Tetrahedron Letters,Vol.22,No.49,pp 4895-4898,1981 0040-4039/81/494895-04$02.00/0
Printed in Great Britain

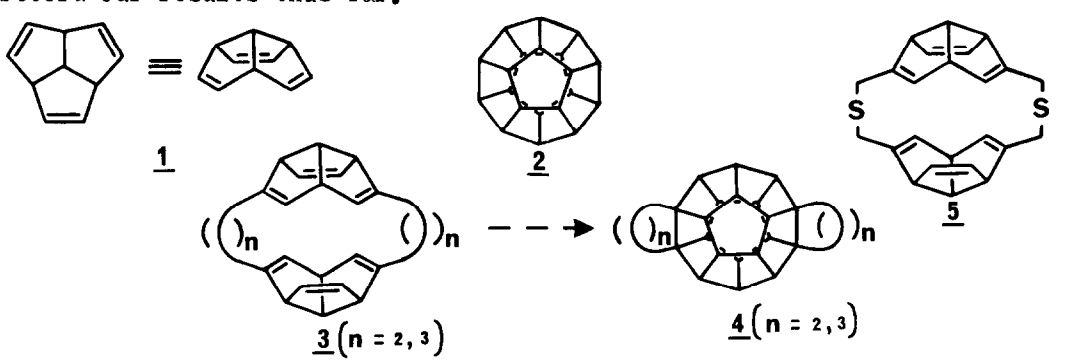
SYNTHESIS AND X-RAY CRYSTAL STRUCTURE OF *anti*-DITHIA[3.3](2,6)TRIQUINACENOPHANE

William P. Roberts* and Gil Shoham
Department of Chemistry, Harvard University
Cambridge, Massachusetts 02138 U.S.A.

Summary: Synthesis of the title compound (5) is presented herein as part of an approach to the synthesis of substituted dodecahedranes.

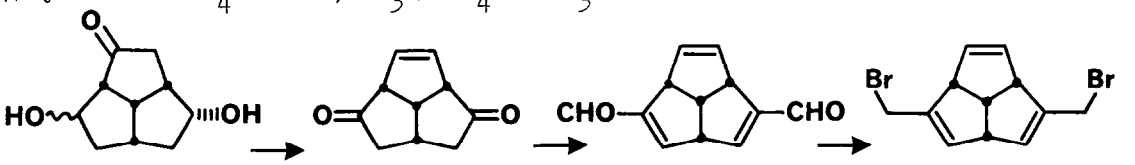
In 1964, Woodward synthesized triquinacene (1), making note of its possible role as precursor of the unknown hydrocarbon dodecahedrane (2; 1 + 1 = 2).[1] Since then, several workers have synthesized triquinacene and studied its reactivity under a variety of conditions.[2] This compound has never been observed to form dodecahedrane under heat, high pressure, irradiation, or transition metal catalysis.[3] Several other approaches to dodecahedrane synthesis have since been explored;[3] thus far, only Paquette has succeeded in producing a dodecahedrane derivative, through elaboration of a "domino Diels-Alder" adduct.[4]

We are interested in converting "*anti*-(2,6)triquinacenophanes" (3)[5] to doubly annelated dodecahedranes (4) by what would be an intramolecular analogue of triquinacene dimerization. We have now completed the synthesis of a compound which corresponds to 3 (*anti*-dithia[3.3](2,6)triquinacenophane, 5), and wish to record our results thus far.



The synthesis of 5 was accomplished in a manner analogous to dithiacyclophane synthesis;[6] it was thus based on the intermediacy of "monomeric" dibromide 9. As starting material for this synthesis we chose dihydroxyketone 6 (mixture of epimers), which had been synthesized and converted to 2,3-dihydrotriquinacen-2-one by Deslongchamps.[7] Compound 6 was prepared as previously described,[7] in six steps from Thiele's acid.[8,9]

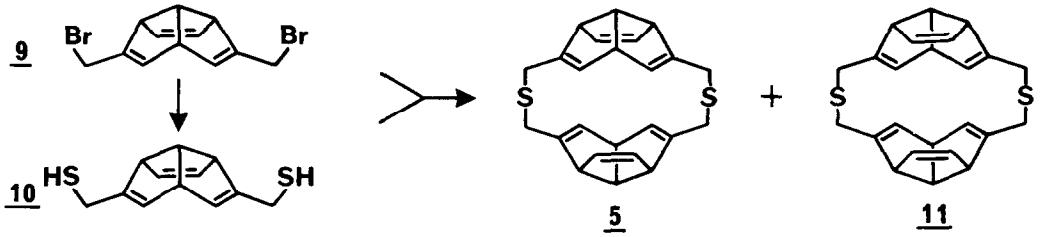
Compound 6 was converted to 2,6-di(bromomethyl)triquinacene (9) in the following manner. First, the carbonyl group and adjacent methylene of 6 were transformed into an olefinic group by use of a modified Shapiro reaction[10] (2,4,6-triisopropylbenzenesulfonyl hydrazide/$MgSO_4$ in CH_2Cl_2; 6 molar equivalents CH_3Li in THF/ether). The resulting enediol (mixture of epimers) was then oxidized (pyridinium chlorochromate/celite in CH_2Cl_2) to enedione 7 (m.p. 97-99°, 30% overall yield from 6).[11] Enedione 7 was elaborated in three steps to dialdehyde 8 (m.p. 125-126°, 50% yield: excess CH_3Li in THF/ether, crude product recycled once; TsOH in refluxing benzene; SeO_2 in refluxing dioxane/H_2O), then 8 was finally converted in two steps to 9 (m.p. 104-105°, 97% yield: $LiAlH_4$ in THF; Ph_3P/CBr_4 in CH_3CN).



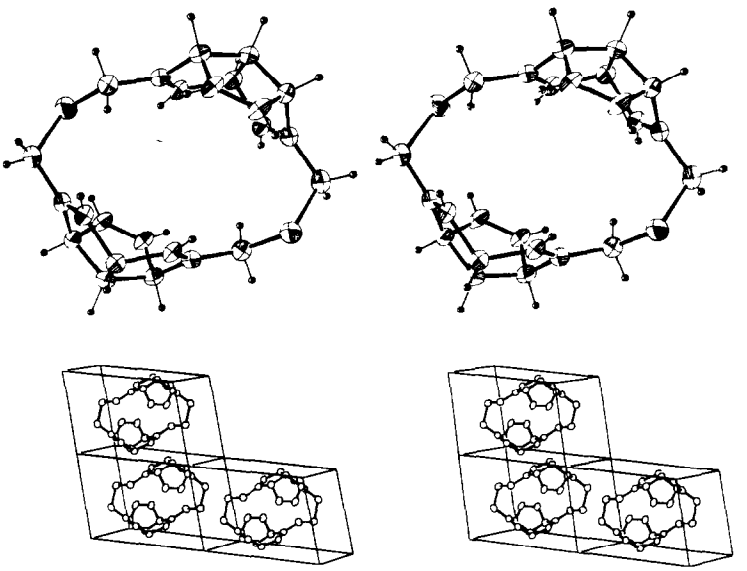
6 7 8 9

Synthesis of 5 was completed as follows: first dibromide 9 was converted to dimercaptan 10 (85% yield: thiourea followed by ethylenediamine in refluxing H_2O/isopropanol), then 10 was coupled with 9 by a procedure similar to that of Boekelheide[12] (slow addition of a 1:1 mixture of 9 and 10 in benzene to 2.5 molar equivalents KOH in 95% ethanol buffered with 4 equivalents phenol). As expected, both anti- and syn-triquinacenophanes 5 and 11 were produced (40% combined yield; respective ratio 3.5 to 1). These isomers could be separated by thin-layer chromatography, but the low solubility of 5 (the high-R_f component) made preparative separation difficult. Instead, 5 was easily isolated from the crude product by crystallization (slow evaporation of a $CHCl_3$ solution; m.p. >250°,

30% yield from 9 and 10). Its identity as the desired anti isomer was established by X-ray crystallography.[13]



The X-ray structure and crystal packing of 5 are depicted below. This compound crystallizes in a centrosymmetric conformation with one molecule per unit cell.[14] The relative orientation of triquinacene units in crystalline 5 is seen to be roughly that required for dodecahedrane formation,[15] though no effort is made here to assess the range of conformations which 5 may adopt in solution.

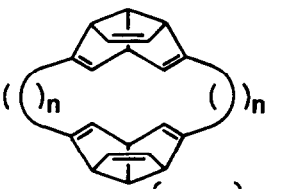


We are now examining possible ways to produce dodecahedrane derivatives from 5. We are also investigating the application of relevant sulfur-extrusion methods[6] to the production of [2.2]triquinacenophanes from 5.

Acknowledgement: Financial support from the National Science Foundation, in the form of a pre-doctoral fellowship (W.P.R.) and an equipment grant (#CHE 8000670) for the X-ray diffractometer, is gratefully acknowledged.

References and Notes:

1. R.B. Woodward, T. Fukunaga, and R.C. Kelly, J. Am. Chem. Soc., 86, 3162 (1964).
2. L.A. Paquette, Top. Curr. Chem., 79, 114-132 (1979) and references therein.
3. P.E. Eaton, Tetrahedron, 35, 2189 (1979) and references therein.
4. L.A. Paquette, D.W. Balogh, R. Usha, D. Kountz, and G.G. Christoph, Science, 211, 575 (1981).
5. syn-(2,6)Triquinacenophanes of the general structure 3a (right) are structural isomers of 3 which, though equally conceivable from the standpoint of synthesis, cannot, in principle, be converted to 4 through a cycloaddition process.



3a (n = 2,3)

6. V. Boekelheide, Accts. Chem. Res., 13, 65 (1980) and references therein.
7. P. Deslongchamps, U.O. Cheriyan, Y. Lambert, J.C. Mercier, L. Ruest, R. Russo, and P. Soucy, Can. J. Chem., 56, 1687 (1978).
8. Compound 6 (exo/endo approx. 1:1) was prepared in 20% overall yield from Thiele's acid using the following reagents: oxalyl chloride; NaN_3, heat, H_3O^+; 2,2-dimethylpropanediol/TsOH; m-CPBA; DIBAL; H_3O^+.
9. Thiele's acid was prepared by carboxylation of cyclopentadienylsodium: H.K. Wiese, U.S. Patent 2,781,395 Feb. 12, 1957, Chem. Abs., 51, 13913i (1957); see also: G.L. Dunn and J.K. Donohue, Tetrahedron Lett., 3485 (1968) and references therein.
10. A.R. Chamberlin, J.E. Stemke, and F.T. Bond, J. Org. Chem., 43, 147 (1978); M.F. Lipton and R.H. Shapiro, J. Org. Chem., 43, 1409 (1978).
11. All new compounds reported gave satisfactory ^1H nmr, IR, and mass spectra.
12. R.H. Mitchell, T. Otsubo, and V. Boekelheide, Tetrahedron Lett., 219 (1975).
13. Gil Shoham, to be Published. The structure was solved by direct methods (MULTAN-78) and refined by block diagonal least-squares methods (SHELX-76) based on 2497 reflections for which $f \geq 4\sigma(f)$, to a final R factor of 4.4%. Crystallographic data: space group $P\bar{1}$, triclinic, a = 7.679(2)Å, b = 7.766(3)Å, c = 9.730(3)Å, α = 111.91(3)°, β = 93.58(3)°, γ = 111.62(3)°, Z = 1, Dcalc = 1.28g/cm^3.
14. Rapid crystallization of 5 afforded crystals with Z = 2; these were not subjected to a thorough X-ray analysis.
15. Contrast this with the reported crystal packing of triquinacene itself: E.D. Stevens, J.D. Kramer, and L.A. Paquette, J. Org. Chem., 41, 2266 (1976).

(Received in USA 19 August 1981)