Pyridazine Chemistry. Part 33.[1,2] 5-Aminopyridazin-4-yl *o*-Fluorophenyl Ketone as a Key Intermediate in the Syntheses of Diaza Analogues of Acridone, Xanthone, and Thioxanthone

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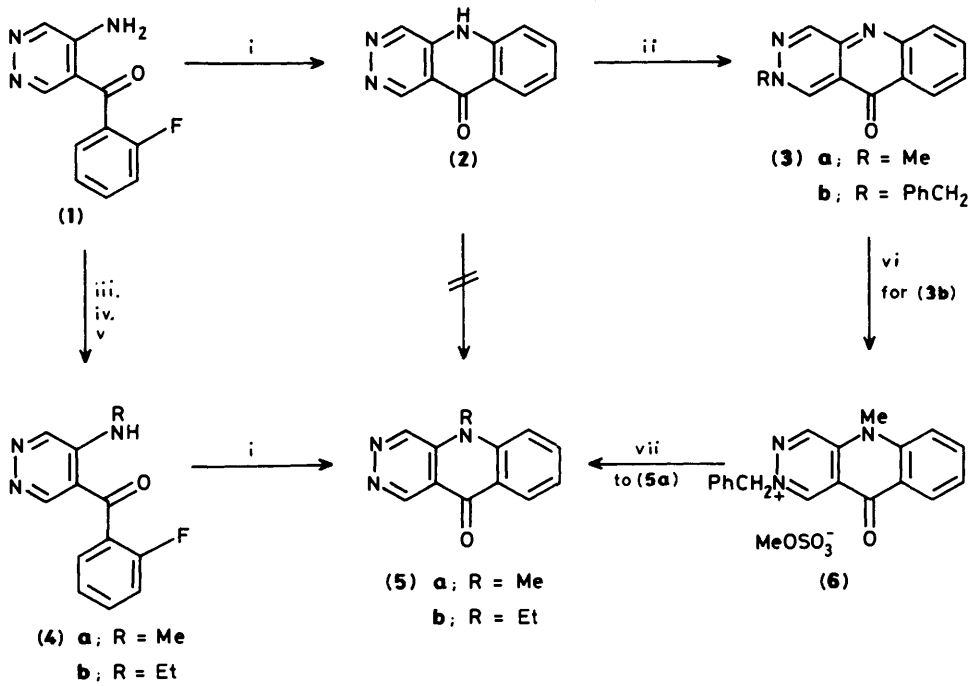
Facile syntheses of pyridazino[4,5-*b*]quinolin-10(5*H*)one (**2**) and 5-substituted derivatives thereof [(**5a**), (**5b**)] are described. 5-(*o*-Fluorobenzoyl)pyridazin-4(1*H*)one (**9**), readily accessible from the title amino ketone (**1**) by a *N*-benzylation–hydrolysis–debenzylation sequence, serves as an intermediate in high-yield syntheses of 10*H*-[1]benzopyrano[2,3-*d*]pyridazin-10-one (**10**) and 10*H*-[1]benzothiopyrano[2,3-*d*]pyridazin-10-one (**11**).

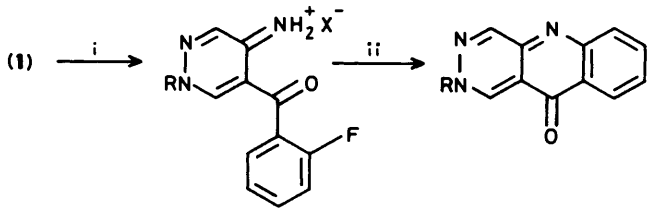
Recently, the versatility of 5-aminopyridazin-4-yl aryl ketones[3] in syntheses of pyridazine-annelated pyrazoles,[4] isoxazoles,[4] pyrimidines,[5] and pyridines[6] was demonstrated. We now report on the utility of the corresponding *o*-fluorophenyl ketone (**1**)[3] as a precursor for pyridazino[4,5-*b*]quinolin-10(5*H*)ones, 10*H*-[1]benzopyrano[2,3-*d*]pyridazin-10-one, and 10*H*-[1]benzothiopyrano[2,3-*d*]pyridazin-10-one. These compounds appear to be of interest as diaza analogues of acridone, xanthone, and thioxanthone, which are commonly used starting materials in the synthesis of various drugs. So far, 2,3-diaza-acridines and -xanthenes in general were accessible only from disubstituted quinolines or benzopyrans, respectively,[7] whereas the 2,3-diaza-thioxanthene system, to our knowledge, has remained totally unexplored.

Synthesis of Diaza-acridones.—In accordance with findings in the *o*-aminobenzophenone series,[8] the activation of the fluorine atom by the carbonyl group in compound (**1**) was found to be high enough for intramolecular nucleophilic substitution. Thus, the diaza-acridone (**2**) could be simply prepared in almost quantitative yield by heating the amino ketone (**1**) in dimethylformamide in the presence of potassium carbonate. Likewise, the alkylamino ketones (**4**), which were obtained from (**1**) applying a reported procedure,[9] cyclized smoothly under these conditions, affording 5-alkyl-diaza-acridones (**5**). Of course, this approach is somewhat limited in scope considering the restricted availability of the appropriate ortho esters required in the first reaction step. On the other hand, treatment of compound (**2**) with alkylating agents expectedly[4] gave no substitution at N-5 but, instead, formation of bright yellow products, identified as N-2-substituted compounds (**3**). However, introduction of a wide variety of alkyl groups into the N-5 position should be possible by alkylating the 2-benzyl compound (**3b**), followed by aluminium trichloride-induced debenzylation. In fact, this reaction sequence, recently applied to the preparation of N-1-substituted pyrazolo[3,4-*d*]pyridazines,[4] proved to be applicable in the diaza-acridone series as well (Scheme 1). It turned out that alkylation of the amino



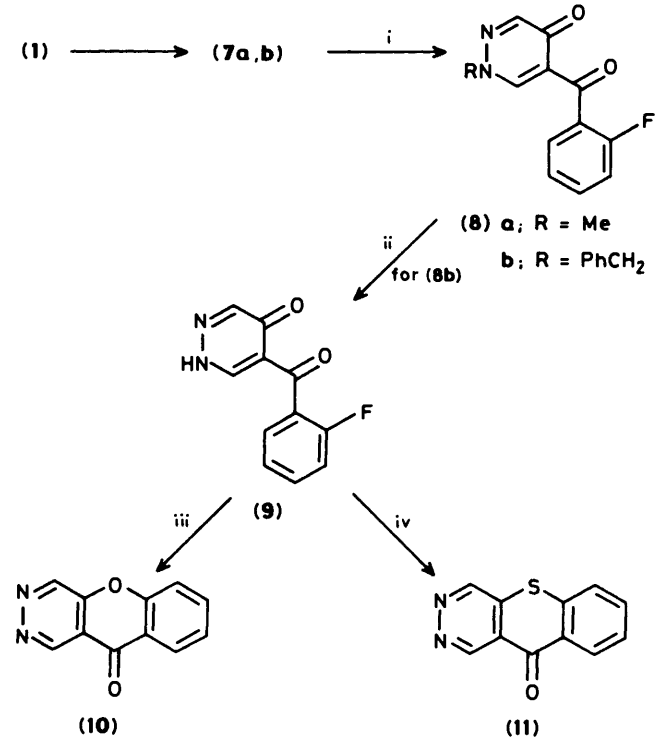
Scheme 1. *Reagents:* i, K_2CO_3–dimethylformamide; ii, MeI–NaH or $PhCH_2Br$–NaH, respectively; iii, $HC(OEt)_3$ or $MeC(OEt)_3$, respectively; iv, $NaBH_4$; v, $KMnO_4$; vi, Me_2SO_4; vii, $AlCl_3$–toluene

ketone (**1**) according to a previously reported procedure,[9] followed by treatment of the resulting iminium salts (**7**) with potassium carbonate in dimethylformamide (Scheme 2) provides even readier access to compounds of type (**3**). In contrast to the reaction (**2**)→(**3**), in this case, there is no need to purify the products by column chromatography. In summary, the proposed methodology permits the synthesis of the 5-alkylated diaza-acridone (**5a**) from (**1**) *via* (**7b**), (**3b**), and (**6**) in reasonable overall yield.



Scheme 2. *Reagents:* i, MeI or $PhCH_2Br$, respectively; ii, K_2CO_3–dimethylformamide

Synthesis of Diazaxanthone and Diazathioxanthone.—It was shown recently that 5-aminopyridazin-4-yl aryl ketones can be easily transformed into 5-aroylpyridazin-4-(1*H*)ones by a *N*-benzylation–hydrolysis–debenzylation sequence.[9] Application of this procedure to the amino ketone (**1**) afforded the 1,3-dicarbonyl-compound (**9**) *via* the intermediates (**7b**) and (**8b**) in high yield (Scheme 3). In turn, 5-(*o*-fluorobenzoyl)-pyridazin-4(1*H*)one (**9**) was found to cyclize smoothly on treatment with potassium carbonate in dimethylformamide to give the novel diazaxanthone (**10**). In addition, reaction of compound (**9**) with phosphorus pentasulphide in refluxing pyridine provides ready access to the 2,3-diazathioxanthone system, since under these reaction conditions not only is the pyridazinone converted into the corresponding thione, but ring closure to compound (**11**) also takes place.*



Scheme 3. *Reagents:* i, NaOH; ii, $AlCl_3$–toluene; iii, K_2CO_3–dimethylformamide; iv, P_2S_5–pyridine

Spectral Confirmation of the Products.—Structural proof for all new compounds rests on elemental analyses† and spectroscopic results. In the ^1H n.m.r. spectra of the *N*-alkylamino ketones (**4a,b**) one of the pyridazine proton signals (8.7 p.p.m.) appears as a doublet (*J* 3 Hz). Since this has to be interpreted in terms of interaction between 3-H and the fluorine atom, the two heteroaromatic proton signals can be assigned unequivocally. A similar heteronuclear 'through-space' coupling is also observed in the ^1H n.m.r. spectrum of a $CDCl_3$ solution of compound (**1**). In the case of compound (**9**), the ^1H n.m.r. data do not permit discrimination between the tautomeric forms to be taken into consideration. However, comparison with the spectrum of the *N*-methylpyridazinone (**8a**) suggests the pyridazinone form for compound (**9**). This is further evidenced by the close resemblance of the u.v. spectra of the ketones (**9**) and (**8a**). Also in the solid state, compound (**9**) obviously exists in the tautomeric form displayed in Scheme 3 (ν_{CO} at 1 650 and 1 610 cm^{-1}); a slight bathochromic shift of one of the ν_{CO} absorption bands—compared with that of the *N*-methyl analogue (**8a**)—may be attributed to intermolecular hydrogen bonding.

The i.r. spectrum of compound (**2**), characterized by a CO vibration band at 1 640 cm^{-1}, clearly indicates an oxo function being present.‡ Neither these data nor the ^1H n.m.r. spectrum [$(CD_3)_2SO$ solution] enabled us to distinguish between the two remaining tautomeric forms of the pyridazinoquinolinone (**2**) (H attached to 2-N or 5-N). However, since the u.v. spectrum of a methanolic solution of compound (**2**) is almost identical with that of the 5-methyl cogener (**5a**) but differs significantly from that of the 2-methyl derivative (**3a**) (Figure) we propose the tautomeric structure displayed in Scheme 1 for this diazaacridone.

The agreement of the results of combustion analyses with the calculated values together with m.s. molecular-weight determinations provides an unequivocal structure proof for the diazaxanthone (**10**). In contrast, two isomeric structures (characterized either by an oxothiopyran or a thioxopyran moiety) initially had to be taken into consideration for the compound $C_{11}H_6N_2OS$ obtained from the reaction of the fluorobenzoylpyridazinone (**9**) with phosphorus pentasulphide. Assignment of the diazathioxanthone structure (**11**), however, clearly follows from the appearance of a ν_{CO} absorption (1 640 cm^{-1}) in the i.r. spectrum.

Experimental

M.p.s were determined on a Reichert-Kofler hot-stage microscope and are uncorrected. I.r. spectra were recorded for

* No further oxo→thioxo conversion was observed with the tricyclic ketone. Traces of compound (**10**), formed as a by-product in this reaction, could be easily removed (see Experimental section).

† Elemental analyses of compounds (**3a,b**) and (**5b**) indicated partial hydration. Since we did not succeed in complete removal of water from analytical samples, structure confirmation in these cases is based on accurate mass measurements.

‡ The marked downfield shift of one of the benzene protons (9-H) in compound (**2**) [also observed with the *N*-alkyl derivatives (**3a,b**) and (**5a,b**)] obviously again reflects the presence of a carbonyl group. On the other hand it seems noteworthy that an n.O.e. experiment with compound (**5a**) showed that the signal of 1-H appears at higher field than that of 4-H. In contrast to compound (**5a**), the corresponding protons in the parent compound (**2**) have identical resonance frequencies, which may be explained in terms of different solvation [$(CD_3)_2SO \cdots HN$ hydrogen bonding in the case of compound (**2**)].

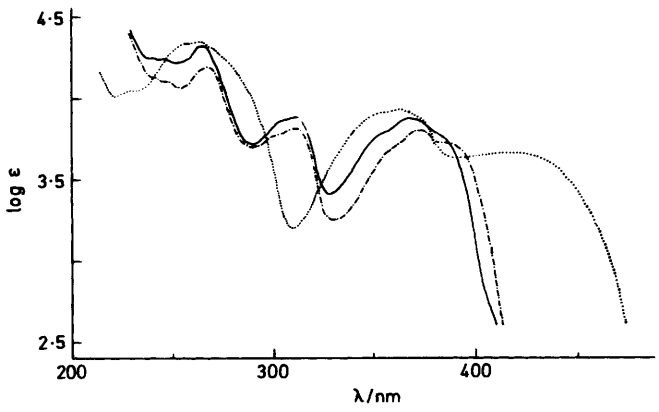


Figure. Electronic spectra of the pyridazino[4,5-*b*]quinolines (**2**) (——), (**3a**) (· · · ·), and (**5a**) (– · – · – · –); solvent: methanol

KBr pellets on a JASCO IRA-1 spectrophotometer, u.v. spectra were recorded for solutions in methanol on a Beckman 25 spectrophotometer. ^{1}H N.m.r. spectra were measured on either a Varian EM 390 (90 MHz) instrument or a Bruker AC 80 (80 MHz) spectrometer (Me_4Si as the internal reference). Mass spectra were obtained on a Varian MAT 311A instrument (70 eV). For t.l.c., Merck aluminium sheets pre-coated with Kieselgel 60 F_{254} were used; column chromatography was carried out on Merck Kieselgel 60 (70—230 mesh), medium-pressure liquid chromatography (m.p.l.c.) was performed on Merck Lobar pre-packed columns (size B, LiChroprep Si 60, 230—400 mesh), 4—6 ml min^{-1}, detection at 280 nm.

5-*Aminopyridazin*-4-*yl* o-*Fluorophenyl Ketone* (**1**).—Preparation and spectral data see ref. 3; δ_H (90 MHz; $CDCl_3$) 7.10—7.75 (6 H, after D_2O addition 4 H, m, C_6H_4F, NH_2), 8.65 (1 H, d, $J_{H,F}$ 3 Hz, 3-H), and 8.90 (1 H, s, 6-H).

Pyridazino[4,5-b]*quinolin*-10(5H)-*one* (**2**).—Potassium carbonate (173 mg, 1.25 mmol) was added to a solution of the amino ketone (**1**) (217 mg, 1 mmol) in dimethylformamide (10 ml) and the mixture was heated at 130 °C for 6 h. After evaporation under reduced pressure, the residue was dissolved in water (5 ml). The solution was acidified (pH 3—4) by addition of 2M hydrochloric acid and the yellow precipitate was collected, washed with water, and dried to afford the product (185 mg, 94%), m.p. >300 °C (decomp., from dimethylformamide–methanol) (Found: C, 66.75; H, 3.75; N, 21.3. $C_{11}H_7N_3O$ requires C, 67.00; H, 3.58; N, 21.33%); $\nu_{max.}$ 1 640 cm^{-1} (CO); $\lambda_{max.}$ 265, 302sh, 312, 370, and 386sh nm (log ε 4.33, 3.85, 3.89, 3.88, and 3.77); δ_H [90 MHz; $(CD_3)_2SO$] 7.40—8.00 (3 H, m, 6-, 7-, and 8-H), 8.30 (1 H, m, 9-H), and 9.55 (2 H, s, 1- and 4-H).

2-*Methylpyridazino*[4,5-b]*quinolin*-10(2H)-*one* (**3a**).—(*a*) Sodium hydride (60 mg of a 80% suspension in paraffin, 2 mmol) followed by methyl iodide (213 mg, 1.5 mmol) was added with stirring to a solution of compound (**2**) (197 mg, 1 mmol) in dimethylformamide (20 ml). The mixture was stirred at room temperature for 6 h and subsequently evaporated under reduced pressure. The residue was treated with water (20 ml) and extracted with dichloromethane. Evaporation of the extract gave a yellow solid which was subjected to column chromatography. Elution with dichloromethane–methanol (96:4), followed by recrystallisation from propan-1-ol afforded *yellow needles* (150 mg, 70%), m.p. 275—278 °C (decomp.); $\nu_{max.}$ 1 630 cm^{-1} (CO); $\lambda_{max.}$ 229, 257, 265, 363, and 420 nm (log ε 4.05, 4.34, 4.35, 3.94, and 3.67); δ_H [90 MHz; $(CD_3)_2SO$] 4.20 (3 H, s, Me), 7.30—7.85 (3 H, m, 6-, 7-, and 8-H), 8.30 (1 H, m, 9-H), 9.00, and 9.50 (each 1 H, d, *J* 1 Hz, 1- and 4-H); *m/z* 211 (M^+, 100%), 184 (67), 105 (43), and 82 (55) (Found: M^+, 211.0754. $C_{12}H_9N_3O$ requires *M*, 211.0746).

(*b*) Potassium carbonate (276 mg, 2 mmol) was added to a solution of the ammonium salt (**7a**) (see below) (359 mg, 1 mmol) in dimethylformamide (10 ml) and the mixture was heated to 100 °C for 1.5 h. It was then diluted with dichloromethane (20 ml), filtered, and evaporated under reduced pressure. Recrystallisation of the residue afforded the pure product (200 mg, 95%).

2-*Benzylpyridazino*[4,5-b]*quinolin*-10(2H)-*one* (**3b**).—(*a*) Preparation as described for (**3a**) [method (*a*)], employing benzyl bromide (257 mg, 1.5 mmol) as the alkylating agent. Column chromatography (eluant: dichloromethane–methanol, 97:3), followed by recrystallisation from ethanol afforded *yellow needles* (211 mg, 73%), m.p. 240—243 °C; $\nu_{max.}$ 1 630 cm^{-1} (CO); δ_H [90 MHz; $(CD_3)_2SO$] 5.70 (2 H, s, CH_2), 7.35—7.90 (8 H, m, Ph, 6-, 7-, and 8-H), 8.30 (1 H, m, 9-H), and 9.05 and 9.80 (each 1 H, d, *J* 1 Hz, 1- and 4-H); *m/z* 287 (M^+, 17%), 91 (100), and 65 (17) (Found: M^+, 287.1065. $C_{18}H_{13}N_3O$ requires *M*, 287.1059).

(*b*) Preparation as described for (**3a**) [method (*b*)], employing the ammonium salt (**7b**) (see below) (388 mg, 1 mmol) as the starting material; yield 270 mg (94%).

2-*Benzyl*-5,10-*dihydro*-5-*methyl*-10-*oxopyridazino*[4,5-b]-*quinolinium Methylsulphate* (**6**).—A solution of compound (**3b**) (287 mg, 1 mmol) and dimethyl sulphate (757 mg, 6 mmol) in dimethoxyethane (40 ml) was refluxed for 24 h and then diluted with diethyl ether (40 ml) and chilled. The precipitate was collected, washed with diethyl ether, and dried to afford colourless crystals (384 mg, 93%); for characterisation, a sample of the product was transformed into the corresponding perchlorate by addition of aqueous sodium perchlorate to a solution of compound (**6**) in methanol. Recrystallisation of the precipitate from aqueous methanol afforded colourless needles, m.p. 190—210 °C (Found: C, 55.3; H, 3.95; N, 10.3. $C_{19}H_{16}ClN_3O_5 \cdot 0.5H_2O$ requires C, 55.55; H, 4.17; N, 10.23%); $\nu_{max.}$ 1 660 cm^{-1} (CO); δ_H [90 MHz; $(CD_3)_2SO$] 4.20 (3 H, s, Me), 6.00 (2 H, s, CH_2), 7.35—7.70 (5 H, m, Ph), 7.75—8.25 (3 H, m, 6-, 7-, and 8-H), 8.50 (1 H, m, 9-H), and 10.15 and 10.50 (each 1 H, d, *J* 1 Hz, 1- and 4-H).

5-*Methylaminopyridazin*-4-*yl* o-*Fluorophenyl Ketone* (**4a**).—A suspension of the amino ketone (**1**) (434 mg, 2 mmol) and a drop of trifluoroacetic acid in triethyl orthoformate (15 ml) was heated to 100 °C for 3 h. It was then evaporated under reduced pressure and the residue dissolved in absolute ethanol (20 ml). Sodium borohydride (152 mg, 4 mmol) was added and the solution was refluxed for 2 h; the pH was then adjusted to 1 by addition of 0.25M sulphuric acid. The mixture was stirred at room temperature for 3 h after which 2M sodium hydroxide was added (pH 8); the resulting suspension was then extracted with dichloromethane. Evaporation of the extract gave a brown residue which was dissolved in 1M sulphuric acid (20 ml). To the stirred solution was added potassium permanganate (220 mg, 1.4 mmol) in small portions. After 2 h the mixture was filtered, neutralised by addition of 2M sodium hydroxide, and extracted with dichloromethane. Evaporation of the extract, followed by m.p.l.c. (eluant: dichloromethane–methanol, 97:3) and subsequent recrystallisation from ethyl acetate–light petroleum (b.p. 50—70 °C) afforded *yellow crystals* (200 mg, 43%), m.p. 151—153 °C (Found: C, 62.0; H, 4.35; N, 17.9. $C_{12}H_{10}FN_3O$ requires C, 62.33; H, 4.36; N, 18.17%); $\nu_{max.}$ 3 280 (NH) and 1 630 cm^{-1} (CO); δ_H (90 MHz; $CDCl_3$) 3.20 (3 H, d, *J* 6 Hz, s after D_2O addition, Me), 7.10—7.75 (4 H, m, C_6H_4F), 8.70 (1 H, d, $J_{H,F}$ 3 Hz, 3-H), 9.05 (1 H, s, 6-H), and 9.15 (1 H, br, NH).

5-Ethylaminopyridazin-4-yl o-Fluorophenyl Ketone (**4b**).—The preparation followed that described for (**4a**), employing triethyl orthoacetate in the first reaction step. M.p.l.c. (eluant: dichloromethane–methanol, 97:3), followed by recrystallisation from ethyl acetate–light petroleum (b.p. 50—70 °C), afforded *yellow crystals* (210 mg, 43%), m.p. 127—129 °C (Found: C, 63.5; H, 5.0; N, 17.5. $C_{13}H_{12}FN_3O$ requires C, 63.67; H, 4.93; N, 17.13%); $\nu_{max.}$ 3 300 (NH) and 1 630 cm^{-1} (CO); δ_H (90 MHz; $CDCl_3$) 1.40 (3 H, t, *J* 7 Hz, CH_2CH_3), 3.55 (2 H, m, q after D_2O addition, *J* 7 Hz, CH_2CH_3), 7.10—7.70 (4 H, m, C_6H_4F), 8.65 (1 H, d, $J_{H,F}$ 3 Hz, 3-H), and 9.00 (2 H, br, overlapped by s, after D_2O addition 1 H; NH, 6-H).

5-Methylpyridazino[4,5-b]*quinolin*-10(5H)-*one* (**5a**).—(*a*) Potassium carbonate (173 mg, 1.25 mmol) was added to a solution of the methylamino ketone (**4a**) (231 mg, 1 mmol) in dimethylformamide (10 ml) and the mixture was heated to 130 °C for 6 h. The solvent was removed under reduced pressure and the residue was partitioned between water and dichloromethane. Evaporation of the organic extract, followed by recrystallisation from butanone afforded *pale yellow crystals* (220 mg, 95%), m.p. 279—280 °C (Found: C, 68.25; H, 4.35; N, 19.85. $C_{12}H_9N_3O$ requires C, 68.24; H, 4.29; N, 19.89%); $\nu_{max.}$ 1 640 cm^{-1} (CO); $\lambda_{max.}$ 269, 303sh, 313, 376, and 392sh nm (log ε 4.20, 3.78, 3.82, 3.81, and 3.73); δ_H [80 MHz; $(CD_3)_2SO$] 4.05 (3 H, s, Me), 7.50—8.00 (3 H, m, 6-, 7-, and 8-H), 8.35 (1 H, m, 9-H), 9.50 (1 H, d, *J* 1 Hz, 1-H), and 9.95 (1 H, d, *J* 1 Hz, 4-H; shows n.O.e. on irradiation at 4.05 p.p.m.).

(*b*) Compound (**6**) (207 mg, 0.5 mmol) was added to a stirred suspension of anhydrous aluminium chloride (266 mg, 2 mmol) in dry toluene (20 ml) and the mixture was heated to 80 °C for 2 h. After concentration under reduced pressure, 1M sodium hydroxide (10 ml) was added, and the suspension was extracted with dichloromethane. Evaporation of the extract, followed by recrystallisation afforded the pure product (80 mg, 75%).

5-Ethylpyridazino[4,5-b]*quinolin*-10-(5H)-*one* (**5b**).—The preparation followed that described for (**5a**) [method (*a*)], employing the ethylamino ketone (**4b**) (245 mg, 1 mmol) as starting material. Recrystallisation from acetone–di-isopropyl ether afforded *pale yellow needles* (214 mg, 95%), m.p. 214—215 °C; $\nu_{max.}$ 1 640 cm^{-1} (CO); δ_H [90 MHz; $(CD_3)_2SO$] 1.45 (3 H, t, *J* 7 Hz, CH_2CH_3), 4.70 (2 H, q, *J* 7 Hz, CH_2CH_3), 7.40—8.10 (3 H, m, 6-, 7-, and 8-H), 8.40 (1 H, m, 9-H), 9.55 (1 H, d, *J* 1 Hz, 1-H), and 10.00 (1 H, d, *J* 1 Hz, 4-H); *m/z* 225 (M^+, 100%), 210 (77), and 170 (69) (Found: M^+, 225.0909. $C_{13}H_{11}N_3O$ requires *M*, 225.0902).

5-(o-*Fluorobenzoyl*)-1,4-*dihydro*-1-*methylpyridazin*-4-*ylidene*-*ammonium Iodide* (**7a**).—A solution of the amino ketone (**1**) (434 mg, 2 mmol) and methyl iodide (568 mg, 4 mmol) in acetone (30 ml) was left at room temperature for 24 h after which it was evaporated under reduced pressure; recrystallisation of the residue from ethanol gave *pale yellow needles* (661 mg, 92%), m.p. 243—248 °C (decomp.) (Found: C, 40.15; H, 3.15; N, 11.75. $C_{12}H_{11}FIN_3O$ requires C, 40.13; H, 3.09; N, 11.70%); $\nu_{max.}$ 1 655 cm^{-1} (CO); δ_H [90 MHz; $(CD_3)_2SO$] 4.10 (3 H, s, Me), 7.35—7.85 (4 H, m, C_6H_4F), 8.80 (1 H, s, 3-H), 9.10 (1 H, d, $J_{H,F}$ 2 Hz, 6-H), and 9.85 (2 H, br, NH_2).

1-*Benzyl*-5-(o-*fluorobenzoyl*)-1,4-*dihydropyridazin*-4-*ylidene*-*ammonium Bromide* (**7b**).—A solution of the amino ketone (**1**) (434 mg, 2 mmol) and benzyl bromide (512 mg, 3 mmol) in acetone (30 ml) was refluxed for 6 h and left at room temperature for 14 h. Diethyl ether (30 ml) was then added and the precipitate collected. Recrystallisation of the latter from ethanol afforded *colourless crystals* (737 mg, 95%), m.p. 210—220 °C (Found: C, 55.4; H, 4.0; N, 10.75. $C_{18}H_{15}BrFN_3O$ requires C, 55.69; H, 3.89; N, 10.82%); $\nu_{max.}$ 1 650 cm^{-1} (CO); δ_H [90 MHz; $(CD_3)_2SO$] 5.65 (2 H, s, CH_2), 7.45 (5 H, s, Ph), 7.50—8.00 (4 H, m, C_6H_4F), 9.00 (1 H, s, 3-H), 9.45 (1 H, d, $J_{H,F}$ 3 Hz, 6-H), and 10.00 (2 H, br, NH_2).

5-(o-*Fluorobenzoyl*)-1-*methylpyridazin*-4(1H)-*one* (**8a**).—0.5M Sodium hydroxide (50 ml) was added to a solution of compound (**7a**) (359 mg, 1 mmol) in methanol (50 ml) and the mixture left at room temperature for 24 h. Concentration under reduced pressure to about half the volume gave a suspension which was extracted with dichloromethane. Evaporation of the extract afforded a brown residue which was subjected to m.p.l.c. (eluant: dichloromethane–methanol, 97:3), followed by recrystallisation from methanol to yield *colourless crystals* (200 mg, 86%), m.p. 153—155 °C (decomp.) (Found: C, 62.15; H, 4.15; N, 12.2. $C_{12}H_9FN_2O_2$ requires C, 62.07; H, 3.91; N, 12.06%); $\nu_{max.}$ 1 655 (CO) and 1 625 cm^{-1} (CO); $\lambda_{max.}$ 262 and 318 nm (log ε 4.22 and 3.80); δ_H [90 MHz; $(CD_3)_2SO$] 3.95 (3 H, s, Me), 7.15—7.80 (4 H, m, C_6H_4F), and 8.00 and 8.80 (each 1 H, s, 3- and 6-H).

1-*Benzyl*-5-(o-*fluorobenzoyl*)*pyridazin*-4(1H)-*one* (**8b**).—The preparation followed that described for (**8a**), employing compound (**7b**) (388 mg, 1 mmol) as the starting material. M.p.l.c. (eluant: dichloromethane–ethyl acetate, 96:4), followed by recrystallisation from cyclohexane afforded *colourless needles* (278 mg, 90%), m.p. 116—117 °C (Found: C, 70.05; H, 4.4; N, 8.8. $C_{18}H_{13}FN_2O_2$ requires C, 70.12; H, 4.25; N, 9.09%); $\nu_{max.}$ 1 650 (CO) and 1 625 cm^{-1} (CO); δ_H (90 MHz; $CDCl_3$) 5.20 (2 H, s, CH_2), 6.95—7.85 (9 H, m, Ph, C_6H_4F), 8.05 and 8.50 (each 1 H, s, 3- and, 6-H).

5-(o-*Fluorobenzoyl*)*pyridazin*-4(1H)-*one* (**9**).—Compound (**8**) (308 mg, 1 mmol) was added to a stirred suspension of anhydrous aluminium chloride (532 mg, 4 mmol) in dry toluene (30 ml) and the mixture was heated to 70 °C for 0.5 h. It was then cooled and diluted with water (2 ml); the precipitate was collected, washed with water, and dried to afford the product (203 mg, 93%). A sample was purified by column chromatography (eluant: dichloromethane–methanol, 96:4), followed by recrystallisation from water to afford *colourless crystals*, m.p. 175—195 °C (Found: C, 60.3; H, 3.35; N, 12.7. $C_{11}H_7FN_2O_2$ requires C, 60.55; H, 3.23; N, 12.84%); $\nu_{max.}$ 1 650 (CO) and 1 610 cm^{-1} (CO); $\lambda_{max.}$ 256 and 314 nm (log ε 4.19 and 3.80); δ_H [90 MHz; $(CD_3)_2SO$] 7.15—7.75 (4 H, m, C_6H_4F), 8.00, 8.60 (each 1 H, s, 3- and 6-H), and 13.60 (1 H, br, NH); *m/z* 218 (M^+, 79%), 123 ($C_6H_4FCO^+$, 100), and 95 ($C_6H_4F^+$, 37).

10H-[1]*Benzopyrano*[2,3-d]*pyridazin*-10-*one* (**10**).—Potassium carbonate (173 mg, 1.25 mmol) was added to a solution of compound (**9**) (218 mg, 1 mmol) in dimethylformamide (10 ml) and the mixture was heated to 130 °C for 6 h. The solvent was removed under reduced pressure and the residue was partitioned between water and dichloromethane. Evaporation of the organic extract, followed by recrystallisation from methanol afforded *pale yellow crystals* (165 mg, 83%), m.p. 189—190 °C (Found: C, 66.55; H, 3.25; N, 14.2. $C_{11}H_6N_2O_2$ requires C, 66.67; H, 3.05; N, 14.14%); $\nu_{max.}$ 1 670 cm^{-1} (CO); δ_H (90 MHz; $CDCl_3$) 7.35—7.95 (3 H, m, 6-, 7-, and 8-H), 8.30 (1 H, m, 9-H), 9.55, and 9.75 (each 1 H, d, *J* 1 Hz, 1- and 4-H); *m/z* 198 (M^+, 100%) and 171 (51).

10H-[1]*Benzothiopyrano*[2,3-d]*pyridazin*-10-*one* (**11**).—A solution of compound (**9**) (218 mg, 1 mmol) and phosphorus pentasulphide (444 mg, 1 mmol of P_4S_{10}) in dry pyridine (20 ml) was heated to 110 °C for 2 h. The solid residue left after removal of the solvent was treated with water (30 ml) then set

aside at room temperature for 14 h. Extraction of the mixture with dichloromethane and evaporation of the extract gave a yellow solid. Purification by m.p.l.c. (eluant: dichloromethane–methanol, 97:3), followed by recrystallisation from acetone afforded *pale yellow needles* (180 mg, 84%), m.p. 228—229 °C (Found: C, 61.55; H, 3.1; N, 13.0; S, 15.8. $C_{11}H_6N_2OS$ requires C, 61.67; H, 2.82; N, 13.08; S, 14.96%); $\nu_{max.}$ 1 640 cm^{-1} (CO); δ_H (90 MHz; $CDCl_3$) 7.50—7.90 (3 H, m, 6-, 7-, and 8-H), 8.60 (1 H, m, 9-H), and 9.45 and 9.90 (each 1 H, d, *J* 1 Hz, 1- and 4-H); *m/z* 214 (M^+, 54%), 187 (100), and 154 (82).

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