HETEROCYCLES, Vol. 63, No. 3, 2004, pp. 609 - 629
Received, 19th November, 2003, Accepted, 8th January, 2004, Published online, 16th January, 2004

SYNTHESIS OF 5-SUBSTITUTED ETHYL 3-OXO-2*H*-PYRAZOLO[4,3–*c*]PYRIDINE-7-CARBOXYLATES

David Bevk, Renata Jakše, Amalija Golobič, Ljubo Golič, Anton Meden, Jurij Svete*, and Branko Stanovnik*

Faculty of Chemistry and Chemical Technology, University of Ljubljana, Aškerčeva 5, 1000 Ljubljana, Slovenia

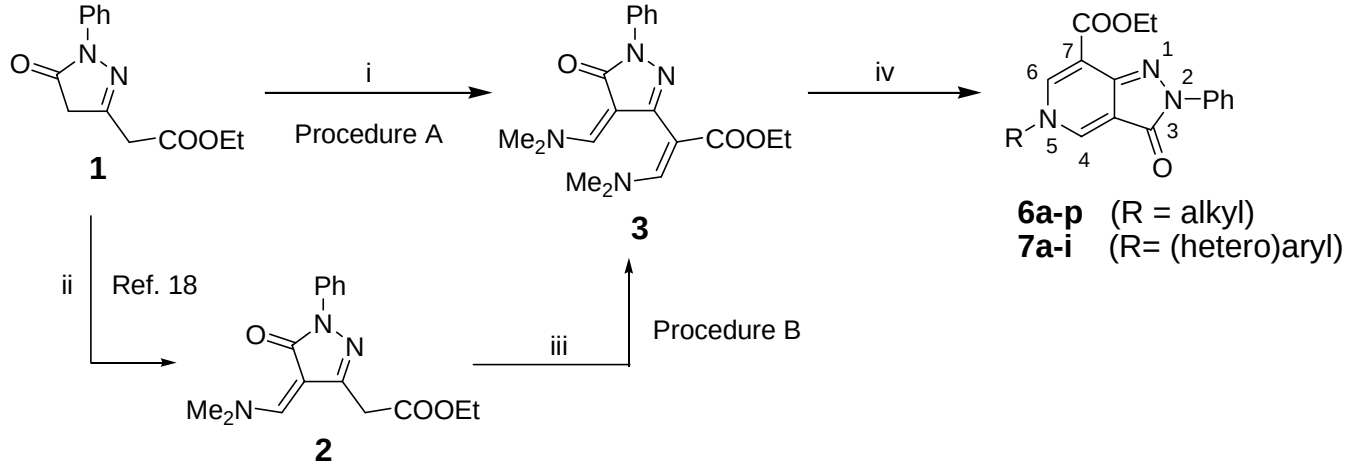
Abstract – Ethyl (2*E*)-3-dimethylamino-2-[(4*Z*)-4-dimethylaminomethylidene-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazol-3-yl]propenoate (**3**) was transformed with *N*-nucleophiles into ethyl 3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylates (**6**, **7**, **9**, **12**, and **14**).

Pyrazolo[4,3–*c*]pyridines and their [3,4–*c*] fused analogs are structurally related to some biologically active purine type heterocycles such as the nucleoside antibiotics formycins[1,2] and the antihyperuricemic drug allopurinol.[3,4] They exhibit interesting pharmacological properties such as antihypertensive,[5] antidepressive,[6] and antitumor activity.[7]

There are only few methods for the preparation of pyrazolo[4,3–*c*]pyridines starting from substituted pyrazoles described in the literature.[8,9] Other methods are based on pyrazolo annelation to the pyridine-type of precursors[7,10–15] and rearrangements of pyrido[4,3–*d*]pyrimidines[16] and isoxazolo[5,4–*b*]pyridines.[17]

Recently, alkyl [(*Z*)-4-dimethylaminomethylidene-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazol-3-yl]acetate (**2**) was transformed with *N*- and *C*-nucleophiles into alkyl 4-(substituted amino)methylidene- and (4-heteroarylmethylidene-4,5-dihydro-1*H*-pyrazol-3-yl)acetates, which have been cyclized with *N*,*N*-dimethylformamide dimethylacetal (DMFDMA) in DMF into 2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylates (**6**).[18] In continuation of our research in the field of applications of alkyl 3-dimethylaminopropenoates and their analogs in heterocyclic synthesis,[19] we describe in this paper the synthesis of ethyl (2*E*)-3-dimethylamino-2-[(4*Z*)-4-dimethylaminomethylidene-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazol-3-yl]propenoate (**3**) and its transformations with primary amines (**4**, **5**, **13**), hydrazines (**8**), and hydroxylamine (**11**) into 2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylates (**6**, **7**, **9**, **12**, **14**).

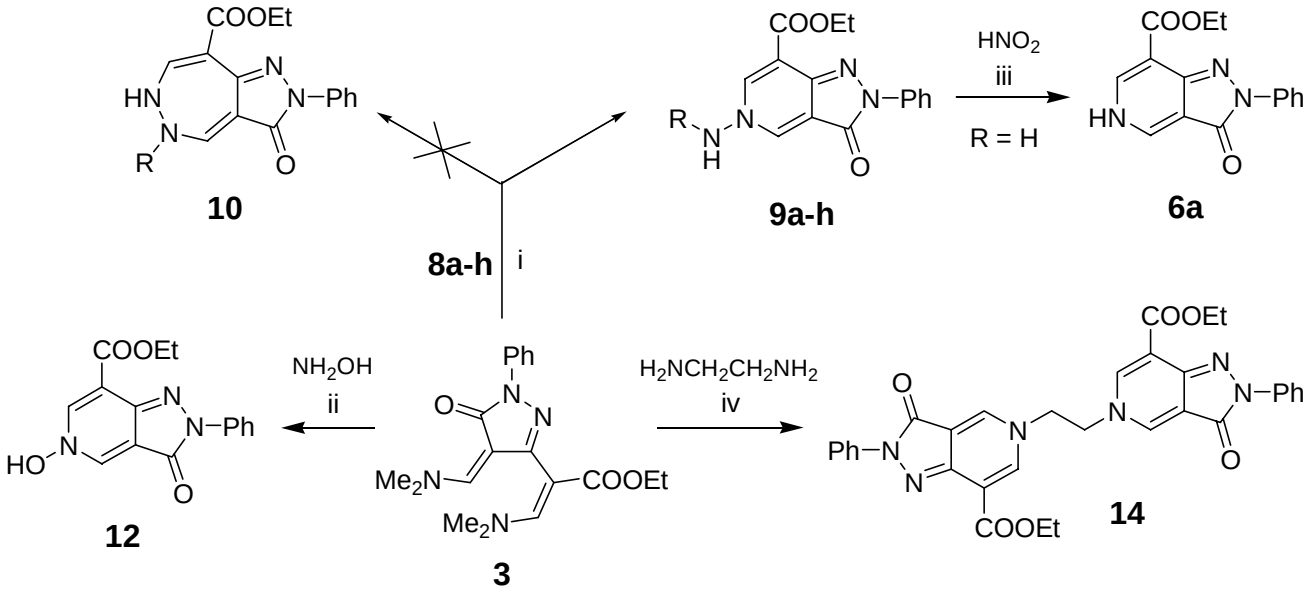
Compound (**3**) was prepared from ethyl 5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazol-3-yl)acetate (**1**) and 2 equivalents of DMFDMA in DMF in 53 % yield (Procedure A). Alternatively, compound (**3**) was also obtained upon treatment of (*Z*)-(4-dimethylaminomethylidene-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazol-3-yl)acetate (**2**)[18] and 1.3 equivalnts of DMFDMA in DMF in 56 % yield (Procedure B). Compound (**3**) was treated with ammonia (**4a**), alkylamines (**4b–p**) and (hetero)arylamines (**5a–i**) in ethanol at room temperature or under reflux to form the corresponding ethyl 3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (**6a**) and its 5-substituted derivatives (**6b-p**, **7a-i**) (Scheme 1).



Reaction	R–NH_2 (**4a–m**)	Reaction	R–NH_2 (**4n–p**, **5a–i**)
3+4a→6a	H	**3+4n→6n**	-TyrOMe (*S*)
3+4b→6b	methyl	**3+4o→6o**	-AlaOEt (*S*)
3+4c→6c	*n*-propyl	**3+4p→6p**	CH_2CN
3+4d→6d	*n*-butyl	**3+5a→7a**	Ph
3+4e→6e	cyclohexyl	**3+5b→7b**	4-methylphenyl
3+4f→6f	benzyl	**3+5c→7c**	4-methoxyphenyl
3+4g→6g	4-methoxybenzyl	**3+5d→7d**	pyrazinyl
3+4h→6h	4-nitrobenzyl	**3+5e→7e**	pyridin-2-yl
3+4i→6i	2-(5-methyl-1*H*-indol-3-yl)ethyl	**3+5f→7f**	quinolin-3-yl
3+4j→6j	1-adamantylmethyl	**3+5g→7g**	1,3-benzothiazol-2-yl
3+4k→6k	$CH_2C{\equiv}CH$	**3+5h→7h**	tetrazol-5-yl
3+4l→6l	CH_2CH_2COOEt	**3+5i→7i**	5-mentylisoxazol-3-yl
3+4m→6m	CH_2COOEt		

Scheme 1. (i) DMFDMA (2 equiv.), DMF, reflux (Procedure A); (ii) DMFDMA, $PhCH_3$, rt; (iii) DMFDMA (1.3 equiv.), DMF, reflux (Procedure B); (iv) R–NH_2 (**4a–p**, **5a–i**), EtOH, rt or reflux.

Treatment of compound (**3**) with monosubstituted hydrazines (**8a–h**) in ethanol at room temperature or under reflux gave 5-amino-substituted pyrazolo[4,3–*c*]pyridine-7-carboxylates (**9a–h**), while with hydroxylamine hydrochloride (**11**) the corresponding 5-hydroxy derivative (**12**) was formed in 82% yield. Nitrosation of **9a** with sodium nitrite in aqueous hydrochloric acid afforded the deamination product (**6a**), identical to that obtained upon treatment of **3** with ammonia. When compound (**3**) was treated with 1,2-ethylenediamine (**13**) in ethanol under reflux for 2 h 1,2-bis(7-ethoxycarbonyl-3,5-dihydro-2*H*-pyrazolo-[4,3–*c*]pyridine-5-yl)ethane (**14**) was isolated in 68% yield (Scheme 2).



Reaction	R	Reaction	R
3+8a→9a	H	**3+8e→9e**	2-Br-C_6H_4-
3+8b→9b	Ph	**3+8f→9f**	2-Cl-C_6H_4-
3+8c→9c	3-MeC_6H_4-	**3+8g→9g**	pyridin-2-yl
3+8d→9d	4-$NO_2C_6H_4$-	**3+8h→9h**	phthalazin-1-yl

Scheme 3. (i) R–$NHNH_2$ (**8a–h**), EtOH, 37% HCl–H_2O (1 equiv.), rt or reflux; (iii) NH_2OH × HCl (**11**), EtOH, reflux; (iii) $NaNO_2$, HCl–H_2O, rt; (iv) $NH_2CH_2CH_2NH_2$ (**13**), EtOH, 37% HCl–H_2O (1 equiv.), reflux.

Structure determination

The structures of all compounds were established on the basis of elemental analysis for C, H, and N, IR, MS and ^1H and ^{13}C NMR spectra. The orientations around the double bonds in compound (**3**) were established on the basis of 2D-HMBC NMR spectral technique. The HMBC correlation technique has been the most suitable for the determination of the orientation around the C=C double bond in analogous compounds.[18,20] Namely, the magnitude of the coupling constants, $^3J_{H–C}$, for the nuclei ***H***-C=C-***C***=O with

cis-configuration around the C=C double bond are smaller (2–6 Hz) than those for the *trans*-oriented ones (8–12 Hz). Accordingly, for compound (**3**) the heteronuclear coupling constants, $^{3}J_{H(3)–C(1)}$ = 5 Hz and $^{3}J_{H(4'')–C(5')}$ = 8 Hz, indicate the (*E*)-configuration around the C(2)=C(3) and the (*Z*)-configuration around the C(4')=C(4'') double bond. (Figure. 1).

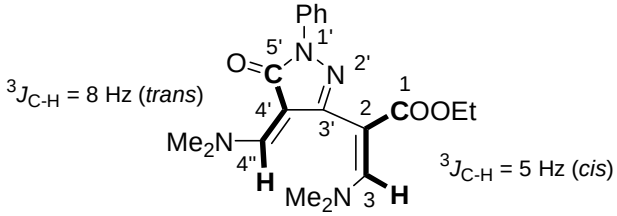


Figure 1. Determination of configuration around the C=C double bonds in compound (**3**) by NMR spectroscopy.

Compounds (**6**) and (**7**) exhibit, besides the signals characteristic for the ester group, phenyl ring and groups attached at pyridine nitrogen atom, two doublets in the range at δ = 7.8–8.8 ppm for *H*–C(4) and at δ = 8.0–9.1 ppm for *H*–C(6) with coupling constant $J_{H(4)–H(6)}$ = 0.8–1.5 Hz. This long range coupling constant was observed also in compounds (**9**), thus excluding formation of the pyrazolodiazepine structure (**10**). Furthermore, the structure of compounds (**9**) was additionally confirmed by deamination of **9a** to afford **6a**, which was prepared by the reaction of **3** with NH_3.

The structures of **6f**, **6p**, and **7e** were determined by X–Ray crystallography. The ORTEP views of **6f**, **6p**, and **7e** show that each molecule consists of an 3-oxo-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine ring (Figures 2–4).

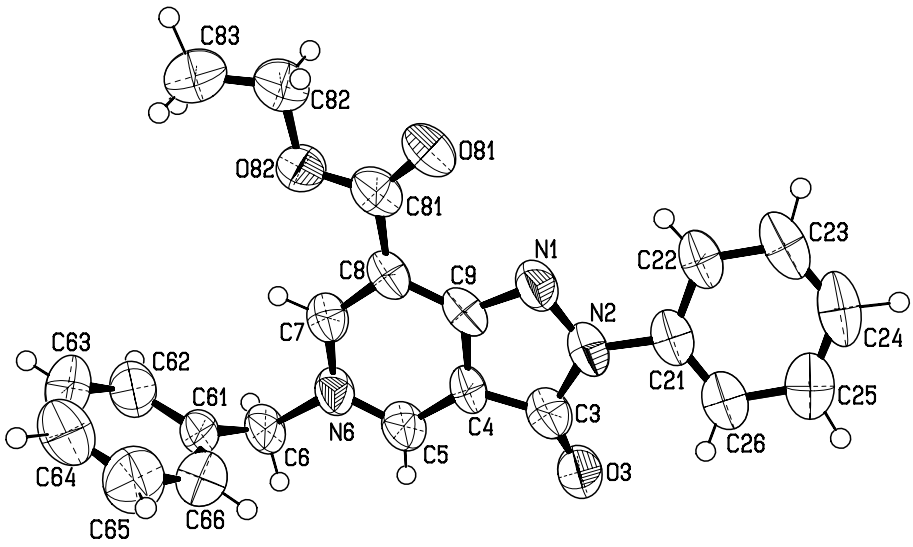


Figure 2. Ortep view of the asymmetric unit of compound (**6f**) with labeling of nonhydrogen atoms. (Ellipsoids are drawn at 50% probability level.)

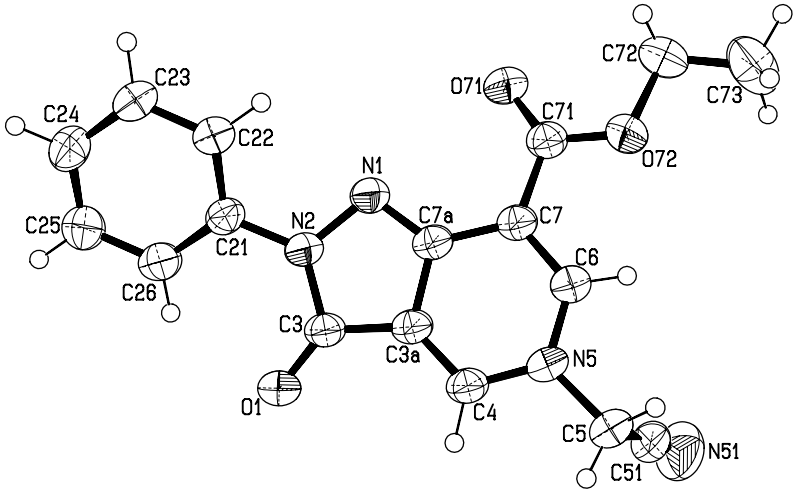


Figure 3. Ortep view of the asymmetric unit of compound (**6p**) with labeling of nonhydrogen atoms. (Ellipsoids are drawn at 50% probability level.)

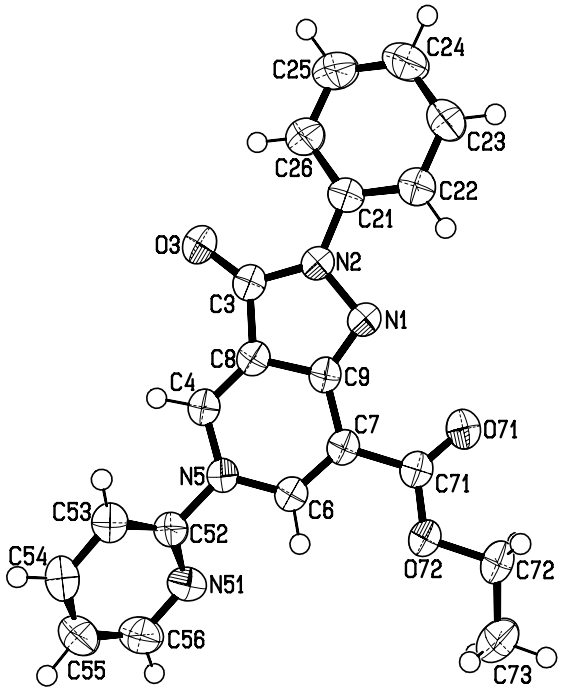


Figure 4. Ortep view of the asymmetric unit of compound (**7e**) with labeling of nonhydrogen atoms. (Ellipsoids are drawn at 50% probability level.)

X-Ray structure analysis

Diffraction data for compounds (**6f**, **6p** and **7e**) were collected on a Nonius Kappa CCD diffractometer with graphite monochromated MoKα radiation. The data were processed using DENZO [21] program.

Structures were solved by direct methods using SIR92.[22] We employed full-matrix least-squares refinements on F magnitudes with anisotropic displacement factors for all non-hydrogen atoms using Xtal3.4.[23] The positions of hydrogen atoms were obtained from the difference Fourier maps. For **6f** H-atoms parameters were not refined, for **6f** and **7e** only positional parameters of H atoms were refined. In the final cycle of the refinement we used 3299, 2870 and 2215 reflections and 254, 293 and 260 parameters for **6f**, **6p** and **7e**, respectively. The weighting scheme was: w = wf*ws, where for **6f** wf (Fo<11.0) = $(Fo/11.0)^{1.5}$, wf (Fo>31.0) = 31.0/Fo, wf (11.0<Fo<31.0)=1.0, ws(sinθ/λ<0.27) = $((\sin\theta/\lambda)/0.27)^{0.5}$, ws(sinθ/λ>0.42) = $(0.42/(\sin\theta/\lambda))^4$, ws(0.27<sinθ/λ<0.64) = 1.0. for **7e**: wf (Fo<19.0) = (Fo/19.0), wf (Fo>49.0) = $(49.0/Fo)^{0.8}$, wf (19.0<Fo<49.0)=1.0, ws(sinθ/λ<0.40) = $((\sin\theta/\lambda)/0.40)^2$, ws(sinθ/λ>0.55) = $(0.55/(\sin\theta/\lambda))^5$, ws(0.40<sinθ/λ<0.55) = 1.0 and for **6p**: wf (Fo<1.7) = (Fo/1.7), wf (Fo>11.0) = (11.0/Fo), wf (1.7<Fo<11.0) = 1.0, ws(sinθ/λ<0.40) = ((sinθ/λ)/0.40), ws(sinθ/λ>0.60) = $(0.60/(\sin\theta/\lambda))^6$, ws(0.40<sinθ/λ<0.60) = 1.0. The resulting crystal data and details concerning data collection and refinement for all three compounds are quoted in Table 3. Final atomic coordinates and equivalent isotropic displacement parameters with their e.s.d.'s are reported in Tables 4, 5 and 6. ORTEP [24] drawings of the content of asymmetric units of all three compounds showing the atom-labeling scheme are presented in Figures 2, 3 and 4.

Table 1. Crystal data, data collection and structure refinement for compounds (**6f**, **6p**, and **7e**).

	compound (**6f**)	compound (**6p**)	compound (**7e**)
Formula	$C_{22}H_{19}N_3O_3$	$C_{17}H_{14}N_4O_3$	$C_{20}H_{16}N_4O_3$
Rel. formula weight	373.411	322.323	360.372
Crystal System	monoclinic	monoclinic	triclinic
Space group	$P2_1/a$, No. 14	$P2_1/c$, No. 14	P-1, No. 2
a (Å)	8.3030(1)	12.9812(2)	9.5730(2)
b (Å)	23.9333(4)	15.1158(3)	9.9337(2)
c (Å)	10.2836(2)	8.0515(1)	10.7427(3)
α (°)	90.00	90.00	66.737(1)
β (°)	111.9370(7)	106.224(1)	71.397
γ (°)	90.00	90.00	68.9825
V ($Å^3$)	1895.58(5)	1516.96(4)	831.26(3)
Z	4	4	2
ρ (Mg m^{-3})	1.308	1.411	1.440
μ (mm^{-1})	0.0889	0.100	0.100
Color of crystal	orange	red	red
Shape of crystal	plate	prism	prism
Dimensions (mm)	0.48×0.32×0.08	0.30×0.20×0.10	0.28×0.14×0.09
Temperature (K)	293(1)	293(1)	293(1)
Wavelength (Å)	0.71073	0.71073	0.71073

θ_{max} (°)	26.0	25.0	27.5
No. of integr. refl.	22191	21719	16184
No. of indep. refl.	3299	1664	3783
R_{int}	0.046	0.049	0.045
No. of observed refl.	1011	2215	2870
Threshold criterion	$I > 2.5\sigma(I)$	$I > 3.0\sigma(I)$	$I > 2.5\sigma(I)$
Final R and R_w	0.044, 0.042	0.045, 0.055	0.055, 0.052
$(\Delta/\sigma)_{max}$	0.0067	0.0002	0.0003
$\Delta\rho_{max}$, $\Delta\rho_{min}$ (e Å^{-3})	0.50, -0.60	0.19, -0.18	0.36, -0.30
Zachariasen ext. coef.	$2.7(5)\cdot10^3$	$14(3)\cdot10^3$	$4.1(9).\cdot10^3$

Table 2. Fractional Coordinates and Equivalent Temperature Factors (Å^2) for compound (**6f**). U_{eq} is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x/a	y/b	z/c	U_{eq}
N(1)	0.0987(3)	0.8120(2)	0.4318(2)	0.041(1)
N(2)	0.1103(2)	0.8060(2)	0.5516(1)	0.044(1)
N(3)	0.4577(3)	1.2703(2)	0.5997(2)	0.054(1)
O(1)	0.5926(3)	1.1037(2)	0.9127(2)	0.071(1)
O(2)	0.5342(2)	0.8841(1)	0.8253(1)	0.049(1)
O(3)	0.1995(2)	0.9733(1)	0.3353(1)	0.055(1)
C(3)	0.2122(3)	0.9292(2)	0.6268(2)	0.042(1)
C(4)	0.2739(3)	1.0249(2)	0.5631(2)	0.041(1)
C(5)	0.1944(3)	0.9440(2)	0.4313(2)	0.041(1)
C(11)	0.0001(3)	0.6904(2)	0.3310(2)	0.043(1)
C(12)	-0.0316(4)	0.6875(2)	0.2077(2)	0.060(2)
C(13)	-0.1293(5)	0.5628(3)	0.1129(2)	0.075(2)
C(14)	-0.1919(4)	0.4423(2)	0.1384(2)	0.070(2)
C(15)	-0.1598(4)	0.4463(2)	0.2609(3)	0.064(2)
C(16)	-0.0658(3)	0.5680(2)	0.3569(2)	0.052(1)
C(31)	0.2484(3)	0.9575(2)	0.7639(2)	0.051(1)
C(32)	0.4770(3)	0.9920(2)	0.8422(2)	0.046(1)
C(33)	0.7518(3)	0.9057(2)	0.8945(2)	0.053(1)
C(34)	0.7745(5)	0.7716(3)	0.8811(4)	0.091(2)
C(41)	0.3846(3)	1.1620(2)	0.6309(2)	0.046(1)
C(42)	0.4349(4)	1.2732(2)	0.4740(3)	0.066(2)
C(43)	0.5641(4)	1.4026(2)	0.6969(3)	0.069(2)

Table 3. Fractional Coordinates and Equivalent Temperature Factors (Å^2) for compound (**6p**). U_{eq} is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x/a	y/b	z/c	U_{eq}
O(3)	1.00551(17)	0.44246(21)	0.85121(17)	0.0483(8)
O(71)	0.34799(19)	0.69717(25)	0.72412(19)	0.0582(9)
O(72)	0.20194(16)	0.80546(20)	0.88840(17)	0.0451(7)
N(1)	0.66118(18)	0.53982(21)	0.74180(18)	0.0359(8)
N(2)	0.81824(18)	0.46389(21)	0.74259(18)	0.0355(7)

N(5)	0.56742(18)	0.71746(20)	1.05552(17)	0.0336(7)
N(51)	0.43691(20)	0.90701(22)	1.16623(19)	0.0395(8)
C(3)	0.87371(22)	0.49011(25)	0.83349(21)	0.0352(9)
C(4)	0.71117(22)	0.63553(24)	1.00905(21)	0.0341(9)
C(6)	0.44914(23)	0.75083(25)	0.99175(21)	0.0334(8)
C(7)	0.46644(22)	0.70124(23)	0.88457(20)	0.0323(8)
C(8)	0.73626(22)	0.58519(24)	0.90104(21)	0.0335(8)
C(9)	0.61597(22)	0.60987(23)	0.83602(20)	0.0323(8)
C(21)	0.89636(22)	0.36978(24)	0.65480(20)	0.0339(8)
C(22)	0.81360(25)	0.3444(3)	0.58427(24)	0.0434(10)
C(23)	0.8872(3)	0.2550(3)	0.4968(3)	0.0513(12)
C(24)	1.0421(3)	0.1878(3)	0.4803(3)	0.0546(13)
C(25)	1.1239(3)	0.2114(3)	0.5513(3)	0.0579(14)
C(26)	1.05302(25)	0.3017(3)	0.63914(25)	0.0481(11)
C(52)	0.53444(22)	0.76717(25)	1.17504(21)	0.0340(9)
C(53)	0.59844(25)	0.6688(3)	1.28889(24)	0.0427(10)
C(54)	0.55899(25)	0.7222(3)	1.40056(25)	0.0476(11)
C(55)	0.46018(25)	0.8693(3)	1.39316(25)	0.0477(11)
C(56)	0.40199(25)	0.9561(3)	1.27571(25)	0.0453(10)
C(71)	0.33488(23)	0.73453(25)	0.82250(21)	0.0355(9)
C(72)	0.06750(25)	0.8296(4)	0.8367(3)	0.0500(12)
C(73)	-0.0684(3)	0.9221(4)	0.9125(4)	0.0586(14)

Table 4. Fractional Coordinates and Equivalent Temperature Factors ($Å^2$) for compound (**7e**). U_{eq} is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x/a	y/b	z/c	U_{eq}
O(3)	0.7388(5)	0.5508(2)	0.9389(5)	0.081(2)
O(81)	0.3386(5)	0.3901(2)	0.4337(5)	0.107(2)
O(82)	0.5545(4)	0.3485(2)	0.3917(4)	0.070(2)
N(1)	0.4415(5)	0.4737(2)	0.6583(5)	0.062(2)
N(2)	0.4884(5)	0.5137(2)	0.7684(5)	0.064(2)
N(6)	0.9325(5)	0.4223(2)	0.7166(5)	0.058(2)
C(21)	0.3521(7)	0.5441(2)	0.7873(7)	0.062(3)
C(22)	0.1884(7)	0.5429(2)	0.6801(6)	0.065(3)
C(23)	0.0540(7)	0.5723(3)	0.6961(8)	0.085(4)
C(24)	0.0795(9)	0.6019(3)	0.816(1)	0.089(4)
C(25)	0.2402(9)	0.6030(3)	0.9211(8)	0.091(4)
C(26)	0.3796(7)	0.5736(3)	0.9073(7)	0.083(3)
C(3)	0.6665(7)	0.5183(3)	0.8414(7)	0.065(3)
C(4)	0.7358(6)	0.4782(2)	0.7722(6)	0.055(3)
C(5)	0.9015(6)	0.4620(2)	0.7973(6)	0.063(3)
C(6)	1.1141(6)	0.4042(3)	0.7395(6)	0.065(3)
C(61)	1.1306(6)	0.3427(3)	0.7548(7)	0.058(3)
C(62)	1.1615(7)	0.3103(3)	0.6561(7)	0.077(3)
C(63)	1.169(1)	0.2530(4)	0.6662(9)	0.104(4)
C(64)	1.154(1)	0.2276(3)	0.776(1)	0.105(4)
C(65)	1.1261(9)	0.2575(4)	0.8778(8)	0.101(4)
C(66)	1.1147(8)	0.3156(4)	0.8683(8)	0.087(4)
C(7)	0.7981(7)	0.3985(2)	0.6088(6)	0.055(3)

C(8)	0.6284(7)	0.4114(2)	0.5778(6)	0.053(3)
C(81)	0.4899(8)	0.3830(3)	0.4609(7)	0.065(3)
C(82)	0.4314(8)	0.3193(3)	0.2742(8)	0.094(4)
C(83)	0.520(1)	0.2766(4)	0.2326(8)	0.137(5)
C(9)	0.5911(7)	0.4530(2)	0.6621(6)	0.055(3)

EXPERIMENTAL PART

Melting points were taken on a Kofler micro hot stage. The ^{1}H NMR, ^{13}C NMR and 2D NMR HMBC, NOESY spectra were obtained on a Bruker Avance DPX 300 (300 MHz) spectrometer with DMSO-d_6 or $CDCl_3$ as solvent and TMS as internal standard (δ in ppm, *J* in Hz). IR spectra were recorded with Perkin–Elmer Spectrum BX FTIR and BIO RAD Excalibur Series FTS 3000 MX FTIR spectrophotometers (KBr discs, ν in cm^{-1}). MS spectra were obtained on an Autospeck Q spectrometer. The microanalyses for C, H, and N were obtained on a Perkin Elmer CHN *Analyser* 2400 and Perkin Elmer Series II CHN *Analyser* 2400.

Synthesis of Ethyl (2*E*)-3-Dimethylamino-2-[(4*Z*)-4-dimethylaminomethylidene-5-oxo-1-phenyl-4,5-dihydro-1*H*-pyrazol-3-yl]propenoate (3).

Procedure A. Compound (**1**) (2.46 g, 10 mmol), and DMFDMA (3 mL) were dissolved in DMF (20 mL) and heated at the reflux temperature for 1 h. Solvent was evaporated under reduced pressure and the residue was treated with ethanol-ether (1:2, 30 mL). After standing for 12 h at –30°C, the yellow crystals were filtered off to give **3**. Yield: 53% (1.9 g).

Procedure B. Compound (**2**) (3.01 g, 10 mmol) and DMFDMA (2 mL) were dissolved in DMF (20 mL) and heated at the reflux temperature for 45 min. Solvent was evaporated under reduced pressure and the residue was treated with ethanol-ether (1:2, 30 mL). After standing for 12 h at –30°C, the yellow crystals were filtered off to give **3**. Yield: 56 % (2.0 g)

mp 155–158 °C. *Anal*. Calcd for $C_{19}H_{24}N_4O_3$: C 64.03; H 6.79; N 15.72. Found: C 64.32; H 6.85; N 15.96. MS: *m/z* (M^+, 356; MH^+, 357). IR (cm^{-1}): 1730, 1670, 1600, 1540, 1490, 1420, 1220, 760, 700. ^{1}H NMR ($CDCl_3$): δ 1.22 (t, 3H, *J* = 7.0 Hz, OCH_2CH_3); 2.92 (s, 6H, NMe_2); 3.29 (s, 3H, NMe); 3.94 (s, 3H, NMe); 4.17 (br s, 2H, OCH_2CH_3); 6.96 (s, 1H, =CH); 7.10–7.15 (m, 1H, Ph); 7.35–7.40 (m, 2H, Ph); 7.75 (s, 1H, =CH); 8.02–8.05 (m, 2H, Ph). ^{13}C NMR ($CDCl_3$): δ 15.1; 43.9; 48.3 (CH_3); 59.9 (CH_2); 87.9 (2-C); 102.0 (4'-C); 120.1 (*m*-Ph); 124.3 (*p*-Ph); 128.8 (*o*-Ph); 140.2 (*i*-Ph); 150.7 (3'-C); 153.2 (3-C); 155.6 (4"-C); 162.6 (5'-C); 169.8 (1-C).

General Procedures for the Preparation of Pyrazolo[4,3–*c*]pyridines (6, 7, 9, 12, and 14).

General procedure A. A solution of **3** (178 mg, 0.5 mmol), amine (**4,5,8,11**) (0.5 mmol) in ethanol (3 mL) was left at rt of 12 h or heated under reflux for 15 min–4.5 h. The product was collected by filtration, washed with ethanol, and recrystallized from ethanol. Compounds (**6a–m,p**, **7a-i**, **9a-h**, **12**, **14**) were prepared in this manner.

General procedure B. A solution of **3** (178 mg, 0.5 mmol), amine (**4n,o**) (0.5 mmol) in ethanol (3 mL) was heated under reflux for 2–10 h, cooled, and solvent was evaporated under *vacuo*. The oily residue was purified by column chromatography on silica gel (EtOAc–hexane, 1:1). Fractions containing the product were combined and evaporated *in vacuo*. The oily residue was dissolved in dichloromethane (3 mL), *n*-heptane (~ 1 mL) was added, and volatile components were evaporated *in vacuo* at 40 °C to give the product in the form of a solid residue. Compounds (**6n,o**) were prepared in this manner.

Ethyl 3-Oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6a). This compound was prepared from **3** and ammonium chloride (**4a**) (27 mg, 0.5 mmol); Procedure A, reflux for 3 h. Yield: 40% (57 mg), mp 258–260 °C, red crystals. *Anal*. Calcd for $C_{15}H_{13}N_3O_3$: C 63.60; H 4.63; N 14.83. Found: C 63.63; H 4.48; N 14.98. MS: *m/z* (M^+, 283; MH^+, 284). IR (cm^{-1}): 1720, 1670, 1650, 1500, 1290, 1150, 760. ^{1}H NMR (DMSO-d_6): δ 1.35 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.34 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.16–7.21 (m, 1H, Ph); 7.41–7.47 (m, 2H, Ph); 8.14 (d, 1H, *J* = 0.8 Hz, 4-H); 8.17–8.20 (m, 2H, Ph); 8.57 (d, 1H, *J* = 0.8 Hz, 6-H); 12.51 (br s, 1H, NH).

Alternatively, this compound was obtained upon nitrosation of **9a**. Aqueous solution of sodium nitrite (2 M, 0.3 mL, 0.6 mmol) was added to a stirred suspension of **6a** (17 mg, 0.057 mmol) in hydrochloric acid (1 M, 1 mL, 1 mmol) and the mixture was stirred at rt for 12 h. The precipitate was collected by filtration to give **6a**, identical in every respect with the compound, prepared from **3** and ammonia. Yield: 81% (13 mg).

Ethyl 5-Methyl-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6b). This compound was prepared from **3** and methylamine hydrochloride (**4b**) (34 mg, 0.5 mmol); Procedure A, rt for 12 h. Yield: 86% (128 mg), mp 231–233 °C, orange crystals. *Anal*. Calcd for $C_{16}H_{15}N_3O_5$: C 64.64; H 5.09; N 14.13. Found: C 64.80; H 5.15; N 14.25. IR (cm^{-1}): 1690, 1670, 1640, 1390, 1300, 1210, 780, 750, 660. ^{1}H NMR (DMSO-d_6): δ 1.36 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 3.89 (s, 3H, CH_3); 4.36 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.16–7.21 (m, 1H, Ph); 7.41–7.46 (m, 2H, Ph); 8.17–8.20 (m, 2H, Ph); 8.22 (d, 1H, *J* = 1.5 Hz, 4-H); 8.67 (d, 1H, *J* = 1.5 Hz, 6-H). ^{13}C NMR (DMSO-d_6): δ 15.1; 44.9 (CH_3); 61.6 (CH_2); 111.9; 116.3 (3a-C, 7-C); 119.6 (*m*-Ph); 125.2 (*p*-Ph); 129.5 (*o*-Ph); 140.7 (*i*-Ph); 141.5; 141.9; 143.1 (4-C, 6-C, 7a-C); 160.9; 163.9 (C=O).

Ethyl 3-Oxo-2-phenyl-5-(prop-1-yl)-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate. (6c). This compound was prepared from **3** and *n*-propylamine (**4c**) (48 mg, 0.5 mmol); Procedure A, reflux for 50 min. Yield: 89% (145 mg), mp 212–214 °C, red crystals. *Anal*. Calcd for $C_{18}H_{19}N_3O_3$: C 66.45; H 5.89; N 12.91. Found: C 66.28; H 6.02; N 13.03. IR (cm^{-1}): 2970, 1730, 1650, 1490, 1300, 1180, 1130, 1050, 790, 760, 650, 510. ^{1}H NMR (DMSO-d_6): δ 0.88 (t, 3H, *J* = 7.3 Hz, $CH_2CH_2CH_3$); 1.37 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 1.81 (s, 2H, *J* = 7.2 Hz, $CH_2CH_2CH_3$); 4.14 (t, 2H, *J* = 7.2 Hz, $CH_2CH_2CH_3$); 4.36 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.16–7.21 (m, 1H, Ph); 7.42–7.47 (m, 2H, Ph); 8.17–8.20 (m, 2H, Ph); 8.29 (d, 1H, *J* = 1.5 Hz, 4-H); 8.76 (d, 1H, *J* = 1.5 Hz, 6-H). ^{13}C NMR (DMSO-d_6): δ 11.1; 15.1 (CH_3); 24.6; 59.0; 61.7 (CH_2); 112.3; 116.5 (3a-C, 7-C); 119.7 (*m*-Ph); 125.3 (*p*-Ph); 129.5 (*o*-Ph); 140.6 (*i*-Ph); 140.9; 141.6; 142.3 (4-C, 6-C, 7a-C); 160.9; 164.0 (C=O).

Ethyl 5-*n*-Butyl-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6d). This compound was prepared from **3** and *n*-butylamine (**4d**) (55 mg, 0.5 mmol); Procedure A, reflux for 1.5 h. Yield: 75% (127 mg), mp 177–178 °C, red crystals. *Anal*. Calcd for $C_{19}H_{21}N_3O_3$: C 67.24; H 6.24; N 12.38. Found: C 66.98; H 6.31; N 12.38. IR (cm^{-1}): 3000, 2930, 1730, 1640, 1490, 1300, 1180, 1130, 1150, 760, 650, 510. ^{1}H NMR (DMSO-d_6): δ 0.92 (t, 3H, *J* = 7.4 Hz, $CH_2CH_2CH_2CH_3$); 1.29 (m, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2CH_3$); 1.37 (t, 3H, *J* = 7.0 Hz, OCH_2CH_3); 1.77 (p, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2CH_3$); 4.18 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2CH_3$); 4.36 (q, 2H, *J* = 7.0 Hz, OCH_2CH_3); 7.16–7.22 (m, 1H, Ph); 7.42–7.47 (m, 2H, Ph); 8.17–8.20 (m, 2H, Ph); 8.29 (d, 1H, *J* = 1.5 Hz, 4-H); 8.76 (d, 1H, *J* = 1.5 Hz, 6-H). ^{13}C NMR (DMSO-d_6): δ 14.3; 15.1 (CH_3); 19.7; 33.3; 57.4; 61.7 (CH_2); 112.3; 116.6 (3a-C, 7-C); 119.7 (*m*-Ph); 125.5 (*p*-Ph); 129.5 (*o*-Ph); 140.7 (*i*-Ph); 140.9; 141.6; 142.2 (4-C, 6-C, 7a-C); 160.9; 164.0 (C=O).

Ethyl 5-Cyclohexyl-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6e). This compound was prepared from **3** and cyclohexylamine (**4e**) (68 mg, 0.5 mmol); Procedure A, reflux for 1.5 h. Yield: 41% (74 mg), mp 252–253 °C, red crystals. *Anal*. Calcd for $C_{21}H_{23}N_3O_3$: C 69.02; H 6.34; N 11.50. Found: C 68.82; H 6.49; N 11.57. IR (cm^{-1}): 2930, 1730, 1650, 1490, 1300, 1180, 1140, 780, 750, 690. ^{1}H NMR (DMSO-d_6): δ 1.24–1.45 (m, 3H, C_6H_{11}); 1.37 (t, 3H, *J* = 7.1 Hz, OCH_2CH_3,); 1.63–1.66 (m, 1H, C_6H_{11}); 1.84–1.97 (m, 6H, C_6H_{11}); 4.20–4.31 (m, 1H, C_6H_{11}); 4.36 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.16–7.22 (m, 1H, Ph); 7.42–7.47 (m, 2H, Ph); 8.16–8.20 (m, 2H, Ph); 8.29 (d, 1H, *J* = 1.5 Hz, 4-H); 8.79 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 5-Benzyl-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6f). This compound was prepared from **3** and benzylamine hydrochloride (**4f**) (72 mg, 0.5 mmol); Procedure A,

reflux for 3.5 h. Yield: 77% (144 mg), mp 216–217 °C, red crystals. *Anal*. Calcd for $C_{22}H_{19}N_3O_3$: C 70.76; H 5.13; N 11.25. Found: C 71.08; H 5.33; N 11.00. MS: *m/z* (M^+, 373; MH^+, 374). IR (cm^{-1}): 1730, 1670, 1650, 1590, 1490, 1300, 1170, 1130, 760, 690. ^{1}H NMR (DMSO-d_6): δ 1.34 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.34 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 5.41 (s, 2H, CH_2); 7.16–7.22 (m, 1H, Ph); 7.37–7.47 (m, 7H, Ph); 8.15–8.18 (m, 2H, Ph); 8.34 (d, 1H, *J* = 1.5 Hz, 4-H); 8.86 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 5-(4-Methoxybenzyl)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6g). This compound was prepared from **3** (178 mg, 0.5 mmol) and 4-methoxybenzylamine hydrochloride (**4g**) (87 mg, 0.5 mmol); Procedure A, reflux for 4.5 h. Yield: 77 % (144 mg), mp 216–217 °C, red crystals. *Anal*. Calcd for $C_{22}H_{17}N_3O_3$: C 70.76; H 5.13; N 11.25. Found: C 71.08; H 5.33; N 11.00. IR (cm^{-1}): 1700, 1650, 1510, 1300, 1180. ^{1}H NMR ($CDCl_3$): δ 1.47 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 3.83 (s, 6H, Me); 4.47 (q, 2H, *J* = 7.0 Hz, OCH_2CH_3); 5.07 (s, 1H, CH_2); 6.93–6.97 (m, 1H, Ph); 7.17–7.22 (m, 3H, Ph); 7.39–7.44(m, 2H, Ph); 7.98 (d, 1H, *J* = 1.5 Hz, 4-H); 8.14 (d, 1H, *J* = 1.5 Hz, 6-H); 8.20–8.23 (m, 2H, Ph).

Ethyl 5-(4-Nitrobenzyl)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6h). This compound was prepared from **3** and 4-nitrobenzylamine hydrochloride (**4h**) (94 mg, 0.5 mmol); Procedure A, reflux for 2 h. Yield: 93% (195 mg), mp 227–229 °C, red crystals. *Anal*. Calcd for $C_{22}H_{18}N_4O_5$: C 63.15; H 4.34; N 13.39. Found: C 63.39; H 4.49; N 13.40. IR (cm^{-1}): 1720, 1670, 1650, 1340, 1300, 1180, 1140, 760, 690. ^{1}H NMR (DMSO-d_6): δ 1.35 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.35 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 5.57 (s, 2H, CH_2); 7.17–7.22 (m, 1H, Ph); 7.42–7.47 (m, 2H, Ph); 7.66–7.69 (m, 2H, Ph); 8.15–8.18 (m, 2H, Ph); 8.25–8.28 (m, 2H, Ph); 8.38 (d, 1H, *J* = 1.5 Hz, 4-H); 8.90 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 5-[2-(5-Methyl-1*H*-indol-3-yl)ethyl]-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6i). This compound was prepared from **3** and 5-methyltryptamine hydrochloride (**4i**) (105 mg, 0.5 mmol); Procedure A, reflux for 30 min. Yield: 80% (176 mg), mp 224–226 °C, red crystals. *Anal*. Calcd for $C_{26}H_{24}N_4O_3$: C 70.89; H 5.49; N 12.72. Found: C 71.10; H 5.53; N 12.80. MS: m/z (M^+, 440; MH^+, 441). IR (cm^{-1}): 1690, 1650, 1490, 1390, 1300, 1190, 1030, 790, 760. ^{1}H NMR (DMSO-d_6): δ 1.31 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 2.35 (s, 3H, Me); 3.19 (t, 2H, *J* = 6.8 Hz, CH_2); 4.29 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 4.42 (t, 2H, *J* = 6.8 Hz, CH_2); 6.89 (dd, 1H, *J* = 1.5, 8.3 Hz, 6'-H); 7.03 (d, 1H, *J* = 2.3 Hz, 4'-H); 7.14–7.23 (m, 2H, Ph, 7'-H); 7.35 (br s, 1H, 2'-H); 7.40–7.46 (m, 2H, Ph); 8.06 (d, 1H, *J* = 1.5 Hz, 4-H); 8.14–8.17 (m, 2H, Ph); 8.57 (d, 2H, *J* = 1.5 Hz, 6-H).

Ethyl 5-[(1-Adamantyl)methyl]-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6j). This compound was prepared from **3** and (1-adamantyl)methylamine (**4j**) (83 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A; rt for 12 h. Yield: 39% (84 mg), mp 295–296°C, red crystals. *Anal*. Calcd for $C_{26}H_{29}N_3O_3$: C 72.37; H 6.77; N 9.74. Found: C 72.20; H 7.04; N 9.64. MS: *m/z* (M^+, 431; MH^+, 432). IR (cm^{-1}): 2910, 2850, 1730, 1670, 1660, 1640, 1490, 1300, 1170, 1140, 1050, 790, 750. ^{1}H NMR ($CDCl_3$): δ 1.49 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 1.53–1.54 (m, 6H, Ad); 1.58 (s, 4H, Ad); 1.73 (br s, 2H, Ad); 1.77 (br s, 1H, Ad); 2.06 (br s, 3H, Ad); 3.65 (s, 2H, CH_2); 4.49 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.17–7.22 (m, 1H, Ph); 7.40–7.45 (m, 2H, Ph); 7.80 (d, 1H, *J* = 1.5 Hz, 4-H); 8.01 (d, 1H, *J* = 1.5 Hz, 6-H); 8.22–8.26 (m, 2H, Ph). ^{13}C NMR ($CDCl_3$): δ 14.7 (CH_3); 28.2; 35.3; 36.7; 40.3; 62.1; 70.4 (CH_2); 112.3; 117.4 (3a-C, 7-C); 120.4 (*m*-Ph); 125.4 (*p*-Ph); 129.0 (*o*-Ph); 140.1; 140.4 (4-C, 6-C); 140.7 (*i*-Ph); 141.2 (7a-C); 160.9; 164.3 (C=O).

Ethyl 3-Oxo-2-phenyl-5-(propyn-3-yl)-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6k). This compound was prepared from **3**, 3-aminopropyne (**4k**) (28 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 64% (103 mg), mp 221–223 °C, red crystals. *Anal*. Calcd for $C_{18}H_{15}N_3O_3$: C 67.28; H 4.71; N 13.08. Found: C 67.01; H 4.86; N 13.10. ^{1}H NMR (DMSO-d_6): δ 1.37 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 3.80 (t, 1H, *J* = 2.6, CH_2); 4.37 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 5.13 (d, *J* = 2.6 Hz, ≡CH); 7.18–7.23 (m, 1H, Ph); 7.42–7.48 (m, 2H, Ph); 8.16–8.19 (m, 2H, Ph); 8.32 (d, 1H, *J* = 1.5 Hz, 4-H); 8.72 (d, 1H, *J* = 1.5 Hz, 6-H). ^{13}C NMR ($CDCl_3$): δ 14.5 (CH_3); 46.0; 61.2 (CH_2); 77.7; 79.3 (C≡C); 112.0; 116.4 (3a-C, 7-C); 119.2 (*m*-Ph); 124.8 (*p*-Ph); 129.0 (*o*-Ph); 139.8; 140.0; 140.8 (*i*-Ph, 4-C, 6-C); 140.9 (7a-C); 160.3; 163.2 (C=O).

Ethyl 5-[2-(Ethoxycarbonyl)ethyl]-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6l). This compound was prepared from **3** and ethyl β-alaninate hydrochloride (**4l**) (77 mg, 0.5 mmol); Procedure A, reflux for 1 h. Yield: 52% (100 mg), mp 199–202 °C, red crystals. *Anal*. Calcd for $C_{20}H_{21}N_3O_5$: C 62.65; H 5.52; N 10.96. Found: C 62.30; H 5.57; N 10.73. IR (cm^{-1}): 1730, 1700, 1640, 1390, 1300, 1180, 790, 760. ^{1}H NMR ($CDCl_3$): δ 1.25 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3);1.47 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 2.89 (t, 2H, *J* = 6.3 Hz, CH_2); 4.18 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 4.30 (t, 2H, *J* = 6.2 Hz, CH_2); 4.48 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.16–7.22 (m, 1H, Ph); 7.39–7.45 (m, 2H, Ph); 7.97 (d, 1H, *J* = 1.7 Hz, 4-H); 8.19 (d, 1H, *J* = 1.7 Hz, 6-H); 8.21–8.25 (m, 2H, Ph). ^{13}C NMR (DMSO-d_6): δ 14.8; 15.1 (CH_3); 35.3; 53.3; 61.2; 61.6 (CH_2); 112.1; 116.4 (3a-C, 7a-C); 119.7 (*m*-Ph); 125.3 (*p*-Ph); 129.5 (*o*-Ph); 140.6 (*i*-Ph); 141.4; 141.6; 142.7 (4-C, 6-C, 7a-C); 160.9; 163.9; 171.3 (C=O).

Ethyl 5-Ethoxycarbonylmethyl-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6m). This compound was prepared from **3** and ethyl glycinate (**4m**) (70 mg, 0.5 mmol); Procedure

A, reflux for 15 min. Yield: 85% (157 mg), mp 232–235 °C, red crystals. *Anal*. Calcd for $C_{19}H_{19}N_3O_5$: C 61.78; H 5.18; N 11.38. Found: C 62.04; H 5.25; N 11.23. IR (cm^{-1}): 1750, 1700, 1670, 1650, 1490, 1380, 1300, 1190, 1030, 760. ^1H NMR ($CDCl_3$): δ 1.31 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 1.47 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.29 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 4.47 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 4.73 (s, 2H, CH_2); 7.18–7.23 (m, 1H, Ph); 7.40–7.45 (m, 2H, Ph); 7.84 (d, 1H, *J* = 1.7 Hz, 4-H); 8.19 (d, 1H, *J* = 1.7 Hz, 6-H); 8.22–8.25 (m, 2H, Ph). ^{13}C NMR (DMSO-d_6): δ 14.9; 15.1 (CH_3); 57.5; 61.7; 62.5 (CH_2); 111.9; 116.5 (3a-C, 7-C); 119.7 (*m*-Ph); 125.4 (*p*-Ph); 129.6 (*o*-Ph); 140.5 (*i*-Ph); 141.3; 142.3; 143.2 (4-C, 6-C, 7a-C); 160.9; 163.8; 168.9 (C=O).

Ethyl 5-[(1*S*)-1-(4-Hydroxybenzyl)-2-methoxy-2-oxoethyl]-2-methyl-3-oxo-3,5-dihydro-2*H*-pyrazolo-[4,3–*c*]pyridine-7-carboxylate (6n). This compound was prepared from **3** and methyl L-tyrosinate hydrochloride (**4n**) (109 mg, 0.5 mmol); Procedure B, reflux for 10 h. Yield: 72% (166 mg), mp 200–226 °C, red crystals. *Anal*. Calcd for $C_{25}H_{23}N_3O_6$: C 65.07; H 5.02; N 9.11. Found: C 65.26; H 5.24; N 9.22. MS: *m/z* (M^+, 461; MH^+, 462). IR (cm^{-1}): 2930, 1750, 1720, 1650, 1520, 1490, 1390, 1300, 1180, 1140, 790, 760. $[\alpha]_D^{20}$ = –161° (c = 1, CH_2Cl_2). ^1H NMR ($CDCl_3$): δ 1.42 (t, 3H, *J* = 7.1 Hz, OCH_2CH_3); 3.15 (dd, 1H, *J* = 11.1, 14.8 Hz, CH_2); 3.49 (dd, 1H, *J* = 4.3, 14.8 Hz, CH_2); 4.42 (q, 2H, *J* = 7.1 Hz, OCH_2CH_3); 4.88 (dd, 1H, *J* = 4.4, 10.9 Hz, CH); 6.62 (d, 2H, *J* = 8.4 Hz, 2',6'-H); 6.79 (d, 2H, *J* = 8.4 Hz, 3',6'-H); 7.17–7.22 (m, 1H, Ph); 7.38–7.43 (m, 2H, Ph); 7.90 (d, 1H, *J* = 1.3 Hz, 4-H); 8.12 (s, 1H, OH); 8.16–8.19 (m, 2H, Ph); 8.26 (d, 1H, *J* = 1.3 Hz, 6-H).

Ethyl 5-[(1*S*)-2-Ethoxy-1-methyl-2-oxoethyl]-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (6o). This compound was prepared from **3** and ethyl L-alaninate hydrochloride (**4o**) (77 mg, 0.5 mmol); Procedure B, reflux for 2 h. Yield: 41% (79 mg), mp 192–193 °C, red crystals. *Anal*. Calcd for $C_{20}H_{21}N_3O_5$: C 62.65; H 5.52; N 10.96. Found: C 62.30; H 5.60; N 10.89. MS: *m/z* (M^+, 383; MH^+, 384). IR (cm^{-1}): 1750, 1730, 1650, 1590, 1490, 1340, 1300, 1190, 1150, 1020, 790, 760, 690. $[\alpha]_D^{20}$ = +1° (c = 1.4, CH_2Cl_2). ^1H NMR ($CDCl_3$): δ 1.29 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 1.47 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 1.86 (d, 3H, *J* = 7.2 Hz, CH_3); 4.27 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 4.48 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 4.79 (q, 1H, *J* = 7.2 Hz, CH); 7.17–7.23 (m, 1H, Ph); 7.40–7.45 (m, 2H, Ph); 7.94 (d, 1H, *J* = 1.9 Hz, 4-H); 8.21–8.25 (m, 3H, Ph, 6-H).

Ethyl 5-Cyanomethyl-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridin-7-carboxylate (6p). This compound was prepared from **3** and aminoacetonitrile hydrochloride (**4p**) (47 mg, 0.5 mmol); Procedure A, rt for 12 h. Yield: 91% (161 mg), mp 291–295 °C, red crystals. *Anal*. Calcd for $C_{51}H_{42}N_{12}O_9$: C 63.55; H 4.38; N 17.38. Found: C 63.24; H 4.56; N 17.62. MS: *m/z* (M^+, 322; MH^+, 967).

IR (cm^{-1}): 1730, 1670, 1660, 1490, 1310, 1190, 1150, 770. ^{1}H NMR (DMSO-d_6): δ 1.37 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.37 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.18–7.23 (m, 1H, Ph); 7.43–7.48 (m, 2H, Ph); 8.41 (d, 1H, *J* = 1.5 Hz, 4-H); 8.79 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 3-Oxo-2,5-diphenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7a). This compound was prepared from **3** and aniline hydrochloride (**5a**) (65 mg, 0.5 mmol); Procedure A, rt for 12 h. Yield: 56% (101 mg), mp 280–281 °C, orange crystals. *Anal*. Calcd for $C_{21}H_{17}N_3O_3$: C 70.18; H 4.77; N 11.69. Found: C 70.24; H 5.02; N 11.45. IR (cm^{-1}): 1720, 1670, 1650, 1480, 1310, 1150, 760. ^{1}H NMR ($CDCl_3$): δ 1.48 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.50 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.19–7.24 (m, 1H, Ph); 7.14–7.49 (m, 5H, Ph); 7.54–7.63 (m, 3H, Ph); 8.22 (d, 1H, *J* = 1.5 Hz, 4-H); 8.24–8.27 (m, 2H, Ph); 8.37 (d, 2H, *J* = 1.5 Hz, 6-H).

Ethyl 5-(4-Methylphenyl)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7b). This compound was prepared from **3** and 4-methylaniline hydrochloride (**5b**) (72 mg, 0.5 mmol); Procedure A, reflux for 4 h. Yield: 50% (93 mg), mp 233–235 °C (lit.,[18] 233–235 °C), red crystals. MS: *m/z* (M^+, 373). IR (cm^{-1}): 1730, 1670, 1650, 1490, 1310, 1150, 790, 760. ^{1}H NMR ($CDCl_3$): δ 1.48 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 1.57 (s, 3H, Me); 4.49 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.18–7.24 (m, 1H, Ph); 7.32–7.47 (m, 6H, 2Ph); 8.19 (d, 1H, *J* = 1.9 Hz, 4-H); 8.24–8.27 (m, 2H, Ph); 8.35 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 5-(4-Methoxyphenyl)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7c). This compound was prepared from **3**, 4-methoxyaniline (**5c**) (62 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, reflux for 15 min. Yield: 79 % (154 mg), mp 236–237 °C (lit.,[18] 235–237), red crystals. MS: *m/z* (M^+, 389; MH^+, 390). IR (cm^{-1}): 1730, 1670, 1650, 1590, 1510, 1480, 1250, 1160, 840, 790, 760. ^{1}H NMR ($CDCl_3$): δ 1.48 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 3.89 (s, 3H, OMe); 4.49 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.05–7.08 (m, 2H, Ph'); 7.18–7.24 (m, 1H, Ph); 7.36–7.39 (m, 2H, Ph'); 7.41–7.46 (m, 2H, Ph); 8.15 (d, 1H, *J* = 1.5 Hz, 4-H); 8.24–8.27 (m, 2H, Ph); 8.32 (d, 1H, *J* = 1.9 Hz, 6-H). ^{13}C NMR (DMSO-d_6): δ 15.0 (CH_3); 61.8 (CH_2); 115.8; 117.0; 119.8; 125.5; 126.2; 129.6; 135.4; 140.5; 141.4 (Ph, Ar, 3a-C, 4-C, 6-C, 7-C); 158.8 (7a-C); 161.1; 163.7 (C=O).

Ethyl 3-Oxo-2-phenyl-5-pyrazinyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7d). This compound was prepared from **3**, aminopyrazine (**5d**) (48 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, reflux for 1.5 h. Yield: 72% (130 mg), mp 215–218 °C, red crystals. *Anal*. Calcd for $C_{19}H_{15}N_5O_3$: C 63.15; H 4.18; N 19.38. Found: C 63.13; H 4.30; N 19.39. MS: *m/z* (M^+, 361; MH^+, 362). IR (cm^{-1}): 1730, 1720, 1670, 1640, 1590, 1320, 1140, 780, 760. ^{1}H NMR ($CDCl_3$): δ

1.50 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.53 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.20–7.25 (m, 1H, Ph); 7.42–7.47 (m, 2H, Ph); 8.21–8.24 (m, 2H, Ph); 8.60 (dd, 1H, *J* = 1.5, 2.6 Hz, 5'-H); 8.74 (d, 1H, *J* = 2.6 Hz, 6'-H); 8.76 (d, 1H, *J* = 1.5 Hz, 4-H); 8.97 (d, 1H, *J* = 1.5 Hz, 6-H); 9.01 (d, 1H, *J* = 1.1 Hz, 3'-H).

Ethyl 3-Oxo-2-phenyl-5-(pyridin-2-yl)-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7e). This compound was prepared from **3**, 2-aminopyridine (**5e**) (48 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, reflux for 4.5 h. Yield: 71% (128 mg), mp 201–204 °C, red crystals. *Anal*. Calcd for $C_{20}H_{16}N_4O_3$: C 66.66; H 4.48; N 15.55. Found: C 67.00; H 4.63; N 15.84. MS: *m/z* (M^+, 360; MH^+, 361). IR (cm^{-1}): 1710, 1670, 1470, 1310, 1150, 790. ^1H NMR ($CDCl_3$): δ 1.49 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.52 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.19–7.24 (m, 1H, Ph); 7.41–7.47 (m, 3H, Ph, 5'-H); 7.58 (dd, 1H, *J* = 0.8, 8.3 Hz, 3'-H); 7.99 (ddd, 1H, *J* = 1.9, 7.5, 8.4 Hz, 4'-H); 8.22–8.26 (m, 2H, Ph); 8.62 (ddd, 1H, *J* = 0.8, 1.9, 4.9 Hz, 6'-H); 8.82 (d, 1H, *J* = 1.5 Hz, 4-H); 9.00 (d, 1H, *J* = 1.9 Hz, 6-H).

Ethyl 3-Oxo-2-phenyl-5-(quinolin-3-yl)-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7f). This compound was prepared from **3**, 3-aminoquinoline (**5f**) (72 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 84% (172 mg), mp 248–251 °C, orange crystals. *Anal*. Calcd for $C_{24}H_{18}N_4O_3$: C 70.23; H 4.42; N 13.65. Found: C 70.09; H 4.41; N 13.69. IR (cm^{-1}): 2940, 1730, 1660, 1630, 1590, 1580, 1320, 1210, 1160, 780, 770. ^1H NMR (DMSO-d_6): δ 1.37 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.39 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.20–7.25 (m, 1H, Ph); 7.46–7.51 (m, 2H, Ph); 7.74–7.79 (m, 1H, Ph'); 7.88–7.93 (m, 1H, Ph'); 8.11–8.22 (m, 4H, Ph, Ph'); 8.55 (d, 1H, *J* = 1.5 Hz, 4-H); 8.84 (d, 1H, *J* = 2.3 Hz, 4'-H); 9.09 (d, 1H, *J* = 1.5 Hz, 6-H); 9.25 (d, 1H, *J* = 2.6 Hz, 2'-H).

Ethyl 5-(1,3-Benzothiazol-2-yl)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7g). This compound was prepared from **3**, 2-amino-1,3-benzothiazole (**5g**) (75 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, reflux for 7 h. Yield: 33% (69 mg), mp 215–217 °C, red crystals. *Anal*. Calcd for $C_{22}H_{16}N_4O_3S$: C 63.45; H 3.87; N 13.45. Found: C 63.68; H 4.08; N 13.78. ^1H NMR ($CDCl_3$): δ 1.51 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.54 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.21–7.23 (m, 1H, Ph); 7.42–7.52 (m, 3H, Ph); 7.59 (ddd, 1H, *J* = 1.5, 7.4, 8.1 Hz, H); 7.90 (d, 1H, *J* = 7.9 Hz, H); 8.01 (d, 1H, *J* = 8.3 Hz, H); 8.19–8.22 (m, 2H, Ph); 8.83 (d, 1H, *J* = 1.9 Hz, 4-H); 8.93 (d, 1H, *J* = 1.9 Hz, 6-H).

Ethyl 3-Oxo-2-phenyl-5-(2*H*-tetrazol-5-yl)-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7h). This compound was prepared from **3**, 5-aminotetrazole monohydrate (**5h**) (52 mg, 0.5 mmol), and

hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 61% (107 mg), mp 290–293 °C, red crystals. *Anal*. Calcd for $C_{16}H_{13}N_7O_3$: C 54.70; H 3.73; N 27.91. Found: C 54.93; H 3.78; N 27.87. IR (cm^{-1}): 3070, 1740, 1660, 1620, 1590, 1520, 1480, 1380, 1290, 1180, 1110, 1010, 780, 760, 690. ^{1}H NMR (DMSO-d_6): δ 1.39 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.41 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.20–7.25 (m, 1H, Ph); 7.45–7.50 (m, 2H, Ph); 8.14–8.17 (m, 2H, Ph); 8.78 (d, 1H, *J* = 1.5, 4-H); 8.94 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 5-(5-Methylisoxazol-3-yl)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (7i). This compound was prepared from **3**, 3-amino-5-methylisoxazole (**5i**) (49 mg, 0.5 mmol), hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 58% (106 mg), mp 197–199 °C, red crystals. *Anal*. Calcd for $C_{19}H_{16}N_4O_4$: C 62.63; H 4.43; N 15.38. Found: C 62.71; H 4.48; N 15.27. IR (cm^{-1}): 3120, 1720, 1670, 1660, 1610, 1500, 1470, 1300, 1180, 1150, 1090, 1030, 780, 750, 690. ^{1}H NMR ($CDCl_3$): δ 1.48 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 2.55 (d, 3H, *J* = 0.8 Hz, CH_3); 4.50 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 6.37 (d, 1H, *J* = 0.8 Hz, 4'-H); 7.20–7.25 (m, 1H, Ph); 7.41–7.47 (m, 2H, Ph); 8.19–8.22 (m, 2H, Ph); 8.47 (d, 1H, *J* = 1.5 Hz, 4-H); 8.55 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 5-Amino-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9a). This compound was prepared from **3** and hydrazine hydrochloride (**8a**) (34 mg, 0.5 mmol); Procedure A, reflux for 10 min. Yield: 98% (146 mg), mp 235–237 °C, red crystals. *Anal*. Calcd for $C_{15}H_{14}N_4O_3$: C 60.40; H 4.73; N 18.78. Found: C 60.29; H 5.07; N 18.58. MS: *m/z* (M^+, 298; MH^+, 299). IR (cm^{-1}): 3310, 1720, 1640, 1490, 1310, 1150, 1050, 860, 790, 750. ^{1}H NMR (DMSO-d_6): δ 1.36 (t, 3H, *J* = 7.0 Hz, OCH_2CH_3); 4.36 (q, 2H, *J* = 7.0 Hz, OCH_2CH_3); 6.87 (s, 2H, NH_2); 7.16–7.21 (m, 1H, Ph); 7.41–7.47 (m, 2H, Ph); 8.12 (d, 1H, *J* = 1.5 Hz, 4-H); 8.17–8.20 (m, 2H, Ph); 8.48 (d, 1H, *J* = 1.5 Hz, 6-H).

Ethyl 5-(Phenylamino)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9b). This compound was prepared from **3** and phenylhydrazine hydrochloride (**8b**) (72 mg, 0.5 mmol); Procedure A, rt for 12 h. Yield: 28% (53 mg), mp 235–237 °C, red crystals. *Anal*. Calcd for $C_{21}H_{18}N_4O_5$: C 67.37; H 4.85; N 14.96. Found: C 67.41; H 4.97; N 15.01. IR (cm^{-1}): 3180, 3070, 1710, 1660, 1640, 1290, 1190, 1030, 760, 690. ^{1}H NMR (DMSO-d_6): δ 1.34 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.34 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 6.72–6.75 (m, 2H, Ph); 6.97–7.02 (m, 1H, Ph); 7.19–7.24 (m, 1H, Ph); 7.28–7.33 (m, 2H, Ph); 7.44–7.50 (m, 2H, Ph); 8.03 (d, 1H, *J* = 1.8 Hz, 4-H); 8.15–8.19 (m, 2H, Ph); 8.73 (d, 1H, *J* = 1.8 Hz, 6-H); 9.83 (s, 1H, NH).

Ethyl 5-(3-Methylphenylamino)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9c). This compound was prepared from **3**, 3-methylphenylhydrazine (**8c**) (61 mg, 0.5 mmol), and

hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 22% (42 mg), mp 232–234 °C, red crystals. *Anal*. Calcd for $C_{22}H_{20}N_4O_3$: C 68.03; H 5.19; N 14.42. Found: C 68.02; H 5.34; N 14.43. IR (cm^{-1}): 1710, 1660, 1630, 1600, 1530, 1290, 1030, 780, 690. ^{1}H NMR (DMSO-d_6): δ 1.34 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 2.25 (s, 3H, CH_3); 4.34 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 6.52–6.54 (m, 2H, Ph); 6.80–6.82 (m, 1H, Ph); 7.16–7.24 (m, 2H, Ph); 7.44–7.50 (m, 2H, Ph); 8.02 (d, 1H, *J* = 1.9 Hz, 4-H); 8.15–8.19 (m, 2H, Ph); 8.70 (d, 1H, *J* = 1.9 Hz, 6-H); 9.74 (s, 1H, NH).

Ethyl 5-(4-Nitrophenylamino)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9d). This compound was prepared from **3**, 4-nitrophenylhydrazine (**8d**) (77 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 25% (53 mg), mp 255–258 °C, red crystals. *Anal*. Calcd for $C_{21}H_{17}N_5O_5$: C 60.14; H 4.09; N 16.70. Found: C 59.97; H 4.26; N 16.42. IR (cm^{-1}): 3270, 1720, 1660, 1600, 1500, 1330, 1300, 1110, 840, 750, 690. ^{1}H NMR (DMSO-d_6): δ 1.34 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.35 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 6.85–6.88 (m, 2H, Ph'); 7.20–7.25 (m, 1H, Ph); 7.45–7.51 (m, 2H, Ph); 8.14–8.19 (m, 5H, Ph, 4-H); 8.88 (d, 1H, *J* = 1.8 Hz, 6-H); 10.85 (s, 1H, NH).

Ethyl 5-(2-Bromophenylamino)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9e). This compound was prepared from **3**, 2-bromophenylhydrazine (**8e**) (94 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 26% (58 mg), mp 207–209 °C, red crystals. *Anal*. Calcd for $C_{21}H_{17}N_4O_3Br$: C 55.64; H 3.78; N 12.36. Found: C 55.49; H 4.02; N 12.10. MS: *m/z* (M^+ 452, 454; MH^+ 453, 455); IR (cm^{-1}): 3080, 1710, 1660, 1640, 1500, 1330, 1290, 1190, 1020, 760. ^{1}H NMR (DMSO-d_6): δ 1.34 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.34 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 6.53 (dd, 1H, *J* = 1.4, 8.2 Hz, 6'-H); 6.95 (ddd, 1H, *J* = 1.5, 7.4, 7.9 Hz, 4'-H); 7.19–7.30 (m, 2H, Ph, 5'-H); 7.44–7.50 (m, 2H, Ph); 7.64 (dd, 1H, *J* = 1.4, 7.9 Hz, 3'-H); 8.10 (d, 1H, *J* = 1.8 Hz, 4-H); 8.14–8.19 (m, 2H, Ph); 8.78 (d, 1H, *J* = 1.8 Hz, 6-H); 9.63 (s, 1H, NH).

Ethyl 5-(2-Chlorophenylamino)-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9f). This compound was prepared from **3**, 2-chlorophenylhydrazine (**8f**) (71 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, rt for 12 h. Yield: 17% (35 mg), mp 212–214 °C, red crystals. *Anal*. Calcd for $C_{21}H_{17}N_4O_3Cl$: C 61.69; H 4.19; N 13.70. Found: C 61.48; H 4.35; N 13.54. IR (cm^{-1}): 3080, 1710, 1660, 1640, 1600, 1500, 1330, 1290, 1190, 1140, 750, 660. ^{1}H NMR (DMSO-d_6): δ 1.34 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.34 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 6.57 (dd, 1H, *J* = 1.3, 8.2 Hz, Ph'); 7.01 (ddd, 1H, *J* = 1.3, 7.5, 7.9 Hz, Ph'); 7.19–7.26 (m, 2H, Ph); 7.44–7.50 (m, 3H, Ph, Ph'); 8.11 (d, 1H, *J* = 1.5 Hz, 4-H); 8.15–8.18 (m, 2H, Ph); 8.80 (d, 1H, *J* = 1.5 Hz, 6-H); 9.80 (s, 1H, NH).

Ethyl 3-Oxo-2-phenyl-5-(pyridin-2-ylamino)-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9g). This compound was prepared from **3**, 2-hydrazinopyridine (**8g**) (55 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, reflux for 1 h. Yield: 79% (149 mg), mp 256–258 °C, red crystals. *Anal*. Calcd for $C_{20}H_{17}N_5O_3$: C 63.99; H 4.56; N 18.66. Found: C 63.59; H 4.73; N 18.44. IR (cm^{-1}): 3070, 1700, 1660, 1630, 1480, 1290, 1200, 790, 760. ^{1}H NMR (DMSO-d_6): δ 1.34 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.34 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 6.83 (dt, 1H, *J* = 0.9, 8.3 Hz, 3'-H); 6.98 (ddd, *J* = 0.9, 5.0, 7.2 Hz, 5'-H); 7.19–7.24 (m, 2H, Ph); 7.43–7.50 (m, 2H, Ph); 7.74 (ddd, *J* = 1.8, 7.2, 8.3 Hz, 4'-H); 8.06 (d, 1H, *J* = 1.8 Hz, 4-H); 7.44–7.50 (m, 2H, Ph); 8.13–8.19 (m, 3H, Ph, 6'-H); 8.72 (d, 1H, *J* = 1.8 Hz, 6-H); 8.15–8.19 (m, 2H, Ph); 8.70 (d, 1H, *J* = 1.9 Hz, 6-H); 10.56 (br s, 1H, NH).

Ethyl 3-Oxo-2-phenyl-5-(phthalazin-1-ylamino)-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (9h). This compound was prepared from **3**, 1-hydrazinophthalazine (**8h**) (80 mg, 0.5 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, reflux for 30 min. Yield: 94% (200 mg), mp 270–273 °C, red crystals. *Anal*. Calcd for $C_{23}H_{18}N_6O_3$: C 64.78; H 4.25; N 19.71. Found: C 64.56; H 4.50; N 19.73. IR (cm^{-1}): 1710, 1640, 1600, 1540, 1490, 1290, 1150, 760, 690. ^{1}H NMR (DMSO-d_6): δ 1.35 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.35 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.18–7.23 (m, 1H, Ph); 7.43–7.49 (m, 2H, Ph); 7.86–7.96 (m, 3H, Ph); 8.10 (d, 1H, *J* = 1.8 Hz, 4-H); 8.21–8.24 (m, 2H, Ph); 8.43 (br s, 1H, 4'-H); 8.65 (d, 1H, *J* = 1.8 Hz, 6-H); 12.41 (br s, 1H, NH).

Ethyl 5-Hydroxy-3-oxo-2-phenyl-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridine-7-carboxylate (12). This compound was prepared from **3** (178 mg, 0.5 mmol) and hydroxylamine hydrochloride (**11**) (35 mg, 0.5 mmol); Procedure A, rt for 12 h. Yield: 82% (123 mg), mp 290–294 °C, red crystals. HRMS Calcd for $C_{23}H_{18}N_6O_3$ (M^+): 299.09110. Found: 299.090606. ^{1}H NMR (DMSO-d_6): δ 1.33 (t, 3H, *J* = 7.2 Hz, OCH_2CH_3); 4.30 (q, 2H, *J* = 7.2 Hz, OCH_2CH_3); 7.09–7.14 (m, 1H, Ph); 7.36–7.41 (m, 2H, Ph); 7.99 (d, 1H, *J* = 1.9 Hz, 4-H); 8.22 (d, 1H, *J* = 1.9 Hz, 6-H); 8.24–8.28 (m, 2H, Ph). ^{13}C (DMSO-d_6): δ 15.0 (CH_3); 61.9 (CH_2); 112.8; 116.5; 117.2; 119.7; 125.5; 129.6; 140.4; 140.7; 142.1 (Ph, 3a-C, 4-C, 6-C, 7-C, 7a-C); 160.7; 163.5 (C=O).

1,2-Bis(7-ethoxycarbonyl-3-oxo-3,5-dihydro-2*H*-pyrazolo[4,3–*c*]pyridin-5-yl)ethane (14). This compound was prepared from **3** (178 mg, 0.5 mmol), 1,2-ethylenediamine (**13**) (15 mg, 0.25 mmol), and hydrochloric acid (37%, 0.05 mL, 0.5 mmol); Procedure A, reflux for 2 h. Yield: 68% (101 mg), mp 338–341 °C, orange crystals. *Anal*. Calcd for $C_{32}H_{28}N_6O_6$: C 64.86; H 4.76; N 14.18. Found: C 64.57; H 4.88; N 14.19. IR (cm^{-1}): 1720, 1670, 1660, 1490, 1310, 1130, 1030, 790, 770. ^{1}H NMR (DMSO-d_6): δ 1.28 (t, 6H, *J* = 7.2 Hz, OCH_2CH_3); 4.28 (q, 4H, *J* = 7.2 Hz, OCH_2CH_3); 4.61 (s, 4H, CH_2); 7.17–7.22 (m, 2H, Ph); 7.42–7.47 (m, 4H, Ph); 8.15–8.19 (m, 6H, Ph, 4-H); 8.78 (d, 2H, *J* = 1.7 Hz, 6-H).

ACKNOWLEDGEMENTS

The financial support from the Ministry of Education, Science and Sport, Slovenia, through grant PS-502-0103, is gratefully acknowledged. The crystallographic data were collected on the Nonius Kappa CCD diffractometer in the Laboratory of Inorganic Chemistry, Faculty of Chemistry and Chemical Technology, University of Ljubljana, Slovenia. We acknowledge with thanks the financial contribution of the Ministry of Education, Science and Sport, Republic of Slovenia through grants X-2000, PS-511-103 and Z1-3246.

REFERENCES

1. J.-C. Milhavet, A. Gueffier, S. Bernal, and J.-C. Tenlade, *Heterocycles*, 1999, **51**, 1661.
2. P. Marakos, N. Pouli, D. S. Wise, and L. B. Townsend, *Synlett*, 1997, 561.
3. A. Ellis, C. G. Li, and M. Rand, *Eur. J. Pharmacol.*, 1998, **356**, 41.
4. L. M. Ovcharova, I. M. Zasosova, L. N. Gerchikov, E. S. Gorovchinskaya, and S. S. Liberman, *Khim. Farm. Zh.*, 1973, **7** (N11), 57 (*Chem. Abstr.*, 1974, **80**, 47949h).
5. A. H. Ratcliffe and B. B. Masek, PCT Int. Appl. WO 94 03,453, 1994 (*Chem. Abstr.*, 1994, **120**, 270465n).
6. G. M. Shutske, K. J. Kapples, and J. D. Tomer, US Patent 5,264, 576, 1993 (*Chem. Abstr.*, 1994, **120**, 217669f).
7. H. I. El-Subbagh, S. M. Abu-Zaid, M. A. Mahran, F. A. Badria, and A. M. Al-Obaid, *J. Med. Chem.*, 2000, **43**, 2915.
8. For a review see: a) J. V. Greenhill, *Pyrazoles with Fused Six-membered Heterocyclic Rings*. In *Comprehensive Heterocyclic Chemistry*; ed. by A. R. Katritzky, C. W. Rees, and K. T. Potts, Pergamon Press, Oxford 1984, Vol. 5, pp. 305–343; L. B. Townsend and D. S. Wise, *Bicyclic 5-6 Systems: Three Heteroatoms 2:1*. In Comprehensive Heterocyclic Chemistry II; ed. by A. R. Katritzky, C. W. Rees, and E. F. V. Scriven, Elsevier Science Ltd., Oxford, 1996, Vol. 7, ed. by C. A. Ramsden, pp. 283–349.
9. P. Molina, E. Aller, and A. Lorenzo, *Tetrahedron*, 1991, **47**, 6737.
10. W. Oppolzer, *Tetrahedron Lett.*, 1970, 3091.
11. V. I. Tyvorskii, D. N. Bobrov, O. G. Kulinkovich, K. A. Tehrani, and N. De Kimpe, *Tetrahedron*, 2001, **57**, 2051.
12. W. J. Michaely, J. K. Curtis, and C. G. Knudsen, US Patent 5,300,478, 1994 (*Chem. Abstr.*, 1994, **121**, 57503n).

13. H. Fukui, K. Inoguchi, and J. Nakano, *Heterocycles*, 2002, **56**, 257.
14. K. Bodendorf and P. Niemeitz, *Arch. Pharm.*, 1957, **290**, 494.
15. S. Hünig and G. Köbrich, *Ann. Chem.*, 1958, **617**, 181.
16. K.-Y. Tserng and L. Bauer, *J. Heterocycl. Chem.*, 1974, 163.
17. D. Donati, S. Fusi, F. Ponticelli, and P. Tedeschi, *Heterocycles*, 1988, **27**, 1899.
18. D. Bevk, R. Jakše, J. Svete, A. Golobič, L. Golič, and B. Stanovnik, *Heterocycles*, 2003, **61**, 197.
19. For reviews see: a) B. Stanovnik and J. Svete, *Synlett*, 2000, 1077; b) B. Stanovnik and J. Svete, *Targets Heterocyclic Systems*, 2000, **4**, 105; c) B. Stanovnik, *J. Heterocycl. Chem.*, 1999, **36**, 1581; d) J. Svete, *J. Heterocycl. Chem.*, 2002, **39**, 437.
20. a) S. Golič Grdadolnik and B. Stanovnik, *Magn. Res. Chem.*, 1997, **35**, 482; b) P. Fischer, E. Schweizer, J. Langer, and U. Schmidt, *Magn. Res. Chem.*, 1994, **32**, 567; b) M. Škof, J. Svete, B. Stanovnik, L. Golič, S. Golič Grdadolnik, and L. Selič, *Helv. Chim. Acta*, 1998, **81**, 2332; c) U. Grošelj, S. Rečnik, J. Svete, A. Meden, and B. Stanovnik, *Tetrahedron Asymmetry*, 2002, **13**, 821.
21. Z. Otwinowski and W. Minor, *Methods Enzymol.*, 1997, **276**, 307.
22. A. Altomare, M. C. Burla, M. Camalli, G. Dascarano, C. Giacovazzo, A. Guagliardi, and G. J. Polidori, *Appl. Cryst.*, 1994, **27**, 435.
23. S. R. Hall, G. S. D. King, and J. M. Stewart, *The Xtal3.4 User's Manual,* University of Western Australia, Lamb, Perth, 1995.
24. C. K. Johnson, *ORTEPII*, Report ORNL-5138. Oak Ridge National Laboratory, Tennessee, USA, 1976.