SUPPORTING INFORMATION

Diene-Transmissive Cycloadditions: Control of Mono-cycloaddition by Self-Assembly on a Lewis Acid Template

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Experimental Procedures

General Methods. All non-aqueous reactions were performed under argon in flame-dried glassware using dry solvents. Tetrahydrofuran was distilled from sodium/benzophenone. Benzene and triethylamine were distilled from calcium hydride. *n*-Butyllithium solutions in hexanes from Aldrich Chemical Company were titrated prior to use against diphenylacetic acid and used directly. Starting materials were purchased from Aldrich Chemical Company and used without further purification unless otherwise stated. Low temperature baths were ice/water (0 °C) and CO_2(C)/acetone (-78 °C). Reaction temperatures refer to that of the bath.

Reactions were monitored by thin layer chromatography (TLC) using commercial aluminum-backed silica gel sheets coated with silica gel 60 F_{254} (E. Merck). TLC spots were developed by heating the plate after treatment with a phosphomolybdic acid (5%) containing a trace of ceric sulfate in aqueous sulfuric acid (5% v/v) or a solution of $KMnO_4$ in aqueous potassium hydroxide. Room temperature corresponds to 23 °C. Anhydrous magnesium sulfate ($MgSO_4$) and sodium sulphate (Na_2SO_4) was used to dry solutions in organic solvents. Excess solvents were removed (concentrated) *in vacuo* at pressures obtained by a water or air aspirator connected to a Büchi rotary evaporator. Trace solvents were removed on a vacuum pump. Product purification by flash chromatography was performed with E. Merck Silica Gel 60 (230-400 mesh) according to Still et al.[1] Preparative TLC (PTLC) was carried out on glass plates (20×20 cm) precoated (0.25 mm) with silica gel 60 F254. Materials were detected by visualization under an ultraviolet lamp (254 nm) and/or by treating a 1 cm vertical strip removed from the plate with a solution of phosphomolybdic acid (5%) containing a trace of ceric sulfate in aqueous sulfuric acid (5% v/v), followed by charring on a hot plate**.**

Spectral Data. Melting points were determined with a Thomas-Hoover Unit melting point apparatus and are uncorrected. ^{1}H NMR (500, 400 or 300 MHz) and ^{13}C NMR (125, 100 or 75MHz) spectra were recorded on a Bruker AVANCE 500, 400 or a 300 spectrometer. Chemical shifts are reported downfield from tetramethylsilane (δ scale) in ppm. ^{1}H NMR data are reported as follows: Chemical shift (multiplicity, coupling constants (Hz), and integration).

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[1] Still, W. C.; Kahn, M.; Mitra, A. *J. Org. Chem.* **1978**, *43*, 2923.

Low resolution mass spectroscopy (MS) using electron impact (EI), were recorded on a V.G. Micromass 7070 HS mass spectrometer with an electron beam energy of 70 eV. High resolution mass spectroscopy (HRMS) were recorded on a Kratos Concept-11A mass spectrometer with an electron beam energy of 70 eV. IR spectra were recorded on a SHIMADZU FTIR-8400S spectrometer. The purity of all title compounds was judged to be >95% as determined by a combination of ^{1}H NMR and ^{13}C NMR analyses.

Materials: The preparations of the following compounds were described previously: (*E*)-5-bromopenta-1,3-diene [2], **1b**[3], and **2**[3]. All other reagents were commercially available and unless otherwise noted, were used as received.

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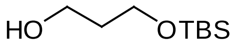
[2] (a) Schneider, M. P.; Goldbach, M. *J. Am. Chem. Soc.* **1980**, *102*, 6114-16.(b) Mori, K. *Tetrahedron* **1974**, *30*, 3807-10.

[3] Smith, A. B., III; Fox, R. J.; Vanecko, J. A. *Org. Lett.* **2005**, *7*, 3099-3102.

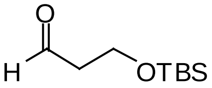
3-(*tert*-Butyldimethylsilyloxy)propan-1-ol (1b)[3]



1b

^{1}**H NMR** (500 MHz, $CDCl_3$) δ 3.76 (t, *J* = 5.5 Hz , 2H), 3.72 (t, *J* = 5.5 Hz, 2H), 2.97 – 2.58 (m, 1H), 1.71 (quintet, *J* = 5.5 Hz, 2H), 0.84 (s, 9H), 0.02 (s, 6H); ^{13}**C NMR** (125 MHz, $CDCl_3$) δ 62.5 (CH_2), 61.9 (CH_2), 34.2 (CH_2), 25.8 (CH_3), 18.2 (C), -5.6 (CH_3); **MS** (EI) *m/z* 133 (M^+ - 57) (24), 105 (41), 75 (100); **HRMS** calculated for $C_5H_{13}O_2Si$ (M^+ - 57) 133.0685, found 133.0691.

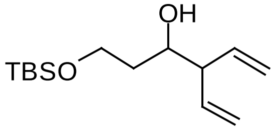
3-(*tert*-Butyldimethylsilyloxy)propanal (2)[3]



2

^{1}**H NMR** (500 MHz, $CDCl_3$) δ 9.77 – 9.75 (m, 1H), 3.96 – 3.94 (m, 2H), 2.57 – 2.54 (m, 2H), 0.84 (s, 9H), 0.02 (s, 6H); ^{13}**C** NMR (125 MHz, $CDCl_3$) δ 202.0 (CH), 57.3 (CH_2), 46.5 (CH_2), 25.8 (CH_3), 18.2 (C) -5.5 (CH_3); **MS** (EI) *m/z* 131 (M^+ - 57) (71), 101 (100), 75 (13), 60 (62), 42 (22); **HRMS** calculated for $C_5H_{11}O_2Si$ (M^+ - 57) 131.0528, found 131.0509.

1-(*tert*-Butyldimethylsilyloxy)-4-vinylhex-5-en-3-ol (3)



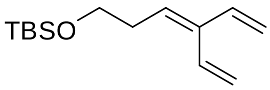
3

3-(*tert*-Butyldimethylsilyloxy)propanal (**2**) (0.50 g, 2.65 mmol) was dissolved in a mixture of DMF (3 mL) and H_2O (1.5 mL). 5-Bromo-1,3-pentadiene (0.78 g, 5.30 mmol) was then added and the solution was cooled to 0 ºC. Indium metal (100 mesh, 0.61 g 5.30 mmol) was added portion-wise, and the reaction was warmed to 23 °C and stirred for 30 minutes. The reaction was then diluted with CH_2Cl_2, poured into ether, filtered (5 cm high silica gel plug) with ether as eluent. After concentration, column chromatography (10:1, petroleum ether:ethyl acetate) provided the title compound as a pale yellow oil (0.47 g, 70%).

^{1}**H NMR** (500 MHz, $CDCl_3$) δ 5.87 (ddd, *J* = 17.0, 10.0 and 8.0 Hz , H), 5.79 (ddd, *J* = 17.0, 10.0 and 8.0 Hz, 1H), 5.13 – 5.05 (m, 4H), 3.88 – 3.85 (m, 1H), 3.79 – 3.74 (m, 2H), 3.27 (br s, 1H), 2.78 (app. q, *J* = 6.0 Hz, 1H), 1.66 – 1.59 (m, 2H), 0.86 (s, 9H), 0.04 (s, 6H); ^{13}**C NMR**

(125 MHz, $CDCl_3$) δ 137.8 (CH), 137.3 (CH), 116.7 (CH_2), 116.4 (CH_2), 73.6 (CH), 62.6 (CH_2), 54.7 (CH), 35.8 (CH_2), 25.8 (CH_3), 18.1 (C), -5.6 (CH_3); **MS** (EI) *m/z* 189 (M^+ - 67) (14), 131 (19), 105 (55), 75 (100), 41 (18); **HRMS** calculated for $C_9H_{21}O_2Si$ (M^+ - 67) 131.1311, found 189.1296.

***tert*-Butyldimethyl(4-vinylhexa-3,5-dienyloxy)silane (4)**

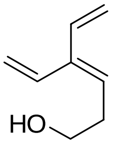


4

1-(*tert*-Butyldimethylsilyloxy)-4-vinylhex-5-en-3-ol (**3**) (2.00 g, 7.80 mmol) and NEt_3 (2.17 mL, 15.6 mmol) were combined in CH_2Cl_2 (30 mL) and cooled to 0 ºC. Methanesulfonyl chloride (0.66 mL, 8.58 mmol) was added and the reaction was stirred at 0 ºC for one hour. The reaction was poured into ether, and the organics were washed with saturated $NaHCO_3$ and brine, dried, filtered and concentrated. The resulting crude oil was dissolved in benzene (30 mL), DBU (1.17 mL, 8.58 mmol) was added and the reaction was heated at reflux overnight. The reaction was extracted with ether, and the organic phase was washed with water and brine. Column chromatography (50:1 petroleum ether:ethyl acetate) afforded the product as a pale yellow oil (1.69 g, 91%).

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.47 (dd, *J* = 18.5 and 10.5 Hz, 1H), 6.38 (dd, *J* = 18.0 and 10.5 Hz, 1H), 5.62 (t, *J* = 7.5 Hz, 1H), 5.28 – 5.24 (m, 3H), 5.02 (dd, *J* = 11.0 and 1.5 Hz, 1H), 3.64 (t, *J* = 7.0 Hz, 2H), 2.43 (app. q, *J* = 7.0 Hz, 2H), 0.88 (s, 9H), 0.04 (s, 6H); **^{13}C NMR** (125 MHz, $CDCl_3$) δ 138.4 (C), 137.8 (CH), 132.0 (CH), 128.5 (CH), 117.4 (CH_2) 114.1 (CH_2), 62.7 (CH_2), 32.0 (CH_2), 25.9 (CH_3), 18.3 (C), -5.3 (CH_3); **MS** (EI) *m/z* 181 (M^+ - 57) (65), 105 (25), 89 (67), 75 (100), 73 (99), 59 (16); **HRMS** calculated for $C_{10}H_{17}OSi$ (M^+ - 57) 181.1049, found 181.1055.

4-vinylhexa-3,5-dien-1-ol (5)

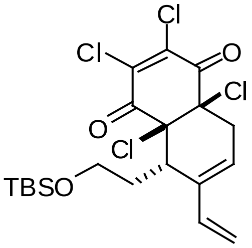


5

TBS protected trienol **4** (1.77g, 7.4 mmol) was dissolved in 200 mL of THF at 0 °C. TBAF (4.29 mL, 14.8 mmol) was added slowly and the reaction was stirred for 2 hours. THF was removed under reduced pressure. The reaction vessel was diluted with CH_2Cl_2 (100 mL). It was then washed with saturated $NaHCO_3$ and brine, dried with $MgSO_4$, filtered, and concentrated. Column chromatography (4:1, petroleum ether: ethyl acetate) provided the title compound as a pale yellow oil **5** (0.92 g, 67%).

IR νmax 3350, 2927, 1047, 989, 912, 734; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.50 (1H, dd, *J* = 11.5, 17.5 Hz), 6.41 (1H, dd, *J* = 11, 17 Hz), 5.63 (1H, t, *J* = 8 Hz), 5.35-5.26 (3H, m), 5.07 (1H, dd, *J* = 1.5, 10.5 Hz), 3.71 (2H, t, *J* = 6.5 Hz, CH_2O), 2.51 (2H, q, *J* = 6.5 Hz, CH_2); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 139.9 (C), 137.9 (CH), 132.1 (CH), 127.9 (CH), 118.4 (CH_2), 114.9 (CH_2), 62.7 (t, CH_2O), 32.2 (t, CH_2); **MS** (EI) *m/z* (relative intensity): 124 ([M]+, 11), 93 (99), 91 (84), 79 (56), 77 (100), 65 (18); **HRMS** *m/z* calcd. for $C_8H_{12}O$: 124.0888; found: 124.0905.

5-(2-(*tert*-Butyldimethylsilyloxy)ethyl)-2,3,4a,8a-tetrachloro-6-vinyl-4a,5,8,8a-tetrahydronaphthalene-1,4-dione (6a)

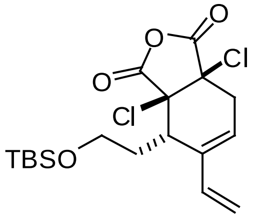


6a

A solution of *tert*-butyldimethyl(4-vinylhexa-3,5-dienyloxy)silane (**4**) (0.10 g, 0.42 mmol) and tetra-chlorobenzoquinone (0.11 g, 0.44 mmol) in toluene (1 mL) was heated at 75 ºC for 48 hours. The reaction mixture was diluted with water and the organic layer was extracted with ether, dried, filtered and concentrated. Column chromatography (40:1 petroleum ether:ethyl acetate) afforded the title compound as a bright yellow oil (0.13 g, 66%).

^{1}**H NMR** (500 MHz, $CDCl_3$) δ 6.25 (dd, *J* = 18.0 and 11.0 Hz, 1H), 5.66 (t, *J* = 4.0 Hz, 1H), 5.32 (d, *J* = 18.0 Hz, 1H), 5.06 (d, *J* = 11.0 Hz, 1H), 3.67 – 3.42 (m, 3H), 3.23 (br s, 1H), 2.84 (dd, *J* = 19.5 and 3.5 Hz, 1H), 1.84 (br, 1H), 1.30 (br, 1H), 0.85 (s, 9H), 0.00 (s, 3H), -0.02 (s, 3H); ^{13}**C NMR** (125 MHz, $CDCl_3$) δ 182.1 (C), 180.0 (C), 143.8 (C), 143.4 (C), 136.7 (C), 136.4 (CH), 122.2 (CH), 114.3 (CH_2), 78.7 (C), 72.9 (C), 60.3 (CH_2), 44.0 (CH), 35.0 (CH_2), 34.0 (CH_2), 25.9 (CH_3), 18.4 (C), -5.7 (CH_3); **MS** (EI) *m/z* 427 (M^+ - 57) (12), 355 (4), 279 (6), 217 (3), 181 (41), 149 (10), 123 (17), 69 (100); **HRMS** calculated for $C_{16}H_{17}Cl_4O_3Si$ (M^+ - 57) 424.9701, found 424.9711.

4-(2-(*tert*-Butyldimethylsilyloxy)ethyl)-3a,7a-dichloro-5-vinyl-3a,4,7,7a-tetrahydroisobenzofuran-1,3-dione (6b)

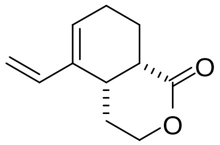


6b

A solution of *tert*-butyldimethyl(4-vinylhexa-3,5-dienyloxy)silane (**4**) (0.10 g, 0.42 mmol) and dichloromaleic anhydride (0.074 g, 0.44 mmol) in toluene (1 mL) was heated to 100 ºC for 48 hours. The reaction mixture was diluted with water, extracted with ether, dried, filtered and concentrated. Column chromatography (100:1 petroleum ether:ethyl acetate) afforded the title compound as a yellow oil (0.028 g, 16%).

^{1}**H NMR** (500 MHz, $CDCl_3$) δ 6.41 (dd, *J* = 10.9 and 17.5 Hz, 1H), 5.83 (dd, *J* = 6.0 and 3.0 Hz, 1H), 5.43 (d, *J* = 17.5 Hz, 1H), 5.12 (d, *J* = 10.9 Hz, 1H), 3.69 (dd, *J* = 10.4 and 4.3, Hz 3H), 3.56 – 3.42 (m, 3H), 2.95 (dd, *J* = 20.3 and 6.5 1H), 1.67 – 1.60 (m, 1H), 1.43 – 1.37 (m, 1H), 0.85 (s, 9H), -0.01 (s, 3H), -0.02 (s, 3H); ^{13}**C NMR** (125 MHz, $CDCl_3$) δ 166.5 (C), 166.4 (C), 138.2 (C), 136.4 (CH), 122.5 (CH), 114.6 (CH_2), 73.64 (C), 67.2 (C), 59.3 (CH_2), 41.7 (CH), 34.0 (CH_2), 32.6 (CH_2), 25.8 (CH_3), 18.1 (CH_2), -5.5 (CH_2); **MS** (EI) *m/z* 347 (M^+ - 57) (47), 325 (6), 231 (32), 165 (19), 123 (56), 95 (29), 75 (100), 59 (32); **HRMS** calculated for $C_{14}H_{17}Cl_2O_4Si$ (M^+ - 57) 347.0273, found 347.0260.

(4aR,8aR)-rel-5-vinyl-3,4,4a,7,8,8a-hexahydro-1H-isochromen-1-one (7)



7

Large-scale MeMgBr mediated DA of trienol **5** with methyl acrylate (MAC):

MeMgBr (3.0 M in ether; 10.7 mL, 32.1 mmoI) and MAC (48 mL, 534 mmol) were added sequentially to a stirred solution of trienol **5** (3.32 g, 26.8 mmol) and 1-pentanol (3.47 mL, 32.0 mmol) in DCM (500 mL) at 0 °C. The reaction mixture was allowed to warm to rt, and after 48 h, saturated $NaHCO_3$ (100 mL) was added. The resulting mixture was passed through a pad of silica, Na_2SO_4 and Celite® and concentrated to give **7** (3.6 g, 76 %).

MeMgBr mediated DA of trienol **5** with methyl acrylate (MAC):

MeMgBr (3.0 M in ether; 65 µL, 0.19 mmoI) and MAC (100 µL, 1.1 mmol) were added sequentially to a stirred solution of trienol **5** (24 mg, 0.19 mmol) and 1-pentanol (21 µL, 0.19 mmol) in DCM (5 mL) at 0 °C. The reaction mixture was allowed to warm to rt, and after 24 h, saturated $NaHCO_3$ (1 mL) was added. The resulting mixture was passed through a column of Na_2SO_4 and Celite®, concentrated and purified by PTLC (40 % ethyl acetate in hexane) to give **7** (29 mg, 85 %).

Et_2AlCl mediated DA of trienol **5** with methyl acrylate (MAC):

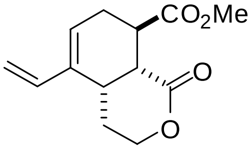
Et_2AlCl (1 M in hexanes; 194 µL, 0.19 mmol) and MAC (0.3 mL, 3.3 mmol) were added sequentially to a stirred solution of trienol **5** (24 mg, 0.19 mmol) in DCM (5 mL) at 0 °C. The reaction mixture was allowed to warm to rt, and after 24 h, saturated $NaHCO_3$ (1 mL) was added. The resulting mixture was passed through a column of Na_2SO_4 and Celite®, concentrated and purified by PTLC (40 % ethyl acetate in hexanes) to give to give **7** (25 mg, 74 %).

Me3Al / *S*-BINOL mediated DA of trienol **5** with methyl acrylate (MAC)

Me_3Al (2 M in hexane; 194 µL, 0.19 mmol) was added to a stirred solution of *S*-BINOL (60 mg, 0.21 mmol) and trienol **5** (24 mg, 0.19 mmol) in DCM (5 mL) at 0 °C. After 5 min, MAC (0.3 mL, 3.3 mmol) was added. The reaction mixture was allowed to warm to rt, and after 48 h was quenched by addition of saturated $NaHCO_3$ (ca. 1 mL). The resulting mixture was passed through a short column of Na_2SO_4 and Celite® and the combined eluant and washings were concentrated and purified by PTLC (40% ethyl acetate in hexane) to give the **7** (27 mg, 80 %, 75% ee by HPLC).[4]

IR νmax 1716, 1402, 1220, 1078; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.24 (1H, dd, *J* = 11, 17.5 Hz), 5.86 (1H, t, *J* = 4 Hz), 5.07 (1H, d, *J* = 17.5 Hz), 5.00 (1H, d, *J* = 11 Hz), 4.39 (1H, ddd, J= 3, 5, 11 Hz, CH_2O), 4.32 (1H, ddd, *J* = 3, 11, 11 Hz, CH_2O), 2.95-2.86 (1H, m), 2.81 (1H, ddd, *J* = 4, 5 11 Hz), 2.29-2.20 (2H, m), 2.14 (1H, dddd, *J* = 3.5, 3.5, 3.5, 14.5 Hz), 2.01-1.77 (3H, m); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 174.4 (s, C=O), 138.2 (CH), 136.4 (C), 130.5 (CH), 111.4 (CH_2), 69.2 (t, CH_2O), 40.5 (CH), 31.8 (CH), 26.5 (CH_2), 25.0 (CH_2), 23.6 (CH_2); **MS** (EI) *m/z* (relative intensity): 178 ([M]+, 16), 150 (15), 105 (10), 91 (26), 79 (10); **HRMS** *m/z* calcd. for $C_{11}H_{14}O_2$: 178.0994; found: 178.0990.

(4aR,8S,8aS)-rel-methyl 1-oxo-5-vinyl-3,4,4a,7,8,8a-hexahydro-1H-isochromene-8-carboxylate (8)



8

<u>MeMgBr mediated DA of trienol **5** with dimethyl fumarate</u>:

MeMgBr (3.0 M in ether; 65 µL, 0.19 mmoI) and dimethyl fumarate (55 mg, 0.38 mmol) were added sequentially to a stirred solution of trienol **5** (24 mg, 0.19 mmol) and 1-pentanol (21 µL, 0.19 mmol) in DCM (5 mL) at 0 °C. The reaction mixture was allowed to warm to rt, and after 24 h, saturated $NaHCO_3$ (1 mL) was added. The resulting mixture was passed through a column of Na_2SO_4 and Celite®, concentrated and purified by PTLC (40 % ethyl acetate in hexane) to give **8** (36 mg, 80 %).

IR νmax 1728, 1724, 1433, 1271, 1166; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.20 (1H, dd, *J* = 11, 17.5 Hz), 5.88 (1H, t, *J* = 4 Hz), 5.08 (1H, d, *J* = 17.5 Hz), 5.03 (1H, d, *J* = 11 Hz), 4.33-4.23 (2H, m, CH_2O), 3.68 (3H, s, OMe), 3.37-3.28 (2H, m), 3.19 (1H, ddd, *J* = 7.5, 7.5, 7.5 Hz), 2.65(1H, ddd, *J* = 4.5, 4.5, 18 Hz), 2.49-2.40 (1H, m), 2.31-2.21 (1H, m), 1.89-1.76 (1H, m); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 174.0 (s, C=O), 172.6 (s, C=O), 137.4 (CH), 136.8 (C), 128.1 (CH),

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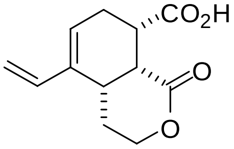
[4] EE was determined using a Chiralcel OJ-H column (2% isopropanol in hexanes)

113.0 (CH_2), 67.1 (t, CH_2O), 52.6 (CH_3, OMe), 41.6 (CH), 39.4 (CH), 30.1 (CH), 27.9 (CH_2), 25.4 (CH_2); **MS** (EI) *m/z* (relative intensity): 236 ([M]+, 24), 205 (13), 176 (95), 148 (19), 131 (22), 104 (100); **HRMS** *m/z* calcd. for $C_{13}H_{16}O_4$: 236.1049; found: 236.1055.

(4aR,8R,8aS)-rel-1-oxo-5-vinyl-3,4,4a,7,8,8a-hexahydro-1H-isochromene-8-carboxylic acid (9)



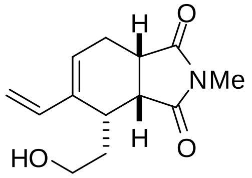
9

<u>Thermal DA of trienol **5** with maleic anhydride:</u>

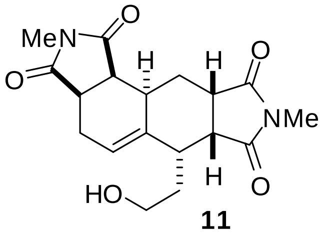
Maleic anhydride (50 mg, 0.51 mmol) was added to a solution of the trienol **5** (32 mg, 0.26 mmol) in DCM (5 mL). After 24 h, the reaction mixture was concentrated. Purification by PTLC (50% ethyl acetate in hexane) gave solely adduct **9** (11 mg, 19 %).

IR νmax 2918, 1733, 1697, 1392, 1251; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.24 (1H, dd, *J* = 11, 17.5 Hz), 5.94-5.89 (1H, m), 5.10 (1H, d, *J* = 17.5 Hz), 5.06 (1H, d, *J* = 11 Hz), 4.28 (1H, ddd, *J* = 3.5, 8.5, 11.5 Hz), 4.18 (1H, ddd, *J* = 4, 7, 11 Hz), 3.62-3.50 (1H, m), 3.26 (1H, dd, *J* = 7, 7 Hz), 2.72-2.41 (3H, m), 2.33 (1H, dddd, *J* = 3.5, 7, 7, 14 Hz), 1.87 (1H, dddd, *J* = 3.5, 7.5, 11.5, 11.5 Hz); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 177.6 (s, C=O), 172.2 (s, C=O), 131.5 (C), 137.2 (CH), 128.8 (CH), 113.6 (CH_2), 66.2 (t, CH2O), 41.3 (CH), 40.1 (CH), 33.1 (CH), 28.6 (CH_2), 24.0 (CH_2); **MS** (EI) *m/z* ; **HRMS** calculated for $C_{12}H_{14}O_4$: 222.0892; found: 222.0892.

(3aR,4S,7aS)-rel-4-(2-hydroxyethyl)-2-methyl-5-vinyl-3a,4,7,7a-tetrahydro-1H-isoindole-1,3(2H)-dione (10) and (11)



10



11

MeMgBr mediated DA of trienol **5** with *N*-methyl maleimide:

MeMgBr (3.0 M in ether; 65 µL, 0.19 mmoI) and *N*-methyl maleimide (19 mg, 0.17 mmol) were added sequentially to a stirred solution of trienol **5** (24 mg, 0.19 mmol) and 1-pentanol (21 µL, 0.19 mmol) in DCM (5 mL) at 0 °C. The reaction mixture was allowed to warm to rt, and after 24 h, saturated NaHCO$_3$ (1 mL) was added. The resulting mixture was passed through a column of Na$_2$SO$_4$ and Celite®, concentrated and purified by PTLC (100% EtOAc) to give **10** (24 mg, 61 %) and **11** (10 mg, 17 %).[5]

Thermal DA of trienol **5** with *N*-methyl maleimide:

N-methyl maleimide (17 mg, 0.15 mmol) was added to to a stirred solution of trienol **5** (24 mg, 0.19 mmol) in DCM (5 mL). After 24 h, the reaction mixture was concentrated and purified by PTLC (100% EtOAc) to give adducts **10** (6 mg, 17%) and **11** (19 mg, 36%).[5]

Data for **9**: **IR** νmax 3433, 2945, 1689, 1435, 1277, 1136; **^{1}H NMR** (400 MHz, CDCl$_3$) δ 6.40 (1H, dd, *J* = 11, 17.5 Hz), 5.96 (1H, dd, *J* = 3.5, 7 Hz), 5.36 (1H, d, *J* = 17.5 Hz), 5.05 (1H, d, *J* = 10.5 Hz), 3.61-3.46 (2H, m, CH2O), 3.36 (1H, ddd, *J* = 5, 5, 10.5 Hz), 3.11-3.02 (2H, m), 3.01 (3H, s, OMe), 2.78-2.67 (1H, m), 2.49-2.37 (1H, m), 1.66-1.57 (1H, m), 1.48-1.35 (1H, m); **^{13}C NMR** (100 MHz, CDCl$_3$) δ 180.4 (s, C=O), 179.0 (s, C=O), 142.4 (C), 137.8 (CH), 127.6 (CH), 112.8 (CH$_2$), 61.1 (CH$_2$), 44.6 (CH), 39.1 (CH), 32.0 (CH$_2$), 31.1 (CH), 25.0 (CH$_3$, NMe), 22.5 (CH$_2$); **MS** (EI) *m/z* (relative intensity): 235 ([M]+, 9), 217 (19), 191 (100), 132 (21), 106 (70), 91 (35); **HRMS** *m/z* calcd. for C$_{13}$H$_{17}$NO$_3$: 235.1208; found: 235.1192.

Data for **10**: **IR** νmax 3493, 2940, 1700, 1683, 1433, 1381, 904; **^{1}H NMR** (400 MHz, CDCl$_3$) δ 5.51-5.54 (1H, m), 3.89 (1H, ddd, *J* = 5, 7, 11.5 Hz, CH2O), 3.77 (1H, ddd, *J* = 5, 7, 11 Hz,

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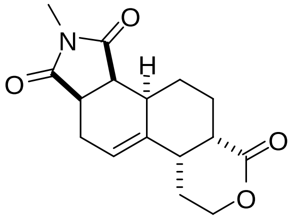
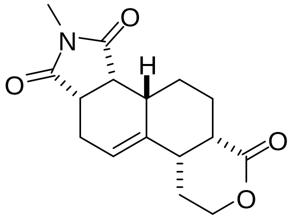
[5] Yields based on amount of *N*-methyl maleimide used.

CH2O), 3.37 (1H, dd, *J* = 6, 9.5 Hz), 3.36 (1H, ddd, *J* = 2, 5.5, 9.5 Hz), 3.10-3.00 (2H, m), 2.90 (3H, s, NMe), 2.88 (3H, s, NMe), 2.84-2.62 (3H, m), 2.37 (1H, ddd, *J* = 2, 4.5, 14 Hz), 2.12-1.94 (3H, m), 1.94-1.84 (1H, m); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 180.2 (s, C=O), 179.8 (s, C=O), 178.8 (s, C=O), 178.1 (s, C=O), 141.0 (C), 120.5 (CH), 61.1 (CH_2), 43.5 (CH), 41.3 (CH), 40.3 (CH), 40.1 (CH), 35.2 (CH), 34.3 (CH), 30.3 (CH_2), 25.2 (CH_3, NMe), 25.11 (CH_2), 25.08 (CH_3, NMe), 23.3 (CH_2) ; **MS** (EI) *m/z* (relative intensity): 346 ([M]+, 4), 328 (100), 316 (20), 242 (15), 112 (57), 91 (19); **HRMS** *m/z* calcd. for $C_{18}H_{22}N_2O_4$: 346.1529; found: 346.1544.

(3aS,3bR,5aS,9aS,11aR)-rel-2-methyl-3b,4,5,5a,9,9a,11,11a-octahydroisochromeno[6,5-e]isoindole-1,3,6(2H,3aH,8H)-trione (12a) and (3aR,3bS,5aS,9aS,11aS)-rel-2-methyl-3b,4,5,5a,9,9a,11,11a-octahydroisochromeno[6,5-e]isoindole-1,3,6(2H,3aH,8H)-trione (12b)



12a



12b

Thermal DA of lactone **7** with *N*-methyl maleimide:

N-methyl maleimide (17 mg, 0.15 mmol) was added to a solution of lactone **7** (25 mg, 0.14 mmol) in DCM (1 mL). After 24 h, the reaction mixture was concentrated and fractionated by PTLC (100% EtOAc) to give adducts **12a** (33 mg, 81%) and **12b** (5 mg, 12%).

Data for **12a**: **IR** νmax 2941, 1730, 1693, 1436, 1286, 1076; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 5.62-5.53 (1H, m), 4.36 (1H, ddd, *J* = 4, 4, 11 Hz, CH2O), 4.23 (1H, ddd, *J* = 2.5, 11, 11 Hz, CH2O), 3.16-3.05 (2H, m), 2.99-2,85 (2H, m), 2.90 (3H, s, NMe), 2.75 (1H, dd, *J* = 7, 15 Hz), 2.37-2.07 (4H, m), 2,05-1.97 (1H, m), 1.93-1.81 (2H, m), 1.78-1.66 (1H, m); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 180.1 (s, C=O), 178.5 (s, C=O), 174.9 (s, C=O), 142.4, 120.2, 66.3 (t, CH2O), 44.9, 40.5, 39.2, 38.0, 33.9, 26.2, 25.1, 24.9, 24.6, 23.0; **MS** (EI) *m/z* 289 ([M]+, 40), 216 (20), 178 (20), 157 (17), 57 (100); **HRMS** calculated for $C_{16}H_{19}NO_4$: 289.1314; found: 289.1302.

Data for **12b**: **IR** νmax 2939, 1726, 1693, 1437, 1384, 1286; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 5.73-5.66 (1H, m), 4.29 (1H, ddd, *J* = 4, 5, 11.5 Hz), 4.21 (1H, ddd, *J* = 4, 11, 11 Hz), 3.13-3.02

(2H, m), 3.01-2.85 (2H, m), 2.93 (3H, s), 2.71 (1H, ddd, *J* = 2, 6, 15.5 Hz), 2.49-2.40 (1H, m), 2.39-2.31 (1H, m), 2.30-2.18 (1H, m), 2.11-1.99 (1H, m), 1.94-1.80 (2H, m), 1.80-1,70 (1H, m), 1.65 (1H, dddd, *J* = 4, 6, 11.5, 14 Hz); **^{13}C NMR** (75 MHz, $CDCl_3$) δ 180.0 (C), 178.9 (C), 173.9 (C), 141.3, 121.8, 67.1, 43.8, 40.1, 39.7, 37.2, 36.9, 29.0, 26.0, 25.0, 24.0, 23.9; **MS** (EI) *m/z* 289 ([M]+, 12), 217 (14), 179 (11), 178 (100), 150 (24), 112 (23), 91 (18); **HRMS** calculated for $C_{16}H_{19}NO_4$: 289.1314; found: 289.1292.