Reactions of *N*-Heteroaromatic Bases with Nitrous Acid. Part I. Diazotisation and Nitrosation of α- and γ-Amino-derivatives in Dilute Acid Solutions

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The diazotisation of 2- and 4-aminopyridine in dilute mineral acid leads to the formation of diazonium ions. Pyridine-4-diazonium ion so obtained has been characterised as 4-2′-hydroxy-1′-naphthylazopyridine. These diazonium ions hydrolyse rapidly to the corresponding hydroxy-compounds in dilute acid solution. In alkaline solution, diazoate ions are formed and are much more stable.

α- and γ-Methylamino-*N*-heteroaromatic bases nitrosate in moderately strong acid solution to secondary *N*-heteroaromatic nitrosamines which, unlike their aromatic analogues, hydrolyse in very weakly acid solutions.

UNLIKE aromatic amines, α- and γ-amino-derivatives of the *N*-heteroaromatic bases of the π-deficient type,[1] *e.g.*, pyridine derivatives, either resist diazotisation in dilute mineral acid or, if reactive towards nitrous acid, form mainly the corresponding hydroxy-compounds.[2] These amines were shown to diazotise only in concentrated sulphuric acid, as evidenced by the intense red colour obtained [2b] with alkaline β-naphthol and in some cases isolation of the adduct.[2e] In concentrated halogen acids they form (in presence of nitrous acid) the corresponding halogen compounds and smaller yields of the hydroxy-compounds.[2a,3a,b] A number of substituted γ-aminopyridines [4] diazotise and many of their derivatives can be formed under conditions typical of the reactions of the aromatic diazonium ions. However, unless the diazotisations were carried out with nitrous acid in almost anhydrous acidic [2e] or with amyl nitrite in alkaline media,[3a] the isolation of the diazonium ions themselves was considered not feasible. On the other hand, the β-amino-*N*-heteroaromatic bases diazotise and couple as readily as aromatic amines.[1]

The work of this Paper deals with a qualitative study of the reactions of primary and secondary α- and γ-amino-*N*-heteroaromatic bases with nitrous acid and shows that, contrary to what has been assumed earlier,[2,5] these reactions are also similar to those of the aromatic amines in dilute acid solutions.

RESULTS

Diazotisation of 2- and 4-Aminopyridine.—4-Aminopyridine was diazotised in 0·5—4·0M-hydrochloric, sulphuric, and perchloric acid, by rapidly mixing the solutions with aqueous sodium nitrite at 0°. The resulting pyridine-4-diazonium ion hydrolysed rapidly (within a few min.) to 4-hydroxypyridine, but it could be isolated as 4,2′-hydroxy-1′-naphthylazopyridine in good yields if it was coupled, immediately after formation, with β-naphthol in alkaline solution.

A solution prepared by the prompt (after 45 sec.) neutralisation (to pH 10—11) of a diazotisation mixture of 4-aminopyridine (0·2M in *ca.* 3M-hydrochloric acid at 0°) with sodium hydroxide–borax buffer, had a maximum ultraviolet absorption at 278 mμ, attributed to the pyridine-4-diazoate ion because, when neutralisation was carried out after complete decomposition of the diazonium ion (*i.e.*, 20 min. later), the neutralised solution had a maximum absorption only at 255 mμ, owing to 4-hydroxypyridine (see Figure 1).

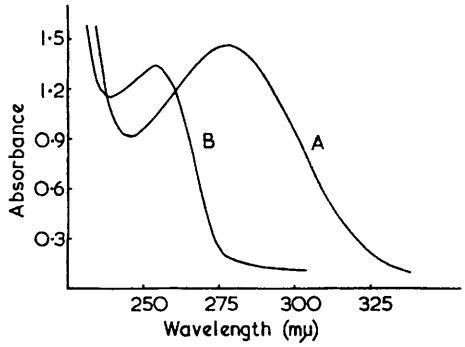


FIGURE 1 Ultraviolet spectra of alkaline solutions: (*A*) containing pyridine-4-diazoate ion, and (*B*) containing 4-hydroxypyridine formed from the hydrolysis of pyridine-4-diazonium ion.

Similar alkaline solutions showed only *ca.* 10% decrease in the concentration of the diazoate ion during 48 hr. at 20°. After acidification of these solutions to 0·5M-perchloric acid, the maximum absorption due to pyridine-4-diazonium ion, formed from the diazoate ion, appeared at 285 mμ (see Figure 2). The absorption at this wavelength (log ε *ca.* 4·5) decreased rapidly, because of hydrolysis of the diazonium ion, and within about 8 min. at 20° disappeared, whilst the absorption at 235 mμ, due to 4-hydroxypyridine (cation), reached a maximum. Thus the rate of hydrolysis of pyridine-4-diazonium ion was found to be rapid and to increase with increase in the acidity of the medium; the reaction was complete after *ca.* 6 min. in 3M, *ca.* 3·5 min. in 4M, and *ca.* 2 min. in 5M-perchloric acid.

An aqueous alkaline solution (pH 8—9) of sodium pyridine-2-diazoate, prepared independently in anhydrous alkaline medium,[3a] showed no appreciable change in its spectrum ($\lambda_{max.}$ 278 mμ) during 2 hr. at 20°. When this solution was acidified with 0·01 or 0·02M-hydrochloric acid

[1] Cf. A. Albert, "Heterocyclic Chemistry," University of London, The Athlone Press, 1959, pp. 52, 81.

[2] (*a*) W. Markwald, *Ber.*, 1894, **27**, 1317; (*b*) A. Albert and B. Ritchie, *J. Chem. Soc.*, 1943, 458; (*c*) G. T. Morgan and L. P. Walls, *ibid.*, 1932, 2227; (*d*) E. Koenigs, G. Kinne, and W. Weiss, *Ber.*, 1924, **57**, 1172; (*e*) E. Koenigs and H. Greiner, *ibid.*, 1931, **64**, 1045.

[3] (*a*) A. E. Chichibabin and M. D. Rjazancev, *J. Russ. Phys. Chem. Soc.*, 1915, **46**, 1571 (*Chem. Abs.*, 1916, 2898); (*b*) E. D. Parker and W. Shire, *J. Amer. Chem. Soc.*, 1947, **69**, 63; (*c*) L. C. Craig, *ibid.*, 1934, **56**, 231.

[4] T. Talik and E. Płazek, *Roczniki Chem.*, 1955, **29**, 1019; 1959, **33**, 387 (*Chem. Abs.*, 1956, 12,045g); T. Talik, *Roczniki Chem.*, 1957, **31**, 569.

[5] S. J. Angyal and C. L. Angyal, *J. Chem. Soc.*, 1952, 1461.

in a continuous-flow ultraviolet apparatus,[6] it gave a spectrum which had a characteristic absorption maximum at 283 mμ and was believed to be mainly due to pyridine-2-diazonium ion. By using a stopped-flow technique, the

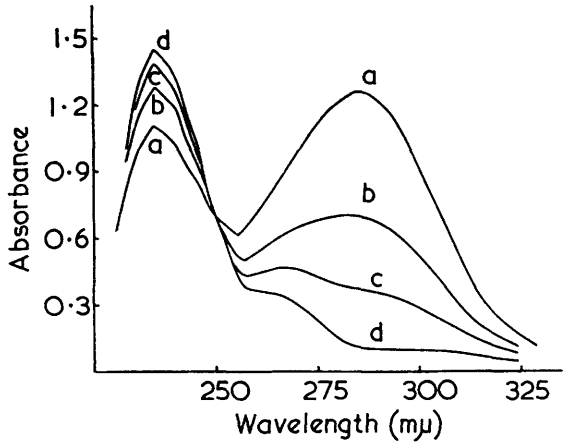


FIGURE 2 Ultraviolet spectrum of an acidified solution containing pyridine-4-diazonium ion ($\lambda_{max.}$ 285 mμ), 4-aminopyridine ($\lambda_{max.}$ 262 mμ), and 4-hydroxypyridine ($\lambda_{max.}$ 235 mμ). Intermediate steps during hydrolysis of diazonium ion: (*a*) 1·32, (*b*) 2·50, (*c*) 3·75, and (*d*) 7·30 min. after acidification. At 235 mμ absorption reached a maximum

changes which occurred in the spectrum of pyridine-2-diazonium ion were shown to be due to hydrolysis to 2-hydroxypyridine ($\lambda_{max.}$ 297 mμ). This hydrolysis was complete within 1 min. at 20° (see Figure 3). Nevertheless, 2-aminopyridine could be diazotised in 1—4M-sulphuric acid and then coupled with β-naphthol in alkaline solution, as described above, to give a brown-red colour. This was due to a mixture of coloured components. When β-naphthol was replaced by 2-aminopyridine a red colour was slowly formed. In the absence of β-naphthol or 2-aminopyridine only faint colours were observed.

Nitrosation of Secondary N-*Heteroaromatic Amines.*—The α- and γ-nitrosomethylamino-*N*-heteroaromatic bases (Table) were formed by reaction of the corresponding secondary-*N*-heteroaromatic amine in N-hydrochloric acid with aqueous sodium nitrite at 5°.

In dilute acid solutions these nitrosamines hydrolyse readily to the parent secondary amine. Thus, changes in ultraviolet spectra of a solution of 4-nitrosomethylaminopyridine ($\lambda_{max.}$ 290 mμ) in 0·1N-hydrochloric acid indicated

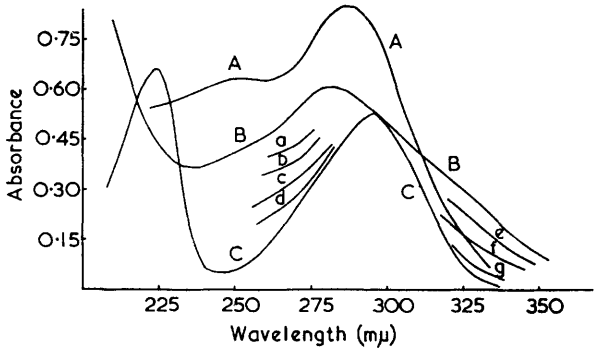


FIGURE 3 Ultraviolet spectra of: (*A*) solution of pyridine-2-diazoate ion in 0·002N-NaOH, (*B*) acidified solution of pyridine-2-diazonium ion (continuous-flow technique), and (*C*) acidified solution after complete decomposition of pyridine-2-diazonium ion to 2-hydroxypyridine. Intermediate steps during hydrolysis: (*a*) 3, (*b*) 5, (*c*) 15, (*d*) 20, (*e*) 5, (*f*) 10, and (*g*) 22 sec. after acidification

that 50% hydrolysis to 4-methylaminopyridine ($\lambda_{max.}$ 273 mμ) took place after *ca.* 9 hr. at 20°. In addition, 2-methylaminopyrimidine was recovered from a solution of 2-nitrosomethylaminopyrimidine in 0·1N-hydrochloric acid left standing for 2 hr.

	Ionisation [a]				Spectroscopy [b]			
	pK_a	Spread (±)	Concn. (10^6M)	A.w.l. [c] (mμ)	λ (mμ)	log ε	Species [d]	pH, H_0, or solvent
2-Nitrosomethylamino-pyridine [e]	0·97	0·04	45·8	275	(231); *243*; 282	(3·34); *3·53*; 4·00	0	Ethanol
					(232); *243*; 280	(3·47); *3·54*; 3·99	0	6·0
					237·5; (263); 309·5	(3·93); (3·29); (3·92)	+	−1·0
4-Nitrosomethylamino-pyridine	4·82	0·02	39·7	305	(233); 258; 272	(3·38); 3·92; 3·95	0	Ethanol
					(232); 272	(3·33); 4·02	0	8·0
					(238); 290	(3·13); 4·17	+	2·0
2-Nitrosomethylamino-pyrimidine [f]	(<1)	—	—	—	(218); *240*; 262	(3·45); *3·86*; 4·00	0	Ethanol
					(217); 261	(3·69); 4·36	0	6·0
					—	—	+	—
4-Nitrosomethylamino-pyrimidine [g]	1·62	0·03	116	315	(223); 243; (260); 276	(3·64); 4·04; (3·70); 380	0	Ethanol
					(228); 276	(3·41); 4·05	0	6·0
					(231); *250*; 291	(3·45); *3·60*; 4·17	+	0·0
9-Nitrosomethylamino-acridine [h]	3·41	0·03	~6·8	260	*218*; 251; *330* + *346* + 361 + *383*	*4·23*; 5·13; *3·53* + *3·85* + 4·36 + *3·65*		Ethanol
					(222); 250; (266)	(~3·99); ~4·90; (~4·09)	0	6·0
					252; 258	~*4·63*; ~4·82	+	1·0

[a] Measured spectrophotometrically (A. Albert and E. P. Serjeant, "Ionisation Constants of Acids and Bases," Methuen, London, 1962) in water at 20°; buffers used had ionic strength 0·01 (except *e*). [b] Inflexions in italics, minima between parentheses, and maxima in normal characters. The figures refer to aqueous buffers. [c] A.w.l., analytical wavelength (mμ). [d] Neutral molecule 0; cation +. [e] Prepared also by Chichibabin *et al.* (ref. 19) in sulphuric acid (20%). [f] pK_a and spectrum of cation could not be determined because of rapid hydrolysis. [e, g] Values (pK_a) by extrapolation; spectra of cations taken 2 min. after mixing of solutions. [h] Prepared in 4M-hydrochloric acid; values of ε in aqueous solutions are approximate because of low solubility.

On the other hand, the alkaline hydrolysis of these *N*-heteroaromatic nitrosamines is much slower. 4-Nitrosomethylaminopyridine ($\lambda_{max.}$ 272 mμ) in 0·1N-sodium hydroxide hydrolysed less than 10% to 4-methylaminopyridine ($\lambda_{max.}$ 254 mμ) in *ca.* 10 hr. at 20°.

[6] D. D. Perrin, "Covalent Hydration II. Quantitative Aspects" in "Advances in Heterocyclic Chemistry," ed. A. R. Katritzky, Academic Press, New York, 1965, vol. 4, p. 53.

[7] Part II, following Paper.

DISCUSSION

The yields of 4,2′-hydroxy-1′-naphthylazopyridine increased with increase in the acidity of the diazotisation medium, presumably because the catalytic effect of this medium is greater (exponential [7]) on the diazotisation than it is on the hydrolysis of the diazonium ion. For example, in 3M-sulphuric acid the yield of the azo-derivative was 56% but in 1M-acid the yield was reduced to 34%.

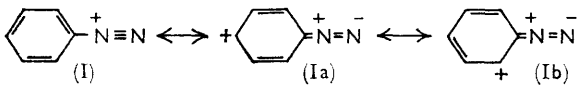
Angyal and Angyal [5] suggested that the diazotisation of the primary *N*-heteroaromatic amines involves the non-protonated species which, because of the deactivation of the amino-group by the ring-nitrogen, reacts only in concentrated acid solution with the strongly electrophilic nitrosonium ion. This interpretation, however, does not explain why diazotisation of some of these amines takes place also in dilute acid solutions, in which the concentration of the nitrosonium ion is small.[8] In fact, kinetic studies of the diazotisation of 4-aminopyridine [7] have shown that the reaction involves the protonated amine and protonated nitrous acid molecules.

Like the aminopyridines, 2- and 4-aminopyrimidine were diazotised in dilute sulphuric acid and with alkaline β-naphthol gave greenish-brown colours.

The present work has shown that although pyridine-2-diazoate ion does not couple with β-naphthol in aqueous strongly alkaline solution [3a] to form 2,2′-hydroxy-1′-naphthylazopyridine, nevertheless it couples when the pH of the solution is reduced to *ca.* 10. This decrease in the rate of coupling with increase in the pH of the medium is also observed with the aromatic diazonium ions.[9a]

The product was a mixture of coloured components and had an ultraviolet spectrum similar to that obtained by direct diazotisation of 2-aminopyridine. These components are presumed to be derived also from 2,2′-hydroxy-1′-naphthylazopyridine, which can be changed into a similar mixture by acid or akaline treatment as evidenced by the change in the ultraviolet spectra.

Only non-protonated *N*-heteroaromatic diazonium ions were considered by Angyal and Angyal [5] who suggested that resonance of the type found in the aromatic series [9b] (see Structures I, Ia, and Ib) does not exist between the *N*-heteroaromatic ring and the diazo-group. The



(I) (Ia) (Ib)

suggested absence of aromatic character from these diazonium ions was considered responsible for their instability, which was compared with that of the aliphatic diazonium ions. These arguments, however, are not justified since the former, but not the latter, can be isolated and even coupled with alkaline β-naphthol.

Because the electronic effect of a ring-nitrogen is similar to that of a nitro-group, the non-protonated pyridinediazonium ion would be expected to hydrolyse by a mechanism similar to that of the *p*-nitrobenzenediazonium ion [10] (S_N1 reaction) and to be relatively stable because the latter hydrolyses 240 times more slowly than the benzenediazonium ion.[10,11] In alkaline solution, where protonation of the ring-nitrogen does not take place, the pyridinediazoate ions are relatively stable.

Hydrolysis of the pyridine-4-diazonium ion appears to involve the protonated species because the rate of the reaction increases with the acidity of the medium. This may be because the protonated ring-nitrogen (whose electron-attracting properties are stronger than those of a nitro-group) enhances a bimolecular reaction with nucleophiles. For example, the nitro-group enhances the bimolecular nucleophilic reactivity of the *p*-nitrobenzenediazonium ion towards bromide ions.[12] Moreover, the observed rate of hydrolysis of pyridine-2-diazonium ion is greater (by a factor of about ten) than that of the 4-isomer, as would be expected in a bimolecular reaction, since the electron attraction of the protonated ring-nitrogen is greater on carbon-2. This behaviour explains also why it was difficult to isolate pyridine-2-diazonium ion during the diazotisation of 2-aminopyridine.

The nitrosation of the secondary *N*-heteroaromatic amines in dilute acid solutions suggests that, under similar conditions, the corresponding primary amines also diazotise, by analogy with the behaviour of primary and secondary aromatic amines.[13] Although the *N*-heteroaromatic secondary nitrosamines are fairly stable in dilute alkaline solutions they are, unlike the secondary aromatic nitrosamines,[13c] completely hydrolysed in very dilute acid solutions. Although the basic strengths (pK_a in the Table) of the *N*-heteroaromatic secondary nitrosamines are much lower than those of the parent amines because of the nitroso-group, protonation of the ring-nitrogen can take place in dilute acid solutions. This leads to hydrolysis, because the amino-nitrogen carrying the nitroso-group acquires a positive charge due to the resonance between structures of the type (II) and (IIa). This resonance is similar to that seen between structures (III) and (IIIa) of the protonated parent amine. 4-Nitrosomethylaminopyridine is presented in the Scheme as a typical example of the group.

On the other hand, in order to hydrolyse the secondary aromatic nitrosamines, strong acid solutions are required for the protonation of the amino-nitrogen which is the

[8] K. Singer and P. A. Vamplew, *J. Chem. Soc.*, 1956, 3971; N. S. Bayliss, R. Dingle, D. W. Watts, and R. J. Wilkie, *Austral. J. Chem.*, 1963, **16**, 933.

[9] Cf. H. Zollinger, "Azo and Diazo Chemistry," Interscience Publishers Ltd., London, 1961, (*a*) pp. 226, 227; (*b*) p. 42.

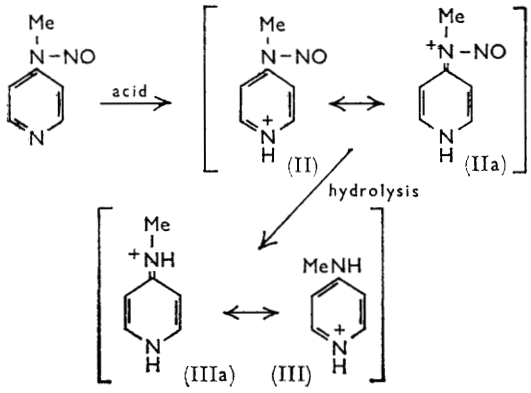
[10] M. L. Crosseley, R. H. Kienle, and C. H. Benbrook, *J. Amer. Chem. Soc.*, 1940, **62**, 1400; E. S. Lewis and E. B. Miller, *ibid.*, 1953, **75**, 429.

[11] A. Waters, *J. Chem. Soc.*, 1942, 266; J. F. Bunnett, *Quart. Rev.*, 1958, **12**, 1.

[12] E. S. Lewis and W. H. Hinds, *J. Amer. Chem. Soc.*, 1952, **74**, 304.

[13] (*a*) E. Kalatzis and J. H. Ridd, *J. Chem. Soc.* (*B*), 1966, 529; (*b*) E. C. R. de Fabrizio, E. Kalatzis, and J. H. Ridd, *ibid.*, p. 533; (*c*) E. Kalatzis, Ph.D. Thesis (London), 1964.

only but very weakly basic centre. Thus *N*-methyl-*N*-nitrosoaniline (pK_a cannot be determined by conventional methods, but the ultraviolet spectrum indicates



Scheme

that it is less than −2·00) hydrolyses rapidly in 4·7M-sulphuric acid but it is quite stable in 2·5M-acid.

EXPERIMENTAL

Microanalyses were by Dr. J. E. Fildes and her staff. 2-Methylamino-[14] and 4-methylaminopyridine,[14] 4-methylaminopyrimidine,[15] 9-methylaminoacridine,[16] 2-methylaminopyrimidine,[17] and *N*-methyl-*N*-nitrosoaniline [18a] were prepared as in the references cited. Spectra were measured on an SP 800 Unicam Recording Spectrophotometer and $\lambda_{max.}$ and extinction values were checked on an Optica CF 4 manual instrument.

4,2′-Hydroxy-1′-naphthylazopyridine.—Sodium nitrite (2 g.; AnalaR) in water (10 ml.) and 4-aminopyridine (Fluka reagent, pract.; 2 g.) in 4M-sulphuric acid (50 ml.) were mixed quickly at 0°. After 50—60 sec. the mixture was poured, with stirring, during 30 sec. into a solution (200 ml.) containing β-naphthol (1·4 g.; AnalaR), sodium hydroxide (17 g.), and borax (5 g.) at 0°. The pH of the final mixture was adjusted to *ca.* 8 and the precipitate (3 g.) filtered off and recrystallised (charcoal) from alcohol (100 ml.) to give *4,2′-hydroxy-1′-naphthylazopyridine* (1·4 g.; 56%), m. p. 191—192° (Found: C, 72·3; H, 4·4; N, 16·9. $C_{15}H_{11}N_3O$ requires C, 72·3; H, 4·45; N, 16·9%).

Pyridine-4-diazonium Ion.—1M-Sodium nitrite (2 ml.) and 5 × 10^{-2} M-4-aminopyridine (4 or 8 ml.) in 6M, 8M, or 10M-perchloric acid (10 or 14 ml.) were mixed at 0°. After 40, 80, 140, and 200 sec., samples (2 ml.) were extracted. Each sample was quenched in an aqueous solution (96 ml.) containing 1N-sodium hydroxide (6, 8, or 10 ml.) and 4% borax (5 ml.) solutions. The quenched solutions (25 ml.) were (*a*) diluted with water (75 ml.) and (*b*) diluted with 0·5M-perchloric acid before examination of the spectra (see Figure 2).

Sodium Pyridine-2-diazoate.—This was prepared in ether by reaction of 2-aminopyridine (Fluka, pract.) with pentyl nitrite (freshly prepared) [18b] in the presence of sodamide as in ref. 3*a*. The precipitated solid was filtered off, washed with ether, and dried under vacuum at 25°. A solution of 36 mg. of this in 1 l. of 0·002N-sodium hydroxide solution (pH 8—9) was used for the examination of the ultraviolet spectrum.

Diazotisation of 2-Aminopyridine.—Sodium nitrite (2 g.) in water (10 ml.) and 2-aminopyridine (2 g.) in 4N-sulphuric acid (40 ml.) were mixed rapidly at 0°. After 10 sec. the mixture was quenched in an aqueous solution (100 ml.) containing sodium hydroxide (6 g.), borax (5 g.), and β-naphthol (1·2 g.). The mixture was extracted with ether and the solid collected was dissolved in alcohol and chromatographed through an alumina (B.D.H.) column. The solid obtained after evaporation of alcohol was extracted with 2N-sulphuric acid (100 ml.), cooled, and the filtrate extracted with ether, after being made alkaline with concentrated ammonia solution. The spectrum of the extract had $\lambda_{max.}$ 412 (infl.), 454 (infl.), 495, 504, and 570 (infl.) mμ in alcohol. The spectrum of the solid collected from the filtration had $\lambda_{max.}$ 495 (infl. at 570) mμ.

2,2′-Hydroxy-1′-naphthylazopyridine.—(*a*) Sodium pyridine-2-diazoate (1·5 g.) was dissolved in aqueous β-naphthol (1·4 g.) and sodium hydroxide (0·5 g.). After adjusting the pH to *ca.* 10, the mixture was left. After 6 days it was extracted with ether and the solid collected was dissolved in alcohol and chromatographed through an alumina (B.D.H.) column. The red alcoholic solution had $\lambda_{max.}$ 404 (infl.), 464, 514 (infl.), and 548 mμ. The alcohol was evaporated and the solid extracted (steam-bath) with 1N-sulphuric acid (50 ml.). The mixture was cooled (after 15 min.) and the filtrate extracted with ether, after being made alkaline (concentrated ammonia). The spectrum of the solid in alcohol showed $\lambda_{max.}$ 514 and 548 mμ. Yields were <5%.

(*b*) 10^{-3}M-2,2′-Hydroxy-1′-naphthylazopyridine ($\lambda_{max.}$ 464 mμ in alcohol), prepared as in ref. 3*a*, was mixed with 2N-sulphuric acid or 2N-sodium hydroxide at 25°. Samples were examined after 1 and 3 days, by neutralising the acid solutions with concentrated ammonia or by acidifying the alkaline solutions and then neutralising with ammonia, and then extracting with ether. The spectra of the alcoholic solutions of the extracts showed additional $\lambda_{max.}$ at 416 (infl.), 482, 514 (infl.), and 548 mμ. The change in acid is faster than in alkaline solution.

2-Nitrosomethylaminopyridine.—Sodium nitrite (4 g.) in water (15 ml.) and 2-methylaminopyridine (1·5 g.) in a solution of concentrated hydrochloric acid (15 ml.) in water (30 ml.) were mixed at 5°. The solution was left for 3 hr. and then treated with solid sodium carbonate until alkaline. It was extracted with ether and the liquid obtained was distilled to give 2-nitrosomethylaminopyridine (1·4 g., 74%), b. p. 53—55°/0·4 mm. (lit.,[19] b. p. 123—124°/30 mm.) (Found: C, 52·5; H, 5·0; N, 30·8. Calc. for $C_6H_7N_3O$: C, 52·5; H, 5·15; N, 30·6%).

4-Nitrosomethylaminopyridine.—Sodium nitrite (1·4 g.) in water (10 ml.) and 4-methylaminopyridine (1 g.) in water (30 ml.) and 5·4N-hydrochloric acid solution (11 ml.) were mixed at 5°. The solution was left for 6 hr. and then treated with solid sodium carbonate until alkaline. It was extracted with ether and the solid obtained after removal

[14] J. B. Wibaut and F. W. Broekman, *Rec. Trav. chim.*, 1961, **80**, 311.
[15] D. J. Brown, *J. Soc. Chem. Ind.*, 1950, **69**, 354; P. B. Russell, G. B. Elion, E. A. Falco, and G. H. Hitchings, *J. Amer. hem. Soc.*, 1949, **71**, 2279.
[16] A. Albert, "The Acridines," Edward Arnold and Co., London, 1966, p. 307.
[17] D. J. Brown, E. Hoerger, and S. F. Mason, *J. Chem. Soc.*, 1955, 4035.
[18] A. I. Vogel, "Practical Organic Chemistry," Longmans, Green and Co., London, 1948, (*a*) p. 547, (*b*) p. 305.
[19] A. E. Chichibabin and I. L. Knunjanz, *Ber.*, 1928, 2216.

of the ether was recrystallised (charcoal) from light petroleum (b. p. 60—80°) to give **4-*nitrosomethylamino-pyridine*** (0·7 g.; 55%), m. p. 84° (Found: C, 52·4; H, 5·1; N, 30·8. $C_6H_7N_3O$ requires C, 52·5; H, 5·15; N, 30·6%).

2-*Nitrosomethylaminopyrimidine*.—Sodium nitrite (1·2 g.) in water (10 ml.) and 2-methylaminopyrimidine (0·9 g.) in a solution of concentrated hyrochloric acid (10 ml.) in water (30 ml.) were mixed at 5°. The solution was treated as in the preceding paragraph to give **2-*nitrosomethyl-aminopyrimidine*** (0·4 g.; 30%), m. p. 82·5° (Found: C, 43·6; H, 4·5; N, 40·6. $C_5H_6N_4O$ requires C, 43·4; H, 4·4; N, 40·6%).

4-*Nitrosomethylaminopyrimidine*.—Sodium nitrite (4 g.) in water (15 ml.) and 4-methylaminopyrimidine (1·5 g.) in a solution of concentrated hydrochloric acid (15 ml.) in water (30 ml.) were mixed at 5°. This was treated as in the preceding paragraph to give **4-*nitrosomethylaminopyrimidine*** (0·6 g.; 32%), m. p. 68° (Found: C, 43·6; H, 4·6; N, 40·3. $C_5H_6N_4O$ requires C, 43·5; H, 4·4; N, 40·6%).

9-*Nitrosomethylaminoacridine*.—Sodium nitrite (0·75 g.) in water (10 ml.) and 9-methylaminoacridine (0·25 g.) in a solution of concentrated hydrochloric acid (60 ml.) in water (90 ml.) were mixed at 25°. The solution was treated as in the preceding paragraph to give **9-*nitrosomethyl-aminoacridine*** (0·11 g.; 32%), m. p. 148—149° (decomp.) (Found: C, 70·85; H, 4·9; N, 17·8. $C_{10}H_{11}N_3O$ requires C, 70·9; H, 4·7; N, 17·7%).

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