SUPPORTING INFORMATION

An IMDA-Radical Cyclization Approach to (+)-Himbacine

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Experimental Procedures and Product Characterization

Diels–Alder reaction of acrylate **10**:

A solution of acrylate **10** (5.90 g, 17.0 mmol, 1 equiv) and 2,6-di-*tert*-butyl-4-methylphenol (187 mg, 0.85 mmol, 0.05 equiv) in chlorobenzene (1.70 L) was heated to reflux for 140 h, before removal of solvent *in vacuo*. The residue was purified by flash chromatography to give *exo*-adduct **11** (3.70 g, 10.7 mmol, 63%) as a colorless oil and *endo*-adduct **12** (705 mg, 2.03 mmol, 12%) as a yellow oil.

Exo-cycloadduct (**11**):

R_f = 0.33 (EtOAc/hexanes 30:70); $[\alpha]_D^{20}$ = +37.8 ° (*c* 0.8, CHCl₃); ¹H NMR (400 MHz, CDCl₃): δ = 6.02 (dd, *J* = 4.0, 2.1 Hz, 1H), 4.59 (s, 2H), 4.33 (dq, *J* = 9.7, 6.0 Hz, 1H), 3.50 (t, *J* = 6.3 Hz, 2H), 3.33 (s, 3H), 2.60–2.53 (m, 2H), 2.47–2.39 (m, 1H), 2.08–2.02 (m, 1H), 1.79–1.65 (m, 1H), 1.65–1.51 (m, 2H), 1.62 (d, *J* = 6.0 Hz, 3H), 1.51–1.28 (m, 4H); ¹³C NMR (100 MHz, CDCl₃): δ = 174.5 (C), 136.6 (CH), 116.2 (C), 96.6 (CH₂), 79.7 (CH), 67.5 (CH₂), 55.2 (CH₃), 52.7 (CH), 43.9 (CH), 38.7 (CH), 35.3 (CH₂), 29.8 (CH₂), 25.6 (CH₂), 24.3 (CH₂), 19.8 (CH₃); IR (neat): ν = 2934, 1784, 1045 cm⁻¹; MS (EI): *m/z* (%): 348 (<1) [*M*(⁸¹Br)]⁺, 346 (<1) [*M*(⁷⁹Br)]⁺, 316 (11) [*M*(⁸¹Br)-CH₃OH]⁺, 314 (11) [*M*(⁷⁹Br)-CH₃OH]⁺, 303 (7) [*M*(⁸¹Br)-CH₂OCH₃]⁺, 301 (7) [*M*(⁷⁹Br)-CH₂OCH₃]⁺, 91 (100); HRMS (EI): calcd for C₁₅H₂₃O₄⁸¹Br [*M*]⁺: 348.0759; found: 348.0744; calcd for C₁₅H₂₃O₄⁷⁹Br [*M*]⁺: 346.0780; found: 346.0775.

Endo-cycloadduct (**12**):

R_f = 0.25 (EtOAc/hexanes 30:70); $[\alpha]_D^{27}$ = +36.6 ° (*c* 0.7, CH₂Cl₂); ¹H NMR (300 MHz, C₆D₆): δ = 5.85 (dd, *J* = 1.1, 1.1 Hz, 1H), 4.49 (s, 2H), 4.05 (dq, *J* = 7.7, 6.1 Hz, 1H), 3.36 (t, *J* = 6.4 Hz, 2H), 3.19 (s, 3H), 2.40–2.27 (m, 2H), 1.73–1.60 (m, 2H), 1.37 (tt, *J* = 7.1, 7.1 Hz, 2H), 1.32 (d, *J* = 6.2 Hz, 3H), 1.20–0.87 (m, 5H); ¹³C NMR (75 MHz, C₆D₆): δ = 175.8 (C), 136.7 (CH), 119.2 (C), 96.6 (CH₂), 79.8 (CH), 67.5 (CH₂), 54.9 (CH₃), 49.6 (CH), 41.6 (CH), 37.6 (CH), 35.0 (CH₂), 30.0 (CH₂), 26.9 (CH₂), 23.5 (CH₂), 21.3 (CH₃); IR (neat): ν = 2934, 1778, 1640, 1042 cm⁻¹; MS (EI): *m/z* (%): 347 (<1) [*M*(⁸¹Br)-

$\text{H}]^+$, 345 (<1) $[M(^{79}\text{Br})-\text{H}]^+$, 333 (<1) $[M(^{81}\text{Br})-\text{CH}_3]^+$, 331 (1) $[M(^{79}\text{Br})-\text{CH}_3]^+$, 317 (48) $[M(^{81}\text{Br})-\text{OCH}_3]^+$, 315 (49) $[M(^{79}\text{Br})-\text{OCH}_3]^+$, 214 (87) $[M(^{81}\text{Br})-\text{CO}_2\text{CHCH}_3-\text{CH}_3\text{OCH}_2\text{OH}]^+$, 212 (100) $[M(^{79}\text{Br})-\text{CO}_2\text{CHCH}_3-\text{CH}_3\text{OCH}_2\text{OH}]^+$; HRMS (EI): calcd for $\text{C}_{15}\text{H}_{22}\text{O}_4^{79}\text{Br}$ $[M-\text{H}]^+$: 345.0701; found: 345.0688.

Radical Cyclization of conjugated diene **3**:

To a solution of selenoester **3** (25 mg, 42 μmol , 1 equiv) in benzene (3.8 mL) was added solutions of triphenyltin hydride (22 mg, 63 μmol , 1.5 equiv) in benzene (0.2 mL) and triethylborane (1M in tetrahydrofuran, 50 μL , 50 μmol , 1.2 equiv). The resulting solution was warmed to reflux before the introduction of dry air (2.5 mL) and the resulting mixture was stirred for 2 h. Solvent was removed *in vacuo* and the crude products were isolated by HPLC (isopropanol/hexanes 5:95) to give (*Z*)-alkene **16Z** (5.8 mg, 13 μmol , 31%) as a white solid and (*E*)-alkene **16E** (3.9 mg, 8.8 μmol , 21%) as a colorless oil, followed by the desired radical product **15** (2.4 mg, 5.4 μmol , 13%) as a colorless oil.

Trisubstituted alkene (**16Z**):

$R_f = 0.30$ (EtOAc/hexanes 40:60); m.p. = 169 °C; $[\alpha]_D^{21} = -17.2^\circ$ (*c* 1.0, CHCl_3); ^1H NMR (300 MHz, C_6D_6): δ = 5.34 (t, $J = 7.8$ Hz, 1H), 4.65 (dq, $J = 9.9, 5.9$ Hz, 1H), 3.89 (qdd, $J = 6.6, 5.0, 3.3$ Hz, 1H), 3.83–3.72 (m, 2H), 2.53 (ddd, $J = 13.6, 7.6, 4.3$ Hz, 1H), 2.42 (td, $J = 13.7, 6.5$ Hz, 1H), 2.26 (td, $J = 7.4, 5.6, 5.6$ Hz, 1H), 2.26–2.17 (m, 2H), 1.91 (ddd, $J = 13.5, 10.9, 8.0$ Hz, 1H), 1.68–1.12 (m, 13H), 1.45 (s, 9H), 1.36 (d, $J = 5.9$ Hz, 3H), 1.08 (d, $J = 6.7$ Hz, 3H); ^{13}C NMR (75 MHz, C_6D_6): δ = 210.1 (C), 176.8 (C), 155.2 (C), 133.2 (C), 129.4 (CH), 78.7 (C), 78.2 (CH), 52.3 (CH), 52.1 (CH), 51.8 (CH), 47.2 (CH), 43.6 (CH), 41.8 (CH_2), 39.2 (CH), 32.4 (CH_2), 30.5 (CH_2), 28.7 ($3\times\text{CH}_3$), 26.8 (CH_2), 26.4 (CH_2), 22.5 (2 coincident peaks; CH_2), 21.4 (CH_3), 18.4 (CH_3), 13.5 (CH_2); IR (KBr disc): ν = 2935, 1773, 1705, 1682, 1393 cm^{-1} ; MS (ESI): m/z (%): 468 (100) $[\text{MNa}]^+$, 346 (15) $[\text{M}-\text{CO}_2\text{C}_4\text{H}_7]^+$; HRMS (ESI): calcd for $\text{C}_{26}\text{H}_{39}\text{O}_5\text{NNa}$ $[\text{MNa}]^+$: 468.2720; found: 468.2721.

Trisubstituted alkene (**16E**):

$R_f = 0.30$ (EtOAc/hexanes 40:60); $[\alpha]_D^{21} = +2.6^\circ$ (c 0.6, CHCl_3); ^1H NMR (300 MHz, C_6D_6): $\delta = 5.15$ (dd, $J = 7.1, 7.1$ Hz, 1H), 4.61 (dq, $J = 12.0, 6.0$ Hz, 1H), 4.02–3.85 (m, 2H), 3.08 (dd, $J = 10.4, 7.3$ Hz, 1H), 2.66 (ddd, $J = 14.3, 8.3, 5.7$ Hz, 1H), 2.62 (d, $J = 4.7$ Hz, 1H), 2.28 (ddd, $J = 12.8, 7.3, 5.7$ Hz, 1H), 2.11–2.02 (m, 1H), 2.00 (ddd, $J = 14.8, 9.1, 6.2$ Hz, 1H), 1.75–1.04 (m, 14H), 1.47 (d, $J = 6.5$ Hz, 3H), 1.46 (s, 9H), 1.19 (d, $J = 6.7$ Hz, 3H); ^{13}C NMR (75 MHz, C_6D_6): $\delta = 209.6$ (C), 176.7 (C), 155.3 (C), 131.5 (CH), 131.1 (C), 79.0 (C), 78.5 (CH), 60.0 (CH), 52.3 (CH), 47.7 (CH), 44.5 (CH), 43.8 (CH), 41.7 (CH_2), 39.4 (CH), 33.2 (CH_2), 30.3 (CH_2), 28.7 ($3\times\text{CH}_3$), 27.4 (CH_2), 26.4 (CH_2), 24.0 (CH_2), 22.2 (CH_2), 21.0 (CH_3), 19.2 (CH_3), 14.4 (CH_2); IR (neat): $\nu = 2930, 1771, 1709, 1682, 1391\text{ cm}^{-1}$; MS (ESI): m/z (%): 468 (99) $[\text{MNa}]^+$, 346 (100) $[\text{M-CO}_2\text{C}_4\text{H}_7]^+$; HRMS (ESI): calcd for $\text{C}_{26}\text{H}_{39}\text{O}_5\text{NNa}$ $[\text{MNa}]^+$: 468.2720; found: 468.2719.

Desired Radical Product (**15**):

$R_f = 0.29$ (EtOAc/hexanes 50:50); $[\alpha]_D^{23} = +40.5^\circ$ (c 0.1, CHCl_3); ^1H NMR (400 MHz, CDCl_3): $\delta = 6.01$ (ddd, $J = 15.4, 9.9, 1.6$ Hz, 1H), 5.57 (dd, $J = 15.5, 5.0$ Hz, 1H), 4.88 (dq, $J = 11.8, 5.9$ Hz, 1H), 4.38 (dt, $J = 4.9, 4.9$ Hz, 1H), 3.99 (qdd, $J = 4.5, 4.5, 3.3$ Hz, 1H), 2.75 (dd, $J = 4.7, 4.7$ Hz, 1H), 2.56 (ddd, $J = 12.9, 7.2, 5.8$ Hz, 1H), 2.47 (ddd, $J = 10.3, 5.2, 5.2$ Hz, 1H), 2.30 (t, $J = 4.5$ Hz, 2H), 2.27–2.17 (m, 2H), 2.08–1.20 (m, 6H), 1.47 (d, $J = 5.9$ Hz, 3H), 1.44 (s, 9H), 1.21 (d, $J = 6.7$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 212.2$ (C), 178.0 (C), 155.3 (C), 135.2 (CH), 129.1 (CH), 79.6 (CH), 79.2 (C), 54.4 (CH), 51.9 (CH), 47.4 (CH), 47.3 (CH), 43.2 (CH), 43.0 (CH_2), 42.5 (CH), 40.2 (CH), 31.1 (CH_2), 28.6 ($3\times\text{CH}_3$), 26.6 (CH_2), 26.0 (CH_2), 25.7 (CH_2), 23.4 (CH_2), 21.6 (CH_3), 20.6 (CH_3), 13.8 (CH_2); IR (neat): $\nu = 2934, 2875, 1771, 1683\text{ cm}^{-1}$; MS (EI): m/z (%): 389 (7) $[\text{M-C}_4\text{H}_8]^+$, 330 (8) $[\text{M-NCO}_2\text{C}_4\text{H}_9]^+$, 124 (34) $[\text{C}_8\text{H}_{14}\text{N}]^+$, 57 (100) $[\text{C}_4\text{H}_9]^+$; HRMS (EI): calcd for $\text{C}_{22}\text{H}_{31}\text{O}_5\text{N}$ $[\text{M-C}_4\text{H}_8]^+$: 389.2202; found: 389.2204.

Radical Cyclization of conjugated enyne **19**:

To a refluxing solution of selenoester **19** (362 mg, 0.60 mmol, 1 equiv) in benzene (50 mL) was added separately, by syringe pump over 18 h, solutions of tributyltin hydride (0.25 mL, 0.93 mmol, 1.5 equiv) in benzene (9.5 mL) and 2,2'-azobisisobutyronitrile (11 mg, 67 μ mol, 0.1 equiv) in benzene (1.0 mL). Solvent was removed *in vacuo* and the products were isolated by flash chromatography to give a mixture of allenes **21** (**1'S**) and **21** (**1'R**) (127 mg, 0.28 mmol, 47%) as a colorless oil followed by the desired radical product **20** (116 mg, 0.26 mmol, 43%) as an amorphous solid. The allenes were separated by HPLC (propanol/hexanes 10:90).

Allene [**21** (**1'S**)]:

R_f = 0.37 (EtOAc/hexanes 50:50); $[\alpha]_D^{25}$ = +61.5 ° (*c* 1.0, CHCl₃); ¹H NMR (300 MHz, CDCl₃): δ = 5.31 (ddd, *J* = 4.3, 1.6, 1.6 Hz, 1H), 4.65 (dq, *J* = 8.3, 6.1 Hz, 1H), 4.52 (ddd, *J* = 4.8, 4.8, 3.1 Hz, 1H), 3.90 (m, 1H), 3.24 (d, *J* = 4.7 Hz, 1H), 2.73 (ddd, *J* = 8.9, 8.9, 1.7 Hz, 1H), 2.65 (ddd, *J* = 10.8, 7.8, 6.0 Hz, 1H), 2.47–2.22 (m, 3H), 2.04–1.40 (m, 12H), 1.46 (s, 9H), 1.44 (d, *J* = 6.1 Hz, 3H), 1.21 (d, *J* = 6.6 Hz, 3H); ¹³C NMR (75 MHz, CDCl₃): δ = 210.0 (C), 202.3 (C), 177.7 (C), 155.1 (C), 96.5 (C), 96.4 (CH), 79.3 (C), 79.1 (CH), 54.3 (CH), 49.7 (CH), 47.3 (CH), 45.0 (CH), 41.5 (CH₂), 41.3 (CH), 38.7 (CH), 29.8 (CH₂), 28.6 (3×CH₃), 26.4 (CH₂), 25.9 (CH₂), 25.1 (CH₂), 23.2 (CH₂), 21.0 (CH₃), 18.9 (CH₃), 13.4 (CH₂); IR (neat): ν = 3852, 3744, 3674, 2936, 1772, 1715, 1684, 1389 cm⁻¹; MS (ESI): *m/z* (%): 466 (66) [MNa]⁺, 447 (100); HRMS (ESI): calcd for C₂₆H₃₇O₅NNa [MNa]⁺: 466.2564; found: 466.2572.

Allene [**21** (**1'R**)]:

R_f = 0.37 (EtOAc/hexanes 50:50); $[\alpha]_D^{25}$ = +32.8 ° (*c* 1.0, CHCl₃); ¹H NMR (300 MHz, CDCl₃): δ = 5.39 (ddd, *J* = 5.1, 1.3, 1.3 Hz, 1H), 4.65 (dq, *J* = 8.2, 6.1 Hz, 1H), 4.45 (ddd, *J* = 4.9, 4.8, 4.8 Hz, 1H), 3.97 (m, 1H), 3.23 (d, *J* = 5.3 Hz, 1H), 2.72 (ddd, *J* = 15.1, 7.6, 1.4 Hz, 1H), 2.67 (dd, *J* = 10.6, 5.7 Hz, 1H), 2.47–2.25 (m, 3H), 2.05–1.40 (m, 12H), 1.47 (d, *J* = 6.0 Hz, 3H), 1.44 (s, 9H), 1.21 (d, *J* = 6.7 Hz, 3H); ¹³C NMR (75 MHz, CDCl₃): δ = 210.1 (C), 201.4 (C), 177.6 (C), 155.4 (C), 97.1 (CH), 96.9 (C), 79.5

(C), 78.9 (CH), 55.4 (CH), 49.9 (CH), 47.9 (CH), 46.3 (CH), 41.7 (CH), 41.3 (CH₂), 38.7 (CH), 29.8 (CH₂), 28.6 (3×CH₃), 27.6 (CH₂), 26.6 (CH₂), 26.0 (CH₂), 23.1 (CH₂), 20.1 (CH₃), 18.9 (CH₃), 14.8 (CH₂); IR (neat): ν = 3837, 3744, 3674, 2934, 1772, 1716, 1684, 1388 cm⁻¹; MS (ESI): m/z (%): 466 (100) [MNa]⁺, 447 (36); HRMS (ESI): calcd for C₂₆H₃₇O₅NNa [MNa]⁺: 466.2564; found: 466.2572.

Desired Radical Product (20):

R_f = 0.22 (EtOAc/hexanes 50:50); m.p. 117–119 °C; $[\alpha]_D^{23}$ = +107.6 ° (*c* 1.0, CHCl₃); ¹H NMR (300 MHz, CDCl₃): δ = 4.87 (dq, *J* = 9.1, 6.0 Hz, 1H), 4.76 (ddd, *J* = 4.6, 2.7, 2.7 Hz, 1H), 3.88 (qdd, *J* = 6.7, 4.6, 4.6 Hz, 1H), 2.93 (ddd, *J* = 6.7, 4.6, 2.3 Hz, 1H), 2.77 (dd, *J* = 5.7, 5.7 Hz, 1H), 2.55 (ddd, *J* = 13.3, 7.7, 5.2 Hz, 1H), 2.42–2.29 (m, 3H), 2.26–1.35 (m, 13H), 1.55 (d, *J* = 6.1 Hz, 3H), 1.43 (s, 9H), 1.22 (d, *J* = 6.7 Hz, 3H); ¹³C NMR (75 MHz, CDCl₃): δ = 210.2 (C), 177.5 (C), 155.0 (C), 84.8 (C), 80.7 (C), 79.7 (CH), 79.7 (C), 51.8 (CH), 48.0 (CH), 44.7 (CH), 43.5 (CH), 42.1 (CH₂), 41.0 (CH), 37.6 (CH), 30.6 (CH₂), 28.6 (CH), 28.5 (3×CH₃), 27.3 (CH₂), 27.1 (CH₂), 26.0 (CH₂), 22.9 (CH₂), 21.2 (CH₃), 20.7 (CH₃), 15.0 (CH₂); IR (neat): ν = 2937, 1774, 1707, 1688, 1389 cm⁻¹; MS (ESI): m/z (%): 466 (100) [MNa]⁺, 447 (48); HRMS (ESI): calcd for C₂₆H₃₇O₅NNa [MNa]⁺: 466.2564; found: 466.2574.

Conversion of secondary alcohol to chloride with retention of configuration:

4 α -Chloride (25):

To a solution of the 4 α -alcohol **23** (9.5 mg, 21 μ mol, 1 equiv) and 4-dimethylaminopyridine (25 mg, 0.20 mmol, 10 equiv) in acetonitrile (1.0 mL) at room temperature was added pentafluorophenyl chlorothionoformate (30 μ L, 0.19 mmol, 9 equiv). The resulting solution was heated to reflux for 5 h before quenching with saturated aqueous sodium hydrogencarbonate (10 mL). The product was extracted into dichloromethane (2×10 mL). The combined organic layers were dried over magnesium sulfate, and solvent was removed *in vacuo*. The crude product was purified by flash chromatography to give the desired compound as a crystalline solid (8.6 mg, 19 μ mol, 87%). R_f = 0.19 (EtOAc/hexanes 20:80);

m.p. 169–171 °C; $[\alpha]_D^{20} = +136.6^\circ$ (c 0.5, CHCl_3); ^1H NMR (300 MHz, CDCl_3): δ = 4.81–4.77 (m, 1H), 4.74–4.70 (m, 1H), 4.61 (dq, J = 10.0, 5.9 Hz, 1H), 3.92 (qdd, J = 6.8, 4.5, 4.5 Hz, 1H), 2.95 (ddd, J = 11.2, 5.5, 2.4 Hz, 1H), 2.58 (ddd, J = 13.1, 6.9, 6.3 Hz, 1H), 2.47 (ddd, J = 10.2, 6.9, 5.4 Hz, 1H), 2.20–2.07 (m, 2H), 1.98–1.34 (m, 12H), 1.62 (d, J = 5.7 Hz, 3H), 1.46 (s, 9H), 1.28–0.82 (m, 2H), 1.24 (d, J = 6.9 Hz, 3H); ^{13}C NMR (75 MHz, CDCl_3): δ = 177.3 (C), 155.1 (C), 86.2 (C), 80.0 (C), 79.8 (C), 77.6 (CH), 61.8 (CH), 48.0 (CH), 46.5 (CH), 45.5 (CH), 43.3 (CH), 40.9 (CH), 34.5 (CH_2), 33.0 (CH_2), 32.3 (CH), 31.5 (CH_2), 30.5 (CH), 28.5 ($3\times\text{CH}_3$), 27.4 (CH_2), 27.1 (CH_2), 21.3 (CH_3), 21.2 (CH_3), 19.5 (CH_2), 14.9 (CH_2); IR (KBr disc): ν = 2936, 1777, 1689, 1389, 1197, 1174, 1062 cm^{-1} ; MS (ESI): m/z (%): 466 (16) $[\text{M}(^{37}\text{Cl})\text{H}]^+$, 464 (45) $[\text{M}(^{35}\text{Cl})\text{H}]^+$, 366 (34) $[\text{M}(^{37}\text{Cl})\text{H}_2\text{-CO}_2\text{C}_4\text{H}_9]^+$, 364 (100) $[\text{M}(^{35}\text{Cl})\text{H}_2\text{-CO}_2\text{C}_4\text{H}_9]^+$; HRMS (FAB+): calcd for $\text{C}_{26}\text{H}_{39}\text{ClINO}_4$ $[\text{M}(^{35}\text{Cl})\text{H}]^+$: 464.2569; found: 464.2567.

15

300 MHz ^1H NMR spectrum
in CDCl_3

15

75 MHz ^{13}C NMR spectrum
in CDCl_3

300 MHz ^1H NMR spectrum
in C_6D_6

16Z

75 MHz ^{13}C NMR spectrum
in C_6D_6

16Z

16E

300 MHz ^1H NMR spectrum
in C_6D_6

16E

75 MHz ^{13}C NMR spectrum
in C_6D_6

20

300 MHz ^1H NMR spectrum
in CDCl_3

20

75 MHz ^{13}C NMR spectrum
in CDCl_3

21(1'S)

300 MHz ^1H NMR spectrum
in CDCl_3

21(1'S)

75 MHz ^{13}C NMR spectrum
in CDCl_3

21(1'*R*)

300 MHz ^1H NMR spectrum
in CDCl_3

21(1'*R*)

75 MHz ^{13}C NMR spectrum
in CDCl_3

22

300 MHz ^1H NMR spectrum
in CDCl_3

22

75 MHz ^{13}C NMR spectrum
in CDCl_3

300 MHz ^1H NMR spectrum
in CDCl_3

75 MHz ^{13}C NMR spectrum
in CDCl_3

300 MHz ^1H NMR spectrum
in CDCl_3

75 MHz ^{13}C NMR spectrum
in CDCl_3