Reaction of 5-Aminopyrazoles with β-Dimethylaminopropiophenones. Synthesis of New Pyrazolo[3,4-*b*]pyridines

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Several new pyrazolo[3,4-*b*]pyridines were obtained from the reaction of 5-amino-1-aryl-3-methylpyrazoles **1** with β-dimethylaminopropiophenones **2** in pyridine. The structure elucidation of 4,5-dihydropyrazolo[3,4-*b*]pyridines **3** is based on nmr measurements and X-ray diffraction. The treatment of compounds **3** with *N*-bromosuccinimide led to the formation of pyrazolo[3,4-*b*]pyridines **4**.

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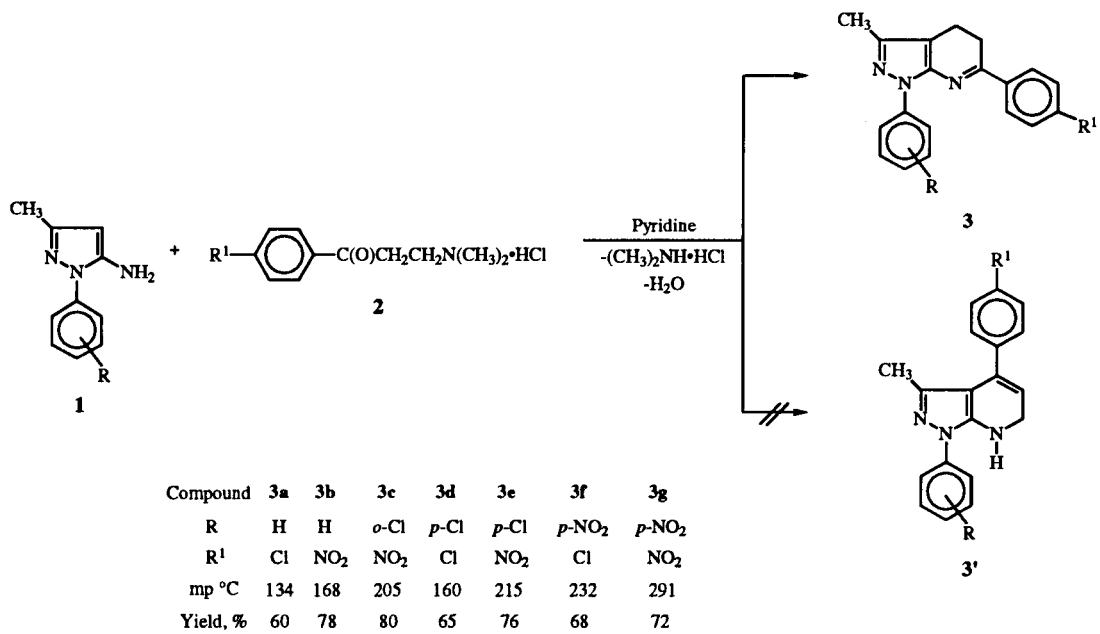
Interest in the synthesis of condensed pyrazoles has recentely revived [1-3] because of the wide variety of their biological and pharmacological properties [4,5].

Continuing with our research on the reaction of aminoazoles with α,β-unsaturated compounds and their precursors, such as β-dimethylaminopropiophenones [6-10], in the present work we report the synthesis of several new pyrazolo[3,4-*b*]pyridines *via* the reaction of 5-amino-1-aryl-3-methylpyrazoles **1** with β-dimethylaminopropiophenones **2**. This work has resulted in the development of a new direct and simple synthetic entry into the pyrazolo[3,4-*b*]pyridine ring system. We have found that 5-aminopyrazoles **1** react with β-dimethylaminopropiophenones hydrochloride (**2**) in refluxing pyridine to yield a product of condensation *via* elimination of water and dimethylamine hydrochloride. These products can thus be formulated as **3** or the isomeric **3'**.

Addition of aryl vinyl ketone, resulting from elimination of dimethylamine hydrochloride from **2**, to the 4-C atom of the pyrazole ring and subsequent cyclization with water elimination gives **3**. On the other hand, addition of an exocyclic amino group to the β-C atom of an aryl vinyl ketone followed by cyclization can afford **3'**.

Scheme 1



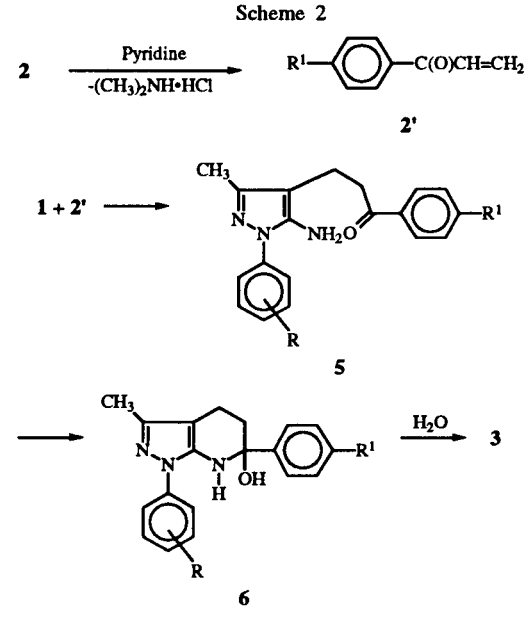
Compound	3a	3b	3c	3d	3e	3f	3g
R	H	H	*o*-Cl	*p*-Cl	*p*-Cl	*p*-NO_2	*p*-NO_2
R^1	Cl	NO_2	NO_2	Cl	NO_2	Cl	NO_2
mp °C	134	168	205	160	215	232	291
Yield, %	60	78	80	65	76	68	72

β-Aminopropiophenones are relatively unstable in basic medium and easily lose the amino group forming aryl vinyl ketones [11,12]. We assume, for the initial step, a Michael addition of **2** to the C=C bond of an aryl vinyl ketone **2'** (Scheme 2). The aminopyrazole reacts with compounds **2'** to generate intermediates **5**, which then undergoes cyclization to form compounds **6**, which loses one molecule of water to produce compounds **3**.

The structures of compounds **3a-g** were established by ^{1}H- and ^{13}C-nmr measurements. Tables 1 and 2 summarize the ^{1}H and ^{13}C chemical shifts. The assignment of the signals was supported by ^{1}H,^{1}H COSY and ^{1}H,^{13}C shift correlation spectra. The protons of the pyridine ring show a typical A_2B_2 pattern for the building block 4-CH_2—5-CH_2, which could be easily characterized by vicinal couplings (^{3}J = 7.8 ±0.2Hz), which is consistent with structures **3a-g**, ruling out an NH function and hence eliminating the structures **3'**.

An unambiguous structure proof was achieved by an examination of the crystal structure of **3a** (Table 3). Figure 1 shows the X-ray crystal structure of compound **3a**; the most important geometric features of this new compound are listed in Tables 4-8. The torsional angles reveal that the annelation of the two rings does not deviate much from planarity.

Scheme 2



The new dihydropyrazolopyridines **3** are smoothly oxidized to compounds **4** by treatment with *N*-bromosuccinimide in ethanol. Compounds **4b**, **4d** and **4e** were isolated in preparative experiments in high yields (Scheme 3).

Table 1

^{1}H-NMR Data for **3a-g** [a]

Compound	CH_3 s	4-H t	5-H t	1-Aryl m	6-aryl m
3a	2.22	2.70	3.01	7.50-7.63	7.89-8.08
3b	2.20	2.78	3.07	7.43-7.85	8.05-8.25
3c	2.20	2.79	3.08	7.40-7.88	8.08-8.26
3d	2.19	2.71	3.00	7.51-7.60	7.91-8.06
3e	2.20	2.74	3.06	7.52-7.92	8.22-8.30
3f	2.30	2.79	3.08	8.02-8.19	8.20-8.34
3g	2.33	2.81	3.07	8.01-8.25	8.19-8.30

[a] Values (δ) in tetramethylsilane.

Table 2

^{13}C-NMR Data of **3a-g** [a]

Compound	**3a**	**3b**	**3c**	**3d**	**3e**	**3f**	**3g**
CH_3	11.9	12.0	11.8	11.8	11.8	11.9	11.8
C-3a	103.7	104.2	102.3	103.9	104.4	104.5	104.3
C-4	15.4	15.4	15.3	15.3	15.2	15.3	15.2
C-5	24.4	24.7	24.9	24.4	24.6	24.6	24.5
CH-aromatic	121.4, 125.7, 128.6, 128.9, 129.0	121.7, 123.6, 126.1, 128.5, 129.1	123.1, 124.2, 128.2, 128.9	122.7, 128.6, 128.8, 129.0	122.8, 123.6, 128.4, 128.9	122.7, 127.5, 128.3, 128.9	123.0, 127.4, 128.2, 129.1
Cq	131.0, 135.7, 136.6, 144.5, 145.8, 165.9	129.7, 138.9, 143.7, 144.8, 148.5, 165.3	130.2, 136.7, 144.4, 145.7, 146.3, 148.9, 165.8	129.8, 135.8, 136.5, 137.9, 144.9, 145.9, 166.2	130.0, 137.7, 143.4, 145.1, 145.7, 148.5, 165.5	131.0, 137.3, 144.0, 145.5, 146.0, 148.6, 166.0	130.8, 137.5, 143.8, 145.7, 146.6, 148.4, 165.5

[a] Values (δ) in tetramethylsilane as the internal standard in dimehtyl-d_6 sulfoxide at 400 MHx.

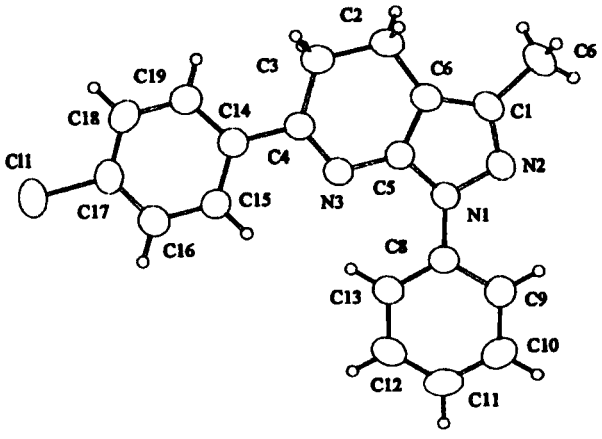


Figure 1. ORTEP drawing for **3a**.

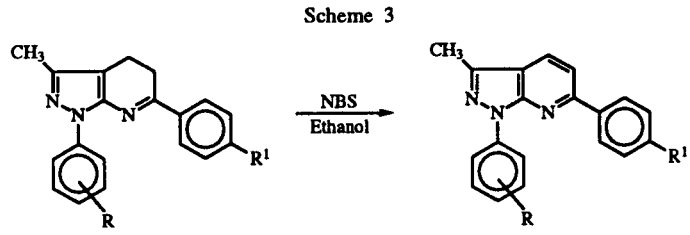
The nmr-spectra of compounds **4b**, **4d** and **4e** exhibit disappearance of the proton signals of the $-CH_2-CH_2-$ fragment and the appearance of two new signals at δ = 7.80-7.91 and 8.31-8.36 ppm, corresponding to the 4-H and 5-H protons of the aromatized pyridine ring respectively.

Table 3

Crystal Data, Details of Data-collection and Structure Refinement

Crystal Data	
$C_{19}H_{16}ClN_3$	Mo K_α radiation
M_r = 321.80	λ = 0.71073(Å)
Monoclinic	cell parameters from 25 reflections
P21/c	θ = 9.80-18.10°
a = 8.1126(4) (Å)	μ = 0.241 mm^{-1}
b = 17.3147(6) (Å)	T = 295 K
c = 11.7894(5) Å	Transparent prisms
β = 104.774(4)°	0.15 x 0.15 x 0.10 mm
V= 1601.52(12)	Colourless
Z = 4	D_x = 1.335 (Mg m^{-3})
Data collection	
Nonius CAD-4 diffractometer	R_{int} = 0.0135
ω/2θ scans	θ_{max} = 26.29°
Absorption correction: none	h = -10→0
3249 measured reflections	k = -21→0
	l = -14→14
2494 observed reflections	3 standard reflections: -2 -7 -1; -2 -2 6; 3 -5 0
Criterion used [I> 2σ(I)]	frequency: 120 minutes intensify variation: 1.0%
Refinement	
Refinement on F^2	$(\Delta/\rho)_{max}$ < 0.001
R(F) = 0.0414	$\Delta\rho_{max}$ = 0.175 e (Å)^3
$wR(F^2)$ = 0.1364	$\Delta\rho_{min}$ = -0.338 e (Å)3
Goodness of fit S = 1.200	Atomic scattering factors from
209 refined parameters	International Tables for X-ray
H-atom parameters not refined	Crystallography (1974, Vol IV,
$w= 1/[\sigma^2 (F_o^2)+ (0.100P)^2]$	Table 2.2B)
where $P = (F_o^2 + 2F_c^2)/3$	

Scheme 3



3b,d,e **4b,d,e**

Compound	4b	4d	4e
R	H	*p*-Cl	*p*-Cl
R^1	NO_2	Cl	NO_2
mp °C	180	195	247
Yield, %	65	70	65

Table 4

Fractional Coordinates of Non-hydrogen Atoms and Isotropic Temperature Factors with Estimated Deviation in Parentheses

$Ueq= (1/3)\Sigma_i\Sigma_j U_{ij}\, a_i^* a_j^*\, a_i\, a_j$

	X	Y	Z	Ueq
Cl1	0.09960(9)	0.15216(4)	0.61127(5)	0.0685(2)
N1	-0.2425(2)	-0.08571(8)	-0.08672(12)	0.0407(4)
N2	-0.3405(2)	-0.08889(9)	-0.20042(13)	0.0454(4)
N3	-0.1745(2)	0.00693(9)	0.07395(13)	0.0435(4)
C1	-0.4124(2)	-0.01943(12)	-0.2216(2)	0.0458(5)
C2	-0.4020(3)	0.11071(12)	-0.0980(2)	0.0561(6)
C3	-0.3491(3)	0.12656(11)	0.0324(2)	0.0501(5)
C4	-0.2175(2)	0.07338(10)	0.1074(2)	0.0402(4)
C5	-0.2569(2)	-0.01443(10)	-0.0395(2)	0.0403(4)
C6	-0.3652(2)	0.02881(11)	-0.1241(2)	0.0432(4)
C7	-0.5282(3)	-0.00217(14)	-0.3393(2)	0.0623(6)
C8	-0.1453(2)	-0.15171(10)	-0.0384(2)	0.0401(4)
C9	-0.1178(3)	-0.20857(11)	-0.1141(2)	0.0479(5)
C10	-0.0225(3)	-0.27321(12)	-0.0686(2)	0.0591(6)
C11	0 0442(3)	-0.28143(12)	0.0505(2)	0.0573(6)
C12	0.0160(3)	-0.22535(12)	0.1247(2)	0.0539(5)
C13	-0.0794(3)	-0.15985(11)	0.0816(2)	0.0487(5)
C14	-0.1367(2)	0.09561(10)	0.2306(2)	0 0418(4)
C1S	-0.0027(3)	0.05180(11)	0.2975(2)	0.0460(5)
C16	0.0712(3)	0.06919(12)	0.4133(2)	0.0520(5)
C17	0.0106(3)	0.13129(12)	0.4641(2)	0.0489(5)
C18	-0.1204(3)	0.17597(13)	0.4006(2)	0.0578(5)
C19	-0.1935(3)	0.15835(12)	0.2840(2)	0.0552(5)

Table 5

Interatomic Distances (Å) with Estimated Standart Deviations in Parentheses

C11—C17	1.739(4)	C8—C13	1.387(3)
N1—C5	1.371(2)	C9—C10	1.388(3)
N1—N2	1.375(4)	C9—H9	0.93
N1—C8	1.423(3)	C10—C11	1.378(4)
N2—C1	1.332(3)	C10—H10	0.93
N3—C4	1.293(2)	C11—C12	1.365(3)
N3—C5	1.385(4)	C11—H11	0.93
C1—C6	1.393(3)	C12—C13	1.394(3)
C1—C7	1.495(4)	C12—H12	0.93
C2—C6	1.497(3)	C13—H13	0.93
C2—C3	1.512(3)	C14—C19	1.392(3)
C2—H21	0.97	C14—C15	1.394(4)
C2—H22	0.97	C15—C16	1.378(4)

Table 5 (continued)

C3—C4	1.513(4)	C15—H15	0.93
C3—H31	0.97	C16—C17	1.381(3)
C3—H32	0.97	C16—H16	0.93
C4—C14	1.484(4)	C17—C18	1.373(4)
C5—C6	1.372(4)	C18—C19	1.385(4)
C7—H71	0.96	C18—H18	0.93
C7—H72	0.96	C19—H19	0.93
1C7—H73	0.96	C8—C9	1.384(3)

Table 6

Bond Angles (Degrees) with Estimated Standard Deviations in Parentheses

C5—N1—N2	110.10(14)	C9—C8—C13	120.1(2)
C5—N1—C8	131.0(2)	C9—C8—N1	118.5(2)
N2—N1—C8	118.8(2)	C13—C8—N1	121.4(2)
C1—N2—N1	105.3(2)	C8—C9—C10	119.4(2)
C4—N3—C5	115.5(2)	C11—C10—C9	120.8(2)
N2—C1—C7	119 8(2)	C11—C12—C13	120.8(2)
C6—C1—C7	128.4(2)	C8—C13—C12	119.3(2)
C6—C2—C3	111.2(2)	C19—C14—C15	117.9(2)
C2—C3—C4	117.3(2)	C19—C14—C4	122.1(2)
N3—C4—C14	116 3(2)	C19—C14—C4	120.0(2)
C14—C4—C3	119.0(2)	C15—C16—C17	121.5(2)
N1—C5—N3	124.2(2)	C18—C17—C16	120.9(2)
C5—C6—C1	105.3(2)	C16—C17—C11	119.4(2)
C5—C6—C2	119.5(2)	C17—C18—C19	119.6(3)
C1—C6—C2	135.3(2)	C18—C19—C14	120.9(2)

Table 7

Torsion Angles (Degrees)

C5—N1—N2—C1	0.5(2)	N2—N1—C8—C9	16.3(2)
C8—N1—N2—C1	-178.7(2)	C5—N1—C8—C13	17.6(3)
N1—N2—C1—C6	-0.6(2)	N2—N1—C8—C13	-163.5(2)
N1—N2—C1—C7	179.6(2)	C13—C8—C9—C10	-0.6(3)
C6—C2—C3—C4	21.7(3)	N1—C8—C9—C10	179.6(2)
C5—N3—C4—C14	177.2(2)	C8—C9—C10—C11	0.2(3)
C5—N3—C4—C3	0.6(3)	C9—C10—C11—C12	0.1(3)
C2—C3—C4—N3	-15.7(3)	C10—C11—C12—C13	0.0(3)
C2—C3—C4—C14	167.9(2)	C9—C8—C10—C12	0.7(3)
N2—N1—C5—C6	-0.2(2)	N1—C8—C13—C12	-179.6(2)
C8—N1—C5—C6	178.9(2)	C11—C12—C13—C8	-0.4(3)
N2—N1—C5—N3	179.6(2)	N3—C4—C14—C19	-168.2(2)
C8—N1—C5—N3	-1.4(3)	C3— C4—C14—C19	8.6(3)
C4—N3—C5—N1	-172.8(2)	N3—C4—C14—C15	9.9(3)
C4—N3—C5—C6	6.9(3)	C3—C4—C14—C15	-173.3(2)
N1—C5—C6—C1	-0.2(2)	C19—C14—C15—C16	0.5(3)
N3—C5—C6—C1	-180.0(2)	C4—C14—C15—C16	-177.7(2)
N1—C5—C6—C2	-178.6(2)	C14—C15—C16—C17	0.2(3)
N3—C5—C6—C2	1.7(3)	C15—C16—C17— C18	-0.7(3)
N2—C1—C6—C5	0.5(2)	C15—C16—C17—C11	178.4(2)
C7—C1—C6—C5	-179.7(2)	C16—C17—C18—C19	0.3(3)
N2—C1—C6—C2	178.5(2)	C11—C17—C18—C19	-178.7(2)
C7—C1—C6—C2	-1.7(4)	C17—C18—C19—C14	0.4(4)
C3—C2—C6—C5	-15.8(3)	C15—C14—C19—C18	-0.8(3)
C3—C2—C6—C1	166.4(2)	C4—C14—C19—C18	177.3(2)
C5—N1—C8—C9	-162.7(2)		

Table 8

Anisotropic Thermal Parameters (Å²)

C11	0.0857(5)	0.0679(4)	0.0454(3)	-0.0123(2)	0.0050(3)	-0.0028(3)
N1	0.0412(8)	0.0417(8)	0.0366(7)	-0.0001(6)	0.0053(6)	0.0034(6)
N2	0.0504(9)	0.0467(9)	0.0351(8)	-0.0004(6)	0.0037(7)	0.0032(7)
N3	0.0448(9)	0.0401(8)	0.0407(8)	-0.0015(6)	0.0017(6)	0.0044(7)
C1	0.0467(11)	0.0513(11)	0.0362(9)	-0.0058(8)	0.0050(8)	0.0014(8)
C2	0.0676(14)	0.0429(10)	0.0505(11)	0.0042(8)	0.0016(10)	0.0105(10)
C3	0.0510(11)	0.0449(10)	0.0520(11)	0.0023(8)	0.0083(9)	0.0071(9)
C4	0.0396(9)	0.0367(9)	0.0433(9)	0.0023(7)	0.0086(7)	-0.0009(7)
C5	0.0399(9)	0.0393(9)	0.0399(9)	-0.0014(7)	0.0068(7)	0.0009(7)
C6	0.0436(10)	0.0418(10)	0.0420(9)	0.0049(7)	0.0067(8)	0.0018(8)
C7	0.075(2)	0.0650(13)	0.0383(11)	0.0070(10)	-0.0021(10)	0.0066(12)
C8	0.0390(9)	0.0363(9)	0.0444(10)	0.0025(7)	0.0093(7)	0.0011(7)
C9	0.0541(12)	0.0426(10)	0.0455(10)	-0.0039(8)	0.0098(9)	-0.0007(8)
C10	0.0699(15)	0.0435(11)	0.0652(13)	-0.0040(10)	0.0197(11)	0.0086(10)
C11	0.0578(13)	0.0393(10)	0.0739(14)	0.0095(9)	0.0151(11)	0.0106(9)
C12	0.0543(12)	0.0525(12)	0.0505(11)	0.0102(9)	0.0055(9)	0.0056(9)
C13	0.0532(11)	0.0457(10)	0.0443(10)	0.0029(8)	0.0069(8)	0.0080(8)
C14	0.0420(10)	0.0379(9)	0.0450(10)	0.0007(7)	0.0101(8)	-0.0033(7)
C15	0.0473(11)	0.0416(10)	0.0467(10)	0.0038(8)	0.0073(8)	0.0022(8)
C16	0.0538(12)	0.0486(11)	0.0485(11)	-0.0019(8)	0.0041(9)	0.0025(9)
C17	0.0556(12)	0.0470(11)	0.0426(10)	0.0048(8)	0.0097(9)	0.0089(9)
C18	0.0673(14)	0.0507(11)	0.0548(12)	-0.0107(9)	0.0144(10)	0.0088(10)
C19	0.0592(13)	0.0498(11)	0.0521(12)	-0.0044(9)	0.0061(10)	0.0108(9)

EXPERIMENTAL

Melting points were taken on a Büchi melting point apparatus and are uncorrected. Column chromatographic purifications were performed on Merck silica gel (60-200 mesh). The ^1H and ^{13}C nmr spectra were obtained on a Bruker AM 400 in dimethyl-d_6 sulfoxide. The mass spectra were recorded on a Varian MAT 711 and Finnigan M 95 spectrometers operating at 70 eV. Elemental analyses were obtained using LECO CHNS-900 equipment.

Synthesis of 1,6-Diaryl-3-methyl-4,5-dihydropyrazolo-[3,4-*b*]pyridines **3**.

General Procedure.

A solution of 5-amino-1-aryl-3-methylpyrazole **1** (0.5 mmole) and the corresponding β-dimethylaminopropiophenone hydrochloride (**2**) (0.5 mmole) in 2 ml of pyridine was heated to reflux for 15-20 minutes. The cyclized products **3** were isolated by cooling, followed by filtration, washing with ethanol, drying and purification by silica gel chromatography with chloroform as the eluent.

1-Phenyl-6-(4-chlorophenyl)-3-methyl-4,5-dihydropyrazolo-[3,4-*b*]pyridine **3a**.

This compound was obtained according to general procedure described above as pale yellow crystals; ms: m/z: 323/321 (32/100, M+), 320 (12), 319 (16), 284 (10), 250 (11), 149 (14).

Anal. Calcd. for $C_{19}H_{16}N_3Cl$: C, 70.91; H, 5.01; N, 13.06. Found: C, 70.82; H, 5.10; N, 13.13.

1-Phenyl-6-(4-nitrophenyl)-3-methyl-4,5-dihydropyrazolo-[3,4-*b*]pyridine **3b**.

This compound was obtained according to general procedure described above as yellow crystals; ms: m/z: 332 (100, M+), 331 (11), 330 (16), 286 (35), 178 (12).

Anal. Calcd. for $C_{19}H_{16}N_4O_2$: C, 68.66; H, 4.85; N, 16.86. Found: C, 68.55; H, 4.73; N, 16.80.

1-(2-Chlorophenyl)-6-(4-nitrophenyl)-3-methyl-4,5-dihydropyrazolo[3,4-*b*]pyridine **3c**

This compound was obtained according to general procedure described above as yellow crystals; ms: m/z: 368/366 (30/100, M+), 367 (27), 365 (24), 364 (43), 331 (33), 330 (14), 329 (58), 319 (10), 283 (22), 282 (11).

Anal. Calcd. for $C_{19}H_{15}N_4O_2Cl$: C, 62.22; H, 4.12; N, 15.27. Found: C, 62.15; H, 4.03; N, 15.20.

1,6-Bis(4-chlorophenyl)-3-methyl-4,5-dihydropyrazolo-[3,4-*b*]pyridine **3d**.

This compound was obtained according to general procedure described above as pale, yellow crystals; ms: m/z: 359/357/355 (10/61/100, M+), 358 (15), 356 (37), 354 (30), 353 (18), 244 (10), 137 (16), 111 (10).

Anal. Calcd. for $C_{19}H_{15}N_3Cl_2$: C, 64.06; H, 4.24; N, 11.79. Found: C, 64.15; H, 4.13; N, 11.73.

1-(4-Chlorophenyl)-6-(4-nitrophenyl)-3-methyl-4,5-dihydropyrazolo[3,4-*b*]pyridine **3e**.

This compound was obtained according to general procedure described above as yellow crystals; ms: m/z: 368/366 (32/100, M+), 365 (21), 364 (24), 319 (11), 218 (10), 111 (13), 102 (14).

Anal. Calcd. for $C_{19}H_{15}N_4O_2Cl$: C, 62.22; H, 4.12; N, 15.27. Found: C, 62.25; H, 4.20; N, 15.32.

1-(4-Nitrophenyl)-6-(4-chlorophenyl)-3-methyl-4,5-dihydropyrazolo[3,4-*b*]pyridine **3f**.

This compound was obtained according to general procedure described above as pale, yellow crystals; ms: m/z: 368/366 (29/100, M+), 365 (16), 364 (20), 319 (13), 278 (13), 149 (11).

Anal. Calcd. for $C_{19}H_{15}N_4O_2Cl$: C, 62.22; H, 4.12; N, 15.27. Found: C, 62.13; H, 4.06; N, 15.29.

1,6-Bis(4-nitrophenyl)-3-methyl-4,5-dihydropyrazolo-[3,4-*b*]pyridine **3g**.

This compound was obtained according to general procedure described above as yellow crystals; ms: m/z: 377 (100, M+), 376 (13), 375 (17), 331 (25), 289 (10), 149 (12).

Anal. Calcd. for $C_{19}H_{15}N_5O_4$: C, 60.48; H, 4.01; N, 16.96. Found: C, 60.45; H, 4.13; N, 16.83.

Synthesis of 1,6-Diaryl-3-methylpyrazolo[3,4-*b*]pyridine **4**.

General Procedure.

A solution of the respective compound **3** (0.1 mmole) and *N*-bromosuccinimide (0.15 mmole) in 20 ml of absolute ethanol was heated to reflux for 20-30 minutes. The precipitated compounds **4** were allowed to cool, filtered, washed with ethanol, dried and recrystallized from ethanol.

1-Phenyl-6-(4-nitrophenyl)-3-methylpyrazolo[3,4-*b*]pyridine **4b**.

This compound was obtained according to general procedure described above as pale, yellow crystals; ^{1}H-nmr (dimethyl-d_6 sulfoxide): 2.49 (s, 3H, CH_3), 7.90 (d, 1H, 5-H), 8.31 (d, 1H, 4-H), 7.12-8.35 ppm (m, 9H, H-aromatic); ^{13}C-nmr (dimethyl-d_6 sulfoxide): 12.0 (CH_3), 116.3 (C-3a), 115.1 (C-5), 131.4 (C-5); ms: m/z: 330 (12, M+), 279 (23), 168 (13), 167 (41), 150 (13), 149 (100), 113 (15), 112 (15), 71 (23), 57 (32), 43 (24).

Anal. Calcd. for $C_{19}H_{14}N_4O_2$: C, 69.08; H, 4.27; N, 16.96. Found: C, 69.14; H, 4.33; N, 16.89.

1,6-Bis(4-chlorophenyl)-3-methylpyrazolo[3,4-*b*]pyridine **4d**.

This compound was obtained according to general procedure described above as white crystals; ^{1}H-nmr (dimethyl-d_6 sulfoxide): 2.47 (s, 3H, CH_3), 7.91 (d, 1H, 5-H), 8.33 (d, 1H, 4-H), 7.14-8.29 ppm (m, 8H, H-aromatic); ^{13}C-nmr (dimethyl-d_6 sulfoxide): 11.9 (CH_3), 116.5 (C-3a), 114.9 (C-5), 131.0 (C-5); ms: m/z: 357/355/353 (12/59/100, M+), 305 (12), 304 (15), 193 (31), 175 (15).

Anal. Calcd. for $C_{19}H_{13}N_3Cl_2$: C, 64.42; H, 3.70; N, 11.86. Found: C, 64.45; H, 3.68; N, 11.78.

1-(4-Chlorophenyl)-6-(4-nitrophenyl)-3-methylpyrazolo-[3,4-*b*]pyridine **4e**.

This compound was obtained according to general procedure described above as pale, yellow crystals; ^{1}H-nmr (dimethyl-d_6 sulfoxide): 2.51 (s, 3H, CH_3), 7.85 (d, 1H, 5-H), 8.36 (d, 1H, 4-H), 7.25-8.40 ppm (m, 8H, H-aromatic); ^{13}C-nmr (dimethyl-d_6 sulfoxide): 12.1 (CH_3), 116.5 (C-3a), 115.3 (C-5), 130.7 (C-5); ms: m/z: 366/364 (33/100, M+), 318 (15), 242 (10), 140 (10).

Anal. Calcd. for $C_{19}H_{13}N_4O_2Cl$: C, 62.62; H, 3.60; N, 15.38. Found: C, 62.58; H, 3.63; N, 15.42.

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