Versatile Deacylative Cross-coupling of Aromatic Ketones

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ABSTRACT: Transition metal-catalyzed cross-couplings represent the most dependable techniques for linking aryl electrophiles with nucleophiles to synthesize a diverse array of valuable aromatic compounds. While aromatic ketones are crucial intermediates in the synthesis of aromatic compounds with numerous known methods for carbonyl transformations and aromatic ring modifications, few consider them as aryl electrophiles suitable for cross-coupling. This is primarily because forming new bonds with nucleophiles requires the cleavage of a strong C–C bond. Herein, we introduce a cross-coupling method that effectively utilizes aromatic ketones as versatile aryl electrophiles. The cornerstone of our strategy is the transformation of aromatic ketones into aromatic esters *via* sequential Claisen and regioselective retro-Claisen condensations. The resulting esters are then capable of undergoing reactions with various nucleophiles in a one-pot process.

INTRODUCTION

Since the turn of the 21st century, the synthesis of substituted aromatic compounds, pivotal in agrochemicals and organic materials, has been greatly simplified due to advances in transition metal-catalyzed cross-coupling methods.[1–3] These methods typically involve reacting haloarenes, a prevalent type of aryl electrophile, with nucleophiles in the presence of transition metal catalysts. Currently, next-generation cross-coupling methods that utilize a variety of electrophiles in versatile functional group cleavage-type reactions have emerged. Notably, these methods focus on aromatic compounds containing carbon–heteroatom bonds such as C–O, C–N, and C–S, effectively replacing traditional haloarenes (C–X).[4–8]. More recently, aromatic compounds containing carbon–carbon bonds, such as carboxylic acids, esters, amides, and nitriles, as well as alkanols have also begun to be used as aryl electrophiles.[9–15] In spite of this progress, aromatic ketones are considered to be some of the most challenging functionalized aromatic compounds to engage in this reaction paradigm.

Aromatic ketones are invaluable synthetic intermediates that can be converted into a diverse array of compounds not only through classical carbonyl transformations such as reductions, 1,2-addition reactions, and α-arylations, but also *via* transition metal-catalyzed aromatic ring C–H functionalization at the *ortho* position (Figure 1A).[16–20] In contrast, deacylative transformations, which employ the acyl group of the aromatic ketones as a leaving group to introduce various functional groups on the aromatic ring at the *ipso* position, are infrequently reported. The development of deacylative transformations that utilize aromatic ketones as arylating agents is significant, as it presents a novel method for derivatizing the aromatic ketone skeleton, further enhancing its value as a synthetic intermediate. A major challenge lies in cleaving the strong C(aryl)–C(acyl) bond of the ketone. Examples of catalytic cleavage of the C(aryl)–C(acyl) bond include methods using ring strain release energy of small-ring aromatic ketones, and oxidative addition of the C(alkynyl)–C(acyl) bond followed by decarbonylation in alkynyl ketones (Figure 1B, left).[21-23] While these methods have been successful with specific types of aromatic ketones (activated ketones), applying them to more general aromatic alkyl ketones or diaryl ketones (non-activated ketones) as arylation agents has been considered challenging. A challenge with deacylative transformations of aromatic ketones has been the requirement for directing groups or excess amounts of transition metals.[24–28]

There are three remarkable examples of decarbonylative cross-coupling methods using non-activated ketones (Figure 1B, right). Dong and coworkers used 2-aminopyridine as a transient directing group to achieve a decarbonylative Suzuki–Miyaura coupling between indanone and aromatic boronic acid esters, as well as ring expansion reactions involving the insertion of ethylene and alkynes.[29-31] This method represents an excellent technique for catalytically transforming ketones without directing groups; however, it is restricted to cyclic ketones, and only ethylene and alkynes can form bonds with aromatic compounds after deacylation. Dai and colleagues reported a sequential transformation method. This technique involves the conversion of aromatic ketones into oxime esters, followed by a coupling with nucleophiles using a Pd catalyst. Using this method, various coupling reactions with nucleophiles can be achieved, including deacylative borylation of aromatic ketones, Suzuki–Miyaura arylation, and Mizoroki–Heck alkenylation.[32–36] However, this method requires the purification of the oxime ester intermediate, making the process multistep. Recently, the Takaya group reported a borylation reaction *via*

decarbonylation, where acyl radicals generated under photoirradiation through Norrish Type I reaction are converted into acyl metal species using a transition metal catalyst.[37] This novel approach allows for the functionalization of non-activated ketones in a single step, although the reaction is limited to borylation.

Inspired by these works, we embarked on developing a versatile decarbonylative cross-coupling reaction that can react with a multitude of nucleophiles in a single step. In our mechanistic blueprint, the key lies in the "esterification" of ketones (Figure 1C). We hypothesized that if ketones could be efficiently esterified within the reaction system, given the recent development of decarbonylative couplings by our group and others,[10-14] the *in situ*-formed intermediate could theoretically react with a variety of reported nucleophiles. We then arrived at a potential solution: the classic Claisen/retro-Claisen condensation.[38,39] If selective retro-Claisen condensation could be achieved, it was assumed that it would convert into phenyl esters, which are effective for decarbonylative coupling.

With this strategy, we developed seven types of decarbonylative cross-coupling reactions: thioetherification, arylation, hydrogenation, α-arylation, and methylphosphonylation, along with amination and etherification.

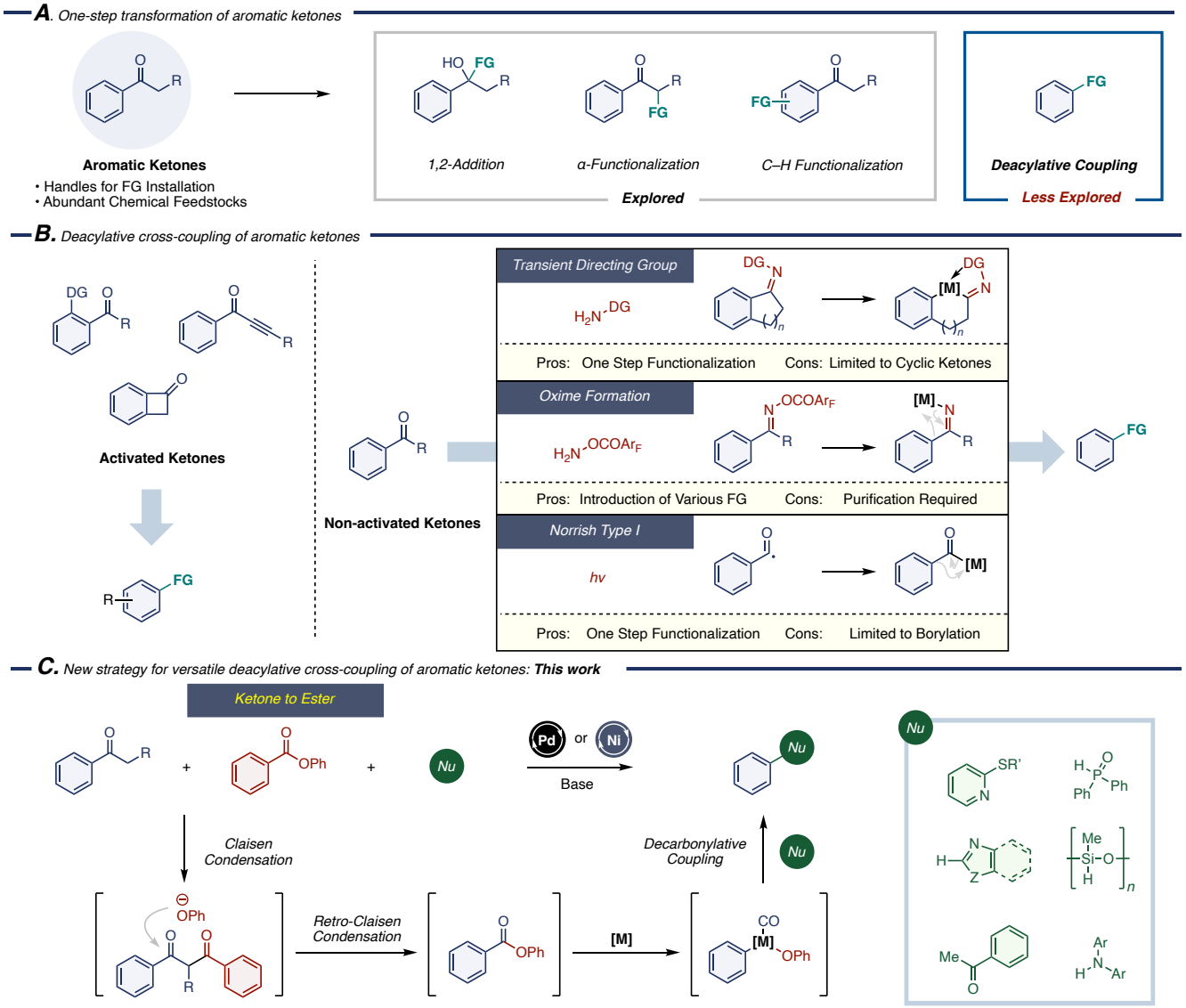

Figure 1. Deacylative transformation of aromatic ketones (A) One-step transformation of aromatic ketones. (B) Deacylative cross-coupling of activated aromatic ketones and non-activated aromatic ketones. (C) New strategy for versatile deacylative cross-coupling of aromatic ketones.

RESULTS AND DISCUSSION

Claisen/regioselective retro-Claisen condensation

This Claisen/regioselective retro-Claisen condensation was discovered serendipitously. While we were developing the decarbonylative α-arylation of ketones,[40] we reacted *p*-methoxyacetophenone (**1a**) with phenyl picolinate (**2A**) in toluene at 150 °C using K_3PO_4, Pd/dppm catalyst, and CsF. Unexpectedly, this resulted in the formation of *p*-anisic acid phenyl ester (**3a**) in a yield of 49% (Figures 2A and S1).

The formation of **3a** was found to not involve the Pd catalyst, but rather to arise from a Claisen condensation and subsequent retro-Claisen condensation between ketone **1a** and ester **2A** (Figure S2). To improve the yields for this reaction, optimization was conducted using 2-

acetylnaphthalene (**1b**) and phenyl picolinate (**2A**), which had functioned as an esterifying agent when the reaction was discovered (Figure 2B). When examining additives under the thermal conditions in toluene at 150 °C, it was found that the addition of K_3PO_4 (1.0 equiv) efficiently promotes the Claisen/retro-Claisen condensation, yielding **3b** in 86% yield (Figure 2B, entry 1). The reaction also proceeded when CsF (2.0 equiv) was added (Figure 2B, entry 2). However, no reaction occurred with K_2CO_3 or without any additives (Figure 2B, entry 3; for screening of other additives, see Table S2).

Next, the structure of the esterifying agent **2** was examined. Interestingly, no Claisen/retro-Claisen condensation occurred with phenyl nicotinate (**2B**) or phenyl isonicotinate (**2C**), which do not have an ester at the C2 position of the pyridine, and the starting material **1b** was recovered (Figure 2B, entries 5 and 6). Even when using the electron-deficient benzoic acid derivative **2D**, only trace amounts of **3b** were obtained (Figure 2B, entry 7). In the case of heteroaromatic esters with a nitrogen atom at the C2 position, **3b** was obtained in low to moderate yields (Table S2). Notably, similar reaction formats involving sequential Claisen and retro-Claisen condensation to exchange functionalities between aromatic ketones and ethyl trifluoroacetate have been reported,[38] but no reaction occurred under those conditions(entry 8). When ester derivatives other than phenyl esters were examined, ethyl ester **2F** and amide **2G** were found to not be suitable; however, Claisen/retro-Claisen condensation proceeded with thioester **2H** (Figure 2B, entries 9–11). Ultimately, the best conditions involve the use of phenyl picolinate (**2A**) as an esterifying agent and adding CsF or K_3PO_4, followed by heating in toluene at 150 ºC, to effectively transform ketone **1b** into phenyl ester **3b**.

With these optimal conditions in hand, we further expanded the substrate scope for aromatic ketones (Figure 2C). Under these conditions, the yield of ester **3a** from ketone **1a**, which were the initial substrates in the discovery of this reaction, improved to 65%. Aromatic ketones with thiomethyl (**1c**), amino (**1d**), and trifluoromethyl (**1e**) groups also reacted smoothly. Heteroaromatic rings such as thiophene (**1f**) and pyridine (**1g**) were efficiently converted to the corresponding phenyl esters **3f** and **3g** in high yields. Not limited to phenyl methyl ketones, aryl ethyl ketone **1h** and phenyl benzyl ketone **1i** were also converted to the desired phenyl esters **3h** and **3i** almost quantitatively. Additionally, aliphatic ketones **1j–1l** could be transformed into

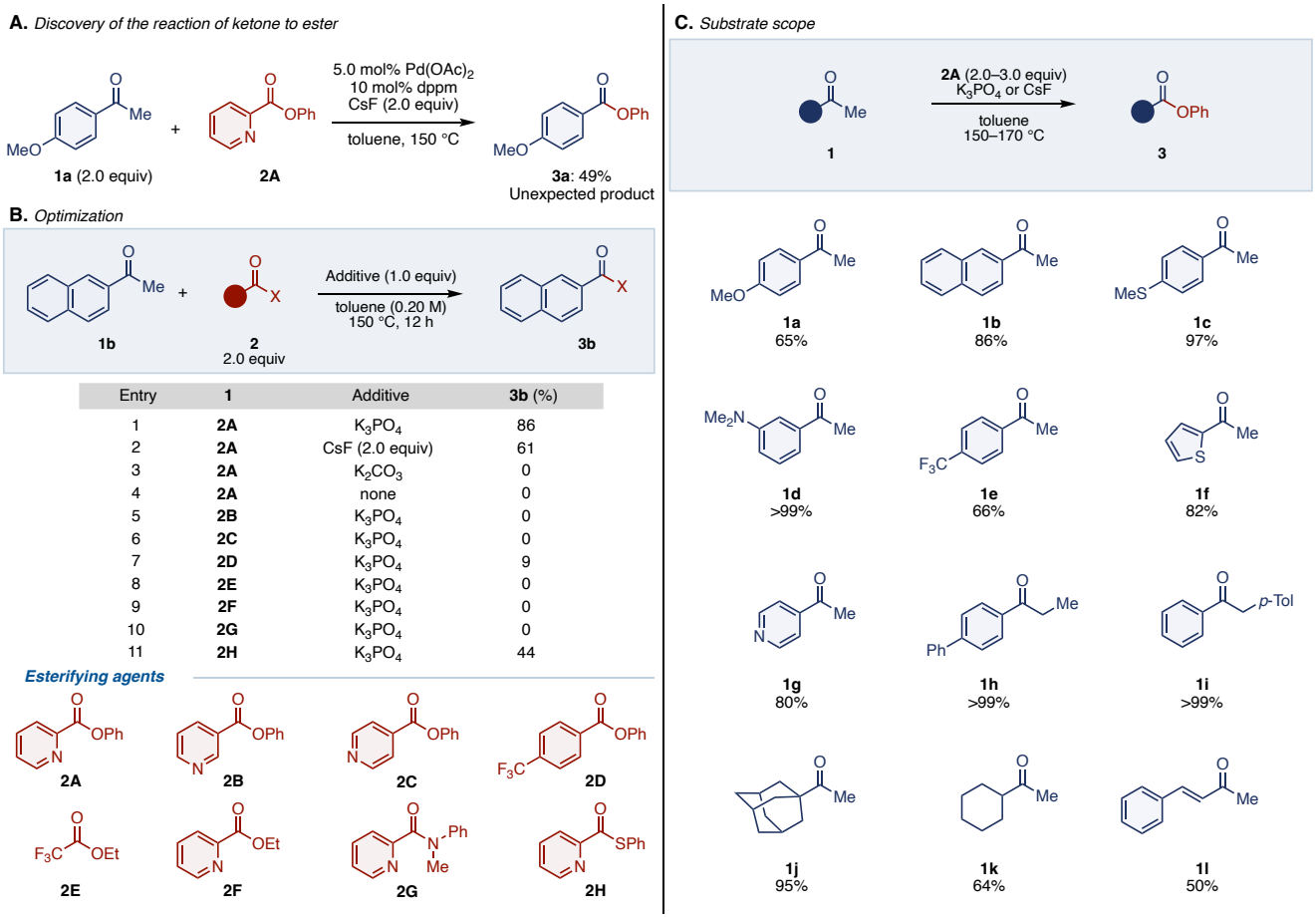

Figure 2. Discovery and optimizations of Claisen/regioselective retro-Claisen condensation (A) Discovery of the reaction from ketone to ester. (B) Reaction optimizations and screening of esterifying agents. (C) Substrate Scope. Detailed reaction conditions are summarized in the supplemental information.

Mechanistic studies for regioselective retro-Claisen Condensation

Our investigation centered on the effective function of picolinate ester **2A** as a phenyl esterifying agent under seemingly simple conditions, with a particular focus on the

selective progression of the retro-Claisen reaction. We tested the retro-Claisen condensation by heating the proposed intermediate, diketone **4aA**, and the by-product **4AA** following Claisen/retro-Claisen condensation, with NaOPh in toluene at 150 °C in the presence of either K_3PO_4 or CsF (Figure 3A). The reaction yielded the desired product **3a** from **4aA** with efficiencies of 26% (with K_3PO_4) and 32% (with CsF), respectively. However, phenyl picolinate (**1A**), expected from reaction at the pyridyl ketone site, was not detected. Although the yield of the product was low, we were able to confirm the same regioselectivity as the reaction. On the other hand, no retro-Claisen condensation occurred with **4AA**, and the starting material **4AA** was completely recovered (82%).

Additionally, to assess the reversibility of the retro-Claisen condensation involving compound **4AA**, we introduced 2-quinolinecarboxylate phenyl ester (**2I**) under analogous conditions. This resulted in the formation of phenyl nicotinate (**2A**) in yields of 42% (with K_3PO_4) and 61% (with CsF), while compound **4IA**, indicating the reaction's reversibility, was obtained in yields of 27% (with K_3PO_4) and 42% (with CsF) respectively.

These outcomes demonstrate that the Claisen/retro-Claisen condensation relative to compound **4AA** is reversible (Figure 3B). **2A** is an electron-deficient ester with high electrophilicity, while product **3** is less electrophilic compared to **2A**. Although all condensations/retro-condensations are equilibrium reactions, the resulting enolate of **2A** preferentially reacts with an excess (an additional equivalent) of the highly electrophilic **2A**, shifting the equilibrium toward **4AA**. Furthermore, since the enolate **4AA** is more stable compared to that of enolate **4aA**, the equilibrium shifts further, leading to the formation of **3** and enolate of **4AA** within the system. This analysis suggests that the presence of stable enolate **4AA** significantly influences the equilibrium dynamics of the reaction.

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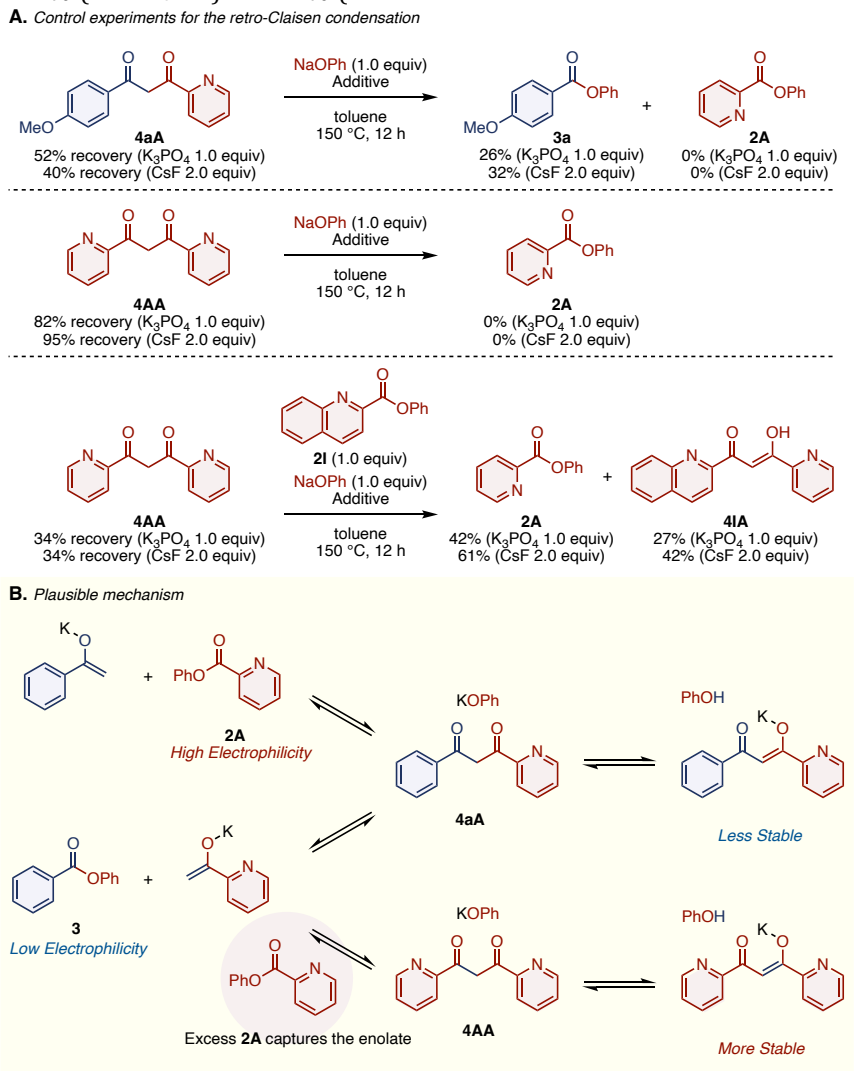

Figure 3. Mechanistic studies (A) Control experiments for the retro-Claisen condensation. (B) Plausible mechanism.

Deacylative sulfide transfer

Next, we initiated the development of a deacylative transformation of aromatic ketones, which involves the catalytic functionalization of the ester **2b** produced in one-pot following the Claisen/retro-Claisen condensation. After the Claisen/retro-Claisen condensation of **1b** and **2A** using K_3PO_4, sulfide **5A**, $Ni(cod)_2$/dcypt catalyst, and zinc were added to the same vessel and the mixture was heated to test

for the progression of the sulfide transfer reaction (the top equation in Figure 4).[41] Although the desired reaction did proceed, the yield of the resulting sulfide **6bA** was limited to 22%, with the main products **3b** and **4AA** resulting solely from the Claisen/retro-Claisen condensation. From our previous studies, it is known that the direct use of phenyl ester **3b** through sulfide transfer yields sulfide **6bA** with 92% efficiency.[41] This result suggests that the byproduct **4AA** from the Claisen/retro-Claisen condensation may have inhibited the sulfide transfer. Consequently, we hypothesized that capturing diketone **4AA** by a chelating agent, released as a byproduct "outside" the reaction system following Claisen/retro-Claisen condensation, would facilitate an efficient sulfide transfer. In our search for additives capable of capturing diketone **4AA**, we discovered that $Zn(OAc)_2$ is effective for sequestering diketone **4AA** (refer to "complexation" in Figure 4 and Tables S4 and S5), allowing its precipitation "outside" the reaction system as a Zn complex.[42] As a result, through esterification, complexation with $Zn(OAc)_2$, and sulfide transfer, we successfully obtained **6bA** in 78% yield in one-pot (the bottom equation in Figure 4).

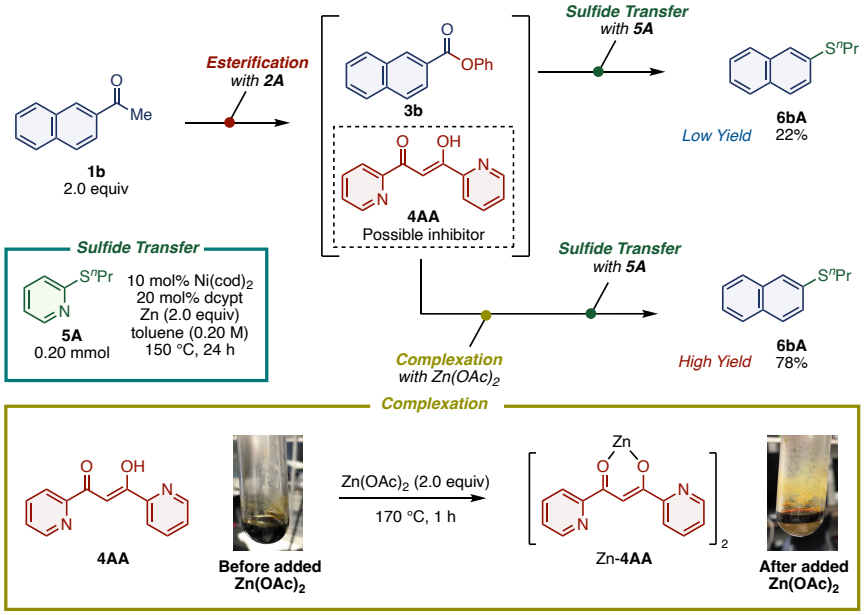

Figure 4. One-pot deacylative sulfide transfer reaction Detailed reaction conditions are summarized in the supplemental information.

Deacylative coupling with various nucleophiles

Using the optimized conditions, we investigated the substrate scope of the deacylative sulfide transfer reaction (Figure 5A). This reaction allowed for the synthesis of naphthyl sulfide **6bA** and biphenyl sulfide **6hA** from the corresponding aromatic methyl ketones with good yields. When using the electron-rich *p*-methoxyacetophenone (**1a**), the yield of sulfide **6aA** was 22%. This low yield is likely due to the moderate yields of both the esterification and sulfide transfer steps. Employing the electron-deficient ketone **2e**, compound **6eA** was synthesized with a yield of 59%. The sulfide transfer reaction tolerated both cyano and amide functional groups (**6mA** and **6nA**). Additionally, the reaction was applicable to secondary and tertiary sulfides (**6bB** and **6bC**). Thus, it has been demonstrated that the reaction proceeds similarly to aromatic esters, efficiently converting various aromatic ketones **1** into sulfides **6**.

Next, we embarked on a deacylative C–H arylation reaction using azoles as nucleophiles (Figure 5B).[43,44] In this case, it was observed that the deacylative C–H arylation could proceed without capturing the diketone with $Zn(OAc)_2$, and the coupling product **8fA** was obtained in 49% yield. However, the use of $ZnCl_2$ as a capturing agent improved the yield, and therefore it was employed for this purpose (Table S6). The substrate scope was investigated under conditions involving azole **7**, $Pd(acac)_2$, dcypt, K_3PO_4, and 1,4-dioxane at 150 ºC for 18 h. The results showed that when 2-acetylthiophene (**1f**) was used as the arylating agent, the deacylative C–H arylation of various azoles proceeded. Using benzothiazole as the nucleophile, the reaction efficiently yielded the desired thiophenylbenzothiazole **8fA** in 55% yield. Thiazole, 4-methylthiazole, 5-methylthiazole, 5-phenylthiazole, benzoxazole, and 5-phenyloxazole also underwent the deacylative C–H arylation reaction, producing the corresponding coupling products **8fB**, **8fC**, **8fD**, **8fE**, **8fF**, and **8fG**. When benzimidazole was used as the nucleophile, the reaction efficiency decreased compared to thiazoles and oxazoles, and the yield of **8fH** was only 21%. This is believed to be due to the higher pKa of the C2 hydrogen in *N*-methylbenzimidazole (theoretical pKa = 32.5) compared to benzothiazole (theoretical pKa = 27.3) and benzoxazole (theoretical pKa = 24.8). Electron-rich heteroaromatics like benzothiophene and furan were applicable as arylating agents (**8oA** and **8pA**). Notably, **8'** was not formed through the decarbonylative coupling of **2A**, and the deacylative coupling with **1** proceeded with high chemoselectivity.

Additionally, using the optimized conditions we discovered (Table S9), we explored the substrate scope of the deacylative hydrogenation reaction (Figure 5C).[45] When acetylnaphthalenes and acetophenones were reacted, the corresponding hydrogenated products were obtained in moderate to good yields (**9b**, **9q**, **9r**, **9h**, and **9s**). Acetylfluorene is also suitable for this reaction; due to the moderate

yields in both esterification and coupling steps, fluorene (**9t**) was obtained in 37% yield. The hydrogenation proceeded efficiently using electron-rich aromatic ketones, resulting in hydrogenated product **9u** with a good yield. We also successfully hydrogenated heteroaromatic ketones, furnishing phenylquinoline (**9v**) in 46% yield.

Furthermore, we attempted sequential reactions involving the α-arylation of ketones (Figure 5D and Table S10).[41] In this reaction, aryl benzyl ketones (R = Bn) were employed for conversion into esters, as they generated fewer byproducts and achieved higher yields compared to aryl methyl ketones (R = H). When ketones with electron-donating substituents on the aromatic ring were used as nucleophiles, the desired α-arylated ketones were obtained with moderate to good yields (**10va**, **10vx**, and **10vr**). Using electronically neutral 4-phenylacetophenone and 2-acetylnaphthalene as nucleophiles, the corresponding products **10vh** and **10vb** were achieved with yields of 45% and 30%, respectively. Regardless of the nature of the ketone used as a nucleophile, the reaction proceeded with high chemoselectivity, and no **10'** was detected.

Subsequently, we applied the deoxygenative coupling reaction between aromatic esters and diarylphosphine oxides to the deoxygenative transformation of aromatic ketones (Figure 5E and Table S11).[46] This reaction was successful with heteroaromatic ketones such as thiophene, furan, and benzothiophene (**12f**, **12p**, **12x**, and **12o**). In the cases of furan and benzothiophene, adding NaOAc improved the yield of benzylphosphine oxide, although the specific effects remain unclear. Even with electron-deficient acetylpyridine, a moderate yield (40%) of **12g** was achieved. When these heteroaromatic ketones were used as benzylating agents, the reaction showed low chemoselectivity; the deoxygenative C–P bond formation with **2A** competed, resulting in the formation of **12'**. When benzoic acid derivative was used as the arylating agent, **12y** was obtained in 54% yield. In this case, the deoxygenative synthesis of benzylphosphine oxide proceeded chemoselectively, and **12'** was almost undetectable. Heteroaromatic ketones exhibited slightly lower esterification yields compared to aromatic ketones, likely due to the residual presence of phenyl picolinate within the system.

Deacylative amination and etherification

We next expanded this methodology by exploring the deacylative amination reaction using amines as nucleophiles with aromatic ketones (Figure 6A).[47,48] From further investigation of reaction conditions, it was realized that using $Zn(OAc)_2$ to capture by-products did not effectively enhance the yield for this reaction (Table S7). Consequently, unlike the aforementioned coupling reactions, direct amination in a one-pot setup was deemed feasible. To this end, a reaction mixture consisting of 4-acetylpyridine, phenyl picolinate (**2A**), diphenylamine (**13A**), K_3PO_4, and CsF were added in toluene in the presence of $Pd(OAc)_2$/dcypt catalyst. This approach successfully afforded the deacylative amination product **14gA** in 73% yield. Importantly, the direct amination proceeded with high chemoselectivity as no amination of the aromatic ester starting from **2A** occurred, resulting in no formation of 2-pyridyldiphenylamine. Efficient amination also occurred with methoxy-substituted amine, producing **14gB** in 71% yield. Additionally, di-*p*-tolylamine and naphthylphenylamine were applicable (producing **14gC** and **14gD**, respectively). Even amines bearing fluorine proceeded with the deacylative amination without loss of fluorine, yielding **14gE** in 47% yield.

Meanwhile, we have previously reported an "ester dance" reaction, where an aromatic ester migrates across the aromatic ring.[49] When employing phenyl nicotinate (**2B**), the ester moves from the C3 to the C4 position, followed by amination at C4, yielding **14gB** in 62% yield. The driving force for selective amination at C4 is attributed to the ease of reductive elimination of the C–N bond at C4 compared to C3 on the pyridine ring. Based on this mechanism, we hypothesized that applying a deacylative amination to 3-acetylpyridine (**1z**) would lead to a novel form as an "acetyl dance coupling reaction", which combines Claisen/retro-Claisen condensation (producing **2C**), ester dance, and decarbonylative amination. Indeed, using **1z**, esterifying agent **2A**, and diarylamine **13B**, and reacting them with Pd/dcypt catalyst along with K_3PO_4 and CsF in one-pot, we successfully carried out the desired acetyl migration and amination. This process afforded amine **14gB** in 41% yield.

Finally, we attempted a sequential coupling involving our developed intramolecular decarbonylative etherification with aromatic esters (Figure 6C and Tables S8, S12, and S13).[50] We conducted a Claisen/retro-Claisen condensation of α-phenylketone **1v** (R = Bn) with phenyl picolinate (**2A**) in the presence of K_3PO_4, and then added $Pd(OAc)_2$, dcypt, and additional K_3PO_4 to the reaction and heated it. This process successfully yielded ether **15vA** in 36% yield. It was observed that this etherification reaction does not proceed under Ni catalysis; only the ester produced *via* Claisen/retro-Claisen condensation was obtained. However, intramolecular decarbonylation product **15'** was also obtained in 58% yield. This reaction exhibited low chemoselectivity, simultaneously yielding the byproduct **15'** along with the targeted product **15vA**. Enhancements in both yield (71%) and chemoselectivity (18:1) were realized by employing **2J**, an esterifying agent featuring a methoxy group at the *para* position. The presence of an electron-donating group at the *para* position in **2J** slows down the oxidative addition of Pd to the C(acyl)–O bond and the subsequent reductive elimination following decarbonylation compared to **2A**. This reduces the likelihood of forming byproduct **15'**, ultimately enhancing the chemoselectivity of the reaction.

We also evaluated picolinic acid derivatives applicable as arylation agents with α-phenylketone under Pd catalysis. While the yield of **15vK** with anisyl ester **2J** was only 25%, efficient decarbonylative etherification with a substrate with phenyloxy group occurred, yielding **15vL** in 68%. Additionally, esters bearing fluorine at the arenol site proceeded with etherification without loss of fluorine (**15vM**). Furthermore, the 4-*t*-butylphenyl ester successfully yielded ester **15vN** in 56% yield, and the phenyl ketone at the arenol site was tolerated (**15vO**: 47% yield).

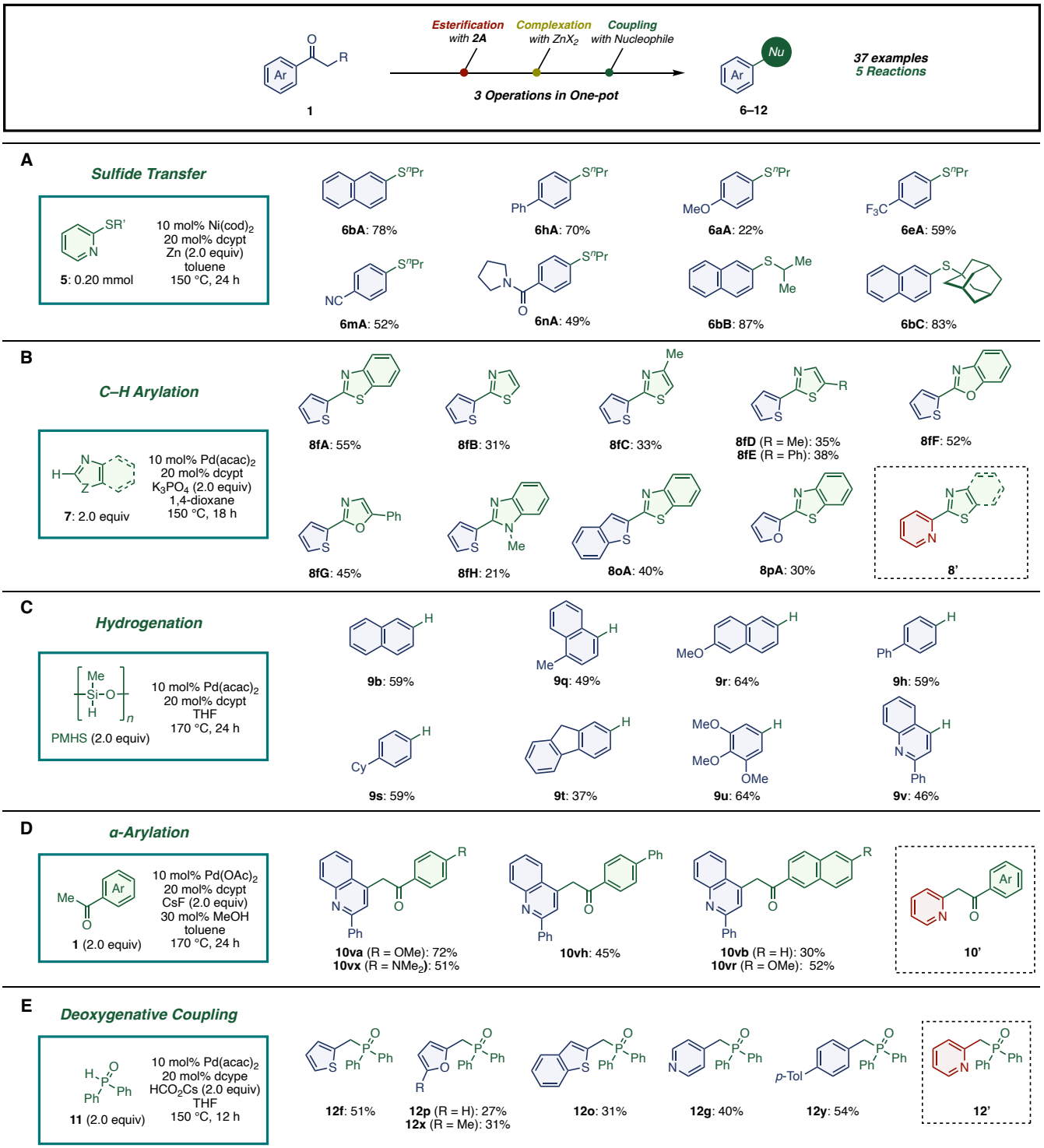

Figure 5. Deacylative cross-coupling with various nucleophiles Detailed reaction conditions are summarized in the supplemental information. (A) Deacylative sulfide transfer. **1**: R = H (B) Deacylative C-H arylation. **1**: R = H, complexation with $ZnCl_2$ instead of $Zn(OAc)_2$ (C) Deacylative hydrogenation. **1**: R = H (D) Deacylative α-arylation. R = Bn (E) Deacylative/Deoxygenative coupling. R = H

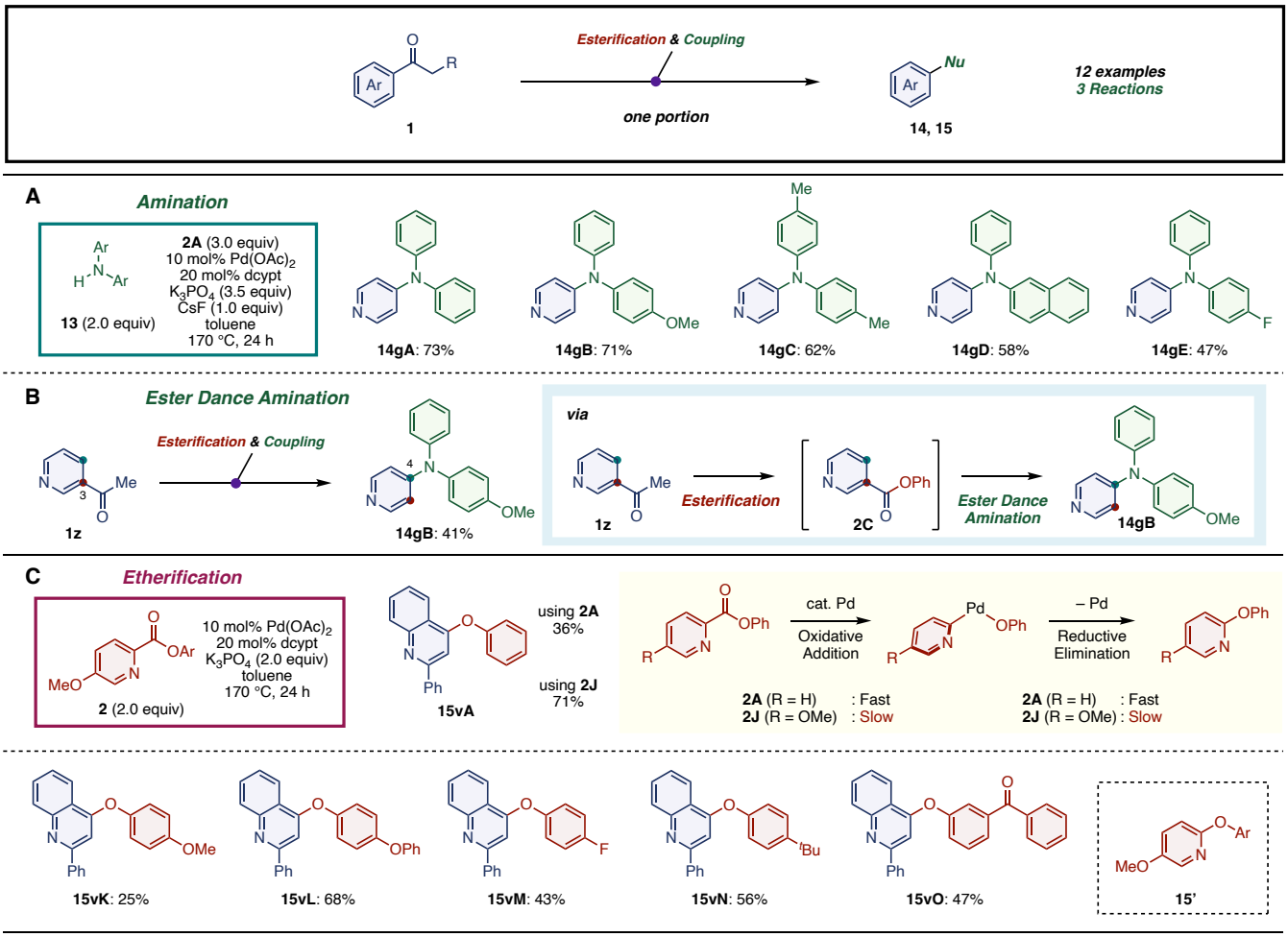

Figure 6. Deacylative amination and etherification Detailed reaction conditions are summarized in the supplemental information. (A) Deacylative amination reaction. **1**: R = H (B) Deacylative ester dance amination. **1**: R = H (C) Deacylative etherification. **1**: R = Bn

Synthetic chemistry applications

The synthetic utility of the developed deacylative couplings was assessed. The Claisen/retro-Claisen reaction involving compound **16**, containing both an ester and a ketone moiety within the same molecule, produced compound **17** with complete exchange between the ester and ketone groups (Figure 7A). This was followed by decarbonylative amination using diphenylamine, affording aminated product **18** in 50% yield. Formally, the ester in the starting material is transformed into compound **18**, where the ketone moiety is converted to a diphenylamino group, effectively altering the functional group from an ethyl ketone to a diphenylamino group.

The next example involves using ketones as directing groups in C–H functionalization (Figure 7B). For example, ketone **1b** can be coaxed into *meta*-C–H alkylation using a Ru catalyst developed by Ackermann and coworkers.[51] Subsequently, the ketone group can be hydrogenated *via* the deacylative hydrogenation method developed in this study, furnishing compound **9aa** in 49% yield. This approach demonstrates that C–H functionalization of aromatic compounds can effectively be achieved by employing ketones as traceless directing groups.

Finally, an example of application to sequential functionalization was illustrated (Figure 7C). From the commercially available ketone **1ab**, synthesis involved converting the fluorine and bromine atoms through an S_NAr reaction and Suzuki–Miyaura coupling, capitalizing on the electron-withdrawing properties of the ketone group. Then, ketone **1ac** was transformed into aryl sulfide **6acA** by subjecting it to the deacylative sulfide transfer conditions developed in this study. This demonstrates the feasibility of synthesizing complex aromatic compounds with multiple diverse functional groups, which are challenging to produce using conventional methods.

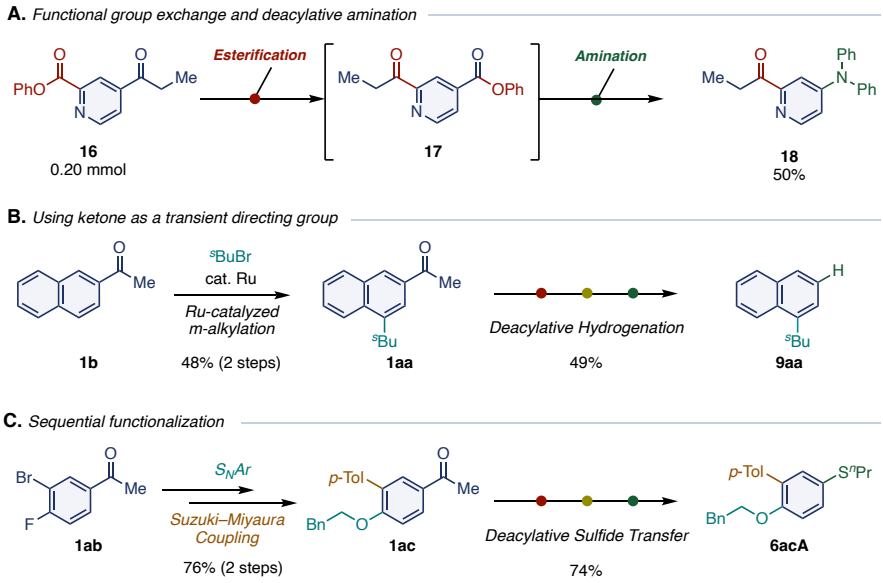

Figure 7. Synthetic chemistry applications (A) Functional group exchange and deacylative amination. (B) Using ketone as a traceless directing group. (C) Sequential functionalization.

Conclusion

We have successfully developed a formal deacylative coupling reaction for aromatic ketones. Through Claisen condensation and retro-Claisen condensation, aromatic esters are generated from phenyl picolinate and aromatic ketones in high yield. Subsequently, in one-pot, these aromatic esters were catalytically transformed into various aromatic compounds. Specifically, reactions such as sulfidation, C–H arylation of azoles, hydrogenation, α-arylation of ketones, amination, etherification, and synthesis of benzylphosphine oxides were carried out using aromatic ketones as formal aryl electrophiles. This reaction represents the first successful example of a direct catalytic transformation of aromatic ketones without the use of directing groups.

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AUTHOR CONTRIBUTIONS

J.Y. directed the projects and designed the experiments. H.N., R.I., M.K., and I.K. performed experiments. All authors contributed to data analysis. J.Y. wrote the manuscript with feedback from the other authors.

DECLARATION OF INTERESTS

The authors declare no competing interests.

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