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An Electrochemical Nickel-Catalyzed Arylation of 3-Amino-6-Chloropyridazines

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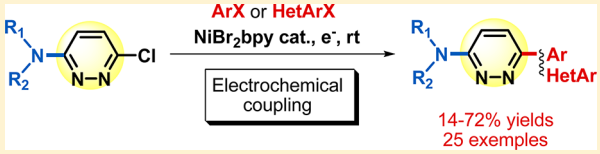
Supporting Information

ABSTRACT: 3-Amino-6-aryl- and 3-amino-6-heteroarylpyridazines have been obtained in generally good yield using a nickel-catalyzed electrochemical cross-coupling between 3-amino-6-chloropyridazines and aryl or heteroaryl halides at room temperature. Comparative experiments involving classical palladium-catalyzed reactions, such as Suzuki, Stille, or Negishi cross-couplings, reveal that the electrochemical method can constitute a reliable alternative tool for biaryl formation. A possible reaction mechanism is proposed on the basis of electrochemical analyses.



INTRODUCTION

3-Amino-6-aryl- and 3-amino-6-heteroarylpyridazines have retained the major attention of the organic community due to diverse biological activities displayed by these 1,2-diazaheterocycles, ranging from, for example, anticancer[1] or analgesic effects[2] to potential treatment of urinary incontinence,[3] inflammatory pain,[4] obesity,[5] and neurodegenerative diseases.[6] The preparation of aryl- and heteroarylpyridazines has been mainly described through palladium-catalyzed cross-coupling strategies, such as Stille[7] and Negishi[8] reactions. However, the most widely employed cross-coupling method remains undoubtedly the Suzuki reaction, due to its general broad applicability.[9] Other original coupling methods have been investigated as well, and the palladium-catalyzed arylation of pyridazine *N*-oxides described by Fagnou and co-workers, a few years ago, illustrated the purpose.[10]

In the past years, our group has been involved in several projects pertaining to the transition-metal-catalyzed electrochemical arylation of aryl- and heteroarylhalides. For instance, it was noticed that a range of azaaromatic and diazaaromatic halides are efficiently cross-coupled with aryl halides via an electroreductive procedure employing a nickel foam or an inox grid[11] cathode, a sacrificial iron rod as the anode, and nickel[12] or cobalt[13] salts as catalyst. Inasmuch as the applicability of the electrochemical procedure was found to be rather efficient from several azaheterocycle partners, we envisaged to extend the process from aminohalopyridazine precursors. This particular class of bifunctional pyridazines is of interest in regard to their high potential in therapy (Figure 1).

As a result, we describe herein the nickel-catalyzed electrochemical arylation of 3-amino-6-chloropyridazines, using an iron/nickel electrode as the sacrificial anode.

RESULTS AND DISCUSSION

We focused on the electrochemical cross-coupling of 3-amino-6-chloropyridazines **1a**−**1k**, prepared following standard methods,[14] with aryl and heteroaryl halides. Although related cross-coupling reactions had been successfully achieved in our group starting from halodiazines,[15] we considered that the arylation of 3-amino-6-chloropyridazines was representing a challenging task, due to the presence of three nitrogen atoms on the final products.[16] In a preliminary experiment, 4-(6-chloropyridazin-3-yl)morpholine **1a** and ethyl 3-bromobenzoate were reacted in standard electrochemical conditions, previously reported by our group:[15a] the coupling reaction between the halodiazine (1 equiv) and the aryl halide (2 equiv) was then run in DMF at room temperature in an undivided electrochemical cell fitted with an iron rod, surrounded by a nickel foam as the cathode, in the presence of $NiBr_2$bpy (10 mol %) as catalyst precursor, and tetrabutylammonium bromide as supporting electrolyte, under a constant current intensity of 0.2 A (Scheme 1).

Unfortunately, under the latter electrochemical conditions, the cross-coupling product **2g** was only obtained in a moderate yield (48%). The reaction parameters were then thoroughly assessed, and the most interesting gathered information indicated that the replacement of the iron anode by an iron/nickel (64/36) anode allowed a significant increase of the reaction yield from 48 to 70%. In this way, nickel salts generated by the anode consumption may permit the continuous regeneration of a reactive organonickel species, thus increasing the efficiency of the nickel-mediated cross-

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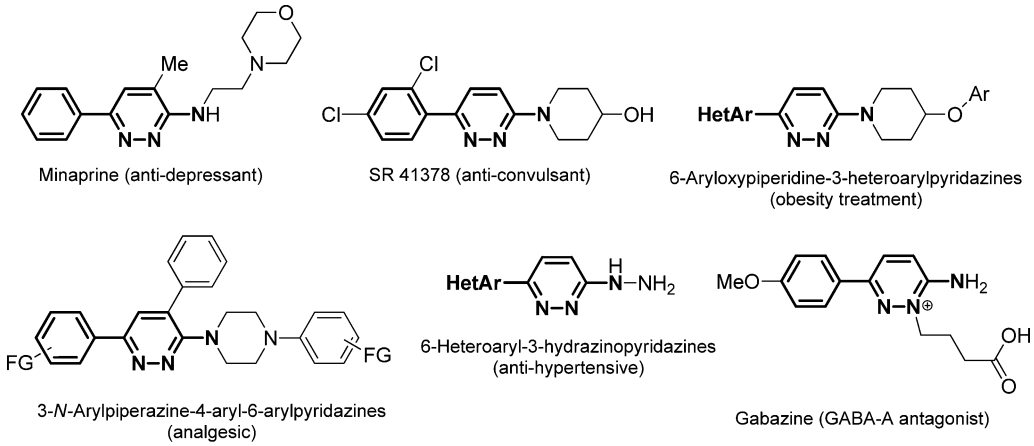
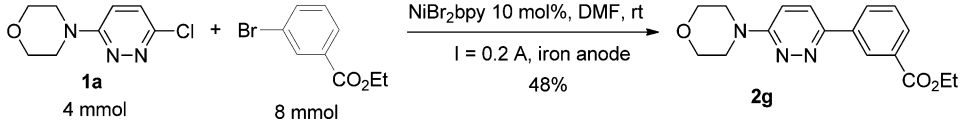


Figure 1. Some biologically active aminoarylpyridazines.

Scheme 1. Model Electrochemical Reaction



coupling reaction. The aryl and heteroaryl halide scope of this optimized protocol was then evaluated, keeping 4-(6-chloropyridazin-3-yl)morpholine **1a** as the model substrate. Results are summarized in Table 1.

Electrochemical cross-coupling reactions generally proceed in good yields with substituted phenyl halides (entries 1−7, Table 1). It can be noticed that almost 2 equiv of the halide (vs 3-amino-6-chloropyridazine) is required to complete the reaction, as illustrated in the case of 3-bromobenzotrifluoride (entry 5, Table 1). As previously noticed,[15a] more reactive aryl iodides are required instead of the bromides when the aryl moiety is not substituted (entry 1, Table 1) or substituted with electron-donating groups (entries 2 and 3, Table 1). This is also the case with a phenyl bearing a fluorine atom (entry 4, Table 1). It was also noticed, in iodides series (entries 1−4, Table 1), that one additional equivalent of the aryl iodide is generally required at an intermediate stage of the electrolysis for completion of the reaction. Indeed, such aryl iodides are, to a greater extent, prone to reduction and/or dimerization under these reaction conditions.

Surprisingly, the electrochemical cross-coupling involving a sterically hindered *ortho*-substituted aryl bromide allowed the formation of the target product **2h** in a modest 30% yield (entry 8, Table 1). However, this result constitutes an interesting feature in favor of the iron/nickel anode, as inextricable mixtures of reduction and homocoupling side products were observed in the electrocoupling of 3-chloro-6-methyl- or 3-chloro-6-methoxypyridazine with ethyl 2-bromobenzoate using a conventional iron rod as the anode.[15a]

Heteroaryl halides (entries 9−11, Table 1) gave also some interesting results, although more limited yields were generally expected. With 3-bromothiophene (entry 9, Table 1), the coupling product **2i** was isolated in good yield (71%), whereas a significant decrease of the yields was observed (around 30%) when 3-bromopyridine (entry 10, Table 1) and 2-chloroquinoline (entry 11, Table 1) were employed. These partial failures rely mainly in the formation of either the hydrodehalogenation product of 3-bromopyridine or the "dimerization" product of 2-chloroquinoline, bis-2,2′-quinoline, indicating that, under such specific substrate conditions, the cross-coupling reaction is not the favored pathway of the reaction.

The scope of the electrochemical cross-coupling methodology was then extended by performing miscellaneous experiments under the optimized experimental conditions. Results are reported in Table 2.

The results confirm the general efficiency of the electrochemical procedure while singular results were obtained in some specific cases. A very limited yield of **2p** (38%) was obtained starting from 4-bromobenzonitrile (entry 5, Table 2) as the aryl halide, whereas ethyl 4-bromobenzoate (entry 7, Table 2) led to a fairly good yield of **2r** (60%), thus indicating that electronic effects are not responsible for the lack of reactivity of the former. Another singular result was obtained with a chloropyridazine bearing a diallylamino substituent (entry 9, Table 2). In this case, no coupling product was obtained and a probable functional incompatibility of this amine with the typical reaction conditions can be suspected.[17] A specific study would be required to understand the nature of this issue, and experimental adaptations would probably be needed to overcome this particular problem.

Attempts Using Classical Palladium-Catalyzed Reactions. At this stage, we found it useful to perform a comparison between our electrochemical process and classical cross-coupling reactions, such as Suzuki and Stille reactions. To this end, the cross-coupling of 4-(6-chloropyridazin-3-yl)-morpholine **1a** and either phenylboronic acids or aryltributylstannanes[18] was undertaken under typical conditions.[19] Results are summarized in Table 3.

It is worth noting that, under standard reaction conditions, Suzuki coupling is less efficient than our electrochemical process, which always gave final products in higher yields, especially with electron-deficient aryl moieties. It can be noted that, in all cases, this latter reaction did not go to completion despite extended reaction times (60 h), thus revealing some limitations of this methodology with these specific substrates, presumably by catalyst poisoning through nitrogen coordina-

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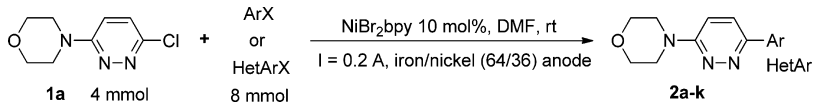
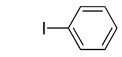
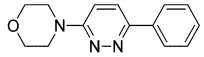
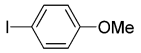
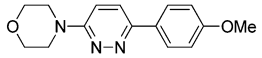
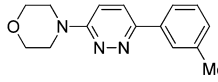
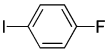
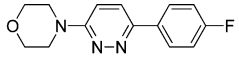
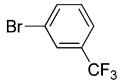
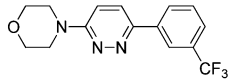
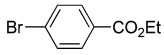
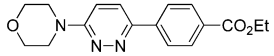
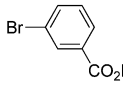
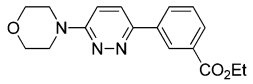
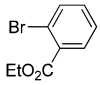
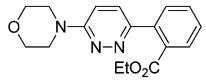
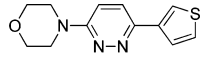
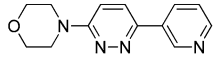
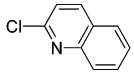
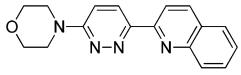
Table 1. Cross-Coupling Reactions between 4-(6-Chloropyridazin-3-yl)morpholine 1a and Aryl or Heteroaryl Halides[a,b,c,d]



1a 4 mmol — 8 mmol — 2a-k

Entry	ArX or HetArX	Reaction time (h)	Product		Yield (%)[b]
1		5		**2a**	62[c]
2		4.5		**2b**	46[c]
3		7		**2c**	64[c]
4		5.5		**2d**	58[c]
5		3.75		**2e**	70, 49[d]
6		4		**2f**	58
7		3.5		**2g**	70
8		5		**2h**	30
9		7		**2i**	71[c]
10		5		**2j**	31[c]
11		4		**2k**	26

[a]Typical reaction conditions: iron/nickel (64/36) rod anode, nickel foam cathode, DMF (50 mL), tetrabutylammonium bromide (1.2 mmol), 1,2-dibromoethane (2.5 mmol), $NiBr_2$bpy complex (10 mol %), 4-(6-chloropyridazin-3-yl)morpholine **1a** (4 mmol), aryl or heteroaryl halide (8 mmol), I = 0.2 A. [b]Isolated yield. [c]One additional equivalent of aryl- or heteroaryl halide was added after 2.5 h electrolysis. [d]Stoichiometric amounts of 4-(6-chloropyridazin-3-yl)morpholine (4 mmol) and aryl bromide (4 mmol) were used.

tion to palladium.[20] The Stille method did not provide notable improvements in the heterocoupling process, and only moderate yields (22−41%) were obtained, albeit more homogeneous than in the case of Suzuki conditions.

To further explore other classical palladium-catalyzed C−C bond formation methods, the Negishi reaction was then investigated starting from the model aminohalopyridazine (4-(6-halopyridazin-3-yl)morpholine) and the organozinc species prepared from 4-bromoanisole.[21] The reaction, conducted at 50 °C in the presence of 10 mol % tetrakis(triphenylphosphine)-palladium, or 10 mol % palladium chloride, associated with 40 mol % triphenylphosphine, was unsuccessful and led mainly to the formation of the homocoupling product, 4,4′-dimethoxybiphenyl, starting from either 6-chloro or 6-iodo derivatives as the starting pyridazine. We then tried to employ another method described by Gosmini and co-workers,[22] involving a zinc/cobalt system in acetonitrile. Unfortunately, the reaction of 4-bromoanisole with 4-(6-chloropyridazin-3-yl)morpholine **1a** did not give the desired product in satisfactory yield. Indeed, the best result was obtained by heating the reaction mixture at 75 °C, for which the coupling product **2b** was observed in only 30% GC yield. Attempts to optimize the reaction conditions failed since the coupling process was hampered by the formation of a significant amount of the biaryl resulting from the homocoupling of bromoanisole. Working at lower temperatures, around 50 or 60 °C, only afforded traces of the desired product **2b**, and the biaryl remained the major product formed in the reaction. The controlled dropwise addition of 4-bromoanisole to the mixture, at 75 °C to intend to the minimization of the homocoupling, did not allow the expected improvement. In this case, the hydrodehalogenation product of 4-bromoanisole was the major product observed in the reaction.

Mechanistic Aspects of the Electrochemical Cross-Coupling. An electrochemical study of $NiBr_2$bpy was undertaken in the presence of 4-(6-chloropyridazin-3-yl)morpholine **1a** (MPzCl). The cyclic voltammogram of $NiBr_2$bpy (black curve, Figure 2) exhibits two partially reversible single-electron reduction steps corresponding to the successive formation of nickel(I) and nickel(0) complexes. In the presence of MPzCl (blue (1 equiv) and red (2 equiv) curves), the loss of the reversibility of the two reduction steps of nickel(II) to nickel(0)

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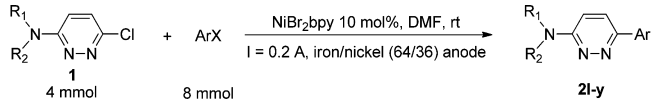
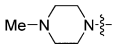
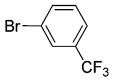
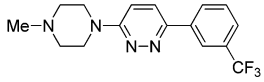
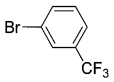
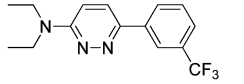
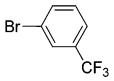
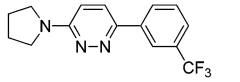
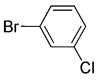
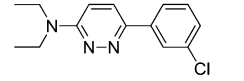
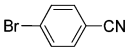
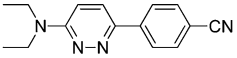
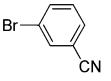
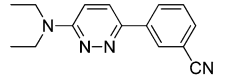
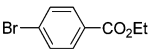
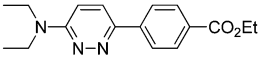
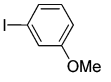
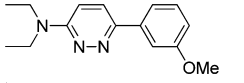
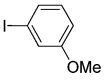
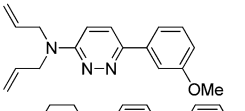
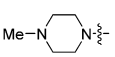
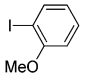
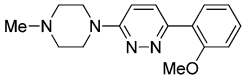
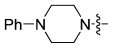
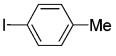
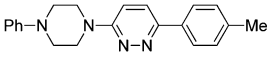
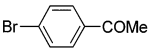
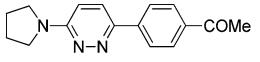
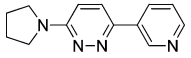
Table 2. Cross-Couplings between 3-Amino-6-Chloropyridazines 1 and Aryl or Heteroaryl Halides[a,b,c]



Entry	R_1NR_2	ArX	Reaction time (h)	Product		Yield (%)[b]
1			5		**2l**	66
2			4		**2m**	68
3			3.5		**2n**	67
4			5		**2o**	48
5			4.5		**2p**	38
6			4		**2q**	65[c]
7			4		**2r**	60
8			5		**2s**	44[c]
9			4			-
10			6		**2t**	67[c]
11			4		**2u**	72
12			4		**2v**	58
13			3			-
14			5		**2w**	52
15			3		**2x**	36
16			5.5		**2y**	14

[a]Typical reaction conditions: iron/nickel (64/36) rod anode, nickel foam cathode, DMF (50 mL), tetrabutylammonium bromide (1.2 mmol), 1,2-dibromoethane (2.5 mmol), $NiBr_2$bpy complex (10 mol %), 3-amino-6-chloropyridazine (4 mmol), aryl or heteroaryl halide (8 mmol), I = 0.2 A. [b]Isolated yield. [c]One additional equivalent of aryl halide was added after 2.5 h electrolysis.

was observed, which accounts for the fast insertion of zerovalent nickel onto the C−Cl bond of MPzCl.

From the mechanistic point of view, the first peak at −1.15 V/SCE is supposed to correspond to the initial formation of an $MPzNi^{II}Cl$ intermediate. Moreover, at −1.3 V/SCE, a second peak of lower intensity is visible, which might be assigned to the formation of an $MPzNi^{I}$ complex by reduction of $MPzNi^{II}Cl$. To confirm the formation of this intermediate species, cyclic voltammograms were performed at different scan rates (Figure 3). Indeed, as the $MPzNi^{I}$ complex was assumed to have a very short lifetime, it was envisaged that an increase of the scan rates would result in an increase of the intensity of the corresponding

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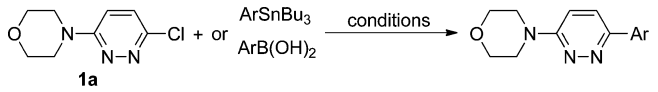
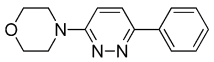
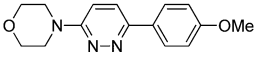
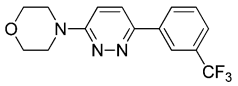
Table 3. Suzuki and Stille Cross-Couplings with 4-(6-Chloropyridazin-3-yl)morpholine 1a[a,b,c]



Entry	Product		Yields (%) Suzuki coupling[a]	Stille coupling[b]	Electrochemical coupling[c]
1		**2a**	35	41	62
2		**2b**	31	22	46
3		**2e**	8	39	70

[a]Isolated yields obtained from typical Suzuki coupling conditions: 1,4-dioxane (3 mL), 4-(6-chloropyridazin-3-yl)morpholine **1a** (1 mmol), arylboronic acid (1.2 mmol), cesium carbonate (2.2 mmol), tetrakis(triphenylphosphine)palladium (5 mol %), reflux, 18−60 h. [b]Isolated yields obtained from typical Stille coupling conditions: toluene (8 mL), 4-(6-chloropyridazin-3-yl)morpholine **1a** (1 mmol), organotin compound (1.2 mmol), tetrakis(triphenylphosphine)palladium (5 mol %), reflux, 18−48 h. [c]For comparison, isolated yields obtained from the electrochemical coupling.

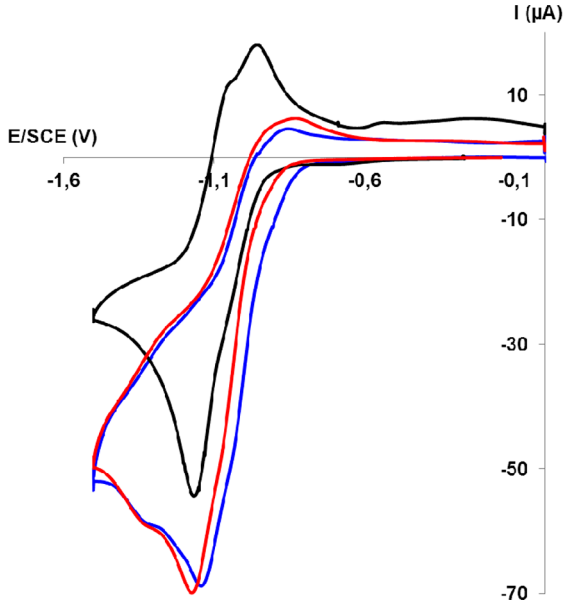


Figure 2. Cyclic voltammograms at a glassy carbon electrode in DMF + Bu_4NBr (0.1 mol·L^{-1}) of $NiBr_2bpy$ (C = 10^{-2} mol·L^{-1}) in the absence (black curve) and in the presence of MPzCl, C = 1.10^{-2} mol·L^{-1} (blue curve) and C = 2.10^{-2} mol·L^{-1} (red curve). v = 50 mV·s^{-1}.

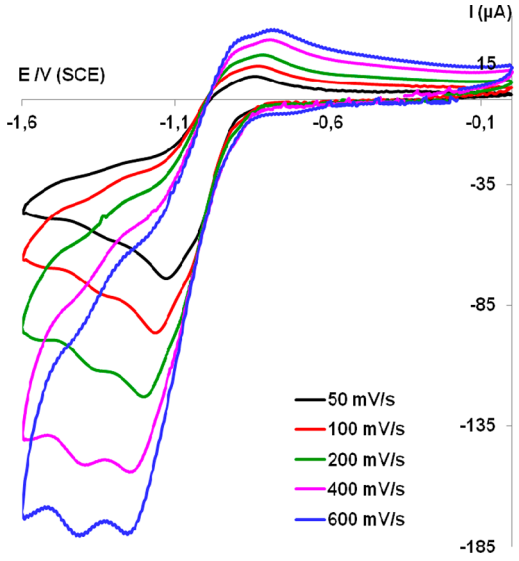


Figure 3. Cyclic voltammograms at a glassy carbon electrode in DMF + Bu_4NBr (0.1 mol·L^{-1}) of $NiBr_2bpy$ (C = 5.10^{-3} mol·L^{-1}) in the presence of **1a** (C = 10^{-2} mol·L^{-1}) at different scan rates.

peak (−1.3 V/SCE). As postulated, increasing the reaction rate from 50 to 600 mV·s^{-1} led to the observation of a more distinct peak at −1.3 V/SCE, which may account for the formation of a transient $MPzNi^{I}$ complex.

As we already reported in a preliminary work, the oxidative addition of an electrogenerated zerovalent nickel complex occurs faster on chloropyridazines than on aryl bromides.[23] On the basis of this postulate, we propose the following reaction mechanism, taking into account the crucial role of a transient Ni^{I} species in the catalytic process (Scheme 2).

In the putative catalytic cycle, the $NiBr_2bpy$ precatalyst is first reduced to Ni^0 (step a) (Scheme 2). Nickel(0) is then subjected to an oxidative addition onto 3-amino-6-chloropyridazine (APzCl) to give an $APzNi^{II}Cl$ intermediate (step b). The monoelectronic reduction of this intermediate (step c), followed by a second oxidative addition in the presence of the aromatic halide, leads to an $APzNi^{III}(Cl)Ar$ complex (step d). Consequently, the latest step should correspond to the reductive elimination of the complex (step e), giving the desired coupling product. This event should be associated with the release of $Ni^{I}X$ species, which is further electrochemically reduced to regenerate Ni^0 (step f).

CONCLUSION

In conclusion, results reported in this paper indicate that an electrochemical method can constitute a valuable alternative to classical reactions for the cross-coupling of aminohalopyridazines and aryl bromides. Indeed, it was shown that 3-amino-6-arylpyridazines can be obtained in good yields by nickel-catalyzed electrochemical arylation of 3-amino-6-chloropyridazines, using an iron/nickel electrode as the sacrificial anode at

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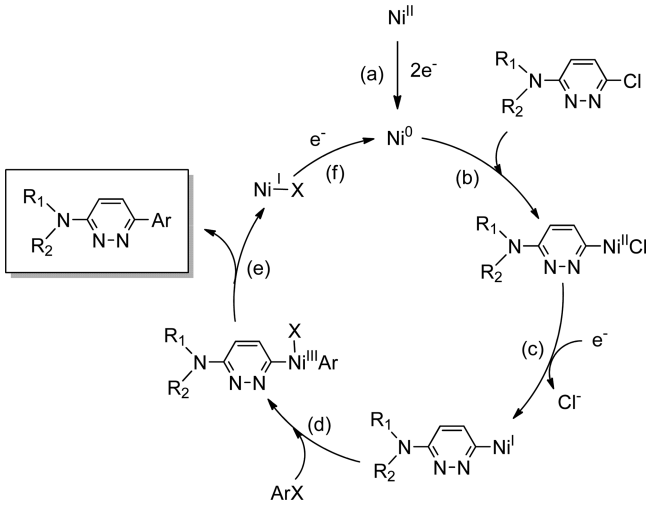
Scheme 2. Reaction Mechanism



room temperature. Comparative experiments involving classical reactions, such as Suzuki, Stille, or Negishi cross-couplings, revealed that the electrochemical method constitutes an alternative tool when the former struggle to deliver the biaryl compound. Electrochemical analyses additionally showed that the reaction mechanism involves the formation of a transient Ni^{I} species, which is a widely postulated intermediate, albeit rarely demonstrated. Current works are dedicated to the electrochemical C−H activation of pyridazines in the presence of nickel complexes and will be reported in due course.

EXPERIMENTAL SECTION

General. Solvents and reagents were purchased from commercial suppliers and used without further purification. The nickel bromide 2,2′-bipyridine complex ($NiBr_2$bpy) was prepared from nickel bromide hydrate and 2,2′-bipyridyl.[24] Reactions were monitored by gas chromatography (GC) using a chromatograph fitted with a capillary column (l = 5 m, Ø = 0.32 mm, df = 0.5 μm). Melting points were measured on a capillary melting apparatus and are uncorrected. Infrared spectra were recorded on an ATR-FTIR spectrophotometer. NMR spectra were recorded in $CDCl_3$ at 400 MHz (^{1}H), 100 MHz (^{13}C), and 376 MHz (^{19}F) on a spectrometer. Chemical shift (δ) are reported in parts per million (ppm) relative to the residual solvent signal. Coupling constant values (J) are given in hertz (Hz) and refer to apparent multiplicities, indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), and dd (doublet of doublets). Mass spectra (in electronic impact (EI^+) ionization mode) were measured on a GC-MS spectrometer. High-resolution mass spectra (HRMS) were performed on a Q-TOF mass spectrometer in positive electrospray ionization (ESI^+) mode. Purifications were performed by flash chromatography on silica gel (granulometry 70−200 μm). Compounds that have been previously described in the literature are linked to the corresponding bibliographic references.

General Procedures for the Preparation of 3-Amino-6-chloropyridazines 1a−1k. *Method A (Compounds 1a−1h).* To a round-bottom flask fitted with a condenser were added DMF (50 mL), 3,6-dichloropyridazine (33.6 mmol), the amine (36.9 mmol, 1.1 equiv), and triethylamine (50.3 mmo, 1.5 equiv). The resulting mixture was stirred at 80 °C for 17−20 h. H_2O (100 mL) was added, and the resulting solution was extracted with CH_2Cl_2/2−5% MeOH (3 × 50 mL). The combined organic layers were dried over $MgSO_4$, filtered, and evaporated under vacuum. Trituration of the crude in pentane afforded the product as a solid (except for the product **1h**, where purification by chromatography on silica is required).

Method B (Compound 1i). 3,6-Dichloropyridazine (33.6 mmol), *para*-anisidine (33.6 mmol), and potassium carbonate were heated at 80 °C, neat in a Schlenk tube during 72 h. H_2O (50 mL) and CH_2Cl_2/2−5%MeOH (50 mL) were added. After separation of the two phases, the aqueous layer was extracted with CH_2Cl_2/2−5% MeOH (2 × 50 mL). The combined organic layers were dried over $MgSO_4$, filtered, and evaporated under vacuum. The purification of the crude by chromatography on silica (elution with pentane/acetone (95/5), then (90/10)) gave the desire product.

Method C (Compounds 1j and 1k). To a solution of pyrrole or imidazole (36.9 mmol) in DMF (40 mL) was added sodium hydride (40.6 mmol of a 60% NaH, dispersion on mineral oil). The resulting solution was stirred at room temperature for 5 min before being transferred dropwise by means of a dropping funnel to a solution of 3,6-dichloropyridazine (33.6 mmol) in DMF (20 mL). The mixture was stirred at room temperature (for pyrrole) or at 80 °C (for imidazole). A saturated NH_4Cl solution (50 mL) was added, and the resulting solution was extracted with CH_2Cl_2/2−5% MeOH (3 × 50 mL). The combined organic layers were dried over $MgSO_4$, filtered, and evaporated under vacuum. Trituration of the crude in pentane afforded the product as a solid.

Typical Procedure for the Cross-Coupling Reactions. To an undivided electrochemical cell, fitted with an iron/nickel (64/36) rod as the anode and surrounded by a nickel foam as the cathode, were added DMF (50 mL), tetrabutylammonium bromide (1.2 mmol, 400 mg), and 1,2-dibromoethane (2.5 mmol, 215 μL). The mixture was electrolyzed under argon at a constant current intensity of 0.2 A at room temperature for 15 min. The current was then stopped, and the $NiBr_2$bpy complex (0.4 mmol, 150 mg), 3-amino-6-chloropyridazine (4 mmol), and aromatic or heteroaromatic halides (8 mmol) were sequentially added. The solution was electrolyzed at 0.2 A at room temperature until one of the starting materials was totally consumed.

Typical Workup and Purification. A saturated aqueous solution of EDTA (100 mL) was added to the mixture, and the solution was extracted with CH_2Cl_2 containing 2−5% methanol (3 × 100 mL). The combined organic layers were dried over $MgSO_4$, filtered, and evaporated under vacuum. The crude product was purified by flash chromatography on silica (20−45 μM), eluted with a gradient of solvents (pentane/acetone). For some polar cross-coupling compounds, a mixture of acetone−methanol (95/5) was necessary.

4-(6-Chloropyridazin-3yl)morpholine (1a):[25] Pale yellow solid. Yield: 6.13 g (92%); mp 132.5−134.5 °C; GC (80 °C, 6 °C/min) RT = 12.84 min; ATR-FTIR (neat, cm^{-1}) ν 3081, 2976, 2863, 1421, 1262, 1244, 1168, 1111, 925, 834, 677; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (d, J = 9.5 Hz, 1H), 6.90 (d, J = 9.5 Hz, 1H), 3.83 (t, J = 5.0 Hz, 4H), 3.60 (t, J = 5.0 Hz, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.2, 147.4, 128.8, 115.1, 66.4, 45.4; MS, m/z (relative intensity) 201 (34), 200 (38), 199 ($[M]^{\cdot+}$, 100), 198 (74), 171 (28), 170 (37), 169 (13), 168 (88), 164 (19), 156 (39), 144 (28), 143 (21), 142 (80), 141 (45), 86 (15), 79 (52), 78 (15), 73 (33), 52 (21).

3-Chloro-6-(piperidin-1-yl)pyridazine (1b):[26] Pale brown solid. Yield: 5.10 g (77%); mp 74−76 °C; GC (80 °C, 6 °C/min) RT = 13.04 min; ATR-FTIR (neat, cm^{-1}) ν 3050, 2927, 2854, 1660, 1582, 1435, 829, 761; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (d, 1H, J = 9.5 Hz), 6,89 (d, 1H, J = 9.5 Hz), 3.70−3.53 (m, 4H), 1.70−1.56 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.1, 145.9, 128.6, 115.3, 46.3, 25.3, 24.4; MS, m/z (relative intensity) 199 (34), 198 (17), 197 ($[M]^{\cdot+}$, 100), 170 (14), 168 (43), 162 (42), 142 (12), 84 (77), 79 (17), 56 (21).

3-Chloro-6- (4-methylpiperazin-1-yl)pyridazine (1c):[27] Dark brown solid. Yield: 4.65 g (65%); mp 105.5−106.5 °C; GC (80 °C, 6 °C/min) RT = 14.15 min; ATR-FTIR (neat, cm^{-1}) ν 3064, 2935, 2842, 1668, 1583, 1425, 1253, 1140, 832, 771; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, J = 9.5 Hz, 1H), 6.90 (d, J = 9.5 Hz, 1H), 3.64 (t, J = 5.0 Hz, 4H), 2.51 (t, J = 5.0 Hz, 4H) 2.33 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.1, 146.8, 128.7, 115.3, 54.5, 46.1, 45.0; MS, m/z (relative intensity): 212 ($[M]^{\cdot+}$, 6), 168 (10), 157 (12), 156 (10), 155 (32), 154 (15), 142 (31), 114 (6), 83 (43), 82 (100).

4−6-(Chloropyridazin-3-yl)piperazine-1-carbaldehyde (1d):[28] Brownish solid. Yield: 4.15 g (55%); mp 153−155 °C; GC (80 °C, 6 °C/min) RT = 20.20 min; ATR-FTIR (neat, cm^{-1}) ν 3050, 2924, 2866, 1649 ($\nu_{C=O}$), 1582, 1431, 1247, 1165, 1005, 659; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.14 (s, 1H), 7.28 (d, J = 9.5 Hz, 1H),

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6.97 (d, J = 9.5 Hz, 1H), 3.78 (t, J = 5.1 Hz, 2H), 3.70 (t, J = 5.1 Hz, 2H), 3.60 (t, J = 5.1 Hz, 2H), 3.53 (t, J = 5.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.9, 158.8, 147.7, 129.1, 115.8, 45.7, 45.0, 44.8, 39.5; MS, m/z (relative intensity) 228 (10), 226 ([M]$^{\cdot+}$, 33), 225 (12), 191 (19), 168 (23), 157 (21), 156 (41), 155 (61), 154 (62), 144 (36), 142 (100), 120 (16), 79 (20), 73 (14), 68 (17).

3-Chloro-6-(4-phenylpiperazin-1-yl)pyridazine (1e):[29] Pale brown solid. Yield: 8.28 g (90%); mp 164−166 °C (lit.: 168−169 °C); GC (80 °C, 6 °C/min) RT = 23.99 min; ATR-FTIR (neat, cm^{-1}) ν 3057, 2853, 1667, 1597, 1583, 1528, 1441, 1231, 1152, 939, 760; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33−7.28 (m, 2H), 7.25 (d, J = 9.5 Hz, 1H), 6.99−6.90 (m, 4H), 3.81 (t, J = 5.1 Hz, 4H), 3.33 (t, J = 5.1 Hz, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.1, 151.0, 147.1, 129.3, 128.9, 120.4, 116.5, 115.4, 49.0, 45.1; MS, m/z (relative intensity) 276 (7), 274 ([M]$^{\cdot+}$, 19), 239 (7), 145 (12), 133 (13), 132 (100), 120 (35), 119 (5), 105 (13), 104 (81), 91 (6), 79 (6), 77 (24), 51 (5).

3-Chloro-6-(pyrrolidin-1-yl)pyridazine (1f):[30] Pale brown solid. Yield: 4.97 g (81%); mp 126−128 °C; GC (80 °C, 6 °C/min) RT = 12.47 min; ATR-FTIR (neat, cm^{-1}) ν 3048, 2957, 2864, 2360, 1672, 1590, 1527, 1470, 1453, 1159, 833; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.13 (d, J = 9.5 Hz, 1H), 6.61 (d, J = 9.5 Hz, 1H), 3.49 (t, J = 6.4 Hz, 4H), 2.03 (t, 4H, J = 6.4 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.8, 145.1, 128.4, 114.8, 46.9, 25.4; MS, m/z (relative intensity) 185 (35), 184 (16), 183 ([M]$^{\cdot+}$, 100), 157 (11), 156 (34), 155 (28), 154 (84), 128 (14), 79 (13), 70 (33).

6-Chloro-*N*,*N*-diethylpyridazin-3amine (1g):[31] Pale yellow solid. Yield: 5.03 g (81%); mp 52.5−53.5 °C; GC (80 °C, 6 °C/min) RT = 7.15 min; ATR-FTIR (neat, cm^{-1}) ν 3063, 2975, 2932, 2870, 2360, 2341, 1673, 1582, 1524, 1489, 1446, 1425, 1200, 1167, 834, 755; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.13 (d, J = 9.5 Hz, 1H), 6.71 (d, J = 9.5 Hz, 1H), 3.56 (q, J = 7.0 Hz, 4H), 1.19 (t, J = 7.0 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.2, 145.0, 128.4, 113.8, 43.0, 12.6; MS, m/z (relative intensity) 187 (29), 186 (25), 185 ([M]$^{\cdot+}$, 79), 184 (31), 170 (20), 158 (31), 156 (100), 144 (14), 142 (41), 79 (18).

***N*,*N*-Diallyl-6-chloropyridazin-3-amine (1h):**[31] Yellow-orange oil. Yield: 4.56 g (65%); GC (80 °C, 6 °C/min) RT = 11.77 min; ATR-FTIR (neat, cm^{-1}) ν 3083, 2982, 2915, 1642, 1586 ($\nu_{C=C}$), 1476, 1414, 1166, 921; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.14 (d, J = 9.5 Hz, 1H), 6.70 (d, J = 9.5 Hz, 1H), 5.90−5.81 (m, 2H), 5.19 (d, J = 1.5 Hz, 2H), 5.16 (dd, J = 1.2, J = 8.5 Hz, 2H), 4.16 (d, J = 5.2 Hz, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.0, 146.0, 132.6, 130.3, 114.6, 117.0, 50.6; MS, m/z (relative intensity) 210 (10), 208 (26), 194 (10), 174 (21), 170 (31), 169 (31), 168 (100), 167 (13), 166 (33), 157 (13), 156 (13), 155 (32), 154 (36), 141 (10), 133 (25), 132 (13), 105 (27), 79 (16), 73 (13), 54 (8).

6-Chloro-*N*-(4-methoxyphenyl)pyridazin-3-amine (1i):[32] Brown solid. Yield: 4.34 g (55%); mp 158−159 °C (lit.: 145−147 °C); GC (80 °C, 6 °C/min) RT = 19.21 min; ATR-FTIR (neat, cm^{-1}) ν 3230, 3036, 2962, 1508, 1444, 1243, 1035, 840, 819; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (broad s, 1H), 7.28−7.18 (m, 3H), 6.94 (m, 3H), 3.83 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.4, 157.3, 147.5, 131.3, 129.4, 124.9, 115.7, 114.9, 55.6; MS, m/z (relative intensity) 237 (18), 236 (40), 235 ([M]$^{\cdot+}$, 56), 234 (100), 222 (7), 221 (5), 220 (19), 219 (9), 185 (9).

3-Chloro-6-(1*H*-pyrrol-1-yl)pyridazine (1j):[33] Brown solid. Yield: 4.99 g (83%); mp 179−180 °C (lit.: 180−182 °C); GC (80 °C, 6 °C/min) RT = 9.45 min; ATR-FTIR (neat, cm^{-1}) ν 3136, 3042, 1477, 1430, 1368, 1327, 1165, 914, 834, 731; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58−7.56 (m, 3H), 7.51 (d, J = 9.2 Hz, 1H), 6.46−6.44 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.2, 153.0, 130.2, 118.4, 118.3, 113.1; MS, m/z (relative intensity) 182 (5), 181 (34), 180 (11), 179 ([M]$^{\cdot+}$, 100), 152 (12), 145 (5), 144 (49), 117 (18), 116 (13), 91 (14), 89 (22), 64 (9), 63 (18).

3-Chloro-6-(1*H*-imidazol-1-yl)pyridazine (1k):[33] Yellowish solid. Yield: 4.41 g (73%); mp 180−182 °C (lit.: 178−180 °C); GC (80 °C, 6 °C/min) RT = 9.85 mi; ATR-FTIR (neat, cm^{-1}) ν 3155, 3041, 1660, 1481, 1433, 1309, 1158, 1034, 819, 743, 650; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (s, 1H), 7.76−7.5 (m, 1H), 7.70 (d, J = 9.2 Hz, 1H), 7.65 (d, J = 9.2 Hz, 1H), 7.29 (broad s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.1, 151.3, 135.0, 131.7, 130.9, 119.4, 116.2; MS, m/z (relative intensity) 182 (5), 181 (34), 180 ([M]$^{\cdot+}$, 11), 179 (100), 152 (12), 145 (5), 144 (49), 117 (18), 116 (13), 91 (14), 89 (22), 64 (9), 63 (18).

4-(6-Phenylpyridazin-3-yl)morpholine (2a): White crystals. Yield: 600 mg (62%); mp 153−155 °C; FC: elution with a gradient of pentane/acetone (90/10), (80/20), and (70/30); GC (80 °C, 6 °C/min) RT = 21.05 min; ATR-FTIR (neat, cm^{-1}) ν 3057, 2972, 2865, 1424, 1262, 1110, 926, 747, 700, 638; ^{1}H NMR (400 MHz) δ 8.00 (d, J = 7.2 Hz, 2H), 7.66 (d, J = 9.5 Hz, 1H), 7.47 (t, J = 7.2 Hz, 2H), 7.41 (d, J = 7.2 Hz, 1H), 6.95 (d, J = 9.5 Hz, 1H), 3.86 (t, J = 4.7 Hz, 4H), 3.67 (t, J = 4.7 Hz, 4H); ^{13}C NMR (100 MHz) δ 159.0, 151.6, 136.7, 128.8, 126.2, 126.0, 125.2, 112.8, 66.6, 45.4; MS, m/z (relative intensity) 242 (15), 241 ([M]$^+$, 100), 240 (72), 213 (20), 212 (7), 211 (22), 210 (98), 199 (6), 198 (27), 197 (6), 196 (29), 185 (10), 184 (77), 183 (63), 157 (6), 156 (12), 155 (11), 115 (40), 104 (8), 77 (7); HRMS (ESI$^+$) m/z calcd for $C_{14}H_{16}N_3O$ [M + H], 242.128789; found, 242.1289149.

4-[6-(4-Methoxyphenyl)pyridazin-3-yl]morpholine (2b):[34] Pale yellow crystals. Yield: 495 mg (46%); mp 174−176 °C; FC: elution with a gradient of pentane/acetone (90/10), (80/20), and (70/30); GC (80 °C, 6 °C/min) RT = 24.62 min; ATR-FTIR (neat, cm^{-1}) ν 2964, 2856, 1440, 1280, 1234, 1112, 1024, 931, 817, 604; ^{1}H NMR (400 MHz) δ 7.93 (d, J = 8.6 Hz, 2H), 7.60 (d, J = 9.5 Hz, 1H), 6.97 (d, J = 8.6 Hz, 2H), 6.93 (d, J = 8.6 Hz, 1H), 3.89−3.82 (m, 7H), 3.63 (t, J = 4.5 Hz, 4H); ^{13}C NMR (100 MHz) δ 160.4, 158.8, 151.4, 129.2, 127.2, 124.8, 114.2, 113.1, 66.6, 55.3, 45.5; MS, m/z (relative intensity) 272 (17), 271 ([M]$^{\cdot+}$, 100), 270 (57), 243 (12), 241 (16), 240 (64), 228 (14), 226 (22), 215 (7), 214 (54), 213 (49), 186 (5), 185 (7), 171 (7), 145 (15), 132 (7), 115 (5); HRMS (ESI$^+$) m/z calcd for $C_{15}H_{18}N_3O_2$ [M + H], 272.139353; found, 272.139745.

4-[6-(3-Tolyl)pyridazin-3-yl]morpholine (2c): Pale yellow crystals. Yield: 650 mg (64%); mp 153−154.5 °C; FC: elution with pentane/acetone (80/20); GC (80 °C, 6 °C/min) RT = 22.45 min; ATR-FTIR (neat, cm^{-1}) ν 2972, 2915, 2863, 1594, 1440, 1379, 1111, 929, 793; ^{1}H NMR (400 MHz) δ 7.87 (s, 1H), 7.75 (d, J = 7.4 Hz, 1H), 7.65 (d, J = 9.5 Hz, 1H), 7.36 (t, J = 7.5 Hz, 1H), 7.22 (d, J = 7.4 Hz, 1H), 6.95 (d, J = 9.5 Hz, 1H), 3.86 (t, J = 4.7 Hz, 4H), 3.67 (t, J = 4.5 Hz, 4H), 2.43 (s, 3H); ^{13}C NMR (100 MHz) δ 159.0, 151.7 138.5, 136.5, 129.6, 128.7, 126.7, 125.3, 123.0, 112.8, 66.6, 45.4, 21.5; MS, m/z (relative intensity) 256 (16), 255 ([M] $^{\cdot+}$, 100), 254 (75), 228 (5), 227 (17), 226 (6), 225 (23), 224 (95), 213 (6), 212 (26), 211 (6), 210 (26), 199 (11), 198 (77), 197 (65), 196 (6), 171 (5), 170 (9), 169 (9), 129 (21), 128 (12), 127 (7), 118 (8), 115 (10), 91 (8); HRMS (ESI$^+$) m/z calcd for $C_{15}H_{18}N_3O$ [M + H], 256.144439; found, 256.144849.

4-[6-(4-Fluorophenyl)pyridazin-3-yl]morpholine (2d): Pale yellow crystals. Yield: 605 mg (58%); mp 166−167.5 °C; FC: elution with a gradient of pentane/acetone (90/10), (80/20), (70/30), and (50/50); GC (80 °C, 6 °C/min) RT = 20.93 min; ATR-FTIR (neat, cm^{-1}) ν 3055, 2972, 2867, 1434, 1227, 1111, 927, 831, 822, 601; ^{1}H NMR (400 MHz) δ 7.97 (broad t, J = 6.2 Hz, 2H), 7.61 (d, J = 9.2 Hz, 1H), 7.14 (dd, J = 7.3, J = 8.5 Hz, 2H), 6.95 (d, J = 9.2 Hz, 1H), 3.92−3.83 (m, 4H), 3.71−3.63 (m, 4H); ^{13}C NMR (100 MHz) δ 163.4 (d, J^1_{C-F} = 248.4 Hz), 159.0, 150.7, 132.8 (d, J^4_{C-F} = 3.1 Hz), 127.8 (d, J^3_{C-F} = 8.3 Hz), 124.9, 115.7 (d, J^2_{C-F} = 21.7 Hz), 112.9, 66.5, 45.4; ^{19}F NMR (376 MHz) δ −113.2; MS, m/z (relative intensity) 260 (13), 259 ([M]$^+$, 100), 258 (79), 231 (16), 230 (6), 229 (18), 228 (97), 217 (5), 216 (27), 215 (8), 214 (29), 203 (12), 202 (71), 201 (56), 200 (5), 188 (5), 175 (6), 174 (10), 173 (12), 147 (6), 133 (37), 122 (8), 52 (5); HRMS (ESI$^+$) m/z calcd for $C_{14}H_{15}FN_3O$ [M + H], 260.1199367; found, 260.119747.

4-[6-(3-(Trifluoromethyl)phenyl)pyridazin-3-yl]morpholine (2e): Pale yellow solid. Yield: 865 mg (70%); mp 116−117.5 °C; FC: elution with a gradient of pentane/acetone (90/10) and (80/20); GC (80 °C, 6 °C/min) RT = 20.67 min; ATR-FTIR (neat, cm^{-1}) ν 2969, 2862, 1416, 1338, 1263, 1179, 1111, 1073, 929, 812, 706; ^{1}H NMR (400 MHz) δ 8.29 (s, 1H), 8.17 (d, J = 7.6 Hz, 1H), 7.69 (d, J = 9.5 Hz, 1H), 7.65 (d, J = 7.7 Hz, 1H), 7.58 (t, J = 7.7 Hz, 1H), 6.98 (d, J = 9.5 Hz, 1H), 3.86 (t, J = 4.0 Hz, 4H), 3.70 (t, J = 4.0 Hz, 4H); ^{13}C NMR (100 MHz) δ 159.2, 150.0, 137.4, 131.3 (q, J^2_{C-F} = 32.4 Hz), 129.3, 128.9, 125.3 (q, J^3_{C-F} = 3.7 Hz), 125.0, 124.1 (q, J^1_{C-F} = 272.5

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Hz), 122.7 (q, J^3_{C-F} = 4.0 Hz), 112.6, 66.5, 45.3; ^{19}F NMR (376 MHz) δ −62.7; MS, *m*/*z* (relative intensity) 310 (18), 309 ([M]$^+$, 100), 308 (79), 290 (18), 281 (15), 280 (5), 279 (23), 278 (92), 267 (6), 266 (27), 265 (6), 264 (25), 253 (14), 252 (81), 251 (50), 238 (6), 224 (8), 223 (9), 184 (7), 183 (31), 172 (8), 145 (6), 133 (6); HRMS (ESI$^+$) *m*/*z* calcd for $C_{15}H_{15}F_3N_3O$ [M + H], 310.116173; found, 310.116459.

Ethyl 4-(6-Morpholinopyridazin-3-yl)benzoate (2f): Pale brown solid. Yield: 720 mg (58%); mp 187−188 °C; FC: elution with a gradient of pentane/acetone (95/5) until 100% acetone; GC (80 °C, 6 °C/min) RT = 27.35 min; ATR-FTIR (neat, cm^{-1}) ν 2973, 2868, 1702, 1434, 1266, 1117, 827, 755; ^{1}H NMR (400 MHz) δ 8.15 (d, *J* = 8.5 Hz, 2H), 8.09 (d, *J* = 8.5 Hz, 2H), 7.73 (d, *J* = 9.6 Hz, 1H), 7.00 (d, *J* = 9.6 Hz, 1H), 4.41 (q, *J* = 7.1 Hz, 2H), 3.88 (t, *J* = 4.8 Hz, 4H), 3.72 (t, *J* = 4.8 Hz, 4H), 1.42 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz) δ 163.9, 156.6, 148.0, 138.1, 128.1, 127.7, 123.3, 123.1, 110.2, 64.1, 58.6, 42.8, 11.9; MS, *m*/*z* (relative intensity) 314 (14), 313 ([M]$^+$, 75), 312 (73), 285 (13), 284 (19), 283 (26), 282 (100), 271 (7), 270 (36), 269 (8), 268 (30), 257 (13), 256 (72), 255 (63), 254 (25), 240 (12), 228 (23), 227 (6), 183 (6), 159 (8); HRMS (ESI$^+$) *m*/*z* calcd for $C_{17}H_{20}N_3O_3$ [M + H], 314.149918; found, 314.150115.

Ethyl 3-(6-Morpholinopyridazin-3-yl)benzoate (2g): Pale yellow solid. Yield: 875 mg (70%); mp 98−99 °C; FC: elution with a gradient of pentane/acetone (95/5) and (90/10); GC (80 °C, 6 °C/min) RT = 27.18 min; ATR-FTIR (neat, cm^{-1}) ν 2969, 2868, 1713 ($\nu_{C=O}$), 1444, 1241, 1109, 1083, 929, 749, 669; ^{1}H NMR (400 MHz) δ 8.61 (s, 1H), 8.26 (d, *J* = 7.7 Hz, 1H), 8.08 (d, *J* = 7.7 Hz, 1H), 7.73 (d, *J* = 9.5 Hz, 1H), 7.54 (t, *J* = 7.7 Hz, 1H), 6.98 (d, *J* = 9.5 Hz, 1H), 4.40 (q, *J* = 7.1 Hz, 2H), 3.86 (t, *J* = 4.8 Hz, 4H), 3.68 (t, *J* = 4.8 Hz, 4H), 1.40 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz) δ 166.4, 159.1, 150.6, 136.9, 131.1, 130.2, 129.8, 129.0, 126.9, 125.3, 112.8, 66.5, 61.2, 45.3, 14.4; MS, *m*/*z* (relative intensity) 314 (15), 313 ([M]$^+$, 92), 312 (80), 285 (16), 284 (22), 283 (26), 282 (100), 271 (8), 270 (34), 269 (10), 268 (35), 257 (14), 256 (69), 255 (58), 254 (27), 240 (15), 228 (20), 227 (8), 182 (9), 159 (11); HRMS (ESI$^+$) *m*/*z* calcd for $C_{17}H_{20}N_3O_3$ [M + H], 314.149918; found, 314.150295.

Ethyl 2-(6-Morpholinopyridazin-3-yl)benzoate (2h): White solid. Yield: 380 mg (30%); mp 124−126 °C; FC: elution with pentane/acetone (80/20); GC (80 °C, 6 °C/min) RT = 24.43 min; ATR-FTIR (neat, cm^{-1}) ν 2975, 2840, 1720, 1432, 1285, 1115, 930, 754; ^{1}H NMR (400 MHz) δ 7.93 (d, *J* = 7.8 Hz, 1H), 7.62−7.57 (m, 2H), 7.51−7.47 (m, 1H), 7.38 (d, *J* = 9.4 Hz, 1H), 6.94 (d, *J* = 9.4 Hz, 1H), 4.22 (q, *J* = 7.1 Hz, 2H), 3.88 (t, *J* = 5.1 Hz, 4H), 3.68 (t, *J* = 5.1 Hz, 4H), 1.19 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz) δ 167.9, 158.8, 153.3, 138.7, 131.5, 130.8, 130.3, 130.2, 128.4, 128.3, 111.6, 66.6, 61.1, 45.3, 14.0; MS, *m*/*z* (relative intensity) 313 ([M]$^+$, 48), 312 (56), 284 (20), 283 (23), 282 (100), 270 (23), 269 (9), 268 (17), 257 (10), 256 (33), 255 (20), 254 (19), 240 (10), 212 (7), 211 (18), 210 (32), 209 (8), 185 (10), 184 (15); HRMS (ESI$^+$) *m*/*z* calcd for $C_{17}H_{20}N_3O_3$ [M + H], 314.149918; found, 314.150272.

4-[6-Thiophen-3-yl]pyridazin-3-yl)morpholine (2i): Pale yellow solid. Yield: 705 mg (71%); mp 183−185 °C; FC: elution with a gradient of pentane/acetone (95/5), (90/10), (80/20), and (50/50); GC (80 °C, 6 °C/min) RT = 21.33 min; ATR-FTIR (neat, cm^{-1}) ν 3084, 2976, 2862, 1434, 1263, 1240, 1114, 929, 817, 798, 654; ^{1}H NMR (400 MHz) δ 7.80 (m, 2H), 7.57 (dd, *J* = 2.8, *J* = 8.9 Hz, 1H), 7.42−7.40 (m, 1H), 6.93 (dd, *J* = 2.8, 8.9 Hz, 1H), 3.86 (t, *J* = 4.7 Hz, 4H), 3.58 (t, *J* = 4.7 Hz, 4H); ^{13}C NMR (100 MHz) δ 158.7, 148.5, 139.1, 126.5, 125.8, 125.3, 122.0, 113.0, 66.6, 45.4; MS, *m*/*z* (relative intensity) 249 (7), 248 (19), 247 ([M]$^+$, 100), 246 (74), 219 (19), 218 (10), 217 (15), 216 (78), 204 (21), 203 (5), 202 (26), 191 (11), 190 (62), 189 (63), 163 (6), 162 (10), 161 (10), 135 (7), 121 (21), 110 (6); HRMS (ESI$^+$) *m*/*z* calcd for $C_{12}H_{14}N_3OS$ [M + H], 248.085210; found, 248.085514.

4-[6-(Pyridin-3-yl)pyridazin-3-yl]morpholine (2j): Brown solid. Yield: 300 mg (31%); mp 131−133 °C; FC: elution with a gradient of pentane/acetone (90/10), then (80/20) and (50/50); GC (80 °C, 6 °C/min) RT = 21.53 min; ATR-FTIR (neat, cm^{-1}) ν 2967, 2855, 1588, 1438, 1263, 1230, 1115, 926, 805, 707; ^{1}H NMR (400 MHz) δ 9.14 (broad s, 1H), 8.63 (broad s, 1H), 8.36 (d, *J* = 7.8 Hz, 1H), 7.69 (d, *J* = 9.5 Hz, 1H), 7.41−7.39 (m, 1H), 6.99 (d, *J* = 9.5 Hz, 1H), 3.86 (t, *J* = 4.8 Hz, 4H), 3.68 (t, *J* = 4.8 Hz, 4H); ^{13}C NMR (100 MHz) δ 159.2, 149.7, 149.0, 147.1, 133.3, 132.4, 125.0, 123.8, 112.7, 66.5, 45.2; MS, *m*/*z* (relative intensity) 243 (16), 242 ([M]$^+$, 100), 241 (85), 214 (23), 213 (7), 212 (21), 211 (100), 200 (6), 199 (33), 197 (23), 186 (9), 185 (68), 184 (63), 116 (29), 105 (9), 104 (6), 89 (9), 79 (9), 78 (6), 52 (6); HRMS (ESI$^+$) *m*/*z* calcd for $C_{13}H_{15}N_4O$ [M + H], 243.124038; found, 243.124133.

4-[6-(Quinolin-2-yl)pyridazin-3-yl]morpholine (2k): Pale brown solid. Yield: 303 mg (26%); mp 231−233 °C; FC: elution with a gradient of pentane/acetone (90/10), then (80/20); GC (80 °C, 6 °C/min) RT = 27.14 min; ATR-FTIR (neat, cm^{-1}) ν 2956, 2849, 1585, 1429, 1237, 1117, 1114, 929, 826, 752; ^{1}H NMR (400 MHz) δ 8.72 (d, *J* = 8.7 Hz, 1H), 8.66 (d, *J* = 9.6 Hz, 1H), 8.28 (d, *J* = 8.7 Hz, 1H), 8.17 (d, *J* = 8.4 Hz, 1H), 7.86 (d, *J* = 7.5 Hz, 1H), 7.74 (t, *J* = 8.2 Hz, 1H), 7.55 (t, *J* = 8.0 Hz, 1H), 7.07 (d, *J* = 9.6 Hz, 1H), 3.90 (t, *J* = 4.8 Hz, 4H), 3.77 (t, *J* = 4.8 Hz, 4H); ^{13}C NMR (100 MHz) δ 159.8, 154.2, 151.3, 147.8, 136.9, 129.7, 129.5, 128.3, 127.8, 126.7, 118.3, 112.7, 66.6, 45.3; MS, *m*/*z* (relative intensity) 293 (14), 292 ([M]$^+$, 84), 291 (86), 281 (22), 264 (13), 263 (21), 262 (38), 261 (100), 249 (28), 247 (31), 235 (69), 234 (51), 210 (11), 209 (23), 208 (35), 207 (77), 206 (20), 192 (21), 129 (14), 128 (16); HRMS (ESI$^+$) *m*/*z* calcd for $C_{17}H_{17}N_4O$ [M + H], 293.139688; found, 293.139953.

3-(4-Methylpiperazin-1-yl)-6-[3-(trifluoromethyl)phenyl]-pyridazine (2l): Pale yellow solid. Yield: 850 mg (66%); mp 112−114 °C; FC: elution with a gradient of pentane/acetone (80/20) until 100% acetone, then acetone/methanol (80/20); GC (80 °C, 6 °C/min) RT = 21.45 min; ATR-FTIR (neat, cm^{-1}) ν 2956, 2936, 2874, 1589, 1417, 1336, 1165, 1106, 1073, 810, 704; ^{1}H NMR (400 MHz) δ 8.29 (s, 1H), 8.18 (d, *J* = 7.6 Hz, 1H), 7.67 (d, *J* = 9.6 Hz, 1H), 7.64 (d, *J* = 7.6 Hz, 1H), 7.58 (t, *J* = 7.6 Hz, 1H), 7.00 (d, *J* = 9.6 Hz, 1H), 3.77 (t, *J* = 5.0 Hz, 4H), 3.77 (t, *J* = 5.0 Hz, 4H), 2.37 (s, 3H); ^{13}C NMR (100 MHz) δ 159.0, 149.5, 137.5, 131.3 (q, J^2_{C-F} = 32.4 Hz), 129.3, 128.9, 125.2 (q, J^3_{C-F} = 3.6 Hz), 125.0, 124.2 (q, J^1_{C-F} = 272.5 Hz), 122.6 (q, J^3_{C-F} = 3.9 Hz), 112.7, 54.6, 46.2, 44.9; ^{19}F NMR (376 MHz) δ −62.7; MS, *m*/*z* (relative intensity) 322 ([M]$^+$, 7), 278 (8), 266 (6), 265 (33), 264 (17), 253 (16), 252 (100), 223 (10), 207 (8), 183 (17), 145 (5); HRMS (ESI$^+$) *m*/*z* calcd for $C_{16}H_{18}F_3N_4$ [M + H], 323.147808; found, 323.148424.

***N*,*N*-Diethyl-6-[3-(trifluoromethyl)phenyl]pyridazin-3-amine (2m):** Pale yellow oil. Yield: 805 mg (68%); FC: elution with a gradient of pentane/acetone (95/5) then (90/10); GC (80 °C, 6 °C/min) RT = 17.58 min; ATR-FTIR (neat, cm^{-1}) ν 2974, 2933, 1590, 1427, 1332, 1282, 1162, 1120, 1095, 802, 698; ^{1}H NMR (400 MHz) δ 8.23 (s, 1H), 8.08 (d, *J* = 7.6 Hz, 1H), 7.54 (d, *J* = 9.6 Hz, 1H), 7.53 (d, *J* = 7.6 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 1H), 6.73 (d, *J* = 9.6 Hz, 1H), 3.57 (q, *J* = 7.0 Hz, 4H), 1.18 (t, *J* = 7.0 Hz, 6H); ^{13}C NMR (100 MHz) δ 157.2, 147.9, 137.9, 131.2 (q, J^2_{C-F} = 31.8 Hz), 129.2, 128.5, 124.8 (q, J^3_{C-F} = 4.2 Hz), 124.7, 124.3 (q, J^1_{C-F} = 272.4 Hz), 122.4 (q, J^3_{C-F} = 3.9 Hz), 111.3, 43.0, 12.8; ^{19}F NMR (376 MHz) δ −62.7; MS, *m*/*z* (relative intensity) 296 (10), 295 ([M]$^+$, 61), 294 (14), 280 (11), 276 (6), 267 (15), 266 (100), 253 (6), 252 (37), 240 (7), 239 (6), 183 (11); HRMS (ESI$^+$) *m*/*z* calcd for $C_{15}H_{17}F_3N_3$ [M + H], 296.136909; found, 296.137419.

3-(Pyrrolidin-1-yl)-6-[3-(trifluoromethyl)phenyl]pyridazine (2n): White solid. Yield: 780 mg (67%); mp 130−132 °C; FC: elution with a gradient of pentane/acetone (95/5), then (90/10); GC (80 °C, 6 °C/min) RT = 20.16 min; ATR-FTIR (neat, cm^{-1}) ν 2961, 2864, 1430, 1333, 1157, 1114, 1071, 810; ^{1}H NMR (400 MHz) δ 8.30 (s, 1H), 8.20 (d, *J* = 7.6 Hz, 1H), 7.65 (d, *J* = 9.5 Hz, 1H), 7.63 (d, *J* = 7.6 Hz, 1H), 7.57 (t, *J* = 7.7 Hz, 1H), 6.72 (d, *J* = 9.5 Hz, 1H), 3.62 (broad s, 4H), 2.11−2.08 (m, 4H); ^{13}C NMR (100 MHz) δ 156.7, 148.0, 138.0, 131.2 (q, J^2_{C-F} = 32.3 Hz), 129.2, 128.6, 124.7 (q, J^3_{C-F} = 3.7 Hz), 124.6, 124.3 (q, J^1_{C-F} = 272.4 Hz), 122.3 (q, J^3_{C-F} = 3.8 Hz), 112.3, 46.7, 25.4; ^{19}F NMR (376 MHz) δ −62.7; MS, *m*/*z* (relative intensity) 294 (18), 293 ([M]$^{\cdot+}$, 100), 292 (5), 275 (16), 274 (9), 266 (10), 265 (51), 264 (99), 251 (8), 239 (5), 238 (28), 224 (25), 204 (7), 183 (12), 172 (6), 95 (5); HRMS (ESI$^+$) *m*/*z* calcd for $C_{15}H_{15}F_3N_3$ [M + H], 294.121259; found, 294.121590.

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6-(3-Chlorophenyl)-*N*,*N*-diethylpyridazin-3-amine (2o): Colorless oil. Yield: 505 mg (48%); FC: elution with a gradient of pentane/acetone (95/5), then (90/10); GC (80 °C, 6 °C/min) RT = 20.12 min; ATR-FTIR (neat, cm^{-1}) ν 2971, 2930, 1590, 1542, 1447, 1432, 1185, 1013, 787, 731; ^1H NMR (400 MHz) δ 8.00 (s, 1H), 7.82 (d, J = 7.4 Hz, 1H), 7.51 (d, J = 9.6 Hz, 1H), 7.35−7.28 (m, 2H), 6.75 (d, J = 9.6 Hz, 1H), 3.60 (q, J = 7.0 Hz, 4H), 1.22 (t, J = 7.0 Hz, 6H); ^{13}C NMR (100 MHz) δ 157.1, 147.9, 138.9, 134.8, 129.9, 128.1, 125.6, 124.8, 123.5, 111.3, 42.9, 12.8; MS, m/z (relative intensity) 263 (16), 262 ([M]$^+$, 13), 261 (50), 260 (17), 246 (8), 235 (7), 234 (34), 232 (100), 221 (5), 220 (15), 219 (19), 218 (29), 207 (5), 206 (7), 149 (8), 115 (6); HRMS (ESI$^+$) m/z calcd for $C_{14}H_{17}ClN_3$ [M + H], 262.110552; found, 262.110841.

4-[6-(Diethylamino)pyridazin-3-yl]benzonitrile (2p): Pale yellow solid. Yield: 380 mg (38%); mp 123−125 °C; FC: elution with a gradient of pentane/acetone (90/10), then (80/20); GC (80 °C, 6 °C/min) RT = 21.73 min; ATR-FTIR (neat, cm^{-1}) ν 2978, 2934, 2222, 1586, 1429, 1282, 1095, 1009, 818; ^1H NMR (400 MHz) δ 8.11 (d, J = 8.3 Hz, 2H), 7.72 (d, J = 8.3 Hz, 2H), 7.62 (d, J = 9.6 Hz, 1H), 6.82 (d, J = 9.6 Hz, 1H), 3.66 (q, J = 7.0 Hz, 4H), 1.25 (t, J = 7.0 Hz, 6H); ^{13}C NMR (100 MHz) δ 157.2, 147.3, 141.3, 132.5, 125.8, 124.9, 119.0, 111.5, 111.1, 43.0, 12.8; MS, m/z (relative intensity) 254 (11), 253 (57), 252 ([M]$^+$, 16), 238 (12), 225 (17), 224 (100), 211 (6), 210 (36), 198 (8), 197 (5), 141 (9); HRMS (ESI$^+$) m/z calcd for $C_{15}H_{17}N_4$ [M + H], 253.144773; found, 253.144993.

3-[6-(Diethylamino)pyridazin-3-yl]benzonitrile (2q): Brown oil. Yield: 660 mg (65%); FC: elution with a gradient of pentane/acetone (90/10), then (80/20); GC (80 °C, 6 °C/min) RT = 21.36 min; ATR-FTIR (neat, cm^{-1}) ν 2974, 2931, 2228, 1592, 1544, 1449, 1282, 1185, 1015, 799, 687; ^1H NMR (400 MHz) δ 8.28−8.26 (m, 2H), 7.64 (d, J = 7.6 Hz, 1H), 7.59 (d, J = 9.6 Hz, 1H), 7.55 (d, J = 8.0 Hz, 1H), 6.84 (d, J = 9.6 Hz, 1H), 3.66 (q, J = 7.1 Hz, 4H), 1.26 (t, J = 7.1 Hz, 6H); ^{13}C NMR (100 MHz) δ 157.3, 147.1, 138.3, 131.5, 129.6, 129.5, 129.0, 124.6, 118.9, 112.9, 111.3, 43.0, 12.8; MS, m/z (relative intensity) 253 (9), 252 ([M]$^+$, 53), 251 (16), 237 (12), 224 (16), 223 (100), 210 (6), 209 (36), 208 (5), 197 (9), 196 (5), 140 (12); HRMS (ESI$^+$) m/z calcd for $C_{15}H_{17}N_4$ [M + H], 253.144773; found, 253.145038.

Ethyl 4-[6-(Diethylamino)pyridazin-3-yl]benzoate (2r): Pale yellow oil. Yield: 720 mg (60%); FC: elution with a gradient of pentane/acetone (95/5), then (90/10); GC (80 °C, 6 °C/min) RT = 24.44 min; ATR-FTIR (neat, cm^{-1}) ν 2977, 2935, 1710, 1592, 1267, 1172, 1103, 1018, 753; ^1H NMR (400 MHz) δ 8.13 (d, J = 8.6 Hz, 2H), 8.08 (d, J = 8.6 Hz, 2H), 7.66 (d, J = 9.6 Hz, 1H), 6.82 (d, J = 9.6 Hz, 1H), 4.40 (q, J = 7.1 Hz, 2H), 3.66 (q, J = 7.0 Hz, 4H), 1.42 (t, J = 7.1 Hz, 3H), 1.27 (t, J = 7.0 Hz, 6H); ^{13}C NMR (100 MHz) δ 165.3, 155.8, 147.0, 139.9, 128.8, 128.7, 124.0, 123.9, 110.0, 59.7, 41.8, 13.1, 11.6; MS, m/z (relative intensity) 300 (10), 299 ([M]$^+$, 53), 298 (16), 284 (7), 271 (20), 270 (100), 257 (11), 256 (53), 255 (8), 254 (7), 243 (8), 242 (35), 228 (6); HRMS (ESI$^+$) m/z calcd for $C_{17}H_{22}N_3O_2$ [M + H], 300.170653; found, 300.171043.

***N*,*N*-Diethyl-6-(3-methoxyphenyl)pyridazin-3-amine (2s):** Pale yellow oil. Yield: 450 mg (44%); FC: elution with a gradient of pentane/acetone (95/5), then (90/10); GC (80 °C, 6 °C/min) RT = 20.82 min; ATR-FTIR (neat, cm^{-1}) ν 2970, 2930, 1592, 1424, 1282, 1218, 1181, 1037, 1013, 785, 752; ^1H NMR (400 MHz) δ 7.65 (s, 1H), 7.54 (d, J = 9.6 Hz, 1H), 7.39 (d, J = 7.6 Hz, 1H), 7.27 (t, J = 8.1 Hz, 1H), 6.86 (dd, J = 2.5 and 8.2 Hz, 1H), 6.74 (d, J = 9.6 Hz, 1H), 3.81 (s, 3H), 3.58 (q, J = 7.0 Hz, 4H), 1.18 (t, J = 7.0 Hz, 6H); ^{13}C NMR (100 MHz) δ 160.1, 156.9, 149.0, 138.3, 129.6, 125.2, 117.8, 115.0, 111.6, 110.2, 55.4, 42.9, 12.9; MS, m/z (relative intensity) 258 (10), 257 ([M]$^+$, 56), 256 (14), 242 (8), 229 (17), 228 (100), 215 (7), 214 (46), 213 (14), 185 (8), 145 (5); HRMS (ESI$^+$) m/z calcd for $C_{15}H_{20}N_3O$ [M + H], 258.160089; found, 258.160453.

3-(2-Methoxyphenyl)-6-(4-methylpiperazin-1-yl)pyridazine (2t): Yellow solid. Yield: 760 mg (67%); mp 117−118 °C; FC: elution with a gradient of pentane/acetone (80/20) until 100% acetone, then actone/methanol (90/10); GC (80 °C, 6 °C/min) RT = 24.10 min; ATR-FTIR (neat, cm^{-1}) ν 2946, 2804, 1425, 1253, 1240, 1147, 1025, 770; ^1H NMR (400 MHz) δ 7.92 (dd, J = 1.5 and 7.5 Hz, 1H), 7.78 (d, J = 9.6 Hz, 1H), 7.36 (t, J = 7.5 Hz, 1H), 7.07 (t, J = 7.5 Hz, 1H), 6.97 (d, J = 8.2 Hz, 1H), 6.91 (d, J = 9.6 Hz, 1H), 3.83 (s, 3H), 3.72 (t, J = 4.9 Hz, 4H), 2.55 (t, J = 5.0 Hz, 4H), 2.35 (s, 3H); ^{13}C NMR (100 MHz) δ 158.5, 156.8, 150.5, 130.5, 129.9, 129.5, 126.4, 121.2, 111.5, 111.2, 55.5, 54.7, 46.2, 44.9; MS, m/z (relative intensity) 284 ([M]$^+$, 3), 228 (6), 227 (19), 226 (9), 215 (16), 214 (100), 203 (5), 202 (38), 199 (12), 198 (7), 185 (5), 158 (6); HRMS (ESI$^+$) m/z calcd for $C_{16}H_{21}N_4O$ [M + H], 285.170988; found, 285.171290.

3-(4-Phenylpiperazin-1-yl)-6-(para-tolyl)pyridazine (2u): Brown solid. Yield: 950 mg (72%); mp 226−228 °C; FC: elution with a gradient of pentane/acetone (50/50) until 100% acetone, then actone/methanol (90/10); GC (120 °C, 8 °C/min) RT = 22.12 min; ATR-FTIR (neat, cm^{-1}) ν 2842, 1594, 1436, 1233, 1164, 943, 819, 752, 686; ^1H NMR (400 MHz) δ 7.93 (d, J = 8.2 Hz, 2H), 7.69 (d, J = 9.6 Hz, 1H), 7.35−7.30 (m, 3H), 7.06 (d, J = 9.6 Hz, 1H), 7.02 (d, J = 8.5 Hz, 2H), 6.93 (t, J = 7.3 Hz, 1H), 3.89 (t, J = 5.5 Hz, 4H), 3.37 (t, J = 5.5 Hz, 4H), 2.43 (s, 3H); ^{13}C NMR (100 MHz) δ 158.7, 151.4, 151.1, 138.8, 133.8, 129.6, 129.2, 125.6, 125.2, 120.4, 116.5, 113.3, 49.2, 45.2, 21.2; MS, m/z (relative intensity) 330 ([M]$^+$, 13), 282 (8), 281 (25), 267 (8), 265 (9), 225 (13), 212 (19), 211 (29), 210 (22), 209 (30), 208 (24), 207 (99), 199 (14), 198 (100), 191 (17), 133 (15), 132 (24), 104 (14), 91 (8), 77 (8); HRMS (ESI$^+$) m/z calcd for $C_{21}H_{23}N_4$ [M + H], 331.191723; found, 331.191885.

1-[4-(6-Pyrrolidin-1-yl)pyridazin-3-yl)phenyl]ethanone (2v): Pale yellow solid. Yield: 620 mg (58%); mp 176−178 °C; FC: elution with a gradient of pentane/acetone (90/10), then (80/20) and (50/50); GC (80 °C, 6 °C/min) RT = 26.21 min; ATR-FTIR (neat, cm^{-1}) ν 2972, 2873, 1680, 1596, 1546, 1457, 1404, 1263, 1177, 821; ^1H NMR (400 MHz) δ 8.12 (d, J = 8.4 Hz, 2H), 8.05 (d, J = 8.4 Hz, 2H), 7.68 (d, J = 9.4 Hz, 1H), 6.72 (d, J = 9.4 Hz, 1H), 3.63 (broad s, 4H), 2.65 (s, 3H), 2.11−2.08 (m, 4H); ^{13}C NMR (100 MHz) δ 197.8, 156.8, 148.3, 141.6, 136.5, 128.9, 125.5, 125.0, 112.1, 46.8, 26.7, 25.5; MS, m/z (relative intensity) 268 (19), 267 ([M]$^+$, 100), 266 (5), 250 (7), 249 (14), 240 (10), 239 (44), 238 (85), 225 (9), 213 (6), 212 (33), 198 (16), 183 (6), 157 (5), 120 (9), 111 (9), 94 (5); HRMS (ESI$^+$) m/z calcd for $C_{16}H_{18}N_3O$ [M + H], 268.144439; found, 268.144676.

***N*-(4-Methoxyphenyl)-6-phenylpyridazin-3-amine (2w):** Orange solid. Yield: 580 mg (52%); mp 181−183 °C; FC: elution with a gradient of pentane/acetone (90/10), then (80/20) and (70/30); GC (100 °C, 10 °C/min) RT = 14.89 min; ATR-FTIR (neat, cm^{-1}) ν 2928, 2833, 1602, 1508, 1453, 1242, 1029, 823, 689; ^1H NMR (400 MHz) δ 7.98 (d, J = 7.2 Hz, 2H), 7.62 (d, J = 9.4 Hz, 1H), 7.51 (broad s, 1H), 7.48 (t, J = 7.0 Hz, 2H), 7.44−7.42 (m, 1H), 7.34 (d, J = 8.9 Hz, 2H), 7.04 (d, J = 9.4 Hz, 1H), 6.93 (d, J = 8.9 Hz, 2H), 3.83 (s, 3H); ^{13}C NMR (100 MHz) δ 159.9, 156.8, 152.4, 136.8, 132.0, 128.9, 128.8, 126.0, 125.7, 124.3, 114.8, 113.4, 55.6; MS, m/z (relative intensity) 278 (12), 277 ([M]$^+$, 62), 276 (100), 262 (18), 261 (10), 132 (5); HRMS (ESI$^+$) m/z calcd for $C_{17}H_{16}N_3O$ [M + H], 278.128789; found, 278.144676.

Methyl 3-[6-(1*H*-pyrrol-1-yl)pyridazin-3-yl]benzoate (2x): Yellow solid. Yield: 405 mg (36%); mp 150−152 °C; FC: elution with a gradient of pentane/diethyl ether (90/10), then (80/20) and pentane/acetone (90/10); GC (100 °C, 10 °C/min) RT = 23.90 min; ATR-FTIR (neat, cm^{-1}) ν 3119, 2959, 1722, 1486, 1431, 1293, 1256, 730; ^1H NMR (400 MHz) δ 8.70 (s, 1H), 8.41 (d, J = 7.8 Hz, 1H), 8.19 (d, J = 7.8 Hz, 1H), 8.03 (d, J = 9.3 Hz, 1H), 7.69−7.65 (m, 3H), 6.62 (d, J = 9.3 Hz, 1H), 6.50−6.47 (m, 2H), 3.99 (s, 3H); ^{13}C NMR (100 MHz) δ 166.7, 155.9, 152.8, 136.0, 131.0, 130.9, 129.3, 127.6, 126.2, 118.2, 116.5, 112.7, 52.4; MS, m/z (relative intensity) 280 (18), 279 ([M]$^+$, 100), 252 (8), 248 (8), 222 (12), 221 (60), 220 (6), 219 (5), 207 (11), 193 (5), 192 (12), 191 (14), 91 (15); HRMS (ESI$^+$) m/z calcd for $C_{16}H_{14}N_3O_2$ [M + H], 280.108053; found, 280.108245.

3-(1*H*-Imidazol-1-yl)-6-(3-methylphenyl)pyridazine (2y): Brown solid. Yield: 130 mg (14%); mp 112−114 °C; FC: elution with a gradient of pentane/diethyl ether (70/30), then (50/50) and pentane/acetone (30/70); GC (80 °C, 6 °C/min) RT = 21.40 min; ATR-FTIR (neat, cm^{-1}) ν 3120, 2960, 1681, 1484, 1435, 1304, 793, 695; ^1H NMR (400 MHz) δ 8.50 (broad s, 1H), 8.02 (d, J = 9.2 Hz, 1H), 7.94 (broad s, 1H), 7.85−7.82 (m, 2H), 7.68 (d, J = 9.2 Hz, 1H),

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7.43 (t, J = 7.4 Hz, 1H), 7.34 (broad d, J = 7.6 Hz, 1H), 7.28 (broad s, 1H), 2.46 (s, 3H); ^{13}C NMR (100 MHz) δ 158.7, 150.8, 139.0, 135.0, 131.2, 130.9, 129.1, 127.6, 126.7, 124.0, 119.5, 117.5, 116.1, 21.5; HRMS (ESI$^+$) m/z calcd for $C_{14}H_{13}N_4$ [M + H], 237.113473; found, 237.113602.

■ ASSOCIATED CONTENT

Supporting Information

NMR spectra for aminochloropyridazines **1a**−**1k** and aryl- and heteroarylpyridazines **2a**−**2y**. This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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