CHEMISTRY LETTERS, pp. 177-180, 1986.

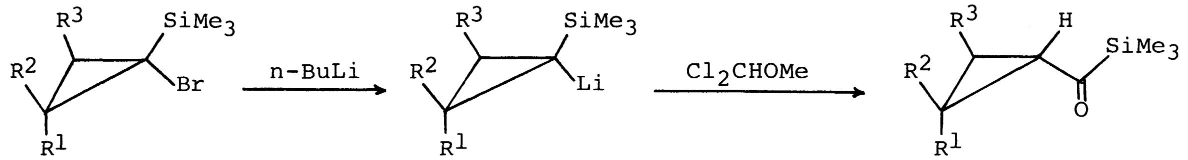
REACTION OF 1-TRIMETHYLSILYLCYCLOPROPYLLITHIUM DERIVATIVES WITH DICHLOROMETHYL METHYL ETHER. A NOVEL SYNTHESIS OF CYCLOPROPYL SILYL KETONES

Tadashi NAKAJIMA,* Masaru TANABE, Katsuhiko OHNO, Masahito SEGI,
and Sohei SUGA
Department of Industrial Chemistry, Faculty of Technology,
Kanazawa University, Kodatsuno, Kanazawa 920

Treatment of 1-trimethylsilylcyclopropyllithium derivatives with dichloromethyl methyl ether affords the corresponding new cyclopropyl silyl ketones in moderate yield. This reaction involves the intramolecular 1,2-silicon shift from carbon to carbon.

Silyl ketones have become of interest as valuable intermediates in organic synthesis[1)] and have been prepared by a variety of methods,[1,2)] only a limited number of which show useful flexibility.[2a-c,3)] However, none of the synthetic methods reported so far could be applied to the preparation of cyclopropyl silyl ketones. Danheiser et al.[4)] have very recently demonstrated a first synthesis of cyclopropyl trialkylsilyl ketone, which was derived through two steps from α,β-unsaturated trialkylsilyl ketone.

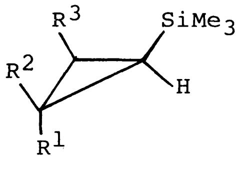
In this paper, we wish to report that a series of the previously unknown cyclopropyl trimethylsilyl ketones (**2**) can be successfully prepared by a reaction of 1-trimethylsilylcyclopropyllithium derivatives (**1'**) with dichloromethyl methyl ether (DCME) (Scheme 1). This reaction accompanied the formation of silylcyclopropane (**3**). Although DCME is well known to be an useful formylating agent in the presence of Lewis acid,[5)] the use of this reagent under basic conditions has been limited to the special cases.[5a,6)] In the present reaction, it is interesting that the intramolecular 1,2-silicon shift from carbon to carbon took place.



1a-g **1'a-g** **2a-g**

+

	a	b	c	d	e	f	g
R^1	H	H	Me	H	Me	H	H
R^2	$(CH_2)_4$	Ph	H	Me	Me	H	n-Bu
R^3		H	Me	Me	H	H	H



3a-g

Scheme 1.

General procedure is as follows. To a solution of the readily available 1-bromo-1-trimethylsilyl cyclopropane7) (**1a-g**, 10 mmol) in dry THF (30 ml) was added n-butyllithium (11 mmol) in hexane dropwise at -95 – -100 °C under nitrogen. The resulting solution was stirred there for 30 min. The lithiocyclopropane (**1'a – g**) thus obtained was treated with DCME (12 – 15 mmol) in THF (5 ml) dropwise at -95 °C. After being stirred for 2 – 3 h at the same temperature, MeOH (2 ml) was added to the mixture. The resulting mixture was then allowed to come to room temperature and poured into brine, and the products were extracted several times with ether. The combined ether layers were washed to neutrality with brine, dried over Na_2SO_4, and concentrated *in vacuo*. The residue was subjected to column chromatography on silica gel using hexane and then ether as eluents. The ether fraction was concentrated and distilled to give the corresponding cyclopropyl silyl ketone (**2a – g**). The hexane fraction gave **3a – g**. Some results are summarized in Table 1.

Table 1. Reaction of 1-trimethylsilylcyclopropyllithium derivatives with dichloromethyl methyl ether (DCME)

Entry	Starting silyl bromide	Silyl ketone			Silylcyclopropane		
			Yield/%a)	*cis* /*trans*c) (*endo*/ *exo*)		Yield/%a)	*cis* /*trans*c) (*endo*/ *exo*)
1	**1a**	**2a**	50	14/ 86	**3a**	40	66/34
2	**1b**	**2b**	46	43/ 57	**3b**	42	40/60
3	**1c**	**2c**	39		**3c**b)		
4	**1*c**	**2*c**	23		**3*c**b)		
	(* Silyl group = $SiMe_2Et$)						
5	**1d**	**2d**	16	0/100	**3d**b)		
6	**1e**	**2e**	35		**3e**b)		
7	**1f**	**2f**	30		**3f**b)		
8	**1g**	**2g**	35	40/ 60	**3g**	40	40/60
9	**1a + 1*c**	**2a + 2*c**					

a) Based on **1** used, and determined by GLC. b) **3** could not be recovered quantitatively because of their low bp. c) Relationship between the silylcarbonyl group (or silyl group) and the alkyl (or aryl) substituents on the three-membered ring. The stereochemistry was assigned by ^{1}H-NMR and the isomer ratio was determined by GLC.

The new cyclopropyl silyl ketones (**2**) obtained here have been characterized by their typical spectral properties. The carbonyl group of **2** absorbs at longer wavelengths in both IR and UV, and at lower fields in ^{13}C-NMR, relative to that of the analogous cyclopropyl alkyl (or aryl) ketones,8,9) as shown in Table 2.

The conversion of **1a** (95% *endo*-TMS) and **1d** (100% *cis*-TMS) into the ketones proceeded stereospecifically to give *exo*(or *trans*)-silylcarbonyl isomer, while the reaction using **1b** (100% *cis* Ph/TMS) and **1g** (100% *cis* n-Bu/TMS) afforded the diastereoisomeric mixture as shown in Table 1. These results are compatible with the reported stereochemical behavior of the intervening lithiocyclopropane (**1'**).10) We also found that **1'b** easily isomerized to the thermodinamically favorable form (*trans* Ph/TMS) and that the equilibrium between two forms (*cis*/*trans*=40/60) was attained within 5 min at -100 °C after the addition of n-BuLi to **1b**.11) The silyl-

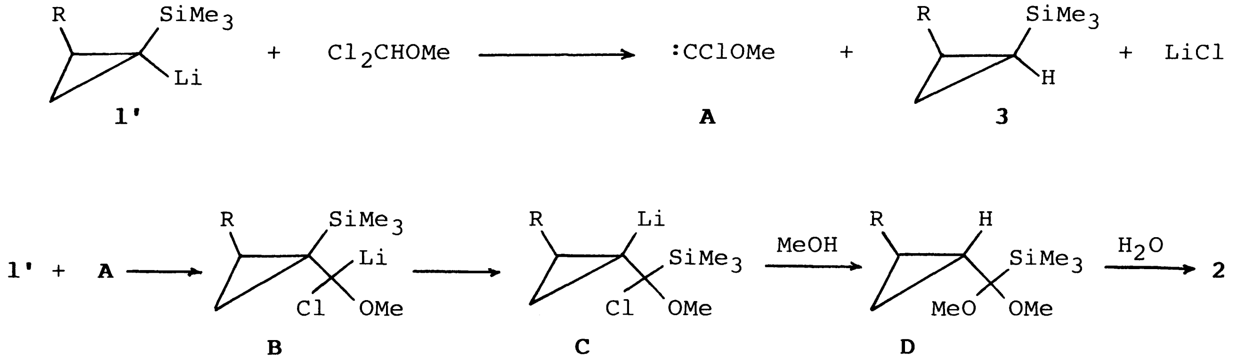
Table 2. Physical data of new cyclopropyl silyl ketones

Silyl	^{13}C-NMR δ/ppm$^{a)}$		IR ν/cm$^{-1 b)}$	UV λ_{max}/nm$^{c)}$	Bp
ketone	C=O	$SiMe_3$	C=O	*n* → π*(ε)	θ_b/°C(Torr)$^{d)}$
2a	245.3	-3.5	1620	365 (68)	69(1.5)
2b	242.8$^{e)}$(244.4)$^{f)}$	-3.4$^{e)}$(-3.7)$^{f)}$	1630	396 (108)	63(0.3)
2c	246.3	-3.4	1620	371 (99)	62(9)
2d	245.2	-3.5	1613	366 (108)	45(2.3)
2e	245.3	-3.5	1620	371 (124)	71(2.5)
2f	246.6	-3.2	1629	365 (132)	50(40)

a) Downfield from internal TMS in $CDCl_3$. b) As film liquid. c) In cyclohexane.
d) 1 Torr = 133.322 Pa. e) *cis* Ph/$COSiMe_3$. f) *trans* Ph/$COSiMe_3$.

cyclopropanes (**3**) were obtained as diastereoisomeric mixture containing the *exo*-silyl isomer in large quantities compared with the isomer ratio expected from the stereochemical purity of **1** used. When an equimolar mixture of **1a** and **1*c** was treated with n-BuLi/DCME, the silyl ketones obtained were **2a** and **2*c** with no crossover products (entry 9). Thus, this reaction to **2** involves the intramolecular 1,2-silicon shift from carbon to carbon.12)

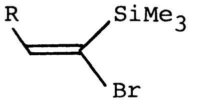
A plausible reaction path is represented in Scheme 2. The lithiocyclopropane (**1'**) derived from **1** reacts with DCME to generate methoxychlorocarbene (**A**) as a first reactive intermediate. The addition of **A** to **1'** can be expected to result in the formation of methoxycarbenoid intermediate (**B**)13) which is then converted into cyclopropyl anion species (**C**) by the 1,2-migration of the silyl group. Thus the half equivalent of **1'** used is converted into **3**. The final step can be interpreted by the reaction of **C** with methanol to afford an acetal derivatives (**D**) which would react with water to produce the silyl ketone (**2**).



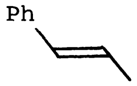
Scheme 2.

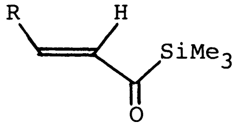
Although no direct evidence for the generation of methoxychlorocarbene from DCME has been obtained at this time, this reaction appears to be very probable taking into account the fact that dichloromethyl phenyl ether reacts with strong bases in the presence of olefines to yield 1-chloro-1-phenoxycyclopropanes,14) the formation of which indicates the intermediacy of carbene.

Similar treatment of (*E*)-1-bromo-1-trimethylsilyl-2-phenylethene (**4a**) and (*E*)-1-bromo-1-trimethylsilyl-4-phenyl-1,3-butadiene (**4b**) with n-BuLi/DCME gave the corresponding α,β-unsaturated silyl ketones (bright orange colored oil), **5a** (40%



4a−**b**

	a	b
R	Ph	



5a−**b**

yield) and **5b** (21% yield), respectively.

A study to find the scope and limitation of this method is now in progress.

References

1) A. G. Brook, Adv. Organomet. Chem., 7, 95 (1968), and references cited therein; J. Miller and G. Zweifel, J. Am. Chem. Soc., 103, 6217 (1981); H. J. Reich, M. J. Kelly, R. E. Olson, and R. C. Holton, Tetrahedron, 39, 949 (1983); T. Sato, K. Matsumoto, T. Abe, and I. Kuwajima, Bull. Chem. Soc. Jpn., 57, 2167 (1984).

2) a) A. G. Brook, J. M. Duff, P. F. Jones, and N. R. Davis, J. Am. Chem. Soc., 89, 431 (1967); b) E. J. Corey, D. Seebach, and R. Freeman, ibid., 89, 434 (1967); c) I. Kuwajima, T. Abe, and N. Minami, Chem. Lett., 1976, 993; d) J.-P. Picard, R. Calas, J. Dunoguès, N. Duffaut, J. Gerval, and P. Lapouyade, J. Org. Chem., 44, 420 (1979); e) K. Yamamoto, S. Suzuki, and J. Tsuji, Tetrahedron Lett., 21, 1653 (1980); f) J. A. Sorderquist and A. Hassner, J. Am. Chem. Soc., 102, 1577 (1980).

3) a) D. Seyferth and R. M. Weinstein, J. Am. Chem. Soc., 104, 5534 (1982); b) S. Murai, I. Ryu, J. Iriguchi, and N. Sonoda, ibid., 106, 2440 (1984); c) T. Mandai, N. Yamaguchi, Y. Nakayama, J. Otera, and M. Kawada, Tetrahedron Lett., 26, 2675 (1985).

4) R. L. Danheiser and D. M. Fink, Tetrahedron Lett., 26, 2513 (1985).

5) a) H. Gross, Z. Chem., 18, 201 (1978), and references cited therein; b) K. Yamamoto, J. Yoshitake, N. T. Qui, and J. Tsuji, Chem. Lett., 1978, 859.

6) H. C. Brown, "Organic Syntheses via Boranes," Wiley, New York (1975), p. 133.

7) R. L. Lambert, Jr. and D. Seyferth, J. Am. Chem. Soc., 94, 9246 (1972); T. Hiyama, A. Kanakura, H. Yamamoto, and H. Nozaki, Tetrahedron Lett., 1978, 3047.

8) Cyclopropyl methyl ketone has νC=O at 1704 cm^{-1} in IR and $\lambda_{max}(n \rightarrow \pi^*)$ at 277 nm in UV: J.-P. Pete, Bull. Soc. Chim. Fr., 1976, 357.

9) The carbonyl carbon of cyclopropyl methyl ketone resonates at δ 205.9 ppm in ^{13}C-NMR: D. H. Marr and J. B. Stothers, Can. J. Chem., 45, 225 (1967).

10) The lithiocyclopropane such as **1'b** has been pointed out to be configurationally unstable even at -100 °C: T. Hiyama, A. Kanakura, Y. Morizawa, and H. Nozaki, Tetrahedron Lett., 23, 1279 (1982).

11) This result is based on the time dependence of the products distribution in the reaction of **1b** with n-BuLi at -100 °C (after MeOH quenching).

12) Recently, Murai et al. have reported similar silicon shift in the reaction of silylalkyllithium with carbon monoxide.$^{3b)}$

13) Chlorocarbene has been known to react with alkyllithium to yield 1-chloroalkyllithium: G. L. Cross, J. Am. Chem. Soc., 84, 809 (1962).

14) U. Schöllkopf, Angew. Chem., Int. Ed. Engl., 7, 588 (1968).

(Received November 2, 1985)