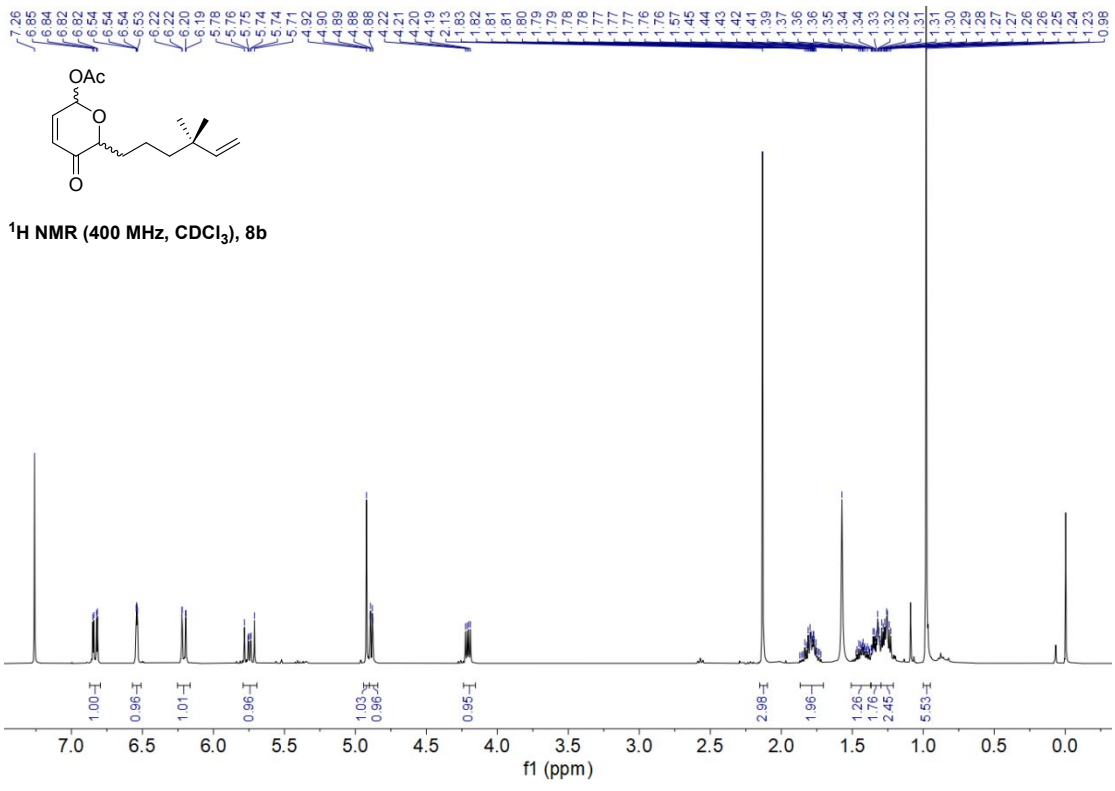
^{13}C NMR (126 MHz, $CDCl_3$), 14



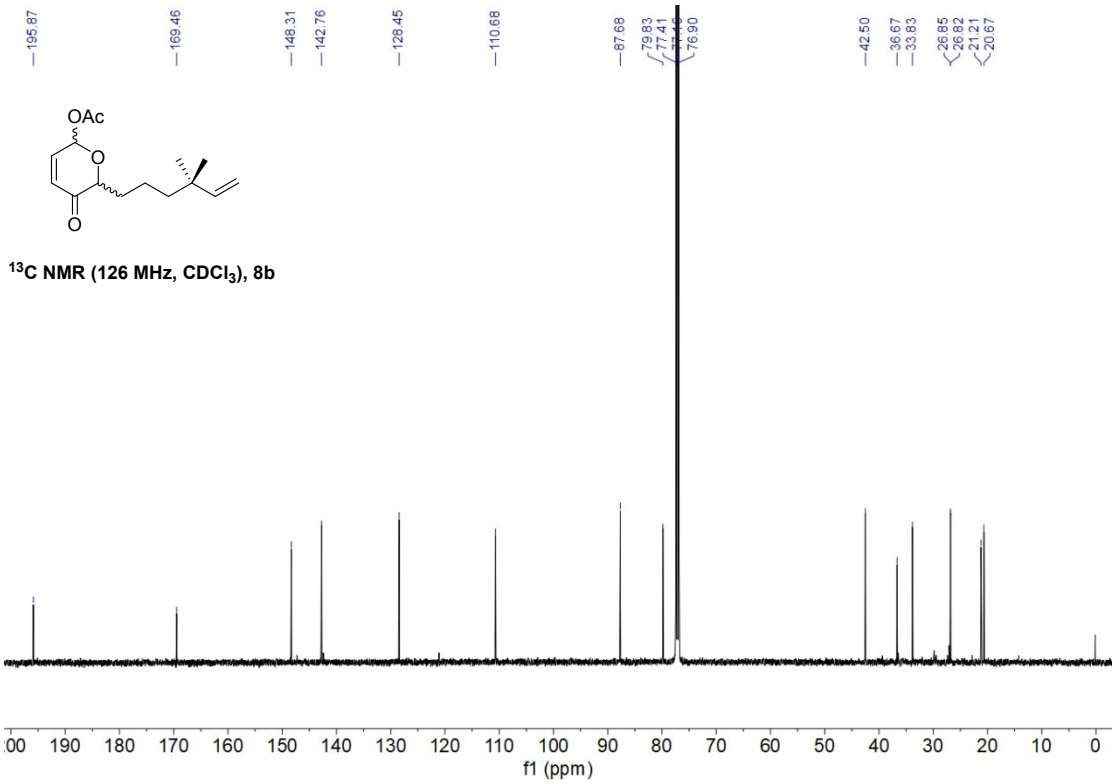
^{1}H NMR (400 MHz, $CDCl_3$), 8a



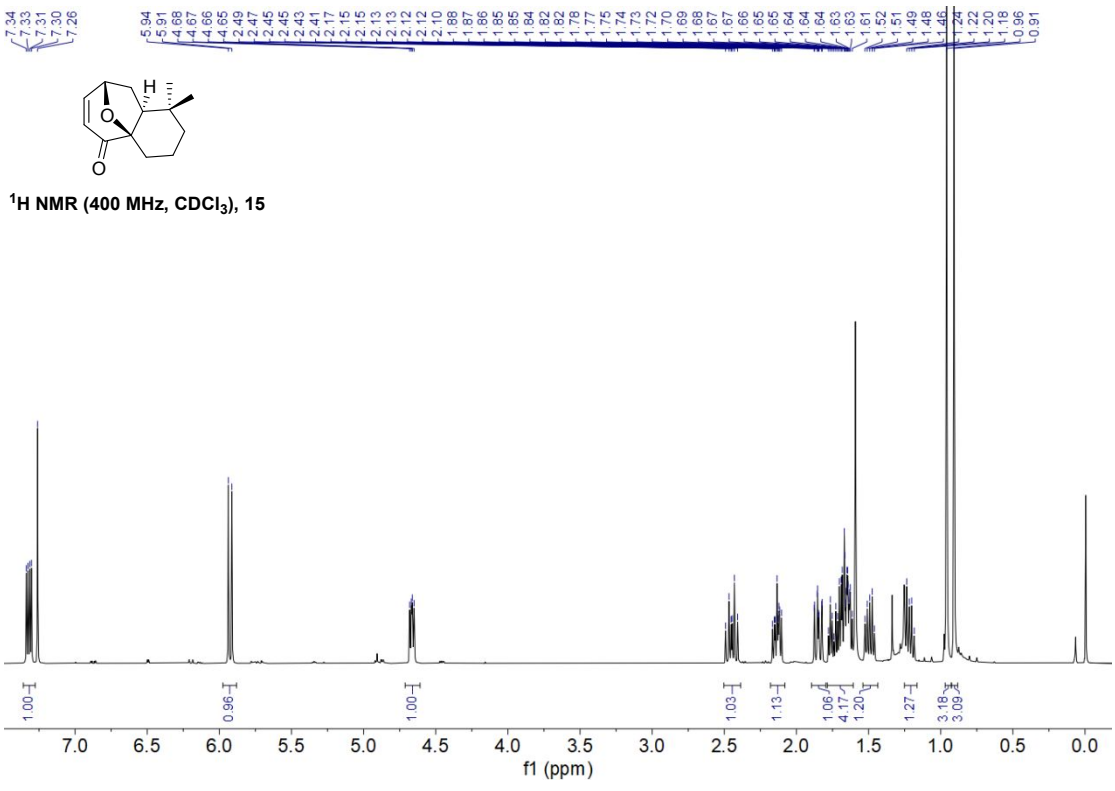
^{13}C NMR (126 MHz, $CDCl_3$), 8a



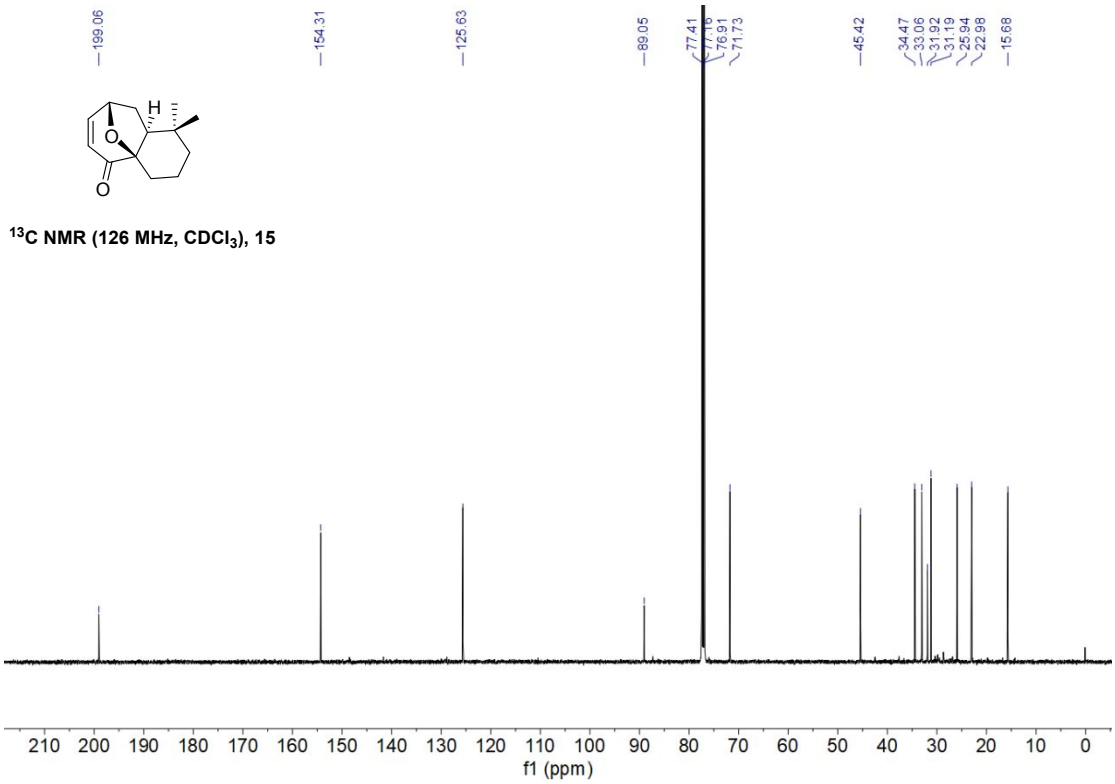
^{1}H NMR (400 MHz, $CDCl_3$), 8b



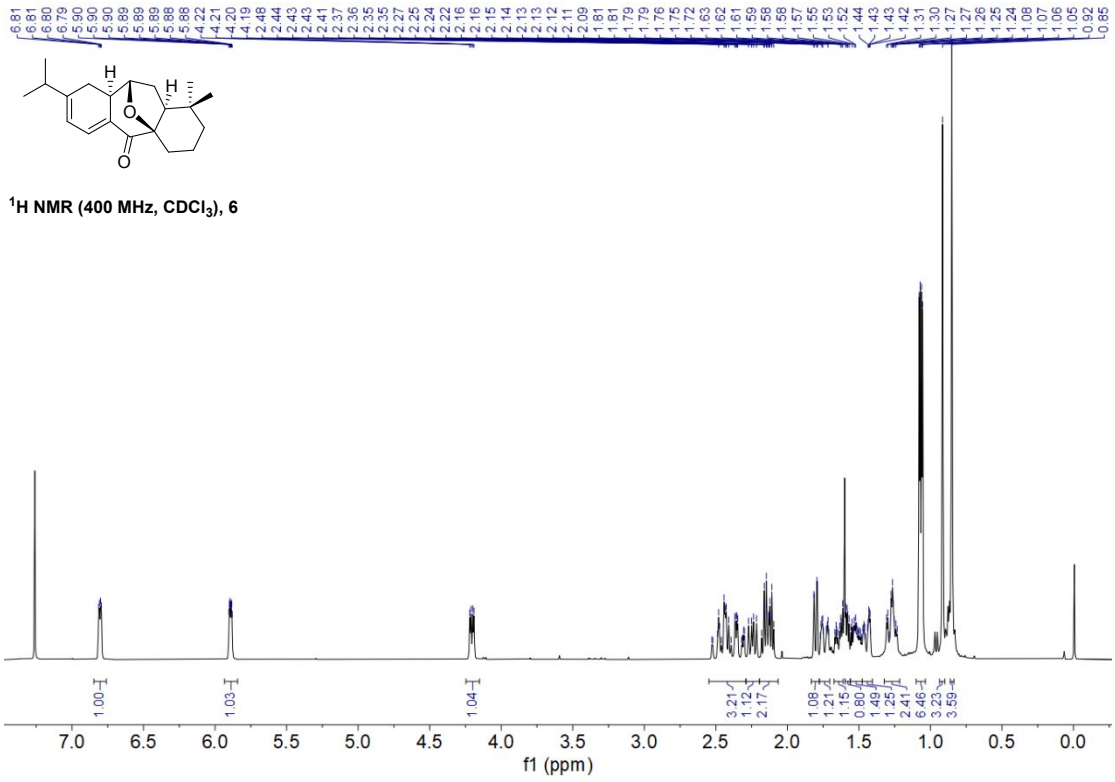
^{13}C NMR (126 MHz, $CDCl_3$), 8b



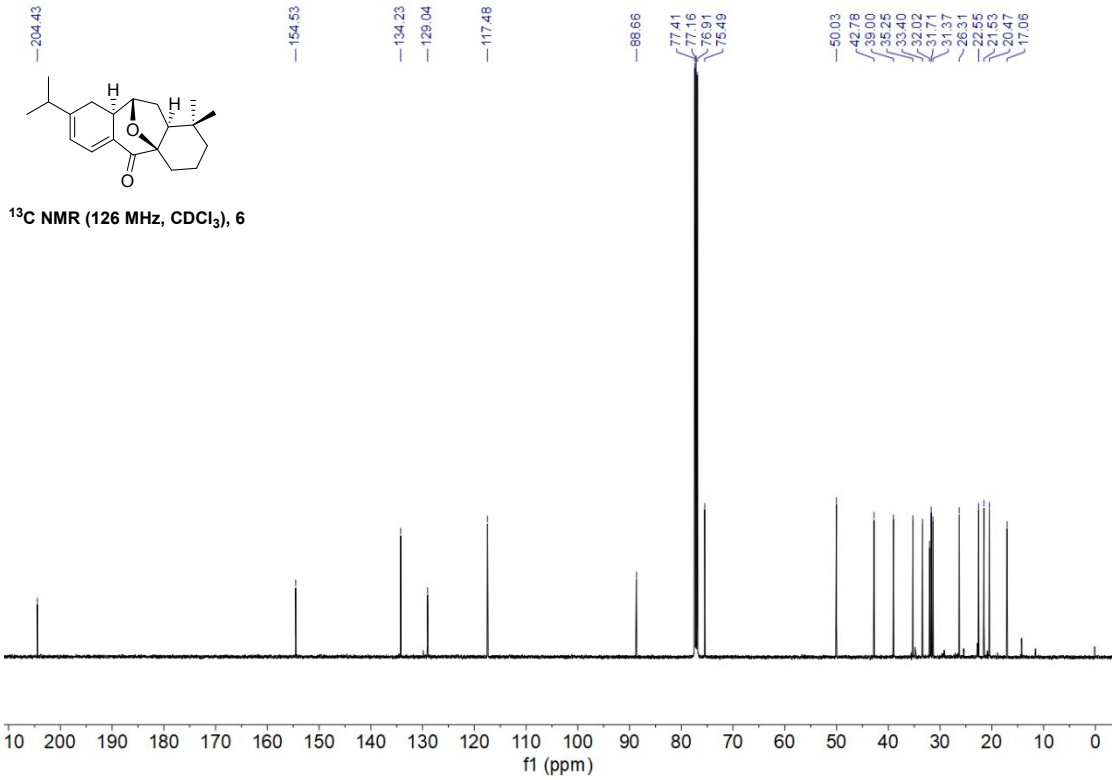
^{1}H NMR (400 MHz, $CDCl_3$), 15



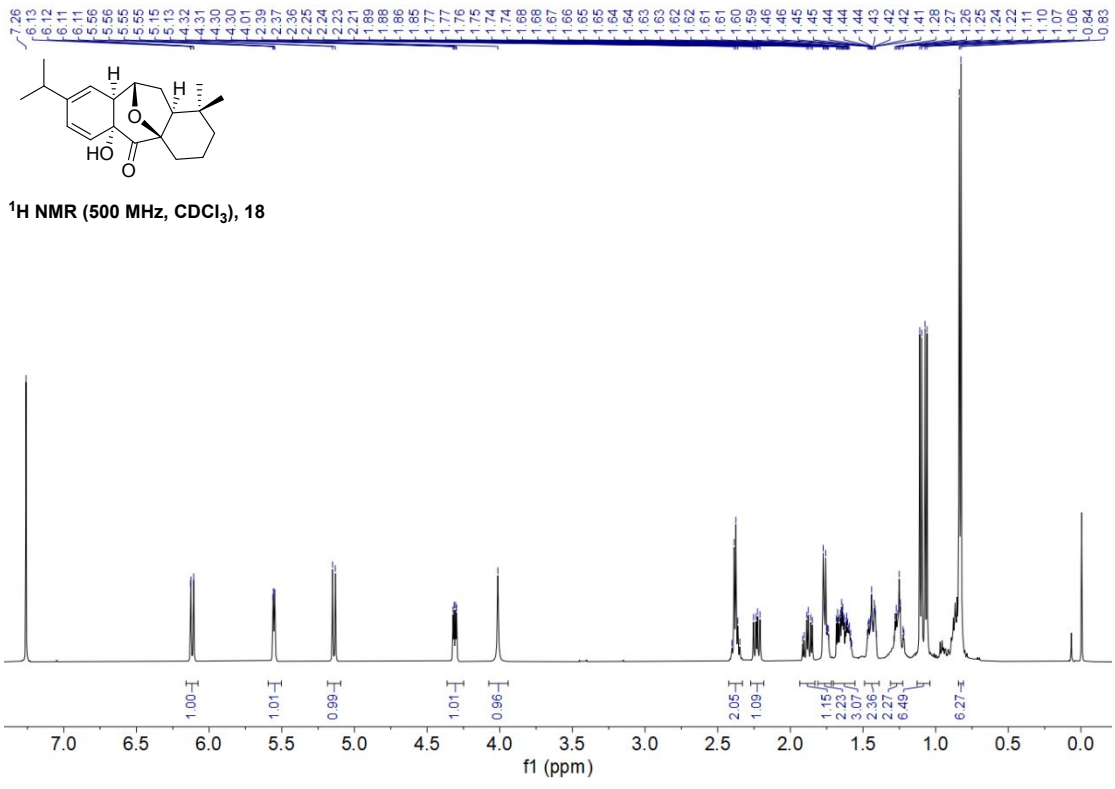
^{13}C NMR (126 MHz, $CDCl_3$), 15



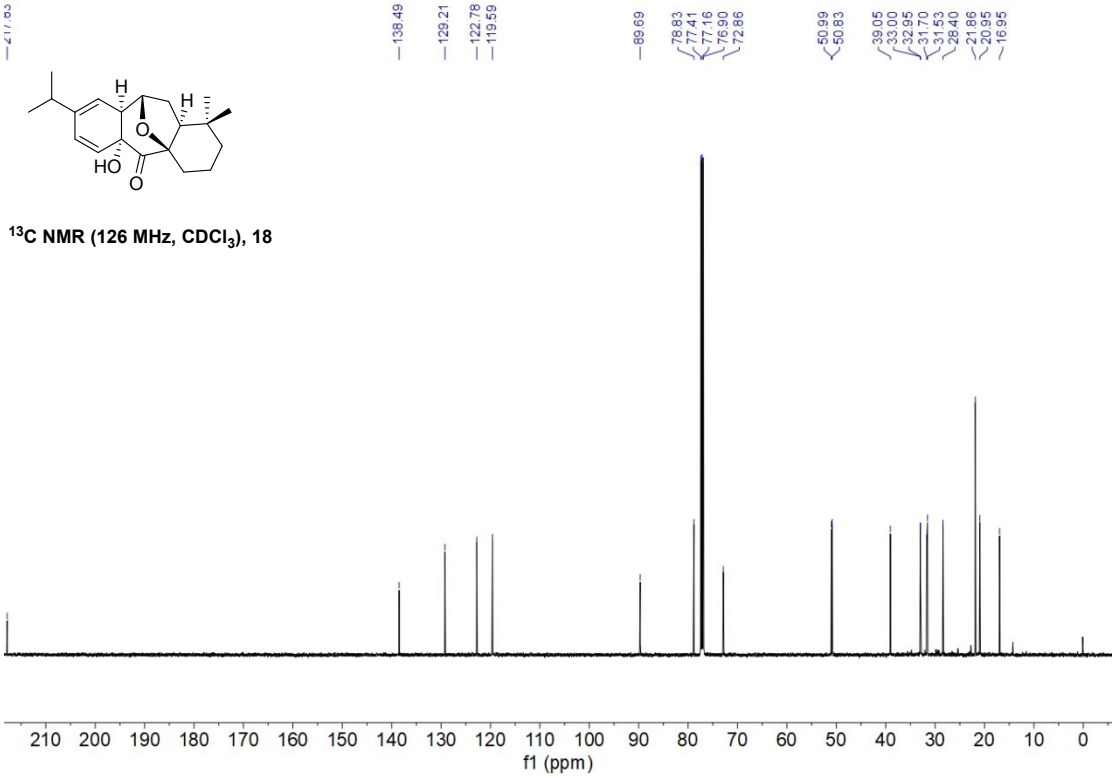
^{1}H NMR (400 MHz, $CDCl_3$), 6



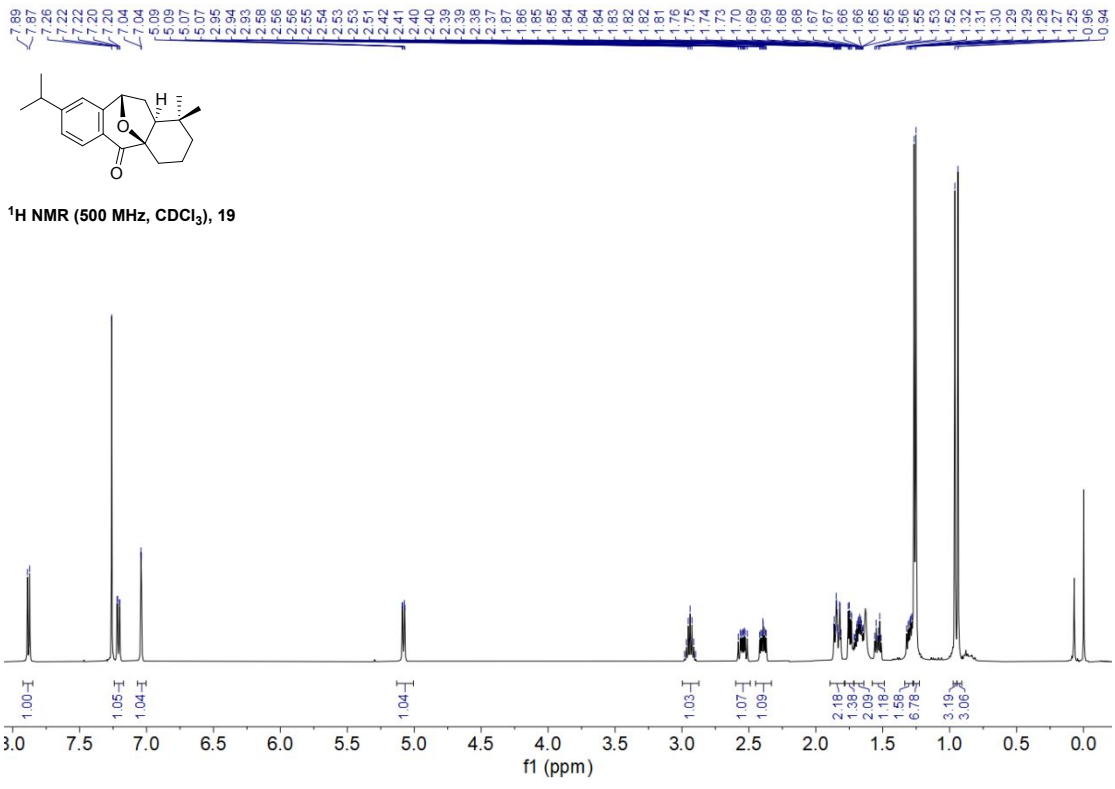
^{13}C NMR (126 MHz, $CDCl_3$), 6



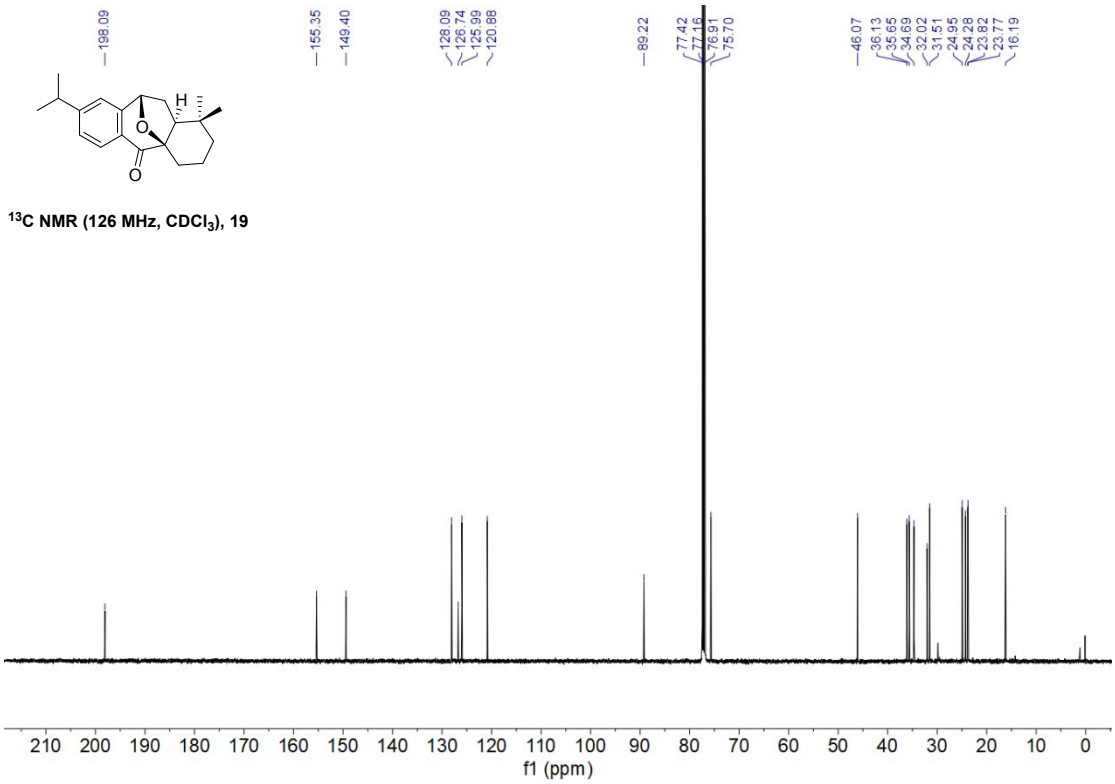
^{1}H NMR (500 MHz, $CDCl_3$), 18



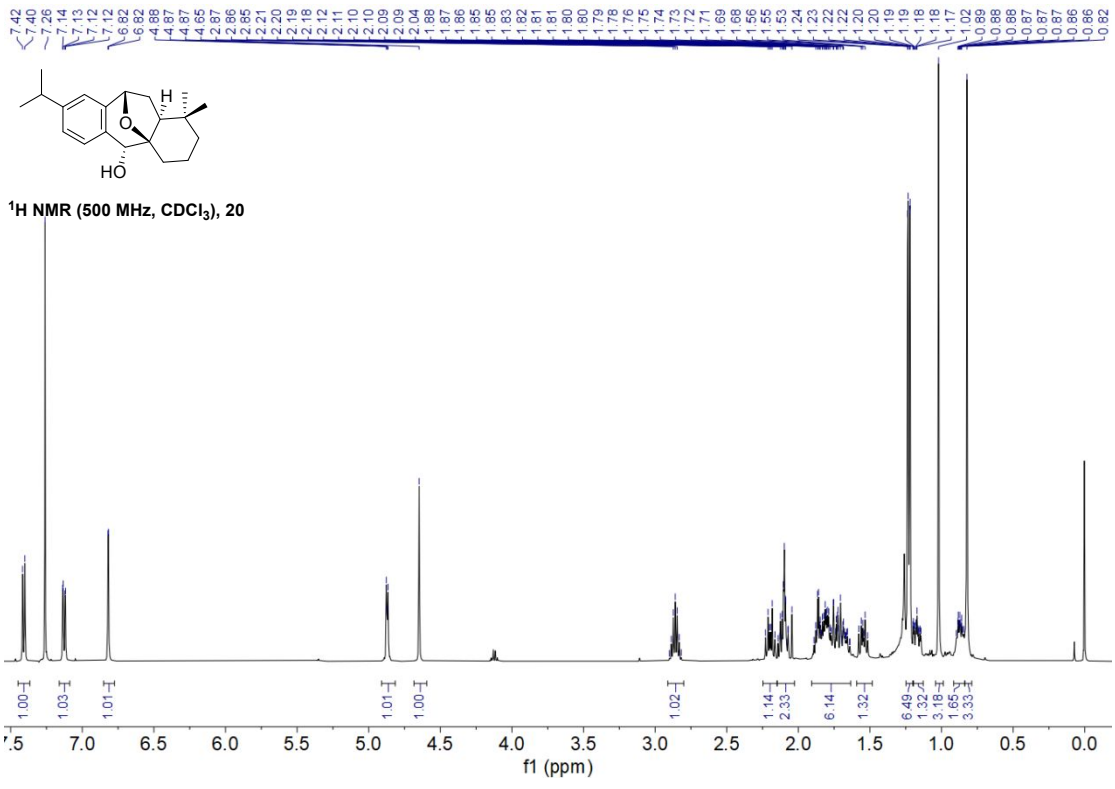
^{13}C NMR (126 MHz, $CDCl_3$), 18



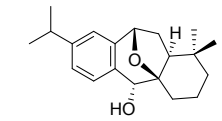
^{1}H NMR (500 MHz, $CDCl_3$), 19



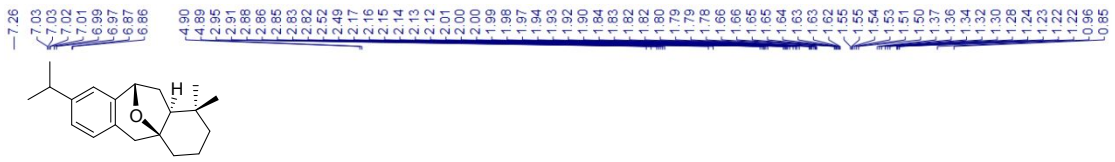
^{13}C NMR (126 MHz, $CDCl_3$), 19



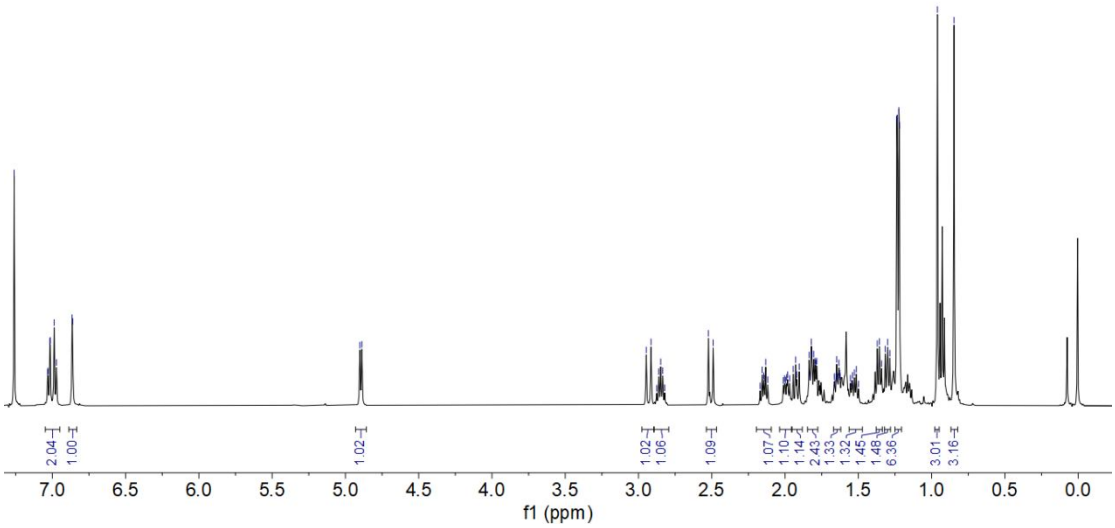
^{1}H NMR (500 MHz, $CDCl_3$), 20

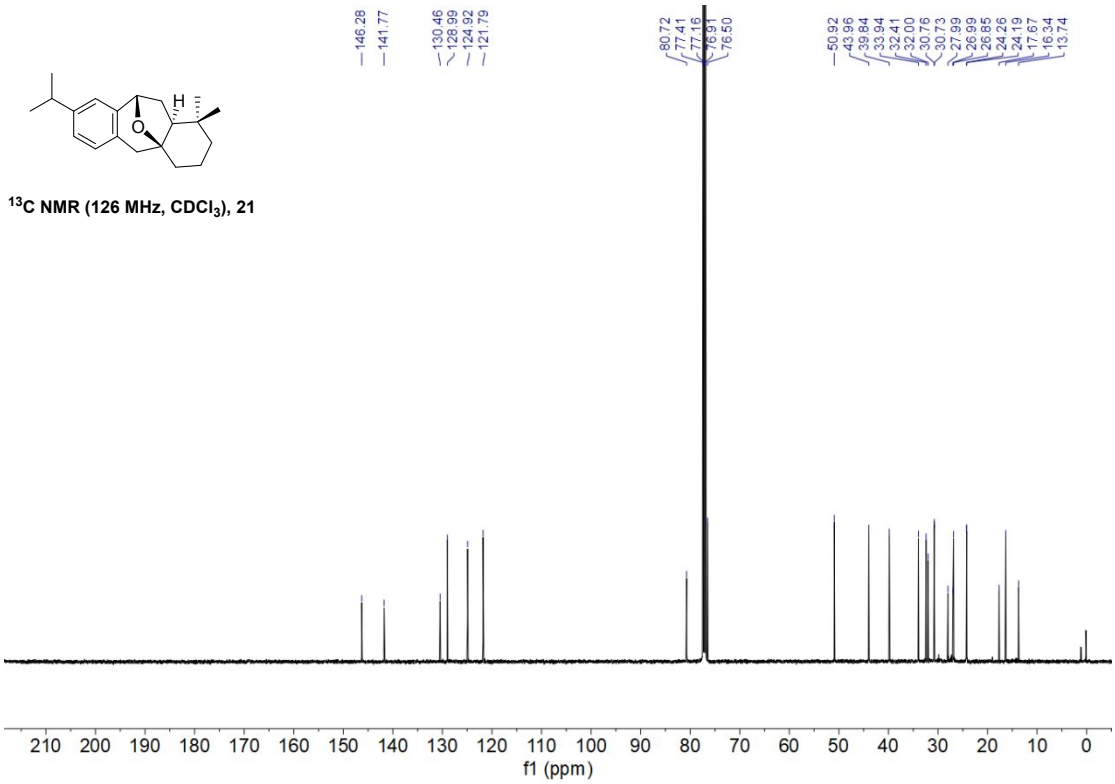


^{13}C NMR (126 MHz, $CDCl_3$), 20

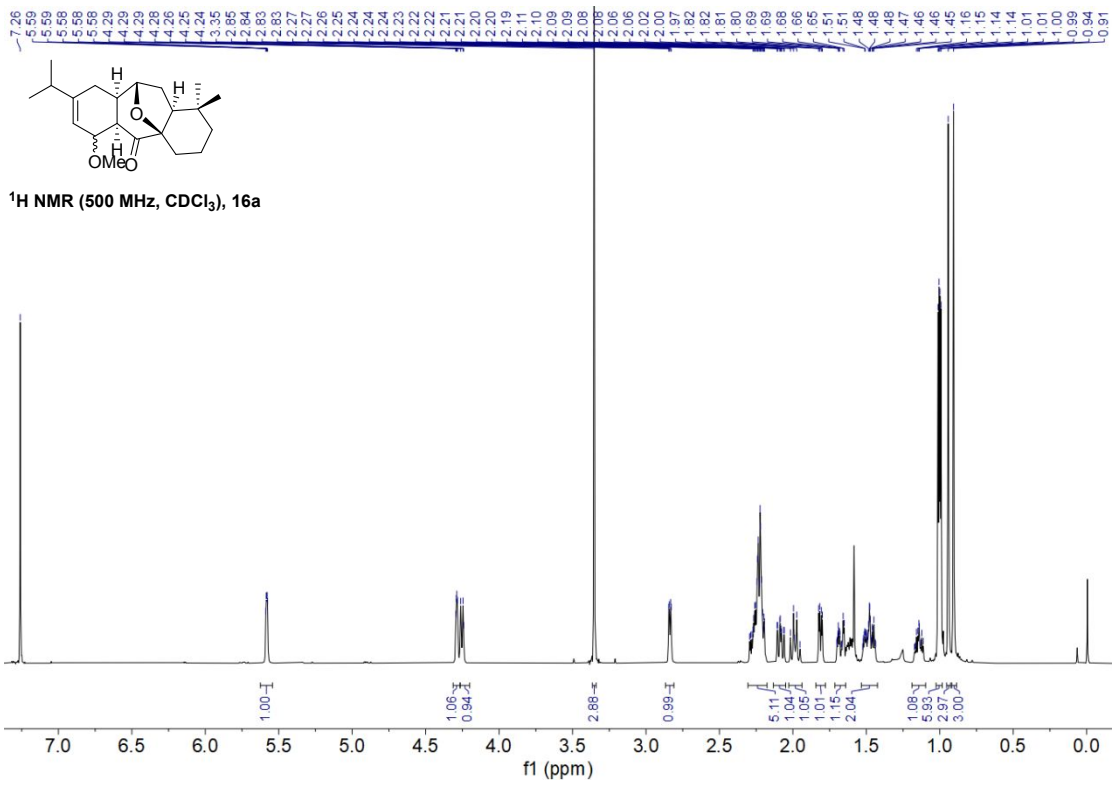


^{1}H NMR (500 MHz, $CDCl_3$), 21

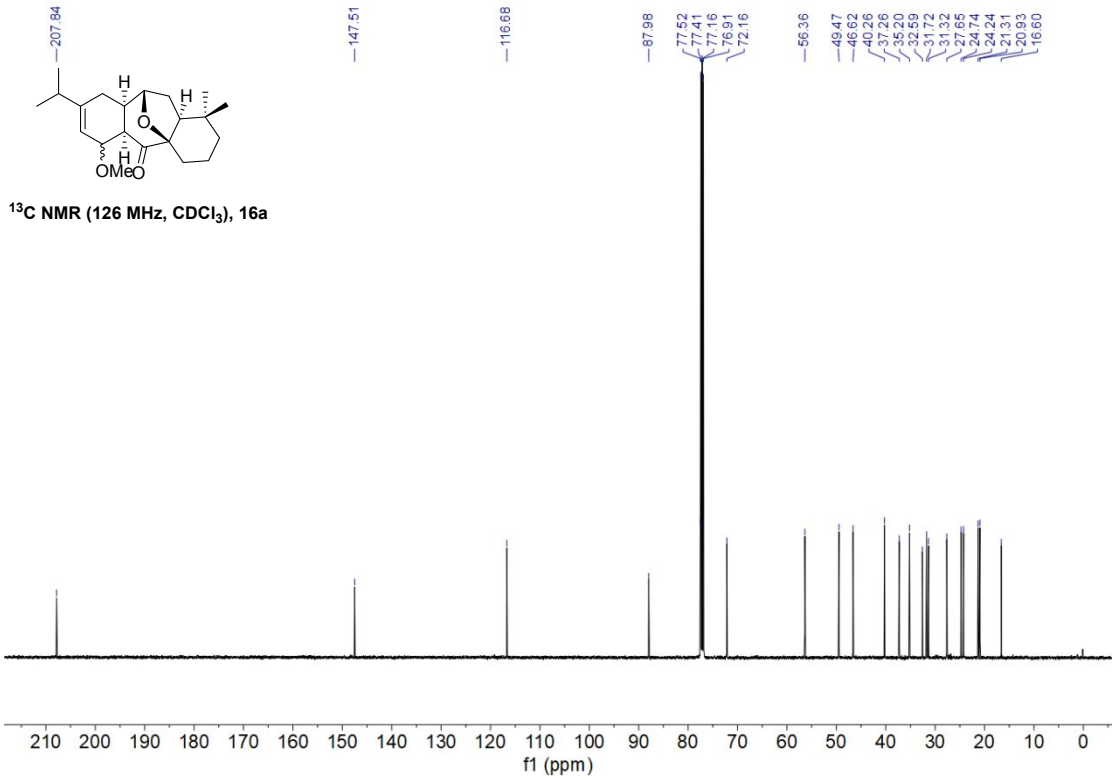




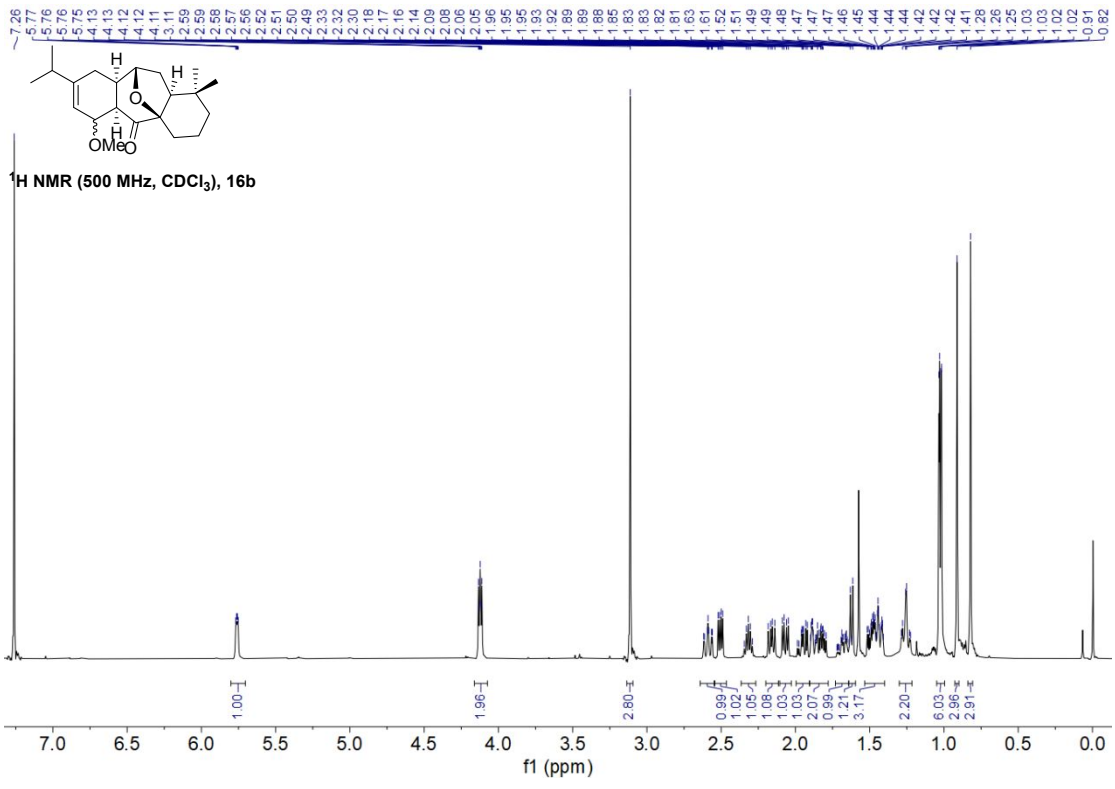
^{13}C NMR (126 MHz, $CDCl_3$), 21



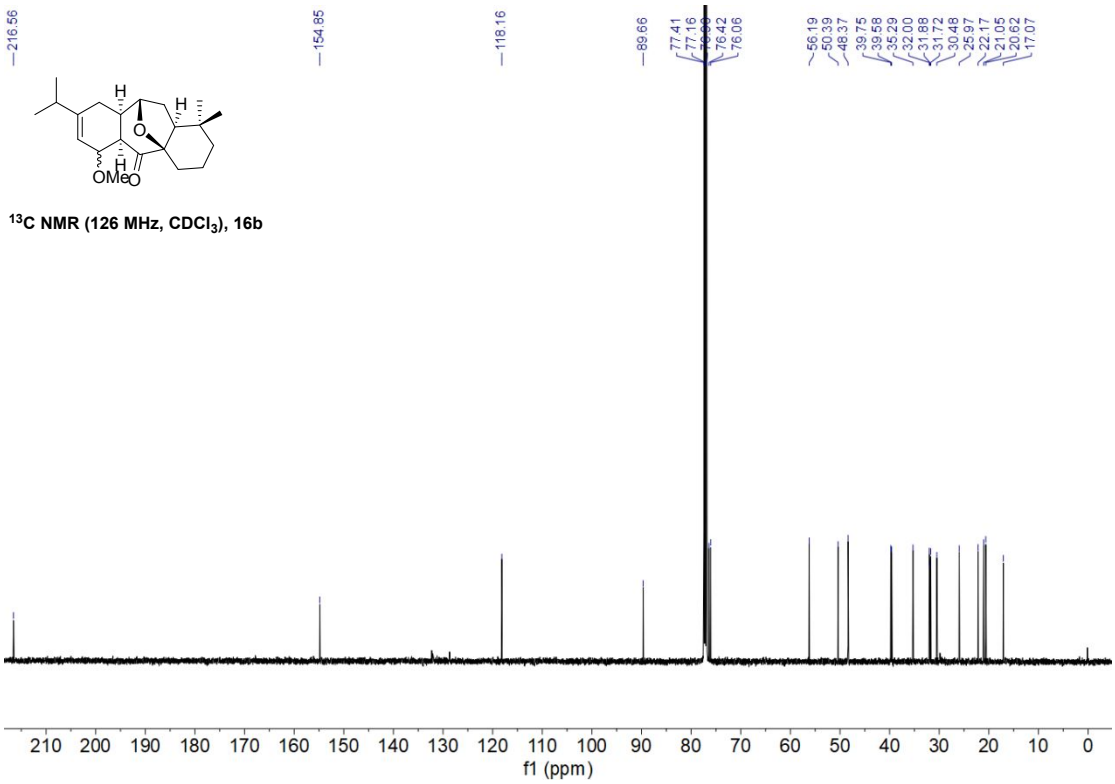
^{1}H NMR (500 MHz, $CDCl_3$), 16a



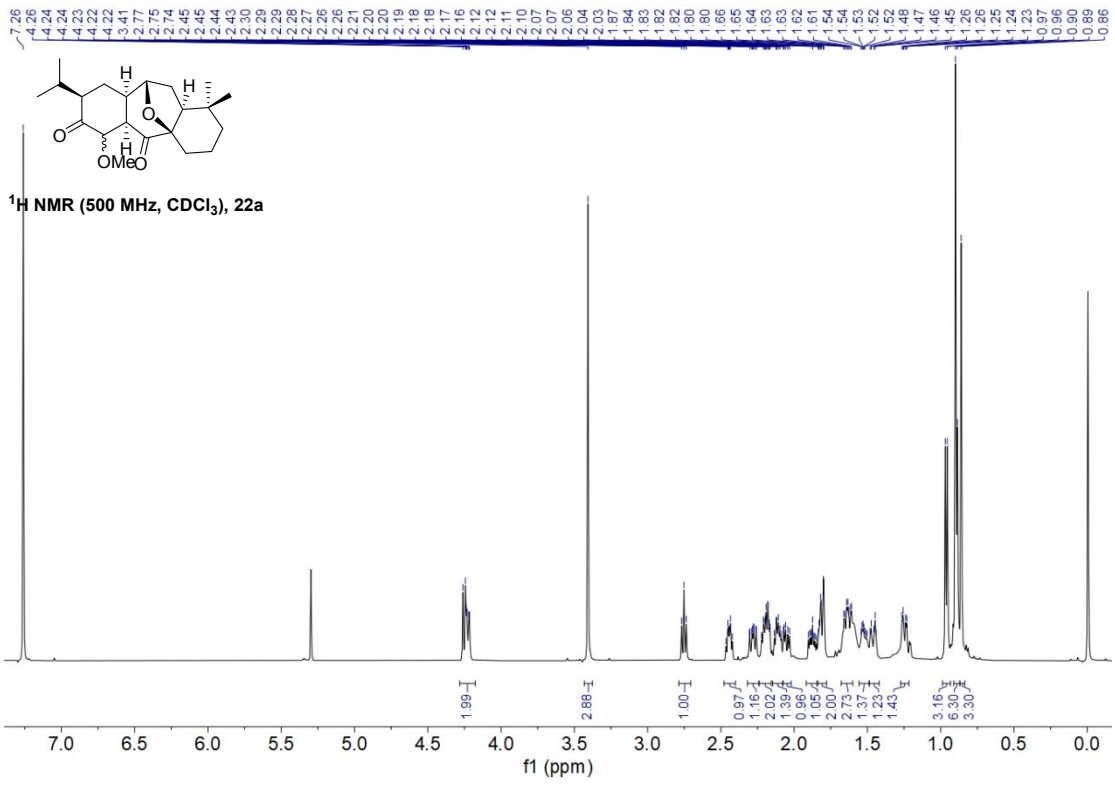
^{13}C NMR (126 MHz, $CDCl_3$), 16a



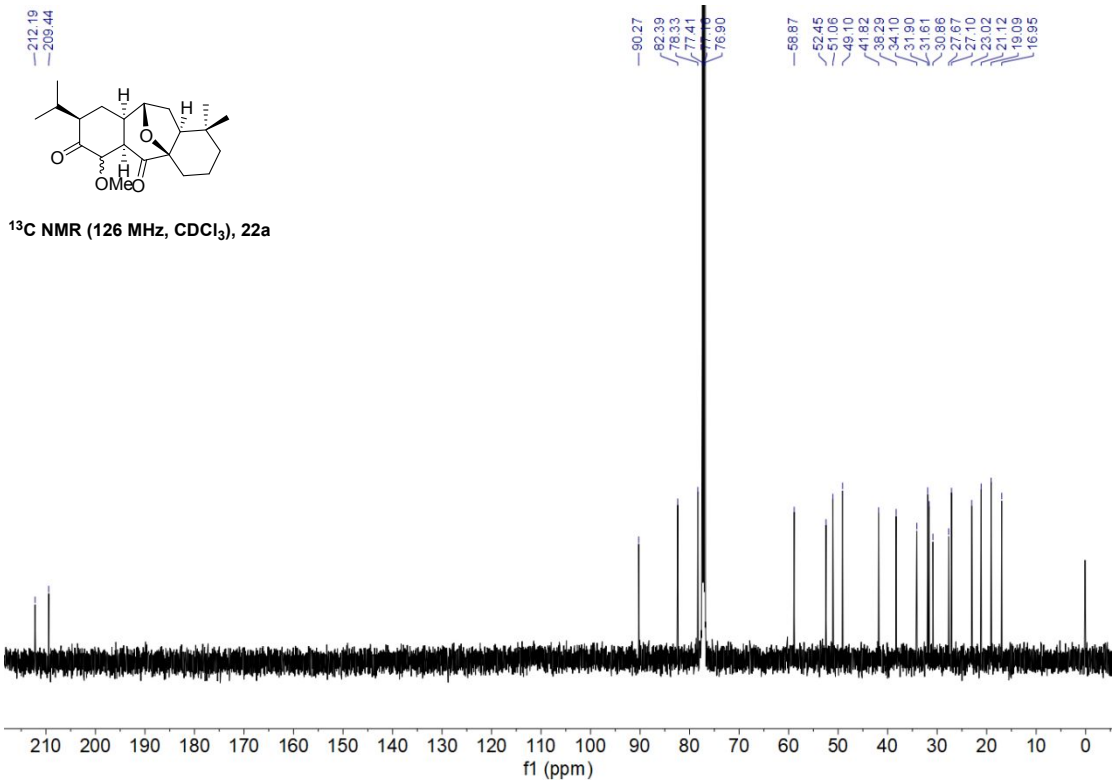
^{1}H NMR (500 MHz, $CDCl_3$), 16b



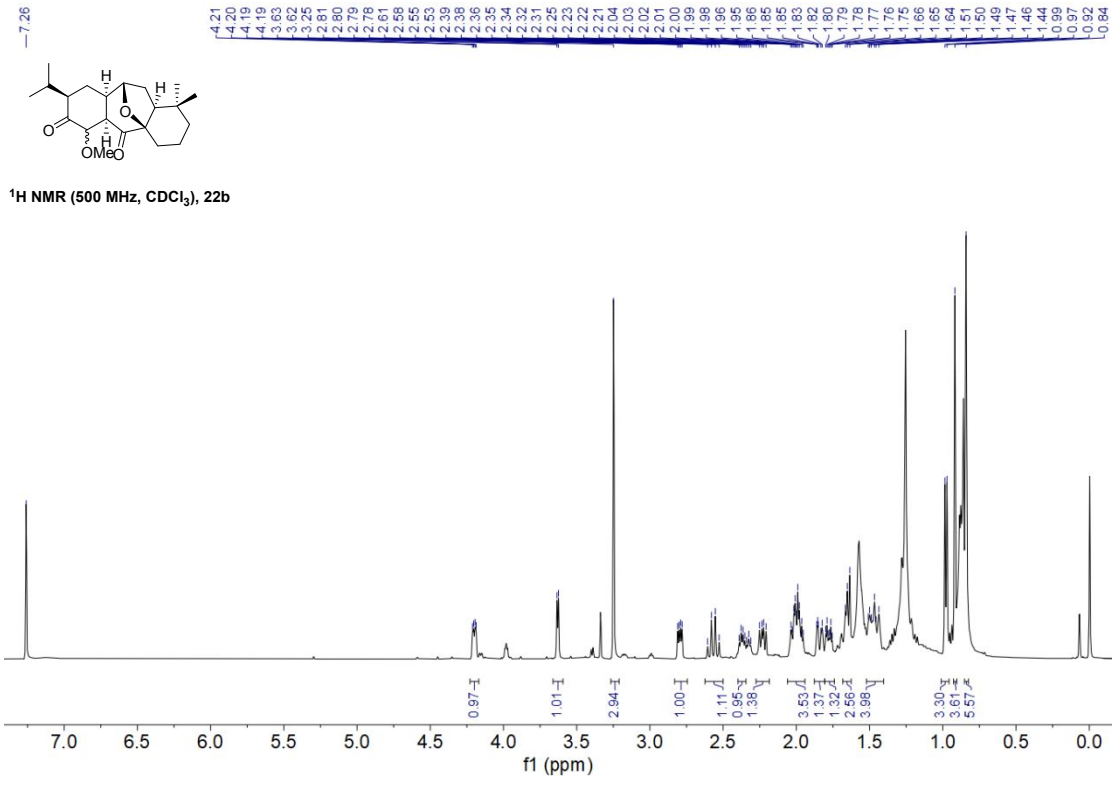
^{13}C NMR (126 MHz, $CDCl_3$), 16b



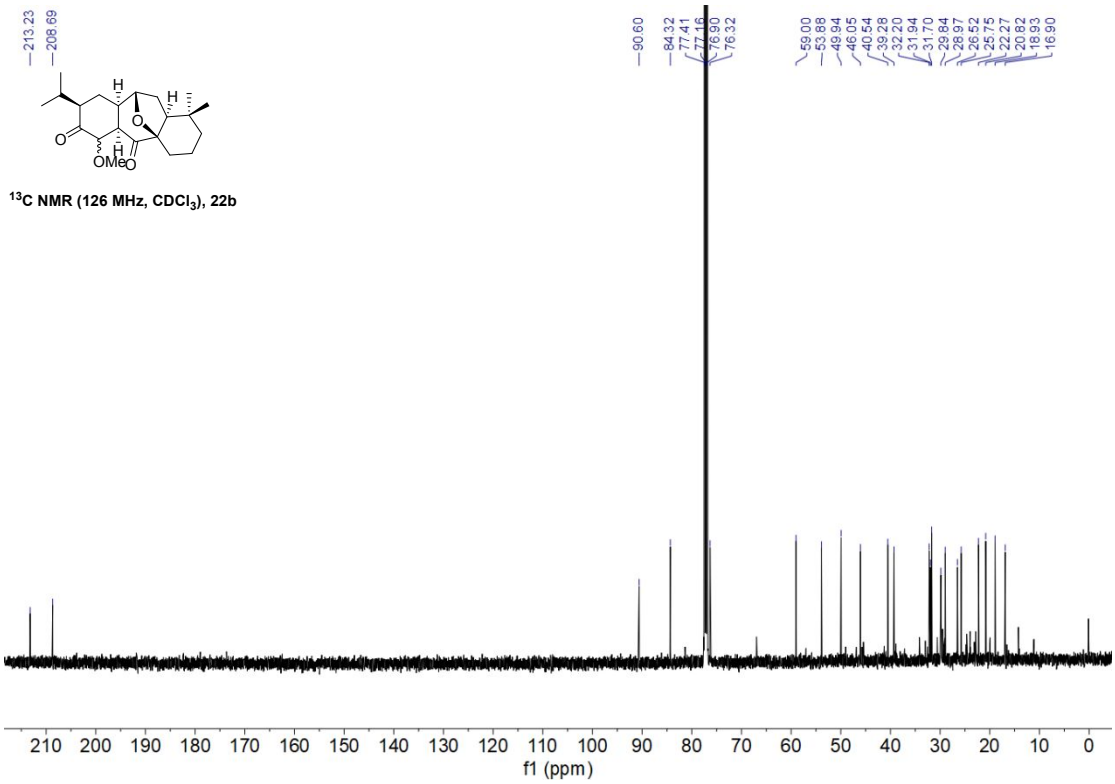
^{1}H NMR (500 MHz, $CDCl_3$), 22a



^{13}C NMR (126 MHz, $CDCl_3$), 22a



^{1}H NMR (500 MHz, $CDCl_3$), 22b



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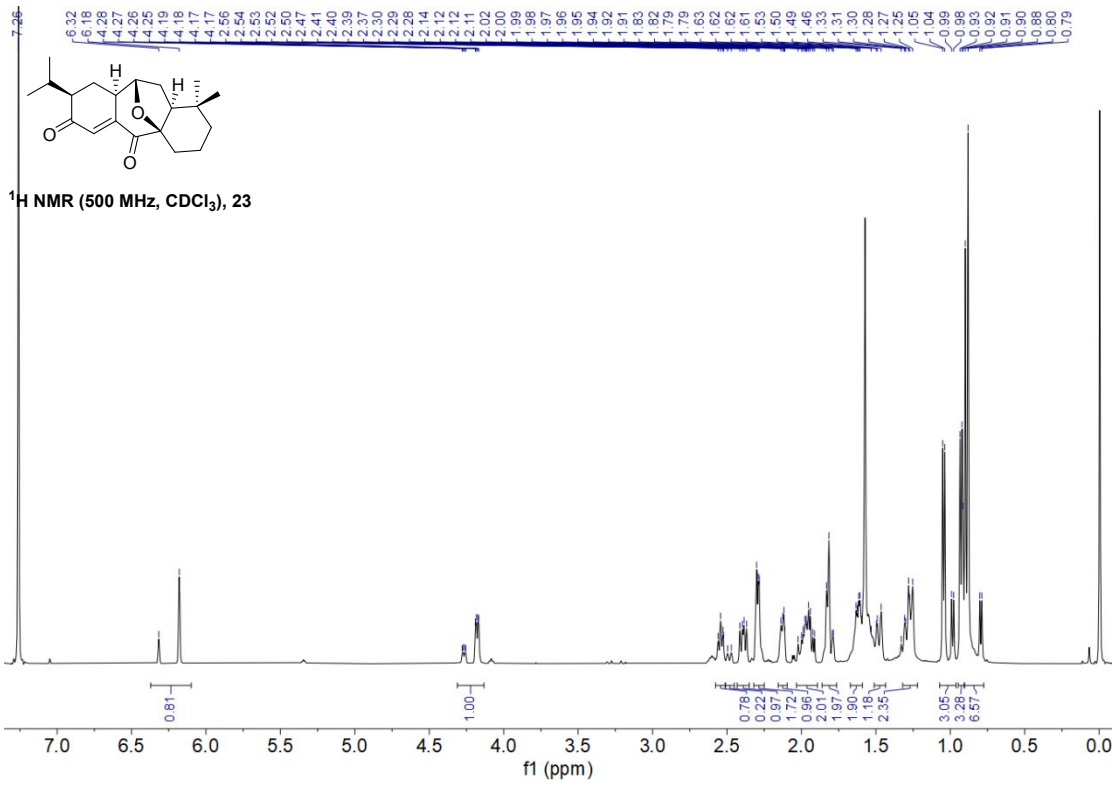
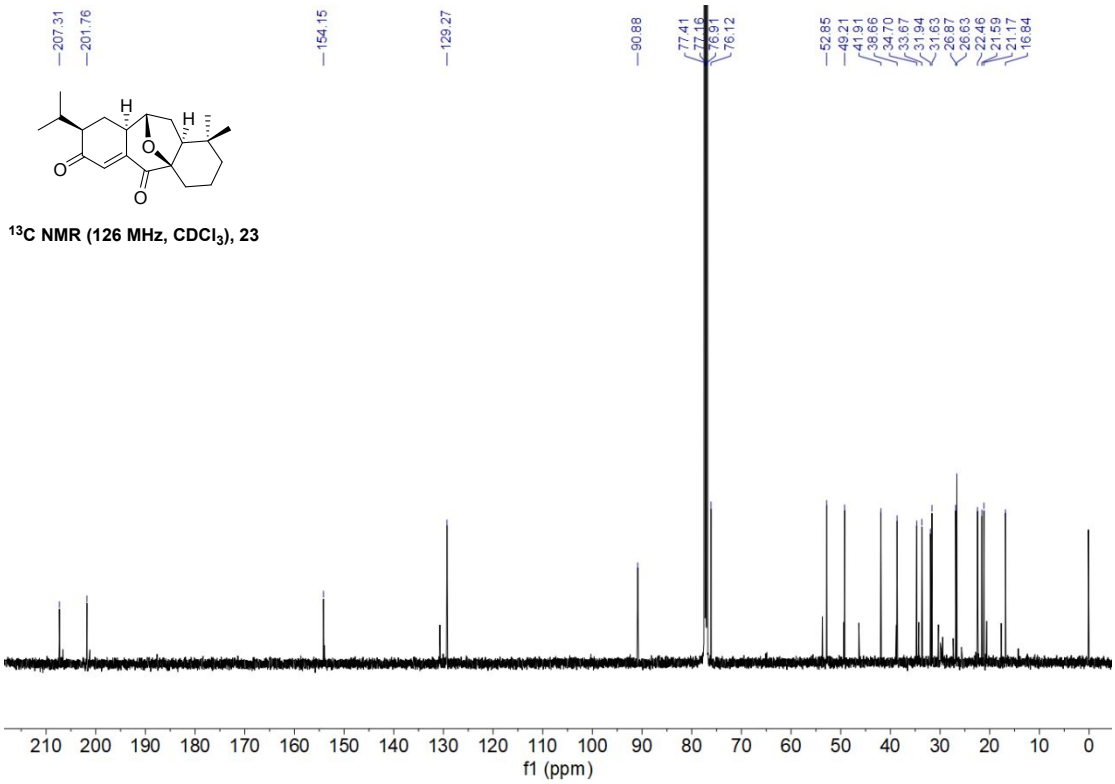
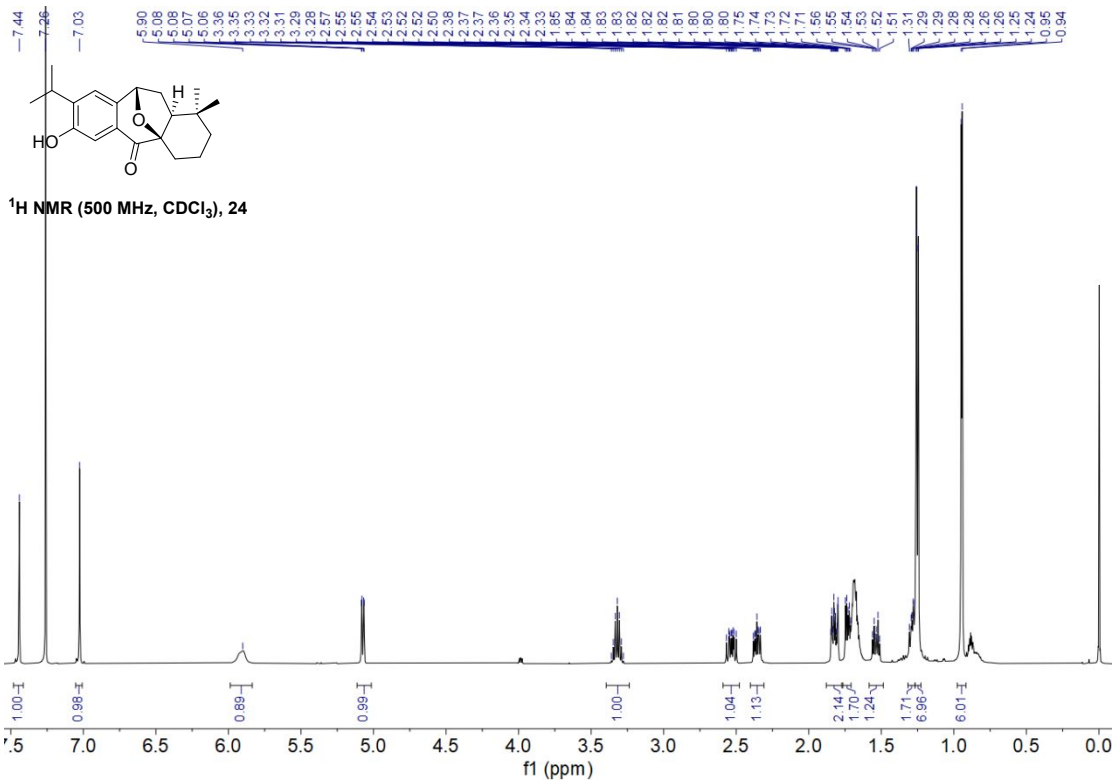


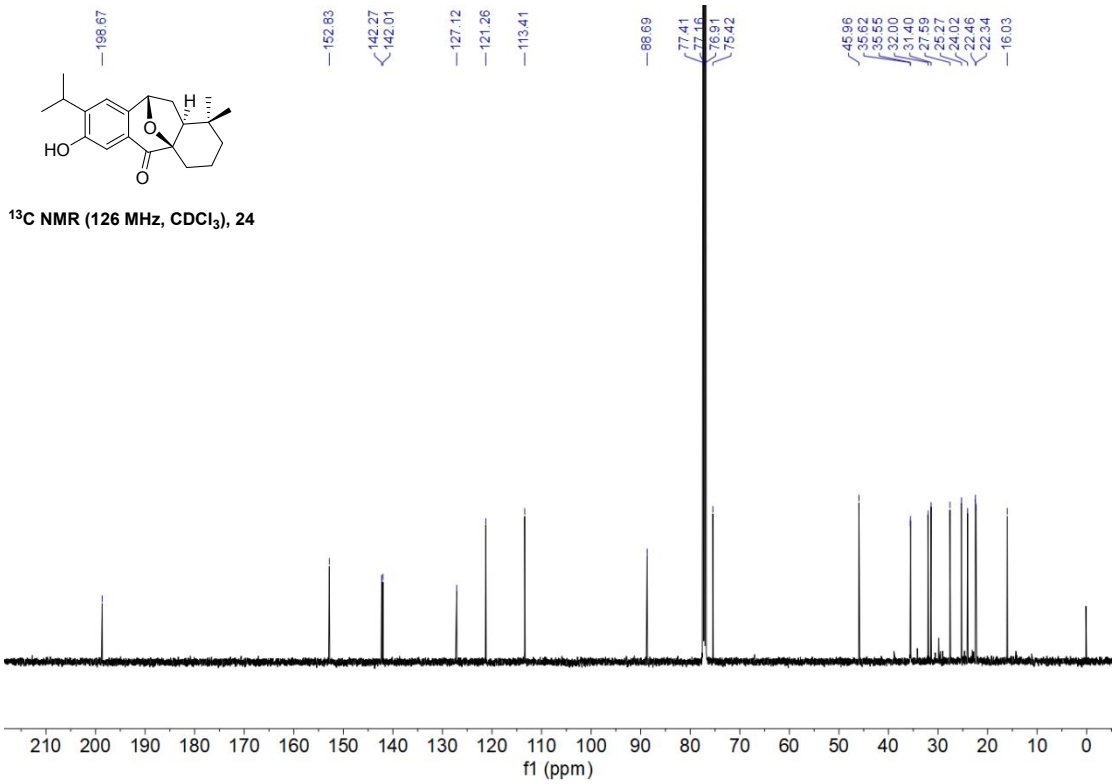
^{1}H NMR (500 MHz, $CDCl_3$), 23



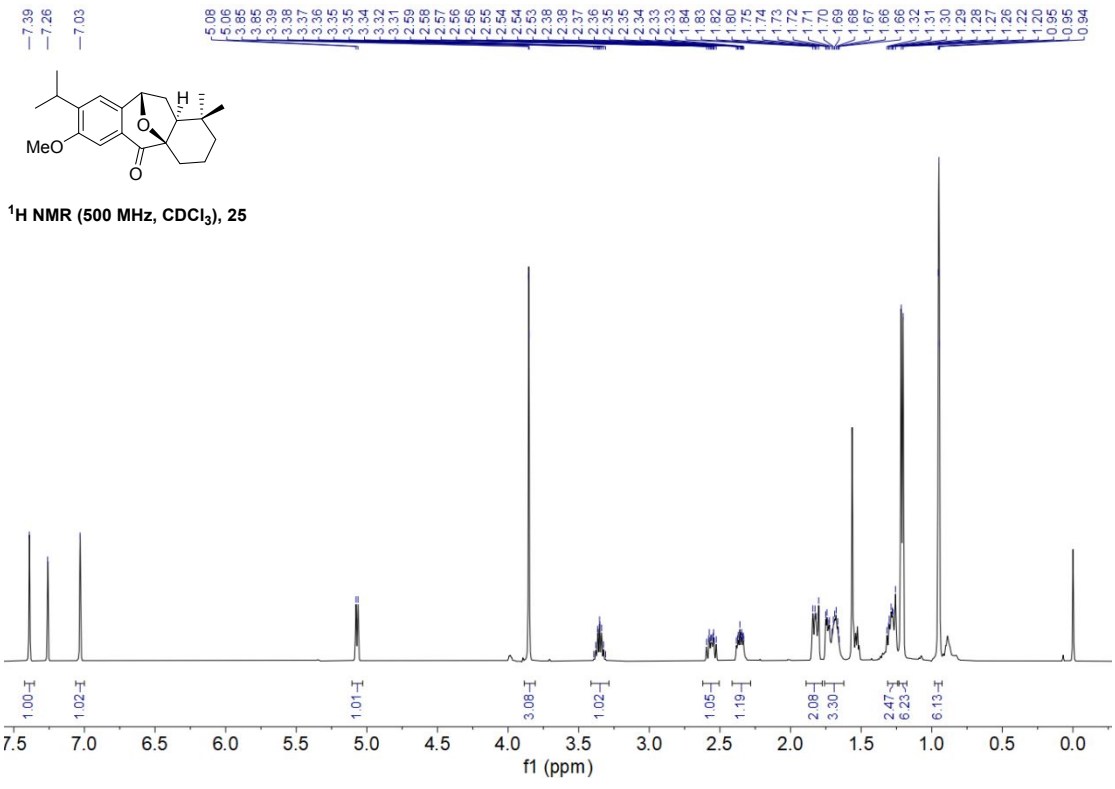
^{13}C NMR (126 MHz, $CDCl_3$), 23



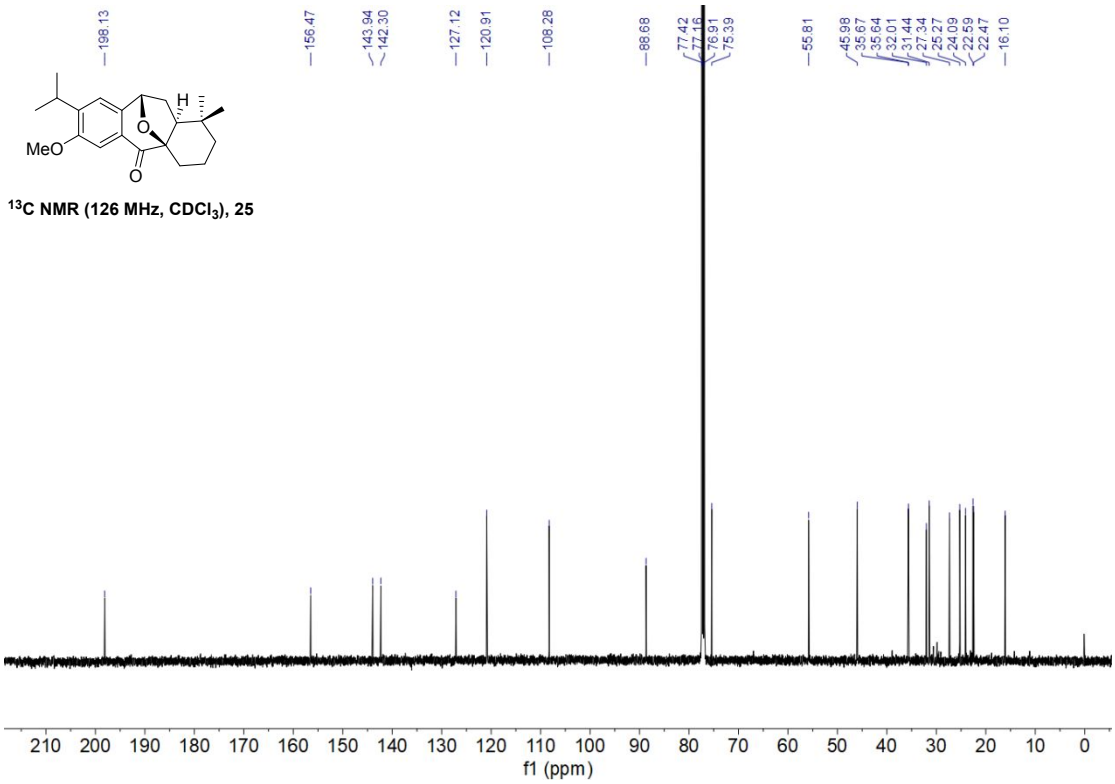
^{1}H NMR (500 MHz, $CDCl_3$), 24



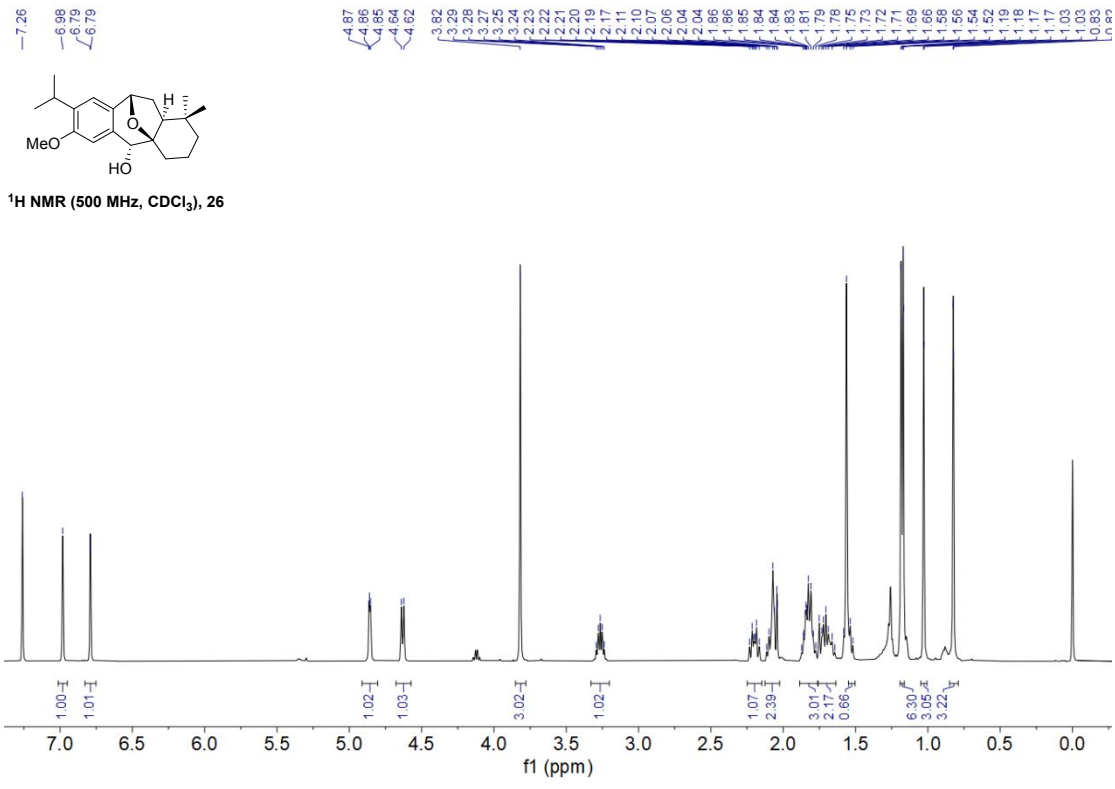
^{13}C NMR (126 MHz, $CDCl_3$), 24



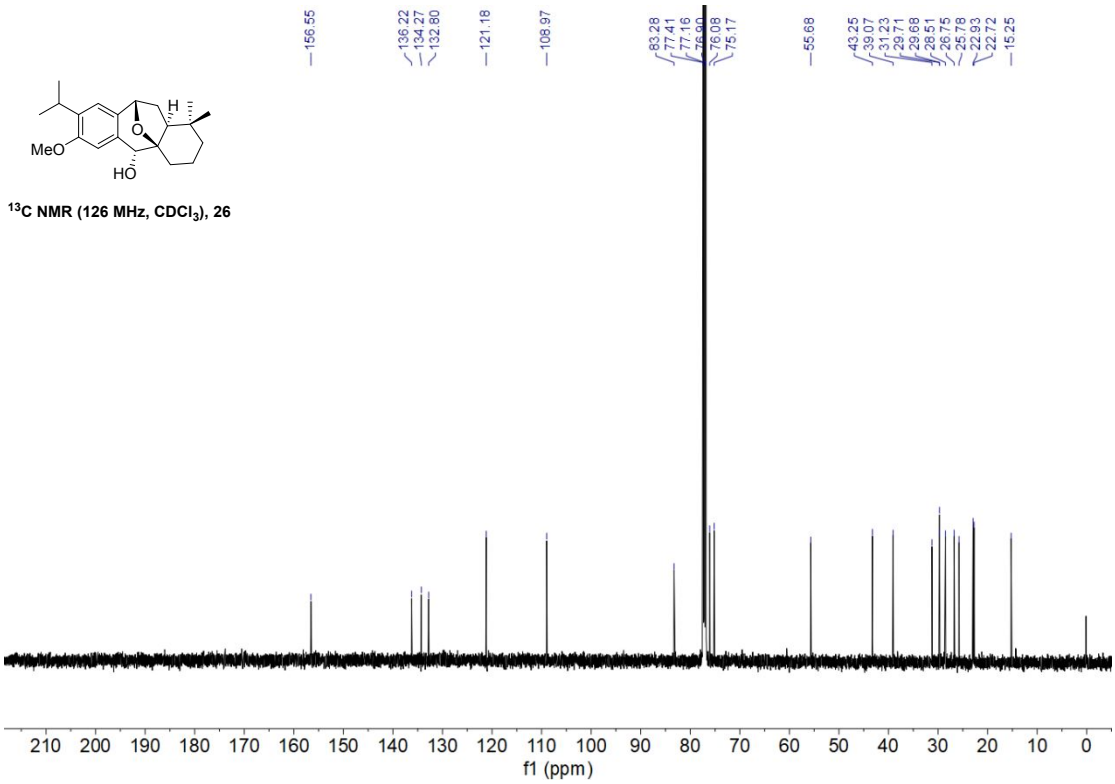
^{1}H NMR (500 MHz, $CDCl_3$), 25



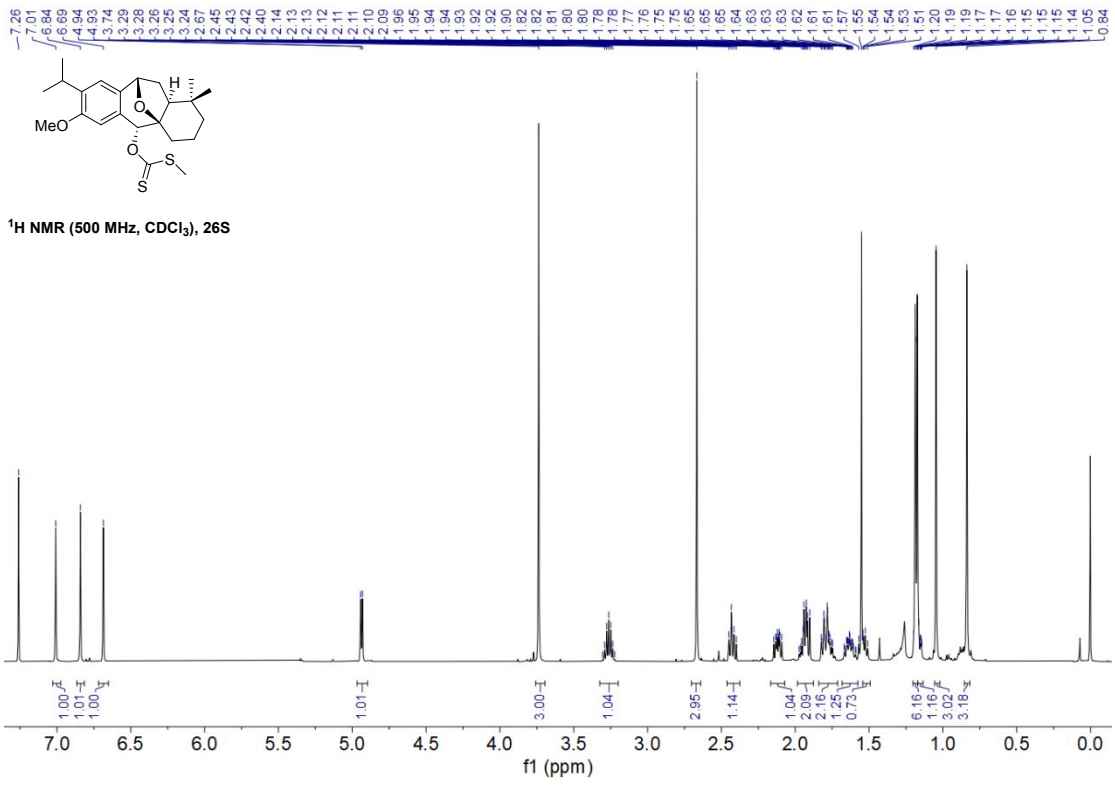
^{13}C NMR (126 MHz, $CDCl_3$), 25



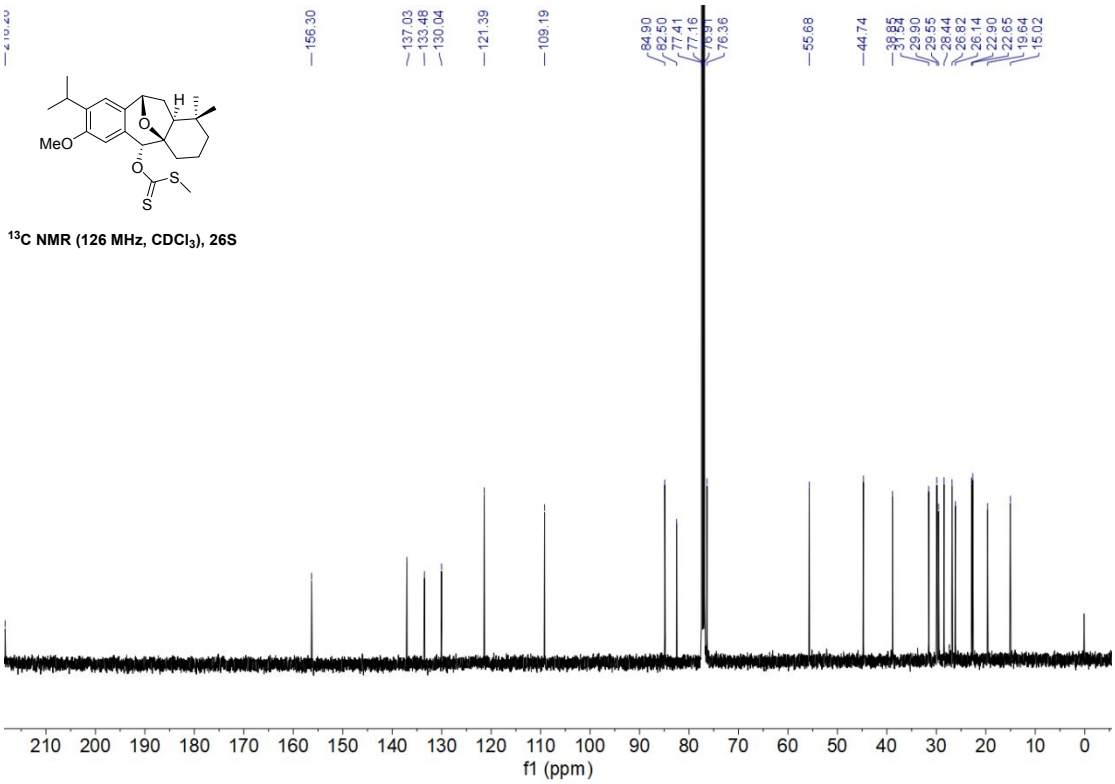
^{1}H NMR (500 MHz, $CDCl_3$), 26



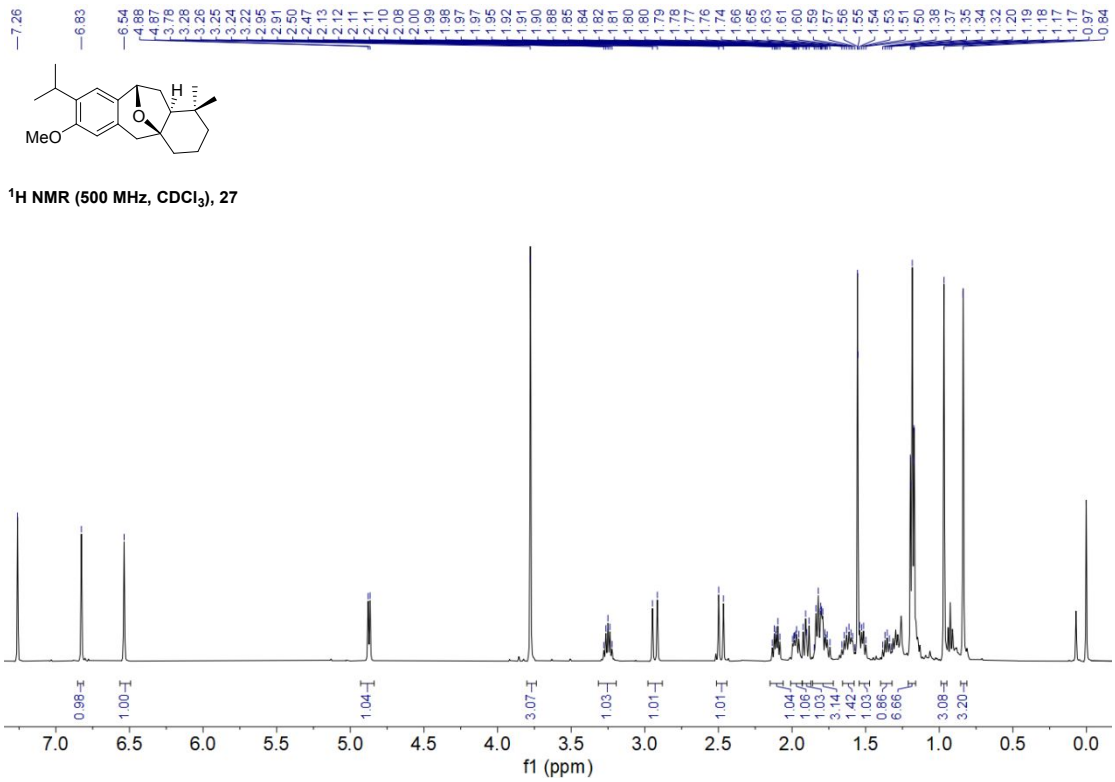
^{13}C NMR (126 MHz, $CDCl_3$), 26



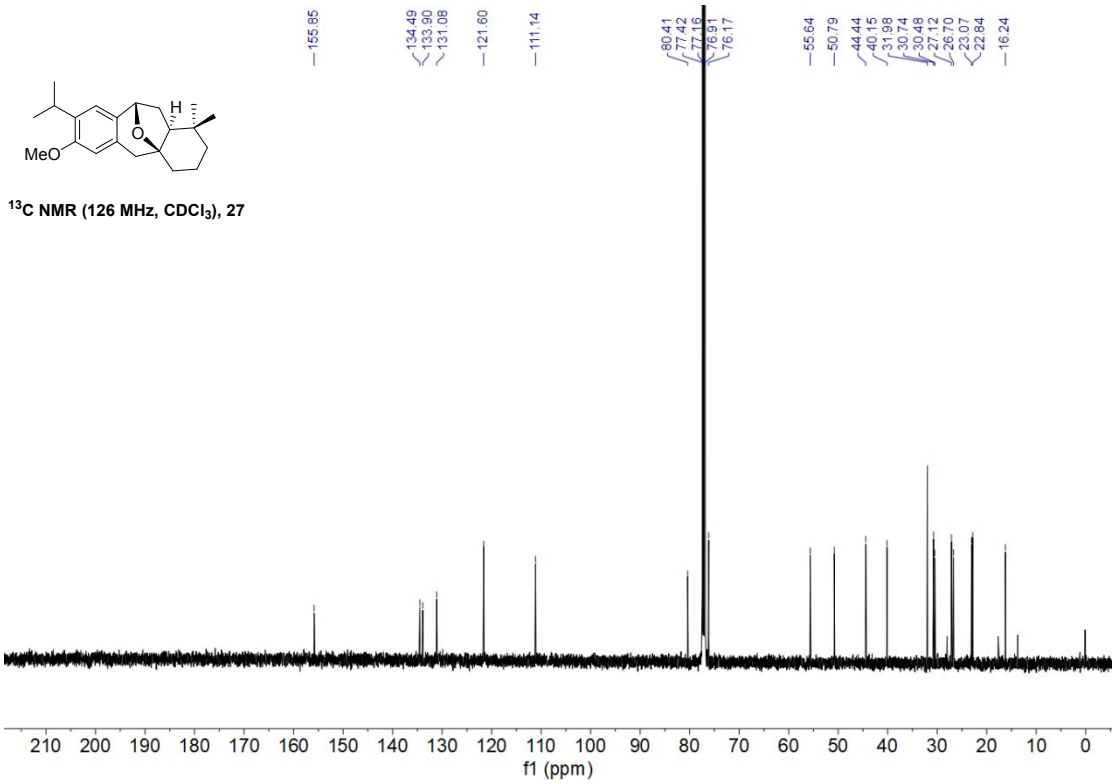
^{1}H NMR (500 MHz, $CDCl_3$), 26S



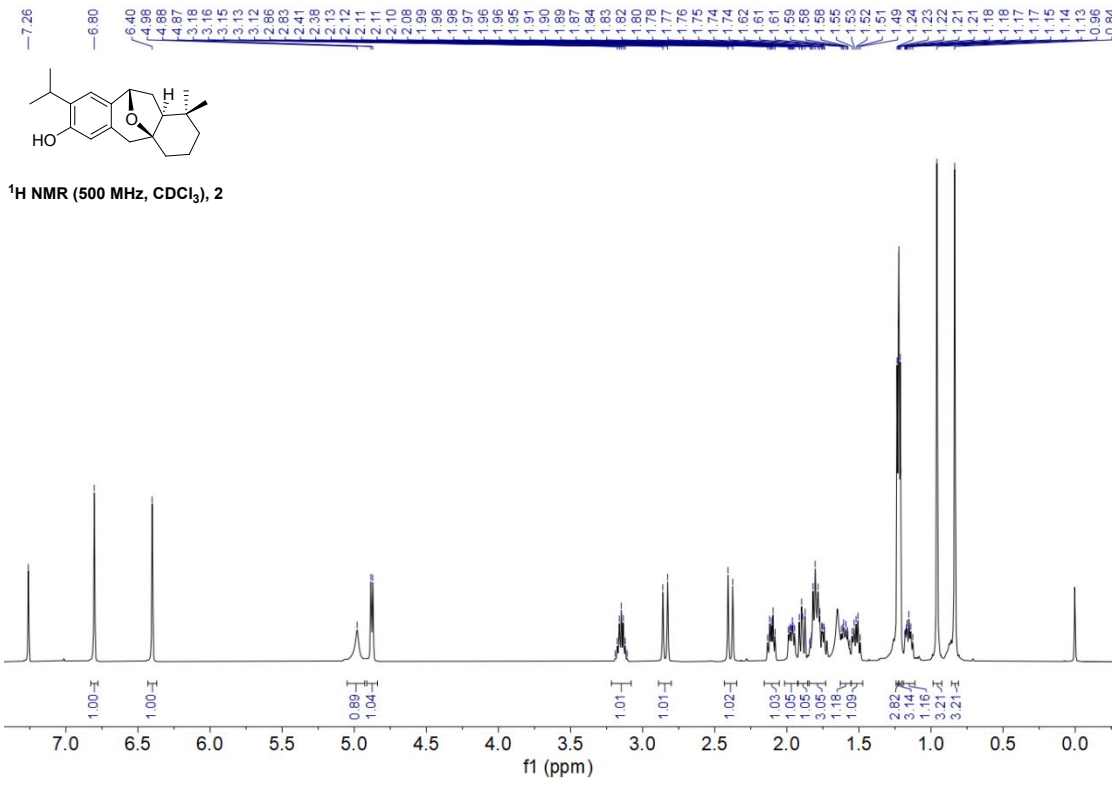
^{13}C NMR (126 MHz, $CDCl_3$), 26S



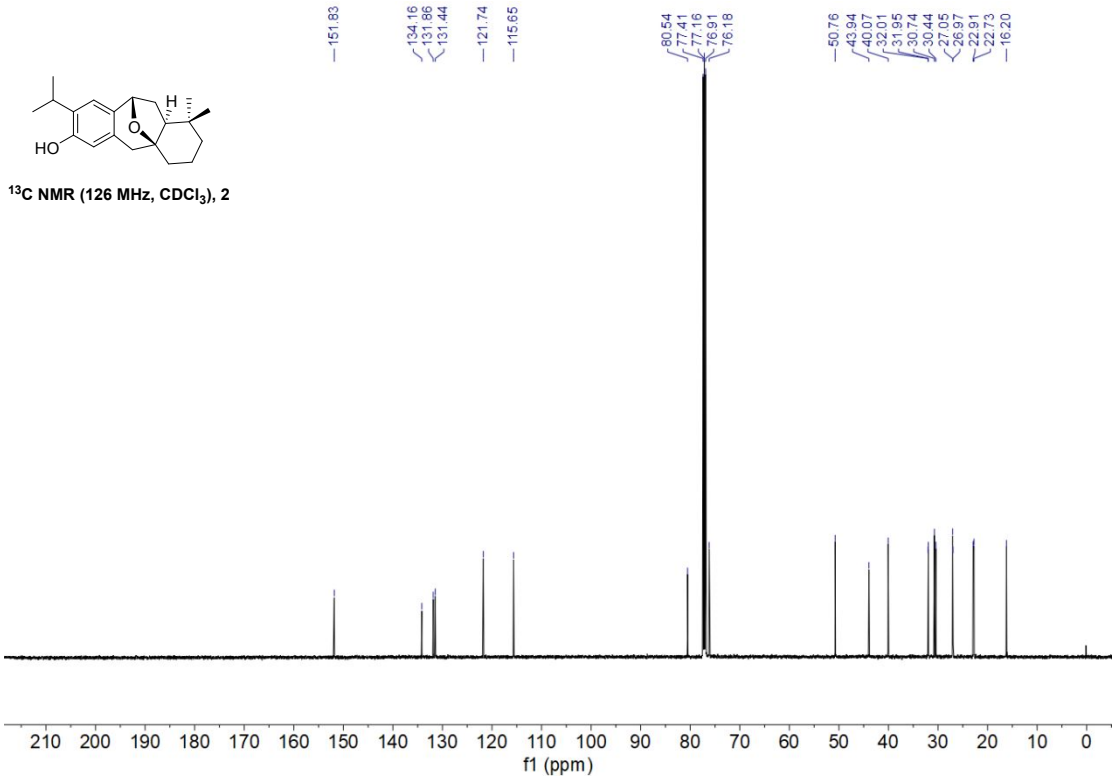
^{1}H NMR (500 MHz, $CDCl_3$), 27



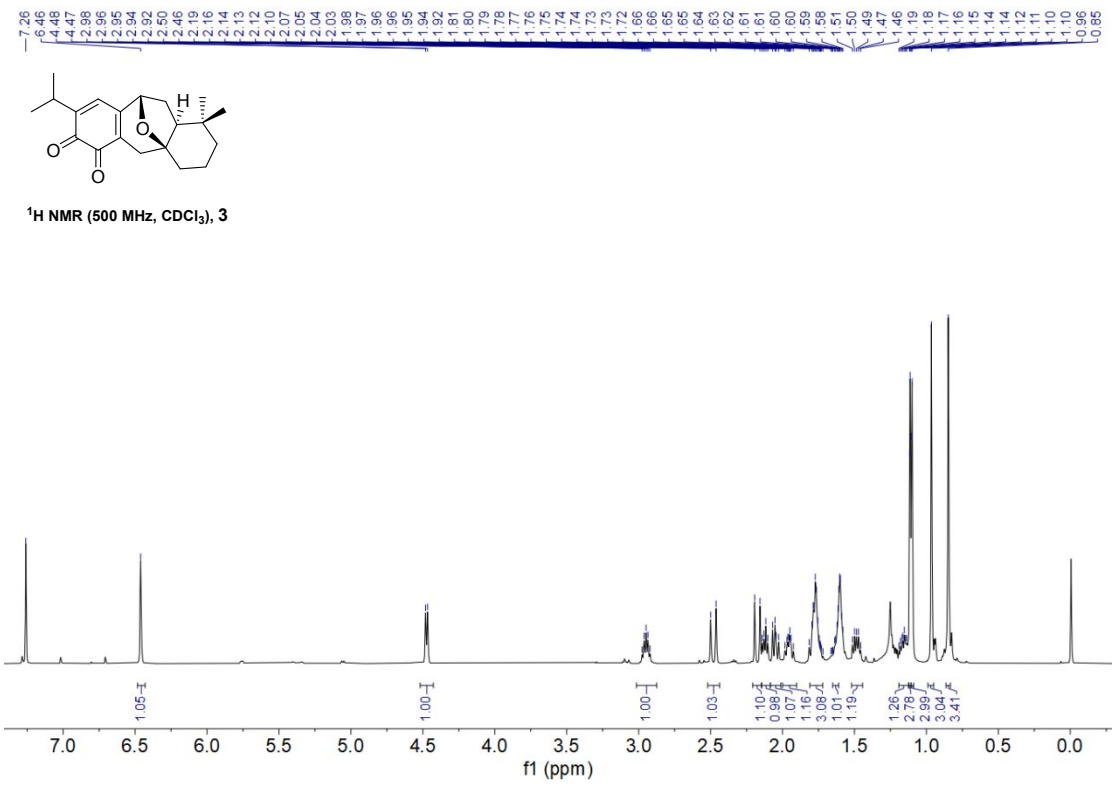
^{13}C NMR (126 MHz, $CDCl_3$), 27



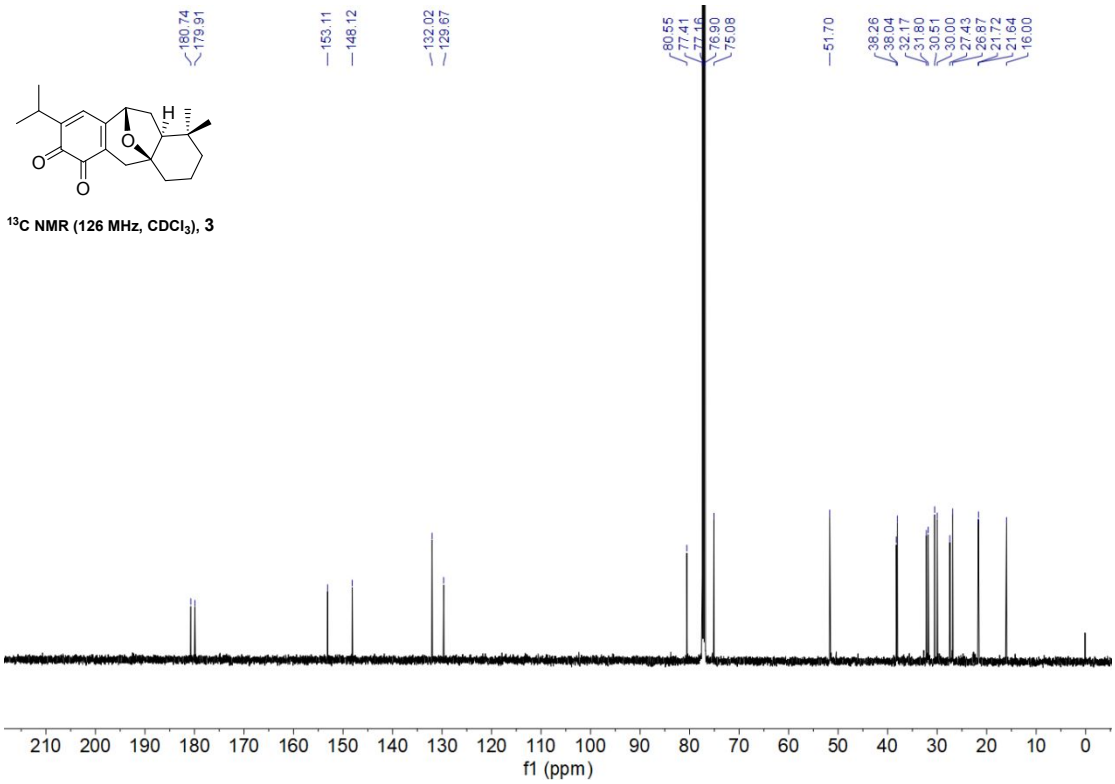
^{1}H NMR (500 MHz, $CDCl_3$), 2



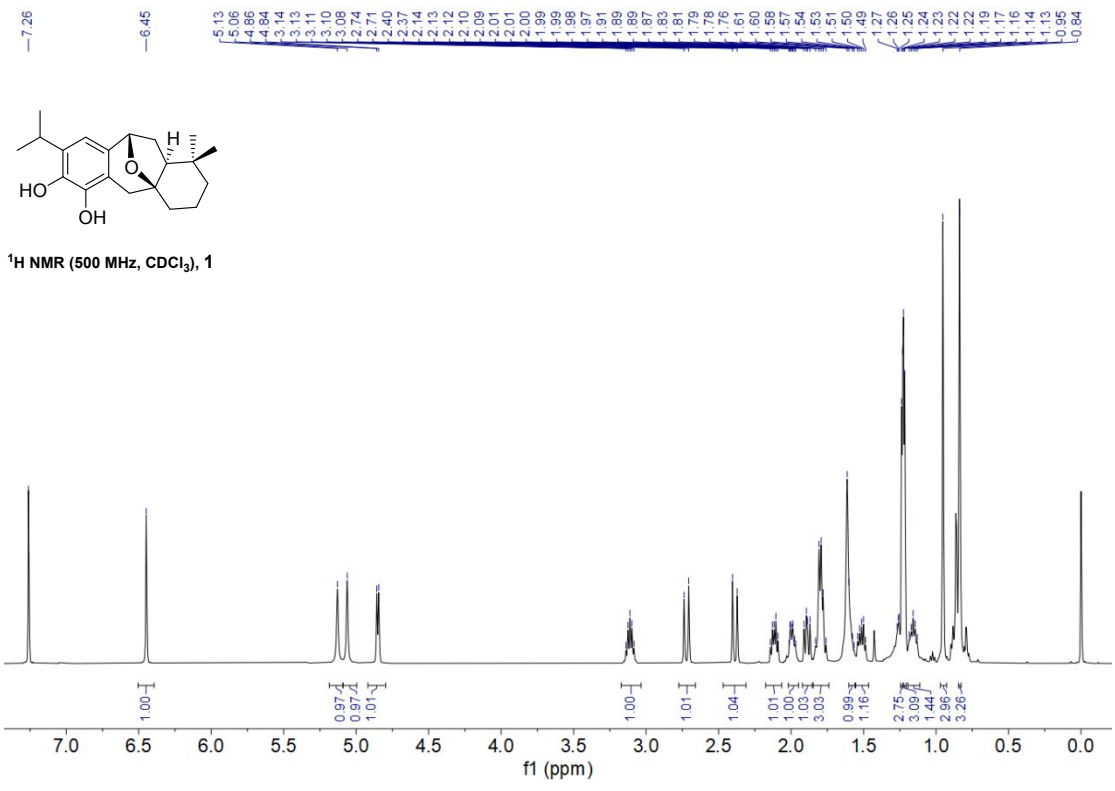
^{13}C NMR (126 MHz, $CDCl_3$), 2



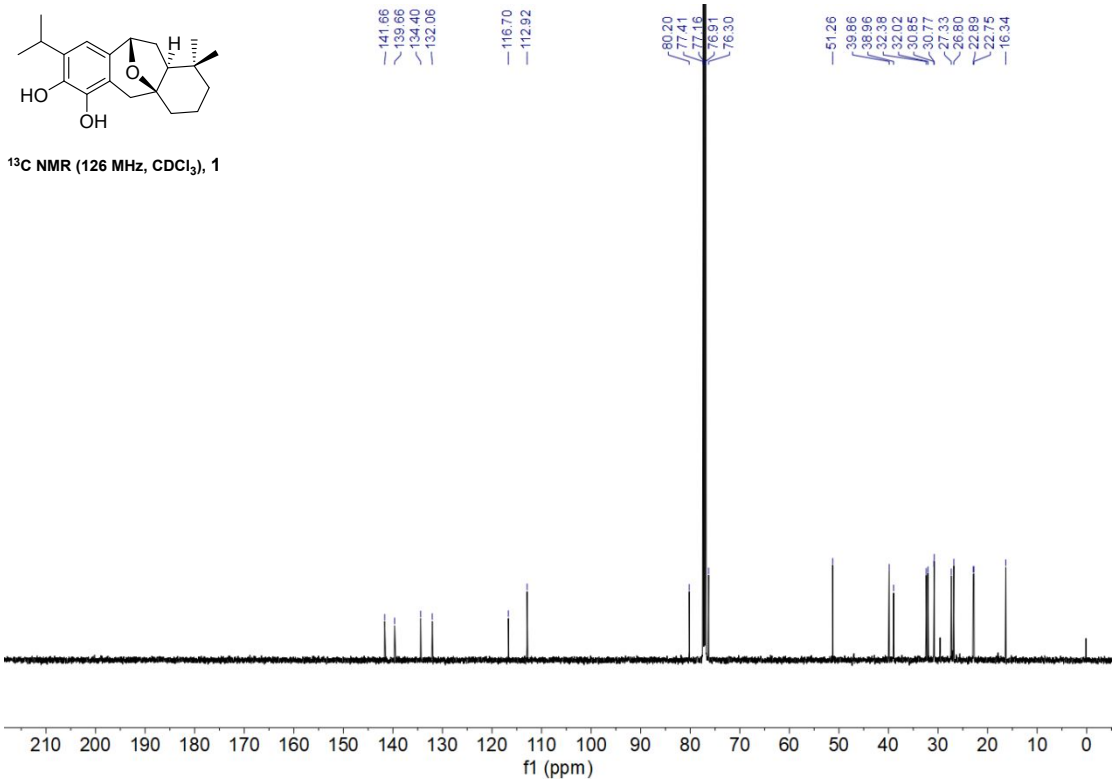
^{1}H NMR (500 MHz, $CDCl_3$), 3



^{13}C NMR (126 MHz, $CDCl_3$), 3



^{1}H NMR (500 MHz, $CDCl_3$), 1



^{13}C NMR (126 MHz, $CDCl_3$), **1**

IV Comparison of the ^{1}H NMR data for synthesized euolutchuol E with the reported data

Synthetic (500 MHz)	Reported
6.80 (s, 1H)	6.81 (s, 1H)
6.40 (s, 1H)	6.45 (s, 1H)
4.88 (d, *J* = 6.5 Hz, 1H)	4.87 (d, *J* = 6.6 Hz, 1H)
4.98 (s, 1H)	4.52 (s, 1H)
3.15 (hept, *J* = 7.0 Hz, 1H)	3.13 (hept, *J* = 6.9 Hz, 1H)
2.84 (d, *J* = 16.3 Hz, 1H)	2.87 (d, *J* = 16.4 Hz, 1H)
2.39 (d, *J* = 16.5 Hz, 1H)	2.43 (d, *J* = 16.4 Hz, 1H)
2.11 (dt, *J* = 12.4, 6.9 Hz, 1H)	2.11 (dt, *J* = 11.7, 6.8 Hz, 2H)
2.02 – 1.92 (m, 1H)	1.96 (td, *J* =7.0, 4.0 Hz, 1H)
1.89 (dd, *J* = 11.9, 8.5 Hz, 1H)	1.89 (dd, *J* = 11.5, 8.6 Hz, 1H)
1.85 – 1.73 (m, 3H)	1.83-1.72 (m, 3H)
1.63-1.55 (m, 1H)	1.63-1.56 (m, 1H)
1.55-1.49 (m, 1H)	1.52-1.47 (m, 1H)
1.23 (d, *J* = 4.2 Hz, 3H)	1.24 (d, *J* = 6.9 Hz, 3H)

1.22 (d, *J* = 4.5 Hz, 3H)	1.22 (d, *J* = 6.9 Hz, 3H)
1.18-1.13 (m, 1H)	1.19-1.11 (m, 1H)
0.96 (s, 3H)	0.96 (s, 3H)
0.84 (s, 3H)	0.83 (s, 3H)

Comparison of the ^{13}C NMR data for synthesized euolutchuol E with the reported data

Synthetic (126 MHz)	Reported
151.8	151.6
134.2	134.5
131.9	131.7
131.4	131.6
121.7	121.8
115.7	115.6
80.5	80.4
76.2	76.1
50.8	50.7
43.9	43.9
40.1	40.1
32.0	32.0
32.0	32.0
30.7	30.7
30.4	30.5
27.0	27.1
27.0	27.0
22.9	23.0
22.7	22.7
16.2	16.2

Comparison of the ^{1}H NMR data for synthesized przewalskine E with the reported data

Synthetic (500 MHz)	Reported
6.46 (s, 1H)	6.47 (s, 1H)
4.47 (d, *J* = 6.8 Hz, 1H)	4.48 (d, J = 6.4 Hz, 1H)
2.98– 2.92 (m, 1H)	2.92-2.99 (m, 1H)
2.48 (d, *J* = 18.6 Hz, 1H)	2.49 (d, J =18.4 Hz, 1H)
2.18 (d, *J* = 18.6 Hz, 1H)	2.18 (d, J = 18.8 Hz, 1H)
2.15 – 2.08 (m, 1H), 2.08 – 2.02 (m, 1H)	2.03-2.14 (m, 2H)
1.99 – 1.91 (m, 1H)	1.93-2.00 (m, 1H)
1.81 – 1.72 (m, 3H)	1.73-1.81 (m, 3H)
1.65 – 1.61 (m, 1H)	1.58-1.65 (m, 1H)

1.52 – 1.45 (m, 1H)	1.46-1.53 (m, 1H)
1.19 – 1.14 (m, 1H)	1.16-1.19 (m, 1H)
1.12 (d, *J* = 2.2 Hz, 3H)	1.12 (d, J = 6.8 Hz, 3H)
1.10 (d, *J* = 2.3 Hz, 3H)	1.11 (d, J = 6.8 Hz, 3H)
0.96 (s, 3H)	0.97 (s, 3H)
0.85 (s, 3H)	0.86 (s, 3H)

Comparison of the ^{13}C NMR data for synthesized przewalskine E with the reported data

Synthetic (126 MHz) (the residual solvent signal of $CDCl_3$: δ = 77.16)	Reported (the residual solvent signal of $CDCl_3$: δ = 77.00)
180.7	180.6
179.9	179.7
153.1	152.9
148.1	147.9
132.0	131.9
129.7	129.5
80.6	80.4
75.1	74.9
51.7	51.5
38.3	38.1
38.0	37.9
32.2	32.0
31.8	31.6
30.5	30.3
30.0	29.8
27.4	27.3
26.9	26.7
21.7	21.6
21.6	21.5
16.0	15.8

Comparison of the ^{1}H NMR data for synthesized brussonol with the reported data

Synthetic (500 MHz)	Reported
6.45 (s, 1H)	6.46 (s, 1H)
5.13 (s, 1H)	4.99 (s, 1H)
5.06 (s, 1H)	4.97 (s, 1H)
4.85 (d, *J* = 6.6 Hz, 1H)	4.86 (d, J = 6.4 Hz, 1H)
3.16 – 3.06 (m, 1H)	3.08-3.15 (m, 1H)

2.72 (d, *J* = 16.0 Hz, 1H)	2.74 (d, J = 16.4 Hz, 1H)
2.39 (d, *J* = 16.2 Hz, 1H)	2.40 (d, J = 16.4 Hz, 1H)
2.15 – 2.08 (m, 1H)	2.10-2.16 (m, 1H)
2.02 – 1.95 (m, 1H)	1.98-2.04 (m, 1H)
1.92 – 1.86 (m, 1H)	1.88-1.93 (m, 1H)
1.85 – 1.74 (m, 3H)	1.77-1.87 (m, 3H)
1.61 – 1.56 (m, 1H)	1.59-1.66 (m, 1H)
1.55 – 1.48 (m, 1H)	1.49-1.57 (m, 1H)
1.23 (d, *J* = 3.7 Hz, 3H)	1.26 (d, J = 6.8 Hz, 3H)
1.22 (d, *J* = 4.3 Hz, 3H)	1.25 (d, J = 6.8 Hz, 3H)
1.19 – 1.13 (m, 1H)	1.23-1.24 (m, 1H)
0.95 (s, 3H)	0.97 (s, 3H)
0.84 (s, 3H)	0.85 (s, 3H)

Comparison of the ^{13}C NMR data for synthesized brussonol with the reported data (*Nat. Commun.* 2015, 6, 7332-7338)

Synthetic (126 MHz) (the residual solvent signal of $CDCl_3$: δ = 77.16)	Reported (the residual solvent signal of $CDCl_3$: δ = 77.00)
141.7	141.6
139.7	139.5
134.4	134.1
132.1	132.0
116.7	116.5
112.9	112.7
80.2	80.2
76.3	76.2
51.3	51.0
39.9	39.7
39.0	38.8
32.4	32.1
32.0	31.8
30.9	30.6
30.8	30.6
27.3	27.1
26.8	26.6
22.9	22.7
22.7	22.6
16.3	16.1

Comparison of the ^{13}C NMR data for synthesized brussonol with the reported data (*Org. Lett.* 2019, *21*, 6079-6083)

Synthetic (126 MHz) (the residual solvent signal of $CDCl_3$: $\delta = 77.16$)	Reported (the residual solvent signal of $CDCl_3$: $\delta = 77.16$)
141.7	141.7
139.7	139.7
134.4	134.3
132.1	132.1
116.7	116.7
112.9	112.9
80.2	80.3
76.3	76.3
51.3	51.2
39.9	39.8
39.0	38.9
32.4	32.3
32.0	32.0
30.9	30.8
30.8	30.8
27.3	27.3
26.8	26.8
22.9	22.9
22.7	22.8
16.3	16.3