

Supplementary Information

for

Total Synthesis of Cyrneines A–B and Glaucopine C

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Part I. Synthesis of Cyrneines A, B, and Glaucopine C

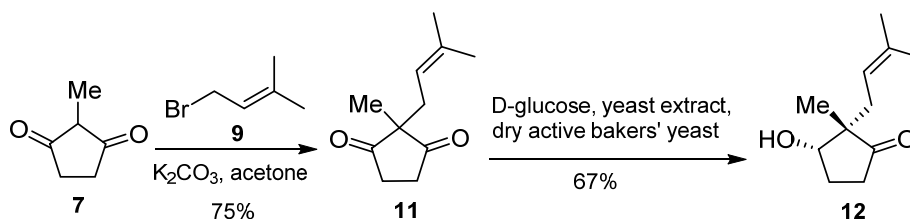
1. General Information

Unless otherwise stated, all oxygen or moisture sensitive reactions were conducted in flame-dried glassware under an atmosphere of nitrogen or argon. All solvents were purified and dried according to standard methods prior to use. Reagents were purchased from commercial sources and were used without further purification.

Analytical thin layer chromatography (TLC) was performed on 0.2 mm thick silica gel 60-F254 plates (Merck) and visualized by exposure to ultraviolet light, or an ethanolic solution of phosphomolybdic acid. Chromatographic purification of products was accomplished using forced-flow chromatography on 230-400 mesh silica gel. The ^1H -NMR spectra were recorded on Bruker AV at 300, 400, or 600 MHz and ^{13}C -NMR spectra were recorded at 103 MHz, 126 MHz, or 151 MHz. Chemical shifts are given relative to TMS or the appropriate solvent peak. High resolution mass spectra (HRMS) were obtained on an IonSpec Ultima 7.0 T FT-ICR-MS (IonSpec, USA) using ESI as ionization method. HPLC analysis was performed on Shimadzu LC solution (CTO-10AS, LC-20AD, RID-10A). X-ray crystallographic analysis was performed on a Bruker D8 ADVANCE diffractometer with Cu- $K\alpha$ radiation ($\lambda = 1.54178 \text{ \AA}$).

2. Experimental Procedures and Spectroscopic Data of the Synthesized Compounds

2.1 Synthesis of compound 12

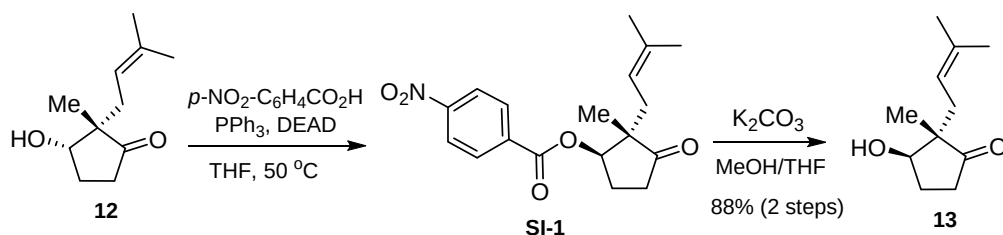


Supplementary Figure 1. Synthesis of compound 12

To a solution of **7** (22.43 g, 200 mmol) in acetone (500 mL) was added **9** (46.54 mL, 400 mmol, 2.0 equiv), and K_2CO_3 (41.46 g, 300 mmol, 1.5 equiv). The mixture was stirred at room temperature overnight and then concentrated under reduced pressure. The crude residue was partitioned between water (100 mL) and CH_2Cl_2 (100 mL). The organic phase was separated, and the aqueous layer was extracted with CH_2Cl_2 (2×100 mL). The combined extracts were dried over Na_2SO_4 and concentrated under reduced pressure. The crude residue was purified by flash chromatography on silica gel (eluent: petroleum ether/EtOAc = 5/1) to afford **11** (27.02 g, 75%) as a light brown oil.

To a solution of D-glucose (90.0 g) and yeast extract (3.0 g) in distilled water (600 mL) at 35–40 °C was added dry active bakers' yeast (80.0 g, Angel Yeast Co., Ltd). The mixture was stirred open to the air for 30 min, maintaining the temperature between 30 and 35 °C, after which the dione **11** (6.0 g, 33.29 mmol) was added dropwise over 5 min. The mixture was vigorously stirred open to the air at 25 °C for 36 h, then diluted with 150 mL of water, and extracted with ethyl acetate (4×400 mL). The organic extract was evaporated to provide a crude product consisting of ketol, unreacted dione, and a trace of diol. The components of the mixture were purified by chromatography on silica gel (eluent: petroleum ether/EtOAc = 5/1 $\rightarrow$ 2/1) to afford **11** (4.1 g, 67%) as a white solid. R_f = 0.3 (petroleum ether/EtOAc = 3/2); $[\alpha]_D^{25} = +99.0$ (c = 1.0 in $CHCl_3$); 1H NMR (300 MHz, $CDCl_3$) δ 5.24–5.14 (m, 1H), 4.16–4.09 (m, 1H), 2.57–2.41 (m, 5H), 2.03–1.93 (m, 2H), 1.73 (s, 3H), 1.66 (s, 3H), 1.00 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 221.4, 135.1, 119.3, 77.6, 53.8, 34.3, 29.5, 27.7, 26.2, 19.9, 18.0; HRMS (ESI) m/z calcd for $C_{11}H_{18}NaO_2^+$ $[M+Na]^+$: 205.1199, found 205.1198; HPLC chiralcel OZ-H column (hexane/isopropanol = 95/5, 1.0 mL/min), Retention time: 8.386 min (major), 15.956 min (minor): 98.9% ee.

2.2 Synthesis of compound 13

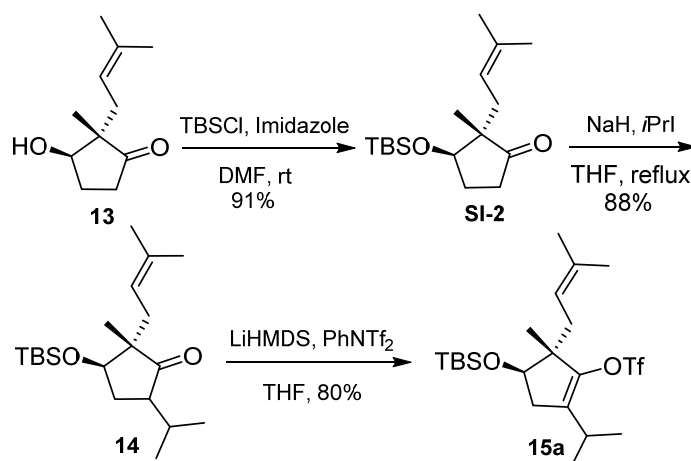


Supplementary Figure 2. Synthesis of compound **13**

To a stirred solution of **12** (3.28 g, 18.0 mmol) in THF (70 mL) containing triphenylphosphine (9.44 g, 36.0 mmol, 2.0 equiv) and *p*-nitrobenzoic acid (6.02 g, 36.0 mmol, 2.0 equiv) was added DEAD (5.67 mL, 36.0 mmol, 2.0 equiv) dropwise over a 10-min period at 0 °C under argon, and the reaction mixture was stirred at 50 °C overnight. The solvent was removed under reduced pressure to leave an oil, which was purified by column chromatography (eluent: petroleum ether/EtOAc = 15/1 → 10/1) to give product **SI-1** (5.37 g, 90%) as a white solid. R_f = 0.2 (petroleum ether/EtOAc = 10/1); $[\alpha]_D^{25} = -57.0$ (c = 1.0 in CHCl_3); ^1H NMR (300 MHz, CDCl_3) δ 8.31 (d, J = 9.0 Hz, 1H), 8.18 (d, J = 9.0 Hz, 1H), 5.55–5.48 (m, 1H), 5.09 (t, J = 7.8 Hz, 1H), 2.60–2.03 (m, 6H), 1.70 (s, 3H), 1.60 (s, 3H), 1.14 (s, 3H); ^{13}C NMR (126 MHz, CDCl_3) δ 218.6, 164.1, 150.8, 136.3, 135.5, 130.8, 123.8, 117.8, 79.3, 53.3, 35.0, 34.0, 26.2, 25.6, 18.1, 16.3.

To a solution of 4-Nitrobenzoate **SI-1** (5.37 g, 16.20 mmol) in the mixed solvents of THF (60 mL) and MeOH (30 mL) was added K_2CO_3 (4.48 g, 32.4 mmol) and the reaction mixture was stirred at 0 °C for 30 min. The solvent was removed and the crude residue was partitioned between water (100 mL) and CH_2Cl_2 (100 mL). The organic layer was separated, and the aqueous layer was further extracted with CH_2Cl_2 (2×100 mL). The combined organic layers were dried with Na_2SO_4 , filtered, and then concentrated in vacuo. The crude residue was purified by flash chromatography on silica gel (eluent: petroleum ether/EtOAc = 5/1 → 5/2) to afford **13** (2.89 g, 98% yield) as a white solid. R_f = 0.3 (petroleum ether/EtOAc = 2/1); $[\alpha]_D^{25} = +88.0$ (c = 1.0 in CHCl_3); ^1H NMR (300 MHz, CDCl_3) δ 5.15–5.05 (m, 1H), 4.23–4.15 (m, 1H), 2.52–2.40 (m, 1H), 2.32–2.09 (m, 4H), 1.92–1.80 (m, 1H), 1.72 (s, 3H), 1.63 (s, 3H), 1.59 (s, 1H), 1.01 (s, 3H). ^{13}C NMR (101 MHz, CDCl_3) δ 220.8, 135.4, 118.8, 75.6, 53.8, 35.1, 33.8, 27.7, 26.1, 18.0, 15.2; HRMS (ESI) m/z calcd for $\text{C}_{11}\text{H}_{18}\text{NaO}_2^+$ $[\text{M}+\text{Na}]^+$: 205.1199, found 205.1198.

2.3 Synthesis of compound 15a



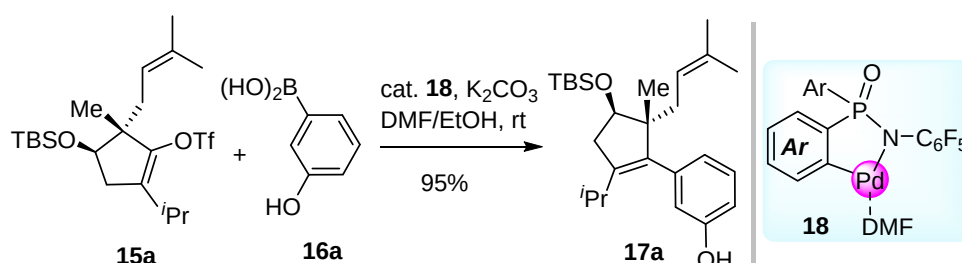
Supplementary Figure 3. Synthesis of compound 15a

To a solution of compound **13** (5.70 g, 31.27 mmol) in DMF (60 mL) was added imidazole (2.56 g, 37.52 mmol, 1.2 equiv) and TBSCl (5.66 g, 37.52 mmol, 1.2 equiv). The mixture was stirred overnight at room temperature. The reaction mixture was poured into sodium bicarbonate solution (50 mL) and extracted with ethyl acetate (3 × 120 mL). The combined organic layers were washed with brine (5 × 30 mL), dried over Na₂SO₄ and evaporated to dryness. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/EtOAc = 30/1) to afford **SI-2** (8.45 g, 91%) as a colorless oil. R_f = 0.4 (petroleum ether/EtOAc = 15/1); $[\alpha]_D^{25} = +8.0$ (c = 0.98 in CHCl₃); ¹H NMR (300 MHz, CDCl₃) δ 5.07–4.97 (m, 1H), 4.17–4.10 (m, 1H), 2.48–2.33 (m, 1H), 2.22–2.02 (m, 4H), 1.88–1.74 (m, 1H), 1.70 (s, 3H), 1.60 (s, 3H), 0.95 (s, 3H), 0.89 (s, 9H), 0.07 (s, 3H), 0.05 (s, 3H); ¹³C NMR (126 MHz, CDCl₃) δ 221.2, 134.5, 119.2, 75.8, 54.4, 35.2, 33.7, 28.8, 26.1, 25.9, 18.2, 18.1, 16.1, -4.2, -4.9; HRMS (ESI) m/z calcd for C₁₇H₃₂NaO₂Si⁺ [M+Na]⁺: 319.2064, found 319.2064.

To a stirred suspension of NaH (60% dispersion in mineral oil, 5.7 g, 142.5 mmol, 5.0 equiv) in THF (160 mL) was added dropwise a solution of **SI-2** (8.45 g, 28.5 mmol) in THF (40 mL) at 0 °C, then 2-iodopropane (28.5 mL, 285.0 mmol, 10.0 equiv) was added. The reaction mixture was refluxed overnight. The resulting mixture was quenched at 0 °C by adding H₂O. Then 2 M HCl (80 mL) was added, and the mixture stirred at room temperature for 1.5 h. Then brine was added to the reaction mixture, and the layers were separated. The aqueous layer was extracted with ethyl acetate (3 × 100 mL), and the combined organic layers were washed with brine (50 mL), dried over Na₂SO₄ and concentrated under reduced pressure. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/CH₂Cl₂ = 3/1) to afford **14** (8.46 g, 88% yield) as a colorless oil.

Ketone **14** (8.57 g, 25.31 mmol) was dissolved in dry THF (50 mL) and the mixture was cooled to -78 °C. LiHMDS (1.0 M in THF, 32.9 mL, 32.90 mmol, 1.3 equiv) was added and the clear solution was stirred at this temperature for 1 h. Then PhNTf₂ (11.75 g, 32.90 mmol, 1.3 equiv) dissolved in dry THF (50 mL) was slowly added and the mixture was allowed to warm to room temperature and stirred for 3 h. Then brine (50 mL) was added to the reaction mixture, and the layers were separated. The aqueous layer was extracted with ethyl acetate (3 × 50 mL), and the combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent: petroleum ether/CH₂Cl₂ = 50/1) to afford **15a** (9.52 g, 80% yield) as a colorless oil. *R*_f = 0.4 (petroleum ether/CH₂Cl₂ = 50/1); $\alpha_D^{25} = -22.5$ (*c* = 1.0 in CHCl₃); ¹H NMR (300 MHz, CDCl₃) δ = 5.09–4.99 (m, 1H), 4.04 (t, *J* = 6.6 Hz, 1H), 2.82 (sept, *J* = 6.9 Hz, 1H), 2.46 (dd, *J* = 15.3, 7.2 Hz, 1H), 2.20–1.95 (m, 3H), 1.70 (s, 3H), 1.60 (s, 3H), 1.03 (s, 3H), 1.01 (d, *J* = 6.9 Hz, 3H), 1.01 (d, *J* = 6.9 Hz, 3H), 0.89 (s, 9H), 0.05 (s, 3H), 0.04 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 143.9, 134.9, 134.0, 118.8 (d, *J* = 320 Hz), 119.8, 73.8, 50.6, 35.1, 34.6, 26.1, 25.9, 25.6, 20.6, 20.1, 18.1, 17.4, -4.1, -4.9; HRMS (ESI) *m/z* calcd for C₂₁H₃₈F₃O₄SSi⁺ [M+H]⁺: 471.2207, found 471.2197.

2.4 Synthesis of compound 17a

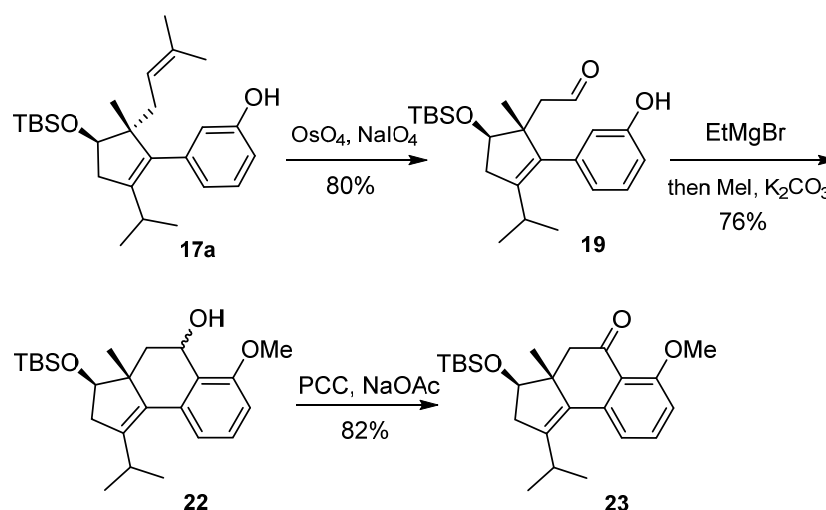


Supplementary Figure 4. Synthesis of compound 17a

To a solution of vinyl triflate **15a** (6.60 g, 14.0 mmol) in the mixed solvents of DMF (60 mL) and EtOH (60 mL) was added arylboronic acid **16a** (3.86 g, 28.0 mmol, 2.0 equiv), palladacycle **18** (0.40 g, 5 mol %), K₂CO₃ (3.87 g, 28.0 mmol, 2.0 equiv) at room temperature under nitrogen. The resulting mixture was stirred at the same temperature until the vinyl triflate had disappeared as monitored by TLC analysis. The reaction mixture was then poured into water (60 mL) and extracted with ethyl acetate (3 × 60 mL). The organic layers were combined, washed with brine (5 × 15 mL), dried over Na₂SO₄ and concentrated under vacuum. The residue was purified by silica gel column chromatography (eluent: petroleum ether/EtOAc = 15/1) to afford the desired cross-coupling product **17a** (5.50 g, 95%). *R*_f = 0.4

(petroleum ether/EtOAc = 5/1); $[\alpha]_D^{25} = -36.4$ ($c = 1.0$ in CHCl_3); ^1H NMR (300 MHz, CDCl_3) δ 7.18 (t, $J = 7.8$ Hz, 1H), 6.73 (dd, $J = 7.8, 1.5$ Hz, 1H), 6.66 (d, $J = 7.8$ Hz, 1H), 6.57 (s, 1H), 5.10–5.00 (m, 1H), 4.63 (s, 1H), 4.12 (t, $J = 6.9$ Hz, 1H), 2.51 (dd, $J = 15.6, 7.2$ Hz, 1H), 2.41 (sept, $J = 6.9$ Hz, 1H), 2.17 (dd, $J = 15.6, 6.6$ Hz, 1H), 2.05–1.81 (m, 2H), 1.66 (s, 3H), 1.49 (s, 3H), 1.01 (s, 3H), 0.97 (d, $J = 6.9$ Hz, 3H), 0.93 (s, 9H), 0.89 (d, $J = 6.9$ Hz, 3H), 0.08 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 155.0, 141.9, 140.7, 140.2, 132.2, 128.9, 122.4, 121.7, 116.5, 113.3, 76.6, 54.3, 37.4, 36.4, 27.6, 26.2, 26.0, 21.7, 21.3, 19.4, 18.3, 18.1, -4.0, -4.9; HRMS (ESI) m/z calcd for $\text{C}_{26}\text{H}_{42}\text{NaO}_2\text{Si}^+ [\text{M}+\text{Na}]^+$: 437.2846, found 437.2840.

2.5 Synthesis of compound 23



Supplementary Figure 5. Synthesis of compound 23

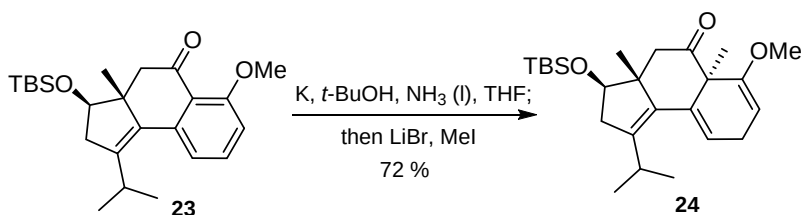
To a solution of **17a** (6.43 g, 15.5 mmol) in the mixed solvents of dioxane (125 mL) and H_2O (25 mL) was added NaIO_4 (16.58 g, 77.5 mmol, 5.0 equiv), pyridine (3.74 mL, 46.5 mmol, 3.0 equiv) and 15.5 mL of OsO_4 solution (0.04 M in H_2O). The mixture was stirred at 80 °C until compound **17** had disappeared as monitored by TLC. H_2O (100 mL) and EtOAc (200 mL) were added to the mixture. The organic phase was separated, and the aqueous layer was extracted with EtOAc (3×60 mL). The combined organic layer were dried over Na_2SO_4 and concentrated under vacuum. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/EtOAc = 10/1) to afford crude **19** (4.8 g, 80%) as a brown oil.

To a solution of **19** (4.8 g) in THF (120 mL) was added EtMgBr (1.0 M in THF, 13.6 mL, 13.6 mmol) slowly at -78 °C, and the mixture was then warmed up to 40 °C, and stirred at the same temperature overnight. Then, K_2CO_3 (3.41 g, 24.7 mmol), MeI (3.8 mL, 61.0 mmol) and

DMF (120 mL) was added. The mixture was stirred at 55 °C for additional 10 h. The reaction mixture was then poured into water (100 mL) and extracted with ethyl acetate (4 × 125 mL), washed with brine (5 × 30 mL). The organic layer was dried and concentrated under vacuum. The residue was purified by silica gel column chromatography (eluent: petroleum ether/CH₂Cl₂/Et₂O = 30/3/1) to afford **22** (3.25 g, 65%) as a brown oil.

Compound **22** (3.8 g) was dissolved in CH₂Cl₂ (40 mL) and added to a mixture of PCC (8.19 g, 38.0 mmol), NaOAc (3.12 g, 38.0 mmol) and celite (~5 g) in CH₂Cl₂ (60 mL). The mixture was reacted at room temperature for 6 h and filtered through celite and washed repeatedly with Et₂O. The solvent was removed under reduced pressure to leave an oil, which was purified by column chromatography (eluent: petroleum ether/EtOAc = 20/1 → 10/1) to give product **23** (3.11 g, 82% yield) as a brown oil. *R_f* = 0.2 (petroleum ether/EtOAc = 6/1); $[\alpha]_D^{25} = +185.9$ (*c* = 1.0 in CHCl₃); ¹H NMR (300 MHz, CDCl₃) δ 7.45 (t, *J* = 8.1 Hz, 1H), 7.11 (d, *J* = 7.8 Hz, 1H), 6.89 (d, *J* = 8.4 Hz, 1H), 4.08 (t, *J* = 8.1 Hz, 1H), 3.92 (s, 3H), 3.23 (sept, *J* = 6.9 Hz, 1H), 2.73 (d, *J* = 15.9 Hz, 1H), 2.66 (dd, *J* = 15.6, 7.8 Hz, 1H), 2.55 (d, *J* = 15.9 Hz, 1H), 2.35 (dd, *J* = 15.6, 8.7 Hz, 1H), 1.18 (d, *J* = 6.9 Hz, 3H), 1.04 (d, *J* = 6.9 Hz, 3H), 0.97 (s, 3H), 0.91 (s, 9H), 0.09 (s, 3H), 0.09 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 197.8, 160.3, 143.2, 139.6, 133.8, 132.8, 120.8, 120.2, 110.8, 80.3, 56.2, 55.4, 51.2, 38.3, 27.4, 26.0, 21.6, 20.9, 18.2, 17.9, -4.3, -4.6; HRMS (ESI) *m/z* calcd for C₂₄H₃₇O₃Si⁺ [*M*+H]⁺: 401.2506, found 401.2511.

2.6 Synthesis of compound 24

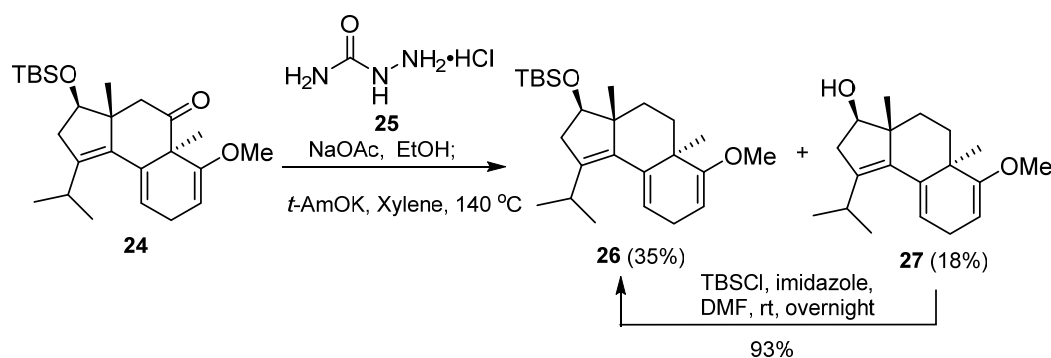


Supplementary Figure 6. Synthesis of compound **24**

A stirred solution of **23** (1.60 g, 4 mmol) and *t*-butyl alcohol (0.38 mL, 4 mmol, 1.0 equiv) in dry Et₂O (25 mL) and dry ammonia (25 mL) under N₂ at -78 °C was treated with potassium metal (0.39 g, 10 mmol, 2.5 equiv). After being stirred for 10 min, a solution of dry LiBr (0.86 g, 10 mmol) in dry THF (10 mL) was added dropwise. By stirring for an additional 20 min, methyl iodide (1.25 mL, 20 mmol, 5.0 equiv) was added. The reaction mixture was stirred at -78 °C for 1 h, and then warmed to room temperature over a period of 1 h while the ammonia was evaporated. Water (50 mL) was added to the residue, and the organic phase was

separated. The aqueous layer was extracted with EtOAc (2 × 50 mL). The combined organic layer were dried over Na₂SO₄ and concentrated under vacuum. The residue was purified by column chromatography (eluent: petroleum ether/CH₂Cl₂/Et₂O = 50/4/1) to afford compound **24** (1.2 g, 72%) as a light yellow solid. *R*_f = 0.5 (petroleum ether/CH₂Cl₂/Et₂O = 9/3/1); $[\alpha]_D^{25} = -2.5$ (*c* = 0.4 in CHCl₃); ¹H NMR (300 MHz, CDCl₃) δ 5.54–5.47 (m, 1H), 4.82–4.77 (m, 1H), 4.12 (t, *J* = 8.4 Hz, 1H), 3.6 (s, 3H), 2.97–2.82 (m, 3H), 2.67 (d, *J* = 12.3 Hz, 1H), 2.49 (dd, *J* = 15.0, 7.5 Hz, 1H), 2.29 (d, *J* = 12.3 Hz, 1H), 2.20 (dd, *J* = 15.0, 8.4 Hz, 1H), 1.48 (s, 3H), 0.99 (d, *J* = 6.9 Hz, 3H), 0.99 (d, *J* = 6.9 Hz, 3H), 0.89 (s, 9H), 0.85 (s, 3H), 0.06 (s, 3H), 0.05 (s, 3H). ¹³C NMR (101 MHz, CDCl₃) δ 208.9, 154.6, 140.3, 136.0, 133.9, 123.3, 92.2, 82.3, 54.6, 54.6, 52.6, 50.9, 37.1, 26.6, 26.4, 25.9, 24.5, 21.5, 21.4, 18.2, 17.6, -4.4, -4.7; HRMS (ESI) *m/z* calcd for C₂₅H₄₁O₃Si⁺ [M+H]⁺: 417.2819, found 417.2816.

2.7 Synthesis of compound 27



Supplementary Figure 7. Synthesis of compound 26

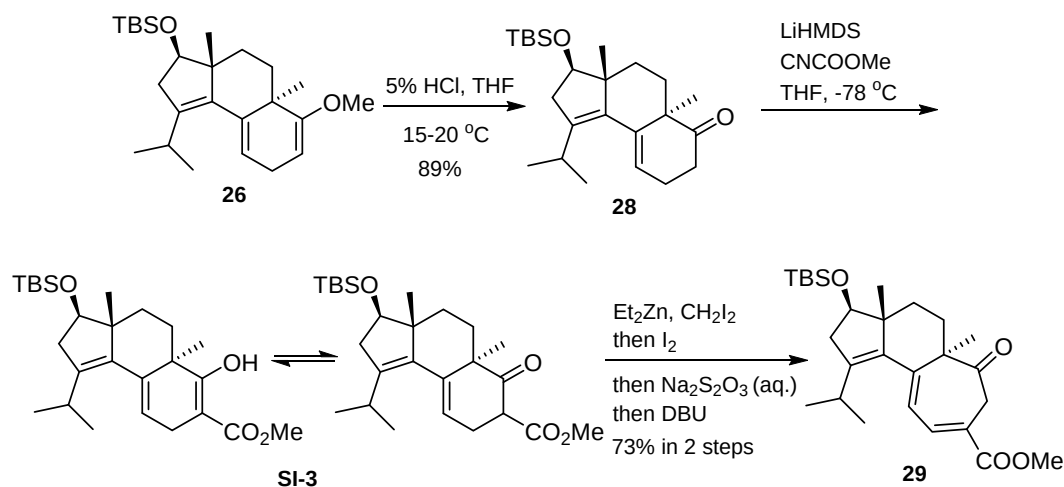
To a solution of **24** (0.15 g, 0.36 mmol) in EtOH (8.0 mL) was added semicarbazide hydrochloride **25** (0.20 g, 1.8 mmol, 5.0 equiv) and NaOAc (0.15 g, 1.8 mmol, 5.0 equiv) under argon atmosphere. The mixture was stirred at 35 °C for 3 h. Reaction mixture was concentrated to dryness under reduced pressure and the residue was dissolved in ethyl acetate. Water (15 mL) and EtOAc (30 mL) were added to the residue, and the organic phase was separated. The aqueous layer was extracted with EtOAc (2 × 20 mL). The combined organic layers were washed with saturated NaHCO₃ solution (10 mL), water (10 mL) and brine (10 mL), then dried over Na₂SO₄ and evaporated under reduced pressure. A mixture of semicarbazone of **24**, degassed xylene (5.0 mL) and *t*-AmOK (0.23 g, 1.8 mmol) was heated at 140 °C for 1.8 h under argon atmosphere. Then water was added, and the xylene solution was separated. The aqueous layer was extracted with EtOAc (3 × 20 mL). The combined organic layers were dried over Na₂SO₄. The solvent was removed under reduced pressure. Purification of the residue by column chromatography (eluent: petroleum ether/CH₂Cl₂ = 25/1)

afforded **26** (51 mg, 35%) as a colorless oil and **27** (19 mg, 18%) as a white solid.

26: R_f = 0.3 (petroleum ether/ CH_2Cl_2 = 10/1); ^1H NMR (300 MHz, CDCl_3) δ 5.36–5.31 (m, 1H), 4.56–4.50 (m, 1H), 3.92 (t, J = 8.4 Hz, 1H), 3.51 (s, 3H), 2.92–2.80 (m, 3H), 2.38 (dd, J = 15.0, 7.8 Hz, 1H), 2.13 (dd, J = 14.7, 9.0 Hz, 1H), 1.93–1.83 (m, 1H), 1.74–1.58 (m, 2H), 1.53–1.40 (m, 1H), 1.10 (s, 3H), 0.96 (d, J = 6.9 Hz, 3H), 0.92 (d, J = 6.9 Hz, 3H), 0.90 (s, 9H), 0.84 (s, 3H), 0.05 (s, 3H), 0.05 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 160.7, 138.1, 137.6, 137.3, 119.3, 88.5, 82.8, 54.3, 49.6, 39.1, 37.0, 35.5, 33.1, 26.4, 26.2, 26.0, 23.4, 21.6, 21.5, 18.3, 16.5, -4.3, -4.8.

27: R_f = 0.3 (petroleum ether/ EtOAc = 6/1); ^1H NMR (300 MHz, CDCl_3) δ 5.39–5.33 (m, 1H), 4.56–4.51 (m, 1H), 4.02 (t, J = 8.7 Hz, 1H), 3.52 (s, 3H), 2.93–2.82 (m, 3H), 2.59 (dd, J = 15.0, 7.8 Hz, 1H), 2.14 (dd, J = 15.0, 9.3 Hz, 1H), 1.96–1.88 (m, 1H), 1.75–1.63 (m, 2H), 1.62–1.47 (m, 1H), 1.11 (s, 3H), 0.97 (d, J = 6.9 Hz, 3H), 0.93 (d, J = 6.9 Hz, 3H), 0.89 (s, 3H). **27** was converted to **26** by executing the same procedure for synthesis of **SI-2** in 93% yield.

2.8 Synthesis of compound 29



Supplementary Figure 8. Synthesis of compound 29

To a solution of **26** (200 mg, 0.5 mmol) in degassed THF (6.0 mL) was added 5% HCl (1.5 mL) and the mixture was stirred at 15–20 °C for 40 min. Brine (20 mL) and ethyl acetate (20 mL) was added to the reaction mixture and the layers were separated. The aqueous layer was extracted with EtOAc (2×20 mL). The combined organic layers were washed with brine (20 mL), dried over Na_2SO_4 , and concentrated in vacuo. The residue was chromatographed on silica gel (eluent: petroleum ether/ Et_2O = 20/1) to give **28** (172 mg, 89%) as a white solid. R_f = 0.3 (petroleum ether/ Et_2O = 10/1); $[\alpha]_D^{25} = +229.0$ (c = 0.8 in CHCl_3); ^1H NMR (300 MHz,

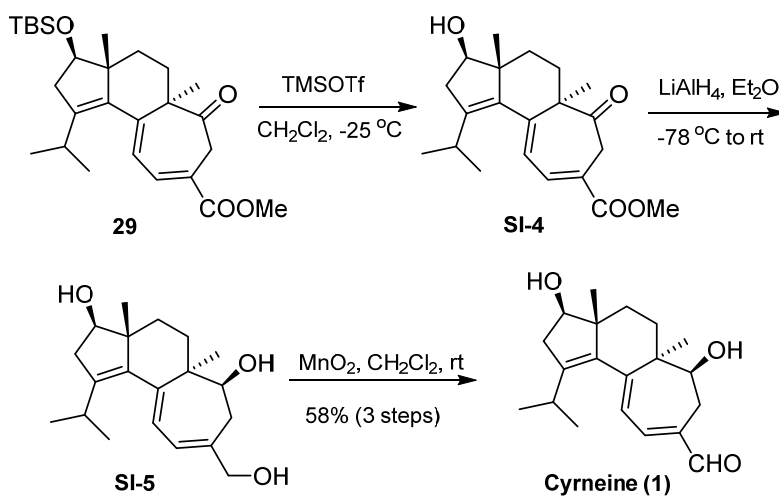
CDCl₃) δ 5.55–5.49 (m, 1H), 3.93 (t, J = 8.1 Hz, 1H), 2.88 (sept, J = 6.9 Hz, 1H), 2.74–2.65 (m, 1H), 2.53–2.36 (m, 4H), 2.15 (dd, J = 15.0, 9.0 Hz, 1H), 1.77–1.64 (m, 3H), 1.55–1.42 (m, 1H), 1.13 (s, 3H), 0.98 (d, J = 6.9 Hz, 3H), 0.95 (d, J = 6.9 Hz, 3H), 0.90 (s, 9H), 0.82 (s, 3H), 0.06 (s, 3H), 0.06 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 215.6, 139.4, 139.1, 136.6, 121.7, 82.4, 49.7, 48.3, 37.1, 35.8, 34.7, 31.2, 26.3, 26.0, 25.6, 22.8, 21.6, 21.5, 18.2, 16.5, -4.3, -4.6; HRMS (ESI) m/z calcd for C₂₄H₄₀NaO₂Si⁺ [M+Na]⁺: 411.2690, found 411.2682.

To a solution of compound **28** (200 mg, 0.515 mmol) in dry THF (4 mL) at -78 °C was added LiHMDS (1M in THF, 2.06 mL, 2.06 mmol, 4 equiv) under N₂ atmosphere and the resulting solution was stirred for 15 min at -78 °C and then 20 min at 0 °C. After that methyl carbonocyanidate (0.164 mL, 2.06 mmol, 4 equiv) was added at -78 °C and the mixture was stirred for 1 h at the same temperature. The reaction mixture was quenched by addition of water. The organic phase was collected, and the aqueous layer was extracted with EtOAc. The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. Purification of the residue by flash chromatography yielded crude β -keto ester **SI-3**.

A 50-mL flask was equipped with a magnetic stirrer bar and charged with 3 mL CH₂Cl₂ and diethyl zinc (1.0 M in PhMe, 3.5 mL, 3.5 mmol) under an atmosphere of N₂ at 0 °C. Methylene iodide (0.282 mL, 3.5 mmol, 7 equiv.) was added. After the mixture was stirred for 5 min, β -keto ester SI-1 was added as a solution in 4 mL of CH₂Cl₂. The mixture was stirred for 2 h at room temperature. Then iodine (1.02 g, 4 mmol) was added to the reaction mixture in a single portion and the solution was allowed to stir until a pink color persisted for 10 min. A saturated solution of sodium thiosulfate was added and the mixture was stirred until the pink color had disappeared. To this solution was added DBU (1.49 mL, 10 mmol). The mixture was stirred for 20 min, washed with saturated aqueous ammonium chloride, and extracted three times with diethyl ether. The combined organic layers were dried with Na₂SO₄ and concentrated in vacuo. The residue was chromatographed on silica (eluent: petroleum ether/CH₂Cl₂/Et₂O = 100/10/1) to yield **29** (175 mg, 73% for 2 steps). R_f = 0.4 (petroleum ether/CH₂Cl₂/Et₂O = 9/3/1); $[\alpha]_D^{25}$ = + 20.0 (c = 0.14 in CHCl₃); ¹H NMR (300 MHz, CDCl₃) δ 7.29 (d, J = 6.0 Hz, 1H), 6.01 (d, J = 6.0 Hz, 1H), 3.98 (t, J = 8.4 Hz, 1H), 3.86 (d, J = 11.4 Hz, 1H), 3.80 (s, 3H), 3.36 (d, J = 11.4 Hz, 1H), 2.92 (sept, J = 6.9 Hz, 1H), 2.48 (dd, J = 15.0, 7.8 Hz, 1H), 2.22 (dd, J = 15.0, 8.7 Hz, 1H), 2.08–1.98(m, 1H), 1.63–1.52 (m, 2H), 1.43 (dt, J = 13.5, 4.8 Hz, 1H), 1.42 (s, 3H), 1.03 (d, J = 6.9 Hz, 3H), 0.98 (d, J = 6.9 Hz, 3H), 0.90 (s, 3H), 0.90 (s, 9H), 0.07 (s, 3H), 0.06 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 206.8, 166.2, 148.3, 141.6, 138.8, 136.1, 124.0, 122.7, 81.1, 56.7, 52.4, 50.6, 41.5, 37.3, 34.5, 33.9, 26.6, 26.0, 23.4, 21.7, 21.3, 18.2, 17.5, -4.3, -4.7; HRMS (ESI) m/z calcd for C₂₇H₄₂NaO₄Si⁺

$[M+Na]^+$: 481.2745, found 481.2740.

2.9 Synthesis of compound Cyrneine (1)



Supplementary Figure 9. Synthesis of cyrneine (1)

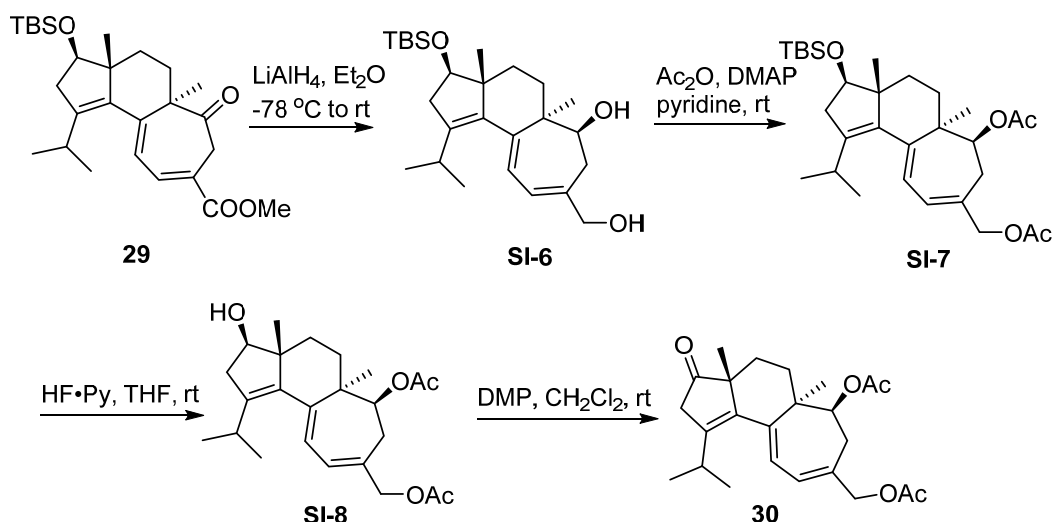
To a solution of **29** (20 mg, 0.043 mmol) in dry CH_2Cl_2 (2.5 ml) was added TMSOTf (39 μL , 0.215 mol, 5.00 equiv) at $-25\text{ }^\circ\text{C}$. The clear solution was stirred at this temperature for 15 min and quenched by the addition of 1 mL of satd. aq. $NaHCO_3$. The aqueous layer was extracted with CH_2Cl_2 . The combined organic layers were dried over Na_2SO_4 , filtered and concentrated. Flash chromatography on silica gel (eluent: petroleum ether/ $EtOAc$ = 3/1) gave compound **SI-4** (12 mg, 81%).

To a solution of **SI-4** (12 mg) in Et_2O (3 mL) was added LAH (8 mg, 0.21 mmol, 6.0 equiv) at $-78\text{ }^\circ\text{C}$. The reaction was stirred for 10 min at $-78\text{ }^\circ\text{C}$ under nitrogen and the solution was warmed to room temperature. The solution was quenched by the addition of H_2O (2 mL). Brine (10 mL) and Et_2O (20 mL) was added to the reaction mixture and the layers were separated. The aqueous layer was extracted with Et_2O ($2 \times 10\text{ mL}$). The combined organic layers were washed with brine (10 mL), dried over Na_2SO_4 , and concentrated in vacuo. The solvent was removed in vacuo and the residue was purified by flash chromatography (eluent: petroleum ether/ $EtOAc$ = 1/1) to give crude compound **SI-5**.

To a solution of **SI-5** in CH_2Cl_2 (3 mL) was added MnO_2 (26 mg, 0.3 mmol), and the resultant mixture was stirred at room temperature overnight. The solution was filtered, dried over Na_2SO_4 , and concentrated under reduced. Flash chromatography of the residue on silica gel (eluent: petroleum ether/ $EtOAc$ = 10/1) gave pure Cyrneine A (8 mg, 58% for 3 steps). R_f = 0.3 (petroleum ether/ $EtOAc$ = 4/1); $[\alpha]_D^{25} = +1049$ (c = 0.307 in CH_2Cl_2); +1093 (c = 0.14 in CH_2Cl_2); +1126 (c = 0.105 in $CHCl_3$); 1H NMR (400 MHz, $CDCl_3$) δ 9.46 (s, 1H), 6.82 (dd,

$J = 8.0, 2.8$ Hz, 1H), 6.00 (d, $J = 8.4$ Hz, 1H), 4.05 (t, $J = 8.4$ Hz, 1H), 3.81–3.73 (m, 1H), 3.16 (dd, $J = 18.4, 6.0$ Hz, 1H), 2.89 (sept, $J = 6.8$ Hz, 1H), 2.70 (dd, $J = 15.6, 7.6$ Hz, 1H), 2.56 (bd, $J = 18.4$ Hz, 1H), 2.42 (td, $J = 13.2, 4.4$ Hz, 1H), 2.25 (dd, $J = 15.6, 9.2$ Hz, 1H), 1.82 (dt, $J = 13.6, 4.0$ Hz, 1H), 1.61 (td, $J = 12.8, 4.4$ Hz, 1H), 1.41 (dt, $J = 14.0, 4.0$ Hz, 1H), 1.04 (d, $J = 6.8$ Hz, 3H), 0.96 (d, $J = 6.8$ Hz, 3H), 0.96 (s, 3H), 0.94 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 194.2, 153.7, 144.3, 143.7, 140.7, 138.3, 120.1, 81.1, 74.4, 50.1, 47.9, 37.6, 34.8, 33.6, 29.7, 26.8, 26.5, 21.7, 21.3, 16.4. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{28}\text{NaO}_3^+$ $[\text{M}+\text{Na}]^+$: 339.1931, found 339.1924.

2.10 Synthesis of compound 30



Supplementary Figure 10. Synthesis of compound 30

To a solution of **29** (175 mg) in Et_2O (8 mL) was added LiAlH_4 (86 mg, 2.27 mmol, 6.0 equiv) at -78°C . The reaction was stirred for 20 min at -78°C under nitrogen atmosphere and then warmed slowly to room temperature. The solution was quenched by the addition of H_2O (2 mL). Brine (10 mL) and Et_2O (30 mL) was added to the reaction mixture and the organic layer was separated. The aqueous layer was extracted with Et_2O (2×10 mL). The combined organic layer was washed with brine (30 mL), dried over Na_2SO_4 , and concentrated in vacuo. The filtered and the solvent was evaporated under reduce pressure. The residue was purified by flash chromatography (eluent: petroleum ether/ acetone = 10/1) to give crud compound **SI-6** (112 mg, 68%). $R_f = 0.3$ (petroleum ether/acetone = 10/3).

To a stirred solution of **SI-6** (112 mg, 0.259 mmol) in pyridine (1.5 mL) containing DMAP (6 mg, 0.2 equiv) was added Ac_2O (0.37 mL, 3.88 mmol, 15 equiv) dropwise at 0°C under argon. The reaction mixture was stirred at rt for 30 min. The reaction mixture was

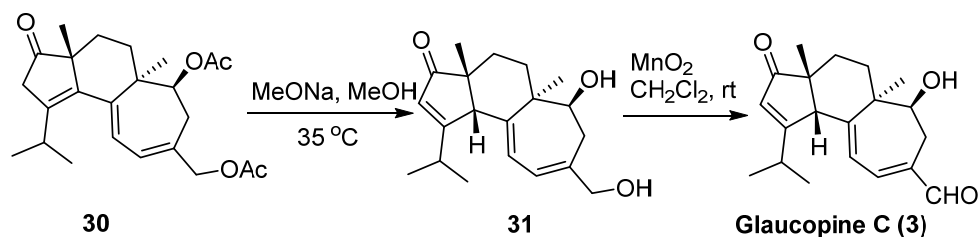
poured into sodium bicarbonate solution (10 mL) and extracted with ethyl acetate (3×15 mL). The combined organic layer was washed with brine (4×15 mL), dried over Na_2SO_4 and evaporated to dryness. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/EtOAc = 50/1 $\rightarrow$ 10/1) to afford **SI-7** (118 mg, 88%). R_f = 0.3 (petroleum ether/EtOAc = 8/1).

To a stirred solution of **SI-7** (118 mg, 0.228 mmol) in THF (3 mL) was added HF $\cdot$ Py (75%, 0.9 mL) dropwise at 0 °C under argon, and the reaction mixture was stirred at rt for 2 h. The reaction mixture was poured into sodium bicarbonate solution (10 mL) and extracted with ethyl acetate (3×20 mL). The combined organic layer was washed with sodium bicarbonate solution (5×15 mL) and brine (15 mL), dried over Na_2SO_4 and evaporated to dryness. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/acetone = 50/1 $\rightarrow$ 10/1) to afford **SI-8** (90 mg, 98%). R_f = 0.3 (petroleum ether/acetone = 4/1).

To a stirred solution of **SI-8** (90 mg, 0.223 mmol) in CH_2Cl_2 (3 mL) was added DMP (156 mg, 1.6 equiv) at rt under argon. The reaction mixture was stirred for 30 min. The reaction mixture was quenched by addition of saturated aqueous $\text{Na}_2\text{SO}_3/\text{NaHCO}_3$. The organic phase was separated, and the aqueous layer was extracted with CH_2Cl_2 (2×10 mL). The combined organic layer was dried over Na_2SO_4 and concentrated under reduced pressure. Purification of the residue by flash chromatography (eluent: petroleum ether/acetone = 20/1 $\rightarrow$ 10/1) yielded **30** (78 mg, 87%) as a colorless oil. R_f = 0.4 (petroleum ether/acetone = 4/1);

$[\alpha]_D^{25} = +362$ (c = 0.093 in CH_2Cl_2); ^1H NMR (400 MHz, CDCl_3) δ 5.99 (d, J = 7.6 Hz, 1H), 5.66 (d, J = 7.6 Hz, 1H), 4.81–4.77 (m, 1H), 4.57 (d, J = 12.4 Hz, 1H), 4.48 (d, J = 12.4 Hz, 1H), 3.04 (d, J = 22.8 Hz, 1H), 3.01 (sept, J = 6.8 Hz, 1H), 2.93 (d, J = 22.8 Hz, 1H), 2.75 (dd, J = 17.2, 6.8 Hz, 1H), 2.58 (d, J = 17.6 Hz, 1H), 2.12–2.01 (m, 1H), 2.08 (s, 3H), 2.04 (s, 3H), 1.69–1.62 (m, 2H), 1.39 (dt, J = 13.6, 3.6 Hz, 1H), 1.07 (d, J = 6.8 Hz, 3H), 1.04 (s, 3H), 1.02 (s, 3H), 0.97 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 220.6, 170.9, 170.7, 141.4, 137.9, 134.1, 124.8, 121.6, 76.4, 69.8, 53.4, 45.4, 39.8, 31.2, 30.9, 28.7, 26.4, 25.9, 21.8, 21.2, 21.1, 21.1, 19.7. HRMS (ESI) m/z calcd for $\text{C}_{24}\text{H}_{32}\text{NaO}_5^+$ $[\text{M}+\text{Na}]^+$: 423.2142, found 423.2143.

2.11 Synthesis of Glaucopine C (**3**)



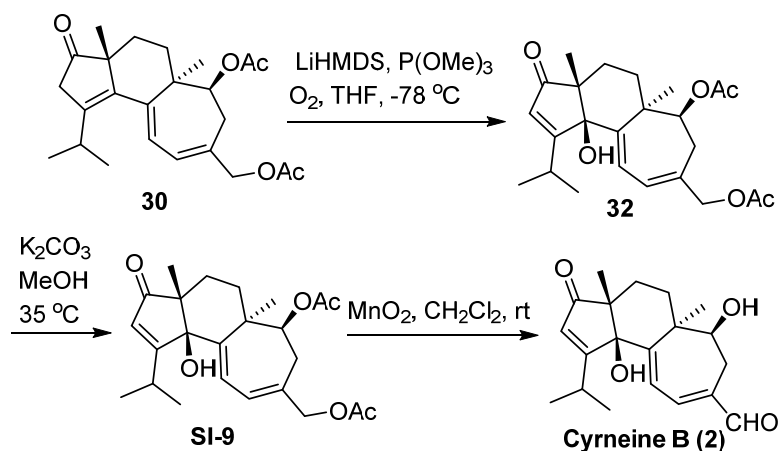
Supplementary Figure 11. Synthesis of compound glaucopine C (**3**)

To a stirred solution of **30** (20 mg, 0.05 mmol) in MeOH (1.3 mL) was added MeONa (30% w/w in MeOH, 0.05 mL) dropwise at rt under argon. The reaction mixture was stirred at 35 °C for 4 h. The reaction mixture was poured into brine (10 mL) and extracted with ethyl acetate (3 × 10 mL). The combined organic layer was dried over Na₂SO₄ and evaporated to dryness. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/CH₂Cl₂/acetone = 3/1/1) to afford **31** (11.5 mg, 73%). *R_f* = 0.3 (petroleum ether/CH₂Cl₂/acetone = 1/1/1). $[\alpha]_D^{25} = -137.2$ (*c* = 0.767 in CHCl₃); ¹H NMR (500 MHz, CDCl₃) δ 6.07–5.99 (m, 3H), 4.12 (d, *J* = 13.5 Hz, 1H), 4.07 (d, *J* = 13.5 Hz, 1H), 3.60 (bs, 1H), 3.25 (bd, *J* = 2.0 Hz, 1H), 2.69–2.57 (m, 2H), 2.48 (dd, *J* = 19.5, 4.5 Hz, 1H), 1.91–1.85 (m, 1H), 1.77 (td, *J* = 14.0, 3.0 Hz, 1H), 1.27 (td, *J* = 14.5, 3.6 Hz, 1H), 1.18 (d, *J* = 6.5 Hz, 3H), 1.15 (d, *J* = 6.5 Hz, 3H), 1.09 (s, 3H), 0.78 (3H). ¹³C NMR (151 MHz, CDCl₃) δ 214.8, 190.0, 144.2, 140.3, 126.8, 125.3, 119.9, 78.1, 68.6, 62.7, 49.4, 44.6, 37.2, 37.1, 33.5, 28.9, 27.9, 24.0, 22.6, 20.4. HRMS (ESI) *m/z* calcd for C₂₀H₂₈NaO₃⁺ [M+Na]⁺: 339.1936, found 339.1932.

To a solution of **31** in CH₂Cl₂ (1.5 mL) was added MnO₂ (47 mg, 0.54 mmol). The reaction mixture was stirred at room temperature for 3 h. The resulting reaction mixture was filtered to remove insoluble matters and the precipitated was washed with CH₂Cl₂. The organic filtrate was dried over Na₂SO₄, and concentrated under reduced. Flash chromatography of the residue on silica gel (eluent: petroleum ether/EtOAc = 3/1) gave pure Glaucopine C (7 mg, 82%). *R_f* = 0.3 (petroleum ether/ EtOAc = 1/1). $[\alpha]_D^{25} = -1.95$ (*c* = 0.02 in CH₂Cl₂); ¹H NMR (600 MHz, CDCl₃) δ 9.46 (s, 1H), 6.80 (dd, *J* = 7.8, 2.4 Hz, 1H), 6.37 (d, *J* = 8.4 Hz, 1H), 6.07 (bs, 1H), 3.80–3.76 (m, 1H), 3.40 (bs, 1H), 2.93 (dd, *J* = 19.8, 3.6 Hz, 1H), 2.61 (dt, *J* = 20.4, 2.4 Hz, 1H), 2.57 (sept, *J* = 6.6 Hz, 1H), 1.94 (dt, *J* = 13.8, 3.6 Hz, 1H), 1.82 (td, *J* = 13.8, 2.4 Hz, 1H), 1.77 (dt, *J* = 14.4, 3.6 Hz, 1H), 1.35 (td, *J* = 14.4, 3.0 Hz, 1H), 1.21 (d, *J* = 6.6 Hz, 3H), 1.20 (d, *J* = 6.6 Hz, 3H), 1.13 (s, 3H), 0.79 (s, 3H). ¹³C NMR (151 MHz, CDCl₃) δ 214.0, 194.6, 188.5, 156.4, 142.2, 139.6, 127.4, 124.8, 77.4, 63.3, 49.9, 45.7, 37.5, 33.4, 32.8, 29.1, 28.5, 24.1, 22.7, 20.4. HRMS (ESI) *m/z* calcd for C₂₀H₂₇O₃⁺

[M+H]⁺: 315.1955, found 315.1961.

2.12 Synthesis of Cyrneine B (2)



Supplementary Figure 12. Synthesis of compound cyrneine B (2)

To a solution of ketone **30** (26 mg, 0.065 mmol) in dry THF (1.2 mL) under argon was added LiHMDS (1 M in THF, 0.13 mL, 0.13 mmol, 2.0 equiv.) at -78 °C and the resulting solution was stirred for 15 min. P(OMe)₃ (0.031 mL, 0.26 mmol, 4.0 equiv.) was added and the argon atmosphere was exchanged to O₂ (balloon). After 2 h the reaction mixture was quenched by water. The mixture was then warmed to rt and the aqueous phase was extracted three times with ethyl acetate (3 × 10 mL). The combined organic layers were dried over Na₂SO₄ and concentrated in vacuo. The residue was purified by flash chromatography (eluent: petroleum ether/CH₂Cl₂/EtOAc = 6/1/1) to give **32** (16 mg, 58%). R_f = 0.4 (petroleum ether/CH₂Cl₂/EtOAc = 3/3/2).

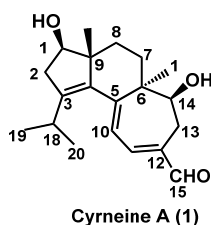
To a stirred solution of **32** (16 mg, 0.038 mmol) in MeOH (1.5 mL) was added K₂CO₃ at rt under argon, and the reaction mixture was stirred at 35 °C for 4 h. The reaction mixture was poured into brine (10 mL) and extracted with ethyl acetate (3 × 10 mL). The combined organic layer was dried over Na₂SO₄ and evaporated to dryness. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/CH₂Cl₂/acetone = 4/1/1) to afford **SI-9** (7.5 mg, 59%). R_f = 0.3 (petroleum ether/CH₂Cl₂/acetone = 1/1/1).

To a solution of **SI-9** in CH₂Cl₂ (1 mL) was added MnO₂ (30 mg), and the resultant mixture was stirred at room temperature for 3.5 h. The reaction mixture was filtered to remove insoluble materials and the precipitate was washed with CH₂Cl₂. The filtrate was dried over Na₂SO₄, and concentrated under reduced pressure. Flash chromatography of the residue on silica gel (eluent: petroleum ether/acetone = 6/1) gave pure Cyrneine B (6.5 mg, 87%). R_f = 0.2 (petroleum ether/acetone = 3/1). $[\alpha]_D^{25} = -203$ (*c* = 0.37 in CH₂Cl₂); ¹H NMR

(600 MHz, CDCl₃) δ 9.49 (s, 1H), 7.14 (d, J = 9.0 Hz, 1H), 6.96 (dd, J = 8.4, 2.4 Hz, 1H), 6.15 (s, 1H), 3.86–3.81 (m, 1H), 2.88 (dd, J = 20.4, 3.6 Hz, 1H), 2.69–2.63 (m, 2H), 2.13 (s, 1H), 1.99 (td, J = 13.8, 3.0 Hz, 1H), 1.93–1.87 (m, 1H), 1.83–1.77 (m, 1H), 1.66 (d, J = 9.0 Hz, 1H), 1.37–1.30 (m, 1H), 1.26 (d, J = 6.6 Hz, 3H), 1.17 (d, J = 6.6 Hz, 3H), 1.12 (s, 3H), 0.79 (s, 3H). ¹H NMR (600 MHz, C₆D₆) δ 9.35 (s), 6.77 (d, J = 8.4 Hz, 1H), 6.30 (dd, J = 8.4, 2.4 Hz, 1H), 6.06 (s, 1H), 3.35–3.30 (m, 1H), 2.85 (dd, J = 20.4, 3.0 Hz, 1H), 2.56 (sept, J = 6.6 Hz, 1H), 2.44 (dt, J = 20.4, 3.0 Hz, 1H), 2.11–2.01 (m, 2H), 1.85 (s, 1H), 1.55–1.50 (m, 1H), 1.22 (d, 6.6 Hz, 3H), 1.22–1.14 (m, 1H), 1.19 (s, 3H), 0.95 (d, J = 6.6 Hz, 3H), 0.40 (s, 3H). ¹³C NMR (151 MHz, CDCl₃) δ 212.1, 194.8, 187.5, 156.4, 142.3, 140.3, 128.5, 122.7, 85.7, 77.2, 54.0, 45.3, 37.0, 33.6, 32.7, 27.3, 26.8, 24.9, 22.3, 19.6. HRMS (ESI) m/z calcd for C₂₀H₂₆NaO₄⁺ [M+Na]⁺: 353.1729, found 353.1728.

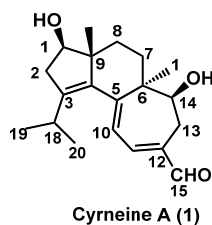
3. Comparison of Spectroscopic Data of Natural and Synthetic Cyrneine A (1)

Supplementary Table 1. Comparison of the ^1H NMR Data of Natural and Synthetic Cyrneine A (1)



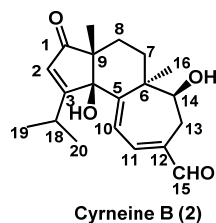
Position	δ_{H} in ppm (mult, J in Hz)		
	Natural ¹	Gademmann's Synthesis ²	This Work
1	3.98 (t, 8.7)	4.05 (t, 8.6)	4.05 (t, 8.4)
2a	2.72 (dd, 15.6, 8.0)	2.71 (dd, 15.6, 8.0)	2.70 (dd, 15.6, 7.6)
2b	2.27 (dd, 15.6, 8.9)	2.26 (dd, 15.6, 8.9)	2.25 (dd, 15.6, 9.2)
7a	2.44 (td, 13.6, 4.5)	2.43 (td, 13.1, 4.3)	2.42 (td, 13.2, 4.4)
7b	1.34 (dt, 14.0, 4.0)	1.40 (td, 14.0, 4.2)	1.41 (dt, 14.0, 4.0)
8a	1.75 (dt, 13.3, 3.8)	1.82 (dt, 13.2, 4.2)	1.82 (dt, 13.6, 4.0)
8b	1.54 (td, 13.1, 4.3)	1.60 (td, 13.1, 4.3)	1.61 (td, 12.8, 4.4)
10	5.93 (d, 8.1)	6.00 (d, 8.1)	6.00 (d, 8.4)
11	6.75 (dd, 8.3, 2.5)	6.82 (dd, 8.2, 2.5)	6.82 (dd, 8.0, 2.8)
13a	3.18 (dd, 18.2, 5.7)	3.16 (dd, 18.3, 5.7)	3.16 (dd, 18.4, 6.0)
13b	2.57 (bd, 18.2)	2.56 (bd, 18.4)	2.56 (bd, 18.4)
14	3.79 (bd, 4.9)	3.77 (m)	3.81-3.72 (m)
15	9.48 (s)	9.46 (s)	9.46 (s)
16	0.89 (s)	0.96 (s)	0.96 (s)
17	0.87 (s)	0.93 (s)	0.94 (s)
18	2.91 (sept, 6.9)	2.89 (sept, 6.8)	2.89 (sept, 6.8)
19	0.89 (d, 6.9)	0.96 (d, 6.9)	0.96 (d, 6.8)
20	0.97 (d, 6.9)	1.04 (d, 6.9)	1.04 (d, 6.8)

Supplementary Table 2. Comparison of the ^{13}C NMR Data of Natural and Synthetic Cyrneine A (1)



Position	δC in ppm		
	Natural ¹	Gademann's Synthesis ²	This work
1	81.3	81.0	81.1
2	37.6	37.4	37.6
3	143.9	143.6	143.7
4	140.9	132.1	140.7
5	153.9	153.5	153.7
6	48.0	48.0	47.9
7	33.7	33.5	33.6
8	34.9	34.6	34.8
9	50.3	50.0	50.1
10	120.3	120.0	12.01
11	144.7	144.1	144.3
12	138.5	138.1	138.3
13	29.7	29.5	29.7
14	74.6	74.5	74.4
15	194.5	194.1	194.2
16	26.7	26.3	26.5
17	16.6	16.3	16.4
18	26.9	26.6	26.8
19	21.9	21.6	21.7
20	21.4	21.2	21.3

Supplementary Table 3. Comparison of the ¹H NMR Data of Natural and Synthetic Cyrneine B (2)

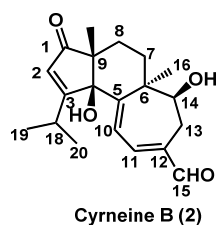


Position	δ_{H} in ppm (mult, J in Hz)	
	Natural ^a	This Work
2	6.16 (s)	6.15 (s)
7a	1.53 (dt, 14.8, 4.0) ^a	1.55–1.50 (m) ^a
7b	1.4–1.2 (m) ^a	1.22–1.14 ^a
8	2.1–2.0 (m) ^a	2.11–2.01 (m) ^a
10	6.97 (dd, 8.4, 2.2)	7.14 (d, 9.0) ^b
11	7.15 (d, 8.3)	6.96 (dd, 8.4, 2.4) ^b
13a	2.85 (dd, 20.4, 3.2) ^a	2.85 (dd, 20.4, 3.0) ^a
13b	2.41 (dt, 20.1, 3.0) ^a	2.44 (dt, 20.4, 3.0) ^a
14	3.42 (t, 3.2) ^a	3.35–3.30 (m) ^a
15	9.49 (s)	9.49 (s)
16	0.78 (s)	0.79 (s)
17	1.20 (s)	1.12 (s)
18	2.66 (sept, 6.8) ^a	2.56 (sept, 6.6) ^a
19	1.17 (d, 6.8)	1.17 (d, 6.6)
20	1.26 (d, 6.8)	1.26 (d, 6.6)

^a Values recorded in C₆D₆.

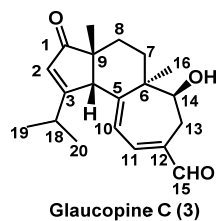
^b Based on the NOESY and HMBC correlations of our synthesized product, it seemed that the H₁₀ and H₁₁ were assigned incorrectly in the reference.

Supplementary Table 4. Comparison of the ^{13}C NMR Data of Natural and Synthetic Cyrneine B (2)



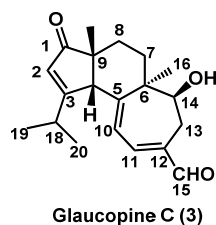
Position	δ_{C} in ppm	
	Natural ¹	This work
1	212.8	212.1
2	127.9	128.5
3	188.0	187.5
4	85.7	85.7
5	156.9	156.3
6	45.3	45.3
7	37.4	37.0
8	32.6	32.7
9	54.3	54.0
10	123.3	122.7
11	142.9	142.3
12	140.5	140.3
13	33.8	33.6
14	77.3	77.2
15	195.2	194.8
16	26.8	26.8
17	20.0	19.6
18	27.3	27.3
19	24.4	24.9
20	22.5	22.3

Supplementary Table 5. Comparison of the ¹H-NMR Data of Natural and Synthetic Glaucopine C (3)



Position	δ_{H} in ppm (mult, J in Hz)	
	Natural ³	This Work
2	6.06 (bs)	6.07 (bs)
4	3.41 (bs)	3.40 (bs)
7a	1.35 (td, 13.9, 13.9, 2.6)	1.35 (td, 14.4, 3.0)
7b	1.78 (dt, 13.9, 3.5, 3.5)	1.77 (dt, 14.4, 3.6)
8a	1.85 (td, 14.0, 14.0, 2.5)	1.82 (td, 13.8, 2.4)
8b	1.94 (dt, 13.3, 3.3, 3.3)	1.94 (dt, 13.8, 3.6)
10	6.39 (d, 8.2)	6.37 (d, 8.4)
11	6.81(dd, 13.5, 6.6)	6.80 (dd, 7.8, 2.4)
13a	2.61 (dt, 20.2, 2.7, 2.7)	2.61 (dt, 20.4, 2.4)
13b	2.93 (dd, 20.2, 4.0)	2.93 (dd, 19.8, 3.6)
14	3.79 (bs)	3.80–3.76 (m)
15	9.48 (s)	9.46 (s)
16	0.80 (s)	0.79 (s)
17	1.12 (s)	1.13 (s)
18	2.58 (sept, 6.7)	2.57 (sept, 6.6)
19	1.22 (d, 6.7)	1.20 (d, 6.6)
20	1.29 (d, 6.7)	1.21 (d, 6.6)

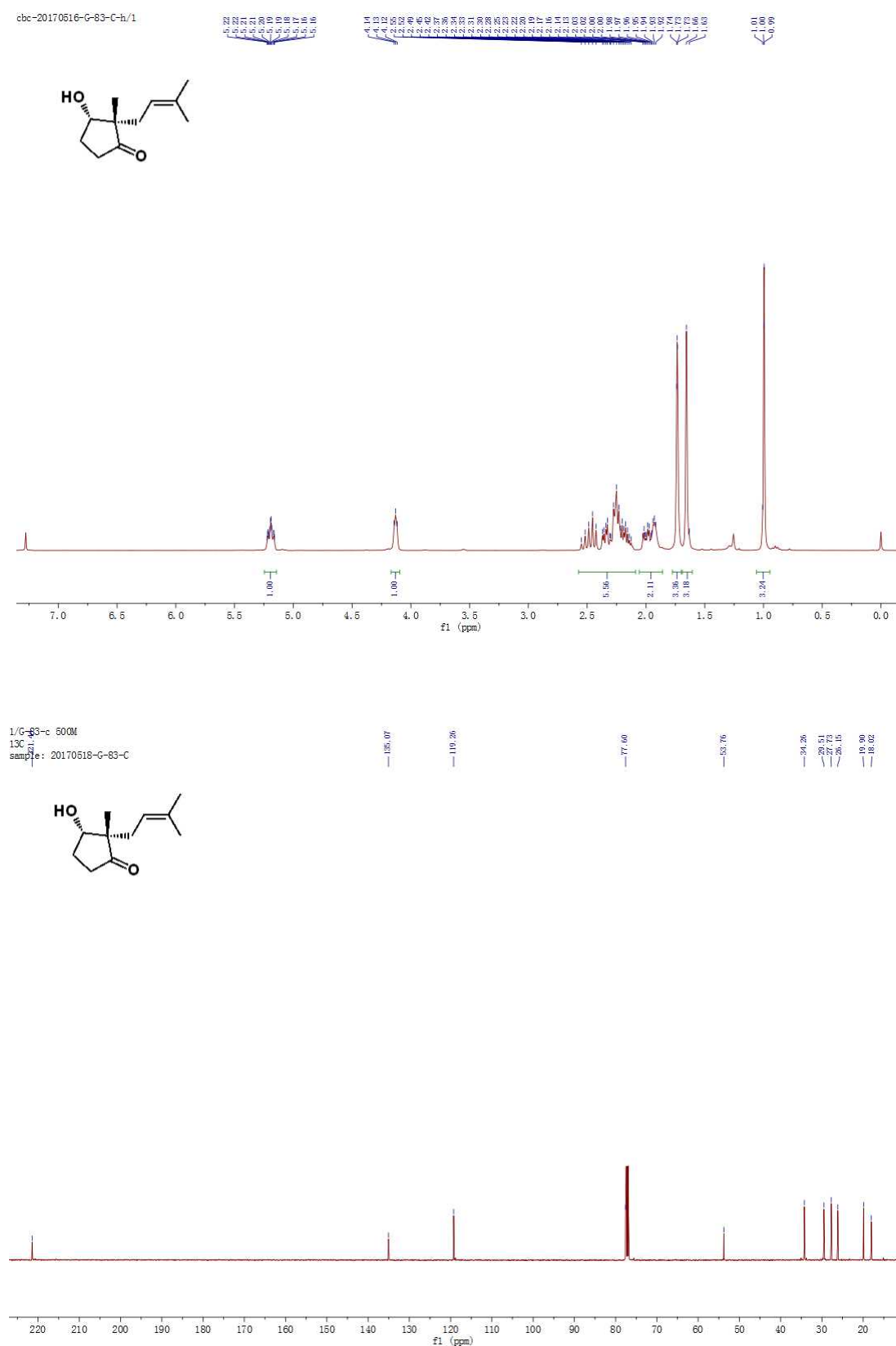
Supplementary Table 6. Comparison of the ^{13}C NMR Data of Natural and Synthetic Glaucopine C (3)



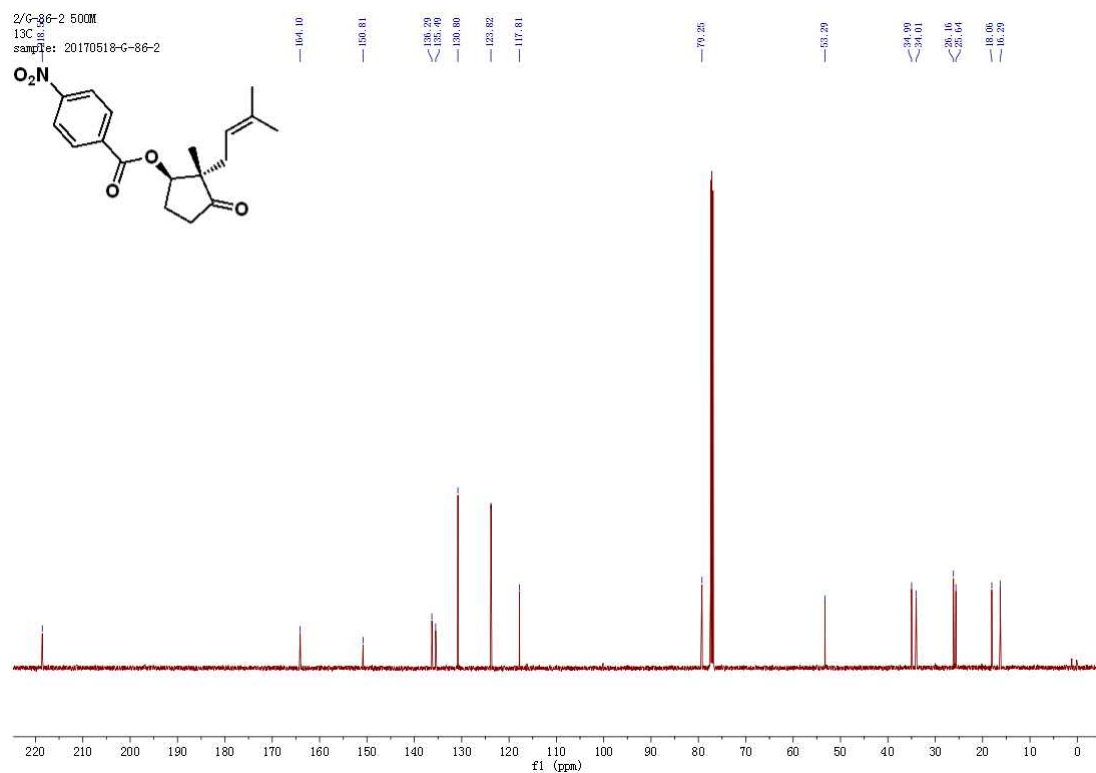
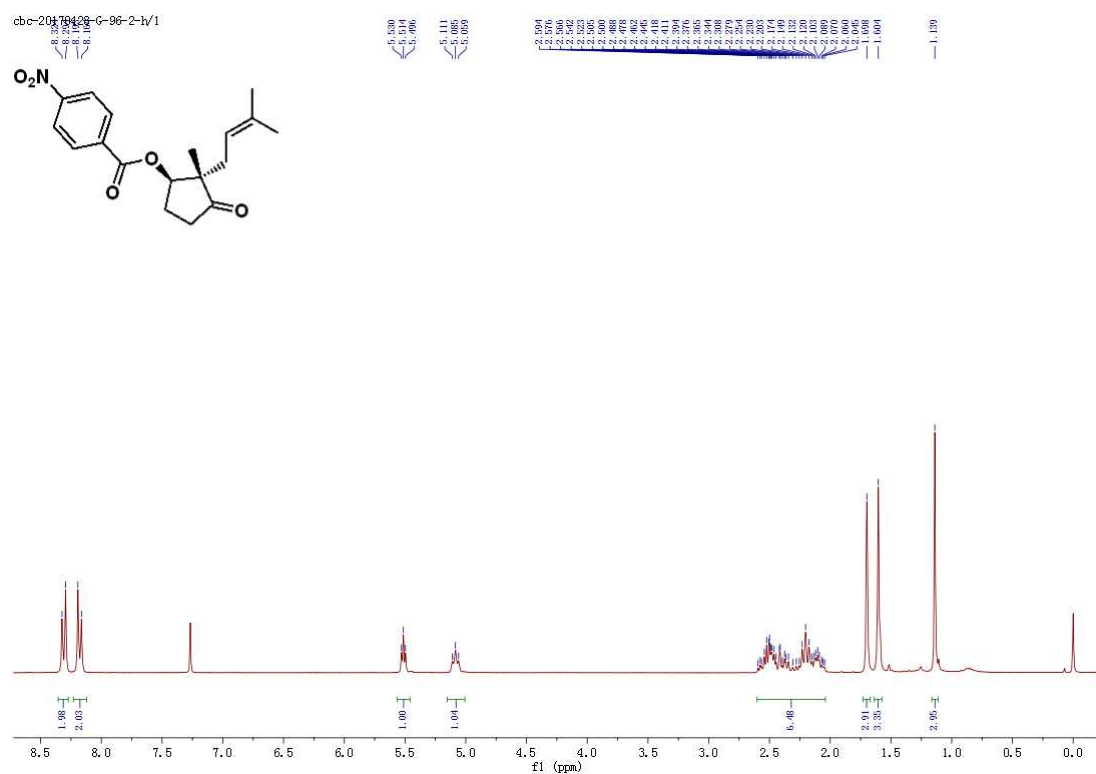
Position	δ_{C} in ppm	
	Natural ³	This work
1	214.3	214.0
2	127.6	127.4
3	188.9	188.5
4	63.5	63.3
5	156.5	156.4
6	45.8	45.7
7	37.7	37.5
8	33.6	33.4
9	50.1	49.9
10	125.0	124.8
11	142.6	142.2
12	139.8	139.6
13	32.9	32.8
14	77.6	77.2
15	194.9	194.6
16	28.7	28.5
17	22.8	22.7
18	29.7	29.1
19	20.6	24.1 ^a
20	20.6	20.4 ^a

^a One of the carbons was incorrectly assigned in the reference.

4. Copies of NMR Spectra

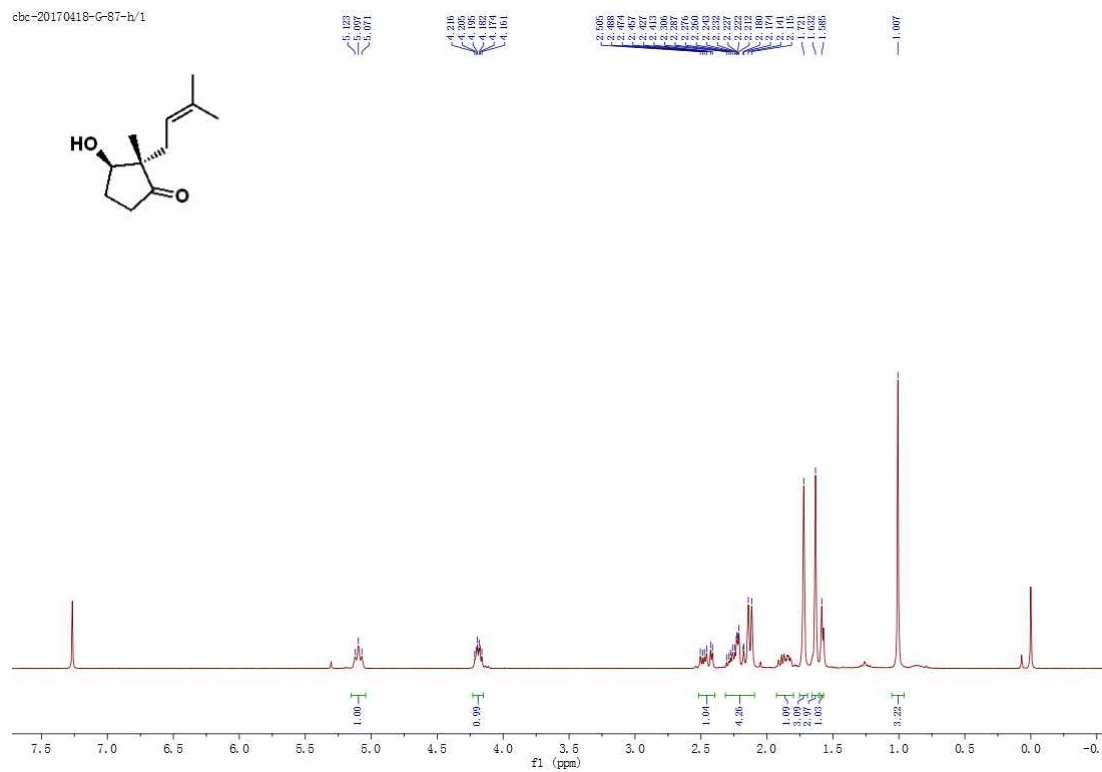


Supplementary Figure 13. ¹H NMR and ¹³C NMR of compound 12

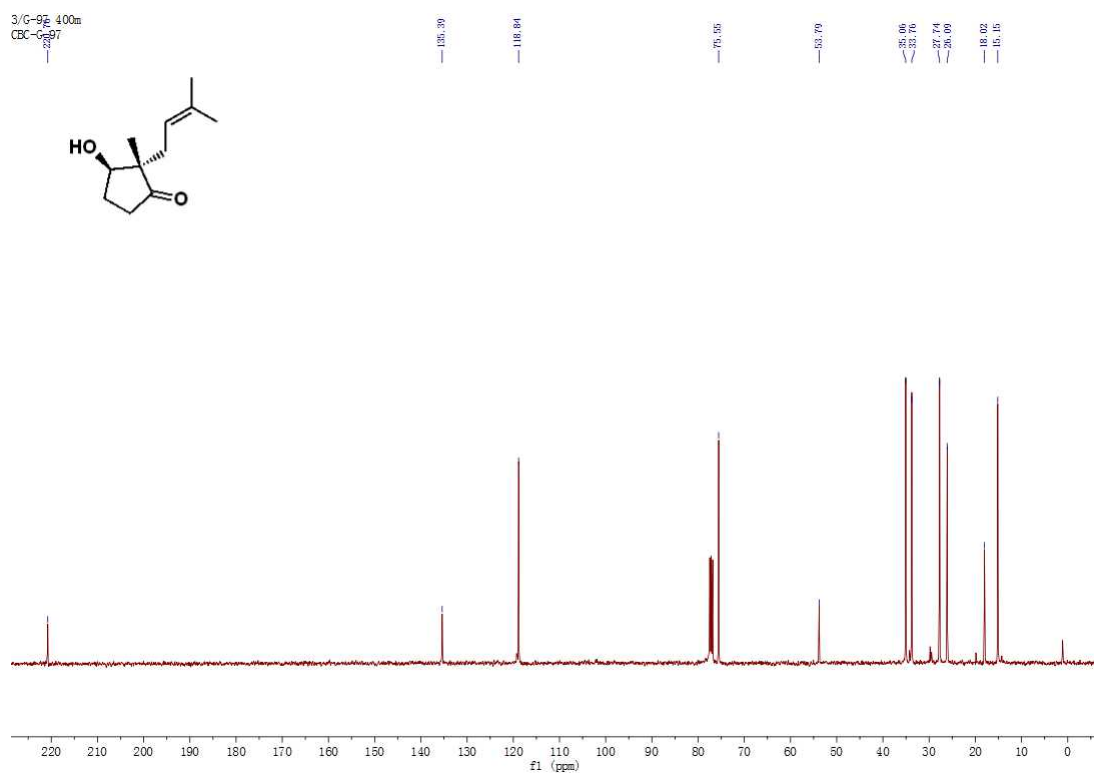


Supplementary Figure 14. ¹H NMR and ¹³C NMR of compound SI-1

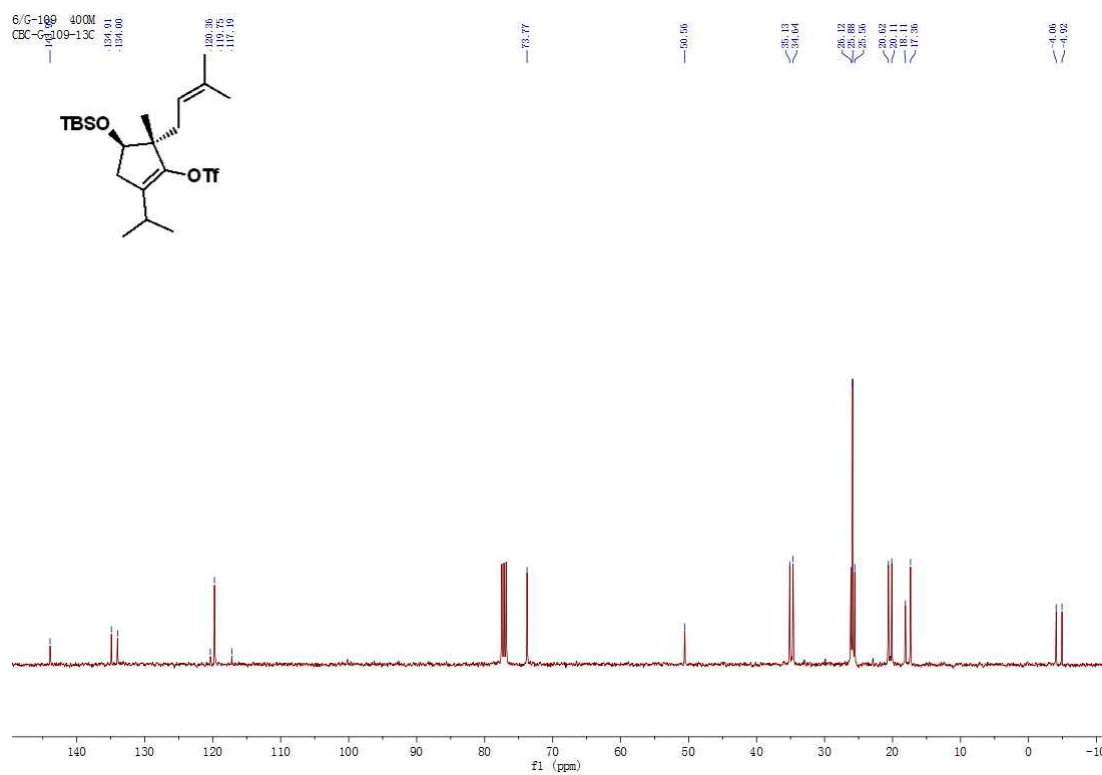
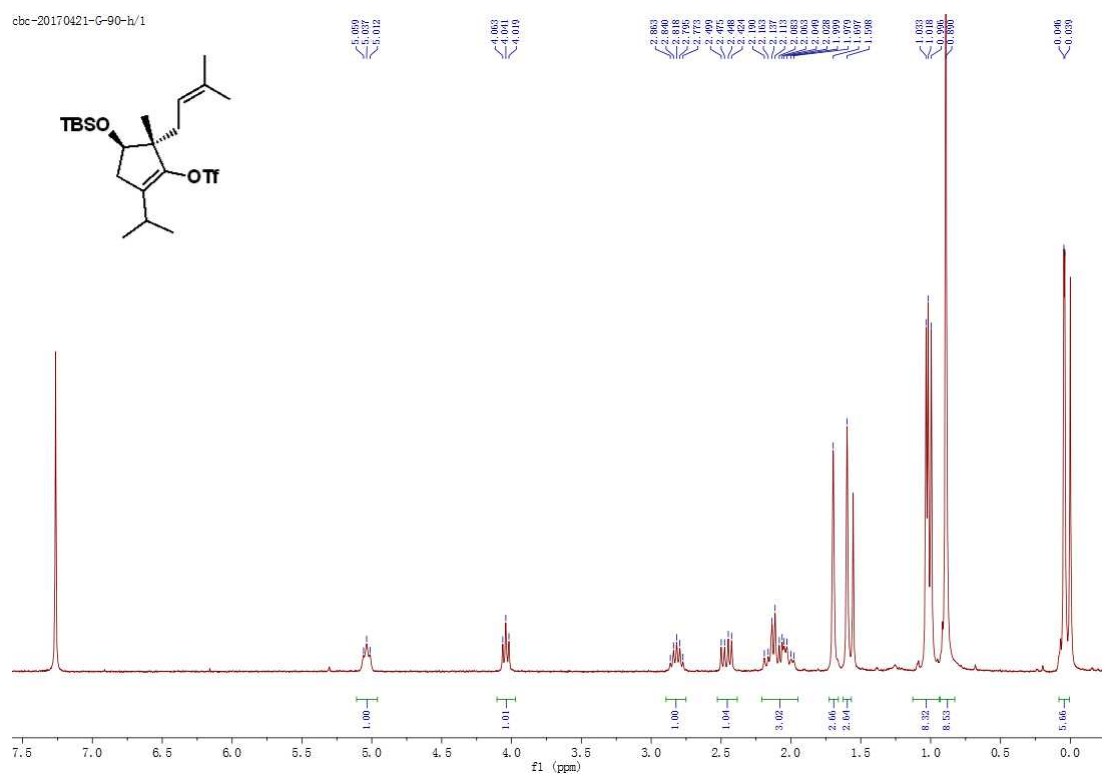
cbe-20170418-G-87-h/1



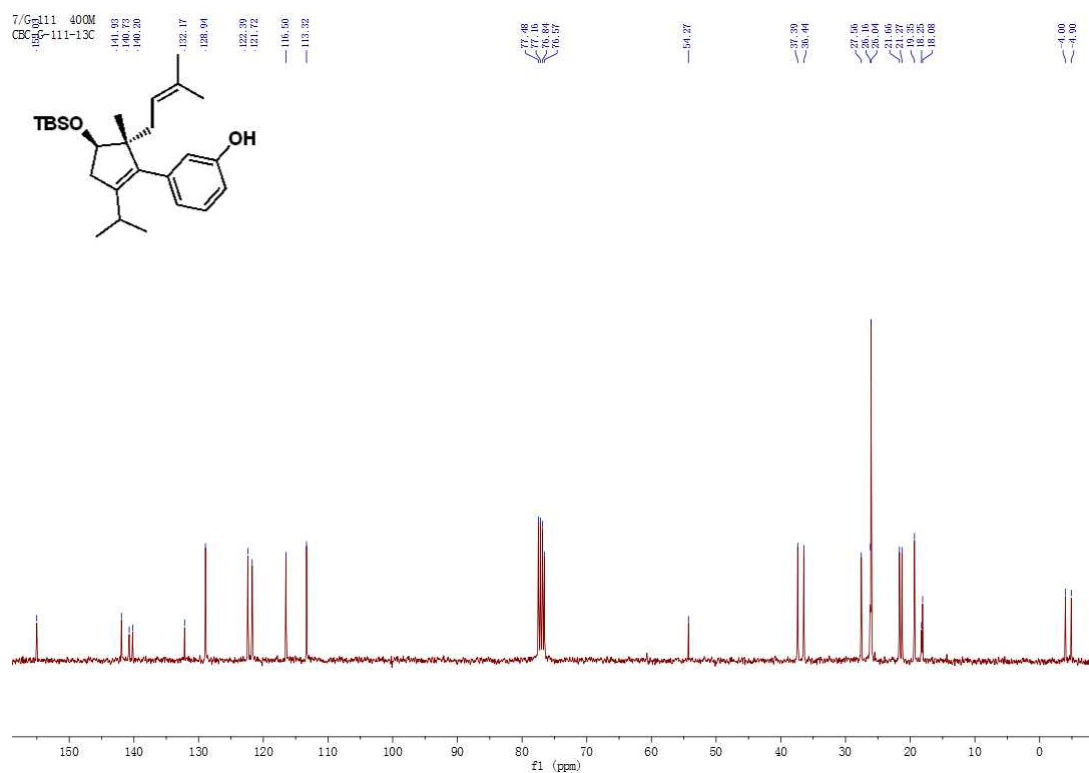
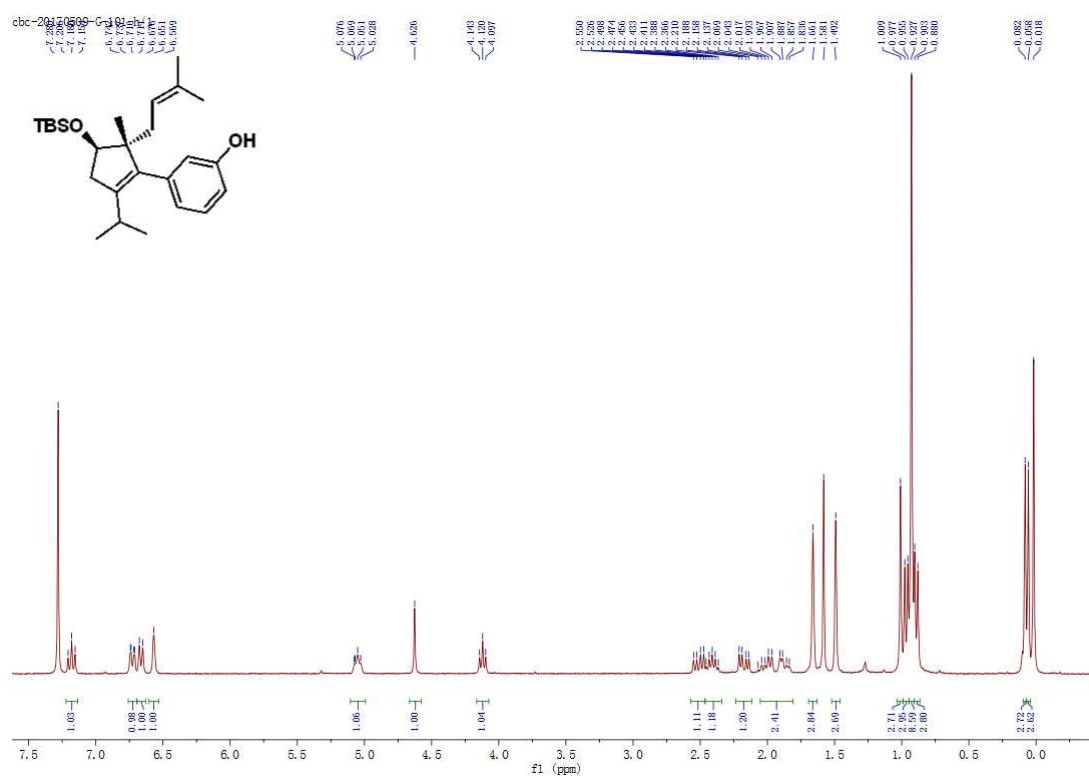
3/G-9E 400m
CBC-C297



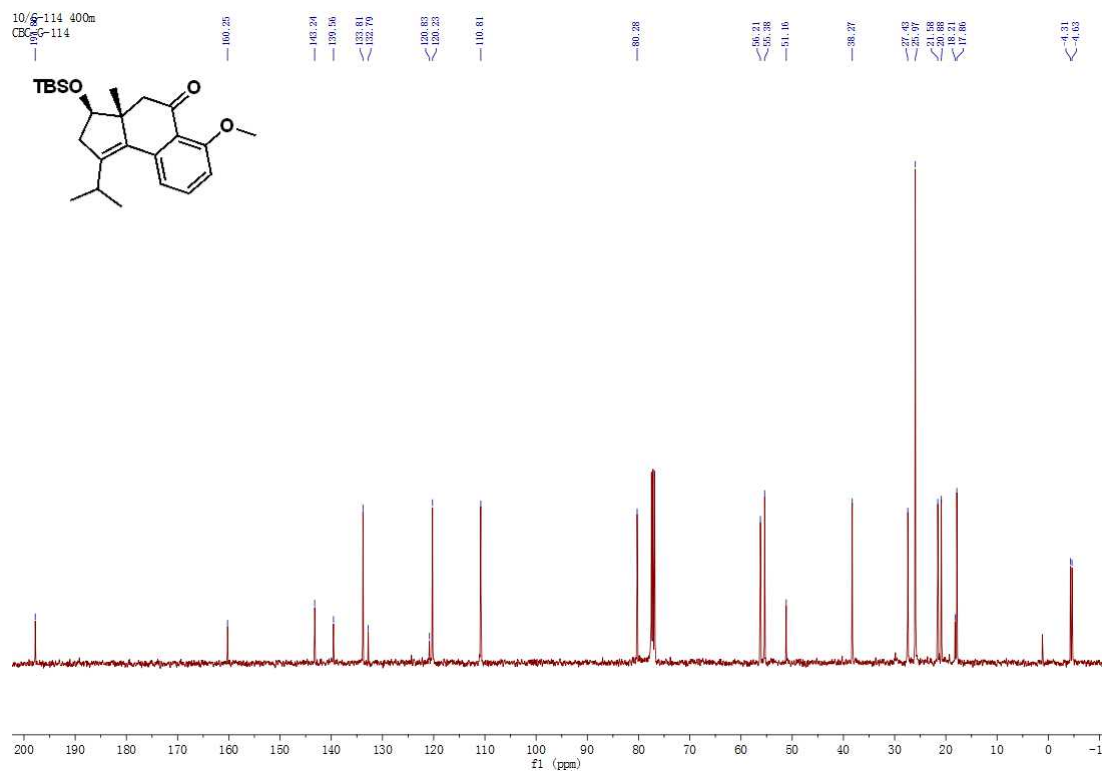
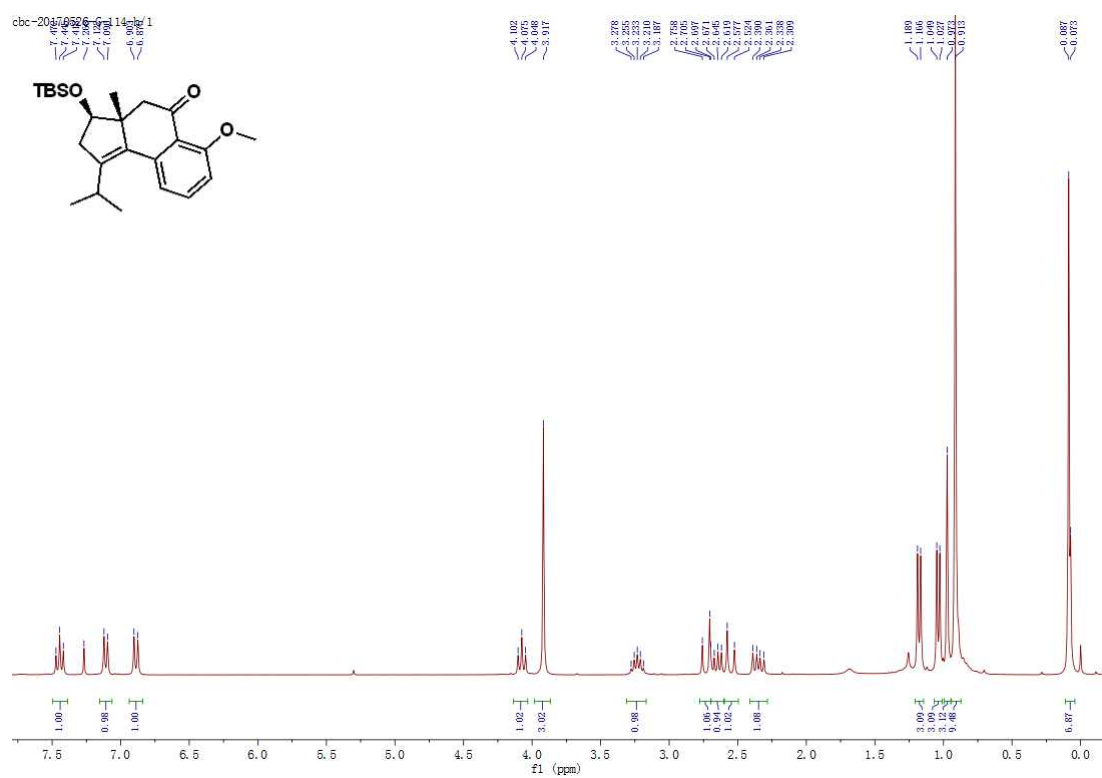
Supplementary Figure 15. ¹H NMR and ¹³C NMR of compound 13



Supplementary Figure 17. ^1H NMR and ^{13}C NMR of compound 15a

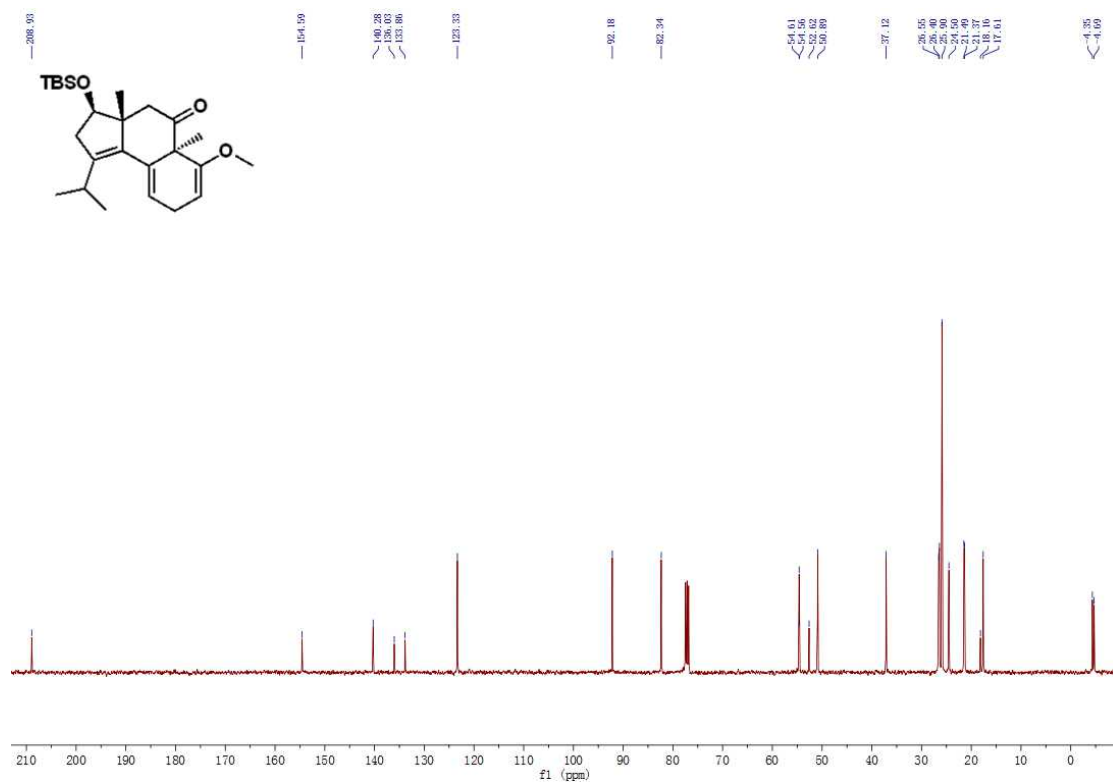
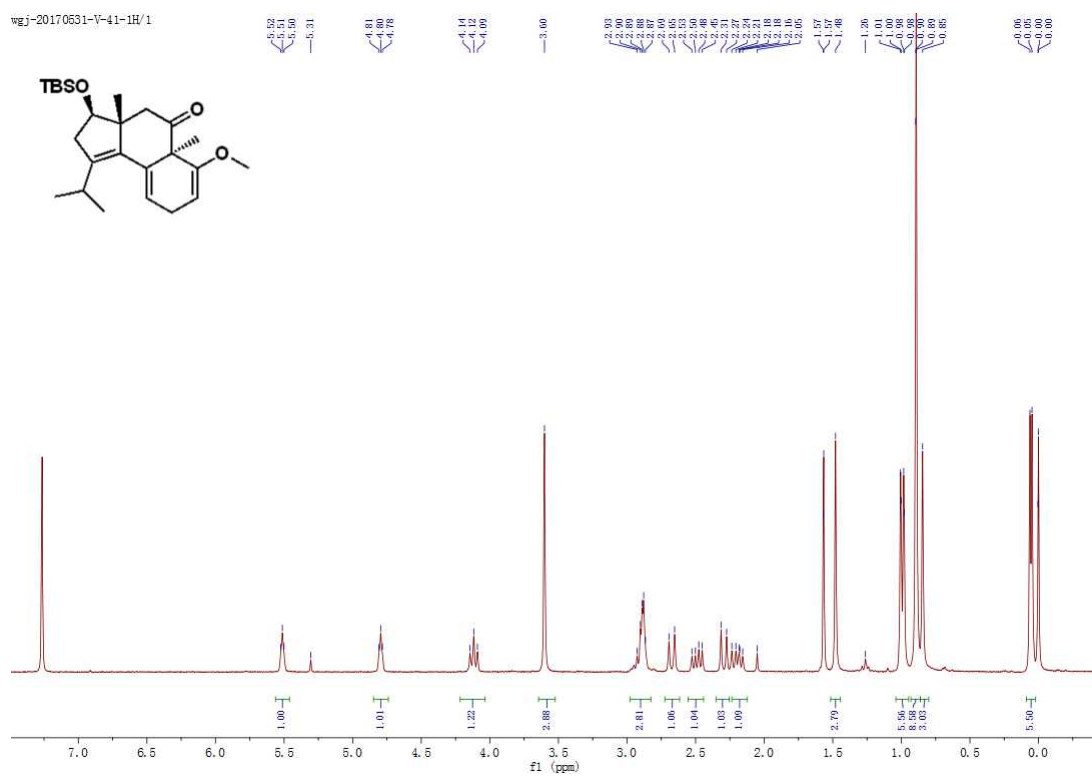


Supplementary Figure 18. ^1H NMR and ^{13}C NMR of compound 17a

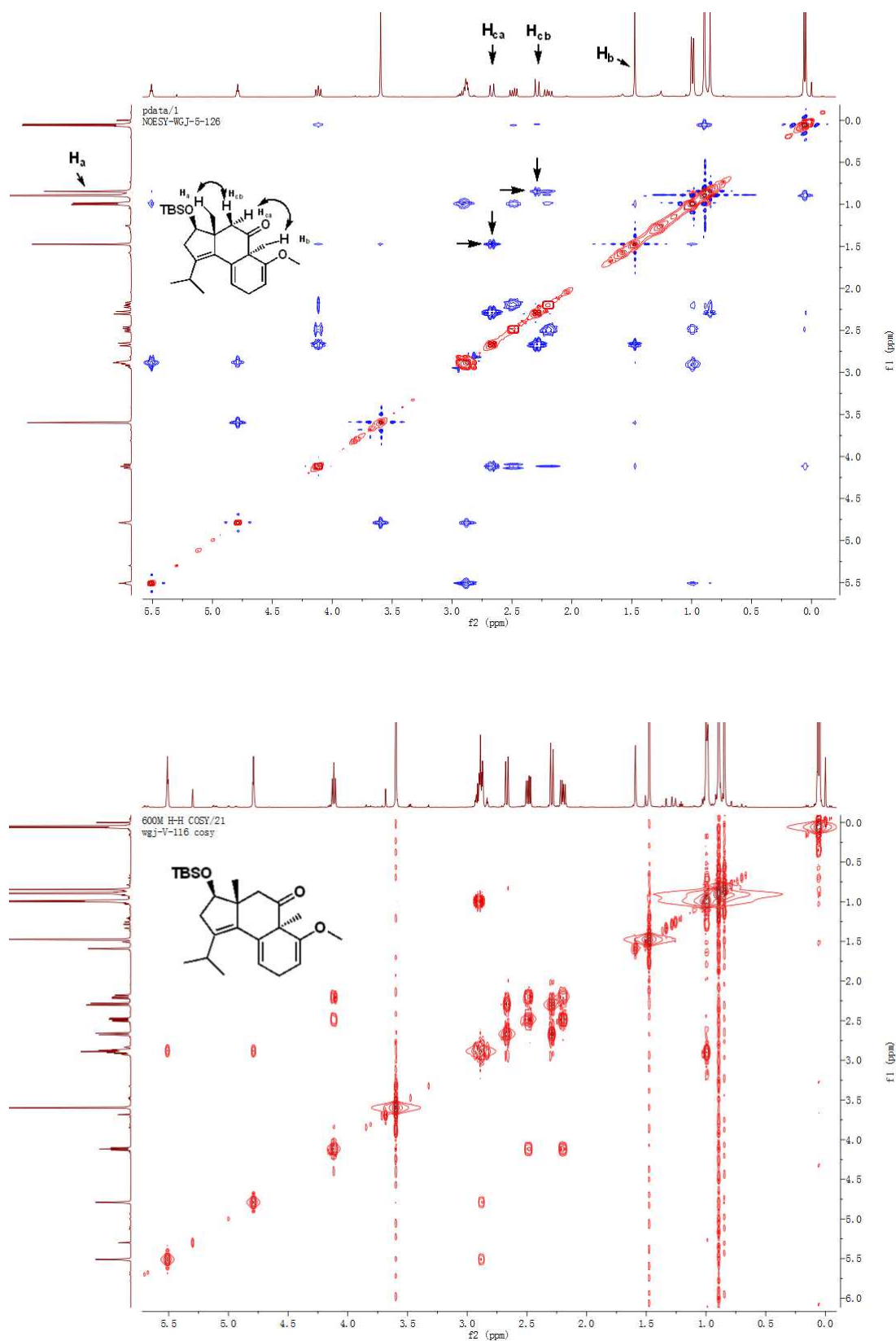


Supplementary Figure 19. ¹H NMR and ¹³C NMR of compound 23

wg-j-20170631-V-41-1H/1

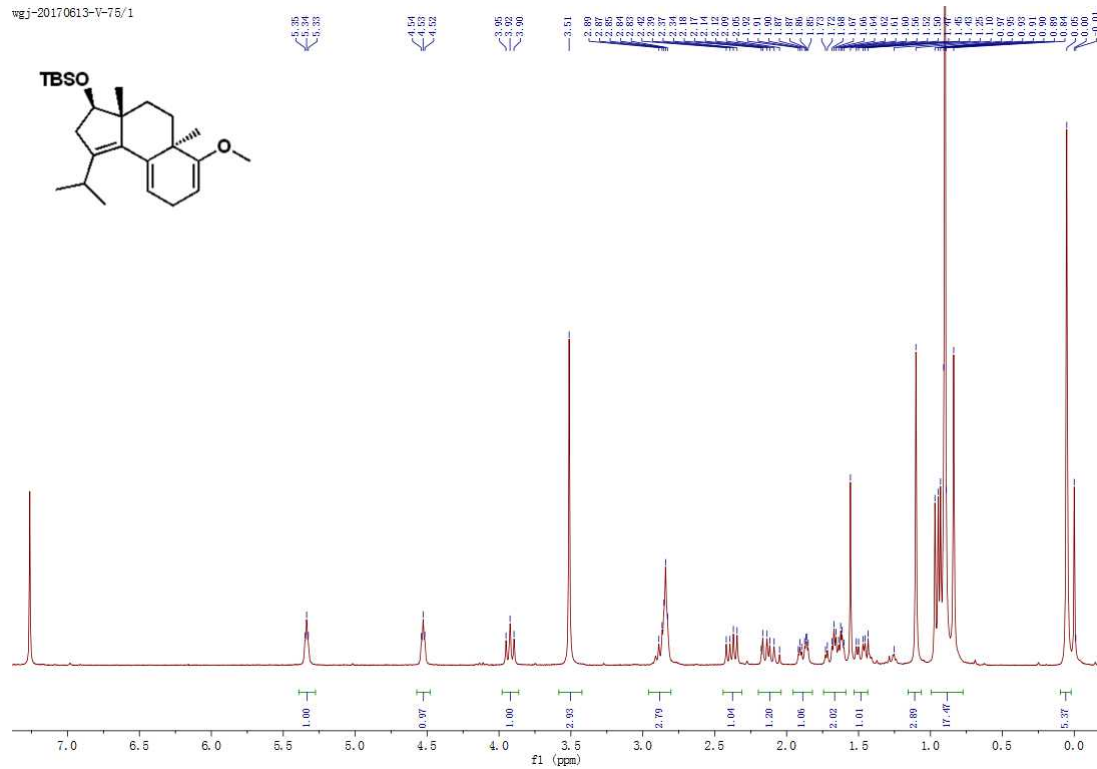


Supplementary Figure 20. ¹H NMR and ¹³C NMR of compound **24**

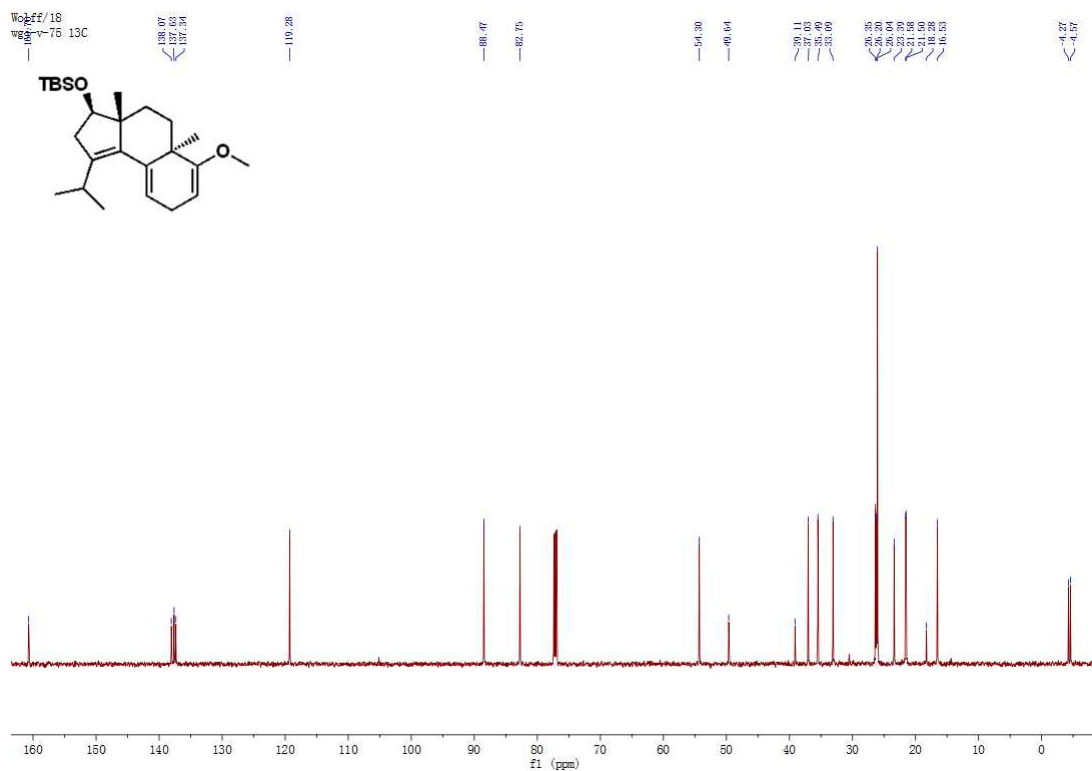


Supplementary Figure 21. NOESY and ^1H - ^1H COSY of compound 24

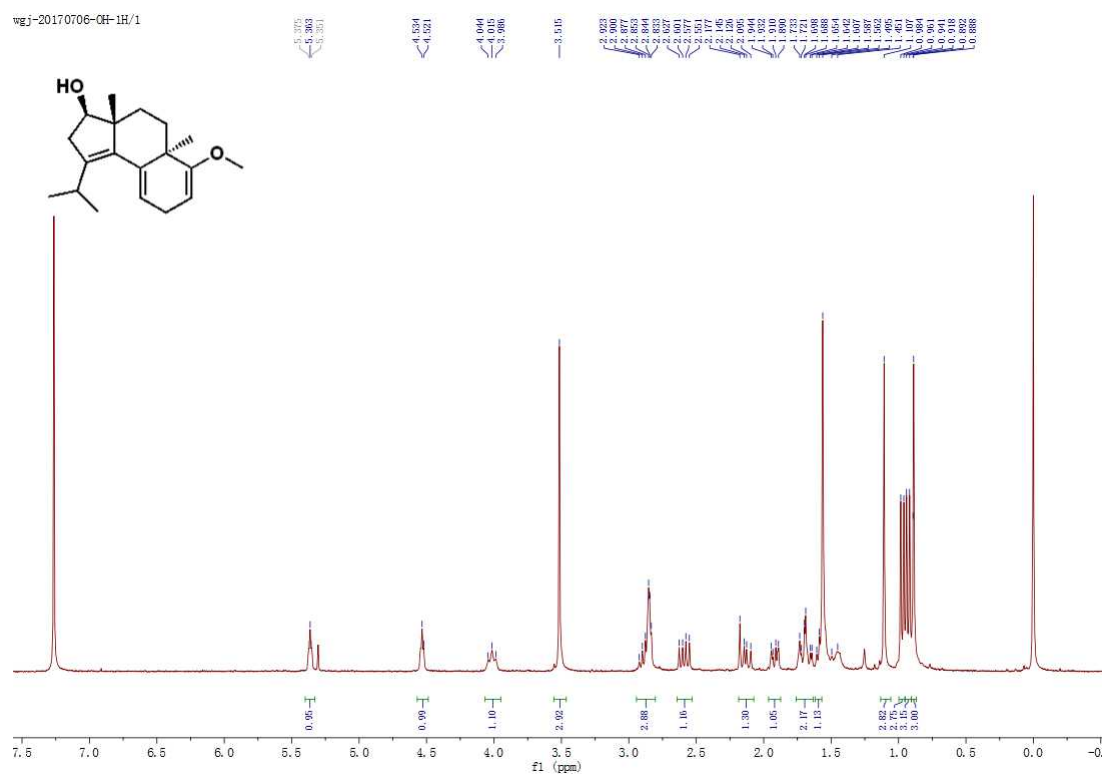
wg-j-20170613-V-75/1



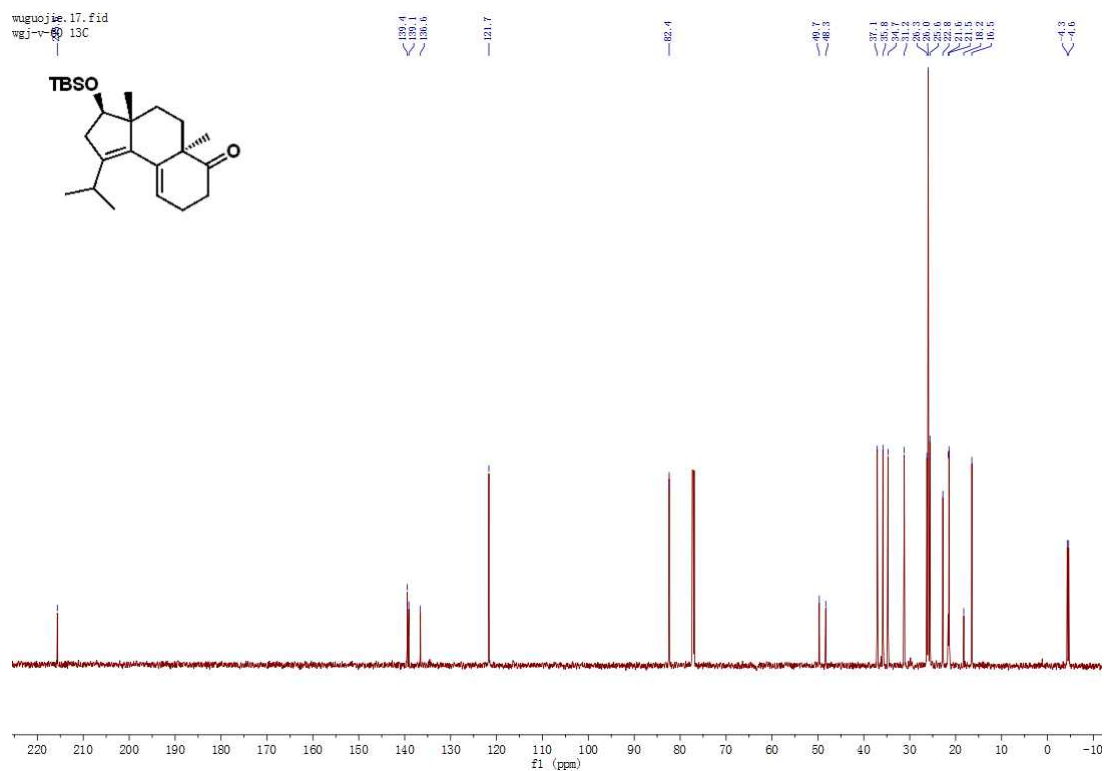
Wojcik/18
wg-j-20170613-V-75/1

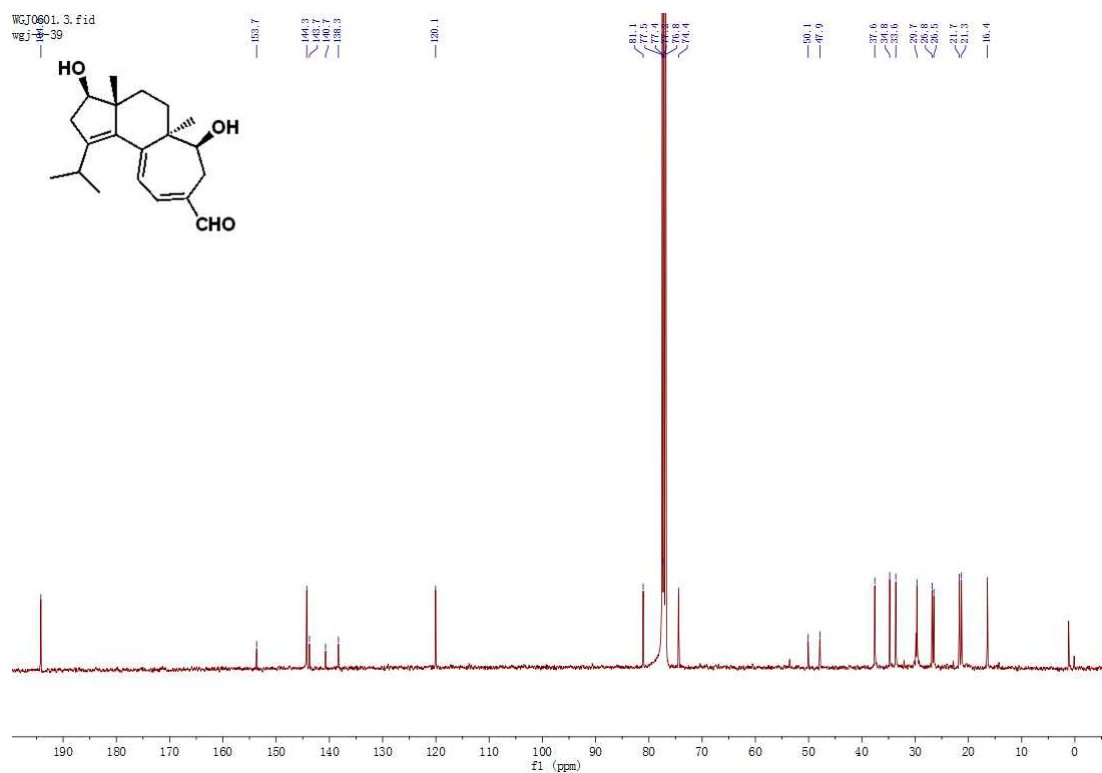
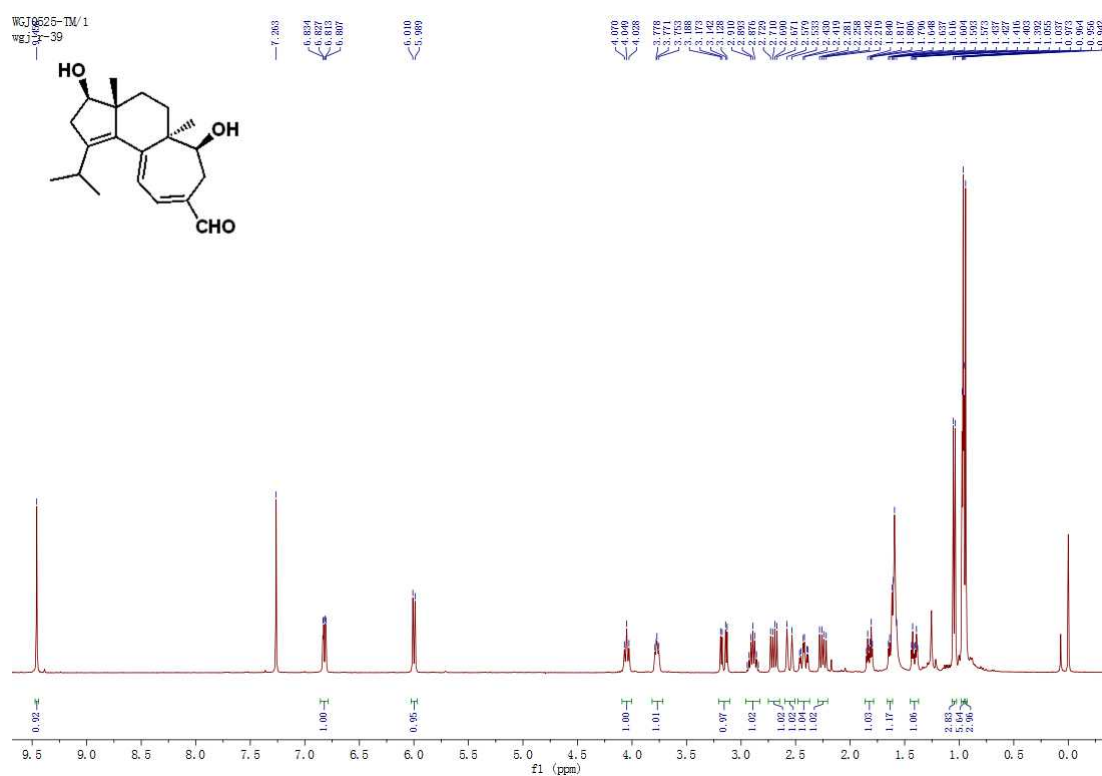


Supplementary Figure 22. ^1H NMR and ^{13}C NMR of compound 26

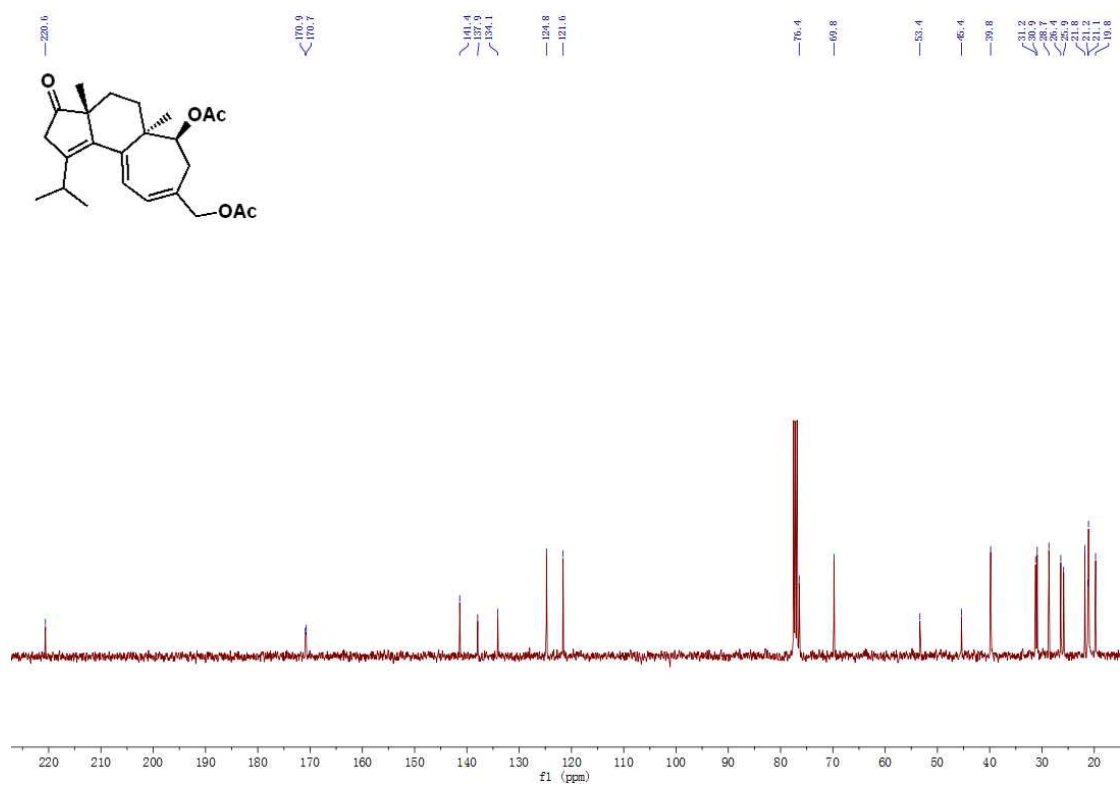
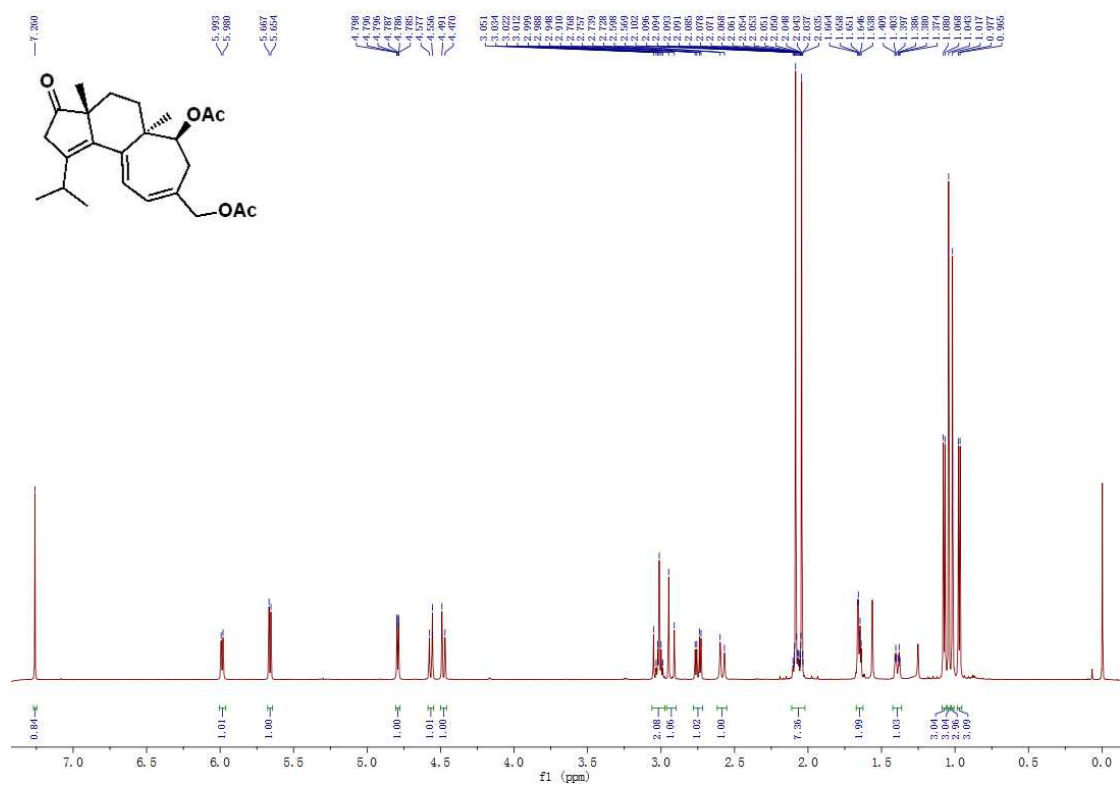


Supplementary Figure 23. ¹H NMR of compound 27

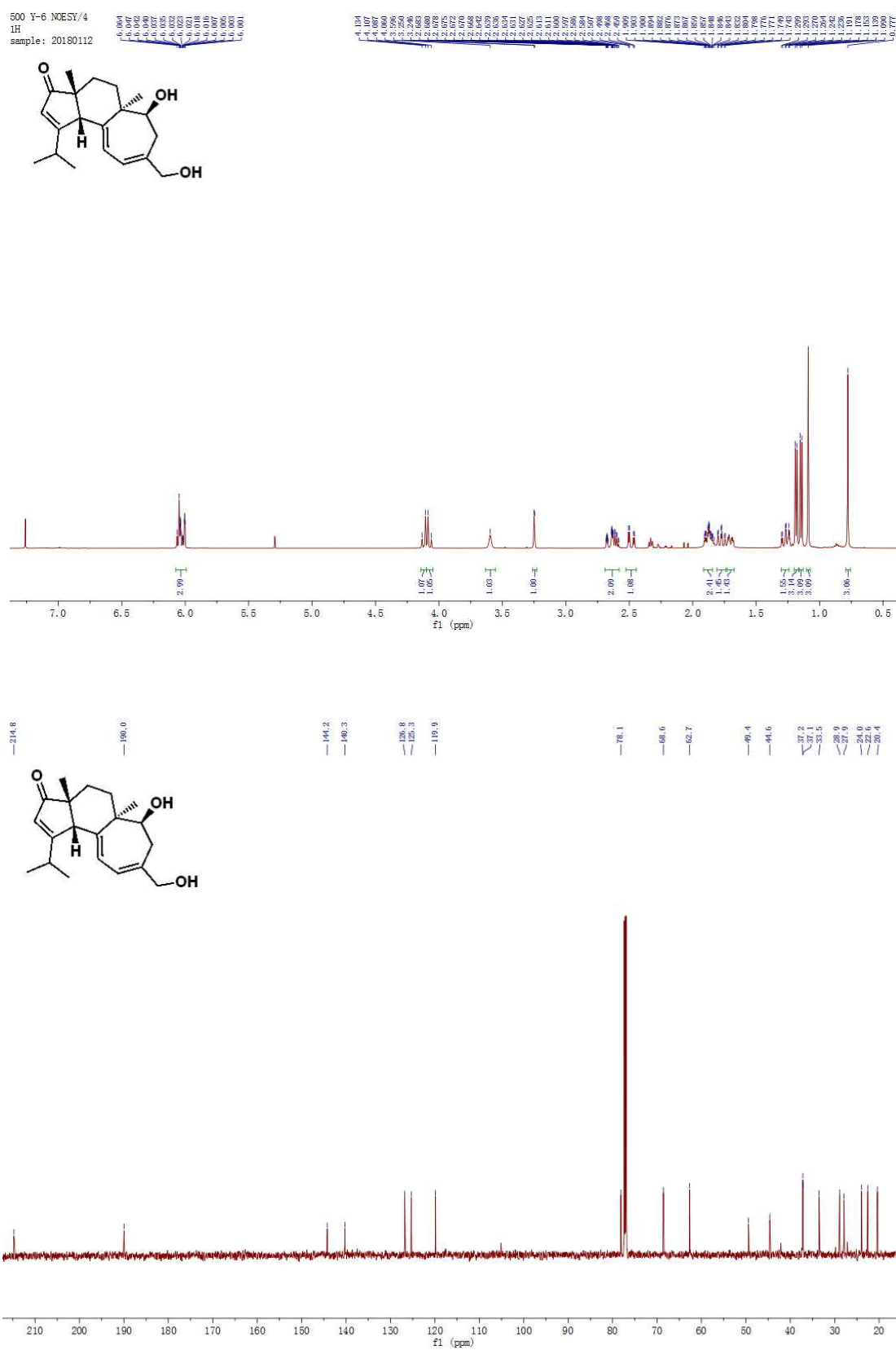




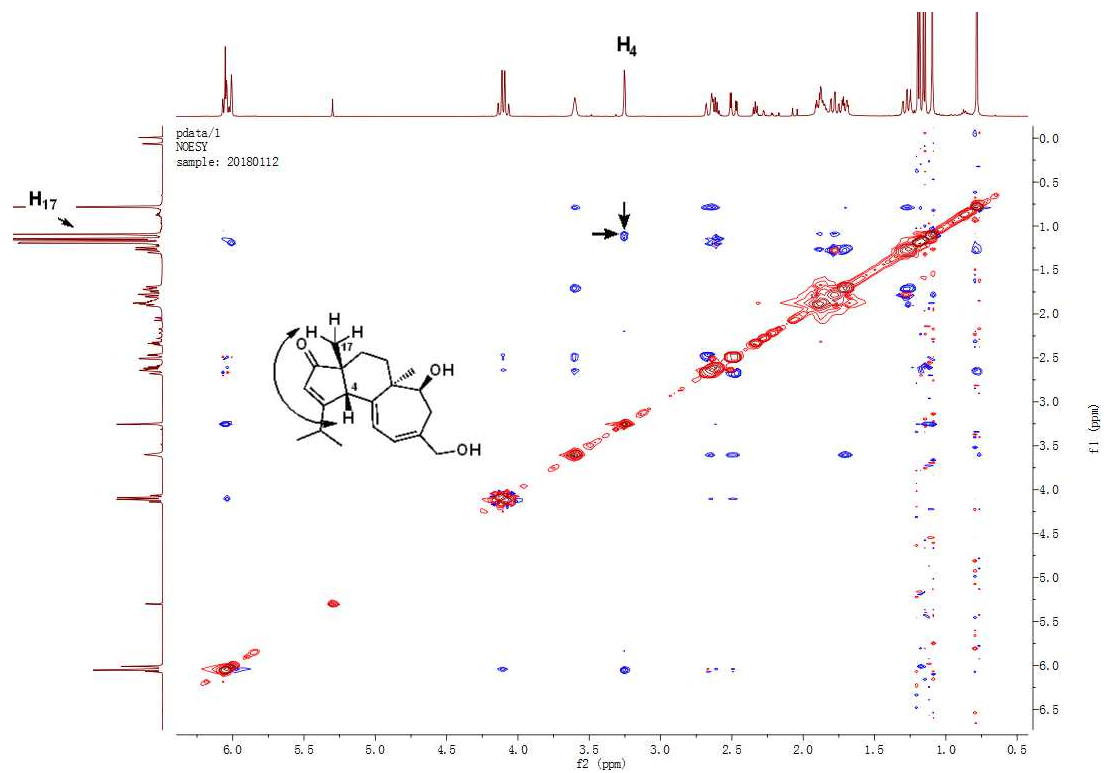
Supplementary Figure 26. ¹H NMR and ¹³C NMR of Cyreneine (1)



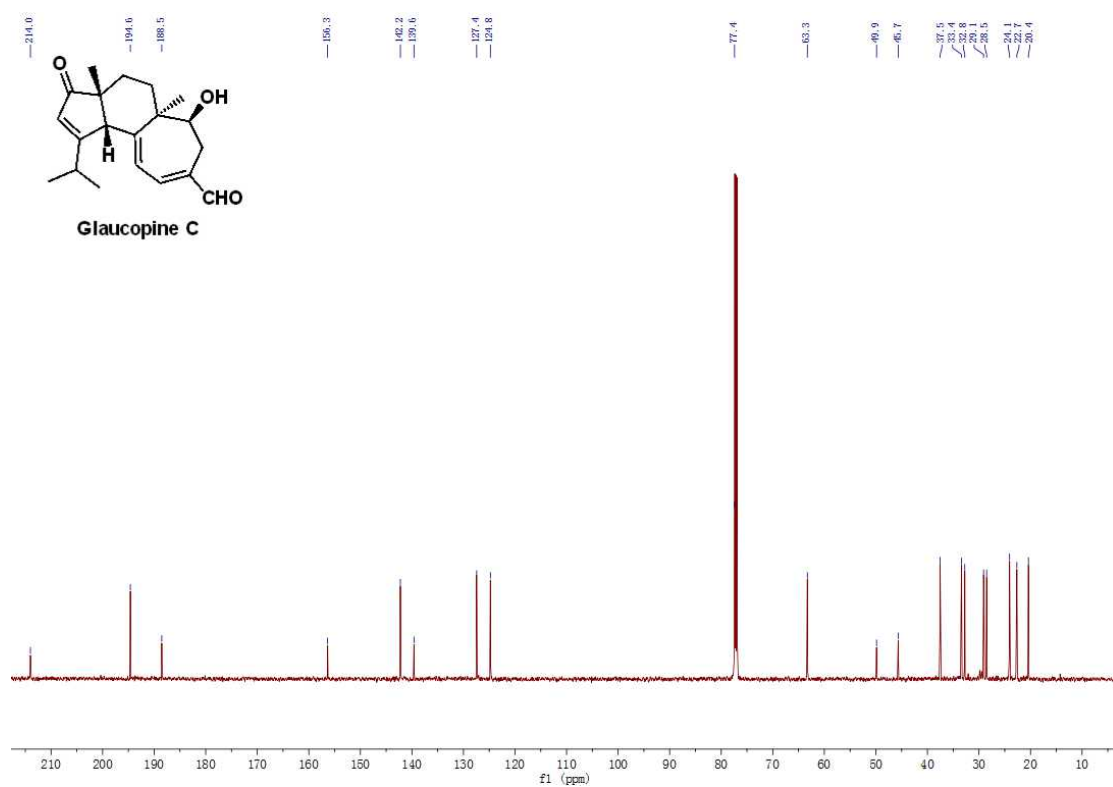
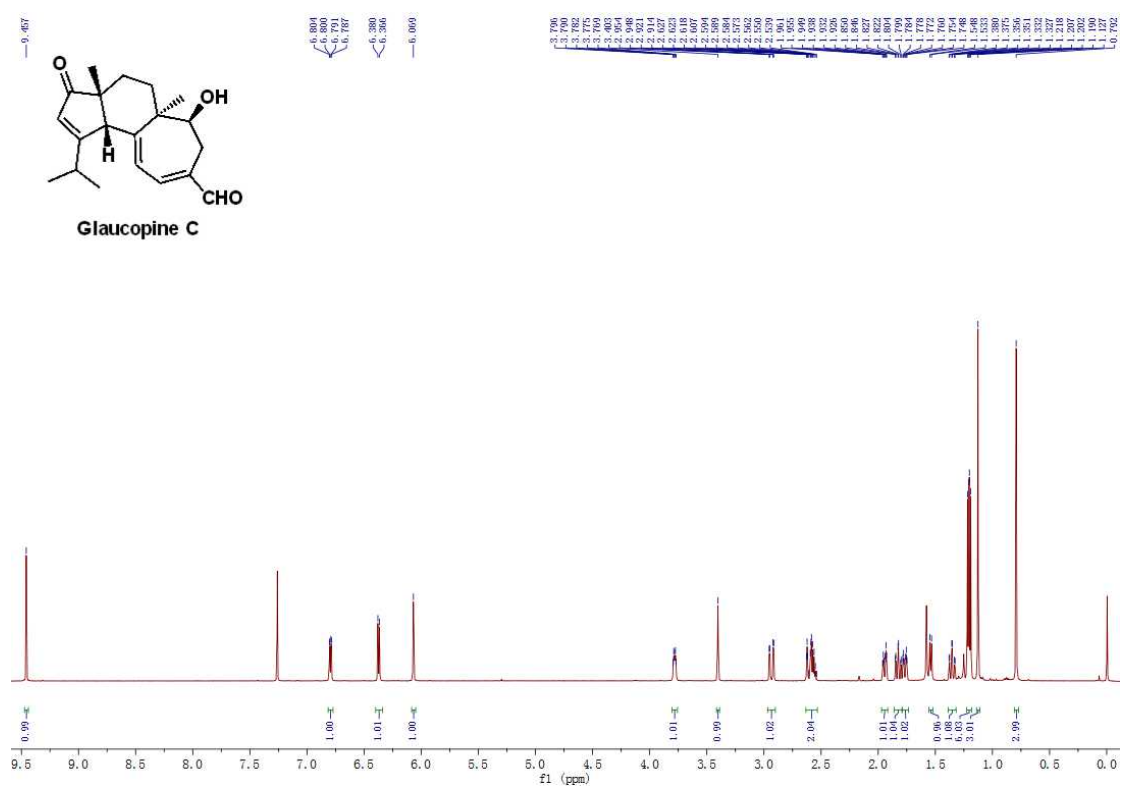
Supplementary Figure 27. ¹H NMR and ¹³C NMR of compound 30



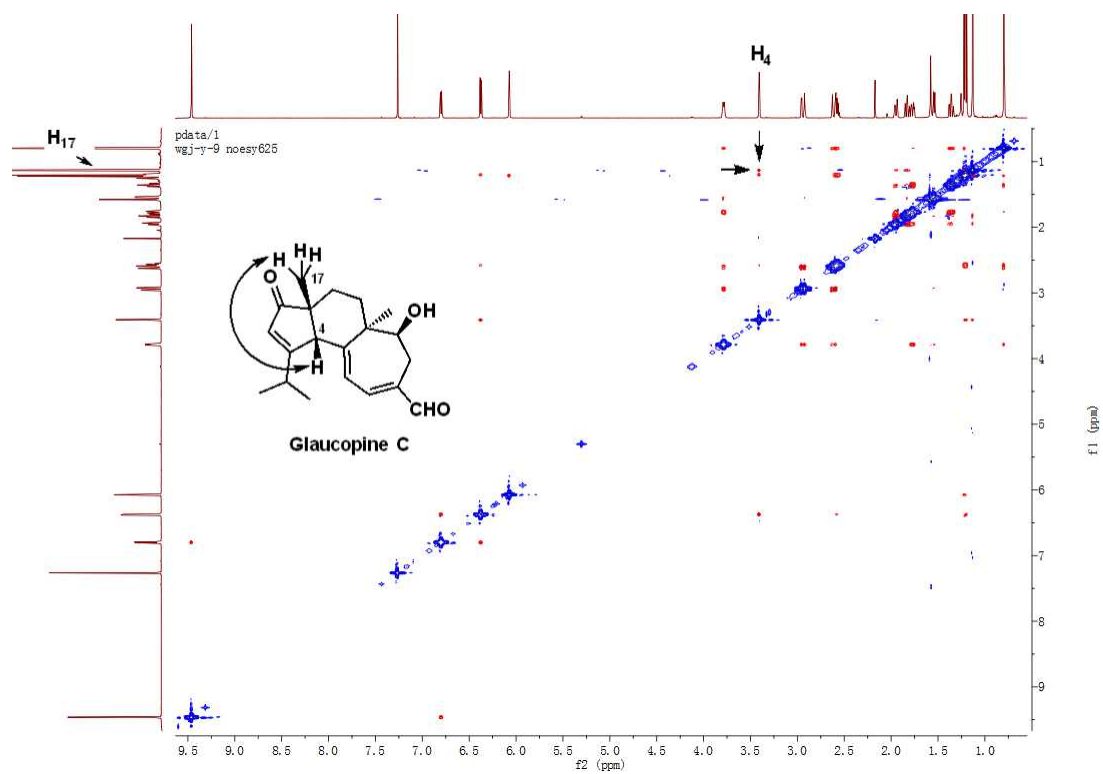
Supplementary Figure 28. ^1H NMR and ^{13}C NMR of compound **31**



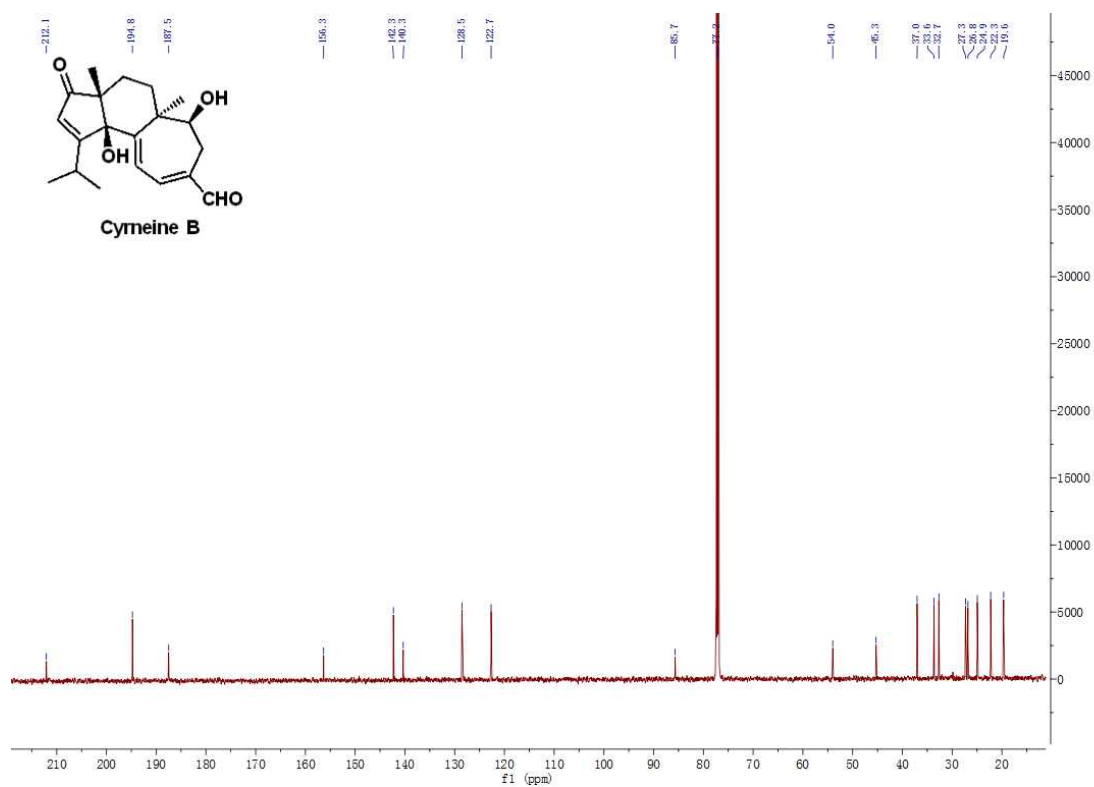
Supplementary Figure 29. Noesy correlation of compound **31**



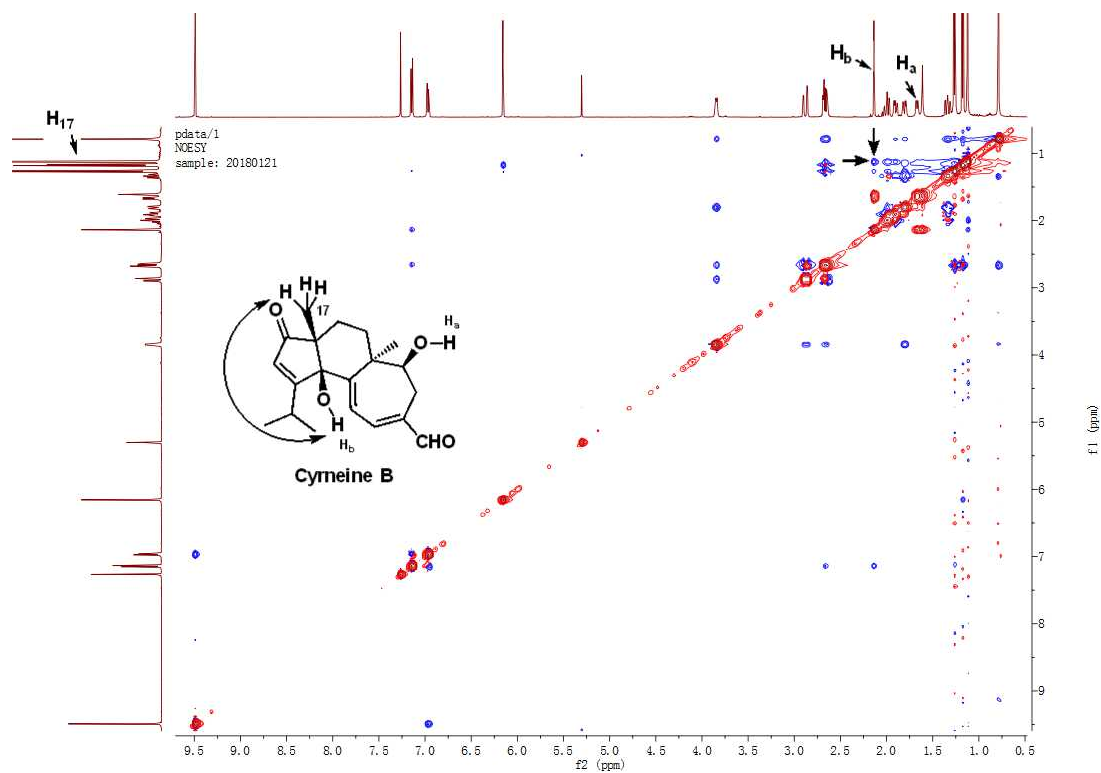
Supplementary Figure 30. ¹H NMR and ¹³C NMR of Glaucopine C



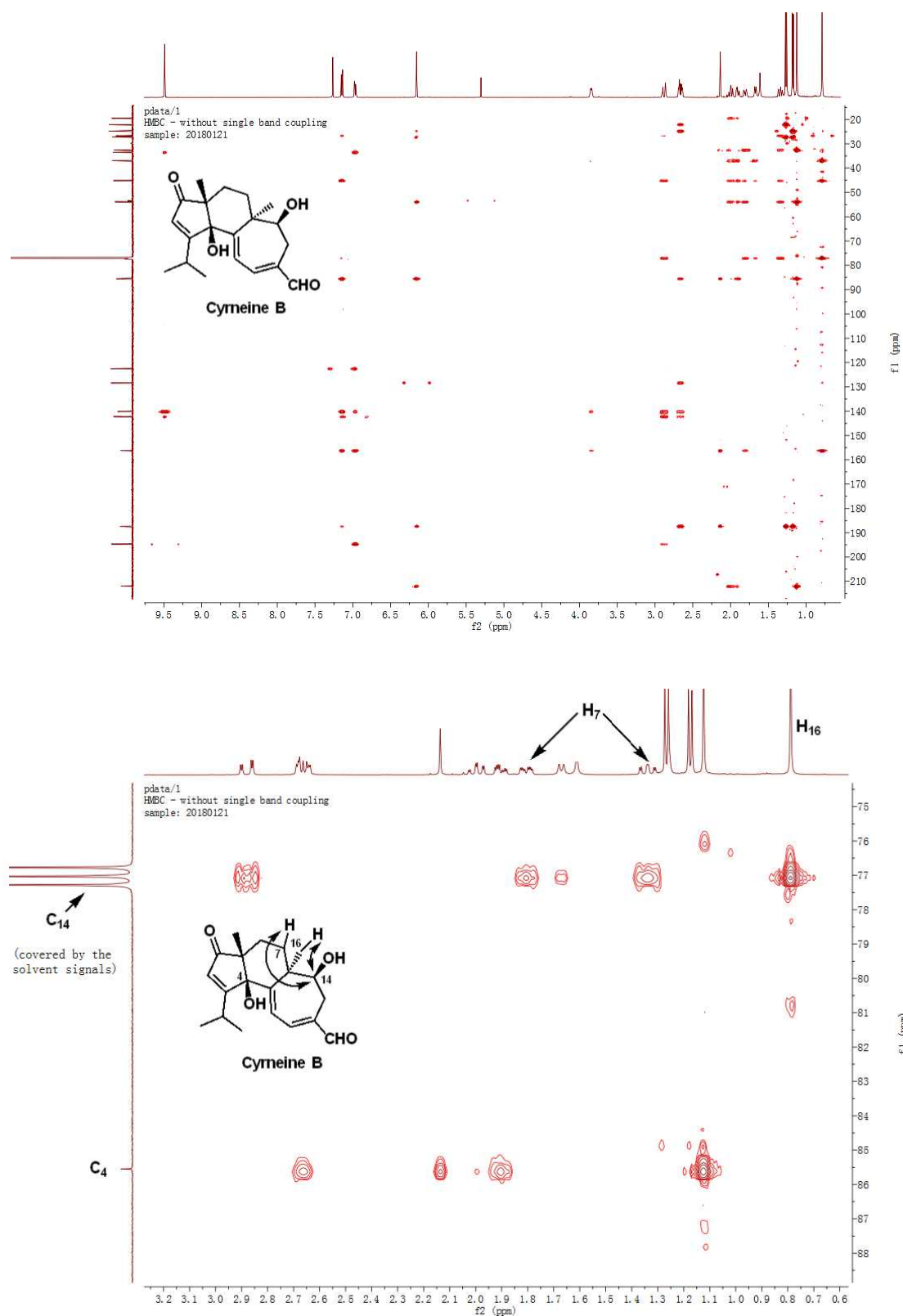
Supplementary Figure 31. Noesy correlation of Glaucopine C



Supplementary Figure 33. ^{13}C NMR of Cyrneine B in CDCl_3



Supplementary Figure 34. Noesy correlation of Cyrneine B in CDCl_3



Supplementary Figure 35. HMBC correlation of Cyrneine B in $CDCl_3$: full spectrum (upper) and zoomed (bottom)

5. X-Ray Single Crystal Diffraction Data for Cyrneine A (1)

Supplementary Table 7. Crystal data and structure refinement for **1**.

	(CCDC 1830226)
Formula	C ₂₀ H ₂₈ O ₃
Formula weight	316.42
Temperature	150(2) K
Z, calculated density	4, 1.217 Mg·m ⁻³
F(000)	688
absorption coefficient	0.632 mm ⁻¹
radiation(wavelength)	Cu K _α (1.54178 Å)
Crystal system, space group	orthorhombic, P 21 21 21
Unit cell dimensions	a = 6.9296(2) Å alpha = 90° b = 13.6851(3) Å beta = 90° c = 18.2162(4) Å gamma = 90°
Volume	1727.48(7) Å ³
Crystal size	0.400 x 0.300 x 0.250 mm
Theta range for data collection	4.855° to 72.395°
Limiting indices	-8<=h<=8, -15<=k<=16, -22<=l<=22
Reflections collected/unique	22615/3397 [R(int) = 0.0453]
Completeness to theta = 72.679	0.995
Absorption correction	None
Refinement method	Full-matrix least-squares on F ²
Data/restraints/parameters	3397/0/214
Goodness-of-fit on F ²	1.068
Final R indices [I>2sigma(I)]	R1 = 0.0353, wR2 = 0.0921
R indices (all data)	R1 = 0.0366, wR2 = 0.0936
Absolute structure parameter	-0.02(7)
Extinction coefficient	n/a
Reflections collected	22615
number of refined parameters	214
Largest diff. peak and hole	0.236 and -0.216 e.Å ⁻³

Supplementary Table 8. Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **1**. U(eq) is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x	y	z	U(eq)
O(2)	8631(2)	5952(1)	5766(1)	25(1)
O(1)	6352(2)	4549(1)	9255(1)	26(1)
O(3)	9749(2)	8909(1)	4681(1)	29(1)
C(4)	9991(3)	5294(1)	7165(1)	21(1)
C(1)	7441(3)	6528(1)	8012(1)	16(1)
C(10)	6998(2)	7561(1)	6941(1)	17(1)
C(20)	8656(3)	8841(1)	5201(1)	21(1)
C(16)	11652(3)	6911(2)	7350(1)	25(1)
C(13)	10503(3)	7457(2)	5796(1)	24(1)
C(7)	6722(3)	7047(1)	8577(1)	19(1)
C(15)	5889(3)	4911(2)	7787(1)	23(1)
C(6)	7536(3)	5439(1)	8186(1)	18(1)
C(3)	9921(3)	6403(1)	6981(1)	16(1)
C(12)	8798(3)	8124(1)	5796(1)	18(1)
C(11)	7321(3)	8127(1)	6278(1)	17(1)
C(5)	9507(3)	5039(1)	7958(1)	21(1)
C(8)	6111(3)	6361(1)	9190(1)	22(1)
C(17)	6531(3)	8137(1)	8675(1)	23(1)
C(2)	8077(3)	6868(1)	7278(1)	15(1)
C(9)	7250(3)	5432(1)	9025(1)	20(1)
C(14)	10157(3)	6456(1)	6139(1)	20(1)
C(18)	4476(4)	8429(2)	8893(1)	35(1)
C(19)	7965(4)	8494(2)	9254(1)	39(1)

Supplementary Table 9. Bond lengths [$\text{\AA}$] and angles [deg] for **1**.

O(2)-C(14)	1.434(2)
O(2)-H(2)	0.8400
O(1)-C(9)	1.422(2)
O(1)-H(1)	0.8400
O(3)-C(20)	1.216(2)
C(4)-C(5)	1.522(3)
C(4)-C(3)	1.556(2)
C(4)-H(4A)	0.9900
C(4)-H(4B)	0.9900
C(1)-C(7)	1.346(3)
C(1)-C(2)	1.483(2)

C(1)-C(6)	1.525(2)
C(10)-C(2)	1.354(3)
C(10)-C(11)	1.453(2)
C(10)-H(10)	0.9500
C(20)-C(12)	1.465(3)
C(20)-H(20)	0.9500
C(16)-C(3)	1.540(3)
C(16)-H(16A)	0.9800
C(16)-H(16B)	0.9800
C(16)-H(16C)	0.9800
C(13)-C(12)	1.493(3)
C(13)-C(14)	1.524(3)
C(13)-H(13A)	0.9900
C(13)-H(13B)	0.9900
C(7)-C(17)	1.509(3)
C(7)-C(8)	1.518(3)
C(15)-C(6)	1.534(3)
C(15)-H(15A)	0.9800
C(15)-H(15B)	0.9800
C(15)-H(15C)	0.9800
C(6)-C(5)	1.529(3)
C(6)-C(9)	1.542(2)
C(3)-C(2)	1.526(2)
C(3)-C(14)	1.544(2)
C(12)-C(11)	1.349(3)
C(11)-H(11)	0.9500
C(5)-H(5A)	0.9900
C(5)-H(5B)	0.9900
C(8)-C(9)	1.527(3)
C(8)-H(8A)	0.9900
C(8)-H(8B)	0.9900
C(17)-C(19)	1.529(3)
C(17)-C(18)	1.531(3)
C(17)-H(17)	1.0000
C(9)-H(9)	1.0000
C(14)-H(14)	1.0000
C(18)-H(18A)	0.9800
C(18)-H(18B)	0.9800
C(18)-H(18C)	0.9800
C(19)-H(19A)	0.9800
C(19)-H(19B)	0.9800
C(19)-H(19C)	0.9800
C(14)-O(2)-H(2)	109.5
C(9)-O(1)-H(1)	109.5

C(5)-C(4)-C(3)	114.93(15)
C(5)-C(4)-H(4A)	108.5
C(3)-C(4)-H(4A)	108.5
C(5)-C(4)-H(4B)	108.5
C(3)-C(4)-H(4B)	108.5
H(4A)-C(4)-H(4B)	107.5
C(7)-C(1)-C(2)	129.40(16)
C(7)-C(1)-C(6)	111.85(16)
C(2)-C(1)-C(6)	118.73(15)
C(2)-C(10)-C(11)	131.74(17)
C(2)-C(10)-H(10)	114.1
C(11)-C(10)-H(10)	114.1
O(3)-C(20)-C(12)	125.80(19)
O(3)-C(20)-H(20)	117.1
C(12)-C(20)-H(20)	117.1
C(3)-C(16)-H(16A)	109.5
C(3)-C(16)-H(16B)	109.5
H(16A)-C(16)-H(16B)	109.5
C(3)-C(16)-H(16C)	109.5
H(16A)-C(16)-H(16C)	109.5
H(16B)-C(16)-H(16C)	109.5
C(12)-C(13)-C(14)	115.18(16)
C(12)-C(13)-H(13A)	108.5
C(14)-C(13)-H(13A)	108.5
C(12)-C(13)-H(13B)	108.5
C(14)-C(13)-H(13B)	108.5
H(13A)-C(13)-H(13B)	107.5
C(1)-C(7)-C(17)	130.13(17)
C(1)-C(7)-C(8)	109.87(16)
C(17)-C(7)-C(8)	119.96(16)
C(6)-C(15)-H(15A)	109.5
C(6)-C(15)-H(15B)	109.5
H(15A)-C(15)-H(15B)	109.5
C(6)-C(15)-H(15C)	109.5
H(15A)-C(15)-H(15C)	109.5
H(15B)-C(15)-H(15C)	109.5
C(1)-C(6)-C(5)	109.42(15)
C(1)-C(6)-C(15)	109.28(15)
C(5)-C(6)-C(15)	111.51(16)
C(1)-C(6)-C(9)	101.95(14)
C(5)-C(6)-C(9)	112.44(15)
C(15)-C(6)-C(9)	111.78(15)
C(2)-C(3)-C(16)	108.07(15)
C(2)-C(3)-C(14)	114.88(15)

C(16)-C(3)-C(14)	109.25(15)
C(2)-C(3)-C(4)	110.86(15)
C(16)-C(3)-C(4)	108.76(15)
C(14)-C(3)-C(4)	104.87(14)
C(11)-C(12)-C(20)	115.32(17)
C(11)-C(12)-C(13)	127.04(16)
C(20)-C(12)-C(13)	117.62(16)
C(12)-C(11)-C(10)	131.00(17)
C(12)-C(11)-H(11)	114.5
C(10)-C(11)-H(11)	114.5
C(4)-C(5)-C(6)	111.84(15)
C(4)-C(5)-H(5A)	109.2
C(6)-C(5)-H(5A)	109.2
C(4)-C(5)-H(5B)	109.2
C(6)-C(5)-H(5B)	109.2
H(5A)-C(5)-H(5B)	107.9
C(7)-C(8)-C(9)	103.10(15)
C(7)-C(8)-H(8A)	111.1
C(9)-C(8)-H(8A)	111.1
C(7)-C(8)-H(8B)	111.1
C(9)-C(8)-H(8B)	111.1
H(8A)-C(8)-H(8B)	109.1
C(7)-C(17)-C(19)	109.92(17)
C(7)-C(17)-C(18)	111.70(18)
C(19)-C(17)-C(18)	110.05(18)
C(7)-C(17)-H(17)	108.4
C(19)-C(17)-H(17)	108.4
C(18)-C(17)-H(17)	108.4
C(10)-C(2)-C(1)	117.66(16)
C(10)-C(2)-C(3)	126.38(16)
C(1)-C(2)-C(3)	115.96(15)
O(1)-C(9)-C(8)	115.05(16)
O(1)-C(9)-C(6)	110.75(14)
C(8)-C(9)-C(6)	104.77(15)
O(1)-C(9)-H(9)	108.7
C(8)-C(9)-H(9)	108.7
C(6)-C(9)-H(9)	108.7
O(2)-C(14)-C(13)	110.70(16)
O(2)-C(14)-C(3)	111.76(15)
C(13)-C(14)-C(3)	117.78(16)
O(2)-C(14)-H(14)	105.1
C(13)-C(14)-H(14)	105.1
C(3)-C(14)-H(14)	105.1
C(17)-C(18)-H(18A)	109.5

C(17)-C(18)-H(18B)	109.5
H(18A)-C(18)-H(18B)	109.5
C(17)-C(18)-H(18C)	109.5
H(18A)-C(18)-H(18C)	109.5
H(18B)-C(18)-H(18C)	109.5
C(17)-C(19)-H(19A)	109.5
C(17)-C(19)-H(19B)	109.5
H(19A)-C(19)-H(19B)	109.5
C(17)-C(19)-H(19C)	109.5
H(19A)-C(19)-H(19C)	109.5
H(19B)-C(19)-H(19C)	109.5

Supplementary Table 10. Anisotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **1**.

The anisotropic displacement factor exponent takes the form:

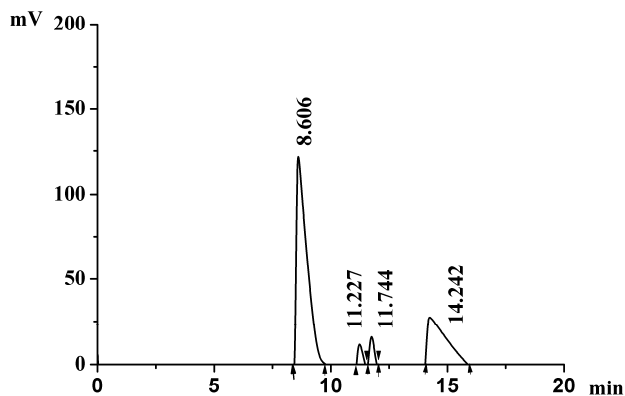
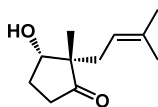
$$-2 \pi^2 [h^2 a^{*2} U_{11} + \dots + 2 h k a^* b^* U_{12}]$$

	U11	U22	U33	U23	U13	U12
O(2)	32(1)	23(1)	18(1)	-6(1)	-4(1)	6(1)
O(1)	40(1)	22(1)	16(1)	7(1)	-2(1)	-8(1)
O(3)	28(1)	36(1)	22(1)	9(1)	4(1)	-1(1)
C(4)	24(1)	16(1)	22(1)	0(1)	2(1)	4(1)
C(1)	17(1)	16(1)	16(1)	2(1)	-2(1)	-1(1)
C(10)	18(1)	18(1)	15(1)	-2(1)	1(1)	0(1)
C(20)	24(1)	20(1)	18(1)	2(1)	-2(1)	-1(1)
C(16)	20(1)	26(1)	30(1)	1(1)	-4(1)	-3(1)
C(13)	24(1)	26(1)	22(1)	8(1)	8(1)	5(1)
C(7)	23(1)	19(1)	15(1)	2(1)	-1(1)	-1(1)
C(15)	28(1)	21(1)	19(1)	1(1)	-1(1)	-6(1)
C(6)	22(1)	15(1)	16(1)	2(1)	-1(1)	-2(1)
C(3)	16(1)	16(1)	18(1)	1(1)	-1(1)	1(1)
C(12)	22(1)	17(1)	16(1)	0(1)	-2(1)	-1(1)
C(11)	20(1)	14(1)	15(1)	-1(1)	-4(1)	2(1)
C(5)	26(1)	17(1)	21(1)	4(1)	-1(1)	3(1)
C(8)	29(1)	23(1)	15(1)	2(1)	4(1)	-2(1)
C(17)	37(1)	17(1)	15(1)	-2(1)	1(1)	-1(1)
C(2)	18(1)	14(1)	13(1)	-2(1)	-1(1)	-2(1)
C(9)	25(1)	19(1)	15(1)	3(1)	-2(1)	-5(1)
C(14)	21(1)	21(1)	19(1)	0(1)	4(1)	5(1)
C(18)	47(1)	28(1)	32(1)	2(1)	9(1)	10(1)
C(19)	59(2)	26(1)	31(1)	-1(1)	-10(1)	-9(1)

Supplementary Table 11. Hydrogen coordinates ($\times 10^4$) and isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **1**.

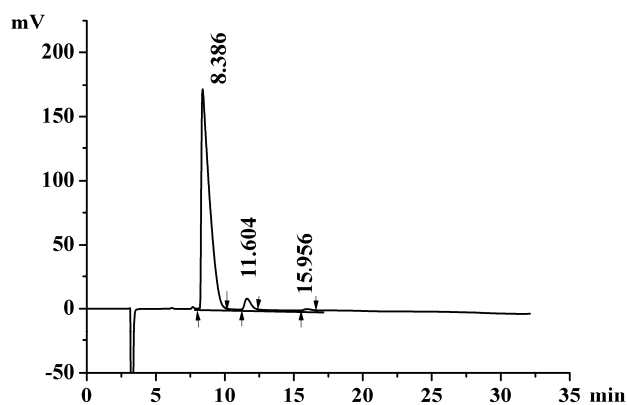
	x	y	z	U(eq)
H(2)	7600	6270	5809	37
H(1)	6429	4500	9714	39
H(4A)	9075	4948	6839	25
H(4B)	11301	5047	7054	25
H(10)	5815	7702	7182	20
H(20)	7617	9293	5224	25
H(16A)	11635	6775	7878	38
H(16B)	11568	7617	7270	38
H(16C)	12855	6662	7137	38
H(13A)	11569	7780	6064	29
H(13B)	10931	7362	5283	29
H(15A)	4649	5125	7990	34
H(15B)	6027	4204	7854	34
H(15C)	5939	5067	7262	34
H(11)	6321	8578	6164	20
H(5A)	10512	5311	8285	26
H(5B)	9511	4320	8016	26
H(8A)	4704	6237	9175	27
H(8B)	6457	6631	9676	27
H(17)	6849	8461	8198	28
H(9)	8543	5481	9267	24
H(14)	11349	6071	6030	24
H(18A)	3573	8222	8509	53
H(18B)	4405	9140	8952	53
H(18C)	4133	8111	9357	53
H(19A)	7653	8198	9729	58
H(19B)	7886	9207	9294	58
H(19C)	9276	8306	9109	58

6. HPLC Charts for compound 12



Pk #	Retention Time	Area	Area %	Height	Height %
1	8.606	4323765	46.012	125152	57.245
2*	11.227	473076	5.034	22592	10.334
3*	11.744	685244	7.292	27958	12.788
4	14.242	3915053	41.662	42922	19.633
Totals		9397138	100.000	218622	100.000

* The diastereoisomer of racemic compound 12



Pk #	Retention Time	Area	Area %	Height	Height %
1	8.386	6952364	95.649	171132	94.738
2*	11.604	278975	3.838	8463	4.685
3	15.956	37266	0.513	1042	0.577
Totals		7268605	100.000	180637	100.000

* The diastereoisomer of chiral 12.

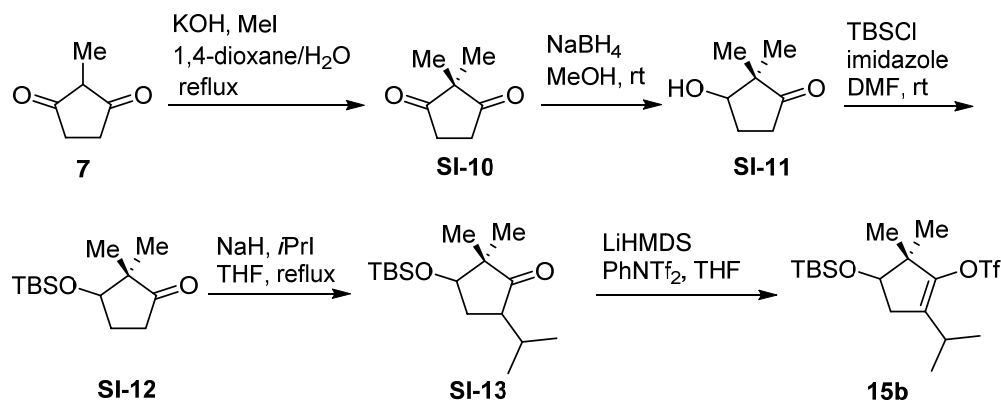
Supplementary Figure 36. HPLC charts of racemic (upper) and chiral (bottom) compound 12

Part II. Cross-coupling of Enol Triflates

7. Experimental Procedures and Characterization Data

7.1 Synthesis of Starting materials

7.1.1 Synthesis of 15b.



Supplementary Figure 37. Synthesis of compound **15b**

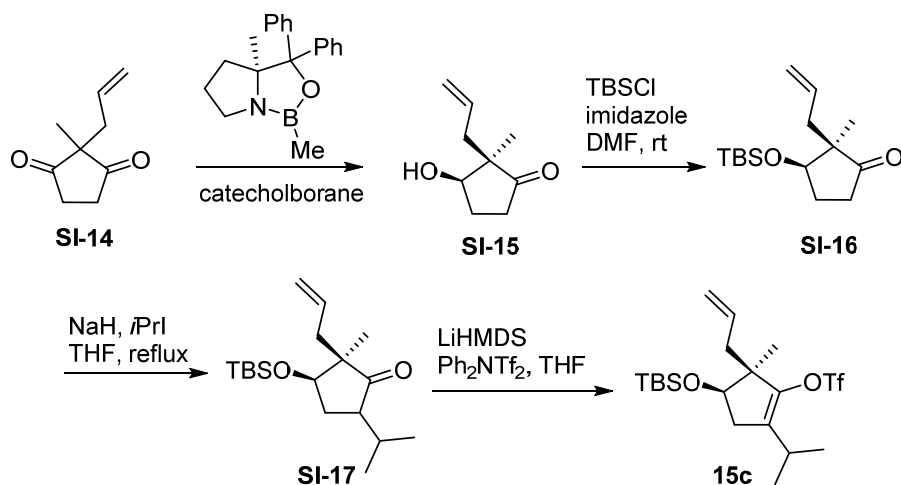
Hydroxyketone **SI-11** was prepared according to the published procedure.^{4,5} The synthesis of **15b** from **SI-11** was as below:

To a solution of compound **SI-11** (2.82 g, 22.0 mmol) in DMF (20 ml) was added imidazole (3.00 g, 44.0 mmol, 2.0 equiv) and TBSCl (6.63 g, 44.0 mmol, 2.0 equiv). The mixture was stirred overnight at room temperature. The reaction mixture was poured into sodium bicarbonate solution (50 mL) and extracted with ethyl acetate (3 × 100 mL). The combined organic layers were washed with brine (5 × 20 mL), dried over Na₂SO₄ and evaporated to dryness. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/EtOAc = 30/1) to afford **SI-12** (4.8 g, 90%) as a colorless oil. *R*_f = 0.3 (petroleum ether/EtOAc = 15/1).

SI-12 (5.09 g, 21.0 mmol) in THF (20 mL) was added dropwise to a suspension of NaH (60% dispersion in mineral oil, 4.2 g, 105 mmol, 5.0 equiv) in THF (140 mL) at 0 °C, then *i*PrI (21.0 mL, 210.0 mmol, 10.0 equiv) was added. The reaction mixture was refluxed overnight. The resulting mixture was quenched at 0 °C by adding H₂O. Then 2 M HCl (60 mL) was added, and the mixture was stirred at room temperature for 1 h. Then brine was added to the reaction mixture, and the organic layer was separated. The aqueous layer was extracted with ethyl acetate (3 × 60 mL). The combined organic layers were washed with brine (50 mL), dried over Na₂SO₄ and concentrated under reduced pressure. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/CH₂Cl₂ = 5/1) to afford **SI-13** (3.48 g, 58%) as a colorless oil. *R*_f = 0.3 (petroleum ether/CH₂Cl₂ = 3/2).

Ketone **SI-13** (1.42 g, 5.0 mmol) was dissolved in dry THF (8 mL) and the mixture was cooled to -78 °C. LiHMDS (1.0 M in THF, 10.0 mL, 10.0 mmol, 2.0 equiv) was added and the clear solution was stirred at -40 °C for 1 h. Then PhNTf₂ (3.57 g, 10.0 mmol, 2.0 equiv) dissolved in dry THF (15 mL) was slowly added at -78 °C and the mixture was allowed to warm to room temperature and stirred for additional 4 h. Then brine (50 mL) was added to the reaction mixture, and the organic layer was separated. The aqueous layer was extracted with ethyl acetate (3 × 50 mL). The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent: petroleum) to afford **15b** (1.64 g, 79%) as a colorless oil. *R*_f = 0.4 (petroleum ether/CH₂Cl₂ = 50/1); ¹H NMR (300 MHz, CDCl₃) δ = 3.91 (t, *J* = 7.2 Hz, 1H), 2.79 (sept, *J* = 6.6 Hz, 1H), 2.44 (dd, *J* = 15.0, 7.2 Hz, 1H), 2.11 (dd, *J* = 15.0, 7.2 Hz, 1H), 1.06 (s, 3H), 1.01 (d, *J* = 6.6 Hz, 3H), 1.00 (s, 3H), 0.99 (d, *J* = 6.6 Hz, 3H), 0.90 (s, 9H), 0.07 (s, 3H), 0.07 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 145.0, 134.1, 118.8 (d, *J* = 321 Hz), 77.5, 46.5, 34.0, 25.9, 25.5, 23.8, 20.4, 20.2, 18.6, 18.2, -4.3, -4.7.

7.1.2 Synthesis of 15c.



Supplementary Figure 38. Synthesis of compound **15b**

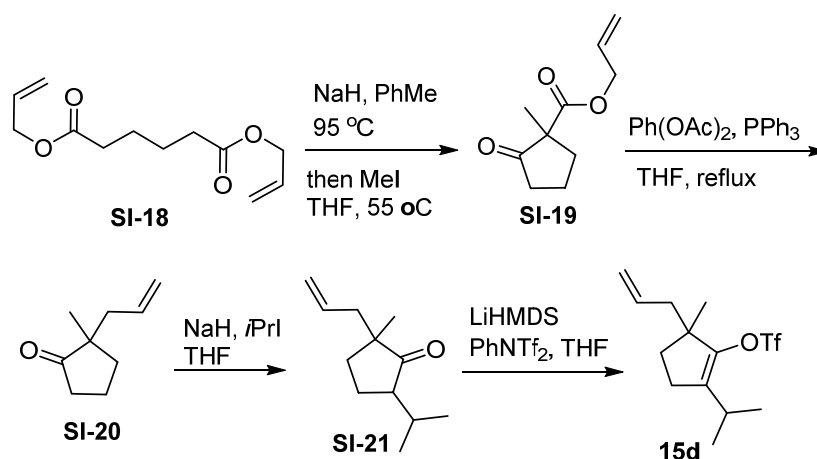
SI-16 was prepared according to the published procedure.⁶ The synthesis of **15c** from **SI-16** was as following:

SI-16 (2.55 g, 9.5 mmol) in THF (30 mL) was added dropwise to a suspension of NaH (60% dispersion in mineral oil, 1.9 g, 47.5 mmol, 5.0 equiv) in THF (50 mL) at 0 °C, then *i*PrI (9.5 mL, 95.0 mmol, 10.0 equiv) was added. The reaction mixture was refluxed overnight. The resulting mixture was quenched at 0 °C by adding H₂O. Then 2 M HCl (35 mL) was added, and the mixture stirred at room temperature for 1 h. Then brine was added to the reaction mixture. The organic layer was separated and the aqueous layer was extracted with ethyl

acetate (3 × 50 mL). The combined organic layers were washed with brine (50 mL), dried over Na₂SO₄ and concentrated under reduced pressure. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/CH₂Cl₂ = 5/1) to afford **SI-17** (1.74 g, 59%) as a colorless oil. *R*_f = 0.3 (petroleum ether/CH₂Cl₂ = 2/1).

Ketone **SI-17** (1.74 g, 5.6 mmol) was dissolved in dry THF (10 mL) and the solution was cooled to -78 °C. LiHMDS (1.0 M in THF, 11.2 mL, 11.2 mmol, 2.0 equiv) was added and the clear solution was stirred at -40 °C for 1 h. Then PhNTf₂ (4.0 g, 2.0 equiv) in dry THF (15 mL) was slowly added at -78 °C and the mixture was allowed to warm to room temperature and stirred for additional 4 h. Then brine (50 mL) was added to the reaction mixture. The organic layer was separated and the aqueous layer was extracted with ethyl acetate (3 × 50 mL). The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent: petroleum ether) to afford **15c** (2.0 g, 81% yield) as a colorless oil. *R*_f = 0.4 (petroleum ether/CH₂Cl₂ = 50/1); ¹H NMR (600 MHz, CDCl₃) δ = 5.91–5.82 (m, 1H), 5.04–4.96 (m, 2H), 4.03 (t, *J* = 7.8 Hz, 1H), 2.83 (sept, *J* = 6.9 Hz, 1H), 2.42 (dd, *J* = 15.0, 7.8 Hz, 1H), 2.28 (dd, *J* = 13.8, 7.2 Hz, 1H), 2.15–2.06 (m, 2H), 1.06 (s, 3H), 1.01 (d, *J* = 6.9 Hz, 3H), 0.97 (d, *J* = 6.9 Hz, 3H), 0.92 (s, 9H), 0.09 (s, 3H), 0.08 (s, 3H).

7.1.3 Synthesis of 15d.



Supplementary Figure 39. Synthesis of compound **15d**

SI-20 was prepared from **SI-18** in 2 steps by a modification of reported procedure.^{7,8}

To a stirred suspension of NaH (60% dispersion in mineral oil, 3.08 g, 77.0 mmol, 2.2 equiv) in dry toluene (50 mL) was added dropwise a solution of diallyl adipate (**SI-18**, 7.76 mL, 35 mmol) in toluene (50 mL) at room temperature. The resulting mixture was heated at 95 °C for 2 h. The solvent was removed under reduced pressure and then THF (50 mL) and

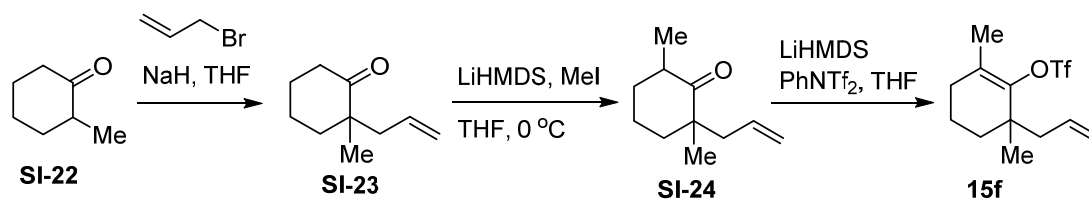
MeI (2.83 mL, 45.5 mmol) was added successively at room temperature. The mixture was heated at 55 °C for 4 h. Then brine (50 mL) was added to the reaction mixture, and the organic layer was separated. The aqueous layer was extracted with ethyl acetate (3 × 30 mL). The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent:petroleum ether/EtOAc = 50/1→20/1) to afford **SI-19**⁹ (4.82 g, 76%) as a colorless oil. *R*_f = 0.3 (petroleum ether/EtOAc = 10/1). ¹H NMR (300 MHz, CDCl₃) δ = 5.98–5.79 (m, 1H), 5.37–5.16 (m, 2H), 4.60 (d, *J* = 5.7 Hz, 2H), 2.61–2.25 (m, 3H), 2.15–21.80 (m, 3H), 1.33 (s, 3H).

SI-20 was prepared from **SI-19** according to the published procedure.⁸ The synthesis of **15d** from **SI-20** was as following:

To a stirred suspension of NaH (60% dispersion in mineral oil, 2.3 g, 57.5 mmol, 5.0 equiv) in THF (30 mL) was added dropwise a solution of **SI-20** (1.59 g, 11.5 mmol) in THF (70 mL) at 0 °C, then *i*PrI (11.5 mL, 115 mmol, 10.0 equiv) was added. The reaction mixture was refluxed overnight. The resulting mixture was quenched at 0 °C by adding H₂O. Then 2 M HCl (40 mL) was added, and the mixture stirred at room temperature for 1 h. Then brine was added to the reaction mixture, and the organic layer was separated. The aqueous layer was extracted with ethyl acetate (3 × 50 mL). The combined organic layers were washed with brine (50 mL), dried over Na₂SO₄, and concentrated under reduced pressure. The resulting crude residue was purified by flash column chromatography (eluent: petroleum ether/CH₂Cl₂ = 5/1) to afford **SI-21** (1.44 g, 70%) as a colorless oil. *R*_f = 0.3 (petroleum ether/CH₂Cl₂ = 2/1).

Ketone **SI-21** (1.44 g, 8.0 mmol) was dissolved in dry THF (10 mL) and the mixture was cooled to -78 °C. LiHMDS (1.0 M in THF, 16.0 mL, 16.0 mmol, 2.0 equiv) was added and the clear solution was stirred at -40 °C for 1 h. Then PhNTf₂ (5.72 g, 16.0 mmol, 2.0 equiv) in dry THF (20 mL) was slowly added at -78 °C and the mixture was allowed to warm to room temperature and stirred for additional 4 h. Then brine (50 mL) was added to the reaction mixture, and the organic layer was separated. The aqueous layer was extracted with ethyl acetate (3 × 50 mL). The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent: petroleum ether) to afford **15d**¹⁰ (2.01 g, 80%) as a colorless oil. *R*_f = 0.4 (petroleum ether); ¹H NMR (600 MHz, CDCl₃) δ = 5.78–5.71 (m, 1H), 5.10–5.04 (m, 2H), 2.83 (sept. *J* = 6.6 Hz, 1H), 2.28–2.17 (m, 3H), 2.10 (ddt, *J* = 13.8, 8.4, 0.9 Hz, 1H), 1.95 (ddd, *J* = 12.6, 8.4, 4.8 Hz, 1H), 1.66 (ddd, *J* = 12.6, 9.0, 6.0 Hz, 1H), 1.14 (s, 3H), 1.03 (d, *J* = 6.6 Hz, 3H), 1.01 (d, *J* = 6.6 Hz, 3H).

7.1.4 Synthesis of 15e.



Supplementary Figure 40. Synthesis of compound **15f**

To a stirred suspension of NaH (60% dispersion in mineral oil, 0.2 g, 5 mmol, 1.0 equiv) in THF (5 mL) was added dropwise a solution of **SI-22** (0.61 mL, 5 mmol) in THF (5 mL) at 0 °C. The reaction mixture was refluxed 1 h. Allyl bromide (0.43 mL, 5 mmol, 1.0 equiv) was added at 0 °C, and the reaction mixture was refluxed 2 h. Then brine (30 mL) was added to the reaction mixture. The organic layer was separated and the aqueous layer was extracted with ethyl acetate (3 × 25 mL). The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent: petroleum ether/EtOAc = 40/1) to afford **SI-23**¹¹ (0.23 g, 30% yield) as a colorless oil. *R*_f = 0.3 (petroleum ether/EtOAc = 15/1); ¹H NMR (300 MHz, CDCl₃) δ = 5.80–5.59 (m, 1H), 5.11–4.96 (m, 2H), 2.45–2.30 (m, 3H), 2.24 (dd, *J* = 13.8, 7.2 Hz, 1H), 1.93–1.50 (m, 6H), 1.07 (s, 3H).

Ketone **SI-23** (0.30 g, 2.0 mmol) was dissolved in dry THF (2 mL) and the mixture was cooled to 0 °C. LiHMDS (1.0 M in THF, 2.4 mL, 2.4 mmol, 1.2 equiv) was added and the reaction mixture was stirred at this temperature for 1 h. Then MeI (0.31 mL, 5.0 mmol, 2.5 equiv) was added slowly and the mixture was allowed to warm to room temperature and stirred for additional 5 h. Then brine (10 mL) was added to the reaction mixture. The organic layer was separated and the aqueous layer was extracted with ethyl acetate (3 × 15 mL). The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent: petroleum ether/Et₂O = 50/1) to afford **SI-24** as a colorless oil. *R*_f = 0.4 (petroleum ether/Et₂O = 10/1).

Ketone **SI-24** was dissolved in dry THF (4 mL) and the mixture was cooled to -78 °C. LiHMDS (1.0 M in THF, 4.0 mL, 4.0 mmol) was added and the reaction mixture was stirred at -78 °C for 1 h. Then PhNTf₂ (0.86 g, 2.4 mmol) in dry THF (4 mL) was slowly added and the mixture was allowed to warm to room temperature and stirred for additional 3 h. Then brine (20 mL) was added to the reaction mixture. The organic layer was separated and the aqueous layer was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried over Na₂SO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (eluent: petroleum ether) to afford **15e** (0.31 g, 52% over 2 steps) as a colorless oil. *R*_f = 0.2 (petroleum ether); ¹H NMR (300 MHz, CDCl₃) δ = 5.77–5.61 (m, 1H), 5.11–5.00 (m, 2H), 2.33

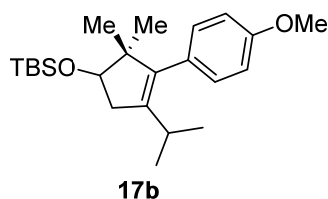
(ddt, $J = 14.1, 6.9, 1.2$ Hz, 1H), 2.18–2.08 (m, 3H), 1.79–1.58 (m, 6H), 1.49–1.40 (m, 1H), 1.16 (s, 3H).

7.1.5 Synthesis of 15f.

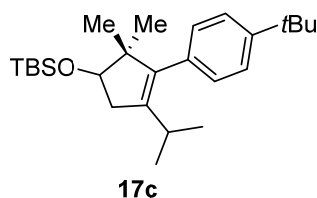
15f was prepared according to the reported procedure.¹²

7.2 General Procedure for Cross-coupling Reaction and Characterization Data

To a solution of vinyl triflate **15** (0.2 mmol) in the mixed solvent of DMF (1.0 mL) and EtOH (1.0 mL) was added arylboronic acid **16** (0.4 mmol, 2.0 equiv), palladacycle **18** (5.6 mg, 5 mmol%), and K_3PO_4 (127 mg, 0.6 mmol, 3.0 equiv) at room temperature under nitrogen. The resulting mixture was stirred at the same temperature until the vinyl triflate had disappeared as monitored by TLC. The reaction mixture was then poured into water and extracted with ethyl acetate (3×25 mL). The organic layer was combined, washed with brine, dried over Na_2SO_4 , and concentrated under vacuum. The residue was purified by silica gel column chromatography to afford the desired cross-coupling product.

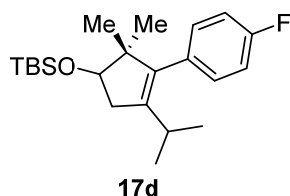


17b: $R_f = 0.5$ (petroleum ether/ $CH_2Cl_2 = 5/2$); Purified by column chromatography on silica gel with petroleum ether/ CH_2Cl_2 (15/1) as eluent in 87% yield as oil. 1H NMR (300 MHz, $CDCl_3$) δ 6.97 (d, $J = 8.7$ Hz, 2H), 6.85 (d, $J = 8.7$ Hz, 2H), 3.94 (t, $J = 7.2$ Hz, 1H), 3.81 (s, 3H), 2.43 (dd, $J = 15.0, 7.2$ Hz, 1H), 2.36 (sept, $J = 6.9$ Hz, 1H), 2.18 (dd, $J = 15.0, 7.8$ Hz, 1H), 0.93 (s, 3H), 0.92 (s, 9H), 0.91 (d, $J = 6.9$ Hz, 3H), 0.88 (d, $J = 6.9$ Hz, 3H), 0.86 (s, 3H), 0.09 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.3, 141.9, 140.4, 130.5, 113.3, 109.7, 80.5, 55.3, 50.0, 36.4, 27.5, 26.0, 25.8, 21.5, 21.4, 19.9, 18.3, -4.2, -4.7; HRMS (EI) m/z calcd for $C_{23}H_{38}O_2Si$ [M]: 374.2641, found 374.2639.

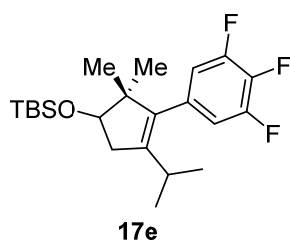


17c: $R_f = 0.4$ (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 92% as oil; 1H NMR (300 MHz, $CDCl_3$) δ 7.30 (d, $J = 7.8$ Hz, 2H), 6.97 (d, $J = 7.8$ Hz, 2H), 3.94 (t, $J = 7.5$ Hz, 1H), 2.43 (dd, $J = 15.0, 7.5$ Hz, 1H), 2.40

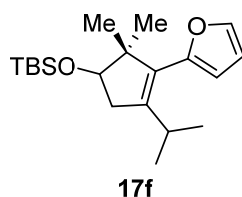
(sept, $J = 6.9$ Hz, 1H), 2.18 (dd, $J = 15.0, 7.8$ Hz, 1H), 1.33 (s, 9H), 0.95 (s, 3H), 0.92 (d, $J = 6.9$ Hz, 3H), 0.92 (s, 9H), 0.88 (d, $J = 6.9$ Hz, 3H), 0.86 (s, 3H), 0.09 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 149.0, 142.3, 140.2, 135.1, 129.1, 124.7, 80.6, 50.0, 36.4, 34.6, 31.6, 27.5, 26.1, 25.8, 21.6, 21.4, 20.0, 18.3, -4.2, -4.7; HRMS (EI) m/z calcd for $\text{C}_{26}\text{H}_{44}\text{OSi}$ [M]: 400.3161, found 400.3157.



17d: $R_f = 0.4$ (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 94% as oil; ^1H NMR (300 MHz, CDCl_3) δ = 7.04–6.95 (m, 4H), 3.95 (t, $J = 7.5$ Hz, 1H), 2.45 (dd, $J = 15.0, 7.2$ Hz, 1H), 2.31 (sept, $J = 6.9$ Hz, 1H), 2.18 (dd, $J = 15.3, 7.5$ Hz, 1H), 0.93 (s, 3H), 0.92 (s, 9H), 0.91 (d, $J = 6.9$ Hz, 3H), 0.88 (d, $J = 6.9$ Hz, 3H), 0.85 (s, 3H), 0.09 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 163.1, 160.7, 141.3, 141.1, 134.1, 131.0, 130.9, 114.9, 114.7, 80.4, 50.0, 36.5, 27.5, 26.0, 25.7, 21.5, 21.3, 19.9, 18.3, -4.2, -4.7; HRMS (EI) m/z calcd for $\text{C}_{22}\text{H}_{35}\text{OFSi}$ [M]: 362.2441, found 362.2438.

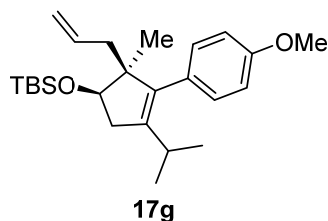


17e: $R_f = 0.5$ (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 75% as oil; ^1H NMR (300 MHz, CDCl_3) δ 6.72–6.58 (m, 2H), 3.92 (t, $J = 7.2$ Hz, 1H), 2.45 (dd, $J = 15.3, 7.2$ Hz, 1H), 2.31 (sept, $J = 6.9$ Hz, 1H), 2.17 (dd, $J = 15.3, 7.2$ Hz, 1H), 0.93 (d, $J = 6.9$ Hz, 3H), 0.93 (s, 3H), 0.92 (s, 9H), 0.89 (d, $J = 6.9$ Hz, 3H), 0.86 (s, 3H), 0.08 (s, 3H), 0.07 (s, 3H); HRMS (EI) m/z calcd for $\text{C}_{22}\text{H}_{33}\text{OF}_3\text{Si}$ [M]: 398.2253, found 398.2259.

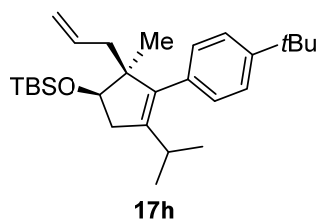


17f: $R_f = 0.4$ (petroleum ether); Purified by column chromatography on silica gel with

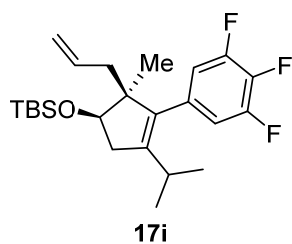
petroleum ether as eluent in 82% as oil; ^1H NMR (300 MHz, CDCl_3) δ 7.38 (d, $J = 1.8$ Hz, 1H), 6.40–6.35 (m, 1H), 6.17 (d, $J = 3.3$ Hz, 1H), 3.87 (t, $J = 7.5$ Hz, 1H), 2.93 (sept, $J = 6.9$ Hz, 1H), 2.47 (dd, $J = 15.9, 7.2$ Hz, 1H), 2.21 (dd, $J = 15.9, 7.8$ Hz, 1H), 1.08 (s, 3H), 1.05 (s, 3H), 1.04 (d, $J = 6.9$ Hz, 3H), 0.96 (d, $J = 6.9$ Hz, 3H), 0.91 (s, 9H), 0.07 (s, 3H), 0.07 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 151.8, 144.0, 141.0, 131.8, 110.4, 107.8, 80.2, 49.5, 37.2, 28.0, 26.1, 25.6, 21.4, 21.1, 20.1, 18.3, -4.2, -4.7; HRMS (EI) m/z calcd for $\text{C}_{20}\text{H}_{34}\text{O}_2\text{Si}$ [M]: 334.2328, found 334.2322.



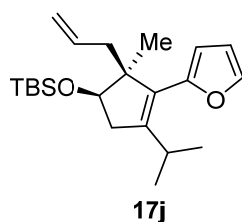
17g: $R_f = 0.4$ (petroleum ether/ $\text{CH}_2\text{Cl}_2 = 10/3$); Purified by column chromatography on silica gel with petroleum ether/ CH_2Cl_2 (15/1) as eluent in 75% as oil; ^1H NMR (300 MHz, CDCl_3) δ 7.01 (d, $J = 8.7$ Hz, 2H), 6.86 (d, $J = 8.7$ Hz, 2H), 6.08–5.90 (m, 1H), 5.05–4.86 (m, 2H), 4.05 (t, $J = 7.8$ Hz, 1H), 3.81 (s, 3H), 2.48–2.34 (m, 2H), 2.32–2.16 (m, 2H), 2.05 (dd, $J = 13.8, 7.5$ Hz, 1H), 0.93 (s, 9H), 0.89 (d, $J = 6.9$ Hz, 3H), 0.89 (d, $J = 6.9$ Hz, 3H), 0.89 (s, 3H), 0.09 (s, 3H), 0.09 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 158.3, 142.3, 139.2, 137.6, 130.7, 130.4, 115.7, 113.3, 80.8, 55.3, 53.6, 40.3, 37.6, 27.6, 26.0, 25.8, 21.7, 21.4, 18.2, -4.2, -4.7; HRMS (EI) m/z calcd for $\text{C}_{25}\text{H}_{40}\text{O}_2\text{Si}$ [M]: 400.2798, found 400.2794.



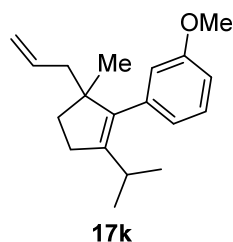
17h: $R_f = 0.6$ (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 85% as oil; ^1H NMR (300 MHz, CDCl_3) δ 7.30 (d, $J = 8.4$ Hz, 2H), 7.01 (d, $J = 8.4$ Hz, 2H), 6.10–5.92 (m, 1H), 5.07–4.86 (m, 2H), 4.06 (t, $J = 7.8$ Hz, 1H), 2.50–2.35 (m, 2H), 2.35–2.16 (m, 2H), 2.08 (dd, $J = 14.1, 7.5$ Hz, 1H), 1.33 (s, 9H), 0.94 (s, 9H), 0.90 (d, $J = 6.9$ Hz, 3H), 0.89 (d, $J = 6.9$ Hz, 3H), 0.89 (s, 3H), 0.10 (s, 3H), 0.09 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 149.0, 142.2, 139.5, 137.6, 135.0, 129.2, 124.7, 115.6, 80.9, 53.7, 40.3, 37.7, 34.6, 31.6, 27.6, 26.1, 25.9, 21.8, 21.5, 18.3, -4.1, -4.7; HRMS (EI) m/z calcd for $\text{C}_{28}\text{H}_{46}\text{OSi}$ [M]: 426.3318, found 426.3314.



17i: R_f = 0.7 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 81% as oil; ^1H NMR (300 MHz, CDCl_3) δ 6.77–6.62 (m, 2H), 6.02–5.84 (m, 1H), 5.05–4.90 (m, 2H), 4.04 (t, J = 7.5 Hz, 1H), 2.45 (dd, J = 15.9, 7.8 Hz, 1H), 2.40–2.16 (m, 3H), 2.00 (dd, J = 14.1, 7.8 Hz, 1H), 0.93 (s, 9H), 0.91 (d, J = 6.9 Hz, 3H), 0.91 (d, J = 6.9 Hz, 3H), 0.89 (s, 3H), 0.09 (s, 3H), 0.09 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 150.9 (dd, J = 250.6, 5.4 Hz), 144.5, 138.7 (dt, J = 250.8, 15.6 Hz), 137.1, 137.0, 134.4–138.8 (m), 116.3, 80.4, 53.8, 40.3, 37.8, 27.8, 26.0, 25.7, 21.6, 21.3, 18.2, -4.2, -4.8; HRMS (EI) m/z calcd for $\text{C}_{24}\text{H}_{35}\text{OF}_2\text{Si}$ [M]: 424.2409, found 424.2406.

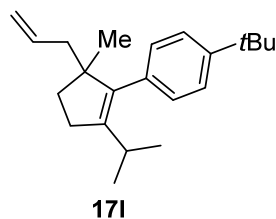


17j: R_f = 0.5 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 85% yield as oil; ^1H NMR (600 MHz, CDCl_3) δ 7.38 (d, J = 1.2 Hz, 1H), 6.82–6.36 (m, 1H), 6.17 (d, J = 3.0 Hz, 1H), 5.95–5.86 (m, 1H), 4.97–4.91 (m, 1H), 4.87–4.83 (m, 1H), 3.99 (t, J = 7.8 Hz, 1H), 2.95 (sept, J = 6.6 Hz, 1H), 2.46 (dd, J = 16.2, 7.8 Hz, 1H), 2.39 (dd, J = 13.2, 7.2 Hz, 1H), 2.27 (dd, J = 13.2, 7.2 Hz, 1H), 2.22 (dd, J = 15.6, 7.8 Hz, 1H), 1.06 (s, 3H), 1.02 (d, J = 6.6 Hz, 3H), 0.95 (d, J = 6.6 Hz, 3H), 0.94 (s, 9H), 0.09 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 151.7, 145.8, 141.0, 137.1, 129.2, 115.9, 110.4, 108.1, 80.4, 53.1, 40.2, 38.3, 28.1, 26.0, 25.6, 21.5, 21.3, 18.2, -4.2, -4.7. HRMS (EI) m/z calcd for $\text{C}_{22}\text{H}_{36}\text{O}_2\text{Si}$ [M]: 360.2485, found 360.2480.

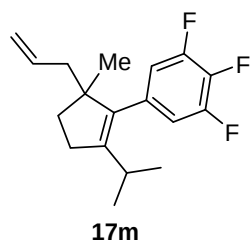


17k: R_f = 0.4 (petroleum ether/ CH_2Cl_2 = 4/1); Purified by column chromatography on silica

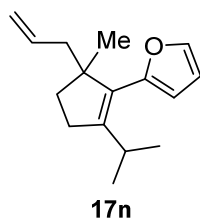
gel with petroleum ether/CH₂Cl₂ (15/1) as eluent in 80% as oil; ¹H NMR (300 MHz, CDCl₃) δ 7.26–7.16 (m, 1H), 6.85–6.75 (m, 1H), 6.70–6.55 (m, 2H), 5.90–5.70 (m, 1H), 5.06–4.93 (m, 2H), 3.81 (s, 3H), 2.44–2.22 (m, 3H), 2.17–2.04 (m, 1H), 2.03–1.85 (m, 2H), 1.69–1.55 (m, 1H), 1.01 (s, 3H), 0.93 (d, *J* = 7.2 Hz, 3H), 0.93 (d, *J* = 7.2 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 159.2, 145.1, 142.0, 140.0, 136.5, 128.7, 122.4, 116.6, 115.8, 111.5, 55.3, 51.3, 44.8, 36.0, 28.2, 27.9, 26.4, 21.8, 21.5; HRMS (EI) *m/z* calcd for C₁₉H₂₆O [M]: 270.1984, found 270.1987.



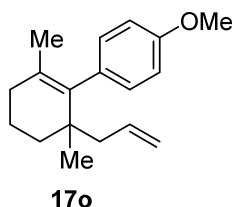
17l: *R_f* = 0.7 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 83% as oil; ¹H NMR (300 MHz, CDCl₃) δ 7.30 (d, *J* = 8.4 Hz, 2H), 6.97 (d, *J* = 8.4 Hz, 2H), 5.90–5.72 (m, 1H), 5.06–4.93 (m, 2H), 2.45–2.23 (m, 3H), 2.15–2.04 (m, 1H), 2.02–1.84 (m, 2H), 1.68–1.52 (m, 1H), 1.33 (s, 9H), 1.00 (s, 3H), 0.93 (d, *J* = 6.9 Hz, 3H), 0.90 (d, *J* = 6.9 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 148.9, 144.8, 142.1, 136.7, 135.3, 129.3, 124.7, 116.4, 51.3, 44.8, 35.9, 34.6, 31.6, 28.1, 27.8, 26.3, 21.8, 21.6; HRMS (EI) *m/z* calcd for C₂₂H₃₂ [M]: 296.2504, found 296.2510.



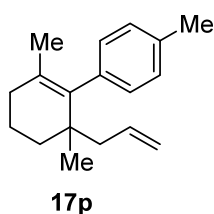
17m: *R_f* = 0.7 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 71% as oil; ¹H NMR (300 MHz, CDCl₃) δ 6.73–6.60 (m, 2H), 5.84–5.65 (m, 1H), 5.08–4.95 (m, 2H), 2.38–2.24 (m, 3H), 2.10–1.85 (m, 3H), 1.73–1.56 (m, 1H), 1.00 (s, 3H), 0.94 (d, *J* = 6.9 Hz, 3H), 0.90 (d, *J* = 6.9 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 150.9 (ddd, *J* = 250.1, 8.8, 4.2 Hz), 147.3, 138.7 (dt, *J* = 251.5, 15.6 Hz), 138.0, 135.6, 134.8–134.2 (m), 117.2, 113.8 (dd, *J* = 15.4, 5.6 Hz), 51.3, 44.7, 35.8, 28.3, 27.9, 26.3, 21.6, 21.4; HRMS (EI) *m/z* calcd for C₁₈H₂₁F₃ [M]: 294.1595, found 294.1597.



7n: R_f = 0.6 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 83% as oil; ^1H NMR (300 MHz, CDCl_3) δ = 7.39 (d, J = 1.8 Hz, 1H), 6.42–6.34 (m, 1H), 6.17 (d, J = 3.3 Hz, 1H), 5.82–5.64 (m, 1H), 5.03–4.90 (m, 2H), 2.94 (sept, J = 6.9 Hz, 1H), 2.38–2.27 (m, 3H), 2.22–2.11 (m, 1H), 1.95–1.82 (m, 1H), 1.62–1.49 (m, 1H), 1.16 (s, 3H), 1.02 (d, J = 6.9 Hz, 3H), 1.01 (d, J = 6.9 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 151.9, 149.1, 140.9, 136.5, 131.4, 116.5, 110.4, 107.8, 50.8, 44.8, 36.0, 29.0, 28.2, 26.4, 21.6, 21.3; HRMS (EI) m/z calcd for $\text{C}_{16}\text{H}_{22}\text{O}$ [M]: 230.1671, found 230.1667.

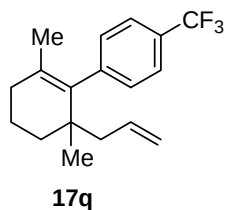


17o: R_f = 0.3 (petroleum ether/ CH_2Cl_2 = 10/3); Purified by column chromatography on silica gel with petroleum ether/ CH_2Cl_2 (15/1) as eluent in 75% as oil; ^1H NMR (400 MHz, CDCl_3) δ 6.92 (d, J = 8.4 Hz, 2H), 6.84 (d, J = 8.4 Hz, 2H), 5.83–5.69 (m, 1H), 5.02–4.89 (m, 2H), 3.81 (s, 3H), 2.17–1.90 (m, 4H), 1.75–1.62 (m, 3H), 1.47–1.37 (m, 1H), 1.30 (s, 3H), 0.92 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 157.8, 140.2, 136.1, 133.8, 131.4, 130.7, 116.7, 113.0, 55.3, 44.8, 37.5, 35.4, 32.2, 26.5, 21.7, 19.2; HRMS (EI) m/z calcd for $\text{C}_{18}\text{H}_{24}\text{O}$ [M]: 256.1827, found 256.1822.

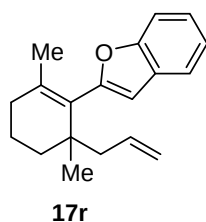


17p: R_f = 0.7 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 83% as oil; ^1H NMR (300 MHz, CDCl_3) δ 0.98 (d, J = 7.8 Hz, 2H), 0.89 (d, J = 7.8 Hz, 2H), 5.84–5.67 (m, 1H), 5.03–4.88 (m, 2H), 2.34 (s, 3H), 2.15–1.89 (m, 4H), 1.75–1.61 (m, 3H), 1.48–1.37 (m, 1H), 1.29 (s, 3H), 0.93 (s, 3H); ^{13}C NMR (151

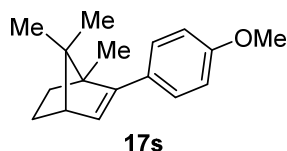
MHz, CDCl₃) δ 140.5, 138.5, 136.2, 135.3, 130.4, 130.2, 128.4, 116.7, 44.8, 37.3, 35.4, 32.2, 26.5, 21.7, 21.3, 19.2; HRMS (EI) m/z calcd for C₁₈H₂₄ [M]: 240.1878, found 240.1880.



17q: R_f = 0.7 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 70% as oil; ¹H NMR (300 MHz, CDCl₃) δ 7.55 (d, J = 7.8 Hz, 2H), 7.14 (d, J = 7.8 Hz, 2H), 5.83–5.66 (m, 1H), 5.05–4.89 (m, 2H), 2.19–1.84 (m, 4H), 1.78–1.62 (m, 3H), 1.50–1.40 (m, 1H), 1.27 (s, 3H), 0.93 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 145.6, 139.7, 135.5, 131.2, 130.8, 128.3 (q, J = 32.5 Hz), 124.6 (q, J = 272.1 Hz), 124.6, 117.2, 44.7, 37.3, 35.2, 32.1, 26.4, 21.6, 19.0; HRMS (EI) m/z calcd for C₁₈H₂₁F₃ [M]: 294.1595, found 294.1598.

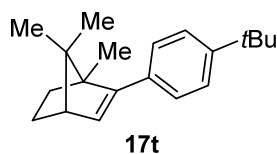


17r: R_f = 0.4 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 81% as oil; ¹H NMR (300 MHz, CDCl₃) δ 7.58–7.50 (m, 1H), 7.50–7.41 (m, 1H), 7.26–7.16 (m, 2H), 6.43 (d, J = 0.9 Hz, 1H), 5.88–5.70 (m, 1H), 5.05–4.89 (m, 2H), 2.29–1.97 (m, 4H), 1.78–1.65 (m, 3H), 1.59 (s, 3H), 1.49–1.36 (m, 1H), 1.07 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 156.3, 154.4, 139.3, 135.8, 131.0, 128.9, 123.4, 122.5, 120.5, 117.0, 111.2, 105.7, 45.1, 37.5, 34.8, 32.3, 26.6, 22.1, 18.8; HRMS (EI) m/z calcd for C₁₉H₂₂O [M]: 266.1671, found 266.1667.

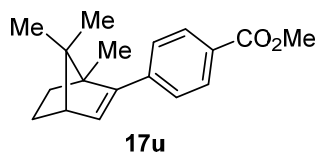


17s: R_f = 0.3 (petroleum ether/CH₂Cl₂ = 10/3); Purified by column chromatography on silica gel with petroleum ether/CH₂Cl₂ (15/1) as eluent in 80% as oil; ¹H NMR (300 MHz, CDCl₃) δ = 7.19 (d, J = 8.4 Hz, 2H), 6.85 (d, J = 8.4 Hz, 2H), 5.91 (d, J = 3.3 Hz, 1H), 3.80 (s, 3H),

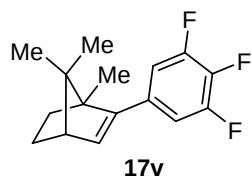
2.41–2.31 (m, 1H), 2.00–1.85 (m, 1H), 1.71–1.58 (m, 1H), 1.35–1.20 (m, 1H), 1.15–1.00 (m, 1H), 1.09 (s, 3H), 0.88 (s, 3H), 0.82 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 158.5, 149.4, 131.3, 130.7, 127.9, 113.7, 57.2, 55.4, 55.0, 51.7, 32.1, 25.9, 20.0, 19.8, 12.9; HRMS (EI) m/z calcd for $\text{C}_{17}\text{H}_{22}\text{O}$ [M]: 242.1671, found 242.1670.



17t: R_f = 0.6 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 80% as oil; ^1H NMR (300 MHz, CDCl_3) δ 7.33 (d, J = 7.8 Hz, 2H), 7.22 (d, J = 7.8 Hz, 2H), 5.98 (d, J = 3.3 Hz, 1H), 2.41–2.33 (m, 1H), 2.01–1.84 (m, 1H), 1.73–1.58 (m, 1H), 1.35–1.22 (m, 1H), 1.32 (s, 9H), 1.13 (s, 3H), 1.15–1.01 (m, 1H), 0.88 (s, 3H), 0.82 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 149.6, 149.4, 135.8, 131.5, 126.4, 125.1, 57.2, 55.0, 51.8, 34.6, 32.1, 31.5, 25.9, 19.9, 19.8, 12.9; HRMS (EI) m/z calcd for $\text{C}_{20}\text{H}_{28}$ [M]: 268.2191, found 268.2195.

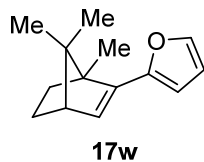


17u: R_f = 0.4 (petroleum ether/ CH_2Cl_2 = 1/1); Purified by column chromatography on silica gel with petroleum ether/ CH_2Cl_2 (4/1) as eluent in 79% as oil; ^1H NMR (300 MHz, CDCl_3) δ = 7.96 (d, J = 8.1 Hz, 2H), 7.32 (d, J = 8.1 Hz, 2H), 6.11 (d, J = 3.3 Hz, 1H), 3.91 (s, 3H), 2.47–2.37 (m, 1H), 2.04–1.89 (m, 1H), 1.77–1.63 (m, 1H), 1.36–1.22 (m, 1H), 1.15–1.05 (m, 1H), 1.12 (s, 3H), 0.88 (s, 3H), 0.83 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 167.2, 149.3, 143.6, 134.0, 129.6, 128.0, 126.5, 57.3, 55.1, 52.1, 51.9, 32.0, 25.7, 19.8, 19.7, 12.7; HRMS (EI) m/z calcd for $\text{C}_{18}\text{H}_{22}\text{O}_2$ [M]: 270.1620, found 270.1623.



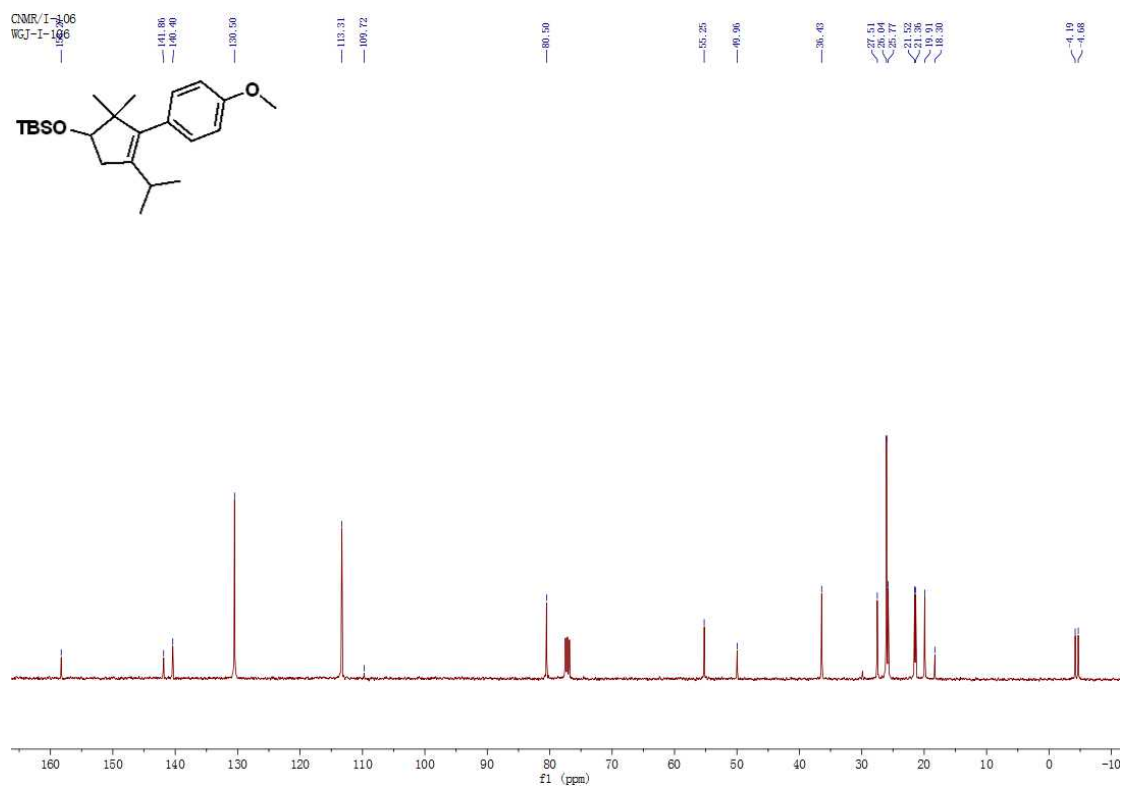
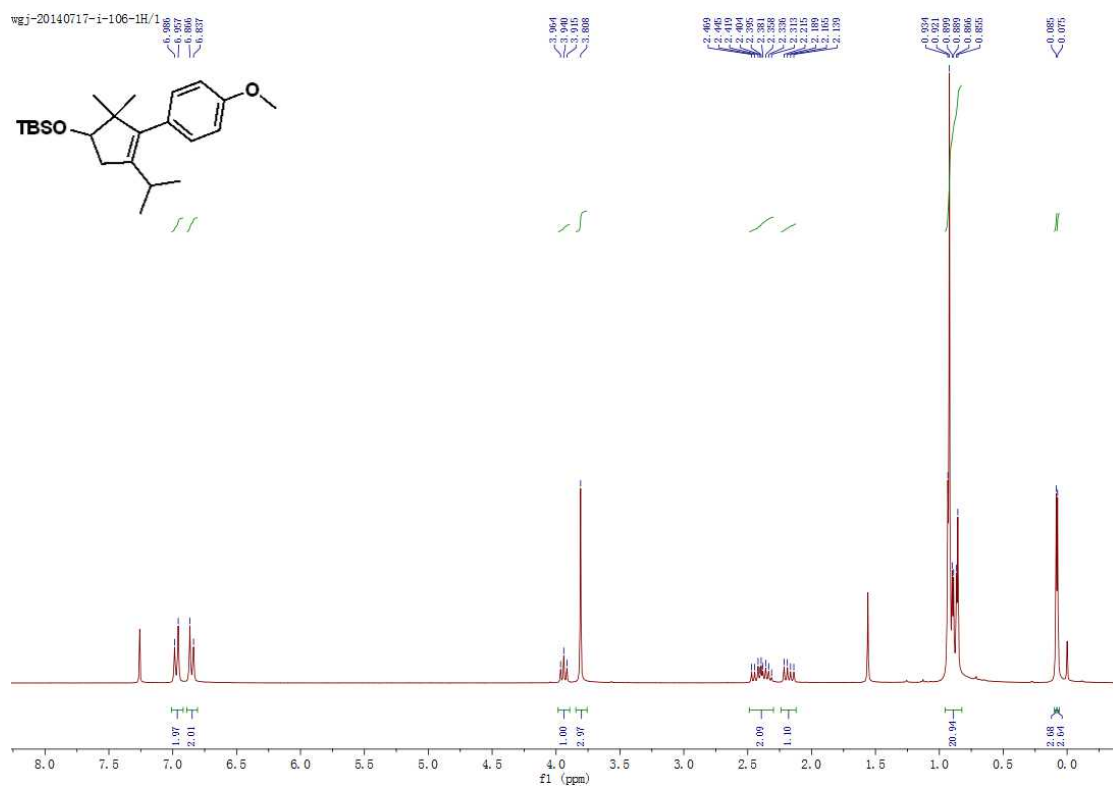
17v: R_f = 0.8 (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 75% as oil; ^1H NMR (300 MHz, CDCl_3) δ 6.93–6.73 (m, 2H), 6.09–5.94 (m, 1H), 2.46–2.32 (m, 1H), 2.04–1.83 (m, 1H), 1.77–1.59 (m, 1H), 1.30–1.15 (m, 1H), 1.14–1.00 (m, 1H), 1.09 (s, 3H), 0.85 (s, 3H), 0.80 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3)

δ 151.1 (ddd, $J = 248.6, 10.1, 4.4$ Hz), 147.5, 138.6 (dt, $J = 250.2, 15.6$ Hz), 134.8–134.6 (m), 134.0, 110.5 (dd, $J = 16.3, 4.5$ Hz), 57.5, 55.2, 51.8, 32.0, 25.7, 19.8, 19.6, 12.6; HRMS (EI) m/z calcd for $C_{16}H_{17}F_3$ [M]: 266.1282, found 266.1280.

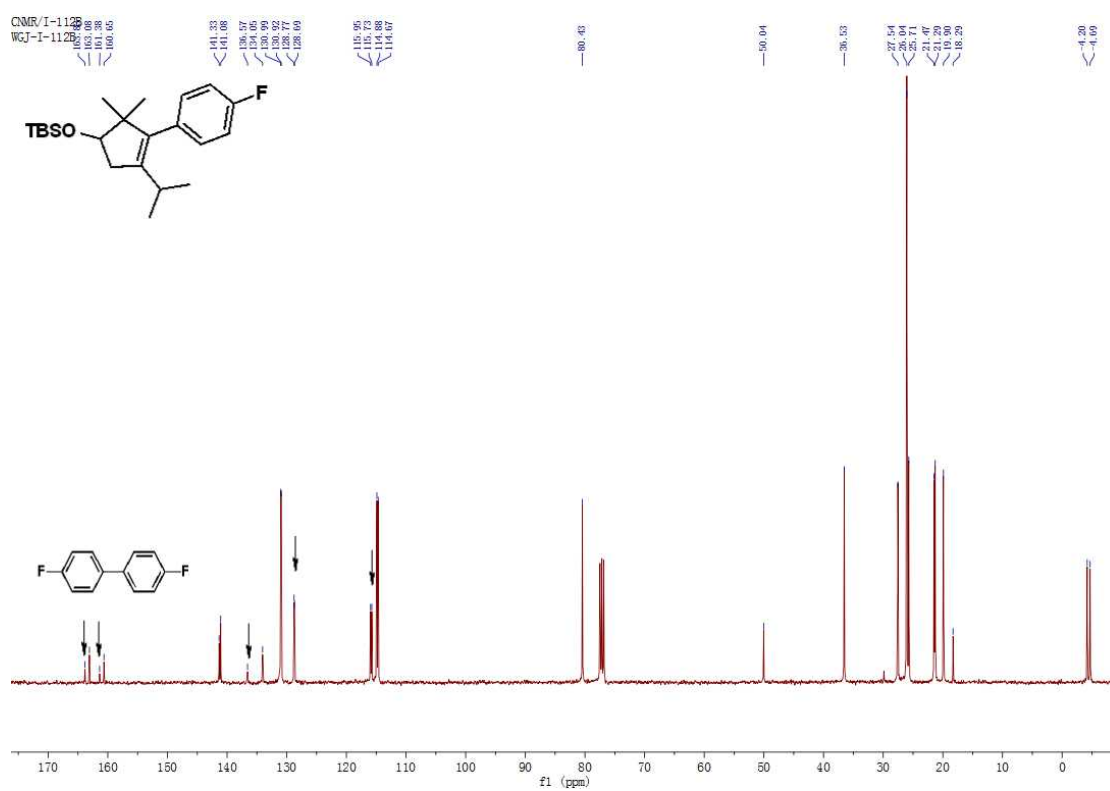
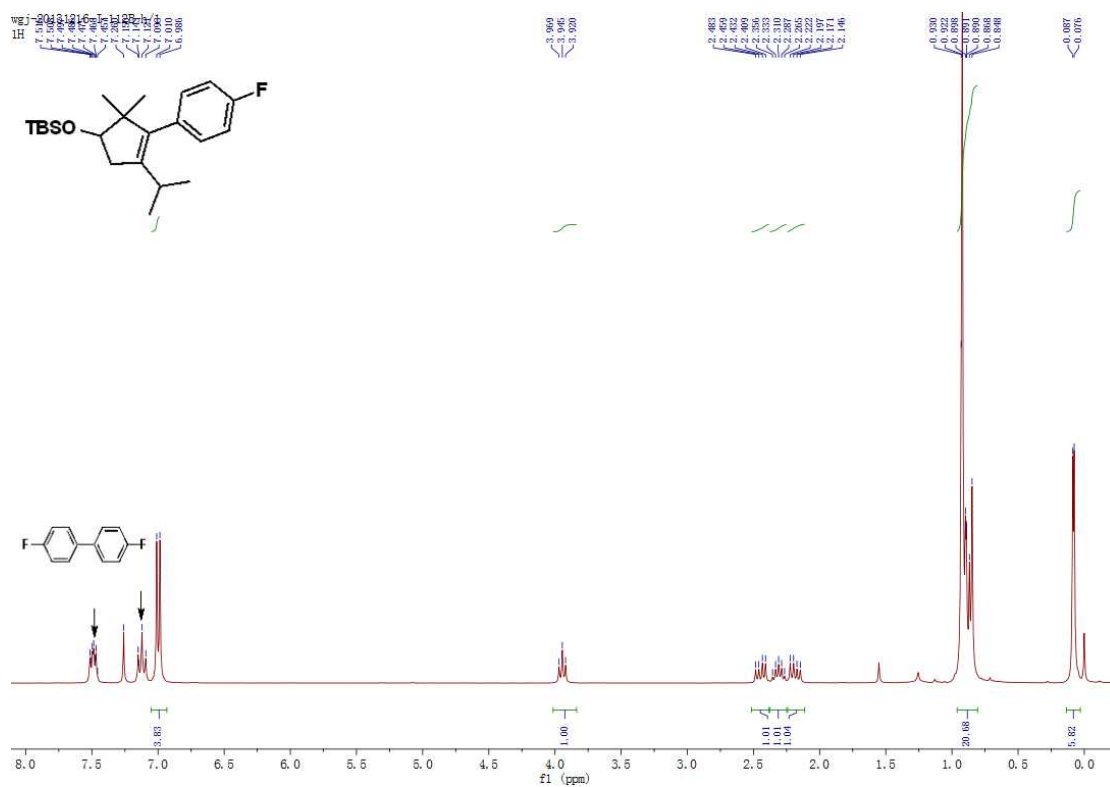


17w: $R_f = 0.7$ (petroleum ether); Purified by column chromatography on silica gel with petroleum ether as eluent in 55% as oil; 1H NMR (300 MHz, $CDCl_3$) δ = 7.34 (d, $J = 1.8$ Hz, 1H), 6.39–6.20 (m, 3H), 2.45–2.34 (m, 1H), 1.99–1.85 (m, 1H), 1.66–1.54 (m, 1H), 1.25 (s, 3H), 1.18–1.00 (m, 2H), 0.85 (s, 3H), 0.82 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$) δ 151.9, 141.2, 139.1, 130.3, 111.0, 105.3, 57.1, 54.3, 51.7, 32.0, 25.7, 19.8, 19.7, 13.2.

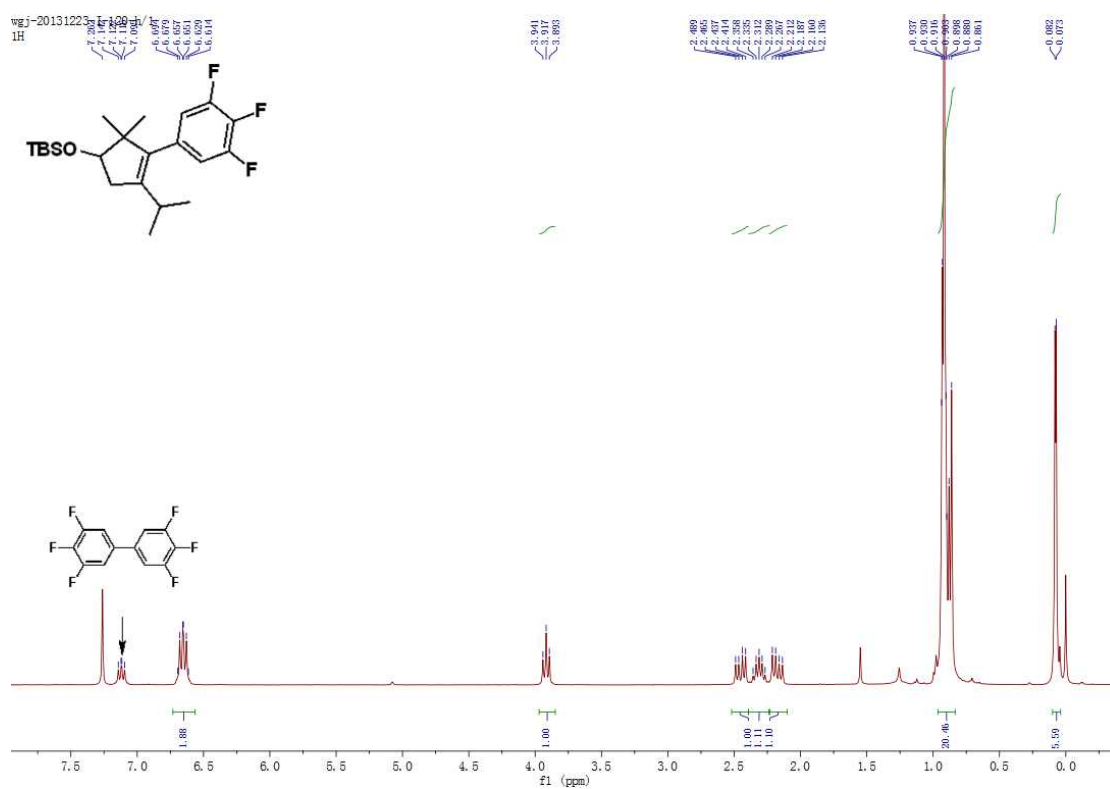
8. Copies of NMR Spectra of Coupling Products



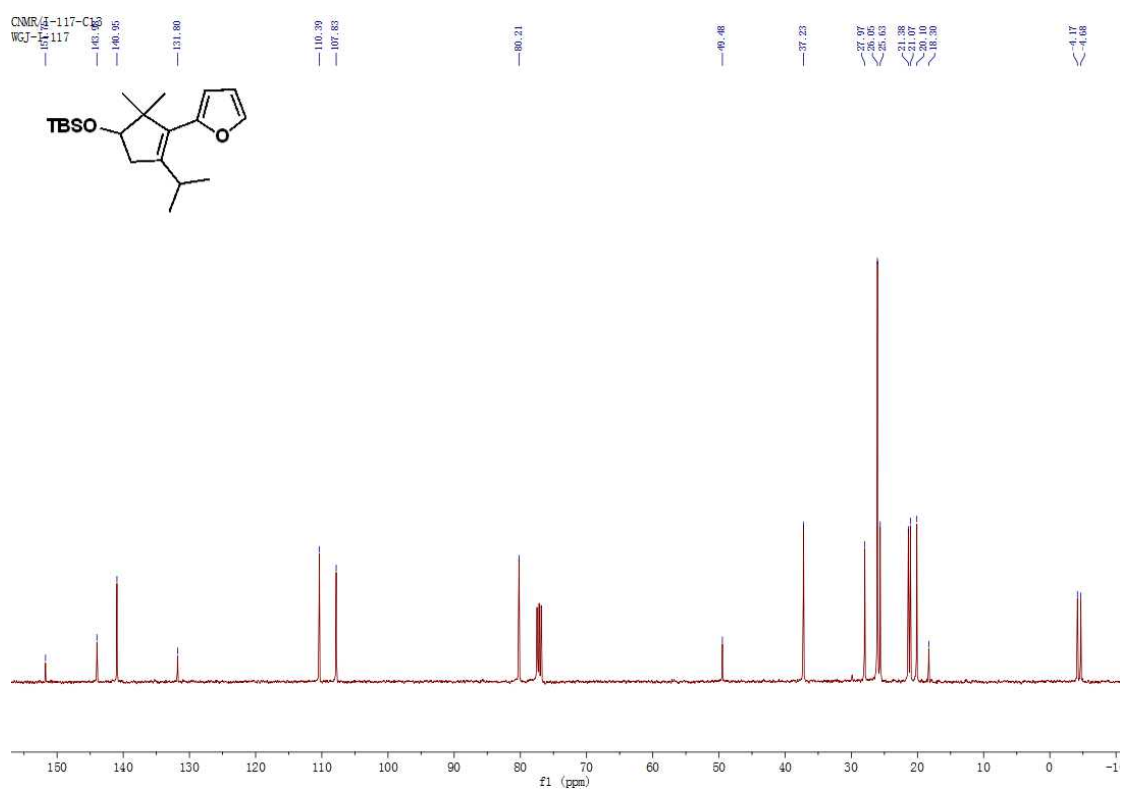
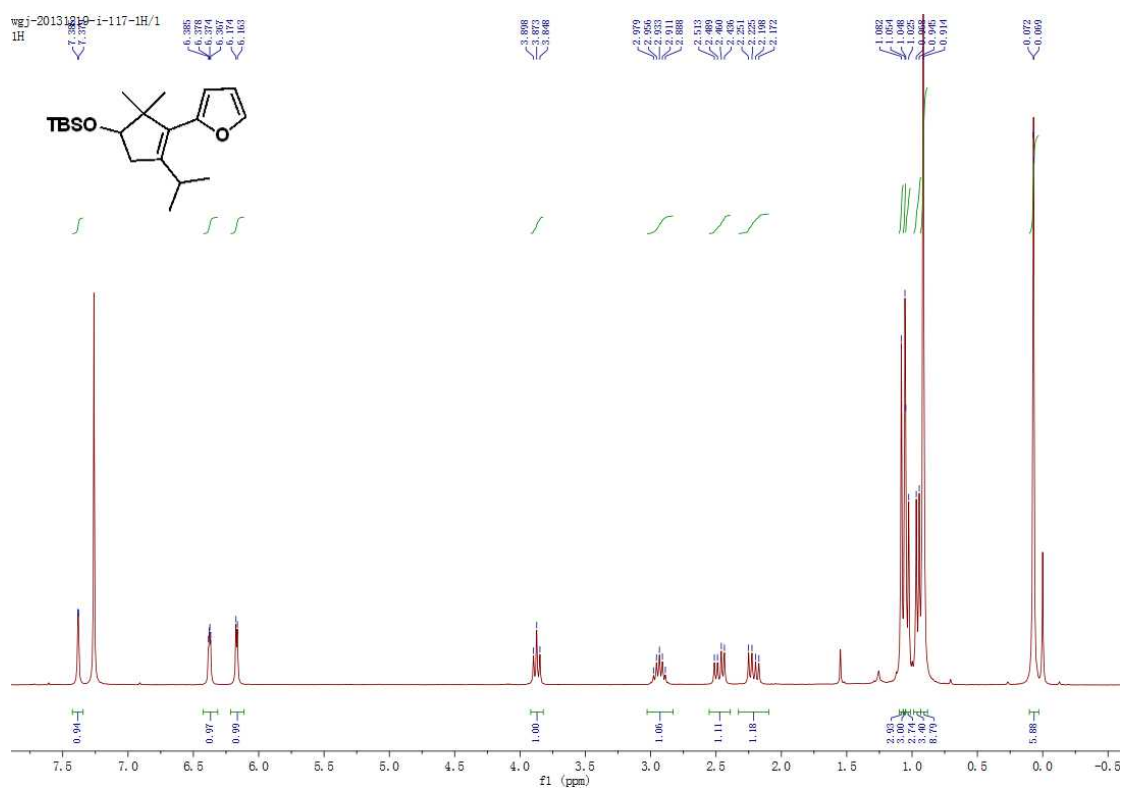
Supplementary Figure 41. ^1H and ^{13}C NMR of compound **17b**



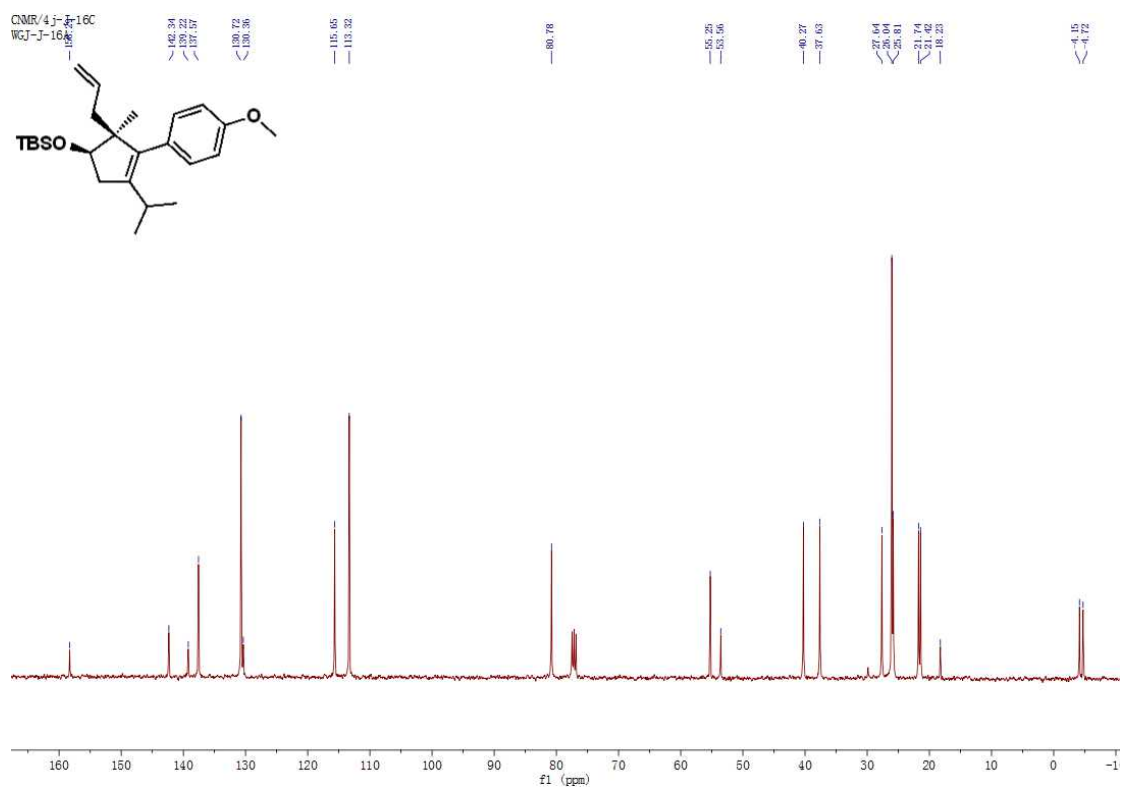
Supplementary Figure 43. ¹H and ¹³C NMR of compound **17d**

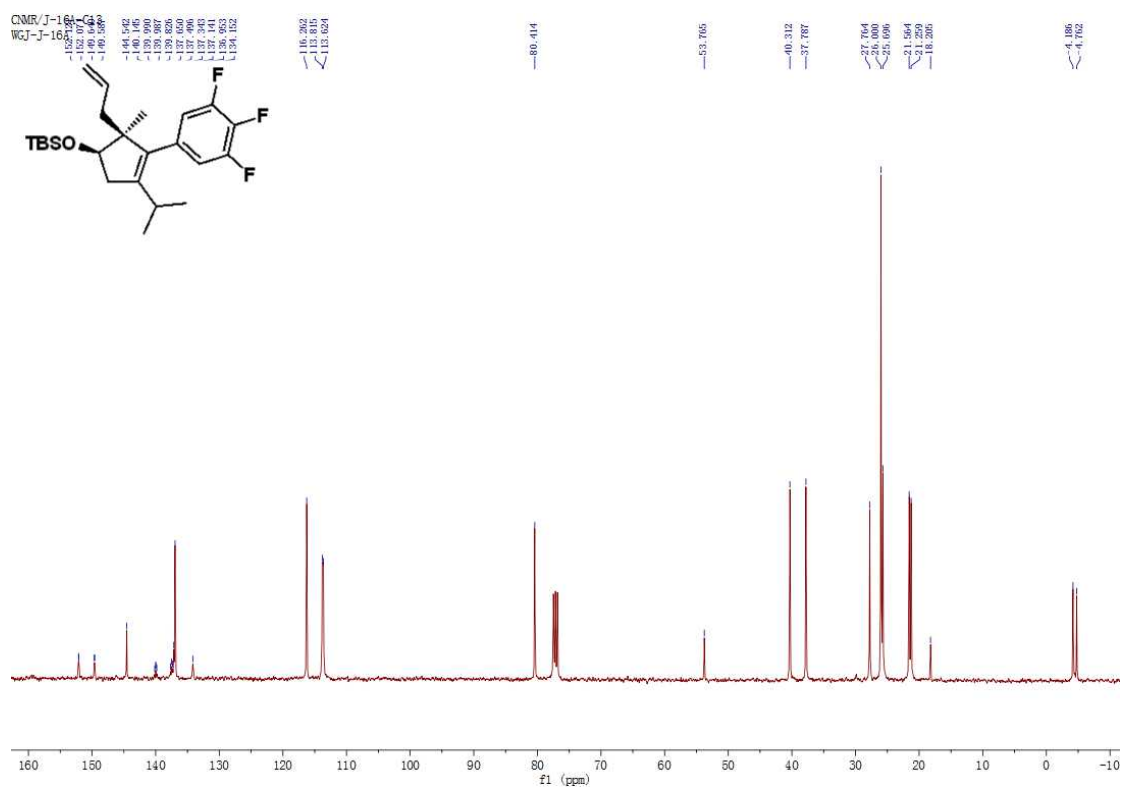
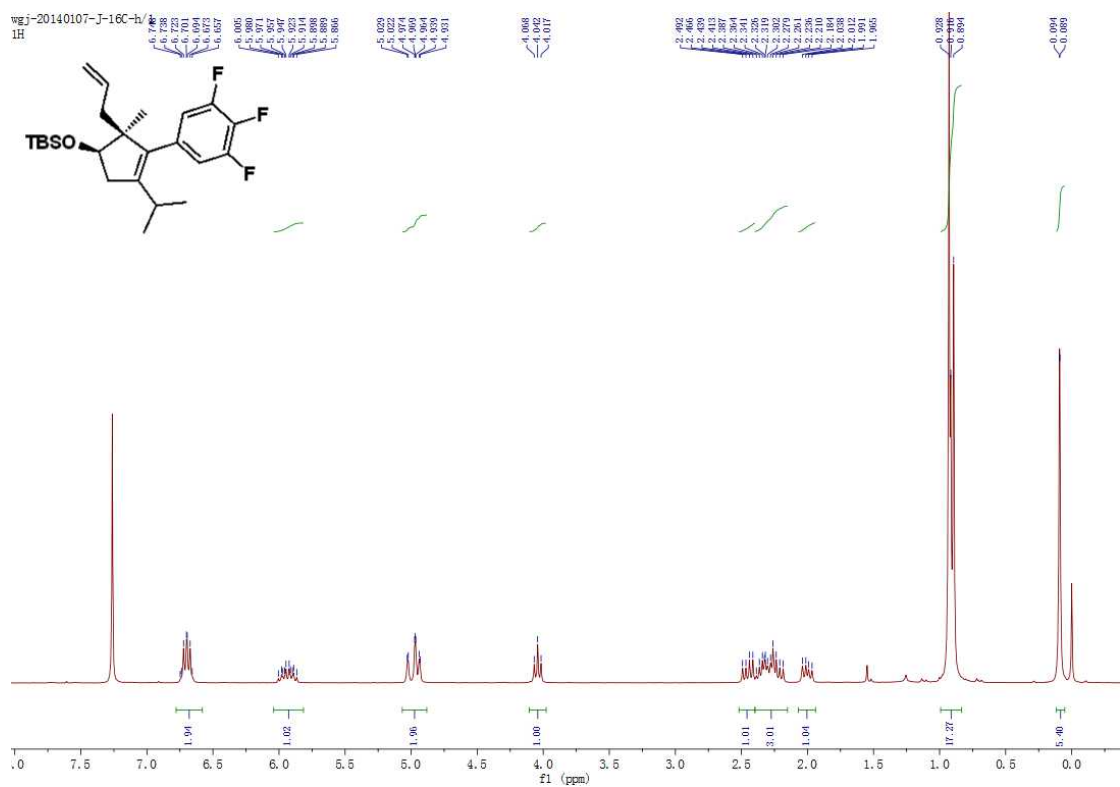


Supplementary Figure 44. ¹H NMR of compound 17e

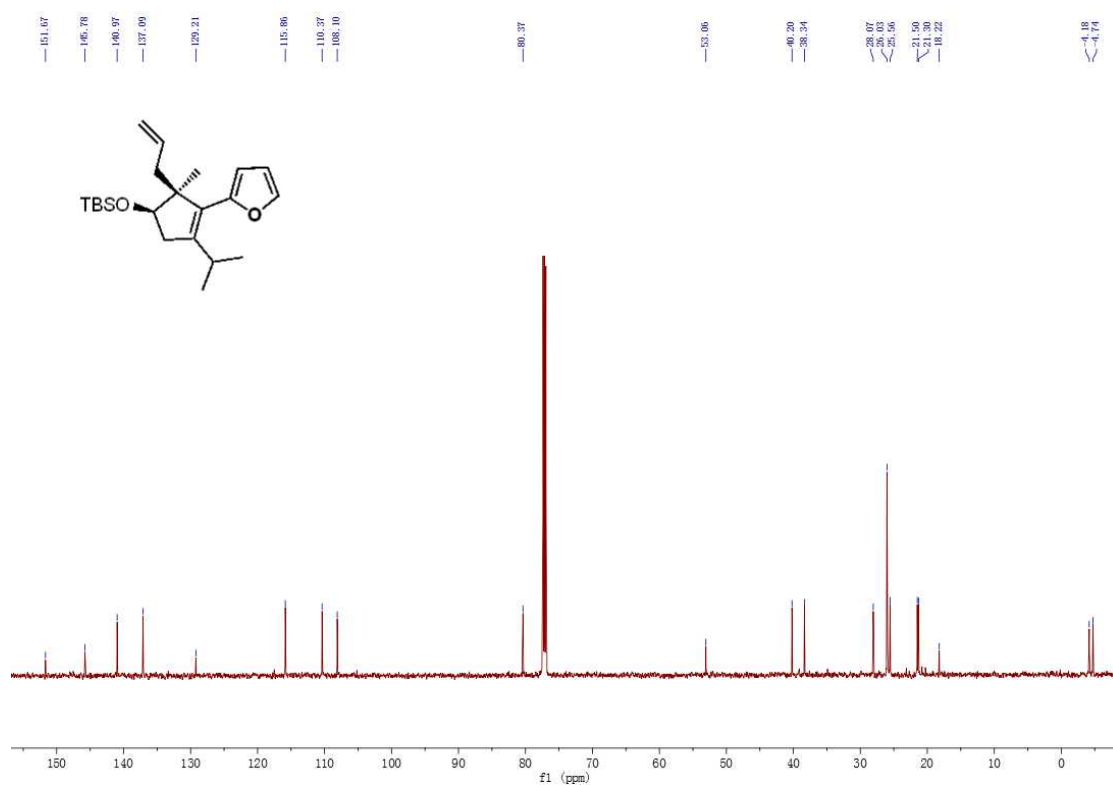
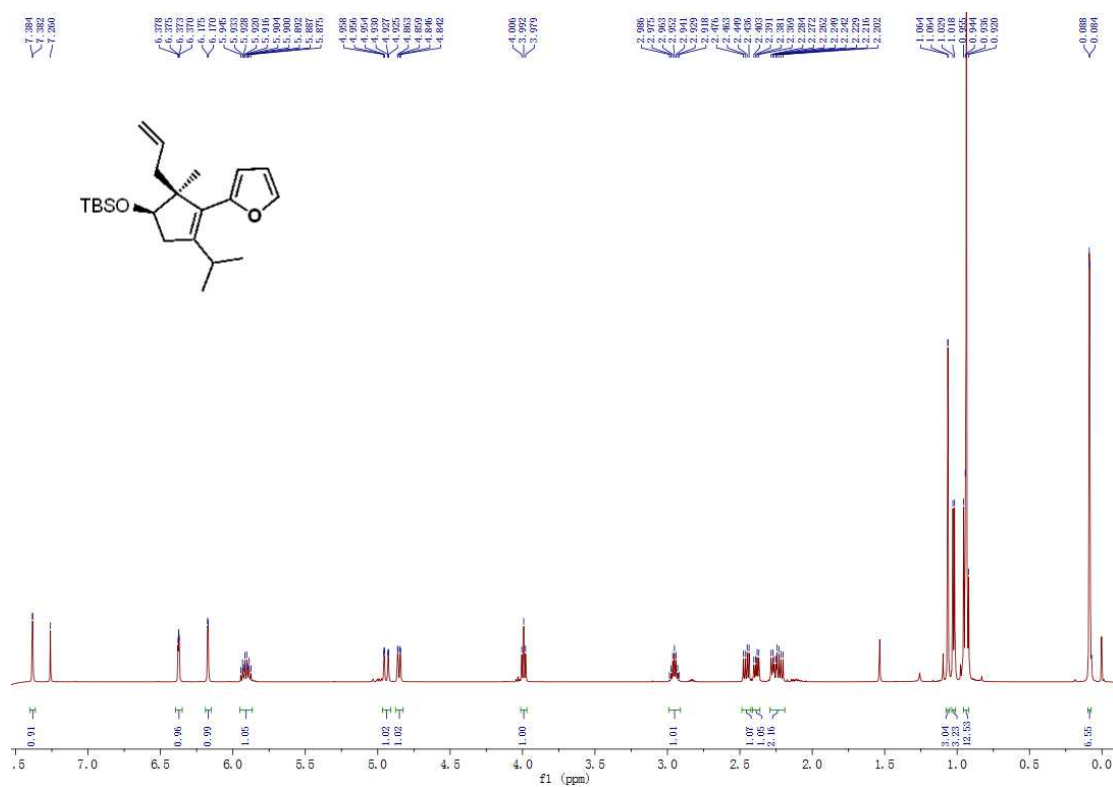


Supplementary Figure 45. ^1H and ^{13}C NMR of compound 17f

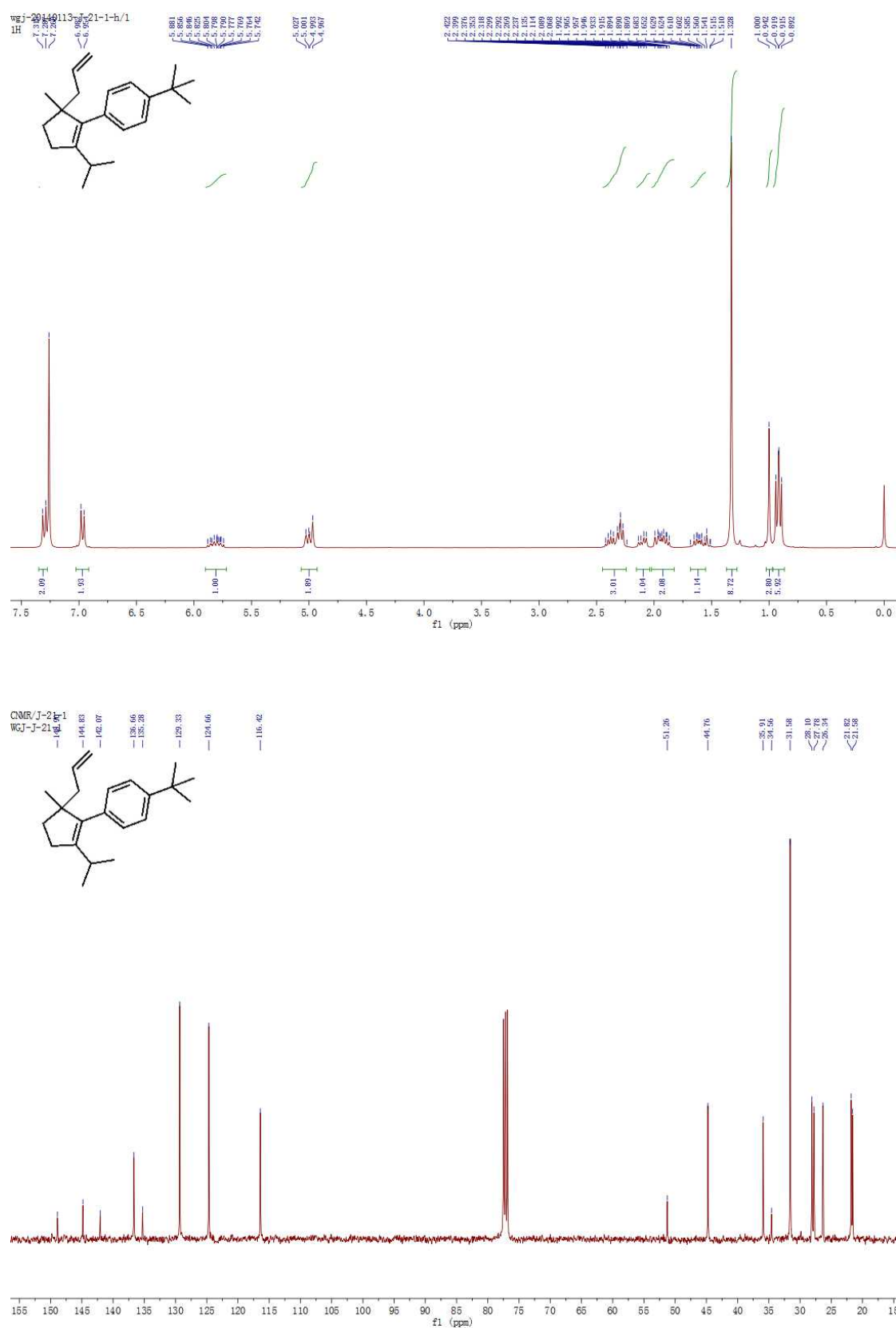




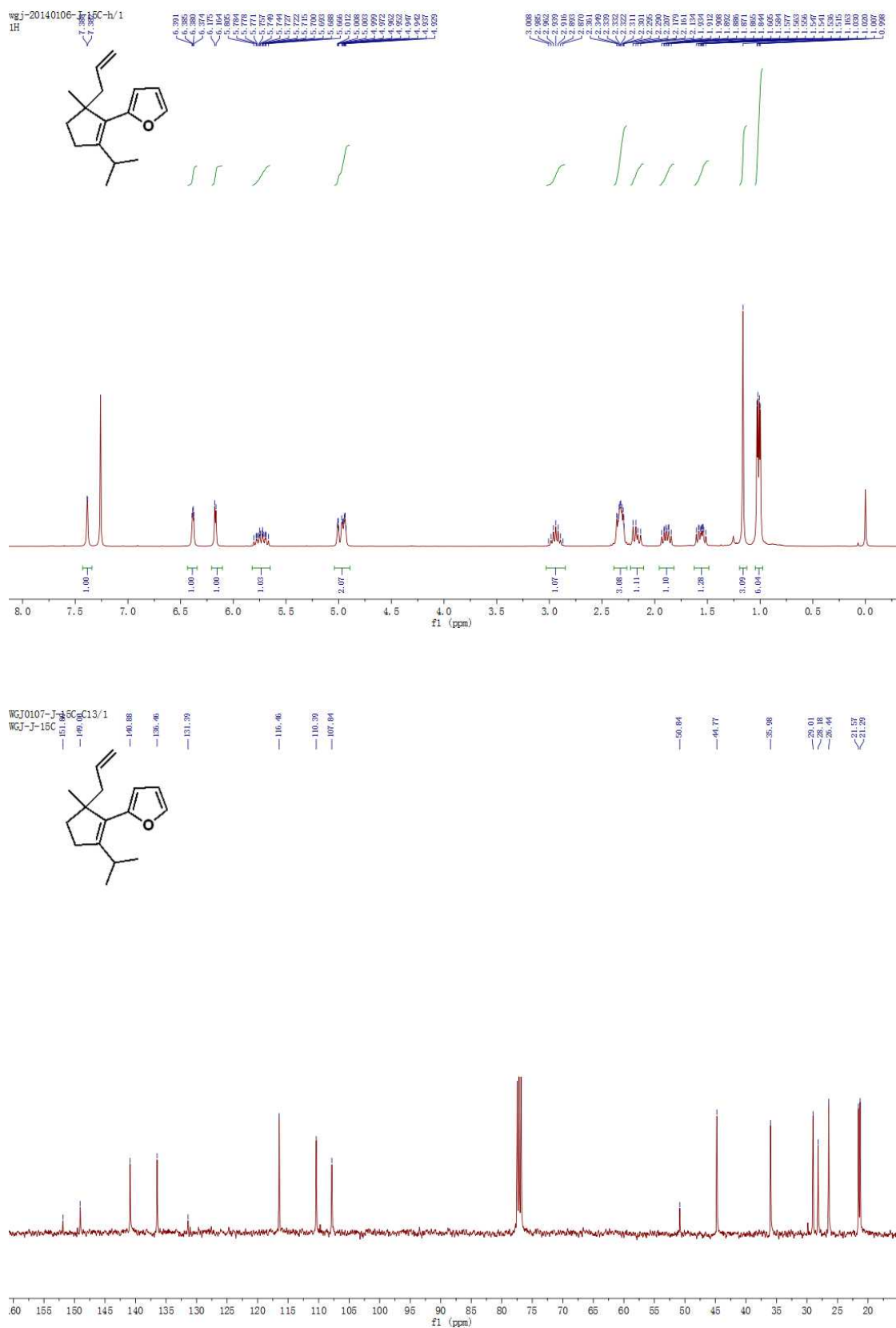
Supplementary Figure 48. ^1H and ^{13}C NMR of compound 17i



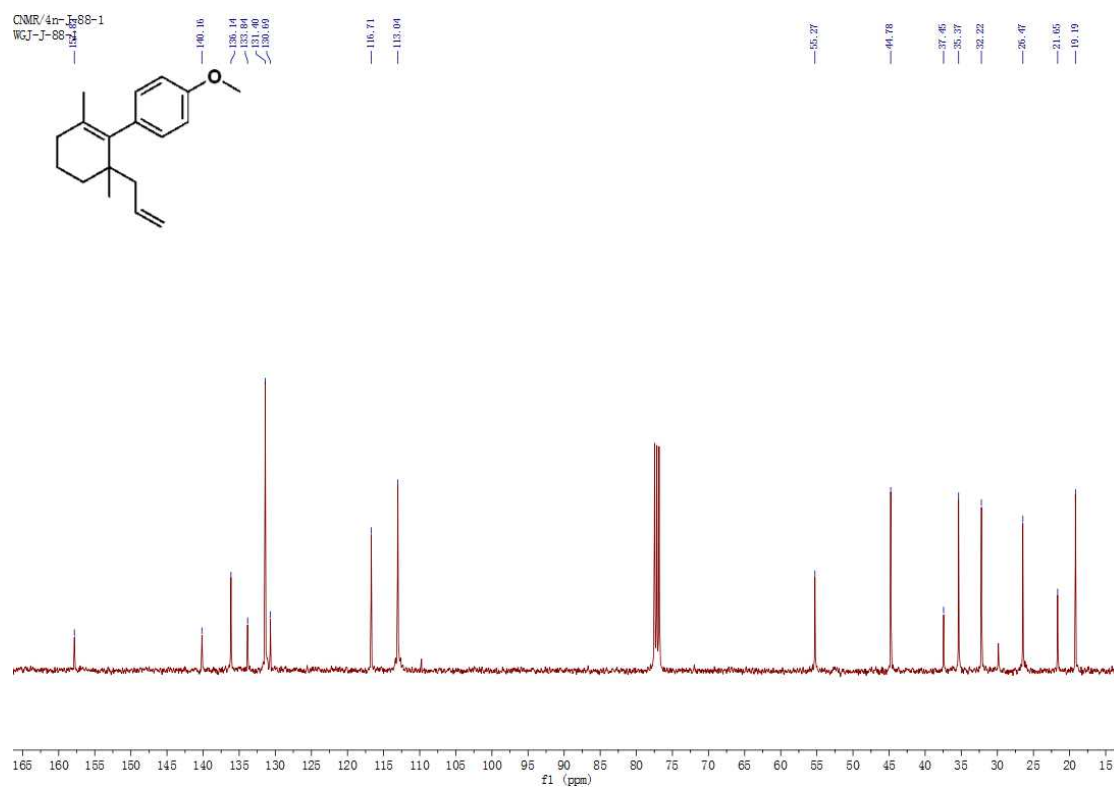
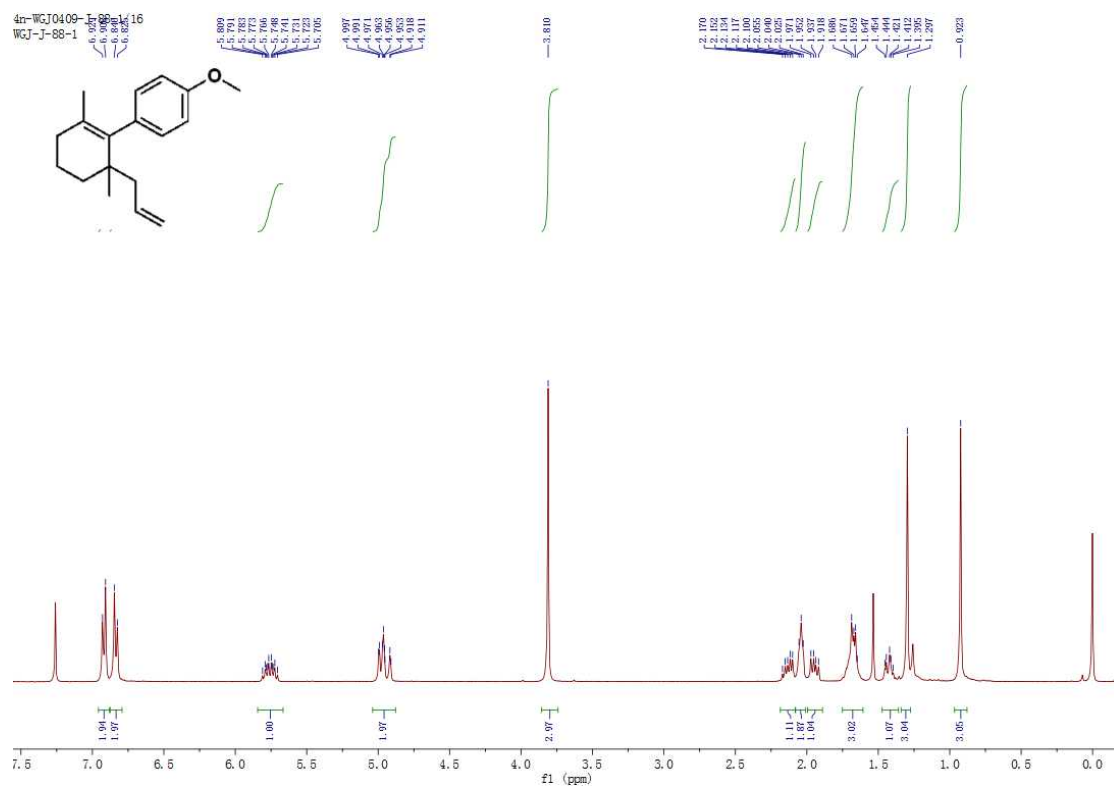
Supplementary Figure 49. ¹H and ¹³C NMR of compound 17j



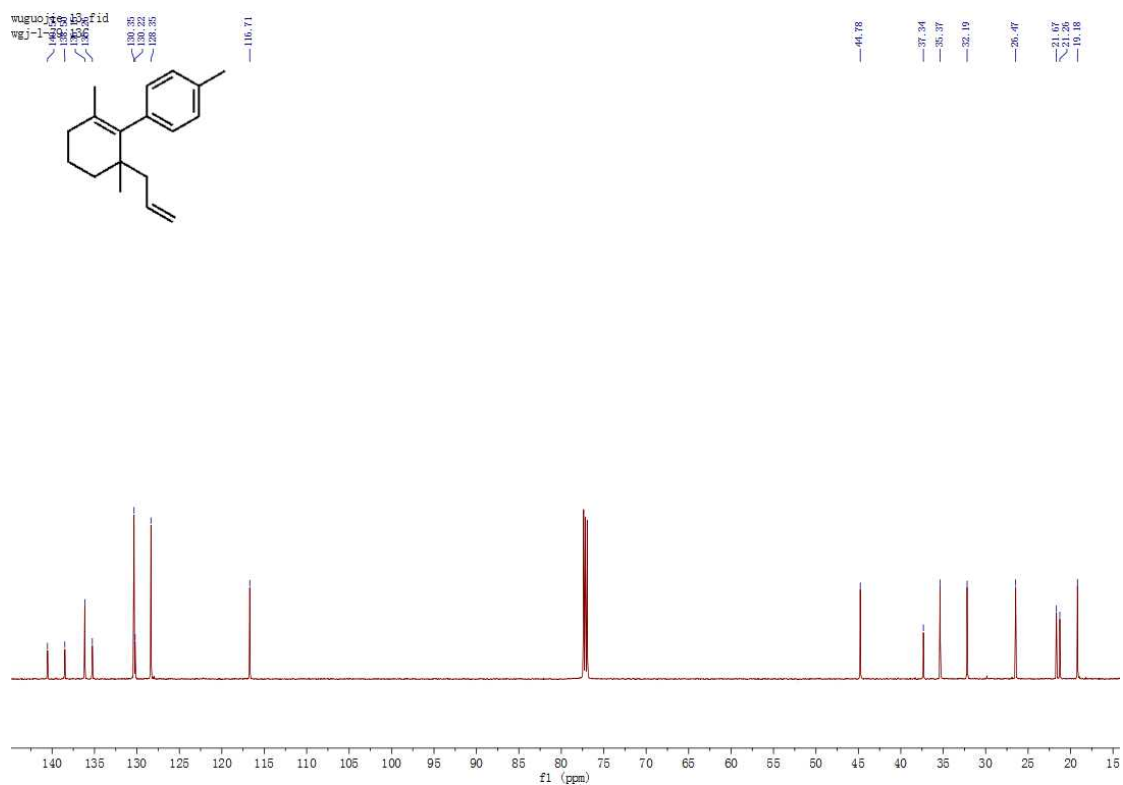
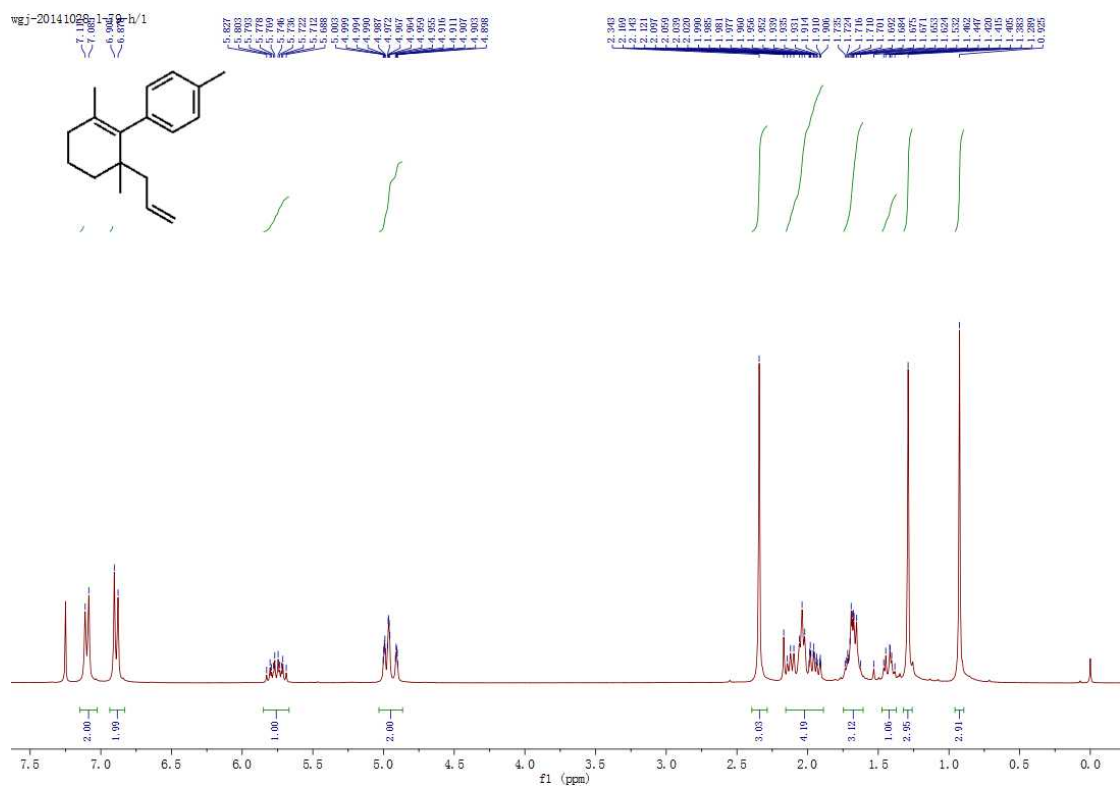
Supplementary Figure S1. ¹H and ¹³C NMR of compound 171



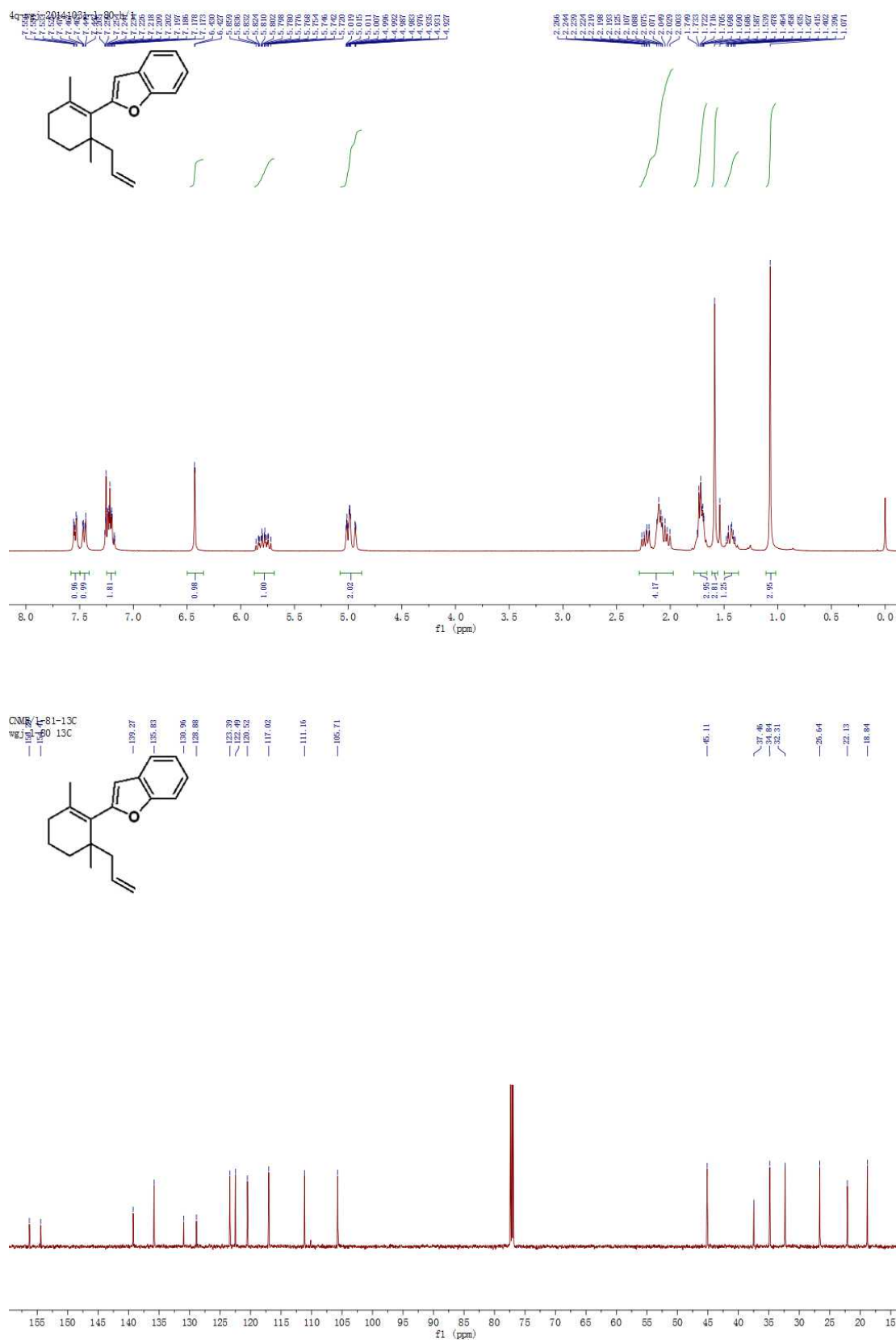
Supplementary Figure 53. ¹H and ¹³C NMR of compound 17n



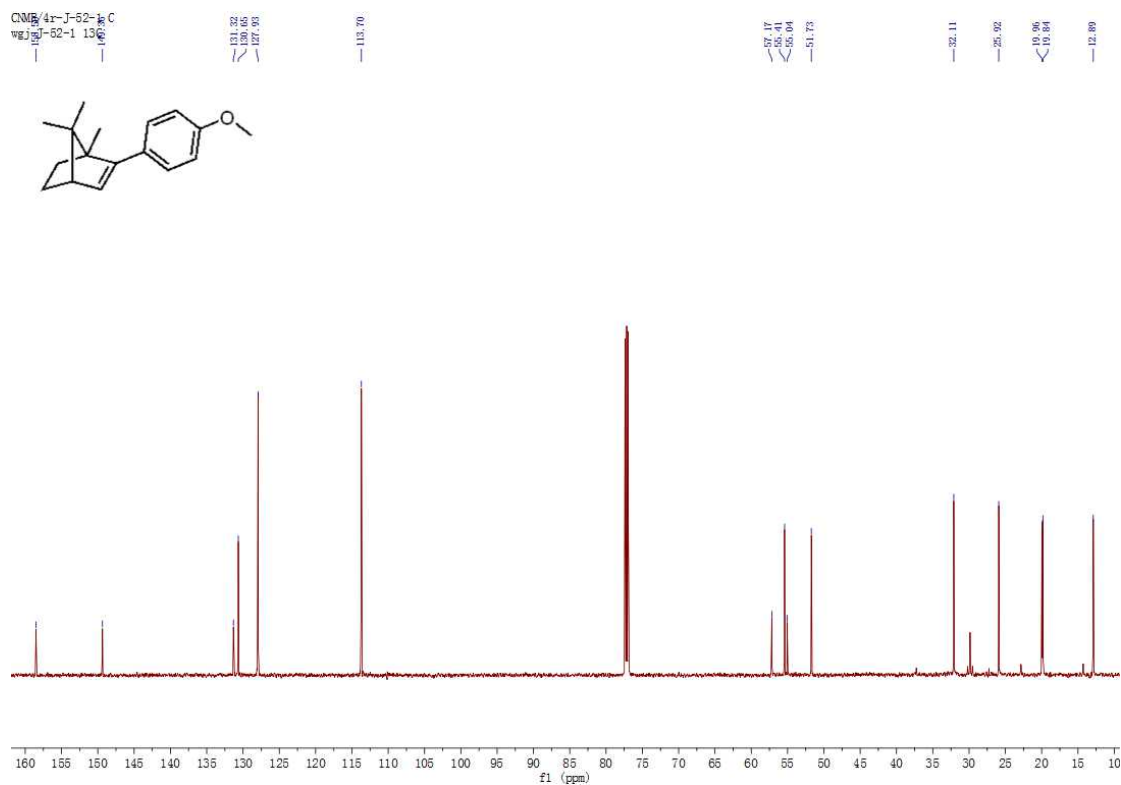
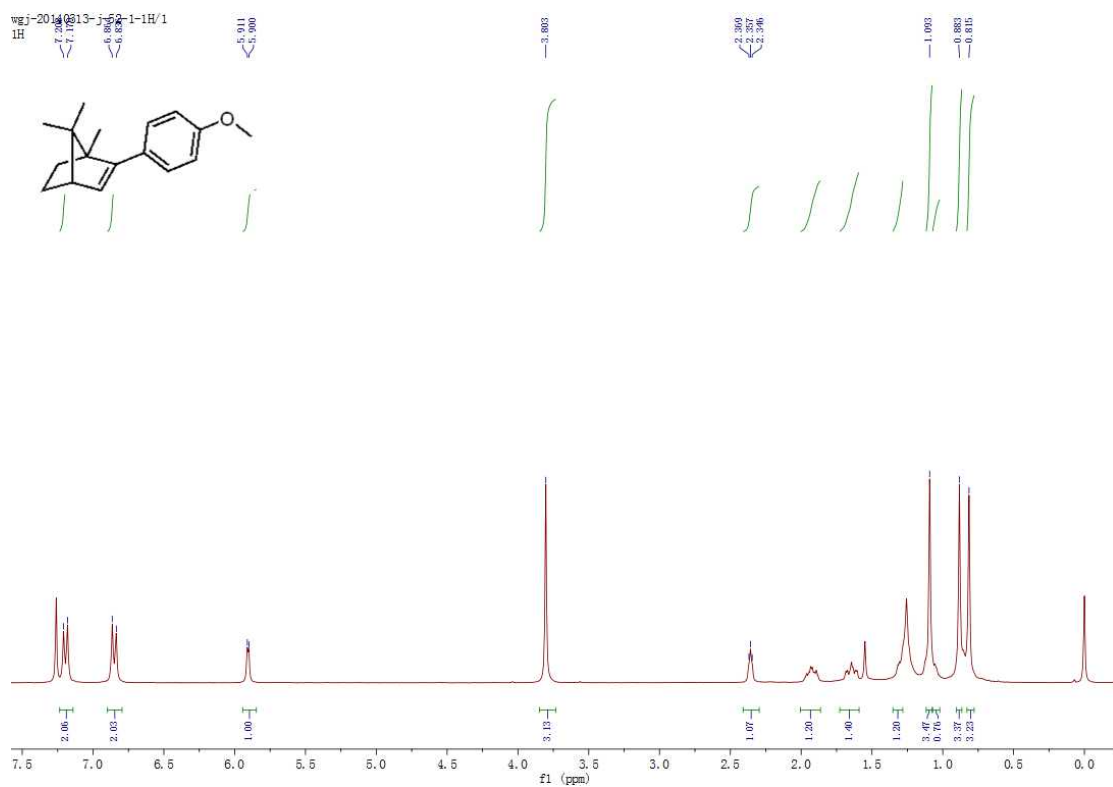
Supplementary Figure 54. ^1H and ^{13}C NMR of compound 17o



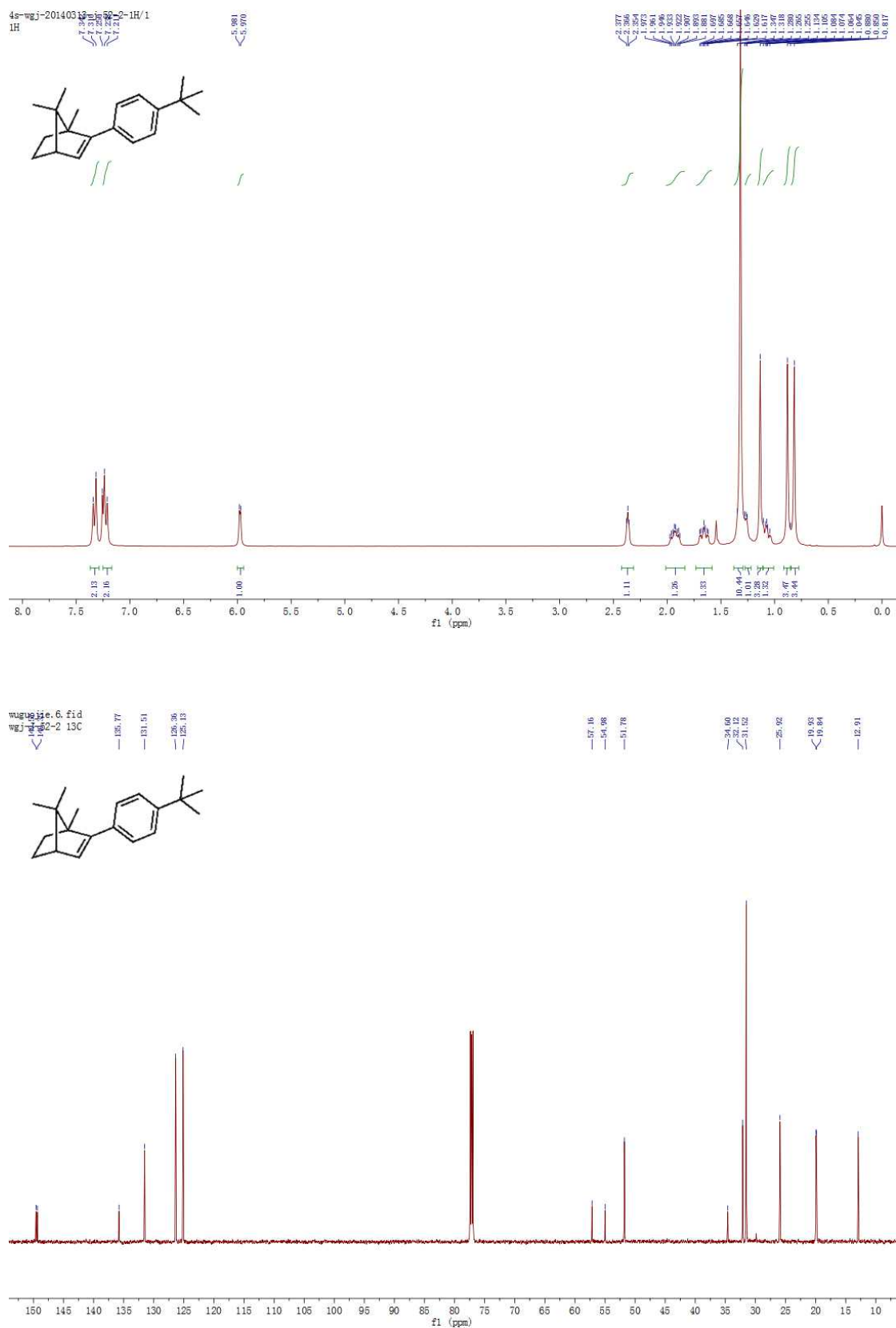
Supplementary Figure 55. ^1H and ^{13}C NMR of compound **17p**



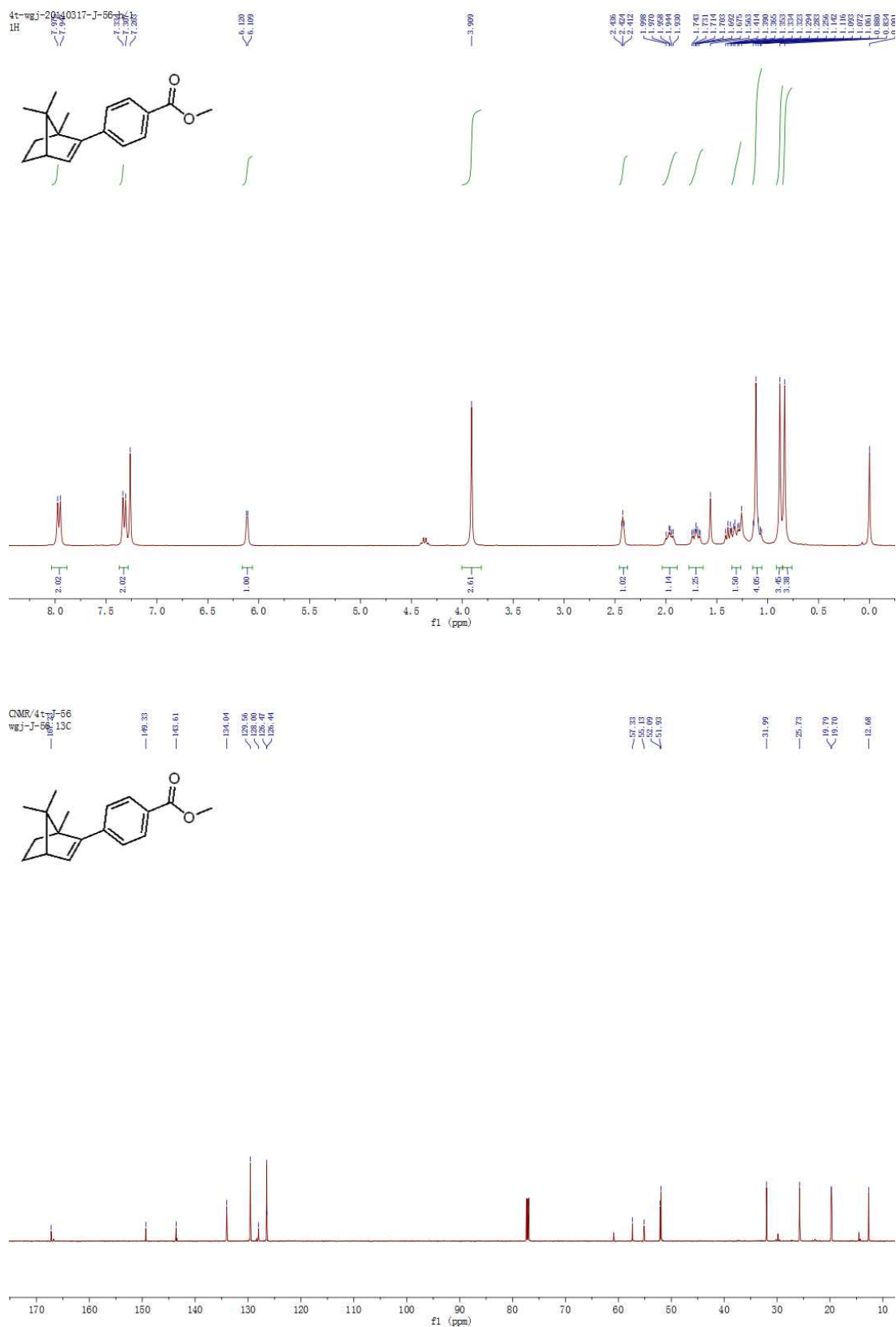
Supplementary Figure 57. ¹H and ¹³C NMR of compound 17r



Supplementary Figure 58. ^1H and ^{13}C NMR of compound **17s**



Supplementary Figure 59. ^1H and ^{13}C NMR of compound **17t**



Supplementary Figure 60. ¹H and ¹³C NMR of compound 17u



9. Supplementary References

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