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1-METHYL-1*H*-1-PYRINDINE

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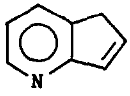
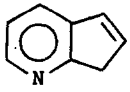
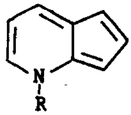
Coincident with the synthesis of the first simple pi-excessive (1) heteroanalogs of azulene, cyclopenta[c]thiapyran and 2-phenyl-2-pyrindine (2) it was postulated that the orange color of pure 1-pyrindine (I) which had been observed by Robison (4) was caused by the presence of some of the 1H-tautomer (IIa). The preparation and characterization of 1-methyl-1*H*-1-pyrindine (IIb), the first compound having this structure, now provides the first direct evidence in support of this supposition (3). Data in agreement with the previous assumption (4) that 1-pyrindine consists predominantly of a mixture of the 5*H* (Ia) and 7*H* (Ib) tautomers is also reported herein.



Ia



Ib



IIa, R=H
IIb, R=CH_3

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The n.m.r. spectrum (carbon tetrachloride) of 1-pyrindine displayed a triplet of unit area centered at 8.33 p.p.m. (chemical shift relative to tetramethylsilane as internal standard) which was further split into doublets. In that a resonance structure having a positive charge at the 6-position (but not at positions 5 or 7) can be written, this signal was assigned to the 6-hydrogen. Each peak of a doublet of unit area assigned to the 7-(5-) vinylic hydrogen and centered at 7.51 p.p.m. was weakly split into a triplet, doublet, and singlet. A complex region at 6.46-7.11 p.p.m. which could be attributed to the pyridine ABX system of the 2-, 3-, and 4-hydrogens had an area for three hydrogens. Each of two peaks (3.22 p.p.m. and 3.36 p.p.m.) with a combined intensity of two was split differently. The dissimilar splitting of these peaks, which were attributed to the 5-(7-) methylene hydrogens, and the complexity of the vinylic hydrogen absorptions constitute evidence for the existence of 1-pyrindine in solution as a mixture of Ia and Ib.

The infrared spectrum of a neat sample of 1-pyrindine showed a small, somewhat broad band at 2.93 μ (3408 cm^{-1}) which could be considered as indicative of the presence of a small amount of the 1H-tautomer. This peak was decreased appreciably in the spectrum of a carbon tetrachloride solution.

Treatment of 1-pyrindine with methyl iodide afforded a tan solid, m.p. 240-241.5° (dec.) (3) which had the elemental composition calculated for 1-methylpyrindinium iodide. This methiodide was difficult to purify and reacted slowly with even weakly basic solvents such as methanol (5). This difficulty, the strong absorption by the iodide ion in the ultraviolet, and the unexpected isolation of a dimeric monoiodide product (78%) (6) following an extractive basification procedure on an aqueous solution of the methiodide led to the conversion of the latter by ion exchange to the corresponding methochloride. The ultraviolet and visible absorption spectra of aqueous solutions of the methiodide (maxima at 223 (4.55) (7), 275 (4.01) and 302 (3.75)) and of the methochloride (maxima at 233 (4.07) (8), 275 (4.10) and 302 (3.79)) were quite similar. On treatment with dilute (0.01-0.1N) sodium hydroxide at spectral concentrations, each was appreciably altered in the same manner and the absorption in the visible reported by Reese (3) was observed (9). The spectral changes caused by the basification were rapidly reversed on acidification. An unanticipated finding was that the spectra of the methiodide, methochloride and the above mentioned dimeric product were very similar in both dilute basic and acidic solutions: e.g. for 0.01N sodium hydroxide solutions maxima were observed for the methiodide at 257 (4.39), 321 (3.90) and 455 (3.13, broad peak), and for the dimeric product at 257 (4.39), 321 (3.90) and 455 (3.22, broad peak); in 0.018N hydroiodic acid for the methiodide at 276 (4.01) and 301 (3.77), and for the dimeric product at 275 (4.01) and 302 (3.74) (10).

Basification of an aqueous solution of the methochloride with sodium carbonate at 0° under an inert atmosphere and with simultaneous extraction with dichloromethane, however, afforded 1-methyl-1H-1-pyrindine (IIb), isolated from the organic phase as a deep red oil (40%) (11), which was stable at -70° under nitrogen but somewhat unstable at higher temperatures and quite unstable in the presence of oxygen. The ultraviolet (Fig. 1) and visible (Fig. 2) spectra of IIb were strikingly like those of the analogous cyclopenta[c]thiapyran (1) and 1-methyl-7-aza-1H-pyrindine (12). The visible spectrum of IIb thus supports the earlier postulate that the presence (ca. 0.1%) of the 1H-tautomer is responsible for the color of pure 1-pyrindine. The infrared spectrum showed no absorption for N-H. The n.m.r. spectrum (carbon tetrachloride solution with tetramethylsilane as internal standard) was complex with area ratios corresponding to six hydrogens in addition to the methyl group. Low yields of IIb were also obtained by the treatment of 1-pyrindine with sodium amide and then methyl iodide, from the basification of the methiodide, and from the reaction of 1-pyrindine with methyl tosylate followed by treatment with base.

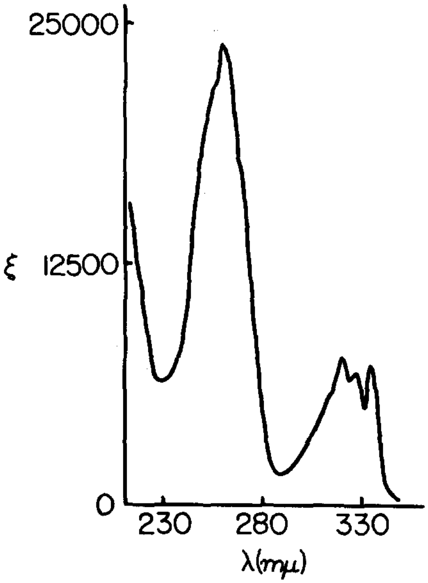


FIG. 1
Ultraviolet spectrum of 1-methyl-1H-1-pyrindine in cyclohexane

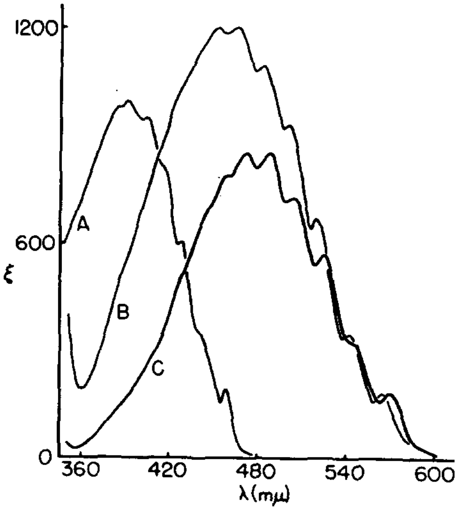
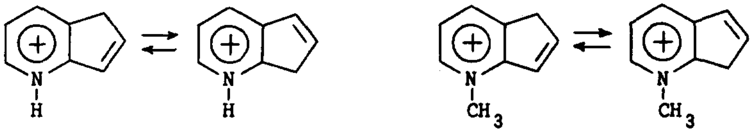


FIG. 2
Visible spectra of 1-methyl-7-aza-1H-1-pyrindine (A), cyclopenta[c]-thiapyran (B) and 1-methyl-1H-1-pyrindine (C) in cyclohexane.

The spectrum of an acidic (0.018N hydroiodic acid) methanol solution of IIb exhibited maxima at 249 (3.50, shoulder) and 297 (4.02) and thus, as expected, closely resembled the absorption at 247 (3.53, shoulder) and 295 (4.08) of an acidic (0.005N hydroiodic acid) methanol solution of 1-pyrindine, and these spectra thus most probably represent the conjugate acids III and IV, respectively (13). Structure IV also represents



III

IV

the cation one would expect to obtain from the reaction of 1-pyrindine with methyl iodide to form the methiodide. The spectrum of an acidic (0.005N hydroiodic acid) methanol solution of the methiodide, however, displayed maxima at 277 and 303 mμ (with relative intensities of *ca.* 2:1) and thus was distinctly different from those of III and IV but, again, was remarkably similar to that of the dimeric product: 275 (4.05) and 303 (3.75) in the same medium.

These results are not compatible with the representation of the organic ion of the methohalides as IV. They indicate the methohalide and dimeric monohalide species to be closely related in structure and that the principal substance observed spectrally as a result of the reversible basification of the methochloride in water is the dimeric monochloride rather than IIb as had previously been assumed (3).

Further results and considerations with regard to these compounds will be reported elsewhere.

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2. A. G. Anderson, Jr., W. F. Harrison, R. G. Anderson and A. G. Osborn, J. Am. Chem. Soc., 81, 1255 (1959).
3. While the present studies were in progress, C. B. Reese, J. Am. Chem. Soc., 84, 3979 (1962) reported the ultraviolet and visible spectra of a basic, aqueous solution presumed to contain IIb. The present results do not support this assumption.
4. M. M. Robison, J. Am. Chem. Soc., 80, 6254 (1958).
5. In contrast to this result, purification by recrystallization from methanol has been reported (3).
6. The structure of this compound has recently been determined by X-ray diffraction analysis: H. L. Ammon and L. H. Jensen, J. Am. Chem. Soc., 88, 681 (1966).
7. Absorption maxima in the ultraviolet and visible regions are given in mμ (log ε).
8. The peaks with maxima at 223 mμ for the methiodide and at 232 mμ for the methochloride are not comparable as the former contains the strong absorption of iodide ion.
9. The maxima at 220 mμ which had been reported (3) was not detected. The intensity of the broad peak with a maximum at ca. 455 mμ was found to be log ε 3.1-3.2 in the present study, rather than 2.8 (3).
10. The absorption by iodide ion is omitted for both compounds. For the purpose of comparison, all extinction coefficients for the methiodide (and also the methochloride) are based on a dimeric structure.
11. A picrate melted at 151-154.5° (dec.), gave satisfactory elemental analyses, and afforded a molecular weight (spectroscopic) value of 363 (calcd. 360). Potentiometric titration of IIb gave a neutralization equivalent of 131.8 (calcd. 131.2).
12. A. G. Anderson, Jr. and H. L. Ammon, unpublished results.
13. The reactions with acid were reversible.