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Beyond a Protecting Reagent: DMAP-Catalyzed Cyclization of Boc-Anhydride with 2-Alkenylanilines

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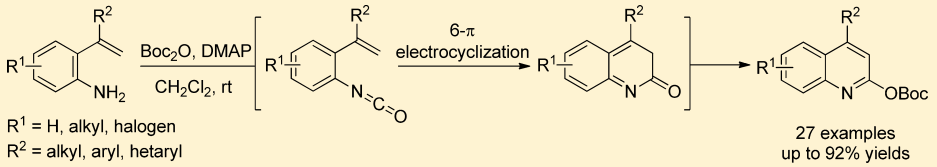
Supporting Information



ABSTRACT: A novel rapid synthesis of quinolines from 2-alkenylanilines has been described; the reaction involves an unexpected DMAP-catalyzed cyclization of 2-alkenylanilines with di-*tert*-butyl dicarbonate (Boc_2O, 2.0 equiv), and a series of *tert*-butyl quinolin-2-yl carbonate with various functional groups have been synthesized in good yields under mild conditions. Furthermore, the *tert*-butyl quinolin-2-yl carbonate can be easily converted into corresponding quinolinones and 2-(pseudo)haloquinolines.

INTRODUCTION

Quinolines and their derivatives are present in a wide range of pharmaceuticals and natural products with unique biological activities and have received considerable attention from the organic and medicinal chemistry community (Figure 1).[1] Many strategies for the construction of the quinoline ring have been developed,[2] including several classic name reactions such as Combes, Skraup, Döbner-Von Miller, Conrad-Limpach, Pfitzinger, Friedländer, and Povarov reactions, etc.[3] Given the importance of quinolines and quinolinones as the pharmacologically active substances, the development of a more practical and effective process for the synthesis is still in great demand.

As an extremely efficient protecting reagent, di-*tert*-butyl dicarbonate (Boc-anhydride) has been extensively applied for the protection of amine, alcohol, and thiol functional groups due to its being easily introduced and removed, especially in peptide synthesis.[4] In some cases, it has also been used for the conversion of amines to corresponding isocyanates,[5] carbamates,[6] and urea derivatives.[7] Our laboratory is engaged in developing transition-metal-free methods for the synthesis of heterocycles, especially through new C−N, C−O bond formation.[8] Herein, we wish to report our discovery that the reaction of substituted 2-vinylanilines with di-*tert*-butyl dicarbonate in the presence of a catalytic amount of 4-dimethylaminopyridine (DMAP) at room temperature leads to *tert*-butyl quinolin-2-yl carbonates. Although various approaches to quinolines and their derivatives starting from 2-alkenylanilines have already been reported,[9] however, to the best of our knowledge, di-*tert*-butyl dicarbonate as the carbon source for the synthesis of these heterocyclic compounds is rarely reported. More importantly, the *tert*-butyl quinolin-2-yl carbonates can be easily converted into quinolinones which possess interesting pharmacological and biological activities[10] and have provided a huge driving force for chemists to develop efficient methods for their synthesis.[11] On the other hand, *tert*-butyl quinolin-2-yl carbonates also serve as valuable synthetic intermediates in organic synthesis by simply transforming into 2-(pseudo)haloquinolines (e.g., 2-Cl), which can readily undergo a broad variety of functionalizations such as nucleophilic aromatic substitutions and coupling reactions.[12]

RESULTS AND DISCUSSION

We commenced our studies by using 2-(1-phenylvinyl)aniline **1a** as the model substrate to search for the optimal reaction conditions (Table 1). Treatment of **1a** with 2 equiv of Boc_2O in the presence of 20 mol % of DMAP catalyst resulted in *tert*-butyl quinolin-2-yl carbonate as a major product in 81% yield after 1.0 h (entry 1), and the structure of compound **2a** was further confirmed by X-ray crystallography (Figure 2). While decreasing the catalyst loading from 20 mol % to 5 mol % can give the desired products with similar yields (entries 2 and 3), a further decrease of the catalyst loading to 1 mol %, the reaction still took place smoothly to provide the desired product with a slightly lower yield (76%, entry 4). However, the reaction cannot occur in the absence of a catalyst, and only the starting material was recovered (entry 5). On the other hand, alteration of key operating parameters (e.g., extending reaction time, elevating or lowering temperatures) was also examined, but there was no significant impact on the yields (entries 16−18). Solvents other than CH_2Cl_2, dichloroethane, and 1,4-dioxane were less effective in delivering the desired *tert*-butyl quinolin-2-yl carbonates (entries 6−14) although the starting materials were completely converted, thus implying that the selectivity becomes poor upon these variations. It was interesting to observe that when reducing

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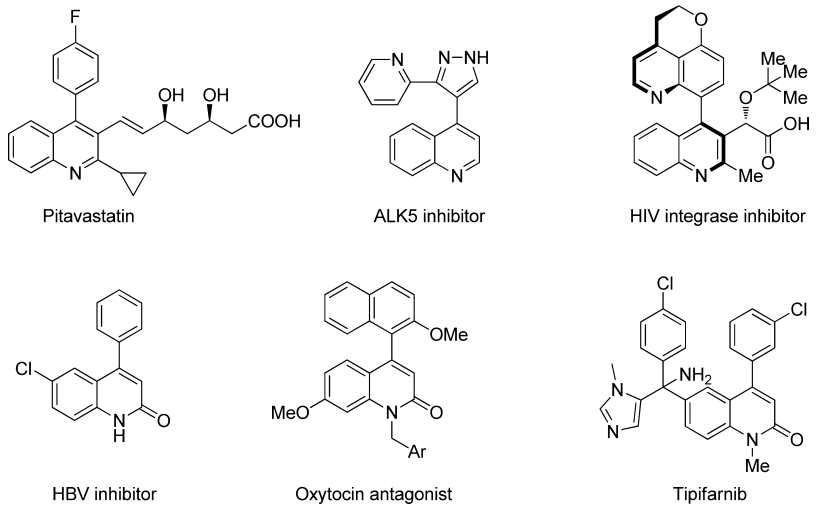
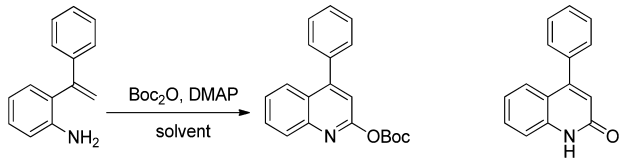


Figure 1. Representative bioactive quinolines and 2-quinolinones.

Table 1. Optimization of Reaction Conditions[a]



entry	catalyst loading (mol %)	solvent	yield (%)[b]
1	20	CH_2Cl_2	81
2	10	CH_2Cl_2	79
3	5	CH_2Cl_2	81
4	1	CH_2Cl_2	76
5	0	CH_2Cl_2	0
6	5	DMSO	55
7	5	CH_3CN	65
8	5	dichloroethane	80
9	5	THF	55
10	5	Et_2O	54
11	5	DMF	65
12	5	toluene	35
13	5	1,4-dioxane	79
14	5	EtOAc	21
15[c]	5	CH_2Cl_2	69
16[d]	5	CH_2Cl_2	56
17[e]	5	CH_2Cl_2	84
18[f]	5	CH_2Cl_2	80

[a]Reaction conditions: **1a** (0.20 mmol), Boc_2O (2.0 equiv), solvent (2.0 mL), 1.0 h at rt. [b]Isolated yield. [c]1.5 equiv Boc_2O was used. [d]Reaction was run at 0 °C for 12 h. [e]Reaction was run at reflux for 1 h; [f]Reaction time was 12 h.

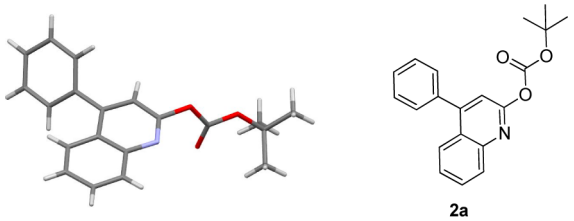
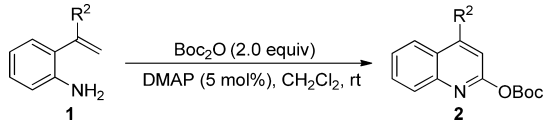


Figure 2. X-ray crystallography of compound **2a**.

the loading of Boc_2O to 1.5 equiv, the reaction successfully gave the product with reasonable yield along with a small amount of quinolinone **7** (entry 15).

With the optimal conditions in hand [5 mol % DMAP, 2.0 equiv of Boc_2O, CH_2Cl_2, rt], the scope of 2-alkenylanilines bearing substituents at each position was studied (Table 2). First,

Table 2. Scope of 2-Alkenylanilines[a]



entry	substrate	R^2	time (h)	product	yield (%)[b]
1	**1a**	Ph	1	**2a**	81
2	**1b**	2-MeO-C_6H_4	1	**2b**	80
3	**1c**	3-MeO-C_6H_4	3	**2c**	55
4	**1d**	4-MeO-C_6H_4	2.5	**2d**	82
5	**1e**	2-Me-C_6H_4	5	**2e**	71
6	**1f**	3-Me-C_6H_4	3	**2f**	76
7	**1g**	4-Me-C_6H_4	3	**2g**	68
8	**1h**	3−F-C_6H_4	5	**2h**	64
9	**1i**	4−F-C_6H_4	3	**2i**	76
10	**1j**	3−Cl-C_6H_4	7	**2j**	53
11	**1k**	4−Cl-C_6H_4	3	**2k**	74
12	**1l**	3-CF_3−C_6H_4	5	**2l**	58
13	**1m**	1-naphthyl	5	**2m**	71
14	**1n**	2-naphthyl	4	**2n**	73
15	**1o**	2-thienyl	1.5	**2o**	81
16	**1p**	Me	0.5	**2p**	50
17	**1q**	*n*-Bu	2	**2q**	92
18	**1r**	4-NO_2−C_6H_4	30	**2r**	27

[a]Reaction conditions: **1** (0.20 mmol), Boc_2O (2.0 equiv), DMAP (5 mol %), CH_2Cl_2 (2.0 mL), rt. [b]Isolated yield.

the substrates with various *ortho*, *meta*, and *para* substituted on the phenyl ring at the alkene moiety were tested. The results revealed that there was no major effect on the substitution pattern or steric hindrance of the substituent on the phenyl ring of the substrates; both electron-donating and electron-withdrawing groups at different positions furnished the corresponding products in moderate to good yields. For example, all three substrates **1b−d** with a methoxyl group which is a strong

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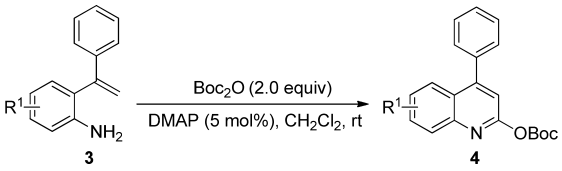
electron-donating group on the phenyl ring provided the desired products **2b–d** in 55–82% yields. Furthermore, electron-rich heterocyclic substrate **1o** afforded the desired *tert*-butyl quinolin-2-yl carbonate **2o** with 81% yield in 1.5 h. In addition, using 2- and 3-naphthyl substituted 2-alkenylanilines **1m–n** as the substrates, products **2m** and **2n** can be obtained in good yields (71% and 73%). To our delight, the aliphatic substituted substrates **1p** and **1q** also can provide the desired products **2p** and **2q** with 50% and 92% yields, respectively. The substrate **1r** with the NO_2 substituent on the phenyl ring showed an adverse effect and delivered the desired product with 27% yield even when the reaction was run for 30 h.

The substrate scope of this process was further examined using a variety of the substitution patterns of aniline (Table 3). The

Table 3. Scope of 2-Alkenylanilines[a]



3 4

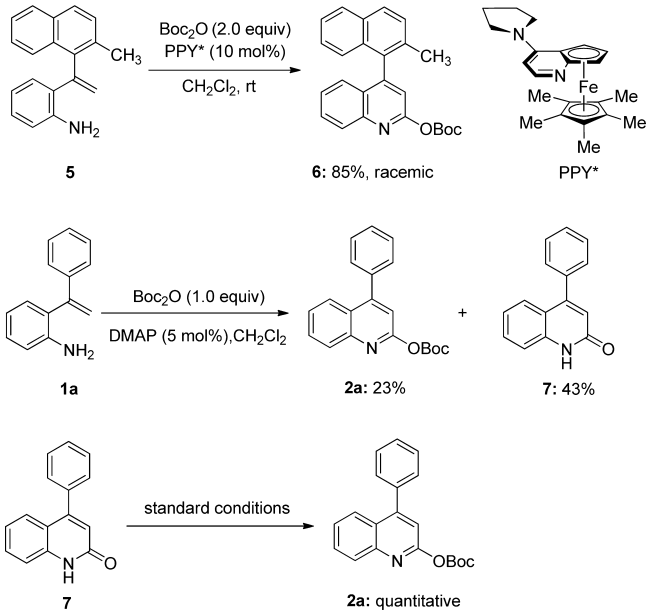
entry	substrate	R^1	time (h)	product	yield (%)[b]
1	**3a**	4-MeO	1.5	**4a**	82
2	**3b**	5-MeO	1	**4b**	65
3	**3c**	6-MeO	22	**4c**	65
4	**3d**	4-F	5	**4d**	74
5	**3e**	5-F	1	**4e**	82
6	**3f**	6-F	3.5	**4f**	78
7	**3g**	4-Cl	7	**4g**	46
8	**3h**	4-Me	1	**4h**	82
9	**3i**	4-NO_2	24		0

[a]Reaction conditions: **3** (0.20 mmol), Boc_2O (2.0 equiv), DMAP (5 mol %), CH_2Cl_2 (2.0 mL), rt. [b]Isolated yield.

reaction exhibited good tolerance to various substituents on the aromatic ring no matter the electron-donating or slight electron-withdrawing group and took place smoothly to provide the desired quinolines in 46–82% yields. Moreover, the reaction was not affected by the position of the substituents on the aromatic ring of anilines; for example, for the substrates **3a–c** with various electron-donating *ortho*, *meta*, and *para* substitutents, the reactions gave the products **4a–4c** with 65%–82% yields. The fluoro and chloro groups could be tolerated in the reaction conditions to generate the quinolines **4d–g** in good to moderate yields. Unfortunately, the substrate containing the strongest electron-withdrawing group (e.g., $-NO_2$) appeared to have completely retarded the reaction only providing the Boc-protected product.

To gain more insight about the mechanism of this reaction, several control experiments were conducted. First, PPY* was selected as a chiral DMAP type catalyst for achieving the asymmetric transformation,[13] but the reaction provided a racemic product with 85% yield at room temperature in CH_2Cl_2. Subsequently, the model substrate **1a** reacted with 1.0 equiv of Boc_2O in the presence of 5 mol % DMAP, and the reaction delivered the product **2a** in 23% yield along with 43% yield of quinolinone product **7**. Furthermore, the quinolinone **7** can be converted into the *tert*-butyl quinolin-2-yl carbonate product **2a** in quantitative yield under the standard conditions, which implies the quinolinone or 2-hydroxyquinoline is a possible intermediate in this transformation (Scheme 1).

Scheme 1. Control Experiments



Based on these findings and the literature reports,[5,14] a plausible mechanism for the DMAP-catalyzed cyclization of Boc-anhydride with 2-alkenylaniline toward *tert*-butyl quinolin-2-yl carbonates is illustrated in Scheme 2. Initially, the Boc-anhydride reacts with the substrate in the presence of DMAP to afford the intermediate **I**, which is already well investigated by Knölker.[5] Afterward, a 6-π electrocyclization of *o*-isocyanatostyrene affords **II**, followed by a rapid proton shift to form 2-hydroxyquinoline **III** or its tautomer **IV**. The 2-hydroxyquinoline **III** reacts with Boc_2O by the catalysis of DMAP to provide the final product **2a**.

To explore the potential synthetic utility of this new method, a gram-scale reaction of **1a** was carried out. The *tert*-butyl quinolin-2-yl carbonate product **2a** was obtained with 92% yield (Scheme 3a). This method also is useful in medicinal chemistry; the HBV inhibitor **8** can be synthesized with 98% yield through simple transformation. In addition, the *tert*-butyl quinolin-2-yl carbonate is a versatile intermediate in organic synthesis. For example, the product **2a** was easily converted into 2-(pseudo)-haloquinoline in 95% yield (Scheme 3b).

CONCLUSION

In conclusion, a new metal-free, simple operation protocol for the rapid synthesis of quinoline derivatives has been described; this process involves an unexpected DMAP-catalyzed cyclization of Boc-anhydride with 2-alkenylaniline. The utility of the methodology is also highlighted by the products which can be easily transformed into corresponding quinolinones and 2-(pseudo)haloquinolines (e.g., 2-Cl) for further functionalizations. This method could be used by the researchers in the areas of organic and medicinal chemistry.

EXPERIMENTAL SECTION

Unless otherwise mentioned, all reactions were performed in flame-dried glassware under N_2. Solvents were distilled prior to use. Reagents were used as purchased without further purification. Chromatographic separations were performed using silica gel 200–300 mesh. ^1H and ^{13}C NMR spectra were obtained on 400, 600 MHz (100, 150 MHz for ^{13}C NMR) spectrometers using $CDCl_3$ with TMS or residual solvent as standard unless otherwise noted. Chemical-shift values are given in ppm and referenced to the internal standard, TMS (tetramethylsilane). The

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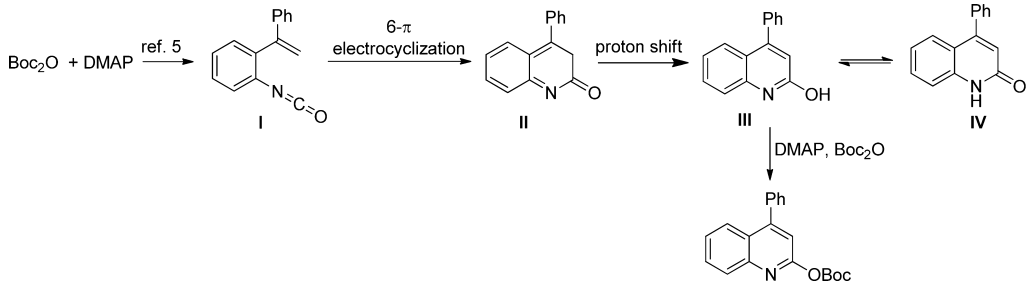
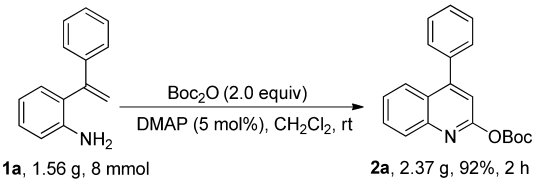
Scheme 2. Proposed Mechanistic Pathway

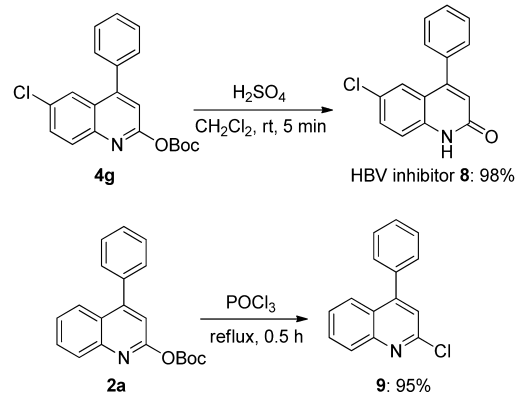


Scheme 3. Demonstration of Synthetic Utility

a) Gram-scale reaction



b) The synthetic transformations



peak patterns are indicated as follows: s, singlet; d, doublet; t, triplet; q, quadruplet; m, multiplet; dd, doublet of doublets, and br s, broad singlet. The coupling constants (J) are reported in Hertz (Hz). Melting points were determined using a micromelting point apparatus without corrections. TLC analysis was performed using glass-backed plates (60 Å, 250 μm) and visualized using UV and iodine stains. Low-resolution mass spectra were obtained using LS/MSD. High-resolution mass spectrometry (HRMS) was obtained on a Q-TOF micro-spectrometer.

General Procedure for the Synthesis of 1 and 3. 1-(2-Aminophenyl)-1-arylethanols **S2** were prepared by the reaction of arylmagnesium bromides with corresponding *o*-aminoacetophenone **S1**.[15,16]

The 2-alkenylanilines **1** and **3** were prepared following the general procedure unless otherwise noted.

To a stirred solution of **S2** (1.0 equiv) in CH_2Cl_2 (4 M) was added *p*-toluenesulfonic acid monohydrate (*p*-TsOH) (1.1 equiv). After the mixture was stirred for 30 min at 0 °C, a drop of H_2SO_4 was added. The mixture was stirred for another 30 min, and then the saturated $NaHCO_3$ solution was added. The organic layer was separated. The aqueous layer was extracted with CH_2Cl_2 (10 mL × 2). The combined extracts were washed with saturated NaCl solution, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by column chromatography on SiO_2 to give the corresponding phenylvinylanilines **1**.

*2-(1-Phenylvinyl)aniline (**1a**).*[16a] White solid, 730 mg, 94% yield from **S1** (4.0 mmol); mp 74 °C (lit. 80−81 °C); R_f = 0.74 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, CCl_3) δ 3.53 (br s, 2H), 5.35 (s, 1H), 5.79 (s, 1H), 6.69 (d, J = 7.8 Hz, 1H), 6.78 (t, J = 7.2 Hz, 1H), 7.10 (d, J = 7.2 Hz, 1H), 7.15 (t, J = 7.8 Hz, 1H), 7.30 (dd, J = 6.6, 14.4 Hz, 3H), 7.37 (d, J = 7.2 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.7, 116.1, 118.4, 126.7, 127.4, 128.1, 128.6, 128.8, 130.8, 139.7, 143.9, 147.2. Mass spectrum (m/z, ESI): 196.8; HRMS (ESI): m/z calculated for $C_{14}H_{13}N$ (M + H)$^+$: 196.1126, found: 196.1130.

*2-(1-(2-Methoxyphenyl)vinyl)aniline (**1b**).* Yellow solid, 332 mg, 37% yield from **S1** (4.0 mmol); mp: 41−42 °C; R_f = 0.36 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.43 (br s, 2H), 3.72 (s, 3H), 5.54 (s, 1H), 5.72 (s, 1H), 6.68 (d, J = 7.8 Hz, 1H), 6.72 (t, J = 7.2 Hz, 1H), 6.91 (dd, J = 7.8, 13.8 Hz, 2H), 7.09−7.05 (m, 2H), 7.19 (d, J = 7.2 Hz, 1H), 7.26 (t, J = 7.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 55.6, 111.4, 115.6, 118.2, 119.6, 120.7, 128.0, 128.9, 129.0, 129.8, 130.2, 130.4, 143.4, 144.2, 157.0. Mass spectrum (m/z, ESI): 226.8; HRMS (ESI): m/z calculated for $C_{15}H_{15}NO$ (M + H)$^+$: 226.1232, found: 226.1229.

*2-(1-(3-Methoxyphenyl)vinyl)aniline (**1c**).*[16b] White solid, 612 mg, 68% yield from **S1** (4.0 mmol); mp: 63−64 °C (lit. 60−62 °C); R_f = 0.52 (20% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.53 (br s, 2H), 3.76 (s, 3H), 5.34 (d, J = 7.2 Hz, 1H), 5.77 (d, J = 1.2 Hz, 1H), 6.66 (d, J = 8.0 Hz, 1H), 6.77 (td, J = 1.2, 7.6 Hz, 1H), 6.83 (dd, J = 2.0, 8.0 Hz, 1H), 6.95−6.92 (m, 2H), 7.16−7.09 (m, 2H), 7.21 (t, J = 8.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 55.2, 112.5, 113.4, 115.7, 116.4, 116.7, 118.4, 119.3, 127.3, 128.8, 129.6, 130.8, 141.3, 147.1, 159.8. Mass spectrum (m/z, ESI): 226.1; HRMS (ESI): m/z calculated for $C_{15}H_{15}NO$ (M + H)$^+$: 226.1232, found: 226.1236.

*2-(1-(4-Methoxyphenyl)vinyl)aniline (**1d**).*[17] Gray solid, 710 mg, 79% yield from **S1** (4.0 mmol); mp: 45−46 °C (lit. 50.5 °C); R_f = 0.42

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(20% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.54 (br s, 2H), 3.80 (s, 3H), 5.24 (s, 1H), 5.70 (s, 1H), 6.71 (d, J = 8.0 Hz, 1H), 6.80 (t, J = 8.0 Hz, 1H), 6.84 (d, J = 8.6 Hz, 2H), 7.11 (d, J = 7.6 Hz, 1H), 7.16 (t, J = 8.0 Hz, 1H), 7.29 (d, J = 8.6 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 55.3, 113.9, 114.2, 115.6, 118.4, 127.6, 127.9, 128.7, 130.8, 132.1, 143.9, 146.6, 159.6. Mass spectrum (m/z, ESI): 226.1; HRMS (ESI): m/z calculated for $C_{15}H_{15}NO$ (M + H)$^+$: 226.1232, found: 226.1237.

*2-(1-(o-Tolyl)vinyl)aniline (**1e**).* Brown solid, 535 mg, 64% yield from **S1** (4.0 mmol); mp: 50−51 °C; R_f = 0.63 (20% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.11 (s, 3H), 3.88 (br s, 2H), 5.46 (d, J = 1.8 Hz, 1H), 5.61 (d, J = 1.8 Hz, 1H), 6.70 (dd, J = 8.0, 20.4 Hz, 2H), 7.01 (dd, J = 1.2 Hz, 1H), 7.08 (td, J = 1.5, 8.0 Hz, 1H), 7.16−7.14 (m, 1H), 7.21 (td, J = 1.6, 8.0 Hz, 2H), 7.31(dd, J = 1.2, 6.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 20.4, 116.0, 118.5, 118.7, 126.0, 127.4, 127.8, 128.5, 129.6, 130.2, 130.6, 135.9, 141.9, 143.5, 148.1. Mass spectrum (m/z, ESI): 210.0; HRMS (ESI): m/z calculated for $C_{15}H_{15}N$ (M + H)$^+$: 210.1283, found: 210.1287.

*2-(1-(m-Tolyl)vinyl)aniline (**1f**).* Pale yellow oil, 686 mg, 82% yield from **S1** (4.0 mmol); R_f = 0.56 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.32 (s, 3H), 5.35 (s, 1H), 5.78 (s, 1H), 6.87−6.88 (m, 2H), 7.10 (d, J = 7.2 Hz, 1H), 7.14 (t, J = 7.2 Hz, 2H), 7.17 (s, 1H), 7.20 (d, J = 5.4 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.5, 115.6, 116.1, 118.3, 123.9, 127.2, 127.5, 128.5, 128.7, 128.9, 130.8, 138.2, 139.7, 143.9, 147.3. Mass spectrum (m/z, ESI): 210.0; HRMS (ESI): m/z calculated for $C_{15}H_{15}N$ (M + H)$^+$: 210.1283, found: 210.1287.

*2-(1-(p-Tolyl)vinyl)aniline (**1g**).* Light brown oil, 334 mg, 40% yield from **S1** (4.0 mmol); R_f = 0.59 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.34 (s, 3H), 3.49 (, 2H), 5.30 (s, 1H), 5.76 (s, 1H), 6.71 (d, J = 7.8 Hz, 1H), 6.79 (t, J = 6.0 Hz, 1H), 7.12 (m, 3H), 7.16 (t, J = 9.6 Hz, 1H), 7.26 (d, J = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.2, 115.3, 115.7, 118.5, 126.6, 127.7, 128.7, 129.3, 130.8, 136.8, 138.0, 143.7, 146.3. Mass spectrum (m/z, ESI): 210.0; HRMS (ESI): m/z calculated for $C_{15}H_{15}N$ (M + H)$^+$: 210.1283, found: 210.1287.

*2-(1-(3-Fluorophenyl)vinyl)aniline (**1h**).* Brown solid, 596 mg, 70% yield from **S1** (4.0 mmol); mp: 40−41 °C; R_f = 0.72 (20% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.63 (br s, 2H), 5.40 (s, 1H), 5.83 (s, 1H), 6.72 (d, J = 8.0 Hz, 1H), 6.80 (t, J = 7.6 Hz, 1H), 6.98 (td, J = 2.4, 4.4 Hz, 1H), 7.08 (m, 2 H), 7.16 (dd, J = 7.6, 11.2 Hz, 2H), 7.27−7.30 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 113.5 (d, J_{C-F} = 22.0 Hz), 114.9 (d, J_{C-F} = 21.2 Hz), 115.7, 117.2, 118.5, 118.5, 122.4, 126.7, 129.0, 130.1 (d, J_{C-F} = 8.0 Hz), 130.8, 142.1(d, J_{C-F} = 7.2 Hz), 143.9, 146.2, 162.5 (d, J_{C-F} = 244.2 Hz). Mass spectrum (m/z, ESI): 214.0; HRMS (ESI): m/z calculated for $C_{14}H_{12}FN$ (M + H)$^+$: 214.1032, found: 214.1036.

*2-(1-(4-Fluorophenyl)vinyl)aniline (**1i**).* White solid, 716 mg, 84% yield from **S1** (4.0 mmol); mp: 50−51 °C; R_f = 0.52 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.04 (br s, 2H), 5.34 (s, 1H), 5.74 (s, 1H), 6.78−6.74 (m, 1H), 6.83 (dd, J = 7.2 Hz, 1H), 7.00−6.97 (m, 2H), 7.10 (d, J = 6.6 Hz, 1H), 7.19−7.17 (m, 1H), 7.33 (d, J = 6.0 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.4, 115.5, 115.7, 115.9, 118.5, 127.1, 128.4 (d, J_{C-F} = 7.8 Hz), 128.9, 130.8, 135.8 (d, J_{C-F} = 3.2 Hz), 143.8, 146.1, 162.7 (d, J_{C-F} = 246.0 Hz). Mass spectrum (m/z, ESI): 213.9; HRMS (ESI): m/z calculated for $C_{14}H_{12}FN$ (M + H)$^+$: 214.1032, found: 214.1037.

*2-(1-(3-Chlorophenyl)vinyl)aniline (**1j**).* Brown oil, 311 mg, 34% yield from **S1** (4.0 mmol); R_f = 0.52 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.24 (br s, 2H), 5.41 (s, 1H), 5.81 (s, 1H), 6.78 (d, J = 7.8 Hz, 1H), 6.84 (t, J = 7.8 Hz, 1H), 7.09 (d, J = 7.2 Hz, 1H), 7.19 (t, J = 8.4 Hz, 1H), 7.22−7.26 (m, 4H), 7.36 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.7, 117.4, 118.5, 125.0, 126.5, 126.7, 128.1, 129.1, 129.8, 130.8, 134.6, 141.7, 143.9, 146.0. Mass spectrum (m/z, ESI): 229.9; HRMS (ESI): m/z calculated for $C_{14}H_{12}ClN$ (M + H)$^+$: 230.0737, found: 230.0743.

*2-(1-(4-Chlorophenyl)vinyl)aniline (**1k**).* Gray solid, 641 mg, 70% yield from **S1** (4.0 mmol); mp: 45−46 °C; R_f = 0.64 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.74 (br s, 2H), 5.37 (s, 1H), 5.79 (s, 1H), 6.72 (d, J = 7.8 Hz, 1H), 6.80 (t, J = 7.8 Hz, 1H), 7.08 (d, J = 7.2 Hz, 1H), 7.17 (t, J = 7.8 Hz, 1H), 7.27−7.30 (m, 4H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.7, 116.6, 118.5, 126.8, 128.0, 128.7, 129.0, 130.8, 134.0, 138.1, 143.8, 146.1. Mass spectrum (m/z, ESI): 230.0. HRMS (ESI): m/z calculated for $C_{14}H_{12}ClN$ (M + H)$^+$: 230.0737, found: 230.0726.

*2-(1-(3-(Trifluoromethyl)phenyl)vinyl)aniline (**1l**).* Light brown oil, 841 mg, 80% yield from **S1** (4.0 mmol); R_f = 0.44 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.52 (br s, 2H), 5.43 (s, 1H), 5.84 (s, 1H), 6.68 (d, J = 7.8 Hz, 1H), 6.78 (t, J = 7.2 Hz, 1H), 7.06 (d, J = 7.2 Hz, 1H), 7.16 (t, J = 7.2 Hz, 1H), 7.38 (t, J = 7.8 Hz, 1H), 7.46 (d, J = 7.8 Hz, 1H), 7.52 (d, J = 7.2 Hz, 1H), 7.67 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.8, 117.7, 118.5, 123.2 (q, J_{C-F} = 3.8 Hz), 124.2 (q, J_{C-F} = 271.0 Hz), 124.8 (q, J_{C-F} = 3.8 Hz), 126.3, 129.1, 129.2, 130.2, 130.8, 131.1 (q, J_{C-F} = 31.8 Hz), 140.7, 143.9, 146.1. Mass spectrum (m/z, ESI): 264.9; HRMS (ESI): m/z calculated for $C_{15}H_{12}F_3N$ (M + H)$^+$: 264.1000, found: 264.1004.

*2-(1-(Naphthalen-1-yl)vinyl)aniline (**1m**).* White solid, 823 mg, 84% yield from **S1** (4.0 mmol); mp: 86−87 °C; R_f = 0.56 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.68 (br s, 2H), 5.59 (s, 1H), 5.77 (s, 1H), 6.57 (d, J = 7.8 Hz, 1H), 6.66 (t, J = 7.2 Hz, 1H), 7.03 (t, J = 7.8 Hz, 1H), 7.08 (d, J = 7.8 Hz, 1H), 7.3−7.43 (m, 4H), 7.78 (dd, J = 7.8, 11.4 Hz, 2H), 8.04 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 116.2, 118.5, 120.1, 125.5, 125.8, 126.0, 126.3, 126.9, 128.2, 128.4, 128.6, 128.8, 130.3, 131.4, 134.1, 140.3, 143.8, 146.9. Mass spectrum (m/z, ESI): 246.1; HRMS (ESI): m/z calculated for $C_{18}H_{15}N$ (M + H)$^+$: 246.1283, found: 246.1289.

*2-(1-(Naphthalen-2-yl)vinyl)aniline (**1n**).* White solid, 141 mg, 38% yield from **S1** (4.0 mmol); mp: 107−108 °C; R_f = 0.68 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.40 (br s, 2H), 5.45 (s, 1H), 5.93 (s, 1H), 6.73 (d, J = 7.2 Hz, 1H), 6.83 (t, J = 7.8 Hz, 1H), 7.18 (dd, J = 7.2, 16.8 Hz, 2H), 7.44 (d, J = 3.6 Hz, 2H), 7.59 (d, J = 8.4 Hz, 1H), 7.72 (s, 1H), 7.75 (d, J = 6.6 Hz, 1H), 7.80 (d, J = 8.4 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.7, 116.7, 118.5, 124.5, 120.6, 126.2, 126.3, 127.4, 127.6, 128.3, 128.4, 128.9, 131.0, 133.2, 133.4, 137.0, 143.9, 147.1. Mass spectrum (m/z, ESI): 246.0; HRMS (ESI): m/z calculated for $C_{18}H_{15}N$ (M + H)$^+$: 246.1283, found: 246.1285.

*2-(1-(2-Methylnaphthalen-1-yl)vinyl)aniline (**5**).* White solid, mp: 104−105 °C; R_f = 0.59 (5% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.36 (s, 3H), 5.51 (s, 1H), 6.08 (s, 1H), 6.59 (t, J = 7.2 Hz, 1H), 6.76 (d, J = 7.2 Hz, 1H), 6.82 (d, J = 7.2 Hz, 1H), 7.03 (t, J = 7.8 Hz, 1H), 7.35 (d, J = 8.4 Hz, 1H), 7.42−7.41 (m, 2H), 7.73 (d, J = 8.4 Hz, 1H), 7.81 (d, J = 7.2 Hz, 1H), 8.03 (d, J = 7.2 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 20.6, 116.3, 118.4, 119.8, 124.9, 125.8, 126.3, 126.4, 127.3, 128.0, 128.3, 128.9, 129.7, 132.2, 132.5, 133.1, 138.9, 143.6, 144.5. Mass spectrum (m/z, ESI): 259.9; HRMS (ESI): m/z calculated for $C_{19}H_{17}N$ (M + H)$^+$: 260.1439, found: 260.1442.

*2-(1-(Thiophen-2-yl)vinyl)aniline (**1o**).*[18] To a solution of thiophene (1.0 mL, 13.2 mmol) in THF (20 mL) was added *n*-BuLi (5.5 mL, 2.4 M in hexanes, 13.5 mmol) dropwise at −78 °C, and the mixture was stirred at −78 °C for 20 min and at 0 °C for 2 h. Then the mixture was cooled to −78 °C, and 1-(2-aminophenyl)ethanone (0.36 mL, 3.0 mmol) in THF (4 mL) was added dropwise. After 15 min, the cooling bath was removed, and the mixture was stirred overnight. Subsequently, a saturated NH_4Cl solution was added, and the aqueous layer was extracted with EtOAc (2 × 10 mL). The combined extracts were washed with saturated NaCl solution, dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. The residue was purified by column chromatography on SiO_2 to give 1-(2-aminophenyl)-1-(thiophen-2-yl)ethanol. **1o** was prepared following the general procedure. Brown oil, 223 mg, 37% yield; R_f = 0.36 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.64 (br s, 2H), 5.18 (s, 1H), 5.79 (s, 1H), 6.73 (d, J = 7.9 Hz, 1H), 6.81−6.77 (m, 2H), 6.93 (t, J = 3.8 Hz, 1H), 7.13 (d, J = 7.4 Hz, 1H), 7.17 (t, J = 7.7 Hz, 1H), 7.20 (d, J = 5.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 114.6, 115.7, 118.3, 125.4, 126.2, 126.8, 127.6, 129.0, 130.3, 140.6, 143.7, 144.2. Mass spectrum (m/z, ESI): 202.0; HRMS (ESI): m/z calculated for $C_{12}H_{11}NS$ (M + H)$^+$: 202.0690, found: 202.0693.

*2-(Prop-1-en-2-yl)aniline (**1p**).*[19] To a solution of Ph_3PMeBr (3.93 g, 11 mmol, 1.5 equiv) in THF (20 mL) was added *t*-BuOK (1.23 g, 1.5 equiv) in portions under N_2 at room temperature. After the mixture was

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stirred at room temperature for 0.5 h, a solution of 1-(2-aminophenyl)-ethanone (676 mg, 5 mmol, 1 equiv) in THF (10 mL) was added dropwise. The reaction mixture was stirred at room temperature under N_2 overnight, then quenched with H_2O, and extracted twice with EtOAc. The combined organic layers were washed with saturated $NaHCO_3$ and NaCl solution, dried over Na_2SO_4, filtered, and concentrated, and the residue was purified by column chromatography on silica gel to obtain the compound **1p**. Brown oil, 88 mg, 13% yield; R_f = 0.50 (10% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.07 (s, 3H), 3.83 (br s, 2H), 5.06 (dd, J = 0.8, 2.0 Hz, 1H), 5.28 (m, 1H), 6.70−6.68 (m, 1H), 6.73 (td, J = 0.8, 7.6 Hz, 1H), 7.02−7.07 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.9, 115.3, 115.6, 118.2, 127.9, 128.2, 129.3, 142.8, 143.5.

*2-(Hex-1-en-2-yl)aniline (**1q**).* The procedure for the synthesis of **1p** using 1-(2-aminophenyl)pentan-1-one (700 mg, 3.95 mmol) as the starting material was followed. Yellow oil, 277 mg, 40% yield; R_f = 0.68 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.88 (t, J = 7.2 Hz, 3H), 1.3 (m, 2H), 1.39 (m, 2H), 2.37 (t, J = 7.2 Hz, 2H), 0.4.03 (br s, 2H), 5.05 (s, 1H), 5.27 (s, 1H), 6.74 (dd, J = 7.2, 13.8 Hz, 2H), 6.99 (d, J = 7.2 Hz, 1H), 7.07 (t, J = 7.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 14.0, 22.5, 30.2, 37.2, 114.5, 115.8, 118.6, 127.8, 128.6, 129.3, 142.4, 147.9. Mass spectrum (m/z, ESI): 176.8; HRMS (ESI): m/z calculated for $C_{12}H_{18}N$ $(M + H)^+$: 176.1439; found: 176.1433.

*2-(1-(4-Nitrophenyl)vinyl)aniline (**1r**).* The procedure for the synthesis of **1p** using (2-aminophenyl)(4-nitrophenyl)methanone (242 mg) as the starting material was followed. Yellow solid, 110 mg, 46% yield, mp: 99−101 °C; R_f = 0.52 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.58 (br s, 2H), 5.57 (s, 1H), 5.97 (s, 1H), 6.73 (d, J = 7.8 Hz, 1H), 6.80 (t, J = 7.2 Hz, 1H), 7.06 (d, J = 7.2 Hz, 1H), 7.19 (t, J = 7.2 Hz, 1H), 7.50 (d, J = 8.4 Hz, 2H), 8.14 (d, J = 8.4 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.8, 118.6, 119.9, 123.9, 125.8, 127.5, 129.4, 130.7, 143.8, 145.5, 146.2, 147.4. Mass spectrum (m/z, ESI): 241.6; HRMS (ESI): m/z calculated for $C_{14}H_{12}N_2O_2$ $(M + H)^+$: 241.0977; found: 241.0978.

*4-Methoxy-2-(1-phenylvinyl)aniline (**3a**).* Brown oil; R_f = 0.56 (20% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.15 (br s, 2H), 3.76 (s, 3H), 5.36 (s, 1H), 5.81 (s, 1H), 6.68 (d, J = 9.6 Hz, 1H), 6.72 (d, J = 2.8 Hz, 1H), 6.78 (dd, J = 3.2, 8.8 Hz, 1H), 7.34−7.29 (m, 3H), 7.37 (d, J = 6.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 55.8, 114.6, 116.1, 116.3, 117.1, 126.6, 128.2, 128.6, 128.8, 137.2, 139.4, 147.0, 152.6. Mass spectrum (m/z, ESI): 226.1; HRMS (ESI): m/z calculated for $C_{15}H_{15}NO$ $(M + H)^+$: 226.1232, found: 226.1236.

*5-Methoxy-2-(1-phenylvinyl)aniline (**3b**).* Yellow solid, 3.51 g, 52% yield from 3-methoxyaniline (30 mmol); mp: 70−71 °C; R_f = 0.56 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.66 (s, 3H), 5.33 (s, 1H), 6.04 (s, 1H), 6.40 (d, J = 7.8 Hz, 1H), 6.46 (d, J = 7.8 Hz, 1H), 7.12 (t, J = 7.8 Hz, 1H), 7.28 (t, J = 7.2 Hz, 3H), 7.37 (d, J = 7.2 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 55.8, 101.4, 108.8, 116.4, 116.8, 125.9, 157.9, 127.8, 128.4, 128.8, 139.3, 142.3, 144.6. Mass spectrum (m/z, ESI): 226.0; HRMS (ESI): m/z calculated for $C_{15}H_{15}NO$ $(M + H)^+$: 226.1232, found: 226.1237.

*2-Methoxy-6-(1-phenylvinyl)aniline (**3c**).* Light yellow gum, 4.05 g, 60% yield from 2-methoxyaniline (30 mmol); R_f = 0.45 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.50 (br s, 2H), 3.87 (s, 3H), 5.37 (s, 1H), 5.80 (s, 1H), 6.75 (d, J = 7.2 Hz, 2H), 6.80 (d, J = 7.2 Hz, 1H), 7.32−7.28 (m, 3H), 7.37 (d, J = 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 55.6, 109.5, 116.0, 117.3, 122.9, 127.2, 126.7, 128.0, 128.0, 128.5, 133.9, 139.7, 146.9, 147.1. Mass spectrum (m/z, ESI): 226.0; HRMS (ESI): m/z calculated for $C_{15}H_{15}NO$ $(M + H)^+$: 226.1232, found: 226.1236.

*4-Fluoro-2-(1-phenylvinyl)aniline (**3d**).* Brown oil; R_f = 0.53 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.34 (br s, 2H), 5.36 (s, 1H), 5.81 (s, 1H), 6.64−6.62 (m, 1H), 6.87 (dd, J = 9.0, 13.8 Hz, 2H), 7.35−7.32 (m, 5H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 115.2 (d, J_{C-F} = 22.5 Hz), 116.5 (d, J_{C-F} = 7.5 Hz), 116.7, 117.1 (d, J_{C-F} = 22.5 Hz), 126.6, 128.3, 128.4 (d, J_{C-F} = 13.5 Hz), 128.7, 139.0, 140.0 (d, J_{C-F} = 6.6 Hz), 146.3, 156.1 (d, J_{C-F} = 234.9 Hz). Mass spectrum (m/z, ESI): 214.4; HRMS (ESI): m/z calculated for $C_{14}H_{12}FN$ $(M + H)^+$: 214.1032, found: 214.1036.

*5-Fluoro-2-(1-phenylvinyl)aniline (**3e**).* White solid, 1.98 g, 31% yield from 3-fluoroaniline (30 mmol); mp: 80−82 °C; R_f = 0.68 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.28 (br s, 2H), 5.34 (s, 1H), 5.79 (s, 1H), 6.44 (d, J = 9.6 Hz, 1H), 6.51 (t, J = 7.2 Hz, 1H), 7.06 (t, J = 7.2 Hz, 1H), 7.33−7.29 (m, 3H), 7.35 (d, J = 7.2 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 102.0 (d, J_{C-F} = 24.6 Hz), 104.8 (d, J_{C-F} = 21.3 Hz), 116.5, 123.2, 126.6, 128.3, 128.6, 132.0 (d, J_{C-F} = 9.7 Hz), 139.5, 145.5 (d, J_{C-F} = 10.8 Hz), 146.3, 162.6, 163.4 (d, J_{C-F} = 163.4 Hz). Mass spectrum (m/z, ESI): 214.0; HRMS (ESI): m/z calculated for $C_{14}H_{12}FN$ $(M + H)^+$: 214.1032, found: 214.1036.

*2-Fluoro-6-(1-phenylvinyl)aniline (**3f**).* Brown oil, 2.36 g, 37% yield from 2-fluoroaniline (30 mmol); R_f = 0.71 (10% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.59 (br s, 2H), 5.35 (s, 1H), 5.79 (s, 1H), 6.66 (dd, J = 7.2, 13.8 Hz, 1H), 6.88 (d, J = 7.8 Hz, 1H), 6.96 (t, J = 9.6 Hz, 1H), 7.30−7.28 (m, 3H), 7.33 (d, J = 7.2 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 114.4 (d, J_{C-F} = 18.9 Hz), 116.6, 117.5 (d, J_{C-F} = 7.6 Hz), 126.0 (d, J_{C-F} = 3.0 Hz), 126.7, 128.4, 128.7, 129.2 (d, J_{C-F} = 3.3 Hz), 132.7 (d, J_{C-F} = 12.3 Hz), 139.3, 146.2 (d, J_{C-F} = 2.6 Hz), 151.8 (d, J_{C-F} = 237.2 Hz). Mass spectrum (m/z, ESI): 214.0; HRMS (ESI): m/z calculated for $C_{14}H_{12}FN$ $(M + H)^+$: 214.1032, found: 214.1035.

*4-Chloro-2-(1-phenylvinyl)aniline (**3g**).* Brown oil; R_f = 0.51 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 3.48 (br s, 2H), 5.36 (s, 1H), 5.81 (s, 1H), 6.62 (d, J = 8.4 Hz, 1H), 7.10 (d, J = 7.8 Hz, 2H), 7.35−7.32 (m, 5H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 116.8, 116.9, 126.6, 128.4, 128.6, 128.7, 130.0, 130.3, 138.9, 142.4, 146.1. Mass spectrum (m/z, ESI): 229.9; HRMS (ESI): m/z calculated for $C_{14}H_{12}ClN$ $(M + H)^+$: 230.0737, found: 230.0736.

*4-Methyl-2-(1-phenylvinyl)aniline (**3h**).* Yellow oil, 1.39 g, 74% yield from *p*-toluidine (30 mmol); R_f = 0.85 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.27 (s, 3H), 5.35 (s, 1H), 5.79 (s, 1H), 6.67 (d, J = 6.0 Hz, 1H), 6.95 (s, 1H), 7.00 (d, J = 6.0 Hz, 1H), 7.30 (dd, J = 6.6, 14.4 Hz, 3H), 7.35 (d, J = 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 20.5, 116.2, 116.3, 126.7, 128.1, 128.6, 129.3, 131.3, 139.7, 147.0. Mass spectrum (m/z, ESI): 210.9; HRMS (ESI): m/z calculated for $C_{15}H_{15}N$ $(M + H)^+$: 210.1283, found: 210.1278.

*4-Nitro-2-(1-phenylvinyl)aniline (**3i**).* Sodium hydride (120 mg, 5 mmol) was suspended in dimethyl sulfoxide (20 mL) and heated at 70 °C under nitrogen until evolution of hydrogen gas ceased (approximately 30 min). To this suspension was added a solution of (methyl)triphenyl phosphonium bromide (1.78 g, 5 mmol) in dimethyl sulfoxide (20 mL) at room temperature. The mixture was stirred at room temperature for 15 min, and 2-amino-5-nitrobenzophenone (605 mg, 2.5 mmol) was added to this solution. The resulting dark red solution was heated at 90 °C for 18 h under nitrogen. The reaction mixture was cooled and quenched with water (500 mL). The pH was adjusted to 7.0 by the addition of 3 N HCl. This solution was extracted with EtOAc. The combined organic extracts were washed with water, dried over Na_2SO_4, and concentrated under reduced pressure. The resulting dark oil was purified by flash column chromatography over silica gel to provide the product 199 mg, 33% yield, yellow solid, mp: 82 °C; R_f = 0.26 (10% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 5.44 (s, 1H), 7.35 (s, 5H), 8.08 (s, 2H), 8.08 (s, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 114.0, 117.9 125.5, 126.0, 126.5, 127.3, 128.8, 128.9, 138.1, 138.9, 150.1, 150.2. Mass spectrum (m/z, ESI): 263.3; HRMS (ESI): m/z calculatd for $C_{14}H_{12}N_2O_2$ $(M + Na)^+$: 263.0796, found: 263.0803.

General Procedure for the Synthesis of 2a−2p, 4a−4h, and 6. To a solution of phenylvinylaniline (0.2 mmol) in CH_2Cl_2 (2 mL) was added Boc_2O (87.3 mg, 0.4 mmol) and DMAP (5 mol %, 1.2 mg). The solution was stirred at room temperature for the indicated time, then the reaction was quenched with H_2O and extracted with CH_2Cl_2 (2 × 4 mL), the combined organic layer was washed with saturated NaCl solution, dried over Na_2SO_4, and concentrated in vacuo, and the crude residue was purified by flash column chromatography eluting with EtOAc and petroleum ether to give the title compounds.

*tert-Butyl (4-Phenylquinolin-2-yl) Carbonate (**2a**).* One h, white solid, 52 mg, 81% yield; mp: 140−142 °C; R_f = 0.28 (5% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.21 (s, 1H), 7.52−7.46 (m, 6H), 7.72 (t, J = 7.2 Hz, 1H), 7.90 (d, J = 8.4 Hz,

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1H), 8.08 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.1, 115.1, 125.8, 126.5, 128.6, 128.8, 129.1, 129.5, 130.1, 137.3, 147.1, 151.1, 152.8, 155.8. Mass spectrum (m/z, ESI): 344.1; HRMS (ESI): m/z calculated for $C_{20}H_{19}NO_3$ (M + Na)$^+$: 344.1263, found: 344.1267.

*tert-Butyl (4-(2-Methoxyphenyl)quinolin-2-yl) Carbonate (**2b**).* One h, white solid, 56 mg, 80% yield; mp: 65−67 °C; R_f = 0.18 (3% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.58 (s, 9H), 3.71 (s, 3H), 7.06 (d, J = 8.3 Hz, 1H), 7.10 (t, J = 7.4 Hz, 1H), 7.20 (s, 1H), 7.29 (d, J = 7.3 Hz, 1H), 7.43 (t, J = 7.7 Hz, 1H), 7.48 (t, J = 7.8 Hz, 1H), 7.60 (d, J = 8.3 Hz, 1H), 7.69 (t, J = 7.6 Hz, 1H), 8.05 (d, J = 8.3 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.3, 55.5, 84.0, 111.1, 116.0, 120.7, 126.10, 126.12, 126.3, 126.5, 129.0, 129.8, 130.3, 131,2, 146.6, 150.2, 151.1, 155.8, 156.7. Mass spectrum (m/z, ESI): 374.2; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_4$ (M + Na)$^+$: 374.1368, found: 374.1363.

*tert-Butyl (4-(3-Methoxyphenyl)quinolin-2-yl) Carbonate (**2c**).* Three h, light yellow solid, 39 mg, 55% yield; mp: 95−96 °C; R_f = 0.56 (20% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.59 (s, 9H), 3.86 (s, 3H), 7.04 (d, J = 6.7 Hz, 2H), 7.09 (d, J = 7.5 Hz, 1H), 7.21 (s, 1H), 7.43 (t, J = 7.6 Hz, 1H), 7.41−7.51 (t, J = 7.2 Hz, 1H), 7.72 (t, J = 7.3 Hz, 1H), 7.92 (d, J = 8.3 Hz, 1H), 8.08 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 55.4, 84.2, 114.3, 115.0, 115.1, 122.0, 126.0, 126.5, 129.1, 129.7, 130.1, 138.7, 147.0, 151.1, 152.7, 155.8, 159.7. Mass spectrum (m/z, ESI): 374.1; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_4$ (M + Na)$^+$: 374.1368, found: 374.1376.

*tert-Butyl (4-(4-Methoxyphenyl)quinolin-2-yl) Carbonate (**2d**).* 2.5 h, gray solid, 58 mg, 82% yield; mp: 45−46 °C; R_f = 0.67 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 3.91 (s, 3H), 7.07 (d, J = 7.9 Hz, 2H), 7.19 (s, 1H), 7.48 (d, J = 7.9 Hz, 2H), 7.51 (d, J = 7.8 Hz, 1H), 7.73 (t, J = 7.4 Hz, 1H), 7.95 (d, J = 8.4 Hz, 1H), 8.10 (d, J = 8.5 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 55.4, 84.3, 114.1, 114.9, 125.9, 126.0, 126.5, 129.0, 129.6, 130.1, 130.8, 146.9, 151.0, 152.8, 155.8, 160.2. Mass spectrum (m/z, ESI): 374.1; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_4$ (M + Na)$^+$: 374.1368, found: 374.1372.

*tert-Butyl (4-(o-Tolyl)quinolin-2-yl) Carbonate (**2e**).* Five h, light yellow gum, 48 mg, 71% yield; R_f = 0.59 (5% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.58 (s, 9H), 2.06 (s, 3H), 7.14 (s, 1H), 7.25 (d, J = 7.2 Hz, 1H), 7.31−7.48 (m, 5H), 7.71 (t, J = 7.2 Hz, 1H), 8.07 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 20.0, 27.7, 84.2, 115.4, 125.8, 125.9, 126.4, 126.5, 128.7, 129.1, 129.5, 130.1, 130.3, 136.0, 136.8, 146.7, 151.0, 152.8, 155.9. Mass spectrum (m/z, ESI): 358.1; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_3$ (M + Na)$^+$: 358.1419, found: 358.1421.

*tert-Butyl (4-(m-Tolyl)quinolin-2-yl) Carbonate (**2f**).* Three h, white solid, 51 mg, 76% yield; mp: 88 °C; R_f = 0.7 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 2.46 (s, 3H), 7.19 (s, 1H), 7.32 (d, J = 9.0 Hz, 3H), 7.42 (t, J = 7.2 Hz, 1H), 7.50 (t, J = 7.2 Hz, 1H), 7.73 (t, J = 7.8 Hz, 1H), 7.91 (d, J = 8.4 Hz, 1H), 8.07 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.2, 27.2, 84.2, 115.0, 125.9, 126.0, 126.4, 126.6, 128.5, 129.1, 129.5, 130.0, 130.1, 137.3, 138.4, 147.0, 151.1, 153.1, 155.8. Mass spectrum (m/z, ESI): 358.2; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_3$ (M + Na)$^+$: 358.1419, found: 358.1427.

*tert-Butyl (4-(p-Tolyl)quinolin-2-yl) Carbonate (**2g**).* Three h, white solid, 46 mg, 68% yield; mp: 77−78 °C; R_f = 0.4 (70% CH_2Cl_2/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.58 (s, 9H), 2.45 (s, 3H), 7.18 (s, 1H), 7.32 (d, J = 7.9 Hz, 2H), 7.40 (d, J = 7.9 Hz, 2H), 7.47 (t, J = 7.4 Hz, 1H), 7.70 (t, J = 7.2 Hz, 1H), 7.91 (d, J = 4.4 Hz, 1H), 8.07 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.3, 27.7, 84.2, 115.0, 125.9, 126.0, 126.4, 129.1, 129.3, 129.4, 130.0, 134.4, 138.8, 147.1, 151.1, 153.0, 155.8. Mass spectrum (m/z, ESI): 358.1; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_3$ (M + Na)$^+$: 358.1419, found: 358.1423.

*tert-Butyl (4-(3-Fluorophenyl)quinolin-2-yl) Carbonate (**2h**).* Five h, white solid, 43 mg, 64% yield; mp: 97−98 °C; R_f = 0.62 (CH_2Cl_2/petroleum ether = 4:1); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.21−7.25 (m, 3H), 7.30 (d, J = 7.4 Hz, 1H), 7.49−7.53 (m, 2H), 7.75 (t, J = 7.2 Hz, 1H), 7.86 (d, J = 8.3 Hz, 1H), 8.08 (d, J = 8.3 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.4, 115.1, 115.8 (d, J_{C-F} = 22.3 Hz), 116.6 (d, J_{C-F} = 22.3 Hz), 125.3 (d, J_{C-F} = 2.8 Hz), 125.5 (d, J_{C-F} = 8.4 Hz), 126.8, 129.2, 130.3 (d, J_{C-F} = 3.0 Hz), 130.4, 139.4 (d, J_{C-F} = 7.6 Hz), 147.0, 151.0, 151.3, 155.7, 162.7 (d, J_{C-F} = 246.0 Hz). Mass spectrum (m/z, ESI): 362.1; HRMS (ESI): m/z calculated for $C_{20}H_{18}FNO_3$ (M + Na)$^+$: 362.1168, found: 362.1179.

*tert-Butyl (4-(4-Fluorophenyl)quinolin-2-yl) Carbonate (**2i**).* Three h, white solid, 52 mg, 76% yield; mp: 105−106 °C; R_f = 0.63 (CH_2Cl_2/petroleum ether = 4:1); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.18 (s, 1H), 7.22 (t, J = 7.7 Hz, 2H), 7.49 (s, 3H), 7.72 (t, J = 6.8 Hz, 1H), 7.83 (d, J = 8.1 Hz, 1H), 8.07 (d, J = 8.1 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.3, 115.2, 115.7 (d, J_{C-F} = 21.5 Hz), 125.5, 125.8, 126.7, 129.2, 130.2, 131.2 (d, J_{C-F} = 8.4 Hz), 133.3, (d, J_{C-F} = 3.2 Hz), 147.0, 151.1, 151.7, 155.7, 163.1 (d, J_{C-F} = 247.4 Hz). Mass spectrum (m/z, ESI): 362.1; HRMS (ESI): m/z calculated for $C_{20}H_{18}FNO_3$ (M + Na)$^+$: 362.1168, found: 362.1179.

*tert-Butyl (4-(3-Chlorophenyl)quinolin-2-yl) Carbonate (**2j**).* Seven h, white solid, 38 mg, 53% yield; mp: 103−104 °C; R_f = 0.5 (CH_2Cl_2/petroleum ether = 4:1); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.20 (s, 1H), 7.40 (d, J = 7.0 Hz, 1H), 7.46 (d, J = 7.0 Hz, 2H), 7.52 (t, J = 11.6 Hz, 2H), 7.75 (t, J = 7.5 Hz, 1H), 7.84 (d, J = 8.4 Hz, 1H), 8.09 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.3, 115.1, 125.4, 125.5, 126.8, 127.7, 128.9, 129.2, 129.4, 129.9, 130.3, 134.7, 139.1, 147.0, 151.0, 151.1, 155.7. Mass spectrum (m/z, ESI): 378.0; HRMS (ESI): m/z calculated for $C_{20}H_{18}ClNO_3$ (M + Na)$^+$: 378.0873, found: 378.0881.

*tert-Butyl (4-(4-Chlorophenyl)quinolin-2-yl) Carbonate (**2k**).* Three h, white solid, 53 mg, 74% yield; mp: 115−116 °C; R_f = 0.47 (CH_2Cl_2/petroleum ether = 4:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.19 (s, 1H), 7.46 (d, J = 8.4 Hz, 2H), 7.51 (m, 3H), 7.75 (t, J = 8.0 Hz, 1H), 7.84 (d, J = 8.4 Hz, 1H), 8.10 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.8, 84.3, 115.1, 125.4, 125.6, 126.8, 129.0, 129.2, 130.2, 130.8, 135.1, 135.7, 147.0, 151.0, 151.5, 155.7. Mass spectrum (m/z, ESI): 378.1; HRMS (ESI): m/z calculated for $C_{20}H_{18}ClNO_3$ (M + Na)$^+$: 378.0873, found: 378.0863.

*tert-Butyl (4-(3-(Trifluoromethyl)phenyl)quinolin-2-yl) Carbonate (**2l**).* Five h, white solid, 45 mg, 58% yield; mp: 40 °C; R_f = 0.67 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.60 (s, 9H), 7.23 (s, 1H), 7.53 (t, J = 7.8 Hz, 1H), 7.68 (t, J = 7.8 Hz, 1H), 7.10 (d, J = 7.2 Hz, 1H), 7.75 (d, J = 7.8 Hz, 1H), 7.78 (d, J = 9.0 Hz, 3H), 8.10 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.4, 115.3, 123.9 (q, J_{C-F} = 271.0 Hz), 125.2, 125.5, 125.6 (q, J_{C-F} = 3.4 Hz), 126.2 (d, J_{C-F} = 3.6 Hz), 127.0, 129.28, 129.32, 130.4, 131.2 (q, J_{C-F} = 32.6 Hz), 132.8, 138.1, 147.0, 151.0, 155.7. Mass spectrum (m/z, ESI): 412.1; HRMS (ESI): m/z calculated for $C_{21}H_{18}F_3NO_3$ (M + Na)$^+$: 412.1136, found: 412.1146.

*tert-Butyl (4-(Naphthalen-1-yl)quinolin-2-yl) Carbonate (**2m**).* Five h, white solid, 53 mg, 71% yield; mp: 135−136 °C; R_f = 0.20 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.31 (s, 1H), 7.35 (t, J = 7.1 Hz, 2H), 7.43−7.40 (m, 2H), 7.52−7.50 (m, 2H), 7.60 (t, J = 7.9 Hz, 1H), 7.71 (t, J = 7.9 Hz, 1H), 7.95 (d, J = 8.2 Hz, 1H), 8.00 (d, J = 8.2 Hz, 1H), 8.13 (d, J = 8.3 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.2, 116.4, 125.8, 126.28, 126.29, 126.5, 126.7, 127.1, 127.5, 128.3, 129.0, 129.1, 130.2, 131.7, 133.5, 134.9, 146.7, 151.0, 151.7, 155.9. Mass spectrum (m/z, ESI): 394.2; HRMS (ESI): m/z calculated for $C_{24}H_{21}NO_3$ (M + Na)$^+$: 394.1419, found: 394.1428.

*tert-Butyl (4-(Naphthalen-2-yl)quinolin-2-yl) Carbonate (**2n**).* Four h, white solid, 54 mg, 73% yield; mp: 89−90 °C; R_f = 0.57 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.60 (s, 9H), 7.32 (s, 1H), 7.51 (t, J = 7.8 Hz, 1H), 7.59 (t, J = 3.6 Hz, 2H), 7.63 (d, J = 8.4 Hz, 1H), 7.76 (t, J = 6.0 Hz, 1H), 7.94 (t, J = 7.8 Hz, 3H), 8.00 (d, J = 7.8 Hz, 2H), 8.15 (d, J = 7.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.8, 84.2, 115.4, 125.9, 126.0, 126.6, 126.8, 126.9, 127.1, 127.8, 128.3, 128.8, 129.2, 130.2, 133.2, 134.8, 147.1, 151.2, 152.8, 155.9. Mass spectrum (m/z, ESI): 394.1; HRMS (ESI): m/z calculated for $C_{24}H_{21}NO_3$ (M + Na)$^+$: 394.1419, found: 394.1421.

*tert-Butyl (4-(Thiophen-2-yl)quinolin-2-yl) Carbonate (**2o**).* 1.5 h, white solid, 53 mg, 81% yield; mp: 128−129 °C; R_f = 0.25 (3% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.23 (d, J = 4.2 Hz, 1H), 7.31 (s, 1H), 7.41 (s, 1H), 7.54 (d, J = 5.4 Hz, 1H), 7.56 (d, J = 7.8 Hz, 1H), 7.75 (t, J = 7.2 Hz, 1H), 8.07 (d, J = 8.4 Hz, 1H), 8.27 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.3, 115.4, 125.5, 125.6, 126.9, 127.8, 127.9, 129.0, 129.2, 130.3, 138.0, 145.2, 147.2,

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151.0, 155.7. Mass spectrum (m/z, ESI): 350.1; HRMS (ESI): m/z calculated for $C_{18}H_{17}NO_3S$ (M + Na)$^+$: 350.0827, found: 350.0835.

*tert-Butyl (4-Methylquinolin-2-yl) Carbonate (**2p**).* 0.5 h, white solid, 26 mg, 50% yield; mp: 145−146 °C; R_f = 0.24 (3% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.59 (s, 9H), 2.73 (s, 3H), 7.11 (s, 1H), 7.56 (t, J = 7.2 Hz, 1H), 7.71 (t, J = 7.2 Hz, 1H), 7.97 (d, J = 8.4 Hz, 1H), 8.03 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 19.0, 27.7, 84.1, 115.3, 123.7, 126.3, 127.2, 129.2, 130.0, 146.2, 149.1, 151.1, 155.9. Mass spectrum (m/z, ESI): 282.1; HRMS (ESI): m/z calculated for $C_{15}H_{17}NO_3$ (M + Na)$^+$: 282.1106, found: 282.1101.

*tert-Butyl (4-Butylquinolin-2-yl) Carbonate (**2q**).* Two h, colorless gum, 49 mg, 92%; R_f = 0.34 (20% CH_2Cl_2/petroleum ether = 4:6); ^{1}H NMR (600 MHz, $CDCl_3$) δ 0.98 (t, J = 7.2 Hz, 3H), 1.47 (m, 2H), 1.59 (s, 9H), 1.76 (m, 2H), 3.08 (t, J = 7.2 Hz, 2H), 7.09 (s, 1H), 7.55 (t, J = 7.2 Hz, 1H), 7.69 (t, J = 7.2 Hz, 1H), 8.02 (t, J = 7.8 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 13.9, 22.7, 27.7, 31.9, 32.1, 84.0, 114.2, 123.5, 126.2, 126.5, 129.4, 129.8, 146.6, 151.1, 153.5, 156.1; Mass spectrum (m/z, ESI): 324.4; HRMS (ESI): m/z calculated for $C_{18}H_{23}NO_3$ (M + Na)$^+$: 324.1576; Found: 324.1562.

*tert-Butyl (4-(4-Nitrophenyl)quinolin-2-yl) Carbonate (**2r**).* Thirty h, white solid, 20 mg, 27%; mp: 280 °C (decomposed); R_f = 0.54 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.60 (s, 9H), 7.23 (s, 1H), 7.55 (t, J = 7.2 Hz, 1H), 7.76 (m, 4H), 8.12 (d, J = 78. Hz, 1H), 8.42 (d, J = 7.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.6, 115.2, 123.9, 125.0, 125.1, 127.2, 129.5, 130.5, 130.6, 143.8, 147.1, 148.1, 150.1, 151.0, 155.6; Mass spectrum (m/z, ESI): 389.5; HRMS (ESI): m/z calculated for $C_{20}H_{18}N_2O_5$ (M + Na)$^+$: 389.1113; Found: 389.1112.

*tert-Butyl (6-Methoxy-4-phenylquinolin-2-yl) Carbonate (**4a**).* 1.5 h, white solid, 58 mg, 82% yield; mp: 107−108 °C; R_f = 0.57 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.58 (s, 9H), 3.77 (s, 3H), 7.16 (s, 1H), 7.19 (s, 1H), 7.38 (d, J = 9.0 Hz, 1H), 7.50 (s, 1H), 7.53 (s, 4H), 7.98 (d, J = 6.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 55.5, 84.1, 104.2, 115.4, 122.2, 126.8, 128.7, 129.3, 130.4, 137.6, 142.5, 151.3, 151.5, 157.9, 154.2. Mass spectrum (m/z, ESI): 374.1; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_4$ (M + Na)$^+$: 374.1368, found: 374.1377.

*tert-Butyl (7-Methoxy-4-phenylquinolin-2-yl) Carbonate (**4b**).* One h, white gum, 46 mg, 65% yield; R_f = 0.71 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.57 (s, 9H), 3.50 (s, 3H), 6.80 (d, J = 7.2 Hz, 1H), 7.04 (s, 1H), 7.37−7.33 (m, 5H), 7.61 (d, J = 7.8 Hz, 1H), 7.67 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 55.3, 84.1, 106.3, 116.5, 117.8, 121.7, 127.1, 127.2, 128.1, 130.3, 141.9, 148.7, 151.0, 152.5, 155.6, 156.5. Mass spectrum (m/z, ESI): 374.1; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_4$ (M + Na)$^+$: 374.1368, found: 374.1381.

*tert-Butyl (8-Methoxy-4-phenylquinolin-2-yl) Carbonate (**4c**).* Twenty-two h, white solid, 41 mg, 65% yield; mp: 120 °C; R_f = 0.69 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.56 (s, 9H), 4.07 (s, 3H), 7.09 (d, J = 13.2 Hz, 1H), 7.23 (s, 1H), 7.40 (t, J = 14.4 Hz, 1H), 7.44 (d, J = 8.4 Hz, 1H), 7.51−7.46 (m, 5H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 56.1, 83.8, 108.6, 115.9, 117.5, 126.4, 127.1, 128.5, 128.6, 129.4, 137.7, 138.7, 151.2, 152.6, 155.0, 155.3. Mass spectrum (m/z, ESI): 374.3; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_4$ (M + Na)$^+$: 374.1368, found: 374.1373.

*tert-Butyl (6-Fluoro-4-phenylquinolin-2-yl) Carbonate (**4d**).* Five h, white solid, 50 mg, 74% yield; mp: 120−121 °C; R_f = 0.67 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.60 (s, 9H), 7.23 (s, 1H), 7.55−7.50 (m, 7H), 8.10−8.07 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 27.7, 84.4, 109.5 (d, J_{C-F} = 23.1 Hz), 115.8, 120.2 (d, J_{C-F} = 25.8 Hz), 126.7 (d, J_{C-F} = 9.6 Hz), 128.7, 128.9 (d, J_{C-F} = 5.8 Hz), 129.1, 129.3, 131.4 (d, J_{C-F} = 9.2 Hz), 136.9, 143.9, 151.1, 152.3 (d, J_{C-F} = 5.6 Hz), 155.4, 159.9, 160.7 (d, J_{C-F} = 246.0 Hz). Mass spectrum (m/z, ESI): 362.1; HRMS (ESI): m/z calculated for $C_{20}H_{18}FNO_3$ (M + Na)$^+$: 362.1168, found: 362.1174.

*tert-Butyl (7-Fluoro-4-phenylquinolin-2-yl) Carbonate (**4e**).* One h, white solid, 56 mg, 82% yield; mp: 120−121 °C; R_f = 0.59 (10% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.17 (s, 1H), 7.26 (td, J = 2.4, 9.2 Hz, 1H), 7.56−7.48 (m, 5H), 7.70 (dd, J = 2.8, 10.0 Hz, 1H), 7.88 (dd, J = 6.0, 9.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 27.7, 84.4, 113.0 (d, J_{C-F} = 20.9 Hz), 114.3 (d, J_{C-F} = 2.3 Hz), 116.6 (d, J_{C-F} = 24.7 Hz), 122.9, 128.0 (d, J_{C-F} = 9.7 Hz), 128.7, 129.0, 129.4, 137.1, 148.4 (d, J_{C-F} = 13.1 Hz), 150.9, 152.9, 156.8, 1623.5 (d, J_{C-F} = 249.5 Hz). Mass spectrum (m/z, ESI): 362.1; HRMS (ESI): m/z calculated for $C_{20}H_{18}FNO_3$ (M + Na)$^+$: 362.1168, found: 362.1173.

*tert-Butyl (8-Fluoro-4-phenylquinolin-2-yl) Carbonate (**4f**).* 3.5 h, white solid, 53 mg, 78% yield; mp: 115 °C; R_f = 0.50 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.58 (s, 9H), 7.26 (s, 1H), 7.42 (d, J = 7.2 Hz, 2H), 7.51 (d, J = 7.2 Hz, 5H), 7.67 (d, J = 7.2 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ. 27.7, 84.4, 114.3 (d, J_{C-F} = 18.6 Hz), 116.3, 121.5 (d, J_{C-F} = 4.4 Hz), 126.1 (d, J_{C-F} = 7.8 Hz), 127.6, 128.7, 129.0, 129.4, 137.0, 137.2 (d, J_{C-F} = 11.9 Hz), 150.9, 152.8 (d, J_{C-F} = 2.7 Hz), 156.0, 157.7 (d, J_{C-F} = 255.2 Hz). Mass spectrum (m/z, ESI): 362.3; HRMS (ESI): m/z calculated for $C_{20}H_{18}FNO_3$ (M + Na)$^+$: 362.1168, found: 362.1170.

*tert-Butyl (6-Chloro-4-phenylquinolin-2-yl) Carbonate (**4g**).* Seven h, light yellow solid, 33 mg, 46% yield; mp: 105−106 °C; R_f = 0.67 (10% EtOAc/petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.59 (s, 9H), 7.24−7.20 (m, 1H), 7.55−7.48 (m, 5H), 7.65 (td, J = 2.0, 9.2 Hz, 1H), 7.84 (dd, J = 2.0 Hz, 1H), 8.00 (t, J = 9.2 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 27.7, 84.5, 116.0, 124.7, 126.6, 128.9, 129.1, 129.4, 130.7, 131.0, 132.5, 136.7, 145.5, 150.9, 152.1, 156.0. Mass spectrum (m/z, ESI): 378.1; HRMS (ESI): m/z calculated for $C_{20}H_{18}ClNO_3$ (M + Na)$^+$: 378.0873, found: 378.0867.

*tert-Butyl (6-Methyl-4-phenylquinolin-2-yl) Carbonate (**4h**).* One h, light yellow solid, 55 mg, 82% yield; mp: 85−87 °C; R_f = 0.59 (10% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.58 (s, 9H), 2.45 (s, 3H), 7.16 (s, 1H), 7.55−7.51 (m, 6H), 7.63 (s, 1H), 7.91 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 21.8, 27.7, 84.1, 115.1, 124.6, 125.8, 128.6, 128.7, 128.8, 129.5, 132.3, 136.5, 137.6, 145.5, 151.2, 152.1, 155.2. Mass spectrum (m/z, ESI): 358.1; HRMS (ESI): m/z calculated for $C_{21}H_{21}NO_3$ (M + Na)$^+$: 358.1419, found: 358.1426.

*tert-Butyl (4-(2-Methylnaphthalen-1-yl)quinolin-2-yl) Carbonate (**6**).* 0.5 h, white solid, 56 mg, 72% yield; mp: 85−86 °C; R_f = 0.37 (20% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 1.57 (s, 9H), 2.14 (s, 3H), 7.12 (d, J = 9.0 Hz, 1H), 7.21 (s, 1H), 7.24 (d, J = 8.4 Hz, 1H), 7.28 (d, J = 7.8 Hz, 1H), 7.33 (t, J = 7.8 Hz, 1H), 7.42 (t, J = 7.8 Hz, 1H), 7.48 (d, J = 7.8 Hz, 1H), 7.71 (t, J = 7.2 Hz, 1H), 7.89 (t, J = 8.4 Hz, 2H), 8.13 (d, J = 8.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 20.5, 27.7, 84.2, 116.7, 125.3, 125.5, 125.8, 126.6, 126.7, 126.8, 128.0, 128.5, 128.7, 129.2, 130.4, 131.9, 132.3, 135.6, 138.0, 146.9, 150.9, 151.2, 156.2. Mass spectrum (m/z, ESI): 408.2; HRMS (ESI): m/z calculated for $C_{25}H_{23}NO_3$ (M + Na)$^+$: 408.1576, found: 408.1570.

The Producer for the Synthetic Transformations of 4g and 2a. To the solution of **4g** (34 mg, 0.09 mmol) in CH_2Cl_2 (2 mL) was added one drop of *con.* H_2SO_4, and the solution was stirred at room temperature. After 5 min, the mixture was quenched with saturated NaOH solution and extracted with CH_2Cl_2 (3 × 2 mL), and the combined organic phase was washed with saturated NaCl solution, dried over Na_2SO_4, filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography on silica gel to give the desired qunolinone **8**:[20] white solid, 24 mg, 98% yield; mp: 258−260 °C (lit. 250−251 °C); R_f = 0.52 (CH_2Cl_2/MeOH = 10:1); ^{1}H NMR (600 MHz, $CDCl_3$) δ 6.72 (s, 1H), 7.46 (d, J = 6.6 Hz, 2H), 7.50 (s, 2H), 7.54 (t, J = 6.6 Hz, 4H), 13.10 (br s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 118.1, 120.7, 121.7, 126.0, 128.2, 128.8, 128.9, 129.2, 131.0, 136.4, 137.4, 152.7, 164.1.

A solution of **2a** (64.3 mg, 0.2 mmol) in $POCl_3$ (2 mL) was heated to reflux for 0.5 h, then the mixture was quenched by saturated NaOH solution and extracted with EtOAc (3 × 2 mL), and the organic phase was washed with saturated NaCl solution, dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel to give the desired 2-chloro-4-phenylquinoline **9**:[21] white solid, 51 mg, 95% yield; mp: 85−87 °C (lit. 87−88 °C); R_f = 0.60 (10% EtOAc/petroleum ether); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34 (s, 1H), 7.54−7.48 (m, 6H), 7.74 (t, J = 7.2 Hz, 1H), 7.88 (d, J = 7.8 Hz, 1H), 8.08 (d, J = 7.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 122.1, 125.6, 126.0, 127.0, 128.7, 128.9, 129.0, 129.4, 130.5, 136.8, 136.8, 150.3, 151.7.

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■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.joc.6b00519.

NMR spectra for all substrates and products (PDF)

X-ray structural file of compound **2a** (CIF)

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Notes

The authors declare no competing financial interest.

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