Aryl Radical Cyclizations: One-Pot Syntheses of Protoberberine and Pavine Alkaloids

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Supporting Information: Characterization Data for Compounds 4 -22

General Procedures. Infrared spectra were determined for Nujol mulls, unless otherwise specified. ^{1}H NMR spectra were measured in $CDCl_3$ (99.8 atom % D, containing 0.03 % v/v TMS, Aldrich). Mass spectra were recorded with EI at 70 eV. Preparative TLC was carried out on a Merck silica gel 60 PF. 6,7- and 7,8-Methylene-dioxyisoquinolines (**5b**[1]and **5c**[2]) and 6,7- and 7,8-dimthoxyisoquinoline (**5d**[3] and **5e**[4]) were prepared according to the reported methods.

2-(Bromo-4,5-dimethoxyphenyl)ethyl Bromide (4a). General Procedure. NBS (1.636 g, 9.19 mmol) was added in portions to a stirred solution of 2-(2-bromo-4,5-dimethoxy-β-phenethyl alcohol (2g, 7.66 mmol) and PPh_3 (2.411 g, 9.19 mmol) in dry benzene (15 mL) at the temperature below 10 °C. After being stirred at rt overnight, the mixture was washed with 5 % $Na_2S_2O_3$ solution (40 mL) and water (40 mL), dried (Na_2SO_4) and concentrated to give a solid (3.453 g). Purification by column chromatography on silica gel (benzene) gave **4a**, mp 69-70 °C (2.246 g, 90 %); IR (Nujol) 1506 cm^{-1}; ^{1}H NMR (270 MHz) δ 3.21 (t, *J* = 7.6 H, 2H), 3.56 (t, *J* = 7.6 Hz, 2H), 3.85 (s, 3H), 3.87 (s, 3H), 6.76 (s, 1H), 7.01 (s, 1H); EI-MS *m/z* (rel. int.) 324 (M^+, 79), 243 (26), 229 (100). Anal. Calcd for $C_{10}H_{12}O_2Br_2$: C, 37.07; H, 3.73; Br, 49.32. Found: C, 37.15; H, 3.77; Br, 49.50.

2-[Bromo-4,5-(methylenedioxy)phenyl]ethyl Bromide (4f): colorless crystals (83%); mp 52-53 °C (Et_2O-pet. ether); IR (Nujol) 1506 cm^{-1}; ^{1}H NMR (270 MHz) δ 3.18 (t, *J* = 7.9 H, 2H), 3.53 (t, *J* = 7.9 Hz, 2H), 3.96 (s, 2H), 6.74, 6.99 (each s, each 1H); EI-MS *m/z* (rel. int.) 308 (M^+, 64), 227 (22), 213 (100), 148 (27). Anal. Calcd for $C_9H_8O_2Br_2$: C, 35.10; H, 2.62; Br, 51.89. Found: C, 35.10; H, 2.64; Br, 51.84.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]isoquinolinium Bromide (6a). **General Procedure.** To a solution of 4,5-dimethoxyisoquinoline (**5a**, 0.485 g, 3.75 mmol) in CH_3CN (2 mL) was added bromide (**4a**, 1 g, 3.09 mmol) in portions. After the mixture was stirred at 100 °C for 6.5 h, the solvent was evaporated. Recrystallization of the residue from AcOEt gave yellow crystals (1.217 g, 87%); mp 230-231 °C; IR (Nujol) 1511 cm^{-1}; ^{1}H NMR (270 MHz) δ 3.59 (t, *J* = 7.9 Hz, 2H), 3.82 (s, 3H), 3.86 (s, 3H), 5.31 (t, *J* = 7.9 Hz, 2H), 6.90 (s, 1H), 7.34 (s, 1H), 7.95-8.10 (m, 3H), 8.12-8.22 (m, 3H), 8.44-8.51 (m, 1H), 8.65-8.68 (m, 1H), 11.14 (s, 1H). Anal. Calcd for $C_{19}H_{19}NO_2Br_2$ + 0.5 MeOH: C, 49.99; H, 4.51; N, 2.98; Br, 34.06. Found: C, 49.82; H, 4.57; N, 2.98; Br, 34.26.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]-6,7-(methylenedioxy)isoquinolinium Bromide (6b): colorless crystals (68%); mp 245-246 °C (EtOH); IR (Nujol) 1619, 1510 cm^{-1}; ^{1}H NMR (270 MHz) δ 3.59 (t, *J* = 7.6 Hz, 2H), 3.85, 3.89 (each s, each

3H), 5.10 (t, *J* = 7.6 Hz, 2H), 6.32 (s, 2H), 6.94, 7.27, 7.37 (each s, each 1H), 7.86 (d, *J* = 6.9 Hz, 1H), 7.92 (s, 1H), 8.13 (dd, *J* = 6.9 Hz, 1H), 10.95 (d, *J* = 1.7 Hz, 1H). Anal. Calcd for $C_{20}H_{19}NO_4Br_2$: C, 48.32; H, 3.85; N, 2.82; Br, 32.14. Found: C, 47.50; H, 4.08; N, 2.74; Br, 32.25.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]-7,8-(methylenedioxy)isoquinolinium Bromide (6c): yellow crystals (66%); mp 259-260 °C; IR (Nujol) 1613, 1509 cm^{-1}; ^1H NMR (270 MHz) δ 3.57 (t, *J* = 7.6 Hz, 2H), 3.84, 3.90 (each 1H, each 3H), 6.45 (s, 2H), 6.92, 7.43 (each s, each 1H), 7.68, 7.75 (AB type *J* = 8.6 Hz, each 1H), 8.16, 8.54 (each d, *J* = 6.9 Hz, each 1H), 10.41 (s, 1H). Anal. Calcd for $C_{20}H_{19}NO_4Br_2$: C, 48.32; H, 3.85; N, 2.82; Br, 32.14. Found: C, 48.10; H, 4.09; N, 2.74; Br, 31.94.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]-6,7-dimethoxyisoquinolinium Bromide (6d): yellow crystals (67%), mp 227-228 °C (EtOH); IR (Nujol) 1494 cm^{-1}; ^1H NMR (270 MHz) δ 3.55 (t, *J* = 7.6 Hz, 2H), 3.84, 3.86, 4.13, 4.14 (each s, each 3H), 5.12 (t, *J* = 7.6 Hz, 2H), 6.94, 7.27, 7.3 1 (each s, each 1H), 7.89 (d, *J* = 6.9 Hz, 1H), 8.07 (d, *J* = 6.9 Hz, 1H), 10.87 (s, 1H). Anal. Calcd for $C_{21}H_{23}NO_2Br_2$: C, 49.15; H, 4.52; N, 2.73; Br, 31.14. Found: C, 48.96; H, 4.67; N, 2.88; Br, 30.25.

2-[2-(2-bromo-4,5-dimethoxyphenyl)ethyl]-7,8-dimethoxyisoquinolinium Bromide (6e): yellow crystals (80%); mp 180.5-181.5 °C (MeOH-ether); IR (Nujol) 1520 cm^{-1}; ^1H NMR (270 MHz) δ 3.61 (t, *J* = 7.6 Hz, 2H), 3.83 (s, 3H), 3.86 (s, 3H), 4.09 (s, 3H), 4.23 (s, 3H), 5.35 (t, *J* = 7.6 Hz, 2H), 6.94 (s, 1H), 7.30 (s, 1H), 7.83 (d, *J* = 8.9 Hz, 1H), 7.89 (d, *J* = 8.9 Hz, 1H), 8.16 (d, *J* = 6.9 Hz, 1H), 8.97 (d, *J* = 6.9 Hz, 1H), 9.86 (s, 1H). Anal. Calcd for $C_{21}H_{23}NO_2Br_2$: C, 49.15; H, 4.52; N, 2.73; Br, 31.14. Found: C, 48.88; H, 4.75; N, 2.58; Br, 30.88.

2-{2-[2-Bromo-4,5-(methylenedioxy)phenyl]ethyl}-6,7-dimethoxyisoquinolinium Bromide (6f): yellow crystals (70%); mp 221-222 °C (MeOH); IR (Nujol) 1493 cm^{-1}; ^1H NMR (270 MHz) δ 3.53 (t, *J* = 7.3 Hz, 2H), 4.14 (s, 6H), 5.09 (t, *J* = 7.3 Hz, 2H), 5.96 (s, 2H), 6.97, 7.03, 7.26 (each s, each 1H), 7.87 (d, *J* = 6.9 Hz, 1H), 7.95 (dd, *J* = 6.6 Hz, 1H), 10.95 (s, 1H). Anal. Calcd for $C_{20}H_{19}NO_2Br_2$: C, 48.32; H, 3.85; N, 2.82; Br, 32.14. Found: C, 48.57; H, 3.93; N, 3.05; Br, 32.10.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]-1-oxo-1,2-dihydroisoquinoline (7a). General Procedure. To a boiling solution of bromide **5a** (1.0 g, 2.21 mmol) in water (18 mL) was slowly added a solution of $K_3[Fe(CN)_6]$ (1.89 g, 5.74 mmol) and KOH (0.458 g, 8.17 mmol) in water (9 mL). The mixture was then refluxed for 30 min, cooled to rt, and extracted with CH_2Cl_2 (15 mL × 5). The extracts were washed with water (30 mL × 4), dried (Na_2SO_4) and concentrated to give a solid (0.816 g). Recrystallization from MeOH-Et_2O gave **7a** (0.740 g, 86 %), mp 114-115 °C; IR (Nujol) 1652, 1508 cm^{-1}; ^1H NMR (270 MHz) δ 3.17 (t, *J* = 7.3 Hz, 2H), 3.60 (s, 3H), 3.85 (s, 3H), 4.21 (t, *J* = 7.3 Hz, 2H), 6.39 (d, *J* = 7.3 Hz, 1H), 6.59 (s, 1H), 6.80 (d, *J* = 7.3 Hz, 1H), 7.01 (s, 1H), 7.46-7.52 (m, 2H), 7.59-7.66 (m, 1H), 8.44-8.47 (m, 1H); EI-MS *m/z* (rel. int.) 387 (M^+, 3), 308 (15), 242 (100), 145 (7). Anal. Calcd for $C_{19}H_{18}NO_2Br$: C, 58.78; H, 4.67; N, 3.61; Br; 20.58. Found: C, 58.80; H, 4.78; N, 3.52, Br; 20.72.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]-6,7-(methylenedioxy)-1-oxo-1,2-dihydroisoquinoline (7b): colorless crystals (84%); mp 194.5-195.5 °C (MeOH); IR (Nujol) 1652, 1609 cm^{-1}; ^1H NMR (270 MHz) δ 3.15 (t, *J* = 7.3 Hz, 2H), 3.64, 3.85 (each s, each 3H), 4.18 (t, *J* = 7.3 Hz, 2H), 6.07 (s, 2H), 6.25 (d, *J* = 7.3 Hz, 1H), 6.60 (s, 1H), 6.73 (d, *J* = 7.3 Hz, 1H), 6.82, 7.01, 7.80 (each s, each 1H); EI-MS *m/z* (rel.

int.) 433 (M^+, 6.0), 431 (M^+, 6.0), 352 [(M - Br) $^+$, 37.0], 244 (98.0), 242 (100), 189 (17). Anal. Calcd for $C_{20}H_{18}NO_5Br$: C, 55.57; H, 4.20; N, 3.24; Br; 18.48. Found: C, 55.31; H, 4.35; N, 3.28, Br; 18.52.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]-7,8-(methylenedioxy)-1-oxo-1,2-dihydroisoquinoline (7c): colorless crystals (85%); mp 159-160 °C (EtOH); IR (Nujol) 1663, 1609 cm^{-1}; ^{1}H NMR (270 MHz) δ 3.15 (t, *J* = 7.6 Hz, 2H), 3.67, 3.85 (each s, each 1H), 4.12 (t, *J* = 7.6 Hz, 2H), 6.23 (s, 2H), 6.27, 6.63 (AB type, *J* = 7.6 Hz, 2H), 6.67 (s, 1H), 6.97, 7.16 (each d, *J* = 8.3 Hz, each 1H), 7.01 (s, 1H). EI-MS *m/z* (rel. int.) 433 (M^+, 6.0), 431 (M^+, 6.0), 352 (5.0), 244 (20), 242 (20), 189 (100). Anal. Calcd. For $C_{20}H_{18}NO_5Br$: C, 55.57; H, 4.20; N, 3.24; Br, 18.48. Found: C, 55.37; H, 4.22; N, 3.19; Br, 18.37.

2-[2-(2-Bromo-4,5-dimethoxyphenyl)ethyl]-6,7-dimethoxy-1-oxo-1,2-dihydroisoquinoline (7d): colorless crystals (87%); mp 71-72 °C (MeOH-ether); IR (Nujol) 1649, 1582, 1510 cm^{-1}; ^{1}H NMR (270 MHz) δ 3.17(t, *J* = 7.3 Hz, 2H), 3.60 (s, 3H), 3.86 (s, 3H), 3.98 (s, 3H), 4.01 (s, 3H), 4.20 (t, *J* = 7.3 Hz, 2H), 6.29 (d, *J* = 7.26 Hz, 1H), 6.57 (s, 1H), 6.73 (d, *J* = 7.3 Hz, 1H), 6.83 (s, 1H), 7.01 (s, 1H), 7.83 (s, 1H); EI-MS *m/z* (rel. int.) 447 (M^+, 9), 368 (33), 244 (70), 205 (100). Anal Carcd for $C_{21}H_{22}NO_5Br$: C, 56.26; H, 4.95; N, 3.12; Br, 17.82. Found: C, 56.24; H, 5.04; N, 3.23; Br, 18.04.

Radical Cyclization of Isocarbostyril 7a. 2,3-Dimethoxy-8-oxoberbine (3a). General Procedure. To a stirred and boiling suspension of isocarbostyril **7a** (30 mg, 0.077 mmol) in benzene (6 mL) under N_2 was added a solution of AIBN (1.3 mg, 0.0077 mmol) and Bu_3SnH (45 mg, 0.155 mmol) in dry benzene (4 mL) at once. After the mixture was refluxed for 4 h, the solvent was evaporated. The residue was dissolved in CH_3CN (15 mL) and washed with hexane (30 mL × 4). The CH_3CN fraction gave an oil (41 mg), which was purified by preparative TLC on silica gel, developed with EtOAc and hexane (3:1). A band with R_f 0.61 gave **3a** (21 mg, 87%); mp 144-145°C (MeOH) (lit.[5] mp 140-141 °C; [6] 141-142 °C; [7] 142 °C; [8]143-145 °C); ^{1}H NMR (270 MHz) δ 2.74-2.90 (m, 1H), 2.93-3.03 (m, 3H), 3.22 (m, 1H), 3.86 (s, 3H), 3.92 (s, 3H), 4.87 (m, 1H), 4.99-5.03 (m, 1H), 6.70 (s, 1H), 6.72 (s, 1H), 7.26 (d, *J* = 7.3 Hz, 1H), 7.39 (t, J = 7.3 Hz, 1H), 7.47 (dt, *J* = 7.6, 1.7 Hz, 1H), 8.14 (d, *J* = 7.6 Hz, 1H).

When the above reaction was curried out using AIBN (13 mg, 0.077 mmol), **3a** and **8a** were obtained in a ratio of 85:15. Preparative TLC gave **3a** (R_f 0.6, 17 mg, 72%), mp 143-144 °C (MeOH) and **8a** (R_f 0.5, 2.5 mg, 8%), mp 188-189 °C (AcOEt) (lit.[9] mp 181-182 °C;[7,10] 189-190 °C; [6] 190-191 °C).

2,3-Dimethoxy-10,11-(methylenedioxy)-8-oxoberbine (3b): colorless cryatals (87%); mp 186-186.5 °C (MeOH); IR (Nujol) 1656, 1645, 1613, 1514 cm^{-1}; ^{1}H NMR (270 MHz) δ 2.73-2.97 (m, 4H), 3.10 (dd, *J* = 12.2, 3.6 Hz, 1H), 3.89, 3.91 (each s, each 3H), 4.81 (dd, *J* = 9.6, 3.6 Hz, 1H), 4.93-4.98 (m, 1H), 6.01, 6.03 (each s, each 1H, 6.69 (s, 3H), 7.59 (s, 1H); EI-MS *m/z* (rel. int.) 353 (M, 100), 352 (69.4), 162 (80.6), 176 (20.8), 134 (65.2). Anal. Calcd. For $C_{20}H_{19}NO_5$: C, 67.98; H, 5.42;N, 3.96. Found: C, 67.05; H, 5.45; N, 3.88.

2,3-Dimethoxy-9,10-(methylenedioxy)-8-oxoberbine (3c): (±)-8-Oxosinactine: colorless crystals (85%); mp 198-202 °C (MeOH) (lit.[2] mp 198-200 °C); IR (Nujol) 1646, 1600, 1514 cm^{-1}; ^{1}H NMR (270 MHz) δ 2.72 - 3.17 (m, 5H), 3.89 (s, 3H), 3.90 (s, 3H), 4.80 (dd, *J* = 12.9, 3.3 Hz, 1H), 4.98 (dd, *J* = 8.6, 3.0 Hz, 1H), 6.12, 6.17 (each d, *J* = 1.3 Hz, each 1H), 6.68 (s, 2H), 6.70, 6.87 (AB type, *J* = 7.9, each 1H); EI-MS

m/z (rel. int.) 353 (M^+, 100), 338 [(M - Me) $^+$, 31.7], 322 [(M - OMe) $^+$, 11.0], 190 (22.4), 162 (85.2), 134 (71.5).

2,3,9,10-Tetramethoxy-8-oxoberbine, 8-oxoxylopinine (3d): colorless crystals (82%); mp 191-192 °C (benzene-ether) (lit.[8] mp 188-89 °C; [11] 190-192 °C; [5]191 °C; [6] 196.5- 198 °C. IR (Nujol) 1607, 1591, 1512 cm^{-1}; ^{1}H NMR (270 MHz) δ 2.74-3.18 (m, 5H), 3.90, 3.91, 3.947, 3.954 (each s, each 3H), 4.84 (dd, *J* = 13.5, 3.6 Hz, 1H), 6.70, 6.71, 6.72, 7.69 (each s, each 1H).

Treatment of Isoquinolinium Salt 5a with Bu_3SnH. A suspension of isoquinolinium salt **6a** (10 mg, 0.022 mmol) and Bu_3SnH (13 mg, 0.044 mmol) in a mixture of toluene and EtOAc (4:1 v%, 2 mL) under N_2 was refluxed for 20 min and evaporated to give an oil (20 mg), which ^{1}H NMR spectrum showed only signals for 2-[2-(2'-bromo-4',5'-dimethoxyphenyl)ethyl]-1,2-dihydroisoquinoline **9a** except those for tin-compounds at δ 0.8-1.9. **9a**: IR (neat) 1620, 1607, 1566, 1510 cm^{-1}; ^{1}H NMR (270 MHz) δ 2.92, 3.22 (each t, *J* = 7.6 Hz, each 2H), 3.70, 3.85 (each 3H, each s), 4.35 (s, 2H), 5.23, 6.10 (each d, *J* = 7.6 Hz, each 1H), 6.69 (s, 1H), 6.82 (dt, *J* = 1.0, 7.6, 7.6 Hz, 1H), 6.90 (d, *J* = 7.6 Hz), 6.96 (dd, *J* = 7.6, 1.3 Hz, 1H), 7.01 (s, 1H), 7.08 (dt, *J* = 1.3, 7.6, 7.6 Hz, 1H); EI-MS *m/z* (rel. int.) 373 (12), 244 (100), 229 (37), 144 (95); HRMS calcd for $C_{19}H_{20}NO_2Br$; 373.0677, found 373.0684.

Radical Cyclization of Isoquinolinium Salt 6a. General Procedure. To a stirred and boiling suspension of isoquinolinium salt **6a** (31 mg, 0.067 mmol) in a mixture of toluene and EtOAc (2:1 v%, 4.5 mL) [this solvent system was also used for **6d**, CH_3CN for **6b**,**c**,**e**, and **f**, and toluene-CH_3CN (1:2) for **10** and **11**] under N_2 was added a solution of AIBN (11 mg, 0.067 mmol) and Bu_3SnH (58 mg, 0.201 mmol) in dry toluene (3 mL) at once. After the mixture was refluxed for 4 h, the solvent was evapotated. The residue was dissolved in CH_3CN (10 mL) and washed with hexane (20 mL × 4). The CH_3CN fraction gave an oil (40 mg), which was purified by preparative TLC on silica gel, developed with 5% MeOH-CH_2Cl_2. A band with R_f 0.5 gave 2,3-dimethoxyberbine (**2a**) as a colorless oil (14.5 mg, 78%);[2,7,20] ^{1}H NMR (270 MHz) δ 2.58 - 2.70 (m, 2H), 2.91 (dd, *J* = 15.4, 11.6 Hz, 1H), 3.10-3.20 (m, 2H), 3.34 (dd, *J* = 16.2, 3.6 Hz, 1H), 3.60-3.68 (m, 1H), 3.88, 3.90 (each s, each 3H), 4.03 (d, *J* = 14.8 Hz, 1H), 6.62, 6.75 (each s, each 1H), 7.07-7.18 (m. 4H).

(±)-Isosinactine (2b): colorless crystals (82%); mp 158-160 °C (MeOH); IR (Nujol) 1509 cm^{-1}; ^{1}H NMR (270 MHz) δ 2.56-2.70 (m, 2H), 2.81 (dd, *J* = 15.8, 10.9 Hz, 1H), 3.08-3.17 (m, 2H), 3.21 (dd, *J* = 16.2, 3.0 Hz, 1H), 3.48-3.67 (m, 2H), 3.87, 3.90 (each s, each 3H), 3.93 (d, *J* = 15.8 Hz, 1H), 5.91 (s, 2H), 6.55, 6.62, 6.63, 6.73 (each s, each 1H); EI-MS *m/z* (rel. int.) 339 (M^+, 44), 324 (7.7), 190 (39.1), 148 (100). Anal. Calcd. for $C_{20}H_{21}NO_4$: C, 70.78; H, 6.24; N, 4.13. Found: C; 70.67; H, 6.21; N, 4.15.

(±)-Sinactine (2c): colorless crystals (77%); mp 170-172 °C (MeOH) (lit.[8] mp 155-156 °C; [12] 163-165 °C; [13] 166 °C; [14,15]167-168 °C; [16] 168-170 °C; [6,17]169-170 °C; ^{1}H NMR (270 MHz) δ 2.60-2.75 (m, 2H), 2.82 (dd, *J* = 15.8, 10.9 Hz, 1H), 3.07-3.32 (m, 2H), 3.28 (dd, *J* = 15.8, 4.0 Hz, 1H), 3.52-3.62 (m, 2H), 3.87-3.89 (each s, each 3H), 4.11 (d, *J* = 15.5 Hz, 1H), 5.93, 5.97 (each d J = 1.4 Hz, each 1H), 6.62 (s, 1H), 6.64, 6.70 (AB type, *J* = 7.9 Hz, each 1H), 6.73 (s, 1H).

(±)-xylopinine (norcoralydine) (2d): colorless crystals (78%); mp 150-151 °C (CH_2Cl_2-ether); (lit.[9] mp 142-143 °C; [19] 146 °C; [2,20] 146-147 °C; [21] 154-157 °C; [22] 155-157 °C; [13] 156-157 °C; [23] 156-158 °C; [5] 157 °C; [6,24]157-158 °C;[25] 158-159 °C; [26] 161-163 °C; [27] 182-183 °C; ^{1}H NMR (270 MHz) δ 2.60-2.70 (m, 2H), 2.83 (dd, *J* =

15.8, 11.2 Hz, 1H), 3.15-3.35 (m, 2H), 3.25 (dd, *J* = 15.8, 3.6 Hz, 1H), 3.85, 3.86, 3.87, 3.90 (each s, each 3H), 4.02 (d, J = 16.8 Hz, 1H), 6.47, 6.52, 6.57, 6.63 (each s, each 1H).

(±)-Tetrahydropalmatine (2e): colorless crystals (79%); mp 150-151 °C (lit.[20] mp 145-146 °C; [12,13,14,28] 147 °C; [29] 148-150 °C; [6] 149.5-150.5 °C; [30] 150-151 °C; [31] 151-151.5 °C; ^{1}H NMR (270 MHz) δ 2.61-2.70 (m, 2H), 2.83 (dd, *J* = 15.8, 11.2 Hz, 1H), 3.15-3.23 (m, 2H), 3.25 (15.8, 4.0 Hz, 1H), 3.52-3.57 (m, 2H), 3.86 (s, 6H), 3.87, 3.89 (each s, each 3H), 4.25 (d, *J* = 15.8 Hz, 2H), 6.67, 6.78 (each s, each 1H), 6.78, 6.88 (each d *J* = 8.3 Hz, each 1H).

(±)-isocanadine (2f): colorless crystals (77%); mp 175-176.5 °C; IR (Nujol) 1521, 1503 cm^{-1}; ^{1}H NMR δ 2.55-2.70 (m, 2H), 2.81 (dd, *J* = 14.5, 11.2 Hz, 1H), 3.05-3.23 (m, 2H), 3.20 (dd, J = 16.2, 3.0 Hz, 1H), 3.54-3.70 (m, 2H), 3.85, 3.86 (each s, each 3H), 3.93 (d, *J* = 14.5 Hz, 1H), 5.92 (s, 2H), 6.57, 6.59, 6.64, 6.74 (each s, each 1H); EI-MS *m/z* (rel. int.) 339 (35), 164 (100). Anal. Calcd. for $C_{20}H_{21}NO_4$: C, 70.78; H, 6.24; N, 4.13. Found: C; 70.59; H, 6.12; N, 4.08.

2-(2'-bromo-4',5'-dimethoxybenzyl)isoquinoline Bromide (10): This was prepared from isoquinoline and 2-bromo-4,5-dimethoxybenzyl bromide [1.0 g, 3.09 mmol, colorless crystals (75% by the aforementioned "General procedure" for salts **6**); mp 84-85°C (Et_2O-Hexane) (lit. mp 82-84°C); ^{1}H NMR (270 MHz) δ 3.85 (s, 3H), 3.86 (s, 3H), 4.56 (s, 2H), 6.91 (s, 1H), 6.99 (s, 1H)]: yellow crystals (75 %); mp 240-242 °C (MeOH); IR (Nujol) 1644, 1509 cm^{-1}; ^{1}H NMR δ 3.88 (s, 3H), 4.04 (s, 3H), 6.34 (s, 2H), 7.02 (s, 1H), 7.91-7.97 (m, 1H), 8.09-8.11 (m, 2H), 8.17 (s, 1H), 8.20-8.23 (m, 1H), 8.67-8.74 (m, 2H), 11.07 (s, 1H). Anal. Calcd for $C_{18}H_{17}NO_3Br_2$: C, 49.23; H, 3.91; N, 3.19; Br, 36.39. Found: C, 49.25; H, 3.98; N, 3.08; Br, 36.34.

2-[3-(2-bromo-4,5-dimethoxyphenyl)propyl]isoquinoline Bromide (11): This was prepared from isoquinoline and 3-[2-bromo-4,5-dimethoxyphenyl]propyl bromide {colorless crystals (89%); mp 32-34 °C (Et_2O-Hexane); IR (Nujol) 1652, 1509 cm^{-1}; ^{1}H NMR δ 2.15 (quartet, *J* = 6.6 Hz, 2H), 2.83 (t, *J* = 6.6 Hz, 2H), 3.42 (t, *J* = 6.6 Hz, 2H), 3.85 (s, 3H), 3.86 (s, 3H), 6.77 (s, 1H), 7.00 (s, 1H); EI-MS *m/z* (rel. int.) 338 (M^+, 71), 229 [(M - $CH_2CH_2Br)^+$, 100]}. Anal. Calcd for $C_{11}H_{14}NO_2Br_2$: C, 39.08; H, 4.18; Br, 47.27. Found C, 38.86; H, 4.27; Br, 47.27]. **11**; yellow crystals (78%); mp 143- 144 °C (AcOEt); IR (Nujol) 1645, 1507 cm^{-1}; ^{1}H NMR δ 2.52 (quint, *J* = 6.9, 7.3, 7.6 Hz, 2H), 2.94 (t, *J* = 6.9, 8.6 Hz, 2H), 3.76 (s, 3H), 3.91 (s, 3H), 5.21 (t, *J* = 7.3, 7.6 Hz, 2H), 6.82 (s, 1H), 7.02 (s, 1H), 7.98 (dt, *J = 1.7, 8.3* Hz, 1H), 8.08-8.17 (m, 2H), 8.20 (d, *J* = 8.6 Hz, 1H), 8.60 (d, *J* = 8.3 Hz, 1H), 8.72 (d, *J* = 8.6 Hz, 1H), 11.27 (s, 1H). Anal. Calcd for $C_{20}H_{21}NO_2Br_2$: C, 51.41; H, 4.54; N, 3.00; Br, 34.20. Found: C, 51.24; H, 4.56; N, 3.04 Br, 34.17.

2-[2-(2-bromo-4,5-dimethoxyphenyl)methyl]-1-oxo-1,2-dihydroisoquinoline (12): colorless crystals (70%); mp 136-137°C (MeOH-Et_2O); IR (Nujol) 1650, 1613 (d), 1509 cm^{-1}; ^{1}H NMR (270 MHz) δ 3.77 (s, 3H), 3.87 (s, 3H), 5.30 (s, 2H), 6.48 (d, *J* = 7.3 Hz, 1H), 6.95 (s, 1H), 7.04 (s, 1H), 7.17 (d, *J* = 7.3 Hz, 1H), 7.47-7.53 (m, 2H), 7.64 (dt, *J* = 1.3, 1.7, 7.3, 7.6 Hz, 1H), 8.47 (dd, *J* = 1.3, 7.6 Hz, 1H); EI-MS *m/z* (rel. int.) 373 (M^+, 3), 294 [(M - Br)$^+$, 100], 229 (22), 149 (20). Anal. Calcd for $C_{18}H_{16}NO_3Br$: C, 57.77; H, 4.32; N, 3.74; Br, 21.35. Found C, 57.61; H, 4.39; N, 3.65; Br, 21.38.

2-[3-(2-bromo-4,5-dimethoxyphenyl)propyl]-1-oxo-1,2-dihydroisoquinoline (13): colorless crystals (87 %); mp 109-110 °C (MeOH-Et_2O); IR (Nujol) 1648, 1615(d), 1504 cm^{-1}; ^{1}H NMR (270 MHz) δ 2.10 (qu, *J* = 7.59, 7.9 Hz, 2H), 2.76 (t, *J* = 7.6, 7.9

Hz, 2H), 3.83 (s, 3H), 3.84 (s, 3H), 4.08 (t, *J* = 7.3 Hz, 2H), 6.50 (d, *J* = 7.3 Hz, 1H), 6.76 (s, 1H), 7.00 (s, 1H), 7.07 (d, *J* = 7.3 Hz, 1H), 7.45-7.52 (m, 2H), 7.63 (dt, *J* = 1.3, 6.9, 6.9 Hz, 1H), 8.44 (dd, *J* = 1.3, 6.9 Hz, 1H); EI-MS *m/z* (rel. int.) 401 (M^+, 7), 322 [$(M - Br)^+$, 25], 159 (54), 40 (100). Anal. Calcd for $C_{20}H_{20}NO_3Br$: C, 59.71; H, 5.02; N, 3.48; Br, 19.86. Found: C, 59.64; H, 5.09; N, 3.40; Br, 19.99.

7,8-Dimethoxy-5,5a,10,12-tetrahydroisoindolo[2,1-*b*]isoquinoline (14a): colorless crystals (49%, R_f 0.5 with 4% MeOH-CH_2Cl_2); mp 129-131 °C (MeOH); IR (Nujol) 1507 cm^{-1}; ^1H NMR (270 MHz) δ 2.98 (dd, *J* = 14.9, 12.2 Hz, 1H), 3.31 (dd, *J* = 14.9, 3.3 Hz, 1H), 3.70-3.80 (m, 2H), 3.80-3.97 (hiding, 1H), 3.89, 3.92 (each s, each 3H), 4.19 (d, *J* = 14.5 Hz, 1H), 4.27 (d, *J* = 10.9 Hz, 1H), 6.82, 6.86 (each s, each 1H), 7.10-7.25 (m, 4H); EI-MS *m/z* (rel. int.) 282 [$(M + H)^+$, 19.8], 281 (M^+, 100), 280 [$(M - H)^+$, 46.1], 190 (13.2), 177 (22.6), 105 (46.3). Anal. Calcd for $C_{18}H_{17}NO_3$: C, 76.84; H, 6.82; N, 4.89. Found: C, 76.62; H, 6.89; N, 4.85.

7,8-Dimethoxy-12-oxo-5,5a,10,12-tetrahydroisoindolo[2,1-*b*]isoquinoline (14b): colorless crystals (74%) [R_f 0.47 with AcOEt and hexane (4:1), R_f 0.72 for by-product, debrominated reactant]; mp 200-202 °C (MeOH); IR (Nujol) 1656, 1511, 1466, 1335, 1277, 1109, 846 cm^{-1}; ^1H NMR (270 MHz, $CDCl_3$) δ 3.05 (t, *J* = 13.5, 14.9 Hz, 1H), 3.31 (dd, *J* = 4.0, 14.9 Hz, 1H), 3.92 (s, 3H), 3.93 (s, 3H), 4.76 (d *J* = 15.5 Hz, 1H), 5.08 (d, *J* = 15.5 Hz, 1H), 5.18 (dd, *J* = 4.0, 13.6 Hz, 1H), 6.81 (s, 1H), 7.28 (dd, *J* = 1.7, 7.3 Hz, 1H), 7.38 (t, *J* = 7.3 Hz, 1H), 7.46 (dt, *J* = 1.7, 7.3, 7.6 Hz, 1H), 8.10 (dd, *J* = 1.3, 7.6 Hz, 1H); EI-MS *m/z* (rel. int.) 295 (M^+, 100), 280 [$(M - CH_3)^+$, 15]. Anal. Calcd for $C_{18}H_{17}NO_3$: C, 73.19; H, 5.81; N, 4.76. Found C, 73.14; H, 5.96; N, 4.76.

7,8-Dimethoxy-5,5a,10,11,14-pentahydroisoquinolino[3,2-*a*]-2-benzazepine (15a): a colorless oil (33%, R_f 0.5 with 5% MeOH-CH_2Cl_2); IR (neat) 1610, 1586, 1517 cm^{-1}; ^1H NMR δ1.59-1.69 (m, 1H), 1.80-1.95 (m, 1H), 2.89-2.97 (m, 2H), 3.18-3.34 (m, 4H), 3.53 (s, 3H), 3.69 (s, 2H), 3.84 (s, 3H), 4.34-4.38 (m, 1H), 6.51 (s, 1H), 6.65 (s, 1H), 6.93-6.96 (m, 1H), 7.06-7.24 (m, 3H); EI-MS *m/z* (rel. int.) 399 (60), 254 (52), 159 (100); HRMS calcd for $C_{20}H_{23}NO_2$ 309.1729, found 309.1743.

7,8-Dimethoxy-5,5a,10,11,14-pentahydro-14-oxoisoquinolino[3,2-*a*]-2-benz-azepine (15b): colorless crystals (72%) [R_f 0.6 with AcOEt and hexane (3:1), R_f 0.8 for by-product, the debrominated reactant]; mp 153-154 °C (AcOEt); IR (Nujol) 1636, 1517, 1377, 1279 cm^{-1}; ^1H NMR (270 MHz) δ 1.75-2.01 (m, 2H), 2.80-2.90 (m, 1H), 2.95-3.13 (m, 2H), 3.34-3.37 (m, 2H), 3.65 (s, 3H), 3.84 (s, 3H), 4.73-4.81 (m, 1H), 4.90-4.95 (m, 1H9, 6.58 (s, 1H), 6.67 (s, 1H), 7.27-7.36 (m, 2H), 7.45 (m, 1H), 8.03 (m, 1H); EI-MS *m/z* (rel. int.) 323 (M^+, 100), 308 [$(M - Me)^+$, 5], 177 (23), 118 (52). Anal. Calcd for $C_{20}H_{21}NO_3$: C, 74.28; H, 6.56; N, 4.33. Found C, 74.59; H, 6.60; N, 4.31.

1-(2-Bromo-4,5-dimethoxybenzyl)-6,7-dimethoxyisoquinoline Methiodide (17). A solution of 2'-bromopapaverie **16** (1.00 g, 2.4 mmol) in methyl iodide (6 ml) was refluxed in an oil bath at 80 °C for 2 h. The resultant solid was washed with ether to give **18** as yellow crystals (1.28 g, 95%), mp 210-211 °C; IR (Nujol) 1514 cm^{-1}; ^1H NMR (270 MHz) δ 3.64, 3.87, 3.97, 4.15, 4.59 (each s, each 3H), 5.02 (s, 2H), 6.37, 7.09, 7.38, 7.57 (each s, each 1H), 8.29 (d, *J* = 7.9 Hz, 1H), 8.87 (d, *J* = 7.9 Hz, 1H). Anal. Calcd for $C_{21}H_{23}NO_4BrI$: C, 45.02; H, 4.14; N, 2.50; Br + I, 36.91. Found: C, 44.99; H, 3.96 ; N, 2.41; Br + I, 36.78.

1-(2-bromo-4,5-dimethoxybenzyl)-2-methyl-6,7-dimethoxy-1,2-dihydroiso-quinoline (18a). To a stirred suspension of methiodide **17** (128 mg, 0.23 mmol) in dry

DME (40 mL) was added $LiAlH_4$ (131 mg, 3.45 mmol), and the mixture was stirred at 0 °C for 2 h. THF (5 mL) containing water (0.12 ml) was added. Precipitates were removed by suction filtration, and the filtrate was concentrated. The residue was dissolved in CH_2Cl_2 (10 mL), washed with water (10 mL), and dried (Na_2SO_4). Evaporation of the solvent gave **19a** as an air-sensitive solid (88 mg, 88%), ^{1}H NMR (270 MHz, $CDCl_3$) δ 2.85 (dd, *J* = 12.8, 8.6 Hz, 1H), 2.96 (s, 3H), 3.10 (dd, *J* = 5.3, 12.8 Hz, 1H), 3.54, 3.58, 3.83, 3.84 (each s, each 3H), 4.45 (dd, *J* = 5.3, 8.6 Hz, 1H), 5.30 (d, *J* = 7.3 Hz, .1H), 5.86 (s, 1H), 6.07 (d, *J* = 7.3 Hz, 1H), 6.09, 6.51, 7.00 (each s, each 1H). This was used for its radical cyclization without further purification.

Treatment of Methiodide 17 with Bu_3SnH. A mixture of **17** (28 mg, 0.05 mmol) and Bu_3SnH (13 mg, 0.15 mmol) in a mixture of DMF and toluene (1:1 v%, 2 mL) was refluxed under N_2 for 4 h and evaporated to give an oil (20 mg), which ^{1}H NMR spectrum showed only signals for **18a** except those for tin-compounds at δ 0.8-1.9.

1-(2-bromo-4,5-dimethoxybenzyl)-2-methoxycarbonyl-6,7-dimethoxy-1,2-dihydroisoquinoline (18b). To a stirred solution of 2'-bromopapaverine **17** (20 mg, 0.048 mmol) in CH_3CN (1 mL) in ice bath was added Bu_3SnH (14 mg, 0.048 mmol, 0.013 ml). Five min later, methyl chloroformate (6 mg, 0.057 mmol) was added, and the mixture was stirred at rt for 3 h. The solvent was evaporated to give an oil, which was dissolved in CH_3CN (10 mL) and washed with hexane (20 mL × 4). The CH_3CN layer was evaporated and purified by preparative TLC on silica gel developed with 3% MeOH-CH_2Cl_2. A band with R_f 0.5 gave **18b** as colorless crystals (0.02 g, 87%): mp 151-153 °C (MeOH); IR (Nujol) 1713, 1634, 1603, 1510 cm^{-1}; ^{1}H NMR (270 MHz, a 1:1 rotamer) δ 2.90 (dd, *J* = 13.1, 6.9 Hz, 0.5H), 2.92 (d, *J* = 6.9 Hz, 1H), 3.10 (dd, *J* = 7.3, 13.1 Hz, 0.5H), 3.54, 3.65, 3.69, 3.71, 3.74, 3.76, 3.84, 3.85, 3.86, 3.88 (each s, each 1.5H), 5.47 (d, *J* = 6.9, 7.3 Hz, 0.5H), 5.56 (dd, *J* = 6.9, 7.3 Hz, 0.5H), 5.76 (d, *J* = 7.6 Hz, 0.5H), 5.90 (d, *J* = 7.9 Hz, 0.5H), 6.17, 6.28, 6.34, 6.36, 6.59, 6.63 (each s, each 0.5H), 6.74 (d, *J* = 7.6 Hz, 0.5H), 6.94 (d, *J* = 7.9 Hz, 0.5H), 6.96, 7.02 (each s, each 0.5H); EI-MS *m/z* (rel. int.) 478 (M^+, 1.0), 264 (100). Anal. Calcd for $C_{22}H_{24}NO_6Br$: 55.23; H, 5.07; N, 2.93; Br, 16.70. Found: C, 55.12; H, 5.15; N, 2.83; Br, 16.56.

1-(2-bromo-4,5-dimethoxybenzyl)-2-ethoxycarbonyl-6,7-dimethoxy-1,2-dihydroisoquinoline (18c): colorless crystals (72%); mp 141-142 °C (benzene-MeOH); IR (Nujol) 1712, 1637, 1604, 1574, 1509 cm^{-1}; ^{1}H NMR (270 MHz, a 1:1 rotamer) δ 1.17, 1.25 (each t, *J* = 7.3 Hz, each 1.5H), 2.89 (dd, *J* = 12.9, 7.3 Hz, 0.5H), 2.93 (d, *J* = 7.3 Hz, 1H), 3.09 (dd, *J* = 12.9, 7.3 Hz, 0.5H), 3.67 (s, 1.5H), 3.71 (s, 3H), 3.75, 3.84, 3.85, 3.86, 3.88 (each s, each 1.5H), 3.85, 4.18 (each q, *J* = 7.3 Hz, each 1H), 5.47, 5.57 (each t, *J* = 6.9 Hz, each 0.5H), 5.76, 5.91 (each d, *J* = 7.9 Hz, each 0.5H), 6.22, 6.35, 6.59, 6.64 (each s, each 0.5H), 6.77, 6.94 (each d, each 0.5H), 6.96, 7.01 (each s, each 0.5H). EI-MS *m/z* (rel. int.) 491 (M^+, 0.3), 262 (100), 189 (27.4), 46 (13.2). Anal. Calcd for $C_{23}H_{26}NO_6Br$: 56.10; H, 5.33; N, 2.84; Br, 16.22. Found: C, 56.18; H, 5.35; N, 2.86; Br, 15.93.

(±)-Argemonine (19a). From 1,2-Dihydroisoquinoline 18a. A solution of **18a** (15 mg, 0.035 mmol) in dry toluene (2 mL) was refluxed in an atmosphere of Ar in an oil bath at 140 °C. A solution of AIBN (6 mg, 0.035 mmol), and Bu_3SnH (0.02 g, 0.07 mmol, 0.02 ml) in dry toluene (1.6 mL) was added, and the mixture was refluxed for 4 h. After the reaction mixture was evaporated, the resultant mixture was dissolved in CH_3CN (10 mL) and washed with hexane (20 mL × 4). The CH_3CN layer was evaporated. The residue oil was subjected to preparative TLC on silica gel developed with 8% MeOH-CH_2Cl_2. A band with R_f 0.28 gave (±)-argemonine (**19a,** 9 mg, 78%),

as colorless prisms: mp 135-140 °C (Et_2O) (lit.[32,33] mp 135-140 °C; [34] 138-140 °C); ^{1}H NMR (270 MHz) δ 2.53 (s, 6H), 2.59 (d, *J* = 16.2 Hz, 2H), 3.40 (dd, *J* = 5.6, 16.2 Hz, 2H), 3.78 (s, 6H), 3.85 (s, 6H), 4.00 (d, *J* = 5.6 Hz, 2H), 6.45, 6.60 (each s, each 1H).

(±)-Argemonine] (19a). From Methiodide 17. To a sotution of **17** (0.1 g, 0.18 mmol) in dry DMF (5 ml) and toluene (7 mL) was added Bu_3SnH (52 mg, 0.18 mmol, 0.05 mL) and stirred at 140 °C for 1 h under Ar. A solution of AIBN (29 mg, 0.18 mmol), and Bu_3SnH (104 mg, 0.36 mmol) in dry toluene (8 mL) was added, and the mixture was refluxed for 4 h. After the solvents were removed by distillation under reduced pressure, the resultant mixture was dissolved in CH_3CN (20 m) and washed with hexane (40 mL × 4). The CH_3CN layer was concentrated. The residue was subjected to preparative TLC on silica gel developed with 8% MeOH-CH_2Cl_2. A band with R_f 0.28 gave (±)-argemonine (**19a**, 38 mg, 62%), mp 135-140 °C (Et_2O).

Radical Cyclization of Carbamate 18b and 18c. To a stirred solution of **18b** (50 mg, 0.11 mmol) in toluene (7 mL) under N_2 was added a solution of AIBN (2.0 mg, 0.011 mmol) and Bu_3SnH (68 mg, 0.21 mmol) in dry toluene (5 mL) at once. After the mixture was refluxed for 4 h, the solvent was evaporated. The residue was dissolved in CH_3CN (15 mL) and washed with hexane (30 mL × 4). The CH_3CN fraction gave an oil (44 mg), which was purified by preparative TLC on silica gel (3% MeOH- CH_2Cl_2. A band with R_f 0.3 gave **(±)**-N-Methoxycarbonylpavine **(19b)** as a colorless oil (62%); IR (neat) 1715, 1654, 1514 cm^{-1}; ^{1}H NMR (270 MHz, a 1:1 rotamer) δ 2.75 (d, *J* = 15.5 Hz, 2H), 3.36 (dd, *J* = 10.9, 5.3 Hz, 1H), 3.45 (dd, *J* = 11.6, 5.3 Hz, 1H), 3.74 (s, 3H), 3.78 (s, 6H), 3.86 (s, 6H), 5.40, 5.51 (each d, *J* = 5.3 Hz, each 1H), 6.45, 6.47, 6.64, 6.67 (each s, each 1H); EI-MS *m/z* (rel. int.) 399 (M^+, 40), 340 [(M - $CO_2Me)^+$, 7], 248 (100); HR-MS calcd for $C_{22}H_{25}NO_6$ 399.1682, found 399.1662.

A band with R_f 0.5 gave 4*H*-6-Methoxycarbonyl-1,2,9,10-tetramethoxy-6a,7-dihydrodibenzo[*de,g*]quinoline (**20b**) as a colorless oil (1.5 mg, 4%); IR (neat) 1698, 1612, 1519 cm^{-1}; ^{1}H NMR (270 MHz) δ 2.86 (t, *J* = 13.2 Hz, 1H), 3.36-3.49 (m, 1H), 3.64, 3.84, 3.89 (each s, 3H), 3.92 (s, 6H),5.02 (dd, J = 3.30, 13.30 Hz, 1H), 5.43 (d, J = 8.3 Hz, 1H), 6.46, 6.81 (each s, each 1H), 6.88 (d, *J* = 8.3 Hz, 1H), 8.06 (s, 1H); EI-MS *m/z* (rel. int.) 397 (M^+, 100), 382 [(M - Me) $^+$, 36], 366 [(M - OMe) $^+$, 23], 307 [(M - COOMe) $^+$, 54]; HRMS calcd for $C_{22}H_{23}NO_6$ 397.1525, found 397.1519.

(±)-N-Ethoxycarbonylpavine (19c): colorless crystals (64%, R_f 0.2 with 1% MeOH-CH_2Cl_2); mp 191-192 °C (AcOEt-pet. ether) (lit.[35] mp 183-184 °C); IR (neat) 1693, 1612, 1517 cm^{-1}; ^{1}H NMR (270 MHz, a 1:1 rotamer) δ 1.26-1.31 (m, 3H), 2.74 (d, *J* = 15.8 Hz, 2H), 3.34-3.49 (m, 2H), 3.78 (s, 6H), 3.85, 3.86 (each s, each 3H), 4.13-4.24 (m, 2H), 5.41 (d, *J* = 5.0 Hz, 1H), 5.52 (d, *J* = 5.4 Hz, 1H), 6.45 (s, 1H), 6.66 (s, 1H).

4*H*-6-Ethoxycarbonyl-1,2,9,10-tetramethoxydibenzo[*de, g*]quinoline (20c): a colorless oil (5 %, R_f 0.4 with 1% MeOH-CH_2Cl_2); IR (neat) 1709, 1654, 1607, 1594, 1578, 1514 cm^{-1}; ^{1}H NMR (270 MHz) δ 1.32-1.38 (m, 3H), 2.82-2.91 (m, 1H), 3.39-3.47 (m, 1H), 3.65, 3.89 (each s, each 3H), 3.92 (s, 6H), 4.18-4.34 8 (m, 2H), 5.00-5.08 (m, 1H), 5.43 (d, *J* = 8.2 Hz, 1H), 6.46, 6.80 (each s, each 1H), 6.90 (d, *J* = 8.2 Hz, 1H), 8.06 (s, 1H); EI-MS *m/z* (rel. int.) 411 (M^+, 100), 394 [(M – Et)$^+$, 17], 307 [(M - COOEt) $^+$, 59]; HRMS calcd for $C_{23}H_{25}NO_6$ 411.1694, found 144.1682.

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