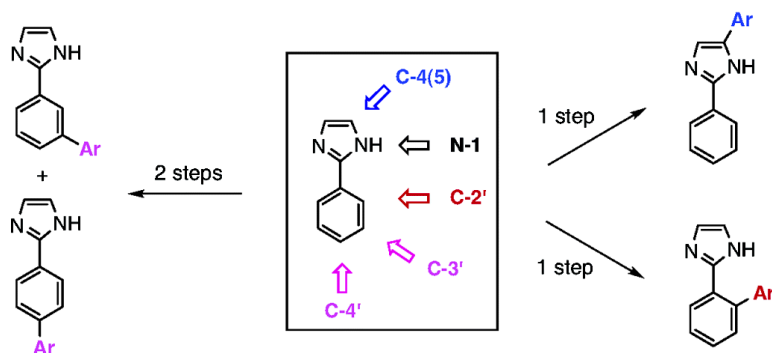## Article

Diversity Synthesis via C–H Bond Functionalization: Concept-Guided Development of New C-Arylation Methods for Imidazoles

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Diversity Synthesis via C−H Bond Functionalization: Concept-Guided Development of New C-Arylation Methods for Imidazoles

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This paper was retracted on June 21, 2006 (*J. Am. Chem. Soc.* 2006, *128*, 8364).

Abstract: Herein, we have formulated the concept of systematic derivatization of a structural motif via C−H bond functionalization. This concept may not only serve as a blueprint for new strategies in diversity synthesis but also provide systematic guidance for the identification of unsolved and important synthetic challenges. To illustrate this point, 2-phenylimidazole was selected as the core motif for this study, a choice inspired by numerous azole-based synthetics, including pharmaceuticals (compound SB 202190), and also fluorescent and chemiluminescent probes. We were able to show that systematic and comprehensive arylation of the 2-phenylimidazole core was feasible, and in the context of this study new arylation methods were developed. The direct 4-arylation of free 2-phenylimidazole was achieved with iodoarenes as the aryl donors in the presence of palladium catalyst (Pd/Ph₃P) and magnesium oxide as the base. A complete switch from C-4 to C-2′ arylation was accomplished using a ruthenium catalyst [CpRu(Ph₃P)₂Cl] and Cs₂CO₃. The corresponding transformations for (*N*,2)-diphenylimidazole (C-5 and C-2′ arylation) were accomplished via the palladium-based method [Pd(OAc)₂/Ph₃P/Cs₂CO₃] and a rhodium-catalyzed procedure [Rh(acac)(CO)₂/Cs₂CO₃], respectively. All of the arylation methods described herein demonstrated broad synthetic scope, high efficiency, and exclusive selectivity. Furthermore, these new methods proved to be orthogonal to one another and applicable to sequential arylation schemes. With these methods in hand, arrays of arylated imidazoles may now be accessed in a direct manner from 2-phenylimidazole. This strategy stands in sharp contrast to a traditional approach, wherein a distinct and multistep synthesis would be required for each analogue.

Introduction

Systematic Derivatization of Structural Motifs via C−H Bond Functionalization: The Concept. The possibility of direct and selective introduction of a new functionality (or a new C−C bond) via C−H bond functionalization[1] has long intrigued both developers and practitioners of organic preparative chemistry.[2] The value of such methods is readily apparent in target-oriented synthesis as multistep synthetic sequences, often needed for establishing a new group at a preset position, may substantially be truncated. As a consequence, the possession of such synthetic ability will inspire new strategies for the assembly of organic compounds.[3]

The impact of C−H bond functionalization may be even greater in the context of diversity synthesis, where multiple
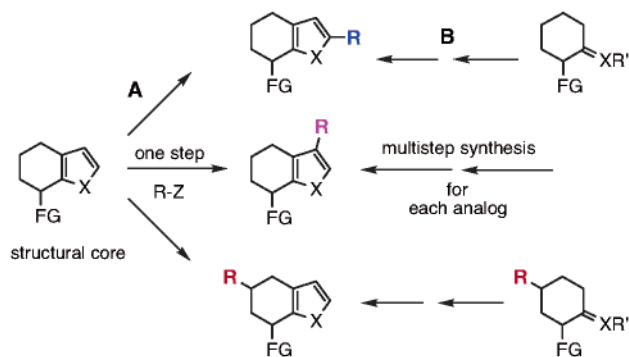

Figure 1. Diversity synthesis via (A) C−H bond functionalization versus (B) traditional methods.

derivatives of a selected structural core may be generated in a direct fashion (one step) from the core motif itself (Figure 1A). This new strategy stands in stark contrast to traditional approaches, which require multistep and often distinct schemes

(1) In our view, the term "C−H bond activation" carries considerable mechanistic claim, while "C−H bond functionalization" simply describes a formal process. Consequently, in the case of unsaturated substrates (e.g., arenes, alkenes) or substrates containing relatively acidic C−H bonds (e.g., alkynes), the term "C−H activation" should be used thoughtfully, as other mechanistic modes are readily available (cf. electrophilic metalation of arenes). Thus, in the absence of a clear mechanistic picture, we prefer the use of a general term "C−H bond functionalization".

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(3) (a) Taber, D. F.; Stiriba, S.-E. *Chem. Eur. J.* **1998**, *4*, 990−992. (b) Dangel, B. D.; Johnson, J. A.; Sames, D. *J. Am. Chem. Soc.* **2001**, *123*, 8149−8150. (c) Johnson, J. A.; Li, N.; Sames, D. *J. Am. Chem. Soc.* **2002**, *124*, 6900−6903. (d) Dangel, B. D.; Godula, K.; Youn, S. W.; Sezen, B.; Sames, D. *J. Am. Chem. Soc.* **2002**, *124*, 11856−11857. (e) Davies, H. M. L.; Venkataramani, C.; Hansen, T.; Hopper, D. W. *J. Am. Chem. Soc.* **2003**, *125*, 6462−6468.
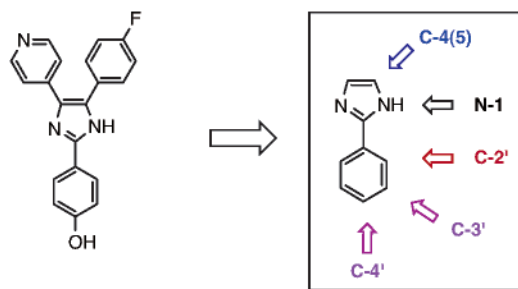
Figure 2. A pharmaceutical lead (SB 202190) inspired the selection of the 2-phenylimidazole motif.

for each derivative (Figure 1B). In addition to significant practical consequences, the concept of comprehensive elaboration of structural motifs serves to systematically expose unsolved and important synthetic challenges.

Systematic Arylation of the 2-Phenylimidazole Core. Heteroaromatics constitute an important class of structural units frequently found in natural products, pharmaceuticals, and other functional synthetics. Recently, we reported a palladium-catalyzed C-arylation of free (NH)-azoles, and this work led us to further explore direct arylation methods with tunable selectivities at the heteroarene core.[4] The selection of 2-phenylimidazole as the structural motif for this study was primarily inspired by compound SB 202190, a synthetic inhibitor of p38 kinase and a clinical candidate for the treatment of inflammatory and immunological disorders.[5] Furthermore, many fluorescent and chemiluminescent probes contain the arylated azole motif.[6] Encouraged by our recent results in the arylation of free azoles and guided by the concept described above, we formulated the challenge of comprehensive arylation of 2-phenylimidazole (Figure 2). Note that this task required the selective targeting of four different C—H bonds in the presence of a free amine functionality, an intriguing chemical challenge, indeed.

This goal stimulated the development of new arylation methods for imidazole substrates, which is the main subject of this report. The direct arylation of positions C-4 and C-2′ in 2-phenylimidazole and positions C-5 and C-2′ in (*N*,2)-diphenylimidazole was accomplished with complete control of regiochemistry. Moreover, these new methods proved to be orthogonal to one another and applicable to sequential arylation schemes. In addition, arylation of positions C-3′ and C-4′ was accomplished via a two-step sequence, yielding a separable mixture of compounds **5** and **6** as the main products (Figure 3). Remarkably, complete and systematic arylation of the 2-phenylimidazole core was achieved, providing a specific example of the general concept introduced earlier. Consequently, diverse arylimidazole compounds may be synthesized directly from the common core, eliminating the need for multistep syntheses of each analogue.

Results and Discussion

Selective C-4 Arylation of 2-Phenylimidazole. In the course of our investigations, we found that known arylation conditions were not applicable to free (NH)-azoles, including methods developed for oxazole and thiazole substrates [Ar-X/Pd(OAc)$_2$/
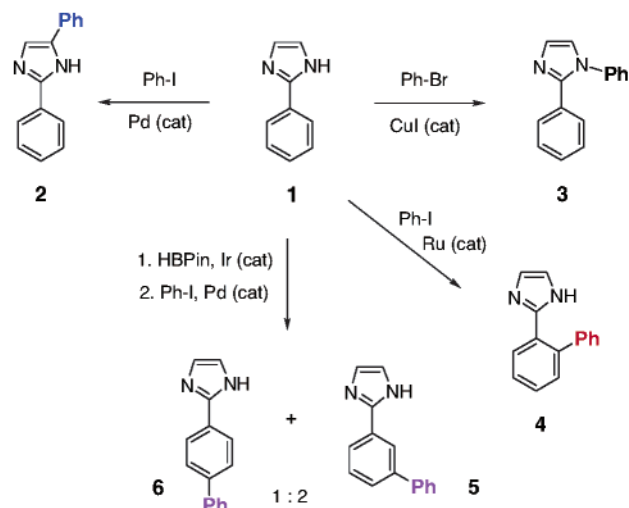

Figure 3. Programmable and comprehensive arylation of the 2-phenyl-imidazole core.

Cs$_2$CO$_3$].[7] Thus, we set out to explore the possibility for selective C-arylation of free (NH)-azole, a challenge attainable via selective targeting of C—H bonds in the presence of free N—H functionality. We hypothesized that the failure of the alkali bases (e.g., NaOMe, KOtBu, Cs$_2$CO$_3$) was due to formation of a solvated azolyl anion, which in turn inhibited the palladium catalyst via formation of a phenylpalladium—azolyl complex.[4] Facing this challenge, we proposed that a salt possessing a strong metal—nitrogen bond may not only protect the amino function but also increase the nucleophilicity of the annular carbon centers of the heteroarene. Led by this hypothesis, we found that MgO proved to be the base of choice when used in combination with Pd(OAc)$_2$ and triphenylphosphine. Exclusive C-arylation was achieved under these conditions with a number of free azoles, including pyrrole, indole, pyrazole, and imidazole. Importantly, 2-phenylimidazole **1** afforded C-4 arylation product **2** in 82% yield (Scheme 1).

The Pd/Ph$_3$P/MgO system was then investigated in the context of 2-phenylimidazole with respect to the substitution on the aryl donor. This method was found to be compatible with both electron-donating and electron-withdrawing substituents in the 4-position of aromatic iodide. While electron-releasing groups (Me, OMe) had no effect on efficiency of this reaction, electron-withdrawing substituents (F, CF$_3$, COMe) resulted in minor reduction of the yields (76–80%, Scheme 1). Regarding the bromide donors, Ph-Br provided the lower yield of product **2** (60%) in comparison to Ph-I (82%), while 4-bromopyridine proved to be an excellent donor, furnishing compound **12** in 80% isolated yield. 2-Iodotoluene also led to exclusive 4-arylation, albeit at a slower rate, furnishing product **13** in 72% yield. A notable exception to an otherwise broad scope was found when a dimethylamino group was placed in the para position of the aryl donor. Both 4-(dimethylamino)iodobenzene and the corresponding bromide decomposed during the reaction, yielding no desired product **8** (Scheme 1). The exclusive formation of the C-4 arylated products is noteworthy, as neither N-arylation

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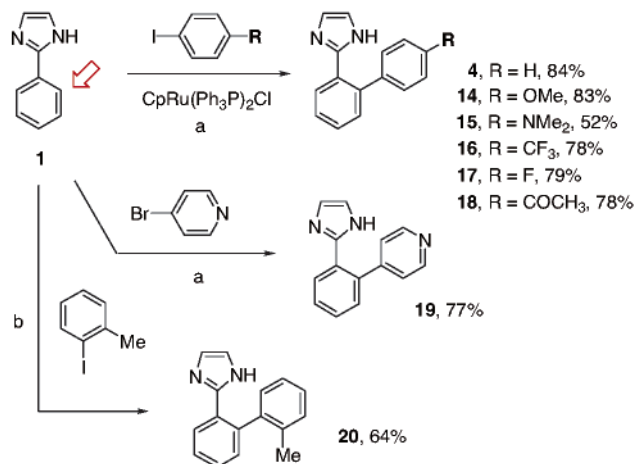
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Scheme 1. Selective 4-Arylation of 2-Phenylimidazole[a]

2, R = H, 82%
7, R = OMe, 82%
8, R = NMe₂, 0%
9, R = CF₃, 80%
10, R = F, 78%
**11**, R = COCH₃, 76%

12, 80%

13, 72%
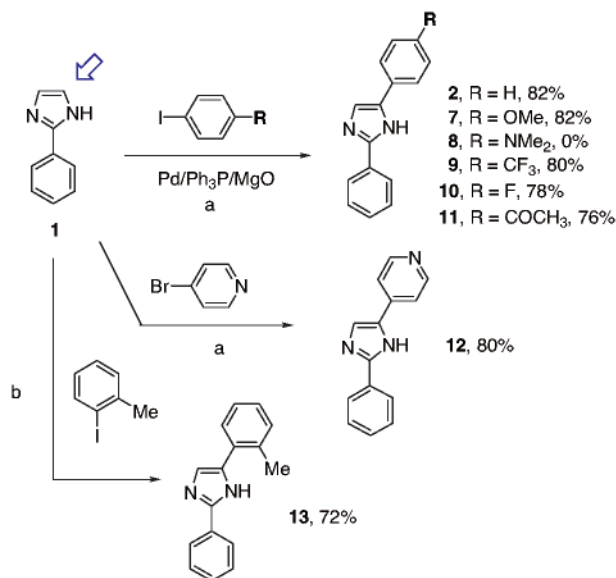
[a] Conditions: (a) Ar-X (1.2 equiv), Pd(OAc)₂ (5 mol %), Ph₃P (20 mol %), MgO (1.2 equiv), dioxane, 150 °C. (b) The same as conditions a except that 1.8 equiv of 2-Me-C₆H₄-I was used.

Scheme 2. Selective 2′-Arylation of 2-Phenylimidazole[a]

4, R = H, 84%
14, R = OMe, 83%
15, R = NMe₂, 52%
16, R = CF₃, 78%
17, R = F, 79%
18, R = COCH₃, 78%

19, 77%

20, 64%

[a] Conditions: (a) Ar-X (1.8 equiv), CpRu(Ph₃P)₂Cl (5 mol %), Cs₂CO₃ (1.2 equiv), DMF, 130 °C. (b) The same as conditions a except that 2.4 equiv of 2-Me-C₆H₄-I was used.

Scheme 3. C-3′ and C-4′ Arylation of 2-Phenylimidazole[a]

5   2 : 1   **6**
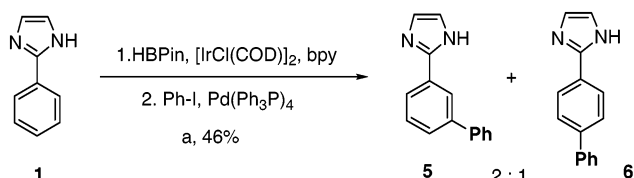
[a] Conditions. Step 1: HBPin (1.2 equiv), [IrCl(COD)]₂ (1.5 mol %), bipyridine (3 mol %), NaOMe (6 mol %), hexane, 80 °C. Step 2: Ph-I (1 equiv), Pd(PPh₃)₄ (5 mol %), K₂CO₃ (1 equiv), DMF, 100 °C. 4-Arylation product **2** was also formed in 6% yield.

nor bis-arylation products were detected even in the presence of an excess of the haloarene donor.

Selective C-2′ Arylation of 2-Phenylimidazole. As the N-arylation of imidazoles has previously been established by other groups,[8–10] the next challenge involved the selective arylation of position C-2′. N-Directed arylation of 2-phenyl-pyridine and arylalkylimines has previously been demonstrated with aryl halide and stannane donors.[11] However, these methods suffered from poor selectivity, as 2′,6′-bis-arylation products were formed in significant amounts in addition to the desired monoarylated compounds.[12] Furthermore, selective 2′-arylation of free 2-phenylimidazole has not been previously reported, and once again the issue of targeting a C–H bond in the presence of a free amine group presented itself. Consequently, we undertook a systematic study focusing on Ru and Rh metal complexes as potential catalysts (see Supporting Information for complete screening results).[13] To our delight, we found that exclusive C-2′ arylation was attainable, CpRu(Ph₃P)₂Cl being the most efficient catalyst. Thus, heating 2-phenylimidazole **1**

with PhI (1.8 equiv) in the presence of CpRu(Ph₃P)₂Cl (5 mol %) and Cs₂CO₃ (1.2 equiv) yielded desired compound **4** in 84% yield (Scheme 2). The use of bromobenzene afforded 69% yield of **4** under identical conditions.
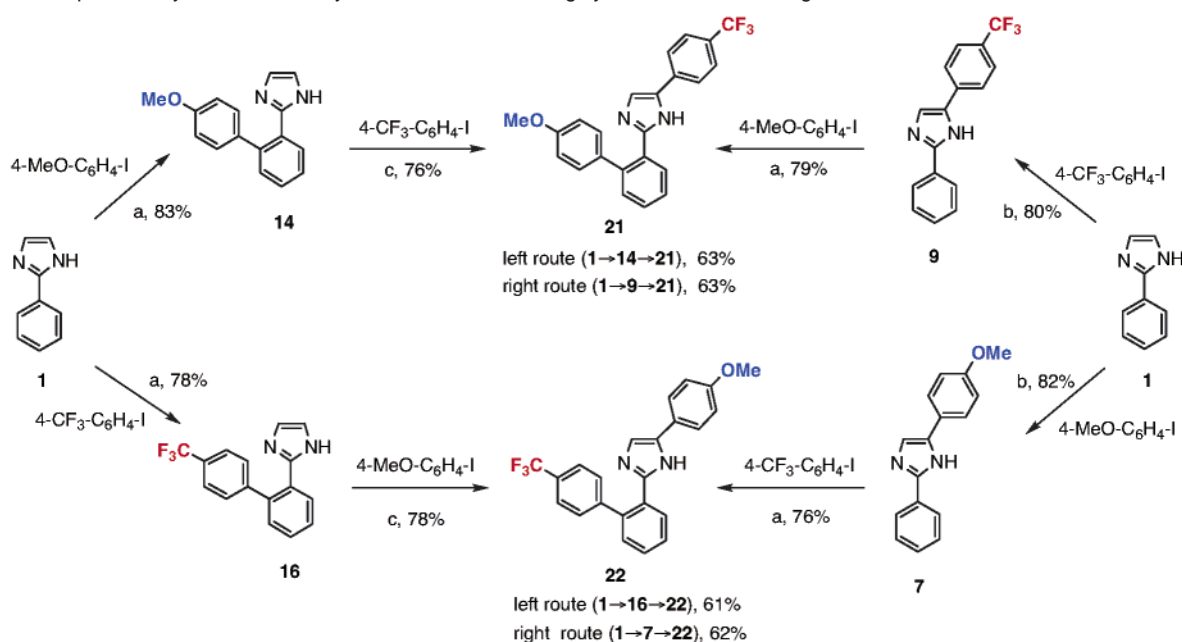
The scope of the ruthenium-catalyzed C-2′ arylation methodology was subsequently explored in terms of the aryl halide substitution. This method also showed broad utility, and tolerated both electron-donating and electron-withdrawing substituents at the 4-position, furnishing C-2′-arylated products in good to excellent yields (77–84%). 2-Iodotoluene and 4-(dimethyl-amino)iodobenzene were less efficient donors, but nevertheless, desired compounds **20** and **15** were obtained in 64 and 52% yields, respectively (Scheme 2).

Although the mechanism of this reaction remains speculative, the oxidative addition of aryl halide to the ruthenium metal and the cyclometalation represent two key events of the catalytic cycle. While the order of these two steps is not certain, the N-directed metalation must presumably be responsible for the observed C-2′ selectivity.

The exclusive formation of 2′-arylated products was found in all studied cases under the optimized conditions. It is remarkable that no arylation of the imidazole ring was observed even in the presence of excess aryl halide and at elevated temperatures (>1.8 equiv of ArI or >130 °C). Only under such forceful conditions were the 2′,6′-diarylated products detected.

(8) Palladium-catalyzed N-arylation of imidazoles has not been reported. For N-arylation of other heterocycles: (a) Mann, G.; Hartwig, J. F.; Driver, M. S.; Fernández-Rivas, C. *J. Am. Chem. Soc.* **1998**, *120*, 827–828. (b) Hartwig, J. F.; Kawatsura, M.; Hauck, S. I.; Shaughnessy, K. H.; Alcazar-Roman, L. M. *J. Org. Chem.* **1999**, *64*, 5575–5580. (c) Old, D. W.; Harris, M. C.; Buchwald, S. L. *Org. Lett.* **2000**, *2*, 1403–1406. (d) Grasa, G. A.; Viciu, M. S.; Huang, J.; Nolan, S. P. *J. Org. Chem.* **2001**, *66*, 7729–7737.

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(12) Recent example of ruthenium-catalyzed arylation of aromatic ketones also suffered from fast bis-arylation unless sterically bulky substrates were used (e.g., pivaloylarenes). Kakiuchi, F.; Kan, S.; Igi, K.; Chatani, N.; Murai, S. *J. Am. Chem. Soc.* **2003**, *125*, 1698–1699.

(13) Examples of other heteroatom-directed and catalytic C–C bond-forming reactions at the arene ring: (a) Kakiuchi, F.; Murai, S. In *Activation of Unreactive Bonds and Organic Synthesis*; Murai, S., Ed.; Springer: Berlin, 1999; pp 47–79. (b) Jun, C.-H.; Hong, J.-B.; Kim, Y.-H.; Chung, K.-Y. *Angew. Chem., Int. Ed.* **2000**, *39*, 3440–3442. (c) Thalji, R. K.; Ahrendt, K. A.; Bergman, R. G.; Ellman, J. A. *J. Am. Chem. Soc.* **2001**, *123*, 9692–9693.

Scheme 4. Sequential Arylation of 2-Phenylimidazole Core with Highly Selective and Orthogonal Methods[a]

left route (**1**→**14**→**21**), 63%
right route (**1**→**9**→**21**), 63%

left route (**1**→**16**→**22**), 61%
right route (**1**→**7**→**22**), 62%

[a] Conditions: (a) Ar–I (1.8 equiv), CpRu(Ph₃P)₂Cl (5 mol %), Cs₂CO₃ (1.2 equiv), DMF, 130 °C. (b) Ar–I (1.2 equiv), Pd(OAc)₂ (5 mol %), Ph₃P (20 mol %), MgO (1.2 equiv), dioxane, 150 °C. (c) Ar–I (1.2 equiv), Pd(OAc)₂ (5 mol %), Ph₃P (20 mol %), MgO (1.2 equiv), K₃PO₄ (1.2 equiv), dioxane/DMF, 150 °C.

The selective formation of 2′-arylation versus 2′,6′-diarylation product merits additional comment. The slower rate of the second arylation step may be ascribed to stereo-electronic effects associated with the conformational change (disfavoring co-planarity between the phenyl ring in the 2-position and the imidazole) exerted by the arene ring in the 2′-position (for arylation rates with **1** vs **4**, see Supporting Information). Importantly, the new catalytic system developed herein [CpRu(Ph₃P)₂Cl/Cs₂CO₃] showed higher selectivity for substrate **1** in comparison to previously reported methods.[11] Thus, formation of bis-arylation products may be completely avoided while achieving high yields of the desired monoarylation products (approximate reaction time, 10 h). Apparently, the Cp ligand provides the favorable tuning of the ruthenium catalyst.

C-3′ and C-4′ Arylation of 2-Phenylimidazole. To complete the systematic arylation of the 2-phenylimidazole core, a selective targeting of positions C-3′ and C-4′ remained. This task posed a considerable challenge as meta and para positions of an electron-deficient benzene ring were to be functionalized selectively, in the presence of the free imidazole ring. Although presently there are no direct arylation methods capable of such fine chemoselectivity, we considered the application of a two-step procedure, consisting of direct borylation, followed by Suzuki coupling (Scheme 3). The iridium-catalyzed borylation of arenes, a remarkable methodology recently reported by others, was indeed shown to target meta and para positions of substituted benzene substrates.[14] However, the issues regarding the selectivity and degree of borylation remained unclear since both arenes and heteroarenes have been shown to undergo facile borylation.[15]

Thus, compound **1** was submitted to a two-step sequence, including the borylation protocol developed in the Miyaura and Hartwig laboratories, followed by Suzuki coupling. After some optimization, a 2:1 mixture of compounds **5** and **6**, products of C-3′ and C-4′ arylation, respectively, was formed in 46% combined yield. A small amount of C-4 arylation product **2** (6%) was also isolated. Compounds **5** and **6** were prepared in a pure form following separation by flash chromatography. We were not able to improve the yields of this sequence, as the addition of excess pinacolborane resulted in the formation of bis-borylation products. The ability to control the extent of borylation remains to be achieved in this methodology, particularly in the context of complex arenes wherein the use of an excess of the arene substrate is impractical. Regardless of the low yields, these results serve to demonstrate the feasibility of selectively targeting relatively unreactive C–H bonds.

In summary, comprehensive arylation of 2-phenylimidazole was achieved affording all five isomers **2**−**6** in a direct fashion from the same starting material (Figure 3). With the exception of positions C-3′ and C-4′ where a mixture of the corresponding products was formed, arylation of positions C-4, N-1, and C-2′ may now be carried out with complete control of regioselectivity.

Sequential Arylation of 2-Phenylimidazole via Fully Orthogonal Arylation Methods. The monoarylation of 2-phenylimidazole was accomplished with excellent selectivity at C-4 and C-2′ positions, employing the methods discussed above. The next key question centered on the possibility of performing two arylation reactions sequentially, thus providing a direct route to diarylated derivatives.

We were gratified to find that both arylation methods were fully orthogonal and applicable to sequential functionalization (Scheme 4). To demonstrate this point, regioisomers **21** and **22** were prepared in two steps from the same starting material **1**. Furthermore, both compounds may be accessed via two alterna-

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Scheme 5. (*N*,2)-Diphenylimidazole Core: Development of the 2′-Arylation Method

81% (no bis-arylation)
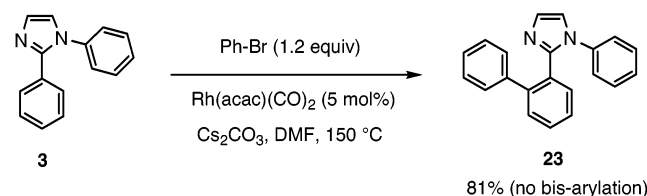
tive routes. For instance, compound **21** was synthesized via two routes, which differed in the order of the arylation steps. The left route (Scheme 4) involved the C-2′ arylation first, followed by the C-4 arylation. The ruthenium-catalyzed C-2′ arylation was conducted in the presence of 4-methoxy-iodobenzene as the arene donor under the conditions developed earlier, furnishing compound **14** in 83% yield. Subsequent palladium-catalyzed arylation with 4-trifluoromethyl-iodobenzene produced the desired compound **21** as the exclusive product in 76% yield. Alternatively, compound **21** was synthesized via the right route wherein the C-4 arylation was carried out first, followed by the C-2′ arylation. Both routes afforded compound **21** with identical overall efficiency (63% yield). Similarly, regioisomer **22** was prepared via two alternative routes with essentially identical yields (61−62%).

A minor modification of the original C-4 selective protocol was required for the biphenylimidazole substrates (cf. **14** and **16**). In these cases, addition of the second base (K_3PO_4) was required to obtain good yields (Scheme 4, conditions c).

Noteworthy is the fact that compounds **7** and **9** contain two arene rings, both of which are poised for potential directed ortho arylation (C-2′ vs C-2″), raising a selectivity issue not previously encountered in substrate **1**. Remarkably, exclusive arylation of the 2′-position was observed, providing the desired products **21** and **22** in 79 and 76% yields, respectively. We rationalized this finding by a simple steric argument. The C-2′ selectivity may be explained by the directing effect of the less hindered
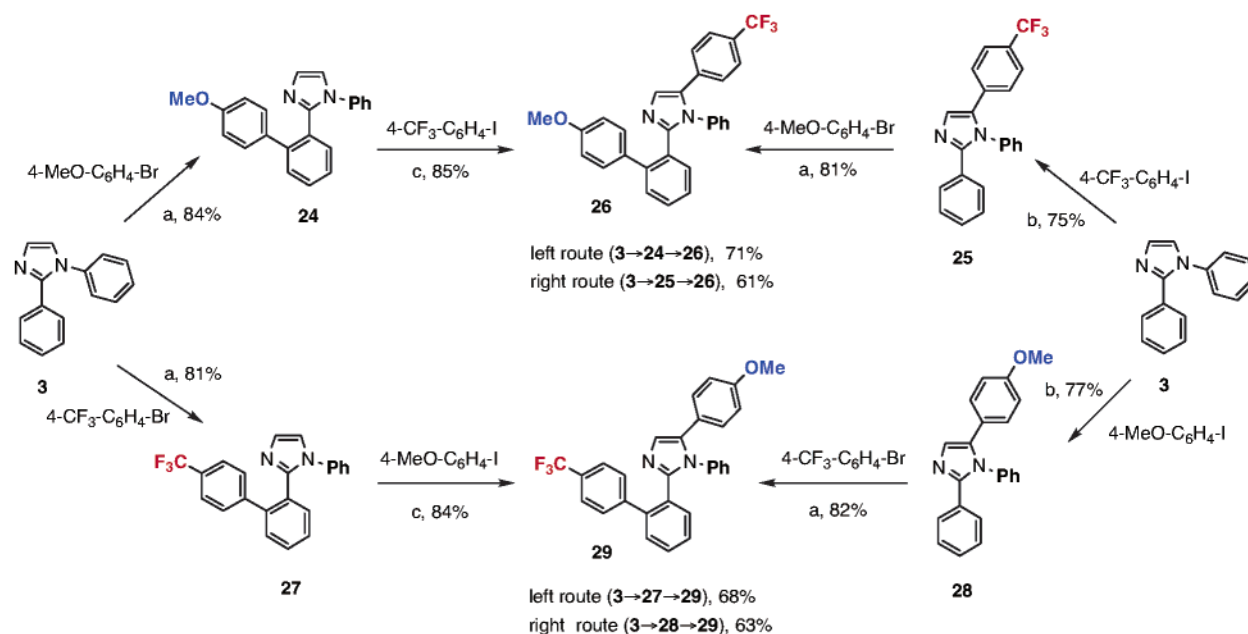
nitrogen atom, whereas the C-2″ arylation would require the involvement of the more crowded nitrogen atom (we assume that compounds **7** and **9** exist as two tautomeric forms in equilibrium). Thus, even in the presence of an electron-rich aryl ring at C-4 position (cf. **7**), exclusive arylation of the electron-poor ring was observed.

These two examples demonstrated the full orthogonality of the new arylation methods, which bears significant consequences for the synthesis of imidazole-based arrays. The power of direct C−H bond functionalization thus becomes apparent in this context as diverse libraries of diarylated analogues may be synthesized from the same starting material, in two steps and via the same methodology for each analogue.

Sequential Arylation of (*N*,2)-Diphenylimidazole. As the N-arylated imidazoles are readily available, we proceeded to examine (*N*,2)-diphenylimidazole substrate **3**. As expected, the methodology developed for substrate **1** proved to be hardly applicable to **3**, a finding that prompted the development of new methods suitable for the *N*-aryl-imidazole substrates.

The ruthenium-catalyzed C-2′ arylation method, developed for substrate **1**, provided low yields of desired product **23** (<50%). Consequently, we submitted substance **3** to a systematic study, focusing primarily on ruthenium and rhodium metal complexes as the potential catalysts (for screening results, see Supporting Information). This effort led to the development of new conditions suitable for substrate **3** (Scheme 5). Efficient C-2′ arylation of this substrate using bromobenzene occurred in the presence of Rh(acac)(CO)$_2$ as the catalyst and Cs$_2$CO$_3$ as the base, affording compound **23** as the only detectable product in 81% yield. In this instance, bromobenzene proved to be a superior arene donor in comparison to iodobenzene, and Rh(acac)(CO)$_2$ outperformed the other Ru(II), Ru(III), and Rh(I) complexes examined in this study (Supporting Information).

The selective C-5 arylation of **3** was achieved under optimized conditions originally reported for 2-phenyloxazole, 2-methyl-thiazole, and (*N*,2)-dimethylimidazole by Miura et al.[7] The use

Scheme 6. Sequential Arylation of (*N*,2)-Diphenylimidazole Core with Highly Selective and Orthogonal Methods[a]

left route (**3**→**24**→**26**), 71%
right route (**3**→**25**→**26**), 61%

left route (**3**→**27**→**29**), 68%
right route (**3**→**28**→**29**), 63%

[a] Conditions: (a) Ar−Br (1.2 equiv), Rh(acac)(CO)$_2$ (5 mol %), Cs$_2$CO$_3$ (1.2 equiv), DMF, 150 °C. (b) Ar−I (1.2 equiv), Pd(OAc)$_2$ (5 mol %), Ph$_3$P (20 mol %), Cs$_2$CO$_3$ (1.2 equiv), DMF, 150 °C. (c) The same as conditions b except that 1.5 equiv of Ar−I was used.

Scheme 7. Direct C–H Bond Arylation versus Traditional Syntheses of Imidazole Analog Arrays
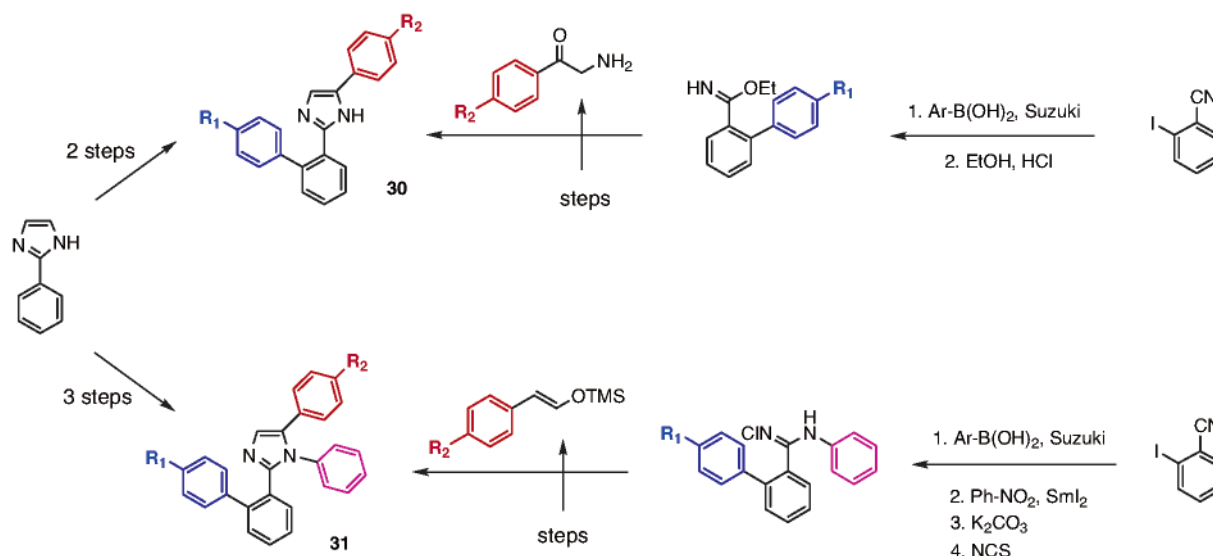
of Cs$_2$CO$_3$ as the base, in addition to aryliodide and Pd(OAc)$_2$, was crucial for the success of this transformation (Scheme 6). This method proved to be highly selective, yielding 1,2,5-triarylated products exclusively and in good yields. The high selectivity for substitution at the sterically hindered C-5 position may be rationalized by invoking an electrophilic metalation of the imidazole ring with the phenylpalladium halide.

Importantly, these two methods were compatible with the sequential functionalization strategy (Scheme 6). In analogy to the previous case, compounds **26** and **29** were prepared in two steps from the same starting material **3**, via two alternative pathways for each compound, highlighting the orthogonality of these arylation methods. In the case of **26**, both pathways gave good yields of the final product; however, the left route, consisting of C-2′ arylation as the first step followed by C-5 arylation, was more efficient in comparison to the right route (71 vs 61%, Scheme 6). For substance **29**, the C-2′→C-5 arylation sequence (the left route) was also superior; however, there seemed to be less difference between the two pathways (68 vs 63%, Scheme 6).

Conclusion

The introduction of a new bond via direct C–H bond functionalization has significant consequences in both target-oriented synthesis and diversity synthesis. In the context of the latter, we formulated the concept of systematic derivatization of a structural motif via C–H bond functionalization. This concept may play two major intellectual roles. First, it may serve as a blueprint for new strategies in diversity synthesis; second, it may provide systematic guidance for identification of unsolved and important synthetic challenges. To illustrate this point, we selected 2-phenylimidazole as the core motif for this study, a choice inspired by numerous azole-based synthetics, including pharmaceuticals (compound SB 202190) and fluorescent and chemiluminescent probes.

We have shown that systematic and comprehensive arylation of the 2-phenylimidazole core was feasible, and in the context of this study, new arylation methods were developed. The direct arylation of positions C-4 and C-2′ in 2-phenylimidazole and positions C-5 and C-2′ in (*N*,2)-diphenylimidazole was accomplished with complete control of regiochemistry. Furthermore, the new methods proved to be orthogonal to one another and applicable to sequential arylation schemes.

With this methodology in hand, arrays of arylated imidazoles may be accessed in a direct manner from 2-phenylimidazole. For instance, two analogue series, namely, the triarylimidazole array and the tetraarylimidazole array, represented by structures **30** and **31**, may be synthesized from the same starting material **1** in two or three steps, respectively. This strategy stands in sharp contrast to the traditional approach, where a distinct and multistep synthesis would be required for each series (Scheme 7). The development of new methods for direct functionalization of other heteroarenes is currently underway in our laboratories.

Supporting Information Available: Experimental procedures and spectral data for all products. This material is available free of charge via the Internet at http://pubs.acs.org.

JA036157J