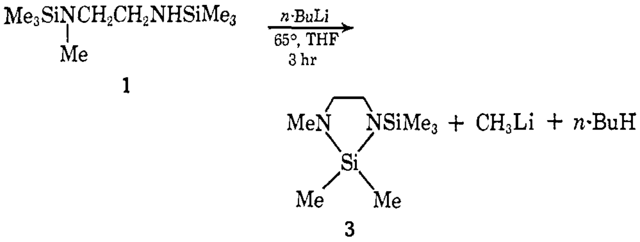
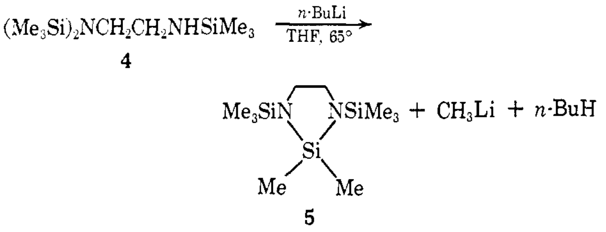
pecting to observe rearrangement to the N,N-bissilyl isomer **2**. When little or no rearrangement was found at 25° in ether, the reaction was repeated in tetrahydrofuran at 65°. Under these conditions, a quite unexpected condensation took place, with the formation of a silamidazolidine ring and *elimination of methyllithium.*



In a typical experiment 21 ml of 1.8 *M* *n*-butyllithium in cyclohexane was added to 8 g (0.037 mole) of **1** dissolved in 30 ml of tetrahydrofuran, with cooling to −70°. Butane is evolved immediately as **1** is converted to its N-lithio derivative. The mixture was slowly warmed to room temperature and then heated to 65° to reflux for 48 hr. The mixture was cooled and pyrrole (2.5 g) was added as a protonating agent. Solvents were removed and the product was obtained by fractional distillation as a colorless liquid, bp 80–83° (22 torr), n^{22}D 1.4413, yield 6.5 g (81%). The proton nmr spectrum showed sharp peaks at τ 7.55, 9.94, and 9.89 with relative intensity 1:2:3 attributed to N–CH_3, >Si(CH_3)$_2$, and –Si(CH_3)$_3$ protons, respectively, as well as a complex pattern attributed to the methylene bridge protons at τ 6.84–7.35.

The methyllithium by-product was identified qualitatively by its nmr spectrum and quantitatively by protonation with pyrrole to give methane. The condensation reaction also takes place with *catalytic* quantities of *n*-butyllithium; in this case methane is evolved continuously as silaimidazolidine formation takes place.

The nature of the condensation product was confirmed by carrying out the reaction using N,N,N′-tris(trimethylsilyl)ethylenediamine (**4**) to give the known⁵ compound 1,3-bis(trimethylsilyl)-2,2-dimethyl-2-silaimidazolidine (**5**). The properties of **5** obtained in this reaction are fully consistent with the proposed structure and agree with those reported for the same substance by Kummer and Rochow.[5]



(2)

The condensation reaction can be viewed as taking place by nucleophilic attack of the anionic amide nitrogen on silicon, perhaps with simultaneous electrophilic attack on methyl carbon by lithium cation.[6] The surprising fact about this condensation reaction is that a C–Li bond in methyllithium is formed from an N–Li bond in the N-lithioethylenediamine. The C–Li bond is expected to be much less stable than N–Li, so other factors, as yet unidentified, must more than compensate for the energy gain involved in the formation of methyllithium from N-lithioethylenediamine.

Later experiments showed that the rearrangement indicated in eq 1 does in fact take place. No rearrangement was observed starting with **1** only because equilibrium in this particular reaction lies >95% toward **1**. If **2** is the starting material nearly complete rearrangement is observed. Moreover, the anionic rearrangement of N-silylethylenediamines appears to be a general reaction.[7] Numerous examples which have been studied in our laboratories will be described in forthcoming papers.[8]

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(5) D. Kummer and E. G. Rochow, *Z. Anorg. Allgem. Chem.*, **321**, 21 (1963).

(6) High-temperature condensation reactions leading to silaimidazolidines have been described by Fink, and these reactions may be related mechanistically to the condensations described here. See W. Fink, *Ber.*, **99**, 2267 (1966).

(7) M. Ishikawa and R. West, Abstracts of Papers, 153rd National Meeting of the American Chemical Society, Miami, Fla., April 1967, Paper L-132.

(8) The silylethylenediamine rearrangements provide the first examples of anionic rearrangement between N atoms in diamines and can be viewed as a new class of Smiles rearrangements.[9]

(9) J. F. Bunnett and R. E. Zahler, *Chem. Rev.*, **49**, 362 (1951).

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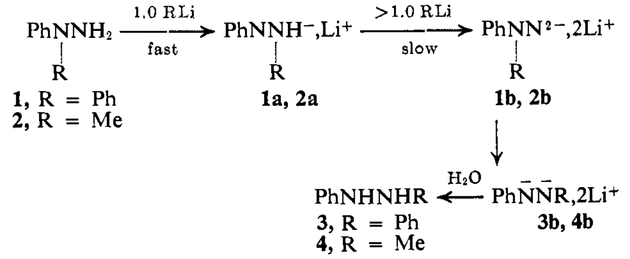
New Anionic Rearrangements. VII.[1] Rearrangement of Dianions of Arylhydrazines[2]

Sir:

The 1,2-anionic rearrangement of organosilylhydrazines, in which organosilyl groups migrate from one nitrogen atom to the other, has been described in a series of recent papers.[1,3,4] We now wish to report the base-catalyzed, 1,2 migration of the phenyl moiety in two phenylhydrazines. However, these rearrangements are strikingly different from the silylhydrazine rearrangements.

When up to 1 equiv of an alkyllithium compound is added to 1,1-diphenylhydrazine (**1**) or 1-phenyl-1-methylhydrazine (**2**), rapid proton transfer takes place to give the monoanion of the hydrazine (as its lithium salt). The monoanions **1a** and **2a** do *not* rearrange even on long heating at temperatures up to 100° in bis-



$$\underset{\displaystyle R}{\underset{|}{\mathrm{PhNNH_2}}} \xrightarrow[\text{fast}]{1.0\ \mathrm{RLi}} \underset{\displaystyle R}{\underset{|}{\mathrm{PhNNH^-,Li^+}}} \xrightarrow[\text{slow}]{>1.0\ \mathrm{RLi}} \underset{\displaystyle R}{\underset{|}{\mathrm{PhNN^{2-},2Li^+}}}$$

1, R = Ph **1a, 2a** **1b, 2b**
2, R = Me

$$\mathrm{PhNHNHR} \xleftarrow{\mathrm{H_2O}} \mathrm{Ph\overset{-}{N}\overset{-}{N}R,2Li^+}$$

3, R = Ph **3b, 4b**
4, R = Me

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(1) Previous paper in this series: R. West and M. Ishikawa, *J. Am. Chem. Soc.*, **89**, 5049 (1967).

(2) Research sponsored by Air Force Office of Scientific Research (SRC), Office of Aerospace Research, U. S. Air Force, Grant No. AF-AFOSR-1061-66.

(3) R. E. Bailey and R. West, *J. Am. Chem. Soc.*, **86**, 5369 (1964); R. West, M. Ishikawa, and R. E. Bailey, *ibid.*, **88**, 4648 (1966); **89**, 4068 (1967); R. West and M. Ishikawa, *ibid.*, **89**, 4981 (1967).

(4) R. West, M. Ishikawa, and R. E. Bailey, *ibid.*, **89**, 4072 (1967).

(2-methoxyethyl) ether. When more than 1 equiv of alkyllithium compound is present, a slow second-step proton transfer apparently takes place to give the dianions **1b** and **2b**. *The dianions, but not the monoanions, rearrange to their 1,2-disubstituted isomers,* **3b** and **4b**.

In typical reactions, measured amounts of hydrazine substrate, solvent (usually diethyl ether), and methyllithium in diethyl ether were injected through a septum into a carefully dried vessel, under nitrogen. The reaction was allowed to proceed with rapid stirring. Samples were removed using syringe technique and quenched in water; the dried organic layer was analyzed either by gas chromatography or nmr spectroscopy, or both. The identity of the rearranged isomers was confirmed by comparison with authentic samples.

Compound **1** is recovered unchanged upon treatment with 1.0 equiv of methyllithium after 90 hr at 30° in diethyl ether and even after heating at 114° in bis(2-methoxyethyl) ether for 26 hr. With more than *1* equiv of methyllithium, slow rearrangement takes place at 30° in ether, as shown by the data in Table I. Complete isomerization to **3** took place in 71 hr in the presence of 8 equiv of methyllithium.

Table I. Rearrangement of 1,1-Diphenylhydrazine Dianions at 30° in Diethyl Ether

Molar ratio, CH_3Li:**1**	Reaction time, hr	% rearr
1.0	90	0
1.8	90	11
2.0	44	29
	90	43
3.0	44	42
	90	61
8.0	47	85
	71	>95

Compound **2** likewise undergoes no rearrangement after 48 hr when treated with 1.0 equiv of methyllithium in ether at 30°. Heating of the reaction to 112° in bis(2-methoxyethyl) ether led to partial decomposition with formation of aniline and N-methylaniline, but no rearrangement of the recovered hydrazine. When **2** was treated with 2.5 equiv of methyllithium in ether solution for 22 hr and then quenched, 35% of **4** was found. Very long reaction times led to considerable decomposition with formation of aniline and N-methylaniline.

That dianions of the hydrazines are actually formed was shown by observing the disappearance of the CH_3Li proton resonance at τ 11.91 in unquenched reaction solutions containing excess methyllithium. One equivalent of CH_3Li reacts with **1** within the time of mixing, and a second equivalent of CH_3Li disappears over several hours. The decrease of CH_3Li resonance is accompanied by a decrease in the N-H resonance at τ 6.1–6.2 as the dianion is formed. The nmr studies suggest that, although reaction of **1a** with a second equivalent of CH_3Li to form **1b** is slow, the rearrangement of **1b** to **3b** is even slower, so that rearrangement is ultimately rate determining.

These experiments show that phenyl-substituted hydrazines will undergo anionic rearrangement, but only as their dianions and then only very slowly.[5] In contrast, anions of silyl-substituted hydrazines appear to rearrange with a half-time of less than 10^{-3} sec at $-80°$. The striking differences between these classes of compounds emphasizes the unique mobility of the organosilyl moiety in anionic rearrangements. The course of anionic rearrangement may be quite different for silyl-[4] and arylhydrazines; the mechanism of the latter reactions is under investigation.

[5] 1,2 migration of phenyl in arylhydrazine anions appears to be much slower than the corresponding rearrangement of aryl groups in ethanes. See E. Grovenstein, Jr., and G. Wentworth, *J. Am. Chem. Soc.*, **89**, 1852 (1967).

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Measurement of Racemization in Peptide Synthesis by Nuclear Magnetic Resonance Spectroscopy

Sir:

A major problem in the synthesis of peptides is associated with the degree of racemization at the coupling stage.[1] For example, the combination of two optically active, suitably blocked amino acids in an idealized system affords a dipeptide whose steric purity is ascertained by the isolation of any enantiomers or diastereoisomers, employing such techniques as countercurrent distribution,[2] fractional crystallization,[3–5] and gas–liquid partition,[6,7] paper,[8,9] and thin layer[10] chromatography. Many experiments have evaluated the effect of changing activating agents, acyl protecting groups, amino components, bases, salts, solvents, and temperatures on the optical purity of the condensation reaction.[11–13] It is still difficult to untangle these entwined factors in detail due to the paucity of separable model peptide pairs.

Recently, a series of diastereoisomeric N-acylalanylphenylalanine methyl esters and N-acylphenylalanylalanine methyl esters were shown to possess different

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[1] For reviews, see: E. Schröder and K. Lübke, "The Peptides," Vol. I, Academic Press Inc., New York, N. Y., 1965, p 319; M. Bodanszky and M. A. Ondetti, "Peptide Synthesis," Interscience Publishers, Inc., New York, N.Y., 1966, p 137.

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