Supporting Information for

Total Synthesis, Structure Revision, and Absolute Configuration of (−)- Brevenal

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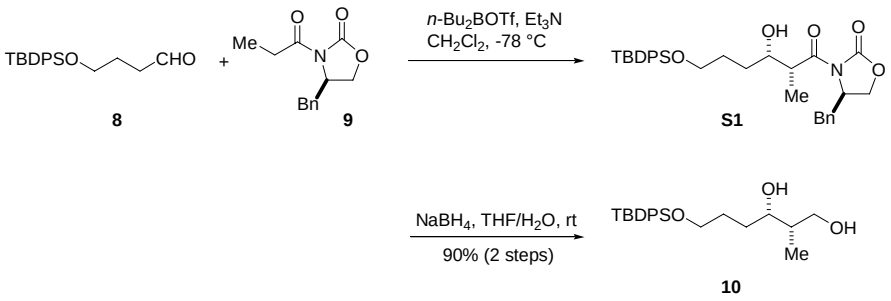
1. Full experimental details and spectroscopic data for all new compounds
2. Comparison of ^{1}H and ^{13}C NMR spectra for natural brevenal and synthetic **2**
3. Copies of ^{1}H and ^{13}C NMR spectra for all new compounds

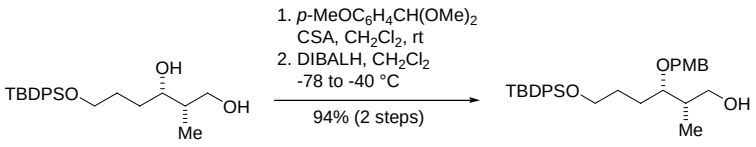
General Methods. All reactions sensitive to moisture and/or air were carried out under an atmosphere of argon in dry, freshly distilled solvents under anhydrous conditions using oven-dried glasswares, unless otherwise noted. Anhydrous dichloromethane (CH_2Cl_2), dimethylsulfoxide (DMSO), and *N*,*N*-dimethylformamide (DMF) were purchased from Kanto Chemical Co. Inc. and used directly without further drying. Tetrahydrofuran (THF) was distilled from sodium/benzophenone under an atmosphere of argon immediately prior to use. Hexamethylphosphoramide (HMPA) was distilled from calcium hydride under reduced pressure. Triethylamine, 2,6-lutidine, chlorotrimethylsilane, toluene, and methanol were distilled from calcium hydride under an atmosphere of argon. *m*-Chloroperbenzoic acid (*m*CPBA) was purified by washing with pH 7 phosphate buffer followed by drying under reduced pressure. 9-BBN dimer was purchased from Aldrich Chemical Co. Inc. and was purified by recrystallization from 1,2-dimethoxyethane. *N*-Iodosuccinimide (NIS), purchased from Acros Organics, was purified by recrystallization from dioxane/carbon tetrachloride immediately prior to use. Tetrakis(triphenylphosphine)palladium(0) was prepared according to the literature procedure (Coulson, D. R. *Inorg. Synth.* **1972**, *13*, 121). All other chemicals were purchased at highest commercial grade and used as supplied. Analytical thin-layer chromatography (TLC) was performed using E. Merck silica gel 60 F_{254} pre-coated plates (0.25-mm thickness). Column chromatography was carried out using Kanto Chemical silica gel 60N (40-100 mesh, spherical, neutral). Flash column chromatography was performed using Fuji Silysia silica gel BW-300 (200-400 mesh). Optical rotations were recorded on a JASCO P-1020 digital polarimeter. IR spectra were recorded on a JASCO FT/IR-4100 spectrometer. ^{1}H and ^{13}C NMR spectra were recorded on a JEOL LA-400, Varian Unity INOVA-500 or INOVA-600 spectrometer. Chemical shift values are reported in δ (ppm) downfield from tetramethylsilane with reference to internal residual solvent [^{1}H NMR, C_6HD_5 (7.15); ^{13}C NMR, C_6D_6 (128.0)]. Coupling constants (*J*) are reported in Hertz (Hz). The following abbreviations were used to designate the multiplicities: s = singlet; d = doublet; m = multiplet; br = broad. FAB mass spectra were recorded on a JEOL JMS-700 spectrometer and ESI-TOF mass spectra were measured on a Bruker microTOFfocus spectrometer.



Diol 10. To a solution of oxazolidinone **9** (20.7 g, 88.8 mmol) in CH_2Cl_2 (250 mL) at 0 °C were added *n*-Bu_2BOTf (1.0 M solution in CH_2Cl_2, 85.0 mL, 85.0 mmol) and Et_3N (13.5 mL, 96.9 mmol), and the resultant mixture was stirred at 0 °C for 1 h. To this mixture at −78 °C was added a solution of aldehyde

8 (25.2 g, 77.2 mmol). The resultant mixture was stirred at −78 °C for 1 h and then allowed to warm to room temperature over a period of 1 h. After addition of pH 7 phosphate buffer (100 mL) and a mixture of MeOH/30% H_2O_2 (2:1, v/v, 300 mL), the reaction mixture was allowed to warm to room temperature over a period of 1 h. The resultant mixture was treated with saturated aqueous Na_2SO_3 and extracted with EtOAc. The organic layer was washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 25% EtOAc/hexanes) gave alcohol **S1** (48.2 g), which was used in the next reaction without further purification. A small amount of the sample was further purified for analytical purposes. **S1**: $[\alpha]_D^{18}$ = −16.2 (*c* 1.07, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, *J* = 6.5 Hz, 4H), 7.40—7.27 (m, 9H), 7.19 (d, *J* = 7.5 Hz, 2H), 4.67 (m, 1H), 4.20—4.15 (m, 2H), 3.95 (m, 1H), 3.76 (m, 1H), 3.72—3.64 (m, 2H), 3.24 (dd, *J* = 13.0, 3.0 Hz, 1H), 2.77 (dd, *J* = 13.0, 9.0 Hz, 1H), 1.72 (m, 1H), 1.65—1.52 (m, 4H), 1.25 (d, *J* = 6.5 Hz, 3H), 1.03 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 177.3, 153.0, 135.6 (× 4), 135.1, 133.7 (× 2), 129.6 (× 2), 129.4 (× 2), 129.0 (× 2), 128.3 (× 2), 127.6 (× 2), 127.4, 71.4, 66.1, 63.9, 55.2, 42.3, 37.8, 30.6, 29.0, 26.8 (× 3), 19.2, 10.6; HRMS (ESI-TOF) calcd for $C_{33}H_{41}NO_5SiNa$ $[(M+Na)^+]$ 582.2652, found 582.2657.

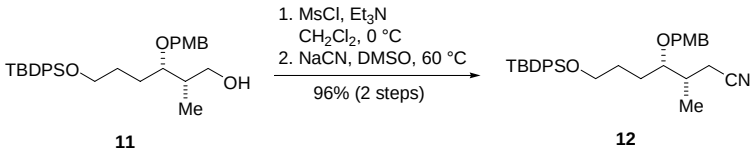
To a solution of alcohol **S1** (48.2 g) in THF (320 mL) at 0 °C was added a solution of $NaBH_4$ (11.8 g, 311 mmol) in H_2O (80 mL) dropwise. The resultant mixture was stirred at room temperature for 5 h before neutralization with 2 M aqueous HCl at 0 °C. The mixture was extracted with EtOAc, and the organic layer was dried over $MgSO_4$, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 50% EtOAc/hexanes) gave diol **10** (26.7 g, 90% for the two steps) as a colorless oil: $[\alpha]_D^{18}$ = −1.3 (*c* 1.5, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66—7.64 (m, 4H), 7.43—7.34 (m, 6H), 3.84 (m, 1H), 3.72—3.67 (m, 4H), 3.11 (br, 1H), 2.60 (br, 1H), 1.80 (m, 1H), 1.70—1.54 (m, 4H), 1.03 (s, 9H), 0.91 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 135.6 (× 2), 135.5 (× 2), 133.4 (× 2), 129.7 (× 2), 127.7 (× 4), 74.8, 67.3, 64.3, 39.1, 31.1, 29.4, 26.8 (× 3), 19.1, 10.4; HRMS (ESI-TOF) calcd for $C_{23}H_{34}O_3SiNa$ $[(M+Na)^+]$ 409.2175, found 409.2176.



Alcohol 11. To a solution of diol **10** (4.82 g, 12.5 mmol) in CH_2Cl_2 (50 mL) were added *p*-methoxybenzaldehyde dimethylacetal (2.55 mL, 15.0 mmol) and CSA (290.3 mg, 1.25 mmol). After being stirred at room temperature for 1 h, the reaction mixture was quenched with the addition of Et_3N and diluted with EtOAc. The organic layer was washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude acetal was used in the next step without further purification.

To a solution of the above material in CH_2Cl_2 (60 mL) at −78 °C was added dropwise DIBALH (0.94 M solution in hexane, 53.2 mL, 50.0 mmol). The resultant mixture was allowed to warm to −40 °C

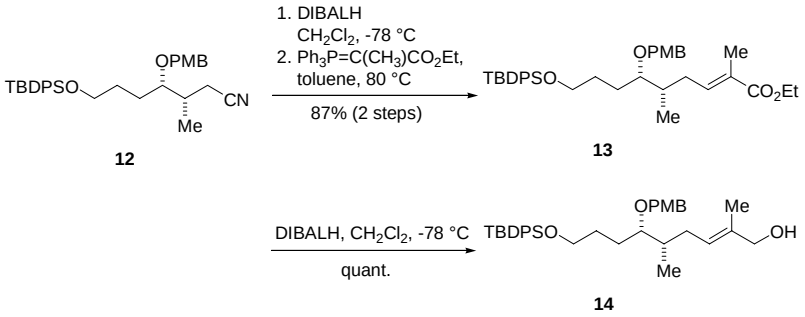
over a period of 1 h before the reaction was quenched with saturated aqueous potassium sodium tartrate. The resultant mixture was diluted with EtOAc and stirred at room temperature until the layers became clear. The organic layer was separated and washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 25% EtOAc/hexanes) gave alcohol **11** (5.99 g, 94% for the two steps) as a colorless oil: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (d, *J* = 6.5 Hz, 4H), 7.42—7.34 (m, 6H), 7.21 (d, *J* = 8.5 Hz, 2H), 6.84 (d, *J* = 8.5 Hz, 2H), 4.46 (d, *J* = 11.5 Hz, 1H), 4.42 (d, *J* = 11.5 Hz, 1H), 3.77 (s, 3H), 3.67—3.62 (m, 3H), 3.51 (m, 1H), 3.46 (m, 1H), 2.49 (m, 1H), 2.03 (m, 1H), 1.67—1.50 (m, 4H), 1.03 (s, 9H), 0.85 (d, *J* = 7.5 Hz, 3H); HRMS (ESI-TOF) calcd for $C_{31}H_{42}O_4SiNa$ [$(M+Na)^+$] 529.2750, found 529.2754.



11 **12**

Nitrile 12. To a solution of alcohol **11** (689.7 mg, 1.363 mmol) in CH_2Cl_2 (15 mL) at 0 °C were added Et_3N (0.570 mL, 4.09 mmol) and MsCl (2.07 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude mesylate was used in the next reaction without further purification.

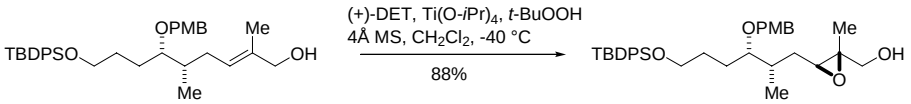
To a solution of the above material in DMSO (14 mL) was added NaCN (334.0 mg, 6.81 mmol). After being stirred at 60 °C for 2.5 h, the reaction mixture was cooled to room temperature, diluted with diethyl ether, washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 20% EtOAc/hexanes) gave nitrile **12** (675.3 mg, 96% for the two steps) as a colorless oil: $[\alpha]_D^{18}$ = +19.3 (*c* 0.79, benzene); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 6.4 Hz, 4H), 7.44—7.34 (m, 6H), 7.22 (d, *J* = 8.2 Hz, 2H), 6.86 (d, *J* = 8.2 Hz, 2H), 4.46 (d, *J* = 11.0 Hz, 1H), 4.37 (d, *J* = 11.0 Hz, 1H), 3.80 (s, 3H), 3.71—3.61 (m, 2H), 3.36 (m, 1H), 2.41 (dd, *J* = 16.5, 5.5 Hz, 1H), 2.24—2.05 (m, 2H), 1.67—1.47 (m, 4H), 1.09—0.98 (m, 12H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.2, 135.5 (× 4), 133.8 (× 2), 129.6 (× 2), 129.35 (× 2), 129.32, 127.6 (× 4), 119.6, 113.8 (× 2), 80.1, 71.5, 63.6, 55.3, 33.3, 28.7, 26.8 (× 3), 26.2, 20.6, 19.2, 14.3; HRMS (ESI-TOF) calcd for $C_{32}H_{41}NO_3SiNa$ [$(M+Na)^+$] 538.2753, found 538.2753.



Allylic alcohol 14. To a solution of nitrile **12** (24.51 g, 47.4 mmol) in CH_2Cl_2 (200 mL) at −78 °C was added dropwise DIBALH (0.94 M solution in hexane, 52.9 mL, 49.7 mmol). After being stirred at −78 °C for 0.5 h, the reaction mixture was treated with saturated aqueous potassium sodium tartrate. The resultant mixture was diluted with EtOAc and stirred at room temperature until the layers became clear. The organic layer was separated, washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 15% EtOAc/hexanes) gave aldehyde (22.20 g, 90%), which was immediately used in the next reaction.

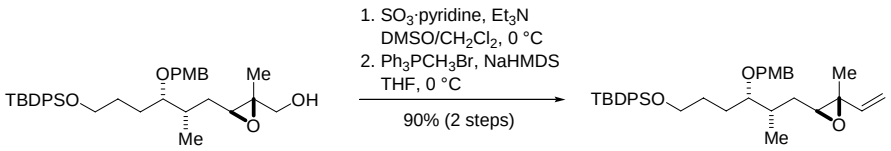
To a solution of the above aldehyde (22.20 g, 42.7 mmol) in toluene (200 mL) was added $Ph_3P=C(CH_3)CO_2Et$ (18.6 g, 51.3 mmol). After being stirred at 100 °C for 30 min, the reaction mixture was cooled to room temperature and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 8% EtOAc/hexanes) gave α,β-unsaturated ester **13** (24.96 g, 97%) as a colorless oil: $[\alpha]_D^{18}$ = +17.7 (*c* 0.82, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, J = 6.5 Hz, 4H), 7.41—7.34 (m, 6H), 7.20 (d, *J* = 8.5 Hz, 2H), 6.83 (d, J = 8.5 Hz, 2H), 6.75 (t, *J* = 7.0 Hz, 1H), 4.39 (s, 2H), 4.17 (q, *J* = 7.5 Hz, 2H), 3.77 (s, 3H), 3.67—3.62 (m, 2H), 3.23 (m, 1H), 2.29 (m, 1H), 1.98 (m, 1H), 1.87 (m, 1H), 1.80 (s, 3H), 1.70—1.50 (m, 4H), 1.28 (t, *J* = 7.5 Hz, 3H), 1.03 (s, 9H), 0.88 (d, *J* = 6.5 Hz, 3H); HRMS (ESI-TOF) calcd for $C_{37}H_{50}O_5SiNa$ [$(M+Na)^+$] 625.3325, found 625.3324.

To a solution of α,β-unsaturated ester **13** (25.0 g, 41.5 mmol) in CH_2Cl_2 (200 mL) at −78 °C was added dropwise DIBALH (0.94 M solution in hexane, 132.0 mL, 124.1 mmol). After being stirred at −78 °C for 0.5 h, the reaction mixture was quenched with saturated aqueous potassium sodium tartrate. The resultant mixture was diluted with EtOAc and stirred at room temperature until the layers became clear. The organic layer was separated, washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 20 → 25% EtOAc/hexanes) gave allylic alcohol **14** (23.5 g, quant.) as a colorless oil: $[\alpha]_D^{25}$ = −1.4 (*c* 0.49, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 7.6 Hz, 4H), 7.43—7.33 (m, 6H), 7.23 (d, *J* = 8.7 Hz, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 5.39 (t, *J* = 6.6 Hz, 1H), 4.41 (s, 2H), 4.00 (d, J = 6.0 Hz, 2H), 3.79 (s, 3H), 3.71—3.61 (m, 2H), 3.24 (m, 1H), 2.19 (m, 1H), 1.87 (m, 1H), 1.82—1.50 (m, 8H), 1.26 (t, *J* = 6.0 Hz, 1H), 1.05 (s, 9H), 0.89 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.0, 135.6 (× 4), 135.4, 134.0, 131.2, 129.5 (× 2), 129.2 (× 2), 128.3, 127.6 (× 4), 125.3 (× 2), 113.6, 82.1, 71.2, 69.1, 63.9, 55.3, 36.1, 30.3, 29.0, 26.8 (× 3), 26.6, 19.2, 15.0, 13.8; HRMS (ESI-TOF) calcd for $C_{35}H_{48}O_4SiNa$ [$(M+Na)^+$] 583.3220, found 583.3221.



14 15

Hydroxy epoxide 15. To a solution of allylic alcohol **14** (940.0 mg, 1.6786 mmol) in CH_2Cl_2 (16 mL) were added 4Å molecular sieves (0.70 g) and (+)-DET (0.52 g, 2.52 mmol). The reaction mixture was cooled to −40 °C, treated with Ti(O*i*-Pr)$_4$ (0.600 mL, 2.03 mmol), and stirred at that temperature for 0.5 h. To this mixture was added *t*-BuOOH (5 M solution in decane, 1.68 mL, 8.40 mmol). After being stirred at −40 °C for 70 min, the reaction mixture was diluted with diethyl ether and treated with 1 M aqueous NaOH. The resultant biphasic mixture was stirred at 0 °C for 1 h. Insoluble materials were filtered off, and the filtrate was washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 30% EtOAc/hexanes) gave hydroxyl epoxide **15** (848.7 mg, 88%) as a colorless oil: $[\alpha]_D^{25} = -11.1$ (*c* 0.97, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 6.0 Hz, 4H), 7.42—7.34 (m, 6H), 7.22 (d, *J* = 8.0 Hz, 2H), 6.83 (d, *J* = 8.0 Hz, 2H), 4.45 (d, *J* = 11.0 Hz, 1H), 4.40 (d, *J* = 11.0 Hz, 1H), 3.79 (s, 3H), 3.72—3.54 (m, 4H), 3.29 (m, 1H), 3.08 (t, *J* = 5.5 Hz, 1H), 1.97 (m, 1H), 1.79—1.49 (m, 6H), 1.40 (m, 1H), 1.26 (s, 3H), 1.04 (s, 9H), 0.94 (d, *J* = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.0, 135.5 (× 4), 134.0 (× 2), 131.0 (× 2), 129.5 (× 2), 129.3 (× 2), 127.6 (× 4), 113.7, 82.2, 71.2, 65.3, 63.8, 61.1, 59.2, 55.2, 33.3, 30.5, 29.1, 26.8 (× 3), 26.5, 19.2, 14.9, 14.5; HRMS (ESI-TOF) calcd for $C_{35}H_{48}O_5SiNa$ [$(M+Na)^+$] 599.3169, found 599.3163.

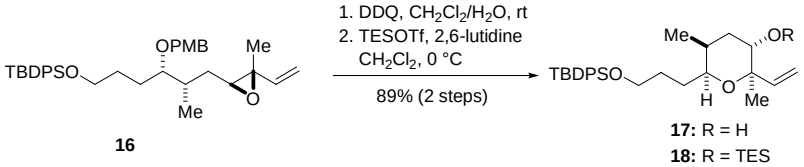


15 16

Vinyl epoxide 16. To a solution of hydroxy epoxide **15** (8.64 g, 15.00 mmol) in CH_2Cl_2/DMSO (3:1, v/v, 120 mL) at 0 °C were added Et_3N (10.5 mL, 75.3 mmol) and SO_3·pyridine complex (9.55 g, 60.0 mmol). After being stirred at 0 °C for 45 min, the reaction mixture was diluted with diethyl ether, washed successively with 1 M aqueous HCl, saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude aldehyde was immediately used in the next reaction without further purification.

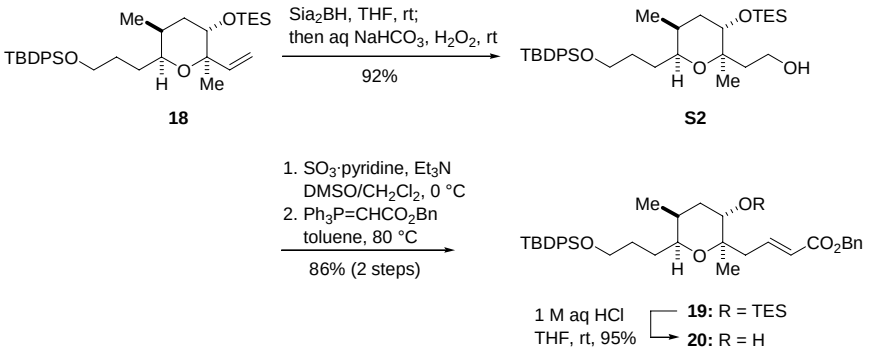
To a suspension of $Ph_3P^+CH_3Br^-$ (16.07 g, 45.0 mmol) in THF (80 mL) at 0 °C was added NaHMDS (1.0 M solution in THF, 42.0 mL, 42.0 mmol), and the resultant suspension was stirred at 0 °C for 30 min. To this suspension was added a solution of the above material in THF (40 mL + 5 mL rinse). After being stirred at 0 °C for 30 min, the reaction mixture was diluted with EtOAc, washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5% EtOAc/hexanes) gave vinyl epoxide **16** (7.71 g,

90% for the two steps) as a colorless oil: $[\alpha]_D^{18} = -1.1$ (*c* 1.05, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, *J* = 6.5 Hz, 4H), 7.42—7.34 (m, 6H), 7.22 (d, *J* = 8.0 Hz, 2H), 6.83 (d, *J* = 8.0 Hz, 2H), 5.65 (dd, *J* = 17.5, 11.0 Hz, 1H), 5.30 (d, *J* = 17.5 Hz, 1H), 5.16 (d, *J* = 11.0 Hz, 1H), 4.43 (d, *J* = 11.0 Hz, 1H), 4.39 (d, *J* = 11.0 Hz, 1H), 3.77 (s, 3H), 3.68—3.62 (m, 2H), 3.28 (m, 1H), 2.82 (t, *J* = 6.0 Hz, 1H), 1.96 (m, 1H), 1.76 (m, 1H), 1.67 (m, 1H), 1.60—1.48 (m, 3H), 1.41 (m, 1H), 1.36 (s, 3H), 1.03 (s, 9H), 0.93 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.0, 141.0, 135.6 (× 4), 134.0 (× 2), 131.1 (× 2), 129.5 (× 2), 129.3 (× 2), 127.8 (× 4), 115.8, 113.7, 82.2, 71.2, 64.5, 63.9, 59.8, 55.2, 33.3, 31.0, 29.1, 26.9 (× 3), 26.5, 19.2, 15.2, 14.8; HRMS (ESI-TOF) calcd for $C_{36}H_{48}O_4SiNa$ $[(M+Na)^+]$ 595.3220, found 595.3205.



Silyl ether 18. To a solution of vinyl epoxide **16** (11.8 g, 20.6 mmol) in CH_2Cl_2/H_2O (20:1, v/v, 157.5 mL) at 0 °C was added DDQ (5.06 g, 22.3 mmol). The reaction mixture was allowed to warm to room temperature over a period of 2 h. To this mixture was added an additional portion of DDQ (0.50 g, 2.20 mmol). After being stirred at room temperature for 5 h, the resultant mixture was cooled to 0 °C and quenched with saturated aqueous $NaHCO_3$. Insoluble materials were filtered off, and the filtrate was diluted with EtOAc, washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 15 → 20% EtOAc/hexanes) gave pyran **17** (11.99 g), which was contaminated with *p*-methoxybenzaldehyde and used in the next reaction without further purification.

To a solution of the above pyran **17** (11.99 g) in CH_2Cl_2 (150 mL) at 0 °C were added 2,6-lutidine (4.80 mL, 41.2 mmol) and TESOTf (6.10 mL, 27.0 mmol). After being stirred at 0 °C for 0.5 h, the reaction mixture was quenched with MeOH, diluted with EtOAc, washed successively with 1 M aqueous HCl, saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5% EtOAc/hexanes) gave silyl ether **18** (10.37 g, 89% for the two steps) as a colorless oil: $[\alpha]_D^{25} = -9.2$ (*c* 1.70, $CHCl_3$); ^{1}H NMR (500 MHz, C_6D_6) δ 7.81—7.79 (m, 4H), 7.26—7.23 (m, 6H), 6.23 (dd, *J* = 17.5, 10.5 Hz, 1H), 5.53 (d, *J* = 17.5 Hz, 1H), 5.10 (d, *J* = 10.5 Hz, 1H), 3.81 (dd, *J* = 12.0, 5.0 Hz, 1H), 3.76—3.66 (m, 2H), 3.51 (m, 1H), 1.84—1.71 (m, 2H), 1.62—1.48 (m, 4H), 1.35 (m, 1H), 1.28 (s, 3H), 1.19 (s, 9H), 1.00 (t, *J* = 7.5 Hz, 9H), 0.94 (d, *J* = 7.5 Hz, 3H), 0.58 (q, *J* = 7.5 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 144.7, 136.0 (× 4), 134.5 (× 2), 129.9 (× 2), 128.5 (× 2), 128.3 (× 2), 111.8, 77.3, 71.2, 70.1, 64.3, 37.3, 33.2, 29.8, 29.5, 27.1 (× 3), 19.5, 15.2, 12.6, 7.2 (× 3), 5.5 (× 3); HRMS (ESI-TOF) calcd for $C_{34}H_{54}O_3Si_2Na$ $[(M+Na)^+]$ 589.3509, found 589.3509.



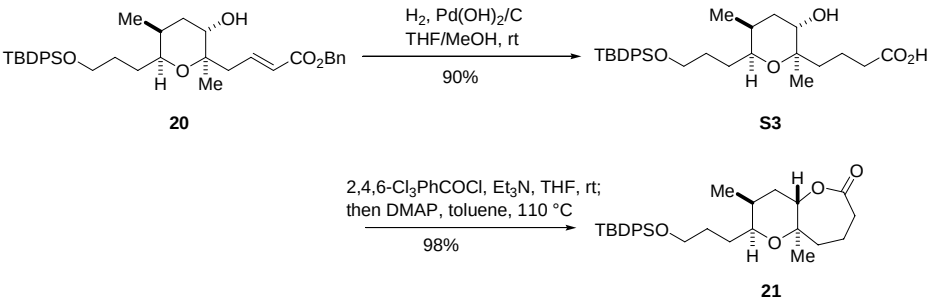
Alcohol 20. To a solution of 2-methyl-2-butene (2.08 mL, 19.6 mmol) in THF (10 mL) at 0 °C was added $BH_3 \cdot SMe_2$ (5.15 mL, 9.79 mmol), and the resulting mixture was stirred at 0 °C for 1 h. To this solution was added a solution of silyl ether **18** (3.61 g, 6.36 mmol) in THF (40 mL). After being stirred at 0 °C for 1.5 h, the reaction mixture was treated with saturated aqueous $NaHCO_3$ (40 mL) and 30% H_2O_2 (20 mL) and stirred at room temperature for 1.5 h. The resultant mixture was extracted with EtOAc and washed successively with H_2O, saturated aqueous Na_2SO_3 and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 25% EtOAc/hexanes) gave alcohol **S2** (3.42 g, 92%) as a colorless oil: $[\alpha]_D^{26} = -7.9$ (*c* 1.51, $CHCl_3$); ^{1}H NMR (500 MHz, C_6D_6) δ 7.81—7.77 (m, 4H), 7.28—7.22 (m, 6H), 3.95 (q, *J* = 5.5 Hz, 2H), 3.70—3.55 (m, 2H), 3.36 (ddd, *J* = 9.0, 4.5, 2.5 Hz, 1H), 3.23 (t, *J* =5.5 Hz, 1H), 1.92—1.85 (m, 2H), 1.70—1.60 (m, 2H), 1.53—1.40 (m, 3H), 1.35 (m, 1H), 1.22 (m, 1H), 1.18 (s, 9H), 1.13 (s, 3H), 0.95 (t, *J* = 7.5 Hz, 9H), 0.88 (d, *J* = 7.5 Hz, 3H), 0.53 (m, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 136.0 (× 4), 134.4, 134.3, 129.9 (× 2), 128.1 (× 4), 79.9, 71.5, 68.9, 64.0, 59.4, 42.1, 36.7, 32.9, 29.6, 29.4, 27.1 (× 3), 19.4, 15.5, 12.5, 7.1 (× 3), 5.5 (× 3); HRMS (ESI-TOF) calcd for $C_{34}H_{56}O_4Si_2Na$ $[(M+Na)^+]$ 607.3615, found 607.3615.

To a solution of alcohol **S2** (3.74 g, 6.39 mmol) in CH_2Cl_2/DMSO (3:1, v/v, 54.0 mL) at 0 °C were added Et_3N (4.50 mL, 32.0 mmol) and SO_3·pyridine complex (3.65 g, 22.4 mmol). After being stirred at 0 °C for 50 min, the reaction mixture was diluted with diethyl ether, washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude aldehyde was used in the next reaction without further purification.

To a solution of the above material in toluene (50 mL) was added $Ph_3P{=}CHCO_2Bn$ (3.93 g, 9.59 mmol). After being stirred at 45 °C for 10 h, an additional portion of $Ph_3P{=}CHCO_2Bn$ (1.31 g, 3.19 mmol) was added to the mixture. After being stirred at 60 °C for another 9 h, the reaction mixture was cooled to room temperature and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 3 → 10% diethyl ether/hexanes) gave α,β-unsaturated ester **19** (3.87 g, 86% for the two steps) as a colorless oil: $[\alpha]_D^{26} = -2.7$ (*c* 1.34, $CHCl_3$); ^{1}H NMR (500 MHz, C_6D_6) δ 7.82—7.78 (m, 4H), 7.53 (ddd, *J* = 16.0, 7.0, 7.0 Hz, 1H), 7.28—7.22 (m, 6H), 7.20—7.17 (m, 2H), 7.09—7.00 (m, 3H), 6.06 (d, *J* = 16.0 Hz, 1H), 5.08 (m, 2H), 3.74 (dd, *J* = 11.5, 5.0 Hz, 1H), 3.74—3.61 (m, 2H), 3.34 (m, 1H), 2.40 (ddd, *J* = 11.0, 8.0, 7.0 Hz, 1H), 1.72 (m, 1H), 1.63 (ddd, *J* = 12.5, 5.0, 4.0 Hz, 1H), 1.58—1.40 (m, 4H), 1.28 (m, 1H), 1.19 (s, 9H), 1.05 (s, 3H), 0.96 (t, *J* = 8.0 Hz,

9H), 0.90 (d, J = 7.5 Hz, 3H), 0.54 (m, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.2, 146.6, 136.3, 135.6 (× 4), 134.1, 134.0, 129.5 (× 2), 128.5 (× 2), 128.0, 127.9 (× 2), 127.6 (× 4), 123.0, 77.1, 71.1, 68.9, 65.8, 63.8, 43.6, 36.7, 32.6, 29.1, 29.0, 26.9 (× 3), 19.2, 15.3, 12.5, 6.9 (× 3), 5.2 (× 3); HRMS (FAB) calcd for $C_{43}H_{62}O_5Si_2Na$ [$(M+Na)^+$] 737.4033, found 737.4038.

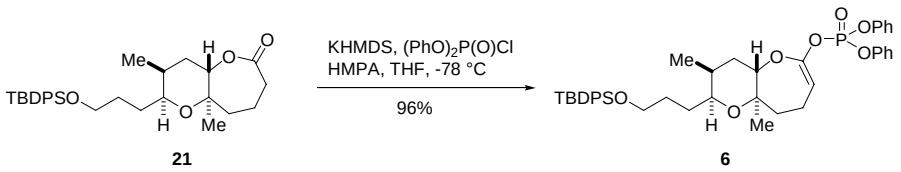
To a solution of α,β-unsaturated ester **19** (4.81 g, 6.72 mmol) in THF (55 mL) was added 1 M aqueous HCl (11 mL), and the resultant mixture was stirred at room temperature for 2 h. After being neutralized with saturated aqueous $NaHCO_3$ at 0 °C, the reaction mixture was extracted with EtOAc. The organic layer was washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 25% EtOAc/hexanes) gave alcohol **20** (3.84 g, 95%) as a colorless oil: $[\alpha]_D^{26}$ = −22.4 (*c* 1.38, $CHCl_3$); ^{1}H NMR (500 MHz, C_6D_6) δ 7.81—7.77 (m, 4H), 7.45 (ddd, J = 15.5, 8.0, 7.0 Hz, 1H), 7.26—7.22 (m, 6H), 7.20 (d, J = 7.5 Hz, 2H), 7.09—7.01 (m, 3H), 5.97 (d, J = 16.0 Hz, 1H), 5.12—5.04 (m, 2H), 3.71—3.58 (m, 2H), 3.34 (m, 1H), 3.25 (m, 1H), 2.27 (d, J = 7.0 Hz, 2H), 1.68 (m, 1H), 1.51 (m, 1H), 1.45—1.36 (m, 3H), 1.28—1.23 (m, 2H), 1.20 (m, 1H), 1.18 (s, 9H), 0.94 (s, 3H), 0.80 (d, J = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.2, 146.1, 136.2, 135.6 (× 4), 134.0 (× 2), 129.5 (× 2), 128.5 (× 2), 128.1, 128.0 (× 2), 127.6 (× 4), 123.3, 76.6, 71.3, 68.1, 65.9, 63.8, 43.6, 36.4, 32.8, 29.0, 28.9, 26.9 (× 3), 19.2, 15.2, 12.3; HRMS (FAB) calcd for $C_{37}H_{48}O_5SiNa$ [$(M+Na)^+$] 623.3169, found 623.3173.



Lactone 21. To a solution of alcohol **20** (4.08 g, 6.79 mmol) in THF/MeOH (2:1, v/v, 60 mL) was added 20% $Pd(OH)_2/C$ (608.0 mg), and the resultant mixture was vigorously stirred at room temperature under hydrogen atmosphere for 2.5 h. The catalyst was filtered off, and the filtrate was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 30% EtOAc/hexanes then 100% EtOAc) gave hydroxyl acid **S3** (3.13 g, 90%) as a colorless oil: $[\alpha]_D^{26}$ = −22.4 (*c* 1.38, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66—7.62 (m, 4H), 7.42—7.33 (m, 6H), 3.70—3.58 (m, 3H), 3.48 (m, 1H), 2.34 (t, J = 7.0 Hz, 2H), 1.78—1.56 (m, 7H), 1.53—1.45 (m, 2H), 1.40—1.32 (m, 2H), 1.06 (s, 3H), 1.02 (s, 9H), 0.90 (d, J = 7.5 Hz, 3H). Two proton signals (CO_2H and OH) are missing due to H/D exchange. ^{13}C NMR (125 MHz, $CDCl_3$) δ 178.1, 135.6 (× 4), 134.0 (× 2), 129.5 (× 2), 127.6 (× 4), 76.7, 71.3, 68.5, 63.8, 39.6, 36.1, 34.2, 32.8, 29.2, 26.9 (× 3), 19.2, 18.1, 14.7, 12.4; HRMS (ESI-TOF) calcd for $C_{30}H_{43}O_5Si$ [$(M-H)^-$] 511.2880, found 511.2881.

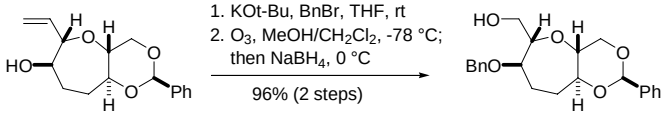
To a solution of hydroxyl acid **S3** (3.36 g, 6.55 mmol) in THF (60 mL) at 0 °C were added Et_3N (1.37 mL, 9.83 mmol) and 2,4,6-trichlorobenzoyl chloride (1.43 mL, 9.17 mmol), and the resultant

mixture was stirred at room temperature for 2 h before dilution with toluene (50 mL). This solution was added dropwise over a period of 3.5 h to a solution of DMAP (1.44 g, 11.8 mmol) in toluene (300 mL) heated to 110 °C. After cooling to room temperature, the reaction mixture was concentrated under reduced pressure. The residue was diluted with EtOAc, washed successively with 1 M aqueous HCl, saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 20% EtOAc/hexanes) gave lactone **21** (3.19 g, 98%) as a colorless oil: $[\alpha]_D^{27} = -52.9$ (*c* 1.56, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$) δ 7.67—7.63 (d, *J* = 7.0 Hz, 4H), 7.44—7.34 (m, 6H), 4.24 (dd, *J* = 12.0, 5.5 Hz, 1H), 3.71—3.60 (m, 2H), 3.55 (t, *J* = 6.0 Hz, 1H), 2.66—2.53 (m, 2H), 1.95—1.78 (m, 5H), 1.72—1.57 (m, 3H), 1.52 (m, 1H), 1.45—1.38 (m, 2H), 1.08 (s, 3H), 1.04 (s, 9H), 0.94 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 174.9, 135.5 (× 4), 133.9 (× 2), 129.5 (× 2), 127.5 (× 4), 76.1, 74.7, 70.8, 63.6, 43.4, 34.2, 33.8, 32.1, 28.9, 28.7, 26.8 (× 3), 19.7, 19.2, 14.4, 11.8; HRMS (ESI-TOF) calcd for $C_{30}H_{42}O_4SiNa$ [$(M+Na)^+$] 517,2750, found 517.2750.



21 6

Enol phosphate 6. To a solution of lactone **21** (51.7 mg, 0.104 mmol) in THF (2 mL) were added HMPA (0.036 mL, 0.208 mmol) and $(PhO)_2P(O)Cl$ (0.040 mL, 0.187 mmol), and the resultant mixture was cooled to −78 °C. To this mixture was added KHMDS (0.5 M solution in toluene, 0.42 mL, 0.21 mmol). After being stirred at −78 °C for 1 h, the reaction mixture was treated with 3% NH_4OH, diluted with diethyl ether, and allowed to warm to room temperature over a period of 20 min. The resultant mixture was extracted with EtOAc, and the organic layer was washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was rapidly purified by flash column chromatography (silica gel, 5 → 20% EtOAc/hexanes) to give enol phosphate **6** (72.7 mg, 96%), which was unstable and used immediately in the next reaction without characterization.

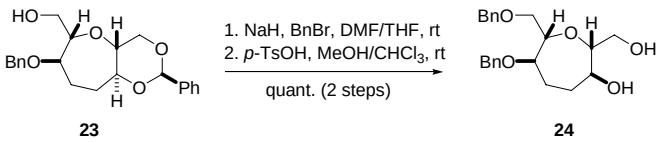


22 23

Alcohol 23. To a solution of alcohol **22** (5.24 g, 18.99 mmol) in THF (150 mL) was added KO*t*-Bu (4.26 g, 38.0 mmol), and the resultant mixture was stirred at room temperature for 20 min before addition of BnBr (3.39 mL, 28.5 mmol) and *n*-Bu_4NI (0.70 g, 1.90 mmol). After being stirred at room temperature for 50 min, the reaction mixture was treated with MeOH. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced

pressure to give crude benzyl ether, which was used in the next reaction without further purification.

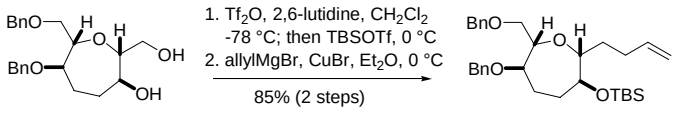
Ozone gas was bubbled through a solution of the above material in MeOH/CH_2Cl_2 (1:1, v/v, 160 mL) at −78 °C until blue color persisted (ca. 1 h). After passing O_2 gas for 5 min to remove residual ozone, $NaBH_4$ (1.44 g, 38.1 mmol) was added to the reation mixture, which was then allowed to warm to 0 °C over a period of 1.5 h. The reaction mixture was treated with saturated aqueous NH_4Cl, diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 30% EtOAc/hexanes) gave alcohol **23** (6.71 g, 96% for the two steps) as a colorless oil: $[\alpha]_D^{20}$ = −6.8 (*c* 1.42, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.0 Hz, 2H), 7.38—7.25 (m, 8H), 5.44 (s, 1H), 4.59 (d, *J* = 12.5 Hz, 1H), 4.37 (d, *J* = 12.5 Hz, 1H), 4.26 (dd, *J* = 10.0, 5.0 Hz, 1H), 3.80 (m, 1H), 3.65—3.51 (m, 5H), 3.46 (m, 1H), 2.16—2.03 (m, 2H), 1.96—1.91 (m, 2H), 1.63 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.0, 137.7, 128.9, 128.4 (× 2), 128.3 (× 2), 127.7, 127.6 (× 2), 126.2 (× 2), 101.0, 84.9, 81.8, 77.9, 74.4, 70.6, 69.6, 64.5, 26.3, 23.7; HRMS (ESI-TOF) calcd for $C_{22}H_{26}O_5Na$ [$(M+Na)^+$] 393.1678, found 393.1682.



23 **24**

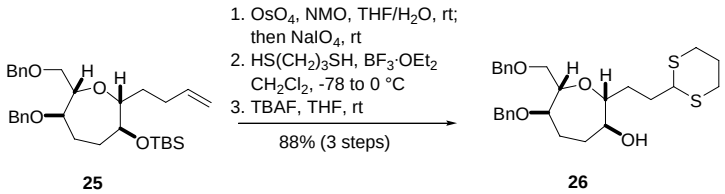
Diol 24. To a solution of alcohol **23** (9.12 g, 24.6 mmol) in DMF/THF (1:1, v/v, 160 mL) was added NaH (60% in oil, 1.28 g, 32.0 mmol), and the resultant mixture was stirred at room temperature for 30 min. BnBr (4.39 mL, 36.9 mmol) was added and the resulting mixture was stirred at room temperature for 1 h. The reaction mixture was treated with MeOH, diluted with EtOAc, washed with saturated aqueous NH_4Cl and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure to give crude bis(benzyl) ether, which was used in the next reaction without further purification.

To a solution of the above material in MeOH/$CHCl_3$ (10:1, v/v, 160 mL) was added CSA (1.71 g, 7.36 mmol). After being stirred at room temperature overnight, the reaction mixture was quenched with Et_3N and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5% MeOH/$CHCl_3$) gave diol **24** (9.10 g, quantitative for the two steps) as a colorless oil: $[\alpha]_D^{20}$ = −40.1 (*c* 0.26, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35—7.21 (m, 10H), 4.54 (d, *J* = 12.0 Hz, 1H), 4.53 (d, *J* = 12.5 Hz, 1H), 4.48 (d, *J* = 12.0 Hz, 1H), 4.29 (d, *J* = 12.5 Hz, 1H), 3.82 (m, 1H), 3.64 (m, 1H), 3.60—3.53 (m, 3H), 3.49—3.43 (m, 2H), 3.39 (ddd, *J* = 9.0, 7.5, 4.0 Hz, 1H), 2.55 (dd, *J* = 9.0, 3.0 Hz, 1H), 1.95 (m, 1H), 1.89—1.81 (m, 2H), 1.75 (m, 1H), 1.60 (d, *J* = 5.5 Hz, 1H); HRMS (ESI-TOF) calcd for $C_{22}H_{28}O_5Na$ [$(M+Na)^+$] 395.1834, found 395.1837.



Olefin 25. To a solution of diol **24** (233.7 mg, 0.628 mmol) in CH_2Cl_2 (12 mL) at −78 °C were added 2,6-lutidine (0.366 mL, 3.14 mmol) and Tf_2O (0.116 mL, 0.690 mmol). After being stirred at −78 °C for 0.5 h, TBSOTf (0.360 mL, 1.57 mmol) was added to the reaction mixture, which was then allowed to warm to 0 °C over a period of 45 min. The resultant mixture was diluted with EtOAc, washed successively with saturated aqueous NH_4Cl, saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure to give crude triflate, which was immediately used in the next reaction without further purification.

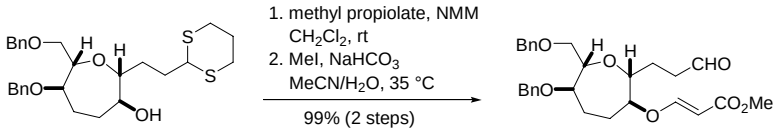
To a suspension of CuBr (90.0 mg, 0.627 mmol) in diethyl ether (6 mL) at 0 °C were added allylmagnesium bromide (1.0 M solution in diethyl ether, 3.14 mL, 3.14 mmol) and a solution of the above triflate in diethyl ether (3 mL + 3 mL rinse). After being stirred at 0 °C for 1 h, the reaction mixture was treated with saturated aqueous NH_4Cl. The resultant mixture was extracted with diethyl ether. The combined ethereal layers were washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% diethyl ether/hexanes) gave olefin **25** (272.1 mg, 85% for the two steps) as a colorless oil: $[\alpha]_D^{21} = -7.2$ (*c* 0.16, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31—7.22 (m, 10H), 5.78 (m, 1H), 4.98 (dd, *J* = 17.0, 2.0 Hz, 1H), 4.90 (d, *J* = 10.5 Hz, 1H), 4.55 (d, *J* = 12.0 Hz, 1H), 4.53 (d, *J* = 11.5 Hz, 1H), 4.49 (d, *J* = 12.0 Hz, 1H), 4.29 (d, *J* = 11.5 Hz, 1H), 3.56—3.49 (m, 4H), 3.45 (ddd, *J* = 8.0, 7.5, 4.0 Hz, 1H), 3.21 (m, 1H), 2.30 (m, 1H), 2.14 (m, 1H), 1.92 (m, 1H), 1.81—1.69 (m, 4H), 1.42 (m, 1H), 0.85 (s, 9H), 0.03 (s, 3H), 0.02 (s, 3H); HRMS (ESI-TOF) calcd for $C_{31}H_{46}O_4SiNa$ $[(M+Na)^+]$ 533.3063, found 533.3073.



Dithioacetal 26. To a solution of olefin **25** (1.66 g, 3.25 mmol) in THF/H_2O (7:1, v/v, 32 mL) were added NMO (50 wt% solution in water, 2.03 mL, 9.74 mmol) and OsO_4 (0.39 M solution in *t*-BuOH, 8.26 mL, 3.22 mmol), and the resultant mixture was stirred at room temperature for 3 h before addition of $NaIO_4$ (1.39 g, 6.50 mmol). After being stirred at room temperature for further 3 h, the reaction mixture was diluted with diethyl ether and the insoluble salts were filtered off. The filtrate was washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude aldehyde was used in the next reaction without further purification.

To a solution of the above material in CH_2Cl_2 (40 mL) at −78 °C were added 1,3-propanedithiol (0.400 mL, 3.98 mmol) and $BF_3{\cdot}OEt_2$ (0.494 mL, 3.90 mmol). The reaction mixture was allowed to warm to 0 °C over a period of 40 min before the reaction was quenched with Et_3N. The resultant mixture was diluted with EtOAc, washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude dithioacetal was used in the next reaction without further purification.

To a solution of the above material in THF (30 mL) was added TBAF (1.0 M solution in THF, 9.75 mL, 9.75 mmol). After being stirred at room temperature overnight, the reaction mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 25 → 40% EtOAc/hexanes) gave dithioacetal **26** (1.39 g, 88% for the three steps) as a colorless oil: $[\alpha]_D^{21}$ = −34.0 (*c* 0.82, benzene); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32—7.21 (m, 10H), 4.56—4.49 (m, 3H), 4.28 (d, *J* = 11.5 Hz, 1H), 4.05 (dd, *J* = 7.0, 6.5 Hz, 1H), 3.59—3.40 (m, 5H), 3.19 (m, 1H), 2.82—2.77 (m, 4H), 2.13—1.95 (m, 3H), 1.95 (m, 1H), 1.88—1.72 (m, 5H), 1.60 (m, 1H), 1.43 (d, *J* = 4.5 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.3 (× 2), 128.3 (× 2), 127.8 (× 2), 127.7 (× 2), 127.6 (× 2), 127.5 (× 2), 86.7, 84.1, 78.1, 75.2, 73.3, 71.3, 71.0, 47.5, 31.5, 31.0, 30.30, 30.26, 29.7, 26.0, 24.2; HRMS (ESI-TOF) calcd for $C_{27}H_{36}O_4S_2Na$ [$(M+Na)^+$] 511.1953, found 511.1953.

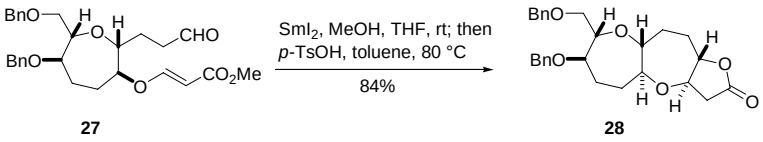


26 **27**

Aldehyde 27. To a solution of dithioacetal **26** (1.30 g, 2.66 mmol) in CH_2Cl_2 (30 mL) were added NMM (0.94 mL, 8.55 mmol) and methyl propiolate (0.76 mL, 8.54 mmol). After being stirred at room temperature for 1.5 days, the reaction mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 20 → 40% EtOAc/hexanes) gave β-alkoxyacrylate (1.57 g) as a colorless oil.

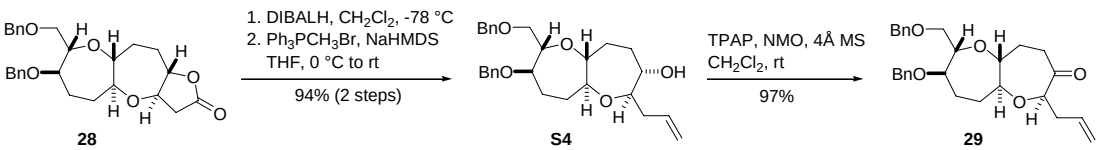
To a solution of the above β-alkoxy acrylate (1.57 g) in MeCN/H_2O (4:1, v/v, 30 mL) were added $NaHCO_3$ (4.47 g, 53.2 mmol) and MeI (3.31 mL, 53.2 mmol). After being stirred at 35 °C overnight, the reaction mixture was cooled to room temperature and concentrated to one-third of the volume under reduced pressure. The residue was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 25 → 40% EtOAc/hexanes) gave aldehyde **27** (1.27 g, 99% for the two steps) as a colorless oil: $[\alpha]_D^{21}$ = +13.9 (*c* 1.15, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 9.36 (t, *J* = 1.5 Hz, 1H), 7.53 (d, *J* = 12.0 Hz, 1H), 7.25 (d, *J* = 6.5 Hz, 2H), 7.20—7.07 (m, 8H), 5.48 (d, *J* = 12.0 Hz, 1H), 4.32 (d, *J* = 12.0 Hz, 1H), 4.28 (d, *J* = 12.0 Hz, 1H), 4.26 (d, *J* = 12.0 Hz, 1H), 4.05 (d, *J* = 12.0 Hz, 1H), 3.50—3.47 (m, 4H), 3.39 (dd, *J* = 9.5, 3.0 Hz, 1H), 3.36 (dd, *J* = 9.5, 6.0 Hz, 1H), 3.29 (m, 1H), 3.25—3.17 (m, 2H), 2.20 (m, 1H), 2.01 (m, 1H), 1.72—1.64 (m, 2H), 1.56 (m, 1H), 1.43—1.31 (m,

3H); ^{13}C NMR (125 MHz, C_6D_6) δ 200.6, 167.8, 161.8, 138.9 (× 2), 128.6 (× 2), 128.5 (× 2), 128.3 (× 4), 127.8 (× 2), 98.3, 85.8, 84.4, 83.0, 78.1, 73.2, 71.7, 70.9, 50.7, 40.1, 26.8, 25.8, 23.7; HRMS (ESI-TOF) calcd for $C_{28}H_{34}O_7Na$ [(M+Na)$^+$] 505.2202, found 505.2192.



27 **28**

Lactone 28. To a solution of aldehyde **27** (4.20 g, 8.71 mmol) in THF (80 mL) were added MeOH (1.06 mL, 26.2 mmol) and SmI_2 (0.1 M solution in THF, 261 mL, 261 mmol). After being stirred at room temperature for 30 min, the reaction mixture was treated with a 1:1 mixture of saturated aqueous $NaHCO_3$ and saturated aqueous Na_2SO_3. The insoluble materials were filtered off, and the filtrate was concentrated under reduced pressure to remove the bulk of THF. The residue was extracted with EtOAc, and the organic layer was washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 35 → 50% EtOAc/hexanes) gave lactone **28** (2.92 g, 74%), along with a mixture containing the corresponding hydroxyl ester (0.78 g). The latter material (0.78 g) was dissolved in toluene (16 mL) and treated with *p*-TsOH·H_2O (30.7 mg, 0.161 mmol). After being stirred at 80 °C for 1 h, the reaction mixture was cooled to room temperature and quenched with Et_3N. The resultant mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 35 → 50% EtOAc/hexanes) gave additional lactone **28** (0.38 g, 10%). Total yield: 3.30 g, 84%. **28**: $[\alpha]_D^{20}$ = −42.4 (*c* 0.97, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.31 (d, *J* = 7.0 Hz, 2H), 7.22—7.09 (m, 8H), 4.45—4.39 (m, 2H), 4.33 (d, *J* = 11.5 Hz, 1H), 4.08 (d, *J* = 11.5 Hz, 1H), 3.64 (m, 1H), 3.56 (dd, *J* = 10.5, 3.0 Hz, 1H), 3.48—3.43 (m, 2H), 3.31 (m, 1H), 3.07—3.01 (m, 2H), 2.91 (ddd, *J* = 8.5, 8.0, 4.0 Hz, 1H), 2.33 (dd, *J* = 17.0, 8.0 Hz, 1H), 2.21 (dd, *J* = 17.0, 10.5 Hz, 1H), 1.97—1.91 (m, 2H), 1.81—1.73 (m, 3H), 1.64 (m, 1H), 1.55 (m, 1H), 1.19 (m, 1H); ^{13}C NMR (125 MHz, C_6D_6) δ 171.6, 139.2, 139.0, 128.6 (× 2), 128.55, 128.53, 128.3 (× 2), 127.9 (× 2), 127.8, 127.7, 86.1, 85.4, 84.5, 82.2, 78.5, 78.1, 73.3, 72.3, 71.0, 36.3, 30.9, 28.0, 25.3, 24.8; HRMS (ESI-TOF) calcd for $C_{27}H_{32}O_6Na$ [(M+Na)$^+$] 475.2097, found 475.2093.



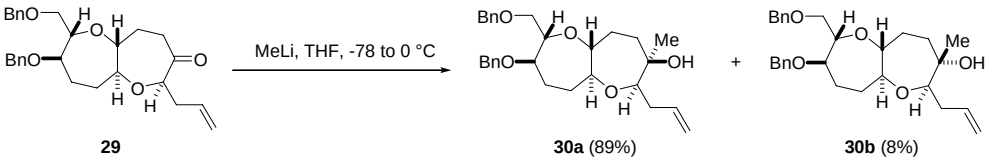
28 **S4** **29**

Ketone 29. To a solution of lactone **28** (178.8 mg, 0.3956 mmol) in CH_2Cl_2 (6 mL) at −78 °C was added DIBALH (0.94 M solution in hexane, 0.460 mL, 0.432 mmol). After being stirred at −78 °C for 0.5 h, the reaction mixture was treated with saturated aqueous potassium sodium tartrate. The resultant

mixture was diluted with EtOAc and stirred at room temperature until the layers became clear. The layers were separated and the organic layer was washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude hemiacetal was used in the next reaction without further purification.

To a suspension of $Ph_3P^+CH_3Br^-$ (706.6 mg, 1.98 mmol) in THF (5 mL) at 0 °C was added NaHMDS (1.0 M solution in THF, 1.78 mL, 1.78 mmol), and the reaction mixture was stirred at 0 °C for 0.5 h. To this suspension was added a solution of the above hemiacetal in THF (5 mL), and the resultant mixture was allowed to warm to room temperature over a period of 0.5 h before the reaction was quenched with saturated aqueous NH_4Cl. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 25 → 40% EtOAc/hexanes) gave olefin **S4** (167.6 mg, 94% for the two steps) as a colorless oil: $[\alpha]_D^{19}$ = −16.6 (*c* 0.35, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.27 (d, *J* = 8.0 Hz, 2H), 7.25 (d, *J* = 7.5 Hz, 2H), 7.19—7.07 (m, 6H), 6.02 (m, 1H), 5.13 (dd, *J* = 17.5, 2.5 Hz, 1H), 5.09 (dd, *J* = 10.0, 0.5 Hz, 1H), 4.36—4.33 (m, 3H), 4.17 (d, *J* = 11.5 Hz, 1H), 3.97 (m, 1H), 3.66 (m, 1H), 3.58 (ddd, *J* = 9.0, 9.0, 5.0 Hz, 1H), 3.46 (dd, *J* = 9.5, 5.5 Hz, 1H), 3.36—3.25 (m, 4H), 2.41 (m, 1H), 2.24 (m, 1H), 2.10 (ddd, *J* = 12.5, 12.0, 11.5 Hz, 1H), 1.98 (m, 1H), 1.88—1.78 (m, 3H), 1.64—1.46 (m, 3H), 0.73 (d, *J* = 4.0 Hz, 1H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.2, 139.1, 136.3, 128.5 (× 4), 128.3 (× 2), 127.7 (× 2), 127.62, 127.55, 116.5, 86.4, 85.8, 84.4, 82.9, 78.9, 74.4, 73.3, 72.1, 70.6, 39.6, 30.0, 28.9, 28.2, 23.5; HRMS (ESI-TOF) calcd for $C_{28}H_{36}O_5Na$ [$(M+Na)^+$] 475.2460, found 475.2462.

To a solution of olefin **S4** (86.0 mg, 0.1909 mmol) in CH_2Cl_2 (3 mL) were added 4Å molecular sieves (80 mg), NMO (44.7 mg, 0.382 mmol) and a catalytic amount of TPAP (ca. 5 mg). After being stirred at room temperature for 50 min, the reaction mixture was diluted with EtOAc and passed through a pad of silica gel to give ketone **29** (83.3 mg, 97%) as a colorless oil: $[\alpha]_D^{18}$ = +34.4 (*c* 0.44, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.29 (d, *J* = 6.5 Hz, 2H), 7.23 (d, *J* = 7.5 Hz, 2H), 7.20—7.08 (m, 6H), 5.86 (m, 1H), 5.07—5.02 (m, 2H), 4.39 (s, 2H), 4.33 (d, *J* = 11.5 Hz, 1H), 4.12 (d, *J* = 11.5 Hz, 1H), 3.76 (dd, *J* = 11.0, 5.5 Hz, 1H), 3.63 (dd, *J* = 8.5, 4.5 Hz, 1H), 3.47 (m, 1H), 3.43—3.41 (m, 2H), 3.34 (ddd, *J* = 11.0, 9.5, 4.5 Hz, 1H), 2.76 (ddd, *J* = 10.0, 9.5, 4.5 Hz, 1H), 2.45—2.39 (m, 2H), 2.28 (m, 1H), 2.11—2.04 (m, 2H), 1.94 (m, 1H), 1.78—1.67 (m, 2H), 1.54—1.40 (m, 2H); ^{13}C NMR (125 MHz, C_6D_6) δ 213.9, 139.2, 139.1, 134.2, 128.5 (× 4), 128.3 (× 4), 127.7 (× 2), 117.4, 86.7 (× 2), 85.5, 84.1, 78.6, 73.2, 72.2, 70.8, 37.4, 37.1, 31.5, 28.3, 24.0; HRMS (ESI-TOF) calcd for $C_{28}H_{34}O_5Na$ [$(M+Na)^+$] 473.2304, found 473.2320.

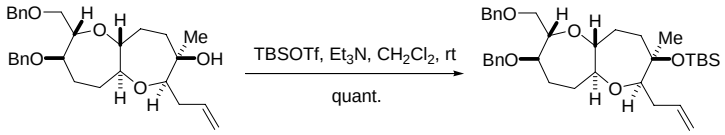


29 **30a** (89%) **30b** (8%)

Tertiary alcohol 30a. To a solution of ketone **29** (407.0 mg, 0.9044 mmol) in THF (18 mL) at −78 °C

was added MeLi (0.98 M in diethyl ether, 1.11 mL, 1.09 mmol). The reaction mixture was allowed to warm to 0 °C over a period of 1 h and quenched with saturated aqueous NH_4Cl. The reaction mixture was diluted with EtOAc, washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. ^{1}H NMR spectrum of the crude mixture indicated that the diastereoselectivity is >10:1. Purification by flash column chromatography (silica gel, 25% EtOAc/hexanes) afforded tertiary alcohol **30a** (374.5 mg, 89%) and its epimer **30b** (35.0 mg, 8%) as colorless oils, respectively. Data for **30a**: $[\alpha]_D^{18} = -1.5$ (*c* 0.67, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.29 (d, *J* = 7.0 Hz, 2H), 7.26 (d, *J* = 6.5 Hz, 2H), 7.19—7.07 (m, 6H), 6.03 (m, 1H), 5.18—5.11 (m, 2H), 4.39 (d, *J* = 11.5 Hz, 1H), 4.34 (d, *J* = 12.0 Hz, 1H), 4.32 (d, *J* = 12.0 Hz, 1H), 4.23 (d, *J* = 11.5 Hz, 1H), 4.01 (m, 1H), 3.75 (m, 1H), 3.60 (m, 1H), 3.44 (dd, *J* = 9.5, 4.5 Hz, 1H), 3.28 (dd, *J* = 9.5, 7.0 Hz, 1H), 3.09—3.05 (m, 2H), 2.44 (m, 1H), 2.19 (dd, *J* = 15.0, 7.5 Hz, 1H), 2.12 (m, 1H), 1.95—1.82 (m, 3H), 1.62 (m, 1H), 1.55—1.42 (m, 3H), 1.08 (d, *J* = 6.5 Hz, 1H), 0.90 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.1, 139.0, 137.6, 128.5 (× 2), 128.3 (× 2), 127.9 (× 2), 127.72 (× 2), 127.70, 127.6, 116.0, 88.8, 87.5, 83.5, 82.4, 78.9, 74.8, 73.3, 71.9, 70.7, 38.2, 35.1, 30.0, 27.8, 25.4, 23.2; HRMS (ESI-TOF) calcd for $C_{29}H_{38}O_5Na$ [$(M+Na)^+$] 489.2617, found 489.2630.

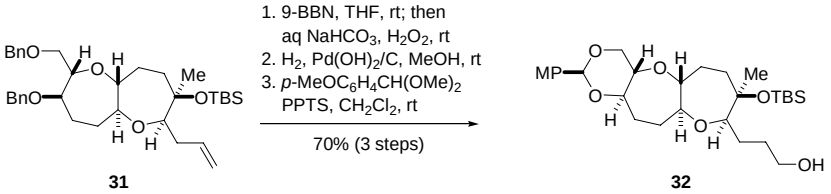
Data for **30b**: $[\alpha]_D^{18} = -0.44$ (*c* 0.89, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.25 (d, J = 7.5 Hz, 4H), 7.19—7.06 (m, 6H), 6.00 (m, 1H), 5.17 (dd, *J* = 17.0, 2.0 Hz, 1H), 5.11 (d, *J* = 10.0 Hz, 1H), 4.37—4.30 (m, 3H), 4.20 (d, *J* = 12.0 Hz, 1H), 4.01 (ddd, *J* = 6.5, 6.0, 2.5 Hz, 1H), 3.71 (m, 1H), 3.55 (ddd, *J* = 10.0, 9.0, 4.5 Hz, 1H), 3.45 (dd, *J* = 9.5, 5.5 Hz, 1H), 3.34 (dd, *J* = 10.5, 2.0 Hz, 1H), 3.30—3.23 (m, 2H), 2.32 (dd, *J* = 14.0, 7.0 Hz, 1H), 2.20—2.08 (m, 2H), 2.00—1.93 (m, 2H), 1.84—1.78 (m, 2H), 1.57—1.43 (m, 3H), 0.93 (s, 3H), 0.59 (d, *J* = 6.0 Hz, 1H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.2 (× 2), 137.2, 128.53 (× 2), 128.50 (× 2), 128.3 (× 2), 127.72 (× 2), 127.65, 127.57, 116.3, 87.9, 87.4, 84.5, 82.7, 78.9, 74.3, 73.3, 72.0, 70.6, 38.8, 35.6, 29.4, 27.9, 24.0, 23.2; HRMS (ESI-TOF) calcd for $C_{29}H_{38}O_5Na$ [$(M+Na)^+$] 489.2617, found 489.2610.



30a **31**

Silyl ether 31. To a solution of tertiary alcohol **30a** (50.3 mg, 0.1079 mmol) in CH_2Cl_2 (3 mL) at 0 °C were added Et_3N (0.120 mL, 0.8609 mmol) and TBSOTf (0.100 mL, 0.4354 mmol). After being stirred at room temperature for 4 h, the reaction mixture was cooled to 0 °C and treated with saturated aqueous $NaHCO_3$. The resultant mixture was extracted with EtOAc, and the organic layer was washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 8% EtOAc/hexanes) gave silyl ether **31** (62.6 mg, quantitative) as a colorless clear oil: $[\alpha]_D^{17} = +21.8$ (*c* 1.74, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.27—7.25 (m, 3H), 7.18—7.08 (m, 7H), 6.11 (m, 1H), 5.22 (dd, *J* = 17.0, 2.0 Hz, 1H), 5.14 (dd, *J* = 10.0, 2.0 Hz, 1H), 4.36 (d, *J* = 12.0 Hz, 1H), 4.34 (s, 2H),

4.17 (d, *J* = 12.0 Hz, 1H), 4.04 (ddd, *J* = 6.5, 5.5, 2.5 Hz, 1H), 3.71 (m, 1H), 3.67 (ddd, *J* = 9.5, 9.0, 4.5 Hz, 1H), 3.46 (dd, *J* = 10.0, 5.5 Hz, 1H), 3.30 (dd, *J* = 10.0, 6.5 Hz, 1H), 3.12—3.07 (m, 2H), 2.62 (m, 1H), 2.24 (dd, *J* = 14.5, 7.5 Hz, 1H), 2.14 (m, 1H), 2.03—1.92 (m, 2H), 1.88—1.79 (m, 2H), 1.64 (dd, *J* = 13.0, 10.0 Hz, 1H), 1.55—1.44 (m, 2H), 0.96 (s, 9H), 0.96 (s, 3H), 0.10 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.2, 139.0, 138.0, 128.53 (× 2), 128.50 (× 2), 127.9 (× 2), 127.71 (× 2), 127.66, 127.5, 115.8, 90.1, 88.1, 84.2, 82.6, 78.7 (× 2), 73.3, 72.0, 70.4, 37.8, 35.9, 30.3, 27.8, 26.6, 26.2 (× 3), 23.2, 18.6, −1.7, −1.8; HRMS (ESI-TOF) calcd for $C_{35}H_{52}O_5SiNa$ [$(M+Na)^+$] 603.3482, found 603.3462.



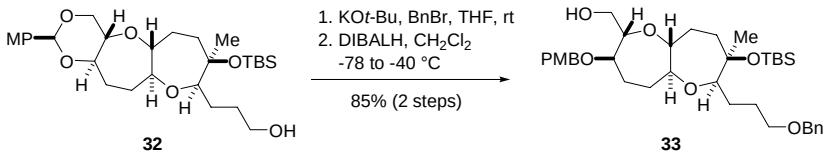
31 **32**

Alcohol 32. To a solution of silyl ether **31** (581.1 mg, 1.002 mmol) in THF (10 mL) was added 9-BBN (0.5 M solution in THF, 6.00 mL, 3.00 mmol), and the reaction mixture was stirred at room temperature overnight. To this mixture at 0 °C were added dropwise saturated aqueous $NaHCO_3$ (6 mL) and 30% H_2O_2 (4 mL), and the resultant mixture was stirred at room temperature for 3 h. The reaction mixture was diluted with EtOAc, washed successively with water, saturated aqueous Na_2SO_3 and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 30% EtOAc/hexanes) gave crude alcohol, which was contaminated with borane byproduct(s) and was used in the next reaction without further purification.

To a solution of the above material in MeOH (20 mL) was added 20% $Pd(OH)_2$/C (100 mg), and the resultant mixture was stirred at room temperature under hydrogen atmosphere (135 min). The catalyst was filtered off, and the filtrate was concentrated under reduced pressure. The residual crude triol was used in the next reaction without further purification.

To a solution of the above material in CH_2Cl_2 (20 mL) were added *p*-methoxybenzaldehyde dimethylacetal (0.255 mL, 1.50 mmol) and PPTS (25.2 mg, 0.100 mmol). After being stirred at room temperature for 1 h, the reaction mixture was quenched with the addition of Et_3N and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 20 → 30% EtOAc/hexanes) gave alcohol **32** (375.3 mg, 70% for the three steps) as a colorless oil: $[\alpha]_D^{17}$ = +44.6 (*c* 1.12, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.62 (d, *J* = 7.0 Hz, 2H), 6.82 (d, *J* = 7.0 Hz, 2H), 5.39 (s, 1H), 4.35 (dd, *J* = 11.0, 5.0 Hz, 1H), 3.58 (dd, J = 11.0, 10.0 Hz, 1H), 3.53—3.42 (m, 2H), 3.34 (ddd, *J* = 9.5, 9.0, 3.0 Hz, 1H), 3.31—3.24 (m, 5H), 3.12 (ddd, *J* = 9.5, 8.5, 6.5 Hz, 1H), 2.84 (apparently d, *J* = 10.5 Hz, 1H), 2.18 (ddd, *J* = 10.5, 10.5, 4.5 Hz, 1H), 2.07—1.94 (m, 2H), 1.83—1.62 (m, 6H), 1.58—1.44 (m, 3H), 1.02 (s, 9H), 0.94 (s, 3H), 0.91 (s, 1H), 0.11 (s, 3H), 0.09 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 160.4, 131.3, 128.5, 128.3, 128.1, 113.7, 101.2, 92.0, 86.2, 82.7, 80.7, 77.7, 76.2, 70.0, 62.7, 54.7, 36.8, 30.3, 29.7, 29.4, 28.6, 27.12, 27.10, 26.3 (× 3), 18.8, −1.60, −1.92; HRMS

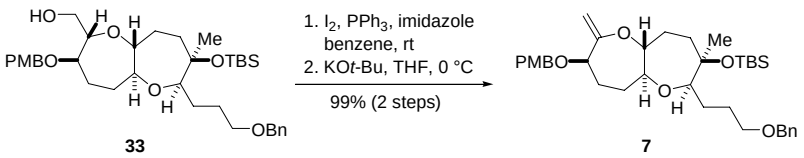
(ESI-TOF) calcd for $C_{29}H_{49}O_7Si$ [$(M+H)^+$] 537.3248, found 537.3246.



32 33

Alcohol 33. To a solution of alcohol **32** (350.0 mg, 0.6530 mmol) in THF (12 mL) was added KO*t*-Bu (146.5 mg, 1.306 mmol), and the resultant mixture was stirred at room temperature for 20 min. To this mixture were added BnBr (0.120 mL, 1.01 mmol) and a catalytic amount of *n*-Bu_4NI (ca. 10 mg). After being stirred at room temperature for 50 min, the reaction mixture was cooled to 0 °C and quenched with MeOH. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residual crude benzyl ether was used in the next reaction without further purification.

To a solution of the above material in CH_2Cl_2 (10 mL) at −78 °C was added DIBALH (0.94 M solution in hexane, 3.47 mL, 3.26 mmol). The reaction mixture was allowed to warm to 0 °C over a period of 1 h before the reaction was quenched with saturated aqueous potassium sodium tartrate. The resultant mixture was diluted with EtOAc and stirred at room temperature until the layers became clear. The organic layer was separated and washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 25% EtOAc/hexanes) gave alcohol **33** (356.6 mg, 87% for the two steps) as a colorless oil: $[\alpha]_D^{21}$ = +24.7 (*c* 0.59, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.33 (d, *J* = 7.0 Hz, 2H), 7.21—7.09 (m, 5H), 6.78 (d, *J* = 7.0 Hz, 2H), 4.37 (s, 2H), 4.26 (d, *J* = 11.0 Hz, 1H), 4.05 (d, *J* = 11.0 Hz, 1H), 3.78 (m, 1H), 3.53 (ddd, *J* = 9.5, 9.0, 4.5 Hz, 1H), 3.49—3.42 (m, 3H), 3.38—3.28 (m, 5H), 3.03—2.97 (m, 2H), 2.11—2.01 (m, 2H), 1.91—1.71 (m, 7H), 1.67—1.60 (m, 2H), 1.39—1.30 (m, 2H), 1.00 (s, 3H), 0.99 (s, 9H), 0.12 (s, 3H), 0.10 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 159.7, 139.5, 130.9, 129.3, 128.54, 128.52, 128.3 (× 2), 127.8 (× 2), 127.6, 114.1, 90.2, 87.9, 84.6, 84.5, 78.7, 78.2, 73.0, 70.9, 70.2, 64.7, 54.7, 37.8, 30.0, 28.0, 27.9, 27.8, 26.8, 26.3 (× 3), 24.0, 18.7, −1.60, −1.72; HRMS (ESI-TOF) calcd for $C_{36}H_{56}O_7SiNa$ [$(M+Na)^+$] 651.3693, found 651.3700.

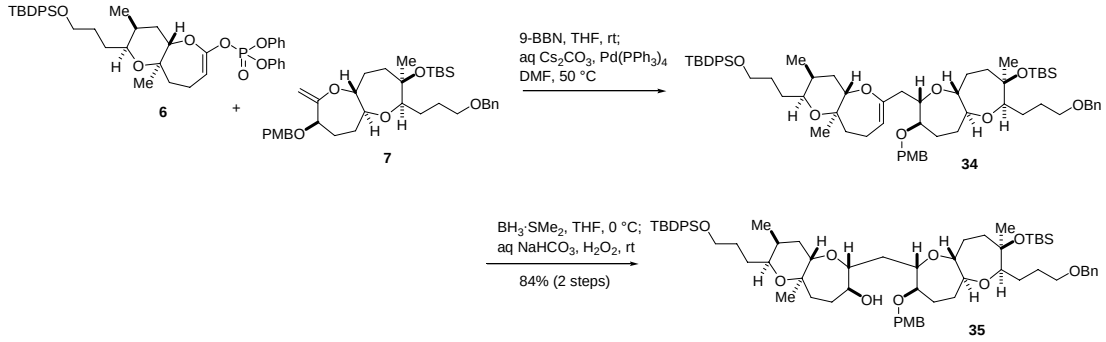


33 7

Exocyclic enol ether 7. To a solution of alcohol **33** (996.8 mg, 1.58 mmol) in benzene (15 mL) were added imidazole (322.7 mg, 4.74 mmol), Ph_3P (1.03 g, 3.95 mmol), and I_2 (1.00 g, 3.95 mmol). After being stirred at room temperature for 1 h, the reaction mixture was quenched with saturated aqueous Na_2SO_3 and extracted with EtOAc. The organic layer was washed with H_2O and brine, dried over

Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 50% EtOAc/hexanes) gave the corresponding iodide (1.32 g), which was used in the next reaction without further purification.

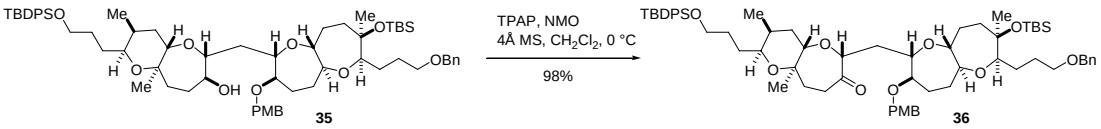
To a solution of the above material in THF (15 mL) at 0 °C was added KO*t*-Bu (354.6 mg, 3.16 mmol). After being stirred at 0 °C for 40 min, the reaction mixture was quenched with H_2O and extracted with EtOAc. The organic layer was washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 3 → 10% EtOAc/hexanes) gave exocyclic enol ether **7** (890.2 mg, 92% for the two steps) as a colorless oil: $[\alpha]_D^{27}$ = +17.0 (*c* 0.95, benzene); ^{1}H NMR (300 MHz, C_6D_6) δ 7.35—7.30 (m, 2H), 7.25—7.05 (m, 5H), 6.78 (d, *J* = 7.0 Hz, 2H), 4.87 (m, 1H), 4.68 (s, 1H), 4.59 (d, *J* = 11.7 Hz, 1H), 4.36 (s, 2H), 4.32 (d, *J* = 11.7 Hz, 1H), 4.01 (s, 1H), 3.96 (brd, *J* = 5.4 Hz, 1H), 3.48—3.34 (m, 2H), 3.30 (s, 3H), 3.14 (ddd, *J* = 11.4, 8.1, 3.0 Hz, 1H), 2.92 (dd, *J* = 10.2, 1.8 Hz, 1H), 2.46 (m, 1H), 2.23 (m, 1H), 2.05—1.54 (m, 9H), 1.44 (dddd, *J* = 13.8, 13.8, 4.2, 1.5 Hz, 1H), 0.97 (s, 9H), 0.96 (s, 3H), 0.070 (s, 3H), 0.065 (s, 3H); HRMS (ESI-TOF) calcd for $C_{36}H_{54}O_6SiNa$ [$(M+Na)^+$] 633.3587, found 633.3590.



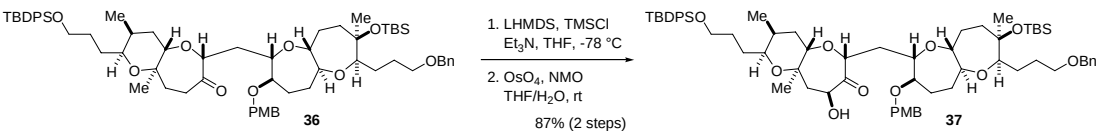
Endocyclic enol ether 35. To a solution of exocyclic enol ether **7** (890.2 mg, 1.45 mmol) in THF (5 mL) was added a solution of $(9\text{-BBN})_2$ (424.3 mg, 1.89 mmol) in THF (15 mL). After being stirred at room temperature for 2.5 h, the reaction mixture was treated with 3 M aqueous Cs_2CO_3 (1.45 mL, 4.35 mmol) and stirred at room temperature for 20 min. To this mixture were added a solution of enol phosphate **6** (1.30 g, 1.79 mmol) in DMF (7 mL + 4 × 2 mL rinse) and $Pd(PPh_3)_4$ (168.3 mg, 0.146 mmol), and the resultant mixture was stirred at 50 °C overnight. The reaction mixture was cooled to room temperature, diluted with diethyl ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 0 → 15% EtOAc/hexanes) to afford coupling product **34** (1.86 g), which was contaminated with byproducts derived from 9-BBN but was used in the next reaction without further purification.

To a solution of the above coupling product **34** (1.86 g, theoretically 1.45 mmol) in THF (15 mL) at 0 °C was added $BH_3{\cdot}SMe_2$ (2.0 M in THF, 2.30 mL, 4.60 mmol), and the resultant mixture was allowed to warm to room temperature. After being stirred for 1 h, the reaction mixture was cooled to 0 °C and treated with saturated aqueous $NaHCO_3$ (30 mL) and 30% aqueous H_2O_2 (15 mL). After being stirred at room temperature for 2.5 h, the reaction mixture was diluted with EtOAc, washed with water

and brine, dried over Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the residue by silica gel column chromatography (15% EtOAc/henaxes) gave alcohol **35** (1.35 g, 1.22 mmol, 84% for the two steps) as a colorless oil: $[\alpha]_D^{18}$ −5.8 (*c* 1.25, $CHCl_3$); IR (film) 3447, 2932, 2856, 1513, 1472, 1457, 1249, 1091, 834, 702 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.81—7.77 (m, 4H), 7.34 (d, *J* = 7.5 Hz, 2H), 7.26—7.19 (m, 11H), 6.85 (d, *J* = 8.5 Hz, 2H), 4.38 (s, 2H), 4.36 (d, *J* = 12.0 Hz, 1H), 4.15 (d, *J* = 11.5 Hz, 1H), 4.07 (dd, *J* = 6.5, 6.0 Hz, 1H), 3.79 (dd, *J* = 12.0, 5.0 Hz, 1H), 3.78—3.65 (m, 5H), 3.52—3.42 (m, 4H), 3.33 (s, 3H), 3.05 (ddd, *J* = 10.0, 10.0, 4.0 Hz, 1H), 3.02 (d, *J* = 10.5 Hz, 1H), 2.21—2.01 (m, 3H), 1.98—1.46 (m, 21H), 1.41 (m, 1H), 1.31 (m, 1H), 1.24 (s, 3H), 1.18 (s, 9H), 0.98 (s, 9H), 0.96 (s, 3H), 0.95 (m, 3H), 0.12 (s, 3H), 0.09 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.1, 138.7, 135.6 (× 4), 134.0 (× 2), 130.5, 129.5 (× 2), 129.1 (× 2), 128.3 (× 2), 127.65 (× 2), 127.57 (× 4), 127.46, 113.8 (× 2), 90.2, 87.3, 83.4, 82.6, 81.3, 79.9, 78.3, 77.2, 76.5, 73.3, 72.9, 70.8, 70.6, 70.3, 63.9, 55.3, 39.8, 37.1, 36.2, 34.5, 32.5, 29.6, 29.2, 29.0, 27.9, 27.3, 27.2, 27.1, 26.9 (× 3), 26.7, 26.0 (× 3), 22.8, 19.2, 18.4, 15.7, 12.5, −1.8, −1.9; HRMS (FAB) calcd for $C_{66}H_{99}O_{10}Si_2$ $[(M+H)^+]$ 1107.6777, found 1107.6774.

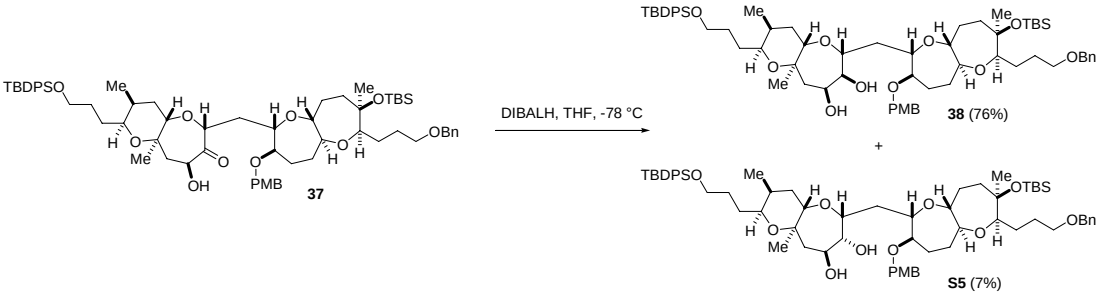


Ketone 36. To a solution of alcohol **35** (2.19 g, 1.98 mmol) in CH_2Cl_2 (20 mL) at 0 °C were added 4Å molecular sieves (0.75 g), NMO (350.1 mg, 2.97 mmol) and TPAP (70.3 mg, 0.198 mmol). After being stirred at 0 °C for 70 min, the reaction mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 20% EtOAc/hexanes) gave ketone **36** (2.16 g, 98%) as a colorless oil: $[\alpha]_D^{27}$ +9.6 (*c* 0.60, $CHCl_3$); IR (film) 2932, 2856, 1713, 1612, 1513, 1462, 1428, 1249, 1093, 834, 702 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.80—7.76 (m, 4H), 7.34 (d, *J* = 7.5 Hz, 2H), 7.24—7.10 (m, 11H), 6.81 (d, *J* = 8.5 Hz, 2H), 4.38 (s, 2H), 4.30 (d, *J* = 11.0 Hz, 1H), 4.13—4.04 (m, 3H), 3.75 (dd, *J* = 9.0, 5.0, 4.0 Hz, 1H), 3.72—3.61 (m, 2H), 3.51—3.36 (m, 4H), 3.31 (s, 3H), 3.19 (dd, *J* = 11.5, 4.5 Hz, 1H), 3.06 (ddd, *J* = 9.5, 4.5, 4.5 Hz, 1H), 3.00 (d, *J* = 10.5 Hz, 1H), 2.79 (ddd, *J* = 12.0, 4.0, 4.0 Hz, 1H), 2.25 (m, 1H), 2.13—1.97 (m, 4H), 1.92—1.38 (m, 18H), 1.23 (m, 1H), 1.19 (s, 3H), 1.18 (s, 9H), 0.98 (s, 12H), 0.77 (d, *J* = 7.0 Hz, 3H), 0.11 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 214.7, 159.7, 139.6, 136.0 (× 4), 134.41, 134.38, 131.0, 129.9 (× 2), 129.4 (× 2), 128.5 (× 2), 128.0 (× 4), 127.7 (× 2), 127.5, 114.1 (× 2), 90.0, 87.6, 84.8, 83.5, 81.3, 79.8, 79.1, 78.8, 76.2, 73.0, 71.1, 70.9, 70.2, 64.2, 54.7, 39.5, 39.0, 37.8, 37.1, 34.8, 33.1, 30.0, 29.7, 29.2, 27.82, 27.80, 27.78, 27.1 (× 3), 26.8, 26.3 (× 3), 22.8, 19.4, 18.7, 14.7, 12.5, −1.6, −1.7; HRMS (FAB) calcd for $C_{66}H_{97}O_{10}Si_2$ $[(M+H)^+]$ 1105.6621, found 1105.6626.



Hydroxy ketone 37. To a solution of ketone **36** (2.16 g, 1.95 mmol) in THF (20 mL) were added TMSCl (4.94 mL, 39.0 mmol) and Et_3N (5.43 mL, 39.0 mmol). The mixture was cooled to −78 °C and treated with LiHMDS (1.0 M solution in THF, 5.85 mL, 5.85 mmol). After being stirred at −78 °C for 35 min, pH 7 phosphate buffer (10 mL) was added to the reaction mixture. The resultant mixture was extracted with EtOAc. The organic layer was washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford enol silyl ether, which was used in the next reaction without further purification.

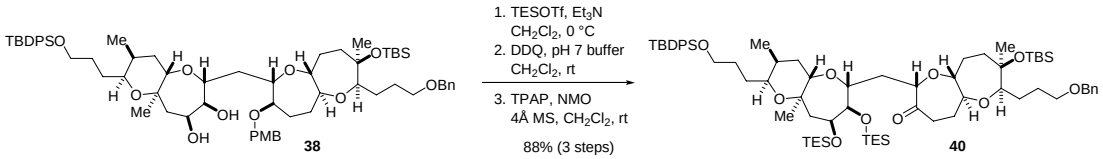
To a solution of the above enol silyl ether in THF/H_2O (4:1, v/v, 15 mL) were added NMO (50 wt% solution in water, 0.81 mL, 3.90 mmol) and OsO_4 (ca. 0.04 M solution in *t*-BuOH, 4.87 mL, ca. 0.20 mmol). After being stirred at room temperature for 9 h, the reaction mixture was diluted with EtOAc, washed with saturated aqueous Na_2SO_3 and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 15% EtOAc/hexanes) gave hydroxy ketone **37** (1.90 g, 87%) as a colorless clear oil: $[\alpha]_D^{26}$ +7.4 (*c* 0.79, $CHCl_3$); IR (film) 3428, 2933, 2857, 1739, 1612, 1513, 1462, 1249, 1105, 834, 702 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.68—7.62 (m, 4H), 7.43—7.30 (m, 10H), 7.28—7.20 (m, 3H), 6.85 (d, *J* = 9.0 Hz, 2H), 4.50 (brd, *J* = 11.5 Hz, 1H), 4.50 (s, 2H), 4.47 (d, *J* = 11.0 Hz, 1H), 4.20 (d, *J* = 11.0 Hz, 1H), 4.06 (dd, *J* = 7.0, 5.0 Hz, 1H), 3.79 (s, 3H), 3.78 (m, 1H), 3.68—3.58 (m, 3H), 3.54—3.38 (m, 4H), 3.08 (dd, *J* = 12.0, 4.5 Hz, 1H), 3.01 (dd, *J* = 9.5, 2.0 Hz, 1H), 2.91 (m, 1H), 2.24 (dd, *J* = 13.0, 3.0 Hz, 1H), 1.99—1.88 (m, 2H), 1.88—1.66 (m, 9H), 1.64—1.30 (m, 12H), 1.29 (s, 3H), 1.11 (s, 3H), 1.03 (s, 9H), 0.86 (d, *J* = 7.0 Hz, 3H), 0.84 (s, 9H), 0.05 (d, *J* = 7.0 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 216.0, 159.1, 138.7, 135.6 (× 4), 134.0, 133.9, 130.3, 129.6 (× 2), 129.2 (× 2), 128.3 (× 2), 127.64 (× 2), 127.59(× 4), 127.4, 113.8 (× 2), 90.2, 87.1, 83.4, 82.9, 81.0, 80.3, 78.3, 78.1, 74.1, 72.9, 71.9, 70.6, 70.5, 70.0, 63.7, 55.3, 48.3, 39.2, 37.0, 34.0, 32.5, 29.1, 29.0, 28.8, 27.23, 27.15, 27.07, 26.9 (× 3), 26.7, 26.0 (× 3), 22.4, 19.2, 18.4, 15.0, 12.4, −1.8, −1.9; HRMS (FAB) calcd for $C_{66}H_{96}O_{11}Si_2Na$ [$(M+Na)^+$] 1143.6390, found 1143.6394.



Diol 38. To a solution of hydroxy ketone **37** (1.90 g, 1.69 mmol) in THF (30 mL) at −78 °C was added DIBALH (0.94 M solution in hexane, 4.50 mL, 4.23 mmol). After being stirred at −78 °C for 30 min, an additional portion of DIBALH (0.94 M solution in hexane, 1.90 mL, 1.79 mmol) was added, and the resultant mixture was further stirred for 30 min. The reaction was quenched by the addition of saturated aqueous potassium sodium tartrate. The resultant mixture was diluted with EtOAc and stirred at room

temperature until the layers became clear (overnight). The aqueous layer was separated and extracted with EtOAc. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 15 → 50% EtOAc/hexanes) gave diol **38** (1.45 g, 76%) and its diastereomer **S5** (124.7 mg, 7%), along with recovered **37** (222.4 mg, 12%). Data for **38**: $[\alpha]_D^{25}$ −10.2 (*c* 0.92, $CHCl_3$); IR (film) 3428, 2932, 2857, 1612, 1513, 1462, 1249, 1105, 834, 701 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.66—7.62 (m, 4H), 7.42—7.32 (m, 11H), 7.28—7.22 (m, 2H), 6.86 (d, *J* = 8,5 Hz, 2H), 4.50 (s, 3H), 4.48 (d, *J* = 11.5 Hz, 1H), 4.24 (d, *J* = 11.5 Hz, 1H), 3.97 (brd, *J* = 10.0 Hz, 1H), 3.85 (brs, 1H), 3.79 (s, 3H), 3.75 (m, 1H), 3.70—3.58 (m, 3H), 3.56—3.40 (m, 6H), 3.04 (dd, *J* = 9.0, 2.0 Hz, 1H), 2.97 (td, *J* = 9.5, 4.5 Hz, 1H), 2.61 (brs, 1H), 2.12 (dd, *J* = 12.5, 11.0 Hz, 1H), 1.98—1.44 (m, 19H), 1.43—1.34 (m, 3H), 1.12 (s, 3H), 1.11 (s, 3H), 1.02 (s, 9H), 0.90 (d, *J* = 7.5 Hz, 3H), 0.84 (s, 9H), 0.04 (d, *J* = 5.5 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.1, 138.7, 135.6 (× 4), 134.04, 134.02, 130.5, 129.5 (× 2), 129.2 (× 2), 128.3 (× 2), 127.64 (× 2), 127.57(× 4), 127.5, 113.8 (× 2), 90.2, 87.4, 83.7, 81.3, 79.9, 79.6, 78.3, 76.5, 74.3, 72.9, 70.6, 70.5, 70.1, 68.6, 63.8, 55.3, 45.2, 40.3, 39.9, 37.7, 37.2, 34.2, 32.4, 29.6, 29.1, 28.9, 27.2, 27.1, 26.8 (× 3), 26.7, 26.0 (× 3), 22.9, 19.2, 18.4, 16.1, 12.4, −1.8, −1.9; HRMS (FAB) calcd for $C_{66}H_{98}O_{11}Si_2Na$ $[(M+Na)^+]$ 1145.6546, found 1145.6548.

Data for **S5**: $[\alpha]_D^{22}$ −4.6 (*c* 1.35, $CHCl_3$); IR (film) 3374, 2930, 2857, 1513, 1463, 1249, 1104, 1041, 997, 834, 702 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.68—7.62 (m, 4H), 7.46—7.33 (m, 11H), 7.32—7.26 (m, 2H), 6.90 (d, *J* = 9.0 Hz, 2H), 4.54 (s, 2H), 4.52 (d, *J* = 11.0 Hz, 1H), 4.30 (d, *J* = 11.0 Hz, 1H), 4.20—4.10 (m, 2H), 3.98 (brd, *J* = 9.0, 5.0 Hz, 1H), 3.83 (s, 3H), 3.80 (m, 1H), 3.74—3.58 (m, 5H), 3.58—3.46 (m, 3H), 3.29 (dd, *J* = 12.0, 4.5 Hz, 1H), 3.06 (d, *J* = 9.5 Hz, 1H), 3.00 (td, *J* = 10.0, 5.0 Hz, 1H), 2.84 (brs, 1H), 2.10—1.94 (m, 2H), 1.94—1.68 (m, 9H), 1.68—1.47 (m, 9H), 1.47—1.37 (m, 3H), 1.19 (s, 3H), 1.14 (s, 3H), 1.06 (s, 9H), 0.93 (d, *J* = 7.5 Hz, 3H), 0.88 (s, 9H), 0.09 (d, *J* = 6.5 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.1, 138.6, 135.5 (× 4), 134.02, 134.00, 130.2, 129.5 (× 2), 129.1 (× 2), 128.3 (× 2), 127.64 (× 2), 127.57 (× 4), 127.5, 113.8 (× 2), 90.3, 87.0, 82.5, 81.5, 78.2, 78.1, 77.5, 77.4, 74.0, 72.9, 70.6, 70.4, 70.0, 69.0, 63.8, 55.3, 49.3, 37.4, 36.8, 34.2, 32.4, 29.09, 29.06, 28.9, 27.2, 27.04, 26.97, 26.8 (× 3), 26.6, 26.1, 26.0 (× 3), 22.5, 19.2, 18.4, 15.9, 12.5, −1.8, −1.9; HRMS (ESI-TOF) calcd for $C_{66}H_{98}O_{11}Si_2Na$ $[(M+Na)^+]$ 1145.6545, found 1145.6546.

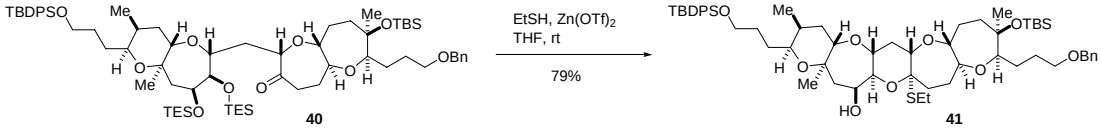


Ketone 40. To a solution of diol **38** (1.62 g, 1.44 mmol) in CH_2Cl_2 (15 mL) at 0 °C were added Et_3N (1.00 mL, 7.20 mmol) and TESOTf (0.81 mL, 3.60 mmol). After being stirred at 0 °C for 25 min, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The mixture was extracted with EtOAc, washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a pad of silica gel to give crude product, which was

used in the next reaction without further purification.

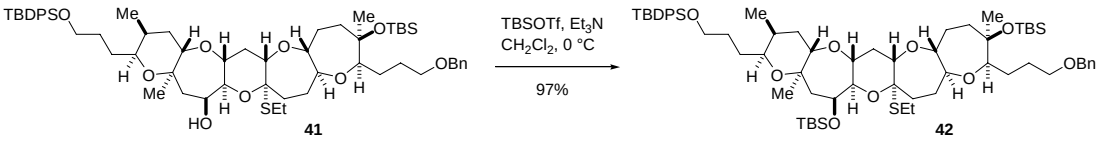
To a solution of the above crude material in CH_2Cl_2/pH 7 phosphate buffer (10:1, v/v, 16.5 mL) at 0 °C was added DDQ (392.3 mg, 1.728 mmol). After being stirred at room temperature for 1 h, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The resultant mixture was extracted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a pad of silica gel to give crude alcohol, which was used in the next reaction without further purification.

To a solution of the above crude material in CH_2Cl_2 (15 mL) at 0 °C were added 4Å molecular sieves (0.70 g), NMO (246.0 mg, 2.10 mmol) and TPAP (49.2 mg, 0.14 mmol). After being stirred at room temperature for 2 h, the reaction mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% EtOAc/hexanes) gave ketone **40** (1.55 g, 88% for the three steps) as a colorless oil: $[\alpha]_D^{26}$ −14.9 (*c* 0.81, $CHCl_3$); IR (film) 3462, 2954, 2935, 2875, 1717, 1461, 1457, 1252, 1103, 834, 741, 700 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.79—7.76 (m, 4H), 7.33 (d, *J* = 8.0 Hz, 1H), 7.25—7.18 (m, 8H), 7.13 (m, 1H), 4.36 (s, 2H), 4.29 (dd, *J* = 11.5, 5.5 Hz, 1H), 4.17 (dd, *J* = 9.5, 5.5 Hz, 1H), 4.07 (dd, *J* = 11.0, 2.0 Hz, 1H), 4.00 (s, 1H), 3.86 (t, *J* = 5.5 Hz, 1H), 3.73—3.61 (m, 2H), 3.49—3.34 (m, 3H), 3.14 (ddd, *J* = 13.5, 6.5, 4.0 Hz, 1H), 2.96 (d, *J* = 10.0 Hz, 1H), 2.89—2.72 (m, 3H), 2.32—2.20 (m, 2H), 2.23 (m, 1H), 1.95—1.40 (m, 18H), 1.32 (m, 1H), 1.29 (s, 3H), 1.17 (s, 9H), 1.10 (t, *J* = 8.0 Hz, 9H), 1.02 (t, *J* = 8.0 Hz, 9H), 1.01 (s, 9H), 1.00 (m, 3H), 0.95 (s, 3H), 0.74 (td, *J* = 7.5, 5.5 Hz, 6H), 0.64 (td, *J* = 7.5, 3.0 Hz, 6H), 0.14 (s, 3H), 0.10 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 213.8, 139.5, 136.0 (× 4), 134.7, 134.5, 129.9, 129.8, 128.5 (× 2), 128.0 (× 4), 127.8 (× 2), 127.6, 90.4, 87.8, 87.1, 84.5, 82.4, 79.2, 78.5, 74.2, 73.1, 72.2, 70.8, 70.6, 69.1, 64.2, 45.3, 39.0, 38.0, 37.8, 34.7, 33.1, 31.4, 30.2, 29.8, 29.4, 27.8, 27.7, 27.1 (× 3), 26.6, 26.2 (× 3), 19.4, 18.7, 16.7, 12.4, 7.3 (× 3), 7.2 (× 3), 5.4 (× 3), 5.1 (× 3), −1.6, −1.7; HRMS (FAB) calcd for $C_{70}H_{116}O_{10}Si_4Na$ $[(M+Na)^+]$ 1251.7545, found 1251.7550.

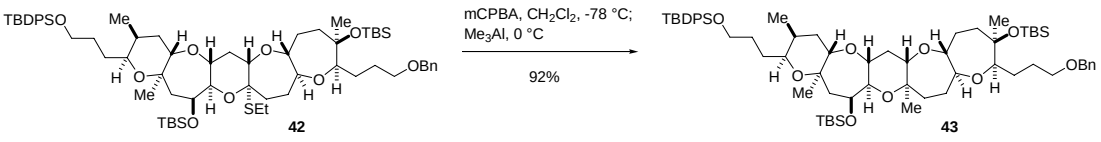


Alcohol 41. To a solution of ketone **40** (1.17 g, 0.951 mmol) in THF (9.5 mL) were added EtSH (3 mL) and $Zn(OTf)_2$ (34.6 mg, 0.095 mmol). Additional two portions of $Zn(OTf)_2$ (34.6 mg × 2) were added to the reaction mixture at 24 h intervals. After being stirred at room temperature for 3 days, the reaction mixture was treated with Et_3N (4 mL) and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 20% EtOAc/hexanes) gave alcohol **41** (788.2 mg, 79%) as a colorless foam: $[\alpha]_D^{26}$ −30.1 (*c* 1.52, $CHCl_3$); IR (film)3467, 2932, 2856, 1739, 1461, 1374, 1251, 1096, 834, 701 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.80—7.76 (m, 4H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.25—7.18 (m, 8H), 7.10 (m, 1H), 4.36 (s, 2H), 4.13 (dd, *J* = 10.5, 6.5 Hz, 1H), 4.07 (t, *J* = 8.0 Hz, 1H), 4.05 (dd, *J* = 9.0, <1.0 Hz, 1H), 3.96 (m, 1H), 3.80 (m, 1H), 3.72—3.62 (m, 2H), 3.48—3.35 (m, 3H), 3.29 (m,1H), 3.05 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.98 (d, *J* = 9.5 Hz, 1H), 2.42 (q, *J* =

12.0 Hz, 1H), 2.36—2.24 (m, 4H), 2.24—2.00 (m, 4H), 2.00—1.91 (m, 2H), 1.90—1.78 (m, 2H), 1.78—1.68 (m, 5H), 1.68—1.40 (m, 7H), 1.28 (m, 1H), 1.18 (s, 3H), 1.16 (s, 9H), 1.03 (t, J = 7.5 Hz, 3H), 1.00 (s, 9H), 0.96 (d, J = 6.5 Hz, 3H), 0.84 (s, 3H), 0.09 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.6, 136.0 (× 4), 134.4 (× 2), 129.9, (× 2), 128.5 (× 2), 128.0 (× 4), 127.7 (× 2), 127.5, 92.3, 91.4, 84.1, 83.9, 83.8, 77.9, 77.3, 75.55, 75.48, 73.0 (× 2), 71.0, 70.9, 70.2, 64.3, 48.0, 36.6, 35.3, 35.2, 33.1, 30.2, 29.8, 29.3, 29.1, 27.7, 27.6, 27.1 (× 3), 26.9, 26.3 (× 3), 26.2, 20.0, 19.9, 19.4, 18.8, 14.9, 12.6, −1.6, −1.7; HRMS (FAB) calcd for $C_{60}H_{93}O_9Si_2S$ [$(M+H)^+$] 1045.6079, found 1045.6078.

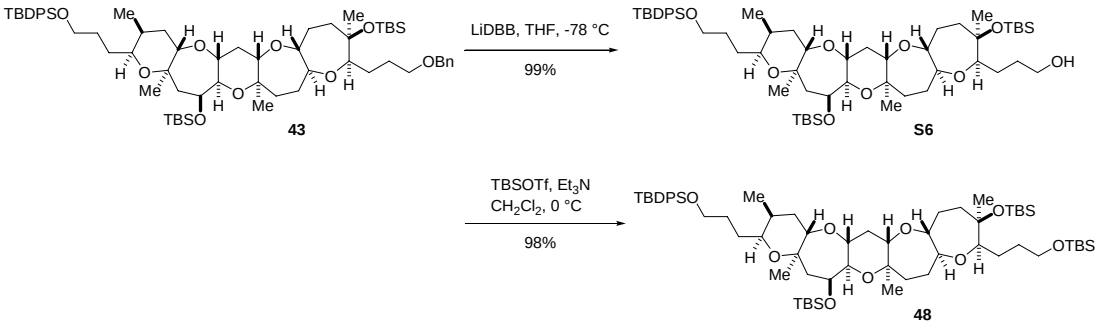


Silyl Ether 42. To a solution of alcohol **41** (1.01 g, 0.966 mmol) in CH_2Cl_2 (10 mL) at 0 °C were added Et_3N (0.40 mL, 2.90 mmol) and TBSOTf (0.33 mL, 1.45 mmol). After being stirred at 0 °C for 35 min, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% EtOAc/hexanes) gave silyl ether **42** (1.09 g, 97%) as a colorless oil: $[\alpha]_D^{26}$ −28.8 (*c* 0.66, $CHCl_3$); IR (film) 2930, 2856, 1471, 1428, 1252, 1097, 834, 701 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 7.81—7.76 (m, 4H), 7.32 (d, J = 7.5 Hz, 2H), 7.26—7.17 (m, 8H), 7.10 (m, 1H), 4.46 (dd, J = 11.5, 4.5 Hz, 1H), 4.38 (s, 2H), 4.15—4.08 (m, 2H), 4.04—3.97 (m, 2H), 3.71—3.60 (m, 2H), 3.50—3.40 (m, 2H), 3.38—3.29 (m, 2H), 3.23 (dd, J = 12.0, 4.0 Hz, 1H), 3.00 (d, J = 9.5 Hz, 1H), 2.48 (t, J = 11.0 Hz, 1H), 2.42—2.34 (m, 2H), 2.30 (m, 1H), 2.28—2.20 (m, 3H), 2.10—2.02 (m, 2H), 1.98 (m, 1H), 1.88—1.69 (m, 8H), 1.65 (m, 1H), 1.60—1.44 (m, 5H), 1.28 (m, 1H), 1.27 (s, 3H), 1.18 (s, 9H), 1.10 (s, 9H), 1.04 (s, 9H), 1.08 (t, J = 7.5 Hz, 3H), 1.05 (m, 3H), 0.86 (s, 3H), 0.18 (s, 3H), 0.17 (s, 3H), 0.12 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.6, 136.0 (× 4), 134.46, 134.45, 129.9 (× 2), 128.5 (× 2), 128.0 (× 4), 127.7 (× 2), 127.5, 92.4, 91.2, 84.4, 84.2, 83.8, 78.03, 77.96, 76.2, 73.2, 73.1, 73.0, 72.9, 71.1, 70.8, 64.3, 50.1, 36.6, 35.6, 35.4, 35.2, 33.0, 30.3, 29.8, 29.4, 29.1, 27.64, 27.60, 27.1 (× 3), 26.8, 26.3 (× 3), 26.2 (× 3), 21.2, 20.0, 19.4, 18.8, 18.5, 14.9, 12.8, −1.6, −1.9, −4.1, −4.8; HRMS (FAB) calcd for $C_{66}H_{107}O_9Si_3S$ [$(M+H)^+$] 1159.6945, found 1159.6951.



Pentacyclic ether 43. To a solution of silyl ether **42** (184.2 mg, 0.159 mmol) in CH_2Cl_2 (8.0 mL) at −78 °C was added a solution of *m*CPBA (142.6 mg, 0.826 mmol) in CH_2Cl_2 (2.0 mL). The resultant solution was stirred at the same temperature for 2 h. Three portions of Me_3Al (1.0 M solution in hexane,

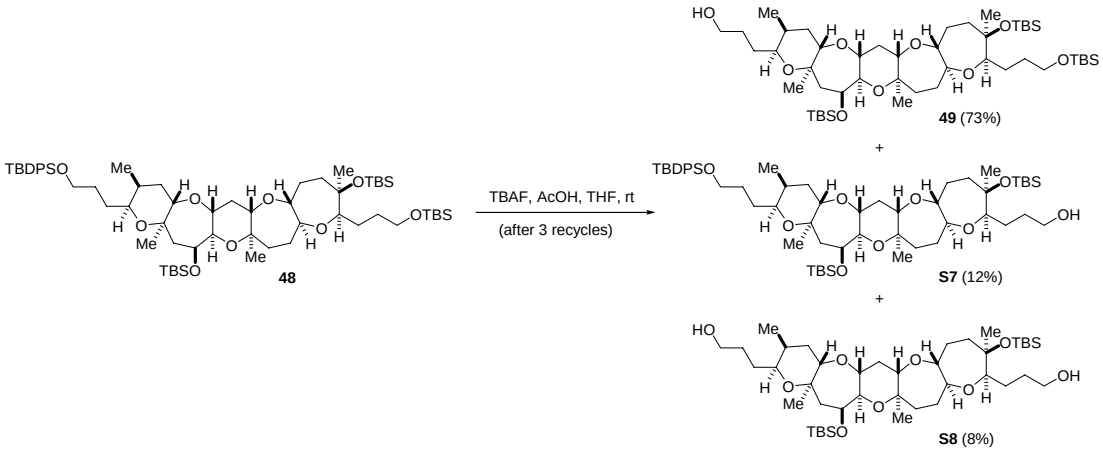
0.65 mL, 0.65 mmol) were added to the reaction mixture at 30-min intervals, during which time the reaction mixture was allowed to warm to 0 °C. After being stirred for 30 min, an additional portion of Me_3Al (1.0 M solution in hexane, 0.30 mL, 0.30 mmol) was added. The reaction mixture was further stirred for 30 min. The reaction mixture was quenched with saturated aqueous potassium sodium tartrate (15 mL), diluted with ether (50 mL), and stirred at room temperature overnight. The aqueous layer was separated and extracted with ether. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 5 → 8% EtOAc/hexanes) to give pentacyclic ether skeleton **43** (162.7 mg, 92%) as a colorless oil: $[\alpha]_D^{19}$ −10.5 (*c* 1.00, $CHCl_3$); IR (film) 2933, 2885, 2856, 1471, 1461, 1428, 1375, 1252, 1086, 835, 773, 701 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) 7.80—7.76 (m, 4H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.25—7.21 (m, 6H), 7.20 (t, *J* = 8.0 Hz, 2H), 7.10 (t, *J* = 8.0 Hz, 1H), 4.44 (dd, *J* = 11.5, 5.5 Hz, 1H), 4.36 (s, 2H), 4.03 (m, 1H), 3.95 (ddd, *J* = 12.0, 10.0, 5.0 Hz, 1H), 3.71—3.60 (m, 2H), 3.48—3.36 (m, 2H), 3.36—3.27 (m, 4H), 3.15 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.95 (d, *J* = 8.0 Hz, 1H), 2.37 (ddd, *J* = 11.5, 4.0, 4.0 Hz, 1H), 2.23 (dd, *J* = 16.0, 3.0 Hz, 1H), 2.15—2.06 (m, 2H), 2.02—1.44 (m, 19H), 1.24 (s, 3H), 1.18 (s, 9H), 1.16 (s, 3H), 1.08 (s, 9H), 1.03 (d, *J* = 6.5 Hz, 3H), 1.02 (s, 9H), 0.94 (S, 3H), 0.17 (d, *J* = 14.5 Hz, 6H), 0.11 (d, *J* = 14.5 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) 139.5, 135.99 (× 2), 135.98 (× 2), 134.46, 134.45, 129.9 (× 2), 128.51 (× 2), 128.0 (× 4), 127.7 (× 2) , 127.5, 90.7, 86.0, 84.1. 82.9, 78.2, 78.0, 76.5, 76.0, 73.6, 73.3, 73.1, 73.0, 71.1, 70.8, 64.3, 49.9, 37.8, 37.2, 35.5, 34.7, 33.1, 29.8, 29.6, 29.5, 29.4, 27.8, 27.6, 27.1 (× 3), 26.7, 26.3 (× 3), 26.2 (× 3), 21.3, 19.4, 18.8, 18.5, 15.7, 12.8, −1.6, −1.8, −4.0, −4.8; HRMS (FAB) calcd for $C_{65}H_{104}O_9Si_3Na$ $[(M+Na)^+]$ 1135.6886, found 1135.6890.



Silyl ether 48. To a solution of pentacyclic ether **43** (279.2 mg, 0.250 mmol) in THF (4 mL) at −78 °C was added excess LiDBB (ca. 0.17 M solution in THF) until blue color persisted. After being stirred at −78 °C for 45 min, the reaction mixture was treated with saturated aqueous NH_4Cl. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 10 → 20% EtOAc/hexanes) to give alcohol **S6** (253.6 mg, 99%) as a colorless oil: $[\alpha]_D^{27}$ −6.2 (*c* 0.43, $CHCl_3$); IR (film) 3463, 2932, 2856, 1471, 1379, 1253, 1084, 835, 701 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.81—7.75 (m, 4H), 7.25—7.20 (m, 6H), 4.40 (dd, *J* = 12.0, 5.5 Hz, 1H), 4.04 (s, 1H), 3.96 (ddd, *J* = 12.0, 9.0, 5.0 Hz, 1H), 3.72—3.61 (m, 2H), 3.52—3.42 (m, 2H), 3.37—3.26 (m, 4H), 3.14

(dd, J = 12.0, 3.5 Hz, 1H), 2.88 (d, J = 10.5 Hz, 1H), 2.37 (m, 1H), 2.23 (dd, J = 16.0, 3.0 Hz, 1H), 2.18—2.06 (m, 2H), 1.96—1.66 (m, 13H), 1.60—1.44 (m, 6H), 1.27 (m, 1H), 1.25 (s, 3H), 1.19 (s, 9H), 1.17 (s, 3H), 1.09 (s, 9H), 1.04 (d, J = 7.0 Hz, 3H), 1.02 (s, 9H), 0.93 (s, 3H), 0.19 (s, 3H), 0.17 (s, 3H), 0.12 (s, 3H), 0.09 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 136.0 (× 4), 134.5 (× 2), 129.9, (× 2), 128.0 (× 4), 90.9, 85.9, 84.0, 83.0, 78.2, 78.0, 76.5, 76.0, 73.6, 73.3, 73.1, 71.1, 64.3, 62.6, 49.9, 37.8, 37.0, 35.5, 34.6, 33.1, 30.4, 29.8, 29.5, 29.44, 29.42, 27.2, 27.1 (× 3), 26.8, 26.3 (× 3), 26.2 (× 3), 21.3, 19.4, 18.7, 18.5, 15.7, 12.8, −1.6, −1.8, −4.0, −4.8; HRMS (FAB) calcd for $C_{58}H_{98}O_9Si_3$ [$(M+H)^+$] 1023.6597, found 1023.6580.

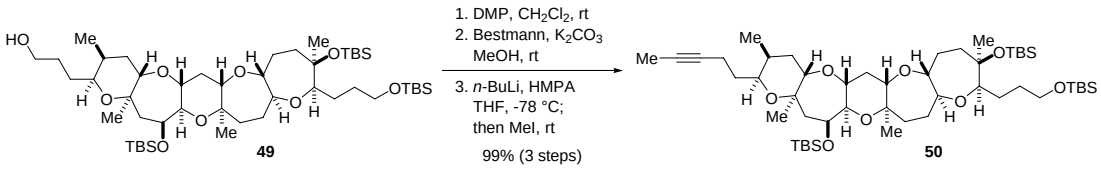
To a solution of the above **S6** in CH_2Cl_2 (5 mL) at 0 °C were added Et_3N (0.10 mL, 0.744 mmol) and TBSOTf (0.085 mL, 0.372 mmol). After being stirred at 0 °C for 30 min, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The resultant mixture was diluted with EtOAc, washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 10 → 20% EtOAc/hexanes) to give silyl ether **48** (277.2 mg, 98%) as a colorless oil: $[\alpha]_D^{27}$ −6.4 (*c* 0.61, $CHCl_3$); IR (film) 2931, 2856, 1472, 1380, 1253, 1087, 835, 773, 701 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 7.81—7.76 (m, 4H), 7.25—7.20 (m, 6H), 4.43 (dd, J = 11.5, 5.5 Hz, 1H), 4.03 (s, 1H), 3.75 (m, 1H), 3.74—3.60 (m, 4H), 3.35—3.27 (m, 4H), 3.14 (dd, J = 12.0, 3.0 Hz, 1H), 2.96 (d, J = 10.5 Hz, 1H), 2.36 (m, 1H), 2.22 (dd, J = 16.0, 3.0 Hz, 1H), 2.18—2.08 (m, 2H), 1.96—1.68 (m, 12H), 1.68—1.46 (m, 6H), 1.26 (m, 1H), 1.24 (s, 3H), 1.18 (s, 9H), 1.17 (s, 3H), 1.09 (s, 9H), 1.04 (m, 3H), 1.03 (s, 9H), 1.01 (s, 9H), 0.99 (s, 3H), 0.19 (s, 3H), 0.16 (s, 3H), 0.14 (s, 3H), 0.12 (s, 3H), 0.093 (s, 3H), 0.086 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 136.0 (× 4), 134.5 (× 2), 129.9, (× 2), 128.0 (× 4), 91.1, 86.0, 84.1, 82.9, 78.2, 78.0, 76.5, 76.0, 73.6, 73.3, 73.1, 71.0, 64.3, 63.6, 49.9, 37.8, 37.1, 35.5, 34.7, 33.1, 30.7, 29.8, 29.6, 29.53, 29.45, 27.6, 27.1 (× 3), 26.8, 26.3 (× 3), 26.22 (× 3), 26.17 (× 3), 21.3, 19.5, 18.8, 18.51, 18.49, 15.7, 12.8, −1.6, −1.8, −4.0, −4.8, −5.1, −5,2; HRMS (FAB) calcd for $C_{64}H_{112}O_9Si_4Na$ [$(M+Na)^+$] 1159.7281, found 1159.7280.



Alcohol 49. To a solution of silyl ether **48** (317.4 mg, 0.279 mmol) in THF (20 mL) was added a stock solution of TBAF/HOAc [0.1 M solution prepared from TBAF (1.0 M solution in THF, 0.50 mL, 0.50 mmol), HOAc (0.030 mL, 0.52 mmol), and THF (4.47 mL), 2.80 mL, 0.28 mmol]. The reaction mixture

was stirred at room temperature for 13 h, at which point ca. 50% of the starting material **48** remained unreacted but a small amount of a material lacking both the TBS and TBDPS groups (**S7**) was observed by TLC analysis. The reaction mixture was treated with water, diluted with EtOAc, washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Separation of **48**, **49**, **S6** and **S7** was performed by flash column chromatography (silica gel, 15% → 70% EtOAc/hexanes then EtOAc). Recycling of the recovered starting material **48** (3 repetitions) provided **49** (195.0 mg, 78%), **S6** (33.9 mg, 12%) and **S7** (17.1 mg, 8%). Data for **49**: $[\alpha]_D^{27}$ −8.3 (*c* 0.59, $CHCl_3$); IR (film) 3434, 2933, 2856, 1472, 1374, 1253, 1086, 835, 773 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 4.43 (dd, *J* = 11.5, 5.5 Hz, 1H), 4.01 (t, *J* = 3.5 Hz, 1H), 3.93 (ddd, *J* = 11.5, 9.0, 4.5 Hz, 1H), 3.71 (m, 1H), 3.63 (m, 1H), 3.52—3.40 (m, 2H), 3.34—3.26 (m, 4H), 3.14 (dd, *J* = 12.0, 4.5 Hz, 1H), 2.96 (d, *J* = 10.0 Hz, 1H), 2.35 (dt, *J* = 11.5, 4.5 Hz, 1H), 2.22 (dd, *J* = 16.0, 3.5 Hz, 1H), 2.18—2.08 (m, 2H), 1.95—1.70 (m, 12H), 1.67—1.56 (m, 2H), 1.53—1.38 (m, 5H), 1.28 (s, 3H), 1.18 (m, 1H), 1.16 (s, 3H), 1.08 (s, 9H), 1.03 (s, 9H), 1.02 (m, 3H), 1.00 (s, 9H), 0.99 (s, 3H), 0.18 (s, 3H), 0.15 (s, 3H), 0.13 (s, 3H), 0.12 (s, 3H), 0.09 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 91.1, 86.0, 84.1, 82.9, 78.5, 78.2, 76.6, 76.0, 73.7, 73.0 (× 2), 72.0, 63.6, 62.7, 49.7, 37.8, 37.1, 35.4, 34.6, 33.6, 30.7, 30.3, 29.6, 29.5, 27.6, 26.8, 26.3 (× 3), 26.20 (× 3), 26.17 (× 3), 23.0, 21.1, 18.8, 18.5, 15.7, 14.3, 12.8, −1.6, −1.8, −4.0, −4.8, −5.1, −5.2; HRMS (FAB) calcd for $C_{48}H_{95}O_9Si_3$ $[(M+H)^+]$ 899.6284, found 899.6254.

Data for **S7**: $[\alpha]_D^{23}$ −6.6 (*c* 1.09, $CHCl_3$); IR (film) 3396, 2931, 2856, 1460, 1376, 1252, 1086, 835, 773 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 4.43 (ddd, *J* = 12.0, 5.5 Hz, 1H), 4.02 (t, *J* = 3.5 Hz, 1H), 3.93 (ddd, *J* = 11.5, 9.0, 4.5 Hz, 1H), 3.52—3.41 (m, 4H), 3.33—3.24 (m, 4H), 3.13 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.88 (d, *J* = 10.5 Hz, 1H), 2.38—2.33 (m, 2H), 2.22 (dd, *J* = 15.5, 3.5 Hz, 1H), 2.18—2.07 (m, 2H), 1.94—1.86 (m, 2H), 1.82—1.68 (m, 9H), 1.58—1.38 (m, 8H), 1.28 (s, 3H), 1.18 (m, 1H), 1.16 (s, 3H), 1.08 (s, 9H), 1.02 (m, 3H), 1.01 (s, 9H), 0.93 (s, 3H), 0.18 (s, 3H), 0.16 (s, 3H), 0.12 (s, 3H), 0.09 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 91.0, 85.9, 84.0, 83.0, 78.5, 78.2, 76.5, 76.0, 73.7, 73.1, 73.0, 72.0, 62.8, 62.7, 49.7, 37.7, 37.0, 35.4, 34.6, 33.6, 30.7, 30.4, 29.5, 29.4, 27.2, 26.8, 26.3 (× 3), 26.2 (× 3), 21.1, 20.9, 18.8, 18.5, 15.7, 12.8, −1.6, −1.8, −4.0, −4.8; HRMS (ESI-TOF) calcd for $C_{42}H_{81}O_9Si_2$ $[(M+H)^+]$ 785.5419, found 785.5373.

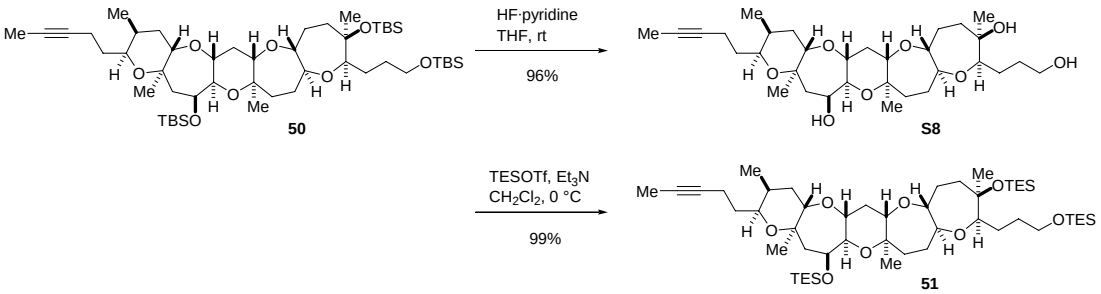


Alkyne 50. To a solution of alcohol **49** (42.7 mg, 0.0475 mmol) in CH_2Cl_2 (2.5 mL) was added Dess-Martin periodinane (30.4 mg, 0.0716 mmol). After being stirred at room temperature for 45 min, the reaction mixture was treated with a 1:1 mixture of saturated aqueous $NaHCO_3$ and saturated aqueous $Na_2S_2O_3$. The resultant mixture was extracted with EtOAc, washed with washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a

pad of silica gel to give crude aldehyde, which was used without further purification.

To a solution of Bestmann reagent (13.8 mg, 0.0716 mmol) in MeOH (0.5 mL) were added K_2CO_3 (14.8 mg, 0.107 mmol) and a solution of the above aldehyde in MeOH (1.0 mL). After being stirred at room temperature for 17 h, the reaction mixture was treated with saturated aqueous $NaHCO_3$, diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% EtOAc/hexanes) gave crude terminal alkyne, which was used in the next reaction without further purification.

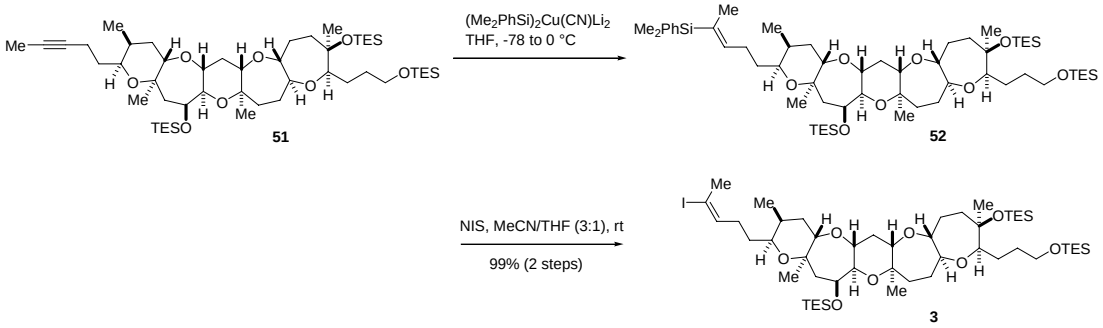
To a solution of the above alkyne in THF/HMPA (10:1, v/v, 2.2 mL) at −78 °C was added *n*-BuLi (1.6 M solution in hexane, 0.11 mL, 0.18 mmol). The resultant mixture was stirred at −78 °C for 0.5 h and then treated with MeI (0.11 mL, 1.79 mmol). The mixture was gradually warmed to room temperature over a period of 1 h and then treated with saturated aqueous NH_4Cl. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 4 → 10% EtOAc/hexanes) gave alkyne **50** (42.8 mg, 99% for the three steps) as a colorless oil: $[\alpha]_D^{25}$ −23.1 (*c* 0.32, $CHCl_3$); IR (film) 2928, 2856, 1472, 1457, 1253, 1085, 835, 772 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 4.42 (ddd, *J* = 12.0, 5.0 Hz, 1H), 4.02 (s, 1H), 3.93 (ddd, *J* = 11.5, 9.0, 5.0 Hz, 1H), 3.70 (m, 1H), 3.63 (m, 1H), 3.56 (m, 1H), 3.34—3.28 (m, 3H), 3.13 (dd, *J* = 12.5, 4.0 Hz, 1H), 2.95 (d, *J* = 9.5 Hz, 1H), 2.34 (dt, *J* = 12.0, 4.0 Hz, 1H), 2.28—2.07 (m, 5H), 1.93—1.70 (m, 11H), 1.70—1.58 (m, 3H), 1.56 (s, 3H), 1.53—1.44 (m, 2H), 1.35 (m, 1H), 1.32 (s, 3H), 1.16 (s, 3H), 1.07 (s, 9H), 1.03 (s, 9H), 1.02—0.98 (m, 15H), 0.18 (s, 3H), 0.15 (s, 3H), 0.13 (s, 3H), 0.12 (s, 3H), 0.09 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 91.1, 86.0, 84.1, 82.9, 79.4, 78.2, 78.1, 76.5, 76.0, 75.4, 73.6, 73.2, 73.1, 70.1, 63.6, 49.8, 37.8, 37.1, 35.46, 35.45, 34.6, 33.1, 32.8, 30.7, 29.6, 29.5, 27.6, 26.8, 26.3 (× 3), 26.20 (× 3), 26.17 (× 3), 21.6, 18.8, 18.5, 16.1, 15.7, 12.9, 3.4, −1.6, −1.8, −4.0, −4.8, −5.1, −5.2; HRMS (ESI-TOF) calcd for $C_{50}H_{94}O_8Si_3Na$ [$(M+Na)^+$] 929.6154, found 929.6149.



Alkyne 51. To a solution of alkyne **50** (42.8 mg, 0.0472 mmol) in THF (2 mL) at 0 °C was added HF·pyridine (1 mL). After being stirred at room temperature for 1 h, the reaction mixture was poured into an ice-cooled saturated aqueous $NaHCO_3$. The aqueous layer was extracted with $CHCl_3$. The combined organic layers were dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% MeOH/$CHCl_3$) gave triol

S8 (25.6 mg, 96%): $[\alpha]_D^{25}$ −31.8 (*c* 0.84, $CHCl_3$); IR (film) 3420, 2937, 2878, 1458, 1381, 1080, 1009, 753 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 4.10 (m, 1H), 4.06 (dd, *J* = 11.5, 4.5 Hz, 1H), 3.77 (ddd, *J* = 11.5, 9.5, 5.5 Hz, 1H), 3.60—3.52 (m, 3H), 3.46 (dd, *J* = 9.0, 2.0 Hz, 1H), 3.29 (m, 1H), 3.23 (t, *J* = 8.5 Hz, 1H), 2.97 (dd, *J* = 12.0, 3.5 Hz, 1H), 2.91 (d, *J* = 10.0 Hz, 1H), 2.86 (br, 1H), 2.37—2.17 (m, 5H), 2.13 (m, 1H), 2.02—1.95 (m, 2H), 1.88—1.66 (m, 11H), 1.60 (m, 1H), 1.59 (m, 3H), 1.57—1.45 (m, 4H), 1.36 (m, 1H), 1.26 (s, 3H), 1.12 (s, 3H), 0.95 (s, 3H), 0.93 (d, *J* = 7.5 Hz, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 90.0, 86.0, 84.0, 82.3, 79.5, 77.2, 76.6, 76.4, 75.5, 75.2, 74.5, 73.6, 69.92, 69.87, 62.7, 47.9, 37.87 37.4, 35.3, 34.4, 33.2, 32.7, 30.2, 29.6, 29.5, 26.6, 25.8, 19.5, 16.1, 15.8, 12.8, 3.4; HRMS (ESI-TOF) calcd for $C_{32}H_{53}O_8$ $[(M+H)^+]$ 565.3740, found 565.3740.

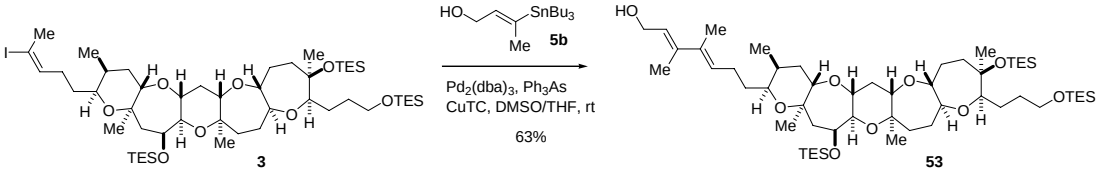
To a solution of the above **S8** (25.6 mg, 0.0453 mmol) in CH_2Cl_2 (3 mL) at 0 °C were added Et_3N (0.126 mL, 0.906 mmol) and TESOTf (0.102 mL, 0.453 mmol). After being stirred at 0 °C for 3 h, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 8% EtOAc/hexanes) gave tris-TES ether **51** (40.8 mg, 99%) as a colorless oil: $[\alpha]_D^{25}$ −18.4 (*c* 0.27, $CHCl_3$); IR (film) 2951, 2875, 1457, 1379, 1238, 1085, 1006, 741 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 4.48 (dd, *J* = 12.0, 5.0 Hz, 1H), 4.04 (s, 1H), 3.95 (ddd, *J* = 12.0, 9.5, 4.5 Hz, 1H), 3.72 (m, 1H), 3.65 (m, 1H), 3.57 (brd, *J* = 9.0 Hz, 1H), 3.36—3.26 (m, 3H), 3.16 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.98 (d, *J* = 9.5 Hz, 1H), 2.35 (m, 1H), 2.29—2.13 (m, 4H), 2.08 (m, 1H), 1.98—1.60 (m, 14H), 1.56 (s, 3H), 1.54—1.45 (m, 2H), 1.37 (m, 1H), 1.32 (s, 3H), 1.17 (s, 3H), 1.09 (t, *J* = 8.0 Hz, 9H), 1.05 (t, *J* = 8.0 Hz, 9H), 1.02 (t, *J* = 8.5 Hz, 9H), 1.00—0.96 (m, 6H), 0.70 (qd, *J* = 8.0, 3.5 Hz, 6H), 0.63 (qd, *J* = 8.0, 3.0 Hz, 12H); ^{13}C NMR (125 MHz, C_6D_6) δ 90.6, 86.2, 84.4, 82.7, 79.4, 78.12, 78.10, 76.6, 76.1, 75.5, 73.6, 73.1, 72.9, 70.1, 63.4, 49.9, 37.8, 37.3, 35.4, 34.7, 33.2, 32.8, 30.7, 29.8, 29.7, 27.3, 26.9, 21.1, 16.1, 15.9, 12.8, 7.5 (× 3), 7.4 (× 3), 7.3 (× 3), 7.1 (× 3), 5.3 (× 3), 4.9 (× 3), 3.4; HRMS (FAB) calcd for $C_{50}H_{94}O_8Si_3Na$ $[(M+Na)^+]$ 929.6154, found 929.6153.



(*E*)-Vinyl iodide 3. To a suspension of CuCN (60.9 mg, 0.68 mmol) in THF (1.0 mL) at 0 °C was added $Me_2PhSiLi$ (ca. 1.36 M solution in THF, 1.0 mL, 1.36 mmol). After being stirred at 0 °C for 20 min, the reaction mixture was cooled to −78 °C. To the mixture was added a cold solution of alkyne **51** (54.8 mg, 0.0604 mmol) in THF (0.8 mL + 0.5 mL rinse). The resultant mixture was stirred at −78 °C for 2 h and

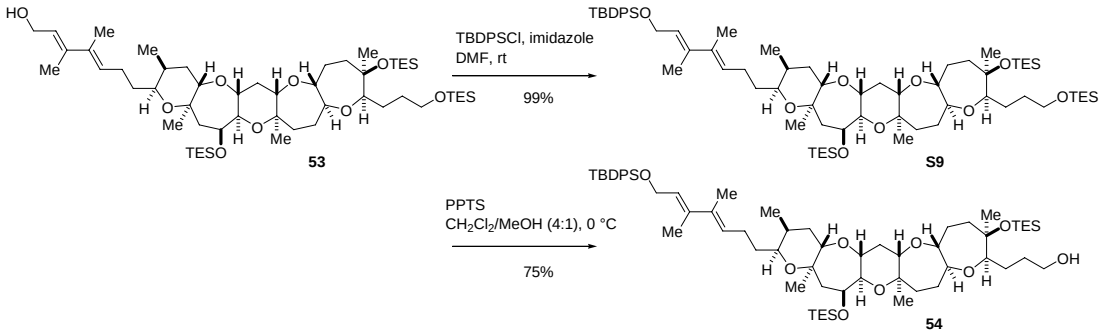
then at 0 °C for 1 h before it was treated with a 9:1 mixture of saturated aqueous NH_4Cl and 28% NH_4OH. The residual precipitate was filtered off, and the filtrate was diluted with EtOAc, washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 2 → 8% ether/hexanes) gave vinylsilane **52** (79.0 mg), which was contaminated with a silane byproduct(s) and used in the next reaction without further purification. ^{1}H NMR spectrum of the crude product indicated that the regioselectivity of the reaction was ca. 9:1.

To a solution of the above vinylsilane **52** in MeCN/THF (3:1, v/v, 4 mL) at 0 °C was added NIS (135.0 mg, 0.60 mmol). After being stirred at room temperature for 5 h, the reaction mixture was cooled to 0 °C and treated with saturated aqueous Na_2SO_3. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 10% EtOAc/hexanes) gave (*E*)-vinyl iodide **3** (62.0 mg, 99% over the two steps) as a colorless oil. ^{1}H NMR analysis indicated that the material was a 6:1 mixture of alkene stereoisomers. **3**: $[\alpha]_D^{24}$ −16.6 (*c* 0.36, benzene); IR (film) 2951, 2875, 1457, 1376, 1238, 1087, 1006, 741 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 6.13 (t, *J* = 7.0 Hz, 1H), 4.43 (dd, *J* = 11.5, 5.5 Hz, 1H), 4.06 (s, 1H), 3.96 (m, 1H), 3.74 (m, 1H), 3.66 (m, 1H), 3.36—3.28 (m, 3H), 3.17 (dd, *J* = 12.5, 4.0 Hz, 1H), 2.99 (d, *J* = 9.5 Hz, 1H), 2.38 (dt, *J* = 12.5, 4.0 Hz, 1H), 2.26—2.14 (m, 5H), 2.10 (m, 1H), 2.00—1.62 (m, 16H), 1.55—1.47 (m, 2H), 1.40—1.32 (m, 2H), 1.23 (s, 3H), 1.20 (s, 3H), 1.11 (t, *J* = 8.0 Hz, 9H), 1.06 (t, *J* = 8.5 Hz, 9H), 1.04 (t, *J* = 8.0 Hz, 9H), 1.00 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.71 (qd, *J* = 8.0, 4.0 Hz, 6H), 0.64 (qd, *J* = 8.0, 3.5 Hz, 12H); ^{13}C NMR (125 MHz, C_6D_6) δ 141.6, 93.7, 90.7, 86.2, 84.4, 82.7, 78.09, 78.07, 76.6, 76.1, 73.6, 73.0, 72.8, 70.5, 63.4, 49.9, 37.8, 37.3, 35.3, 34.7, 33.3, 32.2, 30.7, 29.8, 29.7, 27.8, 27.4, 27.3, 26.9, 21.0, 15.9, 12.8, 7.5 (× 3), 7.4 (× 3), 7.3 (× 3), 7.1 (× 3), 5.4 (× 3), 4.9 (× 3); HRMS (ESI-TOF) calcd for $C_{50}H_{95}IO_8Si_3Na$ [$(M+Na)^+$] 1057.5277, found 1057.5278.



(*E,E*)-Diene 53. To a solution of (*E*)-vinyl iodide **3** (62.0 mg, 0.060 mmol) and (*E*)-vinyl stannane **5b** (108.2 mg, 0.300 mmol) in THF/DMSO (1:1, v/v, 6.0 mL) were added $Pd_2(dba)_3$ (5.5 mg, 0.006 mmol), Ph_3As (14.7 mg, 0.048 mmol), and CuTC (144.2 mg, 0.76 mmol). The resultant mixture was stirred at room temperature for 2 h before the reaction was quenched with water (3.0 mL). The resultant mixture was stirred for another 20 min and then filtered through a short pad of Celite. The filtrate was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 0 → 15% EtOAc/hexanes) to give (*E,E*)-diene **53** (37.0 mg, 0.038 mmol, 63%) as a colorless oil: $[\alpha]_D^{20}$ −17.5 (*c* 1.00, benzene); IR (film) 3447, 2952, 2875, 2362, 2342, 1457, 1375, 1238, 1086, 1005, 742 cm^{-1}; ^{1}H

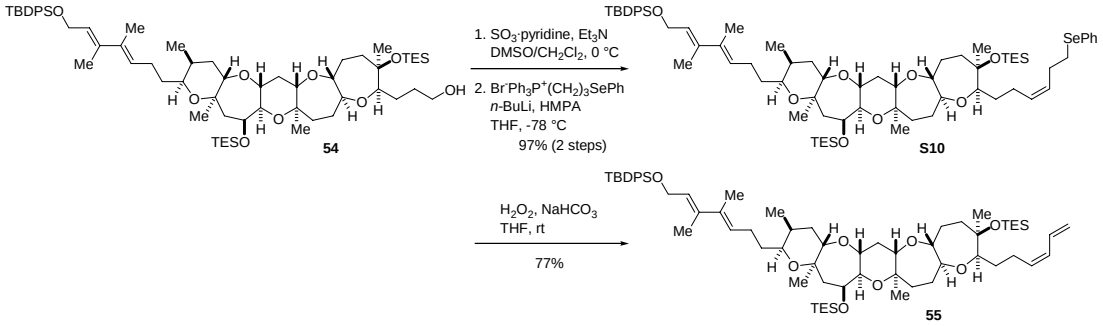
NMR (500 MHz, C_6D_6) δ 5.69 (t, *J* = 6.0 Hz, 1H), 5.63 (t, *J* = 7.5 Hz, 1H), 4.52 (dd, 12.5, 12.0 Hz, 1H), 4.10—4.05 (m, 3H), 3.98 (ddd, *J* = 12.0, 9.5, 4.5 Hz, 1H), 3.73 (ddd, *J* = 10.0, 6.0, 5.5 Hz, 1H), 3.66 (ddd, *J* = 10.0, 6.5, 6.5 Hz, 1H), 3.41 (m, 1H), 3.36—3.24 (m, 3H), 3.18 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.99 (d, *J* = 9.5 Hz, 1H), 2.38 (m, 1H), 2.32—2.23 (m, 2H), 2.22—2.06 (m, 3H), 2.00—1.56 (m, 14H), 1.80 (s, 3H), 1.68 (s, 3H), 1.56—1.47 (m, 2H), 1.35—1.20 (m, 3H), 1.31 (s, 3H), 1.20 (s, 3H), 1.11 (t, *J* = 8.0 Hz, 9H), 1.15 (q, *J* = 8.0 Hz, 18H), 1.05 (m, 3H), 1.00 (s, 3H), 0.72 (qd, *J* = 8.0, 4.0 Hz, 6H), 0.64 (qd, *J* = 8.0, 4.0 Hz, 12H); ^{13}C NMR (125 MHz, C_6D_6) δ 138.1, 136.0, 127.5, 125.5, 90.7, 86.2, 84.4, 82.7, 78.11, 78.08, 76.6, 76.1, 73.6, 73.1, 72.9, 71.1, 63.4, 60.0, 50.0, 37.8, 37.3, 35.5, 34.7, 33.4 (× 2), 30.7, 29.8, 29.7, 27.3, 26.9, 25.9, 21.1, 15.9, 14.2, 14.1, 12.8, 7.5 (× 3), 7.4 (× 6), 7.1 (× 3), 5.4 (× 3), 4.9 (× 3); HRMS (ESI-TOF) calcd for $C_{54}H_{102}O_9Si_3Na$ [$(M+Na)^+$] 1001.6729, found 1001.6726.



Alcohol 54. To a solution of diene **53** (15.5 mg, 0.0158 mmol) in DMF (0.75 mL) at 0 °C were added imidazole (10.7 mg, 0.157 mmol) and TBDPSCl (0.020 mL, 0.079 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was quenched with saturated aqueous $NaHCO_3$ and diluted with diethyl ether. The organic layer was separated and washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 10% EtOAc/hexanes) gave TBDPS ether **S9** (19.0 mg, 99%) as a colorless oil: $[\alpha]_D^{25}$ −12.2 (*c* 1.60, benzene); IR (film) 2952, 2875, 1458, 1378, 1238, 1087, 1006, 740, 701 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 7.86—7.82 (m, 4H), 7.24—7.21 (m, 6H), 5.94 (t, *J* = 6.0 Hz, 1H), 5.59 (t, *J* = 7.5 Hz, 1H), 4.54—4.47 (m, 3H), 4.07 (t, *J* = 3.5 Hz, 1H), 3.98 (ddd, *J* = 11.5, 9.5, 4.5 Hz, 1H), 3.73 (m, 1H), 3.66 (ddd, *J* = 10.0, 6.5, 6.0 Hz, 1H), 3.39 (m, 1H), 3.36—3.28 (m, 3H), 3.18 (dd, *J* = 12.0, 3.5 Hz, 1H), 2.99 (d, *J* = 9.5 Hz, 1H), 2.38 (m, 1H), 2.30—2,06 (m, 5H), 1,98—1.47 (m, 16H), 1.81 (s, 3H), 1.55 (s, 3H), 1.30 (s, 3H), 1.22 (m, 1H), 1.19 (s, 12H), 1.12 (t, *J* = 8.0 Hz, 9H), 1.06 (t, *J* = 8.0 Hz, 9H), 1.04 (t, *J* = 8.0 Hz, 9H), 1.04 (m, 3H), 1.00 (s, 3H), 0.72 (qd, *J* = 8.0, 3.5 Hz, 6H), 0.64 (qd, *J* = 8.0, 4.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 137.4, 136.0 (× 5), 134.4 (× 2), 129.9 (× 2), 128.0 (× 4), 127.3, 125.4, 90.7, 86.2, 84.4, 82.7, 78.10, 78.09, 76.6, 76.1, 73.6, 73.2, 72.9, 71.1, 63.4, 62.3, 50.0, 37.8, 37.3, 35.5, 34.7, 33.4, 30.7, 29.8, 29.7, 27.3, 27.1 (× 3), 26.9, 26.7, 25.9, 21.1, 19.4, 15.9, 14.3, 14.1, 12.8, 7.5 (× 3), 7.4 (× 6), 7.1 (× 3), 5.4 (× 3), 4.9 (× 3); HRMS (ESI-TOF) calcd for $C_{70}H_{120}O_9Si_4Na$ [$(M+Na)^+$] 1239.7907, found1239.7909.

To a solution of TBDPS ether **S9** (19.0 mg, 0.0156 mmol) in CH_2Cl_2/MeOH (4:1, v/v, 1 mL) at

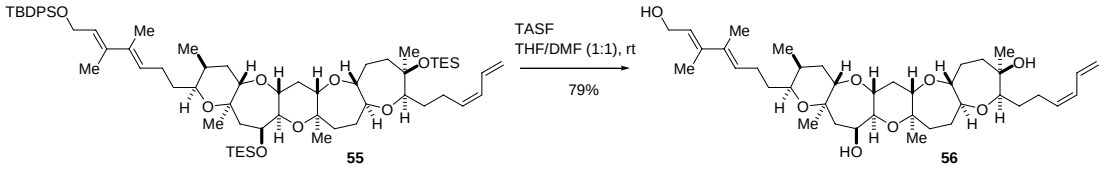
0 °C was added PPTS (1.2 mg, 0.0048 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was quenched with Et_3N and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 30% EtOAc/hexanes) gave alcohol **54** (13.0 mg, 75%) as a colorless oil: $[\alpha]_D^{24}$ −14.4 (*c* 1.30, benzene); IR (film) 3372, 2950, 2874, 1459, 1428, 1378, 1084, 1007, 740, 702 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.85—7.81 (m, 4H), 7.24—7.21 (m, 6H), 5.94 (t, *J* = 6.0 Hz, 1H), 5.59 (t, *J* = 7.5 Hz, 1H), 4.54—4.46 (m, 3H), 4.07 (t, *J* = 3.5 Hz, 1H), 3.98 (ddd, *J* = 11.5, 9.5, 4.5 Hz, 1H), 3.53—3.42 (m, 2H), 3.39 (ddd, *J* = 8.0, 3.0, 2.5 Hz, 1H), 3.34 (d, *J* = 9.5 Hz, 1H), 3.30 (m, 2H), 3.17 (dd, *J* = 12.5, 4.0 Hz, 1H), 2.89 (d, *J* = 9.5 Hz, 1H), 2.38 (m, 1H), 2.30—2,21 (m, 2H), 2.21—2.05 (m, 3H), 1,98—1.66 (m, 11H), 1.81 (s, 3H), 1.64—1.44 (m, 5H), 1.55 (s, 3H), 1.32 (m, 1H), 1.30 (s, 3H), 1.22 (m, 1H), 1.19 (s, 12H), 1.12 (t, *J* = 8.0 Hz, 9H), 1.10 (q, *J* = 8.0 Hz, 9H), 1.04 (m, 3H), 0.94 (s, 3H), 0.72 (qd, *J* = 8.0, 3.5 Hz, 6H), 0.62 (q, *J* = 8.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 137.4, 136.0 (× 5), 134.4 (× 2), 129.9 (× 2), 128.0 (× 4), 127.3, 125.4, 90.6, 86.1, 84.2, 82.8, 78.1, 78.0, 76.5, 76.1, 73.6, 73.2, 72.9, 71.1, 62.8, 62.3, 50.0, 37.8, 37.2, 35.5, 34.7, 33.4, 30.3, 29.7, 29.6, 27.09, 27.06 (× 3), 26.93, 26.88, 25.9, 21.1, 19.4, 15.8, 14.2, 14.1, 12.8, 7.5 (× 3), 7.4 (× 3), 7.3 (× 3), 5.4 (× 3); HRMS (ESI-TOF) calcd for $C_{64}H_{106}O_9Si_3Na$ [$(M+Na)^+$] 1125.7042, found 1125.7053.



(*Z*)-Diene 55. To a solution of alcohol **54** (10.4 mg, 0.0094 mmol) in CH_2Cl_2/DMSO (3:1, v/v, 0.8 mL) at 0 °C were added Et_3N (0.010 mL, 0.075 mmol) and SO_3·pyridine (9.0 mg, 0.056 mmol). After being stirred at 0 °C for 5 h, the reaction mixture was diluted with ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a pad of silica gel to give crude aldehyde, which was used in the next reaction without further purification.

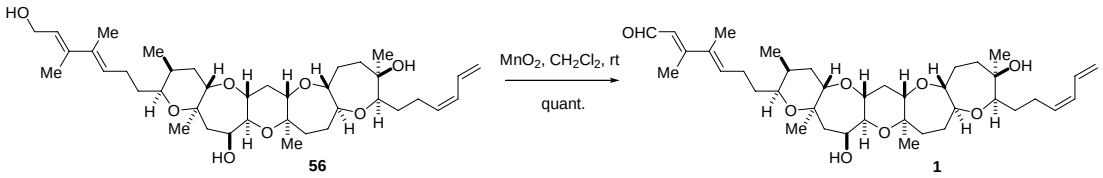
To a solution of $Br^-Ph_3P^+(CH_2)_3SePh$ **4** (25.4 mg, 0.047 mmol) in THF (1.5 mL) at −78 °C was added *n*-BuLi (1.52 M solution in hexane, 0.025 mL, 0.038 mmol). After being stirred at −78 °C for 0.5 h, HMPA (0.008 mL, 0.05 mmol) followed by a solution of the above aldehyde in THF (0.5 mL + 0.5 mL rinse) were added to the reaction mixture. The resultant mixture was allowed to warm to room temperature over a period of 30 min and then treated with water. The aqueous layer was separated and extracted with ether. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 20% EtOAc/hexanes) gave *cis*-olefin **S10** (11.7 mg, 97% for the two steps) as a colorless oil.

To a solution of **S10** (11.7 mg, 0.0091 mmol) in THF (0.6 mL) were added $NaHCO_3$ (15.2 mg, 0.182 mmol) and 30% H_2O_2 (0.2 mL). After being stirred at room temperature for 9 h, the reaction mixture was diluted with ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 20% EtOAc/hexanes) gave (*Z*)-diene **55** (7.9 mg, 77%) as a colorless oil: $[\alpha]_D^{25}$ −3.3 (*c* 0.74, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.85—7.80 (m, 4H), 7.24—7.20 (m, 6H), 6.79 (dt, *J* = 17.0, 10.5 Hz, 1H), 6.10 (t, *J* = 11.0 Hz, 1H), 5.95 (t, *J* = 6.0 Hz, 1H), 5.59 (t, *J* = 7.5 Hz, 1H), 5.44 (m, 1H), 5.16 (d, *J* = 17.0 Hz, 1H), 5.06 (d, *J* = 10.0 Hz, 1H), 4.55—4.46 (m, 3H), 4.09 (t, *J* = 3.0 Hz, 1H), 3.99 (ddd, *J* = 12.0, 9.0, 5.0 Hz, 1H), 3.39 (m, 1H), 3.36—3.24 (m, 3H), 3.19 (dd, *J* = 12.0, 4.5 Hz, 1H), 2.94 (d, *J* = 10.0 Hz, 1H), 2.46—2,08 (m, 8H), 2.04 (m, 1H), 1.96—1.74 (m, 9H), 1.81 (s, 3H), 1.68 (m, 1H), 1.55 (s, 3H), 1.52—1.42 (m, 4H), 1.30 (s, 3H), 1.21 (s, 3H), 1.20 (s, 9H), 1.12 (t, *J* = 8.0 Hz, 9H), 1.06—1.00 (m, 12H), 0.92 (s, 3H), 0.73 (qd, *J* = 8.0, 4.0 Hz, 6H), 0.61 (q, *J* = 8.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 136.0 (× 4), 134.4 (× 2), 133.3, 132.7, 130.1, 129.9 (× 2), 128.1 (× 4), 127.3, 125.4, 117.2, 113.7, 110.1, 89.1, 86.1, 84.5, 82.6, 78.1, 78.0, 76.6, 76.1, 73.6, 73.2, 72.9, 71.1, 62.3, 50.0, 37.9, 37.3, 35.5, 34.8, 33.4 (× 2), 30.6, 29.9, 29.8, 27.1 (× 3), 26.7, 25.9, 24.9, 21.1, 19.4, 16.1, 14.3, 14.1, 12.8, 7.5 (× 3), 7.4 (× 3), 7.3 (× 3), 5.4 (× 3); HRMS (FAB) calcd for $C_{67}H_{108}O_8Si_3Na[(M+Na)^+]$ 1147.7250, found 1147.7247.



Allyl alcohol 56. To a solution of diene **55** (11.8 mg, 0.0105 mmol) in THF/DMF (1:1, v/v, 1 mL) at 0 °C was added TASF (57.9 mg, 0.21 mmol). The resultant mixture was stirred at room temperature. Additional portions of TASF (50 mg × 3, 0.18 mmol × 3) were added to the reaction mixture over a period of 22 h. After completion of the reaction, the resultant mixture was diluted with ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 20 → 60% EtOAc/hexanes) gave allylic alcohol **56** (5.5 mg, 79%) as a colorless oil: $[\alpha]_D^{24}$ −25.1 (*c* 0.44, benzene); IR (film) 2950, 2874, 1458, 1428, 1376, 1237, 1085, 1006, 737 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 6.77 (dt, *J* = 17.0, 10.5 Hz, 1H), 6.08 (t, *J* = 10.5 Hz, 1H), 5.71 (t, *J* = 6.5 Hz, 1H), 5.65 (t, *J* = 7.0 Hz, 1H), 5.45 (dt, *J* = 10.5, 8.0 Hz, 1H), 5.16 (d, *J* = 17.0 Hz, 1H), 5.06 (d, *J* = 10.5 Hz, 1H), 4.14—4.05 (m, 3H), 4.04 (dd, *J* = 11.5, 5.5 Hz, 1H), 3.75 (ddd, *J* = 11.5, 9.5, 5.5 Hz, 1H), 3.46 (dd, *J* = 9.5, 2.5 Hz, 1H), 3.40 (m, 1H), 3.25—3.18 (m, 2H), 2.95—2.88 (m, 2H), 2.51 (br, 1H), 2.40—2.23 (m, 7H), 2.22—2.08 (m, 2H), 1.96—1.58 (m, 10H), 1.82 (s, 3H), 1.71 (s, 3H), 1.56—1.44 (m, 4H), 1.44—1.20 (m, 2H), 1.23 (s, 3H), 1.12 (s, 3H), 0.99 (d, *J* = 7.5 Hz, 3H), 0.87 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 138.1, 136.1, 132.9, 132.6, 130.2, 127.5, 125.6, 117.3, 88.5, 85.7, 83.9, 82.1, 77.1, 76.64, 76.58, 75.0, 74.3, 73.6, 70.8, 69.9, 60.2, 47.9, 37.5, 37.4, 35.3, 34.4, 33.4, 33.3, 29.9, 29.6, 29.4, 25.9, 25.6, 24.8, 19.3, 15.8, 14.19, 14.15, 12.8; HRMS

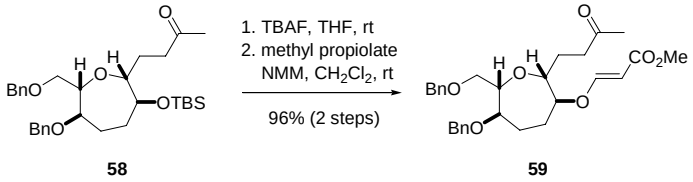
(ESI-TOF) calcd for $C_{39}H_{62}O_8Na$ [$(M+Na)^+$] 681.4342, found 681.4341.



Proposed structure of brevenal (1). To a solution of allylic alcohol **56** (0.8 mg, 0.0012 mmol) in CH_2Cl_2 (0.2 mL) was added MnO_2 (5.8 mg, 0.089 mmol). After being stirred at room temperature for 35 min, the reaction mixture was directly subjected to silica gel column chromatography (30 → 90% EtOAc/hexanes) to give proposed structure of brevenal (**1**) (0.8 mg, quantitative) as a colorless oil: $[\alpha]_D^{20}$ −21.6 (*c* 0.50, benzene); IR (film) 3468, 2935, 2359, 2341, 1654, 1457, 1380, 1083, 1002, 903, 753 cm^{-1}; ^1H NMR (600 MHz, C_6D_6) δ 10.09 (d, *J* = 7.8 Hz, 1H), 6.78 (ddd, *J* = 16.8, 10.8, 10.8 Hz, 1H), 6.15 (d, *J* = 7.8 Hz, 1H), 6.10 (t, *J* = 10.8 Hz, 1H), 5.81 (t, *J* = 7.2 Hz, 1H), 5.39 (ddd, *J* = 10.2, 8.1, 8.1 Hz, 1H), 5.18 (d, *J* = 16.8 Hz, 1H), 5.08 (d, *J* = 10.2 Hz, 1H), 4.10 (m, 1H), 4.04 (dd, *J* = 11.1, 5.7 Hz, 1H), 3.75 (ddd, *J* = 11.4, 9.6, 5.4 Hz, 1H), 3.47 (dd, *J* = 9.0, 2.4 Hz, 1H), 3.27 (m, 1H), 3.25—3.20 (m, 2H), 2.94—2.89 (m, 2H), 2.44 (s, 1H, OH), 2.38—2.21 (m, 6H), 2.18—2.09 (m, 2H), 2.01 (m, 1H), 1.93 (m, 1H), 1.86 (q, *J* = 12.0, 1H), 1.78 (s, 3H), 1.80—1.64 (m, 7H), 1.55 (s, 3H), 1.54—1.46 (m, 3H), 1.45 (m, 1H), 1.40 (m, 1H), 1.19 (s, 3H), 1.16 (s, 1H), 1.14 (s, 3H), 1.08 (m, 1H), 0.96 (d, *J* = 7.2 Hz, 3H), 0.87 (s, 3H); ^{13}C NMR (150 MHz, C_6D_6) δ 190.7, 156.1, 135.8, 134.6, 132.9, 132.6, 130.2, 126.0, 117.3, 88.5, 85.6, 83.9, 82.1, 77.2, 76.7, 76.4, 75.0, 74.3, 73.6, 70.7, 69.9, 47.8, 37.5, 37.4, 35.2, 34.4, 33.4, 32.6, 29.9, 29.6, 29.4, 26.4, 25.7, 24.8, 19.3, 15.8, 13.8, 13.7, 12.8; HRMS (FAB) calcd for $C_{39}H_{61}O_8$ [$(M+H)^+$] 657.4366, found 657.4368.

Ketone 58. To a solution of olefin **25** (209.8 mg, 0.4114 mmol) in DMA/H_2O (7:1, v/v, 4.8 mL) were added $Cu(OAc)_2$ (149 mg, 0.8203 mmol) and $PdCl_2$ (14.6 mg, 0.0823 mmol). The reaction mixture was stirred at room temperature under an atmosphere of oxygen for 1.5 days. The resultant mixture was diluted with diethyl ether and filtered through a pad of Celite. The filtrate was washed with H_2O and brine, dried over Na_2SO_4, filitered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 15 → 30% diethyl ether/hexanes) gave ketone **58** (199.0 mg, 92%) as a colorless clear oil: $[\alpha]_D^{28}$ = −0.6 (*c* 0.64, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.34—7.20 (m, 10H), 4.54 (d, *J* = 11.9 Hz, 1H), 4.52 (d, *J* = 11.9 Hz, 1H), 4.47 (d, *J* = 11.9 Hz, 1H), 4.28 (d, *J* = 11.9 Hz, 1H), 3.56—3.50 (m, 2H), 3.50—3.40 (m, 3H), 3.14 (m, 1H), 2.67 (m, 1H), 2.48 (m, 1H), 2.06—1.86 (m, 5H), 1.86—1.67 (m, 3H), 1.52 (m, 1H), 0.85 (s, 9H), 0.03 (s, 3H), −0.02 (s, 3H);

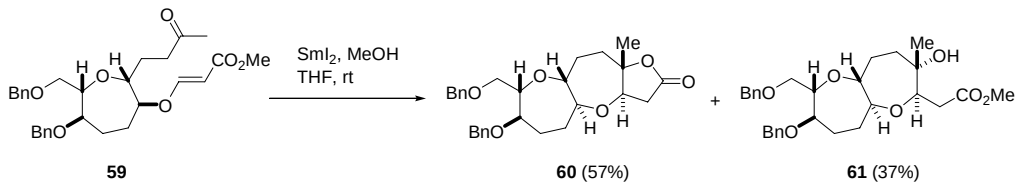
HRMS (ESI) calcd for $C_{31}H_{46}O_5SiNa$ [$(M + Na)^+$] 549.3012, found 549.3011.



58 **59**

β-Alkoxyacrylate 59. To a solution of ketone **58** (189 mg, 0.3593 mmol) in THF (4 mL) at 0 °C was added TBAF (1.0 M solution in THF, 1.00 mL, 1.00 mmol). After being stirred at room temperature for 2.5 h, the resultant mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 50% EtOAc/hexanes) gave alcohol (142.5 mg), which was used in the next reaction without further purification.

To a solution of the above material (142.5 mg) in CH_2Cl_2 (5 mL) were added NMM (0.060 mL, 0.546 mmol) and methyl propiolate (0.096 mL, 1.08 mmol). After being stirred at room temperature overnight, the reaction mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 20 → 40% EtOAc/hexanes) gave β-alkoxyacrylate **59** (178.3 mg, 96% for the two steps) as a pale yellow oil: $[\alpha]_D^{28}$ = +3.8 (*c* 0.22, $CHCl_3$); ^{1}H NMR (400 MHz, C_6D_6) δ 7.56 (dd, *J* = 12.8, 2.7 Hz, 1H), 7.32—7.05 (m, 10H), 5.50 (dd, *J* = 12.8, 2.7 Hz, 1H), 4.34—4.23 (m, 3H), 4.05 (d, J = 11.9 Hz, 1H), 3.54 (m, 1H), 3.50—3.19 (m, 8H), 2.38 (m, 1H), 2.17 (m, 1H), 1.89 (m, 1H), 1.75—1.48 (m, 6H), 1.48—1.32 (m, 2H); HRMS (ESI) calcd for $C_{29}H_{36}O_7Na$ [$(M + Na)^+$] 519.2359, found 519.2357.

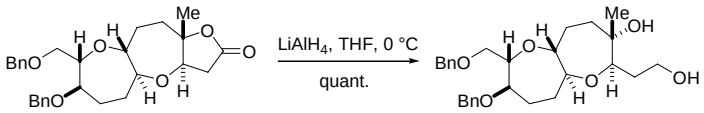


59 **60** (57%) **61** (37%)

Lactone 60 and hydroxy ester 61. To a solution of β-alkoxyacrylate **59** (646.9 mg, 1.3042 mmol) in THF (13 mL) were added MeOH (0.160 mL, 3.95 mmol) and SmI_2 (0.1 M solution in THF, 39.0 mL, 3.90 mmol). After being stirred at room temperature for 0.5 h, the reaction mixture was treated with a 1:1 mixture of saturated aqueous $NaHCO_3$ and saturated aqueous Na_2SO_3. The resultant mixture was extracted with EtOAc, and the organic layer was washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 30 → 50% EtOAc/hexanes) gave lactone **60** (348.1 mg, 57%) along with hydroxy ester **61** (242.1 mg, 37%). Data for **60**: $[\alpha]_D^{30}$ = −11.7 (*c* 1.28, $CHCl_3$); ^{1}H NMR (400 MHz, C_6D_6) δ 7.29—7.07 (m, 10H), 4.38 (s, 2H), 4.29 (d, *J* = 11.9 Hz, 1H), 4.06 (d, *J* = 11.9 Hz, 1H), 3.70 (dd, *J* = 11.0, 5.5 Hz, 1H), 3.47—3.34 (m, 4H), 3.24 (apparent t, *J* = 9.2 Hz, 1H), 2.94 (ddd, *J* = 9.2, 9.2, 2.7 Hz, 1H), 2.36—2.23 (m, 2H), 1.99 (m, 1H), 1.89 (m, 1H), 1.89—1.61 (m, 4H), 1.61—1.46 (m, 2H), 0.94 (s, 3H); ^{13}C NMR (100 MHz, C_6D_6) δ 171.2, 139.04, 138.96, 128.6 (× 2), 128.5 (× 2), 128.2 (× 2), 128.1 (× 2), 127.8 (× 2),

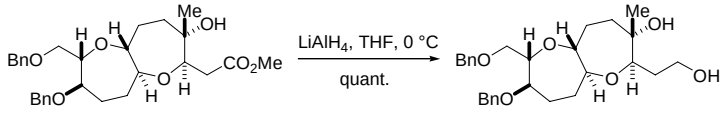
86.6, 85.8, 84.6, 84.1, 78.4, 77.2, 73.3, 72.2, 70.8, 34.5, 33.4, 32.0, 27.9, 24.5, 23.8; HRMS (ESI) calcd for $C_{28}H_{34}O_6Na$ [$(M + Na)^+$] 489.2253, found 489.2253.

Data for **61**: $[\alpha]_D^{30} = -3.3$ (*c* 1.55, $CHCl_3$); ^1H NMR (400 MHz, C_6D_6) δ 7.26—7.07 (m, 10H), 4.38—4.25 (m, 3H), 4.17 (d, *J* = 11.9 Hz, 1H), 4.06 (dd, *J* = 10.1, 2.7 Hz, 1H), 4.01 (ddd, *J* = 6.4, 6.4, 2.7 Hz, 1H), 3.68 (m, 1H), 3.63 (ddd, *J* = 11.0, 10.1, 4.6 Hz, 1H), 3.54 (ddd, *J* = 9.2, 9.2, 4.6 Hz, 1H), 3.44 (dd, *J* = 10.1, 5.5 Hz, 1H), 3.39 (s, 3H), 3.27 (dd, *J* = 10.1, 6.4 Hz, 1H), 2.60 (dd, *J* = 15.6, 2.7 Hz, 1H), 2.51 (dd, *J* = 15.6, 10.1 Hz, 1H), 2.16—1.92 (m, 3H), 1.86—1.75 (m, 2H), 1.60—1.44 (m, 3H), 1.16 (br, 1H), 0.88 (s, 3H); ^{13}C NMR (100 MHz, C_6D_6) δ 172.8, 139.1, 139.0, 128.54, 128.48, 128.35, 128.12, 128.07, 127.89, 127.85, 127.82, 127.7, 127.6, 87.9, 84.5, 83.8, 82.7, 78.9, 73.8, 73.3, 71.9, 70.6, 51.1, 38.7, 36.6, 29.4, 28.1, 23.9, 23.2; HRMS (ESI) calcd for $C_{29}H_{38}O_7Na$ [$(M + Na)^+$] 521.2515, found 521.2502.



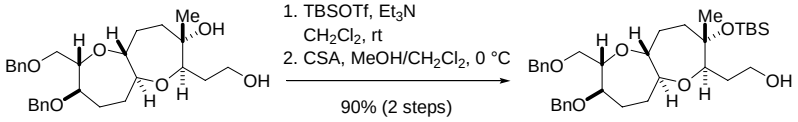
60 **62**

Diol 62 (from lactone 60). To a solution of lactone **60** (304.6 mg, 0.6536 mmol) in THF (10 mL) at 0 °C was added $LiAlH_4$ (37 mg, 0.98 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was sequentially treated with 3 M aqueous NaOH and H_2O with vigorous stirring. The insoluble materials were filtered off, and the filtrate was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5% MeOH/$CHCl_3$) gave diol **62** (308.7 mg, quantitative) as a colorless oil: $[\alpha]_D^{29} = -3.4$ (*c* 0.23, $CHCl_3$); ^1H NMR (400 MHz, C_6D_6) δ 7.26—7.07 (m, 10H), 4.37—4.26 (m, 3H), 4.18 (d, *J* = 11.9 Hz, 1H), 3.99 (ddd, *J* = 5.5, 5.5, 2.7 Hz, 1H), 3.78—3.63 (m, 3H), 3.62—3.50 (m, 2H), 3.47—3.30 (m, 2H), 3.28 (dd, *J* = 10.1, 6.4 Hz, 1H), 2.39 (br, 1H), 2.15—1.95 (m, 2H), 1.95—1.65 (m, 5H), 1.65—1.47 (m, 4H), 1.00 (s, 3H); HRMS (ESI) calcd for $C_{28}H_{38}O_6Na$ [$(M + Na)^+$] 493.2566, found 493.2547.



61 **62**

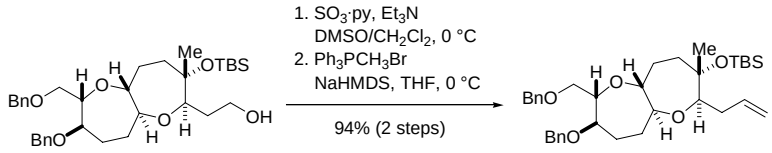
Diol 62 (from hydroxy ester 61). To a solution of hydroxy ester **61** (242.1 mg, 0.4861 mmol) in THF (10 mL) at 0 °C was added $LiAlH_4$ (28 mg, 0.74 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was sequentially treated with 3 M aqueous NaOH and H_2O with vigorous stirring. The insoluble materials were filtered off, and the filtrate was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5% MeOH/$CHCl_3$) gave diol **62** (228.0 mg, quantitative) as a colorless oil.



62 63

Alcohol 63. To a solution of diol **62** (228.0 mg, 0.4861 mmol) in CH_2Cl_2 (9 mL) at 0 °C were added Et_3N (1.36 mL, 9.76 mmol) and TBSOTf (1.12 mL, 4.88 mmol). After being stirred at room temperature for 3 h, the reaction mixture was cooled to 0 °C and treated with saturated aqueous $NaHCO_3$. The resultant mixture was extracted with EtOAc, washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure to give bis-TBS ether, which was used in the next reaction without purification.

To a solution of the above material in MeOH/CH_2Cl_2 (1:1, v/v, 10 mL) at 0 °C was added CSA (56 mg, 0.24 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was treated with Et_3N and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 20% EtOAc/hexanes) gave alcohol **63** (254.8 mg, 90% for the two steps) as a colorless oil: $[\alpha]_D^{29} = -6.7$ (*c* 0.27, $CHCl_3$); ^{1}H NMR (400 MHz, C_6D_6) δ 7.27—7.08 (m, 10H), 4.37 (d, *J* = 11.9 Hz, 1H), 4.33 (s, 2H), 4.20 (d, *J* = 11.9 Hz, 1H), 4.03 (m, 1H), 3.80—3.68 (m, 3H), 3.63—3.55 (m, 2H), 3.47 (dd, *J* = 10.1, 5.5 Hz, 1H), 3.37 (ddd, *J* = 11.0, 11.0, 4.6 Hz, 1H), 3.28 (dd, *J* = 9.2, 6.4 Hz, 1H), 2.15—1.98 (m, 2H), 1.91 (m, 1H), 1.86—1.66 (m, 4H), 1.66—1.47 (m, 4H), 1.03 (s, 3H), 0.93 (s, 9H), 0.03 (s, 6H); ^{13}C NMR (100 MHz, C_6D_6) δ 139.1, 139.0, 128.4 (× 2), 128.12 (× 2), 128.07 (× 2), 127.9 (× 2), 127.8, 127.6, 87.6, 86.8, 84.0, 82.5, 78.8, 77.6, 73.3, 71.9, 70.6, 61.4, 37.9, 33.4, 29.3, 28.1, 26.0, 24.4, 23.1, 18.3, −2.1, −2.2; HRMS (ESI) calcd for $C_{34}H_{52}O_6SiNa$ [$(M + Na)^+$] 607.3431, found 607.3432.

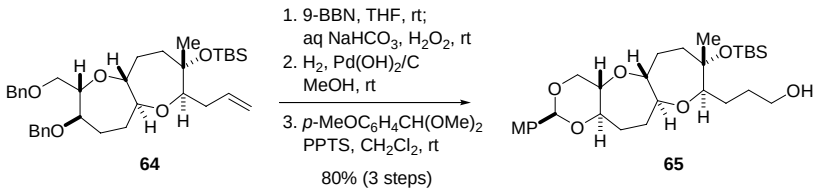


63 64

Olefin 64. To a solution of alcohol **63** (284.2 mg, 0.4866 mmol) in CH_2Cl_2/DMSO (1:1, v/v, 8 mL) at 0 °C were added Et_3N (0.340 mL, 2.44 mmol) and SO_3·pyridine complex (0.31 g, 1.95 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was diluted with diethyl ether and washed successively with 1 M aqueous HCl, saturated aqueous $NaHCO_3$ and brine, dried over $MgSO_4$, filtered, and concentrated under reduced pressure to give crude aldehyde, which was used in the next reaction without further purification.

To a suspension of Ph_3PCH_3Br (1.74 g, 4.87 mmol) in THF (4 mL) at 0 °C was added NaHMDS (1.0 M solution in THF, 3.90 mL, 3.90 mmol), and the resultant mixture was stirred at 0 °C for 30 min.

To this suspension was added a solution of the above crude aldehyde in THF (4 mL + 2 mL rinse). The reaction mixture was stirred at 0 °C for 30 min before the reaction was quenched with saturated aqueous NH_4Cl. The resultant mixture was extracted with EtOAc, washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% EtOAc/hexanes) gave olefin **64** (265.9 mg, 94% for the two steps) as a colorless oil: $[\alpha]_D^{30} = -5.6$ (*c* 0.58, $CHCl_3$); ^{1}H NMR (400 MHz, C_6D_6) δ 7.27—7.08 (m, 10H), 6.07 (m, 1H), 5.24 (d, *J* = 16.5 Hz, 1H), 5.12 (d, *J* = 10.1 Hz, 1H), 4.38 (d, *J* = 11.9 Hz, 1H), 4.32 (s, 2H), 4.21 (d, *J* = 11.9 Hz, 1H), 4.05 (m, 1H), 3.75 (m, 1H), 3.58 (ddd, *J* = 10.1, 10.1, 4.6 Hz, 1H), 3.52—3.40 (m, 2H), 3.37—3.24 (m, 2H), 2.40 (m, 1H), 2.28—1.93 (m, 4H), 1.91—1.76 (m, 2H), 1.70 (m, 1H), 1.64—1.47 (m, 2H), 1.03 (s, 3H), 0.93 (s, 9H), 0.03 (s, 6H); ^{13}C NMR (100 MHz, C_6D_6) δ 139.2, 139.0, 137.5, 128.6 (× 2), 128.53 (× 2), 128.51 (× 2), 128.4 (× 2), 127.8, 127.6, 116.2, 88.4, 88.0, 84.4, 82.5, 78.9, 77.8, 73.3, 72.0, 70.6, 38.1, 35.6, 29.4, 27.9, 26.0, 24.3, 23.2, 18.3, −2.1, −2.2; HRMS (ESI) calcd for $C_{35}H_{52}O_5SiNa$ [$(M + Na)^+$] 603.3482, found 603.3481.

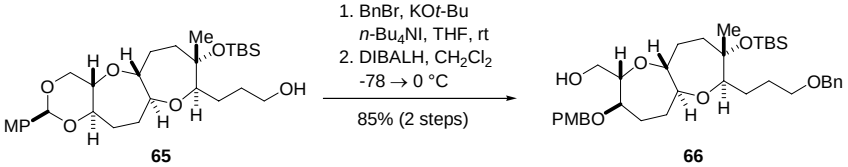


Alcohol 65. To a solution of olefin **64** (355.5 mg, 0.6129 mmol) in THF (7 mL) was added 9-BBN (0.5 M solution in THF, 3.70 mL, 1.85 mmol). After being stirred at room temperature overnight, the reaction mixture was cooled to 0 °C, treated successively with H_2O (0.5 mL), saturated aqueous $NaHCO_3$ (6 mL) and 30% H_2O_2 (3 mL). The resulting mixture was stirred at room temperature for 2 h. The mixture was extracted with EtOAc, washed with saturated aqueous Na_2SO_3 and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a short silica gel column eluting with 25% EtOAc/hexanes to remove the baseline impurities to give crude alcohol (369.8 mg), which was used in the next reaction without further purification.

To a solution of the above crude alcohol (369.8 mg) in MeOH (10 mL) was added 20% $Pd(OH)_2/C$ (100 mg). The resultant mixture was stirred at room temperature under an atmosphere of hydrogen for 1 h. The catalyst was filtered off, and the filtrate was concentrated under reduced pressure to give crude triol, which was used in the next reaction without further purification.

To a solution of the above crude triol in CH_2Cl_2 (10 mL) were added *p*-methoxybenzaldehyde dimethylacetal (0.210 mL, 1.23 mmol) and PPTS (46 mg, 0.18 mmol). After being stirred at room temperature for 1 h, the reaction mixture was quenched with Et_3N and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 25 → 30% EtOAc/hexanes) gave alcohol **65** (263.7 mg, 80% for the three steps) as a colorless oil: $[\alpha]_D^{30} = +27.0$ (*c* 0.22, $CHCl_3$); ^{1}H NMR (400 MHz, C_6D_6) δ 7.63 (d, *J* = 8.2 Hz, 2H), 6.85 (d, *J* = 8.2 Hz, 2H), 5.35 (s, 1H), 4.31 (dd, *J* = 11.0, 4.6 Hz, 1H), 3.58—3.43 (m, 3H), 3.37—3.14 (m, 8H), 2.13—1.66 (m, 7H),

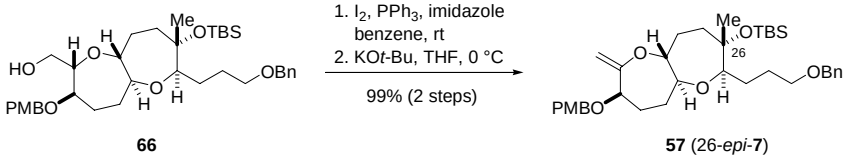
1.63—1.50 (m, 2H), 1.39 (m, 1H), 1.10 (s, 3H), 1.02 (br, 1H), 0.95 (s, 9H), 0.07 (s, 6H); HRMS (ESI) calcd for $C_{29}H_{49}O_7Si$ [$(M + H)^+$] 559.3067, found 537.3244.



65 **66**

Alcohol 66. To a solution of alcohol **65** (172.1 mg, 0.3211 mmol) in THF (6 mL) were added KO*t*-Bu (144 mg, 1.28 mmol). After being stirred at room temperature for 20 min, the reaction mixture was treated with BnBr (0.115 mL, 0.967 mmol) and *n*-Bu_4NI (12 mg, 0.032 mmol). After being stirred at room temperature for 1 h, the resultant mixture was quenched with MeOH and extracted with EtOAc. The organic layer was washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure to give crude benzyl ether, which was used in the next reaction without further purification.

To a solution of the above crude benzyl ether in CH_2Cl_2 (6 mL) at −78 °C was added DIBALH (0.95 M solution in hexane, 3.40 mL, 3.23 mmol). The reaction mixture was allowed to warm to 0 °C over a period of 1 h and then quenched with saturated aqueous potassium sodium tartrate. The resultant mixture was extracted with EtOAc, washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 20% EtOAc/hexanes) gave alcohol **66** (171.6 mg, 85% for the two steps) as a colorless oil: $[\alpha]_D^{30}$ = −8.9 (*c* 0.27, $CHCl_3$); ^{1}H NMR (400 MHz, C_6D_6) δ 7.35 (d, *J* = 7.3 Hz, 2H), 7.21—7.08 (m, 5H), 6.78 (d, *J* = 7.3 Hz, 2H), 4.37 (s, 2H), 4.29 (d, *J* = 11.0 Hz, 1H), 4.10 (d, *J* = 11.0 Hz, 1H), 3.79 (m, 1H), 3.51—3.20 (m, 11H), 2.14—1.63 (m, 10H), 1.57—1.45 (m, 2H), 1.38 (m, 1H), 1.07 (s, 3H), 0.96 (s, 9H), 0.07 (s, 6H); ^{13}C NMR (100 MHz, C_6D_6) δ 159.7, 139.5, 130.9, 129.4, 128.5 (×2), 128.1 (×2), 127.9, 127.7, 127.5, 114.1, 88.3, 87.9, 85.0, 84.6, 78.4, 77.8, 73.0, 70.9, 70.4, 64.8, 54.7, 38.3, 29.2, 28.1, 27.9, 27.8, 26.0, 24.5, 24.0, 18.3, −2.0, −2.2; HRMS (ESI) calcd for $C_{36}H_{56}O_7SiNa$ [$(M + Na)^+$] 651.3693, found 651.3667.

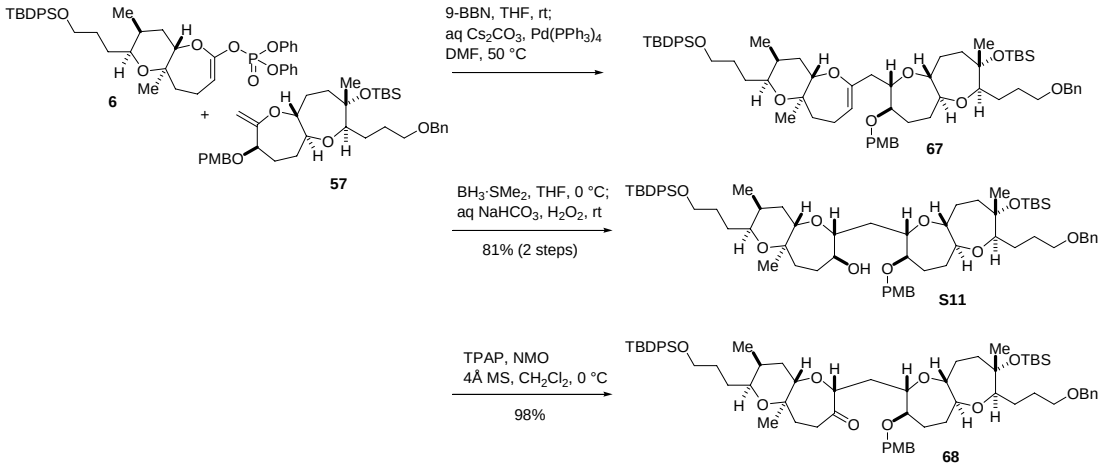


66 **57** (26-*epi*-**7**)

Exocyclic enol ether 57. To a solution of alcohol **66** (487.8 mg, 0.775 mmol) in benzene (5 mL) were added imidazole (154.6 mg, 2.27 mmol), Ph_3P (502.3 mg, 1.91 mmol) and I_2 (493.0 mg, 1.94 mmol). After being stirred at room temperature for 30 min, the reaction mixture was quenched with saturated aqueous Na_2SO_3 and extracted with EtOAc. The organic layer was washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash

column chromatography (silica gel, 0 → 20% EtOAc/hexanes) gave the corresponding iodide (640.5 mg), which was used in the next reaction without further purification.

To a solution of the above material in THF (5 mL) at 0 °C was added KO*t*-Bu (266.4 mg, 2.37 mmol). After being stirred at 0 °C for 45 min, the reaction mixture was quenched with water and extracted with EtOAc. The organic layer was washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 2 → 6% EtOAc/hexanes) gave exocyclic enol ether **57** (462.2 mg, 98% for the two steps) as a colorless oil: ^{1}H NMR (500 MHz, C_6D_6) δ 7.33 (d, *J* = 7.5 Hz, 2H), 7.22 (d, *J* = 8.5 Hz, 2H), 7.20 (t, *J* = 7.5 Hz, 2H), 7.10 (t, *J* = 7.5 Hz, 1H), 6.78 (d, *J* = 8.0 Hz, 2H), 4.71 (m, 1H), 4.67 (s, 1H), 4.60 (d, *J* = 11.0 Hz, 1H), 4.35 (s, 2H), 4.31 (d, *J* = 11.5 Hz, 1H), 3.99 (s, 1H), 3.93 (brd, *J* = 5.5 Hz, 1H), 3.47—3.31 (m, 4H), 3.29 (s, 3H), 2.24 (m, 1H), 2.12 (m, 1H), 2.00—1.79 (m, 6H), 1.72 (m, 1H), 1.64 (m, 1H), 1.52—1.41 (m, 2H), 1.07 (s, 3H), 0.95 (s, 9H), 0.046 (s, 3H), 0.043 (s, 3H); HRMS (ESI-TOF) calcd for $C_{36}H_{54}O_6SiNa$ [$(M+Na)^+$] 633.3587, found 633.3589.

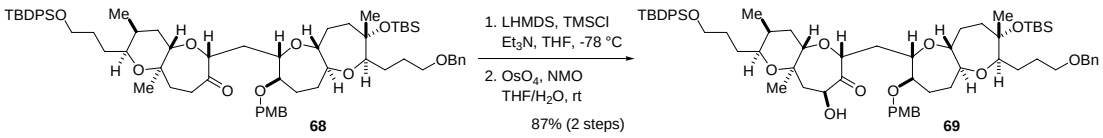


Ketone 68. Exocyclic enol ether **57** (462.2 mg, 0.756 mmol) was treated with 9-BBN (0.5 M solution in THF, 4.0 mL, 2.0 mmol) at 0 °C. After being stirred at room temperature for 2 h, the reaction mixture was treated with 3 M aqueous Cs_2CO_3 (0.75 mL, 2.27 mmol) and stirred at room temperature for 20 min. To this mixture were added a solution of enol phosphate **6** (756.0 mg, 1.04 mmol) in DMF (10 mL + 4 × 3 mL rinse) and $Pd(PPh_3)_4$ (90.6 mg, 0.0784 mmol), and the resultant mixture was stirred at 50 °C overnight. The reaction mixture was cooled to room temperature, diluted with ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 0 → 15% EtOAc/hexanes) to give coupling product **67** (881.6 mg), which was contaminated with byproducts derived from 9-BBN but was used in the next reaction without further purification.

To a solution of the above coupling product **67** (881.6 g, theoretically 0.756 mmol) in THF (7.5 mL) at 0 °C was added BH_3·SMe_2 (2.0 M in THF, 1.90 mL, 3.80 mmol) and the resultant mixture was allowed to warm to room temperature. After being stirred for 2 h, the reaction mixture was cooled to

0 °C and treated with saturated aqueous $NaHCO_3$ (15 mL) and 30% aqueous H_2O_2 (15 mL). After being stirred at room temperature for 2.5 h, the reaction mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (10 → 30% EtOAc/henaxes) to give alcohol **S11** (676.8 mg, 0.611 mmol, 81% for the two steps) as a colorless oil: $[\alpha]_D^{27}$ −13.3 (*c* 1.52, $CHCl_3$); IR (film) 3451, 2932, 2857, 1613, 1514, 1462, 1381, 1361, 1302, 1249, 1092, 1004, 833, 702 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.81—7.77 (m, 4H), 7.34 (d, *J* = 7.0 Hz, 2H), 7.26 (d, *J* = 7.5 Hz, 2H), 7.24—7.19 (m, 8H), 7.12 (m, 1H), 6.83 (d, *J* = 8.0 Hz, 2H), 4.39 (d, *J* = 12.0 Hz, 1H), 4.37 (s, 2H), 4.23 (d, *J* = 12 Hz, 1H), 4.08 (ddd, *J* = 7.0, 6.0, 1.5 Hz, 1H), 3.81 (dd, *J* = 12.5, 5.0 Hz, 1H), 3.78—3.58 (m, 5H), 3.52 (m, 1H), 3.50—3.40 (m, 4H), 3.34 (m, 1H), 3.32 (s, 3H), 2.21—2.10 (m, 2H), 2.09—1.94 (m, 3H), 1.92—1.63 (m, 10H), 1.63—1.44 (m, 9H), 1.30 (m, 1H), 1.27 (m, 1H), 1.23 (s, 3H), 1.18 (s, 9H), 1.07 (s, 3H), 0.94 (s, 9H), 0.92 (d, *J* = 7.0 Hz, 3H), 0.05 (s, 3H), 0.03 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 159.7, 139.5, 136.0 (× 4), 134.5 (× 2), 131.1, 129.9 (× 2), 129.4 (× 2), 128.5 (× 2), 128.0 (× 4), 127.7 (× 2), 127.5, 114.1 (× 2), 88.2, 87.9, 84.2, 82.6, 81.2, 80.4, 77.9, 76.8, 75.8, 74.2, 72.9, 71.0, 70.9, 70.3, 64.3, 54.8, 40.7, 38.3, 36.1, 35.1, 33.0, 29.8, 29.4, 29.3, 28.0, 27.9, 27.7, 27.5, 27.1 (× 3), 26.0 (× 3), 24.4, 23.0, 19.4, 18.3, 16.0, 12.7, −2.0, −2.1; HRMS (ESI-TOF) calcd for $C_{66}H_{99}O_{10}Si_2$ $[(M+H)^+]$ 1107.6777, found 1107.6778.

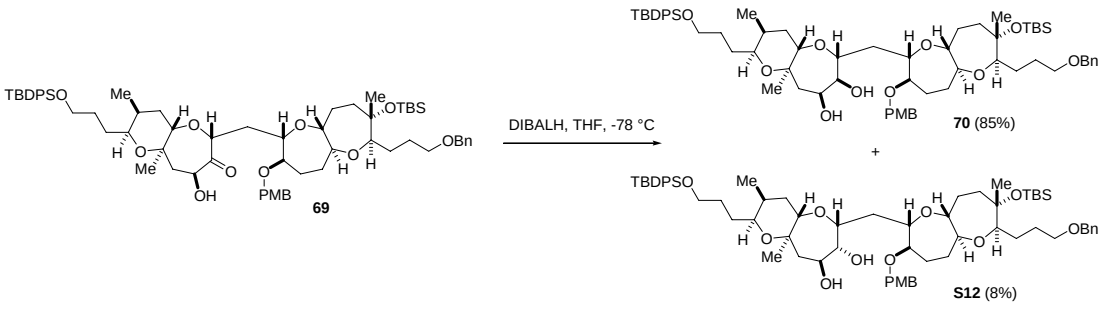
To a solution of alcohol **S11** (635.7 mg, 0.574 mmol) in CH_2Cl_2 (7 mL) at 0 °C were added 4Å molecular sieves (208.4 mg), NMO (105.6 mg, 0.901 mmol) and TPAP (19.4 mg, 0.0552 mmol). After being stirred at 0 °C for 2.5 h, the reaction mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 20% EtOAc/hexanes) gave ketone **68** (623.7 mg, 0.564 mmol, 98%) as a colorless oil: $[\alpha]_D^{26}$ +2.7 (*c* 1.36, $CHCl_3$); IR (film) 2932, 2856, 1714, 1613, 1514, 1457, 1428, 1384, 1361, 1249, 1093, 833, 702 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.66—7.62 (m, 4H), 7.42—7.31 (m, 10H), 7.26 (m, 1H), 7.21 (d, *J* = 8.5 Hz, 2H), 6.85 (d, *J* = 8.5 Hz, 2H), 4.49 (s, 2H), 4.45 (d, *J* = 11.5 Hz, 1H), 4.22 (d, *J* = 11.0 Hz, 1H), 3.84 (t, *J* = 6.5 Hz, 1H), 3.78 (s, 3H), 3.68—3.57 (m, 4H), 3.52—3.46 (m, 2H), 3.44 (m, 1H), 3.31 (m, 1H), 3.23 (d, *J* = 10.5 Hz, 1H), 3.14—3.08 (m, 2H), 2.85 (ddd, *J* = 10.5, 10.0, 2.5 Hz, 1H), 2.23 (m, 1H), 1.92 (m, 1H), 1.88—1.70 (m, 10H), 1.66—1.44 (m, 9H), 1.40—1.34 (m, 2H), 1.28 (m, 1H), 1.23 (s, 3H), 1.07 (s, 3H), 1.02 (s, 9H), 0.87 (d, *J* = 7.0 Hz, 3H), 0.81 (s, 9H), 0.04 (d, *J* = 6.5 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 216.6, 159.1, 138.6, 135.5 (× 4), 134.0 (× 2), 130.4, 129.5 (× 2), 129.1 (× 2), 128.3 (× 2), 127.62 (× 2), 127.58 (× 4), 127.4, 113.8 (× 2), 90.0, 88.0, 87.7, 84.4, 84.2, 80.9, 79.3, 79.1, 77.3, 76.0, 72.8, 71.0, 70.6, 70.1, 63.8, 55.3, 39.1, 38.2, 37.8, 36.8, 34.4, 32.6, 29.1, 28.9, 28.5, 27.32, 27.28, 26.8 (× 3), 25.7 (× 3), 24.3, 22.9, 19.2, 18.0, 14.7, 12.3, −2.2, −2.3; HRMS (ESI-TOF) calcd for $C_{66}H_{96}O_{10}Si_2Na$ $[(M+Na)^+]$ 1127.6440, found 1127.6434.



68 69

Hydroxy ketone 69. To a solution of ketone **68** (625.2 mg, 0.565 mmol) in THF (6 mL) were added TMSCl (1.45 mL, 11.4 mmol) and Et_3N (1.57 mL, 11.5 mmol). The mixture was cooled to −78 °C and treated with LiHMDS (1.0 M solution in THF, 2.45 mL, 2.45 mmol). After being stirred at −78 °C for 70 min, pH 7 phosphate buffer (5 mL) was added to the reaction mixture. The resultant mixture was extracted with EtOAc. The organic layer was washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford silyl enol ether, which was used in the next reaction without further purification.

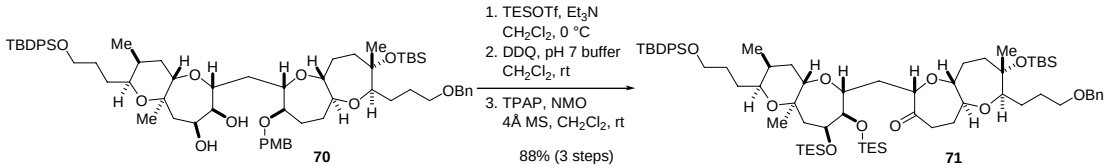
To a solution of the above silyl enol ether in THF/water (4:1, v/v, 5 mL) were added NMO (50 wt% solution in water, 0.23 mL, 1.13 mmol) and OsO_4 (ca. 0.04 M solution in *t*-BuOH, 1.40 mL, ca. 0.0565 mmol). After being stirred at room temperature overnight, the reaction mixture was diluted with EtOAc, washed with saturated aqueous Na_2SO_3 and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 30% EtOAc/hexanes) gave hydroxy ketone **69** (525.7 mg, 83%) as a colorless clear oil: $[\alpha]_D^{28}$ +3.8 (*c* 0.63, $CHCl_3$); IR (film) 3483, 2932, 2856, 1712, 1612, 1514, 1458, 1428, 1385, 1302, 1249, 1090, 833, 702 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.66—7.61 (m, 4H), 7.42—7.30 (m, 10H), 7.26 (m, 1H), 7.20 (d, *J* = 8.5 Hz, 2H), 6.85 (d, *J* = 8.5 Hz, 2H), 4.56 (ddd, *J* = 12.5, 4.5, 4.5 Hz, 1H), 4.49 (s, 2H), 4.45 (d, *J* = 12.0 Hz, 1H), 4.20 (d, *J* = 11.5 Hz, 1H), 4.08 (t, *J* = 6.0 Hz, 1H), 3.78 (s, 3H), 3.70—3.57 (m, 4H), 3.51—3.44 (m, 3H), 3.41 (m, 1H), 3.34 (ddd, *J* = 9.0, 9.0, 3.0 Hz, 1H), 3.22 (d, *J* = 11.0 Hz, 1H), 3.12—3.05 (m, 2H), 2.03 (dd, *J* = 13.5, 3.5 Hz, 1H), 1.92 (m, 1H), 1.88—1.70 (m, 9H), 1.68—1.56 (m, 6H), 1.54—1.45 (m, 3H), 1.42—1.33 (m, 2H), 1.28 (s, 3H), 1.25 (m, 1H), 1.06 (s, 3H), 1.02 (s, 9H), 0.86 (d, *J* = 7.0 Hz, 3H), 0.81 (s, 9H), 0.04 (d, *J* = 12.0 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 216.1, 159.2, 138.6, 135.6 (× 4), 134.01, 133.98, 130.3, 129.5 (× 2), 129.2 (× 2), 128.3 (× 2), 127.62 (× 2), 127.59(× 4), 127.4, 113.8 (× 2), 88.2, 87.5, 84.1, 83.3, 80.9, 80.0, 78.7, 77.2, 74.0, 72.8, 71.7, 70.65, 70.55, 70.1, 63.7, 55.3, 48.5, 39.0, 37.68, 37.67, 34.0, 32.5, 29.1, 28.8, 28.4, 27.29, 27.26, 26.9 (× 3), 25.7 (× 3), 24.2, 22.8, 19.2, 18.0, 15.1, 12.4, −2.2, −2.3; HRMS (ESI-TOF) calcd for $C_{66}H_{96}O_{11}Si_2Na$ $[(M+Na)^+]$ 1143.6389, found 1143.6390.



Diol 70. To a solution of hydroxy ketone **69** (286.0 mg, 0.2550 mmol) in THF (6.5 mL) at −78 °C was added DIBALH (0.94 M solution in hexane, 0.80 mL, 0.752 mmol). After being stirred at −78 °C for 55 min, an additional portion of DIBALH (0.94 M solution in hexane, 0.15 mL, 0.141 mmol) was added, and the resultant mixture was stirred for further 40 min. The reaction was quenched by the addition of

saturated aqueous potassium sodium tartrate. The resultant mixture was diluted with diethyl ether and stirred at room temperature until the layers became clear (40 min). The aqueous layer was separated and extracted with EtOAc. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 25 → 60% EtOAc/hexanes) gave diol **70** (243.4 mg, 85%) and its diastereomer **S12** (21.7 mg, 8%), along with recovered **69** (8.8 mg, 3%). Data for **70**: $[\alpha]_D^{26}$ −14.4 (*c* 1.14, $CHCl_3$); IR (film) 3432, 2932, 2856, 1612, 1513, 1462, 1383, 1249, 1110, 1039, 1005, 833, 772, 702 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.66—7.62 (m, 4H), 7.42—7.32 (m, 10H), 7.26 (m, 1H), 7.23 (d, *J* = 8,5 Hz, 2H), 6.86 (d, *J* = 8,5 Hz, 2H), 4.49 (s, 2H), 4.46 (d, *J* = 11.5 Hz, 1H), 4.24 (d, *J* = 12.0 Hz, 1H), 3.96 (brd, *J* = 10.5 Hz, 1H), 3.84 (brs, 1H), 3.79 (s, 3H), 3.71 (m, 1H), 3.69—3.59 (m, 3H), 3.59—3.46 (m, 5H), 3.31 (ddd, *J* = 10.0, 10.0, 3.0 Hz, 1H), 3.25 (d, *J* = 10.0 Hz, 1H), 3.14 (m, 1H), 2.42 (br, 1H), 2.16 (dd, *J* = 12.5, 11.5 Hz, 1H), 1.94 (m, 1H), 1.90—1.80 (m, 4H), 1.80—1.69 (m, 4H), 1.69—1.46 (m, 11H), 1.42—1.34 (m, 2H), 1.27 (m, 1H), 1.12 (s, 3H), 1.07 (s, 3H), 1.02 (s, 9H), 0.90 (d, *J* = 7.0 Hz, 3H), 0.81 (s, 9H), 0.04 (d, *J* = 7.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 159.7, 139.5, 135.6 (× 4), 134.5 (× 2), 131.1, 129.9 (× 2), 129.4 (× 2), 128.5 (× 2), 128.0 (× 4), 127.7 (× 2), 127.5, 114.1 (× 2), 88.3, 87.9, 84.5, 81.4, 80.4, 79.9, 78.9, 77.9, 75.5, 74.4, 72.9, 70.9, 70.7, 70.4, 68.8, 64.3, 54.8, 45.4, 40.9, 38.4, 34.7, 32.9, 29.8, 29.32, 29.27, 28.0, 27.9, 27.7, 27.1 (× 3), 26.0 (× 3), 24.4, 23.2, 19.4, 18.3, 16.4, 12.6, −2.0, −2.2; HRMS (ESI-TOF) calcd for $C_{66}H_{98}O_{11}Si_2Na$ $[(M+Na)^+]$ 1145.6545, found 1145.6544.

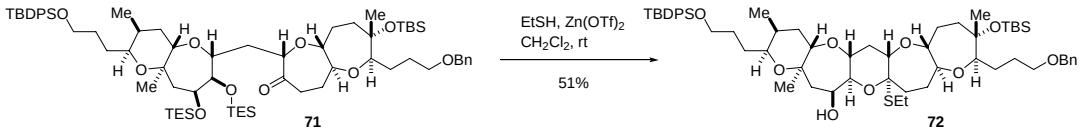
Data for **S12**: ^1H NMR (500 MHz, $CDCl_3$) δ 7.67—7.62 (m, 4H), 7.42—7.30 (m, 11H), 7.23 (d, *J* = 10.0 Hz, 2H), 6.86 (d, *J* = 8.5 Hz, 2H), 4.50 (s, 2H), 4.46 (d, *J* = 11.0 Hz, 1H), 4.30 (d, *J* = 11.5 Hz, 1H), 4.05 (m, 1H), 3.89 (brd, *J* = 7.5 Hz, 1H), 3.79 (s, 3H), 3.78 (m, 1H), 3.69—3.59 (m, 3H), 3.56 (t, *J* = 6.5 Hz, 1H), 3.52—3.45 (m, 4H), 3.29 (dd, *J* = 12.0, 4.5 Hz, 1H), 3.23 (d, *J* = 11.0 Hz, 1H), 3.14 (q, *J* = 8.5 Hz, 1H), 2.67 (brs, 1H), 2.04 (d, *J* = 13.5 Hz, 1H), 1.95 (m, 1H), 1.90—1.72 (m, 8H), 1.72—1.44 (m, 9H), 1.44—1.34 (m, 2H), 1.34—1.20 (m, 3H), 1.15 (s, 3H), 1.07 (s, 3H), 1.03 (s, 9H), 0.90 (d, *J* = 7.0 Hz, 3H), 0.81 (s, 9H), 0.04 (d, *J* = 7.0 Hz, 6H); HRMS (ESI-TOF) calcd for $C_{66}H_{98}O_{11}Si_2Na$ $[(M+Na)^+]$ 1145.6545, found 1145.6545.



Ketone 71. To a solution of diol **70** (500.8 mg, 0.4457 mmol) in CH_2Cl_2 (8 mL) at 0 °C were added Et_3N (0.38 mL, 2.73 mmol) and TESOTf (0.30 mL, 1.34 mmol). After being stirred at 0 °C for 30 min, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The mixture was extracted with EtOAc, washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a pad of silica gel to give crude product, which was used in the next reaction without further purification.

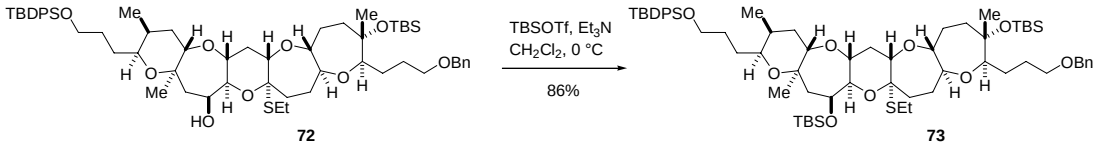
To a solution of the above crude material in CH_2Cl_2/pH 7 phosphate buffer (10:1, v/v, 11 mL) at 0 °C was added DDQ (136.0 mg, 0.599 mmol). After being stirred at room temperature for 45 min, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The resultant mixture was extracted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a pad of silica gel to give crude alcohol, which was used in the next reaction without further purification.

To a solution of the above crude material in CH_2Cl_2 (10 mL) at 0 °C were added 4Å molecular sieves (171.7 mg), NMO (76.0 mg, 0.65 mmol) and TPAP (13.6 mg, 0.04 mmol). After being stirred at room temperature for 2 h, the reaction mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 15% EtOAc/hexanes) gave ketone **71** (478.1 g, 0.391 mmol, 88% for the three steps) as a colorless oil: $[\alpha]_D^{28}$ −16.4 (*c* 1.0, $CHCl_3$); IR (film) 2952, 2875, 2360, 2341, 1716, 1458, 1428, 1380, 1361, 1254, 1106, 1004, 834, 740, 701 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.81—7.75 (m, 4H), 7.33 (d, *J* = 7.0 Hz, 2H), 7.25—7.19 (m, 8H), 7.13 (m, 1H), 4.35 (s, 2H), 4.28 (dd, *J* = 11.5, 5.5 Hz, 1H), 4.18 (dd, *J* = 10.0, 4.5 Hz, 1H), 4.08 (dd, *J* = 11.0, 2.0 Hz, 1H), 4.00 (s, 1H), 3.89 (t, *J* = 5.5 Hz, 1H), 3.74—3.61 (m, 2H), 3.48—3.35 (m, 5H), 2.86 (td, *J* = 12.0, 1.5 Hz, 1H), 2.80—2.72 (m, 2H), 2.30 (dd, *J* = 11.0, 7.0 Hz, 1H), 2.24 (ddd, *J* = 14.0, 10.0, 5.0 Hz, 1H), 2.12—2.04 (m, 2H), 1.94—1.83 (m, 2H), 1.82 —1.62 (m, 8H), 1.62—1.40 (m, 6H), 1.32 (m, 1H), 1.29 (s, 3H), 1.17 (s, 9H), 1.09 (t, *J* = 8.0 Hz, 9H), 1.07 (s, 3H), 1.02 (t, *J* = 8.0 Hz, 9H), 0.98 (d, *J* = 7.0 Hz, 3H), 0.94 (s, 9H), 0.72 (m, 6H), 0.64 (qd, *J* = 8.0, 4.0 Hz, 6H), 0.06 (s, 3H), 0.05 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 213.9, 139.4, 136.0 (× 4), 134.5 (× 2), 129.8(× 2), 128.5 (× 2), 128.0 (× 4), 127.7 (× 2), 127.6, 88.3, 88.2, 87.1, 84.6, 82.4, 79.1, 77.6, 74.2, 73.0, 72.2, 70.7, 70.6, 69.1, 64.3, 45.4, 39.0, 38.3, 37.7, 34.6, 33.1, 31.6, 29.8, 29.4, 29.2, 27.8, 27.7, 27.1 (× 3), 26.0 (× 3), 24.5, 19.4, 18.3, 16.7, 12.4, 7.23 (× 3), 7.19 (× 3), 5.4 (× 3), 5.1 (× 3), −2.1, −2.3; HRMS (ESI-TOF) calcd for $C_{70}H_{116}O_{10}Si_4Na$ $[(M+Na)^+]$ 1251.7543, found 1251.7544.

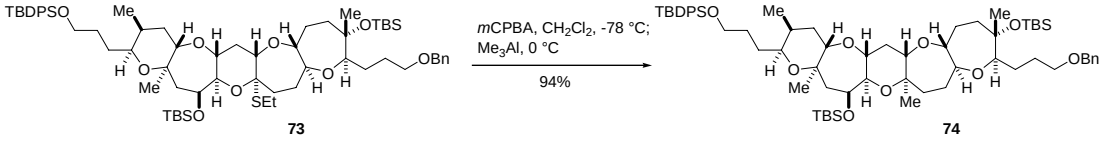


Alcohol 72. To a solution of ketone **71** (468.6 mg, 0.380 mmol) in CH_2Cl_2 (5 mL) were added EtSH (1.5 mL) and $Zn(OTf)_2$ (42.4 mg, 0.117 mmol). After being stirred at room temperature overnight, the reaction mixture was concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10 → 100% EtOAc/hexanes) gave alcohol **72** (201.9 mg, 51%) as a colorless foam: $[\alpha]_D^{28}$ −37.4 (*c* 0.84, $CHCl_3$); IR (film) 3462, 2931, 2856, 1457, 1428, 1380, 1255, 1101, 834, 772, 738, 701 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.81—7.77 (m, 4H), 7.33 (d, *J* = 7.5 Hz, 2H), 7.26—7.21 (m, 6H), 7.19 (d, *J* = 8.0 Hz, 2H), 7.09 (m, 1H), 4.36 (d, *J* = 1.5 Hz, 2H), 4.22 (q, *J* = 8.5 Hz, 1H), 4.14 (dd, *J* = 11.0, 6.0 Hz, 1H), 4.01 (dd, *J* = 10.0, 2.0 Hz, 1H), 3.98 (m, 1H), 3.79 (ddd, *J* = 11.5, 10.0, 5.0 Hz, 1H), 3.72—3.64 (m, 2H), 3.48—3.40 (m, 3H), 3.33—3.26 (m, 2H), 3.05 (dd, *J* = 12.5, 4.5 Hz, 1H), 2.50—2.37 (m, 2H), 2.34 (dd, *J* = 15.5, 3.5 Hz, 1H), 2.27 (m, 1H), 2.24—2.08 (m, 3H),

2.08—1.96 (m, 3H), 1.94—1.61 (m, 10H), 1.61—1.42 (m, 4H), 1.34—1.24 (m, 2H), 1.19 (s, 3H), 1.18 (s, 9H), 1.16 (s, 3H), 1.02 (t, J = 7.5 Hz, 3H), 0.98 (d, J = 7.5 Hz, 3H), 0.91 (s, 9H), 0.06 (s, 3H), 0.02 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.5, 136.0 (× 4), 134.4 (× 2), 129.9 (× 2), 128.5 (× 2), 128.0 (× 4), 127.6 (× 2), 127.5, 92.1, 89.0, 85.0, 84.3, 83.9, 77.5, 75.3, 75.6, 75.5, 73.0, 72.9, 71.0, 70.8, 70.2, 64.3, 48.0, 37.8, 35.4, 35.3, 35.1, 33.1, 30.7, 29.8, 29.4, 29.3, 27.7, 27.6, 27.1 (× 3), 26.0 (× 3), 23.5, 20.0, 19.8, 19.4, 18.3, 14.9, 12.7, −2.0, −2.1; HRMS (ESI-TOF) calcd for $C_{60}H_{92}O_9Si_2SNa$ [$(M+Na)^+$] 1067.5898, found 1067.5898.

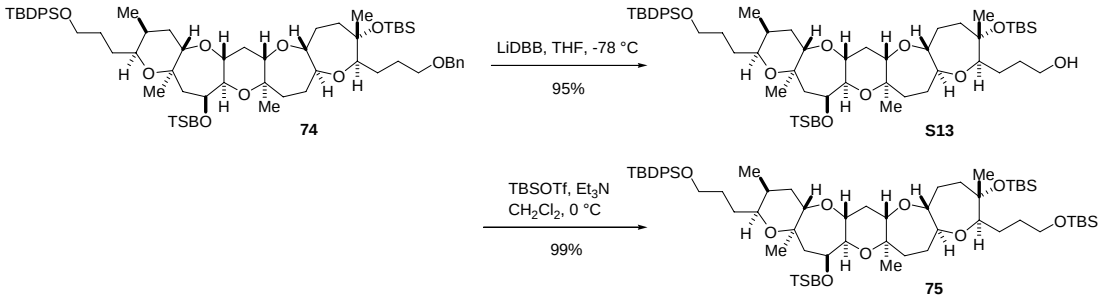


Silyl ether 73. To a solution of alcohol **72** (211.8 mg, 0.202 mmol) in CH_2Cl_2 (4 mL) at 0 °C were added Et_3N (0.085 mL, 0.608 mmol) and TBSOTf (0.070 mL, 0.304 mmol). After being stirred at 0 °C for 60 min and room temperature for 30 min, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% EtOAc/hexanes) gave silyl ether **73** (202.0 mg, 86%) as a colorless oil: $[\alpha]_D^{28}$ −32.4 (*c* 0.85, $CHCl_3$); IR (film) 2930, 2856, 1471, 1459, 1428, 1378, 1361, 1254, 1100, 1053, 1003, 834, 773, 737, 701 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 7.80—7.75 (m, 4H), 7.33 (d, J = 7.0 Hz, 2H), 7.26—7.20 (m, 6H), 7.19 (d, J = 8.0 Hz, 2H), 7.10 (m, 1H), 4.45 (dd, J = 12.5, 5.5 Hz, 1H), 4.35 (d, J = 2.0 Hz, 2H), 4.26 (q, J = 8.5 Hz, 1H), 4.09 (t, J = 3.5 Hz, 1H), 3.99—3.94 (m, 2H), 3.71—3.60 (m, 2H), 3.47—3.39 (m, 3H), 3.34—3.25 (m, 2H), 3.23 (dd, J = 12.0, 4.5 Hz, 1H), 2.54—2.42 (m, 2H), 2.35—2.18 (m, 4H), 2.12 (m, 1H), 2.08—1.99 (m, 2H), 1.96 (dd, J = 15.5, 4.5 Hz, 1H), 1.93—1.67 (m, 9H), 1.62 (dd, J = 13.5, 10.5 Hz, 1H), 1.58—1.44 (m, 4H), 1.28 (m, 1H), 1.25 (s, 3H), 1.18 (s, 9H), 1.16 (s, 3H), 1.10 (s, 9H), 1.05 (t, J = 7.5 Hz, 3H), 1.04 (d, J = 6.0 Hz, 3H), 0.91 (s, 9H), 0.18 (s, 3H), 0.17 (s, 3H), 0.06 (s, 3H), 0.03 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 139.6, 136.0 (× 4), 134.46, 134.45, 129.9 (× 2), 128.4 (× 2), 127.9 (× 4), 127.6 (× 2), 127.4, 92.2, 88.9, 85.1, 84.6, 84.3, 78.0, 77.5, 76.3, 73.3, 73.1, 72.9, 72.8, 71.1, 70.8, 64.3, 50.0, 37.7, 35.7, 35.4, 35.1, 33.0, 30.7, 29.8, 29.44, 29.41, 27.7, 27.6, 27.1 (× 3), 26.2 (× 3), 26.0 (× 3), 23.6, 21.1, 20.0, 19.4, 18.5, 18.3, 14.9, 12.8, −2.0, −2.1, −4.1, −4.7; HRMS (ESI-TOF) calcd for $C_{66}H_{106}O_9Si_3SNa$ [$(M+Na)^+$] 1181.6763, found 1181.6766.



Pentacyclic ether 74. To a solution of silyl ether **73** (62.6 mg, 0.054 mmol) in CH_2Cl_2 (5.0 mL) at

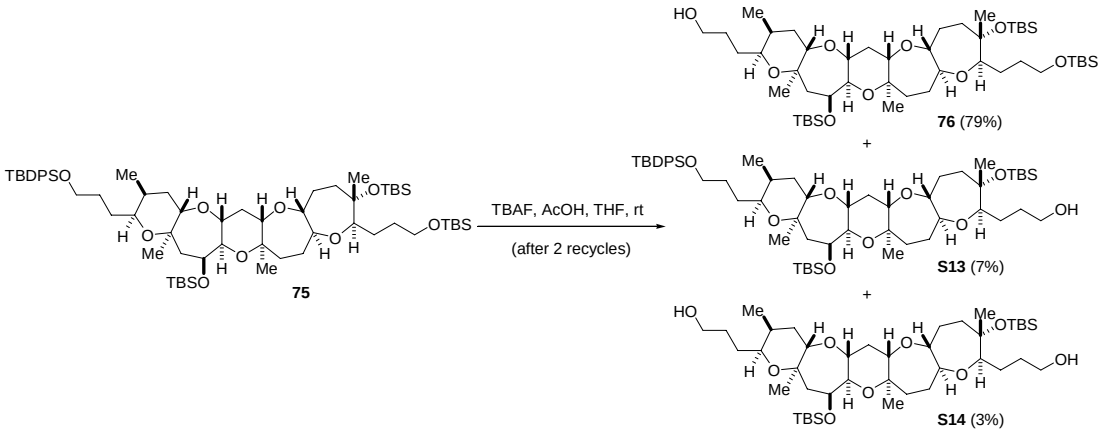
−78 °C was added a solution of *m*CPBA (46.6 mg, 0.270 mmol) in CH_2Cl_2 (1.0 mL). The resultant solution was stirred at the same temperature for 2 h. Three portions of Me_3Al (1.0 M solution in hexane, 0.21 mL, 0.21 mmol) were added to the reaction mixture at 30-min intervals, during which time the reaction mixture was allowed to warm to 0 °C. After being stirred for 30 min, the reaction was quenched with saturated aqueous potassium sodium tartrate (5 mL). The resulting mixture was diluted with diethyl ether (15 mL) and stirred at room temperature overnight. The aqueous layer was separated and extracted with diethyl ether. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 4 → 15% EtOAc/hexanes) to afford pentacycli ether **74** (56.8 mg, 94%) as a colorless oil: $[\alpha]_D^{27}$ −20.6 (*c* 0.43, benzene); ^{1}H NMR (500 MHz, C_6D_6) δ 7.81—7.76 (m, 4H), 7.33 (d, *J* = 7.5 Hz, 1H), 7.32 (d, *J* = 9.5 Hz, 1H), 7.25—7.21 (m, 6H), 7.20 (t, *J* = 7.5 Hz, 2H), 7.10 (m, 1H), 4.42 (dd, *J* = 12.0, 5.0 Hz, 1H), 4.36 (s, 2H), 4.03 (m, 1H), 3.93 (ddd, *J* = 11.5, 9.0, 5.0 Hz, 1H), 3.72—3.62 (m, 2H), 3.51 (q, *J* = 8.5 Hz, 1H), 3.48—3.38 (m, 3H), 3.33 (d, *J* = 9.0 Hz, 2H), 3.23 (td, *J* = 9.0, 4.0 Hz, 1H), 3.16 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.35 (m, 1H), 2.24—2.16 (m, 2H), 2.05 (m, 1H), 2.00—1.71 (m, 12H), 1.65—1.45 (m, 5H), 1.40—1.24 (m, 2H), 1.24 (s, 3H), 1.19 (s, 9H), 1.14 (s, 3H), 1.12 (s, 3H), 1.09 (s, 9H), 1.04 (d, *J* = 6.5 Hz, 3H), 0.94 (s, 9H), 0.20 (s, 3H), 0.17 (s, 3H), 0.07 (s, 3H), 0.05 (s, 3H); ^{13}C NMR (150 MHz, C_6D_6) δ 139.5, 136.0 (× 4), 134.4 (× 2), 129.9 (× 2), 128.5 (× 2), 128.0 (× 4), 127.6 (× 2) , 127.5, 88.6, 86.5. 84.8, 83.0, 78.0, 77.6, 76.5, 76.0, 73.7, 73.3, 73.2, 72.9, 71.1, 70.9, 64.3, 49.9, 38.0 (× 2), 35.5, 34.6, 33.1, 29.8 (× 2), 29.5, 29.4, 27.7 (× 2), 27.1 (× 3), 26.2 (× 3), 26.0 (× 3), 24.0, 21.2, 19.4, 18.5, 18.3, 15.8, 12.8, −2.0, −2.1, −4.0, −4.8; HRMS (ESI-TOF) calcd for $C_{65}H_{104}O_9Si_3Na$ [$(M+Na)^+$] 1135.6886, found 1135.6888.



Silyl ether 75. To a solution of pentacyclic ether **74** (166.8 mg, 0.150 mmol) in THF (6 mL) at −78 °C was added excess LiDBB (ca. 0.17 M solution in THF) until blue color persisted. After being stirred at −78 °C for 40 min, the reaction mixture was treated with saturated aqueous NH_4Cl. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 10 → 35% EtOAc/hexanes) to give alcohol **S13** (146.1 mg, 95%) as a colorless oil: $[\alpha]_D^{21}$ −8.1 (*c* 1.0, $CHCl_3$); IR (film) 3482, 2950, 2933, 2886, 2857, 1472, 1429, 1380, 1255, 1084, 1004, 835, 774, 701cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 7.81—7.76 (m, 4H), 7.25—7.21 (m, 6H), 4.42 (dd, *J* = 11.5, 5.5 Hz, 1H), 4.03 (brs, 1H), 3.92 (ddd, *J* = 12.0, 9.0, 5.0 Hz, 1H), 3.72—3.61 (m, 2H), 3.52—3.42 (m, 3H),

3.35—3.28 (m, 3H), 3.22 (m, 1H), 3.15 (dd, *J* = 12.0, 3.5 Hz, 1H), 2.34 (m, 1H), 2.26—2.17 (m, 2H), 2.03 (m, 1H), 1.96—1.66 (m, 12H), 1.63—1.44 (m, 5H), 1.40 (m, 1H), 1.28 (m, 2H), 1.24 (s, 3H), 1.18 (s, 9H), 1.15 (s, 3H), 1.11 (s, 3H), 1.09 (s, 9H), 1.04 (d, *J* = 6.5 Hz, 3H), 0.94 (s, 9H), 0.20 (s, 3H), 0.17 (s, 3H), 0.06 (s, 3H), 0.05 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 135.99 (× 2), 135.98 (× 2), 134.46, 134.45, 129.9, (× 2), 128.0 (× 4), 88.8, 86.5, 84.7, 83.0, 78.0, 77.6, 76.4, 76.1, 73.6, 73.3, 73.2, 71.1, 64.3, 62.7, 49.8, 37.91, 37.89, 35.5, 34.6, 33.1, 30.6, 29.82, 29.80, 29.5, 29.3, 27.1 (× 3), 27.0, 26.2 (× 3), 26.0 (× 3), 23.9, 21.2, 19.4, 18.5, 18.3, 15.8, 12.8, −2.0, −2.1, −4.0, −4.8; HRMS (ESI-TOF) calcd for $C_{58}H_{98}O_9Si_3Na$ [$(M+Na)^+$] 1045.6416, found 1045.6414

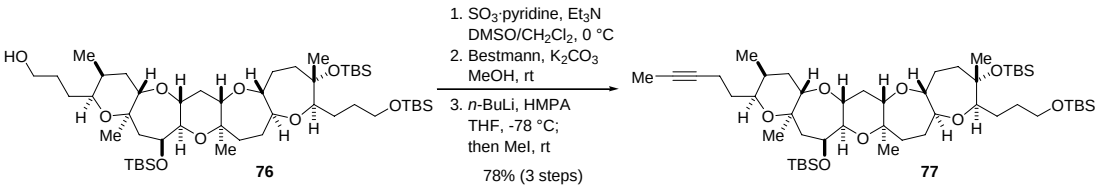
To a solution of the above **S13** in CH_2Cl_2 (4 mL) at 0 °C were added Et_3N (0.06 mL, 0.429 mmol) and TBSOTf (0.050 mL, 0.214 mmol). After being stirred at 0 °C for 25 min, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The resultant mixture was diluted with EtOAc, washed with H_2O and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 4 → 10% EtOAc/hexanes) to give silyl ether **75** (160.6 mg, 99%) as a colorless oil: $[\alpha]_D^{20}$ −11.5 (*c* 1.0, $CHCl_3$); IR (film) 2952, 2933, 2893, 2857, 1472, 1462, 1428, 1380, 1360, 1255, 1216, 1087, 1004, 938, 835, 773, 700 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 7.80—7.76 (m, 4H), 7.25—7.21 (m, 6H), 4.42 (dd, *J* = 12.0, 5.0 Hz, 1H), 4.03 (s, 1H), 3.92 (ddd, *J* = 12.0, 9.0, 5.0 Hz, 1H), 3.75—3.60 (m, 4H), 3.50 (q, *J* = 8.0 Hz, 1H), 3.38—3.29 (m, 3H), 3.23 (ddd, *J* = 9.0, 9.0, 4.0 Hz, 1H), 3.16 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.34 (ddd, *J* = 12.0, 4.0, 4.0 Hz, 1H), 2.26—2.18 (m, 2H), 2.05 (m, 1H), 1.96—1.71 (m, 10H), 1.71—1.39 (m, 5H), 1.27 (m, 1H), 1.23 (s, 3H), 1.18 (s, 9H), 1.151 (s, 3H), 1,145 (s, 3H), 1.09 (s, 9H), 1.04 (d, *J* = 7.0 Hz, 3H), 1.00 (s, 9H), 0.95 (s, 9H), 0.94 (s, 3H), 0.19 (s, 3H), 0.16 (s, 3H), 0.092 (s, 3H), 0.086 (s, 3H), 0.054 (s, 3H), 0.050 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 136.0 (× 4), 134.5 (× 2), 129.9, (× 2), 128.0 (× 4), 88.8, 86.6, 84.8, 83.0, 78.0, 77.6, 76.5, 76.1, 73.6, 73.3, 73.2, 71.1, 64.3, 63.8, 49.9, 38.0, 35.5, 34.6, 33.1, 30.9, 29.9, 29.8, 29.5, 29.4, 27.6, 27.1 (× 3), 26.23 (× 3), 26.22 (× 3), 26.1 (× 3), 25.9, 24.0, 21.2, 19.5, 18.55, 18.52, 18.3, 15.9, 12.8, −2.0, −2.1, −4.0, −4.8, −5.08, −5.10; HRMS (ESI-TOF) calcd for $C_{64}H_{112}O_9Si_4Na$ [$(M+Na)^+$] 1159.7281, found 1159.7280.



Alcohol 76. To a solution of silyl ether **75** (160.6 mg, 0.141 mmol) in THF (7 mL, 0.02 M) was added

a stock solution of TBAF/HOAc [0.1 M solution prepared from TBAF (1.0 M solution in THF, 0.50 mL, 0.50 mmol), HOAc (0.030 mL, 0.52 mmol), and THF (4.47 mL), 1.40 mL, 0.14 mmol]. The reaction mixture was stirred at room temperature for 11.5 h, at which point ca. 50% of the starting material **75** remained unreacted but a small amount of a material lacking both the TBS and TBDPS groups (**S14**) was observed by TLC analysis. The reaction mixture was treated with water, diluted with EtOAc, washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Separation of **75**, **76**, **S13** and **S14** was performed by flash column chromatography (silica gel, 15% → 70% EtOAc/hexanes then EtOAc). Recycling of the recovered starting material **75** (2 repetitions) provided **76** (100.1 mg, 79%), **S13** (10.4 mg, 7%), and **S14** (3.6 mg, 3%). Data for **76**: $[\alpha]_D^{19}$ −15.1 (*c* 1.0, $CHCl_3$); IR (film) 3421, 2951, 2932, 2885, 2856, 1472, 1462, 1387, 1254, 1086, 1004, 937, 835, 773 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 4.45 (dd, *J* = 11.5, 5.5 Hz, 1H), 4.01 (s, 1H), 3.90 (ddd, *J* = 12.0, 9.0, 5.0 Hz, 1H), 3.72 (m, 1H), 3.64 (m, 1H), 3.53—3.41 (m, 3H), 3.36 (d, *J* = 10.0 Hz, 1H), 3.32—3.26 (m, 2H), 3.23 (ddd, *J* = 9.0, 9.0, 4.0 Hz, 1H), 3.15 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.33 (ddd, *J* = 12.5, 4.5, 4.0 Hz, 1H), 2.26—2.18 (m, 2H), 2.05 (m, 1H), 1.95—1.69 (m, 12H), 1.69—1.57 (m, 2H), 1.53—1.38 (m, 5H), 1.27 (s, 3H), 1.23 (m, 1H), 1.14 (s, 6H), 1.08 (s, 9H), 1.02 (d, *J* = 7.5 Hz, 3H), 1.00 (s, 9H), 0.95 (s, 9H), 0.19 (s, 3H), 0.16 (s, 3H), 0.095 (s, 6H), 0.089 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 88.9, 86.6, 84.8, 82.9, 78.5, 77.6, 76.5, 76.0, 73.7, 73.08, 73.07, 72.0, 63.8, 62.7, 49.7, 37.97, 37.94, 35.4, 34.6, 33.6, 30.9, 30.7, 30.3, 29.9, 29.4, 27.6, 26.2 (× 6), 26.0 (× 3), 24.0, 21.0, 18.54, 18.50, 18.3, 15.8, 12.8, −2.0, −2.1, −4.0, −4.8, −5.10, −5.12; HRMS (ESI-TOF) calcd for $C_{48}H_{94}O_9Si_3$ [$(M+Na)^+$] 921.6103, found 921.6104.

Data for **S14**: ^1H NMR (500 MHz, C_6D_6) δ 4.42 (dd, *J* = 12.0, 5.0 Hz, 1H), 4.01 (s, 1H), 3.91 (ddd, *J* = 12.0, 9.5, 5.0 Hz, 1H), 3.52—3.41 (m, 5H), 3.33—3.25 (m, 3H), 3.22 (td, *J* = 9.0, 3.5 Hz, 1H), 3.14 (dd, *J* = 12.0, 3.5 Hz, 1H), 2.39—2.30 (m, 2H), 2.20—2.17 (m, 2H), 2.03 (m, 1H), 1.96—1.66 (m, 10H), 1.62—1.50 (m, 2H), 1.50—1.34 (m, 6H), 1.30 (m, 1H), 1.27 (s, 3H), 1.17 (m, 1H), 1.14 (s, 3H), 1.10 (s, 3H), 1.08 (s, 9H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.94 (s, 9H), 0.19 (s, 3H), 0.16 (s, 3H), 0.06 (s, 3H), 0.04 (s, 3H); HRMS (ESI-TOF) calcd for $C_{42}H_{81}O_9Si_2Na$ [$(M+Na)^+$] 807.5239, found 807.5244.

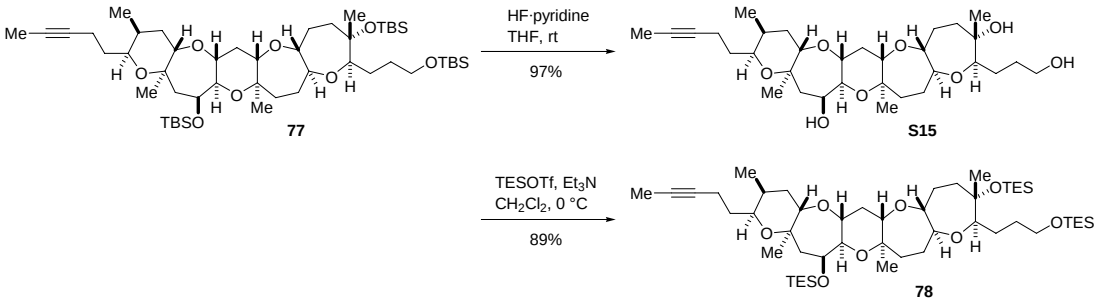


Alkyne 77. To a solution of alcohol **76** (69.0 mg, 0.0767 mmol) in CH_2Cl_2/DMSO (3:1, v/v, 2.0 mL) at 0 °C were added Et_3N (0.056 mL, 0.406 mmol) and SO_3·pyridine (51.6 mg, 0.324 mmol). After being stirred at 0 °C for 45 min, the reaction mixture was diluted with ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a pad of silica gel to give crude aldehyde, which was used without further purification.

To a solution of the above aldehyde and Bestmann reagent (51.7 mg, 0.269 mmol) in MeOH (2.0

mL) at 0 °C was added K_2CO_3 (48.6 mg, 0.352 mmol). The resulting mixture was stirred at room temperature overnight. The reaction mixture was treated with saturated aqueous $NaHCO_3$, diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% EtOAc/hexanes) gave crude terminal alkyne, which was used in the next reaction without further purification.

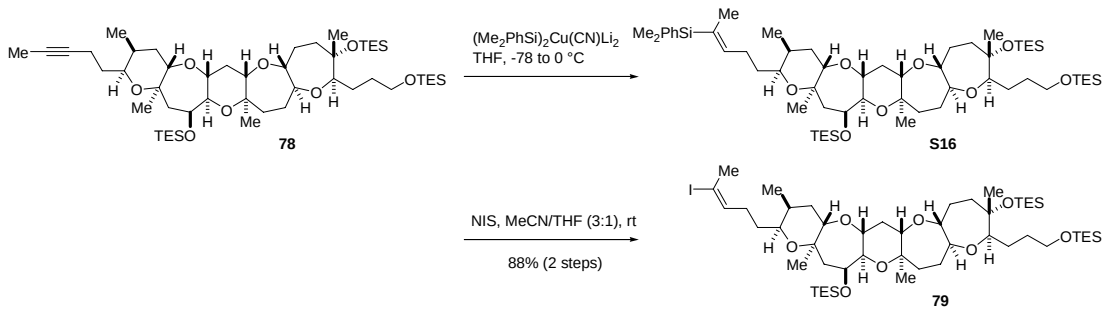
To a solution of the above alkyne in THF/HMPA (10:1, v/v, 2.2 mL) at −78 °C was added *n*-BuLi (1.52 M solution in hexane, 0.22 mL, 0.33 mmol). The resultant mixture was stirred at −78 °C for 0.5 h and then treated with MeI (0.204 mL, 3.28 mmol). The mixture was gradually warmed to room temperature over a period of 1 h and then treated with saturated aqueous NH_4Cl. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 3 → 10% EtOAc/hexanes) gave alkyne **77** (54.6 mg, 78% for the three steps) as a colorless oil: $[\alpha]_D^{19}$ −24.0 (*c* 1.17, $CHCl_3$); IR (film) 2952, 2929, 2886, 2856, 1472, 1462, 1381, 1360, 1255, 1086, 1020, 1005, 835, 773 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 4.41 (ddd, *J* = 12.0, 5.0 Hz, 1H), 4.01 (s, 1H), 3.90 (ddd, *J* = 12.0, 9.5, 5.0 Hz, 1H), 3.71 (m, 1H), 3.64 (m, 1H), 3.56 (m, 1H), 3.49 (q, *J* = 8.0 Hz, 1H), 3.35 (d, *J* = 10.5 Hz, 1H), 3.31 (d, *J* = 9.5 Hz, 1H), 3.22 (ddd, *J* = 9.0, 9.0, 4.0 Hz, 1H), 3.15 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.32 (dt, *J* = 12.0, 4.0 Hz, 1H), 2.29—2.17 (m, 4H), 2.05 (m, 1H), 1.95—1.57 (m, 13H), 1.56 (t, *J* = 2.5 Hz, 3H), 1.53—1.41 (m, 2H), 1.41—1.30 (m, 2H), 1.31 (s, 3H), 1.14 (s, 6H), 1.07 (s, 9H), 1.00 (s, 9H), 1.00 (m, 3H), 0.95 (s, 9H), 0.19 (s, 3H), 0.15 (s, 3H), 0.091 (s, 6H), 0.085 (s, 3H), 0.05 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 88.9, 86.6, 84.8, 83.0, 79.4, 78.1, 77.6, 76.5, 76.0, 75.5, 73.6, 73.3, 73.1, 70.1, 63.8, 49.8, 38.0, 35.5, 34.6, 33.1, 32.8, 30.9, 29.9, 29.4, 27.6, 26.2 (× 6), 26.0 (× 3), 24.01, 24.00, 21.2, 18.54, 18.50, 18.3, 16.1, 15.9, 12.9, 3.4, −2.0, −2.1, −4.0, −4.8, −5.10, −5.12; HRMS (ESI-TOF) calcd for $C_{50}H_{94}O_8Si_3Na$ [$(M+Na)^+$] 929.6154, found 929.6153.



Alkyne 78. To a solution of alkyne **77** (54.6 mg, 0.0602 mmol) in THF (2 mL) at 0 °C was added HF·pyridine (1 mL). After being stirred at room temperature for 15.5 h, the reaction mixture was poured into an ice-cooled saturated aqueous $NaHCO_3$. The aqueous layer was extracted with $CHCl_3$. The combined organic layers were dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 10% MeOH/$CHCl_3$) gave triol **S15** (33.1 mg, 97%): $[\alpha]_D^{20}$ −34.3 (*c* 0.15, $CHCl_3$); IR (film) 3395, 2937, 2876, 1458, 1382, 1339, 1081, 1010, 754 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 4.02 (m, 1H), 3.70—3.57 (m, 5H), 3.40—3.28 (m, 3H),

3.22 (d, J = 11.0 Hz, 1H), 3.12 (dd, J = 12.5, 4.0 Hz, 1H), 2.61 (brs, 1H), 2.21—2.06 (m, 5H), 1.92—1.50 (m, 21H), 1.40—1.29 (m, 2H), 1.16 (s, 3H), 1.15 (s, 3H), 1.10 (s, 3H), 0.92 (d, J = 6.5 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 88.1, 86.1, 84.2, 81.6, 78.9, 77.3, 76.5, 76.4, 75.4, 74.6, 74.2, 73.4, 69.5, 68.9, 62.7, 47.2, 38.1, 37.3, 34.6, 33.7, 32.8, 32.0, 30.0, 29.3, 28.8, 26.6, 23.4, 18.3, 16.0, 15.5, 12.6, 3.5; HRMS (ESI-TOF) calcd for $C_{32}H_{52}O_8Na$ [$(M+Na)^+$] 587.3560, found 587.3557.

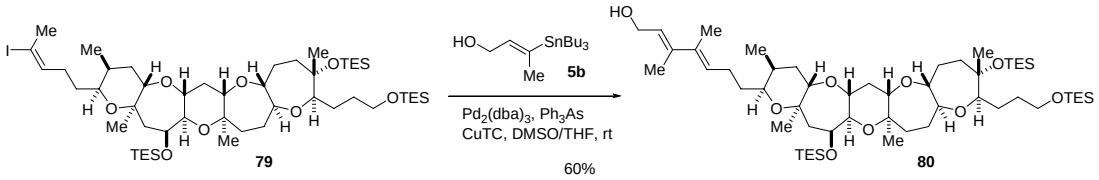
To a solution of the above **S15** (33.1 mg, 0.0586 mmol) in CH_2Cl_2 (3 mL) at 0 °C were added Et_3N (0.16 mL, 1.17 mmol) and TESOTf (0.132 mL, 0.586 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was treated with saturated aqueous $NaHCO_3$. The mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 8% EtOAc/hexanes) gave tris-TES ether **78** (47.2 mg, 89%) as a colorless oil: $[\alpha]_D^{19}$ −25.0 (*c* 0.25, $CHCl_3$); IR (film) 2952, 2914, 2875, 1458, 1415, 1380, 1240, 1086, 1007, 800, 743 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 4.46 (dd, J = 12.0, 5.0 Hz, 1H), 4.04 (t, J = 3.5 Hz, 1H), 3.93 (ddd, J = 12.0, 10.0, 5.0 Hz, 1H), 3.72 (m, 1H), 3.65 (m, 1H), 3.56 (ddd, J = 9.0, 3.0, 3.0 Hz, 1H), 3.50 (m, 1H), 3.39 (d, J = 10.5 Hz, 1H), 3.30 (d, J = 9.5 Hz, 1H), 3.25 (ddd, J = 8.5, 4.0, 4.0 Hz, 1H), 3.17 (dd, J = 12.0, 4.0 Hz, 1H), 2.33 (ddd, J = 12.5, 4.0, 4.0 Hz, 1H), 2.30—2.18 (m, 4H), 2.06 (m, 1H), 1.99—1.75 (m, 10H), 1.74—1.60 (m, 4H), 1.56 (t, J = 2.5 Hz, 3H), 1.52—1.44 (m, 2H), 1.36 (m, 1H), 1.31 (s, 3H), 1.16 (s, 3H), 1.15 (s, 3H), 1.10 (t, J = 8.0 Hz, 9H), 1.04 (t, J = 8.0 Hz, 9H), 0.99 (t, J = 8.0 Hz, 9H), 1.00—0.97 (m, 3H), 0.70 (qd, J = 8.0, 3.5 Hz, 6H), 0.63 (q, J = 8.0 Hz, 6H), 0.58 (q, J = 8.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 89.1, 86.7, 85.0, 82.7, 79.4, 78.1, 77.5, 76.5, 76.1, 75.5, 73.6, 73.2, 72.9, 70.1, 63.4, 49.9, 38.2, 37.9, 35.4, 34.7, 33.2, 32.8, 31.0, 29.9, 29.5, 27.5, 24.3, 21.1, 16.1, 16.0, 12.8, 7.4 (× 3), 7.3 (× 3), 7.13 (× 3), 7.10 (× 3), 5.3 (× 3), 4.9 (× 3), 3.4; HRMS (ESI-TOF) calcd for $C_{50}H_{94}O_8Si_3Na$ [$(M+Na)^+$] 929.6154, found 929.6153.



(*E*)-Vinyl iodide 79. To a suspension of CuCN (54.1 mg, 0.60 mmol) in THF (1.0 mL) at 0 °C was added $Me_2PhSiLi$ (ca. 0.60 M solution in THF, 2.0 mL, 1.20 mmol). After being stirred at 0 °C for 20 min, the reaction mixture was cooled to −78 °C. To the mixture was added a cold solution of alkyne **78** (47.2 mg, 0.052 mmol) in THF (1 mL + 0.5 mL rinse). The resultant mixture was stirred at −78 °C for 2 h and then at 0 °C for 2 h before it was treated with a 9:1 mixture of saturated aqueous NH_4Cl and 28% NH_4OH. The residual precipitate was filtered off, and the filtrate was diluted with EtOAc, washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 2 → 8% ether/hexanes) gave (*E*)-vinylsilane **S16** (48.4 mg),

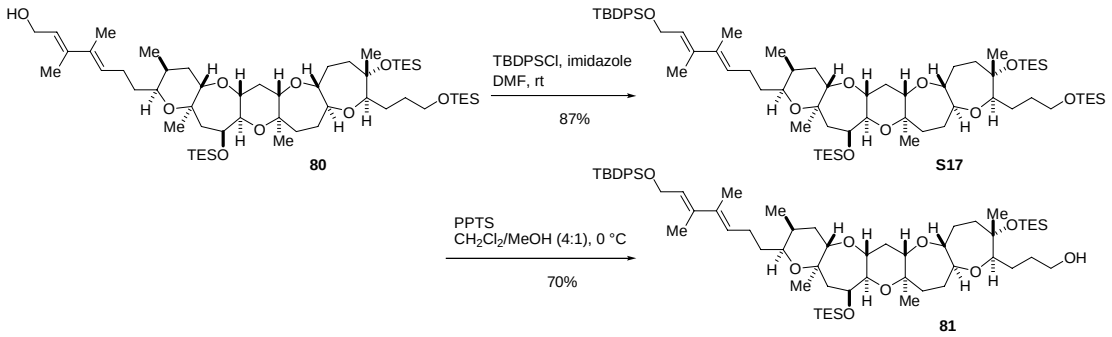
which was contaminated with a silane byproduct(s) and used in the next reaction without further purification. ^{1}H NMR spectrum of the crude product indicated that the regioselectivity of the reaction was ca. 8.5:1.

To a solution of the above (*E*)-vinylsilane **S16** in MeCN/THF (3:1, v/v, 2.8 mL) at 0 °C was added NIS (261.2 mg, 1.16 mmol). After being stirred at room temperature for 11.5 h, the reaction mixture was cooled to 0 °C and treated with a 1:1 mixture of saturated aqueous Na_2SO_3 and $NaHCO_3$. The resultant mixture was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 10% EtOAc/hexanes) gave (*E*)-vinyl iodide **79** (48.0 mg, 88% for the two steps) as a colorless oil. ^{1}H NMR analysis indicated that the material was a 6:1 mixture of alkene stereoisomers. Data for **79**: $[\alpha]_D^{23}$ −31.2 (*c* 1.0, benzene); IR (film) 2952, 2912, 2875, 1459, 1414, 1380, 1241, 1146, 1086, 1006, 805, 743 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 6.11 (td, *J* = 7.5, 1.0 Hz, 1H), 4.43 (dd, *J* = 12.0, 5.0 Hz, 1H), 4.02 (m, 1H), 3.92 (ddd, *J* = 12.0, 9.5, 5.0 Hz, 1H), 3.70 (m, 1H), 3.65 (m, 1H), 3.49 (q, *J* = 8.4 Hz, 1H), 3.38 (d, *J* = 10.5 Hz, 1H), 3.33—3.20 (m, 2H), 3.20—3.13 (m, 2H), 2.33 (dt, *J* = 12.5, 4.5 Hz, 1H), 2.26—2.14 (m, 2H), 2.14 (s, 3H), 2.06 (m, 1H), 1.98—1.54 (m, 15H), 1.46 (m, 1H), 1.39—1.25 (m, 3H), 1.20 (s, 3H), 1.15 (s, 6H), 1.09 (t, *J* = 8.0 Hz, 9H), 1.02 (t, *J* = 8.5 Hz, 9H), 0.98 (t, *J* = 8.0 Hz, 9H), 0.94 (d, *J* = 7.0 Hz, 3H), 0.69 (qd, *J* = 8.5, 4.0 Hz, 6H), 0.62 (q, *J* = 7.5 Hz, 6H), 0.56 (q, *J* = 8.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 141.6, 93.7, 89.1, 86.6, 84.9, 82.7, 78.1, 77.5, 76.5, 76.1, 73.6, 73.0, 72.9, 70.5, 63.4, 49.9, 38.2, 37.9, 35.3, 34.7, 33.3, 32.2, 31.0, 29.9, 29.5, 27.8, 27.5, 27.4, 24.3, 20.9, 16.0, 12.8, 7.4 (× 3), 7.3 (× 3), 7.13 (× 3), 7.11 (× 3), 5.4 (× 3), 4.9 (× 3); HRMS (ESI-TOF) calcd for $C_{50}H_{95}IO_8Si_3Na$ [$(M+Na)^+$] 1057.5277, found 1057.5278.



(*E*,*E*)-Diene 80. To a solution of (*E*)-vinyl iodide **79** (48.0 mg, 0.046 mmol) and (*E*)-vinyl stannane **5b** (83.1 mg, 0.23 mmol) in THF/DMSO (1:1, v/v, 2.0 mL) were added $Pd_2(dba)_3$ (4.2 mg, 0.0046 mmol), Ph_3As (11.3 mg, 0.037 mmol), and CuTC (87.7 mg, 0.46 mmol). The resultant mixture was stirred at room temperature for 3 h before the reaction was quenched with water (3.0 mL). The reaction mixture was stirred for another 30 min and then filtered through a short pad of Celite. The filtrate was diluted with EtOAc, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (silica gel, 0 → 15% EtOAc/hexanes) to give (*E*,*E*)-diene **80** (27.2 mg, 60%) as a colorless oil: $[\alpha]_D^{22}$ −21.5 (*c* 0.50, benzene); IR (film) 3446, 2952, 2875, 1734, 1653, 1559, 1507, 1458, 1415, 1378, 1239, 1086, 1007, 808, 742 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 5.69 (t, *J* = 6.0 Hz, 1H), 5.63 (t, *J* = 7.5 Hz, 1H), 4.51 (dd, *J* = 12.0, 5.5 Hz, 1H), 4.10—4.04 (m, 3H), 3.96 (ddd, *J* = 12.0, 9.5, 4.5 Hz, 1H), 3.73 (m, 1H), 3.66 (m, 1H), 3.51 (m, 1H), 3.44—3.38 (m, 2H), 3.33 (d, *J* = 9.0 Hz, 1H), 3.26 (ddd, *J* = 9.0, 9.0, 4.0 Hz, 1H),

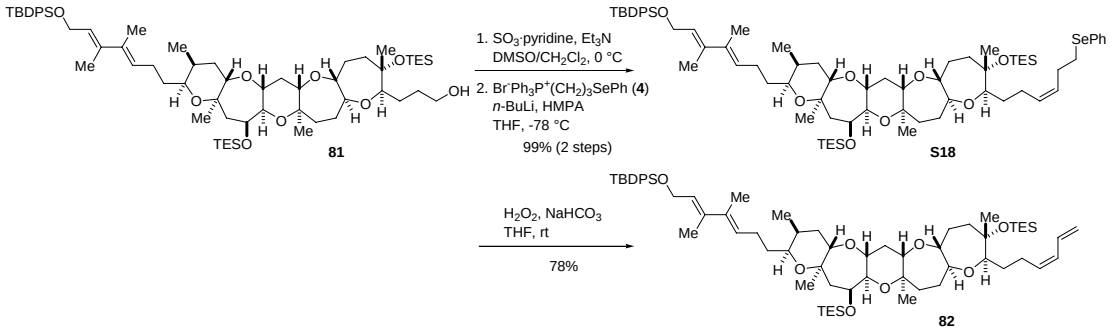
3.19 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.37 (ddd, *J* = 12.0, 4.5, 4.0 Hz, 1H), 2.32—2.02 (m, 5H), 2.00—1.44 (m, 23H), 1.30 (s, 3H), 1.17 (s, 6H), 1.12 (t, *J* = 8.0 Hz, 9H), 1.12 (m, 1H), 1.06 (d, *J* = 7.5 Hz, 3H), 1.04 (t, *J* = 8.0 Hz, 9H), 1.00 (t, *J* = 8.0 Hz, 9H), 0.72 (qd, *J* = 7.5, 4.0 Hz, 6H), 0.64 (q, *J* = 7.5 Hz, 6H), 0.58 (q, *J* = 8.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 138.1, 136.0, 127.5, 125.5, 89.1, 86.7, 84.9, 82.8, 78.1, 77.5, 76.5, 76.1, 73.6, 73.2, 72.9, 71.1, 63.4, 60.0, 50.0, 38.2, 37.9, 35.5, 34.7, 33.4, 31.0, 29.9, 29.5, 27.5, 27.1, 25.9, 24.3, 21.1, 16.0, 14.2, 14.1, 12.8, 7.41 (× 3), 7.37 (× 3), 7.13 (× 3), 7.11 (× 3), 5.4 (× 3), 4.9 (× 3); HRMS (ESI-TOF) calcd for $C_{54}H_{102}O_9Si_3Na$ [(M+Na)$^+$] 1001.6729, found 1001.6722.



Alcohol 81. To a solution of diene **80** (27.1 mg, 0.028 mmol) in DMF (1.5 mL) at 0 °C were added imidazole (9.5 mg, 0.14 mmol) and TBDPSCl (0.021 mL, 0.084 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was quenched with saturated aqueous $NaHCO_3$ and diluted with diethyl ether. The organic layer was separated and washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 2 → 5% EtOAc/hexanes) gave TBDPS ether **S17** (29.6 mg, 87%) as a colorless oil: $[\alpha]_D^{20}$ −17.5 (*c* 0.50, benzene); IR (film) 2952, 2912, 2875, 1458, 1429, 1379, 1239, 1086, 1006, 795, 740, 701 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 7.86—7.82 (m, 4H), 7.24—7.21 (m, 6H), 5.95 (t, *J* = 6.0 Hz, 1H), 5.59 (t, *J* = 7.0 Hz, 1H), 4.53—4.46 (m, 3H), 4.06 (t, *J* = 3.5 Hz, 1H), 3.98 (ddd, *J* = 11.5, 10.0, 4.5 Hz, 1H), 3.73 (m, 1H), 3.66 (m, 1H), 3.51 (q, *J* = 7.5 Hz, 1H), 3.43—3.36 (m, 2H), 3.33 (d, *J* = 9.0 Hz, 1H), 3.26 (m, 1H), 3.19 (dd, *J* = 11.5, 4.0 Hz, 1H), 2.36 (ddd, *J* = 12.5, 4.5, 4.5 Hz, 1H), 2.30—2,19 (m, 3H), 2.14 (m, 1H), 2.08 (m, 1H), 2.00—1.74 (m, 11H), 1.81 (s, 3H), 1.74—1.56 (m, 3H), 1.55 (s, 3H), 1.53—1.46 (m, 2H), 1.29 (s, 3H), 1.20 (s, 9H), 1.18 (s, 6H), 1.12 (t, *J* = 8.0 Hz, 9H), 1.05 (m, 3H), 1.04 (t, *J* = 8.0 Hz, 9H), 1.00 (t, *J* = 8.0 Hz, 9H), 0.72 (qd, *J* = 7.5, 4.0 Hz, 6H), 0.64 (q, *J* = 8.0, 6H), 0.58 (q, *J* = 8.0, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 137.4, 136.0 (× 5), 134.4 (× 2), 129.9 (× 2), 128.0 (× 4), 127.3, 125.4, 89.1, 86.7, 84.9, 82.8, 78.1, 77.5, 76.5, 76.1, 73.6, 73.2, 72.9, 71.1, 63.4, 62.3, 50.0, 38.2, 37.9, 35.5, 34.7, 33.4, 31.0, 29.9, 29.5, 27.5, 27.11, 27.05 (× 3), 25.9, 24.3, 21.1, 19.4, 16.0, 14.3, 14.1, 12.8, 7.40 (× 3), 7.36 (× 3), 7.12 (× 3), 7.11 (× 3), 5.4 (× 3), 4.9 (× 3); HRMS (ESI-TOF) calcd for $C_{70}H_{120}O_9Si_4Na$ [(M+Na)$^+$] 1239.7907, found 1239.7908.

To a solution of TBDPS ether **S17** (29.6 mg, 0.024 mmol) in CH_2Cl_2/MeOH (4:1, v/v, 2 mL) at 0 °C was added PPTS (1.2 mg, 0.0048 mmol). After being stirred at 0 °C for 1 h, the reaction mixture was quenched with Et_3N and concentrated under reduced pressure. Purification of the residue by flash

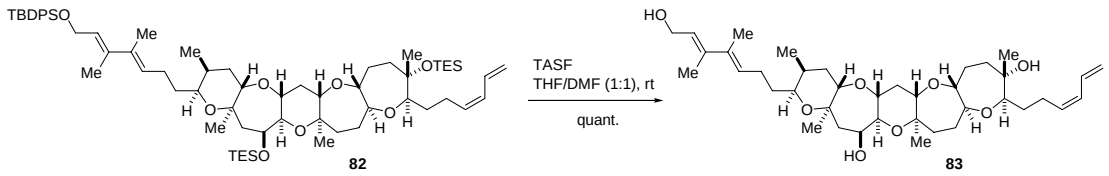
column chromatography (silica gel, 5 → 30% EtOAc/hexanes) gave alcohol **81** (18.6 mg, 70%) as a colorless oil: $[\alpha]_D^{20}$ −15.4 (*c* 0.50, benzene); IR (film) 3503, 2951, 2874, 1458, 1429, 1379, 1339, 1238, 1084, 1007, 741, 701 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 7.86—7.82 (m, 4H), 7.24—7.21 (m, 6H), 5.95 (t, *J* = 6.0 Hz, 1H), 5.59 (t, *J* = 7.0 Hz, 1H), 4.53—4.46 (m, 3H), 4.06 (t, *J* = 3.5 Hz, 1H), 3.96 (ddd, *J* = 12.0, 9.0, 5.0 Hz, 1H), 3.52—3.41 (m, 3H), 3.38 (ddd, *J* = 8.0, 2.5, 2.0 Hz, 1H), 3.33 (d, *J* = 9.5 Hz, 2H), 3.25 (ddd, *J* = 9.0, 4.5, 4.0 Hz, 1H), 3.18 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.37 (m, 1H), 2.30—2.18 (m, 3H), 2.14 (m, 1H), 2.05 (m, 1H), 1.98—1.70 (m, 11H), 1.81 (s, 3H), 1,64—1.47 (m, 4H), 1.56 (s, 3H), 1.46—1.28 (m, 4H), 1.29 (s, 3H), 1.20 (s, 9H), 1.17 (s, 3H), 1.13 (s, 3H), 1.12 (t, *J* = 8.0 Hz, 9H), 1.05 (d, *J* = 7.0 Hz, 3H), 0.98 (q, *J* = 8.0 Hz, 9H), 0.72 (qd, *J* = 8.0, 4.0 Hz, 6H), 0.56 (q, *J* = 8.0 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 137.4, 136.0 (× 5), 134.4 (× 2), 129.9 (× 2), 128.0 (× 4), 127.3, 125.4, 89.1, 86.6, 84.7, 82.8, 78.1, 77.5, 76.5, 76.2, 73.6, 73.2, 72.9, 71.1, 62.8, 62.3, 50.0, 38.1, 37.8, 35.5, 34.7, 33.4, 30.7, 29.9, 29.4, 27.09, 27.05 (× 3), 25.9, 24.2, 25.9, 21.1, 19.4, 15.9, 14.3, 14.1, 12.8, 7.39 (× 3), 7.37 (× 3), 7.1 (× 3), 5.4 (× 3); HRMS (ESI-TOF) calcd for $C_{64}H_{106}O_9Si_3Na$ $[(M+Na)^+]$ 1125.7042, found 1125.7042.



(Z)-Diene 82. To a solution of alcohol **81** (12.5 mg, 0.0113 mmol) in CH_2Cl_2/DMSO (4:1, v/v, 1.5 mL) at 0 °C were added Et_3N (0.016 mL, 0.113 mmol) and SO_3·pyridine (14.4 mg, 0.0904 mmol). After being stirred at 0 °C for 3 h, the reaction mixture was diluted with diethyl ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was passed through a pad of silica gel to give crude aldehyde, which was used in the next reaction without further purification.

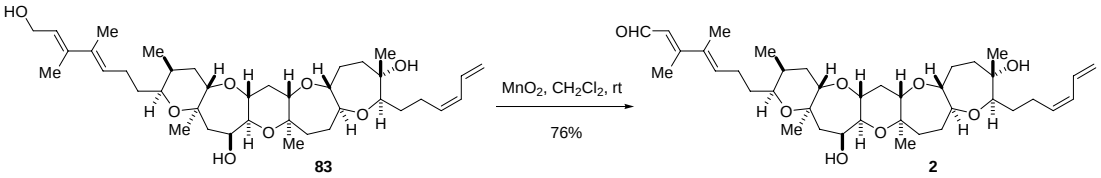
To a solution of $Br^-Ph_3P^+(CH_2)_3SePh$ **4** (29.7 mg, 0.055 mmol) in THF (1.5 mL) at −78 °C was added *n*-BuLi (1.6 M solution in hexane, 0.028 mL, 0.045 mmol). After being stirred at −78 °C for 0.5 h, HMPA (0.010 mL, 0.055 mmol) followed by a solution of the above aldehyde in THF (0.5 mL + 0.3 mL rinse) were added to the reaction mixture. The resultant mixture was allowed to warm to room temperature over a period of 30 min and then treated with water. The aqueous layer was separated and extracted with diethyl ether. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 20% EtOAc/hexanes) gave *cis*-olefin **S18** (14.3 mg, 99% over the two steps) as a colorless oil.

To a solution of **S18** (14.3 mg, 0.0111 mmol) in THF (1.0 mL) were added $NaHCO_3$ (18.6 mg, 0.222 mmol) and 30% H_2O_2 (0.3 mL). After being stirred at room temperature for 18 h, the reaction mixture was diluted with diethyl ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 5 → 10% EtOAc/hexanes) gave (*Z*)-diene **82** (9.8 mg, 78%) as a colorless oil: $[\alpha]_D^{27}$ −27.6 (*c* 0.98, benzene); IR (film) 2952, 2875, 1734, 1458, 1429, 1379, 1238, 1086, 1008, 797, 740, 701 cm^{-1};^{1}H NMR (500 MHz, C_6D_6) δ 7.86—7.81 (m, 4H), 7.25—7.20 (m, 6H), 6.81 (ddd, *J* = 17.0, 11.0, 10.0 Hz, 1H), 6.08 (t, *J* = 11.0 Hz, 1H), 5.95 (t, *J* = 6.0 Hz, 1H), 5.59 (t, *J* = 7.5 Hz, 1H), 5.51 (brq, *J* = 8.5 Hz, 1H), 5.14 (d, *J* = 17.0 Hz, 1H), 5.05 (d, *J* = 10.0 Hz, 1H), 4.54—4.46 (m, 3H), 4.08 (s, 1H), 3.97 (ddd, *J* = 11.5, 9.0, 5.0 Hz, 1H), 3.47 (q, *J* = 8.0 Hz, 1H), 3.41—3.30 (m, 3H), 3.28—3.16 (m, 2H), 2.45—2,33 (m, 3H), 2.31—2.18 (m, 3H), 2.14 (m, 1H), 2.06 (m, 1H), 1.98—1.67 (m, 9H), 1.81 (s, 3H), 1.66—1.46 (m, 4H), 1.56 (s, 3H), 1.40—1.26 (m, 2H), 1.29 (s, 3H), 1.20 (s, 9H), 1.19 (s, 3H), 1.13 (t, *J* = 8.0 Hz, 9H), 1.11 (s, 3H), 1.05 (d, *J* = 7.0 Hz, 3H), 0.97 (t, *J* = 8.5 Hz, 9H), 0.74 (qd, *J* = 8.0, 4.0 Hz, 6H), 0.55 (q, *J* = 8.5 Hz, 6H); ^{13}C NMR (125 MHz, C_6D_6) δ 137.4, 136.0 (× 5), 134.4 (× 2), 133.0, 132.6, 130.2, 129.9 (× 2), 128.0 (× 4), 127.3, 125.4, 117.2, 87.7, 86.4, 85.0, 82.7, 78.1, 77.3, 76.6, 76.2, 73.6, 73.2, 72.9, 71.1, 62.3, 50.0, 38.1, 37.9, 35.5, 34.7, 33.4 (× 2), 30.6, 30.0, 29.4, 27.1 (× 3), 25.9, 25.2, 24.3, 21.1, 19.4, 16.1, 14.3, 14.1, 12.8, 7.39 (× 3), 7.38 (× 3), 7.1 (× 3), 5.4 (× 3); HRMS (ESI-TOF) calcd for $C_{67}H_{108}O_8Si_3Na[(M+Na)^+]$ 1147.7250, found 1147.7239.



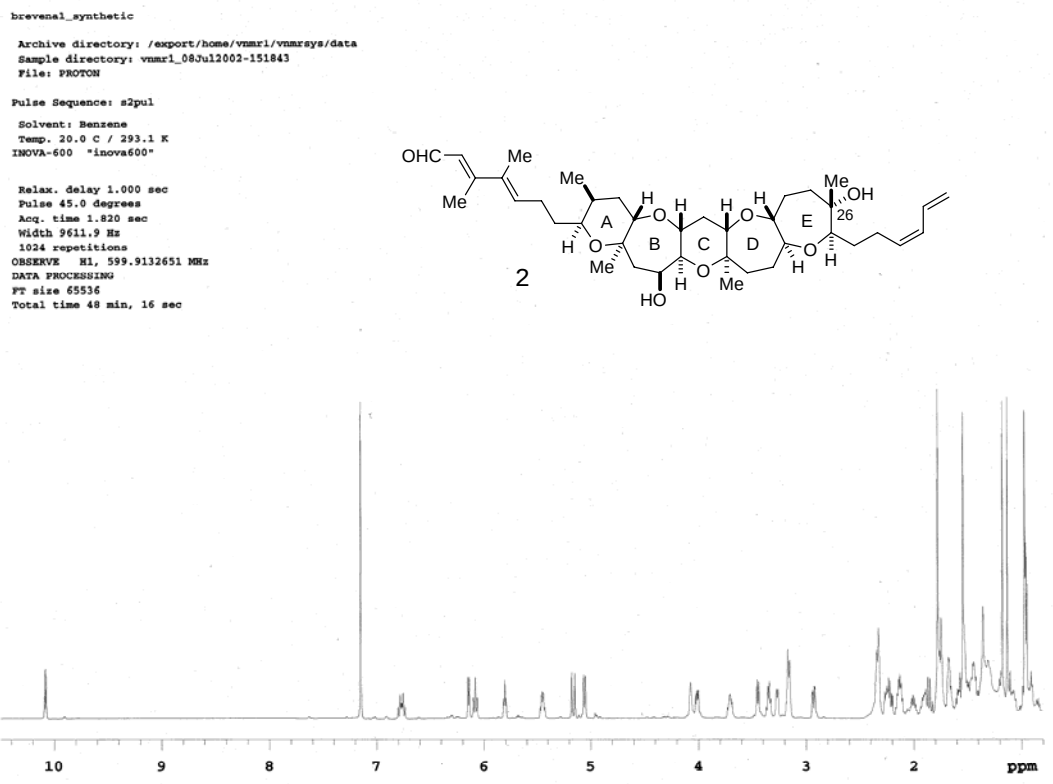
Allyl alcohol 83. To a solution of diene **82** (9.8 mg, 0.0087 mmol) in THF/DMF (1:1, v/v, 1 mL) at 0 °C was added TASF (52.5 mg, 0.19 mmol). The resultant mixture was stirred at room temperature. Additional portion of TASF (20 mg, 0.073 mmol) was added to the reaction mixture over a period of 17 h. After completion of the reaction, the resultant mixture was diluted with diethyl ether, washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification of the residue by flash column chromatography (silica gel, 20 → 80% EtOAc/hexanes) gave allylic alcohol **83** (5.9 mg, quantitative) as a colorless oil: $[\alpha]_D^{26}$ −27.6 (*c* 0.40, benzene); IR (film) 3419, 2927, 1716, 1458, 1380, 1083, 1000, 900 cm^{-1}; ^{1}H NMR (500 MHz, C_6D_6) δ 6.77 (dt, *J* = 17.0, 11.0 Hz, 1H), 6.08 (t, *J* = 11.0 Hz, 1H), 5.70 (t, *J* = 6.5 Hz, 1H), 5.65 (t, *J* = 7.0 Hz, 1H), 5.45 (m, 1H), 5.16 (d, *J* = 17.0 Hz, 1H), 5.06 (d, *J* = 10.0 Hz, 1H), 4.10—4.04 (m, 3H), 4.01 (dd, *J* = 11.5, 5.0 Hz, 1H), 3.75 (ddd, *J* = 11.5, 9.0, 5.5 Hz, 1H), 3.45 (dd, *J* = 9.5, 2.5 Hz, 1H), 3.40 (m, 1H), 3.34 (m, 1H), 3.20—3.12 (m, 2H), 2.92 (dd, *J* = 13.0, 4.5 Hz, 1H), 2.44—2.21 (m, 7H), 2.21—2.07 (m, 2H), 1.94—1.82 (m, 2H), 1.81 (s, 3H), 1.80—1.72 (m, 4H), 1.70 (s, 3H), 1.69—1.56 (m, 5H), 1.56—1.40 (m, 5H), 1.24 (m, 1H), 1.22 (s, 3H), 1.12 (s, 3H), 0.98 (d, *J* = 7.5 Hz, 3H), 0.97 (s, 3H); ^{13}C NMR (125 MHz, C_6D_6) δ 138.1, 136.1, 132.9, 132.6, 130.1, 127.5, 125.5, 117.2, 87.2, 86.1, 84.6, 81.9, 77.1, 76.64, 76.62, 75.0, 74.0, 73.6, 70.7, 69.8,

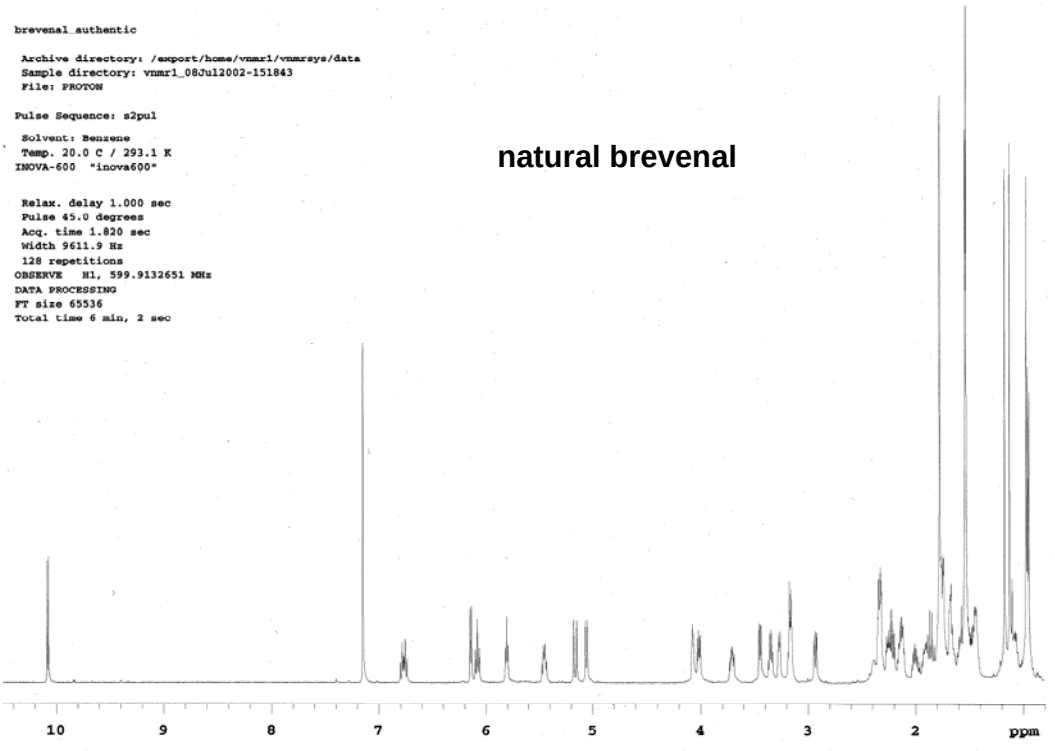
60.0, 47.9, 38.5, 37.6, 35.3, 34.5, 33.4, 33.3, 30.6, 29.8, 29.3, 25.9, 25.1, 23.5, 19.3, 16.1, 14.2, 14.1, 12.8; HRMS (ESI-TOF) calcd for $C_{39}H_{62}O_8Na$ $[(M+Na)^+]$ 681.4342, found 681.4343.



Brevenal (2). To a solution of allylic alcohol **83** (3.3 mg, 0.0050 mmol) in CH_2Cl_2 (0.3 mL) was added MnO_2 (25.7 mg, 0.22 mmol). After being stirred at room temperature for 30 min, the reaction mixture was directly subjected to silica gel column chromatography (30 → 70% EtOAc/hexanes) to afford brevenal (**2**) (2.5 mg, 76%) as a colorless oil: $[\alpha]_D^{27}$ −33.5 (*c* 0.22, benzene); IR (film) 3445, 2927,1716, 1654, 1618, 1458, 1379, 1085, 1001, 901 cm^{-1}; ^1H NMR (500 MHz, C_6D_6) δ 10.09 (d, *J* = 7.0 Hz, 1H), 6.77 (ddd, *J* = 17.0, 10.0, 10.0 Hz, 1H), 6.14 (d, *J* = 7.5 Hz, 1H), 6.08 (t, *J* = 11.0 Hz, 1H), 5.80 (t, *J* = 7.0 Hz, 1H), 5.39 (ddd, *J* = 10.5, 7.5, 7.5 Hz, 1H), 5.16 (d, *J* = 17.0 Hz, 1H), 5.06 (d, *J* = 10.0 Hz, 1H), 4.07 (m, 1H), 4.01 (dd, *J* = 11.0, 6.0 Hz, 1H), 3.71 (ddd, *J* = 11.5, 9.5, 5.5 Hz, 1H), 3.45 (dd, *J* = 9.0, 2.5 Hz, 1H), 3.35 (m, 1H), 3.27 (m, 1H), 3.20—3.13 (m, 2H), 2.93 (dd, *J* = 12.0, 4.0 Hz, 1H), 2.38—2.30 (m, 4H), 2.26 (m, 1H), 2.22 (m, 1H), 2.18—2.08 (m, 2H), 2.01 (m, 1H), 1.95—1.81 (m, 2H), 1.80—1.70 (m, 4H), 1.78 (s, 3H), 1.70—1.62 (m, 2H), 1.62—1.39 (m, 6H), 1.54 (s, 3H), 1.18 (s, 3H), 1.13 (s, 3H), 1.10 (m, 1H), 0.97 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.55 (br, 1H, OH); ^{13}C NMR (150 MHz, C_6D_6) δ 190.7, 156.2, 135.8, 134.6, 132.9, 132.6, 130.1, 126.0, 117.3, 87.2, 86.1, 84.7, 81.9, 77.2, 76.7, 76.4, 74.9, 74.0, 73.6, 70.7, 69.9, 47.8, 38.5, 37.6, 35.2, 34.5, 33.4, 32.6, 30.6, 29.8, 29.3, 26.4, 25.1, 23.5, 19.3, 16.1, 13.8, 13.7, 12.8; HRMS (ESI-TOF) calcd for $C_{39}H_{61}O_8$ $[(M+H)^+]$ 657.4366, found 657.4366.

^{1}H NMR spectra for synthetic 2 and natural brevenal (600 MHz, C_6D_6)





^{13}C NMR spectra for synthetic 2 and natural brevenal (150 MHz, C_6D_6)