Supplementary Material

C-H Activation as a Strategic Reaction: Enantioselective Synthesis of 4-Substituted Indoles

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General: All experiments were performed under anhydrous conditions in an atmosphere of argon except where stated, using flame-dried glassware. 2,2-Dimethylbutane (DMB) was

purified by passing through silica gel (activated by heating under argon) then distilled from sodium and degassed by bubbling argon through the solution for 10 min prior to use. Acetonitrile was dried by a solvent purification system. Aqueous solutions of ammonium chloride (NH_4Cl) and sodium bicarbonate (NaHCO_3) were saturated. Unless otherwise noted, all other reagents were obtained from commercial sources and used as received. ^1H Nuclear Magnetic Resonance (NMR) spectra were recorded at 400 or 500 MHz. Data are presented as follows: chemical shift (in ppm on the δ scale relative to δH 7.26 for the residual protons in CDCl_3), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, p = pentet, m = multiplet), coupling constant (J/Hz), integration. Coupling constants were taken directly from the spectra and are uncorrected. ^{13}C NMR spectra were recorded at 75 or 125 MHz, and all chemical shift values are reported in ppm on the δ scale, with an internal reference of δC 77.0 for CDCl_3 . Mass spectral determinations were carried out by LC-MS (ESI), or electron impact ionization (EI). Melting points are uncorrected. Infrared spectral data are reported in units of cm^{-1} . Optical rotations were measured at the sodium D line (589 nm) and reported as follows: $[\alpha]_{\text{D}}^{25}$, concentration (c in g/100 mL) and solvent (all rotations were measured at 25.0 °C). Enantiomeric excess was determined by HPLC using a Chiralcel OD, Chiralcel OD-H, Chiralcel OJ, Chiralpak AD-H, Chiralpak AS-H or Chiralpak AD-RH chiral analytical column (UV detection at 254 nm). Analytical TLC was performed on silica gel plates using UV light. Flash column chromatography was performed on silica gel 60A (230-400 mesh).

Synthesis of starting materials

tert-Butyl 4,5,6,7-tetrahydro-4-oxoindole-1-carboxylate (11)

Prepared *via* a modified literature procedure:¹ To a flame-dried 250 mL round bottom flask under argon and charged with a stir bar was added 1,5,6,7-tetrahydro-4*H*-indol-4-one (4.8 g, 35.5 mmol), di-*tert*-butyl dicarbonate (8.4 g, 38.6 mmol), and 150 mL dry acetonitrile. DMAP (43 mg, 0.36 mmol) was then added and the solution stirred overnight at ambient temperature. Imidazole (0.48 g, 7.1 mmol) was then added and the solution stirred for an additional 15 min. Chloroform (250 mL) was then added and the mixture washed with 0.5% HCl solution (3X200 mL). The organic layer was then dried over anhydrous MgSO₄, filtered through a plug of silica gel and concentrated *in vacuo* to give pure **11** as a white solid (8.1 g, 97% yield), mp 79-80 °C; R_f 0.24 (1:1 pentane:diethyl ether); FTIR (neat): 2978, 1745, 1671 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.16 (d, *J* = 3.4 Hz, 1H), 6.55 (d, *J* = 3.4 Hz, 1H), 3.13 (t, *J* = 6.0 Hz, 2H), 2.48 (m, 2H), 2.15 (m, 2H), 1.61 (s, 9H), ¹³C NMR (75 MHz, CDCl₃) δ 194.8 (C), 148.5 (C), 144.9 (C), 124.0 (C), 121.4 (CH), 107.1 (CH), 84.8 (C), 37.3 (CH₂), 27.8 (CH₃), 24.2 (CH₂), 23.3 (CH₂); LRMS (EI) *m/z* (relative intensity): 235.1 (40), 57.1 (100); HRMS (EI) Calcd for C₁₃H₁₇NO₃ 235.1203, Found 235.1210; Anal. Calcd for C₁₃H₁₇NO₃: C, 66.36; H, 7.28; N, 5.95. Found: C, 66.25; H, 7.23; N, 5.97.

***tert*-Butyl 4-acetoxy-6,7-dihydroindole-1-carboxylate (1)**

Prepared *via* a modified literature procedure:² To a dry 250 mL round bottom flask charged with a magnetic stir bar was added **11** (2.77 g, 11.8 mmol), isopropenyl acetate (200 mL) and *p*-toluenesulfonic acid monohydrate (1.12 g, 5.9 mmol). The solution was refluxed for 7 h. After cooling the solution to ambient temperature, 300 mL of a 1:1 solution of diethyl ether and saturated aqueous NaHCO₃ was added. The layers were separated and the aqueous layer extracted with 30 mL of diethyl ether. The combined ether extracts were washed with saturated aqueous NaHCO₃ (150 mL) and dried over anhydrous Na₂SO₄. The solution was then filtered and concentrated *in vacuo*. The residue was purified *via* flash chromatography (silica gel, 5:1 pentane:diethyl ether) to give pure **1** as a white solid (1.80 g, 55% yield), mp 79-80 °C; R_f 0.26 (5:1 pentane:diethyl ether); FTIR (neat): 2978, 1736 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 7.09 (d, *J* = 3.5 Hz, 1H), 5.95 (d, *J* = 3.5 Hz, 1H), 5.24 (t, *J* = 4.5 Hz, 1H), 3.10 (t, *J* = 9.5 Hz, 2H), 2.56 (dt, *J* = 9.5, 4.5 Hz, 2H), 2.23 (s, 3H), 1.58 (s, 9H); ¹³C NMR (75 MHz, CDCl₃) δ 169.1 (C), 149.0 (C), 143.3 (C), 130.8 (C), 119.9 (CH), 118.9 (C), 106.8 (CH), 105.4 (CH), 83.8 (C), 27.9 (CH₃), 23.1 (CH₂), 21.7 (CH₂), 20.7 (CH₃); LRMS (ESI) *m/z* (relative intensity): 250.0 (100), 236.0 (90); HRMS (EI) Calcd for C₁₅H₁₉NO₄ 277.1309, Found 277.1309.

2-Bromo-4-oxo-4,5,6,7-tetrahydro-indole-1-carboxylic acid *tert*-butyl ester (**12**)

Prepared *via* a modified literature procedure.¹ To a flame-dried round bottom flask charged with a stir bar and under argon was added 2-bromo-1,5,6,7-tetrahydro-indol-4-one³ (1.05 g, 4.92 mmol), di-*tert*-butyl-dicarbonate (1.18 g, 5.41 mmol) and acetonitrile (70 mL). The solution was stirred and DMAP (6 mg, 0.049 mmol) was added. The solution was stirred for 1 h and then imidazole (0.067 g, 0.98 mmol) was added in one portion. The solution was stirred for an additional 15 min and then diluted with chloroform (100 mL), washed with 0.5% aqueous HCl solution (3X100 mL), dried over anhydrous magnesium sulfate, filtered and concentrated *in vacuo*. The residue was purified *via* flash chromatography (silica gel, 4:1-2:1 pentane:diethyl ether) to yield the pure product as a white solid (1.47 g, 95% yield). R_f 0.17 (2:1 pentane:diethyl ether); FTIR (neat): 2978, 2946, 1753, 1672 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.66 (s, 1H), 3.03 (t, $J = 6.0$ Hz, 2H), 2.47 (m, 2H), 2.14 (m, 2H), 1.65 (s, 9H); ^{13}C NMR (75 MHz, CDCl_3) δ 192.8 (C), 147.3 (C), 145.8 (C), 122.9 (C), 112.0 (CH), 102.2 (C), 86.1 (C), 36.9 (CH_2), 27.5 (CH_3), 24.6 (CH_2), 23.0 (CH_2); LRMS (EI) m/z (relative intensity): 212.9 (38), 57.0 (100); HRMS (EI) Calcd for $[\text{C}_{13}\text{H}_{16}\text{NO}_3\text{Br}]^{81+}$ 315.0288, Found 315.0284; Anal. Calcd for $\text{C}_{13}\text{H}_{16}\text{NO}_3\text{Br}$: C, 49.70; H, 5.13; N, 4.46. Found: C, 49.52; H, 5.10; N, 4.40.

4-Oxo-4,5,6,7-tetrahydro-[2,2']biindolyl-1,1'-dicarboxylic acid di-*tert*-butyl ester (13)

Prepared *via* a modified literature procedure.⁴ To a round bottom flask charged with a stir bar was added **12** (2.5 g, 8.0 mmol) and *N*-BOC indole-2-boronic acid⁵ (2.1 g, 8.0 mmol). The flask was purged with argon and *tetrakis*(triphenylphosphine)palladium (0.19 g, 0.16 mmol) was then added. A reflux condenser was attached and the apparatus was evacuated and refilled with argon three times. Degassed toluene (70 mL) and degassed methanol (10 mL) were added via syringe. Aqueous 2M sodium carbonate solution (10 mL) was then added in one portion. The solution was heated to 80 °C and stirred for 24 h. The solution was then cooled, the layers separated and the organic layer was dried over anhydrous magnesium sulfate, filtered through a plug of silica gel and concentrated *in vacuo*. The residue was then purified *via* flash chromatography (silica gel, 5:1-2:1 pentane:diethyl ether) to give pure **13** as a white solid (2.75 g, 76% yield). mp 163-164 °C, *R*_f 0.14 (2:1 pentane:diethyl ether); FTIR (neat): 2974, 1729, 1672, 1332, 1318, 1161, 1133 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 8.27 (d, *J* = 7.5 Hz, 1H), 7.54 (d, *J* = 7.5 Hz, 1H), 7.34 (*appt.* t, *J* = 7.5 Hz, 1H), 7.24 (*appt.* t, *J* = 7.5 Hz, 1H), 6.61 (s, 1H), 6.56 (s, 1H), 3.22 (m, 2H), 2.53 (t, *J* = 6.5 Hz, 2H), 2.19 (*appt.* p, *J* = 6.5 Hz, 2H), 1.40 (s, 9H), 1.18 (s, 9H); ¹³C NMR (75 MHz, CDCl₃) δ 194.6 (C), 149.6 (C), 148.8 (C), 147.0 (C), 136.7 (C), 131.2 (C), 128.6 (C), 127.8 (C), 124.7 (CH), 122.8 (CH), 122.3 (C), 120.5 (CH), 115.6 (CH), 111.4 (CH), 110.6 (CH), 84.7 (C), 83.4 (C), 37.5 (CH₂), 27.7 (CH₃), 27.3 (CH₃), 25.0 (CH₂), 23.5 (CH₂); LRMS (EI) *m/z* (relative intensity): 450.2 (31) [M]⁺, 294.1 (75), 250.1 (100); HRMS (EI) Calcd for [C₂₆H₃₀N₂O₅]⁺ 450.2149, Found 450.2164.

***tert*-Butyl 2-(1-(*tert*-butoxycarbonyl)-4-oxo-4,5,6,7-tetrahydro-1*H*-indol-2-yl)-1*H*-indole-1-carboxylate (9)**

Prepared *via* a modified literature procedure.¹ To a dry 50 mL round bottom flask charged with a magnetic stir bar was added **13** (0.113 g, 0.25 mmol), isopropenyl acetate (25 mL) and *p*-toluenesulfonic acid monohydrate (0.048 g, 0.25 mmol). The solution was refluxed for 7 h. After cooling the solution to ambient temperature, 50 mL of a 1:1 solution of diethyl ether and saturated aqueous NaHCO₃ was added. The layers were separated and the aqueous layer extracted with 20 mL of diethyl ether. The combined ether extracts were washed with saturated aqueous NaHCO₃ (30 mL) and dried over anhydrous Na₂SO₄. The solution was then filtered and concentrated *in vacuo*. The residue was then purified *via* flash chromatography (silica gel, 5:1 pentane:diethyl ether) to give the product as a white solid (0.065 g, 53% yield). mp 80-82 °C, *R*_f 0.21 (7:1 pentane:diethyl ether); FTIR (neat): 2978, 2929, 1727, 1333, 1158, 1139, 1124 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 8.28 (d, *J* = 8.0 Hz, 1H), 7.51 (d, *J* = 7.5 Hz, 1H), 7.31 (dd, *J* = 8.0, 7.5 Hz, 1H), 7.22 (dd, *J* = 8.0, 7.5 Hz, 1H), 6.54 (s, 1H), 6.03 (s, 1H), 5.29 (t, *J* = 4.5 Hz, 1H), 3.19 (t, *J* = 9.5 Hz, 2H), 2.59 (m, 2H), 2.22 (s, 3H), 1.41 (s, 9H), 1.16 (s, 9H); ¹³C NMR (75 MHz, CDCl₃) δ 169.1 (C), 150.0 (C), 149.2 (C), 143.1 (C), 137.0 (C), 133.3 (C), 132.2 (C), 128.7 (C), 126.0 (C), 124.5 (CH), 122.7 (CH), 120.4 (CH), 117.6 (C), 115.7 (CH), 111.0 (CH), 109.3 (CH), 107.2 (CH), 83.8 (C), 83.3 (C), 27.8 (CH₃), 27.5 (CH₃), 23.3 (CH₂), 22.3 (CH₂), 20.8 (CH₃); LRMS (EI) *m/z* (relative intensity): 492.2 (28) [M]⁺, 336.1 (100), 294.1 (71); HRMS (EI) Calcd for [C₂₈H₃₂N₂O₆]⁺ 492.2255, Found 492.2268.

6,7-Dihydro-2-nitrobenzo[*b*]thiophen-4-yl acetate (**14**)

Prepared via a modified literature procedure:¹ To a flame-dried 100 mL round bottom flask charged with a stir bar was added 6,7-dihydro-2-nitrobenzo[*b*]thiophen-4(5*H*)-one⁶ (0.40 g, 2.0 mmol), isopropenyl acetate (75 mL), and *p*-toluenesulfonic acid monohydrate (50 mg, 0.26 mmol). The solution was refluxed for 8 h during which time the solvent was slowly distilled off at a rate of 7 mL/h. The solution was then allowed to cool to ambient temperature and a solution of 1:1 diethyl ether:saturated aqueous NaHCO₃ was added. The layers were separated and the aqueous layer was extracted with diethyl ether (30 mL). The combined ether layers were then washed with saturated aqueous NaHCO₃ (2X25 mL), brine (25 mL) and dried over anhydrous MgSO₄. The solution was then filtered through a plug of silica gel, concentrated *in vacuo* and the residue purified via flash chromatography (silica gel, 3:1 pentane:diethyl ether) to give pure **14** as a sticky yellow solid (0.215 g, 45% yield), *R*_f 0.36 (1:1 pentane:diethyl ether); FTIR (neat): 1759, 1319, 1204, 1163 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 7.59 (s, 1H), 5.64 (t, *J* = 4.7 Hz, 1H), 2.96 (t, *J* = 8.7 Hz, 2H), 2.63 (td, *J* = 8.7, 4.7 Hz, 2H), 2.29 (s, 3H); ¹³C NMR (75 MHz, CDCl₃) δ 168.8 (C), 145.5 (C), 141.6 (C), 131.9 (C), 122.9 (CH), 112.8 (CH), 22.9 (CH₂), 22.4 (CH₂), 20.7 (CH₃), missing peak attributed to nitro-bearing carbon; LRMS (EI) *m/z* (relative intensity): 238.9 (25); HRMS (EI) Calcd for [C₁₀H₉NO₄S]⁺ 239.0247, Found 239.0252.

General Procedure for the Combined C-H Activation/Cope Rearrangement-Elimination

Reaction and Compound Characterization Data

The following procedure is typical for all of the combined C-H activation/Cope rearrangement-elimination reactions: To a flame-dried 50 mL round bottom flask under argon and charged with a magnetic stir bar was added **1** (0.140 g, 0.50 mmol), $\text{Rh}_2(\text{S-DOSP})_4$ ⁷ (9.4 mg, 0.0050 mmol) and 10 mL of degassed DMB. A solution of diazoacetate (1.2-2.0 eq) in 5 mL of degassed DMB and 5 mL anhydrous α,α,α -trifluorotoluene was then added with stirring at ambient temperature *via* syringe pump over 30 min. The solvent was then removed *in vacuo* and the residue purified by flash chromatography to give the product.

tert-Butyl 4-((*S,E*)-3-(methoxycarbonyl)-1-phenylallyl)-1*H*-indole-1-carboxylate (**4a**)

Reaction was performed using 0.131 g (0.65 mmol, 1.3 eq) of the diazoacetate **3a**. Purified *via* flash chromatography (silica gel, 7:1 pentane:diethyl ether) to give **4a** as a sticky white solid (0.126 g, 65% yield), R_f 0.26 (5:1 pentane:diethyl ether); $[\alpha]_D^{25} +21.0^\circ$ (c 0.82, CHCl_3); FTIR (neat): 2950, 1720, 903, 735 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 8.09 (d, J = 8.1 Hz, 1H), 7.54-7.49 (m, 2H), 7.31-7.17 (m, 6H), 7.02 (d, J = 7.3 Hz, 1H), 6.43 (d, J = 3.7 Hz, 1H), 5.72 (dd, J = 15.7, 1.5 Hz, 1H), 5.24 (d, J = 6.6 Hz, 1H), 3.72 (s, 3H), 1.66 (s, 9H); ^{13}C NMR (75 MHz, CDCl_3) δ 166.8 (C), 149.6 (CH), 141.0 (C), 135.4 (C), 133.5 (C), 129.5 (C), 128.6 (CH), 128.5 (CH), 126.9 (CH), 125.8 (CH), 124.3 (CH), 122.7 (CH), 122.2 (CH), 114.2 (CH), 105.4 (CH), 83.7 (C), 51.5 (CH_3), 50.8 (CH), 28.1 (CH_3), missing carbon attributed to accidental

equivalence); HRMS (EI) Calcd for C₂₄H₂₅NO₄ 391.1778, Found 391.1786; HPLC analysis:

98.5% ee (Chiralcel OD-H, 4% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 8.7 min,

major; 15.9 min, minor).

***tert*-Butyl 4-((*S,E*)-3-(methoxycarbonyl)-1-(4-methoxyphenyl)allyl-1*H*-indole-1-carboxylate**
(4b)

Reaction was performed using 0.151 g (0.65 mmol, 1.3 eq) of the diazoacetate **3b**. Purified via flash chromatography (silica gel, 5:1 pentane:diethyl ether) to give **4b** as a white solid (0.109 g,

52% yield), mp 70-73 °C; R_f 0.16 (5:1 pentane:diethyl ether); $[\alpha]_D^{25} +18.9^\circ$ (c 1.29, CHCl₃);

FTIR (neat): 2978, 1723, 1249, 1157, 1123, 729 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 8.08 (d, J = 8.0 Hz, 1H), 7.54 (d, J = 4.0 Hz, 1H), 7.49 (dd, J = 15.5, 7.0 Hz, 1H), 7.27 (*appt.* t, J = 8.0 Hz, 1H), 7.08 (d, J = 8.5 Hz, 2H), 7.00 (d, J = 7.0 Hz, 1H), 6.83 (d, J = 8.5 Hz, 2H), 6.42 (d, J = 4.0 Hz, 1H), 5.70 (dd, J = 15.5, 1.5 Hz, 1H), 5.18 (d, J = 7.0 Hz, 1H), 3.77 (s, 3H), 3.72 (s, 3H), 1.65

(s, 9H); ¹³C NMR (125 MHz, CDCl₃) δ 166.9 (C), 158.4 (C), 150.0 (CH), 149.6 (C), 135.4 (C), 133.8 (C), 133.0 (C), 129.5 (CH), 129.4 (C), 125.8 (CH), 124.3 (CH), 122.4 (CH), 122.1 (CH), 114.1 (CH), 113.9 (CH), 105.5 (CH), 83.7 (C), 55.2 (CH₃), 51.5 (CH₃), 50.0 (CH), 28.1 (CH₃);

LRMS (ESI) m/z (relative intensity): 444.2 (49) [M+Na]⁺; HPLC analysis: 98.0% ee (Chiralpak AD-RH, 4% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 9.0 min, major; 11.6 min,

minor); Anal. Calcd for C₂₅H₂₇NO₅: C, 71.24; H, 6.46; N, 3.32. Found: C, 71.14; H, 6.57; N, 3.38.

***tert*-Butyl 4-((*S,E*)-3-(methoxycarbonyl)-1-(4-bromophenyl)allyl)-1*H*-indole-1-carboxylate (4c)**

Reaction was performed using 0.210 g (0.75 mmol, 1.5 eq) of the diazoacetate **3c**. Purified via flash chromatography (silica gel, 7:1 pentane:diethyl ether) to give **4c** as a white solid (0.125 g, 53% yield), mp 71-74 °C; R_f 0.26 (5:1 pentane:diethyl ether); [α]_D²⁵ +11.1° (c 1.08, CHCl₃); FTIR (neat): 2974, 1725, 1158, 1123, 760 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 8.10 (d, *J* = 8.0 Hz, 1H), 7.55 (d, *J* = 3.5 Hz, 1H), 7.46 (dd, *J* = 15.5, 7.0 Hz, 1H), 7.41 (d, *J* = 8.5 Hz, 2H), 7.28 (m, 1H), 7.04 (d, *J* = 8.5 Hz, 2H), 6.99 (d, *J* = 7.5 Hz, 1H), 6.38 (d, *J* = 4.0 Hz, 1H), 5.70 (dd, *J* = 15.5, 1.5 Hz, 1H), 5.18 (d, *J* = 7.0 Hz, 1H), 3.73 (s, 3H), 1.66 (s, 9H); ¹³C NMR (75 MHz, CDCl₃) δ 166.7 (C), 149.5 (C), 148.8 (CH), 140.1 (C), 135.5 (C), 132.8 (C), 131.7 (CH), 130.2 (CH), 129.4 (C), 126.1 (CH), 124.4 (CH), 123.1 (CH), 122.2 (CH), 120.9 (C), 114.5 (CH), 105.2 (CH), 83.9 (C), 51.6 (CH₃), 50.2 (CH), 28.1 (CH₃); LRMS (ESI) *m/z* (relative intensity): 470 (17) [M+H]⁺, 370 (100) [M+H-Boc]⁺; HPLC analysis: 98.7% ee (Chiralpak AD-RH, 4% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 11.2 min, major; 13.3 min, minor); Anal. Calcd for C₂₄H₂₄BrNO₄: C, 61.28; H, 5.14; N, 2.98. Found: C, 61.43; H, 5.28; N, 2.91.

***tert*-Butyl 4-((*S,E*)-3-(methoxycarbonyl)-1-(3,4-dichlorophenyl)allyl)-1*H*-indole-1-carboxylate (**4d**)**

Reaction was performed using 0.163 g (0.60 mmol, 1.2 eq) of the diazoacetate **3d**. Purified via flash chromatography (silica gel, 6:1 pentane:diethyl ether) to give **4d** as a white solid (0.104 g, 45% yield), mp 64-67 °C; R_f 0.22 (5:1 pentane:diethyl ether); $[\alpha]_D^{25} +12.9^\circ$ (c 1.02, CHCl_3); FTIR (neat): 2978, 1725, 1346, 1124, 760 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, J = 8.4 Hz, 1H), 7.57 (d, J = 3.6 Hz, 1H), 7.43 (dd, J = 15.6, 6.8 Hz, 1H), 7.36 (d, J = 8.4 Hz, 1H), 7.32-7.25 (m, 2H), 7.01-6.98 (m, 2H), 6.38 (d, J = 4.0 Hz, 1H), 5.72 (dd, J = 15.6, 1.6 Hz, 1H), 5.18 (d, J = 6.8 Hz, 1H), 3.74 (s, 3H), 1.66 (s, 9H); ^{13}C NMR (75 MHz, CDCl_3) δ 166.5 (C), 149.5 (C), 148.1 (CH), 141.3 (C), 135.5 (C), 132.7 (C), 132.2 (C), 131.1 (C), 130.5 (CH), 130.4 (CH), 129.3 (C), 127.9 (CH), 126.2 (CH), 124.5 (CH), 123.4 (CH), 122.1 (CH), 114.7 (CH), 105.0 (CH), 83.9 (C), 51.6 (CH₃), 49.8 (CH), 28.1 (CH₃); LRMS (ESI) m/z (relative intensity): 459.8 (13) $[\text{M}]^+$, 360.1 (100) $[\text{M}+\text{H}-\text{BOC}]^+$; HPLC analysis: 98.0% ee (Chiralpak AD-RH, 2% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 8.4 min, major; 11.1 min, minor); Anal. Calcd for $\text{C}_{24}\text{H}_{23}\text{Cl}_2\text{NO}_4$: C, 62.62; H, 5.04; N, 3.04. Found: C, 62.67; H, 5.04; N, 3.07.

***tert*-Butyl 4-((*S,E*)-3-(methoxycarbonyl)-1-(naphthalen-2-yl)allyl)-1*H*-indole-1-carboxylate**
(4e)

Reaction was performed using 0.164 g (0.65 mmol, 1.3 eq) of the diazoacetate **3e**. Purified via flash chromatography (silica gel, 7:1 pentane:diethyl ether) to give **4e** as a light yellow solid (0.123 g, 56% yield), mp 75-78 °C; R_f 0.23 (5:1 pentane:diethyl ether); $[\alpha]_D^{25}$ -18.4° (c 1.11, CHCl_3); FTIR (neat): 2974, 1725, 1346, 1158, 1127, 761 cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 8.11 (d, J = 7.5 Hz, 1H), 7.80-7.74 (m, 3H), 7.64 (s, 1H), 7.60 (dd, J = 16.0, 7.0 Hz, 1H), 7.52 (d, J = 3.0 Hz, 1H), 7.47-7.42 (m, 2H), 7.31-7.24 (m, 2H), 7.05 (d, J = 8.0 Hz, 1H), 6.45 (d, J = 4.0 Hz, 1H), 5.76 (dd, J = 16.0, 1.5 Hz, 1H), 5.40 (d, J = 6.5 Hz, 1H), 3.72 (s, 3H), 1.65 (s, 9H); ^{13}C NMR (75 MHz, CDCl_3) δ 166.8 (C), 149.6 (C), 149.4 (CH), 138.5 (C), 135.5 (C), 133.4 (C), 133.3 (C), 132.4 (C), 129.6 (C), 128.3 (CH), 127.8 (CH), 127.6 (CH), 127.0 (CH), 126.9 (CH), 126.2 (CH), 125.9 (CH), 125.8 (CH), 124.4 (CH), 122.9 (CH), 122.4 (CH), 114.3 (CH), 105.5 (CH), 83.8 (C), 51.5 (CH_3), 50.9 (CH), 28.1 (CH_3); LRMS (ESI) m/z (relative intensity): 464.3 (23) $[\text{M}+\text{Na}]^+$; HPLC analysis: 98.0% ee (Chiralpak AD-RH, 2% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 14.0 min, major; 17.0 min, minor); Anal. Calcd for $\text{C}_{28}\text{H}_{27}\text{NO}_4$: C, 76.17; H, 6.16; N, 3.17. Found: C, 75.82; H, 6.26; N, 3.20.

***tert*-Butyl 4-((*R,E*)-3-(methoxycarbonyl)-1-(1-*tert*-butoxycarbonyl-1*H*-indol-3-yl)allyl)-1*H*-indole-1-carboxylate (**4f**)**

Reaction was performed using 0.222 g (0.65 mmol, 1.3 eq) of the diazoacetate **3f**. Purified via flash chromatography (silica gel, 7:1 pentane:diethyl ether) to give **4f** as a light yellow solid (0.170 g, 64% yield), mp 104-107 °C; R_f 0.18 (5:1 pentane:diethyl ether); $[\alpha]_D^{25}$ -28.5° (c 1.44, CHCl_3); FTIR (neat): 2978, 1725, 1153, 1123, 761, 729 cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 8.09 (m, 2H), 7.59 (d, J = 3.5 Hz, 1H), 7.49 (dd, J = 15.5, 7.0 Hz, 1H), 7.33 (s, 1H), 7.29-7.21 (m, 3H), 7.12-7.08 (m, 1H), 7.04 (d, J = 7.0 Hz, 1H), 6.59 (d, J = 3.5 Hz, 1H), 5.77 (dd, J = 15.5, 1.5 Hz, 1H), 5.38 (d, J = 7.0 Hz, 1H), 3.71 (s, 3H), 1.67 (s, 9H), 1.66 (s, 9H); ^{13}C NMR (75 MHz, CDCl_3) δ 166.7 (C), 149.7 (C), 149.5 (C), 148.1 (CH), 135.6 (C), 135.4 (C), 131.9 (C), 129.5 (C), 129.4 (C), 126.0 (CH), 124.5 (CH), 124.4 (CH), 124.0 (CH), 122.54 (CH), 122.49 (CH), 122.1 (CH), 120.6 (C), 119.5 (CH), 115.2 (CH), 114.3 (CH), 105.1 (CH), 83.8 (C), 83.7 (C), 51.5 (CH_3), 42.2 (CH), 28.11 (CH_3), 28.08 (CH_3); LRMS (ESI) m/z (relative intensity): 553.3 (90) $[\text{M}+\text{Na}]^+$; HPLC analysis: 97.7% ee (Chiralpak AD-RH, 2% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 8.3 min, major; 12.3 min, minor); Anal. Calcd for $\text{C}_{31}\text{H}_{34}\text{N}_2\text{O}_6$: C, 70.17; H, 6.46; N, 5.28. Found: C, 70.24; H, 6.60; N, 5.13.

***tert*-Butyl 4-((*R*,1*E*,4*E*)-1-(methoxycarbonyl)-5-phenylpenta-1,4-dien-3-yl)-1*H*-indole-1-carboxylate (**4g**)**

Reaction was performed using 0.157 g (0.69 mmol, 1.4 eq) of the diazoacetate **3g**. Purified via flash chromatography (silica gel, 7:1 pentane:diethyl ether) to give **4g** as a sticky white solid (0.117 g, 56% yield), R_f 0.27 (5:1 pentane:diethyl ether); $[\alpha]_D^{25}$ -22.2° (c 1.27, CHCl_3); FTIR (neat): 2978, 1724, 1345, 1157, 1127, 760 cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 8.10 (d, J = 8.0 Hz, 1H), 7.61 (d, J = 3.5 Hz, 1H), 7.36-7.28 (m, 6H), 7.24-7.21 (m, 1H), 7.11 (d, J = 7.0 Hz, 1H), 6.63 (d, J = 4.0 Hz, 1H), 6.47 (d, J = 3.0 Hz, 2H), 5.90 (dd, J = 15.5, 1.5 Hz, 1H), 4.73 (m, 1H), 3.73 (s, 3H), 1.67 (s, 9H); ^{13}C NMR (75 MHz, CDCl_3) δ 166.8 (C), 149.6 (C), 149.2 (CH), 136.8 (C), 135.5 (C), 132.7 (C), 132.0 (CH), 129.3 (C), 129.2 (CH), 128.5 (CH), 127.6 (CH), 126.3 (CH), 126.0 (CH), 124.5 (CH), 121.9 (CH), 121.7 (CH), 114.3 (CH), 105.3 (CH), 83.8 (C), 51.5 (CH_3), 48.2 (CH), 28.2 (CH_3); LRMS (ESI) m/z (relative intensity): 417.9 (100), 318.1 (65); HRMS (ESI) Calcd for $[\text{C}_{26}\text{H}_{27}\text{NO}_4\text{Na}]^+$ ($\text{M}+\text{Na}$) $^+$: 440.1832, Found 440.1820; HPLC analysis: 99.0% ee (Chiralcel OD-H, 2% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 13.6 min, major; 19.9 min, minor).

***tert*-Butyl 4-((*R,E*)-4-(methoxycarbonyl)but-3-en-2-yl)-1*H*-indole-1-carboxylate (**4h**)**

Reaction was performed using 0.105 g (0.75 mmol, 1.5 eq) of the diazoacetate **3h**. Purified via flash chromatography (silica gel, 7:1 pentane:diethyl ether) to give **4h** as a clear oil (0.100 g, 61% yield), R_f 0.32 (5:1 pentane:diethyl ether); $[\alpha]_D^{25} +48.9^\circ$ (c 4.50, CHCl_3); FTIR (neat): 2978, 1724, 1156, 1130, 759, 730 cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 8.06 (d, $J = 8.0$ Hz, 1H), 7.61 (d, $J = 3.5$ Hz, 1H), 7.28 (*appt.* t, $J = 8.0$ Hz, 1H), 7.21 (dd, $J = 16.0$ 6.5 Hz, 1H), 7.06 (d, $J = 8.0$ Hz, 1H), 6.60 (d, $J = 3.5$ Hz, 1H), 5.82 (dd, $J = 16.0$ 1.5 Hz, 1H), 4.01 (m, 1H), 3.70 (s, 3H), 1.67 (s, 9H), 1.53 (d, $J = 7.0$ Hz, 3H); ^{13}C NMR (75 MHz, CDCl_3) δ 167.2 (C), 152.4 (CH), 149.7 (C), 135.4 (C), 129.1 (C), 125.8 (CH), 124.6 (CH), 120.3 (CH), 120.0 (CH), 113.9 (CH), 105.2 (CH), 83.8 (C), 51.5 (CH_3), 39.1 (CH), 28.2 (CH_3), 19.5 (CH_3), missing carbon attributed to accidental equivalence; LRMS (ESI) m/z (relative intensity): 329.9 (68); HRMS (ESI) Calcd for $[\text{C}_{19}\text{H}_{23}\text{NO}_4\text{Na}]^+$ ($\text{M}+\text{Na}$) $^+$: 352.1519, Found 352.1510; HPLC analysis: 98.6% ee (Chiralpak AD-RH, 0.5% *i*Pr-OH in hexanes, 0.8 mL/min, $\lambda = 254$ nm, $t_R = 11.0$ min, major; 14.5 min, minor).

(*R,E*)-*tert*-Butyl 4-(2-(2-methoxy-2-oxoethylidene)cyclopentyl)-1*H*-indole-1-carboxylate (6a**)**

Reaction was performed using 0.108 g (0.65 mmol, 1.3 eq) of the diazoacetate **5a**. Purified via flash chromatography (silica gel, 10:1 pentane:diethyl ether) to give pure **6a** as a sticky white solid (0.169 g, 95% yield), R_f 0.24 (9:1 pentane:diethyl ether); $[\alpha]_D^{25}$ -14.2° (c 1.79, CHCl_3); FTIR (neat): 2951, 1731, 1712, 1344, 1156, 1136, 1113, 759, 730 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 8.06 (d, J = 8.0 Hz, 1H), 7.59 (d, J = 3.6 Hz, 1H), 7.26 (*appt* t, J = 7.8 Hz, 1H), 7.02 (d, J = 7.2 Hz, 1H), 6.49 (d, J = 3.6 Hz, 1H), 5.38 (q, J = 2.4 Hz, 1H), 4.03-3.98 (m, 1H), 3.62 (s, 3H), 3.26-3.19 (m, 1H), 3.00-2.89 (m, 1H), 2.25-2.19 (m, 1H), 2.10-2.04 (m, 1H), 2.00-1.90 (m, 1H), 1.82-1.72 (m, 1H), 1.67(s, 9H); ^{13}C NMR (75 MHz, CDCl_3) δ 170.9 (C), 167.4 (C), 149.7 (C), 135.4 (C), 134.9 (C), 129.5 (C), 125.6 (CH), 124.4 (CH), 122.0 (CH), 113.8 (CH), 113.4 (CH), 105.6 (CH), 83.7 (C), 51.5 (CH), 50.7 (CH_3), 34.2 (CH_2), 33.3 (CH_2), 28.2 (CH_3), 25.0 (CH_2); LRMS (ESI) m/z (relative intensity): 710.9 (100) $[2\text{M}+\text{H}]^+$; HPLC analysis: 98.8% ee (Chiralpak AD-H, 0.3% *i*Pr-OH in hexanes, 0.8 mL/min, λ = 254 nm, t_R = 17.6 min, major; 23.3 min, minor); Anal. Calcd for $\text{C}_{21}\text{H}_{25}\text{NO}_4$: C, 70.96; H, 7.09; N, 3.94. Found: C, 70.67; H, 7.11; N, 3.90.

(*R,E*)-*tert*-Butyl 4-(2-(2-methoxy-2-oxoethylidene)cyclohexyl)-1*H*-indole-1-carboxylate (6b**)**

Reaction was performed using 0.117 g (0.65 mmol, 1.3 eq) of the diazoacetate **5b**. Purified via flash chromatography (silica gel, 15:1 pentane:diethyl ether) to give pure **6b** as a white solid (0.166 g, 90% yield), R_f 0.18 (15:1 pentane:diethyl ether); $[\alpha]_D^{25} +42.7^\circ$ (c 1.82, CHCl_3); FTIR (neat): 2934, 1718, 1347, 1162, 1135, 759 cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 8.07 (d, J = 6.5 Hz, 1H), 7.56 (d, J = 3.5 Hz, 1H), 7.30 (*appt* t, J = 7.8 Hz, 1H), 7.08 (d, J = 7.5 Hz, 1H), 6.46 (d, J = 3.5 Hz, 1H), 4.95 (s, 1H), 4.05-4.02 (m, 1H), 3.73 (dd, J = 12.0, 3.5 Hz, 1H), 3.55 (s, 3H), 2.18-2.16 (m, 1H), 2.12-1.98 (m, 4H), 1.73 (m, 1H), 1.67 (s, 9H), 1.62 (m, 1H); ^{13}C NMR (75 MHz, CDCl_3) δ 167.4 (C), 164.9 (C), 149.7 (C), 135.2 (C), 134.0 (C), 129.9 (C), 125.5 (CH), 124.3 (CH), 121.2 (CH), 113.8 (CH), 113.5 (CH), 105.7 (CH), 83.6 (C), 50.7 (CH_3), 49.1 (CH), 34.2 (CH_2), 30.6 (CH_2), 28.2 (CH_2), 28.1 (CH_3), 26.6 (CH_2); LRMS (EI) m/z (relative intensity): 369.2 (51); ee >94%, determined by ^1H NMR analysis of the methyl ester CH_3 protons using the chiral shift reagent $\text{Eu}(\text{hfc})_3$; the minor enantiomer was not visible in the $\text{Rh}_2(\text{S-DOSP})_4$ catalyzed reaction, but both enantiomers were visible using racemic material; Anal. Calcd for $\text{C}_{22}\text{H}_{27}\text{NO}_4$: C, 71.52; H, 7.37; N, 3.79. Found: C, 71.51; H, 7.51; N, 3.83.

(*S,E*)-Methyl 4-(2-nitrobenzo[*b*]thiophen-4-yl)-4-phenylbut-2-enoate (8**)**

Reaction was performed using 0.151 g (0.75 mmol, 1.5 eq) of the diazoacetate **3a** and 0.120 g (0.5 mmol) of **7**. Purified via flash chromatography (silica gel, 4:1-2:1 pentane:diethyl ether) to give **8** as a yellow solid (0.158 g, 89% yield), mp 50-53 °C; R_f 0.38 (1:1 pentane:diethyl ether); $[\alpha]_D^{25}$ -31.5° (c 0.71, CHCl_3); FTIR (neat): 1718, 1341, 1322, 728 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 8.06 (s, 1H), 7.66 (d, J = 8.0 Hz, 1H), 7.45 (t, J = 8.0 Hz, 1H), 7.38 (dd, J = 15.6 6.8 Hz, 1H), 7.26-7.23 (m, 2H), 7.20-7.16 (m, 2H), 7.08 (d, J = 7.2 Hz, 2H), 5.60 (dd, J = 15.6, 1.2 Hz, 1H), 5.27 (d, J = 6.8 Hz, 1H), 3.65 (s, 3H); ^{13}C NMR (75 MHz, CDCl_3) δ 166.4 (C), 151.4 (C), 148.3 (CH), 141.3 (C), 139.9 (C), 139.7 (C), 135.1 (C), 129.3 (CH), 129.0 (CH), 128.5 (CH), 127.6 (CH), 125.8 (CH), 123.7 (CH), 123.4 (CH), 121.9 (CH), 51.7 (CH_3), 50.8 (CH); LRMS (ESI) m/z (relative intensity): 376.0 (100); HRMS (ESI) Calcd for $[\text{C}_{19}\text{H}_{15}\text{NSO}_4\text{Na}]^+$ 376.0614, Found 376.0616; HPLC analysis: 99.0% ee (Chiralpak AS-H, 10% *i*Pr-OH in hexanes, 0.7 mL/min, λ = 254 nm, t_R = 30.8 min, major; 26.7 min, minor).

***tert*-Butyl 2-(4-((*R,E*)-1-(1-(*tert*-butoxycarbonyl)-1*H*-indol-3-yl)-4-methoxy-4-oxobut-2-enyl)-1-(*tert*-butoxycarbonyl)-1*H*-indol-2-yl)-1*H*-indole-1-carboxylate (**10**)**

Reaction was performed using 0.341 g (1.0 mmol, 2.0 eq) of the diazoacetate **3f**. Purified via flash chromatography (silica gel, 7:1 pentane:diethyl ether) to give **10** as a yellow solid (0.306 g, 82% yield). mp 148-150 °C; R_f 0.16 (5:1 pentane:diethyl ether); $[\alpha]_D^{25}$ -43.7° (c 1.71, CHCl_3); FTIR (neat): 2978, 1727, 1368, 1333, 1151 cm^{-1} ; ^1H NMR (500 MHz, CDCl_3 , 50 °C (to eliminate rotamer peaks)) δ 8.30 (d, J = 8.5 Hz, 1H), 8.27 (d, J = 8.0 Hz, 1H), 8.09 (d, J = 8.0 Hz, 1H), 7.54-7.49 (m, 2H), 7.34-7.21 (m, 6H), 7.09-7.06 (m, 2H), 6.65 (s, 1H), 6.62 (s, 1H), 5.80 (m, 1H), 5.39 (d, J = 6.5 Hz, 1H), 3.71 (s, 3H), 1.66 (s, 9H), 1.22 (s, 9H), 1.16 (s, 9H); ^{13}C NMR (125 MHz, CDCl_3 , 50 °C (to eliminate rotamer peaks)) δ 166.7 (C), 149.8 (C), 149.7 (C), 148.0 (CH), 137.4 (C), 137.1 (C), 135.7 (C), 132.3 (C), 131.8 (C), 131.7 (broad, C), 129.6 (C), 128.6 (C), 127.7 (C), 125.1 (CH), 124.8 (CH), 124.5 (CH), 124.0 (CH), 122.8 (CH), 122.5 (CH), 122.3 (CH), 120.8 (C), 120.5 (CH), 119.5 (broad, CH), 115.7 (CH), 115.3 (CH), 114.9 (CH), 111.3 (CH), 109.0 (CH), 83.9 (C), 83.6 (C), 83.3 (C), 51.4 (CH_3), 42.2 (broad, CH), 28.2 (CH_3), 27.6 (CH_3), 3 missing carbon resonances attributed to accidental equivalence, broad peaks attributed to slow rotation; LRMS (ESI) m/z (relative intensity): 768.4 (100) $[\text{M}+\text{Na}]^+$; HRMS (EI) Calcd for $[\text{C}_{44}\text{H}_{47}\text{N}_3\text{O}_8]^+$ 745.3358, Found 745.3330; HPLC analysis: 97.0% ee (Chiralpak AD-RH, 2% *i*Pr-OH in hexanes, 0.6 mL/min, λ = 254 nm, t_R = 9.9 min, minor; 18.3 min, major);

X-ray Analysis

Compound **4c** was converted to **16** by the following reactions in order to produce material that was suitable for the growth a crystal for X-ray analysis.

(*S*)-*tert*-Butyl 4-(1-(4-bromophenyl)-4-methoxy-4-oxobutyl)-1*H*-indole-1-carboxylate (**15**)

To a standard hydrogenation bottle was added **4c** (0.62 g, 1.3 mmol), Wilkinson's catalyst (0.060 g, 0.065 mmol) and absolute ethanol (100 mL). The bottle was evacuated and filled with H₂ twice and then shaken under 40 psi H₂ for 43 h. The solution was then concentrated *in vacuo*. The residue was then taken up into a 1:1 mixture of pentane:diethyl ether, filtered through another plug of silica gel and concentrated *in vacuo* to yield pure **15** as a sticky white solid (0.61 g, 99% yield), R_f 0.22 (5:1 pentane:diethyl ether); [α]_D²⁵ -41.1° (*c* 1.28, CHCl₃); FTIR (neat): 2979, 1731, 1344, 1155, 1124, 759, 730 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 8.04 (d, *J* = 7.5 Hz, 1H), 7.55 (d, *J* = 3.0 Hz, 1H), 7.37 (d, *J* = 8.5 Hz, 2H), 7.28 (*appt* t, *J* = 7.8 Hz, 1H), 7.14-7.11 (m, 3H), 6.55 (d, *J* = 3.5 Hz, 1H), 4.31 (t, *J* = 7.8 Hz, 1H), 3.64 (s, 3H), 2.51-2.38 (m, 2H), 2.30 (t, *J* = 7.5 Hz, 2H), 1.65 (s, 9H); ¹³C NMR (75 MHz, CDCl₃) δ 173.4 (C), 149.4 (C), 142.8 (C), 135.4 (C), 135.2 (C), 131.4 (CH), 129.6 (C), 129.5 (CH), 125.6 (CH), 124.3 (CH), 120.2 (CH), 120.0 (C), 113.6 (CH), 105.2 (CH), 83.5 (C), 51.4 (CH₃), 46.3 (CH), 32.0 (CH₂), 29.8 (CH₂), 28.0 (CH₃); HRMS (ESI) Calcd for [C₂₄H₂₆BrNO₄Na]⁺ (M+Na)⁺: 494.0937, Found 494.0942.

(S)-4-(1-(*tert*-Butoxycarbonyl)-1*H*-indol-4-yl)-4-(4-bromophenyl)butanoic acid (16**)**

To a 250 mL round bottom flask charged with a magnetic stir bar was added **15** (0.558 g, 1.18 mmol), THF (50 mL), distilled water (50 mL), and lithium hydroxide (0.034 g, 1.4 mmol). The solution was stirred at ambient temperature for 24 h and then acidified to pH 2 by dropwise addition of 10% aqueous HCl solution. The mixture was then extracted with diethyl ether (3X50 mL) and the combined ether extracts dried over anhydrous magnesium sulfate, filtered and concentrated *in vacuo*. The crude residue was purified by flash chromatography (silica gel, 7:1 pentane:diethyl ether with 1% acetic acid by volume) to yield pure **16** as a white solid (0.514 g, 95% yield), mp 65-67 °C; R_f 0.10 (9:1 pentane:diethyl ether); $[\alpha]_D^{25}$ -36.8° (c 1.39, CHCl₃); FTIR (neat): 2977, 1732, 1125, 760, 731 cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 8.05 (d, J = 7.5 Hz, 1H), 7.55 (d, J = 3.5 Hz, 1H), 7.38 (d, J = 8.5 Hz, 2H), 7.29 (*appt* t, J = 7.8 Hz, 1H), 7.14-7.12 (m, 3H), 6.54 (d, J = 4.0 Hz, 1H), 4.33 (t, J = 7.8 Hz, 1H), 2.51-2.39 (m, 2H), 2.37-2.34 (m, 2H), 1.65 (s, 9H), missing H attributed to acid proton; ¹³C NMR (125 MHz, CDCl₃) δ 179.8 (C), 149.5 (C), 142.7 (C), 135.2 (C), 131.5 (CH), 129.6 (C), 129.5 (CH), 125.8 (CH), 124.4 (CH), 120.3 (CH), 120.1 (C), 113.8 (CH), 105.2 (CH), 83.7 (C), 46.3 (CH), 32.2 (CH₂), 29.6 (CH₂), 28.1 (CH₃), missing C attributed to accidental equivalence; HRMS (ESI) Calcd for [C₂₃H₂₄BrNO₄Na]⁺ (M+Na)⁺: 480.0781, Found 480.0772. A crystal of **16** suitable for X-ray analysis was grown as follows: In a 4 mL vial 60 mg of **16** was dissolved in a minimal amount of diethyl ether (~1 mL). The vial was then placed, uncapped, inside a larger 20 mL vial which was filled half way with pentane. The larger vial was then capped and the pentane vapors

allowed to slowly diffuse into the smaller vial for 2 days at which time a crystal suitable for X-ray analysis had formed.

Figure S1. X-ray structure of compound **16**⁸

jim-271
pure
1-17-05

Pulse Sequence: zgpg30
Solvent: CDCl3
Ambient temperature
INOVA-500 "locosy.chem.buffalo.edu"

Relax. delay 2.000 sec
Pulse 34.6 degrees
Acq. time 1.891 sec
Width 10000.0 Hz
16 repetitions
OBSERVE H1, 499.8384016 MHz
DATA PROCESSING
Line broadening 0.7 Hz
FT size 65536
Total time 1 min, 18 sec

S24

nmr 27

jrm-273
frac 20-27
C-H/Cope-elimination product

Pulse Sequence: szpu1

Solvent: CDCl3

Ambient temperature

INDVA-400 "cosy.chem.buffalo.edu"

PULSE SEQUENCE

Relax . delay 2.000 sec

Pulse 29.1 degrees

Acq. time 1.499 sec

Width 12001.2 Hz

16 repetitions

OBSERVE H1, 399.9389026 MHz

DATA PROCESSING

Line broadening 0.7 Hz

FT size 65536

Total time 1 min, 10 sec

jfm-321 pure
entry 2

Pulse Sequence: szpul

Solvent: CDCl₃
Ambient temperature
INOVA-500 "tocsy.chem.buffalo.edu"

Relax. delay 10.000 sec
Pulse 34.6 degrees
Acq. time 1.891 sec
Width 10000.0 Hz
4 repetitions
08SERVE H1 499.8984037 MHz
DATA PROCESSING
Line broadening 0.7 Hz
FT size 65536
Total time 3 min, 58 sec

Pulse Sequence: s2pu1

```
Solvent: CDCl3
Ambient temperature
INOVA-500 "tocsy.chem.buffalo.edu"
```

Relax. delay 8.000 sec
Pulse 34.6 degrees
Acq. time 1.891 sec
Width 10000.0 Hz
16 repetitions
OBSERVE H1, 499.8984043 MHz
DATA PROCESSING
Line broadening 0.7 Hz
FT size 65536
Total time 3 min, 18 sec

Total time 3 min, 8 sec

jrm-357 pure

Pulse Sequence: szpu1

Solvent: CDCl3

Ambient temperature

INOVA-500 "tocsy.chem.buffalo.edu"

Relax. delay 8.000 sec

Pulse 34.6 degrees

Acq. time 1.891 sec

Width 10000.0 Hz

4 repetitions

OBSERVE H1, 499.8984025 MHz

DATA PROCESSING

Line broadening 0.7 Hz

FT size 65536

Total time 3 min, 18 sec

jrm-358 at 40 C

Pulse Sequence: szpu1

Solvent: CDCl3

Temp: 40.0 C / 313.1 K

INOVA-400 "cosy.chem.buffalo.edu"

Relax. delay 10.000 sec

Pulse 46.9 degrees

Acq. time 1.800 sec

Width 6000.6 Hz

8 repetitions

OBSERVE H1, 399.9389091 MHz

DATA PROCESSING

Line broadening 0.9 Hz

FT size 32768

Total time 3 min, 8 sec

10

S30

jrm-356 pure

Pulse Sequence: szpul

Solvent: CDCl₃

Ambient temperature

INOVA-500 "tocsy.chem.buffalo.edu"

Relax. delay 8.000 sec

Pulse 34.6 degrees

Acq. time 1.891 sec

Width 10000.0 Hz

4 repetitions

OBSERVE H1, 499.8984004 MHz

DATA PROCESSING

Line broadening 0.7 Hz

FT size 65536

Total time 3 min, 18 sec

13

jrm-318 pure

Pulse Sequence: s2pul

Solvent: CDCl3

Ambient temperature

INOVA-500 "tocsy.Chem.buffalo.edu"

Relax. delay 8.000 sec

Pulse 34.6 degrees

Acq. time 1.891 sec

Width 10000.0 Hz

4 repetitions

OBSERVE H1, 499.8984022 MHz

DATA PROCESSING

Line broadening 0.7 Hz

FT size 65536

Total time 3 min, 18 sec

14

jrm-331 pure

Pulse Sequence: s2pul

Solvent: CDCl₃

Ambient temperature

Sample #2

File: jrm-331pure

INOVIA-500 "nmrdata.chem.buffalo.edu"

Relax. delay 8.000 sec

Pulse 34.6 degrees

Acq. time 1.891 sec

Width 10000.0 Hz

4 repetitions

OBSERVE H1, 499.8984028 MHz

DATA PROCESSING

Line broadening 0.7 Hz

FT size 65536

Total time 3 min, 18 sec