One Pot Synthesis of Indene through Copper(I)-catalyzed Three-components Coupling and Cyclization Reaction

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General Remarks:
Column chromatography was carried out on silica gel. $^1$H NMR spectra were recorded on 400 MHz in CDCl$_3$ and $^{13}$C NMR spectra were recorded on 100 MHz in CDCl$_3$ using TMS as internal standard. IR spectra were recorded on a FT-IR spectrometer and only major peaks are reported in cm$^{-1}$. Melting points were determined on a microscopic apparatus and were uncorrected. All new compounds were further characterized by element analysis; Copies of their $^1$H NMR and $^{13}$C NMR spectra are provided. Unless otherwise stated, all amines were purchased from commercial suppliers and used without further purification.

Starting Materials:
Diethyl (2-iodophenyl)malonate was prepared according to the literature$^1$
Diethyl (2-iodobenzyl)malonate and Dimethyl (2-iodobenzyl)malonate were prepared according to the literature$^2$

References

Typical procedure for the preparation of propargylic trimethylsilane

Diethyl 2-(2-(trimethylsilyl)entynyl)phenyl)malonate
To a solution of diethyl (2-iodophenyl)malonate (1.81 g, 5.0 mmol) and ethynyltrimethylsiane (0.58 g, 6 mmol) in Et$_2$NH (20.0 mL) was added Pd(PPh$_3$)$_4$ (57.5mg, 0.5 mol %). The mixture was stirred for 5 min and CuI (9.5mg, 1 mol %) was added. The resulting mixture was then stirring under an argon atmosphere at room temperature for 3 h. The ammonium salt was removed by filtration. The solvent was removed under reduced pressure and the residue was purified by column chromatography on silica gel to afford 1.53 g (92 %) as oil;

Diethyl 2-(2-(trimethylsilyl)entynyl)benzyl)malonate
The was prepared by the same method. But employing Diethyl (2-iodobenzyl)malonate (1.88 g, 5.0 mmol) and (0.58 g, 6 mmol) for 3 h afforded 1.54 g (89 %) as oil;

Dimethyl 2-(2-(trimethylsilyl)entynyl)benzyl)malonate
The was prepared by the same method. But employing Dimethyl (2-iodobenzyl)malonate (0.72 g, 2.0 mmol) and (0.17 g, 2.4 mmol) for 3 h afforded 0.54 g (90 %) as oil.

Typical procedure for the preparation of 1a-c.
To a solution of Diethyl 2-(2-(trimethylsilyl)entynyl)phenyl)malonate (0.66 g, 2.0 mmol) in THF (10 mL) was added TBAF at -78°C (0.76g, 2.4 mmol). After stirring for 10 min the reaction mixture was diluted with CH$_2$Cl$_2$. The CH$_2$Cl$_2$ solution was washed with water, dried over anhydrous sodium sulfate, and concentrated. The residue was purified by column chromatography on silica gel to afford the corresponding product $^{1a}$ 0.44g (85 %) as oil.

$^{1}$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.52-7.55 (m, 2H), 7.37-7.39 (m, 1H), 7.27-7.32 (m, 1H), 5.33 (s, 1H), 4.23-4.26 (m, 4H), 3.25 (s, 1H), 1.26-1.27 (t, J = 7.2 Hz, 6H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$
167.9, 135.2, 132.7, 129.1, 128.7, 127.9, 122.6, 82.2, 81.9, 61.9, 55.5, 13.9; IR (neat, cm⁻¹): 2956, 2252, 1631, 1309, 1248, 1146, 1045; Anal. Calcd for C₁₅H₁₆O₄: C 69.22; H 6.33. Found: C 69.08; H 6.33.

Diethyl 2-(2-entynylbenzyl)malonate
The 1b was prepared by the above method, but employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.58 g, 2.0 mmol) and methyl chloroformate afforded 1b 0.61 g (87 %) as oil.

![Image](1b)

¹H NMR (400 MHz, CDCl₃) δ 7.46-7.48 (d, J = 7.2 Hz, 1H), 7.18-7.20 (m, 2H), 4.12-4.18 (m, 4H), 3.87-3.91 (t, J = 7.6Hz, 1H), 3.37-3.39 (d, J = 7.6 Hz, 2H), 3.32 (s, 1H), 1.15-1.18 (t, J = 7.2 Hz, 6H); ¹³C NMR (100 MHz, CDCl₃) δ 168.8, 140.2, 132.9, 129.7, 128.8, 126.7, 121.8, 81.8, 81.5, 61.3, 52.1, 33.4, 13.9; IR (neat, cm⁻¹): 2923, 2167, 1676, 1331, 1234, 1167, 1045; Anal. Calcd for C₂₂H₃₁O₄: C 70.06; H 6.61. Found: C 70.08; H 6.63.

Dimethyl 2-(2-entynylbenzyl) malonate
The 1c was prepared by the above method, but employing Dimethyl 2-(2-(2-(trimethylsilyl)entynyl)benzyl)malonate (0.58 g, 2.0 mmol) and methyl chloroformate afforded 1c 0.61 g (87 %) as oil.

![Image](1c)

¹H NMR (400 MHz, CDCl₃) δ 7.46-7.48 (m, 1H), 7.17-7.28 (m, 3H), 3.91-3.95 (t, J = 7.6Hz, 1H), 3.69 (s, 6H), 3.38-3.40 (d, J = 7.6 Hz, 2H), 3.33 (s, 1H); ¹³C NMR (100 MHz, CDCl₃) δ 169.8, 140.6, 133.1, 129.7, 128.9, 126.8, 121.8, 81.9, 81.4, 52.4, 51.8, 33.5; IR (neat, cm⁻¹): 2956, 2223, 1667, 1354, 1268, 1123; Anal. Calcd for C₁₄H₁₄O₄: C 68.28; H 5.73. Found: C 68.25; H 5.78.

4a

¹H NMR (400 MHz, CDCl₃) δ 7.41-7.52 (m, 1H), 7.23-7.33 (m, 3H), 5.35 (s, 1H), 4.15-4.28 (m, 4H), 3.70 (s, 2H), 3.23-3.29 (m, 2H), 1.24-1.28 (t, J = 6.8 Hz, 6H); ¹³C NMR (100 MHz, CDCl₃) δ 168.2, 134.4, 132.1, 128.0, 127.8, 124.2, 94.1, 81.2, 61.7, 55.4, 48.4, 34.7, 20.7, 14.0; IR (neat, cm⁻¹): 3437, 2982, 2232, 1671, 1301, 1228, 1154, 1032; Anal. Calcd for C₂₂H₃₁NO₄: C 70.75; H 8.37; N 3.75. Found: C 70.77; H 8.35; N 3.68. HRMS (ESI) Calcd for C₂₂H₃₁NO₄: M+H = 374.2345. Found: 374.2326.

6a
1HNMR (400 MHz, CDCl3) δ 7.64-7.62 (d, J = 7.2 Hz, 1H), 7.17-7.26 (m, 3H), 6.82-6.84 (d, J =
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5.6 Hz, 1H), 6.49-6.50 (d, J = 5.6 Hz, 1H), 4.10-4.18 (m, 4H), 1.16-1.22 (m, 6H); 13C NMR (100
MHz, CDCl3) δ 167.6, 143.6, 139.8, 134.7, 133.4, 128.6, 126.3, 125.4, 121.5, 70.4, 62.1, 13.9;

General procedure for the preparation of indenes or dihydronaphthalene (5)
A mixture of (1, 0.20 mmol), paraformaldehyde (2, 0.40 mmol), amine (3, 0.04 mol), CuI (1.9mg,
5.0 mol %), 0.2g 4 ÅMS, THF (3.0 mL) was placed under argon atmosphere in a 10 mL flask.
The resulting mixture was then heated at 60°C. When the reaction was considered the first step complete as determined by TLC analysis, added t-BuOLi (19.2 mg, 0.24mmol), when the reaction was considered the complete as determined by TLC analysis, the reaction mixture was allowed to cool to room temperature. The reaction mixture was concentrated under reduced pressure and the residue was purified by chromatography on silica gel to afford the corresponding 2-substituted indenes 5a.

EtO2C
CO2Et
N(i-Pr)2
5aa

5aa: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 59mg (79 %)
of the indicated compound as oil: 1HNMR (400 MHz, CDCl3) δ 7.49-7.51 (d, J = 7.2 Hz, 1H),
7.14-7.20 (m, 2H), 7.05-7.18 (m, 1H), 6.19 (s, 1H), 4.09-4.19 (m, 4H), 3.441-3.448 (d, J = 2 Hz,
2H), 3.00-3.03 (t, J = 6.8 Hz, 2H), 1.15-1.18 (t, J = 7.2 Hz, 6H), 0.91-0.96 (d, J = 6.8 Hz, 12H); 13C NMR (100 MHz, CDCl3) δ 169.2, 140.1, 131.8, 130.0, 128.4, 126.8, 122.3, 96.7, 81.8, 61.6,
58.6, 52.5, 33.9, 24.2, 13.9; IR (neat, cm⁻¹): 3437, 2982, 1732, 1371, 1301, 1228, 1154, 1032;
Anal. Calcd for C22H31NO4: C 70.75 ; H 8.37; N 3.75. Found: C 70.78; H 8.33; N 3.69.  HRMS
(ESI) Calcd for C22H31NO4: C 70.75; H 8.37; N 3.75. Found: 70.78; H 8.33; N 3.69. HRMS (ESI) Calcd for C22H31NO4: M+H = 374.2351. Found: 374.2326.

EtO2C
CO2Et
NEt2
5ab

5ab: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 48.3 mg (70%
of the indicated compound as oil: 1HNMR (400 MHz, CDCl3) δ 7.49-7.51 (d, J = 7.2 Hz, 1H),
7.10-7.21 (m, 3H), 6.82 (s, 1H), 4.09-4.15 (m, 4H), 3.414-3.418 (d, J = 2 Hz, 2H), 2.48-2.53 (q, J = 7.2 Hz, 4H), 1.27-1.21 (t, J = 7.2 Hz, 6H), 1.06-1.01 (t, J = 7.2 Hz, 6H); 13C NMR (100 MHz,
CDCl3) δ 168.1, 146.2, 144.1, 141.4, 131.6, 128.5, 125.3, 124.8, 120.5, 70.7, 61.8, 52.3, 47.2,
13.9, 11.9; IR (neat, cm⁻¹): 3424, 2972, 1731, 1464, 1234, 1050; Anal. Calcd for C20H27NO4: C 69.54; H 7.88; N 4.05. Found: C 69.48; H 7.84; N 3.96. HRMS (ESI) Calcd for C20H27NO4: M+Li = 352.1568. Found: 352.2095.
5ac: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 52.3 mg (52 %) of the indicated compound as oil: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.56-7.58 (m, 1H), 7.14-7.29 (m, 3H), 6.90 (s, 1H), 4.15-4.23 (m, 4H), 3.45 (s, 2H), 2.41-2.45 (t, $J = 7.6$ Hz, 4H), 1.40-1.50 (m, 4H), 1.18-1.27 (m, 6H), 0.85-0.89 (t, $J = 7.6$ Hz, 6H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 168.2, 144.2, 140.9, 139.6, 131.4, 128.5, 125.3, 124.8, 120.8, 70.7, 61.8, 56.5, 53.3, 13.9, 11.9; IR (neat, cm$^{-1}$): 3434, 2981, 1726, 1459, 1239, 1047; Anal. Calcd for C$_{22}$H$_{31}$NO$_4$: C 70.75; H 8.37; N 3.75. HRMS (ESI) Calcd for C$_{22}$H$_{31}$NO$_4$: M+H = 374.2350. Found: 374.2326.

5ad: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 54.5mg (68 %) of the indicated compound as oil: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.61-7.59 (d, $J = 7.2$ Hz, 1H), 7.19-7.31 (m, 3H), 6.93 (s, 1H), 4.19-4.23 (m, 4H), 3.47 (d, $J = 1.6$ Hz, 2H), 1.36-1.48 (m, 4H), 1.27-1.34 (m, 4H), 1.21-1.25 (m, 6H), 0.90-0.94 (t, $J = 7.2$ Hz, 6H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 168.2, 146.5, 144.2, 141.0, 131.2, 128.5, 125.3, 124.8, 120.8, 70.8, 61.8, 54.3, 53.3, 29.5, 20.6, 14.1, 13.9; IR (neat, cm$^{-1}$): 3434, 2972, 1731, 1464, 1234, 1050; Anal. Calcd for C$_{24}$H$_{35}$NO$_4$: C 71.79; H 8.79; N 3.49. Found: C 71.81; H 8.77; N 3.45. HRMS (ESI) Calcd for C$_{24}$H$_{35}$NO$_4$: M+H = 402.1717. Found: 402.2639.

5ae: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 86.4 mg (82 %) of the indicated compound as oil: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.58-7.60 (d, $J = 7.2$ Hz, 1H), 7.23-7.30 (m, 2H), 7.14-7.18 (m, 1H), 6.91 (s, 1H), 4.12-4.22 (m, 4H), 3.45-3.46 (d, $J = 1.6$ Hz, 2H), 2.45-2.48 (t, $J = 7.6$ Hz, 4H), 1.46 (s, 4H), 1.19-1.28 (m, 26H), 0.85-0.89 (t, $J = 6.8$ Hz, 6H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 168.2, 146.5, 144.2, 141.0, 131.2, 128.5, 125.3, 124.8, 120.7, 70.8, 61.8, 54.5, 53.3, 31.8, 29.6, 29.3, 27.5, 27.3, 22.6, 14.0, 13.9; IR (neat, cm$^{-1}$): 3451,
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1736, 1468, 1254, 1038; Anal. Calcd for C\textsubscript{33}H\textsubscript{55}NO\textsubscript{4}: C 75.10; H 10.12; N 2.65. Found: C 75.12; H 10.06; N 2.63. HRMS (ESI) Calcd for C\textsubscript{33}H\textsubscript{55}NO\textsubscript{4}: M+H = 528.4073. Found: 528.4047.

\textbf{5af:} The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 54.8 mg (80 \%) of the indicated compound as oil: \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 7.59-7.61 (d, J = 8.0 Hz, 1H), 7.24-7.32 (m, 2H), 7.17-7.21 (m, 1H), 6.88 (s, 1H), 4.15-4.23 (m, 4H), 3.59 (s, 2H), 2.60-2.63 (t, J = 6.4 Hz, 4H), 1.78-1.81 (m, 4H), 1.22-1.30 (m, 6H); \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) δ 168.1, 145.2, 144.0, 140.9, 131.7, 128.5, 125.5, 124.9, 120.9, 71.0, 61.8, 54.5, 54.4, 23.7, 13.9; IR ( neat, cm\textsuperscript{-1}): 3402, 2964, 1731, 1463, 1234, 1050; Anal. Calcd for C\textsubscript{20}H\textsubscript{25}NO\textsubscript{4}: C 69.95; H 7.34; N 4.08. Found: C 69.86; H 7.38; N 3.99. HRMS (ESI) Calcd for C\textsubscript{20}H\textsubscript{25}NO\textsubscript{4}: M+H = 344.1837. Found: 344.1856.

\textbf{5ag:} The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 53.6 mg (81\%) of the indicated compound as oil: \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 7.59-7.60 (d, J = 7.6 Hz, 1H), 7.25-7.31 (m, 2H), 7.16-7.20 (m, 1H), 6.85 (s, 1H), 4.16-4.23 (m, 4H), 3.39 (s, 2H), 2.46 (s, 4H), 1.56-1.60 (m, 4H), 1.44-1.45 (d, J = 4.4 Hz, 1H), 1.22-1.26 (t, J = 6.8 Hz, 6H); \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) δ 168.1, 144.5, 143.9, 141.1, 132.1, 128.5, 125.5, 124.8, 120.8, 70.8, 61.9, 57.6, 55.0, 26.1, 24.4, 13.9; IR ( neat, cm\textsuperscript{-1}): 3431, 2934, 1731, 1465, 1236, 1049; Anal. Calcd for C\textsubscript{21}H\textsubscript{27}NO\textsubscript{4}: C 70.56; H 7.61; N 3.92. Found: C 70.36; H 7.67; N 3.78. HRMS (ESI) Calcd for C\textsubscript{21}H\textsubscript{27}NO\textsubscript{4}: M+H = 358.2033. Found: 358.2013.

\textbf{5ah:} The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 52.7 mg (71 \%) of the indicated compound as oil: \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 7.59-7.60 (d, J = 7.6 Hz, 1H), 7.23-7.30 (m, 2H), 7.16-7.20 (m, 1H), 6.85 (s, 1H), 4.15-4.23 (m, 4H), 3.99-3.999 (d, J = 1.2 Hz, 2H), 2.95-2.96 (d, J = 11.6 Hz, 2H), 1.94-2.00 (m, 2H), 1.59-1.62 (d, J = 12.8 Hz, 2H), 1.27-1.38 (m, 1H), 1.18-1.28 (m, 7H), 0.90-0.93 (t, J = 5.6 Hz, 3H); \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) δ 168.1, 144.6, 143.9, 141.1, 132.1, 128.5, 125.4, 124.8, 120.8, 70.8, 61.8, 57.3, 54.3, 34.6, 30.8,

**5ai:** The reaction mixture was chromatographed using 1:1 CH₃OH/EtOAc to afford 53.6 mg (82%) of the indicated compound as oil: ¹H NMR (400 MHz, CDCl₃) δ 7.52-7.53 (d, J = 7.6 Hz, 1H), 7.12-7.22 (m, 3H), 6.78 (s, 1H), 4.11-4.13 (m, 4H), 3.385-3.389 (d, J = 1.6 Hz, 2H), 2.52 (s, 8H), 1.19-1.15 (m, 6H); ¹³C NMR (100 MHz, CDCl₃) δ 167.9, 143.7, 143.6, 141.0, 132.4, 128.5, 125.6, 124.8, 120.9, 70.8, 61.9, 56.6, 55.2, 53.0, 45.9, 13.9; IR (neat, cm⁻¹): 3435, 2939, 1738, 1465, 1238, 1056; Anal. Calcd for C₂₁H₂₈N₂O₄: C 69.72; H 7.58; N 7.52. Found: C 69.75; H 7.62; N 7.49. HRMS (ESI) Calcd for C₂₁H₂₈N₂O₄: M+H = 373.2123. Found: 373.2122.

**5aj:** The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 48.7 mg (62%) of the indicated compound as oil: ¹H NMR (400 MHz, CDCl₃) δ 7.52-7.53 (d, J = 7.6 Hz, 1H), 7.19-7.38 (m, 8H), 7.00 (s, 1H), 4.10-4.20 (m, 4H), 3.60-3.62 (d, J = 10.4 Hz, 2H), 3.48-3.52 (m, 2H), 2.24 (s, 3H), 1.18-1.21 (t, J = 7.2 Hz, 6H); ¹³C NMR (100 MHz, CDCl₃) δ 168.1, 145.1, 143.9, 141.0, 139.5, 132.0, 128.7, 128.6, 125.5, 124.8, 120.9, 70.8, 62.3, 61.9, 56.3, 42.5, 13.9; IR (neat, cm⁻¹): 3435, 2939, 1738, 1465, 1238, 1042; Anal. Calcd for C₂₄H₂₇NO₄: C 72.36; H 6.92; N 3.56. Found: C 72.38; H 7.01; N 3.58. HRMS (ESI) Calcd for C₂₄H₂₇NO₄: M+H = 394.2041. Found: 394.2013.

**5ak:** The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 52.1 mg (64%) of the indicated compound as oil: ¹H NMR (400 MHz, CDCl₃) δ 7.52-7.53 (d, J = 7.6 Hz,
1H), 7.19-7.38 (m, 8H), 7.00 (s, 1H), 4.08-4.18 (m, 4H), 3.67-3.62 (s, 2H), 3.51-3.50 (d, \( J = 1.6 \) Hz, 2H), 2.55-2.60 (q, \( J = 7.2 \) Hz, 4H), 1.16-1.20 (t, \( J = 7.2 \) Hz, 6H), 1.06-1.10 (t, \( J = 7.2 \) Hz, 6H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 168.1, 145.1, 143.9, 141.0, 139.5, 132.0, 128.7, 128.6, 125.5, 124.8, 120.9, 70.8, 62.3, 61.9, 56.3, 42.5, 13.9; IR (neat, cm\(^{-1}\)): 3435, 2939, 1738, 1465, 1238, 1047; Anal. Calcd for C\textsubscript{25}H\textsubscript{29}NO\textsubscript{4}: C 73.68; H 7.17; N 3.44. Found: C 73.36; H 7.18; N 3.45. HRMS (ESI) Calcd for C\textsubscript{25}H\textsubscript{29}NO\textsubscript{4}: M+H = 408.2187. Found: 408.2169.

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**5al**: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 34.1 mg (45 %) of the indicated compound as oil: \(^{1}H\) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.62-7.64 (d, \( J = 7.6 \) Hz, 1H), 7.15-7.28 (m, 8H), 7.76-7.78 (m, 2H), 6.58 (s, 1H), 3.44-3.45 (d, \( J = 1.6 \) Hz, 2H), 4.13-4.11 (m, 4H), 3.07 (s, 3H), 1.27-1.30 (t, \( J = 7.2 \) Hz, 6H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 167.8, 143.4, 143.1, 140.9, 131.3, 129.1, 128.7, 125.6, 125.0, 121.0, 116.2, 62.3, 52.2, 38.5, 13.9; IR (neat, cm\(^{-1}\)): 3453, 2949, 1756, 1467, 1055; Anal. Calcd for C\textsubscript{23}H\textsubscript{25}NO\textsubscript{4}: C 72.80; H 6.64; N 3.69. Found: C 72.86; H 6.67; N 3.68. HRMS (ESI) Calcd for C\textsubscript{23}H\textsubscript{25}NO\textsubscript{4}: M+Na = 402.2660. Found: 402.1676.

**5am**: The reaction mixture was chromatographed using EtOAc to afford 53.6 mg (56 %) of the indicated compound as a solid: mp 146-148 °C; \(^{1}H\) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.59-7.61 (d, \( J = 7.6 \) Hz, 2H), 7.17-7.31 (m, 6H), 6.85 (s, 2H), 4.16-4.23 (m, 8H), 3.45 (s, 4H), 2.56 (s, 8H), 1.19-1.15 (t, \( J = 7.2 \) Hz, 12H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 168.0, 144.0, 143.8, 141.0, 132.4, 128.5, 124.9, 120.9, 70.8, 61.9, 56.8, 13.9; IR (neat, cm\(^{-1}\)): 3435, 2939, 1738, 1465, 1238, 1047; Anal. Calcd for C\textsubscript{36}H\textsubscript{42}N\textsubscript{2}O\textsubscript{8}: C 68.55; H 6.71; N 4.44. Found: C 68.48; H 6.67; N 4.47. HRMS (ESI) Calcd for C\textsubscript{36}H\textsubscript{42}N\textsubscript{2}O\textsubscript{8}: M+H = 631.3061. Found: 631.3014.

**5ba**: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 53.4 mg (69 %) of the indicated compound as oil: \(^{1}H\) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.52-7.53 (d, \( J = 7.6 \) Hz, 1H), 7.12-7.22 (m, 3H), 6.78 (s, 1H), 4.13-4.11 (m, 4H), 3.385-3.389 (d, \( J = 1.6 \) Hz, 2H), 2.52 (s, 8H), 1.19-1.15 (t, \( J = 7.2 \) Hz, 6H), 1.02-1.03 (d, \( J = 6.8 \) Hz, 12H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 170.8, 137.9, 133.1, 132.1, 127.1, 126.9, 126.8, 126.0, 125.0, 61.5, 58.7, 48.0, 47.5, 20.7, 14.0; IR (neat, cm\(^{-1}\)): 3432, 2923, 1743, 1463, 1248, 1056; Anal. Calcd for C\textsubscript{23}H\textsubscript{33}NO\textsubscript{4}: C 71.29; H 8.58;
N 3.61. Found: C 71.36; H 8.57; N 3.68. HRMS (ESI) Calcd for C$_{23}$H$_{33}$NO$_4$: M+H = 388.2514. Found: 388.2482.

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**5bb**: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 36.6 mg (51 %) of the indicated compound as oil: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.07-7.26 (m, 4H), 6.71 (s, 1H), 4.06-4.22 (m, 4H), 3.45 (s, 2H), 3.30-3.33 (d, $J = 1.6$ Hz, 2H), 2.53-2.60 (m, 4H), 1.19-1.23 (t, $J = 7.2$ Hz, 6H), 0.99 (s, 6H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.6, 139.6, 132.4, 130.6, 128.5, 128.2, 126.8, 126.1, 61.4, 57.9, 46.03, 36.2, 14.0, 13.9, 10.9; IR (neat, cm$^{-1}$): 3436, 2949, 1768, 1467, 1238, 1087; Anal. Calcd for C$_{21}$H$_{29}$NO$_4$: C 70.17; H 8.13; N 3.90. Found: C 70.16; H 8.17; N 3.98. HRMS (ESI) Calcd for C$_{21}$H$_{29}$NO$_4$: M+H = 360.2197. Found: 360.2169.

$^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.8, 132.7, 132.5, 127.3, 127.2, 126.9, 126.8, 61.51, 59.6, 57.7, 53.8, 36.1, 23.9, 23.7, 13.9; IR (neat, cm$^{-1}$): 3454, 2980, 1743, 1455, 1239, 1043; Anal. Calcd for C$_{21}$H$_{27}$NO$_4$: C 70.56; H 7.61; N 3.92. Found: C 70.36; H 7.67; N 3.78. HRMS (ESI) Calcd for C$_{21}$H$_{27}$NO$_4$: M+H = 358.2037. Found: 358.2013.

**5be**: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 41.4 mg (56 %) of the indicated compound as oil: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.07-7.16 (m, 4H), 6.04 (s, 1H), 4.06-4.20 (m, 4H), 3.46 (s, 2H), 3.39 (s, 2H), 2.49 (s, 4H), 1.75 (s, 4H), 1.20-1.24 (m, 6H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 171.4, 137.6, 132.9, 131.9, 127.1, 126.1, 125.5, 58.6, 48.5, 36.5, 30.7; IR (neat, cm$^{-1}$): 3435, 2939, 1738, 1465, 1238, 1047; Anal. Calcd for C$_{21}$H$_{29}$NO$_4$: C 70.17; H 7.61; N 3.92. Found: C 70.26; H 7.67; N 3.98. HRMS (ESI) Calcd for C$_{21}$H$_{29}$NO$_4$: M+H = 360.2190. Found: 360.2169.

**5ca**: The reaction mixture was chromatographed using 10:1 hexanes/EtOAc to afford 53.4 mg (69 %) of the indicated compound as oil: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.06-7.16 (m, 4H), 6.97 (s, 1H), 3.74 (s, 6H), 3.45 (s, 2H), 3.27-3.28 (d, $J = 1.6$ Hz, 2H), 3.05-3.12 (m, 2H), 1.01-1.03 (d, $J = 6.8$ Hz, 12H); $^{13}$C NMR (100 MHz, CDCl$_3$) 171.4, 137.6, 132.9, 131.9, 127.1, 127.0, 126.1, 125.5, 58.6, 48.5, 36.5, 20.7; IR (neat, cm$^{-1}$): 3435, 2939, 1738, 1465, 1238, 1047; Anal. Calcd for C$_{21}$H$_{29}$NO$_4$: C 70.17; H 8.13; N 3.90. Found: C 70.26; H 8.17; N 3.98. HRMS (ESI) Calcd for C$_{21}$H$_{29}$NO$_4$: M+H = 360.2190. Found: 360.2169.
EtO₂C
\[ \text{CO₂Et} \]
\[ \text{N} \]
\[ \text{5ag} \]