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ELECTROCYCLIC RING OPENING REACTION OF A 1,3,4-OXADIAZIN-6-ONE INTO ITS AZAKETENE TAUTOMER

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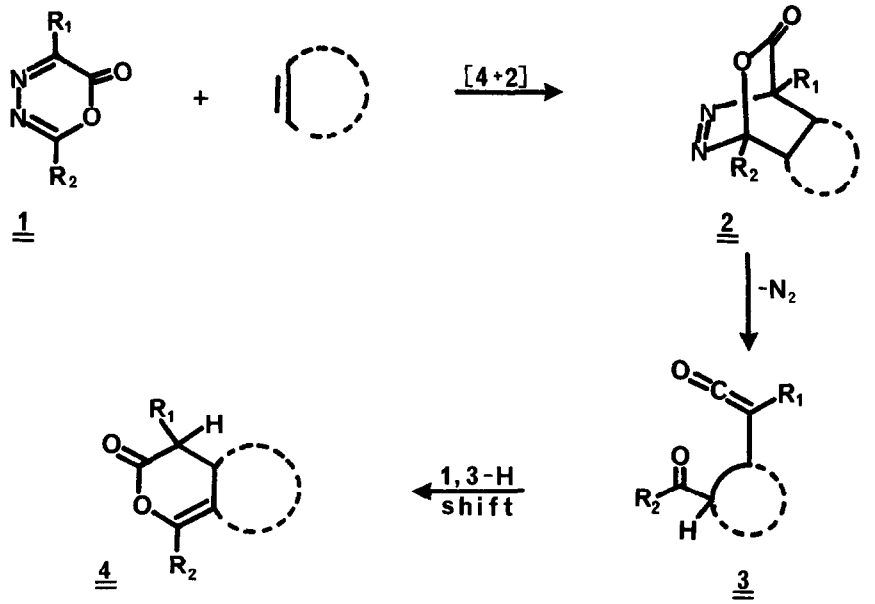
Abstract: 5-Methyl-2-phenyl-1,3,4-oxadiazin-6-one undergoes cycloaddition with 2-methylpropenylpyrrolidine. One of the cycloadducts is derived from the Diels-Alder reaction of a transient azaketene tautomer.

In recent years the Diels-Alder reaction of simple heterosubstituted 1,3-dienes has emerged as a powerful method for preparing highly functionalized ring systems.[1] Dienes substituted with two different heteroatoms are of considerable interest because of their value in natural product synthesis.[2-6] The synthetic utility of the inverse electron demand Diels-Alder reactions of heteroaromatic systems, however, has not been explored in great detail.[7] This is primarily due to the ambiguities concerning the mode of cycloaddition and the lack of demonstrated or dependable synthetic procedures and applications. The 2,3-diazabutadiene unit is incorporated in the



structure of 6-oxo-1,3,4-oxadiazines. Recently, the preparation and cycloaddition behavior of the first member of this class of heterocycles has been described by Steglich and coworkers.[8] In the reactions studied, oxadiazinone 1 behaves as an electron deficient 2,3-diazabutadiene whose Diels-Alder reaction results in the formation of a γ-ketoketene (3) after loss of nitrogen from the initially produced cycloadduct 2. When strained cycloalkenes were used as the dienophile, ketene 3 undergoes a subsequent cyclization to produce an α-pyrone derivative (4).[8,9] In this communication we wish to report evidence which indicates that the oxadiazinone ring system can also undergo electrocyclic ring opening to its azaketene tautomer.

The unknown 5-methyl substituted oxadiazinone 1 (R_1=CH_3; R_2=Ph) was prepared by the dehydration of syn-pyruvic acid benzoylhydrazone with dicyclohexylcarbodiimide. Heating a solution of 1 and 2-methylpropenylpyrrolidine (5) in benzene afforded three crystalline solids and a colorless oil. The products obtained were identified as cycloadducts 9-12 on the basis of their spectral data[10] and elemental analyses. Unequivocal proof of structure 12 derives from a single crystal X-ray structure analysis.[11] Formation of cycloadducts 10-12 can be rationalized in terms of a keto-ketene intermediate (7) formed by cheletropic extrusion of nitrogen from the primary cycloadduct 6. Since a 1,3-hydrogen shift is not possible here, the pyrrolidino group undergoes competitive migration to the ketene carbonyl and benzoyl groups. The latter process probably proceeds in a stepwise fashion initiated by attack of the benzoyl group on the ketene moiety followed by ejection of the pyrrolidino group. We suggest that the formation of compound 9 proceeds by initial valence isomerization of the oxadiazinone to the azaketene tautomer 8 followed by Diels-Alder reaction with enamine 5 to form the cycloadduct. The concentration of 8 is very low since we were unable to detect it by IR spectroscopy.

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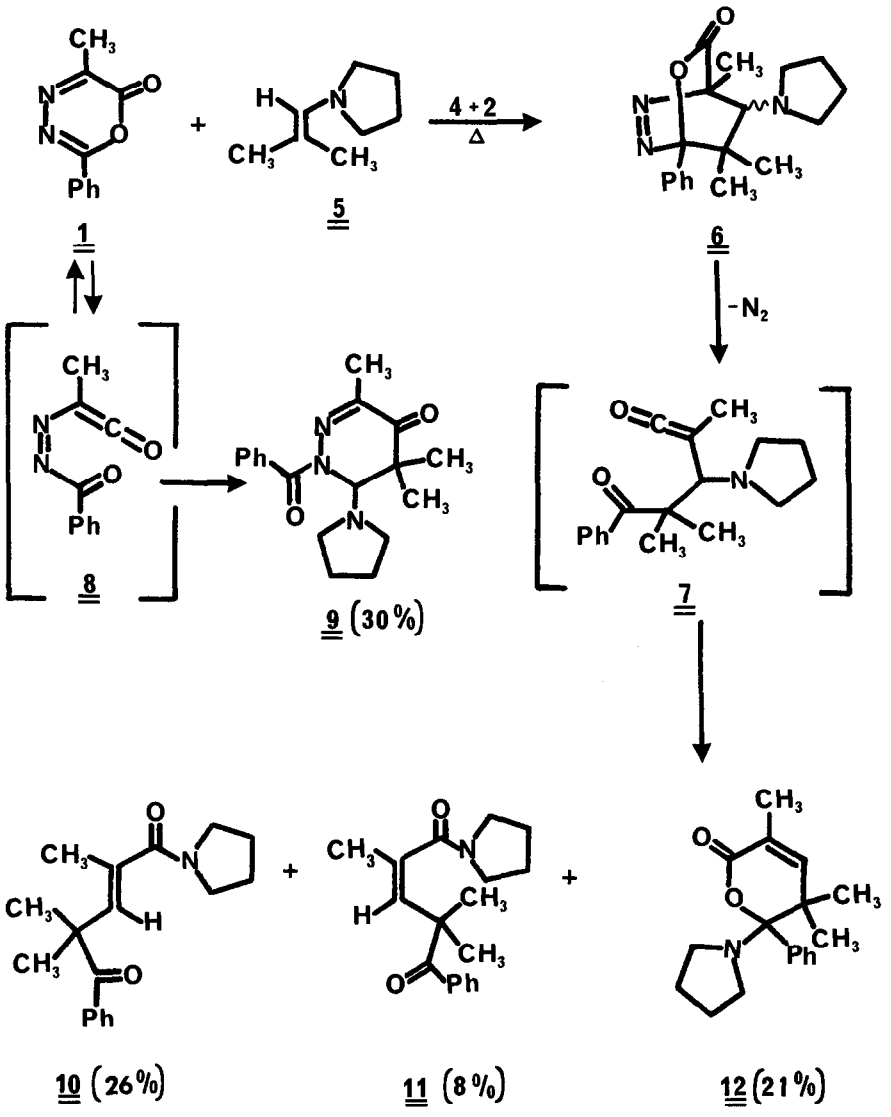
4 + 2
Δ
-N2
1
5
6
8
9 (30%)
7
10 (26%)
11 (8%)
12 (21%)

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(10) Compound 9; mp 124-125°C; NMR ($CDCl_3$, 90 MHz) δ 1.21 (s, 3H), 1.28 (s, 3H), 1.53-1.80 (m, 4H), 1.97 (s, 3H), 2.46-2.78 (m, 4H), 5.82 (s, 1H), 7.30-7.78 (m, 5H); IR (KBr) 1660 cm^{-1}.

Compound 10; oil; NMR δ 1.47 (s, 6H), 1.54 (d, 3H, J=1.5 Hz), 1.84 (m, 4H), 3.30 (m, 4H), 6.05 (q, 1H, J=1.5 Hz) and 7.27-8.11 (m, 5H); IR (neat) 1680 and 1620 cm^{-1}.

Compound 11; mp 58-59°C; NMR δ 1.32 (s, 6H), 1.75 (m, 4H), 1.85 (d, 3H, J=1.6 Hz), 3.30 (m, 4H), 5.40 (q, 1H, J=1.6 Hz) and 7.27-8.07 (m, 5H); IR (KBr) 1670 and 1620 cm^{-1}.

Compound 12; mp 115-116°C; NMR δ 0.63 (brs, 3H), 1.24 (brs, 3H), 1.52-1.75 (m, 4H), 1.92 (d, 3H, J=1.5 Hz), 2.23-2.90 (m, 4H), 6.25 (q, 1H, J=1.5 Hz) and 7.17-7.73 (m, 5H); IR (KBr) 1690 cm^{-1}.

(11) We wish to thank Dr. Karl Peters, Max-Planck Institute fur Festkorperforschung, Stuttgart, for the single X-ray structure determination. Details will be reported elsewhere.

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