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CYCLIZATIONS OF N-ALKYLAZINIUM CATIONS WITH BISNUCLEOPHILES[1]. ONE-STEP ROUTE TO FURO[2,3-b]QUINOXALINES

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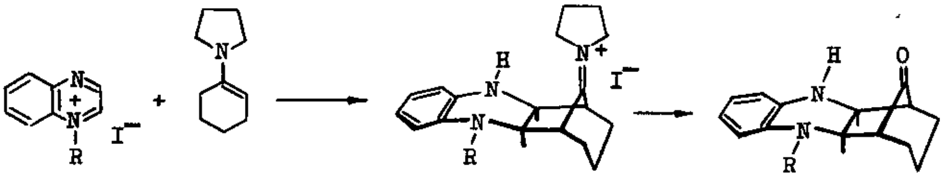
N-Alkylquinoxalinium salts react with anions of β-diketones at a temperature below 20°C to yield endo-furo[2,3-b]quinoxalines.

A number of one-step syntheses of interesting and useful bicyclic and heterobicyclic compounds was developed by M.Strauss and coworkers[2-6] using meta bridging reactions of electron-deficient aromatics with bisnucleophiles. Meta bridging adducts have been also obtained in the reaction of unsubstituted N-ethoxyquinolinium cation with enamines[7]. Similar cyclization, but with ortho-bonding of heteroaromatic system has been discovered to take place in the reaction of N-alkylquinoxalinium salts (1) with enamines of cyclic ketones[1] as shown below.



The present communication describes a novel reaction of salts 1 with β-diketonic reagents such as acetylaceton (AA) and ethyl acetoacetate (EAA) in the presence of base. Addition of base (diethyl or triethylamine) to an ethanolic suspension containing salt 1 and β-diketone at -50 - +20°C resulted in an exothermic reaction which ended in a few minutes to give endo-3a,4,9,9a-tetrahydrofuro[2,3-b]quinoxalines 4 a-d in good yields (table 1).

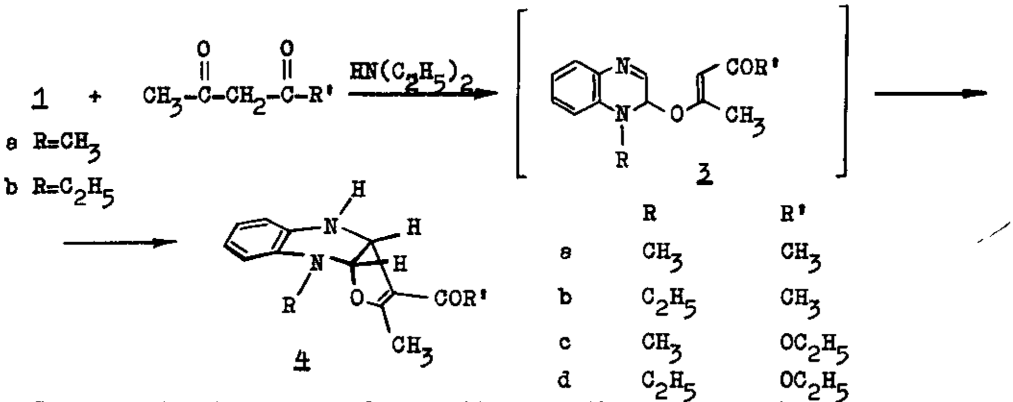


Table 1. Reactions of salts 1 with β-diketones in ethanol

Reagents[a]	Reaction conditions		No	Product	yield (%)
	temp. (°C)	Time (min)		mp(°C)[b]	
1a + AA + DEA	-50	5	4a	118-120	78
1a + AA + DEA	-30	5	4a	"	75
1a + AA + DEA	+20	5	4a	"	58
1a + AA + TEA	+20	15	4a	"	50
1b + AA + DEA	-50	5	4b	114-115	75
1a + EAA + DEA	+20	5	4c	115-116	76
1b + EAA + DEA	-50	5	4d	108-109	75

[a] The ratio of reagents 1: diketone: base was 2:5:5 in all cases.

[b] Melting points were determined approximately under rapid heating. Decomposition of substances took place above 90°C under slow heating.

In accordance with the reactivity of salts 1 in nucleophilic addition reactions[8] we are obliged to suppose that oxygen attack of β-diketone enolate at C-2 occurs initially under these conditions to give intermediate 3 followed by intramolecular cyclization. It should be pointed out that in cyclizations of nitroaromatics with β-diketones the oxygen attack was never observed[2,3].

Other features of this reaction are high regio- and stereoselectivity. For none of the adducts 4 a-d were there any indications of the presence of mixtures of regio- or stereoisomers in ^{1}H and ^{13}C nmr spectra.

Evidence for structure of compounds 4 a-d is provided by ir, nmr and mass spectra. The N-methyl nmr signals for 4a (δ 3.04) and 4c (δ 3.03) and narrow multiplets of aromatic protons for 4 a-d (δ 6.4-6.9) are consistent with tetrahydroquinoxaline structure[8]. The proton H-9a appeared as a simple doublet, while the proton H-3a appeared as a doublet of quarters with a small coupling constant between H-3a and protons of methyl group at position 2 of furan ring (table 2). In order to confirm the assignment of chemical shifts and coupling constants C-3a and C-9a deuterated 4a was prepared and double nmr procedure was used.

Table 2. Some spectral data of compounds 4a-d

Adducts[a]	IR (cm^{-1})		Chemical shifts[b],		Coupling Constants, Hz	
	NH	C=O, C=C	H-3a	H-9a	3a,9a	3a,methyl
4a	3320	1600-1640	5.04	5.78	9.0	0.9
4b	3328	1600-1640	4.95	5.86	8.7	0.9
4c	3370	1695,1635	4.97	5.79	8.9	1.0
4d	3368	1695,1640	4.93	5.91	8.8	0.9

[a] All compounds gave acceptable microanalyses.

[b] The spectra were recorded at 60 MHz in CdCl$_3$ solution with TMS as internal standard.

The coupling constants between H-3a and H-9a were in the range from 8.7 to 9.0 Hz and pointed out to endo-adducts 4 a-d rather than to exo-isomers[9]. Convincing evidence for 4a to be endo-isomer was obtained by X-ray crystallography[10]. Taking into account the similarity of nmr spectra of adducts 4d-a it seems highly probable that all compounds 4 a-d are endo-isomers.

Since ^{13}C nmr signal of methyl group of furan ring was observed for both 4a (δ 15.4) and 4c (δ 14.3) the oxygen of acetic but not carbethoxy group of EAA participates in cyclizations with salts 1.

Thus, the reaction of salts 1 with β-diketones yields endo-adducts 4 a-d and differs from the one with enamines of ketones where exo-adducts 2 have been obtained.

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10. Special communication will be published.

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