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STUDIES ON AZABICYCLOBUTANES AND AZABICYCLOPENTANES

John N. Labows, Jr. and Daniel Swern

Fels Research Institute and Department of Chemistry
Temple University, Philadelphia, Pennsylvania 19122

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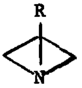
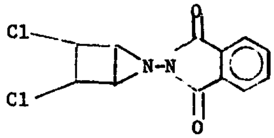
Two ring systems of considerable theoretical and synthetic interest are the 2-azabicyclo-[1.1.0]butanes (1) and the 5-azabicyclo[2.1.0]pentanes (2). No examples of 1 are known; the closest analogues are the 1-azabicyclo[1.1.0] butanes (3) in which the nitrogen is at the bridgehead.[1,2] The only reported example of a 5-azabicyclo[2.1.0]pentane is 4.[3]

1

2

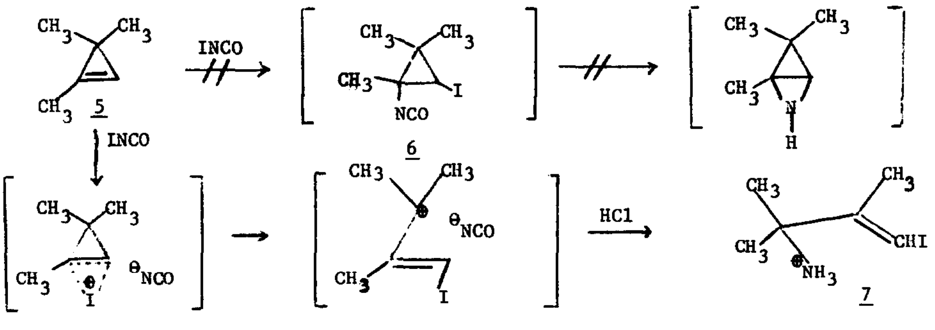


3 (R=H,CH_3,C_2H_5,C_6H_5)



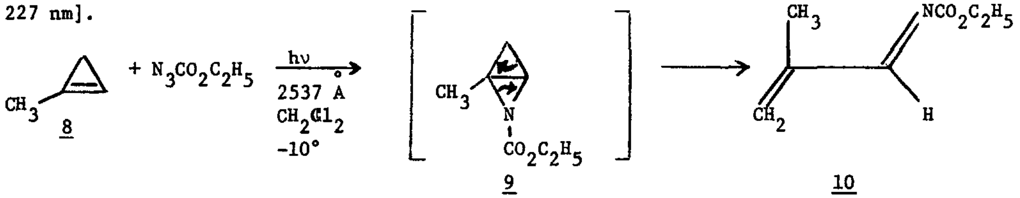
4

Initial studies[4] dealt with the addition of iodine isocyanate preformed in THF[5] to 1,3,3-trimethylcyclopropene (5)[6] with the object of obtaining 6 followed by reaction either with methanol or aqueous acid and then base to ring close. Nmr clearly showed that ring opening had occurred in the initial step even at the low reaction temperatures.



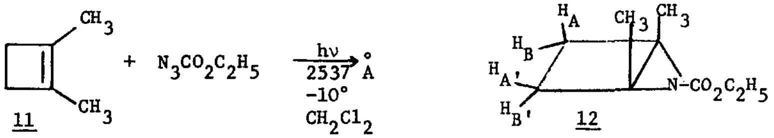
The product that was eventually isolated was 1-iodo-2,3-dimethyl-3-amino-1-butene hydrochloride (7), mp 230°, [nmr 1.65 δ, 6, s; 2.12 δ, 3, s; 6.77 δ, 1, s; ir 1630, 1620, 1520, 1180, 810cm^{-1}].[7]

Since ring opening was so facile we shifted our attention to the addition of carboethoxynitrene[8] to 1-methylcyclopropene (8),[9] a reaction that can be conducted under mild, neutral conditions. Photolysis of a solution of 8 and ethyl azidoformate in methylene chloride at -10° to -15° with 2537 Å radiation (Rayonet reactor) led to evolution of nitrogen and a product, purified by vacuum distillation (30-35°/1 mm) (nmr before and after distillation essentially the same), that was shown by spectral examination to be the conjugated imine 10 [nmr 1.2 δ, 3, t; 1.8 δ, 3, dd; 4.1 δ, 2, q; 5.8 δ, 1, b; 5.9 δ, 1, b; 8.3 δ, 1, s; ir 2980, 1720, 1615, 1222 cm^{-1}; uv, $\lambda_{max}^{CH_3CN}$ = 227 nm].



Chemical evidence was obtained by treatment of 10 with 2,4-dinitrophenylhydrazine reagent; the derivative formed was identical with the 2,4-dnp of methacrolein (tlc, mp, and uv). In the absence of ultraviolet, the azide does not add to 8 (monitored by ir) under the reaction conditions. This eliminates the intermediacy of a triazoline and suggests that carboethoxynitrene is indeed formed, adds to 8 to yield 9, which in turn undergoes valence isomerization to 10. This type of rearrangement has been found in other fused heterobicyclobutane systems[10-13] and suggests that because of strain such products may be difficult to obtain, if at all, unless special stabilizing substituents can be found.

We next directed our attention to the 5-azabicyclo[2.1.0]pentane system. Photolysis of a methylene chloride solution of ethyl azidoformate and 1,2-dimethylcyclobutene (11)[14] at -10° gave the expected fused ring product, N-carboethoxy—1,4-dimethyl-5-azabicyclo[2.1.0]pentane (12), isolated in 65% yield by vacuum distillation, bp 43°/1 mm. [nmr 1.27 δ, 3, t; 1.33 δ, 6,s;



1.87 δ,4, AA',BB' pattern with J_{AB}= 15 Hz and $J_{AB'}$= 2Hz; 4.13 δ, 2, q; ir 3000, 1740, 1470,1460, 1450, 1260, 1100, 825 cm^{-1}].[7]

Surprisingly, 12 is stable and remains unchanged on refluxing in carbon tetrachloride at 77° for 24 hours and in chlorobenzene at 135° for 2 hours, but after 20 hours under the latter conditions extensive decomposition takes place and a multicomponent mixture is formed. This was not studied further. In addition, 12 did not react with neat dimethyl acetylenedicarboxylate at 100° for five days. This is in contrast to the same reaction of bicyclo[2.1.0]pentane under these conditions to yield adducts derived from cleavage of the 1-4 sigma bond (strain energy 47.4 kcal/mole).[15]

Since the 5-azabicyclo[2.1.0]pentane system is relatively stable, other analogs should be readily accessible by the reported procedure and a detailed study of their chemistry should be feasible. These areas are in process.

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