fides in DMF in the presence of piperidine (sixfold) gave no detectable amounts of sulfenamides, resulting in recovery of the starting materials.

Registry No.—**6**, 1155-00-6; **7**, 66552-58-7; carbon disulfide, 75-15-0.

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Identification of 2,5-Dihydropyridine Intermediates in the Reactions of 2-Alkyl(phenyl)-1-lithio-1,2-dihydropyridines with Alkyl Halides

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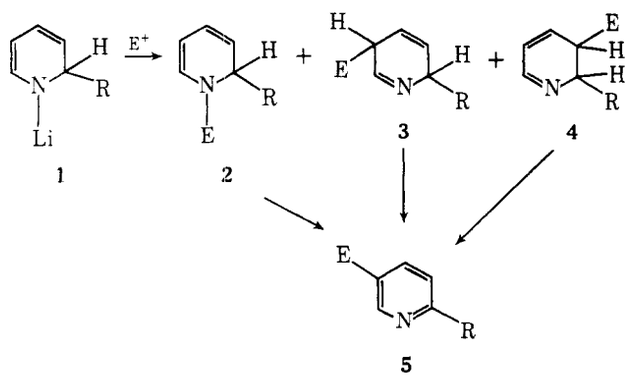
A series of 2,5-disubstituted 2,5-dihydropyridines (**10**) have been prepared from 2-alkyl(phenyl)-1-lithio-1,2-dihydropyridines (**1**) and alkyl halides and have been characterized by their IR and NMR spectra. Each 2,5-dialkyl-2,5-dihydropyridine (**10a–d**) decomposes on exposure to air or when heated to a mixture containing the corresponding 2,5-dialkylpyridine (**11a–d**) and the 2,5-dialkyl-1,2,5,6-tetrahydropyridine (**12a–d**). However, decomposition of a 5-alkyl-2-phenyl-2,5-dihydropyridine (**10d,f**) gives only the 5-alkyl-2-phenylpyridine (**11e,f**). The 2,5-dihydropyridines (**10**) are converted to the corresponding tetrahydropyridines (**12**) by lithium aluminum hydride reduction.

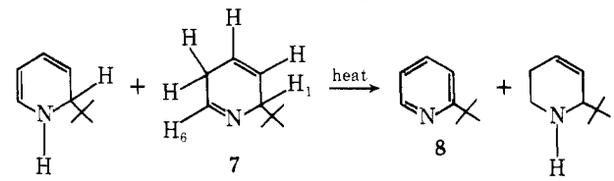
There has been little direct evidence for the existence of unstable 2,5-dihydropyridines.[1] However, they have been proposed as intermediates in reactions which include the sodium borohydride reduction of pyridinium salts,[2,3] the synthesis of 8-azasteroids,[4] the dehydrogenation of a 1,4-dihydropyridine,[5] and the reactions of lithium tetrakis(*N*-dihydropyridyl)aluminate with alkyl halides and bromine.[6]

The reactions of 1-alkyl(aryl)-1,2-dihydropyridines (**1**) with electrophiles can, in theory, lead to 1,2-, 2,5-, and 2,3-dihydropyridines as shown in Scheme I. The stable acylation products[7,8] of complex **1** (R = phenyl) are 1,2-dihydropyridines (**2**) which result from *N*-acylation and 2,5-disubstituted pyridines (**5**) which involve *C*-acylation. The latter are assumed to form from decomposition of 2,5-dihydropyridine intermediates (**3**). Alkylation[8,9,10] of complex **1** (R = phenyl) by the use of alkyl halides leads to 5-alkyl-2-phenylpyridines (**5**) which also presumably are formed on the decomposition of 2,5-dihydropyridines (**3**). Products obtained from the reaction of **1** with bromine,[9] cyanogen bromide,[11] benzophenone,[12] and phenyl disulfide[13] also are assumed to involve 2,5-dihydropyridine precursors.

Scheme I



Scheme II



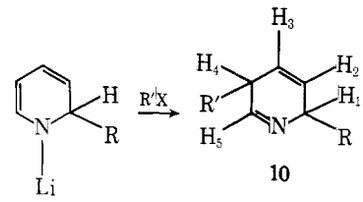
The first direct evidence for a 2,5-dihydropyridine, formed in the reaction of 2-*tert*-butyl-1-lithio-1,2-dihydropyridine (**1a**) with methanol, was reported[14] from this laboratory. This reaction gave dihydropyridines **6** and **7** which were decomposed by heat to 2-*tert*-butylpyridine (**8**) and 2-*tert*-butyl-1,2,5,6-tetrahydropyridine (**9**).

Results and Discussion

We have now identified the 2,5-dihydropyridines (**10**) obtained from the reactions of pyridine–alkyllithium complexes (**1**) with methyl and ethyl halides (Table I). Structural as-

0022-3263/78/1943-3227$01.00/0

Table I. Pyridine–Alkyllithium Complexes (1), 2,5-Dihydropyridines (10), and Vinyl Proton Absorptions of 2,5-Dihydropyridines



1 10

no.	registry no.	R	no.	R	R′	registry no.	chemical shifts for vinyl protons of **10**, δ H_5	H_2,H_3
1a	42540-75-0	*t*-Bu	**10a**	*t*-Bu	CH_3	66562-50-3	8.45	6.00
1b	20180-25-0	*n*-Bu	**10b**	*t*-Bu	C_2H_5		8.09	5.80
ac	24724-75-2	phenyl	**10c**	*n*-Bu	CH_3		8.05	5.73
			10d	phenyl	CH_3	66562-51-4	8.30	5.92
			10e	phenyl	C_2H_5	66562-52-5	8.15	5.87

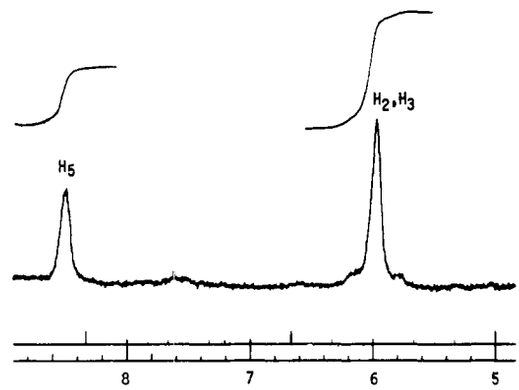


Figure 1. NMR spectrum of the vinyl proton absorptions of 2-*tert*-butyl-5-methyl-2,5-dihydropyridine (**10a**).

signments for these 2,5-dihydropyridines are based on their NMR and IR spectra, their decomposition products, and their facile reduction (lithium aluminum hydride) to the corresponding tetrahydropyridines (**12**). A series of pyridine–alkyllithium complexes (**1**) were prepared as yellow crystalline solids from pyridine and the appropriate alkyllithium compound. The reaction of each complex (**1**) with methyl iodide or ethyl bromide gave a 2,5-dialkyl(aryl)-2,5-dihydropyridine (**10**).

The NMR spectrum of 2-*tert*-butyl-5-methyl-2,5-dihydropyridine (**10a**) is representative of those obtained for other 2,5-dialkyl-2,5-dihydropyridines. It showed a broad absorption at δ 8.45 (1 H) assigned to H_5, a broad absorption at δ 6.00 (2 H) assigned to H_2 and H_3, and a multriplet at δ 4.40 (1 H) assigned to H_4. Other absorptions of **10a** were obscured by those of the solvent. The vinyl proton absorptions for **10a** are shown in Figure 1. A summary of vinyl proton absorptions for all 2,5-dialkyl-2,5-dihydropyridines (**10**) is given in Table I.

The reactions of complexes **1a–c** with alkyl halides could also give 1,2-dialkyl-1,2-dihydropyridines as a result of *N*-alkylation. However, the general absorption patterns reported[1] for the NMR spectra of alkyl-substituted 1,2-dihydropyridines differ substantially in the vinyl proton region from patterns observed in the NMR spectra obtained in these studies. Thus these reactions gave no detectable amounts of the 1,2-dihydropyridines.

The NMR spectra of some solutions containing 2,5-dihydropyridines showed additional absorptions of much lower intensity near those reported for vinyl protons H_2, H_3, and H_5. These absorptions suggest the presence of stereoisomeric 2,5-dihydropyridines in some of these mixtures. This aspect of the structures of the 2,5-dihydropyridines formed in the reactions of complex **1** with alkyl halides is currently under investigation.

Acylation of complex **1a** with acetyl chloride gave, as expected,[8,9] 1,2-dihydropyridine **13** which was sufficiently stable to be collected by preparative GLC at 150 °C.

The reactions of lithium tetrakis(*N*-dihydropyridyl)aluminate[6] and complex **1c**[9] with bromine have been reported to give 3-bromopyridine and 5-bromo-2-phenylpyridine, respectively. However, treatment of complex **1a** with either bromine or pyridinium perbromide gave no detectable amount of 5-bromo-2-*tert*-butylpyridine but did afford 6,6′-di-*tert*-butyl-3,3′-dipyridyl (**16**). The formation of dipyridyl **16** may involve 2,5-dihydropyridine intermediates **14** and **15** (Scheme III). Experiments aimed at identification of these intermediates are currently underway. Dipyridyls also have been reported[10,11] in the reactions of complexes **1b** and **1c** with other halogenating agents.

Workup and analysis of a sample of each 2,5-dialkyl-2,5-dihydropyridine (**10a–c**) revealed that each had decomposed to a mixture containing the corresponding 2,5-dialkylpyridine (**11a–c**) and the 2,5-dialkyl-1,2,5,6-tetrahydropyridine (**12a–c**). The relative percentage of dialkyltetrahydropyridine (**12**) in each reaction was less than that of the dialkylpyridine (**11**). The tetrahydropyridine may have been formed by transfer of a hydride ion from one 2,5-dihydropyridine mol-

Scheme III

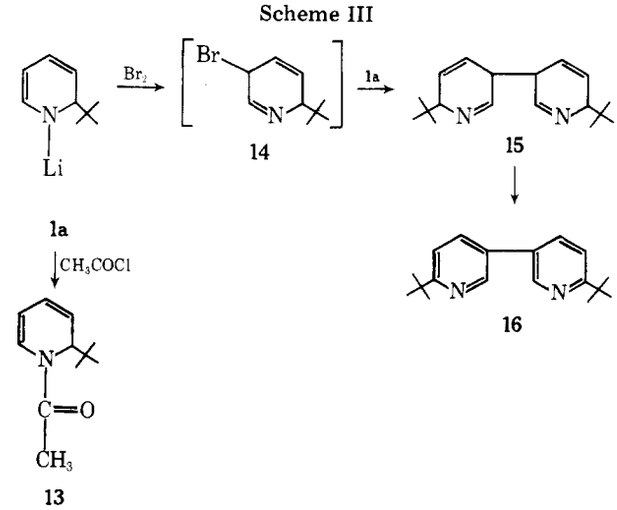
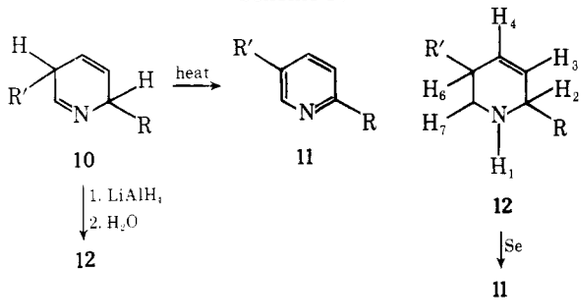


Table II. Vinyl Proton Absorptions and Elemental Analyses of Tetrahydropyridines 12a–e

compd	registry no.	vinyl protons, δ	elemental analysis: calcd C	calcd H	calcd N	found C	found H	found N
12a	66562-53-6	5.62	78.37	12.49	9.14	78.25	12.61	9.29
12b		5.65[a]	78.97	12.96	8.37	78.89	12.84	8.13
12c		5.60[b]	78.43	12.42	9.15	78.40	12.37	9.17
12d	66562-54-7	5.70	83.24	8.67	8.09	83.40	8.60	8.01
12e	66562-55-8	5.70	83.42	9.09	7.49	83.52	9.03	7.49

[a] Two broad absorptions, approximate ratio 5:1. [b] Two broad absorptions, approximate ratio 2:1.

Scheme IV



10 11 12 12 11

ecule to the C=N moiety of another. Compounds **11** and **12** generally could not be separated cleanly by distillation or preparative GLC. In each case a pure sample of the 2,5-dialkylpyridine (**11**) for spectral and elemental analyses was obtained from these mixtures by selenium oxidation of **12** to **11**. A pure sample of the 2,5-dialkyl-1,2,5,6-tetrahydropyridine (**12**) was prepared by the hydride reduction of the 2,5-dialkyl-2,5-dihydropyridine (**10**). These reactions are shown in Scheme IV. Decomposition of each 5-alkyl-2-phenyl-2,5-dihydropyridine (**10d** and **10e**) gave only the 5-alkyl-2-phenypyridine (**11d** and **11e**). A summary of the data obtained from these reactions is given in Table II.

The 2,5-dialkyl(phenyl)-2,5-dihydropyridines (**10**) obtained from the reactions of complex 1 with alkyl halides were expected to undergo hydride reduction at the C=N bond; accordingly, each was treated with lithium aluminum hydride. On reduction, 2,5-dihydropyridines **10a, 10d,** and **10e** each gave a single tetrahydropyridine according to GLC and NMR analyses. However, the NMR spectrum of each of the reduction products of 2,5-dihydropyridines **10b** and **10c** suggested the presence of two stereoisomeric tetrahydropyridines.

The hydride reductions described above generally gave high yields of tetrahydropyridines, and the reaction sequence shown in Scheme V may serve as a convenient synthesis of a variety of 2,5-dialkyl-1,2,5,6-tetrahydropyridines (**12**).

Experimental Section

General. Elemental analyses were performed by Galbraith Laboratories, Inc., Knoxville, Tenn. Nuclear magnetic resonance spectra were obtained on Varian T-60 and HA-100 instruments. Analyses of reaction product mixtures and relative percentage yields of products were obtained on a Varian Aerograph 90-P3 gas chromograph equipped with a 20 ft × 3/8 in. column composed of 30% SE-30 on Chromosorb W (60/80 mesh). Infrared spectra were recorded on a Perkin-Elmer 621 instrument. *tert*-Butyllithium in pentane was obtained from Lithium Corporation of America. Other alkyllithium compounds were prepared by standard procedures.

2-*tert*-Butyl-1-lithio-1,2-dihydropyridine (1a).[14] In a nitrogen-flushed drybox, 0.06 mol of *tert*-butyllithium was added to a 25 × 200 mm test tube. The test tube was sealed with a serum cap, removed from the drybox and cooled to about −70° in a dry ice–isopropyl alcohol bath. A solution of 0.04 mol of pyridine in about 10 mL of dry pentane was added slowly over a period of about 10 min by use of a syringe. The mixture was shaken vigorously after each addition. Complex **1a** began crystallizing as a yellow solid in about 1 h. The mixture was generally allowed to stand at −70 °C overnight to assure maximum crystallization.

Scheme V

$$1 \xrightarrow{R\text{-}X} 10 \xrightarrow{LiAlH_4} \xrightarrow{H_2O} 12$$

2-*n*-Butyl-1-lithio-1,2-dihydropyridine (1b)[15] was prepared according to the procedure described for **1a**. Complex **1b** was obtained from pyridine and butyllithium in hexane as a yellow solid. NMR (ethyl ether): δ 6.70 (1 H, d, H_5), 5.95 (1 H, m, H_3), 4.87 (1 H, t, H_1), 4.43 (2 H, m, H_2 and H_4).

1-Lithio-2-phenyl-1,2-dihydropyridine (1c)[17] was prepared according to the procedure described previously for complex **1a** except that 0.04 mol of pyridine was added to 0.08 mol of phenyllithium[18] in ethyl ether which had been cooled to 0 °C in an ice–water bath. The mixture was allowed to stand at room temperature until the yellow complex **1c** crystallized. The mixture was generally refrigerated overnight to insure maximum crystallization. An NMR spectrum obtained for complex **1c** in tetramethylethylenediamine with Me_4Si as the internal standard agreed with that previously reported.[17]

2-*tert*-Butyl-5-methyl-2,5-dihydropyridine (10a). A syringe was used to remove the supernatent liquid from complex **1a**. The complex was washed by injecting 10 mL of dry ethyl ether or pentane into the test tube, shaking the mixture, allowing the solid to settle, and withdrawing the liquid. This procedure was repeated. A mixture of complex **1a** and about 20 mL of dry ethyl ether was slowly added by use of a syringe. As the components reacted, the solid complex dissolved. The mixture was allowed to stand at 0 °C for 2–3 h. The resultant clear, yellow solution was transferred with a syringe to a small round-bottomed flask which had been flushed with nitrogen, fitted with a serum cap, and cooled in an ice–water bath. The flask was placed on a rotary evaporator, and the mixture was concentrated at 0 °C. A sample of the concentrate was transferred with a syringe to an NMR tube, Me_4Si was added, and an NMR spectrum of complex **1a** in ethyl ether was obtained: δ 8.45 (1 H, br s, H_5), 6.00 (2 H, br s, H_2, H_3), 4.40 (1 H, m, H_4). IR: 1715, 1675, 1640 cm^{-1}.

The signals from H_1 and the methyl and *tert*-butyl groups in the NMR spectrum were obscured by absorptions from the solvent. Attempted removal of the last traces of solvent resulted in considerable decomposition of the 2,5-dihydropyridine **10a** to aromatic compound **11a** and tetrahydropyridine **12a**.

2-*tert*-Butyl-5-ethyl-2,5-dihydropyridine (10b) was prepared according to the procedure described for 2,5-dihydropyridine **10a**. Because complex **10b** proved to be more stable than complex **10a**, most reaction solvent could be removed from the sample by rotary evaporation. An NMR spectrum was obtained on a sample of **10b** in deuteriochloroform with Me_4Si: δ 8.09 (1 H, br s, H_5), 5.80 (2 H, br s, H_2, H_3), 4.02 (1 H, m, H_4), 3.64 (1 H, br, H_1), 2.41 (2 H, q, CH_3CH_2), 1.60 (3 H, t, CH_3CH_2). IR: 1710 (C=N), 1675 and 1655 cm^{-1} (C=C).

2-*n*-Butyl-5-methyl-2,5-dihydropyridine (10c) was prepared from complex **1b** and methyl iodide according to the procedure described for 2,5-dihydropyridine **10a**: NMR δ 8.05 (1 H, br s, H_5), 5.73 (2 H, br s, H_2, H_3), 4.48 (1 H, m, H_1). Absorptions from the methyl and butyl groups were obscured by absorptions from the solvent (pentane).

5-Methyl-2-phenyl-2,5-dihydropyridine (10d) was prepared from complex **1c** and methyl iodide by the procedure described for 2,5-dihydropyridine **10a**. The methyl iodide–ethyl ether mixture was added to complex **1c** in ethyl ether at 0 °C: NMR δ 8.30 (1 H, br s, H_5), 7.57 (5 H, s, phenyl), 5.92 (2 H, br s, H_2, H_3). Other absorptions were obscured by those of the solvent.

5-Ethyl-2-phenyl-2,5-dihydropyridine (10e) was prepared from complex **1c** and ethyl bromide by the procedure described for 2,5-dihydropyridine **10a**. The ethyl bromide–ethyl ether mixture was added to complex **1c** in ethyl ether at 0 °C. NMR δ 8.15 (1 H, br s, H_5),

5.87 (2 H, br s, H_2, H_3). Other absorptions were obscured by those from the solvent.

1-Acetyl-2-*tert*-butyl-1,2-dihydropyridine (13) was prepared from complex **1a** and 0.04 mol of acetyl chloride at −70 °C. The mixture was allowed to warm to 0 °C and stand at this temperature for an additional hour. Workup as described above gave a yellow oil which GLC analysis showed to contain a single major product which was collected by preparative GLC as a colorless oil: NMR δ 6.45 (1 H, d, H_5), 6.02 (1 H, m, H_4), 5.60 (1 H, m, H_3), 5.00 (1 H, d, H_1), 2.20 (3 H, s, CH_3), 1.00 (9 H, s, *t*-Bu); IR 1680 (C=O), 1595 and 1575 cm^{-1} C=C). Anal. Calcd for $C_{11}H_{17}NO$: C, 73.76; H, 9.49; N, 7.81. Found: C, 73.59; H, 9.33; N, 7.79.

6,6′-Di-*tert*-butyl-3,3′-dipyridyl (16) was prepared from complex 1a and bromine dissolved in pentane or pyridine perbromide[19] dissolved in tetrahydrofuran by the general procedure described for 2,5-dihydropyridine **10a**. The addition of the brominating reagent to complex **1a** (−70 °C) resulted in immediate formation of a yellow solid. The mixture was shaken frequently. The resultant mixture, a clear yellow solution, was refluxed for 2 h, cooled, and shaken with 25 mL of water. The organic layer was separated and dried (K_2CO_3), and the solvent was removed by rotary evaporation. The residue, microdistilled at 10 mm, gave a mixture which by GLC analysis contained 2-*tert*-butylpyridine, 2-*tert*-butyl-1,2,5,6-tetrahydropyridine, and 6,6′-di-*tert*-butyl-3,3′-bipyridyl (**16**). Bipyridyl **16** was collected by preparative GLC as a yellow solid: mp 121–122 °C; NMR δ 8.40 (2 H, s, C_6–H, C_6′–H), 7.40 (4 H, m C_3–H, C_4–H, C_3′–H, C_4′–H), 1.25 (18 H, s, *t*-Bu, *t*-Bu′). Anal. Calcd for $C_{18}H_{24}N_2$: C, 80.61; H, 8.94; N, 10.44. Found: C, 80.69; H, 8.88; N, 10.40.

Decomposition of 2,5-Dihydropyridines. Samples (0.04 mol) of 2,5-dialkyl(aryl)-2,5-dihydropyridines were prepared as described in the previous sections. About 2 mL of water was cautiously added to each sample and the mixture was shaken. The organic layer was separated, the aqueous layer was extracted with three 10-mL portions of ethyl ether, and the combined organic portions were dried (K_2CO_3). The solvent was removed by rotary evaporation, and the residue was distilled at 10 mm of pressure. Each distillate was analyzed by GLC. Decomposition of each 2,5-dialkyl-2,5-dihydropyridine (**10a–d**) gave a mixture containing the 2,5-dialkylpyridine (**11a–d**) and the 2,5-dialkyl-1,2,5,6-tetrahydropyridine (**12a–d**). The relative percentages of **11** and **12** formed by decomposition of **10** were: **10a,** 57:43; **10b,** 74:26; **10c,** 77:23; **10d,** 100:0; **10e,** 100:0. The dialkylpyridines and dialkyltetrahydropyridines obtained in these reactions generally could not be separated completely by distillation or GLC, and the relative percentages reported are approximate. Pure samples of these products were obtained by the procedures described in subsequent sections where the spectral and elemental analyses are also reported.

Decomposition of each 5-alkyl-2-phenyl-2,5-dihydropyridine (**10d** and **10e**) gave only the 5-alkyl-2-phenylpyridine (**11e** and **11f**).

5-Methyl-2-phenylpyridine (11d) was obtained as a yellow solid from decomposition of 2,5-dihydropyridine **10d:** NMR δ 8.45 (1 H, m, H_5), 7.90 (2 H, m, H_2, H_3), 7.40 (5 H, m, phenyl), 2.33 (3 H, s, CH_3); IR 1660, 1600, 1563 cm^{-1}. Anal. Calcd for $C_{12}H_{11}N$: C, 85.21; H, 6.51; N, 8.28. Found: C, 85.04; H, 6.70; N, 8.26.

5-Ethyl-2-phenylpyridine (11e) was obtained as a yellow solid from decomposition of 2,5-dihydropyridine **10e:** NMR δ 8.15 (1 H, m, H_5), 8.33 (2 H, m, H_2, H_3), 7.73 (5 H, m, phenyl), 3.03 (2 H, q, CH_2CH_3), 1.63 (3 H, t, CH_2CH_3); IR 1647, 1595, and 1560 cm^{-1}. Anal. Calcd for $C_{13}H_{13}N$: C, 85.25; H, 7.10; N, 7.65. Found: C, 85.18; H, 7.08; N, 7.56.

General Procedure for Preparing Pure 2,5-Dialkylpyridines (11). The crude product containing a 2,5-dialkylpyridine (**11**) and a 2,5-dialkyl-1,2,5,6-tetrahydropyridine (**12**) obtained from decomposition of approximately 0.04 mol of 2,5-dialkyl-2,5-dihydropyridine (**10**) was refluxed with a small excess of selenium (5.0g) in 100 mL of phenyl ether for 36–48 h. The mixture was filtered to remove excess selenium and the filtrate was extracted with five 15-mL portions of 6 N hydrochloric acid. The aqueous layer was separated and made basic with dilute aqueous sodium hydroxide. The aqueous layer was extracted with ethyl ether, the extracts were dried (K_2CO_3), and the ether was removed by rotary evaporation. The residue was analyzed by GLC and samples of 2,5-dialkylpyridines were obtained by preparative GLC as colorless oils.

(a) 2-*tert*-Butyl-5-methylpyridine (11a): NMR δ 8.45 (1 H, s, H_5), 7.40 (2 H, m, H_2, H_3), 2.23 (3 H, s, CH_3), 1.00 (9 H, s, *t*-Bu). Anal. Calcd for $C_{10}H_{15}N$: C, 80.55; H, 10.06; N, 9.38. Found: C, 80.39; H, 9.88; N, 9.19.

(b) 2-*tert*-Butyl-5-ethylpyridine (11b): NMR δ 8.40 (1 H, s, H_5), 7.25 (2 H, m, H_2, H_3), 2.60 (2 H, q, CH_2CH_3), 1.20 (3 H, t, CH_2CH_3), 1.00 (9 H, s, *t*-Bu). Anal. Calcd for $C_{11}H_{17}N$: C, 80.99; H, 10.42; N, 8.58. Found: C, 80.77; H, 10.56; N, 8.70.

(c) 2-*n*-Butyl-5-methylpyridine (11c): NMR δ 8.38 (1 H, br s, H_5), 7.20 (2 H, m, H_2, H_3), 2.78 (2 H, t, $CH_2CH_2CH_3$), 2.30 (3 H, s, $-CH_3$), 1.55 (4 H, m, $CH_2CH_2CH_2CH_3$), 0.97 (3 H, t, $CH_2CH_2CH_2CH_3$). Anal. Calcd. for $C_{10}H_{15}N$: C, 80.54; H, 10.07; N, 9.40. Found: C, 80.46; H, 10.20; N, 9.39.

General Procedure for Preparing 2,5-Dialkyl-1,2,5,6-tetrahydropyridines (12). Pure samples of 2,5-dialkyl-1,2,5,6-tetrahydropyridines, which were formed along with the corresponding aromatic compounds when 2,5-dihydropyridines were decomposed, were prepared according to the following procedure. A 0.04-mol sample of a 2,5-dialkyl-2,5-dihydropyridine (**10**) prepared as previously described was slowly added by use of a syringe to a stirred mixture of 0.02 mol of lithium aluminum hydride in 100 mL of dry ethyl ether at 0 °C. The mixture was allowed to warm to room temperature and was stirred overnight. The reaction was quenched by the slow addition of cold water, and the layers were separated. The aqueous layer was extracted with three 100-mL portions of ethyl ether, and the combined extracts and organic layer were dried (anhydrous K_2CO_3). The crude product obtained on removal of ethyl ether by rotary evaporation was analyzed by GLC.

The NMR spectrum of each of the tetrahydropyridines **12a, 12d,** and **12e** showed a single broad absorption near δ 5.6 which suggested that a single isomer was present. However, the NMR spectrum of each of the tetrahydropyridines **12b** and **12c** was apparently that of a mixture of two stereoisomeric tetrahydropyridines as suggested by the presence of two broad absorptions near δ 5.6 as well as the presence of two sets of absorptions for other protons in the region δ 3.4–0.9. Detailed analyses of these spectra were not attempted; however, the vinyl proton absorptions and the elemental analyses of the tetrahydropyridines are summarized in Table II.

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Registry No.—*cis*-**10b,** 66562-56-9; *trans*-**10b,** 66562-57-0; *cis*-**10c,** 66562-58-1; *trans*-**10c,** 66562-59-2; **11a,** 56029-43-7; **11b,** 66562-60-5; **11c,** 27012-26-6; **11d,** 27012-22-2; **11e,** 66562-61-6; *cis*-**12b,** 66562-62-7; *trans*-**12b,** 66562-63-8; *cis*-**12c,** 66562-64-9; *trans*-**12c,** 66562-65-0; **13,** 66562-66-1; **16,** 66562-67-2; pyridine, 110-86-1; *tert*-butyllithium, 594-19-4; butyllithium, 109-72-8; phenyllithium, 591-51-5.

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