SUPPORTING INFORMATION

Radical Fragmentation of ω -Bromoalkyl Cyclobutanones. A Modular Approach To Eight-membered Carbocycles

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Typical Procedure for Silylation: To a mixture of cyclopropanol **5** (0.39 g, 2.82 mmol) and 2,6-lutidine (3.50 g, 28.2 mmol) in anhydrous CH₂Cl₂ (15 mL) at 0 °C added TMSOTf (1.90 g, 1.70 mL, 8.5 mmol). After the resulting mixture had been stirred for an additional hour at the same temperature, aqueous saturated NaHCO₃ (10 mL) was added. The aqueous layer was extracted with Et₂O (50 mL x 2). The combined organic extracts were washed with water (25 mL x 2) and brine (20 mL), and then dried (MgSO₄). Evaporation of the solvent *in vacuo* gave the crude product. Purification by silica gel column chromatography (10:1 hex–EtOAc containing 1% Et₃N) afforded silyl ether **7** (0.523 g, 2.47 mmol, 88%) as a colorless liquid: ¹H NMR (360 MHz, CDCl₃) δ 0.12 (s, 9H), 0.69 (m, 2H), 0.77 (m, 2H), 1.55 (m, 2H), 1.62 (m, 2H), 1.98–2.05 (m, 4H), 5.66 (m, 1H); ¹³C NMR (90 MHz, CDCl₃) δ 1.3, 13.0, 22.7, 23.0, 25.3, 25.6, 31.5, 60.3, 122.0, 138.3.

8. ¹H NMR (360 MHz, CDCl₃) δ 0.11 (s, 9H), 0.79 (m, 2H), 0.89 (m, 2H), 1.87 (dt, *J* = 15.0, 7.5 Hz, 2H), 2.55 (m, 2H), 2.33 (m, 2H); ¹³C NMR (90 MHz, CDCl₃) δ 1.30, 14.0, 23.9, 32.5, 32.7, 56.5, 123.8, 146.8.

Typical Procedure for a Vinylogous Mukaiyama-Type Condensation: To a solution of **7** (0.50 g, 2.38 mmol) in CH₂Cl₂ (4 mL) were added sequentially at –40 °C 3-bromopropionaldehyde dimethylacetal (0.63 g, 3.1 mmol) and TiCl₄ (0.59 g, 3.1 mmol). The reaction mixture was stirred at the same temperature for 2 h. The

reaction was quenched with addition of wet ether (20 mL) and then allowed to warm to room temperature. The resulting solution was washed with brine (10 mL), dried over MgSO_4 , filtered, and concentrated *in vacuo* to give the crude product. Purification by column chromatography on silica gel using 10:1 hex–EtOAc as an eluent afforded **9a** (more polar, 0.30 g, 1.04 mmol, 44%) and **9b** (less polar, 0.19 g, 0.64 mmol, 27%) as colorless oils.

Spectra data for **9a**: IR (film) 1774 cm^{-1} ; ^1H NMR (360 MHz, CDCl_3) δ 0.97 (m, 1H), 1.26 (m, 2H), 1.47 (m, 1H), 1.59–1.73 (m, 5H), 1.85–1.99 (m, 2H), 2.07 (dddd, $J = 15.0, 8.5, 4.7, 2.8\text{ Hz}$, 1H), 2.26 (dddd, $J = 15.0, 7.4, 6.9, 2.7\text{ Hz}$, 1H), 2.93 (m, H), 3.18 (ddd, $J = 9.1, 4.7, 2.7\text{ Hz}$, 1H), 3.28 (s, 3H), 3.44 (dd, $J = 8.5, 6.9\text{ Hz}$, 2H); ^{13}C NMR (90 MHz, CDCl_3) δ 18.6, 22.0, 25.4, 26.3, 28.8, 34.2, 34.3, 41.5, 44.3, 56.5, 67.1, 81.3, 215.0.

Spectral data for **9b**: IR (film) 1766 cm^{-1} ; ^1H NMR (360 MHz, CDCl_3) δ 1.22 (m, 1H), 1.48–1.77 (m, 8H), 2.25 (m, 1H), 2.91 (t, $J = 8.4\text{ Hz}$, 1H), 3.33 (s, 3H), 3.44–3.57 (m, 3H); ^{13}C NMR (90 MHz, CDCl_3) δ 23.1, 23.3, 25.7, 25.9, 31.1, 35.8, 36.1, 41.6, 46.3, 58.2, 67.1, 80.2, 215.2.

10a. IR (film) 1744 cm^{-1} ; ^1H NMR (360 MHz, CDCl_3) δ 1.29 (m, 1H), 1.60–1.87 (m, 5H), 1.94–2.09 (m, 2H), 2.14–2.24 (m, 2H), 2.39 (ddd, $J = 10.7, 10.0, 8.7\text{ Hz}$, 1H), 2.97 (m, 2H), 3.29 (s, 3H), 3.37 (ddd, $J = 10.0, 4.1, 3.8\text{ Hz}$, 1H), 3.45 (dt, $J = 7.5, 2.0\text{ Hz}$, 2H); ^{13}C NMR (90 MHz, CDCl_3) δ 21.2, 23.4, 27.9, 28.9, 34.9, 37.9, 43.1, 48.3, 55.8, 72.3, 80.3, 215.8.

10b. IR (film) 1770 cm^{-1} ; ^1H NMR (360 MHz, CDCl_3) δ 1.58 (m, 2H), 1.68–1.95 (m, 5H), 2.07 (m, 2H), 2.29 (m, 2H), 2.82 (ddd, $J = 14.8, 9.7, 5.0\text{ Hz}$, 1H), 3.13 (ddd, $J = 17.6, 9.7, 8.0\text{ Hz}$, 1H), 3.37 (s, 3H), 3.42–3.52 (m, 3H); ^{13}C NMR (90 MHz, CDCl_3) δ 21.2, 24.1, 27.3, 30.5, 35.9, 38.7, 43.0, 44.9, 57.6, 72.5, 77.0, 77.2, 77.4, 77.6, 79.9, 215.5.

Typical Procedure for Free Radical-Mediated Cyclization-Fragmentation: A

solution of n-Bu₃SnH (62 mg, 0.21 mmol) and AIBN (2 mg, 0.01 mmol) in benzene (5 mL) was added slowly over a period of 8 h (syring pump) to a stirring, refluxing solution of **9a** (20 mg, 0.07 mmol) in benzene (5 mL). The reaction mixture was cooled to room temperature and concentrated on a rotary evaporator. The resulting crude product was dissolved in CH₂Cl₂ (20 mL) and washed with 10% potassium fluoride solution (10 mL), dried (MgSO₄), filtered, and concentrated to remove tin-containing impurities. Purification by column chromatography on silica gel (15:1 hex–EtOAc) gave **3a** (14.3 mg, 0.068 mmol, 99%): IR (film) 1699 cm⁻¹; ¹H NMR (360 MHz, CDCl₃) δ 1.02–1.47 (m, 6H), 1.51–2.37 (m, 6H), 2.09 (ddd, *J* = 11.4, 7.0, 3.7 Hz, 1H), 2.18 (ddd, *J* = 14.7, 7.0, 5.9 Hz, 1H), 2.29 (ddd, *J* = 14.1, 6.4, 3.6 Hz, 1H), 2.44 (ddd, *J* = 14.1, 12.5, 2.7 Hz, 1H), 2.59 (m, 1H), 2.92 (ddd, *J* = 14.7, 11.4, 3.1 Hz, 1H), 3.20 (m, 1H), 3.34 (s, 3H); ¹³C NMR (90 MHz, CDCl₃) δ 23.7, 26.6, 26.7, 30.1, 31.7, 32.9, 35.2, 41.7, 44.8, 58.1, 85.5, 218.3; MS *m/z* 210 (*M*⁺).

3b. IR (film) 1699 cm⁻¹; ¹H NMR (360 MHz, CDCl₃) δ 1.02–1.81 (m, 12H), 2.09 (ddd, *J* = 11.1, 6.7, 3.7 Hz, 1H), 2.18 (m, 1H), 2.30 (ddd, *J* = 14.1, 6.5, 3.7 Hz, 1H), 2.44 (dt, *J* = 14.1, 2.5 Hz, 1H), 2.59 (m, 1H), 2.92 (dt, *J* = 11.1, 3.4 Hz, 1H), 3.20 (m, 1H), 3.34 (s, 3H); ¹³C NMR (90 MHz, CDCl₃) δ 23.7, 26.6, 26.7, 30.1, 31.7, 32.9, 35.2, 39.0, 41.7, 44.8, 58.1, 85.5, 218.4; MS *m/z* 210 (*M*⁺).

4a. IR (film) 1701 cm⁻¹; ¹H NMR (360 MHz, CDCl₃) δ 1.15 (m, 1H), 1.25–1.68 (m, 6H), 1.91–1.98 (m, 1H), 2.44 (m, 1H), 2.78 (dt, *J* = 11.7, 3.6 Hz, 1H), 3.17 (m, 1H), 3.39 (s, 3H); ¹³C NMR (90 MHz, CDCl₃) δ 26.5, 26.6, 27.0, 28.5, 32.2, 36.4, 38.1, 39.9, 41.1, 47.0, 58.0, 82.7, 217.7.

4b. IR (film) 1698 cm⁻¹; ¹H NMR (360 MHz, CDCl₃) δ 1.16 (m, 1H), 1.26–1.73 (m, 6H), 1.82 (m, 2H), 1.96 (m, 1H), 2.11–2.31 (m, 4H), 2.60 (t, *J* = 13.2 Hz, 1H), 2.79 (dt, *J* = 11.5, 3.5 Hz, 1H), 2.99 (dt, *J* = 10.3, 2.7 Hz, 1H), 3.30 (s, 3H); ¹³C NMR

(90 MHz, CDCl₃) δ 23.4, 25.7, 29.9, 33.2, 36.4, 39.0, 40.0, 41.9, 47.5, 57.0, 84.7, 218.4.

11. IR (film) 1702 cm⁻¹; ¹H NMR (360 MHz, CDCl₃) δ 1.03–1.35 (m, 5H), 1.45 (m, 1H), 1.53–1.70 (m, 5H), 1.72–1.81 (m, 1H), 2.08 (m, 1H), 2.19 (ddd, J = 14.7, 7.0, 5.9 Hz, 1H), 2.31 (ddd, J = 15.7, 6.6, 3.7 Hz, 1H), 2.45 (ddd, J = 15.7, 12.6, 2.6 Hz, 1H), 2.61 (m, 1H), 3.21 (m, 1H), 3.36 (s, 3H); ¹³C NMR (90 MHz, CDCl₃) δ 26.6, 26.7, 30.1, 31.6, 32.9, 34.6, 34.8, 35.1, 38.9, 41.7, 44.8, 58.1, 85.5, 218.3; HRMS calc for C₁₃H₂₁DO₂ (M⁺) 211.1683, found 211.1657.

15. IR (film) 1698 cm⁻¹; ¹H NMR (360 MHz, CDCl₃) δ 1.16 (m, 1H), 1.35–1.73 (m, 6H), 1.80 (m, 2H), 1.95 (m, 1H), 2.13–2.19 (m, 1H), 2.21–2.30 (m, 2H), 2.56 (m, 1H), 2.80 (dt, J = 11.8, 3.5 Hz, 1H), 2.99 (dt, J = 10.1, 2.9 Hz, 1H), 3.30 (s, 3H); ¹³C NMR (90 MHz, CDCl₃) δ 23.3, 23.4, 25.7, 33.3, 36.4, 38.5, 38.7, 38.9, 39.0, 40.0, 41.9, 47.5, 57.0, 84.7, 217.2; HRMS calc for C₁₂H₁₉DO₂ (M⁺) 197.1526; found 197.1557.

Typical Procedure for Radical allylation: A solution of allytributyltin (102 mg, 0.3 mmol) and AIBN (6 mg, 0.04 mmol) in benzene (1 mL) was added over a period of 6 h (syring pump) to a stirring, refluxing solution of **9a** (30 mg, 0.10 mmol) in benzene (1 mL). The reaction mixture was cooled to room temperature and concentrated on a rotary evaporator. The resulting crude product was dissolved in CH₂Cl₂ (30 mL) and washed with 10% potassium fluoride solution (10 mL), dried over MgSO₄, filtered, and concentrated to give the crude product. Purification by column chromatography on silica gel (15:1 hex-EtOAc) afforded **12** (24 mg, 0.096 mmol, 96%) as a 5:1 diastereomeric mixture: IR (film) 1704 cm⁻¹; ¹H NMR (360 MHz, CDCl₃) δ 1.09–1.44 (m, 6H), 1.52–1.75 (m, 5H), 1.78 (dt, J = 5.3, 3.2 Hz, 1H), 1.81–1.91 (m, 2H), 2.1 (dt, J = 14.1, 7.2 Hz, 1H), 2.41 (dt, J = 14.1, 6.8 Hz, 1H), 2.45–2.57 (m, 2H), 2.78 (dddd, J = 17.5, 7.2, 6.8, 3.0 Hz, 1H), 3.25 (s, 3H), 3.41 (m, 1H), 5.01 (dd, J =

9.9, 1.5 Hz, 1H), 5.03 (dd, $J = 17.2, 1.5$ Hz, 1H), 5.72 (dddd, $J = 17.2, 9.9, 7.2, 6.8$ Hz, 1H); ^{13}C NMR (90 MHz, CDCl_3) δ 26.3, 26.6, 32.5, 34.6, 35.8, 36.7, 38.9, 42.0, 46.1, 56.9, 83.5, 116.8, 136.1, 216.4; MS m/z 250 (M^+).

13. IR (film) 1703 cm^{-1} ; ^1H NMR (360 MHz, CDCl_3) δ 1.05–1.42 (m, 6H), 1.51–1.75 (m, 5H), 1.78 (m, 1H), 1.81–1.91 (m, 2H), 2.09 (dt, $J = 14.1, 7.4$ Hz, 1H), 2.40 (dt, $J = 14.1, 6.9$ Hz, 1H), 2.44–2.56 (m, 2H), 2.78 (dddd, $J = 17.4, 12.2, 7.4, 6.9$ Hz, 1H), 3.25 (s, 3H), 3.41 (ddd, $J = 5.9, 3.0, 2.8$ Hz, 1H), 5.01 (dd, $J = 9.9, 1.3$ Hz, 1H), 5.03 (dd, $J = 17.6, 1.3$ Hz, 1H), 5.72 (dddd, $J = 17.6, 9.9, 7.4, 6.9$ Hz, 1H); ^{13}C NMR (90 MHz, CDCl_3) δ 26.3, 26.6, 27.1, 31.1, 32.5, 34.6, 35.8, 36.7, 38.9, 42.0, 46.1, 56.9, 83.5, 116.9, 136.1, 216.3; MS m/z 250 (M^+).

14. IR (film) 1698 cm^{-1} ; ^1H NMR (360 MHz, CDCl_3) δ 0.90 (m, 1H), 1.15 (m, 1H), 1.42–1.68 (m, 5H), 1.77–1.98 (m, 4H), 2.00–2.30 (m, 5H), 2.76 (ddd, $J = 13.2, 11.2, 3.3$ Hz, 1H), 3.14 (ddd, $J = 10.7, 5.0, 2.9$ Hz, 1H), 3.36 (s, 3H), 5.04 (dd, $J = 18.6, 1.4$ Hz, 1H), 5.05 (dd, $J = 10.1, 1.4$ Hz, 1H), 5.71 (m, 1H); ^{13}C NMR (90 MHz, CDCl_3) δ 26.5, 31.8, 32.9, 36.2, 36.4, 38.0, 38.2, 38.4, 46.9, 51.2, 58.1, 82.1, 117.6, 135.0, 219.2.

16. IR (film) 1711 cm^{-1} ; ^1H NMR (360 MHz, CDCl_3) δ 0.90 (m, 1H), 1.16 (m, 1H), 1.35–1.55 (m, 3H), 1.58–1.68 (m, 2H), 1.78 (m, 2H), 1.92–2.25 (m, 6H), 2.62 (m, 1H), 2.77 (m, 1H), 2.96 (dt, $J = 10.0, 2.8$ Hz, 1H), 3.28 (s, 3H), 5.04 (dd, $J = 17.9, 1.2$ Hz, 1H), 5.05 (dd, $J = 10.1, 1.2$ Hz, 1H), 5.71 (dddd, $J = 17.9, 10.1, 7.1, 5.8$ Hz, 1H); ^{13}C NMR (90 MHz, CDCl_3) δ 25.7, 29.4, 33.4, 36.3, 36.4, 37.9, 38.0, 41.9, 47.6, 48.1, 56.9, 84.3, 117.4, 135.3, 218.9.