Synthesis of Novel Pyrano Fused Quinolones, Coumarins, and Pyridones

R. B. Toche and M. N. Jachak

Department of Chemistry, K. T. H. M. College, Nashik 422 002, India

R. W. Sabnis

Brewer Science Inc., 2401 Brewer Drive, Rolla, MO 65401, USA

T. Kappe*

Institute for Organic Chemistry, Karl-Franzens University, A-8010, Graz, Austria

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Dedicated to Professor Dr. Hans Junek, Graz, on the occasion of his 70th birthday

A novel efficient synthesis of pyrano fused heterocycles namely, pyrano[3,2-*c*]quinoline-2,5(6*H*)-diones **3a-e**, **7b-d**, pyrano[3,2-*c*]benzopyran-2,5(6*H*)-dione (**7f**), and pyrano[3,2-*c*]pyridine-2,5(6*H*)-diones **10**, **11** was achieved by the condensation of 4-hydroxy-2-(1*H*)-quinolones **1a-e**, 4-hydroxycoumarin (**1f**), or 4-hydroxy-2(1*H*)-pyridone (**9**) with α-acetyl-γ-butyrolactone (**2**) or the sodium salt of α-formyl-γ-butyrolactone (**6**), respectively, in the presence of ammonium acetate.

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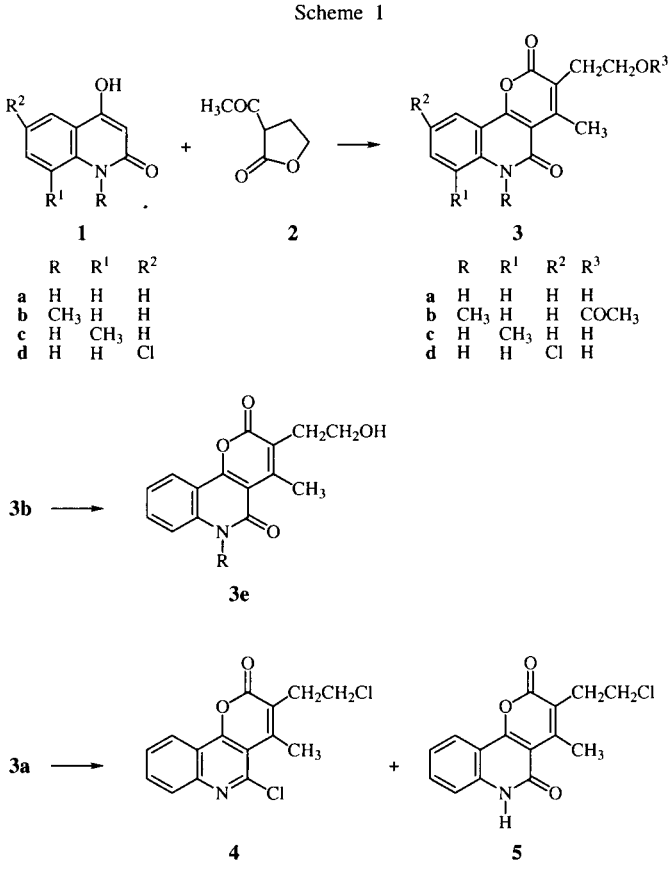
Pyrano fused heterocycles are commercially important as antibacterials [1], antihistamines [2], antimicrobials [3], enzyme substrates [4], and alkaloids [5]. Several patents describe the synthesis and technical importance of pyrano fused derivatives in high technology applications such as liquid crystal display devices [6], ink-jets [7], photochromic materials [8], electroluminescent materials [9], and fluorescent whitening agents [10]. However, in general there has been little exploitation in developing novel routes for the synthesis of pyrano fused derivatives. Pyrano fused dyes attract special attention on account of their strong fluorescence [11-14].

The condensation of β-keto esters with phenolic compounds in the presence of concentrated sulfuric acid yields coumarin derivatives [15]. This synthesis, known as the Pechmann reaction [16], has found extensive applications and has been used in the synthesis of many naturally occurring coumarins. Acidic catalysts such as aluminum trichloride, zinc chloride, phosphoryl chloride, phosphoric acid, polyphosphoric acid, trifluoroacetic acid, and hydrochloric acid have been used. Several years ago, we described a modification of this reaction using β-enamino esters which react with phenolic compounds under the loss of ammonia and alcohol to yield α-pyrane derivatives in excellent yield [17-20]. However, β-enamino esters are not always easily available from the corresponding β-ketoesters. Fortunately, we have found that ammonium acetate can be used as a source of ammonia, and that β-ketoesters in the presence of an excess of ammonium acetate readily react with phenolic heterocyclic compounds to yield the corresponding α-pyrone derivatives [19,20]. This modification of the Pechmann reaction has also been used successfully by others [11,12].

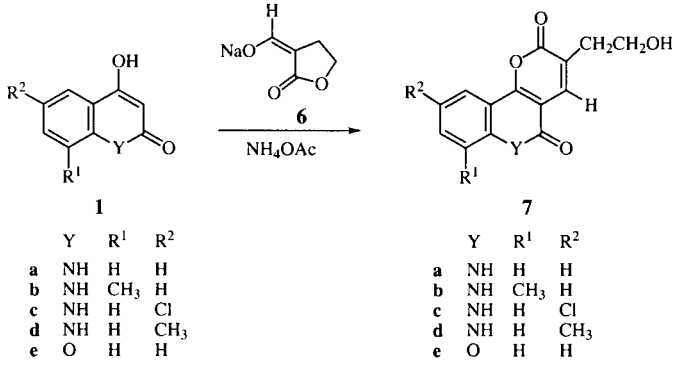
α-Acetyl-γ-butyrolactone (**2**) represents an interesting cyclic β-ketoester [21] which we have used recently for the synthesis of heterocycles containing a hydroxyethyl side chain [22]. In this communication we report on the Pechmann reaction of 4-hydroxy-2(1*H*)-quinolones **1**, and 4-hydroxy-2(1*H*)-pyridone (**9**) with **2**. Furthermore, we have extended this reaction to α-formyl-γ-butyrolactone (used as its sodium salt **6**). Thus the condensation of 4-hydroxy-2-quinolones **1a-d** with α-acetyl-γ-butyrolactone

Scheme 1



2 in ammonium acetate at 120° gave pyrano[3,2-*c*]-quinoline-2,5-diones **3a-d** in 75-80% yield. Interestingly, the *N*-methylquinolone **1b** afforded the acetoxy derivative **3b** which was hydrolyzed with aqueous base to alcohol **3e**. Chlorination of **3a** yielded a mixture of **4** and **5** which could be separated by column chromatography.

Scheme 2

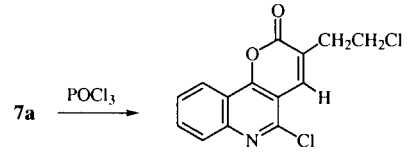


	Y	R^1	R^2
a	NH	H	H
b	NH	CH_3	H
c	NH	H	Cl
d	NH	H	CH_3
e	O	H	H

1

	Y	R^1	R^2
a	NH	H	H
b	NH	CH_3	H
c	NH	H	Cl
d	NH	H	CH_3
e	O	H	H

7



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α-Acetyl-γ-butyrolactone (**2**) represents a convenient reagent since it is at a modest price commercially available [23]. However, it leads only to 2-pyrone derivatives with a methyl group in position 4. α-Formyl-γ-butrolactone itself proved to be too unstable for a Pechmann reaction. On the other hand, its sodium salt **6** [24] (easily obtained by formylation of γ-butyrolactone) reacted smoothly in ammonium acetate to yield the 3-hydroxyethyl-2-pyrane derivatives **7a,c-e** starting with 4-hydroxy-2-quinolones **1a,c-e**, and starting with 4-hydroxycoumarin **1f** the hydroxyethyl-pyrano[3,2-*c*]benzopyran-2,5-dione **7f** was obtained. Action of phosphorus oxychloride on **7a** converted the ethanol side chain to the chloroethyl group, and the lactam carbonyl was converted to the imidoyl chloride system in **8**.

The condensation of 6-methyl-4-hydroxy-2(1*H*)-pyridone (**9**) [25] with ethyl β-aminocrotonate leading to the 4,7-dimethylpyrano[3,2-*c*]pyridine system (**10**, without acetoxyethyl side chain) was the first system with which the new modification of the Pechmann reaction was discovered many years ago [18a]. We have now extended these reactions to the condensation of **9** with **2** and **6** in the presence of amonnium acetate. In the first example again an acetoxyethyl derivative (*i.e.* **10**) was obtained, and reaction with **6** afforded compound **11**, which could be converted with phosphorus oxychloride to the dichloro derivative **12**.

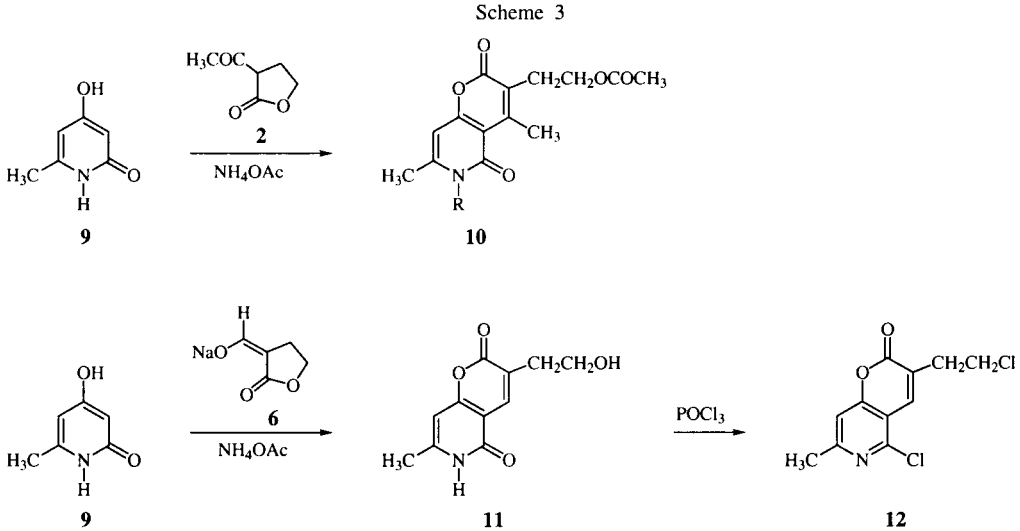
EXPERIMENTAL

Melting points were obtained on a Gallenkamp apparatus MFB-595 instrument. All melting points are uncorrected. The infrared spectra were recorded on Perkin-Elmer Model 298 spectrophotometer in potassium bromide pellets. The ^1H nmr spectra were recorded on a Varian Gemini 200 (200 MHz) instrument using tetramethylsilane as internal standard and the chemical shifts are given in δ-units. The solvent used for nmr was hexadeuteriodimethyl sulfoxide unless otherwise stated. Elemental analysis were performed on a Fison EA 1108 C,H,N Elemental analyzer. All the reactions were monitored by tlc on 0.2 mm silica gel 60 F_{254} Merck plates using uv light. Sodium salt of α-formyl-γ-butyrolactone was synthesized by known method [24].

3-(1-Hydroxyethyl)-4-methylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**3a**).

A mixture of 1.62 g (0.01 mole) 4-hydroxy-2-(1*H*)-quinolone **1a** and 1.28 g (0.01 mole) of α-acetyl-γ-butyrolactone **2** in

Scheme 3



9 **10**

9 **11** **12**

ammonium acetate (3.85 g, 0.05 g) was heated for 2 hours at 120° under a short Vigreux column. The residue obtained after cooling was slowly added to cold water (100 ml) to remove excess of ammonium acetate, and the product precipitated. The product was filtered, washed with water, dried and recrystallised from dimethyl formamide to yield 2.26 g (83%) of **3a**, mp 304°; ir: ν 3540, 2940, 2880, 1700, 1660, 1550, 1500, 1440, 1400 cm^{-1}; ^1H nmr: δ 2.62 (s, 3H, CH_3), 2.82 (t, J = 7 Hz, 2H, CH_2), 3.63 (t, J = 7 Hz, 2H, CH_2O), 4.80 (bs, 1H, OH), 7.25 (m, 2H, aromatic), 7.68 (dd, J = 2 and 8.5 Hz, 1H, aromatic), 7.90 (dd, J = 2 and 8.5 Hz, 1H, aromatic), 11.80 (s, 1H, NH).

Anal. Calcd. for $C_{15}H_{13}NO_4$: C, 66.41; H, 4.83; N, 5.16. Found: C, 66.14; H, 4.76; N, 5.22.

3-(1-Acetoxyethyl)-4,6-dimethylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**3b**).

The same procedure as described for **3a** was applied. Recrystallization from ethanol afforded 2.40 g (73%) of **3b**, mp 164°; ir: ν 2900, 1750, 1720, 1660, 1600, 1540, 1500, 1430 cm^{-1}; ^1H nmr: δ 2.04 (s, 3H, CH_3), 2.82 (s, 3H, CH_3), 3.51 (t, J = 6.8 Hz, 2H, CH_2), 3.70 (s, 3H, CH_3), 4.31 (t, J = 6.8 Hz, 2H, CH_2O), 7.35 (m, 2H, aromatic), 7.69 (dd, J = 2 and 8 Hz, 1H, aromatic), 8.29 (dd, J = 2 and 8 Hz, 1H, aromatic).

Anal. Calcd. for $C_{18}H_{17}NO_5$: C, 66.05; H, 5.23; N, 4.28. Found: C, 66.36; H, 5.01; N, 4.28.

3-(1-Hydroxyethyl)-4, 7-dimethylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**3c**).

The same procedure as described for **3a** was applied. Recrystallization from dimethylformamide afforded 2.03 g (71%) of **3c**, mp 305°; ir: 3500, 3180, 3020, 1700, 1650, 1550, 1480, 1450, 1400 cm^{-1}; ^1H nmr: δ 2.42 (s, 3H, CH_3), 2.68 (s, 3H, CH_3), 2.75 (t, J = 7 Hz, 2H, CH_2), 3.54 (t, J = 7 Hz, 2H, CH_2O), 4.65-4.75 (bs, 1H, OH,), 7.18 (dd, J = 2, 8 Hz, 1H, aromatic), 7.45 (dd, J = 2, 8 Hz, 1H, aromatic), 7.81 (dd, J = 2, 8 Hz, 1H, aromatic), 10.95 (bs, 1H, NH).

Anal. Calcd. for $C_{16}H_{15}NO_4$: C, 67.36; H, 5.30; N, 4.91. Found: C, 66.97; H, 5.17; N, 4.69.

9-Chloro-3-(1-hydroxyethyl)-4-methylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**3d**).

The same procedure as described for **3a** was applied. Recrystallization from dimethylformamide:ethanol (7:3) afforded 2.09 g (68%) of **3d**, mp 292°; ir: 3500, 2900, 1700, 1650, 1600, 1530, 1480, 1380 cm^{-1}; ^1H nmr: δ 2.75 (s, 3H, CH_3), 2.81 (t, J = 7 Hz, 2H, CH_2), 3.55 (t, J = 2 and 7 Hz, 2H, CH_2O), 4.78 (t, J = 6 Hz, 1H, OH), 7.35 (d, J = 8 Hz, 1H, aromatic), 7.75 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.93 (d, J = 2 Hz, 1H, aromatic), 12.20 (s, 1H, NH).

Anal. Calcd. for $C_{15}H_{12}ClNO_4$: C, 58.93; H, 3.96; N, 4.58. Found: C, 58.63; H, 3.92; N, 4.60.

3-(1-Hydroxyethyl)-4,6-dimethylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**3e**).

A mixture of 3.27 g (0.01 mole) of **3b**, ethanol (30 ml), sodium hydroxide (5 ml, 10%) was refluxed for 30 minutes. The solvent was removed and the residue obtained was dissolved in cold water and acidified with concentrated hydrochloric acid, when the product precipitated. The product was filtered, washed with water, dried and recrystallized from ethanol to yield 2.49 g (87%) of **3e**, mp 218°; ir (potassium bromide): 3500, 2940, 2880, 1700, 1650, 1600, 1540, 1500, 1450, 1400 cm^{-1}; ^1H nmr: δ 2.58 (s, 3H, CH_3), 2.75 (t, J = 7 Hz, 2H, CH_2), 3.56 (t, J = 7 Hz, 2H, CH_2O), 3.65 (s, 3H, CH_3), 4.75 (t, J = 6 Hz, 1H, OH), 7.35 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.50 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.82 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.99 (dd, J = 2 and 8 Hz, 1H, aromatic).

Anal. Calcd. for $C_{16}H_{15}NO_4$: C, 67.36; H, 5.30; N, 4.91. Found: C, 67.12; H, 5.07; N, 4.88.

5-Chloro-3-(1-chloroethyl)-4-methylpyrano[3,2-*c*]quinolin-2-one (**4**), and 3-(1-Chloroethyl)-4-methylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**5**).

A mixture of 2.71 g (0.01 mole) of **3a** and phosphorus oxychloride (30 ml) was refluxed for 1 hour. The solvent was removed *in vacuo* and residue was slowly added to ice-water mixture. The excess of acid was neutralized with sodium carbonate solution. The product was filtered, washed with warm water and dried. The mixture obtained of **4** and **5** was separated by column chromatography on Silica gel 60 (Merck) eluting with chloroform. Recrystallization from cyclohexane to afforded 1.34 g (43%) of **4**, mp 144°; ir: ν 1730, 1620, 1600, 1570, 1500, 1460, 1400 cm^{-1}; ^1H nmr (deuteriochloroform): δ 2.92 (s, 3H, CH_3), 3.26 (t, J = 6.8 Hz, 2H, CH_2), 3.85 (t, J = 6.8 Hz, 2H, CH_2Cl), 7.69 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.82 (dd, J = 2 and 8Hz, 1H, aromatic), 7.95 (dd, J = 2 and 8Hz, 1H, aromatic), 8.35 (dd, J = 2 and 8Hz, 1H, aromatic).

Anal. Calcd. for $C_{15}H_{11}Cl_2NO_2$: C, 58.46; H, 3.60; N, 4.55. Found: C, 58.42; H, 3.50; N, 4.47.

The yield of 3-(1-chloroethyl)-4-methylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**5**) was 0.98 g (34%), mp 136°; ir: 1740, 1720, 1620, 1600, 1570, 1550, 1490, 1450 cm^{-1}; ^1H nmr (deuteriochloroform): δ 2.81 (s, 3H, CH_3), 3.25 (t, J = 6.8 Hz, 2H, CH_2), 4.35 (t, J = 6.8 Hz, 2H, CH_2Cl), 7.69 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.78 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.95 (dd, J = 2 and 8 Hz, 1H, aromatic), 8.45 (dd, J = 2 and 8 Hz, 1H, aromatic).

Anal. Calcd. for $C_{15}H_{12}ClNO_3$: C, 62.19; H, 4.17; N, 4.83. Found: C, 62.50; H, 4.18; N, 4.34.

3-(1-Hydroxyethyl)pyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**7a**).

A mixture of 1.61 g (0.01 mole) 4-hydroxy-2(1*H*)-quinolone **1a** and 1.36 g (0.01 mole) of sodium salt of α-formyl-γ-butyrolactone **6** [24] in 3.85 g (0.05 mole) of ammonium acetate was heated for 2 hours at 120° under a short Vigreux column. The residue obtained after cooling was slowly added to ice-water mixture, and neutalized with concentrated hydrochloric acid solution when the product precipitated. The product was filtered, washed with water, dried and recrystallized from ethanol to yield 2.18 g (85%) of **7a**, mp 294°; ir: 3440, 2900, 1730, 1660, 1610, 1550, 1400 cm^{-1}; ^1H nmr: δ 2.67 (t, J = 7 Hz, 2H, CH_2), 3.65 (t, J = 7 Hz, 2H, CH_2O), 4.69 (t, J = 6 Hz, 1H, OH), 7.26 (m, 2H, aromatic), 7.84 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.95 (s, 1H, aromatic), 7.98 (dd, J = 2, 8Hz, 1H, aromatic), 11.85 (s, 1H, NH).

Anal. Calcd. for $C_{14}H_{11}NO_4$: C, 65.37; H, 4.31; N, 5.44. Found: C, 65.25; H, 4.22; N, 5.43.

3-(1-Hydroxyethyl)-7-methylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**7b**).

The same procedure as described for **7a** was applied. Recrystallization from dimethylformamide afforded 2.16 g (79%) of **7b**, mp 242°; ir: ν 3500, 3200, 3000, 1740, 1650, 1600, 1560, 1450, 1400 cm^{-1}; ^1H nmr: δ 2.56 (s, 3H, CH_3), 2.69 (t, J = 7 Hz, 2H, CH_2), 3.73 (t, J = 7 Hz, 2H, CH_2O), 4.75 (t, J = 6 Hz,

1H, OH), 7.25 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.53 (d, J = 8 Hz, 1H, aromatic), 7.85 (d, J = 8 Hz, 1H, aromatic), 7.99 (s, 1H, aromatic), 11.25 (bs, 1H, NH).

Anal. Calcd. for $C_{15}H_{13}NO_4$: C, 66.41; H, 4.83; N, 5.16. Found: C, 66.18; H, 4.56; N, 4.80.

9-Chloro-3-(1-hydroxyethyl)pyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**7c**).

The same procedure as described for **7a** was applied. Recrystallisation from dimethylformamide afforded 2.04 g (70%) of **7c**, mp 313°; ir: 3500, 2900, 1700, 1660, 1600, 1550, 1480 cm^{-1}; ^1H nmr: δ 2.75 (t, J = 7 Hz, 2H, CH_2), 3.75 (t, J = 7 Hz, 2H, CH_2O), 4.39 (t, J = 7 Hz, 1H, OH), 7.39 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.65 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.85 (s, 1H, aromatic), 7.98 (s, 1H, aromatic), 11.82 (s, 1H, NH).

Anal. Calcd. for $C_{14}H_{10}ClNO_4$: C, 57.65; H, 3.46; N, 4.80. Found: C, 57.61; H, 3.27; N, 4.75.

3-(1-Hydroxyethyl)-9-methylpyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**7d**).

The same procedure as described for **7a** was applied. Recrystallization from dimethylformamide afforded 2.07 g (76%) of **7d**, mp 275°; ir: 3400, 2900, 1740, 1650, 1550, 1500, 1430 cm^{-1}; ^1H nmr: δ 2.42 (s, 3H, CH_3), 2.34 (t, J = 7 Hz, 2H, CH_2), 3.72 (t, J = 7 Hz, 2H, CH_2O), 4.39 (t, J = 6 Hz, 1H, OH), 7.25 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.45 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.78 (s, 1H, aromatic), 7.90 (s, 1H, aromatic), 11.80 (s, 1H, NH).

Anal. Calcd. for $C_{15}H_{13}NO_4$: C, 66.41; H, 4.83; N, 5.16. Found: C, 66.19; H, 4.74; N, 5.20.

3-(1-Hydroxyethyl)pyrano[3,2-*c*]benzopyrane-2,5-dione (**7e**).

A mixture of 1.62 g (0.01 mole) 4-hydroxycoumarin **1e** and 1.36 g (0.01 mole) of sodium salt of α-formyl-γ-butyrolyctone **6** [24] in 3.85 g (0.05 mole) of ammonium acetate was heated for 2 hours at 120° under a short Vigreux column. The residue obtained after cooling was slowly added to ice-water mixture, and neutralized with concentrated hydrochloric acid when the product precipitated. The product was filtered, washed with water, dried and recrystallized from ethanol to yield 2.11 g (81%) of **7e**, mp 222°; ir: ν 3000, 1710, 1650, 1600, 1550, 1470, 1420 cm^{-1}; ^1H nmr: δ 2.99 (t, J = 7 Hz, 2H, CH_2), 4.38 (t, J = 7 Hz, 2H, CH_2O), 6.2-6.6 (bs, 1H, OH), 7.4 (m, 2H, aromatic), 7.45 (s, 1H, aromatic), 7.72 (dd, J = 2 and 8 Hz, 1H, aromatic), 8.05 (dd, J = 2 and 8 Hz, 1H, aromatic).

Anal. Calcd. for $C_{14}H_{10}O_5$: C, 65.12; H, 3.90. Found: C, 65.16; H, 3.73.

5-Chloro-3-(1-chloroethyl)pyrano[3,2-*c*]quinolin-2-one (**8**).

A mixture of 2.57 g (0.01 mole) of **7a** and phosphorus oxychloride (30 ml) was refluxed for 1 hour. The solvent was removed and residue was slowly added to ice-water. The excess of acid was neutralized with sodium carbonate solution. The product was filtered, washed with water, dried and recrystallised from ligroin to yield 1.63 g (55%) of **8**, mp 185°; ir: ν 1740, 1630, 1610, 1580, 1490, 1400 cm^{-1}; ^1H nmr (deuteriochloroform): δ 3.15 (t, J = 6.8 Hz, 2H, CH_2), 3.95 (t, J = 6.8 Hz, 2H, CH_2Cl), 7.69 (dd, J = 2 and 8 Hz, 1H, aromatic), 7.85 (dd, J = 2 and 8 Hz, 1H, aromatic), 8.05 (dd, J = 2 and 8 Hz, 1H, aromatic), 8.12 (s, 1H, aromatic), 8.40 (dd, J = 2 and 8 Hz, 1H, aromatic).

Anal. Calcd. For $C_{14}H_9Cl_2NO_2$: C, 57.17; H, 3.08; N, 4.76. Found: C, 57.46; H, 3.08; N, 4.63.

3-(1-Acetoxy)-4,7-dimethylpyrano[3,2-*c*]pyridine-2,5(6*H*)-dione (**10**).

A mixture of 1.25 g (0.01 mole) 4-hydroxy-6-methyl-2-pyridone **9** and 1.28 g (0.01 mole) of α-acetyl-γ-butyrolactone **2** in 3.85 g (0.05 mole) of ammonium acetate was heated for 2 hours at 120° under a short Vigreux column. The residue obtained after cooling, was slowly added to cold water (100 ml) to remove excess of ammonium acetate, when the product precipitated. The product was filtered, washed with water, dried and recrystallized from ethanol to yield 1.55 g (68%) of **10**, mp 227°; ir: 3500, 3000, 2980, 1715, 1661, 1631, 1545, 1500 cm^{-1} ; ^1H nmr: δ 2.25 (s, 3H, CH_3), 2.65 (s, 3H, CH_3), 2.82 (t, J = 7 Hz, 2H, CH_2), 3.65 (s, 3H, CH_3), 4.05 (t, J = 7 Hz, 2H, CH_2O), 6.05 (d, J = 2 Hz, 1H, aromatic), 11.81 (bs, 1H, NH).

Anal. Calcd. for $C_{14}H_{15}NO_5$: C, 60.65; H, 5.45; N, 5.05. Found: C, 60.44; H, 5.36; N, 5.20.

3-(1-Hydroxyethyl)-7-methylpyrano[3,2-*c*]pyridine-2,5(6*H*)-dione (**11**).

A mixture of 1.25 g (0.01 mole) 4-hydroxy-6-methyl-2-pyridone **9** and 1.36 g (0.01 mole) of sodium salt of α-formyl-γ-butyrolactone **6** in 3.85 g (0.05 mole) of ammonium acetate was heated for 2 hours at 120° under a short Vigreux column. The residue obtained after cooling, was slowly added to ice-water and neutralized with concentrated hydrochloric acid when the product precipitated. The product was filtered, washed with water, dried and recrystallized from dimethylformamide to yield 1.32 g (60%) of **11**, mp 261°; ir: ν 2900, 1760, 1680, 1630, 1450 cm^{-1}; ^1H nmr: δ 2.25 (s, 3H, CH_3), 2.56 (t, J = 7 Hz, 2H, CH_2), 3.62 (t, J = 7 Hz, 2H, CH_2O), 4.65 (bs, 1H, OH), 6.12 (d, J = 2 Hz, 1H, aromatic), 7.78 (s, 1H, aromatic), 11.95 (bs, 1H, NH).

Anal. Calcd. for $C_{11}H_{11}NO_4$: C, 59.73; H, 5.01; N, 6.33. Found: C, 59.44; H, 5.06; N, 6.42.

5-Chloro-3-(1-chloroethyl)-7-methyl[3,2-*c*]pyridin-2-one(**12**).

A mixture of 2.21 g (0.01 mole) of **11** and phophorus oxychloride (30 ml) was refluxed for 1 hour. The solvent was removed and the residue was slowly added to ice-water. The excess of acid was neutralized with sodium carbonate solution. The product was filtered, washed with water, dried and recrystallized from ligroin to yield 1.70 g (66%) of **12**, mp 143°; ir: ν 3060, 1730, 1630, 1600, 1550, 1440 cm^{-1}; ^1H nmr (deuteriochloroform): δ 2.62 (s, 3H, CH_3), 3.05 (t, J = 6.8 Hz, 2H, CH_2), 3.85 (t, J = 6.8 Hz, 2H, CH_2), 7.02 (s, 1H, aromatic), 7.85 (s, 1H, aromatic).

Anal. Calcd. for $C_{11}H_9Cl_2NO_2$: C, 51.19; H, 3.52; N, 5.45. Found: C, 51.35; H, 3.28; N, 5.30.

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