ω-Functionalized 3-Alkynylpyrazolo[1, 5-*a*]pyrimidines by Sonogashira Coupling

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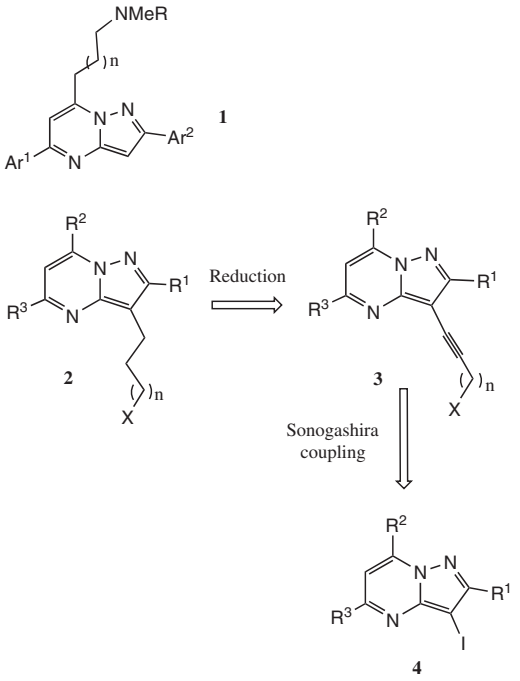
Abstract: ω-Functionalized 3-alkynylpyrazolo[1,5-*a*]pyrimidines were synthesized via the Pd-C/CuI/PPh_3-catalyzed Sonogashira coupling of 3-iodopyrazolo[1,5-*a*]pyrimidines with propargylic and homopropargylic compounds. Subsequent Pd-C-catalyzed hydrogenation of the C-C triple bond afforded 3-(3-dimethylaminopropyl)-pyrazolo[1,5-*a*]pyrimidines.

Keywords: heterocycles, alkynes, cross-coupling, palladium, hydrogenation

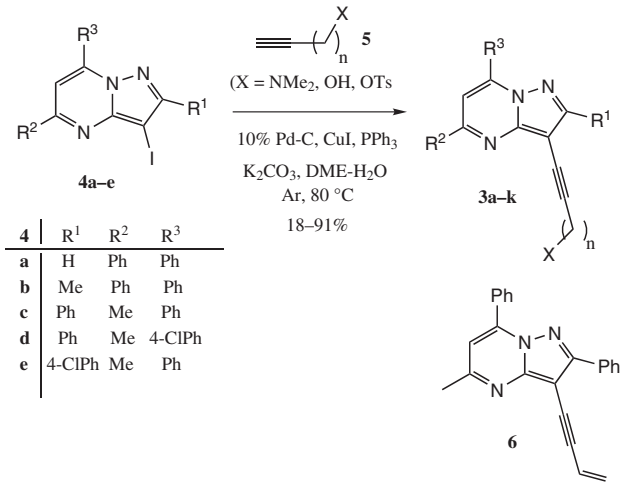
Pyrazolo[1,5-*a*]pyrimidines are purine analogues and have useful properties as antimetabolites in purine biochemical reactions. Compounds of this class have attracted wide pharmaceutical interest because of their antitrypanosomal[1] and antischistosomal activities,[2] and their potential as HMG-CoA reductase inhibitors,[3] COX-2-selective inhibitors,[4] AMP phosphodiesterase inhibitors,[5] KDR kinase inhibitors,[6] selective peripheral benzodiazepine receptor ligands,[7] and antianxiety agents.[8] These interesting biological properties initiated activities to develop new efficient general procedures for the synthesis of pyrazolo[1,5-*a*]pyrimidine derivatives.

On the other hand, bicyclic aminoalkyl heteroaromatics have gained interest as promising compounds in the treatment of cancer by stabilizing the active conformation of the protein P 53 and as potent inhibitors of lck, an src family of tyrosine kinases, which are interesting for treatment of autoimmune and inflammatory diseases.[9] During the development of new phosphatase inhibitors we recently found a versatile ring-chain-transformation[10] providing access to pyrazolo[1,5-*a*]pyrimidines **1** with aminoalkyl substituents in position 7. For structure activity correlation we became interested in isomeric pyrazolo[1,5-*a*]pyrimidines **2**, where the positions of substituents on the bicyclic heterocyclic core is exchanged, i.e. where the aminoalkyl substituent is attached to position 3. We have recently shown[11] that the Pd-catalyzed Heck cross-coupling of 3-iodopyrazolo[1,5-*a*]pyrimidines **4** is a versatile tool to introduce unsaturated substituents in the 3-position. In order to obtain 3-(ω-aminoalkyl)pyrazolo[1,5-*a*]pyrimidines **2**, we envisaged a two-step synthesis via the Sonogashira coupling of 3-iodopyrazolo[1,5-*a*]pyrimidines **4** with ω-aminoalkynes followed by reduction of the resulting 3-(ω-aminoalkynyl)pyrazolo[1,5-*a*]pyrimidines **3** as shown in Scheme 1.



Scheme 1

The Sonogashira coupling has been used extensively in organic synthesis;[12] also of heterocyclic compounds.[13] It is a suitable method to introduce an alkynyl group into a desired position, and subsequent hydrogenation of the



4	R^1	R^2	R^3
a	H	Ph	Ph
b	Me	Ph	Ph
c	Ph	Me	Ph
d	Ph	Me	4-ClPh
e	4-ClPh	Me	Ph

Scheme 2

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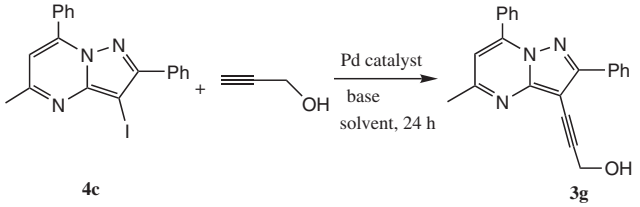
Table 1 Effect of Reaction Condition on the Sonogashira Coupling of **4c** with Propargyl Alcohol



4c **3g**

Entry	Catalyst	Base	Solvent	Temp.	Yield (%)[a]
1	10% Pd-C, CuI, PPh_3	K_2CO_3	DME–H_2O	80 °C	72
2	$Pd(PPh_3)_2Cl_2$, CuI	Et_3N	MeCN	r.t.	9
3	$Pd(PPh_3)_2Cl_2$, CuI	Et_3N	DMF–Et_3N	50 °C	50
4	$Pd(PPh_3)_2Cl_2$, CuI	Et_3N	Et_3N	80 °C	0
5	$Pd(PPh_3)_2Cl_2$, CuI	Et_3N	DMF–Et_3N	100 °C	0
6	$Pd(PPh_3)_2Cl_2$, CuI	$(i\text{-Pr})_2NEt$	CH_2Cl_2	r.t.	14
7	$Pd(PPh_3)_2Cl_2$, CuI	Et_2NH	Et_2NH	50 °C	40
8	$Pd(PPh_3)_4$, CuI	Et_3N	DMF–Et_3N	50 °C	43
9	$Pd(OAc)_2$, PPh_3, Bu_4NHSO_4	Et_3N	MeCN–H_2O	r.t.	27

[a] Yields of isolated products calculated on iodide **4c**. Reaction time 24 h. The following quantities were used: **4c**: (0.5 mmol); propargyl alcohol: 1 mmol (entry 1, 0.6 mmol); Pd catalyst: 0.05 equiv (entry 1: 0.04 equiv of Pd-C, 0.16 equiv PPh_3; entry 9: 0.1 mmol PPh_3 and 0.5 mmol Bu_4NHSO_4); CuI: 0.10 equiv (with exception of entry 9). Base and solvent: entry 1, K_2CO_3/DME–H_2O: 1.2 mmol/5 mL/5 mL; entry 2, Et_3N–MeCN: 2 mmol/10 mL; entries 3, 5 and 8, Et_3N–DMF: 5 mL/5 mL; entry 4 and 7, amine: 10 mL; entry 6, $(i\text{-Pr})_2NEt$–CH_2Cl_2: 2 mmol/10 mL; entry 9, Et_3N–MeCN–H_2O: 2 mmol/9 mL/1 mL.

alkynyl group gives rise to the alkyl substituted compound.[14] Propargylic systems, such as propargyl amines or propargyl alcohols and their homologues and derivatives could also be successfully used in Sonogashira couplings. However, these alkynes tend to be subject of elimination of the heterofunctionality during the course of the cross-coupling affording allenes.[15]

We report herein the Sonogashira coupling of 3-iodopyrazolo[1,5-*a*]pyrimidines **4a–e** with *N,N*-dimethylpropargylamine, propargyl alcohol, homopropargyl alcohol or its tosylate **5** (Scheme 2). In order to identify an appropriate catalyst several systems were tested in the reaction of **4c** with propargyl alcohol (Table 1). Since homogeneous Pd-catalysts such as $Pd(PPh_3)_2Cl_2$, $Pd(PPh_3)_4$, and $Pd(OAc)_2$ turned out to work poorly or not at all (see Table 1, entries 2–9), heterogeneous Pd-C was applied. Pd-C is one of the most common heterogeneous palladium catalysts. It is convenient to handle, inexpensive, reusable and exhibits high catalytic activity.[16] It has been used widely in Suzuki–Miyaura couplings,[17] Heck couplings,[18] and Sonogashira couplings.[19] Indeed, application of Pd-C with CuI, PPh_3, and K_2CO_3 as the base in a mixture of dimethoxyethane and water was also most effective in our test reaction (Table 1, entry 1).

Thus, these conditions were used as standard procedure in the synthesis of various ω-functionalized 3-alkynylpyrazolo[1,5-*a*]pyrimidines **3a–k** (Table 2 and Table 3). High yields were achieved in most cases. 4-Tosyloxybutyne (**5**; n = 2, X = OTs), however, gave the expected pyrazolo[1,5-*a*]pyrimidine **3k** in minor amounts together with its elimination product 3-(3-buten-1-ynyl)pyrazolo[1,5-*a*]pyrimidine (**6**) (36% yield).

We further tried to submit (3-aminophenyl)ethyne (**5**; n = 0, X = 3-NH_2Ph) to Sonogashira coupling with the 3-iodopyrazolo[1,5-*a*]pyrimidine (**4a**) under standard conditions. However, the Glaser condensation product **7** was obtained in quantitative yield (Scheme 3) and no cross-coupling product **3** was observed. It is worth mentioning that the yield was higher than that reported for the Glaser coupling of (2-aminophenyl)ethyne using 2 equivalents of $Cu(OAc)_2 \cdot H_2O$ as oxidizing reagent.[20] In our procedure, no additional oxidizing reagent was used, just the catalytic amounts of CuI and Pd-C. Recently, similar phenomena were observed with $(PPh_3)_2PdCl_2$/CuI.[21]

The 3-(3-dimethylaminopropynyl)pyrazolo[1,5-*a*]pyrimidines **3a** and **3b** were hydrogenated with H_2, catalyzed by 10% Pd-C in EtOH at room temperature and 1 atm (Scheme 4) adopting a known procedure.[14b] The desired products **2** could be obtained in modest yields. Attempts to increase yields by more forcing conditions were not tested because the pyrazolo[1,5-*a*]pyrimidine core can be sensitive to reductive conditions.

In summary, we have developed an efficient synthesis of new ω-functionalized 3-alkynyl-pyrazolo[1,5-*a*]pyrimidines **3** by the Sonogashira coupling of 3-iodopyrazolo[1,5-*a*]pyrimidines. 3-(3-Dimethylaminopropyn-1-

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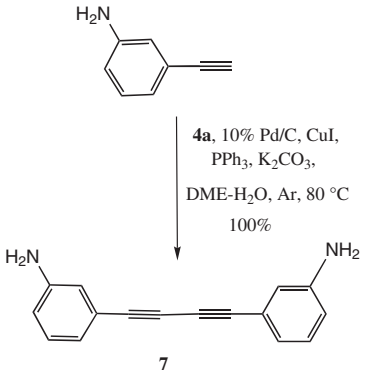
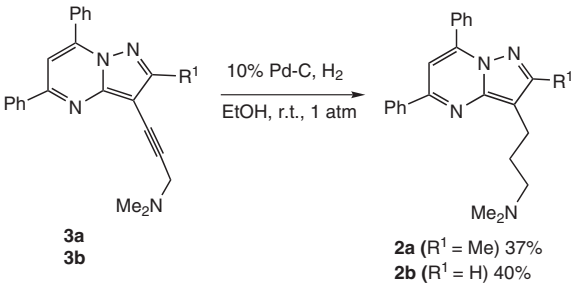
Table 2 3-Alkynylpyrazolo[1,5]pyrimidines **3a–k**

Product	R_1	R_2	R_3	n, X	Mp (°C)	Yield (%)
3a	H	Ph	Ph	1, NMe_2	102–103	91
3b	Me	Ph	Ph	1, NMe_2	109–111	76
3c	Ph	Me	Ph	1, NMe_2	152–154	70
3d	Ph	Me	*p*-Cl-Ph	1, NMe_2	177–178	54
3e	*p*-Cl-Ph	Me	Ph	1, NMe_2	80–82	69
3f	H	Ph	Ph	1, OH	152–154	78
3g	Ph	Me	Ph	1, OH	85–86	72
3h	Ph	Me	Ph	2, OH	182–183	71
3i	H	Ph	Ph	2, OH	132–133	75
3j	Me	Ph	Ph	2, OH	128–129	70
3k	Ph	Me	Ph	2, OTs	158–159	18[a]

[a] +36% **6**.



Scheme 3



Scheme 4

yl)pyrazolo[1,5-*a*]pyrimidines **3a**,**b** (X = NMe_2, n = 1) could be reduced to 3-(3-dimethylaminopropyl)pyrazolo[1,5-*a*]pyrimidines **2a**,**c**, which are now being investigated as phosphatase inhibitors.

All cross-coupling reactions were carried out under Ar in oven-dried glassware. Solvents were dried and deoxygenated by standard procedures. All starting materials were commercially available except for compounds **4a–c** which were prepared according to literature procedures.[11] TLC analysis was performed on Merck silica gel 60F254 plate or Merck Al_2O_3 $60F_{254}$ neutral (Typ E) plates and visualized with UV illumination. Column chromatography was conducted using Merck silica gel 60 (400–639 mesh) or Merck neutral Al_2O_3 gel (90 standard). Melting points were determined on a Boetius hot-stage apparatus and are uncorrected. ^{1}H NMR and ^{13}C NMR spectra were recorded at 300 MHz and 75.5 MHz, respectively, on a Bruker AC-300 in $CDCl_3$ with TMS as internal standard. Mass spectra were measured at 70 eV.

3-Alkynylpyrazolo[1,5-*a*]pyrimidines 3a–k by Sonogashira Coupling; General Procedure

A 25 mL Schlenk flask was charged with 3-iodopyrazolo[1,5-*a*]pyrimidine **4a–e** (0.5 mmol), K_2CO_3 (166 mg, 1.2 mmol), CuI (10 mg, 0.05 mmol,), 10% Pd-C (22 mg, 0.02 mmol), and PPh_3 (21 mg, 0.08 mmol) in dimethoxyethane (DME, 5 mL) and H_2O (5 mL). Ar was passed through the flask 3 times and the mixture was stirred at 25 °C for 0.5 h. Then the alkyne **5** (0.6 mmol) was added. After refluxing under Ar for 24 h the mixture was cooled to 25 °C and filtered through a pad of Celite. After washing with EtOAc, the combined crude solution was washed with H_2O (30 mL) twice. The organic layer was dried with anhyd $MgSO_4$, concentrated in vacuo, and the residue was purified by flash chromatography on silica gel, eluting with EtOAc–MeOH (1:0 → 6:1) for products **3a–e**, and with hexane–EtOAc (1:1 → 0:1) for products **3f–k**. ^{1}H NMR and ^{13}C NMR data for compounds **3a–k** are shown in Table 3.

3-(But-3-en-1-ynyl)-5-methyl-2,7-diphenylpyrazolo[1,5-*a*]pyrimidine (6)

The crude product was purified by flash chromatography on silica, eluting with cyclohexane–EtOAc (4:1 → 2:1) affording a yellow solid in 36% yield; mp 186–188 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.71 (s, 3 H, CH_3), 5.53 (dd, J_1 = 11.3 Hz, J_2 = 2.3 Hz, 1 H, CH=CH_2), 5.77 (dd, J_1 = 17.9 Hz, J_2 = 2.3 Hz, 1 H, CH=CH_2), 6.19 (dd, J_1 = 17.9 Hz, J_2 = 11.3 Hz, 1 H, CH=CH_2), 6.85 (s, 1 H, H-6), 7.40–7.58 (m, 6 H, Ph-H), 8.11 (m, 2 H, Ph-H), 8.29 (m, 2 H, Ph-H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 25.0 (CH_3), 81.7 (C), 90.3 (C), 93.9 (C), 109.6 [CH(C-6)], 117.9 [CH(CH=)], 125.6 [CH_2(=CH_2)], 127.8 (CH), 128.4 (CH), 128.6 (CH), 129.2 (CH), 129.5 (CH), 130.5 (C), 131.2 (CH), 132.5 (C), 146.1 (C), 151.3 (C), 155.5 (C), 160.3 (C).

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Table 3 Spectroscopic Data of 3-Alkynylpyrazolo[1,5]pyrimidines **3**[a]

Product	^{1}H NMR ($CDCl_3$): δ (ppm), *J* (Hz)	^{13}C NMR ($CDCl_3$): δ (ppm)
3a	2.41 (s, 6 H, 2 × CH_3), 3.58 (s, 2 H, CH_2), 7.32 (s, 1 H, H-6), 7.43–8.13 (m, 10 H, Ph-H), 8.15 (s, 1 H, H-2).	44.2 (CH_3), 49.0 (CH_2), 76.2 (C), 87.7 (C), 94.0 (C), 105.9 [CH(H-6)], 127.5 (CH), 128.8 (CH), 128.9 (CH), 129.3 (CH), 129.4 (C), 130.7 (CH),130.9 (C), 131.2 (CH), 136.9 (C), 147.3 [CH(C-2)], 150.1 (C), 157.0 (C).
3b	2.50 (s, 3 H, CH_3), 2.64 (s, 6 H, 2 × CH_3), 3.87 (s, 2 H, CH_2), 7.27 (s, 1 H, H-6), 7.43–7.52 (m, 6 H, Ph-H), 7.96–8.00 (m, 2 H, Ph-H), 8.08–8.11 (m, 2 H, Ph-H).	13.9 (CH_3), 42.9 (CH_3), 48.6 (CH_2), 85.3 (C), 92.1 (C), 105.6 [CH(C-6)], 127.4 (CH), 128.7 (CH), 128.9 (CH), 129.3 (CH), 130.7 (CH), 130.9 (C), 131.3 (CH), 136.9 (C), 146.9 (C), 150.9 (C), 157.1 (C), 157.7 (C).
3c[b]	2.44 (s, 6 H, 2 × CH_3), 2.63 (s, 3 H, CH_3), 3.70 (s, 2 H, CH_2), 6.77 (s, 1 H, H-6), 7.35–7.51 (m, 6 H, Ph-H), 8.04 (m, 2 H, Ph-H), 8.21 (m, 2 H, Ph-H).	25.0 (CH_3), 43.9 (CH_3), 49.2 (CH_2), 77.9 (C), 88.8 (C), 89.9 (C), 109.5 [CH(H-6)], 127.8 (CH), 128.4 (CH), 128.6 (CH), 129.2 (CH), 129.5 (CH), 130.5 (C), 131.2 (CH), 132.5 (C), 146.1 (C), 151.8 (C), 155.6 (C), 160.2 (C).
3d	2.44 (s, 6 H, 2 × CH_3), 2.71 (s, 3 H, CH_3), 3.68 (s, 2 H, CH_2), 6.84 (s, 1 H, H-6), 7.40–7.59 (m, 5 H, Ph-H), 8.09 (m, 2 H, Ph-H), 8.26 (m, 2 H, Ph-H).	25.0 (CH_3), 44.4 (CH_3), 49.3 (CH_2), 76.5 (C), 90.3 (C), 90.7 (C), 109.6 [CH(H-6)], 128.6 (CH), 128.6 (CH), 129.0 (CH), 129.4 (CH), 130.5 (C), 131.2 (C), 131.2 (CH), 134.9 (C), 146.0 (C), 151.7 (C), 154.2 (C), 160.2 (C).
3e	2.50 (s, 6 H, 2 × CH_3), 2.68 (s, 3 H, CH_3), 3.79 (s, 2 H, CH_2), 6.81 (s, 1 H, H-6), 7.43–7.54 (m, 5 H, Ph-H), 8.06 (m, 2 H, Ph-H), 8.26 (m, 2 H, Ph-H).	24.9 (CH_3), 43.1 (CH_3), 48.3 (CH_2), 77.9 (C), 88.4 (C), 90.0 (C), 109.3 [CH(H-6)], 127.7 (CH), 128.5 (CH), 128.9 (CH), 129.3 (CH), 130.7 (C), 130.8 (CH), 132.3 (C), 137.3 (C), 144.8 (C), 151.7 (C), 155.6 (C), 160.2 (C).
3f	4.58 (s, 2 H, CH_2), 7.37 (s, 1 H, H-6), 7.50–7.61 (m, 6 H, Ph-H), 8.01 (m, 2 H, Ph-H), 8.17 (m, 2 H, Ph-H), 8.22 (s, 1 H, H-2).	52.0 (CH_2), 76.1 (C), 91.5 (C), 93.5 (C), 106.1 [CH(H-6)], 127.6 (CH), 128.8 (CH), 128.9 (CH), 129.3 (CH), 130.8 (CH), 131.3 (CH), 136.8 (C), 147.5 [CH(C-2)], 150.0 (C), 157.5 (C).
3g	2.56 (s, 3 H, CH_3), 4.56 (s, 2 H, CH_2), 6.67 (s, 1 H, H-6), 7.33–7.48 (m, 6 H, Ph-H), 7.96 (m, 2 H, Ph-H), 8.15 (m, 2 H, Ph-H).	24.8 (CH_3), 51.9 (CH_2), 77.2 (C), 89. 6 (C), 93.6 (C), 109.5 [CH(H-6)], 127.6 (CH), 128.4 (CH), 128.6 (CH), 129.2 (CH), 129.5 (CH), 130.4 (C), 131.2 (CH), 132.3 (C), 146.1 (C), 151.6 (C), 155.2 (C), 160.3 (C).
3h	2.66 (s, 3 H, CH_3), 2.86 (t, *J* = 6.4 Hz, 2 H, CH_2), 3.91(t, *J* = 6.4 Hz, 2 H, CH_2), 7.06 (s, 1 H, H-6), 7.31–7.44 (m, 6 H, Ph-H), 8.05 (m, 2 H, Ph-H), 8.22 (m, 2 H, Ph-H).	24.7 (CH_2), 24.9 (CH_3), 61.2 (CH_2), 74.3 (C), 91.5 (C), 92.4 (C), 106.1 [CH(C-6)], 127.5 (CH), 127.6 (CH), 128.5 (CH), 128.9 (CH), 129.1 (CH), 130.5 (CH), 132.7 (C), 137.0 (C), 146.2 (C), 150.7 (C), 155.5 (C), 156.5 (C).
3i	2.74 (t, *J* = 6.4 Hz, 2 H, CH_2), 3.80 (t, *J* = 5.7 Hz, 2 H, CH_2), 7.30 (s, 1 H, H-6), 7.44–7.52 (m, 6 H, Ph-H), 7.94 (m, 2 H, Ph-H), 8.10 (m, 2 H, Ph-H), 8.13 (s, 1 H, H-2).	24.4 (CH_2), 61.2 (CH_2), 72.8 (C), 90.3 C, 94.3 (C), 105.9 [CH(C-6)], 127.5 (CH), 128.8 (CH), 129.0 (CH), 129.3 (CH), 130.7 (CH), 130.9 (C), 131.2 (CH), 136.9 (C), 147.2 [CH(C-2)], 147.4 (C), 150.0 (C), 157.1 (C).
3j	2.56 (s, 3 H, CH_3), 2.84 (t, *J* = 6.4 Hz, 2 H, CH_2), 3.88 (t, *J* = 5.8 Hz, 2 H, CH_2), 7.29 (s, 1 H, H-6), 7.50–7.60 (m, 6 H, Ph-H), 8.06 (m, 2 H, Ph-H), 8.18 (m, 2 H, Ph-H).	13.7 (CH_3), 24.5 (CH_2), 61.3 (CH_2), 73.1 (C), 91.6 (C), 93.4 (C), 105.3 [CH(C-6)], 127.5 (CH), 128.7 (CH), 128.9 (CH), 129.3 (CH), 130.5 (CH), 131.0 (C), 131.2 (CH), 137.1 (C), 146.7 (C), 150.4 (C), 156.7 (C), 157.3 (C).
3k	2.36 (s, 3 H, CH_3), 2.67 (s, 3 H, CH_3), 2.95 (t, *J* = 7.1 Hz, 2 H, CH_2), 4.26 (t, *J* = 7.1 Hz, 2 H, CH_2), 6.81 (s, 1 H, H-6), 7.25 (d, *J* = 8.3 Hz, 2 H, Ph-H), 7.42–7.45 (m, 6 H, Ph-H), 7.79 (d, *J* = 8.3 Hz, 2 H, Ph-H), 8.09 (m, 2 H, Ph-H), 8.24 (m, 2 H, Ph-H).	14.2 (CH_3), 21.2 (CH_2), 24.9 (CH_3), 68.0 (CH_2), 74.3 (C), 89.3 (C), 89.8 (C), 109.4 [CH(C-6)], 127.6 (CH), 127.9 (CH), 128.5 (CH), 128.6 (CH), 129.2 (CH), 129.5 (CH), 129.8 (CH), 130.4 (C), 131.2 (CH), 132.4 (C), 132.8 (C), 144.9 (C), 146.0 (C), 151.5 (C), 155.5 (C), 160.2 (C).

[a] Satisfactory microanalyses obtained: C, ± 0.28; H, ± 0.23; N, ± 0.29.
[b] HRMS (EI): *m/z* [M^+] calcd for $C_{24}H_{22}IN_4$: 366.18445; found: 366.18447.

Anal. Calcd for $C_{23}H_{17}N_3$ (335.40): C, 82.32; H, 5.11; N, 12.53. Found: C, 82.07; H, 5.30; N, 12.28.

2-[4-(3-Aminophenyl)-1,3-butadiynyl]phenylamine (7)

The crude product was purified by flash chromatography on silica gel, eluting with cyclohexane–EtOAc (3:1 → 1:1) to afford a grey-green solid; yield: 100%; mp 124–125 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.70 (br s, 4 H, 2 × NH_2), 6.69 (m, 2 H, Ph-H), 6.81 (t, *J* = 1.9 Hz, 2 H, Ph-H), 6.93 (dt, J_1 = 7.5 Hz, J_2 = 1.2 Hz, 2 H, Ph-H), 7.11 (t, *J* = 7.9 Hz, 2 H, Ph-H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 73.4 (C), 81.7 (C), 116.3 (CH), 118.4 (CH), 122.4 [C(C-3)], 123.0 (CH), 129.4 (CH), 146.3 [C(C-1)].

Anal. Calcd for $C_{16}H_{12}N_2$ (232.28): C, 82.73; H, 5.21; N, 12.06. Found: C, 82.84; H, 5.40; N, 12.01.

3-(3-Dimethylaminopropyl)pyrazolo[1,5-*a*]pyrimidines 2a,b: General Procedure

A 25 mL Schlenk flask was charged with **3a** or **3b** (0.3 mmol), 10% Pd-C (67 mg, 0.06 mmol, 0.2 equiv) and EtOH (15 mL). The mixture was stirred under H_2 at atmospheric pressure (balloon) and r.t.

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for 16 h. It was filtered through a pad of Celite, washed with EtOAc. The solvent was evaporated and the residue was purified by flash chromatography on standard neutral Al_2O_3, eluting with EtOAc–MeOH (1:0 → 10:1) to give the product **2a**,**2b**.

***N*,*N*-Dimethyl-*N*-[3-(2-methyl-5,7-diphenylpyrazolo[1,5-*a*]pyrimidin-3-yl)propyl]amine (2a)**
Yield: 37%; yellow solid; mp 72–74 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.95–2.06 (m, 2 H, CH_2), 2.28 (s, 6 H, 2 × CH_3), 2.44 (t, *J* = 7.5 Hz, 2 H, CH_2), 2.95 (t, *J* = 7.9 Hz, 2 H, CH_2), 7.31 (s, 1 H, H-6), 7.50–8.05 (m, 10 H, Ph-H), 8.07 (s, 1 H, H-2).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.0 (CH_2), 28.3 (CH_2), 45.5 (CH_3), 59.4 (CH_2), 104.7 [CH(C-6)], 110.8 (C), 127.2 (CH), 128.7 (CH), 128.9 (CH), 129.2 (CH), 130.1 (CH), 130.8 (CH), 131.7 (C), 137.7 (C), 144.5 (CH), 146.5 (C), 147.1 (C), 154.5 (C).

Anal. Calcd for $C_{23}H_{24}N_4$ (356.46): C, 77.50; H, 6.79; N, 15.72. Found: C, 77.62; H, 6.95; N, 15.48.

***N*,*N*-Dimethyl-*N*-[3-(5,7-diphenylpyrazolo[1,5-*a*]pyrimidin-3-yl)propyl]amine (2b)**
Yield: 40%; yellow solid; mp 93–94 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.82–1.91 (m, 2 H, CH_2), 2.18 (s, 6 H, CH_3), 2.32 (t, *J* = 7.5 Hz, 2 H, CH_2), 2.40 (s, 3 H, CH_3), 2.81 (t, *J* = 7.5 Hz, 2 H, CH_2), 7.13 (s, 1 H, H-6), 7.40–7.49 (m, 6 H, Ph-H), 7.99–8.02 (m, 2 H, Ph-H), 8.06–8.09 (m, 2 H, Ph-H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.2 (CH_3), 20.6 (CH_2), 28.3 (CH_2), 45.6 (CH_3), 59.6 (CH_2), 103.8 [CH (C-6)], 108.3 (C), 127.1 (CH), 128.7 (CH), 128.8 (CH), 129.2 (CH), 129.9 (CH), 130.7 (CH), 131.9 (C), 137.9 (C), 145.7 (C), 147.9 (C), 153.6 (C), 154.2 (C).

Anal**.** Calcd for $C_{24}H_{26}N_4$ (370.49): C, 77.80; H, 7.07; N, 15.12. Found: C, 77.92; H, 7.14; N, 15.07.

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