JOC The Journal of Organic Chemistry

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Iridium(III)-Catalyzed Direct C-7 Amination of Indolines with Organic Azides

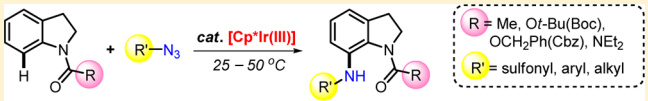
Kwangmin Shin[†,‡] and Sukbok Chang*[,‡,†]

[†]Department of Chemistry, Korea Advanced Institute of Science and Technology (KAIST), Daejon 307-701, Republic of Korea

[‡]Center for Catalytic Hydrocarbon Functionalizations, Institute of Basic Science (IBS), Daejon 307-701, Republic of Korea

Supporting Information

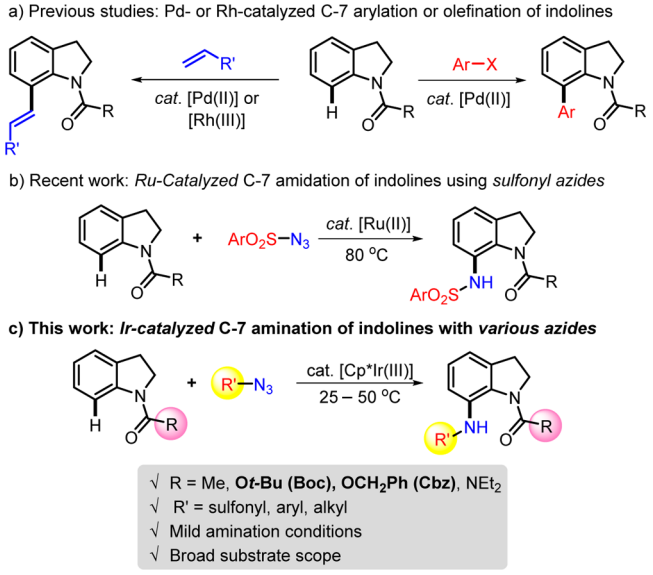
ABSTRACT: Iridium-catalyzed regioselective C-7 amination of indolines has been achieved with organic azides as a facile nitrogen source. The developed procedure is convenient to perform even at room temperature and applicable to a wide range of substrates with high catalytic activity. Various types of organic azides (sulfonyl, aryl, and alkyl derivatives) were all successfully reacted under the present conditions as the viable reactant. Furthermore, indoline substrates bearing easily removable *N*-protecting groups such as *N*-Boc or *N*-Cbz could readily be employed, highlighting the synthetic utility of this methodology.



Among various nitrogen-containing heterocycles, indole and indoline derivatives have been recognized especially as privileged core structures owing to their ubiquity in numerous biologically active compounds and natural products.[1] In particular, C7-substituted indole and indoline scaffolds have received great attention due to their prevalence in important pharmaceutical agents.[2] For this reason, synthetic methods for the introduction of functional groups at the C-7 position of indoles or indolines are in high demand. However, the development of synthetic routes allowing this transformation has been less explored. Indeed, whereas procedures for the selective C2- and C3-functionalization of indoles have been actively investigated,[3−5] approaches to access C7-functionalized indole derivatives are relatively rare, especially with respect to the transition-metal-catalyzed C−H bond functionalization.[6,7] Moreover, while examples of the direct C7-functionalization of indolines via chelation-assisted C−H activation have been disclosed,[8−11] most of those methods allowed for C−C bond formation in reaction with alkenes[8] or arylating reagents[9] (Scheme 1a). Very recently, an elegant example of the Ru-catalyzed C-7 amidation of indolines using sulfonyl azides has been reported,[11] although this procedure requires a somewhat elevated temperature with limited scope (Scheme 1b).

In a few recent years, our group has been engaged in developing selective and efficient C−N bond-forming reactions[12] leading to the Rh- and Ru-catalyzed direct C(sp^2)−H amination procedures by the use of organic azides working both as an amino source and as an internal oxidant via N−N_2 bond cleavage.[13−15] In addition, we also disclosed an iridium catalyst system that offers milder amination reaction conditions with enhanced activity and broader substrate scope.[16] In this context, we report herein a new procedure for the Ir-catalyzed C-7 amination of indolines with a wide range of organic azides (Scheme 1c). The significance of the present direct C−H amination route is 3-fold: (1) the reaction proceeds under mild reaction conditions at room temperature in most cases; (2) the scope of azides is highly broad, including sulfonyl, aryl, and alkyl variants as an efficient amino source; and (3) the present reaction can be applicable to indolines bearing readily removable *N*-protecting groups (e.g., Boc or Cbz), thus enabling subsequent transformations of the obtained aminated products.

Scheme 1

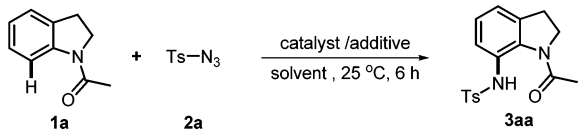


At the outset of the present investigation, we sought the optimal amidation conditions in a model reaction of *N*-acetylindoline (**1a**) with *p*-toluenesulfonyl azide (**2a**, Table 1).

Special Issue: Mechanisms in Metal-Based Organic Chemistry

Received: August 10, 2014
Published: September 14, 2014

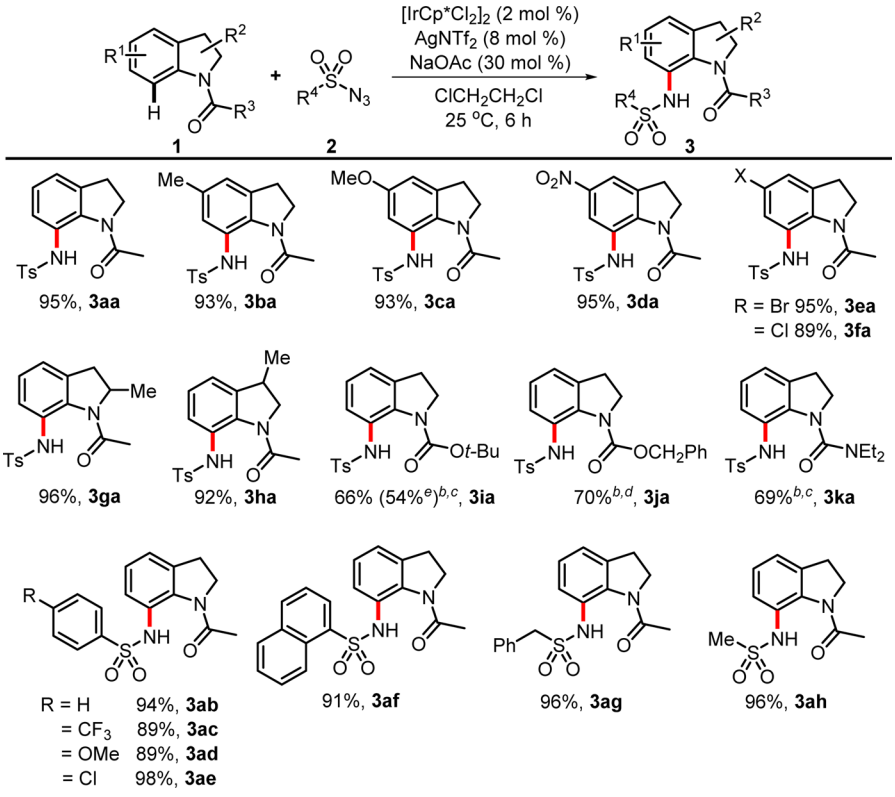
Table 1. Optimization of Ir-Catalyzed Amidation[a]



entry	catalyst (mol %)	additive (mol %)	solvent	yield (%)[b]
1	$[IrCp^*Cl_2]_2$ (4)	$AgSbF_6$ (16)	$ClCH_2CH_2Cl$	75
2		$AgSbF_6$ (16)	$ClCH_2CH_2Cl$	N.R.
3	$[IrCp^*Cl_2]_2$ (4)		$ClCH_2CH_2Cl$	N.R.
4	$[RhCp^*Cl_2]_2$ (4)	$AgSbF_6$ (16)	$ClCH_2CH_2Cl$	N.R.
5[c]	$[RhCp^*Cl_2]_2$ (4)	$AgSbF_6$ (16)	$ClCH_2CH_2Cl$	N.R.
6	$[Ru(p\text{-cymene})Cl_2]_2$ (4)	$AgSbF_6$ (16)	$ClCH_2CH_2Cl$	<5
7	**$[IrCp^*Cl_2]_2$ (4)**	**$AgNTf_2$ (16)**	**$ClCH_2CH_2Cl$**	**98**
8	$[IrCp^*Cl_2]_2$ (4)	AgOAc (16)	$ClCH_2CH_2Cl$	N.R.
9	$[IrCp^*Cl_2]_2$ (4)	$AgPF_6$ (16)	$ClCH_2CH_2Cl$	60
10	$[IrCp^*Cl_2]_2$ (4)	$AgBF_4$ (16)	$ClCH_2CH_2Cl$	46
11	$[IrCp^*Cl_2]_2$ (2)	$AgNTf_2$ (8)	$ClCH_2CH_2Cl$	85
12	**$[IrCp^*Cl_2]_2$ (2)**	**$AgNTf_2$ (8) + NaOAc (30)**	**$ClCH_2CH_2Cl$**	**95**
13	**$[IrCp^*Cl_2]_2$ (1)**	**$AgNTf_2$ (4) + NaOAc (30)**	**$ClCH_2CH_2Cl$**	**90**
14	$[IrCp^*Cl_2]_2$ (2)	$AgNTf_2$ (8) + NaOAc (30)	toluene	90
15	$[IrCp^*Cl_2]_2$ (2)	$AgNTf_2$ (8) + NaOAc (30)	1,4-Dioxane	92
16	$[IrCp^*Cl_2]_2$ (2)	$AgNTf_2$ (8) + NaOAc (30)	THF	65

[a]Reaction conditions: **1a** (0.2 mmol), **2a** (1.5 equiv), catalyst and additive in solvent (0.5 mL) at 25 °C for 6 h. [b]Yield was determined by ^1H NMR spectroscopy by using dibromomethane as an internal standard. [c]At 80 °C.

Scheme 2. Scope of Indolines and Sulfonyl Azides[a,b,c,d,e]

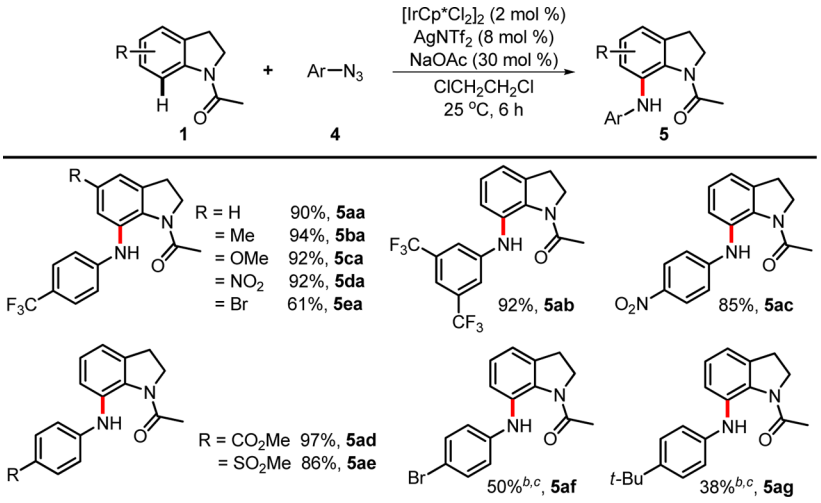


[a]Reaction conditions: **1** (0.2 mmol), **2** (1.5 equiv), $[IrCp^*Cl_2]_2$ (2 mol %), $AgNTf_2$ (8 mol %), and NaOAc (30 mol %) in 1,2-dichloroethane (0.5 mL) at 25 °C for 6 h. [b]$[IrCp^*Cl_2]_2$ (4 mol %), $AgNTf_2$ (16 mol %) were used. [c]At 50 °C. [d]At 80 °C. [e]5 mmol scale (with 5 mmol of **1i**).

We were pleased to see that a high yield of the desired product (**3aa**) was obtained when $[IrCp^*Cl_2]_2$ was applied as a catalyst and $AgSbF_6$ as an additive at ambient temperature (entry 1). Not surprisingly, the amidated product **3aa** was not formed in the absence of either $[IrCp^*Cl_2]_2$ or $AgSbF_6$ (entries 2 and 3), implying that a cationic iridium species is crucial in the current transformation. It should be noted that the present amidation did not proceed at all when $[RhCp^*Cl_2]_2$ catalyst was

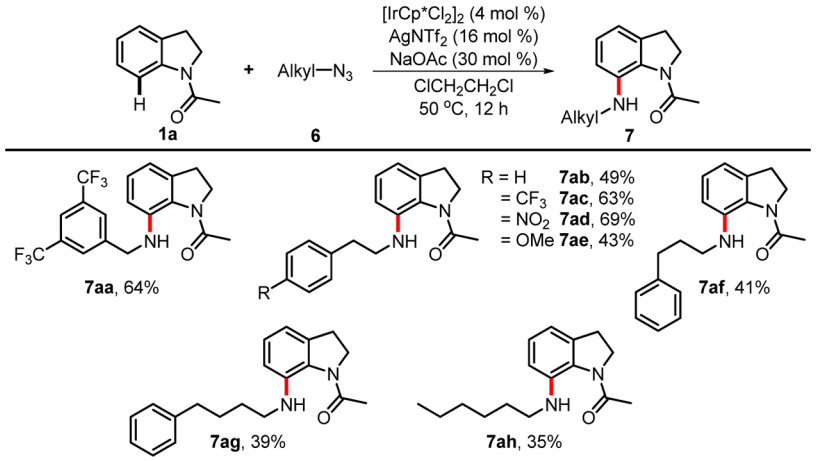
dx.doi.org/10.1021/jo5018475 | J. Org. Chem. 2014, 79, 12197−12204

Scheme 3. Scope of Indolines and Aryl Azides[a,b,c]



[a]Reaction conditions: **1** (0.2 mmol), **4** (1.5 equiv), $[IrCp^*Cl_2]_2$ (2 mol %), $AgNTf_2$ (8 mol %), and NaOAc (30 mol %) in 1,2-dichloroethane (0.5 mL) at 25 °C for 6 h. [b]$[IrCp^*Cl_2]_2$ (4 mol %), $AgNTf_2$ (16 mol %) were used. [c]At 50 °C.

Scheme 4. Scope of Alkyl Azides[a]



[a]Reaction conditions: **1a** (0.2 mmol), **6** (1.5 equiv), $[IrCp^*Cl_2]_2$ (4 mol %), $AgNTf_2$ (16 mol %), and NaOAc (30 mol %) in 1,2-dichloroethane (0.5 mL) at 50 °C for 12 h.

employed even at elevated temperature 80 °C (entries 4 and 5). Interestingly, a ruthenium catalyst system was found to be almost ineffective at 25 °C (entry 6).[11] These results clearly demonstrate the superior catalytic activity of the iridium species toward the C-7 amidation of indolines when compared to the rhodium and ruthenium catalyst systems. On the other hand, among various silver additives screened, $AgNTf_2$ was especially efficient, leading to an almost quantitative product yield (entry 7), whereas others were inferior (entries 8−10). In addition, loading of the iridium catalyst precursor could be reduced down to 1 mol % without much affecting the reaction efficiency when sodium acetate (30 mol %) was added as a coadditive (entries 11−13).[17] The use of solvents other than 1,2-dichloroethane resulted in decreased product yields (entries 14−16).

Having established the optimized conditions for the C-7 amidation of indolines, we set out to explore the scope of this transformation in reactions of substituted indolines with sulfonyl azides (Scheme 2).[18] The amidation proceeded smoothly to give the corresponding amidated products irrespective of electronic variation at the arene part of indolines (**3aa**−**3da**).[19] *N*-Acetylindolines possessing halogen substituents at the C-5 position (**1e**−**1f**) were well-tolerated to afford the desired products **3ea** and **3fa**, respectively, in excellent yields, thus allowing for the possibility of further transformations. Substitution at the C-2 or C-3 position of the indoline did not hamper the reaction efficiency (**3ga**−**3ha**). In addition, we were pleased to observe that synthetically versatile groups such as *N*-Boc-,[20] Cbz-, and carbamoyl-protected indolines (**1i**−**1k**) underwent the current amidation to afford **3ia**−**3ka** in good yields, albeit at slightly higher reaction temperatures. It is also worth mentioning that the present reaction could be performed on a gram scale without much difficulty, as demonstrated in the production of **3ia**. In regard to the scope of sulfonyl azides, it was observed that arenesulfonyl azides bearing electron-donating, electron-withdrawing, or halogen functional groups readily participated in the amidation with excellent efficiency (**3ab**−**3ae**). Moreover, additional derivatives, such as naphthyl, benzyl, and aliphatic sulfonyl

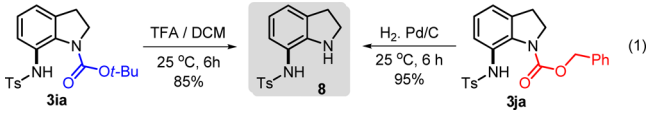
dx.doi.org/10.1021/jo5018475 | J. Org. Chem. 2014, 79, 12197−12204

azides, underwent the amidation also in almost quantitative yields (**3af**–**3ah**).

During the course of our studies, it was found that a series of aryl azides reacted readily with indolines under the present reaction conditions to yield the desired C-7 aminated indolines (Scheme 3).[18] It should be noted that the use of aryl azides as a nitrogen source in the Ir(III)-catalyzed C–N bond formation was of limited success in our previous studies: indeed 3,5-bis(trifluoromethyl)phenyl azide (**4b**) was the only viable reactant in the Ir(III)-catalyzed C–N bond formation of benzamides.[16b] In the current study, however, 4-(trifluoromethyl)phenyl azide (**4a**) also readily participated in the amination reaction with substituted indolines (**5aa**–**5ea**). Moreover, a range of phenyl azides bearing electron-withdrawing groups underwent the desired amination in excellent yields (**5ab**–**5ae**). A phenyl azide substituted with a bromo group at the *para* position smoothly reacted under the developed conditions (**5af**). However, amination with a phenyl azide substituted with an electron-neutral alkyl group was rather sluggish to give the desired product in a moderate yield (**5ag**).

Generality of the current C–H amination method was further investigated by examining the scope of alkyl azides. To our delight, alkyl azides including a benzyl derivative were found to be an efficient amino source for the present transformation, although slightly more forcing conditions were applied when compared to sulfonyl and aryl azides (Scheme 4).[18] Benzyl azide was facile in this amination, leading to the desired product in good yield (**7aa**). An array of phenethyl azides reacted with indoline **1a** to provide the aminated products in moderate to good yields (**7ab**–**7ae**). In addition, more hydrophobic derivatives, such as 3-phenylpropyl, 4-phenylbutyl, and *n*-hexyl azides, were also aminated, albeit in slightly lower product yields (**7af**–**7ah**).

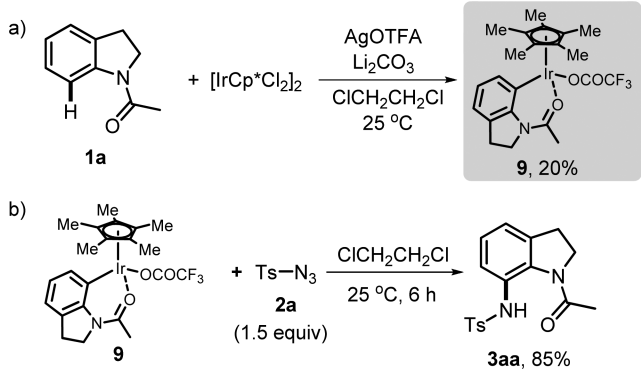
One of the major concerns in the application of the chelation-assisted C–H activation approaches lies in the facile removal of the initially installed directing groups after the targeted C–H functionalizations.[21] To address this issue in the present amination protocol, we were able to prove the feasibility of readily removable *N*-substituents of indoline substrates, as shown in Scheme 2. In fact, not only *N*-acetyl but also *N*-Boc and *N*-Cbz groups were successfully employed to guide the regioselective C-7 amination. As a proof of the concept of facile removal of chelating groups, *N*-directing groups in the aminated products were examined to be deprotected (eq 1). As anticipated, the deprotection processes were highly smooth under the conventional conditions to furnish C-7 amidated indoline compound **8** in high yields.



(1)

To understand the mechanistic aspects of the present amination reaction, a plausible iridacyclic intermediate was isolated and subjected to the amidation conditions (Scheme 5). When *N*-acetylindoline (**1a**) was treated with a dimeric iridium complex in the presence of AgOTFA and Li_2CO_3, a labile iridacycle (**9**) was isolated, albeit in low yield.[16e] Whereas a single-crystal structure of **9** could not be obtained, it was clearly characterized by NMR and mass spectroscopy. A subsequent stoichiometric reaction of **9** with sulfonyl azide **2a** afforded the amidated product **3aa** in high yield, thus indicating the intermediacy of a cyclometalated iridacyclic intermediate in the catalytic cycle.

Scheme 5. Isolation of an Iridacycle (9) and Its Amidation Reaction



In summary, we have developed an iridium-catalyzed direct C–H amination of indolines exclusively at the C-7 position using diverse organic azides as an amino source. A broad range of *N*-substituted indolines were regioselectively aminated under the present amination procedure even at room temperature in high efficiency. In addition, the nitrogen source for the reaction was not limited to sulfonyl azides: aryl and alkyl azides also participated in the amination reaction as an amino source. Synthetic utility of the current approach was highlighted by the use of Boc- and Cbz-protecting groups as a directing group, thus allowing for the facile removal of those chelating groups after the targeted amination. We believe that the above features of the present method will offer a practical route to the synthesis of pharmaceutically relevant C7-aminated indoline derivatives.

EXPERIMENTAL SECTION

General Methods. Unless otherwise stated, all commercial reagents and solvents were used without additional purification. Analytical thin-layer chromatography (TLC) was performed on precoated silica gel 60 F254 plates. Visualization on TLC was achieved by the use of UV light (254 nm). Column chromatography was undertaken on silica gel (400–630 mesh) using a proper eluent system. The NMR data were recorded with 0.1 Hz resolution. Chemical shifts were quoted in parts per million (ppm) referenced to the appropriate solvent peak or 0.0 ppm for tetramethylsilane. The following abbreviations were used to describe peak splitting patterns when appropriate: br (broad), s (singlet), d (doublet), t (triplet), q (quartet), dd (doublet of doublet), td (triplet of doublet), ddd (doublet of doublet of doublet), m (multiplet). Coupling constants, *J*, were reported in hertz unit (Hz). $^{13}C\{^1H\}$ NMR was fully decoupled by broad band proton decoupling. Chemical shifts were reported in ppm referenced to the center of a triplet at 77.0 ppm of chloroform-*d*. Infrared (IR) spectra were recorded on an FT-IR spectrometer using a diamond ATR module. Frequencies are given in reciprocal centimeters (cm^{-1}), and only selected absorbance is reported. High-resolution mass spectra were obtained by using the EI method (analyzer type: Magnetic Sector – Electric Sector, MS/MS) or by using the ESI method (analyzer type: Quadrupole – TOF, MS/MS). Unless otherwise stated, all commercial reagents and solvents were used without additional purification.

Preparation of Substrates. *N*-Acetylindolines **1**,[9d] *N*-Boc-indoline **1i**,[22] *N*-CBz-indoline **1j**,[23] *N*,*N*-diethylcarbamoylindoline **1k**,[8b] and organic azides **2**,[13a] **4**,[13b] and **6**[13c] were prepared according to the previously reported procedures.

dx.doi.org/10.1021/jo5018475 | J. Org. Chem. 2014, 79, 12197–12204

General Procedure for the C-7 Amination of Indolines with Sulfonyl and Aryl Azides. To a screw-capped vial with a spinvane triangular-shaped Teflon stir bar were added *N*-protected indoline (**1**, 0.2 mmol), sulfonyl or aryl azide (**2** or **4**, 0.3 mmol), $[IrCp^*Cl_2]_2$ (3.2 mg, 0.004 mmol, 2 mol %), $AgNTf_2$ (6.2 mg, 0.016 mmol, 8 mol %), NaOAc (4.9 mg, 0.06 mmol, 30 mol %), and 1,2-dichloroethane (0.5 mL) under atmospheric conditions. The reaction mixture was stirred at 25 °C for 6 h, filtered through a pad of Celite, and then washed with dichloromethane (10 mL × 3). Organic solvents were removed under reduced pressure, and the residue was purified by chromatography on silica gel (*n*-hexane/EtOAc) to give the desired product **3** or **5**.

*N-(1-Acetyl-5-methylindolin-7-yl)-4-methylbenzenesulfonamide (**3ba**).* White solid (64.1 mg, 93%); mp 175−176 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.85 (s, 1H), 7.44 (d, J = 8.2 Hz, 2H), 7.16 (d, J = 8.2 Hz, 2H), 7.11 (d, J = 1.1 Hz, 1H), 6.83 (d, J = 1.1 Hz, 1H), 3.57 (t, J = 7.8 Hz, 2H), 2.90 (t, J = 7.8 Hz, 2H), 2.37 (s, 3H), 2.30 (s, 3H), 2.03 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.5, 142.9, 137.4, 136.7, 134.8, 133.1, 129.0, 127.0, 126.0, 125.9, 123.3, 51.2, 28.6, 23.9, 21.4, 20.9; IR (diamond) 2917, 2882, 1632, 1589, 1478, 1417, 1383, 1165, 1134, 1091, 949, 860 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{20}N_2O_3S$ $[M]^+$: 344.1195, found: 344.1192; R_f (*n*-hexane/EtOAc, 1:1): 0.28.

*N-(1-Acetyl-5-methoxyindolin-7-yl)-4-methylbenzenesulfonamide (**3ca**).* White solid (67.0 mg, 93%); mp 169−170 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 10.18 (s, 1H), 7.51 (d, J = 8.2 Hz, 2H), 7.17 (d, J = 8.2 Hz, 2H), 6.85 (d, J = 2.5 Hz, 1H), 6.56 (d, J = 2.5 Hz, 1H), 3.76 (s, 3H), 3.63 (t, J = 7.8 Hz, 2H), 2.91 (t, J = 7.8 Hz, 2H), 2.37 (s, 3H), 2.07 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.3, 158.3, 143.1, 137.3, 136.1, 129.0, 128.4, 127.2, 127.0, 108.8, 108.8, 55.7, 51.3, 28.9, 23.8, 21.4; IR (diamond) 2926, 2843, 1628, 1592, 1458, 1337, 1322, 1285, 1218, 1164, 1040, 807 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{20}N_2O_4S$ $[M]^+$: 360.1144, found: 360.1143; R_f (*n*-hexane/EtOAc, 1:1): 0.13.

*tert-Butyl 7-(4-Methylphenylsulfonamido)indoline-1-carboxylate (**3ia**).* White solid (51.3 mg, 66%); mp 145−146 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.83 (s, 1H), 7.43 (d, J = 8.2 Hz, 2H), 7.34 (dd, J = 7.5, 1.3 Hz, 1H), 7.13 (d, J = 8.2 Hz, 2H), 7.03 (dd, J = 7.5, 7.5 Hz, 1H), 6.98 (dd, J = 7.5, 1.3 Hz, 1H), 3.56 (t, J = 8.2 Hz, 2H), 2.86 (t, J = 8.2 Hz, 2H), 2.37 (s, 3H), 1.53 (s, 9H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 153.7, 142.8, 137.4, 135.4, 134.3, 129.0, 126.9, 125.9, 125.1, 125.0, 122.5, 82.4, 49.7, 28.3, 28.2, 21.4; IR (diamond) 2985, 2933, 1659, 1467, 1391, 1329, 1308, 1250, 1153, 1132, 1090, 789 cm^{-1}; HRMS (EI) m/z calcd. for $C_{20}H_{24}N_2O_4S$ $[M]^+$: 388.1457, found: 388.1454; R_f (*n*-hexane/EtOAc, 5:1): 0.22.

*Benzyl 7-(4-Methylphenylsulfonamido)indoline-1-carboxylate (**3ja**).* White solid (59.1 mg, 70%); mp 110−111 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.67 (s, 1H), 7.45−7.38 (m, 5H), 7.35−7.32 (m, 3H), 7.06−7.03 (m, 1H), 6.99−6.97 (m, 3H), 5.19 (s, 2H), 3.62 (t, J = 8.2 Hz, 2H), 2.87 (t, J = 8.2 Hz, 2H), 2.29 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 154.0, 142.9, 137.1, 135.6, 135.0, 134.3, 129.0, 128.7, 128.7, 128.6, 126.9, 126.0, 125.5, 125.1, 122.6, 68.3, 49.5, 28.3, 21.4; IR (diamond) 3039, 2956, 1676, 1595, 1446, 1323, 1256, 1241, 1165, 1155, 1024, 823 cm^{-1}; HRMS (EI) m/z calcd. for $C_{23}H_{22}N_2O_4S$ $[M]^+$: 422.1300, found: 422.1298; R_f (*n*-hexane/EtOAc, 3:1): 0.30.

*N,N-Diethyl-7-(4-methylphenylsulfonamido)indoline-1-carboxamide (**3ka**).* White solid (53.5 mg, 69%); mp 118−119 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.51 (d, J = 8.2 Hz, 2H), 7.24 (dd, J = 7.7, 1.5 Hz, 1H), 7.17 (d, J = 8.2 Hz, 2H), 7.02−6.97 (m, 2H), 3.71 (t, J = 8.2 Hz, 2H), 3.09−3.03 (m, 6H), 2.36 (s, 3H), 1.17 (t, J = 7.1 Hz, 6H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 160.5, 142.8, 138.4, 138.1, 133.4, 129.2, 126.7, 125.5, 124.8, 124.2, 122.4, 52.5, 41.6, 30.0, 21.4, 13.1; IR (diamond) 2971, 2874, 1617, 1584, 1460, 1353, 1317, 1195, 1156, 1091, 1051, 788 cm^{-1}; HRMS (EI) m/z calcd. for $C_{20}H_{25}N_3O_3S$ $[M]^+$: 387.1617, found: 387.1615; R_f (*n*-hexane/EtOAc, 2:1): 0.19.

*N-(1-Acetylindolin-7-yl)naphthalene-1-sulfonamide (**3af**).* Gray solid (66.7 mg, 91%); mp 183−184 °C; ^{1}H NMR (600 MHz, CD_2Cl_2) δ 9.90 (bs, 1H), 8.40 (d, J = 8.2 Hz, 1H), 7.98 (d, J = 8.2 Hz, 1H), 7.90 (m, 2H), 7.54 (ddd, J = 8.2, 6.9, 1.4 Hz, 1H), 7.49 (ddd, J = 8.2, 6.9, 1.4 Hz, 1H), 7.37−7.33 (m, 2H), 7.12−7.10 (m, 1H), 6.96 (dd, J = 7.4, 1.5 Hz, 1H), 3.04 (t, J = 7.9 Hz, 2H), 2.67 (t, J = 7.9 Hz, 2H), 1.66 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, CD_2Cl_2) δ 169.1, 135.7, 135.4, 135.1, 133.9, 133.8, 129.4, 128.6, 128.2, 127.6, 126.6, 126.3, 126.2, 125.6, 124.7, 124.1, 122.6, 50.6, 28.3, 23.5; IR (diamond) 2962, 2855, 1625, 1581, 1460, 1421, 1243, 1165, 1118, 1088, 1005, 806 cm^{-1}; HRMS (EI) m/z calcd. for $C_{20}H_{18}N_2O_3S$ $[M]^+$: 366.1038, found: 366.1039; R_f (*n*-hexane/EtOAc, 1:1): 0.17.

*N-(1-Acetylindolin-7-yl)-1-phenylmethanesulfonamide (**3ag**).* White solid (63.4 mg, 96%); mp 137−138 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 10.14 (s, 1H), 7.37 (dd, J = 8.1, 1.3 Hz, 1H), 7.32−7.28 (m, 3H), 7.23−7.22 (m, 2H), 7.08 (dd, J = 8.1, 8.1 Hz, 1H), 6.99 (dd, J = 8.1, 1.3 Hz, 1H), 4.21 (s, 2H), 3.98 (t, J = 8.0 Hz, 2H), 3.07 (t, J = 8.0 Hz, 2H), 2.09 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.6, 135.3, 133.2, 130.5, 129.1, 128.4, 127.0, 126.7, 121.2, 121.2, 57.9, 51.3, 28.7, 24.4; IR (diamond) 2954, 2923, 1625, 1582, 1424, 1327, 1149, 1120, 1012, 916, 888, 764 cm^{-1}; HRMS (EI) m/z calcd. for $C_{17}H_{18}N_2O_3S$ $[M]^+$: 330.1038, found: 330.1039; R_f (*n*-hexane/EtOAc, 1:1): 0.18.

*N-(1-Acetylindolin-7-yl)methanesulfonamide (**3ah**).* White solid (48.8 mg, 96%); mp 110−111 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 10.09 (s, 1H), 7.38 (dd, J = 7.9, 1.1 Hz, 1H), 7.14 (dd, J = 7.9, 7.9 Hz, 1H), 7.04 (dd, J = 7.9, 1.1 Hz, 1H), 4.12 (t, J = 8.0 Hz, 2H), 3.14 (t, J = 8.0 Hz, 2H), 2.92 (s, 3H), 2.35 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.9, 135.4, 133.7, 127.2, 126.9, 121.9, 121.4, 51.4, 39.9, 28.8, 24.5; IR (diamond) 3016, 2924, 1629, 1584, 1462, 1377, 1308, 1149, 1012, 967, 811, 787 cm^{-1}; HRMS (EI) m/z calcd. for $C_{11}H_{14}N_2O_3S$ $[M]^+$: 254.0725, found: 254.0721; R_f (*n*-hexane/EtOAc, 1:2): 0.25.

*1-[7-{4-(Trifluoromethyl)phenylamino}indolin-1-yl]ethanone (**5aa**).* Light yellow solid (57.7 mg, 90%); mp 102−103 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.33 (s, 1H), 7.41 (d, J = 8.5 Hz, 2H), 7.27 (d, J = 7.9 Hz, 1H), 7.09 (dd, J = 7.9, 7.9 Hz, 1H), 7.03 (d, J = 8.5 Hz, 2H), 6.87 (d, J = 7.9 Hz, 1H), 4.08 (t, J = 7.7 Hz, 2H), 3.09 (t, J = 7.7 Hz, 2H), 2.31 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.1, 146.8, 135.9, 132.9, 132.3, 127.5, 126.5, 126.5, 126.5, 126.5, 126.4, 125.7, 123.9, 122.1, 121.2, 121.0, 120.7, 120.5, 118.8, 118.1, 115.3, 51.6, 29.4, 24.2; IR (diamond) 3208, 2924, 1642, 1616, 1527, 1396, 1318, 1242, 1157, 1099, 1062, 834 cm^{-1}; HRMS (EI) m/z calcd. for $C_{17}H_{15}F_3N_2O$ $[M]^+$: 320.1136, found: 320.1133; R_f (*n*-hexane/EtOAc, 2:1): 0.48.

*1-[5-Methyl-7-{4-(trifluoromethyl)phenylamino}indolin-1-yl]-ethanone (**5ba**).* Light brown solid (62.9 mg, 94%); mp 111−112 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.41 (s, 1H), 7.41 (d, J = 8.4 Hz, 2H), 7.08 (s, 1H), 7.04 (d, J = 8.4 Hz, 2H), 6.68 (s, 1H), 4.06 (t, J = 8.1 Hz, 2H), 3.04 (t, J = 8.1 Hz, 2H), 2.29 (s, 3H), 2.28 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.8, 146.9, 136.5, 136.0, 136.0, 131.8, 130.6, 127.5, 126.5, 126.5, 126.5, 126.4, 125.7, 123.9, 122.1, 121.0, 120.8, 120.6, 120.4, 119.0, 118.9, 115.3, 51.6, 29.3, 24.1, 21.1; IR (diamond) 2923, 2855, 1643, 1590, 1531, 1418, 1396, 1313, 1239, 1161, 1114, 826 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{17}F_3N_2O$ $[M]^+$: 334.1293, found: 334.1291; R_f (*n*-hexane/EtOAc, 2:1): 0.50.

*1-[5-Methoxy-7-{4-(trifluoromethyl)phenylamino}indolin-1-yl]-ethanone (**5ca**).* Brown solid (64.5 mg, 92%); mp 118−119 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.59 (s, 1H), 7.43 (d, J = 8.3 Hz, 2H), 7.09 (d, J = 8.3 Hz, 2H), 6.79 (s, 1H), 6.44 (s, 1H), 4.07 (t, J = 7.7 Hz, 2H), 3.74 (s, 3H), 3.06 (t, J = 7.7 Hz, 2H), 2.30 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.4, 158.7, 146.4, 137.1, 133.0, 127.4, 126.5, 126.5, 126.5, 126.4, 126.3, 125.6, 123.8, 122.0, 121.4, 121.2, 121.0, 120.8, 115.8, 104.1, 103.0, 55.6, 51.7, 29.7, 24.0; IR (diamond) 3005, 2951, 1636, 1593, 1317, 1260, 1147, 1101, 1063, 940, 925, 818 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{17}F_3N_2O_2$ $[M]^+$: 350.1242, found: 350.1239; R_f (*n*-hexane/EtOAc, 2:1): 0.38.

*1-[5-Nitro-7-{4-(trifluoromethyl)phenylamino}indolin-1-yl]-ethanone (**5da**).* Yellow solid (67.2 mg, 92%); mp 133−134 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.43 (s, 1H), 8.14 (d, J = 1.4 Hz, 1H), 7.64 (d, J = 1.4 Hz, 1H), 7.50 (d, J = 8.3 Hz, 2H), 7.10 (d, J = 8.3 Hz, 2H), 4.23 (t, J = 8.0 Hz, 2H), 3.20 (t, J = 8.0 Hz, 2H), 2.38 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 170.2, 146.2, 145.2, 137.3, 137.1, 133.0, 127.2, 126.9, 126.8, 126.8, 126.8, 125.4, 123.6, 123.1, 122.9, 122.7, 122.5, 121.8, 116.9, 112.9, 112.3, 51.9, 28.9, 24.4; IR (diamond) 3204, 2924, 1651, 1604, 1579, 1516, 1406, 1311, 1250, 1180, 1111,

dx.doi.org/10.1021/jo5018475 | *J. Org. Chem.* 2014, 79, 12197−12204

1064 cm^{-1}; HRMS (EI) m/z calcd. for $C_{17}H_{14}F_3N_3O_3$ $[M]^+$: 365.0987, found: 365.0985; R_f (*n*-hexane/EtOAc, 2:1): 0.33.

*1-[5-Bromo-7-{4-(trifluoromethyl)phenylamino}indolin-1-yl]-ethanone (**5ea**).* Light brown solid (48.7 mg, 61%); mp 114−115 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.42 (s, 1H), 7.46 (d, J = 8.5 Hz, 2H), 7.38 (d, J = 1.6 Hz, 1H), 7.07 (d, J = 8.5 Hz, 2H), 6.96 (d, J = 1.6 Hz, 1H), 4.10 (t, J = 7.8 Hz, 2H), 3.08 (t, J = 7.8 Hz, 2H), 2.32 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.3, 145.8, 137.7, 133.7, 131.7, 127.3, 126.7, 126.7, 126.6, 126.6, 125.5, 123.7, 122.3, 122.0, 121.9, 121.8, 121.6, 120.5, 120.4, 119.2, 116.3, 51.6, 29.2, 24.2; IR (diamond) 3237, 2923, 1645, 1616, 1584, 1522, 1186, 1146, 1102, 1065, 941, 869 cm^{-1}; HRMS (EI) m/z calcd. for $C_{17}H_{14}BrF_3N_2O$ $[M]^+$: 398.0242, found: 398.0239; R_f (*n*-hexane/EtOAc, 2:1): 0.40.

*1-[7-{3,5-Bis(trifluoromethyl)phenylamino}indolin-1-yl]ethanone (**5ab**).* Beige solid (71.4 mg, 92%); mp 143−144 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.57 (s, 1H), 7.37 (s, 2H), 7.24−7.22 (m, 2H), 7.14 (dd, J = 7.2, 7.2 Hz, 1H), 6.93 (d, J = 7.2 Hz, 1H), 4.12 (t, J = 7.8 Hz, 2H), 3.13 (t, J = 7.8 Hz, 2H), 2.34 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.3, 145.2, 136.2, 133.0, 132.8, 132.5, 132.3, 132.1, 131.5, 126.7, 126.2, 124.4, 122.6, 120.8, 118.8, 118.5, 115.2, 115.2, 115.1, 112.1, 112.1, 112.1, 112.1, 112.0, 51.6, 29.3, 24.2; IR (diamond) 3243, 2977, 1640, 1599, 1417, 1274, 1169, 1123, 1109, 1011, 921, 762 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{14}F_6N_2O$ $[M]^+$: 388.1010, found: 388.1011; R_f (*n*-hexane/EtOAc, 5:1): 0.16.

*1-[7-(4-Nitrophenylamino)indolin-1-yl]ethanone (**5ac**).* Yellow solid (50.5 mg, 85%); mp 226−227 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.89 (s, 1H), 8.06 (d, J = 9.2 Hz, 2H), 7.29 (d, J = 7.9 Hz, 1H), 7.16 (dd, J = 7.9, 7.9 Hz, 1H), 6.98 (d, J = 7.9 Hz, 1H), 6.94 (d, J = 9.2 Hz, 2H), 4.14 (t, J = 7.8 Hz, 2H), 3.15 (t, J = 7.8 Hz, 2H), 2.35 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.4, 150.0, 139.2, 136.2, 133.7, 130.5, 126.5, 126.2, 120.3, 119.7, 113.7, 51.6, 29.3, 24.3; IR (diamond) 3176, 3121, 1633, 1583, 1476, 1301, 1241, 1103, 925, 839, 765, 747 cm^{-1}; HRMS (EI) m/z calcd. for $C_{16}H_{15}N_3O_3$ $[M]^+$: 297.1113, found: 297.1110; R_f (*n*-hexane/EtOAc, 1:1): 0.38.

*1-[7-{4-(Methoxycarbonyl)phenylamino}indolin-1-yl]ethanone (**5ad**).* White solid (60.2 mg, 97%); mp 146−147 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.44 (s, 1H), 7.87 (d, J = 8.7 Hz, 2H), 7.30 (dd, J = 8.1, 1.4 Hz, 1H), 7.10 (dd, J = 8.1, 8.1 Hz, 1H), 6.98 (d, J = 8.7 Hz, 2H), 6.88 (dd, J = 8.1, 1.4 Hz, 1H), 4.09 (t, J = 7.7 Hz, 2H), 3.85 (s, 3H), 3.09 (t, J = 7.7 Hz, 2H), 2.32 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.1, 167.1, 148.1, 135.9, 133.0, 131.9, 131.3, 126.4, 120.4, 119.3, 118.3, 114.6, 51.6, 51.6, 29.4, 24.3; IR (diamond) 3004, 2942, 1711, 1642, 1585, 1519, 1433, 1306, 1274, 1170, 1105, 786 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{18}N_2O_3$ $[M]^+$: 310.1317, found: 310.1314; R_f (*n*-hexane/EtOAc, 2:1): 0.27.

*1-[7-{4-(Methylsulfonyl)phenylamino}indolin-1-yl]ethanone (**5ae**).* Beige solid (56.8 mg, 86%); mp 186−187 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.62 (s, 1H), 7.69 (d, J = 8.8 Hz, 2H), 7.28 (d, J = 7.5 Hz, 1H), 7.13 (dd, J = 7.5, 7.5 Hz, 1H), 7.03 (d, J = 8.8 Hz, 2H), 6.94 (d, J = 7.5 Hz, 1H), 4.12 (t, J = 7.7 Hz, 2H), 3.13 (t, J = 7.7 Hz, 2H), 3.00 (s, 3H), 2.33 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 169.3, 148.8, 136.1, 133.4, 131.0, 129.2, 126.4, 119.7, 119.1, 114.6, 51.6, 44.9, 29.3, 24.3; IR (diamond) 3017, 2923, 1646, 1585, 1437, 1393, 1286, 1134, 1088, 956, 827, 765 cm^{-1}; HRMS (EI) m/z calcd. for $C_{17}H_{18}N_2O_3S$ $[M]^+$: 330.1038, found: 330.1037; R_f (*n*-hexane/EtOAc, 1:1): 0.15.

*1-[7-(4-Bromophenylamino)indolin-1-yl]ethanone (**5af**).* Brown solid (33.1 mg, 50%); mp 92−93 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 (s, 1H), 7.29 (d, J = 8.8 Hz, 2H), 7.18 (dd, J = 7.9, 1.3 Hz, 1H), 7.04 (dd, J = 7.9, 7.9 Hz, 1H), 6.92 (d, J = 8.8 Hz, 2H), 6.79 (dd, J = 7.9, 1.3 Hz, 1H), 4.08 (t, J = 7.7 Hz, 2H), 3.08 (t, J = 7.7 Hz, 2H), 2.32 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.9, 142.6, 135.7, 133.6, 132.0, 132.0, 126.4, 119.0, 117.2, 116.9, 111.8, 51.6, 29.4, 24.3; IR (diamond) 3188, 2925, 1641, 1583, 1473, 1444, 1409, 1303, 1177, 1071, 971, 815 cm^{-1}; HRMS (EI) m/z calcd. for $C_{16}H_{15}BrN_2O$ $[M]^+$: 330.0368, found: 330.0367; R_f (*n*-hexane/EtOAc, 3:1): 0.35.

*1-[7-(4-tert-Butylphenylamino)indolin-1-yl]ethanone (**5ag**).* White solid (23.4 mg, 38%); mp 131−132 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.25 (d, J = 8.6 Hz, 2H), 7.21 (dd, J = 8.0, 1.2 Hz, 1H), 7.02−6.99 (m, 3H), 6.74 (dd, J = 8.0, 1.2 Hz, 1H), 4.08 (t, J = 7.7 Hz, 2H), 3.07 (t, J = 7.7 Hz, 2H), 2.31 (s, 3H), 1.30 (s, 9H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.7, 143.4, 140.6, 135.5, 134.9, 131.4, 126.3, 126.0, 117.9, 116.7, 115.8, 51.6, 34.1, 31.5, 29.5, 24.2; IR (diamond) 3225, 2958, 1644, 1592, 1515, 1438, 1411, 1310, 1240, 1189, 1112, 825 cm^{-1}; HRMS (EI) m/z calcd. for $C_{20}H_{24}N_2O$ $[M]^+$: 308.1889, found: 308.1886; R_f (*n*-hexane/EtOAc, 2:1): 0.46.

Analytic data of C-7 amidated indoline products [**3aa**, **3da**−**3ha**, **3ab**−**3ae**] have been already reported.[11]

General Procedure for the C-7 Amination of *N*-Acetylindoline with Alkyl Azides. To a screw-capped vial with a spinvane triangular-shaped Teflon stir bar were added *N*-acetylindoline (**1a**, 32.2 mg, 0.2 mmol), alkyl azide (**6**, 0.3 mmol), $[IrCp^*Cl_2]_2$ (6.4 mg, 0.008 mmol, 4 mol %), $AgNTf_2$ (12.4 mg, 0.032 mmol, 16 mol %), NaOAc (4.9 mg, 0.06 mmol, 30 mol %), and 1,2-dichloroethane (0.5 mL) under atmospheric conditions. The reaction mixture was stirred in a preheated heating block at 50 °C for 12 h, filtered through a pad of Celite, and then washed with dichloromethane (10 mL × 3). Organic solvents were removed under reduced pressure, and the residue was purified by chromatography on silica gel (*n*-hexane/EtOAc or CH_2Cl_2/acetone) to give the desired product **7**.

*1-[7-{3,5-Bis(trifluoromethyl)benzylamino}indolin-1-yl]ethanone (**7aa**).* White solid (51.5 mg, 64%); mp 144−145 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.86 (s, 2H), 7.75 (s, 1H), 6.96 (dd, J = 7.9, 7.9 Hz, 1H), 6.85 (s, 1H), 6.63 (d, J = 7.9 Hz, 1H), 6.37 (d, J = 7.9 Hz, 1H), 4.52 (s, 2H), 4.08 (t, J = 7.8 Hz, 2H), 3.06 (t, J = 7.8 Hz, 2H), 2.33 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.3, 142.9, 138.2, 135.1, 132.0, 131.8, 131.6, 131.3, 129.3, 127.3, 127.3, 127.3, 127.2, 126.9, 126.1, 124.3, 122.5, 121.0, 121.0, 120.9, 120.9, 120.9, 120.7, 113.9, 111.4, 51.5, 47.0, 29.4, 24.4; IR (diamond) 3280, 3261, 1638, 1600, 1516, 1449, 1430, 1275, 1183, 1120, 873, 844 cm^{-1}; HRMS (EI) m/z calcd. for $C_{19}H_{16}F_6N_2O$ $[M]^+$: 402.1167, found: 402.1165; R_f (*n*-hexane/EtOAc, 3:1): 0.29.

*1-[7-(Phenethylamino)indolin-1-yl]ethanone (**7ab**).* Yellow oil (27.5 mg, 49%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.32−7.20 (m, 5H), 7.05−7.03 (m, 1H), 6.61−6.59 (m, 2H), 6.16 (s, 1H), 4.02 (t, J = 7.7 Hz, 2H), 3.38 (t, J = 7.9 Hz, 2H), 3.03−2.98 (m, 4H), 2.30 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 167.9, 139.9, 139.3, 134.9, 128.9, 128.7, 128.4, 126.9, 126.2, 113.0, 111.1, 51.6, 45.6, 36.0, 29.6, 24.4; IR (diamond) 3230, 3026, 2928, 1638, 1603, 1473, 1445, 1432, 1357, 1323, 1245, 1182 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{20}N_2O$ $[M]^+$: 280.1576, found: 280.1575; R_f (*n*-hexane/EtOAc, 3:1): 0.22.

*1-[7-{4-(Trifluoromethyl)phenethylamino}indolin-1-yl]ethanone (**7ac**).* Beige solid (43.9 mg, 63%); mp 99−100 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.55 (d, J = 7.9 Hz, 2H), 7.37 (d, J = 7.9 Hz, 2H), 7.04 (dd, J = 7.8, 7.8 Hz, 1H), 6.60 (d, J = 7.8 Hz, 1H), 6.60 (d, J = 7.8 Hz, 1H), 6.22 (s, 1H), 4.02 (t, J = 7.7 Hz, 2H), 3.40 (t, J = 7.7 Hz, 2H), 3.06−3.01 (m, 4H), 2.30 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 167.9, 144.1, 139.0, 135.0, 129.1, 129.0, 128.8, 128.6, 128.4, 128.2, 127.1, 126.9, 125.3, 125.3, 125.3, 125.3, 123.5, 121.7, 113.2, 111.1, 51.5, 45.0, 35.7, 29.5, 24.3; IR (diamond) 3192, 2930, 2855, 1642, 1604, 1408, 1322, 1159, 1111, 1065, 1039, 844 cm^{-1}; HRMS (EI) m/z calcd. for $C_{19}H_{19}F_3N_2O$ $[M]^+$: 348.1449, found: 348.1448; R_f (*n*-hexane/EtOAc, 2:1): 0.22.

*1-[7-(4-Nitrophenethylamino)indolin-1-yl]ethanone (**7ad**).* Yellow solid (44.9 mg, 69%); mp 117−118 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.15 (d, J = 8.6 Hz, 2H), 7.41 (d, J = 8.6 Hz, 2H), 7.05 (dd, J = 7.9, 7.9 Hz, 1H), 6.62 (d, J = 7.9 Hz, 1H), 6.58 (d, J = 7.9 Hz, 1H), 6.25 (s, 1H), 4.03 (t, J = 7.8 Hz, 2H), 3.43 (td, J = 7.4, 5.0 Hz, 2H), 3.09 (t, J = 7.4 Hz, 2H), 3.04 (t, J = 7.8 Hz, 2H), 2.30 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 168.0, 147.8, 146.6, 138.9, 135.0, 129.6, 129.0, 126.9, 123.6, 113.4, 111.0, 51.6, 44.6, 35.7, 29.5, 24.4; IR (diamond) 3184, 2927, 2846, 1629, 1601, 1510, 1401, 1339, 1182, 1127, 1106, 830 cm^{-1}; HRMS (EI) m/z calcd. for $C_{18}H_{19}N_3O_3$ $[M]^+$: 325.1426, found: 325.1425; R_f (CH_2Cl_2/acetone, 100:1): 0.72.

*1-[7-(4-Methoxyphenethylamino)indolin-1-yl]ethanone (**7ae**).* Yellow oil (26.7 mg, 43%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.19 (d, J = 8.4 Hz, 2H), 7.03 (m, 1H), 6.85 (d, J = 8.4 Hz, 2H), 6.60 (m, 2H), 6.14 (s, 1H), 4.02 (t, J = 7.7 Hz, 2H), 3.78 (s, 3H), 3.34 (t, J = 7.9 Hz, 2H), 3.02 (t, J = 7.7 Hz, 2H), 2.95−2.92 (m, 2H), 2.30 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 167.8, 158.1, 139.3, 134.8, 132.0,

dx.doi.org/10.1021/jo5018475 | J. Org. Chem. 2014, 79, 12197−12204

129.6, 128.9, 126.8, 113.9, 112.9, 111.1, 55.2, 51.5, 45.8, 35.1, 29.6, 24.3; IR (diamond) 3232, 2930, 2834, 1638, 1605, 1510, 1471, 1444, 1432, 1245, 1178, 1126 cm^{-1}; HRMS (EI) m/z calcd. for $C_{19}H_{22}N_2O_2$ $[M]^+$: 310.1681, found: 310.1678; R_f (CH_2Cl_2/acetone, 100:1): 0.78.

*1-[7-(3-Phenylpropylamino)indolin-1-yl]ethanone (**7af**).* White solid (24.1 mg, 41%); mp 112−113 °C; ^1H NMR (600 MHz, $CDCl_3$) δ 7.28−7.16 (m, 5H), 7.02 (dd, J = 7.9, 7.9 Hz, 1H), 6.58 (d, J = 7.9 Hz, 1H), 6.54 (d, J = 7.9 Hz, 1H), 6.13 (s, 1H), 4.02 (t, J = 7.7 Hz, 2H), 3.14 (t, J = 7.1 Hz, 2H), 3.02 (t, J = 7.7 Hz, 2H), 2.78 (t, J = 7.1 Hz, 2H), 2.30 (s, 3H), 2.02 (p, J = 7.2 Hz, 2H); $^{13}C\{^1H\}$ NMR (150 MHz, $CDCl_3$) δ 167.8, 142.0, 139.5, 134.8, 128.8, 128.5, 128.3, 126.8, 125.7, 112.8, 111.1, 51.6, 43.0, 33.5, 30.9, 29.6, 24.4; IR (diamond) 3221, 2933, 2918, 2821, 1626, 1601, 1579, 1480, 1431, 1377, 1126, 923 cm^{-1}; HRMS (EI) m/z calcd. for $C_{19}H_{22}N_2O$ $[M]^+$: 294.1732, found: 294.1729; R_f (n-hexane/EtOAc, 3:1): 0.33.

*1-[7-(4-Phenylbutylamino)indolin-1-yl]ethanone (**7ag**).* Yellow oil (24.1 mg, 39%); ^1H NMR (600 MHz, $CDCl_3$) δ 7.28−7.15 (m, 5H), 7.03 (m, 1H), 6.57 (m, 2H), 6.03 (s, 1H), 4.01 (t, J = 7.7 Hz, 2H), 3.14 (t, J = 6.8 Hz, 2H), 3.01 (t, J = 7.7 Hz, 2H), 2.67 (t, J = 7.4 Hz, 2H), 2.30 (s, 3H), 1.77 (ddddd, J = 17.1, 14.2, 12.0, 7.1, 3.3 Hz, 4H); $^{13}C\{^1H\}$ NMR (150 MHz, $CDCl_3$) δ 167.8, 142.4, 139.6, 134.8, 128.8, 128.4, 128.2, 126.8, 125.6, 112.7, 111.0, 51.5, 43.5, 35.7, 29.6, 29.1, 29.0, 24.4; IR (diamond) 3025, 2931, 2856, 1638, 1604, 1585, 1495, 1474, 1445, 1432, 1405, 1126 cm^{-1}; HRMS (EI) m/z calcd. for $C_{20}H_{24}N_2O$ $[M]^+$: 308.1889, found: 308.1886; R_f (n-hexane/EtOAc, 3:1): 0.28.

*1-[7-(Hexylamino)indolin-1-yl]ethanone (**7ah**).* White solid (18.2 mg, 35%); mp 64−65 °C; ^1H NMR (600 MHz, $CDCl_3$) δ 7.04 (dd, J = 7.7 Hz, 1H), 6.58 (d, J = 7.7 Hz, 2H), 6.01 (s, 1H), 4.03 (t, J = 7.7 Hz, 2H), 3.11 (t, J = 7.3 Hz, 2H), 3.02 (t, J = 7.7 Hz, 2H), 2.31 (s, 3H), 1.69 (p, J = 7.3 Hz, 2H), 1.44 (p, J = 7.1 Hz, 2H), 1.34−1.31 (m, 4H), 0.89 (t, J = 6.8 Hz, 3H); $^{13}C\{^1H\}$ NMR (150 MHz, $CDCl_3$) δ 167.8, 139.7, 134.7, 128.8, 126.8, 112.6, 111.1, 51.5, 43.8, 31.7, 29.6, 29.4, 27.1, 24.4, 22.6, 14.0; IR (diamond) 3219, 2953, 2921, 2845, 1630, 1602, 1582, 1435, 1408, 1318, 1247, 1160 cm^{-1}; HRMS (EI) m/z calcd. for $C_{16}H_{24}N_2O$ $[M]^+$: 260.1889, found: 260.1884; R_f (n-hexane/EtOAc, 3:1): 0.38.

Procedure for *N*-Boc Deprotection of 3ia. To a solution of the amidated product **3ia** (194.2 mg, 0.5 mmol) in dichloromethane (1.5 mL) was added dropwise trifluoroacetic acid (0.4 mL) at 0 °C under a N_2 atmosphere, and the mixture was allowed to stir for 30 min. After stirring for 6 h at room temperature, the reaction mixture was quenched with $NaHCO_3$ (5.0 mL). Water (30 mL) was added, and the crude mixture was extracted with CH_2Cl_2 (30 mL × 3), dried over $MgSO_4$, and evaporated under reduced pressure to afford the desired deprotected product **8** (122.6 mg, 85%).

Procedure for *N*-Cbz Deprotection of 3ja. To a solution of the amidated product **3ja** (126.7 mg, 0.3 mmol) in ethanol (1.4 mL) and dichloromethane (0.6 mL) was added Pd/C (3.2 mg, 10%, 10 mol %). The flask was purged with hydrogen gas for three times, and the reaction mixture was allowed to stir for 6 h at room temperature under a H_2 atmosphere. The crude product was filtered through a pad of Celite and then washed with dichloromethane (30 mL × 3). Organic solvents were removed under reduced pressure to afford the desired deprotected product **8** (82.2 mg, 95%).

*N-(Indolin-7-yl)-4-methylbenzenesulfonamide (**8**).* White solid; mp 193−194 °C; ^1H NMR (600 MHz, DMSO-d_6) δ 9.27 (s, 1H), 7.60 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 8.2 Hz, 2H), 6.81 (d, J = 7.8 Hz, 1H), 6.60 (d, J = 7.8 Hz, 1H), 6.38 (dd, J = 7.8, 7.8 Hz, 1H), 5.05 (s, 1H), 3.36 (t, J = 8.6 Hz, 2H), 2.86 (t, J = 8.6 Hz, 2H), 2.34 (s, 3H); $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6) δ 146.9, 143.3, 137.7, 130.7, 129.9, 127.2, 122.9, 122.3, 119.1, 117.7, 46.8, 29.9, 21.4; IR (diamond) 3346, 3335, 2956, 2702, 1480, 1399, 1335, 1302, 1244, 1203, 1149, 1034 cm^{-1}; HRMS (EI) m/z calcd. for $C_{15}H_{16}N_2O_2S$ $[M]^+$: 288.0932, found: 288.0929.

Preparation of Iridacycle 9. A solution of $[IrCp^*Cl_2]_2$ (298.8 mg, 0.375 mmol), *N*-acetylindoline (120.9 mg, 0.75 mmol), silver trifluoroacetate (165.7 mg, 0.75 mmol), and lithium carbonate (55.4 mg, 0.75 mmol) in 1,2-dichloroethane (15 mL) was allowed to stir for 12 h at room temperature under an argon atmosphere. Silver trifluoroacetate (165.7 mg, 0.75 mmol) was added, and the reaction mixture was stirred for an additional 12 h at room temperature, filtered through a pad of Celite with dichloromethane (30 mL), and concentrated under reduced pressure. A mixture of *n*-hexane and EtOAc (5 mL, *n*-hexane:EtOAc = 2:1) was added to the crude product, and the resulting yellow precipitate was collected by careful filtration and washed with a small amount of *n*-hexane/EtOAc mixture (10 mL, *n*-hexane:EtOAc = 2:1). The precipitate was dried under the reduced pressure to give the desired product as a yellow solid (**9**): yellow solid (90.1 mg, 20%); mp 191−192 °C; ^1H NMR (600 MHz, $CDCl_3$) δ 7.82 (dd, J = 7.4, 1.4 Hz, 1H), 6.89 (dd, J = 7.4 Hz, 1H), 6.81 (dd, J = 7.4, 1.4 Hz, 1H), 3.94 (t, J = 8.2 Hz, 2H), 3.08 (t, J = 8.2 Hz, 2H), 2.27 (s, 3H), 1.59 (s, 15H); $^{13}C\{^1H\}$ NMR (150 MHz, $CDCl_3$) δ 164.0, 162.1, 161.8, 161.6, 161.4, 138.8, 138.0, 135.7, 127.2, 125.3, 119.3, 118.4, 116.5, 114.5, 112.6, 85.6, 49.2, 27.7, 23.1, 9.1; $^{19}F\{^1H\}$ NMR (375 MHz, $CDCl_3$) δ −74.5; IR (diamond) 3048, 2967, 2918, 1704, 1693, 1599, 1555, 1475, 1191, 1132, 1031, 838 cm^{-1}; HRMS (ESI) m/z calcd. for $C_{22}H_{25}F_3IrNO_3$ $[M - CF_3CO_2^-]^+$: 488.1560, found:488.1563.

Stoichiometric Reaction of Iridacycle 9 with Sulfonyl Azide 2a. To a screw-capped vial with a spinvane triangular-shaped Teflon stir bar were added the iridacyclic complex (**9**, 60.1 mg, 0.1 mmol), *p*-toluenesulfonyl azide (**2a**, 22.5 μL, 0.15 mmol), and 1,2-dichloroethane (0.3 mL) under atmospheric conditions. The reaction mixture was stirred at 25 °C for 12 h and filtered through a pad of Celite with dichloromethane (10 mL × 3), and organic solvents were removed under reduced pressure. CH_2Cl_2 (5 mL) and 5 N HCl (2 mL) were added to the crude mixture and allowed to stir at room temperature for 12 h and then neutralized by saturated aqueous $NaHCO_3$ solution and water. The crude mixture was extracted with CH_2Cl_2 (10 mL × 3), dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography with *n*-hexane/EtOAc (2:1) as an eluent to give the desired product **3aa**.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

Copies of ^1H and ^{13}C NMR spectra data for all compounds. This material is available free of charge via the Internet at http://pubs.acs.org.

■ AUTHOR INFORMATION

Corresponding Author

*E-mail: sbchang@kaist.ac.kr (S.C.).

Notes

The authors declare no competing financial interest.

■ ACKNOWLEDGMENTS

This research was supported by the Institute for Basic Science (IBS). We thank Mr. Hyunggeun Lim for helpful discussions.

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