Reaction of Ethyl 3-Ethoxymethylene-2,4-dioxovalerate and Ethyl Ethoxymethyleneoxaloacetate with 3-Aminopyrazole Analogs. Synthesis and Chemistry of 3,6,7-Trisubstituted Pyrazolo[1,5-*a*]pyrimidine Derivatives (1)

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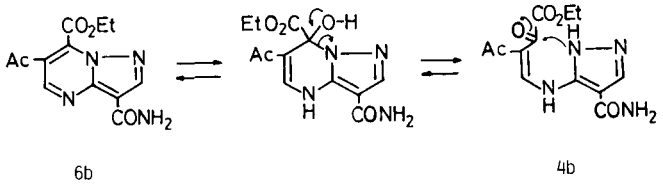
The chemical reactivity of a series of 3-substituted-6-acetyl-7-carbethoxypyrazolo[1,5-*a*]pyrimidines (**6a,b,c**) and 3-substituted-6,7-dicarbethoxypyrazolo[1,5-*a*]pyrimidines (**7a,b,c**), prepared by the condensations of the 3-aminopyrazole analogs (**3a,b,c**) with ethyl 3-ethoxymethylene-2,4-dioxovalerate (**1**) or ethyl 3-ethoxymethyleneoxaloacetate (**2**), was investigated. Catalytic hydrogenation of **6** or **7** afforded 4,7-dihydro derivatives (**8** or **9**). Treatment of **6a,b** with acetic acid and water underwent ring transformation into 6*H*-pyrazolo[1,5-*a*][1,3]diazepin-6-ones (**17a,b**). By treatment with phenylhydrazine compounds of type **6** underwent cyclization to yield 2*H*-dipyrazolo[1,5-*a*:4',3'-*e*]pyrimidines (**18a,b,c**). Compounds **6** or **7** were treated with an excess of diazomethane at room temperature to give 5-methyl-6*H*-cyclopropa[5a,6a]pyrazolo-[1,5-*a*]pyrimidines (**24** and **25**) in excellent yields. However, when this reaction was carried out under ice cooling, only compounds of type **23** were isolated. Reaction of **6a** with ethyl diazoacetate is also described.

J. Heterocyclic Chem., **18**, 163 (1981).

The synthesis of some derivatives of pyrazolo[1,5-*a*]-pyrimidine have hitherto been reported by many workers (2), but there is no report on the synthesis of pyrazolo-[1,5-*a*]pyrimidine having three carbonyl groups at position 3, 6 and 7. Recently, in a short communication (4) we reported the reaction of ethyl 3-ethoxymethylene-2,4-dioxovalerate (**1**) with 2-substituted-3-aminopyrazole-4-carboxamides to give pyrrolo[1,2-*a*]pyrazolo[3,4-*e*]pyrimidines (3), and with 3-aminopyrazole-4-carboxamide (**3b**) to afford 6-acetyl-7-carbethoxypyrazolo[1,5-*a*]pyrimidine-3-carboxamide (**6b**).

During the measurement of proton nmr spectra we observed that compound **6b**, when treated with deuterium oxide, readily changed partially to ethyl 3-(4-carbamoyl-3-pyrazoloamino)methylene-2,4-dioxovalerate (**4b**) to react with water as shown below.



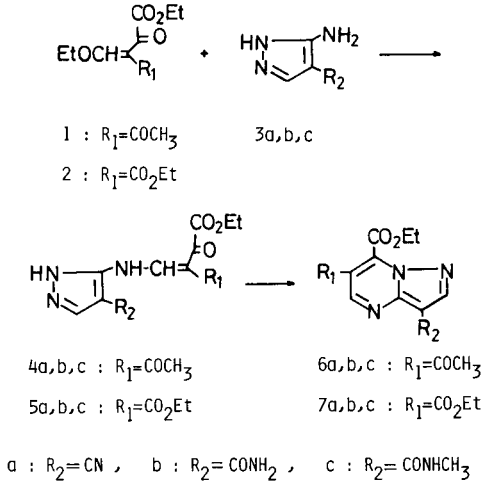
6b 4b

Scheme I

This result strongly prompted us to examine the chemical reactivity of a series of 3,6,7-trisubstituted-pyrazolo[1,5-*a*]pyrimidines. This paper describes the results.

Synthesis.

Condensation of **1** and ethyl ethoxymethyleneoxaloacetate (**2**) (5) with aminopyrazole analogs (**3a,b,c**) in ethanol or methanol in ice cooling or at room temperature



Scheme II

afforded the 3-aminomethylene derivatives (**4a,b,c** and **5a,b,c**) in 85-95% yields, the physical and analytical data of which are listed in Table I.

These were further cyclized by refluxing in ethanol or dimethylformamide to give 3-substituted-6-acetyl-7-carbethoxypyrazolo[1,5-*a*]pyrimidines (**6a,b,c**) and 3-substituted-6,7-dicarbethoxypyrazolo[1,5-*a*]pyrimidines (**7a,b,c**) in a moderate yield, the structural assignments of which were based on their elemental and spectral analysis. The reaction conditions, yields, spectral and analytical data are listed in Tables II and III. Direct cyclization is possible, but provides lower yields in some cases.

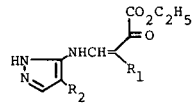
Catalytic Hydrogenation.

Catalytic hydrogenation of **6a** in the presence of 5%

0022-152X/81/010163-11$02.25

Table I

Physical Data for 3-Pyrazoloaminomethylene Derivatives

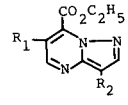


Compound No.	R_1	R_2	M.p. (°C) (a)	Formula	Analyses (%) Calcd. (Found) C	H	N
4a	$COCH_3$	CN	162-163	$C_{12}H_{12}N_4O_4$	52.17 (52.17)	4.38 (4.39)	20.28 (20.10)
4b	$COCH_3$	$CONH_2$	146-147	$C_{12}H_{14}N_4O_5$	48.98 (48.73)	4.80 (4.70)	19.04 (18.83)
4c	$COCH_3$	$CONHCH_3$	202-203	$C_{13}H_{16}N_4O_5$	50.64 (50.77)	5.23 (5.15)	18.18 (18.12)
5a (b)	$CO_2C_2H_5$	CN					
5b	$CO_2C_2H_5$	$CONH_2$	184-186	$C_{13}H_{16}N_4O_6$	48.15 (48.17)	4.97 (5.09)	17.28 (17.45)
5c	$CO_2C_2H_5$	$CONHCH_3$	175-177	$C_{14}H_{18}N_4O_6$	49.70 (49.92)	5.36 (5.27)	16.56 (16.65)

(a) All compounds were analysed without recrystallization. (b) Could not be isolated in a pure form.

Table II

Physical Data for Pyrazolo[1,5-*a*]pyrimidine Derivatives



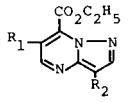
Compound No.	R_1	R_2	Reaction Condition	Yield (%)	M.p. (°C) (Recrystallization Solvent)	Formula	Analyses (%) Calcd. (Found) C	H	N
6a	$COCH_3$	CN	ethanol/reflux 5 minutes	100	152-153 (ethanol)	$C_{12}H_{10}N_4O_3$	55.81 (55.73)	3.90 (4.10)	21.70 (21.79)
6b	$COCH_3$	$CONH_2$	ethanol/reflux 5 minutes	98	202-204 (ethanol)	$C_{12}H_{12}N_4O_4$	52.17 (52.32)	4.38 (4.29)	20.28 (20.16)
6c	$COCH_3$	$CONHCH_3$	DMF/reflux 8 minutes	63.9	192-193 (ethyl acetate)	$C_{13}H_{14}N_4O_4$	53.79 (53.83)	4.86 (4.90)	19.30 (19.42)
7a	$CO_2C_2H_5$	CN	ethanol/reflux 5 minutes	92.5 (a)	105-106 (ethanol)	$C_{13}H_{12}N_4O_4$	54.16 (54.13)	4.20 (4.20)	19.44 (19.71)
7b	$CO_2C_2H_5$	$CONH_2$	ethanol/reflux 5 minutes	94.9	189-190 (ethanol)	$C_{13}H_{14}N_4O_5$	50.98 (51.16)	4.61 (4.41)	18.29 (18.19)
7c	$CO_2C_2H_5$	$CONHCH_3$	DMF/reflux 15 minutes	91.6	160-162 (ethanol)	$C_{14}H_{16}N_4O_5$	52.49 (52.69)	5.04 (5.19)	17.49 (17.41)

(a) Calculated from **3a**.

palladium-carbon as a catalyst under atmospheric pressure gave the 4,7-dihydro derivative (**8a**) in 82% yield. This compound showed one proton singlet at δ 5.62 of position 7 as well as two singlet at δ 8.0 and 7.82 due to position 2 and 5 in its proton nmr spectrum. Alkaline hydrolysis gave the corresponding carboxylic acid (**10a**). Facile decarboxylation by dehydrogenation of **10a** with manganese dioxide in dimethylsulfoxide afforded 6-acetylpyrazolo[1,5-*a*]pyrimidine-3-carbonitrile (**15a**).

Table III

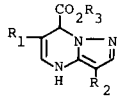
Spectral Data for Pyrazolo[1,5-*a*]pyrimidine Derivatives



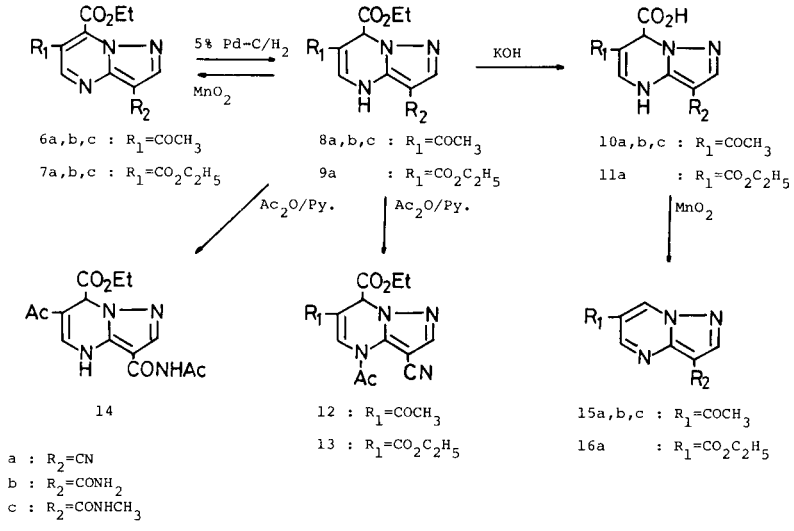
Compound No.	Ir ν Max Cm^{-1} NH	CN	CO	Uv λ Max Nm (log ϵ)	$CO_2CH_2CH_3$	$COCH_3$	C_2-H	C_5-H
6a		2240	1750 1690	250 (4.37) 308 (3.86) 360 (3.94)	1.37 (3H, t) 4.50 (2H, q)	2.55	9.0	9.47
6b	3400		1760 1695 1660	257 (4.40) 312 (3.90)	1.47 (3H, t) 4.57 (2H, q)	2.77	8.85	9.50
6c	3380		1740 1690 1640		1.37 (3H, t) 4.55 (2H, q)	2.75	8.75	9.35
7a		2240	1750 1710	245 (4.54) 292, 303 (3.76) 345 (3.50)	1.35 (6H, m) 4.50 (4H, m)		9.05	9.27
7b	3440		1740 1720 1650		1.35 (6H, m) 4.50 (4H, m)		8.80	9.20
7c	3400		1750 1730 1660		1.35 (6H, m) 4.45 (4H, m)		8.77	9.15

Table IV

Physical Data for 4,7-Dihydropyrazolo[1,5-*a*]pyrimidine Derivatives



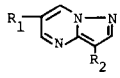
Compound No.	R_1	R_2	R_3	M.p. (°C) (Recrystallization Solvent)	Formula	Analyses (%) Calcd. (Found) C	H	N
8a	$COCH_3$	CN	C_2H_5	209-210 (ethanol)	$C_{12}H_{12}N_4O_3$	55.38 (55.59)	4.65 (4.60)	21.53 (21.40)
8b	$COCH_3$	$CONH_2$	C_2H_5	237-238 (methanol)	$C_{12}H_{14}N_4O_4$	51.76 (51.83)	5.07 (4.93)	20.14 (20.01)
8c	$COCH_3$	$CONHCH_3$	C_2H_5	238-239 (ethanol)	$C_{13}H_{16}N_4O_4$	53.42 (53.55)	5.52 (5.56)	19.17 (19.37)
9a	$CO_2C_2H_5$	CN	C_2H_5	176-177 (isopropyl alcohol)	$C_{13}H_{14}N_4O_4$	53.79 (53.74)	4.86 (4.77)	19.30 (19.15)
10a	$COCH_3$	CN	H	258-259 (water)	$C_{10}H_8N_4O_3$	51.72 (51.69)	3.47 (3.50)	24.13 (24.33)
10b	$COCH_3$	$CONH_2$	H	293-295 (water)	$C_{10}H_{10}N_4O_4$	48.00 (47.94)	4.02 (3.87)	22.39 (22.46)
10c	$COCH_3$	$CONHCH_3$	H	297-299 (water)	$C_{11}H_{12}N_4O_4$	50.00 (50.17)	4.58 (4.40)	21.20 (21.39)
11a	$CO_2C_2H_5$	CN	H	199-203 (water)	$C_{11}H_{10}N_4O_4$	50.38 (50.11)	3.84 (3.62)	21.37 (21.34)



Scheme III

Table V

Physical Data for Pyrazolo[1,5-*a*]pyrimidine Derivatives



Compound No.	R_1	R_2	M.p. (°C) (Recrystallization Solvent)	Formula	Analyses (%) Calcd. (Found) C	H	N
15a	$COCH_3$	CN	203-204 (methanol)	$C_9H_6N_4O$	58.06 (57.95)	3.25 (3.30)	30.10 (30.03)
15b	$COCH_3$	$CONH_2$	289-290 (ethanol)	$C_9H_8N_4O_2$	52.94 (52.71)	3.95 (4.10)	27.44 (27.36)
15c	$COCH_3$	$CONHCH_3$	208-210 (ethanol)	$C_{10}H_{10}N_4O_2$	55.04 (55.01)	4.62 (4.57)	25.68 (25.48)
16a	$CO_2C_2H_5$	CN	130-131 (ethanol)	$C_{10}H_8N_4O_2$	55.55 (55.76)	3.73 (3.62)	25.92 (25.84)

Analogously, compounds **6b,c** and **7a** were reacted to give **8a,c, 9a, 10b,c, 11a, 15b,c** and **16a** under the same conditions. All analytical and physical data are listed in Tables IV and V.

When the dihydro derivatives (**8a,b, 9a**) were treated with acetic anhydride and pyridine, the mono-acetates (**12-14**) were obtained, respectively. The structure for the acetates was suggested on the bases of uv spectral data. Namely, while the spectrum of **14** is quite similar to that of **8a, 12** showed the absorption maxima at 246 and 289 nm as shown in Figure 1. These data clearly show that the acetyl group is introduced at position 4 in compound **12** or **13**, and at the carbamoyl group in **14**.

Reaction with Acetic Acid and Water.

When the compound **6a** was cautiously treated with acetic acid and water at 70°, 8-carbethoxy-3-cyano-7-methyl-6*H*-pyrazolo[1,5-*a*][1,3]diazepin-6-one (**17a**), which has the same empirical formula as **6a**, was obtained in 74.4% yield. Compound **17a** exhibited the absorption bands in the ir at 2230 and 1700 cm^{-1} for the nitrile and carbonyl groups. A peak corresponding at [M^+-43 ($COCH_3$)] was not observed in the mass spectrum of **17a**. The detailed proton nmr analysis and carbon-13 nmr analysis with off-resonance decoupling characterized the molecule completely as shown in the Experimental. Similar to the nitrile, **6b** reacted with acetic acid and

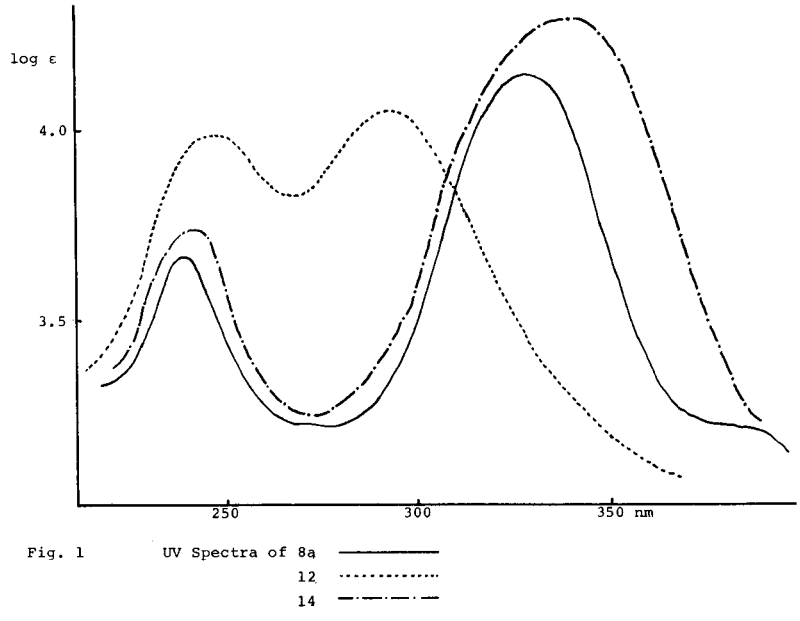
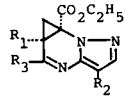


Figure 1. UV Spectra of 8a____ 12------- 14__.__.__.

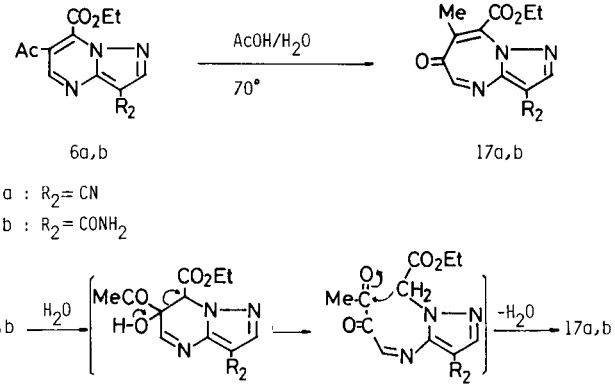
Table VI

Physical Data for 6*H*-Cyclopropapyrazolo[1,5-*a*]pyrimidines Derivatives



Compound No.	R_1	R_2	R_3	Yield (%)	M.p. (°C)	Formula	Analyses (%) Calcd. / Found C	H	N
23a	$COCH_3$	CN	H	93	147-148 (benzene-ligroin)	$C_{13}H_{12}N_4O_3$	57.35 (57.57)	4.44 (4.40)	20.58 (20.69)
23b	$COCH_3$	$CONH_2$	H	90	152-153 (benzene)	$C_{13}H_{14}N_4O_4$	53.79 (53.51)	4.86 (5.02)	19.30 (19.43)
23c	$COCH_3$	$CONHCH_3$	H	67	152-153 (ethyl acetate-ligroin)	$C_{14}H_{16}N_4O_4$	55.25 (55.13)	5.30 (5.24)	18.41 (18.37)
24a	$COCH_3$	CN	CH_3	100	134-135 (ethanol)	$C_{14}H_{14}N_4O_3$	58.73 (58.88)	4.93 (4.89)	19.57 (19.60)
24b	$COCH_3$	$CONH_2$	CH_3	61	176-177 (ethyl acetate)	$C_{14}H_{16}N_4O_4$	55.25 (55.47)	5.30 (5.37)	18.41 (18.60)
24c	$COCH_3$	$CONHCH_3$	CH_3	80	131-133 (ligroin)	$C_{15}H_{18}N_4O_4$	56.59 (56.64)	5.70 (5.66)	17.60 (17.63)
25a	$CO_2C_2H_5$	CN	CH_3	100	124-125 (isopropyl alcohol)	$C_{15}H_{16}N_4O_4$	56.96 (57.05)	5.10 (5.12)	17.71 (17.52)
25b	$CO_2C_2H_5$	$CONH_2$	CH_3	91	157-158 (ethanol)	$C_{15}H_{18}N_4O_5$	53.88 (53.94)	5.43 (5.69)	16.76 (16.77)
25c	$CO_2C_2H_5$	$CONHCH_3$	CH_3	85	159-160 (benzene-ligroin)	$C_{16}H_{20}N_4O_5$	55.16 (55.45)	5.79 (6.02)	16.08 (15.85)

water to yield **17b** under the same conditions in 82% yield. A plausible mechanism for the formation of diazepines is included in Scheme IV. Reaction of **7a**, however, with aqueous acetic acid was much less facile than that of **6a,b**, and resulted only in the formation of **7b** under more drastic condition.

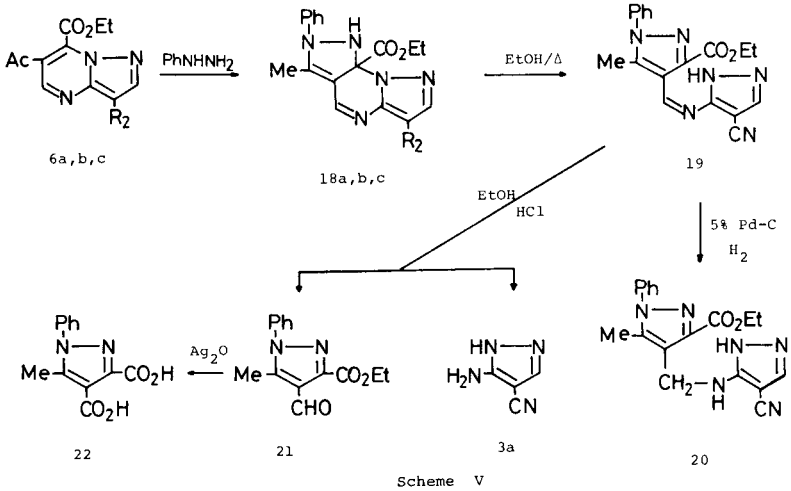


Scheme IV

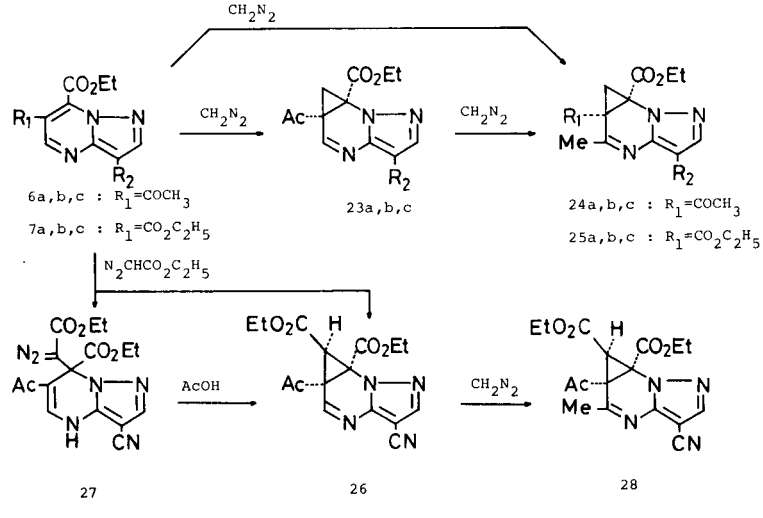
Reaction with Phenylhydrazine.

Compounds **6a,b,c** reacted with phenylhydrazine in ethanol at room temperature to yield 1,9a-dihydro-2*H*-dipyrazolo[1,5-*a*:4',3'-*e*]pyrimidine derivatives (**18a,b,c**), all of which are derivatives of a new ring system, in yields of 13, 38 and 29%, respectively.

The structure of these compounds was infered from analytical and spectral data, and finally confirmed by the following chemical reactions. When the reaction of **6a** with phenylhydrazine was carried out in refluxing ethanol, ethyl 4-(4-cyano-3-pyrazoleiminomethyl)-5-methyl-1-phenylpyrazole-3-carboxylate (**19**), which was alternatively obtained by just refluxing **18a** in ethanol with cleavage of the 9-9a bond, was isolated. The latter compound was catalytically hydrogenated to yield **20**, and also hydrolyzed with ethanolic hydrochloric acid to yield a mixture of **3a** and the aldehyde (**21**), which was subsequently oxidized with silver oxide (6) to the known 5-methyl-1-phenylpyrazole-3,4-dicarboxylic acid (**22**) (7). Formation of **18a,b,c** proceeds through nucleophilic addition of



Scheme V



Scheme VI

phenylhydrazine on the reactive 7-position of the pyrimidine ring.

Reaction with Diazomethane Analogs.

Compounds of type **6** having the acetyl group at the 6-position reacted with diazomethane under ice cooling to give the 6*H*-cyclopropa[5a,6a]pyrazolo[1,5-*a*]pyrimidines (**23a,b,c**) in good yield. However, when this reaction was performed at room temperature for a prolonged period of time, 5-methyl-6*H*-cyclopropa[5a,6a]pyrazolo[1,5-*a*]pyrimidines (**24a,b,c**) could be successfully obtained. In contrast, attempts to isolate the product corresponding to **23** from compounds of type **7** were unsuccessful, even in a short reaction time under ice cooling, giving a mixture of **25a,b,c** and the starting materials.

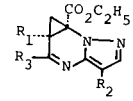
The structures of these compounds were established mainly from their proton nmr spectra. For instance, the signals of the methylene protons on the cyclopropane ring (δ 1.65 and 2.69 in **23a**, and δ 1.62 and 2.81 in **24a**) each gave a doublet with a coupling constant of 6 Herz. Analytical and spectral data of these compounds are listed in Tables VI and VII. Detailed assignments of C-13 nmr of the typical example are included in the Experimental

Further, compound **6a** reacted with ethyl diazoacetate in dioxane in the presence of copper as a catalyst at 70° to yield a mixture of the 6-carbethoxy-6*H*-cyclopropa[5a,6a]-pyrazolo[1,5-*a*]pyrimidine (**26**) and the unexpected product (**27**) in yields of 61 and 2.2%. Compound **26**, upon treatment with diazomethane at room temperature, afforded the C_5-methyl derivative (**28**) in 89% yield. Both products (**26** and **28**) were found to be homogeneous, and their stereochemistry appear to be *trans* (8), because the methine proton on the cyclopropane ring at δ 2.65 and 2.88, respectively, appeared as a singlet shifted downfield by the anisotropic effects of the acetyl and ester carbonyl groups located on the same side (9).

Product **27**, having an empirical formula of $C_{16}H_{16}N_6O_5$, showed strong bands in the ir at 2220 and 2130 cm^{-1} for the nitrile and diazo groups. The uv spectrum of **27** showed a close similarity to that of 4,7-dihydropyrazolopyrimidine (**8a**). Additionally, comparing the carbon chemical shift of **27** with **8a**, the structure of **27** was assigned as ethyl 6-acetyl-7-carbethoxy-3-cyano-4,7-dihydropyrazolo-[1,5-*a*]pyrimidine-7-diazoacetate. The diazo compound (**27**) readily underwent cyclization into **26** on treatment with acetic acid, while it was stable on heating with copper

Table VII

Spectral Data for 6*H*-Cyclopropapyrazolo[1,5-*a*]pyrimidine Derivatives



Compound No.	Ir ν Max Cm^{-1}			Pmr (DMSO-d_6) δ					
	NH	CN	CO	$CO_2CH_2CH_3$	$COCH_3$	C_5-CH_3	C_6-H_2	C_2-H	C_5-H
22a		2240	1750, 1715	1.17 (3H, t) 4.15 (2H, q)	2.53		1.65 (d)[(a)] 2.69 (d)	8.19	8.90
22b	3460		1730, 1710 1670	1.15 (3H, t) 4.15 (2H, q)	2.53		1.55 (d) 2.65 (d)	7.93	8.90
22c	3360		1750, 1710 1640	1.15 (3H, t) 4.15 (2H, q)	2.50		1.55 (d) 2.70 (d)	7.90	8.85
23a		2240	1750, 1705	1.14 (3H, t) 4.16 (2H, q)	2.43	2.35	1.62 (d) 2.81 (d)	8.14	
23b	3400		1740, 1700 1660	1.15 (3H, t) 4.25 (2H, q)	2.50	2.40	1.55 (d) 2.85 (d)	8.00	
23c	3360		1740, 1710 1650	1.15 (3H, t) 4.15 (2H, q)	2.47	2.35	1.50 (d) 2.75 (d)	7.87	
24a		2220	1750	1.20 (6H, m) 4.20 (4H, m)		2.50	1.75 (d) 2.73 (d)	8.20	
24b	3400		1740, 1650	1.17 (6H, m) 4.20 (4H, m)		2.50	1.65 (d) 2.65 (d)	7.90	
24c	3360		1760, 1650	1.20 (6H, m) 4.20 (4H, m)		2.52	1.65 (d) 2.69 (d)	7.88	

(a) The coupling constants of doublet are 6 Hz.

in dioxane at 70°. In the case of the reaction of **7a** with ethyl diazoacetate under the same condition, only the starting material recovered unchanged.

EXPERIMENTAL

Melting points were determined using Yanagimoto micro melting point apparatus and uncorrected. The ultraviolet and infrared spectra were obtained, respectively, with a JASCO Model IRA-1 as potassium bromide tablets and a Schimadzu Uv-200 spectrophotometer as solutions in 95% ethanol. The proton nmr spectra were recorded on a Hitachi R-40 spectrometer with tetramethylsilane as an internal standard in deuteriodimethylsulfoxide. C-13 nmr spectra were recorded on a JEOL FX-100 spectrometer in deuteriodimethylsulfoxide. Mass spectra were taken in a Hitachi RMU-7L. The synthetic methods for the 3-pyrazoleaminomethylene derivatives (Table I) as well as for some reaction products (Tables IV and V) were described in detail for the particular type as examples, other compounds in the table (Tables IV and V) having only all analytical and physical data.

Ethyl 3-(4-Cyanopyrazoleamino)methylene-2,4-dioxovalerate (**4a**, Table I).

To a solution of 1.08 g. (0.01 mole) of **3a** in 30 ml. of ethanol was added 2.14 g. (0.01 mole) of **1** dissolved in 10 ml. of ethanol with stirring under ice cooling. The precipitate formed was collected by filtration, washed with cold ethanol and dried giving 2.54 g. (92%) of pale yellow powder of **4a**, m.p. 162-163°; ir: ν max cm^{-1} 2235, 1740, 1600; pmr δ 1.10 (3H, t, J = 6 Hz, CH_2CH_3), 2.25 (3H, s, $COCH_3$), 4.05 (2H, q, J = 6 Hz, CH_2CH_3), 7.13 (1H, s, NHC*H*), 7.80 (1H, s, NH), 7.93 (1H, s, CH).

Ethyl 3-(4-Methylcarbamoylamino)methylene-2,4-dioxovalerate (**4c** Table I).

To a solution of 1.39 g. (0.01 mole) of **3c** in 40 ml. of methanol was added 2.14 g. (0.01 mole) of **1** dissolved in 10 ml. of methanol with stirring at room temperature. The precipitate formed was collected by filtration, washed with cold methanol, and dried giving 2.80 g. (90.2%) of pale yellow powder of **4c**, m.p. 202-203°; ir: ν max cm^{-1} 3400, 1750, 1640, 1600; pmr: δ 1.09 (3H, t, J = 6 Hz, CH_2CH_3), 2.22 (3H, s, $COCH_3$), 2.90 (3H, d, J = 5 Hz, $NHCH_3$), 4.10 (2H, q, J = 6 Hz, CH_2CH_3), 7.75 and 7.88 (each 1H, each s, 2 × CH).

Ethyl 3-(4-Carbamoylamino)methyleneoxaloacetate (**5b**, Table I).

To a solution of 1.26 g. (0.01 mole) of **3b** in 30 ml. of ethanol was added 2.44 g. (0.01 mole) of **2** dissolved in 10 ml. of ethanol with stirring under ice cooling. The precipitate formed was collected by filtration, washed with cold ethanol and dried giving 2.61 g. (80.5%) of pale yellow powder of **5b**, m.p. 184-186°; ir: ν max cm^{-1} 3300, 1750, 1690, 1650, 1600; pmr: δ 1.20 (6H, m, 2 × CH_2CH_3), 4.10 (4H, m, 2 × CH_2CH_3), 7.60 (1H, d, J = 6 Hz, NHC*H*), 7.95 (1H, s, CH), 10.45 (1H, d, J = 6 Hz, NH).

General Preparaton of 3,6,7-Trisubstituted-pyrazolo[1,5-*a*]pyrimidines (**6a,b,c** and **7a,b,c**, Tables II and III).

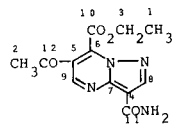
Method a).

A suspension of 0.01 mole of **4a,c** or **5a,c** in 50 ml. of ethanol was refluxed for 5 minutes. After cooling, the precipitate was collected by filtration and recrystallized.

Method b).

A suspension of 0.01 mole of **4b** or **5b** in 30 ml. of dimethylformamide was refluxed. The solvent was evaporated *in vacuo*, and the residue was recrystallized.

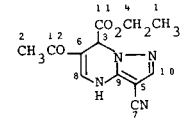
C-13 Nmr (off-resonance decoupling with correct multiplicities) of **6b** showed 12 signals assigned as indicated in the structure diagram.



C atom	ppm	C atom	ppm
1	13.95	7	145.78
2	27.95	8	149.25
3	63.22	9	153.07
4	106.62	10	159.81
5	115.85	11	161.80
6	139.20	12	194.11

Ethyl 6-Acetyl-3-cyano-4,7-dihydropyrazolo[1,5-*a*]pyrimidine-7-carboxylate (**8a**, Table IV).

A solution of 258 mg. (1 mmole) of 6-acetyl-3-cyanopyrazolo[1,5-*a*]-pyrimidine-7-carboxylate (**6a**) and 90 mg. of 5% palladium-carbon in 30 ml. of methanol was hydrogenated using a Skita apparatus for 10 hours. The catalyst was removed by filtration, and the filtrate was evaporated *in vacuo*. The residue obtained was recrystallized from ethanol giving 201 mg. (78%) of colorless crystal of **8a**; ir: ν max cm^{-1} 3150, 2230, 1740, 1660; pmr: δ 1.13 (3H, t, J = 6 Hz, CH_2CH_3), 2.30 (3H, s, $COCH_3$), 4.05 (2H, q, J = 6 Hz, CH_2CH_3), 5.63 (1H, s, C_7-H), 7.83 (1H, s, C_5-H), 8.0 (1H, s, C_2-H); uv: λ max nm (log ϵ) 325 (4.16), 377 (3.53); ms: m/e 260 (M^+), 187 ($M^+ - CO_2C_2H_5$) (base peak). C-13 Nmr (off-resonance decoupled with correct multiplicities) showed 12 signals as indicated in the structure diagram.



C atom	ppm	C atom	ppm
1	13.73	7	112.72
2	24.59	8	136.67
3	58.06	9	141.07
4	61.23	10	142.54
5	75.03	11	168.14
6	108.61	12	193.09

Ethyl 6-Acetyl-4,7-dihydro-3-methylcarbamoylpyrazolo[1,5-*a*]pyrimidine-7-carboxylate (**8c**, Table IV).

A mixture of 290 mg. (1 mmole) of 6-acetyl-3-methylcarbamoylpyrazolo[1,5-*a*]pyrimidine-7-carboxylate (**6c**) and 90 mg. of 5% palladium-carbon in 30 ml. of methanol was hydrogenated for 10 hours. The catalyst was removed by filtration, and the filtrate was evaporated *in vacuo*. The residue obtained was recrystallized from ethanol giving 220 mg. (75%) of colorless needles of **8c**; ir: ν max cm^{-1} 3400, 1750, 1630; pmr: δ 1.12 (3H, t, J = 6 Hz, CH_2CH_3), 2.23 (3H, s, $COCH_3$), 2.73 (3H, d, J = 5 Hz, $NHCH_3$), 4.05 (2H, q, J = 6 Hz, CH_2CH_3), 5.58 (1H, s, C_7-H), 7.65 (1H, d, J = 3 Hz, C_5-H), 8.10 (1H, d, J = 5 Hz, $NHCH_3$), 8.89 (1H, s, C_2-H), 10.15 (1H, d, J = 3 Hz, NH).

Diethyl 3-Cyano-4,7-dihydropyrazolo[1,5-*a*]pyrimidine-6,7-dicarboxylate (**9a**).

A mixture of 288 mg. (1 mmole) of diethyl 3-cyanopyrazolo[1,5-*a*]-pyrimidine-6,7-dicarboxylate (**7a**) and 90 mg. of 5% palladium-carbon in 20 ml. of methanol was hydrogenated for 10 hours. The catalyst was removed by filtration, and the filtrate was evaporated *in vacuo*. The residue obtained was recrystallized from isopropyl alcohol giving 220 mg. (75.5%) of colorless needles of **9a**; ir: ν max cm^{-1} 3200, 2230, 1740,

1660; pmr: δ 1.20 (6H, t, J = 6 Hz, 2 × CH_2CH_3), 4.14 (4H, q, J = 6 Hz, 2 × CH_2CH_3), 5.70 (1H, s, C_7-H), 7.55 (1H, s, C_5-H), 8.0 (1H, s, C_2-H), 11.46 (1H, s, NH).

Manganese Dioxide Oxidation of **8a**.

A mixture of 260 mg. (1 mmole) of **8a** and 1.30 g. of manganese dioxide in 10 ml. of dimethylformamide was stirred at room temperature for 10 hours. Manganese dioxide was removed by filtration, and the filtrate was evaporated *in vacuo*. The resulting solid was recrystallized from ethanol giving 210 mg. (81.4%) of **6a** which was identical with the authentic sample in all aspects.

6-Acetyl-3-cyano-4,7-dihydropyrazolo[1,5-*a*]pyrimidine-7-carboxylic Acid (**10a**, Table IV).

A solution of 260 mg. (1 mmole) of **8a** and 140 mg. (2.5 mmole) of potassium hydroxide in 20 ml. of 95% ethanol was refluxed for 7 hours. Evaporation of the solvent *in vacuo* left a yellow solid, which was dissolved in 5 ml. of water. Acidification of aqueous solution by the addition of hydrochloric acid under ice cooling precipitated 182 mg. (78%) of **10a**, which was recrystallized from water giving an analytical sample as colorless needles; ir: ν max cm^{-1} 3200, 2230, 1750, 1630; pmr: δ 2.30 (3H, $COCH_3$), 5.55 (1H, s, C_7-H), 7.70 (1H, s, C_5-H), 7.90 (1H, s, C_2-H).

6-Carbethoxy-3-cyano-4,7-dihydropyrazolo[1,5-*a*]pyrimidine-7-carboxylic Acid (**11a**, Table IV).

A solution of 290 mg. (1 mmole) of **9a** and 140 mg. (2.5 mmole) of potassium hydroxide in 15 ml. of 95% ethanol was refluxed for 6.5 hours. Evaporation of the solvent *in vacuo* left a yellow solid, which was dissolved in 5 ml. of water. Acidification of the aqueous solution by the addition of hydrochloric acid under ice cooling precipitated 184 mg. (70.3%) of **11a**, which was recrystallized from water giving an analytical sample as colorless needles; ir: ν max cm^{-1} 3150, 2230, 1740, 1710; pmr: δ 1.22 (3H, t, J = 6 Hz, CH_2CH_3), 4.15 (2H, q, J = 6 Hz, CH_2CH_3), 5.60 (1H, s, C_7-H), 7.50 (1H, d, J = 5 Hz, C_5-H), 7.97 (1H, s, C_2-H), 11.35 (1H, d, J = 5 Hz, NH), 13.30 (1H, s, OH).

Ethyl 3-Cyano-4,6-diacetyl-4,7-dihydropyrazolo[1,5-*a*]pyrimidine-7-carboxylate (**12**).

A solution of 260 mg. (1 mmole) of **8a** and one drop of pyridine in 10 ml. of acetic anhydride was gently refluxed for 5 hours. After evaporation of acetic anhydride *in vacuo*, the residue was dissolved in chloroform. The chloroform solution was washed with saturated sodium bicarbonate solution, water and dried (sodium sulfate). Evaporation of the solvent resulted in a crystalline solid, which was recrystallized from a mixture of benzene-ligroin giving 251 mg. (83%) of colorless needles of **12**, m.p. 125-126°; ir: ν max cm^{-1} 2230, 1740, 1640; uv: λ max nm (log ε) 246 (4.00), 289 (4.15); pmr: δ 1.14 (3H, t, J = 6 Hz, CH_2CH_3), 2.48 (3H, s, $COCH_3$), 2.69 (3H, s, $NCOCH_3$), 4.11 (2H, q, J = 6 Hz, CH_2CH_3), 8.18 (1H, s, C_2-H), 8.21 (1H, s, C_5-H).

Anal. Calcd. for $C_{14}H_{14}N_4O_4$: C, 55.62; H, 4.67; N, 18.54. Found: C, 55.64; H, 4.79; N, 18.74.

Diethyl 4-Acetyl-3-cyano-4,7-dihydropyrazolo[1,5-*a*]pyrimidine-6,7-dicarboxylate (**13**).

A solution of 290 mg. (1 mmole) of **9a** and one drop of pyridine in 10 ml. of acetic anhydride was worked up as described for the preparation of **12** to give 287 mg. (86.5%) of colorless needles of **13**, m.p. 107-108°, recrystallized from a mixture of benzene-ligroin; ir: ν max cm^{-1} 2230, 1740, 1650; pmr: δ 1.20 (6H, t, J = 6 Hz, 2 × CH_2CH_3), 2.60 (3H, s, $COCH_3$), 4.20 (4H, q, J = 6 Hz, 2 × CH_2CH_3), 5.89 (1H, s, C_7-H), 8.03 (1H, s, C_2-H), 8.21 (1H, s, C_5-H).

Anal. Calcd. for $C_{15}H_{16}N_4O_5$: C, 54.21; H, 4.85; N, 16.86. Found: C, 54.07; H, 4.69; N, 16.99.

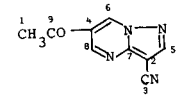
Ethyl 3-Acetocarbamoyl-6-acetyl-4,7-dihydropyrazolo[1,5-*a*]pyrimidine-7-carboxylate (**14**).

A solution of 278 mg. (1 mmole) of **8b** and two drops of pyridine in 12 ml. of acetic anhydride was gently refluxed for 6 hours. The acetic anhydride was evaporated *in vacuo*, and the residue was dissolved in chloroform. The chloroform solution was washed with saturated sodium bicarbonate solution, water and dried (sodium sulfate). After evaporation of the solvent, the resulting viscous oil was submitted on an alumina column chromatography eluted by chloroform. From the first eluate was obtained 39 mg. (12%) of **14** as colorless needles, m.p. 271-272°, recrystallized from ethanol; ir: ν max cm^{-1} 3280, 1760, 1710, 1670; uv: λ max nm (log ε) 248 (3.92), 336 (4.25); pmr: δ 1.15 (3H, t, J = 6 Hz, CH_2CH_3), 2.28 (3H, s, $COCH_3$), 2.39 (3H, s, $NCOCH_3$), 4.10 (2H, q, J = 6 Hz, CH_2CH_3), 5.65 (1H, s, C_7-H), 7.68 (1H, d, J = 6 Hz, C_5-H), 8.30 (1H, s, C_2-H), 10.50 (1H, d, J = 6 Hz, NH), 10.80 (1H, s, NH).

Anal. Calcd. for $C_{14}H_{16}N_4O_5$: C, 52.49; H, 5.04; N, 17.49. Found: C, 52.55; H, 4.99; N, 17.29.

6-Acetylpyrazolo[1,5-*a*]pyrimidine-3-carbonitrile (**15a**, Table V).

A mixture of 464 mg. (2 mmoles) of **10a** and 3 g. of manganese dioxide in 10 ml. of dimethylsulfoxide was vigorously stirred at 40° for 5 hours. Manganese dioxide was removed by filtration, and the filtrate was diluted with 50 ml. of water. After the mixture was allowed to stand overnight in a refrigerator, the resulting precipitate was collected by filtration and recrystallized from methanol giving 23 mg. (12%) of **15a** as yellow crystals; ir: ν max cm^{-1} 2230, 1680; pmr: δ 2.68 (3H, s, $COCH_3$), 8.90 (1H, s, C_2-H), 9.12 (1H, d, J = 3 Hz, C_7-H), 9.95 (1H, d, J = 6 Hz, C_5-H). C-13 Nmr (off-resonance decoupled with correct multiplicities) showed 9 signals assigned in the structure diagram.



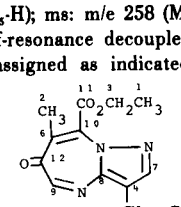
C atom	ppm	C atom	ppm
1	24.04	6	149.90
2	82.29	7	150.32
3	112.66	8	152.62
4	120.88	9	194.25
5	140.35		

Ethyl 3-Cyanopyrazolo[1,5-*a*]pyrimidine-6-carboxylate (**16a**, Table V).

A mixture of 262 mg. (1 mmole) of **11a** and 1.3 g. of manganese dioxide in 4 ml. of dimethylsulfoxide was treated as described for the preparation of **15a** giving 120 mg. (56.5%) of **16a** as yellow crystals; ir: ν max cm^{-1} 2230, 1720; pmr: δ 1.39 (3H, t, J = 6 Hz, CH_2CH_3), 4.41 (2H, q, J = 6 Hz, CH_2CH_3), 8.98 (1H, s, C_2-H), 9.18 (1H, d, J = 3 Hz, C_7-H), 9.82 (1H, d, J = 3 Hz, C_5-H).

8-Carbethoxy-3-cyano-7-methyl-6*H*-pyrazolo[1,5-*a*][1,3]diazepin-6-one (**17a**).

A solution of 258 mg. (1 mmole) of **6a** in 30 ml. of acetic acid containing 1 ml. of water was heated at 70° for 5 hours. The solution was evaporated to dryness *in vacuo* and the residue was recrystallized from ethanol giving 192 mg. (74.4%) of **17a** as colorless needles, m.p. 112-113°; ir: ν max cm^{-1} 2230, 1700, 1610; pmr: 1.33 (3H, t, J = 6 Hz, CH_2CH_3), 2.96 (3H, s, CH_3), 4.34 (2H, q, J = 6 Hz, CH_2CH_3), 8.93 (1H, s, C_2-H), 9.02 (1H, s, C_5-H); ms: m/e 258 (M^+), 185 (M^+ - $CO_2C_2H_5$) (base peak). C-13 Nmr (off-resonance decoupled with correct multiplicities) showed 12 signals assigned as indicated in the structure diagram.



C atom	ppm	C atom	ppm
1	14.09	7	149.12
2	15.32	8	150.12
3	63.64	9	152.65
4	85.01	10	153.93
5	111.72	11	161.81
6	116.54	12	183.47

Anal. Calcd. for $C_{12}H_{10}N_4O_3$: C, 55.91; H, 3.90; N, 21.70. Found: C, 55.89; H, 3.67; N, 21.86.

8-Carbethoxy-3-carbamoyl-7-methyl-6*H*-pyrazolo[1,5-*a*][1,3]diazepin-6-one (**17b**).

A solution of 276 mg. (1 mmole) of **6b** in 30 ml. of acetic acid containing 1 ml. of water was treated as described for the preparation of **17a** to give 230 mg. (83.3%) of **17b** as colorless needles, m.p. 195-196°, recrystallized from ethanol; ir: ν max cm^{-1} 3160, 1710, 1650, 1610; pmr: δ 1.35 (3H, t, J = 6 Hz, CH_2CH_3), 3.03 (3H, s, CH_3), 4.40 (2H, q, J = 6 Hz, CH_2CH_3), 7.50 (2H, bs, $CONH_2$), 8.73 (1H, s, C_2-H), 9.07 (1H, s, C_5-H); ms: m/e 276 (M^+), 203 (M^+ - $CO_2C_2H_5$) (base peak).

Anal. Calcd. for $C_{12}H_{12}N_4O_4$: C, 52.17; H, 4.38; N, 20.28. Found: C, 51.92; H, 4.53; N, 20.47.

Reactions of **6a,b,c** with Phenylhydrazine.

General Procedure.

A solution of 4 mmoles of **6a,b,c** and 6 mmoles of phenylhydrazine in 500 ml. of ethanol was stirred for 2 days at room temperature. The resulting precipitate was collected by filtration and recrystallized.

Ethyl 6-Cyano-3-methyl-2-phenyl-1,9a-dihydro-2*H*-dipyrazolo[1,5-*a*:4',3'-*e*]-pyrimidine-9a-carboxylate (**18a**).

This compound had m.p. 208-209° (from ethanol), yield 13%; ir: ν max cm^{-1} 2230, 1725; uv: λ max nm (log ϵ) 228 (4.38), 280 (4.13), 313 (4.16); pmr: δ 1.30 (3H, t, J = 6 Hz, CH_2CH_3), 2.60 (3H, s, CH_3), 4.25 (2H, q, J = 6 Hz, CH_2CH_3), 7.0-7.50 (5H, m, Ar-H), 8.75 and 8.95 (each 1H, each s, C_4- and/or C_7-H), 10.30 (1H, s, NH).

Anal. Calcd. for $C_{18}H_{15}N_6O_2$: C, 62.06; H, 4.63; N, 24.13. Found: C, 61.89; H, 4.66; N, 24.17.

Ethyl 6-Carbamoyl-3-methyl-2-phenyl-1,9a-dihydro-2*H*-dipyrazolo[1,5-*a*:4',3'-*e*]pyrimidine-9a-carboxylate (**18b**).

This compound had m.p. 214-216° (from dimethylformamide), yield 38%; ir: ν max cm^{-1} 1725, 1660; pmr: δ 1.30 (3H, t, J = 6 Hz, CH_2CH_3), 2.60 (3H, s, CH_3), 4.25 (2H, q, J = 6 Hz, CH_2CH_3), 7.0-7.60 (7H, m, Ar-H and $CONH_2$), 8.65 and 8.70 (each 1H, each s, C_4- and/or C_7-H), 10.35 (1H, s, NH).

Anal. Calcd. for $C_{18}H_{18}N_6O_3$: C, 59.01; H, 4.95; N, 22.94. Found: C, 59.01; H, 4.71; N, 23.08.

Ethyl 3-Methyl-6-methylcarbamoyl-2-phenyl-1,9a-dihydro-2*H*-dipyrazolo-[1,5-*a*:4',3'-*e*]pyrimidine-9a-carboxylate (**18c**).

This compound had m.p. 215-216° (from ethanol), yield 29%; ir: ν max cm^{-1} 3400, 1720, 1640; pmr: δ 1.26 (3H, t, J = 6 Hz, CH_2CH_3), 1.58 (3H, s, CH_3), 1.90 (3H, d, J = 5 Hz, $NHCH_3$), 4.23 (2H, q, J = 6 Hz, CH_2CH_3), 6.95-7.40 (5H, m, Ar-H), 8.60 and 8.65 (each 1H, each s, C_4-and/or C_7-H).

Anal. Calcd. for $C_{19}H_{20}N_6O_3 \cdot \frac{1}{2}\ H_2O$: C, 58.60; H, 5.39; N, 21.59. Found: C, 58.62; H, 5.46; N, 21.90.

Ethyl 4-(4-Cyano-3-pyrazoleiminomethyl)-5-methyl-1-phenylpyrazole-3-carboxylate (**19**).

A solution of 348 mg. (1 mmole) of **18a** in 100 ml. of ethanol was refluxed until the starting material disappeared. After the solvent was evaporated *in vacuo*, the residue was recrystallized from ethanol giving 314 mg. (90.3%) of **19** as colorless needles, m.p. 180-181°; ir: ν max cm^{-1} 2230, 1700; pmr: δ 1.35 (3H, t, J = 6 Hz, CH_2CH_3), 2.70 (3H, s, CH_3), 4.35 (2H, q, J = 6 Hz, CH_2CH_3), 7.62 (5H, s, Ar-H), 8.46 (1H, s, pyrazole ring-H), 9.55 (1H, s, CH).

Anal. Calcd. for $C_{18}H_{16}N_6O_2$: C, 62.06; H, 4.63; N, 24.13. Found: C, 62.31; H, 4.59; N, 24.34.

Ethyl 4-(4-Cyano-3-pyrazoleaminomethyl)-5-methyl-1-phenylpyrazole-3-carboxylate (**20**).

A mixture of 348 mg. (1 mmole) of **19** and 190 mg. of 5% palladium-carbon in 130 ml. of methanol was hydrogenated using Skita apparatus at room temperature for 12 hours. The catalyst was removed by filtration, and the filtrate was evaporated *in vacuo*. The residue was recrystallized from ethanol giving 214 mg. (61.2%) of **20** as colorless needles, m.p. 182-183°; ir: ν max cm^{-1} 3340, 3280, 2230, 1700; pmr: δ 1.27 (3H, t, J = 6 Hz, CH_2CH_3), 2.32 (3H, s, CH_3), 4.30 (2H, q, J = 6 Hz, CH_2CH_3), 4.40 (2H, bs, CH_2), 6.20 and 12.48 (each 1H, each s, 2 × NH), 7.54 (5H, s, Ar-H), 7.96 (1H, s, pyrazole ring-H).

Anal. Calcd. for $C_{18}H_{18}N_6O_2$: C, 61.70; H, 5.18; N, 23.99. Found: C, 61.55; H, 5.28; N, 24.31.

Ethyl 4-Formyl-5-methyl-1-phenylpyrazole-3-carboxylate (**21**).

A solution of 348 mg. (1 mmole) of **19** and 3 ml. of concentrated hydrochloric acid in 100 ml. of ethanol was refluxed for 10 hours. After the solvent was evaporated to dryness *in vacuo*, the residue was taken up with water and the insoluble solid was collected by filtration. Recrystallization from 75% ethanol gave 190 mg. (73.5%) of **21** as colorless needles, m.p. 123-124°; ir: ν max cm^{-1} 1720, 1660; pmr: δ 1.31 (3H, t, J = 6 Hz, CH_2CH_3), 2.50 (3H, s, CH_3), 4.35 (2H, q, J = 6 Hz, CH_2CH_3), 7.55 (5H, s, Ar-H), 10.38 (1H, s, CHO).

Anal. Calcd. for $C_{14}H_{14}N_2O_3$: C, 65.10; H, 5.46; N, 10.85. Found: C, 65.22; H, 5.40; N, 10.62.

5-Methyl-1-phenylpyrazole-3,4-dicarboxylic Acid (**22**).

To a solution of 150 mg. (0.581 mmole) of **21** in 25 ml. of ethanol was added 217 mg. (1.28 mmoles) of silver nitrate in 0.8 ml. of water, and then 211 mg. (3.19 mmoles) of potassium hydroxide in 7.5 ml. of water with stirring at room temperature. Stirring was continued overnight. Silver oxide was removed by filtration, and the filtrate was evaporated to dryness *in vacuo*. The residue was dissolved in 5 ml. of water and aqueous solution was acidified by the addition of hydrochloric acid. The resulting solid was collected by filtration and recrystallized from ethanol giving 70 mg. (51.5%) of **22** as colorless needles, m.p. 265-266° (lit. m.p. 241-243°) (10).

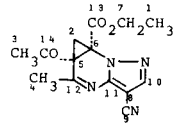
Anal. Calcd. for $C_{11}H_{10}N_2O_4$: C, 56.41; H, 4.30; N, 11.96. Found: C, 56.58; H, 4.03; N, 11.78.

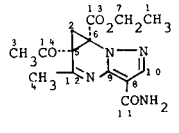
General Procedure for Preparation of 3-Substituted-5a-acetyl-6a-carbethoxy-5a,6a-dihydro-6*H*-cyclopropa[5a,6a]pyrazolo[1,5-*a*]pyrimidines (**23a,b,c**, Tables VI and VII).

To 10 ml. of diazomethane ether solution, prepared from 20.6 g. of nitrosomethylurea in 200 ml. of ether (11), was added 1 mmole of **6a,b,c** in small portions with vigorous stirring under cooling with a mixture of ice and salt. The stirring was continued for 1-2 hours, and the precipitate was collected by filtration and recrystallized.

General Procedure for Preparation of 3-Substituted-5a-acetyl-6a-carbethoxy-5a,6a-dihydro-5-methyl-6*H*-cyclopropa[5a,6a]pyrazolo[1,5-*a*]-pyrimidines (**24a,b,c**, Tables VI and VII).

To 10 ml. of diazomethane ether solution prepared as above was added 1 mmole of **6a,b,c** or **7a,b,c** in small portions with vigorous stirring under ice cooling. The stirring was further continued for 2 hours at room temperature, and the precipitate was collected by filtration and recrystallized. C-13 Nmr (off-resonanced decoupling with correct multiplicities) of compound **23a** and **23b** showed 14 signals assigned as indicated in the structure diagram, respectively.





C atom	ppm	C atom	ppm
1	13.59	1	13.60
2	15.52	2	15.81
3	25.73	3	25.75
4	29.40	4	29.41
5	44.09	5	43.38

6	48.24	6	48.26
7	62.86	7	62.68
8	86.89	8	110.19
9	112.57	9	138.37
10	142.45	10	140.92
11	144.28	11	162.33
12	162.89	12	163.27
13	170.07	13	167.65
14	198.52	14	198.81

Reaction of **6a** with Ethyl Diazoacetate.

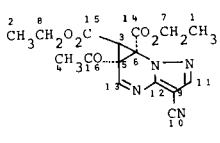
A mixture of 2.58 g. (0.01 mole) of **6a**, 3.42 g. (0.03 mole) of ethyl diazoacetate, and catalytic amount of copper powder in 150 ml. of dioxane was heated with stirring at 40° for 3 hours and then 70° for 4 hours. After the copper was removed by filtration, the filtrate was evaporated *in vacuo* to give a viscous oil which crystallized by agitating with small volume of ethanol. The precipitate formed was collected by filtration and recrystallized from ethanol giving 2.11 g. (62%) of 5a-acetyl-6,6a-dicarbethoxy-5a,6a-dihydro-6*H*-cyclopropa[5a,6a]pyrazolo[1,5-*a*]pyrimidine-3-carbonitrile (**26**), m.p. 137-138°; ir: ν max cm^{-1} 2230, 1770, 1740, 1710; pmr: δ 1.05 and 1.18 (each 3H, each t, J = 6 Hz, 2 × CH_2CH_3), 2.58 (3H, s, $COCH_3$), 2.65 (1H, s, C_6-H), 3.93 and 4.20 (each 2H, each q, J = 6 Hz, 2 × CH_2CH_3), 8.28 (1H, s, C_2-H), 8.85 (1H, s, C_5-H).

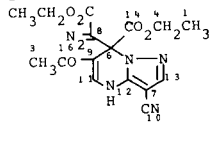
Anal. Calcd. for $C_{16}H_{16}N_4O_5$: C, 55.91; H, 4.68; N, 16.27. Found: C, 55.66; H, 4.84; N, 16.48.

The filtrate was condensed *in vacuo*, and the resulting solid was repeatedly recrystallized from ethanol giving 82 mg. (2.2%) of **27**, m.p. 167-168°; ir: ν max cm^{-1} 3250, 2230, 2120, 1760, 1670; uv: λ max nm (log ϵ) 330 (4.11), 380 (3.85); pmr: δ 1.0 (6H, m, 2 × CH_2CH_3), 2.30 (3H, s, $COCH_3$), 4.05 (4H, m, 2 × CH_2CH_3), 7.91 and 7.99 (each 1H, each s, C_2-and/or C_5-H), 12.0 (1H, s, NH).

Anal. Calcd. for $C_{16}H_{16}N_6O_5$: C, 51.61; H, 4.33; N, 22.57. Found: C, 51.90; H, 4.55; N, 22.42.

C-13 Nmr (off-resonance decoupled with correct multiplicities) of compounds **26** and **27** showed 16 signals assigned as indicated in the structure diagram, respectively.





C atom	ppm	C atom	ppm
1(2)	13.70	1(2)	13.44
2(1)	13.79	2(1)	13.83
3	26.07	3	24.69
4	29.62	4	60.44
5	44.74	5	62.41
6	53.72	6	63.96
7(8)	62.38	7	74.12
8(7)	63.85	8	79.05
9	90.29	9	110.17
10	111.63	10	112.72
11	142.87	11	136.71
12	145.72	12	142.05
13	155.23	13	142.84
14(15)	161.24	14(15)	164.27
15(14)	162.36	15(14)	165.24
16	195.68	16	194.41

Treatment of **27** with Acetic Acid.

A solution of 37 mg. (0.1 mmole) of **27** in 2 ml. of acetic acid was heated at 50° for 5 minutes. After evaporation of acetic acid, the residue was recrystallized from ethanol to give 25 mg. of **28**, which was identical with the authentic sample in all aspects.

5a-Acetyl-6,6a-dicarbethoxy-5a,6a-dihydro-5-methyl-6*H*-cyclopropa-[5a,6a]pyrazolo[1,5-*a*]pyrimidine-3-carbonitrile (**28**).

To a solution of diazomethane ether solution was added 344 mg. (1 mmole) of **26** with stirring under ice cooling. The stirring was further continued for 2 hours at room temperature. The precipitate was collected by filtration and recrystallized from ethanol giving 319 mg. (89%) of **28** as colorless needles, m.p. 116-117°; ir: ν max cm^{-1} 2230, 1760, 1750, 1720; pmr: δ 1.01 and 1.16 (each 3H, each t, J = 6 Hz, 2 × CH_2CH_3), 2.42 (3H, s, CH_3), 2.47 (3H, s, $COCH_3$), 3.89 (1H, s, C_6-H), 3.92 and 4.20 (each 2H, each q, J = 6 Hz, 2 × CH_2CH_3), 8.22 (1H, s, C_2-H).

Anal. Calcd. for $C_{17}H_{18}N_4O_5$: C, 56.98; H, 5.06; N, 15.64. Found: C, 57.14; H, 4.96; N, 15.42.

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