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A NOVEL AND SIMPLE METHOD FOR THE PREPARATION OF IMINIUM SALTS

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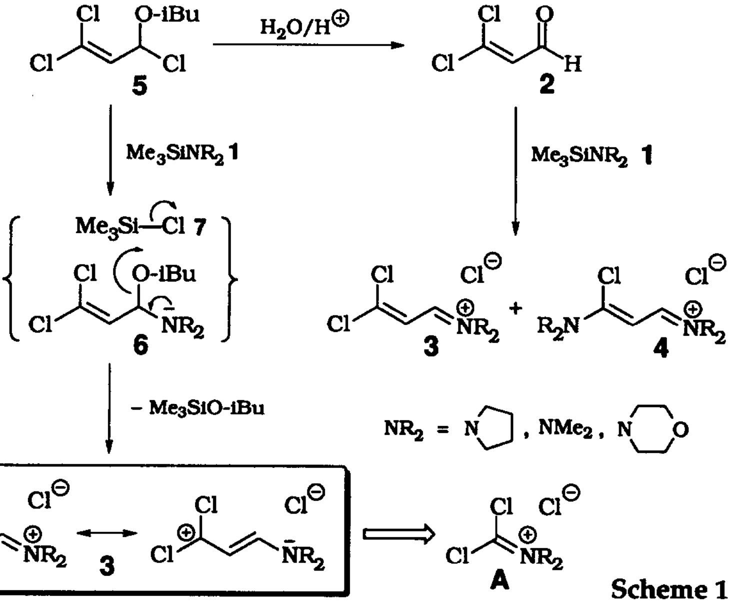
Abstract: α-Chloroethers such as chloromethyl alkyl ethers or 1,3,3-trichloro-1-isobutoxyprop-2-ene react with trimethylsilyl-N,N-dialkylamines to give the *Mannich*-reagent and new 3,3-dichloroprop-2-en-1-ylidene-N,N-dialkyliminium chlorides (vinylogous *Viehe*-reagents), respectively. Extension of this method leads to the reagent system trimethylsilyl-N,N-dialkylamine/trimethylsilylchloride or -triflate, which allows the direct conversion of carbonyl compounds into iminium salts.

Iminium salts play an important role in organic chemistry.[1] Particularly in regard to the increasing importance of carbanion chemistry, interest is growing concerning the development of synthetic approaches which allow the isolation of these classical electrophilic intermediates.[2] The utilization of such stable intermediates offers many advantages over the *in situ* generation of these species. So far there are a few methods for preparing such species.[1,3-5] Mostly they are not general and require either a preceding functionalization[4] of the carbonyl compound or the use of dangerous mixtures like ammonium perchlorates.[5]

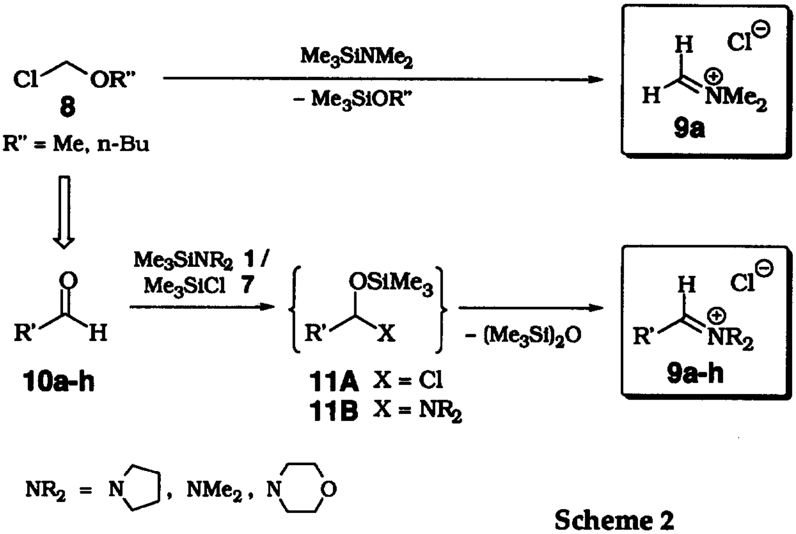
In the course of our studies of the reactivity of trimethylsilyl-N,N-dialkylamines **1** towards activated halogen compounds such as β-chlorovinylketones[6] we became interested in the behaviour of 3,3-dichloroacrolein **2**. Whereas β-chlorovinylketones react exclusively under chloro substitution, we obtained a mixture of the new 3,3-dichloroprop-2-en-1-ylidene-N,N-dialkyliminium chlorides **3** and the chlorotrimethinium salts **4** (scheme 1).



Scheme 1

In order to gain a clean and efficient access to the 1,3-electrophilic iminium salts **3** which formally represent vinylogues of the *Viehe*-reagent **A**, we have chosen 1,3,3-trichloro-1-isobutoxyprop-2-ene **5**, the nonconjugated precursor of 3,3-dichloroacrolein. The reactivity of **5** is limited to the α-chloroether function. This allows the isolation of **3** in about 80% yield. The course of the reaction was monitored by ^{29}Si nmr spectroscopy. After mixing the chloroether **5** with trimethylsilyl-N,N-dimethylamine in $CDCl_3$ we detected the resonance of trimethylchlorosilane **7** as the main signal, which could have resulted only from a substitution of the silylamine forming the α-aminoether **6**. In the second step **7** acts as anether cleavage reagent leading in an irreversible reaction to the iminium salt and trimethylsilyl ether. This is in agreement with investigations of *Heaney* and coworkers[7] who studied the reactivity of halosilanes towards α-aminoethers.

This procedure is applicable to other α-chloroethers of nonenolizable aldehydes, too. Reaction of chloromethyl methyl ether or chloromethyl butyl ether **8** with trimethylsilyl-N,N-dimethylamine in ether results in the formation of the MANNICH-reagent **9a** in almost quantitative yield (scheme 2). It is worth mentioning here that the chloroethers have to be free of dissolved HCl in order to avoid product contamination with amine hydrochloride.



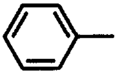
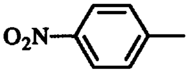
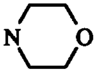
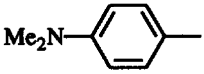
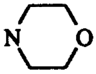
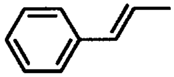
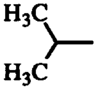
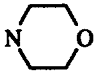
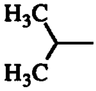
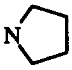
Scheme 2

The possibility of extending this method is evident: Regardless whether a carbonyl compound **10** adds first to silylamine **1** or chlorosilane **7** intermediates **11A** or **11B** result which can be cleaved as described above. This principle works well in many cases. The method is applicable to a wide range of aromatic and nonenolizable aliphatic aldehydes and formic acid derivatives.[8] The results are shown in the table.

The reaction proceeds *via* addition of the silylamine followed by cleavage of the resulting unstable α-silyloxymethylamine **11B** as could be shown by ^{13}C and ^{29}Si nmr measurements. In a representative ^{13}C nmr experiment the carbonyl resonance at 191 ppm belonging to benzaldehyde disappeared after addition of trimethylsilyl-N,N-dimethylamine, simultaneously a signal at 89,6 ppm belonging to the quaternary carbon appeared. In contrast the ^{13}C and ^{29}Si nmr spectra remain unchanged after the addition of **7** to benzaldehyde alone. In the case of dimethylformamide, however, evidence for a competing first addition of both trimethylsilyl-N,N-dimethylamine and trimethylchlorosilane is given from appropriate nmr measurements.

The main limitation is the failure of the desired reaction with enolizable carbonyl compounds. According to *Weinreb* et al.[9] who applied silylamines in the syntheses of enamines, the latter are formed, too (scheme 3). GC/MS studies of the reaction mixture of cyclohexanone **10i**, trimethylsilylmorpholine and **7** indicate that the cleavage of

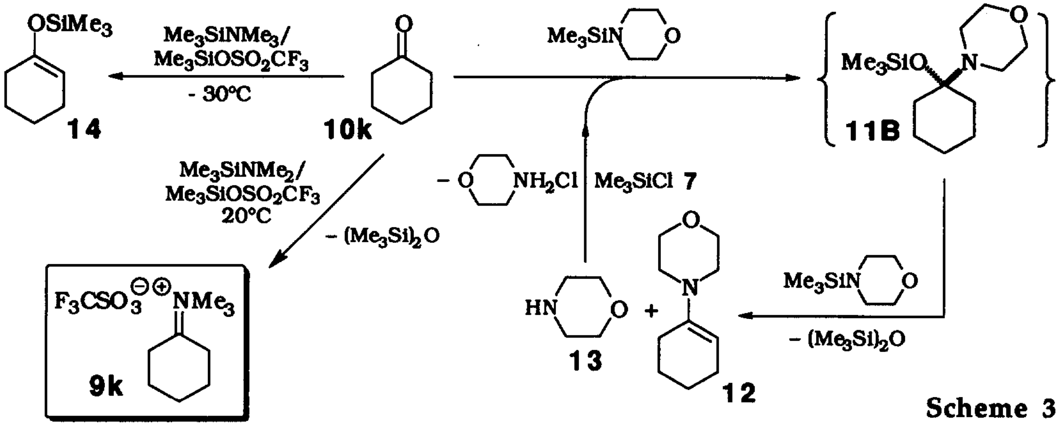
Table: Iminium Salts from Carbonyl Compounds and Trimethylsilyl-N,N-dialkylamines/Trimethylchlorosilane

compound	R'	NR$_2$	characteristic nmr signals N-CH$_{2(3)}$	^{1}H nmr ^{13}C nmr	characteristic nmr signals CH=N	time (h)	yield (%)[a]
9a[b]	H	NMe$_2$	3.78		8.52	2	93
9b			4.11/4.36 54.0/95.7		10.08 168.5	24	92
9c[c]			4.31 55.7		10.53 169.1	24	89
9d			4.21/4.36 51.1/56.8		9.71 166.5	240	92
9e		NMe$_2$	3.65/3.75 42.1/49.0		9.76 171.8	24	75
9f[c]			4.03 54.2/62.7		9.09 167.3	24	81
9g[d]			3.53/3.78 52.1/58.3		8.52 181.8	24	59
9h[e]	Me$_2$N	NMe$_2$	2.87 39.2/45.5		8.58 156.9	24	89

a) All compounds are characterized by ^{1}H and ^{13}C nmr, IR and elemental analysis. They decompose on heating. - b) Prepared by passing 1.5 equivalents gaseous formaldehyde over one equivalent of the system trimethylsilyl-N,N-dimethylamine/trimethylchlorosilane in 10 ml dry ether. - c) Solvent ether/acetonitrile 5:1. - d) Solvent ether/acetonitrile 10:1, addition of the reagents at 0°C and slow warming to room temperature. - e) Solvent 1 ml dry acetonitrile, after the end of the reaction careful dilution with 25 ml dry ether to precipitate the salt.

the originally formed hemiaminal **11B** occurs by action of unreacted silylmorpholine forming hexamethyldisiloxane, the enamine **12** and morpholine **13** which is now resilylated by trimethylchlorosilane. These limitations could be overcome by use of the more efficient ether cleavage reagent trimethylsilyltriflate. Here the desired iminium salts are isolated in good yields. The reaction requires at least room temperature. At lower temperatures the rate of the addition of the silylamine becomes slow so that formation of the silylenol ether **14** by trimethylsilyltriflate[10] dominates.

On the whole, the method has the advantage of starting from conveniently available materials, of simple procedures and of unproblematical isolation of the products. Finally, these results are promising concerning an easy access to chiral iminium salts. – Detailed information will be given in a subsequent paper.[11]



Scheme 3

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Dedicated to Professor E. V. Dehmlow with the best wishes on the occasion of his 60th birthday

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