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SUBSTITUENT CONTROL OF STEREOCHEMISTRY IN THE REARRANGEMENTS OF 1,8-BISHOMOCUBANES CATALYZED BY SILVER(I) ION[1]

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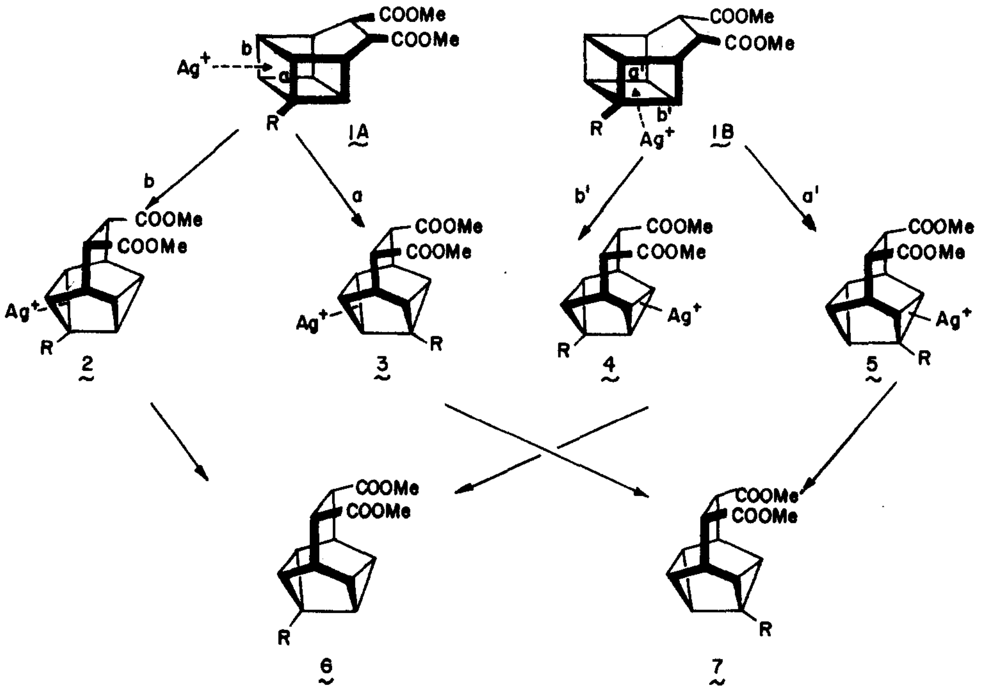
The remarkable facility with which cubyl systems undergo skeletal rearrangement in the presence of silver(I) ions was described initially in 1970.[3] Subsequently, it has been shown with seco-cubyl diesters that small incremental strain differences have little effect on the rate of reaction.[4] In contrast, electronic effects exert appreciable kinetic influence.[1,5] As yet, no attention has been paid to the stereochemical aspects of such isomerizations. Because important mechanistic information can in principle be derived from this source, we have initiated a study of Ag^+ promoted reactions which are expected to reveal pertinent stereochemical effects and report here our initial findings.

When a substituent is positioned at C_4 in a cis-9,10-disubstituted 1,8-bishomocubane as in 1, the resulting unsymmetrical structure can conceivably participate in four distinct yet interwoven pathways (Scheme I). Should Ag^+ complexation occur on the cyclobutane face more remote from the 9,10 substituent pair (cf 1A), 2 and 3 could be produced. During these transformations, the $C_{4,5}$ bond must rotate by approximately 90° in either of two directions. Should steric factors assume importance in the transition state of kinetic consequence, the formation of 2 would intuitively be expected to be less favorable than the pathway giving rise to 3 because of developing non-bonded R--Ag^+ interactions in the former. Conversely, if the R group contained a donor heteroatom with favorable coordination properties for Ag^+,[6] then 2 could arise preferentially. Like considerations can be applied to 1B. Final products 6 and 7 would then arise in proportions determined by the relative rates of the four processes shown.



a, R = CH_3; **b**, R = CH_2OAc

Two other considerations merit brief mention. Firstly, since the sole structural feature which distinguishes **1A** from **1B** is the spatial orientation of the 9,10-substituents and because a change in the nature of these groups could affect the preequilibrium balance,^{7} diester derivatives were employed in the present study. More importantly as relates to mechanism, we point out that initial migration of the more highly substituted bond (a) in **1A** leads to **7** whereas in **1B** this process (now involving b′) affords isomer **6**. As a result, ultimate phenomenological distinction between the various competing pathways is further complicated.

The isomerization of **1a** with 0.0161 M silver perchlorate in anhydrous benzene led to the formation of **6a** (82%) and **7a** (18%) in high yield.^{8} These diesters were separated chromatographically and their respective structures were assigned initially on the basis

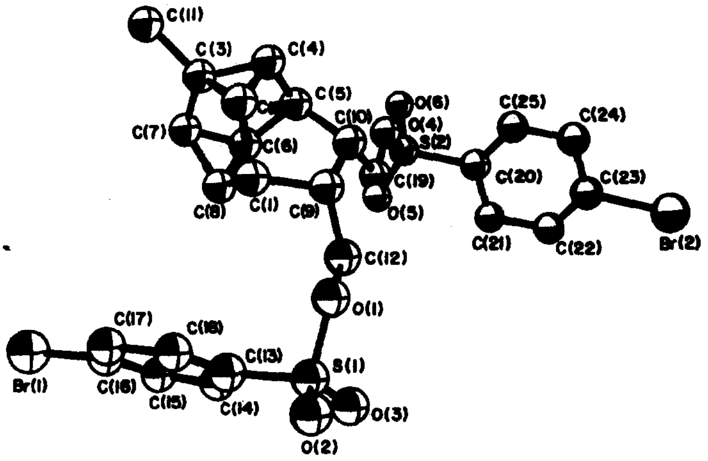
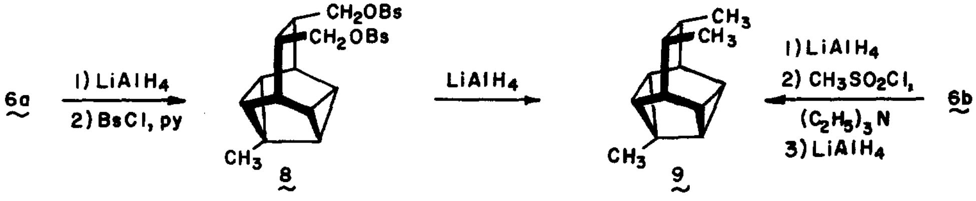


Figure 1. A structural view of 8 as determined by X-ray analysis.



of Eu(fod)$_3$-shifted nmr spectra. Confirmatory datum was derived from lithium aluminum hydride reduction of the major product and reaction of the diol with p-bromobenzenesulfonyl chloride in pyridine. The stereochemistry of dibrosylate 8 was established unequivocally by three-dimensional X-ray analysis (Figure 1). Precession films revealed only inversion symmetry and diffractometer measured cell constants were a = 17.40(1), b = 10.34(1), c = 10.05(1) Å, α = 66.48(3), β = 91.58(3), and γ = 126.06(2)°. ρ_{calc} for Z = 2 was 1.66 g/cc and ρ_{obs} (flotation) was 1.64 g/cc. All unique reflections with θ < 25 were collected on a fully automated Hilger Watts four-circle diffractometer with an approximately cubic crystal 0.1 mm on an edge using Zr-filtered M_oK_α radiation. A systematic decrease of ~15% was observed for the periodically monitored reflections. A total of 4473 reflections were measured of which only 1657 were judged observed after background, Lorentz, and polarization correction. The sharpened three-dimensional Patterson synthesis was readily deconvoluted in the presumed space group $P\bar{1}$ and all 33 remaining non-hydrogen atoms were clearly revealed in the subsequent Br-phased electron density synthesis. Full-matrix least-squares refinements smoothly converged to the present minimum of 12.1% for the unweighted discrepancy index. This relatively high value is attributed to sample decomposition for which no correction has been made.

Exposure of **1b** to Ag^+ under identical conditions afforded anti isomer **6b** (65%) and syn isomer **7b** (35%). Elucidation of structure in this case was achieved by conversion of **6b** to trimethylsnoutane **9** which was identical with the hydrocarbon produced by hydride reduction of **8**.

Consequently, a preference for formation of the respective anti isomers without regard for whether R is an alkyl group or an oxygen-containing substituent has been demonstrated. Determination of whether **6a** and **6b** result exclusively, predominantly, or competitively from pathway b or b′ must await the results of further studies now in progress aimed at gaining insight into the preferential proximal (i.e., **1B**) or distal (i.e., **1A**) coordination of Ag^+ to the bishomocubyl framework.[9]

FOOTNOTES AND REFERENCES

1) Part XVI of the series dealing with ''Silver(I) Ion Catalyzed Rearrangements of Strained σ Bonds''. Part XV is the preceding paper.

2) University Postdoctoral Fellow, 1970-71; National Institutes of Health Postdoctoral Fellow, 1971-72.

3) W.G. Dauben, M.G. Buzzolini, C.H. Schallhorn, D.L. Whalen, and K.J. Palmer, *Tetrahedron Lett.*, 787 (1970); L.A. Paquette and J.C. Stowell, *J. Amer. Chem. Soc.*, **92**, 2584 (1970).

4) L.A. Paquette, R.S. Beckley, and T. McCreadie, *Tetrahedron Lett.*, 775 (1971); H.H. Westberg and H. Ona, *Chem. Commun.*, 248 (1971).

5) L. Cassar, P.E. Eaton, and J. Halpern, *J. Amer. Chem. Soc.*, **92**, 6366 (1970); L.A. Paquette and R.S. Beckley, unpublished observations.

6) For a detailed review, see C.D.M. Beverwijk, G.J.M. vander Kerk, A.J. Leusink, and J.G. Noltes, *Organometal. Chem. Rev.* A, **5**, 215 (1970).

7) Both through-bond and through-space effects are likely operative.

8) Product compositions were determined by nmr analysis of unpurified reaction mixtures. Satisfactory elemental analyses and compatible nmr spectra were obtained for all the new compounds.

9) Partial support of this work by the National Science Foundation (O.S.U.) and the U.S. Atomic Energy Commission (I.S.U.) is gratefully acknowledged.