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A General Preparation of Polyfunctional Benzylic Zinc Organometallic Compounds

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Dedicated to Professor Ryoji Noyori on the occasion of his 70th birthday

Abstract: A new method for the preparation of highly functionalized benzylic zinc chlorides by the direct insertion of zinc dust into the corresponding benzylic chlorides in the presence of LiCl is described without the formation of homocoupling products (<5%). Various reactions of these benzylic zinc reagents with a broad range of electrophiles, which lead to polyfunctionalized products, are reported. In particular, the cross-coupling reactions of the benzylic zinc chlorides with aromatic chlorides, bromides, and tosylates in the presence of [Ni(acac)$_2$] (acac = acetylacetonate) and PPh$_3$ proceeded in good to excellent yields to give the corresponding diaryl and heterodiaryl methanes.

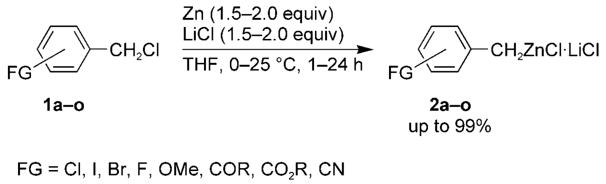
Keywords: cross-coupling · insertion · nickel · organometallics · zinc

Introduction

Organometallic zinc compounds are widely used in organic synthesis.[1] They combine good reactivity with high functional-group tolerance.[2] Furthermore, the preparation of organozinc compounds is possible under mild conditions by using cheap and nontoxic zinc dust. Functionalized benzylic zinc compounds that bear sensitive functional groups, such as ester or nitrile, occupy a unique place in the field of organometallics as the corresponding lithium or magnesium benzylic reagents are not compatible with most functional groups.[3] Recently, we found that LiCl considerably facilitates direct zinc insertion into alkyl, aryl, and heteroaryl iodides and bromides.[4] We successfully applied this reaction to the preparation of benzylic zinc chlorides by performing an insertion of zinc dust in the presence of LiCl into polyfunctional benzylic chlorides.[5] Herein, we report the scope of this preparation as well as applications of benzylic zinc compounds in organic synthesis, particularly in Cu-catalyzed and Cu-mediated reactions as well as in Ni-catalyzed cross-coupling reactions.

Results and Discussion

Benzylic chlorides **1** can be easily converted into the corresponding benzylic zinc chlorides **2** at 25 °C by using LiCl and commercially available zinc dust (Scheme 1).[6] The use of stoichiometric amounts of LiCl is essential for fast zinc insertion. This zinc insertion proceeds at ambient temperature without the formation of homocoupling products (<5%). Thus, addition of 2-chlorobenzyl chloride (**1a**; 1.0 equiv) to zinc dust (1.5 equiv) and LiCl (1.5 equiv) at 0 °C followed by stirring at 25 °C for 2 h led to the corresponding 2-chlorobenzylzinc chloride (**2a**) in 99% yield (Table 1, entry 1).



Scheme 1. Preparation of benzylic zinc chlorides **2** by the direct insertion of zinc dust in the presence of LiCl into the corresponding benzylic chlorides **1**.

Furthermore, 2-iodobenzyl chloride (**1b**), 3-bromobenzyl chloride (**1c**), and 4-fluorobenzyl chloride (**1d**) could be converted into the benzylic zinc chlorides **2b–d** in 87–99% yield (Table 1, entries 2–4). Even electron-rich benzylic

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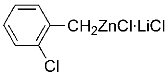
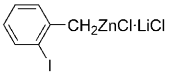
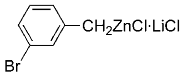
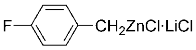
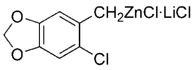
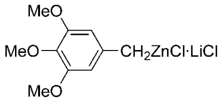
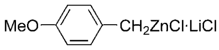
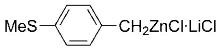
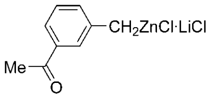
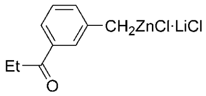
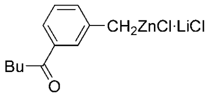
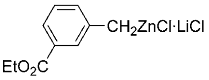
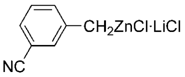
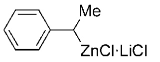
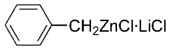
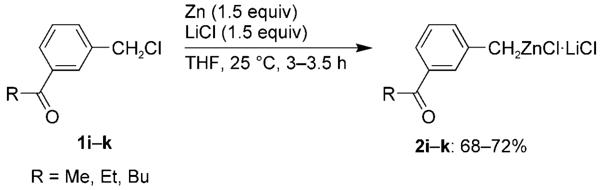
Table 1. Preparation of functionalized benzylic zinc reagents **2**.

Entry	2		*t* [h][a]	Yield [%][b]
1		**2a**	2	99
2		**2b**	2	99
3		**2c**	4	95
4		**2d**	24[c]	87
5		**2e**	1	93
6		**2f**	3.5[c]	78
7		**2g**	6.5	73
8		**2h**	2	77[d]
9		**2i**	3.5	68
10		**2j**	3	72
11		**2k**	3.5	72
12		**2l**	3.5[c]	85
13		**2m**	3	93
14		**2n**	11	85
15		**2o**	6.5[e]	88

[a] Reaction time at 25 °C. [b] Yield determined by iodometric titration.[7] [c] Zn (2.0 equiv), LiCl (2.0 equiv). [d] 7 % of the homocoupling was observed. [e] Reaction time at 40 °C.

Abstract in German: Hochfunktionalisierte benzylische Zinkverbindungen können ausgehend von benzylischen Chloriden unter Verwendung von LiCl und Zinkstaub hergestellt werden, ohne dass Homokopplungsprodukte auftreten (<5 %). Diese Zinkreagenzien können mit verschiedenen Elektrophilen umgesetzt werden. Weiterhin ist eine neuartige Ni-katalysierte Kreuzkupplung dieser Zinkreagenzien unter Verwendung von $[Ni(acac)_2]$ und PPh_3 als Katalysatorsystem mit aromatischen Chloriden, Bromiden, und Tosylaten möglich und führt zu hochfunktionalisierten Diaryl- und Heterodiarylmethanen.

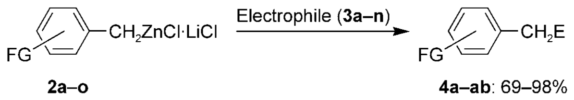
chlorides, such as **1e**–**h**, reacted with zinc dust and LiCl under the standard protocol to afford the expected benzylic zinc chlorides **2e**–**h** in 73–93 % yield (Table 1, entries 5–8). Benzylic chlorides **1i**–**k**, which bear a keto group in the *meta* position, were readily transformed in a similar way into the desired zinc compounds **2i**–**k** in 68–72 % yield (Table 1, entries 9–11 and Scheme 2).



Scheme 2. Preparation of benzylic zinc chlorides bearing a keto group in the *meta* position.

Similarly, cyano or ester groups are tolerated with this method. Thus, 3-ethoxycarbonylbenzyl chloride (**1l**) and 3-cyanobenzyl chloride (**1m**) were smoothly converted into the corresponding benzylic zinc chlorides **2l** and **2m** in 3–3.5 h in 85–93 % yield (Table 1, entries 12 and 13). Moreover, secondary benzylic zinc chlorides can be prepared as well. Addition of 1-chloroethylbenzene (**1n**) to zinc dust (1.5 equiv) and LiCl (1.5 equiv) at 25 °C gave the desired zinc compound **2n** in 85 % yield (Table 1, entry 14). Benzyl chloride (**1o**) itself was converted into benzylzinc chloride (**2o**) in 88 % yield without significant homocoupling at 40 °C (Table 1, entry 15).

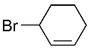
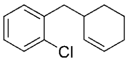
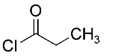
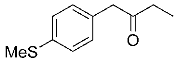
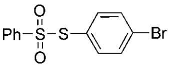
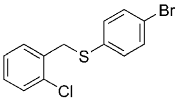
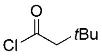
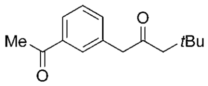
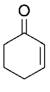
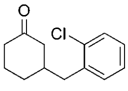
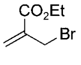
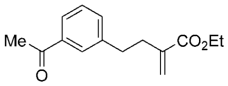
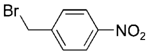
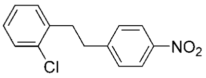
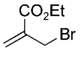
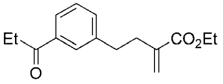
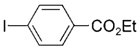
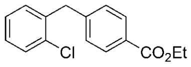
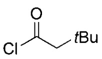
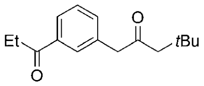
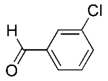
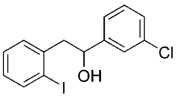
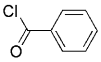
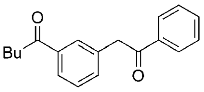
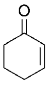
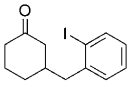
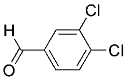
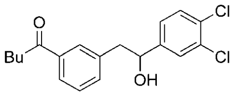
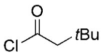
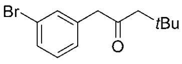
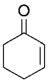
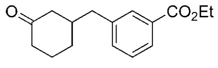
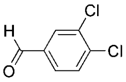
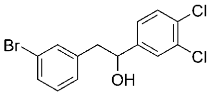
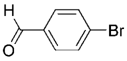
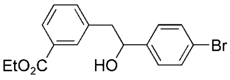
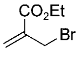
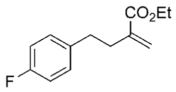
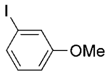
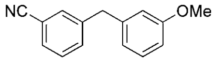
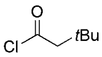
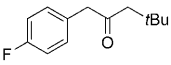
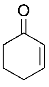
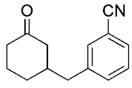
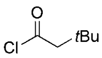
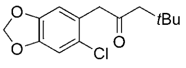
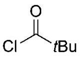
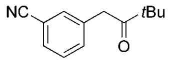
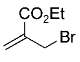
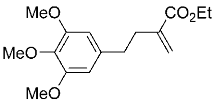
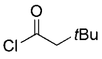
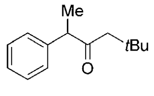
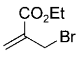
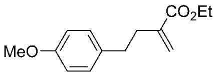
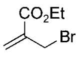
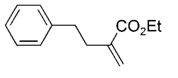
These benzylic zinc chlorides can be treated with various electrophiles to lead to a range of highly functionalized products **4** (Scheme 3 and Table 2). Thus, the copper(I)-catalyzed reaction of **2a** (1.0 equiv) with 3-bromocyclohex-1-ene (**3a**; 1.3 equiv) at 0 °C, with $CuCN\cdot 2LiCl$,[8] led to the product **4a** in 94 % yield (Table 2, entry 1).



Scheme 3. Reaction of various benzylic zinc chlorides **2** with a variety of electrophiles to lead to polyfunctional products **4**. E = electrophile.

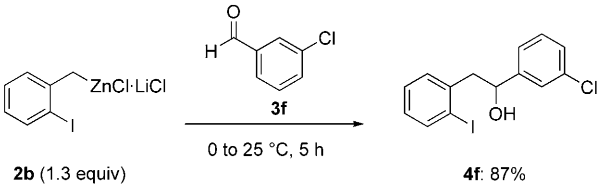
2-Chlorobenzylzinc chloride (**2a**) reacted with *S*-(4-bromophenyl)benzenesulfonothioate (**3b**; 0.8 equiv) at 25 °C in 1 h to give the expected thioether **4b** in 89 % yield (Table 2, entry 2). Also, copper(I)-mediated 1,4-addition of cyclohexenone (**3c**; 0.8 equiv) with $CuCN\cdot 2LiCl$ (1.0 equiv) and TMSCl[9] (2.0 equiv) furnished the substituted cyclohexanone **4c** in 93 % yield (Table 2, entry 3). The copper(I)-catalyzed cross-coupling reaction with 4-nitrobenzyl bromide (**3d**; 0.8 equiv) led to the nitro compound **4d** in 89 % yield (Table 2, entry 4). Also, the Negishi Pd-catalyzed cross-coupling reaction[10] of ethyl 4-iodobenzoate (**3e**; 0.8 equiv)

Table 2. Reaction of benzylic zinc reagents with various electrophiles.

Entry	Zinc reagent (**2**)	Electrophile (**3**)	Product (**4**)	Yield [%][a]	Entry	Zinc reagent (**2**)	Electrophile (**3**)	Product (**4**)	Yield [%][a]
1	**2a**	 **3a**	 **4a**[e]	94[b]	15	**2h**	 **3j**	 **4o**	71[c]
2	**2a**	 **3b**	 **4b**	89	16	**2i**	 **3g**	 **4p**	74[c]
3	**2a**	 **3c**	 **4c**	93[c]	17	**2i**	 **3i**	 **4q**	97[b]
4	**2a**	 **3d**	 **4d**	89[b]	18	**2j**	 **3i**	 **4r**	92[b]
5	**2a**	 **3e**	 **4e**	97[d]	19	**2j**	 **3g**	 **4s**	69[c]
6	**2b**	 **3f**	 **4f**	87	20	**2k**	 **3k**	 **4t**	85[c]
7	**2b**	 **3c**	 **4g**	72[c]	21	**2k**	 **3h**	 **4u**	95
8	**2c**	 **3g**	 **4h**	96[c]	22	**2l**	 **3c**	 **4v**	97[c]
9	**2c**	 **3h**	 **4i**	98	23	**2l**	 **3l**	 **4w**	91
10	**2d**	 **3i**	 **4j**	93[b]	24	**2m**	 **3m**	 **4x**	88[d]
11	**2d**	 **3g**	 **4k**	95[c]	25	**2m**	 **3c**	 **4y**	97[c]
12	**2e**	 **3g**	 **4l**	93[c]	26	**2m**	 **3n**	 **4z**	78[c]
13	**2f**	 **3i**	 **4m**	98[b]	27	**2n**	 **3g**	 **4aa**	96[c]
14	**2g**	 **3i**	 **4n**	97[b]	28	**2o**	 **3i**	 **4ab**	93[b]

[a] Yield of isolated analytically pure product. [b] Catalytic CuCN·2LiCl. [c] Stoichiometric CuCN·2LiCl and, in the case of 1,4-additions, TMSCl. [d] [Pd(PPh$_3$)$_4$] (cat.). [e] The limiting reagent is the benzylic zinc chloride **2a**.

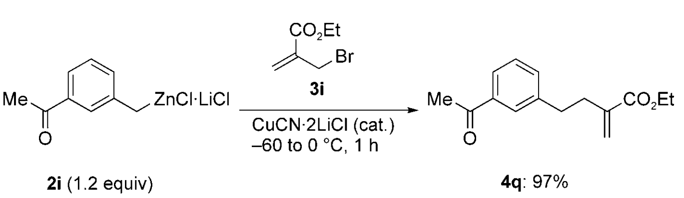
with [Pd(PPh_3)$_4$] (2 mol %) as catalyst at 60 °C gave the expected diaryl methane **4e** in 97 % yield in 5 h (Table 2, entry 5). Addition of 2-iodobenzylzinc chloride (**2b**) to 3-chlorobenzaldehyde (**3f**; 0.7 equiv, 0→25 °C, 5 h) in the absence of catalyst led to the secondary benzylic alcohol **4f** in 87 % yield (Table 2, entry 6 and Scheme 4).



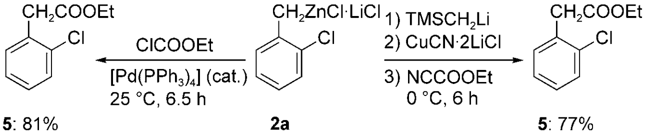
Scheme 4. Reaction of 2-iodobenzylzinc chloride (**2b**) with 3-chlorobenzaldehyde (**3f**) to provide the secondary benzylic alcohol **4f**.

Copper(I)-mediated 1,4-addition of cyclohexenone (**3c**; 0.8 equiv) with CuCN·2 LiCl (1.0 equiv) and TMSCl (2.0 equiv) gave the desired cyclohexanone **4g** in 72 % yield (Table 2, entry 7). Furthermore, benzylic zinc chlorides such as **2c** and **2d**, which bear halogen substituents in the *meta* or *para* position, react similarly with various electrophiles to furnish the polyfunctional products **4h**–**k** in 93–98 % yield (Table 2, entries 8–11). The electron-rich benzylic zinc chloride **2e** reacted smoothly with 3,3-dimethylbutyryl chloride (**3g**; 0.7 equiv) in the presence of CuCN·2 LiCl (1.0 equiv, −40→25 °C, overnight) to give the expected ketone **4l** in 93 % yield (Table 2, entry 12). The trimethoxy-substituted benzylic zinc chloride **2f** underwent smooth allylation with ethyl (2-bromomethyl)acrylate[11] (**3i**; 0.8 equiv) in 1 h to give the allylated derivative **4m** in 98 % yield (Table 2, entry 13). In an analogous manner, 4-methoxybenzylzinc chloride (**2g**) was allylated to afford the acrylate **4n** in 97 % yield (Table 2, entry 14). 4-Methylthiobenzylzinc chloride (**2h**) was also converted into the corresponding ketone **4o** (71 %; Table 2, entry 15) in 4 h by using propionyl chloride (**3j**; 0.8 equiv) in the presence of CuCN·2 LiCl (0.5 equiv). Notably, the keto group is compatible with various reactions such as allylation, acylation, and nucleophilic attack on an aldehyde. Thus, the products **4p**–**u** were obtained in 69–97 % yield (Table 2, entries 16–21 and Scheme 5).

Copper(I)-mediated 1,4-addition of 3-ethoxycarbonylbenzylzinc chloride (**2l**) to cyclohexenone (**3c**; 0.8 equiv) with CuCN·2 LiCl (1.0 equiv) and TMSCl (2.0 equiv) led to the Michael adduct **4v** in 97 % yield (Table 2, entry 22). Also, the reaction with 4-bromobenzaldehyde (**3l**; 0.8 equiv) furnished the benzylic alcohol **4w** (91 %; Table 2, entry 23). Use of the benzylic zinc reagent **2m**, which bears a cyano group on the aromatic ring, towards a Negishi Pd-catalyzed cross-coupling reaction with 3-iodoanisole (**3m**; 0.8 equiv) provided the desired diaryl methane **4x** in 88 % yield (Table 2, entry 24). These benzylic zinc reagents were used to prepare various ketones in 78–97 % yield (**4y** and **4z**; Table 2, entries 25 and 26). Acylation is also possible with a secondary benzylic zinc reagent. Thus, **2n** reacted with 3,3-dimethylbutyryl chloride (**3g**; 0.7 equiv) in the presence of CuCN·2 LiCl (1.0 equiv) to give the ketone **4aa** in 96 % yield (Table 2, entry 27). Benzylzinc chloride (**2o**) was allylated with (2-bromomethyl)acrylate (**3i**; 0.8 equiv) to give the expected unsaturated ester **4ab** (93 %; Table 2, entry 28). Benzylic zinc reagents can also be used to prepare phenyl acetic acid derivatives, which are common targets in pharmaceutical research.[12] Two possible ways have been explored (Scheme 6). The first is Negishi Pd-catalyzed acylation[13] with ethyl chloroformate as an electrophile. Alternatively, we developed a copper(I)-mediated acylation with ethyl cyanoformate[14] as the electrophilic species. Thus, the benzylic zinc chloride **2a** reacted smoothly with ethyl chloroformate in the presence of [Pd(PPh_3)$_4$] (5 mol %) in 6.5 h at 25 °C to give the phenylacetic acid ethyl ester **5** (81 %). To perform the copper(I)-mediated reaction, it was mandatory to prepare the mixed diorganozinc compound of the type $ArCH_2ZnCH_2SiMe_3$[15] by adding $TMSCH_2Li$ at −30 °C to **2a**. After transmetalation to copper with CuCN·2 LiCl and the addition of ethyl cyanoformate, the expected ethyl phenylacetic ester **5** was obtained in 77 % yield.

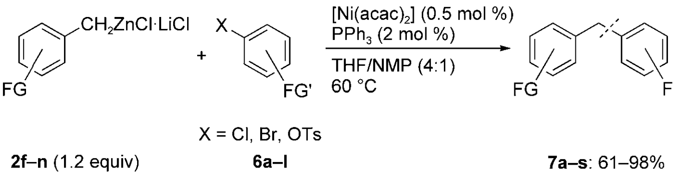


Scheme 5. Reaction of 3-acetylbenzylzinc chloride (**2i**) with ethyl (2-bromomethyl)acrylate (**3i**) to afford the keto ester **4q**.



Scheme 6. Reaction of 2-chlorobenzylzinc chloride (**2a**) with either ethyl chloroformate or ethyl cyanoformate.

The high reactivity of these polyfunctionalized benzylic zinc ragents can be extended to produce polyfunctional diaryl methanes[16,17] **7** by a new Ni-catalyzed cross-coupling reaction. Recently, we found that this cross-coupling reaction can be achieved by using a cheap and convenient catalyst system such as [Ni(acac)$_2$] and PPh_3 (Scheme 7).[18–21] Therefore, the benzylic zinc reagents **2f**–**n** were treated with

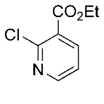
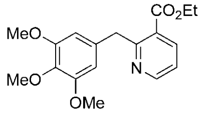
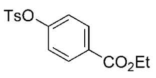
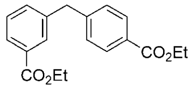
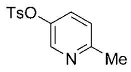
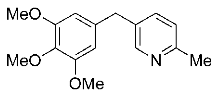
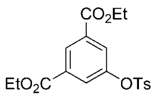
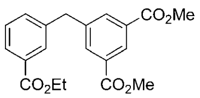
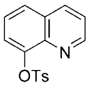
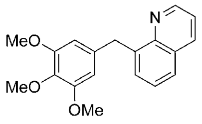
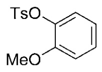
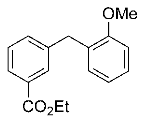
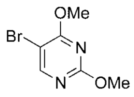
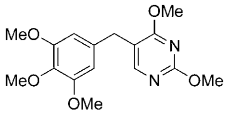
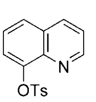
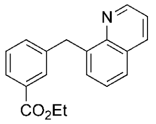
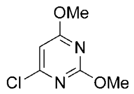
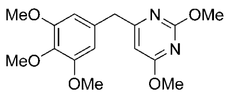
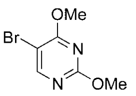
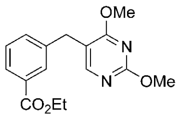
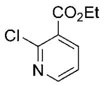
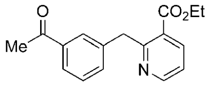
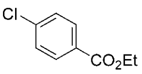
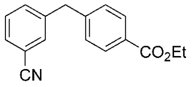
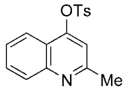
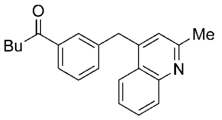
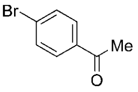
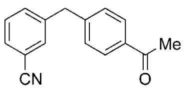
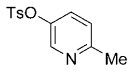
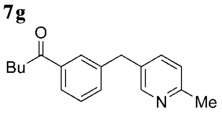
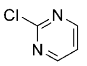
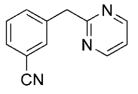
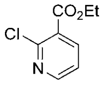
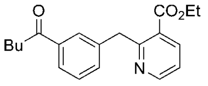
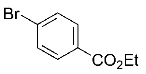
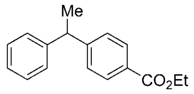
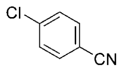
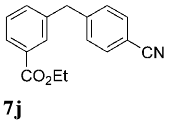


Scheme 7. Nickel-catalyzed cross-coupling reactions of benzylic zinc reagents with aromatic and heteroaromatic chlorides, bromides, and tosylates. acac = acetylacetonate, NMP = *N*-methyl-2-pyrrolidone, Ts = *p*-toluenesulfonyl.

various aromatic and heteroaromatic chlorides, bromides, and tosylates at 60 °C in a 4:1 mixture of THF and NMP. Only 0.5 mol % of [Ni(acac)$_2$] and 2 mol % of PPh$_3$ were necessary to achieve full conversion within a few hours' reaction time at 60 °C (Table 3).

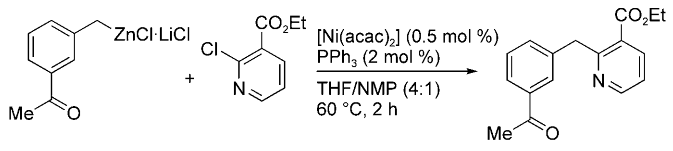
Thus, 3,4,5-trimethoxybenzylzinc chloride (**2f**) reacted smoothly with ethyl 2-chloronicotinate (**6a**) in 30 min at 60 °C to give the expected product **7a** in 97 % yield (Table 3, entry 1). Furthermore, cross-coupling reactions between **2f** and the tosylated heterocycles **6b** and **6c** led to the heterodiaryl methane derivatives **7b** and **7c** in 83–90 % yield (Table 3, entries 2 and 3). This electon-rich benzylic zinc chloride **2f** was coupled under these reaction conditions with protected bromo- and chlorouracils **6d** and **6e** in 2 h at 60 °C to provide the products **7d** and **7e** (86–98 %; Table 3, entries 4 and 5).

Table 3. [Ni(acac)$_2$]/PPh$_3$-catalyzed reactions leading to polyfunctional diaryl methanes **7a–s**.

Entry	Zinc reagent (**2**)	Electrophile (**6**)	Product (**7**)	Yield [%][a]	Entry	Zinc reagent (**2**)	Electrophile (**6**)	Product (**7**)	Yield [%][a]
1	**2f**	 **6a**	 **7a**	97	11	**2l**	 **6h**	 **7k**	65
2	**2f**	 **6b**	 **7b**	90	12	**2l**	 **6i**	 **7l**	61
3	**2f**	 **6c**	 **7c**	83	13	**2l**	 **6j**	 **7m**	69
4	**2f**	 **6d**	 **7d**	86	14	**2l**	 **6c**	 **7n**	85
5	**2f**	 **6e**	 **7e**	98	15	**2l**	 **6d**	 **7o**	84
6	**2i**	 **6a**	 **7f**	68[b]	16	**2m**	 **6k**	 **7p**	89
7	**2k**	 **6f**	 **7g**	92	17	**2m**	 **6l**	 **7q**	75
8	**2k**	 **6b**	 **7h**	84	18	**2m**	 **6m**	 **7r**	69
9	**2k**	 **6a**	 **7i**	90	19	**2n**	 **6n**	 **7s**	95
10	**2l**	 **6g**	 **7j**	91					

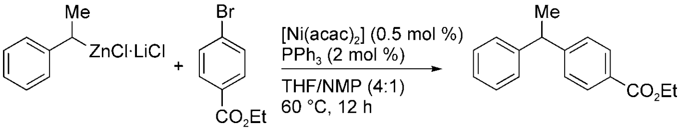
[a] Yield of isolated analytically pure product. [b] The benzylic zinc reagent was added by syringe pump over a period of 30 min.

Remarkably, the acetyl-substituted benzylic zinc chloride **2i** reacted with ethyl 2-chloronicotinate (**6a**) in 2 h at 60 °C without significant enolization to give the expected nicotinic acid derivative **7f** in 68 % yield (Table 3, entry 6 and Scheme 8). Similarly, the pentanoyl-substituted zinc reagent **2k** underwent cross-coupling under these reaction conditions to lead to the functionalized products **7g–i** (Table 3, entries 7–9). Furthermore, 3-ethoxycarbonylbenzylzinc chloride (**2l**) reacted smoothly with 4-chlorobenzonitrile (**6g**) and various aryl tosylates (**6h–j**) to provide the products **7j–m** in 61–91 % yield (Table 3, entries 10–13). Also, Ni-catalyzed cross-coupling reactions of **2l** with the tosylated quinoline **6c** or the brominated dimethoxypyrimidine **6d** were possible and gave the heterocyclic products **7n** and **7o** (84–85 %; Table 3, entries 14 and 15). Interestingly, a cyano group attached to the ring of the benzylic zinc chloride can be tolerated in this cross-coupling procedure too. Thus, the reaction of 4-chloroethylbenzoate (**6k**) with 3-cyanobenzylzinc chloride (**2m**) gave the expected diaryl methane **7p** in 89 % yield (Table 3, entry 16). Furthermore, the tolerance of relatively acidic protons in the electrophile is remarkable. So, 4-bromoacetophenone (**6l**) was coupled in 0.5 h to afford the corresponding carbonitrile **7q** (75 %; Table 3, entry 17). Even cross-coupling with 3-chloropyrimidine (**6m**) is possible and gave the heterocyclic diaryl methane derivative **7r** in 69 % yield (Table 3, entry 18). The Ni-catalyzed reaction with PPh_3 as ligand could also be extended successfully to secondary benzylic zinc chlorides such as **2n**. The product **7s** was provided as a result of the cross-coupling reaction of ethyl 4-bromobenzoate (**6n**) with 1-phenylethylzinc chloride (**2n**) in 12 h at 60 °C (95 %; Table 3, entry 19 and Scheme 9).



2i (1.2 equiv) **6a** **7f**: 68%

Scheme 8. Nickel-catalyzed cross-coupling reactions of 3-acetylbenzylzinc chloride (**2i**) with ethyl 2-chloronicotinate (**6a**).



2n (1.2 equiv) **6n** **7s**: 95%

Scheme 9. $[Ni(acac)_2]/PPh_3$-catalyzed cross-coupling reaction of the secondary benzylic zinc chloride **2n** with ethyl 4-bromobenzoate (**6n**).

Conclusions

In summary, we have developed a new and general method for the preparation of highly functionalized benzylic zinc chlorides by the direct insertion of zinc dust into the corresponding benzylic chlorides in the presence of LiCl. These zinc reagents can react with various electrophiles such as allylic halides, acyl chlorides, and enones, thus leading to a broad range of polyfunctional products. We have also reported a new cross-coupling reaction of benzylic zinc chlorides with various aromatic chlorides, bromides, and tosylates under nickel catalysis by using $[Ni(acac)_2]$ and PPh_3 as the catalytic system, thus leading to polyfunctionalized diaryl methanes.

Experimental Section

General

All reactions were carried out under argon atmosphere in dried glassware. All starting materials purchased from commercial sources were used without further purification. Solvents were dried according to the standard method by distillation over drying agents under nitrogen atmosphere as follows: dichloromethane (DCM; CaH_2), toluene (Na), diethyl ether (Na/benzophenone). THF was heated continuously under reflux and freshly distilled from sodium benzophenone ketyl under nitrogen before use. Yields refer to those of isolated compounds estimated to be >95 % pure as determined by ^1H NMR spectroscopy and capillary GC.

Syntheses

Typical procedure for the preparation of the benzylic zinc reagents **2a–o** (TP1): A Schlenk flask equipped with a magnetic stirrer bar and a septum was charged with LiCl (1.5–2.0 equiv). The flask was heated with a heat gun (400 °C) for 10 min under high vacuum. After being cooled to 25 °C, the flask was flushed with argon (×3). Zinc dust[2] (1.5–2.0 equiv) was added followed by THF. 1,2-Dibromoethane was added (5 mol %), and the reaction mixture was heated until ebullition occurred. After the mixture was cooled to 25 °C, trimethylsilyl chloride (1 mol %) was added, and the mixture was heated again until ebullition occurred. The benzylic chloride (1.0 equiv) was added at the required temperature (usually 25 °C) as a solution in THF (usually 4 M). When capillary GC analysis of a hydrolyzed aliquot containing an internal standard showed a conversion of >98 %, the Schlenk flask was centrifuged for 75 min at 2000 rpm, or the reaction mixture was allowed to settle for some hours. The yield of the resulting benzylic zinc chloride was determined by iodometric titration.[22]

Typical procedure for the reaction of benzylic zinc chlorides with aldehydes (TP2): The aldehyde (1.0 equiv) was dissolved in THF at 0 °C, and a solution of the benzylic zinc chloride (1.3 equiv) was added dropwise. The resulting solution was allowed to warm slowly to 25 °C and stirred for the required time. Next, saturated aqueous NH_4Cl (20 mL) was added. The phases were separated, and the aqueous layer was extracted with Et_2O (3×20 mL). The combined organic extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography afforded the expected alcohols.

Typical procedure for the reaction of benzylic zinc chlorides with acid chlorides (TP3): A solution of the desired benzylic zinc chloride (1.4 equiv) was added dropwise to CuCN·2 LiCl (1.4 equiv, 1 M in THF) at −25 °C. The resulting reaction mixture was stirred for 15 min at this temperature. The solution was then cooled to the required temperature, and the acid chloride (1.0 equiv) was added dropwise. The reaction mixture was stirred overnight and allowed to warm to 25 °C. Next, saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 2:1 was added, the layers were separated, and the aqueous layer was extracted with Et_2O (3×100 mL). The combined organic extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography afforded the expected ketones.

Typical procedure for the reaction of benzylic zinc chlorides with unsaturated ketones (TP4): A solution of the desired benzylic zinc chloride

(1.25 equiv) was added dropwise to CuCN·2 LiCl (1.25 equiv, 1 M in THF) at −25 °C. The resulting reaction mixture was stirred for 15 min at this temperature. The solution was then cooled to the required temperature, and a mixture of the unsaturated ketone (1.0 equiv), trimethylsilyl chloride (2.5 equiv), and THF was added dropwise. The reaction mixture was stirred overnight and allowed to reach 25 °C. Next, saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 2:1 was added. The layers were separated, and the aqueous layer was extracted with Et_2O (3 × 100 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography afforded the expected ketones.

Typical procedure for the Cu^I-catalyzed allylic substitution of benzylic zinc chlorides with ethyl (2-bromomethyl)acrylate (TP5): A solution of the desired benzylic zinc chloride (1.2–1.3 equiv) was added to a solution of the acrylate in THF at the required temperature followed by CuCN·2 LiCl (0.01 mL, 1 M in THF). The reaction mixture was stirred for the required time. Next, saturated aqueous NH_4Cl (25 mL) was added. The phases were separated, and the aqueous layer was extracted with Et_2O (3 × 25 mL). The combined organic extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography afforded the expected acrylates.

Typical procedure for the Ni-catalyzed cross-coupling reactions (TP6): In a dry argon-flushed Schlenk flask equipped with a septum and a magnetic stirrer bar, the aromatic chloride, bromide, or tosylate (2.00 mmol) was dissolved in NMP (0.4 mL), and PPh_3 (0.1 mL, 0.4 M in THF, 0.40 mmol, 2 mol %) was added. Next, $[Ni(acac)_2]$ (0.1 mL, 0.1 M in THF, 0.1 mmol, 0.5 mol %) was added. After the addition of the corresponding benzylic zinc reagent (2.40 mmol, 1.2 equiv), the reaction mixture was warmed to 60 °C and stirred for the given time until GC analysis showed full conversion of the electrophile. The reaction was quenched with saturated aqueous NH_4Cl, and the mixture was extracted with EtOAc (× 3). The combined organic layers were washed with brine and dried over Na_2SO_4, and the solvent was removed in vacuo. The product was purified by flash column chromatography.

2a: Prepared according to TP1: 2-Chlorobenzyl chloride (**1a**; 3.22 g, 20.0 mmol, in 5 mL THF) was added dropwise at 0 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30.0 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The reaction mixture was stirred for 15 min at 0 °C followed by 1.75 h at 25 °C. After decantation, iodometric titration of **2a** indicated a yield of 99 %.

2b: Prepared according to TP1: 2-Iodobenzyl chloride (**1b**; 5.05 g, 20.0 mmol, in 5 mL THF) was added dropwise at 0 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30.0 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The reaction mixture was stirred for 20 min at 0 °C followed by 100 min at 25 °C. After decantation, iodometric titration of **2b** indicated a yield of 99 %.

2c: Prepared according to TP1: 3-Bromobenzyl chloride (**1c**; 4.11 g, 20.0 mmol, in 5 mL THF) was added dropwise at 25 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30.0 mmol) in THF (3.5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The reaction mixture was stirred for 4 h at 25 °C. After decantation, iodometric titration of **2c** indicated a yield of 95 %.

2d: Prepared according to TP1: 4-Fluorobenzyl chloride (**1d**; 2.17 g, 15.0 mmol, in 4 mL THF) was added dropwise at 25 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30.0 mmol) in THF (3.5 mL; activation: $BrCH_2CH_2Br$ (0.07 mL, 5 mol %), TMSCl (0.02 mL, 1 mol %)). The reaction mixture was stirred for 24 h at 25 °C. After decantation, iodometric titration of **2d** indicated a yield of 87 %.

2e: Prepared according to TP1: 6-Chloro-1,3-benzodioxol-5-ylmethyl chloride (**1e**; 4.10 g, 20.0 mmol, in 5 mL THF) was added dropwise at 0 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30.0 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The ice bath was removed, and the reaction mixture was stirred for 1 h at 25 °C. After decantation, iodometric titration of **2e** indicated a yield of 93 %.

2f: Prepared according to TP1: 3,4,5-Trimethoxybenzyl chloride (**1f**; 2.71 g, 12.5 mmol, in 3 mL THF) was added dropwise at 0 °C to a suspension of LiCl (1.06 g, 25.0 mmol) and zinc dust (1.64 g, 25.0 mmol) in THF (3.5 mL; activation: $BrCH_2CH_2Br$ (0.05 mL, 5 mol %), TMSCl (0.02 mL, 1 mol %)). The ice bath was removed, and the reaction mixture was stirred for 3 h at 25 °C. After decantation, iodometric titration of **2f** indicated a yield of 78 %.

2g: Prepared according to TP1: 4-Methoxybenzyl chloride (**1g**; 1.57 g, 10.0 mmol, in 5 mL THF) was added dropwise at 0 °C to a suspension of LiCl (636 mg, 15.0 mmol) and zinc dust (981 mg, 15.0 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.04 mL, 5 mol %), TMSCl (0.01 mL, 1 mol %)). The reaction mixture was stirred for 6.5 h at 25 °C. After decantation, iodometric titration of **2g** indicated a yield of 73 %.

2h: Prepared according to TP1: 4-Methylthiobenzyl chloride (**1h**; 2.59 g, 15.0 mmol, in 3 mL THF) was added dropwise at 0 °C to a suspension of LiCl (954 mg, 22.5 mmol) and zinc dust (1.47 g, 22.5 mmol) in THF (4.5 mL; activation: $BrCH_2CH_2Br$ (0.07 mL, 5 mol %), TMSCl (0.02 mL, 1 mol %)). The reaction mixture was stirred for 2 h at 25 °C. After decantation, iodometric titration of **2h** indicated a yield of 77 %.

2i: Prepared according to TP1: 3-Acetylbenzyl chloride (**1i**; 1.85 g, 11.0 mmol, in 2.5 mL THF) was added dropwise at 25 °C to a suspension of LiCl (0.70 g, 16.5 mmol) and zinc dust (1.08 g, 16.5 mmol) in THF (3 mL; activation: $BrCH_2CH_2Br$ (0.05 mL, 5 mol %), TMSCl (0.01 mL, 1 mol %)). The reaction mixture was stirred for 3.5 h at 25 °C. After decantation, iodometric titration of **2i** indicated a yield of 68 %.

2j: Prepared according to TP1: 3-Propionylbenzyl chloride (**1j**; 2.01 g, 11.0 mmol, in 3.5 mL THF) was added dropwise at 25 °C to a suspension of LiCl (0.70 g, 16.5 mmol) and zinc dust (1.08 g, 16.5 mmol) in THF (3 mL; activation: $BrCH_2CH_2Br$ (0.05 mL, 5 mol %), TMSCl (0.01 mL, 1 mol %)). The reaction mixture was stirred for 3 h at 25 °C. After decantation, iodometric titration of **2j** indicated a yield of 72 %.

2k: Prepared according to TP1: 3-Pentanoylbenzyl chloride (**1k**; 4.21 g, 20.0 mmol, in 5 mL THF) was added dropwise at 25 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The reaction mixture was stirred for 3.5 h at 25 °C. After decantation, iodometric titration of **2k** indicated a yield of 72 %.

2l: Prepared according to TP1: 3-Ethoxycarbonylbenzyl chloride (**1l**; 3.97 g, 20.0 mmol, in 5 mL THF) was added dropwise at 25 °C to a suspension of LiCl (1.70 g, 40.0 mmol) and zinc dust (2.62 g, 40.0 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The reaction mixture was stirred for 3.5 h at 25 °C. After decantation, iodometric titration of **2l** indicated a yield of 85 %.

2m: Prepared according to TP1: 3-Cyanobenzyl chloride (**1m**; 3.03 g, 20.0 mmol, in 5 mL THF) was added dropwise at 0 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30.0 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The ice bath was removed, and the reaction mixture was stirred for 3 h at 25 °C. After decantation, iodometric titration of **2m** indicated a yield of 93 %.

2n: Prepared according to TP1: 1-Phenylethyl chloride (**1n**; 2.81 g, 20.0 mmol, in 5 mL THF) was added dropwise at 0 °C to a suspension of LiCl (1.27 g, 30.0 mmol) and zinc dust (1.96 g, 30.0 mmol) in THF (5 mL; activation: $BrCH_2CH_2Br$ (0.09 mL, 5 mol %), TMSCl (0.03 mL, 1 mol %)). The ice bath was removed, and the reaction mixture was stirred for 11 h at 25 °C. After decantation, iodometric titration of **2n** indicated a yield of 85 %.

2o: Prepared according to TP1: Benzyl chloride (**1o**; 1.27 g, 10.0 mmol, in 2.5 mL THF) was added dropwise at 25 °C to a suspension of LiCl (636 mg, 15.0 mmol) and zinc dust (981 mg, 15.0 mmol) in THF (2.5 mL; activation: $BrCH_2CH_2Br$ (0.04 mL, 5 mol %), TMSCl (0.01 mL, 1 mol %)). The reaction mixture was stirred for 6.5 h at 40 °C. After decantation, iodometric titration of **2o** indicated a yield of 88 %.

4a: 3-Bromocyclohexene (**3a**; 419 mg, 2.6 mmol) was added to 2-chlorobenzylzinc chloride (**2a**; 1.23 mL, 2.0 mmol, 1.62 M in THF) at 0 °C, followed by CuCN·2 LiCl (0.01 mL, 1 M in THF). The solution was stirred for 1.5 h at 25 °C, and the reaction was quenched with saturated aqueous

NH_4Cl. The phases were separated, and the aqueous layer was extracted with Et_2O (3×5 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane) afforded 1-chloro-2-(cyclohex-2-en-1-ylmethyl)benzene (**4a**; 389 mg, 94 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}=3017$ (m), 2922 (s), 2857 (m), 2834 (m), 1473 (s), 1446 (m), 1439 (m), 1052 (m), 1032 (m), 746 (vs), 718 (m), 683 (m), 665 cm^{-1} (m); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=7.33$ (dd, $J=7.7$, 1.3 Hz, 1 H), 7.20–7.11 (m, 3 H), 5.72–5.68 (m, 1 H), 5.58–5.54 (m, 1 H), 2.77–2.72 (m, 1 H), 2.69–2.65 (m, 1 H), 2.51–2.43 (m, 1 H), 2.02–1.96 (m, 1 H), 1.77–1.66 (m, 2 H), 1.55–1.47 (m, 1 H), 1.33–1.27 ppm (m, 1 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta=138.5$, 134.3, 131.4, 131.0, 129.5, 127.5, 127.3, 126.4, 40.0, 35.4, 28.8, 25.4, 21.2 ppm; MS (EI, 70 eV): m/z (%) = 208 $[M]^+$ (9), 206 (31), 125 (22), 82 (12), 81 (24), 80 (100), 79 (24); HRMS: m/z calcd for $C_{13}H_{15}Cl$: 206.0862 $[M]^+$; found: 206.0840.

4b: 2-Chlorobenzylzinc chloride (**2a**; 1.55 mL, 2.4 mmol, 1.55 M in THF) was added to a solution of *S*-(4-bromophenyl)benzenesulfonothioate (**3b**; 658 mg, 2.00 mmol) in THF (4 mL) at 25 °C. The reaction mixture was stirred for 1 h, and the reaction was quenched with saturated aqueous NH_4Cl. The phases were separated, and the aqueous layer was extracted with DCM (3×20 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane) afforded 1-{[(4-bromophenyl)thio]methyl}-2-chlorobenzene (**4b**; 559 mg, 89 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}=1567$ (w), 1471 (vs), 1442 (s), 1386 (m), 1235 (w), 1090 (s), 1068 (m), 1051 (s), 1037 (s), 1006 (vs), 804 (s), 757 (s), 741 (vs), 728 (s), 698 (m), 681 (s), 666 cm^{-1} (m); ^{1}H NMR (300 MHz, $CDCl_3$): $\delta=7.40$–7.33 (m, 3 H), 7.23–7.10 (m, 5 H), 4.18 ppm (s, 2 H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta=134.8$, 134.8, 134.1, 132.4, 131.9, 130.6, 129.7, 128.7, 126.8, 120.9, 37.0 ppm; MS (EI, 70 eV): m/z (%) = 316 (35), 314 (50), 312 $[M]^+$ (100), 127 (15), 125 (26), 107 (43), 98 (15), 90 (13), 89 (40), 63 (20); HRMS: m/z calcd for $C_{13}H_{10}BrClS$: 311.9375 $[M]^+$; found: 311.9366.

4c: Prepared according to TP4. A mixture of cyclohex-2-en-1-one (**3c**; 480 mg, 5.0 mmol) and TMSCl (1.6 mL, 12.5 mmol) in THF (2 mL) was added dropwise to a mixture of CuCN·2 LiCl (6.3 mL, 6.3 mmol, 1 M in THF) and 2-chlorobenzylzinc chloride (**2a**; 3.83 mL, 6.25 mmol, 1.63 M in THF) at −40 °C. The reaction mixture was allowed to reach 25 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 2:1 (20 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 4:1) afforded 3-(2-chlorobenzyl)cyclohexanone (**4c**; 1.03 g, 93 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2936$ (w), 2864 (w), 1708 (vs), 1476 (m), 1444 (m), 1348 (w), 1312 (w), 1224 (m), 1128 (w), 1052 (m), 1036 (m), 748 (vs), 680 (s), 596 cm^{-1} (w); ^{1}H NMR (300 MHz, $CDCl_3$): $\delta=7.33$–7.27 (m, 1 H), 7.18–7.05 (m, 3 H), 2.81–2.62 (m, 2 H), 2.38–1.94 (m, 6 H), 1.89–1.78 (m, 1 H), 1.66–1.48 (m, 1 H), 1.47–1.32 ppm (m, 1 H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta=211.4$, 137.5, 134.4, 131.5, 129.9, 128.0, 126.9, 47.9, 41.6, 40.6, 39.6, 31.2, 25.3 ppm; MS (EI, 70 eV): m/z (%) = 222 $[M]^+$ (3), 187 (39), 186 (23), 164 (18), 142 (19), 130 (10), 129 (24), 127 (11), 125 (28), 115 (16), 97 (87), 91 (29), 89 (14), 69 (100), 55 (46), 44 (15), 41 (58); HRMS: m/z calcd for $C_{13}H_{15}ClO$: 222.0811 $[M]^+$; found: 222.0800.

4d: 2-Chlorobenzylzinc chloride (**2a**; 2.17 mL, 3.3 mmol, 1.62 M in THF) and CuCN·2 LiCl (0.01 mL, 1 M in THF) were added successively to a solution of 4-nitrobenzyl bromide (**3d**; 594 mg, 2.75 mmol) in THF (2.7 mL) at 0 °C. The mixture was stirred for 3 h at 0 °C, and the reaction was quenched with saturated aqueous NH_4Cl. The phases were separated, and the aqueous layer was extracted with Et_2O (5×5 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane/Et_2O = 98:2) afforded 1-chloro-2-[2-(4-nitrophenyl)ethyl]benzene (**4d**; 643 mg, 89 %) as a white solid. M.p.: 66.9–67.9 °C; IR (diamond/ATR, neat): $\tilde{\nu}=2932$ (w), 2854 (w), 1596 (m), 1509 (s), 1470 (m), 1457 (m), 1444 (m), 1334 (m), 1313 (m), 1256 (m), 1107 (m), 1049 (m), 1036 (m), 829 (s), 750 (vs), 698 cm^{-1} (s); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=8.14$–8.11 (m, 2 H), 7.38–7.34 (m, 1 H), 7.32–7.29 (m, 2 H), 7.18–7.13 (m, 2 H), 7.09–7.06 (m, 1 H), 3.07–3.00 ppm (m, 2 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta=149.3$, 138.2, 134.1, 130.7, 129.9, 129.6, 128.1, 127.1, 123.9, 36.0, 35.4 ppm; MS (EI, 70 eV): m/z (%) = 263 (11), 261 $[M]^+$ (29), 127 (33), 125 (100), 89 (13); HRMS: m/z calcd for $C_{14}H_{12}ClNO_2$: 261.0557 $[M]^+$; found: 261.0560.

4e: 2-Chlorobenzylzinc chloride (**2a**; 1.96 mL, 3.0 mmol, 1.53 M in THF) and $[Pd(PPh_3)_4]$ (69 mg, 2 mol %) were added successively to a solution of ethyl 4-iodobenzoate (**3e**; 690 mg, 2.5 mmol) in THF (2.5 mL) at 25 °C. The resulting reaction mixture was heated to 60 °C for 5 h. After it was cooled to 25 °C, the reaction mixture was diluted with Et_2O (5 mL), and the reaction was quenched with saturated aqueous NH_4Cl. The phases were separated, and the aqueous layer was extracted with Et_2O (5×5 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane/Et_2O = 9:1) afforded ethyl 4-(2-chlorobenzyl)benzoate (**4e**; 667 mg, 97 %) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2980$ (w), 1712 (vs), 1610 (m), 1473 (w), 1443 (m), 1415 (m), 1366 (w), 1271 (vs), 1177 (m), 1103 (s), 1050 (m), 1039 (m), 1020 (m), 747 cm^{-1} (s); ^{1}H NMR (300 MHz, $CDCl_3$): $\delta=8.06$–8.01 (m, 3 H), 7.46–7.42 (m, 1 H), 7.34–7.28 (m, 2 H), 7.27–7.18 (m, 2 H), 4.42 (q, $J=7.2$ Hz, 2 H), 4.21 (s, 2 H), 1.44 ppm (t, $J=7.2$ Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta=166.8$, 145.0, 138.0, 134.5, 131.3, 130.0, 129.9, 129.1, 128.9, 128.2, 127.2, 61.1, 39.5, 14.6 ppm; MS (EI, 70 eV): m/z (%) = 276 (23), 275 (15), 274 $[M]^+$, (77), 248 (109), 246 (30), 239 (13), 232 (38), 231 (17), 230 (100), 211 (21), 203 (12), 201 (32), 167 (20), 166 (399), 165 (67); HRMS: m/z calcd for $C_{16}H_{15}ClO_2$: 274.0671 $[M]^+$; found: 274.0748.

4f: Prepared according to TP2. 2-Iodobenzylzinc chloride (**2b**; 1.28 mL, 2.0 mmol, 1.53 M in THF) was treated with 3-chlorobenzaldehyde (**3f**; 211 mg, 1.5 mmol, in 1.5 mL THF). After 5 h, the reaction was quenched with saturated aqueous NH_4Cl. Purification by flash chromatography (silica gel, pentane/Et_2O = 9:1→7:3) afforded 1-(3-chlorophenyl)-2-(2-iodophenyl)ethanol (**4f**; 470 mg, 87 %) as a pale-yellow solid. M.p.: 67.6–69.5 °C; IR (diamond/ATR, neat): $\tilde{\nu}=3322$ (w), 3252 (w), 1596 (w), 1575 (w), 1468 (m), 1435 (m), 1198 (m), 1055 (s), 1015 (s), 884 (m), 783 (s), 746 (s), 725 (s), 695 cm^{-1} (vs); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=7.86$ (dd, $J=7.8$, 1.2 Hz, 1 H), 7.45 (m, 1 H), 7.30–7.24 (m, 3 H), 7.18 (dd, $J=7.5$, 1.8 Hz, 1 H), 5.01–4.97 (m, 1 H), 3.17–3.13 (m, 1 H), 3.08–3.03 (m, 1 H), 1.92 ppm (d, $J=3.3$ Hz, 1 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta=145.7$, 140.4, 139.7, 134.4, 131.3, 129.7, 128.7, 128.3, 127.8, 125.9, 123.9, 100.9, 72.8, 50.4 ppm; MS (EI, 70 eV): m/z (%) = 358 $[M]^+$ (1), 218 (100), 142 (8), 141 (27), 77 (13); HRMS: m/z calcd for $C_{14}H_{12}ClIO$: 357.9621 $[M]^+$; found: 357.9629.

4g: Prepared according to TP4. A mixture of cyclohex-2-en-1-one (**3c**; 480 mg, 5.0 mmol) and TMSCl (1.6 mL, 12.5 mmol) in THF (2 mL) was added dropwise to a mixture of CuCN·2 LiCl (6.3 mL, 6.3 mmol, 1 M in THF) and 2-iodobenzylzinc chloride (**2b**; 4.81 mL, 6.25 mmol, 1.30 M in THF) at −40 °C. The reaction mixture was allowed to reach 25 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 2:1 (20 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 4:1) afforded 3-(2-iodobenzyl)cyclohexanone (**4g**; 1.13 g, 72 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2933$ (m), 2863 (m), 1706 (vs), 1466 (m), 1446 (m), 1224 (m), 1008 (s), 744 (s), 646 cm^{-1} (m); ^{1}H NMR (300 MHz, $CDCl_3$): $\delta=7.80$ (dd, $J=7.8$ Hz, $J=1.2$ Hz, 1 H), 7.28–7.22 (m, 1 H), 7.13–7.09 (m, 1 H), 6.91–6.85 (m, 1 H), 2.82–2.64 (m, 2 H), 2.43–1.98 (m, 6 H), 1.95–1.83 (m, 1 H), 1.70–1.53 (m, 1 H), 1.53–1.37 ppm (m, 1 H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta=211.3$, 142.2, 139.7, 130.4, 128.1 (overlapped), 101.0, 47.6, 47.2, 41.4, 39.5, 30.9, 25.1 ppm; MS (EI, 70 eV): m/z (%) = 314 $[M]^+$ (9), 217 (18), 188 (13), 187 (100), 126 (15), 115 (16), 97 (66), 91 (22), 89 (12), 69 (72), 55 (34), 41 (33); HRMS: m/z calcd for $C_{13}H_{15}IO$: 314.0168 $[M]^+$; found: 314.0166.

4h: Prepared according to TP3. 3,3-Dimethylbutyryl chloride (**3g**; 581 mg, 4.32 mmol) was added dropwise to a mixture of CuCN·2 LiCl (6.02 mL, 6.02 mmol, 1 M in THF) and 3-bromobenzylzinc chloride (**2c**; 1.72 mL, 6.02 mmol, 1.53 M in THF) at −60 °C. The reaction mixture was allowed to reach −20 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 2:1 (25 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 98:2) afforded 1-(3-bromophenyl)-4,4-dimethylpentan-2-one (**4h**; 1.11 g, 96 %) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2868$ (m), 1596 (m), 1188 (m), 1222 (m), 996 (m), 1428 (m), 1350 (m), 1568 (m), 2954 (m), 668 (s), 1364 (s), 696 (s), 1474 (s), 772 (s), 1072 (vs), 1714 cm^{-1} (vs); ^{1}H NMR

(600 MHz, $CDCl_3$): $\delta = 7.40$–7.37 (m, 1 H), 7.33–7.32 (m, 1 H), 7.18 (t, $J = 7.8$ Hz, 1 H), 7.11–7.08 (m, 1 H), 3.62 (s, 2 H), 2.35 (s, 2 H), 1.00 ppm (s, 9 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta = 206.9$, 136.4, 132.5, 130.1, 130.0, 128.2, 122.6, 54.3, 51.3, 31.1, 29.7 ppm; MS (EI, 70 eV): *m*/*z* (%) = 268 $[M]^+$ (6), 180 (16), 169 (16), 99 (100), 90 (15), 71 (14), 57 (79); HRMS: *m*/*z* calcd for $C_{13}H_{17}BrO$: 268.0463 $[M]^+$; found: 268.0457.

4i: Prepared according to TP2. 3-Bromobenzylzinc chloride (**2c**; 1.72 mL, 2.7 mmol, 1.56 M in THF) was treated with 3,4-dichlorobenzaldehyde (**3h**; 361 mg, 2.1 mmol, in 1.5 mL THF). After 17 h, the reaction was quenched with saturated aqueous NH_4Cl. Purification by flash chromatography (silica gel, pentane/$Et_2O = 98:2$) afforded 2-(3-bromophenyl)-1-(3,4-dichlorophenyl)ethanol (**4i**; 699 mg, 98 %) as a white solid. M.p.: 64.2–65.4 °C; IR (diamond/ATR, neat): $\tilde{\nu} = 3288$ (m), 1564 (m), 1470 (s), 1424 (m), 1202 (m), 1128 (m), 1070 (s), 1046 (s), 1026 (s), 998 (s), 884 (s), 782 (vs), 668 cm^{-1} (vs); ^1H NMR (600 MHz, $CDCl_3$): $\delta = 7.43$ (d, $J = 2.0$ Hz, 1 H), 7.41–7.34 (m, 3 H), 7.16 (t, $J = 7.7$ Hz, 1 H), 7.12 (dd, $J = 8.4$, 2.0 Hz, 1 H), 7.06 (d, $J = 7.5$ Hz, 1 H), 4.81 (dd, $J = 8.4$, 4.6 Hz, 1 H), 2.96–2.85 (m, 2 H), 2.09 ppm (s, 1 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta = 143.6$, 139.6, 132.6, 132.4, 131.5, 130.4, 130.1, 130.0, 128.1, 127.8, 125.1, 122.6, 73.8, 45.4 ppm; MS (ESI): *m*/*z* (%) = 328 (3), 175 (100), 111 (40), 91 (20), 75 (10); HRMS: *m*/*z* calcd for $C_{15}H_{12}BrCl_2O_3$: 388.9352 $[M+\text{formiate}]^+$; found: 388.9360.

4j: Prepared according to TP5. A solution of ethyl 2-bromomethylacrylate (**3i**; 965 mg, 5.00 mmol) in THF (3 mL) at −60 °C was treated with 4-fluorobenzylzinc chloride (**2d**; 4.12 mL, 6.00 mmol, 1.45 M in THF) and CuCN·2 LiCl (0.01 mL, 1 M in THF). The reaction mixture was stirred at −60 °C for 1.5 h, followed by stirring at 0 °C for a further 30 min. Workup as usual and purification by flash chromatography (silica gel, pentane/$Et_2O = 98:2$) afforded ethyl 2-[2-(4-fluorophenyl)ethyl]acrylate (**4j**; 1.03 g, 93 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu} = 2932$ (w), 2984 (w), 1632 (w), 1304 (m), 524 (m), 944 (m), 1028 (m), 1092 (m), 1156 (m), 820 (s), 1132 (s), 1220 (s), 1184 (s), 1712 (s), 1508 cm^{-1} (s); ^1H NMR (600 MHz, $CDCl_3$): $\delta = 7.14$–7.10 (m, 2 H), 6.97–6.92 (m, 2 H), 6.15–6.13 (m, 1 H), 5.47–5.45 (m, 1 H), 4.21 (q, $J = 7.2$ Hz, 2 H), 2.79–2.72 (m, 2 H), 2.61–2.54 (m, 2 H), 1.30 ppm (t, $J = 7.2$ Hz, 3 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta = 167.0$, 161.3 (d, $^1J_{C,F} = 243$ Hz), 139.9, 137.0 (d, $^4J_{C,F} = 3$ Hz), 129.8 (d, $^3J_{C,F} = 8$ Hz), 125.2, 115.0 (d, $^2J_{C,F} = 21$ Hz), 60.6, 34.1, 34.0, 14.2 ppm; MS (EI, 70 eV): *m*/*z* (%) = 222 $[M]^+$ (5), 209 (9), 176 (13), 148 (7), 109 (100), 101 (8), 83 (6); HRMS: *m*/*z* calcd for $C_{13}H_{15}FO_2$: 222.1056 $[M]^+$; found: 222.1032.

4k: Prepared according to TP3. 3,3-Dimethylbutyryl chloride (**3g**; 377 mg, 2.8 mmol) was added dropwise to a mixture of CuCN·2 LiCl (3.92 mL, 3.9 mmol, 1 M in THF) and 4-fluorobenzylzinc chloride (**2d**; 2.69 mL, 3.9 mmol, 1.46 M in THF) at −40 °C. The reaction mixture was allowed to reach 25 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 4:1 (25 mL). Purification by flash chromatography (silica gel, pentane/$Et_2O = 98:2$) afforded 1-(4-fluorophenyl)-4,4-dimethylpentan-2-one (**4k**; 555 mg, 95 %) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu} = 2956$ (m), 1712 (s), 1508 (vs), 1364 (m), 1352 (m), 1220 (vs), 1160 (m), 1084 (m), 1064 (m), 824 (m), 780 (m), 524 cm^{-1} (m); ^1H NMR (600 MHz, $CDCl_3$): $\delta = 7.15$–7.10 (m, 2 H), 7.02–6.97 (m, 2 H), 3.36 (s, 1 H), 2.35 (s, 1 H), 1.00 ppm (s, 9 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta = 207.8$, 161.9 (d, $^1J_{C,F} = 245$ Hz), 131.0 (d, $^3J_{C,F} = 8$ Hz), 129.9 (d, $^4J_{C,F} = 3$ Hz), 115.4 (d, $^2J_{C,F} = 21$ Hz), 54.4, 51.2, 31.3, 29.9 ppm; MS (EI, 70 eV): *m*/*z* (%) = 208 (3), 109 (53), 99 (60), 71 (17), 57 (100), 43 (13), 42 (16); HRMS: *m*/*z* calcd for $C_{13}H_{17}FO$: 208.1263 $[M]^+$; found: 208.1261.

4l: Prepared according to TP3. 3,3-Dimethylbutyryl chloride (**3g**; 377 mg, 2.80 mmol) was added dropwise to a mixture of CuCN·2 LiCl (3.92 mL, 3.92 mmol, 1 M in THF) and 6-chloro-1,3-benzodioxol-5-ylmethylzinc chloride (**2e**; 2.80 mL, 3.92 mmol, 1.40 M in THF) at −60 °C. The reaction mixture was allowed to reach 25 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 5:1 (25 mL). Purification by flash chromatography (silica gel, pentane/$Et_2O = 95:5$) afforded 1-(6-chloro-1,3-benzodioxol-5-yl)-4,4-dimethylpentan-2-one (**4l**; 703 mg, 93 %) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu} = 2952$ (m), 2904 (w), 1716 (m), 1504 (s), 1480 (vs), 1364 (m), 1248 (s), 1232 (s), 1120 (s), 1036 (vs), 984 (m), 932 (s), 840 (s), 724 (w), 684 cm^{-1} (w); ^1H NMR (600 MHz, $CDCl_3$): $\delta = 6.84$ (s, 1 H), 6.63 (s, 1 H), 5.95 (s, 2 H), 3.70 (s, 2 H), 2.38 (s, 2 H), 1.02 ppm (s, 9 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta = 206.5$, 147.4, 146.7, 126.0, 125.7, 110.9, 109.8, 101.7, 54.3, 49.2, 31.0, 29.6 ppm; MS (EI, 70 eV): *m*/*z* (%) = 268 (77), 171 (76), 169 (50), 110 (23), 99 (100), 71 (65), 57 (43), 41 (33); HRMS: *m*/*z* calcd for $C_{14}H_{17}ClO_3$: 268.0866 $[M]^+$; found: 268.0855.

4m: Prepared according to TP5. A solution of ethyl 2-bromomethylacrylate (**3i**; 579 mg, 3.00 mmol) in THF (1.5 mL) was treated with 3,4,5-trimethoxybenzylzinc chloride (**2f**; 7.40 mL, 3.75 mmol, 0.51 M in THF) and CuCN·2 LiCl (0.01 mL, 1 M in THF). The reaction mixture was stirred at −60 °C for 30 min, followed by stirring at 0 °C for a further 30 min. Workup as usual and purification by flash chromatography (silica gel, pentane/$Et_2O = 7:1$) afforded ethyl 2-[2-(3,4,5-trimethoxyphenyl)ethyl]-acrylate (**4m**; 867 mg, 98 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu} = 2936$ (w), 2840 (w), 1712 (m), 1588 (m), 1508 (m), 1456 (m), 1420 (m), 1332 (m), 1236 (s), 1184 (s), 1120 (vs), 1008 (m), 944 (m), 820 cm^{-1} (m); ^1H NMR (300 MHz, $CDCl_3$): $\delta = 6.36$ (s, 2 H), 6.11 (s, 1 H), 5.48 (s, 1 H), 4.17 (q, $J = 7.1$ Hz, 2 H), 3.79 (s, 6 H), 3.77, (s, 3 H), 2.73–2.63 (m, 2 H), 2.62–2.51 (m, 2 H), 1.26 ppm (t, $J = 7.2$ Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 167.3$, 153.3, 140.3, 137.5, 136.4, 125.3, 105.6, 61.0, 60.8, 56.2, 35.6, 34.2, 14.4 ppm; MS (EI, 70 eV): *m*/*z* (%) = 294 (31), 182 (20), 181 (100), 148 (7), 121 (9); HRMS: *m*/*z* calcd for $C_{16}H_{22}O_5$: 294.1467 $[M]^+$; found: 294.1457.

4n: Prepared according to TP5. A solution of ethyl 2-bromomethylacrylate (**3i**; 772 mg, 4.00 mmol) in THF (2 mL) at −40 °C was treated with 4-methoxybenzylzinc chloride (**2g**; 7.19 mL, 5.00 mmol, 0.70 M in THF) and CuCN·2 LiCl (0.01 mL, 1 M in THF). The reaction mixture was stirred at −40 °C for 30 min, followed by stirring at 0 °C for a further 30 min. Workup as usual and purification by flash chromatography (silica gel, pentane/$Et_2O = 98:2$) afforded ethyl 2-[2-(4-methoxyphenyl)ethyl]acrylate (**4n**; 0.91 g, 97 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu} = 2936$ (w), 1712 (s), 1612 (m), 1512 (vs), 1300 (m), 1244 (vs), 1176 (vs), 1132 (s), 1104 (m), 1032 (s), 944 (m), 816 (s), 520 cm^{-1} (m); ^1H NMR (300 MHz, $CDCl_3$): $\delta = 7.14$–7.06 (m, 2 H), 6.86–6.79 (m, 2 H), 6.15–6.13 (m, 1 H), 5.49–5.46 (m, 1 H), 4.22 (q, $J = 7.1$ Hz, 2 H), 3.78 (s, 3 H), 2.78–2.69 (m, 2 H), 2.62–2.53 (m, 2 H), 1.31 ppm (t, $J = 7.1$ Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 167.1$, 157.8, 140.2, 133.5, 129.3, 125.0, 113.7, 60.6, 55.2, 34.1, 34.0, 14.2 ppm; MS (EI, 70 eV): *m*/*z* (%) = 234 $[M]^+$ (50), 189 (31), 161 (12), 121 (100), 115 (10), 91 (25), 77 (30); HRMS: *m*/*z* calcd for $C_{14}H_{18}O_3$: 234.1256 $[M]^+$; found: 234.1233.

4o: 4-Methylthiobenzylzinc chloride (**2h**; 0.85 mL, 1.20 mmol, 1.42 M in THF) and CuCN·2 LiCl (0.5 mL, 0.5 mmol, 1 M in THF) were added dropwise to a solution of propanoyl chloride (**3j**; 95.3 mg, 1.03 mmol) at −20 °C in THF (0.5 mL). The reaction mixture was stirred at 0 °C and slowly warmed to 25 °C within 4 h. Next, saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 9:1 (25 mL) was added, and the layers were separated. The aqueous layer was extracted with Et_2O (5 × 20 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane/$Et_2O = 9:1$) afforded 1-[4-(methylthio)phenyl]butan-2-one (**4o**; 143 mg, 71 %) as a white solid. M.p.: 42.1–43.4 °C; IR (diamond/ATR, neat): $\tilde{\nu} = 2978$ (w), 2937 (w), 2922 (w), 2903 (w), 1711 (vs), 1601 (w), 1496 (s), 1456 (m), 1438 (m), 1413 (s), 1378 (m), 1351 (m), 1317 (m), 1111 (s), 1098 (m), 1087 (m), 1038 (s), 1020 (m), 993 (m), 969 (m), 959 (m), 866 (m), 823 (m), 803 (vs), 725 (m), 667 cm^{-1} (m); ^1H NMR (600 MHz, $CDCl_3$): $\delta = 7.23$–7.19 (m, 2 H), 7.13–7.10 (m, 2 H), 3.63 (s, 2 H) 2.46 (q, $J = 7.3$ Hz, 2 H), 2.46 (s, 3 H), 1.02 ppm (t, $J = 7.3$ Hz, 3 H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta = 208.8$, 137.0, 131.3, 129.8, 127.0, 49.2, 35.2, 16.0, 7.8 ppm; MS (EI, 70 eV): *m*/*z* (%) = 194 $[M]^+$ (26), 137 (100), 122 (11), 57 (10); HRMS: *m*/*z* calcd for $C_{11}H_{14}OS$: 194.0765 $[M]^+$; found: 194.0747.

4p: Prepared according to TP3. 3,3-Dimethylbutyryl chloride (**3g**; 192 mg, 1.44 mmol) was added dropwise to a mixture of CuCN·2 LiCl (1.88 mL, 1.88 mmol, 1 M in THF) and 3-acetylbenzylzinc chloride (**2i**; 1.68 mL, 1.88 mmol, 1.12 M in THF) at −60 °C. The reaction mixture was stirred at −20 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 5:1 (25 mL). Purification by flash chromatography (silica gel, pentane/$Et_2O = 7:3$) afforded 1-(3-acetylphenyl)-4,4-dimethylpentan-2-one (**4p**; 248 mg, 74 %) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2868$ (w), 920 (w), 1602 (w), 1584 (w), 2953 (m), 1439 (m), 790 (m), 1063 (m), 1083 (m), 1189 (m), 1713 (m), 1356 (s), 693 (s), 1269 (s), 1681 cm^{-1} (vs); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=7.85$–7.82 (m, 1H), 7.75–7.74 (m, 1H), 7.43–7.40 (m, 1H), 7.38–7.36 (m, 1H), 3.73 (s, 2H), 2.58 (s, 3H), 2.37 (s, 2H), 1.00 ppm (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta=207.1$, 197.9, 137.4, 134.7, 134.2, 129.2, 128.8, 127.0, 54.4, 51.5, 31.1, 29.6, 26.6 ppm; MS (EI, 70 eV): m/z (%) = 232 $[M]^+$ (3), 134 (18), 133 (50), 99 (100), 90 (15), 71 (17), 57 (72), 43 (27); HRMS: m/z calcd for $C_{15}H_{20}O_2$: 232.1463 $[M]^+$; found: 232.1447.

4q: Prepared according to TP5. A solution of ethyl 2-bromomethylacrylate (**3i**; 193 mg, 1.00 mmol) in THF (3 mL) at −60 °C was treacted with 3-acetylbenzylzinc chloride (**2i**; 1.16 mL, 1.30 mmol, 1.12 M in THF) and CuCN·2LiCl (0.01 mL, 1 M in THF). The reaction mixture was stirred at −60 °C for 30 min, followed by stirring at 0 °C for a further 30 min. Workup as usual and purification by flash chromatography (silica gel, pentane/Et_2O = 9:1→6:1) afforded ethyl 2-[2-(3-acetylphenyl)ethyl]acrylate (**4q**; 239 mg, 97 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2980$ (w), 2931 (w), 1711 (s), 1682 (vs), 1438 (m), 1357 (m), 1300 (m), 1270 (s), 1241 (m), 1184 (vs), 1133 (s), 1114 (m), 1026 (m), 946 (m), 795 (m), 693 cm^{-1} (s); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=7.80$–7.75 (m, 2H), 7.41–7.34 (m, 2H), 6.16–6.14 (m, 1H), 5.50–5.47 (m, 2H), 4.21 (q, $J=7.1$ Hz, 2H), 2.87–2.81 (m, 2H), 2.65–2.60 (m, 2H), 2.59 (s, 3H), 1.30 ppm (q, $J=7.1$ Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta=198.3$, 167.0, 142.0, 139.8, 137.3, 133.3, 128.6, 128.2, 126.2, 125.4, 60.7, 34.8, 33.8, 26.7, 14.2 ppm; MS (EI, 70 eV): m/z (%) = 234 $[M]^+$ (23), 201 (18), 200 (29), 185 (29), 157 (19), 133 (100), 129 (20), 118 (11), 90 (18), 42 (48); HRMS: m/z calcd for $C_{15}H_{18}O_3$: 246.1156 $[M]^+$; found: 246.1143.

4r: Prepared according to TP5. A solution of ethyl 2-bromomethylacrylate (**3i**; 560 mg, 2.90 mmol) in THF (1.5 mL) at −60 °C was treated with 3-propionylbenzylzinc chloride (**2j**; 2.80 mL, 3.48 mmol, 1.25 M in THF) and CuCN·2LiCl (0.01 mL, 1 M in THF). The reaction mixture was stirred at −60 °C for 30 min, followed by stirring at 0 °C for a further 30 min. Workup as usual and purification by flash chromatography (silica gel, pentane/Et_2O = 95:5) afforded ethyl 2-[2-(3-propionylphenyl)ethyl]acrylate (**4r**; 694 mg, 92 %) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2978$ (w), 2938 (w), 1712 (vs), 1684 (vs), 1300 (m), 1240 (s), 1184 (vs), 1164 (s), 1132 (s), 1028 (m), 944 (m), 782 (s), 694 cm^{-1} (s); ^{1}H NMR (300 MHz, $CDCl_3$): $\delta=7.80$–7.74 (m, 2H), 7.39–7.34 (m, 2H), 6.16–6.14 (m, 1H), 5.48 (q, $J=1.3$ Hz, 1H), 4.21 (q, $J=7.1$ Hz, 2H), 2.98 (q, $J=7.1$ Hz, 2H), 2.89–2.80 (m, 2H), 2.66–2.59 (m, 2H), 1.30 (t, $J=7.2$ Hz, 3H), 1.21 ppm (t, $J=7.3$ Hz, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta=200.9$, 167.0, 141.9, 139.8, 137.1, 133.1, 128.5, 128.0, 125.8, 125.4, 60.7, 34.8, 33.8, 31.8, 14.2, 8.3 ppm; MS (EI, 70 eV): m/z (%) = 260 $[M]^+$ (23), 232 (16), 231 (100), 214 (11), 213 (11), 185 (16), 147 (28), 129 (14), 128 (12), 118 (10), 91 (12), 90 (19), 57 (15); HRMS: m/z calcd for $C_{16}H_{20}O_3$: 260.1412 $[M]^+$; found: 260.1419.

4s: Prepared according to TP3. 3,3-Dimethylbutyryl chloride (**3g**; 192 mg, 1.44 mmol) was added dropwise to a mixture of CuCN·2LiCl (1.88 mL, 1.88 mmol, 1 M in THF) and 3-propionylbenzylzinc chloride (**2j**; 1.76 mL, 1.88 mmol, 1.07 M in THF) at −60 °C. The reaction mixture was allowed to reach −20 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 5:1 (25 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 9:1) afforded 4,4-dimethyl-1-(3-propionylphenyl)pentan-2-one (**4s**; 246 mg, 69 %) as a white solid. M.p.: 39.4–41.5 °C; IR (diamond/ATR, neat): $\tilde{\nu}=2947$ (m), 2938 (m), 2899 (w), 2867 (w), 1711 (s), 1677 (vs), 1604 (w), 1459 (m), 1440 (m), 1411 (m), 1404 (m), 1369 (m), 1364 (m), 1340 (s), 1311 (m), 1247 (m), 1235 (m), 1193 (m), 1167 (s), 1149 (m), 1085 (s), 1037 (m), 1024 (m), 983 (m), 898 (m), 778 (vs), 747 (m), 697 (vs), 647 (w), 571 cm^{-1} (m); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=7.86$–7.83 (m, 1H), 7.77–7.75 (m, 1H), 7.41 (t, $J=7.6$ Hz, 1H), 7.37–7.35 (m, 1H), 3.73 (s, 2H), 2.99 (q, $J=7.3$ Hz, 2H), 2.38 (s, 2H), 1.21 (t, $J=7.2$ Hz, 3H), 1.00 ppm (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta=207.2$, 200.6, 137.2, 134.7, 134.0, 129.0, 128.8, 126.7, 54.4, 51.6, 31.8, 31.1, 29.7, 8.2 ppm; MS (EI, 70 eV): m/z (%) = 246 $[M]^+$ (2), 217 (9), 148 (23), 147 (33), 118 (11), 99 (75), 71 (18), 57 (100), 43 (11), 41 (14); HRMS: m/z calcd for $C_{16}H_{22}O_2$: 246.1620 $[M]^+$; found: 246.1626.

4t: Prepared according to TP3. Benzoyl chloride (**3k**; 278 mg, 1.98 mmol) was added dropwise to a mixture of CuCN·2LiCl (2.6 mL, 2.6 mmol, 1 M in THF) and 3-pentanoylbenzylzinc chloride (**2k**; 2.3 mL, 2.6 mmol, 1.15 M in THF) at −20 °C. The reaction mixture was stirred overnight at this temperature, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 5:1 (25 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 9:1) afforded 1-[3-(2-oxo-2-phenylethyl)phenyl]pentan-1-one (**4t**; 470 mg, 85 %) as a white solid. M.p.: 33.3–36.0 °C; IR (diamond/ATR, neat): $\tilde{\nu}=2956$ (w), 2932 (w), 1678 (vs), 1594 (m), 1580 (m), 1446 (m), 1328 (m), 1266 (m), 1206 (s), 1164 (m), 994 (m), 974 (m), 748 (s), 692 cm^{-1} (vs); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=8.03$–8.00 (m, 2H), 7.86–7.83 (m, 2H), 7.59–7.55 (m, 1H), 7.49–7.40 (m, 4H), 4.35 (s, 2H), 2.94 (t, $J=7.4$ Hz, 2H), 1.73–1.67 (m, 2H), 1.43–1.35 (m, 2H), 0.94 ppm (t, $J=7.4$ Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): $\delta=200.4$, 197.0, 137.4, 136.4, 135.0, 134.1, 133.4, 129.2, 128.8, 128.7, 128.5, 126.7, 45.1, 38.4, 26.4, 22.4, 13.9 ppm; MS (EI, 70 eV): m/z (%) = 280 $[M]^+$ (6), 223 (6), 105 (100), 77 (17); HRMS: m/z calcd for $C_{19}H_{20}O_2$: 280.1463 $[M]^+$; found: 280.1439.

4u: Prepared according to TP2. 3-Pentanoylbenzylzinc chloride (**2k**; 2.4 mL, 2.6 mmol, 1.08 M in THF) was treated with 3,4-dichlorobenzaldehyde (**3h**; 350 mg, 2.0 mmol, in 1.5 mL THF). After 5.5 h, the reaction was quenched with saturated aqueous NH_4Cl. Purification by flash chromatography (silica gel, pentane/Et_2O = 2:1) afforded 1-{3-[2-(3,4-dichlorophenyl)-2-hydroxyethyl]phenyl}pentan-1-one (**4u**; 665 mg, 95 %) as a white solid. M.p.: 46.8–47.8 °C; IR (diamond/ATR, neat): $\tilde{\nu}=3434$ (w), 2871 (w), 2930 (m), 1583 (m), 2956 (m), 1379 (m), 885 (m), 1179 (m), 656 (m), 730 (m), 1163 (m), 1261 (m), 787 (m), 1042 (s), 1057 (s), 1466 (s), 675 (s), 820 (s), 1673 (s), 692 (s), 1028 cm^{-1} (vs); ^{1}H NMR (300 MHz, $CDCl_3$): $\delta=7.84$–7.80 (m, 1H), 7.75–7.72 (m, 1H), 7.45–7.30 (m, 4H), 7.16–7.11 (m, 1H), 4.92–4.85 (m, 1H), 3.04–3.00 (m, 2H), 2.01 (t, $J=7.4$ Hz, 2H), 2.11–1.93 (s, 1H), 1.76–1.62 (m, 2H), 1.47–1.32 (m, 2H), 0.94 ppm (t, $J=7.3$ Hz, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta=200.5$, 143.8, 137.8, 137.4, 134.1, 132.6, 131.5, 130.4, 129.0, 128.8, 127.9, 126.7, 125.2, 73.9, 45.7, 38.4, 26.5, 22.5, 13.9 ppm; MS (EI, 70 eV): m/z (%) = 350 $[M]^+$ (<1), 293 (7), 177 (15), 176 (100), 175 (14), 119 (8); HRMS: m/z calcd for $C_{19}H_{20}Cl_2O_2$: 350.0840 $[M]^+$; found: 350.0839.

4v: Prepared according to TP4. A mixture of cyclohex-2-en-1-one (**3c**; 480 mg, 5.0 mmol) and TMSCl (1.6 mL, 12.5 mmol) in THF (2 mL) was added dropwise to a mixture of CuCN·2LiCl (6.3 mL, 6.3 mmol, 1 M in THF) and 3-ethoxycarbonylbenzylzinc chloride (**2l**; 4.46 mL, 6.25 mmol, 1.40 M in THF) at −40 °C. The reaction mixture was allowed to reach 25 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25 % in H_2O) = 2:1 (20 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 5:1→1:1) afforded ethyl 3-[(3-oxocyclohexyl)methyl]benzoate (**4v**; 1.26 g, 97 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2936$ (w), 1708 (vs), 1444 (m), 1368 (w), 1276 (vs), 1196 (s), 1108 (s), 1024 (m), 864 (w), 748 (s), 700 (m), 672 cm^{-1} (w); ^{1}H NMR (300 MHz, $CDCl_3$): $\delta=7.82$–7.78 (m, 1H), 7.74–7.72 (m, 1H), 7.28–7.24 (m, 1H), 7.24–7.21 (m, 1H), 4.28 (q, $J=7.2$ Hz, 2H), 2.63–2.53 (m, 2H), 2.28–2.21 (m, 2H), 2.20–2.13 (m, 1H), 2.01–1.89 (m, 3H), 1.79–1.73 (m, 1H), 1.57–1.47 (m, 1H), 1.33–1.25 (m, 1H), 1.30 ppm (t, $J=7.2$ Hz, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta=211.2$, 166.7, 140.0, 133.7, 130.8, 130.2, 128.6, 127.7, 61.1, 47.8, 42.9, 41.5, 40.9, 31.0, 25.2, 14.5 ppm; MS (EI, 70 eV): m/z (%) = 260 $[M]^+$ (30), 215 (36), 214 (79), 164 (26), 129 (39), 121 (83), 115 (20), 97 (80), 91 (33), 69 (100), 55 (46), 41 (50); HRMS: m/z calcd for $C_{16}H_{20}O_3$: 260.1412 $[M]^+$; found: 260.1386.

4w: Prepared according to TP2. 3-Ethoxycarbonylbenzylzinc chloride (**2l**; 4.1 mL, 5.4 mmol, 1.3 M in THF) was treated with 4-bromobenzaldehyde (**3l**; 775 mg, 4.2 mmol, in 3 mL THF). After 4.5 h, the reaction was quenched with saturated aqueous NH_4Cl. Purification by flash chromatography (silica gel, pentane/Et_2O = 7:3) afforded ethyl 3-[2-(4-bromophenyl)-2-hydroxyethyl]benzoate (**4w**; 1.33 g, 91 %) as a white solid. M.p.: 64.5–65.8 °C; IR (diamond/ATR, neat): $\tilde{\nu}=3466$ (w), 1704 (s), 1682 (s), 1484 (m), 1446 (m), 1400 (m), 1366 (m), 1278 (s), 1200 (s), 1108 (s), 1066 (s), 1024 (s), 1004 (s), 746 (vs), 698 cm^{-1} (s); ^{1}H NMR (600 MHz, $CDCl_3$): $\delta=7.92$–7.90 (m, 1H), 7.86–7.85 (m, 1H), 7.47–7.44 (m, 2H), 7.37–7.30 (m, 2H), 7.22–7.19 (m, 2H), 4.91–4.87 (m, 1H), 4.36 (q, $J=7.1$ Hz, 2H), 3.04–3.01 (m, 2H), 1.97 (d, $J=3.1$ Hz, 1H), 1.39 ppm (t, $J=$

7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ = 166.5, 142.5, 137.9, 134.1, 131.5, 130.7, 130.4, 128.5, 127.9, 127.6, 121.5, 74.6, 61.0, 45.6, 14.3 ppm; MS (EI, 70 eV): *m/z* (%) = 348 $[M]^+$ (<1), 164 (100), 136 (29), 135 (13), 118 (10), 92 (10), 91 (16), 90 (11), 78 (10), 77 (20); HRMS: *m/z* calcd for $C_{17}H_{17}BrO_3$: 348.0361 $[M]^+$; found: 348.0372.

4x: 3-Cyanobenzylzinc chloride (**2m**; 2.03 mL, 3.0 mmol, 1.48 M in THF) and $[Pd(PPh_3)_4]$ (139 mg, 5 mol%) were added successively to a solution of 3-iodoanisole (**3m**; 585 mg, 2.5 mmol) in THF (2.0 mL) at 25 °C. The resulting reaction mixture was heated to 60 °C for 5 h. After it was cooled to 25 °C, the reaction mixture was diluted with Et_2O (5 mL), and the reaction was quenched with saturated aqueous NH_4Cl. The phases were separated, and the aqueous layer was extracted with Et_2O (5× 5 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane/Et_2O = 9:1) afforded 3-(3-methoxybenzyl)benzonitrile (**4x**; 492 mg, 88%) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2937 (w), 2228 (s), 1596 (s), 1582 (s), 1488 (s), 1453 (m), 1435 (m), 1257 (vs), 1151 (m), 1048 (s), 779 (m), 741 (m), 686 cm^{-1} (s); ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.51–7.34 (m, 4H), 7.26–7.20 (m, 1H), 6.81–6.67 (m, 3H), 3.97 (s, 2H), 3.78 ppm (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 160.2, 142.7, 141.2, 133.6, 132.6, 130.2, 130.0, 129.5, 121.5, 119.2, 115.2, 112.8, 112.0, 55.4, 41.6 ppm; MS (EI, 70 eV): *m/z* (%) = 224 (15), 223 $[M]^+$ (100), 222 (12), 208 (13), 190 (10); HRMS: *m/z* calcd for $C_{15}H_{13}NO$: 223.0997 $[M]^+$; found: 223.0988.

4y: Prepared according to TP4. A mixture of cyclohex-2-en-1-one (**3c**; 480 mg, 5.0 mmol) and TMSCl (1.6 mL, 12.5 mmol) in THF (2 mL) was added dropwise to a mixture of CuCN·2LiCl (6.3 mL, 6.3 mmol, 1 M in THF) and 3-cyanobenzylzinc chloride (**2m**; 4.05 mL, 6.25 mmol, 1.55 M in THF) at −40 °C. The reaction mixture was allowed to reach 25 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25% in H_2O) = 2:1 (20 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 3:1) afforded 3-[(3-oxocyclohexyl)methyl]benzonitrile (**4y**; 1.034 g, 97%) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2933 (w), 2863 (w), 2227 (m), 1706 (vs), 1582 (w), 1483 (w), 1448 (m), 1429 (w), 1346 (w), 1312 (w), 1277 (w), 1258 (w), 1225 (m), 1100 (w), 1059 (w), 912 (w), 901 (w), 866 (w), 796 (m), 753 (w), 723 (m), 691 (s), 572 (w), 558 cm^{-1} (w); ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.53–7.46 (m, 1H), 7.43–7.32 (m, 3H), 2.73–2.57 (m, 2H), 2.42–2.18 (m, 3H), 2.14–1.95 (m, 3H), 1.90–1.79 (m, 1H), 1.71–1.53 (m, 1H), 1.45–1.29 ppm (m, 1H); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 210.6, 140.8, 133.5, 132.5, 130.1, 129.2, 118.8, 112.5, 47.5, 42.4, 41.2, 40.5, 30.7, 24.9 ppm; MS (EI, 70 eV): *m/z* (%) = 213 $[M]^+$ (52), 155 (78), 142 (12), 116 (28), 97 (100), 89 (15), 69 (93), 55 (45); HRMS: *m/z* calcd for $C_{14}H_{15}NO$: 213.1154 $[M]^+$; found: 213.1153.

4z: Prepared according to TP3. 2,2-Dimethylpropionyl chloride (**3n**; 225 mg, 1.87 mmol) was added dropwise to a mixture of CuCN·2LiCl (2.6 mL, 2.6 mmol, 1 M in THF) and 3-cyanobenzylzinc chloride (**2m**; 1.9 mL, 2.6 mmol, 1.37 M in THF) at −60 °C. The reaction mixture was allowed to reach −20 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25% in H_2O) = 5:1 (25 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 6:1) afforded 3-(3,3-dimethyl-2-oxobutyl)benzonitrile (**4z**; 292 mg, 78%) as a white solid. M.p.: 38.5–39.7 °C; IR (diamond/ATR, neat): $\tilde{\nu}$ = 2956 (m), 2226 (m), 1700 (s), 1482 (m), 1364 (m), 1330 (s), 1058 (vs), 1020 (s), 808 (m), 770 (vs), 684 cm^{-1} (vs); ^{1}H NMR (600 MHz, C_6D_6): δ = 7.03–7.01 (m, 1H), 6.98–6.95 (m, 2H), 6.74 (t, *J* = 7.8 Hz, 1H), 3.13 (s, 2H), 0.89 ppm (s, 9H); ^{13}C NMR (150 MHz, C_6D_6): δ = 209.7, 136.7, 134.0, 133.2, 130.2, 128.8, 118.9, 112.9, 44.3, 42.2, 26.1 ppm; MS (EI, 70 eV): *m/z* (%) = 201 $[M]^+$ (<1), 117 (28), 116 (22), 85 (22), 57 (100), 41 (30); HRMS: *m/z* calcd for $C_{13}H_{15}NO$: 201.1154 $[M]^+$; found: 201.1131.

4aa: Prepared according to TP3. 3,3-Dimethylbutyryl chloride (**3g**; 382 mg, 2.84 mmol) was added dropwise to a mixture of CuCN·2LiCl (3.90 mL, 3.90 mmol, 1 M in THF) and 1-phenylethylzinc chloride (**2n**; 2.73 mL, 3.90 mmol, 1.43 M in THF) at −60 °C. The reaction mixture was allowed to reach 25 °C overnight, and the reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25% in H_2O) = 9:1 (25 mL). Purification by flash chromatography (silica gel, pentane/Et_2O = 95:5) afforded 5,5-dimethyl-2-phenylhexan-3-one (**4aa**; 556 mg, 96%) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2952 (m), 2868 (w), 1712 (s), 1492 (w), 1452 (m), 1364 (m), 1068 (w), 1044 (w), 1028 (w), 1016 (w), 912 (w), 756 (m), 700 (vs), 548 (m), 520 cm^{-1} (w); ^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.39–7.35 (m, 2H), 7.32–7.28 (m, 1H), 7.26–7.23 (m, 2H), 3.76 (q, *J* = 6.9 Hz, 1H), 2.37 (d, *J* = 15.3 Hz, 1H), 2.23 (d, *J* = 15.5 Hz, 1H), 1.40 (d, *J* = 6.9 Hz, 3H), 1.00 ppm (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$): δ = 210.3, 140.5, 128.8, 128.0, 127.0, 54.4, 53.2, 30.9, 29.6, 17.4 ppm; MS (EI, 70 eV): *m/z* (%) = 204 $[M]^+$ (3), 105 (63), 99 (74), 83 (14), 79 (11), 71 (29), 69 (13), 57 (100), 55 (13), 43 (23); HRMS: *m/z* calcd for $C_{14}H_{20}O$: 204.1514 $[M^+]^+$; found: 204.1525.

4ab: Prepared according to TP5. A solution of ethyl 2-bromomethylacrylate (**3i**; 965 mg, 5.00 mmol) in THF (2.5 mL) at −60 °C was treated with benzylzinc chloride (**2o**; 3.85 mL, 6.00 mmol, 1.56 M in THF) and CuCN·2LiCl (0.01 mL, 1 M in THF). The reaction mixture was stirred at −60 °C for 30 min, followed by stirring at 0 °C for a further 30 min. Workup as usual and purification by flash chromatography (silica gel, pentane/Et_2O = 98:2) afforded ethyl 2-(2-phenylethyl)acrylate (**4ab**; 948 mg, 93%) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2980 (w), 2932 (w), 1712 (vs), 1632 (w), 1456 (w), 1308 (m), 1240 (m), 1184 (s), 1156 (m), 1132 (s), 1028 (m), 944 (m), 748 (m), 700 cm^{-1} (vs); ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.33–7.24 (m, 2H), 7.23–7.15 (m, 2H), 6.18–6.14 (m, 1H), 5.52–5.47 (m, 1H), 4.23 (q, *J* = 7.1 Hz, 2H), 2.85–2.76 (m, 2H), 2.67–2.58 (m, 2H), 1.32 ppm (q, *J* = 7.2 Hz, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 167.1, 141.4, 140.1, 128.4, 128.3, 125.9, 125.0, 60.6, 34.9, 33.9, 14.2 ppm; MS (EI, 70 eV): *m/z* (%) = 234 $[M]^+$ (7), 158 (17), 130 (26), 91 (100), 65 (11), 57 (13); HRMS: *m/z* calcd for $C_{13}H_{16}O_2$: 204.1150 $[M]^+$; found: 204.1144.

5: Reaction 1 with ethyl chloroformate: THF (0.5 mL) was added to 2-chlorobenzylzinc chloride (**2a**; 2.62 mL, 4.00 mmol, 1.5 M in THF) at −30 °C followed by $[Pd(PPh_3)_4]$ (116 mg, 5 mol%). The reaction mixture was stirred for 5 min. Next, ethyl chloroformate (227 mg, 2.09 mmol) was added dropwise. Stirring was continued for 10 min at −30 °C followed by 6.25 h at 25 °C. The reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25% in H_2O) = 4:1 (15 mL). The layers were separated, and the aqueous layer was extracted with DCM (3×50 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane/Et_2O = 98:2) afforded (2-chlorophenyl)acetate (**5**; 336 mg, 81%) as a colorless liquid. Reaction 2 with ethyl cyanoformate: $TMSCH_2Li$ (1.00 mL, 1.00 mmol, 1 M in pentane) was added dropwise to **2a** (0.67 mL, 1.00 mmol, 1.5 M in THF) at −30 °C. The reaction mixture was stirred for 30 min. CuCN·2LiCl (1.00 mL, 1.00 mmol, 1 M in THF) was added dropwise, and the mixture was stirred for a further 30 min. Ethyl cyanoformate (150 mg, 1.5 mmol) was added dropwise. Stirring was continued for 10 min at −30 °C followed by 6 h at 0 °C. The reaction was quenched with saturated aqueous NH_4Cl/NH_3 (25% in H_2O) = 2:1 (15 mL). The layers were separated, and the aqueous layer was extracted with DCM (3× 50 mL). The combined extracts were dried over $MgSO_4$. Evaporation of the solvents in vacuo and purification by flash chromatography (silica gel, pentane/Et_2O = 98:2) afforded **5** (152 mg, 77%) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2981 (w), 1367 (m), 1335 (m), 1122 (m), 1475 (m), 1445 (m), 1246 (m), 1053 (s), 681 (s), 1216 (s), 1028 (s), 741 (vs), 1156 (vs), 1731 cm^{-1} (vs); ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.42–7.34 (m, 1H), 7.32–7.17 (m, 3H), 4.17 (q, *J* = 7.1 Hz, 2H), 3.76 (s, 2H), 1.25 ppm (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ = 170.5, 134.5, 132.5, 131.4, 129.4, 128.6, 126.8, 61.0, 39.2, 14.1 ppm; MS (EI, 70 eV): *m/z* (%) = 198 $[M]^+$ (4), 163 (100), 135 (23) 127 (78), 125 (35, 89 (21); HRMS: *m/z* calcd for $C_{10}H_{11}ClO_2$: 198.0448 $[M]^+$; found: 198.0462.

7a: Prepared according to TP6 from **2f** (2.00 mL, 1.21 M in THF, 2.40 mmol) and **6a** (371 mg, 2.00 mmol). Reaction time: 0.5 h. Purification by flash chromatography (*n*-pentane/Et_2O = 1:1) yielded 2-(3,4,5-trimethoxybenzyl)nicotinic acid ethyl ester (**7a**; 639 mg, 97%) as a pale-yellow oil. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2979 (w), 2937 (w), 2836 (w), 1718 (s), 1587 (m), 1505 (m), 1456 (m), 1420 (s), 1330 (m), 1235 (s), 1119 (vs), 1079 (s), 1057 (s), 1006 (s), 968 (m), 809 (m), 789 (m), 739 (m), 680 (m), 656 cm^{-1} (m); ^{1}H NMR (300 MHz, $CDCl_3$): δ = 8.68 (dd, *J* = 4.9, 1.9 Hz, 1H), 8.16 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.23 (dd, *J* = 7.9, 4.7 Hz, 1H), 6.52 (s, 2H), 4.51 (s, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 3.78 (s, 6H), 3.77 (s, 3H), 1.34 ppm (t, $J=7.1$ Hz, 3H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=166.5$, 161.0, 152.9, 151.8, 138.6, 136.4, 135.2, 126.1, 121.3, 106.2, 61.4, 60.7, 56.0, 42.3, 14.2 ppm; MS (EI, 70 eV): m/z (%) = 331 $[M]^+$ (100), 316 (64), 286 (10), 270 (15), 227 (22), 44 (21); HRMS: m/z calcd for $C_{18}H_{21}NO_5$: 331.1420; found: 331.1395.

7b: Prepared according to TP6 from **2f** (1.90 mL, 1.27 M in THF, 2.40 mmol) and **6b** (527 mg, 2.00 mmol). Reaction time: 1 h. Purification by flash chromatography (Et$_2$O) yielded 2-methyl-5-(3,4,5-trimethoxybenzyl)pyridine (**7b**; 493 mg, 90%) as a yellow oil. IR (diamond/ATR, neat): $\tilde{\nu}=2998$ (w), 2936 (w), 2837 (w), 1588 (s), 1568 (w), 1505 (m), 1489 (m), 1455 (m), 1419 (s), 1391 (m), 1331 (m), 1297 (w), 1234 (s), 1182 (w), 1148 (m), 1121 (vs), 1029 (m), 1005 (s), 969 (m), 816 (m), 781 (m), 759 (m), 727 (m), 672 (m), 645 cm^{-1} (m); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=$ 8.37 (d, $J=1.9$ Hz, 1H), 7.35 (dd, $J=7.9$, 2.3 Hz, 1H), 7.06 (d, $J=7.8$ Hz, 1H), 6.35 (s, 2H), 3.85 (s, 2H), 3.80 (s, 3H), 3.79 (s, 6H), 2.51 ppm (s, 3H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=156.2$, 153.3, 149.1, 136.6, 136.6, 135.7, 133.1, 123.0, 105.8, 60.8, 56.1, 38.9, 23.9 ppm; MS (EI, 70 eV): m/z (%) = 273 $[M]^+$ (100), 258 (37), 230 (14), 215 (11), 172 (6), 106 (7); HRMS: m/z calcd for $C_{16}H_{19}NO_3$: 273.1365; found: 273.1364.

7c: Prepared according to TP6 from **2f** (2.20 mL, 1.09 M in THF, 2.40 mmol) and **6c** (599 mg, 2.00 mmol). Reaction time: 2 h. Purification by flash chromatography (*n*-pentane/Et$_2$O = 1:1) yielded 8-(3,4,5-trimethoxybenzyl)quinoline (**7c**; 510 mg, 83%) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}=3062$ (vw), 2994 (w), 2944 (w), 2832 (w), 1586 (s), 1496 (m), 1450 (m), 1420 (m), 1327 (m), 1232 (s), 1181 (m), 1121 (vs), 997 (s), 967 (m), 833 (m), 796 (vs), 768 (s), 672 (m), 613 cm^{-1} (m); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=8.98$ (dd, $J=4.1$, 1.7 Hz, 1H), 8.17 (dd, $J=8.3$, 1.7 Hz, 1H), 7.72–7.67 (m, 1H), 7.49–7.40 (m, 3H), 6.58 (s, 2H), 4.62 (s, 2H), 3.81 (s, 3H), 3.78 ppm (s, 6H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=153.1$, 149.3, 146.4, 139.9, 136.8, 136.6, 136.2, 129.4, 128.4, 126.5, 126.4, 121.0, 106.4, 60.8, 56.0, 37.1 ppm; MS (EI, 70 eV): m/z (%) = 309 $[M]^+$ (72), 294 (100), 278 (10), 263 (8), 208 (9), 181 (8), 180 (9); HRMS: m/z calcd for $C_{19}H_{19}NO_3$: 309.1365; found: 309.1363.

7d: Prepared according to TP6 from **2f** (2.00 mL, 1.21 M in THF, 2.40 mmol) and **6d** (438 mg, 2.00 mmol). Reaction time: 2 h. Purification by flash chromatography (*n*-pentane/Et$_2$O = 1:2) yielded 2,4-dimethoxy-5-(3,4,5-trimethoxybenzyl)pyrimidine (**7d**; 551 mg, 86%) as a white solid. M.p.: 74.1–76.3°C; IR (diamond/ATR, neat): $\tilde{\nu}=2947$ (w), 2909 (w), 2842 (w), 2828 (w), 1593 (s), 1573 (s), 1510 (m), 1456 (s), 1403 (s), 1373 (s), 1331 (s), 1286 (s), 1249 (s), 1232 (s), 1193 (s), 1121 (vs), 1076 (vs), 1005 (vs), 976 (s), 935 (m), 859 (s), 833 (s), 784 (vs), 749 (s), 699 (m), 636 (m), 602 cm^{-1} (s); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=7.94$ (s, 1H), 6.39 (s, 2H), 3.98 (s, 3H), 3.96 (s, 3H), 3.80 (s, 9H), 3.72 ppm (s, 2H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=169.2$, 164.2, 157.1, 153.2, 136.6, 134.6, 114.5, 105.7, 60.8, 56.1, 54.7, 53.9, 32.7 ppm; MS (EI, 70 eV): m/z (%) = 320 $[M]^+$ (100), 305 (45), 289 (9), 230 (14), 181 (62); HRMS: m/z calcd for $C_{16}H_{20}N_2O_5$: 320.1372; found: 320.1348.

7e: Prepared according to TP6 from **2f** (2.00 mL, 1.21 M in THF, 2.40 mmol) and **6e** (349 mg, 2.00 mmol). Reaction time: 2 h. Purification by flash chromatography (*n*-pentane/Et$_2$O = 1:2) yielded 2,4-dimethoxy-6-(3,4,5-trimethoxybenzyl)pyrimidine (**7e**; 628 mg, 98%) as a colorless solid. M.p.: 60.8–62.9°C; IR (diamond/ATR, neat): $\tilde{\nu}=3083$ (w), 2945 (w), 2932 (w), 2831 (w), 1588 (s), 1564 (vs), 1505 (s), 1451 (s), 1433 (m), 1419 (s), 1375 (m), 1350 (vs), 1331 (s), 1299 (s), 1244 (s), 1233 (s), 1204 (s), 1193 (m), 1186 (m), 1149 (s), 1121 (vs), 1092 (vs), 1036 (s), 1003 (s), 980 (s), 922 (m), 862 (m), 835 (s), 826 (s), 816 (m), 792 (m), 742 (m), 729 (s), 717 (m), 686 (m), 612 (m), 602 cm^{-1} (s); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=6.49$ (s, 2H), 6.12 (s, 1H), 3.98 (s, 3H), 3.91 (s, 3H), 3.84 (s, 2H), 3.82 (s, 6H), 3.81 ppm (s, 3H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=172.0$, 171.4, 165.2, 153.2, 136.8, 133.2, 106.3, 99.9, 60.8, 56.1, 54.6, 53.7, 44.0 ppm; MS (EI, 70 eV): m/z (%) = 320 $[M]^+$ (74), 305 (60), 181 (13), 69 (13), 57 (11), 44 (100); HRMS: m/z calcd for $C_{16}H_{20}N_2O_5$: 320.1372; found: 320.1360.

7f: Prepared according to a procedure slightly modified from TP6 from **2i** (2.24 mL, 1.07 M in THF, 2.40 mmol), which was added by a syringe pump over 30 min, and **6a** (371 mg, 2.00 mmol). Reaction time: 2 h. Purification by flash chromatography (*n*-pentane/Et$_2$O = 1:1→1:3) yielded 2-(3-acetylbenzyl)nicotinic acid ethyl ester (**7f**; 385 mg, 68%) as a yellow oil. IR (diamond/ATR, neat): $\tilde{\nu}=3049$ (vw), 2982 (w), 2936 (w), 1718 (s), 1681 (vs), 1601 (w), 1582 (m), 1568 (m), 1484 (w), 1436 (m), 1357 (m), 1296 (m), 1258 (vs), 1173 (m), 1130 (m), 1079 (s), 1057 (m), 1018 (w), 976 (w), 956 (w), 863 (w), 777 (m), 741 (m), 693 (m), 589 (w), 577 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=8.67$ (dd, $J=4.7$, 1.8 Hz, 1H), 8.19 (dd, $J=7.9$, 1.8 Hz, 1H), 7.88–7.85 (m, 1H), 7.75 (d, $J=7.5$ Hz, 1H), 7.46 (d, $J=7.5$ Hz, 1H), 7.32 (t, $J=7.7$ Hz, 1H), 7.24 (dd, $J=7.9$ and 4.7 Hz, 1H), 4.63 (s, 2H), 4.32 (q, $J=7.2$ Hz, 2H), 2.54 (s, 3H), 1.32 ppm (t, $J=7.2$ Hz, 3H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=198.2$, 166.3, 160.5, 151.9, 140.1, 138.8, 137.1, 133.8, 129.0, 128.4, 126.2, 126.0, 121.5, 61.5, 42.1, 26.6, 14.1 ppm; MS (EI, 70 eV): m/z (%): 283 $[M]^+$ (100), 267 (37), 210 (39), 195 (13), 167 (29), 135 (12), 43 (58); HRMS: m/z calcd for $C_{17}H_{17}NO_3$: 283.1208; found: 283.1187.

7g: Prepared according to TP6 from **2k** (2.30 mL, 1.06 M in THF, 2.40 mmol) and **6f** (627 mg, 2.00 mmol). Reaction time: 16 h. Purification by flash chromatography (*n*-pentane/Et$_2$O = 1:1→0:1) yielded 1-[3-(2-methylquinolin-4-ylmethyl)phenyl]pentan-1-one (**7g**; 585 mg, 92%) as a colorless, highly viscous oil. IR (diamond/ATR, neat): $\tilde{\nu}=3063$ (w), 2954 (s), 2930 (m), 2871 (m), 1674 (vs), 1601 (s), 1585 (m), 1562 (w), 1511 (m), 1466 (w), 1437 (m), 1415 (m), 1376 (m), 1336 (m), 1274 (m), 1227 (m), 1158 (m), 1024 (w), 964 (w), 910 (w), 869 (w), 763 (s), 756 (s), 733 (m), 700 (m), 637 (w), 570 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=8.04$ (d, $J=8.5$ Hz, 1H), 7.92 (d, $J=9.2$ Hz, 1H), 7.81 (m, 2H), 7.64 (t, $J=7.7$ Hz, 1H), 7.44 (t, $J=7.7$ Hz, 1H), 7.35 (m, 2H), 7.00 (s, 1H), 4.43 (s, 2H), 2.89 (t, $J=7.4$ Hz, 2H), 2.68 (s, 3H), 1.67 (quint, $J=7.5$ Hz, 2H), 1.39 (sext, $J=7.5$ Hz, 2H), 0.91 ppm (t, $J=7.3$ Hz, 3H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=200.4$, 158.8, 148.0, 145.8, 139.3, 137.5, 133.2, 129.3, 129.2, 128.9, 128.3, 126.5, 125.8, 125.6, 123.4, 122.7, 38.4, 38.0, 26.4, 25.3, 22.4, 13.9 ppm; MS (EI, 70 eV): m/z (%) = 317 $[M]^+$ (25), 275 (100), 261 (44), 260 (38), 247 (15), 231 (63), 216 (15), 189 (18), 115 (12); HRMS: m/z calcd for $C_{22}H_{23}NO$: 317.1780; found: 317.1756.

7h: Prepared according to TP6 from **2k** (2.30 mL, 1.06 M in THF, 2.40 mmol) and **6b** (527 mg, 2.00 mmol). Reaction time: 16 h. Purification by flash chromatography (*n*-pentane/Et$_2$O = 1:1→0:1) yielded 1-[3-(6-methylpyridin-3-ylmethyl)phenyl]pentan-1-one (**7h**; 448 mg, 84%) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2957$ (s), 2930 (m), 2871 (m), 1681 (vs), 1601 (m), 1585 (w), 1568 (w), 1488 (m), 1465 (m), 1438 (m), 1409 (w), 1392 (m), 1378 (w), 1346 (w), 1320 (w), 1297 (m), 1266 (m), 1256 (m), 1228 (m), 1176 (m), 1159 (m), 1109 (w), 1096 (w), 1029 (m), 913 (w), 812 (w), 792 (w), 754 (m), 728 (m), 693 (m), 646 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=8.36$ (s, 1H), 7.78 (m, 2H), 7.35 (m, 3H), 7.05 (d, $J=8.0$ Hz, 1H), 3.97 (s, 2H), 2.90 (t, $J=7.4$ Hz, 2H), 2.5 (s, 3H), 1.67 (quint, $J=7.4$ Hz, 2H), 1.37 (sext, $J=7.4$ Hz, 2H), 0.92 ppm (t, $J=7.3$ Hz, 3H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=200.4$, 156.4, 149.2, 140.7, 137.4, 136.7, 133.2, 132.7, 128.8, 128.2, 126.2, 123.1, 38.5, 38.3, 26.4, 23.9, 22.4, 13.9 ppm; MS (EI, 70 eV): m/z (%) = 268 $[M+H]^+$ (100), 225 (26), 224 (10), 211 (12), 210 (72), 183 (10), 182 (13), 181 (15); HRMS: m/z calcd for $C_{18}H_{22}NO$: 268.1701 $[M+H]^+$; found: 268.1697.

7i: Prepared according to TP6 from **2k** (2.30 mL, 1.06 M in THF, 2.40 mmol) and **6a** (371 mg, 2.00 mmol). Reaction time: 1 h. Purification by flash chromatography *n*-pentane/Et$_2$O = 6:1→1:1) yielded 2-(3-pentanoylbenzyl)nicotinic acid ethyl ester (**7i**; 583 mg, 90%) as a pale-yellow liquid. IR (diamond/ATR, neat): $\tilde{\nu}=2958$ (m), 2933 (m), 2872 (w), 1719 (vs), 1681 (s), 1582 (m), 1568 (m), 1436 (m), 1366 (m), 1274 (s), 1256 (vs), 1173 (m), 1158 (m), 1130 (s), 1111 (m), 1079 (s), 1057 (m), 1018 (m), 862 (w), 776 (m), 752 (m), 741 (m), 694 (m), 629 (w), 576 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): $\delta=8.67$ (dd, $J=4.9$, 1.9 Hz, 1H), 8.12 (dd, $J=7.9$, 1.8 Hz, 1H), 7.86 (m, 1H), 7.75 (m, 1H), 7.44 (m, 1H), 7.32 (t, $J=7.7$ Hz, 1H), 7.24 (dd, $J=8.0$, 4.9 Hz, 1H), 4.63 (s, 2H), 4.32 (q, $J=$ 7.1 Hz, 2H), 2.90 (t, $J=7.3$ Hz, 2H), 1.67 (quint, $J=7.4$ Hz, 2H), 1.37 (sext, $J=7.5$ Hz, 2H), 1.32 (t, $J=7.2$ Hz, 3H), 0.92 ppm (t, $J=7.3$ Hz, 3H); ^{13}C NMR (75 MHz, CDCl$_3$): $\delta=200.6$, 166.3, 160.6, 151.9, 140.1, 138.8, 137.1, 133.6, 128.7, 128.4, 126.1, 125.9, 121.4, 61.5, 42.1, 38.3, 26.5, 22.4, 14.1, 13.9 ppm; MS (EI, 70 eV): m/z (%) = 325 $[M]^+$ (79), 283 (12), 282 (12), 269 (16), 268 (100), 212 (10), 211 (13), 167 (27), 166 (24); HRMS: m/z calcd for $C_{20}H_{23}NO_3$: 325.1678; found: 325.1666.

7j: Prepared according to TP6 from **2l** (1.74 mL, 1.38 M in THF, 2.40 mmol) and **6g** (276 mg, 2.00 mmol). Reaction time: 0.5 h. Purification by flash chromatography (*n*-pentane/Et$_2$O = 9:1) yielded 3-(4-cyanobenzyl)benzoic acid ethyl ester (**7j**; 482 mg, 91 %) as a white solid. M.p.: 51.0–53.0 °C; IR (diamond/ATR, neat): $\tilde{\nu}$ = 3054 (vw), 2991 (w), 2983 (w), 2937 (w), 2912 (w), 2874 (vw), 2228 (m), 1707 (vs), 1669 (w), 1604 (m), 1586 (w), 1477 (w), 1446 (m), 1362 (m), 1279 (s), 1188 (s), 1105 (m), 1024 (m), 939 (m), 854 (m), 796 (w), 762 (m), 734 (m), 696 (m), 602 cm^{-1} (m); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 7.93–7.89 (m, 1 H), 7.87–7.85 (m, 1 H), 7.56 (d, J = 8.3 Hz, 2 H), 7.40–7.30 (m, 2 H), 7.27 (d, J = 8.5 Hz, 2 H), 4.36 (q, J = 7.1 Hz, 2 H), 4.07 (s, 2 H), 1.37 ppm (t, J = 7.2 Hz, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 166.3, 146.0, 139.6, 133.3, 132.4, 131.0, 130.0, 129.6, 128.8, 127.9, 118.8, 110.3, 61.0, 41.7, 14.3 ppm; MS (EI, 70 eV): m/z (%) = 265 [M]$^+$ (56), 237 (49), 221 (20), 220 (100), 207 (29), 193 (16), 192 (30), 191 (21), 190 (26), 165 (17); HRMS: m/z calcd for $C_{17}H_{15}NO_2$: 265.1103; found: 265.1089.

7k: Prepared according to TP6 from **2l** (1.74 mL, 1.38 M in THF, 2.40 mmol) and **6h** (641 mg, 2.00 mmol). Reaction time: 2 h. Purification by flash chromatography (n-pentane/Et$_2$O = 9:1) yielded ethyl 3-[4-(ethoxycarbonyl)benzyl]benzoate (**7k**; 385 mg, 65 %) as a yellow oil. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2982 (w), 2937 (vw), 2906 (vw), 1711 (vs), 1609 (w), 1588 (w), 1444 (w), 1415 (w), 1366 (w), 1270 (vs), 1187 (m), 1177 (m), 1100 (s), 1082 (m), 1020 (m), 940 (w), 855 (w), 746 (m), 710 (m), 689 (w), 637 (vw), 590 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 7.99 (d, J = 8.4 Hz, 2 H), 7.94–7.91 (m, 2 H), 7.41–7.34 (m, 2 H), 7.27 (d, J = 8.6 Hz, 2 H), 4.38 (q, J = 7.2 Hz, 2 H), 4.38 (q, J = 7.1 Hz, 2 H), 4.09 (s, 2 H), 1.40 (t, J = 7.1 Hz, 3 H), 1.40 ppm (t, J = 7.2 Hz, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 166.5, 166.5, 145.7, 140.4, 140.4, 133.3, 130.8, 130.0, 129.9, 128.8, 128.7, 128.6, 127.6, 61.0, 60.8, 41.6, 14.3 ppm; MS (EI, 70 eV): m/z (%) = 312 [M]$^+$ (40), 268 (17), 267 (100), 240 (14), 239 (37), 167 (15), 166 (16), 165 (36), 111 (11); HRMS: m/z calcd for $C_{19}H_{20}O_4$: 312.1362; found: 312.1354.

7l: Prepared according to TP6 from **2l** (1.74 mL, 1.38 M in THF, 2.40 mmol) and **6i** (729 mg, 2.00 mmol). Reaction time: 5 h. Purification by flash chromatography (n-pentane/Et$_2$O = 4:1) yielded 5-(3-ethoxycarbonylbenzyl)isophthalic acid dimethyl ester (**7l**; 432 mg, 61 %) as a colorless oil. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2982 (vw), 2952 (w), 1713 (vs), 1602 (w), 1588 (w), 1432 (m), 1334 (m), 1276 (s), 1236 (vs), 1192 (s), 1104 (s), 1081 (m), 1001 (s), 920 (w), 868 (w), 818 (w), 789 (w), 749 (s), 706 (s), 632 cm^{-1} (m); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 8.53–8.52 (m, 1 H), 8.04 (d, J = 2.2 Hz, 2 H), 7.91–7.87 (m, 2 H), 7.39–7.31 (m, 2 H), 4.35 (q, J = 7.2 Hz, 2 H), 4.10 (s, 2 H), 3.91 (s, 6 H), 1.37 ppm (t, J = 7.1 Hz, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 166.4, 166.2, 141.5, 140.1, 134.2, 133.3, 131.0, 130.9, 129.9, 128.8, 128.8, 127.8, 61.0, 52.3, 41.3, 14.3 ppm; MS (70 eV, EI): m/z (%) = 356 [M]$^+$ (60), 325 (35), 312 (18), 311 (100), 284 (15), 252 (13), 165 (32), 140 (20); HRMS: m/z calcd for $C_{20}H_{20}O_6$: 356.1260; found: 356.1257.

7m: Prepared according to TP6 from **2l** (1.74 mL, 1.38 M in THF, 2.40 mmol) and **6j** (557 mg, 2.00 mmol). Reaction time: 24 h. Purification by flash chromatography (n-pentane/Et$_2$O = 19:1) yielded 3-(2-methoxybenzyl)benzoic acid ethyl ester (**7m**; 370 mg, 69 %) as a colorless liquid. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2978 (w), 2936 (w), 2835 (vw), 1713 (s), 1586 (m), 1492 (m), 1463 (m), 1438 (m), 1366 (m), 1275 (s), 1241 (vs), 1193 (m), 1182 (s), 1102 (s), 1079 (m), 1049 (m), 1026 (s), 1002 (m), 929 (w), 741 (vs), 714 (m), 691 (m), 670 (m), 619 cm^{-1} (m); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 7.95–7.92 (m, 1 H), 7.86 (d, J = 7.5 Hz, 1 H), 7.40–7.35 (m, 1 H), 7.31 (t, J = 7.4 Hz, 1 H), 7.20 (td, J = 7.8, 1.9 Hz, 1 H), 7.07 (dd, J = 7.9, 1.8 Hz, 1 H), 6.91–6.84 (m, 2 H), 4.35 (q, J = 7.1 Hz, 2 H), 4.01 (s, 2 H), 3.81 (s, 3 H), 1.38 ppm (t, J = 7.1 Hz, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 166.8, 157.3, 141.4, 133.4, 130.4, 130.2, 130.1, 129.1, 128.2, 127.6, 127.1, 120.5, 110.5, 60.8, 55.3, 35.8, 14.3 ppm; MS (EI, 70 eV): m/z (%) = 270 [M]$^+$ (87), 225 (66), 224 (96), 196 (100), 165 (49), 135 (89), 91 (53); HRMS: m/z calcd for $C_{17}H_{18}O_3$: 270.1256; found: 270.1259.

7n: Prepared according to TP6 from **2l** (1.74 mL, 1.38 M in THF, 2.40 mmol) and **6c** (599 mg, 2.00 mmol). Reaction time: 2 h. Purification by flash chromatography (n-pentane/Et$_2$O = 6:1) yielded 3-quinolin-8-ylmethylbenzoic acid ethyl ester (**7n**; 491 mg, 85 %) as a colorless oil. IR (diamond/ATR, neat): $\tilde{\nu}$ = 3033 (vw), 2979 (w), 2928 (w), 2902 (w), 1710 (vs), 1594 (w), 1497 (m), 1442 (m), 1366 (m), 1272 (vs), 1188 (s), 1103 (s), 1081 (s), 1024 (m), 928 (w), 870 (w), 818 (m), 809 (m), 789 (s), 751 (s), 713 (s), 689 (m), 672 (m), 612 cm^{-1} (m); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 8.96 (dd, J = 4.3, 1.8 Hz, 1 H), 8.15 (dd, J = 8.3, 1.7 Hz, 1 H), 8.05–8.02 (m, 1 H), 7.89–7.84 (m, 1 H), 7.72–7.66 (m, 1 H), 7.52–7.47 (m, 1 H), 7.46–7.38 (m, 3 H), 7.32 (t, J = 7.8 Hz, 1 H), 4.73 (s, 2 H), 4.34 (q, J = 7.2 Hz, 2 H), 1.36 ppm (t, J = 7.2 Hz, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 166.8, 149.4, 146.4, 141.6, 139.5, 136.4, 133.9, 130.5, 130.4, 129.6, 128.4, 128.3, 127.2, 126.5, 126.4, 121.1, 60.8, 36.6, 14.3 ppm; MS (EI, 70 eV): m/z (%) = 291 [M]$^+$ (100), 262 (63), 246 (12), 218 (28), 217 (55), 108 (34); HRMS: m/z calcd for $C_{19}H_{17}NO_2$: 291.1259; found: 129.1261.

7o: Prepared according to TP6 from **2l** (1.74 mL, 1.38 M in THF, 2.40 mmol) and **6d** (438 mg, 2.00 mmol). Reaction time: 1.5 h. Purification by flash chromatography (n-pentane/Et$_2$O = 1:1) yielded 3-(2,4-dimethoxypyrimidin-5-ylmethyl)benzoic acid ethyl ester (**7o**; 505 mg, 84 %) as a colorless oil. IR (diamond/ATR, neat): $\tilde{\nu}$ = 2985 (w), 2957 (w), 2902 (w), 1715 (s), 1600 (s), 1567 (s), 1466 (s), 1398 (s), 1379 (vs), 1350 (m), 1273 (vs), 1239 (m), 1190 (s), 1153 (w), 1104 (m), 1070 (s), 1052 (m), 1015 (s), 788 (w), 763 (w), 744 (m), 694 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 7.96 (s, 1 H), 7.89–7.86 (m, 2 H), 7.34–7.32 (m, 2 H), 4.35 (q, J = 7.2 Hz, 2 H), 3.95 (s, 3 H), 3.95 (s, 3 H), 3.82 (s, 2 H), 1.36 ppm (t, J = 7.2 Hz, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 169.2, 166.5, 164.3, 157.1, 139.4, 133.0, 130.7, 129.7, 128.4, 127.6, 114.1, 60.9, 54.7, 53.9, 32.3, 14.3 ppm; MS (EI, 70 eV): m/z (%) = 302 [M]$^+$ (100), 301 (53), 287 (27), 273 (33), 257 (33), 241 (21), 200 (25); HRMS: m/z calcd for $C_{16}H_{18}N_2O_4$: 302.1267; found: 302.1269.

7p: Prepared according to TP6 from **2m** (1.75 mL, 1.37 M in THF, 2.40 mmol) and **6k** (370 mg, 2.00 mmol). Reaction time: 0.5 h. Purification by flash chromatography (n-pentane/Et$_2$O = 6:1) yielded 4-(3-cyanobenzyl)benzoic acid ethyl ester (**7p**; 473 mg, 89 %) as a white solid. M.p.: 60.5–62.4 °C; IR (diamond/ATR, neat): $\tilde{\nu}$ = 3076 δ(w), 3052 (w), 3000 (w), 2976 (w), 2956 (w), 2900 (w), 2228 (m), 1708 (vs), 1608 (m), 1576 (w), 1476 (w), 1448 (w), 1436 (w), 1416 (w), 1392 (w), 1364 (m), 1324 (w), 1308 (w), 1276 (vs), 1192 δ(w), 1176 (m), 1128 (m), 1108 (s), 1020 (m), 980 (w), 940 (w), 908 (w), 876 (w), 856 (w), 788 (m), 764 (m), 728 (m), 700 (w), 688 (m), 652 (w), 560 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 7.98 (d, J = 8.4 Hz, 2 H), 7.53–7.38 (m, 4 H), 7.22 (d, J = 8.4 Hz, 2 H), 4.36 (q, J = 7.1 Hz, 2 H), 4.05 (s, 2 H), 1.37 ppm (t, δJ = 7.1 Hz, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 166.5, 144.7, 141.9, 133.6, 132.6, 130.4, 130.3, 129.6, 129.3, 129.1, 118.9, 112.9, 61.2, 41.5, 14.6 ppm; MS (EI, 70 eV): m/z (%) = 265 [M]$^+$ (37), 237 (20), 220 (100), 192 (30), 190 (28), 165 (24); HRMS: m/z calcd for $C_{17}H_{15}NO_2$: 265.1103; found: 265.1077.

7q: Prepared according to TP6 from **2m** (1.75 mL, 1.37 M in THF, 2.40 mmol) and **6l** (398 mg, 2.00 mmol). Reaction time: 0.5 h. Purification by flash chromatography (n-pentane/Et$_2$O = 2:1) yielded 3-(4-acetylbenzyl)benzonitrile (**7q**; 352 mg, 75 %) as a white solid. M.p.: 71.6–73.9 °C; IR (diamond/ATR, neat): $\tilde{\nu}$ = 3516 (m), 2228 (m), 1672 (vs), 1600 (m), 1584 (m), 1568 (w), 1484 (w), 1456 (w), 1412 (m), 1356 (m), 1268 (m), 1200 (w), 1184 (w), 1140 (w), 1112 (w), 1076 (w), 1012 (w), 960 (w), 904 (w), 888 (w), 848 (w), 824 (m), 808 (w), 792 (m), 748 (m), 716 (w), 692 (m), 624 (m), 592 (w), 576 (w), 560 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 7.90 (d, J = 8.2 Hz, 2 H), 7.53–7.50 (m, 1 H), 7.45 (s, 1 H), 7.42–7.40 (m, 2 H), 7.25 (d, J = 8.6 Hz, 2 H), 4.06 (s, 2 H), 2.58 ppm (s, 3 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 197.6, 144.8, 141.5, 135.7, 133.4, 132.3, 130.2, 129.4, 129.1, 128.9, 126.8, 112.7, 41.3, 26.6 ppm; MS (EI, 70 eV): m/z (%) = 235 [M]$^+$ (33), 220 (100), 201 (83), 199 (90), 116 (24), 89 (43); HRMS: m/z calcd for $C_{16}H_{13}NO$: 235.0997; found: 235.1009.

7r: Prepared according to TP6 from **2m** (1.75 mL, 1.37 M in THF, 2.40 mmol) and **6m** (230 mg, 2.00 mmol). Reaction time: 0.5 h. Purification by flash chromatography (Et$_2$O) yielded 3-pyrimidin-2-ylmethylbenzonitrile (**7r**; 269 mg, 69 %) as a yellow oil. IR (diamond/ATR, neat): $\tilde{\nu}$ = 3040 (w), 2972 (vw), 2924 (vw), 2228 (m), 1604 (vw), 1560 (vs), 1484 (w), 1416 (vs), 1320 (vw), 1296 (vw), 1280 (vw), 1232 (w), 1180 (w), 1152 (vw), 1096 (w), 996 (w), 944 (vw), 912 (w), 856 (vw), 792 (m), 716 (w), 688 (m), 636 (w), 584 (w), 564 cm^{-1} (w); ^{1}H NMR (300 MHz, CDCl$_3$): δ = 8.67 (d, J = 5.1 Hz, 2 H), 7.64 (s, 1 H), 7.60–7.57 (m, 1 H), 7.52–7.48 (m, 1 H), 7.41–7.36 (m, 1 H), 7.16 (t, J = 4.9 Hz, 1 H), 4.30 ppm (s, 2 H); ^{13}C NMR (75 MHz, CDCl$_3$): δ = 168.7, 157.4, 139.5, 133.7, 132.7, 130.3, 129.2, 119.0, 118.8, 112.5, 45.3 ppm; MS (EI, 70 eV): m/z (%) = 196 (6), 195 [M]$^+$ (53), 194 (100), 193 (5), 167 (2). 142 (3), 116 (4), 115 (5), 114 (3); HRMS: m/z calcd for $C_{12}H_9N_3$: 195.0796; found: 195.0803.

7s: Prepared according to TP6 from **2n** (1.78 mL, 1.35 M in THF, 2.40 mmol) and **6n** (458 mg, 2.00 mmol). Reaction time: 12 h. Purification by flash chromatography (*n*-pentane/Et_2O = 98:2) yielded 4-(1-phenylethyl)benzoic acid ethyl ester (**7s**; 485 mg, 95 %) as a colorless oil. IR (diamond/ATR, neat): $\tilde{\nu}$ = 3028 (vw), 2973 (w), 2934 (vw), 1712 (s), 1610 (m), 1494 (w), 1451 (w), 1415 (w), 1367 (m), 1310 (w), 1271 (vs), 1178 (m), 1102 (s), 1019 (s), 857 (m), 758 (m),738 (m), 698 (vs), 646 (w), 595 cm^{-1} (w); ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.97 (d, *J* = 8.3 Hz, 2 H), 7.33–7.25 (m, 4 H), 7.23–7.16 (m, 3 H), 4.36 (q, *J* = 7.1 Hz, 2 H), 4.20 (q, *J* = 7.1 Hz, 1.66 (d, *J* = 7.3 Hz, 3 H), 1.37 ppm (t, *J* = 7.1 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 166.5, 151.5, 145.4, 129.7, 128.5, 128.4, 127.6, 127.5, 126.3, 60.7, 44.8, 21.6, 14.3 ppm; MS (EI, 70 eV): *m*/*z* (%) = 254 $[M]^+$ (100), 239 (45), 209 (40), 181 (41), 165 (57); HRMS: *m*/*z* calcd for $C_{17}H_{18}O_2$: 254.1307; found: 254.1305.

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