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A TRANSANNULAR REACTION IN AN ANIONIC OXY-COPE SYSTEM[9]

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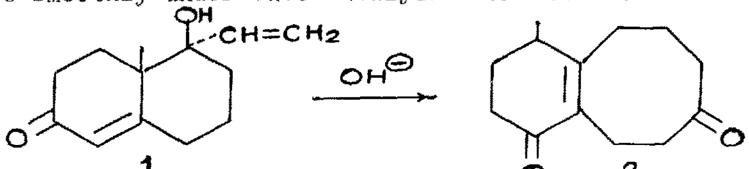
Summary: The carbinol 8 is found to rearrange to the bicyclo (2,2,2) octane derivative 10 in the presence of base; the rearrangement involves a transannular reaction in a ten membered ring resulting from an Oxy-Cope system.

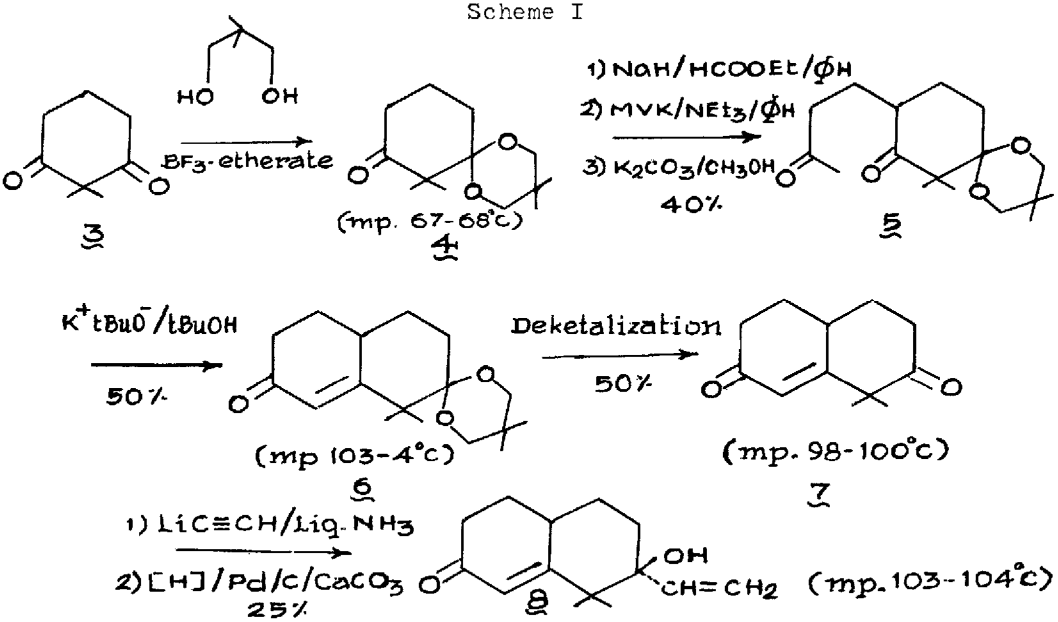
The first example reported in the literature of a formal anionic Oxy-Cope rearrangement is the rearrangement of the vinyl carbinol 1 to the diketone 2.[1,2] Similar bicyclic δ-hydroxy-α,β-enones have also been found to rearrange smoothly under base catalyzed conditions.[3,4,5] The thermal rearrangement of the neutral substrate 1 to diketone 2 has also been reported[3] under more drastic conditions. The thermal rearrangement is believed to involve a concerted Cope mechanism whereas the anionic rearrangement may occur by a Cope mechanism or by an ionic mechanism. The pronounced enhancement in rates of rearrangement of anions from Oxy-Cope systems as compared to neutral substrates has been confirmed recently by other workers[2,6,7] in quantitative terms for suitably substituted vinyl-alcohols derived from bicyclo (2,2,2) octene and bicyclo (2,2,1)heptene systems. As contrasted with these systems, compound 1 and other bicyclic systems studied by us contain a carbonyl group conjugated with one of the olefinic components; undoubtedly this serves to delocalize the anionic charge and facilitates the base catalyzed rearrangements.



1 2

In our continuing studies of such rearrangements, we report here the synthesis and base catalyzed rearrangement of the vinyl carbinol 8. This contains all the stereoelectronic features present in 1 which trigger its rearrangement to the diketone 2.

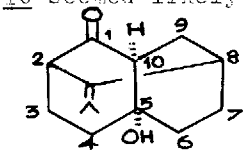
The synthesis of the carbinol 8 was achieved as detailed in Scheme I, Scheme I



starting from 2,2-dimethyl cyclohexane-1,3-dione. Compound 5, obtained as a liquid, was used immediately after preparation. Compounds 4, 6 and 7 gave satisfactory spectral and analytical data. The desired compound 8 had the expected C, H composition and the following spectral characteristics: IR (KBr)- 3420 Cm^{-1} (-OH), 1660 Cm^{-1} (α,β-Unsaturated C=O); 1620 Cm^{-1} (vinyl C=C); UV-λ^{max}_{EtOH} 243μ(ε =13,750); NMR (CCl$_4$/TMS) δ-values 1.1, 1.3 (2 s, 2 CH$_3$, 6 H); 1.5 - 3.0 (m, 10 H); 5.2 - 6.2 (m, vinyl protons, 4 H); M.S - m/e 220.

The rearrangement of the vinyl carbinol 8 was effected by refluxing it with catalytic amounts of 4% aqueous potassium hydroxide in methanol for 2 hr. to furnish a single product in almost quantitative yield (m.pt. 169 - 70°c). The product showed the following spectral data: IR (KBr)- 3420 Cm^{-1} (OH), 1705 Cm^{-1}(C=O); NMR (CDCl$_3$/TMS) δ values - 1.7 (s, 2 vinyl CH$_3$ 6H), 1.8 - 2.6 (m, 13H), 2.85 (s, -OH, 1H); m/e - 22o. Analysis showed the rearranged product to be isomeric with carbinol 8. It was found difficult to derivatize the -OH group and also to effect deuterium exchange (D$_2$O) with it. It was therefore concluded that the -OH was tertiary in nature. The ^{13}C spectral studies indicated the presence of four quarternary carbons (C=O carbon at 216.4 ppm, s, olefinic carbons at 134.99, s and 124.85, s and a carbon bearing -OH at 75.7 ppm, s), three -CH groups (at 53.5, 42.28 and 27.75 ppm), five -CH$_2$ groups (at 33.60, 32.30, 30.47, 28.31 and 24.60 ppm) and two methyls (at 20.65 and 20.25 ppm).

Based on the spectral data and by analogy with our previous report[8], structure 9 and 10 seemed likely for the product. Structure 10 was preferred



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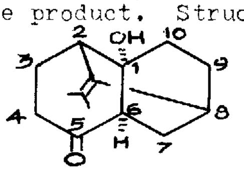
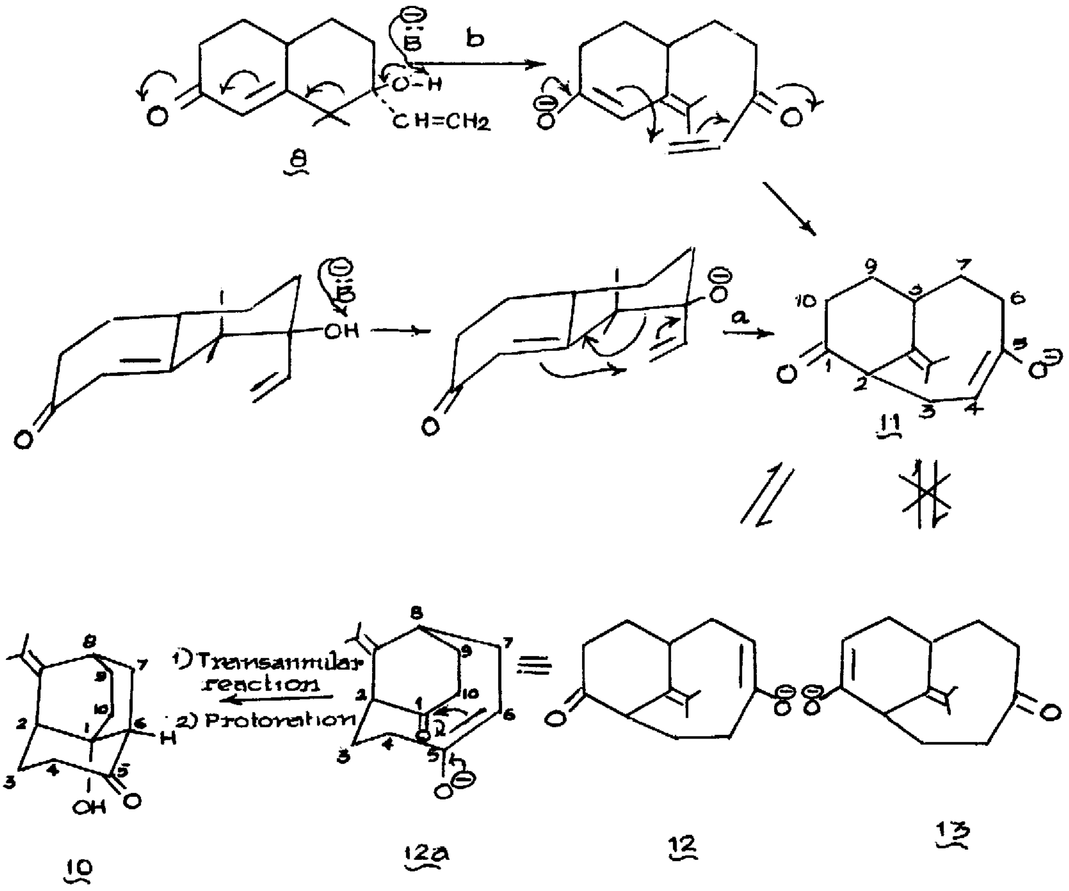


10

over structure 9 on the following grounds: the absence of any carbon bound proton downfield beyond 2.6δ in ^{1}H NMR was not consistent with structure 9 in which the proton at C-2 might be expected to appear beyond 2.6δ . Important proton coupling constants could be obtained from decoupling experiments and these were consistent only with structure 10. Dreiding models of 9 and 10 revealed in particular that in 10, the C-2 proton would be coupled strongly to one methyl and weakly to the other methyl (measured values were 1.5 and 0.8 Hz) and the proton at C-8 coupled too weakly to resolve whereas in 9 both these protons would couple equally well to both the methyls. Further deuterium exchange experiments (refluxing with calculated amounts of NaH in dry benzene for 6 hr. under N_2 atmosphere and quenching the reaction with D_2O) showed that the rearranged product could exchange 3 protons - a fact which is in agreement with structure 10 only.

As in the analogous rearrangement of compound 1, the rearrangement of the carbinol 8 probably involves the enolate 11 (Scheme II) formed by either a concerted Oxy-Cope mechanism (a) or through an initial retroaldol fragmentation followed by an intramolecular addition of the intermediate dienolate to the resulting enone (mechanism b).

Scheme II



The anion 11 may equilibrate with species 12 and 13; the enolate double bond in 12 is more stabilised by hyperconjugation and hence this equilibrium may be more in favour of 12, in which a transannular reaction, as depicted in the conformation 12a, may occur leading to the product 10 after protonation.

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