

AN ABSTRACT OF THE THESIS OF

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Date thesis is presented _____

Title REACTIONS OF 1-PHENYL-4-(2-PYRIDYL)-1-BUTENE-
-3-OL. *July 5, 1966*

Abstract approved Redacted for Privacy
(Major professor)

2-Picolylolithium reacted with cinnamaldehyde to form 1-phenyl-4-(2-pyridyl)-1-butene-3-ol, Compound I. The melting point was 74°C. Compound I formed phenyl urethane which melted at 121°C.

Compound I reacted with hydrogen bromide in benzene to form 1-phenyl-4-(2-pyridylhydrobromide)-1-butene-3-ol, Compound II, which melted at 133° - 134°C. Compound II was brominated to form 1-phenyl-4-(2-pyridylhydrobromide)-1, 2 dibromobutanol, Compound III, which melted at 144° C.

Compound III reacted with a saturated solution of sodium carbonate to form the base 1-phenyl-4-(2-pyridyl)-1, 2 dibromobutanol. The analysis showed it was not pure.

Compound I reacted with 48% hydrobromic acid in ether to form 1-phenyl-4-(2-pyridylhydrobromide)-3-bromo-1-butene. It was brominated to form 1-phenyl-4-(2-pyridylhydrobromide)-1, 2, 3 tribromobutane, Compound IV, which melted at 170°C.

Compound I was brominated to obtain Compound V, 2-hydroxy-3-bromo-4-phenyl-1, 2, 3, 4 tetrahydro quinolizinium bromide, which melted at 195^oC (decomposed).

Compound I was esterified with benzoyl chloride in dry ether to form 1-phenyl-4-(2-pyridylhydrochloride)-1-butene-3-benzoate. It reacted with sodium carbonate solution to form the free base, 1-phenyl-4-(2-pyridyl)-1-butene-3-benzoate, Compound VII.

Compound I was dehydrated easily at room temperature with concentrated hydrobromic, hydriodic acid or phosphorus pentachloride to form 1-phenyl-4-(2-pyridylhydrohalide)-1, 3 butadiene, Compound VIII.

Compound VIII reacted with saturated sodium carbonate or saturated alcoholic sodium carbonate to form Compound IX, 1-phenyl-4-(2-pyridyl)-1, 3 butadiene, which melted at 122^oC.

REACTIONS OF 1-PHENYL-4-(2-PYRIDYL)-1-BUTENE-3-OL.

by

PAIROJE POJANAGARON

A THESIS

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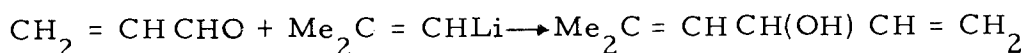
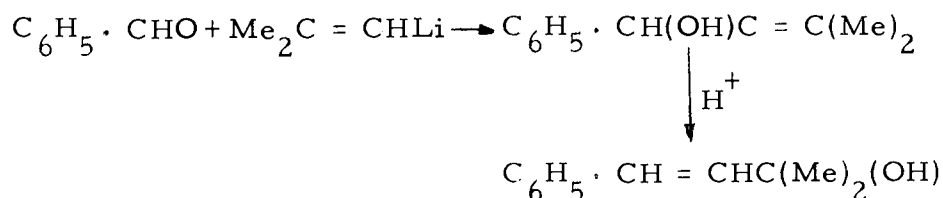
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REACTIONS OF 1-PHENYL-4-(2-PYRIDYL)-1-BUTENE-3-OL.

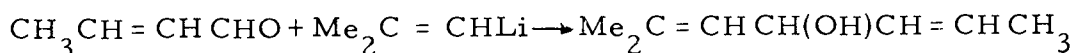
INTRODUCTION

The purpose of this investigation was to study the addition, substitution, esterification and dehydration of the condensate of 2-picolyllithium and cinnamaldehyde. Some derivatives might have structural similarities with natural occurring alkaloids. They might be of some pharmacological interest, especially their water soluble salts.

The use of 2-picolyllithium in condensation reactions with certain unsaturated aldehydes is related to a number of similar reactions in the literature. Braude and co-workers (3, 4, 5, 6, 7) condensed isobutenyllithium with benzaldehyde, acrolein and crotonaldehyde in dry ether:



and



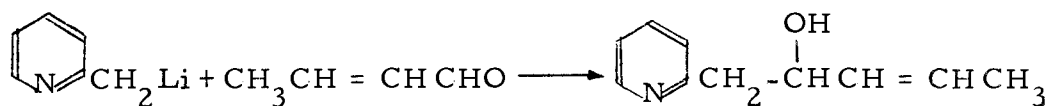
They also condensed isobutenyllithium with excess solid carbon dioxide in dry ether and formed the lithium salt of the unsaturated

acid:

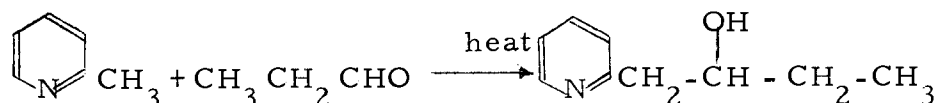


Braude and co-workers also investigated the condensation of cyclopentenyllithium and cis-propenyllithium with benzaldehyde, acrolein and crotonaldehyde in dry ether.

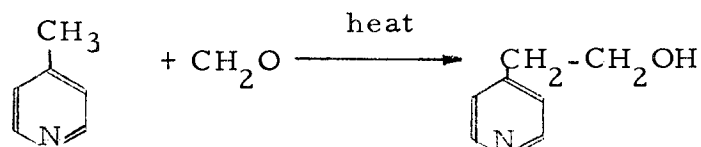
Arens, Dorp and Dijk (1) condensed β -ionone with 2, 4 dimethyl pyridine, and also condensed 2-picolyllithium with crotonaldehyde.



Matzdorf (15) heated 2-picoline with propionaldehyde, obtaining a condensation product:

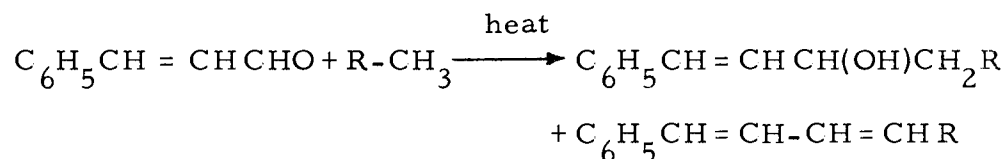


Karl Loeffler and Fritz Stietzel (14) condensed γ -picoline with formaldehyde by heating at $125-6^\circ\text{C}$:



Spath and co-workers (18) heated equimolar cinnamaldehyde with 2-methyl, 4-methyl and 2, 5 dimethyl pyridene using ZnCl_2 as a condensing agent, obtaining some butadienes. They also heated equivalent moles of aldehydes with bases at $150-160^\circ\text{C}$,

obtaining a small yield of condensation products, alcohols mixed with butadienes:

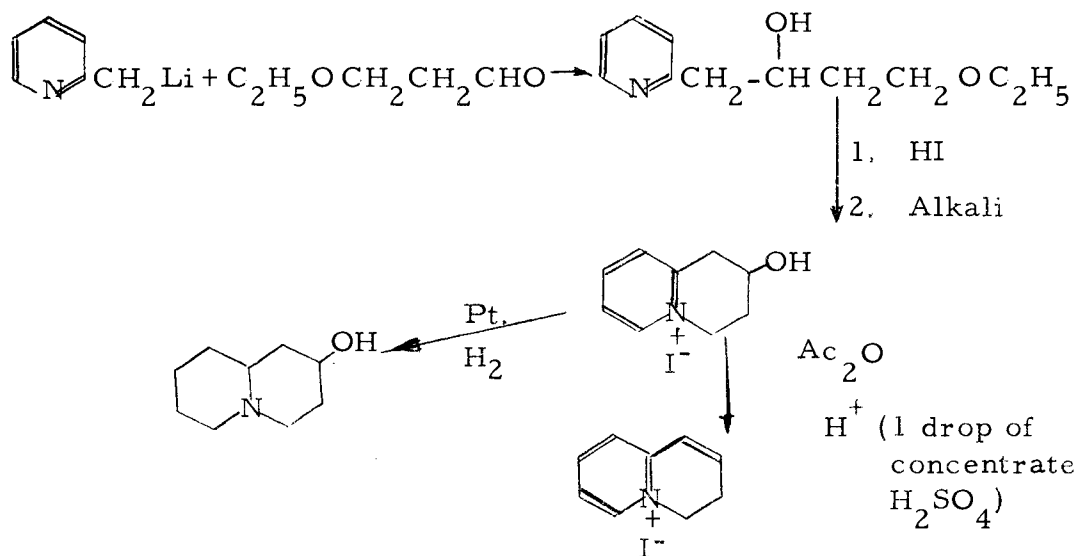


R = 2-pyridyl

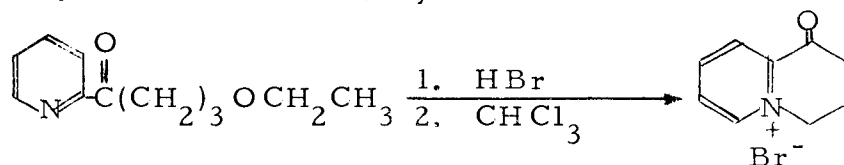
4-pyridyl

5-methyl-2 pyridyl

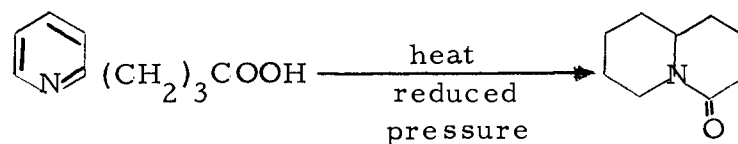
Boeckelheide and Gall (2) worked with quinolizinium salts. They condensed picolylithium with β -ethoxypropionaldehyde and cyclized by treating with hydriodic acid. The resultant quinolizinium iodide salt was dehydrated and hydrogenated:



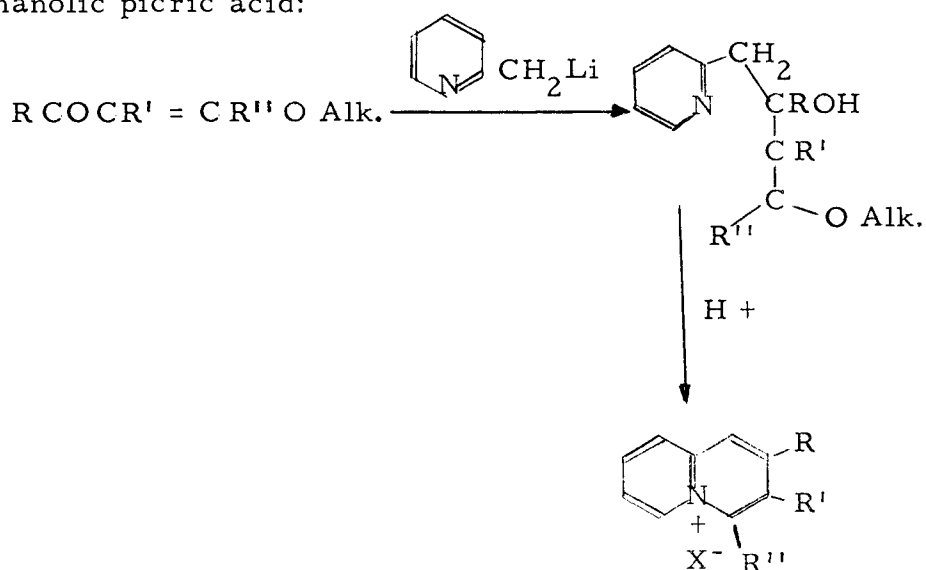
Glover and Jones (11, 12, 13) cyclized 1-(α -pyridyl)-4-ethoxybutanone with 35% hydrobromic acid and chloroform:



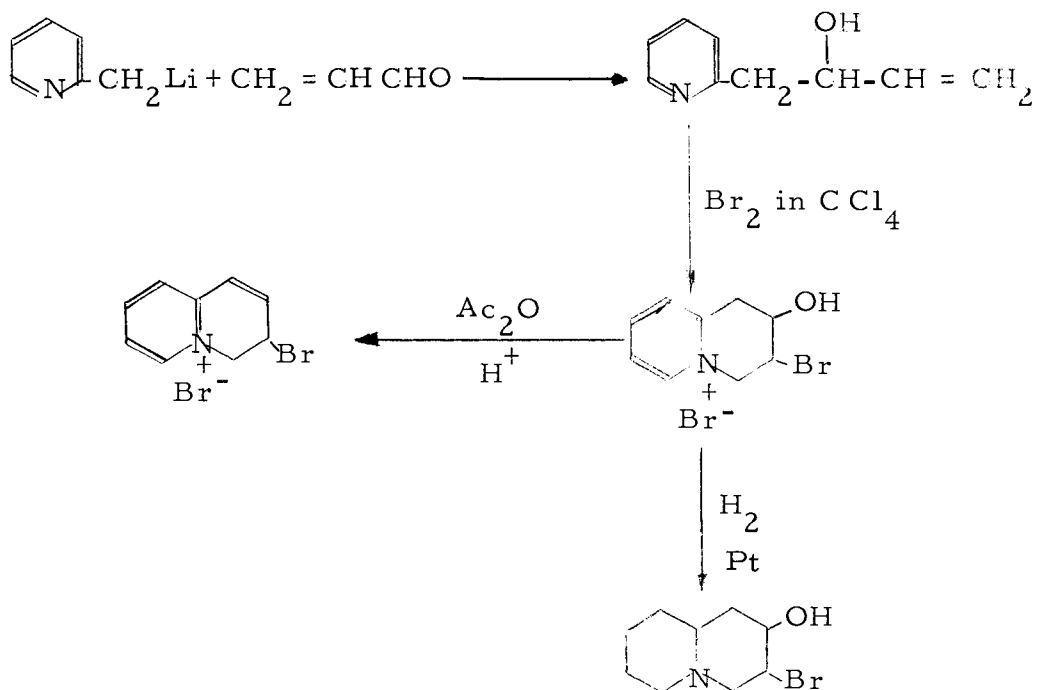
Doering and Weil (10) cyclized γ -(2-pyridyl) butyric acid in a molecular still under reduced pressure:



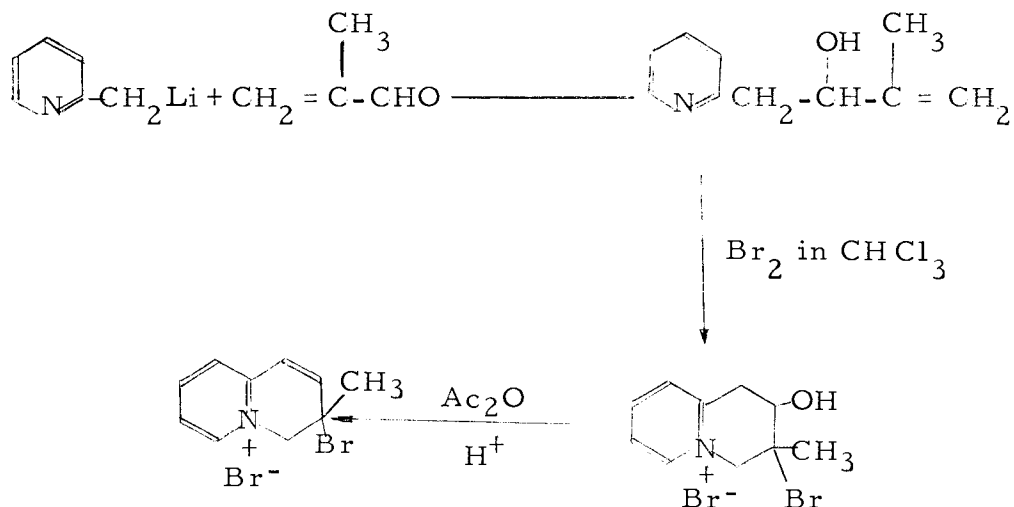
Richards and Stevens (17) prepared several quinolizinium salts. They condensed the enol ether or the monoacetal of a β -diketone with 2-picolylithium and cyclized the product with ethanolic picric acid:



Wischman (19) prepared 1(2-pyridyl)-3-butene-2-ol by condensing 2-picolylithium with acrolein. The resultant alcohol brominated in carbon tetrachloride obtaining quinolizinium salt and the product was dehydrated by refluxing with acetic anhydride and a drop of concentrated sulfuric acid:

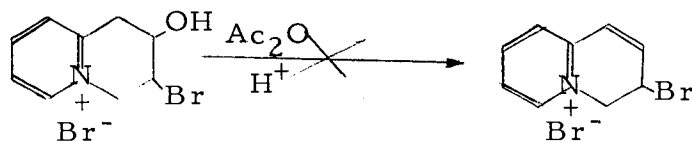


Nash (16) similarly condensed 2-picolyl lithium with methacrolein and cyclized the product with bromine in chloroform, obtaining a quinolizinium salt:



Davis (9) did not agree with Wischman. He reported that 2-hydroxy-3-bromo-1, 2, 3, 4 tetrahydroquinolizinium bromide

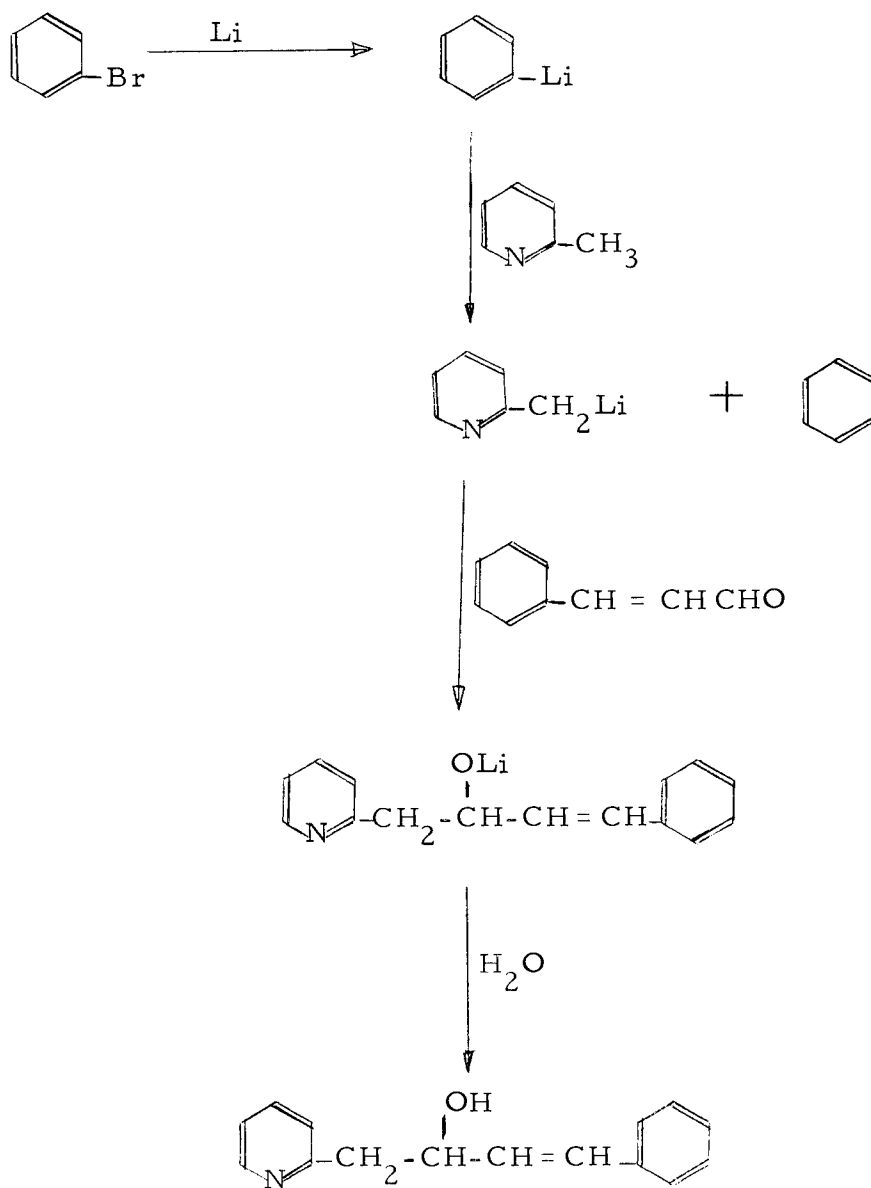
refluxed with acetic anhydride and a drop of concentrated sulfuric acid did not form a dehydrated compound:



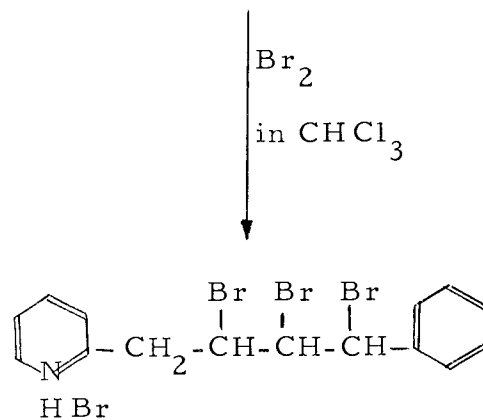
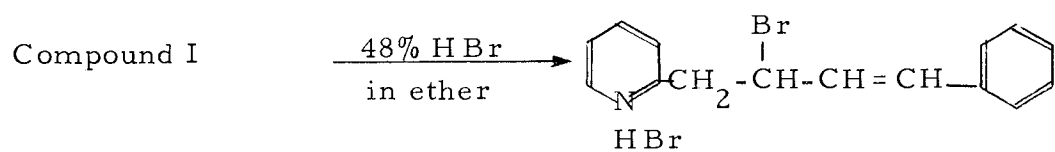
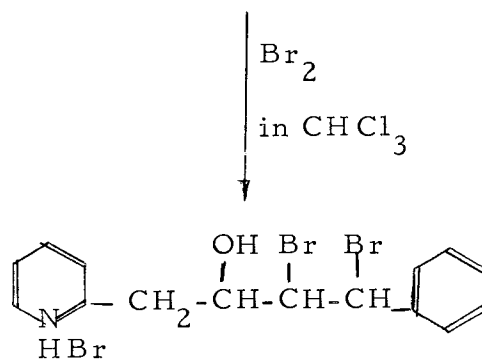
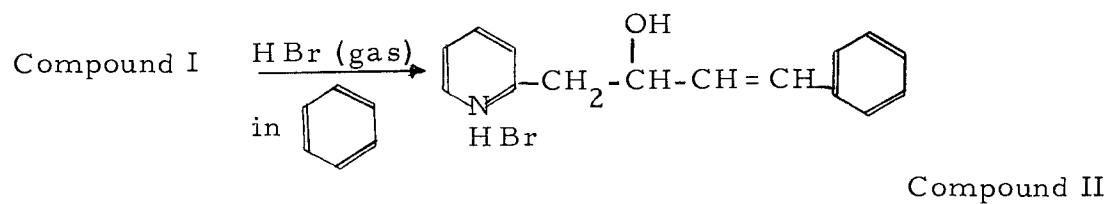
(did not obtain this compound)

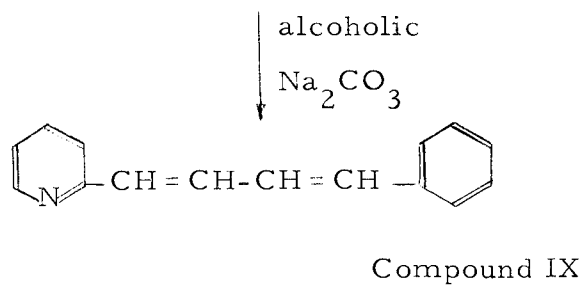
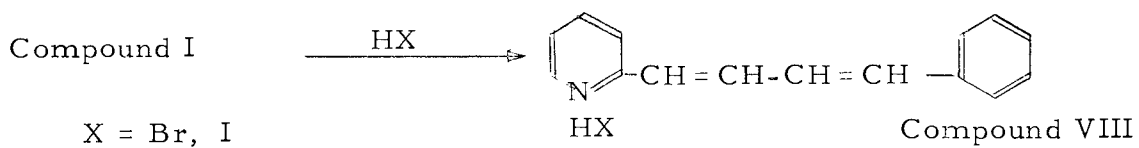
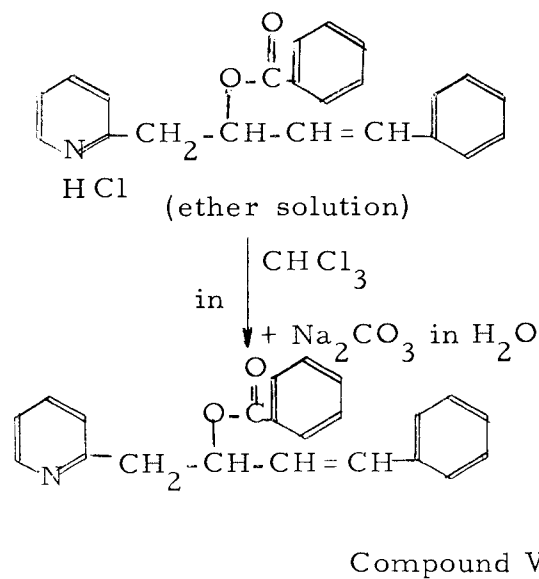
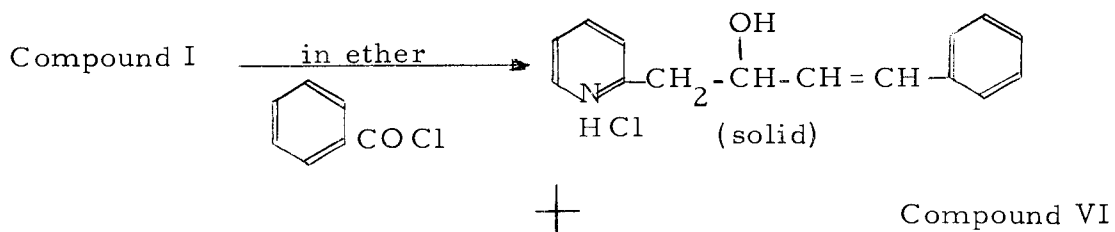
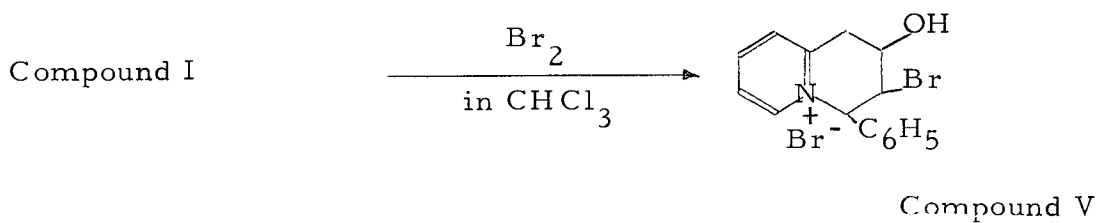
Clark (8) similarly condensed 2-picolyllithium with cinnamaldehyde obtaining 1-phenyl-4-(2-pyridyl)-1-butene-3-ol. The alcohol brominated in chloroform gave aquinolizinium salt. This compound absorbed moisture from the air. Analyses showed the two compounds not to be pure.

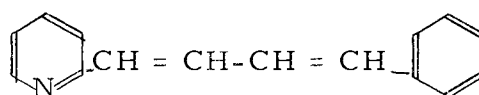
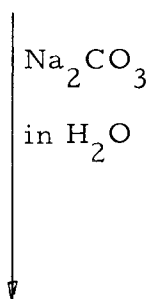
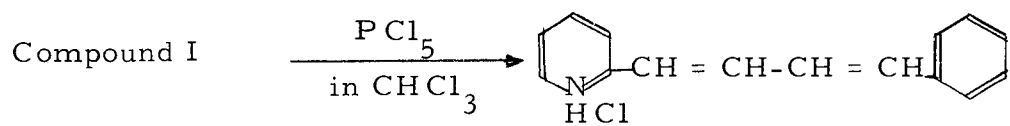
FLOW SHEET OF COMPOUNDS PREPARED



Compound I

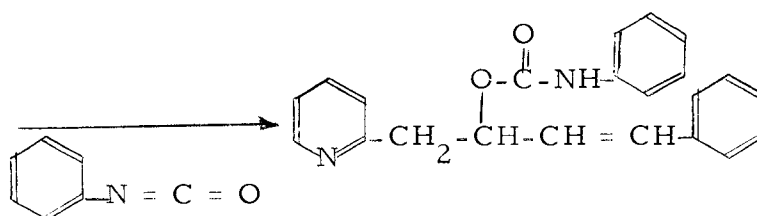




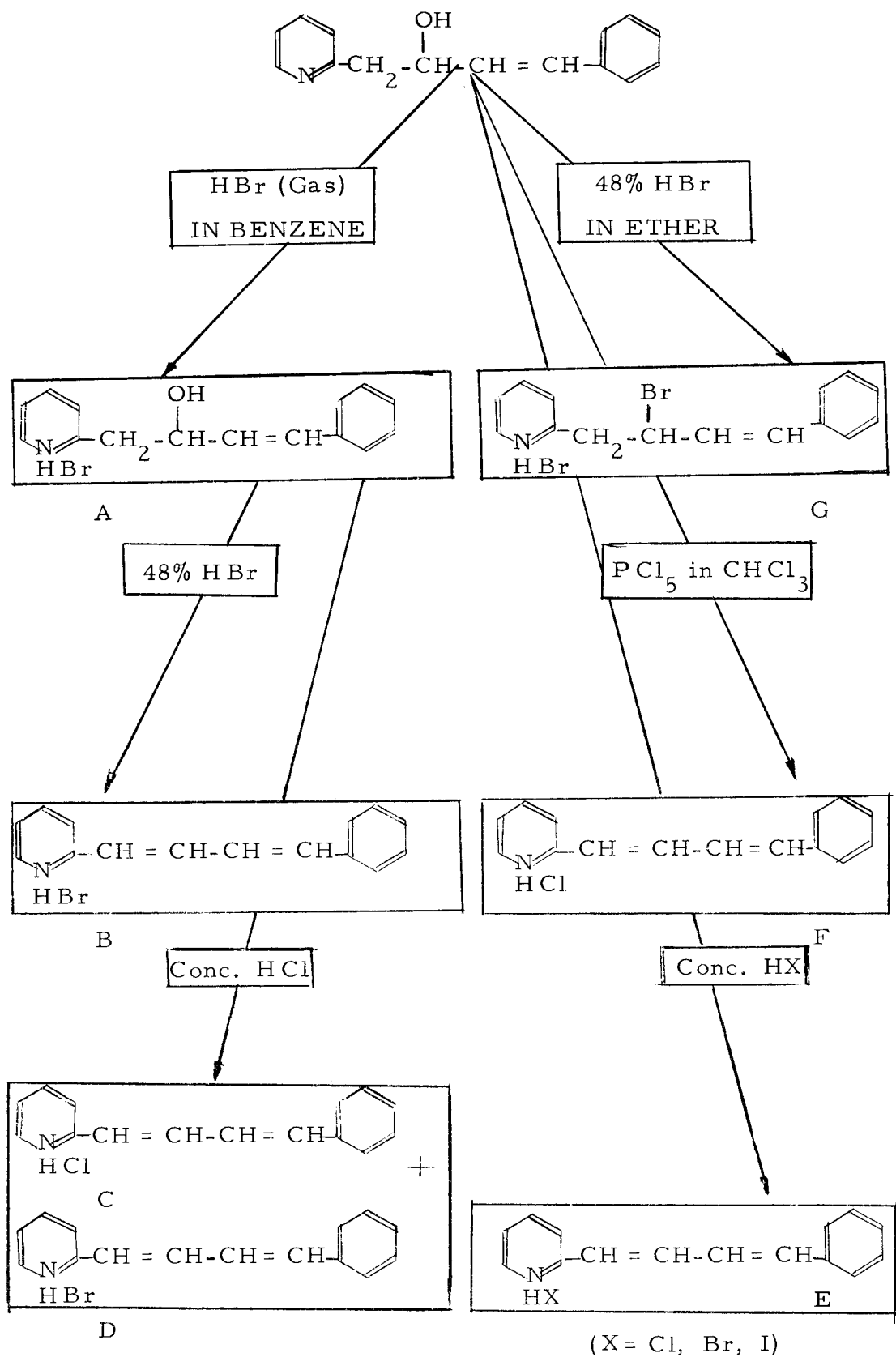


Compound IX

Compound I



Compound X



DISCUSSION

The series of reactions discussed in this investigation are shown in the flow sheet.

1-Phenyl-4-(2-pyridyl)-1-butene-3-ol, Compound I, was prepared by the condensation of 2-picolyllithium with cinnamaldehyde following the procedure presented by Clark (8). Phenyllithium was prepared by the reaction of monobromobenzene with lithium metal in anhydrous ethyl ether under nitrogen atmosphere. Addition of 2-picoline exchange of the lithium took place to give a blood red compound. At this point, it was found that a nitrogen atmosphere is not necessary because of the refluxing ether providing a sufficiently inert atmosphere to prevent decomposition of the organolithium compound, 2-picolyllithium. The same observation was found by Davis (10). The mixture was cooled to 0°C and freshly distilled cinnamaldehyde in dry ether was slowly added. The reaction mixture was hydrolysed by water. At this point in the investigation, it was found that by using ice and water a smoother reaction could be obtained, and side reaction could be prevented.

The ether layer was removed and extracted with 15% hydrochloric acid. In subsequent preparations, 10% hydrochloric acid was used. The salt of the compound is very soluble in water and nearly insoluble in ether. The higher concentration of acid did

give some dehydration and substitution products. The acid extraction was washed with ether and then made basic with a saturated solution of sodium carbonate.

The basic mixture was extracted with chloroform. The chloroform solution was dried over magnesium sulfate, filtered, and the chloroform was removed with a rotary vacuum evaporator until dry.

Clark extracted the tarry residue many times with petroleum ether. However, instead of petroleum ether, addition of some chloroform to the dry residue and cooling in a refrigerator overnight, resulted in the formation of cubical crystals which were removed by filtration. If the crystals did not form, the Erlenmeyer flask was scratched with a glass rod and refrigerated for a few hours. The addition of excess chloroform prevents crystallization because the compound is very soluble in chloroform. The addition of insufficient chloroform prevents crystallization because of the tar holding the compound. A little solvent was evaporated from the mother liquor; it was crystallized to get a second and a third crop. The crystals were combined and dried. The crystals were extracted with petroleum ether many times. Some of the petroleum ether was removed by a rotary vacuum evaporator; after that the remaining solution was placed in the refrigerator until the crystallization occurred. In this way an increase in the theoretical yield was

reported by Clark (8) from 18% to 28%. The melting point is 74°C.

The analysis:

Calculation for $C_{15}H_{15}NO$: C = 79.98%, H = 6.70%, N = 6.18%

Found: C = 80.11% H = 6.77% N = 6.00%

Clark (8) reported the melting point is 80-81°C; the analysis found C = 80.20% and H = 7.25%.

This compound is very soluble in chloroform, benzene, acetone, and alcohol. It is slightly soluble in petroleum ether and in water. The hydrochloride and hydrobromide salts of this compound are water soluble and colorless. This compound is dehydrated easily with concentrated HX (X = Cl, Br, I) at room temperature.

The rate of dehydration with HI is faster than HBr and HBr better than HCl. A concentrated HX solution was added to Compound I at room temperature. The halide salts of the compound were crystallized; all of the salts were yellow needle crystals. The HI salt crystallized in half an hour, HBr salt in one and a half hours and HCl salt in six hours. The salts of the dehydrated compounds, Compound VIII, 1-phenyl-4-(2-pyridyl hydrohalides)-1,3 butadiene are water soluble but less soluble than hydrohalides of Compound I. The solubility of the halogen salt in water decreases with increased atomic weight of the halogen atom.

Compound VIII dissolved in a mixture of methanol and water reacted with alcoholic sodium carbonate to produce the free base,

Compound IX.

Alcoholic sodium carbonate was used with the hydrobromide and hydriodide salts while a water solution of sodium carbonate was used with the hydrochloride salt. The product, Compound IX, was very soluble in methanol, but not soluble in water. Inorganic salt products were slightly soluble in methanol. Therefore, it was easy to separate the free base from the salts by filtering. This solution was evaporated with a rotary vacuum evaporator and the product was crystallized, filtered and washed with water five times to eliminate all inorganic salts. The residue was extracted with petroleum ether and crystallized, obtaining Compound IX. The melting point was 120-121°C.

Compound I was also easily dehydrated by phosphorous pentachloride at room temperature.

Compound I was dissolved in chloroform and phosphorous pentachloride was added. The mixture was stirred overnight at room temperature; the dehydrated salt of Compound VIII was the product.

The salt was stirred with saturated aqueous sodium carbonate solution, obtaining Compound IX. The hydrochloride salt was soluble in water; therefore, it was better to use saturated aqueous sodium carbonate. The product, Compound IX, was not water soluble. The product was separated and washed with water to

eliminate all inorganic salts. The compound was dried and extracted with petroleum ether and crystallized, obtaining Compound IX.

Compound I was brominated by bromine in chloroform obtaining a cyclized ring product, Compound V, 2-hydroxy-3-bromo-4-tetrahydroquinolizinium bromide.

This compound Clark (8) had prepared before, by dissolving Compound I in chloroform and slowly adding an equivalent amount of bromine. The white precipitate of quinolizinium compound formed. Clark reported that it was very hard to crystallize from acetone, and it was exceedingly hygroscopic.

At this point in the investigation, it was found that this compound crystallized in methanol and recrystallized again in methanol showed a little color in the crystals, but was colorless when it was dry and it was not hygroscopic. The melting point was 195°C (decomposed). The analysis:

Calculation for $\text{C}_{15}\text{H}_{15}\text{NOBr}_2$: C = 46.79%, H = 3.92%

Found: C = 47.00% H = 4.12%

Clark reported that the melting point of this compound was $190\text{-}193^{\circ}\text{C}$ (decomposed) and the analysis was found C = 47.59%, H = 3.93%.

This compound was water soluble but not soluble in chloroform. The compound was refluxed with acetic anhydride and a drop of concentrated sulfuric acid for five minutes. It did not give a purple

precipitate as the compound that Wischman (19) and Nash (16) reported. The solvent was evaporated until the product was dry; a polymeric compound was obtained which could not be isolated.

The Compound I was soluble in dry benzene and anhydrous hydrogen bromide gas was slowly bubbled through the solution at 0°C, obtaining Compound II, 1-phenyl-4-(2-pyridylhydrobromide)-1-butene-3-ol. The hydrobromide precipitated. It was recrystallized from acetone, giving colorless needles. The compound was very soluble in water and alcohol, soluble in acetone and chloroform. This compound was synthesized by following a procedure similar to that of Nash's (16).

Compound II was dissolved in chloroform and an equivalent mole of bromine was added to the double bond, producing Compound III.

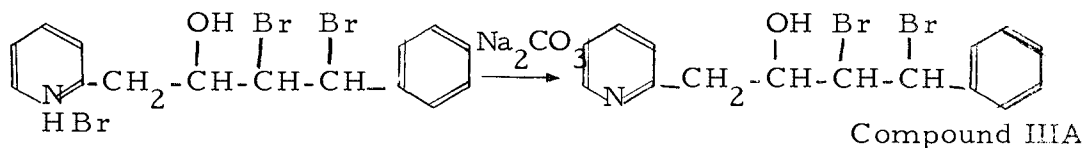
Compound III was stirred in a saturated sodium carbonate at room temperature for four hours. The product was filtered and washed with distilled water five times. The product was dried under a vacuum overnight and extracted with benzene and crystallized from the benzene solution. The melting point was 115°C. The analysis:

Calculation for $C_{15}H_{15}NOBr_2$: C = 48.81%, H = 4.09%

Found: C = 47.77% H = 4.15%

(Analysis sample 40 at Oregon State University)

The analysis showed that it was a free base but not pure. Therefore, it was reported as an attempt to prepare this compound:



The purpose of preparing this compound was for comparison with Compound V. These two compounds had the same molecular formula, but one is a straight chain compound (Compound III-A) and the other is a ring compound, Compound V. Compound III-A is the free base, not soluble in water, could form salt with acid, and melting point is only 115°C . Compound V is a salt, water soluble, and the melting point is 195°C (decomposition point):



The bromide ion was substituted for the alcoholic group of Compound I, by treating with 48% HBr in ether.

The Compound I was suspended in ether. To the mixture 48% HBr was added slowly and the mixture was stirred at room temperature for four hours. The mixture was extracted with dilute hydrobromic acid. The acid extract was evaporated until dry. The residue was soluble in chloroform. A little excess of bromine was added slowly and the solution was stirred at room

temperature for five hours. The product precipitated. The compound was boiled with methanol, giving colorless crystals, Compound IV.

This compound was very slightly soluble in water, methanol, acetone, chloroform, and benzene. Therefore, it is very hard to make it a free base.

An attempt to make the free base by stirring the compound with 0.2 normal sodium hydroxide overnight was not successful.

Compound I reacted with HBr depending on the solvent. It reacted with anhydrous hydrogen bromide gas at 0°C using benzene as the solvent producing only the hydrobromide salt, Compound A. No functional group was attacked.

When Compound I was treated with concentrated hydrobromic acid in ether, the bromide ion substituted for the alcoholic group, giving Compound G.

When Compound I was treated with concentrated halogen acid (hydrochloric, hydrobromic, or hydroiodic acid), a dehydrated compound was produced.

Compound A was treated with concentrated hydrochloric acid; a mixture of dehydrated hydrochloride and hydrobromide salts was produced (Compounds C and D). Refer to page 11.

The phenyl urethane derivative was prepared to characterize the alcohol; the preparation of this compound followed Nash's

method (16).

Nash reported that the urethane was produced by stirring one gram of the alcohol [1-(2-pyridyl)-3-methyl-3-butene-2-ol] with 1 cc. of phenyl isocyanate. A better yield of the urethane was obtained by reacting the alcohol with an equivalent amount of the phenyl isocyanate. The solution was allowed to stand several minutes, during which time the product solidified. This was recrystallized in carbon tetrachloride.

Compound I was esterified with benzyl chloride in dry ether giving Compound VII. The preparation of this compound followed the method that Nash used.

Nash reported that he added an equivalent amount of benzyl chloride to an anhydrous ether solution of alcohol. The solution was allowed to stand and occasionally stirred for several hours, during which time a white precipitate settled out of the solution. In this investigation, it was found that Compound I was only slightly soluble in ether. The alcohol benzoyl chloride mixture was stirred three days. The mixture was protected from moisture by a drying tube. The solid was recrystallized from acetone, giving colorless crystals, Compound VI. It was determined that Compound VI was not the ester but was 1-phenyl-4-(2-pyridylhydrochloride)-1-butene-3-ol.

The ether solution and acetone solution were combined and

evaporated until a dry residue was obtained. The residue was dissolved in chloroform and stirred with saturated sodium carbonate solution at room temperature for one hour. The mixture was extracted with chloroform. The chloroform solution was evaporated in a rotary vacuum evaporator until a solid was obtained. The residue was extracted with petroleum ether and crystallized from petroleum ether as a colorless crystalline, Compound VII, but the yield was poor, because most of the reactants had formed the hydrochloride salt, Compound VI.

Nash reported that he used dilute sodium hydroxide solution for making the free base but failed because all the ester was hydrolysed.

EXPERIMENTAL

1-Phenyl-4-(2-pyridyl)-1-butene-3-ol,
Compound I

Into a one liter, 3-necked flask equipped with a mechanical stirrer, a dropping funnel, and a reflux condenser protected with a calcium chloride tube was placed 6.9 grams (1 gram atom) of lithium chips in 400 ml. of dry ether. The solution was stirred as 10-15 ml. of a mixture of 79 grams (0.5 mole) of dry bromobenzene in 100 ml. of dry ether was added from the dropping funnel. The rest of the mixture was next added to maintain a gentle reflux and stirred until all lithium had disappeared (three-four hours), then 46 grams (.5 mole) of 2-picoline was added and the reaction mixture was stirred for one hour. During this time dark red 2-picolyl lithium was formed. The mixture was cooled in a salt ice bath to 0°C. Sixty grams (.45 mole) of freshly distilled cinnamaldehyde was added dropwise over a period of 20 minutes. During the addition stirring was continued and the temperature kept at 0°C. The mixture was stirred until the red color disappeared. A mixture of 100 grams ice and 100 grams of water was added slowly and stirring continued for 30 minutes.

The ether layer was separated from the water and extracted with 450 ml. 10% hydrochloric acid. The acid extract was washed

three times with 100 ml. of ether and then made basic with saturated sodium carbonate. The solution was extracted with three times with 100 ml. of chloroform. The chloroform extract was filtered and dried overnight with magnesium sulfate. The dry chloroform solution was filtered and evaporated until dry with a rotary vacuum evaporator. Thirty to 40 ml. chloroform was added to the residue and the mixture was placed in the refrigerator for 36 hours. The product emerged as cubical crystals. The crystals were dried by suction. Some of the solution of mother liquor was evaporated and placed in the refrigerator; thus a second crop and third crop of crystals were obtained.

The crystals were extracted with 200 ml. petroleum ether ten times and crystallized. The product was 28.5 grams (28% the theoretical yield calculated base on cinnamaldehyde). The melting point was 74°C .

Analysis: $\text{C}_{15}\text{H}_{15}\text{NO}$ (Sample No. 1)¹

Calculation: C = 79.98% H = 6.70% N = 6.18%

Found: C = 80.11% H = 6.77% N = 6.00%

The infrared spectrum of this compound showed significant band at 3400 cm^{-1} , characteristic of an alcohol, and a broad band at 1550 cm^{-1} , probably due to overlap of a double bond and an aromatic bond.

¹Nearly all carbon and hydrogen analyses were made by Galbraith Laboratories, Inc.

1-Phenyl-4-(2-pyridyl hydrobromide)-1-butene-3-ol,
Compound II

Four grams (.0178 mole) of 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were dissolved in 100 cc. of dry benzene in 250 ml. Erlenmeyer flask with rubber stopper having a gas outlet tube and a gas bubble tube and a magnetic stirrer. The flask was cooled in an ice bath and anhydrous hydrogen bromide was slowly bubbled into the solution. In about 30 minutes the crude product was precipitated. The gas was passed through the solution for another 15 minutes. The precipitate was filtered and crystallized from acetone. There was a yield of colorless crystals 3.8 grams (70% of the theoretical yield). The melting point was 133-134°C.

Analysis: $C_{15}H_{16}NOBr$ (Sample No. 13)

Calculation: C = 58.81% H = 5.26%

Found: C = 58.63% H = 5.33%

1-Phenyl-4-(2-pyridyl hydrobromide)-1, 2, dibromo-3-butanol,
Compound III

One gram (.00327 mole) of 1-phenyl-4-(2-pyridyl hydrobromide)-1-butene-3-ol was dissolved in 30 cc. chloroform and 0.52 gram bromine in 5 cc. chloroform was added slowly with constant stirring. The mixture was stirred for four to five hours. The product was precipitated as an oil. The oil was separated and

crystallized from methanol, obtaining 0.8 grams of colorless crystals (55% of the theoretical yield). Melting point was 144°C.

Analysis: $C_{15}H_{16}NOBr_3$ (Sample No. 30)

Calculation: C = 38.68% H = 3.47%

Found: C = 38.88% H = 3.68%

1-Phenyl-4-(2-pyridyl hydrobromide)-1, 2, 3-tribromobutane,
Compound IV

Two grams (.0089 mole) 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were stirred with 30 cc. ether and 4 cc. 48% hydrobromic acid was slowly added. The mixture was stirred four hours at room temperature. The product was extracted with 5 cc. dilute hydrobromic acid. The acid extract was evaporated until dry in a rotary vacuum evaporator. The residue was dissolved in 75 cc. dry chloroform. Two point five grams of bromine (.015 mole, excess) in 10 cc. chloroform were slowly added. During the bromine addition, the mixture was stirred with a magnetic stirrer and stirring was continued another five hours. The product was precipitated and removed by filtration from the mother liquor. The precipitate was crystallized from methanol. The yield of colorless crystals was 1.8 grams (39% of the theoretical yield); the melting point was 170°C.

Analysis: $C_{15}H_{15}NBr_4$ (Sample No. 7)

Calculation: C = 34.47% H = 2.86% N = 2.64%

Found: C = 34.30% H = 2.90% N = 2.62%

2-Hydroxy-3-bromo-4-phenyl-1, 2, 3, 4 tetrahydro
quinolizinium bromide, Compound V

Two grams (.0089 mole) of 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were dissolved in 50 cc. chloroform. The solution was stirred and a solution of 1.82 grams bromine in 15 cc. chloroform was added dropwise. Immediately upon the addition of bromine, a white precipitate formed. The reaction mixture was stirred for an hour and filtered. The precipitate was crystallized from methanol and recrystallized from methanol. The yield of colorless crystals was 1.35 grams (40% of the theoretical yield); melting point was 195°C (decomposition).

Analysis: $C_{15}H_{15}NOBr_2$ (Sample No. 12)

Calculation: C = 46.79% H = 3.92%

Found: C = 47.00% H = 4.12%

1-Phenyl-4-(2-pyridyl hydrochloride)-1-butene-3-ol,
Compound VI

Two grams (.0089 mole) of 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were stirred with 30 ml. of anhydrous ether and 1.41 grams (.0089 mole) of benzoyl chloride were added slowly. The reaction

mixture was stirred three days at room temperature. The mixture was filtered and the solid was washed with ether three to four times and then crystallized from acetone, obtaining colorless crystals. Yield was 1.2 grams (51.5% of the theoretical yield) and the melting point was 134°C.

Analysis: $C_{15}H_{16}NOCl$ (Sample No. 16)

Calculation: C = 69.21% H = 6.15%

Found: C = 69.21% H = 6.11%

1-Phenyl-4-(2-pyridyl)-1-butene-3-benzoate,
Compound VII

The solution and the mother liquor from Compound VI were evaporated until dry with a rotary vacuum evaporator. The residue was dissolved in chloroform and stirred with excess sodium carbonate solution for 30 minutes at room temperature. The chloroform solution was separated and washed with sodium carbonate solution and evaporated until dry with a rotary vacuum evaporator. The residue was extracted with petroleum ether (reagent grade). The extract was evaporated until dry. The residue was extracted with petroleum ether and crystallized. The yield of colorless crystals was 0.6 grams (20.4% of the theoretical yield), and the melting point was 62°C.

Analysis: $C_{22}H_{20}NO_2$ (Sample No. 17)

Calculation: C = 80.19% H = 5.82%

Found: C = 79.97% H = 5.95%

The infrared spectrum displayed significant bands at 1720 cm^{-1} characteristic of a benzoate carbonyl, and at 1110 cm^{-1} characteristic of an ester carbon-oxygen bond.

1-Phenyl-4-(2-pyridyl hydrobromide)-1, 3 butadiene,
Compound VIIIA

Four grams (0.0178 mole) of 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were dissolved in 15 cc. 48% hydrobromic acid and left to stand at room temperature for four hours. The product was crystallized and filtered. The crystals were recrystallized from acetone. The yield of yellow needle crystals was 3.75 grams (65% of the theoretical yield); melting point was $183-184^{\circ}\text{C}$.

Analysis: $C_{15}H_{14}NBr$ (Sample No. 38)

Calculation: C = 62.51% H = 4.89%

Found: C = 62.25% H = 4.95%

1-Phenyl-4-(2-pyridyl hydroiodide)-1, 3 butadiene,
Compound VIIIB

Four grams (.0178 mole) of 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were dissolved in 15 cc. concentrated hydriodic acid and left to stand at room temperature for 30 minutes. The product

solidified and was recrystallized from acetone. The yield of yellow crystals was 4.2 grams (70% of the theoretical yield) and the melting point was 182°C.

Analysis: C₁₅H₁₄Nl (Sample No. 39)

Calculation: C = 53.90% H = 4.20%

Found: C = 53.76% H = 4.20%

Compound VIII was dissolved in methanol and water and stirred with a solution of sodium carbonate in water and methanol for one hour and filtered. The filtrate was evaporated with a rotary vacuum evaporator. A crystalline residue remained. The crystals were extracted with petroleum ether and crystallized from that solvent. The yield was colorless crystals, melting point 121°C, the Compound IX, 1-phenyl-4-(2-pyridyl)-1, 3 butadiene.

1-Phenyl-4-(2-pyridyl)-1-butadiene,
Compound IX

Four grams (.0178 mole) of 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were dissolved in 25 cc. dry chloroform in a 250 ml. Erlenmeyer flask provided with a drying tube. The solution was stirred with a magnetic stirrer. Phosphorous pentachloride was slowly added into the solution. The mixture was stirred for 18 hours; the product solidified and it was filtered. The residue was stirred with saturated sodium carbonate solution for 30 minutes. The product

was filtered and washed with water several times, and dried. It was extracted with petroleum ether and crystallized from that solvent. The yield was colorless crystals, 1.84 grams (50% of the theoretical yield). Melting point was 121°C.

Analysis: $C_{15}H_{13}N$ (Sample No. 31 Analysis at O. S. U.)

Calculation: C = 86.89% H = 6.30%

Found: C = 86.60% H = 6.05%

1-Phenyl-4-(2-pyridyl)-1-butene-3-ol urethane,
Compound X

Two grams (.0089 mole) of 1-phenyl-4-(2-pyridyl)-1-butene-3-ol were added into 1.2 grams (.0089 mole) of phenyl isocyanate and stirred for several minutes. The product solidified. It was crystallized from carbon tetrachloride and recrystallized from carbon tetrachloride. The yield was colorless crystals, 2.10 grams (70% of the theoretical yield), and melting point was 121°C.

Analysis: $C_{22}H_{20}N_2O_2$ (Sample No. 15)

Calculation: C = 76.74% H = 5.84%

Found: C = 76.59% H = 5.63%

SUMMARY

2-Picolylolithium was condensed with cinnamaldehyde to form an alcohol with allylic type structure. The free base of this alcohol was prepared. It formed a phenyl urethane which melted at 121°C .

The alcohol was dehydrated by concentrated hydrobromic, hydriodic acid or phosphorous pentachloride in chloroform. The dehydrated salts were treated with sodium carbonate solution to make the free base.

The alcohol was treated with concentrated hydrobromic acid in ether; bromine substituted for the OH group. The substituted salt was brominated. Bromine was added to the double bond of the substituted salt.

Hydrogen bromide was added to the free base of the alcohol to form a hydrobromide salt.

Bromine was added to the double bond of the hydrobromide salt, which was treated with sodium carbonate to obtain a free base of the brominated compound, but this compound was not pure.

The free base of the alcohol was reacted with benzoyl chloride to form the hydrochloride of the ester. The salt was treated with sodium carbonate to obtain a free base of the ester.

Bromination of the free base alcohol resulted in the formation of quinolizinium salt.

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