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THE π-ROUTE TO 2-SUBSTITUTED ADAMANTANES

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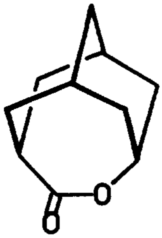
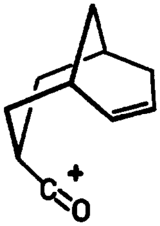
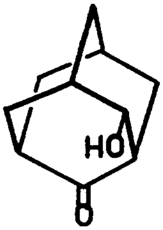
Cyclization processes involving nucleophilic participation of a remote double bond have been used to provide information on the mechanism of solvolytic reactions. (1,2) Such reactions can also be of considerable synthetic utility. (3,4) For example, McKervey has recently reported (4) the rearrangement of the lactone I in 50% sulfuric acid to an equilibrium mixture of I and the hydroxy ketone III; this reaction presumably involves



I



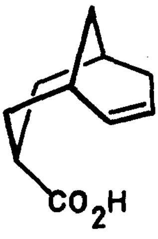
II

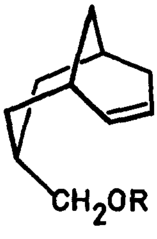


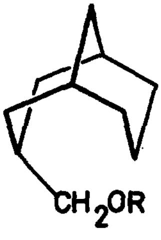
III

cyclization of the acylium ion II. We report here the cyclication of the analogous carbinol derivative V under the considerably milder conditions of a solvolytic reaction in aqueous acetone. The cyclization of V has been demonstrated (5) in 48% sulfuric acid, but kinetic data for this system have not yet been reported.

The unsaturated carbinol V was prepared by $LiAlH_4$ reduction of the carboxylic acid IV, (5,6) and catalytic hydrogenation of V afforded the saturated carbinol VII. Reaction of the alcohols V and VII with p-toluenesulfonyl chloride in pyridine yielded the corresponding tosylates VI (mp 52.2-53.8°) and VIII (mp 109.5-112.0°).


IV


V, R = H
VI, R = Ts


VII, R = H
VIII, R = Ts

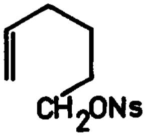
The great propensity for cyclization of the unsaturated derivatives is illustrated by the ca. 50% rearrangement to 2-adamantyl tosylate of a $CDCl_3$ solution of the tosylate VI in 2 days at 6°. The high reactivity of VI is further demonstrated by the kinetic data for solvolysis in 80% acetone (Table). The rate ratio at 25° for solvolysis of VI and VIII is 2×10^4. Clearly the presence of the double bond in VI results in greatly enhanced solvolytic reactivity. As anticipated (9) from the large rate enhancement, the solvolysis of VI proceeds entirely by the k_Δ pathway to yield 2-adamantanol (<0.2% of V by glpc). Ca. 5% of the internal return product, 2-adamantyl tosylate (which is unreactive under these conditions), was also isolated.

Table. Kinetic Data for the Solvolysis of VI and VII in 80% Acetone.

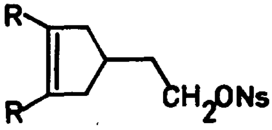
Compound	Temp. (°C)	k (sec^{-1})	$\Delta H^{\ddagger}$ (kcal/mol)	$\Delta S^{\ddagger}$ (e.u.)
VI	25.0[a]	$2.29 \pm 0.04 \times 10^{-4}$	19.4	-10.0
	50.8[a]	$3.40 \pm 0.14 \times 10^{-3}$		
VIII	25.0[b]	1.02×10^{-8}	22.4	-19.9
	100.2[a]	$2.61 \pm 0.09 \times 10^{-5}$		
	124.1[c]	$1.71 \pm 0.12 \times 10^{-4}$		

[a] Conductimetric. [b] Extrapolated from other temperatures. [c] Titrimetric.

The rate effect produced by the remote double bond in VI is considerably greater than that reported for the solvolyses of other Δ^5-hexenyl derivatives. A rate enhancement of only 2 was found (2c) for 5-hexenyl nosylate (IX), and that observed for Δ^3-cyclopentenylethyl nosylate (X) was 95 (1). Even the presence of two methyl groups on the double bond of the latter compound (*i.e.*, XI) resulted in a rate enhancement of only 3×10^3 (2b).

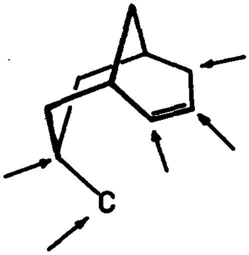


IX



X, R = H
XI, R = CH_3

The work reported here further demonstrates the great facility of π-route cyclizations to adamantane derivatives. Considering the ready availability of the unsaturated carboxylic acid IV and the opportunities for introduction of functional groups into the positions indicated in Structure XII, cyclizations of the type



XII

described here should permit the convenient synthesis of a variety of substituted adamantane derivatives. (11)

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References and Footnotes

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(3) See W. S. Johnson, *Accounts Chem. Res.*, **1**, 1 (1968).

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(6) Prepared by the reaction of 2-adamantanone with sodium azide in methanesulfonic acid (7) followed by treatment of the reaction mixture with concentrated aqueous sodium hydroxide (8).

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(11) For example, McKervey, Faulkner and Hamill have found that 4,4-dimethyl-2-adamantanol can be prepared from the tertiary carbinol corresponding to V by reaction in formic acid. (4)