[Chem. Pharm. Bull. 27(5)1207—1213(1979)]

UDC 547.823.04 : 547.415.04

Studies on the Syntheses of 2(1H)-Pyridone Derivatives. II.[1] Reactions of N-Substituted 6-Chloro-2(1H)-pyridones with Ethylenediamine, 2-Aminoethanethiol and Related Compounds

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(Received December 22, 1978)

It has been found that Smiles rearrangement leading to N-*p*-chlorophenyl-6-*β*-hydroxyethylamino-4-phenyl-2(1H)-pyridone (II) took place when 6-*β*-aminoethoxy-N-*p*-chlorophenyl-4-phenyl-2(1H)-pyridone (III) was heated in acetic acid, and that the reaction of an N-substituted 6-chloro-4-phenyl-2(1H)-pyridone (I) with ethylenediamine, 2-aminoethanethiol or *o*-aminothiophenol gives condensed heterocyclic pyridones such as imidazopyridone (IV), thiazolopyridone (X) or benzothiazolopyridone (XV). This reaction is considered to proceed by ring transformation of an intermediate of the Smiles rearrangement.

Some of these pyridone derivatives showed strong biological activities as analgesic and antiinflammatory agents.

Keywords——1-substituted 6-chloro-2(1H)-pyridone; Smiles rearrangement; imidazo[1,2-*a*]pyridone; thiazolo[3,2-*a*]pyridone; oxo-pyrido[2,1-*b*]benzothiazole; antiinflammatory activity; analgesic activity

In the previous paper[1] we reported that N-substituted 4-phenyl-2(1H)-pyridones having an alkoxy or amino group at the 6-position have strong analgesic and antiinflammatory activities.

The present report describes the reaction of an N-substituted 6-chloro-4-phenyl-2(1H)-pyridone with a binucleophile such as ethylenediamine or 2-aminoethanethiol, resulting in the formation of an imidazopyridone or thiazolopyridone, respectively, *via* ring transformation. The imidazopyridones and thiazolopyridones thus obtained exhibited strong activities in biological screening tests.

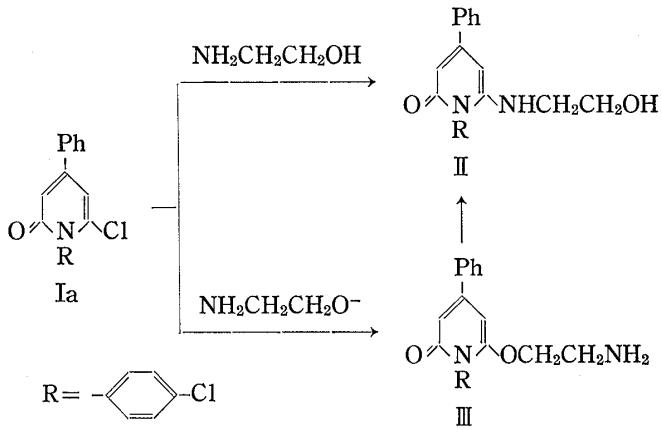

Chart 1

First, the reaction of 6-chloro-1-*p*-chlorophenyl-4-phenyl-2(1H)-pyridone[1] (Ia) with 2-aminoethanol was investigated. When Ia was allowed to react with 2-aminoethanol in ethoxyethanol under reflux for 1 hour, 1-*p*-chlorophenyl-6-*β*-hydroxyethylamino-4-phenyl-2(1H)-pyridone (II) was obtained. On the other hand, 6-*β*-aminoethoxy-1-*p*-chlorophenyl-4-phenyl-2(1H)-pyridone (III) was obtained by the reaction of Ia with sodium 2-aminoethylate in a mixture of benzene and dimethylformamide (DMF) at room temperature.

1) Part I: K. Kubo, N. Ito, Y. Isomura, I. Sozu, H. Arima, H. Homma, and M. Murakami, *Yakugaku Zasshi*, accepted.

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When compound III was heated under reflux in acetic acid for 1 hour, Smiles rearrangement occurred and it was converted into the compound II. This result indicates specific reactivity at the 6-position of 2(1H)-pyridone toward nucleophilic reagents.

When Ia was treated with ethylenediamine in ethoxyethanol under reflux, 5-oxo-7-phenyl-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridine (IVa) was obtained in 61.4% yield instead of a 2(1H)-pyridone simply replaced by the amine at the 6-position. From the mass spectral and microanalytical data for IVa, the molecular formula $C_{13}H_{12}N_2O$ was established, which corresponds to the loss of *p*-chloroaniline and hydrogen chloride from Ia plus ethylenediamine. The infrared (IR) spectrum of IVa showed absorption at 1660 cm^{-1} due to the carbonyl group. The nuclear magnetic resonance (NMR) data indicated the existence of one aromatic ring, two olefinic bonds (6.06 ppm, 5.64 ppm) and two methylene groups (4.23 ppm, 3.74 ppm). These spectral data are analogous to those for 7-methyl-5-oxo-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridine[3] prepared by the condensation of 2-methyl-2-imidazoline with diketene followed by acid treatment. These data were consistent with the structure IVa.

On the other hand, the reaction of Ia with N-methylethylenediamine in boiling xylene afforded prisms of mp 179—180° (V), $C_{20}H_{18}ClN_3$, as well as the expected 1-methyl-5-oxo-7-phenyl-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridine (IVb). The NMR spectrum of V showed signals analogous to those of IVb, except that it indicated the existence of two aromatic rings. On hydrolysis with 47% hydrobromic acid, V afforded IVb. On the basis of these data, the structure of V was assigned as 5-*p*-chlorophenylimino-1-methyl-7-phenyl-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridine.

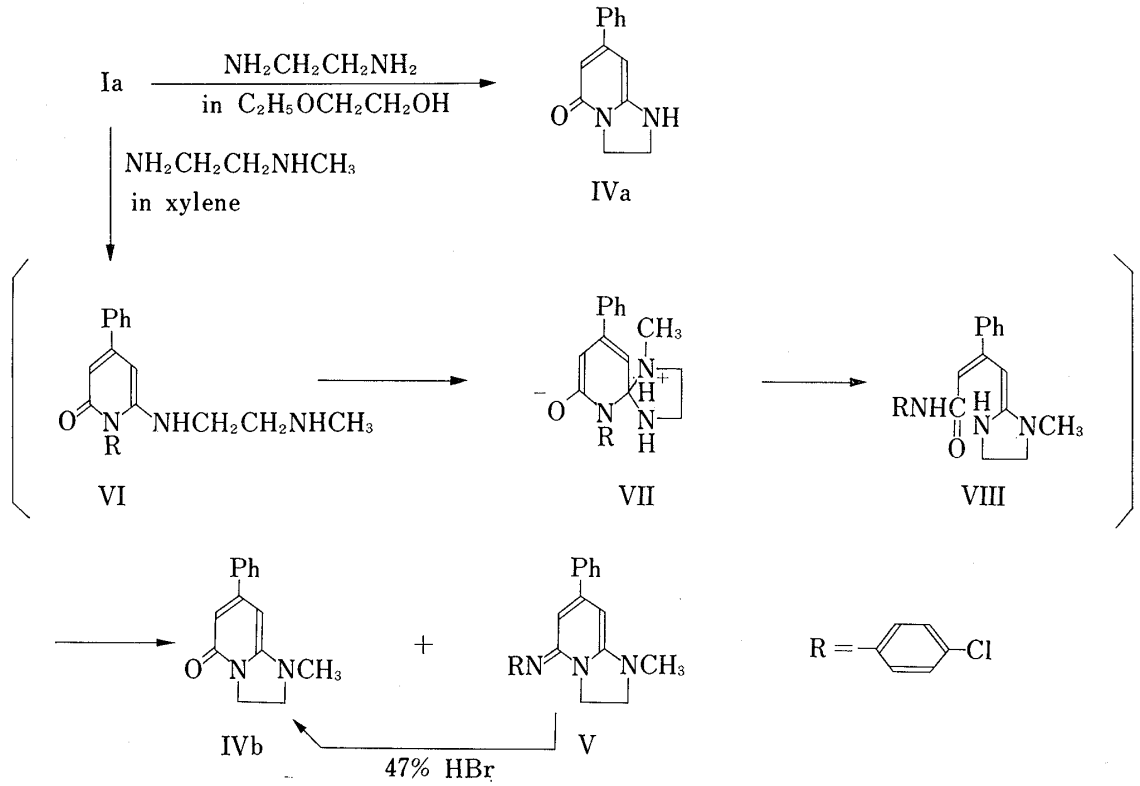


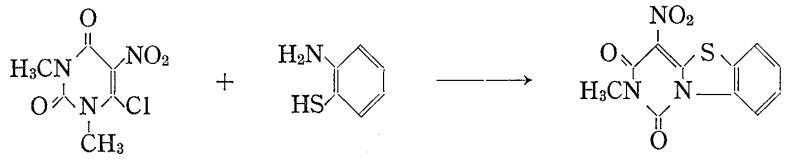
Chart 2

On the basis of these findings the reaction pathway was presumed to proceed as follows: the replacement of 6-chlorine in Ia with N-methylenediamine led to the 6-amino substituted 2(1H)-pyridone (VI), which formed the intermediate[4] (VII) by Smiles rearrangement with

3) T. Kato and T. Sakamoto, *Yakugaku Zasshi*, **91**, 1174 (1971).
4) W.E. Truce, E.M. Kreider, W.W. Brand, "Organic Reactions," Vol. 18, ed. by W.G. Dauben, John Wiley and Sons, Inc., New York, 1970, p. 99.

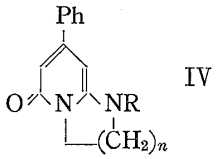
the intramolecular nucleophilic attack of the NH–CH_3 group. N–C_6 bond cleavage of VII resulted in the formation of VIII. VIII was cyclized to IVb with the loss of *p*-chloroaniline. In addition, dehydration of VIII gave rise to the formation of V.

Analogous ring transformation[5] in the Smiles rearrangement intermediate was observed in the reaction of 1,3-dimethyl-5-nitro-6-chlorouracil with *o*-aminothiophenol in an acidic medium.



The compounds (IVa—IVg), prepared similarly by the reaction of Ia with an aliphatic 1,2- or 1,3-diamine, are listed in Table I.

TABLE I. 5-Oxo-7-phenyl-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridines and 6-Oxo-8-phenyl-1,2,3,4-tetrahydro-6H-pyrido[1,2-*a*]pyrimidines



IV

Compd. No.	R	*n*	Reaction conditions: Solvent[a]	Reaction conditions: Time (hr)	Yield (%)	mp (°C) (Recryst. solvent)	Formula	Analysis (%) Calcd. (Found): C	H	N
IVa	H	1	Ethoxyethanol	4	61.4	198—200 (iso-PrOH)	$C_{13}H_{12}N_2O$	73.57 (73.55	5.70 5.82	13.20 13.46)
IVb	CH_3	1	Xylene	20	35.0	158—159 (AcOEt)	$C_{14}H_{14}N_2O$	74.31 (74.02	6.24 6.09	12.38 12.05)
IVc	H	2	Ethoxyethanol	6	44.7	201—203 (AcCN)	$C_{14}H_{14}N_2O$	74.31 (74.21	6.24 6.20	12.38 12.49)
IVd	CH_3	2	Ethoxyethanol *o*-Dichlorobenzene	50 18	27.6 65.8	142—143 (AcOEt)	$C_{15}H_{16}N_2O$	74.97 (75.13	6.71 6.79	11.66 11.91)
IVe	C_2H_5	1	Ethoxyethanol	20	45.8	83—85 (AcOEt–H_2O)	$C_{15}H_{20}N_2O_3$[b]	65.20 (65.01	7.29 7.36	10.14 9.95)
IVf	$PhCH_2$	1	Ethoxyethanol	50	26.3	165—167 (AcOEt)	$C_{20}H_{18}N_2O$	79.44 (79.46	6.00 6.12	9.26 9.36)
IVg		1	Ethoxyethanol	100	24.5	210—214 (AcCN–AcOEt)	$C_{19}H_{23}ClN_2O$[c]	68.98 (69.31	7.01 7.20	8.47 8.42)

a) Under reflux. *b*) Dihydrate. *c*) HCl salt.

When Ia was allowed to react with 2-aminoethanethiol hydrochloride in the presence of triethylamine in ethoxyethanol under reflux, 6-*β*-aminoethylthio-1-*p*-chlorophenyl-4-phenyl-2(1H)-pyridone (IX) was obtained by the replacement of 6-chlorine in Ia with an SH group. In order to examine the Smiles rearrangement, IX was heated in ethyleneglycol at 190°, and prisms of mp 142—143°, $C_{13}H_{11}NOS$ (Xa), were obtained in 62.1% yield. The compound (Xa) was characterized as 5-oxo-7-phenyl-2,3-dihydro-5H-thiazolo[3,2-*a*]pyridine from spectral data. Namely, the IR spectrum of Xa showed absorption at 1640 cm^{-1} due to a carbonyl group and the NMR spectrum indicated the presence of one aromatic ring, two olefinic bonds (6.48 ppm, 6.40 ppm) and two methylene groups (4.52 ppm, 3.42 ppm). These data are consistent with the structure Xa.

5) Y. Maki, R. Hiramitsu, and M. Suzuki, *Chem. Pharm. Bull.* (Tokyo), **22**, 1265 (1974).

Oxidation of Xa with hydrogen peroxide gave the corresponding sulfoxide (XI) and sulfone (XII). By means of the Pummerer reaction using acetic anhydride XI was converted to a 2-acetoxy derivative (XIII). 5-Oxo-7-phenyl-5H-tiazolo[3,2-*a*]pyridine (XIV) was obtained by the treatment of XIII with conc. sulfuric acid. The NMR spectrum of XIV showed two doublet signals at 6.92 ppm and 8.12 ppm attributable to the thiazole ring and lacked the two methylene signals present in Xa.

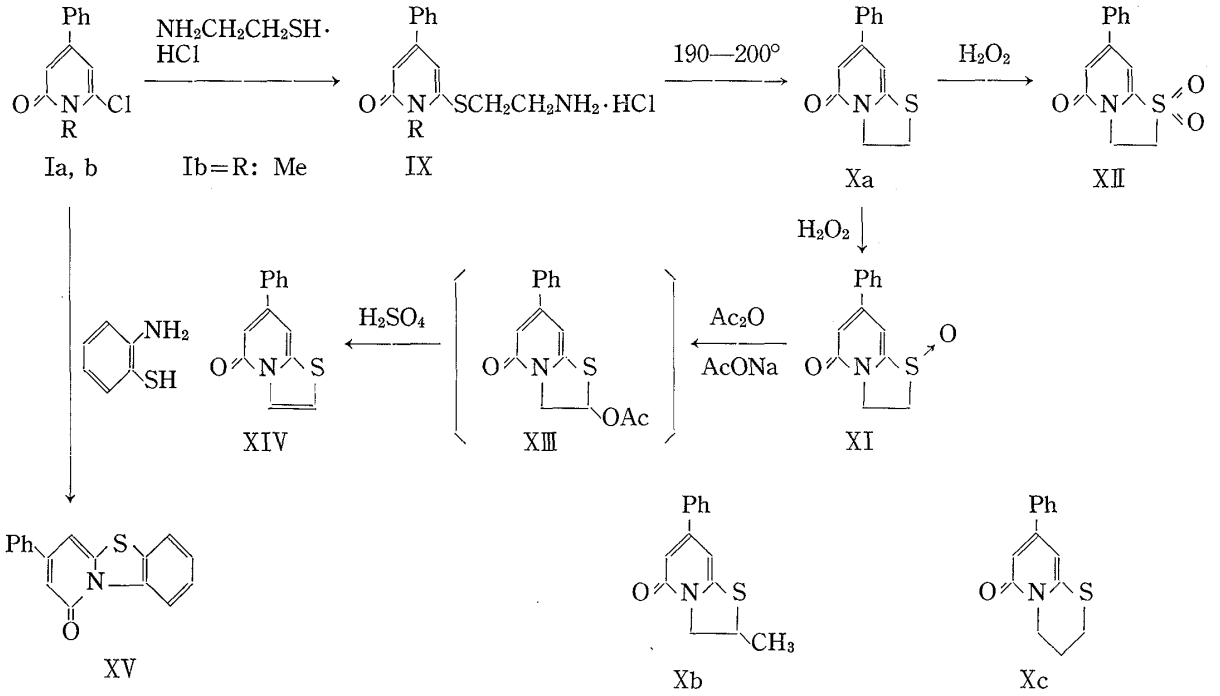


Chart 3

Table II. Antiinflammatory and Analgesic Activities

Compd. No.	Antiinflammatory activity[a] *p.o.*		Analgesic activity[b] *p.o.*	
	25 mg/kg	50 mg/kg	25 mg/kg	50 mg/kg
IVa	45.3	71.6	28.9	50.7
IVb	43.0	69.2	41.2	67.4
IVc	42.4	72.7	69.0	91.5
IVd	43.2	66.7	41.8	87.6
IVe	14.9	51.4	14.1	31.1
IVf		10>		
IVg		10>		
Xa		69.1		22.0
Xb		41.7		20.6
Xc		10.0		
XI	50.3	70.2		18.3
XII		12.7		
XIV	18.1	46.9		58.1
XV		10>		
Phenylbutazone	29.4	44.5		
Aminopyrine			29.6	58.1

a) Inhibition (%) of edema induced by carrageenin in rats.
b) Inhibition (%) of writhing caused by acetic acid in mice.

Xa was also obtained by reacting 6-chloro-1-methyl-4-phenyl-2(1H)-pyridone[6] (Ib) with 2-aminoethanethiol in the presence of triethylamine at 190° in ethyleneglycol in 52.2% yield, without isolating the 6-mercapto substituted product. Similarly, compounds (Xb, c) were prepared by the reaction of Ia with the corresponding 1,2 or 1,3 aliphatic aminothiol.

The reaction of Ib with *o*-aminothiophenol in ethoxyethanol under reflux gave 1-oxo-3-phenyl-1H-pyrido[2,1-*b*]benzothiazole (XV) in 58.8% yield. This reaction occurred more readily than the reaction with 2-aminoethanethiol. In the NMR spectrum of XV, the proton at the 9-position was shifted to lower field (9.18—9.36 ppm) compared with the other aromatic ring protons (7.36—7.68 ppm) by the effect of anisotropy of the carbonyl group at the 1-position.

These reactions were considered to be acid-catalyzed, because no formation of Xa was noted on heating the free base of IX in ethyleneglycol at 190°.

Biological activities such as antiinflammatory or analgesic activities of these condensed heterocyclic 2(1H)-pyridones (IV, X—XV) were assayed by the carrageenin foot edema method[7] (rats) and the acetic acid writhing method[8] (mice) in comparison with phenylbutazone or aminopyrine. The series (IV, X) showed strong activities as analgesic and antiinflammatory agents.

Experimental[9]

1-*p*-Chlorophenyl-6-*β*-hydroxyethylamino-4-phenyl-2(1H)-pyridone (II)——A mixture of 6-chloro-1-*p*-chlorophenyl-4-phenyl-2(1H)-pyridone[1] (Ia) (0.95 g) and 2-aminoethanol (0.5 ml) in ethoxyethanol (5 ml) was heated under reflux for 8 hr. After cooling, the precipitated crystals were collected and recrystallized from DMF to give 0.67 g (65.7%) of II, mp 267—268°. *Anal.* Calcd. for $C_{19}H_{17}ClN_2O_2$: C, 66.96; H, 5.03; N, 8.22. Found: C, 67.01; H, 5.26; N, 8.35.

6-*β*-Aminoethoxy-1-*p*-chlorophenyl-4-phenyl-2(1H)-pyridone (III)——Ia (2.5 g) was added to a stirred solution of sodium 2-aminoethylate prepared from 2-aminoethanol (0.7 g) and 50% oiled NaH (0.5 g) in a mixture of benzene (15 ml) and DMF (10 ml). After stirring for 1.5 hr at room temperature, the reaction mixture was poured into water, then acidified with HCl and extracted with benzene. The aqueous phase was made basic with 20% NaOH and again extracted with benzene. After removal of the solvent, the residue was recrystallized from AcOEt to give 1.46 g (54.1%) of III. mp 172—173°. *Anal.* Calcd. for $C_{19}H_{17}ClN_2O_2$: C, 66.96; H, 5.03; N, 8.22. Found: C, 66.74; H, 4.97; N, 8.17.

Conversion of III into II——A solution of III (0.4 g) in AcOH (3 ml) was heated under reflux for 1 hr, then diluted with H_2O. The precipitated solid was collected and dissolved in a small amount of DMF by heating. To the DMF solution was added 10% NaOH (0.5 ml) at 50—60°, and the mixture was stirred for 10 min in order to hydrolyze the O-acetyl product of II, which had been partially formed in the reaction of II with AcOH. After cooling, the precipitated crystals were collected and washed with MeOH to give 0.27 g (67.5%) of II, identical with a sample of II obtained from the run described previously.

5-Oxo-7-phenyl-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridine (IVa)——A mixture of Ia (15 g) and ethylenediamine (6.0 g) in ethoxyethanol (60 ml) was heated under reflux for 4 hr. After removal of most of the solvent by evaporation, H_2O (60 ml) was added to the residue, then it was acidified to pH<2 with HCl. The precipitated hydrochloride salt was collected, washed with H_2O and dissolved in MeOH (50 ml) with heating. The resulting solution was made basic with 5% K_2CO_3 to give IVa, which was purified by recrystallization. (The series of compounds IV is shown in Table I). IR ($CHCl_3$) cm^{-1}: 3460 (NH), 1660 (CO). NMR ($CDCl_3$) ppm: 3.74 (2H, t, J=8 Hz, $-CH_2-$), 4.24 (2H, t, J=8 Hz, $-CH_2-$), 4.98 (1H, br s, NH), 5.64 (1H, d, $J\fallingdotseq$1.5 Hz, $-CH=C\langle$), 6.06 (1H, d, $J\fallingdotseq$1.5 Hz, $-CH=C\langle$), 7.20—7.56 (5H, m, aromatic protons). MS *m/e*: 212 (M^+).

The Reaction of Ia with N-Methylethylenediamine in Xylene——A mixture of Ia (2.0 g) and N-methylethylenediamine (2.0 g) in xylene (10 ml) was heated under reflux for 20 hr. Water (5 ml) was added to the

6) G. Simchen, *Chem. Ber.*, **103**, 389 (1970).
7) C.A. Winter, E.A. Risley, and G.W. Nuss, *Proc. Soc. Exp. Biol. Med.*, **111**, 544 (1962).
8) R. Kostar, M. Anderson, and E.J. Debbeer, *Fed. Proc.*, **22**, 248 (1963).
9) All melting points are uncorrected. IR spectra were run on a Hitachi 215 spectrometer. NMR spectra were recorded at 100 MHz with a JEOL-MH 100 or a JEOL-FX 100 spectrometer using TMS as an internal standard. The following abbreviations are used: s=singlet, d=doublet, t=triplet, m=multiplet, br=broad. Mass spectra (MS) were obtained on a Hitachi RMU-6MG double-focusing mass spectrometer.

reaction mixture, which was then acidified to pH<2 with HCl. The precipitated hydrochloride salt was collected, washed with H_2O and dissolved in H_2O (20 ml) with heating. The resulting solution was made basic with K_2CO_3 and extracted with $CHCl_3$. The extract was dried over $MgSO_4$ and evaporated down. The residue was recrystallized from AcOEt to give 0.5 g (35.0%) of 1-methyl-5-oxo-7-phenyl-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridine (IVb), as shown in Table I. IR (KBr) cm^{-1}: 1650 (CO). NMR ($CDCl_3$) ppm: 2.90 (3H, s, NCH_3), 3.58 (2H, t, J=8 Hz, $-CH_2-$), 4.16 (2H, t, J=8 Hz, $-CH_2-$), 5.44 (1H, d, $J\fallingdotseq$1.5 Hz, -CH=C<), 6.08 (1H, d, $J\fallingdotseq$1.5 Hz, -CH=C<), 7.32—7.64 (5H, m, aromatic protons). MS *m/e*: 226 (M^+).

The mother liquor was concentrated and the residue was purified by recrystallization from EtOH to give 0.32 g (15.0%) of 5-*p*-chlorophenylimino-1-methyl-7-phenyl-2,3-dihydro-1H,5H-imidazo[1,2-*a*]pyridine (V). mp 179—180°. *Anal.* Calcd. for $C_{20}H_{18}ClN_3$: C, 71.53; H, 5.40; N, 12.51. Found: C, 71.67; H, 5.53; N, 12.78. NMR ($CDCl_3$) ppm: 2.80 (3H, s, NCH_3), 3.52 (2H, t, J=8 Hz, $-CH_2-$), 4.10 (2H, t, J=8 Hz, $-CH_2-$), 5.16 (1H, d, $J\fallingdotseq$1.5 Hz, -CH=C<), 5.94 (1H, d, $J\fallingdotseq$1.5 Hz, -CH=C<), 6.84—7.54 (9H, m, aromatic protons). MS *m/e*: 335 (M^+).

Hydrolysis of V——A solution of V (0.1 g) in 47% HBr (1 ml) was heated under reflux for 12 hr, then concentrated under reduced pressure. The residual hydrobromide salt was purified by recrystallization from H_2O, giving 0.07 g of VIb hydrobromide, which was identical with a sample of IVb hydrobromide obtained from the previously described run.

6-β-Aminoethylthio-1-*p*-chlorophenyl-4-phenyl-2(1H)-pyridone (IX)——A mixture of Ia (0.95 g), 2-aminoethanethiol hydrochloride (0.45 g), and triethylamine (0.36 g) in ethoxyethanol (5 ml) was heated under reflux for 2 hr, then 2% NaOH (20 ml) was added. The precipitated solid was collected and dissolved in AcOEt. After washing with H_2O, the AcOEt solution was acidified with HCl to give 0.8 g (68.6%) of IX hydrochloride. mp 261—262° (from DMF). *Anal.* Calcd. for $C_{19}H_{18}Cl_2N_2OS$: C, 58.02; H, 4.61; N, 7.12; S, 8.15. Found: C, 57.84; H, 4.72; N, 7.06; S, 8.23.

To a well-stirred suspension of IX HCl salt (0.8 g) in 50% EtOH (8 ml), 2% NaOH (10 ml) was added. The crystals obtained were collected and recrystallized from aqueous EtOH to give 0.65 g (60%, from Ia) of IX. mp 183—184°. *Anal.* Calcd. for $C_{19}H_{17}ClN_2OS$: C, 63.95; H, 4.80; N, 7.85; S, 8.98. Found: C, 63.75; H, 4.71; N, 7.61; S, 9.12.

5-Oxo-7-phenyl-2,3-dihydro-5H-thiazolo[3,2-*a*]pyridine (Xa)——A) IX hydrochloride (0.8 g) was heated in ethyleneglycol (5 ml) at 190—200° for 3 hr. The reaction mixture was poured into H_2O and extracted with AcOEt, and the extract was washed with H_2O, dried over Na_2SO_4 and evaporated down. The residue was chromatographed on silica gel, and elution with $CHCl_3$ followed by recrystallization from AcOEt gave 0.29 g (62.1%) of Xa. mp 142—143°. *Anal.* Calcd. for $C_{13}H_{11}NOS$: C, 68.10; H, 4.84; N, 6.11; S, 13.98. Found: C, 68.15; H, 4.80; N, 6.14; S, 13.73. IR (KBr) cm^{-1}: 1640 (CO). NMR ($CDCl_3$): 3.42 (2H, t, J=8 Hz, $-CH_2-$), 4.52 (2H, t, J=8 Hz, $-CH_2-$), 6.40 (1H, d, $J\fallingdotseq$1.5 Hz, -CH=C<), 6.48 (1H, d, $J\fallingdotseq$1.5 Hz, -CH=C<), 7.32—7.64 (5H, m, aromatic protons). MS *m/e*: 229 (M^+).

B) A mixture of Ia (1.58 g) and 2-aminoethanethiol (0.5 g) in ethyleneglycol (5 ml) was heated at 190—200° for 5 hr. The reaction mixture was treated as described above, yielding 0.57 g (49.8%) of Xa.

C) The reaction of 6-chloro-1-methyl-4-phenyl-2(1H)-pyridone (Ib) (0.88 g) with 2-aminoethanethiol hydrochloride (0.55 g) was carried out in the manner described above, yielding 0.48 g (52.3%) of Xa.

3-Methyl-5-oxo-7-phenyl-2,3-dihydro-5H-thiazolo[3,2-*a*]pyridine (Xb)——The reaction of Ia with 2-aminopropanethiol was carried out as described for Xa-B, giving Xb in 61.7% yield. mp 117—118° (from AcOEt–cyclohexane). *Anal.* Calcd. for $C_{14}H_{13}NOS$: C, 69.11; H, 5.39; N, 5.76; S, 13.18. Found: C, 69.16; H, 5.50; N, 6.08; S, 13.04.

6-Oxo-8-phenyl-3,4-dihydro-2H,6H-1,3-thiazino[3,2-*a*]pyridine (Xc)——The reaction of Ia with 3-aminopropanethiol was carried out in the manner described for Xa-B, giving Xc in 29% yield. mp 156—157° (from isopropanol). *Anal.* Calcd. for $C_{14}H_{13}NOS$: C, 69.11; H, 5.39; N, 5.76; S, 13.18. Found: C, 68.84; H, 5.24; N, 5.75; S, 13.41.

5-Oxo-7-phenyl-2,3-dihydro-5H-thiazolo[3,2-*a*]pyridine 1-Oxide (XI)——To a solution of Xa (2.0 g) in AcOH (10 ml) was added 30% H_2O_2 (1.4 ml). The mixture was kept at room temperature for 15 hr, then condensed under reduced pressure. Water was added to the residue and the crystals obtained were purified by recrystallization from EtOH to give 1.3 g (70.2%) of XI mp 217—218°. *Anal.* Calcd. for $C_{13}H_{11}NO_2S$: C, 63.66; H, 4.52; N, 5.71. Found: C, 63.80; H, 4.54; N, 5.52.

5-Oxo-7-phenyl-2,3-dihydro-5H-thiazolo[3,2-*a*]pyridine 1,1-Dioxide (XII)——To a solution of Xa (0.46 g) in AcOH (4 ml) was added 30% H_2O_2 (0.5 ml), and the solution was heated under reflux for 2 hr. After cooling, the precipitated crystals were collected, then recrystallized from aqueous AcOH, giving 0.35 g (66.8%) of XII. mp 233—234°. *Anal.* Calcd. for $C_{13}H_{11}NO_3S$: C, 59.76; H, 4.24; N, 5.36. Found: C, 59.30; H, 3.77; N, 5.38.

5-Oxo-7-phenyl-5H-thiazolo[3,2-*a*]pyridine (XIV)——A solution of XI (2.0 g) and AcONa (0.2 g) in Ac_2O (20 ml) was heated under reflux for 7 hr, then the Ac_2O was removed by evaporation under reduced pressure. Water was added to the residue, then the resulting solution was made basic with K_2CO_3. Extraction with $CHCl_3$ and removal of the solvent left a residue. The residue was dissolved in conc. H_2SO_4 (15 ml), kept at room temperature for 30 min then poured onto ice-H_2O, neutralized with K_2CO_3 and extracted with benzene. After removal of the solvent, the residue was chromatographed on silica gel and eluted with $CHCl_3$,

followed by recrystallization from AcOEt to give 1.3 g (70.3%) of XIV. mp 132—133°. *Anal.* Calcd. for $C_{13}H_9NOS$: C, 68.70; H, 3.99; N, 6.16; S, 14.11. Found: C, 68.52; H, 3.70; N, 6.00; S, 13.88. IR (KBr) cm^{-1}: 1635 (CO). NMR ($CDCl_3$): 6.59 (1H, d, $J=1.7$ Hz, pyridone proton), 6.92 (1H, d, $J=4$ Hz, S–CH=C⟨), 6.94 (1H, d, $J=1.7$ Hz, pyridone proton), 7.32—7.66 (5H, m, aromatic proton), 8.12 (1H, d, $J=4$ Hz, N–CH=C⟨). MS *m/e*: 227 (M^+).

1-Oxo-3-phenyl-1H-pyrido[2,1-*b*]benzothiazole (XV)——A solution of Ib (0.9 g) and *o*-aminothiophenol (0.6 g) in ethoxyethanol (5 ml) was heated under reflux for 3 hr. After cooling, the precipitated crystals were collected and washed with EtOH, giving 0.67 g (58.8%) of XV. mp 172—173°. *Anal.* Calcd. for $C_{17}H_{11}NOS$: C, 73.62; H, 4.00; N, 5.05; S, 11.56. Found: C, 73.63; H, 3.83; N, 5.09; S, 11.81. IR (KBr) cm^{-1}: 1635 (CO). NMR ($CDCl_3$) ppm: 6.70 (1H, d, $J=1.7$ Hz, –CH=C⟨), 6.86 (1H, d, $J=1.7$ Hz, –CH=C⟨), 7.36—7.68 (3H, m, C_6, C_7, C_8 protons), 9.18—9.36 (1H, m, C_9 proton).

XV was also prepared by the reaction of Ia with *o*-aminothiophenol as described above.

Acknowledgement The authors are grateful to Dr. K. Takahashi for his encouragement. They are also indebted to the members of the analytical department of this laboratory for spectral measurements and elemental analyses.