**Highly Regioselective Arylation of sp^3 C-H Bonds Catalyzed by Palladium
Acetate**

Vladimir G. Zaitsev, Dmitry Shabashov and Olafs Daugulis*

SUPPORTING INFORMATION

Experimental Section

General considerations. The coupling reactions were performed without special precautions in 1-dram screw-cap vials. Flash chromatography was performed on 60Å silica gel (Sorbent Technologies). GC analyses were performed on a Shimadzu GC-2010 chromatograph equipped with a Restek column (Rtx[®]-5, 15 m, 0.25 mm ID). The ¹H and ¹³C NMR spectra were recorded on a GE QE-300 spectrometer using residual solvent or TMS peak as a reference. Melting points were measured on a Mel-Temp apparatus and are uncorrected. Elemental analyses were performed by Atlantic Microlab Inc. of Norcross, GA. IR-spectra were obtained using a ThermoNicolet Avatar 370 FT-IR instrument.

Materials. Palladium acetate (J&J Materials) was used as obtained. Silver acetate was either used as received (Fischer) or freshly prepared from silver nitrate (Strem) and sodium acetate (EMD) in water. Butyric anhydride was purchased from Avocado. 8-Aminoquinoline is available from Aldrich. Picolinic acid, 4-iodoacetophenone, 4-iodotoluene, hydrocinnamoyl chloride, isobutyric anhydride, cyclohexanecarbonyl chloride, 3-iodobenzoic acid, thionyl chloride, propylamine, sec-butylamine, amylamine, 3-bromobenzylamine, 4-iodoanisole, 1-bromo-4-iodobenzene were purchased from Acros. Picolinoyl chloride hydrochloride was synthesized according to the literature procedure.¹ Propylpicolinamide is a known compound.^{2,3a} Amylpicolinamide may be obtained according to literature procedure.^{3b} 3-Iodobenzoyl chloride was prepared according to literature procedure.⁴

Preparation of 8-aminoquinoline amides

General procedure:

8-Aminoquinoline (1 equiv.) and NEt₃ (1.05 equiv.) were dissolved in dichloromethane (15 mL) followed by slow dropwise addition of acid anhydride or acid chloride (1.05 equiv.). The resulting mixture was stirred at room temperature for 6 hours. The mixture was transferred to a separating funnel and washed with water (15 mL), sat. NaHCO₃ (15 mL) and brine (15 mL). Organic layer was dried over MgSO₄. Filtration and evaporation of solvent gave the product.

8-Butylamidoquinoline (1): The general procedure was followed with 8-aminoquinoline (1.5 g, 10.4 mmol), NEt₃ (1.52 mL, 10.9 mmol) and butyric anhydride (1.78 mL, 10.9 mmol). Workup yielded 2.20 g (98%) of the amide as a brownish oil. R_f=0.34 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 9.82 (1H, br s) 8.83-8.77 (2H, m) 8.17 (1H, dd, J= 8.4, 1.6 Hz) 7.58-7.44 (3H, m) 2.56 (2H, t, J= 7.5 Hz) 1.87 (2H, sextet, J= 7.5 Hz) 1.07 (3H, t, J= 7.5 Hz). This compound has been reported previously.⁵

8-(3-Phenylpropionamido)quinoline (2): The general procedure was followed with 8-aminoquinoline (1.5 g, 10.4 mmol), NEt₃ (1.52 mL, 10.9 mmol) and hydrocinnamoyl chloride (1.72 mL, 10.9 mmol). Workup as above followed by crystallization from EtOAc-hexanes yielded 1.65 g (58%) of the amide as pale brown crystals, mp=65-66 °C (EtOAc/hexanes). R_f=0.33 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 9.84 (1H, br s) 8.83-8.75 (2H, m) 8.18 (1H, dd, *J*= 8.3, 1.3 Hz) 7.59-7.43 (3H, m) 7.32-7.28 (3H, m) 7.25-7.15 (2H, m) 3.19-3.12 (2H, m) 2.94-2.87 (2H, m). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 171.0, 148.1, 141.0, 138.3, 136.8, 134.6, 128.8, 128.6, 128.2, 127.7, 126.4, 121.7, 121.6, 117.0, 39.9, 31.7. FT-IR (neat, cm⁻¹) ν 3350, 1688. Anal. calcd. for C₁₈H₁₆N₂O: C 78.24, H 5.84, N 10.14. Found C 78.13, H 5.81, N 10.03.

8-Cyclohexanecarboxamidoquinoline (3): The general procedure was followed with 8-aminoquinoline (1.5 g, 10.4 mmol), NEt₃ (1.52 mL, 10.9 mmol) and cyclohexanecarbonyl chloride (1.46 mL, 10.9 mmol). Workup as above yielded 2.59 g (98%) of the amide as a brown oil. R_f=0.52 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 10.08 (1H, br s) 9.02-8.96 (2H, m) 8.35 (1H, dd, *J*= 8.2, 1.5 Hz) 7.76-7.61 (3H, m) 2.73-2.61 (1H, m) 2.32-2.22 (2H, m) 2.12-2.01 (2H, m) 1.97-1.74 (3H, m) 1.66-1.47 (3H, m). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 175.1, 148.2, 138.6, 136.5, 134.8, 128.1, 127.6, 121.7, 121.4, 116.6, 47.1, 30.0, 26.0. The signal for one aliphatic carbon could not be located. FT-IR (neat, cm⁻¹) ν 3354, 1683. Anal. calcd. for C₁₆H₁₈N₂O: C 75.56, H 7.13, N 11.01. Found C 75.31, H 7.13, N 11.04.

8-(2-Methylpropionamido)quinoline (5): The general procedure was followed with 8-aminoquinoline (1.5 g, 10.4 mmol), NEt₃ (1.52 mL, 10.9 mmol) and 2-methylpropionic anhydride (1.8 mL, 10.9 mmol). Workup as above yielded 2.1 g (94%) of the amide as a

brown oil. $R_f=0.36$ (EtOAc/hexanes 1/4). ^1H NMR (300 MHz, CDCl_3 , ppm) δ 9.91 (1H, br s) 8.83-8.78 (2H, m) 8.17 (1H, dd, $J=8.3, 1.6$ Hz) 7.58-7.48 (2H, m) 7.46 (1H, dd, $J=8.3, 4.4$ Hz) 2.78 (1H, septet, $J=6.9$ Hz) 1.36 (6H, d, $J=6.9$ Hz). ^{13}C NMR (75 MHz, CDCl_3 , ppm) δ 175.9, 148.2, 138.6, 136.5, 134.8, 128.1, 127.6, 121.7, 121.5, 116.6, 37.3, 19.9. FT-IR (neat, cm^{-1}) ν 3360, 1689. Anal. calcd. for $\text{C}_{13}\text{H}_{14}\text{N}_2\text{O}$: C 72.87, H 6.59, N 13.07. Found C 72.98, H 6.66, N 12.95.

8-(3-Iodobenzoyl)aminoquinoline (6): The general procedure was followed with 8-aminoquinoline (1.05 g, 7.3 mmol), NEt_3 (1.52 mL, 8.06 mmol) and a solution of 3-iodobenzoyl chloride (2.14 g, 8.06 mmol) in dichloromethane (5 mL). Workup as above followed by crystallization from EtOAc-hexanes yielded 2.29 g (83%) of the amide, mp=118-119 °C (EtOAc/hexanes). $R_f=0.40$ (EtOAc/hexanes 1/4). ^1H NMR (300 MHz, CDCl_3 , ppm) δ 10.68 (1H, br s) 8.90 (1H, dd, $J=7.0, 2.1$ Hz) 8.87 (1H, dd, $J=4.2, 1.6$ Hz) 8.41 (1H, dd, $J=1.6, 1.6$ Hz) 8.20 (1H, dd, $J=8.2, 1.6$ Hz) 8.05-8.00 (1H, m) 7.94-7.89 (1H, m) 7.64-7.54 (2H, m) 7.50 (1H, dd, $J=8.2, 1.4$ Hz) 7.33-7.25 (1H, m). ^{13}C NMR (75 MHz, CDCl_3 , ppm) δ 163.8, 148.5, 140.8, 138.8, 137.2, 136.7, 136.5, 134.4, 130.5, 128.1, 127.5, 126.4, 122.1, 121.9, 116.8, 94.8. FT-IR (neat, cm^{-1}) ν 3344, 1654. Anal. calcd. for $\text{C}_{16}\text{H}_{11}\text{IN}_2\text{O}$: C 51.36, H 2.96, N 7.49. Found C 51.02, H 2.88, N 7.32.

C-H activation experiments

The conversion in all cases was monitored by GC. The reactions were run in 2-dram vials.

8-(3-(4-Methoxyphenyl)butyramido)quinoline (entry 1, Table 1):

8-Butyramidoquinoline (150 mg, 0.7 mmol), $\text{Pd}(\text{OAc})_2$ (7.8 mg, 0.035 mmol), AgOAc (128 mg, 0.77 mmol), and 4-iodoanisole (655 mg, 2.8 mmol) were stirred at 110 °C for 5 minutes. Purification by flash chromatography (EtOAc/hexanes 1/5 to 1/3) gave 207 mg (92%) of the product as a viscous oil. $R_f=0.27$ (EtOAc/hexanes 1/4). ^1H NMR (300 MHz,

CDCl₃, ppm) δ 9.71 (1H, br s) 8.78-8.72 (2H, m) 8.11 (1H, dd, J = 8.3, 1.7 Hz) 7.53-7.43 (2H, m) 7.41 (1H, dd, J = 8.3, 4.2 Hz) 7.27-7.21 (2H, m) 6.86-6.81 (2H, m) 3.74 (3H, s) 3.71-3.59 (1H, m) 3.04 (1H, dd, J = 14.4, 7.1 Hz) 2.93 (1H, dd, J = 14.4, 8.0 Hz) 1.57 (3H, d, J = 7.1 Hz). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 170.4, 158.2, 148.1, 138.4, 138.1, 136.3, 134.6, 128.0, 127.8, 127.4, 121.6, 121.4, 116.5, 114.1, 55.2, 47.2, 36.2, 22.1. FT-IR (neat, cm⁻¹) ν 3350, 1683. Anal. calcd. for C₂₀H₂₀N₂O₂: C 74.98, H 6.29, N 8.74. Found C 75.05, H 6.28, N 8.63.

8-((3-Phenyl)-(3-(4-acetylphenyl)))propionamidoquinoline (entry 2, Table 1):

8-(3-Phenylpropionamido)-quinoline (138 mg, 0.5 mmol), Pd(OAc)₂ (2.2 mg, 0.01 mmol), AgOAc (92 mg, 0.55 mmol), and 4-iodoacetophenone (492 mg, 2.0 mmol) were stirred at 120 °C for 20 minutes. Purification by flash chromatography (EtOAc/hexanes 1/7 to 1/3) gave 118 mg (60%) of the product as a colorless crystalline material, mp=151-152 °C (EtOAc/hexanes). R_f=0.10 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 9.78 (1H, br s) 8.74 (1H, dd, J = 4.2, 1.7 Hz) 8.68 (1H, dd, J = 5.5, 3.6 Hz) 8.12 (1H, dd, J = 8.3, 1.5 Hz) 7.89-7.84 (2H, m) 7.49-7.40 (5H, m) 7.35-7.26 (4H, m) 7.23-7.16 (1H, m) 4.85 (1H, t, J = 7.7 Hz) 3.34 (2H, d, J = 7.7 Hz) 2.52 (3H, s). ¹³C NMR (75 MHz, DMSO-d₆, ppm) δ 197.3, 169.5, 149.8, 148.7, 143.6, 137.9, 136.5, 134.9, 134.4, 128.44, 128.36, 127.9, 127.7, 127.6, 126.8, 126.3, 122.0, 121.7, 116.5, 46.8, 41.6, 26.5. FT-IR (neat, cm⁻¹) ν 3337, 1672. Anal. calcd. for C₂₆H₂₂N₂O₂: C 79.16, H 5.62, N 7.10. Found C 78.72, H 5.62, N 7.01.

4-Phenyl-1,2,3,4-tetrahydro-1,10-phenantroline-2-one was obtained as a side product in the above reaction (42 mg, 31%). R_f=0.21 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 8.74 (1H, dd, J = 4.0, 1.6 Hz) 8.31 (1H, dd, J = 6.5, 2.5 Hz) 7.99 (1H, dd, J =8.3, 1.6 Hz) 7.55-7.45 (2H, m) 7.43-7.36 (2H, m) 7.31-7.11 (4H, m) 6.27 (1H, dd, J = 5.6, 2.7 Hz) 3.71 (1H, dd, J = 15.2, 5.6 Hz) 3.09 (1H, dd, J = 15.2, 2.7 Hz). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 166.9, 148.9, 141.0, 140.8, 135.9, 133.5, 129.1, 128.7, 127.9, 126.7, 126.3, 124.5, 122.1, 121.4, 58.9, 48.0.

8-(*cis, cis*-2,6-Di-(4-methoxyphenyl)cyclohexanecarboxamido)quinoline (4):

8-(Cyclohexanecarboxamido)quinoline (178 mg, 0.7 mmol), Pd(OAc)₂ (7.8 mg, 0.035 mmol), AgOAc (245 mg, 1.47 mmol), and 4-iodoanisole (655 mg, 2.8 mmol) were stirred at 120 °C for 1 hour. Purification by flash chromatography (EtOAc/hexanes 1/10 to 1/5) gave 181 mg (56%) of the product as a colorless crystalline material, mp=185-186 °C (EtOAc/hexanes). The structure was verified by X-ray crystallography. *R*_f=0.31 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 8.62 (1H, br s) 8.49 (1H, dd, *J*= 7.5, 1.3 Hz) 8.45 (1H, dd, *J*= 4.3, 1.6 Hz) 7.99 (1H, dd, *J*= 8.3, 1.6 Hz) 7.44-7.32 (2H, m) 7.31-7.18 (5H, m) 6.65-6.59 (4H, m) 3.51 (6H, s) 3.15-3.04 (3H, m) 2.79-2.62 (2H, m) 2.26-2.16 (1H, m) 1.82-1.72 (2H, m) 1.67-1.59 (1H, m). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 171.4, 158.1, 147.5, 138.1, 136.6, 135.8, 134.4, 128.6, 127.6, 127.2, 121.2, 121.0, 116.1, 113.8, 57.5, 55.1, 47.2, 26.9, 26.0. FT-IR (neat, cm⁻¹) ν 3348, 1674. Anal. calcd. for C₃₀H₃₀N₂O₃: C 77.23, H 6.48, N 6.00. Found C 77.00, H 6.60, N 6.12. The monoarylation product (13 mg, 5%; relative stereochemistry not determined) and *trans*-diaryl substituted product (31 mg, 9%) were also obtained.

8-(2-(4-Methoxyphenyl)cyclohexanecarboxamido)quinoline: *R*_f=0.43 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 9.25 (1H, br s) 8.67 (1H, dd, *J*= 7.3, 1.7 Hz) 8.62 (1H, dd, *J*= 4.3, 1.7 Hz) 8.07 (1H, dd, *J*= 8.3, 1.7 Hz) 7.49-7.33 (3H, m) 7.25-7.20 (2H, m) 6.72-6.65 (2H, m) 3.57 (3H, s) 3.07-2.96 (2H, m) 2.54-2.39 (1H, m) 2.28-2.18 (1H, m) 2.16-1.94 (2H, m) 1.91-1.73 (2H, m) 1.68-1.57 (1H, m) 1.56-1.39 (1H, m).

8-(*cis, trans*-2,6-Di-(4-methoxyphenyl)cyclohexanecarboxamido)quinoline: *R*_f=0.25 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 9.31 (1H, br s) 8.65 (1H, dd, *J*= 4.2, 1.7 Hz) 8.49 (1H, dd, *J*= 6.1, 3.0 Hz) 8.05 (1H, dd, *J*= 8.3, 1.7 Hz) 7.40-7.32 (5H, m) 7.31-7.26 (2H, m) 6.82-6.79 (2H, m) 6.66-6.61 (2H, m) 3.74 (3H, s) 3.54 (3H, s) 3.54-3.46 (2H, m) 3.32-3.25 (1H, m) 2.38-2.18 (2H, m) 2.06-1.90 (2H, m) 1.88-1.73 (2H, m).

Low temperature C-H activation:

8-(2,6-Di-(4-methoxyphenyl)cyclohexanecarboxamido)quinoline (entry 3, Table 1):

8-(Cyclohexanecarboxamido)-quinoline (178 mg, 0.7 mmol), Pd(OAc)₂ (7.8 mg, 0.035 mmol), AgOAc (245 mg, 1.47 mmol), and 4-iodoanisole (655 mg, 2.8 mmol) were stirred at 70 °C for 5 hours. Purification by flash chromatography (EtOAc/hexanes 1/10 to 1/5)

gave 2,6-*cis*-di-(4-methoxyphenyl)-substituted product (198 mg, 61%), 2,6-*trans*-di-(4-methoxyphenyl)-substituted product (37 mg, 8%) and 2-(4-methoxyphenyl)-substituted product (22 mg, 9%).

8-(Di-(*p,p'*-dimethylbenzhydryl)acetamido)quinoline (entry 4, Table 1): 8-(2-Methylpropionamido)-quinoline (150 mg, 0.7 mmol), Pd(OAc)₂ (7.8 mg, 0.035 mmol), AgOAc (479 mg, 2.87 mmol), and *p*-iodotoluene (915 mg, 4.2 mmol) were stirred at 120 °C for 30 minutes. Purification by flash chromatography (EtOAc/hexanes 1/10 to 1/7) gave 245 mg (61%) of the product as a colorless crystalline material, mp=107-108 °C (EtOAc/hexanes). *R*_f=0.42 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 9.21 (1H, br s) 8.57 (1H, dd, *J*= 4.2, 1.6 Hz) 8.52 (1H, dd, *J*= 5.9, 3.2 Hz) 8.05 (1H, dd, *J*= 8.3, 1.6 Hz) 7.39-7.33 (3H, m) 7.23-7.14 (8H, m) 7.01-6.91 (8H, m) 4.34 (2H, d, *J*= 8.2 Hz) 4.19 (1H, t, *J*= 8.2 Hz) 2.20 (6H, s) 2.16 (6H, s). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 171.0, 147.5, 140.4, 138.8, 138.3, 136.0, 135.8, 134.6, 129.4, 129.1, 129.0, 128.4, 127.7, 127.4, 124.3, 121.3, 121.0, 116.1, 58.4, 52.0, 21.1. FT-IR (neat, cm⁻¹) ν 3354, 1688. Anal. calcd. for C₄₁H₃₈N₂O: C 85.68, H 6.66, N 4.87. Found C 85.38, H 6.68, N 4.89.

8-((2-(4-bromophenyl))-5-iodobenzoylamino)quinoline: 8-(3-Iodobenzoylamino)-quinoline (262 mg, 0.7 mmol), Pd(OAc)₂ (4.7 mg, 0.021 mmol), AgOAc (128 mg, 0.77 mmol), and 4-bromoiodobenzene (792 mg, 2.8 mmol) were stirred at 120 °C for 30 minutes. Purification by flash chromatography (EtOAc/hexanes 1/6) gave 250 mg (67%) of the product as a colorless crystalline material, mp=183-184°C (EtOAc/hexanes). *R*_f=0.50 (EtOAc/hexanes 1/4). ¹H NMR (300 MHz, CDCl₃, ppm) δ 9.76 (1H, br s) 8.75 (1H, dd, *J*= 6.4, 2.2 Hz) 8.56 (1H, dd, *J*= 4.1, 1.3 Hz) 8.24 (1H, d, *J*= 1.8) 8.12 (1H, dd, *J*= 8.3, 1.5 Hz) 7.89 (1H, dd, *J*= 8.3, 1.6 Hz) 7.57-7.49 (2H, m) 7.45-7.32 (5H, m) 7.17 (1H, d, *J*= 8.3 Hz). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 166.0, 148.2, 139.8, 138.6, 138.50, 138.3, 138.1, 137.7, 136.3, 134.2, 132.2, 131.9, 130.6, 127.9, 127.4, 122.7, 122.1,

121.8, 116.8, 93.7. FT-IR (neat, cm^{-1}) ν 3353, 1673. Anal. calcd. for $\text{C}_{22}\text{H}_{14}\text{BrIN}_2\text{O}$: C 49.93, H 2.67, N 5.29. Found C 49.83, H 2.60, N 5.02.

C-H Activation with 0.1 mol% $\text{Pd}(\text{OAc})_2$

8-((2-(4-bromophenyl))-5-iodobenzoylamino)quinoline: (entry 5, Table 1):

8-(3-Iodobenzoyl)-aminoquinoline (374 mg, 1.0 mmol), $\text{Pd}(\text{OAc})_2$ (0.224 mg, 0.001 mmol; 47 μL of a 0.021M solution in acetic acid), AgOAc (183 mg, 1.1 mmol), and 4-bromoiodobenzene (1.41 g, 5.0 mmol) were stirred at 130 $^\circ\text{C}$ for 16 hours. Purification by flash chromatography (EtOAc /hexanes 1/5) gave 345 mg (65%) of the product.

General procedure for the synthesis of picolinamide starting materials. To a suspension of picolinoyl chloride hydrochloride¹ (0.89 g, 5 mmol) in dry THF (20 mL) was added neat amine (15 mmol) at 0 $^\circ\text{C}$. The reaction mixture was subsequently stirred for 30 min at RT. After addition of water (50 mL) the mixture was extracted with CH_2Cl_2 (3x50 mL), the extracts dried (MgSO_4) and the solution was filtered. After removal of the solvent (aspirator) the residue was filtered through a pad of silica gel in ethyl acetate-hexanes (1:1.5). Amylpicolinamide (**9**) may be prepared according to literature procedure.^{3b}

Propylpicolinamide (7) was prepared according to the general procedure. Light yellow oil, yield: 700 mg (85.3%). $R_f=0.13$ (hexanes:ethyl acetate 4/1). The product was identical with that described in literature.^{2,3a}

1-Methylpropylpicolinamide (8) was prepared according to general procedure. Light yellow solid, yield: 750 mg (83.6%). $R_f=0.18$ (hexanes:ethyl acetate 4/1). FT-IR (neat,

cm⁻¹) ν 1655, 3230. ¹H NMR (300 MHz, CDCl₃, ppm) δ 0.95 (d, 3H, J =7.4 Hz) 1.24 (d, 3H, J =6.8 Hz) 1.59-1.64 (m, 2H) 4.02-4.18 (m, 1H) 7.37-7.43 (m, 1H) 7.76-7.93 (m, 2H) 8.17-8.22 (m, 1H) 8.51-8.55 (m, 1H). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 10.4, 20.5, 29.7, 46.6, 112.1, 122.1, 137.2, 147.9, 150.1, 163.5.

3-Bromobenzylpicolinamide (10) was prepared according to the general procedure on one mmol scale with the following modification. One equiv. of amine was added to the suspension of picolinoyl chloride in dry THF (5 mL) followed by the addition of triethylamine (0.42 mL, 3 mmol) at 0 °C. After workup and filtration through silica gel (4:1 then 1.5:1 hexanes/ethyl acetate) followed by evaporation (aspirator) 230 mg (75.5%) of colorless oil was obtained. R_f =0.09 (hexanes:ethyl acetate 4/1). ¹H NMR (300 MHz, CDCl₃, ppm) δ 4.64 (d, 2H; J = 6.2 Hz) 7.17-7.35 (m, 2H) 7.40-7.56 (m, 3H) 7.80-7.87 (m, 1H) 8.21 (d, 1H, J = 8.1 Hz) 8.46 (br s, 1H) 8.51 (d, 1H, J =4.8 Hz). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 42.7, 122.2, 122.5, 126.2, 130.1, 130.4, 130.5, 130.6, 137.3, 140.6, 148.0, 149.5, 164.2. Found: %C 53.54, %H 3.79, %N 9.49. C₁₃H₁₁BrN₂O. Calculated: %C 53.63, %H 3.81, %N 9.62.

General procedure for arylation of picolinamides.

A mixture of picolinamide (1 mmol), palladium acetate (11 mg, 0.05 mmol), silver acetate (187 mg, 1.1 mmol) and iodoarene (4.0 mmol) in a screw-cap vial was heated and intensively stirred at 130-150 °C for 1-12 h. Products were isolated by flash chromatography. In order to get repeatable results, the starting amides need to be carefully purified. For example, if amylpicolinamide is overheated upon distillation, C-H activations from the particular batch of starting material show random reaction times that may be as low as 1-2 hours (instead of 12 hours for pure material).

3-(p-Methoxyphenyl)propylpicolinamide (Table 2, entry 1). Conditions: 6h at 130 °C. Purification by flash chromatography (toluene, then 2:1 hexanes/ethyl ether) afforded 205 mg (76%) of the product as a colorless oil. R_f = 0.3 (1:1 hexanes/ethyl ether). FT-IR (neat, cm⁻¹) ν 1669, 3390. ¹H NMR (300 MHz, CDCl₃, ppm) δ 1.96 (quintet, 2H, J = 7.2 Hz) 2.65 (t, 2H, J = 7.2 Hz) 3.48 (q, 2H, J = 7.2 Hz) 3.75 (s, 3H) 6.80-6.87 (m, 2H) 7.10-7.16 (m, 2H) 7.40-7.46 (m, 1H) 7.82-7.89 (m, 1H) 8.1 (br s, 1H) 8.18 (d, 1H, J = 7.8 Hz) 8.52-8.56 (m, 1H). ¹³C NMR (75 MHz, CDCl₃, ppm) δ 31.3, 32.2, 38.9, 55.1, 113.8, 122.0, 126.0, 129.0, 133.4, 137.2, 147.9, 149.9, 157.8, 164.2. Found: %C 70.93, %H 6.66, %N 10.22. C₁₆H₁₈N₂O₂. Calculated: %C 71.09, %H 6.71, %N 10.36.

3-(p-Bromophenyl)-1-methylpropylpicolinamide (Table 2, entry 2). Conditions: 1h at 150 °C. Purification by flash chromatography (toluene, then 3:1 hexanes/ethyl ether) afforded 240 mg (72%) of the product as a colorless oil. $R_f = 0.55$ (1:1 hexanes/ethyl ether). FT-IR (neat, cm^{-1}) ν 1671, 3370. ^1H NMR (300 MHz, CDCl_3 , ppm) δ 1.30 (d, 3H, $J = 7.3$ Hz) 1.78-1.93 (m, 2H) 2.67 (t, 2H, $J = 8.1$ Hz) 4.16-4.29 (m, 1H) 7.07 (d, 2H, $J = 8.1$ Hz) 7.37 (d, 2H, $J = 8.1$ Hz) 7.41-7.46 (m, 1H) 7.80-7.90 (m, 2H) 8.20 (d, 1H, $J = 7.5$ Hz) 8.54 (d, 1H, $J = 4.2$ Hz). ^{13}C NMR (75 MHz, CDCl_3 , ppm) δ 21.0, 31.8, 38.4, 44.8, 119.4, 122.1, 126.0, 130.0, 131.3, 137.2, 140.6, 147.8, 149.8, 163.5. Found: %C 57.54, %H 5.10, %N 8.18. $\text{C}_{16}\text{H}_{17}\text{BrN}_2\text{O}$. Calculated: %C 57.67, %H 5.14, %N 8.41.

3-(p-Methoxyphenyl)amylpicolinamide (Table 2, entry 3). Conditions: 12h at 150 °C. Purification by flash chromatography (toluene, then 5:1, and then 2:1 hexanes/ethyl ether) afforded 160 mg (54%) of the product as a pale yellow oil. $R_f = 0.35$ (1:1 hexanes/ethyl ether). Starting amylpicolinamide (65 mg, 33%) was recovered from initial fractions (5:1 hexanes/ether). FT-IR (neat, cm^{-1}) ν 1673, 3395. ^1H NMR (300 MHz, CDCl_3 , ppm) δ 0.76 (t, 3H, $J = 6.9$ Hz) 1.50-1.90 (m, 3H) 1.96-2.10 (m, 1H) 2.43-2.56 (m, 1H) 3.24-3.38 (m, 2H) 3.78 (s, 3H) 6.80-6.90 (m, 2H) 7.06-7.14 (m, 2H) 7.36-7.44 (m, 1H) 7.82 (tt, 1H, $J = 1.8, 8.1$ Hz) 7.95 (br s, 1H) 8.16 (d, 1H, $J = 8.1$ Hz) 8.51 (d, 1H; $J = 4.4$ Hz). ^{13}C NMR (75 MHz, CDCl_3 , ppm) δ 12.0, 29.9, 36.2, 38.0, 44.8, 55.1, 113.8, 122.0, 125.9, 128.4, 136.5, 137.2, 147.9, 149.9, 157.9, 164.1. Found: %C 72.18, %H 7.45, %N 9.11. $\text{C}_{18}\text{H}_{22}\text{N}_2\text{O}_2$. Calculated: %C 72.41, %H 7.43, %N 9.39.

5-Bromo-2-(4-bromophenyl)benzylpicolinamide (Table 2, entry 4). Conditions: 5h at 150 °C. Purification by flash chromatography (toluene, then 3:1 hexanes/ethyl ether) afforded 360 mg (81%) of the product as a white solid. $R_f = 0.4$ (1:1 hexanes/ethyl ether), mp=110-111 °C (hexanes). FT-IR (neat, cm^{-1}) ν 1645, 3295. ^1H NMR (300 MHz, CDCl_3 , ppm) δ 4.54 (d, 2H, $J = 5.7$ Hz) 7.10-7.65 (m, 8H) 7.86 (dt, 1H, $J = 1.5, 7.8$ Hz) 8.18 (d, 1H, $J = 8.4$ Hz) 8.25 (br s, 1H) 8.54 (dd, 1H, $J = 1.5, 5.1$ Hz). ^{13}C NMR (75 MHz, CDCl_3 , ppm) δ 40.8, 121.9, 122.1, 122.3, 126.0, 130.5, 130.6, 131.2, 131.5, 131.8, 137.4, 137.7,

138.4, 139.2, 148.0, 149.3, 164.2. Found: %C 51.17, %H 3.09, %N 6.18. C₁₉H₁₄Br₂N₂O. Calculated: %C 51.15, %H 3.16, %N 6.28.

Complex 11. A mixture of Pd(OAc)₂ (0.112 g, 0.5 mmol), benzylamide of picolinic acid⁶ (0.106 g, 0.5 mmol) and acetic acid (1 mL) was heated in a sealed tube at 110 °C for 1h. NMR of crude reaction mixture showed that at least 80% of the material was **11**, together with *ca.* 5% of the starting material and an unknown impurity. If reaction was run in CHCl₃ under the same conditions, only **11** was observed in the crude mixture by NMR. The crystallization of acetic acid reaction product from acetic acid-water afforded **11** as dark orange crystals, 88 mg (48.8%). The structure was verified by X-ray crystallography. ¹H NMR (300 MHz, CDCl₃) δ 2.13 (s, 3H) 3.11 (d, 1H, *J*= 14.1 Hz) 4.14 (d, 1H, *J*= 14.1 Hz) 7.15-7.44 (m, 6H) 7.62-7.73 (m, 1H) 7.86-8.01 (m, 2H). ¹³C NMR (75 MHz, CDCl₃) δ 24.3, 48.9, 125.9, 126.4, 126.9, 128.3, 128.4, 140.3, 140.8, 146.5, 155.2, 170.2, 185.1. Anal. calcd. for C₃₀H₂₈N₄O₆Pd₂: C 47.83, H 3.75, N 7.44. Found C 47.37, H 3.58, N 7.29.

X-Ray Data for 4.

All measurements were made with a Siemens SMART platform diffractometer equipped with a 1K CCD area detector. A hemisphere of data (1271 frames at 5 cm detector distance) was collected using a narrow-frame method with scan widths of 0.30° in omega and an exposure time of 25 s/frame. The first 50 frames were re-measured at the end of data collection to monitor instrument and crystal stability, and the maximum correction on I was <1%. The data were integrated using the Siemens SAINT program, with the intensities corrected for Lorentz factor, polarization, air absorption, and absorption due to variation in the path length through the detector faceplate. A psi scan absorption correction was applied based on the entire data set. Redundant reflections were averaged. Final cell constants were refined using 5295 reflections having *I*>10σ(*I*), and these, along with other information pertinent to data collection and refinement, are listed in Table 1. The Laue symmetry was determined to be 2/m, and from the systematic absences noted the space group was shown unambiguously to be P2(1)/c.

Acknowledgment for use of MRSEC/TCSUH Facilities:

This work made use of MRSEC/TCSUH Shared Experimental Facilities supported by the National Science Foundation under Award Number DMR-9632667 and the Texas Center for Superconductivity at the University of Houston.

Table S1. Crystal data and structure refinement for **4**.

Empirical formula	C30 H30 N2 O3
Formula weight	466.56

Temperature	223(2) K
Wavelength	0.71073 Å
Crystal system, space group	Monoclinic, P2(1)/c
Unit cell dimensions	a = 15.6660(16) Å alpha = 90 deg. b = 14.2237(15) Å beta = 102.645(2) deg. c = 11.4188(12) Å gamma = 90 deg.
Volume	2482.7(4) Å ³
Z, Calculated density	4, 1.248 Mg/m ³
Absorption coefficient	0.081 mm ⁻¹
F(000)	992
Crystal size	0.40 x 0.35 x 0.25 mm
Theta range for data collection	1.33 to 23.57 deg.
Limiting indices	-17<=h<=17, 0<=k<=15, 0<=l<=12
Reflections collected / unique	11494 / 3861 [R(int) = 0.0573]
Completeness to theta = 23.57	99.5 %
Absorption correction	Empirical
Max. and min. transmission	0.9388 and 0.7307
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	2566 / 0 / 322
Goodness-of-fit on F ²	1.158
Final R indices [I>4sigma(I)]	R1 = 0.0374, wR2 = 0.0933
R indices (all data)	R1 = 0.0619, wR2 = 0.1205
Extinction coefficient	0.0076(11)
Largest diff. peak and hole	0.210 and -0.204 e.Å ⁻³

Figure S1. View of **4** showing the atom numbering scheme. Thermal ellipsoids are 40% equiprobability envelopes, with all hydrogens except that attached to N omitted.

Table S2. Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **4**. $U(\text{eq})$ is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x	y	z	$U(\text{eq})$
O(1)	7672(1)	4377(1)	7326(1)	47(1)
O(2)	6039(1)	-118(1)	5816(2)	63(1)
O(3)	8092(1)	7544(1)	3165(1)	50(1)
N(1)	6821(1)	3775(1)	5632(2)	35(1)
N(2)	5509(1)	3161(1)	3926(2)	42(1)
C(1)	8387(1)	3572(1)	5934(2)	35(1)
C(2)	8731(1)	2646(1)	6606(2)	40(1)
C(3)	9168(1)	2836(2)	7915(2)	50(1)
C(4)	9904(2)	3549(2)	8009(2)	53(1)
C(5)	9601(1)	4463(2)	7354(2)	46(1)

C(6)	9144(1)	4297(1)	6053(2)	38(1)
C(7)	7600(1)	3959(1)	6368(2)	34(1)
C(8)	5971(1)	3905(1)	5829(2)	36(1)
C(9)	5780(1)	4321(2)	6832(2)	44(1)
C(10)	4896(2)	4414(2)	6909(2)	53(1)
C(11)	4226(2)	4114(2)	6030(2)	53(1)
C(12)	4401(1)	3672(2)	4994(2)	45(1)
C(13)	3751(2)	3332(2)	4034(3)	59(1)
C(14)	3987(2)	2920(2)	3069(3)	61(1)
C(15)	4876(2)	2857(2)	3061(2)	52(1)
C(16)	5281(1)	3569(1)	4897(2)	38(1)
C(17)	8038(1)	1887(1)	6421(2)	40(1)
C(18)	7392(1)	1845(2)	7097(2)	44(1)
C(19)	6745(1)	1169(2)	6875(2)	48(1)
C(20)	6716(1)	517(2)	5968(2)	47(1)
C(21)	7344(2)	539(2)	5288(2)	51(1)
C(22)	7996(2)	1219(2)	5535(2)	48(1)
C(23)	5996(2)	-840(2)	4953(3)	66(1)
C(24)	8846(1)	5180(1)	5329(2)	35(1)
C(25)	8890(1)	6069(1)	5837(2)	42(1)
C(26)	8637(1)	6871(2)	5151(2)	43(1)
C(27)	8333(1)	6794(1)	3931(2)	38(1)
C(28)	8262(1)	5913(2)	3401(2)	42(1)
C(29)	8519(1)	5128(2)	4094(2)	41(1)
C(30)	8189(2)	8454(2)	3678(2)	61(1)

Table S3. Bond lengths [Å] and angles [deg] for **4**.

O(1)-C(7)	1.229(2)
O(2)-C(20)	1.374(3)
O(2)-C(23)	1.414(3)
O(3)-C(27)	1.379(2)
O(3)-C(30)	1.416(3)
N(1)-C(7)	1.347(3)
N(1)-C(8)	1.412(2)
N(2)-C(15)	1.309(3)
N(2)-C(16)	1.367(3)
C(1)-C(7)	1.528(3)
C(1)-C(6)	1.555(3)
C(1)-C(2)	1.560(3)
C(2)-C(17)	1.513(3)
C(2)-C(3)	1.526(3)
C(3)-C(4)	1.523(3)

C(4)-C(5)	1.522(3)
C(5)-C(6)	1.521(3)
C(6)-C(24)	1.519(3)
C(8)-C(9)	1.378(3)
C(8)-C(16)	1.423(3)
C(9)-C(10)	1.412(3)
C(10)-C(11)	1.352(3)
C(11)-C(12)	1.419(3)
C(12)-C(13)	1.409(3)
C(12)-C(16)	1.414(3)
C(13)-C(14)	1.368(4)
C(14)-C(15)	1.398(3)
C(17)-C(22)	1.379(3)
C(17)-C(18)	1.402(3)
C(18)-C(19)	1.379(3)
C(19)-C(20)	1.385(3)
C(20)-C(21)	1.380(3)
C(21)-C(22)	1.390(3)
C(24)-C(25)	1.386(3)
C(24)-C(29)	1.394(3)
C(25)-C(26)	1.391(3)
C(26)-C(27)	1.375(3)
C(27)-C(28)	1.385(3)
C(28)-C(29)	1.378(3)

C(20)-O(2)-C(23)	118.89(18)
C(27)-O(3)-C(30)	117.06(18)
C(7)-N(1)-C(8)	129.26(18)
C(15)-N(2)-C(16)	117.61(18)
C(7)-C(1)-C(6)	112.73(16)
C(7)-C(1)-C(2)	111.14(15)
C(6)-C(1)-C(2)	110.05(16)
C(17)-C(2)-C(3)	114.68(17)
C(17)-C(2)-C(1)	111.92(17)
C(3)-C(2)-C(1)	111.43(18)
C(4)-C(3)-C(2)	110.93(18)
C(3)-C(4)-C(5)	112.63(18)
C(6)-C(5)-C(4)	112.17(19)
C(5)-C(6)-C(24)	115.23(18)
C(5)-C(6)-C(1)	112.03(17)
C(24)-C(6)-C(1)	111.34(16)
O(1)-C(7)-N(1)	122.86(18)
O(1)-C(7)-C(1)	122.72(18)
N(1)-C(7)-C(1)	114.38(17)
C(9)-C(8)-N(1)	125.0(2)
C(9)-C(8)-C(16)	119.85(18)

N(1)-C(8)-C(16)	115.17(17)
C(8)-C(9)-C(10)	119.1(2)
C(11)-C(10)-C(9)	122.4(2)
C(10)-C(11)-C(12)	119.9(2)
C(13)-C(12)-C(16)	117.0(2)
C(13)-C(12)-C(11)	124.2(2)
C(16)-C(12)-C(11)	118.7(2)
C(14)-C(13)-C(12)	119.8(2)
C(13)-C(14)-C(15)	118.5(2)
N(2)-C(15)-C(14)	124.4(2)
N(2)-C(16)-C(12)	122.6(2)
N(2)-C(16)-C(8)	117.36(17)
C(12)-C(16)-C(8)	120.02(19)
C(22)-C(17)-C(18)	116.7(2)
C(22)-C(17)-C(2)	120.79(18)
C(18)-C(17)-C(2)	122.46(19)
C(19)-C(18)-C(17)	121.3(2)
C(18)-C(19)-C(20)	120.41(19)
O(2)-C(20)-C(21)	124.7(2)
O(2)-C(20)-C(19)	115.64(18)
C(21)-C(20)-C(19)	119.7(2)
C(20)-C(21)-C(22)	119.0(2)
C(17)-C(22)-C(21)	122.91(19)
C(25)-C(24)-C(29)	116.51(19)
C(25)-C(24)-C(6)	123.02(19)
C(29)-C(24)-C(6)	120.47(18)
C(24)-C(25)-C(26)	122.0(2)
C(27)-C(26)-C(25)	119.87(19)
C(26)-C(27)-O(3)	124.57(18)
C(26)-C(27)-C(28)	119.46(19)
O(3)-C(27)-C(28)	115.97(19)
C(29)-C(28)-C(27)	119.8(2)
C(28)-C(29)-C(24)	122.3(2)

Table S4. Anisotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **4**. The anisotropic displacement factor exponent takes the form: $-2 \pi^2 [h^2 a^{*2} U_{11} + \dots + 2hka^*b^*U_{12}]$

	U11	U22	U33	U23	U13	U12
O(1)	46(1)	53(1)	46(1)	-13(1)	18(1)	-1(1)

O(2)	72(1)	58(1)	71(1)	-9(1)	40(1)	-20(1)
O(3)	52(1)	38(1)	58(1)	5(1)	7(1)	2(1)
N(1)	35(1)	39(1)	36(1)	-4(1)	15(1)	2(1)
N(2)	42(1)	40(1)	47(1)	0(1)	14(1)	-3(1)
C(1)	38(1)	32(1)	38(1)	2(1)	17(1)	2(1)
C(2)	42(1)	36(1)	49(1)	6(1)	24(1)	8(1)
C(3)	47(1)	52(1)	52(1)	13(1)	15(1)	10(1)
C(4)	45(1)	61(2)	51(1)	9(1)	7(1)	7(1)
C(5)	37(1)	51(1)	49(1)	2(1)	10(1)	-1(1)
C(6)	35(1)	38(1)	45(1)	2(1)	17(1)	2(1)
C(7)	40(1)	27(1)	37(1)	2(1)	16(1)	0(1)
C(8)	38(1)	29(1)	46(1)	7(1)	21(1)	5(1)
C(9)	49(1)	40(1)	49(1)	1(1)	24(1)	6(1)
C(10)	60(2)	47(1)	61(2)	7(1)	37(1)	14(1)
C(11)	43(1)	49(1)	77(2)	20(1)	33(1)	14(1)
C(12)	36(1)	40(1)	62(2)	17(1)	19(1)	6(1)
C(13)	35(1)	58(2)	84(2)	24(1)	13(1)	-1(1)
C(14)	48(2)	61(2)	71(2)	6(1)	3(1)	-11(1)
C(15)	51(2)	49(1)	54(2)	-2(1)	8(1)	-8(1)
C(16)	39(1)	30(1)	48(1)	10(1)	17(1)	2(1)
C(17)	49(1)	32(1)	45(1)	10(1)	25(1)	9(1)
C(18)	54(1)	42(1)	44(1)	3(1)	28(1)	6(1)
C(19)	55(1)	47(1)	51(1)	4(1)	34(1)	1(1)
C(20)	55(1)	39(1)	52(1)	9(1)	26(1)	0(1)
C(21)	73(2)	38(1)	54(1)	0(1)	37(1)	0(1)
C(22)	62(2)	38(1)	56(1)	5(1)	40(1)	5(1)
C(23)	83(2)	50(2)	74(2)	-5(1)	33(2)	-14(1)
C(24)	31(1)	37(1)	42(1)	-1(1)	15(1)	-3(1)
C(25)	50(1)	39(1)	38(1)	-4(1)	14(1)	-8(1)
C(26)	51(1)	31(1)	50(1)	-5(1)	16(1)	-5(1)
C(27)	33(1)	35(1)	48(1)	4(1)	13(1)	-1(1)
C(28)	45(1)	41(1)	40(1)	-2(1)	9(1)	-4(1)
C(29)	48(1)	32(1)	46(1)	-6(1)	15(1)	-4(1)
C(30)	78(2)	35(1)	71(2)	6(1)	22(1)	2(1)

Table S5. Hydrogen coordinates (x 10⁴) and isotropic displacement parameters (Å² x 10³) for **4**.

	x	y	z	U(eq)
H(1N)	6802(13)	3463(15)	4950(20)	42
H(1)	8188	3417	5072	42

H(2)	9199	2411	6223	48
H(3A)	8732	3075	8338	60
H(3B)	9403	2247	8301	60
H(4A)	10372	3275	7672	63
H(4B)	10147	3687	8858	63
H(5A)	9200	4787	7767	55
H(5B)	10108	4872	7382	55
H(6)	9586	4001	5670	46
H(9)	6231	4539	7456	53
H(10)	4769	4695	7596	63
H(11)	3646	4198	6106	64
H(13)	3157	3388	4055	71
H(14)	3561	2684	2426	74
H(15)	5030	2579	2389	62
H(18)	7400	2285	7713	53
H(19)	6320	1152	7343	57
H(21)	7331	100	4669	61
H(22)	8427	1224	5077	57
H(23A)	5487	-1230	4948	100
H(23B)	6521	-1222	5153	100
H(23C)	5950	-563	4165	100
H(25)	9096	6131	6671	50
H(26)	8675	7464	5522	52
H(28)	8039	5852	2570	50
H(29)	8472	4535	3720	50
H(30A)	7965	8918	3065	91
H(30B)	8804	8576	4011	91
H(30C)	7866	8493	4311	91

Table S6. Torsion angles [deg] for **4**.

C(7)-C(1)-C(2)-C(17)	59.6(2)
C(6)-C(1)-C(2)-C(17)	-174.80(16)
C(7)-C(1)-C(2)-C(3)	-70.3(2)
C(6)-C(1)-C(2)-C(3)	55.3(2)
C(17)-C(2)-C(3)-C(4)	175.39(17)
C(1)-C(2)-C(3)-C(4)	-56.2(2)
C(2)-C(3)-C(4)-C(5)	55.2(3)
C(3)-C(4)-C(5)-C(6)	-53.8(3)
C(4)-C(5)-C(6)-C(24)	-178.26(17)
C(4)-C(5)-C(6)-C(1)	53.1(2)
C(7)-C(1)-C(6)-C(5)	71.1(2)

C(2)-C(1)-C(6)-C(5)	-53.6(2)
C(7)-C(1)-C(6)-C(24)	-59.6(2)
C(2)-C(1)-C(6)-C(24)	175.75(16)
C(8)-N(1)-C(7)-O(1)	-7.9(3)
C(8)-N(1)-C(7)-C(1)	169.99(17)
C(6)-C(1)-C(7)-O(1)	-47.2(3)
C(2)-C(1)-C(7)-O(1)	76.9(2)
C(6)-C(1)-C(7)-N(1)	134.87(18)
C(2)-C(1)-C(7)-N(1)	-101.0(2)
C(7)-N(1)-C(8)-C(9)	4.7(3)
C(7)-N(1)-C(8)-C(16)	-175.27(18)
N(1)-C(8)-C(9)-C(10)	179.40(19)
C(16)-C(8)-C(9)-C(10)	-0.6(3)
C(8)-C(9)-C(10)-C(11)	-0.3(3)
C(9)-C(10)-C(11)-C(12)	1.1(3)
C(10)-C(11)-C(12)-C(13)	179.7(2)
C(10)-C(11)-C(12)-C(16)	-1.0(3)
C(16)-C(12)-C(13)-C(14)	0.4(3)
C(11)-C(12)-C(13)-C(14)	179.7(2)
C(12)-C(13)-C(14)-C(15)	-0.7(4)
C(16)-N(2)-C(15)-C(14)	-0.4(3)
C(13)-C(14)-C(15)-N(2)	0.7(4)
C(15)-N(2)-C(16)-C(12)	0.0(3)
C(15)-N(2)-C(16)-C(8)	-179.44(18)
C(13)-C(12)-C(16)-N(2)	0.0(3)
C(11)-C(12)-C(16)-N(2)	-179.39(19)
C(13)-C(12)-C(16)-C(8)	179.41(19)
C(11)-C(12)-C(16)-C(8)	0.0(3)
C(9)-C(8)-C(16)-N(2)	-179.78(18)
N(1)-C(8)-C(16)-N(2)	0.2(3)
C(9)-C(8)-C(16)-C(12)	0.8(3)
N(1)-C(8)-C(16)-C(12)	-179.28(17)
C(3)-C(2)-C(17)-C(22)	-136.5(2)
C(1)-C(2)-C(17)-C(22)	95.3(2)
C(3)-C(2)-C(17)-C(18)	46.0(3)
C(1)-C(2)-C(17)-C(18)	-82.2(2)
C(22)-C(17)-C(18)-C(19)	-0.4(3)
C(2)-C(17)-C(18)-C(19)	177.2(2)
C(17)-C(18)-C(19)-C(20)	-0.4(3)
C(23)-O(2)-C(20)-C(21)	3.7(3)
C(23)-O(2)-C(20)-C(19)	-176.4(2)
C(18)-C(19)-C(20)-O(2)	-179.3(2)
C(18)-C(19)-C(20)-C(21)	0.6(3)
O(2)-C(20)-C(21)-C(22)	-180.0(2)
C(19)-C(20)-C(21)-C(22)	0.1(3)
C(18)-C(17)-C(22)-C(21)	1.1(3)

C(2)-C(17)-C(22)-C(21)	-176.5(2)
C(20)-C(21)-C(22)-C(17)	-1.0(4)
C(5)-C(6)-C(24)-C(25)	-7.4(3)
C(1)-C(6)-C(24)-C(25)	121.6(2)
C(5)-C(6)-C(24)-C(29)	171.97(17)
C(1)-C(6)-C(24)-C(29)	-59.0(2)
C(29)-C(24)-C(25)-C(26)	-1.3(3)
C(6)-C(24)-C(25)-C(26)	178.07(18)
C(24)-C(25)-C(26)-C(27)	0.1(3)
C(25)-C(26)-C(27)-O(3)	-177.94(18)
C(25)-C(26)-C(27)-C(28)	1.5(3)
C(30)-O(3)-C(27)-C(26)	1.8(3)
C(30)-O(3)-C(27)-C(28)	-177.69(19)
C(26)-C(27)-C(28)-C(29)	-1.8(3)
O(3)-C(27)-C(28)-C(29)	177.68(17)
C(27)-C(28)-C(29)-C(24)	0.6(3)
C(25)-C(24)-C(29)-C(28)	1.0(3)
C(6)-C(24)-C(29)-C(28)	-178.41(18)

X-Ray Data for 11.

All measurements were made with a Siemens SMART platform diffractometer equipped with a 1K CCD area detector. A hemisphere of data (1271 frames at 5 cm detector distance) was collected using a narrow-frame method with scan widths of 0.30° in omega and an exposure time of 25 s/frame. The first 50 frames were re-measured at the end of data collection to monitor instrument and crystal stability, and the maximum correction on I was <1%. The data were integrated using the Siemens SAINT program, with the intensities corrected for Lorentz factor, polarization, air absorption, and absorption due to variation in the path length through the detector faceplate. A psi scan absorption correction was applied based on the entire data set. Redundant reflections were averaged. Final cell constants were refined using 5915 reflections having $I > 10\sigma(I)$, and these, along with other information pertinent to data collection and refinement, are listed in Table 1. The Laue symmetry was determined to be 2/m, and from the systematic absences noted the space group was shown to be either Cc or C2/c. The asymmetric unit consists of one-half dimer situated about a two-fold axis.

Acknowledgment for use of MRSEC/TCSUH Facilities:

This work made use of MRSEC/TCSUH Shared Experimental Facilities supported by the National Science Foundation under Award Number DMR-9632667 and the Texas Center for Superconductivity at the University of Houston.

Table S7. Crystal data and structure refinement for **11**.

Empirical formula	C ₃₀ H ₂₈ N ₄ O ₆ Pd ₂
Formula weight	753.36
Temperature	218(2) K
Wavelength	0.71073 Å
Crystal system, space group	Monoclinic, C2/c
Unit cell dimensions	a = 15.7191(7) Å alpha = 90 deg. b = 15.8526(7) Å beta = 110.888(1) deg. c = 12.4020(6) Å gamma = 90 deg.
Volume	2887.3(2) Å ³
Z, Calculated density	4, 1.733 Mg/m ³
Absorption coefficient F(000)	1.296 mm ⁻¹ 1504
Crystal size	0.55 x 0.20 x 0.20 mm
Theta range for data collection	1.89 to 25.04 deg.
Limiting indices	-18 ≤ h ≤ 17, 0 ≤ k ≤ 18, 0 ≤ l ≤ 14
Reflections collected / unique	7579 / 2649 [R(int) = 0.0245]
Completeness to theta = 25.04	99.5 %
Absorption correction	Empirical
Max. and min. transmission	0.9791 and 0.7087
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	2286 / 0 / 192
Goodness-of-fit on F ²	1.114
Final R indices [I > 4σ(I)]	R1 = 0.0184, wR2 = 0.0506
R indices (all data)	R1 = 0.0218, wR2 = 0.0531

Extinction coefficient	0.00041(7)
Largest diff. peak and hole	0.808 and -0.382 e.Å ⁻³

Figure S2. View of **11** showing the atom numbering scheme. Thermal ellipsoids are 40% equiprobability envelopes, with hydrogens omitted.

Table S8. Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **11**.

U(eq) is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x	y	z	U(eq)
Pd	5386(1)	5113(1)	6633(1)	25(1)
O(1)	4271(1)	4352(1)	5879(1)	34(1)
O(2)	3957(1)	4085(1)	7482(1)	33(1)
O(3)	6858(1)	7276(1)	7286(2)	46(1)

N(1)	4817(1)	6167(1)	5821(2)	29(1)
N(2)	6439(1)	5880(1)	7284(2)	30(1)
C(1)	3970(2)	6248(2)	5043(2)	35(1)
C(2)	3651(2)	7018(2)	4526(2)	45(1)
C(3)	4213(2)	7707(2)	4817(3)	51(1)
C(4)	5082(2)	7627(2)	5635(2)	43(1)
C(5)	5365(2)	6845(2)	6117(2)	31(1)
C(6)	6305(2)	6688(2)	6968(2)	33(1)
C(7)	7343(2)	5633(2)	8085(2)	35(1)
C(8)	7956(2)	5339(2)	7461(2)	38(1)
C(9)	8356(2)	5918(2)	6954(3)	57(1)
C(10)	8885(2)	5649(2)	6330(3)	70(1)
C(11)	9030(2)	4801(2)	6221(3)	62(1)
C(12)	8656(2)	4223(2)	6744(3)	57(1)
C(13)	8125(2)	4485(2)	7360(3)	46(1)
C(14)	3892(2)	3940(1)	6454(2)	31(1)
C(15)	3297(2)	3217(2)	5856(3)	52(1)

Table S9. Bond lengths [Å] and angles [deg] for **11**.

Pd-N(2)	1.9794(19)
Pd-N(1)	1.9922(19)
Pd-O(2)#1	2.0285(16)
Pd-O(1)	2.0580(16)
Pd-Pd#1	2.8206(3)
O(1)-C(14)	1.262(3)
O(2)-C(14)	1.263(3)
O(2)-Pd#1	2.0285(16)
O(3)-C(6)	1.239(3)
N(1)-C(1)	1.343(3)
N(1)-C(5)	1.344(3)
N(2)-C(6)	1.334(3)
N(2)-C(7)	1.467(3)
C(1)-C(2)	1.387(4)
C(2)-C(3)	1.370(4)
C(3)-C(4)	1.387(4)
C(4)-C(5)	1.378(3)
C(5)-C(6)	1.499(3)
C(7)-C(8)	1.509(4)
C(8)-C(9)	1.384(4)
C(8)-C(13)	1.393(4)
C(9)-C(10)	1.390(4)
C(10)-C(11)	1.378(5)
C(11)-C(12)	1.370(5)
C(12)-C(13)	1.381(4)

C(14)-C(15)	1.498(3)
N(2)-Pd-N(1)	81.35(8)
N(2)-Pd-O(2)#1	94.76(7)
N(1)-Pd-O(2)#1	176.11(7)
N(2)-Pd-O(1)	176.99(7)
N(1)-Pd-O(1)	96.06(7)
O(2)#1-Pd-O(1)	87.83(7)
C(14)-O(1)-Pd	122.90(14)
C(14)-O(2)-Pd#1	122.31(14)
C(1)-N(1)-C(5)	119.7(2)
C(1)-N(1)-Pd	126.48(17)
C(5)-N(1)-Pd	113.85(15)
C(6)-N(2)-C(7)	117.91(19)
C(6)-N(2)-Pd	116.70(15)
C(7)-N(2)-Pd	125.39(15)
N(1)-C(1)-C(2)	121.2(2)
C(3)-C(2)-C(1)	119.1(2)
C(2)-C(3)-C(4)	119.6(3)
C(5)-C(4)-C(3)	118.7(3)
N(1)-C(5)-C(4)	121.6(2)
N(1)-C(5)-C(6)	115.7(2)
C(4)-C(5)-C(6)	122.6(2)
O(3)-C(6)-N(2)	127.6(2)
O(3)-C(6)-C(5)	120.2(2)
N(2)-C(6)-C(5)	112.3(2)
N(2)-C(7)-C(8)	112.13(19)
C(9)-C(8)-C(13)	118.1(3)
C(9)-C(8)-C(7)	120.3(2)
C(13)-C(8)-C(7)	121.6(2)
C(8)-C(9)-C(10)	120.6(3)
C(11)-C(10)-C(9)	120.4(3)
C(12)-C(11)-C(10)	119.5(3)
C(11)-C(12)-C(13)	120.4(3)
C(12)-C(13)-C(8)	120.9(3)
O(1)-C(14)-O(2)	126.3(2)
O(1)-C(14)-C(15)	116.9(2)
O(2)-C(14)-C(15)	116.8(2)

Symmetry transformations used to generate equivalent atoms:
#1 -x+1,y,-z+3/2

Table S10. Anisotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **11**.

The anisotropic displacement factor exponent takes the form:

$$-2\pi^2 [h^2 a^{*2} U_{11} + \dots + 2 h k a^* b^* U_{12}]$$

	U11	U22	U33	U23	U13	U12
Pd	27(1)	27(1)	23(1)	1(1)	9(1)	-1(1)
O(1)	36(1)	37(1)	28(1)	-4(1)	11(1)	-8(1)
O(2)	39(1)	31(1)	31(1)	-3(1)	16(1)	-5(1)
O(3)	40(1)	33(1)	60(1)	-4(1)	11(1)	-8(1)
N(1)	31(1)	32(1)	24(1)	0(1)	13(1)	2(1)
N(2)	27(1)	31(1)	29(1)	0(1)	8(1)	-1(1)
C(1)	32(1)	43(1)	28(1)	0(1)	8(1)	3(1)
C(2)	41(1)	51(2)	38(1)	3(1)	7(1)	14(1)
C(3)	57(2)	40(2)	50(2)	8(1)	12(1)	16(1)
C(4)	47(2)	31(1)	50(2)	2(1)	15(1)	2(1)
C(5)	34(1)	32(1)	29(1)	0(1)	14(1)	3(1)
C(6)	32(1)	33(1)	34(1)	-3(1)	13(1)	-1(1)
C(7)	29(1)	40(1)	32(1)	2(1)	6(1)	-3(1)
C(8)	25(1)	45(1)	37(1)	5(1)	5(1)	3(1)
C(9)	59(2)	47(2)	77(2)	19(2)	39(2)	13(1)
C(10)	72(2)	67(2)	90(3)	28(2)	52(2)	16(2)
C(11)	53(2)	72(2)	70(2)	5(2)	33(2)	15(2)
C(12)	46(2)	52(2)	77(2)	-6(2)	25(2)	4(1)
C(13)	38(1)	41(2)	58(2)	0(1)	16(1)	0(1)
C(14)	31(1)	29(1)	34(1)	-2(1)	11(1)	-2(1)
C(15)	62(2)	47(2)	50(2)	-18(1)	26(2)	-26(1)

Table S11. Hydrogen coordinates ($\times 10^4$) and isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **11**.

	x	y	z	U(eq)
H(1)	3586	5774	4846	42
H(2)	3056	7066	3983	54
H(3)	4011	8231	4463	61

H(4)	5471	8097	5857	52
H(7A)	7277	5179	8585	42
H(7B)	7626	6116	8576	42
H(9)	8269	6498	7032	69
H(10)	9146	6048	5980	84
H(11)	9382	4621	5791	74
H(12)	8762	3645	6683	69
H(13)	7874	4082	7716	55
H(15A)	2916	3387	5083	77
H(15B)	2916	3052	6286	77
H(15C)	3675	2744	5811	77
H(15D)	3422	2735	6370	77
H(15E)	3422	3071	5167	77
H(15F)	2663	3378	5643	77

Table S12. Torsion angles [deg] for **11**.

N(2)-Pd-O(1)-C(14)	-152.9(13)
N(1)-Pd-O(1)-C(14)	-122.21(18)
O(2)#1-Pd-O(1)-C(14)	57.66(18)
N(2)-Pd-N(1)-C(1)	177.82(19)
O(2)#1-Pd-N(1)-C(1)	-179(20)
O(1)-Pd-N(1)-C(1)	-0.63(19)
N(2)-Pd-N(1)-C(5)	-2.31(16)
O(2)#1-Pd-N(1)-C(5)	1.1(10)
O(1)-Pd-N(1)-C(5)	179.25(15)
N(1)-Pd-N(2)-C(6)	2.76(17)
O(2)#1-Pd-N(2)-C(6)	-177.00(17)
O(1)-Pd-N(2)-C(6)	33.6(14)
N(1)-Pd-N(2)-C(7)	-177.71(18)
O(2)#1-Pd-N(2)-C(7)	2.52(18)
O(1)-Pd-N(2)-C(7)	-146.8(13)
C(5)-N(1)-C(1)-C(2)	0.7(3)
Pd-N(1)-C(1)-C(2)	-179.40(18)
N(1)-C(1)-C(2)-C(3)	0.0(4)
C(1)-C(2)-C(3)-C(4)	-1.2(4)
C(2)-C(3)-C(4)-C(5)	1.5(4)
C(1)-N(1)-C(5)-C(4)	-0.3(3)
Pd-N(1)-C(5)-C(4)	179.78(19)
C(1)-N(1)-C(5)-C(6)	-178.51(19)
Pd-N(1)-C(5)-C(6)	1.6(2)
C(3)-C(4)-C(5)-N(1)	-0.8(4)
C(3)-C(4)-C(5)-C(6)	177.2(2)
C(7)-N(2)-C(6)-O(3)	-1.2(4)

Pd-N(2)-C(6)-O(3)	178.4(2)
C(7)-N(2)-C(6)-C(5)	177.85(19)
Pd-N(2)-C(6)-C(5)	-2.6(2)
N(1)-C(5)-C(6)-O(3)	179.7(2)
C(4)-C(5)-C(6)-O(3)	1.6(4)
N(1)-C(5)-C(6)-N(2)	0.6(3)
C(4)-C(5)-C(6)-N(2)	-177.6(2)
C(6)-N(2)-C(7)-C(8)	-92.3(3)
Pd-N(2)-C(7)-C(8)	88.2(2)
N(2)-C(7)-C(8)-C(9)	76.5(3)
N(2)-C(7)-C(8)-C(13)	-102.5(3)
C(13)-C(8)-C(9)-C(10)	2.2(5)
C(7)-C(8)-C(9)-C(10)	-176.9(3)
C(8)-C(9)-C(10)-C(11)	-0.9(6)
C(9)-C(10)-C(11)-C(12)	-0.8(6)
C(10)-C(11)-C(12)-C(13)	1.1(5)
C(11)-C(12)-C(13)-C(8)	0.2(5)
C(9)-C(8)-C(13)-C(12)	-1.8(4)
C(7)-C(8)-C(13)-C(12)	177.2(3)
Pd-O(1)-C(14)-O(2)	19.9(3)
Pd-O(1)-C(14)-C(15)	-161.02(19)
Pd#1-O(2)-C(14)-O(1)	6.1(3)
Pd#1-O(2)-C(14)-C(15)	-172.98(19)

Symmetry transformations used to generate equivalent atoms:

#1 -x+1,y,-z+3/2

References

1. Christensen, J. B. *Molecules* **2001**, 6, 47.
2. Kajikawa, Y.; Azuma, N.; Tajima, K. *Inorg. Chim. Acta* **1999**, 288, 90.
3. (a) Recnik, S.; Svete, J.; Stanovnik, B. *Z. Naturforsch. B* **2004**, 59, 380. (b) Billman, J. H.; Rendall, J. L. *J. Am. Chem. Soc.* **1944**, 66, 540.
4. Beak, P., Musick, T. J., Chen, C.-w. *J. Am. Chem. Soc.* **1988**, 110, 3538.
5. Pagani, G.; Baruffini, A.; Caccialanza, G. *Farmaco, Edizione Scientifica* **1971**, 26, 118.
6. Ragnarsson, U.; Grehn, L.; Maia, H. L. S.; Monteiro, L. S. *J. Chem. Soc., Perkin Trans. 1* **2002**, 97.