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CYCLOADDITIONS TO KETENE-S,N-ACETALS. NEW SYNTHESES OF BENZO[b]- AND NAPHTHO[1,2-b]FURANS, 1-BENZ- AND NAPHTH[1,2-b]OXEPININS, AND BENZ[b]FURAN-2-ONES

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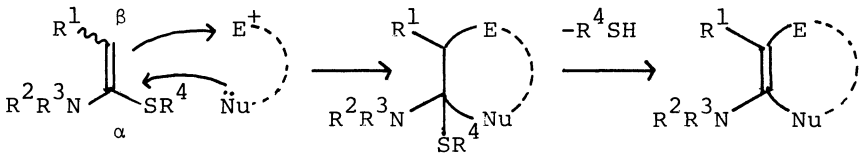
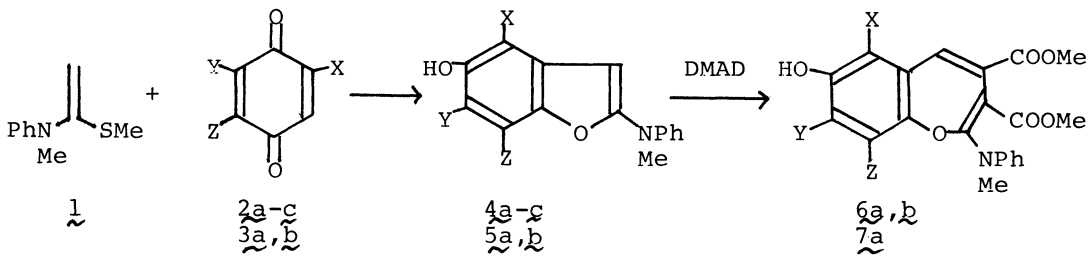
Annulation of ketene-S,N-acetal with 1,4-quinones gave benzo[b]- and naphtho[1,2-b]furans which were converted to 1-benz- and naphth[1,2-b]oxepins and benzo[b]furan-2-ones.

We have exploited new and interesting syntheses of heterocycles using ketene-S,N-acetals as attractive enamines.[1-3] They react with a variety of electrophiles to form carbon-carbon bond at β position and are then attacked by nucleophiles at α position followed by selective elimination of alkyl mercaptan to give enamine moiety again as shown below.



In our continuing studies on the synthetic application of ketene-S,N-acetals as a C_2 building block, we describe a new synthesis of benzo[b]- and naphtho[1,2-b]furans by the first enamine reaction of a new ketene-S,N-acetal (1)[4] with 1,4-quinones and their transformation using the second enamine reaction to oxepin and 3-substituted benzo[b]furan-2-one derivatives.

Annulation of 1 with 1,4-benzoquinones (2a-c) and 1,4-naphthoquinones (3a,b) in boiling toluene or tetrahydrofuran (THF) gave benzo[b]furans (4a-c) and naphtho[1,2-b]furans (5a,b),[5] respectively, in moderate yields (Table 1). The use of other solvents (benzene, acetonitrile, and 1,2-dimethoxyethane) resulted in poor yields. In order to demonstrate the character of the furans (4 and 5), we carried out the following reactions. At first, the ring-expansion[6] of 4a,b, and 5a with dimethyl acetylenedicarboxylate (DMAD) in refluxing dioxane afforded 1-benz- and naphth[1,2-b]oxepins (6a,b, and 7a),[5] respectively (Table 2).



1 2a-c 3a,b 4a-c 5a,b 6a,b 7a

Table 1. Synthesis of 4 and 5

Entry	1,4-Quinone		Product[a]	Yield/%	Solvent
1	2a	X=Y=Z=H	4a	45	THF
2	2b	X=Y=Cl, Z=H	4b	51	Toluene
3	2c	X=H, Y=Z=CN	4c[b]	10	THF
4	3a	X=H, Y,Z= 	5a	35	Toluene
5	3b	X=Cl, Y,Z= 	5b	48	THF

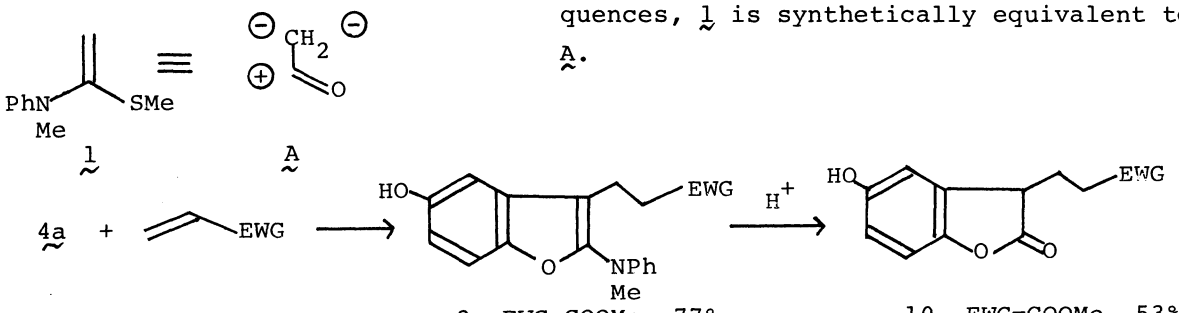
a) The reaction was carried out using each 1 mmol of 1 and 2 or 3. All reaction times were 15 h.
b) The reaction was carried out at room temperature, because the reaction at reflux resulted in decomposition.

Table 2. Synthesis of 6 and 7

Entry	Product[a]	Yield/%	δ/ppm[b]
1	6a	62	6.15
2	6b	42	6.61
3	7a	57	6.47

a) All reaction times were 12 h.
b) The values present the chemical shifts of protons at C-5 as singlets.

Secondly, the Michael addition of 4a with methyl acrylate and methyl vinyl ketone at 150 °C gave 3-substituted benzo[b]furans 8 and 9,[5] respectively. The compounds 8 and 9 were converted to benzo[b]furan-2-ones (10 and 11)[5] by hydrolysis with 10% hydrochloric acid in THF at room temperature. In these synthetic sequences, 1 is synthetically equivalent to A.



1 A

4a + EWG → 8, EWG=COOMe 77%; 9, EWG=COMe 67%

8, 9 → 10, EWG=COOMe 53%; 11, EWG=COMe 24%

References

1) H. Takahata, T. Nakajima, and T. Yamazaki, Synth. Commun., 14, 675 (1984).
2) H. Takahata, T. Nakajima, and T. Yamazaki, Chem. Pharm. Bull., 32, 1658 (1984).
3) H. Takahata, T. Nakajima, K. Matoba, and T. Yamazaki, Synth. Commun., 14, 1257 (1984).
4) The compound 1 was prepared as follows. Condensation of N-methylaniline with acetyl chloride in pyridine followed by thiation with P_2S_5 in one flask reaction gave N-methyl-N-phenylthioacetamide, which was converted to methyl iodide salt. The salt was treated with ^{t}BuOK to afford 1 as an oil (bp 71-73 °C/0.3 mmHg) in 42% overall yield.
5) All new compounds were fully characterized spectroscopically (IR, ^{1}H NMR, MS) and by elemental analyses.
6) D. N. Reinhoudt and C. G. Kouwenhoven, Tetrahedron Lett., 1972, 5203.

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