View Online / Journal Homepage / Table of Contents for this issue

Nucleophilic Displacement of *N*-Aryl and Heteroaryl Groups. Part 5.[1] Conversion of 2-Aminopyridines into 2-Pyridones

Alan R. Katritzky * and Radi Awartani
Department of Chemistry, University of Florida, Gainesville, Fla. 32611, U.S.A.

2-Ethoxycarbonyl-1-(2-pyridyl)pyridinium cations (3) (easily prepared from 2-aminopyridine and the appropriate pyrylium salt) are converted by dilute NaOH at 25 °C into 1-(substituted 2-pyridylcarbonyl)-2-pyridones (7). Compounds (7) are readily hydrolysed to 2-pyridones.

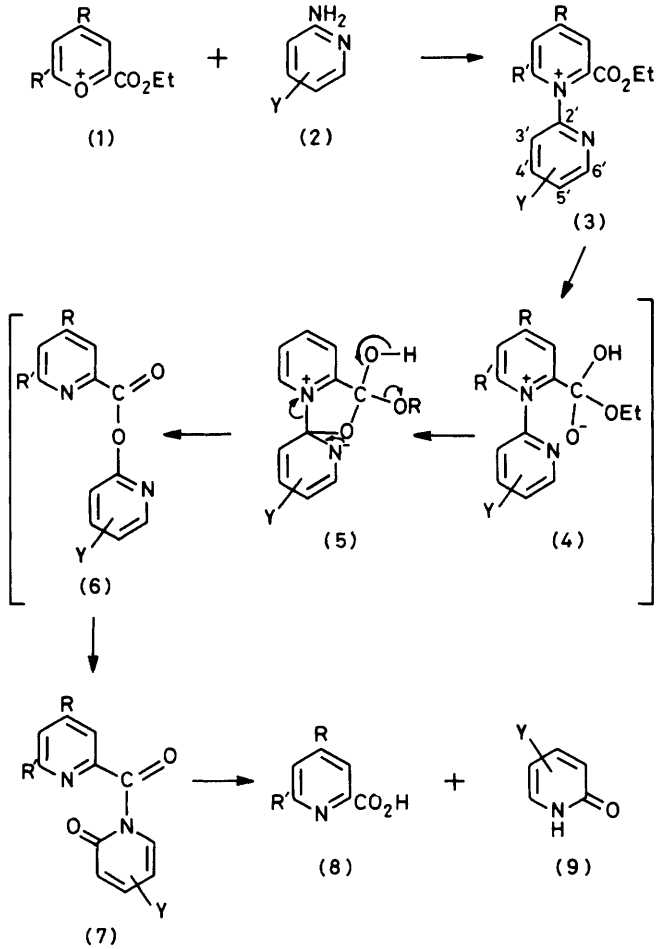
Published on 01 January 1983 on http://pubs.rsc.org | doi:10.1039/P19830002623
Downloaded by Duke University on 12 September 2012

In the preceding paper [1] we have outlined the potential importance of a general method for the transformation of the amino group of heteroarylamines into other functionalities and our initial attempts towards this objective. While pyrylium-mediated reactions relying on intermolecular displacements appeared unpromising for synthetic purposes, indications were obtained [1] of intramolecular displacements, considerably easier than those successfully developed [2,3] in the arylamine series. The present paper describes the development of such intramolecular displacements of heteroarylamines into a general method for the conversion of 2-aminopyridines into 2-pyridones.

Conversion of 2-Aminopyridines into 2-Pyridones.—The key step in our sequence is the discovery that 1-(2-pyridyl)-2-ethoxycarbonylpyridinium cations of type (3) are smoothly converted by dilute aqueous sodium hydroxide at 25 °C into the 1-(substituted 2-pyridylcarbonyl)-2-pyridones (7). The pyridinium salts (3) are easily made from the 2-aminopyridine (2) and the corresponding pyrylium salt (1). The products (7) are readily hydrolysed into the 2-pyridone (9) and the picolinic acid (8). Hence the overall scheme forms a convenient two-stage transformation of 2-aminopyridines into 2-pyridones. We believe that the mechanism involves intramolecular nucleophilic displacement on the addition product (4) to give (6) *via* (5), followed by rearrangement of (6) into (7); however, we have no direct evidence for this sequence. Indeed we have shown that the betaine (10) on dissolution in aqueous ethanol and acidification also gives a rearrangement product of type (7). We have explored various substitutions on the pyrylium ring (1) to optimise the reaction and various substitutions on the 2-aminopyridine ring of (2) to determine the scope of the reaction.

Preparation of Pyrylium and Pyridinium Salts.—The pyrylium salts (1A),[2,4] (1B),[5] (1C),[6] (1D),[5] (1E), and (1F) each reacted with heteroarylamines (2) to give the corresponding pyridinium salts (3) in good yield (Table 1). The structures of the salts (3) were established on the basis of their spectra.

The structures of all the foregoing pyridinium salts were supported by their spectra. Thus, ν(C=O) of the ester group occurred characteristically near 1 740 cm^{-1}. Strong bands at 1 620 cm^{-1} were assigned to the pyridinium ring together with peaks at 1 265 and 1 030 cm^{-1} for the anion in the trifluoromethanesulphonate series, whereas broad bands at 1 045 cm^{-1} were characteristic of the tetrafluoroborate series. Salient features of the ^1H n.m.r. spectra are reported in Table 2. The CH_2 and CH_3 of CO_2Et occur at δ 4.2 and 1.1, respectively. The C(3)H and C(5)H signals for the 6-aryl series appear as finely split doublets near δ 8.3 and 8.6 (*J* 2.2 Hz), respectively. In contrast to the 6-aryl series, the 3-H and 5-H doublets of the 6-t-butyl series absorbed at δ 8.4 and 8.3, respectively. The rest of the aromatic signals were usually multiplets in the region δ 7.0—8.3.



Scheme 1. In formulae numbers, capital letters designate substituents derived from the original pyrylium ring, small letters designate substituents derived from the 2-aminopyridine: A, R = R′ = Ph; B, R = Ph, R′ = Bu^t; C, R = *p*-tolyl, R′ = Ph; D, R = Ph, R′ = C_8H_8 [see formula (11)]; E, R = *p*-ClC_6H_4, R′ = Ph; F, R = Ph, R′ = $MeOC_6H_4$.

a, Y = H; b, Y = 4-Me; c, Y = 5-Me; d, Y = 6-Me; e, Y = 5-Cl; f, Y = 4,6-Me_2; g, Y = 5-Br; h, Y = 5-NO_2; i, Y = 5-aza; j, Y = 3-aza

Reactions of the Pyridinium Salts (3) *with Alkali.*—On treatment of the pyridinium salts (3) with aqueous sodium hydroxide at 25 °C the esters slowly dissolved. On immediate acidification mixtures of products were formed; if, however, the mixtures were stirred for 48 h prior to acidification, the 1-(substituted 2-pyridylcarbonyl)-2-pyridone (7) precipitated in good yield (Table 3). The reaction appeared not to depend

View Online

Published on 01 January 1983 on http://pubs.rsc.org | doi:10.1039/P19830002623
Downloaded by Duke University on 12 September 2012

Table 1. Preparation of 2-ethoxycarbonyl-1-(2-pyridyl)pyridinium salts (3) [a]

Series (3)	Pyridinium ring substituent		Pyridinium ring substituent [b]		Time	Yield	M.p. (form) [c]	Found (%) (Required %)			
X	R′	R	Y	Anion	(h)	(%)	(°C)	C	H	N	Molecular formula
Aa	Ph	Ph	—	BF_4 [d]	—	—	194—196 (N)	—	—	—	—
								(—)	(—)	(—)	
Ab	Ph	Ph	4-Me	BF_4	6	91	190—191 (N)	64.8	4.8	5.8	$C_{26}H_{23}BF_4N_2O_2$
								(64.7	4.8	5.8)	
Ac	Ph	Ph	5-Me	BF_4	12	85	222—223 (P)	64.8	4.8	5.8	$C_{26}H_{23}BF_4N_2O_2$
								(64.7	4.8	5.8)	
Ad	Ph	Ph	6-Me	BF_4	8	93	185—187 (Mi)	64.9	4.9	5.7	$C_{26}H_{23}BF_4N_2O_2$
								(64.7	4.8	5.8)	
Ae	Ph	Ph	5-Cl	BF_4	15	82	204—206 (P)	59.8	4.0	5.5	$C_{25}H_{20}BClF_4N_2O_5$
								(59.7	4.0	5.6)	
Af	Ph	Ph	4,6-Me_2	CF_3SO_3	12	87	116—117 (P)	60.0	4.5	5.0	$C_{28}H_{25}F_3N_2O_5S$
								(60.2	4.5	5.0)	
Ag	Ph	Ph	5-Br	BF_4	20	59	216—217 (C)	54.9	3.7	5.1	$C_{25}H_{20}BrBF_4N_2O_2$
								(54.8	3.7	5.1)	
Ah	Ph	Ph	5-NO_2	BF_4	24	56	159—161 (N)	58.4	3.9	8.1	$C_{25}H_{20}BF_4N_3O_4$
								(58.5	3.9	8.2)	
Ai	Ph	Ph	5-Aza	BF_4 [e]	30	65	185—187 (N)	—	—	—	
								(61.4	4.5	8.9)	
Aj	Ph	Ph	3-Aza	CF_3SO_3	6	78	180—182	56.4	3.8	7.8	$C_{25}H_{20}F_3N_3O_5S$
								(56.5	3.8	7.9)	
Ak	Ph	Ph	*f*	BF_4	—	—	196—198 (N)	—	—	—	—
								(—	—	—)	
Ca	Ph	*p*-Tol	—	BF_4	10	84	171—173 (N)	64.9	4.8	5.8	$C_{26}H_{23}BF_4N_2O_2$
								(64.7	4.8	5.8)	
Cc	Ph	*p*-Tol	5-Me	BF_4	12	92	145—146 (Pl)	65.4	5.1	5.6	$C_{27}H_{25}BF_4N_2O_2$
								(65.3	5.0	5.6)	
Cg	Ph	*p*-Tol	5-Br	BF_4	30	64	196—197 (P/N)	56.0	3.9	4.8	$C_{26}H_{22}BrBF_4N_2O_2$
								(55.6	3.9	5.0	
Ba	Bu^t	Ph	—	BF_4	6	94	178—181 (N)	61.4	5.6	6.2	$C_{23}H_{25}BF_4N_2O_2$
								(61.6	5.6	6.3)	
Bc	Bu^t	Ph	5-Me	BF_4	6	90	197—198 (P/N)	62.1	5.9	6.1	$C_{24}H_{27}BF_4N_2O_2$
								(62.3	5.8	6.1)	
Ad	Ph	Ph	6-Me	CF_3SO_3 [f]	8	85	188—190 (Pl)	58.7	4.0	5.3	$C_{26}H_{21}F_3N_2O_5S$
								(58.9	4.0	5.3)	
Ea	Ph	*p*-ClC_6H_4	—	CF_3SO_3	6	90	158—159 (P)	55.3	3.6	4.9	$C_{26}H_{20}ClF_3N_2O_5S$
								(55.3	3.5	5.0)	
Fa	*p*-$MeOC_6H_4$	Ph	—	CF_3SO_3	10	87	144—146 (P)	58.0	4.1	5.0	$C_{27}H_{23}F_3N_2O_6S$
								(57.9	4.1	5.0)	
Da	C_8H_8 [h]	Ph	*i*	BF_4	24	85	223—225 (N)	65.4	4.7	5.6	$C_{27}H_{23}BF_4N_2O_2$
								(65.6	4.7	5.7)	

[a] All reactions were run in CH_2Cl_2 at 25 °C, and absolute ethanol was used for recrystallisation. [b] Y indicates substituents on the pyridyl ring. [c] Crystal form: N = needles, P = prisms, Pl = plates, C = cubes, Mi = microcrystals. [d] M.p.[1] 192—193 °C. [e] m.p.[1] 187—188 °C. [f] *N*-Substituent = benzothiazolyl, m.p.[1] 190—192 °C. [g] 2-Methoxycarbonylpyridinium. [h] C_8H_8 dihydronaphtho.

on the nature of the pyrylium ring substituents [*i.e.* series A—F gave similar yields, although the initial time used for solution in the NaOH was least for series C and F (see Scheme 1)].

By contrast, the nature of the substituent in the pyridine ring was critical. The reaction went well with chlorine, methyl, and bromine substituents, but failed for 5-nitro and 5-aza derivatives; it proceeded further for the 3-aza derivative to give 2-pyrimidone and 2-ethoxycarbonyl-4,6-diphenylpyridine (as previously reported [1]).

The structures of the 1-(substituted 2-pyridylcarbonyl)-2-pyridones (7) were confirmed on the basis of spectral data. The i.r. spectra showed the disappearance of bands characteristic of the pyridinium entity at 1 640, and 1 265, 1 030 ($CF_3SO_3^-$) or 1 040 (BF_4^-). Instead, strong absorption bands occurred at 1 760 and 1 740 cm^{-1} for two different types of carbonyls, together with absorption bands typical of pyridine at 1 600—1 580 cm^{-1}. The ^1H n.m.r. spectra (Table 4) showed the disappearance of the CH_2 and CH_3 signals of the CO_2Et. In contrast to the pyridinium salts, the 3-H and 5-H signal occurred at δ 8.1 and 8.4 (*J* 1.61 Hz).

Hydrolysis of the 1-(*Substituted* 2-*Pyridylcarbonyl*)-2-*pyridones*.—Several examples of the substituted 2-pyridylcarbonyl-2-pyridones were hydrolysed in ethanolic sodium hydroxide to the corresponding 2-pyridones. The 2-pyridones (9) were isolated and characterised by m.p. and spectral data (Table 5).

The substituted 2-pyridylcarbonyl-2-pyridones also underwent aminolysis and ethanolysis. Thus compound (7Ae) reacted with t-butylamine to give 2-(t-butylcarbamoyl)-4,6-diphenylpyridine (13) and the derivative (7Aa) with ethanol formed the corresponding ester (12).

Assessment and Conclusions.—Previous conversion of 2-aminopyridines into 2-pyridones have involved diazotization. The yield is variable, and in some cases the use of nitrous acid may be disadvantageous.

View Online

Published on 01 January 1983 on http://pubs.rsc.org | doi:10.1039/P19830002623
Downloaded by Duke University on 12 September 2012

Table 2. ^{1}H N.m.r. spectral data of 2-EtCO$_2$-pyridinium salts [a]

Series (3)	CH_3CH_2O [b] δ	m	H	Bu^t	Aromatic region C_3H [c]	C_5H [c]	δ	m	H	*J*
Ab [d]	1.15	t	3	—	8.25	8.64	7.20—7.50	m	7	—
	4.24	q	2				7.60—7.75	m	4	—
							7.82	dd	1	7.2, 2.2
							8.63	d	1	2.2
Ac [e]	1.18	t	3	—	8.27	8.65	7.00—7.20	m	10	—
	4.26	q	2	—			7.24—7.34	m	3	—
Ad [f]	1.13	t	3	—	8.24	8.61	7.26—7.63	m	12	—
	4.23	q	2				7.95—8.00	m	1	—
Ae	1.22	t	3	—	8.29	8.68	8.00—8.27	m	12	—
	4.28	q	2				8.41	m	1	—
Af [g]	1.15	t	3	—	8.25	8.62	7.05—7.66	m	10	—
	4.25	q	2				7.92—8.02	m	2	—
Ag	1.21	t	3	—	8.25	8.70	7.26—8.01	m	12	—
	4.28	q	2				8.51, 8.53	dd	1	0.9, 2.3
Ah	1.13	t	3	—	8.31	8.84	7.27—8.06	m	11	—
	4.34	q	2				8.44	dd	1	2.6, 8.9
							9.26	d	1	2.6
Ca [h]	1.05	t	3	—	8.24	8.63	7.14—7.34	m	10	—
	4.21	q	2				7.89	d	2	8.3
							8.48	m	1	—
Cc [i]	1.17	t	3	—	8.24	8.63	7.35—7.45	m	9	—
	4.25	q	2				7.88	d	2	8.3
							8.30	m	1	—
Cg [j]	1.20	t	3	—	8.22	8.67	7.27—7.91	m	11	—
	4.27	q	2				8.51	dd	1	2.3, 0.7
Ba	1.12	t	3	1.34	8.45	8.35	7.28—8.00	m	9	—
	4.23	q	2							
Bc [k]	1.15	t	3	1.35	8.42	8.36	7.00—7.98	m	8	—
	4.23	q	2							
Ea	1.13	t	3	—	8.27	8.64	7.35—7.72	m	10	—
	4.22	q	2				7.95	d	2	8.8
							8.48	m	1	—
Fa	1.12	t	3	—	8.27	8.56	6.82	d	2	9.0
							7.35	d	2	9.0
							7.44—8.01	m	8	—
							8.50	m	1	—
Da [l]	1.17	t	3	—	8.16	—	6.58	d	1	7.9
	4.16	q	2				6.95	m	1	—
							7.34	d	2	3.9
							7.55—7.90	m	9	—
							8.48—8.70	m	1	—

[a] δ(CDCl$_3$), *J* in Hz. [b] *J* 7.2 Hz. [c] Doublet, $J_{A,B}$ 2.2 Hz. [d] δ 4′-Me, 2.22. [e] δ 5′-Me, 2.38. [f] δ 6′-Me, 2.53, [g] δ 6-Me, 2.48, δ 4-Me, 2.20. [h] δ 4-Me, 2.45. [i] δ 4-Me, 2.45; δ 5′-Me, 2.53. [j] δ 4′-Me, 2.46. [k] δ 5′-Me, 2.52. [l] δ 6′-Me, 2.53. [m] Doublet, *J* 2.0 Hz. [n] δ(CH_2CH_2) m, δ 3.06.

The present work offers a simple alternative to the diazotization. For general purposes the use of 2-ethoxycarbonyl-4,6-diphenylpyrylium (Series A) is recommended: the intermediate substituted 2-pyridylcarbonyl-2-pyridones are more stable than in some of the other series, and are hydrolysed smoothly.

Experimental

^{1}H N.m.r. spectra were recorded at ambient temperature (*ca.* 22 °C) on a JEOL FX-100 FT spectrometer in $CDCl_3$. A flip angle of 90° was used and the free induction decay was accumulated in 16 K data points per 1 200 Hz spectral width; repetition times were 8—10 s. Chemical shifts are expressed in p.p.m. relative to internal $SiMe_4$. I.r. spectra were obtained on a Perkin-Elmer 283 grating spectrometer. M.p.s were recorded on a Reichert hot-stage microscope and are uncorrected. Microanalyses were performed by Atlantic Microlab, Inc.

Starting Materials.—Heteroarylamines (Aldrich and Alpha) were purified either by distillation over NaOH or by recrystallisation. The following pyrylium salts were prepared by using literature methods: 2-ethoxycarbonyl-4,6-diphenylpyrylium tetrafluoroborate (1A) [m.p. 157—158 °C (lit.,[4] m.p. 155—157 °C)] and trifluoromethanesulphonate [m.p. 184—186 °C (lit.,[2] m.p. 194—196 °C)]; 2-ethoxycarbonyl-4-phenyl-6-t-butylpyrylium tetrafluoromethanesulphonate [m.p. 221—222 °C (lit.,[5] m.p. 221—222 °C)]; 2-ethoxycarbonyl-6-phenyl-4-*p*-tolylpyrylium tetrafluoroborate (1C) [m.p. 155—157 °C (lit.,[6] m.p. 154—156 °C)]; 2-ethoxycarbonyl-5,6-dihydro-4-phenylbenzo[*h*]chromenylium tetrafluoroborate (1D) [m.p. 170—172 °C (lit.,[5] m.p. 170—172 °C)].

2-*Ethoxycarbonyl*-4-p-*chlorophenyl*-6-*phenylpyrylium Trifluoromethanesulphonate* (1E).—4-Chlorobenzylideneacetophenone (2 g, 8.2 mmol), ethyl pyruvate (0.96 g, 8.2 mmol), and CF_3SO_3H (0.9 ml, 9.8 mmol) were refluxed in ether (20 ml) for 8 h. The resulting yellow crystalline mass was triturated with ether (50 ml). The crystals were filtered off and recrystallised from absolute ethanol to give yellow needles of the

View Online

Downloaded by Duke University on 12 September 2012
Published on 01 January 1983 on http://pubs.rsc.org | doi:10.1039/P19830002623

Table 3. Preparation of 1-(4,6-diaryl-2-pyridylcarbonyl)pyridones

Series (7)	R′	R	Y	Yield (%)	M.p. (form) (°C)	Found (%) (Required %) C	H	N	Molecular formula
Aa	Ph	Ph	—	65	129—131 (N)	78.3 (78.4	4.6 4.5	7.9 8.0)	$C_{23}H_{16}N_2O_2$
Ac	Ph	Ph	5-Me	92	155—156 (N)	78.5 (78.7	5.0 4.9	7.6 7.7)	$C_{24}H_{18}N_2O_2$
Ad	Ph	Ph	6-Me	85	124—126 (P)		*a*	—	$C_{24}H_{18}N_2O_2$
Af	Ph	Ph	4,6-Me_2	60	144—146 (N)		*b*	—	$C_{25}H_{20}N_2O_2$
Ae	Ph	Ph	5-Cl	90	152—154 (N)	71.2 (71.4	4.0 3.9	7.2 7.2)	$C_{23}H_{15}ClN_2O_2$
Ag	Ph	Ph	5-Br	85	144—146 (N)	64.1 (64.0	3.5 3.5	6.5 6.5)	$C_{23}H_{15}BrN_2O_2$
Ca	Ph	*p*-Tol	—	92 [c]					
Cc	Ph	*p*-Tol	5-Me	75	124—125 (N)	78.7 (78.9	5.4 5.3	7.3 7.4)	$C_{25}H_{20}N_2O_2$
Cg	Ph	*p*-Tol	5-Br	67	158—159 (N)	64.7 (64.7	3.8 3.8	6.2 6.3)	$C_{24}H_{17}BrN_2O_2$
Bc	Bu^t	Ph	5-Me	85	145—147 (N)		*d*	—	$C_{22}H_{22}N_2O_2$
Fa	*p*-$MeOC_6H_4$	Ph	—	75 [c]	163—164 (P)				$C_{24}H_{18}N_2O_3$
Da	C_8H_8	Ph	—	65	160—162 (P)		*e*		$C_{25}H_{18}N_2O_2$
Ea	Ph	*p*-ClC_6H_4	—	75	158—159 (P)	70.0 (69.9	4.2 [f] 3.9)		$C_{23}H_{15}ClN_2O_2$

[a] Characterised by mass spec.: *m/z* 366.1370 (requires *m/z* 366.1368). [b] Characterised by ^1H and ^{13}C n.m.r. spectroscopy. [c] Decomposes rapidly on standing. [d] Characterised by mass spec.: *m/z* 346.1670 (requires *m/z* 346.1681). [e] Characterised by mass spec.: *m/z* 378.1373 (requires *m/z* 378.1368). [f] The acylpyridone (7Ea) decomposed during purification to give 4-(*p*-chlorophenyl)-6-phenylpyridinecarboxylic acid; analysis fits the acid, also characterised by mass spec.: *m/z* 309.0546 (requires *m/z* 309.0556).

Table 4. ^1H N.m.r. spectral data of 1-(4,6-diphenyl-2-pyridyl-carbonyl)pyridones [a]

Series (7)	CH_3	C_3H [b]	C_5H [b]	2-Pyridone δ	m	*J*	H	Others δ	m	H
								7.17—7.91	m	9
								8.11—8.20	m	3
Aa	—	8.12	8.42					8.41—8.50	m	2
Ac	2.37	8.10	8.36	6.18	dd	1.50, 6.70	1	7.44—8.07	m	10
				6.50	d	1.50	1			
				7.33	d	6.70	1			
Ad	2.58	*c*	8.50	7.08	d	3.54	1	7.25—8.20	m	12
				7.35	d	3.05	1			
Af	2.37	8.21	8.49	6.61	s	—	1	7.27—8.29	m	10
	2.49			6.66	s	—	1			
Ae	—	*c*	8.43	*c*	—	—	—	7.26—8.17	m	14
Ag	—	*c*	*c*	*c*	—	—	—	7.18—8.43	m	14
								8.52	d	1 [d]
Cc	2.38	*c*	8.43 [e]	*c*	—	—	—	7.15—8.34	m	13
	2.43									
Cg	2.43	*c*	8.41	*c*	—	—	—	7.17—8.42	m	12
								8.52	dd	1 [f]
Bc	1.44 [g]	*c*	*c*	*c*	—	—	—	6.70	d	1 [h]
	2.15							7.51—7.75	m	4
								7.81—7.91	m	3
								8.13	m	1
								8.50	m	1

[a] See footnote *a* in Table 3. [b] Doublet, J_{AB} 1.61 Hz. [c] Signal is hidden within the aromatic multiplet. [d] *J* 2.54 Hz. [e] *J* 1.47 Hz. [f] *J* 0.60 Hz. [g] Bu^t. [h] *J* 9 Hz.

pyrylium (1E) (0.72 g, 18%), m.p. 218—220 °C (Found: C, 51.4; H, 3.3. $C_{21}H_{16}ClF_3O_6S$ requires C, 51.6; H, 3.3%), $\nu_{max.}$ 1 740, 1 640, 1 580, 1 540, 1 530, 1 500, 1 470, 1 430, 1 380, 1 270, 1 095, 1 080, 1 025, 1 000, 880, 780, 760, and 700 cm^{-1}; δ($CDCl_3$–CF_3CO_2H) δ 1.5 (t, 3 H, *J* 7.2 Hz), 4.6 (q, 2 H, *J* 7.2 Hz), 7.26—8.40 (m, 9 H), 8.68 (d, 1 H, *J* 1.76 Hz), and 8.93 (d, 1 H, *J* 1.76 Hz).

2-*Ethoxycarbonyl*-6-p-*methoxyphenyl*-4-*phenylpyrylium Trifluoromethanesulphonate* (1F).—This compound was prepared following the above procedure from benzylidene-*p*-anisophenone (2 g, 8.4 mmol), ethyl pyruvate (1 g, 8.6 mmol), and CF_3SO_3H (0.9 ml, 10.1 mmol); it formed orange needles (0.94 g, 23%), m.p. 170—172 °C (Found: C, 54.6; H, 4.0. $C_{22}H_{19}F_3O_7S$ requires C, 54.5; H, 3.9%); $\nu_{max.}$ 1 750, 1 640,

View Online

Published on 01 January 1983 on http://pubs.rsc.org | doi:10.1039/P19830002623
Downloaded by Duke University on 12 September 2012

Table 5. Preparation of 2-pyridones (9)

Starting material	Substituents in 2-pyridone	Yield (%)	M.p. (°C)	Lit. m.p. (°C)
(7Ac)	5-Me	65	182—185	184—188 [a]
(7Ad)	6-Me	72	156—157	158—159 [b]
(7Af)	4,6-Me_2	60	176—178	180 [c]
(7Ae)	5-Cl	58	164—166	163 [d]

[a] M. Barash, J. M. Osbond, and J. C. Wickens, *J. Chem. Soc.*, 1959, 3530. [b] R. Adams and A. W. Shrecker, *J. Am. Chem. Soc.*, 1949, **71**, 1186. [c] E. Knoewvenagel and W. Cremer, *Ber.*, 1902, **35**, 2390. [d] A. E. Chichibabin and A. F. Egorov, *J. Russ. Phys. Chem. Soc.*, 1928, **60**, 683 (*Chem. Abstr.*, 1929, **23**, 2182).

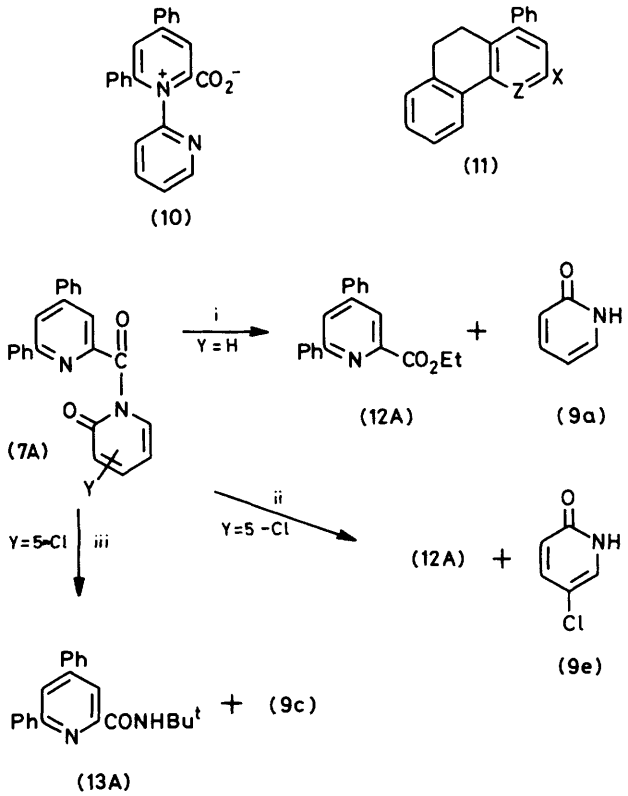
1 605, 1 515, 1 265, 1 030, 840, and 760 cm^{-1}; δ($CDCl_3$–CF_3CO_2H) δ 1.51 (t, 3 H, *J* 7.2 Hz), 3.92 (s, 3 H), 4.61 (q, 2 H, *J* 7.2 Hz), 7.04 (d, 2 H, *J* 9.1 Hz), 7.26—8.20 (m, 5 H), 8.44 (d, 2 H, *J* 9.1 Hz), 8.47 (d, 1 H, *J* 2.05 Hz), and 8.87 (d, 1 H, *J* 2.05 Hz).

General Procedure for the Preparation of 1-(4,6-*Diphenyl*-2-*pyridylcarbonyl*)-2-*pyridones* (7).—A suspension of the pyridinium salt (4 mmol) in 0.5M-aqueous sodium hydroxide (16 ml) was stirred at 25 °C for 48 h. The solution was filtered, cooled to 0 °C, and acidified to pH 2 with 0.5M-aqueous hydrochloric acid (*ca.* 10 ml). A white precipitate appeared; the whole was stirred for *ca.* 2 h during which time the reaction was allowed to warm to 25 °C. The products were obtained by filtration and purified by crystallisation or chromatography (see Table 3).

Hydrolysis of 1-(4,6-*Diphenyl*-2-*pyridylcarbonyl*)-2-*pyridones*.—The amide (2 mmol) was refluxed with aqueous sodium hydroxide (2 mmol; 0.5M) in 95% ethanol (10 ml) for 2 h. The reaction mixture on cooling to 25 °C precipitated the sodium salt of the pyridinecarboxylic acid. This was filtered off and treated with 2M-aqueous hydrochloric acid to give either (*a*) 4,6-diphenylpyridine-2-carboxylic acid (8A) [m.p. 150 °C (lit.,[7] m.p. 150 °C (decomp.)] or (*b*) 6-phenyl-4-*p*-tolylpyridine-2-carboxylic acid (8C) in quantitative yield, m.p. 89—91 °C (Found: C, 77.6; H, 5.7. $C_{19}H_{15}NO_2$ requires C, 78.9; H, 5.2%), δ ^1H n.m.r. ($CDCl_3$), 2.4 (s, 3 H), 7.28 (d, 2 H, *J* 8.5 Hz), 7.40—8.03 (m, 7 H), 8.07 (d, 1 H, *J* 1.61 Hz), 8.36 (d, 1 H, *J* 1.61 Hz), 9.12br (singlet, 1 H); $\nu_{max.}$ 3 200—3 600, 1 760, 1 605, 1 540, 1 440, 1 365, 1 220, 815, and 770 (Found: *m/z* 289.112. Calc. for $C_{19}H_{15}NO_2$: *m/z* 289.1102).

The filtrate was evaporated to dryness at 65 °C (25 mmHg), and the residue was extracted with hot benzene (30 ml). The extract was concentrated at 50 °C (25 mmHg) to give upon filtration the 2-pyridones (Table 5).

Aminolysis of 5-*Chloro*-1-(4,6-*diphenyl*-2-*pyridylcarbonyl*)-2-*pyridone*.—The acylpyridone (7Ae) (500 mg, 1.3 mmol) was refluxed with t-butylamine (115 mg, 1.6 mmol) in chloroform (5 ml) for 6 h. The solvent was removed at 45 °C/25 mmHg and the P_2O_5 dried material was chromatographed on silica gel (25 g), using diethyl ether as eluant to give 4,6-diphenyl-2-(t-butylcarbamoyl)pyridine (13A) (70%) as prisms, m.p. 123—124 °C (Found: C, 80.0; H, 6.7; N, 8.5. $C_{22}H_{22}N_2O$ requires C, 80.0; H, 6.7; N, 8.4%), δ 1.55 (s, 9 H), 7.24—8.1 (m, 12 H), and 8.40 (d, 1 H, *J* 1.61 Hz); $\nu_{max.}$ 3 380, 2 970, 1 675, 1 605, 1 600, 1 500, 1 455, 1 425, 1 390, 1 365, 1 270, 1 230, 890, 760, and 690 cm^{-1}.



Scheme 2. *Reagents:* i, EtOH and heat; ii, $EtOH/H^+$ and heat; iii, $CHCl_3$–Bu^tNH_2 and heat

Ethanolysis of 1-(4,6-*Diphenyl*-2-*pyridylcarbonyl*)-2-*pyridone*.—When heated in ethanol, the acylpyridone (7Aa) gave 2-ethoxycarbonyl-4,6-diphenylpyridine (12A) (100%), m.p. 98—99 °C (lit.,[4] m.p. 95—96 °C). 5-Chloro-1-(4,6-diphenyl-2-pyridylcarbonyl)-2-pyridone (7Ae) similarly reacted with ethanol in the presence of a trace of hydrochloric acid to give 2-ethoxycarbonyl-4,6-diphenylpyridine (12A) (95%) which was isolated by chromatography (silica gel, ether).

References

1 Part 4, preceding paper.
2 A. R. Katritzky and A. Cozens, *J. Chem. Soc., Perkin Trans. 1*, 1983, 2611.
3 A. R. Katritzky, R. T. Langthorne, H. A. Muathin, and R. C. Patel, *J. Chem. Soc., Perkin Trans. 1*, 1983, 2601.
4 A. R. Katritzky, A. Chermprapai, R. C. Patel, and A. Tárraga-Tomas, *J. Org. Chem.*, 1982, **47**, 492.
5 A. R. Katritzky, R. Awartani, and R. C. Patel, *J. Org. Chem.*, 1982, **47**, 498.
6 T. Siddiqui, Ph.D. Thesis, University of East Anglia, 1981.
7 K. Dimroth, K. Vogel, and W. Krafft, *Chem. Ber.*, 1968, **101**, 2215.

Received 21*st December* 1982; *Paper* 2/2136