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SYNTHESIS OF A HOMOCUBANE BRIDGEHEAD ALCOHOL

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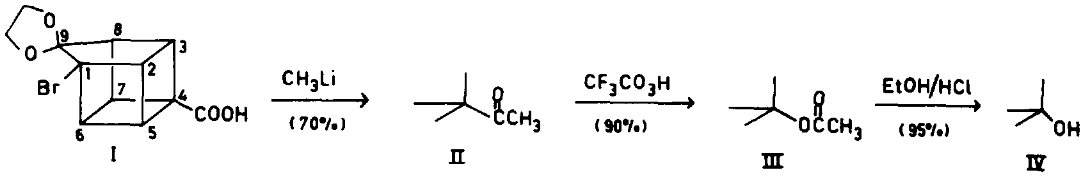
We are interested in the reactivity of functional groups at bridgehead positions in strained molecules, particularly in cage compounds such as cubane and homocubane. In this report we wish to describe our results on the preparation of a homocubane bridgehead alcohol, e.g. IV, a hitherto unknown type of compound.

Two approaches were considered, namely conversion of the acetate III or deamination of the corresponding 4-amino compound VI. The acetate[1] III was prepared by a Baeyer-Villiger oxidation of the methyl ketone II with trifluoro peracetic acid (Scheme I). Exclusive migration of the cage moiety was observed. This smooth conversion of II to III is in contrast with the failure of the perchloro analog, nonachloropentacyclo$[4.3.0.0^{2,5}.0.^{3,8}0^{4,7}]$nonyl-4-methyl ketone, to undergo a Baeyer-Villiger reaction.[2] The ketone[1] II was obtained from the carboxylic acid I by treatment with methyl lithium. The required material I was synthesized according to the recent modification[3,4] of the original procedure of Eaton and Cole.[5]

Scheme I

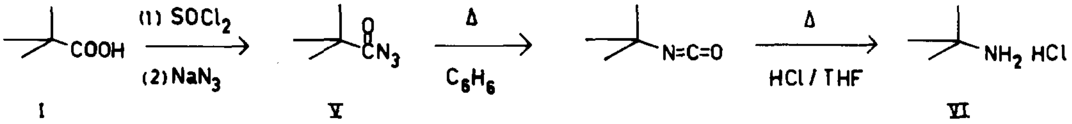


Reduction of III with $LiAlH_4$ was attempted under a variety of conditions but always a mixture of products was formed among which no alcohol IV was present. However, transesterification of III in dry ethanol containing 0.001 M gaseous HCl gave exclusively the desired bridgehead alcohol IV (mp 90-95°, dec.). Hydrolysis of III in dilute aqueous hydrochloric acid resulted in a mixture of five products of which, according to t.l.c., IV dominated.

The alcohol[1] IV was characterized by its IR spectrum (ν_{OH} at 3400 cm^{-1}) and its PMR spectrum[6] in C_6D_6 (δ 3.35-4.08, sym. m. 4H, ketal group at C_9; δ 3.15-3.38, m. 5H, protons at C 2, 3, 5, 6, 7; δ 2.55-2.85, m. 1H, proton at C_8). Treatment of IV with acetyl chloride gave the acetate III, showing that the cage system has retained during the acid-catalyzed[7] ethanolysis. Pure IV is quite stable, it can be heated in benzene solution at 50° for 7 hr without noticeable decomposition. Prolonged heating (75°, 22 hr), however, led to at least four products in which, according to spectral data, the cage skeleton was no longer present.

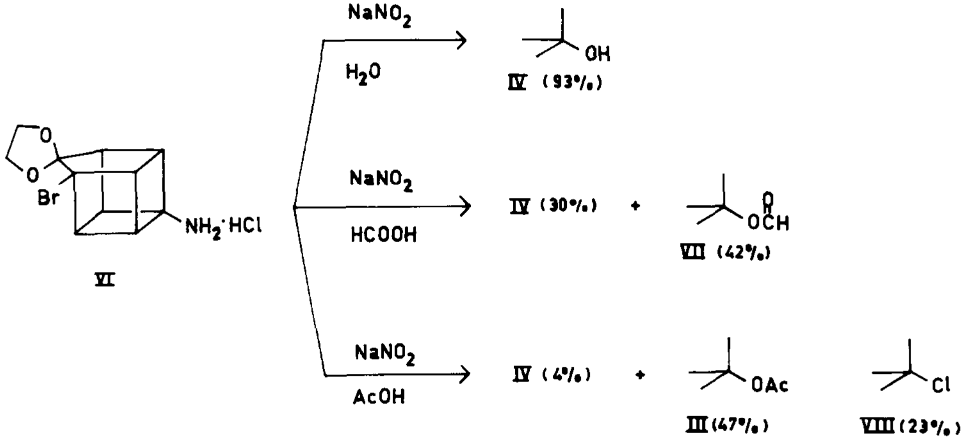
The amino compound VI needed for the deamination approach was prepared in 63% yield from I by a Curtius rearrangement of the carbonyl azide V (Scheme II).

Scheme II



Deamination of VI was studied under three different conditions. Treatment with $NaNO_2$ in water at 0° gave in 93% yield the alcohol IV as shown by its spectral properties and the conversion to the acetate III. Diazotation in formic acid resulted in the alcohol IV and its formate VII. Reaction of VI with $NaNO_2$ in acetic acid as the solvent produced three products, the alcohol IV in a low yield, the acetate III and the chloride[8] VIII (Scheme III).

Scheme III



The behaviour of a perchloro analog of VI, e.g. nonachloropentacyclo$[4.3.0.0^{2,5}.0^{3,8}.0^{4,7}]$nonyl-4-amine, in deamination reactions is quite different[9]: in formic acid only displacement of the amino group by hydrogen could be accomplished. Scherer and Lunt[9] present evidence that in this case the deamination proceeds by a radical mechanism. In our case, however, the formation of the observed products is adequately rationalized by an ionic mechanism.[10] Especially, the formation of the chloride VIII can only be reconciled by an ionic process. Several ionic pathways[10] have been proposed for the deamination of bridgehead amines, most likely bypassing[10] the interesting free bridgehead carbonium ion.

Reactions of this peculiar bridgehead alcohol are under investigation.

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