Supporting Information

Reactive Ketimino Radical Acceptors: Intermolecular Alkyl Radical Addition to Imines with a Phenolic Hydroxyl Group

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General. Melting points were taken on a micromelting point apparatus and are uncorrected. ¹H and ¹³C NMR spectra were recorded in CDCl₃ at 500 MHz, and at 125 MHz, respectively. IR spectra were recorded on a Fourier-transfer infrared spectrometer. Mass spectra were obtained by EI or FAB method. Optical rotations were recorded on a polarimeter. Preparative TLC separations were carried out on precoated silica gel plates (E. Merck 60F₂₅₄).

Preparation of Aldimines 4-7. Ketimines **4-7** were prepared by the method described in literature.¹⁻⁴

General Procedure for Radical Addition to Aldimines 4-7. To a solution of aldimine **4-7** (0.5 mmol) in CH₂Cl₂ (5 mL) were added RI (15 mmol) and Et₃B (1.0 M in hexane, 1.25 mL, 1.25 mmol) under nitrogen atmosphere at 20 °C. After being stirred at the same

temperature for 5 min, the reaction mixture was diluted with saturated NaHCO₃ and then extracted with AcOEt. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by preparative TLC (hexane:AcOEt=10:1-4:1, 2-fold development) afforded **8a-11b**.

8a: A colorless crystal.⁵ mp 92-94 °C (AcOEt/hexane). IR (CHCl₃) 1707, 1497, 1457 cm⁻¹. ¹H NMR (CDCl₃) δ 7.35-7.21 (5H, m), 4.81 (1H, br s), 4.54 (1H, br s), 1.77 (2H, br m), 1.42 (9H, s), 0.89 (3H, t, *J*=7.3 Hz). ¹³C NMR (CDCl₃) δ 155.4, 142.9, 128.5, 127.1, 126.4, 79.3, 56.3, 29.8, 28.3, 10.6. MS (EI⁺): *m/z* 236 (M+H⁺, 23), 106 (100). Anal. Calcd for C₁₄H₂₁NO₂: C, 71.46; H, 8.99; N, 5.95. Found: C, 71.20; H, 9.02; N, 5.90.

9a: A colorless crystal.⁶ mp 52-54 °C (AcOEt/hexane). IR (CHCl₃) 1718, 1509, 1457 cm⁻¹. ¹H NMR (CDCl₃) δ 7.45-7.20 (5H, m), 4.95 (1H, br s), 4.57 (1H, br m), 3.63 (3H, s), 1.82 (2H, br m), 0.89 (3H, t, *J*=7.6 Hz). ¹³C NMR (CDCl₃) δ 156.5, 142.6, 128.5, 127.2, 126.4, 56.8, 51.9, 29.5, 10.5. MS (EI⁺): *m/z* 193 (M⁺, 5), 164 (100). Anal. Calcd for C₁₁H₁₅NO₂: C, 68.37; H, 7.82; N, 7.25. Found: C, 68.36; H, 7.91; N, 7.16.

10a: A colorless oil.⁷ IR (CHCl₃) 1603, 1502 cm⁻¹. ¹H NMR (CDCl₃) δ 7.35-7.30 (4H, m), 7.21 (1H, m), 7.07 (2H, br t, *J*=8.0 Hz), 6.62 (1H, t, *J*=7.3 Hz), 6.50 (2H, d, *J*=8.0 Hz), 4.22 (1H, t, *J*=6.7 Hz), 4.05 (1H, br s), 1.89-1.75 (2H, m), 0.95 (3H, t, *J*=7.6 Hz). ¹³C NMR (CDCl₃) δ 147.5, 143.9, 129.1, 128.5, 126.9, 126.5, 117.2, 113.3, 59.7, 31.6, 10.7. MS (EI⁺): *m/z* 211 (M⁺, 11), 182 (100). HRMS (EI⁺): calcd for C₁₅H₁₇N (M⁺): 211.1361, Found: 211.1363.

11a: A colorless oil.⁸ IR (CHCl₃) 1517, 1449 cm⁻¹. ¹H NMR (CDCl₃) δ 7.36-7.17 (5H, m), 6.68 (2H, m), 6.54 (1H, br t, *J*=7.6 Hz), 6.43 (1H, br d, *J*=7.6 Hz), 4.75 (2H, br s), 4.20 (1H, br t, *J*=6.4 Hz), 1.93-1.78 (2H, m), 0.96 (3H, t, *J*=7.3 Hz). ¹³C NMR (CDCl₃) δ 143.9, 143.5, 136.2, 128.5, 126.9, 126.6, 121.5, 117.5, 114.2, 113.6, 60.1, 31.4, 10.7. MS (EI⁺): *m/z* 227 (M⁺, 38), 198 (100). HRMS (EI⁺): calcd for C₁₅H₁₇NO (M⁺): 227.1310, Found: 227.1316.

11b: A colorless oil. IR (CHCl₃) 1517, 1448 cm⁻¹. ¹H NMR (CDCl₃) δ 7.32-7.17 (5H, m), 6.69-6.63 (2H, m), 6.51 (1H, br t, *J*=7.6 Hz), 6.37 (1H, br d, *J*=7.6 Hz), 4.72 (1H, br s), 4.47 (1H, br s), 4.09 (1H, br d, *J*=5.8 Hz), 2.07 (1H, m), 1.02 (3H, d, *J*=6.7 Hz), 0.93 (3H, d, *J*=7.0 Hz). ¹³C NMR (CDCl₃) δ 143.3, 142.7, 136.6, 128.1, 127.2, 126.8, 121.6, 117.0,

114.1, 113.1, 64.1, 34.8, 19.6, 18.7. MS (EI^+): m/z 241 (M^+ , 5), 198 (100). HRMS (EI^+): calcd for $\text{C}_{16}\text{H}_{19}\text{NO}$ (M^+): 241.1467, Found: 241.1462.

Preparation of Ketimines 12, 13, and 15-19. Ketimines **12**, **13**, and **15-19** were prepared by a modification of the method described in literature.⁹

12: A colorless crystal.⁹ mp 96-99 °C (AcOEt/hexane). IR (CHCl_3) 1741 cm^{-1} . ^1H NMR (CDCl_3) δ 7.70 (1H, br d, $J=8.0$ Hz), 7.46 (1H, br t, $J=8.0$ Hz), 7.35 (1H, br t, $J=8.0$ Hz), 7.27 (1H, br d, $J=8.0$ Hz), 2.57 (3H, s). ^{13}C NMR (CDCl_3) δ 155.2, 153.2, 146.6, 131.1, 130.5, 128.6, 125.4, 116.4, 21.2. MS (EI^+): m/z 161 (M^+ , 48), 133 (100). Anal. Calcd for $\text{C}_9\text{H}_7\text{NO}_2$: C, 67.07; H, 4.38; N, 8.69. Found: C, 67.19; H, 4.41; N, 8.65.

13: A colorless crystal. mp 126-128 °C (AcOEt/hexane). IR (CHCl_3) 1739 cm^{-1} . ^1H NMR (CDCl_3) δ 7.34 (1H, br t, $J=7.9$ Hz), 7.18 (1H, br d, $J=7.9$ Hz), 7.10 (1H, br d, $J=7.9$ Hz), 2.61 (3H, s), 2.58 (3H, s). ^{13}C NMR (CDCl_3) δ 153.5, 153.4, 146.9, 138.0, 130.1, 129.8, 126.6, 114.0, 21.3, 16.8. MS (EI^+): m/z 175 (M^+ , 85), 147 (100). Anal. Calcd for $\text{C}_{10}\text{H}_9\text{NO}_2$: C, 68.56; H, 5.18; N, 8.00. Found: C, 68.63; H, 5.39; N, 8.03.

15: A colorless crystal.⁹ mp 136-138 °C (AcOEt/hexane). IR (CHCl_3) 1741 cm^{-1} . ^1H NMR (CDCl_3) δ 7.35 (1H, br t, $J=8.3$ Hz), 7.17 (1H, br s), 6.88 (1H, br d, $J=8.3$ Hz), 6.79 (1H, br d, $J=8.3$ Hz), 2.56 (3H, s). ^{13}C NMR (CDCl_3) δ 153.8, 152.7, 152.5, 147.1, 131.8, 119.8, 110.5, 107.2, 21.0. MS (EI^+): m/z 177 (M^+ , 70), 107 (100). Anal. Calcd for $\text{C}_9\text{H}_7\text{NO}_3$: C, 61.02; H, 3.98; N, 7.91. Found: C, 60.94; H, 4.12; N, 7.87.

16: A colorless crystal. mp 80-82 °C (AcOEt/hexane). IR (CHCl_3) 1763 cm^{-1} . ^1H NMR (CDCl_3) δ 7.90 (1H, d, $J=7.9$ Hz), 7.65 (1H, t, $J=8.2$ Hz), 7.45 (1H, t, $J=7.9$ Hz), 7.36 (1H, d, $J=8.2$ Hz), 4.51 (2H, q, $J=7.3$ Hz), 1.45 (3H, t, $J=7.3$ Hz). ^{13}C NMR (CDCl_3) δ 161.8, 149.7, 147.2, 145.1, 133.8, 130.5, 130.2, 126.1, 116.7, 63.0, 14.0. MS (EI^+): m/z 219 (M^+ , 22), 91 (100). Anal. Calcd for $\text{C}_{11}\text{H}_9\text{NO}_4$: C, 60.27; H, 4.14; N, 6.39. Found: C, 60.25; H, 4.28; N, 6.40.

17: A colorless crystal. mp 115-117 °C (AcOEt/hexane). IR (CHCl_3) 1764, 1715 cm^{-1} . ^1H NMR (CDCl_3) δ 7.53 (1H, t, $J=8.5$ Hz), 7.38 (1H, s), 6.95 (1H, d, $J=8.5$ Hz), 6.85 (1H, d, $J=8.5$ Hz), 4.59 (2H, q, $J=7.0$ Hz), 1.44 (3H, t, $J=7.0$ Hz). ^{13}C NMR (CDCl_3) δ 161.6, 154.6, 150.1, 147.9, 141.3, 135.7, 119.6, 111.5, 107.4, 63.0, 14.0. MS (EI^+): m/z 235 (M^+ , 65), 107 (100). Anal. Calcd for $\text{C}_{11}\text{H}_9\text{NO}_5$: C, 56.17; H, 3.86; N, 5.96. Found: C, 56.04; H,

3.89; N, 5.90.

18: A colorless crystal.¹⁰ mp 80-82 °C (AcOEt/hexane). IR (CHCl₃) 1741 cm⁻¹. ¹H NMR (CDCl₃) δ 8.33 (2H, d, *J*=7.3 Hz), 7.85 (1H, d, *J*=7.6 Hz), 7.57-7.45 (4H, m), 7.39 (1H, t, *J*=7.6 Hz), 7.33 (1H, d, *J*=8.2 Hz). ¹³C NMR (CDCl₃) δ 152.3, 150.9, 146.5, 134.1, 131.7, 131.4, 131.2, 129.5, 128.4, 125.6, 116.2. One peak was missing due to overlapping. MS (EI⁺): *m/z* 223 (M⁺, 29), 195 (100). Anal. Calcd for C₁₄H₉NO₂: C, 75.33; H, 4.06; N, 6.27. Found: C, 75.38; H, 4.24; N, 6.31.

19: A colorless crystal.⁹ mp 185-187 °C (AcOEt/hexane). IR (CHCl₃) 1741 cm⁻¹. ¹H NMR (CDCl₃) δ 8.28 (2H, d, *J*=6.7 Hz), 7.57-7.45 (3H, m), 7.41 (1H, t, *J*=8.2 Hz), 7.29 (1H, s), 6.93 (1H, d, *J*=8.2 Hz), 6.84 (1H, d, *J*=8.2 Hz). ¹³C NMR (CDCl₃) δ 153.4, 152.8, 148.1, 147.0, 133.7, 132.7, 131.6, 129.4, 128.5, 120.5, 110.6, 107.1. MS (EI⁺): *m/z* 239 (M⁺, 36), 211 (100). Anal. Calcd for C₁₄H₉NO₃: C, 70.29; H, 3.79; N, 5.86. Found: C, 70.33; H, 3.68; N, 5.86.

Preparation of Ketimine 14. To a solution of ketimine **13** (500 mg, 2.83 mmol) in DMF (10 mL) were added K₂CO₃ (780 mg, 5.66 mmol) and MeI (0.53 mL, 8.49 mmol) under argon atmosphere at 20 °C. After being stirred at the same temperature for 10 h, the reaction mixture was diluted with H₂O and then extracted with Et₂O. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by chromatography (hexane:AcOEt=3:1) afforded **14** (216 mg, 40%) as a colorless crystal. mp 145-147 °C (AcOEt/hexane). IR (CHCl₃) 1741 cm⁻¹. ¹H NMR (CDCl₃) δ 7.41 (1H, br t, *J*=8.2 Hz), 6.89 (1H, br d, *J*=8.2 Hz), 6.85 (1H, br d, *J*=8.2 Hz), 4.03 (3H, s), 2.56 (3H, s). ¹³C NMR (CDCl₃) δ 155.6, 153.4, 153.3, 147.9, 131.1, 121.8, 108.6, 107.1, 56.6, 21.4. MS (EI⁺): *m/z* 191 (M⁺, 82), 134 (100). Anal. Calcd for C₁₀H₉NO₃: C, 62.82; H, 4.74; N, 7.33. Found: C, 62.98; H, 4.80; N, 7.35.

General Procedure for Radical Addition to Ketimines 12-14 in the presence of Yb(OTf)₃. To a solution of ketimine **12-14** (0.5 mmol) in THF-CH₂Cl₂ (1:2, v/v, 3 mL) were added Yb(OTf)₃ (310 mg, 0.5 mmol), RI (7.5 mmol) and Et₃B (1.0 M in hexane, 1.25 mL, 1.25 mmol) under nitrogen atmosphere at 20 °C. After being stirred at the same temperature for 5 min, Et₃B (1.0 M in hexane, 1.25 mL, 1.25 mmol) added to the reaction mixture. After being stirred at the same temperature for 5 min, Et₃B (1.0 M in hexane, 1.25

mL, 1.25 mmol) added to the reaction mixture. After being stirred for 5-50 min, the reaction mixture was diluted with saturated NaHCO₃ and then extracted with AcOEt. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by preparative TLC (hexane:AcOEt=4:1, 2-fold development) afforded **20a-24b**.

20a: A colorless crystal. mp 45-48 °C (hexane). IR (CHCl₃) 1731 cm⁻¹. ¹H NMR (CDCl₃) δ 7.05-6.90 (2H, m), 6.82 (1H, br t, *J*=7.5 Hz), 6.73 (1H, br t, *J*=7.5 Hz), 3.71 (1H, br s), 1.85 (1H, m), 1.68 (1H, m), 1.45 (3H, s), 0.97 (3H, t, *J*=7.3 Hz). ¹³C NMR (CDCl₃) δ 168.6, 141.0, 131.8, 124.9, 119.8, 116.3, 115.0, 57.8, 36.2, 23.0, 7.6. MS (EI⁺): *m/z* 191 (M⁺, 37), 134 (100). Anal. Calcd for C₁₁H₁₃NO₂: C, 69.09; H, 6.85; N, 7.32. Found: C, 68.89; H, 6.75; N, 7.16.

20b: A colorless crystal. mp 117-119 °C (AcOEt/hexane). IR (CHCl₃) 1762 cm⁻¹. ¹H NMR (CDCl₃) δ 7.00-6.85 (2H, m), 6.80 (1H, br t, *J*=7.9 Hz), 6.72 (1H, br d, *J*=7.9 Hz), 3.88 (1H, br s), 2.12 (1H, m), 1.40 (3H, s), 0.96 (3H, d, *J*=7.0 Hz), 0.92 (3H, d, *J*=7.0 Hz). ¹³C NMR (CDCl₃) δ 168.2, 141.1, 131.5, 124.9, 119.7, 116.2, 114.8, 60.4, 31.7, 19.2, 16.8, 15.8. MS (EI⁺): *m/z* 205 (M⁺, 17), 162 (100). Anal. Calcd for C₁₂H₁₅NO₂: C, 70.22; H, 7.37; N, 6.82. Found: C, 70.18; H, 7.46; N, 6.72.

20c: A colorless crystal. mp 120-123 °C (AcOEt/hexane). IR (CHCl₃) 1763 cm⁻¹. ¹H NMR (CDCl₃) δ 7.00-6.85 (2H, m), 6.80 (1H, br t, *J*=7.6 Hz), 6.69 (1H, br d, *J*=7.6 Hz), 3.83 (1H, br s), 1.83-1.60 (6H, m), 1.42 (3H, s), 1.23-1.02 (5H, m). ¹³C NMR (CDCl₃) δ 168.1, 141.0, 131.5, 124.9, 119.5, 116.2, 114.6, 60.5, 42.2, 27.0, 26.1 (3C), 25.9, 20.4. MS (EI⁺): *m/z* 245 (M⁺, 15), 162 (100). Anal. Calcd for C₁₅H₁₉NO₂: C, 73.44; H, 7.81; N, 5.71. Found: C, 73.47; H, 7.90; N, 5.72.

20d: A colorless crystal. mp 137-140 °C (AcOEt/hexane). IR (CHCl₃) 1754 cm⁻¹. ¹H NMR (CDCl₃) δ 6.95-6.85 (2H, m), 6.70 (1H, br t, *J*=7.9 Hz), 6.64 (1H, br d, *J*=7.9 Hz), 3.90 (1H, br s), 1.51 (3H, s), 1.03 (9H, s). ¹³C NMR (CDCl₃) δ 167.5, 140.4, 132.5, 125.0, 118.4, 116.0, 113.0, 63.2, 40.1, 25.5, 22.2. MS (EI⁺): *m/z* 219 (M⁺, 19), 163 (100). Anal. Calcd for C₁₃H₁₇NO₂: C, 71.21; H, 7.81; N, 6.39. Found: C, 71.15; H, 7.85; N, 6.41.

21a: A colorless crystal. mp 49-51 °C (AcOEt/hexane). IR (CHCl₃) 1762 cm⁻¹. ¹H NMR (CDCl₃) δ 6.87 (2H, br d, *J*=7.6 Hz), 6.74 (1H, br t, *J*=7.6 Hz), 3.54 (1H, br s), 2.19 (3H, s),

1.82 (1H, m), 1.66 (1H, m), 1.47 (3H, s), 0.95 (3H, t, $J=7.6$ Hz). ^{13}C NMR (CDCl_3) δ 168.7, 141.0, 129.8, 126.1, 123.2, 119.3, 114.3, 57.7, 30.0, 23.1, 16.4, 7.5. MS (EI^+): m/z 205 (M^+ , 40), 148 (100). Anal. Calcd for $\text{C}_{12}\text{H}_{15}\text{NO}_2$: C, 70.22; H, 7.37; N, 6.82. Found: C, 70.25; H, 7.35; N, 6.79.

21b: A colorless crystal. mp 83-85 °C (AcOEt/hexane). IR (CHCl_3) 1761 cm^{-1} . ^1H NMR (CDCl_3) δ 6.88-6.83 (2H, m), 6.73 (1H, br t, $J=7.9$ Hz), 3.67 (1H, br s), 2.20 (3H, s), 2.06 (1H, m), 1.43 (3H, s), 0.96 (3H, d, $J=6.7$ Hz), 0.89 (3H, d, $J=6.7$ Hz). ^{13}C NMR (CDCl_3) δ 168.2, 141.1, 129.5, 126.1, 122.8, 119.1, 114.0, 60.4, 31.4, 18.9, 16.9, 16.3, 15.7. MS (EI^+): m/z 219 (M^+ , 45), 69 (100). Anal. Calcd for $\text{C}_{13}\text{H}_{17}\text{NO}_2$: C, 71.21; H, 7.81; N, 6.39. Found: C, 71.24; H, 7.88; N, 6.32.

21d: A colorless crystal. mp 99-102 °C (AcOEt/hexane). IR (CHCl_3) 1753 cm^{-1} . ^1H NMR (CDCl_3) δ 6.82 (1H, br d, $J=7.9$ Hz), 6.78 (1H, br d, $J=7.9$ Hz), 6.63 (1H, br t, $J=7.9$ Hz), 3.64 (1H, br s), 2.19 (3H, s), 1.54 (3H, s), 1.01 (9H, s). ^{13}C NMR (CDCl_3) δ 167.5, 140.3, 130.5, 126.0, 120.9, 117.9, 113.9, 63.1, 39.9, 25.6, 22.5, 16.3. MS (EI^+): m/z 233 (M^+ , 15), 176 (100). Anal. Calcd for $\text{C}_{14}\text{H}_{19}\text{NO}_2$: C, 72.07; H, 8.21; N, 6.00. Found: C, 71.88; H, 8.26; N, 5.92.

23b: A colorless oil. IR (CHCl_3) 1758 cm^{-1} . ^1H NMR (CDCl_3) δ 6.96 (1H, br d, $J=6.7$ Hz), 6.97-6.80 (2H, m), 3.81 (1H, br s), 2.88 (1H, m), 2.08 (1H, m), 1.42 (3H, s), 1.31 (3H, d, $J=6.7$ Hz), 1.23 (3H, d, $J=6.7$ Hz), 0.96 (3H, d, $J=6.7$ Hz), 0.90 (3H, d, $J=6.7$ Hz). ^{13}C NMR (CDCl_3) δ 168.3, 141.5, 133.9, 128.2, 121.2, 119.6, 113.8, 60.1, 31.3, 27.3, 22.8, 22.3, 18.9, 16.9, 15.9. MS (EI^+): m/z 247 (M^+ , 7), 204 (100). HRMS (EI^+): calcd for $\text{C}_{15}\text{H}_{21}\text{NO}_2$ (M^+): 247.1572, Found: 247.1579.

24b: A colorless solid. IR (CHCl_3) 1760 cm^{-1} . ^1H NMR (CDCl_3) δ 6.84 (1H, s), 6.83 (1H, br d, $J=7.0$ Hz), 6.64 (1H, br d, $J=7.0$ Hz), 3.75 (1H, br s), 2.82 (1H, m), 2.11 (1H, m), 1.38 (3H, s), 1.21 (6H, d, $J=7.0$ Hz), 0.95 (3H, d, $J=7.0$ Hz), 0.92 (3H, d, $J=7.0$ Hz). ^{13}C NMR (CDCl_3) δ 168.5, 141.1, 141.0, 129.0, 122.7, 114.7, 114.0, 60.4, 33.2, 31.3, 24.0, 19.0, 16.8, 15.7. One peak was missing due to overlapping. MS (EI^+): m/z 247 (M^+ , 15), 204 (100). HRMS (EI^+): calcd for $\text{C}_{15}\text{H}_{21}\text{NO}_2$ (M^+): 247.1572, Found: 247.1568.

General Procedure for Radical Addition to Ketimine 15 in CH_2Cl_2 at 20 °C. To a solution of ketimine **15** (100 mg, 0.57 mmol) in CH_2Cl_2 (4 mL) were added Bu_3SnH (0.46

mL, 1.7 mmol), RI (17 mmol) and Et₃B (1.0 M in hexane, 1.43 mL, 1.43 mmol) under nitrogen atmosphere at 20 °C. After being stirred at the same temperature for 5 min, the reaction mixture was diluted with saturated NaHCO₃ and then extracted with AcOEt. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by preparative TLC (hexane:AcOEt=4:1, 2-fold development) afforded **25a-25d**.

25b: A colorless crystal. mp 99-101 °C (Et₂O/hexane). IR (CHCl₃) 1762 cm⁻¹. ¹H NMR (CDCl₃) δ 6.70 (1H, br t, *J*=8.0 Hz), 6.64-6.57 (2H, m), 5.63 (1H, br s), 4.01 (1H, br s), 2.08 (1H, m), 1.42 (3H, s), 0.96 (3H, d, *J*=6.7 Hz), 0.92 (3H, d, *J*=7.0 Hz). ¹³C NMR (CDCl₃) δ 168.9, 144.3, 142.6, 120.0, 119.6, 111.0, 108.7, 60.4, 31.3, 18.8, 16.9, 15.7. MS (EI⁺): *m/z* 221 (M⁺, 7), 178 (100). Anal. Calcd for C₁₂H₁₅NO₃: C, 65.14; H, 6.83; N, 6.33. Found: C, 65.12; H, 6.82; N, 6.22.

25c: A colorless crystal. mp 110-112 °C (Et₂O/hexane). IR (CHCl₃) 1761 cm⁻¹. ¹H NMR (CDCl₃) δ 6.69 (1H, br t, *J*=8.0 Hz), 6.62 (1H, br d, *J*=8.0 Hz), 6.57 (1H, br d, *J*=8.0 Hz), 5.35 (1H, s), 3.99 (1H, s), 1.65-1.67 (6H, m), 1.44 (3H, s), 1.45-1.05 (5H, m). ¹³C NMR (CDCl₃) δ 169.2, 144.0, 142.1, 120.2, 119.1, 111.1, 108.5, 60.5, 41.8, 27.1, 26.1 (2C), 26.0, 25.7, 20.1. MS (EI⁺): *m/z* 261 (M⁺, 4), 178 (100). Anal. Calcd for C₁₅H₁₉NO₃: C, 68.94; H, 7.33; N, 5.36. Found: C, 68.88; H, 7.42; N, 5.33.

25d: A colorless crystal. mp 118-119 °C (Et₂O/hexane). IR (CHCl₃) 1752 cm⁻¹. ¹H NMR (CDCl₃) δ 6.62-6.48 (3H, m), 5.06 (1H, br s), 4.01 (1H, br s), 1.53 (3H, s), 1.04 (9H, s). ¹³C NMR (CDCl₃) δ 168.2, 142.2, 141.4, 121.1, 117.8, 111.0, 108.7, 63.1, 39.9, 25.6, 22.3. MS (EI⁺): *m/z* 235 (M⁺, 5), 178 (100). Anal. Calcd for C₁₃H₁₇NO₃: C, 66.36; H, 7.28; N, 5.95. Found: C, 66.38; H, 7.14; N, 5.92.

General Procedure for Radical Addition to Ketimines 16, 18, and 19 in the presence of Zn(OTf)₂. To a solution of ketimine **16-19** (0.5 mmol) in CH₂Cl₂ (5 mL) were added Zn(OTf)₂ (182 mg, 0.5 mmol), RI (7.5 mmol), Bu₃SnH (0.40 mL, 1.5 mmol or none) and Et₃B (1.0 M in hexane, 1.25 mL, 1.25 mmol) under nitrogen atmosphere at 20 °C. After being stirred for 5-60 min, the reaction mixture was diluted with saturated NaHCO₃ and then extracted with AcOEt. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by preparative TLC (hexane:AcOEt=4:1,

2-fold development) afforded **26a-b**, **28a** and **29a-b**.

General Procedure for Radical Addition to Ketimines 17 and 19. To a solution of ketimines **17** or **19** (0.5 mmol) in CH₂Cl₂ (5 mL) were added RI (7.5 mmol), Bu₃SnH (0.40 mL, 1.5 mmol or none) and Et₃B (1.0 M in hexane, 1.25 mL, 1.25 mmol) under nitrogen atmosphere at 20 °C. After being stirred at the same temperature for 5 min, the reaction mixture was diluted with saturated NaHCO₃ and then extracted with AcOEt. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by preparative TLC (hexane:AcOEt=4:1, 2-fold development) afforded **27a-d** and **29d**.

26a: A colorless oil. IR (CHCl₃) 1777, 1738 cm⁻¹. ¹H NMR (CDCl₃) δ 7.01 (2H, m), 6.87 (2H, m), 4.42 (1H, br s), 4.13 (2H, m), 2.26 (1H, m), 2.10 (1H, m), 1.13 (3H, t, *J*=7.0 Hz), 1.12 (3H, t, *J*=7.6 Hz). ¹³C NMR (CDCl₃) δ 170.2, 163.4, 140.8, 132.1, 125.1, 121.1, 116.7, 115.7, 65.9, 62.6, 28.3, 13.9, 7.9. MS (EI⁺): *m/z* 249 (M⁺, 8), 176 (100). HRMS (EI⁺): calcd for C₁₃H₁₅NO₄ (M⁺): 249.1001, Found: 249.0992.

26b: A colorless oil. IR (CHCl₃) 1775, 1737 cm⁻¹. ¹H NMR (CDCl₃) δ 7.03-6.97 (2H, m), 6.89-6.82 (2H, m), 4.35 (1H, br s), 4.22-4.08 (2H, m), 2.68 (1H, m), 1.18 (3H, d, *J*=6.7 Hz), 1.16 (3H, t, *J*=7.1 Hz), 1.07 (3H, d, *J*=7.0 Hz). ¹³C NMR (CDCl₃) δ 169.7, 162.8, 140.2, 132.3, 125.1, 120.7, 116.6, 115.7, 69.1, 62.5, 33.7, 17.6, 16.3, 13.9. MS (EI⁺): *m/z* 263 (M⁺, 10), 190 (100). HRMS (EI⁺): calcd for C₁₄H₁₇NO₄ (M⁺): 263.1158, Found: 263.1151.

27a: A colorless crystal. mp 92-94 °C (AcOEt/hexane). IR (CHCl₃) 1773, 1739 cm⁻¹. ¹H NMR (CDCl₃) δ 6.72 (1H, br t, *J*=7.9 Hz), 6.65 (1H, br d, *J*=7.9 Hz), 6.56 (1H, br d, *J*=7.9 Hz), 5.58 (1H, br s), 4.74 (1H, br s), 4.16 (2H, m), 2.27 (1H, m), 2.14 (1H, m), 1.16 (3H, t, *J*=7.0 Hz), 1.13 (3H, t, *J*=7.3 Hz). ¹³C NMR (CDCl₃) δ 170.7, 164.0, 144.4, 141.6, 121.1, 120.3, 111.4, 108.8, 66.0, 62.8, 28.0, 13.7, 7.9. MS (EI⁺): *m/z* 265 (M⁺, 26), 192 (100). Anal. Calcd for C₁₃H₁₅NO₅: C, 58.86; H, 5.70; N, 5.28. Found: C, 58.56; H, 5.60; N, 5.26.

27b: A colorless oil. IR (CHCl₃) 1774, 1740 cm⁻¹. ¹H NMR (CDCl₃) δ 7.09 (1H, t, *J*=8.2 Hz), 6.77 (1H, d, *J*=8.2 Hz), 6.67 (1H, d, *J*=8.2 Hz), 5.90 (1H, br s), 4.69 (1H, s), 4.10 (2H, q, *J*=7.0 Hz), 3.41 (1H, m), 1.30 (3H, d, *J*=6.7 Hz), 1.10 (3H, t, *J*=7.0 Hz), 1.09 (3H, d, *J*=6.1 Hz). ¹³C NMR (CDCl₃) δ 166.1, 163.9, 151.5, 147.6, 126.9, 119.0, 112.0, 108.6, 62.7, 59.6, 54.3, 20.5, 19.0, 13.6. MS (EI⁺): *m/z* 279 (M⁺, 28), 164 (100). HRMS (EI⁺): calcd for

C₁₄H₁₇NO₅ (M⁺): 279.1107, Found: 279.1111.

27d: A colorless oil. IR (CHCl₃) 1776, 1736 cm⁻¹. ¹H NMR (CDCl₃) δ 6.68 (1H, br t, *J*=8.2 Hz), 6.60 (1H, br d, *J*=8.2 Hz), 6.53 (1H, br d, *J*=8.2 Hz), 5.69 (1H, br s), 5.00 (1H, br s), 4.14 (2H, m), 1.32 (9H, s), 1.13 (3H, t, *J*=7.3 Hz). ¹³C NMR (CDCl₃) δ 170.1, 163.1, 144.4, 141.2, 121.5, 120.1, 111.1, 108.3, 71.0, 62.4, 37.5, 25.7, 13.8. MS (EI⁺): *m/z* 293 (M⁺, 20), 191 (100). HRMS (EI⁺): calcd for C₁₅H₁₉NO₅ (M⁺): 293.1263, Found: 293.1271.

28a: A colorless crystal. mp 130-133 °C (AcOEt/hexane). IR (CHCl₃) 1760 cm⁻¹. ¹H NMR (CDCl₃) δ 7.36 (2H, d, *J*=7.6 Hz), 7.31-7.20 (3H, m), 6.99 (1H, t, *J*=7.6 Hz), 6.89 (1H, d, *J*=7.6 Hz), 6.86 (1H, d, *J*=7.6 Hz), 6.75 (1H, t, *J*=7.6 Hz), 4.41 (1H, br s), 2.41 (1H, m), 2.04 (1H, m), 1.00 (3H, t, *J*=7.3 Hz). ¹³C NMR (CDCl₃) δ 166.4, 140.8, 139.3, 132.1, 128.7, 128.0, 125.6, 125.0, 120.0, 116.5, 115.0, 64.2, 33.3, 8.1. MS (EI⁺): *m/z* 253 (M⁺, 9), 196 (100). Anal. Calcd for C₁₆H₁₅NO₂: C, 75.87; H, 5.97; N, 5.53. Found: C, 75.65; H, 6.02; N, 5.45.

29a: A colorless oil. IR (CHCl₃) 1760 cm⁻¹. ¹H NMR (CDCl₃) δ 7.30-7.19 (5H, m), 6.64 (1H, t, *J*=7.9 Hz), 6.56 (1H, d, *J*=7.9 Hz), 6.50 (1H, d, *J*=7.9 Hz), 5.22 (1H, br s), 4.51 (1H, br s), 2.40 (1H, m), 2.08 (1H, m), 1.01 (3H, t, *J*=7.3 Hz). ¹³C NMR (CDCl₃) δ 167.3, 143.9, 142.0, 138.8, 128.8, 128.1, 125.3, 120.9, 119.8, 110.9, 108.9, 64.4, 33.4, 8.1. MS (EI⁺): *m/z* 269 (M⁺, 19), 240 (100). HRMS (EI⁺): calcd for C₁₆H₁₅NO₃ (M⁺): 269.1052, Found: 269.1057.

29b: A colorless crystal. mp 158-160 °C (AcOEt/hexane). IR (CHCl₃) 1756 cm⁻¹. ¹H NMR (CDCl₃) δ 7.38-7.18 (5H, m), 6.62 (1H, br t, *J*=7.9 Hz), 6.57 (1H, br d, *J*=7.9 Hz), 6.48 (1H, br d, *J*=7.9 Hz), 5.23 (1H, br s), 4.49 (1H, br s), 2.87 (1H, m), 1.25 (3H, d, *J*=6.7 Hz), 0.71 (3H, d, *J*=7.0 Hz). ¹³C NMR (CDCl₃) δ 167.4, 143.4, 141.2, 138.4, 128.8, 128.0, 125.7, 121.1, 119.2, 110.9, 109.0, 67.4, 36.7, 18.3, 15.5. MS (EI⁺): *m/z* 283 (M⁺, 7), 240 (100). Anal. Calcd for C₁₇H₁₇NO₃: C, 72.07; H, 6.05; N, 4.94. Found: C, 72.00; H, 5.98; N, 4.93.

29d: A colorless oil. IR (CHCl₃) 1761, 1733 cm⁻¹. ¹H NMR (CDCl₃) δ 7.33-7.16 (5H, m), 6.56 (1H, br t, *J*=7.9 Hz), 6.50 (1H, br d, *J*=7.9 Hz), 6.38 (1H, br d, *J*=7.9 Hz), 5.55 (1H, br s), 4.88 (1H, br s), 1.22 (9H, s). ¹³C NMR (CDCl₃) δ 165.5, 144.0, 142.3, 134.8, 128.0, 127.8, 127.5, 121.3, 119.8, 110.4, 108.5, 69.5, 38.1, 26.0. MS (EI⁺): *m/z* 297 (M⁺, 3), 240 (100). HRMS (EI⁺): calcd for C₁₈H₁₉NO₃ (M⁺): 297.1365, Found: 297.1350.

General Procedure for Aminolysis of Cyclic Esters **30 and **35**.** To a solution of **30** or **35**¹¹ (0.36 mmol) in THF (10 mL) were added PhCH₂CH₂NH₂ (1.1 g, 9.0 mmol) and 2-pyridinol (170 mg, 1.8 mmol) under nitrogen atmosphere at 20 °C. After being stirred at the same temperature for 12 h, the reaction mixture was diluted with water and then extracted with AcOEt. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by column chromatography (hexane:AcOEt=4:1) afforded **31** or **36**.

31: A colorless oil. IR (CHCl₃) 3440, 3310, 1636 cm⁻¹. ¹H NMR (CDCl₃) δ 7.96 (2H, s), 7.31-7.20 (3H, m), 7.12 (2H, d, *J*=7.0 Hz), 6.30 (2H, s), 5.91 (1H, br m), 3.60 (2H, m), 3.32 (1H, br s), 2.83 (2H, t, *J*=6.7 Hz), 2.50 (2H, q, *J*=7.6 Hz), 1.78-1.64 (2H, m), 1.18 (3H, t, *J*=7.6 Hz), 1.09 (3H, s), 0.93 (3H, t, *J*=7.6 Hz). ¹³C NMR (CDCl₃) δ 180.5, 155.2, 144.6, 138.2, 128.8, 128.7, 126.8, 113.8, 106.0, 63.0, 41.5, 36.4, 35.2, 28.7, 21.0, 15.1, 8.2. MS (FAB⁺): *m/z* 357 (M+H⁺, 47), 208 (100). HRMS (FAB⁺): calcd for C₂₁H₂₉N₂O₃ (M+H⁺): 357.2178, Found: 357.2169. [α]_D²⁴ +14.9 (*c* 1.0, CHCl₃).

36: A colorless solid. IR (CHCl₃) 3350, 1656 cm⁻¹. ¹H NMR (CDCl₃) δ 7.34-7.13 (10H, m), 3.76 (1H, dd, *J*=8.6, 4.6 Hz), 3.57 (1H, dd, *J*=10.7, 4.6 Hz), 3.47-3.36 (2H, m), 3.28 (1H, m), 2.66 (2H, t, *J*=7.0 Hz), 2.10 (3H, br s), 1.70 (1H, m), 1.63 (1H, m), 1.07 (3H, s), 0.76 (3H, t, *J*=7.6 Hz). ¹³C NMR (CDCl₃) δ 176.5, 142.8, 139.2, 128.8, 128.6 (2C), 127.4, 127.1, 126.4, 67.7, 62.7, 59.2, 40.1, 35.4, 30.6, 23.8, 8.0. MS (FAB⁺): *m/z* 341 (M+H⁺, 94), 192 (100). HRMS (FAB⁺): calcd for C₂₁H₂₉N₂O₂ (M+H⁺): 341.2229, Found: 341.2232. Anal. Calcd for C₂₁H₂₈N₂O₂: C, 74.08; H, 8.29; N, 8.23. Found: C, 73.82; H, 8.27; N, 8.15. [α]_D²⁶ -28.7 (*c* 1.0, CHCl₃).

Methylation of **31.** To a solution of **31** (249 mg, 0.70 mmol) in DMF (15 mL) were added K₂CO₃ (496 mg, 3.4 mmol) and MeI (0.24 mL, 3.4 mmol) under nitrogen atmosphere at 20 °C. After being stirred at the same temperature for 5 h, the reaction mixture was diluted with Et₂O and then washed with water. The organic phase was dried over MgSO₄ and concentrated at reduced pressure. Purification of the residue by column chromatography (hexane:AcOEt=6:1) afforded **32** (263 mg, 98%).

32: A colorless oil. IR (CHCl₃) 3383, 1652 cm⁻¹. ¹H NMR (CDCl₃) δ 7.66 (1H, br m), 7.28-7.17 (5H, m), 6.35 (2H, s), 4.30 (1H, br s), 3.75 (6H, s), 3.58 (1H, m), 3.47 (1H, m),

2.82 (2H, m), 2.58 (2H, q, $J=7.6$ Hz), 1.81-1.69 (2H, m), 1.22 (3H, t, $J=7.6$ Hz), 1.16 (3H, s), 0.88 (3H, t, $J=7.6$ Hz). ^{13}C NMR (CDCl_3) δ 178.3, 151.3, 139.6, 137.4, 128.8, 128.4, 126.2, 121.5, 103.7, 61.9, 55.4, 40.7, 36.2, 33.5, 29.0, 21.3, 15.6, 8.1. MS (EI^+): m/z 384 (M^+ , 4), 236 (100). HRMS (EI^+): calcd for $\text{C}_{23}\text{H}_{32}\text{N}_2\text{O}_3$ (M^+): 384.2413, Found: 384.2404. $[\alpha]_D^{25} +30.1$ (c 0.9, CHCl_3).

Reaction of **32 with CAN.** To a solution of **32** (22.7 mg, 0.06 mmol) in wet MeOH (1 mL) was added a solution of cerium ammonium nitrate (132 mg, 0.24 mmol) in wet MeOH (1 mL) under nitrogen atmosphere at -45°C . After being stirred at the same temperature for 2 h, the reaction mixture was diluted with water, and then solid Na_2CO_3 was added till pH of solution became >7 . Insoluble inorganic materials were filtered and the aqueous layer was extracted with AcOEt. The organic phase was dried over MgSO_4 and concentrated at reduced pressure. Purification of the residue by column chromatography ($\text{CH}_3\text{Cl}:\text{MeOH}=10:1$) afforded **33** (8.2 mg, 62%). The amino acid derivative **33** was also prepared by hydrogenolysis of **36** under the standard reaction conditions.

33: A colorless oil. IR (CHCl_3) 3367, 1654 cm^{-1} . ^1H NMR (CDCl_3) δ 7.60 (1H, br m), 7.25-7.11 (5H, m), 3.48-3.36 (2H, m), 2.74 (2H, m), 1.77 (1H, m), 1.49 (2H, br s), 1.39 (1H, m), 1.19 (3H, s), 0.74 (3H, t, $J=7.6$ Hz). ^{13}C NMR (CDCl_3) δ 176.7, 139.1, 128.7, 128.5, 126.3, 57.7, 40.2, 35.8, 33.8, 27.5, 8.1. MS (EI^+): m/z 220 (M^+ , 2), 104 (100). HRMS (EI^+): calcd for $\text{C}_{13}\text{H}_{20}\text{N}_2\text{O}$ (M^+): 220.1576, Found: 220.1578. A sample from **32** gave $[\alpha]_D^{25} +14.0$ (c 0.4, CHCl_3). A sample from **36** gave $[\alpha]_D^{25} +18.8$ (c 1.2, CHCl_3).

A hypothesis for the reversal in enantioselectivity between the zinc- and copper-mediated reactions.

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17

18

21d

27a

27b

27b

27d

27d

29b

29d

29d

30

30

36

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