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Iron-Catalyzed *ortho* C–H Arylation and Methylation of Pivalophenone N–H Imines

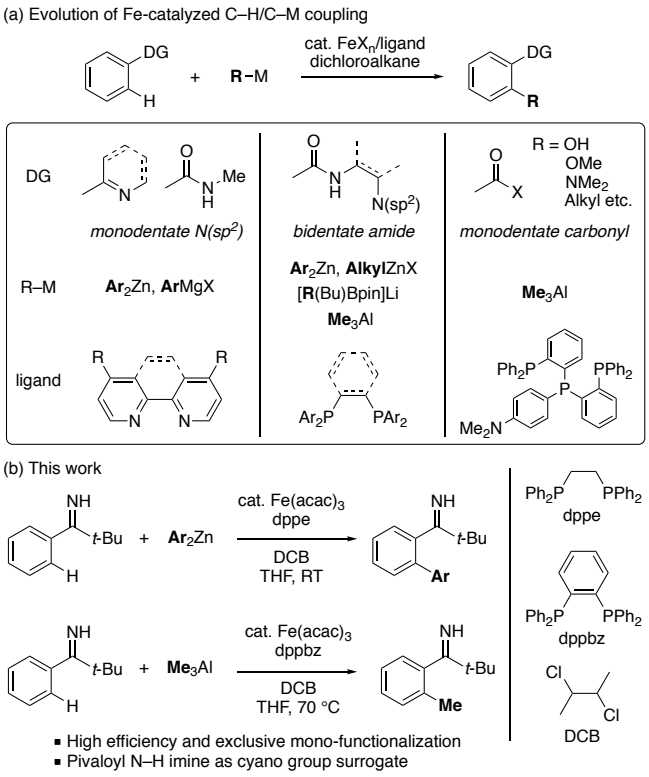
Wengang Xu and Naohiko Yoshikai*[a]

Dedication ((optional))

Abstract: Iron-catalyzed *ortho* C–H arylation and methylation reactions of pivalophenone N–H imines are reported. The pivaloyl N–H imine proved to serve as an excellent directing group for the arylation using diarylzinc reagents in the presence of an iron–diphosphine catalyst and 2,3-dichlorobutane at room temperature. A similar catalytic system also allowed methylation using trimethylaluminum at 70 °C. The pivaloyl imine of the product can be readily converted to a cyano group, thus allowing convenient preparation of *ortho*-functionalized benzonitriles.

The transition metal-catalyzed, directing group-assisted C–H bond functionalization of arenes has been extensively studied over the last few decades, leading to a number of methods for the synthesis of functionalized aromatic compounds.[1] While this area of research has long been dominated by precious transition metals, recent years have witnessed significant progress in the use of more cost-effective first-row transition metals,[2] among which iron has received particular attention for its high natural abundance and low toxicity.[3] The *ortho*-arylation of 2-arylpyridine with a diarylzinc reagent using an iron–phenanthroline catalyst and a vicinal-dichloroalkane oxidant, reported by Nakamura in 2008, represents a milestone in this context.[4] Since then, the scope of iron-catalyzed oxidative C–H/C–M coupling has been significantly extended in terms of the directing group and the coupling partner (Scheme 1a). Monodentate directing groups such as N-heterocycle, N-aryl imine, and N-methylamide were employed for C–H arylation using diarylzinc and aryl Grignard reagents using bidentate nitrogen ligands.[5] Bidentate amide directing groups[6] enabled the use of various organometallic coupling partners such as organozinc reagents,[7] organoboron reagents,[8] and trimethylaluminum[9] together with iron–diphosphine catalysts. Furthermore, Ilies and Nakamura recently developed a novel tridentate phosphine to achieve *ortho*-methylation directed by simple carbonyl functionalities such as carboxylic acid, ester, amide, and ketone.[10]

Recently, we have demonstrated that pivaloyl N–H imine serves as an excellent directing group for cobalt-catalyzed *ortho* C–H functionalization reactions such as hydroarylation to alkenes[11] and alkylation/arylation with the corresponding organic halides.[12] The imine functionality can be readily transformed into a cyano group, thus allowing facile preparation of *ortho*-functionalized benzonitriles.[12a] Given this background and other reports on transition metal-catalyzed, N–H imine-directed C–H functionalization,[13] we became interested in the competence of pivaloyl N–H imine as a monodentate directing group for the iron-catalyzed C–H/C–M coupling manifold. Herein, we report that *ortho*-arylation of pivalophenone N–H imine with a diarylzinc reagent proceeds efficiently under iron–diphosphine catalysis (Scheme 1b). Pivalophenone N–H imine has also proved to undergo efficient C–H methylation with Me_3Al.



Scheme 1. Iron-catalyzed, chelation-assisted arene C–H/C–M couplings.

The present study commenced with screening of reaction conditions for the *ortho*-phenylation of pivalophenone N–H imine (**1a**) with diphenylzinc reagent prepared from PhMgBr (5 equiv) and $ZnCl_2$•TMEDA (2.5 equiv) (Table 1). In the presence of $Fe(acac)_3$ (10 mol%), dppe (10 mol%), and 1,2-dichloroisobutane (DCIB, 2 equiv), the reaction proceeded smoothly in THF at room temperature to afford the desired *ortho*-monophenylated product **2aa** in 95% yield (entry 1). The reaction became sluggish with dppp (entry 2), and was completely shut down with dppb (entry 3). A moderate efficiency was achieved using dppen or dppbz (entries 4 and 5). It is worthwhile to note that diphosphine ligands with a two-carbon

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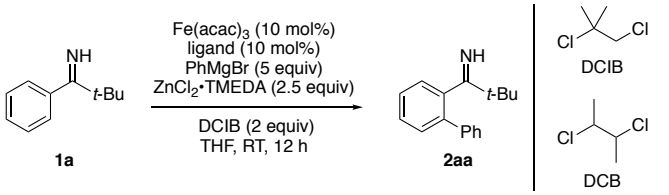
bridge, such as dppe, dppen, and dppbz have been often used for iron-catalyzed, bidentate amide-assisted C–H functionalization.[7-9,14] Bidentate nitrogen ligands such as dtbpy and phen, which proved optimal for the *ortho*-arylation directed by monodentate directing groups,[4,5] displayed poor performance (entries 6 and 7). Reduction of the catalyst loading to 5 mol% resulted in a slight decrease in the yield (entry 8). Using 2,3-dichlorobutane (DCB) instead of DCIB, the reaction proceeded with equally high efficiency to afford **2aa** in an isolated yield of 97% (entry 9). We decided to use DCB to explore the reaction scope because of its better availability.[15] Note that a bisphenylated product did not form in any of the screening experiments.

Table 1. Ligand effect on iron-catalyzed reaction between pivalophenone N–H imine and diphenylzinc reagent.



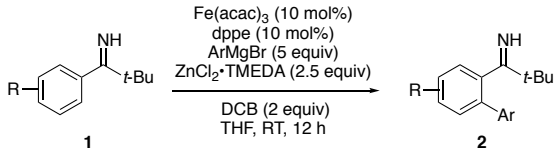
Entry	Ligand[a]	Yield [%][b]
1	dppe	95
2	dppp	18
3	dppb	0
4	dppen	73
5	dppbz	75
6	dtbpy	29
7	phen	13
8[c]	dppe	83
9[d]	dppe	97[e]

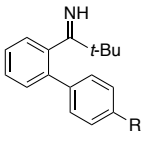
[a] dppe = 1,2-bis(diphenylphosphino)ethane; dppp = 1,3-bis(diphenylphosphino)propane; dppb = 1,4-bis(diphenylphosphino)butane; dppen = *cis*-1,2-bis(diphenylphosphino)ethene; dppbz = 1,2-bis(diphenylphosphino)benzene; dtbpy = 4,4'-di-*tert*-butyl-2,2'-bipyridine; phen = 1,10-phenanthroline. [b] Determined by GC using n-tridecane as an internal standard. [c] $Fe(acac)_3$ (5 mol%) and dppe (5 mol%) were used. [d] DCB was used instead of DCIB. [e] Isolated yield.

Table 2 summarizes the scope of the iron-catalyzed *ortho*-arylation of pivalophenone N–H imines. The reaction of **1a** with diarylzinc reagents bearing electron-donating substituents at the *para*-position afforded the desired monoarylation products **2aa**–**2ae** in excellent yields. On the other hand, 4-fluorophenylzinc reagent afforded the desired product **2af** and its Negishi coupling product with 4-fluorophenylzinc (R = 4-FC_6H_4) in 88% overall yield with a ratio of 2:1. Similar observation was made for the reaction of 4-chlorophenylzinc reagent, with a greater extent of Negishi arylation. Thus, the desired product **2ag** and its Negishi coupling product (R = 4-ClC_6H_4) were obtained in a 1:1 ratio. A series of *meta*-substituted arylzinc reagents also participated in the arylation of **1a** to afford the products **2ah**–**2ap** in good to excellent yields. Note that the reaction of 3-fluorophenyl- or 3-chlorophenylzinc reagent was not accompanied by Negishi-type arylation, presumably because the carbon–halogen bonds in **2aj** and **2ak** are not mesomerically activated by the pivalophenone imine moiety. Unfortunately, *ortho*-substituted arylzinc reagents such as *ortho*-tolylzinc failed to undergo the arylation reaction.[4,5]

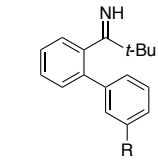
A variety of *para*-substituted pivalophenone imines were amenable to the reaction with diphenylzinc reagent to afford the desired products **2ba**–**2ia** in excellent yields, with tolerance to substituents such as methoxy, trifluoromethoxy, dimethylamino, chloro, and methylthio groups. The phenylation of *meta*-substituted pivalophenone imines uniformly took place at the less hindered position, and regioselectively afforded the products **2ja**–**2oa** in good yields. The same was the case for 2-naphthyl imine, which underwent exclusive phenylation at the 3-position (see **2pa**). It is worthwhile to note on the difference between this regioselectivity trend and that of the cobalt-catalyzed arylation using aryl chloride,[12a] which is susceptible to secondary directing effect of *meta*-oxygen or fluorine substituent. For example, the cobalt-catalyzed arylation of 3,4-methylenedioxyphenyl imine took place on the *ortho* position proximal to the oxygen atom to afford the regioisomer of **2na**.

Table 2. Scope of iron-catalyzed *ortho*-arylation of pivalophenone N–H imines.[a]

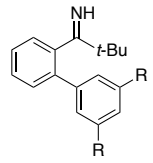




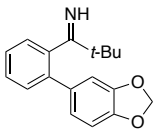
2ab (R = *t*-Bu), 95%
2ac (R = OMe), 95%
2ad (R = NMe_2), 94%
2ae (R = $SiMe_3$), 89%
2af (R = F), 88%[b]
2ag (R = Cl), 84%[c]



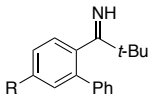
2ah (R = Me), 91%
2ai (R = OMe), 89%
2aj (R = F), 90%
2ak (R = Cl), 89%
2al (R = CF_3), 84%
2am (R = OMOM), 77%



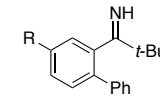
2an (R = Me), 94%
2ao (R = OMe), 91%



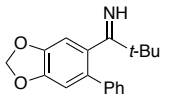
2ap, 92%



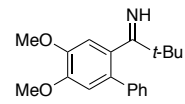
2ba (R = Me), 92%
2ca (R = Ph), 89%
2da (R = OMe), 91%
2ea (R = OCF_3), 86%
2fa (R = NMe_2), 91%
2ga (R = F), 90%
2ha (R = Cl), 88%
2ia (R = SMe), 88%



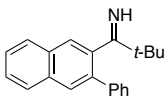
2ja (R = Me), 90%
2ka (R = OMe), 91%
2la (R = F), 86%
2ma (R = Cl), 84%



2na, 89%



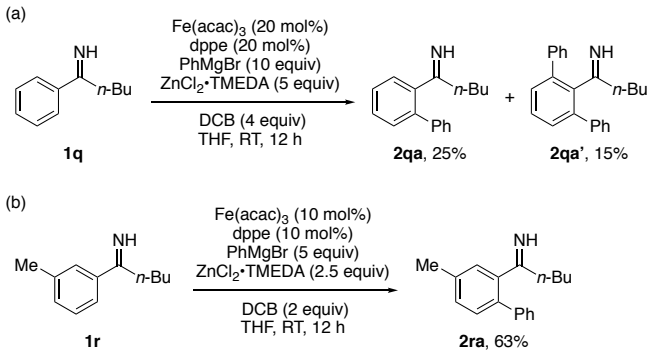
2oa, 87%



2pa, 84%

[a] The reaction was performed on a 0.3 mmol scale under conditions in Table 1, entry 9. [b] **2af** was accompanied by its Negishi coupling product with 4-fluorophenylzinc reagent (where R = 4-FC_6H_4) in a ratio of 2:1. The yield refers to the overall yield. [c] **2ag** was accompanied by its Negishi coupling product with 4-chlorophenylzinc reagent (where R = 4-ClC_6H_4) in a ratio of 1:1. The yield refers to the overall yield.

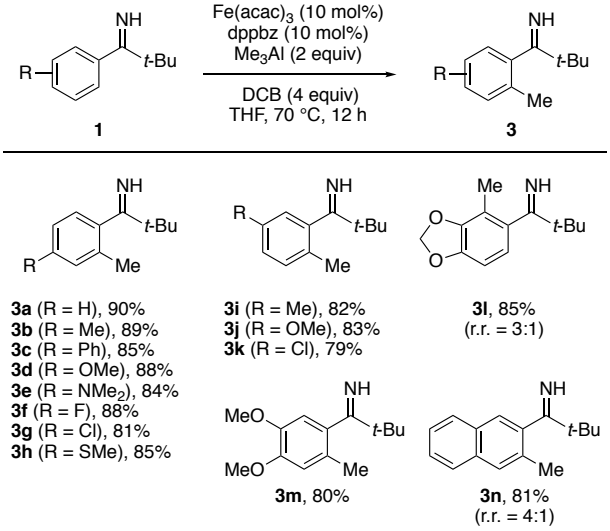
Compared with the above selective monoarylation, the reaction of aryl *n*-butyl N–H imine was found to be unselective and sluggish. Phenyl *n*-butyl imine **1q** afforded the monophenylation product **2qa** and the bisphenylation product **2qa'** in 25% and 15% yields, respectively, even with 20 mol% of the catalyst and 5 equiv of the diphenylzinc reagent (Scheme 2a). The reaction of 3-tolyl *n*-butyl imine **1r** took place at the less hindered position to afford the product **2ra** in a moderate yield (Scheme 2b). These results highlight the superiority of the pivaloyl imine as an efficient and selective directing group.



Scheme 2. *ortho*-Arylation of aryl *n*-butyl N–H imines.

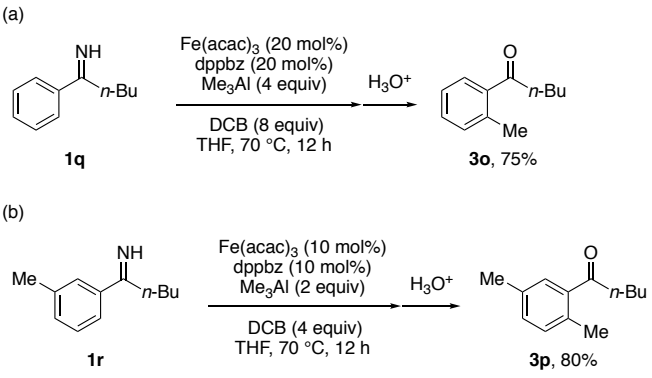
We next explored methylation of pivalophenone N–H imine using Me_3Al (Table 3).[9,10] Thus, selective mono-methylation of **1a** with Me_3Al (2 equiv) was achieved using a modified catalytic system comprised of $Fe(acac)_3$ (10 mol%), dppbz (10 mol%), and DCB (4 equiv) at 70 °C to afford the product **3a** in 90% yield. Note that the reaction using 2 equiv of DCB at room temperature was somewhat sluggish, affording **3a** in 66% yield. As was the case with the *ortho*-arylation, a variety of *para*- and/or *meta*-substituted pivalophenone imines underwent the *ortho*-methylation to afford the products **3a**–**3m** in good yields. In contrast to the arylation (Table 2), methylation of 3,4-methylenedioxyphenyl imine took place preferentially at the proximity of the *meta*-oxygen atom in a regioselectivity of 3:1 (see **3l**). This may be a reflection of secondary directing effect of the oxygen atom, and may point to difference in the nature of catalytically active organoiron species responsible for C–H activation. Note also that 2-naphthyl imine afforded a mixture of 3-methylated product **3n** and 1-methylated isomer in a 4:1 ratio.

Table 3. Iron-catalyzed *ortho*-methylation of pivalophenone N–H imines with Me_3Al.[a]



[a] The reaction was performed on a 0.3 mmol scale.

Aryl *n*-butyl N–H imines also participated in the *ortho*-methylation. Increased catalyst loading and large excess Me_3Al and DCB were necessary to achieve efficient methylation of **1q**, which was followed by acidic hydrolysis to afford the methylated ketone **3o** in 75% yield without a trace of bis-methylation (Scheme 3a). The *meta*-methyl imine **1r** underwent smooth and regioselective methylation of the less hindered position to afford **3p** in 80% yield (Scheme 3b).

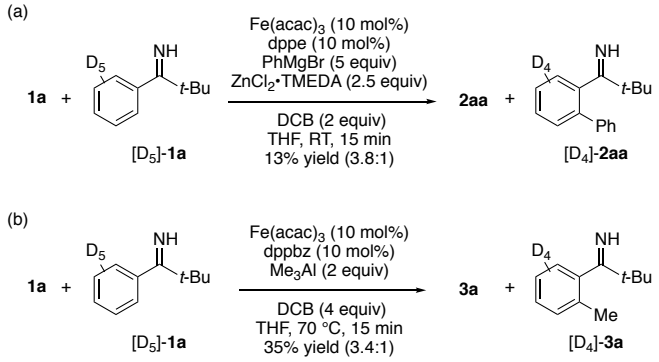


Scheme 3. Iron-catalyzed *ortho*-methylation of aryl *n*-butyl N–H imines.

We previously demonstrated that *ortho*-arylated and alkylated pivalophenone N–H imines efficiently undergo fragmentation of the pivaloyl imine moiety into a cyano group under peroxide photolysis or aerobic copper catalysis.[12a] The same transformation proved feasible for the methylated products, as conversion of **3c** into *ortho*-methylated aryl nitrile **4** was achieved in good yield under aerobic copper catalysis (Scheme 4).[16]

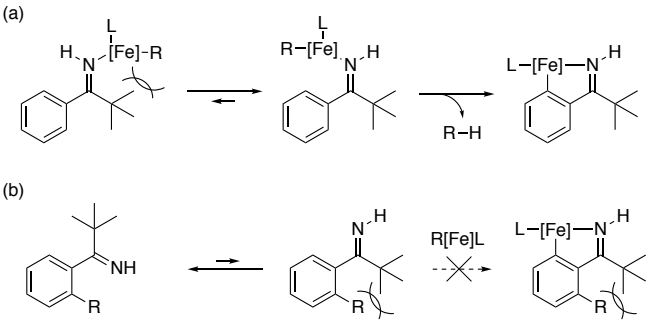
Scheme 4. Conversion of *ortho*-methylated pivalophenone imine to benzonitrile derivative.

The distinct directing group ability of pivaloyl N–H imine compared with N-aryl (*para*-methoxyphenyl, PMP) imine was demonstrated by control experiments. Thus, acetophenone N-PMP imine did not give any *ortho*-phenylation product under the present Fe–dppe catalytic system, regardless of its ability to undergo facile *ortho*-phenylation under the Fe–dtbpy system.[5a] Acetophenone N-PMP imine also failed to undergo *ortho*-methylation under the Fe–dppbz system. Thus, N–H and N-aryl imines appear to require electronically distinct iron catalysts for efficient C–H activation. A competition between **1a** and pentadeuterated imine [D_5]-**1a** under the phenylation conditions resulted in preferential phenylation of **1a** with a ratio of 3.8:1 (Scheme 5a), which likely reflected the nature of the C–H activation step. A similar result was obtained for the competitive methylation of **1a** and [D_5]-**1a** (Scheme 5b). Thus, coordination of the imine to an active organoiron species would occur in a reversible fashion, and the C–H activation would be the first irreversible step of the reaction.



Scheme 5. Intermolecular competition between parent and deuterated pivalophenone imines.

The ability of the pivalophenone imine to promote efficient and selective mono-arylation/methylation may be rationalized as follows. First, coordination of the imine to the organoiron species would preferentially take place on the side of the benzene ring to avoid steric repulsion with the *tert*-butyl group, thus assisting C–H activation via deprotonative metalation or σ-bond metathesis (Scheme 6a).[17] Once the first arylation or methylation is complete, steric repulsion between the *tert*-butyl group and the aryl (or methyl) group would prevent the second C–H activation (Scheme 6b).



Scheme 6. Rationale for efficient and selective mono-functionalization.

In summary, we have demonstrated that pivaloly N–H imine serves as an excellent monodentate directing group for the iron-catalyzed *ortho*-arylation and methylation reactions. The reactions are achieved in good to excellent yields using readily available iron–diphosphine catalytic systems, and display exclusive mono-functionalization selectivity. Given the broad scope of iron–diphosphine catalysts for bidentate chelation-assisted C–H functionalizations,[7-9,14] the N–H imine directing group may also hold promise for iron-catalyzed C–H functionalization using various coupling partners other than arylzinc and methylaluminum reagents. Further exploration of N–H imine as directing group for iron- and cobalt-catalyzed C–H functionalization is underway.

Acknowledgements

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Keywords: C–H activation • arylation • methylation • iron • organometallic reagents

[1] a) D. A. Colby, R. G. Bergman, J. A. Ellman, *Chem. Rev.* **2010**, *110*, 624-655; b) T. W. Lyons, M. S. Sanford, *Chem. Rev.* **2010**, *110*, 1147-1169; c) P. B. Arockiam, C. Bruneau, P. H. Dixneuf, *Chem. Rev.* **2012**, *112*, 5879-5918; d) K. M. Engle, T.-S. Mei, M. Wasa, J.-Q. Yu, *Acc. Chem. Res.* **2012**, *45*, 788-802; e) S. De Sarkar, W. Liu, S. I. Kozhushkov, L. Ackermann, *Adv. Synth. Catal.* **2014**, *356*, 1461-1479.

[2] a) K. Gao, N. Yoshikai, *Acc. Chem. Res.* **2014**, *47*, 1208-1219; b) M. Moselage, J. Li, L. Ackermann, *ACS Catal.* **2016**, *6*, 498-525; c) W. Liu, L. Ackermann, *ACS Catal.* **2016**, *6*, 3743-3752; d) J. Yamaguchi, K. Muto, K. Itami, *Top. Curr. Chem.* **2016**, *374*; e) T. Yoshino, S. Matsunaga, *Adv. Synth. Catal.* **2017**, *359*, 1245-1262; f) G. Pototschnig, N. Maulide, M. Schnürch, *Chem. Eur. J.* **2017**, *23*, 9206-9232; g) Y. Hu, B. Zhou, C. Wang, *Acc. Chem. Res.* **2018**, *51*, 816-827; h) P. Gandeepan, T. Müller, D. Zell, G. Cera, S. Warratz, L. Ackermann, *Chem. Rev.* **2018**.

[3] a) R. Shang, L. Ilies, E. Nakamura, *Chem. Rev.* **2017**, *117*, 9086-9139; b) N. Yoshikai, *Isr. J. Chem.* **2017**, *57*, 1117-1130; c) C.-L. Sun, B.-J. Li, Z.-J. Shi, *Chem. Rev.* **2011**, *111*, 1293-1314; d) E. Nakamura, N. Yoshikai, *J. Org. Chem.* **2010**, *75*, 6061-6067.

[4] J. Norinder, A. Matsumoto, N. Yoshikai, E. Nakamura, *J. Am. Chem. Soc.* **2008**, *130*, 5858-5859.

[5] a) N. Yoshikai, A. Matsumoto, J. Norinder, E. Nakamura, *Angew. Chem.* **2009**, *121*, 2969-2972; *Angew. Chem. Int. Ed.* **2009**, *48*, 2925-2928; b) L. Ilies, S. Asako, E. Nakamura, *J. Am. Chem. Soc.* **2011**, *133*, 7672-7675; c) N. Yoshikai, S. Asako, T. Yamakawa, L. Ilies, E. Nakamura, *Chem. Asian J.* **2011**, *6*, 3059-3065; d) L. Ilies, M. Kobayashi, A. Matsumoto, N. Yoshikai, E. Nakamura, *Adv. Synth. Catal.* **2012**, *354*, 593-596; e) L. Ilies, E. Konno, Q. Chen, E. Nakamura, *Asian J. Org. Chem.* **2012**, *1*, 142-145.

[6] a) G. Rouquet, N. Chatani, *Angew. Chem.* **2013**, *125*, 11942-11959; *Angew. Chem. Int. Ed.* **2013**, *52*, 11726-11743; b) O. Daugulis, J. Roane, L. D. Tran, *Acc. Chem. Res.* **2015**, *48*, 1053-1064.

[7] a) Q. Gu, H. H. Al Mamari, K. Graczyk, E. Diers, L. Ackermann, *Angew. Chem.* **2014**, *126*, 3949-3952; *Angew. Chem. Int. Ed.* **2014**, *53*, 3868-3871; b) R. Shang, L. Ilies, A. Matsumoto, E. Nakamura, *J. Am. Chem. Soc.* **2013**, *135*, 6030-6032; c) L. Ilies, S. Ichikawa, S. Asako, T. Matsubara, E. Nakamura, *Adv. Synth. Catal.* **2015**, *357*, 2175-2179; d) K. Graczyk, T. Haven, L. Ackermann, *Chem. Eur. J.* **2015**, *21*, 8812-8815; e) Z. Shen, G. Cera, T. Haven, L. Ackermann, *Org. Lett.* **2017**, *19*, 3795-3798.

[8] a) R. Shang, L. Ilies, S. Asako, E. Nakamura, *J. Am. Chem. Soc.* **2014**, *136*, 14349-14352; b) L. Ilies, Y. Itabashi, R. Shang, E. Nakamura, *ACS Catal.* **2017**, *7*, 89-92.

[9] R. Shang, L. Ilies, E. Nakamura, *J. Am. Chem. Soc.* **2015**, *137*, 7660-7663.

[10] R. Shang, L. Ilies, E. Nakamura, *J. Am. Chem. Soc.* **2016**, *138*, 10132-10135.

[11] a) W. Xu, N. Yoshikai, *Angew. Chem.* **2016**, *128*, 12923-12927; *Angew. Chem. Int. Ed.* **2016**, *55*, 12731-12735; b) W. Xu, N. Yoshikai, *Org. Lett.* **2018**, *20*, 1392-1395.

[12] a) W. Xu, N. Yoshikai, *Chem Sci* **2017**, *8*, 5299-5304; b) W. Xu, N. Yoshikai, *Beilstein J Org Chem* **2018**, *14*, 709-715.

[13] a) T. Fukutani, N. Umeda, K. Hirano, T. Satoh, M. Miura, *Chem. Commun.* **2009**, 5141-5143; b) D. N. Tran, N. Cramer, *Angew. Chem.* **2013**, *125*, 10824-10828; *Angew. Chem. Int. Ed.* **2013**, *52*, 10630-10634; c) J. Zhang, A. Ugrinov, P. Zhao, *Angew. Chem.* **2013**, *125*, 6813-6816; *Angew. Chem. Int. Ed.* **2013**, *52*, 6681-6684; d) R. He, Z.-T. Huang, Q.-Y. Zheng, C. Wang, *Angew. Chem.* **2014**, *126*, 5050-5053; *Angew. Chem. Int. Ed.* **2014**, *53*, 4950-4953; e) T. Jia, C. Zhao, R. He, H. Chen, C. Wang, *Angew. Chem.* **2016**, *128*, 5354-5357; *Angew. Chem. Int. Ed.* **2016**, *55*, 5268-5271; f) W. Xu, J. H. Pek, N. Yoshikai, *Asian J. Org. Chem.* **2018**, *7*, 1351-1354.

[14] a) S. Asako, L. Ilies, E. Nakamura, *J. Am. Chem. Soc.* **2013**, *135*, 17755-17757; b) T. Matsubara, S. Asako, L. Ilies, E. Nakamura, *J. Am. Chem. Soc.* **2014**, *136*, 646-649; c) L. Ilies, T. Matsubara, S. Ichikawa, S. Asako, E. Nakamura, *J. Am. Chem. Soc.* **2014**, *136*, 13126-13129; d) E. R. Fruchey, B. M. Monks, S. P. Cook, *J. Am. Chem. Soc.* **2014**, *136*, 13130-13133; e) B. M. Monks, E. R. Fruchey, S. P. Cook, *Angew. Chem.* **2014**, *126*, 11245-11249; *Angew. Chem. Int. Ed.* **2014**, *53*, 11065-11069; f) T. Matsubara, L. Ilies, E. Nakamura, *Chem. Asian J.* **2016**, *11*, 380-384; g) G. Cera, T. Haven, L. Ackermann, *Angew. Chem.* **2016**, *128*, 1506-1510; *Angew. Chem. Int. Ed.* **2016**, *55*, 1484-1488; h) G. Cera, T. Haven, L. Ackermann, *Chem. Eur. J.* **2017**, *23*, 3577-3582; i) G. Cera, T. Haven, L. Ackermann, *Chem. Commun.* **2017**, *53*, 6460-6463; j) L. Ilies, Y. Arslanoglu, T. Matsubara, E. Nakamura, *Asian J. Org. Chem.* **2018**, *7*, 1327-1329.

[15] During this study, it became difficult to purchase DCIB from suppliers in Singapore.

[16] L. Zhang, G. Y. Ang, S. Chiba, *Org. Lett.* **2010**, *12*, 3682-3685.

[17] Y. Sun, H. Tang, K. Chen, L. Hu, J. Yao, S. Shaik, H. Chen, *J. Am. Chem. Soc.* **2016**, *138*, 3715-3730.

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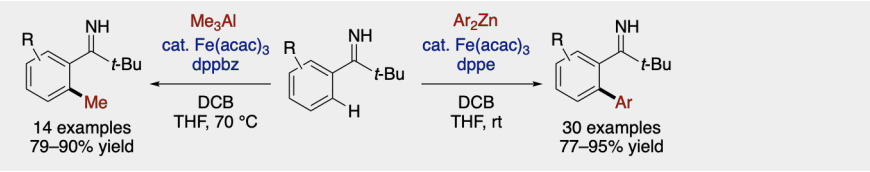

*Wengang Xu and Naohiko Yoshikai**

Page No. – Page No.

Iron-Catalyzed *ortho* C–H Arylation and Methylation of Pivalophenone N–H Imines

Iron-catalyzed *ortho* C–H arylation and methylation reactions of pivalophenone N–H imines are reported. The pivaloyl N–H imine proved to serve as an excellent directing group for the arylation using diarylzinc reagents in the presence of an iron–diphosphine catalyst and 2,3-dichlorobutane at room temperature. A similar catalytic system allowed methylation using trimethylaluminum at 70 °C. The pivaloyl imine of the product can be readily converted to a cyano group, thus allowing convenient preparation of *ortho*-functionalized benzonitriles.