Supporting Information

CuBr/*rac*-BINOL-Catalyzed *N*-Arylations of Aliphatic Amines at Room Temperature

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General experimental procedures

All reactions were carried out under nitrogen atmosphere. DMF was dried over CaH_2 and freshly distilled before use. Proton and carbon magnetic resonance spectra (^1H NMR and ^{13}C NMR) were recorded with tetramethylsilane or solvent resonance as the internal standard (^1H NMR: TMS at 0.00 ppm, CDCl_3 at 7.24 ppm; ^{13}C NMR: CDCl_3 at 77.0 ppm).

General procedure A: room temperature coupling of aryl iodides with amines. A flask was charged with CuBr (28 mg, 0.2 mmol), 1,1'-binaphthyl-2,2'-diol (57 mg, 0.2 mmol), K_3PO_4 (424 mg, 2 mmol), and any remaining solids (amine and/or aryl halide). The flask was evacuated and backfilled with nitrogen (this procedure was repeated three times). Aryl halide (1 mmol, if liquid) and amine (1.5 mmol, if liquid), DMF (1 mL) were added to the flask under nitrogen atmosphere. The flask was sealed and the mixture was allowed to stir under nitrogen atmosphere at the shown temperature for the indicated period of time in text (see Table 2). After completion of the reaction, the mixture was diluted with ethyl acetate, the solution was filtered, and the inorganic salts were removed. The solvent of the filtrate was removed with the aid of a rotary evaporator, and the residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate (60:1 to 4:1) as eluent to provide the desired product.

4-Methyl-N-pentylbenzenamine (3a).¹ Yellow oil, yield 56%. ^1H NMR (CDCl_3 , 300 MHz) δ 7.06 (d, 2H, $J = 8.43$ Hz), 6.61 (d, 2H, $J = 8.43$ Hz), 3.35 (s, br, 1H), 3.15 (t, 2H, $J = 7.21$ Hz), 2.32 (s, 3H), 1.63-1.70 (m, 2H), 1.43-1.45 (m, 2H), 1.00-1.03 (m, 2H). ^{13}C NMR (CDCl_3 , 75 MHz) δ 146.2, 129.6, 126.1, 112.8, 44.3, 29.3, 22.5, 20.2, 14.0. HR-EI-MS M^+ m/z Calcd for $\text{C}_{12}\text{H}_{19}\text{N}$: 177.1517. Found: 177.1523. Elem. Anal. Calcd for $\text{C}_{12}\text{H}_{19}\text{N}$: C 81.30; H 10.80. Found: C 81.61; H 10.83.

***N*-Pentylbenzenamine (3b).**² Yellow oil, yield 65%. ¹H NMR (CDCl₃, 300 MHz) δ 7.17-7.26 (m, 2H), 6.70 (t, J = 6.87 Hz, 1H), 6.62 (d, J = 7.53 Hz, 2H), 3.12 (s, br, 1H), 1.64 (t, J = 6.87 Hz, 2H), 1.38-1.45 (m, 4H), 0.94 (t, J = 6.51 Hz, 3H). ¹³C NMR (CDCl₃, 75 MHz) δ 148.6, 129.3, 117.2, 117.2, 112.8, 44.1, 29.5, 29.4, 22.6, 14.2. HR-EI-MS M^+ m/z Calcd for C₁₁H₁₇N: 163.1361. Found: 163.1369. Elem. Anal. Calcd for C₁₁H₁₇N: C 80.93; H 10.50. Found: C 81.17; H 10.54.

4-Bromo-*N*-pentylbenzenamine (3c). Yellow oil, yield 80%. ¹H NMR (CDCl₃, 300 MHz) δ 7.20-7.25 (m, 2H), 6.43-6.48 (m, 2H), 3.49 (s, br, 1H), 3.05 (t, J = 6.89 Hz, 2H), 1.55-1.64 (m, 2H), 1.28-1.41 (m, 4H), 0.89-0.93 (t, J = 6.87 Hz, 3H). ¹³C NMR (CDCl₃, 75 MHz) δ 147.4, 131.8, 114.2, 108.5, 43.9, 29.2, 29.0, 23.4, 15.0. HR-EI-MS M^+ m/z Calcd for C₁₁H₁₆BrN: 241.0466. Found: 241.0475.

4-Chloro-*N*-pentylbenzenamine (3d).³ Yellow oil, yield 85%. ¹H NMR (CDCl₃, 300 MHz) δ 7.08-7.11 (m, 2H), 6.51 (d, J = 7.56 Hz, 2H), 3.38 (s, br, 1H), 3.05 (t, J = 6.81 Hz, 2H), 1.55-1.61 (m, 2H), 1.26-1.41 (m, 4H), 0.90 (t, J = 5.85 Hz, 3H). ¹³C NMR (CDCl₃, 75 MHz) δ 147.0, 129.0, 121.5, 113.7, 44.1, 29.2, 29.0, 22.5, 14.0. HR-EI-MS M^+ m/z Calcd for C₁₁H₁₆ClN: 197.0971. Found: 197.0982. Elem. Anal. Calcd for C₁₁H₁₆ClN: C 66.83; H 8.16. Found: C 66.75; H 8.19.

3-Nitro-*N*-pentylbenzenamine (3e). Yellow oil, yield 77%. ¹H NMR (CDCl₃, 300 MHz) δ 7.48 (d, 1H, 6.91 Hz), 7.36 (s, 1H), 7.21-7.26 (m, 1H), 6.84 (d, 1H, J = 7.23 Hz), 0.98 (s, br, 1H), 3.11-3.21 (m, 2H), 1.64 (t, 2H, 6.92 Hz), 1.36-1.41 (m, 4H), 0.90-0.94 (t, 3H, 6.65 Hz). ¹³C NMR (CDCl₃, 75 MHz) δ 149.3, 149.2, 129.6, 118.6, 111.5, 106.0, 43.7, 29.1, 28.8, 22.4, 14.9. HR-EI-MS M^+ m/z Calcd for C₁₁H₁₆N₂O₂:

208.1212. Found: 208.1221. Elem. Anal. Calcd for C₁₁H₁₆N₂O₂: C 63.44; H 7.74. Found: C 63.67; H 7.76.

N-Dodecylbenzenamine (3f).⁴ Milk-white oil, yield 83%. ¹H NMR (CDCl₃, 300 MHz) δ 7.15 (t, 2H, *J* = 7.58 Hz), 6.65 (t, 1H, *J* = 7.27 Hz), 6.56 (d, 2H, *J* = 7.91 Hz), 3.08 (t, 2H, *J* = 7.03 Hz), 1.56-1.62 (m, 2H), 1.25 (m, 18H), 0.87 (t, 3H, *J* = 6.00 Hz). ¹³C NMR (CDCl₃, 75 MHz) δ 148.5, 129.2, 117.0, 112.6, 44.0, 31.9, 29.6, 29.4, 29.3, 27.1, 22.7, 14.1. HR-EI-MS M⁺ m/z Calcd for C₁₈H₃₁N: 261.2457. Found: 261.2463. Elem. Anal. Calcd for C₁₈H₃₁N: C 82.69; H 11.95. Found: C 82.87; H 12.01.

4-Bromo-N-dodecylbenzenamine (3g). Yellow solid, yield 72%. ¹H NMR (CDCl₃, 300 MHz) δ 7.24 (d, 2H, *J* = 6.31 Hz), 6.46 (d, 2H, *J* = 6.31 Hz), 3.05 (t, 2H, *J* = 6.62 Hz), 1.58-1.60 (m, 2H), 1.28-1.37 (m, 18H), 0.88 (t, 3H, *J* = 6.62 Hz). ¹³C NMR (CDCl₃, 75 MHz) δ 147.5, 131.8, 114.2, 108.5, 43.7, 31.9, 29.6, 29.5, 29.4, 29.3, 27.1, 22.7, 15.1. HR-EI-MS M⁺ m/z Calcd for C₁₈H₃₀BrN: 339.1562. Found: 339.1555.

4-Chloro-N-dodecylbenzenamine (3h).⁵ Yellow oil, yield 83%. ¹H NMR (CDCl₃, 300 MHz) δ 7.11 (d, 8.71 Hz, 2H), 6.51 (d, *J* = 8.71 Hz, 2H), 3.06 (t, 6.92 Hz, 2H), 1.58-1.63 (m, 2H), 1.28-1.38 (m, 18H), 0.90 (t, *J* = 7.2 Hz, 3H). ¹³C NMR (CDCl₃, 75 MHz) δ 147.0, 129.0, 121.5, 113.6, 44.1, 31.9, 29.6, 29.5, 29.4, 29.3, 27.1, 22.7, 14.1. HR-EI-MS M⁺ m/z Calcd for C₁₈H₃₀ClN: 295.2067. Found: 295.2072. Elem. Anal. Calcd for C₁₈H₃₀ClN: C 73.07; H 10.22. Found: C 72.79; H 10.26.

N-Dodecyl-3-nitrobenzenamine (3i).⁶ Yellow oil, yield 77%. ¹H NMR (CDCl₃, 300 MHz) δ 7.48 (d, *J* = 6.87 Hz, 1H), 7.36 (s, 1H), 7.24-7.27 (m, 1H), 6.82-6.85 (m, 1H), 3.97 (s, br, 1H), 3.15 (t, *J* = 6.87 Hz, 2H), 1.59-1.68 (m, 1H). ¹³C NMR (CDCl₃, 75 MHz) δ 149.4, 149.2, 129.6, 118.6, 111.5, 106.0, 43.8, 31.9, 29.6, 29.5, 29.3, 29.2, 27.0, 22.7, 14.1. HR-EI-MS *M*⁺ *m/z* Calcd for C₁₈H₃₀N₂O₂: 306.2307. Found: 306.2301.

1-(4-Bromophenyl)pyrrolidine (3j).⁷ Yellow solid, yield 67%. mp 99-100 °C (lit.^[7] 98-100 °C) ¹H NMR (CDCl₃, 300 MHz) δ 7.24-7.28 (m, 2H), 6.41 (d, *J* = 8.91 Hz, 2H), 3.22 (t, *J* = 6.18 Hz, 4H), 2.97-2.01 (m, 4H). ¹³C NMR (CDCl₃, 75 MHz) δ 146.8, 131.6, 113.2, 107.1, 47.6, 25.4. HR-EI-MS *M*⁺ *m/z* Calcd for C₁₀H₁₂BrN: 225.0153. Found: 225.0142.

1-(4-Chlorophenyl)pyrrolidine (3k).⁸ White solid, yield 71%. mp 77-79 °C (lit.^[8] 73-78 °C). ¹H NMR (CDCl₃, 300 MHz) δ 7.14 (d, *J* = 8.74 Hz, 2H), 6.46 (d, *J* = 8.74 Hz, 2H), 3.25 (t, *J* = 6.67 Hz, 4H), 2.01 (t, *J* = 6.67 Hz, 4H). ¹³C NMR (CDCl₃, 75 MHz) δ 146.5, 128.8, 120.0, 112.6, 47.7, 25.4. HR-EI-MS *M*⁺ *m/z* Calcd for C₁₀H₁₂ClN: 181.0658. Found: 181.0667.

1-(Cyclopenta-2,4-dienyl)benzene (3l).⁹ Yellow oil, yield 52%. ¹H NMR (CDCl₃, 300 MHz) δ 7.55-7.57 (m, 4H), 7.39-7.41 (m, 1H), 7.28 (t, *J* = 2.4 Hz, 2H), 6.57 (t, *J* = 2.4 Hz, 2H). ¹³C NMR (CDCl₃, 75 MHz) δ 140.6, 129.4, 125.4, 120.3, 119.1, 110.3. HR-EI-MS *M*⁺ *m/z* Calcd for C₁₀H₉N: 143.0735. Found: 143.0727.

1-(4-Bromophenyl)-1H-pyrrole (3m).⁸ White solid, yield 51%. mp 95-98 °C (lit.^[8] 95-96 °C). ¹H NMR (CDCl₃, 300 MHz) δ 7.46-7.48 (m, 2H), 7.18-7.21(m, 2H), 6.99-7.00 (m, 2H), 6.31-6.33 (m, 2H). ¹³C NMR (CDCl₃, 75 MHz) δ 139.6, 132.5, 121.7, 119.1, 118.6, 110.8. HR-EI-MS M⁺ m/z Calcd for C₁₀H₈BrN: 220.9840. Found: 220.9849.

1-(4-Chlorophenyl)piperidine (3n).⁷ Yellow solid, yield 67%. mp 43-46 °C (lit.^[7] 40-44 °C) ¹H NMR (CDCl₃, 300 MHz) δ 7.17-7.20 (d, *J* = 6.87 Hz, 2H), 6.85 (d, *J* = 6.87 Hz, 2H), 3.12 (t, *J* = 5.12 Hz, 4H), 1.68-1.72 (m, 4H), 1.55-1.61 (m, 2H). ¹³C NMR (CDCl₃, 75 MHz) δ 150.8, 128.8, 123.9, 117.6, 50.6, 25.7, 24.1. HR-EI-MS M⁺ m/z Calcd for C₁₁H₁₄ClN: 195.0815. Found: 195.0825.

4-*p*-Tolylmorpholine (3o).¹⁰ Yellow oil, yield 54%. ¹H NMR (CDCl₃, 300 MHz) δ 7.07 (d, 2H, *J* = 6.8 Hz), 6.80-6.83 (m, 1H), 3.83 (t, 4H, *J* = 4.8 Hz), 3.07 (t, 4H, *J* = 4.8 Hz), 2.26 (d, 3H, *J* = 4.2 Hz). ¹³C NMR (CDCl₃, 75 MHz) δ 149.1, 129.6, 129.4, 116.0, 66.9, 49.0, 20.3. HR-EI-MS M⁺ m/z Calcd for C₁₁H₁₅NO: 177.1154. Found: 177.1151.

4-Phenylmorpholine (3p).¹¹ White solid, yield 73%. mp 51-54 °C (lit.^[11] 54 °C). ¹H NMR (CDCl₃, 300 MHz) δ 7.28 (t, 2H, *J* = 7.20 Hz), 6.89-6.94 (m, 3H), 3.86 (t, 4H, *J* = 4.47 Hz), 3.17 (t, 4H, *J* = 4.47 Hz). ¹³C NMR (CDCl₃, 75 MHz) δ 155.8, 129.8, 120.3, 115.4, 67.0, 49.6. HR-EI-MS M⁺ m/z Calcd for C₁₀H₁₃NO: 163.0997. Found: 163.1001.

4-(4-Chlorophenyl)morpholine (3q).¹² White solid, yield 75%. mp 73-75 °C (lit.^[12] 71-72 °C). ¹H NMR (CDCl₃, 300 MHz) δ 7.20-7.24 (m, 2H), 6.81-6.84 (m, 2H), 3.83-3.86 (m, 4H), 3.09-3.12 (m, 4H). ¹³C NMR (CDCl₃, 75 MHz) δ 149.9, 129.0, 124.9, 116.9, 66.7, 49.3. HR-EI-MS M⁺ m/z Calcd for C₁₀H₁₂ClNO: 197.0607. Found: 197.0613.

4-(3-Nitrophenyl)morpholine (3r).¹³ Yellow solid, yield 72%. mp 108-110 °C (lit.^[13] 104-105 °C). ¹H NMR (CDCl₃, 300 MHz) δ 7.68 (dd, *J* = 7.92, 1.71 Hz), 7.69 (s, 1H), 7.38 (t, *J* = 7.92, 1H), 7.17 (dd, *J* = 7.92, 1.71 Hz, 1H), 3.87 (t, 4.89Hz, 4H), 3.24 (t, 4.8 Hz, 4H). ¹³C NMR (CDCl₃, 75 MHz) δ 151.7, 149.2, 129.7, 120.8, 114.0, 109.3, 66.5, 48.4. HR-EI-MS M⁺ m/z Calcd for C₁₀H₁₂N₂O₃: 208.0848. Found: 208.0848.

N-Cyclohexylbenzenamine (3s).¹⁴ Colorless oil, yield 71%. ¹H NMR (CDCl₃, 300 MHz) δ 7.16 (t, 2H, *J* = 7.56 Hz), 6.66 (t, 1H, *J* = 8.25 Hz), 6.57 (d, 2H, *J* = 8.58 Hz), 3.42 (s, br, 1H), 3.19-3.28 (m, 1H), 2.02 -2.07 (m, 2H), 1.72-1.78 (m, 2H), 1.61-1.67 (m, 1H), 1.11-1.38 (m, 5H). ¹³C NMR (CDCl₃, 75 MHz) δ 147.3, 129.2, 116.7, 113.3, 51.6, 33.4, 25.9, 25.0. HR-EI-MS M⁺ m/z Calcd for C₁₂H₁₇N: 175.1361. Found: 175.1357. Elem. Anal. Calcd for C₁₂H₁₇N: C 82.23; H 9.78. Found: C 81.96; H 9.81.

4-Chloro-N-cyclohexylbenzenamine (3t).¹⁵ White solid, yield 71%. mp 41-43°C (lit.^[15] 42-44°C). ¹H NMR (CDCl₃, 300 MHz) δ 7.07 (t, 2H, *J* = 6.6 Hz), 6.48 (t, 2H, *J* = 6.6 Hz), 3.35 (s, br, 1H), 3.15-3.26 (m, 1H), 2.01-2.06 (m, 2H), 1.73-1.80 (m,

2H), 1.63-1.69 (m, 1H), 1.07-1.44 (m, 5H). ^{13}C NMR (CDCl_3 , 75 MHz) δ 145.9, 129.0, 121.1, 114.1, 51.8, 33.2, 25.8, 24.9. HR-EI-MS M^+ m/z Calcd for $\text{C}_{12}\text{H}_{16}\text{ClN}$: 209.0971. Found: 209.0977.

***N*-Cyclohexyl-3-nitrobenzenamine (3u).**¹⁶ Yellow solid, yield 62%. mp 75-78 °C. ^1H NMR (CDCl_3 , 300 MHz) δ 7.43-7.47 (m, 1H), 7.34-7.36 (m, 1H), 7.28 (t, 1H, J = 8.4 Hz), 6.80-6.84 (m, 1H), 3.95 (s, br, 1H), 3.27-3.32 (m, 1H), 2.02-2.19 (m, 2H), 1.75-1.81 (m, 2H), 1.62-1.69 (m, 1H), 1.16-1.44 (m, 5H). ^{13}C NMR (CDCl_3 , 75 MHz) δ 149.5, 148.0, 129.7, 118.9, 111.3, 106.4, 51.6, 33.0, 25.7, 24.8. HR-EI-MS M^+ m/z Calcd for $\text{C}_{12}\text{H}_{16}\text{N}_2\text{O}_2$: 220.1212. Found: 220.1204.

5-(4-Chlorophenylamino)pentan-1-ol (3v). Yellow oil, yield 72%. ^1H NMR (CDCl_3 , 300 MHz) δ 7.07-7.12 (m, 2H), 6.47-6.53 (m, 2H), 3.62 (t, J = 6.18 Hz, 2H), 3.06 (t, J = 6.87 Hz, 2H), 2.74 (s, br, 1H), 1.54-1.61 (m, 4H), 1.41-1.49 (m, 2H). ^{13}C NMR (CDCl_3 , 75 MHz) δ 146.8, 129.0, 121.6, 113.7, 62.5, 43.9, 32.3, 29.0, 23.2. HR-EI-MS $[\text{M}+\text{H}]^+$ m/z Calcd for $\text{C}_{11}\text{H}_{17}\text{ClNO}$: 214.0999. Found: 214.1003.

***N*-(4-Chlorophenyl)-valine methyl ester (3w).** Yellow oil, yield 61%. ^1H NMR (CDCl_3 , 300 MHz) δ 7.10 (d, 2H, J = 7.98 Hz), 6.54 (d, 2H, J = 7.98 Hz), 7.11 (s, br, 1H), 3.70 (s, 3H), 2.07-2.11 (m, 1H), 0.98-1.04 (m, 6H). ^{13}C NMR (CDCl_3 , 75 MHz) δ 173.9, 145.9, 129.1, 122.8, 114.6, 62.6, 51.9, 31.5, 19.0, 18.6. HR-EI-MS $[\text{M}+\text{H}]^+$ m/z Calcd for $\text{C}_{12}\text{H}_{17}\text{ClNO}_2$: 242.0948. Found: 242.0953.

(4-Methoxy-phenyl)-pentyl-amine (3z). Yellow oil, yield 55%. ^1H NMR (CDCl_3 , 300 MHz) δ 6.77 (d, $J = 8.94$ Hz, 2H), 6.57 (d, $J = 8.94$ Hz, 2H), 3.73 (s, 3H), 3.34 (s, br, 1H), 3.05 (t, $J = 6.87$ Hz, 2H), 1.62-1.82 (m, 2H), 1.34-1.38 (m, 4H), 0.91 (t, $J = 6.84$, 3H). ^{13}C NMR (CDCl_3 , 75 MHz) δ 152.0, 142.7, 114.8, 114.0, 55.8, 45.1, 29.3, 22.5, 14.0. HR-EI-MS M^+ m/z Calcd for $\text{C}_{12}\text{H}_{19}\text{NO}$: 193.1467. Found: 193.1479.

General procedure B: Coupling of Aryl Iodides with Amino Acids. The procedure is similar to General procedure A. 3.0 mmol of K_3PO_4 was used as the base, and the reaction temperature was maintained at 40 $^\circ\text{C}$ for 10 h. After the coupling the solution was cooled to 25 $^\circ\text{C}$, and water (5 mL) and Et_2O (5 mL) were added to the solution. The resulting solution was partitioned into two phases, the aqueous phase was separated, and the organic fraction was extracted with additional 10% NaOH (3×3 mL). The combined aqueous phase was neutralized to pH = 4 with 20% HCl, and extracted with Et_2O (3×20 mL). The resulting organic fraction was dried over MgSO_4 . After removal of the solvent, the residue was purified by column chromatography on silica gel to provide the target product.

N-Phenyl-3-aminoisobutyric acid (3x). Eluent: petroleum ether/ethyl acetate/methanol (30:10:1). Yellow oil, yield 72%. ^1H NMR (CDCl_3 , 300 MHz) δ 7.26 (s, br, 1H), 7.20 (t, 2H, $J = 7.56$ Hz), 6.78 (t, 1H, $J = 7.42$ Hz), 6.61 (d, 2H, $J = 7.56$ Hz), 3.93 (m, 1H), 2.55 (m, 2H), 1.27-1.31 (d, 3H, $J = 6.51$ Hz). ^{13}C NMR (CDCl_3 , 75 MHz) δ 177.2, 146.0, 129.4, 118.8, 114.5, 46.6, 40.6, 20.4. HR-ESI-MS $[\text{M}+\text{H}]^+$ m/z Calcd for $\text{C}_{10}\text{H}_{14}\text{NO}_2$: 180.1025. Found: 180.1033.

N-Phenyl-L-tryptophan (3y). Eluent: ethyl acetate/methanol (10:1). Yellow oil, yield 81%. ^1H NMR (DMSO- d_6 , 300 MHz) δ 7.52 (d, 2H, $J = 7.81$ Hz), 7.31 (d, 1H, $J = 7.82$ Hz), 7.16 (s, 1H), 6.92-7.05 (m, 4H), 6.48-6.55 (m, 3H), 4.11 (t, $J = 6.87$ Hz, 1H), 3.51 (s, br, 2H), 3.04-3.23 (m, 2H). ^{13}C NMR (DMSO- d_6 , 75 MHz) δ 175.6, 148.2, 136.5, 129.4, 127.7, 124.2, 121.5, 118.9, 118.7, 116.9, 112.9, 111.9, 110.5, 57.4, 28.5. HR-ESI-MS $[\text{M}+\text{H}]^+$ m/z Calcd for $\text{C}_{17}\text{H}_{17}\text{N}_2\text{O}_2$: 281.1290. Found: 281.1300.

References

- (1) Bowman, W. R.; Stephenson, P. T.; Terrett N. K.; Young, A. R. *Tetrahedron* **1995**, *51*, 7959.
- (2) Koelsch, C. F.; Carney, J. J. O. *J. Am. Chem. Soc.* **1950**, *72*, 2285.
- (3) Kumar, H. M. S.; Reddy, B.V. S.; Anjaneyulu, S.; Yadav, J. S. *Tetrahedron Letters*, **1999**, *40*, 8305.
- (4) Skrylev, I. D.; Sazonova, V. F.; Skryleva, T. L. *Ukrainskii Khimicheskii Zhurnal (Russ. Ed.)*. **1995**, *61*, 82.
- (5) Kumar, H. M. S.; Reddy, B. V. S.; Anjaneyulu, S.; Yadav, J. S. *Tetrahedron Letters*. **1999**, *40*, 8305.
- (6) Funatsu, E.; Kuraki, Y. *Jpn. Kokai Tokyo Koho*. **1990**, 27.
- (7) Xu, G.; Wang, Y.-G. *Org. Lett.* **2004**, *6*, 985.
- (8) Zhang, H.; Cai, Q.; Ma, D. *J. Org. Chem.* **2005**, *70*, 5164.
- (9) Manning, C.; McClory, M. R.; McCullough, J. J. *J. Org. Chem.* **1981**, *46*, 919.
- (10) Guinó, M.; Hii, K. K. *Tetrahedron Letters*, **2005**, *46*, 7363.
- (11) Brenner, E.; Schneider, R.; Fort, Y. *Tetrahedron* **1999**, *55*, 12829.
- (12) Pearson, A. J.; Gelormini, A. M. *J. Org. Chem.* **1994**, *59*, 4561.
- (13) Zim, D.; Buchwald, S. L. *Org. Lett.* **2003**, *5*, 2413.

- (14) Randell, K. D.; Johnston, B. D.; Green, D. F.; Pinto, B. M. *J. Org. Chem.* **2000**, 65, 220.
- (15) Cho, D. J.; Wu, C. J.; Sujith, S.; Han, W.-S.; Kang, S. O.; Lee, B. Y. *Organometallics*. **2006**, 25, 2133.
- (16) Markov, V. I.; L. Dmitrikova, V.; Dubina, V. L.; Burmistrov, K. S. *Zhurnal Organicheskoi Khimii* **1988**, 24, 2463.

ids-060700-H-N-pentylaniline-6.jdt
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3d

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ids-060725-65-H-single_pulse-63.tif
single_pulse

jd-060725-C-65-angle.pulse_dec-3.jcf
 angle.pulse decoupled gated NOE

single_pulse

id=06072-C-81-sample pulis dec-2.jdt
single pulse decoupled gated NOE

ids-060725-H-78-single_pulse-4.pdf
single_pulse

161-060725-C-78-single, pulse dec-2,1dft
single pulse decoupled gated NOE

Id: 060801-H-113-single_pulse-4.jdr
single_pulse

jd-060801-C-113-angle pulse dec-3.jdr
 single pulse decoupled gated NOE

jd-060713-H-96-sample-4.jdt
 sample_pulse

id-080718-C-06-single pulse dec-3.jif
single pulse decoupled gated NOE

Id: 060717-H-92-sample_pulse-4.jdt
 sample_pulse

X : parts per Million : 1H

zsm-060728-H-SC-N8-single_pulse-2.pdf
single_pulse

33x-100718-C-31X-imp1e_pulse_dec-2.jdt
single pulse decoupled gated NDE

jd5-060723-H-95-single_pulse-4.jdt
single_pulse

X: parts per Million: 1H

jd-C-060718-05-single pulse dec-3.jdt
single pulse decoupled gated NOE

jjk0077-H-90-sample_pulse-7.fid
sample_pulse

X : parts per Million : 1H

jd060727-C-90-angle pulse dec-4.jdt
single pulse decoupled gated NOE

jd-00709-H-4-p-oximorpholine-2.jdf
 sample_pulse

X: parts per Million: 1H

jd-160709-C-4-p-tolymorpholine-single-pulse-dec-5-2.jdt
single pulse decoupled gated NOE

jd-060902-H-204-single_pulse-4.jdr
single_pulse

jd-00076-H-88-sample_pulse-2.jdt
sample_pulse

jd-000726-C-88-sample_pulse_dec-3.jdf
 sample_pulse decoupled gated NOE

jis-060802-H-112-single_pulse-7.pdf
single_pulse

single pulse decoupled gated NOE

ids-000002-h-203-single_pulse-4.pdf
single_pulse

jet-030902-H-203-single pulse dec-2.jdt
single pulse decoupled gntet1 NOE

ids-060801-H-114-single_pulse-3.jdr
single_pulse

jid-06301-C-11-mg₂g₁ha₂ac⁻¹.jid
image puis decoupage grand VOE

ids-060801-H-116-single_pulse-7.pdf
single_pulse

X : parts per Million : 1H

jd-00001-C-116-single pulse dec-2.jdt
single pulse decoupled gated NOE

ids-060804-H-126-single_pulse-7.jiff
single_pulse

single pulse decoupled gated NOE

jdt-060827-H-190-single_pulse-3.jdt
 sample_pulse

file:06837-C-sample_puls dec-2.pdf
single pulse decoupled gated NOE

file:060317-H-184-single_pulse-3.pdf
single_pulse

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ids-060824-H-01-single_pulse-3.pdf
single_pulse

ft-060317-C-TF-sample_pulse_dec-1.jed
single pulse decoupled gated NOE

je-061119-e-angle_pulse dec-2.jdt
 angle pulse decoupled gated NOE.jdt