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STERIC EFFECTS IN THE REGIOSPECIFICITY OF THE CYCLOADDITION OF ENAMINES AND IMINES TO DIPHENYLKETENE[1a]

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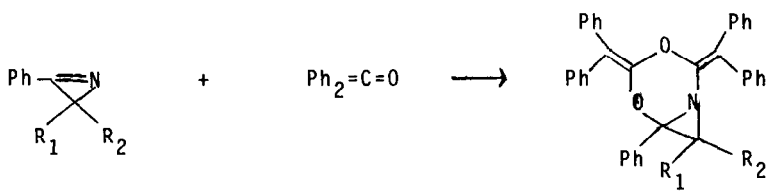
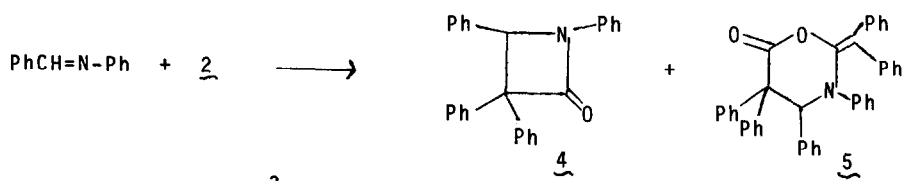
Recently, we have shown that a number of 1-azirines (1, R_1=R_2=H, R_1=CH_3, R_2=H, R_1=R_2=CH_3) reacted with diphenylketene (2) to yield 1:2 adducts that possess structure 3.[2]



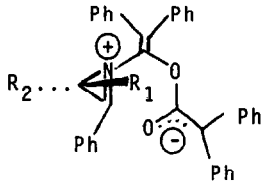
1 2 3

Adduct 3 is not the predicted product if the above reaction had followed the route of cycloaddition of simple imines to diphenylketene. The latter reaction is known[3] to give a mixture of 1:1 and 1:2 adducts (4 and 5). On the



basis of previous studies,[3] one can assume that adducts 3 and 5 arise via the dipolar intermediates 6 and 7, and hence, the difference in the structure of the

observed products is due to an oxygen-carbon ring closure of 6 versus a carbon-



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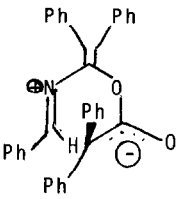

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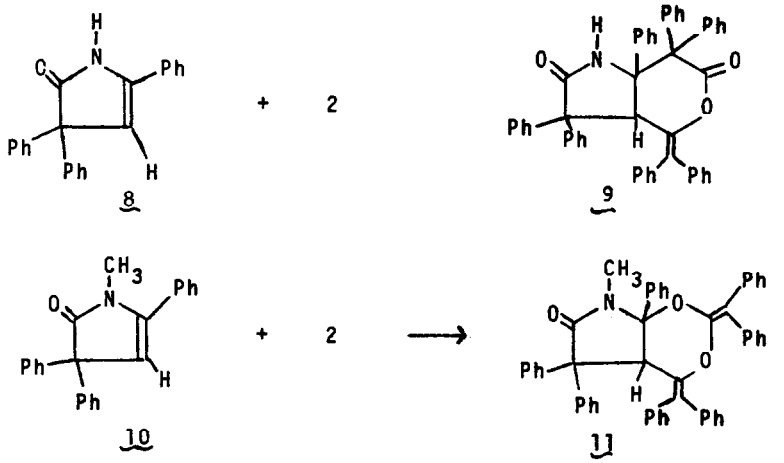
carbon ring closure of 7. Among the most likely factors that influence the fate of intermediate 6 are first: The possibility that the azirinium ion is so "hot" that it reacts with the center of highest electron density of the enolate (namely O) to give product 3, and/or second: The steric interaction between the R substituents and the phenyl groups during the ring closure of 6 forces the phenyl groups away from the reaction site and hence favors an oxygen-carbon ring closure.

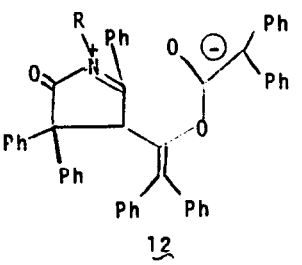
The first factor serves to explain the formation of 3 (R_1=R_2=H), since little steric interaction is expected by the hydrogen atoms in the azirinium intermediate 6. On the other hand, steric effects cannot be ignored in the case of 3 (R_1=R_2 =CH_3). Since both factors favor the same mode of ring closure it is difficult to evaluate their separate effects. We present below findings that reveal the importance of steric effects in the regiospecificity of ring closure in systems analogous to 3.

Enaminoamide[4] 8 was found to react smoothly (1/2 hr at 60°) with diphenylketene to yield 9 (m.p. 238) in good yield. The structure of 9 was established by elemental analysis, infrared absorptions at 3400 (NH), 1780 (vinyl lactone), 1700 (C=O of lactam); nmr τ 6 (s, 1H) 3.75-3.4 (m, 4H), 3.2-2.5 (m, 32H); and mass spec. m at 699.[6] In contrast, the reaction of enaminoketone 10 with 2 proceeded slowly (5 days at room temperature) to give 11 in fair yield. Product 11 (m.p. 210) did not show any carbonyl absorption above 1710 cm^{-1} yet exhibited bands at 1705 (C=O of lactam) 1665, 1630, 1595 cm^{-1}; nmr τ 6.68 (s, 3H), 5.0 (s, 1H), 2.5-3.3 (m, 35H); and mass spec. m/e 713.

Examination of a molecular model of the dipolar intermediates (12, R=H or CH_3) that lead to 9 and 11, indicated that a severe steric interaction results from



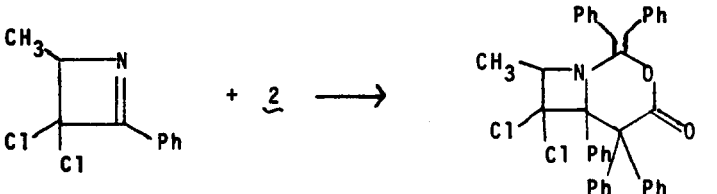
an attempted carbon to carbon ring closure in 12 ($R=CH_3$), and this interaction virtually disappears if the phenyl groups are located away from the site of the reaction. Such a situation is achieved in the process of an oxygen-carbon ring closure (formation of 11 from 12.



Since the "hotness" of the azirinium ion is most probably due to its highly strained structure, it would be expected that such high reactivity would decrease in larger rings. Hence the results of ring closure of the five-membered ring iminium ion (12) indicate an overriding steric effect in this system.

Furthermore, the cycloaddition of azetine[5] 13, to diphenylketene (2) leads to a C-C closure and formation of lactone 14 (ir 1760 cm^{-1}). This result can be rationalized on the basis that enlargement from a three to a four membered ring

system diminishes the steric effect as well as the strain and renders the azetinium ion similar to a simple iminium ion (which leads to formation of 5).



13 14

In brief, steric effects appear to be among the prominent factors involved in the regiospecificity of the cycloaddition of imines and enamines to diphenylketene.

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6. All new compounds gave satisfactory elemental analyses.

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