SUPPORTING INFORMATION

for

"Oxidative Cleavage of *p*-Methoxybenzyl Ethers with Methyl(trifluoromethyl)dioxirane"

by Leo A. Paquette,* Matthew M. Kreilein, Matthew W. Bedore, and Dirk Friedrich

Evans Chemical Laboratories, The Ohio State University, Columbus, Ohio 43210

General experimental details and characterization data for all compounds including
their recorded ^1H NMR spectra.

pp S1-S47

Expoxidation of 1 with Dimethyldioxirane. A vigorously stirred mixture of **1**² (155 mg, 0.210 mmol), NaHCO₃ (265 mg, 3.15 mmol), 10.5 mL of acetone, and 10.5 mL of water was cooled to 0 °C and treated with Oxone[®] (645 mg, 1.05 mmol, 5 eq). The reaction mixture was stirred in the cold for 2 h and filtered through a plug of silica gel. The separated aqueous layer was extracted with 3 x 10 mL of EtOAc, and the combined organic fractions were washed with brine, dried, and concentrated under reduced pressure. The resulting oil was purified by column chromatography on silica gel (5:1 hexane:EtOAc) to yield 20 mg of unreacted **1** and 62 mg (45%) of **2** as a cloudy oil: IR (neat, cm⁻¹) 3378, 1728, 1611; ¹H NMR (500 MHz, C₆D₆) δ 8.29 (d, *J* = 8.2 Hz, 2H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.21 (d, *J* = 7.8 Hz, 1H), 7.13 (d, *J* = 7.8 Hz, 2H), 6.95 (d, *J* = 8.2 Hz, 2H), 5.98 (d, *J* = 1.9 Hz, 1H), 5.72 (d, *J* = 13.3 Hz, 1H), 4.96 (d, *J* = 10.6 Hz, 1H), 4.56 (s, 1H), 4.44 (d, *J* = 13.3 Hz, 1H), 4.38 (d, *J* = 10.6 Hz, 1H), 4.19 (dd, *J* = 11.4, 4.7 Hz, 1H), 4.08 (s, 1H), 3.84 (s, 3H), 3.70 (s, 1H), 3.45 (s, 3H), 3.43 (s, 1H), 3.27 (d, *J* = 4.7 Hz, 1H), 3.13 (s, 1H), 2.98 (s, 1H), 2.35 (t, *J* = 13.7 Hz, 1H), 2.12 (d, *J* = 4.7 Hz, 1H), 1.80-1.78 (m, 1H), 1.77 (s, 3H), 1.63 (s, 1H), 1.59 (s, 1H), 1.52 (s, 1H), 1.44-1.40 (m, 1H), 1.38 (s, 1H), 1.00 (s, 3H), 0.96-0.88 (m, 1H), 0.10 (s, 3H), 0.09 (s, 3H); ¹³C NMR (125 MHz, C₆D₆) δ 206.5, 164.3, 159.6, 133.4, 130.7, 130.1 (2C), 129.7, 129.4 (2C), 129.1 (2C), 128.8 (2C), 113.9, 84.8, 84.0, 77.8, 76.0, 73.1, 73.0, 67.4, 61.3, 60.6, 59.8, 57.7, 54.5, 53.5, 51.5, 39.3, 37.9, 35.2, 30.2, 29.4, 25.9 (3C), 21.3, 20.3, 18.2, 13.4, 10.6, -2.4, -4.0; ES HRMS *m/z* (M+Na)⁺ calcd 775.3484, obsd 775.3496; [α]_D¹⁸ -22.1 (*c* 0.10, CHCl₃).

Oxidative Cleavage of 3 with Methyl(trifluoromethyl)dioxirane. A mixture of **3** (26 mg, 0.032 mmol), NaHCO₃ (40 mg, 0.48 mmol, 15 eq), and Oxone[®] (196 mg, 0.319 mmol, 10 eq) in 1.6 mL of CH₃CN and 800 μL of H₂O was cooled to 0 °C. To this solution was added trifluoroacetone (9 μL, 0.096 mmol, 3 eq), and the reaction mixture was stirred for 3 h, filtered

through a plug of silica gel, and concentrated under reduced pressure. The resulting oil was purified by column chromatography on silica gel (5% EtOAc in hexane) to return 13 mg of **3** (50% conversion) and provide 6 mg (46%) of **4** as a cloudy oil; IR (neat, cm^{-1}) 3382, 1728, 1682; ^1H NMR (500 MHz, C_6D_6) δ 9.93 (d, , $J = 8.1$ Hz, 1H), 8.27 (d, $J = 7.8$ Hz, 2H), 7.19 (d, $J = 7.3$ Hz, 1H), 7.11 (d, $J = 7.8$ Hz, 2H), 6.64 (dd, $J = 8.0, 1.5$ Hz, 1H), 6.36 (d, $J = 12.2$ Hz, 1H), 5.94 (d, $J = 2.3$ Hz, 1H), 5.89 (d, $J = 12.2$ Hz, 1H), 5.73 (d, $J = 13$ Hz, 1H), 5.23 (d, $J = 1.2$ Hz, 1H), 4.72 (d, $J = 2.1$ Hz, 1H), 4.67 (d, $J = 14.4$ Hz, 1H), 4.40 (d, $J = 13$ Hz, 1H), 4.37 (d, $J = 14.4$ Hz, 1H), 4.28 (dd, $J = 11.3, 4.8$ Hz, 1H), 3.80 (s, 3H), 3.41 (s, 3H), 3.37 (s, 1H), 3.18 (dd, $J = 4.2, 1.9$ Hz, 1H), 2.75 (s, 1H), 2.11 (t, $J = 13.8$ Hz, 1H), 2.04 (d, $J = 4.4$ Hz, 1H), 1.73-1.66 (m, 1H), 1.56 (s, 3H), 1.46 (s, 3H), 1.44-1.37 (m, 1H), 1.18 (s, 3H), 1.06-1.01 (m, 1H), 1.00 (s, 9H), 0.89 (dt, $J = 13, 3.1$ Hz, 1H), 0.14 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 207.0, 189.9, 164.6, 164.2, 154.9, 154.2, 138.4, 133.4 (2C), 130.0 (2C), 129.4 (2C), 128.9 (2C), 126.5, 125.1, 106.7, 83.3, 76.9, 75.8, 73.7, 72.9, 70.6, 61.8, 60.6, 59.8, 57.5, 53.6, 51.3, 41.7, 36.4, 35.9, 30.2, 29.0, 25.9 (3C), 20.1, 18.2, 13.9, 10.4, -2.6, -4.3; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 869.2538, obsd 869.2512; $[\alpha]_{\text{D}}^{21}$ -3.2 (c 0.06, CHCl_3).

Isomerization of 4 to 5. The C_6D_6 solution from above was allowed to evaporate to dryness and the residue was kept in a vial at room temperature for 1 week before being redissolved in C_6D_6 for NMR and MS analysis: ^1H NMR (500 MHz, C_6D_6) δ 9.81 (d, $J = 7.0$ Hz, 1H), 8.15 (m, 2H), 8.08 (d, $J = 16$ Hz, 1H), 7.07 (m, 1H), 6.98 (m, 2H), 6.56 (dd, $J = 16, 0.5$ Hz, 1H), 6.49 (br d, $J = 7$ Hz, 1H), 5.82 (d, $J = 2.5$ Hz, 1H), 5.62 (d, $J = 13$ Hz, 1H), 5.12 (d, $J = 1.5$ Hz, 1H), 4.65 (br dd, $J = 13.5, 1.5$ Hz, 1H), 4.59 (d, $J = 2.5$ Hz, 1H), 4.26 (dd, $J = 13, 2$ Hz, 1H), 4.17 (dd, $J = 11, 4.5$ Hz, 1H), 4.11 (dd, $J = 13.5, 1.5$ Hz, 1H), 3.68 (s, 3H), 3.39 (s, 3H), 3.23 (br dd, $J = 2, 1.5$ Hz, 1H), 3.05 (dd, $J = 4.5, 2$ Hz, 1H), 2.60 (s, 1H), 1.99 (br dddd, $J = 14,$

13.5, 4, 2 Hz, 1H), 1.91 (d, $J = 4.5$ Hz, 1H), 1.58 (dddd, $J = 12.5, 4.5, 4, 4$ Hz, 1H), 1.47 (s, 3H), 1.33 (s, 3H), 1.28 (dddd, $J = 14, 12.5, 11, 3$ Hz, 1H), 1.03 (s, 3H), 0.88 (s, 9H), 0.77 (ddd, $J = 13.5, 4, 3$ Hz, 1H), -0.02 (s, 3H), -0.05 (s, 3H); ^{13}C NMR (100 MHz, C_6D_6) δ 207.3, 189.0, 166.1, 164.4, 154.5, 148.5, 136.2, 133.6, 131.7, 130.2 (2C), 129.1 (2C), 125.3, 106.6, 83.7, 77.1, 76.0, 73.8, 73.0, 70.8, 61.9, 60.8, 59.9, 57.8, 53.8, 51.5, 41.9, 36.6, 36.1, 30.3, 29.2, 26.1 (3C), 20.1, 18.5, 10.6, -2.4, -3.9; ES HRMS m/z ($\text{M}+\text{Na}$) $^{+}$ calcd 869.2538 and 871.2571, obsd 869.2512 and 871.2518.

Table of NMR Data for 5 (C₆D₆, 25 °C)^{a-g)}

Pos.	δ_C Mult.	δ_H Mult. & Integral	J_{HH} [Hz]	Multiple-Bond H-C Connectivity (HMBC)	H-H Spatial Proximity (NOESY, NOED)
1	77.1 C	--	--		
1-OH	--	2.60 s (1H)	--	C-15	H-2, H-14, Bz
2	73.0 CH	5.82 d (1H)	2.5	C-1, C-8, C-14, Bz (C=O); C-3 (w), C-15 (w)	1-OH, H-3, H-17, H-19
3	36.6 CH	4.59 d (1H)	2.5	C-1, C-4, C-8, C-18, C-19; C-2 (w), C-9 (w)	H-2, H-5, H-7, H-10
4	60.8 C	--	--		
5 (α)	36.1 CH ₂	1.99 brdddd (1H)	14, 13.5, 4, 2	C-4 (w)	H-3, H-7
5' (β)	--	0.77 ddd (1H)	13.5, 4, 3	C-3 (w), C-4 (w), C-7 (w)	H-18'
6 (α)	30.3 CH ₂	1.58 dddd (1H)	12.5, 4.5, 4, 4		H-7
6' (β)	--	1.28 dddd (1H)	14, 12.5, 11, 3		
7	76.0 CH	4.17 dd (1H)	11, 4.5		H-3, H-5, H-6, H-10
8	59.9 C	--	--		
9	207.3 C	--	--		
10	83.7 CH	5.12 d (1H)	1.5	C-11, C-12, C-15, C-27; C-9 (w)	H-3, H-7, H-11, H-27, H-27'
11	61.9 CH	3.23 brdd (1H)	2, 1.5	C-1, C-9, C-10, C-12, C-13, C-15	H-10, H-16, H-17
12	106.6 C	--	--		
13	154.5 C	--	--		
14	73.8 CH	4.26 dd (1H)	13, 2	C-1, C-12, C-13; C-2 (w)	1-OH, H-16, H-20
14-OH	--	5.62 d (1H)	13		H-3, H-20, Bz
15	41.9 C	--	--		
16	29.2 CH ₃	1.03 s (3H)	--	C-1, C-11, C-15, C-17	H-11, H-14, H-17
17	20.1 CH ₃	1.47 s (3H)	--	C-1, C-11, C-15, C-16	H-2, H-11, H-16
18 (endo)	53.8 CH ₂	3.05 dd (1H)	4.5, 2		H-19, Bz
18' (exo)	--	1.91 d (1H)	4.5		H-5'
19	10.6 CH ₃	1.33 s (3H)	--	C-3, C-7, C-8, C-9	H-2, H-18
20	57.8 CH ₃	3.68 s (3H)	--	C-13	H-14, 14-OH
21	166.1 C	--	--		
22	125.3 CH	6.56 dd (1H)	16, 0.5	C-24	H-27, H-27'
23	136.2 CH	8.08 d (1H)	16	C-21	H-26
24	148.5 C	--	--		
25	131.7 CH	6.49 brd (1H)	7	C-23 (w)	H-27, H-27'
26	189.0 CH	9.81 d (1H)	7	C-25	H-23
27	70.8 CH ₂	4.65 brdd (1H)	13.5, 1.5	C-24, C-25	H-10, H-22, H-25
27'	--	4.11 dd (1H)	13.5, 1.5	C-24, C-25; C-10 (w)	H-10, H-22, H-25
28	51.5 CH ₃	3.39 s (3H)	--	C-21	

a) spectrometers: Varian UNITYPlus with 11.7 T magnet (500 MHz ¹H frequency), Varian UNITY with 9.4 T magnet (100 MHz ¹³C frequency) **b)** probes: Varian 500 MHz Triple•nmr™ triple-resonance (HCN) indirect detection probe, Varian 400 MHz auto•nmr™ four-nucleus (HFPC) probe **c)** sample: ca. 5 mg/mL solution in C₆D₆ **d)** chemical shifts reported in ppm and internally referenced to the resonances of C₆D₅H (7.15 ppm, ¹H) and C₆D₆ (128.0 ppm, ¹³C) **e)** s - singlet, d - doublet, br - broad, w - weak **f)** 2-OBz: 8.15 m (2H; ortho), 7.07 m (1H; para), 6.98 m (2H; meta); 164.4 C (C=O), 129.6 C (ipso), 133.6 CH (para), 130.2 CH (2C; ortho), 129.1 CH (2C; meta) **g)** 7-OTBS: 0.88 s (9H), -0.02 s (3H), -0.05 s (3H); 26.1 CH₃ (3C), 18.5 C, -2.4 CH₃, -3.9 CH₃

General Procedure for PMB oxidative cleavage.

Method A: To a solution of the PMB ether (0.51 mmol, 1 equiv), Oxone[®] (5.1 mmol, 10 equiv), and NaHCO₃ (7.65 mmol, 15 equiv) in H₂O (13 mL) and CH₃CN (25.5 mL) was added trifluoroacetone (1.53 mmol, 3 equiv) at 0 °C. The reaction mixture was stirred at this temperature for 3 h before being filtered and washed with CH₂Cl₂. The filtrate was diluted with H₂O (10 mL), the separated aqueous layer was extracted with CH₂Cl₂ (3 x 10 mL), and the combined organic layers were dried and concentrated. The residue was purified by column chromatography to return starting material and furnish the desired product.

Method B: To a solution of the PMB ether (0.82 mmol, 1 equiv) and trifluoroacetone (4.1 mmol, 5 equiv) in Na₂EDTA•H₂O (4 x 10⁻⁴ M, 4 mL) and CH₃CN (8 mL) was added a mixture of NaHCO₃ (6.35 mmol, 7.75 equiv) and Oxone[®] (4.1 mmol, 5 equiv) portionwise over 1 h at 0 °C. The reaction mixture was stirred at this temperature for 3 h before being poured into H₂O (20 mL) and extracted with CH₂Cl₂ (3 x 20 mL). The combined organic layers were dried and concentrated. The residue was purified by column chromatography using deactivated silica gel (6 % H₂O w/w) to return starting material and yield the desired product.

Method C: To a solution of the PMB ether (1.02 mmol, 1 equiv), NaHCO₃ (7.91 mmol, 7.75 equiv), and trifluoroacetone (5.10 mmol, 5 equiv) in CH₃CN (10 mL) and H₂O•Na₂EDTA (5 mL, 4 x 10⁻⁴ M) at 0 °C was added Oxone[®] (5.10 mmol, 5 equiv) in portions over 2 h. The reaction mixture was stirred for an additional hour at 0 °C before the solid was filtered off and washed with CH₂Cl₂ (20 mL). The filtrate was diluted with H₂O (20 mL), the separated aqueous layer was washed with CH₂Cl₂ (3 x 20 mL), and the combined organic layers were dried and concentrated. The residue was purified by column chromatography using deactivated silica gel (6 % H₂O w/w) to return starting material and afford the desired product.

The residue was purified by column chromatography (2:1 hexane/ethyl acetate) using deactivated silica gel (6 % H₂O w/w) to return 0.105 g (48 % conversion, 0.96 mmol scale) of **6** and yield 35 mg (32 % based on conversion) of **14** as a yellow oil: IR (neat, cm⁻¹) 1722, 1674, 1281; ¹H NMR (400 MHz, CDCl₃) δ 9.75 (d, *J* = 8.0 Hz, 1H), 6.74 (d, *J* = 12 Hz, 1H), 6.15 (d, *J* = 12 Hz, 1H), 6.14 (d, *J* = 8.0 Hz, 1H), 4.28 (s, 2H), 4.08 (s, 3H), 3.58 – 3.45 (m, 4H), 2.09 – 1.94 (br, m, 2H), 0.89 (d, *J* = 7.2 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 191.1, 164.9, 156.5, 138.1, 126.2, 125.7, 75.1, 72.3, 66.6, 51.8, 35.8, 13.5; ES HRMS *m/z* (M+Na)⁺ calcd 265.1052, obsd 265.1048.

***E,E*-Isomer:** ¹H NMR (400 MHz, CDCl₃) δ 10.26 (d, *J* = 7.6 Hz, 1H), 8.06 (d, *J* = 16.0 Hz, 1H), 6.29 (d, *J* = 7.6 Hz, 1H), 6.22 (d, *J* = 16.0 Hz, 1H), 4.28 (s, 2H) 3.79 (s, 3H), 3.58 (t, *J* = 3.8 Hz, 2H), 3.47 (t, *J* = 4.6 Hz, 2H), 2.56 – 1.94 (m, 1H), 1.85 – 1.65 (br, s, 1H), 0.92 (d, *J* = 6.8 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 189.9, 166.2, 149.8, 135.6, 130.7, 124.8, 74.7, 70.5, 66.2, 52.2, 35.9, 13.6.

The residue was purified by column chromatography (2:1 hexane/ethyl acetate) using deactivated silica gel (6 % H₂O w/w) to return 50 mg of **7** (50 % conversion, 0.40 mmol scale) and yield 21 mg (36 % based on conversion) of **15** as a yellow oil: IR (neat, cm⁻¹) 1726, 1674,

1280; ^1H NMR (400 MHz, CDCl_3) δ 9.76 (d, $J = 8.0$ Hz, 1H), 6.75 (d, $J = 12.0$ Hz, 1H), 6.18 – 6.14 (m, 2H), 4.17 (s, 2H), 4.06 – 4.01 (dd, $J = 16.0, 11.0$ Hz, 1H), 3.99 – 3.95 (dd, $J = 6.0, 11.0$ Hz, 1H), 3.69 (s, 3H), 3.43 – 3.39 (m, 2H), 2.14 – 2.05 (m, 1H), 2.03 (s, 3H), 0.96 (d, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 191.1, 171.1, 164.9, 156.7, 138.2, 125.9, 125.6, 72.9, 72.0, 66.2, 51.8, 33.4, 20.9, 14.0; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 307.1158, obsd 307.1148.

***E,E*-Isomer:** ^1H NMR (400 MHz, CDCl_3) δ 10.25 (d, $J = 8.0$ Hz, 1H), 8.06 (d, $J = 16.0$ Hz, 1H), 6.30 (d, $J = 8.0$ Hz, 1H), 6.21 (d, $J = 16.0$ Hz, 1H), 4.25 (s, 2H), 4.05 – 3.95 (m, 2H), 3.79 (s, 3H), 3.43 – 3.34 (m, 2H), 2.13 – 2.06 (m, 1H), 2.03 (s, 3H), 0.96 (d, $J = 6.8$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 189.9, 171.1, 166.2, 149.9, 135.6, 130.7, 124.7, 72.9, 70.3, 66.1, 52.9, 33.1, 20.9, 14.0.

The residue was purified by column chromatography (2:1 hexane/ethyl acetate) using deactivated silica gel (6 % H_2O w/w) to return 0.103 g (49 % conversion, 0.82 mmol scale) of **8** and yield 45 mg (39 % based on conversion) of **16** as a yellow oil: IR (neat, cm^{-1}) 1721, 1673, 1216; ^1H NMR (400 MHz, CDCl_3) δ 9.63 (s, 1H), 6.86 (s, 1H), 6.27 (d, $J = 12.6$ Hz, 1H), 5.53 (d, $J = 12.6$ Hz, 1H), 4.20 (t, $J = 6.7$ Hz, 2H), 3.62 (m, 5H), 3.47 (t, $J = 6.7$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 199.3, 166.8, 156.9, 142.2, 114.0, 111.3, 73.1, 51.3, 41.4, 20.0; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 298.9895, obsd 298.9891.

***E,E*-Isomer:** ^1H NMR (400 MHz, CDCl_3) δ 10.24 (d, $J = 8.0$ Hz, 1H), 8.05 (d, $J = 16.0$ Hz, 1H), 6.33 (d, $J = 8.0$ Hz, 1H), 6.23 (d, $J = 16.0$ Hz, 1H), 4.34 (s, 2H), 3.80 (t, $J = 6.7$ Hz, 2H),

3.78 (s, 3H), 3.46 (t, $J = 6.0$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 189.9, 166.2, 149.3, 135.4, 130.9, 124.9, 70.9, 70.3, 52.2, 29.9.

The residue was purified by column chromatography (1:1 hexane/ethyl acetate) using deactivated silica gel (6 % H_2O w/w) to return 96 mg (52 % conversion, 0.90 mmol scale) of **9** and yield 25 mg (21 % based on conversion) of **17** as a clear oil: IR (neat, cm^{-1}) 1718, 1675, 1438; ^1H NMR (400 MHz, CDCl_3) δ 9.76 (d, $J = 8.2$ Hz, 1H), 6.76 (d, $J = 12.0$ Hz, 1H), 6.15 (d, $J = 12.0$ Hz, 1H), 6.02 (d, $J = 8.2$ Hz, 1H), 4.24 (s, 2H), 3.83 – 3.78 (m, 1H), 3.68 (s, 3H), 3.71 – 3.65 (m, 1H), 3.51 – 3.36 (m, 3H), 2.01 – 1.94 (br, 1H), 1.83 – 1.74 (m, 1H), 1.64 – 1.48 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 191.1, 164.9, 157.1, 138.2, 125.9, 125.6, 73.6, 70.1, 69.4, 67.9, 51.8, 29.0, 23.6; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 277.1052, obsd 277.1045.

***E,E*-Isomer:** ^1H NMR (400 MHz, CDCl_3) δ 10.24 (d, $J = 7.8$ Hz, 1H), 8.06 (d, $J = 16.2$ Hz, 1H), 6.35 (d, $J = 7.8$ Hz, 1H), 6.20 (d, $J = 16.2$ Hz, 1H), 4.32 (s, 2H), 3.78 (s, 3H), 3.83 – 3.73 (m, 1H), 3.73 – 3.64 (m, 1H), 3.51 – 3.36 (m, 3H), 2.00 – 1.94 (m, 1H), 1.83 – 1.75 (m, 1H), 1.62 – 1.48 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 189.9, 166.2, 150.2, 135.7, 130.7, 124.6, 73.8, 69.9, 67.9, 67.5, 52.2, 28.9, 23.6.

The residue was purified by column chromatography (4:1 hexane/ethyl acetate) using deactivated silica gel (6 % H_2O w/w) to return 114 mg (43 % conversion, 0.40 mmol scale) of **10**

and yield 28 mg (31 % based on conversion) of **18** as a clear oil: IR (neat, cm^{-1}) 1716, 1669, 1218; ^1H NMR (400 MHz, CDCl_3) δ 9.76 (d, $J = 8.0$ Hz, 1H), 7.64 (d, $J = 6.0$ Hz, 4H), 7.42 – 7.33 (m, 6H), 6.73 (d, $J = 12.2$ Hz, 1H), 6.17 (d, $J = 8.0$ Hz, 1H), 6.14 (d, $J = 12.2$ Hz, 1H), 4.13 (s, 2H), 3.67 (s, 3H), 3.57 – 3.46 (m, 2H), 3.32 – 3.18 (dt, $J = 6.0$, 19.3 Hz, 2H), 1.81 – 1.71 (sextet, $J = 6.5$ Hz, 1H), 1.53 – 1.45 (m, 1H), 1.39 – 1.31 (m, 2H), 1.29 – 1.22 (m, 1H), 1.21 – 1.13 (m, 1H), 1.03 (s, 9H), 0.88 (d, $J = 6.1$ Hz, 3H) 0.79 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 191.2, 164.9, 157.1, 138.4, 135.6, 134.1, 132.0, 129.5, 127.6, 126.0, 72.0, 68.6, 66.3, 51.8, 39.3, 34.9, 31.1, 26.9, 23.4, 19.3, 17.6, 10.9; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 559.2856, obsd 559.2840.

***E,E*-Isomer:** ^1H NMR (400 MHz, CDCl_3) δ 10.26 (d, $J = 8.1$ Hz, 1H), 8.06 (d, $J = 16.1$ Hz, 1H), 7.64 (d, $J = 8.1$ Hz, 4H), 7.40 – 7.33 (m, 6H), 6.32 (d, $J = 8.1$ Hz, 1H), 6.20 (d, $J = 16.1$ Hz, 1H), 4.19 (s, 2H), 3.79 (s, 3H), 3.57 – 3.47 (m, 2H), 3.31 – 3.17 (m, 2H), 1.82 – 1.72 (m, 1H), 1.52 – 1.44 (m, 1H), 1.39 – 1.14 (m, 4H), 1.03 (s, 9H), 0.88 (d, $J = 7.3$ Hz, 3H), 0.78 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 189.9, 166.2, 150.4, 135.6, 134.1, 133.9, 130.6, 129.5, 127.6, 124.6, 70.1, 68.6, 66.3, 52.1, 39.3, 34.9, 31.0, 26.9, 23.5, 19.3, 17.6, 10.9.

The residue was purified by column chromatography (3:1 hexane/ethyl acetate) using deactivated silica gel (6 % H_2O w/w) to return 121 mg (40 % conversion, 0.80 mmol scale) of **11** and yield 41 mg (46 % based on conversion) of **19** as a yellow oil: IR (neat, cm^{-1}) 1716, 1669, 1218; ^1H NMR (400 MHz, CDCl_3) δ 9.75 (d, $J = 7.9$ Hz, 1H), 6.75 (d, $J = 12.2$ Hz, 1H), 6.17 (d, $J = 7.9$ Hz, 1H), 6.14 (d, $J = 12.2$ Hz, 1H), 4.15 (s, 2H), 3.66 (s, 3H), 3.45 (t, $J = 6.7$ Hz, 2H),

1.59 – 1.52 (quintet, $J = 7.3$, Hz, 2H), 1.33 – 1.22 (series of m, 10 H), 0.84 (t, $J = 6.7$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 191.2, 164.9, 157.2, 138.3, 125.9, 125.4, 71.8, 71.4, 51.8, 31.8, 29.7, 29.4, 29.2, 26.1, 22.6, 14.1; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 305.1729, obsd 305.1714.

***E,E*-Isomer:** ^1H NMR (400 MHz, CDCl_3) δ 10.26 (d, $J = 7.6$ Hz, 1H), 8.06 (d, $J = 16.0$ Hz, 1H), 6.33 (d, $J = 7.6$ Hz, 1H), 6.22 (d, $J = 16.0$ Hz, 1H), 4.25 (s, 2H), 3.79 (s, 3H), 3.46 (t, $J = 6.5$ Hz, 2H), 1.60 – 1.54 (series of m, 2H), 1.30 – 1.23 (br, s, 10H), 0.86 (t, $J = 6.5$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 189.9, 166.3, 150.4, 135.8, 130.7, 124.6, 71.5, 70.0, 52.2, 31.8, 29.6, 29.4, 29.2, 26.1, 22.6, 14.1.

The residue was purified by column chromatography (1:1 hexane/ethyl acetate) using deactivated silica gel (6 % H_2O w/w) to return 147 mg (26 % conversion, 0.85 mmol scale) of **12** and yield 25 mg (41 % based on conversion) of **20** as a yellow oil: IR (neat, cm^{-1}) 1716, 1674, 1215; ^1H NMR (400 MHz, CDCl_3) δ 9.72 (d, $J = 7.9$, 1H), 6.70 (d, $J = 12.2$ Hz, 1H), 6.12 (d, $J = 12.2$ Hz, 1H), 6.09 (d, $J = 7.9$ Hz, 1H), 4.13 (s, 2H), 3.66 (s, 3H), 3.67 – 3.60 (m, 1H), 3.47 – 3.43 (dd, $J = 5.4, 9.1$ Hz, 1H), 2.89 – 2.79 (sextet, $J = 7.0$ Hz, 1H), 2.51 – 2.44 (ddd, $J = 3.6, 5.4, 7.3$ Hz, 2H), 1.03 (t, $J = 7.3$ Hz, 3H), 0.99 (d, $J = 7.3$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 213.3, 191.1, 164.9, 156.5, 138.1, 126.0, 125.5, 73.0, 72.1, 51.8, 45.9, 35.5, 13.6, 7.5; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 291.1208, obsd 291.1211.

***E,E*-Isomer:** ^1H NMR (400 MHz, CDCl_3) δ 10.23 (d, $J = 7.3$ Hz, 1H), 8.03 (d, $J = 16.0$ Hz, 1H), 6.24 (d, $J = 7.3$ Hz, 1H), 6.17 (d, $J = 16.0$ Hz, 1H), 4.23 (s, 2H), 3.78 (s, 3H), 3.64 (t, $J = 8.5$ Hz, 1H), 3.47 – 3.43 (dd, $J = 4.8, 8.5$ Hz, 1H), 2.91 – 2.81 (sextet, $J = 7.3$ Hz, 1H), 2.52 –

2.43 (m, 2H), 1.06 (d, $J = 7.3$ Hz, 3H), 1.02 (t, $J = 7.3$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 213.3, 189.9, 166.2, 149.7, 135.6, 130.7, 124.8, 73.0, 70.5, 52.2, 45.9, 35.5, 13.7, 7.5.

The residue was purified by column chromatography (2:1 hexane/ethyl acetate) using deactivated silica gel (6 % H_2O w/w) to return 42 mg (72 % conversion, 0.39 mmol scale) of **13** and yield 56 mg (48 % based on conversion) of **21** as a yellow oil: IR (neat, cm^{-1}) 1778, 1722, 1709, 1677, 1216; ^1H NMR (400 MHz, CDCl_3) δ 9.76 (d, $J = 7.3$ Hz, 1H), 7.40 – 7.34 (m, 3H), 7.30 – 7.26 (m, 2H), 6.75 (d, $J = 12.2$ Hz, 1H), 6.18 – 6.13 (m, 2H), 5.66 (d, $J = 7.3$ Hz, 1H), 4.78 – 4.70 (quintet, $J = 6.5$ Hz, 1H), 4.18 (s, 2H), 3.68 (s, 3H), 3.59 – 3.54 (m, 2H), 3.06 – 3.00 (m, 2H), 2.02 – 1.92 (m, 2H), 0.87 (d, $J = 6.5$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 191.2, 172.6, 164.9, 156.9, 153.1, 138.1, 133.4, 128.7, 128.6, 125.9, 125.7, 125.6, 79.0, 71.7, 69.9, 54.8, 51.8, 32.5, 24.3, 14.5; ES HRMS m/z ($\text{M}+\text{Na}$) $^+$ calcd 438.1529, obsd 438.1536.

***E,E*-Isomer:** ^1H NMR (400 MHz, CDCl_3) δ 10.26 (d, $J = 8.1$ Hz, 1H), 8.05 (d, $J = 16.2$ Hz, 1H), 7.41 – 7.31 (m, 3H), 7.29 (d, $J = 7.3$ Hz, 2H), 6.30 (d, $J = 8.1$ Hz, 1H), 6.20 (d, $J = 16.2$ Hz, 1H), 5.66 (d, $J = 7.3$ Hz, 1H), 4.78 – 4.70 (quintet, $J = 6.5$ Hz, 1H), 4.26 (s, 2H), 3.79 (s, 3H), 3.59 – 3.54 (m, 2H), 3.06 – 3.01 (m, 2H), 2.02 – 1.93 (m, 2H), 0.87 (d, $J = 6.5$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 189.9, 172.5, 166.2, 153.1, 150.1, 135.6, 133.3, 130.5, 128.8, 128.7, 125.7, 124.7, 79.1, 70.1, 69.8, 54.8, 52.2, 32.5, 24.1, 14.5.