

Supporting Information

**Construction of a C(30-38) Dioxabicyclo[3.2.1]octane Subtarget for
(+)-Sorangicin A, Exploiting a Regio- and Stereocontrolled Acid-Catalyzed
Epoxide Ring Opening**

Amos B. Smith, III,* and Richard J. Fox

*Department of Chemistry, Laboratory for Research on the Structure of Matter, and Monell Chemical
Senses Center, University of Pennsylvania, Philadelphia, PA 19104, U.S.A.*

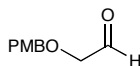
1. Materials and Methods

Except as otherwise indicated, all reactions were carried out under an argon atmosphere in flame- or oven-dried glassware, and solvents were freshly distilled. The argon was deoxygenated and dried by passage through an OXICLEAR™ filter from Aldrich and Drierite tube, respectively. Diethyl ether (Et₂O) and tetrahydrofuran (THF) were distilled from sodium/benzophenone. Dichloromethane (CH₂Cl₂) was distilled from calcium hydride. *n*-Butyllithium (*n*-BuLi) and methyllithium (MeLi) were purchased from Aldrich and titrated against *n*-benzylbenzamide prior to use.¹ Boron trifluoride etherate (BF₃•OEt₂) was purchased from Aldrich and distilled over calcium hydride prior to use. 1,2:4,5-Di-*O*-isopropylidene- α -D-*erythro*-2,3-hexodiulo-2,6-pyranose² was purchased from Aldrich and recrystallized prior to use. All other reagents were purchased from Aldrich, Acros or Strem Chemicals and used as received.

Reactions were monitored by thin layer chromatography (TLC) with 0.25-mm E. Merck pre-coated silica gel plates. Silica gel for flash chromatography (particle size 0.040-0.063 mm) was supplied by Bodman, Silicycle and Sorbent Technologies. Yields refer to chromatographically and spectroscopically pure compounds unless otherwise noted.

All melting points were determined on a Thomas-Hoover apparatus and are uncorrected. ¹H and ¹³C spectra were recorded on a Bruker AMX-500 spectrometer. Chemical shifts are reported as δ values relative to internal chloroform (δ 7.26) or benzene (δ 7.15) for ¹H and either chloroform (δ 77.0) or benzene (δ 128.0) for ¹³C. Infrared spectra were recorded on either a Perkin-Elmer model 283B, Perkin-Elmer model 1600 FTIR, or Jasco FTIR-480plus spectrometer. Optical rotations were measured on a Perkin-Elmer model 241 polarimeter in the solvent indicated. High resolution mass spectra were measured at the University of Pennsylvania Mass Spectrometry Center by Dr. Rakesh Kohli or Mr. John Dykins on either a VG Micromass 70/70H or VG ZAB-E spectrometer. Single crystal X-ray structures were determined by Dr. Patrick Carroll at the University of Pennsylvania with an Enraf Nonius CAD-4 automated diffractometer.

2. Experimental Procedures

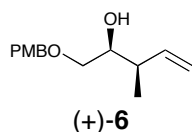


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Aldehyde 5. The NaH (5.59 g, 2.3 equiv., 60% wt.) was first washed with HPLC grade hexanes (3 x 30 mL) and dried *in vacuo*. Anhydrous DMF (90 mL) was then added and the white suspension was carefully treated with a solution of distilled *cis*-2-butene-1,4-diol (5.32 g, 60.4 mmole) in DMF (35 mL). Gas evolution! The pale brown solution was then warmed to 60 °C, and after 2 h, treated with tetrabutylammonium iodide (1.11 g, 0.05 equiv.) and *p*-methoxybenzyl chloride (18.8 mL, 2.3 equiv.). Exotherm! After 2.5 h, the reaction was cooled to ambient temperature and diluted with ether (150 mL) and water (150 mL). The aqueous phase was then washed with ether (3 x 100 mL) and the combined organic layers were washed with water (2 x 50 mL), brine (50 mL), dried over MgSO₄ and concentrated *in vacuo*. Purification by flash chromatography (6/1, hexanes/EtOAc) gave 18.70 g (94% yield) of the bis-PMB compound as a colorless oil: *R*_f 0.13 (6/1, hexanes/EtOAc); IR (thin film, CDCl₃) 3000 (w), 2934 (w), 2836 (m), 1612 (s), 1586 (m), 1513 (s), 1464 (m), 1302 (m), 1248 (s), 1173 (m), 1081 (s), 1035 (s) cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 7.25 (d, *J* = 8.7 Hz, 4 H), 6.87 (d, *J* = 8.7 Hz, 4 H), 5.77 (m, 2 H), 4.42 (s, 4 H), 4.04 (d, *J* = 3.7 Hz, 4 H), 3.80 (s, 6 H); ¹³C NMR (125 MHz, CDCl₃) δ 159.24, 130.27, 129.50, 129.34, 113.80, 71.86, 65.46, 55.24; high resolution mass spectrum (ES+) *m/z* 351.1571 [(M+Na)⁺; calcd for C₂₀H₂₄O₄Na⁺: 351.1580].

A solution of the above olefin (7.07 g, 21.5 mmole) and a catalytic amount of Sudan III in HPLC grade CH₂Cl₂ (215 mL) was cooled to -78 °C and a stream of ozone was bubbled through the orangish/pink solution for 25 min. until a yellowish/brown color persisted. After purging the reaction with oxygen, a solution of triphenylphosphine (8.48 g, 1.5 equiv.) in CH₂Cl₂ (60 mL) was added dropwise over 15 min. and the solution was allowed to slowly warm to ambient temperature. After 5.5 h, the orange solution was concentrated *in vacuo* and purified *via* bulb to bulb distillation to afford 4.10 g (53% yield) of aldehyde **5** as an orange oil, bp ~135 °C (~5 mmHg): IR (thin film, CDCl₃) 3002 (w), 2837 (m), 2710 (w), 1733 (s), 1612 (s), 1586 (m), 1515 (s), 1465 (m), 1303 (m), 1249 (s), 1175 (m), 1109 (m), 1033 (s) cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 9.70 (s, 1 H), 7.28 (d, *J* = 8.6 Hz, 2 H), 6.89 (d, *J* = 8.6 Hz, 2 H), 4.56 (s, 2 H),

4.05 (s, 2 H), 3.80 (s, 3 H); ^{13}C NMR (125 MHz, CDCl_3) δ 200.56, 159.65, 129.70, 128.89, 113.98, 75.00, 73.32, 55.25; high resolution mass spectrum (CI, NH_3) m/z 180.0786 [M^+ ; calcd for $\text{C}_{10}\text{H}_{12}\text{O}_3$: 180.0782].



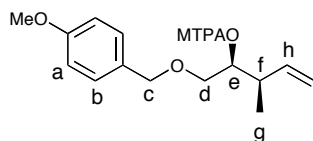
Alcohol (+)-6. The potassium *tert*-butoxide (~5.5 g) was heated at 100 °C under high vac overnight to dry. Some of this solid was then removed, and the flask containing the remaining KO^tBu (4.23 g, 1.5 equiv.) was equipped with a mechanical stir bar, charged with THF (16 mL) and cooled to –45 °C. *cis*-2-butene (3.7 mL, 1.6 equiv.) was then added *via* cannula, followed by *n*-BuLi (15.1 mL, 2.5 M in hexanes, 1.5 equiv.) dropwise over 20 min. to produce an orange suspension. After an additional 5 min., the reaction was cooled to –78 °C and treated with 44 mL (13.50 g, 1.7 equiv.) of a solution of (–)-methoxydiisocampheylborane (22.56 g, weighed out using a glove-bag) in THF (50 mL) dropwise over 15 min. After an additional 30 min., the colorless slurry was treated with $\text{BF}_3 \cdot \text{OEt}_2$ (6.4 mL, 2.0 equiv.) dropwise over 10 min., the azeotroped aldehyde **5** (4.52 g, 25.1 mmole) *via* syringe pump over 1.5 h and 2 x 5 mL THF rinses. After an additional 3 h, the pale yellow slurry was charged with 3N NaOH (45 mL) and allowed to slowly warm to ambient temperature. During this period, H_2O_2 (30% aq., 14 mL) was added in 1.5 mL portions to control bubbling and then brought to reflux for 1 h. The biphasic solution was then cooled to ambient temperature, and after 12 h, diluted with water (50 mL). The aqueous phase was then washed with ether (3 x 50 mL) and the combined organic layers were washed with brine (50 mL), dried over MgSO_4 and concentrated *in vacuo*. Removal of the IPC-OH by distillation (bp ~60 °C, 0.15 mmHg) left 6.23 g of a residue which was purified by flash chromatography (4/1, CH_2Cl_2 /ether) to afford 4.94 g (84% yield) of alcohol (+)-**6** as a pale yellow oil: R_f 0.60 (4/1 CH_2Cl_2 /ether); $[\alpha]_D^{20} +18.2$ (c 0.63, C_6H_6); IR (thin film, CDCl_3) 3457 (m, br), 3075 (w), 2959 (m), 2907 (m), 2865 (m), 2836 (m), 1639 (w), 1612 (m), 1586 (w), 1513 (s), 1462 (m), 1302 (m), 1248 (s), 1173 (m), 1098 (m), 1035 (s) cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 7.25 (d, J = 8.5 Hz, 2 H), 6.88 (d, J = 8.5 Hz, 2 H), 5.73 (ddd, J = 7.9, 10.3, 17.5 Hz, 1 H), 5.03 (m, 2 H), 4.47 (s, 2 H), 3.80 (s, 3 H), 3.62 (m, 1 H), 3.53 (dd, J = 3.1, 9.5 Hz, 1 H), 3.36 (dd, J = 7.8, 9.5 Hz, 1 H), 2.33 (m, 1 H), 1.07 (d, J = 6.8 Hz, 3 H); ^{13}C NMR (125 MHz, CDCl_3) δ 159.21, 140.32,

130.04, 129.30, 114.97, 113.76, 73.33, 72.94, 72.39, 55.19, 41.03, 15.58; high resolution mass spectrum (Cl, NH₃) m/z 236.1413 [M⁺; calcd for C₁₄H₂₀O₃: 236.1412].

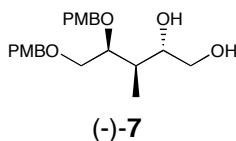
Determination of Absolute Stereochemistry of (+)-6. (*R*)-(-)- α -methoxy- α -trifluoromethyl-phenylacetyl chloride [(*R*)-MTPACl, 16 μ L, 2.0 equiv.) was added to a solution of (+)-**6** (10.0 mg, 42.3 μ mole) and 4-(*N,N*-dimethylamino)pyridine (20.6 mg, 4.0 equiv.) in CH₂Cl₂ (500 μ L). After 3 h, direct purification by Preparative-TLC (5/1, hexanes/EtOAc, 500 μ m plate) afforded 18.0 mg (94% yield, >20:1 ratio of diastereomers) of the (*S*)-MTPA ester of (+)-**6** as a colorless oil: R_f 0.42 (5/1, hexanes/EtOAc); [α]_D²⁰ -4.5 (c 0.71, C₆H₆); IR (thin film, CDCl₃) 3071 (w), 2953 (m), 2851 (w), 1749 (s), 1613 (m), 1514 (s), 1452 (m), 1249 (s), 1172 (s), 1123 (m), 1022 (m) cm⁻¹; ¹H NMR (500 MHz, CDCl₃, * represents the minor diastereomer) δ 7.60 (d, *J* = 7.8 Hz, 2 H), 7.35 (m, 1 H), 7.29 (m, 2 H), 7.21 (d, *J* = 8.6 Hz, 2 H), 6.86 (d, *J* = 8.6 Hz, 2 H), 5.66 (ddd, *J* = 7.6, 10.0, 17.5 Hz, 1 H), 5.26 (ddd, *J* = 3.2, 7.1, 7.1 Hz, 1 H), 5.15 (m, 2 H), 4.48 (d, *J* = 11.4 Hz, 1 H), 4.41 (d, *J* = 11.4 Hz, 1 H), 3.80 (s, 3 H), 3.63 (dd, *J* = 3.2, 10.9 Hz, 1 H), 3.59 (dd, *J* = 7.1, 10.9 Hz, 1 H), 3.56 (s, 3 H), 2.55 (m, 1 H), *1.05 (d, *J* = 6.9 Hz, 3 H), 0.95 (d, *J* = 6.8 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 166.26, 159.28, 138.65, 132.56, 129.86, 129.42, 129.21, 128.20, 127.51, 124.59, 122.30, 116.04, 113.80, 77.85, 72.74, 69.36, 55.45, 55.27, 38.80, 15.13; high resolution mass spectrum (ES+) m/z 475.1728 [(M+Na)⁺; calcd for C₂₄H₂₇F₃O₅Na: 475.1811].

In similar fashion, the (*R*)-MTPA ester of (+)-**6** was obtained in 94% yield (>20:1 mixture of diastereomers) as a colorless oil: R_f 0.42 (5/1, hexanes/EtOAc); [α]_D²⁰ +36.6 (c 0.85, C₆H₆); IR (thin film, CDCl₃) 3070 (w), 2952 (m), 2867 (w), 1747 (s), 1613 (m), 1513 (s), 1452 (m), 1250 (s), 1171 (s), 1121 (m), 1019 (m) cm⁻¹; ¹H NMR (500 MHz, CDCl₃, * represents the minor diastereomer) δ 7.56 (d, *J* = 7.6 Hz, 2 H), 7.39-7.31 (m, 3 H), 7.16 (d, *J* = 8.6 Hz, 2 H), 6.84 (d, *J* = 8.6 Hz, 2 H), 5.76 (ddd, *J* = 7.2, 10.4, 17.4 Hz, 1 H), 5.29 (ddd, *J* = 3.7, 6.8, 6.8 Hz, 1 H), 5.09 (m, 2 H), 4.39 (d, *J* = 11.5 Hz, 1 H), 4.34 (d, *J* = 11.5 Hz, 1 H), 3.80 (s, 3 H), 3.56 (dd, *J* = 3.7, 10.8 Hz, 1 H), 3.52 (dd, *J* = 6.8, 10.8 Hz, 1 H), 3.49 (s, 3 H), 2.62 (m, 1 H), 1.06 (d, *J* = 6.9 Hz, 3 H), *0.95 (d, *J* = 6.9 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 166.26, 159.23, 138.95, 132.16, 129.94, 129.46, 129.17, 128.22, 127.81, 124.52, 122.23, 116.02, 113.75, 77.97, 72.77, 69.23, 55.44, 55.26, 38.55, 14.90; high resolution mass spectrum (ES+) m/z 475.1712 [(M+Na)⁺; calcd for

C₂₄H₂₇F₃O₅: 475.1811].

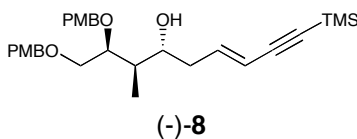


Proton	(<i>S</i>)-MTPA ester	(<i>R</i>)-MTPA ester	(<i>S</i>)-(<i>R</i>)
a	7.21	7.16	+0.05
b	6.86	6.84	+0.02
c1/c2	4.48/4.41	4.39/4.34	+0.09/+0.07
d1/d2	3.63/3.59	3.56/3.52	+0.07/+0.07
e	5.26	5.29	-0.03
f	2.55	2.62	-0.07
g	0.95	1.06	-0.11
h	5.66	5.76	-0.10



Diol (-)-7. A suspension of NaH (723 mg, 1.5 equiv., 95% wt.) and tetrabutylammonium iodide (cat.) in anhydrous DMF (230 mL) was cooled to 0 °C, and treated with a solution of azeotroped alcohol (+)-6 (4.50 g, 19.0 mmole) in DMF (20 mL) *via* cannula. After 1 h, the orangish slurry was charged with *p*-methoxybenzyl chloride (3.9 mL, 1.5 equiv.), and the reaction was allowed to warm to ambient temperature. After 14 h, the reaction mixture was diluted with water (200 mL) and 1:1 hexanes:EtOAc (200 mL). The aqueous phase was then washed with 1:1 hexanes:EtOAc (3 x 100 mL) and the combined organic layers were washed with brine (100 mL), dried over MgSO₄ and concentrated *in vacuo*. Purification by flash chromatography (10/1, hexanes/EtOAc) afforded 6.59 g (97% yield) of the bis-PMB compound as a pale yellow oil: *R*_f 0.18 (10/1 hexanes/EtOAc); [α]_D²⁰ +6.1 (*c* 0.98, CH₂Cl₂); IR (thin film, CDCl₃) 2933 (w), 2904 (w), 2862 (w), 2835 (w), 1612 (m), 1513 (s), 1464 (w), 1301 (m), 1247 (s), 1172 (m), 1088 (m), 1035 (s) cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 7.27 (d, *J* = 8.7 Hz, 2 H), 7.26 (d, *J* = 8.7 Hz, 2 H), 6.88 (d, *J* = 8.7 Hz, 2 H), 6.86 (d, *J* = 8.7 Hz, 2 H), 5.81 (ddd, *J* = 7.6, 10.3, 17.6 Hz, 1 H), 5.04 (m, 1 H), 4.99 (m, 1 H), 4.65 (d, *J* = 11.2 Hz, 1 H), 4.51 (d, *J* = 11.2 Hz, 1 H), 4.46 (s, 2 H), 3.81 (s, 3 H), 3.80 (s, 3 H), 3.58 (dd, *J* = 3.7, 10.2 Hz, 1 H), 3.50 (dd, *J* = 6.1, 10.2 Hz, 1 H), 3.44 (ddd, *J* = 3.7, 6.1, 6.1 Hz, 1 H), 2.48 (m, 1 H), 1.05 (d, *J* = 6.8 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 159.07, 159.00, 141.01, 131.07, 130.54, 129.31, 129.15, 114.39, 113.68, 113.60, 81.43, 72.91, 72.35, 71.20, 55.22, 39.94, 15.51; high resolution mass spectrum (ES+) *m/z* 379.1875 [(*M*+Na)⁺; calcd for C₂₂H₂₈O₄Na: 379.1988].

A mechanically stirred suspension of $\text{K}_3\text{Fe}(\text{CN})_6$ (18.23 g, 3.0 equiv.), K_2CO_3 (7.65 g, 3.0 equiv.) and $(\text{DHQ})_2\text{-PYR}$ (325 mg, 0.02 equiv.) in 1:1 $t\text{BuOH}:\text{H}_2\text{O}$ (150 mL) was cooled to 0 °C and treated with OsO_4 (1.1 mL, 0.01 equiv., 4% wt. in H_2O) dropwise. After a few minutes, the above bis-PMB compound (6.58 g, 18.46 mmole) was added dropwise followed by 1:1 $t\text{BuOH}:\text{H}_2\text{O}$ rinses (3 x 12 mL). After 14 h, the orange suspension was *carefully* quenched by the portionwise addition of NaHSO_3 (31 g). Gas evolution! The brown suspension was then diluted with water (250 mL), EtOAc (250 mL) and the aqueous phase was washed with EtOAc (3 x 100 mL). The combined organic layers were then washed with brine (50 mL), dried over MgSO_4 and concentrated *in vacuo* to afford an ~10:1 mixture of diastereomers. Purification by flash chromatography (1/2, hexanes/EtOAc) afforded 5.95 g (83% yield) of diol (-)-**7** as a pale yellow, viscous oil: R_f 0.32 (1/2 hexanes/EtOAc); $[\alpha]_D^{20}$ -14.1 (c 1.52, CHCl_3); IR (thin film, CDCl_3) 3418 (m, br), 2933 (m), 2836 (m), 1612 (m), 1514 (s), 1463 (m), 1302 (m), 1248 (s), 1173 (m), 1074 (m), 1034 (s) cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 7.26 (d, J = 8.5 Hz, 2 H), 7.25 (d, J = 8.5 Hz, 2 H), 6.88 (d, J = 8.5 Hz, 2 H), 6.87 (d, J = 8.5 Hz, 2 H), 4.66 (d, J = 11.3 Hz, 1 H), 4.54 (d, J = 11.3 Hz, 1 H), 4.49 (d, J = 11.5 Hz, 1 H), 4.46 (d, J = 11.5 Hz, 1 H), 3.85 (m, 1 H), 3.81 (s, 3 H), 3.80 (s, 3 H), 3.68 (dd, J = 6.1, 10.2 Hz, 1 H), 3.64 (m, 1 H), 3.59 (app dd, J = 4.1, 10.2 Hz, 2 H), 3.47 (dd, J = 5.8, 10.8 Hz, 1 H), 1.99 (m, 1 H), 0.88 (d, J = 7.1 Hz, 3 H); ^{13}C NMR (125 MHz, CDCl_3) δ 159.25, 159.20, 130.20, 130.04, 129.48, 129.22, 113.80, 113.78, 79.59, 74.14, 73.07, 72.01, 70.40, 65.00, 55.23, 36.91, 12.08; high resolution mass spectrum (ES+) m/z 413.1946 $[(\text{M}+\text{Na})^+]$; calcd for $\text{C}_{22}\text{H}_{30}\text{O}_6\text{Na}$: 413.2042].

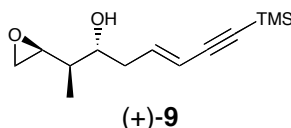


Enyne (-)-8. In flask A, a suspension of NaH (15.3 mg, 3.3 equiv., 95% wt.) in THF (2.1 mL) was cooled to 0 °C and treated with a solution of azeotroped diol (-)-**7** (79.3 mg, 1.1 equiv.) in THF (2.0 mL). After 1 h, a solution of trisylimidazole (61.5 mg, 18.4 μmole) in THF (1.0 mL) was added dropwise *via* syringe pump over 1 h 40 min. Concurrently, in flask B, MeLi (370 μL , 2.5 equiv., 1.24 M in ether) was added dropwise to a solution of 1,4-bis(trimethylsilyl)-1,3-butadiyne (89.4 mg, 2.5 equiv.) in THF (1.8 mL). This slightly cloudy, pale yellow solution was kept stirring at ambient temperature for 2.5 h. Returning to

flask A, after an additional 30 min., the white slurry was cooled to $-78\text{ }^{\circ}\text{C}$ and treated with the lithium anion in flask B *via* cannula followed by $\text{BF}_3\cdot\text{OEt}_2$ (93 μL , 4.0 equiv.). After 45 min., the slurry was quenched with MeOH (5 mL), and after 1 min. diluted with $\text{NH}_4\text{Cl}_{(\text{aq})}$ (15 mL, 50% sat.) and 2:1 hexanes:EtOAc (15 mL). The aqueous phase was then washed with 2:1 hexanes:EtOAc (2 x 10 mL) and the combined organic layers were dried over MgSO_4 and concentrated *in vacuo*. Purification by flash chromatography (3/1, hexanes/EtOAc) afforded 45.2 mg (50% yield) of the bis-acetylene compound as a pale yellow oil: R_f 0.40 (3/1 hexanes/EtOAc); $[\alpha]_D^{20}$ -74.0 (c 1.82 C_6H_6); IR (thin film, CH_2Cl_2) 3446 (m, br), 2957 (m), 2909 (m), 2836 (m), 2224 (m), 2107 (m), 1612 (m), 1513 (s), 1464 (m), 1302 (m), 1249 (s), 1173 (m), 1035 (m) cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 7.26 (d, J = 8.6 Hz, 2 H), 7.24 (d, J = 8.6 Hz, 2 H), 6.89 (d, J = 8.6 Hz, 2 H), 6.86 (d, J = 8.6 Hz, 2 H), 4.67 (d, J = 11.2 Hz, 1 H), 4.54 (d, J = 11.2 Hz, 1 H), 4.49 (d, J = 11.5 Hz, 1 H), 4.46 (d, J = 11.5 Hz, 1 H), 3.94 (m, 1 H), 3.81 (s, 3 H), 3.80 (s, 3 H), 3.58 (app dd, J = 6.3, 10.2 Hz, 2 H), 3.56 (dd, J = 4.2, 10.2 Hz, 1 H), 3.35 (d, J = 5.6 Hz, 1 H), 2.50 (dd, J = 5.4, 17.4 Hz, 1 H), 2.44 (dd, J = 5.6, 17.4 Hz, 1 H), 2.01 (m, 1 H), 0.90 (d, J = 7.1 Hz, 3 H), 0.18 (s, 9 H); ^{13}C NMR (125 MHz, CDCl_3) δ 159.24, 159.19, 130.19, 130.09, 129.59, 129.23, 113.78, 88.31, 83.49, 78.37, 76.46, 73.01, 72.52, 72.06, 71.10, 67.30, 55.21, 38.73, 26.17, 11.81, -0.40 ; high resolution mass spectrum (ES+) m/z 517.2372 $[(\text{M}+\text{Na})^+]$; calcd for $\text{C}_{29}\text{H}_{38}\text{O}_5\text{SiNa}$: 517.2489].

The LiAlH_4 (9.0 mg, 2.5 equiv., 95%) was charged with a solution of the above azeotroped bis-alkyne (44.8 mg, 90.5 μmole) in ether (2.6 mL). Gas Evolution! The suspension was then warmed to $35\text{ }^{\circ}\text{C}$, and after 5 h, *carefully* quenched with 2:1 $\text{Na}_2\text{SO}_4\cdot 10\text{H}_2\text{O}$:celite until stirring ceased. The suspension was then diluted with 1.5 mL CH_2Cl_2 , and after 30 min., charged with Na_2SO_4 , filtered, and concentrated *in vacuo*. Purification by flash chromatography (2/1, hexanes/EtOAc) afforded 38.5 mg (86% yield) of enyne (-)-**8** as a pale yellow oil: R_f 0.64 (2/1 hexanes/EtOAc); $[\alpha]_D^{20}$ -14.5 (c 1.90 CH_2Cl_2); IR (thin film, CDCl_3) 3473 (m, br), 2956 (s), 2906 (s), 2171 (w), 2132 (w), 1935, (w), 1612 (s), 1585 (m), 1514 (s), 1302 (s), 1248 (s), 1173 (m) cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 7.26 (d, J = 8.6 Hz, 2 H), 7.24 (d, J = 8.6 Hz, 2 H), 6.89 (d, J = 8.6 Hz, 2 H), 6.86 (d, J = 8.6 Hz, 2 H), 6.25 (ddd, J = 7.3, 7.3, 15.9 Hz, 1 H), 5.54 (d, J = 15.9 Hz, 1 H), 4.66 (d, J = 11.3 Hz, 1 H), 4.53 (d, J = 11.3 Hz, 1 H), 4.48 (d, J = 11.6 Hz, 1 H), 4.45 (d, J = 11.6 Hz, 1 H), 3.90 (m, 1 H), 3.81 (s, 3 H), 3.80 (s, 3 H), 3.67 (dd, J = 6.3, 10.1 Hz, 1 H), 3.56 (m, 1 H),

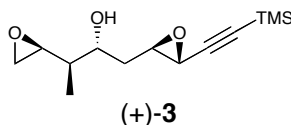
3.54 (dd, $J = 4.3, 10.1$ Hz, 1 H), 2.31 (m, 1 H), 2.17 (m, 1 H), 1.80 (m, 1 H), 0.88 (d, $J = 7.1$ Hz, 3 H), 0.18 (s, 9 H); ^{13}C NMR (125 MHz, CDCl_3) δ 159.25, 159.20, 142.27, 130.26, 130.14, 129.60, 129.23, 113.79, 111.97, 103.85, 93.06, 78.76, 73.42, 73.03, 71.98, 71.08, 55.24, 39.25, 38.92, 11.96, -0.06; high resolution mass spectrum (ES+) m/z 519.2525 $[(\text{M}+\text{Na})^+]$; calcd for $\text{C}_{29}\text{H}_{40}\text{O}_5\text{SiNa}$: 519.2645].



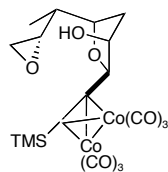
Epoxide (+)-9. A 0 °C solution of (-)-8 (26.9 mg, 54.1 μmole) in CH_3CN (1.4 mL) and pH 7.0 aq. buffer (140 μL) was charged with the ceric ammonium nitrate (408 mg, 6.0 equiv.) in three portions. The orange solution was then allowed to warm to ambient temperature, and after 45 min. was charged with Na_2SO_4 and immediately purified by flash chromatography (100% EtOAc, prepared column with 1% Et_3N) to afford 13.4 mg (97% yield) of the triol as a colorless oil: R_f 0.33 (100% EtOAc); $[\alpha]_D^{20} +20.5$ (c 0.36, C_6H_6); IR (thin film, CDCl_3) 3356 (s, br), 2958 (s), 2898 (s), 2171 (w), 2133 (m), 1421 (m), 1249 (s), 1082 (m), 843 (s) cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 6.21 (m, 1 H), 5.61 (d, $J = 15.9$ Hz, 1 H), 3.98 (m, br, 1 H), 3.67 (m, br, 2 H), 3.61 (m, br, 1 H), 2.41 (m, 1 H), 2.29 (m, 1 H), 1.73 (m, 1 H), 0.94 (d, $J = 7.0$ Hz, 3 H), 0.18 (s, 9 H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.03, 113.17, 103.27, 93.81, 74.21, 73.38, 64.44, 39.33, 39.20, 12.17, -0.15; high resolution mass spectrum (CI, NH_3) m/z 257.1575 $[(\text{MH})^+]$; calcd for $\text{C}_{13}\text{H}_{25}\text{O}_3\text{Si}$: 257.1573].

A 0 °C solution of the above azeotrope triol (1.6 mg, 6.2 μmole) in THF (300 μL) was charged with the NaH (1.0 mg, 4.0 equiv., 60% wt.). After 1 h, a solution of the trisylimidazole (2.0 mg, 1.0 equiv.) in THF (200 μL) was added dropwise over 2 h 10 min. The white slurry was then diluted with $\text{NH}_4\text{Cl}_{(\text{aq})}$ (10 mL, 50% sat.) and CH_2Cl_2 (10 mL). The aqueous phase was then washed with CH_2Cl_2 (3 x 3 mL) and the combined organic layers were dried over Na_2SO_4 and concentrated *in vacuo*. Purification by Prep-TLC (2/1, hexanes/EtOAc, 500 μm plate) afforded 0.9 mg (61% yield) of epoxide (+)-9 as a pale yellow oil: R_f 0.26 (2/1 hexanes/EtOAc); $[\alpha]_D^{20} +31.8$ (c 0.66 C_6H_6); IR (thin film, CDCl_3) 3445 (s, br), 2962 (s), 2899 (m), 2172 (w), 2134 (m), 1409 (w), 1249 (s), 1082 (s), 957 (m), 843 (s) cm^{-1} ; ^1H NMR (500 MHz, C_6D_6) δ 6.20 (ddd $J = 7.4, 7.4, 15.9$ Hz, 1 H), 5.52 (ddd, $J = 1.4, 1.4, 15.9$ Hz, 1 H), 3.05 (ddd, $J = 4.1, 8.0,$

11.9 Hz, 1 H), 2.58 (ddd, J = 2.8, 3.8, 6.5 Hz, 1 H), 2.29 (dd, J = 3.8, 4.9 Hz, 1 H), 2.17 (dd, J = 2.7, 4.9 Hz, 1 H), 1.92 (dddd, J = 1.5, 3.9, 7.0, 14.4 Hz, 1 H), 1.84 (m, 1 H), 1.40 (d, J = 4.3 Hz, 1 H), 1.13 (m, 1 H), 0.70 (d, J = 6.9 Hz, 3 H), 0.21 (s, 9 H); ^{13}C NMR (125 MHz, C_6D_6) δ 142.18, 112.91, 104.60, 93.56, 72.92, 53.91, 46.06, 40.57, 38.61, 12.97, 0.04; high resolution mass spectrum (CI, NH_3) m/z 239.1461 [(MH) $^+$]; calcd for $\text{C}_{13}\text{H}_{22}\text{O}_2\text{Si}$: 239.1466].

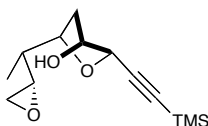


Epoxide (+)-3. All glassware was placed in a saturated KOH/*i*-PrOH mixture overnight prior to use and teflon tubing was used as the needle for the K_2CO_3 and oxone solutions. A solution of (+)-9 (62.9 mg, 264 μmole), and (-)-10 (34.0 mg, 0.5 equiv.) in HPLC grade CH_3CN (4.0 mL) and buffer [2.6 mL, 0.05 M $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ in 4×10^{-4} M aq. $\text{Na}_2(\text{EDTA})$] was charged with the Bu_4NHSO_4 (3.6 mg, 0.04 equiv.). After 2-3 min., the suspension was sequentially treated with a drop of the solution of K_2CO_3 (317 mg, 8.7 equiv.) in water (1.7 mL) followed by a drop of the solution of oxone (336 mg, 2.07 equiv.) in aqueous Na_2EDTA (1.7 mL, 4×10^{-4} M). This process was uniformly repeated making the total addition time 1.5 h. The white suspension was then diluted with CH_2Cl_2 (15 mL) and water (15 mL), and the aqueous phase was washed with CH_2Cl_2 (3×10 mL). The combined organic layers were then washed with brine (15 mL), dried over MgSO_4 and concentrated *in vacuo*. Purification *via* Semi-Prep HPLC (Waters Nova-Pak silica 6 μm , 19 x 300 mm column, flow rate 10 mL/min., 2% IPA in hexanes) afforded 14.6 mg ($R_f \sim 28$ min., 23% yield) of recovered (+)-9 and 27.2 mg ($R_f \sim 32$ min., 41% yield) of bis-epoxide (+)-3 as a colorless oil: R_f 0.21 (2/1 hexanes/EtOAc with 1% Et_3N); $[\alpha]_D^{20} +46.4$ (c 0.95, C_6H_6); IR (thin film, CDCl_3) 3465 (m, br), 2963 (m), 2180 (w), 1250 (s), 844 (s) cm^{-1} ; ^1H NMR (500 MHz, C_6D_6) δ 3.27 (m, 2 H), 3.02 (d, J = 2.2 Hz, 1 H), 2.57 (ddd, J = 2.8, 3.9, 6.6 Hz, 1 H), 2.29 (dd, J = 4.0, 4.9 Hz, 1 H), 2.19 (dd, J = 2.7, 4.9 Hz, 1 H), 1.90 (d, J = 4.4 Hz, 1 H), 1.40 (ddd, J = 4.2, 10.0, 14.2 Hz, 1 H), 1.13 (m, 2 H), 0.68 (d, J = 6.9 Hz, 3 H), 0.13 (s, 9 H); ^{13}C NMR (125 MHz, C_6D_6) δ 103.19, 89.20, 70.97, 58.44, 53.81, 45.91, 45.84, 41.25, 36.71, 12.78, -0.30; high resolution mass spectrum (ES $^+$) m/z 277.1224 [(M+Na) $^+$]; calcd for $\text{C}_{13}\text{H}_{22}\text{O}_3\text{SiNa}$: 277.1234].



(+)-11

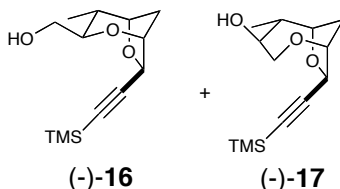
Epoxide (+)-11. The $\text{Co}_2(\text{CO})_8$ (27.7 mg, 1.5 equiv., weighed out using a glove bag) was rapidly treated with a solution of azeotroped (+)-3 (13.9 mg, 54.6 μmole) in CH_2Cl_2 (1.6 mL). Gas evolution! After 50 min., the dark brown solution was cooled to -78°C , stirred an additional 30 min., and treated with 50 μL (0.69 μL , 0.1 equiv.) of a solution of $\text{BF}_3\cdot\text{OEt}_2$ (82 μL) in CH_2Cl_2 (6.0 mL). After 15 min., the reaction was quenched with water (2 mL), warmed to ambient temperature and the aqueous phase was washed with CH_2Cl_2 (2 x 1.5 mL). The combined organic layers were then dried over MgSO_4 and concentrated *in vacuo*. Purification by Preparative-TLC (3/1, hexanes/EtOAc, 500 μm plate) afforded 23.0 mg (78% yield) of (+)-11 as a brown oil: R_f 0.23 (5/1, hexanes/EtOAc); $[\alpha]_D^{20} +45.0$ (c 0.71, C_6H_6); IR (thin film, CDCl_3) 3446 (w), 2963 (w), 2086 (s), 2046 (s), 2016 (s), 1559 (w), 1456 (w), 1247 (w), 1047 (w), 839 (m) cm^{-1} ; ^1H NMR (500 MHz, CDCl_3) δ 4.79 (d, J = 3.8 Hz, 1 H), 4.35 (m, 1 H), 3.87 (ddd, J = 8.0, 8.0, 8.0 Hz, 1 H), 2.92 (m, 1 H), 2.74 (dd, J = 4.2, 4.6 Hz, 1 H), 2.63 (dd, J = 2.7, 4.7 Hz, 1 H), 2.52 (m, 1 H), 1.77 (ddd, J = 2.2, 7.4, 13.7 Hz, 1 H), 1.59 (d, J = 6.7 Hz, 1 H), 1.57 (m, 1 H), 1.03 (d, J = 6.8 Hz, 3 H), 0.31 (s, 9 H); ^{13}C NMR (125 MHz, CDCl_3) δ 200.17, 128.33, 102.15, 84.62, 79.90, 73.31, 54.68, 47.53, 41.77, 40.76, 13.02, 0.84; high resolution mass spectrum (FAB) m/z 427.9899 $[(\text{M}-4\text{CO})^+]$; calcd for $\text{C}_{15}\text{H}_{22}\text{Co}_2\text{O}_5\text{Si}$: 427.9697]. Vapor diffusion crystallization (EtAc/heptane) afforded crystals suitable for X-ray analysis: mp $70-71^\circ\text{C}$.



(-)-15

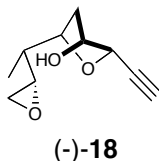
Epoxide (-)-15. A solution of azeotroped (+)-3 (22.7 mg, 89.2 μmole) in CH_2Cl_2 (2.3 mL) was treated with 156 μL (38.6 mg, 1.26 equiv.) of a solution of Co_2CO_8 (175 mg, weighed out using a glove bag) in CH_2Cl_2 (710 μL). After 1 h, the brown solution was cooled to -78°C , and treated with 50 μL (1.3 μL , 0.11 equiv.) of a solution of $\text{BF}_3\cdot\text{OEt}_2$ (128 μL) in CH_2Cl_2 (5.0 mL). After 10 min., the CAN (309 mg, 6.3 equiv.) in

MeOH (1.6 mL) was added to produce a much lighter color solution. After an additional 10 min., water (5 mL) was added, the reaction was warmed to ambient temperature and diluted with water (5 mL) and CH₂Cl₂ (10 mL). The aqueous phase was then washed with CH₂Cl₂ (4 x 10 mL) and the combined organic layers were dried over MgSO₄ and concentrated *in vacuo*. Purification by flash chromatography (2/1, hexanes/EtOAc) afforded 19.9 mg (88% yield) of epoxide (-)-**15** as a pale orange oil: R_f 0.23 (2/1 hexanes/EtOAc); $[\alpha]_D^{20}$ -47.3 (*c* 0.55 C₆H₆); IR (thin film, CDCl₃) 3457 (w, br), 3053 (w), 2962 (s), 2928 (w), 2168 (w), 1326 (w), 1251 (s), 1086 (s), 1045 (s), 844 (s) cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 4.47 (d, *J* = 4.9 Hz, 1 H), 4.30 (dddd, *J* = 4.9, 4.9, 4.9, 6.4 Hz, 1 H), 3.81 (ddd, *J* = 7.7, 7.7, 7.7 Hz, 1 H), 2.89 (ddd, *J* = 2.7, 3.9, 6.8 Hz, 1 H), 2.82 (dd, *J* = 4.0, 4.9 Hz, 1 H), 2.67 (dd, *J* = 2.7, 4.9 Hz, 1 H), 2.31 (m, 1 H), 2.10 (d, *J* = 5.2 Hz, 1 H), 1.78 (ddd, *J* = 4.5, 7.7, 13.0 Hz, 1 H), 1.66 (m, 1 H), 0.98 (d, *J* = 6.9 Hz, 3 H), 0.20 (s, 9 H); ¹³C NMR (125 MHz, CDCl₃) δ 100.11, 94.71, 80.79, 74.01, 72.13, 54.54, 47.47, 41.59, 37.76, 12.73, -0.22; high resolution mass spectrum (CI, NH₃) *m/z* 254.1326 [M⁺; calcd for C₁₃H₂₂O₃Si: 254.1337].

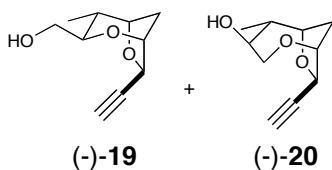


Bicycles (-)-16 and (-)-17. Representative procedure from entry 3 in Table 1. A 0 °C solution of azeotroped (-)-**15** (5.7 mg, 22.4 μ mole) in CH₂Cl₂ (1.4 mL) was treated with 50 μ L (0.3 μ L, 0.1 equiv.) of a solution of BF₃•OEt₂ (84 μ L) in CH₂Cl₂ (15.0 mL). After 1 h, the reaction was immediately passed through a plug of silica and concentrated *in vacuo* to afford a 1:1 ratio of bicycles. Purification *via* Semi-Prep HPLC (Waters Nova-Pak silica 6 μ m, 19 x 300 mm column, flow rate 10 mL/min., 13% IPA in hexanes) afforded 2.7 mg (R_f~ 14 min., 47% yield) of bicycle (-)-**16** and 2.8 mg (R_f~ 17 min., 49% yield) of bicycle (-)-**17** as colorless oils. For bicycle (-)-**16**: R_f 0.26 (8/1 CH₂Cl₂/EtOAc); $[\alpha]_D^{20}$ -80.0 (*c* 0.13, C₆H₆); IR (thin film, C₆D₆) 3445 (m, br), 2960 (s), 2181 (w), 1457 (m), 1250 (m), 1076 (s), 842 (s) cm⁻¹; ¹H NMR (500 MHz, C₆D₆) δ 4.37 (d, *J* = 2.7 Hz, 1 H), 4.33 (ddd, *J* = 2.7, 5.0, 9.7 Hz, 1 H), 3.96 (m, 1 H), 3.81 (app dd, *J* = 6.2, 6.2 Hz, 1 H), 3.75 (ddd, *J* = 2.5, 6.2, 11.6 Hz, 1 H), 3.44 (ddd, *J* = 5.2, 6.4, 11.6 Hz, 1 H), 1.87 (dd, *J* = 6.5, 6.5 Hz, 1 H), 1.24 (m, 2 H), 1.18 (m, 1 H), 0.76 (d, *J* = 6.7 Hz, 3 H), 0.17 (s, 9 H); ¹³C NMR (125 MHz,

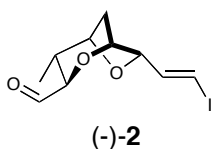
C₆D₆) δ 101.94, 92.61, 80.20, 78.27, 76.55, 71.76, 63.61, 38.31, 36.36, 15.32, -0.20; high resolution mass spectrum (ES+) m/z 277.1229 [(M+Na)⁺; calcd for C₁₃H₂₂O₃SiNa: 277.1337]. For bicycle (-)-**17**: R_f 0.16 (8/1 CH₂Cl₂/EtOAc); $[\alpha]_D^{20}$ -83.2 (*c* 0.13, C₆H₆); IR (thin film, C₆D₆) 3407 (m, br), 2958 (s), 2183 (w), 1457 (w), 1249 (m), 1077 (s), 842 (s) cm⁻¹; ¹H NMR (500 MHz, C₆D₆) δ 4.31 (d, *J* = 3.2 Hz, 1 H), 3.97 (dd, *J* = 3.8, 3.8 Hz, 1 H), 3.93 (dd, *J* = 2.1, 12.6 Hz, 1 H), 3.78 (app dd, *J* = 1.7, 9.1 Hz, 1 H), 3.57 (m, 1 H), 3.36 (dd, *J* = 9.0, 12.6 Hz, 1 H), 1.77 (app d, *J* = 14.0 Hz, 1 H), 1.20 (ddd, *J* = 4.5, 9.1, 14.0 Hz, 1 H), 1.11 (d, *J* = 6.8 Hz, 3 H), 1.02 (m, 1 H), 0.85 (d, *J* = 6.1 Hz, 1 H), 0.18 (s, 9 H); ¹³C NMR (125 MHz, C₆D₆) δ 102.37, 92.29, 81.34, 77.11, 75.62, 73.77, 68.65, 45.06, 32.96, 16.44, -0.01; high resolution mass spectrum (ES+) m/z 277.1239 [(M+Na)⁺; calcd for C₁₃H₂₂O₃SiNa: 277.1337].



Epoxide (-)-18. A solution of azeotroped (-)-**15** (14.3 mg, 56.2 μ mole) in THF (1.2 mL) was charged with tetrabutylammonium fluoride (62 μ L, 1.1 equiv., 1 M in THF). After 1 h, the reaction was concentrated *in vacuo* and purified by flash chromatography (1/1, hexanes/EtOAc) to afford 9.6 mg (94% yield) of epoxide (-)-**18** as a colorless oil: R_f 0.27 (1/1 hexanes/EtOAc); $[\alpha]_D^{20}$ -43.7 (*c* 0.40 C₆H₆); IR (thin film, C₆D₆) 3418 (m), 3267 (m), 3054 (w), 2971 (m), 2928 (m), 2111 (w), 1457 (w), 1327 (w), 1261 (w), 1101 (m), 1042 (s) cm⁻¹; ¹H NMR (500 MHz, C₆D₆) δ 4.05 (dd, *J* = 2.1, 4.9 Hz, 1 H), 3.77 (m, 1 H), 3.33 (m, 1 H), 2.78 (ddd, *J* = 2.6, 3.9, 6.6 Hz, 1 H), 2.51 (dd, *J* = 3.9, 5.1 Hz, 1 H), 2.44 (dd, *J* = 2.6, 5.1 Hz, 1 H), 1.96 (d, *J* = 2.1 Hz, 1 H), 1.75 (d, *J* = 5.5 Hz, 1 H), 1.65 (m, 1 H), 1.49 (m, 2 H), 0.79 (d, *J* = 6.8 Hz, 3 H); ¹³C NMR (125 MHz, C₆D₆) δ 80.61, 79.69, 76.62, 73.32, 72.47, 54.14, 46.91, 41.77, 37.93, 12.67; high resolution mass spectrum (CI, NH₃) m/z 182.0942 [M⁺; calcd for C₁₀H₁₄O₃: 182.0942].



Bicycles (-)-19 and (-)-20. Representative procedure from entry 2 in Table 2. To a 40 °C solution of $\text{BF}_3 \cdot \text{OEt}_2$ (74 μL , 10.0 equiv.) in CH_2Cl_2 (2.5 mL) was added a solution of azeotroped (-)-**18** (10.7 mg, 58.7 μmole) in CH_2Cl_2 (1.4 mL) dropwise over 5 min.. The solution was then quenched with water (1.5 mL), cooled to ambient temperature, and diluted with CH_2Cl_2 (10 mL). The aqueous phase was then washed with CH_2Cl_2 (3 x 5 mL), and the combined organic layers were washed with brine (5 mL), dried over MgSO_4 and concentrated *in vacuo* to afford a 2.1:1 ratio of bicycles. Purification by flash chromatography (3/1, $\text{CH}_2\text{Cl}_2/\text{Et}_2\text{O}$) afforded 7.2 mg (65% yield) of bicycle (-)-**19** and 3.5 mg (32% yield) of bicycle (-)-**20** as colorless oils. For bicycle (-)-**19**: R_f 0.25 (3/1 $\text{CH}_2\text{Cl}_2/\text{OEt}_2$); $[\alpha]_D^{20}$ -120.0 (*c* 0.25 C_6H_6); IR (thin film, C_6D_6) 3432 (m, br), 3279 (m, br), 2959 (m), 2198 (s), 2876 (m), 2849 (m), 2119 (w), 1718 (w), 1457 (m), 1149 (m), 1045 (s) cm^{-1} ; ^1H NMR (500 MHz, C_6D_6) δ 4.26 (dd, J = 2.5, 2.5 Hz, 1 H), 4.17 (ddd, J = 2.6, 4.4, 9.6 Hz, 1 H), 3.90 (m, 1 H), 3.80 (app d, J = 6.2 Hz, 1 H), 3.68 (ddd, J = 2.6, 5.4, 11.6 Hz, 1 H), 3.38 (ddd, J = 4.4, 7.2, 11.6 Hz, 1 H), 2.15 (d, J = 2.4 Hz, 1 H), 1.72 (dd, J = 5.4, 7.2 Hz, 1 H), 1.31 (m, 1 H), 1.24 (app dd, J = 1.4, 11.6 Hz, 1 H), 1.19 (ddd, J = 2.7, 6.2, 11.6 Hz, 1 H), 0.74 (d, J = 6.7 Hz, 3 H); ^{13}C NMR (125 MHz, C_6D_6) δ 80.16, 79.53, 78.07, 76.38, 75.85, 71.10, 63.28, 38.14, 36.14, 15.28; high resolution mass spectrum (CI, NH_3) m/z 183.1018 [(MH) $^+$; calcd for $\text{C}_{10}\text{H}_{15}\text{O}_3$: 183.1020]. Vapor diffusion crystallization (EtAc/heptane) afforded crystals suitable for X-ray analysis: mp 71-73 °C. For bicycle (-)-**20**: R_f 0.15 (3/1 $\text{CH}_2\text{Cl}_2/\text{Et}_2\text{O}$); $[\alpha]_D^{20}$ -33.0 (*c* 0.06, C_6H_6); IR (thin film, C_6D_6) 3401 (s, br), 3229 (s), 2917 (s), 2121 (w), 1462 (m), 1230 (m), 1158 (m), 1049 (s), 1028 (m) cm^{-1} ; ^1H NMR (500 MHz, C_6D_6) δ 4.19 (dd, J = 2.3, 3.0 Hz, 1 H), 3.91 (m, 1 H), 3.83 (dd, J = 2.2, 12.6 Hz, 1 H), 3.77 (app dd, J = 1.7, 9.0 Hz, 1 H), 3.50 (m, 1 H), 3.34 (dd, J = 9.2, 12.6 Hz, 1 H), 2.21 (d, J = 2.3 Hz, 1 H), 1.76 (app d, J = 14.0 Hz, 1 H), 1.22 (ddd, J = 4.6, 9.0, 14.0 Hz, 1 H), 1.12 (d, J = 6.8 Hz, 3 H), 1.00 (m, 1 H), 0.83 (d, J = 5.1 Hz, 1 H); ^{13}C NMR (125 MHz, C_6D_6) δ 81.45, 80.00, 76.98, 75.88, 75.08, 73.56, 68.86, 44.98, 32.67, 16.39; high resolution mass spectrum (CI, NH_3) m/z 182.0948 [M^+ ; calcd for $\text{C}_{10}\text{H}_{14}\text{O}_3$: 182.0942].



Aldehyde (-)-2. A solution of azeotroped (-)-**19** (1.8 mg, 9.8 μ mole) and a catalytic amount of AIBN in distilled Bu₃SnH (75 μ L) was heated to 100 °C. After 2.5 h, the colorless solution was cooled to ambient temperature, charged with CH₂Cl₂ (300 μ L) and treated with a solution of iodine in CH₂Cl₂ until the dark brown/purple color persisted. After an additional 5 min., the reaction was diluted with CH₂Cl₂ (10 mL) and Na₂S₂O_{5(aq)} (5 mL, sat.). The aqueous phase was then washed with CH₂Cl₂ (3 x 5 mL), and the combined organic layers were washed with brine (5 mL), dried over MgSO₄ and concentrated *in vacuo*. The residue was then dissolved in Et₂O (5 mL) and charged with KF/celite³ (195 mg). After 2 h, the suspension was filtered through a pad of celite, concentrated *in vacuo* and purified by flash chromatography (3/2, hexanes/EtOAc) to afford 2.3 mg (77% yield) of the *E*-vinyl iodide: R_f 0.17 (3/2 hexanes/EtOAc); $[\alpha]_D^{20}$ -30.7 (*c* 0.07 CH₂Cl₂); IR (thin film, CDCl₃) 3418 (m, br), 2921 (s), 2863 (m), 1724 (w), 1600 (m), 1456 (m), 1074 (s), 1050 (s) cm⁻¹; ¹H NMR (500 MHz, CDCl₃) δ 6.81 (dd, *J*= 5.2, 14.5 Hz, 1 H), 6.56 (dd, *J*= 1.7, 14.5 Hz, 1 H), 4.38 (m, 1 H), 4.32 (m, 1 H), 4.27 (app d, *J*= 6.6 Hz, 1 H), 3.70 (ddd, *J*= 2.5, 5.2, 11.7 Hz, 1 H), 3.63 (ddd, *J*= 2.5, 4.3, 9.6 Hz, 1 H), 3.49 (ddd, *J*= 4.3, 7.5, 11.7 Hz, 1 H), 2.00 (ddd, *J*= 2.8, 6.6, 11.7 Hz, 1 H), 1.89 (dd, *J*= 5.2, 7.5 Hz, 1 H), 1.83 (app dd, *J*= 1.5, 11.7 Hz, 1 H), 1.67 (m, 1 H), 0.93 (d, *J*= 6.7 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 141.01, 83.56, 79.74, 79.39, 77.85, 75.76, 63.41, 38.35, 36.25, 15.52; high resolution mass spectrum (CI, NH₃) *m/z* 310.0052 [M⁺; calcd for C₁₀H₁₅IO₃: 310.0065].

A 0 °C solution of the above azeotroped vinyl iodide (1.3 mg, 4.1 μ mole) and pyridine (5 μ L, 12.5 equiv.) in CH₂Cl₂ (250 μ L) was charged with the Dess-Martin periodinane (2.6 mg, 1.5 equiv.). The reaction was then allowed to warm to ambient temperature, and after 1 h, the white suspension was diluted with CH₂Cl₂ (10 mL) and NaHCO_{3(aq)} (5 mL, sat.). The aqueous phase was then washed with CH₂Cl₂ (2 x 5 mL) and the combined organic layers were washed with brine (5 mL), dried over Na₂SO₄ and concentrated *in vacuo*. Purification by flash chromatography (3/1, hexanes/EtOAc with 1% Et₃N) afforded 1.3 mg (100% yield) of aldehyde (-)-**2**: R_f 0.19 (3/1 hexanes/EtOAc); $[\alpha]_D^{20}$ -20.0 (*c* 0.05 CHCl₃); IR (thin film, CH₂Cl₂) 2917 (s), 2849 (s), 1738 (m), 1462 (w), 1261 (w), 1075 (m), 1044 (m) cm⁻¹; ¹H NMR (500 MHz, C₆D₆) δ 9.34 (d, *J*= 1.4 Hz, 1 H), 6.60 (dd, *J*= 4.8, 14.5 Hz, 1 H), 6.38 (dd, *J*= 1.8, 14.5 Hz, 1 H), 3.75 (dd, *J*= 1.4, 10.3 Hz, 1 H), 3.73 (m, 1 H), 3.68 (m, 2 H), 1.21 (ddd, *J*= 2.7, 6.5, 11.8 Hz, 1 H), 1.13 (app dd, *J*= 1.4, 11.8 Hz, 1 H), 1.06 (m, 1 H), 0.82 (d, *J*= 6.7 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ

190.54, 140.51, 83.34, 81.18, 79.31, 78.24, 75.53, 37.99, 36.86, 14.82; high resolution mass spectrum (Cl, NH₃) m/z 308.9993 [(MH)⁺; calcd for C₁₀H₁₄IO₃: 308.9987].

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