SUPPLEMENTARY MATERIAL

Total Synthesis of (−)-Mandelalide A Exploiting Anion Relay Chemistry (ARC):
Identification of a Type II ARC/CuCN Cross-Coupling Protocol

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Experimental procedures and spectral data for all new compounds, including copies of \(^{1}\)H and
\(^{13}\)C NMR spectra.
A. General

All moisture-sensitive reactions were performed using syringe-septum cap techniques under an inert atmosphere of N₂. All glassware was flame dried or dried in an oven (140 °C) for at least 4 h prior to use. Reactions were magnetically stirred unless otherwise stated. Tetrahydrofuran (THF), dichloromethane (CH₂Cl₂), diethyl ether (Et₂O) and toluene were dried by passage through alumina in a Pure Solve™ PS-400 solvent purification system. THF was degassed vigorously via freeze-pump-thaw before being employed in Anion Relay Chemistry protocols. Unless otherwise stated, solvents and reagents were used as received. Analytical thin layer chromatography was performed on pre-coated silica gel 60 F-254 plates (particle size 40-55 micron, 230-400 mesh) and visualized by a uv lamp or by staining with PMA (2 g phosphomolybdic acid dissolved in 20 mL absolute ethanol), KMnO₄ (1.5 g of KMnO₄, 10 g of K₂CO₃ and 2.5 mL of 5% aq. NaOH in 150 mL H₂O), or CAM (4.8 g of (NH₄)₆Mo₇O₂₄·4H₂O and 0.2 g of Ce(SO₄)₂ in 100 mL of a 3.5 N H₂SO₄ solution). Column chromatography was performed using silica gel (Silicycle Silaflash®) P60, 40-63 micron particle size, 230-300 mesh) and compressed air pressure with commercial grade solvents. Yields refer to chromatographically and spectroscopically pure compounds, unless otherwise stated. NMR spectra were recorded at 500 MHz/125 MHz (¹H NMR/¹³C NMR) on a Bruker Avance III 500 MHz spectrometer at 300 K. Chemical shifts are reported relative to chloroform (δ 7.26), acetone (δ 2.05), methanol (δ 3.31), or benzene (δ 7.16) for ¹H-NMR and chloroform (δ 77.16), acetone (δ 29.84), methanol (δ 49.00), or benzene (δ 128.06) for ¹³C-NMR. ¹H NMR spectra are tabulated as follows: chemical shift, multiplicity (s=singlet, d=doublet, t=triplet, q=quartet, qn=quintet, dd=doublet of doublets, ddd= doublet of doublet of doublets, dddd= doublet of doublet of doublet of doublets, dt= doublet of triplet,
m=multiplet, b=broad), coupling constant and integration. $^{13}$C NMR spectra are tabulated by observed peak. Optical rotations were measured on a Jasco P-2000 polarimeter. Melting points were determined using a Thomas-Hoover capillary melting point apparatus and are uncorrected. Infrared spectra were measured on a Jasco FT/IR 480 plus spectrometer. High-resolution mass spectra (HRMS) were obtained at the University of Pennsylvania on a Waters GCT Premier spectrometer. GPC analysis of the polymer samples were done on a Perkin-Elmer Series 10 high-performance liquid chromatography (HPLC), equipped with an LC-100 column oven (30 °C), a Nelson Analytical 900 Series integration data station, a Perkin-Elmer 785 UV-vis detector (254 nm), a Varian star 4090 refractive index detector, and three AM gel columns (500 Å, 5 µm; 1000 Å, 5 µm; and $10^4$ Å, 5 µm). THF (Fisher, HPLC grade) was used as eluent at a flow rate of 1 mL/min. SFC purifications were performed with a JASCO system equipped with a Chiralpak AD-H column (10 mm x 250 mm), a PU-280-CO2 plus CO2 Delivery System, a CO-2060 plus Intelligent Column Thermostat, an HC-2068-01 Heater Controller, a BP-2080 plus Automatic Back Pressure Regulator, an MD-2018 plus Photodiode Array Detector (200-648 nm), and PU-2080 plus Intelligent HPLC Pumps.

B. Experimental Procedures

I. Preparation of Coupling Partners for ARC:

1,3-dithiane 7a and (S)-epichlorohydrin 12 were purchased from commercial sources and used as received. Compound 2-TBS-1,3-dithiane 10a$^1$ were prepared according to previously reported procedures.
1. Synthesis of vinyl epoxide linchpin 8:

A tared, septa-capped, 50 mL vial containing 25 mL MeCN and a stir bar was purged with propyne gas (1.36 g, 34.0 mmol) and weighed to determine the mass of dissolved propyne gas in solution. Liquid t-butyldimethylsilane (1.9 mL, 11.3 mmol) was added via syringed and the resulting solution was solidified by cooling down to −78 °C. The septa was removed, solid catalyst Rh(acac)(CO)₂ (29.2 mg, 0.113 mmol) was added and the vial was then quickly assembled into a Parr bomb and heated to 90 °C under an atmosphere of CO (500 psi) for 15 h. The solution was then cooled to room temperature and carefully removed from the Parr bomb. The resulting mixture was extracted with Et₂O (2 x 100 mL). The combined organic layers were washed with brine, dried with MgSO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (5% Et₂O/Hexanes) to afford the desired aldehyde 8b as a yellow oil (2.06 g, 11.19 mmol, 99%): IR (film, cm⁻¹) 2939, 2854, 2738, 1687, 1594, 1470, 1362, 1323, 1252, 1029, 1008, 841, 782, 705; ¹H NMR (500 MHz, CDCl₃) δ 9.82 (s, 1 H), 6.86 (q, J = 1.4 Hz, 1 H), 1.94 (d, J = 1.4 Hz, 3 H), 0.93 (s, 9 H), 0.22 (s, 6 H); ¹³C NMR (125 MHz, CDCl₃) δ 193.7, 153.2, 150.4, 26.5, 19.2, 17.1, −2.9; HRMS (Cl⁺) m/z (M–Me)⁺: Calcd for C₉H₁₇OSi: 169.1049, found: 169.1049.
Chloroiodomethane (2.85 mL, 39.13 mmol) was added to a stirred solution of aldehyde 8b (2.405 g, 13.04 mmol) in 35 mL THF at –78 °C. A solution of n-BuLi (2.43 M, 16.1 mL, 39.13 mmol) in hexanes was added dropwise via syringe over 15 min. The obtained solution was then stirred at –78 °C for 1 h, then tetrabutylamonium iodide (TBAI, 481.7 mg, 1.304 mmol) was added and the solution was then stirred at room temperature for 15 h. The solution was quenched with saturated aqueous NH₄Cl (50 mL) and d.i. H₂O (50 mL). The resulting mixture was extracted with Et₂O (2 x 100 mL). The combined organic layers were washed with brine, dried with MgSO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (2-5% Et₂O/Hexanes) to afford the desired epoxide 8a as a yellow oil (2.42 g, 11.2 mmol, 94%): IR (film, cm⁻¹) 2945, 2854, 1616, 1470, 1380, 1250, 895, 841, 761, 686; ¹H NMR (500 MHz, CDCl₃) δ 5.64 (bs, 1 H), 3.59 (t, J = 3.2 Hz, 1 H), 2.86 (t, J = 4.8 Hz, 1 H), 2.79 (dd, J = 5.2, 2.8 Hz, 1 H), 1.67 (d, J = 1.2 Hz, 3 H), 0.91 (s, 9 H), 0.14 (s, 3 H), 0.13 (s, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 150.8, 128.9, 53.4, 46.4, 26.5, 20.1, 17.1, –3.6, –3.7; HRMS (ES⁺) m/z (M+H): Calcd for C₁₁H₂₃OSi: 199.1518, found: 199.1529.

To a mixture of the pre-catalyst (R, R)-(−)-N, N'-bis(3,5-di-tert-butylsalicylidene)-1,2-cyclohexanediaminocobalt(II) (379 mg, 0.628 mmol) in 1 mL toluene was added glacial acetic acid (72 µL, 1.255 mmol), and the resulting mixture was stirred at room temperature under air for 30 min. The volatile components were removed via rotary evaporation and the remaining
residue was dissolved in epoxide 8a (2.49 g, 12.55 mmol) and 2 mL THF. The solution was then cooled to 0 °C and H₂O (160 µL, 8.79 mmol) was added via syringe. The resulting mixture was stirred at room temperature for 8 days, after which time Et₂O (50 mL) was added, the mixture was filtered through a short pad of silica gel and concentrated in vacuo. Flash chromatography on silica gel (5% Et₂O/Hexanes), followed by Kugelrohr distillation (70 – 90 °C, 0.025 mmHg) afforded the desired epoxide 8 as a colorless oil (1.12 g, 5.65 mmol, 45%, >95% ee based on ¹H NMR analysis of 5): [α]²⁰_D −33.97 (c 1.04, CH₂Cl₂).

2. Synthesis of vinyl iodide 9:

To a flask containing CrCl₂ (18.65 g, 151.7 mmol) under N₂ was added 140 mL 1,4-dioxane and 23 mL THF. The mixture was stirred vigorously for 45 min at room temperature to obtain a homogeneous suspension. Recrystallized CHI₃ (19.65 g, 49.91 mmol) was added and the resulting mixture was stirred for 2 h at room temperature, at which time a solution of known aldehyde 9a² (3.13 g, 21.7 mmol) in 7 mL 1,4-dioxane was added dropwise via cannula. The resulting mixture was stirred for 3 h at room temperature. The reaction was then quenched with 100 mL d.i. H₂O and extracted with Hexanes (3 x 100 mL). The combined organic layers were washed with saturated aqueous Na₂S₂O₃, brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (5% Et₂O/Hexanes) to afford the desired vinyl iodide 9 as a colorless oil (4.13 g, 15.4 mmol, 71%): [α]²⁰_D +6.45 (c 0.59, CHCl₃); IR (film, cm⁻¹) 2984, 2934, 2877, 1607, 1370, 1212, 1153, 1065, 948, 835; ¹H NMR (500 MHz, CDCl₃) δ 6.52 (dt, J = 14.5, 7.3 Hz, 1 H), 6.16 (d, J = 14.5 Hz, 1 H), 4.15 (qn,
$J = 6.2 \text{ Hz}, 1 \text{ H}$), $4.03 (\text{dd}, J = 8.0, 6.0 \text{ Hz}, 1 \text{ H})$, $3.57 (\text{dd}, J = 8.0, 6.8 \text{ Hz}, 1 \text{ H})$, $2.40-2.25 (\text{m}, 2 \text{ H})$, $1.41 (\text{s}, 3 \text{ H})$, $1.35 (\text{s}, 3 \text{ H});$ $^{13}\text{C NMR}$ (125 MHz, CDCl$_3$) $\delta$ 141.5, 109.4, 77.7, 74.4, 68.8, 40.2, 27.0, 25.7; $\text{HRMS}$ (Cl$^+$) $m/z$ (M–Me)$^+$: Calcd for C$_7$H$_{10}$O$_2$I: 252.9726, found: 252.9715.

3. Synthesis of vinyl epoxide linchpin 20:

![Chemical diagram]

The known epoxide 20a$^3$ was prepared according to the following procedure: chloroiodomethane (7.03 mL, 96.45 mmol) was added to a stirred solution of aldehyde 20b$^4$ (4.575 g, 32.15 mmol) in 100 mL THF at $-78 \degree \text{C}$. A solution of n-BuLi (2.5 M, 38.6 mL, 96.45 mmol) in hexanes was added dropwise via syringe over 30 min. The obtained solution was then stirred at $-78 \degree \text{C}$ for 1 h, then tetrabutylammonium iodide (TBAI, 1.19 g, 3.22 mmol) was added and the solution was then stirred at room temperature for 15 h. The solution was then quenched with saturated aqueous NH$_4$Cl (50 mL) and d.i. H$_2$O (50 mL). The resulting mixture was extracted with Et$_2$O (2 x 150 mL). The combined organic layers were washed with brine, dried with MgSO$_4$, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (2-5% Et$_2$O/Hexanes) to afford the desired epoxide 20a as a pale yellow oil (4.77 g, 30.54 mmol, 95%): $\text{IR}$ (film, cm$^{-1}$) 3049, 2955, 1637, 1419, 1249, 1160, 953, 891, 852; $^1\text{H NMR}$ (500 MHz, CDCl$_3$) $\delta$ 5.00 (bs, 1H), 4.75 (bs, 1 H), 3.26 (t, $J = 3.0 \text{ Hz}, 1 \text{ H}$), 2.86 (dd, $J = 5.5, 4.2 \text{ Hz}, 1 \text{ H}$), 2.60 (dd, $J = 5.5, 2.6 \text{ Hz}, 1 \text{ H}$), 1.45 (dd, $J = 21.6, 14.1 \text{ Hz}, 2 \text{ H}$), 0.04 (s, 9 H); $^{13}\text{C NMR}$ (125 MHz,
CDCl$_3$ δ 143.5, 109.8, 54.3, 48.2, 21.3, −1.26; HRMS (Cl$^+$) m/z (M−Me)$^+$: Calcd for C$_8$H$_{16}$OSi: 156.0970, found: 156.0966.

To a mixture of the pre-catalyst ($R$, $R$)-($-$-$N$, $N'$-bis(3,5-di-tert-butylsalicylidene)-1,2-cyclohexanediaminocobalt(II) (147 mg, 0.244 mmol) in 1 mL toluene was added glacial acetic acid (28 µL, 0.487 mmol), and the resulting mixture was stirred at room temperature under air for 30 min. The volatile components were removed via rotary evaporation and the remaining residue was dissolved in epoxide 20a (3.806 g, 24.35 mmol) and 3.4 mL THF. The solution was then cooled to 0°C and H$_2$O (241 µL, 13.39 mmol) was added via syringe. The resulting mixture was stirred at room temperature for 5 days, after which time Et$_2$O (30 mL) was added, the mixture was filtered through a short pad of silica gel and concentrated in vacuo. Flash chromatography on silica gel (5% Et$_2$O/Pentanes) afforded the desired epoxide 20 as a pale yellow oil (1.71 g, 10.96 mmol, 45%, >95% ee as determined via SFC analysis of alcohol 20$'$): $[\alpha]_{20}^{20}$D $-5.12$ (c 0.083, CH$_2$Cl$_2$)

A solution of $n$-BuLi (2.48 M, 508 µL, 1.26 mmol) in hexanes was added to a stirred solution of 1,3-dithiane (151.5 mg, 1.26 mmol) in 2 mL THF at $-20$ °C and stirred for 2 h. A solution of epoxide 20 (164.1 mg, 1.05 mmol) in 0.5 mL THF was added via cannula dropwise (followed
with a 0.5 mL rinse with THF). The resulting solution was stirred at –20 °C for 3 h then cooled to –78 °C and HMPA (183 µL, 1.05 mmol) was then added. The resulting mixture was warmed to –40 °C and stirred for another 2 h. The solution was then cooled to –78 °C and aqueous H₂SO₄ (1 N, 2 mL) was added dropwise. The resulting mixture was warmed to room temperature, extracted with Et₂O (3 x 50 mL). The combined organic layers were washed with saturated aqueous NaHCO₃, brine, dried with MgSO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (20% Et₂O/Hexanes) to afford 20’ as a colorless oil (232.3 mg, 0.84 mmol, 80%, >95% ee via SFC analysis): [α]₂⁰Ð –7.75 (c 1.13, CH₂Cl₂); IR (film, cm⁻¹) 3436, 2951, 2898, 1636, 1423, 1276, 1248, 1159, 1053, 886, 853, 692, 668; ¹H NMR (500 MHz, CDCl₃) δ 4.98 (s, 1 H), 4.70 (s, 1 H), 4.28–4.22 (m, 2 H), 2.95–2.82 (m, 4 H), 2.17–2.10 (m, 1 H), 2.05–1.97 (m, 1 H), 1.94–1.85 (m, 2 H), 1.81–1.76 (m, 1 H), 1.63 (d, J = 14.1 Hz, 1 H), 1.41 (d, J = 13.9 Hz, 1 H), 0.04 (s, 9 H); ¹³C NMR (125 MHz, CDCl₃) δ 149.4, 107.6, 72.2, 44.3, 41.7, 30.4, 30.1, 26.1, 22.9, −1.08; HRMS (ES⁺) m/z (M+H)⁺: Calcd for C₁₂H₂₅OS₂Si: 277.1116, found: 277.1110.

4. Synthesis of known epoxide 11⁵:

To a 1L round-bottomed flask containing 11c⁶ (6.12 g, 61.1 mmol) in 190 mL CH₂Cl₂ at 0 °C was added pyridine (12.4 mL, 153 mmol), trityl chloride (34.1 g, 122 mmol), and DMAP (1.49 g, 1.22 mmol). The resulting solution was stirred at room temperature for 39 h, after which time...
TLC indicated complete consumption of 11c. The reaction mixture was diluted with \( \text{CH}_2\text{Cl}_2 \) and water at 0 °C. The resulting mixture was washed with water twice, saturated aqueous \( \text{NH}_4\text{Cl} \) twice, brine, dried over anhydrous sodium sulfate, and filtered. The organic solvents were removed under reduced pressure to give a crude residue, which was purified by silica gel column chromatography (3% EtOAc/Hexanes) to afford 11b as a colorless oil (14.9 g, 43.5 mmol, 71%): 

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[\alpha]^{20}_D +0.57 \ (c \ 0.83, \ \text{CH}_2\text{Cl}_2); \ \text{IR} \ (\text{film, cm}^{-1}) \ 3061, 2916, 1636, 1491, 1448, 1153, 1072, 913, 744, 705; \ 1^\text{H NMR} \ (500 \text{ MHz, CDCl}_3) \ \delta \ 7.45 \ (d, \ J = 7.5 \text{ Hz, 6 H}), 7.32-7.27 \ (m, 6 H), 7.25-7.21 \ (m, 3 H), 5.75-5.65 \ (m, 1 H), 4.99-4.89 \ (m, 2 H), 2.97-2.89 \ (m, 2 H), 2.30-2.22 \ (m, 1 H), 1.96-1.79 \ (m, 2 H), 0.93 \ (d, \ J = 6.5 \text{ Hz, 3 H}); \ 13^\text{C NMR} \ (125 \text{ MHz, CDCl}_3) \ \delta \ 144.6, 137.3, 128.9, 127.8, 126.9, 115.9, 86.3, 68.0, 38.3, 34.0, 17.1; \ \text{HRMS \ (ES\textsuperscript{+}) m/z} \ (M+Na)^+: \ \text{Calcd for C}_{25}\text{H}_{26}\text{ONa: 365.1881, found: 365.1899}.
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To a 1L round-bottomed flask containing 11b (13.06 g, 38.1 mmol) and \( \text{Na}_2\text{HPO}_4 \) (10.8 g, 38.1 mmol) in 380 mL \( \text{CH}_2\text{Cl}_2 \) at 0 °C was added mCPBA (<77% commercial supply, 12.0 g, ca. 53.5 mmol) and the resulting mixture was stirred at room temperature for 14 h, after which time TLC indicated complete consumption of 11b. The reaction was quenched with saturated aqueous \( \text{NaHCO}_3 \) and saturated aqueous \( \text{Na}_2\text{SO}_3 \) (1:1 mixture, ca. 300 mL) at 0 °C. The resulting mixture was extracted with \( \text{CH}_2\text{Cl}_2 \) three times and the combined organic extracts were washed with saturated aqueous \( \text{NaHCO}_3 \), dried over anhydrous sodium sulfate, and filtered. The organic solvents were removed under reduced pressure to give crude material, which was purified by silica gel column chromatography (10% Et\textsubscript{2}O/Hexanes) to afford epoxide 11a as a colorless oil.
(12.6 g, 35.1 mmol, 92%): IR (film, cm$^{-1}$) 3056, 2917, 1490, 1448, 1219, 1153, 1071, 899, 764, 746, 707; $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.44 (d, $J = 7.5$ Hz, 6 H), 7.33-7.27 (m, 6 H), 7.25-7.20 (m, 3 H), 3.02-2.94 (m, 2 H), 2.91-2.82 (m, 1 H), 2.72 (t, $J = 4.5$ Hz, 0.5 H), 2.64 (t, $J = 4.5$ Hz, 0.5 H), 2.45-2.40 (m, 0.5 H), 2.37-2.33 (m, 0.5 H), 2.06-1.94 (m, 1 H), 1.78-1.67 (m, 1 H), 1.43-1.31 (m, 1 H), 1.06 (d, $J = 6.7$ Hz, 1.5 H), 1.02 (d, $J = 6.7$ Hz, 1.5 H); $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 144.5, 144.4, 128.9, 127.9, 127.03, 127.02, 86.4, 68.3, 67.9, 51.5, 50.9, 47.7, 47.2, 37.1, 36.9, 32.7, 32.1, 18.1, 17.4; HRMS (ES$^+$) m/z (M+Na)$^+$: Calcd for C$_{25}$H$_{26}$O$_2$Na: 381.1831, found: 381.1829.

To a 50 mL two-necked round-bottomed flask containing pre-catalyst (R, R)-(−)-N, N’-bis(3,5-di-tert-butylsalicylidene)-1,2-cyclohexanediaminocobalt(II) (404 mg, 0.669 mmol) in 8.2 mL toluene was added glacial acetic acid (76.5 µL, 1.34 mmol), and the mixture was stirred at room temperature for 1 h. The volatile components were then removed and the residue was dried under high vacuum (~30 min). To the resulting residue was added a solution of epoxide 11a (12.0 g, 33.5 mmol) in 12 mL THF and the resulting mixture was cooled to 0 °C. To the solution was added H$_2$O (332 µL, 18.4 mmol) and the mixture was stirred at room temperature for 3 days, after $^1$H-NMR indicated consumption of almost an isomer of 11a. The reaction mixture was purified by silica gel column chromatography (15% Et$_2$O/Hexanes) to afford the epoxide 11 (5.84 g, 16.3 mmol, 49%, >12:1 d.r. as determined by $^1$H-NMR analysis): [α]$^\text{D}$ +2.52 (c 0.67, CH$_2$Cl$_2$); $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.44 (d, $J = 7.5$ Hz, 6 H), 7.33-7.27 (m, 6 H), 7.25-7.20 (m, 3 H), 3.02-2.94 (m, 2 H), 2.91-2.86 (m, 1 H), 2.72 (t, $J = 4.5$ Hz, 1 H), 2.45-2.40 (m, 1 H),
2.06-1.94 (m, 1 H), 1.78-1.72 (m, 1 H), 1.39-1.31 (m, 1 H), 1.02 (d, J = 6.7 Hz, 3 H); $^{13}$C NMR (125 MHz, CDCl$_3$) δ 144.5, 128.9, 127.8, 127.0, 86.4, 68.3, 50.9, 47.7, 36.9, 32.1, 17.4.

II. Procedure for Anion Relay Chemistry:

1. Synthesis of 5 employing type II ARC/Pd cross-coupling:

A solution of $n$-BuLi (2.4 M, 381 µL, 0.914 mmol) in hexanes was added to a stirred solution of 1,3-dithiane (109.9 mg, 0.914 mmol) in 2.5 mL THF and stirred for 5 min at room temperature. The solution was then cooled to –20 °C and a solution of epoxide 8 (170 mg, 0.857 mmol) in 1 mL THF was added via cannula dropwise (followed with a 0.7 mL rinse with THF). The resulting solution was slowly warmed up to room temperature over 5 h. The solution was then cannulated (followed with a 0.5 mL rinse with THF) into another flask containing CuI (217.5 mg, 1.142 mmol) that has been stirred in 6.8 mL of THF/HMPA mixture (1:1 in volume) at –20 °C for 20 min. The resulting suspension was stirred at room temperature for 30 min to obtain a homogeneous solution, which was then cannulated (followed with a 1.0 mL rinse with THF) into another flask containing a mixture of vinyl iodide 9 (153 mg, 0.571 mmol), Pd(OAc)$_2$ (12.8 mg, 0.0571 mmol), and dpdf (63.3 mg, 0.114 mmol) that has been stirred in 1.5 mL THF at rt for 15 min. The resulting solution was then stirred at room temperature for 19 h. The solution was then quenched with saturated aqueous NH$_4$Cl (5 mL) and d.i. H$_2$O (5 mL). The resulting mixture was extracted with Et$_2$O (3 x 50 mL). The combined organic layers were washed with brine, dried
with MgSO$_4$, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (5% Et$_2$O/Hexanes) to afford the desired three-component adduct 5 as a pale yellow oil (212.2 mg, 0.463 mmol, 81%): [α]$^{20}$D $-2.99$ (c 0.82, CH$_2$Cl$_2$); IR (film, cm$^{-1}$) 2979, 2929, 2893, 2856, 1472, 1369, 1252, 1210, 1155, 1069, 1004, 965, 935, 837, 777, 668; $^1$H NMR (500 MHz, CDCl$_3$) δ 6.43 (dd, $J = 14.9$, 11.3 Hz, 1 H), 5.8 (d, $J = 11.1$ Hz, 1 H), 5.55 (dt, $J = 14.9$, 7.2 Hz, 1 H), 4.95 (dd, $J = 8.0$, 5.1 Hz, 1 H), 4.18-4.11 (m, 1 H), 4.05-4.00 (m, 1 H), 3.97 (dd, $J = 8.6$, 5.8 Hz, 1 H), 3.60-3.54 (m, 1 H), 2.88-2.77 (m, 4 H), 2.50-2.43 (m, 1 H), 2.36-2.28 (m, 1 H), 2.15-2.07 (m, 1 H), 2.06-2.00 (m, 1 H), 1.94-1.84 (m, 1 H), 1.81-1.74 (m, 1 H), 1.71 (s, 3 H), 1.42 (s, 3 H), 1.35 (s, 3 H), 0.89 (s, 9 H), 0.08 (s, 3 H), 0.00 (s, 3 H); $^{13}$C NMR (125 MHz, CDCl$_3$) δ 138.5, 128.2, 128.1, 126.4, 109.08, 75.5, 69.1, 67.3, 43.9, 41.9, 37.2, 30.3, 30.0, 27.0, 26.2, 26.0, 25.7, 18.3, 17.9, $-4.68$, $-4.87$; HRMS (ES$^+$) m/z (M+Na)$^+$: Calcd for C$_{23}$H$_{42}$O$_3$NaS$_2$Si: 481.2242, found: 481.2245.

2. Synthesis of 23 employing type II ARC/CuCN cross-coupling:

A solution of n-BuLi (2.5 M, 4.53 mL, 11.33 mmol) in hexanes was added to a solution of 1,3-dithiane (1.36 g, 11.33 mmol) in 15 mL THF at $-20^\circ$C and stirred for 2 h at this temperature. A solution of epoxide 20 (1.66 g, 10.62 mmol) in 13.5 mL THF (dried over anhydrous Na$_2$SO$_4$ and degassed via freeze-pump-thaw) was added via syringe dropwise (followed with a 6 mL rinse with THF). The solution was stirred at $-20^\circ$C for 3 h, then cooled to $-78^\circ$C and HMPA (1.85 mL, 10.62 mmol) was added dropwise. The resulting mixture was placed in $-40^\circ$C cold bath and
stirred at this temperature for 1 h. The solution was then cooled to −78 °C and solid CuCN (476 mg, 5.31 mmol) was quickly added. The resulting bright yellow suspension was stirred at −78 °C for 45 min, then vinyl iodide 9 (1.9 g, 7.08 mmol) in 9 mL THF (dried over anhydrous Na2SO4) was added via syringe dropwise (followed with a 6 mL rinse with THF). The resulting yellow suspension was placed in +10 °C cold bath and stirred at this temperature for 20 h to give a dark, clear solution, which was slowly warmed to room temperature over 15 h. The solution was then added a solution of TBAF (1.0 M in THF, 42.5 mL, 42.5 mmol) and stirred at room temperature for 2 h, followed by addition of saturated aqueous NH4Cl (50 mL) and d.i. H2O (50 mL). The resulting mixture was extracted with Et2O (3 x 150 mL). The combined organic layers were washed with brine, dried with MgSO4, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (30% Et2O/Hexanes) to afford the desired three-component adduct 23 as a pale yellow oil (2.17 g, 6.30 mmol, 89%): [α]20D +4.61 (c 0.64, CH2Cl2); IR (film, cm−1) 3448, 2984, 2930, 1423, 1369, 1214, 1155, 1060, 974, 909, 848; 1H NMR (500 MHz, CDCl3) δ 5.58-5.44 (m, 2 H), 5.12 (s, 1 H), 4.90 (s, 1 H), 4.43-4.37 (m, 1 H), 4.23-4.18 (m, 1 H), 4.17-4.11 (m, 1 H), 4.03 (dd, J = 8.0, 6.0 Hz, 1 H), 3.61-3.55 (m, 1 H), 2.95-2.80 (m, 5 H), 2.77-2.70 (m, 1 H), 2.42-2.35 (m, 1 H), 2.30-2.23 (m, 1 H), 2.16-2.09 (m, 1 H), 2.00-1.85 (m, 4 H), 1.42 (s, 3 H), 1.35 (s, 3 H); 13C NMR (125 MHz, CDCl3) δ 149.9, 130.8, 127.6, 111.5, 109.1, 75.6, 71.5, 69.0, 44.1, 41.3, 37.0, 35.6, 30.4, 30.1, 27.0, 26.1, 25.8; HRMS (ES+) m/z (M+Na)+: Calcd for C17H28O3NaS2: 367.1378, found: 367.1390.

3. Synthesis of 6 employing type I ARC:
A solution of TBS-dithiane \( \text{10a} \) (406 mg, 1.73 mmol) in 5.4 mL THF was treated with a solution of \( n-\text{BuLi} \) (2.3 M, 0.826 mL, 1.9 mmol) in hexanes at room temperature and stirred for 5 min. The reaction mixture was then cooled to \(-40 \, ^\circ\text{C}\) and a solution of epoxide \( \text{11} \) (414 mg, 1.15 mmol) in 15 mL \( \text{Et}_2\text{O} \) was added via syringe dropwise. The mixture was stirred at \(-40 \, ^\circ\text{C}\) and monitored by TLC (30% \( \text{Et}_2\text{O}/\text{Hexanes} \)). After 30 min, TLC analysis showed complete consumption of dithiane. The reaction was then cooled to \(-78 \, ^\circ\text{C}\) and a solution of (\( S \))-epichlorohydrin (266 mg, 2.87 mmol) in 5 mL \( \text{Et}_2\text{O} \) (dried over anhydrous \( \text{Na}_2\text{SO}_4 \)) was added dropwise via syringe, followed by HMPA (0.327 mL, 1.72 mmol). The reaction mixture was stirred at \(-78 \, ^\circ\text{C}\) for 5 min, then allowed to warm to 0 °C using an ice/water bath over 1 hour. The cold bath was then removed and the reaction mixture was allowed to warm to room temperature for about 1 h. Freshly prepared vinylmagnesium bromide (1.0 M, 3.5 mL, 3.5 mmol) in THF was added to a suspension of CuI (110 mg, 0.58 mmol) in 11 mL \( \text{Et}_2\text{O} \) at \(-78 \, ^\circ\text{C}\) via syringe. The reaction mixture containing the ARC product was then added via syringe over 5 min. The resulting mixture was stirred at \(-78 \, ^\circ\text{C}\) for 30 min, and the reaction flask was then placed in an ice/water bath at 0 °C and allowed to warm to room temperature for over 1.5 hour. An aqueous solution of Rochelle’s salt (15% w/v) was finally added and the resulting biphasic mixture was stirred at room temperature for 20 min, then extracted with \( \text{EtOAc} \) twice. The
combined organic extracts were washed with water and brine, dried over anhydrous Na₂SO₄ and concentrated *in vacuo*. The crude material obtained was purified by silica gel column chromatography (5-30% Et₂O/ Hexanes) to afford 6 as a colorless oil (676 mg, 1.00 mmol, 87%); [α]²⁰ᵇ −13.7 (c 0.65, CH₂Cl₂); IR (film, cm⁻¹) 3434, 3058, 2927, 2856, 1596, 1490, 1472, 1448, 1255, 1069, 909, 836, 808, 774, 745, 707, 633; **¹H NMR** (500 MHz, CDCl₃) δ 7.44 (d, J = 7.7 Hz, 6 H), 7.32-7.19 (m, 9 H), 5.89-5.77 (m, 1 H), 5.11-5.04 (m, 2 H), 4.16-4.08 (m, 1 H), 4.04-3.98 (m, 1 H), 3.93-3.89 (m, 1 H), 3.02-2.96 (m, 1 H), 2.89-2.69 (m, 4 H), 2.64-2.55 (m, 1 H), 2.30-2.03 (m, 6 H), 2.00-1.85 (m, 3 H), 1.66-1.59 (m, 1 H), 1.47-1.39 (m, 1 H), 1.05 (d, J = 6.5 Hz, 3 H), 0.88 (s, 9 H), 0.12 (s, 3 H), 0.04 (s, 3 H); **¹³C NMR** (125 MHz, CDCl₃) δ 144.5, 135.1, 128.9, 127.8, 126.9, 117.5, 86.4, 69.0, 68.6, 67.6, 51.5, 45.4, 45.3, 44.0, 43.0, 31.2, 26.5, 26.4, 26.3, 25.1, 18.7, 18.2, −3.0, −4.0; **HRMS (ES⁺)** m/z (M+Na)⁺: Calcd for C₄₀H₅₆O₃NaSiS₂: 699.3338, found: 699.3328.

4. Substrate-scope study of type II ARC/CuCN cross-coupling:

![Reaction Scheme](image)

A solution of n-BuLi (2.5 M, 324 µL, 0.81 mmol) in hexanes was added to a solution of aldehyde 20b (108 mg, 0.759 mmol) in 2.5 mL THF at −78 °C and stirred for 1 h at this temperature. HMPA (132 µL, 0.759 mmol) was added dropwise and the resulting mixture was
placed in –40 °C cold bath and stirred at this temperature for 5 min to obtain a clear solution. The solution was then cooled to –78 °C and solid CuCN (34 mg, 0.38 mmol) was quickly added. The bright yellow suspension was stirred at –78 °C for 45 min, then vinyl iodide (E)-(4-iodobut-3-en-1-yl)benzene (130.6 mg, 0.506 mmol) in 1 mL THF (dried over anhydrous Na₂SO₄) was added via syringe dropwise (followed with a 1.5 mL rinse with THF). The resulting yellow suspension was placed in +10 °C cold bath and stirred at this temperature for 20 h to give a dark, clear solution, which was slowly warmed to room temperature over 15 h. The above solution was then added a solution of TBAF (1.0 M in THF, 3.04 mL, 3.04 mmol) and stirred at room temperature for 2 h, followed by addition of saturated aqueous NH₄Cl (5 mL) and d.i. H₂O (5 mL). The resulting mixture was extracted with Et₂O (3 x 50 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (5% Et₂O/Hexanes) to afford the desired three-component adduct 23a as a colorless oil (107.2 mg, 0.415 mmol, 82%): \( \text{IR (film, cm}^{-1}\) 3368, 3027, 2929, 2857, 1645, 1604, 1496, 1454, 1016, 971, 902, 743, 698; \( \text{^1H NMR (500 MHz, CDCl}_3\) \( \delta \) 7.31-7.25 (m, 2 H), 7.21-7.16 (m, 3 H), 5.56-5.40 (m, 2 H), 4.99 (s, 1 H), 4.78 (s, 1 H), 4.05 (bs, 1 H), 2.82-2.75 (m, 1 H), 2.73-2.63 (m, 3 H), 2.39-2.32 (m, 2 H), 1.57-1.47 (m, 1 H), 1.39-1.21 (m, 5 H), 0.90 (t, \( J = 6.8 \text{ Hz} \), 3 H); \( \text{^13C NMR (125 MHz, CDCl}_3\) \( \delta \) 151.1, 142.1, 131.8, 128.6, 128.5, 128.4, 125.9, 110.7, 75.4, 36.0, 35.2, 35.1, 34.4, 28.0, 22.8, 14.2; \( \text{HRMS} \) (ES⁺) \text{m/z (M+Na)}^+): Calcd for C₁₈H₂₆ONa: 281.1881, found: 281.1884.

![23b](image-url)
A solution of PhLi (1.7 M, 460 µL, 0.78 mmol) in dibutyl ether was added to a solution of aldehyde 20b (104 mg, 0.731 mmol) in 2.5 mL THF at −78 °C and stirred for 1 h at this temperature. HMPA (127 µL, 0.731 mmol) was added dropwise and the resulting mixture was placed in −40 °C cold bath and stirred at this temperature for 5 min to obtain a clear solution. The solution was then cooled to −78 °C and solid CuCN (32.7 mg, 0.365 mmol) was quickly added. The bright yellow suspension was stirred at −78 °C for 45 min, then (Z)-1-iodohept-1-ene (109.1 mg, 0.487 mmol) in 1 mL THF (dried over anhydrous Na₂SO₄) was added via syringe dropwise (followed with a 1.5 mL rinse with THF). The resulting yellow suspension was placed in +10 °C cold bath and stirred at this temperature for 20 h to give a dark, clear solution, which was slowly warmed to room temperature over 15 h. The above solution was then added a solution of TBAF (1.0 M in THF, 2.92 mL, 2.92 mmol) and stirred at room temperature for 2 h, followed by addition of saturated aqueous NH₄Cl (5 mL) and d.i. H₂O (5 mL). The resulting mixture was extracted with Et₂O (3 x 50 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (5% Et₂O/Hexanes) to afford the desired three-component adduct 23b as a colorless oil (91.6 mg, 0.375 mmol, 77%): IR (film, cm⁻¹) 3365, 3063, 3010, 2956, 2927, 2856, 1648, 1493, 1453, 1247, 1189, 1025, 906, 840, 762, 700; ¹H NMR (500 MHz, C₆D₆) δ 7.34 (d, J = 7.3 Hz, 2 H), 7.20-7.13 (m, 2 H), 7.11-7.05 (m, 1 H), 5.51-5.42 (m, 2 H), 5.27 (s, 1 H), 4.96 (d, J = 2.8 Hz, 1 H), 2.82-2.74 (m, 1 H), 2.68-2.60 (m, 1 H), 1.91-1.83 (m, 2 H), 1.34 (d, J = 3.8 Hz, 1 H), 1.28-1.10 (m, 6 H), 0.85 (t, J = 7.0 Hz, 3 H); ¹³C NMR (125 MHz, C₆D₆) δ 150.6, 142.9, 132.0, 128.5, 127.7, 127.0, 126.9, 110.8, 77.4, 31.8, 29.9, 29.6, 27.4, 22.9, 14.3; HRMS (Cl⁺) m/z (M⁺): Calcd for C₁₇H₂₄O: 244.1827, found: 244.1831.
A solution of \( n\)–BuLi (2.5 M, 303 µL, 0.757 mmol) in hexanes was added to a solution of aldehyde 20b (101 mg, 0.71 mmol) in 2.5 mL THF at \(-78^\circ\text{C}\) and stirred for 1 h at this temperature. HMPA (124 µL, 0.71 mmol) was added dropwise and the resulting mixture was placed in \(-40^\circ\text{C}\) cold bath and stirred at this temperature for 5 min to obtain a clear solution. The solution was then cooled to \(-78^\circ\text{C}\) and solid CuCN (31.8 mg, 0.355 mmol) was quickly added. The bright yellow suspension was stirred at \(-78^\circ\text{C}\) for 45 min, then 4-iodobenzonitrile (108.3 mg, 0.473 mmol) in 1 mL THF was added via cannula (followed with a 1.5 mL rinse with THF). The resulting yellow suspension was placed in \(+10^\circ\text{C}\) cold bath and stirred at this temperature for 20 h to give a dark, clear solution, which was slowly warmed to room temperature over 15 h. The above solution was then added a solution of TBAF (1.0 M in THF, 2.8 mL, 2.8 mmol) and stirred at room temperature for 2 h, followed by addition of saturated aqueous \( \text{NH}_4\text{Cl}\) (5 mL) and d.i. \( \text{H}_2\text{O}\) (5 mL). The resulting mixture was extracted with \( \text{Et}_2\text{O}\) (3 x 50 mL). The combined organic layers were washed with brine, dried with \( \text{Na}_2\text{SO}_4\), and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (15% \( \text{Et}_2\text{O}/\text{Hexanes}\) to afford the desired three-component adduct 23c as a pale yellow oil (87.9 mg, 0.383 mmol, 81%): IR (film, cm\(^{-1}\)) 3436, 3079, 2930, 2860, 2228, 1648, 1606, 1504, 1177, 1116, 1019, 906, 857, 814; \(^1\text{H NMR}\) (500 MHz, CDCl\(_3\)) \(\delta\) 7.59 (d, \( J = 7.9 \text{ Hz}, 2 \text{ H}\)), 7.31 (d, \( J = 7.9 \text{ Hz}, 2 \text{ H}\)), 5.15 (s, 1 H), 4.69 (s, 1 H), 4.08 (bs, 1 H), 3.51 (d\(_{\text{A,B}}\), \( J = 15.7 \text{ Hz}, 1 \text{ H}\)), 3.38 (d\(_{\text{A,B}}\), \( J = 15.7 \text{ Hz}, 1 \text{ H}\)), 1.59-1.52 (m, 2 H), 1.48 (bs, 1 H), 1.41-1.22 (m, 4 H), 0.89 (t, \( J = 6.9 \text{ Hz}, 3 \text{ H}\)); \(^{13}\text{C NMR}\) (125 MHz, CDCl\(_3\)) \(\delta\) 150.3, 145.5, 132.3, 130.2, 119.2, 113.3, 110.3, 75.0, 38.4, 35.3, 27.9, 22.7, 14.2; \(^{1}\text{HRMS}\) \(\text{ES}^+\) \(m/z\) (M–H): Calcd for C\(_{15}\)H\(_{18}\)NO: 228.1388, found: 228.1387.
A solution of n-BuLi (2.5 M, 400 µL, 0.999 mmol) in hexanes was added to a solution of 4-phenyl-1-butyne (130.0 mg, 0.999 mmol) in 1.5 mL THF at –78 °C and stirred for 1 h at this temperature. A solution of aldehyde 20b (133.3 mg, 0.937 mmol) in 1.5 mL THF was cannulated dropwise into the above flask and the resulting solution was stirred at –78 °C. After 1 h, HMPA (163 µL, 0.937 mmol) was added dropwise and the resulting mixture was placed in –40 °C cold bath and stirred at this temperature for 5 min to obtain a clear solution. The solution was then cooled to –78 °C and solid CuCN (42.0 mg, 0.469 mmol) was quickly added. The bright yellow suspension was stirred at –78 °C for 45 min, then 4-iodomethylbenzoate (163.5 mg, 0.624 mmol) in 1.5 mL THF was added via cannula (followed with a 1.5 mL rinse with THF). The resulting yellow suspension was placed in +10 °C cold bath and stirred at this temperature for 20 h to give a dark, clear solution, which was slowly warmed to room temperature over 15 h. The above solution was then added a solution of TBAF (1.0 M in THF, 3.7 mL, 3.7 mmol) and stirred at room temperature for 2 h, followed by addition of saturated aqueous NH₄Cl (5 mL) and d.i. H₂O (5 mL). The resulting mixture was extracted with Et₂O (3 x 50 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (10% EtOAc/Hexanes) to afford the desired three-component adduct 23d as a pale yellow oil (146.1 mg, 0.437 mmol, 70%): IR (film, cm⁻¹) 3439, 3057, 3021, 2946, 2922, 2845, 2214, 1705, 1608, 1435, 1277, 1179, 1110, 1019, 912, 699; ¹H NMR (500 MHz, CDCl₃) δ 7.96 (d, J = 8.1 Hz, 2 H), 7.33-7.19 (m, 7 H), 5.32 (s, 1 H), 4.80 (s, 1 H), 4.73 (d, J = 5.0 Hz, 1 H), 3.91 (s, 3 H), 3.57-3.47 (m, 2 H), 2.82 (t, J = 7.5 Hz, 2 H), 2.53 (td, J = 7.4, 1.6 Hz, 2 H), 1.86 (d, J = 5.9 Hz, 1 H); ¹³C NMR (125 MHz, CDCl₃) δ 167.2,
147.3, 144.7, 140.5, 129.8, 129.4, 128.54, 128.4, 126.5, 113.8, 86.7, 79.8, 65.2, 52.2, 38.6, 34.9, 20.9; (ES\(^+\)) \textit{m/z} (M+Na\(^+\))\+: Calcd for C\(_{22}\)H\(_{22}\)O\(_3\)Na: 357.1467, found: 357.1467.

**III. Synthesis of Mandelalide A Northern Hemisphere:**

A solution of TBAF (1.0 M, 1.23 mL, 1.23 mmol) in THF was added to a stirred solution of compound 5 (187.8 mg, 0.409 mmol) in 6 mL THF at room temperature. After stirring at room temperature for 3 h, the solution was quenched with d.i. H\(_2\)O (15 mL). The resulting mixture was extracted with Et\(_2\)O (2 x 50 mL). The combined organic layers were washed with brine, dried with MgSO\(_4\), and concentrated \textit{in vacuo}. The crude product was purified by flash chromatography on silica gel (30\% EtOAc/Hexanes) to afford the desired alcohol 5a as a pale yellow oil (136.7 mg, 0.397 mmol, 97\%): \([\alpha]^{20}_D\) −12.86 (c 0.34, CH\(_2\)Cl\(_2\)); IR (film, cm\(^{-1}\)) 3745, 2979, 2934, 2901, 1424, 1370, 1214, 1155, 1059, 961, 841, 668; \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 6.43 (dd, \(J = 14.9, 11.3\) Hz, 1 H), 5.87 (d, \(J = 11.1\) Hz, 1 H), 5.58 (dt, \(J = 14.7, 7.2\) Hz, 1 H), 5.03 (bs, 1 H), 4.17-4.10 (m, 2 H), 4.02 (dd, \(J = 7.9, 5.9\) Hz, 1 H), 3.59-3.54 (m, 1 H), 2.93-2.81 (m, 4 H), 2.49-2.41 (m, 1 H), 2.36-2.28 (m, 1 H), 2.17-2.07 (m, 2 H), 1.95-1.80 (m, 2 H), 1.77 (s, 3 H), 1.41 (s, 3 H), 1.35 (s, 3 H); \(^{13}\)C NMR (125 MHz, CDCl\(_3\)) \(\delta\) 137.3, 129.0, 127.8, 127.6, 109.1, 75.5, 69.1, 67.1, 44.1, 40.8, 37.2, 30.2, 30.1, 27.1, 26.1, 25.8, 17.9; HRMS (ES\(^+\)) \textit{m/z} (M+Na\(^+\))\+: Calcd for C\(_{17}\)H\(_{28}\)O\(_3\)S\(_2\)Na: 367.1378, found: 367.1387.
To a solution of alcohol 5a (39.7 mg, 0.115 mmol) in MeCN (4 mL) and d.i. H₂O (0.4 mL) was added MeI (108 µL, 1.73 mmol) and CaCO₃ (173.2 mg, 1.73 mmol). After stirring at 65 °C for 6 h, the solution was then cooled to room temperature and filtered through a short pad of celite. The resulting mixture was extracted with Et₂O (2 x 50 mL). The combined organic layers were washed with brine, dried with MgSO₄, and concentrated in vacuo. The crude was then taken up in 2 mL MeOH and NaBH₄ (21.8 mg, 0.576 mmol) was added at 0 °C. After stirring for 1 h at room temperature, the solution was quenched with d.i. H₂O (2 mL). The resulting mixture was extracted with Et₂O (2 x 5 mL). The combined organic layers were washed with brine, dried with MgSO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (50% EtOAc/Hexanes) to afford diol 16 as a colorless oil (23.0 mg, 0.0897 mmol, 78%): [α]²⁰D +36.47 (c 1.37, CH₂Cl₂); IR (film, cm⁻¹) 3855, 2985, 2937, 2881, 1438, 1372, 1215, 1155, 1059, 966, 848, 790; ¹H NMR (500 MHz, CDCl₃) δ 6.41 (dd, J = 14.9, 11.3 Hz, 1 H), 5.85 (d, J = 11.1 Hz, 1 H), 5.56 (dt, J = 14.8, 7.4 Hz, 1 H), 4.93 (dd, J = 9.0, 4.3 Hz, 1 H), 4.16-4.09 (m, 1 H), 4.00 (dd, J = 7.9, 5.9 Hz, 1 H), 3.85-3.75 (m, 2 H), 3.58-3.53 (m, 1 H), 2.57-2.38 (m, 2 H), 2.35-2.27 (m, 1 H), 1.99-1.91 (m, 1 H), 1.78 (s, 3 H), 1.66-1.59 (m, 1 H), 1.40 (s, 3 H), 1.34 (s, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 138.3, 128.6, 127.9, 126.9, 109.2, 75.6, 69.9, 69.0, 61.4, 37.2, 36.9, 27.0, 25.8, 18.2; HRMS (ES⁺) m/z (M+Na)⁺: Calcd for C₁₄H₂₄O₄Na: 279.1572, found: 279.1561.
To a solution of alcohol 23 (1.56 g, 4.53 mmol) in MeCN (150 mL) and d.i. H₂O (15 mL) was added MeI (4.2 mL, 67.92 mmol) and CaCO₃ (6.8 g, 67.92 mmol). After stirring at 60 °C for 5 h, the solution was then cooled to room temperature and filtered through a short pad of celite. The resulting mixture was extracted with EtOAc (2 x 200 mL). The combined organic layers were washed with brine, dried with MgSO₄, and concentrated in vacuo. The crude was then taken up in 70 mL MeOH and NaBH₄ (0.86 g, 22.64 mmol) was added at 0 °C. After stirring for 30 min at room temperature, the solution was quenched with d.i. H₂O (50 mL). The resulting mixture was extracted with EtOAc (2 x 200 mL). The combined organic layers were washed with brine, dried with MgSO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (50-100% EtOAc/Hexanes) to afford diol 24 as a colorless oil (1.06 g, 4.14 mmol, 91%): [α]²⁰ʙ +22.35 (c 0.25, CH₂Cl₂); IR (film, cm⁻¹) 3399, 2984, 2927, 2872, 1370, 1214, 1154, 1061, 973, 902; ¹H NMR (500 MHz, CDCl₃) δ 5.59-5.44 (m, 2 H), 5.12 (s, 1 H), 4.90 (s, 1 H), 4.34 (dd, J = 7.6, 3.9 Hz, 1 H), 4.17-4.11 (m, 1 H), 4.02 (dd, J = 7.9, 6.1 Hz, 1 H), 3.88-3.78 (m, 2 H), 3.61-3.55 (m, 1 H), 2.86-2.78 (m, 1 H), 2.76-2.69 (m, 1 H), 2.53-2.32 (m, 3 H), 2.31-2.24 (m, 1 H), 1.88-1.75 (m, 2 H), 1.41 (s, 3 H), 1.35 (s, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 150.4, 130.9, 127.5, 110.9, 109.1, 75.6, 74.8, 68.9, 61.6, 37.0, 36.9, 35.8, 27.0, 25.7; HRMS (ES⁺) m/z (M+Na)⁺: Calcd for C₁₄H₂₄O₄Na: 279.1572, found: 279.1568.
A solution of diol 24 (800 mg, 3.12 mmol) in 66 mL MeCN was added 46 mL pH 6.5 phosphate buffer and stirred vigorously. To the mixture was added sequentially pyridine-N-oxide (593 mg in 8 mL MeCN, 6.24 mmol), citric acid monohydrate (492 mg in 8 mL pH 6.5 phosphate buffer, 2.34 mmol), Cu(OTf)₂ (1.13 g in 8 mL MeCN, 3.12 mmol) and solid K₂OsO₄·2H₂O (230 mg, 0.624 mmol). The resulting mixture was stirred vigorously at room temperature for approximately 2 weeks, at which time 600 mL EtOAc was added and the organic layer was separated. The aqueous layer was extracted with EtOAc (2 x 300 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was quickly purified by flash chromatography on neutral alumina (1% H₂O/EtOAc) to recover starting material 24 (88 mg, 0.34 mmol) and obtain desired product 25 as a colorless oil (663 mg, 2.43 mmol, 78%, 88% b.r.s.m); [α]²⁰D −68.87 (c 0.33, CH₂Cl₂); IR (film, cm⁻¹) 3421, 2985, 2935, 2871, 1666, 1371, 1219, 1158, 1058, 881; ¹H NMR (500 MHz, C₆D₆) δ 4.77 (s, 1 H), 4.60 (s, 1 H), 4.37-4.28 (m, 2 H), 3.96-3.91 (m, 1 H), 3.69-3.42 (m, 5 H), 2.81 (bs, 1 H), 2.34-2.26 (m, 1 H), 2.23-2.06 (m, 2 H), 1.76-1.68 (m, 1 H), 1.62-1.50 (m, 3 H), 1.43 (s, 3 H), 1.36 (s, 3 H); ¹³C NMR (125 MHz, C₆D₆) δ 151.4, 108.7, 104.8, 82.1, 80.5, 74.0, 70.5, 70.2, 60.2, 38.5, 37.8, 35.1, 27.4, 26.0; HRMS (ES⁺) m/z (M+Na)⁺: Calcd for C₁₄H₂₄O₅Na: 295.1521, found: 295.1520.

A solution of diol 25 (400 mg, 1.47 mmol) in 24 mL CH₂Cl₂ at −78 °C was added sequentially 2,6-lutidine (1.7 mL, 14.69 mmol) and TBSOTf (2.0 mL, 8.81 mmol) via syringe dropwise. The resulting mixture was warmed to 0 °C and stirred at this temperature for 4 h. The solution was
quenched with saturated aqueous NaHCO\textsubscript{3} (20 mL). The resulting mixture was extracted with EtOAc (2 x 100 mL). The combined organic layers were washed with brine, dried with Na\textsubscript{2}SO\textsubscript{4}, and concentrated \textit{in vacuo}. The crude product was purified by flash chromatography on silica gel (2-4\% EtOAc/Hexanes) to afford the desired product 25a as a colorless oil (721 mg, 1.44 mmol, 98\%): $[\alpha]^{20}_{D}$ $-63.04$ (c 0.38, CH\textsubscript{2}Cl\textsubscript{2}); IR (film, cm\textsuperscript{-1}) 2982, 2956, 2929, 2857, 1472, 1369, 1252, 1101, 836, 777; $^1$H NMR (500 MHz, C\textsubscript{6}D\textsubscript{6}) $\delta$ 4.81 (bs, 1 H), 4.75 (bs, 1 H), 4.43-4.33 (m, 2 H), 4.10-4.04 (m, 1 H), 3.92-3.83 (m, 3 H), 3.71 (dt, $J$ = 9.90, 6.30 Hz, 1 H), 3.41-3.35 (m, 1 H), 2.23-2.10 (m, 2 H), 2.04-1.95 (m, 1 H), 1.86-1.77 (m, 1 H), 1.58-1.50 (m, 1 H), 1.44 (s, 3 H), 1.40-1.33 (m, 1 H), 1.38 (s, 3 H), 1.06 (s, 9 H), 1.01 (s, 9 H), 0.25 (s, 6 H), 0.13 (s, 3 H), 0.12 (s, 3 H); $^{13}$C NMR (125 MHz, C\textsubscript{6}D\textsubscript{6}) $\delta$ 151.9, 109.0, 104.3, 82.1, 78.2, 72.6, 72.3, 70.1, 60.5, 39.1, 37.6, 35.4, 27.5, 26.4, 26.2, 26.1, 18.60, 18.55, $-3.8$, $-4.4$, $-5.05$, $-5.10$; HRMS (ES$^+$) $m/z$ (M+Na$^+$): Calcd for C\textsubscript{26}H\textsubscript{52}O\textsubscript{5}NaSi\textsubscript{2}: 523.3251, found: 523.3263.

To a 150 mL flask was added Wilkinson’s catalyst (76 mg, 0.082 mmol) under N\textsubscript{2}. A solution of alkene 25a (822 mg, 1.64 mmol) in toluene (70 mL, degassed by freeze-pump-thaw) was added via cannula and the flask was purged with 10 cycles of H\textsubscript{2} gas/vacuum. A H\textsubscript{2} balloon was attached and the resulting solution was stirred vigorously for 21 h at room temperature. The solution was then concentrated to obtain the crude as a mixture of diastereomers (d.r. = 6:1 by H-NMR). Purification by flash chromatography on silica gel (2-3\% EtOAc/Hexanes) afforded the desired product 26 as a colorless oil (685 mg, 1.36 mmol, 83\%): $[\alpha]^{20}_{D}$ $-50.48$ (c 0.27, CH\textsubscript{2}Cl\textsubscript{2});
IR (film, cm⁻¹) 2953, 2928, 2856, 1461, 1379, 1252, 1095, 836, 776; ¹H NMR (500 MHz, CDCl₃) δ 4.29-4.21 (m, 1 H), 4.04 (dd, J = 7.7, 5.9 Hz, 1 H), 3.91-3.82 (m, 2 H), 3.81-3.75 (m, 1 H), 3.72-3.62 (m, 2 H), 3.51-3.44 (m, 1 H), 2.32-2.20 (m, 1 H), 1.97 (dt, J = 12.4, 7.3 Hz, 1 H), 1.71-1.56 (m, 3 H), 1.54-1.47 (m, 1 H), 1.39 (s, 3 H), 1.34 (s, 3 H), 1.24-1.18 (m, 1 H), 0.91 (d, J = 6.9 Hz, 3 H), 0.89 (s, 9 H), 0.88 (s, 9 H), 0.09 (s, 6 H), 0.05 (s, 6 H); ¹³C NMR (125 MHz, CDCl₃) δ 108.7, 81.8, 78.4, 72.8, 72.0, 70.2, 61.4, 37.2, 35.7, 35.5, 34.5, 27.3, 26.18, 26.15, 26.0, 18.5, 18.4, 15.8, −3.8, −4.6, −5.1, −5.2; HRMS (ES⁺) m/z (M+Na⁺): Calcd for C₁₂₆H₂₅₅O₅NaSi₂: 525.3408, found: 525.3417.

To a polyethylene bottle containing a solution of compound 26 (557 mg, 1.109 mmol) in 56 mL THF at 0 °C was added HF. pyridine (70%, 2.72 mL) via eppendorf pipette. After stirring for 4 h at 0 °C, the solution was quenched slowly with 130 mL saturated aqueous NaHCO₃. The resulting mixture was then diluted with 50 mL EtOAc and stirred vigorously at room temperature for 15 min. The organic layer was separated and the aqueous layer was extracted with EtOAc (2 x 200 mL). The combined organic layers were washed with saturated aqueous CuSO₄, brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (20% EtOAc/Hexanes) to afford the desired product 26a as a colorless oil (414 mg, 1.065 mmol, 96%): [α]²⁰D −46.72 (c 0.52, CH₂Cl₂); IR (film, cm⁻¹) 3434, 2960, 2929, 2851, 1462, 1378, 1251, 1062, 837, 777; ¹H NMR (500 MHz, CDCl₃) δ 4.26-4.19 (m, 1 H), 4.04 (dd, J = 7.6, 6.0 Hz, 1 H), 3.98 (ddd, J = 10.5, 7.4, 2.6 Hz, 1 H), 3.95-3.90 (m, 1
H), 3.82-3.74 (m, 3 H), 3.51-3.46 (m, 1 H), 2.53 (bs, 1 H), 2.33 (dt, J = 14.5, 7.2 Hz, 1 H), 1.99-1.91 (m, 1 H), 1.75-1.63 (m, 2 H), 1.60-1.52 (m, 2 H), 1.39 (s, 3 H), 1.36-1.28 (m, 1 H), 1.33 (s, 3 H), 0.94 (d, J = 7.1 Hz, 3 H), 0.89 (s, 9 H), 0.10 (s, 3 H), 0.09 (s, 3 H); ^13^C NMR (125 MHz, CDCl3) δ 108.8, 82.2, 81.4, 72.7, 70.9, 70.1, 62.1, 37.4, 35.9, 35.1, 33.2, 27.2, 26.1, 25.9, 18.3, 15.5, −4.0, −4.5; HRMS (ES^+^) m/z (M+H)^+: Calcd for C_{20}H_{41}O_{5}Si: 389.2723, found: 389.2739.

To a solution of alcohol 26a (336.7 mg, 0.866 mmol) in 30 mL CH₂Cl₂ at 0 °C was added NaHCO₃ (291.1 mg, 3.466 mmol) and Dess-Martin periodinane (735 mg, 1.733 mmol). The resulting mixture was stirred at 0 °C for 5 min. The cold bath was then removed and the solution was stirred at room temperature for another 2 h. The solution was quenched with saturated aqueous NaHCO₃ (30 mL) and saturated aqueous Na₂S₂O₃ (30 mL). The resulting mixture was extracted with EtOAc (2 x 100 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated. The obtained crude was passed through a short pad of silica gel (wash with EtOAc), and concentrated in vacuo to afford the desired aldehyde, which was used directly in the next step.

A solution of NaHMDS (1.0 M, 4.07 mL, 4.07 mmol) in THF was added dropwise to a solution of Ph₃PCH₂I₂ (2.30 g, 4.33 mmol) in 10 mL THF at 0 °C and the resulting solution was stirred at this temperature for another 15 min. The solution was then cooled to −78 °C and 1,3-dimethyl-3,4,5,6-tetrahydro-2(1H)-pyrimidinone (DMPU, 0.87 mL, 7.19 mmol) was added via syringe dropwise. A solution of the above aldehyde in 5 mL THF was added via cannula dropwise and
the resulting mixture was stirred at −78 °C for 2.5 h. The solution was then quenched with saturated aqueous NH₄Cl (20 mL) and let warm to room temperature over 45 min. The resulting mixture was extracted with EtOAc (3 x 100 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (3% EtOAc/Hexanes) to afford the desired product 27 as a yellow oil (340.5 mg, 0.667 mmol, 77% over 2 steps): [α]²⁰D −40.89 (c 0.29, CH₂Cl₂); IR (film, cm⁻¹) 2953, 2928, 2855, 1462, 1369, 1252, 1092, 1065, 837, 777; ¹H NMR (500 MHz, CDCl₃) δ 6.35-6.29 (m, 1 H), 6.28-6.24 (m, 1 H), 4.29-4.23 (m, 1 H), 4.04 (dd, J = 7.7, 5.9 Hz, 1 H), 3.96-3.86 (m, 2 H), 3.72 (dt, J = 9.3, 6.4 Hz, 1 H), 3.53-3.47 (m, 1 H), 2.39-2.30 (m, 1 H), 2.27-2.20 (m, 2 H), 1.98 (dt, J = 12.5, 7.0 Hz, 1 H), 1.71-1.65 (m, 1 H), 1.55-1.49 (m, 1 H), 1.40 (s, 3 H), 1.33-1.24 (m, 1 H), 1.34 (s, 3 H), 0.98 (d, J = 7.1 Hz, 3 H), 0.88 (s, 9 H), 0.09 (bs, 6 H); ¹³C NMR (125 MHz, CDCl₃) δ 139.1, 108.8, 83.5, 82.1, 80.1, 72.7, 71.8, 70.2, 37.2, 37.1, 35.8, 35.4, 27.3, 26.2, 26.0, 18.4, 15.5, −3.8, −4.6; HRMS (ES⁺) m/z (M+Na)⁺: Calcd for C₂₁H₃₉O₄NaSi: 533.1560, found: 533.1570.

To a solution of acetonide 27 (119.6 mg, 0.234 mmol) in a mixture of THF (2.6 mL) and MeCN (10.3 mL) was added solid CeCl₃.7H₂O (261.9 mg, 0.703 mmol) and a solution of oxalic acid dihydrate (1mg/mL in MeCN, 1.48 mL, 0.0117 mmol). The suspension was stirred vigorously at room temperature for 30 min, then quenched with saturated aqueous NaHCO₃ (10 mL) and stirred for another 30 min. The resulting mixture was extracted with EtOAc (2 x 50 mL). The
combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (20% EtOAc/Hexanes) to afford diol 27a as a white solid (101 mg, 0.215 mmol, 92%): [α]²βD −29.09 (c 0.20, CH₂Cl₂); IR (film, cm⁻¹) 3398, 2959, 2926, 2854, 1461, 1254, 1090, 837, 777; ¹H NMR (500 MHz, CDCl₃) δ 6.35-6.24 (m, 2 H), 4.01-3.87 (m, 4 H), 3.64-3.57 (m, 2 H), 3.48-3.40 (m, 1 H), 2.42-2.33 (m, 1 H), 2.27-2.22 (m, 2 H), 2.08-2.00 (m, 2 H), 1.81-1.72 (m, 1 H), 1.56-1.48 (m, 1 H), 1.29-1.23 (m, 1 H), 0.99 (d, J = 6.9 Hz, 3 H), 0.90 (s, 6 H), 0.11 (s, 6 H); ¹³C NMR (125 MHz, CDCl₃) δ 138.9, 83.8, 81.3, 80.2, 73.9, 69.3, 67.4, 37.2, 36.3, 36.1, 35.8, 26.1, 18.3, 15.5, −4.1, −4.7; HRMS (ES⁺) m/z (M+H)⁺: Calcd for C₁₈H₃₆O₄Si: 471.1428, found: 471.1434.

A solution of diol 27a (104.4 mg, 0.222 mmol) in 16 mL CH₂Cl₂ at 0 °C was added sequentially a solution of imidazole (48 mg/mL in CH₂Cl₂, 1.63 mL, 1.15 mmol) and a solution of TBSCl (80 mg/mL in CH₂Cl₂, 1.63 mL, 0.865 mmol) via syringe dropwise. The resulting mixture was stirred at room temperature for 4.5 h. The solution was quenched with saturated aqueous NH₄Cl (25 mL). The resulting mixture was extracted with EtOAc (2 x 50 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (3% EtOAc/Hexanes) to afford the northern hemisphere 2 as a colorless oil (125 mg, 0.213 mmol, 96%): [α]²βD −23.14 (c 0.58, CHCl₃); IR (film, cm⁻¹) 3456, 2955, 2925, 2850, 1731, 1257, 1117, 837, 777, 668; ¹H NMR (500 MHz, CDCl₃) δ 6.35-6.30 (m, 1 H), 6.28-6.23 (m, 1 H), 3.96-3.89 (m, 2 H), 3.88-3.77 (m, 2 H), 3.55-
3.44 (m, 2 H), 2.96 (d, J = 2.8 Hz, 1 H), 2.39-2.30 (m, 1 H), 2.27-2.20 (m, 2 H), 2.05-1.97 (m, 1 H), 1.60-1.50 (m, 2 H), 1.31-1.22 (m, 1 H), 0.98 (d, J = 6.9 Hz, 3 H), 0.90 (s, 9 H), 0.89 (s, 9 H), 0.11 (s, 3 H), 0.10 (s, 3 H), 0.06 (bs, 6 H); \textsuperscript{13}C NMR (125 MHz, CDCl\textsubscript{3}) \(\delta\) 139.1, 83.5, 81.9, 80.2, 73.0, 68.8, 67.8, 37.2, 36.7, 35.9, 35.8, 26.2, 26.1, 18.44, 18.41, 15.5, −4.0, −4.7, −5.2;

HRMS (ES\textsuperscript{+}) m/z (M+H\textsuperscript{+}): Calcd for C\textsubscript{24}H\textsubscript{50}O\textsubscript{4}Si\textsubscript{2}I: 585.2292, found: 585.2287.

IV. Synthesis of Mandelalide A Southern Hemisphere:

A solution containing alcohol 6 (1.617 g, 2.39 mmol) and Et\textsubscript{3}N (1.032 mL, 7.41 mmol) in 12.5 mL Et\textsubscript{2}O was added MsCl (0.555 mL, 7.17 mmol) at 0 °C. The resulting mixture was stirred at room temperature for 16 h, and monitored by TLC for complete consumption of 6. The reaction mixture was added TBAF (1.0 M in THF, 12.0 mL, 12.0 mmol) and placed under reflux at 60 °C for 48 h. The reaction mixture was then cooled to room temperature and diluted with EtOAc and water. The organic layer was separated, washed with saturated aqueous NaHCO\textsubscript{3}, water and brine, dried over anhydrous Na\textsubscript{2}SO\textsubscript{4}, and filtered. The organic solvents were removed under reduced pressure to give crude material, which was purified by silica gel column chromatography (10-20% Et\textsubscript{2}O/Hexanes) to afford 32 as a colorless foam (0.812 g, 1.49 mmol, 62%): [\(\alpha\)]\textsuperscript{D}\textsuperscript{20} = −8.67 (c 1.05, CH\textsubscript{2}Cl\textsubscript{2}); IR (film, cm\textsuperscript{−1}) 3057, 2916, 1684, 1653, 1636, 1557, 1490, 1448, 1424, 1374, 1339, 1266, 1220, 1152, 1070, 1002, 910, 742, 706; \textsuperscript{1}H NMR (500 MHz,
A mixture of 32 (0.45 g, 0.826 mmol) in MeCN (10 mL) and water (3.4 mL) was added CaCO₃ (372 mg, 3.71 mmol) and MeI (3.0 mL, 49 mmol) and stirred at room temperature over 2 days for complete consumption of 32 by TLC. The suspension was then diluted with Et₂O and water. The aqueous layer was extracted with Et₂O twice and the combined organic extracts were dried over anhydrous Na₂SO₄ and filtered. The filtrate was concentrated under reduced pressure to give material, which was purified by silica gel column chromatography (10-20% Et₂O/Hexanes) to afford ketone 33a (0.364 g, 0.80 mmol, 97%) as a colorless oil: [α]²⁰_D −13.8 (c 1.0, CH₂Cl₂); IR (film, cm⁻¹) 3057, 2916, 1719, 1642, 1596, 1491, 1449, 1359, 1329, 1221, 1154, 1067, 920, 764, 746, 707, 632; ¹H NMR (500 MHz, CDCl₃) δ 7.44 (d, J = 7.5 Hz, 6 H), 7.32 – 7.19 (m, 9 H), 5.85-5.74 (m, 1 H), 5.10-5.00 (m, 2 H), 3.80-3.66 (m, 2 H), 3.02 (dd, J = 8.5, 5.4 Hz, 1 H), 2.90-2.82 (m, 3 H), 2.74-2.68 (m, 1 H), 2.30-2.08 (m, 4 H), 2.07-1.97 (m, 3 H), 1.62-1.49 (m, 4 H), 1.27-1.19 (m, 1 H), 1.01 (d, J = 6.5 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 144.6, 134.7, 128.9, 127.8, 126.9, 117.0, 86.2, 72.3, 70.6, 68.7, 48.3, 43.9, 42.9, 40.2, 39.9, 30.5, 26.1, 26.0, 17.5; HRMS (ES⁺) m/z (M+Na)⁺: Calcd for C₃₄H₄₀O₂NaS₂: 567.2367, found: 567.2372.

\[ \text{CDCl}_3 \delta 7.44 \ (d, J = 7.5 \text{ Hz}, \ 6 \text{ H}), \ 7.32 \rightarrow 7.19 \ (m, \ 9 \text{ H}), \ 5.85-5.74 \ (m, \ 1 \text{ H}), \ 5.10-5.00 \ (m, \ 2 \text{ H}), \ 3.80-3.66 \ (m, \ 2 \text{ H}), \ 3.02 \ (dd, \ J = 8.5, 5.4 \text{ Hz}, \ 1 \text{ H}), \ 2.90-2.82 \ (m, \ 3 \text{ H}), \ 2.74-2.68 \ (m, \ 1 \text{ H}), \ 2.30-2.08 \ (m, \ 4 \text{ H}), \ 2.07-1.97 \ (m, \ 3 \text{ H}), \ 1.62-1.49 \ (m, \ 4 \text{ H}), \ 1.27-1.19 \ (m, \ 1 \text{ H}), \ 1.01 \ (d, \ J = 6.5 \text{ Hz}, \ 3 \text{ H}); \ \text{¹³C NMR} \ (125 \text{ MHz, CDCl}_3) \ \delta 144.6, 134.7, 128.9, 127.8, 126.9, 117.0, 86.2, 72.3, 70.6, 68.7, 48.3, 43.9, 42.9, 40.2, 39.9, 30.5, 26.1, 26.0, 17.5; \ \text{HRMS} \ (\text{ES⁺}) \ m/z \ (\text{M+Na})⁺: \ \text{Calcd for} \ C₃₄H₄₀O₂NaS₂: 567.2367, \ \text{found:} \ 567.2372. \]
86.3, 76.5, 75.0, 68.5, 48.5, 47.4, 40.6, 30.6, 17.4; HRMS (ES\(^+\)) \textit{m/z} (M+Na\(^+\)): Calcd for C\(_{31}\)H\(_{34}\)O\(_3\)Na: 477.2406, found: 477.2391.

A solution of 33a (0.325 g, 0.715 mmol) in 9 mL MeOH was cooled to \(-5\) °C with an ice/brine bath. Solid NaBH\(_4\) (0.135 g, 3.57 mmol) was added and the reaction mixture was stirred at \(-5\) °C for 40 min for complete consumption of 33a by TLC. The reaction was then quenched with 1.0 M aqueous HCl and diluted with saturated aqueous NH\(_4\)Cl. The aqueous layer was extracted with ethyl acetate twice and the combined organic extracts were dried over anhydrous Na\(_2\)SO\(_4\) and filtered. The filtrate was concentrated under reduced pressure to give the crude material, which was purified by silica gel chromatography (10-25% EtOAc/Hexanes) to afford the desired product 33 as a colorless oil (0.278 g, 0.609 mmol, 85%). The minor diastereomer was also obtained as a colorless oil (0.026 g, 0.0766 mmol, 8%): [\(\alpha\)]\(^{20}\) \(+\)6.02 (c 0.51, CH\(_2\)Cl\(_2\)); IR (film, cm\(^{-1}\)) 3376, 2923, 2850, 1636, 1448, 1375, 1323, 1071, 706; \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 7.44 (d, \(J = 7.5\) Hz, 6 H), 7.30 –7.21 (m, 9 H), 5.82-5.77 (m, 1 H), 5.07-5.01 (m, 2 H), 3.74-3.71 (m, 1 H), 3.30-3.22 (m, 2 H), 3.03-3.00 (m, 1 H), 2.88 (dd, \(J = 8.5, 2.0\) Hz, 1 H), 2.32-2.28 (m, 1 H), 2.18-2.14 (m, 1 H), 2.03-1.99 (m, 1 H), 1.95-1.92 (m, 1 H), 1.88-1.84 (m, 1 H), 1.65-1.59 (m, 1 H), 1.39 (d, \(J = 8.5, 5\) Hz, 1 H), 1.27-1.22 (m, 1 H), 1.14-1.07 (m, 2 H), 0.99 (d, \(J = 7.0\) Hz, 3 H); \(^{13}\)C NMR (125 MHz, CDCl\(_3\)) \(\delta\) 144.6, 134.9, 128.9, 127.8, 126.9, 116.8, 86.3, 75.2, 73.4, 68.7,
A solution of alcohol 33 (0.63 g, 1.38 mmol) in 6.5 mL DMF was added tert-BuOK (0.744 g, 6.9 mmol) at 0 °C. The resulting mixture was stirred at 0 °C for 30 min, followed by addition of p-methoxybenzyl bromide (0.82 mL, 5.52 mmol). The obtained mixture was then allowed to warm to room temperature and stirred overnight at which point TLC analysis showed complete consumption of 33. The reaction was quenched with water. The aqueous layer was extracted with EtOAc. The organic extract was washed with water (twice), brine and dried over anhydrous Na₂SO₄ and filtered. The filtrate was concentrated under reduced pressure. The residue was filtered through a pad of silica gel (20% Et₂O/Hexanes) and concentrated in vacuo to afford crude product, which was directly used in next step without further purification.

To a mixture of the above crude in 14 mL methanol was added pyridinium p-toluenesulfonate (1.3 g, 5.2 mmol) at room temperature. The resulting mixture was stirred at room temperature overnight. The reaction was quenched with saturated aqueous NaHCO₃ and diluted with water. The aqueous layer was extracted with EtOAc twice. The combined organic extracts were washed with saturated aqueous NaHCO₃ and brine, dried over anhydrous Na₂SO₄ and filtered. The filtrate was concentrated under reduced pressure to give the crude material, which was purified by silica gel chromatography (25-30% EtOAc/Hexanes) to afford primary alcohol 34a as a
colorless oil (0.38 g, 1.14 mmol, 83%): [α]_D^20 +9.11 (c 0.51, CH₂Cl₂); IR (film, cm⁻¹) 3415, 2919, 2850, 1613, 1513, 1248, 1173, 1073, 1037, 916, 822; ^1H NMR (500 MHz, CDCl₃) δ 7.25 (d, J = 8.5 Hz, 2 H), 6.89 (d, J = 8.5 Hz, 2 H), 5.84-5.76 (m, 1 H), 5.11-5.06 (m, 2 H), 4.49 (s, 2 H), 3.82 (s, 3 H), 3.58-3.52 (m, 2 H), 3.41-3.35 (m, 3 H), 2.39-2.34 (m, 1 H), 2.28-2.22 (m, 1 H), 2.07-2.04 (m, 1 H), 2.00-1.97 (m, 1 H), 1.86-1.80 (m, 1 H), 1.63-1.57 (m, 1 H), 1.43-1.38 (m, 1 H), 1.30-1.18 (m, 2 H), 0.91 (d, J = 7.0 Hz, 3 H); ^13C NMR (125 MHz, CDCl₃) δ 159.3, 134.3, 130.7, 129.3, 117.7, 114.0, 75.6, 75.5, 74.3, 69.4, 68.5, 55.4, 41.7, 40.6, 39.1, 37.5, 34.9, 18.4; HRMS (ES⁺) m/z (M+H)^+: Calcd for C₂₀H₃₁O₄: 335.2222, found: 335.2221.

Hoveyda-Grubbs 2nd gen. catalyst (40 mg, 0.064 mmol) was added to a solution of 34a (0.268 g, 0.801 mmol) and methyl acrylate (0.433 mL, 4.8 mmol) in 12 mL CH₂Cl₂. The mixture was stirred for 18 h at room temperature. The resulting mixture was then concentrated to obtain the crude (E/Z > 20:1 based on ^1H NMR integration), which was purified by silica gel chromatography (20-50% EtOAc/Hexanes) to afford the desired single isomer 34 as a colorless oil (0.284 g, 0.727 mmol, 91%): [α]_D^20 +5.96 (c 0.65, CH₂Cl₂); IR (film, cm⁻¹) 3448, 2918, 1719, 1658, 1613, 1586, 1614, 1438, 1247, 1071, 823; ^1H NMR (500 MHz, CDCl₃) δ 7.25 (d, J = 9.0 Hz, 2 H), 6.98-6.91 (m, J = 1 H), 6.89 (d, J = 9.0 Hz, 2 H), 5.90 (d, J = 15.5 Hz, 1 H), 4.49 (s, 2 H), 3.82 (s, 3 H), 3.75 (s, 3 H), 3.57-3.37 (m, 5 H), 2.51-2.46 (m, 1 H), 2.42-2.36 (m, 1 H), 2.05-1.97 (m, 2 H), 1.86-1.80 (m, 1 H), 1.64-1.58 (m, 1 H), 1.38-1.35 (m, 1 H), 1.30-1.21 (m, 2
H), 0.92 (d, J = 7.0 Hz, 3 H); $^{13}$C NMR (125 MHz, CDCl$_3$) δ 166.9, 159.3, 144.7, 130.6, 129.3, 123.5, 114.0, 75.2, 74.5, 74.1, 69.5, 68.4, 55.4, 51.6, 41.0, 38.9, 38.7, 37.5, 34.2, 18.0; HRMS (ES$^+$) m/z (M+Na)$^+$: Calcd for C$_{22}$H$_{32}$O$_6$Na: 415.2097, found: 415.2097.

To a solution of alcohol 34 (276 mg, 0.703 mmol) in 13 mL CH$_2$Cl$_2$ at 0 ºC was added NaHCO$_3$ (354.5 mg, 4.22 mmol) and Dess-Martin periodinane (894.8 mg, 2.11 mmol). The resulting mixture was stirred at 0 ºC for 5 min. The cold bath was then removed and the solution was stirred at room temperature for another 3 h. The solution was quenched with saturated aqueous NaHCO$_3$ (15 mL) and saturated aqueous Na$_2$S$_2$O$_3$ (25 mL). The resulting mixture was extracted with EtOAc (2 x 100 mL). The combined organic layers were washed with brine, dried with Na$_2$SO$_4$, and concentrated. The obtained crude was passed through a short pad of silica gel (wash with EtOAc), and concentrated in vacuo to afford the desired aldehyde, which was used directly in the next step.

A solution of NaHMDS (1.0 M, 0.914 mL, 0.914 mmol) in THF was added dropwise to a solution of sulfone 35 (236.4 mg, 1.055 mmol) in 6.5 mL THF at −78 ºC and the resulting solution was stirred at this temperature for another 30 min. A solution of the above aldehyde in 12 mL THF was added via cannula dropwise and the resulting mixture was slowly warmed up to
room temperature over 20 h. The solution was then quenched with d.i. H2O (20 mL) and the resulting mixture was extracted with EtOAc (3 x 50 mL). The combined organic layers were washed with brine, dried with Na2SO4, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (5% EtOAc/Hexanes) to afford the desired product 34b as a colorless oil (245.9 mg, 0.633 mmol, 90% over 2 steps): [α]20D −7.86 (c 0.73, CH2Cl2); IR (film, cm−1) 3073, 2999, 2919, 2851, 1722, 1658, 1612, 1586, 1513, 1355, 1248, 1173, 1074, 1037, 912, 822, 762; 1H NMR (500 MHz, CDCl3) δ 7.25 (d, J = 8.3 Hz, 2 H), 7.01-6.93 (m, 1 H), 6.88 (d, J = 8.3 Hz, 2 H), 5.87 (d, J = 15.7 Hz, 1 H), 5.73 (ddd, J = 17.3, 10, 7.5 Hz, 1 H), 4.99-4.87 (m, 2 H), 4.48 (s, 2 H), 3.80 (s, 3 H), 3.73 (s, 3 H), 3.56-3.47 (m, 1 H), 3.40-3.26 (m, 2 H), 2.50-2.62 (m, 1 H), 2.38-2.29 (m, 2 H), 2.06-1.97 (m, 2 H), 1.66 (dt, J = 14.0, 7.3 Hz, 1 H), 1.37-1.29 (m, 1 H), 1.28-1.13 (m, 2 H), 0.99 (d, J = 6.5 Hz, 3 H); 13C NMR (125 MHz, CDCl3) δ 167.0, 159.3, 145.6, 144.6, 130.7, 129.3, 123.0, 114.0, 112.5, 74.4, 74.3, 73.8, 69.4, 55.4, 51.6, 42.7, 39.0, 38.1, 38.0, 34.2, 20.0; HRMS (ES+): m/z (M+Na)+: Calcd for C23H32O5Na: 411.2147, found: 411.2150.

To a solution of methyl ester 34b (208 mg, 0.535 mmol) in 16.1 mL THF was added aqueous LiOH solution (1.0 M, 5.35 mL) dropwise and the resulting mixture was stirred at room temperature for 34 h. The reaction mixture was then diluted with d.i. H2O (50 mL) and EtOAc (50 mL), cooled to 0 °C, followed by dropwise addition of aqueous HCl solution (1.0 M, 5.35
mL) to give an acidic solution (pH ~ 2 with pH paper). The resulting mixture was extracted with EtOAc (3 x 100 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (20% EtOAc/Hexanes) to afford the desired product 3 as a colorless oil (186.5 mg, 0.498 mmol, 93%): [α]^{20}_D −6.36 (c 0.27, CH₂Cl₂); IR (film, cm⁻¹) 3069, 2920, 2853, 1696, 1654, 1612, 1513, 1420, 1357, 1248, 1173, 1073, 913, 821; ¹H NMR (500 MHz, CDCl₃) δ 11.50-10.50 (bs, 1 H), 7.25 (d, J = 8.5 Hz, 2 H), 7.13-7.03 (m, 1 H), 6.88 (d, J = 8.5 Hz, 2 H), 5.88 (d, J = 15.7 Hz, 1 H), 5.73 (ddd, J = 17.3, 10.1, 7.5 Hz, 1 H), 4.99-4.88 (m, 2 H), 4.49 (s, 2 H), 3.8 (s, 3 H), 3.57-3.49 (m, 1 H), 3.42-3.34 (m, 1 H), 3.34-3.27 (m, 1 H), 2.53-2.45 (m, 1 H), 2.41-2.29 (m, 2 H), 2.06-1.98 (m, 2 H), 1.70-1.63 (m, 1 H), 1.37-1.29 (m, 1 H), 1.28-1.12 (m, 2 H), 0.99 (d, J = 6.7 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 170.8, 159.3, 148.3, 144.6, 130.7, 129.3, 122.5, 114.0, 112.6, 74.3, 74.1, 73.8, 69.5, 55.5, 42.7, 39.0, 38.12, 38.09, 34.2, 20.0; HRMS (ES⁺) m/z (M+Na)⁺: Calcd for C₂₂H₃₀O₅Na: 397.1991, found: 397.1993.

V. Fragments Union:
A solution of carboxylic acid 3 (31.0 mg, 0.0827 mmol) in 0.56 mL toluene was added a solution of Et₃N (13% v/v in toluene, 0.8 mL, 0.744 mmol) and a solution of 2,4,6-trichlorobenzoylchloride (4.6% v/v in toluene, 0.56 mL, 0.165 mmol) via syringe dropwise. The solution was stirred at room temperature for 5 h, at which time a solution of alcohol 2 (32.2 mg, 0.0551 mmol) in 2 mL toluene was added via cannula. A solution of DMAP (20.2 mg, 0.165 mmol) in 0.56 mL toluene was added and the resulting mixture was stirred for 27 h at room temperature. The solution was then quenched with saturated aqueous NH₄Cl (5 mL) and the resulting mixture was extracted with EtOAc (3 x 20 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (5% EtOAc/Hexanes) to afford the desired product 36 as a colorless oil (44.1 mg, 0.0468 mmol, 85%); [α]²⁰°D −26.97 (c 0.35, CH₂Cl₂); IR (film, cm⁻¹) 2955, 2926, 2855, 1717, 1655, 1614, 1559, 1539, 1511, 1459, 1363, 1250, 1173, 1090, 837, 776; ¹H NMR (500 MHz, CDCl₃) δ 7.25 (d, J = 8.5 Hz, 2 H), 6.99-6.91 (m, 1 H), 6.88 (d, J = 8.5 Hz, 2 H), 6.35-6.29 (m, 1 H), 6.27-6.23 (m, 1 H), 5.88 (d, J = 15.7 Hz, 1 H), 5.71 (ddd, J = 17.3, 10.1, 7.5 Hz, 1 H), 5.05-4.99 (m, 1 H), 4.98-4.89 (m, 2 H), 4.52-4.45 (m, 2 H), 3.95-3.89 (m, 1 H), 3.80 (s, 3 H), 3.79-3.74 (m, 2 H), 3.71-3.66 (m, 2 H), 3.56-3.49 (m, 1 H), 3.41-3.27 (m, 2 H), 2.51-2.43 (m, 1 H), 2.38-2.29 (m, 3 H), 2.27-2.21 (m, 1 H), 2.06-1.97 (m, 3 H), 1.88-1.81 (m, 1 H), 1.71-1.62 (m, 2 H), 1.37-1.13 (m, 5 H), 1.01-0.97 (m, 6 H), 0.87 (bs, 18 H), 0.05-0.01 (m, 12 H); ¹³C NMR (125 MHz, CDCl₃) δ 166.1, 159.3, 145.3, 144.6, 139.1, 130.8, 129.3, 123.6, 114.0, 112.6, 83.5, 81.8, 80.2, 74.4, 74.3, 73.8, 72.0, 71.2, 69.4, 64.7, 55.4, 42.7, 39.0, 38.1, 38.0, 37.1, 35.7, 35.3, 34.4, 34.1, 26.2, 26.0, 20.0, 18.39, 18.35, 15.5, −3.8, −4.8, −5.2; HRMS (ES⁺) m/z (M+H)⁺: Calcld for C₄₆H₇₈O₈Si₂I: 941.4280, found: 941.4301.
A solution of 36 (27.4 mg, 0.0291 mmol) in 0.7 mL CH₂Cl₂ and 0.156 mL pH 7 phosphate buffer (0.5 M) was added a solution of DDQ (recrystallized over CHCl₃, 19.8 mg, 0.0873 mmol) in 1.5 mL CH₂Cl₂ dropwise at 0 °C. After stirring at 0 °C for 2.5 h, the mixture was then quenched with pH 7 phosphate buffer (5 mL) and the resulting mixture was extracted with CH₂Cl₂ (3 x 30 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (10% EtOAc/Hexanes) to afford the desired product 36a as a colorless oil (22.7 mg, 0.0276 mmol, 95%): [α]²⁰D –30.53 (c 0.40, CH₂Cl₂); IR (film, cm⁻¹) 3424, 3075, 2951, 2928, 2856, 1719, 1655, 1462, 1362, 1255, 1177, 1102, 1006, 911, 837, 777, 668; ¹H NMR (500 MHz, CDCl₃) δ 6.99-6.91 (m, 1 H), 6.36-6.30 (m, 1 H), 6.29-6.24 (m, 1 H), 5.88 (d, J = 15.7 Hz, 1 H), 5.71 (ddd, J = 17.3, 10.0, 7.5 Hz, 1 H), 5.05-4.98 (m, 1 H), 4.98-4.90 (m, 2 H), 3.95-3.89 (m, 1 H), 3.82-3.74 (m, 3 H), 3.71-3.66 (m, 2 H), 3.43-3.29 (m, 2 H), 2.50-2.43 (m, 1 H), 2.38-2.29 (m, 3 H), 2.27-2.21 (m, 1 H), 2.04-1.90 (m, 3 H), 1.88-1.80 (m, 1 H), 1.70-1.63 (m, 2 H), 1.46 (bs, 1 H), 1.38-1.26 (m, 2 H), 1.21-1.07 (m, 2 H), 1.02-0.96 (m, 6 H), 0.94-0.85 (m, 1 H), 0.87 (s, 9 H), 0.86 (s, 9 H), 0.06-0.00 (m, 12 H); ¹³C NMR (125 MHz, CDCl₃) δ 166.1, 145.2, 144.5, 139.1, 123.7, 112.7, 83.6, 81.8, 80.1, 74.2, 73.7, 72.0, 71.2, 68.3, 64.6, 42.6, 41.1, 41.0, 38.8, 37.1, 35.7,
A flask containing activated 4A MS powder (380 mg) was added sugar donor 4 (90.1 mg, 0.175 mmol) in 1.2 mL Et₂O and 2,6-di-t-butyl-4-methylpyridine (77.0 mg, 0.375 mmol) in 0.56 mL Et₂O and the resulting mixture was stirred at room temperature for 1 h. The flask was the cooled to −78 °C and a solution of Tf₂O (25.2 µL, 0.15 mmol) in 0.3 mL Et₂O was added dropwise and the mixture was stirred at −78 °C for 20 min. A solution of alcohol 36a (20.4 mg, 0.0248 mmol) in 2.4 mL Et₂O was added via cannula dropwise. The resulting mixture was stirred at −78 °C for 1 h, then at −40 °C for 2 h and at −35 °C for 1 h. The flask was then cooled to −78 °C and the reaction was quenched with d.i. H₂O (7 mL), diluted with EtOAc (10 mL) and allowed to warm to room temperature. The reaction mixture was filtered, extracted with EtOAc (3 x 20 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (3-5% EtOAc/Hexanes) to afford the desired product 37 as a colorless oil (26.1 mg, 0.0216 mmol, 87%): [α]²⁰ᵇ −46.92 (c 0.40, CH₂Cl₂); IR (film, cm⁻¹) 2954, 2928, 2856, 1720, 1656, 1471, 1362, 1255, 1097, 1049,
To a solution of compound 37 (25.0 mg, 0.0207 mmol) in 3 mL anhydrous DMF (degassed via freeze-pump-thaw) was added a solid mixture of Pd(OAc)$_2$ (8.4 mg, 0.0373 mmol) and Cs$_2$CO$_3$
(13.5 mg, 0.0414 mmol), followed by a solution of Et₃N (4.3 µL, 0.031 mmol) in 0.43 mL DMF. The resulting solution was stirred at room temperature for 2 days. The reaction was quenched with d.i. H₂O (10 mL), extracted with EtOAc (3 x 20 mL). The combined organic layers were washed with brine, dried with Na₂SO₄, and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (3-4% EtOAc/Hexanes) to afford the desired product 37a as a colorless oil (17.9 mg, 0.0165 mmol, 80%): [α]²⁰D −13.44 (c 0.03, CH₂Cl₂); IR (film, cm⁻¹) 2952, 2928, 2892, 2856, 1720, 1653, 1471, 1389, 1359, 1254, 1126, 1096, 1047, 863, 838, 777, 668; ¹H NMR (500 MHz, CDCl₃) δ 6.97-6.89 (m, 1 H), 6.28 (dd, J = 14.9, 11.1 Hz, 1 H), 6.05-5.94 (m, 2 H), 5.46 (dd, J = 14.9, 8.9 Hz, 1 H), 5.28 (td, J = 10.7, 4.8 Hz, 1 H), 5.07-5.01 (m, 1 H), 4.89 (d, J = 2.4 Hz, 1 H), 4.02-3.96 (m, 1 H), 3.88-3.84 (m, 1 H), 3.83-3.29 (m, 11 H), 2.50-2.30 (m, 5 H), 2.05-1.98 (m, 1 H), 1.98-1.88 (m, 3 H), 1.73-1.56 (m, 3 H), 1.31-1.19 (m, 7 H), 1.02 (d, J = 6.7 Hz, 3 H), 0.94-0.91 (m, 12 H), 0.89 (s, 9 H), 0.87 (s, 9 H), 0.85 (s, 9 H), 0.10 (s, 9 H), 0.08 (s, 3 H), 0.01 (s, 3 H), 0.01 (s, 6 H), −0.05 (s, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 166.1, 145.8, 140.5, 130.2, 128.1, 125.1, 123.7, 83.3, 81.3, 73.9, 73.7, 73.34, 73.30, 72.8, 71.6, 70.6, 64.7, 58.9, 43.6, 39.7, 39.4, 38.1, 36.7, 36.5, 36.0, 33.5, 31.4, 29.9, 26.4, 26.2, 26.0, 18.9, 18.8, 18.5, 18.4, 18.3, 18.2, 14.7, −3.7, −4.0, −4.1, −5.0, −5.27, −5.32; HRMS (ES⁺) m/z (M+H)⁺: Calcd for C₅₇H₁₀₉O₁₁Si₄: 1081.7047, found: 1081.7057.
To a solution of \(37a\) (7.0 mg, 0.0065 mmol) in 0.9 mL THF in a polypropylene tube at 0 °C was added 0.9 mL pyridine and 0.9 mL HF. Pyridine complex (70% HF) dropwise via Eppendorf pipette. The resulting solution was stirred at 0 °C for 5 min. The cold bath was then removed and the resulting solution was stirred at room temperature for another 29 h. The reaction was then quenched with 20 mL sat. aq. NaHCO\(_3\) solution slowly and stirred at room temperature for 30 min. The organic phase was extracted with CH\(_2\)Cl\(_2\) (3 x 30 mL). The combined organic layers were dried with Na\(_2\)SO\(_4\), and concentrated in vacuo. The crude product was purified by flash chromatography on silica gel (4% MeOH/CH\(_2\)Cl\(_2\)) to afford the natural product 1 as colorless amorphous solid (3.8 mg, 0.00608 mmol, 94%) which displayed spectral properties identical in all respects to those reported for the natural product: \(^7\) [\(\alpha\)]\(^{20}\)D \(-53.92\) (c 0.25, MeOH); IR (film, cm\(^{-1}\)) 3433, 2961, 2920, 2852, 1717, 1656, 1461, 1374, 1315, 1222, 1180, 1105, 1043, 731, 604; \(^1\)H NMR (600 MHz, CDCl\(_3\), residual solvent peak set at \(\delta\) 6.24 ppm) \(\delta\) 6.97 (ddd, \(J = 15.1, 10.4, 4.6\) Hz, 1 H), 6.28 (dd, \(J = 14.3, 11.4\) Hz, 1 H), 6.05 (t, \(J = 10.8\) Hz, 1 H), 6.01 (d, \(J = 15.4\) Hz, 1 H), 5.45 (dd, \(J = 14.7, 10.3\) Hz, 1 H), 5.28 (td, \(J = 10.5, 5.7\) Hz, 1 H), 5.25-5.20 (m, 1 H), 5.02 (s, 1 H), 4.0-3.95 (m, 1 H), 3.85-3.78 (m, 2 H), 3.71-3.65 (m, 1 H), 3.66-3.59 (m, 3 H), 3.46 (s, 3 H), 3.44-3.29 (m, 5 H), 2.63-2.57 (m, 1 H), 2.57-2.49 (m, 1 H), 2.43-2.19 (m, 7 H), 2.05-1.99 (m,
2 H), 1.91-1.85 (m, 2 H), 1.76 (t, J = 12.7 Hz, 1 H), 1.63-1.43 (m, 2 H), 1.26 (d, J = 6.2 Hz, 3 H), 1.25-1.15 (m, 4 H), 1.02 (d, J = 7.0 Hz, 3 H), 0.85 (d, J = 6.6 Hz, 3 H); **13C NMR** (125 MHz, CDCl₃, residual solvent peak set at δ 77.23 ppm) δ 167.4, 147.1, 141.5, 131.3, 126.9, 123.9, 123.1, 94.2, 83.2, 81.0, 80.8, 74.2, 73.9, 73.1, 73.0, 72.5, 72.3, 71.7, 68.2, 66.1, 59.1, 43.1, 39.7, 38.8, 37.6, 37.4, 36.8, 34.2, 34.1, 31.1, 18.3, 17.7, 14.5; **HRMS** (ES⁺) m/z (M+Na)⁺: Calcd for C₃₃H₅₂O₁₁Na: 647.3407, found: 647.3411.

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**D. **³H NMR and **13C NMR Spectra of New Compounds and Cross-Coupling Products**
$^1$H-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^1$H-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^1\text{H-NMR in CDCl}_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
\[^1\text{H-NMR in CDCl}_3\text{ (500 MHz)}\]
\textsuperscript{1}H-NMR in CDCl\textsubscript{3} (500 MHz)
\[^1\text{H-NMR in CDCl}_3\ (500\ MHz)\]
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{1}H$-NMR in CDCl$_3$ (500 MHz)
$^1$H-NMR in CDCl$_3$ (500 MHz)
\[ ^1\text{H-NMR in CDCl}_3 \text{ (500 MHz)} \]
$^{1}$H-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^1$H-NMR in CDCl$_3$ (500 MHz)
$^{13}\text{C-NMR in CDCl}_3 (125\text{ MHz})$
$^1$H-NMR in CD$_3$OD (500 MHz)
$^{13}$C-NMR in C$_6$D$_6$ (125 MHz)
$^{1}$H-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{1}$H-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{1}$H-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{1}H$-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{1}$H-NMR in CDCl$_3$ (500 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
\[ ^1H\text{-NMR in CDCl}_3 (500 \text{ MHz}) \]
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^1$H-NMR in CDCl$_3$ (500 MHz)
$^{1}\text{H-NMR in CDCl}_3 (500 \text{ MHz})$
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
$^{13}$C-NMR in CDCl$_3$ (125 MHz)
(-)-mandelalide A (1)

$^1$H-NMR in CDCl$_3$ (600 MHz)
(-)-mandelalide A (1)

$^{13}$C-NMR in CDCl$_3$ (125 MHz)