SUPPORTING INFORMATION

for
the
communication
entitled

A Tandem 1,3-H-Shift - 6π - Electrocyclization - Cyclic 2-Amido-diene Intramolecular Diels-Alder Cycloaddition Approach to BCD-Ring of Atropurpuran.

authored by

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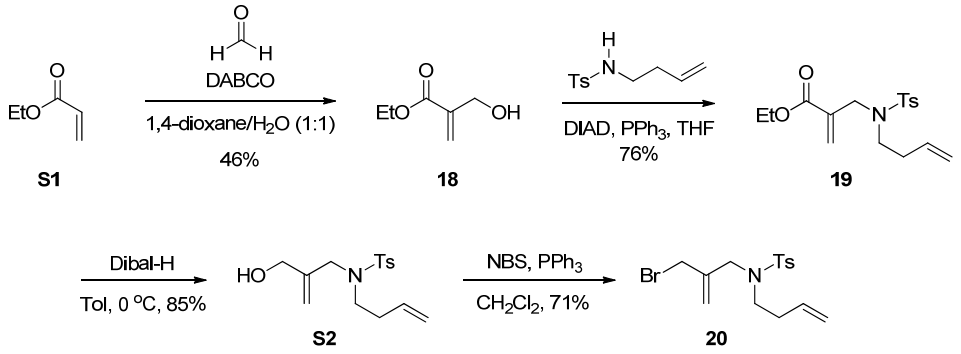
GENERAL EXPERIMENTAL INFORMATION

All reactions were performed in flame-dried glassware under nitrogen atmosphere. Solvents were distilled prior to use. Reagents were used as purchased from Aldrich, Acros, Alfa Aesar, or TCI unless otherwise noted. Chromatographic separations were performed using Silicycle 43-60 Å SiO_2. ^1H and ^{13}C NMR spectra were obtained on Varian VI-400 and VI-500 spectrometers using $CDCl_3$ with TMS or residual solvent as standard unless otherwise noted. Melting points were determined using a Laboratory Devices MEL-TEMP and are uncorrected/calibrated. Infrared spectra were obtained on Bruker EQUINOX 55 FTIR. TLC analysis was performed using Aldrich 254 nm polyester-backed plates (60 Å, 250 μm) and visualized using UV and $KMnO_4$ stains. Low-resolution mass spectra were obtained using an Agilent 1100 series LS/MSD and are APCI. All spectral data obtained for new compounds are reported here.

GENERAL PROCEDURE FOR PREPARATIONS OF STARTING MATERIALS.



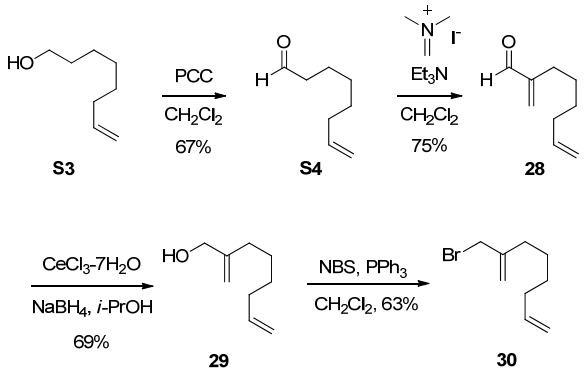
The known compound **18** was prepared from the ester **S1** via Morita-Baylis-Hillman reaction.[i]

To a solution of alcohol **18** (1.0 equiv), tosylamide (1.1 equiv), and PPh_3 (1.1 equiv) in THF (0.2 M) was added dropwise DIAD (1.1 equiv). The resulting solution was stirred for 16 hours at room temperature. The solution was washed with sat. aq. NaCl twice, dried over Na_2SO_4, and concentrated under reduced pressure. Separation and purification of the resulting crude residue via silica gel flash column chromatography (gradient eluent: EtOAc in hexanes) afforded the desired Mitsunobu product **19**.

To a solution of ester **19** (1 equiv) in toluene (0.2 M) at 0 ˚C was added DIBAL-H (2.2 equiv). The resulting solution was stirred for 3 hours at 0 ˚C. Potassium Sodium Tartrate was added to the resulting solution and additionally stirred until two layers became clearly separated. The solution was washed with sat. aq. NaCl twice, dried over Na_2SO_4, and concentrated under reduced pressure. Separation

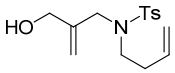
and purification of the resulting crude residue via silica gel flash column chromatography (gradient eluent: EtOAc in hexanes) afforded the desired alcohol **S2**.

To a solution of NBS (1.2 equiv) in anhydrous DMF (0.5 M), PPh_3 (1.2 equiv) was slowly added. To the resulting dark red solution, alcohol **S2** was added. After the resulting solution was stirred for 30 min at room temperature, sat. sodium sulfate solution was added. The solution was extracted with hexanes twice, dried over Na_2SO_4, and concentrated under reduced pressure. Separation and purification of the resulting crude residue via silica gel flash column chromatography (gradient eluent: EtOAc in hexanes) afforded the desired bromide **20**.



Compound **29** was prepared from **S3** in three steps. PCC oxidation[ii], condensation of the aldehyde **S4**[iii], followed by Luche reduction of **28** afforded **29**. Bromide **30** was prepared from alcohol **29** according to the standard procedure for bromide **20**.

CHARACTERIZATIONS OF STARTING MATERIALS.

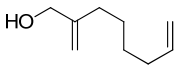


S2

Alcohol **S2** (215 mg, 0.73 mmol) was prepared in 85% yield according to the general procedure.

R_f = 0.50 [40% EtOAc/hexanes];

^{1}H NMR (500 MHz, $CDCl_3$) δ 3.26 (dd, 2H, *J* = 6.0, 7.5 Hz), 3.86 (s, 3H), 4.23 (s, 2H), 5.06 (dd, 2H, *J* = 15.0, 18.5 Hz), 5.23 (s, 1H), 5.65-5.74 (m, 1H), 7.38 (d, 2H, *J* = 8.0 Hz), 7.77 (d, 2H, *J* = 8.0 Hz).



29

Alcohol **29** (837 mg, 5.98 mmol) was prepared in 69% yield according to the general procedure.

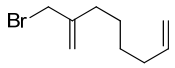
R_f = 0.40 [35% EtOAc/hexanes];

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.38-1.52 (m, 4H), 2.05-2.09 (m, 4H), 4.07 (d, 2H, *J* = 2.8 Hz), 4.87 (d, 1H, *J* = 0.8 Hz), 4.93-5.03 (m, 3H), 5.76-5.86 (m, 1H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 27.4, 28.8, 33.0, 33.8, 66.1, 109.4, 114.6, 139.1, 19.3;

IR (neat) cm^{-1}: 3323br, 2929s, 1641m, 1439m;

mass spectrum (APCI): m/e (% relative intensity) 123.2 (38) $(M+H-H_2O)^+$.



30

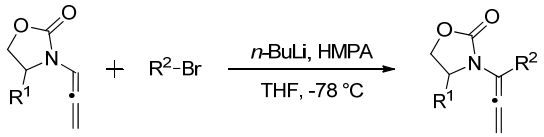
Bromide **30** (318 mg, 1.57 mmol) was prepared in 63% yield according to the general procedure.

R_f = 0.60 [Pure hexanes];

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.38-1.56 (m, 4H), 2.08 (dt, 2H, *J* = 6.8, 6.8 Hz), 2.22 (t, 2H, *J* = 7.4 Hz), 3.97 (s, 2H), 4.93-5.04 (m, 3H), 5.22 (s, 1H), 5.76-5.86 (m, 1H);

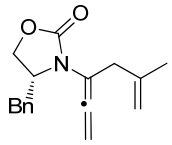
^{13}C NMR (125 MHz, $CDCl_3$) δ 27.0, 28.7, 33.4, 33.8, 37.1, 114.7, 115.2, 139.0, 145.7.

GENERAL PROCEDURE FOR PREPARATIONS OF ALLENAMIDES VIA α-ALKYLATIONS.[iv]



To a cooled (-78 ºC) solution of a given allenamide (1.0 equiv) and HMPA (1.5 equiv) in anhydrous THF (0.1 M) was added dropwise *n*-BuLi (1.5 equiv, 2.5 M in Hexanes). After stirring for 45 min for complete deprotonation, a corresponding allelic halide (1.5 equiv) was added dropwise. The resulting solution was stirred at -78 ºC for 1 h and gradually warmed up to rt over 2 h. The solution was washed with sat aq NaCl twice, dried over Na_2SO_4, and concentrated under reduced pressure. Separation and purification of the resulting crude residue via silica gel flash column chromatography (gradient eluent: EtOAc in hexanes) afforded the desired α-substituted allenamides.

CHARACTERIZATIONS OF ALLENAMIDES.



12

Allenamide **12** (94.6 mg, 0.35 mmol) was prepared in 70% yield according to the general procedure.

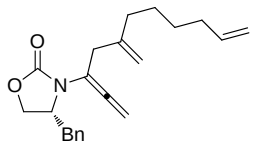
R_f = 0.35 [25% EtOAc/hexanes]; $[\alpha]_D^{23}$ = -1.54° [c 0.095 CH_2Cl_2];

^{1}H NMR (500 MHz, $CDCl_3$) δ 1.85 (s, 3H), 2.69 (dd, 1H, *J* = 9.5, 14.0 Hz), 3.22 (d, 1H, *J* = 15.5 Hz), 3.31 (dd, 1H, *J* = 3.5, 14.0 Hz), 3.42 (dt, 1H, *J* = 3.0, 15.5 Hz), 4.09 (dd, 1H, *J* = 5.5, 8.0 Hz), 4.14-4.23 (m, 2H), 4.93 (d, 2H, *J* = 0.5 Hz), 5.31 (dt, 1H, *J* = 2.0, 10.5 Hz), 5.42 (dt, 1H, *J* = 2.5, 13.0 Hz), 7.21 (d, 2H, *J* = 7.0 Hz), 7.31 (dd, 1H, *J* = 1.5, 5.5 Hz), 7.37 (t, 2H, *J* = 6.0 Hz);

^{13}C NMR (125 MHz, $CDCl_3$) δ 22.3, 38.8, 39.2, 58.0, 67.0, 83.8, 106.8, 113.7, 127.5, 129.2, 129.3, 136.0, 141.8, 155.8, 205.2;

IR (neat) cm^{-1}: 3055w, 2917w, 1757s, 1391m;

mass spectrum (APCI): m/e (% relative intensity) 270.1 (100) $(M+H)^+$.



31

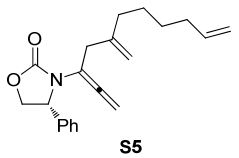
Allenamide **31** (223 mg, 0.66 mmol) was prepared in 66% yield according to the general procedure.

R_f = 0.35 [25% EtOAc/hexanes];

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.36-1.52 (m, 3H), 2.07 (m, 5H), 2.69 (dd, 1H, *J* = 9.2, 13.6 Hz), 3.16 (d, 1H, *J* = 15.2 Hz), 3.25 (dd, 1H, *J* = 3.6, 13.6 Hz), 3.34 (dt, 1H, *J* = 2.8, 19.2 Hz), 4.03 (dd, 1H, *J* = 5.2, 7.6 Hz), 4.06-4.17 (m, 2H), 4.87 (s, 1H), 4.91-4.95 (m, 1H), 4.97 (ddd, 1H, *J* = 2.0, 2.8, 8.8 Hz), 5.01 (ddd, 1H, *J* = 1.2, 1.6, 3.0 Hz), 5.22 (dt, 1H, *J* = 2.0, 10.4 Hz), 5.37 (dt, 1H, *J* = 3.0, 10.5 Hz), 5.39 (dt, 1H, *J* = 2.0, 10.4 Hz), 5.82 (ddd, 1H, *J* = 6.8, 10.0, 13.2 Hz), 7.15 (dd, 2H, *J* = 1.6, 8.8 Hz), 7.24-7.34 (m, 3H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 27.3, 28.8, 33.9, 35.5, 37.4, 38.7, 578.0, 66.9, 83.7, 106.8, 112.6, 114.6, 127.4, 129.1, 129.3, 135.9, 139.1, 145.6, 155.7, 205.3;

mass spectrum (APCI): m/e (% relative intensity) 338.1 (100) $(M+H)^+$.



S5

Allenamide **S5** (461 mg, 1.42 mmol) was prepared in 84% yield according to the general procedure.

R_f = 0.55 [25% EtOAc/hexanes]; $[\alpha]_D^{23}$ = -11.3 [*c* 0.62, $CHCl_3$];

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.22-1.39 (m, 4H), 1.75 (q, 2H, *J* = 7.2 Hz), 1.99 (dt, 2H, *J* = 6.8, 6.8 Hz), 2.97 (d, 1H, *J* = 14.4 Hz), 3.27 (dt, 1H, *J* = 3.2, 14.4 Hz), 4.12 (dd, 1H, *J* = 7.6, 8.8 Hz), 4.61 (dd, 1H, *J* = 8.8, 8.8 Hz), 4.80 (d, 1H, *J* = 1.2 Hz), 4.83 (d, 1H, *J* = 0.8 Hz), 4.90-5.01 (m, 4H), 5.78 (m, 1H), 7.27-7.33 (m, 2H), 7.34-7.39 (m, 3H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 27.0, 28.8, 33.8, 35.0, 37.6, 61.3, 70.0, 83.7, 106.6, 112.7, 114.5, 127.5, 129.1, 138.5, 139.2, 145.5, 156.2, 205.7;

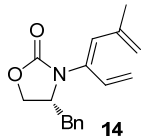
IR (neat) cm^{-1}: 2929m, 1754s, 1641w, 1393m;

mass spectrum (APCI): m/e (% relative intensity) 324.3 (100) $(M+H)^+$.

GENERAL PROCEDURE FOR THE ACID-CATALYZED ISOMERIZATION OF ALLENAMIDES.[v]

To a solution of a respective allenamide (1.0 equiv) in anhydrous CH_2Cl_2 (0.1 M) in a small vial was added CSA (10 mol%) in a small screw-cap scintillation vial equipped with a magnetic stir bar. The solution was stirred for 10 min and filtered through a short pad of silica gel. Elution with EtOAc/Hexanes (1:1) followed by concentration *in vacuo* afforded a crude product. Separation and purification of the resulting crude residue via silica gel flash column chromatography (gradient eluent: EtOAc in hexanes) afforded the desired 1- or 2-amido-diene.

CHARACTERIZATIONS OF TRIENES.



14

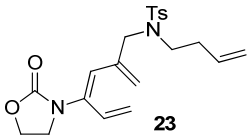
Triene **14** (95 mg, 0.36 mmol) was prepared in 71% yield according to the general procedure.

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.93 (s, 3H), 2.59-2.65 (m, 1H), 3.09 (dd, 1H, *J* = 4.4, 13.6 Hz), 4.09-4.16 (m, 1H), 4.24-4.32 (m, 2H), 5.09 (s, 1H), 5.18, (t, 1H, *J* = 1.6 Hz), 5.32 (dd, 2H, *J* = 10.0,

18.0 Hz), 6.14 (s, 1H), 6.78 (dd, 1H, *J* = 11.2, 17.6 Hz), 7.16 (d, 2H, *J* = 6.8 Hz), 7.22-7.32 (m, 3H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 23.2, 39.3, 58.0, 67.4, 116.9, 120.0, 127.4, 129.1, 129.2, 129.7, 132.3, 134.4, 135.8, 139.5, 156.8;

mass spectrum (APCI): m/e (% relative intensity) 270.1 (100) $(M+H)^+$.

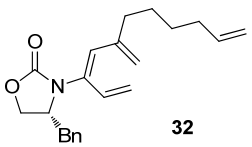


23

Triene **23** (71 mg, 0.18 mmol) was prepared in 35% yield over two steps from the corresponding allenamide according to the general procedure.

^{1}H NMR (500 MHz, $CDCl_3$) δ 2.22 (dd, 2H, *J* = 7.0, 8.0 Hz), 2.43 (s, 3H), 3.16 (t, 2H, *J* = 5.5, 7.5 Hz), 3.78 (t, 1H, *J* = 7.5 Hz), 3.82 (s, 2H), 4.43 (t, 2H, *J* = 7.5 Hz), 5.00 (ddd, 2H, *J* = 2.0, 8.0, 20.0 Hz), 5.24-5.41 (m, 4H), 5.60-5.68 (m, 1H), 6.01 (s, 1H), 6.63 (dd, 1H, *J* = 9.5, 17.0 Hz), 7.32 (d, 2H, *J* = 8.0 Hz), 7.70 (d, 2H, *J* = 8.0 Hz);

mass spectrum (APCI): m/e (% relative intensity) 403.1 (100) $(M+H)^+$.



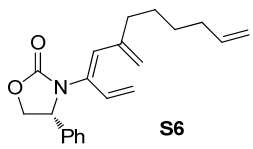
32

Triene **32** (103 mg, 0.31 mmol) was prepared in 83% yield according to the general procedure.

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.36-1.50 (m, 4H), 2.04 (dd, 2H, *J* = 7.2, 14.8 Hz), 2.17 (t, 2H, *J* = 7.2 Hz), 2.58-2.64 (m, 1H), 3.07 (dd, 1H, *J* = 4.0, 13.6 Hz), 4.09-4.15 (m, 1H), 4.24-4.31 (m, 2H), 4.90 (dq, 1H, *J* = 1.2, 10.4 Hz), 4.96 (dq, 1H, *J* = 0.4, 15.2 Hz), 5.09 (t, 1H, *J* = 1.6 Hz), 5.19 (dd, 1H, *J* = 1.6, 3.2 Hz), 5.31 (dt, 1H, *J* = 1.6, 10.8 Hz), 5.37 (dt, 1H, *J* = 0.8, 17.2 Hz), 5.73-5.83 (m, 1H), 6.11 (s, 1H), 6.74 (ddd, 1H, *J* = 0.8, 11.2, 17.6 Hz), 7.12 (dd, 2H, *J* = 1.6, 3.6 Hz), 7.23-7.33 (m, 3H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 27.9, 28.6, 33.7, 36.9, 39.3, 57.9, 60.6, 67.3, 114.7, 116.7, 117.8, 127.4, 129.2, 129.2, 129.7, 133.2, 133.7, 135.8, 138.9, 143.6, 156.8;

mass spectrum (APCI): m/e (% relative intensity) 338.2 (100) $(M+H)^+$.



S6

Triene **S6** (384 mg, 1.18 mmol) was prepared in 83% yield according to the general procedure.

R_f = 0.25 [15% EtOAc/hexanes]; $[\alpha]_D^{23}$ = 100.1 [*c* 0.97, $CHCl_3$];

^{1}H NMR (500 MHz, $CDCl_3$) δ 0.95-1.04 (m, 2H), 1.17 (sep, 2H, *J* = 7.5 Hz), 1.82, (dd, 4H, *J* = 7.5, 15.0 Hz), 4.37 (dd, 1H, *J* = 6.5, 9.0 Hz), 4.75 (t, 1H, *J* = 10.5 Hz), 4.90-4.94 (m, 2H), 4.94 (dd, 1H, *J* = 1.5, 3.0 Hz), 4.98 (s, 1H), 5.07 (dd, 1H, *J* = 6.5, 8.5 Hz), 5.27 (d, 1H, *J* = 11.0 Hz), 5.35 (d, 1H, *J* = 17.0 Hz), 5.68-5.77 (m, 2H), 6.52 (dd, 1H, *J* = 11.0, 17.5 Hz), 7.29 (dd, 2H, *J* = 2.0, 8.0 Hz), 7.32-7.39 (m, 3H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 27.5, 28.5, 33.7, 37.0, 114.6, 116.3, 117.4, 127.8, 129.3, 129.3, 129.4, 133.1, 134.2, 138.2, 139.1, 143.5, 156.9;

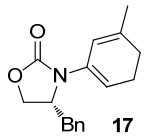
IR (neat) cm^{-1}: 2930m, 1755s, 1638w, 1396m;

mass spectrum (APCI): m/e (% relative intensity) 324.1 (100) $(M+H)^+$.

GENERAL PROCEDURE FOR THE ELECTROCYCLIC RING-CLOSURE.

In the presence of 1.0 equivalent of $AlMe_3$, a solution of a triene in a xylene (0.1 M) in a sealed tube was heated to 135 or up to 185 ºC. Upon completion of the reaction (~16 h), the solution was cooled to RT. The resulting solution was directly loaded to silica gel flash column chromatography (gradient eluent: EtOAc in hexanes) afforded the desired amido-cyclohexadienes.

CHARACTERIZATIONS OF AMIDO-DIENES.

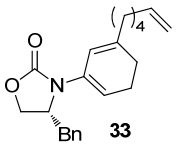


17

Diene **17** (26 mg, 0.097 mmol) was prepared in 95% yield according to the general procedure.

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.86 (s, 3H), 2.04-2.22 (m, 2H), 2.31-2.40 (m, 2H), 2.68 (dd, 1H, *J* = 9.2, 14.0 Hz), 3.15 (dd, 1H, *J* = 4.0, 13.6 Hz), 4.05 (dd, 1H, *J* = 5.2, 8.4 Hz), 4.22 (t, 1H, *J* = 4.4 Hz), 4.27-4.34 (m, 1H), 5.57, (t, 1H, *J* = 4.0 Hz), 5.89 (t, 1H, *J* = 1.2 Hz), 7.14 (d, 2H, *J* = 6.8 Hz), 7.23-7.33 (m, 3H);

mass spectrum (APCI): m/e (% relative intensity) 270.1 (100) $(M+H)^+$.



33

Diene **33** (26 mg, 0.077 mmol) was prepared in 95% yield according to the general procedure.

^{1}H NMR (500 MHz, $CDCl_3$) δ 1.33-1.46 (m, 4H), 1.92-2.11 (m, 4H), 2.13-2.30 (m, 2H), 2.60 (dd, 2H, *J* = 9.0, 13.5 Hz), 3.04 (dd, 2H, *J* = 3.5, 14.0 Hz), 3.99 (dd, 1H, *J* = 8.5, 14.0 Hz), 4.17 (dd, 1H, *J* = 8.0, 16.5 Hz), 4.21-4.26 (m, 1H), 4.92 (ddd, 2H, *J* = 2.0, 8.0, 12.5 Hz), 5.55 (t, 1H, *J* = 4.0 Hz), 5.70-5.79 (m, 2H), 7.05-7.30 (m, 5H);

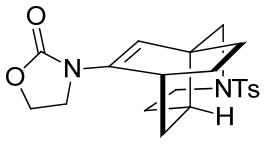
^{13}C NMR (100 MHz, $CDCl_3$) δ 22.7, 26.5, 27.2, 28.9, 33.9, 37.4, 38.5, 57.3, 66.6, 114.2, 114.8, 117.1, 127.4, 129.2, 129.2, 129.3, 129.5, 132.4, 135.9, 139.1, 143.6, 156.0;

mass spectrum (APCI): m/e (% relative intensity) 338.2 (100) $(M+H)^+$.

GENERAL PROCEDURE FOR THE ELECTROCYCLIC RING-CLOSURE-DIELS-ALDER CYCLIZATION.

In the presence of 2.0 equivalent of Ti(O*i*-Pr)$_4$, a solution of a triene in a toluene (0.1 M) in a sealed tube was heated to 110 ˚C for 16 h. The solution was cooled to RT, and decane (0.1 M) was added. The resulting solution was heated to 185 ˚C for 48 h. The resulting solution was directly loaded to silica gel flash column chromatography (gradient eluent: EtOAc in hexanes) to afford the desired Diels-Alder product.

CHARACTERIZATIONS OF TANDEM DIELS-ALDER PRODUCT.



26

Enamide **26** (36 mg, 0.089 mmol) was prepared in 69% yield according to the general procedure.

R_f = 0.50 [35% EtOAc/hexanes];

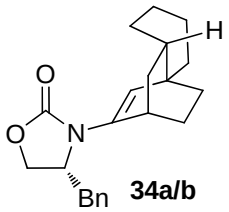
^{1}H NMR (500 MHz, $CDCl_3$) δ 0.92-0.96 (m, 1H), 1.17 (ddd, 1H, *J* = 6.0, 11.0, 17.0 Hz), 1.16-1.33 (m, 4H), 1.48 (dd, 1H, *J* = 6.5, 9.5 Hz), 1.50-1.59 (m, 2H), 1.84 (dt, 1H, *J* = 2.5, 9.0 Hz), 2.04 (dd, 1H, *J* =

2.5, 14.5 Hz), 2.11 (dt, 1H, *J* = 3.0, 12.0 Hz), 2.45 (s, 3H), 3.71-3.83 (m, 4H), 3.86 (dd, 1H, *J* = 2.5, 5.0 Hz), 4.40 (t, 2H, *J* = 7.5 Hz), 5.26 (d, 1H, *J* = 1.5 Hz), 7.35 (d, 2H, *J* = 8.0 Hz), 7.65 (d, 2H, *J* = 7.5 Hz),;

^{13}C NMR (100 MHz, $CDCl_3$) δ 21.8, 25.6, 29.1, 31.4, 32.4, 33.8, 38.3, 38.7, 45.3, 47.0, 54.4, 61.8, 111.2, 127.9, 129.9, 133.4, 141.8, 143.7, 155.2;

IR (neat) cm^{-1}: 2919m, 1744s, 1632w, 1405s;

mass spectrum (APCI): m/e (% relative intensity) 403.2 (100) $(M+H)^+$.



34a/b

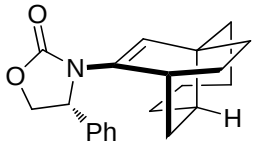
Enamide **34a/b** (dr = 2:1, 7.7 mg, 0.023 mmol) was prepared in 46% yield according to the general procedure.

R_f = 0.65 [35% EtOAc/hexanes];

^{1}H NMR (400 MHz, $CDCl_3$) δ 0.72-0.87 (m, 2H, major and minor), 1.08-1.27 (m, 3H, major and minor), 1.34-1.47 (m, 4H, major and minor), 1.51-1.63 (m, 3H, major and minor), 1.82-1.88 (m, 1H, major and minor), 2.62 (dd, 1H, *J* = 9.6, 13.6 Hz), 3.11 (ddd, 1H, *J* = 2.8, 13.6, 16.8 Hz), 3.23 (ddd, 1H, *J* = 3.2, 5.6, 9.2 Hz), 3.99-4.03 (m, 1H, major and minor), 4.13-4.18 (m, 1H, major and minor), 4.25-4.32 (m, 1H, major and minor), 5.48 (s, 1H, major), 5.56 (s, 1H, minor), 7.10 (dd, 2H, *J* = 1.6, 6.4 Hz), 7.19-7.30 (m, 3H);

IR (neat) cm^{-1}: 2924w, 1751m, 1451w, 1405w;

mass spectrum (APCI): m/e (% relative intensity) 338.2 (100) $(M+H)^+$.



35a/b

Enamide **35a/b** (dr = 2:1, 55 mg, 0.17 mmol) was prepared in 73% yield according to the general procedure.

R_f = 0.40 [15% EtOAc/hexanes]; $[\alpha]_D^{23}$ = -131.8 [*c* 0.92, $CHCl_3$];

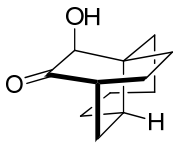
^{1}H NMR (400 MHz, $CDCl_3$) δ 0.82 (dd, 1H, *J* = 4.5, 12.5 Hz, major), 1.16-1.33 (m, 3H, major and minor), 1.36-1.52 (m, 3H, major and minor), 1.53-1.70 (m, 4H, major and minor), 1.76-1.96 (m, 4H, major and minor), 1.99-2.08 (m, 1H, major and minor), 3.30 (dd, 1H, *J* = 2.5, 5.0 Hz, minor), 3.57 (dd, 1H, *J* = 2.5, 5.5 Hz, major), 4.45-4.51 (m, 1H, major and minor), 5.03 (t, 1H, *J* = 8.5 Hz, major and minor), 5.44 (d, 1H, *J* = 1.5 Hz, major), 5.52 (dd, 1H, *J* = 8.5, 16.5 Hz, major and minor), 5.72 (s, 1H, minor), 7.61-7.74 (m, 5H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 23.2 (major), 23.6 (minor), 26.1 (major), 26.2 (major), 26.3 (minor), 26.4 (minor), 31.6 (major), 32.1 (minor), 33.1 (major), 33.8 (minor), 34.7 (minor), 34.8 (major), 34.9 (major), 35.2 (minor), 35.8 (major), 36.1 (minor), 38.5 (major), 38.8 (minor), 40.4 (minor), 41.0 (major), 60.6 (major), 60.7 (minor), 69.9 (minor), 70.0 (major), 119.2 (major), 121.1 (minor), 126.9 (minor), 127.2 (major), 128.9 (minor), 129.0 (major), 129.2 (minor), 129.3 (major), 138.2 (minor), 138.3 (major), 138.5 (major), 139.0 (minor), 155.7 (major), 155.8 (minor);

IR (neat) cm^{-1}: 2920m, 1748s, 1640w;

mass spectrum (APCI): m/e (% relative intensity) 324.3 (100) $(M+H)^+$.

ENAMIDE OXIDATION AND X-RAY CONFIRMATION.



37

To a solution of **35a/b** (124 mg, 0.38 mmol) in acetone (2 mL) was added freshly prepared DMDO (9.2 mL, 1.14 mmol, 0.124 M in acetone) at -40 ^{o}C. The reaction was slowly warmed up to RT and stirred for another 2h. Then the solvent was evaporated and the residue was redissolved in acetone (3 mL) and H_2O (1 mL). TsOH (15 mg, 0.078 mmol) was added and the reaction was kept at RT for another 1h. The reaction was quenched with sat. $NaHCO_3$ solution, extracted with EtOAc, washed with brine, dried over Na_2SO_4, filtered and concentrated *in vacuo* to give the crude product. Further purification via silica gel column chromatography (6/1, Hexanes/EtOAc) afforded **37** as a white solid (63 mg, 85%).

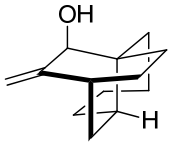
R_f = 0.40 [25% EtOAc/hexanes]; $[\alpha]_D^{23}$ = -131.8 [*c* 0.92, $CHCl_3$]; mp 39-40 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 0.93 (dt, 1H, *J* = 4.0 Hz, 13.6 Hz), 1.03-1.10 (m, 1H), .18-1.43 (m, 4H), 1.56-1.62 (m, 1H), 1.65-1.86 (m, 6H), 1.98-2.07 (m, 2H), 2.34-2.37 (m, 1H), 2.76 (s, 1H), 4.13 (s, 1H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 22.2, 26.1, 27.2, 28.6, 29.2, 31.3, 32.4, 36.6, 40.7, 41.4, 72.7, 220.6;

IR (neat) cm^{-1}: 3453br, 1720m, 1454w;

mass spectrum (APCI): m/e (% relative intensity) 193.2 (50) $(M-H)^-$.



38

To a suspension of Ph_3PCH_3Br (452 mg, 1.26 mmol) in THF (2 mL) was added KO*t*-Bu (1.2 mL, 1.2 mmol, 1 M in THF) at 0 °C. Then the reaction was kept at RT for 1h. **37** (41 mg, 0.21 mmol) in THF (2 mL) was added to the yellow solution and the mixture was slowly warmed up to RT overnight. The reaction was quenched with aq. NH_4Cl, extracted with Et_2O, washed with brine, dried over Na_2SO_4, filtered and concentrated *in vacuo* to give the crude product. Further purification via silica gel column chromatography (20/1, Hexanes/ EtOAc) afforded **38** as a white solid (30 mg, 73%).

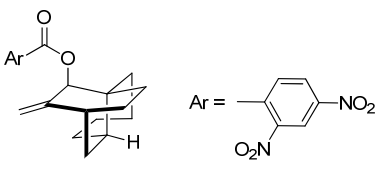
R_f = 0.40 [15% EtOAc/hexanes]; $[\alpha]_D^{23}$ = 298.2 [*c* 0.56, $CHCl_3$]; mp 41~42 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 0.83 (dt, 1H, *J* = 4.4, 13.6 Hz), 0.93-1.01 (m, 2H), 1.13-1.21 (m, 2H), 1.24-1.30 (m, 1H), 1.35-1.47 (m, 1H), 1.49-1.71 (m, 7H), 1.85-1.93 (m, 2H), 2.22-2.25 (m, 1H), 4.44 (brs, 1H), 4.98 (t, 1H, *J* = 1.8 Hz), 5.08 (t, 1H, *J* = 1.8 Hz);

^{13}C NMR (100 MHz, $CDCl_3$) δ 21.9, 26.5, 27.3, 28.6, 31.1, 32.7, 34.4, 36.4, 37.0, 38.0, 68.1, 108.0, 157.7;

IR (neat) cm^{-1}: 3433br, 2924s, 2859m, 1652w, 1451m;

mass spectrum (APCI): m/e (% relative intensity) 175.2 (90) $(M+H-H_2O)^+$.



39

To a solution of **38** (21 mg, 0.11 mmol) in CH_2Cl_2 (2 mL) was added 2,4-dinitrobenzoic acid (70 mg, 0.33 mmol), DCC (68 mg, 0.33 mmol) and DMAP (14 mg, 0.11 mmol) successively. The reaction was kept at RT overnight. Then it was quenched with aq. $NaHCO_3$, extracted with EtOAc, washed with brine, dried over Na_2SO_4, filtered and concentrated *in vacuo* to give the crude product. Further purification via silica gel column chromatography (40/1, Hexanes/EtOAc) afforded **39** as a white solid (30 mg, 71%).

R_f = 0.55 [15% EtOAc in hexanes]; $[\alpha]_D^{23}$ = 295.9 [*c* 1.20, $CHCl_3$]; mp 140-141 ^oC;

^1H NMR (400 MHz, $CDCl_3$) δ 0.92-0.99 (m, 1H), 1.05-1.10 (m, 2H), 1.19-1.31 (m, 3H), 1.54-1.76 (m, 8H), 1.94-2.00 (m, 1H), 2.31 (t, 1H, *J* = 2.8 Hz), 5.11 (t, 2H, *J* = 1.4 Hz), 6.17 (d, 1H, *J* = 1.6 Hz), 7.94 (d, 1H, *J* = 8.4 Hz), 8.52 (dd, 1H, *J* = 2.4, 8.4 Hz), 8.76 (d, 1H, *J* = 2.0 Hz);

^{13}C NMR (100 MHz, $CDCl_3$) δ 21.7, 26.3, 26.3, 29.3, 31.1, 32.9, 34.7, 36.0, 36.6, 38.8, 74.1, 111.7, 119.8, 127.5, 131.4, 133.5, 150.3, 163.0;

IR (neat) cm^{-1}: 2929w, 1731m, 1540m, 1346m.

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