Supporting Online Material for

Asymmetric Catalysis of the Transannular Diels-Alder Reaction

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Supporting Information

Asymmetric Catalysis of the Transannular Diels–Alder Reaction

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General Information: ^{1}H and ^{13}C NMR spectra were acquired in $CDCl_3$ at 600 MHz and 125 MHz on Varian Inova-600 and -500 NMR spectrometers unless specified otherwise. Chemical shifts are reported in parts per million downfield from tetramethylsilane using the solvent resonance as internal standard (chloroform, 7.26 and 77.0 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad), integration, and coupling constant. All alkene products are a single geometric isomer (>95% by ^{1}H NMR) unless stated otherwise. In the case of mixtures of diastereomers or geometric isomers, signals reported are for the major isomer unless stated otherwise. Infrared Resonance spectra were recorded as a thin film between NaCl plates on a Matteson FTIR 3000 spectrophotometer referenced to a polystyrene standard. Data are reported as follows: frequency of absorption (cm^{-1}), intensity of absorption (s = strong, m = medium, w = weak). Optical rotations were measured using a 2 mL cell with a 1 dm path length on a Jasco DIP 370 polarimeter at 589 nm, and are reported as $[\alpha]_D$ (concentration in grams/100 mL solvent). Mass spectral data were obtained in the Harvard Chemistry Department Mass Spectrometry Laboratory. Unless otherwise stated, all reagents were purchased from Aldrich, Strem or Alfa Aesar and used without further purification. Solvents were purified and dried using standard methods: dichloromethane (CH_2Cl_2), benzene (C_6H_6), toluene ($CH_3C_6H_5$), and acetonitrile (CH_3CN) were distilled from calcium hydride; and tetrahydrofuran (THF), *tert*-butyl methyl ether (TBME) and diethyl ether (Et_2O) were distilled from sodium and benzophenone prior to use. All reactions were carried out in oven-dried glassware under nitrogen atmosphere unless otherwise noted. Analytical thin layer chromatography (TLC) was performed on silica gel 60 F254 plates (0.25 mm thickness) precoated with a fluorescent indicator. Flash chromatography was performed using silica gel 60 (230 – 400 mesh) from EM Science or Davisil™ grade 643 (200 – 425 mesh, 150 Å) from Aldrich. Chiral GC analysis was performed on a Hewlett-Packard 5890 gas chromatograph using commercially available chiral columns.

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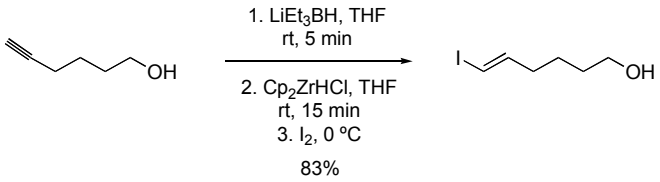
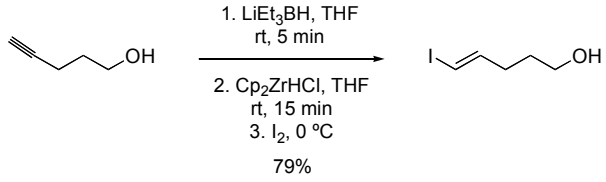
Experimental Procedures:

Preparation of Vinyl Iodides:

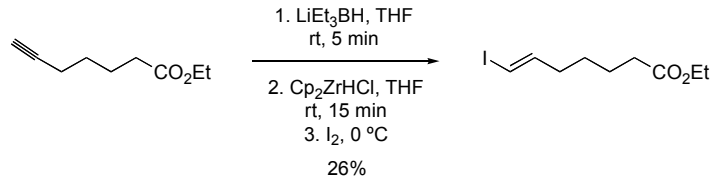
Representative Hydrozirconation Procedure



(*E*)-6-iodohex-5-en-1-ol: To a solution of bis(cyclopentadienyl)zirconocenedichloride (8.93 g, 30.56 mmol, 2.0 equiv.) in tetrahydrofuran (75 mL) at rt in a foil-covered flask was added Super-Hydride (30.6 mL of a 1.0 M solution in tetrahydrofuran, 30.6 mmol, 2.0 equiv.). The reaction mixture was stirred in the dark for 1 h, at which time the formation of a bright white precipitate was observed. During this time, Super-Hydride (15.3 mL of a 1.0 M solution in tetrahydrofuran, 15.3 mmol, 1.0 equiv.) was added at rt to a flask containing 5-hexyn-1-ol (1.50 g, 15.28 mmol, 1.0 equiv.) in tetrahydrofuran (20 mL). This alkoxide solution was added to the suspension of Schwartz reagent via syringe, and the transfer was quantitated with tetrahydrofuran (2 x 5 mL). The resulting mixture was stirred at room temperature for 15 min. The reaction flask was cooled to 0 ºC and iodine (7.94 g, 31.3 mmol, 2.05 equiv.) was added portionwise until a dark brown color persisted. The reaction mixture was partitioned between 20% ethyl acetate in hexanes (250 mL) and saturated aqueous sodium bicarbonate solution (250 mL). The aqueous layer was extracted with 20% ethyl acetate in hexanes (2 x 200 mL), and the combined organic extracts were filtered through a pad of silica topped with celite. The filtrate was concentrated and the residue purified by flash chromatography (2% → 5% → 10% ethyl acetate in dichloromethane) to afford (*E*)-6-iodohex-5-en-1-ol (2.86 g, 83%) as a pale yellow oil. All spectral data matched that previously reported. (*S1*)



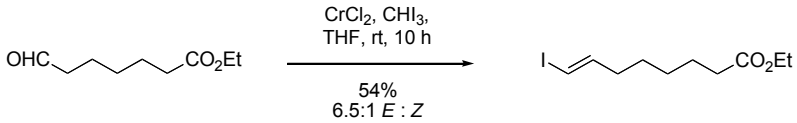
(*E*)-5-iodopent-4-en-1-ol: 4-pentyn-1-ol (1.00 g, 11.5 mmol, 1.0 equiv.) was reacted using the representative hydrozirconation procedure. Chromatography (dichloromethane → 2% ethyl acetate in dichloromethane) afforded (*E*)-5-iodopent-4-en-1-ol (1.93 g, 79%) as a pale yellow oil. All spectral data matched that previously reported. (*S2*)



(*E*)-ethyl 7-iodohept-6-enoate: Ethyl hept-6-ynoate (2.17 g, 14.1 mmol, 1.0 equiv.) was reacted using the representative hydrozirconation procedure. Chromatography (25% → 33% dichloromethane in hexanes) afforded *E*-ethyl 7-iodohept-6-enoate (1.03 g, 26%) as a pale yellow oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.50 (dt, 1H, *J* = 7.2, 14.4 Hz, C**H**=CHI), 6.00 (d, 1H, *J* = 14.4 Hz, CH=C**H**I), 4.12 (q, 2H, *J* = 7.2 Hz, OC**H$_2$**CH_3), 2.29 (t, 2H, *J* = 7.5 Hz, C**H$_2$**CO_2Et), 2.04 (m, 2H, C**H$_2$**CH=CHI), 1.65-1.60 (C**H$_2$**CH_2CO_2Et), 1.46-1.41 (m, 2H, C**H$_2$**CH_2CH=CHI), 1.26 (t, 3H, *J* = 7.2 Hz, OCH_2C**H$_3$**). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 173.4, 146.0, 74.8, 60.3, 35.6, 34.0, 27.8, 24.2, 14.2. FTIR (neat), cm^1: 2979 (m), 2934 (s), 2861 (m), 1736 (s). HRMS (ES): Calcd for $C_9H_{15}IO_2$ $[M + H]^+$: 283.0195, Found: 283.0200.

Representative Takai Olefination Procedure



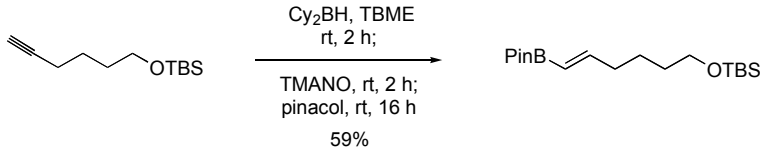
(*E*)-ethyl 8-iodooct-7-enoate: To a suspension of anhydrous chromium (II) chloride (1.16 g, 9.46 mmol, 4.0 equiv.) in tetrahydrofuran (21.5 mL) at rt was added ethyl 7-oxoheptanoate (*S3*) (407.2 mg, 2.36 mmol, 1.0 equiv.) as a solution in tetrahydrofuran (4.9 mL). The transfer was quantitated with tetrahydrofuran (2 x 2.4 mL) and the reaction flask was covered with foil. Iodoform (976.5 mg, 2.48 mmol, 1.05 equiv.) was added as a solid, and the reaction mixture was stirred at rt for 10 h. Water (50 mL) was added, and the resulting mixture was partitioned between 10% diethyl ether in hexanes (75 mL) and water (50 mL). The aqueous layer was extracted with 10% diethyl ether in hexanes (2 x 20 mL) and the combined organic extracts were washed with brine (2 x 25 mL), dried over sodium sulfate, filtered and concentrated. The residue was purified by flash chromatography on Davisil (10% diethyl ether in pentane) to afford (*E*)-ethyl 8-iodooct-7-enoate (698.9 mg, 54%, 6.5:1 mixture of *E* and *Z* isomers) as a pale yellow oil. *E*/*Z* ratio determined by ^{1}H NMR integration (δ_E = 6.49 ppm, δ_Z = 6.19-6.13 ppm, m, 2H).

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.49 (dt, 1H, *J* = 7.2, 14.4 Hz, C**H**=CHI), 5.98 (dt, 1H, *J* = 1.3,

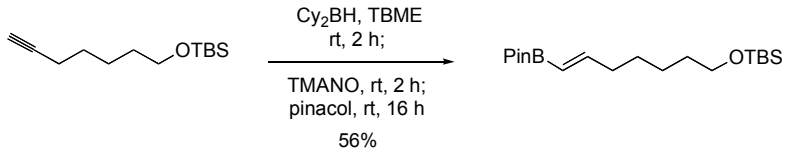
14.4 Hz, CH=C**H**I), 4.12 (q, 2H, *J* = 7.2 Hz, $CH_3C\mathbf{H_2}O$), 2.28 (t, 2H, *J* = 7.5 Hz, $C\mathbf{H_2}CO_2Et$), 2.05 (ddt, 2H, *J* = 1.3, 7.3, 7.3 Hz, $C\mathbf{H_2}CH{=}CHI$), 1.64-1.58 (m, 2H, $C\mathbf{H_2}CH_2CO_2Et$), 1.43-1.37 (m, 2H, $C\mathbf{H_2}CH_2CH{=}CHI$), 1.34-1.29 (m, 2H, $C\mathbf{H_2}CH_2CH_2CO_2Et$), 1.25 (t, 3H, *J* = 7.2 Hz, $C\mathbf{H_3}CH_2O$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 173.6, 146.3, 74.6, 60.2, 35.8, 34.2, 28.3, 27.9, 24.6, 14.2. FTIR (neat), cm^{1}: 2979 (w), 2939 (m), 2857 (w), 1736 (s). HRMS (ES): Calcd for $C_{10}H_{18}IO_2$ $[M + H]^+$: 297.0351, Found: 297.0343.

Preparation of Vinyl Pinacol Boronate Esters:

Representative Hydroboration Procedure

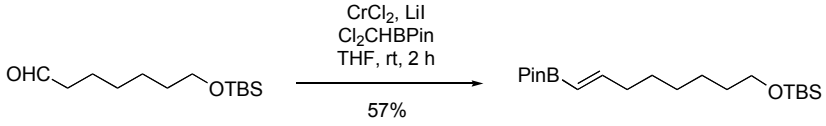


(*E*)-*tert*-butyldimethyl(6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)hex-5-enyloxy)silane:
To a solution of borane-dimethylsulfide complex (600 μL, 6.0 mmol, 1.4 equiv.) in TBME (15 mL) at 0 ºC was added cyclohexene (1.21 mL, 12 mmol, 2.8 equiv.) dropwise. The reaction mixture was stirred at 0 ºC for 15 min, then warmed to rt for 1 h. The mixture was recooled to 0 ºC and TBS-protected 5-hexyn-1-ol (*S4*) (903 mg, 4.25 mmol, 1.0 equiv.) was added as a neat liquid. The reaction mixture was stirred at rt for 3 h and cooled to 10 ºC. Trimethylamine *N*-oxide (901 mg, 12.0 mmol, 2.8 equiv) was added in a single portion, and the resulting suspension was stirred at rt for 2 h. Pinacol (650 mg, 5.5 mmol, 1.3 equiv.) was added in a single portion, and the reaction mixture was stirred at rt for 16 h. The solvent was concentrated and the residue purified by rapid flash chromatography on Davisil (2.5% diethyl ether in hexanes) to afford the desired vinyl pinacol boronate ester (861.2 mg, 59%) as a colorless oil.
^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.62 (dt, 1H, *J* = 6.3, 17.6 Hz, CH=C**H**CH_2), 5.42 (d, 1H, *J* = 18.1 Hz, PinBC**H**=CH), 3.59 (t, 2H, *J* = 6.3 Hz, $C\mathbf{H_2}$OTBS), 2.16 (dt, 2H, *J* = 6.8, 6.8 Hz, $CH{=}CHC\mathbf{H_2}$), 1.55-1.38 (m, 4H, $C\mathbf{H_2}$), 1.26 (s, 12H, pinacol $C\mathbf{H_3}$), 0.88 (s, 9H, $SiC(C\mathbf{H_3})_3$), 0.03 (s, 6H, $SiC\mathbf{H_3}$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 154.5, 118.8, 83.0, 63.0, 35.5, 32.3, 26.0, 24.7, 24.4, 18.3, –5.3. FTIR (neat), cm^{1}: 2931 (s), 1639 (m). HRMS (ES): Calcd for $C_{18}H_{37}BO_3Si$ $[M + H]^+$: 341.2798, Found: 341.2811.



(*E*)-*tert*-butyldimethyl(7-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)hept-6-enyloxy)silane: TBS-protected 6-heptyn-1-ol (*S5*) (1.33 g, 4.99 mmol, 1.0 equiv.) underwent hydroboration using the representative procedure. Chromatography on Davisil (2.5% diethyl ether in hexanes) afforded the desired vinyl pinacol boronate ester (1.34 g, 56%) as a colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.62 (dt, 1H, *J* = 6.4, 17.9 Hz, CH=C**H**CH_2), 5.42 (d, 1H, *J* = 17.9 Hz, PinBC**H**=CH), 3.58 (t, 2H, *J* = 6.4 Hz, C**H**$_2$OTBS), 2.15 (dt, 2H, *J* = 6.9, 6.9 Hz, CH=CHC**H**$_2$), 1.53-1.48 (m, 2H, C**H**$_2$$CH_2$OTBS), 1.45-1.38 (m, 2H, CH=CHCH_2C**H**$_2$), 1.35-1.32 (m, 2H, C**H**$_2$$CH_2$$CH_2$OTBS), 1.26 (s, 12H, pinacol C**H**$_3$), 0.88 (s, 9H, SiC(C**H**$_3$)$_3$), 0.03 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 154.6, 118.8, 83.0, 63.1, 35.8, 32.7, 28.0, 26.0, 25.4, 24.8, 18.4, –5.3. FTIR (neat), cm^1: 2930 (s), 1639 (m). HRMS (ES): Calcd for $C_{19}H_{39}BO_3Si$ [M + H]$^+$: 355.2840, Found: 355.2840.

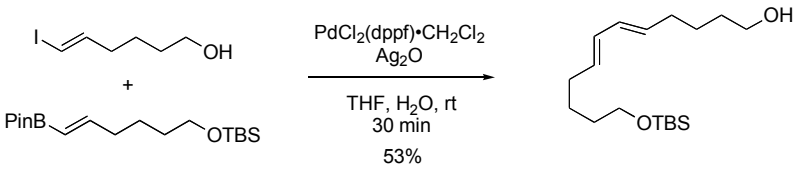


(*E*)-*tert*-butyldimethyl(8-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)oct-7-enyloxy)silane: 7-(*tert*-butyldimethylsilyloxy)heptanal (*S6*) (1.04 g, 4.26 mmol, 1.0 equiv.) was subjected to the representative Takai olefination procedure using anhydrous chromium (II) chloride (3.14 g, 25.56 mmol, 6.0 equiv.), lithium iodide (1.71 g, 12.78 mmol, 3.0 equiv.) and $Cl_2CHBPin$ (*S7*) (1.39 g, 6.39 mmol, 1.5 equiv.). Chromatography on Davisil (2.5 → 5% diethyl ether in hexanes) afforded the desired vinyl pinacol boronate ester (888 mg, 57%) as a colorless oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.62 (dt, 1H, *J* = 6.4, 17.9 Hz, C**H**=CHBPin), 5.42 (dt, 1H, *J* = 1.5, 18.0 Hz, CH=C**H**BPin), 3.58 (t, 2H, *J* = 6.6 Hz, C**H**$_2$OTBS), 2.14 (m, 2H, C**H**$_2$CH=CHBPin), 1.50-1.48 (m, 2H, C**H**$_2$$CH_2$OTBS), 1.42-1.40 (m, 2H, C**H**$_2$$CH_2$CH=CHBPin), 1.31-1.29 (m, 4H, C**H**$_2$), 1.26 (s, 12H, pinacol C**H**$_3$), 0.88 (s, 9H, SiC(C**H**$_3$)$_3$), 0.04 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 154.7, 118.7, 83.0, 63.2, 35.8, 32.8, 29.0, 28.2, 26.0, 25.7, 24.8, 18.4, –5.3. FTIR (neat), cm^1: 2930 (s), 1639 (m). HRMS (ES): Calcd for $C_{20}H_{41}BO_3Si$ [M + H]$^+$: 369.2996, Found: 369.2993.

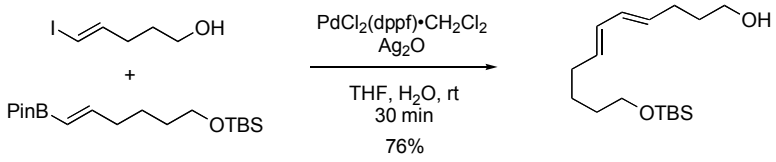
Suzuki Couplings:

Representative Suzuki Coupling Procedure



(5*E*,7*E*)-12-(tert-butyldimethylsilyloxy)dodeca-5,7-dien-1-ol: A flask containing vinyl iodide (665 mg, 2.94 mmol, 1.0 equiv.) and vinyl pinacol boronate ester (1.00 g, 2.94 mmol, 1.0 equiv.) was evacuated and backfilled three times with nitrogen. Tetrahydrofuran (32.5 mL) was added to the mixture, followed by water (2.0 mL), $PdCl_2(dppf)•CH_2Cl_2$ (180 mg, 0.22 mmol, 0.075 equiv.), and silver (I) oxide (2.04 g, 8.82 mmol, 3.0 equiv.) in quick succession. The reaction mixture was stirred at room temperature for 30 min and was partitioned between diethyl ether (50 mL) and water (50 mL). The aqueous phase was extracted with diethyl ether (2 x 50 mL). The combined organic extracts were dried over Na_2SO_4 and filtered through a pad of celite. The filtrate was concentrated, and the residue was purified by flash chromatography on Davisil (15% ethyl acetate in hexanes) to afford the desired diene (487 mg, 53%) as an oil

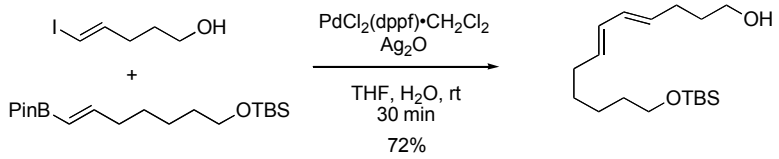
^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.03-5.96 (m, 2H, CH=C**H**-C**H**=CH), 5.58-5.52 (m, 2H, C**H**=CH-CH=C**H**), 3.64-3.62 (m, 2H, C**H$_2$**OH), 3.60 (t, 2H, *J* = 6.3 Hz, C**H$_2$**OTBS), 2.11-2.04 (m, 4H, C**H$_2$**CH=CH), 1.60-1.38 (m, 8H, C**H$_2$**), 0.89 (s, 9H, SiC(C**H$_3$**)$_3$), 0.04 (s, 6H, SiC**H$_3$**). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 132.4, 131.8, 130.7, 130.4, 63.1, 62.8, 32.3, 32.3, 32.2, 26.0, 26.0, 25.6, 25.5, 18.3, –5.3. FTIR (neat), cm^1: 3317 (m, OH), 2929 (s) 2857 (s). HRMS (ES): Calcd for $C_{18}H_{36}O_2Si$ $[M + H]^+$: 313.2563, Found: 313.2564.



(4*E*,6*E*)-11-(*tert*-butyldimethylsilyloxy)undeca-4,6-dien-1-ol: Vinyl iodide (141.6 mg, 0.668 mmol, 1.0 equiv.) and vinyl pinacol boronate ester (250.0 mg, 0.734 mmol, 1.1 equiv.) were cross-coupled using the representative procedure. Chromatography on Davisil (10% → 20% diethyl ether in hexanes) afforded the desired diene (151.9 mg, 76%) as an oil.

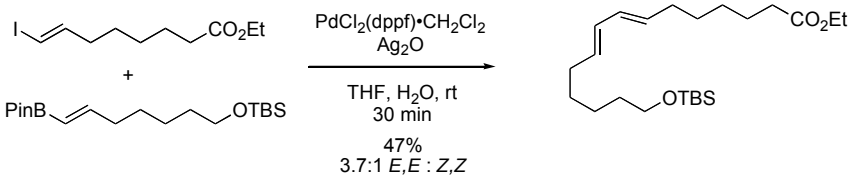
^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.06-5.97 (m, 2H, CH=C**H**-C**H**=CH), 5.60-5.54 (m, 2H, C**H**=CH-CH=C**H**), 3.66 (t, 2H, *J* = 6.3 Hz, C**H$_2$**OH), 3.60 (t, 2H, *J* = 6.3 Hz, C**H$_2$**OTBS), 2.15

(dt, 2H, *J* = 6.8, 6.8 Hz, C**H**$_2$CH=CH), 2.07 (dt, 2H, *J* = 7.3, 7.3 Hz, C**H**$_2$CH=CH), 1.66 (tt, 2H, *J* = 6.3, 6.3 Hz, C**H**$_2$), 1.52 (tt, 2H, *J* = 6.3, 6.3 Hz, C**H**$_2$), 1.42 (tt, 2H, *J* = 7.3, 7.3 Hz, C**H**$_2$), 0.89 (s, 9H, SiC(C**H**$_3$)), 0.04 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 132.7, 131.2, 131.0, 130.2, 63.1, 62.4, 32.4, 32.3, 32.3, 28.9, 26.0, 25.6, 18.4, –5.3. FTIR (neat), cm^1: 3321 (m, OH), 2930 (s) 2858 (s). HRMS (ES): Calcd for $C_{17}H_{34}O_2Si$ [M + H]$^+$: 299.2406, Found: 299.2416.



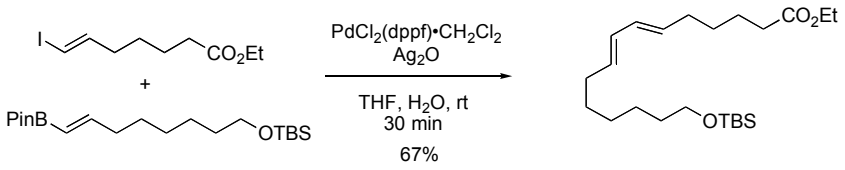
(4*E*,6*E*)-12-(tert-butyldimethylsilyloxy)dodeca-4,6-dien-1-ol: Vinyl iodide (167 mg, 0.709 mmol, 1.0 equiv.) and vinyl pinacol boronate ester (276 mg, 0.779 mmol, 1.1 equiv.) were cross-coupled using the representative procedure. Chromatography on Davisil (10% ethyl acetate in hexanes) afforded the desired diene (159 mg, 72%) as an oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.06-5.97 (m, 2H, CH=C**H**-C**H**=CH), 5.60-5.54 (m, 2H, C**H**=CH-CH=C**H**), 3.66 (t, 2H, *J* = 6.3 Hz, C**H**$_2$OH), 3.59 (t, 2H, *J* = 6.8 Hz, C**H**$_2$OTBS), 2.15 (dt, 2H, *J* = 6.8, 6.8 Hz, C**H**$_2$CH=CH), 2.06 (dt, 2H, *J* = 7.3, 7.3 Hz, C**H**$_2$CH=CH), 1.69-1.64 (m, 2H, C**H**$_2$CH$_2$OH), 1.54-1.48 (m, 2H, C**H**$_2$CH$_2$OTBS), 1.42-1.29 (m, 4H, C**H**$_2$C**H**$_2$CH$_2$CH$_2$OTBS), 0.89 (s, 9H, SiC(C**H**$_3$)), 0.04 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 132.8, 131.1, 131.0, 130.2, 63.2, 62.5, 32.7, 32.5, 32.3, 29.1, 28.9, 26.0, 25.4, 18.4, –5.3. FTIR (neat), cm^1: 3340 (m, OH), 2930 (s), 2857 (s). HRMS (ES): Calcd for $C_{18}H_{36}O_2Si$ [M + H]$^+$: 313.2563, Found: 313.2563.



(7*E*,9*E*)-ethyl 15-(*tert*-butyldimethylsilyloxy)pentadeca-7,9-dienoate: Vinyl iodide (277.0 mg, 0.935 mmol, 1.0 equiv., 6.5:1 mixture of *E* and *Z* isomers) and vinyl pinacol boronate ester (365.0 mg, 1.03 mmol, 1.1 equiv.) were cross-coupled using the representative procedure. Chromatography on Davisil (1% → 2% diethyl ether in hexanes) afforded the desired diene (175.1 mg, 47%, 3.7:1 mixture of *E,E* and *E,Z* isomers) as an oil. *E,E*/*E,Z* ratio determined by ^{1}H NMR integration ($\delta_{E,E}$ = 6.02-5.96 ppm, $\delta_{E,Z}$ = 6.28 ppm, dd, 1H).

^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.02-5.96 (m, 2H, CH=C**H**-C**H**=CH), 5.60-5.50 (m, 2H, C**H**=CH-CH=C**H**), 4.12 (q, 2H, *J* = 7.3 Hz, OC**H$_2$**CH$_3$), 3.59 (t, 2H, *J* = 6.8 Hz, C**H$_2$**OTBS), 2.28 (t, 2H, *J* = 7.3 Hz, C**H$_2$**CO$_2$Et), 2.05 (dt, 4H, *J* = 6.8, 6.8 Hz, C**H$_2$**CH=CH-CH=CHC**H$_2$**), 1.65-1.59 (m, 2H, C**H$_2$**CH$_2$OTBS), 1.54-1.48 (m, 2H, C**H$_2$**CH$_2$CO$_2$Et), 1.42-1.29 (m, 8H, C**H$_2$**), 1.25 (t, 3H, *J* = 6.3 Hz, OCH$_2$C**H$_3$**), 0.89 (s, 9H, SiC(C**H$_3$**)), 0.04 (s, 6H, SiC**H$_3$**). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 173.8, 132.4, 132.0, 130.5, 130.4, 63.2, 60.2, 34.3, 32.7, 32.6, 32.4, 29.2, 29.0, 28.7, 26.0, 25.4, 24.8, 18.4, 14.2, –5.3. FTIR (neat), cm^1: 2929 (s), 2857 (m), 1738 (s). HRMS (ES): Calcd for $C_{23}H_{44}O_3Si$ [M + H]$^+$: 397.3138, Found: 397.3136.

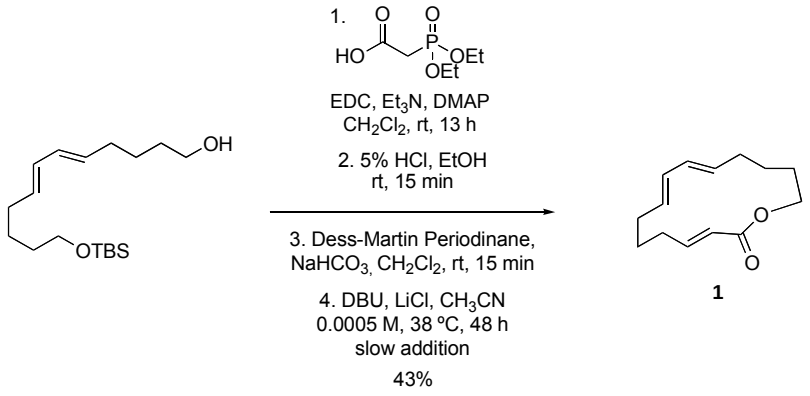


(6*E*,8*E*)-ethyl 15-(*tert*-butyldimethylsilyloxy)pentadeca-6,8-dienoate: Vinyl iodide (200.0 mg, 0.709 mmol, 1.0 equiv.) and vinyl pinacol boronate ester (287.0 mg, 0.780 mmol, 1.1 equiv.) were cross-coupled using the representative procedure. Chromatography on Davisil (5% → 10% → 15% diethyl ether in hexanes) afforded the desired diene (189.7 mg, 67%) as an oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.02-5.96 (m, 2H, CH=C**H**-C**H**=CH), 5.59-5.51 (m, 2H, C**H**=CH-CH=C**H**), 4.12 (q, 2H, *J* = 7.0 Hz, OC**H$_2$**CH$_3$), 3.59 (t, 2H, *J* = 6.6 Hz, C**H$_2$**OTBS), 2.29 (t, 2H, *J* = 7.5 Hz, C**H$_2$**CO$_2$Et), 2.09-2.02 (m, 4H, C**H$_2$**CH=CH-CH=CHC**H$_2$**), 1.66-1.61 (m, 2H, C**H$_2$**CH$_2$CO$_2$Et), 1.51-1.48 (m, 2H, C**H$_2$**CH$_2$OTBS), 1.43-1.35 (m, 4H, C**H$_2$**), 1.31-1.30 (m, 4H, C**H$_2$**), 1.25 (3H, t, *J* = 7.2 Hz, OCH$_2$C**H$_3$**), 0.89 (s, 9H, SiC(C**H$_3$**)), 0.04 (s, 6H, SiC**H$_3$**). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 173.7, 132.7, 131.5, 130.8, 130.2, 63.3, 60.2, 34.2, 32.8, 32.5, 32.2, 29.4, 29.0, 28.9, 26.0, 25.7, 24.8, 18.4, 14.2, –5.3. FTIR (neat), cm^1: 2930 (s), 2857 (m), 1738 (s). HRMS (ES): Calcd for $C_{23}H_{44}O_3Si$ [M + H]$^+$: 397.3138, Found: 397.3121.

Syntheses of Macrolactones:

Representative Procedure



(3*E*,8*E*,10*E*)-oxacyclopentadeca-3,8,10-trien-2-one (1):

To a solution of diene (444.0 mg, 1.42 mmol, 1.0 equiv.) in dichloromethane (3 mL) at room temperature was added DMAP (33.0 mg, 0.27 mmol, 0.2 equiv.), triethylamine (282 μL, 2.02 mmol, 1.5 equiv.), diethylphosphonoacetic acid (457 μL, 2.7 mmol, 2.0 equiv.) and EDC (518 mg, 2.7 mmol, 2.0 equiv.). The reaction mixture was stirred at room temperature for 13 h then was poured into ethyl acetate (50 mL). This solution was washed with 1 M HCl (25 mL), 1 M NaOH (25 mL) and brine (20 mL). The organic layer was dried over Na_2SO_4, filtered, and concentrated to afford the phosphonate ester, which was used in the next step without purification.

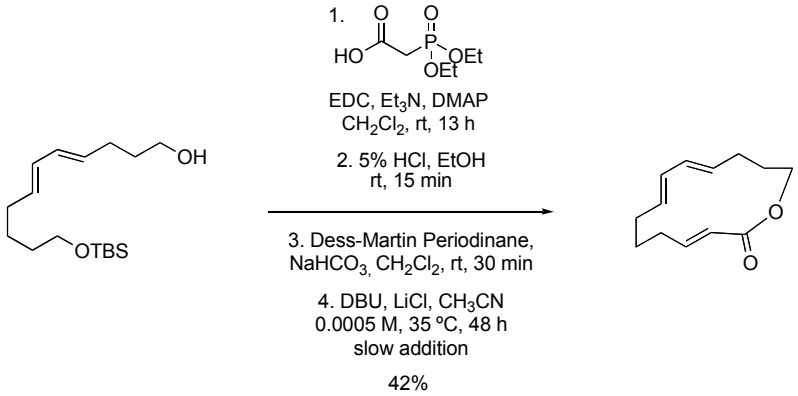
To a solution of ester in ethanol (16.0 mL) at rt was added 5% conc. HCl in ethanol (4.0 mL). The reaction mixture was stirred at room temperature for 15 min, then was partitioned between ethyl acetate (50 mL) and half-saturated aqueous sodium bicarbonate solution (25 mL). The aqueous layer was extracted with ethyl acetate (2 x 15 mL). The combined organic extracts were dried over Na_2SO_4, filtered and evaporated to afford the alcohol, which was used in the next step without purification.

Solid sodium bicarbonate (40.1 mg, 0.478 mmol, 2.0 equiv.) and Dess–Martin periodinane (183.6 mg, 0.436 mmol, 1.75 equiv.) were added in sequence to a solution of alcohol (1/4 of the total unpurified material, 0.249 mmol, 1.0 equiv.) in dichloromethane (15 mL) at 23 °C. The reaction mixture was stirred at rt for 10 min, then was partitioned between ethyl acetate (20 mL) and half-saturated aqueous sodium thiosulfate solution (20 mL). The layers were separated, and the organic phase was washed sequentially with half-saturated aqueous sodium thiosulfate solution (10 mL), saturated aqueous sodium bicarbonate solution (20 mL), and brine

(10 mL). The organic phase was dried over Na_2SO_4 and concentrated, providing the aldehyde as an oil, which was used immediately in the next step, without purification.

To a suspension of lithium chloride (2.28 g, 53.8 mmol, 237 equiv., flame-dried prior to use) in acetonitrile (40 mL) at room temperature was added DBU (815 μL, 5.45 mmol, 24.0 equiv.). The reaction mixture was heated to 38 ºC and aldehyde was added from an addition funnel as a solution in acetonitrile (525 mL) slowly over 48 h. Upon completion of the addition, the funnel was rinsed with an additional portion of acetonitrile (10 mL) and this was added to the reaction mixture over 1 h. After cooling the mixture to rt, the material was partitioned between diethyl ether (250 mL) and 0.1 M aqueous sodium phosphate dibasic solution (250 mL). The organic layer was washed with water (250 mL) and brine (3 x 100 mL). The organic phase was dried over 1:1 $Na_2SO_4/MgSO_4$, filtered and concentrated. The residue was chromatographed on Davisil (2.5% → 5% diethyl ether in hexanes), affording macrolactone **1** (23.7 mg, 43%) as an oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.77 (dt, 1H, *J* = 7.5, 15.5 Hz, C**H**=CHCO$_2$), 5.86 (dd, 1H, *J* = 10.1, 14.6 Hz, CH=C**H**-CH=CH), 5.81 (dd, 1H, *J* = 10.1, 14.6 Hz, CH=CH-C**H**=CH), 5.61 (dt, 1H, *J* = 1.5, 15.7 Hz, CH=C**H**CO$_2$), 5.47 (dt, 1H, *J* = 7.6, 15.1 Hz, C**H**=CH-CH=CH), 5.36 (dt, 1H, *J* = 7.6, 14.9 Hz, CH=CH-CH=C**H**), 4.10 (t, 2H, C**H$_2$**O), 2.34 (ddt, 2H, *J* = 1.5, 7.5, 7.5 Hz, C**H$_2$**CH=CHCO$_2$), 2.21 (dt, 2H, *J* = 7.2, 7.2 Hz, C**H$_2$**CH=CH-CH=CH), 1.96 (dt, 2H, *J* = 7.6, 7.6 Hz, CH=CH-CH=CHC**H$_2$**), 1.72-1.68 (m, 2H, CH$_2$C**H$_2$**CH$_2$), 1.62-1.57 (m, 4H, CH$_2$C**H$_2$**C**H$_2$**CH$_2$O). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 167.2, 151.9, 134.3, 132.6, 131.1, 130.5, 121.0, 65.1, 34.0, 33.3, 32.1, 27.1, 26.9, 26.2. FTIR (neat), cm^1: 2963 (s) 1717 (s). HRMS (ES): Calcd for $C_{14}H_{20}O_2$ $[M + H]^+$: 221.1541, Found: 221.1534.

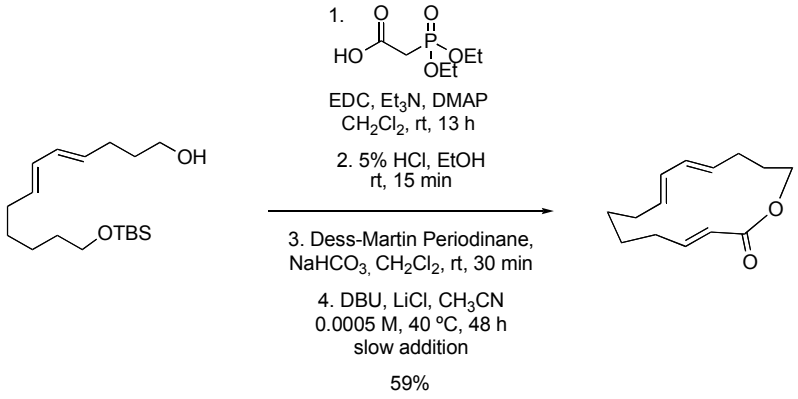


(3*E*,8*E*,10*E*)-oxacyclotetradeca-3,8,10-trien-2-one:

Diene (72.5 mg, 0.243 mmol, 1.0 equiv.) was subjected to the representative reaction

sequence. Chromatography afforded macrolactone (20.9 mg, 42%) as a colorless oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.68 (dt, 1H, *J* = 7.3, 15.5 Hz, C**H**=CHCO$_2$), 5.90 (dd, 1H, *J* = 10.2, 14.9 Hz, CH=C**H**-CH=CH), 5.82 (dd, 2H, *J* = 10.2, 15.2 Hz, CH=CH-C**H**=CH), 5.57 (dt, 1H, *J* = 1.5, 15.5 Hz, CH=C**H**CO$_2$), 5.57 (dt, 1H, *J* = 7.3, 14.6 Hz, C**H**=CH-CH=CH), 5.28 (dt, 1H, *J* = 7.6, 15.3 Hz, CH=CH-CH=C**H**), 4.32 (t, 2H, *J* = 7.3 Hz, C**H$_2$**O), 2.34 (ddt, 2H, *J* = 1.5, 7.3, 7.3 Hz, C**H$_2$**CH=CHCO$_2$), 2.24 (dt, 2H, *J* = 6.4, 6.4 Hz, C**H$_2$**CH=CH-CH=CH), 2.21 (dt, 2H, *J* = 7.0, 7.0 Hz, CH=CH-CH=CHC**H$_2$**), 1.78-1.74 (m, 2H, CH$_2$C**H$_2$**CH$_2$), 1.70-1.66 (m, 2H, CH$_2$C**H$_2$**CH$_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 167.7, 152.5, 135.5, 133.4, 131.4, 129.5, 121.0, 64.6, 34.1, 33.2, 32.4, 27.2, 26.9. FTIR (neat), cm^1: 2921 (s) 1717 (s). HRMS (ES): Calcd for $C_{13}H_{18}O_2$ [M + H]$^+$: 207.1385, Found: 207.1383.



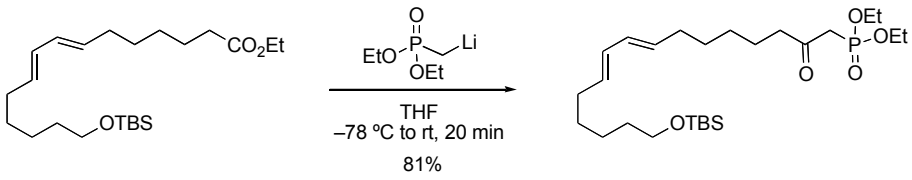
(3*E*,9*E*,11*E*)-oxacyclopentadeca-3,9,11-trien-2-one:

Diene (45.0 mg, 0.144 mmol, 1.0 equiv.) was subjected to the representative reaction sequence. Chromatography afforded macrolactone (18.4 mg, 59%) as a colorless oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.78 (dt, 1H, *J* = 7.3, 15.4 Hz, C**H**=CHCO$_2$), 5.95 (dd, 1H, *J* = 10.0, 14.6 Hz, CH=C**H**-CH=CH), 5.90 (dd, 1H, *J* = 10.0, 14.8 Hz, CH=CH-C**H**=CH), 5.66 (d, 1H, *J* = 15.7 Hz, CH=C**H**CO$_2$Et), 5.56 (dt, 1H, *J* = 7.3, 14.6 Hz, CH=C**H**CH$_2$), 5.49 (dt, 1H, *J* = 7.6, 14.9 Hz, CH$_2$C**H**=CH), 4.28 (t, 2H, *J* = 5.0 Hz, CO$_2$C**H$_2$**), 2.25 (dt, 2H, *J* = 6.6, 6.6 Hz, CH=CHC**H$_2$**CH$_2$CH$_2$O), 2.11 (ddt, 2H, *J* = 1.3, 7.3, 7.3 Hz, C**H$_2$**CH=CHCO$_2$), 1.95 (dt, *J* = 7.8, 7.8 Hz, C**H$_2$**CH=CH-CH=CH), 1.82-1.79 (m, 2H, C**H$_2$**CH$_2$O), 1.56-1.52 (m, 2H, C**H$_2$**CH$_2$CH=CHCO$_2$), 1.49-1.45 (m, 2H, C**H$_2$**CH$_2$CH$_2$CH=CHCO$_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 166.8, 149.9, 132.2, 132.0, 131.5, 130.3, 122.1, 65.3, 32.4, 32.1, 31.7, 27.8, 27.7, 25.8. FTIR (neat), cm^1: 2928 (s) 1719 (s). HRMS (ES): Calcd for $C_{14}H_{20}O_2$ [M + H]$^+$: 221.1541, Found: 221.1537.

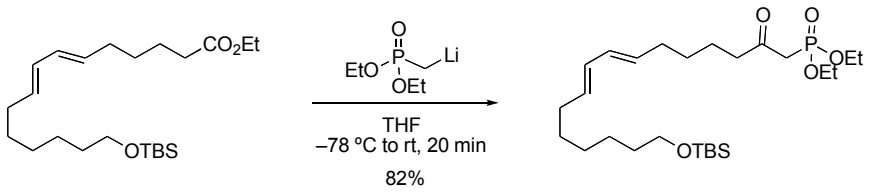
Syntheses of Macrocyclic Ketones:

Representative Procedure for Ketophosphonate Formation



diethyl (8*E*,10*E*)-16-(*tert*-butyldimethylsilyloxy)-2-oxohexadeca-8,10-dienylphosphonate): A solution of *n*-butyllithium (229 μL of a 2.5 M solution in hexane, 0.572 mmol, 3.0 equiv.) was added to a solution of dimethyl methylphosphonate (100 μL, 0.668 mmol, 3.5 equiv.) in tetrahydrofuran (4.2 mL) at –78 °C. The resulting solution was stirred at –78 °C for 30 min and then was transferred via cannula to a solution of ester (75.6 mg, 0.572 mmol, 1.0 equiv., 3.7:1 mixture of *E,E* and *E,Z* isomers) in tetrahydrofuran (1.7 mL) at –78 °C. The reaction mixture was stirred at –78 °C for 15 min, then was allowed to warm to rt over 15 min. The reaction mixture was stirred at rt for 20 min, then was cooled to –78 °C, and acetic acid (25 μL), saturated aqueous sodium bicarbonate solution (3 mL), and ethyl acetate (2 mL) were added in sequence. The resulting biphasic mixture was warmed to rt, then was partitioned between ethyl acetate (40 mL) and a mixture of saturated aqueous sodium bicarbonate solution and water (4:1, 10 mL). The organic phase was washed with brine (15 mL) and the aqueous washes were extracted with ethyl acetate (2 × 15 mL). The combined organic extracts were dried over Na_2SO_4, filtered and concentrated. Purification of the residue by flash column chromatography (60% ethyl acetate in hexanes) gave the phosphonate (77.3 mg, 81%, 3.7:1 mixture of *E,E* and *E,Z* isomers) as an oil. *E*/*Z* ratio determined by ^{1}H NMR integration ($\delta_{E,E}$ = 6.01-5.95 ppm, $\delta_{E,Z}$ = 6.27 ppm).

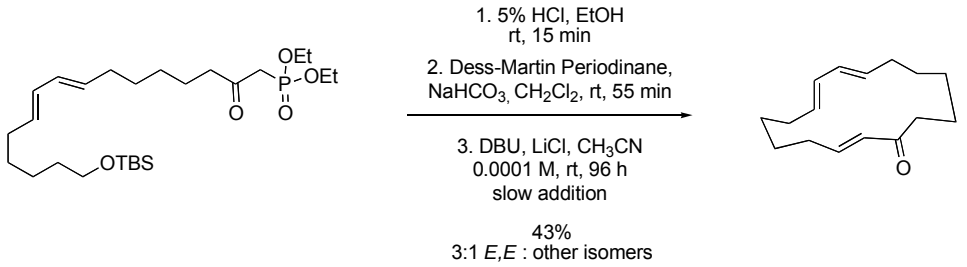
^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.01-5.95 (m, 2H, CH=C**H**-C**H**=CH), 5.58-5.50 (m, 2H, C**H**=CH-CH=C**H**), 4.17-4.10 (m, 4H, OC**H$_2$**CH$_3$), 3.59 (t, 2H, *J* = 6.8 Hz, C**H$_2$**OTBS), 3.06 (d, 2H, J_{HCP} = 22.5 Hz, C**H$_2$**P(O)(OEt)$_2$), 2.61 (t, 2H, *J* = 7.3 Hz, C**H$_2$**C(O)CH$_2$P(O)(OEt)$_2$), 2.07-2.02 (m, 4H, C**H$_2$**CH=CH-CH=CHC**H$_2$**), 1.62-1.48 (m, 4H, CH_2CH_2OTBS and C**H$_2$**CH$_2$C(O)CH$_2$P(O)(OEt)$_2$), 1.41-1.25 (m, 8H, CH_2), 1.33 (t, 6H, *J* = 7.3 Hz, P(O)(OCH$_2$C**H$_3$**)$_2$), 0.87 (s, 9H, SiC(C**H$_3$**)), 0.04 (s, 6H, SiC**H$_3$**). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 202.1, 132.4, 132.0, 130.5, 130.3, 63.2, 62.5 (d, J_{COP} = 6.4 Hz), 44.0, 42.4 (d, J_{CP} = 127 Hz), 32.7, 32.5, 32.3, 29.2, 29.1, 28.5, 26.0, 25.4, 23.3, 18.4, 16.3 (d, J_{CCOP} = 6.4 Hz), –5.3. FTIR (neat), cm^{-1}: 2930 (s), 2857 (s), 1716 (s). HRMS (ES): Calcd for $C_{26}H_{51}O_5PSi$ $[M + NH_4]^+$: 521.3665, Found: 521.3662.



diethyl (7*E*,9*E*)-16-(*tert*-butyldimethylsilyloxy)-2-oxohexadeca-7,9-dienylphosphonate: Ester (180.0 mg, 0.454 mmol, 1.0 equiv.) was subjected to the representative procedure. Chromatography (60% ethyl acetate in hexanes) afforded the ketophosphonate (186.2 mg, 82%) as an oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.01-5.95 (m, 2H, CH=C**H**-C**H**=CH), 5.58-5.50 (m, 2H, C**H**=CH-CH=C**H**), 4.16-4.11 (m, 4H, OC**H**$_2$CH$_3$), 3.58 (t, 2H, J = 6.6 Hz, C**H**$_2$OTBS), 3.06 (d, 2H, J_{HCP} = 22.7 Hz, C**H**$_2$P(O)(OEt)$_2$), 2.62 (t, 2H, J = 7.3 Hz, C**H**$_2$C(O)CH$_2$P(O)(OEt)$_2$), 2.07-2.02 (m, 4H, C**H**$_2$CH=CH-CH=CHC**H**$_2$), 1.61-1.56 (m, 2H, C**H**$_2$CH$_2$C(O)CH$_2$P(O)(OEt)$_2$), 1.51-1.47 (m, 2H, C**H**$_2$CH$_2$OTBS), 1.40-1.29 (m, 8H, CH$_2$), 1.33 (t, 2H, J = 7.0 Hz, OCH$_2$C**H**$_3$), 0.88 (s, 9H, SiC(C**H**$_3$)), 0.04 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 202.0, 132.7, 131.5, 130.8, 130.2, 63.3, 62.5 (d, J_{COP} = 6.4 Hz), 43.9, 42.4 (d, J_{CP} = 127 Hz), 32.8, 32.5, 32.3, 29.4, 28.4, 29.0, 28.7, 26.0, 25.7, 22.9, 18.4, 16.3 (d, J_{CCOP} = 6.4 Hz), –5.3. FTIR (neat), cm^1: 2930 (s), 2857 (s), 1716 (s). HRMS (ES) Calcd for $C_{26}H_{51}O_5PSi$ $[M + NH_4]^+$: 520.3587, Found: 520.3577.

Representative Procedure for Macrocyclization



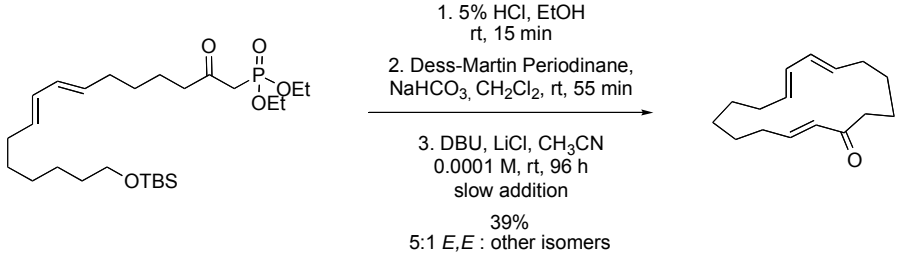
(2*E*,8*E*,10*E*)-cyclohexadeca-2,8,10-trienone: To a solution of ketophosphonate in ethanol (4.0 mL) at rt was added 5% conc. HCl in ethanol (986 μL). The reaction mixture was stirred at rt for 15 min, then was partitioned between ethyl acetate (25 mL) and half-saturated aqueous sodium bicarbonate solution (20 mL). The aqueous phase was extracted with ethyl acetate (2 x 10 mL). The combined organic extracts were dried over Na_2SO_4, filtered and evaporated to afford the alcohol, which was used directly in the next step without purification.

Solid sodium bicarbonate (54.8 mg, 0.652 mmol, 2.0 equiv.) and Dess–Martin periodinane (205.9 mg, 0.489 mmol, 1.5 equiv.) were added in sequence to a solution of alcohol

in dichloromethane (18.9 mL) at rt. The reaction mixture was stirred at rt for 55 min, then was partitioned between ethyl acetate (50 mL) and half-saturated aqueous sodium thiosulfate solution (20 mL). The layers were separated, and the organic phase was washed sequentially with half-saturated aqueous sodium thiosulfate solution (20 mL), saturated aqueous sodium bicarbonate solution (20 mL), and brine (10 mL). The organic phase was dried over Na_2SO_4 and concentrated, providing the aldehyde, which was used directly in the next step without purification.

To a suspension of lithium chloride (2.76 g, 65.2 mmol, 200 equiv., flame-dried prior to use) in acetonitrile (1.6 L) at rt was added DBU (390.3 μL, 2.61 mmol, 8.0 equiv.). The reaction mixture was stirred at rt and the aldehyde was added using a syringe pump as a solution in acetonitrile (50 mL) over 96 h. The mixture was partitioned between diethyl ether (500 mL) and 0.05 M aqueous sodium phosphate dibasic solution (500 mL). The organic phase was washed with water (300 mL) and brine (3 x 200 mL). The organic phase was dried over 1:1 $Na_2SO_4/MgSO_4$, filtered and concentrated. The residue was chromatographed on Davisil (2.5% → 5% diethyl ether in hexanes) to afford macrocycle (32.6 mg, 43%, 3:1 ratio of *E,E* diene : other diene isomers) as an oil. *E,E*/other diene isomer ratio determined by ^{1}H NMR integration ($\delta_{E,E}$ = 6.82 ppm, $\delta_{other\ isomers}$ = 6.78-6.71 ppm).

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.82 (dt, 1H, *J* = 6.7, 15.5 Hz, C**H**=CHCO), 6.13 (d, 1H, *J* = 15.7 Hz, CH=C**H**CO), 6.05-5.99 (m, 2H, CH=C**H**-C**H**=CH), 5.56 (dt, 1H, *J* = 7.6, 14.6 Hz, C**H**=CH-CH=CH), 5.49 (dt, 1H, *J* = 7.5, 14.6 Hz, CH=CH-CH=C**H**), 2.36 (t, 2H, *J* = 7.3 Hz, C(O)C**H$_2$**), 2.18-2.13 (m, 4H, C**H$_2$**CH=CH-CH=CHC**H$_2$**), 2.12-2.09 (m, 2H, C**H$_2$**CH=CHCO), 1.64-1.57 (m, 2H, CH_2), 1.48-1.46 (m, 6H, CH_2), 1.34-1.29 (m, 2H, CH_2). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 201.6, 147.3, 132.7, 132.2, 131.2, 131.1, 128.5, 42.3, 32.1, 31.1, 30.7, 27.8, 27.2, 27.2, 25.5, 25.1. FTIR (neat), cm^1: 2928 (s), 2853 (s), 1691 (m). HRMS (ES): Calcd for $C_{16}H_{24}O$ $[M + H]^+$: 233.1905, Found: 233.1913.



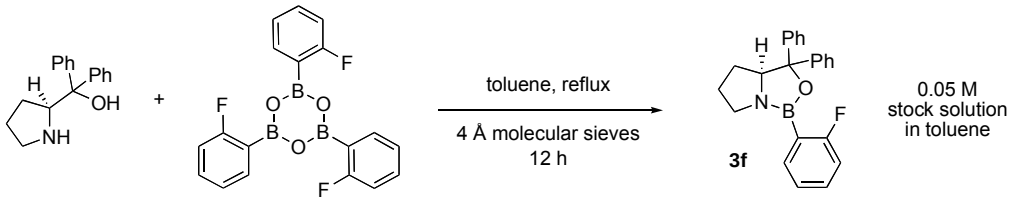
(2*E*,7*E*,9*E*)-cyclopentadeca-2,7,9-trienone: Ketophosphonate (120.7 mg, 0.240 mmol, 1.0 equiv.) was subjected to the representative reaction sequence. Chromatography (2.5% → 5%

diethyl ether in hexanes) afforded macrocycle (21.9 mg, 39%, 5:1 ratio of *E,E* diene : other diene isomers) as an oil. *E,E*/other diene isomer ratio determined by ^{1}H NMR integration (δ_E = 6.63 ppm, $\delta_{other\ diene\ isomers}$ = 6.72-6.66 ppm).

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.63 (dt, 1H, *J* = 7.2, 16.0 Hz, C**H**=CHCO), 6.04-5.97 (m, 2H, CH=C**H**-C**H**=CH), 5.95 (d, 1H, *J* = 16.0 Hz, CH=C**H**CO), 5.50 (dt, 1H, *J* = 7.5, 14.2 Hz, C**H**=CH-CH=CH), 5.40 (dt, 1H, *J* = 7.5, 14.3 Hz, CH=CH-CH=C**H**), 2.57 (t, 2H, *J* = 7.8 Hz, COC**H$_2$**), 2.21-2.18 (m, 2H, C**H$_2$**CH=CHCO), 2.18-2.09 (m, 4H, C**H$_2$**CH=CH-CH=CHC**H$_2$**), 1.65-1.60 (m, 2H, $COCH_2$C**H$_2$**), 1.55-1.51 (m, 2H), 1.46-1.40 (m, 4H), 1.25-1.20 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 201.5, 147.9, 132.7, 131.9, 131.7, 131.5, 131.5, 38.9, 32.5, 31.9, 30.7, 26.8, 26.6, 25.8, 25.1, 23.8. FTIR (neat), cm^1: 2528 (s), 2854 (s), 1671 (m). HRMS (ES): Calcd for $C_{16}H_{24}O$ $[M + H]^+$: 233.1905, Found: 233.1905.

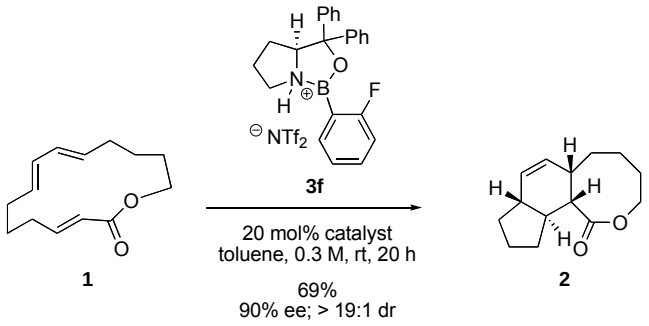
Transannular Diels Alder Reactions:

Preparation of Catalyst Precursor (S8)

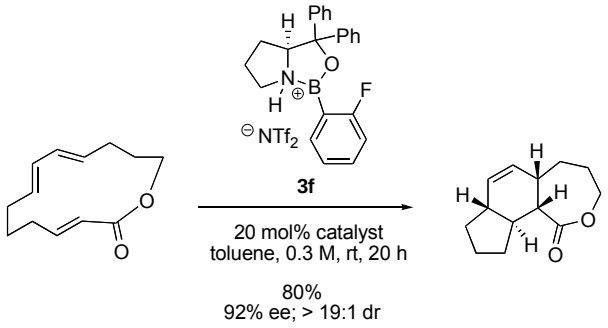


A solution of (*S*)-(–)-α,α-diphenyl-2-pyrrolidinemethanol (60.7 mg, 0.237 mmol, 1.0 equiv.) and tri-2-fluorophenylboroxine (*S9*) (28.6 mg, 0.78 mmol, 0.33 equiv.) in toluene (12 mL) was prepared in a 10 mL recovery flask with stir bar. This flask had been previously marked with a line denoting 4.75 mL in volume. This flask was fitted with a Dean–Stark trap with Teflon stopcock, the arm of which was filled with 4 Å molecular sieves. The solution was heated at reflux for 12 h in an oil bath (approximate temperature of 155 ºC). Upon completion of this reflux period, the solvent was drained from the Dean–Stark trap. The flask was removed from the oil bath briefly and refilled with toluene (10 mL) through the top of the Dean–Stark apparatus. The solution was concentrated by distillation into the Dean-Stark trap until a volume of approximately 1 mL was reached. This distillation procedure was repeated two more times, draining the trap after each iteration. After the final distillation, the entire apparatus was cooled to rt. Toluene was then added to the flask through the top of the apparatus until the total volume equaled 4.75 mL. The Dean–Stark trap was then quickly replaced by a rubber septum containing a nitrogen inlet line. The resulting 0.05 M stock solution of oxazaborolidine catalyst precursor **3f** was used immediately in the asymmetric TADA reaction.

Representative Procedure for Asymmetric TADA

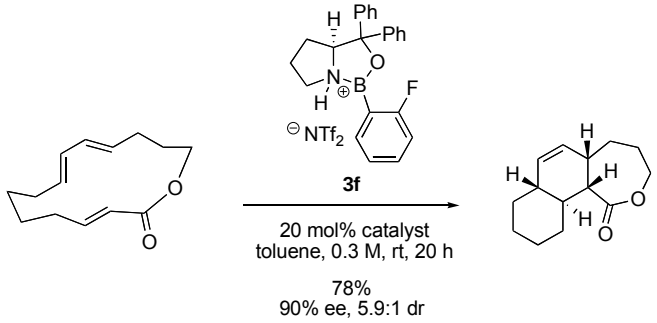


(3a*R*, 5a*S*, 11a*S*, 11b*S*)-2,3,3a,5a,6,7,8,9,11a,11b-decahydro-1*H*-10-oxa-cycloocta[e]inden-11-one (2): A 2-dram vial containing a stir bar and fitted with a screw cap lid containing a Teflon septum was flame dried and allowed to cool under high vacuum. The vial was placed under an a nitrogen atmosphere and a solution of catalyst precursor (748 μL of a 0.05 M stock solution, 0.037 mmol, 0.3 equiv.) was added. The toluene was removed from this solution using high vacuum, and after evacuating the vial and backfilling with nitrogen three times, the residual colorless oil was redissolved in toluene (195 μL). This solution was cooled to –20 ºC and trifluoromethanesulfonimide (25.0 μL of 1.0 M stock solution in toluene, 0.025 mmol, 0.2 equiv.) was added dropwise to the catalyst precursor. The trifluoromethanesulfonimide used to make this stock solution was stored in a glove box, and the stock solution was freshly prepared immediately prior to use. The resulting pale yellow solution was stirred at –20 ºC for 30 min. During this time, macrocycle **1** (27.5 mg, 0.125 mmol, 1.0 equiv.) was azeotroped with benzene (3 x 300 μL) and placed under nitrogen. The macrocycle was added to the reaction mixture as a solution in toluene (100 μL) and the addition was quantitated with toluene (2 x 50 μL). The reaction mixture was immediately warmed to room temperature and stirred for 20 h. Addition of triethylamine (10 μL), concentration of the reaction mixture, and flash chromatography on Davisil (2.5% → 5% diethyl ether in hexanes) afforded TADA product **2** (18.9 mg, 69 %, >19:1 ratio of diastereomers) as an oil; 90% enantiomeric excess as determined by analysis using chiral GC (β-cyclodex, 125 ºC isotherm, $rt_{minor\ enantiomer}$ = 58.8 min, $rt_{major\ enantiomer}$ = 57.7 min). $[\alpha]_D^{27}$ +158.3º (c = 0.905, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.78 (d, 1H, *J* = 10.1 Hz, C**H**=CH), 5.41 (ddd, *J* = 2.8, 3.7, 9.6 Hz, CH=C**H**), 4.41-4.20 (m, 2H, $CO_2C\mathbf{H_2}$), 2.71-2.69 (m, 1H, CH=CHC**H**CHCO$_2$), 2.66 (dd, 1H, *J* = 6.9, 11.0 Hz, C**H**CO$_2$), 2.07 (m, 1H), 1.96-1.62 (m, 8H), 1.54-1.50 (m, 1H), 1.32-1.10 (m, 4H). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 177.6, 132.5, 129.0, 65.6, 48.7, 45.2, 44.4, 40.5, 33.2, 30.1, 28.8, 27.9, 25.8, 22.3. FTIR (neat), cm^1: 2359 (m), 1742 (s). HRMS (ES): Calcd for $C_{14}H_{20}O_2$ $[M + H]^+$: 221.1541, Found: 221.1533.



(3a*R*, 5a*S*, 10a*S*, 10b*S*)-2,3,3a,5a,6,7,8,9,10a,10b-decahydro-9-oxa-cyclohepta[e]inden-10-one: Macrocycle (20.5 mg, 0.099 mmol, 1.0 equiv.) was subjected to the representative TADA reaction conditions. Chromatography (2.5% → 5% → 10% diethyl ether in hexanes) afforded TADA product (16.5 mg, 80%, > 19:1 ratio of diastereomers) as an oil; 92% enantiomeric excess as determined by analysis using chiral GC (γ-TA, 130 ºC isotherm, $rt_{minor\ enantiomer}$ = 108 min, $rt_{major\ enantiomer}$ = 111 min).

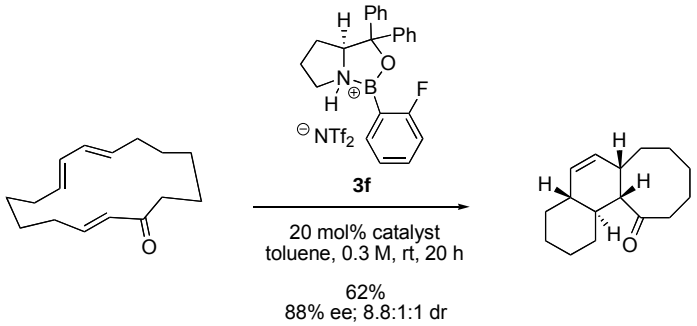
$[\alpha]_D^{27}$ +157º (c = 0.825, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.99 (ddd, 1H, *J* = 2.5, 2.5, 9.5 Hz, C**H**=CH), 5.43 (ddd, 1H, *J* = 2.6, 9.5 Hz, CH=C**H**), 4.34 (ddd, 1H, *J* = 4.2, 4.2. 12.4 Hz, C$\mathbf{H_2}$O), 4.27 (ddd, 1H, *J* = 2.9, 6.1, 12.4 Hz, C$\mathbf{H_2}$O), 3.04 (dd, 1H, *J* = 11.1, 11.1 Hz, C**H**CO_2), 2.59-2.55 (m, 1H, CH=CHC**H**$CHCO_2$), 2.08-2.03 (m, 2H), 1.97-1.92 (m, 1H), 1.87-1.68 (m, 6H), 1.64-1.56 (m, 1H), 1.30 (ddd, 1H, *J* = 8.6, 10.5, 12.0 Hz), 1.11 (ddd, 1H, *J* = 7.9, 11.1, 12.1 Hz). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 175.1, 133.3, 131.1, 65.1, 49.0, 44.5, 42.6, 33.7, 30.3, 29.2, 29.1, 26.8, 22.8. FTIR (neat), cm^1: 2940 (m), 2868 (s), 1728 (s). HRMS (ES): Calcd for $C_{13}H_{18}O_2$ [M + H]$^+$: 207.1385, Found: 207.1395.



(4a*R*, 6a*S*, 11a*S*, 11b*S*)-2,3,4,4a,6a,7,8,9,11a,11b-decahydro-1*H*-10-oxa-cyclohepta[a]napthalen-11-one: Macrocycle (26.2 mg, 0.119 mmol, 1.0 equiv.) was subjected to the representative TADA reaction conditions. Chromatography (2.5% → 5% → 10% diethyl ether in hexanes) afforded the TADA product (20.5 mg, 78%, 5.9:1 ratio of diastereomers) as an oil; 90% enantiomeric excess as determined by analysis using chiral GC (γ-TA, 130 ºC isotherm, $rt_{minor\ enantiomer}$ = 179 min, $rt_{major\ enantiomer}$ = 191.4 min). Diastereomeric ratio determined by ^{1}H NMR

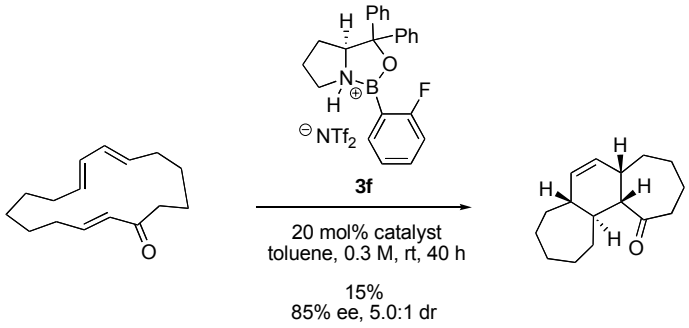
integration (δ_{major} = 5.57 ppm, δ_{minor} = 5.79 ppm).

$[\alpha]_D^{27}$ +55.1º (c = 1.025, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.57 (ddd, 1H, *J* = 2.6, 4.6, 9.8 Hz, C**H**=CH), 5.44 (d, 1H, *J* = 9.8 Hz, CH=C**H**), 4.26-2.18 (m, 2H, $CO_2C\mathbf{H_2}$), 3.08 (dd, 1H, *J* = 6.2, 11.0 Hz, C**H**CO_2), 2.46 (m, 1H, CH=CHC**H**CHCO_2), 2.00-1.91 (m, 2H), 1.81-1.61 (m, 8H), 1.36-1.27 (m, 2H), 1.20-1.08 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 175.5, 132.1, 130.3, 67.1, 53.2, 43.3, 37.1, 34.5, 32.6, 31.8, 30.4, 27.9, 26.3, 26.3. FTIR (neat), cm^1: 2923 (s), 2852 (s), 1716 (s). HRMS (ES): Calcd for $C_{14}H_{20}O_2$ $[M + H]^+$: 221.1541, Found: 221.1537.



(4a*R*, 6a*S*, 12a*S*, 12b*S*)-2,3,4,4a,6a,7,8,9,10,11,12a,12b-dodecahydro-1*H*-cycloocta[a]napthalen-12-one: Macrocycle (32.6 mg, 0.140 mmol, 1.0 equiv., 4:1 mixture of *E,E* : other diene isomers) was subjected to the representative TADA reaction conditions. Chromatography (2.5% → 5% diethyl ether in hexanes) afforded the TADA product (20.1 mg, 62%, 83% based on *E,E* diene, 8.8:1.1:1 mixture of diastereomers) as an oil; 88% enantiomeric excess as determined by analysis using chiral GC (β-cyclodex, 100 ºC isotherm, $rt_{minor\ enantiomer}$ = 625 min, $rt_{major\ enantiomer}$ = 611 min). Diastereomeric ratio determined by ^{1}H NMR integration (δ_{major} = 5.47 ppm, δ_{minor} = 5.54 ppm, δ_{minor} = 5.63).

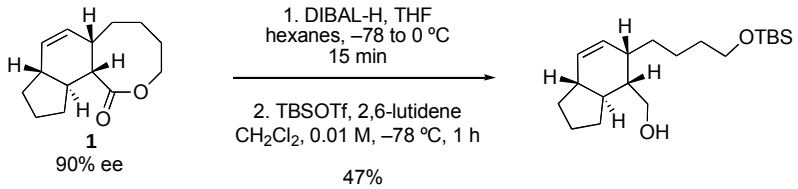
$[\alpha]_D^{27}$ +75.9º (c = 0.635, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.47 (ddd, 1H, *J* = 2.8, 4.4, 9.8 Hz, C**H**=CH), 5.36 (d, 1H, *J* = 10.0 Hz, CH=C**H**), 2.69-2.65 (m, 1H, C(O)$C\mathbf{H_2}$), 2.55 (dd, 1H, *J* = 5.9, 11.3 Hz, C**H**C(O)CH_2), 2.52-2.49 (m, 1H, CH=CHC**H**CHC(O)), 2.24 (ddd, 1H, *J* = 4.1, 6.9, 11.6 Hz, C(O)$C\mathbf{H_2}$), 1.98-1.91 (m, 1H). 1.81-1.64 (m, 8H), 1.61-1.54 (m, 2H), 1.52-1.46 (m, 1H), 1.46-1.28 (m, 4H), 1.12-1.06 (m, 1H), 0.96-0.90 (m, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 218.2, 131.2, 130.7, 58.4, 42.3, 39.6, 39.3, 37.5, 33.1, 31.3, 30.3, 27.3, 27.3, 27.0, 26.7, 26.6. FTIR (neat), cm^1: 3010 (w), 2924 (s), 2852 (s), 1699 (s). HRMS (ES): Calcd for $C_{13}H_{18}O_2$ $[M + H]^+$: 233.1905, Found: 233.1907.



(5a*R*, 7a*S*, 12a*R*, 12b*R*)-3,4,5,5a,7a,8,9,10,11,12,12a,12b-decahydro-2*H*-benzo[1,2;3,4]dicyclohepten-1-one: Macrocycle (21.9 mg, 0.094 mmol, 1.0 equiv., 5:1 mixture of *E,E* : other diene isomers) was subjected to the representative TADA reaction conditions. The reaction proceeded to 25% conversion as measured by ^{1}H NMR integration. Chromatography (2.5% → 5% diethyl ether in hexanes) afforded the TADA product (3.2 mg, 15%, 5.0:1 mixture of diastereomers) as an oil. 85% enantiomeric excess as determined by analysis using chiral GC (γ-TA, 90 ºC isotherm, 2 sequential 600 min runs, $rt_{minor\ enantiomer}$ = 1087 min, $rt_{major\ enantiomer}$ = 1065 min). Diastereomeric ratio determined by ^{1}H NMR integration (δ_{major} = 5.65 ppm, δ_{minor} = 5.60 ppm).

$[\alpha]_D^{27}$ –145.0º (c = 0.160, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.65 (ddd, 1H, *J* = 2.3, 5.1, 9.7 Hz, C**H**=CH), 5.36 (ddd, 1H, *J* = 1.9, 1.9, 10.0 Hz, CH=C**H**), 2.55-2.40 (m, 3H, C**H**C(O)C**H$_2$**), 2.34-2.28 (m, 1H, CH=CH**CH**CHC(O)), 2.25 (m, 1H), 2.00-1.94 (m, 2H), 1.92-1.87 (m, 2H), 1.87-1.72 (m, 4H), 1.70-1.64 (m, 1H), 1.62-1.56 (m, 1H), 1.48-1.46 (m, 1H), 1.36-1.25 (m, 3H), 1.23-1.08 (m, 3H), 0.87 (ddd, 1H, *J* = 10.4, 10.4, 14.1 Hz). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 216.4, 131.9, 128.9, 53.8, 45.6, 40.4, 38.8, 38.5, 36.2, 31.7, 31.4, 30.7, 30.6, 26.7, 24.0, 23.1. FTIR (neat), cm^1: 2920 (s), 2850 (s), 1702 (s). HRMS (ES): Calcd for $C_{16}H_{24}O$ $[M + H]^+$: 233.1905, Found: 233.1897.

Determination of Absolute and Relative Stereochemical Outcome of TADA

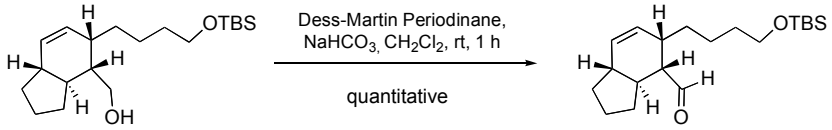


((3a*S*,4*S*,5*S*,7a*R*)-5-(4-(*tert*-butyldimethylsilyloxy)butyl)-2,3,3a,4,5,7a-hexahydro-1*H*-inden-4-yl)methanol: A solution of TADA product **1** (7.0 mg, 0.032 mmol, 1.0 equiv.) in tetrahydrofuran (1.0 mL) was cooled to –78 ºC and a solution of diisobutylaluminum hydride (95

μL of a 1.0 M solution in hexanes, 0.095 mmol, 3.0 equiv.) was added dropwise. The reaction mixture was stirred at –78 ºC for 15 min and warmed to 0 ºC for 15 min before recooling to –78 ºC. A saturated aqueous solution of Rochelle's salt (1 mL) and diethyl ether (1 mL) were added, and the resulting suspension was warmed to rt with rapid stirring. Upon formation of a biphasic system, the layers were separated and the aqueous phase was extracted with diethyl ether (2 x 1 mL) and ethyl acetate (1 mL). The combined organic extracts were dried over Na_2SO_4, filtered, and evaporated to afford the diol, which was used in the next step without further purification.

A solution of diol and 2,6-lutidene (8.9 μL, 0.077 mmol, 2.4 equiv.) in dichloromethane (3.2 mL) was cooled to –78 ºC and TBSOTf (9.0 μL, 0.038 mmol, 1.2 equiv.) was added dropwise. The reaction mixture was stirred at –78 ºC for 1 h. Saturated aqueous sodium bicarbonate solution (1 mL) was added, and the resulting suspension was warmed to rt. The crude reaction mixture was partitioned between ethyl acetate (10 mL) and half-saturated aqueous sodium bicarbonate (5 mL). The organic phase was washed with saturated aqueous copper (II) sulfate (5 mL) and brine (2 x 5 mL), dried over Na_2SO_4, filtered and evaporated. The residue was chromatographed on Davisil (10% → 25% diethyl ether in hexanes) to afford the monoprotected diol (5.1 mg, 47%) as an oil.

$[\alpha]_D^{27}$ +114.5º (c = 0.255, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.83 (d, 1H, *J* = 10.0 Hz, C**H**=CH), 5.72 (ddd, 1H, *J* = 2.8, 4.1, 9.8 Hz, CH=C**H**), 3.73 (dd, 1H, *J* = 5.7, 10.7 Hz, C**H**$_2$OH), 3.66 (dd, 1H, *J* = 10.5, 10.5 Hz, C**H**$_2$OH), 3.63-3.59 (m, 2H, C**H**$_2$OTBS), 2.42-2.40 (C**H**CHCH$_2$OH), 1.92-1.78 (m, 3H), 1.76-1.67 (m, 3H), 1.59-1.46 (m, 3H), 1.37-1.29 (m, 1H), 1.25-1.09 (m, 4H), 0.89 (s, 9H, SiC(C**H**$_3$)), 0.05 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 131.1, 129.4, 63.7, 63.2, 46.7, 45.5, 42.2, 37.1, 33.3, 30.3, 28.7, 27.7, 26.0, 23.8, 22.5, 18.4, –5.2. FTIR (neat), cm^1: 3390 (s, br), 2954 (m), 2930 (s), 2860 (m). HRMS (ES): Calcd for $C_{20}H_{38}O_2Si$ $[M + H]^+$: 339.2719, Found: 339.2704.



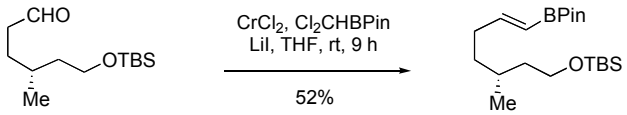
(3a*S*,4*S*,5*S*,7a*R*)-5-(4-(*tert*-butyldimethylsilyloxy)butyl)-2,3,3a,4,5,7a-hexahydro-1*H*-indene-4-carbaldehyde: Solid sodium bicarbonate (2.2 mg, 0.026 mmol, 2.0 equiv.) and Dess–Martin periodinane (8.3 mg, 0.020 mmol, 1.5 equiv.) were added in sequence to a solution of alcohol (5.1 mg, 0.015 mmol, 1.0 equiv) in dichloromethane (760 μL) at rt. The reaction mixture was

stirred at rt for 55 min, then was partitioned between ethyl acetate (5 mL) and half-saturated aqueous sodium thiosulfate solution (2 mL). The layers were separated, and the organic phase was washed sequentially with half-saturated aqueous sodium thiosulfate solution (2.5 mL), half-saturated aqueous sodium bicarbonate solution (5 mL), and brine (2.5 mL). The organic phase was dried over Na_2SO_4 and concentrated, providing the aldehyde as an oil (5.0 mg, quantitative), which was of sufficient purity to characterize directly. Characterization data matched that reported previously, (*S10*) except for the optical rotation, which was opposite in sign.

$[\alpha]_D^{27}$ +112.8º (c = 0.250, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 9.79 (d, 1H, *J* = 2.5 Hz, C**H**=O), 5.88 (d, 1H, *J* = 10.0 Hz, C**H**=CH), 5.68 (ddd, 1H, *J* = 2.6, 4.0, 10.0 Hz, CH=C**H**), 3.59-3.57 (m, 2H, C**H**$_2$OTBS), 2.74 (m, 1H, CH=CHC**H**CHCH=O), 2.57 (ddd, *J* = 2.5, 6.3, 11.3 Hz, C**H**CH=O), 2.08-2.03 (m, 1H), 1.86-1.80 (m, 2H), 1.78-1.72 (m, 2H), 1.70-1.61 (m, 1H), 1.56-1.42 (m, 3H), 1.41-1.38 (m, 2H), 1.35-1.30 (m, 1H), 1.21-1.06 (m, 2H), 0.88 (s, 9H, SiC(C**H**$_3$)), 0.04 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 205.0, 129.9, 129.8, 62.9, 56.8, 45.5, 39.9, 37.3, 32.9, 32.6, 28.3, 27.6, 26.0, 23.9, 22.5, 18.3, –5.3. FTIR (neat), cm^1: 2951 (m), 2929 (s), 2860 (m), 1723(s), HRMS (ES): Calcd for $C_{20}H_{36}O_2Si$ $[M + H]^+$: 337.2563, Found: 337.2574.

Catalyst Controlled Diastereoselective TADA Reactions

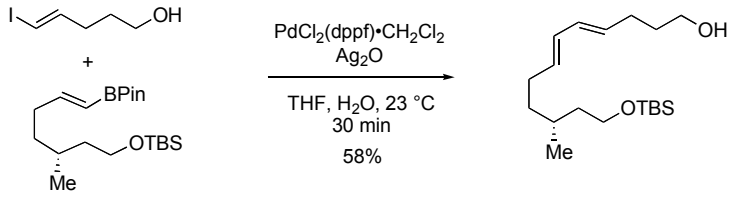
*Synthesis of Biased Macrocycle **4***



(*R*,*E*)-*tert*-butyldimethyl(3-methyl-7-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)hept-6-enyloxy)silane: (*R*)-6-(*tert*-butyldimethylsilyloxy)-4-methylhexanal (*S11*) was subjected to the representative Takai olefination procedure using anhydrous chromium (II) chloride (1.36 g, 11.04 mmol, 6.0 equiv.), $Cl_2CHBPin$ (599.0 mg, 2.76 mmol, 1.5 equiv.) and lithium iodide (739.0 mg, 5.52 mmol, 3.0 equiv.). Chromatography (10% diethyl ether in hexanes) afforded vinyl pinacol boronate ester (350.6 mg, 52%) as an oil.

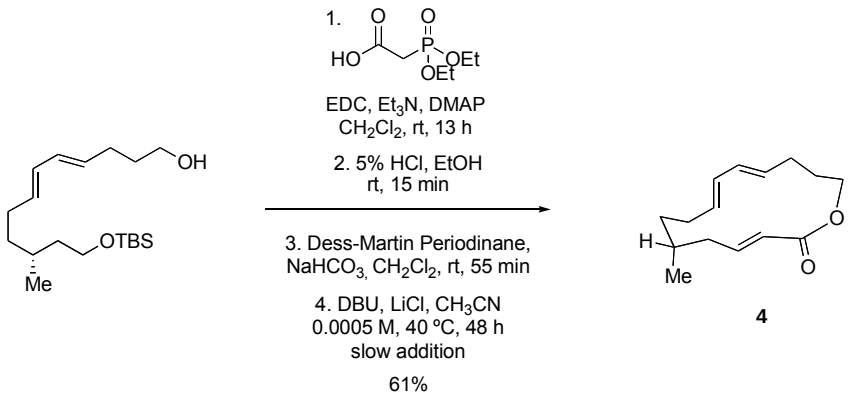
$[\alpha]_D^{27}$ +4.5º (c = 1.11, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.62 (dt, 1H, *J* = 6.4, 18.0 Hz, C**H**=CHBPin), 5.43 (d, 1H, *J* = 18.0 Hz, CH=C**H**BPin), 3.66-3.59 (m, 2H, C**H**$_2$OTBS), 2.22-2.09 (m, 2H, C**H**$_2$CH=CHBPin), 1.59-1.52 (m, 2H, C**H**$_2$CH$_2$OTBS and C**H**CH$_3$), 1.46-1.40 (m, 1H, C**H**$_2$CH$_2$CH=CHBPin), 1.36-1.30 (m, 1H, C**H**$_2$CH$_2$OTBS), 1.26 (s, 12H, pinacol C**H**$_3$), 1.26-1.21 (m, 1H, C**H**$_2$CH$_2$CH=CHBPin), 0.88 (s, 9H, SiC(C**H**$_3$)), 0.87 (d, 3H, *J* = 6.4 Hz, CH(C**H**$_3$)), 0.04

(s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 154.8, 118.7, 83.0, 61.3, 39.8, 35.5, 33.3, 29.1, 28.0, 24.8, 19.5, 18.3, –5.3. FTIR (neat), cm^1: 2978 (m), 2957 (s), 2929 (s), 2857 (m), 1639 (w). HRMS (ES): Calcd for $C_{20}H_{41}BO_3Si$ $[M + H]^+$: 369.2996, Found: 369.2997.



(*R*,4*E*,6*E*)-12-(*tert*-butyldimethylsilyloxy)-10-methyldodeca-4,6-dien-1-ol: Vinyl iodide (198 mg, 0.934 mmol, 1.0 equiv.) and vinyl pinacol boronate ester (350 mg, 0.950 mmol, 1.0 equiv.) were cross-coupled using the representative procedure. Chromatography on Davisil (15% ethyl acetate in hexanes) afforded the diene (181.0 mg, 58%) as an oil.

$[\alpha]_D^{27}$ +4.3º (c = 0.720, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.06-5.97 (m, 2H, CH=C**H**-C**H**=CH), 5.60-5.53 (m, 2H, C**H**=CH-CH=C**H**), 3.67-3.59 (m, 4H, C**H**$_2$OH, C**H**$_2$OTBS), 2.15 (ddd, 2H, *J* = 6.8, 6.8, 6.8 Hz, CH=CHC**H**$_2$CH$_2$CH$_2$OH), 2.11-1.99 (m, 2H, CH(CH$_3$)CH$_2$C**H**$_2$CH=CH), 1.69-1.63 (m, 2H, C**H**$_2$CH$_2$OH), 1.58-1.51 (m, 2H, TBSOCH$_2$C**H**$_2$), 1.42-1.17 (m, 4H), 0.89 (s, 9H, SiC(C**H**$_3$)), 0.87 (d, 3H, *J* = 6.8 Hz, CH(C**H**$_3$)), 0.04 (s, 6H, SiC**H**$_3$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 133.0, 131.1, 131.1, 130.0, 62.5, 61.4, 39.8, 36.7, 32.3, 30.0, 29.0, 28.9, 26.0, 19.5, 18.3, –5.3. FTIR (neat), cm^1: 3255 (s, br), 2954 (m), 2930 (s). HRMS (ES): Calcd for $C_{19}H_{38}O_2Si$ $[M + H]^+$: 327.2719, Found: 327.2732.

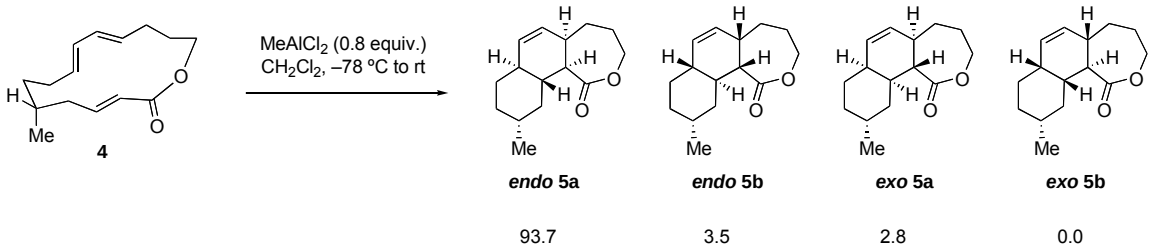


(3*E*,9*E*,11*E*)-(*R*)-6-Methyl-oxacyclopentadeca-3,9,11-trien-2-one (4):

Diene (53.9 mg, 0.165 mmol, 1.0 equiv.) was subjected to the representative macrolactonization reaction sequence. Chromatography afforded macrolactone **4** (23.7 mg, 61%)

as a colorless oil.

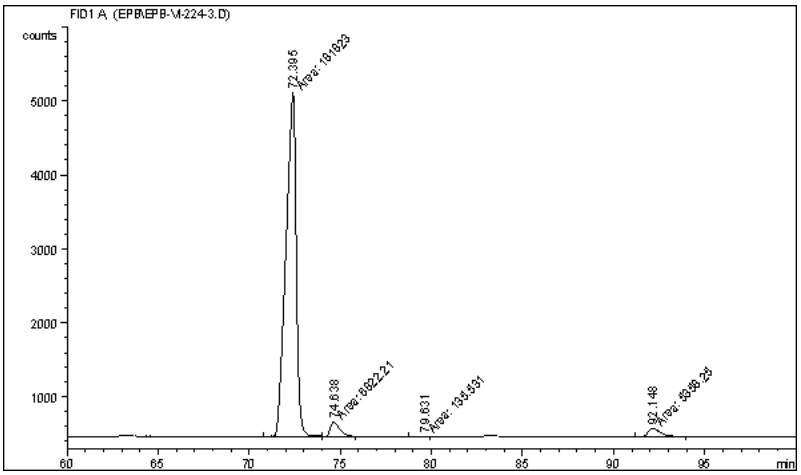
$[\alpha]_D^{27}$ –59.6º (c = 0.490, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.79 (dt, 1H, *J* = 7.2, 14.9 Hz, C**H**=CHCO$_2$), 5.94 (dd, 1H, *J* = 10.1, 14.9 Hz, CH=C**H**-CH=CH), 5.88 (dd, 1H, *J* = 10.3, 15.1 Hz, CH=CH-C**H**=CH), 5.66 (d, *J* = 15.8 Hz), CH=C**H**CO$_2$), 5.54 (ddd, 1H, *J* = 7.5, 7.5, 14.8 Hz, CH=CH-CH=C**H**), 5.50 (ddd, 1H, *J* = 6.3, 8.6, 15.1 Hz, C**H**=CH-CH=CH), 4.49 (ddd, 1H, *J* = 2.6, 8.2, 11.1, CO$_2$C**H$_2$**), 4.05 (ddd, 1H, *J* = 2.8, 6.4, 11.4, CO$_2$C**H$_2$**), 2.32-2.27 (m, 1H, C**H$_2$**C=CH-CH=CH), 2.21-2.13 (m, 1H, CH=CH-CH=CHC**H$_2$**), 2.08 (dddd, 1H, *J* = 2.3, 2.3, 6.9, 13.9 Hz, C**H$_2$**CH=CHCO$_2$), 1.90 (ddd, 1H, *J* = 8.1, 10.1, 13.9 Hz, C**H$_2$**CH=CHCO$_2$), 1.85-1.73 (m, 3H, C**H$_2$**CH=CH-CH=CH and C**H$_2$**CH$_2$O), 1.48-1.43 (m, 1H, C**H**(CH$_3$)), 1.38 (dddd, 1H, *J* = 2.3, 6.2, 6.2, 13.9 Hz, C**H$_2$**CH(CH$_3$)CH$_2$CH=CHCO$_2$), 1.29 (dddd, 1H, *J* = 2.3, 2.3, 13.9, 13.9 Hz, C**H$_2$**CH(CH$_3$)CH$_2$CH=CHCO$_2$), 1.02 (3H, d, *J* = 6.9 Hz, CH(C**H$_3$**)). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 166.8, 148.9, 132.0, 132.0, 131.8, 130.1, 122.5, 65.2, 40.2, 36.2, 33.0, 32.1, 30.1, 27.8, 23.2. FTIR (neat), cm^1: 2950 (m), 2921(s) 1720 (s). HRMS (ES): Calcd for $C_{15}H_{22}O_2$ $[M + H]^+$: 235.1698, Found: 235.1701.



Note: this representative procedure was used to prepare all racemic TADA adducts for ee analysis

To a solution of macrocycle **4** (3.0 mg, 0.013 mmol, 1.0 equiv.) in dichloromethane (250 μL) at –78 ºC was added $MeAlCl_2$ (10 μL of a 1.0 M solution in hexanes, 0.01 mmol, 0.8 equiv.). The solution was allowed to warm to rt over 5 h. A saturated aqueous solution of Rochelle's salt (1 mL) and diethyl ether (1 mL) were added to the mixture, and the resulting suspension was stirred until the mixture became biphasic. The layers were separated and the aqueous phase was washed with diethyl ether (2 x 1.5 mL). The combined organic extracts were dried over Na_2SO_4, filtered, and evaporated. Purification of the residue by flash chromatography on Davisil (5% → 10% → 25% diethyl ether in hexanes) afforded the TADA products (2.5 mg, 83%) as an inseparable mixture. Analysis of the product mixture using ^{1}H NMR integration ($\delta_{endo\ 5a}$ = 5.48 ppm, $\delta_{endo\ 5b}$ = 5.44 ppm; $\delta_{endo\ 5a}$ = 5.75 ppm, $\delta_{exo\ 5b}$ = 5.81 ppm) and chiral GC (β-cyclodex, 150 ºC isotherm, $rt_{endo\ 5a}$ = 72.4 min, $rt_{endo\ 5b}$ = 74.7 min, $rt_{exo\ 5a}$ = 79.5 min, $rt_{exo\ 5b}$ = 92.1 min) showed

a 93.7 : 3.5 : 2.8 : 0.0 ratio of ***endo* 5a** : ***endo* 5b** : ***exo* 5a** : ***exo* 5b** diastereomers.



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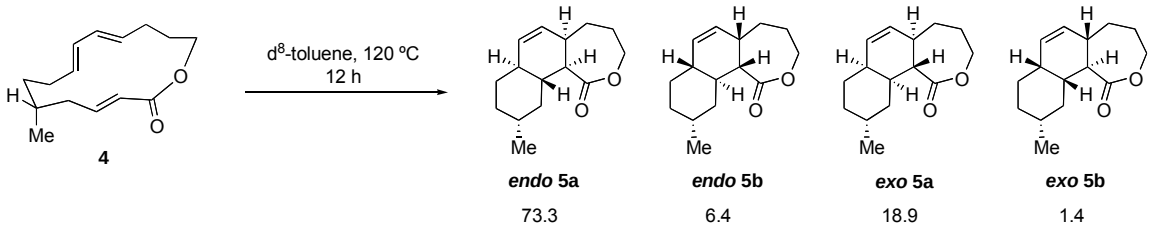
1	72.395	MM	0.6517	1.81823e5	4649.95361	93.65611
2	74.638	MM	0.5850	6822.20898	194.38144	3.51408
3	79.631	MM	0.4654	135.53064	4.85334	0.06981
4	92.148	MM	0.7868	5358.24609	113.50375	2.76000

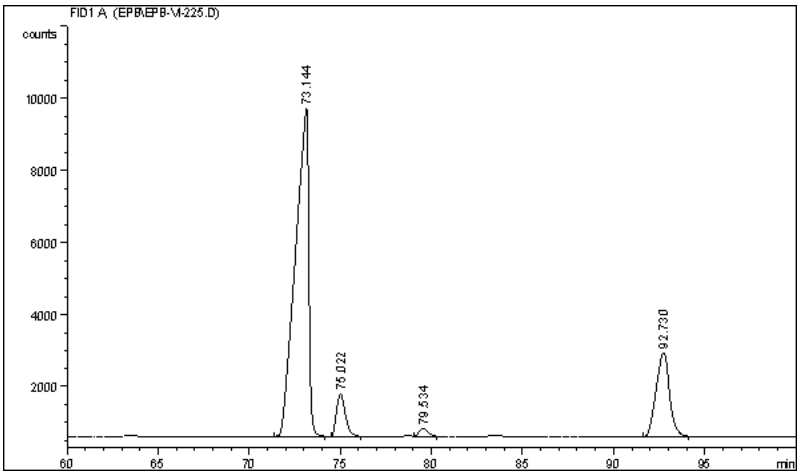
Characterization of the major ***endo* 5a** diastereomer:

$[\alpha]_D^{27}$ –25.6º (c = 0.125, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.58 (ddd, 1H, *J* = 2.5, 4.0, 9.7 Hz, C**H**=CH), 5.48 (d, 1H, *J* = 9.8 Hz, CH=C**H**), 4.27-4.19 (m, 2H, $CO_2C\mathbf{H_2}$), 3.08 (dd, 1H, *J* = 6.3, 10.8 Hz, C**H**CO_2), 2.48 (m, 1H, CH=CHC**H**CHCO_2), 1.99-1.92 (m, 2H), 1.82-1.61 (m, 7H), 1.53-1.47 (m, 1H), 1.16 (dddd, 1H, *J* = 3.4, 12.9, 12.9, 12.9 Hz), 1.01 (dddd, 1H, *J* = 3.8, 13.0, 13.0, 13.0 Hz), 0.92-0.87 (m, 1H), 0.92 (d, 3H, *J* = 6.6 Hz, CHC$\mathbf{H_3}$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 175.5, 132.0, 130.4, 67.2, 53.2, 42.8, 39.0, 36.9, 35.1, 34.5, 32.9, 32.3, 31.8, 27.9, 22.4. FTIR (neat), cm^1: 3017 (w), 2917 (m), 2845 (s), 1714 (s). HRMS (ES): Calcd for $C_{15}H_{22}O_2$ [M + H]$^+$: 235.1698, Found: 235.1698.



A solution of macrocycle **4** (1.2 mg, 0.005 mmol, 1.0 equiv.) in d^8-toluene (2 mL) was heated in an NMR tube to 120 ºC for 12 h. Concentration of the reaction mixture afforded the TADA products as an inseparable mixture. Analysis of the product mixture using ^{1}H NMR integration and chiral GC showed a 73.3 : 6.4 : 18.9 : 1.4 ratio of ***endo* 5a** : ***endo* 5b** : ***exo* 5a** : ***exo***

5b diastereomers.



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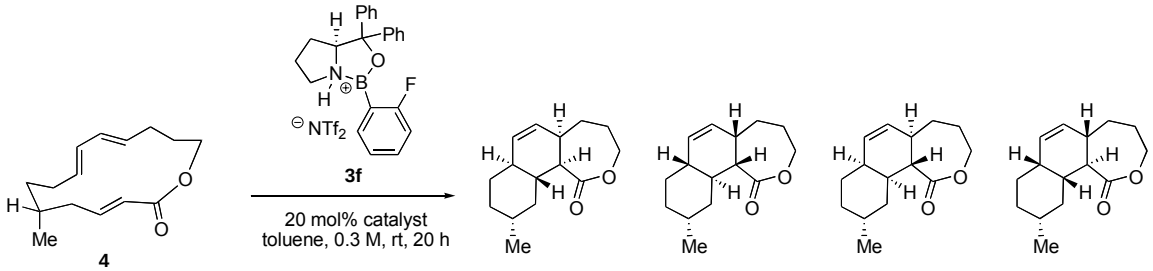
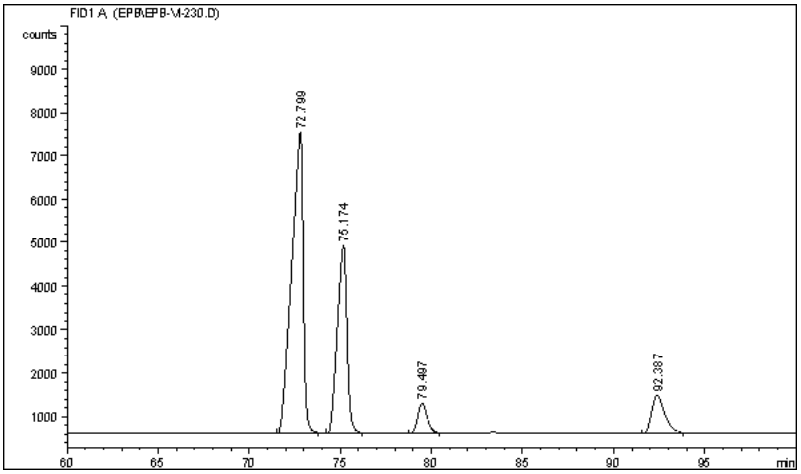
1	73.144	VV	0.6025	4.63146e5	9119.38672	73.30850
2	75.022	VV	0.4017	4.04745e4	1187.46191	6.40646
3	79.534	VV	0.4265	8623.91211	238.68602	1.36502
4	92.730	BV	0.5951	1.19532e5	2359.12451	18.92001

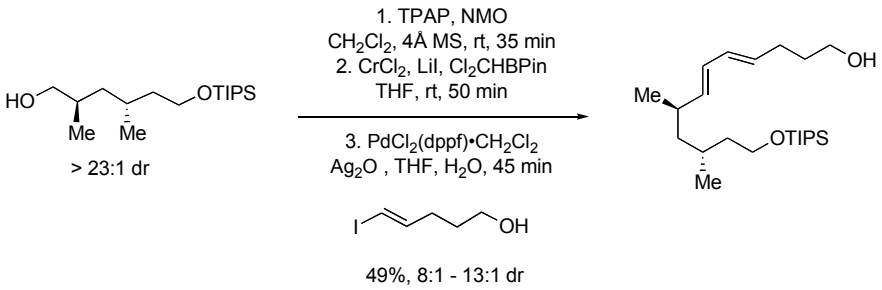


Macrocycle **4** (9.8 mg, 0.042 mmol, 1.0 equiv.) was subjected to the representative TADA reaction conditions. Chromatography (2.5% → 5% → 10% diethyl ether in hexanes) afforded TADA products (9.7 mg, quantitative) as an inseparable mixture. Analysis of the product mixture using ^{1}H NMR integration and chiral GC showed a 57.3 : 29.8 : 8.1 : 4.7 ratio of ***endo* 5a** : ***endo* 5b** : ***exo* 5a** : ***exo* 5b** diastereomers.



Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	72.799	VV	0.5209	3.05321e5	6918.09229	57.34933
2	75.174	BV	0.4357	1.58632e5	4317.40381	29.79631
3	79.497	VB	0.4210	2.50975e4	698.83429	4.71415
4	92.387	VB	0.5885	4.33375e4	868.06116	8.14022

*Synthesis of Unbiased Macrocycle **6**:*



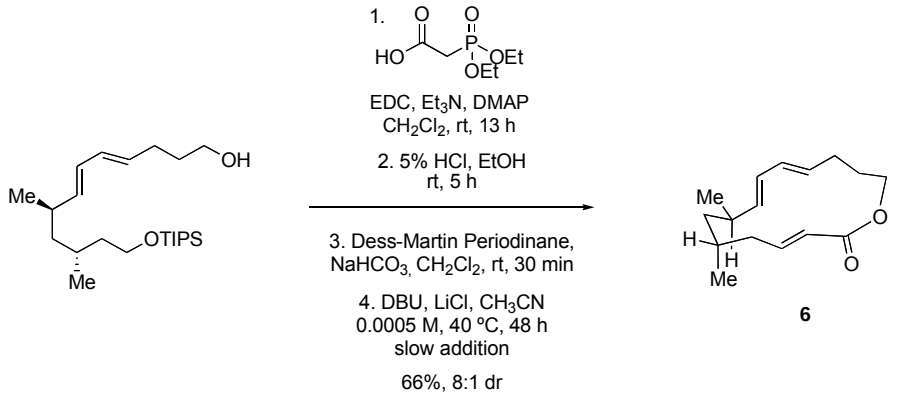
(4*E*,6*E*,8*R*,10*R*)-8,10-dimethyl-12-(triisopropylsilyloxy)dodeca-4,6-dien-1-ol: To a suspension of (2*R*,4*R*)-2,4-dimethyl-6-(triisopropylsilyloxy)hexan-1-ol (*S12*) (150 mg, 0.496 mmol, 1.0 equiv.), NMO (87.1 mg, 0.744 mmol, 1.5 equiv.) and powdered 4 Å molecular sieves (122 mg) in dichloromethane (2.6 mL) was added tetrapropyl ammonium perruthenate (TPAP) (8.8 mg, 0.025 mmol, 0.05 equiv.) as a solid. The reaction mixture was stirred at room temperature for 35 min. The mixture was diluted with 5% diethyl ether in hexanes (5 mL) and filtered through a pad of silica gel, rinsing with 5% diethyl ether in hexanes (25 mL). Concentration of the filtrate afforded the desired aldehyde (112.1 mg, 0.372 mmol), which was used immediately without further purification.

The aldehyde was subjected to the representative Takai olefination procedure using anhydrous chromium (II) chloride (600.0 mg, 4.88 mmol, 13.1 equiv.), $Cl_2CHBPin$ (330.8 mg, 1.49 mmol, 4.0 equiv.), and lithium iodide (398.7 mg, 2.98 mmol, 8.0 equiv.) in tetrahydrofuran (3.32 mL). Aldehyde, pinacol boronate and lithium iodide were added as solutions in

tetrahydrofuran (4.0 mL total). Standard work up after 50 min gave the desired vinyl pinacol boronate ester, which was used immediately without further purification.

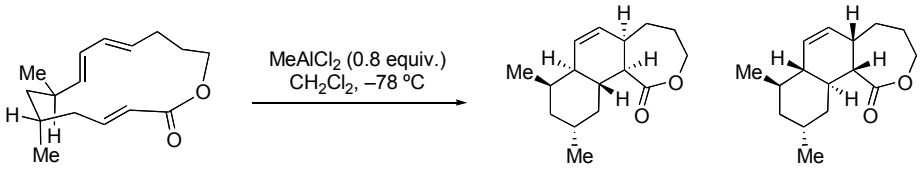
Vinyl iodide (71.7 mg, 0.338 mmol, 1.0 equiv.) and unpurified vinyl pinacol boronate ester were cross-coupled using the representative procedure. Chromatography on Davisil (1% → 2% diethyl ether in hexanes) afforded the diene (63.0 mg, 49%, epimerization occurs during the Takai olefination, with the ratio of diastereomers varying with each reaction and ranging between 8:1 and 13:1) as an oil. Diastereomeric ratio determined by ^{1}H NMR integration (δ_{major} = 5.46 ppm, δ_{minor} = 5.40 ppm).

$[\alpha]_D^{27}$ +6.0º (c = 0.050, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.02 (dd, 1H, *J* = 10.4, 14.8 Hz, CH=C**H**-CH=CH), 5.96 (dd, 1H, *J* = 10.4, 14.8 Hz, CH=CH-C**H**=CH), 5.56 (dt, 1H, *J* = 7.0, 14.4 Hz, CH=C**H**CH_2), 5.46 (dd, 1H, *J* = 7.8, 14.9 Hz, $CH(CH_3)$C**H**=CH), 3.74-3.65 (m, 2H, C**H$_2$**OTIPS), 3.66 (t, 2H, *J* = 6.4 Hz, C**H$_2$**OH), 2.29-2.22 (C**H**(CH_3)CH=CH), 2.15 (dt, 2H, *J* = 7.2, 7.2 Hz, CH=CHC**H$_2$**), 1.69-1.58 (m, 4H, C**H$_2$**CH_2OH, C**H**$(CH_3)CH_2CH_2$OTIPS and C**H$_2$**CH_2OTIPS), 1.36-1.28 (m, 1H, C**H$_2$**CH_2OTIPS), 1.24-1.20 (m, 1H, $CH(CH_3)$C**H$_2$**$CH(CH_3)$), 1.17-1.11 (m, 1H, $CH(CH_3)$C**H$_2$**$CH(CH_3)$), 1.10-1.05 (m, 21 H, $Si(CHC(CH_3)_2)_3$), 0.95 (d, 3H, *J* = 6.6 Hz, C**H$_3$**CH), 0.86 (d, 3H, *J* = 6.6 Hz, C**H$_3$**CH). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 139.3, 131.2, 131.1, 128.0, 62.5, 61.5, 44.8, 40.0, 34.1, 32.3, 28.9, 27.0, 20.4, 20.0, 18.1, 12.0. FTIR (neat), cm^1: 3350 (br, s), 2940 (s), 2866 (s). HRMS (ES): Calcd for $C_{23}H_{46}O_2Si$ $[M + H]^+$: 383.3345, Found: 383.3332.

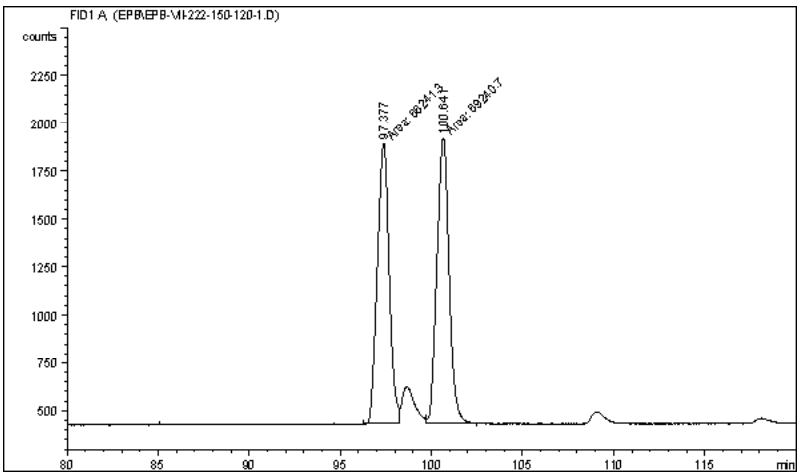


(2*E*,5*S*,7*R*,8*E*,10*E*)-5,7-dimethyl-oxacyclopentadeca-2,8,10-trienone (6): Diene (62.0 mg, 0.162 mmol, 1.0 equiv., 9:1 ratio of diastereomers) was subjected to the representative macrolactonization reaction sequence. Chromatography afforded macrolactone **6** (26.5 mg, 66%, 8:1 mixture of diastereomers) as a colorless oil. Diastereomeric ratio determined by ^{1}H NMR integration (δ_{major} = 5.41 ppm, δ_{minor} = 5.36 ppm).

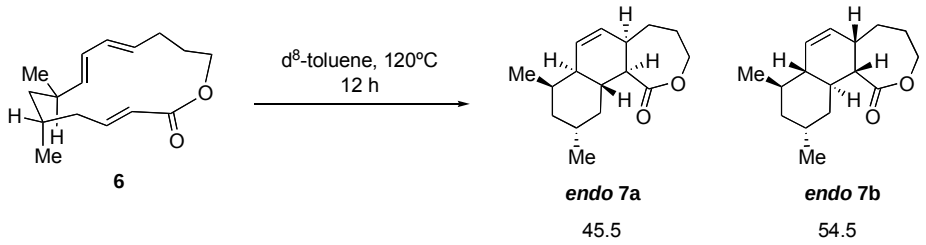
$[\alpha]_D^{27}$ –32.0º (c = 0.100, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.76 (ddd, 1H, *J* = 7.6, 7.6, 15.5 Hz, C**H**=$CHCO_2$), 5.93 (dd, 1H, *J* = 10.1, 15.1 Hz, CHCH=CH-C**H**=CH_2), 5.87 (dd, 1H, *J* = 10.1, 15.2 Hz, CHCH=C**H**-CH=$CHCH_2$), 5.62 (d, 1H, *J* = 15.7 Hz, CH=C**H**CO_2), 5.57 (ddd, 1H, *J* = 6.4, 8.1, 14.8 Hz, CHCH=CH-CH=C**H**CH_2), 5.41 (dd, 1H, *J* = 7.9, 15.2 Hz, $CH(CH_3)$C**H**=CH-CH=$CHCH_2$), 4.40 (ddd, 1H, *J* = 2.6, 6.9, 11.4 Hz, CO_2C**H$_2$**), 4.16 (ddd, 1H, *J* = 2.3, 8.6, 11.1 Hz, CO_2C**H$_2$**), 2.45-2.40 (m, 1H, C**H**(CH_3)CH=CH), 2.32-2.27 (m, 1H, CH=CH-CH=CHC**H$_2$**), 2.24-2.19 (m, 1H, CH=CH-CH=CHC**H$_2$**), 2.02-1.99 (m, 2H, C**H$_2$**CH=$CHCO_2$), 1.88-1.82 (m, 1H, CO_2CH_2C**H$_2$**), 1.79-1.73 (m, 1H, CO_2CH_2C**H$_2$**), 1.59-1.55 (m, 1H, C**H**$(CH_3)CH_2$CH=$CHCO_2$), 1.50 (ddd, 1H, *J* = 3.8, 3.8, 13.9 Hz, $CH(CH_3)$C**H$_2$**$CH(CH_3)$), 1.38 (ddd, 1H, *J* = 4.8, 6.0, 13.8 Hz, $CH(CH_3)$C**H$_2$**$CH(CH_3)$), 1.00 (d, 6H, *J* = 6.9 Hz, $CH(CH_3)CH_2CH(CH_3)$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 166.9, 149.3, 137.1, 132.6, 130.2, 129.9, 122.0, 65.4, 43.6, 40.4, 34.4, 31.8, 28.9, 27.8, 24.8, 18.4. FTIR (neat), cm^1: 2949 (m), 2909 (m), 1720 (s). HRMS (ES): Calcd for $C_{16}H_{24}O_2$ $[M + H]^+$: 249.1854, Found: 249.1859.



To a solution of macrocycle **6** (1.0 mg, 0.004 mmol, 1.0 equiv., 13:1 ratio of diastereomers) in dichloromethane (200 μL) at –78 ºC was added $MeAlCl_2$ (3.2 μL of a 1.0 M solution in hexanes, 0.0032 mmol, 0.8 equiv.). The solution was allowed to warm to rt over 35 min and stirred for an additional 20 min. A saturated aqueous solution of Rochelle's salt (250 μL) and diethyl ether (1 mL) were added to the mixture, and the resulting suspension was stirred until the mixture became biphasic. The layers were separated and the aqueous phase was extracted with diethyl ether (2 x 1 mL). The combined organic extracts were dried over Na_2SO_4, filtered, and evaporated. Purification of the residue by flash chromatography on Davisil (2.5% → 5% → 10% diethyl ether in hexanes) afforded the TADA products as an inseparable mixture. Analysis of the product mixture using ^{1}H NMR integration ($\delta_{endo\ 7a}$ = 5.67 ppm, $\delta_{endo\ 7b}$ = 5.62 ppm; $\delta_{endo\ 7a}$ = 5.39 ppm, $\delta_{endo\ 7b}$ = 5.78 ppm; $\delta_{endo\ 7a}$ = 3.08 ppm, $\delta_{endo\ 7b}$ = 3.02 ppm) and chiral GC chiral GC (β-cyclodex, 150 ºC isotherm, $rt_{endo\ 7a}$ = 97.4 min, $rt_{endo\ 7b}$ = 100.6 min) showed a 50.0 : 50.0 ratio of ***endo* 7a** : ***endo* 7b** diastereomers, as well as unassigned *exo* isomers and products derived from the diastereomeric macrocycle.



Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	97.377	MM	0.7542	6.62413e4	1463.80371	48.89307
2	100.641	MM	0.7745	6.92407e4	1489.99683	51.10693



6

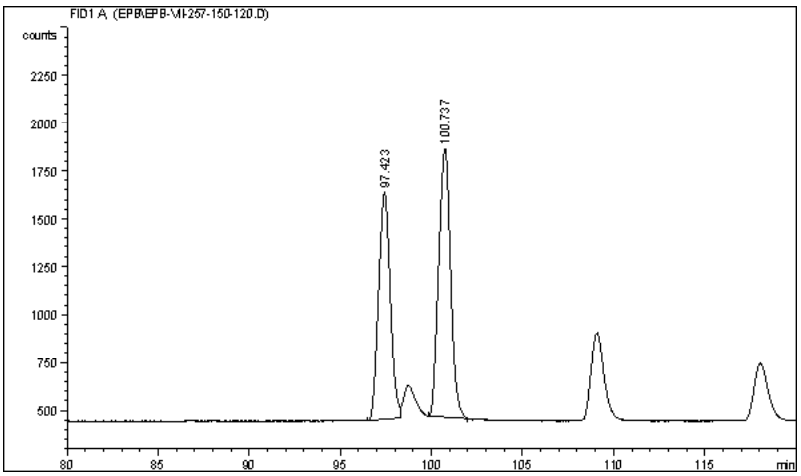
***endo* 7a**

45.5

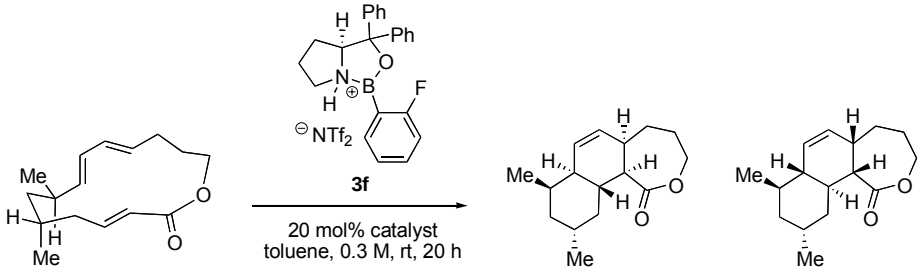
***endo* 7b**

54.5

A solution of macrocycle **6** (1.0 mg, 0.004 mmol, 1.0 equiv., 12:1 ratio of diastereomers) in d^8-toluene (1.5 mL) was heated in an NMR tube at 120 ºC for 12 h. Concentration of the reaction mixture afforded the TADA products as an inseparable mixture. Analysis of the product mixture using ^{1}H NMR integration and chiral GC showed a 45.5 : 54.5 ratio of ***endo* 7a** : ***endo* 7b** diastereomers, as well as unassigned *exo* isomers and products derived from the diastereomeric macrocycle.

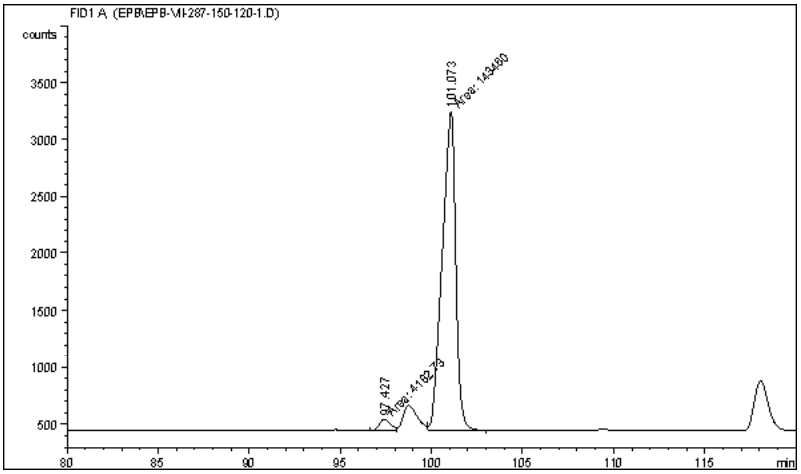


Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	97.423	VV	0.5249	5.28293e4	1185.49658	45.39290
2	100.737	BB	0.5374	6.35530e4	1400.68054	54.60710



6 | ***endo* 7a** 2.8 | ***endo* 7b** 97.2

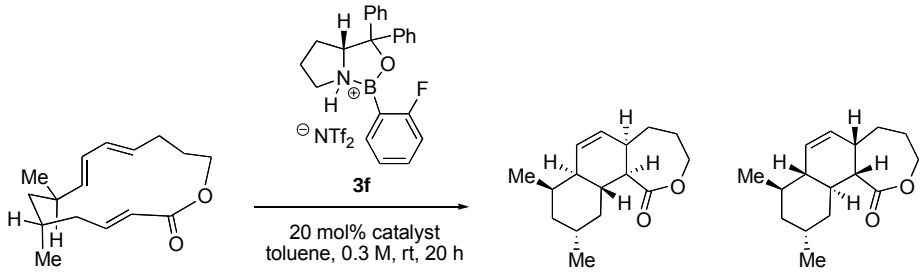
Macrocycle **6** (25.9 mg, 0.104 mmol, 1.0 equiv., 8:1 ratio of diastereomers) was subjected to the representative TADA reaction conditions using catalyst **3f**. Chromatography (2.5% → 5% → 10% diethyl ether in hexanes) afforded TADA products (23.0 mg, 89%) as an inseparable mixture. Analysis of the product mixture using ^{1}H NMR integration and chiral GC showed a 2.8 : 97.2 ratio of ***endo* 7a** : ***endo* 7b** diastereomers, as well as unassigned *exo* isomers and products derived from the diastereomeric macrocycle.



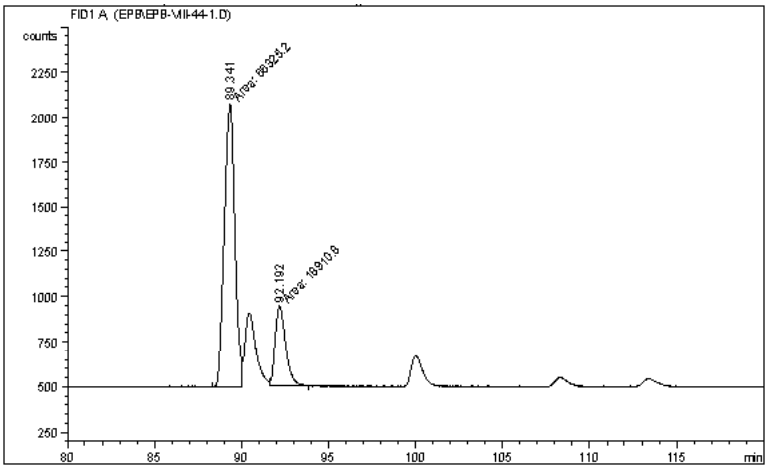
Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	97.427	MM	0.7100	4182.73291	98.18117	2.83302
2	101.073	MM	0.8530	1.43460e5	2803.13525	97.16698

Characterization of the major ***endo* 7b** diastereomer:

$[\alpha]_D^{27}$ +26.2º (c =1.15, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.78 (d, 1H, *J* = 10.0 Hz, C**H**=CH), 5.62 (ddd, 1H, *J* = 2.8, 4.0, 9.8 Hz, CH=C**H**), 4.29-4.23 (m, 1H, $CO_2C\mathbf{H_2}$), 4.18 (ddd, 1H, *J* = 2.5, 8.1, 12.4 Hz, $CO_2C\mathbf{H_2}$), 3.02 (dd, 1H, *J* = 6.3, 11.1 Hz, C**H**CO_2), 2.46-2.43 (m, 1H, CH=CHC**H**$CHCO_2$), 2.11-2.03 (m, 2H, C**H**(CH_3)CHCH=CH and $CH_2C\mathbf{H}CHCO_2$), 2.01-1.93 (m, 2H, CH=CHCHC$\mathbf{H_2}CH_2CH_2O$ and CH=CHCHC$H_2C\mathbf{H_2}CH_2O$), 1.78-1.71 (m, 1H, CH=CHCHC$H_2C\mathbf{H_2}CH_2O$), 1.68-1.61 (m, 1H, CH=CHCHC$\mathbf{H_2}CH_2CH_2O$), 1.55-1.42 (m, 4H, $CH(CH_3)C\mathbf{H_2}CH(CH_3)CH_2$, $CH(CH_3)CH_2C\mathbf{H}(CH_3)CH_2$, $CH(CH_3)CH_2CH(CH_3)C\mathbf{H_2}$), 1.40-1.35 (m, 1H, $CH(CH_3)C\mathbf{H}CH=CH$), 1.28 (ddd, 1H, *J* = 4.8, 12.7, 12.7 Hz, $CH(CH_3)CH_2CH(CH_3)C\mathbf{H_2}$), 1.04 (d, 3H, *J* = 7.3 Hz, $CH(C\mathbf{H_3})CH=CH$), 0.94 (d, 3H, *J* = 6.2 Hz, $CH_2CH(C\mathbf{H_3})CH_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ:175.4, 131.0, 129.4, 66.9, 53.1, 49.8, 41.4, 36.2, 34.2, 32.8, 31.7, 30.5, 27.8, 27.7, 19.6, 18.8. FTIR (neat), cm^1: 2953 (s), 2924 (s), 2874 (m), 1730 (s). HRMS (ES): Calcd for $C_{16}H_{24}O_2$ $[M + H]^+$: 249.1854, Found: 249.1845.



Macrocycle **6** (31.2 mg, 0.126 mmol, 1.0 equiv., 8:1 ratio of diastereomers) was subjected to the representative TADA reaction conditions using catalyst **ent-3f**. Chromatography (2.5% → 5% → 10% diethyl ether in hexanes) afforded the TADA products (10.4 mg, 33%) as an inseparable mixture. Analysis of the product mixture using ^{1}H NMR integration and chiral GC showed a 3.5 : 1 ratio of ***endo* 7a** : ***endo* 7b** diastereomers, as well as unassigned *exo* isomers and products derived from the diastereomeric macrocycle.

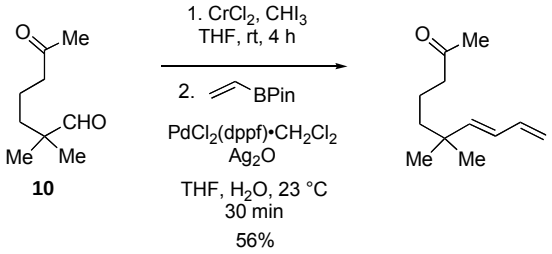


Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	89.341	MM	0.7012	6.63252e4	1576.36560	77.81359
2	92.192	MM	0.7087	1.89108e4	444.74228	22.18641

Characterization of the major *endo* ***7a*** diastereomer:

^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.67 (ddd, 1H, *J* = 2.5, 4.5, 9.8 Hz, C**H**=CH), 5.39 (d, 1H, *J* = 9.8 Hz, CH=C**H**), 4.30-4.16 (m, 2H, $CO_2C\mathbf{H_2}$), 3.08 (dd, 1H, *J* = 5.0, 11.4 Hz, C**H**CO_2), 2.46-2.44 (m, 1H, CH=CHC**H**CHCO_2), 2.13-2.06 (m, 1H, $CH_2C\mathbf{H}CHCO_2$), 2.03-1.92 (m, 3H, $CH(CH_3)C\mathbf{H}CH=CH$, $C\mathbf{H}(CH_3)CHCH=CH$ and $CH=CHCHCH_2C\mathbf{H_2}CH_2O$), 1.84-1.21 (m, 8H), 0.89 (d, 3H, *J* = 6.5 Hz, $CH(C\mathbf{H_3})CH=CH$), 0.88 (d, 3H, *J* = 7.0 Hz, $CH_2CH(C\mathbf{H_3})CH_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ:175.6, 131.1, 130.7, 67.7, 54.0, 47.2, 41.4, 39.0, 34.8, 32.6, 32.5, 28.8, 28.4, 27.0, 22.5, 13.7. FTIR (neat), cm^1: 2950 (s), 2923 (s), 2870 (m), 1732 (s). HRMS (ES): Calcd for $C_{16}H_{24}O_2$ $[M + H]^+$: 249.1854, Found: 249.1853.

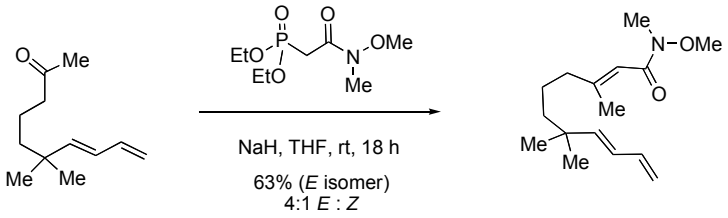
Total Synthesis of 11,12-diacetoxydrimane



(*E*)-6,6-dimethyl-deca-7,9-dien-2-one: 2,2-Dimethyl-6-oxoheptanal (**10**) (*S13*) (8.03 g, 51.4 mmol, 1.0 equiv.) was subjected to the representative Takai olefnation procedure using anhydrous chromium (II) chloride (25.2 g, 206 mmol, 4.0 equiv.) and iodoform (19.2 g, 48.8 mmol, 0.95 equiv.). The vinyl iodide was used immediately without further purification and was split into two batches for the next step.

Vinyl iodide (6.43 g, 23.0 mmol, 1.0 equiv., ½ of unpurified material) and vinyl pinacol boronate ester (4.51 mL, 25.2 mmol, 1.1 equiv.) were cross-coupled using the representative procedure. Combination of the two product mixtures, followed by chromatography on Davisil (5% → 10% diethyl ether in hexanes) afforded the diene (4.86 g, 56%) as an oil.

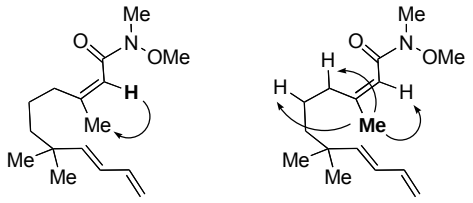
^{1}H NMR (500 MHz, $CDCl_3$) δ: 6.30 (ddd, 1H, *J* = 10.2, 10.2, 17.1 Hz, CH=CH-C**H**=CH_2), 5.96 (dd, 1H, *J* = 10.2, 15.6 Hz, CH=C**H**-CH=CH_2), 5.63 (d, 1H, *J* = 15.6 Hz, C**H**=CH-CH=CH_2), 5.11 (dd, 1H, *J* = 2.0, 17.1 Hz, CH=CH-CH=C$\mathbf{H}_{\mathbf{trans}}$), 4.96 (dd, 1H, *J* = 2.0, 10.2 Hz, CH=CH-CH=C$\mathbf{H}_{\mathbf{cis}}$), 2.37 (t, 2H, *J* = 7.3, 7.3 Hz, C$\mathbf{H}_2$$COCH_3$), 2.11 (s, 3H, COC$\mathbf{H}_3$), 1.52-1.46 (2H, m, C$\mathbf{H}_2$$CH_2COCH_3$), 1.27-1.24 (m, 2H, C$\mathbf{H}_2$$C(CH_3)_2$), 1.00 (s, 6H, C(C$\mathbf{H}_3$)$_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 209.1, 144.6, 137.6, 127.2, 114.9, 44.3, 42.4, 36.0, 29.9, 27.0, 19.1. FTIR (neat), cm^1: 2959 (s), 1718 (s).



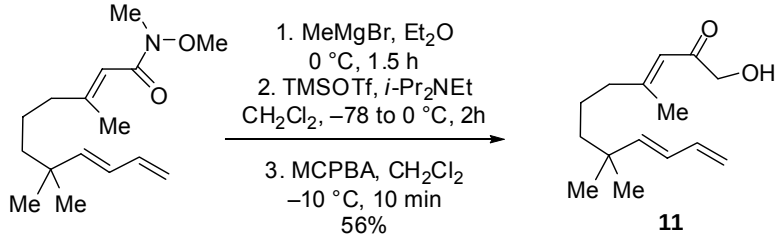
(2*E*,8*E*)-3,7,7-trimethylundeca-2,8,10-trienoic acid methoxy-methyl-amide: A suspension of sodium hydride (16.6 mg, 0.692 mmol, 1.2 equiv.) in tetrahydrofuran (725 μL) was cooled to 0 ºC and diethyl (*N*-methoxy-*N*-methylcarbamoylmethyl)-phosphonate (142 μL, 0.692 mmol, 1.2 equiv.) was added dropwise. The reaction mixture was stirred at 0 ºC for 30 min. Ketone (104.0 mg, 0.577 mmol, 1.0 equiv.) was added as a solution in tetrahydrofuran (200 μL) via syringe. The transfer was quantitated with tetrahydrofuran (2 x 140 μL), and the reaction mixture was

stirred at rt for 19 h before slow addition of saturated aqueous ammonium chloride solution (1 mL). The resulting suspension was partitioned between ethyl acetate (30 mL) and water (20 mL). The aqueous phase was extracted with ethyl acetate (2 x 20 mL). The combined organic extracts were dried over Na_2SO_4, filtered and concentrated to obtain the Weinreb amide product as a 4:1 mixture of *E* and *Z* isomers. Chromatography on Davisil (5% → 7.5% → 10% diethyl ether in hexanes) afforded the desired *E* isomer (96.0 mg, 63% yield based on ketone).

Assignment of E and Z Isomers (NOE studies on minor isomer):



^{1}H NMR *E isomer*- (500 MHz, $CDCl_3$) δ: 6.30 (ddd, 1H, *J* = 9.8, 9.8, 16.6 Hz, CH=CH-C**H**=CH_2), 6.08 (s, 1H, C(CH_3)=C**H**CON(OCH_3)CH_3), 5.95 (dd, 1H, *J* = 10.2, 15.6 Hz, CH=C**H**-CH=CH_2), 5.63 (d, 1H, *J* = 15.6 Hz, C**H**=CH-CH=CH_2), 5.11 (d, 1H, *J* = 17.1 Hz, CH=CH-CH=C$\mathbf{H}_{\mathbf{trans}}$), 4.96 (d, 1H, *J* = 10.2 Hz, CH=CH-CH=C$\mathbf{H}_{\mathbf{cis}}$), 3.66 (s, 3H, OC$\mathbf{H_3}$), 3.20 (s, 3H, NC$\mathbf{H_3}$**)**, 2.12-2.09 (2H, m, C$\mathbf{H_2}$C(CH_3)=CH), 2.09 (s, 3H, C(C$\mathbf{H_3}$)= CHCON(OCH_3)CH_3), 1.44-1.37 (2H, m, C$\mathbf{H_2}$$CH_2$C($CH_3$)=CH), 1.29-1.26 (2H, m, C$\mathbf{H_2}$C(CH_3)$_2$), 1.00 (s, 6H, C(C$\mathbf{H_3}$)$_2$); *Z isomer*- (600 MHz, $CDCl_3$) δ: 6.31 ((ddd, 1H, *J* = 10.1, 10.1, 17.0 Hz, CH=CH-C**H**=CH_2), 6.08 (s, 1H, C(CH_3)=C**H**CON(OCH_3)CH_3), 5.95 (dd, 1H, *J* = 10.2, 15.5 Hz, CH=C**H**-CH=CH_2), 5.66 (d, 1H, *J* = 15.5 Hz, C**H**=CH-CH=CH_2), 5.10 (d, 1H, *J* = 17.1 Hz, CH=CH-CH=C$\mathbf{H}_{\mathbf{trans}}$), 4.95 (d, 1H, *J* = 10.1 Hz, CH=CH-CH=C$\mathbf{H}_{\mathbf{cis}}$), 3.67 (s, 3H, OC$\mathbf{H_3}$), 3.19 (s, 3H, NC$\mathbf{H_3}$**)**, 2.55 (t, 2H, *J* = 7.0 Hz, C$\mathbf{H_2}$C(CH_3)=CH), 1.87 (s, 3H, C(C$\mathbf{H_3}$)= CHCON(OCH_3)CH_3), 1.42-1.32 (4H, m, C$\mathbf{H_2}$C$\mathbf{H_2}$$CH_2$C($CH_3$)=CH), 1.00 (s, 6H, C(C$\mathbf{H_3}$)$_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 168.2, 156.4, 144.8, 137.6, 127.1, 114.9, 114.0, 61.4, 42.4, 41.6, 35.9, 32.2, 27.0, 22.5, 18.5. FTIR (neat), cm^1: 2959 (s), 2940 (s), 1657 (s). HRMS (ES): Calcd for $C_{16}H_{27}NO_2$ $[M + H]^+$: 266.2120, Found: 266.2109.



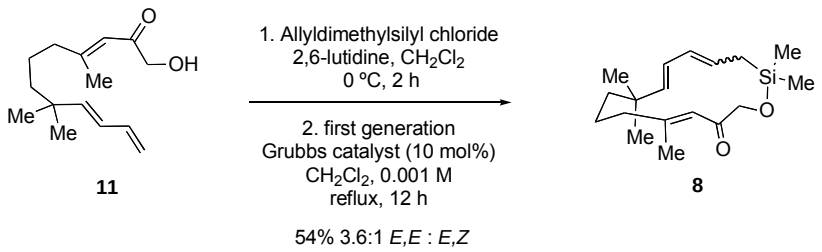
(3*E*,9*E*)-1-Hydroxy-4,8,8-trimethyl-dodeca-3,9,11,trien-2-one (11): Methylmagnesiumbromide (697 μL of a 3.0 M solution in diethyl ether, 2.09 mmol, 1.25 equiv.) was added dropwise to a

solution of Weinreb amide (443.6 mg, 1.67 mmol, 1.0 equiv.) in tetrahydrofuran (5.4 mL) at 0 ºC. The reaction mixture was stirred at 0 ºC for 1.5 h. Saturated aqueous ammonium chloride solution (5 mL) was added, and the resulting suspension was partitioned between diethyl ether (40 mL) and water (30 mL). The aqueous phase was extracted with diethyl ether (2 x 10 mL), and the combined organic extracts were dried over Na_2SO_4, filtered and concentrated to afford the desired methyl ketone, which was used in the next reaction without further purification.

To a solution of methyl ketone (1/2 of the unpurified material) and *i*-Pr_2NEt (233 μL, 1.34 mmol, 1.6 equiv.) in dichloromethane (20 mL) at –78 ºC was added TMSOTf (196 μL, 1.09 mmol, 1.3 equiv.). The reaction mixture was warmed to 0 ºC over 2 h, then recooled to –78 ºC. Saturated aqueous sodium bicarbonate solution (5 mL) was added, and the resulting suspension was warmed to rt. The mixture was partitioned between diethyl ether (20 mL) and half-saturated aqueous sodium bicarbonate solution (10 mL). The layers were separated and the organic phase was washed with saturated aqueous copper (II) sulfate solution (2 x 5 mL) and brine (10 mL). The organic phase was dried over Na_2SO_4, filtered and concentrated to give the desired silyl enol ether as an oil, which was used immediately in the next reaction without purification.

To a solution of methyl ketone in dichloromethane (20 mL) at –10 ºC was added solid *m*CPBA (280.6 mg, 1.25 mmol, 1.5 equiv.). The reaction mixture was stirred at –10 ºC for 10 min. Saturated aqueous sodium bicarbonate solution (5 mL) was added, and the resulting suspension was warmed to rt. The mixture was partitioned between diethyl ether (20 mL) and half-saturated sodium bicarbonate solution (10 mL). The layers were separated and the organic phase was washed sequentially with half-saturated aqueous sodium bicarbonate solution (10 mL), half-saturated aqueous sodium thiosulfate solution (2 x 10 mL), 2 M HCl (3 x 10 mL), and saturated aqueous sodium bicarbonate solution (5 mL). The organic layer was dried over Na_2SO_4, filtered and concentrated. The residue was purified by flash chromatography (15% diethyl ether in hexanes) to afford the α-hydroxy ketone (110.9 mg, 56%).

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.31 (ddd, 1H, *J* = 10.2, 10.2, 20.5 Hz, CH=CH-C**H**=CH_2), 5.96 (dd, 1H, *J* = 10.2, 15.5 Hz, CH=C**H**-CH=CH_2), 5.94 (s, 1H, $C(CH_3)$=C**H**$COCH_2OH$), 5.62 (d, 1H, *J* = 15.7 Hz, C**H**=CH-CH=CH_2), 5.13 (d, 1H, *J* = 17.0 Hz, CH=CH-CH=C$\mathbf{H_{trans}}$), 4.99 (d, 1H, *J* = 10.1 Hz, CH=CH-CH=C$\mathbf{H_{cis}}$), 4.23 (d, 2H, *J* = 4.4 Hz, C$\mathbf{H_2}$OH), 3.37 (t, 1H, *J* = 4.5 Hz, CH_2O**H**), 2.21 (s, 3H, C(C$\mathbf{H_3}$)= $CHCOCH_2OH$), 2.13 (t, 2H, *J* = 7.3 Hz, C$\mathbf{H_2}C(CH_3)$=CH), 1.44-1.38 (m, 2H, C$\mathbf{H_2}CH_2C(CH_3)$=CH), 1.28-1.25 (m, 2H, C$\mathbf{H_2}C(CH_3)_2$), 1.01 (s, 6H, C(C$\mathbf{H_3}$)$_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 198.2, 162.8, 144.5, 137.5, 127.3, 118.4, 115.1, 68.7, 42.5, 41.9, 36.0, 227.0, 22.5, 20.0. FTIR (neat), cm^1: 3461 (s, br), 2959 (s), 1687 (s), 1624 (s). HRMS (ES): Calcd for $C_{15}H_{24}O_2$ $[M + H]^+$: 237.1854, Found: 237.1864.

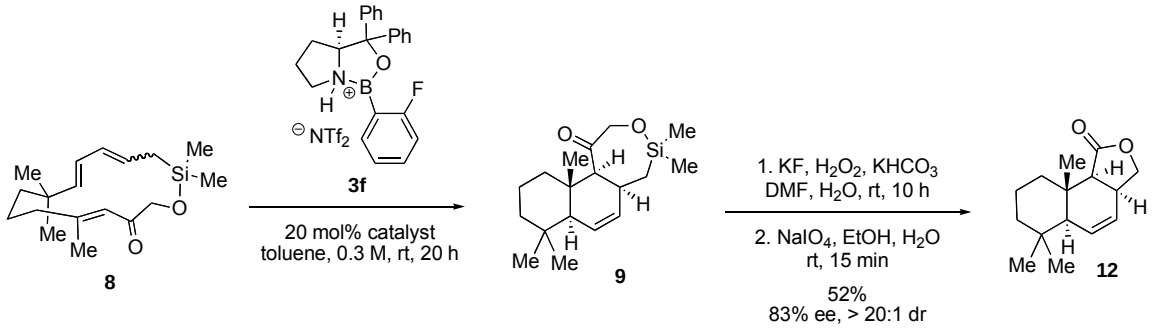


(4*E*,6*E*,12*E*)-2,2,8,8,12-Pentamethyl-1-oxa-2-sila-cyclopentadeca-4,6,12-trien-14-one (8): To a solution of alcohol **11** (47.3 mg, 0.200 mmol, 1.0 equiv.) and 2,6-lutidene (58.0 μL, 0.500 mmol, 2.5 equiv.) in dichloromethane (2.1 mL) at 0 ºC was added allyldimethylsilyl chloride (34.3 μL, 0.220 mmol, 1.1 equiv.). The reaction mixture was stirred at 0 ºC for 2.25 h. Saturated aqueous sodium bicarbonate solution (1.0 mL) was added, and the mixture was partitioned between diethyl ether (25 mL) and half-saturated aqueous sodium bicarbonate solution (20 mL). The organic phase was washed with saturated aqueous copper (II) sulfate solution (10 mL) and brine (10 mL), dried over Na_2SO_4, filtered and concentrated to afford the desired silyl ether, which was used in the next reaction without further purification.

To a flame-dried flask containing dichloromethane (100 mL) was added a solution of the Grubbs first-geneation metathesis catalyst (16.5 mg, 0.020 mmol, 0.01 equiv.) in dichloromethane (20 mL) via cannula. The transfer was quantitated with dichloromethane (2 x 15 mL). The Grubbs catalyst was stored and handled in a glove box. To the catalyst solution was added a solution of crude silyl ether in dichloromethane (20 mL) via cannula. The transfer was quantitated with dichloromethane (2 x 15 mL). The flask was fitted with a reflux condenser and the reaction mixture was heated to 50 ºC for 12 h. After cooling to rt, the mixture was concentrated and the residue purified by rapid flash chromatography on Davisil (10% diethyl ether in hexanes) to afford macrocycle **8** (32.9 mg, 54%, 3.6:1 ratio of *E,E* and *E,Z* diene isomers) as an oil. The product was contaminated with trace amounts of colored catalyst byproducts, but was used in the TADA reaction without further purification.

^{1}H NMR (600 MHz, $CDCl_3$) δ: 6.50 (s, 1H, $C(CH_3)$=C**H**), 6.02 (dd, 1H, *J* = 10.1, 14.9 Hz, $C(CH_3)_2CH$=CH-C**H**=CH), 5.91 (dd, 1H, *J* = 10.2, 15.5 Hz), 5.65 (dt, 1H, *J* = 8.2, 16.4 Hz, $C(CH_3)_2CH$=CH-CH=C**H**), 5.38 (d, *J* = 15.5 Hz, $C(CH_3)_2$C**H**=CH-CH=CH), 4.02 (s, 2H, C**H$_2$**OSi), 2.15 (s, 3H, C(C**H$_3$**)=CH), 2.07 (t, 2H, *J* = 7.9 Hz, C**H$_2$**$C(CH_3)$=CH), 1.68 (d, 2H, *J* = 8.2 Hz, C**H$_2$**Si), 1.40-1.35 (m, 2H, C**H$_2$**$CH_2C(CH_3)$=CH), 1.29-1.27 (m, 2H, C**H$_2$**$C(CH_3)_2$), 0.99 (s, 6H, $C(CH_3)_2$), 0.17 (s, 6H, $Si(CH_3)_2$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 200.9, 162.7, 139.4, 130.3, 127.3, 127.2, 18.9, 68.7, 42.7, 41.2, 36.8, 27.3, 23.6, 23.2, 19.9, –2.0. FTIR (neat), cm^1:

2955 (s), 2907 (m), 1683 (s), 1610 (s). HRMS (ES): Calcd for $C_{18}H_{30}O_2Si$ $[M + H]^+$: 307.2093, Found: 307.2101.



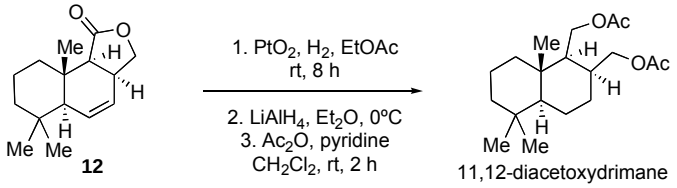
(3a*S*,5a*S*,9a*S*,9b*S*)-6,6,9a-Trimethyl-3a,5a,6,7,8,9,9a,9b-octahydro-3*H*-naptho[1,2-*c*]furan-1-one (12):

Macrocycle **8** (32.9 mg, 0.107 mmol, 1.0 equiv.) was subjected to the representative TADA reaction conditions to afford tricycle **9**. The product mixture was unstable to chromatography on Davisil, so the residue was used immediately in the next reaction.

To a solution of TADA product **9** in DMF (2.3 mL) at rt was added solid potassium bicarbonate (42.8 mg, 0.428 mmol, 4.0 equiv.), potassium fluoride (24.9 mg, 0.428 mmol, 4.0 equiv.) and hydrogen peroxide (242 μL of 30 wt% aqueous solution, 2.14 mmol, 20.0 equiv.). The reaction mixture was stirred at rt for 10 h. A saturated aqueous solution of $NaHSO_3$ (1 mL) was slowly added to the reaction mixture (CAUTION: gas evolution and exotherm). The mixture was partitioned between ethyl acetate (15 mL) and half-saturated aqueous sodium bicarbonate solution (10 mL). The organic phase was washed with saturated aqueous lithium chloride solution (5 mL) and brine (5 mL), dried over Na_2SO_4, filtered and concentrated to afford a mixture of oxidation products that was used immediately in the next reaction without further purification.

To a solution of the Tamao oxidation products in ethanol (3.2 mL) was added sodium periodate (1.82 mL of a 6 wt% aqueous solution). The reaction mixture was stirred at rt for 15 min. The crude material was partitioned between ethyl acetate (15 mL) and water (10 mL), and the aqueous phase was extracted with ethyl acetate (2 x 5 mL). The combined organic extracts were dried over Na_2SO_4, filtered, and evaporated. The residue was chromatographed on Davisil (5% → 10% → 25% diethyl ether in hexanes) affording lactone **12** (13.3 mg, 52%, > 20:1 dr) as a white solid; 83% enantiomeric excess as determined by analysis using chiral GC (γ-TA, 150 ºC isotherm, $rt_{minor\ enantiomer}$ = 83.6 min, $rt_{major\ enantiomer}$ = 72.7 min).

$[\alpha]_D^{27}$ –61.2º (c = 0.595, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$) δ: 5.85 (ddd, 1H, *J* = 2.0, 2.0, 10.0 Hz, C**H**=CH), 5.65 (ddd, 1H, *J* = 2.9, 2.9, 10.0 Hz, CH=C**H**), 4.45 (dd, 1H, *J* = 8.6, 9.8 Hz, C**H$_2$**O), 3.87 (dd, 1H, *J* = 8.6, 10.8 Hz, C**H$_2$**O), 3.21-3.14 (m, 1H, C**H**CH_2O), 2.43 (d, 1H, *J* = 10.1 Hz, C**H**CO_2), 2.22 (d, 1H, *J* = 13.5 Hz), 1.81 (d, *J* = 2.6 Hz), 1.61 (dddd, 1H, *J* = 3.5, 3.5, 14.1, 17.6 Hz), 1.54-1.48 (m, 2H), 1.26-1.19 (m, 2H), 0.95 (s, 3H, C**H$_3$**), 0.94 (s, 3H, C**H$_3$**), 0.88 (s, 3H, C**H$_3$**). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 177.8, 129.7, 123.2, 71.3, 52.4, 51.6, 41.1, 38.1, 35.6, 35.5, 32.7, 32.6, 21.6, 18.0, 16.0. FTIR (neat), cm^1: 2925 (s), 1770 (s). HRMS (ES): Calcd for $C_{15}H_{22}O_2$ $[M + NH_4]^+$: 252.1964, Found: 252.1965.



11,12-Diacetoxydrimane:

Platinum (IV) oxide (0.5 mg) was added to a solution of lactone **12** (3.7 mg, 0.016 mmol, 1.0 equiv.) in ethyl acetate (1.4 mL) under a nitrogen atmosphere. The flask was evacuated and backfilled with hydrogen gas, and the resulting suspension was stirred for 8 h at rt under an balloon atmosphere of hydrogen. The reaction mixture was filtered through a pad of celite and concentrated to afford the saturated lactone, which was used without further purification.

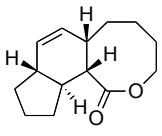
To a solution of lactone in diethyl ether (1.5 mL) at 0 ºC was added lithium aluminum hydride (48 μL of a 1.0 M solution in diethyl ether, 0.48 mmol, 3.0 equiv.). The reaction mixture was stirred at 0 ºC for 2 h. A saturated aqueous solution of Rochelle's salt (1 mL) was slowly added to the mixture, and the resulting suspension was warmed to rt and stirred until the mixture became biphasic. The layers were separated and the aqueous phase was extracted with ethyl acetate (2 x 1 mL). The combined organic extracts were dried over Na_2SO_4, filtered and evaporated to afford the diol, which was used without further purification.

To a solution of diol in dichloromethane (550 μL) was added pyridine (66 μL, 0.82 mmol, 50 equiv.) and acetic anhydride (33 μL, 0.35 mmol, 22 equiv.). The reaction mixture was stirred at rt for 2 h. The mixture was partitioned between ethyl acetate (2.5 mL) and half-saturated aqueous sodium bicarbonate solution (1 mL). The organic layer was washed with saturated aqueous copper (II) sulfate solution (1 mL) and brine (1 mL), dried over Na_2SO_4, filtered, and concentrated. The residue was purified by flash chromatography on Davisil (5% →

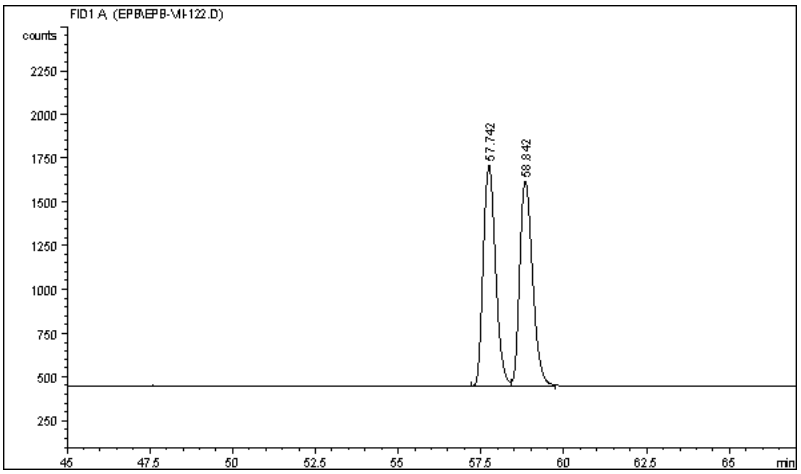
10% ethyl acetate in hexanes) to afford 11,12-diacetoxydrimane (3.0 mg, 58%) as a colorless oil. $[\alpha]_D^{27}$ +37.0º (c = 0.150, $CHCl_3$). Characterization data matched that reported previously for the natural product. (*S14*)

^{1}H NMR (500 MHz, $CDCl_3$) δ: 4.29 (dd, 1H, *J* = 5.4, 11.2 Hz, C**H**OAc), 4.15 (dd, 1H, *J* = 10.7, 10.7 Hz, C**H**OAc), 4.07 (dd, 1H, *J* = 2.0, 11.2 Hz, C**H**OAc), 4.05 (dd, *J* = 9.3, 11.2 Hz, C**H**OAc), 2.20-2.17 (m, 1H, C**H**CH_2OAc), 2.05 (s, 3H, $CO_2C\mathbf{H_3}$), 2.04 (s, 3H, $CO_2C\mathbf{H_3}$), 1.89-1.86 (m, 1H), 1.70 (ddd, 1H, *J* = 4.9, 4.9, 9.8 Hz, C**H**CH_2OAc), 1.61-1.58 (m, 1H), 1.58-1.52 (m, 2H), 1.46-1.25 (m, 4H), 1.16 (ddd, *J* = 3.4, 12.7, 12.7 Hz), 1.04 (ddd, *J* = 3.4, 12.7, 12.7 Hz), 0.91 (m, 1H), 0.86 (s, 3H, C$\mathbf{H_3}$), 0.84 (s, 3H, C$\mathbf{H_3}$), 0.81 (s, 3H, C$\mathbf{H_3}$). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 171.2, 171.2, 64.0, 62.7, 56.2, 51.4, 41.8, 39.2, 37.2, 34.9, 33.4, 33.2, 29.1, 21.5, 21.5, 21.1, 18.4, 17.6, 16.5. FTIR (neat), cm^1: 2930 (s), 2922 (s), 1741 (s). HRMS (ES): Calcd for $C_{19}H_{32}O_4$ [M + NH_4]$^+$: 342.2640, Found: 342.2657.

GC Traces:



2
90% ee
β-cyclodex, 125 ºC isotherm



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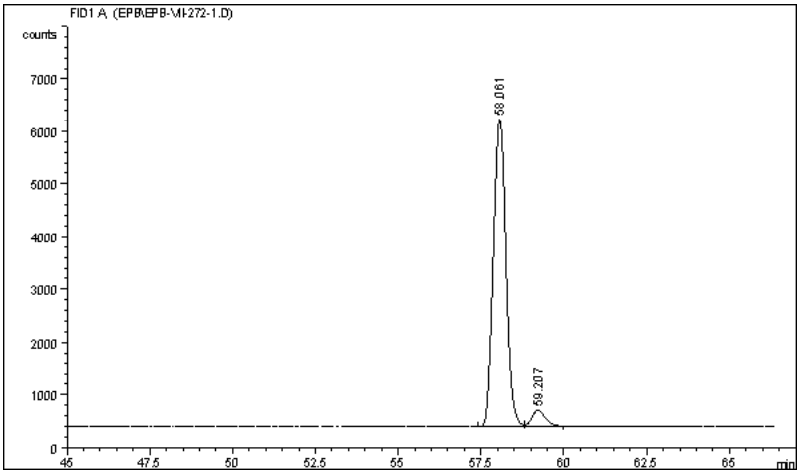
2	58.842	VV	0.3199	3.17293e4	1171.89783	49.19504



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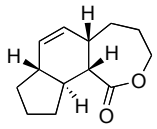
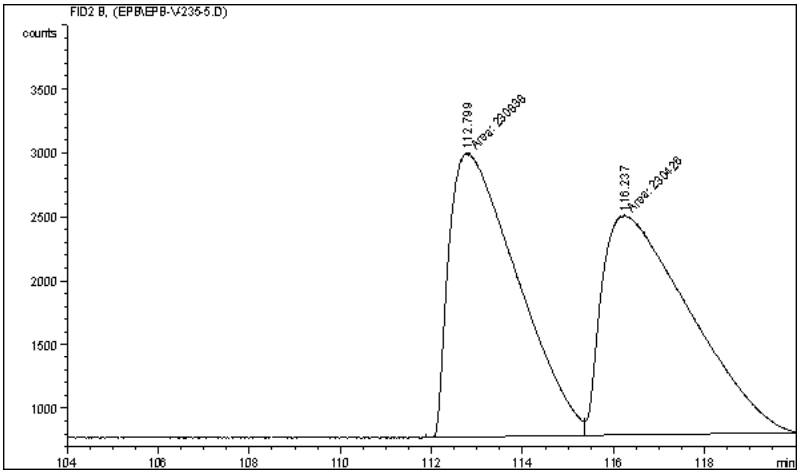
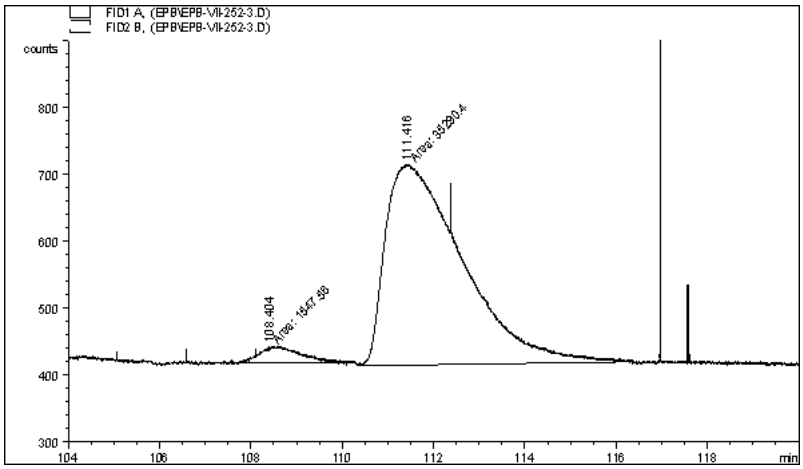
2	59.207	VB	0.3319	8481.37500	304.51901	5.20134



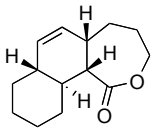
92% ee
γ-TA, 130 ºC isotherm



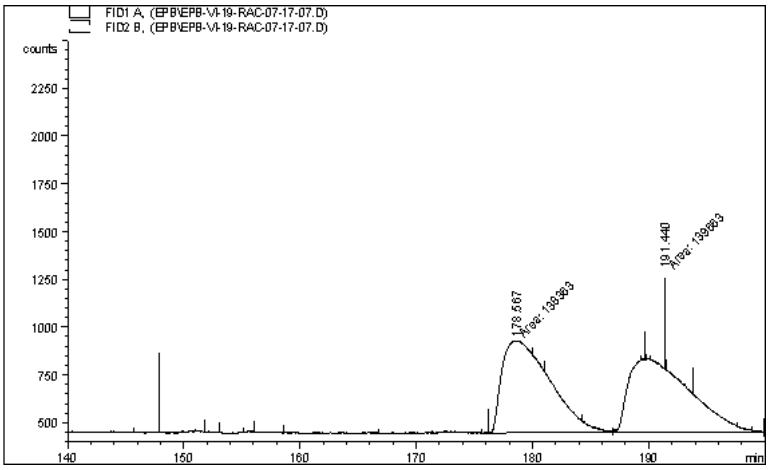
Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	112.799	MF	1.7255	2.30838e5	2229.65649	50.04463
2	116.237	FM	2.2263	2.30426e5	1725.02539	49.95537



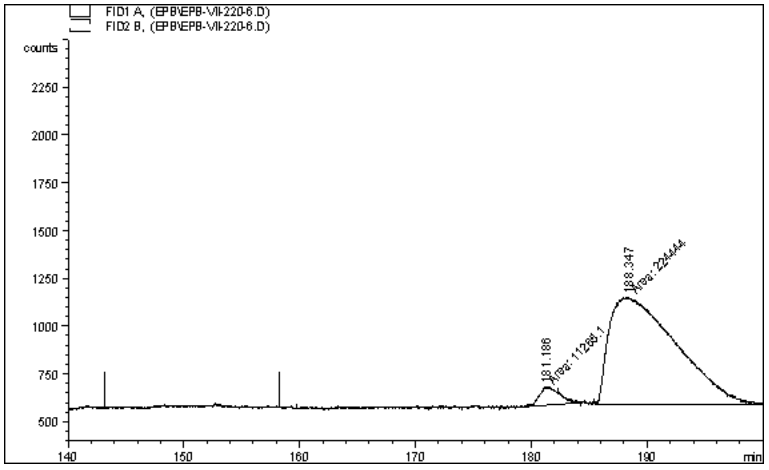
Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	108.404	MM	1.0234	1547.56226	25.20286	4.20100
2	111.416	MM	1.9597	3.52904e4	300.14136	95.79900



90% ee
γ-TA, 130 ºC isotherm



Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	178.567	MM	4.1939	1.38363e5	484.81509	49.76616
2	191.440	MM	2.7693	1.39663e5	840.55109	50.23384



Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	181.186	MM	1.9442	1.12651e4	96.57035	4.77923
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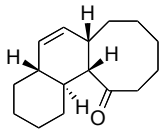
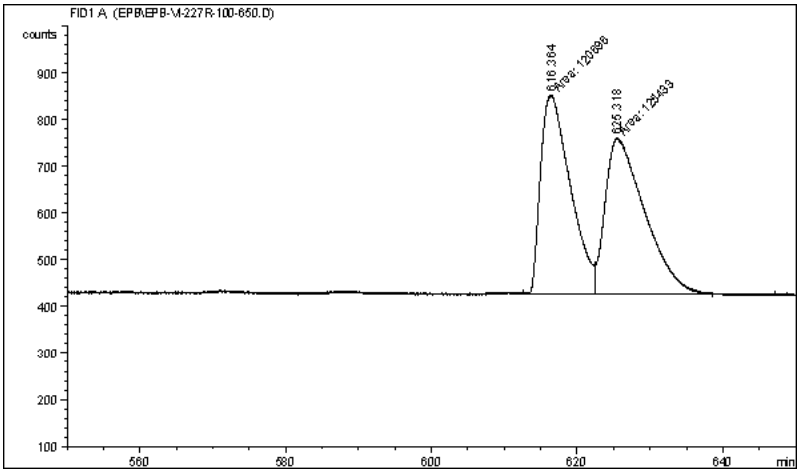
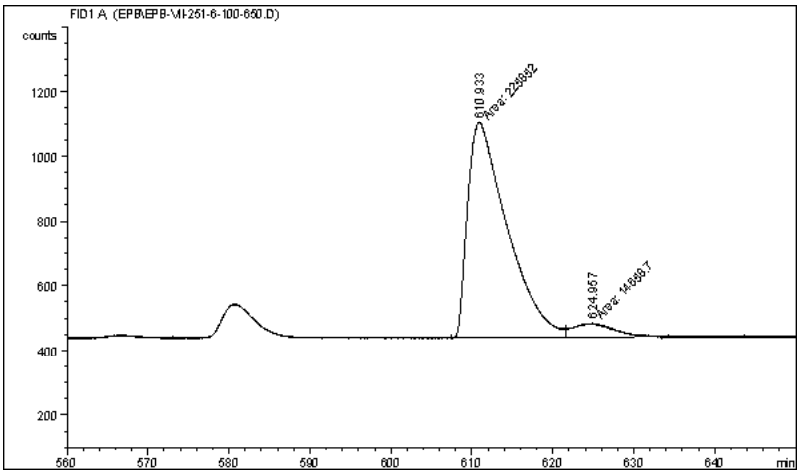


88% ee
β-cyclodex, 100 ºC isotherm



Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	616.364	MF	4.7104	1.20696e5	427.05688	49.03771
2	625.318	FM	6.2600	1.25433e5	333.95428	50.96229



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1	610.933	MF	5.6362	2.25852e5	667.85718	93.90517
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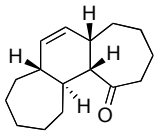
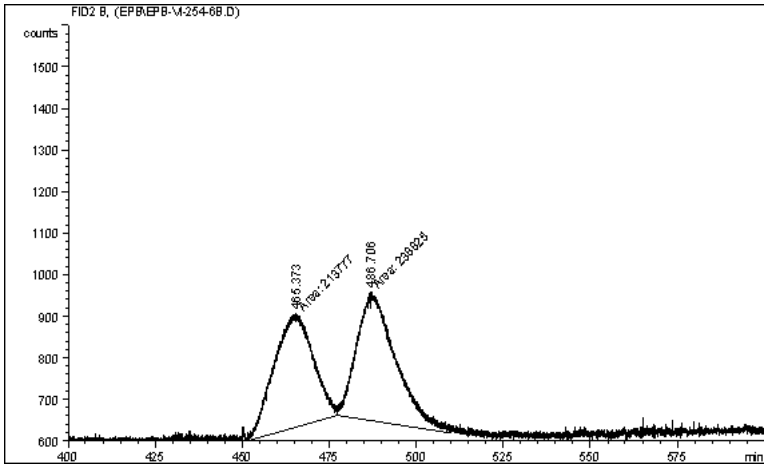


85% ee
γ-TA, 90 ºC isotherm



Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	465.373	MM	12.9997	2.13777e5	274.07950	47.23280
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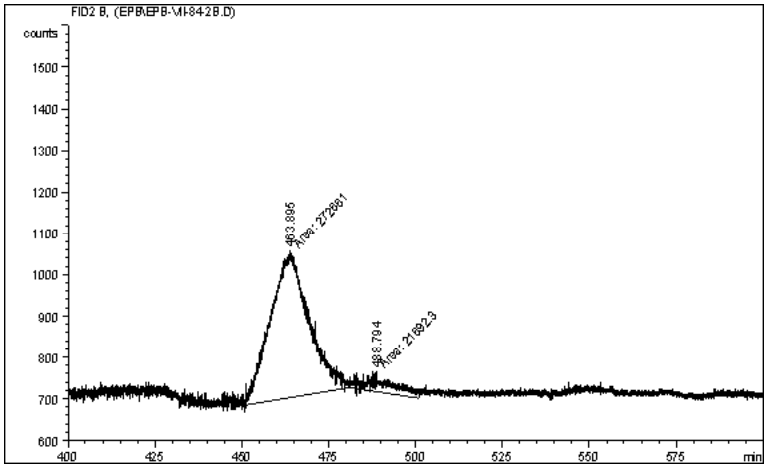
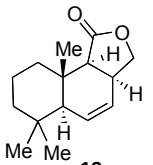
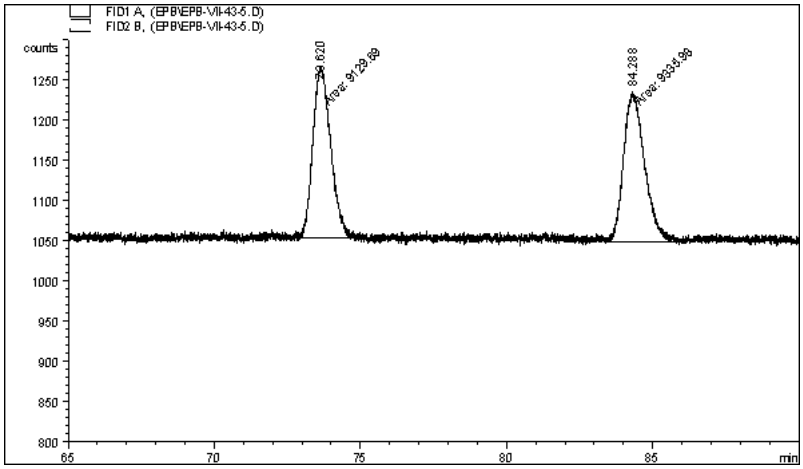


Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	463.895	MM	12.7896	2.72661e5	355.31549	92.63053
2	488.794	MM	7.3410	2.16923e4	49.24910	7.36947



12

83% ee
γ-TA, 150 ºC isotherm



Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	73.620	MM	0.7086	9129.69434	214.73911	49.44144
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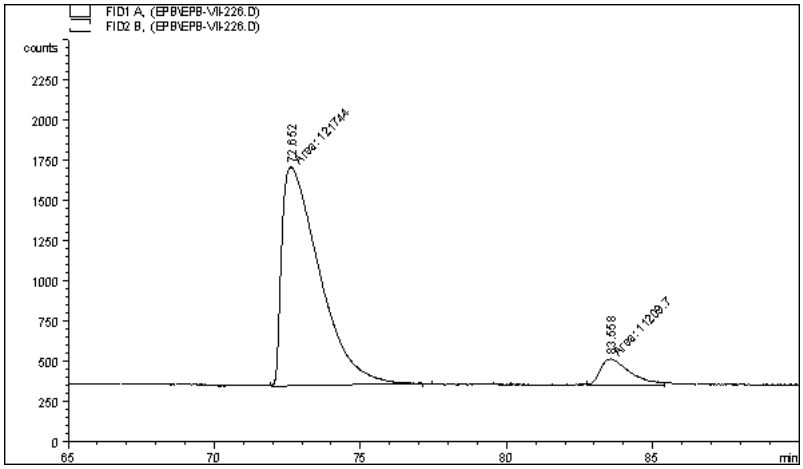

Peak #	RetTime [min]	Type	Width [min]	Area counts*s	Height [counts]	Area %
1	72.652	MM	1.4881	1.21744e5	1363.48865	91.56872
2	83.558	MM	1.1424	1.12097e4	163.54639	8.43128

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