Syntheses with Isoxazoles. Part II.[1] Rearrangement of Isoxazolo[2,3-*a*]-pyridinium Salts into 5,6-Dihydro-4*H*-furo[3,2-*b*]pyridin-2-ones

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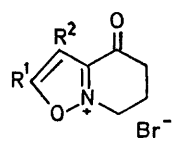
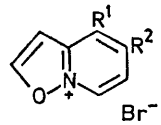
Brief treatment of the tetrahydro-4-oxoisoxazolo[2,3-*a*]pyridinium salts (1) and (12) with boiling acetic anhydride gave the 5,6-dihydro-4*H*-furo[3,2-b]pyridin-2-ones (4) and (13). The structure of compound (4) has been proved by complete hydrogenation to piperidin-2-ylacetic acid, and by *X*-ray diffraction. The 2-methylisoxazolo-[2,3-a]pyridinium salt (11) did not undergo the rearrangement; this suggests a keten intermediate, formed by removal of the hydrogen atom at position 2. The 5-bromo-derivative (22) gave no furopyridine; cleavage of either the pyridine or the isoxazole ring occurred.

We have reported [1,2] that the tetrahydro-4-oxoisoxazolo-[2,3-*a*]pyridinium salt (1) can be easily prepared, and converted by a bromination–dehydrobromination sequence into the fully unsaturated 5-bromo-4-hydroxy-isoxazolo[2,3-*a*]pyridinium salt (2). We briefly mentioned [1] that hot acetic anhydride did not convert the salt (1) into the parent isoxazolopyridinium salt (3); we report here details of the rearrangement observed on treatment of the salt (1) with hot acetic anhydride. This work forms part of a general investigation of the properties of isoxazolium salts.



(1) $R^1 = R^2 = H$
(11) $R^1 = Me, R^2 = H$
(12) $R^1 = H, R^2 = Me$



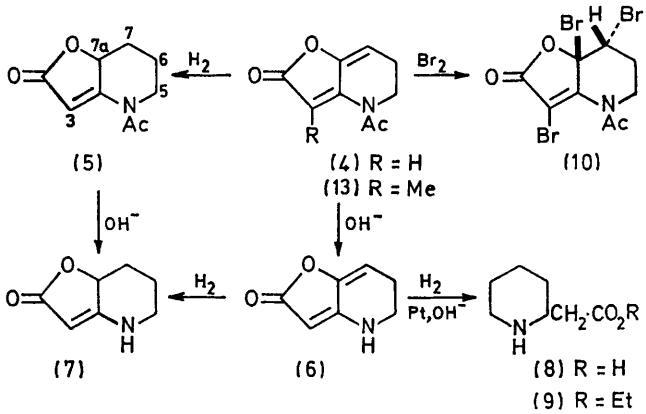
(2) $R^1 = OH, R^2 = Br$
(3) $R^1 = R^2 = H$

The salt (1) reacted rapidly with boiling acetic anhydride; the maximum yield of product was obtained when the salt was heated to the b.p. in acetic anhydride and maintained at the b.p. for a few minutes only. Further heating led to decomposition with formation of high molecular weight materials. The major proportion of the product was non-quaternary; chromatography gave up to 49% of one product, shown by spectroscopic (including a single crystal *X*-ray diffraction study) and chemical evidence to be a dihydrofuro[3,2-*b*]pyridin-2-one (4). The furopyridone (4) had several absorption bands in the 1800—1500 cm^{-1} region, notably one at 1778 cm^{-1}, which was assigned to a small ring containing a carbonyl group or to an unsaturated acetate. The n.m.r. spectrum (Table) showed that an acetyl group was present (confirmed by a loss of 42 mass units in the mass spectral breakdown pattern), and also indicated two deshielded alkene protons, and two methylene groups, one probably adjacent to a nitrogen atom. The coupling pattern indicated the presence of the system $-\overset{|}{\underset{\beta}{N}}-\overset{\alpha}{CH_2}\cdot\overset{\gamma}{CH}=\overset{\delta}{C}-C=CH$; hydrogenation of the rearrangement product under mild conditions gave a dihydro-derivative (5) in which the $\gamma\delta$-double bond had been reduced.

[1] Part I, R. H. Good and G. Jones, *J. Chem. Soc.* (*C*), 1971, 1196.

[2] R. H. Good, G. Jones, and J. R. Phipps, *Tetrahedron Letters*, 1972, 609.

The furopyridone (4) showed a u.v. maximum at 276 nm; addition of a trace of aqueous base to the ethanolic solution produced an instant and irreversible change in the spectrum with development of a maximum at 312 nm.



Isolation of the hydrolysis product (6) showed that the acetyl group had been removed; the maximum at 312 nm accords well with that expected for an enamino-ketone or -lactone (a model enamino-ketone is that reported by Grob and Wilkens [3]). In the n.m.r. spectrum compound (6) showed an exchangeable proton signal at δ 6·0 p.p.m. (vinylogous amide), and an i.r. maximum at 1750 cm^{-1} confirmed the carbonyl absorption as being due to a small ring rather than an unsaturated acetate. Hydrolysis of the dihydro-derivative (5) was slower, giving the tetrahydrofuropyridone (7), which was also obtained by reduction of compound (6). Further hydrogenation of compounds (6) and (7) was achieved cleanly only under basic conditions, by use of Adams catalyst, when 2 or 3 mol. equiv. of hydrogen were absorbed, respectively, giving piperidin-2-ylacetic acid (8), identified as its ethyl ester (9) picrate.[4] With the carbon–nitrogen skeleton thus established, few structures were available for the rearrangement product (4); the structure was established by a single crystal *X*-ray determination and the dimensions are shown in the Figure. Full details of the *X*-ray determination will be published elsewhere.

The rearrangement product (4) reacted rapidly with bromine in chloroform, giving a brominated product,

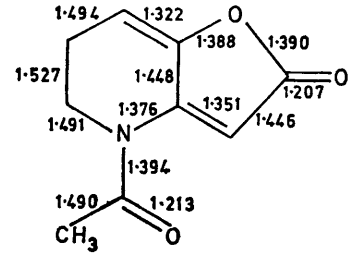


FIGURE Bond lengths in compound (4)

$C_9H_8Br_3NO_2$. The n.m.r. spectrum (Table) showed no alkene absorptions, the single downfield signal at δ 4·95 p.p.m. being assigned to a methine group bearing a bromine atom. The most satisfactory formula for this tribromo-derivative is (10); the low coupling constant ($J \leqslant 3·0$ Hz) suggest that this hydrogen atom is equatorial and hence that the bromine atom is axial, a suggestion borne out by the downfield shift of one of the signals for the methylene group at position 5.

N.m.r. and mass spectral data for furo[3,2-*b*]pyridones *

Compd.	3-H	5-H	δ (p.p.m.) 6-H	7-H	7a-H	Other	*J*/Hz	*m/e*
(4)	6·1(d)	3·9(t)	2·6(m)	5·8(m)		2·34 (3H, s, Ac)	$J_{3,7}$ 1; $J_{6,7}$ 5	179 (M^+), 137, 108, 80, 68, 53, 43 (100%); *m** 105 (179→137)
(5)	5·9br(s)	3·6—4·0(m)	1·93(m)	2·25—2·65(m)	4·85(q)	2·3 (3H, s, Ac)	$J_{7,7a}$ 1 and 6	181 (M^+), 139, 137, 111, 110, 83, 70, 68, 55, 43; *m** 88 (139→110)
(6)	6·0(m)	3·4(m)	2·3—2·7(m)	5·6(m)		4·72 (NH) †		137·0480 (M^+), 108, 80, 68
(7)	4·63(s)	3·3(m)	1·26—2·65(m)	4·54—4·86(m)		6·18 (NH) †		139 (M^+), 110, 83, 70, 68, 55; *m** 88 (139→110), 62 (110→83)
(10)		2·8—3·8 (3H,m)		4·95(t)		2·2 (3H, s, Ac), 4·4—4·85 (1H, m, H-5*ax*)		421, 419, 417, 415 (M^+)
(13)		4·0(t)	2·6(m)	5·8(t)		2·0 (3H, s, Me), 2·3 (3H, s, Ac)		193 (M^+)

* For numbering see formula (5). † Exchangeable with D_2O.

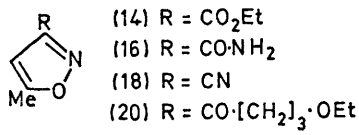
During attempts to clarify the structure of the rearrangement product (4), three other isoxazolopyridinium salts, (11), (12), and (22), were heated with acetic anhydride. Of these the 2-methyl derivative (11) gave no identifiable products, but the 3-methyl derivative (12) gave the homologous furopyridone (13). The substituted isoxazolopyridinium salts (11) and (12) were prepared from the appropriate methylisoxazole esters (14) and (15), *via* the amides (16) and (17), the nitriles (18) and (19), and the ethoxybutanoyl derivatives (20) and (21). These monocyclic ketones were cyclised by hydrobromic acid treatment as previously described.

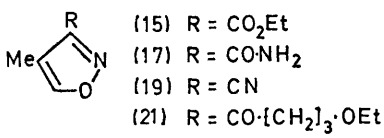
The n.m.r. spectrum (Table) of compound (13) showed that one of the alkene proton absorptions of compound (4) was absent. The 5-bromo-ketone [1] (22) gave no furopyridone on brief heating with acetic anhydride. Two products were isolated; the minor product had a molecular weight of 257 (mass spectrum) and an isotope pattern which indicated the presence of one bromine

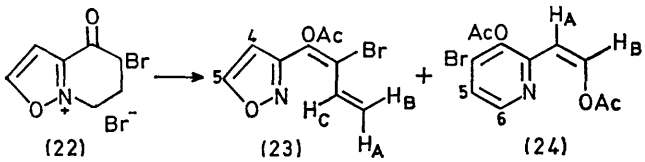
[3] See for example C. A. Grob and H. J. Wilkens, *Helv. Chim. Acta*, 1967, **50**, 725.

[4] G. R. Clemo, W. M. Morgan, and R. Raper, *J. Chem. Soc.*, 1935, 1743.

atom. The n.m.r. spectrum showed two isoxazole absorptions at δ 6·45 and 8·54 p.p.m. (J 2 Hz), a vinyl system at δ 5·62, 5·97, and 7·12—7·56 p.p.m. (J 10 and 16 Hz), and a three-proton singlet. An i.r. absorption at 1770 cm^{-1} (enol acetate) completed the evidence for

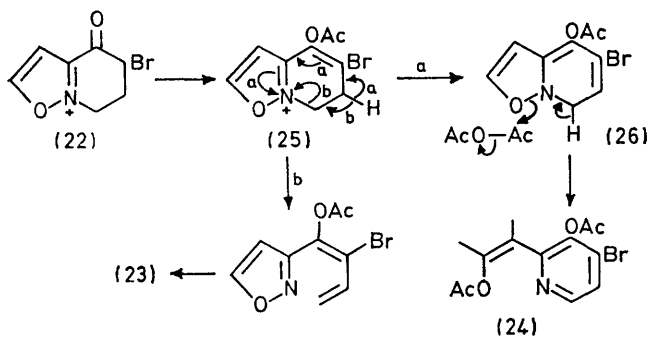






structure (23). The major product again showed enol acetate absorption in the i.r. spectrum. The n.m.r. spectrum showed the presence of two acetyl groups, confirmed by two losses of 42 mass units in the mass spectrum, which indicated a molecular weight of 299 with one bromine atom. The n.m.r. spectrum showed two AB systems: one at δ 7·48 and 8·32 p.p.m. (J 5 Hz) was due to pyridine α- and β-protons. The second system was associated with a *cis*-alkene and the spectral evidence leads to the acetoxyvinylpyridine structure (24).

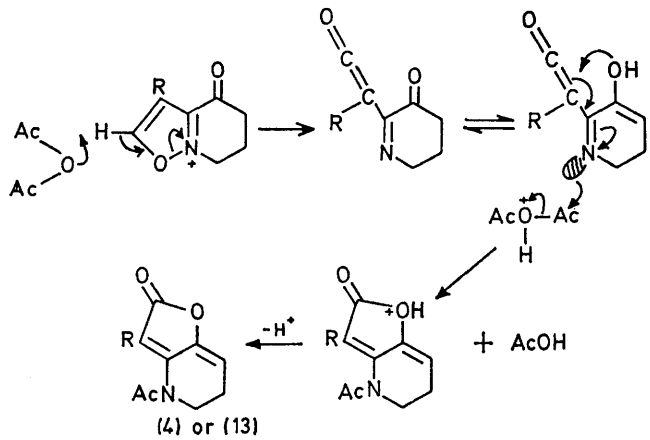
The mechanisms for the various rearrangements and degradations are shown in Schemes 1 and 2. The route



SCHEME 1

to the products (23) and (24) (Scheme 1) is similar to one which we have reported [5] to be the normal mode of attack by acetic anhydride on oxopyridinium salts.

The normal progress of the acetic anhydride aromatisation reaction *via* the enol acetate (25) to the non-ionic intermediate (26) provides routes to the isoxazole (23) by Hofmann elimination, or to the pyridine (24) by isoxazole ring opening. The normally favourable but slower aromatisation reaction which takes precedence with more stable cyclic systems is incomplete before extensive decomposition takes place with the unstable isoxazole derivatives.



SCHEME 2

The suggested mechanism for the conversion of the isoxazolopyridinium salts (1) and (12) into furopyridone derivatives follows a known breakdown of the isoxazole ring to a keten intermediate. The assumption that the reaction is initiated by a proton abstraction from position 2 finds support in the differing behaviour of the methyl derivatives (11) and (12), since the presence of a methyl group in position 2 completely inhibits the reaction. Further work on the behaviour of salts of type (1) towards nucleophiles is under examination.

EXPERIMENTAL

M.p.s were determined on a Kofler heated stage. Column chromatography was performed on Woelm alumina and the activity is shown thus (III). Preparative layer chromatography was performed on 40 cm plates coated with Merck silica gel PF_{254}. N.m.r. shifts are given as δ values, in p.p.m. from tetramethylsilane.

4-*Acetyl*-5,6-*dihydro*-4H-*furo*[3,2-b]*pyridin*-2-*one* (4).—A solution of 4,5,6,7-tetrahydro-4-oxoisoxazolo[2,3-*a*]pyridinium bromide (5 g) in acetic anhydride (100 ml) was boiled for 5 min. The dark brown viscous oil obtained after evaporation of the acetic anhydride *in vacuo* was dissolved in absolute ethanol and the solution was again evaporated. The residue was chromatographed on alumina (100 g; IV) in benzene; evaporation of the eluate gave the N-*acetylfuropyridone* (4), m.p. 110—112° [from benzene–petroleum (b.p. 60—80°)] (2·01 g, 49%) (Found: C, 60·2; H, 5·2; N, 7·8. $C_9H_9NO_3$ requires C, 60·4; H, 5·05; N, 7·8%); $\lambda_{max.}$ (95% EtOH) 276 nm (log ε 4·24); $\nu_{max.}$ ($CHCl_3$) 1778, 1684, and 1590 cm^{-1}; n.m.r. and mass spectra in Table.

4-*Acetyl*-5,6,7,7a-*tetrahydro*-4H-*furo*[3,2-b]*pyridin*-2-*one* (5).— A solution of the furopyridone (4) (0·179 g) in 95% ethanol (20 ml) containing palladium–charcoal (20 mg) was hydrogenated to completion at atmospheric temperature and pressure. The filtered solution was evaporated; the residue was purified by p.l.c. (chloroform–ethyl acetate); the major band yielded a solid, recrystallised from benzene–carbon tetrachloride to give the *tetrahydro*-N-*acetylfuropyridone* (5), m.p. 99—100° (68 mg, 38%) (Found: C, 59·9;

[5] D. G. Jones and G. Jones, *J. Chem. Soc.* (*C*), 1969, 707.

H, 6·35; N, 7·7. $C_9H_{11}NO_3$ requires C, 59·65; H, 6·1; N, 7·75%); $\lambda_{max.}$ (95% EtOH) 264 nm (log ε 4·18); $\nu_{max.}$ ($CHCl_3$) 1740, 1687, and 1610 cm^{-1}; n.m.r. and mass spectra in Table.

5,6-*Dihydro*-4H-*furo*[3,2-b]*pyridin*-2-*one* (6).—A solution of the furopyridone (4) (40 mg) in 95% ethanol (20 ml) was treated dropwise with N-sodium hydroxide solution until there was no further change in the u.v. spectrum. The solution was neutralised (pH 7) with dil. hydrochloric acid and the solvent was removed under reduced pressure. The residue was extracted with chloroform and the dried extracts were evaporated, giving a yellow solid (32 mg, 96%) which afforded the *furopyridone* (6), m.p. 110—111° (from benzene) (Found: M^+, 137·0480. $C_8H_7NO_3$ requires M, 137·0478); $\lambda_{max.}$ (95% EtOH) 260 and 312 nm (log ε 3·82 and 4·03); $\nu_{max.}$ ($CHCl_3$) 3420, 1750, and 1620 cm^{-1}; n.m.r. and mass spectra in Table.

5,6,7,7a-*Tetrahydro*-4H-*furo*[3,2-b]*pyridin*-2-*one* (7).—Prepared as described for compound (6) in quantitative yield, and crystallised from benzene–carbon tetrachloride as needles, the *tetrahydrofuropyridone* (7) had m.p. 119—120° (Found: C, 60·9; H, 6·5; N, 10·2. $C_7H_9NO_2$ requires C, 60·4; H, 6·5; N, 10·05%); $\lambda_{max.}$ (95% EtOH) 260 nm (log ε 4·34); $\nu_{max.}$ ($CHCl_3$) 3395, 1720, and 1625 cm^{-1}; n.m.r. and mass spectra in Table.

Ethyl Piperidin-2-*ylacetate* (9).—(*a*) A solution of the dihydro-derivative (5) (0·5 g) in 95% ethanol (100 ml) was treated with aqueous 40% sodium hydroxide (2 drops). When hydrolysis was complete (u.v.) Adams catalyst (100 mg) was added and the mixture shaken with hydrogen at atmospheric temperature and pressure (uptake 2 mol. equiv.). Filtration and evaporation of the neutralised solution gave piperidin-2-ylacetic acid (8), m.p. 214° (decomp.) (from ethanol–ether) (lit.,[6] 214°). The acid (8) was esterified by passing hydrogen chloride through a boiling ethanolic solution; the ethyl ester (9) had b.p. 125° at 20 mmHg (lit.,[4] 105° at 14 mmHg). The picrate had m.p. 128° (lit.,[4] 125°).

(*b*) The ethyl ester (9) prepared by reduction of ethyl 2-pyridylacetate formed a picrate, m.p. 128°; mixed m.p. with sample prepared as in (*a*) showed no depression.

4-*Acetyl*-3,7,7a-*tribromo*-5,6,7,7a-*tetrahydro*-4H-*furo*-[3,2-b]*pyridin*-2-*one* (10).—A solution of bromine (1 g) in dry chloroform (10 ml) was added dropwise (0·5 h) to a solution of the furopyridone (4) (0·5 g) and pyridine (0·25 g) in dry chloroform (25 ml); the mixture was left overnight. The chloroform was evaporated off and the residue taken up in the minimum of hot absolute ethanol. The solid which separated on cooling was filtered off and recrystallised from carbon tetrachloride to give the *tribromofuropyridone* (10), m.p. 132—133° (0·22 g, 20%) (Found: C, 25·9; H, 2·3; N, 3·4. $C_9H_8Br_3NO_3$ requires C, 25·85; H, 1·95; N, 3·35%) $\lambda_{max.}$ (95% EtOH) 295 nm (log ε 3·76); $\nu_{max.}$ ($CHCl_3$) 1790, 1690, and 1640 cm^{-1}; n.m.r. and mass spectra in Table.

Ethyl 5-*Methylisoxazole*-3-*carboxylate* (14).—A solution of ethyl chloroglyoxylate oxime (50 g) in ether (200 ml) was added to a boiling solution of isopropenyl acetate (340 g) and triethylamine (35 g) in ether (500 ml), and the mixture was then boiled (2 h). Water was added to the cooled mixture and the ethereal layer was separated, dried ($MgSO_4$), and evaporated. The residual oil was heated to 180° (2 h) and acetic acid was distilled off. Distillation of the residue gave the isoxazole ester (14), b.p. 140° at 15 mmHg (lit.,[7] 105° at 10 mmHg) (15·5 g, 30%); *m/e* 155 and 110 (Calc. for $C_7H_9NO_3$: M, 155); $\lambda_{max.}$ (95% EtOH) 243·5 nm (log ε 3·43); $\nu_{max.}$ (film) 1735 cm^{-1}; δ($CDCl_3$) 1·4 (3H, t), 2·5 (3H, s), 4·4 (2H, q), and 6·4 p.p.m. (1H, s).

Ethyl 4-*Methylisoxazole*-3-*carboxylate* (15).—Prepared as described for ester (14), but from n-propenyl acetate, in 45% yield, the *ester* (15) had m.p. 55—56°, b.p. 165° at 18 mmHg (Found: C, 54·5; H, 5·85; N, 9·10. $C_7H_9NO_3$ requires C, 54·2; H, 5·85; N, 9·05%); $\lambda_{max.}$ (95% EtOH) 248 nm (log ε 3·404); $\nu_{max.}$ ($CHCl_3$) 1730 cm^{-1}; δ(CCl_4) 1·5 (3H, t), 2·3 (3H, s), 4·5 (2H, q), and 8·4 p.p.m. (1H, s); *m/e* 155 (M^+).

5-*Methylisoxazole*-3-*carboxamide* (16).—The ester (14) (15·0 g) was dissolved in methanol (30 ml) and added dropwise to ammonia (200 ml; s.g. 0·88) at 0°. After 3 days at 0° the amide (16) was filtered off and crystallised from water; m.p. 166° (8·2 g, 65%) (lit.,[8] 164°); $\lambda_{max.}$ (95% EtOH) 219 nm (log ε 3·66); $\nu_{max.}$ (paraffin) 3380, 3190, and 1670 cm^{-1}; δ($CF_3{\cdot}CO_2H$) 2·6 (3H, s), 6·7 (1H, s), and 8·0br p.p.m. (2H, s); *m/e* 126 (M^+).

4-*Methylisoxazole*-3-*carboxamide* (17).—Prepared from ester (15) as described for amide (16) in 30% yield, the *isoxazolecarboxamide* (17) had m.p. 103—103·5° (Found: C, 47·5; H, 4·5; N, 21·8. $C_5H_6N_2O_2$ requires C, 47·6; H, 4·8; N, 22·2%); $\lambda_{max.}$ (95% EtOH) 220 nm (log ε 3·56); $\nu_{max.}$ ($CHCl_3$) 3510, 3400, and 1695 cm^{-1}; δ($CF_3{\cdot}CO_2H$) 2·4 (3H, s), 7·6—8·4br (2H, s), and 8·5 p.p.m. (1H, s); *m/e* 126 (M^+).

5-*Methylisoxazole*-3-*carbonitrile* (18).—A mixture of the amide (16) (7 g) and phosphorus pentoxide (14 g) was heated to 160°; when the pressure was reduced the nitrile distilled out, b.p. 87—88° at 25 mmHg on redistillation (3·6 g, 60%) (lit.,[8] b.p. 182° at 760 mmHg); $\lambda_{max.}$ (95% EtOH) 237 nm (log ε 3·56); $\nu_{max.}$ (film) 3140 and 2250 cm^{-1}; δ($CDCl_3$) 2·6 (3H, s) and 6·5 p.p.m. (1H, s); *m/e* 108 (M^+).

4-*Methylisoxazole*-3-*carbonitrile* (19).—Prepared as described for nitrile (18), from the amide (17), in 84% yield, the *nitrile* (19) had b.p. 80—83° at 30 mmHg; $\lambda_{max.}$ (95% EtOH) 247 nm (log ε 3·48); $\nu_{max.}$ (film) 3130 and 2250 cm^{-1}; δ($CDCl_3$) 2·8 (3H, s) and 8·43 p.p.m. (1H, s); *m/e* 108 (M^+).

4-*Ethoxy*-1-(5-*methylisoxazol*-3-*yl*)*butan*-1-*one* (20).—The Grignard reagent from 3-ethoxypropyl bromide (12 g) and magnesium (1·88 g) in dry ether (100 ml) was added to a stirred solution of 5-methylisoxazole-3-carbonitrile (18) (6·1 g) in dry ether (200 ml) at −5 °C. The mixture was then stirred overnight at room temperature. Ice-cold 2N-hydrochloric acid was added slowly, and the ether layer was separated and extracted with a further quantity of acid. The combined acid layers were diluted (to dissolve solids present) and the solution was stirred (2 h) then neutralised at 0° with ammonia (s.g. 0·88). The mixture was extracted with ether, and the ether solution was dried and evaporated. The *ketone* (20) was distilled; b.p. 81—84° at 0·2 mmHg (7 g, 63%) (Found: C, 60·5; H, 7·65; N, 7·2. $C_{10}H_{15}NO_3$ requires C, 60·9; H, 7·65; N, 7·1%); $\lambda_{max.}$ (95% EtOH) 247 nm (log ε 3·27); $\nu_{max.}$ (film) 3140 and 1700 cm^{-1}; δ($CDCl_3$) 1·1 (3H, t), 2·0 (2H, q), 2·5 (3H, s), 2·9—3·7 (6H, m), and 6·35 p.p.m. (1H, s).

4-*Ethoxy*-1-(4-*methylisoxazol*-3-*yl*)*butan*-1-*one* (21).—From 4-methylisoxazole-3-carbonitrile (19) by the method used to prepare compound (20), the *ketone* (21) was prepared in 38% yield; b.p. 78—80° at 0·1 mmHg (Found: C, 60·7; H,

[6] Heilbron's 'Dictionary of Organic Compounds,' Eyre and Spottiswoode, London, 1965.

[7] Shionogi and Co. Ltd., Jap Pat. 18,106/1965 (*Chem. Abs.*, 1965, **63**, 18,093).

[8] A. Quilico, L. Panizzi, and U. Cavazzuti, *Gazzetta*, 1938, **68** 625 (*Chem. Abs.*, 1939, **33**, 1728).

7·75; N, 7·1. $C_{10}H_{15}NO_3$ requires C, 60·9; H, 7·65; N, 7·1%); $\lambda_{max.}$ (95% EtOH) 253 nm (log ε 3·29); $\nu_{max.}$ (film) 3120 and 1700 cm^{-1}; δ(CCl_4) 1·15 (3H, t), 2·0 (2H, m), 2·25 (3H, s), 2·9—3·6 (6H, m), and 8·2 p.p.m. (1H, s).

4,5,6,7-*Tetrahydro*-2-*methyl*-4-*oxoisoxazolo*[2,3-a]*pyridinium Bromide* (11).—A solution of the ketone (20) (4·2 g) in 48% hydrobromic acid (100 ml) was boiled (1·5 h). Evaporation under reduced pressure gave a gum, solidifying when triturated with acetone. Recrystallised from ethanol–ethyl acetate, the *isoxazolopyridinium bromide* (11) *hydrate*, had m.p. >300° (4·6 g, 93%) (Found: C, 38·6; H, 4·95; N, 5·6. $C_8H_{10}BrNO_2,H_2O$ requires C, 38·4; H, 4·85; N, 5·6%); $\lambda_{max.}$ (95% EtOH) 233·5 and 290 nm (log ε 3·83 and 3·30); $\nu_{max.}$ (mull) 3190 cm^{-1} (no C=O absorption); δ($CF_3{\cdot}CO_2H$) 2·6—3·2 (4H, m), 2·8 (3H, s), 5·0 (2H, t, $\overset{+}{N}-CH_2$), and 7·2 p.p.m. (1H, s).

4,5,6,7-*Tetrahydro*-3-*methyl*-4-*oxoisoxazolo*[2,3-a]*pyridinium Bromide* (12).—Prepared from the isoxazole (21), as described for compound (11), in 53% yield, the 3-*methylisoxazolopyridinium bromide* (12) *hemihydrate* had m.p. >300° (Found: C, 39·4; H, 5·0; N, 6·1. $2C_8H_{10}BrNO_2,H_2O$ requires C, 39·85; H, 4·6; N, 5·8%); $\lambda_{max.}$ (95% EtOH) 237 and 301 nm (log ε 3·69 and 3·22); $\nu_{max.}$ (mull) 1725 cm^{-1}; δ($CF_3{\cdot}CO_2H$) 2·4—3·3 (4H, m), 2·52 (3H, s), 6·05 (2H, t, $\overset{+}{N}{\cdot}CH_2$), and 8·9 p.p.m. (1H, s).

4-*Acetyl*-5,6-*dihydro*-3-*methyl*-4H-*furo*[3,2-b]*pyridin*-2-*one* (13).—Prepared from the salt (12) as described for compound (4), the N-*acetyl*-3-*methylfuropyridone* (13) (30%), had m.p. 102—104° (Found: C, 62·0; H, 6·0; N, 7·3. $C_{10}H_{11}NO_3$ requires C, 62·15; H, 5·75; N, 7·25%); $\lambda_{max.}$ (95% EtOH) 276 nm (log ε 4·21); $\nu_{max.}$ ($CHCl_3$) 1765, 1675, and 1640 cm^{-1}; n.m.r. and mass spectra given in Table.

Action of Boiling Acetic Anhydride on 5-*Bromo*-4,5,6,7-*tetrahydro*-4-*oxoisoxazolo*[2,3-a]*pyridinium Bromide* (22).—A solution of the bromide (22) (0·8 g) in acetic anhydride (20 ml) was boiled for 2 min. P.l.c. separation of the residue after evaporation of the acetic anhydride (reduced pressure) [chloroform–ethyl acetate (4 : 1) as eluant] gave two main bands.

Band I yielded an oil, shown by its spectral characteristics to be 2-*bromo*-1-*isoxazol*-3-*ylbuta*-1,3-*dienyl acetate* (23) (45 mg); *m/e* 259 (M + 2), 257 (M^+), 241, 239, 226, 224, 217, 215, 199, 197, 189, 187, 148, 146, 108, 90, 60, and 43; $\lambda_{max.}$ (95% EtOH) 264 nm; $\nu_{max.}$ ($CHCl_3$) 1760 and 1646 cm^{-1}; δ($CDCl_3$) 2·32 (3H, s, Ac), 5·62 (1H, d, J 10 Hz, H_A), 5·97 (1H, d, J 16 Hz, H_B), 6·45 (1H, d, J 2 Hz, H-4), 7·12—7·56 (1H, m, J 16 and 10 Hz, H_C), and 8·54 p.p.m. (1H, d, J 2 Hz, H-5).

Band II (152 mg) was shown by spectral evidence to be due to 2-(2-*acetoxyvinyl*)-4-*bromo*-3-*pyridyl acetate* (24); *m/e* 301 (M + 2), 299 (M^+), 259, 257, 217, 215, 200, 198, 119, 117, 78, and 43; $\lambda_{max.}$ (95% EtOH) 223, 253, and 295 nm; $\nu_{max.}$ ($CHCl_3$) 1760 and 1646 cm^{-1}; δ($CDCl_3$) 2·21 (3H, s, Ac), 2·42 (3H, s, Ac), 6·5 (1H, d, J 12 Hz, H_A), 7·48 (1H, d, J 5 Hz, H-5), 8·31 (1H, d, J 5 Hz, H-6) and 8·6 p.p.m. (1H, d, J 12 Hz, H_B).

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