Cu-Catalyzed *N*- and *O*-Arylation of 2-, 3-, and 4-Hydroxypyridines and Hydroxyquinolines

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Supporting Information

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General Considerations.

All reactions were carried out in resealable test tubes with teflon septa under a dry argon or nitrogen atmosphere. Copper(I) iodide (99.99%) was purchased from Strem as an off-white solid. Ligands **1**, **2**, **4** and **5** were purchased from commercial sources and used without further purification. Ligand **3** was prepared according to our previously reported procedure.¹ Anhydrous K₂CO₃ (99.99%) was purchased from Aldrich in glass ampules. Powdered K₃PO₄ was purchased from Riedel-de Haën. Cs₂CO₃ (99.9%) was purchased from Alfa Aesar. The bulk of the bases were stored under nitrogen in a Vacuum Atmospheres glovebox. Small portions (~5 g) were removed from the glovebox in glass vials, stored in the air in a desiccator filled with anhydrous calcium sulfate, and weighed in the air. Hydroxypyridines and hydroxyquinolines were purchased from commercial sources and used without further purification. Aryl halides were purchased from commercial sources and filtered through neutral alumina or distilled. Anhydrous solvents were purchased from Aldrich in Sure-Seal® bottles. Flash column chromatography was performed using a Biotage SP4 Flash Purification System using KP-Sil silica cartridges. In all cases, dichloromethane was used to transfer the crude reaction material onto the silica gel samplet. A gradient elution technique was performed, based on the recommendation from the Biotage TLC Wizard.

Yields reported in the publication are of the isolated material and represent an average of at least two independent runs. Yields reported in the supporting information refer to a single experiment. Compounds described in the literature were characterized by comparing their ¹H NMR and ¹³C NMR spectra, and melting points (m.p.) to the previously reported data; their purity was confirmed by gas chromatography (GC) or elemental analysis. GC analyses were performed on a Hewlett Packard 6890 instrument with an FID detector and a Hewlett Packard 10 m x 0.2 mm i.d. HP-1 capillary column using dodecane as an internal standard. Previously unknown compounds were synthesized, purified and

analyzed from a single run and were then repeated to determine an average yield. They were characterized by ^1H NMR, ^{13}C NMR, m.p., IR and elemental analysis. Elemental analyses were performed by Atlantic Microlabs, Inc., Norcross, GA. For those compounds that did not give a satisfactory elemental analysis, a copy of their ^1H NMR spectra is included. ^1H NMR and ^{13}C NMR spectra were recorded on Varian 500 MHz instruments with chemical shifts reported relative to the deuterated solvent or TMS. IR spectra were recorded on a Perkin-Elmer System 2000 FT-IR instrument for all previously unknown compounds (KBr disc). Melting points (uncorrected) were obtained on a Mel-Temp II capillary melting point apparatus.

General procedure for the *N*- and *O*-Arylation of hydroxypyridines and hydroxyquinolines.

An oven-dried screw-cap test tube was charged with CuI, ligand (if solid), hydroxypyridine (1.2 mmol), aryl halide (1.00 mmol, if solid), base (2.0 mmol), and a magnetic stir bar. The reaction vessel was fitted with a rubber septum. The test tube was evacuated and back-filled with dry argon or nitrogen. Aryl halide (1.00 mmol, if liquid), ligand (if liquid) and solvent were then added successively. The rubber septum was removed and the reaction tube was quickly sealed with a Teflon septum. The vessel was immersed in a pre-heated oil bath and stirred vigorously for the designated time period.

Workup A: The reaction mixture was cooled to room temperature, diluted with ethyl acetate (15 mL), and filtered through a plug of silica, eluting with additional ethyl acetate (50 mL). The filtrate was concentrated and the resulting residue was purified by flash chromatography to provide the desired product.

Workup B: The crude reaction mixture was diluted in CH_2Cl_2 (15 mL) and filtered through a celite plug

eluting with additional CH_2Cl_2 (20 mL). The filtrate was washed successively with aqueous NH_4OH then brine. The combined aqueous layers were extracted twice with CH_2Cl_2 . The combined organic layers were dried over MgSO_4 and then concentrated. The resulting residue was purified by flash chromatography to provide the desired product.

Experimental procedures for compounds in Table 1

1-(quinolin-3-yl)pyridin-2(1H)-one (Entry 1)

The general procedure was followed using CuI (9.5 mg, 0.05 mmol), **3** (36 mg, 0.15 mmol), K_2CO_3 (0.28 g, 2.0 mmol), 3-bromoquinoline (136 μL , 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMF (0.5 mL) as solvent for 24 h at 110 $^\circ\text{C}$. Workup B, followed by chromatographic purification (hexane / ethyl acetate) provided the title compound as a white solid (177 mg, 80%). ^1H NMR (500 MHz, CDCl_3) δ 8.95 (d, 1H, $J = 2.4$ Hz), 8.21 (d, 1H, $J = 2.3$ Hz), 8.16 (d, 1H, $J = 8.5$ Hz), 7.85 (d, 1H, $J = 8.4$ Hz), 7.78 (m, 1H), 7.61 (m, 1H), 7.47-7.40 (m, 3H), 6.72 (d, 1H, $J = 9.7$ Hz), 6.33 (td, 1H, $J = 6.7, 1.2$ Hz). ^{13}C NMR (125 MHz, CDCl_3) δ 162.6, 148.5, 147.5, 140.6, 137.7, 134.5, 133.0, 130.6, 129.6, 128.2, 127.8, 122.3, 106.9. IR (KBr disc, cm^{-1}) 1661, 1584, 1535, 1148, 927, 767, 759, 747. Anal. Calc. for $\text{C}_{14}\text{H}_{10}\text{N}_2\text{O}$: C 75.66, H 4.54. Found: C 75.34, H 4.71. m.p. 145-146 $^\circ\text{C}$. (Lit. 145-146 $^\circ\text{C}$).²

1-(thiazol-2-yl)pyridin-2(1H)-one (Entry 2)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K_2CO_3 (0.28 g, 2.0 mmol), 2-bromothiazole (90 μL , 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMF

(1.0 mL) as solvent for 24 h at 110 °C. Workup A followed by chromatographic purification (hexane / ethyl acetate) provided the title compound (white solid, 142 mg, 80%). ¹H NMR (500 MHz, CDCl₃) δ 8.74 (ddd, 1H, *J* = 0.6, 1.9, 8.2 Hz), 7.59 (d, 1H, *J* = 3.5 Hz), 7.37-7.34 (m, 1H), 7.17 (d, 1H, 3.5 Hz), 6.68 (dt, 1H, *J* = 1.0, 9.2 Hz), 6.33 (m, 1H). ¹³C NMR (125 MHz, CDCl₃) δ 160.6, 156.1, 139.8, 137.9, 131.9, 121.6, 118.8, 107.5. IR (KBr disc, cm⁻¹) 3118, 1670, 1543, 1500, 1275, 1138, 981, 867, 844, 771, 717, 621. Anal. Calc. for C₈H₆N₂OS: C 53.92, H 3.39. Found: C 53.94, H 3.42. m.p. 89-90 °C. (Lit. 85.5-86 °C).³

1-(1H-indol-5-yl)pyridin-2(1H)-one (Entry 3)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **1** (32 μL, 0.40 mmol), K₂CO₃ (0.28 g, 2.0 mmol), 5-iodoindole (243 mg, 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup A followed by chromatographic purification (CH₂Cl₂ / ethyl acetate), and then recrystallization from CH₂Cl₂, provided 165 mg of the product as a white solid (78%). ¹H NMR (500 MHz, DMSO-D₆) δ 11.3 (bs, 1H), 7.65 (dd, *J* = 1.6, 6.8 Hz), 7.51-7.45 (m 3H), 7.03 (dd, 1H, *J* = 4.3, 6.1 Hz), 6.50-6.45 (m, 2H), 6.28 (td, 1H, *J* = 6.7, 1.7 Hz). ¹³C NMR (125 MHz, DMSO-D₆) δ 161.8, 140.3, 140.0, 135.0, 133.0, 127.5, 126.9, 120.4, 119.9, 118.0, 111.5, 105.1, 101.6. m.p. 218-220 °C. A copy of the ¹H NMR spectrum can be found at the end of this document to confirm the compound's purity.

1-(pyrimidin-5-yl)pyridin-2(1H)-one (Entry 4)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K₂CO₃ (0.28

g, 2.0 mmol), 5-bromopyrimidine (159 mg, 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. The crude reaction mixture was diluted with CH₂Cl₂ and filtered. The filtrate was concentrated to a white/yellow solid. The product was recrystallized from hot EtOAc to provide 1-(pyrimidin-5-yl)pyridin-2(1H)-one as a white solid (83.5 mg, 48%). ¹H NMR (500 MHz, CDCl₃) δ 9.26 (s, 1H), 8.91 (s, 2H), 7.47 (m, 1H), 7.31 (m, 1H), 6.70 (m, 1H), 7.36 (m, 1H). ¹³C NMR (125 MHz, CDCl₃) δ 161.9, 158.0, 154.6, 141.1, 136.5, 122.4, 107.5, 100.0. IR (KBr disc, cm⁻¹) 1664, 1591, 1415, 1299, 1147, 994, 847, 765, 721. Anal. Calc. for C₉H₇N₃O: C 62.42, H 4.07. Found: C 62.63, H 4.03. m.p. 201-202 °C.

1-(4-chlorophenyl)pyridin-2(1H)-one (Entry 5)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K₂CO₃ (0.28 g, 2.0 mmol), 1-chloro-4-iodobenzene (243 mg, 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup B, followed by chromatographic purification (hexane / ethyl acetate) provided the title compound (white solid, 169 mg, 82%). ¹H NMR (500 MHz, CDCl₃) δ 7.49-7.45 (m, 2H), 7.43-7.39 (m, 1H), 7.35-7.25 (m, 2H), 7.30 (ddd, *J* = 0.8, 2.1, 6.9 Hz), 6.66 (m, 1H), 6.26 (td, 1H, *J* = 6.7, 1.3 Hz). ¹³C NMR (125 MHz, CDCl₃) δ 162.4, 140.2, 139.5, 137.8, 1344.6, 129.7, 128.1, 122.2, 106.4. Anal. Calc. for C₁₁H₈NOCl: C 64.25, H 3.92. Found: C 64.09, H 3.92. m.p. 122-124 °C. (Lit. 133 °C)⁴

1-(3-aminophenyl)pyridin-2(1H)-one (Entry 6)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K₂CO₃ (0.28

g, 2.0 mmol), 3-bromoaniline (109 μ L, 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup A followed by chromatographic purification (ethyl acetate / isopropanol) provided the title compound (off-white solid, 162 mg, 87%). ^1H NMR (500 MHz, CDCl_3) δ 7.41-7.19 (m, 3H), 6.70-6.21 (m, 3H), 62.1 (td, 1H, $J = 1.1, 6.9$ Hz), 3.54 (bs, 2H). ^{13}C NMR (125 MHz, CDCl_3) δ 162.7, 147.8, 142.0, 140.0, 138.3, 130.3, 121.8, 116.1, 115.4, 113.4, 105.9. m.p. 180-182 °C. (Lit. 182.5-184.5°C).⁵ A copy of the ^1H NMR spectrum can be found at the end of this document to confirm the compound's purity.

4-chloro-1-(4-(dimethylamino)phenyl)pyridin-2(1H)-one (Entry 7)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K_2CO_3 (0.28 g, 2.0 mmol), *N,N*-dimethyl-4-bromoaniline (200 mg, 1.00 mmol), 5-chloro-2-hydroxypyridine (156 mg, 1.2 mmol) with DMSO (1.0 mL) as solvent for 24 h at 110 °C. Workup B, followed by chromatographic purification (hexane / ethyl acetate) provided the product as a pale yellow solid (193 mg, 78%). ^1H NMR (500 MHz, CDCl_3) δ 7.39 (d, 1H, $J = 2.9$ Hz), 7.32 (dd, 2.9, $J = 9.8$ Hz), 7.21-7.18 (m, 2H), 6.77-6.74 (m, 2H), 6.61 (d, 1H, $J = 9.8$ Hz), 3.00 (s, 6H). ^{13}C NMR (125 MHz, CDCl_3) δ 161.5, 150.6, 140.6, 136.4, 129.2, 126.9, 122.5, 112.5, 112.1. IR (KBr disc, cm^{-1}) 1664, 1363, 1266, 1120, 1062, 944, 782, 728, 646. Anal. Calc. for $\text{C}_{13}\text{H}_{13}\text{ClN}_2\text{O}$: C 62.78, H 5.27. Found: C 62.52, H 5.24. m.p. 159-160 °C.

Experimental procedures for compounds in Table 2

2-(o-tolyloxy)pyridine⁶ (Entry 1)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **5** (29 mg, 0.20 mmol), K_2CO_3 (0.28 g,

2.0 mmol), 2-iodotoluene (127 μL , 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (1.0 mL) as solvent for 48 h at 120 $^{\circ}\text{C}$. GC analysis of the crude reaction mixture showed full conversion of the aryl iodide and a 1.0 : 4.7 ratio of *N*- to *O*-arylated products. Workup B, followed by chromatographic purification (hexane / ethyl acetate) provided the *O*-arylated product (white solid, 135 mg, 73%). ^1H NMR (500 MHz, CDCl_3) δ 8.09 (dd, J = 1.2, 4.9 Hz), 7.59-7.56 (m, 1H), 7.20-7.14 (m, 2H), 7.06 (td, 1H, J = 0.8, 7.5 Hz), 6.98 (dd, 1H, J = 1.2, 7.9 Hz), 6.87 (ddd, 1H, J = 0.9, 5.0, 7.2 Hz), 6.77 (m, 1H), 2.10 (s, 3H). ^{13}C NMR (125 MHz, CDCl_3) δ 163.9, 152.4, 148.0, 139.5, 133.3, 131.6, 131.0, 130.7, 127.3, 125.4, 122.0, 118.1, 110.8, 16.6. m.p. 44-45.5 $^{\circ}\text{C}$. A copy of the ^1H NMR spectrum can be found at the end of this document to confirm the compound's purity.

1-*o*-tolylpyridin-2(1H)-one⁷ (Entry 2)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K_2CO_3 (0.28 g, 2.0 mmol), 2-iodotoluene (153 μL , 1.20 mmol), 2-hydroxypyridine (96 mg, 1.0 mmol) with DMSO (0.5 mL) as solvent for 96 h at 150 $^{\circ}\text{C}$. GC analysis of the crude reaction mixture showed full conversion of the aryl iodide and a 1.6 : 1 ratio of *N*- to *O*-arylated products. Workup B, followed by chromatographic purification (hexane / ethyl acetate) provided the *N*-arylated product as a slightly yellow solid (79 mg, 43%). ^1H NMR (500 MHz, CDCl_3) δ 7.45-7.42 (m, 1H), 7.36-7.30 (m, 3H), 7.21-7.18 (m, 2H), 6.69-6.67 (m, 1H), 6.27-6.24 (m, 1H), 2.16 (s, 3H). ^{13}C NMR (125 MHz, CDCl_3) δ 162.21, 140.3, 140.1, 138.1, 135.1, 131.2, 129.2, 127.2, 127.1, 121.9, 105.9, 17.7. Anal. Calc. for $\text{C}_{12}\text{H}_{11}\text{NO}$: C 77.81, H 77.19. Found: C 77.49, H 6.03. m.p. 71-72.5 $^{\circ}\text{C}$. A copy of the ^1H NMR spectrum can be found at the end of this document to confirm the compound's purity.

2-(naphthalen-1-yloxy)pyridine (Entry 3)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **5** (36 mg, 0.15 mmol), K₂CO₃ (0.28 g, 2.0 mmol), 1-iodonaphthalene (260 μ L, 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (1.0 mL) as solvent for 48 h at 120 °C. GC analysis of the crude reaction mixture showed full conversion of the aryl iodide and a 1.0 : 3.7 ratio of *N*- to *O*-arylated products. Workup B, followed by chromatographic purification (hexane / ethyl acetate) provided 137 mg of the *O*-arylated product (white solid, 62%). ¹H NMR (500 MHz, CDCl₃) δ 8.2 (dd, 1H, *J* = 1.3, 4.6 Hz), 8.04-8.02 (m, 1H), 7.91 (dd, 1H, *J* = 0.6, 8.2 Hz), 7.76 (d, 1H, *J* = 8.2 Hz), 7.53-7.46 (m, 3H), 7.26 (dd, 1H, *J* = 0.9, 7.5 Hz), 7.02-6.99 (m, 1H), 6.96 (d, 1H, *J* = 8.2 Hz). ¹³C NMR (125 MHz, CDCl₃) δ 150.2, 148.2, 139.7, 125.2, 128.2, 127.7, 126.6, 126.3, 126.0, 125.2, 122.2, 118.6, 117.3, 111.1. IR (KBr disc, cm⁻¹) 1592, 1465, 1426, 1387, 1282, 1156, 1070, 1037, 1013, 890, 839, 799, 773, 672, 534. Anal. Calc. for C₁₅H₁₁NO: C 81.43, H 5.01. Found: C 81.27, H 4.98. m.p. 80.5-82 °C.

1-(naphthalen-1-yl)pyridin-2(1H)-one (Entry 4)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K₂CO₃ (0.28 g, 2.0 mmol), 1-iodonaphthalene (175 μ L, 1.20 mmol), 2-hydroxypyridine (96 mg, 1.0 mmol) with DMSO (0.5 mL) as solvent for 96 h at 150 °C. GC analysis of the crude reaction mixture showed full conversion of the aryl iodide and a 1.7 : 1.0 ratio of *N*- to *O*-arylated products. Workup B, followed by chromatographic purification (hexane / ethyl acetate) provided 97 mg of the *N*-arylated product (yellow solid, 44%). ¹H NMR (500 MHz, CDCl₃) δ 7.98-7.89 (m, 1H), 7.60-7.46 (m, 7H), 7.33-7.31 (m, 1H), 6.77 (dd, 1H, *J* = 0.8, 9.3 Hz), 6.32 (td, 1H, *J* = 6.7, 1.2 Hz). ¹³C NMR (125 MHz, CDCl₃) δ 162.9,

140.5, 139.1, 137.8, 134.5, 129.7, 129.4, 128., 127.6, 126.9, 125.6, 125.2, 122.5, 122.0, 106.0. IR (KBr disc, cm^{-1}) 3062, 1660, 1590, 1571, 1394, 1284, 1136, 964, 773. Anal. Calc. for $\text{C}_{15}\text{H}_{11}\text{NO}$: C 81.43, H 5.01. Found: C 81.05, H 5.00. m.p. 132-134 °C.

Experimental procedures for compounds in Table 3

1-(3-methoxyphenyl)pyridin-4(1H)-one (Entry 1)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K_2CO_3 (0.28 g, 2.0 mmol), 3-bromoanisole (125 μL , 1.00 mmol), 4-hydroxypyridine (114 mg, 1.2 mmol) with DMF (0.5 mL) as solvent for 24 h at 110 °C. Workup B, followed by chromatographic purification (ethyl acetate/ isopropanol) provided 197 mg of product (white solid, 98%). ^1H NMR (500 MHz, CDCl_3) δ 7.64-7.59 (m, 2H), 7.43 (t, 1H, $J = 8.3$ Hz), 7.00-6.91 (m, 2H), 6.85 (t, 1H, $J = 2.5$ Hz), 6.52 (m, 2H), 3.88 (s, 3H). ^{13}C NMR (125 MHz, CDCl_3) δ 179.1, 160.0, 144.3, 139.2, 131.1, 119.0, 114.8, 113.8, 109.0, 55.8. IR (KBr disc, cm^{-1}) 3034, 2954, 1666, 1569, 1347, 1286, 1051, 845, 762, 679. Anal. Calc. for $\text{C}_{12}\text{H}_{11}\text{NO}_2$: C 71.63, H 5.51. Found: C 71.85, H 5.43. m.p. 151-152 °C.

1-(pyridin-3-yl)pyridin-4(1H)-one (Entry 2)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **3** (36 mg, 0.15 mmol), K_2CO_3 (0.28 g, 2.0 mmol), 3-bromopyridine (98 μL , 1.00 mmol), 4-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup A followed by chromatographic purification (ethyl acetate/ isopropanol) provided 1-(pyridin-3-yl)pyridin-4(1H)-one (white solid, 167 mg, 97%). ^1H NMR (500 MHz, CDCl_3) δ 8.71-8.69 (m, 2H), 7.74 (m, 1H), 7.59 (m, 2H), 7.30 (m, 1H), 6.52 (m, 2H). ^{13}C

NMR (125 MHz, CDCl_3) δ 178.9, 149.8, 144.1, 141.0, 139.0, 130.4, 124.6, 119.5. m.p. 205-206 °C. (Lit. 189-191 °C)⁸ A copy of the ^1H NMR spectrum can be found at the end of this document to confirm the compound's purity.

1-(4-propanoylphenyl)pyridin-4(1H)-one (Entry 3)

The general procedure was followed using CuI (9.5 mg, 0.05 mmol), **4** (20 μL , 0.20 mmol), K_2CO_3 (0.28 g, 2.0 mmol), 4'-bromopropiophenone (213 mg, 1.00 mmol), 4-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup B, followed by chromatographic purification (ethyl acetate/ methanol) provided the title compound as a white solid (199 mg, 87%). ^1H NMR (500 MHz, CDCl_3) δ 8.10 (m, 2H), 7.65 (m, 2H), 7.44 (m, 2H), 6.48 (m, 2H), 3.02 (q, 2H, $J = 7.2$ Hz), 1.22 (t, 3H, $J = 7.2$ Hz). ^{13}C NMR (125 MHz, CDCl_3) δ 199.2, 179.0, 146.1, 138.6, 138.3, 130.2, 122.5, 119.3, 32.0, 8.1. IR (KBr disc, cm^{-1}) 1636, 1412, 1342, 1281, 1192, 1017, 952. m.p. 182-184 °C. A copy of the ^1H NMR spectrum can be found at the end of this document to confirm the compound's purity.

1-o-tolylpyridin-4(1H)-one (Entry 4)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **4** (40 μL , 0.40 mmol), K_2CO_3 (0.28 g, 2.0 mmol), 2-iodotoluene (127 μL , 1.00 mmol), 4-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (1.0 mL) as solvent for 24 h at 110 °C. Workup B, followed by chromatographic purification (ethyl acetate/ methanol) provided a white solid (121 mg, 65%). ^1H NMR (500 MHz, CDCl_3) δ 7.41-7.31 (m, 4H), 7.24 (dd, 1H, $J = 1.2, 7.8$ Hz), 6.48-6.45 (m, 2H). ^{13}C NMR (125 MHz, CDCl_3) δ 178.9, 142.4, 140.5, 133.9, 132.0, 129.9, 127.7, 126.3, 118.7, 17.6. m.p. 149-150 °C. (Lit. 148 °C).⁹ A copy of the ^1H NMR

spectrum can be found at the end of this document to confirm the compound's purity.

1-(benzo[b]thiophen-3-yl)pyridin-4(1H)-one (Entry 5)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **4** (42 mL, 0.40 mmol), K₂CO₃ (0.28 g, 2.0 mmol), 3-bromothiophene (131 µL, 1.00 mmol), 4-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup B followed by chromatographic purification (ethyl acetate/ methanol) provided the title product as an oil, which was then triturated with CH₂Cl₂ and hexane (white solid, 164 mg, 72%). ¹H NMR (500 MHz, CDCl₃) δ 7.95-7.93 (m, 1H), 7.66-7.49 (m, 6H), 6.56-6.53 (m, 2H). ¹³C NMR (125 MHz, CDCl₃) δ 179.1, 140.4, 139.1, 135.7, 133.2, 126.3, 125.8, 123.8, 121.5, 120.6, 119.1. IR (KBr disc, cm⁻¹) 1632, 1558, 1402, 1367, 1191, 939, 855, 760, 586, 564. Anal. Calc. for C₁₃H₉NOS: C 68.70, H 3.99. Found: C 68.44, H 4.12. m.p. 188.5-190 °C.

1-(3,5-dimethylphenyl)pyridin-4(1H)-one (Entry 6)

The general procedure was followed using CuI (3.8 mg, 0.020 mmol), **4** (8 µL, 0.08 mmol), K₂CO₃ (0.28 g, 2.0 mmol), 5-iodo-*m*-xylene (144 µL, 1.00 mmol), 4-hydroxypyridine (114 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup B followed by chromatographic purification (ethyl acetate/ methanol) provided the product as a white solid (175 mg, 88%). ¹H NMR (500 MHz, CDCl₃) δ 7.59-7.57 (m, 2H), 7.07 (s, 1H), 6.95 (s, 2H), 6.49-6.47 (m, 2H). ¹³C NMR (125 MHz, CDCl₃) δ 179.1, 143.3, 140.4, 139.4, 130.2, 120.6, 119.0, 21.4. IR (KBr disc, cm⁻¹) 1650, 1617, 1555, 1457, 1333, 1203, 846, 696. Anal. Calc. for C₁₃H₁₃NO: C 78.36, H 6.58 Found: C 77.96 H 6.49. m.p. 138-139 °C.

7-chloro-1-(4-methoxyphenyl)quinolin-4(1H)-one (Entry 7)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **4** (40 μ L, 0.15 mmol), K₃PO₄ (0.42 g, 2.0 mmol), 4-iodoanisole (234 mg, 1.00 mmol), 7-chloro-4-hydroxyphenanthroline (216 mg, 1.2 mmol) with DMSO (1.0 mL) as solvent for 24 h at 120 °C. Workup B followed by chromatographic purification (hexane / ethyl acetate) provided 198 mg of the title compound as a white solid (69%). ¹H NMR (500 MHz, CDCl₃) δ 8.28 (dd, 1H, *J* = 0.5, 8.7 Hz), 7.47 (d, 1H, *J* = 7.8 Hz), 7.24-7.20 (m, 3H), 7.03-7.00 (m, 2H), 6.88 (d, 1H, *J* = 3.3 Hz), 6.24 (d, 1H, *J* = 7.8 Hz), 3.84 (s, 3H). ¹³C NMR (125 MHz, CDCl₃) δ 177.7, 160.5, 143.6, 142.6, 138.4, 133.6, 128.7, 128.4, 125.0, 124.6, 117.1, 115.7, 110.7, 55.9. IR (KBr disc, cm⁻¹) 1603, 1510, 1449, 1252, 1169, 1032, 909, 813, 734, 646. Anal. Calc. for C₁₆H₁₂NO₂Cl: C 67.26, H 4.23. Found: C 66.99, H 4.19. m.p. 173-176 °C.

4-(pyridin-3-yl)thieno[3,2-b]pyridin-7(4H)-one (Entry 8)

The general procedure was followed using CuI (9.5 mg, 0.05 mmol), **4** (21 μ L, 0.20 mmol), K₃PO₄ (0.42 g, 2.0 mmol), 2-bromopyridine (49 μ L, 1.00 mmol), thieno[3,2-b]pyridin-7-ol (90 mg, 1.2 mmol) with DMSO (0.5 mL) as solvent for 24 h at 110 °C. Workup B followed by chromatographic purification (ethyl acetate/ methanol) provided the product (white solid, 83 mg, 73%). ¹H NMR (500 MHz, CDCl₃) δ 8.76-8.74 (m, 2H), 7.87 (ddd, 1H, *J* = 1.5, 2.6, 8.1 Hz), 7.61 (d, 1H, *J* = 5.5 Hz), 7.56 (dd, 1H, *J* = 4.7, 8.1 Hz), 7.49 (d, 1H, *J* = 7.6 Hz), 6.76 (d, *J* = 5.5 Hz), 6.33 (d, 1H, *J* = 7.6 Hz). ¹³C NMR (125 MHz, CDCl₃) δ 174.1, 150.6, 147.1, 144.5, 139.9, 133.7, 132.5, 130.7, 129.7, 124.7, 117.3, 112.1. IR (KBr

disc, cm^{-1}) 1610, 1493, 1425, 1291, 1221, 1124, 877, 820, 711. m.p. 189-190 °C. A copy of the ^1H NMR spectrum can be found at the end of this document to confirm the compound's purity.

Experimental procedures for compounds in Table 4

3-(2-methylpyridin-3-yloxy)quinoline (Entry 1)

The general procedure was followed using CuI (9.5 mg, 0.05 mmol), **4** (20 μL , 0.20 mmol), K_3PO_4 (0.42 g, 2.0 mmol), 3-bromoquinoline (136 μL , 1.00 mmol), 3-hydroxy-2-methylpyridine (131 mg, 1.2 mmol) with DMF (1.0 mL) as solvent for 24 h at 110 °C. Workup B followed by chromatographic purification (hexane / ethyl acetate) provided the title compound as a white solid (184 mg, 78%). ^1H NMR (500 MHz, CDCl_3) δ 8.84 (d, 1H, $J = 2.7$ Hz), 8.42 (dd, 1H, $J = 1.2, 4.7$ Hz), 8.12 (d, 1H, $J = 8.4$ Hz), 7.69–7.52 (m, 3H), 7.37 (d, 1H, $J = 2.7$ Hz), 7.30 (m, 1H), 7.21 (m, 1H), 2.56 (s, 3H). ^{13}C NMR (125 MHz, CDCl_3) δ 151.7, 150.7, 150.5, 145.4, 144.9, 144.6, 129.4, 128.6, 128.3, 127.7, 127.2, 126.9, 122.6, 119.1, 19.6. IR (KBr disc, cm^{-1}) 1602, 1497, 1424, 1342, 1246, 1175, 984, 911, 783, 754. Anal. Calc. for $\text{C}_{15}\text{H}_{12}\text{N}_2\text{O}$: C 76.25, H 5.12. Found: C 76.36, H 5.09. m.p. 67-69 °C.

3-(quinolin-3-yloxy)benzonitrile (Entry 2)

The general procedure was followed using CuI (19 mg, 1.0 mmol), **4** (42 μL , 0.40 mmol), K_3PO_4 (0.42 g, 2.0 mmol), 3-bromobenzonitrile (182 mg, 1.00 mmol), 6-hydroxyquinoline (174 mg, 1.2 mmol) and 3Å mol. sieves (200 mg flame activated under vacuum) with DMF (1.0 mL) as solvent for 24 h at 110 °C. Workup A followed by chromatographic purification (hexane / ethyl acetate) provided 191 mg of the title compound as a white solid (78%). ^1H NMR (500 MHz, CDCl_3) δ 8.85 (s, 1H), 8.10 (d, 1H, $J = 9.2$

Hz), 8.02 (dd, 1H, $J = 1.4, 8.2$ Hz), 7.45-7.37 (m, 4H), 7.28-7.24 (m, 3H). ^{13}C NMR (125 MHz, CDCl_3) δ 157.5, 153.9, 149.9, 145.7, 135.5, 132.1, 131.0, 127.3, 123.5, 123.3, 122.0, 118.2, 115.1, 114.8, 113.8. IR (KBr disc, cm^{-1}) 2232, 1622, 1579, 1500, 1480, 1326, 1216, 1156, 967, 795, 682. Anal. Calc. for $\text{C}_{16}\text{H}_{10}\text{N}_2\text{O}$: C 78.03, H 4.11. Found: C 77.99, H 4.11. m.p. 85-87 °C.

3-(3,5-dimethylphenoxy)pyridine (Entry 3)

The general procedure was followed using CuI (1.9 mg, 0.01 mmol), **4** (4 μL , 0.04 mmol), K_3PO_4 (0.42 g, 2.0 mmol), 5-iodo-*m*-xylene (145 μL , 1.00 mmol), 2-hydroxypyridine (114 mg, 1.2 mmol) with DMF (1.0 mL) as solvent for 24 h at 110 °C. Workup A followed by chromatographic purification (hexane / ethyl acetate) provided the title compound as a yellow oil (177 mg, 89%). ^1H NMR (500 MHz, CDCl_3) δ 8.40 (s, 1H), 8.34 (d, 1H, $J = 3.6$ Hz), 7.29-7.23 (m, 2H), 6.79 (m, 1H), 6.64 (m, 2H). ^{13}C NMR (125 MHz, CDCl_3) δ 156.3, 144.2, 141.5, 140.0, 125.9, 125.5, 124.1, 116.8, 21.4. IR (KBr disc, cm^{-1}) 1615, 1573, 1475, 1422, 1297, 1137, 1022, 950, 853, 803, 709. Anal. Calc. for $\text{C}_{13}\text{H}_{13}\text{NO}$: C 78.36, H 6.58. Found: C 78.55, H 6.80.

8-(benzo[d][1,3]dioxol-5-yloxy)quinoline (Entry 4)

The general procedure was followed using CuI (19 mg, 0.10 mmol), **4** (42 μL , 0.40 mmol), K_3PO_4 (0.42 g, 2.0 mmol), 4-bromo-1,2-methylenedioxybenzene (120 μL , 1.00 mmol), 8-hydroxyquinoline (174 mg, 1.2 mmol) with DMSO (1.0 mL) as solvent for 48 h at 130 °C. Workup B followed by chromatographic purification (hexane / ethyl acetate) provided 145 mg of the title compound (yellow oil, 56%). ^1H NMR (500 MHz, CDCl_3) δ 8.99 (dd, 2H, $J = 1.7, 4.1$ Hz), 8.18 (dd, 1H, $J = 1.7, 8.4$ Hz), 7.50 (dd, 1H, $J = 1.2,$

8.2 Hz), 7.39 (t, 1H, $J = 7.9$ Hz), 7.01 (dd, 1H, $J = 1.2, 7.8$ Hz), 6.80 (d, 1H, $J = 8.3$ Hz), 6.72 (d, 1H, $J = 2.2, 3$ Hz), 6.65 (dd, 1H, $J = 2.3, 8.4$ Hz), 5.99 (s, 2H). ^{13}C NMR (125 MHz, CDCl_3) δ 155.0, 151.1, 150.2, 148.5, 144.4, 140.6, 136.2, 129.8, 126.7, 122.1, 121.8, 114.0, 113.2, 108.6, 103.1, 101.7. IR (KBr disc, cm^{-1}) 1614, 1500, 1373, 1315, 1181, 1125, 1037, 930, 792, 770. Anal. Calc. for $\text{C}_{16}\text{H}_{11}\text{NO}_3$: C 72.45, H 4.18. Found: C 72.16, H 4.39.

4-(5-chloropyridin-3-yloxy)isoquinoline (Entry 5)

The general procedure was followed using CuI (19 mg, 0.05 mmol), **4** (40 μL , 0.40 mmol), K_3PO_4 (0.42 g, 2.0 mmol), 4-bromoisoquinoline (229 mg, 1.00 mmol), 5-chloro-3-hydroxypyridine (130 mg, 1.2 mmol) with DMF (0.8 mL) as solvent for 24 h at 120 $^\circ\text{C}$. Workup B followed by chromatographic purification (hexane / ethyl acetate) provided a yellow solid (180 mg, 70%). ^1H NMR (500 MHz, CDCl_3) δ 9.19 (bs, 1H), 8.37-8.15 (m, 3H), 8.07 (dd, 1H, $J = 0.7, 8.2$ Hz), 8.00 (d, 1H, $J = 8.4$ Hz), 7.77-7.68 (m, 2H), 7.23 (m, 1H). ^{13}C NMR (125 MHz, CDCl_3) δ 154.7, 149.7, 143.7, 138.4, 133.2, 131.2, 130.5, 129.5, 128.6, 127.9, 126.7, 124.5, 120.8. IR (KBr disc, cm^{-1}) 1627, 1574, 1499, 1417, 1386, 1305, 1252, 1164, 1092, 1064, 1051, 920, 872, 783, 626. Anal. Calc. for $\text{C}_{14}\text{H}_9\text{N}_2\text{OCl}$: C 65.51, H 3.53. Found: C 65.65, H 3.57. m.p. 153-155 $^\circ\text{C}$.

1-(3-(4-*tert*-butylphenoxy)pyridin-2-yl)-*N,N*-dimethylmethanamine (Entry 6)

The general procedure was followed using CuI (19 mg, 0.05 mmol), K_3PO_4 (0.42 g, 2.0 mmol), 4-*tert*-butylbromobenzene (173 μL , 1.00 mmol), 2(dimethylaminomethyl)-3-hydroxypyridine (182 mg, 1.2 mmol) with DMF (0.8 mL) as solvent for 24 h at 110 $^\circ\text{C}$. Workup B followed by chromatographic purification (ethyl acetate/ methanol) provided the product as a brown oil (214 mg, 75%). ^1H NMR (500

MHz, CDCl_3) δ 8.37 (dd, 1H, $J = 1.5, 4.5$ Hz), 7.36-7.34 (m, 2H), 7.19-7.12 (m, 2H), 6.91-6.89 (m, 2H), 3.68 (s, 2H), 2.34 (s, 6H), 1.31 (s, 9H). ^{13}C NMR (125 MHz, CDCl_3) δ 154.5, 152.5, 150.4, 146.7, 144.1, 128.9, 125.8, 123.1, 118.2, 59.3, 45.9, 34.5, 31.6. IR (KBr disc, cm^{-1}) 1575, 1508, 1364, 1211, 1179, 1105, 1014, 853, 728, 608, 550. A copy of the ^1H NMR spectrum can be found at the end of this document to confirm the compound's purity.

ethyl 3-(pyridin-3-yloxy)benzoate (Entry 7)

The general procedure was followed using CuI (9.5 mg, 0.05 mmol), **4** (20 μL , 0.20 mmol), Cs_2CO_3 (0.65 g, 2.0 mmol), ethyl-3-iodobenzoate (240 μL , 1.00 mmol), 3-hydroxypyridine (114 mg, 1.2 mmol) and 3Å mol sieves (200 mg flame activated under vacuum) with DMF (1.0 mL) as solvent for 36 h at 80 °C. Workup A followed by chromatographic purification (hexane / ethyl acetate) provided the title compound (yellow oil, 260 mg, 89%). ^1H NMR (500 MHz, CDCl_3) δ 8.42 (bs, 1H), 8.40 (bs, 1H), 7.84 (m, 1H), 7.68 (dd, 1H, $J = 1.5, 10.1$ Hz), 7.44 (td, 1H, $J = 7.8, 0.5$ Hz), 7.31-7.28 (m, 2H), 7.23-7.21 (m, 1H). ^{13}C NMR (125 MHz, CDCl_3) δ 165.9, 156.6, 144.9, 141.7, 132.8, 130.8, 130.2, 125.8, 125.4, 124.4, 123.5, 119.9, 61.5, 14.5. IR (KBr disc, cm^{-1}) 1717, 1575, 1444, 1161, 1100, 1021, 940, 756, 692, 621. Anal. Calc. for $\text{C}_{14}\text{H}_{14}\text{NO}_3$: C 69.12, H 5.39. Found: C 68.86, H 5.45.

Table 1, Entry 3

RAAVI61
exp1 s2pul

SAMPLE		DEC. & VT	
date	Jul 29 2006	dfrq	125.673
solvent	DMSO	dn	13
file	/data/slbuch/~dpwr	30	
4ra/4ra072906v161.~	dof	0	
fid	nm	nm	
ACQUISITION		dm	w
sfrq	499.751	dfrq	10000
tn	H1	dseq	
at	3.001	dres	1.0
np	83050	homo	DEC2
pw	10504.2	not used	0
bs	8	dfrq2	
twr	56	dpwr2	1
pw	8.9	dof2	0
dl	2.000	dmm2	n
tof	1519.5	dmm2	c
nt	16	dmf2	200
ct	16	dseq2	
alock	not used	dres2	1.0
gain	not used	homo2	DEC3
FLAGS		dfrq3	0
il	n	dn3	
in	n	dpwr3	1
dp	y	dof3	0
hs	nm	nm	n
DISPLAY		dm3	c
sp	-142.7	dmm3	200
wp	6416.3	dmf3	
vs	151	dseq3	1.0
sc	0	dres3	
wc	250	homo3	n
hzmm	25.67	wtfile	
is	33.57	proc	ft
rfl	2482.6	fn	131072
rffp	1249.4	math	f
th	1.000	werr	
ins	cdc	wexp	
nm	ph	wds	
		wht	
		wft	

DMSO

Table 1, Entry 6

expl	s2put
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	SAMPLE	DEC. & VT
date Aug 7 2005	CDC13	dfrq 125.673
solvent CCl3	exp	dn 0
file ACQUISITION	dm	dwr 30
sfrq 499.749	H1	dmm nnn
at 3.001	dnf	w 10000
np 63050.2	dseq	
sw 10504.2	dres	1.0
rb not used	homo	DEC2
bs 16	dfrq2	0
tpwr 8.9	dpr2	0
el 2.000	dwr2	1
tof 1519.5	dm2	0
nt 16	dnf2	0
ct 16	dnm2	C
ataclock	dmf2	200
gain not used	dseq2	
FLAGS	dres2	1.0
il n	homoz	DEC3
in n	dfrq3	0
lms y	dn3	0
DISPLAY	dwr3	1
exp 5.7	dpr3	0
vwp 4016.7	dn3	0
vs 151	dnm3	C
sc 0	dnf3	200
wc 250	dseq3	
zmm 16.07	dres3	1.0
rfl 43.54	homoz3	n
si 4869.8		PROCESSING
rfp 3633.1	wfile	
th proc	fn	ft
lms cdc ph 1.000	math	131072
	werr	f
	wexp	
	wds	wft
	wnt

Table 2, Entry 1

Table 2, Entry 2

RAAV173
exp5 s2pul

SAMPLE		DEC. & VT	
date	Jul 17 2006	dfrq	125.795
solvent	CDCl3	dn	0.13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.235	dm	nnn
tn	3.200	dmm	c
at	6400	dmf	10000
np	10000.0	dseq	
sw	not used	dres	1.0
fb	not used	homo	n
bs	8	PROCESSING	
ss	1	wtfile	ft
tpwr	59	proc	fn
pw	9.8	math	131072
dn	1498.2	corr	
tof	16	wexp	
ct	16	wsb	
alock	n	gain	not used
gain	not used	wt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-164.5		
wp	4891.1		
vs	138		
sc	250		
h2mm	18.26		
is	388.42		
rfl	1044.8		
rpf	0		
th	7		
ins	3.000		
nm	ph

STANDARD 1H OBSERVE

exp1 std1h

SAMPLE
 date Aug 23 2006
 solvent CDCl3
 file ACQUISITION exp
 sfrq 300.100
 at 1.995
 nt 17984
 np 4506.5
 sw not used
 fb not used
 bs 16
 tpwr 54
 pw 7.0
 d1 1.000
 tof 0
 nt 16
 ct 16
 alock not used
 gain n
 fl n
 in n
 dp y
 DISPLAY
 sp -716.6
 wp 4506.3
 vs 74
 sc 0
 wc 250
 hzmm 18.03
 ls 500.00
 rfl 2898.6
 rfp 2181.2
 th 2.00
 ins cdc
 nm ph 2.000

Table 3, Entry 2

RAAV36
 exp1 stdih
 date 5 2006 DEC. & VT
 solvent Jun CDC13 dn 300.100
 file exp H1 30
 ACQUISITION exp 0
 sfrq 300.100 dm nnn
 tn H1 c
 at 1.995 dmf 200
 np 17984 wtfile
 sw 4506.5 proc
 fb not used ft
 bs 16 fn not used
 tpwr 54
 pw 7.0 werr
 ta 1.000 wexp
 tof 16 wds
 nt 16 wnt
 ct 16
 alock not used
 gain n
 FLAGS
 il n
 in n
 dp y
 DISPLAY
 sp -716.3
 wp 4506.3
 vs 151
 sc 0
 wc 250
 izmm 4.00
 iz 500.00
 rfl 2898.3
 rfp 2181.7
 th 20
 ins 1.000
 nm cdc ph

Table 3, Entry 3

Table 3, Entry 8

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RAAV82
exp5  s2pu1
SAMPLE
date   Jun 2 2006   dfrq   DEC. & VT
solvent CCl3      dn      125.795
file    exp      dpr      C13
ACQUISITION
sfrq    500.235   dm      37
tn      3.200    df      0
at      54000    dref   nnn
sw      10000.0  dseq   c
fb      not used gres   10000
bs      8        gres   1.0
ss      1        homo   n
wifile  1        PROCESSING
tpwr    59       wifile
pw      9.8      proc
dl      0        fn      131072
tof     1498.2   math
nt      16       werr
ct      0        wexp
gain    not used wbs
flags   not used wnt
il      n
in      n
ds      n
hs      n
DISPLAY
sp      -50.3
wp      5124.7
vs      41
sc      0
wc      250
hzmm    20-50
ls      18.75
rfi     4533.1
rfp     3536.7
tms     3
nm      2.000
ph

```

Table 4, Entry 6

RAAV1308
exp1 szpul

date	Jun 21 2006	DEC. & VT	125.795
solvent	CDCl3	dn	37
file	exp	dof	0
ACQUISITION	exp	nm	10000
sfrq	500.235	dm	C
tn	H1	dmm	10000
at	3.200	dmm	10000
np	64000	dseq	1.0
sw	10000.0	dres	1.0
fb	not used	homo	n
bs	not used	homo	n
ss	8	PROCESSING	
tpwr	1	wtfile	
pw	58	proc	fc
dn	9.8	fn	131072
do	0	math	f
nof	1498.2		
ct	16	werr	
ct	16	wexp	
gain	not used	was	
gain	not used	wnt	
il	n	FLAGS	
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-77.3		
wp	4625.5		
vs	151		
sc	0		
wc	250		
hzmm	18.50		
ls	201.49		
rfl	4632.5		
trf	3636.7		
trf	3636.7		
ins	2.000		
nm			
ph

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- ¹ Altman, R. A.; Buchwald, S. L. *Org. Lett.* **2006**, *8*, 2779-2782.
- ² Sugahara, M.; Ukita, T. *Chem. Pharm. Bull.* **1997**, *45*, 719.
- ³ Wang, P. S.; Liang, C. K.; Leung, M. K. *Tetrahedron* **2005**, *61*, 2931.
- ⁴ Firl, J.; Kresze, G. *Chem. Ber.* **1966**, *99*, 3695.
- ⁵ Wallace & Tiernan Inc. Substituted 1-(m-aminophenyl)-2-pyridones. US 2947755. February 5, 1959.
- ⁶ Renshaw, R. R.; Conn R. C. *J. Am. Chem. Soc.* **1937**, *59*, 297.
- ⁷ Lawrence, R.; Waight, E. S. *J. Chem. Soc. B.* **1968**, 1.
- ⁸ Fleet, G. W. J.; Fleming, I.; Philippides D. *J. Chem. Soc. C.* **1971**, 3948.
- ⁹ Smirnoff, A. P. *Helv. Chim. Acta* **1921**, *4*, 604.