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SYNTHESIS OF 2,5H-2,5-AZEPINDIONES BY THE REACTION OF QUINONES WITH HYDRAZOIC ACID*

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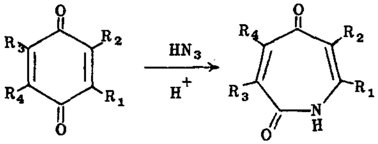
The reactions of some alkyl-substituted quinones with hydrazoic acid in concentrated sulfuric acid give high yields of azepindiones (II). This synthesis is essentially the Schmidt reaction, but with quinones instead of the more commonly used carbonyl compounds. Azepindiones of this ring system are comparatively rare and the previously known compounds were made by more involved procedures (1,2).



I

II

	R_1	R_2	R_3	R_4
a)	H	CH_3	CH_3	CH_3
b)	H	$CH(CH_3)_2$	H	CH_3
c)	H	CH_3		
d)	H	CH_3	H	CH_3
e)	CH_3	CH_3	CH_3	CH_3

The reaction conditions (conc. sulfuric acid at 0°) are important, since the quinones Ib, Ic, and Id have been previously subjected to the Schmidt reaction using other solvents and acids but with quite different results (1, 3-7). A solution of the quinone in conc. sulfuric acid was cooled to 0° and an equimolar amount of sodium azide was slowly added. When

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* Coenzyme Q. LXIV.

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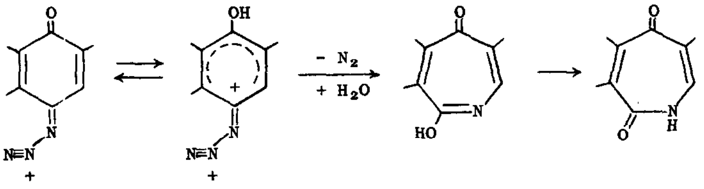
nitrogen evolution ceased, the reaction mixture was poured into a mixture of ice and water, and the resulting precipitate was recrystallized from aqueous ethanol to give 75 to 85% yields of the azepindiones.***

It is evident from the data in Table I that the reaction takes place on the least hindered carbonyl group and that the NH group has inserted in such a manner that it is attached to the least substituted carbon atom. For example, NMR decoupling experiments on the azepindiones obtained from quinones Ia, Ib, and Ic show that the NH proton is directly coupled to the =CH proton and, therefore, these groups are adjacent.

It has been reported that electronic effects play only a minor role in the Schmidt reaction (8-10) and that the products arise mainly by steric control. It is evident from the data reported here that besides steric effects electronic effects are important in the reaction of quinones with hydrazoic acid in sulfuric acid. These quinones give the azepindiones arising from migration of the smaller group. In concentrated sulfuric acid, it is very likely that the intermediate (III) is protonated on the carbonyl group to give IV, and then loses nitrogen in a trans displacement by the migrating group. For unsymmetrical quinones, that group migrates which one



III IV II

***The C, H, N analyses on these products were in good agreement with the calculated values.

1

TABLE

Physical Properties of 2,5H-2,5-Azepindiones

Compound	M.P. (°C)	U.V. (mμ)	I.R. (cm^{-1})	NMR Chemical Shifts (τ)*		
				NH	=CH	=C-R
IIa	194-6	228 (1134) 287.5 (332)	in $CHCl_3$ 3320 3150 1850 1670	-0.05 (1) b	3.22 (1)**m	7.71 (3) s 7.82 (3) d 7.98 (3) s
IIb	168	228 (1450) 288 (292)	in $CHCl_3$ 3320 3200 1850 1770 1690	-0.04 (1) b	3.35 (1)***d 4.12 (1) m	6.69 (1) h 7.82 (3) s 8.90 (6) d
IIc ****	203-4	207 (1548) 233 (1205) 274 (541)	in $CHCl_3$ 3320 3200 1850 1750 1670	-0.4 (1) b	3.19 (1)**b	7.75 (3) d
IId	216-7	228 (1808) 288 (337)	in nujol 3220 3120 3070 1870 1790 1720	0.09 (1) b	3.16 (1) m 4.12 (1) s	7.77 (3) s 7.83 (3) d
IIe	214-5	233 (1188) 298 (266)	in $CHCl_3$ 3350 3220 1830 1700	0.39 (1) b		7.85 (9) s 8.05 (3) s

* b = broad; d = doublet; m = multiplet; h = heptet; s = singlet.

** Irradiation at NH frequency resulted in collapse of the multiplet to a quartet. Irradiation at CH_3 frequency resulted in collapse of the multiplet to a doublet.

*** Irradiation at NH frequency resulted in collapse of the doublet to a singlet.

**** The protons in the aromatic portion of the compound show absorption at τ, 1.94-2.99 (4) m.

would predict to bear the least positive charge density, *i.e.*, the least substituted carbon atom of the ethylene linkage. The migratory aptitude observed in this series is monosubstituted ethylene > disubstituted ethylene, phenyl.

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