Gold(I)-Catalyzed Intramolecular Hydroamination of Alkyne with
Trichloroacetimidates

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Supporting Information

Table of Contents

● General Information.....	page 3
● Representative procedure for cyclization of propargylic trichloroacetimidate.....	page 3
● Characterization of 2a-f	page 3
● Representative procedure for cyclization of homopropargyl trichloroacetimidate.....	page 5
● Characterization of 4a-n	page 5
● Cyclization of imidates from homoallyl homopropargyl alcohol.....	page 9
● Diels-Alder cycloaddition.....	page 10

General Information

All reactions were performed in oven-dried glassware under argon atmosphere with freshly distilled solvents. 1,2-Dichloroethane and acetonitrile were distilled from CaH_2 under Ar. Nitromethane was distilled over anhydrous CaCl_2 under Ar. Tetrahydrofuran (THF) was distilled from sodium/benzophenone under Ar. All other commercially available reagents (Aldrich) were used without further purification.

Analytical thin layer chromatography (TLC) was performed on silica gel plates (0.25 mm E. Merck precoated). Flash column chromatography was performed with 230-400 mesh silica gel.

^1H and ^{13}C NMR spectra were acquired on Varian 400 MHz (Mercury) spectrometer. Chemical shifts are reported relative to chloroform (7.26) for ^1H NMR and chloroform (77.0) for ^{13}C NMR. Elemental Analysis was performed at Department of Chemistry, Sogang University, Seoul, Korea and High resolution mass spectrum was performed on JMS-700 (Jeol, Japan) instrument at the Korean Basic Research Center, Seoul, Korea. Infrared spectra were recorded on a Jasco Model FTIR-480 Plus spectrometer.

Representative procedure for cyclization of propargyl trichloroacetimidates:

To a solution of **1a** (56.5mg, 0.2mmol) in 1,2-dichloroethane(0.5ml) was added $\text{Au}(\text{PPh}_3)\text{NTf}_2$ (1.48 mg, 0.002 mmol) at 40°C and reaction mixture was left stirred at rt for 3h. After removal of solvent in vacuo, the residue was purified on a silica gel column using EtOAc/Hexane(1/10) as eluent to provide **2a** (49.0mg) as yellow oil.

^1H NMR (400MHz, CDCl_3): δ 5.42 (dd, $J = 1.4, 2.9$ Hz, 1H), 5.24 (dd, $J = 2.9, 5.8$ Hz, 1H), 4.77 (dd, $J = 1.5, 2.4$ Hz, 1H), 1.09-1.89 (m, 11H), ^{13}C NMR (400MHz, CDCl_3): δ 168.0, 156.4, 103.1, 91.6, 44.1, 29.2, 26.7, 26.5, 25.6. Anal Calcd for $\text{C}_{11}\text{H}_{14}\text{Cl}_3\text{NO}$: C, 46.75; H, 4.99; N, 4.96, found : C, 46.36; H, 5.25; N, 4.69.

Yellow oil.

^1H NMR (400MHz, CDCl_3): δ 5.40 (m, 1H), 5.37 (dd, $J = 1.5, 4.4$ Hz, 1H), 4.76 (dd, $J = 1.5, 2.6$ Hz, 1H),

1.70-1.96 (m, 2H), 1.22-1.54 (m, 10H), 0.88 (t, $J = 6.6$ Hz, 3H). ^{13}C NMR (400MHz, CDCl_3): δ 167.9, 157.8, 102.6, 87.7, 36.3, 32.3, 29.8, 29.7, 24.3, 23.3, 14.7. Anal Calcd for $\text{C}_{12}\text{H}_{18}\text{Cl}_3\text{NO}$: C, 48.26; H, 6.08; N, 4.69, found : C, 48.37; H, 6.06; N, 4.53.

2c

Yellow oil.

^1H NMR (400MHz, CDCl_3): δ 5.42 (dd, $J = 1.5, 3.0$ Hz, 1H) 5.27 (dd, $J = 2.9, 5.8$ Hz, 1H), 4.78 (dd, $J = 1.4, 2.5$ Hz, 1H), 2.01 (m, 1H), 1.11 (d, $J = 7.0$ Hz, 3H), 0.95 (d, $J = 7.0$ Hz, 3H). ^{13}C NMR (400MHz, CDCl_3): δ 168.0, 156.5, 103.2, 92.0, 34.5, 18.7, 15.4. Anal Calcd for $\text{C}_8\text{H}_{10}\text{Cl}_3\text{NO}$: C, 39.62; H, 4.16; N, 5.78, found: C, 39.63; H, 4.55; N, 5.64.

2d

Yellow oil.

^1H NMR (400MHz, CDCl_3): δ 5.48 (dd, $J = 1.4, 2.9$ Hz, 1H), 5.03 (dd, $J = 2.5, 2.6$ Hz, 1H), 4.85 (dd, $J = 1.1, 2.2$ Hz, 1H), 0.98-1.25(s, 9H). ^{13}C NMR (400MHz, CDCl_3): δ 167.5, 155.3, 105.4, 94.8, 36.2, 24.8. Anal Calcd for $\text{C}_9\text{H}_{12}\text{Cl}_3\text{NO}$: C, 42.13; H, 4.71; N, 5.46, found: C, 42.26; H, 4.94; N, 5.50.

2e

Yellow oil.

^1H NMR (400MHz, CDCl_3): δ 7.20-7.40 (m, 5H), 5.56 (m, 1H), 5.39 (dd, $J = 1.4, 2.9$ Hz, 1H), 4.70 (dd, $J = 1.4, 2.5$ Hz, 1H) 3.14 (dd, $J = 6.6, 14.3$ Hz, 1H), 3.07 (dd, $J = 5.1, 14.3$ Hz, 1H). ^{13}C NMR (400MHz, CDCl_3): δ 167.5, 156.8, 135.1, 130.5, 129.2, 127.9, 103.7, 87.4, 42.4. HRMS (FAB) calcd for $\text{C}_{12}\text{H}_{11}\text{Cl}_3\text{NO}$ $[\text{M}+\text{H}]$; 289.9906, found 289.9884.

2f

Yellow oil.

^1H NMR (400MHz, CDCl_3): δ 5.41 (td, $J = 3.3, 1.8$ Hz, 1H), 5.24 (t, $J = 3.3$ Hz, 2H), 4.88 (td, $J = 3.0, 1.6$ Hz, 1H). ^{13}C NMR (400MHz, CDCl_3): δ 169.2, 153.9, 102.7, 75.1. HRMS (FAB) calcd for $\text{C}_5\text{H}_5\text{Cl}_3\text{NO}$ $[\text{M}+\text{H}]$; 199.9437, found 199.9477.

Representative procedure for cyclization of homopropargyl trichloroacetimidates:

To a solution of imidate **3a** (100 mg, 0.34 mmol) in 1,2-dichloroethane was added $\text{Au}(\text{PPh}_3)\text{Cl}$ (8.5 mg, 0.017 mmol) and AgBF_4 (3.4 mg, 0.017 mmol) and the reaction mixture was left stirred at 0°C for 0.5 h. After removal of solvent *in vacuo*, the resulting oil was purified on a silica gel column, using EtOAc/hexane(1/10) as eluent to produce 91 mg (91 %) of **4a** as pale yellow solid.

IR (neat): 1622, 1287, 1211, 1033, 899, 785 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.51-7.27 (m, 5H), 5.38 (d, $J = 1.8$ Hz, 1H), 5.35 (dd, $J = 3.7, 14.3$ Hz, 1H), 4.91 (d, $J = 1.8$ Hz, 1H), 2.87 (dd, $J = 3.7, 15.0$ Hz, 1H), 2.63 (tdd, $J = 1.8, 14.3, 15.0$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 154.8, 141.3, 138.8, 129.5, 126.4, 112.7, 112.0, 79.1, 33.9. Anal. Calcd for $\text{C}_{12}\text{H}_{10}\text{Cl}_3\text{NO}$: C, 49.60; H, 3.47; N, 4.82; found: C, 49.72; H, 3.25; N, 4.75.

4b

Yellow oil; IR (neat): 1623, 1287, 1213, 1037, 886, 815, 791 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.31 (m, 1H), 7.18 (m, 3H), 5.37 (d, $J = 1.5$ Hz, 1H), 5.30 (dd, $J = 3.7,$

11.0 Hz, 1H), 4.91 (d, $J = 1.5$ Hz, 1H), 4.62 (tdd, $J = 1.5, 11.0, 15.0$ Hz, 1H), 2.39 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 154.9, 142.2, 139.3, 138.8, 130.3, 129.4, 127.1, 123.1, 112.6, 80.0, 34.8, 22.2. Anal. Calcd for $\text{C}_{13}\text{H}_{12}\text{Cl}_3\text{NO}$: C, 51.26; H, 3.97; N, 4.60; found: C, 51.38; H, 4.13; N, 4.81

Pale yellow oil; IR (neat): 1622, 1287, 1213, 1037, 884, 815 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.37-7.31 (t, 1H), 6.98-6.89 (m, 3H), 5.37 (d, $J = 1.5$ Hz, 1H), 5.32 (dd, $J = 3.3, 10.3$ Hz, 1H), 4.91 (d, $J = 1.1$ Hz, 1H), 3.81 (s, 3H), 2.86 (dd, $J = 3.7, 15.4$ Hz, 1H), 2.61 (tdd, $J = 1.5, 10.6, 15.4$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 160.6, 154.7, 142.0, 140.4, 130.6, 118.5, 114.7, 112.7, 112.1, 79.7, 56.0, 34.7. Anal. Calcd for $\text{C}_{13}\text{H}_{12}\text{Cl}_3\text{NO}_2$: C, 48.70; H, 3.77; N, 4.37; found: C, 49.96; H, 4.01; N, 3.99.

Yellow oil; IR (neat): 2230, 1623, 1286, 1211, 1040, 901 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.76-7.70 (m, 1H), 7.57-7.45 (m, 4H), 5.42 (d, $J = 1.8$ Hz, 1H), 5.41 (dd, $J = 3.7, 10.6$ Hz, 1H), 4.96 (d, $J = 1.1$ Hz, 1H), 2.89 (dd, $J = 3.3, 15.4$ Hz, 1H), 2.57 (tdd, $J = 1.8, 10.3, 15.0$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 154.0, 143.9, 140.9, 133.4, 133.3, 129.2, 126.9, 118.9, 113.7, 78.6, 34.3, 30.3. Anal. Calcd for $\text{C}_{13}\text{H}_9\text{Cl}_3\text{N}_2\text{O}$: C, 49.48; H, 2.87; N, 8.88; found: C, 49.66; H, 3.02; N, 9.05.

Yellow oil; IR (neat): 1623, 1495, 1287, 1210, 1038, 900, 795 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.41-7.31 (m, 4H), 5.39 (d, $J = 1.5$ Hz, 1H), 5.32 (dd, $J = 3.7, 10.3$ Hz, 1H), 4.93 (d, $J = 1.1$ Hz, 1H), 2.85 (dd, $J = 3.7, 15.0$ Hz, 1H), 2.59 (tdd, $J = 1.5, 10.3, 15.0$ Hz, 1H). ^{13}C

NMR (100 MHz, CDCl₃): δ 154.5, 141.6, 137.3, 135.4, 129.9, 129.8, 128.7, 127.8, 126.6, 113.1, 79.1, 34.5. Anal. Calcd for C₁₂H₉Cl₄NO : C, 44.34; H, 2.79; N, 4.31; found : C, 44.26; H, 2.98; N, 4.33.

Pale yellow solid; IR (neat): 2995, 2962, 2900, 1652, 1624, 1289, 1218, 908, 823. 796 cm⁻¹

¹H NMR (400 MHz, CDCl₃): δ 5.30 (s, 1H), 4.87 (s, 1H), 4.46 (t, *J* = 5.9 Hz, 2H), 2.63 (t, *J* = 5.9 Hz, 2H)

¹³C NMR (100 MHz, CDCl₃): δ 154.3, 141.6, 112.1, 68.0, 26.8. Anal. Calcd for C₆H₆Cl₃NO : C, 33.60; H, 2.82; N, 6.53; found : C, 33.53; H, 3.05; N, 6.36.

Pale yellow solid; IR (neat): 1673, 1175, 1075 cm⁻¹

¹H NMR (400 MHz, CDCl₃): δ 5.28 (d, *J* = 1.5 Hz, 1H), 4.83 (d, *J* = 0.7 Hz, 1H), 4.09 (ddd, *J* = 3.7, 7.0, 9.9 Hz, 1H), 2.57 (dd, *J* = 3.7, 15.0 Hz, 1H), 2.41 (tdd, *J* = 1.5, 9.9, 15.0 Hz, 1H), 2.10 (m, 1H), 1.84-1.58 (m, 5H), 1.32-1.10 (m, 5H). ¹³C NMR (100 MHz, CDCl₃): δ 155.1, 142.6, 111.9, 82.9, 41.9, 29.6, 28.9, 28.5, 26.9, 26.5, 26.3. Anal. Calcd for C₁₂H₁₆Cl₃NO : C, 48.59; H, 5.44; N, 4.72; found: C, 48.66, H, 5.55, N: 4.36.

Dark yellow oil; IR (neat): 2917, 1623, 1495, 1287, 1210, 1092, 1038, 900, 795 cm⁻¹

¹H NMR (400 MHz, CDCl₃): δ 5.29 (s, 1H), 4.85 (s, 1H), 4.40 (m, 1H), 2.62 (dd, *J* = 3.7, 15.0 Hz, 1H), 2.34 (broad dd, *J* = 8.4, 15.0 Hz, 1H), 1.78-1.70 (m, 1H), 1.64-1.43 (m, 1H), 0.98 (t, *J* = 7.3 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 154.7, 142.0, 112.3, 78.5, 36.8, 32.1, 18.7, 14.4. Anal. Calcd for C₉H₁₂Cl₃NO : C, 42.13; H, 4.71; N, 5.46; found : C, 42.17; H, 4.85; N, 5.46.

Pale yellow solid; IR (neat): 1624, 1291, 1230, 1040, 890, 815 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 5.29 (d, $J = 1.5$ Hz, 1H), 4.85 (d, $J = 2.2$ Hz, 1H), 3.93 (dd, $J = 2.9, 12.5$ Hz, 1H), 2.55 (dd, $J = 2.9, 15.0$ Hz, 1H), 2.55 (tdd, $J = 2.2, 12.5, 14.7$ Hz, 1H), 1.03 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 155.4, 143.3, 111.8, 111.8, 86.0, 34.8, 27.6, 25.7. Anal. Calcd for $\text{C}_{10}\text{H}_{14}\text{Cl}_3\text{NO}$: C, 44.39; H, 5.22; N, 5.18; found: C, 44.51; H, 5.25; N, 4.86.

Yellow solid; IR (neat): 1653, 1554, 1250, 1050 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.94 (d, $J = 7.3$ Hz, 2H), 7.46-7.23 (m, 8H), 6.04 (s, 1H), 5.46 (dd, $J = 3.6, 10.3$ Hz, 1H), 2.89 (dd, $J = 3.6, 15.4$ Hz, 1H), 2.75 (ddd, $J = 1.5, 10.6, 15.0$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 154.6, 138.9, 136.1, 134.1, 131.0, 129.6, 129.5, 128.9, 128.2, 126.5, 125.2, 80.4, 36.1. Anal. Calcd for $\text{C}_{18}\text{H}_{14}\text{Cl}_3\text{NO}$: C, 58.96; H, 3.85; N, 3.82; found: C, 58.93; H, 4.14; N, 3.95.

yellow liquid; IR (neat): 2954, 1648, 1602, 1244, 1228, 842 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.43-7.33 (m, 5H), 5.33 (dd, $J = 3.7, 10.6$ Hz, 1H), 5.34 (t, $J = 0.7, 1.5$ Hz, 1H), 2.78 (broad ddd, $J = 0.7, 3.7, 15.4$ Hz, 1H), 2.63 (ddd, $J = 1.5, 10.6, 15.4$ Hz, 1H), 0.19 (s, 9H). ^{13}C NMR (100 MHz, CDCl_3): δ 153.5, 147.9, 139.3, 129.4, 129.3, 128.5, 126.4, 92.4, 80.2, 37.5, 30.4, 0.55. HRMS (FAB) calcd for $\text{C}_{15}\text{H}_{19}\text{Cl}_3\text{NOSi}$ $[\text{M}+\text{H}]$; 362.0302, found 362.0350.

Yellow oil; IR (neat): 2928, 2857, 1656, 1623, 1457, 1327, 1260, 1218, 1033, 965, 884, 782 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 5.26 (s, 1H), 4.88 (s, 1H), 4.19 (td, $J = 4.4, 12.8$ Hz, 1H), 2.43 (q, $J = 4.8,$

7.0 Hz, 1H), 1.64-1.53 (m, 2H), 1.35-1.26 (m, 10H), 1.18 (d, $J = 7.3$ Hz, 3H), 0.88 (t, $J = 6.6$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 153.2, 146.6, 111.1, 83.5, 35.2, 33.9, 32.4, 29.9, 29.8, 25.4, 23.3, 17.0, 14.8. Anal. Calcd for $\text{C}_{14}\text{H}_{22}\text{Cl}_3\text{NO}$: C, 51.47; H, 6.79; N, 4.29; found: C, 50.98; H, 6.39; N, 4.46.

Colorless white solid; IR (neat): 1622, 961, 884, 811 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 5.23 (s, 1H), 4.86 (s, 1H), 3.92 (dd, $J = 4.4, 7.0$ Hz, 1H), 2.62 (tdd, $J = 2.2, 4.8, 7.0$ Hz, 1H), 1.98 (broad d, 1H), 1.79-1.47 (m, 5H), 1.25-1.10 (m, 5H), 1.17 (d, $J = 2.6$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 153.5, 146.8, 110.5, 87.8, 40.3, 32.2, 29.1, 28.3, 26.8, 26.7, 26.2, 16.9. Anal. Calcd for $\text{C}_{13}\text{H}_{18}\text{Cl}_3\text{NO}$: C, 50.26; H, 5.84; N, 4.51; found : C, 50.39; H, 5.48; N, 4.49.

Pale yellow oil; IR (neat): 2961, 2928, 1624, 1288, 1214, 1038, 898, 791 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 5.36 (s, 1H), 4.92 (d, $J = 1.1$ Hz, 1H), 4.36 (ddd, $J = 4.4, 4.8, 8.8$ Hz, 1H), 3.05 (ddd, $J = 2.2, 4.8$ Hz, 1H), 2.67 (dd, $J = 4.4, 15.4$ Hz, 1H), 2.56 (tdd, $J = 1.1, 8.8, 15.4$ Hz, 1H), 1.66-1.42 (m, 4H), 0.98 (t, $J = 7.3$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 153.9, 140.8, 113.1, 77.3, 58.7, 55.8, 34.1, 19.9, 14.5. Anal. Calcd for $\text{C}_{11}\text{H}_{14}\text{Cl}_3\text{NO}_2$: C, 44.25; H, 4.73; N, 4.69; found: C, 44.64; H, 4.86; N, 4.56.

Cyclization of imidates from homoallyl homopropargyl alcohol:

To a solution of imidate **3o** (80.0mg, 0.22mmol) in 1,2-dichloroethane was added $\text{Au}(\text{PPh}_3)\text{Cl}$ (5.5mg, 0.011mmol) and AgBF_4 (2.2mg, 0.011mmol) and the reaction mixture was left stirred at RT for 24h. After removal of solvent *in vacuo*, the resulting oil was purified on a silica gel column, using EtOAc/hexane(1/10) as eluent to give **4o** (58mg, 73%) as dark yellow oil.

IR (neat): 1627, 812 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.36-7.27 (m, 5H), 5.77 (m, 1H), 5.15 (s, 1H), 5.11 (m, 1H), 4.72 (m, 1H), 4.68 (d, $J=11.4\text{Hz}$, 1H), 4.41 (d, $J=11.7\text{Hz}$, 1H), 3.92 (d, $J=2.2\text{Hz}$, 1H), 2.39 (m, 1H), 2.21 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 153.7, 139.7, 138.1, 131.9, 129.2, 128.5, 120.0, 115.7, 92.1, 81.1, 72.4, 70.5, 70.4, 36.8, 30.4. HRMS (FAB) calcd for $\text{C}_{16}\text{H}_{17}\text{Cl}_3\text{NO}_2$ [$\text{M}+\text{H}$]; 360.0325, found 360.0334.

Imidate **3o** (57.9 mg, 0.160 mmol) and K_2CO_3 (24.4 mg, 0.177 mmol) was dissolved in propionitrile (2 mL) and the solution was cooled to -78°C . IBr (83 mg, 0.401 mmol) was then added in one lot. After 30 min at -78°C , the reaction was quenched with water (5 mL) and the organic layer was extracted with Et_2O (5 mL $\times$ 3). The combined organic layers were dried (MgSO_4), and evaporated. The residual oil was purified on silica gel ($\text{EtOAc}/\text{Hex} = 1/4$) to give **6** (48.3 mg, 62 %) as yellow oil.

IR (neat): 3294, 2925, 2860, 1674, 1240, 1103 cm^{-1}

^1H NMR (400 MHz, CDCl_3): δ 7.40-7.27 (m, 5H), 4.86 (d, $J=12.1\text{Hz}$, 1H), 4.62 (d, $J=12.1\text{Hz}$, 1H), 4.46 (ddd, $J=2.6, 3.7, 11.7\text{Hz}$, 1H), 4.42 (dd, $J=2.2, 3.7\text{Hz}$, 1H), 3.67 (m, 1H), 3.48 (dd, $J=4.8, 9.9\text{Hz}$, 1H), 3.28 (dd, $J=7.7, 9.9\text{Hz}$, 1H), 2.57 (d, $J=2.2\text{Hz}$, 1H), 2.47 (ddd, $J=2.6, 3.4, 13.9\text{Hz}$, 1H), 1.77 (ddd, $J=2.2, 13.9\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 154.5, 137.6, 129.2, 128.8, 128.7, 128.6, 79.4, 78.7, 77.1, 71.9, 69.6, 54.6, 27.9, 11.5. Anal. Calcd for $\text{C}_{16}\text{H}_{15}\text{Cl}_3\text{INO}_2$: C, 39.50; H, 3.11; N, 2.88; found: C, 39.56; H, 3.32; N, 2.88.

Diels-Alder Cycloaddition:

To a solution of **3a** (30.0mg, 0.10mmol) and $\text{Zn}(\text{OTf})_2$ (0.02mmol, 7.5mg) in toluene (2 mL) was added dimethyl acetylenedicarboxylate (0.21mmol, 25.4 μL) and the reaction mixture was left stirred at 100°C for 48h. After removal of solvent in vacuo, the resulting oil was purified on a silica gel column, using $\text{EtOAc}/\text{hexane}(1/1)$ as eluent to produce **7** (25.5 mg, 57%) as dark yellow oil.

IR (neat): 3320, 1712 cm^{-1} .

^1H NMR (400 MHz, CDCl_3): δ 7.69 (s, 1H), 7.33-7.17 (m, 5H), 6.15 (td, $J=1.9, 2.2, 4.1\text{Hz}$, 1H), 4.56 (td, $J=7.7, 4.0\text{Hz}$, 1H), 3.79 (s, 1H), 3.54 (s, 1H), 3.60 (ddd, $J=1.8, 7.7, 14.3\text{Hz}$, 1H), 3.30 (ddd, $J=1.1, 7.4, 15.0\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 168.5, 167.3, 160.1, 140.8, 138.5, 129.5, 129.0, 128.6,

128.3, 128.2, 116.5, 53.2, 52.8, 45.7, 30.4, 29.5. HRMS submitted for analysis.