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Gold-Catalyzed Hydroarylation of *N*-Aryl Alkynamides for the Synthesis of 2-Quinolinones

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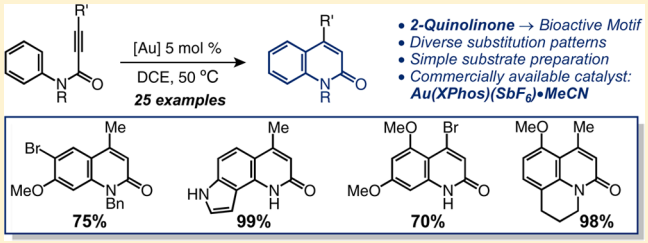
Supporting Information

ABSTRACT: A mild method for the synthesis of 2-quinolinones via hydroarylation of *N*-aryl alkynamides is reported. While traditional methods have relied on the use of strong Brønsted or Lewis acids, this report describes the development of mild reaction conditions that yield 2-quinolinones in good to excellent yield using a commercially available gold catalyst. Substrates bearing a variety of functional groups are presented, with *N*-substitution proving to be key to the reactivity of several substrates.



INTRODUCTION

The intramolecular coupling of arenes with C−C π-bonds is a versatile approach to the synthesis of a wide array of heterocyclic compounds. Depending on the nature of the cyclization substrate, various mechanisms can be engaged leading to significant structural variation from comparatively similar compounds. For example, *ortho*-halogenated arenes (**1**, Figure 1) have been reported to yield 5-*exo*-cyclization

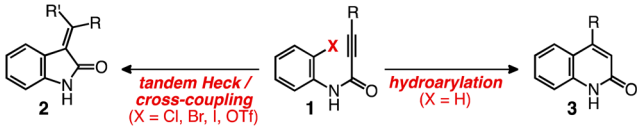


Figure 1. Divergent cyclizations of *N*-aryl alkynamides.

products (**2**) under palladium catalysis via carbopalladation of the alkyne π-bond followed by reaction with a coupling partner.[1,2] Several reports have also been published that describe palladium-catalyzed 5-*exo*-cyclization processes where the *ortho* position is a hydrogen.[3] Alternatively, under Lewis acidic conditions, the nonhalogenated compounds favor 6-*endo*-cyclization, particularly when electronically biased alkyne coupling partners are employed (i.e., α,β-unsaturated carbonyl compounds) (**1** → **3**).[4]

Aryl alkynoate esters have been widely studied in the latter context and have been shown to afford coumarins under a number of Lewis acidic reaction conditions.[5] Surprisingly, far fewer investigations of *N*-aryl alkynamide hydroarylation (**1** → **3**) have been reported, despite the value of the resulting 2-quinolinone products in medicinal chemistry (Figure 2).[6,7] The majority of methods disclosed rely on stoichiometric or superstoichiometric amounts of highly Brønsted or Lewis acidic promoters.[4]

In regards to the use of mild Lewis acids for the hydroarylation of *N*-aryl alkynamides, Tanaka and co-workers

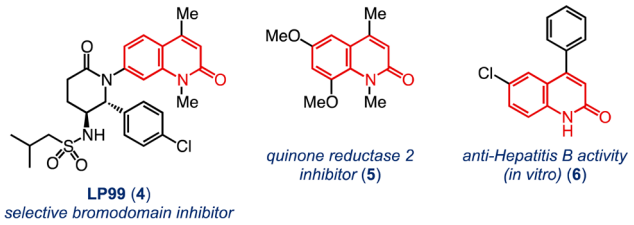


Figure 2. Representative bioactive 2-quinolinones.

have published two catalytic systems employing palladium[7a] and gold[7b] precatalysts in conjunction with chiral ligands. However, these reports focused solely on the enantioselective synthesis of axially chiral 4-naphthyl-2-quinolinones products. Here we report the development of a general and catalytic method for the hydroarylation of *N*-aryl alkynamides, with good functional group tolerance. This approach grants access to an array of 2-quinolinones under mild reactions conditions, with substitution on the amide nitrogen playing a key role in modulating substrate reactivity.

RESULTS AND DISCUSSION

We began our investigation into potential catalysts by screening an array of gold complexes along with silver salt activators that have been demonstrated to catalyze the activation of alkynes toward nucleophiles.[8] The use of 5 mol % of $Au(PPh_3)Cl$ as a precatalyst in 1,2-dichloroethane (DCE, 0.1 M) at 50 °C activated by 5 mol % AgOTf led to a modest 59% yield of the 2-quinoline product **8a** (entry 1, Table 1). Evaluation of alternative silver salt activators revealed a significant counterion effect, with $AgN(Tf)_2$ delivering an 80% yield of **8a** (entry 4). We next examined alternative gold(I) complexes with $AgN(Tf)_2$ as the optimized activator (entries 5−9) and found

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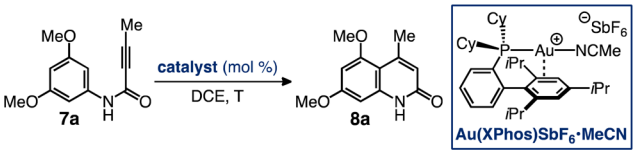
Table 1. Optimization of *N*-Aryl Alkynamides Hydroarylation Conditions



entry[a]	catalyst (mol %)	activator (mol %)	T (°C)	time	% yield[b]
1	$Au(PPh_3)Cl$ (5)	AgOTf (5)	50	20 h	59
2	$Au(PPh_3)Cl$ (5)	$AgSbF_6$ (5)	50	20 h	65
3	$Au(PPh_3)Cl$ (5)	$AgBF_4$ (5)	50	20 h	77
4	$Au(PPh_3)Cl$ (5)	$AgN(Tf)_2$ (5)	50	20 h	80
5	$Au((p\text{-}CF_3Ph)_3P)Cl$ (5)	$AgN(Tf)_2$ (5)	50	20 h	73
6	$Au(PtBu_3)Cl$ (5)	$AgN(Tf)_2$ (5)	50	20 h	80
7	Au(IPr)Cl (5)	$AgN(Tf)_2$ (5)	50	20 h	32
8	$(dppm)(AuCl)_2$ (5)	$AgN(Tf)_2$ (5)	50	20 h	13
9	Au(XPhos)Cl (5)	$AgN(Tf)_2$ (5)	50	1 h[c]	96
10	Au(XPhos)SbF_6·MeCN (5)	---	50	1 h[c]	>99
11	Au(XPhos)SbF_6·MeCN (5)	---	23	2 h[c]	>99
12	**Au(XPhos)SbF_6·MeCN (2.5)**	---	**23**	**4 h[c]**	**>99**

[a]All reactions were stirred at 50 °C and analyzed after 20 h unless otherwise noted. [b]Isolated yields. [c]Monitored by TLC to determine actual reaction end point.

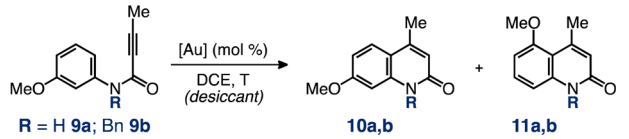
Au(XPhos)Cl to be a far superior precatalyst providing a 96% yield of the **8a** after 1 h at 50 °C. Moreover, the commercially available preactivated air-stable complex Au(XPhos)(SbF_6)·MeCN was even more effective, affording **8a** in a quantitative yield in 4 h at room temperature with catalyst loadings as low as 2.5 mol % (entries 10−12).

Our initial probe of the substrate scope began by subjecting *N*-aryl alkynamide **9a** to our optimized reaction conditions: 2.5 mol % of Au(XPhos)(SbF_6)·MeCN in DCE (0.1 M) at room temperature. While we suspected the absence of a second activating group on the arene might decrease the reactivity of this substrate in comparison to **8a**, we were surprised by the magnitude of the decrease with the regioisomeric products **10a** and **11a** being formed in a combined 13% yield and 73% of the starting amide being recovered (Table 2, entry 1). Increases in reaction temperature to 50 and 80 °C, along with increased catalyst loadings of 5% and 10%, failed to deliver the products in greater than 47% combined yield (entry 8; 10 mol % at 80 °C).

The poor mass recovery of many of these reactions, particularly entries 3−8, prompted a closer examination of the crude reaction mixtures by GC-MS and ^{1}H NMR, which revealed significant amide hydrolysis, especially in the reactions conducted above room temperature. In order to combat hydrolysis, several reactions were conducted employing 10 mol % catalyst at 80 °C in the presence of drying agents: 4 Å molecular sieves, $MgSO_4$, and Na_2SO_4 (Table 2, entries 9−11). While all of these reactions led to higher yields of the product mixture, the use of 4 Å molecular sieves was most promising, affording not only the highest yield (64%) for the reaction of **9a** but also an excellent mass recovery of 97%. Thus, it would appear that for substrates with minimally activated arenes the rate of cyclization decreases allowing the rate of hydrolysis to become competitive, which leads to significant cleavage of the amide bond of the substrate.

With the issue of substrate decomposition in mind, we sought to slow the rate of hydrolysis by adding a second substituent to the amide nitrogen. We expected that conversion to the tertiary amide would both increase the steric environment around the amide carbonyl, thereby impeding nucleophilic addition to the carbonyl, while also decreasing the electrophilicity of the carbonyl carbon due to the increased electron donating ability of the disubstituted nitrogen.

Table 2. Effect of *N*-Substitution on Reactivity



entry[a]	R-group	[Au] (mol %)	T (°C)	% yield (**10** : **11**)[b]	% recov. **9**
1	H	2.5%	23	13 (1.7 : 1.0)	73
2	H	2.5%	50	16 (1.8 : 1.0)	63
3	H	2.5%	80	42 (1.8 : 1.0)	23
4	H	5%	50	20 (2.0 : 1.0)	36
5	H	5%	80	42 (2.0 : 1.0)	10
6	H	10%	23	15 (2.0 : 1.0)	35
7	H	10%	50	27 (2.0 : 1.0)	14
8	H	10%	80	47 (2.0 : 1.0)	0
9	**H**	**10% + 4Å MS**	**80**	**64 (1.9 : 1.0)**	**33**
10	H	10% + $MgSO_4$	80	52 (2.0 : 1.0)	0
11	H	10% + Na_2SO_4	80	55 (2.0 : 1.0)	0
12	Bn	5%	80	92 (1.7 : 1.0)	0
13	Bn	5%	50	87 (1.7 : 1.0)	0
14	**Bn**	**5%**	**23**	**87 (1.7 : 1.0)**	**0**
15[c]	Bn	5%	-12	42 (1.9 : 1.0)	52

[a]All reactions were run with Au(XPhos)SbF_6·MeCN and analyzed after 20 h. [b]^{1}H NMR yields determined using dibenzyl ether as an external standard. [c]Reaction run for 40 h.

The *N*-benzyl derivative **9b** was prepared and subjected to 5 mol % of catalyst at 80 °C. The impact of *N*-substitution was dramatic. The *N*-substituted 2-quinolinone products **10b** and **11b** were isolated in a combined 92% yield (Table 2, entry 12). Further analysis of the reaction parameters revealed a return to the original optimized conditions of 5 mol % Au(XPhos)-(SbF_6)·MeCN in DCE at room temperature, which afforded **10b** and **11b** in 87% (entry 14). In an attempt to improve the regioselectivity of the transformation we ran the reaction of **9b** at −12 °C. After 36 h the progress of the reaction stalled at 48% conversion, with only a minor improvement in selectivity from 1.7:1.0 (**10b**:**11b**) at room temperature to 1.9:1.0 at −12 °C (entry 15). From these collective investigations of reaction conditions we concluded that *secondary amide substrates require a highly activated arene for the rate of hydroarylation to exceed that of hydrolysis, while tertiary amides provide a higher barrier to hydrolysis thus favoring the desired cyclization pathway.*

In addition to the impact on substrate reactivity, substitution on the amide nitrogen provides an additional point of functionalization allowing for greater variation in the target 2-quinolinone products. To further investigate the tolerance for *N*-substitution, we prepared a series of substrates represented by the general structure **9** (Figure 3) bearing a selection of *N*-substituents. The reaction of the *N*-cinnamyl substrate **9d** was particularly interesting given the absolute selectivity exhibited for alkyne activation over the alkene. Moreover, the allyl group present in products **10d** and **11d** provides a handle from which an array of potential derivatives could be prepared.

The rate enhancement and increase in yield observed for the reaction of benzylated substrate **9b** proved to be a general pattern for all *N*-substituted amides. While the regioselectivities for these substrates were minimal, in all cases the regioisomers were easily separable by column chromatography.

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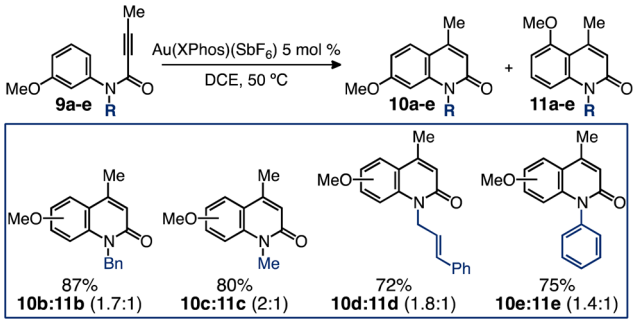


Figure 3. Investigation of *N*-substituted substrates.

We next investigated the effect of substitution at the alkynyl position of the amide substrates (Figure 4). Given the preparation of our substrates from alkynoic acids, alternate substituents can be introduced at the 4-position of the product simply by varying the alkynoic acid coupling partner or by functionalization of the terminal alkynyl amide substrate **7b** (R = H). For example **7c** (R = Ph) was prepared by acylation with phenylpropiolic acid, while selective *β*-bromination of **7b** with NBS and $AgNO_3$ afforded **7d** (R = Br). All of the substrates in the series performed well, giving modest yields of the 2-quinolinones. The cyclization of the *β*-phenyl substrate **7c** is particularly interesting given the significant steric crowding between the phenyl ring and 5-methoxy group in the product **8c**.

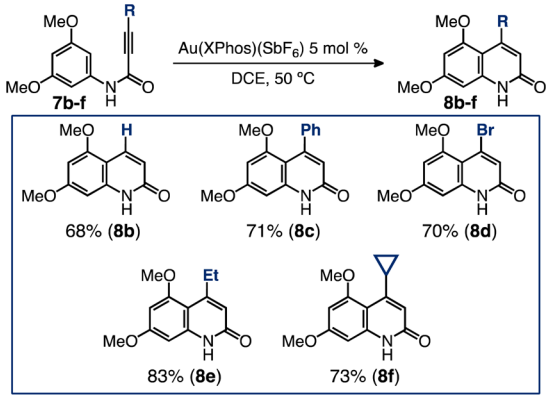
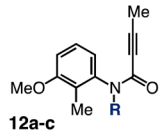
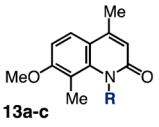
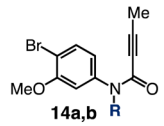
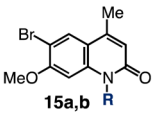
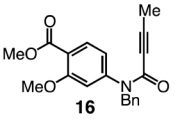
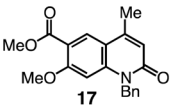
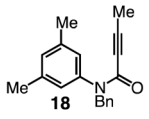
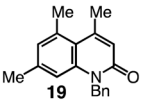
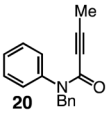
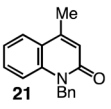
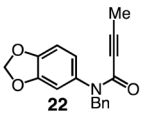
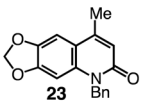
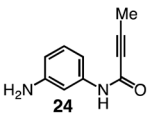
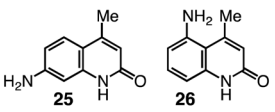
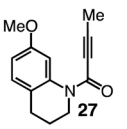
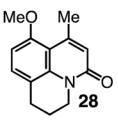


Figure 4. Investigation of alkynyl substitution.

Our final investigation of substrate scope explored variations around the aromatic ring of the substrate, with probes into the steric and electronic allowances of the transformation (Table 3). The *ortho*-methylated substrates **12a–c** furnished the corresponding 2-quinolinones in good yields, with significant variability depending on the nature of the *N*-substituent. The presence of the *ortho*-methyl group was not entirely benign as substrate **12c** (R = Bn) furnished a 75% yield of the product, while the non-*ortho*-methylated analog **9a** gave an 87% yield under identical reaction conditions.

Substrates **14a**, **14b**, and **16** probed the electronics of the substrates by introducing deactivating groups, bromine and methyl ester, *para* to the amide nitrogen. The reactions of substrates **14a** and **14b** were particularly interesting in that the effect of *N*-substitution on the product yields was highly significant. After 24 h at 80 °C the nonsubstituted substrate **14a** failed to go to completion, delivering the product **15a** in 19% yield, with significant hydrolysis of the starting amide also being

Table 3. Substitution on the Aromatic Ring

entry[a]	substrate	product(s)	yield
1	 12a-c	 13a-c	R = H, 65% (**13a**)[b] R = Me, 69% (**13b**) R = Bn, 75% (**13c**)
2	 14a,b	 15a,b	R = H, 19% (**15a**)[b] R = Bn, 75% (**15b**)
3	 16	 17	66%
4	 18	 19	96%
5	 20	 21	38%
6	 22	 23	58%
7	 24	 25 26	86% **25**:**26** (7:1)
8	 27	 28	98%

[a]All reactions conducted at 50 °C in DCE (0.1 M) with 5 mol % Au(XPhos)SbF_6·MeCN unless otherwise noted. [b]Reaction conducted at 80 °C with 4 Å molecular sieves.

observed. The *N*-benzyl analog **14b**, however, afforded **15b** in 75% yield after only 8 h at 50 °C.

Substrate **18** replaced the strong donating methoxy groups for significantly weaker methyl groups, while **20** removed all substituents. To our surprise both substrates afforded the target products. While the yield of **21** was low, 38%, the fact that the substrate reacted to such a significant degree is a reflection of the high reactivity of the catalyst. The electron-rich substrates **22** and **24** both proved highly regioselective, with **22** curiously affording only a single regioisomer. It should also be noted that the successful cyclization of **24** was not obvious from the outset, as the primary amino group could serve as a competing ligand for the gold center, which could in turn deactivate the catalyst.

The cyclization of a selection of nonaniline derived substrates provided an expansion of the utility of the transformation (Table 4). Many of these compounds exhibited greater fluorescence than the products discussed in Table 3. In fact, the non-*N*-benzyl analogs of compounds **30** and **32** have been previously studied for their photophysical properties,[9] along

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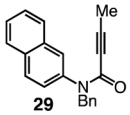
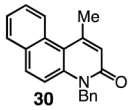
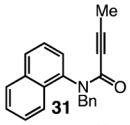
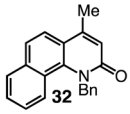
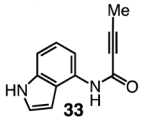
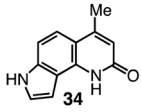
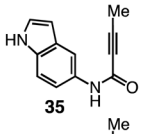
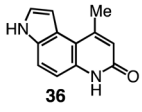
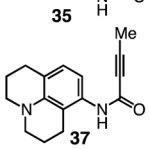
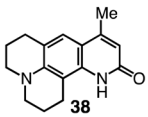
Table 4. Non-aniline Derived Substrates

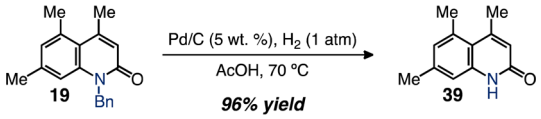
entry[a]	substrate	product(s)	yield
1			23 °C: 74% 50 °C: 76%
2			50 °C: 98%
3			50 °C: 99%
4			50 °C: 97%
5			23 °C: 72% 50 °C: 78%

[a]All reactions conducted in DCE (0.1 M) with 5 mol % Au(XPhos)SbF_6·MeCN.

with the 7-amino-2-quinolinone **25**, which is marketed as the fluorescent laser dye carbostyril 124.

While the introduction of the benzyl group onto the nitrogen of the substrates had a significant effect on both the yield and rate of several reactions above, the requirement for such a group limited the pool of accessible 2-quinilinones. To resolve this issue we sought to develop conditions to debenzylate the amide nitrogen and reveal the secondary amide products. Under 1 atm of hydrogen gas in neat acetic acid we found we could debenzylate 2-quinolinone **19** with Pd/C after 5 h at 70 °C (Scheme 1). Following filtration through Celite and neutralization of the solution, pure product **39** was isolated in 96% yield.

Scheme 1. Debenzylation of *N*-Benzyl-2-quinolinones



CONCLUSION

In summary, we have identified the commercially available complex Au(XPhos)SbF_6·MeCN as a highly efficient catalyst for the hydroarylation of *N*-aryl alkynamides to yield 2-quinolinones. Employing catalyst loadings as low as 2.5 mol % at 50 °C, or room temperature in some cases, an array of substrates were cyclized exhibiting both electron-donating and -withdrawing groups, as well as *ortho*-substituents. For secondary amide substrates, with an arene of low to moderate nucleophilicity, hydrolysis of the amide bond provided to be a competing process. Tertiary amides, however, exhibited excellent reactivity and provided significantly higher yields of the tertiary amide analogs. Moreover, the nature of the additional *N*-substituent appeared to have little impact on the success of the reaction, with a range of groups being tolerated.

EXPERIMENTAL SECTION

General Comments. All manipulations of air and/or water sensitive compounds were performed using standard Schlenk techniques. Nitrogen was purified by passage through Drierite. Nuclear Magnetic Resonance spectra were recorded at 300 K on a 300 MHz Fourier transform spectrometer. ^{1}H NMR spectra recorded in $CDCl_3$ were referenced to TMS (0.00 ppm). Spectra in DMSO-d_6 were referenced to the solvent residual peak (2.50 ppm). ^{13}C NMR recorded in $CDCl_3$ or DMSO-d_6 were referenced to the residual solvent peak (77.16 and 39.52 ppm respectively). Manual flash column chromatography was conducted on SILICYCLE silica gel (230−400 mesh). Automated flash column chromatography was conducted using RediSep Rf normal-phase silica flash columns. Mass spectra were recorded on a Q-TOF ESI spectrometer. Reactions were monitored by TLC analysis using EtOAc/hexanes and/or Et_2O/hexanes mixtures as the eluent and visualized using UV light followed by potassium permanganate stain and/or ceric ammonium molybdate stain.

Part 1. General Procedures for *N*-Aryl Alkynamide Substrate Synthesis. *General Procedures for the Reductive Amination of Aniline Derivatives.* Following a literature procedure,[10] to a solution of amine (1 equiv) in DCM (0.5 M) was added AcOH (1.1 equiv), followed by benzaldehyde (1.1 equiv). The mixture was cooled to 0 °C and $NaBH(OAc)_3$ (1.5 equiv) was added portionwise. The resulting solution was stirred at room temperature and monitored by TLC. Upon complete consumption of the aniline the mixture was diluted with one volume of DCM and washed with NaOH aq. (1 M). The organic layer was dried over $MgSO_4$ and concentrated to afford the benzyl amine derivative. Yields were typically near quantitative and the product thus isolated was pure enough for use in the subsequent acylation reaction without further purification.

General Procedures for the Acylation of Aniline Derivatives with Alkynoic Acids. Acylation Method A. To a solution of alkynoic acid (1.5 equiv) in THF (0.2 M) was added $SOCl_2$ (1.5 equiv) in one portion, followed by five drops of DMF. The resulting solution was stirred at room temperature for 40 min. The mixture was then cooled to 0 °C in an ice−water bath and *N*,*N*-diisopropylethylamine (3 equiv) was added, followed by the requisite aniline derivative (1 equiv). The reaction mixture was allowed to slowly warm to room temperature. Upon consumption of the starting material as determined by TLC, the reaction mixture was poured into a separatory funnel and diluted with 4 volumes of water. The solution was extracted three times with EtOAc. The combined extracts were then washed with 10% HCl (aq.), saturated $NaHCO_3$ (aq.), and brine. The organic layer was dried over $MgSO_4$, filtered through a fritted funnel, and concentrated by rotary evaporation to yield the amide. In several instances ^{1}H NMR revealed the product to be pure. Otherwise the impure amide was purified via column chromatography on silica gel eluting with ethyl acetate and hexanes.

Acylation Method B. To a solution of alkynoic acid (1.5 equiv) in ethyl acetate (0.8 M) was added *N*-methyl morpholine (1.5 equiv), followed by slow addition of isopropyl chloroformate (1.0 M solution in toluene, 1.5 equiv). The resulting mixture was stirred at room temperature for 30 min. The mixture was then filtered to remove the precipitated ammonium salt, and the filtrate was concentrated to yield the mixed carbonic acid anhydride as a golden oil. The oil was dissolved in DMF (2.0 M) and added slowly to a solution of the appropriate amine (1.0 equiv) in DMF (0.5 M) at room temperature. The reaction is monitored by GC-MS. After complete consumption of the aniline was observed the mixture was poured into 5 volumes of water and extracted three times with ethyl acetate. The combined organic layers were then washed with 10% HCl (aq), followed by saturated $NaHCO_3$ (aq), and last dried over $MgSO_4$. The mixture was filtered, and the filtrate was concentrated to yield the crude amide. In many instances ^{1}H NMR revealed the product to be pure. Otherwise the impure amide was purified via column chromatography on silica gel eluting with ethyl acetate and hexanes.

Part 2. Synthesis and Characterization of *N*-Aryl Alkynamide Substrates. *N-(3,5-Dimethoxyphenyl)but-2-ynamide (**7a**).* Acylation method A was followed using 2-butynoic acid and 3,5-dimethoxyaniline (5 mmol). Extractive workup afforded pure amide

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7a (832 mg, 76%) as an amorphous beige solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.33 (bs, 1H), 6.73 (d, J = 2.1 Hz, 2H), 6.25 (t, J = 2.1 Hz, 1H), 3.78 (s, 6H), 2.00 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.1, 151.2, 139.3, 98.3, 97.2, 84.6, 75.5, 55.5, 3.9; FT-IR (cm^{-1}) 3285, 3163, 3146, 3003, 2962, 2918, 2847, 2233, 1651, 1614, 1553, 1456, 1421, 1283, 1265, 1205, 1153, 1065, 843; HRMS (ES+) m/z calcd for $C_{12}H_{14}NO_3$ $[M + H]^+$ 220.0974, found 220.0978.

*N-(3,5-Dimethoxyphenyl)prop-2-ynamide (**7b**).* A previously reported procedure was followed.[11] To a solution of propiolic acid (1.2 equiv) in dichloromethane (DCM, 0.25 M) cooled to 0 °C in an ice−water bath was added diisopropylcarbodiimide (1.5 equiv). The solution was stirred for 5 min at 0 °C, after which 3,5-dimethoxyaniline (6 mmol, 1 equiv) was added, followed by a solution of 4-(dimethylamino)pyridine in DCM (10 mol %, 0.5 M). The reaction mixture was allowed to warm slowly to room temperature. Upon consumption of the starting material as determined by TLC, the reaction mixture was passed through a pad of Celite, which was washed with a minimal amount of EtOAc. The filtrate was concentrated by rotary evaporation, and the resulting residue was purified by flash column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40% to afford amide **7b** (324 mg, 26%) as an amorphous pale yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.53 (bs, 1H), 6.74 (d, J = 2.4 Hz, 2H), 6.27 (t, J = 2.1 Hz, 1H), 3.78 (s, 6H), 2.92 (s, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.3, 138.8, 98.5, 97.7, 77.8, 74.2, 55.6; FT-IR (cm^{-1}) 3298, 3277, 3246, 2993, 2912, 2849, 2363, 2112, 1655, 1601, 1549, 1460, 1420, 1263, 1238, 1209, 1198, 1165, 1149, 1072, 1063, 968; HRMS (ES+) m/z calcd for $C_{11}H_{12}NO_3$ $[M + H]^+$ 206.0817, found 206.0822.

*N-(3,5-Dimethoxyphenyl)-3-phenylprop-2-ynamide (**7c**).* Acylation method A was followed using phenylpropiolic acid and 3,5-dimethoxyaniline (5 mmol). Extractive workup afforded pure amide **7c** (1.22 g, 87%) as an amorphous beige solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.58 (d, J = 6.9 Hz, 2H), 7.50−7.39 (m, 4H), 6.80 (d, J = 2.1 Hz, 2H), 6.28 (s, 1H), 3.80 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.2, 151.2, 139.2, 132.8, 130.5, 128.7, 120.0, 98.4, 97.4, 85.9, 83.6, 55.6; FT-IR (cm^{-1}) 3276, 3148, 3062, 3002, 2959, 2938, 2840, 2210, 1832, 1774, 1609, 1555, 1482, 1455, 1424, 1343, 1300, 1208, 1158, 1069, 1027, 961, 923, 838, 757, 730, 688; HRMS (ES+) m/z calcd for $C_{17}H_{16}NO_3$ $[M + H]^+$ 282.1130, found 282.1133.

*3-Bromo-N-(3,5-dimethoxyphenyl)propiolamide (**7d**).* Following a literature procedure for terminal alkyne bromination,[12] amide **7b** (103 mg, 0.5 mmol, 1 equiv) was weighed into a 20 mL vial and dissolved in acetone (12.5 mL). $AgNO_3$ (43 mg, 0.25 mmol, 0.5 equiv) was added, and the mixture was stirred for 5 min at room temperature. The vial was then cooled to 0 °C, and NBS (94 mg, 0.525 mmol, 1.05 equiv) was added. The vial was wrapped in foil and stirred in the dark for 2 h at 0 °C. The resulting heterogeneous mixture was filtered through Celite, and the filtrate was concentrated onto Celite and purified via automated flash column chromatography eluting with a gradient of EtOAc/Hex 0−30%. The product **7d** (69 mg, 49%) was isolated as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.65 (bs, 1H), 6.74 (s, 2H), 6.26 (s, 1H), 3.77 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.2, 149.5, 138.8, 98.5, 97.6, 75.7, 55.6, 52.0; FT-IR (cm^{-1}) 3295, 2975, 2917, 2852, 1665, 1624, 1596, 1536, 1466, 1440, 1403, 1391, 1366, 1277, 1230, 1212, 1169, 1144, 976, 848, 818, 766; HRMS (ES+) m/z calcd for $C_{11}H_{11}BrNO_3$ $[M + H]^+$ 283.9922, found 283.9927.

*N-(3,5-Dimethoxyphenyl)pent-2-ynamide (**7e**).* Acylation method A was followed using 2-pentynoic acid and 3,5-dimethoxyaniline (3 mmol). Extractive workup afforded pure amide **7e** (552 mg, 79%) as a viscous syrup that solidified after 12 h at −10 °C. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.40 (bs, 1H), 6.74 (d, J = 2.1 Hz, 2H), 6.25 (t, J = 2.1 Hz, 1H), 3.78 (s, 6H), 2.35 (quart, J = 7.5 Hz, 2H), 1.22 (t, J = 7.5 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.2, 151.2, 139.3, 98.3, 97.2, 89.8, 75.6, 55.6, 12.9, 12.6; FT-IR (cm^{-1}) 3271, 3097, 3065, 2978, 2939, 2839, 2230, 1640, 1611, 1550, 1453, 1418, 1273, 1202, 1153, 1070; HRMS (ES+) m/z calcd for $C_{13}H_{16}NO_3$ $[M + H]^+$ 233.1052, found 233.1054.

*3-Cyclopropyl-N-(3,5-dimethoxyphenyl)propiolamide (**7f**).* Acylation method A was followed using 3-cyclopropylpropiolic acid and 3,5-dimethoxyaniline (3 mmol). Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40%, afforded pure amide **7f** (618 mg, 84%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.90 (bs, 1H), 6.77 (s, 2H), 6.23 (s, 1H), 3.75 (s, 6H), 1.33 (broad multiplet, 1H), 0.90−0.87 (broad multiplet, 4H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.0, 151.4, 139.4, 98.3, 97.0, 92.3, 71.3, 55.5, 9.1, −0.6; FT-IR (cm^{-1}) 3278, 3094, 3004, 2958, 2938, 2839, 2224, 1614, 1550, 1456, 1421, 1279, 1195, 1153, 1066; HRMS (ES+) m/z calcd for $C_{14}H_{16}NO_3$ $[M + H]^+$ 245.1052, found 245.1052.

*N-(3-Methoxyphenyl)but-2-ynamide (**9a**).* Acylation method A was followed using 2-butynoic acid and *m*-anisidine (5 mmol). Extractive workup afforded pure amide **9a** (841 mg, 89%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.35 (bs, 1H), 7.26−7.19 (m, 2H, partly obscured by residual solvent peak), 6.97 (d, J = 8.1 Hz, 1H), 6.68 (dd, J = 8.4 Hz, J = 2.1 Hz, 1H), 3.80 (s, 3H), 2.01 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 160.2, 151.2, 138.7, 129.8, 112.1, 110.6, 105.8, 84.6, 75.5, 55.4, 3.8; FT-IR (cm^{-1}) 3275, 3138, 3088, 2953, 2916, 2843, 2235, 1643, 1609, 1543, 1458, 1427, 1267, 1159, 1047; HRMS (ES+) m/z calcd for $C_{11}H_{12}NO_2$ $[M + H]^+$ 190.0868, found 190.0872.

*N-(3-Methoxyphenyl)-N-methylbut-2-ynamide (**9c**).* Acylation method A was followed using 2-butynoic acid and *N*-methyl-3-methoxyaniline (3 mmol). The mixture was stirred overnight. Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40%, afforded amide **9c** (296 mg, 49%) as an orange oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.31 (multiplicity obscured by residual solvent peak, 1H), 6.89−6.82 (m, 3H), 3.83 (s, 3H), 3.30 (s, 3H), 2.07 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 160.0, 154.2, 144.2, 129.7, 119.3, 113.2, 112.9, 89.8, 74.0, 55.4, 36.3, 3.9; FT-IR (cm^{-1}) 2935, 2918, 2837, 2235, 1637, 1597, 1489, 1366, 1319, 1232; HRMS (ES+) m/z calcd for $C_{12}H_{14}NO_2$ $[M + H]^+$ 204.1025, found 204.1029.

*N-Benzyl-N-(3-methoxyphenyl)but-2-ynamide (**9b**).* The general procedure for reductive amination was followed using *m*-anisidine (7.5 mmol) to afford *N*-benzyl-3-methoxyaniline (1.51 g, 94%). The crude amine (4 mmol) was then acylated with 2-butynoic acid following method A. Extractive workup, followed by chromatography on silica gel eluting with EtOAc/Hex 30%, afforded amide **9b** (785 mg, 70%) as a viscous pale golden oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.92−7.18 (m, 6H), 6.83 (dd, J = 8.4 Hz, J = 1.8 Hz, 1H), 6.76 (d, J = 8.7 Hz, 1H), 4.92 (s, 2H), 3.72 (s, 3H), 1.74 (s, 3H); Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data include all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 160.0, 154.4, 142.9, 137.0, 129.9, 129.7, 128.8, 128.6, 127.9, 127.6, 120.8, 114.1, 113.8, 90.6, 74.2, 55.5, 52.4, 4.1; FT-IR (cm^{-1}) 3066, 3032, 3008, 2928, 2840, 2254, 2229, 1634, 1605, 1492, 1450, 1437, 1391, 1370, 1287, 1203, 1170, 1081, 1031, 960, 734, 700; HRMS (ES+) m/z calcd for $C_{18}H_{18}NO_2$ $[M + H]^+$ 280.1338, found 280.1335.

*N-Cinnamyl-N-(3-methoxyphenyl)but-2-ynamide (**9d**).* To a solution of *m*-anisidine (4.45 mL, 1.1 equiv) in benzene [1.5 M] was added $MgSO_4$ (4.33g, 1 equiv), followed by cinnamaldehyde (4.5 mL, 1 equiv). The solution was stirred at room temperature for 2 h after which it was filtered through Celite and concentrated. The crude imine was then dissolved in methanol [0.3 M] and cooled to 0 °C. To the resulting solution was added $NaBH_4$ (1.68 g, 1.25 equiv) portionwise. The mixture was then warmed to room temperature and stirred for 2 h after which the reaction was quenched with aqueous NaOH [1 M]. The mixture was then diluted with water and extracted with EtOAc. The combined extracts were dried over $MgSO_4$ and concentrated by rotary evaporation to yield *N*-cinnamyl-3-methoxyaniline (>99%) as a red oil. The crude *N*-cinnamyl-3-methoxyaniline (439 mg, 1.84 mmol) was then acylated with 2-butynoic acid according to method B. Extractive workup, followed by automated column chromatography eluting with a gradient of EtOAc/Hex 0−50%, afforded amide **9d** (271 mg, 48%) as a viscous golden oil. The NMR

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spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.32−7.20 (apparent m, 6H), 6.87−6.81 (apparent m, 3H), 6.43 (d, J = 15.9 Hz, 1H), 6.23 (dt, J = 15.9 Hz, J = 6.6 Hz, 1H), 4.47 (d. J = 6.0 Hz, 2H), 3.76 (s, 3H), 1.73 (s, 3H); The following ^{13}C NMR chemical shifts correspond to the major atropisomer. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 159.9, 153.9, 142.9, 136.5, 133.4, 129.7, 128.5, 127.7, 126.4, 123.7, 120.5, 113.9, 113.5, 90.1, 74.1, 55.4, 51.0, 3.9; FT-IR (cm^{-1}) 3057, 3027, 3007, 2957, 2940, 2917, 2833, 2255, 2229, 1635, 1600, 1490, 1450, 1432, 1389, 1315, 1282, 1239, 1199, 1175, 1045, 967, 785, 749, 733, 695; HRMS (ES+) m/z calcd for $C_{20}H_{20}NO_2$ $[M + H]^+$ 306.1494, found 306.1494.

*N-(3-Methoxyphenyl)-N-phenylbut-2-ynamide (**9e**).* Following a modified literature procedure[13] amide **9a** (189 mg, 1.0 mmol, 1 equiv) was weighed into a flame-dried round-bottom flask and dissolved in anhydrous toluene (20 mL) under nitrogen. Ph_2IOTf (645 mg, 1.5 mmol, 1.5 equiv) was added, and the reaction stirred at room temperature for 30 min. NaH 60% in mineral oil (60 mg, 1.5 mmol, 1.5 equiv) was then added, and the mixture was stirred at room temperature overnight. The mixture was then treated with MeOH (5 mL) and concentrated by rotary evaporation. The resulting residue was concentrated onto Celite and purified via automated flash column chromatography eluting with a gradient of EtOAc/Hex 0−40% to afford the product **9f** (120 mg, 45%) as a brown oil that solidified upon standing under vacuum. The NMR spectra revealed an unresolved mixture of atropisomers. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 7.41−7.28 (m, 6H), 6.96−6.89 (m, 3H), 3.75 (s, 3H), 1.79 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 160.0, 153.7, 143.4, 142.5, 141.3, 129.7, 129.1, 128.7, 127.9, 126.5, 126.1, 121.2, 118.5, 114.6, 113.5, 112.2, 91.5, 74.8, 55.4, 4.03; HRMS (ES+) m/z calcd for $C_{17}H_{16}NO_2$ $[M + H]^+$ 266.1181, found 266.1182.

*N-(3-Methoxy-2-methylphenyl)but-2-ynamide (**12a**).* Acylation method B was followed using 2-butynoic acid and 2-methyl-3-methoxyaniline (15 mmol). Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40%, afforded product **12a** (2.80 g, 92%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.40 (d, J = 8.1 Hz, 1H), 7.30 (bs, 1H), 7.15 (d, J = 8.1 Hz, 1H), 6.71 (d, J = 8.1 Hz, 1H), 3.82 (s, 3H), 2.14 (s, 3H), 2.00 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 157.9, 151.5, 135.8, 126.7, 118.3, 116.1, 107.8, 84.4, 75.5, 55.8, 10.0, 3.9; FT-IR (cm^{-1}) 3481, 3062, 3029, 2999, 2923, 2836, 2250, 2220, 1634, 1584, 1471, 1437, 1400, 1312, 1261, 1178, 1136, 1077, 1027, 956, 788, 729, 717, 700; HRMS (ES+) m/z calcd for $C_{12}H_{14}NO_2$ $[M + H]^+$ 204.1025, found 204.1030.

*N-(3-Methoxy-2-methylphenyl)-N-methylbut-2-ynamide (**12b**).* To a flame-dried flask was added amide **12a** (406 mg, 2.0 mmol), followed by THF (10 mL). The mixture was cooled to 0 °C, and NaH 60% in mineral oil (120 mg, 3 mmol) was added. The mixture was stirred at 0 °C for 30 min, after which methyl iodide (187 mg, 3 mmol) was added. The mixture was allowed to slowly warm to room temperature and stirred overnight, after which the mixture was concentrated onto Celite and purified by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−50% to afford **12b** (312 mg, 72%) as a colorless oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.19 (t, J = 7.8 Hz, 1H), 6.87−6.73 (m, 2H), 3.87 (s, 3H), 3.20 (s, 3H), 2.11 (s 3H), 1.70 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 158.6, 154.9, 143.0, 126.8, 125.3, 120.5, 118.9, 110.1, 89.1, 74.1, 56.0, 35.9, 10.8, 4.1; FT-IR (cm^{-1}) 3003, 2920, 2840, 2237, 1638, 1592, 1479, 1437, 1375, 1320, 1257, 1194, 1178, 1144, 1073, 880, 821, 788, 738, 717; HRMS (ES+) m/z calcd for $C_{13}H_{16}NO_2$ $[M + H]^+$ 218.1181, found 218.1181.

*N-Benzyl-N-(3-methoxy-2-methylphenyl)but-2-ynamide (**12c**).* To a flame-dried flask was added amide **12a** (406 mg, 2.0 mmol), followed by THF (10 mL). The mixture was cooled to 0 °C, and NaH 60% in mineral oil (120 mg, 3 mmol) was added. The mixture was stirred at 0 °C for 30 min, after which benzyl bromide (0.36 mL, 3 mmol) was added. The mixture was allowed to slowly warm to room temperature and stirred overnight, after which the mixture was concentrated onto Celite and purified by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40% to afford **12c** (381 mg, 65%) as a viscous colorless oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.28−7.19 (m, 5H), 7.05 (t, J = 8.1 Hz, 1H), 6.80 (d, J = 8.1 Hz, 1H), 6.48 (d, J = 7.2 Hz, 1H), 5.18 (d, J = 14.1 Hz, 1H), 4.43 (d, J = 14.1 Hz, 1H), 3.84 (s, 3H), 1.94 (s, 3H), 1.68 (s, 3H). Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data includes all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 158.4, 154.9, 141.2, 136.7, 129.5, 128.8, 128.6, 128.5, 128.3, 128.1, 127.7, 126.7, 126.3, 125.9, 121.8, 120.1, 110.0, 109.9, 89.3, 74.1, 55.8, 51.9, 10.8, 4.4, 4.0; FT-IR (cm^{-1}) 3029, 2999, 2916, 2853, 2252, 2218, 1634, 1584, 1472, 1434, 1396, 1308, 1258, 1174, 1130, 1077, 1031, 955, 787, 733, 719, 702; HRMS (ES+) m/z calcd for $C_{19}H_{20}NO_2$ $[M + H]^+$ 294.1494, found 294.1497.

*N-(4-Bromo-3-methoxyphenyl)but-2-ynamide (**14a**).* Acylation method A was followed using 2-butynoic acid and 4-bromo-3-methoxyaniline (2.5 mmol). Extractive workup afforded pure amide **14a** (612 mg, 92%) as an amorphous beige solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.57 (bs, 1H), 7.45−7.42 (m, 2H), 6.80 (d, J = 8.7 Hz, 1H), 3.89 (s, 3H), 1.99 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 156.3, 151.1, 138.1, 133.2, 112.6, 106.7, 104.4, 85.2, 75.4, 56.4, 3.9; FT-IR (cm^{-1}) 3275, 3117, 3052, 3009, 2966, 2940, 2919, 2830, 2232, 1654, 1597, 1532, 1490, 1463, 1403, 1317, 1261, 1205, 1179, 1136, 1023, 846, 808, 739, 622; HRMS (ES+) m/z calcd for $C_{11}H_{11}BrNO_2$ $[M + H]^+$ 267.9973, found 267.9974.

*N-Benzyl-N-(4-bromo-3-methoxyphenyl)but-2-ynamide (**14b**).* The general procedure for reductive amination was followed using 4-bromo-3-methoxyaniline (1.52 g, 7.5 mmol) to afford *N*-benzyl-4-bromo-3-methoxyaniline (1.6 g, 73%). The crude amine (1.47 g, 5 mmol) was then acylated with 2-butynoic acid following method A. Extractive workup, followed by flash column chromatography on silica gel eluting with EtOAc/Hex 20%, afforded **14b** (1.3 g, 73%) as a golden oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.47 (d, J = 8.4 Hz, 1H), 7.26−7.19 (m, 6H), 6.62−6.50 (m, 2H), 4.91 (s, 2H), 3.72 (s, 3H), 1.76 (s, 3H). Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data includes all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 156.1, 154.1, 142.0, 136.8, 133.4, 129.0, 128.9, 128.7, 128.0, 127.9, 121.8, 120.0, 112.6, 111.3, 91.0, 74.1, 56.4, 56.3, 52.3, 4.1; FT-IR (cm^{-1}) 3066, 3028, 2919, 2849, 2254, 1637, 1582, 1487, 1449, 1384, 1318, 1299, 1250, 1207, 1057, 1025, 961, 853, 809, 732, 700, 713, 666; HRMS (ES+) m/z calcd for $C_{18}H_{17}BrNO_2$ $[M + H]^+$ 358.0443, found 358.0438.

*Methyl 4-(N-Benzylbut-2-ynamido)-2-methoxybenzoate (**16**).* The general procedure for reductive amination was followed using methyl 4-amino-2-methoxybenzoate (906 mg, 5 mmol) to afford methyl 4-(benzylamino)-2-methoxybenzoate (1.12 g, 83%). The crude amine (814 mg, 3 mmol) was then acylated with 2-butynoic acid following method B. Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40%, afforded **16** (607 mg, 60%) as a golden oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.76 (d, J = 8.1 Hz, 1H), 7.29 (peak obscured by residual solvent peak, 4H), 7.22 (peak partly obscured by residual solvent peak, 1H), 6.77 (dd, J = 8.1 Hz, J = 1.8 Hz, 1H), 6.61 (s, 1H), 4.94 (s, 2H), 3.88 (s, 3H), 3.73 (s, 3H), 1.83 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 165.7, 159.2, 153.5, 146.0, 136.4, 132.0, 128.4, 127.5, 119.6, 119.1, 112.2, 90.8, 73.8, 55.9, 51.9, 51.7, 3.7; FT-IR (cm^{-1}) 3027, 3002, 2946, 2916, 2843, 2252, 2227, 1729, 1635, 1601, 1576, 1496, 1433, 1385, 1293, 1242, 1138, 1091, 1024, 960, 773, 699; HRMS (ES+) m/z calcd for $C_{20}H_{20}NO_4$ $[M + H]^+$ 338.1392, found 338.1393.

*N-Benzyl-N-(3,5-dimethylphenyl)but-2-ynamide (**18**).* The general procedure for reductive amination was followed using 3,5-dimethylaniline (242 mg, 2 mmol) to afford *N*-benzyl-3,5-demethylaniline (414 mg, 98%). The crude amine (359 mg, 1.7 mmol) was then acylated

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with 2-butynoic acid following method A. Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−25%, afforded **18** (283 mg, 60%) as a colorless oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.29−7.19 (apparent m, 5H), 6.90 (s, 1H), 6.70 (s, 2H), 4.90 (s, 2H), 2.25 (s, 6H), 1.73 (s, 3H). Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data includes all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.5, 141.7, 138.6, 137.1, 129.6, 128.6, 128.4, 127.8, 127.5, 125.9, 124.7, 90.3, 74.3, 52.4, 21.2, 4.1; FT-IR (cm^{-1}) 3036, 2917, 2852, 2252, 1634, 1595, 1472, 1454, 1433, 1389, 1323, 1244, 1078, 1030, 964, 855, 732, 706; HRMS (ES+) m/z calcd for $C_{19}H_{20}NO$ $[M + H]^+$ 278.1545, found 278.1549.

N-Benzyl-N-phenylbut-2-ynamide (**20**). Acylation method B was followed using 2-butynoic acid and *N*-benzylaniline (733 mg, 4 mmol). Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−20%, afforded **20** (87%, 866 mg) as a colorless oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.31−7.20 (apparent m, 8H), 7.09−7.07 (apparent m, 2H), 4.93 (s, 2H), 1.70 (s, 3H). Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data include all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.4, 141.7, 136.9, 136.8, 129.1, 128.9, 128.6, 128.5, 128.4, 127.9, 127.7, 127.5, 126.8, 90.5, 74.1, 52.2, 4.2, 3.9; FT-IR (cm^{-1}) 3260, 3062, 3037, 2921, 2848, 2253, 2231, 1953, 1885, 1810, 1745, 1639, 1594, 1495, 1455, 1437, 1392, 1318, 1295, 1280, 1222, 1156, 1028, 962, 771, 728, 698, 638; HRMS (ES+) m/z calcd for $C_{17}H_{16}NO$ $[M + H]^+$ 250.1232, found 250.1237.

N-(Benzo[d][1,3]dioxol-5-yl)-N-benzylbut-2-ynamide (**22**). The general procedure for reductive amination was followed using benzo[*d*][1,3]dioxol-5-amine (686 mg, 5 mmol) to afford *N*-benzylbenzo[*d*][1,3]dioxol-5-amine (1.03 g, 91%). The crude amine (682 mg, 3 mmol) was then acylated with 2-butynoic acid following method A. Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−30%, afforded **22** (664 mg, 75%) as a golden oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.28−7.21 (apparent m, 5H), 6.70 (d, J = 8.7 Hz, 1H), 6.53−6.44 (apparent m, 2H), 5.98 (s, 2H), 4.86 (s, 2H), 1.77 (s, 3H). Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data include all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.7, 147.8, 147.3, 136.8, 135.6, 128.9, 128.8(4), 128.7(5), 128.6, 128.5, 128.0, 127.7, 127.5, 122.4, 121.9, 120.5, 119.5, 109.4, 108.9, 108.6, 108.3, 108.1, 101.8, 101.8, 90.8, 75.2, 56.6, 52.8, 52.5, 27.5, 4.3, 4.1; FT-IR (cm^{-1}) 3063, 3029, 2916, 2782, 2239, 1653, 1483, 1446, 1389, 1339, 1245, 1198, 110, 1037, 934, 810, 729, 703, 660; HRMS (ES+) m/z calcd for $C_{18}H_{16}NO_3$ $[M + H]^+$ 294.1130, found 294.1133.

N-(3-Aminophenyl)but-2-ynamide (**24**). A modification of acylation method B was used. To a solution of 2-butynoic acid (252 mg, 3 mmol, 1 equiv) in ethyl acetate (3.8 mL) was added *N*-methyl morpholine (0.33 mL, 3 mmol, 1.5 equiv), followed by slow addition of isopropyl chloroformate (3 mL, 3 mmol, 1.0 M solution in toluene, 1.5 equiv). The resulting mixture was stirred at room temperature for 30 min. The mixture was then filtered to remove the precipitated ammonium salt, and the filtrate was concentrated to yield the mixed carbonic acid anhydride as a golden oil. The oil was dissolved in DMF (2 mL) and added slowly to a solution of the *m*-phenylenediamine (324 mg, 3 mmol, 1.0 equiv) in DMF (6 mL) at room temperature. After the mixture was stirred overnight, it was poured into 5 volumes of water and extracted three times with ethyl acetate. The combined organic layers were then dried over $MgSO_4$. The mixture was filtered, and the filtrate was concentrated by rotary evaporation. The resulting solid was recrystallized from EtOAc and hexanes to afford **24** (408 mg, 78%) as a white solid. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.28 (bs, 1H), 7.15 (t, J = 1.8 Hz, 1H), 7.07 (t, J = 7.8 Hz, 1H), 6.63 (dd, J = 7.8 Hz, J = 1.8 Hz, 1H), 6.44 (dd, J = 7.8 Hz, J = 1.8 Hz, 1H), 3.72 (bs, 2H), 2.00 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 151.1, 147.4, 138.5, 129.9, 111.6, 109.7, 106.7, 84.4, 75.6, 3.9; FT-IR (cm^{-1}) 3371, 2907, 2850, 2292, 1659, 1588, 1536, 1446, 1252; HRMS (ES+) m/z calcd for $C_{10}H_{11}N_2O$ $[M + H]^+$ 175.0871, found 175.0874.

1-(7-Methoxy-3,4-dihydroquinolin-1(2H)-yl)but-2-yn-1-one (**27**). Acylation method B was followed using 2-butynoic acid and 7-methoxytetrohydroquinoline (2.3 mmol), which was prepared by a known literature procedure.[14] Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−30%, afforded **27** (492 mg, 93%) as an amorphous pale yellow solid. The NMR spectra revealed a mixture of conformers, likely due to slow changes between the pseudochair conformations of the piperidinyl ring. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.66 + 7.23 (bs + bs, $1H_{\text{combined integration}}$), 7.02 (d, J = 8.1 Hz, 1H), 6.69 (bs, 1H), 4.02 (bs, 2H), 3.78 (s, 3H), 2.75 (bs, 2H), 1.97 (bs, 5H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 156.9, 152.4, 137.7, 129.4, 121.4, 110.9, 109.4, 91.1, 74.3, 55.2, 46.9, 25.6, 23.2, 3.5; FT-IR (cm^{-1}) 3007, 2943, 2841, 2224, 1637, 1615, 1581, 1505, 1445, 1390, 1347, 1305, 1283, 1262, 1249, 1224, 1207, 1168, 1130, 1117, 1041, 938, 866, 807, 730; HRMS (ES+) m/z calcd for $C_{14}H_{16}NO_2$ $[M + H]^+$ 230.1181, found 230.1184.

N-Benzyl-N-(naphthalen-2-yl)but-2-ynamide (**29**). Acylation method A was followed using 2-butynoic acid and 2-aminonaphthalene (4 mmol). Extractive workup afforded the crude amide, which was used directly in the next reaction. The crude amide (314 mg, 1.5 mmol) was added to a flame-dried flask, followed by THF (12 mL). The mixture was cooled to 0 °C, and NaH 60% in mineral oil (90 mg, 1.5 mmol) was added. The mixture was stirred at 0 °C for 30 min, after which benzyl bromide (0.27 mL, 1.5 mmol) was added. The mixture was allowed to slowly warm to room temperature and stirred overnight. The mixture was then concentrated by rotary evaporation, and the residue was purified via flash column chromatography on silica gel eluting with a gradient of EtOAc/Hex 10−20% to afford **29** (44%, 195 mg) as a viscous brown oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.85−7.75 (apparent m, 3H), 7.56 (d, J = 1.5 Hz, 1H), 7.51−7.48 (apparent m, 2H), 5.02 (s, 2H), 1.64 (s, 3H). Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data include all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 154.5, 139.1, 136.8, 133.3, 132.5, 128.9, 128.7, 128.5, 128.1, 127.7, 127.6, 127.0, 126.6(2), 126.5(5), 126.4, 90.8, 74.3, 52.5, 3.9; FT-IR (cm^{-1}) 3061, 3031, 2912, 2848, 2252, 2225, 1637, 1624, 1596, 1504, 1395, 1316, 1290, 1240, 1214, 1075, 1028, 962, 860, 818, 749, 730, 701, 675; HRMS (ES+) m/z calcd for $C_{21}H_{18}NO$ $[M + H]^+$ 300.1388, found 300.1394.

N-Benzyl-N-(naphthalen-1-yl)but-2-ynamide (**31**). The general procedure for reductive amination was followed using 1-aminonaphthalene (859 mg, 6 mmol) to afford *N*-benzyl-1-aminonaphthelanene (1.12 g, 80%). The crude *N*-benzyl-1-aminonaphthelanene (700 mg, 3 mmol) was then acylated with 2-butynoic acid following method B. Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−35%, afforded **31** (753 mg, 84%) as a golden oil. The NMR spectra revealed a mixture of atropisomers. The following ^{1}H NMR chemical shifts correspond to the major atropisomer. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.91−7.70 (apparent m, 3H), 7.55−7.46 (apparent m, 2H), 7.33 (t, J = 7.5 Hz, 1H), 7.30−7.19 (apparent m, 5H), 6.98 (dd, J = 7.2 Hz, J = 0.9 Hz, 1H), 4.66 (d, J = 15.3 Hz, 1H), 4.30 (d, J = 14.1 Hz, 1H), 1.47 (s, 3H). Due to the complexity of the spectrum of the atropisomeric mixture the following ^{13}C NMR data include all recorded chemical shifts. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 155.4, 137.6, 137.0, 134.6, 130.7, 129.4, 129.0, 128.7, 128.6, 128.5(3), 128.4(6), 127.8, 127.7, 127.2, 126.5, 125.3, 122.7, 90.1, 74.2, 56.4, 52.0, 3.8; FT-IR (cm^{-1}) 3059, 3026, 2917, 2851, 2254, 2221, 1633, 1595, 1401, 1386, 1293, 1253, 1225, 1074, 953, 776, 732, 700; HRMS (ES+) m/z calcd for $C_{21}H_{18}NO$ $[M + H]^+$ 300.1388, found 300.1395.

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*N-(1H-Indol-4-yl)but-2-ynamide (**33**).* Acylation method A was followed using 2-butynoic acid and 4-aminoindole (529 mg, 4 mmol). Extractive workup, followed by automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−45%, afforded product **33** (264 mg, 33%) as an amorphous pale yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 11.14 (bs, 1H), 10.34 (bs, 1H), 7.50 (d, J = 7.5 Hz, 1H), 7.30 (s, 1H), 7.20 (d, J = 7.8 Hz, 1H), 7.03 (t, J = 7.8 Hz, 1H), 6.73 (s, 1H), 2.07 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 150.8, 136.7, 129.7, 124.4, 120.9, 120.5, 108.3, 99.6, 84.1, 76.3, 3.4; FT-IR (cm^{-1}) 3047, 2922, 2847, 2291, 1623, 1581, 1529, 1429, 1415, 1357, 1299, 1263, 1207, 1094, 901, 750; HRMS (ES+) m/z calcd for $C_{12}H_{11}N_2O$ $[M + H]^+$ 199.0871, found 199.0875.

*N-(1H-Indol-5-yl)but-2-ynamide (**35**).* Acylation method B was followed using 2-butynoic acid and 5-aminoindole (397 mg, 3 mmol). Following the method B extractive workup the resulting residue was dissolved in hot EtOAc. The slow addition of hexanes led to precipitation of the product **35** (444 mg, 75%) as an amorphous white solid, which was isolated following filtration through filter paper and drying under vacuum. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.02 (bs, 1H), 10.38 (s, 1H), 7.86 (d, J = 0.9 Hz, 1H), 7.32−7.29 (apparent m, 2H), 7.22 (dd, J = 8.6 Hz, J = 1.8 Hz, 1H), 6.38 (d, J = 2.1 Hz, 1H), 2.03 (s, 3H); ^{13}C NMR (DMSO-d_6, 75 MHz) δ 150.2, 132.9, 130.6, 127.4, 126.0, 114.8, 111.2, 111.1, 101.2, 83.1, 76.3, 3.2; FT-IR (cm^{-1}) 2919, 2849, 2231, 2208, 1647, 1581, 1537, 1471, 1419, 1335, 1265, 1243, 1221, 873, 803, 766, 733, 696; HRMS (ES+) m/z calcd for $C_{12}H_{11}N_2O$ $[M + H]^+$ 199.0871, found 199.0876.

*N-(1,2,3,5,6,7-Hexahydropyrido[3,2,1-ij]quinolin-8-yl)but-2-ynamide (**37**).* Acylation method A was followed using 2-butynoic acid and 7-aminojulolidine (206 mg, 1.1 mmol), which was prepared according to a published procedure.[15] Extractive workup, followed by flash column chromatography on silica gel eluting with EtOAc/Hex 30%, afforded product **37** (128 mg, 46%) as an amorphous yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.04 (bs, 1H), 6.86 (d, J = 7.8 Hz, 1H), 6.78 (d, J = 7.5 Hz, 1H), 3.10 (bs, 4H), 2.72 (bs, 2H), 2.62 (bs, 2H), 1.99 (bs, 7H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 151.5, 143.7, 132.5, 127.1, 120.1, 114.4, 112.2, 83.9, 75.6, 50.3, 49.4, 27.7, 23.1, 22.1, 21.7, 3.9; FT-IR (cm^{-1}) 3325, 2928, 2854, 2237, 1649, 1599, 1523, 1491, 1438, 1393, 1304, 1275, 1198, 1124, 791, 731; HRMS (ES+) m/z calcd for $C_{16}H_{19}N_2O$ $[M + H]^+$ 255.1497, found 255.1496.

Part 3. General Procedure for *N*-Aryl Alkynamide Hydroarylation. To a 4 mL vial was added Au(XPhos) (SbF_6)·MeCN (5 mol %) followed by a Teflon coated micro stir bar, benchtop DCE (0.1 M), and last the *N*-aryl alkynamide substrate. The vial was then capped with a Teflon lined screw cap and placed into an aluminum heating block preheated to 50 °C. Upon complete consumption of the starting material as judged by TLC (developing with mixtures of EtOAc in hexanes or benzene) the reaction mixture was cooled to room temperature. For products that precipitated from solution a volume of hexanes equal to that of the DCE employed was added to the solution and the vial was cooled to −15 °C in a freezer for 30 min. The mixture was then filtered, and the solid was washed with hexanes. For products that did not precipitate from solution the reaction was concentrated via rotary evaporation and chromatographed on silica gel eluting with mixtures of EtOAc and hexanes.

Part 4. 2-Quinolinone Product Characterization Data. *5,7-Dimethoxy-4-methylquinolin-2(1H)-one (**8a**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **7a**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **8a** (44 mg, >99%) as an amorphous white solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.37 (bs, 1H), 6.44 (d, J = 2.4 Hz, 1H), 6.29 (d, J = 2.4 Hz, 1H), 6.01 (d, J = 0.9 Hz, 1H), 3.82 (s, 3H), 3.78 (s, 3H), 2.51 (s, 3H) peak partly obscured by residual DMSO peak; ^{13}C NMR (DMSO-d_6, 75 MHz) δ 161.5, 161.3, 159.1, 148.6, 142.2, 118.1, 104.7, 93.4, 91.1, 55.8, 55.3, 24.1; FT-IR (cm^{-1}) 2973, 2915, 2849, 1666, 1631, 1609, 1542, 1436, 1412, 1385, 1283, 1229, 1208, 1141, 966, 824, 817. 769; HRMS (ES+) m/z calcd for $C_{12}H_{14}NO_3$ $[M + H]^+$ 220.0974, found 220.0978.

*5,7-Dimethoxyquinolin-2(1H)-one (**8b**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **7b**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−30% to afford the product **8b** (68%) as an amorphous white solid. Spectral data matched those previously reported for compound **8b**.[16]

*5,7-Dimethoxy-4-phenylquinolin-2(1H)-one (**8c**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **7c**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **8c** as an amorphous white solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.68 (bs, 1H), 7.35−7.33 (m, 3H), 7.24−7.20 (m, 2H), 6.54 (d, J = 2.1 Hz, 1H), 6.25 (d, J = 2.4 Hz, 1H), 5.92 (s, 1H), 3.80 (s, 3H), 3.34 (s, 3H) peak partly obscured by water peak at 3.33; ^{13}C NMR (DMSO-d_6, 75 MHz) δ 161.9, 161.2, 158.0, 151.0, 142.3, 141.2, 127.2, 127.1, 126.9, 119.0, 103.3, 93.9, 91.3, 55.4, 55.3; FT-IR (cm^{-1}) 2959, 2923, 2849, 1660, 1629, 1599, 1540, 1512, 1449, 1437, 1409, 1388, 1277, 1228, 1208, 1140, 984, 818, 759, 695; HRMS (ES+) m/z calcd for $C_{17}H_{16}NO_3$ $[M + H]^+$ 282.1130, found 282.1132.

*4-Bromo-5,7-dimethoxyquinolin-2(1H)-one (**8d**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **7d**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **8d** (40 mg, 70%) as an amorphous white solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.80 (bs, 1H), 6.62 (s, 1H), 6.48 (s, 1H), 6.39 (s, 1H), 3.84 (s, 3H), 3.81 (s, 3H); ^{13}C NMR (DMSO-d_6, 75 MHz) δ 162.3, 160.1, 157.5, 142.0, 130.6, 123.0, 102.8, 94.4, 91.3, 55.8, 55.5; FT-IR (cm^{-1}) 2922, 2851, 1667, 1623, 1598, 1552, 1442, 1407, 1384, 1360, 1326, 1277, 1230, 1209, 1167, 1144, 1063, 1035, 1009, 977, 849, 817, 764; HRMS (ES+) m/z calcd for $C_{11}H_{11}BrNO_3$ $[M + H]^+$ 283.9922, found 283.9928.

*4-Ethyl-5,7-dimethoxyquinolin-2(1H)-one (**8e**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **7e**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **8e** (39 mg, 83%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 12.45 (bs, 1H), 6.50 (d, J = 2.4 Hz, 1H), 6.33 (s, 1H), 6.24 (d, J = 2.4 Hz, 1H), 3.90 (s, 3H), 3.87 (s, 3H), 3.04 (quart, J = 7.5 Hz, 2H), 1.24 (t, J = 7.5 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 164.8, 162.0, 159.2, 156.7, 142.5, 116.3, 105.9, 94.7, 91.6, 55.8, 55.6, 30.1, 14.8, 0.1; FT-IR (cm^{-1}) 2959, 2913, 1654, 1608, 1547, 1455, 1385, 1313, 1276, 1213, 1200, 1165, 1139, 1084; HRMS (ES+) m/z calcd for $C_{13}H_{16}NO_3$ $[M + H]^+$ 233.1052, found 233.1055.

*4-Cyclopropyl-5,7-dimethoxyquinolin-2(1H)-one (**8f**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **7f**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **8f** (36 mg, 73%) as an amorphous white solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.36 (bs, 1H), 6.43 (d, J = 2.4 Hz, 1H), 6.32 (d, J = 2.4 Hz, 1H), 5.83 (s, 1H), 3.83 (s, 3H), 3.76 (s, 3H), 2.61−2.57 (multiplet, 1H), 0.90−0.86 (apparent quartet, J = 3.9 Hz, 2H), 0.68−0.63 (apparent quartet, J = 4.5 Hz, 2H); ^{13}C NMR (DMSO-d_6, 75 MHz) δ 161.8, 161.2, 159.2, 153.5, 142.2, 113.2, 105.0, 93.7, 91.2, 55.9, 55.2, 16.3, 8.2; FT-IR (cm^{-1}) 2914, 1663, 1602, 1541, 1442, 1387, 1273, 1203, 1162, 1135, 1002; HRMS (ES+) m/z calcd for $C_{14}H_{16}NO_3$ $[M + H]^+$ 245.1052, found 245.1053.

*7-Methoxy-4-methylquinolin-2(1H)-one (**10a**).* Substrate **9a** (0.2 mmol) was added to a 4 mL vial followed by Au(XPhos)(SbF_6)·MeCN (10 mol %), 4 Å molecular sieves (200 wt % with respect to the substrate mass), a Teflon coated micro stir bar, and DCE (0.1 M). The vial was placed in a heating block preheated to 80 °C. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient EtOAc/Hex 0−60% to afford the product mixture **10a** and **10b** (64%; 42% yield of regioisomer **10a**) as an amorphous white solid. Compound

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10a has been previously characterized and reported.[17] Comparison of the spectral data for our mixture of **10a** and **10b** to the reported data confirmed the identity of the major component of our mixture as **10a**.

*5-Methoxy-4-methylquinolin-2(1H)-one (**11a**).* The product was obtained as the minor component of a mixture with regioisomer **10a** as described in detail above from substrate **9a**. Spectral assignments of **11a** were made based on comparison of the obtained mixture of **10a** and **11a** to published spectra of pure **10a**.[17] ^{1}H NMR ($CDCl_3$:DMSO-d_6, 300 MHz) δ 11.61 (bs, 1H), 7.34 (t, J = 8.4 Hz, 1H), 6.97 (dd, J = 8.4 Hz, J = 1.2 Hz, 1H), 6.61 (d, J = 7.2 Hz, 1H), 6.33 (s, 1H), 3.88 (s, 3H), 2.65 (s, 3H); ^{13}C NMR ($CDCl_3$:DMSO-d_6, 75 MHz) δ 162.6, 157.9, 149.7, 140.4, 130.2, 120.6, 114.1, 108.8, 103.2, 55.1, 24.6; FT-IR for the mixture of **10a** and **10b** (cm^{-1}) 2956, 2917, 2846, 1669, 1626, 1609, 1554, 1520, 1472, 1442, 1417, 1391, 1263, 1252, 1215, 1181, 1098, 1029, 855, 809, 729. HRMS for the mixture of **10a** and **10b** (ES+) m/z calcd for $C_{11}H_{12}NO_2$ $[M + H]^+$ 190.0868, found 190.0871.

*N-Methyl-7-methoxy-4-methylquinolin-2(1H)-one (**10c**).* The general hydroarylation procedure was followed using 0.5 mmol of substrate **9c**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−60% to afford the product **10c** (53%; total yield of regioisomers **10c** and **11c** was 80%) as an amorphous pale yellow solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 7.68 (d, J = 8.4 Hz, 1H), 6.91 (s, 1H), 6.91−6.87 (dd, 1H, partly obscured by singlet at 6.91), 6.34 (s, 1H), 3.89 (s, 3H), 3.56 (s, 3H), 2.38 (s, 3H); ^{13}C NMR (DMSO-d_6, 75 MHz) δ 161.3, 161.2, 146.4, 141.2, 126.8, 117.3, 114.6, 109.4, 98.9, 55.5, 28.8, 18.4; FT-IR (cm^{-1}) 2946, 2843, 1653, 1623, 1597, 1559, 1456, 1387, 1370, 1327, 1302, 1237, 1177, 1066, 1036, 972, 861, 822; HRMS (ES+) m/z calcd for $C_{12}H_{14}NO_2$ $[M + H]^+$ 204.1025, found 204.1028.

*N-Methyl-5-methoxy-4-methylquinolin-2(1H)-one (**11c**).* The product (**11c**. 27%) was obtained as an amorphous pale yellow solid as the minor component of a mixture with regioisomer **10c** as described in detail above from substrate **9c**. ^{1}H NMR (d_6-DMSO, 300 MHz) δ 7.53 (t, J = 8.4 Hz, 1H), 7.08 (d, J = 8.7 Hz, 1H), 6.85 (d, J = 8.4 Hz, 1H), 6.34 (s, 1H), 3.87 (s, 3H), 3.55 (s, 3H), 2.55 (s, 3H); ^{13}C NMR (d_6-DMSO, 75 MHz) δ 160.4, 158.3, 146.9, 141.5, 131.2, 120.4, 110.9, 107.7, 104.6, 55.9, 29.5, 24.6; FT-IR (cm^{-1}) 2971, 2933, 2841, 1645, 1582, 1489, 1468, 1435, 1389, 1338, 1263, 1235, 1153, 1111. 1069, 1019, 860; HRMS (ES+) m/z calcd for $C_{12}H_{14}NO_2$ $[M + H]^+$ 204.1025, found 204.1028.

*N-Benzyl-7-methoxy-4-methylquinolin-2(1H)-one (**10b**).* The general hydroarylation procedure was followed using 0.5 mmol of substrate **9c**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40% to afford the product **10b** (55%; total yield of regioisomers **10b** and **11b** was 87%) as a golden oil. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.59 (d, J = 8.7 Hz, 1H), 7.31−7.19 (apparent m, 6H), 6.77 (dd, J = 8.7 Hz, J = 2.4 Hz, 1H), 6.71 (d, J = 2.4 Hz, 1H), 6.54 (s, 1H), 5.52 (s, 2H), 3.72 (s, 3H), 2.45 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 162.9, 161.5, 147.1, 140.9, 136.8, 128.9, 127.3, 126.8, 126.7, 118.2, 115.8, 109.6, 99.9, 55.4, 46.0, 19.2; FT-IR (cm^{-1}) 3092, 3062, 3033, 3010, 2975, 2937, 2893, 1651, 1621, 1591, 1560, 1497, 1458, 1440, 1394, 1378, 1322, 1286, 1237, 1224, 1192, 1179, 1112, 1100, 1080, 1036, 863, 858, 837, 728, 709; HRMS (ES+) m/z calcd for $C_{18}H_{18}NO_2$ $[M + H]^+$ 280.1338, found 280.1334.

*N-Benzyl-5-methoxy-4-methylquinolin-2(1H)-one (**11b**).* The product (**11b**, 32%) was obtained as a golden oil as the minor component of a mixture with regioisomer **10b** as described in detail above from substrate **9b**. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.31−7.16 (apparent m, 6H), 6.85 (d, J = 8.4 Hz, 1H), 6.63 (d, J = 8.1 Hz, 1H), 6.54 (s, 1H), 5.53 (s, 2H), 3.87 (s, 3H), 2.67 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 162.2, 159.0, 148.6, 141.4, 136.8, 130.8, 128.8, 127.2, 126.5, 121.2, 112.6, 108.6, 104.2, 55.7, 46.4, 25.4; FT-IR (cm^{-1}) 3061, 3034, 2973, 2937, 2842, 1650, 1590, 1564, 1498, 1469, 1456, 1440, 1386, 1365, 1330, 1307, 1267, 1222, 1151, 1115, 1070, 1030, 937, 908, 860, 789, 737, 717; HRMS (ES+) m/z calcd for $C_{18}H_{18}NO_2$ $[M + H]^+$ 280.1338, found 280.1334.

*1-Cinnamyl-7-methoxy-4-methylquinolin-2(1H)-one (**10d**).* The general hydroarylation procedure was followed using 0.3 mmol of substrate **9d**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40% to afford the product **10d** (46%; total yield of regioisomers **10d** and **11d** was 72%) as an amorphous pale yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.62 (d, J = 8.7 Hz, 1H), 7.33−7.24 (apparent m, 5H), 6.88 (d, J = 2.1 Hz, 1H), 6.82 (dd, J = 9.0 Hz, J = 2.1 Hz, 1H), 6.57−6.49 (apparent m, 2H), 6.29 (dt, J = 15.9 Hz, J = 5.1 Hz, 1H), 5.09 (d, J = 4.2 Hz, 2H), 3.87 (s, 3H), 2.45 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.6, 146.9, 141.0, 136.5, 132.5, 128.6, 127.8, 126.8, 126.5, 124.0, 118.4, 115.9, 109.3, 99.8, 55.6, 44.3, 19.2; FT-IR (cm^{-1}) 3052, 3026, 3000, 2926, 2843, 1647, 1621, 1590, 1555, 1442, 1394, 1315, 1237, 1175, 1079, 1031, 962; HRMS (ES+) m/z calcd for $C_{20}H_{20}NO_2$ $[M + H]^+$ 306.1494, found 306.1495.

*1-Cinnamyl-5-methoxy-4-methylquinolin-2(1H)-one (**11d**).* The product (**11d**. 32%) was obtained as an amorphous pale yellow solid as the minor component of a mixture with regioisomer **10d** as described in detail above from substrate **9d**. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.41 (t, J = 8.4 Hz, 1H), 7.32−7.19 (apparent m, 5H), 7.02 (d, J = 8.7 Hz, 1H), 6.67 (d, J = 8.1 Hz, 1H), 6.51−6.46 (apparent m, 2H), 6.29 (d, J = 16.2 Hz, 1H), 5.11 (s, 2H), 3.89 (s, 3H), 2.66 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 159.0, 148.4, 141.4, 136.6, 132.2, 130.8, 128.6, 127.7, 126.5, 124.0, 121.4, 112.6, 108.3, 104.1, 55.7, 44.7, 25.4; FT-IR (cm^{-1}) 3058, 3024, 2967, 2833, 2837, 1653, 1589, 1466, 1436, 1263, 1145, 1112, 1028, 964, 854, 791, 742; HRMS (ES+) m/z calcd for $C_{20}H_{20}NO_2$ $[M + H]^+$ 306.1494, found 306.1496.

*N-Phenyl-7-methoxy-4-methylquinolin-2(1H)-one (**10e**).* The general hydroarylation procedure was followed using 0.3 mmol of substrate **9e**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated and purified via automated column chromatography on silica gel eluting with EtOAc/Hex 0−60% to afford the product **10e** (44%; total yield of regioisomers **10e** and **11e** was 75%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.63 (d, J = 8.7 Hz, 1H), 7.58 (t, J = 7.5 Hz, 2H), 7.50 (t, J = 7.5 Hz, 1H), 7.27 (d, J = 7.2 Hz, 2H), 6.80 (dd, J = 8.7 Hz, J = 2.4 Hz, 1H), 6.52 (s, 1H), 6.10 (d, J = 2.4 Hz, 1H), 3.65 (s, 3H), 2.48 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 162.7, 161.1, 147.4, 142.7, 138.0, 130.3, 129.0, 128.9, 126.4, 118.8, 115.4, 109.6, 100.7, 55.4, 19.3; FT-IR (cm^{-1}) 3062, 2963, 2940, 2920, 2844, 1659, 1621, 1598, 1557, 1490, 1454, 1426, 1390, 1373, 1231, 1206, 1174, 1153, 1080, 1030, 915, 856, 717, 695; HRMS (ES+) m/z calcd for $C_{17}H_{16}NO_2$ $[M + H]^+$ 266.1181, found 266.1186.

*N-Phenyl-5-methoxy-4-methylquinolin-2(1H)-one (**11e**).* The product (**11e** 31%) was obtained as an amorphous white solid as the minor component of a mixture with regioisomer **10e** as described in detail above from substrate **9e**. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.57 (t, J = 6.9 Hz, 2H), 7.49 (t, J = 7.2 Hz, 1H), 7.25−7.16 (apparent m, 3H), 6.64 (d, J = 8.1 Hz, 1H), 6.52 (s, 1H), 6.23 (d, J = 8.1 Hz, 1H), 3.91 (s, 3H), 2.70 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 162.0, 158.7, 149.0, 143.2, 138.6, 130.2(5), 130.2(2), 129.1, 128.8, 121.8, 112.1, 109.6, 104.1, 55.8, 25.4; FT-IR (cm^{-1}) 3058, 3007, 2969, 2931, 2838, 1660, 1591, 1560, 1463, 1434, 1384, 1306, 1263, 1112, 1037, 975, 863, 791, 705; HRMS (ES+) m/z calcd for $C_{17}H_{16}NO_2$ $[M + H]^+$ 266.1181, found 266.1186.

*7-Methoxy-4,8-dimethylquinolin-2(1H)-one (**13a**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **12a**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **13a** (65%) as an amorphous pale gray solid. ^{1}H NMR (DMSO-d_6/$CDCl_3$ 2:1, 300 MHz) δ 10.41 (bs, 1H), 7.50 (d, J = 8.7 Hz, 1H), 6.86 (d, J = 8.7 Hz, 1H), 6.19 (s, 1H), 3.85 (s, 3H), 2.37 (s, 3H), 2.23 (s, 3H); ^{13}C NMR (d_6-DMSO-d_6/$CDCl_3$ 2:1, 75 MHz) δ 161.0, 156.6, 146.4, 136.4, 121.6, 116.2, 112.6, 108.1, 104.0, 54.1, 17.2, 7.3; FT-IR (cm^{-1}) 3415, 3149, 3025, 2950, 2916, 2852, 1648, 1606, 1456, 1383, 1274, 1123, 1039, 1006, 850, 825, 798, 764; HRMS (ES+) m/z calcd for $C_{12}H_{14}NO_2$ $[M + H]^+$ 204.1025, found 204.1028.

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*7-Methoxy-1,4,8-trimethylquinolin-2(1H)-one (**13b**).* The general hydroarylation procedure was followed using 0.35 mmol of substrate **12b**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−50% to afford the product **13b** (69%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.50 (d, J = 8.1 Hz, 1H), 6.86 (d, J = 8.1 Hz, 1H), 6.41 (s, 1H), 3.93 (s, 3H), 3.69 (s, 3H), 2.42 (s, 3H), 2.39 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 165.5, 160.3, 146.7, 143.3, 123.5, 118.4, 117.5, 113.3, 105.9, 56.1, 38.5, 19.2, 15.4; FT-IR (cm^{-1}) 3093, 2973, 2926, 2844, 1646, 1585, 1439, 1401, 1375, 1319, 1289, 1255, 1178, 1148, 1097, 1062, 1036, 1016, 855, 812, 766, 734, 718, 701, 627; HRMS (ES+) m/z calcd for $C_{13}H_{16}NO_2$ [M + H]$^+$ 218.1181, found 218.1183.

*N-Benzyl-7-methoxy-4,8-dimethylquinolin-2(1H)-one (**13c**).* The general hydroarylation procedure was followed using 0.5 mmol of substrate **12c**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−50% to afford the product **13c** (75%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.54 (d, J = 8.7 Hz, 1H), 7.26 (dt, J = 7.2 Hz, J = 1.8 Hz, 2H), 7.18 (t, J = 7.2 Hz, 1H), 7.09 (d, J = 7.2 Hz, 1H), 6.85 (d, J = 8.7 Hz, 1H), 6.47 (s, 1H), 5.48 (s, 2H), 3.87 (s, 3H), 2.43 (s, 3H), 2.28 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 165.4, 160.3, 147.2, 142.8, 138.9, 128.5, 126.6, 126.0, 123.9, 118.6, 117.8, 113.5, 106.0, 56.1, 51.9, 19.5, 15.1; FT-IR (cm^{-1}) 3056, 3022, 2993, 2980, 2942, 2900, 2843, 1662, 1590, 1557, 1493, 1472, 1451, 1434, 1401, 1380, 1363, 1317, 1266, 1228, 1194, 1131, 1077, 1030, 997, 929, 891, 862, 811, 799, 764, 745, 710, 609; HRMS (ES+) m/z calcd for $C_{19}H_{20}NO_2$ [M + H]$^+$ 294.1494, found 294.1495.

*6-Bromo-7-methoxy-4-methylquinolin-2(1H)-one (**15a**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **14a**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **15a** (19%) as an amorphous pale gray solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.56 (s, 1H), 7.86 (s, 1H), 6.93 (s, 1H), 6.26 (s, 1H), 3.88 (s, 3H), 2.37 (s, 3H); ^{13}C NMR (DMSO-d_6, 75 MHz) δ 161.8, 156.5, 147.2, 139.7, 128.7, 118.8, 114.7. 104.5, 98.1, 56.3, 18.4; FT-IR (cm^{-1}) 2922, 2853, 1662, 1652, 1615, 1555, 1495, 1456, 1408, 1381, 1265, 1219, 1079, 1050, 1019, 944, 877, 827; HRMS (ES+) m/z calcd for $C_{11}H_{11}BrNO_2$ [M + H]$^+$ 267.9973, found 267.9974.

*N-Benzyl-6-bromo-7-methoxy-4-methylquinolin-2(1H)-one (**15b**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **14b**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated and purified via flash column chromatography on silica gel eluting with an EtOAc/Hex 30% to afford the product **15b** (75%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.80 (s, 1H), 7.30−7.21 (apparent m, 6H), 6.68 (s, 1H), 6.57 (s, 1H), 5.53 (s, 2H), 3.73 (s, 3H), 2.44 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 162.5, 157.2, 146.2, 140.1, 136.5, 129.6, 129.1, 127.6, 126.7, 119.1, 116.8, 105.9, 98.8, 56.3, 46.2, 19.2; FT-IR (cm^{-1}) 3061, 3030, 2964, 2918, 2849, 1661, 1591, 1545, 1506, 1454, 1420, 1394, 1327, 1308, 1240, 1097, 1070, 1026, 881, 820, 725; HRMS (ES+) m/z calcd for $C_{18}H_{17}BrNO_2$ [M + H]$^+$ 358.0443, found 358.0440.

*Methyl 1-Benzyl-7-methoxy-4-methyl-2-oxo-1,2-dihydroquinoline-6-carboxylate (**17**).* The general hydroarylation procedure was followed using 0.3 mmol of substrate **16**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with EtOAc/Hex 0−40% to afford the product **17** (66%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.18 (s, 1H), 7.33−7.21 (apparent m, 5H), 6.70 (s, 1H), 6.58 (s, 1H), 5.54 (s, 2H), 3.89 (s, 3H), 3.74 (s, 3H), 2.49 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 165.9, 162.8, 160.7, 147.4, 143.4, 136.4, 130.1, 129.1, 127.7, 126.8, 119.0, 114.9, 114.6, 98.6, 56.1, 52.3, 46.2, 19.2; FT-IR (cm^{-1}) 3062, 2948, 2918, 2847, 1725, 1657, 1624, 1598, 1556, 1458, 1437, 1398, 1320, 1259, 1242, 1218, 1092, 1026, 949, 912, 827, 729; HRMS (ES+) m/z calcd for $C_{20}H_{20}NO_4$ [M + H]$^+$ 338.1392, found 338.1395.

*1-Benzyl-4,5,7-trimethylquinolin-2(1H)-one (**19**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **18**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−50% to afford **19** (96%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.30−7.17 (apparent m, 6H), 6.96 (s, 1H), 6.79 (s, 2H), 6.57 (s, 1H), 5.53 (bs, 2H), 2.71 (s, 3H), 2.66 (s, 3H), 2.26 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.9, 148.7, 141.0, 140.0, 137.1, 136.8, 128.8, 128.2, 127.1, 126.5, 121.9, 119.2, 114.7, 46.4, 26.0, 25.4, 21.7; FT-IR (cm^{-1}) 3061, 3039, 2957, 2920, 2852, 1653, 1610, 1597, 1488, 1454, 1437, 1384, 1365, 1293, 1261, 1125, 1106, 1071, 1029, 940, 858, 834, 719, 702; HRMS (ES+) m/z calcd for $C_{19}H_{20}NO$ [M + H]$^+$ 278.1545, found 278.1546.

*1-Benzyl-4-methylquinolin-2(1H)-one (**21**).* The general hydroarylation procedure was followed at 80 °C using 0.2 mmol of substrate **20**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−40% to afford **21** (38%) as an amorphous white solid. Spectral data matched those previously reported for compound **21**.[18]

*5-Benzyl-8-methyl[1,3]dioxolo[4,5-g]quinolin-6(5H)-one (**23**).* The general hydroarylation procedure was followed using 0.5 mmol of substrate **22**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−50% to afford **23** (58%) as an amorphous pale yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.31−7.17 (apparent m, 5H), 7.06 (s, 1H), 6.74 (s, 1H), 6.58 (s, 1H), 5.96 (s, 2H), 5.50 (bs, 2H), 2.41 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 162.3, 150.5, 146.7, 143.6, 136.5, 136.3, 128.9, 127.3, 126.6, 118.7, 116.2, 103.3, 101.9, 96.3, 46.4, 19.7; FT-IR (cm^{-1}) 3062, 3030, 2998, 2953, 2914, 2853, 1654, 1603, 1505, 1495, 1456, 1417, 1302, 1246, 1175, 1105, 1038, 933, 862, 824, 733, 722; HRMS (ES+) m/z calcd for $C_{18}H_{16}NO_3$ [M + H]$^+$ 294.1130, found 294.1135.

*7-Amino-4-methylquinolin-2(1H)-one (**25**) and 5-Amino-4-methylquinolin-2(1H)-one (**26**).* The general 0hydroarylation procedure was followed using 0.2 mmol of substrate **24**. The starting material was insoluble at room temperature and only partly soluble at 50 °C, which made monitoring the reaction by TLC or GC-MS unusually difficult. Thus, the mixture was stirred for 24 h. The resulting heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield an inseparable mixture of **25** and **26** (86%) as an amorphous pale yellow solid. Spectral data matched those previously reported for compound **25**.[19]

*10-Methoxy-1-methyl-6,7-dihydropyrido[3,2,1-ij]quinolin-3(5H)-one (**28**).* The general hydroarylation procedure was followed using 0.4 mmol of substrate **27**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−70% to afford **28** (98%) as an amorphous white solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 7.24 (d, J = 8.4 Hz, 1H), 6.70 (d, J = 8.4 Hz, 1H), 6.28 (s, 1H), 3.95 (t, J = 5.4 Hz, 2H), 3.80 (s, 3H), 2.81 (t, J = 5.7 Hz, 2H), 2.51 (s, 3H), 1.89 (quint., J = 5.4 Hz, 2H); ^{13}C NMR (DMSO-d_6, 75 MHz) δ 160.1, 156.6, 146.8, 137.7, 130.4, 120.2, 117.0, 110.9, 103.9, 55.8, 41.8, 27.1, 24.7, 20.1; FT-IR (cm^{-1}) 2929, 2891, 2840, 1649, 1585, 1473, 1426, 1388, 1311, 1264, 1246, 1229, 1169, 1157, 1135, 1079, 1032, 934, 861, 797, 694, 660; HRMS (ES+) m/z calcd for $C_{14}H_{16}NO_2$ [M + H]$^+$ 230.1181, found 230.1185.

*4-Benzyl-1-methylbenzo[f]quinolin-3(4H)-one (**30**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **29**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−45% to afford **30** (76%) as an

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amorphous beige solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.65 (d, J = 8.7 Hz, 1H), 7.83−7.78 (apparent m, 2H), 7.60 (t, J = 8.4 Hz, 1H), 7.48 (t, J = 7.2 Hz, 2H), 7.29−7.19 (apparent m, 5H), 6.84 (s, 1H), 5.72 (bs, 2H), 2.98 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 161.7, 148.4, 139.9, 136.7, 132.4, 131.1, 130.1, 129.2, 129.0, 127.4, 127.3, 126.5, 125.6, 125.0, 123.0, 116.8, 116.1, 46.7, 27.2; FT-IR (cm^{-1}) 3059, 3026, 2967, 2918, 2850, 1652, 1575, 1543, 1515, 1489, 1453, 1429, 1387, 1308, 1028, 940, 864, 808, 724, 696; HRMS (ES+) m/z calcd for $C_{21}H_{18}NO$ $[M + H]^+$ 300.1388, found 300.1394.

*1-Benzyl-4-methylbenzo[h]quinolin-2(1H)-one (**32**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **32**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−45% to afford **32** (98%) as an amorphous white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.21 (d, J = 8.7 Hz, 1H), 7.86 (d, J = 8.1 Hz, 1H), 7.72 (d, J = 8.7 Hz, 1H), 7.65 (d, J = 8.4 Hz, 1H), 7.49 (t, J = 7.2 Hz, 1H), 7.39−7.25 (apparent m, 6H), 6.75 (s, 1H), 5.65 (s, 2H), 2.56 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 147.6, 139.9, 135.4, 128.9, 128.7, 127.2, 127.1, 126.1, 126.0, 125.3, 123.9, 123.8, 121.8, 120.9, 119.5, 55.1, 20.0; FT-IR (cm^{-1}) 3062, 3025, 2917, 2849, 1651, 1612, 1592, 1539, 1477, 1386, 1360, 1296, 1263, 929, 858, 818, 753, 719, 694; HRMS (ES+) m/z calcd for $C_{21}H_{18}NO$ $[M + H]^+$ 300.1388, found 300.1393.

*4-Methyl-1H-pyrrolo[2,3-h]quinolin-2(7H)-one (**34**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **33**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **34** (99%) as an amorphous pale gray solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.84 (bs, 1H), 11.47 (bs, 1H), 7.40 (d, J = 8.7 Hz, 1H), 7.35 (t, J = 2.4 Hz, 1H), 7.26 (d, J = 9.0 Hz, 1H), 7.24 (t, J = 2.4 Hz, 1H), 6.27 (s, 1H), 2.46 (s, 3H); ^{13}C NMR (DMSO-d_6, 75 MHz) δ 162.8, 149.9, 137.1, 133.4, 124.8, 118.2, 117.1, 115.5, 112.0, 107.8, 101.0, 19.9; FT-IR (cm^{-1}) 2915, 2849, 1635, 1619, 1541, 1508, 1394, 1376, 1350, 1274, 1246, 885, 796, 743; HRMS (ES+) m/z calcd for $C_{12}H_{11}N_2O$ $[M + H]^+$ 199.0871, found 199.0874.

*9-Methyl-3H-pyrrolo[3,2-f]quinolin-7(6H)-one (**36**).* The general hydroarylation procedure was followed using 0.4 mmol of substrate **35**. Following complete consumption of the starting material, as observed by TLC, the heterogeneous mixture was filtered through filter paper. The solid was dried under vacuum to yield **36** (97%) as an amorphous pale gray solid. ^{1}H NMR (DMSO-d_6, 300 MHz) δ 11.60 (s, 1H), 11.50 (s, 1H), 7.61 (d, J = 8.7 Hz, 1H), 7.47 (t, J = 3.0 Hz, 1H), 7.15 (d, J = 8.7 Hz, 1H), 6.87 (t, J = 2.1 Hz, 1H), 6.36 (s, 1H), 2.69 (s, 3H); FT-IR (cm^{-1}) 2919, 2847, 1651, 1541, 1521, 1420, 1356, 1328, 1219, 1171, 1102, 911, 842, 729; HRMS (ES+) m/z calcd for $C_{12}H_{11}N_2O$ $[M + H]^+$ 199.0871, found 199.0875.

*9-Methyl-2,3,5,6,7,12-hexahydropyrido[3,2,1-gh][1,7]-phenanthrolin-11(1H)-one (**38**).* The general hydroarylation procedure was followed using 0.2 mmol of substrate **37**. Following complete consumption of the starting material, as observed by TLC, the solution was concentrated onto Celite and purified via automated column chromatography on silica gel eluting with a gradient of EtOAc/Hex 0−60% to afford **38** (78%) as an amorphous yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.41 (bs, 1H), 7.11 (s, 1H), 6.19 (s, 1H), 3.23 (apparent m, 4H), 2.82 (t, J = 6.3 Hz, 2H), 2.67 (t, J = 6.6 Hz, 2H), 2.37 (s, 3H), 2.08 (quint., J = 6.0 Hz, 2H), 1.99 (quint., J = 6.3 Hz, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 163.4, 149.2, 144.9, 135.8, 122.5, 118.0, 114.8, 111.0, 102.7, 50.4, 49.3, 28.1, 22.0, 21.2(4), 21.1(9), 19.3; FT-IR (cm^{-1}) 3166, 3098, 3033, 2941, 2839, 1646, 1617, 1559, 1511, 1469, 1434, 1383, 1349, 1318, 1300, 1241, 1206, 1182, 1158, 1131, 1077, 1056, 1024, 910, 845, 731; HRMS (ES+) m/z calcd for $C_{16}H_{19}N_2O$ $[M + H]^+$ 255.1497, found 255.1496.

Part 5. *N*-Benzyl-2-quinolinone Debenzylation Procedure. A round-bottom flask was charged with Pd/C 5% by wt (19 mg, 50% by wt with respect to substrate), hydroarylation product **19** (38 mg, 1.4 mmol), AcOH (1.4 mL, 0.1M), and a Teflon coated micro stir bar. The flask was sealed with a septum and purged with hydrogen three times, after which a balloon of hydrogen gas affixed to a syringe was inserted through the septum. The flask was heated to 70 °C and stirred vigorously. The progress of the reaction was monitored by GC-MS. After 5 h complete consumption of the starting material was observed. The mixture was cooled to room temperature, diluted with DCM, and filtered through Celite. The filtrate was neutralized by the slow addition of $NaHCO_3$ (satd. aq). The organic layer was dried over $MgSO_4$, filtered, and concentrated to yield the known compound **39** (24.7 mg, 96%) as an amorphous white solid.[20]

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.joc.6b02984.

^{1}H and ^{13}C NMR spectra (PDF)

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Notes

The authors declare no competing financial interest.

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