

A SYNTHESIS OF 5-SILACYCLOTRIVERATRYLENES†

Hiroshi Hara, Hiroya Satoh, and Osamu Hoshino*

Faculty of Pharmaceutical Sciences, Science University of Tokyo, Shinjuku-ku,
Tokyo 162, Japan

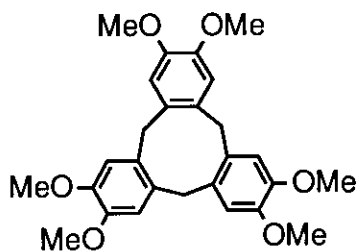
Abstract---- The dilithio compound (4), derived from 4,5-bis(6-bromoveratryl)-veratrol (3), reacted with dichlorodimethylsilane to give 5,5-dimethyl-5-silacyclocotrimeratrylene (2a). Similarly, several 5-silacyclocotrimeratrylenes (2b, 2c, and 2d) and a methylenedioxy analogue (6) were prepared. On the basis of ¹H-nmr spectra flexible conformation of the sila-heterocyclic system was elucidated.

Cyclotrimeratrylene (1) and its analogues have been widely studied because of their interesting properties such as conformational behavior and host compounds.¹ Although many investigations on their synthesis have been reported so far, a few cyclotribenzylene and cyclotrimeratrylene derivatives, methylene groups in which were replaced with hetero atom such as oxygen,² sulfur,^{2,3} or silicon, have been synthesized. Among them, only one example on synthesis of trisilacyclocotribenzylene⁴ as a silicon containing compound has been reported. Therefore, we have been interested in synthesis of silacyclocotrimeratrylenes and their conformational behavior. Here we wish to report a first synthesis of 5-silacyclocotrimeratrylenes (2).

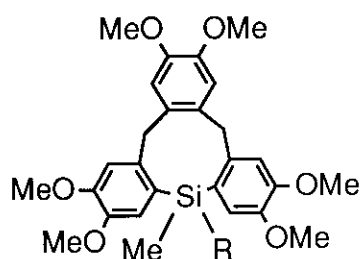
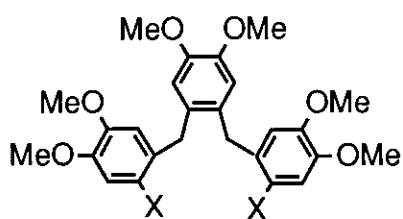
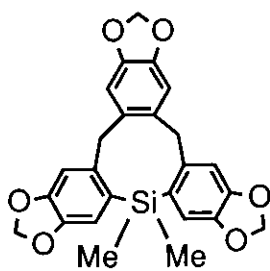
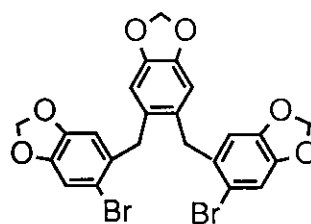
Previously, we have reported that bromination of cyclotrimeratrylene (1) cleaves the ring to give rise to 4,5-bis(6-bromoveratryl)veratrole (3).⁵ The dibromide (3) is anticipated to be a key compound for synthesis of 5-silacyclocotrimeratrylene; dilithiated compound (4) generated from 3 could react with compounds containing silicon-halogen or silicon-oxygen bonds to give silacyclocotrimeratrylene system.⁶

In order to confirm generation of 4 from 3, lithiation of 3 was carried out. After addition of *n*-BuLi (2.5 eq.) to tetrahydrofuran solution of 3⁷ at -50°C the mixture was stirred at the same temperature, and then quenched

† Dedicated to Professor Emeritus Masatomo Hamana on the occasion of his 75th birthday.



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2a: R=Me2b: R=CH₂Cl2c: R=CH=CH₂2d: R= 3: X=Br4: X=Li5: X=D67

by excess deuteromethanol to afford a dideutero product (5). ^1H -Nmr spectrum of 5 showed three singlets of aromatic protons demonstrating formation of the dilithiated compound (4).

Thus, reaction of 4 with dichlorodimethylsilane (1.1 eq.) at -50°C for 1 h and subsequent quenching with aqueous ammonium chloride afforded 5,5-dimethylsilacyclotrimeratrylene (2a),⁸ mp 174°C , in 54% yield, ^1H -nmr spectrum of which showed six kinds of singlets [δ 0.54 (6H, SiMe_2), 3.73 (6H, OMe), 3.87 (12H, OMe), 6.58, 6.72, 6.98 (each 2H, ArH)]. The data verified the symmetrical structure of the sila compound (2a). Methylene protons in the ^1H -nmr spectrum could not be observed clearly because of being overlapped by numerous protons of six methoxyl groups, while those⁹ of cyclotrimeratrylene (1) appear characteristically as AB pattern to clarify the rigid conformation. This findings suggested that 2a might exist as a flexible conformation.¹

For the purpose of revealing the flexible conformation, we tried to synthesize a methylenedioxy analogue (6) having no obstructive protons in the region (δ 3.5-4.0) of resonance due to methoxyl protons in the ^1H -nmr spectrum. By similar protocol as above, the dibromide (7)^{8,10} (mp 204°C) was prepared from methylenedioxybenzene and 6-bromopiperonyl alcohol. Analogous treatment of the dibromide (7) as described above gave 5,5-dimethyl-5-silacyclotripiperonylene (6)^{8,10} in 36% yield. As we would expect, in the ^1H -nmr spectrum, methylene protons appeared clearly but as broad singlet at δ 3.80 without splitting pattern. Thus, conformation of these sila derivatives must be flexible undoubtedly.

Similarly, reaction of the dilithiated compound (4) with some dichlorosilano reagents produced 5-chloromethyl- (2b),^{8,10} 5-vinyl- (2c),^{8,10} and 5-phenyl- (2d)^{8,10} 5-methyl-5-silacyclotrimeratrylenes in the yields of 43, 40, and 23%, respectively. On the basis of ^1H -nmr spectra, those sila-heterocycles (2b, 2c, and 2d) should be also flexible molecules.

Construction of other metal-containing cyclophanes could be engaged by this methodology.

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REFERENCES AND NOTES

1. A. Collet, *Tetrahedron*, 1987, **43**, 5725 and references cited therein.
2. T. Sato, K. Uno, and M. Kainosho, *J. Chem. Soc., Chem. Commun.*, **1972**, 579; T. Sato and K. Uno, *J. Chem. Soc., Perkin Trans. I*, **1973**, 895.
3. T. Weiss and G. Klar, *Z. Naturforsch.*, 1979, **34B**, 448 [*Chem. Abstr.*, 1979, **90**, 204069x].
4. H. Sakurai, Y. Eriyama, A. Hosomi, Y. Nakadaira, and C. Kabuto, *Chemistry Lett.*, **1984**, 595.
5. B. Umezawa, O. Hoshino, H. Hara, and S. Mitsubayashi, *J. Chem. Soc. C*, **1970**, 465.
6. J. Y. Corey and E. R. Corey, *Tetrahedron Lett.*, **1972**, 4669; J. Y. Corey, "Advances in Organometal Chemistry", Vol., 13, ed. by F. G. A. Stone and R. West, Academic Press, New York, 1975, pp. 139-271.
7. The bromide (3) was practically prepared in 75% yield by reaction of 6-bromoveratryl alcohol (2 eq.) with veratrole (1 eq.) in the presence of concentrated sulfuric acid.
8. All new compounds described in the text gave satisfactory mass spectral and microanalytical data.
9. B. Umezawa, O. Hoshino, H. Hara, and J. Sakakibara, *Chem. Pharm. Bull.*, 1968, **16**, 177; B. Umezawa, O. Hoshino, H. Hara, K. Ohyama, S. Mitsubayashi, and J. Sakakibara, *ibid.*, 1969, **17**, 2240.
10. **2b**: mp 141°C. $^1\text{H-Nmr}$ δ 0.70 (3H, s, SiMe), 3.23 (2H, s, SiCH₂Cl), 3.76 (6H, s, 2xOMe), 3.89 (12H, s, 4xOMe), 6.61, 6.73, 7.09 (each 2H, s, ArH); **2c**: mp 68°C. $^1\text{H-Nmr}$ δ 0.67 (3H, s, SiMe), 3.76, 3.87, 3.90 (each 6H, s, 2xOMe), 6.61, 6.74, 7.00 (each 2H, s, ArH); **2d**: mp 85°C. $^1\text{H-Nmr}$ δ 0.85 (3H, s, SiMe), 3.70, 3.77, 3.90 (each 6H, s, 2xOMe), 6.68, 6.80, 6.88 (each 2H, s, ArH); **6**: mp 236-237°C. $^1\text{H-Nmr}$ δ 0.49 (6H, s, SiMe₂), 3.80 (4H, bs, 2xCH₂), 5.84 (4H, s, 2xOCH₂O), 5.88 (2H, s, OCH₂O), 6.60, 6.68, 6.96 (each 2H, s, ArH).

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