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INTRAMOLECULAR COMPETITION OF "COPE" REARRANGEMENT WITHIN A CONFORMATIONALLY MOBILE (3,8,3) TRICYCLE

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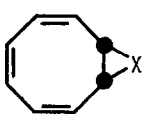
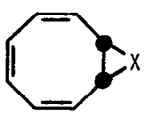
Contrasting the previously described thermolytic response of a conformationally restricted (3,8,3) oxatricyclodiene, the "Cope" transposition of its conformationally mobile epimer occurs via rupture of the molecule's cyclopropane rather than oxirane cross-link.

The rate at which the cross-link of a cis bicyclo[6.1.0]nona-2,4,6-triene[1] (1) or the corresponding 2,6-diene[2] (2) undergoes "Cope" transposition is known to depend heavily on (i) the nature of X, rapidly increasing in the order X = O,[2] CH_2,[1a,2] NCOOR[1b,2] and (ii) steric access by the expanding 3-membered rings to a "folded" geometry. While possibly less immediately obvious, the conformational restriction, i.e., factor (ii), appears to play the dominant role in the rearrangement as exemplified by our recent finding[3] that the bifunctional variant 3, believed to be sterically constrained to the conformation depicted in 3 [F(O), E(CHCl)] undergoes "Cope" transposition exclusively via the less thermally labile oxirane cross-link.



1
X = O, CH_2, NCOOR



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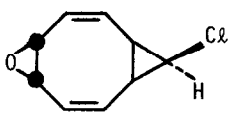

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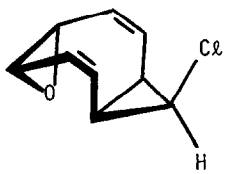


3 [F(O), E(CHCl)]

In an attempt to further assess the influence exerted by molecular conformation on the direction of "Cope" transposition followed by bifunctional tricyclics such as 3 we resolved to examine the thermal response of the hitherto unknown epimeric variant of 3, namely 4. The central significance of this molecule in the study of conformational factors stems from its anticipated steric freedom to readily adopt either one of the two possible conformational alternatives shown in 4 [F(O), E(CHCℓ)] and 4 [CHCℓ), E(O)] which are necessary for respectively triggering the "Cope" process via transposition of an oxirane or cyclopropane cross-link.

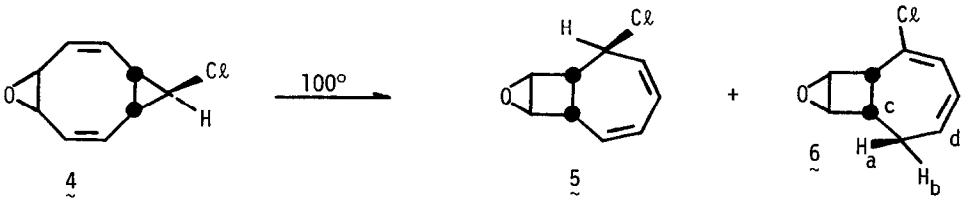
4 [F(O), E(CHCℓ)] 4 [F(CHCℓ), E(O)]

The desired oxirane 4[4] was synthesized in ca. 30% yield on 4-day treatment of anti-chloro cis-bicyclo[6.1.0]nona-2,4,6-triene with an equimolar quantity of m-chloroperbenzoic acid (MCPBA) at ambient temperature. It is thermally labile, rapidly and cleanly rearranging in hot benzene ($\Delta G^{\ddagger}_{100.4^{\circ}}$ = 26.6 kcal/mol., $\Delta H^{\ddagger}$ = 23.8 kcal/mol., $\Delta S^{\ddagger}$ = -7.5 eu)[5] to produce a two-component equilibrium mixture consisting of 5 and 6 in a ratio (^{1}H-NMR) of 0.39. The interconverting nature of these products was established by heating pure samples at 100° and obtaining in each case the indicated composition, i.e., 28%, 5[6] and 72%, 6.[6] Further, upon monitoring (^{1}H-NMR), the buildup of 6 from pure 5 at 100.5° we find that $k_{5\rightarrow 6}$ = 6.18 x 10^{-3} sec.$^{-1}$ ($\Delta G^{\ddagger}$ = 25.8 kcal/mol.) and $k_{6\rightarrow 5}$ = 2.41 x 10^{-3} sec^{-1}.

Operationally, the basic skeletal arrangement formulated in 5 and 6 may securely be viewed to arise from the specific, and apparently thermally labile, "Cope" product of 4 namely 8 which is properly structured for delivering 5 via Mobius-suprafacial 1,3 shift of Cℓ. In turn, the final two component [5 ⇌ 6] mixture may suitably be viewed to arise via reversible Huckel-suprafacial 1,5 transposition of the hydrogen associated with the CHCℓ function of 5.

We conclude by calling attention to the fact that "Cope" rearrangement in 4 obtains exclusive-

ly via transposition of the weaker cyclopropane cross-link ($\Delta G^{\ddagger}_{100.4^{\circ}}$ = 26.6 kcal/mol.) and that this observation is entirely in keeping with the anticipated conformational mobility of this molecule. Further, comparison of the thermal response of 4 with that of its conformationally restricted epimer 3 which was previously shown to undergo the rearrangement by transposition of the less labile oxirane cross-link ($\Delta G^{\ddagger}$ = 28.5 kcal/mol.)[3] convincingly establishes the paramount importance of proper conformation in the thermolysis of these substances.



4 5 6

7 8

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References and Notes

(1) (a) A. G. Anastassiou and R. C. Griffith, J. Am. Chem. Soc., 93, 3083 (1971).
(b) A. G. Anastassiou, R. L. Elliott and A. Lichtenfeld, Tetrahedron Letters, 4569 (1972); see also A. G. Anastassiou, R. L. Elliott, H. Wright and J. Clardy, J. Org. Chem., 38, 1959 (1973).

(2) W. Grimme and K. Seel, Angew. Chem., 85, 514 (1973).

(3) A. G. Anastassiou and R. L. Mahaffey, Angew. Chem., 90, 646 (1978).

(4) Separation of this substance in pure form (^{1}H-NMR, UV, IR, MS) from the reaction mixture, containing its stereoisomer, a position isomer and various polyoxa analogs, was accomplished by way of column chromatography ($A\ell_2O_3$) at ca. -15°C.

(5) These activation constants were determined by monitoring (^{1}H-NMR) the rate of disappearance of 4 in benzene at 100.4° and 122.5°C.

(6) This substance was obtained in pure form (^{1}H-NMR, UV, IR, MS) by column chromatography ($A\ell_2O_3$) at ca. -15°C. Specific structural assignments derive from the following observations: (i) the minor product 5 displays a ^{13}C-NMR signal ($CDC\ell_3$) at δ (TMS) 63.4 ppm ($>CHC\ell$) which shifts to δ (TMS) 27.5 ppm ($>CH_2$; triplet (J = 126 Hz) in proton-coupled spectrum) on passing to the major component 6 and (ii) analysis of the ^{1}H-NMR spectrum of 6 in the presence of "shift reagent" revealed that $J_{b,c}$ = 12 Hz, $J_{a,b}$ = 12 Hz, $J_{b,d}$ = 6 Hz and $J_{a,d}$ = 7 Hz. The observation described in (ii) allows one to securely eliminate the only viable alternative to 6; i.e., structure 7.

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