1.6-Naphthyridines (1). II. 2,3-Disubstituted Derivatives and some new Tricyclic Ring Systems.

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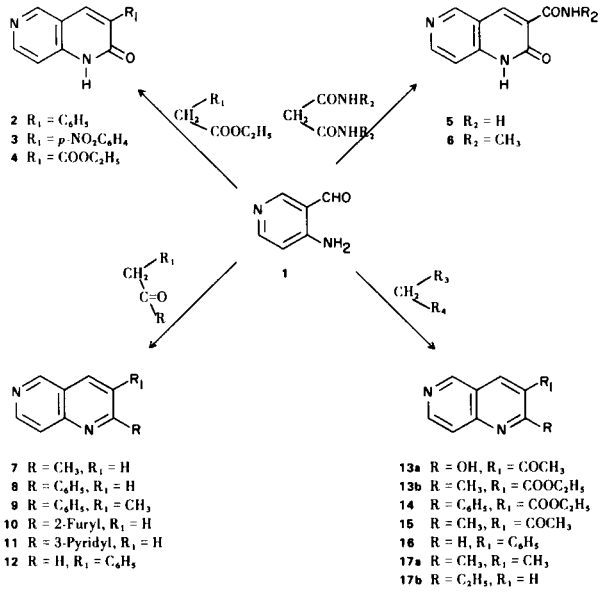
A number of new 2- and/or 3-substituted 1,6-naphthyridines were prepared *via* Friedländer reactions with 4-aminonicotinaldehyde and methylene compounds containing α-esters and α-ketones. Methylene compounds with two reactive α-centres were also used. The facile conversion of the 1,6-naphthyridines into new tricyclic ring systems is reported.

In a previous paper (1), we reported that 2-amino-3-substituted 1,6-naphthyridines could be readily prepared through an application of the Friedländer method. Many of these 1,6-naphthyridines synthesized either directly from 4-aminonicotinaldehyde (**1**), or by subsequent reactions of the bicyclic products, have been shown to possess diuretic activity in rats (2). We now wish to describe the extension of the Friedländer method to other methylene compounds, and also the synthesis of various tricyclic ring systems derived from 1,6-naphthyridines.

The investigation as to the versatility of the Friedländer synthesis was limited to base catalysis. The reagent methylene compounds used can be categorized (Scheme I) as either esters (**2-4**), malonamides (**5**, **6**), ketones and aldehydes (**7-12**), or bifunctional moieties where two products are possible (**13a-17b**). The results are presented in Table I.

SCHEME I



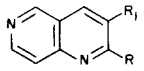
An earlier paper from these laboratories reported the preparation of some 3-substituted 1,6-naphthyridin-2(1*H*)-ones (2). Similarly ethyl phenylacetate, ethyl *p*-nitrophenylacetate, and diethylmalonate when treated with **1** afforded the anticipated products (**2-4**). Malonamide and *N*,*N*^{1}-bis(methyl)malonamide also yielded 3-substituted 1,6-naphthyridin-2(1*H*)ones (**5**, **6**), resulting from the elimination of ammonia and methylamine, respectively.

Compounds **7-11** were readily obtained when **1** was treated with the respective ketones and sodium hydroxide as catalyst. 2-Methyl-1,6-naphthyridine (**7**) has been previously reported, a Skraup synthesis gave a 0.5% yield (3). Phenylacetaldehyde, the only aldehyde used in this work, gave the anticipated product (**12**) with piperidine as catalyst. The greater electrophilicity of the aldehydes and ketones as compared to esters and previously reported nitriles suggests that in this Friedländer mechanism Schiff base formation may be the initial step, in contrast to the suggested reaction course for the synthesis of 2-amino-3-substituted 1,6-naphthyridines from substituted acetonitriles (1). This is further substantiated by the fact that piperidine was used as catalyst for all analogous reactions with 2-aminonicotinaldehyde (**4**). The major difference between this and **1** is the greater nucleophilicity of the amino group in the former.

With polyfunctional reagents the nature of the product(s) depend upon the relative electrophilic and nucleophilic activities of the reactive centres. Firstly two methylene compounds were used with two α-substituents, either of which could react with the amino function of **1**. Ethyl acetoacetate with piperidine yielded an almost equal mixture of 3-acetyl-1,6-naphthyridin-2(1*H*)one (**13a**) and ethyl 2-methyl-1,6-naphthyridine-3-carboxylate (**13b**), yet with sodium hydroxide as catalyst only the latter was isolated. It has been shown that 2-aminonicotinaldehyde in an analogous reaction produces only ethyl 2-methyl-1,8-naphthyridine-3-carboxylate (4). Thus competing reactions

TABLE I

2,3-Disubstituted 1,6-Naphthyridines

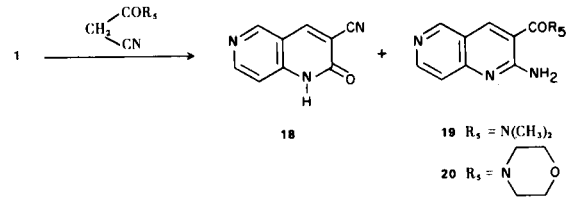


Cmpd. No.	R	R_1	Reagent	Reaction Time (hr.) (a)	Yield %	m.p., °C	Formula	Analyses Calcd. C	H	N	Found C	H	N	Chemical Shift (δ) of Ring protons (g) H_4	H_5	H_7	H_8	Other
2	OH	C_6H_5	Ethyl phenylacetate	120	21	>300	$C_{14}H_{10}N_2O$	75.68	4.50	12.61	75.40	4.57	12.87	8.31 (h)	9.25	8.66	7.94	
3	OH	p-$NO_2C_6H_4$	Ethyl p-nitrophenylacetate	10	76	>300	$C_{14}H_9N_3O_3$	62.92	3.37	15.73	62.80	3.31	15.49	8.52 (h)	9.38	8.78	8.01	
4	OH	$COOC_2H_5$	Diethyl malonate	16	97	213-214 dec.	$C_{11}H_{10}N_2O_3$	60.55	4.59	12.84	60.61	4.56	12.69	8.56	8.94	8.50	7.23	
5	OH	$CONH_2$	Malonamide	24	84	>300	$C_9H_7N_3O_2$	57.14	3.70	22.22	56.93	3.59	22.30	9.55 (h)	9.56	8.82	8.01	
6	OH	$CONHCH_3$	N, N'-Bis (methyl)-malonamide	48	56	>300	$C_{10}H_9N_3O_2$	59.11	4.43	20.69	58.90	4.55	20.76	9.55 (h)	9.56	8.81	8.02	
7	CH_3	H	Acetone	48 (b) (c)	57	59-61 (e)												
8	C_6H_5	H	Acetophenone	24 (b)	83	95-97	$C_{14}H_{10}N_2$	81.55	4.85	13.59	81.72	5.02	13.46	8.74	9.50	8.86	8.05	7.69 (H_3)
9	C_6H_5	CH_3	Propiophenone	24 (b)	80	140-142	$C_{15}H_{12}N_2$	81.82	5.45	12.73	81.90	5.61	12.58	8.50	9.42	8.76	7.94	
10	2-Furyl	H	2-Acetylfuran	1 (b)	87	103-104	$C_{12}H_8N_2O$	73.47	4.08	14.29	73.34	4.17	14.16	8.63	9.40	8.78	7.92	8.08 (H_3)
11	3-Pyridyl	H	3-Acetylpyridine	1 (b)	80	149-150	$C_{13}H_9N_3$	75.36	4.35	20.29	75.10	4.21	20.40	8.74	9.46	8.92	7.98	8.37 (H_3)
12	H	C_6H_5	Phenylacetaldehyde	24	50	104-105	$C_{14}H_{10}N_2$	81.55	4.85	13.59	81.85	4.96	13.80	8.84	9.53	8.82	7.97	9.52 (H_2)
13a	OH	$COCH_3$	Ethylacetoacetate	12	48 (d)	>300	$C_{10}H_8N_2O_2$	63.83	4.26	14.89	63.55	4.39	14.98	9.02 (h)	9.43	8.78	7.98	
13b	CH_3	$COOC_2H_5$			46 (d)	94-95	$C_{12}H_{12}N_2O_2$	66.67	5.56	12.96	66.90	5.58	13.20	9.04	9.56	8.90	7.93	
14	C_6H_5	$COOC_2H_5$	Ethylbenzoylacetate	24	66	122-124	$C_{17}H_{14}N_2O_2$	73.38	5.04	10.07	73.14	4.94	10.11	9.06	9.60	8.90	8.01	
15	CH_3	$COCH_3$	Acetylacetone	24	60	106-108	$C_{11}H_{10}N_2O$	70.97	5.38	15.05	70.71	5.30	14.95	9.17	9.52	8.90	7.93	
16	CH_3	C_6H_5	Phenylacetone	24	61	84-86	$C_{15}H_{12}N_2$	81.82	5.45	12.73	81.75	5.26	12.90	8.37	9.41	8.76	7.90	
17a	CH_3	CH_3	Methyl ethyl ketone	48 (c)	44	112-114 (f)								7.90 (i)	9.11	8.63	7.77	
17b	C_2H_5	H			47	51-54	$C_{10}H_{10}N_2$	75.95	6.33	17.72	75.84	6.42	17.79	8.17 (i)	9.12	8.69	7.83	7.38 (H_3)

(a) Prepared by method A unless otherwise noted. (b) Prepared by method B. (c) The reagent was used as solvent instead of ethanol. (d) With method B, **13a** = 0%, **13b** = 56%. (e) Lit. (4) m.p. 60-61°. (f) Lit. (3). (g) Deuteriodimethylsulfoxide solutions with DSS as internal standard unless otherwise noted. (h) Trifluoroacetic acid solution. (i) Deuteriochloroform solution with TMS as internal standard.

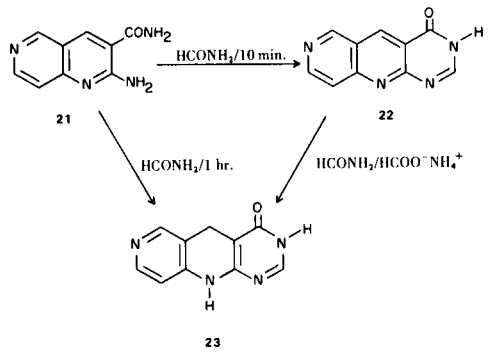
involving the aldol condensation of the anion of the methylene group and Schiff base formation are indicated in the formation of **13a** and **13b**, respectively. The weak nucleophilicity of the 4-amino group of **1** is indicated since by consideration of the ethyl acetoacetate reagent only **13b** would be expected to be the major product, even with piperidine. As anticipated with reagents with widely different functional group activity, ethyl benzoylacetate yielded **14** rather than 3-benzoyl-1,6-naphthyridin-2(1*H*)-one. Secondly three ketone reagents with more than one α-carbon atom capable of reacting with the aryl aldehyde were investigated. Acetylacetone and phenylacetone gave **15** and **16**, rather than 2-acetonyl and 2-benzyl-1,6-naphthyridines, respectively. However, **17a** and **17b** were obtained in almost equimolar amounts from methyl ethyl ketone and piperidine. We have previously reported that sodium hydroxide yielded **17a** exclusively (2). The stabilization of the anions can be explained by inductive effects with the methyl and by hyperconjugation with the methylene, the latter being predominant in strong base (5).

The Friedländer synthesis of 2-amino-3-substituted 1,6-naphthyridines has been further extended to 3-carboxamides from *N,N*-disubstituted cyanoacetamides. Upon treatment of **1** with piperidine as catalyst an unexpected elimination cyclization afforded 3-cyano-1,6-naphthyridin-2(1*H*)one (**18**). With sodium hydroxide, however, good yields of the desired *N,N*-disubstituted carboxamides (**19**, **20**) were obtained, with only trace amounts of **18**.

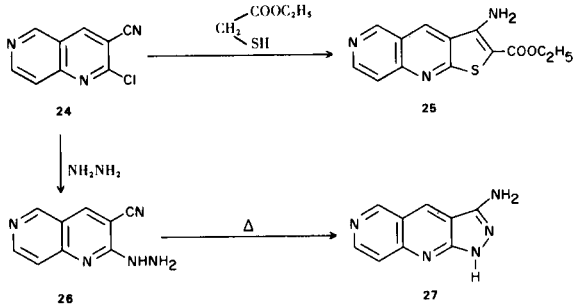


Some of the 1,6-naphthyridines either synthesized directly by the Friedländer method, or by subsequent conversion to suitable compounds, are useful intermediates for the synthesis of new tricyclic ring systems. Thus 2-amino-1,6-naphthyridine (**28**) and its 3-carbamoyl derivative (**21**) readily prepared from **1** (1), and 2-chloro-3-cyano-1,6-naphthyridine (**24**) synthesized by halogenation of **18** (2) served as examples. So as to demonstrate the potential of the route four new ring systems are reported.

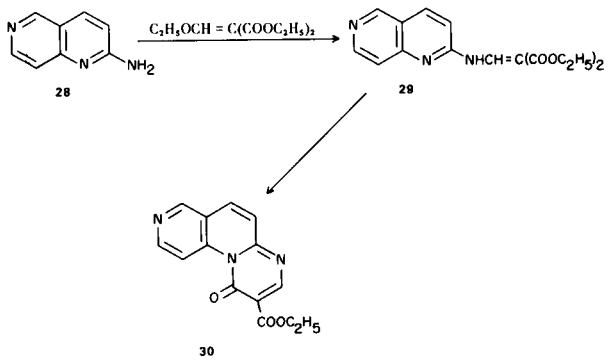
4-Oxo-3,4-dihydropyrimido[4,5-*b*][1,6]naphthyridine (**22**) was formed from **21** and formamide upon heating under reflux for a few minutes. However, after an hour the tetrahydro derivative (**23**) was isolated, and this compound was also obtained from **22** by treatment with the Leuckart reaction reagents ammonium formate and formamide. These observations are analogous to those of Campaigne and Randau with pyrimido[4,5-*b*]quinoline systems (6).



By applying the condition of Santilli and coworkers (7) ethyl 3-aminothieno[2,3-*b*][1,6]naphthyridine-2-carboxylate (**25**) was readily obtained from ethyl mercaptoacetate and **24**. The latter was also converted to 3-aminopyrazolo[3,4-*b*][1,6]naphthyridine (**27**) upon treatment with hydrazine. The intermediate 2-hydrazino compound (**26**) was isolated and its structure indicated by infrared spectroscopy.



Various workers have reported the synthesis of anthyridines or pyrimido[1,2-*a*][1,8]naphthyridines from 1,8-naphthyridines and diethyl ethoxymethylenemalonate (8). 2-Amino-1,6-naphthyridine (**28**) upon treatment with this reagent yielded the acrylate (**29**). When treated in refluxing Dowtherm-A **29** cyclized at the bridgehead nitrogen rather than at C_3 to yield the pyrimido[1,2-*a*][1,6]-naphthyridine (**30**).



EXPERIMENTAL

Infrared spectra were recorded as potassium bromide pellets on a Unicam SP-200 G spectrometer. Nmr spectra were determined on a Varian T-60 spectrometer, with DDS as the internal standard for deuteriodimethylsulfoxide and trifluoroacetic acid solutions, and TMS for deuteriochloroform. All melting points are uncorrected. Elemental analysis were determined by Dr. Strauss, Oxford, England.

2,3-Disubstituted 1,6-Naphthyirdines (Table I).

Piperidine was initially tried with all reagents, but if no products or mixtures were isolated, the reaction was reinvestigated with sodium hydroxide.

Procedure A.

A mixture of 0.336 g. (0.003 mole) of 4-aminonicotinaldehyde (**1**), the appropriate reagent (0.006 mole) and 0.075 g. (0.00075 mole) of piperidine in 5 ml. of absolute ethanol were heated under reflux on a steam bath. The naphthyridines were obtained in the recorded yield by direct filtration or on evaporation, trituration with a suitable solvent and filtration. The products were purified by crystallization from a suitable solvent.

Procedure B.

The conditions and work-up is as described for Procedure A, except that 0.4 ml. (0.001 mole) of 10% aqueous sodium hydroxide was used instead of piperidine.

2-Amino-*N*,*N*-disubstituted 1,6-Naphthyridine-3-carboxamides.

Procedure A.

N,*N*-Dimethylcyanoacetamide or 4-cyanoacetylmorpholine when treated with piperidine as above for 1 hour yielded 3-cyano-1,6-naphthyridine-2(1*H*)one (**18**). The product was identical (m.p., ir, nmr) with an authentic sample.

Procedure B.

N,*N*-Dimethylcyanoacetamide upon treatment with sodium hydroxide as above for 3 hours gave 0.408 g. (63% yield) of 2-amino-*N*,*N*-dimethyl-1,6-naphthyridine-3-carboxamide (**19**). Recrystallization from ethanol gave white prisms, m.p. 207-210°; ir 3440 and 3280 (N-H stretching), 3200 (N-H bonded), 1620 (C=O) and 1610 cm^{-1} (N-H bending); nmr (DMSO-d_6) δ 8.96 (s, 1, C_5-*H*), 8.48 (d, 1, $J_{7,8}$=6.0 Hz, C_7-*H*), 8.16 (s, 1, C_4-*H*), 7.38 (d, 1, $J_{8,7}$ =6.0 Hz, C_8-*H*), 6.98 (s, 2, exchanges with deuterium oxide, NH_2) and 3.0 ppm (s, 6, $[CH_3]_2$).

Anal. Calcd. for $C_{11}H_{12}N_4O$: C, 61.11; H, 5.69; N, 25.90. Found: C, 61.23; H, 5.60; N, 25.82.

Similarly 4-cyanoacetylmorpholine for 2 hours gave 0.503 g. (65% yield) of 2-amino-3-*N*-morpholinocarbonyl-1,6-naphthyridine (**20**). Recrystallization from ethanol gave white needles, m.p. 203-205° dec., ir 3350 and 3330 (N-H stretching), 3125 (N-H bonded), 1670 (C=O) and 1620 cm^{-1} (N-H bending); nmr (DMSO-d_6) δ 8.97 (s, 1, C_5-*H*), 8.47 (d, 1, $J_{7,8}$=6.0Hz, C_7-*H*), 8.14 (s, 1, C_4-*H*), 7.37 (d, 1, $J_{8,7}$ = 6.0 Hz, C_8-*H*), 6.98 (s, 2, exchanges with deuterium oxide, NH_2) and 3.60 ppm (s, 8 morpholine-*H*).

Anal. Calcd. for $C_{13}H_{14}N_4O_2$: C, 60.47; H, 5.43; N, 21.71. Found: C, 60.28; H, 5.33; N, 21.50.

Conversion of 1,6-Naphthyridines to Tricyclic Ring Systems.

4-Oxo-3,4-dihydropyrimido[4,5-*b*][1,6]naphthyridine (**22**).

A mixture of 2-amino-1,6-naphthyridine-3-carboxamide (**21**) (0.002 mole, 0.376 g.) and formamide (4 ml.) was heated under reflux for 10 minutes. The resulting precipitate was filtered and washed with water to give 0.30 g. (75% yield) of **22**. Recrystallization from dimethylsulfoxide gave cream flakes, m.p. > 300°, ir 3040 (N-H stretching), 2920-2600 (N-H bonded) and 1705 cm^{-1} (C=O); nmr (TFAA) δ 10.22 (s, 1, C_2-*H* or C_6-*H*), 10.12 (s, 2, C_2-*H* or C_6-*H*), 9.67 (s, 1, C_5-*H*), 9.06 (d, 1, $J_{8,9}$ = 7.0 Hz, C_8-*H*) and 8.70 ppm (d, 1, $J_{8,9}$ = 7.0 Hz, C_9-*H*).

Anal. Calcd. for $C_{10}H_6N_4O$: C, 60.61; H, 3.03; N, 28.28. Found: C, 60.42; H, 2.98; N, 28.06.

4-Oxo-3,4,5,10-tetrahydropyrimido[4,5-*b*][1,6]naphthyridine (**23**).

a) Treatment of **21** as above but with a 1 hour reflux gave 0.28 g. (70% yield) of **23**. Recrystallization from water gave tan needles, m.p. > 300°; ir 3425 and 3125 (N-H) and 1660 cm^{-1} (C=O); nmr (TFAA) δ 8.70 (s, 1, C_2-*H* or C_6-*H*), 8.37 (s, 1, C_2-*H* or C_6-*H*), 8.27 (d, 1, $J_{8,9}$ = 7.0 Hz, C_8-*H*), 7.20 (d, 1, $J_{9,8}$ 7.0 Hz, C_9-*H*) and 4.22 ppm (s, 2, C_5-H_2).

Anal. Calcd. for $C_{10}H_8N_4O \cdot H_2O$: C, 55.05; H, 4.59; N, 25.69. Found: C, 54.80; H, 4.78; N, 25.60.

b) A mixture of **22** (0.0005 mole, 0.099 g.), formamide (3 ml.) and ammonium formate (0.30 g.) was heated under reflux for 1 hour. The reaction mixture was cooled and the precipitate formed filtered and washed with water to yield 0.06 g. (60% yield) of the reduced pyrimidonaphthyridine (**23**) identical (ir) with the above sample.

Ethyl 3-Aminothieno[2,3-*b*][1,6]naphthyridine-2-carboxylate (**25**).

A mixture of 2-chloro-3-cyano-1,6-naphthyridine (**24**) (0.002 mole, 0.308 g.), ethyl mercaptoacetate (0.002 mole, 0.240 g.), anhydrous sodium carbonate (0.002 mole, 0.220 g.) and absolute ethanol (15 ml.) was heated under reflux for 3 hours. The reaction mixture was cooled and the resulting precipitate collected by filtration to yield 0.32 g. (59% yield) of **25**. Recrystallization from ethanol gave bright orange flakes, m.p. 260-262° dec., ir 3400 and 3280 (N-H stretching), 3190 (N-H bonded), 1685 (C=O), 1625 (N-H bending), 1275 and 1110 cm^{-1} (C-O); nmr (TFAA) δ 10.13 (s, 1, C_5-*H*), 9.80 (s, 1, C_4-*H*), 8.99 (d, 1, $J_{7,8}$ = 7.0 Hz, C_7-*H*), 8.78 (d, 1, $J_{8,7}$ = 7.0 Hz, C_8-*H*), 4.58 (q, 2, CH_2) and 1.50 ppm (t, 3, CH_3).

Anal. Calcd. for $C_{13}H_{11}N_3O_2S$: C, 57.14; H, 4.03; N, 15.38; S, 11.72. Found: C, 56.85; H, 4.23; N, 15.12; S, 11.31.

3-Aminopyrazolo[3,4-*b*][1,6]naphthyridine (**27**).

To a stirred solution of **24** (0.0025 mole, 0.473 g.) in absolute ethanol (50 ml.) was added dropwise anhydrous hydrazine (0.75 ml.) and the resulting suspension was heated under reflux for 12 hours. The reaction mixture was cooled and filtered to yield 0.41 g. (88% yield) of **27**. Recrystallization from water gave orange needles, m.p. > 300°; ir 3375 and 3300 (N-H stretching) and 1635 cm^{-1} (N-H bending); nmr (TFAA) δ 9.81 (s, 1, C_4-*H* or C_5-*H*), 9.76 (s, 1, C_4-*H* or C_5-*H*), 8.89 (d, 1, $J_{7,8}$ = 6.5 Hz, C_7-*H*) and 8.30 ppm (d, 1, $J_{8,7}$ = 6.5 Hz, C_8-*H*).

Anal. Calcd. for $C_9H_7N_5$: C, 58.38; H, 3.78; N, 37.84. Found: C, 58.21; H, 3.61; N, 37.60.

2-(2,2-Diethoxycarbonylvinylamino)-1,6-naphthyridine (**29**).

A stirred mixture of 2-amino-1,6-naphthyridine (**28**) (0.003 mole, 0.435 g. diethyl ethoxymethylenemalonate (0.003 mole, 0.648 g.) and absolute ethanol (10 ml.) was heated under reflux for 12 hours. The solvent was evaporated off and the oily residue treated with water to yield 0.485 g. (51% yield) of **29**. Recrystallization from petroleum ether (60-80°) gave white needles, m.p. 124-125°; ir 3280 (N-H stretching), 3150 (N-H bonded), 1700

(C=O) and 1260 cm^{-1} (C-O); nmr (DMSO-d_6) δ 10.79 (broad d, 1, J = 12.5 Hz, exchanges with deuterium oxide, N-*H*-CH=), 9.23 (s, 1, C_5-*H*), 9.10 (d, 1, J = 12.5 Hz, NH-C*H*=), 8.69 (d, 1, $J_{7,8}$ = 6.0 Hz, C_7-*H*), 8.52 (d, 1, $J_{4,3}$ = 9.5 Hz, C_4-*H*), 7.72 (d, 1, $J_{8,7}$ = 6.0 Hz, C_8-*H*), 7.66 (d, 1, $J_{3,4}$ = 9.5 Hz, C_3-*H*), 4.30 (m, 4, [$COOCH_2CH_3$]$_2$) and 1.32 ppm (t, 6, [$COOCH_2$ CH_3]$_2$).

Anal. Calcd. for $C_{16}H_{17}N_3O_4$: C, 60.95; H, 5.40; N, 13.33. Found: C, 61.35; H, 5.41; N, 13.91.

Ethyl 10-Oxo-10*H*-pyrimido[1,2-*a*][1,6]naphthyridine-9-carboxylate (**30**).

The acrylate (**29**) (0.001 mole, 0.315 g.) and Dowtherm-A (3.0 g.) were heated under reflux for 10 minutes. The reaction mixture was cooled and an excess of petroleum ether (40-60°) was added to precipitate 0.148 g. (55% yield) of **30**. Recrystallization from petroleum ether (40-60°) gave yellow flakes, m.p. 135-137°; ir 1750 (ester C=O), 1685 (ring C=O), 1265 and 1105 cm^{-1} (C-O); nmr (DMSO-d_6) δ 9.41 (d, 1, $J_{2,1}$ = 6.0 Hz, C_2-*H*), 9.29 (s, 1, C_4-*H*), 8.81 (d, 1, $J_{1,2}$ = 6.0 Hz, C_1-*H*), 8.72 (s, 1, C_8-*H*), 8.40 (d, 1, $J_{5,6}$ = 9.5 Hz, C_5-*H*), 7.55 (d, 1, $J_{6,5}$ = 9.5 Hz, C_6-*H*), 4.33 (q, 2, CH_2) and 1.34 ppm (t, 3, CH_3).

Anal. Calcd. for $C_{14}H_{11}N_3O_3$: C, 62.45; H, 4.09; N, 15.61. Found: C, 62.10; H, 4.23; N, 15.54.

ACKNOWLEDGEMENT

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REFERENCES

(1) Part I. E. M. Hawes and D. K. J. Gorecki, *J. Heterocyclic Chem.*, **9**, 703 (1972).

(2) E. M. Hawes, D. K. J. Gorecki, and D. D. Johnson, *J. Med. Chem.*, **15**, 849 (1973).

(3) W. W. Paudler and T. J. Kress, *J. Org. Chem.*, **31**, 3055 (1966).

(4) E. M. Hawes and D. G. Wibberley, *J. Chem. Soc. (C)*, 315 (1966).

(5) H. O. House, "Modern Synthetic Reactions", 2nd ed., W. A. Benjamin, Inc., Menlo Park, Calif., 1972, pp 557-560.

(6) E. Campaigne and G. Randau, *J. Heterocyclic Chem.*, **8**, 111 (1971).

(7) A. A. Santilli, D. H. Kim, and S. V. Wanser, *ibid.*, **8**, 445 (1971).

(8) J. F. Harper and D. G. Wibberley, *J. Chem. Soc. (C)*, 2895 (1971); S. Carboni, A. Da Settimo, D. Segnini, and I. Tonetti, *Gazz. Chim. Ital.*, **96**, 1443 (1966); S. Carboni, A. Da Settimo, P. L. Ferranini, and I. Tonetti, *ibid*, **97**, 1262 (1967); S. Carboni, A. Da Settimo, P. L. Ferranini, I. Tonetti, and D. Bertini, *ibid.*, **97**, 1274 (1967).