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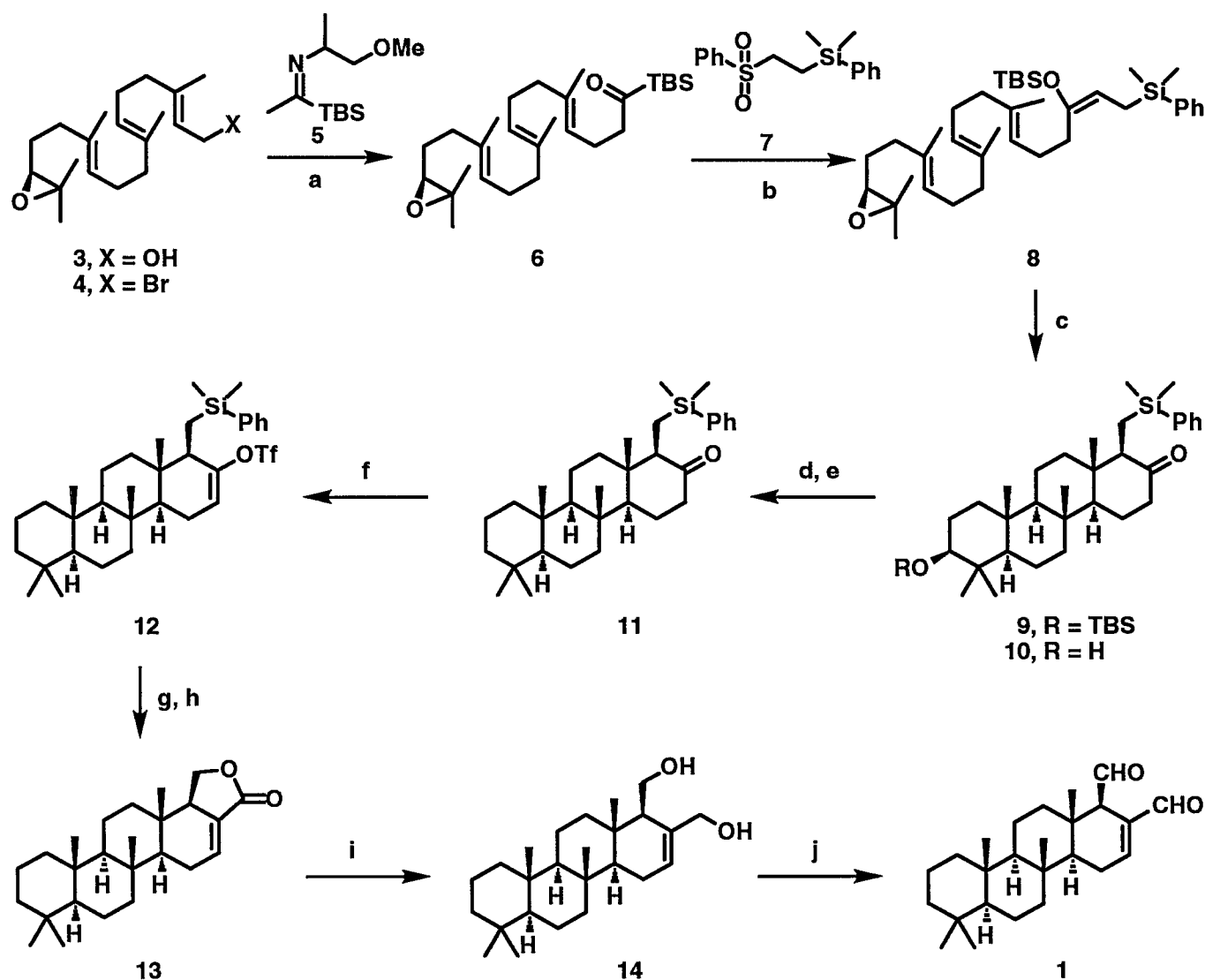
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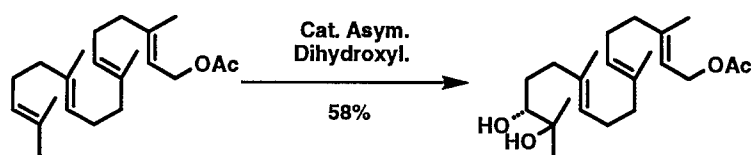
**A Simple Enantioselective Synthesis of the Biologically Active Tetracyclic Marine  
Sesterterpene Scalarenedial**

E. J. Corey,\* Guanglin Luo, and Linus Shouzhong Lin

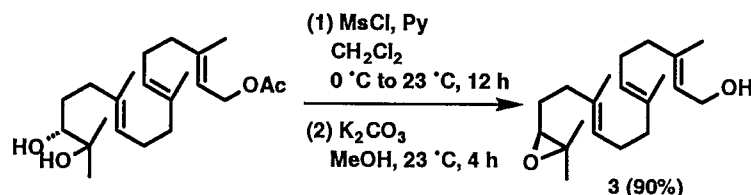
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**Supplementary Material**

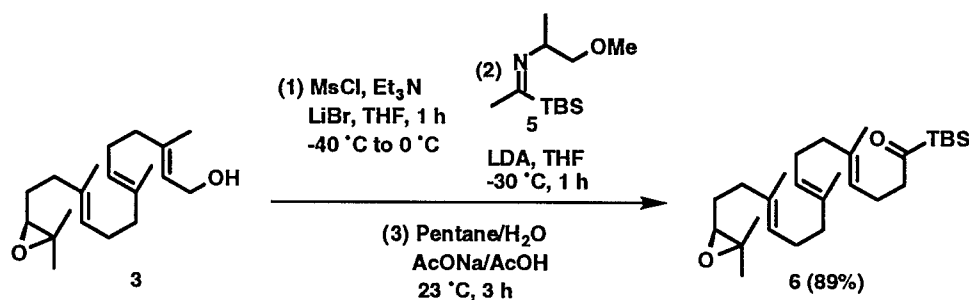




A mixture of the Noe-Lin catalyst,<sup>9a</sup> 1,4-bis[O6'-(4-heptyl)hydrocupreidyl]naphthalazine monomethiodide salt (158 mg, 0.14 mmol), K<sub>2</sub>OsO<sub>4</sub>·H<sub>2</sub>O (26 mg, 0.07 mmol), K<sub>3</sub>Fe(CN)<sub>6</sub> (1.38 g, 42 mmol), K<sub>2</sub>CO<sub>3</sub> (5.8 g, 42 mmol), CH<sub>3</sub>SO<sub>2</sub>NH<sub>2</sub> (1.34 g, 14 mmol), geranyl geranyl acetate (2.32 g, 7 mmol), and 140 mL of 1:1 *t*-BuOH-H<sub>2</sub>O was stirred at 0 °C for 6 h. The reaction mixture was treated with 30 mL of saturated aqueous Na<sub>2</sub>SO<sub>3</sub> and 30 mL of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> at 0 °C and was then allowed to warm to 23 °C for 45 min. Solvent *t*-BuOH was stripped off *in vacuo*. The resulting mixture was extracted with EtOAc (4x20 mL), and the combined extracts were washed with dilute KOH, brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated *in vacuo*. The residue was purified by silica gel chromatography (2:3 EtOAc-hexane) to give 1.5 g of the above diol (58%), 0.23 g of geranyl geranyl acetate (10%), and 103 mg (65% recovery) of the Noe-Lin ligand, which was recovered for reuse by further eluting the column with 20:1:0.1 CHCl<sub>3</sub>-MeOH-NH<sub>4</sub>OH. Found for the diol: [α]<sub>D</sub><sup>23</sup> = +16.3 (c 0.51, C<sub>6</sub>H<sub>6</sub>); IR (neat) ν 3400, 1740, 1232 cm<sup>-1</sup>; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 5.35 (1H, t, J = 7.2 Hz), 5.17 (1H, t, J = 6.8 Hz), 5.09 (1H, t, J = 6.9 Hz), 4.58 (2H, d, J = 7.1 Hz), 3.35 (1H, d, J = 10.0 Hz), 2.30 - 1.90 (10H, m), 2.04 (3H, s), 1.69 (3H, s), 1.61 (3H, s), 1.59 (3H, s), 1.45 - 1.35 (2H, m), 1.19 (3H, s), 1.15 (3H, s); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 171.2, 142.2, 135.3, 134.9, 125.0, 123.8, 118.2, 78.3, 72.9, 61.4, 39.5, 39.47, 36.8, 29.6, 26.5, 26.4, 26.1, 23.3, 21.0, 16.4, 15.9, 15.85; HRMS (FAB) calcd for [C<sub>22</sub>H<sub>38</sub>O<sub>4</sub> + Na]<sup>+</sup>: 389.2666, found: 389.2675.

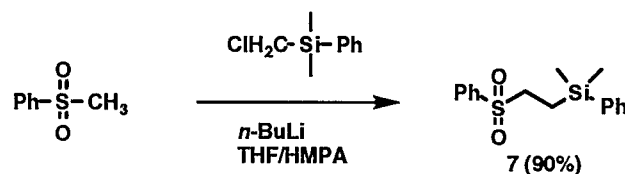


To a solution of (14*R*)-14,15-dihydroxy-14,15-dihydrogeranylgeranylacetate (1.37 g, 3.74 mmol) and pyridine (0.61 mL, 7.49 mmol) in 5 mL of  $\text{CH}_2\text{Cl}_2$  at  $0\text{ }^\circ\text{C}$  was added MsCl (0.35 mL, 4.49 mmol). After stirring at  $23\text{ }^\circ\text{C}$  for 12 h, the reaction mixture was diluted with 45 mL of MeOH, and was treated with  $\text{K}_2\text{CO}_3$  (9 g, 64.9 mmol). After stirring at  $23\text{ }^\circ\text{C}$  for 5 h, the reaction mixture was extracted with EtOAc (3x20 mL), and the combined extracts were washed with dilute  $\text{CuSO}_4$  (2x50 mL), brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was purified by silica gel chromatography (2:1 EtOAc-hexane) to give pure **3** (1.03g, 90%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -3.7$  (c 0.1, MeOH); IR (neat)  $\nu$  3450, 2916, 1378  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  5.41 (1H, t,  $J = 6.9$  Hz), 5.15 (1H, t,  $J = 6.8$  Hz), 5.10 (1H, t,  $J = 6.8$  Hz), 4.17 - 4.06 (2H, m), 2.70 (1H, t,  $J = 6.2$  Hz), 2.20 - 2.02 (8H, m), 1.99 (2H, q,  $J = 7.7$  Hz), 1.67 (3H, s), 1.66 - 1.56 (2H, m), 1.61 (3H, s), 1.59 (3H, s), 1.29 (3H, s), 1.25 (3H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  139.5., 135.2, 134.0, 124.8, 123.9, 123.4, 64.2, 59.3, 58.3, 39.6, 39.5, 36.3, 27.5, 26.5, 26.3, 24.9, 18.7, 16.2, 16.0; HRMS (CI) calcd for  $[\text{C}_{20}\text{H}_{34}\text{O}_2 + \text{NH}_4]^+$ : 324.2903, found: 324.2894.

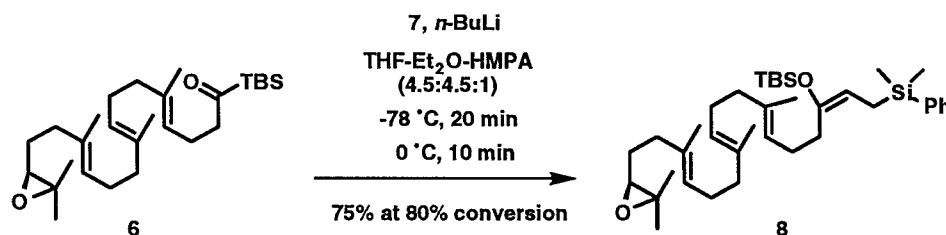


To a solution of (*S*)-14,15-oxido-*E,E,E*-geranylgeraniol **3** (0.93 g, 2.95 mmol) and MsCl (0.30 mL, 3.83 mmol) in 15 mL of THF at  $-45\text{ }^\circ\text{C}$  was added  $\text{Et}_3\text{N}$  (0.82 mL, 5.9 mmol). After

stirring at -45 °C for 45 min, a solution of LiBr (1.03 g, 11.8 mmol, flame-dried under vacuum) in 5 mL of THF was added via cannula. After stirring at 0 °C for 1 h, the mixture was partitioned between hexane (30 mL) and cold water (30 mL). The organic layer was separated, and the aqueous layer was extracted with hexane (2x30 mL). The combined organic solution was successively washed with saturated NaHCO<sub>3</sub> and brine, dried (Na<sub>2</sub>SO<sub>4</sub>) and concentrated to give the crude allylic bromide, which was dried by azeotrope with anhydrous benzene and used without further purification. Thus, to a solution of LDA (4.7 mmol, prepared by reaction of 4.9 mmol of diisopropylamine and 4.7 mmol of BuLi in 7 mL of THF) at -30 °C was added the imine **5**<sup>10a</sup> (1.27 mL, 4.42 mmol) via syringe, and the resulting yellow solution was allowed to warm up to 0 °C for 30 min. The solution was cooled to -30 °C and a solution of the crude bromide in 1 mL of THF (plus a 2 mL rinse) was added via cannula. The reaction mixture was slowly warmed up to -10 °C over 1 h, and quenched with saturated NH<sub>4</sub>Cl (20 mL) at -40 °C. The organic layer was separated, and the aqueous layer was extracted with ethyl acetate (2x30 mL). The combined organic solution was washed with brine, dried (Na<sub>2</sub>SO<sub>4</sub>) and concentrated *in vacuo*. The residue was dissolved in 25 mL of pentane and treated with 25 mL of AcOH-AcONa buffer (a stock solution was prepared by mixing 33 g of AcONa, 7 mL of AcOH and 30 mL of water). After stirring vigorously for 3 h, the mixture was diluted with water and extracted with hexane (3x40 mL). The combined organic solution was successively washed with saturated NaHCO<sub>3</sub> and brine, dried (Na<sub>2</sub>SO<sub>4</sub>) and concentrated *in vacuo*. The residue was purified by silica gel chromatography to afford acylsilane **6** (1.17 g, 89%) as a light yellow oil:  $[\alpha]_D^{23} = -2.69$  (c 1.86, MeOH); IR (neat)  $\nu$  2957, 2929, 2858, 1642, 1249, 838, 824 cm<sup>-1</sup>; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  5.15 (1H, t, J = 6.9 Hz), 5.09 (1H, t, J = 7.5 Hz), 5.06 (1H, t, J = 7.8 Hz), 2.70 (1H, t, J = 6.2 Hz), 2.62 (2H, t, J = 7.4 Hz), 2.19 (2H, q, J = 7.4 Hz), 2.16 - 1.94 (10H, m), 1.70 - 1.50 (2H, m), 1.62 (3H, s), 1.60 (3H, s), 1.59 (3H, s), 1.30 (3H, s), 1.26 (3H, s), 0.92 (9H, s), 0.18 (6H, s); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  196.7, 135.9, 134.9, 134.1, 124.9, 124.3, 123.2, 64.2, 58.3, 50.3, 39.74, 39.68, 36.4, 27.5, 26.72, 26.68, 26.5, 25.0, 20.7, 18.8, 16.6, 16.1, 16.0, -6.9; HRMS (FAB) calcd for [C<sub>28</sub>H<sub>50</sub>O<sub>2</sub>Si + Na]<sup>+</sup>: 469.3478, found: 469.3476.

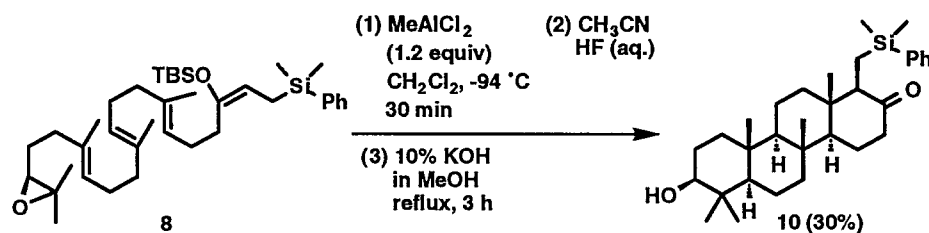


To a solution of methyl phenylsulfone (1.94 g, 12.44 mmol) in 20 mL of THF containing 1.88 mL of TMDEA (12.44 mmol) at  $-78^\circ\text{C}$  was added *n*-butyllithium (1.6 M in hexane, 8.17 mL, 13.07 mmol) dropwise. After the addition of *n*-butyllithium was complete and the reaction mixture allowed to  $-40^\circ\text{C}$ , chloromethyl(phenyldimethyl)silane (2.25 mL, 12.44 mmol) was added via syringe. The mixture was allowed to warm up to  $23^\circ\text{C}$  overnight (12 h). The reaction mixture was hydrolyzed with aqueous 1 M HCl. The organic layer was separated and the aqueous layer was extracted with ether (2x30 mL). The combined organic extracts were successively washed with saturated  $\text{NaHCO}_3$  and brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was purified by silica gel chromatography to afford **7** (3.41 g, 90%) as a colorless crystalline compound: mp  $72 - 74^\circ\text{C}$ ; IR (neat)  $\nu$  3069, 2956, 1318, 1308, 1168, 1144, 838, 819  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 - 7.30 (10H, m), 2.99 - 2.93 (2H, m), 1.20 - 1.13 (2H, m), 0.28 (6H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  138.5, 136.4, 133.5, 133.3, 129.5, 129.1, 128.1, 128.0, 52.3, 8.4, -3.5; HRMS (CI) calcd for  $[\text{C}_{16}\text{H}_{20}\text{O}_2\text{SSi} + \text{NH}_4]^+$ : 322.1297, found: 322.1299.



To a solution of sulfone **7** (394 mg, 1.29 mmol) in 10 mL of THF-ether-HMPA (4.5:4.5:1) at  $-78^\circ\text{C}$  was added *n*-BuLi (1.62 M in hexane, 0.8 mL, 1.29 mmol) dropwise. The resulting yellow solution was then treated with acylsilane **6** (0.6 mL, 534 mg, 1.2 mmol) via

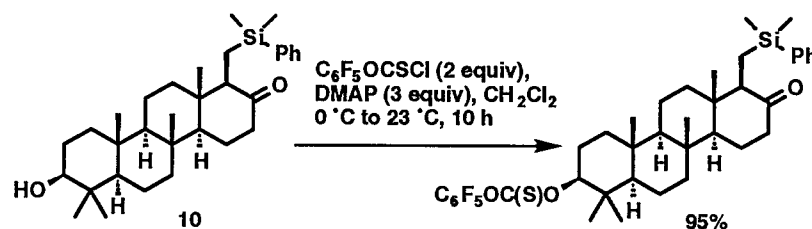
syringe. After stirring at  $-78\text{ }^{\circ}\text{C}$  for 20 min, the reaction mixture was allowed to warm up to  $0\text{ }^{\circ}\text{C}$  for 10 min. The reaction mixture was partitioned between saturated aqueous  $\text{NaHCO}_3$  (5 mL) and hexane (10 mL). The organic layer was separated and the aqueous layer was extracted with hexane (3x10 mL). The combined organic solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was carefully purified by silica gel chromatography (100:10:1 hexane-ether- $\text{Et}_3\text{N}$ ) to afford enolsilane **8** (546 mg, 75%) as a light yellow oil and the starting material acylsilane **6** (105 mg, 20%). Found for enolsilane **8**:  $[\alpha]_{\text{D}}^{23} = -4.11$  (c 1.46,  $\text{C}_6\text{H}_6$ ); IR (neat)  $\nu$  2958, 2929, 1249, 1123, 1114, 836  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{C}_6\text{D}_6$ )  $\delta$  7.50 - 7.44 (2H, m), 7.26 - 7.18 (3H, m), 5.36 (1H, t,  $J = 6.9\text{ Hz}$ ), 5.29 (1H, t,  $J = 6.4\text{ Hz}$ ), 5.26 (1H, t,  $J = 6.8\text{ Hz}$ ), 4.76 (1H, t,  $J = 8.4\text{ Hz}$ ), 2.56 (1H, t,  $J = 6.2\text{ Hz}$ ), 2.36 (2H, q,  $J = 7.6\text{ Hz}$ ), 2.22 - 1.98 (16H, m), 1.66 (3H, s), 1.59 (3H, s), 1.54 (3H, s), 1.15 (3H, s), 1.10 (3H, s), 0.99 (9H, s), 0.26 (6H, s), 0.13 (6H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{C}_6\text{D}_6$ )  $\delta$  150.4, 135.3, 134.9, 134.4, 133.9, 129.2, 125.1, 124.9, 124.7, 102.3, 63.5, 40.2, 40.1, 36.9, 31.7, 28.0, 27.2, 27.1, 26.1, 26.0, 25.0, 18.9, 18.3, 16.2, 16.1, 16.0, 15.6, -3.2, -4.2; FABMS: 608  $[\text{C}_{38}\text{H}_{64}\text{O}_2\text{Si}_2]^+$ , 631  $[\text{M} + \text{Na}]^+$ .



To a solution of enolsilane **8** (190 mg, 0.31 mmol) in 80 mL of anhydrous  $\text{CH}_2\text{Cl}_2$  at  $-95\text{ }^{\circ}\text{C}$  was added a precooled solution of  $\text{MeAlCl}_2$  (1 M in hexane, 0.37 mL, 0.37 mmol) in 20 mL of anhydrous  $\text{CH}_2\text{Cl}_2$  ( $-95\text{ }^{\circ}\text{C}$ ) along the side of the flask via cannula. After stirring at  $-95\text{ }^{\circ}\text{C}$  for 30 min, the reaction mixture was quenched by successive addition of  $\text{Et}_3\text{N}$  (1.3 mL) and a 4:1  $\text{MeOH-H}_2\text{O}$  solution (1.3 mL) again along the side of the flask at  $-95\text{ }^{\circ}\text{C}$ . The resulting mixture was then poured into 40 mL of half saturated  $\text{NH}_4\text{Cl}$ , the organic phase was separated,

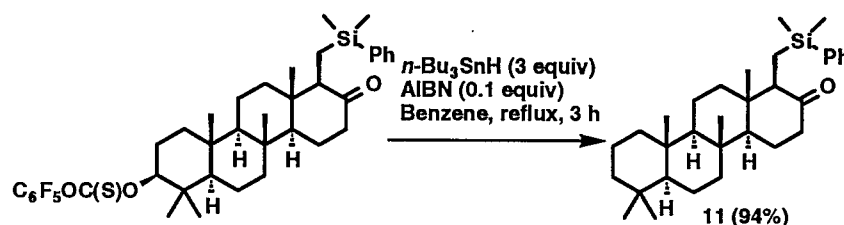
and the aqueous phase was extracted with ether (2x20 mL). The combined organic solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was dissolved in 9.5 mL of  $\text{CH}_3\text{CN}$  and treated with 0.46 mL of aqueous HF (48%) at 23 °C for 1.5 h. The reaction mixture was neutralized with saturated  $\text{NaHCO}_3$  (2 mL), and then partitioned between 20 mL of EtOAc and 20 mL of 1 M KOH. The organic layer was separated, and the aqueous layer was extracted with EtOAc (2x10 mL). The combined organic extract was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was dissolved in 4.6 mL of 10% KOH in MeOH. After refluxing for 3 h under argon, the mixture was diluted with water, and the product was extracted into ethyl acetate (3x10 mL). The combined organic solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was carefully purified by flash column chromatography to afford the more stable  $\beta$ -epimer **10** (47 mg, 30 %) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -17.6$  (c 0.37,  $\text{CHCl}_3$ ); IR (neat)  $\nu$  3453, 2939, 1710, 1388, 1248, 1112, 909, 838  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.51 - 7.45 (2H, m), 7.37 - 7.30 (3H, m), 3.19 (1H, dd,  $J = 11.6, 4.6$  Hz), 2.36 - 2.28 (1H, m), 2.17 (1H, d,  $J = 11.0$  Hz), 2.12 (1H, dt,  $J = 13.3, 7.2$  Hz), 1.99 - 1.91 (1H, m), 1.82 (1H, dt,  $J = 12.6, 3.2$  Hz), 1.79 - 1.69 (2H, m), 1.69 - 0.98 (14H, m), 0.97 (3H, s), 0.83 (3H, s), 0.82 (3H, s), 0.77 (3H, s), 0.67 (3H, s), 0.54 (1H, d,  $J = 14.1$  Hz), 0.20 (3H, s), 0.19 (3H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  211.9, 139.6, 133.7, 128.8, 127.7, 79.0, 60.9, 60.3, 59.3, 55.5, 43.7, 42.2, 41.8, 40.9, 38.9, 38.4, 38.2, 37.3, 28.0, 27.4, 23.0, 18.1, 17.9, 17.3, 16.4, 15.2, 14.6, 7.1, -1.9, -2.9; HRMS (FAB) calcd for  $[\text{C}_{32}\text{H}_{50}\text{O}_2\text{Si} + \text{Na}]^+$ : 517.3478, found: 517.3464.



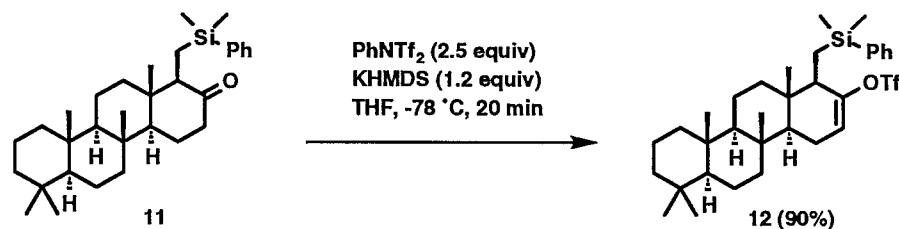


To a solution of **10** (34.9 mg, 0.07 mmol) in 1 mL of  $\text{CH}_2\text{Cl}_2$  at  $0\text{ }^\circ\text{C}$  under argon was added DMAP (25.8 mg, 0.21 mmol) followed by pentafluorophenyl chlorothionoformate\* (23  $\mu\text{L}$ , 0.14 mmol). After the addition was complete, the cooling bath was removed and the reaction mixture was stirred overnight (11 h). The brown-colored mixture was partitioned between 10 mL of EtOAc and 10 mL of water. The organic layer was separated and the aqueous layer was extracted with EtOAc (2x10 mL). The combined organic solution was washed with water, brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was purified by silica gel chromatography to afford the thionoformate (48.5 mg, 95%) a colorless oil: IR (neat)  $\nu$  2951, 1712, 1522, 1307, 1139, 998  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.52 - 7.44 (2H, m), 7.37 - 7.31 (3H, m), 4.93 (1H, dd,  $J = 11.6, 4.7$  Hz), 2.37 - 2.30 (1H, m), 2.20 - 2.09 (2H, m), 2.03 - 1.90 (2H, m), 1.90 - 1.01 (15H, m), 0.98 (3H, s), 0.95 (3H, s), 0.89 (3H, s), 0.85 (3H, s), 0.68 (3H, s), 0.53 (1H, d,  $J = 14.2$  Hz), 0.20 (6H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  211.8, 191.8, 139.5, 133.7, 128.8, 127.7, 95.3, 60.6, 60.2, 59.2, 55.5, 43.6, 42.0, 41.8, 40.7, 38.7, 38.1, 37.9, 37.2, 27.7, 23.0, 22.2, 17.9, 17.8, 17.3, 16.6, 16.4, 14.6, 7.0, -1.9, -3.0; HRMS (FAB) calcd for  $[\text{C}_{39}\text{H}_{49}\text{F}_5\text{O}_3\text{SSi} + \text{Na}]^+$ : 743.2990, found: 743.2983.

\* Corey, E. J.; Rao, K. S.; Ghosh, A. K. *Tetrahedron Lett.* **1992**, 6955.

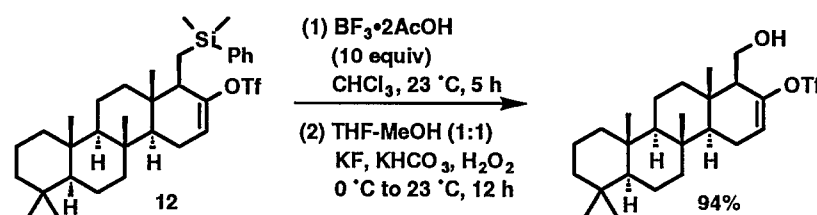


To a solution of the thionoformate (46.5 mg, 0.065 mmol) in refluxing benzene (14 mL) under argon was slowly added a mixture of *n*-Bu<sub>3</sub>SnH (52  $\mu$ L, 0.19 mmol) and AIBN (0.88 mg, 0.0065 mmol) in 10 mL of benzene via syringe pump over 3 h. The resulting mixture was refluxed for another hour and cooled to 23 °C. Benzene was evaporated *in vacuo* and the residue was directly purified by silica gel chromatography to afford the deoxygenated ketone **11** (29 mg, 94%) as a colorless oil:  $[\alpha]_D^{23} = -21.3$  (c 0.45, CHCl<sub>3</sub>); IR (neat)  $\nu$  2948, 1713, 838 cm<sup>-1</sup>; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  7.52 - 7.45 (2H, m), 7.36 - 7.31 (3H, m), 2.35 - 2.28 (1H, m), 2.18 (1H, d, *J* = 10.9 Hz), 2.12 (1H, dt, *J* = 13.3, 7.3 Hz), 2.0 - 1.92 (1H, m), 1.82 - 1.25 (15H, m), 1.22 (1H, dd, *J* = 14.5, 11.1 Hz), 1.12 (1H, dt, *J* = 13.4, 4.0 Hz), 1.07 - 0.95 (2H, m), 0.84 (3H, s), 0.82 (3H, s), 0.81 (3H, s), 0.80 (3H, s), 0.66 (3H, s), 0.55 (1H, d, *J* = 13.7 Hz), 0.20 (3H, s), 0.19 (3H, s); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  212.2, 139.7, 133.7, 128.8, 127.7, 61.0, 60.3, 59.4, 56.6, 43.7, 42.2, 42.1, 41.9, 40.9, 39.9, 38.3, 37.5, 33.4, 33.3, 22.9, 21.4, 18.7, 18.4, 17.7, 17.3, 16.3, 14.6, 7.0, -1.9, -2.9; HRMS (CI) calcd for [C<sub>32</sub>H<sub>50</sub>OSi + NH<sub>4</sub>]<sup>+</sup>: 496.3975, found: 496.3976.



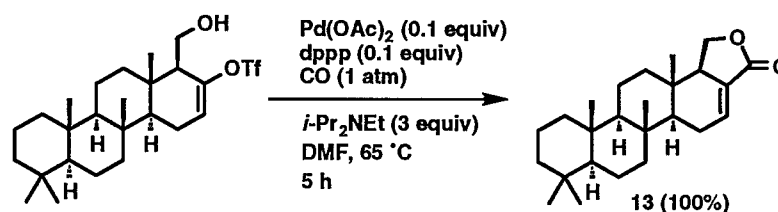
To a solution of **11** (28.7 mg, 0.06 mmol) and *N*-phenyltrifluoromethanesulfonimide<sup>12</sup> (53.5 mg, 0.15 mmol) in anhydrous THF (2 mL) at -78 °C under argon was added KHMDS

(78  $\mu$ L, 0.072 mmol) via syringe. After 20 min the reaction was quenched by saturated  $\text{NH}_4\text{Cl}$  (1 mL). The mixture was extracted with hexane (3x10 mL). The combined organic phase was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was purified by silica gel chromatography (100:1 hexane-ether) to afford the vinyl triflate **12** as a colorless oil (34 mg, 90%):  $[\alpha]_{\text{D}}^{23} = +45.7$  (c 0.7,  $\text{CHCl}_3$ ); IR (neat)  $\nu$  2926, 1414, 1208, 1143, 875  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.56 - 7.50 (2H, m), 7.38 - 7.32 (3H, m), 5.73 - 5.68 (1H, m), 2.33 - 2.28 (1H, m), 2.18 - 2.01 (2H, m), 1.74 - 1.08 (17H, m), 0.87 (3H, s), 0.84 (3H, s), 0.81 (3H, s), 0.80 (3H, s), 0.78 (3H, s), 0.75 - 0.68 (1H, m), 0.33 (3H, s), 0.32 (3H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  151.4, 139.2, 133.8, 129.0, 127.8, 115.4, 60.8, 56.5, 54.5, 48.1, 42.2, 41.7, 40.6, 39.9, 38.8, 37.6, 37.4, 33.4, 33.3, 21.6, 21.4, 18.6, 18.2, 17.5, 16.6, 16.5, 13.5, 11.2, -2.3, -3.0; HRMS (FAB) calcd for  $[\text{C}_{33}\text{H}_{49}\text{F}_3\text{O}_3\text{SSi} + \text{Na}]^+$ : 633.3022, found: 633.3018.



To a solution of vinyl triflate **12** (28.3 mg, 0.046 mmol) in 1 mL of  $\text{CHCl}_3$  at 23  $^\circ\text{C}$  was slowly added  $\text{BF}_3 \cdot 2\text{AcOH}$  (70  $\mu$ L, 0.46 mmol). The resulting mixture was stirred at 23  $^\circ\text{C}$  for 5 h, diluted by ether (10 mL) and neutralized by saturated aqueous  $\text{NaHCO}_3$ . The organic layer was separated and the aqueous layer was extracted with ether (2x10 mL). The combined organic solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was dissolved in 1 mL of THF-MeOH (1:1) at 0  $^\circ\text{C}$ , and followed by the addition of KF (17 mg, 0.29 mmol) and  $\text{KHCO}_3$  (140 mg, 1.4 mmol). The mixture was kept stirring at 0  $^\circ\text{C}$  for 15 min followed by the addition of 30 % aqueous  $\text{H}_2\text{O}_2$  (0.2 mL). The reaction was warmed up to 23  $^\circ\text{C}$  overnight (12 h). The reaction mixture was cooled at 0  $^\circ\text{C}$ , diluted with EtOAc (5 mL) and treated with saturated  $\text{Na}_2\text{SO}_3$  (1 mL). The organic layer was separated and the aqueous layer was

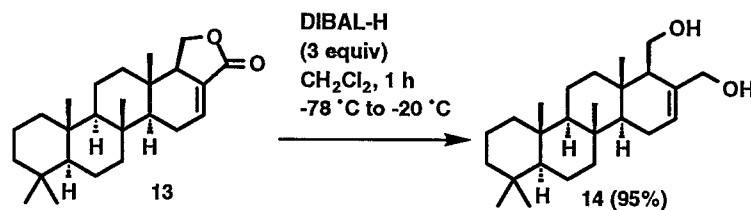
extracted with ethyl acetate (2x10 mL). The combined organic solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was purified by silica gel chromatography to afford the homoallylic alcohol (21.5 mg, 94%) as colorless fine crystals:  $[\alpha]_{\text{D}}^{23} = +10.6$  (c 1.26,  $\text{CHCl}_3$ ); mp 172 - 173 °C; IR (neat)  $\nu$  2931, 1417, 1206, 1144, 880  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  5.79 - 5.83 (1H, m), 3.87 (1H, dd,  $J = 11.7, 3.2$  Hz), 3.77 (1H, dd,  $J = 11.7, 5.9$  Hz), 2.35 - 2.01 (4H, m), 1.74 - 0.91 (16H, m), 0.90 (3H, s), 0.85 (3H, s), 0.84 (3H, s), 0.82 (3H, s), 0.80 (3H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  149.5, 119.1, 60.7, 59.1, 56.4, , 56.1, 54.0, 42.1, 41.8, 40.9, 39.9, 37.6, 37.5, 37.4, 33.3, 21.4, 18.6, 18.2, 17.4, 17.1, 16.5, 15.3; HRMS (FAB) calcd for  $[\text{C}_{25}\text{H}_{39}\text{F}_3\text{SO}_4 + \text{Na}]^+$ : 515.2419, found: 515.2411.



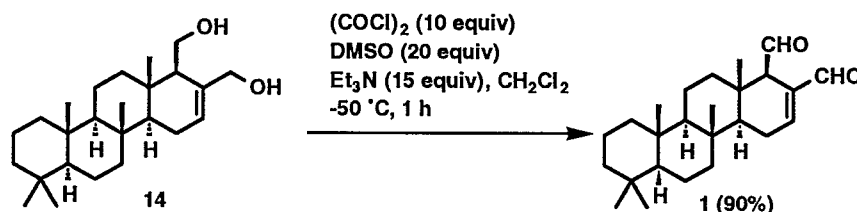
A mixture of the homoallylic alcohol (20 mg, 0.041 mmol),  $\text{Pd}(\text{OAc})_2$  (0.91 mg, 0.0041 mmol, 90  $\mu\text{L}$  was added from the stock solution 10.4 mg in 1 mL of DMF), and dppp (1.67 mg, 0.0041 mmol, 90  $\mu\text{L}$  was added from the stock solution of 19.6 mg in 1 mL of DMF) in DMF (0.67 mL) was heated to 65 °C under CO balloon (1 atm).<sup>\*</sup> After 15 min, during which time the color of the solution changed from light brown to deep brown,  $\text{Et}_3\text{N}$  (22  $\mu\text{L}$ ) in 106  $\mu\text{L}$  of DMF was added via syringe. Stirring was continued at the same temperature for 5 h. After dilution with  $\text{H}_2\text{O}$ , the reaction mixture was extracted with  $\text{Et}_2\text{O}$  (3x10 mL). The combined organic solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was purified by silica gel chromatography to afford the lactone **13** (15 mg, 100%) as colorless needle crystals:  $[\alpha]_{\text{D}}^{23} = -5.6$  (c 0.84,  $\text{CHCl}_3$ ); mp 194 - 196 °C; IR (neat)  $\nu$  2923, 1765  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  6.88 - 6.84 (1H, m), 4.36 (1H, t,  $J = 9.2$  Hz), 4.03 (1H, t,  $J = 9.1$  Hz), 2.79 - 2.75 (1H, m), 2.38 - 2.26 (1 H, m), 2.16 - 2.05 (1H, m), 1.74 - 1.05 (15H, m), 0.92 (3H, s), 0.84 (6H, s), 0.80 (3H, s), 0.76 (3H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  170.3, 136.5, 127.0,

67.3, 61.4, 56.5, 54.9, 51.2, 42.1, 41.8, 40.9, 40.0, 37.7, 37.6, 34.3, 33.3, 24.2, 21.4, 18.6, 18.1, 17.2, 16.5, 14.1; HRMS (EI) calcd for  $[C_{25}H_{38}O_2]^+$ : 370.2872, found: 370.2882.

\* Kotsuki, H.; Datta, P. K.; Suenaga, H. *Synthesis* **1996**, 470.



To a solution of lactone **13** (14.7 mg, 0.04 mmol) in anhydrous  $\text{CH}_2\text{Cl}_2$  (2 mL) at  $-78\text{ }^\circ\text{C}$  under argon was added DIBAL-H (1.0 M in  $\text{CH}_2\text{Cl}_2$ , 0.12 mL, 0.12 mmol) dropwise via syringe. The reaction mixture was stirring at  $-78\text{ }^\circ\text{C}$  for 30 min and at  $-20\text{ }^\circ\text{C}$  for 30 min. Excess DIBAL-H was consumed by the addition of EtOAc and water. The organic layer was separated and the aqueous layer was extracted with EtOAc (3x10 mL). The combined organic solution was washed with 0.5 M HCl (10 mL), brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. Purification by silica gel chromatography (2:1 EtOAc-hexane) afforded the diol **14** (14.2 mg, 95%) as colorless fine crystals: mp  $215\text{--}217\text{ }^\circ\text{C}$ ; IR (neat)  $\nu$  3290 (br), 2919  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  5.76 - 5.80 (1H, m), 4.35 (1H, d,  $J = 11.9\text{ Hz}$ ), 3.99 (1H, d,  $J = 12.0\text{ Hz}$ ), 3.90 (1H, d,  $J = 9.6\text{ Hz}$ ), 3.70 (1H, dd,  $J = 10.3, 8.8\text{ Hz}$ ), 2.20 - 1.0 (18 H, m), 0.89 (3H, s), 0.85 (3H, s), 0.84 (3H, s), 0.81 (3H, s), 0.73 (3H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  141.6, 136.7, 67.5, 61.6, 60.9, 56.5, 55.0, 54.8, 42.2, 41.8, 41.1, 39.9, 37.7, 37.5, 35.7, 33.3, 22.6, 21.4, 18.7, 18.2, 17.7, 16.8, 16.5, 15.9; HRMS (EI) calcd for  $[C_{25}H_{42}O_2]^+$ : 374.3185, found: 374.3168.



A solution of diol **14** (5.5 mg, 0.0147 mmol) in  $\text{CH}_2\text{Cl}_2$  (1 mL, plus a 0.5 mL rinse) was added dropwise to the swern reagent (prepared by adding a solution of DMSO (21  $\mu\text{L}$ ) in  $\text{CH}_2\text{Cl}_2$  (50  $\mu\text{L}$ ) to a solution of oxalyl chloride (13  $\mu\text{L}$ ) in  $\text{CH}_2\text{Cl}_2$  (0.3 mL) at  $-50\text{ }^\circ\text{C}$  for 5 min) under argon at  $-50\text{ }^\circ\text{C}$ , and stirred for 1 h at the same temperature.<sup>14c</sup> To the reaction mixture was then added  $\text{Et}_3\text{N}$  (31  $\mu\text{L}$ ) dropwise. After 10 min, the reaction was quenched by water and the mixture was extracted with  $\text{EtOAc}$  (3x10 mL). The combined organic solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated *in vacuo*. The residue was purified by silica gel chromatography (4:1 hexane- $\text{EtOAc}$ ) to afford scalar-16-ene-19,20-dial (scalarenedial) **1** (4.8 mg, 90%) as colorless fine crystals:  $[\alpha]_{\text{D}}^{23} = -20.7$  (c 0.27,  $\text{CHCl}_3$ ) (lit.  $[\alpha]_{\text{D}}^{25} = -19$  (c 0.7,  $\text{CHCl}_3$ )); mp  $203 - 204\text{ }^\circ\text{C}$  (lit. mp  $200 - 203\text{ }^\circ\text{C}$ ); IR (neat)  $\nu$  2925, 2846, 1711, 1673  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  9.53 (1H, d,  $J = 4.4\text{ Hz}$ ), 9.45 (1H, s), 7.09 - 7.11 (1H, m), 2.80 (1H, br, s), 2.48 - 2.28 (2H, m), 1.90 (1H, dt,  $J = 13.3, 3.0\text{ Hz}$ ), 1.74 (1H, dt,  $J = 12.6, 3.2\text{ Hz}$ ), 1.70 - 1.25 (11H, m), 1.22 (1H, dd,  $J = 11.7, 4.9\text{ Hz}$ ), 1.13 (1H, dt,  $J = 13.4, 4.0\text{ Hz}$ ), 0.95 (3H, s), 0.91 (3H, s), 0.84 (3H, s), 0.83 (3H, s), 0.80 (3H, s);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  202.10, 193.18, 154.39, 138.18, 60.98, 60.84, 56.43, 54.29, 42.13, 41.77, 41.21, 39.87, 37.93, 37.52, 36.97, 33.33, 24.37, 21.40, 18.60, 18.12, 17.07, 16.49, 16.09; HRMS (EI) calcd for  $[\text{C}_{25}\text{H}_{38}\text{O}_2]^+$ : 370.2872, found: 370.2871.