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## A FACILE AND CONVENIENT SYNTHETIC METHOD FOR FLUORINE-CONTAINING DIBENZO[*b,h*][1,6]NAPHTHYRIDINES, THIOCHROMENO[3,2-*c*]QUINOLINES, AND CHROMENO[3,2-*c*]QUINOLINES

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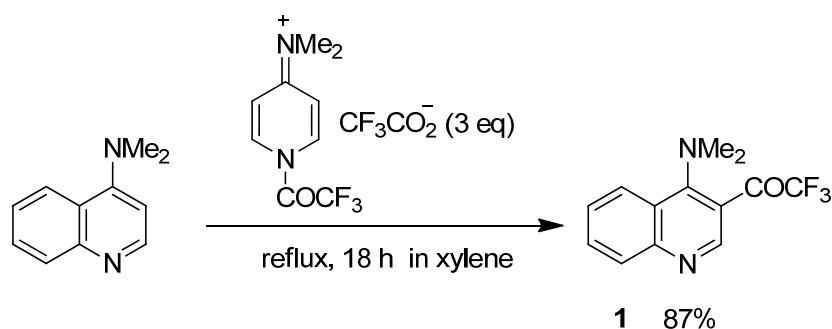
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**Abstract** – Novel fluorine-containing dibenzo[*b,h*][1,6]naphthyridines (**3**), thiochromeno[3,2-*c*]quinolines (**5**), and chromeno[3,2-*c*]quinolines (**7**) were synthesized in moderate to high yields by the trifluoromethanesulfonic acid catalyzed cyclization of *N*-aryl-3-trifluoroacetyl-4-quinolyamines (**2**) and aryl 3-trifluoroacetyl-4-quinolyl sulfides (**4**) and ethers (**6**), easily prepared by aromatic nucleophilic substitution reactions of *N,N*-dimethyl-3-trifluoroacetyl-4-quinolyamine (**1**) with *p*-substituted anilines, thiophenols, and phenols, respectively.

Dibenzo[*b,h*][1,6]naphthyridines have attracted much attention because of their biological properties. For example, they have demonstrated potential applications as antibacterial,<sup>1</sup> fungicidal,<sup>1</sup> neoplasm inhibitory,<sup>2</sup> amebicide,<sup>3</sup> and using for the treatment of Alzheimer's disease.<sup>4</sup> Thiochromenoquinolines and the related derivatives have been known to possess interesting biological activities such as antiproliferative,<sup>5</sup> antitumor,<sup>5</sup> enzyme inhibit,<sup>5</sup> and antifungal activity.<sup>6</sup> Chromenoquinoline derivatives have also constituted an important class of heterocyclic compounds because of its interesting pharmacological properties such as anticancer activity,<sup>7</sup> analgesic effect,<sup>8</sup> and anti-inflammatory activity.<sup>9</sup> Besides, considerable attention in recent years has been paid to the development of new methodologies for the syntheses of many kinds of fluorine-containing heterocycles, since these compounds are now widely recognized as important organic materials showing interesting biological activities for their

potential use in medicinal and agricultural scientific fields.<sup>10</sup> Thus, it would be very important to develop facile and convenient synthetic methods for novel fluorine-containing dibenzo[*b,h*][1,6]naphthyridines, thiochromeno[3,2-*c*]quinolines, and chromeno[3,2-*c*]quinolines, which would be strongly expected to present new bioactivities or functionalities.

Previously, we have found that in *N,N*-dimethyl-2,4-bis(trifluoroacetyl)-1-naphthylamine<sup>11</sup> and *N,N*-dimethyl-5,7-bis(trifluoroacetyl)-8-quinolylamine<sup>12</sup> activated by trifluoroacetyl group, the dimethylamino group, which is not generally lost in aromatic systems, actually behaves as an excellent leaving group and the novel aromatic nucleophilic substitutions (*N-N*, *N-S*, and *N-O* exchanges) takes place with various *N*-, *S*-, and *O*-nucleophiles. Moreover, we carried out applying this type of aromatic nucleophilic substitution and the subsequent cyclization with the use of acid catalyst to the simple syntheses of naphthalene<sup>13</sup> and quinoline<sup>14</sup> fused heterocycles bearing trifluoromethyl groups. Recently, we have reported the synthesis of *N,N*-dimethyl-3-trifluoroacetyl-4-quinolylamine (**1**)<sup>15,16</sup> and its aromatic nucleophilic *N-N*,<sup>15,16</sup> *N-S*,<sup>16</sup> and *N-O*<sup>16</sup> exchange reactions with amines, thiols, alcohols, and phenols to give the corresponding 3-trifluoroacetyl-4-quinolylamines, sulfides, and ethers in high yields, respectively. In this paper, we describe the efficient syntheses of novel fluorine-containing dibenzo[*b,h*][1,6]naphthyridines (**3**), thiochromeno[3,2-*c*]quinolines (**5**), and chromeno[3,2-*c*]quinolines (**7**) using the intramolecular Friedel-Crafts type reactions of the corresponding cyclization precursors (**2**, **4**, and **6**), prepared by the exchange reactions of **1** with *p*-substituted anilines, thiophenols, and phenols.



Ref. 15,16

Scheme 1

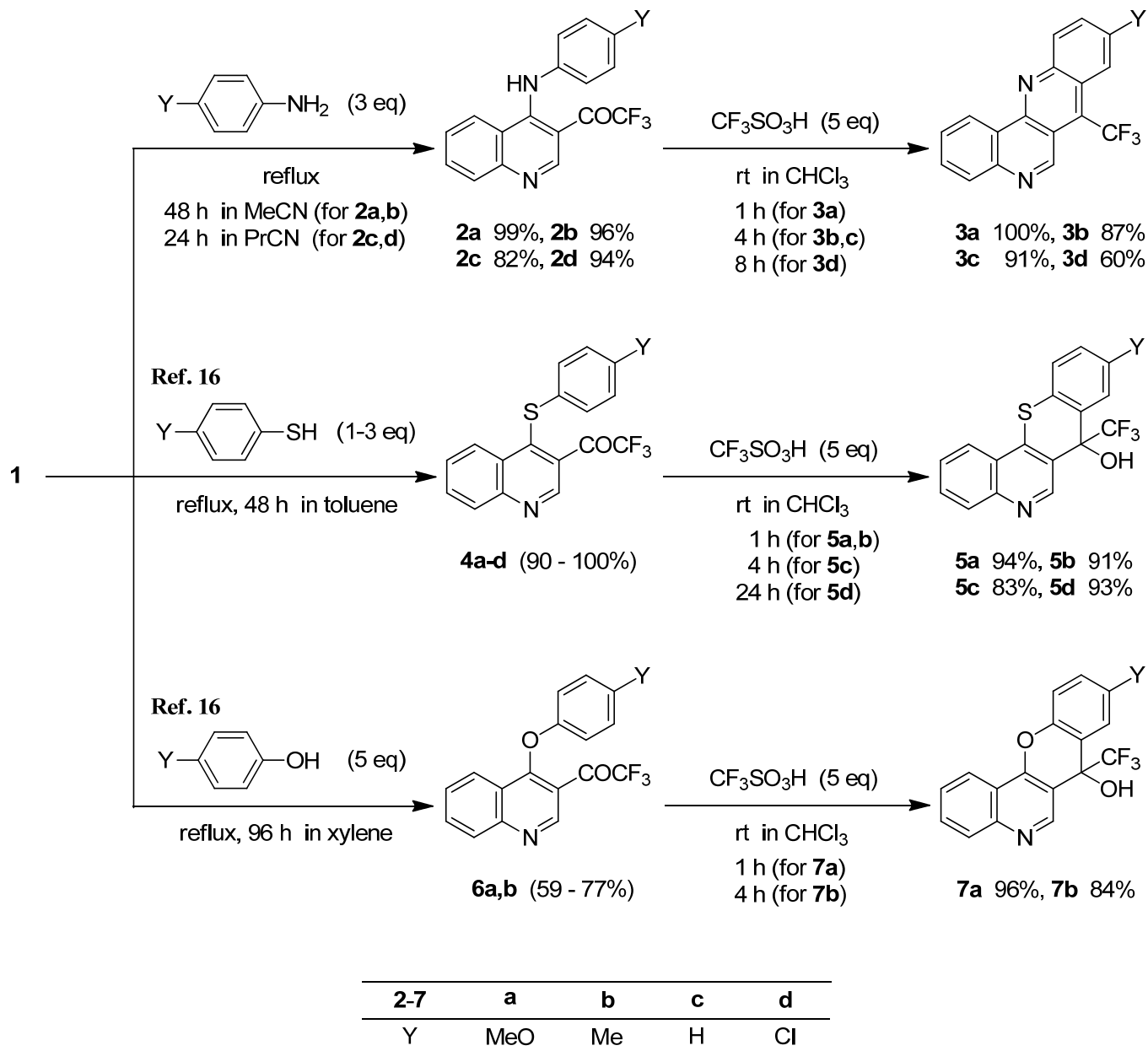
Firstly, we carried out the syntheses of the cyclization precursors, *N*-aryl-3-trifluoroacetyl-4-quinolylamines (**2**) and aryl 3-trifluoroacetyl-4-quinolyl sulfides (**4**) and ethers (**6**). Reaction of *N,N*-dimethyl-3-trifluoroacetyl-4-quinolylamine (**1**), which was easily synthesized by trifluoroacetylation

of *N,N*-dimethyl-4-quinolylamine with 1-trifluoroacetyl-4-dimethylaminopyridinium trifluoroacetate (Scheme 1),<sup>15,16</sup> with *p*-anisidine occurred readily in refluxing acetonitrile for 48 h to give the desired dimethylamino-*p*-anisidino exchanged product (**2a**)<sup>15,16</sup> in almost quantitative yield (Scheme 2). Similarly, *p*-toluidine also reacted cleanly to provide **2b** in 96% yield. In the cases of aniline and *p*-chloroaniline, the reactions were performed in refluxing butyronitrile to obtain exclusively the desired products (**2c** and **2d**) in high yields. Aromatic thiols, *p*-substituted benzenethiols, also underwent cleanly the dimethylamino-arylthio exchanges for 48 h in refluxing toluene to afford the corresponding aryl 3-trifluoroacetyl-4-quinolyl sulfides (**4a-d**) in over 90% yields.<sup>16</sup> Moreover, the desired aryl 3-trifluoroacetyl-4-quinolyl ethers (**6a** and **6b**) were prepared in moderate to good yields by the dimethylamino-aryloxy exchange reactions of **1** with *p*-substituted phenols such as *p*-methoxyphenol and *p*-cresol.<sup>16</sup>

Next, we attempted to synthesize the novel fluorine-containing dibenzo[*b,h*][1,6]naphthyridines (**3**), thiochromeno[3,2-*c*]quinolines (**5**), and chromeno[3,2-*c*]quinolines (**7**) by the cyclization of the corresponding exchanged products (**2**, **4**, and **6**) with the use of trifluoromethanesulfonic acid (TFSA) as an acid catalyst. The desired cyclization of *N*-(*p*-methoxyphenyl)-3-trifluoroacetyl-4-quinolylamine (**2a**) with TFSA (5 eq) proceeded easily even at room temperature for 1 h in chloroform to afford the target heterocycle, 9-methoxy-7-(trifluoromethyl)dibenzo[*b,h*][1,6]naphthyridine (**3a**) in quantitative yield. Reactions of *p*-methyl and *p*-unsubstituted derivatives (**2b** and **2c**) for 4 h provided 9-methyl and 9-unsubstituted dibenzo[*b,h*][1,6]naphthyridines (**3b** and **3c**) in 87% and 91% yields, respectively. In the case of *p*-chloro derivative (**2d**), the prolonged time (8 h) was required for completion of the reaction and the target 9-chloro derivative (**3d**) was obtained in moderate yield (60%). The present synthetic strategy could be extended further to the construction of the fluorine-containing thiochromeno[3,2-*c*]quinoline system from aryl 3-trifluoroacetyl-4-quinolyl sulfides (**4**). All the substrates, 4-arylthioquinolines (**4a-d**) cleanly underwent the TFSA catalyzed cyclization under almost the same conditions as those for 4-arylaminoquinolines (**2a-d**) to give the desired 7*H*-thiochromeno[3,2-*c*]quinolines (**5a-d**) in excellent yields. Lastly, the present method was applied to 4-aryloxyquinolines (**6**) to synthesize the CF<sub>3</sub>-containing chromeno[3,2-*c*]quinolines (**7**). Similarly to the cases of arylamino and arylthio derivatives (**2** and **4**) mentioned above, both cyclization reactions of *p*-methoxy and *p*-methyl derivatives (**6a** and **6b**) with TFSA proceeded smoothly at room temperature to afford the corresponding 7*H*-chromeno[3,2-*c*]quinolines (**7a** and **7b**) in high yields over 80%.

The structures of new compounds (**2b-d**, **3**, **5**, and **7**) were determined from their <sup>1</sup>H-NMR and IR spectra and elemental analyses, and <sup>13</sup>C-NMR spectra were measured for representative products.

In conclusion, the present method, composed of only three steps (trifluoroacetylation, *N-N*, *N-S*, and *N-O* exchanges, and cyclization) starting from *N,N*-dimethyl-4-quinolylamine, provides a facile and



Scheme 2

convenient access to dibenzo[*b,h*][1,6]naphthyridines, thiochromeno[3,2-*c*]quinolines, and chromeno[3,2-*c*]quinolines bearing trifluoromethyl group, which are difficult to obtain by other methods. Evaluation of biological activities for **3**, **5**, and **7** is now under way.

## EXPERIMENTAL

All reagents and solvents were purchased as reagent grade and used without further purification. Melting points were determined on an electrothermal digital melting point apparatus and are uncorrected.  $^1\text{H}$  NMR spectra were obtained with JEOL PMX 60SI (60 MHz) and Bruker Avance 500 (500 MHz) spectrometers and  $^{13}\text{C}$  NMR spectra were obtained with a Bruker Avance 500 (125 MHz) spectrometer; TMS was used as an internal standard. IR spectra were recorded on Hitachi EPI-G3 and PerkinElmer Spectrum ONE spectrophotometers. Microanalyses were taken with a Yanaco CHN-Coder MT-5 analyzer.

### *N-N* Exchange Reaction of **1** with Anilines; General Procedure

To a solution of **1**<sup>15,16</sup> (268 mg, 1 mmol) in MeCN (7 mL) and in PrCN (7 mL) was added the appropriate anilines (3 mmol) and the mixture was stirred at reflux temperature for 24-48 h. After removal of the solvent under reduced pressure,  $\text{CH}_2\text{Cl}_2$  (50 mL) was added to the residue. The mixture was washed with 1N HCl (50 mL), and the organic layer was separated and dried ( $\text{Na}_2\text{SO}_4$ ). The solvent was evaporated to give the practically pure products (**2b-d**).

### Cyclization of **2a-d**, **4a-d**, and **6a,b** with Trifluoromethanesulfonic Acid; General Procedure

To a solution of 1 mmol of the cyclization precursors (**2a**,<sup>15,16</sup> **2b-d**, **4a-d**,<sup>16</sup> and **6a,b**<sup>16</sup>) in  $\text{CHCl}_3$  (7 mL) was added  $\text{CF}_3\text{SO}_3\text{H}$  (750 mg, 5 mmol) and the mixture was stirred at room temperature for 1-24 h. Most of the solvent was evaporated and  $\text{CH}_2\text{Cl}_2$  (50 mL) was then added. The mixture was washed with saturated solution of  $\text{Na}_2\text{CO}_3$  (50 mL), and the organic layer was separated and dried ( $\text{Na}_2\text{SO}_4$ ). Removal of the solvent gave the practically pure cyclized products (**3a-d**, **5a-d**, and **7a,b**).

**2,2,2-Trifluoro-1-(4-(4-methoxyphenylamino)quinolin-3-yl)ethanone (2a):** mp 150-151 °C (*n*-hexane/EtOAc).<sup>16</sup>

**2,2,2-Trifluoro-1-(4-(*p*-tolylamino)quinolin-3-yl)ethanone (2b):** mp 97-98 °C (*n*-hexane); IR (KBr): 3051, 1638, 1193, 1140  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  11.72 (br s, 1H, NH), 9.07 (s, 1H, H-2), 7.94 (d,  $J = 8.0$  Hz, 1H), 7.66 (t,  $J = 8.0$  Hz, 1H), 7.59 (d,  $J = 8.0$  Hz, 1H), 7.20 (d,  $J = 7.7$  Hz, 2H), 7.14-7.03 (m, 3H), 2.40 (s, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR ( $\text{CDCl}_3$ ): 180.8 (q,  $J_{\text{CF}} = 34.6$  Hz), 155.9, 151.0 (q,  $J_{\text{CF}} = 4.6$  Hz), 150.5, 138.0, 137.0, 132.9, 130.5, 130.1, 127.2, 124.8, 124.2, 118.1, 117.1 (q,  $J_{\text{CF}} = 290.3$  Hz), 106.2, 21.1. Anal. Calcd for  $\text{C}_{18}\text{H}_{13}\text{F}_3\text{N}_2\text{O}$ : C, 65.45; H, 3.97; N, 8.48. Found: C, 65.46; H, 4.10; N, 8.34.

**2,2,2-Trifluoro-1-(4-(phenylamino)quinolin-3-yl)ethanone (2c):** mp 115-116 °C (*n*-hexane/EtOAc); IR (KBr): 3051, 1644, 1197, 1140  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  11.69 (br s, 1H, NH), 9.10 (s, 1H, H-2), 7.96 (d,  $J = 8.0$  Hz, 1H), 7.67 (t,  $J = 8.0$  Hz, 1H), 7.57 (d,  $J = 8.0$  Hz, 1H), 7.40 (t,  $J = 7.2$  Hz, 2H), 7.31 (t,  $J = 7.2$  Hz, 1H), 7.20 (d,  $J = 7.2$  Hz, 2H), 7.11 (t,  $J = 8.0$  Hz, 1H);  $^{13}\text{C}$  NMR ( $\text{CDCl}_3$ ): 180.9 (q,  $J_{\text{CF}} = 35.1$  Hz), 155.6, 150.9 (q,  $J_{\text{CF}} = 5.5$  Hz), 150.5, 140.8, 133.0, 130.2, 129.8, 127.2, 126.8, 124.9, 124.1, 118.1, 117.1 (q,  $J_{\text{CF}} = 290.1$  Hz), 106.6. Anal. Calcd for  $\text{C}_{17}\text{H}_{11}\text{F}_3\text{N}_2\text{O}$ : C, 64.56; H, 3.51; N, 8.86. Found: C, 64.45; H,

3.65; N, 8.86.

**1-(4-(4-Chlorophenylamino)quinolin-3-yl)-2,2,2-trifluoroethanone (2d):** mp 143-144 °C (*n*-hexane/EtOAc); IR (KBr): 3031, 1645, 1191, 1139 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 11.56 (br s, 1H, NH), 9.11 (q, *J*<sub>HF</sub> = 2.1 Hz, 1H, H-2), 7.99 (d, *J* = 8.1 Hz, 1H), 7.72 (t, *J* = 8.1 Hz, 1H), 7.58 (d, *J* = 8.1 Hz, 1H), 7.36 (d, *J* = 8.6 Hz, 2H), 7.19 (t, *J* = 8.1 Hz, 1H), 7.13 (d, *J* = 8.6 Hz, 2H); <sup>13</sup>C NMR (CDCl<sub>3</sub>): 181.1 (q, *J*<sub>CF</sub> = 35.5 Hz), 155.3, 150.8 (q, *J*<sub>CF</sub> = 5.3 Hz), 150.6, 139.4, 133.2, 132.2, 130.3, 130.0, 126.9, 125.2, 125.1, 118.0, 117.0 (q, *J*<sub>CF</sub> = 289.8 Hz), 107.0. Anal. Calcd for C<sub>17</sub>H<sub>10</sub>ClF<sub>3</sub>N<sub>2</sub>O: C, 58.22; H, 2.87; N, 7.99. Found: C, 57.82; H, 3.13; N, 8.13.

**9-Methoxy-7-(trifluoromethyl)dibenzo[*b,h*][1,6]naphthyridine (3a):** mp 178-179 °C (*n*-hexane/EtOAc); IR (KBr): 1215, 1164, 1132, 1115 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 9.75 (q, *J*<sub>HF</sub> = 2.0 Hz, 1H, H-6), 9.18-9.02 (m, 1H), 8.18-7.38 (m, 6H), 3.90 (s, 3H, OCH<sub>3</sub>). Anal. Calcd for C<sub>18</sub>H<sub>11</sub>F<sub>3</sub>N<sub>2</sub>O: C, 65.85; H, 3.38; N, 8.53. Found: C, 65.80; H, 3.39; N, 8.58.

**9-Methyl-7-(trifluoromethyl)dibenzo[*b,h*][1,6]naphthyridine (3b):** mp 191-192 °C (*n*-hexane/EtOAc); IR (KBr): 1225, 1171, 1141, 1120 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>-CDCl<sub>3</sub>): δ 9.71 (s, 1H, H-6), 9.08 (d, *J* = 7.4 Hz, 1H), 8.09-7.99 (m, 3H), 7.75 (t, *J* = 7.4 Hz, 1H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.58 (d, *J* = 8.6 Hz, 1H), 2.50 (s, 3H, CH<sub>3</sub>); <sup>13</sup>C NMR (DMSO-*d*<sub>6</sub>-CDCl<sub>3</sub>): 144.6 (q, *J*<sub>CF</sub> = 7.8 Hz), 144.3, 141.7, 139.6, 134.2, 129.5, 126.1, 125.9 (q, *J*<sub>CF</sub> = 32.8 Hz), 125.6, 124.5, 123.4, 120.3 (q, *J*<sub>CF</sub> = 279.1 Hz), 119.7, 119.6, 118.4 (q, *J*<sub>CF</sub> = 5.3 Hz), 117.9, 110.7, 17.8. Anal. Calcd for C<sub>18</sub>H<sub>11</sub>F<sub>3</sub>N<sub>2</sub>: C, 69.23; H, 3.55; N, 8.97. Found: C, 69.33; H, 3.59; N, 8.84.

**7-(Trifluoromethyl)dibenzo[*b,h*][1,6]naphthyridine (3c):** mp 159-160 °C (*n*-hexane/EtOAc); IR (KBr): 1217, 1164, 1142, 1126 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>-CDCl<sub>3</sub>): δ 9.76 (s, 1H, H-6), 9.15 (d, *J* = 7.5 Hz, 1H), 8.41 (d, *J* = 7.5 Hz, 1H), 8.27 (d, *J* = 7.5 Hz, 1H), 8.07 (d, *J* = 7.5 Hz, 1H), 7.87 (t, *J* = 7.5 Hz, 1H), 7.81 (t, *J* = 7.5 Hz, 1H), 7.76-7.63 (m, 2H); <sup>13</sup>C NMR (DMSO-*d*<sub>6</sub>-CDCl<sub>3</sub>): 145.2, 144.4 (q, *J*<sub>CF</sub> = 7.3 Hz), 142.3, 139.5, 126.8, 126.3, 125.9, 124.7 (q, *J*<sub>CF</sub> = 37.3 Hz), 124.3, 123.8, 123.4, 119.9 (q, *J*<sub>CF</sub> = 5.5 Hz), 119.6, 119.3, 117.9 (q, *J*<sub>CF</sub> = 280.4 Hz), 117.6, 110.5. Anal. Calcd for C<sub>17</sub>H<sub>9</sub>F<sub>3</sub>N<sub>2</sub>: C, 68.46; H, 3.04; N, 9.39. Found: C, 68.35; H, 3.17; N, 9.37.

**9-Chloro-7-(trifluoromethyl)dibenzo[*b,h*][1,6]naphthyridine (3d):** mp 195-196 °C (*n*-hexane/EtOAc); IR (KBr): 1217, 1159, 1142, 1126 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 9.91 (s, 1H, H-6), 9.35 (d, *J* = 7.5 Hz, 1H), 8.56 (s, 1H, H-8), 8.42 (d, *J* = 9.2 Hz, 1H), 8.23 (d, *J* = 7.5 Hz, 1H), 7.97-7.89 (m, 2H), 7.84 (t, *J* = 7.5 Hz, 1H). Anal. Calcd for C<sub>17</sub>H<sub>8</sub>ClF<sub>3</sub>N<sub>2</sub>: C, 61.37; H, 2.42; N, 8.42. Found: C, 61.23; H, 2.61; N, 8.37.

**9-Methoxy-7-(trifluoromethyl)-7H-thiochromeno[3,2-*c*]quinoline-7-ol (5a):** mp 231-232 °C (*n*-hexane/EtOAc); IR (KBr): 3038, 1164, 1118 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 9.39 (br s, 1H, H-6), 8.20-6.87 (m, 8H), 3.87 (s, 3H, OCH<sub>3</sub>). Anal. Calcd for C<sub>18</sub>H<sub>12</sub>F<sub>3</sub>NO<sub>2</sub>S: C, 59.50; H, 3.33; N, 3.85. Found: C, 59.33; H, 3.33; N, 4.02.

**9-Methyl-7-(trifluoromethyl)-7H-thiochromeno[3,2-c]quinoline-7-ol (5b):** mp 246-247 °C (*n*-hexane/EtOAc); IR (KBr): 3041, 1156, 1120 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 9.33 (br s, 1H, H-6), 8.26-7.13 (m, 8H), 2.43 (s, 3H, CH<sub>3</sub>). Anal. Calcd for C<sub>18</sub>H<sub>12</sub>F<sub>3</sub>NOS: C, 62.24; H, 3.48; N, 4.03. Found: C, 61.95; H, 3.76; N, 4.03.

**7-(Trifluoromethyl)-7H-thiochromeno[3,2-c]quinoline-7-ol (5c):** mp 245-246 °C (*n*-hexane/EtOAc); IR (KBr): 3058, 1164, 1112 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 9.33 (br s, 1H, H-6), 8.30-7.40 (m, 9H). Anal. Calcd for C<sub>17</sub>H<sub>10</sub>F<sub>3</sub>NOS: C, 61.26; H, 3.02; N, 4.20. Found: C, 61.08; H, 3.11; N, 4.29.

**9-Chloro-7-(trifluoromethyl)-7H-thiochromeno[3,2-c]quinoline-7-ol (5d):** mp 214-215 °C (*n*-hexane/EtOAc); IR (KBr): 3068, 1172, 1118 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>-CDCl<sub>3</sub>): δ 9.38 (s, 1H, H-6), 8.86-8.14 (m, 3H), 7.85 (br s, 1H, OH), 7.78 (t, *J* = 7.2 Hz, 1H), 7.65 (t, *J* = 7.2 Hz, 1H), 7.54 (s, 1H, H-8), 7.42 (d, *J* = 7.9 Hz, 1H); <sup>13</sup>C NMR (DMSO-*d*<sub>6</sub>-CDCl<sub>3</sub>): 149.6, 146.6, 139.9, 135.4, 130.9, 130.9, 130.7, 129.9, 129.5, 127.4, 127.4, 125.5, 125.2 (q, *J*<sub>CF</sub> = 288.2 Hz), 123.7, 123.4, 122.3, 73.0 (q, *J*<sub>CF</sub> = 30.5 Hz). Anal. Calcd for C<sub>17</sub>H<sub>9</sub>ClF<sub>3</sub>NOS: C, 55.52; H, 2.47; N, 3.81. Found: C, 55.37; H, 2.55; N, 3.88.

**9-Methoxy-7-(trifluoromethyl)-7H-chromeno[3,2-c]quinoline-7-ol (7a):** mp 239-240 °C (*n*-hexane/EtOAc); IR (KBr): 3068, 1214, 1171 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 9.12 (br s, 1H, H-6), 8.80-7.28 (m, 8H), 4.10 (s, 3H, OCH<sub>3</sub>). Anal. Calcd for C<sub>18</sub>H<sub>12</sub>F<sub>3</sub>NO<sub>3</sub>: C, 62.25; H, 3.48; N, 4.03. Found: C, 61.93; H, 3.67; N, 4.16.

**9-Methyl-7-(trifluoromethyl)-7H-chromeno[3,2-c]quinoline-7-ol (7b):** mp 231-232 °C (*n*-hexane/CHCl<sub>3</sub>); IR (KBr): 3065, 1221, 1168 cm<sup>-1</sup>; <sup>1</sup>H NMR (CDCl<sub>3</sub>): δ 9.04 (s, 1H, H-6), 8.19 (d, *J* = 8.0 Hz, 1H), 7.81 (s, 1H, H-8), 7.66 (d, *J* = 8.0 Hz, 1H), 7.56 (t, *J* = 8.0 Hz, 1H), 7.52 (t, *J* = 8.0 Hz, 1H), 7.34 (d, *J* = 8.2 Hz, 1H), 7.22 (d, *J* = 8.2 Hz, 1H), 5.69-5.49 (br, 1H, OH), 2.48 (s, 3H, CH<sub>3</sub>); <sup>13</sup>C NMR (DMSO-*d*<sub>6</sub>-CDCl<sub>3</sub>): 148.3, 145.6, 143.9, 143.1, 129.3, 126.5, 125.7, 124.0, 123.6, 121.9, 119.8 (q, *J*<sub>CF</sub> = 286.8 Hz), 116.9, 115.1, 113.5, 111.4, 105.0, 63.4 (q, *J*<sub>CF</sub> = 31.2 Hz), 16.0. Anal. Calcd for C<sub>18</sub>H<sub>12</sub>F<sub>3</sub>NO<sub>2</sub>: C, 65.26; H, 3.65; N, 4.23. Found: C, 65.30; H, 3.84; N, 4.00.

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