Supplementary Material

Methylsulfenylation of Thioacetals as a Method for Synthesizing 2-Thio Substituted Furans

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Supporting Information Available: Text giving experimental procedures and characterization data for the compounds. This material is available free of charge via the internet at http://pubs.acs.org.

Experimental Section

Melting points are uncorrected. Mass spectra were determined at an ionizing voltage of 70eV. Unless otherwise noted, all reactions were performed in flame dried glass-ware under an atmosphere of dry argon. Solutions were evaporated under reduced pressure with a rotary evaporator and the residue was chromatographed on a silica gel column using an ethyl acetate/hexane mixture as the eluent unless specified otherwise. All solids were recrystallized from ethyl acetate/hexane for analytical data.

3-Hydroxy-4,4-bis(methylsulfanyl)-1-phenylbutan-1-one (6). To a cooled solution of 1.3 mL (9.1 mmol) of diisopropylamine at -40 °C in 18 mL of THF was added 4 mL of a 2.5 M n-butyllithium solution (10 mmol) in hexane. The reaction mixture was stirred at this temperature for 40 min and then cooled to -78 °C. To this solution was added 1.0 mL (8.3 mmol) of acetophenone. The reaction mixture was stirred at -78 °C for 40 min and 1.0 g (7.5 mmol) of 2,2-bis(methylsulfanyl)acetal-dehyde in 8 mL of THF was added. The mixture was stirred for 1 h at -78 °C and quenched with a saturated solution of NH_4Cl. The organic layer was separated and the aqueous layer was extracted with EtOAc. The combined organic phases were dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to give 1.6 g (84%) of **6** as a colorless oil: IR (neat) 3467, 1674, 1211, and 1040 cm^{-1}; ^1H-NMR (400 MHz, $CDCl_3$) δ 2.14 (s, 3H), 2.18 (s, 3H), 3.32 (dd, 1H, J = 17.4 and 8.0 Hz), 3.47 (d, 1H, J = 3.2 Hz), 3.48 (dd, 1H, J = 17.4 and 3.6 Hz), 3.80 (d, 1H, J = 6.0 Hz), 4.44 (m, 1H), 7.42 (dd, 2H, J = 8.2 and 5.4 Hz), 7.53 (t, 2H, J = 8.2 Hz), and 7.93 (d, 2H, J = 5.4 Hz); ^{13}C-NMR (100 MHz, $CDCl_3$) δ 13.6, 14.4, 42.3, 60.5, 69.2, 128.0, 128.4, 133.3, 136.5, and 199.1; HRMS Calcd. for $C_{12}H_{16}O_2S_2$: 256.0592. Found: 256.0587.

4,4-bis(Methylsulfanyl)-1-phenylbut-3-en-1-one (8). To a solution of 0.9 g (3.6 mmol) of alcohol **6** in 18 mL of toluene at 0 °C was added 0.8 mL (5.4 mmol) of Et_3N and 0.3 mL (4.0 mmol) of mesyl chloride. The reaction mixture was stirred at 0

°C for 1 h and 2.5 mL (9.0 mmol) of additional Et_3N was added. The mixture was warmed to rt for 30 min and then heated at reflux for 6 h. The solution was cooled to rt, poured into ether, and washed with a saturated solution of $NaHCO_3$. The organic layer was dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure, and the crude oil was purified by silica gel chromatography to give 0.65 g (76%) of **8** as a colorless oil: IR (neat) 1681, 1595, 1332, and 1204 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 300 MHz) δ 2.33 (s, 3H), 2.34 (s, 3H), 4.10 (d, 2H, J = 6.6 Hz), 6.13 (t, 1H, J = 6.6 Hz), 7.48 (dd, 2H, J = 8.2 and 7.6 Hz), 7.58 (t, 1H, J = 7.6 Hz), and 8.00 (d, 2H, J = 8.2 Hz); ^{13}C-NMR ($CDCl_3$, 75 MHz) δ 16.8, 17.0, 40.2, 124.2, 128.1, 128.5, 133.1, 136.0, 136.3, and 196.9; Anal. Calcd. for $C_{12}H_{14}OS_2$: C, 60.49; H, 5.93. Found: C, 60.32; H, 5.81.

2-Methylsulfanyl-5-phenyl-furan (12). To a 0.26 g (1.1 mmol) sample of **8** in 10 mL of toluene was added a catalytic amount of camphorsulfonic acid and the mixture was heated at reflux for 6 h, cooled to rt and the solvent was removed under reduced pressure. The residue was purified by silica gel chromatography to give 0.15 g (72%) of **12** as a colorless oil: IR (neat) 1496, 1474, 1019, and 756 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 300 MHz) δ 2.50 (s, 3H), 6.54 (d, 1H, J = 3.4 Hz), 6.65 (d, 1H, J = 3.4 Hz), 7.29 (m, 1H), 7.41 (m, 2H), and 7.71 (m, 2H); ^{13}C-NMR ($CDCl_3$, 75 MHz) δ 19.2, 106.5, 116.4, 123.6, 127.5, 128.6, 130.3, 146.7, and 155.9; Anal. Calcd. for $C_{11}H_{10}OS$: C, 69.46; H, 5.30. Found: C, 69.24; H, 5.20.

5-Hydroxy-4-methyl-6,6-bis(methylsulfanyl)hexan-3-one (7). To a solution of 1.8 mL (12.8 mmol) of diisopropylamine in 26 mL of THF at -40 °C was added 5.6 mL of a 2.5 M n-butyllithium (14.0 mmol) solution in hexane. The reaction mixture was stirred at this temperature for 40 min and then cooled to -78 °C. To this solution was added 1.2 mL (11.6 mmol) of 3-pentanone. The solution was stirred at -78 °C for 40 min and to this solution was added 1.4 g (10.4 mmol) of 2,2-bis(methylsulfanyl)-acetaldehyde dissolved in 11 mL of THF. The mixture was stirred for 1 h at -78 °C

and quenched with a saturated solution of NH_4Cl. The organic layer was separated and the aqueous layer was extracted with EtOAc. The combined organic phases were dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to give 1.9 g (81%) of alcohol **7** as an inseparable 1:1-mixture of diastereomers which were used directly in the next step.

4-Methyl-6,6-bis(methylsulfanyl)hex-5-en-3-one (9). To a solution of 0.79 g (3.5 mmol) of the above alcohol in 18 mL of toluene was added 0.7 mL (5.3 mmol) of Et_3N followed by 0.3 mL (4.0 mmol) of mesyl chloride. The reaction mixture was stirred at 0 °C for 1 h and to this solution was added 2.5 mL (9.0 mmol) of additional Et_3N. The solution was warmed to rt for 30 min and was then heated at reflux for 6 h. The mixture was cooled to rt, poured into ether, and washed with a saturated solution of $NaHCO_3$. The organic layer was dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel chromato-graphy to give 0.5 g (70%) of **9** as a colorless oil: IR (neat) 2968, 1709, 1446, and 848 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 300 MHz) δ 0.98 (t, 3H, J = 7.1 Hz), 1.19 (d, 3H, J = 7.0 Hz), 2.20 (s, 3H), 2.28 (s, 3H), 2.33-2.60 (m, 2H), 3.39 (q, 1H, J = 7.0 Hz), and 6.16 (s, 1H); ^{13}C-NMR ($CDCl_3$, 75 MHz) δ 7.96, 15.7, 15.9, 17.1, 33.6, 53.1, 129.5, 133.4, and 210.1; Anal. Calcd. for $C_9H_{16}OS_2$: C, 52.92; H, 7.90. Found: C, 52.76; H, 7.83.

2-Ethyl-3-methyl-5-methylsulfanylfuran (13). To a 0.64 g (3.2 mmol) sample of **9** in 30 mL of toluene was added a catalytic amount of camphorsulfonic acid and the reaction mixture was heated at reflux for 36 h. After cooling to rt, the solvent was removed under reduced pressure and the residue was purified by silica gel chromato-graphy to give 0.4 g (83 %) of **13** as a colorless oil: IR (neat) 2919, 1432, 1190, and 1069 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 300 MHz) δ 1.20 (t, 3H, J = 7.6 Hz), 1.93 (s, 3H), 2.36 (s, 3H), 2.58 (q, 2H, J = 7.6 Hz), and 6.23 (s, 1H); ^{13}C-NMR ($CDCl_3$, 75

MHz) δ 9.55, 12.8, 19.3, 19.6, 114.8, 118.0, 143.0, and 155.1; Anal. Calcd. for $C_8H_{12}OS$: C, 61.51; H, 7.75. Found: C, 61.64; H, 7.62.

3-(1-Hydroxy-2,2-bis(methylsulfanyl)ethyl)tetrahydropyran-2-one (14). To a 1.5 mL (11.0 mmol) solution of diisopropylamine in 22 mL of THF at -40 °C was added 4.8 mL of a 2.5 M n-butyllithium (12.0 mmol) solution in hexane. The reaction mixture was stirred at this temperature for 40 min and then cooled to -78 °C. To this solution was added 1.0 g (10 mmol) of δ-valerolactone. The solution was stirred at -78 °C for 40 min and 1.2 g (9.0 mmol) of 2,2-bis(methylsulfanyl)acetaldehyde in 9 mL of THF was added. The reaction mixture was stirred for 1 h at -78 °C and quenched with a saturated solution of NH_4Cl. The organic layer was separated and the aqueous layer was extracted with EtOAc. The combined organic phases were dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to give 1.5 g (71%) of **14** as a colorless oil: IR (neat) 1718, 1390, and 1084 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.77 (m, 1H), 1.90 (m, 2H), 2.02 (m, 1H), 2.11 (s, 3H), 2.14 (s, 3H), 3.10 (ddd, 1H, J = 12.4, 8.0 and 4.8 Hz), 3.70 (d, 1H, J = 3.2 Hz), 3.83 (m, 1H), 4.02 (d, 1H, J = 7.2 Hz), and 4.31 (m, 2H); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 12.2, 13.9, 21.9, 22.3, 42.8, 58.0, 68.6, 74.3, and 173.0; HRMS Calcd. for $C_9H_{14}O_2S_2$ $[M-H_2O]^+$: 218.0435. Found: 218.0435.

3-(2,2-bis(Methylsulfanylvinyl)tetrahydropyran-2-one (15). To a 0.7 g (2.9 mmol) solution of alcohol **14** in 14 mL of toluene at 0 °C was added 0.6 mL (4.3 mmol) of Et_3N followed by 0.25 mL (3.3 mmol) of mesyl chloride. The reaction mixture was stirred at 0 °C for 1 h and to this solution was added 1.0 mL (7.2 mmol) of additional Et_3N. The mixture was warmed to rt for 30 min and then heated at reflux for 6 h. The reaction mixture was cooled to rt, poured into ether, and washed with a saturated solution of $NaHCO_3$. The organic layer was dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by

silica gel chromatography to give 0.4 g (62%) of **15** as a colorless oil: IR (neat) 2925, 1725, 1628, and 1139 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.85-2.14 (m, 4H), 2.28 (s, 3H), 2.32 (s, 3H), 3.44 (dd, 1H, J = 10.4 and 7.2 Hz), 4.36 (dd, 1H, J = 7.2 and 5.2 Hz), and 6.43 (s, 1H); ^{13}C-NMR ($CDCl_3$, 100 MHz) 16.2, 16.8, 21.9, 26.0, 50.5, 69.6, 127.8, 138.7, and 170.9; HRMS Calcd for $C_9H_{14}O_2S_2$: 218.0435. Found: 218.0428.

3-(1,2-bis(Methylsulfanylethylidene)tetrahydropyran-2-one (16). To a 0.3 g (1.4 mmol) solution of **15** in 20 mL of toluene was added a catalytic amount of camphorsulfonic acid. The reaction mixture was heated at reflux for 3 h, cooled to rt, poured into ether, and washed with a saturated solution of $NaHCO_3$. The organic layer was separated and dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to give 0.25 g (80%) of **16** as a colorless oil: IR (neat) 2918, 1683, 1544, 1265, and 1111 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.93 (m, 2H), 2.11 (s, 3H), 2.48 (s, 3H), 2.52 (t, 2H, J = 7.2 Hz), 4.11 (s, 2H), and 4.18 (t, 2H, J = 5.2 Hz); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 13.9, 14.5, 22.7, 26.8, 31.3, 67.6, 119.2, 154.3, and 164.6; HRMS Calcd for $C_9H_{14}NO_2S_2$: 218.0435. Found: 218.0431.

Acetic Acid 2,2-bis(Methylsulfanyl)-1-(2-oxo-tetrahydropyran-3-yl) Ethyl Ester. To a cooled solution of 1.2 g (5.2 mmol) of **14** in 10 mL of CH_2Cl_2 at 0 °C was added 0.065 g (0.5 mmol) of DMAP, 0.5 mL (5.6 mmol) of pyridine, and 0.5 mL (5.3 mmol) of acetic anhydride. The reaction mixture was allowed to warm slowly to rt and was stirred for 4 h before pouring the mixture into a saturated solution of sodium bicarbonate. The organic phase was separated and the aqueous phase was extracted with CH_2Cl_2. The combined organic layers were washed with water, brine and dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to give 1.3 g (87 %) of the title compound as a colorless oil: IR (neat) 1748, 1437, 1229 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.71 (m, 1H), 1.92 (m, 2H), 2.05 (m, 1H), 3.27 (ddd, 1H, J = 2.8,

7.2, and 11.6 Hz), 4.28 (m, 1H), 4.36 (d, 1H, J = 9.2 Hz), 4.36 (m, 1H), 5.26 (dd, 1H, J = 9.6 and 3.2 Hz); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 13.1, 13.5, 21.2, 22.6, 23.2, 42.4, 56.4, 69.1, 73.5, 169.8, 170.5.; HRMS Calcd for $C_{11}H_{18}O_4S_2$: 278.0646. Found: 278.0645.

2-Methyl-5,6-dihydro-4H-furo[2,3-b]pyran (17). To a solution of 0.2 g (0.7 mmol) of the above compound in 1.5 mL of CH_2Cl_2 at -40 °C was added 0.16 g (0.8 mmol) of DMTSF. The reaction mixture was stirred at -40 °C for 30 min before warming to 0 °C. The solution was stirred for an additional 4 h at 0 °C and then quenched with 0.5 mL (3.5 mmol) of triethyl amine. The reaction mixture was poured into a saturated solution of sodium bicarbonate and the organic phase was separated and the aqueous phase was washed with CH_2Cl_2. The combined organic layers were washed with brine, dried over sodium sulfate and the solvent was removed under reduced pressure. The crude residue was purified by passing it through a plug of basic alumina to provide 0.1 g (80%) of **17** as a colorless oil; IR (neat) 2860, 1638, 1517, 1414, 1042, and 978 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.95 (m, 2H), 2.31 (s, 3H), 2.39 (t, 2H, J = 6.2 Hz), 4.27 (m, 2H), and 6.33 (s, 1H); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 18.9, 21.0, 23.2, 69.8, 92.1, 119.1, 135.0, and 158.3; Anal. Calcd. for $C_8H_{10}O_2S$: C, 56.46; H, 5.93. Found: C, 56.31; H, 5.87.

3-(1-Hydroxy-2,2-bis(Methylsulfanyl)ethyl-1-(toluene-4-sulfonyl)piperidin-2-one. To a 1.2 mL (8.7 mmol) solution of diisopropylamine in 40 mL of THF at -40 °C was added 3.6 mL of a 2.5 M n-butyllithium (9.1 mmol) solution in hexane. The reaction mixture was stirred at this temperature for 40 min and then cooled to -78 °C. To this solution was added a solution containing 2.0 g (7.9 mmol) of N-(p-toluensulfonyl)-δ-valerolactam in 20 mL of toluene. The solution was stirred at -78 °C for 40 min and 1.0 g (7.5 mmol) of 2,2-bis(methylsulfanyl)acetaldehyde dissolved in 8 mL of THF was added. The reaction mixture was stirred for 1 h and was quenched with a saturated solution of NH_4Cl. The organic layer was isolated and the aqueous

layer was extracted with EtOAc. The combined organic phases were dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to give 2.2 g (76%) of the title compound as a colorless oil: IR (neat) 1688, 1346, 1168, and 1083 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.65 (m, 1H), 1.76-1.90 (m, 2H), 1.91-2.10 (m, 1H), 2.00 (s, 3H), 2.08 (s, 3H), 2.43 (s, 3H), 2.96 (m, 1H), 3.42 (s, 1H), 3.76-3.92 (m, 3H), 4.10 (m, 1H), 7.29 (d, 2H, J = 7.9 Hz), and 7.86 (d, 2H, J = 7.9 Hz); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 12.2, 13.6, 21.6, 22.6, 23.4, 46.4, 46.5, 58.4, 74.0, 128.6, 128.7, 129.3, 144.7, and 171.5; HRMS Calcd for $C_{16}H_{21}NO_3S_3$ $[M-H_2O]^+$: 371.0684. Found: 371.0689.

Acetic Acid 2,2-bis(Methylsulfanyl)-1-[2-oxo-1-(toluene-4-sulfonyl)-piperidin-3-yl] Ethyl Ester (22). To a 3.9 g (9.9 mmol) solution of the above alcohol in 20 mL of CH_2Cl_2 at 0 °C was added 2.4 mL (30.0 mmol) of pyridine, 0.12 g (1.0 mmol) of DMAP, and 1.9 mL (20.0 mmol) of acetic anhydride. The reaction mixture was stirred at 0 °C for 2 h, warmed to rt for 10 min, and poured into a saturated solution of $NaHCO_3$. The organic phase was separated and the aqueous layer was extracted with CH_2Cl_2. The combined organic layers were washed with a saturated solution of NaCl and dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was crystallized to give 3.6 g (84%) of **22** as a white solid: mp 140-142 °C; IR (neat) 1745, 1681, 1346, 1225, and 1161 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.57-1.73 (m, 1H), 1.74-1.82 (m, 1H), 1.79 (s, 3H), 1.94-1.97 (m, 1H), 1.99 (s, 3H), 2.00 (s, 3H), 2.04-2.10 (m, 1H), 2.42 (s, 3H), 2.96 (ddd, 1H, J = 11.7, 6.7 and 2.5 Hz), 3.63 (dt, 1H, J = 12.1 and 3.8 Hz), 3.97 (d, 1H, J = 10.2 Hz), 4.21 (m, 1H), 5.31 (dd, 1H, J = 10.2 and 2.5 Hz), 7.28 (d, 2H, J = 8.3 Hz), and 7.87 (d, 2H, J = 8.3 Hz); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 12.0, 13.1, 20.8, 21.6, 22.8, 23.0, 46.0, 46.7, 55.5, 73.2, 128.8, 129.1, 136.1, 144.5, 168.1, and 169.7; Anal. Calcd. for $C_{18}H_{25}NO_5S_3$: C, 50.09; H, 5.84; N, 3.25. Found: C, 50.05; H, 5.89; N, 3.25.

2-Methylsulfanyl-7-(toluene-4-sulfonyl)-4,5,6,7-tetrahydrofuro[2,3b]-pyridine (24). To a solution of 0.05 g (0.12 mmol) of the above acetate in 5 mL of CH_2Cl_2 at -40 °C was added 0.03 g (0.14 mmol) of DMTSF. The reaction mixture was warmed to 0 °C for 15 min and to this solution was added 84 μL (0.6 mmol) of Et_3N. The solution was diluted with ether and washed with a saturated solution of $NaHCO_3$. The organic layer was dried over anhydrous K_2CO_3 and the solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to give 0.04 g (98%) of **24** as a colorless oil: IR (neat) 1624, 1353, and 1190 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.42 (m, 2H), 2.20 (t, 2H, J = 6.4 Hz), 2.37 (s, 3H), 2.38 (s, 3H), 3.68 (m, 2H), 6.23 (s, 1H), 7.23 (d, 2H, J = 8.4 Hz), and 7.61 (d, 2H, J = 8.4 Hz); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 19.6, 19.8, 20.6, 21.6, 47.9, 107.4, 116.5, 127.5, 129.7, 135.2, 142.4, 144.2, and 144.8; Anal. Calcd. for $C_{15}H_{17}NO_3S_2$: C, 55.72; H, 5.30; N, 4.33. Found: C, 55.63; H, 5.25; N, 4.18.

1-(2,2-Dimethyl-propanoyl)azepan-2-one. To a solution of 5.0 g (44 mmol) of ε-caprolactam and 6.8 mL (50 mmol) of triethyl amine in 50 mL of benzene at 0 °C was added 6.0 mL (50 mmol) of acetyl chloride in 50 mL of benzene. The mixture was allowed to warm slowly to rt and was stirred for 12 h. The solution was poured into 100 mL of water and the organic phase was separated. The aqueous phase was washed with EtOAc and the combined organic layers were washed with water, brine and dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the crude residue was purified by passing through a plug of silica gel to provide 8.6 g (97%) of the title compound as a clear colorless liquid: IR (neat) 1702, 1682, 1393, 1177, and 1146 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.29 (s, 9H), 1.75 (m, 6H), 2.60 (m, 2H), and 3.59 (m, 2H); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 23.7, 27.3, 28.3, 29.6, 30.1, 38.8, 44.3, 47.5, 177.8, and 190.3.

Acetic Acid 1-[1-(2,2-Dimethyl-propanoyl)-2-oxo-azepan-3-yl]-2,2-bis(methylsulfanyl) Ethyl Ester (23). To a cooled solution of 1.5 mL (10.6

mmol) of diisopropylamine at -40 °C in 20 mL of THF was added 7.2 mL of a 1.5 M solution of n-butyllithium (10.6 mmol) in hexane. The mixture was stirred at -40 °C for 30 min and cooled to -78 °C. To the reaction mixture was added 2.0 g (10 mmol) of the above azepan-2-one in 10 mL of THF. The reaction was allowed to warm to -40 °C and stirred at this temperature for 30 min before being cooled to -78 °C. To this mixture was added 1.5 g (11 mmol) of 2,2-bis(methylsulfanyl)acetaldehyde in 30 mL of THF over a 3 h period using a syringe pump. After the addition of the aldehyde was complete, the mixture was stirred at -78 °C for 30 min before being quenched by the addition of 1.4 mL (15 mmol) of acetic anhydride. The mixture was allowed to warm to rt and was stirred for 12 h, poured into a saturated sodium bicarbonate solution and extracted with EtOAc. The combined organic phases were washed with water, brine and dried over anhydrous $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by recrystallization from ether/hexane to give 2.7 g (72 %) **23** as a single diasteromer, mp 114-116 °C; IR (film) 1748, 1705, 1684, 1262, and 1219 1162 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.28 (s, 9H), 1.63 (m, 3H), 1.88 (m, 1H), 1.94 (m, 2H), 2.09 (s, 3H), 2.14 (s, 3H), 2.14 (s, 3H), 3.37 (m, 2H), 3.77 (m, 1H), 4.21 (d, 1H, J = 6.8 Hz), and 5.38 (m, 1H); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 12.9, 14.6, 21.2, 27.1, 28.1, 28.6, 44.4, 47.1, 47.2, 56.5, 73.6, 170.7, 175.7, and 191.4; Anal. Calcd. for $C_{17}H_{29}NO_4S_2$: C, 54.37; H, 7.78; N, 3.37; S, 17.07. Found: C, 54.43; H, 7.73; N, 3.83; S, 16.90.

2,2-Dimethyl-1-(2-methylsulfanyl-4,5,6,7-tetrahydrofuro[2,3-b]azepin-8-yl-propan-1-one (25). To a solution containing 1.0 g (2.7 mmol) of **23** in 10 mL of CH_2Cl_2 at -40 °C was added 0.7 g (3.4 mmol) of DMTSF. The mixture was stirred at -40 °C for 30 min before warming to 0 °C. The solution was stirred for an additional 4 h at 0 °C and quenched with 0.5 mL (3.5 mmol) of triethyl amine. The reaction mixture was poured into a saturated solution of sodium bicarbonate. The organic phase was separated and the aqueous phase was washed with CH_2Cl_2. The combined organic

layers were washed with brine, dried over sodium sulfate and the solvent was removed under reduced pressure. The crude residue was purified by silica gel chromatography to provide 0.56 g (78 %) of **25** as a white solid; mp 60-62 °C; IR (neat) 1661, 1628, and 1162 cm^{-1}; ^{1}H-NMR ($CDCl_3$, 400 MHz) δ 1.12 (s, 9H), 1.60 (m, 2H), 1.80 (m, 2H), 2.37 (m, 2H), 2.39 (s, 3H), 3.61 (brs, 2H), and 6.31 (s, 1H); ^{13}C-NMR ($CDCl_3$, 100 MHz) δ 19.8, 24.8, 25.8, 28.1, 29.9, 30.7, 40.9, 48.1, 117.9, 118.7, 141.2, and 178.3; Anal. Calcd. for $C_{14}H_{21}NO_2S$: C, 62.89; H, 7.92; N, 5.24. Found: C, 62.74; H, 7.88; N, 5.25.