

CONJUGATE ADDITION OF N-SUBSTITUTED ORGANO(SILYLIMINO-
METHYL)COPPER(I) TO α,β -UNSATURATED CARBONYL COMPOUNDS

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Summary: The organocopper reagent prepared from [(2,6-xylylimino)-(trialkylsilyl)methyl]lithium undergoes the conjugate addition to α,β -unsaturated carbonyl compounds to produce γ -(2,6-xylylimino)- γ -(trialkylsilyl)carbonyl compounds or the organosilyl ethers of their enols.

Nucleophilic introduction of acyl groups in organic synthesis has been often achieved by use of synthetic equivalents of acyl anions. Although acylmetals may be potentially useful for this purpose, synthetic application of acylmetals has been so far limited,¹⁾ probably due to unavailability and instability of acylmetals. Recently, we reported that [(2,6-xylylimino)-(trialkylsilyl)methyl]lithium (2) generated in situ by transmetalation of

with electrophiles as a synthetic equivalent of organosilylcarbonyl anion and carbonyl dianion.²⁾ The reactions with 2 have provided a new access to organosilylimine derivatives. Herein, we wish to report the conjugate addition of organocopper reagents derived by transmetalation of 1 via 2 to α,β -unsaturated carbonyl compounds.

[(2,6-Xylylimino)(trialkylsilyl)methyl]lithium (2) generated in situ in THF at -78°C reacted with 2-cyclohexenone to give only 1,2-adduct 3-[(2,6-xylylimino)methyl]-3-(trialkylsilyloxy)-1-cyclohexene (3),³⁾ after hydrolysis, in a moderate yield. In contrast, the reactions of [(2,6-xylylimino)-(trialkylsilyl)methyl]copper reagents (4) derived from 2 with 2-cyclohexenone produced the conjugate addition product (6) in a moderate yield under the same conditions (Runs 1-5 of Table). [(2,6-Xylylimino)(trialkylsilyl)methyl]copper

reagents did not afford the conjugate addition product with 2-cyclohexenone. However, Lewis acid and chlorotrialkylsilane efficiently promoted the conjugate addition, giving 3-[(2,6-xylylimino)(trialkylsilyl)methyl]-

2 and copper(I) acetylide remarkably improved the conjugate addition, i.e. 6i was obtained in 83% yield without any additive, and the respective trialkylsilyl enol ethers [7i (75%) and 7ii (68%)] were obtained in the presence of chlorotrialkylsilanes.

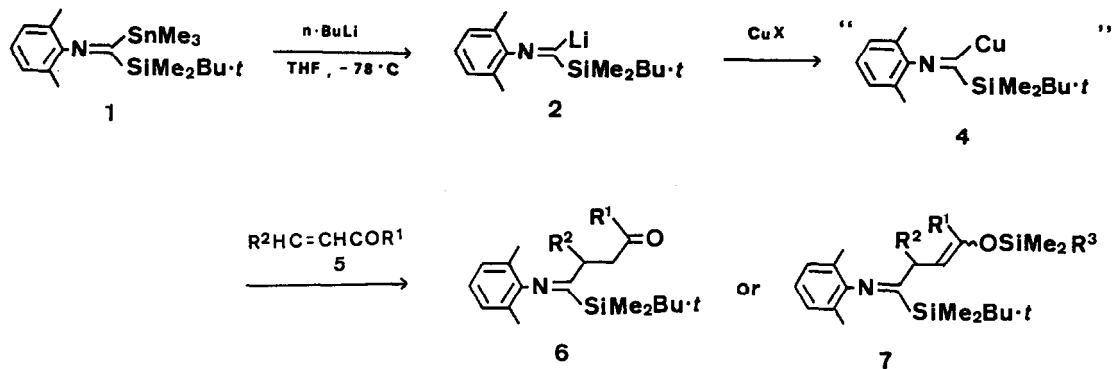


Table.

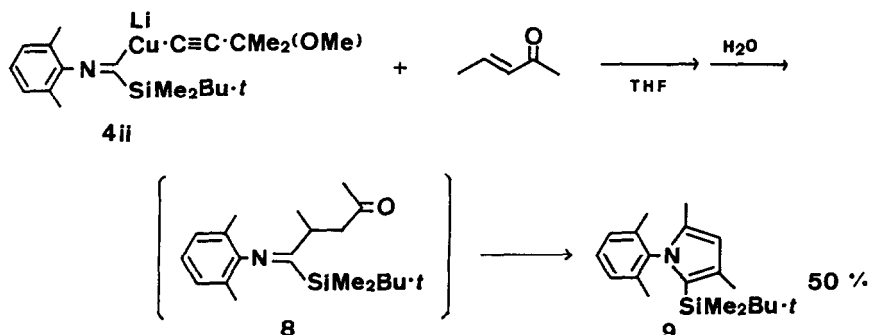
Run	5	4 ^a)	Additive	Product	Yield(%)
1		$\text{Xy-N}(\text{SiMe}_2\text{Bu-t})\text{Cu}$ 4i	$\text{BF}_3 \cdot \text{OEt}_2$	6i	30
2		4i	$\text{Me}_3\text{SiCl-HMPA}$	7i ($\text{R}^3=\text{Me}$)	46
3		$\text{Xy-N}(\text{SiMe}_2\text{Bu-t})\text{Li}$ $\text{Cu-C}\equiv\text{C-CMe}_2(\text{OMe})$ 4ii	—	6i	83
4		4ii	$\text{Me}_3\text{SiCl-Et}_3\text{N}$	7i ($\text{R}^3=\text{Me}$)	75
5		4ii	$t\text{-BuMe}_2\text{SiCl-HMPA}$	7ii ($\text{R}^3=t\text{-Bu}$)	68
6		4i	$\text{BF}_3 \cdot \text{OEt}_2$	6ii	56
7		4ii	—	6ii	30
8	$\text{MeCH}=\text{CHCOMe}$	4ii	$t\text{-BuMe}_2\text{SiCl-HMPA}$	7ii ($\text{R}^3=t\text{-Bu}$)	74
9	$\text{MeCH}=\text{CHCHO}$	4ii	$t\text{-BuMe}_2\text{SiCl-Et}_3\text{N}$	7iv ($\text{R}^3=t\text{-Bu}$)	70
10	$\text{CH}_2=\text{CHCHO}$	4ii	$t\text{-BuMe}_2\text{SiCl-Et}_3\text{N}$	7v ($\text{R}^3=t\text{-Bu}$)	70

a) The organocopper reagents (4i and 4ii) were prepared in situ by addition of a THF-dimethylsulfide (1:1) solution of copper(I) bromide dimethylsulfide (1.0 equiv) and a THF solution of copper(I) acetylide⁴⁾ (1.1 equiv), respectively, to a THF solution of 2 at -78°C , and stirring the mixture at the same temperature. Xy- = 2,6-xylyl.

The conjugate additions of [(2,6-xylylimino)(trialkylsilyl)methyl]copper reagents (4) with some other α,β -unsaturated carbonyl compounds are shown in Runs 6-10. The reaction of 2-cyclopentenone with organocopper reagents (4) was still unsatisfactory. With the mixed cuprate (4ii) in the presence of chlorotrialkylsilane, 2-cyclopentenone gave the corresponding silyl enol ether

in the presence of chlorotrialkylsilane (Runs 8-10). Of interest is that the similar treatment of organocopper (4ii) with acyclic α,β -unsaturated carbonyl compounds in the absence of chlorotrialkylsilane resulted in the formation of

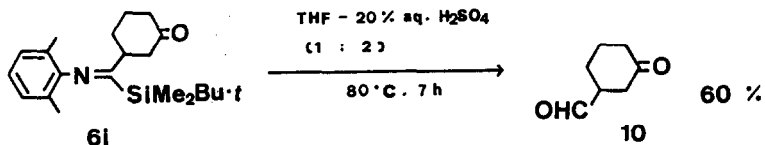
aqueous workup.



Typical experimental procedure for the synthesis of the conjugate addition product (5) is as follows: To a stirred THF solution (0.5 ml) of 3-methoxy-3-methylbut-1-yne (125 mg, 1.27 mmol) was added a hexane solution of n-butyllithium (0.92 ml, 1.28 mmol) at 0°C under nitrogen. The resulting pale yellow solution was added to a suspension of copper(I) iodide in THF (0.5 ml) at 0°C to give dark brown solution, which was then transferred to a THF solution of [(2,6-xylylimino)(tert-butyl dimethylsilyl)methyl]lithium prepared

temperature, and the mixture was warmed to room temperature over about 3 h. Extractive workup with ether and subsequent TLC on silica gel gave 6i (228 mg, 83%). Analytical sample was prepared by Kugelrohr distillation; b.p. 200°C (pot temperature, 0.4 mmHg). IR (neat) 1716, 1612, 1592 cm^{-1} ; ^1H NMR (CDCl_3 , cyclohexane as an internal standard) δ -0.31~0.36 (6H, br), 1.00 (9H, s), 1.19~3.05 (9H, br), 1.99 (3H, s), 2.00 (3H, s), 6.70~7.05 (3H, br); MS m/z 343 (M^+), 246 ($\text{M} - 3\text{-oxocyclohexyl}$). Anal. (%) Calcd for $\text{C}_{21}\text{H}_{33}\text{NOSi}$: C, 73.41; H, 9.68; N, 4.08. Found: C, 73.20; H, 9.59; N, 4.03.

The 1,4-addition product (6i) thus obtained was hydrolyzed to γ -oxoaldehyde (10) by treatment with aqueous sulfuric acid.⁵⁾



Extensions of the present methodology are now in progress in our laboratory.

References and Notes.

- 1) (a) H. M. Walborsky and G. E. Niznik, *J. Am. Chem. Soc.*, **91**, 7778 (1969).
 (b) G. E. Niznik, W. H. Morrison, III, and H. M. Walborsky, *J. Org. Chem.*, **39**, 600 (1974).
 (c) D. Seyferth and R. M. Weinstein, *J. Am. Chem. Soc.*, **104**, 5534 (1982).
 (d) Y. Ito, H. Imai, T. Matsuura, and T. Saegusa, *Tetrahedron Lett.*, **25** 3091 (1984).
 (e) D. Seyferth and R. C. Hui, *J. Am. Chem. Soc.*, **107**, 4551 (1985).
- 2) (a) Y. Ito, T. Bando, T. Matsuura, and M. Ishikawa, *J. Chem. Soc., Chem. Commun.*, **1986**, 980.
 (b) Y. Ito, T. Matsuura, and M. Murakami, *J. Am. Chem. Soc.*, in press.
- 3) 3: bp 160°C (pot temperature by Kugelrohr distillation, 0.1 mmHg). IR (neat) 1668, 1596 cm^{-1} . ^1H NMR (CDCl_3 , cyclohexane as an internal standard) δ 0.11 (6H, s), 0.87 (9H, s), 1.70~2.24 (6H, br), 2.07 (6H, s), 5.70~6.26 (2H, br), 6.75~7.10 (3H, br), 7.59 (1H, s). MS m/z 343 (M^+), 286 ($\text{M} - t\text{-Bu}$), 211.
- 4) F. J. Carey, D. Floyd, and D. V. Litchner, *J. Org. Chem.*, **43**, 3412 (1978).
- 5) All attempts to hydrolyze 6 to the corresponding γ -oxoacylsilane have so far failed.

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