A New Strategy toward Fused-Pyridine Heterocyclic Scaffolds: Bischler−Napieralski-type Cyclization, Followed by Sulfoxide Extrusion Reaction

Xianxiu Xu,[†,‡] Sigen Guo,[†] Qun Dang,[†] Jin Chen,[†] and Xu Bai*[,†]

The Center for Combinatorial Chemistry and Drug Discovery, Jilin University, 75 Haiwai Street, Changchun, Jilin 130012, P. R. China, and Department of Chemistry, Northeast Normal University, Changchun, Jilin 130024, P. R. China

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Method development was completed for a new strategy to obtain fused-pyridine heterocyclic scaffolds. The synthetic route entails a Bischler−Napieralski-type reaction as the key step, followed by a sulfoxide extrusion reaction. The reactions of 3-amino-2-arylthiopyridines or 3-amino-4-arylthiopyridines and carboxylic acids promoted by a Lewis acid such as $SnCl_4$ yielded novel tricyclic pyridobenzothiazepines, which could be readily converted to their corresponding oxidized products via a sequence of sulfur oxidations and eventually to benzonaphthyridines via a sulfoxide extrusion. The synthetic strategy provides an efficient way to access libraries of novel structurally diversified heterocyclic compounds with potential pharmaceutical or biological activities.

Introduction

Pyridobenzothiazepine and benzonaphthyridine derivatives are of special interest in drug discovery because they have been extensively studied as potential agents to modulate the activity of the central nervous system. This area of research led to the development of clozapine-like analogs with intriguing biological activities.[1] For example, 10-(4-methylpiperazin-l-yl)pyrido[4,3-*b*][l,4]benzothiazepine possesses potent antidepressant-like activity.[2] Benzonaphthyridine analogs are known as antagonists of 5-HT_4 receptors,[3] antitumor agents,[4] potential antimalarials,[5] α-adrenoreceptor blockers,[6] PKC inhibitors,[7] and cancer cell growth inhibitors.[8] Thus far, a few studies have been directed toward the synthesis of pyridobenzothazepines and benzo[*c*][1,5] or benzo[*c*][1,7]-naphthyridines. Pyridobenzothiazepines could be prepared by condensation of *o*-aminochloropyridines with thiosalicyclic acid or from 2-chloronicotinic acid and substituted thiophenol in several steps via azide and isocyanate intermediates.[1a] Petrow et al. developed a route to benzo[*c*]-[1,7]naphthyridines (2,10-diazaphenanthrenes) by Stieglitz[9] or Schmidt rearrangement reaction[10] from 2-azaflurenones. Rocca et al. prepared benzo[*c*][1,7]naphthyridinones (2,10-diazaphenanthrenones) by a Suzuki coupling reaction from 3-amino-4-iodopyrdines and (2-((diisopropy1amino)carbonyl)-pheny1)boronic acid.[11] To the best of our knowledge, there is no report describing the synthesis of 6-aryl or 10-aryl pyridobenzothiazepines and their subsequent conversion to benzonaphthyridines.

Recently, we introduced a new methodology for the efficient synthesis of pyrimidine-fused benzodiazepines and benzothiazepines via Bischler−Napieralski-type reactions.[12] The resulting benzothiazepine derivatives were successfully converted to pyrimido[5,4-*c*]isoquinolines.[13] This conversion entailed the selective oxidations of the two sulfur atoms, the subsequent displacement of the resulted side-chain arylsulfonyl groups, and the final sulfur monoxide extrusion reaction from the ring. To expand the scope of this method and to access new heterocyclic scaffolds, we envisioned that libraries of 6-aryl pyridobenzothiazepines **3** or 10-arylpyridobenzothiazepines **4** with multiple diversity points could be readily prepared from 2-chloro-3-nitropyridine **7** or 4-chloro-3-nitropyridine **8** in a similar fashion. Furthermore, the resulting thiazepines **3** and **4** could be readily transformed to the corresponding benzo[*c*][1,5]naphthyridines **5** or benzo-[*c*][1,7]naphthyridines **6** by oxidation of the ring sulfur and subsequent sulfoxide extrusion from the ring (Scheme 1). Herein, the details of these studies are presented.

Results and Discussion

Preparation of Precursors. The synthesis of precursors **1** and **2** is shown in Scheme 2. 3-Nitro-2-(arylthio)pyridine **9** or 3-nitro-4-(arylthio)pyridine **10** were readily prepared using a modified procedure reported by Hamed.[14] Commercially available 2-chloro-3-nitropyridine **7** or 4-chloro-3-nitropyridine **8** was treated with a thiophenol in EtOH in the presence of EtONa at 0 °C to give 3-nitro-2-(arylthio)-pyridines **9** or 3-nitro-4-(arylthio)pyridine **10** in high yields. The nitro intermediates were then successfully converted to the corresponding amines **1** or **2** in excellent yields by reaction with Fe/NH_4Cl in refluxing EtOH/H_2O (v/v, 3/1).

Preparation of Pyridobenzothiazepine Libraries. Our initial plan was to subject aminopyridines **1** and **2** to the analogous reaction conditions reported previously,[12] which should give the corresponding thiazepine derivatives **3** and

* To whom correspondence should be addressed. Phone: +86-431-85188955. Fax: +86-431-85188900. E-mail: xbai@jlu.edu.cn.

† Jilin University.

‡ Northeast Normal University.

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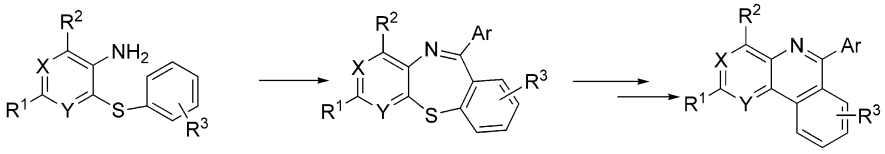
Scheme 1. Strategy for Preparation of Pyridobenzothiazepine and Benzonaphthyridine Derivatives

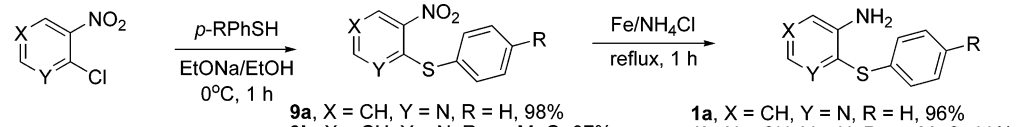


1, X = CH, Y = N
2, X = N, Y = CH

3, X = CH, Y = N
4, X = N, Y = CH

5, X = CH, Y = N
6, X = N, Y = CH

Scheme 2. Synthesis of 3-Amino-2-arylthiopyridines **1** and 3-Amino-4-(*p*-methylphenyl)thiopyridine **2**



7, X = CH, Y = N
8, X = N, Y = CH

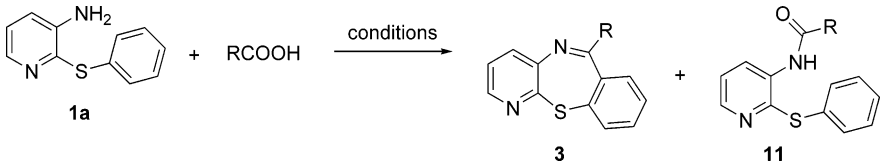
p-RPhSH, EtONa/EtOH, 0°C, 1 h

9a, X = CH, Y = N, R = H, 98%
9b, X = CH, Y = N, R = *p*-MeO, 97%
9c, X = CH, Y = N, R = *p*-Me, 96%
9d, X = CH, Y = N, R = *p*-Cl, 97%
10, X = N, Y = CH, R = *p*-Me, 95%

Fe/NH_4Cl, reflux, 1 h

1a, X = CH, Y = N, R = H, 96%
1b, X = CH, Y = N, R = *p*-MeO, 93%
1c, X = CH, Y = N, R = *p*-Me, 96%
1d, X = CH, Y = N, R = *p*-Cl, 90%
2, X = N, Y = CH, R = *p*-Me, 95%

Table 1. Optimization of Bischler−Napieralski-type Reaction Conditions in Pyridine Systems

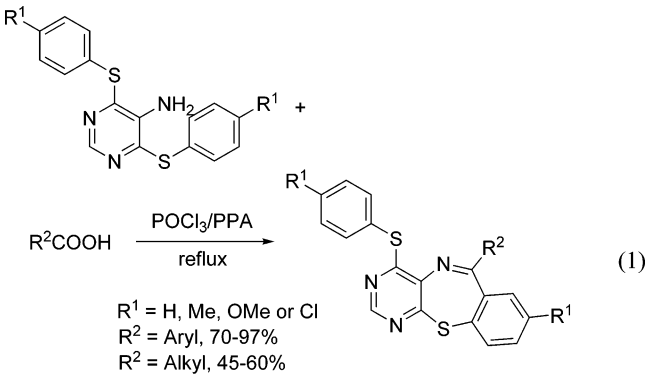


1a + RCOOH, conditions → **3** + **11**

			yields	
entry	R	conditions	**3**	**11**
1	Ph	PPA (1.5 equiv)/ $POCl_3$, reflux, 10 h	**3a**, 32%	**11a**, 52%
2	Ph	PPA (1.5 equiv)/ $POCl_3$, reflux, 48 h	**3a**, 46%	**11a**, 27%
3	Ph	PPA (1.5 equiv)/$POCl_3$ (10 equiv), CH_3CN, reflux, 3 h		**11a**, 91%
4	Ph	PPA (1.5 equiv)/$POCl_3$ (10 equiv), CH_3CN, reflux, 14 h		**11a**, 43%
5	Ph	$POCl_3$, reflux, 3 h		**11a**, 23%
6	Ph	$TiCl_4$ (2 equiv)/$POCl_3$, reflux, 52 h	**3a**, 73%	
7	Ph	$SnCl_4$ (2 equiv)/$POCl_3$, reflux, 34 h	**3a**, 78%	
8	Ph	$SnCl_4$ (1 equiv)/$POCl_3$, reflux, 51 h	**3a**, 69%	**11a**, 8%
9	Et	$SnCl_4$ (2 equiv)/$POCl_3$, reflux, 20 min		**11b**, 69%
10	Et	$SnCl_4$ (2 equiv)/$POCl_3$, reflux, 1 h		
11	Et	$SnCl_4$ (2 equiv)/$POCl_3$, 80 °C, 14 h		**11b**, 80%
12	Et	PPA (1.5 equiv)/$POCl_3$, reflux, 0.5 h		**11b**, 86%
13	Et	PPA (1.5 equiv)/$POCl_3$, reflux, 6 h		
14	Et	CCl_4 (3.3 equiv)/PPh_3 (3.3 equiv), CH_3CN, reflux, 2.5 h		**11b**, 88%
15	Et	CCl_4 (3.3 equiv)/PPh_3 (3.3 equiv), CH_3CN, reflux, 7 h		**11b**, 90%

4. 3-Amino-2-phenylthiopyridine **1a** was selected to test the reaction conditions required to generate thiazepine **3a**. When **1a** and 1.5 equiv of benzoic acid were treated with PPA in refluxed $POCl_3$ for 10 h, cyclization product **3a** was obtained in only 32% yield, and the intermediate amide **11a** was obtain in 52% yield. Simply prolonging the reaction time improved the yield of **3a** to 46%. It was observed that this reaction mixture remained a suspension, despite being refluxed. These observations prompted us to screen for an optimized cyclization condition, and the results are summarized in Table 1. In an attempt to increase the solubility, acetonitrile was added as a cosolvent. However this modification led to exclusive formation of amide **11a** (entries 3 and 4, Table 1). Leaving the PPA out of the reaction mixture produced a complex mixture from which only amide **11a** was isolated in low yield (entry 5, Table 1), indicating that an acid was required for the cyclization. Given that PPA is generally considered a strong acid, we then explored the potential replacement of PPA with Lewis acids to discover milder reaction conditions. Thus, $TiCl_4$ or $SnCl_4$ were used instead of PPA, and cyclized product **3a** was obtained in good yield (entries 6 and 7, Table 1). When the amount of $SnCl_4$ was reduced to 1 equiv, the reaction was much slower (entry 8, Table 1). Unfortunately, no desired pyridobenzothiazepine product was obtained; instead amide **11b** was isolated when substrate **1a** and propionic acid were subjected to this new Lewis acid-promoted reaction condition (entry 9, Table 1). Furthermore, amide **11b** appeared to be liable under the reaction condition because a longer reaction time led to decomposition of **11b** (entry 10, Table 1). A decrease of the reaction temperature led to amide **11b** in a good yield without the desired cyclization product (entry 11, Table 1). The use of the strong acid, PPA, only produced amide **11b** (entry 12, Table 1), and a longer reaction time again led to decomposition (entry 13, Table 1). Inspired by the publication of Weinreb and co-workers,[15] we also attempted to treat 3-amino-2-phenylthiopyridine **1a** and propionic acid with CCl_4 and PPh_3 in refluxing acetonitrile. In this case, amide **11b** was isolated in high yield after 2.5 and 7 h, and no desired thiazepine product was obtained (entries 14 and 15,

Table 1). These results indicate that the amide bond formation step is facile, while the subsequent cyclization step is much slower. Given that aliphatic amide **11b** showed an apparent lack of stability under these reaction conditions, it is therefore not surprising that the scope of this reaction is limited to aromatic acids. In contrast, our previously reported cyclizations with pyrimidines allow both aromatic and aliphatic acids as substrates to give the desired thiazepines in good yield.[12] Therefore, it appears that the thiazepine formation reactions for the current pyridine system are not as facile as our previously reported. One difference between these two systems is that there is a single arylthio group in the pyridines, while there are two arylthio groups next to the amino group of the pyrimidines. Since both aryl groups of the pyrimidines can participate in the cyclization reactions leading to the same products, this should render the cyclization reactions with these pyrimidines more facile than the current pyridines, statistically. Moreover, for the pyrimidines, the presence of a bulky group next to the amino group but on the opposite side of the arythio group could serve as a steric driving force to push the iminium reaction center into closer proximity to the electrophile, the other arylthio group. In contrast, the lack of a steric factor next to the amino group in the current pyridine system might permit the iminium reaction center to adopt unproductive conformations more readily. The apparent instability of the aliphatic amides of the pyridine systems and the slower cyclization reactions may explain why the current pyridine reactions are limited to only aromatic acids.

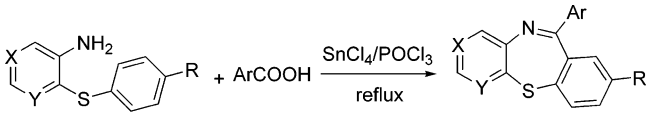


(1)

The current cyclization reactions of pyridines, while limited to aromatic acids, represent a useful method to prepare highly diverse pyridothiazepines and complement existing methodologies. A test set of pyridothiazepine derivatives were prepared by application of the above $SnCl_4$-promoted cyclization conditions, and the results are summarized in Table 2.

In general, various aromatic acids participated well in the cyclization reactions with 3-amino-2-phenylthiopyridines **1** to give 6-aryl pyridobenzothiazopines **3a**−**h** in good to high yields (entries 1−8, Table 2). However, the reaction rates for these aromatic acids differ from each other and are correlated to electronic effects of their substituents. The presence of an electron-donating group on an aromatic acid tends to speed up the reaction compared to the unsubstituted benzoic acid (entries 2−4, Table 2). In contrast, electron-withdrawing groups led to a slow down of this reaction

Table 2. Cyclization Results of 3-Amino-2-arylthiopyridines **1** and 3-Amino-4-(*p*-methylphenyl)thiopyridine **2**



1, 2 **3, 4**

entry	X	Y	R	Ar	time (d)	products	yield (%)[a]
1	CH	N	H	Ph	1.4	**3a**	78
2	CH	N	H	4-Me-Ph	0.9	**3b**	77
3	CH	N	H	3-Me-Ph	1	**3c**	76
4	CH	N	H	4-MeO-Ph	1	**3d**	75
5	CH	N	H	4-F-Ph	2.2	**3e**	80
6	CH	N	H	4-NO_2-Ph	2.4	**3f**	85
7	CH	N	H	3-NO_2-Ph	2.3	**3g**	82
8	CH	N	H	4-F-3-NO_2-Ph	7	**3h**	71
9	CH	N	H	furan-2-yl	2.8	**3i**	45
10	CH	N	Me	Ph	1.6	**3j**	84
11	CH	N	Me	4-Me-Ph	0.8	**3k**	87
12	CH	N	Me	4-MeO-Ph	0.8	**3l**	76
13	CH	N	Me	4-F-Ph	1.9	**3m**	88
14	CH	N	Me	3-NO_2-Ph	2.2	**3n**	92
15	CH	N	Me	furan-2-yl	1.5	**3o**	41
16	CH	N	OMe	Ph	1.7	**3p**	38
17	CH	N	OMe	4-F-Ph	2.4	**3q**	52
18	CH	N	OMe	4-Me-Ph	2	**3r**	23
19	CH	N	OMe	3-Me-Ph	2	**3s**	25
20	CH	N	OMe	4-NO_2-Ph	3	**3t**	67
21	CH	N	Cl	Ph	1.9	**3u**	63
22	CH	N	Cl	4-Me-Ph	4	**3v**	41[b]
23	CH	N	Cl	3-Me-Ph	4	**3w**	40[c]
24	CH	N	Cl	4-NO_2-Ph	3.5	**3x**	77
25	CH	N	Cl	3-NO_2-Ph	4	**3y**	75
26	N	CH	Me	Ph	1	**4a**	73
27	N	CH	Me	4-MeO-Ph	0.8	**4b**	81
28	N	CH	Me	4-NO_2-Ph	2	**4c**	86

[a] Isolated yields; >99% purity by LC-MS-ELSD. [b] The corresponding amide intermediate was obtained in a 24% yield. [c] The corresponding amide was obtained in a 19% yield.

(entries 5−7, Table 2). Moreover, the presence of two electron-withdrawing groups led to a further slow down of the reaction (entry 8, Table 2). Two examples of heteroaromatic acids were also tested using 2-furoic acid (entries 9 and 15, Table 2), and the reactions were much slower and gave lower yields of the thiazepines than the benzoic acid. On the other hand, substitutions on the phenyl ring of pyridines **1** appear to have little effect on both the reaction rates and yields (entries, 1, 10, 16, and 21, Table 2). The presence of a methoxy group in pyridines **1** appears to have a negative effect on the yield of the final products (entries 15−18, Table 2). This could be caused by the potential instability of methoxy group under the current acidic reaction conditions. Furthermore, pyridine **2** appears to be more reactive under the current reaction conditions than pyridine **1a** because it tolerated benzoic acids with both electron-donating and electron-withdrawing groups (entries 24−26, Table 2).

Preparation of Benzonaphthyridine Derivatives via Sulfur Oxidations and Sulfoxide Extrusion. Pyridobenzothiazepines **3** and **4** were readily oxidized to their corresponding sulfoxides or sulfones using previously reported methods (Scheme 3).[13] Thus, treatment of pyridobenzothiazepines **3a** and **b** with 1.2 equiv of *m*-CPBA in dichlo-

Scheme 3. Sequential Oxidation and Explorations of Sulfur Extrusions

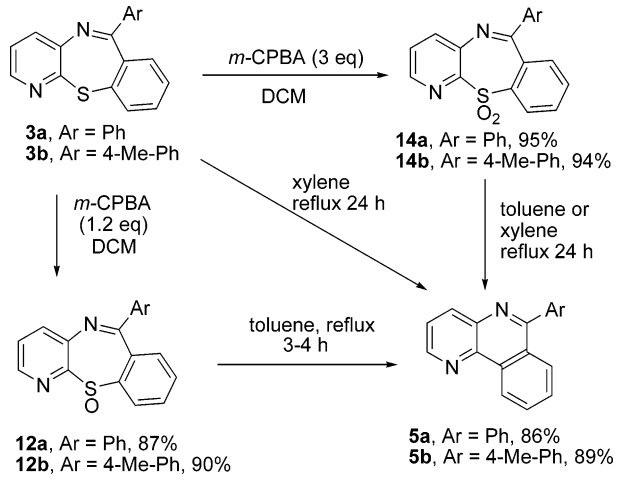
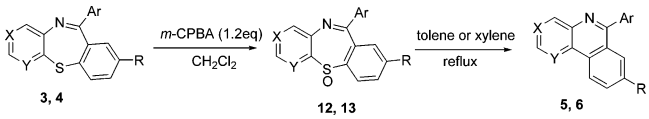


Table 3. Preparation of Benzonaphthyridines



entry	substrate	X	Y	Ar	R	product **5** or **6**	yield (%)[a]
1	**3a**	CH	N	Ph	H	**5a**	86
2	**3b**	CH	N	4-Me-Ph	H	**5b**	89
3	**3c**	CH	N	3-Me-Ph	H	**5c**	76
4	**3d**	CH	N	4-MeO-Ph	H	**5d**	75
5	**3e**	CH	N	4-F-Ph	H	**5e**	85
6	**3f**	CH	N	4-NO_2-Ph	H	**5f**	81
7	**3g**	CH	N	3-NO_2-Ph	H	**5g**	83
8	**3k**	CH	N	4-MeO-Ph	Me	**5h**	80
9	**3m**	CH	N	4-F-Ph	Me	**5i**	86
10	**3n**	CH	N	3-NO_2-Ph	Me	**5j**	82
11	**3s**	CH	N	3-Me-Ph	OMe	**5k**	82
12	**3t**	CH	N	4-NO_2-Ph	OMe	**5l**	87
13	**3u**	CH	N	Ph	Cl	**5m**	74
14	**4a**	N	CH	Ph	Me	**6a**	72
15	**4b**	N	CH	4-MeO-Ph	Me	**6b**	81
16	**4c**	N	CH	4-NO_2-Ph	Me	**6c**	83

[a] Overall isolated yields in two steps (except for **5a** and **5b** from **12a** and **12b)**; >99% in purity by LC-MS-ELSD.

romethane at 0 °C provided sulfoxides **12a** and **b**, while treatment with 3.0 equiv of *m*-CPBA gave sulfones **14a** and **b** in high yields.

Subsequently, sulfoxide extrusion reactions of substrates **3**, **12**, and **14** were investigated. When sulfides **3** or sulfones **14** were subjected to the standard sulfur extrusion reaction conditions, no extrusion occurred. On the other hand, sulfoxides **12** were smoothly converted to the expected ring-contracted benzonaphthyridines **5a** and **b** in high yields under the same reaction conditions. These results are consistent with our previous observations in pyrimidobenzothiazepine systems.[13] Therefore, the selective oxidation and sulfoxide extrusion sequence were applied to the synthesis of a series of benzonaphthyridine derivatives, and the results are summarized in Table 3. Pyridothiazepines **3** and **4** were readily converted to the desired naphthyridines **5** and **6** in good to excellent yields, although the extrusion reactions of 10-arylpyrido[4,3-*b*][1,4]benzothiazepines **4a**−**c** were much slower (sulfoxide of **4a** refluxing in xylene for 23 h, **4b** for 15 h, and **4c** for 23 h).

Conclusion

In summary, a new synthetic route to pyridobenzothiazepines was developed to access novel heterocyclic scaffolds. Thus, the previously reported Bischler−Napieralski-type reaction in pyrimidine systems was applied to the synthesis of pyridobenzothiazepine scaffolds by reactions of arylthioaminopyridines and aromatic acids. Investigations of Lewis acids led to the introduction of a milder $SnCl_4/POCl_3$-promoted cyclization with aromatic acids. The Lewis acid condition should tolerate substrates with functional groups that are sensitive to the previously reported strong acidic conditions. Furthermore, the resulting pyridothiazepines could be readily converted to either their corresponding sulfoxides or sulfones through careful selective oxidation. Finally, novel naphthyridine scaffolds could be generated from these new thiazepines via the sulfur oxidation−extrusion sequence in excellent yields. These reactions could be used to generate several novel pyridine-fused heterocyclic scaffolds, and the library design has been demonstrated through the preparation of a library of various 6- and 10-aryl-substituted pyridobenzothiazopines and naphthyridine derivatives. This new methodology should complement existing ones for rapid access to such libraries of pharmaceutically interesting heterocyclic scaffolds.

Experimental Section

General Considerations. Phosphoryl oxychloride ($POCl_3$) was freshly distilled. Dichloromethane (DCM) was dried over anhydrous $CaCl_2$. All other commercial reagents were used as received without additional purification. Melting points were uncorrected. Mass spectra and HPLC (ELSD) data were recorded on an Agilent 1100 LC/MS-ELSD (Altech) system using a 4.6 × 50 mm column (5 μm) with a linear gradient of 30−90% (v/v) acetonitrile−water with 0.035% trifluoroacetic acid (TFA) over 5 min with a flow rate of 3.5 mL/min. Analytical TLC was performed using 2.5 × 5 cm plates coated with a 0.25 mm thickness of silica gel 60 F_{254}. Column chromatography was performed using silica gel G (200−300 mesh). All ^{1}H NMR spectra (300 or 500 MHz) are reported as follows: chemical shifts in parts per million downfield from TMS as an internal standard (δ scale) and $CDCl_3$ or DMSO-d_6 as the solvent. Multiplicities are indicated as the following: multiplicity [br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, and coupling constant (Hz)]. All ^{13}C NMR spectra (75 or 125 MHz) were determined with complete proton decoupling and are reported in parts per million.

General Procedure for the Synthesis of 3-Nitro-2-arylthiopyridines 9 or 3-Nitro-4-(*p*-methylphenyl)thiopyridne 10. Thiophenol (5.6 g, 40 mmol) was added to a solution of EtONa in EtOH (1 N, 40 mL), cooled in an ice bath. 2-Chloro-3-nitropyridine (6.34 g, 40 mmol) was added to the mixture in portions, while it was stirred. After it was stirred for an additional 20 min, the reaction mixture was concentrated in vacuo and diluted with water (100 mL). The precipitate was filtered, washed with water (20 mL), and then

dried to give 3-nitro-2-phenylthiopyridine **9a** (9.09 g, 98%) as a yellow solid. mp: 105−106 °C. ^{1}H NMR ($CDCl_3$): δ 8.49 (m, 2 H), 7.57−7.54 (m, 2 H), 7.47−7.45 (m, 3 H), 7.20−7.15(m, 1H). ES-MS: *m*/*z* 232.9 [M + H$^+$].

3-Nitro-2-(*p*-methoxyphenyl)thiopyridine (9b). Yield: 10.1 g, 97%. Yellow solid. mp: 140−142 °C. ^{1}H NMR ($CDCl_3$): δ 8.52−8.47 (m, 2H), 7.47 (d, J = 9.0, 2H), 7.19−7.14 (m, 1H), 6.98 (d, J = 9.0, 2H), 3.86 (s, 3H). ES-MS: *m*/*z* 263.0 [M + H$^+$].

3-Nitro-2-(*p*-methylphenyl)thiopyridine (9c). Yield: 11.0 g, 96%. Yellow solid. mp: 92−94 °C. ^{1}H NMR ($CDCl_3$): δ 8.51−8.47 (m, 2H), 7.43 (d, J = 7.8, 2H), 7.26 (d, J = 7.8, 2H), 7.18−7.14 (m, 1H), 2.42 (s,3H). ES-MS: *m*/*z* 247.0 [M + H$^+$].

3-Nitro-2-(*p*-chlorophenyl)thiopyridine (9d). Yield: 10.0 g, 97%. Yellow solid. mp: 124−126 °C. ^{1}H NMR ($CDCl_3$): δ 8.53−8.50 (m, 2H), 7.49 (d, J = 8.7, 2H), 7.43 (d, J = 8.7, 2H), 7.21 (dd, J = 8.1, 4.8, 1H). ES-MS: *m*/*z* 267.0 [M + H$^+$].

3-Nitro-4-(*p*-methylphenyl)thiopyridine (10). Yield: 1.4 g, 95%. Yellow solid. mp: 109−111 °C. ^{1}H NMR ($CDCl_3$): δ 9.34 (s, 1H), 8.34 (d, J = 5.4, 1H), 7.46 (d, J = 8.1, 2H), 7.35 (d, J = 8.1, 2H), 6.70 (d, J = 6.0, 1H), 2.46 (s, 3H). ES-MS: *m*/*z* 247.0 [M + H$^+$].

General Procedure for the Synthesis of 3-Amino-2-arylthiopyridines 1 or 3-Amino-4-(*p*-methylphenyl)thiopyridne 2. 3-Nitro-2-phenylthiopyridine **9a** (8.12 g, 35 mmol), iron powder (5.9 g, 105 mmol), and NH_4Cl (1.87 g, 35 mmol) were added in sequence to a solution of water (30 mL) in EtOH (120 mL). The mixture was stirred and heated to reflux for 1 h and filtered through celite, and the filtrate was concentrated in vacuo. The residue was diluted with water (120 mL) and extracted by EtOAc (3 × 40 mL). The combined organic phase was washed by brine, dried over anhydrous Na_2SO_4, and concentrated in vacuo to give 3-amino-2-phenylthiopyridine **1a** as a pale white solid (6.79 g, 96%). mp: 68−69 °C. ^{1}H NMR ($CDCl_3$): δ 8.04−8.02 (m, 1 H), 7.30−7.18(m, 5H), 7.10−7.06 (m, 1 H), 7.03−7.00 (m, 1H). ^{13}C NMR ($CDCl_3$): δ 144.17, 140.28, 138.94, 134.04, 129.27, 129.06, 126.60, 124.24, 122.01. ES-MS: *m*/*z* 203.0 [M + H$^+$].

3-Amino-2-(*p*-methoxyphenyl)thiopyridine (1b). Yield: 6.5 g, 93%. Yellow solid. mp: 92−94 °C. ^{1}H NMR ($CDCl_3$): δ 7.96 (dd, J = 4.2, 1.5, 1H), 7.35 (d, J = 6.9, 2H), 6.99−6.93 (m, 2H), 6.85(d, J = 6.9, 2H), 4.15 (br, 2H), 3.78 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 159.19, 142.80, 141.19, 140.02, 133.09, 123.37, 123.20, 121.63, 114.73, 55.21. ES-MS: *m*/*z* 233.0 [M + H$^+$].

3-Amino-2-(*p*-methylphenyl)thiopyridine (1c). Yield: 7.2 g, 96%. Yellow solid. mp: 94−96 °C. ^{1}H NMR ($CDCl_3$): δ 7.99 (dd, J = 4.2, 1.5, 1H), 7.22 (d, J = 8.1, 2H), 7.08 (d, J = 8.1, 2H), 7.05−6.95 (m, 2H), 4.18 (br, 2H), 2.30 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 143.58, 140.11, 136.86, 130.14, 129.85, 123.76, 121.84, 21.00. ES-MS: *m*/*z* 217.0 [M + H$^+$].

3-Amino-2-(*p*-chlorophenyl)thiopyridine (1d). This compound was purified by crystallization with petroleum ether−EtOAc (5:2, v/v). Yield: 4.5 g, 90%. Brown solid. mp: 88−100 °C. ^{1}H NMR ($CDCl_3$): δ 8.04 (d, J = 4.5, 1H), 7.26 (d, J = 8.5, 2H), 7.23 (d, J = 8.5, 2H), 7.11 (dd, J = 8.0, 4.5 Hz, 1H), 7.04 (d, J = 8.0, 1H), 4.23 (br, 2H). ^{13}C NMR ($CDCl_3$): δ 144.00, 140.29, 132.63, 132.46, 130.71, 129.30, 129.14, 124.33, 122.10. ES-MS: *m*/*z* 237.0 [M + H$^+$].

3-Amino-4-(*p*-methylphenyl)thiopyridine (2). Yield: 1.2 g, 95%. Orange solid. mp: 50−52 °C. ^{1}H NMR ($CDCl_3$): δ 8.06 (s, 1H), 7.88 (d, J = 4.8, 1H), 7.24 (d, J = 7.8, 2H), 7.15 (d, J = 7.8, 2H), 4.08 (br, 2H), 2.35 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ 139.74, 138.19, 137.10, 131.40, 130.31, 128.53, 128.02, 125.47, 21.06. ES-MS: *m*/*z* 217.0 [M + H$^+$].

General Procedure for the Synthesis of 6-Arylpyrido-[2,3-b][1,4]benzothiazepines 3a−y and 10-Arylpyrido[4,3-b][1,4]benzothiazepines 4a−c. 3-Amino-2-arylthiopyridines **1** or 3-amino-4-(*p*-methylphenyl)thiopyridine **2** (1 mmol), aromatic acid (184 mg, 1.5 mmol), and $SnCl_4$ (2 mmol) were dissolved in $POCl_3$ (5 mL). After the mixture was refluxed for the appropriate time, the mixture was poured to ice water (20 mL) and treated with 5 N aqueous NaOH to pH 9−10; then it was extracted with EtOAc (3 × 20 mL). The combined organic phase was washed with saturated Na_2CO_3 and brine, dried with anhydrous Na_2SO_4, concentrated in vacuo, and purified by flash chromatography with petroleum ether−EtOAc (10:1, v/v) as eluent to afford products **3** or **4**.

6-Phenylpyrido[2.3-*b*][1,4]benzothiazepine (3a). Yield: 356 mg, 78%. Yellow solid. mp: 131−133 °C. ^{1}H NMR ($CDCl_3$): δ 8.28 (dd, J = 4.8, 1.5 Hz, 1H), 7.81−7.78 (m, 2H), 7.68−7.62 (m, 2H), 7.51−7.41 (m, 4H), 7.33−7.22 (m, 3H). ^{13}C NMR ($CDCl_3$): δ 169.64, 147.38, 146.34, 144.64, 139.76, 138.78, 136.77, 133.06, 133.00, 131.47, 131.01, 130.33, 129.76, 128.19, 127.79, 123.76. ES-MS: *m*/*z* 289.0 [M + H$^+$]. Anal. Calcd for $C_{18}H_{12}N_2S$: C, 74.97; H, 4.19; N, 9.71. Found: C, 74.98; H, 4.20; N, 9.87.

6-(*p*-Methylphenyl)pyrido[2,3-*b*][1,4]benzothiazepine (3b). Yield: 258 mg, 77%. Yellow solid. mp: 159−161 °C. ^{1}H NMR ($CDCl_3$): δ 8.27 (dd, J = 4.5, 1.8, 1H), 7.69 (d, J = 8.4, 2H), 7.66−7.61 (m, 2H), 7.45 (td, J = 7.5, 1.8, 1H), 7.34−7.31 (m, 1H), 7.29−7.25 (m, 2H), 7.24 (d, J = 8.4, 2H), 2.43 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.49, 147.47, 146.14, 144.77, 141.51, 138.77, 137.06, 136.84, 132.98, 131.38, 130.37, 129.78, 128.94, 127.75, 123.75, 21.43. ES-MS: *m*/*z* 303.0 [M + H$^+$]. Anal. Calcd for $C_{19}H_{14}N_2S$: C, 75.47; H, 4.67; N, 9.26. Found: C, 75.57; H, 4.48; N, 9.21.

6-(*m*-Methylphenyl)pyrido[2,3-*b*][1,4]benzothiazepine (3c). Yield: 163 mg, 76%. Yellow solid. mp: 133−134 °C. ^{1}H NMR ($CDCl_3$): δ 8.28 (d, J = 4.8, 1H), 7.68−7.63 (m, 3H), 7.52−7.44 (m, 2H), 7.34−7.23 (m, 5H), 2.41 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.88, 147.42, 146.26, 144.64, 139.78, 138.71, 137.94, 136.88, 133.01, 132.94, 131.81, 131.41, 130.34, 130.04, 128.04, 127.75, 127.18, 123.72, 21.32. ES-MS: *m*/*z* 303.0 [M + H$^+$].

6-(*p*-Methoxyphenyl)pyrido[2,3-*b*][1,4]benzothiazepine (3d). Yield: 110 mg, 75%. Yellow solid. mp: 148−150 °C. ^{1}H NMR ($CDCl_3$): δ 8.26 (dd, J = 4.8, 1.8, 1H), 7.77 (d, J = 8.7, 2H), 7.67 (dd, J = 8.7, 0.6, 1H), 7.61 (dd, J = 8.4, 1.5, 1H), 7.46 (td, J = 7.5, 1.8, 1H), 7.32 (td, J = 7.8, 1.2, 1H), 7.28−7.23 (m, 2H), 6.95 (d, J = 8.7, 2H), 3.88 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 168.80, 162.06, 147.47, 145.94, 144.87, 138.75, 136.77, 133.01, 132.92, 132.31, 131.53, 131.33, 130.36, 127.73, 123.73, 113.55, 55.37. ES-MS: *m*/*z* 319.0 [M + H$^+$].

6-(*p*-Fluorophenyl)pyrido[2,3-*b*][1,4]benzothiazepine (3e). Yield: 167 mg, 80%. Yellow solid. mp: 149−151 °C. ^{1}H NMR ($CDCl_3$): δ 8.29 (dd, J = 4.8, 1.5, 1H), 7.84−7.79 (m, 2H), 7.68(dd, J = 7.2, 0.9, 1H), 7.62 (dd, J = 8.1, 1.8, 1H), 7.48 (td, J = 7.2, 1.8, 1H), 7.33 (td, J = 7.2, 0.9, 1H), 7.29−7.22 (m, 2H), 7.16−7.10 (m, 2H). ^{13}C NMR ($CDCl_3$): δ 168.35, 164.60 (d, J = 250.65), 147.33, 146.41, 144.57, 138.86, 136.52, 135.94 (d, J = 3.45), 133.15, 133.04, 131.93 (d, J = 9.15), 131.64, 130.19, 127.90, 123.83, 115.29 (d, J = 21.75). ES-MS: m/z 307.1 [M + H$^+$].

6-(*p*-Nitrophenyl)pyrido[2,3-*b*][1,4]benzothiazepine (3f). Yield: 163 mg, 85%. Yellow solid. mp: 179−181 °C. ^{1}H NMR ($CDCl_3$): δ 8.36 (dd, J = 4.8, 1.8, 1H), 8.30 (d, J = 9.0, 2H), 7.99 (d, J = 9.0 Hz, 2H), 7.72−7.67 (m, 2H), 7.53 (td, J = 7.5, 1.5, 1H), 7.39−7.31 (m, 2H), 7.19 (dd, J = 7.5, 1.5, 1H). ^{13}C NMR ($CDCl_3$) δ 167.54, 149.12, 147.27, 146.98, 145.27, 144.17, 139.03, 135.97, 133.44, 133.40, 132.11, 130.63, 129.81, 128.16, 123.98, 123.37. ES-MS: m/z 334.0 [M + H$^+$].

6-(*m*-Nitrophenyl)pyrido[2,3-*b*][1,4]benzothiazepine (3g). Yield: 131 mg, 82%. Yellow solid. mp: 222−224 °C. ^{1}H NMR ($CDCl_3$): δ 8.72 (s, 1H), 8.38−8.35 (m, 2H), 8.12 (d, J = 8.1, 1H), 7.74−7.68 (m, 2H), 7.64 (t, J = 8.1, 1H), 7.53 (t, J = 7.8, 1H), 7.40−7.30 (m, 2H), 7.22 (d, J = 7.8, 1H). ^{13}C NMR ($CDCl_3$): δ 167.13, 148.29, 147.15, 147.02, 144.12, 141.36, 139.01, 135.75, 135.44, 133.47, 133.35, 132.16, 129.72, 129.27, 128.22, 125.37, 124.38, 123.96. ES-MS: m/z 334.0 [M + H$^+$]. Anal. Calcd for $C_{18}H_{11}N_3O_2S$: C, 64.85; H, 3.33; N, 12.60. Found: C, 64.65; H, 3.25; N, 12.58.

6-(*p*-Fluoro-*m*-nitrophenyl)pyrido[2,3-*b*][1,4]benzothiazepine (3h). Yield: 162 mg, 71%. Yellow solid. mp: 224−226 °C. ^{1}H NMR ($CDCl_3$): δ 8.57 (dd, J = 7.2, 2.1, 1H), 8.35 (dd, J = 4.8, 1.8, 1H), 8.13−8.08 (m, 1H), 7.72 (m, 1H), 7.67 (dd, J = 8.1, 1.8, 1H), 7.54 (td, J = 7.2, 1.8, 1H), 7.42−7.30 (m, 3H), 7.22 (dd, J = 7.8, 1.5, 1H). ^{13}C NMR ($CDCl_3$): δ 165.97, 156.78 (d, J = 269.03), 147.25, 147.03, 144.05, 139.13, 136.65 (d, J = 4.58), 136.40, 136.26, 135.38, 133.65, 133.35, 132.33, 129.59, 128.33, 127.34, 124.02, 118.38 (d, J = 20.63). ES-MS: m/z 352.0 [M + H$^+$].

6-(Furan-2-yl)pyrido[2,3-*b*][1,4]benzothiazepine (3i). Yield: 102 mg, 45%. Yellow solid. mp: 159−161 °C. ^{1}H NMR ($CDCl_3$): δ 8.28 (dd, J = 4.5, 1.5, 1H), 7.72−7.65 (m, 3H), 7.55 (dd, J = 7.8, 1.5, 1H), 7.49 (td, J = 7.5, 1.5, 1H), 7.41−7.36 (m, 1H), 7.29−7.25 (m, 1H), 6.76 (d, J = 3.3, 1H), 6.57 (dd, J = 3.6, 1.8, 1H). ^{13}C NMR ($CDCl_3$): δ 158.69, 152.72, 147.33, 146.40, 144.55, 139.15, 135.07, 133.52, 133.11, 131.79, 129.87, 127.96, 123.95, 118.59, 112.24. ES-MS: m/z 279.0 [M + H$^+$].

6-Phenyl-8-methylpyrido[2,3-*b*][1,4]benzothiazepine (3j). Yield: 167 mg, 84%. Yellow solid. mp: 132−134 °C. ^{1}H NMR ($CDCl_3$): δ 8.28 (dd, J = 4.8, 1.8, 1H), 7.83−7.79 (m, 2H), 7.62 (dd, J = 7.8, 1.8, 1H), 7.54 (d, J = 8.1, 1H), 7.52−7.42 (m, 3H), 7.29−7.23 (m, 2H), 7.04 (d, J = 1.5, 1H), 2.28 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.72, 147.71, 146.17, 144.66, 139.82, 137.99, 136.57, 135.50, 132.97, 132.82, 132.37, 130.92, 130.63, 129.75, 128.18, 123.64, 20.97. ES-MS: m/z 303.0 [M + H$^+$]. Anal. Calcd for $C_{19}H_{14}N_2S$: C, 75.47; H, 4.67; N, 9.26. Found: C, 75.44; H, 4.88; N, 9.01.

6-(*p*-Methyl-phenyl)-8-methylpyrido[2,3-*b*][1,4]-benzothiazepine (3k). Yield: 555 mg, 87%. Yellow solid. mp: 184−186 °C. ^{1}H NMR ($CDCl_3$): δ 8.26 (dd, J = 4.5, 1.5, 1H), 7.70 (d, J = 8.4, 2H), 7.63 (dd, J = 8.1, 1.5, 1H), 7.27−7.22 (m, 4H), 7.05 (s, 1H), 2.43 (s, 3H), 2.27 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.58, 147.83, 146.00, 144.81, 141.41, 137.91, 137.13, 136.66, 135.50, 132.91, 132.80, 132.28, 130.69, 129.78, 128.92, 123.63, 21.43, 20.99. ES-MS: m/z 317.0 [M + H$^+$].

6-(*p*-Methoxyphenyl)-8-methylpyrido[2,3-*b*][1,4]-benzothiazepine (3l). Yield: 505 mg, 76%. Yellow solid. mp: 179−181 °C. ^{1}H NMR ($CDCl_3$): δ 8.24 (dd, J = 4.2, 1.5, 1H), 7.78 (d, J = 9.0, 2H), 7.58 (dd, J = 7.8, 1.5, 1H), 7.54 (d, J = 7.8, 1H), 7.25−7.21 (m, 2H), 7.06 (s, 1H), 6.95 (d, J = 9.0, 2H), 3.88 (s, 3H), 2.28 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 168.83, 161.95, 147.76, 145.71, 144.88, 137.85, 136.52, 135.39, 132.77, 132.31, 132.19, 131.46, 130.65, 123.57, 113.49, 55.28, 20.96. ES-MS: m/z 333.0 [M + H$^+$].

6-(*p*-Fluorophenyl)-8-methylpyrido[2,3-*b*][1,4]-benzothiazepine (3m). Yield: 565 mg, 88%. Yellow solid. mp: 175−177 °C. ^{1}H NMR ($CDCl_3$): δ 8.28 (dd, J = 4.8, 1.8, 1H), 7.85−7.80 (m, 2H), 7.60 (dd, J = 7.8, 1.8, 1H), 7.55 (d, J = 8.1, 1H), 7.29−7.23 (m, 2H), 7.13 (t, J = 8.4, 2H), 7.02 (s, 1H), 2.28 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 168.45, 164.52 (d, J = 250.73), 147.57, 146.14, 144.60, 138.11, 136.31, 135.94 (d, J = 3.45), 135.49, 132.94, 132.53, 131.87 (d, J = 9.15), 130.48, 123.70, 115.23 (d, J = 21.75), 20.96. ES-MS: m/z 321.0 [M + H$^+$]. Anal. Calcd for $C_{19}H_{13}FN_2S$: C, 71.23; H, 4.09; N, 8.74. Found: C, 71.39; H, 3.97; N, 8.77.

6-(*m*-Nitrophenyl)-8-methylpyrido[2,3-*b*][1,4]benzothiazepine (3n). Yield: 640 mg, 92%. Yellow solid. mp: 208−211 °C. ^{1}H NMR ($CDCl_3$): δ 8.72 (s, 1H), 8.37−8.33 (m, 2H), 8.11 (d, J = 7.5, 1H), 7.68 (dd, J = 8.0, 1.5, 1H), 7.64 (t, J = 8.0, 1H), 7.58 (d, J = 8.0, 1H), 7.34−7.30 (m, 2H), 6.99 (s, 1H), 2.29 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 167.65, 148.62, 147.64, 147.24, 144.53, 141.79, 138.88, 135.99, 135.92, 135.79, 133.69, 133.63, 133.44, 130.36, 129.60, 125.65, 124.68, 124.22, 21.36. ES-MS: m/z 348.0 [M + H$^+$].

6-(Furan-2-yl)-8-methylpyrido[2,3-*b*][1,4]benzothiazepine (3o). Yield: 200 mg, 41%. Yellow solid. mp: 156−158 °C. ^{1}H NMR ($CDCl_3$): δ 8.26 (dd, J = 4.2, 1.5, 1H), 7.71 (s, 1H), 7.65 (dd, J = 8.4, 1.5, 1H), 7.53 (d, J = 8.4, 1H), 7.34 (s, 1H), 7.30−7.22 (m, 2H), 6.78 (d, J = 3.3, 1H), 6.57 (dd, J = 3.3, 1.8, 1H), 2.35 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 158.72, 152.70, 147.62, 146.31, 146.23, 144.55, 138.16, 135.78, 134.86, 133.43, 132.89, 132.65, 130.27, 123.83, 118.54, 112.20, 21.08. ES-MS: m/z 293.1 [M + H$^+$].

6-Phenyl-8-methoxypyrido[2,3-*b*][1,4]benzothiazepine (3p). Yield: 180 mg, 38%. Yellow solid. mp: 144−145 °C. ^{1}H NMR ($CDCl_3$): δ 8.27 (d, J = 4.5, 1H), 7.84 (d, J = 7.5, 2H), 7.62 (d, J = 8.0, 1H), 7.57 (d, J = 8.5, 1H), 7.51 (t, J = 7.0, 1H), 7.45 (t, J = 7.5, 2H), 7.27−7.24 (m, 1H), 7.00 (dd, J = 8.5, 2.5, 1H), 6.75 (d, J = 2.5, 1H), 3.70 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.52, 159.44, 148.30, 146.47, 144.95, 139.79, 138.04, 134.51, 133.25, 131.38, 130.19, 130.07, 128.54, 123.96, 117.66, 115.75, 55.75. ES-MS: m/z

319.0 [M + H$^+$]. Anal. Calcd for $C_{19}H_{14}N_2OS$: C, 71.67; H, 4.43; N, 8.80. Found: C, 71.65; H, 4.30; N, 8.69.

6-(*p*-Fluoro-phenyl)-8-methoxypyrido[2,3-*b*][1,4]-benzothiazepine (3q). Yield: 263 mg, 52%. Yellow solid. mp: 179−181 °C. ^{1}H NMR ($CDCl_3$): δ 8.28 (dd, J = 4.8, 1.5, 1H), 7.89−7.84 (m, 4H), 7.61 (dd, J = 7.5, 1.5, 1H), 7.58 (d, J = 8.7, 1H), 7.27 (dd, J = 8.1, 4.8, 1H), 7.14 (t, J = 8.7, 2H), 7.01 (dd, J = 8.7, 3.0, 1H), 6.73 (d, J = 3.0, 1H), 3.72 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 167.92, 164.61 (d, J = 251.78), 159.22, 147.93, 146.28, 144.55, 137.47, 135.65, 134.36, 132.94, 131.93 (d, J = 9.15), 129.88, 123.70, 117.42, 115.37, 115.32 (d, J = 21.75), 55.47. ES-MS: m/z 337.0 [M + H$^+$].

6-(*p*-Methylphenyl)-8-methoxypyrido[2,3-*b*][1,4]-benzothiazepine (3r). Yield: 158 mg, 23%. Yellow solid. mp: 173−175 °C. ^{1}H NMR ($CDCl_3$): δ 8.25 (dd, J = 4.5, 1.0, 1H), 7.73 (d, J = 8.0, 2H), 7.60 (dd, J = 7.5, 1.0 Hz, 1H), 7.56 (d, J = 9.0, 1H), 7.26−7.23 (m, 3H), 6.99 (dd, J = 7.5, 2.5, 1H), 6.75 (d, J = 2.5, 1H), 3.70 (s, 3H), 2.43 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.08, 159.13, 148.11, 146.00, 144.80, 141.56, 137.84, 136.80, 134.20, 132.91, 129.90, 129.81, 129.00, 123.66, 117.35, 115.43, 55.47, 21.46. ES-MS: m/z 333.0 [M + H$^+$].

6-(*m*-Methylphenyl)-8-methoxypyrido[2,3-*b*][1,4]-benzothiazepine (3s). Yield: 113 mg, 25%. Yellow solid. mp: 144−146 °C. ^{1}H NMR ($CDCl_3$): δ 8.27 (dd, J = 4.8, 1.5, 1H), 7.71 (s, 1H), 7.63 (dd, J = 7.8, 1.0, 1H), 7.58−7.55 (m, 2H), 7.33−7.23 (m, 2H), 7.25 (dd, J = 7.8, 4.8, 1H), 7.00 (dd, J = 8.4, 3.0, 1H), 6.75 (d, J = 3.0, 1H), 3.70 (s, 3H), 2.42 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.49, 159.16, 148.08, 146.14, 144.70, 139.55, 138.05, 137.91, 134.20, 132.97, 131.91, 130.04, 129.87, 128.13, 127.29, 123.67, 117.34, 115.48, 55.50, 21.41. ES-MS: m/z 333.0 [M + H$^+$].

6-(*p*-Nitrophenyl)-8-methoxypyrido[2,3-*b*][1,4]-benzothiazepine (3t). Yield: 368 mg, 67%. Yellow solid. mp: 198−200 °C. ^{1}H NMR ($CDCl_3$): δ 8.34 (dd, J = 4.5, 1.5, 1H), 8.30 (d, J = 9.0, 2H), 8.03 (d, J = 9.0, 2H), 7.66 (dd, J = 8.0, 1.5, 1H), 7.59 (d, J = 8.5, 1H), 7.30 (dd, J = 8.0, 3.0, 1H), 7.04 (dd, J = 8.5, 3.0, 1H), 6.66 (d, J = 3.0, 1H), 3.72 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 167.43, 159.67, 149.43, 147.88, 147.40, 145.35, 144.48, 137.19, 134.93, 133.64, 130.95, 130.28, 124.17, 123.71, 118.03, 115.44, 55.82. ES-MS: m/z 364.0 [M + H$^+$].

6-Phenyl-8-chloropyrido[2,3-*b*][1,4]benzothiazepine (3u). Yield: 102 mg, 63%. Yellow solid. mp: 137−139 °C. ^{1}H NMR ($CDCl_3$): δ 8.30 (dd, J = 4.5, 1.5, 1H), 7.80 (d, J = 6.9, 2H), 7.66−7.60 (s, 2H), 7.54−7.42 (m, 4H), 7.30 (dd, J = 8.1, 4.8, 1H), 7.23 (d, J = 2.4, 1H). ^{13}C NMR ($CDCl_3$): δ 168.54, 147.16, 146.91, 144.78, 139.42, 138.27, 137.48, 134.54, 134.49, 133.47, 131.86, 131.64, 130.25, 129.99, 128.72, 124.30. ES-MS: m/z 322.9 [M + H$^+$].

6-(*p*-Methylphenyl)-8-chloropyrido[2,3-*b*][1,4]-benzothiazepine (3v). Yield: 209 mg, 41%. Yellow solid. mp: 175−176 °C. ^{1}H NMR ($CDCl_3$): δ 8.28 (dd, J = 4.2, 1.5, 1H), 7.69 (d, J = 7.8, 2H), 7.64−7.58 (m, 2H), 7.42 (dd, J = 8.4, 2.1, 1H), 7.30−7.27 (m, 3H), 7.23 (d, J = 2.7, 1H), 2.44 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 168.10, 146.99, 146.44, 141.94, 138.11, 137.20, 136.48, 134.23, 134.16, 133.14, 131.49, 130.04, 129.73, 129.18, 123.99, 21.48. ES-MS: m/z 336.9 [M + H$^+$].

6-(*m*-Methylphenyl)-8-chloropyrido[2,3-*b*][1,4]-benzothiazepine (3w). Yield: 203 mg, 40%. Yellow solid. mp: 141−142 °C. ^{1}H NMR ($CDCl_3$): δ 8.29 (dd, J = 4.2, 1.5, 1H), 7.66−7.59 (m, 3 H), 7.52−7.49 (m, 1H), 7.43 (dd, J = 8.4, 2.1, 1H), 7.35 (d, J = 4.5, 2H), 7.30−7.7.28 (m, 1H), 7.22 (d, J = 2.1, 1H), 2.43 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 168.50, 146.92, 146.58, 144.51, 139.18, 138.26, 138.13, 137.10, 134.20, 134.17, 133.17, 132.19, 131.55, 129.98, 129.95, 128.30, 127.18, 124.01, 21.41. ES-MS: m/z 336.9 [M + H$^+$].

6-(*p*-Nitrophenyl)-8-chloropyrido[2,3-*b*][1,4]-benzothiazepine (3x). Yield: 142 mg, 77%. Yellow solid. mp: 141−143 °C. ^{1}H NMR ($CDCl_3$): δ 8.37 (dd, J = 4.8, 1.5, 1H), 8.32 (d, J = 9.0, 2H), 7.99 (d, J = 9.0, 2H), 7.69 (dd, J = 8.1, 1.8, 1H), 7.64 (d, J = 8.4, 1H), 7.49 (dd, J = 8.4, 2.4, 1H), 7.35 (dd, J = 8.1, 4.8, 1H), 7.16 (d, J = 2.4, 1H). ^{13}C NMR ($CDCl_3$): δ 166.19, 149.36, 147.61, 146.51, 144.61, 144.07, 137.42, 137.19, 134.70, 134.66, 133.62, 132.28, 130.63, 129.50, 124.28, 123.65. ES-MS: m/z 367.9 [M + H$^+$].

6-(*m*-Nitrophenyl)-8-chloropyrido[2,3-*b*][1,4]-benzothiazepine (3y). Yield: 275 mg, 75%. Yellow solid. mp: 221−223 °C. ^{1}H NMR ($CDCl_3$): δ 8.75 (s, 1H), 8.41−8.36 (m, 2H), 8.07 (d, J = 7.8, 1H), 7.72−7.64 (m, 3H), 7.50 (dd, J = 7.8, 1.8, 1H), 7.36 (dd, J = 7.8, 4.5, 1H), 7.19 (d, J = 2.1, 1H). ^{13}C NMR ($CDCl_3$): δ 165.75, 148.41, 147.42, 147.35, 146.48, 143.93, 140.75, 137.35, 136.95, 135.32, 134.69, 134.62, 133.47, 132.24, 129.50, 129.32, 125.64, 124.19. ES-MS: m/z 367.9 [M + H$^+$].

10-Phenyl-8-methylpyrido[4,3-*b*][1,4]benzothiazepine (4a). Yield: 167 mg, 73%. Yellow solid. mp: 119−121 °C. ^{1}H NMR ($CDCl_3$): δ 8.59 (s, 1H), 8.26 (d, J = 4.8, 1H), 7.83 (d, J = 6.6, 2H), 7.52−7.40 (m, 4H), 7.33 (d, J = 5.1, 1H), 7.25 (d, J = 6.6, 1H), 7.03 (s, 1H), 2.27 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 170.68, 146.93, 146.02, 144.78, 140.03, 138.49, 137.82, 136.78, 135.75, 132.38, 132.31, 131.14, 130.98, 129.64, 128.21, 125.90, 20.99. ES-MS: m/z 303.0 [M + H$^+$].

10-(*p*-Methoxyphenyl)-8-methylpyrido[4,3-*b*][1,4]-benzothiazepine (4b). Yield: 378 mg, 81%. Yellow solid. mp: 113−116 °C. ^{1}H NMR ($CDCl_3$): δ 8.56 (s, 1H), 8.23 (d, J = 4.8, 1H), 7.80 (d, J = 8.7, 2H), 7.41 (d, J = 8.1, 1H), 7.31 (d, J = 4.8, 1H), 7.25 (d, J = 8.1, 1H), 7.05 (s, 1H), 6.96 (d, J = 8.7, 2H), 3.89 (s, 3H), 2.28 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 169.86, 162.04, 146.87, 145.64, 145.01, 138.42, 137.73, 136.74, 135.70, 132.54, 132.31, 132.22, 131.40, 131.18, 125.87, 113.55, 55.37, 21.08. ES-MS: m/z 333.0 [M + H$^+$].

10-(*p*-Nitrophenyl)-8-methylpyrido[4,3-*b*][1,4]-benzothiazepine (4c). Yield; 340 mg, 86%. Yellow solid. mp: 192−194 °C. ^{1}H NMR ($CDCl_3$): δ 8.62 (s, 1H), 8.31 (d, J = 8.7, 3H), 8.02 (d, J = 8.7, 2H), 7.46 (d, J = 8.1, 1H), 7.37 (d, J = 5.1, 1H), 7.31 (d, J = 8.1, 1H), 6.95 (s, 1H), 2.29 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 168.58, 149.09, 146.96, 146.80, 145.51, 144.29, 138.95, 137.79, 135.97, 135.78, 132.98, 132.69, 130.62, 130.48, 126.12, 123.35, 20.99. ES-MS: m/z 348.0 [M + H$^+$].

General Procedure for Synthesis of 6-Arylpyrido[2,3*b*]-[1,4]benzothiazepine sulfoxides 12 and 10-Arylpyrido[4,3-*b*][1,4]benzothiazepine Sulfoxides 13. 6-Arylpyrido[2.3-*b*][1,4]benzothiazepine **3** or **4** (0.64 mmol) was dissolved in DCM (40 mL) and cooled to 0−5 °C in an ice bath. A solution of *m*-CPBA (0.77 mmol) in DCM (15 mL) was added dropwise over 1 h. After it was stirred for an additional 20 min, the reaction mixture was treated with saturated $NaHSO_3$. The organic layer was washed with saturated Na_2CO_3 and brine, dried over anhydrous Na_2SO_4, and concentrated in vacuo to afford sulfoxides **12** and **13**. Compounds **12a** and **b** were purified by flash chromatography with petroleum ether−EtOAc (2:1−1:1) as eluent, and all other products were used directly in the next step.

6-Phenylpyrido[2,3*b*][1,4]benzothiazepine Sulfoxide (12a). Yield: 142 mg, 87%. Yellow solid. mp: 162−163 °C. ^{1}H NMR ($CDCl_3$): δ 8.56 (d, J = 4.2, 1H), 8.09 (d, J = 7.8, 1H), 7.87 (d, J = 6.9, 2H), 7.78 (t, J = 7.5, 1H), 7.69 (d, J = 7.8, 1H), 7.60−7.47 (m, 4H), 7.42−7.34 (m, 2H). ^{13}C NMR ($CDCl_3$): δ 167.37, 150.25, 147.89, 147.01, 138.34, 138.25, 132.77, 132.46, 131.90, 129.98, 129.58, 128.50, 128.25, 126.08, 125.20, 120.56. ES-MS: *m*/*z* 305.1 [M + H^+].

6-(*p*-Methylphenyl)pyrido[2,3*b*][1,4]benzothiazepine Sulfoxide (12b). Yield: 115 mg, 90%. Yellow solid. mp: 175−177 °C. ^{1}H NMR ($CDCl_3$): δ 8.55 (d, J = 4.2, 1H), 8.08 (d, J = 7.5, 1H), 7.89−7.74 (m, 3H), 7.67 (d, J = 7.8, 1H), 7.48 (t, J = 7.5, 1H), 7.40−7.28 (m, 4H), 2.45 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 167.09, 150.21, 147.57, 146.87, 142.54, 138.42, 135.47, 132.62, 132.25, 129.90, 129.55, 129.49, 129.15, 126.07, 125.09, 120.39, 21.41. ES-MS: *m*/*z* 319.0 [M + H^+].

General procedure for Synthesis of 6-Arylpyrido[2,3*b*]-[1,4]benzothiazepine Sulfone 14. 6-Arylpyrido[2.3-*b*][1,4]-benzothiazepine **3** (0.12 mmol) was dissolved in DCM (10 mL), and *m*-CPBA (0.36 mmol) was added. After it was stirred for 2 h, the reaction mixture was treated with saturated $NaHSO_3$. The organic layer was washed by saturated Na_2CO_3 and brine in sequence, dried over anhydrous Na_2SO_4, concentrated in vacuo, and purified by flash chromatography with petroleum ether−EtOAc (2:1−1:1) as eluent to afford sulfoxide **14**.

6-Phenylpyrido[2,3*b*][1,4]benzothiazepine Sulfone (14a). Yield: 36 mg, 95%. Yellow solid. mp: 214−216 °C. ^{1}H NMR ($CDCl_3$): δ 8.56 (dd, J = 4.5, 1.5, 1H), 8.29 (dd, J = 7.5, 1.5, 1H), 7.94 (dd, J = 8.4, 1.8, 1H), 7.88 (m, 2H), 7.79−7.67 (m, 2H), 7.61−7.56 (m, 2H), 7.54−7.46 (m, 4H). ^{13}C NMR ($CDCl_3$): δ 168.65, 146.35, 143.47, 141.15, 139.29, 135.72, 134.43, 133.15, 131.76, 130.95, 130.14, 129.21, 128.44, 127.98, 125.64. ES-MS: *m*/*z* 321.1 [M + H^+].

6-(*p*-Methylphenyl)pyrido[2,3*b*][1,4]benzothiazepine Sulfone (14b). Yield: 32 mg, 94%. Yellow solid. mp: 236−238 °C. ^{1}H NMR ($CDCl_3$): δ 8.54 (d, J = 4.5, 1H), 8.27 (d, J = 7.5, 1H), 7.90 (d, J = 8.0, 1H), 7.76−7.73 (m, 3H), 7.69 (t, J = 8.0, 1H), 7.57 (dd, J = 8.0, 4.5, 1H), 7.52 (d, J = 7.5, 1H), 7.28 (d, J = 8.0, 2H), 2.44 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 168.50, 147.74, 146.12, 143.44, 142.51, 141.33, 136.62, 135.67, 133.07, 131.64, 130.98, 130.21, 129.27, 129.18, 127.93, 125.64, 21.54. ES-MS: *m*/*z* 335.0 [M + H^+].

General Procedure for the Synthesis of 6-Arylbenzo-[*c*][1,5]naphthyridines 5a−m. 6-Arylpyrido[2,3*b*] [1,4]-benzothiazepine sulfoxides **12** (0.2 mmol) were dissolved in toluene (15 mL) and refluxed for 3−4 h. The reaction mixture was concentrated in vacuo and purified by chromatography with petroleum ether−EtOAc (5:1−2:1) as eluent to afford products **5**.

6-Phenylbenzo[*c*][1,5]naphthyridine (5a). Yield: 42 mg, 86%. White solid. mp: 155−157 °C. ^{1}H NMR ($CDCl_3$): δ 9.30 (d, J = 8.4, 1H), 9.02 (dd, J = 3.9, 1.5, 1H), 8.51 (dd, J = 8.1, 1.5, 1H), 8.12 (d, J = 8.4, 1H), 7.95 (t, J = 8.1, 1H), 7.77−7.67 (m, 4H), 7.60−7.55 (m, 3H). ^{13}C NMR ($CDCl_3$): δ 162.10, 149.18, 140.77, 139.24, 138.52, 137.27, 134.22, 130.94, 129.63, 128.95, 128.71, 128.44, 128.18, 127.08, 123.92, 123.69. ES-MS: *m*/*z* 257.0 [M + H^+]. Anal. Calcd for $C_{18}H_{12}N_2$: C, 84.35; H, 4.72; N, 10.93. Found: C, 84.41; H, 4.64; N, 11.06.

6-(*p*-Methylphenyl)benzo[*c*][1,5]naphthyridine (5b). Yield: 58 mg, 89%. White solid. mp: 130−131 °C. ^{1}H NMR ($CDCl_3$): δ 9.30 (d, J = 8.1, 1H), 9.01 (dd, J = 4.2, 1.5, 1H), 8.50 (dd, J = 8.7, 1.6, 1H), 8.16 (d, J = 8.1, 1H), 7.76−7.68 (m, 2H), 7.67 (d, J = 7.8, 2H), 7.39 (d, J = 7.8, 2H), 2.49 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 162.20, 149.07, 140.78, 138.92, 138.63, 137.27, 136.45, 134.27, 130.88, 129.63, 129.14, 128.66, 128.28, 127.20, 123.89, 123.69, 21.37. ES-MS: *m*/*z* 271.0 [M + H^+].

6-(*m*-Methylphenyl)benzo[*c*][1,5]naphthyridine (5c). Yield: 67 mg, 76%. White solid. mp: 166−168 °C. ^{1}H NMR ($CDCl_3$): δ 9.30 (d, J = 8.4, 1H), 9.02 (dd, J = 4.5, 1.5, 1H), 8.51 (dd, J = 8.4, 1.2, 1H), 8.12 (d, J = 8.4, 1H), 7.95 (td, J = 7.8, 1.2, 1H), 7.75−7.67 (m, 2H), 7.57 (s, 1H), 7.53 (d, J = 7.5, 1H), 7.46 (t, J = 7.5, 1H), 7.36 (d, J = 7.8, 1H), 2.49 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 162.36, 149.12, 140.77, 139.18, 138.51, 138.25, 137.26, 134.19, 130.91, 130.14, 129.69, 128.66, 128.28, 128.21, 127.15, 126.76, 123.89, 123.63, 21.48. ES-MS: *m*/*z* 271.0 [M + H^+]. Anal. Calcd for $C_{19}H_{14}N_2$: C, 84.42; H, 5.22; N, 10.36. Found: C, 84.38; H, 5.04; N, 10.40.

6-(*p*-Methoxyphenyl)benzo[*c*][1,5]naphthyridine (5d). Yield: 48 mg, 75%. White solid. mp: 148−150 °C. ^{1}H NMR ($CDCl_3$): δ 9.29 (d, J = 7.8, 1H), 9.00 (dd, J = 4.2, 1.8, 1H), 8.49 (dd, J = 8.4, 1.5, 1H), 8.18 (d, J = 8.1, 1H), 7.95 (t, J = 7.5, 1H), 7.76−7.72 (m, 2H), 7.68 (dd, J = 8.1, 4.2, 1H), 7.11 (d, J = 8.7, 1H), 3.92 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 161.74, 160.35, 148.98, 140.72, 138.63, 137.18, 134.33, 131.76, 131.18, 130.85, 128.68, 128.25, 127.20, 123.89, 123.72, 113.94, 55.42. ES-MS *m*/*z* 287.0 [M + H^+].

6-(*p*-Fluorophenyl)benzo[*c*][1,5]naphthyridine (5e). Yield: 63 mg, 85%. White solid. mp: 175−177 °C. ^{1}H NMR ($CDCl_3$): δ 9.31 (d, J = 7.8, 1H), 9.03 (dd, J = 4.5, 1.5, 1H), 8.49 (dd, J = 8.4, 1.5, 1H), 8.09 (d, J = 8.1, 1H), 7.99−7.94 (m, 1H), 7.78−7.68 (m, 4H), 7.31−7.25 (m, 2H). ^{13}C NMR ($CDCl_3$): δ 164.91, 161.29 (d, J = 49.2), 149.30, 140.72, 138.45, 137.21, 135.30 (d, J = 3.45), 134.28, 131.56 (d, J = 8.03 Hz), 131.04, 128.82, 127.89, 126.95, 123.98, 123.80, 115.49 (d, J = 20.55). ES-MS: *m*/*z* 275.0 [M +

H^+]. Anal. Calcd for $C_{18}H_{11}FN_2$: C, 78.82; H, 4.04; N, 10.21. Found: C, 78.60; H, 4.09; N, 10.06.

6-(*p*-Nitrophenyl)benzo[*c*][1,5]naphthyridine (5f). Yield: 39 mg, 81%. White solid. mp: 228−230 °C. ^{1}H NMR ($CDCl_3$): δ 9.35 (dd, J = 8.7, 1.5, 1H), 9.08 (dd, J = 4.5, 1.5, 1H), 8.51 (dd, J = 8.1, 1.5, 1H), 8.46 (d, J = 8.7, 2H), 8.03−7.99 (m, 1H), 7.97 (d, J = 8.7, 1H), 7.81−7.73 (m, 2H). ^{13}C NMR ($CDCl_3$): δ 159.63, 150.03, 148.20, 145.57, 140.84, 138.45, 137.47, 134.43, 131.52, 130.86, 129.23, 127.28, 126.53, 124.31, 124.16, 123.75. ES-MS: *m*/*z* 302.0 [M + H^+].

6-(*m*-Nitrophenyl)benzo[*c*][1,5]naphthyridine (5g). Yield: 59 mg, 83%. White solid. mp: 228−230 °C. ^{1}H NMR ($CDCl_3$): δ 9.36 (d, J = 7.5, 1H), 9.08 (d, J = 3.0, 1H), 8.68 (s, 1H), 8.51 (dd, J = 8.4, 1.5, 1H), 8.43 (d, J = 8.4, 1H), 8.13 (d, J = 7.5, 1H), 8.02 (t, J = 8.1, 2H), 7.81−7.73 (m, 2H). ^{13}C NMR ($CDCl_3$): δ 159.31, 149.97, 148.38, 140.94, 140.81, 138.46, 137.44, 135.75, 134.51, 131.52, 129.59, 129.29, 127.24, 126.53, 124.89, 124.30, 124.19, 123.89. ES-MS: *m*/*z* 302.0 [M + H^+].

6-(*p*-Methoxyphenyl)-8-methylbenzo[*c*][1,5]naphthyridine (5h). Yield: 86 mg, 80%. White solid. mp: 156−158 °C. ^{1}H NMR ($CDCl_3$): δ 9.17 (d, J = 8.4, 1H), 8.98 (dd, J = 4.5, 1.8, 1H), 8.47 (dd, J = 8.1, 1.8, 1H), 7.93 (d, J = 0.6, 1H), 7.78 (dd, J = 8.4, 1.2, 1H), 7.72 (d, J = 8.7, 2H), 7. 66 (dd, J = 8.7, 4.5, 1H), 7.12 (d, J = 8.7, 2H), 3.93 (s, 3H), 2.56 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 161.75, 160.55, 149.19, 141.15, 139.16, 138.53, 137.38, 132.91, 132.50, 132.22, 131.37, 127.87, 127.68, 123.90, 123.75, 114.20, 55.68, 22.22. ES-MS: *m*/*z* 301.0 [M + H^+].

6-(*p*-Fluorophenyl)-8-methylbenzo[*c*][1,5]naphthyridine (5i). Yield: 141 mg, 86%. White solid. mp: 175−177 °C. ^{1}H NMR ($CDCl_3$): δ 9.17 (d, J = 8.4, 1H), 8.98 (d, J = 3.3, 1H), 8.45 (d, J = 8.1, 1H), 7.82−7.72 (m, 4H), 7.66 (dd, J = 8.1, 4.2, 1H), 7.31−7.25 (m, 2H), 2.55 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 164.90, 161.18 (d, J = 63.0), 149.28, 140.92, 139.12, 138.13, 137.18, 135.51 (d, J = 3.45), 132.88, 132.24, 131.53 (d, J = 9.15), 127.28, 123.73, 123.61, 115.53 (d, J = 21.75), 21.98. ES-MS: *m*/*z* 289.0 [M + H^+]. Anal. Calcd for $C_{19}H_{13}FN_2$: C, 79.15; H, 4.54; N, 9.72. Found: C, 79.41; H, 4.36; N, 9.73.

6-(*m*-Nitrophenyl)-8-methylbenzo[*c*][1,5]naphthyridine (5j). Yield: 85 mg, 82%. White solid. mp: 196−197 °C. ^{1}H NMR ($CDCl_3$): δ 9.22 (d, J = 8.4, 1H), 9.04 (dd, J = 4.5, 1.8, 1H), 8.66 (t, J = 1.8, 1H), 8.48 (dd, J = 8.4, 1.5, 1H), 8.45−8.41 (m, 1H), 8.11 (dt, J = 7.8, 1.5, 1H), 7.85−7.69 (m, 4H), 2.58 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 158.94, 149.82, 148.32, 141.03, 140.89, 139.53, 137.99, 137.24, 135.65, 133.24, 132.30, 129.50, 126.66, 126.48, 124.77, 123.95, 123.81, 123.75, 21.99. ES-MS: *m*/*z* 316.0 [M + H^+].

6-(*m*-Methylphenyl)-8-methoxybenzo[*c*][1,5]naphthyridine (5k). Yield: 42 mg, 82%. White solid. mp: 129−131 °C. ^{1}H NMR ($CDCl_3$): δ 9.20 (d, J = 8.7, 1H), 8.97 (d, J = 3.3, 1H), 8.47 (d, J = 8.1, 1H), 7.64−7.53 (m, 4H), 7.47−7.43 (m, 2H), 7.35 (d, J = 7.2, 1H), 3.86 (s, 3H), 2.49 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 161.57, 159.86, 149.25, 140.94, 139.38, 138.43, 137.66, 137.23, 130.04, 129.72, 128.71, 128.28, 126.51, 125.54, 123.05, 121.23, 108.65, 55.50, 21.52. ES-MS: *m*/*z* 301.0 [M + H^+].

6-(*p*-Nitrophenyl)-8-methoxybenzo[*c*][1,5]naphthyridine (5l). Yield: 99 mg, 87%. White solid. mp: 245−247 °C. ^{1}H NMR ($CDCl_3$): δ 9.26 (d, J = 9.3, 1H), 9.03 (dd, J = 4.2, 1.5, 1H), 8.48−8.45(m, 3H), 7.98 (d, J = 9.0, 2H), 7.68 (dd, J = 7.8, 4.2, 1H), 7.62 (dd, J = 9.3, 2.4, 1H), 7.30 (d, J = 2.4, 1H), 3.88 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 160.21, 158.73, 150.14, 148.22, 145.82, 140.95, 137.55, 137.39, 130.63, 128.89, 128.02, 126.02, 123.86, 123.41, 121.77, 107.57, 55.62. ES-MS: *m*/*z* 332.0 [M + H^+].

6-Phenyl-8-chlorobenzo[*c*][1,5]naphthyridine (5m). Yield: 27 mg, 74%. White solid. mp: 183−184 °C. ^{1}H NMR ($CDCl_3$): δ 9.24 (d, J = 9.0, 1H), 9.01 (dd, J = 4.5, 1.5, 1H), 8.49 (dd, J = 8.0, 1.5, 1H), 8.07 (d, J = 1.5, 1H), 7.88 (dt, J = 8.0, 1.0, 1H), 7.75−7.69 (m, 3H), 7.62−7.59 (m, 3H). ^{13}C NMR ($CDCl_3$): δ 161.07, 149.65, 140.22, 138.66, 138.55, 137.42, 135.03, 132.71, 131.64, 129.56, 129.29, 128.71, 127.99, 127.26, 125.70, 124.25. ES-MS: *m*/*z* 291.0 [M + H^+].

General Procedure for the Synthesis of 6-Arylbenzo[*c*][1,7]naphthyridines 6a−c. 10-Arylpyrido[4,3-*b*][1,4]-benzothiazepine sulfoxides **13** (0.2 mmol) were dissolved in xylene (15 mL) and refluxed for 15−23 h. The reaction mixture was concentrated in vacuo and then purified by chromatography with petroleum ether−EtOAc (2:1) as eluent to afford products **6**.

6-Phenyl-8-methylbenzo[*c*][1,7]naphthyridine (6a). Yield: 32 mg, 72%. White solid. mp: 139−141 °C. ^{1}H NMR ($CDCl_3$): δ 9.55(s, 1H), 8.78 (d, J = 5.4, 1H), 8.59 (d, J = 8.4, 1H), 8.33 (d, J = 5.4, 1H), 7.94 (s, 1H), 7.78−7.73 (m, 3H), 7.60−7.58 (m, 3H), 2.55 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 162.64, 153.54, 145.24, 139.84, 139.21, 138.69, 132.85, 129.61, 129.35, 129.05, 128.73, 128.54, 126.91, 122.73, 114.97, 21.96. ES-MS: *m*/*z* 271.0 [M + H^+].

6-(*p*-Methoxyphenyl)-8-methylbenzo[*c*][1,7]naphthyridine (6b). Yield: 28 mg, 81%. White solid. mp: 163−165 °C. ^{1}H NMR ($CDCl_3$): δ 9.53 (s, 1H), 8.77 (d, J = 5.7, 1H), 8.59 (d, J = 8.4, 1H), 8.31 (d, J = 5.7, 1H), 8.01 (s, 1H), 7.76 (d, J = 8.4, 1H), 7.72 (d, J = 8.7, 2H), 7.12 (d, J = 8.7, 2H), 3.94 (s, 3H), 2.57 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 162.24, 160.38, 153.47, 145.06, 139.73, 132.71, 131.69, 131.12, 129.41, 128.59, 127.00, 122.73, 114.94, 114.00, 55.43, 21.98. ES-MS: *m*/*z* 301.0 [M + H^+].

6-(*p*-Nitrophenyl)-8-methylbenzo[*c*][1,7]naphthyridine (6c). Yield: 30 mg, 83%. White solid. mp: 256−258 °C. ^{1}H NMR ($CDCl_3$): δ 9.54 (s, 1H), 8.83 (d, J = 5.4, 1H), 8.65 (d, J = 8.4, 1H), 8.47 (d, J = 8.4, 2H), 8.37 (d, J = 5.4, 1H), 7.95 (d, J = 8.4, 2H), 7.84−7.81 (m, 2H), 2.59 (s, 3H). ^{13}C NMR ($CDCl_3$): δ 160.06, 153.63, 148.20, 145.93, 145.44, 140.39, 138.42, 133.35, 130.74, 129.46, 128.83, 127.55, 126.27, 123.75, 123.06, 115.00, 21.98. ES-MS: *m*/*z* 316.0 [M + H^+].

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References and Notes

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