

Moetaz I. Attalla, Geoffrey R. Burnett and Lindsay A. Summers\*

Department of Chemistry, The University of Newcastle,  
2308, New South Wales, Australia  
Received June 28, 1984

3-(3'-Pyridinyloxymethyl)pyridine is prepared by reaction of 3-hydroxymethylpyridine with 3-bromopyridine and converted to the 1,1'-dimethyl and 1,1'-diethyl diquaternary salts with alkyl iodides. The salts are reduced polarographically at a potential ( $E_p$ ) of about  $-1.02$  to  $-1.10$  V in the pH range of 5.5-8.5.

*J. Heterocyclic Chem.*, **22**, 319 (1985).

We have recently been interested in the preparation and mass spectra of 3,3'-oxybispyridine (I) [1] and 3,3'-thiobispyridine (II) [2] and the polarographic reduction of their dimethyl diquaternary salts as part of a programme on the synthesis of new heterocyclic systems [3-15]. We now report extension of the study to the preparation and mass spectrum of 3-(3'-pyridinyloxymethyl)pyridine (III) and the polarographic behaviour of its dimethyl and diethyl diquaternary salts.

3-(3'-Pyridinyloxymethyl)pyridine (III) was prepared by reacting 3-hydroxymethylpyridine (IV) [16] as its sodium alkoxide with 3-bromopyridine at  $150^\circ$  in a nitrogen atmosphere. The 3-(3'-pyridinyloxymethyl)pyridine was purified by conversion to the bis(hydroperchlorate) salt (V) from which it was regenerated by basification.

The electron impact mass spectrum of 3-(3'-pyridinyloxymethyl)pyridine (Figure 1) is relatively simple. The peak due to the molecular ion at mass 186 ( $C_{11}H_{10}N_2O$ ) is not the base peak but amounts to 18% of the intensity of

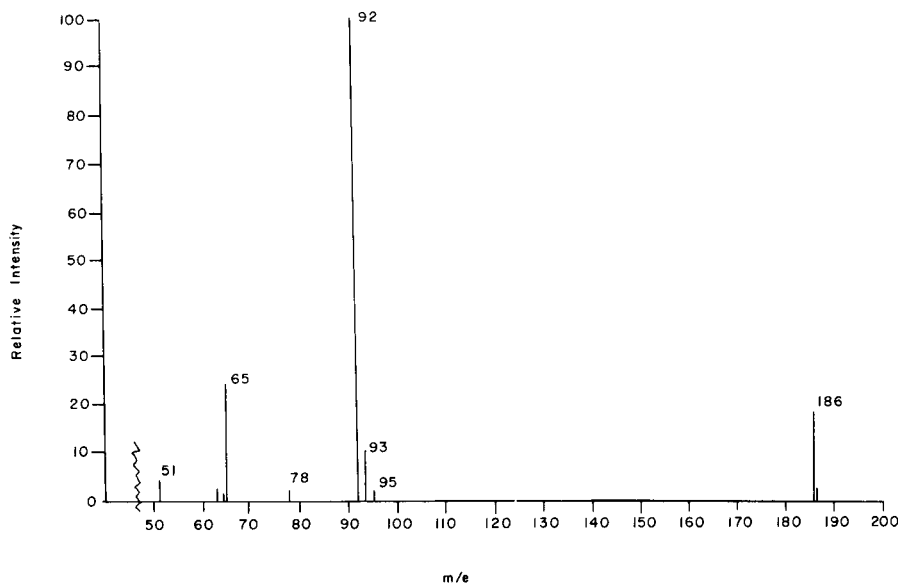
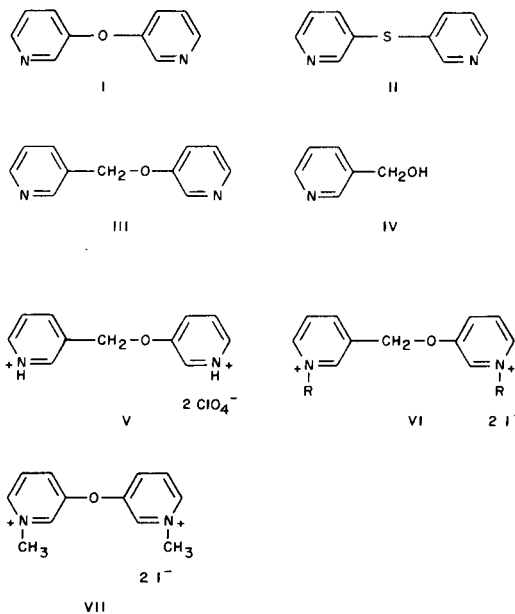


Figure 1. Mass spectrum of 3-(3'-pyridinyloxymethyl)pyridine.

the base peak which is at mass 92 and is due to the  $C_6H_6N^+$  ion formed by rupture of the  $CH_2-O$  bond. It is interesting to recall that the  $C_6H_6N^+$  ion is responsible for a strong peak in the mass spectrum of 3-picoline [17]. In the spectrum of III the  $C_6H_6N^+$  ion at mass 92 loses HCN to afford a peak at mass 65 ( $C_5H_5^+$ ) of 25% of the intensity of the base peak. There are no other peaks in the spectrum of III above mass 50 and of intensity greater than 5% of the base peak apart from the peak at mass 93 (10%) due to the  $C_5C^{13}H_6N^+$  ion. The other fragment from the rupture of the  $CH_2-O$  bond namely the  $C_5H_4NO^+$  ion of mass 94, does not survive to any significant extent.

3-(3'-Pyridinyloxymethyl)pyridine was converted to the 1,1'-dimethyl (VI, R =  $CH_3$ ) and 1,1'-diethyl (VI, R =  $C_2H_5$ ) diquaternary salts by reaction with excess methyl iodide and ethyl iodide respectively. The salts were stable in aqueous solution up to a pH of about 9.0 (uv evidence). They were examined by polarography in the pH range 5.5-8.5. In this pH range the salts (VI, R =  $CH_3$ ) and (VI, R =  $C_2H_5$ ) each gave a reduction wave with a half-wave potential ( $E_0$ ) of about  $-1.02$  to  $-1.10$  V which corresponded approximately to the uptake of two electrons. The wave was pH dependent. In contrast the diquaternary salt (VII) from 3,3'-oxybispyridine is reduced at a potential ( $E_0$ ) of  $-0.81$  V by a one electron reduction independent of pH to a radical cation which is further reduced at  $-0.97$  V [1]. The two diquaternary salts from 3-(3'-pyridinyloxymethyl)pyridine (III) are thus much less easily reduced than the salt from 3,3'-oxybispyridine. This presumably reflects the fact that the methylene group in the bridge of III prevents conjugation between the two pyridine rings.

#### EXPERIMENTAL

Britton and Robinson buffers were used in the polarography experiments which were conducted at  $20^\circ$  with a standard calomel electrode and 0.002 M and 0.003 M solutions. The half-wave potentials are given as  $E_0$  values and were calculated by adding 0.25 V to the  $E_{1/2}$  values. The mass spectrum was determined with an A.E.I. MS-30 spectrometer. The sample was analysed by a direct insertion probe at an ionizing current of 70 eV.

#### 3-(3'-Pyridinyloxymethyl)pyridine (III).

Finely divided sodium (3.4 g) was added to freshly distilled 3-hydroxymethylpyridine (30 g) [16]. The mixture was placed under a nitrogen atmosphere and heated to  $100^\circ$  until all the sodium had reacted. 3-Bromopyridine (14.5 g) was added slowly and the resultant mixture heated at  $150^\circ$  for 48 hours. The dark brown mixture was cooled and extracted three times with benzene (50 ml). The benzene extracts were filtered and the solvent removed. Unreacted 3-bromopyridine and 3-hydroxymethylpyridine were distilled off under reduced pressure leaving a dark brown liquid, which was passed through a chromatographic column packed with potassium carbonate using benzene as eluant. The benzene was removed and the residual liquid distilled three times to afford a product as a pale yellow liquid, bp  $155-160^\circ/0.20$  mm (yield 2.35 g). The liquid was dissolved in ethanol and excess perchloric acid added dropwise. The pale yellow precipitate of 3-(3'-pyridinyloxymethyl)pyridine bis(hydroperchlorate) (V) was collected and recrystallized from aqueous ethanol to afford white needles mp  $222-224^\circ$ . The nmr spectrum (deuterium oxide) consisted of a singlet at  $\delta$  5.60 (2H,  $CH_2$  protons) and a multiplet at 8.0-9.1 ppm (8H, aromatic protons). The uv spectrum (water) showed  $\lambda$  max 193, 262 and 267 nm (log  $\epsilon$  4.52, 3.85 and 3.85).

*Anal.* Calcd. for  $C_{11}H_{12}Cl_2N_2O_2$ : C, 34.1; H, 3.1; N, 7.2. Found: C, 34.25;

H, 2.8; N, 7.4.

3-(3'-Pyridinyloxymethyl)pyridine (III) was regenerated from the bis(hydroperchlorate) (V) using sodium ethoxide in ethanol. It distilled as a pale yellow liquid bp  $155-160^\circ/0.20$  mm. The nmr spectrum (deuteriochloroform) consisted of a singlet at  $\delta$  5.10 (2H,  $CH_2$  protons) and a multiplet at 7.20-8.71 ppm (8H, aromatic protons). The uv spectrum (ethanol) showed  $\lambda$  max 205, 262 and 268 nm (log  $\epsilon$  4.24, 3.77 and 3.77).

*Anal.* Calcd. for  $C_{11}H_{10}N_2O$ : C, 70.9; H, 5.4; N, 15.05. Found: C, 70.6; H, 5.75; N, 14.8.

#### 1,1'-Dimethyl 3-(3'-Pyridiniumoxymethyl)pyridinium Diiodide (VI, R = $CH_3$ ).

A solution of 3-(3'-pyridinyloxymethyl)pyridine (1 g) and methyl iodide (5 g) in ethanol (10 ml) was refluxed for two hours. The yellow solid was recrystallised from aqueous ethanol to give the product, mp  $203-205^\circ$  (yield 1.5 g). The nmr spectrum (deuterium oxide) consisted of a singlet at  $\delta$  4.44 (3H, methyl protons), a singlet at 4.47 (3H, methyl protons), a singlet at 5.70 (2H,  $CH_2$  protons) and a multiplet at 8.10-9.14 ppm (8H, aromatic protons). The uv spectrum (water) showed  $\lambda$  max 226, 270 and 285 nm (log  $\epsilon$  4.50, 3.83 and 3.75).

*Anal.* Calcd. for  $C_{13}H_{16}I_2N_2O$ : C, 33.2; H, 3.4; N, 6.0. Found: C, 33.3; H, 3.5; N, 5.7.

#### 1,1'-Diethyl 3-(3'-Pyridiniumoxymethyl)pyridinium Diiodide (IV, R = $C_2H_5$ ).

A solution of 3-(3'-pyridinyloxymethyl)pyridine (0.5 g) and ethyl iodide (5 g) in ethanol (10 ml) was refluxed for two hours. The yellow solid was recrystallised from ethanol to give the product, mp  $189-191^\circ$  (yield 1.05 g). The nmr spectrum consisted of a triplet at  $\delta$  1.60-1.85 (6H, methyl protons), a multiplet at  $\sim$  4.50-4.90 (4H, ethyl  $CH_2$  protons), a singlet at 5.70 (2H, O- $CH_2$  protons) and a multiplet at 8.10-9.24 ppm (8H, aromatic protons). The uv spectrum (water) showed  $\lambda$  max 226, 270 and 285 nm (log  $\epsilon$  4.50, 3.80 and 3.75).

*Anal.* Calcd. for  $C_{15}H_{20}I_2N_2O$ : C, 36.1; H, 4.0; N, 5.6. Found: C, 36.3; H, 4.2; N, 5.3.

#### Acknowledgements.

A grant from the Australian Research Grants Scheme is gratefully acknowledged.

#### REFERENCES AND NOTES

- [1] D. J. Barker and L. A. Summers, *J. Heterocyclic Chem.*, **20**, 1411 (1983).
- [2] L. A. Summers and S. Trotman, *J. Heterocyclic Chem.*, **21**, 917 (1984).
- [3] J. E. Rockley and L. A. Summers, *Chem. Ind. (London)*, 666 (1979).
- [4] H. G. Grant and L. A. Summers, *Z. Naturforsch.*, **33B**, 118 (1978).
- [5] I. F. Eckhard, N. G. Keats and L. A. Summers, *Z. Naturforsch.*, **33B**, 80 (1978).
- [6] I. F. Eckhard, R. Fielden and L. A. Summers, *Chem. Ind. (London)*, 275 (1973).
- [7] A. L. Black and L. A. Summers, *J. Chem. Soc. (C)*, 2394 (1970).
- [8] J. E. Dickeson and L. A. Summers, *Aust. J. Chem.*, **23**, 1023 (1970).
- [9] A. L. Black and L. A. Summers, *Tetrahedron*, **24**, 6453 (1968).
- [10] L. A. Summers, *Tetrahedron*, **24**, 5433 (1968).
- [11] L. A. Summers, *Tetrahedron*, **24**, 2697 (1968).
- [12] A. L. Black, L. A. Summers, and V. A. Pickles, *Chem. Ind. (London)*, 1836 (1967).
- [13] L. A. Summers, and V. A. Pickles, *Chem. Ind. (London)*, 619 (1967).
- [14] L. A. Summers, *Chem. Commun.*, 546 (1966).
- [15] L. A. Summers, *Angew. Chem., Int. Ed. Engl.*, **5**, 605 (1966).
- [16] R. G. Jones and E. C. Kornfeld, *J. Am. Chem. Soc.*, **73**, 107 (1951).
- [17] Q. N. Porter and J. Baldas, "Mass Spectrometry of Heterocyclic Compounds", Wiley-Interscience, New York, NY, 1971.