Synthesis of the C(29)–C(45) Bis-Pyran (E-F) Subunit of Spongistatin 1 (Altohyrtin A)

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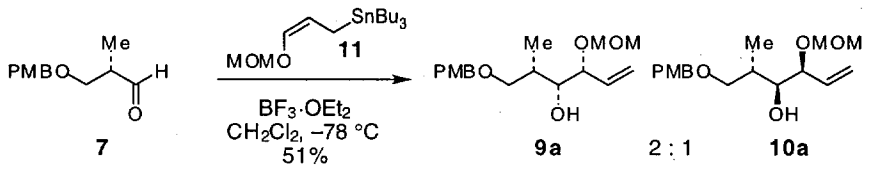
SUPPORTING INFORMATION:

Complete experimental procedures for the synthesis of the C(29)-C(45) Bis-Pyran subunit (E-F) of spongistatin 1 (altohyrtin A) and ^{1}H NMR spectra of compounds **2, 3, 17, 19, 31, 38, 39, 40, 41, 42, 43, 44, 61, 62, 68, 70,** and **71** (46 pages).

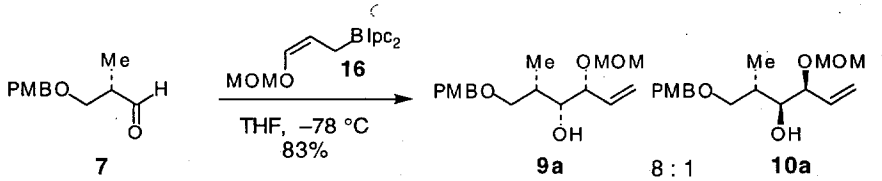
General. All reactions were conducted in flame dried glassware under nitrogen. All solvents were purified before use. THF and Et_2O were dried by distillation from sodium benzophenone ketyl. CH_2Cl_2, pyridine, DMF were dried by distillation from CaH_2. Methanol was distilled from magnesium turnings. Toluene was dried by distillation from sodium. All other commercially available reagents and solvents were used as received.

^1H NMR data were recorded at either 500 MHz or 400 MHz using a Varian I-500 or a Varian XL-400 instrument respectively. ^1H NMR chemical shifts are reported relative to residual $CHCl_3$ (7.26 ppm). ^{13}C NMR data were recorded at either 125 MHz or 100 MHz using a Varian I-500 or a Varian XL-400 instrument respectively. ^{13}C chemical shifts are reported relative to the central line of $CDCl_3$ (77.0 ppm). Infrared spectra were recorded using a Perkin Elmer Spectrum 1000 FT-IR (thin film) . High resolution mass spectroscopy were performed on a VG 70-250-S Micromass, Inc. mass spectrometer at the University of Michigan Mass Spectrometry Laboratory. Optical rotations were measured on either a Rudolph Autopol III polarimeter using a 1 mL capacity quartz cell with a 10 cm path length. Elemental analyses were performed by the Elemental Analysis Laboratory at the University of Michigan.

Chromatographic purifications were performed using Kieselgel 60, 230-400 mesh, silica gel unless indicated otherwise. All compounds purified by chromatography were sufficiently pure for use in further experiments, unless indicated otherwise. Analytical and semi-preparative HPLC normal phase separations were performed using an HPLC system composed of two Rainin HXPL pumps, a Rheodyne 7125 injector, a Dynamax UV-C or RI-1 detector and Dynamax software on a Macintosh II SI to integrate the peaks.



(2*S*,3*R*,4*R*)-1-(4-methoxy-benzyloxy)-4-methoxy-methoxy-2-methyl-hex-5-en-3-ol (9a). **Method A**: To a –78 °C solution of the aldehyde **7** (34 mmol) in 100 mL of CH_2Cl_2 was added the γ-alkoxyallylstannane **11** (14.4 g, 36.7 mmol) followed by $BF_3{\cdot}OEt_2$ (5.2 mL, 41 mmol). The solution was stirred at –78 °C under N_2 for 4.5 h, after which time, the reaction was quenched with 5 mL of NEt_3. The solution was warmed to room temperature, diluted with EtOAc and washed sequentially with $NaHCO_3$ (sat), $KHSO_4$ (1M), NH_4Cl (sat), $NaHCO_3$ (sat), then brine. The organic layer was dried overnight with Na_2SO_4. The crude product was purified by flash column chromatography (hexanes/ethyl acetate) to afford 5.38 g (51%) of a 2 : 1 mixture of diastereomers **9a** and **10a**.

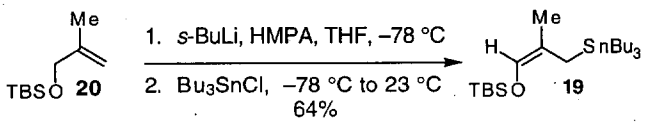


Method B: To a –78 °C solution of the allyl MOM ether (2.05 g, 20.1 mmol) in 8 mL of THF was added 14.5 mL of *s*-BuLi (1.16 M in cyclohexane; 16.8 mmol). The solution was stirred for 10 min after which time (-)IpcBOMe (5.02 g, 15.9 mmol) in 8 mL of THF was added dropwise via cannula. The solution was stirred at –78 °C for 90 min, then $BF_3{\cdot}OEt_2$ (2.6 mL, 20.5 mmol) was added via syringe, followed by the dropwise addition of aldehyde **7** (16.9 mmol) as a solution in 7 mL of THF. The solution was allowed to stir overnight (–78 °C to 23 °C), then cooled to 0 °C, and diluted with 3N NaOH (8 mL) and H_2O_2 (3.3 mL, 30% solution). The mixture was stirred for 3 h, then was diluted with EtOAc and washed sequentially with NH_4Cl (sat), $NaHCO_3$ (sat), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide a crude oil which was purified by flash column chromatography [160 g SiO_2 - 100% hexanes (500 mL), 20 : 1 hexanes : EtOAc (1 L), 15 : 1 hexanes : EtOAc (1 L), 9 : 1 hexanes : EtOAc (1 L), 6 : 1 hexanes : EtOAc (700 mL), 4 : 1 hexanes : EtOAc (500 mL)], which afforded 4.46 g (83% based on **7**) of an 8 : 1 mixture of diastereomers **9a** : **10a** (the mixture was then repurified by HPLC - 35 % EtOAc in hexanes, 21 mm column Dynamax 60A, U.V. detection, 10 ml/min, to obtain analytically pure **10a**).

Data for (2*S*,3*R*,4*R*)-1-(4-methoxy-benzyloxy)-4-methoxy-methoxy-2-methyl-hex-5-en-3-ol (9a): $[\alpha]_D^{26}$ -61.1° (*c* 1.4, CH_2Cl_2); ^1H NMR (500 MHz, $CDCl_3$) δ 7.28-7.26 (m, 2

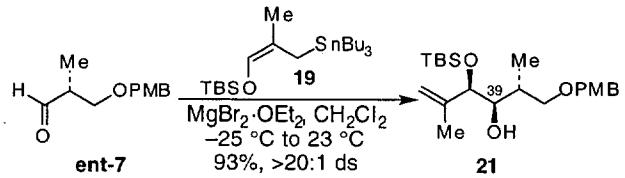
H), 6.90-6.87 (m, 2 H), 5.66 (ddd, J =17.4, 8.4, 1.7 Hz, 1 H), 5.35-5.31 (m, 2 H), 4.76 (A of AB, J = 6.6 Hz, 1 H), 4.61 (B of AB, J = 6.6 Hz, 1 H), 4.47 (A of AB, J = 11.6 Hz, 1 H), 4.44 (B of AB, J = 11.6 Hz, 1 H), 4.01 (dd, J = 8.3, 8.3 Hz, 1 H), 3.82 (s, 3 H), 3.77 (ddd, J = 8.1, 5.2, 2.8 Hz, 1 H), 3.54 (dfd, J = 9.0, 6.8 Hz, 1 H), 3.43-3.40 (m, 4 H), 2.73 (d, J = 2.4 Hz, 1 H), 1.95-1.93 (m, 1 H), 0.94 (d, J = 7.1 Hz, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.1, 134.5, 130.6, 129.2, 120.0, 113.7, 94.0, 80.1, 73.51, 73.47, 72.8, 55.7, 55.2, 34.6, 10.0; IR (thin film) 3497, 3076, 2935, 2888, 2857, 2062, 1882, 1613, 1586, 1514, 1465, 1442, 1422, 1403, 1363, 1302, 1248, 1212, 1173, 1142, 1094, 1035 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{17}H_{27}O_5$, 311.1858 *m/z* (M + H)$^+$; observed, 311.1863 *m/z*. *Anal.* Calcd for $C_{17}H_{26}O_5$: C, 65.78; H, 8.44. Found: C, 65.63; H, 8.40.

Data for (2*S*,3*S*,4*S*)-1-(4-methoxy-benzyloxy)-4-methoxy-methoxy-2-methyl-hex-5-en-3-ol (10a): Characterized as a 3 : 1 mixture with an unidentified minor diastereomer; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.27-7.24 (m, 2 H), 6.89-6.87 (m, 2 H), 5.86 (ddd, J = 17.7, 10.5, 7.6 Hz, 1 H), 5.31-5.26 (m, 2 H), 4.73 (A of AB, J = 6.8 Hz, 1 H), 4.59 (B of AB, J = 6.8 Hz, 1 H), 4.45 (s, 3 H), 4.15 (dd, J = 7.6, 4.6 Hz, 1 H), 3.81 (s, 3 H), 3.58-3.47 (m, 3 H), 3.40 (s, 3 H), 3.27 (d, J = 4.2 Hz, 1 H), 2.15-2.10 (m, 1 H), 1.00 (de, J = 6.8 Hz, 3 H); IR (thin film) 3480, 3076, 2934, 2063, 2004, 1883, 1643, 1614, 1586, 1514, 1464, 1422, 1404, 1362, 1302, 1248, 1212, 1173, 1151, 1094, 1033 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{17}H_{27}O_5$, 311.1858 *m/z* (M + H)$^+$; observed, 311.1854 *m/z*.



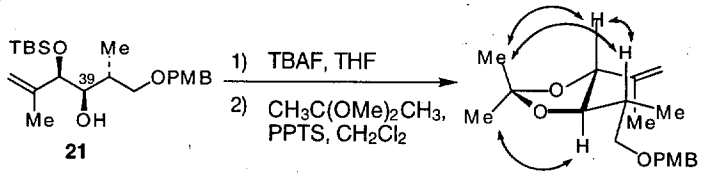
(*Z*)-γ-(*tert*-butyldimethylsilanyloxy)methallyltributylstannane (19). To a 78 °C solution of **20** (50g, 268 mmol) in 300 mL of THF was added 240 ml of *s*-BuLi (1.16M in cyclohexane, 280 mmol) via a jacketed addition funnel (over 15 min). Immediately thereafter 50 mL of HMPA was added. The solution was stirred at –78 °C for 15 min, then 74 mL of Bu_3SnCl (270 mmol) was added via syringe. The solution was stirred for 15 min between –70 to –60 °C, then the ice bath was removed. The solution was stirred for 2 h at ambient temperature, then quenched with NH_4Cl (sat), diluted with hexanes and washed with $NaHCO_3$ (sat), then H_2O. The organic phase was dried over $MgSO_4$ and concentrated to afford a crude oil which was purified by distillation at reduced pressure (ca

0.3 mm Hg; b.p. 160 to 172 °C) providing 81.4 g (64%)of **19**. The distilled product was used as obtained for the allylation of **ent-7**. A small portion of **19** was purified by HPLC (21 mm column Dynamax 60A, 100 % hexanes, 8 ml/min) for characterization purposes: ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.89-5.85 (m, 1 H), 1.77-1.65 (m, 2 H), 1.54-1.44 (m, 9 H), 1.34-1.26 (m, 6 H), 0.93 (s, 9 H), 0.90-0.87 (m, 9 H), 0.85-0.82 (m, 6 H), 0.10 (s, 6 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 130.0, 116.4, 29.2, 27.4, 25.8, 19.7, 18.2, 13.7, 11.8, 9.6, –5.2; IR (thin film) 2957, 2928, 1667, 1464, 1378, 1362, 1252, 1170, 1087, 1006 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{18}H_{39}OSiSn$, 419.1792 *m/z* $(M–C_4H_9)^+$; observed, 419.1778 *m/z*. Stereochemistry of **19** was confirmed by ^{1}H nOe's observed between the allylic methyl protons and the olefinic proton.

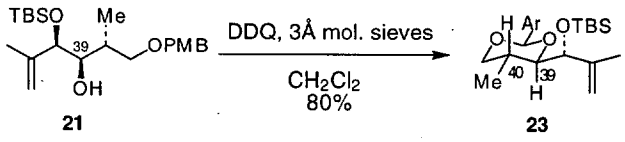


(2*R*,3*R*,4*R*)-4-(*tert*-butyldimethylsilanyloxy)-1-(4-methoxy-benzyloxy)-2,5-dimethyl-hex-5-en-3-ol (21). To a 25 °C solution of aldehyde **ent-7**[1] (14 mmol) in 60 mL of CH_2Cl_2 was added $MgBr_2{\cdot}OEt_2$ (7.2 g, 28 mmol). The solution was stirred at –25 °C for 30 min, after with time the β-methyl-γ-silyloxyallylstannane **19** (10 g, 21 mmol) was added dropwise as a solution in 60 mL of CH_2Cl_2. The solution was allowed to warm to room temperature overnight, then was diluted with 25 mL of CH_3OH and stirred for 30 min. At this point 25 mL of H_2O was added and the solution was stirred an additional 30 min. The solution was diluted with EtOAc and washed sequentially with $NaHCO_3$ (sat) followed by brine. The organic layer was dried over $MgSO_4$, and the solution was filtered and concentrated to proved the crude product **21** as >20 : 1 mixture of diasteriomers. Crude **21** was purified by flash column chromatography [200 g SiO_2 - 100% hexanes (500 mL), 30 : 1 hexanes : EtOAc (600 mL), 20 : 1 hexanes : EtOAc (600 mL), 15 : 1 hexanes : EtOAc (600 mL)], which afforded 5.14 g (93%) analytically pure **21**: $[\alpha]_{365}^{25}$ +3.6° (*c* 2.2, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.27-7.24 (m, 2 H), 6.89-6.86 (m, 2 H), 4.93 (m, 1 H), 4.89 (m, 1 H), 4.43 (s, 2 H), 4.15, (d, *J* = 5.4 Hz, 1 H), 3.80 (s, 3 H), 3.62 (dd, *J* = 9.0, 5.1 Hz, 1 H), 3.41 (dd, *J* = 9.0, 6.5 Hz, 1 H), 3.38 (m, 1 H), 2.64 (d, *J* = 4.9 Hz, 1 H), 1.93-1.86 (m, 1 H), 1.71 (s, 3 H), 1.03 (d, *J* = 6.8 Hz, 3 H), 0.91 (s, 9 H),

0.07 (s, 3 H), 0.03 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.0, 145.3, 130.8, 129.2, 113.7, 113.6, 77.1, 75.6, 72.8, 71.9, 55.2, 35.3, 25.8, 18.2, 18.0, 15.4, -4.5, -5.1; IR (thin film) 3563, 3073, 2956, 2930, 2858, 1613, 1514, 1249, 1093, 1040 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{22}H_{39}SiO_4$, 395.2618 *m/z* $(M + H)^+$; observed, 395.2619 *m/z*. *Anal.* Calcd for $C_{22}H_{38}SiO_4$: C, 66.96; H, 9.71. Found: C, 67.00; H, 9.84.

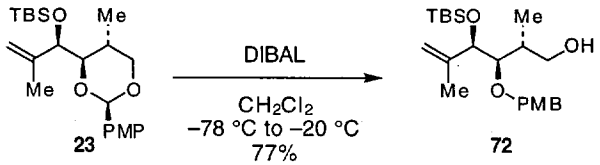


(2*R*,3*R*,4*R*)-3,4-O-isopropyliden-1-(4-methoxy-benzyloxy)-2,5-dimethyl-hex-5-en (22). To a solution of **21** (240 mg, 0.6mmol) in 2 mL of THF was added TBAF (0.6 mL of a 1.0M solution in THF). The solution was stirred for 2 h, then diluted with EtOAc and washed sequentially with $NaHCO_3$ (sat) and brine. The organic layer was dried over $MgSO_4$, concentrated and purified by flash column chromatography [15 g SiO_2 - 100% hexanes (200 mL), 1 : 1 hexanes : EtOAc (400 mL)]. The purified diol was diluted with 2 mL of CH_2Cl_2 and 2,2-dimethoxypropane (370 μL, 3 mmol) was added along with a catalytic amount of PPTS. The solution was stirred overnight, then was diluted with EtOAc and washed with $NaHCO_3$ then brine and dried over $MgSO_4$, affording **22** as an analytically pure oil: $[\alpha]_D^{25}$ –1.7° (*c* 1.7, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.27-7.24 (m, 2 H), 6.89-6.86 (m, 2 H), 5.08 (s, 1 H), 4.97 (m, 1 H), 4.44 (A of AB, *J* = 11.6 Hz, 1 H), 4.40 (B of AB, *J* = 11.6 Hz, 1 H), 4.31 (d, *J* = 8.3 Hz, 1 H), 3.83-3.80 (m, 1 H), 3.80 (s, 3 H), 3.58 (dd, *J* = 9.3, 5.6 Hz, 1 H), 3.34 (dd, *J* = 9.1, 6.7 Hz, 1 H), 2.08-2.03 (m, 1 H), 1.78 (s, 3 H), 1.41 (s, 3 H), 1.39 (s, 3 H), 0.98 (d, *J* = 7.1 Hz, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.1, 142.4, 130.7, 129.1, 115.6, 113.7, 108.1, 83.1, 79.6, 72.7, 71.9, 55.3, 36.3, 27.2, 27.0, 17.1, 13.9; IR (thin film) 3077, 2985, 2934, 2860, 1651, 1613, 1587, 1514, 1248, 1173 cm^{-1}; HRMS (EI) calcd for $C_{19}H_{28}O_4$, 320.1988 *m/z* (M^+); observed, 320.1999 *m/z*. *Anal.* Calcd for $C_{19}H_{28}O_4$: C, 71.22; H, 8.81. Found: C, 70.88; H, 8.91. The stereochemistry of **22** was confirmed by the ^{1}H nOe's summarized above.



21 23

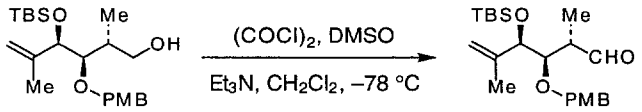
(2*R*,3*R*,4*R*)-1,3-O-(4-methoxy-benzylidene)-4-(*tert*-butyldimethylsilanyloxy)-2,5-dimethyl-hex-5-en (23). A solution of **21** (1.81 g, 4.59 mmol) in 25 mL of CH_2Cl_2 with 1 g of freshly activated 3Å mol sieves was stirred for 10 min, after which time DDQ (1.09 g, 4.80 mmol) was added in a single portion.[2] The reaction mixture was stirred for 3.5 h, then diluted with EtOAc and washed sequentially with $NaHCO_3$ (sat) and brine. The organic layer was dried overnight over Na_2SO_4, then filtered and concentrated to afford an oil which was purified by flash column chromatography [80 g SiO_2 - 100% hexanes (250 mL), 50 : 1 hexanes : EtOAc (200 mL), 40 : 1 hexanes : EtOAc (200 mL), 20 : 1 hexanes : EtOAc (200 mL)] providing 1.44 g **23** (79%): $[\alpha]_D^{25}$ –7.0° (*c* 1.2, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42-7.39 (m, 2 H), 6.90-6.87 (m, 2 H), 5.37 (s, 1 H), 5.09 (m, 1 H), 4.94 (m, 1 H), 4.24 (d, *J* = 2.4 Hz, 1 H), 4.03 (dd, *J* = 11.2, 4.9 Hz, 1 H), 3.80 (s, 3 H), 3.49 (dd, *J* = 10.0, 2.9, Hz, 1 H), 3.47 (dd, *J* = 11.23, 4.9 Hz, 1 H), 2.05-2.00 (m, 1 H), 1.85 (s, 3 H), 0.92 (s, 9 H), 0.83 (d*J* = 6.6 Hz, 3 H), 0.06 (s, 3 H), 0.03 (s, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 159.7, 145.2, 131.3, 127.4, 113.5, 111.9, 101.4, 86.1, 76.9, 73.1, 55.3, 30.1, 25.9, 20.4, 18.3, 12.8, –4.8, –5.1; IR (thin film) 3072, 2955, 2930, 2857, 1722, 1651, 1615, 1590, 1520, 1250 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{22}H_{37}SiO_4$, 393.2461 *m/z* $(M + H)^+$; observed, 393.2450 *m/z*. *Anal.* Calcd for $C_{22}H_{36}SiO_4$: C, 67.30; H, 9.24. Found: C, 67.07; H, 9.29. The C(39-40) stereochemistry was assigned on the basis of the following coupling constant, $J_{39,40}$ = 10 Hz.



23 72

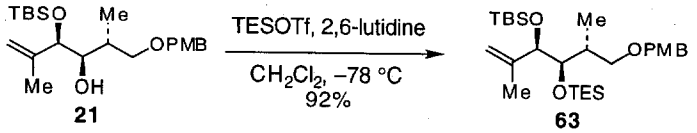
(2*R*,3*R*,4*R*)-4-(*tert*-butyldimethylsilanyloxy)-3-(4-methoxy-benzyloxy)-2,5-dimethyl-hex-5-en-1-ol (72). To a –78 °C solution of the PMP acetal **23** (1.43 g, 3.64 mmol) in 20 mL of CH_2Cl_2 was added 11 mL of DIBAL (1.0 M in CH_2Cl_2, 11 mmol). The solution was warmed to –20 °C over 4 h, after which time 10 mL of a saturated solution of Rochelle's salt was added. After the aluminum salts went into solution, EtOAc was added, and the solution was washed with

$NaHCO_3$ (sat) and brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide the crude product which was purified by flash column chromatography (hexanes/EtOAc) In this way 1.11 g of the primary carbinol **72** (77%) was obtained: $[\alpha]_D^{25}$ +25.2° (*c* 1.0, CH_2Cl_2); ^1H NMR (500 MHz, $CDCl_3$) δ 7.28-7.23 (m, 2 H), 6.89-6.86 (m, 2 H), 4.97 (s, 1 H), 4.89 (s, 1 H), 4.85 (A of AB, *J* = 10.8 Hz, 1 H), 4.47 (B of AB, *J* = 10.8 Hz, 1 H), 4.31 (d, *J* = 7.1 Hz, 1 H), 3.80-3.75 (m, 1 H), 3.80 (s, 3 H), 3.47 (ddd, *J* = 11.7, 7.1, 5.1 Hz, 1 H), 3.41 (dd, *J* = 7.1, 3.9 Hz, 1 H), 2.93 (dd, *J* = 7.1, 4.4 Hz, 1 H), 1.78-1.70 (m, 4 H), 0.99 (d, *J* = 7.3 Hz, 3 H), 0.91 (s, 9 H), 0.09 (s, 3 H), 0.05 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.2, 145.1, 130.5, 129.4, 113.8, 87.1, 79.0, 75.2, 65.4, 55.24, 55.21, 35.3, 25.9, 18.2, 18.0, 15.8, –4.7, –4.8; IR (thin film) 3446, 3074, 2954, 2064, 1879, 1809, 1652, 1646, 1615, 1587, 1516, 1506, 1302, 1249, 1174, 1039 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{22}H_{39}SiO_4$, 395.2618 *m/z* $(M + H)^+$; observed, 395.2615 *m/z*. *Anal.* Calcd for $C_{22}H_{38}SiO_4$: C, 66.96; H, 9.71. Found: C, 66.81; H, 9.85.

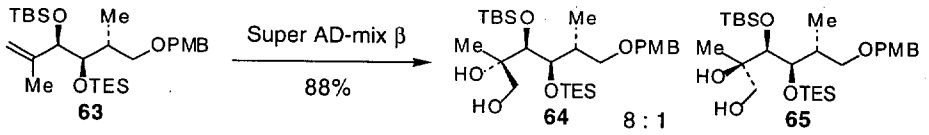


(2*S*,3*R*,4*R*)-4-(*tert*-butyldimethylsilanyloxy)-3-(4-methoxy-benzyloxy)-2,5-dimethyl-5-hexenal (31). To a –78 °C solution of DMSO (58 μL, 0.82 mmol) in 1 mL of CH_2Cl_2 was added $(COCl)_2$ (54 μL, 0.62 mmol). The solution was stirred at –78 °C for 5 min, after which time a solution of the primary alcohol **72** (0.41 mmol) was added dropwise as a solution in 1.5 mL of CH_2Cl_2. The solution was stirred at –78 °C for 15 min, then Et_3N was added (230 μL, 1.65 mmol) and the solution was warmed to ambient temperature. The solution was then diluted with EtOAc, and washed sequentially with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to afford the crude aldehyde **31** which was used in subsequent experiments without purification: ^1H NMR (500 MHz, $CDCl_3$) δ 9.70 (m, 1 H), 7.23 (m, 2 H), 6.87 (m, 2 H), 5.03 (d, *J* = 1.0 Hz, 1 H), 4.95 (s, 1 H), 4.76 (A of AB, *J* = 11.1 Hz, 1 H), 4.49 (B of AB, *J* = 11.1 Hz, 1 H), 4.35 (d, *J* = 6.3 Hz, 1 H), 3.80 (s, 3 H), 3.56 (dd, *J* = 6.6, 3.9 Hz, 1 H), 2.58-2.52 (m, 1 H), 1.77 (s, 3 H), 1.07 (d, *J* = 7.1 Hz, 3 H), 0.91 (s, 9 H), 0.06 (s, 3 H), 0.03 (s, 3 H); IR (thin film) 3074, 2955, 2931, 2886, 2857, 2063, 21006, 1924, 1880, 1728, 1648, 1614, 1587, 1515,

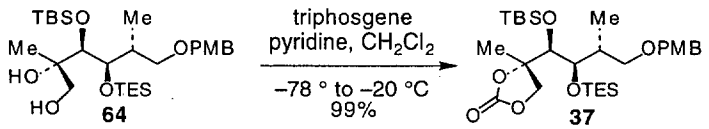
1471, 1464, 1390, 1374, 1361, 1302, 1250, 1174, 1090 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{22}H_{37}SiO_4$, 393.2461 *m/z* $(M + H)^+$; observed, 393.2454 *m/z*.



(2*R*,3*R*,4*R*)-4-(*tert*-butyldimethylsilanyloxy)-1-(4-methoxy-benzyloxy)-2,5-dimethyl-3-triethylsilanyloxy-hex-5-en (63). To a –78 °C solution of **21** (1.02 g, 2.58 mmol) in 15 mL of CH_2Cl_2 added 2,6-lutidine (450 µL, 3.9 mmol) followed by TESOTf (750 µL, 3.3 mmol). The mixture was allowed to warm to –50 °C over 50 min. The reaction was quenched by the addition of 5 mL of $NaHCO_3$ (sat) and the solution was warmed to room temperature. The mixture was diluted with EtOAc and washed sequentially with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to afford a crude oil which was purified by flash column chromatography [80 g SiO_2 - 100% hexanes (200 mL), 40 : 1 hexanes - EtOAc (400 mL), 20 : 1 hexanes - EtOAc (400 mL)] and provided 1.22 g (92%) of the silyl ether **63** as an analytically pure oil: $[\alpha]_D^{25}$ +25.1° (*c* 2.0, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26-7.24 (m, 2 H), 6.87-6.86 (m, 2 H), 5.02 (s, 1 H), 4.85 (s, 1 H), 4.41 (s, 2 H), 4.06 (d, *J* = 5.1 Hz, 1 H), 3.80 (s, 3 H), 3.59 (dd, *J* = 4.9, 4.9 Hz, 1 H), 3.55 (dd, *J* = 9.1, 4.0 Hz, 1 H), 3.22 (dd, *J* = 8.8, 8.8 Hz, 1 H), 2.00-1.95 (m, 1 H), 1.74 (s, 3 H), 1.02 (d, *J* = 6.8 Hz, 3 H), 0.95 (t, *J* = 8.1 Hz, 9 H), 0.90 (s, 9 H), 0.61 (q, *J* = 7.8 Hz, 6 H), 0.04 (s, 3 H), 0.00 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.0,145.2, 131.1, 129.1, 113.6, 112.7, 78.5, 78.1, 72.5, 72.4, 55.3, 35.4, 26.0, 20.1, 18.2, 16.2, 7.1, 5.2, –4.7, –4.8; IR (thin film) 3096, 2955, 2878, 2858, 1648, 1614, 1587, 1514, 1464, 1249 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{28}H_{56}Si_2NO_4$, 526.3748 *m/z* $(M + NH_4)^+$; observed, 526.3761 *m/z*. *Anal.* Calcd for $C_{28}H_{52}Si_2O_4$: C, 66.09; H, 10.30. Found: C, 66.02; H, 10.27.

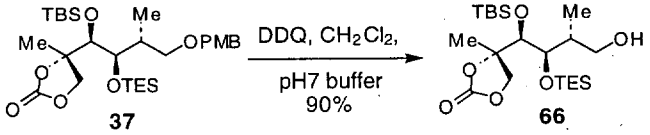


(2*S*,3*S*,4*R*,5*R*)-3-(*tert*-butyldimethylsilanyloxy)-6-(4-methoxy-benzyloxy)-2,5-dimethyl-4-triethylsilanyloxy-hexane-1,2-diol (64). To a solution of **63** (5.34 g, 10.5 mmol) in 50 mL of *t*-BuOH was added $(DHQD)_2$-Phal (402 mg, 0.52mmol) followed by methanesulfonamide (10.4 mmol), K_2CO_3 (4.4 g, 31.8 mmol), and $K_3Fe(CN)_6$ (10.4 g, 31.6 mmol).[3] The solution was diluted with 50 mL of H_2O and $K_2OsO_4 \cdot 2H_2O$ (46 mg, 0.12 mmol) was added in a single portion. The mixture was stirred vigorously at 0 °C for 21 h, after which time the reaction was quenched by the addition of solid sodium sulfite (10g). The solution was stirred at room temperature for 45 min, then diluted with EtOAc and washed sequentially with $NaHCO_3$ (sat) and brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to afford a crude oil (8 : 1 d.s. by ^1H NMR analysis) which was purified by flash column chromatography [400 g SiO_2 - 100% hexanes (500 mL), 18 : 1 hexanes - EtOAc (1 L)] providing 4.12 g pure **64** (72%) along with 898 mg of a mixture of **64** and **65** (16%). Data for **64**: $[\alpha]_D^{25}$ +19.5° (*c* 1.0, CH_2Cl_2);^1H NMR (500 MHz, $CDCl_3$) δ 7.26-7.24 (m, 2 H), 6.88-6.86 (m, 2 H), 4.45-4.39 (m, 3 H), 3.92 (d, *J* = 4.2 Hz, 1 H), 3.80-3.78 (m, 4 H), 3.58 (dd, *J* = 8.8, 3.2 Hz, 1 H), 3.46 (dd, *J* = 11.4, 8.9 Hz, 1 H), 3.32 (dd, *J* = 8.5, 7.6 Hz, 1 H), 3.27 (dd, *J* = 11.4, 5.0 Hz, 1 H), 2.47-2.42 (m, 2 H), 1.19 (s, 3 H), 1.15 (d, *J* = 6.6 Hz, 3 H), 0.96 (t, *J* = 8.1 Hz, 9 H), 0.90 (s, 9 H), 0.63 (q, *J* = 7.8 Hz, 6 H), 0.11 (s, 6 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.0, 130.8, 129.1, 113.6, 78.5, 76.5, 74.0, 72.72, 72.69, 68.5, 55.2, 35.9, 25.9, 21.8, 18.0, 16.7, 6.9, 4.9, –3.2, –5.4; IR (thin film) 3446, 2955, 2067, 1879, 1742, 1614, 1587, 1514, 1248 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{28}H_{55}Si_2O_6$, 543.3537 *m/z* $(M + H)^+$; observed, 543.3539 *m/z*. *Anal.* Calcd for $C_{28}H_{54}Si_2O_6$: C, 61.95; H, 10.03. Found: C, 61.97; H, 10.09.



4-[(1*S*,2*R*,3*R*)-1-(*tert*-butyldimethylsilanyloxy)-4-(4-methoxy-benzyloxy)-3-methyl-2-triethylsilanyloxy-butyl]-4-methyl-[1,3]-dioxolan-2-one (37). To a 78 °C solution of the diol **64** (4.12 g, 7.6 mmol) in 40 mL of $CH_2Cl_2$was added pyridine (2.5 mL, 30.9 mmol), followed by triphosgene (1.8 g, 6.1 mmol) as a solution in 15 mL of CH_2Cl_2. The solution was warmed from –78 °C to 0 °C over 1.5 h. The reaction mixture was diluted with $NaHCO_3$ (sat), warmed

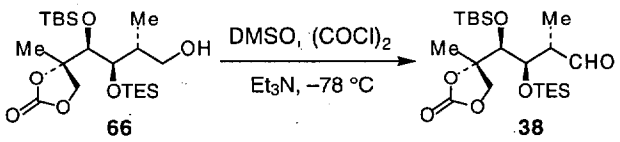
to room temperature and diluted with EtOAc. The solution was washed with $NaHCO_3$ (sat) and brine. The organic layer was dried over Na_2SO_4, filtered and concentrated to provide a crude oil which was purified by flash column chromatography [160 g SiO_2 - 100% hexanes (500 mL), 12 : 1 hexanes - EtOAc (1 L), 9 : 1 hexanes - EtOAc (500 mL)] providing 4.30 g of **37** (99%): $[\alpha]_D^{25}$ +26.8° (*c* 2.1, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26-7.22 (m, 2 H), 6.89-6.87 (m, 2 H), 4.64 (d, *J* = 8.1 Hz, 1 H), 4.45 (A of AB, *J* = 11.5 Hz, 1 H), 4.34 (B of AB, *J* = 11.5 Hz, 1 H), 3.90 (d, *J* = 3.7 Hz, 1 H), 3.87 (d, *J* = 8.1 Hz, 1 H), 3.81 (s, 3 H), 3.67 (dd, *J* = 7.1, 3.7 Hz, 1 H), 3.43 (dd, *J* = 8.9, 4.3 Hz, 1 H), 3.17 (dd, *J* = 8.2, 8.2 Hz, 1 H), 1.80-1.75 (m, 1 H), 1.50 (s, 3 H), 1.08 (d, *J* = 6.6 Hz, 3 H), 0.95 (t, *J* = 8.1 Hz, 9 H), 0.89 (s, 9 H), 0.60 (q, *J* = 7.9 Hz, 6 H), 0.12 (s, 3 H), 0.11 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.3, 154.3, 130.2, 129.5, 113.8, 87.0, 77.6, 77.2, 76.4, 72.3, 72.0, 70.4, 55.3, 35.6, 25.8, 23.7, 18.0, 17.0, 7.0, 5.1, –4.0, –4.9; IR (thin film) 2955, 2062, 2010, 1956, 1808, 1614, 1514 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{29}H_{56}Si_2NO_7$, 586.3595 *m/z* $(M + NH_4)^+$; observed, 586.3615 *m/z*. *Anal.* Calcd for $C_{29}H_{52}Si_2O_7$: C, 61.23; H, 9.21. Found: C, 60.96; H, 9.29.



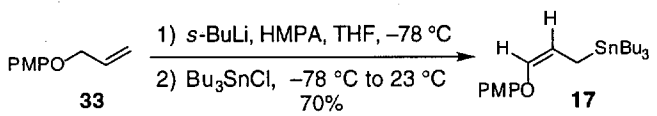
37 66

4-[(1*S*,2*R*,3*R*)-1-(*tert*-butyldimethylsilanyloxy)-4-hydroxy-3-methyl-2-triethylsilanyloxy-butyl]-4-methyl-[1,3]dioxolan-2-one (66). To a solution of **37** (620 mg, 1.1 mmol) in 8 mL of CH_2Cl_2 and 2 mL pH 7 buffer was added DDQ (275 mg, 1.2 mmol).[2] The solution was stirred for 1 h, then diluted with EtOAc and washed with $NaHCO_3$ (sat) (3 x 100 ml), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide a crude oil which was purified by flash column chromatography [40 g SiO_2 - 100% hexanes (500 mL), 9 : 1 hexanes - EtOAc (500 mL), 4 : 1 hexanes - EtOAc (500mL), providing 444 mg of the primary carbinol **66** (90%): $[\alpha]_D^{25}$ +28.0° (*c* 1.5, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 4.68 (A of AB, *J* = 7.8 Hz, 1 H), 4.09 (B of AB, *J* = 7.8 Hz, 1 H), 3.95 (d, *J* = 3.4 Hz, 1 H), 3.71 (dd, *J* = 8.8, 3.4 Hz, 1 H), 3.62-3.58 (m, 1 H), 3.41-3.36 (m, 1 H), 2.62 (dd, *J* = 8.9, 3.3 Hz, 1 H), 1.75-1.57 (m, 4 H), 1.03-0.98 (m, 12 H), 0.88 (s, 9 H), 0.68 (q, *J* = 7.9 Hz, 6 H), 0.14 (s, 3 H), 0.13 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ

154.0, 86.8, 79.1, 78.4, 70.3, 67.0, 37.7, 25.7, 23.8, 17.9, 15.8, 6.9, 5.0, –4.0, –5.1; IR (thin film) 3522, 2956, 1790, 1542, 1472, 1413, 1392, 1364, 1072, 1007, 940, 874 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{21}H_{45}Si_2O_6$, 449.2755 *m/z* $(M + H)^+$; observed, 449.2755 *m/z*. *Anal.* Calcd for $C_{21}H_{44}Si_2O_6$: C, 56.21; H, 9.88. Found: C, 56.11; H, 9.90.



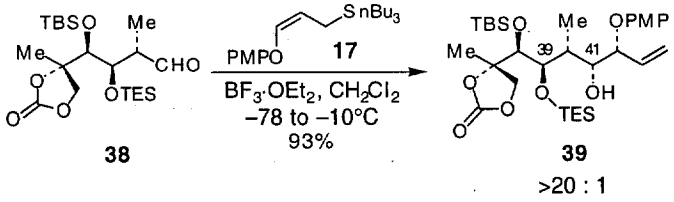
(1S,2R,3S)-4-(*tert*-butyldimethylsilanyloxy)-2-methyl-4-(4-methyl-2-oxo-[1,3]dioxolan-4-yl)-3-triethylsilanyloxy-butyraldehyde (38). To a –78 °C solution of DMSO (1.2 mL, 17 mmol) in 20 mL of CH_2Cl_2 was added $(COCl)_2$ (1.1 mL, 13 mmol). The solution was stirred for –78 °C for 5 min, then a solution of the primary alcohol **66** was added dropwise via cannula (8.62 mmol in 20 mL of CH_2Cl_2). The solution was stirred at –78 °C for 10 min and Et_3N (4.8 mL, 34 mmol) was added. The ice bath was removed and the solution was brought to room temperature. The solution was diluted with EtOAc and washed sequentially with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide 3.82 g of the crude aldehyde **38** which was used without purification in subsequent experiments: ^1H NMR (500 MHz, $CDCl_3$) δ 9.63 (d, *J* = 3.4 Hz, 1 H), 4.68 (A of AB, *J* = 8.6 Hz, 1 H), 4.06 (B of AB, *J* = 8.6 Hz, 1 H), 4.01 (dd, *J* = 5.4, 3.9 Hz, 1 H), 3.95 (d, *J* = 3.2 Hz, 1 H), 2.53-2.47 (m, 1 H), 1.54 (s, 3 H), 1.21 (d, *J* = 7.1 Hz, 3 H), 0.97 (t, *J* = 8.0 Hz, 9 H), 0.91 (s, 9 H), 0.64 (q, *J* = 7.9 Hz, 6 H), 0.16 (s, 3 H), 0.14 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 203.0, 154.0, 86.4, 77.2, 76.3, 70.3, 47.7, 25.7, 23.7, 18.0, 13.6, 6.8, 5.1, –4.1, –4.8; IR (thin film) 2956, 1799, 1732, 1539, 1472, 1464, 1456, 1417, 1393, 1362, 1327, 1255, 1197, 1172, 1071, 1007 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{21}H_{46}Si_2NO_6$, 464.2864 *m/z* $(M + NH_4)^+$; observed, 464.2866 *m/z*.



PMP = *p*-methoxyphenyl

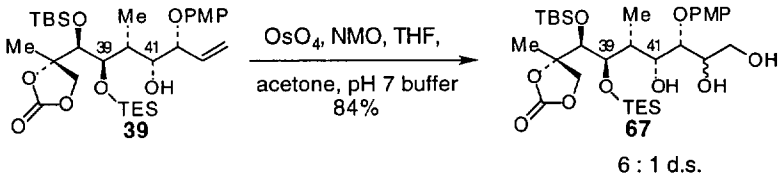
(Z)-γ-(4-methoxy-phenoxy)allyltributylstannane (17). To a solution of **33** (14.8g, 90 mmol) in 150 mL of THF cooled to –78 °C, was added 75 mL of *s*-BuLi (1.27 M in cyclohexane, 95

mmol), followed immediately by the addition of HMPA (15 mL). The solution was stirred at –78 °C for 15 min, then Bu_3SnCl (26 mL, 96 mmol) was added via syringe, and the –78 °C bath was removed. The solution was stirred for 2 h at ambient temperature, then quenched with NH_4Cl (sat), diluted with hexanes and EtOAc and washed with $NaHCO_3$ (sat), then H_2O. The organic phase was dried over $MgSO_4$ and concentrated to afford a crude oil which was purified by distillation at reduced pressure (ca 0.3 mm Hg; b.p. 195 to 205 °C) providing 28.7 g (70%) of **17**. The distilled product was used as is for the allylation of **38**, however a small portion was purified by HPLC (21 mm column, 100 % hexanes 15 min then 20% EtOAc/hexanes 10 min, 8 ml/min) to afford a sample for analytical characterization: ^1H NMR (500 MHz, $CDCl_3$) δ 6.94-6.90 (m, 2 H), 6.86-6.83 (m, 2 H), 6.19-6.14 (m, 1 H), 4.99-4.94 (m, 1 H), 3.78 (s, 3 H), 1.87-1.72 (m, 2 H), 1.58-1.45 (m, 6 H), 1.35-1.26 (m, 6 H), 0.91-0.87 (m, 15 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 154.7, 152.0, 137.4, 116.9, 114.5, 111.4, 55.7, 29.1, 27.4, 13.7, 9.4, 6.0; IR (thin film) 3043, 2956, 2925, 2871, 2853, 1652, 1591, 1505, 1465, 1442, 1418, 1373, 1340, 1292, 1241, 1225, 1180, 1153, 1102, 1052 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{18}H_{29}O_2SiSn$, 397.1190 *m/z* $(M–C_4H_9)^+$; observed, 397.1184 *m/z*. Stereochemistry of **17** was confirmed by the observation of ^1H nOe's between the two olefinic protons.



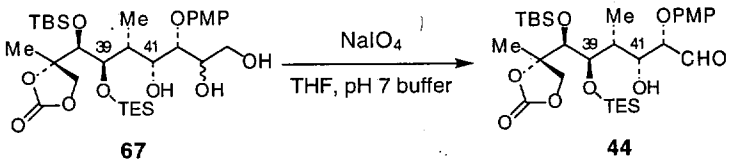
4-[(1*S*,2*R*,3*R*,4*R*,5*R*)1-(*tert*-butyldimethylsilanyloxy)-4-hydroxy-5-(4-methoxy-phenoxy)-3-methyl-2-triethylsilanyloxy-hept-6-enyl]-4-methyl-[1,3]dioxolan-2-one (39). To a –78 °C solution of the crude 2,3-*anti* aldehyde **38** (8.62 mmol) and the γ-alkoxyallylstannane **17** (5.5 g, 12.1 mmol) in 25 mL of CH_2Cl_2 was added $BF_3·OEt_2$ (2.2 mL, 17.4 mmol). The reaction mixture was stirred at –78 °C for 16 h, then warmed slowly to –20 °C and quenched by the addition of 10 mL $NaHCO_3$ (sat). The cold bath was removed and the solution was brought to room temperature. The solution was diluted with EtOAc and washed with $NaHCO_3$ (sat) followed by brine. The organic layer was dried ovr $MgSO_4$, filtered and concentrated to provide **39** as a crude oil (>20 : 1 ds by ^1H NMR analysis) which was purified by flash column chromatography [160 g

SiO_2 - 18 : 1 hexanes - EtOAc (1 L), 9 : 1 hexanes - EtOAc (1 L), 5 : 1 hexanes - EtOAc (1 L)] providing 4.92 g of analytically pure **39** (93% over 2 steps): $[\alpha]_D^{24}$ +16.3° (*c* 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.89-6.86 (m, 2 H), 6.82-6.79 (m, 2 H), 5.68 (ddd, *J* = 17.6, 10.4, 7.4 Hz, 1 H), 5.33-5.28 (m, 1 H), 4.70 (d, *J* = 7.8 Hz, 1 H), 4.37 (dd, *J* = 8.2, 8.2 Hz, 1 H), 4.05 (d, *J* = 2.7 Hz, 1 H), 3.99 (d, *J* = 8.5 Hz, 1 H), 3.95 (d, *J* = 7.8 Hz, 1 H), 3.84 (dd, *J* = 9.5, 2.7 Hz, 1 H), 3.76 (s, 3 H), 2.57 (s, 1 H), 1.6-1.5 (m, 1 H), 1.52 (s, 3 H), 1.06 (d, *J* = 6.6 Hz, 3 H), 1.01 (t, *J* = 7.9 Hz, 9 H), 0.90 (s, 9 H), 0.75-0.66 (m, 6 H), 0.15 (s, 3 H), 0.14 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.26, 154.2, 151.8, 134.4, 120.2, 118.4, 114.5, 86.9, 84.0, 77.2, 75.1, 71.7, 70.4, 55.6, 36.1, 25.8, 23.8, 18.1, 10.2, 7.1, 5.3, –4.1, –4.8; IR (thin film) 3586, 2955, 2881, 1808, 1644, 1614, 1593, 1505, 1471, 1417, 1392, 1365, 1225, 1101, 1006 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{31}H_{58}Si_2NO_8$, 628.3701 *m/z* $(M + NH_4)^+$; observed, 628.3699 *m/z*.



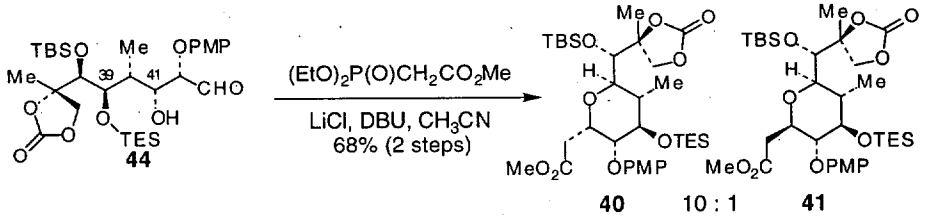
4-[1-(*tert*-butyldimethylsilanyloxy)-5-(4-methoxy-phenoxy)-3-methyl-2-triethylsilanyloxy-hept-4,6,7-triol]-4-methyl-[1,3]dioxolan-2-one (67). To a solution of the terminal olefin **39** (175 mg, 0.29 mmol) in 3 mL THF, 2 mL acetone, and 1 mL pH7 buffer was added 137 μL of a 50% solution of NMO[4] in (0.58 mmol) followed by 150 μL of a 0.2M solution of OsO_4 in toluene (0.03 mmol). The solution was stirred at ambient temperature for ca. 48 h, after which time the reaction was quenched with sodium sulfite and stirred vigorousy for 1 h. The solution was diluted with EtOAc and washed with $NaHCO_3$ (sat) and brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to afford the crude diol **67**. This material was purified by flash column chromatography eluting with hexanes/EtOAc, giving 157 mg (84%) diol **67**, as a 6 : 1 mixture of diastereomeric diols: ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.95-6.93 (m, 2 H), 6.83-6.81 (m, 2 H), 4.65 (d, *J* = 7.8 Hz, 1 H), 4.26 (dd, *J* = 5.6, 5.6 Hz, 1 H), 4.19 (ddd, *J* = 7.1, 5.1, 1.8 Hz, 1 H), 4.01 (d, *J* = 3.2 Hz, 1 H), 3.97 (d, *J* = 7.8 Hz, 1 H), 3.90-3.88 (m, 1 H), 3.79-3.74 (m, 2 H), 3.76 (s, 3 H), 3.70-3.65 (m, 1 H), 2.89 (d, *J* = 5.6 Hz, 1 H), 2.68 (d, *J* = 6.6 Hz, 1 H), 2.11 (dd, *J* = 5.5, 5.5 Hz, 1 H), 1.75-1.72 (m, 1 H), 1.50 (s, 3 H), 1.11 (d, *J* = 6.6 Hz, 3 H), 0.98 (t, *J* = 7.8 Hz, 9 H), 0.88 (s, 9

H), 0.70-0.65 (m, 6 H), 0.14 (s, 3 H), 0.12 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.6, 154.3, 152.5, 117.0, 114.9, 94.4, 86.9, 81.0, 77.2, 76.0, 72.2, 70.5, 69.8, 63.1, 55.7, 38.0, 25.8, 23.8, 18.0, 11.4, 7.0, 5.1, –4.0, –5.0; IR (thin film) 3469, 2956, 2936, 2881, 1798, 1507, 1465, 1443, 1391, 1365, 1288, 1226, 1180, 1158, 1100, 1070, 1007 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{31}H_{60}Si_2NO_{10}$, 662.3756 *m/z* $(M + NH_4)^+$; observed, 662.3764 *m/z*.



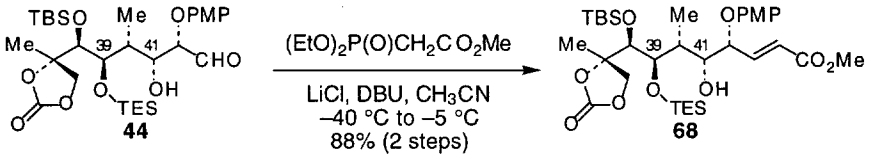
67 44

(2*S*,3*R*,4*R*,5*R*,6*S*)-6-(*tert*-butyldimethylsilanyloxy)-2-(4-methoxy-phenoxy)-4-methyl-6-((2*S*)-4-methyl-2-oxo-[1,3]dioxolan-4yl)-5-triethylsilanyloxy-3-hyroxy-hexanal (44). The crude diol **67** (0.24 mmol) was diluted in 2 mL THF and 1 mL pH 7 buffer, and $NaIO_4$ (0.93 mmol) was added. The solution was stirred at ambient temperature for 2 h, then was diluted with EtOAc and washed with $NaHCO_3$ followed by brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to afford the crude aldehyde **44** which was used in subsequent experiments without purification: ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.71-9.70 (m, 1 H), 6.86-6.83 (m, 4 H), 4.68 (d, *J* = 7.8 Hz, 1 H), 4.36 (dd, *J* = 7.2, 2.6 Hz, 1 H), 4.31-4.28 (m, 1 H), 4.04 (d, *J* = 11.2 Hz, 1 H), 4.04 (s, 3 H), 3.81 (dd, *J* = 9.0, 2.9 Hz, 1 H), 3.77 (s, 3 H), 2.48 (d, *J* = 4.2 Hz, 1 H), 1.65-1.59 (m, 1 H), 1.48 (s, 3 H), 1.15 (d, *J* = 6.6 Hz, 3 H), 1.00 (t, *J* = 7.9 Hz, 9 H), 0.90 (s, 9 H), 0.70 (q, *J* = 7.7 Hz, 6 H), 0.16 (s, 3 H), 0.14 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 202.6, 155.2, 154.1, 151.3, 116.7, 115.0, 86.8, 84.7, 75.5, 70.3, 68.7, 55.7, 36.5, 25.8, 23.8, 18.0, 11.2, 7.0, 5.1, –4.1, –5.0; IR (thin film) 3505, 2955, 2880, 2859, 1803, 1733, 1594, 1508, 1465, 1392, 1364, 1225, 1071 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{30}H_{56}Si_2NO_9$, 630.3494 *m/z* $(M + NH_4)^+$; observed, 630.3520 *m/z*.



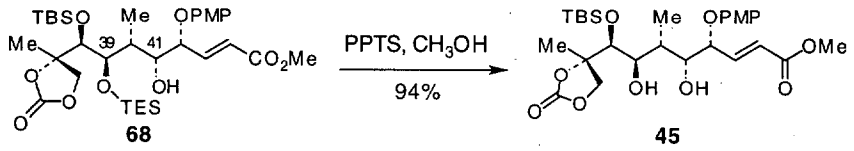
44 40 10 : 1 41

[6-[1'-(*tert*-butyldimethylsilanyloxy)-1'-(4-methyl-2-oxo-[1,3]dioxolan-4-yl)-methyl]-4-triethylsilanyloxy-3-(4-methoxy-phenoxy)-5-methyl-tetrahydro-pyran-2-yl]-acetic acid methyl ester (40). To a suspension of LiCl (148 mg, 3.5 mmol) in 2 mL of CH_3CN was added the phosphonate (185 μL, 1.0 mmol) followed by DBU (150 μL, 1.0 mmol), followed by a solution of the crude aldehyde **44** (0.24 mmol) in 2 mL of CH_3CN. The solution was stirred at room temperature for 23 h, then was diluted with EtOAc and washed sequentially with NH_4Cl (sat), $NaHCO_3$ (sat), and brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to afford a crude oil which was purified by flash column chromatography [30 g SiO_2 - 100% hexanes (200 mL), 9 : 1 hexanes : EtOAc (200 mL), 4 : 1 hexanes : EtOAc (250 mL)] affording 109 mg of a 10 : 1 mixture of diastereomeric pyrans **40** and **41**. The pyrans were seperated by HPLC to obtain analytically pure **40** and **41**. Data for **40**: $[\alpha]_D^{23}$ +2.0° (*c* 2.1, CH_2Cl_2); ^1H NMR (500 MHz, $CDCl_3$) δ 6.87-6.81 (m, 4 H), 4.69-4.65 (m, 2 H), 4.11 (dd, *J* = 9.0, 5.9 Hz, 1 H), 3.97 (s, 3 H), 3.87 (d, *J* = 9.0 Hz, 1 H), 3.77 (s, 3 H), 3.62 (s, 3 H), 3.55 (dd, *J* = 9.4, 9.4 Hz, 1 H), 3.34 (d, *J* = 10.7, 1 H), 2.69-2.56 (m, 2 H), 2.02-1.94 (m, 2 H), 1.36 (s, 3 H), 1.00 (d, *J* = 6.3 Hz, 3 H), 0.94 (s, 9 H), 0.89 (t, *J* = 7.9 Hz, 9 H), 0.61-0.53 (m, 6 H), 0.14 (s, 6 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 171.3, 154.3, 150.7, 116.6, 114.7, 86.6, 78.1, 74.2, 73.4, 73.0, 70.6, 70.5, 55.7, 51.9, 38.4, 30.9, 26.2, 22.7, 18.7, 14.2, 7.0, 5.4, –4.0, –4.4; IR (thin film) 2954, 2878, 2559, 2058, 2000, 1960, 1804, 1741, 1593, 1507, 1463, 1439, 1416, 1389, 1365, 1319, 1277, 1226, 1195, 1170, 1139, 1097, 1053 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{33}H_{56}Si_2O_{10}$, 668.3412 *m/z* $(M + H)^+$; observed, 668.3419 *m/z*.



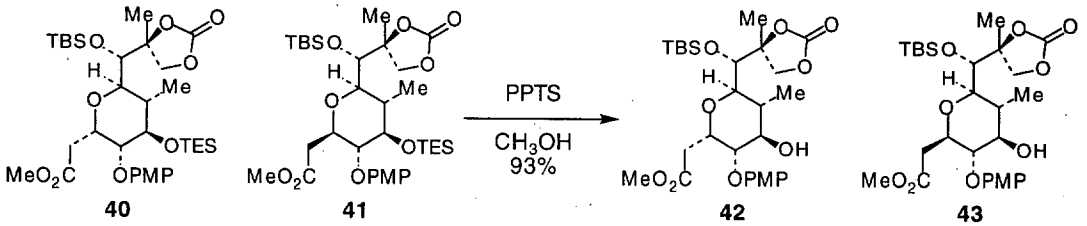
(4*R*,5*R*,6*R*,7*R*,8*S*,4'*S*)-8-(*tert*-butyldimethylsilanyloxy)-5-hydroxy-4-(4-methoxy-phenoxy)-6-methyl-8-(4'-methyl-2-oxo-[1,3]dioxolan-4-yl)-7-triethylsilanyloxy-oct-2-enoic acid methyl ester (68). To a heterogeneous solution of LiCl (78 mg, 1.8 mmol) in 3 mL of CH_3CN was added the methyl diethylphosphonoacetate (335 μL, 1.8 mmol) followed by DBU (275 μL, 1.8 mmol). The solution was cooled to –40 °C and the crude aldehyde **44** (0.61 mmol) was added as a solution in 4 mL of CH_3CN. The solution was warmed over 50 min from

–40 °C to –5 °C, then quenched with $NaHCO_3$ (sat). The solution was diluted with EtOAc and washed sequentially with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide a crude oil which was purified by flash column chromatography [40 g SiO_2 - 6 : 1 hexanes - EtOAc (350 mL), 4 : 1 hexanes - EtOAc (500 mL)] providing 357 mg of the desired enoate **68** (88%): $[\alpha]_D^{23}$ –2.8° (*c* 1.5, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 684-6.78 (m, 5 H), 6.03 (dd, *J* = 15.9, 1.0 Hz, 1 H), 4.68 (d, *J* = 7.8 Hz, 1 H), 4.56 (dd, *J* = 7.2, 7.2 Hz, 1 H), 4.02 (d, *J* = 2.4 Hz, 1 H), 4.02-4.00 (m, 1 H), 3.94 (d, *J* = 7.8 Hz, 1 H), 3.82 (dd, *J* = 9.2, 2.6 Hz, 1 H), 3.75 (s, 3 H), 3.72 (s, 3 H), 2.61 (d, *J* = 1 Hz, 1 H), 1.6-1.48 (m, 1 H), 1.48 (s, 3 H), 1.08 (d, *J* = 6.6 Hz, 3 H), 0.99 (t, *J* = 7.9 Hz, 9 H), 0.88 (s, 9 H), 0.73-0.65 (m, 6 H), 0.133 (s, 3 H), 0.127 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.6, 154.8, 154.1, 151.3, 142.9, 124.3, 117.8, 114.7, 86.7, 81.5, 77.2, 75.2, 72.2, 70.4, 55.6, 51.8, 36.4, 25.7, 23.7, 18.1, 10.6, 7.0, 5.4, –4.2, –4.8; IR (thin film) 3513, 2954, 2880, 2859, 1805, 1727, 1659, 1508, 1466, 1439, 1390, 1364, 1280, 1226, 1172, 1102, 1071 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{33}H_{60}Si_2NO_{10}$, 686.3756 *m/z* $(M + NH_4)^+$; observed, 686.3752 *m/z*.



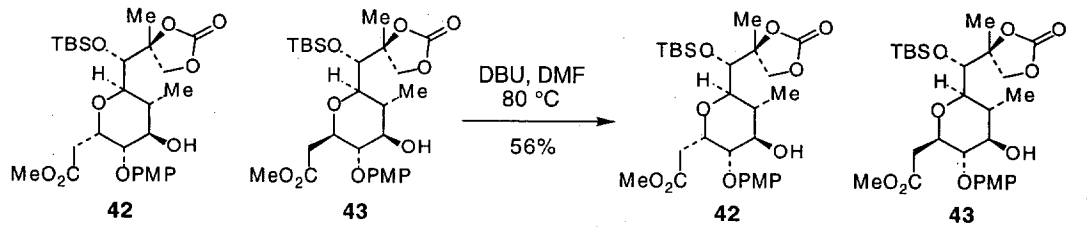
(4*R*,5*R*,6*R*,7*R*,8*S*,4'*S*)-8-(*tert*-butyldimethylsilanyloxy)-4-(4-methoxy-phenoxy)-5,7-dihydroxy-6-methyl-8-(4'-methyl-2-oxo-[1,3]dioxolan-4-yl)-oct-enoic acid methyl ester (45). To a solution of enoate **68** (201 mg, 0.30 mmol) in 4 mL of CH_3OH was added PPTS (178mg, 0.71 mmol). The solution was stirred at ambient temperature for 71 h, then was diluted with EtOAc and washed sequentially with $NaHCO_3$ and brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide an oil which was purified by flash column chromatography [40 g SiO_2 - 4 : 1 hexanes : EtOAc (250 mL), 1 : 1 hexanes : EtOAc (500 mL)] providing 156 mg of the diol **45** (94%): $[\alpha]_D^{23.6}$ –24.5 (*c* 0.7, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 6.90-6.79 (m, 5 H), 6.05 (dd, *J* = 15.9, 1.0 Hz, 1 H), 4.60 (ddd, *J* = 7.8, 7.8, 1.0 Hz, 1 H), 4.16 (ddd, *J* 8.2, 4.5, 2.3 Hz, 1 H), 4.08 (d, *J* = 8.8 Hz, 1 H), 3.99 (s, 1 H), 3.76 (s, 3 H), 3.71 (s, 3 H), 3.62 (dd, *J* = 9.9, 9.9 Hz, 1 H), 2.79 (d, *J* = 1.2 Hz, 1 H), 2.04 (d, *J* =9.8 Hz, 1 H), 1.85-1.82 (m, 1 H), 1.52 (s, 3 H), 0.95 (d,

J = 6.6 Hz, 3 H), 0.87 (s, 9 H), 0.16 (s, 3 H), 0.09 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.6, 154.9, 154.2, 151.3, 142.5, 124.7, 117.7, 114.7, 86.5, 81.3, 77.2, 73.5, 72.4, 72.2, 70.5, 55.7, 51.7, 36.1, 25.9, 23.4, 18.3, 10.0, –4.1, –4.7; IR (thin film) 3494, 2953, 2858, 1798, 1726, 1661, 1506, 1464, 1439, 1390, 1362, 1280, 1226, 1170, 1114, 1051 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{27}H_{43}SiO_{10}$, 555.2626 *m/z* $(M + H)^+$; observed, 555.2618*m/z*. *Anal.* Calcd for $C_{27}H_{42}SiO_{10}$: C, 58.46; H, 7.63. Found: C, 58.04; H, 7.51.



40 41 (10 : 1) → 42 43

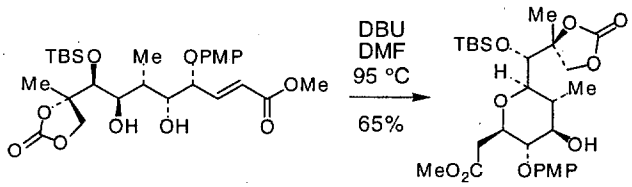
[6-[1'-(*tert*-butyl-dimethyl-silanyloxy)-1'-(4-methyl-2-oxo-[1,3]dioxolan-4-yl)-methyl]-4-hydroxy-3-(4-methoxy-phenoxy)-5-methyl-tetrahydro-pyran-2-yl]-acetic acid methyl ester (42) and [6-[1'-(*tert*-butyl-dimethyl-silanyloxy)-1'-(4-methyl-2-oxo-[1,3]dioxolan-4-yl)-methyl]-4-hydroxy-3-(4-methoxy-phenoxy)-5-methyl-tetrahydro-pyran-2-yl]-acetic acid methyl ester (43). Method A: To a solution of the pyrans **40** and **41** (200 mg, 0.3 mmol) in methanol (4 mL) was added PPTS (179 mg). The solution was stirred at ambient temperature for 1.25 h, after which time was diluted with EtOAc and washed with $NaHCO_3$ (sat) then brine). The organic layer was then dried over $MgSO_4$, filtered and concentrated to provide 154 mg (93%) of a mixture of secondary alcohols **42** and **43** which was used without purification in the subsequent equilibration study.



42 43 (10 : 1) → 42 43 (1 : 9)

Method B: To a solution of a 10 : 1 mixture of pyrans **42** and **43** (55 mg, 0.1 mmol) in 2.5 mL of DMF, was added 300 μL DBU (2 mmol). The solution was heated at 80 °C for ca. 12 h, then for 8 h at 100 °C. The solution was cooled to ambient temperature, diluted with EtOAc and washed

sequentially with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide a crude oil which was purified by flash column chromatography [15 g SiO_2 - 100% hexanes (150 mL), 4 : 1 hexanes - EtOAc (250 mL), 1 : 1 hexanes - EtOAc (200 mL)] affording 31 mg of a 1 : 9 mixture of pyrans **42** : **43** (56%).

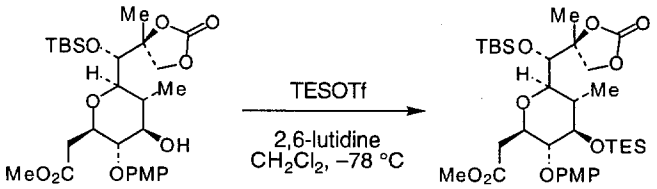


45 **43** (25 : 1 d.s.)

Method C: To a solution of the diol **45** (339 mg, 0.6 mmol) in 12 mL of anhydrous DMF, was added 1.8 mL of DBU (12 mmol). The solution was heated to 95 °C and stirred at that temperature for 22 h. The solution was cooled to ambient temperature, diluted with EtOAc and washed sequentially with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The combined aqueous phase was extracted with EtOAc, and then the EtOAc from this extraction was washed with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The combined organic layers were dried over Na_2SO_4, filtered and concentrated to provide the crude product **43** as a 25 : 1 mixture of diastereomeric pyrans. The material was purified via flash column chromatography [40 g SiO_2 - 100% hexanes (200 mL), 3 : 1 hexanes - EtOAc (400 mL), 1 : 1 hexanes - EtOAc (400 mL)] to give 222 mg of the purified mixture of pyran diastereomers (25 : 1 d.s.; 65%).

Data for 42: $[\alpha]_D^{23}$ –2.4° (*c* 0.63, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 6.92-6.90 (m, 2 H), 6.84-6.82 (m, 2 H), 4.72 (ddd, *J* = 9.9, 5.6, 3.2 Hz, 1 H), 4.66 (d, *J* = 9.0 Hz, 1 H), 4.09 (dd, *J* = 9.2, 6.0 Hz, 1 H), 3.99 (s, 1 H), 3.87 (d, *J* = 9.0 Hz, 1 H), 3.77 (s, 3 H), 3.65 (s, 3 H), 3.54 (dd, *J* = 9.8, 9.8 Hz, 1 H), 3.35 (d, *J* = 10.5 Hz, 1 H), 2.72-2.59 (m, 2 H), 2.48 (d, *J* = 2.2 Hz, 1 H), 2.04-1.99 (m, 1 H), 1.37 (s, 3 H), 1.07 (d, *J* = 6.6 Hz, 3 H), 0.93 (s, 9 H), 0.15 (s, 3 H), 0.14 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.4, 155.0, 154.4, 151.2, 117.5, 114.9, 86.5, 79.6, 74.2, 73.1, 71.9, 70.7, 70.5, 55.7, 52.0, 36.9, 30.6, 26.1, 22.6, 18.5, 13.5, –4.1, –4.5; IR (thin film) 3500, 2954, 2933, 2898, 2858, 1801, 1738, 1507, 1464, 1439, 1389, 1364, 1320, 1276, 1260, 1226, 1196, 1169, 1135, 1113, 1078, 1054 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{27}H_{43}SiO_{10}$, 555.2626 *m/z* (M + H)$^+$; observed, 555.2610*m/z*.

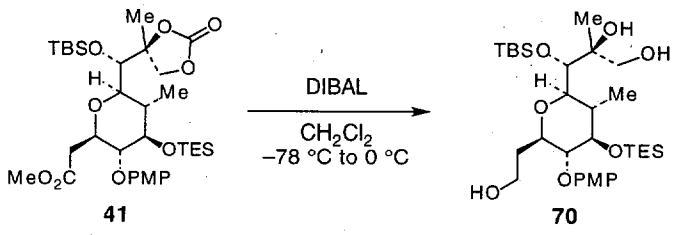
Data for 43: $[\alpha]_D^{23}$ +66.4° (*c* 1.1, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.96-6.94 (m, 2 H), 6.82-6.80 (m, 2 H), 4.60 (d, *J* = 8.8 Hz, 1 H), 4.00 (s, 1 H), 3.79-3.71 (m, 2 H), 3.76 (s, 3 H), 3.68 (s, 3 H), 3.49 (ddd, *J* = 11.8, 9.9, 3.2 Hz, 1 H), 3.17 (d, *J* = 10.3 Hz, 1 H), 2.69 (d, *J* = 16.1 Hz, 1 H), 2.35-2.29 (m, 2 H), 2.04-1.99 (m, 1 H), 1.46 (s, 3 H), 1.05 (d, *J* = 6.3 Hz, 3 H), 0.92 (s, 9 H), 0.15 (s, 3 H), 0.13 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.5, 154.7, 154.4, 153.1, 117.4, 114.9, 110.1, 94.4, 86.8, 81.8, 80.7, 77.7, 77.2, 75.3, 73.2, 70.4, 55.7, 51.9, 36.9, 26.1, 23.1, 18.6, 13.5, –4.2, –4.5; IR (thin film) 3496, 2954, 2933, 2896, 2859, 1802, 1740, 1507, 1464, 1440, 1389, 1228, 1054 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{27}H_{42}SiO_{10}$, 554.2547 *m/z* $(M)^+$; observed, 554.2524*m/z*.



43 **41**

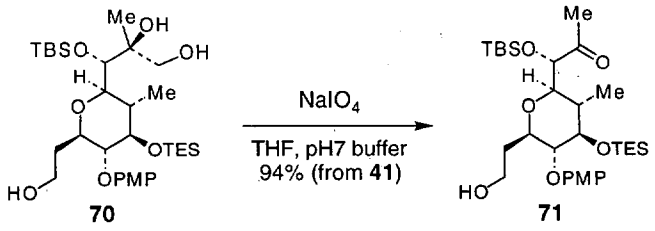
[6-[1-(*tert*-butyl-dimethyl-silanyloxy)-1-(4-methyl-2-oxo-[1,3]dioxolan-4-yl)-methyl]-4-triethylsilanyloxy-3-(4-methoxy-phenoxy)-5-methyl-tetrahydro-pyran-2-yl]-acetic acid methyl ester (41). To a solution of the pyran **43** (518 mg, 0.93mmol) in 10 mL of CH_2Cl_2 was added 2,6-lutidine (163 µl, 1.40 mmol). The solution was cooled to –78 °C and TESOTf (267 µl, 1.18 mmol) was added via syringe. The solution was warmed from –78 °C to –40 °C over 1.25 h, then the reaction was quenched by addition of CH_3OH. The solution was warmed to ambient temperature, diluted with EtOAc and washed sequentially with $NaHCO_3$ (sat), $KHSO_4$ (1 M; two times), $NaHCO_3$ (sat), then brine. The organic layer was dried over Na_2SO_4, filtered and concentrated to afford the crude silylated pyran **41**, which was used directly in the next step without purification. A small portion was synthesized and purified via the above procedure to obtain analytically pure **41**: $[\alpha]_D^{24}$ +53.2° (*c* 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.87-6.85 (m, 2 H), 6.80-6.78 (m, 2 H), 4.59 (d, *J* = 8.9 Hz, 1 H), 3.98 (s, 1 H), 3.81-3.75 (m, 5 H), 3.69 (ddd, *J* = 9.9, 9.9, 1.6 Hz, 1 H), 3.65 (s, 3 H), 3.50 (dd, *J* = 9.0, 9.0 Hz, 1 H), 3.14 (d, *J* = 10.4 Hz, 1 H), 2.58 (dd, *J* = 16.2, 1.6 Hz, 1 H), 2.22 (dd, *J* = 16.4, 10.5 Hz, 1 H), 1.99-1.94 (m, 1 H), 1.45 (s, 3 H), 0.99 (d, *J* = 6.6 Hz, 3 H), 0.93 (s, 9 H), 0.85 (t, *J* = 7.9 Hz, 9 H), 0.48 (q, *J* = 8.0 Hz, 6 H), 0.14 (d, *J* = 9.0 Hz, 6 H); ^{13}C

NMR (100 MHz, $CDCl_3$) δ 171.7, 154.4, 154.0, 153.0, 116.7, 114.5, 86.9, 80.6, 80.4, 78.2, 75.9, 73.4, 70.4, 55.6, 51.8, 38.4, 37.1, 26.1, 23.0, 18.6, 14.1, 6.8, 5.1, –4.1, –4.6; IR (thin film) 2954, 2937, 2878, 2860, 1805, 1741, 1506, 1464, 1539, 1415, 1388, 1322, 1276, 1253, 1229, 1193, 1172, 1137, 1116, 1077, 1057, 1007 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{33}H_{57}Si_2O_{10}$, 669.3690 *m/z* (M + H)$^+$; observed, 669.3469*m/z*.

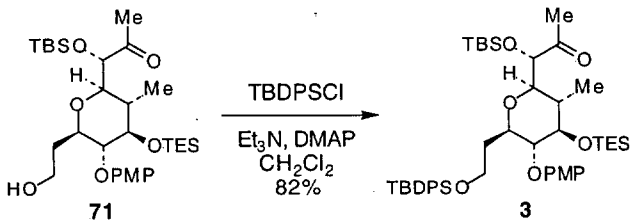


41 **70**

3-(*tert*-butyl-dimethyl-silanyloxy)-3-[4'-triethylsilanyloxy-5'-(4-methoxy-phenoxy)-6'-hydroxyethyl-3'-methyl-tetrahydro-pyran-2'-yl]-2-methyl-1,2-propanediol (70). To a –78 °C solution of the crude silyl ether **41** (ca. 0.93 mmol) in 10 mL of CH_2Cl_2 was added 6.5 mL DIBAL (1.0 M in hexanes). The solution was stirred at –78 °C for 3.5 h, then the reaction was quenched with CH_3OH (1 mL). The mixture was then warmed to ambient temperature, and 7 mL of a saturated solution of Rochelle's salt was added. The solution was stirred until the aluminum salts dissolved, then the solution was diluted with EtOAc, washed with $NaHCO_3$ (sat) and brine. The combined aqueous layers were extrancted with EtOAc and this solution was washed once with brine. The combined organic layers were dried over Na_2SO_4, filtered and concentrated to provide the crude triol **70** which was used directly in the next step. A small quantity was synthesized via the above procedure to and characterize as the crude oil **70:** ^1H NMR (500 MHz, $CDCl_3$) δ 6.87-6.86 (m, 2 H), 6.79-6.77 (m, 2 H), 3.88 (dd, *J* = 8.9, 8.9 Hz, 1 H), 3.76-3.54 (m, 8 H), 3.47 (dd, *J* = 9.0, 9.0 Hz, 1 H), 3.42 (br d, *J* = 9.0 Hz, 1 H), 3.26 (d, *J* = 10.5 Hz, 1 H), 3.11 (s, 1 H), 2.90 (br s, 1 H), 2.67 (b s, 1 H), 1.94-1.84 (m, 2 H), 1.56-1.48 (m, 1 H), 1.12 (s, 3 H), 0.98 (d, *J* = 6.6 Hz, 3 H), 0.93 (s, 9 H), 0.85 (t, *J* = 7.9 Hz, 9 H), 0.48 (q, *J* = 8.1 Hz, 6 H), 0.16 (s, 6 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.8, 153.4, 116.7, 114.4, 81.3, 78.6, 77.8, 75.6, 74.0, 68.1, 59.8, 55.6, 39.9, 34.2, 26.1, 21.6, 18.5, 13.9, 6.9, 5.2 –3.9, –4.1: IR (thin film) 3402, 2955, 2878, 1506, 1464, 1418, 1376, 1290, 1230, 1181, 1150, 1081, 1045, 1013 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{31}H_{59}Si_2O_8$, 615.3749 *m/z* (M + H)$^+$; observed, 615.3736 *m/z*.

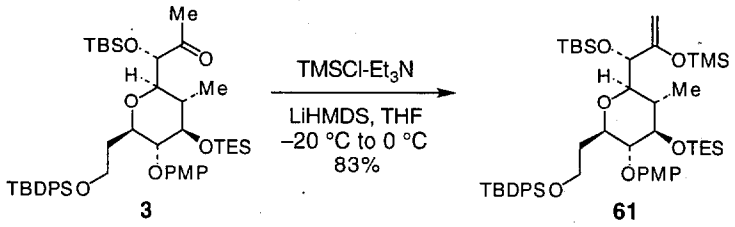


1-(4-triethylsilanyloxy-5-(4-methoxy-phenoxy)-6-(hydroxyethyl)-tetrahydro-pyran-2-yl)-1-(*tert*-butyl-dimethyl-silanyloxy)-propan-2-one (71). To a solution of the crude triol **70** (ca. 0.93 mmol) in 12 mL of THF and 4 mL pH7 buffer was added $NaIO_4$ (600 mg, 2.8 mmol). The solution was stirred at ambient temperature for 1.5 h, then more $NaIO_4$ (200 mg, 0.94 mmol) was added. The solution was stirred for an additional 45 min, then was diluted with EtOAc, and washed sequentially with $NaHCO_3$ (sat) and brine. The organic layer was dried over Na_2SO_4, filtered and concentrated to afford the crude ketone which was purified by flash column chromatography [70 g SiO_2 - 100% hexanes (200 mL), 3 : 1 hexanes - EtOAc (800 mL)] providing 510 mg (94%) of the desired ketone **72**: $[\alpha]_D^{23}$ +26.5° (*c* 2.3, CH_2Cl_2); ^1H NMR (500 MHz, $CDCl_3$) δ 6.88-6.86 (m, 2 H), 6.77-6.75 (m, 2 H), 4.11 (s, 1 H), 3.94 (dd, *J* = 8.9, 8.9 Hz, 1 H), 3.74 (s, 1 H), 3.57-3.47 (m, 4 H), 3.37 (d, *J* = 10.5 Hz, 1 H), 2.26 (b s, 1 H), 2.20 (s, 3 H), 1.94-1.82 (m, 2 H), 1.58-1.51 (m, 1 H), 0.99 (d, *J* = 6.6 Hz, 3 H), 0.97 (s, 9 H), 0.85 (t, *J* = 7.8 Hz, 9 H), 0.49 (q, *J* = 8.0 Hz, 6 H), 0.08 (s, 6 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 212.1, 153.8, 153.3, 116.8, 114.3, 83.1, 80.6, 78.3, 78.2, 77.9, 59.8, 55.6, 38.7, 33.4, 27.2, 25.8, 18.2, 13.5, 6.9, 5.1, –4.5, –4.8; IR (thin film) 3452, 2955, 2934, 2878, 2859, 1734, 1715, 1592, 1506, 1464, 1442, 1416, 1376, 1350, 1290, 1230, 1181, 1136, 1086, 1044, 1012 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{30}H_{55}Si_2O_7$, 583.3486 *m/z* $(M + H)^+$; observed, 583.3484*m/z*.



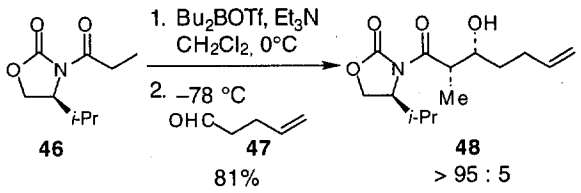
1-(4-triethylsilanyloxy-5-(4-methoxy-phenoxy)-6-(*tert*-butyldiphenyl-silanyloxy-ethyl)-tetrahydro-pyran-2-yl)-1-(*tert*-butyl-dimethyl-silanyloxy)-propan-2-

one (3). To a solution of the primary carbinol **71** (245 mg, 0.42 mmol) in 2 mL of CH_2Cl_2 was added Et_3N (88 μL, 0.63 mmol), followed by DMAP (cat.) and TBDPSCl (138 μL, 0.53 mmol). The solution was stirred at ambient temperature for 5 h, then was diluted with EtOAc and washed sequentially with $KHSO_4$ (1M), $NaHCO_3$ (sat), then brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to provide the crude product which was purified by HPLC (15% EtOAc in hexanes, 21 mm column, 10 mL/min.), affording the 282 mg of the pure ketone **3** (82%): $[\alpha]_D^{23}$ +18.2° (*c* 2.5, $CHCl_3$);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.62-7.58 (m, 4 H), 7.52-7.33 (m, 6 H), 6.90-6.89 (m, 2 H), 6.82-6.80 (m, 2 H), 4.12 (d, *J* = 2.2 Hz, 1 H), 3.83-3.79 (m, 4 H), 3.66-3.58 (m, 2 H), 3.50 (dd, *J* = 9.2, 9.2 Hz, 1 H), 3.41 (ddd, *J* = 9.5, 9.5, 2.0 Hz, 1 H), 3.31 (dd, *J* = 10.4, 2.1 Hz, 1 H), 2.03 (s, 3 H), 1.95-1.89 (m, 2 H), 1.48-1.45 (m, 1 H), 1.03 (s, 9 H), 1.00 (d, *J* = 6.6 Hz, 3 H), 0.97 (s, 9 H), 0.89 (t, *J* = 7.9 Hz, 9 H), 0.53 (q, *J* = 7.9 Hz, 6 H), 0.08 (s, 6 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 211.5, 153.69, 153.66, 135.4, 133.93, 133.89, 129.5, 129.4, 127.6, 127.5, 116.9, 114.3, 82.8, 81.8, 78.7, 78.3, 75.9, 60.4, 55.6, 38.8, 35.2, 27.1, 26.8, 25.9, 19.2, 18.3, 13.5, 6.9, 5.2, –4.4, –4.8; IR (thin film) 3072, 2956, 2932, 2877, 2859, 1736, 1716, 1506, 1464, 1428, 1378, 1362, 1350, 1229, 1153, 1088, 1042, 1012 cm^{-1}; HRMS (FAB) calcd for $C_{46}H_{72}Si_3O_7Na$, 843.4484 *m/z* (M + H)$^+$; observed, 843.4454 *m/z*.



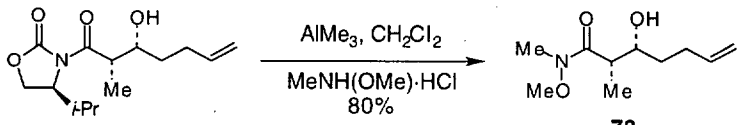
1-(4-triethylsilanyloxy-5-(4-methoxy-phenoxy)-6-(*tert*-butyldiphenyl-silanyloxy-ethyl)-tetrahydro-pyran-2-yl)-1-(*tert*-butyl-dimethyl-silanyloxy)-2-trimethylsilanyloxy-prop-2-ene (61). To a solution of the methyl ketone **3** (241 mg, 0.29 mmol) in 4 mL of THF cooled to –20 °C, was added 2 mL Et_3N : TMSCl (1 : 1), followed by 2 mL of LiHMDS (1.0 M in THF).[5] The mixture was allowed to warm to 0 °C, and an addition 1 mL of Et_3N : TMSCl (1 : 1) was added, followed by 0.5 mL of LiHMDS (1.0 M in THF). The reaction was then quenched with pH 7 buffer, diluted with hexanes and washed sequentially with pH 7 buffer and brine. The organic layers were dried over Na_2SO_4, filtered and concentrated to afford the crude enol silane **61**,

which was purified by HPLC (5% EtOAc in hexanes, 21 mm column, 10 mL/min.) affording 214 mg (83%) of the pure enol silane **3**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61-7.58 (m, 4 H), 7.40-7.30 (m, 6 H), 6.87-6.85 (m, 2 H), 6.79-6.77 (m, 2 H), 4.31 (s, 1 H), 4.10 (s, 1 H), 3.95 (s, 1 H), 3.79-3.75 (m, 4 H), 3.73-3.70 (m, 2 H), 3.44 (dd, *J* = 9.2, 9.2 Hz, 1 H), 3.33 (ddd, *J* = 9.4, 9.4, 2.1 Hz, 1 H), 3.04 (dd, *J* = 10.4, 1.8 Hz, 1 H), 1.00 (s, 9 H), 0.99 (d, *J* = 6.6, Hz, 3 H), 0.92 (s, 9 H), 0.86 (t, *J* = 7.9 Hz, 9 H), 0.50 (q, *J* = 8.0 Hz, 6 H), 0.14 (s, 9 H), 0.05 (s, 3 H), 0.04 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.4, 153.9, 153.6, 135.5, 134.2, 129.3, 127.5, 119.7, 116.9, 114.3, 90.8, 82.3, 80.8, 79.2, 75.6, 73.7, 60.9, 55.7, 39.5, 35.7, 26.9, 26.0, 19.2, 18.2, 13.7, 7.0, 5.3, 0.2, –4.3, –5.0; IR (thin film) 3072, 3050, 2957, 2932, 2878, 2858, 1643, 1591, 1506, 1472, 1464, 1428, 1377, 1362, 1305, 1253, 1230, 1156, 1111, 1088, 1044, 1009 cm^{-1}; HRMS (EI) calcd for $C_{49}H_{80}Si_4O_7$, 892.4981 *m/z* $(M)^+$; observed, 892.4938*m/z*.



[3(2'*S*, 3'*R*)4*S*]-3-[3'-Hydroxy-2'-methyl-6'-heptenoyl]-4-isopropyl-2-oxazolidinone (48).[6] To a 0 °C solution of N-propionyl oxazolidinone **46** (1.53 g, 8.24 mmol) in 18 mL of was added di-*n*-butylboron triflate (2.28 mL, 9.07 mmol) dropwise followed by Et_3N (1.37 mL, 9.89 mmol). The mixture was stirred for an additional 30 min. at 0 °C, then was cooled to –78 °C and neat 4-pentenal (0.76 g, 9.03 mmol) was added via syringe. The reaction was stirred for 30 min at –78 °C and then for 2 h at 0 °C. The mixture was diluted with CH_3OH (30 mL) and pH 7 phosphate buffer (10 mL), and stirred for 10 min at 0 °C. A solution of 30% aqueous H_2O_2 (10 mL) was then added dropwise with vigorous stirring. After 1 h at 0 °C, the reaction mixture was diluted with brine and extracted with EtOAc (3x). The combined extracts were washed with $NaHCO_3$ (sat), dried over Na_2SO_4, filtered and concentrated. Purification of the crude product by flash column chromatography on silica gel in hexane-EtOAc (gradient from 9: 1 to 3 : 1) provided 1.8 g (81%) of aldol **48** as a colorless oil: $[\alpha]_D^{23}$ +66° (*c* 2.0, $CHCl_3$);^{1}H NMR (360 MHz, $CDCl_3$) δ 5.81 (app ddt, *J* = 18.0, 11.0, 7.0 Hz, 1 H), 5.03 (app ddt, *J* = 18.0, 1.5, 1.5 Hz, 1 H), 4.95 (app ddt, *J* = 11.0, 1.5, 1.5 Hz, 1 H),

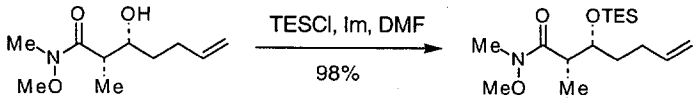
4.48-4.43 (m, 1 H), 4.27 (dd, J = 9.0, 9.0 Hz, 1 H), 4.19 (dd, J = 9.5, 3.5 Hz, 1 H), 3.97-3.92 (m, 1 H), 3.75 (qd, J = 7.2, 3.0 Hz, 1 H), 3.0 (br s, 1 H), 2.38-2.28 (m, 1 H), 2.28-2.17 (m, 1 H), 2.17-2.05 (m, 1 H), 1.70-1.59 (m, 1 H), 1.51-1.41 (m, 1 H), 1.24 (d, J = 7.3 Hz, 3 H), 0.91 (d, J = 7.0 Hz, 3 H), 0.87 (d, J = 7.0 Hz, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 177.83, 153.5, 138.1, 115.0, 70.5, 63.3, 58.2, 42.0, 32.8, 30.1, 28.3, 17.9, 14.6, 10.7; IR (thin film) 3522, 2967, 1780, 1694, 1386, 1301, 1204, 1121, 1056, 1016, 992 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{14}H_{24}NO_4$, 270.1705 *m/z* (M + H)$^+$; observed, 270.1702*m/z*. *Anal.* Calcd for $C_{14}H_{23}NO_4$: C, 62.43; H, 8.61; N, 5.20. Found: C, 62.31; H, 8.26; N, 5.20.



48 **73**

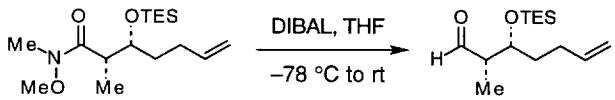
(2*S*,3*R*)-N-methoxy-N,2-dimethyl-3-hydroxy-hept-6-ene-amide (73).[6] To a stirred suspension of *N*, *O*-dimethylhydroxylamine hydrochloride (540 mg, 5.54 mmol) in 7.5 mL of CH_2Cl_2 at –10 °C was slowly added a 2.0 M solution of Me_3Al in toluene (2.76 mL, 5.52 mmol). The reaction mixture was stirred at 0 °C for 15 min until gas evolution ceased. The solution was recooled again to –10 ° and a solution of aldol **48** (496 mg, 1.84 mmol) in CH_2Cl_2 (7.5 mL) was added. The reaction mixture was stirred for 1 h at –10 ° to –5 °C, then 2 h at 0 °C and finally 0.5 h at ambient temperature and then poured into an ice-cold mixture of 0.5 N HCl (50 mL) and CH_2Cl_2 (25 mL). After being stirred vigorously for 5 min, the mixture was extracted with CH_2Cl_2 (3x). The combined extracts were washed with pH 7 buffer, dried over Na_2SO_4, filtered and concentrated to provide a crude product which was purified by silica gel chromatography in hexane-EtOAc (gradient from 6 : 4 to 7 : 3) to give 295 mg of the amide **73** as a pale yellow oil (80%): $[\alpha]_D^{23}$ +13.2° (*c* 2.0, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.84 (app ddt, J = 17.9, 10.3, 6.7 Hz, 1 H), 5.04 (app ddt, J = 18.0, 1.5, 1.5 Hz, 1 H), 4.96 (app ddt, J = 11.0, 1.5, 1.5 Hz, 1 H), 3.90-3.85 (m, 1 H), 3.78 (b s, 1 H), 3.70 (s, 3 H), 3.19 (s, 3 H), 2.91-2.84 (m, 1 H), 2.30-2.20 (m, 1 H), 2.17-2.06 (m, 1 H), 1.72-1.62 (m, 1 H), 1.47-1.38 (m, 1 H), 1.7 (d, J = 7 Hz, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 179.3, 139.4, 115.9, 71.9, 62.6, 39.7, 34.1, 32.9, 31.3, 11.2; IR (thin film) 3436, 2976, 2939, 1652, 1450, 1386, 1179, 1099, 1040, 994 cm^{-1}; MS (CI,

NH_3) calcd for $C_{10}H_{20}NO_3$, 202.1 *m/z* $(M + H)^+$; observed, 202.1*m/z*. *Anal.* Calcd for $C_{10}H_{19}NO_3$: C, 59.68; H, 9.52; N, 6.96. Found: C, 59.97; H, 9.52 ; N, 6.86.



73 **49**

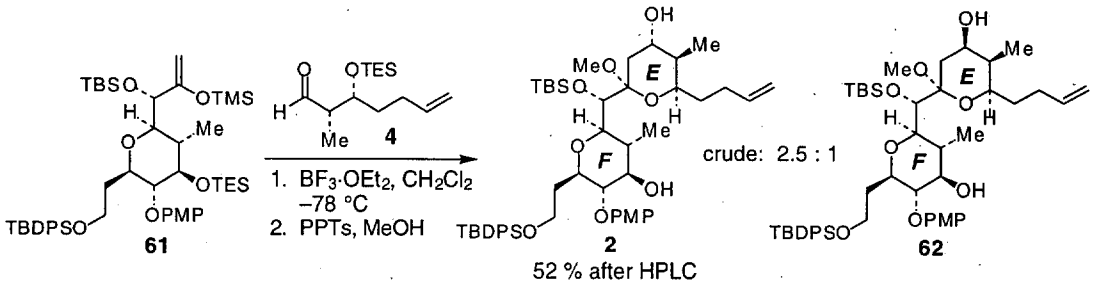
(2*S*,3*R*)-N-methoxy-N,2-dimethyl-3-triethylsilanyloxy-hept-6-ene-amide(49).[7] To a solution of amide **73** (413 mg, 2.05 mmol) and imidazole (586 mg, 8.61 mmol) in 2 mL of dimethylformamide was added TESCl (0.72 mL, 4.29 mmol) dropwise at ambient temperature. The reaction was stirred for 2.5 h at ambient temperature, then quenched with $NaHCO_3$ (sat). The solution was diluted with EtOAc and washed sequentially with $NaHCO_3$ (sat) and brine, dried over Na_2SO_4, filtered and concentrated. The crude material was purified by flash column chromatography and eluted with hexanes-EtOAc (gradient from 9: 1 to 8 : 2) affording 646 mg of the desired TES ether **49** (98%) as a pale yellow oil: $[\alpha]_D^{23}$ +2.9° (*c* 4.6, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 5.81 (app ddt, *J* = 17.9, 10.3, 6.6 Hz, 1 H), 5.00 (app ddt, *J* = 18.0, 1.5, 1.5 Hz, 1 H), 4.93 (app ddt, *J* = 11.0, 1.5, 1.5 Hz, 1 H), 3.95 (dt, *J* = 8.4, 4.8 Hz, 1 H), 3.69 (s, 3 H), 3.18 (s, 3 H), 3.10-2.94 (m, 1 H), 2.16-2.08 (m, 2 H), 1.62-1.48 (m, 2 H), 1.18 (d, *J* = 7.0 Hz, 3 H), 0.98 (t, *J* = 8 Hz, 9 H), 0.64 (q, *J* = 8 Hz, 6 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.5, 138.8, 114.2, 73.6, 61.4, 41.0, 35.2, 32.1, 28.9, 14.7, 7.0, 5.2; IR (thin film) 2955, 2877, 1668, 1456, 1416, 1384, 1239, 1110, 1054, 1000 cm^{-1}; HRMS (CI, NH_3) calcd for $C_{16}H_{34}NO_3Si$ 316.2308 *m/z* $(M + H)^+$; observed, 316.2299*m/z*. *Anal.* Calcd for $C_{16}H_{33}NO_3Si$: C, 60.91; H, 10.54; N, 4.44. Found: C, 60.98; H, 10.59; N, 4.35.



49 **4**

(2*S*, 3*R*)-2-methyl-3-triethylsilanyloxy-6-heptenal (4).[7] To a –50 °C solution of amide **49** (45 mg, 0.14 mmol) in 1 mL THF was added 400 μL DIBAL (1 M in hexanes). The solution was stirred under N_2 for 20 minutes (–50 °C to –20 °C). The reaction was diluted with 500 μL CH_3OH, then 1 mL of a saturated solution of Rochelle's salt was added. The solution was stirred at ambient temperature until the aluminum salts dissolved (c.a. 1 h). The solution was diluted with EtOAc and

washed with $NaHCO_3$(sat) and brine. The organic layer was dried over $MgSO_4$, filtered and concentrated to afford the aldehyde (**4**) as a light yellow oil which was used without purification in the aldol reaction with enolsilane **61**.

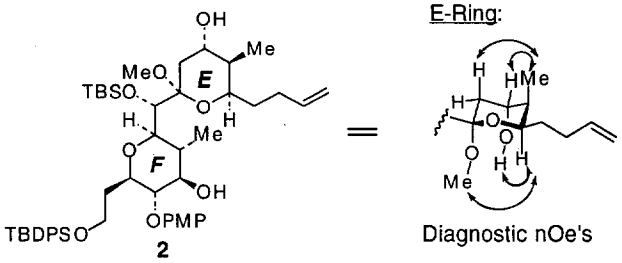


52 % after HPLC

(2*R*, 3*S*, 4*R*, 5*R*, 6*R*)-2-(*tert*-butyldiphenylsilanyloxy-ethyl)-6-[(1'*S*)[(4''*S*, 2''*R*, 5''*R*)-2''-methoxy-4''-hydroxy-5''-methyl-6''-(3-butenyl)tetrahydro-2H-pyran-2-yl]-1'-*tert*-butyldimethyl-silanyloxy-methyl]-3-(methoxy-phenoxy)-5-methyl-tetrahydro-2H-pyran-4-ol (2) and (2*R*, 3*S*, 4*R*, 5*R*, 6*R*)-2-(*tert*-butyldiphenyl-silanyloxy-ethyl)-6-[(1'*S*)[(4''*R*, 2''*R*, 5''*R*)-2''-methoxy-4''-hydroxy-5''-methyl-6''-(3-butenyl)tetrahydro-2H-pyran-2-yl]-1'-*tert*-butyldimethyl-silanyloxy-methyl]-3-(methoxy-phenoxy)-5-methyl-tetrahydro-2H-pyran-4-ol (62) The aldehyde **4** (0.14 mmol) was concentrated in a 0.5 mL conical vial via the aid of a stream of N_2. To the crude yellow oil was added freshly activated 4Å molecular sieves, and then the enol silane **61** (44 mg, 0.049 mmol) was added as a solution in 250 μL of CH_2Cl_2. The mixture was stirred at ambient temperature for 5 min, then cooled to –78 °C. To the cold solution, was added $BF_3{\cdot}OEt_2$ (32 μL, 0.25 mmol) - care was taken to ensure that the $BF_3{\cdot}OEt_2$ was added to the side of the flask to allow for cooling of the Lewis acid prior to entering the reaction medium. The solution was stirred for 4.5 h at –78 °C, then warmed to –20 °C over 2 h. The reaction was quenched by the addition of 200 μL Et_3N. The solution was diluted with EtOAc and washed sequentially with brine, $KHSO_4$ (1M) (2x), $NaHCO_3$ (sat), then brine. The organic phase was dried over Na_2SO_4, filtered and concentrated to provide an oil which was diluted with 1.5 mL CH_2Cl_2 and 2.0 mL of CH_3OH. To this solution was added PPTS (57 mg). The solution was stirred at ambient temperature for 2 h, then quenched with 2 mL of $NaHCO_3$ (sat). The solution was diluted with EtOAc and washed with $NaHCO_3$ (sat), then brine. The organic phase was dried over $MgSO_4$, filtered and concentrated to provide a crude mixture of **2** and **62** (2.5 : 1 by ^1H NMR analysis). After

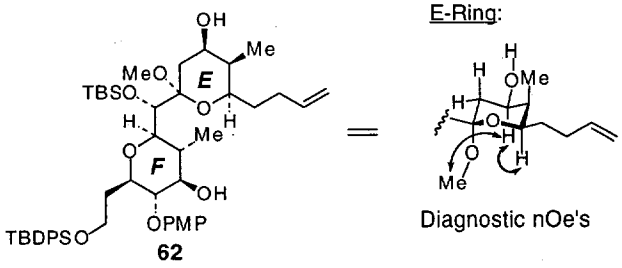
purification by HPLC (25% EtOAc in hexanes, 21 mm column Dynamax 60A, 10 mL/min), 22.2 mg (53 %)of the E-F bis-pyran subunit **2** was obtained .

Data for 2: $[\alpha]_D^{23}$ +44.2° (*c* 0.59, $CHCl_3$);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64-7.59 (m, 4 H), 7.41-7.32 (m, 10 H), 6.95-6.92 (m, 2 H), 6.83-6.80 (m, 2 H), 5.89-5.81 (m, 1 H), 5.06-5.02 (m, 1 H), 4.99 (m, 1 H), 3.95 (m, 1 H), 3.81-3.72 (m, 7 H), 3.68 (dd, *J* = 9.0, 9.0 Hz, 1 H), 3.52-3.48 (m, 2 H), 3.4 (ddd, *J* = 9.5, 9.5, 2.5 Hz, 1 H), 3.23 (d, *J* = 10.5 Hz, 1 H), 3.17 (s, 3 H), 2.32-2.25 (m, 2 H), 2.13-2.06 (m, 1 H), 2.04-1.97 (m, 2 H), 1.87-1.79 (m, 1 H), 1.76-1.68 (m, 1 H), 1.66-1.53 (m, 4 H), 1.46-1.33 (m, 1 H), 1.05 (d, *J* = 6.3 Hz, 3 H), 1.03 (s, 9 H), 0.87 (s, 9 H), 0.80 (d, *J* = 7.3 Hz, 3 H), 0.09 (s, 3 H), 0.07 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 154.3, 153.7, 138.5, 135.45, 135.43, 134.00, 133.98, 129.5, 127.6, 127.5, 117.6, 114.71, 114.68, 102.8, 83.4, 78.2, 78.1, 74.6, 70.4, 70.1, 67.0, 60.9, 55.7, 47.1, 38.2, 37.5, 35.5, 31.8, 30.3, 28.7, 26.9, 26.0, 19.2, 18.4, 13.7, 10.6, –3.1, –4.7; IR (thin film) 3412, 3072, 3049, 2955, 2930, 2857, 1641, 1590, 1506, 1472, 1463, 1442, 1428, 1376, 1362, 1309, 1229, 1178, 1156, 1106, 1087, 1064, 1029, 1001 cm^{-1}; HRMS (FAB) calcd for $C_{49}H_{74}Si_2O_9Na$, 885.4769*m/z* $(M + Na)^+$; observed, 885.4791*m/z*. The stereochemistry of **2** was assigned by ^{1}H nOe's as summarized below:



Data for 62: $[\alpha]_D^{23}$ +26.2° (*c* 0.5, $CHCl_3$);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67-7.60 (m, 4 H), 7.41-7.33 (m, 6 H), 6.95-6.93 (m, 2 H), 6.83-6.81 (m, 2 H), 5.87-5.79 (m, 1 H), 5.05-5.00 (m, 1 H), 4.98-4.96 (m, 1 H), 3.89-3.83 (m, 1 H), 3.79-3.71 (m, 6 H), 3.68 (dd, *J* = 8.9, 8.9 Hz, 1 H), 3.53-3.42 (m, 3 H), 3.25 (d, *J* = 10.5 Hz, 1 H), 3.10 (s, 3 H), 2.27 (d, *J* = 2.9 Hz, 1 H), 2.26-2.22 (m, 1 H), 2.10-1.97 (m, 2 H), 1.86-1.81 (m, 1 H), 1.77-1.68 (m, 3 H), 1.60-1.52 (m, 5 H), 1.46-1.41 (m, 1 H), 1.05 (d, *J* = 6.6 Hz, 3 H), 1.02 (s, 9 H), 0.91 (s, 9 H), 0.75 (d, *J* = 7.1 Hz, 3 H), 0.53 (d, *J* = 6.3 Hz, 1 H), 0.09 (s, 3 H), 0.07 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 154.3, 153.8, 138.5, 135.5, 134.0, 129.6, 129.5, 127.6, 117.5, 114.71, 114.66, 102.0, 83.5, 78.2, 78.1, 77.2, 74.6, 71.7, 70.0, 67.7, 60.9, 55.7, 47.2, 38.2, 37.3, 35.6, 32.2, 31.8, 30.4, 26.9, 26.1, 19.1, 18.4,

13.7, 4.3, –3.1, –4.6; IR (thin film) 3460, 3073, 2930, 2857, 1642, 1590, 1506, 1472, 1464, 1442, 1428, 1374, 1306, 1229, 1111, 1038, 1006 cm^{-1}; HRMS (FAB) calcd for $C_{49}H_{74}Si_2O_9Na$ 885.4769*m/z* $(M + Na)^+$; observed, 885.4770*m/z*. The stereochemistry of **62** was assigned by ^1H nOe's as summarized below.



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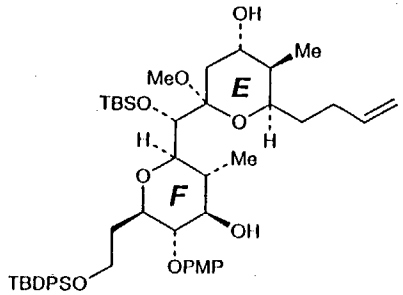
E-F bis-pyran 2

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: gcm-4-100-a
INOVA-500 "NI.Chem.LSA.UMich.Edu"
PULSE SEQUENCE
Relax. delay 1.000 sec
Pulse 40.0 degrees
Acq. time 2.500 sec
Width 8000.0 Hz
8 repetitions
OBSERVE H1, 499.9042607 MHz
DATA PROCESSING
FT size 65536
Total time 0 min, 28 sec



2

methyl ketone 3

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: gcm-4-23-hplc
INOVA-500 "Ni.Chem.LSA.UMich.Edu"
PULSE SEQUENCE
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Pulse 40.2 degrees
Acq. time 2.500 sec
Width 8000.0 Hz
8 repetitions
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DATA PROCESSING
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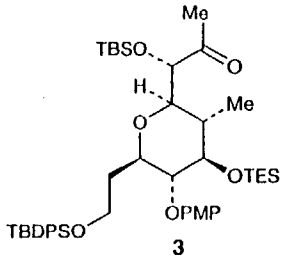
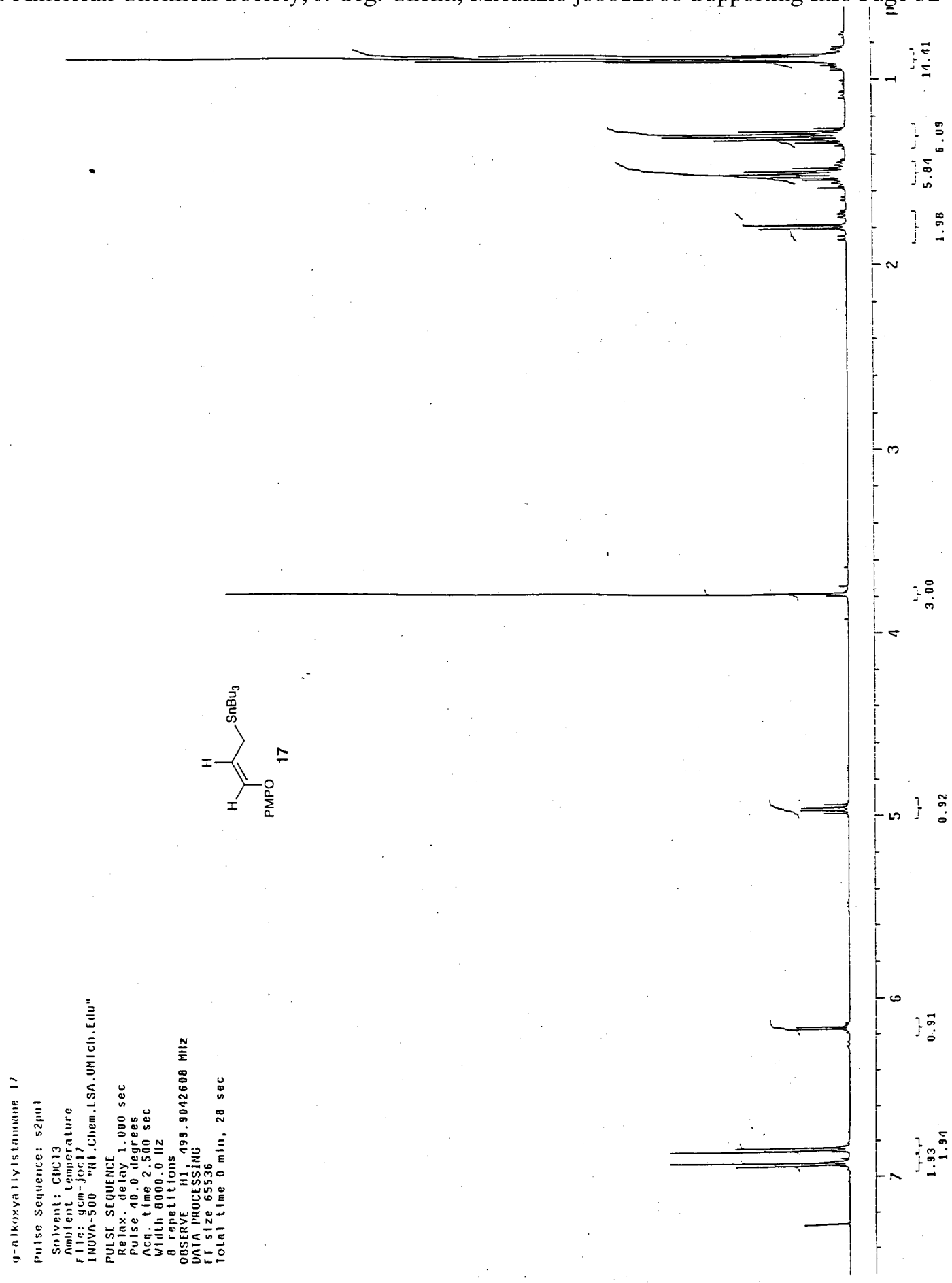
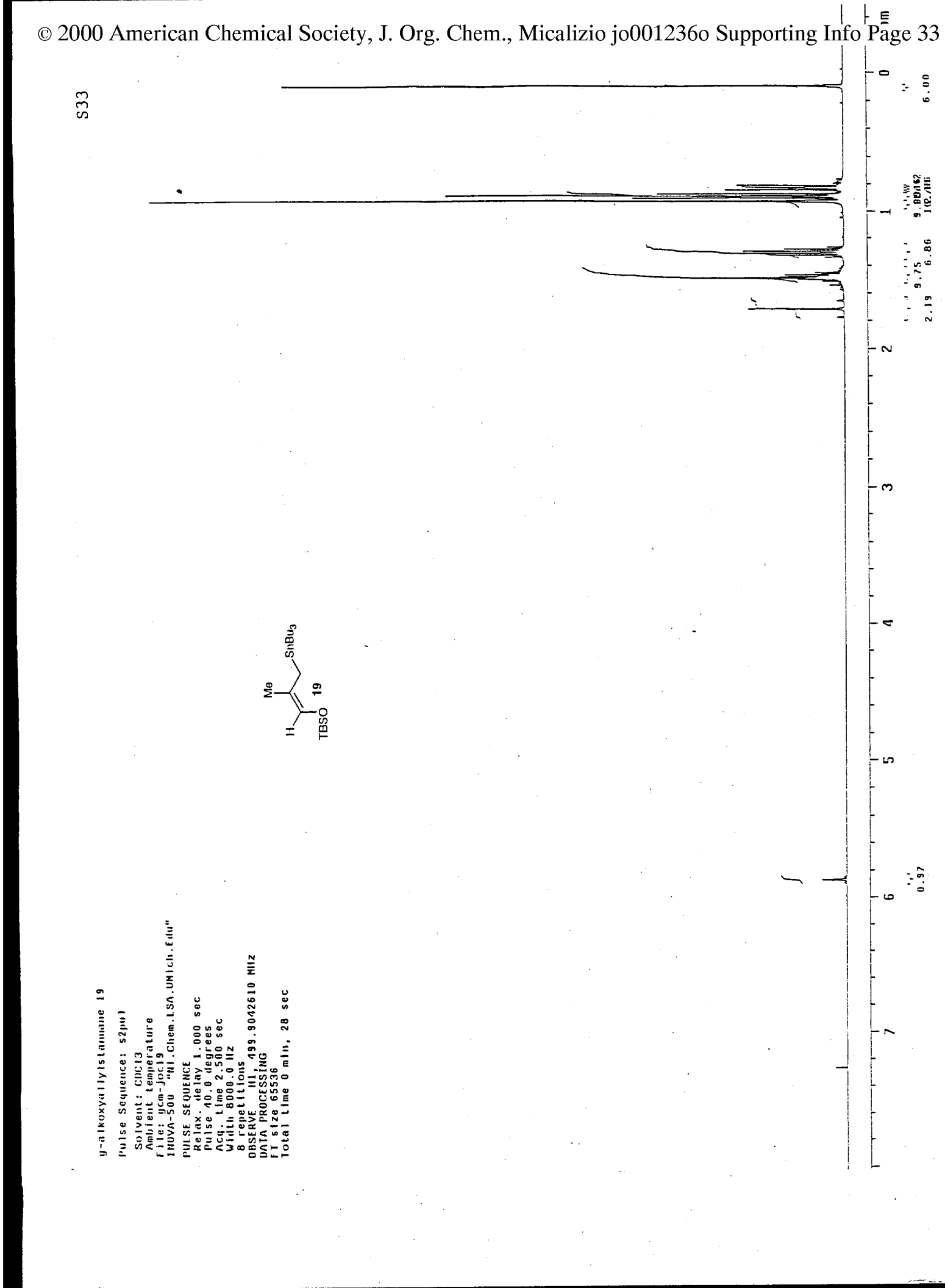
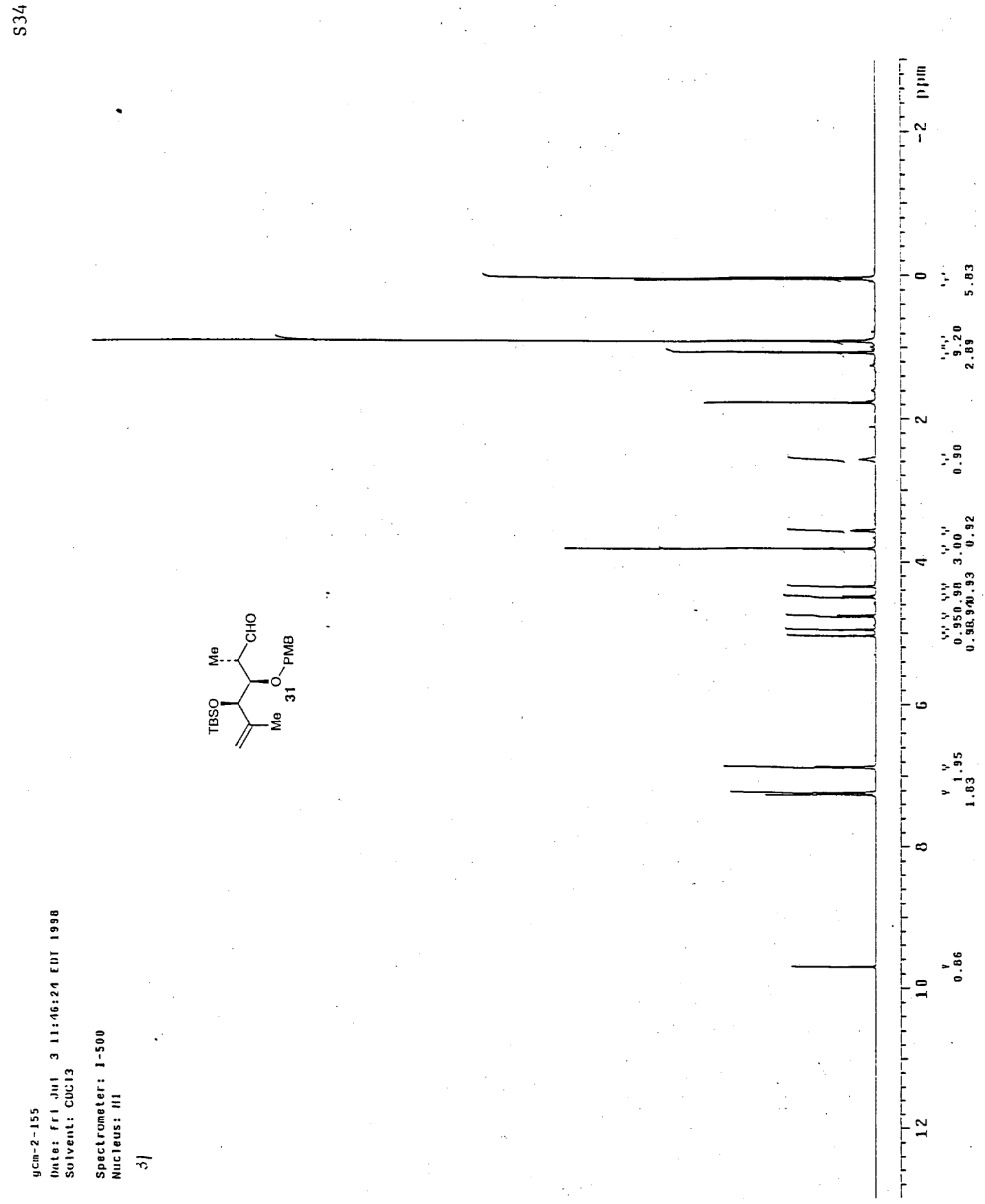
Total time 0 min, 28 sec



3







aldehyde 38

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: gcm-2-208
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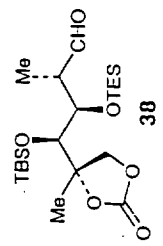
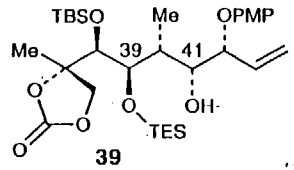
PULSE SEQUENCE
Relax. delay 1.000 sec
Pulse 33.2 degrees
Acq. time 2.500 sec
Width 8000.0 Hz
8 repetitions
OBSERVE H1, 499.9042600 MHz
DATA PROCESSING
FT size 65536
Total time 0 min, 28 sec



38

alcohol 39

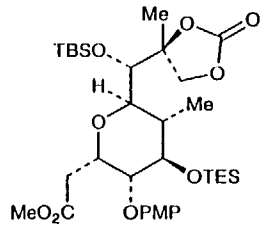
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: gcm-2-209
INOVA-500 "NI.Chem.LSA.UMich.Edu"
PULSE SEQUENCE
Relax. delay 1.000 sec
Pulse 33.2 degrees
Acq. time 2.500 sec
Width 8000.0 Hz
8 repetitions
OBSERVE H1, 499.9042600 MHz
DATA PROCESSING
FT size 65536
Total time 0 min, 28 sec



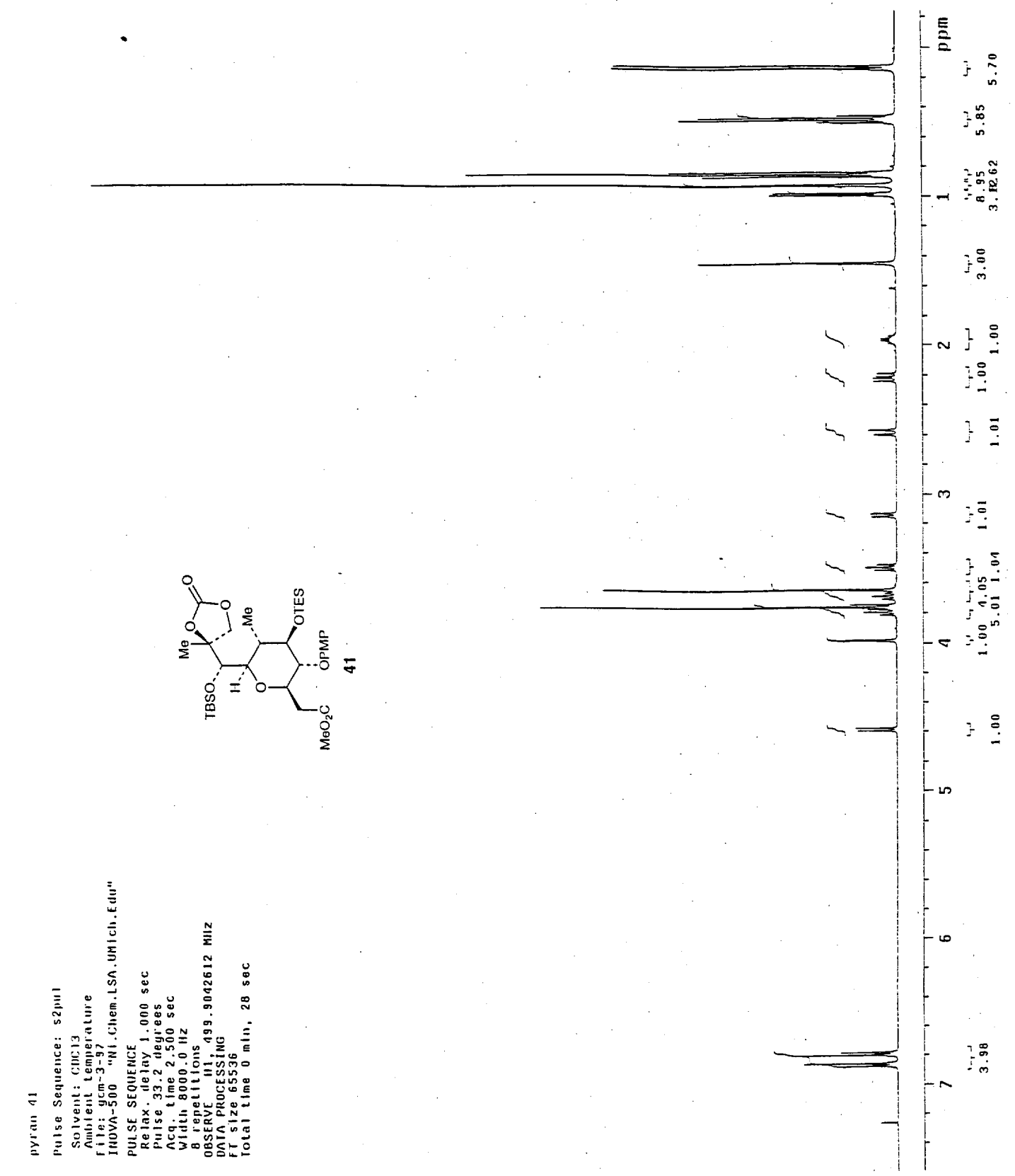
39

pyran 40

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: gcm-2-220-hplc
INOVA-500 "NI.Chem.LSA.UMich.Edu"
PULSE SEQUENCE
Relax. delay 1.000 sec
Pulse 39.0 degrees
Acq. time 2.500 sec
Width 8000.0 Hz
8 repetitions
OBSERVE H1, 499.9042605 MHz
DATA PROCESSING
FT size 65536
Total time 0 min, 28 sec

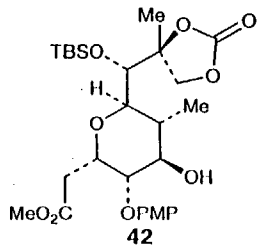


40



pyran 42

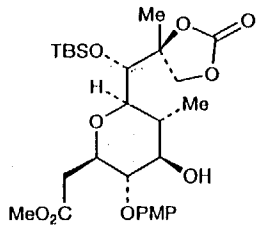
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: gcm-2-248
INOVA-500 "NI.Chem.LSA.UMich.Edu"
PULSE SEQUENCE
Relax. delay 1.000 sec
Pulse 39.0 degrees
Acq. time 2.500 sec
Width 8000.0 Hz
8 repetitions
OBSERVE H1, 499.9042617 MHz
DATA PROCESSING
FT size 65536
Total time 0 min, 28 sec



42

pyran 43

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: gcm-3-28
INOVA-500 "NI.Chem.LSA.UMich.Edu"
PULSE SEQUENCE
Relax. delay 1.000 sec
Pulse 40.0 degrees
Acq. time 2.500 sec
Width 8000.0 Hz
8 repetitions
OBSERVE H1, 499.9042612 MHz
DATA PROCESSING
FT size 65536
Total time 0 min, 28 sec



43