A mixture melting point with an authentic sample[6] of the diacetate was not depressed.

The solvent was removed from the filtrate and the resulting oil was dissolved in water and extracted with ether. The combined extracts were concentrated and gave 0.12 g. (4.7%) of V, m.p. 144–146°. A mixture melting point with an authentic sample was not depressed.

Reaction of 2-Mercaptoacetophenone (VI) with Potassium Ethoxide in the Presence of Sulfur.—To a suspension of 0.9 g. (0.03 g.-atom) of sulfur in 20 ml. of ethanol containing 1.08 g. (0.028 g.-atom) of potassium, was added 0.5 g. (0.0229 mole) of VI. On addition of the mercaptan, the solution turned red and the suspended sulfur dissolved. After 2 hr. a solid began to precipitate from the reaction mixture. The suspension was allowed to stand at room temperature for 72 hr. Analysis of a 1-ml. aliquot in the vapor fractometer indicated the presence of 30.2% acetophenone in the reaction mixture.

Filtration of the suspension gave 1.46 g. (40.6%) of V, m.p. 144–146°, m.m.p. 145–146°. The filtrate, worked up in the usual manner,[6] provided 0.3 g. (15.6%) of hydrogen sulfide (as lead sulfide) and 1.02 g. of a salt which was not identical with XXVIII and not further characterized.

Notes

The Formation of N-(β-Anilinoethyl)-2-pyridone from the Action of N-Phenylethanolamine on 2-Bromopyridine

RICHARD G. HISKEY AND JEROME HOLLANDER[1]

Venable Chemical Laboratory,
The University of North Carolina, Chapel Hill, North Carolina

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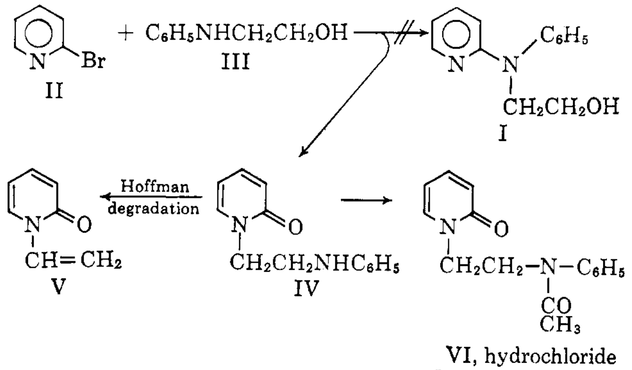
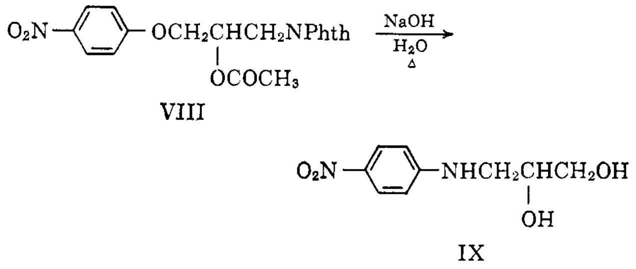
As part of another program a sample of 2-(N-β-hydroxyethylanilino)pyridine (I) was desired for investigation. A well-known route to compounds of this type[2a-c] involves displacement of a halogen by the appropriate amine. When 2-bromopyridine (II) was heated at 200–250° with 2 equiv. of N-phenylethanolamine (III), a crystalline solid (analysis showed $C_{13}H_{14}N_2O$) was obtained in 41.5% yield. The structure of this product was assigned as N-(β-anilinoethyl)-2-pyridone (IV) on the basis of the following transformations. The alkylation product, IV, reacted smoothly with dry hydrogen chloride and phenyl isothiocyanate to provide the corresponding amine derivatives. A Hofmann degradation converted IV to N-vinyl-2-pyridone (V) and N,N-dimethylaniline.



VI, hydrochloride
VII, free base

Acylation of IV with acetyl chloride in benzene provided the hydrochloride of N-(β-acetanilinoethyl)-2-pyridone (VI) which could be converted to N-(β-acetanilinoethyl)-2-pyridone (VII) with either silver oxide or triethylamine. The amide VII could also be prepared directly from IV by acylation with acetic anhydride in the presence of base. Hydrolysis of VII with either acid or base provided IV.

Several mechanistic possibilities can be proposed to explain the rather unusual course of the alkylation reaction. The 2-alkoxypyridines are known[3] to rearrange to N-alkyl-2-pyridones when heated. Caldwell and Schweiber[4] have reported that a similar rearrangement of VIII afforded IX and suggested that the transformation



was analogous to the Smiles rearrangement.[5,6] Thus O-alkylation of III followed by rearrangement may have occurred. However, the initial formation of a O-alkylation product is considered unlikely since N-phenylethanolamine normally provides N-alkyl derivatives. Alternatively I may have been produced and rearranged to IV *via* either intermediate X or XI. Compounds similar to X have previously been reported[2] in reactions of this type while decomposition of XI would provide the 2-alkoxypyridine. No decision between these possible pathways can be reached from the present data.

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(1) Abstracted in part from a dissertation by J. Hollander submitted in partial fulfillment of the requirements for the Ph.D. degree to the University of North Carolina, June, 1959.

(2) (a) H. S. Mosher "Heterocyclic Compounds," Vol. I., R. C. Elderfield, Ed., John Wiley and Sons, Inc., New York, N. Y., 1950, p. 397; (b) N. Weiner and I. A. Kaye, *J. Org. Chem.*, **14**, 868 (1949); (c) A. P. Gray, D. E. Heitmeier, and E. E. Spinner, *J. Am. Chem. Soc.*, **81**, 4351 (1959).

(3) K. B. Wiberg, T. M. Shryne, and R. R. Kintner [*ibid.*, **79**, 3160 (1957)] have shown that the reaction is probably intermolecular and may involve a radical chain mechanism.

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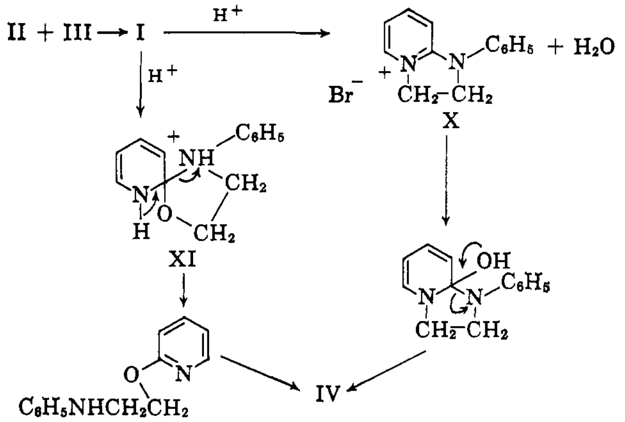

Experimental[7]

Preparation of N-(β-Anilinoethyl)-2-pyridone (IV).—A mixture of 47.4 g. (0.3 mole) of 2-bromopyridine and 82.2 g. (0.6 mole) of N-phenylethanolamine were heated at reflux for 6 hr. The solution was diluted with water and extracted with chloroform; the aqueous layer (pH 6) was made alkaline with 50% sodium hydroxide solution. The brown oil which separated solidified on standing. Two recrystallizations from carbon tetrachloride provided 26.8 g. (41.5%) of IV as the one-half hydrate, m.p. 109.5–110°.

Anal. Calcd. for $C_{13}H_{14}N_2O\cdot 0.5H_2O$: C, 69.92; H, 6.77; N, 12.55. Found: C, 69.97; H, 6.49; N, 12.55.

A 2.0-g. sample of IV was refluxed for 39 hr. in benzene under a Dean–Stark trap. Anhydrous IV was obtained as white needles, m.p. 108–109°.

Anal. Calcd. for $C_{13}H_{14}N_2O$: C, 72.87; H, 6.58; N, 13.08. Found: C, 72.82; H, 6.58; N, 13.13.

The infrared spectrum of anhydrous IV exhibited peaks at 1653, 3340, 1513, and 1256 cm.$^{-1}$. The ultraviolet spectrum in ethanol exhibited absorption maxima at 298 mμ (ε 2375), 247 (4575), and 237 (4280). Similar spectra have been observed for other 2-pyridones.[8]

Treatment of IV with phenyl isothiocyanate and recrystallization of the resulting solid from carbon tetrachloride provided the phenylthiourea derivative of IV, m.p. 144–146°.

Anal. Calcd. for $C_{20}H_{19}N_3OS$: C, 68.74; H, 5.48; N, 12.03. Found: C, 68.61; H, 5.37; N, 12.10.

Hofmann Degradation of IV.—To 1.30 g. (0.006 mole) of IV in 25 ml. of ethanol was added 1.7 g. (0.012 mole) of potassium carbonate and 2.56 g. (0.018 mole) of methyl iodide. The mixture was refluxed for 31 hr. and additional potassium carbonate and methyl iodide were occasionally added. The reaction mixture was filtered and evaporated to provide the yellow quaternary salt.

The salt was dissolved in water and treated with 5.0 g. of silver oxide. The solution was stirred for 1 hr., filtered, and slowly distilled. The distillate was extracted with ether to provide 0.6 g. of N,N-dimethylaniline: b.p. 193.9°, n^{20}_{D} 1.5583; lit.[9] b.p. 192.5–193.5, n^{20}_{D} 1.5582. The infrared spectrum of the compound was identical with that of authentic N,N-dimethylaniline.

The distillation residue was extracted with ether. Removal of the solvent provided an oil which crystallized to yield 0.9 g. of V, m.p. 118–121°. Sublimation raised the melting point to 121–123°, lit.[10] m.p. 119–122°. The mercury(II) chloride salt melted at 193–195°, lit.[10] m.p. 193°.

Preparation of N-(β-Acetanilinoethyl)-2-pyridone Hydrochloride (VI).—To 7.7 g. (0.036 mole) of IV in 600 ml. of benzene was added 3.14 g. (0.04 mole) of acetyl chloride. The addition was carried out at 5°. Crystallization of the precipitate from ethanol–ether provided 8.5 g. (80.6%) of VI, m.p. 118–124°.

Anal. Calcd. for $C_{15}H_{17}ClN_2O_2$: C, 61.53; H, 5.85; N, 9.57. Found: C, 61.46; H, 5.95; N, 9.66.

Titration of VI with standard potassium hydroxide gave a neutralization equivalent of 245 (calcd. for $C_{15}H_{17}ClN_2O_2$, 292.8). The pK_a value of the hydrochloride salt VI was determined as 2.65. Titration of VI with standard silver nitrate solution, using a potassium chromate indicator, provided a molecular weight of 267.

Preparation of N-(β-Acetanilinoethyl)-2-pyridone (VII).—A solution of 1.0 g. (0.0034 mole) of VI in 30 ml. of a 10:1 ether–alcohol mixture was treated with 0.34 g. (0.0034 mole) of triethylamine. Filtration of triethylamine hydrochloride followed by evaporation of the solution provided an oil which crystallized. Recrystallization from carbon tetrachloride provided 0.83 g. (95.4%) of VII, m.p. 100–104°.

When IV was allowed to react with 25 ml. of acetic anhydride followed by treatment with dilute sodium hydroxide, a brown oil was obtained. The oil was extracted with ether, the extract was evaporated, and the oil was allowed to crystallize. Recrystallization of the yellow solid from carbon tetrachloride provided VII, m.p. 104–105°, identical in all respects with the sample obtained from VI.

Hydrolysis of N-(β-Acetanilinoethyl)-2-pyridone (VII).—A 2.0-g. (0.007-mole) sample of VII was refluxed with 50 ml. of 25% sodium hydroxide solution for 26 hr. The brown oil was extracted with chloroform and the extracts were evaporated to provide 1.40 g. (93.3%) of IV as yellow needles, m.p. 109–111°. A mixture melting with a sample of IV prepared from II and III was not depressed. Acid hydrolysis of VI followed by neutralization provided a 73.3% yield of IV, m.p. 108–110°.

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[7] Melting points and boiling points are uncorrected. Elemental analyses were by Micro-Tech Laboratories, Skokie, Ill.

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Exchange of Magnesium between the Ethyl Grignard Reagent and Magnesium Bromide[1a]

DWAINE O. COWAN, JOHN HSU,[1b] AND JOHN D. ROBERTS[1c]

Contribution No. 3148 from Gates and Crellin Laboratories of Chemistry, California Institute of Technology, Pasadena, California

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Much has been said but little settled about the precise nature of the Grignard reagent. The X-ray structure studies of Stucky and Rundle,[2] the vapor pressure studies of Vreugdenhil and Blomberg,[3] the work of Ashby and Becker,[4] and the far-infrared experiments of Salinger and Mosher[5] all indicate that the Grignard reagent can exist, at least in part, as a monomer (RMg-X) under a variety of experimental conditions. However, the nuclear magnetic resonance studies of Roos and Zeil,[6] the association studies of Slough and Ubbelohde[7] (concentrated solutions), plus the Grignard reaction studies of several groups (Bikales and Becker,[8] Mosher and co-workers,[9] House and Traficante,[10] Anteunis and D'Hollander,[11] Hamelin,[12] and Dessy and

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[1] (a) Supported by the National Science Foundation; (b) National Science Foundation Undergraduate Fellow, summer, 1963; (c) to whom correspondence should be addressed at the Department of Chemistry, The Johns Hopkins University, Baltimore, Md. 21218.

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