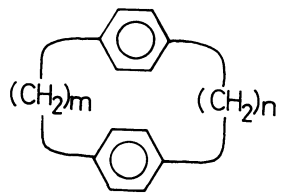
CHEMISTRY LETTERS, pp. 43-46, 1977. Published by the Chemical Society of Japan

SYNTHESES OF [3.3]PARACYCLOPHANES AND THEIR HIGHER CYCLIC OLIGOMERS

Teruo SYNMYOZU, Kimitaka KUMAGAE,[1] Takahiko INAZU, and Tamotsu YOSHINO
Department of Chemistry, Faculty of Science, Kyushu University,
Hakozaki 6-10-1, Higashi-ku, Fukuoka 812

Tetraethyl [3.3]paracyclophane-2,2,11,11-tetracarboxylate, its 5,8-dimethyl and 5,6,8,9-tetramethyl homologues, and respective higher cyclic oligomer(s) were synthesized by condensation of tetraethyl p-diethylbenzene-$\omega,\omega,\omega',\omega'$-tetracarboxylate with 1,4-bis(bromomethyl)-benzene, and its 2,5-dimethyl and 2,3,5,6-tetramethyl homologues in presence of sodium hydride under high dilution condition, respectively. 5,6,8,9-Tetramethyl[3.3]paracyclophane was obtained by hydrolysis, decarboxylative chlorination and reduction of tetraethyl 5,6,8,9-tetramethyl[3.3]paracyclophane-2,2,11,11-tetracarboxylate.

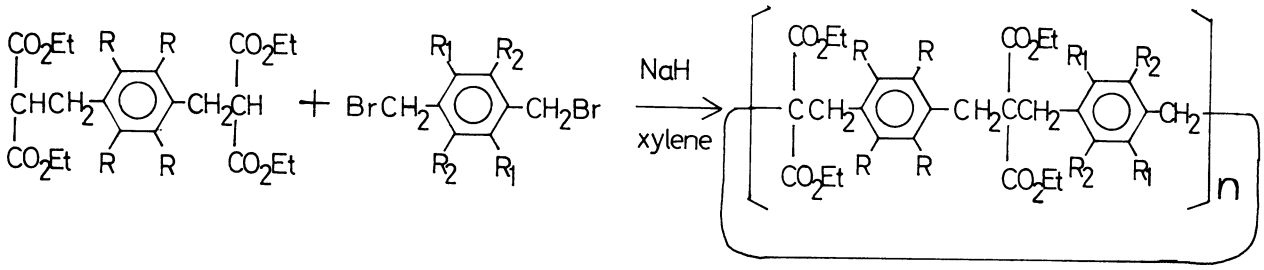


I

[m.n]Paracyclophane[2] I, especially [3.3]paracyclophane[3] (abbreviated as [3.3]PC or [3^2]PC), has been noted to form a stable charge-transfer complex with tetracyanoethylene. For investigation of transannular interaction, [3.3]PC may be more suitable, because of less strain and more flexibility, than [2.2]paracyclophane. However, only a few studies on [3.3]PC have been reported because few useful synthetic methods have been found as yet except syntheses from [2.2]-paracyclophane.[4] In the present paper, we wish to report synthesis of [3.3]PC's as an application of a synthetic method for [3.3]metacyclophane reported previously.[5]

A xylene solution of tetraethyl p-diethylbenzene-$\omega,\omega,\omega',\omega'$-tetracarboxylate II and 1,4-bis(bromomethyl)benzene derivatives IIIa, b or c was added to an excess of sodium hydride in refluxing xylene under high dilution condition(shown in Scheme 1). The crude products were separated by chromatography on silica gel and crystallized. Elemental analysis and molecular weight determination data of all new compounds were

satisfactory. Tetraethyl [3.3]paracyclophane-2,2,11,11-tetracarboxylate(IVa; n=1), its 5,8-dimethyl(IVb; n=1), 5,6,8,9-tetramethyl homologue(IVc; n=1) and their higher cyclic oligomers(IVa, b or c; n=2,3, or 4) were synthesized. The results are listed in Table 1.



II a R=H
b R=CH_3

III a $R_1=R_2=H$
b $R_1=CH_3$, $R_2=H$
c $R_1=R_2=CH_3$

IV a R=H, $R_1=R_2=H$
b R=H, $R_1=CH_3$, $R_2=H$
c R=H, $R_1=R_2=CH_3$

Scheme 1

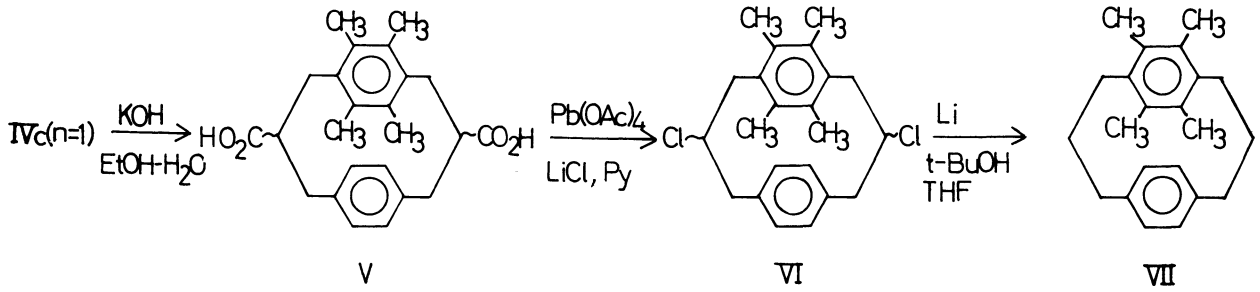
Table 1.

Units		Yield(%)	Mp(°C)
IVa;	n=1	0.05	127.5-128.3
	n=2	3.8	218-219
	n=3	8.4	184-185
IVb;	n=1	0.27	112.8-113.2
	n=2	1.5	203.5-204.5
IVc;	n=1	4.1	149-150
	n=2	1.8	192-194
	n=3	3.3	94-95
	n=4	2.4	119-120

The yield of [3.3]PC's (IVa, b or c; n=1 in Table 1.) seems to increase with increasing number of methyl groups in the dibromide III's and therefore the yield may depend on the reactivity of the dibromides III's. This inference is supported by the following fact: the condensation between IIa and IIIc gave IVc(n=1), which could not be synthesized by the condensation between IIb and IIIa.

Although the yields of [3.3]PC's were comparatively low, this demerit may be covered by a fact that the starting materials are readily available. This method has intrinsic value particularly for synthesis of substituted [3.3]PC that contains benzene rings with mutually different substituents and therefore is difficult to synthesize by known methods. Tetraethyl

5,6,8,9-tetramethyl[3.3]paracyclophane-2,2,11,11-tetracarboxylate IVc(n=1) was almost quantitatively hydrolyzed into the diacid V under alkaline condition. V; white powder from acetone, mp 300°C(decomp). Found: C, 75.53; H, 7.18 %. Calcd for $C_{24}H_{28}O_4$; C, 75.76; H, 7.42 %. The diacid V was treated with lead tetraacetate and lithium chloride in pyridine to give the dichloride VI in 56 % yield.[6] VI; colorless crystals from ethanol, mp 191-194°C. Found: C, 72.93; H, 7.30 %, mol wt(MS, M^+), 360. Calcd for $C_{22}H_{26}Cl_2$; C, 73.13; H, 7.25 %, mol wt, 361.4. The dichloride VI was reduced by lithium and tert-butanol in refluxing THF to give 5,6,8,9-tetramethyl[3.3]-paracyclophane VII in 33 % yield. VII; colorless needles from methanol, mp 110.5-111.5°C. Found: C, 90.02; H, 9.57 %, mol wt(MS, M^+), 292. Calcd for $C_{22}H_{28}$: C, 90.35; H, 9.65 %, mol wt, 292.5. PMR($CDCl_3$, δ): 2.12(s, 12H), ca 2.1(m, 4H), 2.53(t, 4H), 2.86(t, 4H), 6.77(s, 4H).



Scheme 2.

The synthetic studies and the spectral properties of [3ⁿ]cyclophane systems are now under investigation.

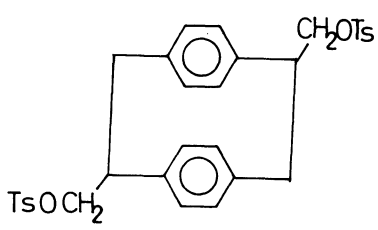
Reference

1) Present address:Shin-etsu Chemical Industry Co, Ltd., Isobe, Annaka, Gunma 379.

2) M. Sheehan and D. J. Cram, J. Am. Chem. Soc., 91, 3553(1969).

3) D. J. Cram, N. L. Allinger, and H. Steinberg, ibid., 76, 6432(1954). They reported the first synthesis of [3.3]paracyclophane. This method required the difficult ten-step synthesis involving acyloin reaction occurring in about 1 % yield, and over-all yield was only about 0.1 %.

4a) E. Hedaya and L. M. Kyle, ibid., 88, 3667(1966). E. Hedaya, Chem. Abstr., 79, 115374y(1973); ibid., 80, 133130r(1974). U. S. Pat., 3,754,015(1973). They obtained [3.3]paracyclophane derivatives by the double ring expansion of the ditosylate VIII. [3.3]Paracyclophane was obtained in about 7 % yield based on [2.2]-paracyclophane.



VIII

4b) D. J. Cram and R. C. Helgeson, J. Am. Chem. Soc., 88, 3515(1966). They reported the four-step syntheses of [3.3]-, [3.4]-, and [4.4]paracyclophane from [2.2]-paracyclophane in which the ring enlarging step involves treatment of either 1,9- or 1,10-dioxo[2.2]paracyclophane with diazomethane. The best over-all yield of [3.3]paracyclophane was 23 %.

5) T. Shinmyozu, T. Inazu, and T. Yoshino, Chem. Lett., 1976, 1405.

6a) J. K. Kochi, J. Am. Chem. Soc., 87, 2500(1969).

6b) H. J. Reich and D. J. Cram, ibid., 91, 3517(1969).

(Received October 18, 1976)