Development of a General, Sequential, Ring Closing Metathesis/Intramolecular Cross-Coupling Reaction for the Synthesis of Polyunsaturated Macrolactones

Scott E. Denmark* and Joseck M. Muhuhi

Department of Chemistry, University of Illinois, 600 South Mathews Avenue, Urbana, Illinois 61801

SUPPORTING INFORMATION

Table of Contents **Page**

General Experimental

All reactions were performed in oven-dried (150 °C) and/or flame-dried glassware under an atmosphere of dry argon unless otherwise specified. Commercial reagents were purified using distillation or recrystallization prior to use. All syringes were glass. Reaction solvents tetrahydrofuran (Fisher, HPLC grade), diethyl ether (Fisher, BHT stabilized ACS grade), and dichloromethane (Fisher, unstabilized HPLC grade) were dried by percolation through two columns packed with neutral alumina under a positive pressure of argon. Reaction solvents hexane (Fisher, OPTIMA grade), and toluene (Fisher, ACS grade) were dried by percolation through a column packed with neutral alumina and a column packed with Q5 reactant, a supported copper catalyst for scavenging oxygen, under a positive pressure of argon. Methanol (ACS grade) was distilled from $Mg(OMe)_2$ and chloroform (ACS grade) was distilled from P_2O_5. Collidine was distilled from calcium hydride. All reaction temperatures correspond to internal temperatures measured by Teflon-coated thermocouples unless otherwise noted. A 1.0 M solution of tetrabutylammonium fluoride in THF was prepared from solid tetrabutylammonium fluoride trihydrate (TBAF•$3H_2O$, Fluka, Acros) and THF in a volumetric flask and was stored in a Schlenk flask. "Brine" refers to a sat. aq. solution of NaCl.

Bulb-to-bulb distillations were carried on a Büchi GKR-50 Kugelrohr and boiling points (bp) correspond to the uncorrected recorded air bath temperatures (ABT). Melting points (mp)

were determined in sealed tubes using a Thomas Unimelt Hoover capillary melting point apparatus and were corrected. Melting point samples were contained in a vacuum-sealed glass capillary.

Analytical thin-layer chromatography was performed on Merck silica gel 60 F_{254} or Merck silica gel 60 RP-18 F_{254s} plates. Visualization was accomplished with UV light and/or $KMnO_4$, H_2SO_4, ninhydrin solution. R_f values reported were measured using a 10 × 2 cm TLC plate in a developing chamber containing the solvent system described. Diethyl ether, ethyl acetate, hexanes, dichloromethane, acetonitrile and methanol were of reagent grade and used as received. Flash chromatography was performed using Merck silica gel 60 230-400 mesh (60-63 μ, 60 Å pore size). Solvents for chromatography were: hexanes (ACS grade), ethyl acetate (ACS grade), diethyl ether (ACS grade), dichloromethane (ACS grade), dimethoxyethane (ACS grade), acetonitrile (ACS grade), and methanol (ACS grade).

^{1}H NMR spectra were recorded on a Varian Inova (500 MHz, ^{1}H), Varian Unity-500 (500 MHz, ^{1}H, 126 MHz, ^{13}C), Varian 500 VXR (500 MHz, ^{1}H, 126 MHz, ^{13}C) spectrometer in chloroform-*d*, using chloroform (7.27 ppm, ^{1}H, 77.00 ppm, ^{13}C) as an internal reference. Chemical shifts are reported in ppm (d); multiplicities are indicated by s (singlet), d (doublet), q (quartet), qn (quintet), sext (sextet), m (multiplet), and br (broad). Coupling constants, *J*, are reported in Hertz (Hz); integration is provided and assignments are indicated. All ^{13}C NMR and ^{1}H NMR assignments are corroborated by 2-D experiments (COSY, HETCOR/and or HMQC, and HMBC).

Infrared (IR) spectra were as thin films (neat) in NaCl cells or as KBr plates, using a Perkin Elmer Spectrum BX FT-IR spectrophotometer or a Mattson Galaxy 5020 spectrophotometer, and peaks are reported in cm^{-1} along with relative signal intensities: s

(strong); m (medium); w (weak).

Low-resolution and high-resolution electron impact mass spectrometry (EI) was performed at 70 eV, on a Micromass 70-VSE spectrometer. Low-resolution and high-resolution chemical ionization mass spectra (CI) were obtained using methane as the carrier gas, on a Micromass 70-VSE spectrometer. Low-resolution and high-resolution electrospray ionization (ESI) mass spectrometry was performed on a Micromass Q-Tof Ultima spectrometer. University of Illinois School of Chemistry Mass Spectrometry Laboratory conducted all the analyses. Data are reported in the form of *m*/*z* (intensity relative to base peak = 100.0).

Microanalysis (CHN) was performed on an Exeter CE440 analyzer by the University of Illinois School of Chemistry Microanalysis Service Laboratory.

Literature Preparations

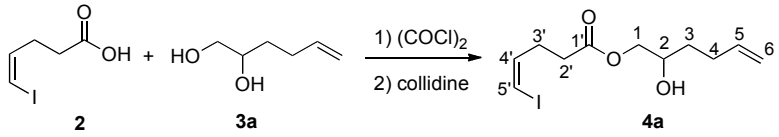
(Z)-5-Iodo-4-pentenol (**1**),[1] (Z)-5-iodopent-4-enoic acid (**2**),[1] diols (**3a**-**e**),[2] and 2,2-dimethyl-5-(trifluoromethanesulfonyl)-benzo[1,3]dioxin-4-one (**15**),[3] and 2,2-dimthyl-5-hydroxy-4-oxo-benzo1,4-dioxin (**17**)[4] were prepared according to literature procedures. Schrock cat (**6**) was purchased from Strem and used as received.

General Procedure I. Acylation of (*Z*)-5-Iodopent-4-enoic Acid (2).

In a flame-dried, 100-mL, three-necked round-bottomed flask under argon was charged acid **2** and anhydrous benzene added to give a pale-red solution. Oxalyl chloride was then added dropwise followed by DMF and the reaction mixture let stir under ambient temperature for 6 h. After 6 h ^{1}H NMR and ^{13}C NMR showed the reaction was complete. The solvent removed in vacuo to afford the acid chloride as red oil.

In another 100-mL, three-necked, round-bottomed flask containing CH_2Cl_2 under argon was dissolved diol **3** and collidine and the mixture then cooled in *i*-PrOH/CO_2 bath to -76 °C as monitored with an internal probe. A solution of the acid chloride in CH_2Cl_2 was then added dropwise by a syringe pump at a rate of 8 mL/h. The mixture was stirred at -76 °C for 4 h then was allowed to gradually warm to ambient temperature and was stirred for another 6 h. The mixture was poured onto 0.5 M aq. HCl solution and the aqueous layer was extracted with CH_2Cl_2. The organic layers were washed with H_2O, sat. $NaHCO_3$ solution, and dried over $MgSO_4$ then concentrated. The crude product was then purified by silica gel chromatography using a hexane/EtOAc solvent gradient system. An analytical sample was then re-purified by chromatography with Et_2O/pentane.

Preparation of 2-Hydroxy-5-hexenyl (*Z*)-5-Iodo-4-pentenoate (4a).



2 **3a** **4a**

Following General Procedure I, the acid **2** (3.00 g, 13.3 mmol) was dissolved in anhydrous benzene (65 mL) to give a pale-red solution. Oxalyl chloride (1.62 mL, 18.6 mmol equiv) then added dropwise followed by DMF (25 μL, 0.32 mmol equiv) and the reaction mixture was allowed stir at ambient temperature for 6 h. After 6 h ^{1}H NMR and ^{13}C NMR analysis showed that the reaction was complete. The solvent removed in vacuo to afford 3.41 g (105%) of the acid chloride as red oil.

In 100-mL, three-necked, round-bottomed flask containing CH_2Cl_2 (65 mL) was dissolved diol **3a** (906 mg, 7.80 mmol) and collidine (1.72 mL, 13.0 mmol equiv) to afford a clear colorless solution. The mixture then cooled in an *i*-PrOH/CO_2 bath and a solution of the

acid chloride (1.59 g, 6.50 mmol equiv) in CH_2Cl_2 (10 mL) then added dropwise by a syringe pump at a rate of 8 mL/h. The mixture was stirred at -78 °C for 4 h then was allowed to warm to ambient temperature and was stirred for another 6 h. The mixture poured onto 0.5 M aq. HCl (50 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 30 mL). The organic layers were washed with H_2O (1 × 20 mL) and sat. $NaHCO_3$ solution (1 × 20 mL), then were dried over $MgSO_4$ and were concentrated in vacuo to afford 2.98 g of a red brown oil. The crude product was purified by silica gel chromatography (190 g) using hexane/EtOAc (6:1 to 3:1) to afford 1.67 g (79%) of **4a** as a light-green oil. An analytical sample was prepared by a second chromatography with Et_2O/pentane, 1:1.

Analytical Data for **4a**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.28 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.22 (q, *J* = 6.5 Hz, 1 H, HC(4')), 5.81 (ddt, *J* = 17.3, 10.0, 6.5 Hz, 1 H, HC(5)), 5.05 (dq, *J* = 16.8, 1.5 Hz, 1 H, HC(6)), 4.98 (dd, *J* = 10.0, 1.5 Hz, 1 H, HC(6)), 4.14 (dd, J = 11.5, 3.5 Hz, 1 H, HC(1)), 3.98 (dd, *J* = 11.3, 7.5 Hz, 1 H, HC(1)), 3.88-3.83 (m, 1 H, HC(2)), 2.50-2.43 (m, 4 H, HC(2', 3')), 2.26-2.10 (m, 3 H, HC(4), OH), 1.61-1.54 (m, 2 H, HC(3)).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.6 (C(1')), 139.0 (C(4')), 137.8 (C(5)), 115.3 (C(6)), 84.0 (C(5')), 69.2 (C(2)), 68.6 (C(1)), 32.3 (C(3)), 32.3 (C(3)), 30.1 (C(3')), 29.5 (4)).

IR: (thin film, NaCl plates)

3453 (m), 3075 (w), 2978 (m), 2922 (m), 1739 (s), 1642 (m), 1611 (w), 1417 (m), 1385 (m), 1356 (m), 1285 (s), 1263 (s), 1180 (s), 1094 (m), 994 (s), 919 (s), 689 (m), 629 (m).

LRMS: (CI):

325.0 ([M+H]$^+$(5)), 307.0 (15), 227.0 (15), 209.0 (20), 99.1 (25), 81.1 (100), 71.1 (15).

HRMS: (CI, [MH]$^+$):

calcd.: 325.03277

found: 325.03014

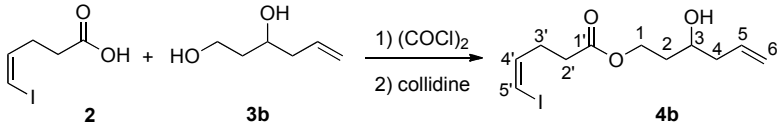
Analysis: $C_{11}H_{17}IO_3$ (324.16)

calcd.: C, 40.76; H, 5.29; I, 39.15.

found: C, 40.45; H, 5.23; I, 38.71.

TLC: 0.35 (silica gel, hexane/EtOAc, 3:1, UV)

Preparation of 3-Hydroxy-5-hexenyl (*Z*)-5-Iodo-4-pentenoate (4b).



Following General Procedure I, the acid **2** (2.70 g, 12.0 mmol equiv) was dissolved in anhydrous benzene (60 mL) to give a pale-red solution. Oxalyl chloride (1.45 mL, 16.7 mmol equiv) was then added dropwise followed by DMF (30 μL, 0.39 mmol equiv) and the reaction mixture allowed to stir at ambient temperature for 6 h. After 6 h, ^{1}H NMR and ^{13}C NMR analysis showed that the reaction was complete. The solvent removed in vacuo to afford 3.01 g (103%) of the acid chloride as red oil.

In 100-mL, three-necked, round-bottomed flask containing CH_2Cl_2 (120 mL) was dissolved diol **3b** (1.67 g, 14.3 mmol equiv) and collidine (3.17 mL, 23.9 mmol equiv) to afford a clear colorless solution. The mixture was then cooled in an *i*-PrOH/CO_2 bath and a solution of

the acid chloride (2.92 g, 12.0 mmol equiv) in CH_2Cl_2 (10 mL) was then added dropwise by a syringe pump at a rate of 10 mL/h. The mixture was stirred at -78 °C for 4 h then was allowed to warm to ambient temperature and was stirred for another 6 h. The mixture was poured onto 0.5 M aq. HCl (50 mL) and aqueous layer was extracted with CH_2Cl_2 (3 × 30 mL). The organic layers were washed with H_2O (1 × 30 mL), sat. $NaHCO_3$ solution (1 × 30 mL), then were dried over $MgSO_4$ and were concentrated in vacuo to afford 2.98 g of a red-brown oil. The crude product was purified by silica gel chromatography (200 g) with hexane/EtOAc (6:1 to 3:1) to afford 2.78 g (72%) of **4b** as a light-green oil. An analytical sample was prepared by a second chromatography with Et_2O/pentane, 1:1.

Analytical Data for **4b**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.26 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.22-6.18 (m, 1 H, HC(4')), 5.80 (ddt, *J* = 16.5, 10.0, 7.0 Hz, 1 H, HC(5)), 5.12 (dt, *J* = 13.5, 1.5 Hz, 2 H, HC(6)), 4.33-4.28 (m, 1 H, HC(1)), 4.17 (q, *J* = 5.79 Hz, 1 H, HC(1)), 3.75-3.71 (m, 1 H, HC(3)), 2.43 (d, *J* = 3.0 Hz, 4 H, HC(2',3')), 2.30-2.25 (m, 1 H, HC(4)), 2.22-2.15 (m, 2 H, HC(4, OH)), 1.85-1.79 (m, 1 H, HC(2)), 1.73-1.66 (m, 1 H, HC(2)).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.7 (C(1')), 139.1 (C(4')), 134.2 (C(5)), 118.3 (C(6)), 83.8 (C(5')), 67.5 (C(3)), 61.7 (C(1)), 41.9 (C(4)), 35.6 (C(2)), 32.9 (C(2')), 30.1 (C(3')).

IR: (thin film, NaCl plates)

3441 (m), 3074 (w), 2927 (m), 1732 (s), 1641 (m), 1438 (m), 1392 (m), 1358 (m), 1286 (m), 1264 (s), 1182 (s), 997 (s), 952 (m), 916 (m), 869 (m), 688 (m), 629 (m).

LRMS: (CI):

325.0 ($[M+H]^+$(4)), 307.0 (10), 227.0 (16), 208.9 (24), 99.1 (24), 81.1 (100).

HRMS: (CI, $[M+H]^+$):

calcd.: 325.03277

found: 325.03046

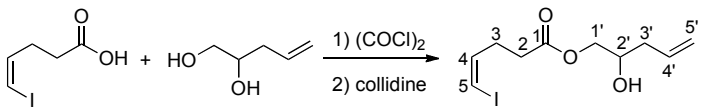
Analysis: $C_{11}H_{17}IO_3$ (324.16)

calcd.: C, 40.76; H, 5.29; I, 39.15.

found: C, 40.74; H, 5.22; I, 38.93.

TLC: R_f 0.36 (silica gel, pentane/Et_2O, 1:1, UV)

Preparation of 2-Hydroxy-4-pentenyl (*Z*)-5-Iodo-4-pentenoate (4c).



Following General Procedure I, the acid **2** (3.00 g, 13.3 mmol equiv) was dissolved in anhydrous benzene (65 mL) to give a pale-red solution. Oxalyl chloride (1.62 mL, 18.6 mmol equiv) then added dropwise followed by DMF (25 μL, 0.32 mmol equiv) and the reaction mixture allowed to stir at ambient temperature for 6 h. After 6 h, ^{1}H NMR and ^{13}C NMR analysis showed that the reaction was complete. The solvent was removed in vacuo to afford 3.41 g (105%) of the acid chloride as red oil.

In 100-mL, three-necked, round-bottomed flask containing CH_2Cl_2 (65 mL) was dissolved diol **3c** (797 mg, 7.80 mmol equiv) and collidine (1.72 mL, 13.0 mmol equiv) to afford a clear colorless solution. The mixture then cooled in an *i*-PrOH/CO_2 bath and solution of the acid chloride (1.59 g, 6.50 mmol) in CH_2Cl_2 (10 mL) was then added dropwise by a syringe

pump at a rate of 8 mL/h. The mixture was stirred at -78 °C for 4 h then was allowed to warm to ambient temperature and was stirred for another 6 h. The mixture was poured onto 0.5 M aq. HCl (50 mL) and aqueous layer extracted with CH_2Cl_2 (3 × 30 mL). The organic layers were washed with H_2O (1 × 20 mL), sat. $NaHCO_3$ solution (1 × 20 mL), then were dried over $MgSO_4$ and were concentrated in vacuo to afford 2.98 g of a red-brown oil. The crude product was purified by silica gel chromatography (200 g) using hexane/EtOAc (6:1 to 3:1) to afford 1.53 g (76%) of **4c** as a light-green oil. An analytical sample was prepared by a second chromatography with Et_2O/pentane, 1:1.

Analytical Data for **4c**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.29 (d, *J* = 7.5 Hz, 1 H, HC(5)), 6.22 (dd, *J* = 13.8, 6.5 Hz, 1 H, HC(4)), 5.80 (ddt, *J* = 17.0, 10.5, 7.0 Hz, 1 H, HC(4')), 5.16 (dd, *J* = 9.8, 1.5 Hz, 1 H, HC(5')), 5.15 (dd, *J* = 17.0, 1.0 Hz, 1 H, HC(5')), 4.16 (dd, *J* = 11.5, 3.0 Hz, 1 H, HC(1')), 4.01 (dd, *J* = 11.5, 7.0 Hz, 1 H, HC(1')), 3.93-3.88 (m, 1 H, HC(2')), 2.51-2.43 (m, 4 H, HC(2,3)), 2.33-2.22 (m, 2 H, HC(3')), 2.18 (d, *J* = 2.0 Hz, OH).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5 (C(1)), 139.0 (C(4)), 133.4 (C(4')), 118.6 (C(5')), 84.0 (C(5)), 68.9 (C(1')), 68.0 (C(2')), 38.0 (C(3')), 32.3 (C(2)), 30.1 (C(3)).

IR: (thin film, NaCl plates)

3452 (m), 3075 (w), 2978 (m), 2922 (m), 1733 (s), 1642 (m), 1611 (w), 1418 (m), 1385 (m), 1356 (m), 1286 (s), 1264 (s), 1181 (s), 1095 (m), 994 (m), 919 (m), 690 (m), 629 (m).

LRMS: (CI):

311.0 ([M+H]$^+$(8)), 180.9 (20), 95.1 (95), 71.1 (100).

HRMS: (CI, [M+H]$^+$):

calcd.: 311.0145

found: 311.0148

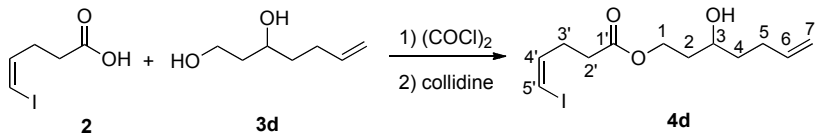
Analysis: $C_{10}H_{15}IO_3$ (310.13)

calcd.: C, 38.73; H, 4.88; I, 40.92.

found: C, 38.66; H, 4.80; I, 40.53.

TLC: R_f 0.32 (silica gel, hexane/EtOAc, 3:1, UV)

Preparation of 3-Hydroxy-6-heptenyl (*Z*)-5-Iodo-4-pentenoate (4d).



Following General Procedure I, the acid **2** (5.30 g, 23.5 mmol equiv) was dissolved in anhydrous benzene (100 mL) to give a pale-red solution. Oxalyl chloride (4.09 mL, 46.9 mmol equiv) then added dropwise followed by DMF (60 μL, 0.78 mmol equiv) and the reaction mixture was allowed to stir at ambient temperature for 6 h. After 6 h, ^{1}H NMR and ^{13}C NMR analysis showed the reaction was complete. The solvent removed in vacuo to afford 5.83 g (102%) of the acid chloride as red oil.

In 100-mL, three-necked, round-bottomed flask containing CH_2Cl_2 (92 mL) was dissolved diol **3d** (1.43 g, 11.0 mmol equiv) and collidine (2.43 mL, 18.3 mmol equiv) to afford a clear colorless solution. The mixture was then cooled in an *i*-PrOH/CO_2 bath and a solution of the acid chloride (2.24 g, 9.15 mmol equiv) in CH_2Cl_2 (10 mL) was then added dropwise by a syringe

pump at a rate of 8 mL/h. The mixture was stirred at -78 °C for 4 h then was allowed to warm to ambient temperature and was stirred for another 6 h. The mixture was poured onto 0.5 M aq. HCl (40 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 30 mL). The organic layers were washed with H_2O (1 × 30 mL), sat. $NaHCO_3$ solution (1 × 30 mL), then were dried over $MgSO_4$ and concentrated in vacuo to afford a 3.60 g of a red-brown oil. The crude product was purified by silica gel chromatography (220 g) with hexane/EtOAc (2:1 to 1:1) to afford 2.16 g (70%) of **4d** as a light-green oil. An analytical sample was re-purified by a second chromatography with Et_2O/pentane, 1:1.

Analytical Data for **4d**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.27 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.20 (ddt, *J* = 10.0, 6.5, 3.5 Hz, 1 H, HC(4')), 5.81 (ddt, *J* = 17.0, 10.5, 6.5 Hz, 1 H, HC(6)), 5.03 (dq, *J* = 17.3, 1.5 Hz, 1 H, HC(7)), 4.96 (dd, *J* = 10.0, 2.0 Hz, 1 H, HC(7)), 4.33 (ddt, *J* = 9.0, 7.0, 5.0 Hz, 1 H, HC(1)), 4.15 (q, *J* = 7.0 Hz, 1 H, HC(1)), 3.70-3.65 (m, 1 H, HC(3)), 2.45-2.42 (m, 4 H, HC(2', 3')), 2.23-2.10 (m, 3 H, OH, HC(5)), 1.84-1.77 (m, 1 H, HC(2)), 1.67 (ddt, *J* = 14.5, 9.5, 5.0 Hz, 1 H, HC(2)), 1.54 (dq, *J* = 6.8, 1.5 Hz, 2 H, HC(4)).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.8 (C(1')), 139.0 (C(4')), 138.2 (C(6)), 114.9 (C(7)), 83.9 (C(5')), 68.0 (C(3)), 61.8 (C(1)), 36.4 (C(4)), 36.2 (C(2)), 32.4 (C(2')), 30.1 (C(3')), 29.9 (5)).

IR: (thin film, NaCl plates)

3444 (w), 2926 (m), 1732 (s), 1641 (w), 1611 (w), 1439 (m), 1392 (m), 1357 (m), 1285 (m), 1263 (m), 1181 (m), 996 (m), 916 (m), 628 (m).

LRMS: (CI):

339.0 [(M+H)]+, 321.0 (2), 226.9 (4), 208.9 (12), 180.9 (4), 113.1 (8), 95.1 (80), 71.1 (100), 67.0 (4).

HRMS: (CI, $[M+H]^+$):

calcd.: 339.04575

found: 339.04394

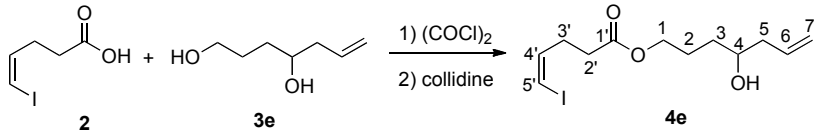
Analysis: $C_{12}H_{19}IO_3$ (338.18)

calcd.: C, 42.62; H, 5.66; I, 37.53.

found: C, 42.99; H, 5.79; I, 37.53.

TLC: R_f 0.26 (silica gel, pentane/Et_2O, 1:1, UV)

Preparation of 4-Hydroxy-6-heptenyl (*Z*)-5-Iodo-4-pentenoate (4e).



2 **3e** **4e**

Following General Procedure I, the acid **2** (5.30 g, 23.5 mmol equiv) was dissolved in anhydrous benzene (100 mL) to give a pale-red solution. Oxalyl chloride (4.09 mL, 46.9 mmol equiv) then added dropwise followed by DMF (60 μL, 0.78 mmol equiv) and the reaction mixture was allowed to stir at ambient temperature for 6 h. After 6 h, ^{1}H NMR and ^{13}C NMR analysis showed that the reaction was complete. The solvent was removed in vacuo to afford 5.83 g (102%) of the acid chloride as a red oil.

In 100-mL, three-necked, round-bottomed flask containing CH_2Cl_2 (117 mL) was dissolved diol **3e** (1.83 g, 14.0 mmol equiv) and collidine (3.10 mL, 23.4 mmol equiv) to afford a clear colorless solution. The mixture was then cooled in an *i*-PrOH/CO_2 bath and a solution of

the acid chloride (2.86 g, 11.7 mmol equiv) in CH_2Cl_2 (10 mL) was then added dropwise by a syringe pump at a rate of 8 mL/h. The mixture was stirred at -78 °C for 4 h then was allowed to warm to ambient temperature and was stirred for another 6 h. The mixture was poured onto 0.5 M aq. HCl (50 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 40 mL). The organic layers were washed with H_2O (1 × 40 mL), sat. $NaHCO_3$ solution (1 × 40 mL), then were dried over $MgSO_4$ and were concentrated in vacuo to afford 4.82 g of a red-brown oil. The crude product was purified by silica gel chromatography (300 g) with pentane/Et_2O (2:1 to 1:1) to afford 3.00 g (76%) of **4e** as a light-green oil. An analytical sample was prepared by a second chromatography with an Et_2O/pentane, 1:1.

Analytical Data for **4e**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.26 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.22-6.18 (m, 1 H, HC(4')), 5.84-5.75 (m, 1 H, HC(6)), 5.12 (dd, *J* = 13.0, 1.5 Hz, 1 H, HC(7)), 5.11 (dd, J = 15.0, 1.0 Hz, 1 H, HC(7)), 4.09 (t, *J* = 6.8 Hz, 2 H, HC(1)), 3.65 (dd, *J* = 7.0, 4.0 Hz, 1 H, HC(4)), 2.45-2.40 (m, 4 H, HC(2', 3')), 2.31-2.25 (m, 1 H, HC(5)), 2.14 (dt, *J* = 9.0, 7.5 Hz, 1 H, HC(5)), 1.83 (d, *J* = 2.0 Hz, 1 H, OH), 1.82-1.76 (m, 1 H, HC(2)), 1.69 (tq, *J* =10.0, 6.5 Hz, 1 H, HC(2)), 1.57-1.43 (m, 2 H, HC(3)).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5 (C(1')), 139.1 (C(4')), 134.4 (C(6)), 118.3 (C(7)), 83.7 (C(5')), 70.0 (C(4)), 64.5 (C(1)), 42.0 (C(5)), 32.9 (C(3)), 32.4 (C(2')), 30.1 (C(3')), 24.9 (C(2)).

IR: (thin film, NaCl plates)

3443 (m), 3074 (w), 2927 (m), 1733 (s), 1641 (w), 1611 (w), 1438 (m), 1392 (m), 1357 (m), 1286 (m), 1263 (m), 1182 (m), 997 (m), 916 (m), 688 (w), 629 (w).

LRMS: (CI):

338.1 (M+), 209 (16), 181.0 (16), 167.0 (8), 113.1 (8), 99.1 (12), 71.2 (100), 52.7 (12).

HRMS: (CI, $[M+]^+$):

calcd.: 338.03793

found: 338.03775

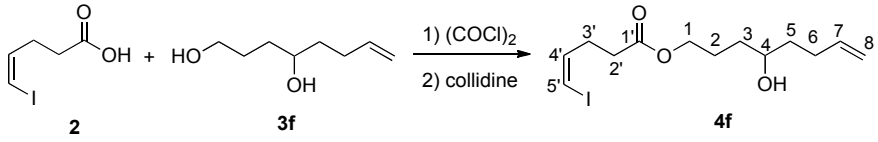
Analysis: $C_{12}H_{19}IO_3$ (338.18)

calcd.: C, 42.62; H, 5.66; I, 37.53.

found: C, 42.65; H, 5.67; I, 37.24.

TLC: R_f 0.37 (silica gel, pentane/Et_2O, 1:1, UV)

Preparation of 4-Hydroxy-7-octenyl (*Z*)-5-Iodo-4-pentenoate (4f).



Following General Procedure I, the acid **2** (2.80 g, 12.4 mmol equiv) was dissolved in anhydrous benzene (61 mL) to give a pale-red solution. Oxalyl chloride (2.16 mL, 24.8 mmol equiv) was then added dropwise followed by DMF 2 drops and the reaction mixture was allowed stir at ambient temperature for 4 h. After 4 h, ^{1}H NMR and ^{13}C NMR analysis showed that the reaction was complete. The solvent was removed in vacuo to afford 3.22 g (106 %) of the acid chloride as red oil.

In 100-mL, three-necked, round-bottomed flask containing CH_2Cl_2 (120 mL) was dissolved diol **3f** (1.82 g, 12.6 mmol equiv) and collidine (3.18 mL, 24.0 mmol equiv) to afford a clear colorless solution. The mixture was then cooled in an *i*-PrOH/CO_2 bath and a solution of

the acid chloride (2.93 g, 12.0 mmol equiv) in CH_2Cl_2 (10 mL) was then added dropwise by a syringe pump at a rate of 8 mL/h. The mixture was stirred at -78 °C for 4 h then was allowed to warm to ambient temperature and was stirred for another 6 h. The mixture was poured onto 0.5 M aq. HCl (60 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 40 mL). The organic layers were washed with H_2O (1 × 50 mL), sat. $NaHCO_3$ solution (1 × 50 mL), then were dried over $MgSO_4$ and concentrated in vacuo to afford 5.16 g of a red-brown oil. The crude product was purified by silica gel chromatography (310 g) with pentane/Et_2O (2:1 to 1:1) to afford 3.04 g (72%) of **4f** as a light-green oil. An analytical sample was prepared by a second chromatography with Et_2O/pentane, 1:1.

Analytical Data for **4f**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.27 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.21 (ddt, *J* = 8.3, 5.3, 2.0 Hz, 1 H, HC(4')), 5.82 (ddt, *J* = 17.0, 10.0, 7.0 Hz, 1 H, HC(7)), 5.03 (dd, *J* = 17.0, 1.5 Hz, 1 H, HC(8)), 4.96 (dd, *J* = 10.0, 1.0 Hz, 1 H, HC(8)), 4.10 (t, *J* = 6.5 Hz, 2 H, HC(1)), 3.63 (h, *J* = 4.0 Hz, 1 H, HC(4)), 2.46-2.41 (m, 4 H, HC(2', 3')), 2.17 (h, *J* = 7.3 Hz, 1 H, HC(6)), 2.13 (h, *J* = 7.5 Hz, 1 H, HC(6)), 1.84-1.75 (m, 1 H, HC(2)), 1.73-1.64 (m, 1 H, HC(2)), 1.67 (s, 1 H, OH), 1.59-1.41 (m, 4 H, HC(3, 5)).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5 (C(1')), 139.1 (C(4')), 138.4 (C(7)), 114.9 (C(8)), 83.8 (C(5')), 70.9 (C(4)), 64.6 (C(1)), 36.5 (C(5)), 33.6 (C(3)), 32.4 (C(2')), 30.1 (6)), 30.0 (C(6)), 24.8 (C(2)).

IR: (thin film, NaCl plates)

3453 (m), 3078 (m), 2977 (m), 2923 (m), 1736 (s), 1642 (m), 1611 (m), 1417 (m),

1385 (m), 1356 (m), 1286 (s), 1263 (s), 1181 (s), 1095 (m), 994 (s), 919 (s), 689 (m), 629 (m).

LRMS: (CI):

255.0 (28), 194.9 (100), 67.0 (16).

Analysis: $C_{13}H_{21}IO_3$ (352.21)

calcd.: C, 44.33; H, 6.01; I, 36.03.

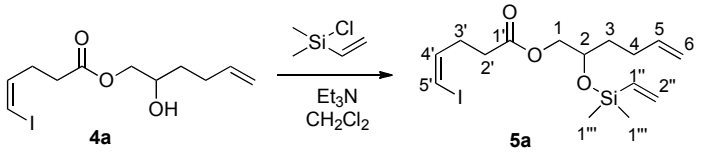
found: C, 44.23; H, 6.36; I, 36.16.

TLC: R_f 0.39 (silica gel, pentane/Et_2O, 1:1, UV)

General Procedure II. Silylation of 4 and 24 with Chlorodimethylvinylsilane.

In a three-neck round-bottom flask under argon was placed ester **4** (1 equiv) or **24** (1 equiv) and Et_3N (3 equiv) in CH_2Cl_2 and the solution cooled to 0 °C using an ice bath. To the cooled solution was added dropwise chlorodimethylvinylsilane (1.2 equiv) to afford a white suspension. The cooling bath removed and the solution mixture stirred at ambient temperature while being monitored by TLC. Upon reaction completion the mixture was poured onto an ice/water mixture and the aqueous layer extracted with CH_2Cl_2. The organic layers then washed with brine and dried over Na_2SO_4. The solvent removed in vacuo and crude purified by silica gel.

Preparation of 2-(Dimethylvinylsilyl)-5-hexenyl (*Z*)-5-Iodo-4-pentenoate (5a).



Following General Procedure II, a solution of **4a** (1.50 g, 4.63 mmol equiv) and Et_3N (1.94 mL, 13.9 mmol equiv) in CH_2Cl_2 (46 mL) at 0 °C was added dropwise

chlorodimethylvinylsilane (0.77 mL, 5.55 mmol equiv) to afford a white suspension. The cooling bath removed and the reaction mixture was stirred at ambient temperature for 3 h. The reaction progress monitored using basified TLC and upon reaction completion the mixture was poured onto an ice/water mixture (30 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layers were washed with brine (1 × 25 mL) and dried over Na_2SO_4. The solvent removed in vacuo and crude product was purified by chromatography (silica gel (90 g), pentane/Et_2O, 10:1 /Et_3N (1 %)) to afford 1.76 g (93%) of **5a** as a clear colorless oil.

Analytical Data for **5a**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.27 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.24-6.20 (m, 1 H, HC(4')), 6.13 (dd, *J* = 20.5, 14.5 Hz, 1 H, HC(2'')), 6.00 (dd, *J* = 15.0, 4.0 Hz, HC (2'')), 5.82-5.74 (m, 1 H, HC(5)), 5.76 (dd, *J* = 19.8, 4.0 Hz, 1 H HC(1'')), 4.98 (d, *J* = 17.5 Hz, 1 H, HC(6)), 4.96 (d, *J* = 10.5 Hz, 1 H, HC(6)), 4.03 (dd, *J* = 11.3, 4.0 Hz, 1 H, HC(1)), 3.95 (dd, *J* = 11.0, 6.0 Hz, 1 H, HC(1)), 3.87 (p, *J* = 5.5 Hz, 1 H, HC(2)), 2.47-2.44 (m, 4 H, HC(2', 3')), 2.15 (h, *J* = 7.3 Hz, 1 H, HC(4)), 2.05 (h, *J* = 7.2 Hz, 1 H, HC(4)), 1.54 (h, *J* = 7.5 Hz, 2 H, HC(3)), 0.19 (s, 6 H, Si-CH_3).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.2 (C(1')), 139.1 (C(4')), 138.0 (C(2'')), 137.6 (C(5)), 133.1 (C(1'')), 114.8 (C(6)), 83.8 (C(5')), 69.8 (C(2)), 68.3 (C(1)), 33.3 (C(3)), 32.3 (C(2')), 30.1 (3')), 29.4 (C(4)), -1.43 (C(1'''), -1.45 (C(1''').

IR: (thin film, NaCl plates)

3076 (w), 3051 (m), 2947 (m), 1739 (s), 1641 (m), 1611(w), 1594 (w), 1442 (m), 1407 (m), 1370 (m), 1286 (m), 1252 (s), 1177 (s), 1149 (s), 1054 (m), 996 (s), 959

(m), 913 (m), 837 (s), 786 (s), 696 (m), 629 (m).

LRMS: (CI):

408.1 $(M)^+$, 353.0 (100), 295.0 (20), 283.0 (16), 208.9 (80), 180.9 (44), 155.1 (34), 85.0 (92), 59.0 (35).

HRMS: (CI, $[M]^+$):

calcd.: 408.06181

found: 408.06198

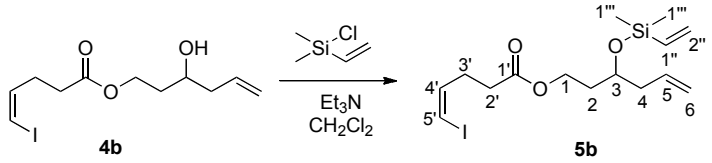
Analysis: $C_{15}H_{25}IO_3Si$ (408.35)

calcd.: C, 44.12; H, 6.17; I, 31.08.

found: C, 44.03; H, 6.12; I, 30.82.

TLC: R_f 0.61 (silica gel, pentane/Et_2O, 9:1, UV)

Preparation of 3-(Dimethylvinylsilyl)-5-hexenyl (*Z*)-5-Iodo-4-pentenoate (5b).



Following General Procedure II, a solution of **4b** (1.70 g, 5.24 mmol equiv) and Et_3N (2.19 mL, 15.7 mmol equiv) in CH_2Cl_2 (52 mL) at 0 °C was added dropwise chlorodimethylvinylsilane (0.87 mL, 6.29 mmol equiv) to afford a white suspension. The cooling bath removed and the reaction mixture was stirred at ambient temperature for 3 h. The reaction progress monitored using basified TLC and upon reaction completion the mixture was poured onto an ice/water mixture (30 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were washed with brine (1 × 25 mL) and dried over Na_2SO_4. The solvent removed in vacuo and crude product was purified by chromatography (silica gel

(135 g), pentane/Et_2O, 10:1-6:1 /Et_3N (1 %)) to afford 1.70 g (79%) of **5b** as a clear colorless oil.

Analytical Data for **5b**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.29 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.26-6.23 (m, 1 H, HC(4')), 6.15 (dd, *J* = 21.0, 15.0 Hz, 1 H, HC(2'')), 6.02 (dd, *J* = 14.8, 4.0 Hz, 1 H, HC(2'')), 5.83-5.78 (m, 1 H, HC(5)), 5.78 (dd, *J* = 20.3, 4.0 Hz, 1 H, HC(1'')), 5.04 (dd, *J* = 17.8, 2.0 Hz, 1 H, HC(6)), 4.98 (d, *J* = 10.0 Hz, 1 H, HC(6)), 4.05 (dd, *J* = 11.8, 4.0 Hz, 1 H, HC(1)), 3.97 (dd, *J* = 11.5, 6.5 Hz, 1 H, HC(1)), 3.89 (p, *J* = 5.0 Hz, 1 H, HC(3)), 2.46 (m, 4 H, HC(2', 3')), 2.17 (h, *J* = 7.3 Hz, 1 H, HC(4)), 2.07 (h, *J* = 7.3 Hz, 1 H, HC(4)), 1.57 (h, *J* = 6.8 Hz, 2 H, HC(2)), 0.21 (s, 6 H, HC(1''')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.3 (C(1')), 139.1 (C(4')), 138.0 (C(2'')), 137.7 (C(5)), 133.2 (C(1'')), 114.9 (C(6)), 83.8 (C(5')), 69.9 (C(3)), 68.3 (C(1)), 33.3 (2)), 32.3 (C(2')), 30.1 (C(3')), 29.4 (C(4)), -1.41 (C(1'''), -1.46 (C(1''')).

IR: (thin film, NaCl plates)

3076 (w), 3051 (w), 2947 (m), 1739 (s), 1641 (m), 1611 (w), 1594 (w), 1442 (w), 1407 (m), 1369 (m), 1309 (m), 1286 (m), 1252 (s), 1177 (s), 1149 (s), 1053 (m), 996 (s), 913 (m), 837 (s), 786 (s), 695 (m), 629 (w).

LRMS: (CI):

408.1 (M+), 311.0 (10), 295.0 (10), 208.9 (12), 181.0 (12), 141.1 (100), 113.0 (12), 85.0 (72), 59.0 (24).

HRMS: (CI, $[M-H]^+$):

calcd.: 408.0618

found: 408.0617

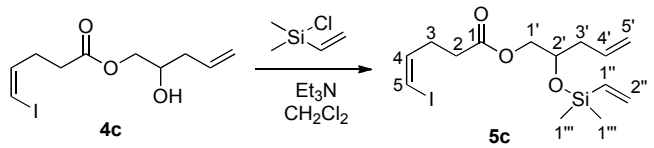
Analysis: $C_{15}H_{25}IO_3Si$ (408.35)

calcd.: C, 44.12; H, 6.17; I, 31.08.

found: C, 44.42; H, 6.27; I, 30.88.

TLC: R_f 0.59 (silica gel, pentane/Et_2O, 9:1, UV)

Preparation of 2-(Dimethylvinylsilyl)-5-pentenyl (*Z*)-5-Iodo-4-pentenoate (5c).



Following General Procedure II, a solution of **4c** (1.50 g, 4.84 mmol equiv) and Et_3N (2.02 mL, 14.5 mmol equiv) in CH_2Cl_2 (48 mL) at 0 °C was added dropwise chlorodimethylvinylsilane (0.80 mL, 5.80 mmol equiv) to afford a white suspension. The cooling bath removed and the reaction mixture was stirred at ambient temperature for 3 h. The reaction progress monitored using basified TLC and upon reaction completion the mixture was poured onto an ice/water mixture (30 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were washed with brine (1 × 25 mL) and dried over Na_2SO_4. The solvent removed in vacuo and crude product was purified by chromatography (silica gel (98 g), pentane/Et_2O, 10:1-9:1/Et_3N (1 %)) to afford 1.69 g (89%) **5c** as a clear colorless oil.

Analytical Data for **5c**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.26 (d, *J* = 8.0 Hz, 1 H, HC(5)), 6.21 (dd, *J* = 8.0, 1.5 Hz, 1 H, HC(4)), 6.12 (ddd, *J* = 20.9, 14.8, 1.5 Hz, 1 H, HC(2'')), 5.99 (ddd, *J* = 17.0, 4.0, 1.5 Hz, 1 H, HC(2'')), 5.80-5.72 (m, 1 H, HC(4')), 5.76 (dd, *J* = 20.0, 4.0 Hz, 1 H, HC(1''),

5.69 (d, J = 9.5 Hz, 1 H, HC(5')), 5.60 (d, J = 18.5 Hz, 1 H, HC(5')), 4.04 (dd, J = 11.0, 3.5 Hz, 1 H, HC(1')), 3.95 (dd, J = 6.8, 1.5 Hz, 1 H, HC(1')), 3.93-3.87 (m, 1 H, HC(2')), 2.48-2.41 (m, 4 H, HC(2', 3')), 2.22 (h, J = 7.5 Hz, 1 H, HC(3')), 0.18 (s, 6 H, Si-CH_3).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.2 (C(1)), 139.1 (C(4)), 137.5 (C(2'')), 133.8 (4')), 133.2 (C(1'')), 117.6 (C(5')), 83.7 (C(5)), 70.0 (C(2')), 67.8 (C(1')), 38.9 (C(3')), 32.3 (C(2)), 30.0 (C(3)), -1.51 (C(Si-CH_3)), -1.53 (C(Si-CH_3)).

IR: (thin film, NaCl plates)

3076 (w), 2944 (m), 1736 (s), 1641 (w), 1594 (w), 1448 (m), 1407 (m), 1358 (m), 1286 (m), 1252 (s), 1176 (s), 1050 (s), 1009 (m), 958 (m), 911 (m), 836 (s), 784 (s), 693 (m), 628 (m), 526 (w).

LRMS: (CI):

393.0 (M+), 353.0 (4), 295.0 (8), 209.0 (8), 181.0 (12), 169.1 (28), 84.0 (100), 59.0 (12).

HRMS: (CI, $[M-H]^+$):

calcd.: 393.03833

found: 393.03842

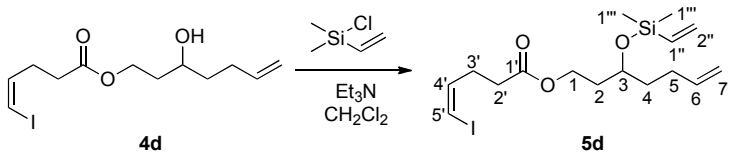
Analysis: $C_{14}H_{23}IO_3Si$ (338.18)

calcd.: C, 42.64; H, 5.88; I, 32.18.

found: C, 42.42; H, 5.87; I, 31.87.

TLC: R_f 0.56 (silica gel, pentane/Et_2O, 9:1, UV)

Preparation of 3-(Dimethylvinylsilyl)-5-heptenyl (*Z*)-5-Iodo-4-pentenoate (5d).



Following General Procedure II, a solution of **4d** (2.00 g, 5.91 mmol equiv) and Et_3N (2.45 mL, 17.7 mmol equiv) in CH_2Cl_2 (59 mL) at 0 °C was added dropwise chlorodimethylvinylsilane (0.98 mL, 7.10 mmol equiv) to afford a white suspension. The cooling bath removed and the reaction mixture was stirred at ambient temperature for 4 h. The reaction progress monitored using basified TLC and upon reaction completion the mixture was poured onto an ice/water mixture (30 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were washed with brine (1 × 30 mL) and dried over Na_2SO_4. The solvent removed in vacuo and crude product was purified by chromatography (silica gel (120 g), pentane/Et_2O, 15:1-9:1/Et_3N (1 %)) to afford 2.25 g (90%) of **5d** as a clear colorless oil.

Analytical Data for **5d**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.28 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.24-6.20 (m, 1 H, HC(4')), 6.13 (dd, *J* = 20.3, 14.5 Hz, 1 H, HC(2'')), 6.00 (dd, *J* = 18.8, 4.0 Hz, 1 H, HC(2'')), 5.83-5.75 (m, 1 H, HC(6)), 5.76 (dd, *J* = 20.3, 4.0 Hz, HC(1'')), 5.01 (dq, *J* = 18.0, 2.0 Hz, 1 H, HC(7)), 4.95 (dt, *J* = 11.0, 1.0 Hz, 1 H, HC(7)), 4.18 (dp, *J* = 5.9, 1.0 Hz, 1 H, HC(1)), 4.13 (ddd, *J* = 9.9, 8.0, 6.0 Hz, 1 H, HC(1)), 3.81 (ddd, *J* = 7.5, 6.0, 4.5 Hz, 1 H, HC(3)), 2.45-2.41 (m, 4 H, HC(2', 3')), 2.15-2.02 (m, 2 H, HC(5)), 1.83-1.77 (m, 1 H, HC(2)), 1.75-1.68 (m, 1 H, HC(2)), 1.61-1.50 (m, 2 H, HC(4)).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.4 (C(1')), 139.2 (C(4')), 137.8 (C(6)), 134.8 (C(2'')), 133.0 (C(1'')), 117.1

(C(7)), 83.7 (C(5')), 42.0 (C(4)), 32.9 (C(2)), 32.4 (C(2')), 30.1 (C(3')), 24.7 (C(5)), -1.43 (C(1''')), -1.46 (C(1''')).

IR: (thin film, NaCl plates)

3076 (w), 2947 (m), 1739 (s), 1641 (w), 1611 (w), 1594 (w), 1442 (m), 1407 (m), 1369 (m), 1286 (m), 1252 (s), 1177 (s), 1149 (s), 1054 (m), 996 (s), 959 (m), 913 (m), 837 (m), 786 (s), 695 (m), 629 (w), 526 (m).

LRMS: (CI):

423.2 (M+H), 381.1 (8), 311.1 (8), 283 (12), 197.2 (28), 155.1 (32), 95.1 (100), 71.1 (16).

HRMS: (CI, $[M+H]^+$):

calcd.: 423.08528

found: 423.08490

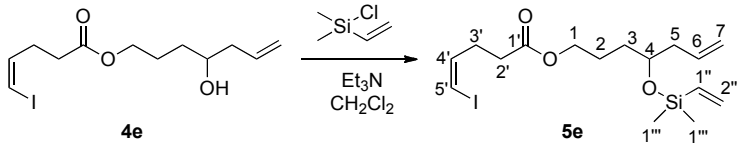
Analysis: $C_{16}H_{27}IO_3Si$ (422.37)

calcd.: C, 45.50; H, 6.44;

found: C, 45.32; H, 6.65;

TLC: R_f 0.49 (silica gel, pentane/Et_2O, 9:1, UV)

Preparation of 4-(Dimethylvinylsilyl)-5-heptenyl (*Z*)-5-Iodo-4-pentenoate (5e).



4e **5e**

Following General Procedure II, a solution of **4e** (1.00 g, 2.96 mmol equiv) and Et_3N (1.24 mL, 8.88 mmol equiv) in CH_2Cl_2 (30 mL) at 0 °C was added dropwise chlorodimethylvinylsilane (0.49 mL, 3.55 mmol equiv) to afford a white suspension. The cooling

bath removed and the reaction mixture was stirred at ambient temperature for 3 h. The reaction progress monitored using basified TLC and upon reaction completion the mixture was poured onto an ice/water mixture (20 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were washed with brine (1 × 20 mL) and dried over Na_2SO_4. The solvent removed in vacuo and crude product was purified by chromatography (silica gel (26 g), hexane/EtOAc 15:1-8:1/Et_3N (1.5 %)) to afford 1,18 g (95%) of **5e** as a clear colorless oil.

Analytical Data for **5e**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.27 (d, *J* = 8.0 Hz, 1 H, HC(5')), 6.23-6.19 (m, 1 H, HC(4')), 6.13 (dd, *J* = 20.3, 15.0 Hz, HC(2'')), 5.99 (dd, *J* = 15.0, 4.0 Hz, 1 H, HC(2'')), 5.81-5.73 (m, 1 H, HC(6)), 5.76 (dd, *J* = 20.0, 4.0 Hz, 1 H, HC(1'')), 5.06-5.02 (m, 2 H, HC(7)), 4.06 (t, *J* = 7.5 Hz, 2 H, HC(1)), 3.73-3.68 (m, 1 H, HC(4)), 2.46-2.40 (m, 4 H, HC(2', 3')), 2.21 (dt, *J* = 6.3 Hz, 2 H, HC(5)), 1.75-1.67 (m, 1 H, HC(2)), 1.64-1.55 (m, 1 H, HC(2)), 1.54-1.42 (m, 2 H, HC(3)), 0.18 (s, 6 H, HC(1''')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5(C(1')), 139.2 (C(4')), 137.9 (C(2'')), 134.8 (C(6)), 133.0 (C(1'')), 117.1 (C(7)), 83.7 (C(5')), 71.8 (C(4)), 64.6 (C(1)), 42.0 (C(5)), 32.9 (C(3)), 32.4 (C(2')), 30.2 (C(3')), 24.8 (C(2)), -1.42 (C(1'''), -1.43 (C(1''')).

IR: (thin film, NaCl plates)

3076 (w), 3051 (w), 2947 (m), 1740 (s), 1641 (m), 1611 (w), 1594 (w), 1442 (m), 1407 (m), 1370 (m), 1309 (m), 1286 (m), 1252 (s), 1177 (s), 1149 (s), 1054 (m), 996 (s), 959 (m), 913 (m), 837 (s), 786 (s), 696 (m), 629 (m), 526 (w).

LRMS: (CI):

422.1 (M^+), 381.1 (8), 311.0 (8), 283.0 (8), 209.0 (8), 155.1 (100), 95.1 (12), 71.2 (58).

HRMS: (CI, $[M-H]^+$):

calcd.: 421.0696

found: 421.0695

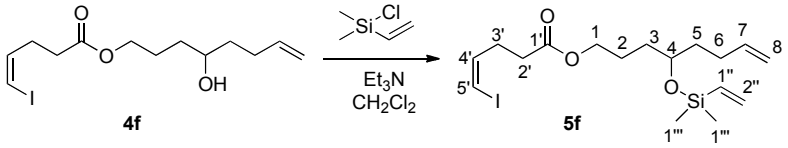
Analysis: $C_{16}H_{27}IO_3Si$ (422.37)

calcd.: C, 45.50; H, 6.44;

found: C, 45.82; H, 6.55;

TLC: R_f 0.59 (silica gel, hexane/EtOAc, 10:1, UV)

Preparation of 4-(Dimethylvinylsilyl)-5-octenyl (*Z*)-5-Iodo-4-pentenoate (5f).



Following General Procedure II, a solution of **4f** (1.20 g, 3.41 mmol equiv) and Et_3N (1.43 mL, 10.2 mmol equiv) in CH_2Cl_2 (34 mL) at 0 °C was added dropwise chlorodimethylvinylsilane (0.57 mL, 4.09 mmol) to afford a white suspension. The cooling bath removed and the reaction mixture was stirred at ambient temperature for 3 h. The reaction progress monitored using basified TLC and upon reaction completion the mixture was poured onto an ice/water mixture (20 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were washed with brine (1 × 20 mL) and dried over Na_2SO_4. The solvent removed in vacuo and crude product was purified by chromatography (silica gel (135 g), pentane/Et_2O 12:1-9:1/Et_3N (1%)) to afford 1.35 g (91%) of **5f** as a clear colorless oil.

Analytical Data for **5f**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.27 (dd, *J* = 8.0, 1.0 Hz, 1 H, HC(5')), 6.24-6.20 (m, 1 H, HC(4')), 6.14 (dd, *J* = 20.0, 15.0 Hz, 1 H, HC(2'')), 5.93 (dd, *J* = 10.0, 4.0 Hz, 1 H, HC(2'')), 5.83-5.75 (m, 1 H, HC(7)), 5.75 (dd, *J* = 14.5, 4.0 Hz, 1 H, HC(1'')), 5.01 (dq, *J* = 11.9, 2.0 Hz, 1 H, HC(8)), 4.94 (dq, *J* = 10.3, 1.5 Hz, 1 H, HC(8)), 4.07 (t, *J* = 6.8 Hz, 2 H, HC(1)), 3.69 (dp, *J* = 6.0, 1.5 Hz, 1 H, HC(4)), 2.47-2.41 (m, 4 H, HC(2', 3')), 2.13-2.01 (m, 2 H, HC(6)), 1.74-1.42 (m, 6 H, HC(2, 3, 5)), 0.18 (s, 6 H, HC(1''')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5(C(1')), 139.2 (C(4')), 138.5 (C(2'')), 138.0 (C(7)), 133.0 (C(1'')), 114.5 (C(8)), 83.7 (C(5')), 71.6 (C(4)), 64.7 (C(1)), 36.3 (C(5)), 33.3 (C(3)), 32.4 (C(2')), 30.2 (C(3')), 29.7 (C(6)), 24.6 (C(2)), -1.38 (C(1''')).

IR: (thin film, NaCl plates)

3075 (w), 2944 (m), 2862 (w), 1736 (s), 1641 (w), 1611 (w), 1594 (w), 1448 (w), 1407 (m), 1358 (m), 1286 (m), 1252 (s), 1177 (m), 1151 (m), 1050 (m), 1009 (m), 958 (m), 911 (m), 836 (s), 784 (m), 693 (m), 629 (w).

LRMS: (CI):

436.2 (M^+), 381.2 (8), 311.1 (8), 295.1 (20), 283.1 (20), 211.2 (24), 169.2 (64), 155.1 (92), 85.1 (100), 71.1 (60).

HRMS: (CI, $[M]^+$):

calcd.: 436.09311

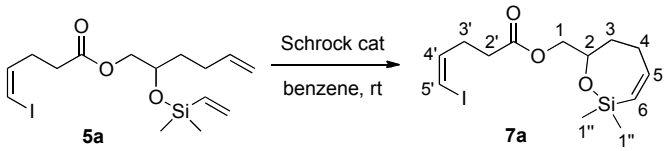
found: 436.09308

TLC: R_f 0.59 (silica gel, pentane/Et_2O, 9:1, UV)

General Procedure III. Molybdenum-Catalyzed Ring-Closing Metathesis of 5 and 11.

In a flame-dried, 100-mL, round-bottom flask equipped with a stop-cock adopter was dissolved compound **5** or **11** in benzene. The solution was freeze-pump-thaw degassed with argon (3 ×) then flask was transferred to the dry box. To this mixture was added 2,6-diisopropylphenylimidoneophylidenemolybdenum(VI) bis(hexafluoro-*t*-butoxide), Schrock catalyst (**6**) in one portion. The solution was then stirred at rt until reaction was complete as judged by ^{1}H NMR analysis of an aliquot. Upon completion the mixture was removed from the dry box and filtered through Celite. The solvent was removed in vacuo and the crude product was purified by silica chromatography. An analytical sample was prepared by a second chromatography with pentane/Et_2O.

Preparation of 2,2-Dimethyl-2-[(1-oxa-2-silacyclohept-3-enyl)methyl] (*Z*)-5-Iodopent-4-enoate (7a).



Following General Procedure III, compound **5a** (1.02 g, (2.50 mmol equiv) was dissolved in benzene (25 mL) to give a colorless solution. The solution was freeze-pump-thaw degassed with argon (3 ×) then transferred to the dry box. To this mixture was added Schrock catalyst (0.15 g, 0.20 mmol equiv) in one portion to afford an orange solution that later became light brown. The solution was then stirred for 12 h at ambient temperature. The mixture was removed from the dry box and filtered through Celite (5 g) and the plug was rinsed with Et_2O (30 mL).

The solvent removed in vacuo and the crude product was purified by chromatography (silica gel (28 g), hexane/Et_2O (11:1-8:1)) to afford 827 mg (87%) of **7a** as a light brown liquid. An analytical sample was prepared by a second chromatography with pentane/Et_2O (5:1).

Analytical Data for **7a**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.73 (ddd, *J* = 14.2, 5.5, 2.5 Hz, 1 H, HC(5)), 6.26 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.23-6.19 (m, 1 Hz, 1 H, HC(4')), 5.73 (ddd, *J* = 14.2, 2.5, 1.0 Hz, 1 H, HC(5)), 4.27-4.19 (m, 2 H, HC(1)), 4.04-3.99 (m, 1 H, HC(2)), 2.46-2.36 (m, 4 H, HC(2', 3')), 2.21-2.08 (m, 2 H, HC(4)), 1.85-1.77 (m, 2 H, HC(3)), 0.16 (s, 3 H, HC(1'')), 0.15 (s, 3 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.4(C(1')), 146.7 (C(5)), 139.2 (C(4')), 127.2 (C(6)), 83.7 (C(5')), 67.9 (C(2)), 61.4 (C(1)), 36.5 (C(3)), 36.4 (C(4)), 32.4 (C(2')), 30.1 (C(3')), -0.49 (C(1'')), -0.69 (C(1'')).

IR: (thin film, NaCl plates)

3071 (w), 2989 (m), 2957 (s), 2922 (m), 1739 (s), 1610 (m), 1588 (s), 1422 (m), 1392 (m), 1354 (m), 1309 (m), 1286 (s), 1251 (s), 1160 (s), 1103 (m), 1057 (m), 963 (s), 844 (s), 791 (s), 760 (s), 691 (s), 649 (m).

LRMS: (CI):

422.1 (M^+),.

HRMS: (CI, $[M-H]^+$):

calcd.: 421.0696

found: 421.0695

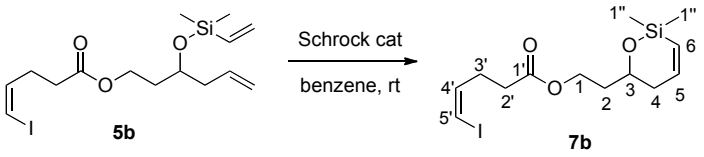
Analysis: $C_{16}H_{27}IO_3Si$ (422.37)

calcd.: C, 45.50; H, 6.44;

found: C, 45.82; H, 6.55;

TLC: R_f 0.59 (silica gel, hexane/EtOAc, 10:1, UV)

Preparation of 2,2-Dimethyl-3-[(1-oxa-2-silacyclohex-3-enyl)ethyl] (*Z*)-5-Iodopent-4-enoate (7b).



Following General Procedure III, compound **5b** (1.02 g, (2.50 mmol equiv) was dissolved in benzene (25 mL) to give a colorless solution. The solution was freeze-pump-thaw degassed with argon (3 ×) then transferred to the dry box. To this mixture was added Schrock catalyst (0.15 g, 0.20 mmol equiv) in one portion to afford an orange solution that later turned light brown. The solution was then stirred for 15 h at ambient temperature. The mixture was removed from the dry box and filtered through Celite (5 g) and the plug was rinsed with Et_2O (30 mL). The solvent removed in vacuo and the crude product was purified by chromatography (silica gel (30 g), pentane/Et_2O (8:1)) to afford 851 mg (89%) of **7b** as a light brown liquid. An analytical sample was prepared by a second chromatography with pentane/Et_2O (5:1).

Analytical Data for **7b**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.75 (ddd, *J* = 14.3, 5.5, 2.5 Hz, 1 H, HC(5)), 6.26 (dd, *J* = 8.0, 1.0 Hz, 1 H, HC(5')), 6.23-6.19 (m, 1 H, HC(4')), 5.73 (ddd, *J* = 14.1, 2.5, 1.0 Hz, 1 H, HC(6)), 4.27-4.19 (m, 2 H, HC(1)), 4.03-3.99 (m, 1 H, HC(3)), 2.46-2.36 (m, 4 H,

HC(2', 3')), 2.21-2.09 (m, 2 H, HC(4)), 1.85-1.77 (m, 2 H, HC(2)), 0.15 (dd, J = 3.3, 1.0 Hz, 6 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.4(C(1')), 146.7 (C(5)), 139.2 (C(4')), 127.2 (C(6)), 83.7 (C(5')), 67.9 (C(3)), 61.4 (C(1)), 36.5 (C(2/4)), 36.4 (C(2/4)), 32.4 (C(2')), 30.2 (C(3')), -0.49 (C(1'')), -0.69 (C(1'')).

IR: (thin film, NaCl plates)

3071 (w), 2987 (m), 2958 (s), 2917 (m), 1736 (s), 1611 (m), 1588 (s), 1422 (m), 1354 (s), 1286 (s), 1250 (s), 1181 (s), 1161 (s), 1104 (m), 1049 (m), 999 (m), 949 (m), 899 (s), 844 (s), 789 (s), 757 (s), 689 (m), 648 (m).

LRMS: (CI):

380.1 (M^+), 365.0 (4), 283.0 (28), 253.1 (4), 209.0 (20), 181.0 (30), 154.1 (100), 127.1 (50), 98.1 (72), 75.0 (100), 52.8 (25).

HRMS: (CI, $[M]^+$):

calcd.: 380.0305

found: 380.0303

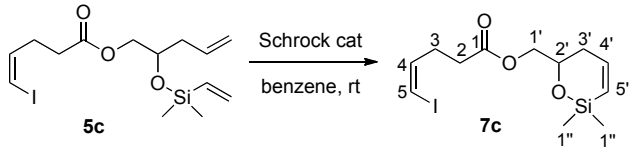
Analysis: $C_{13}H_{21}IO_3Si$ (380.29)

calcd.: C, 41.06; H, 5.57; I, 31.37;

found: C, 41.40; H, 5.62; I, 31.93

TLC: R_f 0.48 (silica gel, pentane/Et_2O, 8:1, UV)

Preparation of 2,2-Dimethyl-2-[(1-oxa-2-silacyclohex-3-enyl)methyl] (*Z*)-5-Iodopent-4-enoate (7c).



Following General Procedure III, compound **5c** (0.99 g, (2.50 mmol equiv) was dissolved in benzene (25 mL) to give a colorless solution. The solution was freeze-pump-thaw degassed with argon (3 ×) then transferred to the dry box. To this mixture was added Schrock catalyst (0.15 g, 0.20 mmol equiv) in one portion to afford an orange solution that later turned light brown. The solution was then stirred for 15 h at ambient temperature. Upon reaction completion the mixture was removed from the dry box and filtered over Celite (5 g) and the plug was rinsed with Et_2O (30 mL). The solvent removed in vacuo and the crude product was purified by chromatography (silica gel (25 g), pentane/Et_2O (8:1)) to afford 742 mg (81%) of **7c** as a light brown liquid. An analytical sample was prepared by a second chromatography with pentane/Et_2O (5:1).

Data for **7c**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.75 (ddd, *J* = 14.0, 5.5, 2.5 Hz, 1 H, HC(4')), 6.27 (d, *J* = 7.5 Hz, 1 H, HC(5)), 6.23 (q, *J* = 6.9 Hz, 1 H, HC(4)), 5.76 (dd, J = 14.5, 1.5 Hz, 1 H, HC(4')), 4.17-4.12 (m, 1 H, HC(2')), 4.10 (d, *J* = 5.5 Hz, 2 H, HC(1')), 2.50-2.43 (m, 4 H, HC(2, 3)), 2.24-2.12 (m, 2 H, HC(3')), 0.19 (s, 6 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.4(C(1')), 146.0 (C(4')), 139.2 (C(4)), 127.3 (C(5')), 83.8 (C(5)), 69.1 (C(2')), 68.2 (C(1')), 32.6 (C(3')), 32.4 (C(2)), 30.2 (C(3)), -0.38 (C(1'')), -0.60 (C(1'')).

IR: (thin film, NaCl plates)

3071 (w), 2986 (m), 2956 (m), 2917 (m), 1735 (s), 1611 (w), 1588 (m), 1419 (m), 1390 (m), 1353 (m), 1309 (m), 1250 (s), 1176 (s), 1101 (m), 1049 (m), 952 (s), 911 (m), 844 (s), 789 (s), 757 (m), 689 (m), 648 (m).

LRMS: (CI):

366.1 (M^+), 351.0 (8), 283.0 (8), 239.1 (8), 209.0 (8), 181.0 (20), 167.0 (8), 141.1 (40), 127.1 (100), 98.1 (24), 75.1 (28), 52.9 (16).

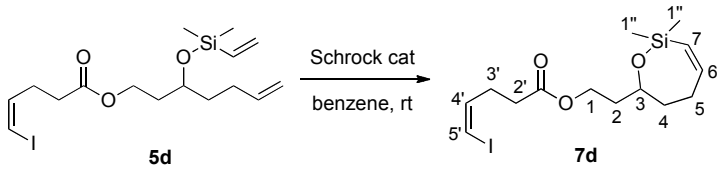
HRMS: (CI, $[M]^+$):

calcd.: 366.0149

found: 366.0151

TLC: R_f 0.63 (silica gel, hexane/Et_2O, 8:1, UV)

Preparation of 2,2-Dimethyl-3-[(1-oxa-2-silacyclohept-3-enyl)ethyl] (*Z*)-5-Iodopent-4-enoate (7d).



Following General Procedure III, compound **5d** (0.95 g, (2.25 mmol equiv) was dissolved in benzene (23 mL) to give a colorless solution. The solution was freeze-pump-thaw degassed with argon (3 ×) then transferred to the dry box. To this mixture was added Schrock catalyst (0.17 g, 0.23 mmol equiv) in one portion to afford an orange solution that later turned light brown. The solution was then stirred for 15 h at ambient temperature. The mixture was removed from the dry box and filtered through Celite (5 g) and the plug was rinsed with Et_2O (30 mL). The solvent removed in vacuo and the crude product was purified by chromatography (silica gel

(19 g), hexane/Et_2O (12:1-8:1)) to afford 745 mg (84%) of **7d** as a light brown liquid. An analytical sample was prepared by a second chromatography with pentane/Et_2O (5:1).

Analytical Data for **7d**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.62 (dd, *J* = 15.0, 11.0 Hz, 1 H, HC(6)), 6.27 (d, *J* = 7.5 Hz, 1 H, HC(5')), 6.24-6.20 (m, 1 H, HC(4')), 5.61 (d, *J* = 14.5 Hz, 1 H, HC(7)), 4.24-4.16 (m, 2 H, HC(1)), 4.00-3.95 (m, 1 H, HC(3)), 2.52-2.41 (m, 5 H, HC(2, 2', 3'), 2.29-2.17 (m, 1 H, HC(2)), 1.86-1.69 (m, 4 H, HC(4, 5)), 0.21 (s, 3 H, HC(1'')), 0.12 (s, 3 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5(C(1')), 147.8 (C(6)), 139.2, (C(4')), 129.8 (C(7)), 83.7 (C(5')), 69.8 (C(3)), 62.0 (C(1)), 36.7 (C(4/5)), 35.4 (C(4/5)), 32.4 (C(2')), 30.2 (C(3')), 29.2 (C(2)), 0.62 (C(1'')), -0.44 (C(1'')).

IR: (thin film, NaCl plates)

2989 (m), 2956 (m), 2915 (m), 1732 (s), 1611 (w), 1589 (m), 1419 (w), 1391 (w), 1353 (m), 1309 (w), 1286 (m), 1251 (s), 1216 (m), 1178 (m), 1160 (m), 1046 (m), 952 (m), 910 (m), 844 (s), 790 (s), 757 (s), 689 (m).

LRMS: (CI):

395.0 ($M+H^+$), 379.0 (12), 283.0 (24), 227.0 (12), 208.9 (24), 169.1 (28), 95.1 (100), 75.0 (28), 54.9 (16).

HRMS: (CI, $[M+H]^+$):

calcd.: 395.0540

found: 395.0539

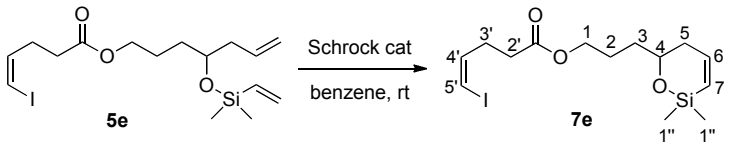
Analysis: $C_{14}H_{23}IO_3Si$ (394.32)

calcd.: C, 42.64; H, 5.88; I, 32.18;

found: C, 42.61; H, 5.94; I, 31.42;

TLC: R_f 0.43 (silica gel, hexane/Et_2O, 8:1, UV)

Preparation of 2,2-Dimethyl-4-[(1-oxa-2-silacyclohex-3-enyl)propyl] (*Z*)-5-Iodopent-4-enoate (7e).



Following General Procedure III, compound **5e** (1.00 g, (2.37 mmol equiv) was dissolved in benzene (24 mL) to give a colorless solution. The solution was freeze-thaw pumped with argon (3 ×) then transferred to the dry box. To this mixture was added Schrock catalyst (0.14 g, 0.19 mmol equiv) in one portion to afford an orange solution that later turned light brown. The solution was then stirred for 15 h at ambient temperature. Upon reaction completion the mixture was removed from the dry box and filtered over Celite (3 g) and the plug was rinsed with Et_2O (30 mL). The solvent removed in vacuo and the crude product was purified by chromatography (silica gel (20 g), pentane/Et_2O (12:1-8:1)) to afford 776 mg (83%) of **7e** as a yellow oil. An analytical sample was prepared by a second chromatography with pentane/Et_2O (5:1).

Analytical Data for **7e**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.73 (ddd, *J* = 14.3, 5.0, 3.0 Hz, 1 H, HC(6)), 6.26 (dd, *J* = 7.5, 1.0 Hz, 1 H, HC(5')), 6.23-6.19 (m, 1 H, HC(4')), 5.72 (ddd, *J* = 14.6, 2.3, 1.5 Hz, 1 H, HC(7)), 4.09 (dt, *J* = 6.6, 1.0 Hz, 2 H, HC(1)), 3.88 (tt, *J* = 8.3, 4.5 Hz, 1 H,

HC(4)), 2.47-2.40 (m, 4 H, HC(2', 3')), 2.14-2.11 (m, 2 H, HC(5)), 1.87-1.78 (m, 1 H, HC(2)), 1.71-1.63 (m, 1 H, HC(2)), 1.61-1.47 (m, 2 H, HC(3)), 0.16 (s, 3 H, HC(1'')), 0.16 (s, 3 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5(C(1')), 146.9 (C(6)), 139.2 (C(4')), 127.1 (C(7)), 83.7 (5')), 70.8 (C(4)), 64.6 (C(1)), 36.4 (C(5)), 34.0 (C(3)), 32.4 (2')), 30.1 (C(3')), 24.8 (C(2)), -0.47 (C(1'')), -0.62 (C(1'')).

IR: (thin film, NaCl plates)

3070 (w), 2986 (m), 2956 (m), 2915 (m), 1736 (s), 1613 (w), 1588 (m), 1419 (m), 1353 (m), 1309 (m), 1286 (m), 1250 (s), 1176 (m), 1049 (m), 952 (m), 910 (m), 843 (s), 789 (s), 689 (m), 648 (m).

LRMS: (CI):

395.0 ($M+H^+$), 283.0 (28), 213.1 (20), 169.1 (100), 153.1 (20), 127.1 (76), 111.0 (24), 98.0 (56), 71.1 (76).

HRMS: (CI, $[M+H]^+$):

calcd.: 394.04616

found: 394.04639

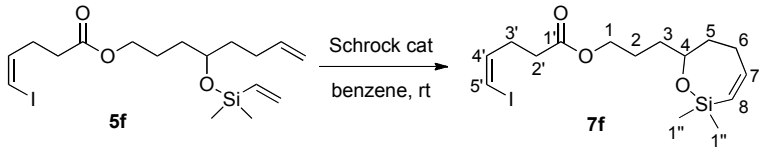
Analysis: $C_{14}H_{23}IO_3Si$ (394.32)

calcd.: C, 42.64; H, 5.88; I, 32.18;

found: C, 42.38; H, 5.99; I, 32.01;

TLC: R_f 0.46 (silica gel, hexane/EtOAc, 8:1, UV)

Preparation of 2,2-Dimethyl-4-[(1-oxa-2-silacyclohept-3-enyl)propyl] (*Z*)-5-Iodopent-4-enoate (7f).



Following General Procedure III, compound **5f** (1.00 g, (2.29 mmol equiv) was dissolved in benzene (23 mL) to give a colorless solution. The solution was freeze-pump-thaw degassed with argon (3 ×) then transferred to the dry box. To this mixture was added Schrock catalyst (0.14 g, 0.18 mmol equiv) in one portion to afford an orange solution that later turned light brown. The solution was then stirred for 12 h at ambient temperature. The mixture was removed from the dry box and filtered through Celite (3 g) and the plug was rinsed with Et_2O (20 mL). The solvent removed in vacuo and the crude purified by chromatography (silica gel (19 g), pentane/Et_2O (12:1-8:1)) to afford 711 mg (76%) of **7f** as an almost colorless oil. An analytical sample was prepared by a second chromatography with pentane/Et_2O (5:1).

Analytical Data for **7f**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.60 (dt, *J* = 18.0, 6.8 Hz, 1 H, HC(7)), 6.26 (d, *J* = 9.0 Hz, 1 H, HC(5')), 6.23-6.18 (m, 1 H, HC(4')), 5.58 (d, *J* = 18.0 Hz, 1 H, HC(8)), 4.08 (dt, *J* = 8.3, 3.0 Hz, 2 H, HC(1)), 3.82 (tt, *J* = 10.5, 5.5 Hz, 1 H, HC(4)), 2.50-2.34 (m, 5 H, HC(2, 2', 3')), 2.27-2.19 (m, 1 H, HC(2)), 1.86-1.42 (m, 6 H, HC(3, 5, 6)), 0.20 (s, 3 H, HC(1'')), 0.12 (s, 3 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

172.5(C(1')), 147.9 (C(8)), 139.2 (C(4')), 129.7 (C(7)), 83.7 (C(5')), 72.9 (C(4)), 64.6 (C(1)), 35.3 (C(5)), 34.2 (C(3)), 32.3 (2')), 30.1 (C(3')), 29.2 (C(6)), 25.4

(C(2)), 0.73 (C(1'')), -0.34 (C(1'')).

IR: (thin film, NaCl plates)

3071 (w), 2987 (m), 2958 (m), 2917 (m), 1736 (s), 1610 (w), 1588 (s), 1422 (m), 1354 (m), 1308 (m), 1286 (m), 1250 (s), 1181 (s), 1161 (m), 1104 (m), 1049 (m), 999 (m), 949 (s), 899 (s), 844 (s), 789 (s), 689 (m), 648 (m).

LRMS: (CI):

409.1 ($M+H^+$), 353.0 (20), 307.0 (100), 283.0 (60), 208.9 (48), 169.1 (36), 81.1 (92).

HRMS: (CI, $[M+H]^+$):

calcd.: 409.0696

found: 409.0698

Analysis: $C_{15}H_{25}IO_3Si$ (408.35)

calcd.: C, 44.12; H, 6.17; I, 31.08;

found: C, 43.88; H, 6.21; I, 30.82;

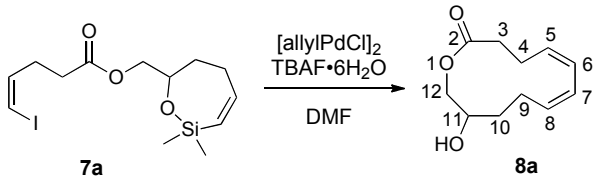
TLC: R_f 0.42 (silica gel, pentane/Et_2O, 8:1, UV)

General Procedure IV. Intramolecular Cross-Coupling of 7a-f and 10.

To a 1 M TBAF•$3H_2O$ solution in DMF under argon was added H_2O (3 equiv) $[allylPdCl]_2$ (10 mol %). To this solution was added slowly a solution of **7a-f** and **10** in DMF (0.1 M) with the aid of a syringe pump. After complete addition of **7a-f** or 10 the dark solution was stirred for additional 3 h and the mixture poured onto biphasic mixture of 10 % LiCl aqueous solution and the aqueous layer was extracted with benzene. The combined organic layers washed with 10 % aq. LiCl solution, brine, and then were dried over $MgSO_4$. The solvent

was removed by rotatory evaporation and the crude product was purified by chromatography (SiO_2) to afford **8a-f** and **9**.

Preparation of 11-Hydroxyoxacyclododeca-(5*Z*,7*Z*)-dien-22-one (8a/8a').



Following General Procedure IV, a 1 M solution of TBAF•$3H_2O$ in DMF (5 mL, 5 mmol equiv), H_2O (270 μL, 15 mmol equiv), and $[allylPdCl]_2$ (37 mg, 0.1 mmol equiv) were combined. To this yellow solution was added slowly over 40 h a solution of **7a** in DMF (0.1 M, 381 mg, 1.00 mmol equiv) using a syringe pump. After complete addition the dark solution was stirred for an additional 3 h and the mixture poured onto biphasic mixture of 10 % LiCl aq. solution (20 mL) and benzene (20 mL). The aqueous layer was separated and extracted with benzene (3 × 20 mL) and the combined organic layers were washed with 10 % aq. LiCl solution (2 × 20 mL), brine (2 × 20 mL), and then were dried over $MgSO_4$. The solvent was removed by rotatory evaporation and the dark crude purified by chromatography (silica gel (10 g), hexane/EtOAc (2:1 to 1:1)) to afford 145 mg (74%) of **8a** as a brown oil.

Analytical Data for **8a**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.08 (dd, *J* = 10.8, 7.0 Hz, 1 H, HC(6/7)), 5.98 (dd, *J* = 11.0, 7.0 Hz, 1 H, HC(6/7)), 5.62-5.46 (m, 2 H, HC(4/8)), 4.19 (dd, *J* = 11.3, 3.0 Hz, 1 H, HC(12)), 3.93 (dd, *J* = 11.5, 5.0 Hz, 1 H, HC(12)), 3.89-3.86 (m, 1 H, HC(11)), 2.62-2.32 (m, 2 H, HC(3/4/9:10)), 2.24-1.98 (m, 2 H, HC(3/4/9:10)), 1.93 (d, *J* = 6.5 Hz, 1

H, OH), 1.84-1.65 (m, 2 H, HC(3/4/9:10)).

^{13}C NMR: (126 MHz, $CDCl_3$)

173.3 (C(2)), 130.6 (C(5/8)), 129.7 (C(5/8)), 128.0 (C(6/7)), 125.7 (C(6/7)), 69.2 (C(11)), 68.1 (C(12)), 65.6 (C(3/4/9:10)), 35.3 (C(3/4/9:10)), 34.6 (C(3/4/9:10)), 33.0 (C(3/4/9:10)), 25.0 (C(3/4/9:10)), 24.5 (C(3/4/9:10)), 23.4(C(3/4/9:10)).

IR: (thin film, NaCl plates)

3440 (m), 3000 (w), 2943 (m), 2851 (w), 1729 (s), 1440 (w), 1334 (m), 1261 (m), 1200 (w), 1148 (s), 1097 (w), 1061 (m), 994 (w), 961 (w), 848 (w), 792 (w), 727 (m), 640 (w).

LRMS: (CI):

197.0 (M+H), 179.0 (60), 161.0 (52), 151.0 (16), 143.0 (16), 137.0 (28), 133.0 (44), 119.0 (68), 105.0 (20), 101.0 (50), 93.0 (25), 79.0 (30), 67.0 (15), 58.9 (100).

HRMS: (CI, $[M]^+$):

calcd.: 196.10995

found: 196.10913

Analysis: $C_{11}H_{16}O_3$ (196.24)

calcd.: C, 67.32; H, 8.22;

found: C, 67.12; H, 7.95;

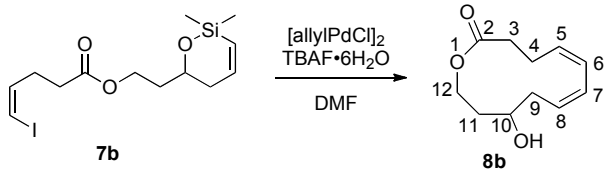
TLC: R_f 0.33 (silica gel, hexane/EtOAc (1:1), UV)

Analytical Data for **8a'**:

^{1}H NMR: (500 MHz, $CDCl_3$)

5.88 (d, *J* = 11.0 Hz, 1 H), 4.96 (ddt, *J* = 11.8, 7.0, 3.5 Hz, 1 H), 3.66 (ddd, *J* = 11.8, 5.8, 3.5 Hz, 1 H), 3.58-3.53 (m, 1 H)..

Preparation of 10-Hydroxyoxacyclododeca-(5*Z*,7*Z*)-dien-22-one (8b).



Following General Procedure IV, a 1 M solution of TBAF•3H_2O in DMF (1 mL, 5 mmol equiv), H_2O (270 μL, 15 mmol equiv), and $[allylPdCl]_2$ (37 mg, 0.1 mmol equiv) were combined. To this yellow solution was added slowly over 40 h a solution of **7b** in DMF (0.1 M, 381 mg, 1.00 mmol) using a syringe pump. After complete addition the dark solution was stirred for an additional 3 h and the mixture poured onto biphasic mixture of 10 % LiCl aq. solution (15 mL) and benzene (15 mL). The aqueous layer was separated and extracted with benzene (3 × 15 mL) and the combined organic layers were washed with 10 % aq. LiCl solution (2 × 15 mL), brine (2 × 15 mL), and then were dried over $MgSO_4$. The solvent was removed by rotatory evaporation and the dark crude product was purified by chromatography (silica gel (10 g), hexane/EtOAc (2:1 to 1:1)) to afford 137 mg (70%) of **8b** as a brown oil.

Data for **8b**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.12-6.05 (m, 2 H, HC(6, 7)), 5.60-5.55 (m, 1 H, HC(5/8)), 5.51-5.46 (m, 1 H, HC(5/8)), 4.21 (ddd, *J* = 11.6, 7.3, 3.0 Hz, 1 H, HC(12)), 4.11 (w, 1 H, HC(10)), 4.01 (ddd, *J* = 11.9, 8.8, 2.5 Hz, 1 H, HC(12)), 2.46-2.16 (m, 5 H, HC(3/4/9)),

2.02 (s, 1 H, OH), 1.97-1.90 (m, 1 H, (HC(11)), 1.78-1.72 (m, 1 H, HC(11)).

^{13}C NMR: (126 MHz, $CDCl_3$)

173.3 (C(2)), 130.4 (C(5/8)), 127.7 (C(5/8)), 127.5 (C(6/7)), 126.9 (C(6/7)), 68.5 (C(10)), 61.4 (C(12)), 34.9 (C(3/4/9)), 34.8 (C(3/4/9)), 33.9 (C(112)), 24.7 (C(3/4/9)).

IR: (thin film, NaCl plates)

3450 (w), 3003 (w), 2946 (w), 2851 (w), 1720 (m), 1441 (w), 1334 (w), 1264 (m), 1200 (w), 1150 (m), 1062 (m), 910 (s), 793 (w), 733 (s), 649 (m).

LRMS: (CI):

197.0 (M+H), 179.0 (8), 161.0 (8), 151.0 (2), 143.0 (2), 133.0 (8), 119.0 (10), 101.0 (10), 93.0 (5), 79.0 (4), 67.0 (4), 58.9 (100).

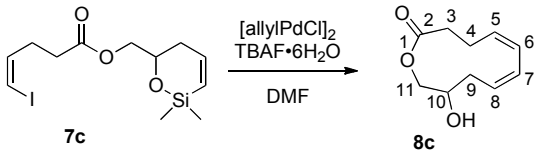
HRMS: (CI, $[M+H]^+$):

calcd.: 197.11778

found: 197.11813

TLC: R_f 0.37 (silica gel, hexane/EtOAc (1:1), UV)

Preparation of 10-Hydroxyoxacycloundeca-(5*Z*,7*Z*)-dien-22-one (8c).



7c **8c**

Following General Procedure IV, a 1 M solution of TBAF•$3H_2O$ in DMF (5 mL, 5 mmol equiv), H_2O (270 μL, 15 mmol equiv), and $[allylPdCl]_2$ (37 mg, 0.1 mmol equiv) were combined. To this yellow solution was added slowly over 40 h a solution of **7c** in DMF (0.1 M, 366 mg, 1.00 mmol equiv) using a syringe pump. After complete addition the dark solution was

stirred for an additional 3 h and the mixture poured onto biphasic mixture of 10 % aq. LiCl aqueous (15 mL) and benzene (15 mL). The aqueous layer was separated and extracted with benzene (3 × 15 mL) and the combined organic layers were washed with 10 % aq. LiCl solution (2 × 10 mL), brine (2 × 15 mL), and then were dried over $MgSO_4$. The solvent was removed by rotatory evaporation and the dark crude product was purified by chromatography (silica gel (10 g), hexane/EtOAc (2:1 to 1:1)) to afford 105 mg (58%) of **8c** as a brown oil.

Analytical Data for **8c**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.04 (t, *J* = 9.8 Hz, 2 H, HC(6, 7)), 5.60-5.54 (m, 2 H, HC(5, 8)), 4.20 (dd, *J* = 11.0, 3.0, 1 H, HC(10)), 4.06-4.03 (m, 2 H, HC(9, 10)), 2.50-2.26 (m, 6 H, HC(2, 4, 9)), 2.17 (d, *J* = 6.5 Hz, 1 H, OH)).

^{13}C NMR: (126 MHz, $CDCl_3$)

173.5 (C(2)), 131.0 (C(5/8)), 127.9 (C(6/7)), 127.6 (C(5/8)), 127.2 (C(6/7)), 69.1 (C(11)), 68.3 (C(10)), 34.6 (C(3/4/9)), 24.6 (C(3/4/9)).

IR: (thin film, NaCl plates)

3451 (w), 3007 (w), 2951 (w), 2922 (w), 2851 (w), 1721 (s), 1439 (w), 1381 (w), 1332 (m), 1262 (m), 1194 (w), 1150 (m), 1090 (w), 1064 (m), 1026 (m), 999 (w), 909 (s), 787 (w), 731 (s), 650 (m), 627 (w).

LRMS: (CI):

183.1 (M+H), 165.1 (12), 147.1 (12), 129.1 (12), 105.1 (15), 89.1 (48), 84.0 (22), 61.0 (100).

HRMS: (CI, $[M+H]^+$):

calcd.: 183.10213

found: 183.10177

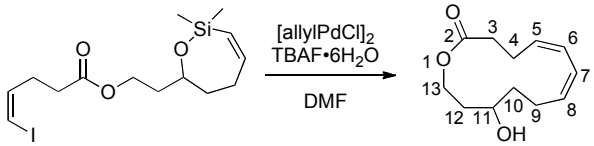
Analysis: $C_{11}H_{16}O_3$ (196.24)

calcd.: C, 65.91; H, 7.74;

found: C, 65.97; H, 7.74;

TLC: R_f 0.44 (silica gel, hexane/EtOAc (1:1), UV)

Preparation of 11-Hydroxyoxacyclotrideca-(5*Z*,7*Z*)-dien-22-one (8d).



Following General Procedure IV, To a 1 M solution of TBAF•$3H_2O$ solution in DMF (1 mL, 5 mmol equiv), H_2O (270 μL, 15 mmol equiv), and $[allylPdCl]_2$ (37 mg, 0.1 mmol equiv) were combined. To this yellow solution was added slowly over 54 h a solution of **7d** in DMF (0.1 M, 394 mg, 1.00 mmol equiv) using a syringe pump. After complete addition the dark solution was stirred for an additional 3 h and the mixture poured onto biphasic mixture of 10 % aq. LiCl solution (15 mL) and benzene (15 mL). The aqueous layer was separated and extracted with benzene (3 × 15 mL) and the combined organic layers washed with 10 % aq. LiCl solution (2 × 15 mL), brine (2 × 15 mL), and then were dried over $MgSO_4$. The solvent was removed by rotatory evaporation and the dark crude product was purified by chromatography (silica gel (10.2 g), hexane/EtOAc (2:1 to 1:1)) to afford 128.4 mg (53%) of **8d** as a brown oil.

Data for **8d**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.24-6.15 (m, 2 H, HC(6, 7)), 5.50-5.42 (m 2 H, HC(5, 8)), 4.31 (dt, *J* = 11.4, 1.5

Hz, 1 H, HC(13)), 4.19-4.09 (m, 1 H, HC(13)), 3.54 (w, 1 H, HC(10)), 2.53-2.07 (m, 6 H, HC(3/4/9:11:12)), 2.19 (d, J = 5.5 Hz, 1 H, OH), 1.86 (t, J = 13.3 Hz, 1 H, HC(12)), 1.74-1.69 (m, 1 H, HC(3/4/9:11)), 1.54-1.47 (m, 1 H, HC(3/4/9:11)), 1.35 (ddd, J = 13.9, 11.0, 3.0 Hz, 1 H, HC(12)).

^{13}C NMR: (126 MHz, $CDCl_3$)

173.6 (C(2)), 132.7 (C(5/8)), 130.4 (C(5/8)), 126.0 (C(5/6)), 125.5 (C(5/6)), 66.5 (C(10)), 60.8 (C(13)), 36.8 (C(3/4/9:11:12)), 36.4 (C(3/4/9:11:12)), 34.6 (C(3/4/9:11:12)), 24.9 (C(3/4/9:11:12)), 24.5 (C(3/4/9:11:12)).

IR: (thin film, NaCl plates)

3423 (m), 3005 (m), 2923 (s), 1729 (s), 1444 (m), 1384 (m), 1337 (m), 1249 (s), 1201 (m), 1179 (m), 1118 (s), 1064 (m), 1041 (s), 1001 (m), 984 (m), 937 (w), 908 (w), 845 (w), 756 (m), 720 (m), 566 (w).

LRMS: (CI):

210.1 (M+), 193.1 (100), 175.1 (92), 164.1 (8), 157.1 (16), 147.1 (28), 133.1 (64), 119.1 (24), 105.1 (16), 93.1 (24), 79.1 (36), 71.0 (28), 56.9 (12).

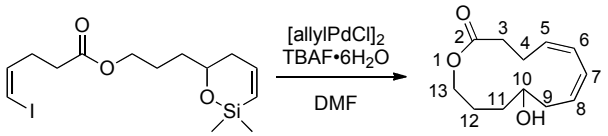
HRMS: (CI, $[M+H]^+$):

calcd.: 210.12560

found: 210.12544

TLC: R_f 0.37 (silica gel, hexane/EtOAc (1:1), UV)

Preparation of 10-Hydroxyoxacyclotrideca-(5*Z*,7*Z*)-dien-22-one (8e).



Following General Procedure IV, To a 1 M solution of TBAF•$3H_2O$ in DMF (1 mL, 5 mmol equiv), H_2O (270 μL, 15 mmol equiv), and $[allylPdCl]_2$ (37 mg, 0.1 mmol equiv) were combined. To this yellow solution was added slowly over a 48 h a solution of **7e** in DMF (0.1 M, 394 mg, 1.00 mmol equiv) using a syringe pump. After complete addition the dark solution was stirred for an additional 3 h and the mixture poured onto biphasic mixture of 10 % aq. LiCl solution (15 mL) and benzene (15 mL). The aqueous layer was separated and extracted with benzene (3 × 15 mL) and the combined organic layers washed with 10 % aq. LiCl solution (2 × 15 mL), brine (2 × 15 mL), and then were dried over $MgSO_4$. The solvent was removed by rotatory evaporation and the dark crude product was purified by chromatography (silica gel (10 g), hexane/EtOAc (2:1 to 1:1)) to afford 111 mg (53%) of **8e** as a brown oil.

Data for **8e**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.30-6.23 (m, 2 H, HC(6, 7)), 5.58-5.49 (m 2 H, HC(5, 8)), 4.23 (m, 1 H, HC(12)), 4.02-3.99 (m, 1 H, HC(13)), 3.75 (w, 1 H, HC(10)), 2.56-2.34 (m, 6 H, HC(3/4/9:11:12)), 1.81-1.69 (m, 1 H, HC(3/4/9:11:12)), 1.60-1.57 (m, 2 H, HC(3/4/9:11:12)), 1.50-1.46 (m, 1 H, HC(3/4/9:11:12)), 1.43 (d, J = 4.5 Hz, 1 H, OH).

^{13}C NMR: (126 MHz, $CDCl_3$)

173.1 (C(2)), 130.6 (C(5/8)), 128.0 (C(5/8)), 127.1 (C(5/6)), 126.1 (C(5/6)), 71.0 (C(10)), 63.9 (C(13)), 34.6 (C(3/4/9:11:12)), 32.8 (C(3/4/9:11:12)), 25.2

(C(3/4/9:11:12)), 24.2 (C(3/4/9:11:12)).

IR: (thin film, NaCl plates)

3425 (m), 3007 (m), 2924 (s), 2856 (m), 1720 (s), 1444 (m), 1384 (m), 1336 (m), 1250 (s), 1179 (m), 1153 (s), 1118 (s), 1065 (m), 1041 (s), 1001 (m), 984 (m), 910 (m), 845 (w), 757 (s), 734 (s), 667 (m), 648 (m), 618 (m), 566 (w).

LRMS: (CI):

210.1 (M+), 193.1 (50), 175.1 (48), 165.1 (4), 157.1 (8), 147.1 (16), 133.1 (50), 123.1 (20), 105.1 (20), 97.1 (24), 80.1 (64), 71.0 (100), 58.9 (12).

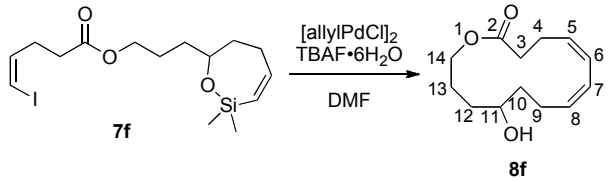
HRMS: (CI, $[M+H]^+$):

calcd.: 210.12560

found: 210.12606

TLC: R_f 0.40 (silica gel, hexane/EtOAc (1:1), UV)

Preparation of 11-Hydroxyoxacyclotetradeca-(5*Z*,7*Z*)-dien-22-one (8f).



Following General Procedure IV, To a 1 M solution of TBAF•$3H_2O$ in DMF (5 mL, 5 mmol equiv), H_2O (270 μL, 15 mmol equiv), and $[allylPdCl]_2$ (37 mg, 0.1 mmol equiv) were combined. To this yellow solution was added slowly over 54 h a solution of **7f** in DMF (0.1 M, 408 mg, 1.00 mmol equiv) using a syringe pump. After complete addition the dark solution was stirred for an additional 3 h and the mixture poured onto biphasic mixture of 10 % aq. LiCl solution (15 mL) and benzene (15 mL). The aqueous layer was separated and extracted with

benzene (3 × 15 mL) and the combined organic layers were washed with 10 % aq. LiCl solution (2 × 15 mL), brine (2 × 15 mL), and then were dried over $MgSO_4$. The solvent was removed by rotatory evaporation and the dark crude product was purified by chromatography (silica gel (10 g), hexane/EtOAc (2:1 to 1:1)) to afford 155 mg (69%) of **8f** as a brown oil.

Data for **8f**:

^{1}H NMR: (500 MHz, $CDCl_3$)

6.32 (t, *J* = 10.5 Hz, 1 H, HC(6/7)), 6.23 (t, *J* = 10.8 Hz, 1 H, HC(6/7)), 5.50-5.40 (m, 2 H, HC(5, 8)), 4.27-4.23 (m, 1 H, HC(14)), 4.00 (w, 1 H, HC(14)), 2.57-2.37 (m, 5 H, HC(3/4/9:10:12:13)), 2.16-2.13 (m, 1 H, HC(3/4/9/9:12:13)), 1.87-1.63 (m, 4 H, HC(3/4/9:10:12:13)), 1.55-1.48 (m, 1 H, HC(3/4/9:10:12:13)), 1.44 (s, 1 H, OH), 1.18-1.12 (m, 1 H, HC(3/4/9:10:12:13)).

^{13}C NMR: (126 MHz, $CDCl_3$)

173.4 (C(2)), 132.2 (C(5/8)), 130.6 (C(5/8)), 125.4 (C(6/7)), 124.0 (C(6/7)), 69.7 (C(11)), 63.3 (C(14)), 35.7 (C(3/4/9:10:12:13)), 34.9 (C(3/4/9:10:12:13)), 30.4 (C(3/4/9:10:12:13)), 24.5 (C(3/4/9:10:12:13)), 23.9 (C(3/4/9:10:12:13)), 23.3 (C(3/4/9:10:12:13)).

IR: (thin film, NaCl plates)

3424 (m), 3008 (w), 2923 (m), 1726 (s), 1440 (m), 1387 (w), 1340 (m), 1220 (m), 1156 (s), 1121 (w), 1078 (w), 990 (s), 965 (m), 754 (s), 712 (m), 667 (m), 518 (s).

LRMS: (CI):

225.1 (M+H), 207.1 (100), 189.1 (84), 177.1 (8), 171.1 (30), 161.1 (25), 147.1 (65), 137.1 (20), 123.1 (48), 105.1 (20), 97.1 (65), 79.1 (40), 71.0 (100), 54.9 (12).

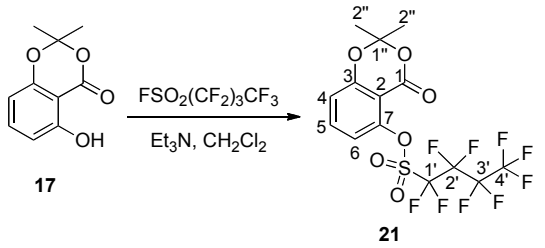
HRMS: (CI, $[M+H]^+$):

calcd.: 224.14125

found: 224.14104

TLC: R_f 0.29 (silica gel, hexane/EtOAc (1:1), UV)

Preparation of 2,2-Dimethyl-5-(nonafluorobutanesulfonyl)benzo[1,3]dioxin-4-one (21).



In a 100-mL, three-necked, round-bottomed flask under argon was charged CH_2Cl_2 (20 mL), phenol **17**[4] (1.20 g, 6.18 mmol equiv), Et_3N (2.85 mL, 15.5 mmol equiv), and nonafluorobutanesulfonic fluoride (2.22 mL, 12.36 mmol equiv) and the mixture was stirred at rt for 24 h. The mixture was diluted with CH_2Cl_2 (80 mL) and sat. aq. $NaHCO_3$ solution (25 mL). The layers separated and the aqueous layer was extracted with CH_2Cl_2 (2 × 25 mL). The organic layer dried over $MgSO_4$ and concentrated to give a thick brown oil/solid mixture. Acetone (30 mL) added and a cream white solid precipitated. The solid was washed with acetone (3 × 15 mL) to afford shiny cream-colored crystals. The acetone washings concentrated to give a brown oil that was washed with acetone (3 × 15) and the solid collected. This process was repeated (× 4) to afford a total of 2.66 g (90%) of **21**. The solid recrystallized in hot CH_2Cl_2 to afford 1st crop of shiny cream-colored crystals weighing 2.20 g (75 %). The second crop gave 0.38 g (13 %). This reaction has been carried out several times on a 33 mmol scale.

Analytical Data for **21**:

^{1}H NMR: (500 MHz, $CDCl_3$)

7.61 (t, *J* = 8.5 Hz, 1 H, HC(5)), 7.06 (d, *J* = 8.5 Hz, 1 H, HC(6)), 7.01 (d, *J* = 8.0 Hz, 1 H, HC(4)), 1.76 (s, 6 H, HC(2'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

157.3, 157.2, 148.9, 136.2, 117,8, 116.5, 108.5, 106.8, 25.5 (C(2'')).

^{19}F NMR: (470 MHz, $CDCl_3$)

-81.1 (t, *J* = 9.8 Hz), -109.4, -121.2, -126.3, -126.3.

IR: (thin film, NaCl plates)

3055 (m), 2985 (m), 1744 (m), 1623 (m), 1560 (w), 1475 (m), 1433 (s), 1392 (w), 1383 (w), 1353 (w), 1324 (m), 1265 (s), 1208 (s), 1145 (m), 1075 (m), 1052 (m), 1024 (m), 966 (w), 928 (m), 896 (m), 857 (w), 739 (s), 622 (w), 583 (m).

LRMS: (CI):

477.0 ($M+H^+$), 419.0 (100), 354.0 (3), 195.1 (4), 165.1 (3), 137.0 (16), 107.0 (4), 87.1 (12), 59.0 (6).

HRMS: (CI, $[M+H]^+$):

calcd.: 477.0054

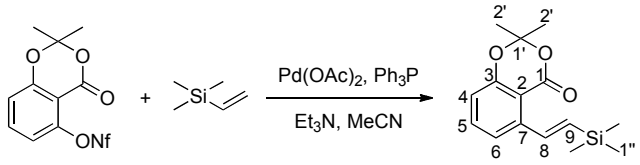
found: 477.0060

Analysis: $C_{15}H_{25}IO_3Si$ (408.35)

calcd.: C, 35.31; H, 1.90; F, 35.90;

found: C, 35.14; H, 1.69; I, 35.84;

Preparation of 2,2-Dimethyl-5-(2(*E*)-(trimethylvinylsilyl)benzo[1,3]-dioxin-4-one (14).



21 **14**

In a 250-mL, three-necked flask equipped with a reflux condenser and a septum was charged aryl nonaflate **21** (4.65 g, 9.76 mmol equiv) and DMF (140 mL), the mixture dissolved to afford a pale yellow-creamy colored solution. Palladium acetate (164 mg, 0.49 mmol equiv), triphenylphosphine (257 mg, 0.98 mmol equiv), and trimethylvinylsilane (4.52 mL, 29.3 mmol equiv) were added sequentially to afford a pale brown solution. The mixture immersed in a preheated oil bath at 80 °C and was allowed to stir for 15 h. The cooling bath removed and the dark solution allowed to cool to ambient temperature then was poured onto a biphasic mixture of benzene (200 mL):10 % aq. LiCl (140 mL) solution. The aqueous layer was separated and was extracted with EtOAc (2 × 70 mL). The combined organic layers were washed with 10 % aq. LiCl solution (2 × 60 mL), brine (2 × 30 mL), and dried over $MgSO_4$ then concentrated to afford a brown oil. The crude product was purified by chromatography (silica gel (105 g), hexane/EtOAc (20:1 to 15:1)) to give 2.36 g (87%) of **14** as a pale-green oil that was then Kugelrohr distilled (185-190 °C/0.6 mmHg, ABT) to afford 2.27 g (84%) of analytically pure **14** as a white solid.

Analytical Data for **14**:

mp: 58-60 °C

^{1}H NMR: (500 MHz, $CDCl_3$)

7.92 (d, J = 19.0 Hz, 1 H, HC(8)), 7.45 (t, J = 8.0 Hz, 1 H, HC(5)), 7.32 (d, J = 8.0 Hz, 1 H, HC(6)), 6.86 (dd, J = 7.5, 1.0 Hz, 1 H, HC(4)), 6.47 (d, J = 19.0 Hz,

1 H, HC(9)), 1.71 (s, 6 H, HC(2')), 0.18 (s, 9 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

160. 2 (C(1)), 156.6 (C(3)), 143.3 (C(7)), 141.8 (C(8)), 135.0 (C(5)), 134.9 (C(4)), 121.3 (C(6)), 116.3 (C(9)), 110.7 (C(2)), 105.2 (C(1')), 25.6 (C(2')), -1.31 (C(1'')).

IR: (thin film, NaCl plates)

3000 (m), 2955 (m), 2894 (m), 1738 (s), 1694 (m), 1597 (s), 1573 (s), 1475 (s), 1390 (s), 1380 (m), 1318 (s), 1275 (s), 1205 (s), 1168 (m), 1078 (m), 1047 (s), 1017 (m), 924 (m), 867 (s), 843 (s), 784 (m), 688 (m).

LRMS: (CI):

277.1 ($M+H^+$), 261.1 (100), 247.1 (4), 219.1 (80), 203.0 (84), 187.1 (6), 147.0 (8), 131.1 (28), 87.1 (4), 73.1 (6), 59.0 (4).

HRMS: (CI, $[M+H]^+$):

calcd.: 277.1287

found: 277.1260

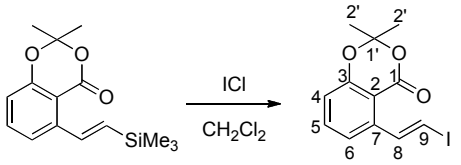
Analysis: $C_{15}H_{20}O_3Si$ (276.40)

calcd.: C, 65.18; H, 7.29;

found: C, 64.82; H, 7.43;

TLC: R_f 0.48 (silica gel, hexane/EtOAc, 15:1, UV)

Preparation of 2,2-Dimethyl-5-(2(*E*)-iodovinyl)benzo[1,3]dioxin-4-one (12).



In a 100-mL, three-necked flask under argon was charged vinylsilane **14** (870 mg, 3.15 mmol equiv) and MeCN (30 mL). The clear colorless solution was cooled to 0 °C and iodine monochloride (767 mg, 4.72 mmol equiv) was added in one portion to afford a dark red solution, the mixture was stirred for 2 h and ^{1}H NMR analysis of an aliquot used to confirm reaction completion. The reaction was quenched by a dropwise addition of sat. aq. $Na_2S_2O_3$ solution (20 mL). The biphasic mixture was stirred until it became colorless. The aqueous layer was separated and extracted with MTBE (3 × 20 mL). The combined organic layer was washed with sat. aq. $Na_2S_2O_3$ solution (20 mL), brine (2 × 20 mL), that was dried over $MgSO_4$, and concentrated to afford a cream-colored solid. The crude product was chromatographed (silica gel (62 g), hexane/CH_2Cl_2/EtOAc (19:1:1 to 15:1:1) to afford 862 mg (83%) of **12** as a white-cream solid. This reaction has been carried out several times on a 10 mmol scale.

Analytical Data for **12**:

mp: 115-117 °C

^{1}H NMR: (500 MHz, $CDCl_3$)

8.46 (d, *J* = 15.0 Hz, 1 H, HC(8)), 7.47 (t, *J* = 8.0 Hz, 1 H, HC(5)), 7.13 (d, *J* = 6.93 Hz, 1 H, HC(6)), 6.93 (d, *J* = 8.0 Hz, 1 H, HC(4)), 6.89 (d, *J* = 15.0 Hz, 1 H, HC(9)), 1.71 (s, 6 H, HC(2')).

^{13}C NMR: (126 MHz, $CDCl_3$)

160.0 (C(1)), 156.7 (C(3)), 143.1 (C(8)), 141.3 (C(7)), 135.4 (C(5)), 121.5 (C(6)),

117.2 (C(4)), 110.0 (C(2)), 105.5 (C(1')), 80.9 (C(9)), 25.6 (C(2')).

IR: (thin film, NaCl plates)

3056 (w), 2994 (w), 2943 (w), 1731 (s), 1606 (m), 1578 (m), 1476 (s), 1438 (w), 1390 (m), 1380 (m), 1320 (s), 1266 (s), 1210 (m), 1170 (w), 1079 (m), 1019 (w), 966 (w), 924 (m), 852 (w), 820 (m), 738 (s), 704 (m), 585 (w)..

LRMS: (CI):

331.0 ($M+H^+$), 301.0 (4), 273.0 (100), 263.1 (2), 203.1 (36), 189.1 (15), 163.0 (15), 147.1 (16), 121.1 (2), 107.1 (4), 87.1 (10), 69.1 (4), 57.0 (68).

HRMS: (CI, $[M+H]^+$):

calcd.: 330.98315

found: 330.98349

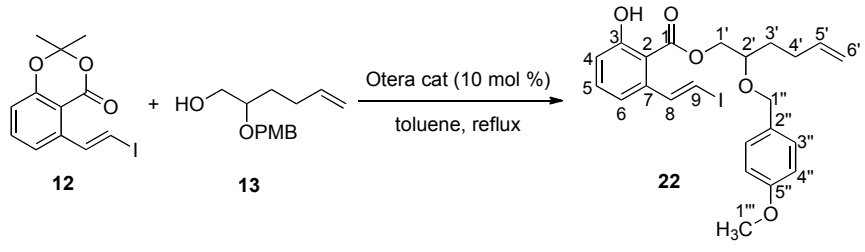
Analysis: $C_{12}H_{11}IO_3$ (330.12)

calcd.: C, 43.66; H, 3.36; I, 38.44

found: C, 43.87; H, 2.97; I, 37.93

TLC: R_f 0.44 (silica gel, hexane/CH_2Cl_2/EtOAc, 15:1:1, UV)

Preparation of 2-[(4-Methoxybenzyl)oxy]hex-5-en-1-yl 2-Hydroxy-6-(2(*E*)-iodovinylbenzoate (22).



In a 100-mL, three-necked flask equipped with a reflux condenser and containing toluene (64 mL) was added **12** (2.10 g, 6.36 mmol equiv), **13** (1.88 g, 7.95 mmol equiv), and 1-hydroxy-

3-(isothiocyanato)tetrabutyldistannoxane (Otera catalyst)[5] (0.36 g, 0.64 mmol equiv) sequentially with stirring. The resulting pale yellow solution was heated to reflux for 36 h. The reaction mixture was allowed to cool to ambient temperature and the solvent was removed in vacuo to afford a brown colored oil. The crude product was then purified by chromatography (silica gel (195 g), hexane/CH_2Cl_2/EtOAc (15:1:1)) to afford 2.87 g (89%) of analytically pure **22** as a pale-green oil.

Analytical Data for **22**:

^{1}H NMR: (500 MHz, $CDCl_3$)

11.2 (s, 1 H, OH), 7.98 (d, *J* = 15.0 Hz, 1 H, HC(8)), 7.39 (t, *J* = 7.8 Hz, 1 H, HC(5)), 7.27 (d, *J* = 8.5 Hz, 2 H, HC(3'')), 6.98 (d, *J* = 8.5 Hz, 1 H, HC(4)), 6.85 (d, *J* = 8.5 Hz, 2 H, HC(4'')), 6.83 (d, *J* = 7.0 Hz, 1 H, HC(6)), 6.53 (d, *J* = 14.5 Hz, 1 H, HC(9)), 5.88-5.80 (m, 1 H, HC(5')), 5.06 (dd, *J* = 17.0, 1.5 Hz, 1 H, HC(6')), 5.00 (d, *J* = 10.0 Hz, 1 H, HC(6')), 4.63 (d, *J* = 11.0 Hz, 1 H, HC(1'')), 4.55 (d, *J* = 11.5 Hz, 1 H, HC(1'')), 4.48 (dd, *J* = 11.5, 4.0 Hz, 1 H, HC(1')), 4.40 (dd, *J* = 11.5, 4.4 Hz, 1 H, HC(1')), 3.79 (s, 3 H, HC(1''')), 2.31-2.18 (m, 2 H, HC(4')), 1.88-1.81 (m, 1 H, HC(3')), 1.79-1.72 (m, 1 H, HC(3')).

^{13}C NMR: (126 MHz, $CDCl_3$)

170.5 (C(1)), 162.4 (C(3)), 159.2 (C(5'')), 146.0 (C(8)), 141.1 (C(7)), 137.9 (C(5')), 134.6 (C(5)), 130.2 (C(2'')), 129.4 (C(3'')), 120.1 (C(6)), 118.0 (C(4)), 115.3 (C(6')), 113.8 (C(4'')), 109.8 (C(2)), 78.2 (C(9)), 75.4 (C(2')), 71.4 (C(1'')), 66.8 (C(1')), 55.2 (C(1''')), 31.2 (C(3')), 29.6 (C(4')).

IR: (thin film, NaCl plates)

3068 (w), 3005 (w), 2934 (w), 2858 (w), 1664 (s), 1609 (m), 1586 (m), 1514 (s),

1450 (s), 1390 (m), 1303 (m), 1252 (s), 1215 (s), 1170 (m), 1122 (m), 1036 (m), 997 (m), 945 (m), 915 (m), 826 (m), 756 (s), 698 (m).

LRMS: (CI):

508.1 ($M+H^+$), 381.2 (4), 331.0 (2), 272.9 (16), 203.1 (6), 163.0 (4), 137.1 (8), 121.1 (64), 82.9 (100), 59.0 (6).

HRMS: (CI, $[M-H]^+$):

calcd.: 507.06687

found: 507.06715

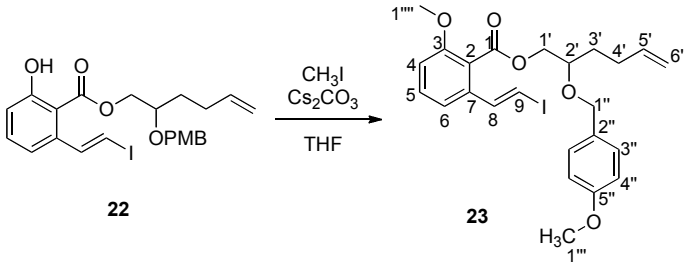
Analysis: $C_{23}H_{25}IO_5$ (508.35)

calcd.: C, 54.34; H, 4.96;

found: C, 54.10; H, 4.78;

TLC: R_f 0.38 (silica gel, hexane/CH_2Cl_2/EtOAc, 15:1:1, UV)

Preparation of 2-[(4-Methoxybenzyl)oxy]hex-5-en-1-yl 2-(2(*E*)-Iodovinyl)-6-methoxybenzoate (23).



In a three-necked, 250-mL flask under argon was charged **22** (2.00 g, 3.93 mmol equiv) and THF (78 mL) and reaction mixture was stirred to give a pale green colored solution. To this mixture was added Cs_2CO_3 (2.56 g, 7.86 mmol equiv) to give a pale green colored suspension. After being stirred for 3 minutes at room temperature, the mixture was treated with iodomethane

(0.74 mL, 11.8 mmol equiv) and the mixture was stirred for 6 h. The mixture was then filtered through a Celite plug and the Celite rinsed with EtOAc (50 mL). The solvent was removed in vacuo and to give a crude product that was purified by chromatography (silica gel (72 g), hexane/CH_2Cl_2/EtOAc (15:1:1 to 10:1:1)) to afford 1.97 g (96%) of analytically pure **23** as a light-green oil.

Analytical Data for **23**:

^{1}H NMR: (500 MHz, $CDCl_3$)

7.46 (d, *J* = 14.5 Hz, 1 H, HC(8)), 7.33 (t, *J* = 8.3 Hz, 1 H, HC(5)), 7.28 (d, *J* = 8.5 Hz, 2 H, HC(3'')), 7.01 (d, *J* = 8.0 Hz, 1 H, HC(6)), 6.88 (d, *J* = 14.5 Hz, 1 H, HC(9)), 6.87 (d, *J* = 8.0 Hz, 1 H, HC(4)), 6.86 (d, *J* = 8.5 Hz, 2 H, HC(4'')), 5.81 (ddt, *J* = 17.0, 10.0, 7.0 Hz, 1 H, HC(5')), 5.03 (dd, *J* = 17.0, 1.5 Hz, 1 H, HC(6')), 4.97 (d, *J* = 10.5 Hz, 1 H, HC(6')), 4.67 (d, *J* = 11.0 Hz, 1 H, HC(1'')), 4.50 (d, *J* = 11.5 Hz, 1 H, HC(1'')), 4.49 (dd, *J* = 11.0, 4.5 Hz, 1 H, HC(1')), 4.37 (dd, *J* = 11.5, 5.0 Hz, 1 H, HC(1')), 3.81 (s, 3 H, HC(1'''')), 3.80 (s, 3 H, HC(1''')), 3.71 (ddt, *J* = 8.3, 5.0, 4.5 Hz, 1 H, HC(2')), 2.29-2.22 (m, 1 H, HC(4')), 2.19-2.11 (m, 1 H, HC(4')), 1.78-1.66 (m, 2 H, HC(3')).

^{13}C NMR: (126 MHz, $CDCl_3$)

167.3 (C(1)), 159.1 (C(5'')), 156.5 (C(3)), 141.6 (C(8)), 138.1 (C(5')), 136.3 (C(7)), 130.6 (C(5)), 130.5 (C(2'')), 129.5 (C(3'')), 121.7 (C(2)), 117.7 (C(6)), 115.0 (C(6')), 113.7 (C(4'')), 110.6 (C(4)), 80.3 (C(9)), 75.6 (C(2')), 66.7 (C(1')), 55.9 (C(1''')), 55.9 (C(1'''')), 55.2 (C(1''')), 31.1 (C(3')), 29.6 (C(4')).

IR: (thin film, NaCl plates)

3065 (w), 3002 (w), 2938 (m), 2838 (w), 1730 (s), 1640 (w), 1612 (m), 1602 (m),

1590 (m), 1514 (s), 1471 (s), 1437 (m), 1346 (w), 1271 (s), 1249 (s), 1112 (m), 1068 (s), 1035 (m), 1035 (m), 943 (m), 914 (m), 820 (m), 760 (m), 622 (w).

LRMS: (CI):

523.1 $(M+H)^+$, 522.1 $(M)^+$, 395.2 (12), 305.0 (2), 287.0 (20), 259.1 (4), 220.2 (8), 203.0 (8), 177.1 (20), 121.1 (90), 82.9 (100), 59.0 (100).

HRMS: (CI, $[M+H]^+$):

calcd.: 523.09817

found: 523.09751

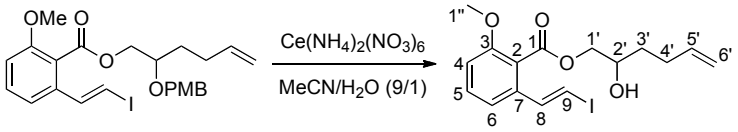
Analysis: $C_{24}H_{27}IO_5$ (522.37)

calcd.: C, 55.18; H, 5.21;

found: C, 55.47; H, 5.27;

TLC: R_f 0.23 (silica gel, hexane/CH_2Cl_2/EtOAc, 10:1:1, UV)

Preparation of 2-Hydroxyhex-5-en-1-yl 2[2(*E*)-Iodovinyl]-6-methoxybenzoate (24).



23 **24**

In a 100-mL, three necked, round bottomed flask under argon was dissolved **23** (1.20 g, 2.30 mmol equiv) in MeCN/H_2O (46 mL, 9:1). To the colorless mixture was added ceric ammonium nitrate (3.78 g, 6.89 mmol equiv). The orange solution was stirred for 4 h and sat. aq. $NaHCO_3$ solution (35 mL) and EtOAc (20 mL) were added sequentially. The aqueous layer was separated and extracted with EtOAc (3 × 25 mL). The combined organic layers were washed with sat. aq. $NaHCO_3$ solution (25 mL), water (20 mL), sat. aq. $NaHCO_3$ solution (25 mL), and then was dried over $MgSO_4$. The solvent removed by rotatory evaporation to afford a green oil

that was purified by chromatography (silica gel (55 g), hexane/CH_2Cl_2/EtOAc (10:2:2 to 10:3:3)) to afford 796 mg (86%) of analytically pure **24** as a pale-green oil.

Analytical Data for **24**:

^{1}H NMR: (500 MHz, $CDCl_3$)

7.48 (d, *J* = 15.0 Hz, 1 H, HC(8)), 7.34 (t, *J* = 8.0 Hz, 1 H, HC(5)), 7.02 (d, *J* = 8.0 Hz, 1 H, HC(6)), 6.89 (d, *J* = 14.5 Hz, 1 H, HC(9)), 6.88 (d, *J* = 9.5 Hz, 1 H, HC(4)), 5.85 (ddt, *J* = 17.0, 10.0, 7.0 Hz, 1 H, HC(5')), 5.08 (dd, *J* = 16.8, 2.0 Hz, 1 H, HC(6')), 5.01 (d, *J* = 10.0 Hz, 1 H, HC(6')), 4.42 (dd, *J* = 11.3, 3.5 Hz, 1 H, HC(1')), 4.26 (dd, *J* = 11.0, 7.5 Hz, 1 H, HC(1')), 3.99-3.97 (m, 1 H, HC(2')), 3.84 (s, 3 H, HC(1'')), 2.48 (s, 1 H, OH), 2.32-2.16 (m, 2 H, HC(4')), 1.71-1.59 (m, 2 H, HC(3')).

^{13}C NMR: (126 MHz, $CDCl_3$)

167.1 (C(1)), 156.4 (C(3)), 141.5 (C(8)), 137.9 (C(5')), 136.6 (C(7)), 130.9 (C(5)), 121.2 (C(2)), 118.0 (C(6)), 115.2 (C(6')), 110.7 (C(4)), 80.6 (C(9)), 69.3 (C(2')), 69.0 (C(1')), 56.1 (C(1'')), 32.0 (C(3')), 29.6 (C(4')).

IR: (thin film, NaCl plates)

3520 (m), 3073 (w), 2941 (m), 2842 (m), 1726 (s), 1641 (w), 1602 (m), 1592 (m), 1573 (s), 1472 (s), 1454 (m), 1437 (s), 1416 (w), 1272 (s), 1190 (w), 1117 (s), 1068 (s), 995 (w), 943 (m), 911 (s), 811 (w), 761 (m), 733 (s), 648 (m), 623 (m).

LRMS: (CI):

402.9 $(M+H)^+$, 384.9 (12), 304.9 (4), 286.8 (100), 275.0 (16), 260.9 (2), 194.9 (20), 177.0 (64), 159.9 (4), 131.9 (4), 101.9 (4), 81.0 (10), 54.8 (4).

HRMS: (CI, $[M+H]^+$):

calcd.: 403.04066

found: 403.04153

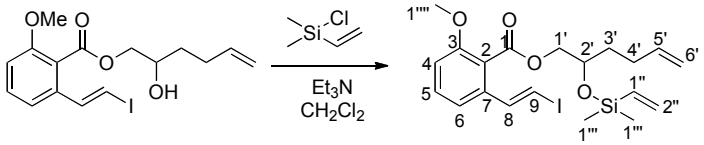
Analysis: $C_{16}H_{19}IO_4$ (402.22)

calcd.: C, 47.78; H, 4.76;

found: C, 47.64; H, 4.73;

TLC: R_f 0.35 (silica gel, hexane/CH_2Cl_2/EtOAc, 10/3/3, UV)

Preparation of 2-[(Dimethylvinylsilyl)oxy]hex-5-en-1-yl 2-[2(*E*)-Iodovinyl]-6-methoxybenzoate (11).



Following General Procedure II, a solution of **24** (700 mg, 1.74 mmol equiv) and Et_3N (728 μL, 5.22 mmol equiv) in CH_2Cl_2 (17 mL) at 0 °C was added dropwise chlorodimethylvinylsilane (288 μL, 2.09 mmol equiv) to afford a white suspension. The cooling bath was removed and the mixture stirred at ambient temperature for 4 h. The mixture was poured onto an ice/water mixture (20 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were then washed with brine (2 × 15 mL) and were dried over $MgSO_4$. The solvent was removed in vacuo and crude product was purified by chromatography (silica gel (26 g), hexane/EtOAc (10:1)/Et_3N (3 %)) to afford 787 mg (93%) of analytically pure **11** as a green oil.

Analytical Data for **11**:

^{1}H NMR: (500 MHz, $CDCl_3$)

7.43 (d, *J* = 15.0 Hz, 1 H, HC(8)), 7.32 (t, *J* = 8.3 Hz, 1 H, HC(5)), 7.00 (d, *J* = 7.5 Hz, 1 H, HC(6)), 6.87 (d, *J* = 14.5 Hz, 1 H, HC(9)), 6.86 (d, *J* = 8.5 Hz, 1 H, HC(4)), 6.14 (dd, *J* = 20.5, 15.0 Hz, 1 H, HC(2'')), 6.00 (dd, *J* = 14.8, 4.0 Hz, 1 H, HC(2'')), 5.87-5.79 (m, 1 H, HC(5')), 5.76 (dd, *J* = 20.0, 4.0 Hz, 1 H, HC(2'')), 5.05 (dd, *J* = 17.3, 2.0 Hz, 1 H, HC(6')), 4.98 (d, *J* = 10.0 Hz, 1 H, HC(6')), 4.31 (dd, *J* = 11.0, 5.0 Hz, 1 H, HC(1')), 4.20 (dd, *J* = 11.0, 5.5 Hz, 1 H, HC(1')), 3.96 (h, *J* = 5.5 Hz, 1 H, HC(2')), 3.81 (s, 3 H, HC(1'''')), 2.27-2.19 (m, 1 H, HC(4')), 2.14-2.06 (m, 1 H, HC(4')), 1.71-1.59 (m, 2 H, HC(3')).

^{13}C NMR: (126 MHz, $CDCl_3$)

167.3 (C(1)), 156.4 (C(3)), 141.6 (C(8)), 138.2 (C(5')), 137.6 (C(2'')), 136.3 (C(7)), 133.3 (C(1'')), 130.6 (C(5)), 121.8 (C(2)), 117.7 (C(6)), 114.8 (C(6')), 110.6 (C(4)), 80.2 (C(9)), 69.8 (C(2')), 68.7 (C(1')), 55.9 (C(1'''')), 33.3 (C(3')), 29.6 (C(4')), -1.55 (C(1''')), -1.60 (C(1''')).

IR: (thin film, NaCl plates)

3064 (m), 3008 (m), 2945 (s), 1731 (s), 1641 (w), 1602 (m), 1592 (m), 1573 (s), 1472 (s), 1454 (m), 1437 (s), 1408 (m), 1382 (m), 1272 (s), 1190 (m), 1175 (m), 1113 (s), 1069 (s), 990 (s), 959 (m), 914 (m), 838 (s), 787 (s), 759 (s), 701 (m), 623 (w), 526 (w).

LRMS: (CI):

487.1 $(M+H)^+$, 471.0 (4), 431.0 (12), 385.0 (8), 359.2 (16), 287.0 (100), 261.1 (24), 183.1 (32), 141.1 (4), 115.1 (12).

HRMS: (CI, $[M+H]^+$):

calcd.: 487.08019

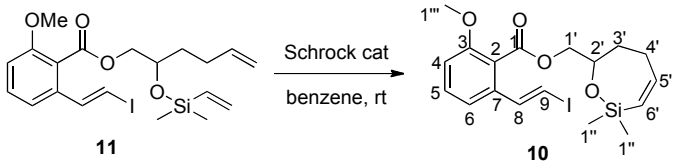
found: 487.08003

Analysis: $C_{20}H_{27}IO_4Si$ (486.42)

calcd.: C, 49.38; H, 5.59;

found: C, 49.13; H, 5.57;

Preparation of 2,2-Dimethyl-2-[(1-oxa-2-silacyclohept-3-enyl)methyl] 2-[2(*E*)-Iodovinyl]-6-methoxybenzoate (10).



Following General Procedure III, **11** (625 mg, 1.28 mmol equiv) was dissolved in benzene (15 mL) and the solution was freeze-pump-thaw degassed with argon (3 ×) then, the flask was transferred to the dry box. To this mixture was added Schrock's catalyst (78 mg, 0.10 mmol equiv) in one portion to afford an orange solution that later turned light brown. The solution was stirred for 15 h at ambient temperature. The flask was removed from the dry box and the solution was filtered over Celite (5 g). The Celite plug was rinsed with EtOAc (30 mL). The solvents were removed in vacuo and the crude product was purified by chromatography (silica gel (30 g), hexane/EtOAc (6:1 to 5:1)) to afford 487 mg (83%) of **10** as a light brown liquid. An analytical sample repurified again with pentane/Et_2O, 3:1.

Data for **10**:

^{1}H NMR: (500 MHz, $CDCl_3$)

7.44 (d, J = 15.0 Hz, 1 H, HC(8)), 7.31 (t, J = 8.5 Hz, 1 H, HC(5)), 6.99 (d, J =

7.5 Hz, 1 H, HC(6)), 6.86 (d, *J* = 8.5 Hz, 1 H, HC(4)), 6.86 (d, *J* = 14.5 Hz, 1 H, HC(9)), 6.64 (dt, *J* = 14.8, 5.0 Hz, 1 H, HC(5')), 5.62 (d, *J* = 15.0 Hz, 1 H, HC(6')), 4.40 (dd, *J* = 10.5, 6.0 Hz, 1 H, HC(1')), 4.24 (dd, *J* = 11.3, 6.0 Hz, 1 H, HC(1')), 4.21-4.18 (m, 1 H, HC(2')), 3.82 (s, 3 H, HC(1''')), 2.57-2.52 (m, 1 H, HC(3')), 2.36-2.31 (m, 1 H, HC(3')), 2.00-1.94 (m, 1 H, HC(3')), 1.89-1.82 (m, 1 H, HC(3')), 0.25 (s, 3 H, HC(1'')), 0.17 (s, 3 H, HC(1'')).

^{13}C NMR: (126 MHz, $CDCl_3$)

167.2 (C(1)), 156.5 (C(3)), 147.9 (C(5')), 141.7 (C(8)), 136.4 (C(7)), 130.6 (C(5)), 129.4 (C(6')), 121.8 (C(2)), 117.8 (C(6)), 110.7 (C(4)), 80.3 (C(9)), 71.5 (C(2')), 68.9 (C(1')), 56.0 (C(1''')), 31.8 (C(4')), 29.5 (C(3')), 1.13 (C(1'')), -0.20 (C(1'')).

IR: (thin film, NaCl plates)

3064 (w), 2958 (m), 2922 (m), 1731 (s), 1602 (s), 1591 (m), 1572 (s), 1472 (s), 1437 (m), 1378 (w), 1272 (s), 1190 (m), 1110 (s), 1068 (s), 981 (m), 946 (m), 838 (s), 789 (s), 760 (s), 674 (m), 640 (m), 624 (m).

LRMS: (CI):

459.1 $(M+H)^+$, 443.1 (8), 361.0 (12), 331.2 (16), 287.0 (100), 197.0 (4), 177.1 (12), 155.1 (36), 125.1 (4), 75.0 (40).

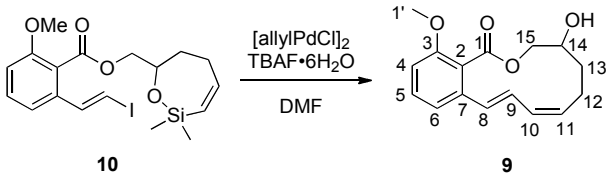
HRMS: (CI, $[M+H]^+$):

calcd.: 459.0489

found: 459.0491

TLC: R_f 0.46 (silica gel, hexane/ EtOAc, 5:1, UV)

Preparation of 14-Hydroxy-3-methoxy (8*E*,10*Z*)-1H-benzo[c][1]oxacyclododeca-8,10-dien-1-one (9).



10 **9**

Following General Procedure IV, a 1 M solution of TBAF•$3H_2O$ in DMF (5 mL, 5 mmol equiv), H_2O (270 μL, 15 mmol equiv), and $[allylPdCl]_2$ (37 mg, 0.1 mmol equiv) were combined. To this yellow solution was added slowly over 48 h a solution of **10** in DMF (0.1 M, 458 mg, 1.00 mmol equiv) using a syringe pump. After complete addition the dark solution was stirred for an additional 3 h and the mixture poured onto a biphasic mixture of 10 % aq. LiCl solution (30 mL) and benzene (50 mL). The aqueous layer was separated and was extracted with benzene (2 × 20 mL) and EtOAc (1 × 20 mL), and the combined organic layers washed with 10 % aq. LiCl solution (2 × 20 mL), brine (2 × 20 mL), and then were dried over $MgSO_4$. The solvent was removed by rotatory evaporation and the crude product was purified by chromatography (silica gel (23 g) hexane/EtOAc (2:1 to 1:1)) to afford 203 mg (74%) of **9** as a brown oil.

Data for **9**:

^{1}H NMR: (500 MHz, $CDCl_3$)

7.30 (t, *J* = 8.0 Hz, 1 H, HC(5)), 6.89 (d, *J* = 7.5 Hz, 1 H, HC(6)), 6.83 (d, *J* = 8.0 Hz, 1 H, HC(4)), 6.73 (dd, *J* = 15.5, 9.0 Hz, 1 H, HC(9)), 6.53 (d, *J* = 15.5 Hz, 1 H, HC(8)), 6.13 (t, *J* = 10.0 Hz, 1 H, HC(10)), 5.72 (dt, *J* = 10.5, 7.5 Hz, 1 H, HC(11)), 4.67 (dd, *J* = 12.0, 2.5 Hz, 1 H, HC(15)), 4.29 (dd, *J* = 11.5, 6.0 Hz, 1 H, HC(15)), 3.98-3.97 (m, 1 H, HC(14)), 3.84 (s, 3 H, HC(1')), 2.34 (q, *J* = 7.4 Hz, 2

H, HC(12)), 2.17 (s, 1 H, OH), 2.08-2.01 (m, 1 H, HC(13)), 1.72 (ddt, *J* = 13.5, 9.0, 5.0 Hz, 1 H, HC(13)).

^{13}C NMR: (126 MHz, $CDCl_3$)

168.6 (C(1)), 156.7 (C(3)), 137.2 (C(7)), 132.0 (C(11)), 130.5 (C(5)), 130.1 (C(9)), 128.9 (C(8)), 128.5 (C(10)), 121.7 (C(2)), 120.8 (C(6)), 109.8 (C(4)), 69.0 (C(15)), 68.2 (C(14)), 56.0 (C(1')), 33.6 (C(13)), 23.9 (C(12)).

IR: (thin film)

3449 (w), 3019 (m), 2957 (w), 2942 (w), 2841 (w), 1721 (m), 1592 (m), 1572 (m), 1468 (m), 1438 (w), 1267 (s), 1216 (s), 1110 (m), 1090 (m), 1057 (m), 993 (w), 955 (w), 910 (s), 755 (s), 668 (m), 650 (w), 522 (w).

LRMS: (CI):

274.1 [$(M)^+$], 225.2 (4), 174.1 (92), 150.0 (80), 135.0 (40), 84.0 (94), 57.0 (62).

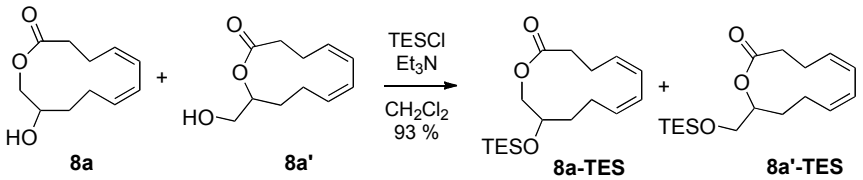
HRMS: (CI, $[M]^+$):

calcd.: 274.1205

found: 274.1202

TLC: R_f 0.30 (silica gel, hexane/ EtOAc, 1:1, UV)

Silylation of 8a/8a' with Triethylchlorosilane (8a-TES/8a'-TES).



Key Data for **8a-TES**

^{1}H NMR: (500 MHz, $CDCl_3$)

6.05 (dd, *J* = 11.0, 6.5 Hz, 1 H), 5.96 (dd, *J* = 11.0, 6.0 Hz, 1 H), 4.05 (dd, *J* =

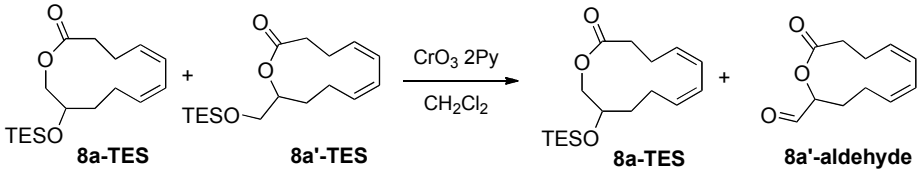
11.0, 3.5 Hz, 1 H), 3.94-3.90 (m, 1 H), 3.84 (dd, *J* = 11.0, 6.5 Hz).

Key Data for **8a'-TES**

^{1}H NMR: (500 MHz, $CDCl_3$)

5.85 (d, *J* = 10.5 Hz, 1 H), 4.92-4.88 (m, 1 H), 3.60 (dd, *J* = 10.5, 5.0 Hz, 1 H), 3.53 (dd, *J* = 11.0, 5.0 Hz, 1 H).

Oxidation of 8a'-TES with Chromium Trioxide to 8a'-Aldehyde.



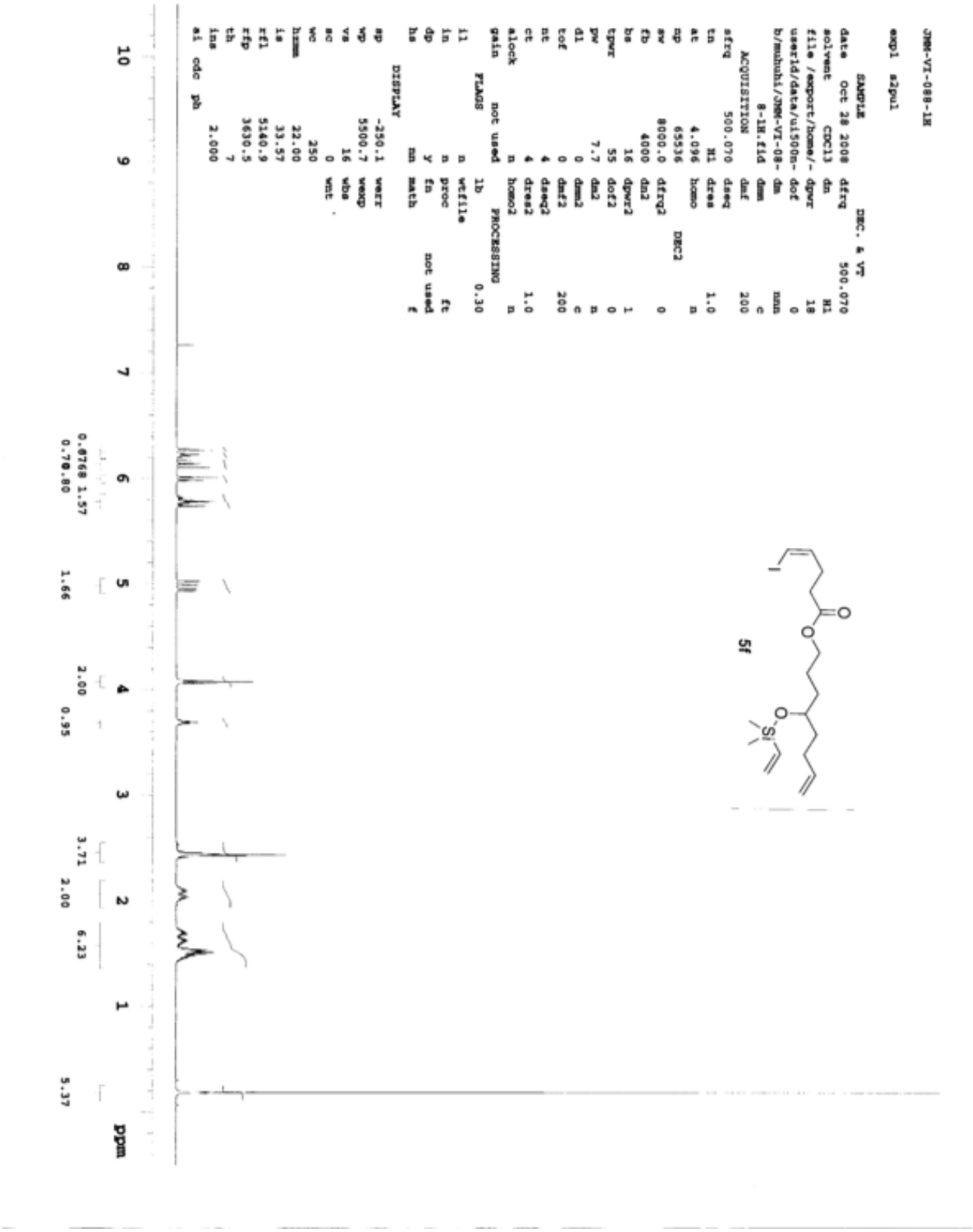
Key Data for **8a'-aldehyde**:

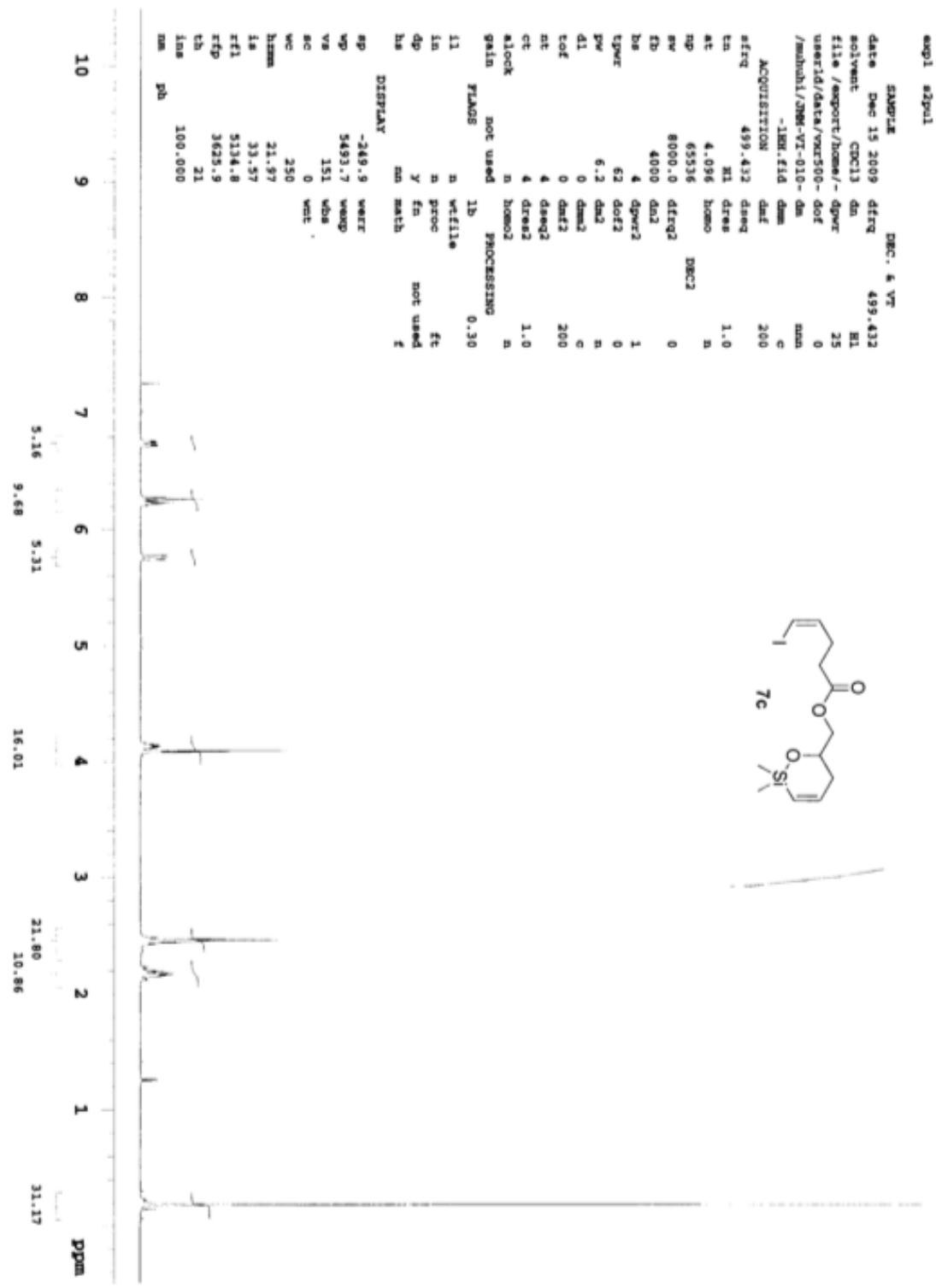
^{1}H NMR: (500 MHz, $CDCl_3$)

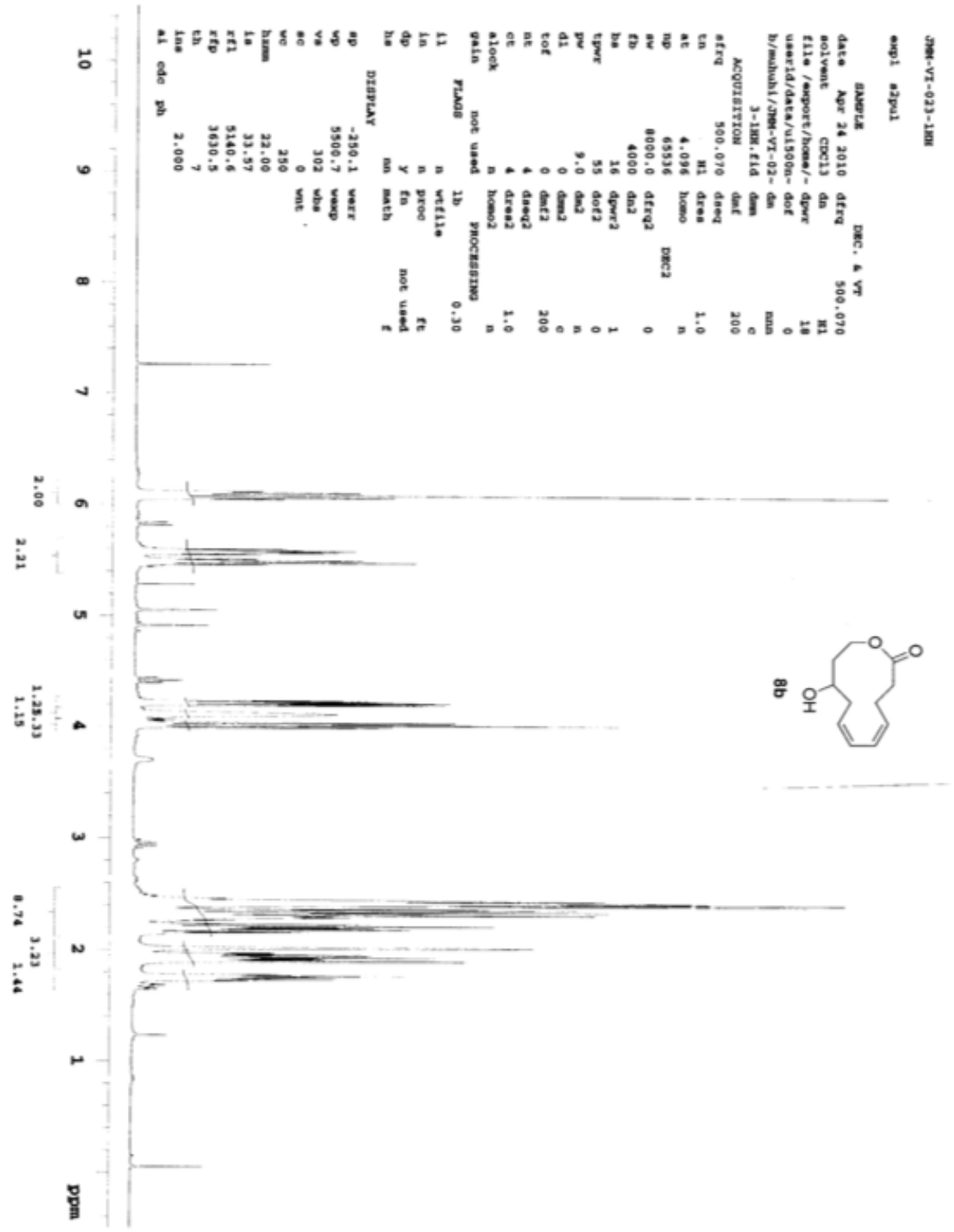
6.11-6.06 (m, 2 H), 5.64-5.59 (m, 2 H), 4.49 (s, 1 H).

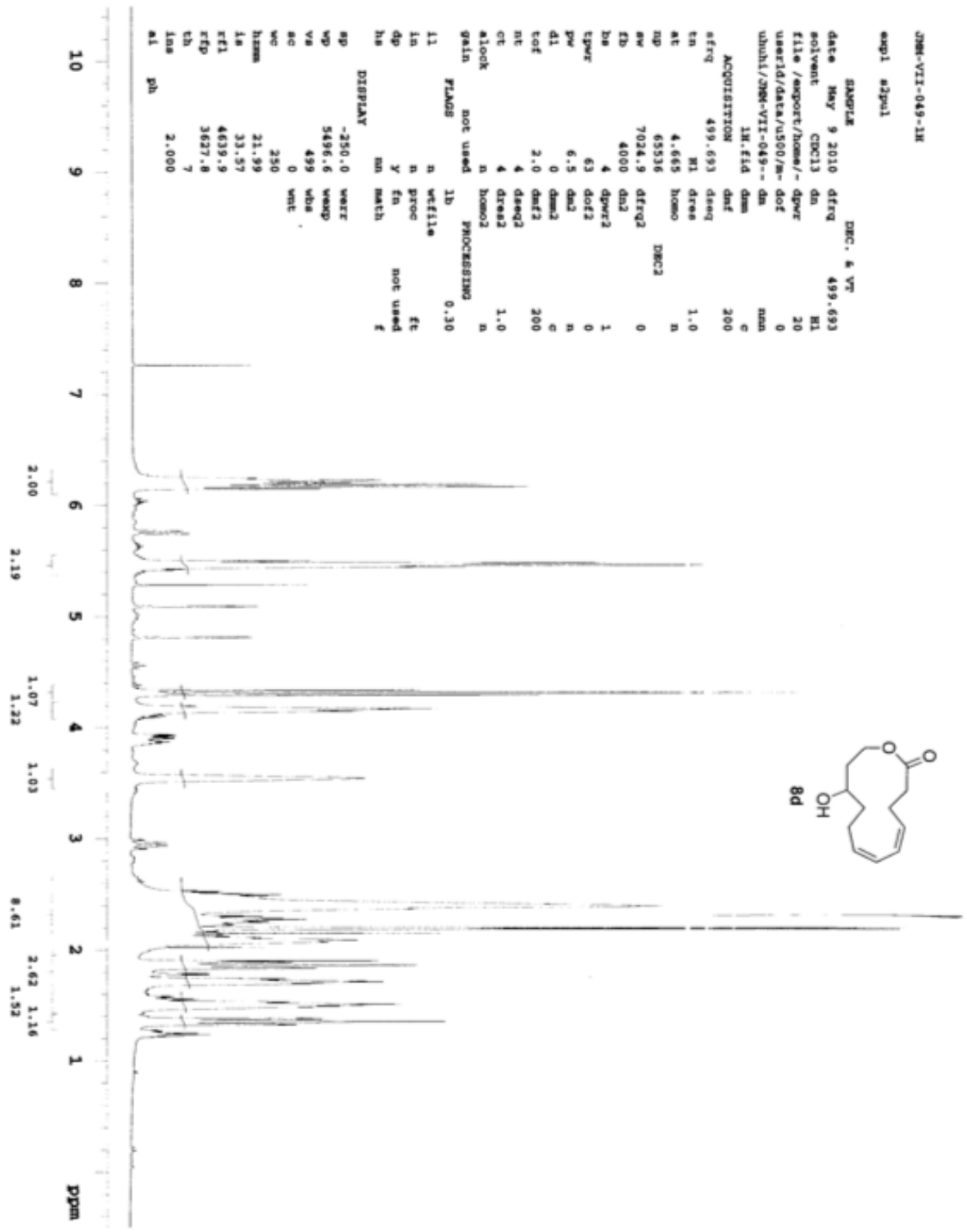
^{13}C NMR: (126 MHz, $CDCl_3$)

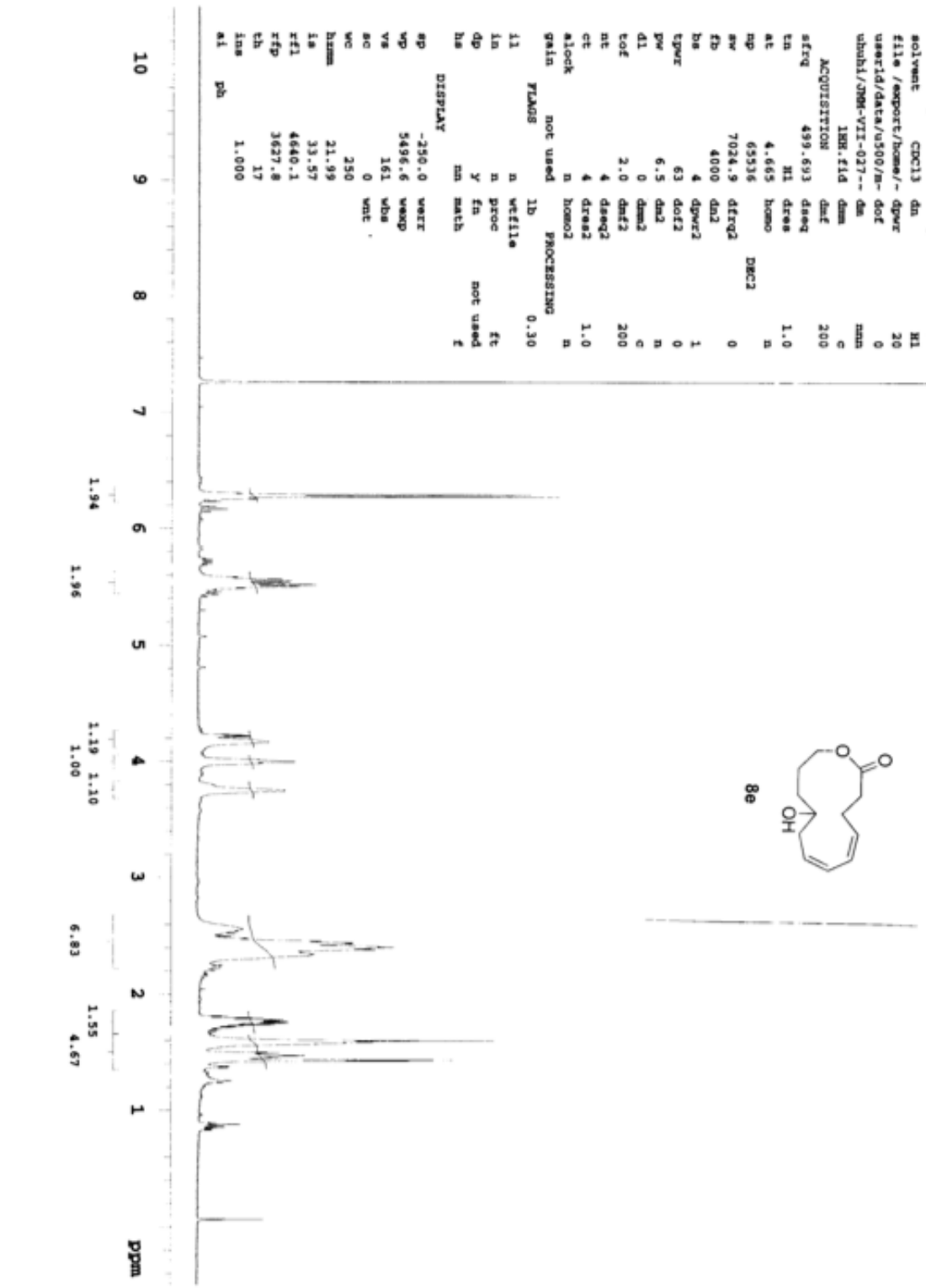
216.1, 130.3, 129.5, 127.4, 127.1, 68.3, 37.5, 34.1, 24.7, 23.5.

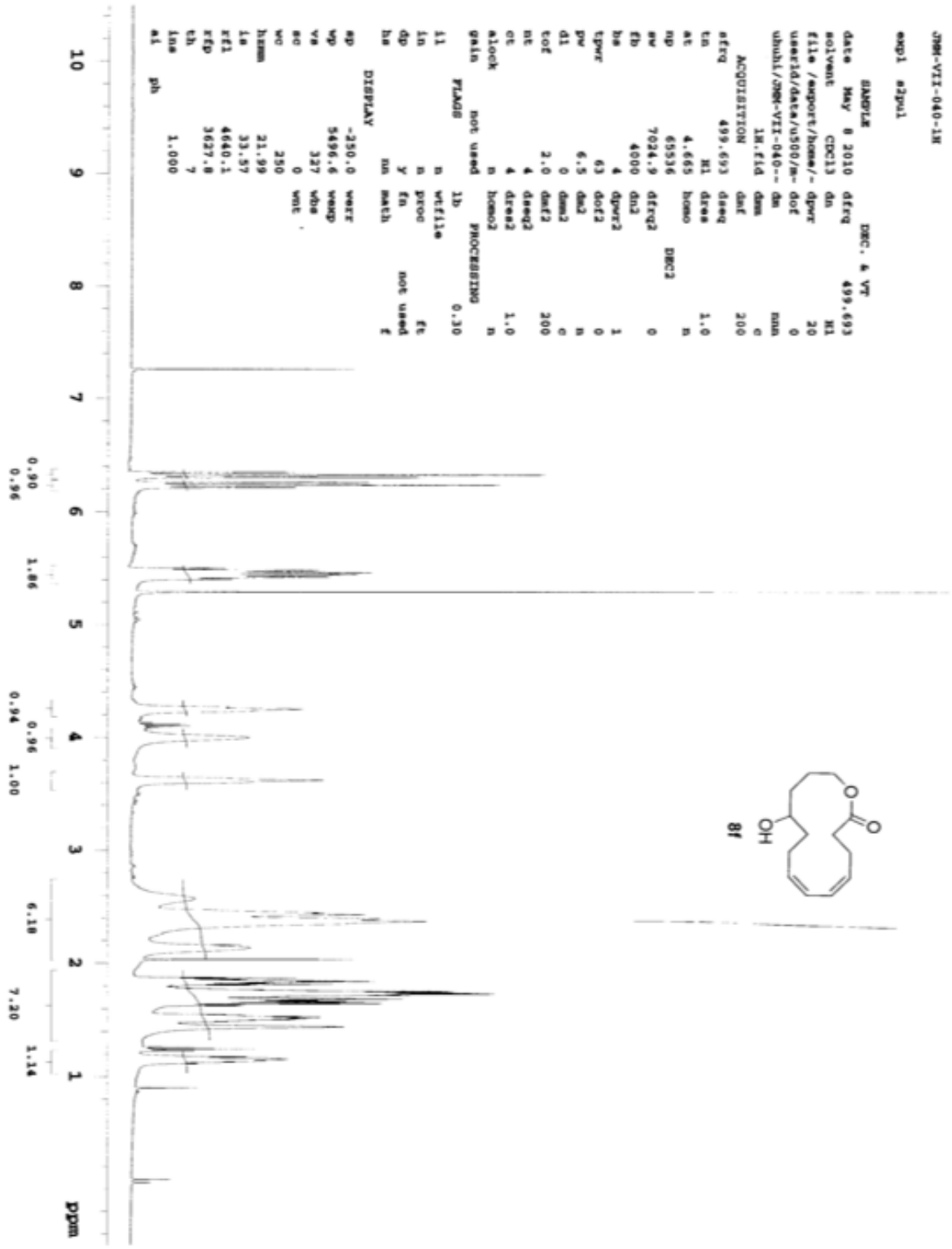

JNM-VI-088-1H
expl s2pul
SAMPLE
date Oct 28 2008
solvent CDCl3
file /export/home/- dgwr
userid/data/ui500m- dof
h/muhuhi/JNM-VI-08- dm
8-1H.fid dmm
ACQUISITION dmf
sfrq 500.070 dseq
tn H1 dres
at 4.096 homo
sp 65536
sw 8000.0 dfrq2
fb 4000 dn2
bs 16 dgwr2
tpwr 55 dof2
pw 7.7 dm2
d1 0 dmm2
tof 0 dmf2
nt 4 dseq2
ct 4 dres2
alock n homo2
gain not used
FLAGS
il n wtfile
in n proc
dp y fn not used
hs nn math
DISPLAY
sp -250.1 wexr
wp 5500.7 wexp
vs 16 wbs
sc 0 wnt
wc 250
hzmm 22.00
is 33.57
rf1 5140.9
rfp 3630.5
th 7
ins 2.000
ai cdc ph
PROCESSING 1b 0.30
ft
not used
f
5f
10
9
8
7
6
5
4
3
2
1
ppm
0.8768 1.57
0.78 0.80
1.66
2.00
0.95
3.71
2.00
6.23
5.37

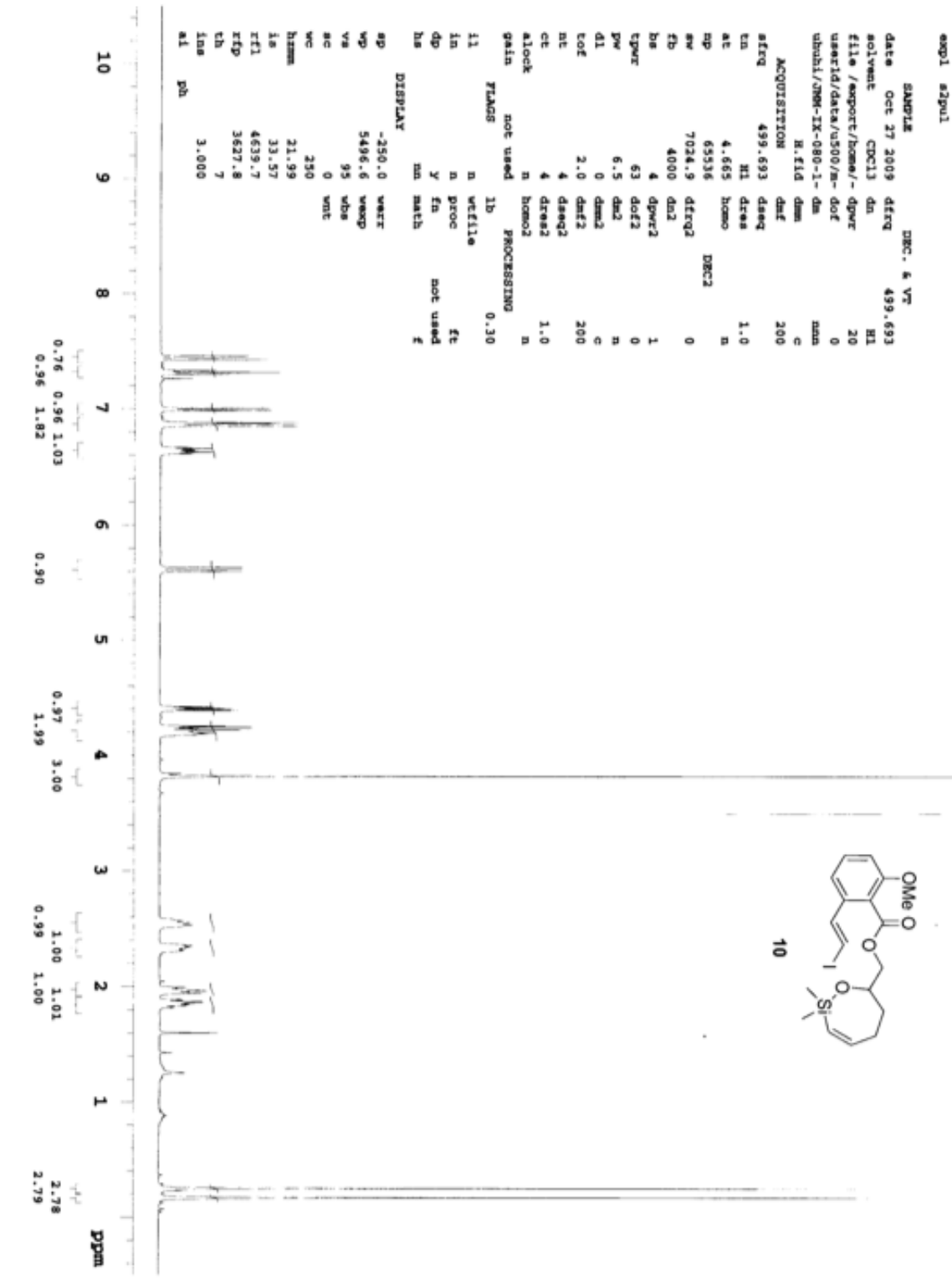

JMM-VI-010-1RH
expl s2pul
SAMPLE
date Dec 15 2009
solvent CDCl3
file /export/home/- dpwr
userid/data/vxr500- dof
/muhuhi/JMM-VI-010- dm
-1RH.fid dmm
ACQUISITION dmf
sfrq 499.432 dseq
tn H1 dres
at 4.096 homo
np 65536
sw 8000.0 dfrq2
fb 4000 dn2
bs 4 dpwr2
tpwr 62 dof2
pw 6.2 dm2
d1 0 dmm2
tof 0 dmf2
nt 4 dseq2
ct 4 dres2
alock n homo2
gain not used
FLAGS
il n wtfile
in n proc
dp y fn not used
hs nn math f
DISPLAY
sp -249.9 werr
wp 5493.7 wexp
vs 151 wbs
sc 0 wet
wc 250
hzmm 21.97
is 33.57
rfl 5134.8
rfp 3625.9
th 21
ins 100.000
nm pb
DEC. & VT
499.432
H1
25
0
nnn
c
200
H1
1.0
n
DEC2
0
1
0
n
c
200
1.0
n
PROCESSING
lb 0.30
wtfile
proc ft
fn
not used
math f
7c
5.16
9.68
5.31
16.01
21.80
10.86
31.17
10
9
8
7
6
5
4
3
2
1
ppm

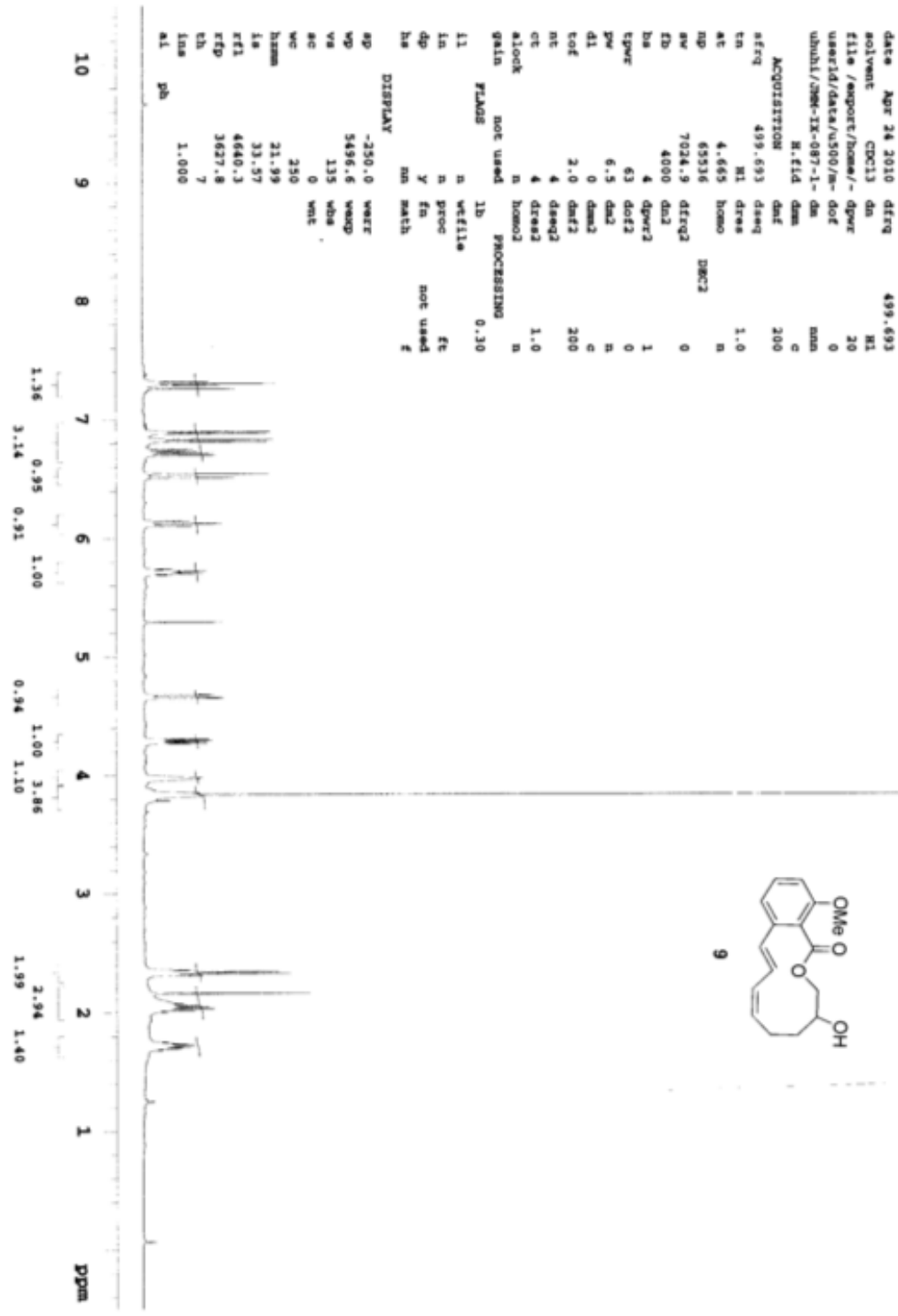

JNM-VT-023-1HH
expl s2pul
SAMPLE
date Apr 24 2010
solvent CDCl3
file /export/home/- dpwr
userid/data/ul500n- dof
h/muhuhi/JNM-VT-02- dn
3-1HH.fid dmm
ACQUISITION dmf
sfrq 500.070 dseq
tn H1 dres
at 4.096 homo
np 65536
sw 8000.0 dfrq2
fb 4000 dn2
bs 16 dpwr2
tpwr 55 dof2
pw 9.0 dn2
dl 0 dmm2
tof 0 dmf2
nt 4 dseq2
ct 4 dres2
alock n homo2
gain not used
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -250.1
wp 5500.7
vs 302
sc 0
wc 250
hzmm 22.00
is 33.57
rfl 5140.6
rfp 3630.5
th 7
ins 2.000
ai cdc ph
DEC. & VT
dfrq 500.070
dn H1
dm nnn
dmm c
dmf 200
dseq 0
dres 1.0
homo n
dfrq2
dn2
dpwr2 1
dof2 0
dn2 n
dmm2 c
dmf2 200
dseq2
dres2 1.0
homo2 n
PROCESSING
lb 0.30
wtfile
proc ft
fn not used
math f
wexp
wbs
wnt
2.00
2.21
1.25.33
1.15
3.23
0.74
1.44
8b
OH
10
9
8
7
6
5
4
3
2
1
ppm


JNM-VII-049-1H
expl s2pul
SAMPLE DEC. & VT
date May 9 2010 dfrq 499.693
solvent CDCl3 dn H1
file /export/home/- dpwr 20
userid/data/u500/m- dof 0
uhuhi/JNM-VII-049-- dm nnn
1H.fid dmm c
ACQUISITION dmf 200
sfrq 499.693 dseq
tn H1 dres 1.0
at 4.665 homo n
np 65536 DBC2
sw 7024.9 dfrq2 0
fb 4000 dn2
bs 4 dpwr2 1
tpwr 63 dof2 0
pw 6.5 dn3 n
d1 0 dmm2 c
tof 2.0 dmf2 200
nt 4 dseq2
ct 4 dres2 1.0
alock n homo2 n
gain not used PROCESSING
FLAGS lb 0.30
il n wtfile
in n proc ft
dp y fn not used
hs nn math f
DISPLAY
sp -250.0 werr
wp 5496.6 wexp
vs 499 wbs
sc 0 wnt
wc 250
hzmm 21.99
is 33.57
rf1 4639.9
rfp 3627.8
th 7
ins 2.000
ai ph
OH
8d
2.00
2.19
1.07
1.22
1.03
8.61
2.62
1.52
1.16
10
9
8
7
6
5
4
3
2
1
ppm


JMM-VII-027-1RH
expl s2pul
SAMPLE
date May 8 2010
solvent CDCl3
file /export/home/- dpwr
userid/data/u500/m- dof
uhuhi/JMM-VII-027-- dm
1RH.fid dmm
ACQUISITION dmf
sfrq 499.693 dseq
tn H1 dres
at 4.665 homo
np 65536
sw 7024.9 dfrq2
fb 4000 dn2
bs 4 dpwr2
tpwr 63 dof2
pw 6.5 dm2
d1 0 dmm2
tof 2.0 dmf2
nt 4 dseq2
ct 4 dres2
alock n homo2
gain not used
FLAGS
il n wtfile
in n proc
dp y fn
hs nn math
DISPLAY
sp -250.0 werr
wp 5496.6 wexp
vs 161 wbs
sc 0 wnt
wc 250
hzmm 21.99
is 33.57
rfl 4640.1
rfp 3627.8
th 17
ins 1.000
ai ph
DEC. & VT
dfrq 499.693
dn H1
20
0
nnn
c
200
dseq 1.0
n
dres n
DEC2
dfrq2 0
dn2 1
dpwr2 0
dof2 n
dm2 n
dmm2 c
dmf2 200
dseq2
dres2 1.0
homo2 n
PROCESSING
lb 0.30
wtfile
proc ft
not used
fn f
math
wexp
wbs
wnt
8e
OH
1.94
1.96
1.19
1.10
1.00
6.83
1.55
4.67
10
9
8
7
6
5
4
3
2
1
ppm


JNM-VII-040-1H
expl s2pul
SAMPLE
date May 8 2010
solvent CDCl3
file /export/home/- dpwr
userid/data/n500/m- dof
ubuhi/JNM-VII-040-- dn
1H.fid dmm
ACQUISITION dmf
sfrq 499.693 dseq
tn H1 dres
at 4.665 homo
np 65536
sw 7024.9 dfrq2
fb 4000 dn2
bs 4 dpwr2
tpwr 63 dof2
pw 6.5 dm2
d1 0 dmm2
tof 2.0 dmf2
nt 4 dseq2
ct 4 dres2
alock n homo2
gain not used
FLAGS
il n wtfile
in n proc
dp y fn
hs nn math
DISPLAY
sp -250.0 wexp
wp 5496.6 wexp
vs 327 wbs
sc 0 wnt
wc 250
hzm 21.99
is 33.57
rf1 4640.1
rfp 3627.8
th 7
ins 1.000
ai ph
DEC. & VT
499.693
H1
20
0
nna
c
200
1.0
n
DEC2
0
1
0
n
c
200
1.0
n
PROCESSING
lb 0.30
ft
not used
f
8f
0.90
0.96
1.86
0.94
0.96
1.00
6.18
7.20
1.14
10
9
8
7
6
5
4
3
2
1
ppm


JMM-IX-080-1H
expl s2pul
SAMPLE
date Oct 27 2009
solvent CDCl3
file /export/home/- dpwr
userid/data/u500/m- dof
ubnbi/JMM-IX-080-1- dm
H.fld dmm
ACQUISITION dmf
sfrq 499.693 dseq
tn H1 dres
at 4.665 homo
np 65536 DEC2
sw 7024.9 dfrq2
fb 4000 dn2
bs 4 dpwr2
tpwr 63 dof2
pw 6.5 dn2
dl 0 dmm2
tof 2.0 dmf2
nt 4 dseq2
ct 4 dres2
alock n homo2
gain not used PROCESSING
FLAGS lb
il n wtfile
in n proc
dp y fn
hs nn math
DISPLAY
sp -250.0 werr
wp 5496.6 wexp
vs 95 wbs
sc 0 wnt
wc 250
hzmm 21.99
is 33.57
rfl 4639.7
rfp 3627.8
th 7
ins 3.000
ai ph
DEC. & VT
499.693
H1
20
0
nnn
c
200
1.0
n
DEC2
0
1
0
n
c
200
1.0
n
FROCESSING
0.30
ft
not used
f
OMe O
I
O
O
Si
10
0.76 0.96 1.03
0.96 1.82
0.90
0.97 3.00
1.99
1.00 1.01
0.99 1.00
2.78
2.79
10 9 8 7 6 5 4 3 2 1 ppm


JMM-IX-087-1H
expl s2pul
SAMPLE
date Apr 24 2010
solvent CDCl3
file /export/home/- dper
userid/data/u500/m- dof
uhihl/JMM-IX-087-1- dm
H.fid dmm
ACQUISITION dmf
sfrq 499.693 dseq
tn H1 dres
at 4.665 homo
np 65536
sw 7024.9 dfrq2
fb 4000 dn2
bs 4 dpwr2
tpwr 63 dof2
pw 6.5 dn2
d1 0 dmm2
tof 2.0 dmf2
nt 4 dseq2
ct 4 dres2
alock n homo2
gain not used PROCESSING
FLAGS lb
il n wtfile
in n proc
dp y fn
hs nn math
DISPLAY
sp -250.0 wexr
wp 5496.6 wexp
vs 135 wbs
sc 0 wnt
wc 250
hzmm 21.99
is 33.57
rfl 4640.3
rfp 3627.8
th 7
ins 1.000
ai ph
DBC, & VT
499.693
H1
20
0
mnn
c
200
dseq
1.0
n
DBC2
0
1
0
n
c
200
1.0
n
0.30
ft
not used
f
OMe O
OH
9
10
9
8
7
6
5
4
3
2
1
ppm
1.36
3.14
0.95
0.91
1.00
0.94
1.00
3.86
1.10
1.99
2.94
1.40

References:

(1) Wu, Y.; Gao, J. *Org*. *Lett*. **2008**, *10*, 1533-1536.

(2) (a) Pospisil, J.; Marko, I. E. *Tetrahedron Lett.* **2006**, *47*, 5933-5937. (b) Takaoka, L. R.; Buckmelter, A. J.; LaCruz, T. E.; Rychnovsky, S. D. *J. Am. Chem. Soc.* **2005**, *127*, 528-529. (c) Crawford, R. J.; Lutener, S. B.; Cockcroft, R. D. *Can. J. Chem.* **1976**, *54*, 3364-3376. (d) Sugawara, M.; Yoshida, J. *Tetrahedron Lett.* **1999**, *40*, 1717-1720. (e) Nishikawa, T.; Shinokubo, H.; Oshima, K. *Tetrahedron* **2003**, *59*, 9661-9668. (f) Klos, A. M.; Heintzelman, G. R.; Weinreb, S. M. *J. Org. Chem.* **1997**, *62*, 3758-3761.

(3) Fürstner, A.; Konetzki, I. *Tetrahedron* **1996**, *52*, 15071-15078.

(4) Hadfield, A.; Schweitzer, H.; Trova, M. P.; Green, K. *Synth. Commun.* **1994**, *24*, 1025-1028.

(5) Otera, J.; Danoh, N.; Nozaki, H. *J. Org. Chem.* **1991**, *56*, 5307-5311.