Asymmetric Synthesis of α -Amino 1,3-DithioKetals from Sulfinimines (*N*-Sulfinyl Imines). Synthesis of ((2*S*,3*R*)-(-)-3-Hydroxy-3-methylproline

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Experimental

General Procedures. Column chromatography was performed on silica gel, Merck grade 60 (230-400 mesh). TLC plates were visualized with UV, in an iodine chamber, or with phosphomolybdic acid, unless otherwise noted. ^1H NMR and ^{13}C NMR spectra were recorded at 500 and 125 MHz, respectively. Unless stated otherwise, all reagents were purchased from commercial sources and used without additional purification. (*S*)-(+)- and (*R*)-(-)-*N*-(benzylidene)-*p*-toluenesulfinamide (**3a**),¹ (*S*)-(+)-*N*-(isobutylidene)-*p*-toluenesulfinamide (**3b**),¹ and 2-(2-hydroxyethyl)-1,3-dithiane (**8**)² were prepared as previously described.

(*S,S*)-(+)-*N*-(*p*-Toluenesulfinyl)-2-phenylamino methyl-2-methyl-1,3-dithiane (4a**).** In a 25-mL, oven-dried, two-necked, round-bottomed flask equipped with a magnetic stirring bar, a rubber septum, and an argon filled balloon was placed 2-methyl-1,3-dithiane (0.24 mL, 1.99 mmol, Aldrich) in THF (7 mL). The solution was cooled to -20°C and *n*-BuLi (0.74 mL, 1.86 mmol, 2.5 M in hexane) was added slowly. After 1.5 h, the resulting solution was cooled to -78°C and added *via* cannula to a -78°C solution of (+)-**3a** (0.32 g, 1.33 mmol) in THF (8 mL). The reaction was stirred for 20 min and quenched at -78°C by addition of sat. NH_4Cl solution (3 mL). To the reaction mixture was added EtOAc (25 mL), the aqueous phase was washed with EtOAc (2 x 10 mL), and the combined organic phases were washed with brine (10 mL), dried (Na_2SO_4), and concentrated. Flash chromatography (EtOAc/hexane, 2:8) afforded 0.38 g (76%) of a white solid, mp 130-131 °C; $[\alpha]_D^{20} +81.8$ (*c* 0.73, CHCl_3); IR (KBr) 3210, 2921, 1450, 1088 cm^{-1} ; ^1H NMR (CDCl_3) δ 7.32 (d, *J* = 8.0 Hz, 2 H), 7.08-6.98 (m, 5 H), 6.92 (d, *J* = 8.0 Hz, 2 H), 5.40 (d, *J* = 3.5 Hz, 1 H), 4.84 (d, *J* = 3.5 Hz, 1 H), 3.13-3.01 (m, 2 H), 2.79-2.64 (m, 2 H), 2.23 (s, 3 H), 2.09 (m, 2H), 1.43 (s, 3 H); ^{13}C NMR (CDCl_3) δ 140.5, 139.6, 137.4, 129.5, 128.5, 126.8, 126.7, 125.3, 56.7, 52.7, 26.6, 25.4, 24.8, 24.1, 21.0. Anal. Calcd for $\text{C}_{19}\text{H}_{23}\text{NOS}_3$: C, 60.48; H, 6.10; N, 3.71. Found: C, 60.92; H, 5.80; N, 3.71.

(*S,S*)-(+)-*N*-(*p*-Toluenesulfinyl)-2-(1-amino-2-methylpropyl)-2-methyl-1,3-dithiane (4b**).** Flash chromatography (EtOAc/hexane (3:7) gave 0.156 g (84%) of a white solid, mp 83-85 °C; $[\alpha]_D^{20} +42.1$ (*c* 1.0, CHCl_3); IR (KBr) 3145, 2937, 1423, 1373 cm^{-1} ; ^1H NMR (CDCl_3) δ 7.86 (d, *J* = 8.0 Hz, 2 H), 7.29 (d, *J* = 8.0 Hz, 2 H), 4.05 (d, *J* = 9.5 Hz, 1 H), 3.68 (d, *J* = 9.5 Hz, 1 H), 3.00-2.78 (m, 4 H), 2.66 (m, 1 H), 2.40 (s, 3 H), 2.02-1.96 (m, 2 H), 1.56 (s, 3 H), 1.19 (d, *J* = 7.0 Hz, 3 H), 0.89 (d, *J* = 7.0 Hz, 3 H); ^{13}C NMR (CDCl_3) δ 143.5, 141.3, 129.4, 126.1, 66.3, 55.9, 27.4, 26.4, 26.3, 24.7, 24.0, 23.1, 21.3, 18.1; HRMS calcd for $\text{C}_{16}\text{H}_{25}\text{NOS}_3\text{Na}$ (*M* + *Na*) 366.0996. Found 366.0989.

(*S*)-(+)- α -(2-Methyl-1,3-dithian-2-yl)-benzylamine (5a**).** Dess-Martin periodinane (0.225 g, 0.53 mmol) was added in one portion to a 25-mL, oven-dried,

single-necked, round-bottomed flask equipped with a magnetic stirring bar that contained (+)-**4a** (0.1 g, 0.26 mmol) in CH₃CN/CH₂Cl₂/H₂O (8:1:1; 10 mL). After stirring the reaction mixture at rt for 2 h, the solution was quenched by addition of sat. NaHCO₃ solution (10 mL). The phases were separated, the aqueous phase was extracted with EtOAc (2 x 10 mL), and the combined organic phases were washed with brine (10 mL), dried (Na₂SO₄), and concentrated. Flash chromatography (EtOAc/hexane, 60:40) afforded 0.048 g (76%) of a colorless oil; $[\alpha]_D^{20}$ 7.6 (*c*, 1.0, CHCl₃); IR (neat) 3372, 3261, 2907, 1436, 1074 cm⁻¹; ¹H NMR (CDCl₃) δ 7.27-7.40 (m, 2 H), 7.19-7.25 (m, 3 H), 4.36 (s, 1 H), 2.91-2.94 (m, 2 H), 2.73-2.76 (m, 2 H), 1.89-1.94 (m, 4 H), 1.48 (s, 3 H); ¹³C NMR (CDCl₃) δ 140.3, 129.2, 128.1, 127.9, 61.6, 54.9, 27.1, 26.4, 25.1, 23.9. HRMS calcd for C₁₂H₁₇NS₂ (M+1) 240.0880. Found 240.0878. A chiral shift reagent experiment using Eu(hfc)₃ determined that (+)-**5a** was > 97% ee.

(S)-(+)-2-Methyl-1-(2-methyl-1,3-dithian-2-yl)propan-1-amine (5b). Flash chromatography (EtOAc/hexane, 65:35) afforded 0.042 g (71%) of a colorless oil; $[\alpha]_D^{20}$ 11.5 (*c*, 1.0, CHCl₃); IR (neat) 3385, 2959, 2917, 909, 731 cm⁻¹; ¹H NMR (CDCl₃) δ 3.07 (d, *J* = 1.5 Hz, 1 H), 2.98-2.80 (m, 4 H), 2.45-2.52 (m, 1 H), 2.05-1.96 (m, 2 H), 1.62 (s, 3 H), 1.31 (m, 2H), 1.14 (d, *J* = 6.6 Hz, 3 H), 0.99 (d, *J* = 6.6 Hz, 3 H); ¹³C NMR (CDCl₃) δ 60.3, 56.4, 29.7, 27.7, 26.4, 24.3, 23.4, 16.9. HRMS calcd for C₉H₁₉NS₂ (M+1) 206.1037. Found 206.1038.

(S_S,S)-(-)-N-(*p*-Toluenesulfinyl)-3-amino-3-phenyl-2-propanone (6a). In a 25-mL, oven-dried, one-necked, round-bottomed flask equipped with a magnetic stirring bar, was placed (+)-**4a** (0.1 g, 0.26 mmol) in 15 mL of acetonitrile/H₂O (9:1). The solution was cooled to -20 °C (CCl₄/CO₂) and bis(trifluoroacetoxy)iodobenzene (0.2 g, 0.47 mmol) was added in one portion. After 20 min, the reaction mixture was quenched by addition of sat. NaHCO₃ aqueous solution (2 mL), followed by addition of 1,3-dithiane (0.06 g, 0.47 mmol). The solution was diluted with EtOAc (5 mL), the aqueous phase was extracted with EtOAc (2 x 5 mL), and the combined organic phases were washed with brine (10 mL), dried (Na₂SO₄), and concentrated. Flash chromatography (EtOAc/hexane, 30:70) afforded 0.05 g (72%) of a white solid, mp 114-115 °C; $[\alpha]_D^{20}$ -274.0 (*c*, 1.2, CHCl₃); IR (KBr) 3235, 1715, 1095 cm⁻¹; ¹H NMR (CDCl₃) δ 7.31 (d, *J* = 8.5 Hz, 2 H), 7.16-7.06 (m, 3 H), 6.99 (d, *J* = 8.5 Hz, 2 H), 6.77 (d, *J* = 7.5 Hz, 2 H), 6.06 (d, *J* = 5.0 Hz, 1 H), 4.95 (d, *J* = 4.5 Hz, 1 H), 2.28 (s, 3 H), 1.99 (s, 3 H). ¹³C NMR (CDCl₃) δ 203.8, 141.0, 139.8, 137.3, 128.9, 128.6, 127.9, 127.6, 126.2, 60.4, 26.7, 21.2; HRMS calcd for C₁₆H₁₈NO₂SNa (M + H) 288.1058. Found 288.1056.

(S_S,S)-(-)-N-(*p*-Toluenesulfinyl)-3-amino-3-isopropyl-2-propanone (6b). Flash chromatography (EtOAc/hexane, 40:70) gave 0.44 g (60%) of a solid, mp 93-94 °C; $[\alpha]_D^{20}$ -90.2 (*c* 0.45, CHCl₃); IR (KBr) 3224, 2944, 1708, 1475, 1332 cm⁻¹; ¹H NMR (CDCl₃) δ 7.78 (d, *J* = 7.8 Hz, 2 H), 7.24 (d, *J* = 8.0 Hz, 2 H), 4.84 (d, *J* = 8.0 Hz, 1 H), 3.56 (d, *J* = 8.8 Hz, 1 H), 2.29-2.27 (m, 1 H), 2.30 (s, 3 H), 2.18 (s, 3 H), 1.10 (d, *J* = 7.0 Hz, 3 H), 0.94 (d, *J* = 7.0 Hz, 3 H); ¹³C NMR (CDCl₃) δ 208.4, 141.3, 135.4, 128.3, 121.3, 74.1, 25.9, 23.3, 22.4, 20.3, 19.8. Anal. Calcd for C₁₃H₁₉NO₂S: C, 61.63; H, 7.56; N, 5.53. Found: C, 61.60; H, 7.51; N, 5.55.

(S)-(+)-N-(*p*-Toluenesulfonyl)-3-amino-3-phenyl-2-propanone (7). In a 25-mL, oven-dried, one-necked, round-bottomed flask equipped with a magnetic stirring bar, was placed (-)-**6a** (0.02 g, 0.08 mmol) in DCM (8 mL). The solution was cooled to 0 °C and *m*-CPBA (0.04 g, 0.17 mmol, 60%) was added in one portion. After 40 min, the

mixture was quenched by addition of sat. Na₂S₂O₃ aqueous solution (2 mL), and diluted with CHCl₃ (5 mL). The organic phase was washed with sat. Na₂S₂O₃ aqueous solution (2 x 5 mL), sat. NaHCO₃ aqueous solution (5 mL), brine (5 mL), and dried (Na₂SO₄). Concentration under vacuum gave 0.02 g (89%) of a white solid, mp 136-137 °C [lit³ mp 139-140 °C]; [α]_D²⁰ +287.6 (*c*, 0.8, CHCl₃), [lit³ [α]_D²⁰ +258.4 (*c*, 1.0, CHCl₃)]; IR (KBr) 3271, 1712, 1345 cm⁻¹; ¹H NMR (CDCl₃) δ 7.46 (d, *J* = 8.5 Hz, 2 H), 7.25-7.19 (m, 3 H), 7.14-7.06 (m, 4 H), 6.09 (d, *J* = 8.5 Hz, 1 H), 5.02 (d, *J* = 5.0 Hz, 1 H), 2.33 (s, 3 H), 1.98 (s, 3 H); ¹³C NMR (CDCl₃) δ 201.8, 143.1, 137.2, 135.0, 129.3, 129.0, 128.6, 128.0, 126.9, 60.4, 26.7, 21.2. Anal. Calcd for C₁₆H₁₇NO₃S: C, 63.37; H, 5.61; N, 4.62. Found: C, 63.03; H, 5.83; N, 4.31. The % ee of (+)-**7** was determined to be >98% by an NMR chiral shift reagent experiment using Eu(hfc)₃.

(*R*,*R*)-(-)-*N*-(*p*-Toluenesulfinyl)-2-phenyl-3,3-(propylenedisulfanyl)

pyrrolidine (9). In a 25-mL, oven-dried, two-necked, round-bottomed flask equipped with a magnetic stirring bar, a rubber septum, and an argon filled balloon was placed (0.15 g, 0.93 mmol) of 2-(2-hydroxyethyl)-1,3-dithiane² in THF (5 mL). The solution was cooled to -20°C (CCl₄/CO₂) and *n*-BuLi (1.17 mL, 1.87 mmol, 1.6 M in hexane) was added slowly. After 1.5 h, the reaction mixture was cooled to -78°C and added via cannula to a -78 °C solution of (*R*)-(-)-**(3)** (0.15 g, 0.62 mmol) in THF (6 mL). The solution was stirred for 2 h at -78°C and 0.26 g (1.37 mmol) of tosyl chloride in THF (5 mL) was added. After 1 h at -78°C, the reaction mixture was slowly warmed to rt, cooled to 0°C, and after 30 min quenched by addition of sat. NH₄Cl aqueous solution (3 mL). The solution was diluted with EtOAc (5 mL); the aqueous phase was extracted with EtOAc (2 x 10 mL), and the combined organic phases were washed with brine (10 mL), dried (Na₂SO₄), and concentrated. Flash chromatography (EtOAc/hexane, 50:50) afforded 0.17 g (70%) of a white solid, mp 120 °C (dec.); [α]_D²⁰ -39.42 (*c*, 0.69, CHCl₃); IR (KBr) 2801, 2355, 1453, 1087 cm⁻¹; ¹H NMR (CDCl₃) δ 7.33 (d, *J* = 8.0 Hz, 2 H), 7.16-7.04 (m, 5 H), 6.95 (d, *J* = 8.0 Hz, 2 H), 4.73 (s, 1 H), 3.89-3.84 (m, 1 H), 3.66-3.60 (m, 1 H), 3.00-2.94 (m, 1 H), 2.82-2.69 (m, 2 H), 2.66-2.56 (m, 2H), 2.53-2.47 (m, 1 H), 2.22 (s, 3 H), 2.02-1.94 (m, 1 H), 1.86-1.77 (m, 1 H); ¹³C NMR (CDCl₃) δ 140.8, 139.1, 138.2, 128.8, 128.3, 127.5, 127.2, 125.5, 69.9, 58.8, 47.4, 39.1, 28.3, 28.1, 24.9, 21.1; Anal. Calcd for C₂₀H₂₃NOS₃: C, 61.70; H, 5.91; N, 3.60. Found: C, 61.61; H, 6.04; N, 3.43.

(*R*)-(+)-*N*-(*p*-Toluenesulfonyl)-2-phenyl-3,3-(propylenedisulfanyl)pyrrolidine

(10). In a 25-mL, oven-dried, single-necked, round-bottomed flask equipped with a magnetic stirring bar, rubber septum, and argon balloon was placed (-)-**9** (0.12 g, 0.308 mmol) in CH₂Cl₂:H₂O (1:1, 5 mL). To the vigorously stirred solution was added TFA (1.18 mL, 15.4 mmol). After stirring for 2 h, the reaction mixture was diluted with H₂O (5 mL) and the pH was adjusted to 9 using aq NH₄OH. The reaction mixture was extracted with DCM (2 x 10 mL), and the combined organic phases were dried (Na₂SO₄), and concentrated. The crude residue was dissolved in DMC (5 mL), triethyl amine (0.086 mL, 0.616 mmol), and cat. DMAP was added. The solution was cooled to 0°C, and after 5 min tosyl chloride (0.088 g, 0.462 mmol) was added. After stirring the reaction mixture for 6 h at 0°C, H₂O (10 mL), and DCM (10 mL) were added. The aqueous phase was extracted with DCM (2 x 10 mL), and the combined organic phases were washed with brine (10 mL), dried (Na₂SO₄), and concentrated. Flash chromatography (EtOAc/hexane, 55:45) afforded 0.118 g (95%) of a white solid, mp 172-173 °C; [α]_D²⁰

+85.31 (*c*, 0.1, CHCl₃); IR (KBr) 2921, 2235, 1484, 1107 cm⁻¹; ¹H NMR (CDCl₃) δ 7.68 (d, *J* = 7.5 Hz, 2 H), 7.31-7.28 (m, 5 H), 7.22 (d, *J* = 7.5 Hz, 2 H), 4.70 (s, 1 H), 3.84-3.81 (m, 1 H), 3.61-3.58 (m, 1 H), 2.82-2.78 (m, 1 H), 2.65-2.55 (m, 4 H), 2.50-2.46 (m, 1 H), 2.11 (s, 3 H), 1.98-1.94 (m, 1 H), 1.86-1.78 (m, 1 H); ¹³C NMR (CDCl₃) δ 143.9, 138.7, 134.6, 129.8, 128.7, 128.3, 128.2, 128.1, 73.5, 58.8, 47.5, 37.5, 28.5, 28.4, 25.2, 22.0; Anal. Calcd for C₂₀H₂₃NO₂S₃: C, 59.22; H, 5.72; N, 3.45. Found: C, 59.19; H, 5.68; N, 3.43.

(*R*)-(-)-2-Phenyl-1-(toluene-4-sulfonyl)-pyrrolidin-3-one (11). In a 25-mL, oven-dried, single-necked, round-bottomed flask equipped with a magnetic stirring bar, was placed (+)-**10** (0.15 g, 0.37 mmol) in 9:1 acetonitrile:H₂O (15 mL). The solution was cooled to -20 °C (CCl₄/CO₂) and 0.318 g (0.74 mmol) of bis(trifluoroacetoxy)iodobenzene was added in one portion. After 2 h, the reaction mixture was quenched by addition of sat. NaHCO₃ aqueous solution (2 mL), followed by 1,3-dithiane (0.089 g, 0.74 mmol). The solution was diluted with EtOAc (5 mL); the aqueous phase was extracted with EtOAc (2 x 5 mL); and the combined organic phases were washed with brine (10 mL), dried (Na₂SO₄), and concentrated. Flash chromatography (EtOAc/hexane, 50:50) afforded 0.091 g (78%) of a white crystalline solid; mp 131-132 °C; [α]_D²⁰ -201.2 (*c*, 1.0, CHCl₃); IR (KBr) 3018, 1725, 1195, 1087 cm⁻¹; ¹H NMR (CDCl₃) δ 7.53 (d, *J* = 8.0 Hz, 2 H), 7.25-7.18 (m, 7 H), 4.49 (s, 1 H), 3.87-3.83 (m, 1 H), 3.66-3.61 (m, 1 H), 2.51-2.49 (m, 1 H), 2.48-2.39 (m, 1 H), 2.34 (s, 3 H); ¹³C NMR (CDCl₃) δ 208.6, 144.7, 138.7, 135.8, 130.3, 129.8, 129.1, 128.7, 128.3, 67.6, 47.4, 37.5, 22.0; Anal. Calcd for C₁₇H₁₇NO₃S: C, 67.74; H, 5.43; N, 4.44. Found: C, 67.68; H, 5.39; N, 4.38.

(2*R*,3*R*)-(-)-3-Methyl-2-phenyl-1-(toluene-4-sulfonyl)-pyrrolidin-3-ol (12). In a 25-mL, single-necked, round-bottomed flask equipped with a magnetic stirring bar, rubber septum, and argon balloon was placed (-)-**11** (0.13 g, 0.412 mmol) in 1:1 THF:Et₂O (25 mL). The solution was cooled to -78°C, and after 10 min MeMgBr (0.206 mL, 0.62 mmol, 3.0 M in Et₂O) was added dropwise via syringe. The reaction mixture was stirred at this temperature for 2 h and quenched by addition of sat. NH₄Cl (5 mL). At this time the solution was warmed to rt, extracted with EtOAc (2 x 10 mL), and the combined organic phases were dried (MgSO₄) and concentrated. Flash chromatography (EtOAc/hexane, 60:40) afforded 0.116 g (85%) of a white solid; mp 102-103 °C; [α]_D²⁰ -38.3 (*c*, 1.0, CHCl₃); IR (KBr) 3398, 2967, 1171 cm⁻¹; ¹H NMR (CDCl₃) δ 7.56 (d, *J* = 8.2 Hz, 2 H), 7.26-7.18 (m, 7 H), 4.28 (s, 1 H), 3.69-3.64 (m, 1 H), 3.58-3.55 (m, 1 H), 2.35 (s, 3 H), 1.87-1.82 (m, 1 H), 1.58-1.48 (m, 1 H), 1.05 (s, 3H), 1.02 (s, 1 H); ¹³C NMR (CDCl₃) δ 143.8, 137.0, 135.3, 129.9, 128.9, 128.6, 128.3, 127.9, 78.8, 72.4, 47.6, 38.5, 25.9, 21.9; Anal. Calcd for C₁₈H₂₁NO₃S: C, 65.23; H, 6.39; N, 4.23. Found: C, 65.19; H, 6.36; N, 4.18.

(2*S*,3*R*)-(-)-3-Hydroxy-3-methyl-1-(toluene-4-sulfonyl)-pyrrolidine-2-carboxylic acid methyl ester (13). In a 25-mL, single-necked, round-bottomed flask equipped with a magnetic stir bar was placed (-)-**12** (0.11g, 0.332 mmol), CCl₄ (2 mL), MeCN (2 mL), and H₂O (3 mL). NaIO₄ (1.06 g, 4.98 mmol) and RuCl₃·H₂O (0.0034 g, 0.016 mmol) were added and solution was stirred vigorously for 8 h.⁴ At this time the solution was filtered through Celite, and the Celite was washed with DCM (2 x 15 mL). The combined organic phases were dried (Na₂SO₄) and concentrated. To the crude residue was added methanol (5 mL), benzene (5 mL), and TMSCHN₂ (0.332 mL, 0.664

mmol, 3.0 M in hexane) at rt. The mixture was stirred for 1 h at this temperature and concentrated. Chromatography (EtOAc/hexane, 80:20) gave 0.079 (76%) of a white solid; mp 110-111 °C; $[\alpha]_D^{20}$ -24.3 (*c*, 1.0, CHCl₃); IR (KBr) 3432, 2947, 1742, 1387, 1164 cm⁻¹; ¹H NMR (CDCl₃) δ 7.69 (d, *J* = 8.0 Hz, 2 H), 7.25 (d, *J* = 8.0 Hz, 2 H), 3.98 (s, 1 H), 3.69 (s, 3 H), 3.52-3.48 (m, 1 H), 3.34-3.30 (m, 1 H), 2.36 (s, 3 H), 2.27 (s, 1 H), 2.02-1.98 (m, 1 H), 1.68-1.56 (m, 1 H), 1.18 (s, 3 H); ¹³C NMR (CDCl₃) δ 170.8, 144.2, 135.3, 130.1, 127.9, 79.2, 69.5, 52.9, 46.7, 39.3, 26.7, 22.0. Anal. Calcd for C₁₄H₁₉NO₅S: C, 53.66; H, 6.11; N, 4.47. Found: C, 53.58; H, 6.09; N, 4.47.

(2*S*,3*R*)-(-)-3-Hydroxy-3-methylproline (14) In a 25-mL, one-necked, round-bottom flask, equipped with a magnetic stir bar was placed ester **13** (0.075 g, 0.239 mmol) in THF (4 mL) and H₂O (2 mL). To the solution was added LiOH·H₂O (0.019 g, 0.479 mmol) and the solution was stirred for 6 h at rt. At this time the pH of the reaction mixture was adjusted to pH 3 by addition of 1 N HCl (10 mL); the solution was extracted with EtOAc (2 x 15 mL); and the combined organic phases were concentrated in vacuo to give the crude acid as a white solid. In a separate 50-mL, two-necked, round-bottomed flask equipped with a magnetic stirring bar, rubber septum, and dry-ice condenser cooled to -78 °C was passed NH₃ (g) until approximately 25 mL of liq. NH₃ was collected. The crude acid prepared above was dissolved in THF (10 mL) and added to the liq. NH₃ solution, and the enough Na was added until a permanent deep blue color persisted. After stirring for 30 min at -78 °C, the reaction mixture was quenched with solid NH₄Cl (2-3 g). The NH₃ was removed by passing argon gas over the solution and the THF was evaporated in vacuo. The residue was dissolved in H₂O (5 mL), and the pH was adjusted to 7 by addition of ice cold 2 N HCl. At this time the aqueous solution was loaded on an acidic ion-exchange resin (Dowex 50 x 2, 100-200 mesh), and the column was eluted with water (100 mL) followed by 5% NH₄OH solution (100 mL). The ammonia solution was concentrated to gave 0.025 g (72%) of a solid, mp 199-200 °C (dec), [lit⁵ mp 198-201 °C (dec)]; $[\alpha]_D^{20}$ -41.4 (*c*, 0.9, H₂O), [lit⁵ $[\alpha]_D^{20}$ -41.0 (*c*, 0.4, H₂O)]; IR (film) 3371, 2969, 1637, 1411, 1262 cm⁻¹; ¹H NMR (D₂O) δ 3.84 (s, 1H), 3.52 (m, 1H), 3.41 (m, 1H), 2.10-2.17 (m, 2H), 1.60 (m, 3H); ¹³C NMR (D₂O) δ 171.3, 73.2, 70.1, 43.5, 39.9, 24.3; (EI, *m/z*): 145 (M⁺). Spectral properties of (-)-**14** prepared in this manner were consistent with literature values.⁵

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