Quinone Sulfinyl Imines as Versatile Intermediates in Alkaloid Natural Product Synthesis: Total Synthesis of 3-Demethoxyerythratidinone

Kangway V. Chuang, Raul Navarro and Sarah E. Reisman*

The Warren and Katharine Schlinger Laboratory for Chemistry and Chemical Engineering, Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, California 91125 reisman@caltech.edu

Supporting Information 1 (Experimental Procedures):

General. Unless otherwise stated, reactions were performed under a nitrogen atmosphere using freshly dried solvents. Tetrahydrofuran (THF), methylene chloride (CH₂Cl₂), diethyl ether (Et₂O), acetonitrile (MeCN), toluene and benzene were dried by passing through activated alumina columns. Dimethylformamide (DMF) was dried over activated molecular sieves, MeOH was distilled over magnesium oxide, dichloroethane (DCE) and triethyl amine (Et_3N) were distilled over calcium hydride. All other commercially obtained reagents were used as received unless specifically indicated. All reactions were monitored by thin-layer chromatography using EMD/Merck silica gel 60 F254 pre-coated plates (0.25 mm). Flash column chromatography was performed either as described by Still et al. (Still, W. C., Kahn, M.; Mitra, A. J. Org. Chem. 1978, 43, 2923-2925.) using silica gel (partical size 0.032-0.063) purchased from Silicycle or using pre-packaged RediSep[®]Rf columns on a CombiFlash Rf system (Teledyne ISCO Inc.). Microwave experiments were performed using a Biotage Initiator[®] microwave reactor. Diastereomeric ratios were determined using an Agilent 1190 or 1290 Series LC/MS ($\lambda = 254$ nm) using a ZORBAX Eclipse Plus C18 column (RRHD 1.8 µm, 2.1 x 50 mm, 11,072 plates). Optical rotations were measured on a Jasco P-2000 polarimeter using a 100 mm path-length cell at 589 nm. ¹H and ¹³C NMR spectra were recorded on a Varian Mercury 300 (at 300 MHz and 75 MHz respectively) or a Varian Inova 500 (at 500 MHz and 126 MHz respectively), and are reported relative to internal chloroform (¹H, $\delta = 7.26$, ¹³C, $\delta = 77.0$). Data for ¹H NMR spectra are reported as follows: chemical shift (δ ppm) (multiplicity, coupling constant (Hz), integration). Multiplicity and qualifier abbreviations are as follows: s = singlet, d = doublet, t =triplet, q = quartet, m = multiplet, br = broad, app = apparent. IR spectra were recorded on a Perkin Elmer Paragon 1000 spectrometer and are reported in frequency of absorption (cm⁻¹). High-resolution mass spectra were obtained from the Caltech Mass Spectral Facility.

Me

S2a

Preparation of 2,4,5-substituted phenols:



Steps 1 and 2: Baeyer-Villiger Oxidation / Saponification. Preparation of 4-methoxy-3-methylphenol (S2a).

A 50 mL flask was charged with 4-methoxy-3-methylbenzaldehyde (S1a) (500 mg, 3.33 mmol, 1 equiv) and CH_2Cl_2 (11 mL). The resulting solution was cooled to 0 °C in an ice-water bath and *m*-CPBA (1.40 g, 70-75%, 5.66 mmol, 1.7 equiv) was added in 3 portions. The resulting suspension was allowed to warm to room temperature, and was stimed for 2 hours at that temperature. The resultion was guerehold with

and was stirred for 2 hours at that temperature. The reaction was quenched with saturated aqueous NaHCO₃ (11 mL), and the aqueous layer was extracted with CH₂Cl₂ (3 x 20 mL). The combined organic layers were dried over Na₂SO₄ and concentrated to give a pale yellow oil. The crude formate ester was dissolved in MeOH (17 mL) and cooled to 0 °C. Solid K₂CO₃ (920 mg, 6.66 mmol) was added in one portion, and the resulting solution was stirred at 0 °C for 15 min. The reaction was quenched with aqueous HCl (9 mL of a 2N solution). The organic solvent was removed by rotary evaporation, and resulting aqueous layer was extracted with Et₂O (2 x 30 mL). The combined organic layers were dried over MgSO₄, concentrated, and purified by flash chromatography (10% EtOAc/Hexanes) to afford **S2a** (361 mg, 78% yield over 2 steps) as a white solid. ¹H NMR (500 MHz, CDCl₃) δ 6.70 (d, *J* = 8.8 Hz, 1H), 6.66 (d, *J* = 3.2 Hz, 1H), 6.62 (dd, *J* = 8.7, 3.1 Hz, 1H), 4.77 (s, 1H), 3.78 (s, 3H), 2.19 (s, 3H); ¹³C NMR (126 MHz, CDCl₃) δ 152.0, 149.0, 128.1, 118.0, 112.5, 111.3, 56.0, 16.2; IR (NaCl/thin film): 3350, 2950, 2833, 1501, 1465, 1430, 1286, 1217, 1180, 1034 721 cm⁻¹; HRMS (EI+) calc'd for C₈H₁₀O₂ [M+H]⁺ 138.0681, found 138.0685.

Preparation of 3-chloro-4-methoxyphenol (S2b). Prepared from 11.1 mmol of 3-chloro-4methoxybenzaldehyde (S1b) using the above general procedure. The crude product was purified by flash chromatography (5 \rightarrow 20% EtOAc/Hexanes) to give S2b (1.10 g, 62% yield) as a beige solid. ¹H NMR (500 MHz, CDCl₃) δ 6.91 (d, *J* = 2.9 Hz, 1H), 6.81 (d, *J* = 8.8 Hz, 1H), 6.70 (dd, $J = 8.8, 2.9 \text{ Hz}, 1\text{H}, 4.94 \text{ (s, 1H)}, 3.84 \text{ (s, 3H)}; {}^{13}\text{C NMR} (126 \text{ MHz}, \text{CDCl}_3) \delta$ 149.6, 149.4, 123.0, 117.6, 114.2, 113.5, 56.8; IR (NaCl/thin film): 3400, 2947, $2837, 1500, 1437, 1278, 1209, 1180, 1058, 907, 746 \text{ cm}^{-1}; \text{HRMS} (\text{EI+}) \text{ calc'd for}$ $C_7 \text{H}_7 \text{O}_2 \text{Cl} [\text{M+H}]^+ 158.0135, \text{ found } 158.0125.$

Step 3. Bromination. Preparation of 2-bromo-4-methoxy-5-methylphenol (S3a).



A 50 mL flask was charged with phenol **S2a** (300 mg, 2.17 mmol, 1 equiv) and CH_2Cl_2 (11 mL). The resulting solution was cooled to 0 °C in an ice-water bath, and bromine (0.117 mL, 2.28 mmol, 1.05 equiv) was added dropwise. (*Caution!* A copious amount of HBr gas is generated as the reaction proceeds. A 16-gauge needle was pierced through the septa to allow the reaction to vent). The reaction

was allowed to stir at 0 °C for 30 min, then quenched with saturated aqueous NaHCO₃ (11 mL). The organic layer was washed with water (2 x 10 mL), and the combined aqueous layers were extracted with CH_2Cl_2 (20 mL). The combined organic layers were dried over Na₂SO₄, concentrated, and purified by flash chromatography (10% EtOAc/Hexanes) to give **S3a** (440 mg, 93% yield) as a beige solid. The spectral data obtained for **S3a** is consistent with that reported in the literature.¹

Preparation of 2-bromo-5-chloro-4-methoxyphenol (S3b).



Prepared from 1.26 mmol of 3-chloro-4-methoxyphenol (**S2b**) using the general procedure. **S3b** (288 mg, 96% yield) was isolated as a pale beige solid. The crude product was used without further purification. ¹H NMR (500 MHz, CDCl₃) δ 7.08 (s, 1H), 7.01 (s, 1H), 5.17 (s, 1H), 3.84 (s, 3H); ¹³C NMR (126 MHz, CDCl₃) δ 149.5, 146.6, 123.0, 117.6, 115.4, 107.6, 56.9; IR (NaCl/thin film): 3248, 2969,

1504, 1442, 1400, 1205, 1182, 1073, 859, 784 cm⁻¹; HRMS (EI–) calc'd for $C_7H_7O_2Cl [M–H]^-$ 234.9167, found 234.9198.

⁽¹⁾ Vyvyan, J.R.; Loitz, C.; Looper, R.E.; Mattingly, C.S.; Peterson, E.A.; Staben, S.T. J. Org. Chem. 2004, 69, 2461-2468.



General procedure for the preparation of quinone sulfinimine substrates:





A 250 mL flask was charged with 2-chloro-4-methoxyphenol (2.00 g, 12.6 mmol, 1.0 equiv) and MeOH (70 mL). The resulting solution was cooled to 0 °C in an icewater bath and a solution of iodobenzene diacetate (4.47 g, 13.9 mmol, 1.1 equiv) in MeOH (40 mL) was added dropwise via cannula. The reaction was allowed to stir at 0 °C for 10 min, then quenched with saturated aq. NaHCO₃ (30mL). The organic

solvent was removed by rotary evaporation, and the resulting residue was diluted with Et₂O (60 mL). The aqueous layer was extracted with Et₂O (2 x 50 mL), and the combined organic layers were washed with brine (60 mL), dried over MgSO₄, concentrated, and purified by flash chromatography (6:1 Hexanes:EtOAc) to afford **6b** (2.33 g, 98% yield) as a pale yellow oil. ¹H NMR (500 MHz, CDCl₃) δ 7.01 (d, *J* = 2.9 Hz, 1H), 6.85 (dd, *J* = 10.3, 2.9 Hz, 1H), 6.36 (d, *J* = 10.3 Hz, 1H), 3.38 (s, 6H); ¹³C NMR (126 MHz, CDCl₃) δ 177.9, 143.7, 139.3, 134.0, 128.6, 94.2, 50.6; IR (NaCl/thin film): 2943, 2833, 1684, 1647, 1616, 1331, 1118, 1061, 1036, 1018, 962, 948, 824, 812 cm⁻¹; HRMS (EI+) calc'd for C₈H₉O₃Cl [M+H]⁺ 188.0240, found 188.0211.

Preparation of bromoquinone 6c.



Prepared from 19.7 mmol of 2-bromo-4-methoxyphenol² using the general procedure. The quinone product was purified by flash chromatography (10 \rightarrow 20% EtOAc/Hexanes) to give **6c** (4.00 g, 87% yield) as a pale yellow solid. ¹H NMR (500 MHz, CDCl₃) δ 7.25 (d, *J* = 3.2 Hz, 1H), 6.82 (dd, *J* = 10.3 Hz, 3.2 Hz, 1H), 6.33 (d, *J* = 10.3 Hz, 1H), 3.34 (s, 6H); ¹³C NMR (126 MHz, CDCl₃) δ 177.6,

^{(2) 2-}Bromo-4-methoxyphenol is commercially available from TCI America or readily prepared in one step from *p*-methoxyphenol.

143.9, 143.5, 128.0, 125.7, 94.2, 50.5; IR (NaCl/thin film); 3057, 2944, 2834, 1680, 1644, 1612, 1460, 1375, 1332, 1298, 1280, 1221, 1180, 1119, 1062, 1038, 1010, 964, 939, 823, 742 cm⁻¹: HRMS (EI+) calc'd for $C_8H_9O_3Br [M-OMe]^+ 200.9551$, found 200.9551.³

Preparation of dihaloguinone 6d.



Prepared from 0.97 mmol of 2-bromo-5-chloro-4-methoxyphenol (S3b) using the general procedure. The quinone product was purified by flash chromatography $(5 \rightarrow 10\% \text{ EtOAc/Hexanes})$ to give 6d (229 mg, 88% yield) as a white solid. ¹H NMR (500 MHz, CDCl₃) δ 7.26 (s, 1H), 6.72 (s, 1H), 3.34 (s, 6H); ¹³C NMR (126 MHz, CDCl₃) & 176.1, 153.2, 144.2, 129.5, 126.5, 96.4, 51.7; IR (NaCl/thin film): 3435, 3051, 2940, 2841, 1673, 1612, 1458, 1328, 1105, 1071, 997, 755 cm⁻¹; HRMS (EI+) calc'd for $C_8H_8O_3ClBr [M-OMe]^+ 234.9161$, found 234.9160.

Preparation of bromoquinone 6e.



Prepared from 1.53 mmol of 2-bromo-4-methoxy-5-methylphenol (S3a) using the general procedure. The quinone product was purified by flash chromatography ($0 \rightarrow 20\%$ EtOAc/Hexanes) to give **6e** (350 mg, 93% yield) as a white solid. ¹H NMR (500 MHz, CDCl₃) δ 7.23 (s, 1H), 6.33 (q, J = 1.5 Hz, 1H), 3.26 (s, 6H), 1.94 (d, J = 1.5 Hz, 3H); ¹³C NMR (126 MHz, CDCl₃) δ 177.7.

156.8, 144.7, 128.0, 127.2, 97.1, 51.2, 16.6; IR (NaCl/thin film): 3315, 3050, 2936, 2832, 1675, 1609, 1437, 1327, 1226, 1104, 1055, 923, 742 cm⁻¹; HRMS (EI+) calc'd for C₉H₁₁O₃Br [M-OMe]⁺ 214.9708, found 214.9706.

Step 2. Sulfinamide condensation. Preparation of quinone sulfinimine 7b.



A 50 mL oven-dried Schlenk tube was charged with (R)-tert-butanesulfinamide (1.78 g, 14.7 mmol, 1.1 equiv) followed by a solution of chloroquinone **6b** (2.64 g, 14.0 mmol, 1.0 equiv) and titanium (IV) ethoxide (6.4 mL, 30.5 mmol, 2.2 equiv) in THF (14 mL). The Schlenk tube was sealed and heated to 70°C in an oil-bath for 72 h while keeping the reaction from light. The reaction was

⁽³⁾ Quinone monoketals **6b** and **6c** have been previously prepared by employing thallium (III) nitrate as the oxidant: McKillop, A.; Perry, D.H.; Edwards, M. J. Org. Chem. 1976, 41, 282-287.

allowed to cool to room temperature, diluted with EtOAc, and slowly poured into a stirring solution of brine (40 mL). The resulting suspension was filtered through a plug of celite and the organic layer was washed with brine (2 x 30 mL). The combined aqueous layers were extracted with EtOAc (40 mL), and the combined organic layers were dried over Na₂SO₄, concentrated, and purified by flash chromatography (20% EtOAc/Hexanes) to furnish 7b (3.82 g, 93% yield) as an orange oil. ¹H NMR (500 MHz, CDCl₃) δ 7.78 (d, J = 10.7 Hz, 1H), 6.68 (d, J = 2.4 Hz, 1H), 6.45 (dd, J = 10.5, 2.7 Hz, 1H), 3.34 (s, 3H), 3.33 (s, 3H), 1.33 (s, 9H); ¹³C NMR (126) MHz, CDCl₃) & 156.2, 137.0, 134.0, 133.8, 122.3, 94.2, 60.9, 50.3, 50.2, 23.2; IR (NaCl/thin film): 2961, 2945, 1569, 1457, 1168, 1113, 1082, 1039, 957, 790 cm⁻¹; HRMS (EI+) calc'd for $C_{12}H_{18}NO_3ClS [M+H]^+$ 292.0769, found 292.0769; $[\alpha]_D^{25}$ –344.7 (*c* 0.62, CH₂Cl₂).

Preparation of quinone sulfinimine 7c.



Prepared from 6.44 mmol of bromoquinone **6c** using the general procedure. The sulfinimine product was purified by flash chromatography $(9 \rightarrow 33\%)$ EtOAc/Hexanes) to yield 7c (1.91 g, 85% yield) as an orange solid. ¹H NMR $(500 \text{ MHz}, \text{CDCl}_3) \delta 7.79 \text{ (d, } J = 10.7 \text{ Hz}, 1\text{H}), 6.94 \text{ (d, } J = 2.4 \text{ Hz}, 1\text{H}), 6.46$ (dd, J = 10.5, 2.7 Hz, 1H), 3.35 (s, 3H), 3.34 (s, 3H) 1.33 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) & 156.5, 138.4, 137.0, 125.6, 122.1, 94.5, 61.0, 50.33, 50.25, 23.2; IR (NaCl/thin film): 3198, 2958, 2929, 1669, 1597, 1290, 1057, 956, 886 cm⁻¹; HRMS (EI+) calc'd

for C₁₂H₁₈NO₃BrS $[M+H]^+$ 336.0264, found 336.0258; $[\alpha]_D^{25}$ –235.6 (*c* 0.80, CH₂Cl₂).

Preparation of quinone sulfinimine 7d.



Prepared from 0.75 mmol of bromoquinone **6d** using the general procedure. The sulfinimine product was purified by flash chromatography $(0 \rightarrow 20\%)$ EtOAc/Hexanes) to yield 7d (233 mg, 84% yield) as an orange oil. ¹H NMR (500 MHz, CDCl₃) δ 8.17 (s, 1H), 6.88 (s, 1H), 3.30 (s, 3H), 3.28 (s, 3H), 1.35 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 155.0, 145.4, 138.5, 126.2, 123.3, 96.4,

61.5, 51.6, 51.5, 23.2; IR (NaCl/thin film): 3078, 2947, 2832, 1596, 1561, 1457, 1363, 1234, 1112, 1081, 1001, 977 cm⁻¹; HRMS (EI+) calc'd for C₁₂H₁₇NO₃SClBr [M+H]⁺ 369.9874 found 369.9873; $[\alpha]_{D}^{25}$ -346.2 (*c* 1.54, CH₂Cl₂).

Preparation of quinone sulfinimine 7e.



1611, 1565, 1456, 1362, 1225, 1109, 1079, 969, 939 cm⁻¹; HRMS (EI+) calc'd for $C_{13}H_{20}NO_3SBr [M+H]^+$ 350.0420, found 350.0423; $[\alpha]_D^{25}$ –261.7 (*c* 0.98, CH₂Cl₂).

General procedures for the diastereoselective addition of organolithium and organomagnesium reagents to quinone sulfinimine substrates:



Method A.

An oven-dried 10 mL flask was charged with quinone sulfinimine 7 (0.30 mmol, 1 equiv) and Et₂O (0.6 mL). The resulting solution was cooled to -78 °C in a dry ice-acetone bath, and the organolithium reagent (0.33 mmol, 1.1 equiv) was added dropwise. After stirring at -78 °C for 1 h, the reaction was quenched at that temperature by the addition of aq. 1N HCl (0.6 mL). The reaction mixture was allowed to warm to room temperature and was vigorously stirred for 20 min. The reaction was diluted with EtOAc (30 mL) and washed with saturated aq. NaHCO₃ (15 mL). The aqueous layer was extracted with EtOAc (30 mL), and the combined organic layers were washed with brine (20 mL), dried over Na₂SO₄, and concentrated under reduced pressure to provide the crude product, which was analyzed by LC/MS and purified by flash chromatography.

Method B.

An oven-dried 10 mL flask was charged with aryl or vinyl bromide (0.48 mmol, 2.0 equiv) and Et₂O (0.4 mL). The resulting solution was cooled to -78 °C in a dry-ice acetone bath, and *t*-BuLi (0.99 mmol, 1.7 M in pentane, 4.1 equiv) was added dropwise. The resulting solution was warmed to 0 °C and stirred at that temperature for 45 min. The reaction mixture was recooled to -78 °C, and a solution of quinone sulfinimine 7 (0.24 mmol, 1 equiv) in Et₂O (0.5 mL) was added dropwise. The resulting suspension was stirred at -78 °C for 1 h, then quenched at that temperature by the addition of aq. 1N HCl (0.5 mL). Reaction work-up was conducted as described in Method A to obtain the crude product, which was analyzed by LC/MS and purified by flash chromatography.

Sulfinamide 8a. Method A. The reaction was run using guinone sulfinimine 7b (90 mg, 0.30 mmol) and n-BuLi (0.22 mL, 1.5 M in hexanes, 0.33 mmol). The -NH *n-*Bu diastereoselectivity was determined by LC/MS: 97:3 d.r. ($5 \rightarrow 95\%$ MeCN/H₂O, t-Bu t = 0–7 min, 1 mL/min. Minor diastereomer: $t_R = 5.3$ min, major diastereomer: $t_{\rm R} = 5.6$ min). The crude material was purified by flash chromatography 8a $(30 \rightarrow 80\% \text{ EtOAc/Hexanes})$ to provide **8a** (85 mg, 90% yield) as a pale yellow

foam. ¹H NMR (500 MHz, CDCl₃) δ 6.99 (d, J = 10.3 Hz, 1H), 6.53 (d, J = 1.5 Hz, 1H), 6.38 (dd, J = 10.0, 1.7 Hz, 1H), 3.60 (s, 1H), 2.12 (ddd, J = 12.8, 10.5, 6.9 Hz, 1H), 1.67 (ddd, J = 12.8, 10.5, 10.12.7, 10.9, 5.5 Hz, 1H), 1.29 (dt, J = 14.7, 7.4 Hz, 2H), 1.22 (s, J = 5.0 Hz, 9H), 1.12 - 1.01 (m, 2H), 0.86 (t, J = 7.4 Hz, 3H); ¹³C NMR (126 MHz, CDCl₃) δ 184.2, 155.9, 150.9, 131.0, 128.7, 62.1, 56.7, 38.8, 25.2, 22.4, 22.3, 13.7; IR (NaCl/thin film): 3198, 2959, 2929, 1660, 1599, 1057, 976, 885 cm⁻¹; HRMS (EI+) calc'd for $C_{14}H_{22}NO_2SCI [M+H]^+$ 304.1133, found 304.1131; $[\alpha]_D^{25}$ -160.7 (c 0.50, CH₂Cl₂).

Sulfinamide 8b. Method A. The reaction was run using quinone sulfinimine 7b (80 mg, 0.27







mmol) and PhLi (0.18 mL, 1.7 M in di-n-butyl ether, 0.30 mmol). The diastereoselectivity was determined by LC/MS: 78:22 d.r. $(5 \rightarrow 95\%)$ MeCN/H₂O, t = 0–7 min, 1 mL/min. Minor diastereomer: t_{R} = 4.9 min, major diastereomer: $t_R = 5.1$ min). The crude material was purified by flash chromatography (20 \rightarrow 80% EtOAc/Hexanes) to give (R,R)-8b (68 mg, 76% yield) as a pale yellow solid. Major diastereomer: ¹H NMR (500 MHz, CDCl₃) δ 7.49 – 7.37 (m, 5H), 7.12 (d, J = 9.8 Hz, 1H), 6.57 (d, J = 1.5 Hz, 1H), 6.40 (dd, J = 10.0, 1.7 Hz, 1H), 4.15 (s, 1H), 1.33 (s, 9H); ¹³C NMR (126) MHz, CDCl₃) δ 184.1, 155.9, 150.5, 137.2, 129.8, 129.4, 129.3, 126.34, 126.23, 64.5, 57.4, 22.6; IR (NaCl/thin film): 3186, 2960, 1658, 1596, 1300, 1062, 976 cm⁻¹; HRMS (EI+) calc'd for $C_{14}H_{22}NO_2ClS [M+H]^+$ 324.0820, found 324.0827; [α]- $_{\rm D}^{25}$ -102.4 (c 0.80, CH₂Cl₂). The minor diastereomer ((R,S)-8b) was obtained as a pale vellow oil: ¹H NMR (500 MHz, CDCl₃) δ 7.48 – 7.32 (m, 5H), 6.80 (d, J = 10.3 Hz, 1H), 6.74 (d, J = 2.0 Hz, 1H), 6.27 (dd, J = 10.0, 1.7 Hz, 1H), 4.53 (s, 1H), 1.36 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) & 184.1, 158.0, 148.4, 137.5, 129.8, 129.5, 129.2, 126.9, 125.6, 64.3, 57.4, 22.7; IR (NaCl/thin film): 3186, 2960, 1658, 1596, 1491, 1448, 1378, 1364, 1300, 1062, 976, 958 cm⁻¹;

HRMS (EI+) calc'd for $C_{14}H_{22}NO_2CIS [M+H]^+$ 324.0820, found 324.0823; $[\alpha]_D^{25}$ –365.9 (*c* 0.40, CH₂Cl₂).

Sulfinamide 8c. Method A. The reaction was run using quinone sulfinimine 7c (80 mg, 0.24



mmol) and *n*-BuLi (0.18 mL, 1.5 M in hexanes, 0.26 mmol). The diastereoselectivity was determined by LC/MS: 98:2 d.r. (5 \rightarrow 95% MeCN/H₂O, t = 0–7 min, 1 mL/min. Minor diastereomer: t_R = 5.4 min, major diastereomer: t_R = 5.7 min). The crude material was purified by flash chromatography (30 \rightarrow 90% EtOAc/Hexanes) to furnish **8c** (73 mg, 88% yield)

as a pale yellow foam. ¹H NMR (500 MHz, CDCl₃) δ 7.10 (d, J = 9.8 Hz, 1H), 6.79 (d, J = 2.0 Hz, 1H), 6.41 (dd, J = 10.0, 1.7 Hz, 1H), 3.61 (s, 1H), 2.17 – 2.07 (m, 1H), 1.70 – 1.59 (m, 2H), 1.35 – 1.26 (m, 2H), 1.24 (s, 9H), 1.10 – 1.00 (m, 2H), 0.87 (t, J = 7.3 Hz, 3H); ¹³C NMR (126 MHz, CDCl₃) δ 183.5, 151.1, 150.1, 135.3, 128.6, 62.4, 56.8, 39.8, 25.1, 22.6, 22.3, 13.7; IR (NaCl/thin film): 2946, 1567, 1457, 1179, 1110, 1082, 1039, 962, 764 cm⁻¹; HRMS (EI+) calc'd for C₁₄H₂₂NO₂SBr [M+H]⁺ 348.0627, found 348.0628; [α]_D²⁵ –139.0 (*c* 0.50, CH₂Cl₂).

Sulfinamide 8d.



Method A. The reaction was run using quinone sulfinimine 7c (80 mg, 0.24 mmol) and EtLi (0.52 mL, 0.5 M in 90:10 cyclohexane:benzene, 0.26 mmol). The diastereoselectivity was determined by LC/MS: 98:2 d.r. (5 \rightarrow 95% MeCN/H₂O, t = 0–7 min, 1 mL/min. Minor diastereomer: t_R = 4.4 min, major diastereomer: t_R = 4.7 min). The crude material was purified by flash chromatography (50 \rightarrow 75% EtOAc/Hexanes) to give 8d (74 mg, 96% yield) as a pale yellow solid. The solid was recrystallized from CH₂Cl₂/pentane to give crystals suitable for single crystal X-ray diffraction. ¹H NMR (500 MHz, CDCl₃) δ 7.07 (d, *J* = 10.3 Hz, 1H), 6.81 (d, *J* = 1.5 Hz, 1H), 6.43 (dd, *J* = 10.0, 1.7 Hz, 1H), 2.14 (dq, *J* = 13.1, 7.5 Hz, 1H), 1.72 (dq, *J* = 13.1, 7.4 Hz, 1H), 1.24 (s, 9H), 0.76 (t, *J* = 7.3 Hz, 3H); ¹³C NMR (126 MHz, CDCl₃) δ 183.5,

150.8, 149.7, 135.6, 128.9, 63.0, 56.8, 33.3, 22.6, 7.5; melting point: 60 °C (decomposition); IR (NaCl/thin film): 3196, 2970, 1669, 1597, 1286, 1052, 954 cm⁻¹; HRMS (EI+) calc'd for $C_{12}H_{18}NO_2SBr [M+H]^+$ 320.0314, found 320.0318. $[\alpha]_D^{25}$ –160.7 (*c* 1.20, CH₂Cl₂).

Sulfinamide 8e. Method A. The reaction was run using quinone sulfinimine 7c (90 mg, 0.27



mmol) and MeLi (0.10 mL, 2.9 M in diethoxymethane, 0.29 mmol). The diastereoselectivity was determined by LC/MS: 98:2 d.r. $(5\rightarrow95\%$ MeCN/H₂O, t = 0–7 min, 1 mL/min. Minor diastereomer: t_R = 4.0 min, major diastereomer: t_R = 4.3 min). The crude material was purified by flash chromatography (50 \rightarrow 100% EtOAc/Hexanes) to provide **8e** (75 mg, 91%)

yield) as a pale yellow solid. ¹H NMR (500 MHz, CDCl₃) δ 7.19 (d, *J* = 10.3 Hz, 1H), 6.74 (d, *J* = 1.5 Hz, 1H), 6.33 (dd, *J* = 10.0, 1.7 Hz, 1H), 3.63 (s, 1H), 1.61 (s, 3H), 1.25 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.1, 151.9, 151.1, 133.9, 126.7, 58.7, 56.8, 28.1, 22.6; IR (NaCl/thin film): 3139, 2991, 1668, 1636, 1599, 1296, 1048, 960, 884 cm⁻¹; HRMS (EI+) calc'd for C₁₁H₁₆NO₂SBr [M+H]⁺ 306.0158, found 306.0158; [α]_D²⁵ –190.3 (*c* 0.71, CH₂Cl₂).

Sulfinamide 8f. Method A. The reaction was run using quinone sulfinimine 7d (83 mg, 0.22



mmol) and MeLi (0.091 mL, 2.72 M in diethoxymethane, 0.25 mmol). The diastereoselectivity was determined by LC/MS: 97:3 d.r. (5 \rightarrow 95% MeCN/H₂O, t = 0–10 min, 1 mL/min. Minor diastereomer: t_R = 3.1 min, major diastereomer: t_R = 3.4 min). The crude material was purified by flash chromatography (25 \rightarrow 70% EtOAc/Hexanes) to provide **8f** (70 mg, 92% yield)

as a pale yellow solid. ¹H NMR (500 MHz, CDCl₃) δ 7.35 (s, 1H), 6.84 (s, 1H), 3.71 (s, 1H), 1.65 (s, 3H), 1.25 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 176.4, 151.2, 147.8, 132.6, 131.0, 60.6, 57.0, 28.2, 22.5; IR (NaCl/thin film): 3126, 2981, 2930, 2868, 1674, 1609, 1365, 1334, 1040, 1005, 892, 873 cm⁻¹; HRMS (EI+) calc'd for C₁₁H₁₅NO₂SClBr [M+H]⁺ 339.9768, found 339.9765. [α]_D²⁵ –138.1 (*c* 1.2, CH₂Cl₂).

Sulfinamide 8g. Method A. The reaction was run using quinone sulfinimine 7e (73 mg, 0.21 mmol) and MeLi (0.08 mL, 2.72 M in diethoxymethane, 0.23 mmol). The diastereoselectivity was determined by LC/MS: 98:2 d.r. (5 \rightarrow 95% MeCN/H₂O, t = 0–10 min, 1 mL/min. Minor

diastereomer: $t_R = 3.0$ min, major diastereomer: $t_R = 3.3$ min). The crude material was purified by flash chromatography (30 \rightarrow 80% EtOAc/Hexanes) to provide 8g (61 mg, 91% yield) as a white solid. ¹H NMR (500 MHz, CDCl₃) δ 6.94 (q, J = 1.4 Hz, 1H), 6.72 (s, 1H), 3.59 (s, 1H), 1.93 (d, J = 1.5 Hz, 3H), 1.57 (s, 3H), 1.23 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.9, 150.7, 147.4,

133.5, 133.5, 59.0, 56.7, 28.4, 22.6, 15.2; IR (NaCl/thin film): 3125, 2989, 2926, 2870, 1663 1649, 1608, 1460, 1365, 1113, 1040, 1015, 901, 892 cm⁻¹; HRMS (EI+) calc'd for $C_{12}H_{18}NO_2SBr [M+H]^+$ 320.0314, found 320.0316. [α]_D²⁵ –168.9 (*c* 1.05, CH₂Cl₂).

Sulfinamide 8h. Method A. The reaction was run using quinone sulfinimine 7c (80 mg, 0.24



t-Bu

Me

8g



mmol) and PhLi (0.15 mL, 1.7 M in di-*n*-butyl ether, 0.26 mmol). The diastereoselectivity was determined by LC/MS: 80:20 d.r. (5 \rightarrow 95% MeCN/H-2O, t = 0–7 min, 1 min/mL. Minor diastereomer: t_R = 5.0 min, major diastereomer: t_R = 5.2 min). The crude material was purified by flash chromatography (20 \rightarrow 80% EtOAc/Hexanes) to yield (*R*,*R*)-**8h** (65 mg, 74% yield) as a yellow solid. Major diastereomer: ¹H NMR (500 MHz, CDCl₃) δ 7.48 – 7.35 (m, 5H), 7.20 (d, *J* = 9.8 Hz, 1H), 6.83 (d, *J* = 1.5 Hz, 1H), 6.40 (dd, *J* = 10.0, 1.7 Hz, 1H), 4.20 (s, 1H), 1.34 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.4, 150.8, 149.9, 137.6, 133.8, 129.31, 129.25, 126.2, 126.0, 64.8, 57.4, 22.8; IR (NaCl/thin film): 3184, 2960, 1669, 1292, 1059, 954 cm⁻¹;

HRMS (EI+) calc'd for $C_{16}H_{18}NO_2SBr [M+H]^+$ 368.0314, found 368.0317. $[\alpha]_D^{25}$ –102.8 (*c* 0.60, CH₂Cl₂). The minor diastereomer ((*R*,*S*)-**8h**) was obtained as a pale yellow oil. ¹H NMR (500 MHz, CDCl₃) δ 7.46 – 7.33 (m, 5H), 6.97 (d, *J* = 2.0 Hz, 1H), 6.89 (d, *J* = 9.8 Hz, 1H), 6.29 (dd, *J* = 10.0, 1.7 Hz, 1H), 4.56 (s, 1H), 1.37 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.3, 152.5, 148.6, 137.9, 133.6, 129.4, 129.2, 126.8, 125.6, 64.8, 57.4, 22.7; IR (NaCl/thin film): 3287, 2959, 1669, 1295, 1078, 952 cm⁻¹; HRMS (EI+) calc'd for C₁₆H₁₈NO₂SBr [M+H]⁺ 368.0314, found 368.0313; $[\alpha]_D^{25}$ –281.0 (*c* 0.45, CH₂Cl₂).

Sulfinamide 8i. Method B. The reaction was run using quinone sulfinimine 7c (81 mg, 0.24 mmol), and *o*-bromotoluene (57 μ L, 0.48 mmol). The diastereoselectivity was determined by LC/MS: 97:3 d.r. (5% MeCN/H₂O, t = 0–0.5 min; 5–45% MeCN/H₂O, t = 0.5–10.5 min, 1

mL/min. Minor diastereomer: $t_R = 8.3$ min, major diastereomer: $t_R = 8.7$ min). The crude material was purified by flash chromatography (25→50% EtOAc/Hexanes) to furnish **8i** (79 mg, 86% yield) as a pale yellow foam. ¹H NMR (500 MHz, CDCl₃) δ 7.72 (dd, J = 7.8, 1.5 Hz, 1H), 7.34 (dt, J = 7.8, 1.5 Hz, 1H), 7.31 (dt, J = 7.3, 1.5 Hz, 1H), 7.16 (dd, J = 7.3, 1.5 Hz, 1H), 7.10 (d, J = 10.3 Hz, 1H), 6.90 (d, J = 1.7 Hz, 1H), 6.48 (dd, J = 9.9, 1.7 Hz, 1H), 4.23 (s, 1H), 2.26 (s, 3H), 1.32 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.4, 149.3, 148.5, 136.0, 135.7, 134.2, 133.2, 129.3, 127.4, 127.2, 126.9, 64.8, 57.3, 22.7, 20.7; IR (NaCl/thin film): 3188, 2960, 1666, 1641, 1594, 1291, 1082, 1068, 951 cm⁻¹; HRMS (EI+) calc'd for C₁₇H₂₀NO₂SBr [M+H]⁺ 382.0471, found 382.0469. [α]p²⁵ −107.7 (c 0.60, CH₂Cl₂).

Sulfinamide 8j. Method B. The reaction was run using quinone sulfinimine 7c (81 mg, 0.24 mmol) and *m*-bromotoluene (58 μ L, 0.48 mmol). The diastereoselectivity was determined by LC/MS: 91:9 d.r. (5 \rightarrow 40% MeCN/H₂O, t = 0–0.5 min; 40 \rightarrow 50% MeCN/H₂O, t = 0.5–8.5 min, 1 mL/min. Minor diastereomer: t_R = 5.2 min, major diastereomer: t_R = 5.5 min). The crude material was purified by flash chromatography (25 \rightarrow 50% EtOAc/Hexanes) to yield 8j (73 mg, 79% yield) as a pale yellow foam. ¹H NMR (500 MHz, CDCl₃) δ 7.33 – 7.29 (m, 1H), 7.29 – 7.26 (m, 1H), 7.19 (d, *J* = 10.3 Hz, 1H), 7.19 (m, 1H), 6.83 (d, *J* = 2.0 Hz, 1H), 6.39 (dd, *J* = 9.8, 1.5 Hz, 1H), 4.19 (s, 1H), 2.37 (s, 3H), 1.34 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ

183.5, 150.9, 150.1, 139.3, 137.5, 133.8, 130.1, 129.2, 126.7, 125.9, 123.2, 64.8, 57.4, 22.8, 21.6; IR (NaCl/thin film): 3188, 2959, 1669, 1595, 1292, 1079, 1062, 954 cm⁻¹; HRMS (EI+) calc'd for $C_{17}H_{20}NO_2SBr [M+H]^+$ 382.0471, found 382.0468. [α]_D²⁵ –99.1 (*c* 0.60, CH₂Cl₂).

Sulfinamide 8k. Method B. The reaction was run using quinone sulfinimide 7c (80 mg, 0.24 mmol) and *p*-bromotoluene (81 mg, 0.48 mmol). The diastereoselectivity was determined by LC/MS: 91:9 d.r. (5 \rightarrow 30% MeCN/H₂O, t = 0–0.5 min; 30 \rightarrow 50% MeCN/H₂O, t = 0.5–10.5 min, 1 mL/min. Minor diastereomer: t_R = 8.2 min, major diastereomer: t_R = 8.7 min). The crude material was purified by flash chromatography (25 \rightarrow 60% EtOAc/Hexanes) to provide 8k (72 mg, 78% yield) as a pale yellow foam. ¹H NMR (500 MHz, CDCl₃) δ 7.32 (app d, *J* = 8.3 Hz, 2H),

7.22 (d, J = 8.3 Hz, 2H), 7.19 (d, J = 9.8 Hz, 1H), 6.81 (d, J = 1.5 Hz, 1H), 6.38 (dd, J = 10.0, 1.7 Hz, 1H), 4.17 (s, 1H), 2.36 (s, 3H), 1.34 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.5, 160.0, 150.2, 139.4, 134.6, 133.7, 130.0, 126.1, 125.8, 64.7, 57.4, 22.8, 21.1; IR (NaCl/thin film): 3186, 2959, 2920, 1668, 1292, 1079, 1062, 955 cm⁻¹; HRMS (EI+) calc'd for C₁₇H₂₀NO₂SBr [M+H]⁺ 382.0471, found 382.0470. [α]_D²⁵ –84.7 (*c* 0.50, CH₂Cl₂).

Sulfinamide 81. Method B. The reaction was run in THF using quinone sulfinimide 7c (80 mg,



0.24 mmol) using β -bromostyrene⁴ (87 mg, 0.48 mmol). The diastereoselectivity was determined by LC/MS: 98:2 d.r. (5 \rightarrow 50% MeCN/H₂O, t = 0–10 min; 50 \rightarrow 100% MeCN/H₂O, t = 10–13 min, 1 mL/min. Minor diastereomer: t_R = 11.6 min, major diastereomer: t_R = 11.8 min). The crude material was purified by flash chromatography (25 \rightarrow 90%

EtOAc/Hexanes) to furnish **81** (64 mg, 68% yield) as a pale yellow solid.⁵ ¹H NMR (500 MHz, CDCl₃) δ 7.42 – 7.37 (m, 2H), 7.37 – 7.29 (m, 3H), 7.25 (d, *J* = 9.8 Hz, 1H), 6.79 (d, *J* = 1.5 Hz, 1H), 6.69 (d, *J* = 16.1 Hz, 1H), 6.44 (dd, *J* = 10.0, 1.7 Hz, 1H), 6.19 (d, *J* = 16.1 Hz, 1H), 3.92 (s, 1H), 1.30 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.1, 149.7, 149.0, 135.0, 134.0, 133.8, 129.1, 128.8, 127.02, 127.00, 126.9, 62.4, 57.2, 22.7, 22.4; IR (NaCl/thin film): 3189, 2960, 1669, 1596, 1293, 1060, 955, 735 cm⁻¹; HRMS (EI+) calc'd for C₁₈H₂₀NO₂SBr [M+H]⁺ 394.0471, found 394.0476. [α]_D²⁵ –115.0 (*c* 0.65, CH₂Cl₂).

Sulfinamide 8m. Method A. The reaction was run in THF using quinone sulfinimine 7c (80 mg, 0.24 mmol) and vinyllithium⁶ (0.48 mmol). The diastereoselectivity was determined by LC/MS: 98:2 d.r. (5 \rightarrow 50% MeCN/H₂O, t = 0–10 min, 1 mL/min. Minor diastereomer: t_R = 7.9 min, major diastereomer: t_R = 8.3 min). The crude material was purified by flash chromatography (40 \rightarrow 90%

EtOAc/Hexanes) to yield 8m (55 mg, 72% yield) as a yellow foam. ¹H NMR (500 MHz, CDCl₃)

⁽⁴⁾ β-bromostyrene was isolated as a 9:1 mixture of E:Z olefin isomers. See: Brown, H.C.; Subrahmanyam, C.; Hamaoka, T.; Ravindran, N.; Bowman, D.H.; Misumi, S.; Unni, M.K.; Somayaji, V.; Bhat, N.G. J. Org. Chem. **1989**, *54*, 6068.

⁽⁵⁾ The product isolated contained <2% minor diastereomer and 3% *cis* addition product.

⁽⁶⁾ Vinyllithium was prepared by treating a solution of tetravinyl tin (95 μ L, 0.52 mmol) in Et₂O (0.3 mL) at 0 °C with *n*-BuLi (0.33 mL, 1.5 M in hexanes, 0.48 mmol). The reaction was allowed to stir 20 min at that temperature, then warmed to room temperature prior to use. See: Liu, H.; Tomooka, C.S.; Xu, S.L. Yerxa, B.R.; Sullivan, R.W.; Xiong, Y.; Moore, H.W. *Org. Synth.* **2004**, *76*, 178.

 δ 7.13 (d, J = 9.8 Hz, 1H), 6.76 (d, J = 1.0 Hz, 1H), 6.39 (dd, J = 10.0, 1.2 Hz, 1H), 5.87 (dd, J = 10.0, 1H), 5.87 (dd, J = 10.0, 1H), 5.87 (dd, J = 10.0, 1H), 5.87 (dd, J = 10 17.3, 10.5 Hz, 1H), 5.45 (d, J = 10.7 Hz, 1H), 5.45 (d, J = 17.1 Hz, 1H), 3.82 (s, 1H), 1.27 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.0, 149.6, 148.5, 136.4, 134.1, 127.1, 119.3, 62.6, 57.2, 22.6; IR (NaCl/thin film): 3186, 2959, 1669, 1594, 1294, 1060, 954 cm⁻¹; HRMS (EI+) calc'd for C₁₂H₁₆NO₂SBr [M+H]⁺ 318.0158, found 318.0161. $[\alpha]_D^{25}$ –175.9 (*c* 0.85, CH₂Cl₂).

Sulfinamide 8n. Method A. The reaction was run in THF using quinone sulfinimide 7c (80 mg,



0.24 mmol) and allylmagnesium chloride (0.13 mL, 2.0 M in THF, 0.26 mmol). The diastereoselectivity was determined by LC/MS: 87:13 d.r. $(5 \rightarrow 40\% \text{ MeCN/H}_2\text{O}, t = 0-0.5 \text{ min}; 40 \rightarrow 60\% \text{ MeCN/H}_2\text{O}, t = 0.5-5.5 \text{ min},$ 1 mL/min. Minor diastereomer: $t_R = 3.0$ min, major diastereomer: $t_R = 3.4$ min). The crude material was purified by flash chromatography $(30 \rightarrow 80\%)$ EtOAc/Hexanes) to give (R,R)-8n (49 mg, 82% yield) as a pale yellow solid. Major diastereomer: ¹H NMR (500 MHz, CDCl₃) δ 7.14 (d, J = 10.0 Hz, 1H), 6.79 (d, J = 1.8 Hz, 1H), 6.39 (dd, J = 10.0, 1.8 Hz, 1H), 5.52 (dddd, J = 17.1, 1.1)10.1, 7.7, 7.1 Hz, 1H), 5.26 - 5.22 (m, 1H), 5.22 - 5.20 (m, 1H), 3.77 (s, J =minor diastereomer 10.4 Hz, 1H), 2.75 (ddt, J = 13.2, 7.1, 1.0 Hz, 1H), 2.57 (ddt, J = 13.2, 7.8, 1.0Hz, 1H), 1.25 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.2, 150.6, 149.7, 135.4, 128.8, 128.2, 122.1, 61.6, 57.1, 44.6, 22.6. IR (NaCl/thin film): 3196, 2959, 1669, 1597, 1056, 957 cm⁻¹; HRMS (EI+) calc'd for $C_{13}H_{18}NO_2SBr [M+H]^+$ 332.0314, found 332.0316. $[\alpha]_D^{25}$ –129.0 (*c* 0.6, CH₂Cl₂). The minor diastereomer ((R,S)-8n) was obtained as a pale vellow solid. ¹H NMR (500 MHz, CDCl₃) δ 6.89 (d, J = 10.3 Hz, 1H), 6.76 (d, J = 1.5 Hz, 1H), 6.39 (dd, J = 10.0, 1.7 Hz, 1H), 5.47 (ddt, J = 17.1, 10.3, 7.3 Hz, 1H), 5.20 – 5.13 (m, 2H), 3.95 (s, 1H), 2.70 – 2.59 (m, 2H), 1.26 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.1, 152.0, 148.3, 133.8, 129.7, 128.7,

121.2, 61.8, 56.9, 43.9, 22.5; IR (NaCl/thin film): 3195, 2956, 1670, 1595, 1070, 955, 883 cm⁻¹; HRMS (EI+) calc'd for $C_{13}H_{18}NO_2S^{81}Br [M+H]^+$ 333.0221, found 333.0209. $[\alpha]_D^{25}$ -95.7 (c 0.80, CH₂Cl₂).

Sulfinamide 80. Method A. The reaction was run using quinone sulfinimine 7c (80 mg, 0.24 mmol) and propargylmagnesium bromide (0.48 mL, 0.55 M in Et₂O, 0.26 mmol). The diastereoselectivity was determined to be >97:3 by ¹H NMR. The crude material was purified by

flash chromatography $(25 \rightarrow 75\% \text{ EtOAc/Hexanes})$ to give **80** (72 mg, 91% yield) as a white solid. ¹H NMR (500 MHz, CDCl₃) δ 7.34 (d, J = 10.3 Hz, 1H), 6.85 (d, J = 1.7 Hz, 1H), 6.40 (dd, J = 10.1, 1.8 Hz, 1H), 4.12 (s, 1H), 3.02 (dd, J = 16.6, 2.7 Hz, 1H), 2.61 (dd, J = 16.6, 2.7 Hz, 1H), 2.27 (t, J = 2.7 Hz, 1H), 1.26 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 182.7, 150.0, 147.7,

136.2, 127.6, 76.0, 74.7, 60.1, 57.2, 31.5, 22.6; IR (NaCl/thin film): 3283, 3128, 2962, 1671, 1600, 1377, 1308, 1278, 1047, 1036, 957 cm⁻¹; HRMS (EI+) calc'd for $C_{13}H_{16}NO_2SBr [M+H]^+$ 330.0158, found 330.0159. [α]_D²⁵ –94.6 (*c* 1.05, CH₂Cl₂).

Sulfinamide 8p. Method A. The reaction was run in THF at 0 °C using quinone sulfinimine 7c



(40 mg, 0.12 mmol) and lithium (trimethylsilyl)acetylide⁷ (0.24 mmol). The diastereoselectivity was determined by LC/MS: >98:2 d.r. (30 \rightarrow 50% MeCN/H₂O, t = 0–10 min; 50 \rightarrow 70% MeCN/H₂O, t = 10–15 min, 1 mL/min. Minor diastereomer: t_R = 11.6 min, major diastereomer: t_R = 12.0 min). The crude material was purified by flash chromatography (10 \rightarrow 40%

EtOAc/Hexanes) to give **8p** (46 mg, 99% yield) as a pale yellow foam. ¹H NMR (500 MHz, CDCl₃) δ 7.18 (d, J = 9.8 Hz, 1H), 6.73 (d, J = 1.7 Hz, 1H), 6.36 (dd, J = 9.9, 1.7 Hz, 1H), 4.00 (s, 1H), 1.26 (s, 9H), 0.20 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 182.5, 147.2, 146.1, 133.5, 126.4, 98.1, 93.7, 57.2, 56.5, 22.5, -0.6; IR (NaCl/thin film): 3185, 2960, 1673, 1599, 1292, 1251, 1076, 955, 845 cm⁻¹; HRMS (EI+) calc'd for C₁₅H₂₂NO₂SSiBr [M+H]⁺ 388.0397, found 388.0401. [α]_D²⁵ –41.0 (*c* 0.50, CH₂Cl₂).

⁽⁷⁾ Lithium (trimethylsilyl)acetylide was prepared by treating a solution of trimethylsilylacetylene (37 mL, 0.26 mmol) in THF (0.2 mL) at -78 °C with *n*-BuLi (0.16 mL, 0.24 mmol, 1.5 M in hexanes). The reaction was allowed to stir 10 min at that temperature, then warmed to room temperature prior to use. See: Raminelli, C.; Gargalaka, J.; Silveira, C.C.; Comasseto, J.V. *Tetrahedron* **2007**, *63*, 8801-8809.

Sulfinamide 8q. Method A. The reaction was run in THF using quinone sulfinimine 7c (270 mg, 0.80 mmol) and (3,4-dimethoxyphenethyl)magnesium bromide⁸ (1.6 mL, 0.55 M in THF, 0.88 mmol). The diastereoselectivity was determined by LC/MS: 96:4 d.r. (30 \rightarrow 50% MeCN/H₂O, t = 0–10 min, 1 mL/min. Minor diastereomer: t_R = 5.8 min, major diastereomer: t_R = 7.2 min). The crude material was purified by flash chromatography (50 \rightarrow 100%

^{8q} Hexanes/EtOAc) to provide **8q** (301 mg, 82% yield) as a pale yellow foam. ¹H NMR (500 MHz, CDCl₃) δ 7.18 (d, J = 10.0 Hz, 1H), 6.87 (d, J = 1.7 Hz, 1H), 6.77 (d, J = 8.1 Hz, 1H), 6.66 (dd, J = 8.1, 2.0 Hz, 1H), 6.62 (d, J = 2.0 Hz, 1H), 6.46 (dd, J = 10.0, 1.7 Hz, 1H), 3.86 (s, 3H), 3.84 (s, 3H), 3.67 (s, 1H), 2.47 – 2.27 (m, 3H), 2.04 – 1.93 (m, 1H), 1.23 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.3, 150.7, 149.6, 149.0, 147.7, 135.6, 132.0, 128.8, 120.1, 111.5, 111.4, 62.2, 56.8, 56.0, 55.9, 41.8, 29.2, 22.5; IR (NaCl/thin film): 3246, 2958, 2835, 1669, 1645, 1596, 1516, 1465, 1258, 1236, 1157, 1060, 1027, 730 cm⁻¹; HRMS (EI+) calc'd for C₂₀H₂₆NO₄SBr [M+H]⁺ 456.0839, found 456.0841. [α]_D²⁵ –63.3 (*c* 1.15, CH₂Cl₂).

Preparation of dienone 9



8e 1.0 Sulfinamide (51.9)mg, 0.169 mmol. equiv), dichlorobis(triphenylphosphine)palladium (5.6 mg, 8.0 µmol, 0.05 equiv), and tributylphenylstannane (75 mg, 0.20 mmol, 1.2 equiv) were dissolved in PhMe (1 mL), and the resulting solution was heated to 100°C for 3 hours. The reaction mixture was cooled to room temperature, filtered through a plug of silica gel, and rinsed with EtOAc (15 mL). The filtrate was concentrated in vacuo and purified by flash chromatography ($20 \rightarrow 70\%$ CH₂Cl₂/EtOAc) to afford phenyldienone **9** as a white solid (47.8 mg, 0.158 mmol, 93% yield). ¹H NMR (500 MHz, CDCl₃) δ 7.50 – 7.47 (m, 2H), 7.37 - 7.35 (m, 3H), 7.09 (d, J = 10.0 Hz, 1H), 6.37 (d, J = 2.0 Hz, 1H), 6.30 (dd, J = 10.0 Hz, 1H),

⁽⁸⁾ To a suspension of Mg turnings (239 mg, 9.8 mmol) in THF (1 mL) was added DIBAL-H (1 mol %). The resulting suspension was heated to reflux, and a solution of 3,4-dimethoxyphenethyl bromide (1 g, 4.1 mmol) in THF (4 mL) was added dropwise. The reaction was maintained at reflux for 1.5 hrs, then cooled to room temperature and used for the sulfinimine addition reaction.

10.0 Hz, 2.0 Hz, 1H), 3.55 (s, 1H), 1.72 (s, 3H), 1.03 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 185.7, 159.5, 154.0, 137.2, 129.5, 129.1, 128.6, 128.2, 126.2, 57.4, 56.6, 28.0, 22.3; IR (NaCl/thin film): 3434, 3151, 2986, 2958, 2930, 2868, 1660, 1626, 1570, 1472, 1457, 1364, 1290, 1274, 1147, 1114, 1040, 893, 813, 763, 705 cm⁻¹; HRMS (ES+) calc'd for C₁₇H₂₂NO₂S [M+H]⁺ 304.1366, found 304.1358; [α]_D²⁵ –134.2 (*c* 0.81, CH₂Cl₂).

Preparation of trienone S4



Sulfinamide 8n (100 mg, 0.30 mmol, 1.0 equiv), tris(dibenzylideneacetone)dipalladium (4.1 mg, 0.0045 mmol, 1.5 mol%), tri-tert-butylphosphine (3.7 mg, 0.018 mmol, 6 mol%), cesium fluoride (101 mg, 0.66 mmol, 2.2 equiv), and vinyltributylstannane (93µL, 0.32 mmol, 1.1 equiv), and 1,4-dioxane (3.0 mL) were sequentially added to a Schlenk tube. The solution was then stirred and thoroughly degassed via sequential freeze-pump-thaw cycles (3x), then heated to 40°C for 20 hours. The solution was cooled and filtered through a plug of silica, rinsed with EtOAc (30 mL), and concentrated to afford a brown oil. Flash chromatography $(1\rightarrow 5\%)$ MeOH/CH₂Cl₂) afforded allyltrienone S4 (78 mg, 0.28 mmol, 93% yield) as a bright yellow oil. ¹H NMR (500 MHz, CDCl₃) δ 6.89 (d, J = 10.1 Hz, 1H), 6.46 (d, J = 1.8 Hz), 6.42 (ddd, J = 17.4, 11.0, 0.6 Hz, 1H), 6.23 (dd, J = 10.1, 2.0 Hz, 1H), 5.79 (dd, J = 17.5, 1.0 Hz, 1H), 5.40 (dd, J = 11.0, 1.0 Hz, 1H), 5.45 - 5.35 (m, 1H), 5.08 - 5.00 (m, 2H), 3.88 (s, 1H), 2.55 - 2.43 (m, 2H), 1.11 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 185.9, 155.3, 151.8, 132.1, 129.5, 127.9, 125.7, 121.1, 120.8, 59.0, 56.5, 43.5, 22.5; IR (NaCl/thin film): 3197, 2980, 2960, 2234, 1663, 1624, 1474, 1420, 1390, 1364, 1295, 1192, 1175, 1154, 1057, 992, 9224, 895, 818, 734 cm⁻¹; HRMS (ES+) calc'd for C₁₅H₂₂NO₂S $[M+H]^+$ 280.1366, found 280.1376; $[\alpha]_D^{25}$ –247.5 (*c* 0.92, CH_2Cl_2).

Preparation of bicycle 10



To a solution of trienone S4 (18 mg, 0.065 mmol, 1.0 equiv) in CH₂Cl₂ (0.75 mL) was added Hoveyda-Grubbs 2nd Generation Catalyst (2.6 mg, 4.6 µmol, 0.06 equiv). The solution was stirred at 23°C for 3 hrs. The reaction mixture was concentrated and purified by flash chromatography (1 \rightarrow 5% MeOH/CH₂Cl₂) to afford bicycle **10** (14 mg, 0.058 mmol, 88% yield) as a white crystalline solid. ¹H NMR (500 MHz, CDCl₃) δ 7.08 (dd, *J* = 9.8, 0.7 Hz, 1H), 6.58 (dt, *J* = 5.2 Hz, 2.6 Hz, 1H), 6.47 (dt, *J* = 5.8, 2.0 Hz, 1H), 6.25 (dd, *J* = 9.8, 1.7 Hz, 1H), 6.13 (d, *J* = 1.5 Hz, 1H), 3.43 (s, 1H), 2.77 (t, *J* = 2.2 Hz, 2H), 1.12 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 186.3, 166.7, 145.5, 143.7, 130.9, 130.6, 120.2, 61.7, 56.4, 43.4, 22.3; IR (NaCl/thin film): 3152, 2979, 2918, 2866, 1726, 1653, 1634, 1597, 1561, 1474, 1457, 1379, 1362, 1289, 1190, 1050, 1037, 929, 891, 865, 811, 740 cm⁻¹; HRMS (ES+) calc'd for C₁₃H₁₇NO₂S [M+H]⁺ 252.1058, found 252.1061; [α]_D²⁵-80.4 (*c* 0.29, CH₂Cl₂).

Preparation of dienone 11



A 10 mL flask was charged with sulfinamide **8e** (50 mg, 0.16 mmol, 1.0 equiv), dichlorobis(triphenylphosphine)palladium (6.0 mg, 8 µmol, 0.05 equiv), copper iodide (3.0 mg, 16 µmol, 0.1 equiv), and THF (0.8 mL). Nitrogen was bubbled through the resulting suspension for 20 minutes, then Et₃N (0.8 mL) and ethynyltrimethylsilane (25 µL, 0.18 mmol, 1.1 equiv) were added. The reaction mixture was allowed to stir 1 h at room temperature. The mixture was filtered through Celite, rinsed with EtOAc, concentrated, and purified by flash chromatography (0 \rightarrow 70% EtOAc/CH₂Cl₂) to provide dienone **11** (49 mg, 92% yield) as a pale yellow solid. ¹H NMR (500 MHz, CDCl₃) δ 7.01 (d, *J* = 10.1 Hz, 1H), 6.44 (d, *J* = 2.0 Hz, 1H), 6.28 (dd, *J* = 10.3, 2.0 Hz, 1H), 3.62 (s, 1H), 1.60 (s, 3H), 1.22 (s, 9H), 0.21 (s, 9H); ¹³C NMR (126 MHz,

CDCl₃) δ 184.7, 152.1, 143.7, 133.6, 127.5, 107.4, 100.8, 56.4, 56.3, 27.9, 22.4, -0.5; IR (NaCl/thin film): 3139, 2960, 2253, 2149, 1662, 1623, 1586, 1364, 1251, 1105, 1043, 897, 843 cm⁻¹; HRMS (ES+) calc'd for C₁₆H₂₅NO₂SSi [M+H]⁺ 324.1454, found 324.1463; [α]_D²⁵ –191.8 (*c* 1.13, CH₂Cl₂).

Preparation of dienone 12



Sulfinamide (48 1.0 **8**e 0.16 mmol, equiv), dichloromg, bis(triphenylphosphine)palladium (5.5 mg, 7.8 µmol, 0.05 equiv), and allyltributyltin (62 mg, 0.19 mmol, 1.2 equiv) were dissolved in PhMe (1 mL), and the resulting solution was heated to 100°C for 3 hours. The reaction mixture was cooled to room temperature, filtered through a plug of silica gel, and rinsed with EtOAc (15 mL). The resulting solution was concentrated in vacuo and the crude residue was purified by flash chromatography ($20 \rightarrow 70\%$ EtOAc/CH₂Cl₂) to afford allyldienone 12 (35.1 mg, 0.131 mmol, 84% yield) as a white solid. ¹H NMR (500 MHz, CDCl₃) δ 6.96 (d, J = 10.0 Hz, 1H), 6.22 (dd, J = 9.8, 2.0 Hz, 1H), 6.19 (app. q, J = 1.6 Hz, 1H), 5.75 (m, 1H), 5.20 (dq, J = 10.0, 1.2 Hz, 1H), 5.14 (dq, J = 17.0, 1.5 Hz, 1H), 3.55 (s, 1H), 3.15 (dddd, J = 17.3, 6.3, 2.8, 1.4 Hz, 1H), 2.99 (dddd, J = 17.3, 7.3, 2.3, 1.3 Hz, 1H), 1.48 (s, 3H), 1.20 (s, 9H). ¹³C NMR (126 MHz, CDCl₃) δ 185.5, 160.5, 153.6, 133.5, 128.4, 126.7, 118.9, 57.2, 56.4, 34.7, 26.3, 22.5; IR (NaCl/thin film): 3128, 2983, 2964, 2928, 2870, 1672, 1635, 1460, 1419, 1388, 1363, 1285, 1270, 1157, 1064, 1043, 916, 892, 810 cm⁻¹; HRMS (ES+) calc'd for $C_{14}H_{22}NO_{2}S[M+H]^{+}268.1366$, found 268.1376. $[\alpha]_{D}^{25}$ -82.7 (*c* 0.70, CH₂Cl₂).



To a solution of 3,4-dimethoxyphenethanol (S5) (4.72g, 25.9 mmol, 1.0 equiv) in CH₂Cl₂ (250 mL) at 0°C was added triphenylphosphine (13.6 g, 51.8 mmol, 2.0 equiv). The solution was

stirred for 10 min, and trichloroacetonitrile (3.89 mL, 38.9 mmol, 1.5 equiv) was added dropwise via syringe over 5 min. The solution was stirred at 0 °C for 10 min and was then slowly warmed to room temperature. After stirring for an additional 45 minutes at room temperature, the reaction mixture was concentrated and purified by flash chromatography (5→20% EtOAc/Hexanes) to afford 3,4-dimethoxyphenethyl chloride (S6) (4.82 g, 24.0 mmol, 93 % yield) as a clear colorless oil. ¹H NMR (500 MHz, CDCl₃) δ 6.81 (d, *J* = 8.30 Hz, 1H), 6.76 (dd, *J* = 8.1, 2.0 Hz, 1H), 6.73 (d, *J* = 2.0 Hz, 1H), 3.87 (s, 3H), 3.86 (s, 3H), 3.68 (t, *J* = 7.5 Hz, 2H), 3.00 (t, *J* = 7.5 Hz, 2H); ¹³C NMR (126 MHz, CDCl₃) δ 148.9, 147.9, 130.6, 120.7, 112.0, 111.2, 55.8, 55.8, 45.1, 38.7; IR (NaCl/thin film): 3000, 2956, 2909, 2867, 2934, 1607, 1591, 1516, 1464, 1418, 1325, 1260, 1232, 1191, 1146, 1027, 914, 854, 809, 767 cm⁻¹; HRMS (ES+) calc'd for C₁₀H₁₃O₂Cl [M+H]⁺ 200.0604, found 200.0591.

Preparation of 2-bromo-3,4-dimethoxyphenethyl chloride (S7)



To a solution of 3,4-dimethoxyphenethyl chloride **S6** (4.82 g, 24.0 mmol, 1.0 equiv) in CH₂Cl₂ (240 mL) at 0°C was added bromine (1.25 mL, 24.2 mmol, 1.01 equiv) dropwise via syringe. (*Caution! A copious amount of HBr gas is generated as the reaction proceeds. A 16-gauge needle was pierced through the septa to allow the reaction to vent*). The solution was stirred at 0°C for 10 min, warmed to room temperature, and stirred at that temperature for 20 min. The reaction mixture was quenched with saturated aqueous Na₂S₂O₃ (50 mL) and washed with saturated sodium bicarbonate (3 x 100 mL). The combined aqueous layers were back-extracted with CH₂Cl₂ (1 x 50 mL), and the combined organic layers were dried over Na₂SO₄, concentrated, and purified by flash chromatography (5→20% EtOAc/Hexanes) to afford bromide **S7** (6.70 g, 24.0 mmol, quantitative yield) as white needles. ¹H NMR (500 MHz, CDCl₃) δ 7.01 (s, 1H), 6.77 (s, 1H), 3.87 (s, 3H), 3.86 (s, 3H), 3.71, (t, *J* = 7.3 Hz, 2H), 3.12 (t, *J* = 7.3 Hz, 2H); ¹³C NMR (126 MHz, CDCl₃) δ 148.6, 148.3, 129.2, 115.6, 114.2, 113.9, 56.2, 56.1, 43.5, 39.1; IR (NaCl/thin film): 3009, 2955, 2940, 2906, 2836, 1602, 1576, 1510, 1469, 1461, 1451, 1435, 1382, 1344, 1266, 1254, 1217, 1166, 1033, 959, 856, 834, 865, 834, 802, 759 cm⁻¹; HRMS (ES+) calc'd for C₁₀H₁₂O₂Cl⁸¹Br [M+H]⁺ 279.9689, found 279.9691.

Preparation of sulfinamide 14



To a solution of aryl bromide S7 (506 mg, 1.8 mmol) in Et₂O (18 mL) at -78°C was added a solution of tert-butyllithium (1.6 M in pentane, 1.31 mL, 2.1 mmol) dropwise via syringe, and the resulting mixture was stirred 2 hrs at -78 °C. A solution of sulfinimine 7c (495 mg, 1.5 mmol) in Et₂O (3 mL) was added by cannula transfer over 5 min. The reaction mixture was stirred 1 h at -78°C, and allowed to warm to room temperature and stirred for an additional hour. The reaction was guenched by the slow addition of aqueous HCl (0.1 N) and stirred for 30 min at room temperature. The resulting mixture was diluted with EtOAc (60 mL) and washed with saturated aq. NaHCO₃ (3 x 20 mL). The combined aqueous layers were back extracted with EtOAc (1 x 25 mL), and the combined organic layers were dried over Na₂SO₄ and concentrated to give a light brown oil. The diastereoselectivity was determined by LC/MS: >98:2 d.r. $(5 \rightarrow 95\% \text{ MeCN/H}_2\text{O}, t = 0-10 \text{ min}, 1 \text{ mL/min}$. Minor diastereomer: $t_R = 3.7 \text{ min}, \text{ major}$ diastereomer: $t_R = 4.0$ min). Flash chromatography (10 \rightarrow 30% EtOAc/CH₂Cl₂) afforded tricyclic dienone 14 (491 mg, 1.08 mmol, 74% yield) as an off-white, flaky solid. ¹H NMR (500 MHz, CDCl₃) δ 7.30 (d, J = 9.8Hz, 1H), 6.77 (d, J = 1.5 Hz, 1H), 6.63 (s, 1H), 6.42 (dd, J = 9.8, 1.5Hz, 1H), 6.32 (s, 1H), 3.86 (s, 3H), 3.72 (s, 3H), 3.52 (dt, J = 13.2, 4.4 Hz, 1H), 3.33 (ddd, J = 13.2, 4.4 Hz, 1H), 3.38 (ddd, J = 13.2, 4.4 Hz, 1H), 3.4 13.2, 9.8, 2.9 Hz, 1H), 3.03 (ddd, J=15.4, 10.0, 3.9 Hz, 1H), 2.79 (dt, J=15.4, 3.8 Hz, 1H), 1.30 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 183.7, 153.0, 149.6, 149.1, 148.3, 133.5, 128.5, 126.0, 122.7, 111.5, 109.1, 66.7, 59.2, 56.1, 55.8, 38.5, 29.0, 24.4; IR (NaCl/thin film): 2958, 2925, 2855, 1669, 1644, 1594, 1516, 1436, 1363, 1298, 1262, 1230, 1199, 1126, 1076, 1022, 954, 915, 796, 731 cm⁻¹; HRMS (EI+) calc'd for C₂₀H₂₄BrNO₄S [M+H]⁺ 454.0682, found 454.0697; $[\alpha]_{D}^{25}$ –17.3 (*c* 0.39, CH₂Cl₂).

Preparation of aminodienone S8



To a solution of dienone **14** (376 mg, 0.83 mmol, 1.0 equiv) in MeOH (4 mL) was added HCl (2N in MeOH, 4 mL) dropwise at 0°C. The solution stirred for 10 min 0 °C, then warmed to 23 °C and stirred for an additional 30 min. The reaction was quenched through the addition of aq. NaOH (10% w/w, 30 mL) and extracted with CH₂Cl₂ (3 x 25 mL). The combined organic layers were dried over Na₂SO₄, concentrated, and purified by flash chromatography (30 \rightarrow 80% EtOAc/Hexanes) to afford amine **S8** as a pale tan solid (277 mg, 0.79 mmol, 96% yield). ¹H NMR (500 MHz, CDCl₃) δ 7.25 (d, *J* = 9.8Hz, 1H), 6.74 (d, *J* = 1.7 Hz, 1H), 6.62 (s, 1H), 6.30 (s, 1H), 6.16 (dd, *J* = 9.8 Hz, 1.8 Hz, 1H), 3.86 (s, 3H), 3.72 (s, 3H), 3.35 (ddd, *J* = 12.1 Hz, 5.2 Hz, 3.3 Hz, 1H), 3.23 (ddd, *J* = 12.9 Hz, 10.4 Hz, 3.5 Hz, 1H), 3.05-2.97 (m, 1H), 2.68 (dt, *J* = 15.6 Hz, 3.4 Hz, 1H), 1.97 (s, 1H); ¹³C NMR (126 MHz, CDCl₃) δ 183.7, 155.5, 151.7, 148.8, 148.0, 132.5, 128.7, 123.1, 122.9, 112.0, 108.8, 61.0, 56.0, 55.8, 39.2, 29.0; IR (NaCl/thin film): 3324, 3055, 2999, 2932, 2832, 1667, 1645, 1610, 1593, 1513, 1464, 1402, 1380, 1363, 1347, 1260, 1226, 1192, 1118, 1039, 1008, 954, 881, 823, 808, 732 cm⁻¹; HRMS (ES+) calc'd for C₁₆H₁₇BrNO₃ [M+H]⁺ 350.0386, found 350.0383. [α]p²⁵ +52.9 (*c* 0.62, CH₂Cl₂).

Preparation of trienone S9



To a solution of dienone **14** (238 mg, 0.52 mmol, 1.0 equiv) in DMF (10 mL) was added tris(dibenzylideneacetone)dipalladium (14 mg, 0.016 mmol, 0.030 equiv), triphenylarsine (19 mg, 0.063 mmol, 0.12 equiv) and *cis*-2-ethoxyvinyltributylstannane (**15**) (164 mg, 0.63 mmol, 1.2 equiv). Nitrogen was then bubbled through the solution for 30 minutes, and the reaction was then stirred at 100°C for 1 h. Upon cooling to room temperature, the reaction mixture was passed

through a plug of Celite, rinsed and diluted with Et₂O (40 mL), and washed with H₂O (3x50 mL). The combined organic layers were dried over MgSO₄, concentrated, and purified by flash chromatography (35 \rightarrow 100% EtOAc/Hexanes) to afford trienone **S9** (~5.4:1 mixture of *Z:E*-isomers by ¹H NMR) as a tan solid (199 mg, 0.446 mmol, 85% yield). *Z*-**S9**: ¹H NMR (500 MHz, CDCl₃) δ 7.14 (d, *J* = 10.0 Hz, 1H), 7.13 (d, *J* = 2.0 Hz, 1H), 6.59 (s, 1H), 6.36 (dd, *J* = 10.0, 2.0 Hz, 1H), 6.34 (s, 1H), 6.28 (d, *J* = 7.3 Hz, 1H), 4.46 (d, *J* = 7.1 Hz, 1H), 3.97 – 3.90 (m, 2H), 3.84 (s, 3H), 3.67 (s, 3H), 3.49 (ddd, *J* = 13.1, 4.3, 3.4 Hz, 1H), 3.17 (ddd, *J* = 13.1, 11.3, 2.8 Hz, 1H), 3.05 (ddd, *J* = 15.5, 11.2, 4.0 Hz, 1H), 2.81 (dt, *J* = 15.5, 3.0 Hz, 1H), 1.28 (t, *J* = 7.1 Hz, 3H), 1.19 (s, 9H); ¹³C NMR (126 MHz, CDCl₃) δ 187.4, 155.4, 153.3, 148.5, 148.1, 147.3, 127.6, 127.2, 126.8, 125.0, 111.3, 109.9, 102.8, 70.4, 63.9, 58.4, 56.0, 55.8, 38.1, 29.0, 24.1, 15.4. IR (NaCl/thin film): 2979, 2959, 2932, 1658, 1625, 1574, 1516, 1464, 1360, 1262, 1249, 1124, 1072, 1038, 1021, 893, 795 cm⁻¹; HRMS (ES+) calc'd for C₂₄H₃₂NO₅S [M+H]⁺ 446.1996, found 446.2006. *E*-**S9** gave the following diagnostic resonances by ¹H NMR (500 MHz, CDCl₃): 7.18 (d, *J* = 10.0 Hz, 1H), 6.89 (d, *J* = 13.0 Hz, 1H), 5.09 (d, *J* = 13.2 Hz).

Preparation of enamine 16



To a solution of trienone **S9** (50 mg, 0.11 mmol, 1.0 equiv) in THF (2.2 mL) at 0 °C was added a solution of hydrogen chloride (2.0 M solution in Et₂O, 1.1 mL, 2.2 mmol, 20 equiv) dropwise by syringe. The reaction was allowed to stir 2 min at 0 °C, then quenched by the addition of aq. NaOH (10% w/w, 4 mL) and stirred for an additional 5 min. The mixture was diluted with H₂O (5 mL) and extracted with EtOAc (4 x 10 mL). The combined organic layers were dried over Na₂SO₄, concentrated, and purified by flash chromatography (10 \rightarrow 20% EtOAc/CH₂Cl₂) to afford enamine **16** (29 mg, 0.098 mmol, 88% yield) as a bright orange solid. ¹H NMR (500 MHz, CDCl₃) δ 7.02 (d, *J* = 9.8 Hz, 1H), 6.99 (d, *J* = 3.4 Hz, 1H), 6.85 (s, 1H), 6.53 (s, 1H), 6.06 (dd, *J* = 9.8 Hz, 2.0 Hz, 1H), 6.03 (d, *J* = 1.5 Hz, 1H), 5.62 (d, *J* = 3.4 Hz, 1H), 3.83 (s, 1H), 3.78 (ddd, *J* = 14.2 Hz, 6.8 Hz, 1.0 Hz, 1H), 3.74 (s, 1H), 3.56 (ddd, *J* = 14.2 Hz, 12.7 Hz, 4.4 Hz, 1H), 2.93 (ddd, *J* = 16.9 Hz, 12.5 Hz, 6.4 Hz, 1H), 2.75 (dd, 16.4 Hz, 4.2 Hz, 1H); ¹³C

NMR (126 MHz, CDCl₃) δ 186.5, 172.8, 152.9, 148.6, 148.0, 143.6, 127.8, 125.7, 124.6, 112.7, 111.4, 107.5, 105.2, 71.3, 55.9, 55.8, 42.1, 28.5; IR (NaCl/thin film): 2992, 2955, 2936, 2835, 1636, 1605, 1571, 1523, 1513, 1455, 1450, 1442, 1402, 1356, 1333, 1256, 1218, 1204, 1190, 1166, 1140, 1111, 1081, 1068, 1039, 1001, 895, 852, 784, 731 cm⁻¹; HRMS (ES+) calc'd for C₁₈H₁₈NO₃ [M+H]⁺ 296.1281, found 296.1272. [α]²⁵_D –1307 (*c* 0.72, CH₂Cl₂).

Preparation of (-)-3-demethoxyerythratidinone (ent-1)



To a solution of enamine 16 (20 mg, 0.068 mmol, 1.0 equiv) in EtOH (3.3 mL) was added palladium on CaCO₃ (14 mg, 5 wt %, 7.0 µmol, 0.1 equiv). The solution was placed under an atmosphere of hydrogen (balloon) and was allowed to stir 3 h at room temperature. The reaction mixture was filtered through a plug of Celite, rinsed with EtOAc, concentrated, and chromatography (0→20% purified by flash acetone/ CH_2Cl_2) to afford (-)demethoxyerythratidinone (*ent-1*) as a pale yellow oil (13 mg, 0.043 mmol, 65% yield). ¹H NMR (500 MHz, CDCl₃) δ 6.65 (s, 1H), 6.56 (s, 1H), 6.11 (app. s, 1H), 3.86 (s, 3H), 3.75 (s, 3H), 3.49 (ddd, J = 14.4, 11.7, 6.6 Hz, 1H), 3.24 (dd, J = 14.4 Hz, 7.6 Hz, 1H), 3.12 - 3.00 (m, 2H), 2.86(q, J = 7.7 Hz, 1H), 2.77 - 2.68 (m, 1H), 2.62 - 2.50 (m, 3H), 2.46 (dd, J = 18.3, 4.2 Hz, 1H),2.31 (ddd, J = 12.5, 5.6, 2.0 Hz, 1H), 2.24 - 2.15 (m, 1H); ¹³C NMR (126 MHz, CDCl₃) δ 199.5, 169.2, 148.3, 146.8, 125.7, 124.8, 123.4, 112.8, 110.3, 63.5, 56.0, 55.9, 45.7, 40.1, 36.1, 32.8, 28.7, 21.4; IR (NaCl/thin film): 2928, 2848, 1667, 1509, 1464, 1329, 1253, 1229, 1205, 1165, 1106 cm⁻¹; HRMS (ES+) calc'd for $C_{18}H_{21}NO_3 [M+H]^+$ 300.1600, found 300.1606. $[\alpha]^{25}D_{-1}$ 296.5 (c 0.57, CHCl₃).

natural⁹ synthetic 3-demethoxy-Comparison of spectroscopic for and data erythratidinone.^{10,11}



(-)-3-demethoxyerythratidinone (ent-1)

¹H NMR Data

Natural ¹²	Simpkins Synthetic (+)-1	Reisman Synthetic (–)-1			
	(400 MHz)	(500 MHz)			
δ 6.59 (s, 1H)	δ 6.66 (s, 1H)	δ 6.65 (s, 1H)			
6.51 (s, 1H)	6.56 (s, 1H)	6.56 (s, 1H)			
6.04 (s, 1H)	6.12 (s, 1H)	6.11 (app. s, 1H)			
3.79 (s, 3H)	3.88 (s, 3H)	3.86 (s, 3H)			
3.68 (s, 3H)	3.76 (s, 3H)	3.75 (s, 3H)			
3.52 – 1.85 (m, 12H)	3.52 – 3.45 (m, 1H)	3.49 (ddd, <i>J</i> = 14.4, 11.7, 6.6			
		Hz, 1H)			
	3.26 (dd, <i>J</i> = 14.4, 7.6 Hz, 1H)	3.24 (dd, <i>J</i> = 14.4 Hz, 7.6 Hz,			
		1H)			
	3.12 – 3.03 (m, 2H)	3.12 – 3.00 (m, 2H)			
	2.92 – 2.68 (m, 2H)	2.86 (q, J = 7.7 Hz, 1H),			
		2.77 – 2.68 (m, 1H)			
	2.68 – 2.43 (m, 4H)	2.62 – 2.50 (m, 3H),			
		2.46 (dd, <i>J</i> = 18.3, 4.2 Hz, 1H)			
	2.33 – 2.24 (m, 2H)	2.31 (ddd, <i>J</i> = 12.5, 5.6, 2.0			
		Hz, 1H)			
		2.24 – 2.15 (m, 1H)			

¹³C NMR Data

Natural	Simpkins Synthetic (+)-1	Reisman Synthetic (–)-1		
	(101 MHz)	(126 MHz)		
No ¹³ C NMR reported with isolation.	199.3	δ 199.5		
	168.5	169.2*		
	148.4	148.3		
	146.9	146.8		
	125.4	125.7		
	124.4	124.8*		

⁹ Isolation of natural (+)-3-demethoxyerythratidinone: D. H. R. Barton, A. A. L. Gunatilaka, R.M. Letcher, A. M. F. T. Lobo and D. A. Widdowson, *J. Chem. Soc., Perk. Trans. 1*, 1973, 874-880. ¹⁰ F. Zhang, N. S. Simpkins and C. Wilson, *Tetrahedron Lett.*, 2007, **48**, 5942-5947.

¹¹ As noted by Simpkins et. al, relatively limited spectroscopic data is available for the natural product despite a number of completed total syntheses. See reference 9.

¹² ¹H NMR resonances were converted from the reported units of τ to chemical shift δ by the conversion formula τ = $10 - \delta$ (ppm). As the authors do not list a standard for reference, the converted chemical shifts remain unreferenced.

^{*} Although these chemical shifts exhibit small discrepancies with those reported by Simpkins et. al, they remain in close agreement with other reported data, see: J. M. Joo. R. A. David, Y. Yuan, C. Lee, Org. Lett., 2010, 12, 5704-5705.

Supplementary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011

123.9	123.4
112.8	112.8
110.2	110.3
63.7	63.5
56.0	56.0
55.9	55.9
45.7	45.7
40.1	40.1
35.9	36.1
32.8	32.8
28.6	28.7
21.5	21.4

Infrared Data (C=O Stretch)

Natural	Simpkins Synthetic (+)-1	Simpkins Synthetic (+)-1
1667 cm^{-1}	1666 cm^{-1}	1667 cm^{-1}

Optical Rotation		
Natural	Simpkins Synthetic (+)-1	Simpkins Synthetic (+)-1
$[\alpha]^{22}{}_{\rm D}$ +325 (<i>c</i> 0.249, CHCl ₃).	$[\alpha]^{26}_{D}$ +316 (<i>c</i> 0.4, CHCl ₃)	$[\alpha]^{25}_{D}$ –297 (<i>c</i> 0.57, CHCl ₃)

Benzoquinone Sulfinyl Imines as Versatile Intermediates in Alkaloid Synthesis: Total Synthesis of (–)-3-Demethoxyerythratidinone

Kangway V. Chuang, Raul Navarro, Sarah E. Reisman*

The Warren and Katharine Schlinger Laboratory for Chemistry and Chemical Engineering, Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, California 91125 reisman@caltech.edu

Supporting Information 2 (Spectral Data):



S28

	I				
		.		I	
		11			
FT size 65536 Total time 34 min					
DATA PROCESSING Line broadening 0.5 Hz					
WALTZ-16 modulated					
Power 39 dB continuously on					
DECOUPLE H1, 499.7445450 MHz					
1000 repetitions OBSERVE C13, 125,6602414 MHz					
Width 31446.5 Hz					
Pulse 45.0 degrees					
Relax. delay 1.000 sec					
Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro					
Data collected on: Oct 4 2010					
Solvent: cdcl3					
Pulse Sequence: CARBON (s2pul)					
FidFile: CARBON01		S2a			
Sample directory:		ÔMe	÷		
Archive directory: /home/navarro/vnmrsys/data		Me			
indy.caltech.edu-inova500					
Data Collected on:		\checkmark			
DN III 224					
Sample Name	· · · · · · · · · · · · · · · · · · ·	ОН			
This journal is (c) The Royal Society	of Chemistry 2011	ОН			



RN-III-214								
PUSAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	ience							
This journal is (c) The Poyal Society of Chemi	stry 2011							
Sample Name:	50 y 2011							
DN_TTT_214								
RN-111-214								
Data Collected on:			ОH					
indy.caltech.edu-inova500								
Archive directory:								
/home/navarro/vnmrsys/data								
Sample directory:								
RN-III-214			CI ^r Y					
FidFile: CARBON01			- Ma					
			Coh					
Pulse Sequence: CARBON (s2pul)			520					
Solvent: cdcl3								
Data collocted on: Son 23 2010								
Data corrected on. Sep 25 2010								
Temp. 25.0 C / 298.1 K								
Sample #40, Operator: navarro								
Relax, delay 1.000 sec								
Pulse 45.0 degrees								
$\lambda a = \pm i \pi a = 1 0.02 a = a = a = a = a = a = a = a = a = a$								
Neq. Cime 1.042 Sec								
Width 31446.5 Hz								
800 repetitions								
OBSERVE C13, 125.6602414 MHz								
DECOUPLE H1, 499.7445450 MHz				1				
Power 39 dB		I.						
continuously on								
WALTZ-16 modulated								
DATA PROCESSING								
Line broadening 1.0 Hz					1			
FT size 65536								
Total time 27 min								
Iotai time 27 min								
	1							
				1				
				A				
new generity a series of an analysis of a series of the series of the series of the series generity and the series of t		ومعينيكم الانتجابية كالتشمية بالبادية والتنديبية والمديده	a ni Ditang pangkan kangkan pangkan pangkan kangkan pangkan kangkan kangkan kangkan kangkan kangkan kangkan ka Kangkan kangkan k	anglering disconstanticity of Approximation	the second s	nen andre stationer ander sin einer stationer ander stationer ander stationer ander stationer and and a station	finn an har fan yn hefer fan hefer fan hefer fan hefer fan de	with the star of the start of the
200 100 100	140	120	100	00	60	40	20	
700 TQ0 TQ0	140	TZO	100	00	00	40	20	ppm



S32

FT size 65536 Total time 23 min				
DATA PROCESSING Line broadening 0.5 Hz				
Power 39 dB continuously on WALTZ-16 modulated				
700 repetitions OBSERVE C13, 125.6602394 MHz DECOUPLE H1, 499.7445450 MHz			I	
Acq. time 1.042 sec Width 31446.5 Hz				
Relax. delay 1.000 sec Pulse 45.0 degrees				
Temp. 25.0 C / 298.1 K Sample #41, Operator: navarro				
Solvent: cdcl3 Data collected on: Sep 23 2010				
Pulse Sequence: CARBON (s2pul)				
RN-III-215 FidFile: CARBON01		OMe S3b		
/home/navarro/vnmrsys/data	С			
indy.caltech.edu-inova500				
Data Collected on:		Br		
Sampie Name.				
Sample Name:		ОН		






	$1 \dots \dots \dots$						 	<u> </u>	<u> </u>
							 A		******
	I					l.			
ICCAI CIME IN MIN									
FT size 65536 Total time 10 min									
Line broadening 0.	5 Hz								
WALTZ-16 modulated DATA PROCESSING									
continuously on									
Power 39 dB	193430 MHZ								
OBSERVE C13, 125.6	602538 MHz								
300 repetitions									
Acq. time 1.042 se Width 31446.5 Hz	2								
Pulse 45.0 degrees	_								
Relax. delay 1.000	sec		1						
Sample #14, Operato	r: kangway								
Temp. 25.0 C / 298	.1 K								
Data collected on: 2	Aug 17 2010								
Pulse Sequence: CAR	BON (s2pul)								
_				6c					
FidFile: CARBON01				MeO´`O	Ме				
Sample directory: KVC5-083-flashed				\times					
/home/kangway/vn	nrsys/data								
Archive directory:					Br				
indv.caltech.edu	-inova500			U II					
KVC5-083-flashed				0					
Samisljounanteis (c) The	e Royal Socie	ety of Chemistr	y 2011						
Supplementary Mate	rial (ESI) for (Chemical Scie	nce						
KVC5-083-flashed									

RN-III-218 ஸ்சீத்த்தின் Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-218 Data Collected on: Br indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data CI Sample directory: MeO `OMe RN-III-218 FidFile: PROTON01 6d Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Oct 6 2010 Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 65536 Total time 1 min 12 sec 10 9 8 5 7 6 4 3 2 1 ppmΨ Y μ 1.16 1.00 7.23

Prespective This juncase This juncase This juncase This juncase The control of the Keyl School of Chemistry 2011 The control of the Chemistry 2011 The control of the Keyl School of the Chemistry 2011 The control of th
Protegrammetic (LS) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-218 Data Collected on: indy-cattech.edu-incova500 Archive directory: /home/havarco/numeys/data Sample directory: RN-III-218 Pulse Sequence: CARBON (#2pul) Solvent: cdcl3 Solvent: cdcl3 Solvent: cdcl3 Sample #40, Operator: navarco Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 1000 repetitions OBSERVE Cl3, 125.6602404 MHz DECOUPLE HI, 489.7445450 MHz Power 39 dB continuously on MALT2-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65356 Total time 34 min
P*Gupplementary Material (S1) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-218 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarco/rumrsys/data Sample directory: RN-III-218 FidFile: CARBON01 Pulse Sequence: CARBON (s2pul) Solvent: cdcl3 Data collected on: Oct 6 2010 Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro Relax. delay 1.000 sec
Prodeption mutary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-218 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-218 FidFile: CARBON01 Pulse Sequence: CARBON (s2pul) Solvent: cdcl3 Data collected on: Oct 6 2010
Produppmementary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-218 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-218 FidFile: CARBON01 FidFile: CARBON01 FidFile: CARBON01 FidFile: CARBON01
Produppiermentary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-218 Data Collected on: O



RN-III-226								
P ¹ S访问时mentary Material (ESI) for Chemical S	Science							
This journal is (c) The Royal Society of Chen	nistry 2011							
Sample Name:		•						
RN-111-226		Ŭ						
Jata Collected on:			Br					
Indy.caltech.edu-inova500		ĺ	Ϋ́					
Archive directory:		ļ	J					
/nome/navarro/vnmrsys/data		Me 🗡						
Sample directory:		MeO	ОМе					
RN-111-226		•						
FIGFILE: CARBONUI		66						
Pulse Sequence: CARBON (s2pul)								
Solvent: cdcl3								
Data collected on: Oct 4 2010								
Тетр. 25.0 С / 298.1 К								
Sample #41, Operator: navarro								
Relax. delay 1.000 sec								
Pulse 45.0 degrees								
Acq. time 1.042 sec								
Width 31446.5 Hz								
1000 repetitions								
OBSERVE C13, 125.6602404 MHz								
DECOUPLE H1, 499.7445450 MHz								
Power 39 dB								
continuously on								
WALTZ-16 modulated								
DATA PROCESSING								
Line broadening 0.5 Hz								
FT size 65536								
Total time 34 min								
					ļ			
. In processing water of a set of the set of	alle statistic marited as the state state and the state			and the second design of the		a transference pour la construction de la determinación de la destruction de la destruction de la destruction d La destruction de la d		
200 180 160	140	120	100	80	60	40	20	maa
	. = =					-	-	T- T









RN-III-219 ஸ்சீத்த்தின் Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: ο RN-III-219 Data Collected on: t-Bu[✔] indy.caltech.edu-inova500 Br Archive directory: /home/navarro/vnmrsys/data Sample directory: CI RN-III-219 MeO `OMe FidFile: PROTON01 7d Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Oct 4 2010 Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 65536 Total time 1 min 12 sec 10 9 5 8 7 6 3 2 4 1 ppm6.73 -[¥ Ψ 0.94 1.00 10.37

						 NUMBER OF STREET		under son and an and a stand of the stand
Sample #40, Ope Relax. delay : Pulse 45.0 deg Acq. time 1.0 Width 31446.5 1400 repetitic OBSERVE C13, : DECOUPLE H1, & Power 39 dB continuously of WALTZ-16 modu: DATA PROCESSING Line broadenin FT size 65536 Total time 47 r	erator: navarr 1.000 sec grees 42 sec Hz ons 125.6602404 MH 499.7445450 MH on lated 3 ng 0.5 Hz min	o Iz Iz						
Pulse Sequence Solvent: cdcl3 Data collected Temp. 25.0 C ,	: CARBON (s2pu on: Oct 4 20 / 298.1 K	1) 10						
PuSupptementary This journal is (Sample Name: RN-III-219 Data Collected indy.calted Archive direct /home/navar: Sample directo RN-III-219 FidFile: CARBO	Material (ESI) f (c) The Royal So d on: h.edu-inova500 tory: ro/vnmrsys/dat pry: pN01	or Chemical So ociety of Chem a	cience istry 2011	EBU CI MeO 7d	Br Me			





ஸ்சீத்த்தின் Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-II-287 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-II-287 FidFile: RN-II-287-proton Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Mar 26 2010 Temp. 25.0 C / 298.1 K Sample #46, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec





RN-II-287 Pபகுத்தின் mentary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: Ο RN-II-287 S—NH *n*-Bu Data Collected on: t-Bu indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-II-287 8a FidFile: RN-II-287-carbon Pulse Sequence: CARBON (s2pul) Solvent: cdc13 Data collected on: Mar 26 2010 Temp. 25.0 C / 298.1 K Sample #46, Operator: navarro Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 900 repetitions OBSERVE C13, 125.6602404 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING

Line broadening 0.5 Hz

FT size 65536

200	180	160	140	120	100	80	60	40	20	ppm
										<u> </u>
aliferensis alien sin ander som	er de projektionel der Verschaften die ster der scher de gescher die	and have no statement and shared and the state of the		in de sense sinte a la companya de sense de sen	the legal to a second to be a second	n facilité d'ainst thus particul	ne konserven andere andere geste ste ste ste ste ste ste ste ste ste	ana anala da aka aka aka aka aka aka aka aka aka		na men kuna utama (http://kites.d.km. errora (natyra yika menu) Men (http://kites.d.km. error (http://kites.d.km.
		1								
Total time 30	min									

m=Sigpternewtary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-II-292-A Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-II-292-A FidFile: RN-II-292-major-1H Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Mar 30 2010

Temp. 25.0 C / 298.1 K Sample #41, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING Line broadening 0.2 Hz FT size 32768 Total time 1 min 5 sec





Pபகுத்தின் mentary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-54 -NH Ph Data Collected on: t-Bu С indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: (*R*,*R*)-8b RN-III-54 n FidFile: CARBON02 major diastereomer Pulse Sequence: CARBON (s2pul) Solvent: cdc13 Data collected on: Oct 20 2010 Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 1400 repetitions OBSERVE C13, 125.6602414 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65536 Total time 47 min

RN-III-54

an a	under hand spin an elisa of other	www.commence.com			n de his gest angen ag santangten sing dig pet mit mit die sing a bieren der finsterlige sig		and the second second second second second	Record, white topic control and weathing at the state of the	and the state of t	a ang sa ang
200	180	160	140	120	100	80	60	40	20	ppm



180	160	140	120	100	80	60	40	20	ppm
r, 45 min									
on lated G ng 0.5 Hz									
125.6602385 M 499.7445450 M	Hz Hz								
HZ ONS									
42 sec									
1.000 sec									
/ 298.1 K erator: navar	ro								
on: Jun 62	010								
: CARBON (SZP	ul)								
			minor diastere	omer					
inor ON01			Ö						
ory:			(<i>R</i> , <i>S</i>)-8b						
tory: ro/vnmrsvs/da	ta								
h.edu-inova50	0		t-Bu	_CI					
d on:				ו	1				
inor									
			0						
	hinor ed on: eh.edu-inova50 etory: ero/vnmrsys/dator ory: hinor Hinor Hilden (s2p) i on: Jun 6 2 / 298.1 K herator: navar 1.000 sec egrees H2 sec i Hz cons 125.6602385 M 499.7445450 M on Hated HG ng 0.5 Hz hr, 45 min 180	hinor ad on: bh.edu-inova500 story: bro/vnmrsys/data cory: hinor scory: hinor scory: hinor scory: hinor scory: hinor scory: hinor scory: hinor 1000 (s2pul) (298.1 K berator: navarro 1.000 sec sgrees 125.6602385 MHz 499.7445450 MHz on hlated 16 ng 0.5 Hz hr, 45 min 180 160	hinor hed on: h.edu-inova500 ttory: pro/vnmrsys/data ory: inor NON01 :: CARBON (s2pul) d on: Jun 6 2010 / 298.1 K berator: navarro 1.000 sec tgrees 42 sec Hz ons 125.6602385 MHz 499.7445450 MHz on hlated IG ing 0.5 Hz hr, 45 min 180 160 140	hinor d on: h. adu-inova500 story: iro/vnmrsys/data ory: inor WON01 I on: Jun 6 2010 / 298.1 K werator: navarro 1.000 sec igrees 125.6602385 MHz 499.7445450 MHz on llated IG ing 0.5 Hz ir, 45 min 180 160 140 120	hinor sh can: the du-inova500 ttory: tro/vnmrsys/data ory: inor tr CARBON (s2pul) t on: Jun 6 2010 / 298.1 K ercator: navarro 1.000 sec tgrees 42 sec Hz ons 125.6602385 MHz 499.7445450 MHz on lated 16 160 140 120 100	hinor di on: th.edu-inova500 trory: inor ory: inor inor inor inor diastereomer : CARBON (s2pul) i on: Jun 6 2010 / 298.1 K minor diastereomer 1.000 sec grees 42 sec i Iz ons 125.6602385 MHz 49.744450 MHz on lated G G m 0.5 Hz tr, 45 min 180 160 140 120 100 80	hinor d on: h.edu-inova500 tory: tory: tory: tory: (R,S)-8b	11007 d o: h.edu-invox500 troy:	inor d on: h.edu-inor200 tory: rol/marge/data ory: inor MND 1 on: Jun 6 2010 / 298.1 K erator: navarro 1.000 sec grees 42 sec hz 125.602255 MHz 499.7465400 MHz on lated of ng 0.5 Hz r, 45 min 180 160 140 120 100 80 60 40 20



200	180	160	140	120	100	80	60	40	20	ppm
n bilgen strike her jober det jober op strike her strike		ganila, das matiens à directo atra de services ganilares de services de se		n and a start while with date to a local		and the second	alara ang sa	adalah kanan k	anne an the second second	er man eine seinen auf ansten alle besterne aus berfragen die seiter bester Neuer eine seiter auf auf ein der eine seiter beiter bester bester aus
	I									
			1							
Total time 1 h	nr, 8 min									
Line broadeni FT size 65536	ing 0.5 Hz									
DATA PROCESSIN										
WALTZ-16 modu	ulated									
Power 39 dB	on									
DECOUPLE H1,	499.7445450 M	Hz								
2000 repetiti OBSERVE C13.	lons 125.6602394 M	Hz								
Width 31446.5	5 Hz									
Acq. time 1.0	042 sec									
Pulse 45.0 de	egrees									
Relay delay	1 000 sec									
Sample #40, Op	perator: navar	ro							I	
Tana 25 0 0	(200 1 2									
Data collected	d on: May 42	010								
Solvent: cdcl3	3 3	·····)								
	- CAPBON /-2-			0						
FidFile: RN-1	II-288-13C			8c						
RN-II-288-1	13C			\sim						
/home/navai	rro/vnmrsys/da	ta								
Archive direc	ctory:			t-Bu						
indy.calted	ch.edu-inova50	0			<i>п</i> -ви					
Data Collecte	ed on:			^л і 9—МН	n Bu	I				
RN-II-288-1	13C			0						
This journal is	(c) The Royal S	ociety of Cher	mistry 2011							
PUSupplementar	y Material (ESI)	for Chemical	Science							

Supplementary Material (ESI) for Chemical Science SPMBJeLWARE'S (c) The Royal Society of Chemistry 2011 RN-II-299-2 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-II-299-2 FidFile: RN-II-299-1H

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: May 26 2010

Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING Line broadening 0.3 Hz FT size 32768 Total time 1 min 5 sec





EtSupplementary Material (ESI) for Chemical Science puthisijed rnal is (c) The Royal Society of Chemistry 2011



PuSdifighterimentary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-II-298 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-II-298 FidFile: PROTON01 Pulse Sequence: PROTON (s2pul)

Solvent: cdcl3 Data collected on: Mar 26 2010

Temp. 25.0 C / 298.1 K Sample #46, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec







PuSdifipHetmentary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-229b Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-229b FidFile: PROTON01 Pulse Sequence: PROTON (s2pul)

Solvent: cdcl3 Data collected on: Oct 6 2010

Temp. 25.0 C / 298.1 K Sample #42, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING Line broadening 0.2 Hz FT size 65536 Total time 1 min 12 sec





RN-III-229 ஸ்சீத்த்தின் Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-229b 0 Data Collected on: -NH Me S indy.caltech.edu-inova500 t-Bu Br Archive directory: /home/navarro/vnmrsys/data Sample directory: CI RN-III-229b FidFile: CARBON01 Ο 8f Pulse Sequence: CARBON (s2pul) Solvent: cdcl3 Data collected on: Oct 6 2010 Temp. 25.0 C / 298.1 K Sample #42, Operator: navarro Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 2500 repetitions OBSERVE C13, 125.6602404 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65536 Total time 1 hr, 25 min 200 180 160 140 120 100 80 60 40 20 ppm

PuSdifigHetmentary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-228 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-228 FidFile: PROTON01

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Oct 6 2010

Temp. 25.0 C / 298.1 K Sample #41, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 65536 Total time 1 min 12 sec







masinplementary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-II-293-A Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-II-293-A FidFile: RN-II-293-major-1H Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Mar 30 2010 Temp. 25.0 C / 298.1 K Sample #46, Operator: navarro Relax. delay 2.000 sec Pulse 45.0 degrees

Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec





Sample Name: RN-II-293	, ,		0	_					
Data Collected on:			S-NH	Ph					
indy.caltech.edu-inova500			t-Bu	<br< th=""><th></th><th></th><th></th><th></th><th></th></br<>					
Archive directory:			ĺ	Ì					
/home/navarro/vnmrsys/data			્	J					
Sample directory:			(<i>R</i> , <i>R</i>)-8h	ſ					
RN-II-293				5					
FidFile: RN-II-293-major-13C			major diast	ereomer					
Pulse Sequence: CARBON (s2pul)	i								
Solvent: cdc13									
Data collected on: Mar 30 2010)								
Temp. 25.0 C / 298.1 K Sample #46, Operator: navarro									
					I				
Relax. delay 1.000 sec									
Aca time 1 042 sec									
Width 31446.5 Hz									
800 repetitions									
OBSERVE C13, 125.6602404 MHz									
DECOUPLE H1, 499.7445450 MHz									
Power 39 dB									
continuously on									
WALTZ-16 MODULATED									
Line broadening 0.5 Hz									
FT size 65536									
Total time 27 min									
			1						
	Ĭ								
	1	1							
a series and a series and a series of a distance of the series and a series and a series and the series and the		1		a hade a day line, as the stress was stand in the stand of			a daram taka didatan mutan ar a amat	the summer of the barn shared it - Arr street	man kan tanan kan kan kan sa
an de la constant de	a la sector de la filippe d		almining gamma and desired and the second second				and provide the first of a second	anna falsan falsan la shiran ta shiran ta falsan sa	an and a standard standard and an and a standard standard standard standards and a standard standard standard s
						1			
200 180	160	140	120	100	80	60	40	20	mara










ppm

Supplementary Material (ESI) for Chemical Science STMBLJOUNABERS (C) The Royal Society of Chemistry 2011 RN-III-68 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-68 FidFile: PROTON01 Pulse Sequence: PROTON (s2pul)

Solvent: cdcl3 Data collected on: May 15 2010

Temp. 25.0 C / 298.1 K Sample #41, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING Line broadening 0.2 Hz FT size 32768 Total time 1 min 5 sec









Supplementary Material (ESI) for Chemical Science SPHNB190LWARPIS (c) The Royal Society of Chemistry 2011 RN-III-62 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-62 FidFile: PROTON01

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: May 16 2010

Temp. 25.0 C / 298.1 K Sample #42, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING Line broadening 0.2 Hz FT size 32768 Total time 1 min 5 sec







Supplementary Material (ESI) for Chemical Science STATELIGO Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-60 FidFile: PROTON01

9

10

8

44

2.16 3.21 1.51 ΨЦ

0.89 1.07 1.00

ч ч

05

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: May 25 2010

Temp. 25.0 C / 298.1 K Sample #42, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec



5

6

4

1.08

3

2

Т

ppm

1

Ψ

10.41



Supplementary Material (ESI) for Chemical Science SPINS jeuManes (c) The Royal Society of Chemistry 2011 RN-III-75 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-75 FidFile: PROTON01

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: May 26 2010

Temp. 25.0 C / 298.1 K Sample #42, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec





200	180	160	140	120	100	80	60	40	20	ppm
an and the production of the product of the state of the		ale Maria a gray tanggin kanan tahun			unigen grant de la grant de la composition				the second s	a define any filtration of the second state of the second state
				l						
Total time 58	6 min									
FT size 65530	6 8 min									
DATA PROCESSI Line broader	ING ning 0.5 Hz									
continuously WALTZ-16 mod	y on dulated									
Power 39 dB	, 499.7443430 MA	12								
OBSERVE C13,	, 125.6602404 MH	lz								
Width 31446	.5 Hz									
Pulse 45.0 d Acq. time 1	degrees .042 sec									
Relax. delay	y 1.000 sec									
Sample #42, 0	Operator: navarr	0								
Temp. 25.0 (с / 298.1 к									
Data collecte	ed on: May 26 20	010								
Solvent: cdcl	13	11)		0						
	an CARRON (almu	-1 \		_{8m}						
RN-III-75 FidFile: CAN	RBON01			Į	J					
Sample direc	ctory:			t-Bu X	, → ^{Br}					
Archive dire /home/nava	ectory: arro/vnmrsvs/dat	a		S-NH	,—					
indy.calte	ech.edu-inova500)		Ő.						
Data Collect	ted on:									
Semisijouiraati	is (c) The Royal Sc	ociety of Chen	nistry 2011							
Supplements	ary Material (ESI) f	for Chemical	Science							

RN-III-20-2

Supplementary Material (ESI) for Chemical Science SPNBjeuNARPis (c) The Royal Society of Chemistry 2011 RN-III-20-2 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-20-2 FidFile: PROTON01

S-NH t-Bu (*R*,*R*)-8n

major diastereomer

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: May 19 2010

Temp. 25.0 C / 298.1 K Sample #41, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec



	New York () a free first first of the section of t			un film and for any diversities of patients	nd had a law of the first first stars the second	n generikaan yn die wythet praasgestel webe		latur territor and the state	n fan fi fi yn	the survey of a state state state.	and stand and special productions of	er assleben jeter et separte et interde	Anna an
			1 11						1				
				I									
			1										
,													
r, 8 min													
ng 0.5 Hz													
G													
on lated													
199./119190 MH	-												
125.6602394 MH	Z 7												
ons													
42 sec Hz													
grees													
1.000 sec													
erator: navarr	0												
/ 298.1 К													
	-												
on: May 19 20	10												
: CARBON (s2pu	1)		n	najor diast	tereomer								
JAO L			,	· (ö								
ON0.1			(<i>R,R</i>)-8n			1						
ory:				l	J								
ro/vnmrsys/dat	a		i	-Bu	^S Br								
h.edu-inova500				S-NH									
d on:				<u> </u>	. //								
c) The Royal So	ciety of Chemis	Stry 2011		•									
Material (ESI) fo	or Chemical Sci	ience											
	Material (ESI) fc c) The Royal So i on: 1.edu-inova500 cory: co/vnmrsys/dat. yry: yN01 c CARBON (s2pu on: May 19 20 / 298.1 K erator: navarre L000 sec grees 12 sec Hz yns 125.6602394 MH 199.7445450 MH on Lated g 0.5 Hz c, 8 min	Material (ESI) for Chemical Sc c) The Royal Society of Chemis i on: edu-inova500 :ory: :o/vnmrsys/data >ry: NN01 : CARBON (s2pul) on: May 19 2010 / 298.1 K #rator: navarro 1.000 sec grees 12 sec Hz Dns 125.6602394 MHz 199.7445450 MHz Son Lated 3 ng 0.5 Hz c, 8 min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 i on: edu-inova500 :ory: :o/vnmrsys/data >ry: NNO1 : CARBON (s2pul) on: May 19 2010 / 298.1 K Prator: navarro L.000 sec yrees 12 sec Hz ns L25.6602394 MHz 199.7445450 MHz on Lated 5 ng 0.5 Hz r, 8 min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 i on: edu-inova500 :ory: :o/vnmrsys/data >ry: >N01 ((: CARBON (s2pul) // on: May 19 2010 / 298.1 K #rator: navarro 1.000 sec yrees 12 sec Hz ons 125.6602394 MHz 199.7445450 MHz ig 0.5 Hz r, 8 min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 i on: .edu-inova500 :ory: :o/vnmrsys/data >ry: N01 : CARBON (s2pul) on: May 19 2010 / 298.1 K >rator: navarro 1.000 sec press 12 sec Hz >ns 125.6602394 MHz 199.7445450 MHz >n lated 5 ng 0.5 Hz c, 8 min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 i on: edu-inova500 .ory: :://mmrsys/data >ry: NN01 :: CARBON (s2pul) on: May 19 2010 ' 298.1 K srator: navarro 1.000 sec prees 122 sec Hz 2015 :: Cfo02394 MHz 199.7445450 MHz 199.7445450 MHz :: A min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 i on: i.edu-inova500 iory: iorymarsys/data iry: N01 : CARBON (s2pul) on: May 19 2010 ' 298.1 K arator: navarro 1.000 sec press 12 sec Hz Sm Lated 3 19 0.5 Hz r, 8 min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 i on: edu-inova500 :ory: :ory: :not :ory: :not :core: :not :core: :not :core: :not :core: :major diastereomer :	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 1 on: 1. edu-inova500 iory: io/vnmrsys/data iry: NOI 2 CARBON (s2pul) on: May 19 2010 7 298.1 K srator: navarco 1.000 sec press 12 sec Hz ns 125.6602394 MHz 199.7445450 MHz ig 0.5 Hz z, 8 min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 1 on: 1 adu-inova500 iory: ior/manegys/data yry: imol c CARBON (s2pul) on: May 19 2010 / 298.1 K krator: navarro 1.000 sec press 12 sec Hz ms 125.6602394 MHz 199.7445450 MHz ign 0.5 Hz c, 8 min	Material (ESI) for Chemistry 2011 I on: . edu-throws500 .orgy: . for missrys/data . y . edu-throws500 . orgy: . major diastereomer on: May 19 2010 . 298.1 K stator: navarroo L.000 sec press 12 sec Hz ma 12 sec Hz ma 12 5. 6002394 MHz 139.7 Hz . 8 min	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 I on: i.edu-innova500 iory; isy of vanuerge/data Xry: MOI c CARGON (a2pul) c C CARGON (a2pul) c C CARGON (a2pul) c C C CARGON (a2pul) c C C C C C C C C C C C C C C C C C C C	Material (ESI) for Chemical Science c) The Royal Society of Chemistry 2011 t on: t edu-incovs100 $\frac{1}{1000}$: casBoon (a2pul) on: May 19 2010 / 298.1 K trator: navarroo 1:000 sec press

RN-III-20-1

Supplementary Material (ESI) for Chemical Science SPMBljeLWARPHS (c) The Royal Society of Chemistry 2011 RN-III-20-1 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-20-1 FidFile: PROTON01

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: May 19 2010

Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec

0 -NH t-Bu Br (R,S)-8n Ο

minor diastereomer





PuSififiementary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-221 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-221 FidFile: PROTON01

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Sep 22 2010

Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420507 MHz DATA PROCESSING FT size 65536 Total time 1 min 12 sec





RN-III-221 PS: Sample Name: RN-III-221 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-221 FidFile: CARBON01	emical Science of Chemistry 2011	S-NH t-Bu 80	Br			
Pulse Sequence: CARBON (s2pul) Solvent: cdcl3 Data collected on: Sep 22 2010			5			
Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro					1	
Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 1400 repetitions OBSERVE C13, 125.6602404 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65536 Total time 47 min		1				

na fall de la classe que para de la canton de la calle de la migre de la c			han an a						ulayar dalama Angerta aya ana angerta ang	n gan dia kata manang Malakang mananang mananang mananang mananang mananang mananang mananang mananang mananang
200	180	160	140	120	100	80	60	40	20	ppm

Supplementary Material (ESI) for Chemical Science SPHNB190LWARPHS (c) The Royal Society of Chemistry 2011 RN-III-72 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-72 FidFile: PROTON01

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: May 26 2010

Temp. 25.0 C / 298.1 K Sample #41, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.048 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 32768 Total time 1 min 5 sec





Pபகுத்தின் mentary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-86 SiMe₃ Data Collected on: 0 indy.caltech.edu-inova500 -NH Archive directory: /home/navarro/vnmrsys/data t-Bu Br Sample directory: RN-III-86 FidFile: CARBON01 8p n Pulse Sequence: CARBON (s2pul) Solvent: cdcl3 Data collected on: Oct 17 2010 Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 1500 repetitions OBSERVE C13, 125.6602414 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65536 Total time 51 min 200 180 160 140 120 100 80 60 40 20 ppm



S88

PuSafetementary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-174 0≃s^{,,,,t-Bu} Data Collected on: indy.caltech.edu-inova500 Archive directory: NH /home/kangway/vnmrsys/data Br Sample directory: RN-III-174 FidFile: CARBON01 MeO OMe Pulse Sequence: CARBON (s2pul) 0 Solvent: cdcl3 8q Data collected on: Oct 6 2010 Temp. 25.0 C / 298.1 K Sample #40, Operator: kangway Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 1000 repetitions OBSERVE C13, 125.6602414 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65536 Total time 34 min <u>.</u> 200 180 160 140 120 100 80 60 40 20 ppm

Supplementary Material (ESI) for Chemical Science SHNB19LNABPIS (c) The Royal Society of Chemistry 2011 KVC5-251 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/kangway/vnmrsys/data Sample directory: KVC5-251 FidFile: PROTON03

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Sep 30 2010

Temp. 25.0 C / 298.1 K Sample #13, Operator: kangway

Relax. delay 5.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 32 repetitions OBSERVE H1, 499.7420463 MHz DATA PROCESSING Line broadening 0.2 Hz FT size 65536 Total time 4 min 0 sec







ADL-I-135

Supplementary Material (ESI) for Chemical Science SPINEljeLNARPENS (c) The Royal Society of Chemistry 2011 ADL-I-135 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/kangway/vnmrsys/data Sample directory: ADL-I-135 FidFile: PROTON01

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Oct 2 2010

Temp. 25.0 C / 298.1 K Sample #37, Operator: kangway

Relax. delay 5.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 32 repetitions OBSERVE H1, 499.7420502 MHz DATA PROCESSING Line broadening 0.2 Hz FT size 65536 Total time 4 min 0 sec





200	180	160	140	120	100	80	60	40	20	ppm
			1 1 1 1 1 1 1 1		1 1 1 1 1 1 1 1 1 1		1 1 1 1 1 1 1 1			
		ll	l			l		l	l	
						1				
						li I				
	I									
			I							
Total time 34	min						l.			
FT size 65536										
Line broadeni	ing 0.5 Hz									
DATA PROCESSIN	1G									
WALTZ-16 modu	lated									
Power 39 dB	on									
DECOUPLE H1,	499.7445450 M	Hz								
OBSERVE C13,	125.6602586 M	Hz								
1000 repetiti	Lons									
Acq. time 1.0 Width 31446 5	J4∠ SEC									
Pulse 45.0 de	egrees									
Relax. delay	1.000 sec									
· · · · · · · · · · · · · · · · · · ·		-								
Sample #37, Or	/ 290.1 K perator: kangwa	ay								
	/ 200 1 2									
Data COTTected	1 OIL 2 Z	010								
Solvent: cdcl3	3	010								
Pulse Sequence	e: CARBON (s2p	ul)								
				0						
FidFile: CARE	BON01			S4						
ADL-I-135	1.			س ا	ッ					
/nome/kangw Sample direct	ay/vnmrsys/da .orv:	La		ĺ						
Archive direc	ctory:	* ~		t-Bu 🗡	\checkmark					
indy.calted	ch.edu-inova50	0		S-NH						
Data Collecte	ed on:			0, '	(
ADL-I-135	(-)			-	//					
SamislieuMameis	(c) The Roval S	ociety of Chemistry	2011							
Supplementar	Matorial (ESI)	for Chomical Scion	<u></u>							
ADTT-135										



Supplementary Material (ESI) for Chemical Science SPMBJeLWARPIS (c) The Royal Society of Chemistry 2011 KVC5-217 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/kangway/vnmrsys/data Sample directory: KVC5-217 FidFile: PROTON03

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Oct 2 2010

Temp. 25.0 C / 298.1 K Sample #38, Operator: kangway

Relax. delay 10.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 32 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING Line broadening 0.2 Hz FT size 65536 Total time 6 min 40 sec







PuSififiementary Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-235 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-235 FidFile: PROTON01

9

10

8

1.05 -{**7**

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Oct 13 2010

Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro

Relax. delay 2.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 16 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 65536 Total time 1 min 12 sec



5

3

4

÷

1.07

2

3.23 -[

1

 ${\bf r}_{\rm r}$

9.81

ppm

8.80

6

ΥΨ

0.92 1.00

ஸ்சீத்த்தின் Material (ESI) for Chemical Science This journal is (c) The Royal Society of Chemistry 2011 Sample Name: RN-III-235 Data Collected on: Ś−NH Me _TMS indy.caltech.edu-inova500 t-Bu Archive directory: /home/navarro/vnmrsys/data Sample directory: RN-III-235 11 FidFile: CARBON01 n Pulse Sequence: CARBON (s2pul) Solvent: cdc13 Data collected on: Oct 13 2010 Temp. 25.0 C / 298.1 K Sample #40, Operator: navarro Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 1500 repetitions OBSERVE C13, 125.6602404 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65536 Total time 51 min

200	180	160	140	120	100	80	60	40	20	ppm

Supplementary Material (ESI) for Chemical Science SPMSJeLNARFIS (c) The Royal Society of Chemistry 2011 KVC5-261 Data Collected on: indy.caltech.edu-inova500 Archive directory: /home/kangway/vnmrsys/data Sample directory: KVC5-261 FidFile: PROTON01

9

10

8

Pulse Sequence: PROTON (s2pul) Solvent: cdcl3 Data collected on: Oct 1 2010

Temp. 25.0 C / 298.1 K Sample #34, Operator: kangway

Relax. delay 5.000 sec Pulse 45.0 degrees Acq. time 2.500 sec Width 8000.0 Hz 32 repetitions OBSERVE H1, 499.7420505 MHz DATA PROCESSING FT size 65536 Total time 4 min 0 sec

ő″ -NH Me S t-Bu 12

6

Ψ

0.97

щ

0.99 0.98 <mark>火</mark> 5

0.99 1.01

1.04 ± **7**

al la

, **3** 누 누

0.98 1.00

Ψ

0.97

4

2

Т

ppm

1

ų

Ψ

3.01 9.33

Supplementary ^{STIMIS 1} jeutinateis (y Material (ESI) for (c) The Royal Soc	r Chemical Scien ciety of Chemistry	ice / 2011							
KVC5-261	don		c)						
indv.caltec	h.edu-inova500		-						1	
Archive direct	tory:				~ /.					
/home/kangwa	_ ay/vnmrsys/data	ı	τ-Βι	' <u>~</u>	$\sim $					
Sample direct	ory:									
KVC5-261				\sim						
FidFile: CARB	ON01			12 0						
Pulse Sequence	: CARBON (s2pul	.)								
Solvent: cdcl3										
Data collected	on: Oct 1 201	.0								
Temp. 25.0 C	/ 298.1 К									
Sample #34, Op	erator: kangway	7								
Relax. delay	1.000 sec									
Pulse 45.0 de	grees									
Acq. time 1.0	42 sec									
512 repetition	HZ									
OBSERVE C13	125.6602433 MHz									
DECOUPLE H1,	499.7445450 MHz									
Power 39 dB						í.				
continuously of	on									
WALTZ-16 modu	lated									
DATA PROCESSIN	IG									
Line broadenin	ng 0.5 Hz									
FT size 65536										
Total time 17 i	min									
si anala, ka mili a Marinan di Milanda ana ili ing ka sa sa si ka sa	ntere al dese bereche lieden sont der det an die der der				na ka kana kana kakana dan si di kana kana ka kana ka dan sana ya ka ka Na manga di pana mangana ka kana ya manga kana ya manga ya kana ya ka				and and a second se	n ble å skyltere og som allere i slæge som er se som årere allere at det skyltere som er som er som er som er s Som af er ansar er er som er skyltere at skyltere at som er er som er
200	180	160	140	120	100	80	60	40	20	ppm



200	180	160	140	12	20	100	80	60	4	10	20	ppm
					1	1				1		
المتعاد المتعارية والمتعارية والمتعارية والمتعارية والمتعارية والمتعارية والمتعارية والمتعارية والمتعارية والم	مىر 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 19				100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100	and an other second		A COLUMN TO A C	a and an an an and a second	- Mar	a na	ي يوني مي المراجع و يعني الجاري و الله من المراجع المراجع المراجع المراجع المراجع المراجع المراجع ال
n al a star de la company d	ubal inco, foreit file and firms of your all and an an also be							H <mark>urden Alder and Alman Landscore and Alman Landscore and Alman Landscore and Alman Landscore and Alman Landscore</mark>	l	. June	anayada yafayi dawana ana bahayani dipahayi yang	tenfedere deskriver ander mennen der til efter ander statisticker ander
								l I				
			1									
Total time 17	min											
FT size 65536												
Line broaden:	ing 0.5 Hz											
DATA PROCESSI	NG											
WALTZ-16 modu	ulated											
Power 39 dB	07											
DECOUPLE H1,	499.7445450 MHz	:										
OBSERVE C13,	125.6602481 MHz	:										
512 repetitio	ons											
Width 31446.	5 Hz											
Acq. time 1.0	042 sec											
Pulse 45.0 de	egrees											
Relax delaw	1.000 sec											
Sampie #38, Op	perator: kangway	,										
Temp. 25.0 C	/ 298.1 K											
Data COLLECTED	a on: Oct 6 201	.0										
Solvent: cdcl		0										
Pulse Sequence	e: CARBON (s2pul	.)										
									I.			
FidFile: CAR	BON01											
KVC5-279						1						
Sample direct	tory:											
/home/kangu	way/vnmrsys/data	L										
Archive dire	ctory:			30								
indy.calted	ch.edu-inova500			SE 1								
Data Collecte	ed on:		MeO	\checkmark								
KVC5-279		sety of Chemis	suy 2011									
Supplementar	y Material (ESI) for	r Unemical Sc		$\sim \sim$								
KVC5-279												









Supplementary Material (ESI) for Chemical Science Sphisljeulinatis (c) The Royal Society of Chemistry 2011 KVC5-223 Data Collected on: MeO. O indy.caltech.edu-inova500 Archive directory: [™]t-Bu MeO /home/kangway/vnmrsys/data Br Sample directory: KVC5-223 FidFile: CARBON01 14 0 Pulse Sequence: CARBON (s2pul) Solvent: cdcl3 Data collected on: Sep 21 2010 Temp. 25.0 C / 298.1 K Sample #34, Operator: kangway Relax. delay 1.000 sec Pulse 45.0 degrees Acq. time 1.042 sec Width 31446.5 Hz 1000 repetitions OBSERVE C13, 125.6602442 MHz DECOUPLE H1, 499.7445450 MHz Power 39 dB continuously on WALTZ-16 modulated DATA PROCESSING Line broadening 0.5 Hz FT size 65536 Total time 34 min 200 180 160 140 120 100 80 60 40 20 ppm






S107









0 M H M O





RN-III-236

