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Nonplanar Cyclobutane: Deamination of 3-Ethoxycyclobutylamine

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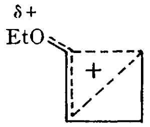
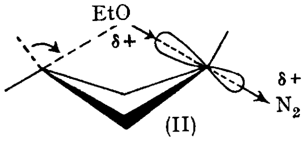
Carbonium ion reactions of cyclobutane and cyclopropylmethyl derivatives have been characterized in terms of nonclassical bicyclobutonium ions functioning as common intermediates.[1] Recently, however, a number of cyclopropylmethyl reactions have been shown to involve unrearranged cyclopropylmethyl cations rather than bicyclobutonium ions.[2] We have interpreted the amine deamination[3] and *p*-bromobenzenesulphonate solvolysis[4] of derivatives of the *cis*- and *trans*-isomers of the 3-isopropylcyclobutyl system in terms of conformationally-controlled reactions involving classical intermediates. In related work, we have examined the deamination of 3-ethoxycyclobutylamine. We report that, unlike 3-alkyl-substituted cyclobutylamines, this compound gives 86% of unrearranged cyclobutane.

Synthesis was accomplished by conventional base-catalysed condensation of a 2-ethoxy-1,3-dihalogenopropane with malonic ester in 20—30% yield, followed by hydrolysis, decarboxylation, and a Schmidt reaction. The amine consisted of approximately 58% *trans*- and 42% *cis*-product, by v.p.c. and n.m.r. analysis). The proton geminal to the NH_2 gives a multiplet centred at 4·5 p.p.m. (*trans*) or 3·5 (*cis*) (60 MHz). Deamination was carried out in conventional fashion in glacial acid containing a trace of acetic anhydride. In addition to 86% of a mixture of approximately 59% *trans*- and 41% *cis*-3-ethoxycyclobutyl acetate, there was obtained 14% of side products predominantly composed of a straight-chain unsaturated acetate, as yet unidentified. Ethyl alcohol was also obtained in the reaction.

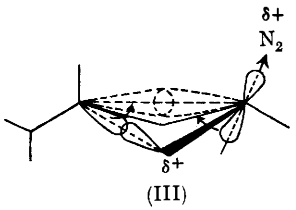
That this reaction does not involve bicyclobutonium intermediates may be readily apprehended from the failure of the concept of the electrically-most-stabilized ion[5] (I) to explain its course. This ion, involving donor participation by an ethoxy-group, must clearly lead to different products. It appears instead that the course of the reaction is determined by nucleophilic competition of the ethoxy-group with ring-bond migration,[3] resulting in the probable transition state (II) analogous to (III). Such neighbouring-group participation across the short (< 2 Å) transannular distance sufficiently stabilizes the charge accumulating on the ring so that rearrangement is minimal. These results support the original suggestion that similar hydroxy-participation may be responsible for *trans*-rate-acceleration in the



(I)



(II)



(III)

isomeric 3-hydroxy-2,2,4,4-tetramethylcyclobutyl toluene-*p*-sulphonates.[6]

The present results are analogous to those reported for the deamination of 3-benzyloxycyclobutylamine several years ago,[7] in which the corresponding cyclobutanol and benzyl alcohol were obtained. It is now evident, however, that no special aromatic effect is involved, but that the presence of an alkoxy-group is sufficient to divert a predominant amount of diazonium intermediate to unrearranged products. Further, the complete absence of cyclopropane products, reported by these authors, is now confirmed in the present work by n.m.r.

Implicit in the present suggestions is expectation of some discrimination between *cis*- and *trans*-amines, since it is thought that backside *trans*-ethoxy-participation would be preferred in formation of (II).

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