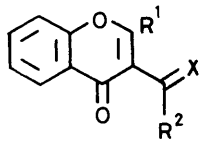
Benzopyrans. Part 23.[1] Nitrogen Heterocycles Fused with or Linked to 1-Benzopyran from 3-Acyl-2-methyl-1-benzopyran-4-one

Chandra Kanta Ghosh,* Chandana Pal, Jharna Maiti, and Manjusha Sarkar
Organic Chemistry Laboratory, Department of Biochemistry, Calcutta University, 35 B. C. Road, Calcutta 700 019, India

The enamine (**2**), prepared from the title benzopyranone (**1**; R^2 = H, Me, and Ph) and dimethylformamide dimethyl acetal, on treatment with ammonia and hydroxylamine gives the fused pyridine (**5**) and pyridine 2-oxide (**10**), respectively. Hydrazine, phenylhydrazine, and guanidine undergo initial 1,6-addition to the enamine (**2**) ultimately giving the pyrazoles (**14**) and (**15**), and the pyrimidine (**17**), respectively. The pyridinioacetamidate (**11**), prepared from the enamine (**2**; R^2 = Me and Ph) and acetohydrazide, thermolyses to the fused pyridine (**5**). A refluxing ethanolic solution of the enamine (**2**; R^2 = Me and Ph) with ethyl glycinate forms the ester (**18**) which on treatment with ethanolic sodium ethoxide produces the azepine (**20**).

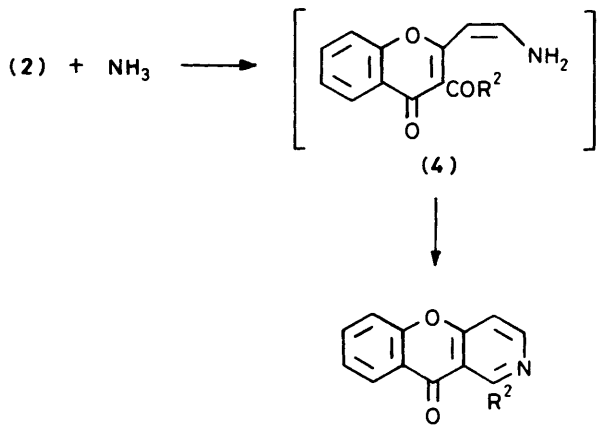
The methyl group of 2-methyl-4-pyrone and -1-benzopyran-4-one, being vinylogous with a methyl ketone, is both acidic and reactive.[2,3] Hence, methylenation of the allylic methyl group[4] of 3-acyl-2-methyl-1-benzopyran-4-one (**1**) (3-acyl-2-methylchromone) with dimethylformamide dimethyl acetal (DFDA) provides an α, β, γ, δ-unsaturated carbonyl compound (**2**) which has a highly nucleofugal dimethylamino group at the δ-position. 3-Acylchromones, including the 3-formyl analogue, function as Michael acceptors towards various nucleophiles.[5] Thus a nitrogen nucleophile is likely to undergo 1,6-addition to the acyl enamine (**2**) with concomitant expulsion of dimethylamine. Also, the hydrazide undergoes 1,2-addition to α,β,γ,δ-unsaturated carbonyl compounds.[6] Hydrazine and guanidine undergo 1,2-addition to the aldehyde function of 2-dimethylamino-3-formyl-4-pyrone[7] [*cf.* (**2a**)], whereas 2-alkyl-(or-aryl-) aminoaniline undergoes both 1,2- and 1,4-addition to the above compound depending on the reaction conditions.[8] Hence, initial nucleophilic 1,2-addition to the exocyclic carbonyl function of the enamine (**2**) cannot be ruled out and is worth studying further. Adducts resulting from such reactions may be further transformed, depending on the nature of the nucleophile and the mode of initial addition, to heterocycles either fused with, or linked to, 1-benzopyran.



	R^1	R^2	X
(**1**) **a**;	Me	H	O
b;	Me	Me	O
c;	Me	Ph	O
(**2**) **a**;	*E*-CH=CHNMe$_2$	H	O
b;	*E*-CH=CHNMe$_2$	Me	O
c;	*E*-CH=CHNMe$_2$	Ph	O
(**3**)	Me	H	NNMe$_2$

In our hands, the reported[9] methylation of 3-formylchromone with diazomethane to give the chromone (**1a**) failed,[10] the reaction in either ether or dichloromethane affording instead the chromone (**1b**), 3,3a-dihydrofuro[3,4-*b*][1]benzopyran-9-one, and [1]benzopyrano[2,3-*d*]pyrazol-9-one.[11] We could, however, prepare 3-formyl-2-methylchromone (**1a**) by hydrolytic decomposition of the hydrazone (**3**) arising from nucleophilic 1,4-addition of 1,1-dimethylhydrazine to 3-acetylchromone with concomitant opening of the pyran ring and subsequent recyclisation[3] (see Experimental section). Its analogues (**1b**) and (**1c**) were prepared from ω-acetyl- and ω-benzoyl-*o*-hydroxyacetophenone,[12] respectively, following a literature procedure.[13]

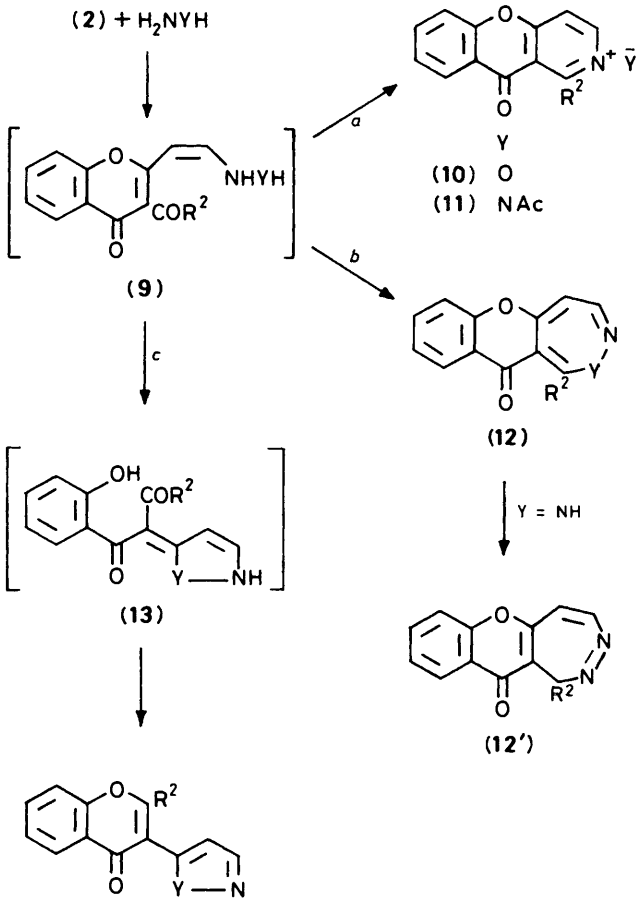
On treatment with DFDA 2-methylchromone (**1**) gave the *trans*-enamine (**2**), the *cisoid* or *transoid* geometry of its diene system not being established. The acylmethyl group of the enamine (**2b**), being part of a vinylogous acetamide, remained unreactive towards DFDA. Refluxing the chromone (**2**) with ammonium acetate in acetic acid produced the pyridine (**5**) (Table 1). Presumably ammonia brings about the transamination of the enamine (**2**) *via* a 1,6-addition–elimination sequence and the resultant enamine, due to prototropy, assumes a stereochemical configuration (*cisoid* diene with *cis* geometry around the exocyclic olefinic bond) as shown in the chromone (**4**) so as to undergo [6 + 0]nucleophile→electrophile cyclisation to the pyridine (**5**) (Scheme 1).



	R^2
(**5**) **a**;	H
b;	Me
c;	Ph
(**6**)	OAc
(**7**)	CH_2OAc
(**8**)	Ph; 3-H substituted by OAc

Scheme 1.

Like ammonia, a bisnucleophile such as H_2NYH (Y = O, NH, NPh, and NAc) is likely to transaminate the enamine (**2**) to compound (**9**) which may then take one of the following three reaction courses: (i) cyclisation to the six-membered heterocycle (Scheme 2, path *a*), the feasibility of this being particularly high for compound (**9**; Y = 0); (ii) cyclisation to the seven-membered heterocycle (**12**) (path *b*), the diazepine (**12**; Y = NH) preferentially assuming the diazo structure (**12'**);[6] and (iii) intramolecular 1,4-addition of its nucleophilic element Y at the 2-position of the pyran with concomitant opening of the pyran ring to give the intermediate (**13**) which recyclises to the five-membered heterocycle linked to the 3-position of 1-benzopyran (path *c*). In fact treatment of the ketone (**2**) with hydroxylamine yielded the pyridine 2-oxide (**10**) (Table 1). The ^{1}H n.m.r. data, in particular for the protons at the 3- and 4-positions of compounds (**5**) and (**10**), are in agreement with those reported for the corresponding protons of pyridine[14] and pyridine 1-oxide,[15] respectively. The structures (**5**) and (**10**) were further confirmed by conversion of the former into the latter by treatment with peracetic acid. On refluxing in acetic anhydride, the oxides (**10a**), (**10b**), and (**10c**) formed the pyridines (**6**), (**7**), and (**8**), respectively (Table 1).



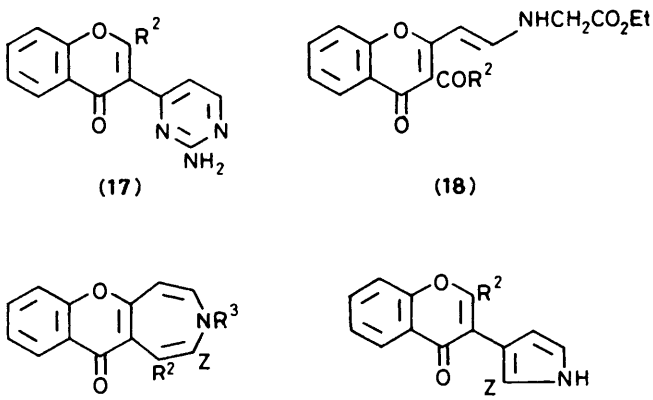
Y
(**14**) NH
(**15**) NPh
(**16**) NAc

Scheme 2. **a**, R^2 = H; **b**, R^2 = Me; **c**, R^2 = Ph

The chromone (**2a**) gave an intractable tar with hydrazine whereas the other two analogues (**2b**) and (**2c**) cleanly gave the products, the ^{1}H n.m.r. spectra of which are compatible with the pyrazole structures (**14b**) and (**14c**), respectively (Table 2). The, 4-H of the pyrazole (**14b**) appears as a doublet (*J* 2 Hz) at the normal position (δ 6.46) whereas the same proton in the pyrazole (**14c**) appears at a relatively higher field (δ 5.52 p.p.m.). In both these compounds, due to strong hydrogen bonding, the pyrazole moiety is in the same plane as that of the α,β-unsaturated oxo system of the pyrone ring. In this conformation of structure (**14c**), the benzene ring cannot be in the same plane because of severe steric hindrance between the *o*-hydrogen of the phenyl ring and 4-H of the pyrazole moiety; the benzene ring has to be perpendicular to the pyrazole moiety and 4-H of the latter falls in the phenyl ring current and consequently becomes shielded. Phenylhydrazine reacted with all three entities of the enamino ketone (**2**) yielding the 1-phenylpyrazole (**15**) (Table 2). The formation of the pyrazoles (**14**) and (**15**) convincingly proves that hydrazine and phenylhydrazine undergo 1,6-addition to the α,β,γ,δ-unsaturated carbonyl group of the enamino ketone (**2**) and the resultant adduct after elimination of dimethylamine follows reaction path *c* as depicted in Scheme 2.

Acetylhydrazine and the chromone (**2**) were expected to produce the pyrazole (**16**) or its deacylated[16] product (**14**) provided that the nucleophile acetylhydrazine behaved similarly towards the chromone (**2**) as did hydrazine and phenylhydrazine. In contrast, the reaction in refluxing acetic acid afforded the pyridinioacetamidate (**11**) (Table 2) which on refluxing in ethylene glycol underwent thermolysis[17] to yield the pyridine (**5**). The enamino aldehyde (**2a**), however, gave an intractable tar with acetohydrazide. As expected, u.v. and ^{1}H n.m.r. spectra of the pyridinioacetamidate (**11**) are closely similar to those of the pyridine 2-oxide (**10**).[18] In its mass spectral fragmentation, the pyridinioacetamidate (**11b**) underwent α-cleavage followed by loss of NCO to give the base peak at *m/z* 211 corresponding to the ion of the pyridine (**5b**).[19] Condensation of an acylhydrazine with the chromone (**2**) (or with any α,β,γ,δ-unsaturated carbonyl compound having a nucleofuge at the δ-position) as reported here is analogous to that of hydrazine with a pyrylium salt leading to the 1-aminopyridinium salt[20] and offers a new addition to the known methods[21] for the synthesis of the pyridinioacetamidate.

Guanidine, when treated with the enamine (**2**), produced the pyrimidine derivative (**17**) by a mechanism similar to that involved in the reaction of hydrazine and phenylhydrazine with the enamine (**2**). When refluxed with glycine ester hydrochloride in ethanol–pyridine, the enamine (**2a**) gave an intractable tar whereas the enamines (**2b**) and (**2c**) gave the enamino ketones (**18b**) and (**18c**), respectively. Under carbanion generating conditions, the glycine ester (**18**) may cyclise to either the



a, R^2 = H; **b**, R^2 = Me; **c**, R^2 = Ph

Table 1. Analytical and spectral data for the [1]benzopyrano[3,2-*c*]pyridin-10-ones (**5**)—(**8**), pyridine 2-oxides (**10**), and pyridinioacetamidates (**11**)

Compd. (Formula)	Yield (%)	M.p. (°C)	Found (%) (Requires) C	H	N	$\lambda_{max.}$(EtOH) nm (log ε)	δ_H ($CDCl_3$) 3-H[a]	9-H[b]	R^2	Other ArH (m)
(**5a**)[c] ($C_{12}H_7NO_2$)	91	185	73.1 (72.7	3.6 3.2	7.1 7.3)	238, 325 (4.46, 3.73)	8.82	8.36	9.54 (1 H, s)	7.76—7.32
(**5b**) ($C_{13}H_9NO_2$)	93	175	73.9 (74.1	4.3 4.0	6.6 6.8)	233, 323 (4.30, 3.70)	8.36	8.03	2.93 (3 H, s)	7.70—6.53
(**5c**) ($C_{18}H_{11}NO_2$)	95	215	79.1 (78.8	4.1 3.7	5.1 4.8)	237, 330 (4.64, 3.94)	8.76	8.20	7.84—7.32	
(**6**) ($C_{14}H_9NO_4$)	60	225		*d*		236, 316 (4.42, 3.69)	8.36	7.73	2.88 (3 H, s)	7.60—6.44
(**7**) ($C_{15}H_{11}NO_4$)	85	170		*d*		235, 325 (4.40, 3.81)	8.72	8.32	*e*	7.88—7.20
(**8**) ($C_{20}H_{13}NO_4$)	80	183		*d*		230, 280 (4.40, 4.25)	*f*	8.32	7.92—7.32	
(**10a**)[g] ($C_{12}H_7NO_3$)	50	248	67.6 (67.3	3.3 2.9	6.6 6.3)	278, 365 (4.38, 3.43)	8.48	8.32	9.06 (1 H, dd)[a]	7.80—7.32
(**10b**) ($C_{13}H_9NO_3$	81	215	68.7 (68.9	4.0 4.1	6.2 6.3)	265, 365 (4.31, 3.43)	8.47	8.27	3.17 (3 H, s)	7.92—7.17
(**10c**) ($C_{18}H_{11}NO_3$)	96	276	74.7 (74.9	3.8 3.5	4.8 4.6)	278, 367 (4.56, 3.14)	8.46	8.26	7.86—7.32	
(**11b**)[h,i] ($C_{15}H_{12}N_2O_3$)	75	208	67.4 (67.2	2.7 3.1	10.1 10.4)	260, 360 (4.15, 3.40)	8.52	8.28	3.28 (3 H, s)	7.76—7.28
(**11c**)[i] ($C_{20}H_{14}N_2O_3$)	61	215 (decomp.)	72.4 (72.7	4.0 4.3	8.6 8.5)	270, 365 (4.35, 3.10)	8.56	8.08	7.84—6.24	

[a] This proton in compound (**10a**) appeared as a doublet of a doublet ($J_{3,4}$ 7 Hz, $J_{1,3}$ 2 Hz) whereas in the other compounds, it appeared as a doublet (*J* 7—8 Hz). [b] dd, *J* 8, 2 Hz. [c] $\nu_{max.}$ 1 655 (CO) and 1 605 cm^{-1} (C=C); *m/z* 197 (M^+), 169 (*M* − CO), 142 (169 − HCN), and 121 ($C_7H_4O_2$ + H). [d] No analysis. [e] δ 5.88 (2 H, s, CH_2) and 2.24 (3 H, s, OAc). [f] δ 2.40 (3 H, s, OAc). [g] *m/z* 213 (M^+), 197 (*M* − O), and 169 (197 − CO). [h] $\nu_{max.}$ 1 665 (amide carbonyl) and 1 610 cm^{-1} (pyrone carbonyl); *m/z* 268 $(M)^+$, 253 (*M* − Me), 211 (253 − NCO, 100%), and 183 (211 − CO). [i] In ^1H n.m.r. spectra protons of the COMe groups of compounds (**11b**) and (**11c**) appeared as singlets at δ 2.08 and 1.68, respectively.

Table 2. Analytical and spectral data for 5-(4-oxo-1-benzopyran-3-yl)pyrazoles (**14**) and (**15**)

Compd. (Formula)	Yield (%)	M.p. (°C)	Found (%) (Requires) C	H	N	$\lambda_{max.}$(EtOH) nm (log ε)	δ_H($CDCl_3$) pyran 5-H[a]	pyrazole 3-H[b]	Other ArH (m)	R^2	pyrazole 4-H[b]
(**14b**) ($C_{13}H_{10}N_2O_2$)	62	162	69.2 (69.0	4.1 4.5	12.2 12.4)	238, 303 (4.45, 3.96)	8.30	7.86	——— 7.34	2.70 (3 H, s)	6.46
(**14c**) ($C_{18}H_{12}N_2O_2$)	69	162	75.2 (75.0	3.8 4.2	9.5 9.7)	247, 305 (4.35, 4.09)	8.32	7.84	——— 7.32		5.52
(**15a**) ($C_{18}H_{12}N_2O_2$)	35	225	74.8 (75.0	3.9 4.2	9.3 9.7)	230, 289 (4.31, 3.56)	8.00	7.48	7.24—6.72	7.36 (1 H, s)	6.08
(**15b**)[c] ($C_{19}H_{14}N_2O_2$)	79	224	75.2 (75.5	4.3 4.7	9.0 9.3)	233, 295 (4.42, 3.77)	8.07	7.64	7.57—7.00	2.05 (3 H, s)	6.32
(**15c**) ($C_{24}H_{16}N_2O_2$)	82	165	79.2 (79.1	4.0 4.4	7.9 7.7)	250, 310 (4.46, 3.92)	8.32	7.72	7.68	6.80	6.52

[a] d, *J* 8, 2 Hz. [b] d, *J* 2 Hz. [c] *m/z* 302 (M^+), 287 (*M* − Me), 247 (*M* − CO), 181 (*M* − $C_7H_4O_2$ − H), and 121 ($C_7H_4O_2$ + H).

compound (**18**) in ethanol–sodium ethoxide followed by treatment with acid, the azepine (**20**) was afforded, presumably by hydrolysis and subsequent decarboxylation of compound (**19**). Neither of the pyrroles (**22**) or (**23**) were isolated. On treatment with acetic anhydride in pyridine the azepine (**20b**) formed the acetate (**21b**).

Experimental

The recorded m.p.s are uncorrected. U.v. spectra were recorded in ethanol on a Hitachi 100-60, i.r. as a Nujol mull on a Beckman IR-20A, and ^1H n.m.r. in $CDCl_3$ solution, unless otherwise stated, with $SiMe_4$ as internal reference on a Jeol JNM-FX-100 spectrophotometer. Light petroleum refers to the fraction with b.p. 60–80 °C.

3-Formyl-2-methyl-1-benzopyran-4-one (**1a**).—A mixture of 3-acetylchromone (9.40 g, 0.05 mol) and 1,1-dimethylhydrazine (3.00 g, 0.05 mol) was refluxed in dry methanol (75 ml) for 4 h. The reaction mixture was treated with charcoal, filtered, and the filtrate concentrated to afford *2-methyl-4-oxochromene-3-carbaldehyde dimethylhydrazone* (**3**) (9.20 g, 80%), m.p. 105 °C; $\lambda_{max.}$ 220 and 283 nm (log ε 4.06 and 4.45); δ 8.17 (1 H, dd, *J* 8, 2 Hz, 5-H), 7.60—7.27 (4 H, m, ArH and CH=N), 2.96 (6 H, s, NMe_2), and 2.67 (3 H, s, 2-Me). The preceding hydrazone (**3**) (9.20 g, 0.04 mol) was refluxed in ethanol (50 ml)–water (10 ml)–hydrochloric acid (5 ml) for 16 h. On concentration and subsequent cooling of the reaction mixture, the precipitate was filtered off, dried, and crystallised from benzene to afford the

chromone (**1a**) (3.90 g, 40%), m.p. 142 °C (Found: C, 70.5; H, 4.0. $C_{11}H_8O_3$ requires C, 70.2; H, 4.3%); δ 10.81 (1 H, s, CHO), 8.52 (1 H, dd, *J* 8, 2 Hz, 5-H), 7.62—7.48 (3 H, m, other ArH), and 2.72 (3 H, s, Me).

3-*Acyl*-2-(2-*dimethylaminovinyl*)-1-*benzopyran*-4-*ones* (**2**).—The chromone (**1**) (5 mmol) in benzene (40 ml) containing DFDA (1.20 g, 10 mmol) was warmed in a water-bath for 6 h. The reaction mixture, after treatment with charcoal, was concentrated and cooled to afford the acyl enamine (**2**). The *benzopyranone* (**2a**) (53%) had m.p. 238 °C (Found: C, 68.7; H, 5.5; N, 5.5. $C_{14}H_{13}NO_3$ requires C, 69.1; H, 5.4; N, 5.8%); $\lambda_{max.}$ 235, 290, and 395 nm (log ε 4.33, 4.23, and 4.83); δ 10.56 (1 H, s, CHO), 8.20 (1 H, dd, *J* 8, 2 Hz, 5-H), 7.94 (1 H, d, J_{trans} 12 Hz, C*H*NMe$_2$), 7.54 (1 H, m, 6-H), 7.38—7.16 (2 H, m, other ArH), 6.94 (1 H, d, J_{trans} 12 Hz, C*H*=CHNMe$_2$), 3.30 (3 H, s, Me), and 3.06 (3 H, s, Me). The *enaminone* (**2b**) (66%) had m.p. 150 °C (Found: C, 69.7; H, 5.5; N, 5.6. $C_{15}H_{15}NO_3$ requires C, 70.0; H, 5.9; N, 5.4%); $\lambda_{max.}$ 240, 280, and 395 nm (log ε 4.25, 4.04, and 4.70); δ 8.16 (1 H, dd, *J* 8, 2 Hz, 5-H), 7.77 (1 H, d, J_{trans} 12 Hz, C*H*NMe$_2$), 7.57 (1 H, m, 6-H), 7.30 (2 H, *m*, other ArH), 6.17 (1 H, d, J_{trans} 12 Hz, C*H*=CHNMe$_2$), 3.30 and 3.20 (6 H, br s, NMe$_2$), and 2.69 (3 H, s, COMe). The compound (**2c**) (57%) had m.p. 238 °C (Found: C, 75.7; H, 4.9; N, 4.0. $C_{20}H_{17}NO_3$ requires C, 75.2; H, 5.2; N, 4.4%); $\lambda_{max.}$ 248, 280, and 395 nm (log ε 4.22, 4.14, and 4.50).

[1]*Benzopyrano*[3,2-c]*pyridin*-10-*one* (**5**).—The chromone (**2**) (0.5 mmol) was refluxed in glacial acetic acid (5 ml)–ammonium acetate (1.0 g) for 5 h. The reaction mixture was diluted with water (20 ml), and the preciptate filtered off, dried, and crystallised from benzene–light petroleum to yield the *pyridine* (**5**) (Table 1).

10-*Oxo*-[1]*benzopyrano*[3,2-c]*pyridine* 2-*Oxide* (**10**).—A mixture of the chromone (**2**) (0.5 mmol), hydroxylamine hydrochloride (35 mg, 0.5 mmol), and sodium acetate (100 mg) was refluxed in acetic acid (5 ml). The reaction mixture was diluted with water (20 ml), and the precipitate filtered off, dried, and crystallised from chloroform–light petroleum to afford the *pyridine* 2-*oxide* (**10**) (Table 2).

Oxidation of the Pyridine (**5**) *to the Corresponding* 2-*Oxide* (**10**).—Hydrogen peroxide (30 vol; 10 ml) was added to a solution of the pyridine (**5**) (1 mmol) dissolved in acetic acid (10 ml) and the mixture was kept at room temperature for 2 days. After concentration of the mixture the precipitate was filtered off, dried, and crystallised from benzene–light petroleum (charcoal) to give the *oxide* (**10**) (70—80%) identical with that obtained from the appropriate enamine (**2**) and hydroxylamine.

Treatment of the Pyridine 2-*Oxide* (**10**) *with Acetic Anhydride*.—The oxide (**10a**) (43 mg, 0.2 mmol) was refluxed with acetic anhydride (5 ml) for 4 h. The reaction mixture on concentration followed by decomposition of the residual acetic anhydride afforded 1-*acetoxy*-[1]*benzopyrano*[3,2-c]*pyridin*-10-*one* (**6**) (33 mg, 60%) (Table 1). The other two oxides (**10b**) and (**10c**) on similar treatment with acetic anhydride yielded the *pyridines* (**7**) and (**8**), respectively (Table 1).

5-(4-*Oxo*-1-*benzopyran*-3-*yl*)*pyrazoles* (**14**) *and* (**15**).—The enamine (**2**) (2 mmol), hydrazine or phenylhydrazine hydrochloride (2 mmol), and sodium acetate (1.0 g) were refluxed together in acetic acid (10 ml) for 6 h and subsequently diluted with water. The substrate (**2a**) gave an intractable tar with hydrazine. In all other cases, the resultant precipitate was filtered off, dried, and crystallised from chloroform–light petroleum to afford the pyrazole (**14**) or (**15**) (Table 2).

10-*Oxo*-[1]*benzopyrano*[3,2-c]*pyridinio*-2-*acetamidate* (**11**).—The ketone (**2**) (2 mmol) was refluxed with acetohydrazide (148 mg, 2 mmol) in acetic acid for 6 h. The reaction mixture on work-up as described for the preparation of the pyrazoles (**14**) and (**15**) yielded the *pyridinioacetamidate* (**11**) (Table 1) which was further crystallised from chloroform.

Conversion of the Pyridinioacetamidate (**11**) *into the Pyridine* (**5**).—The pyridinioacetamidate (**11**) (1 mmol) was refluxed in ethylene glycol (5 ml) for 6 h and the reaction mixture was diluted with water to yield the *pyridine* (**5**) (70—80%) identical with that obtained by treating the appropriate enamine (**2**) with ammonium acetate as described earlier.

2-*Amino*-4-(4-*oxo*-1-*benzopyran*-3-*yl*)*pyrimidine* (**17**).—The enamine (**2**) (1 mmol) and guanidine carbonate (90 mg, 0.5 mmol) were refluxed together in ethanol (80%, 20 ml) for 8 h. The reaction mixture after work-up afforded the *pyrimidine* (**17**) which was further crystallised from chloroform. The pyrimidine (**17a**) (42%) had m.p. 190 °C (Found: C, 65.1; H, 3.1; N, 17.4. $C_{13}H_9N_3O_2$ requires C, 65.3; H, 3.7; N, 17.6%); δ[$(CD_3)_2SO$] 8.36 (1 H, s, pyran 2-H), 8.14 (1 H, dd, *J* 8, 2 Hz, pyran 5-H), 7.48—6.80 (5 H, m, other ArH), and 5.88 (2 H, br s, NH_2).

The pyrimidine (**17b**) (40%) had m.p. 200 °C (Found: C, 66.8; H, 4.0; N, 16.2. $C_{14}H_{11}N_3O_2$ requires C, 66.4; H, 4.4; N, 16.6%); δ 7.65—6.70 (6 H, m, ArH), 5.25 (2 H, br s, exchangeable, NH_2), and 2.20 (3 H, s, Me). The product (**17c**) (69%) had m.p. 240 °C (Found: C, 71.8; H, 3.8; N, 12.8. $C_{19}H_{13}N_3O_2$ requires C, 72.3; H, 4.2; N, 13.3%).

Treatment of the Enamine (**2**) *with Ethyl Glycinate*.—A mixture of the enamine (**2**) (0.5 mmol) and ethyl glycinate hydrochloride (70 mg, 0.5 mmol) was refluxed in dry ethanol (10 ml)–pyridine (2 ml) for 8 h. The reaction mixture was concentrated, cooled, diluted with water, and extracted with chloroform. The organic extract was dried (Na_2SO_4) and concentrated to afford the *ester* (**18**), but not the ester (**18a**), as stated earlier. The characterisation data for the esters (**18**) are given below.

Ester (**18b**): Yield 48%; m.p. 172 °C (chloroform) (Found: C, 64.4; H, 5.6; N, 3.6. $C_{17}H_{17}NO_5$ requires C, 64.8; H, 5.4; N, 4.4%); $\lambda_{max.}$ 210, 263, and 330 nm (log ε 4.49, 4.45, and 3.47); δ 7.64—6.40 (7 H, m, ArH and CH=CHNH), 4.56 (2 H, s, NCH_2), 4.28 (2 H, q, CH_2Me), 2.08 (3 H, s, COMe), and 1.32 (3 H, t, CH_2*Me*).

Ester (**18c**): Yield 53%; m.p. 180 °C (benzene) (Found: C, 69.6; H, 4.6; N, 3.6. $C_{22}H_{19}NO_5$ requires C, 70.0; H, 5.1; N, 3.7%); $\lambda_{max.}$ 213, 263, and 340 nm (log ε 4.72, 2.63, and 3.86); δ 7.56 (1 H, dd, *J* 8, 2 Hz, 5-H), 7.44 (10 H, ArH and CH=C*H*N*H*), 6.56 (1 H, d, *J* 8 Hz, C*H*=CHNH), 4.28 (2 H, s, NCH_2), 4.24 (2 H, q, CH_2Me), and 1.20 (3 H, t, CH_2*Me*).

3H-*Azepino*[4,5-b][1]*benzopyran*-11-*one* (**20**).—The ester (**18**) (0.5 mmol) was refluxed in an ethanolic solution of sodium ethoxide [prepared from sodium (500 mg) and ethanol (10—15 ml)] for 8 h. The reaction mixture was cooled and acidified with conc. hydrochloric acid, and the precipitate filtered off, and washed with warm ethanol to afford the *azepine* (**20**). The azepine (**20b**) (54%) had m.p. 205 °C (Found: C, 74.2; H, 5.1; N, 6.5. $C_{14}H_{11}NO_2$ requires C, 74.6; H, 4.9; N, 6.2%); $\lambda_{max.}$ 208 and 263 nm (log ε 4.65 and 4.41); δ[$(CD_3)_2SO$] 11.40 (1 H, s, NH), 8.04 (1 H, d, *J* 8 Hz, 4-H), 7.80—6.82 (5 H, m, PhH and 2-H), 6.42 (1 H, d, *J* 8 Hz, 5-H), and 2.32 (3 H, s, 1-Me). Its acetate (**21b**) exhibited δ 7.62—6.74 (6 H, m, Ph, 2-, and 4-H), 6.42 (1 H, d, *J* 8 Hz, 5-H), 3.62 (3 H, s, NCOMe), and 2.22 (3 H, s, 1-Me). The azepine (**20c**) (52%) had m.p. 185 °C (Found: C, 80.2; H, 4.0; N, 5.2. $C_{19}H_{13}NO_2$ requires C, 79.4; H, 4.6; N, 4.9%); $\lambda_{max.}$ 213 and 267 nm (log ε 4.23 and 4.34); δ[$(CD_3)_2SO$]

11.44 (1 H, s, NH), 8.00 (1 H, d, *J* 8 Hz, 4-H), 7.68—6.80 (10 H, m, PhH and 2-H), and 6.40 (1 H, d, *J* 8 Hz, 5-H).

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