

PHOTOCYCLIZATION OF SUCCINIMIDE DERIVATIVES WITH AMIDO GROUP IN
SIDE CHAINS. SYNTHESIS OF TRICYCLIC PYRROLO[1,2-a]PYRAZINE RING
SYSTEMS.¹

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Abstract ----- Succinimide derivatives (2) with amido group in
their side chains were irradiated in acetonitrile to give bi-
and tricyclic pyrrolo[1,2-a]pyrazines (3).

The photoreactions of cyclic imides have been extensively studied giving rise to a variety of new heterocycles.² As to synthesizing various multicyclic fused heterocycles with two nitrogen atoms, we have already reported the photolysis of N-substituted phthalimides such as N-(ω -methylanilino³ and ω -amino⁴)alkylphthalimides. Furthermore, efficiencies of these reactions were highly improved by incorporating an acyl group on the nitrogen atom in their N-alkyl side chains (1).^{1b} As an extension of the application of these reactions to the alicyclic imide system, we now wish to report an easy synthesis of bi- and tricyclic aliphatic systems containing two nitrogen atoms.

Substrates 2 and 4 were prepared from succinimidoacetyl chloride and the corresponding amines, and succinimide and the corresponding ω -amidoalkyl acetate, respectively. Their photolysis was performed with a 60 or 120 W low-pressure mercury lamp in acetonitrile (10-24 mM) in an atmosphere of nitrogen and the products were purified by silica gel column chromatography. The results are summarized in Table 1.

The photolysis of 2 which lacks γ - and δ -hydrogens relative to the imide carbonyl² gave bi- and tricyclic pyrazine derivatives 3 in moderate yields. In all cases a new carbon-carbon bond was formed between the imide carbonyl and the carbon

adjacent to nitrogen in the side chain by initial ϵ -hydrogen abstraction. These structures were assigned on the basis of the elemental analysis and spectral data. In the IR spectra of 3a-e the bands in the regions 3200-3500 and 1625-1700 cm^{-1} indicated the presence of the cyclol and lactam moieties, respectively. In the $^1\text{H-NMR}$ spectra of 3b-d, the methylene signal on the pyrazine ring showed two doublets at 3.46-3.72 and 3.97-4.95 ppm, which exhibit the large coupling constant ($J=18-19$ Hz) due to the geminal methylene protons. In the $^{13}\text{C-NMR}$ spectra of 3b-d, doublets in the off-resonance decoupled spectra appeared at 62.8-65.8 ppm, suggesting the presence of a tertiary carbon due to a new carbon-carbon bond formation. In the case of 2b-d two diastereoisomers (3-i and 3-ii) were isolated, though their stereochemistry is still unknown.

Upon the irradiation of 4a which also lacks γ -hydrogen, dipyrrolo[1,2-c : 2',1'-e]-imidazoline 5 was obtained in a moderate yield, a product of δ -hydrogen abstraction.² In the IR spectrum of 5 the bands at 3280, 1690, and 1660 cm^{-1} indicated the presence of the cyclol and lactam moieties, respectively. The photolysis of 4b-e having γ -hydrogens relative to the imide carbonyl gave mainly keto lactam 6 by a ring expansion reaction.⁵

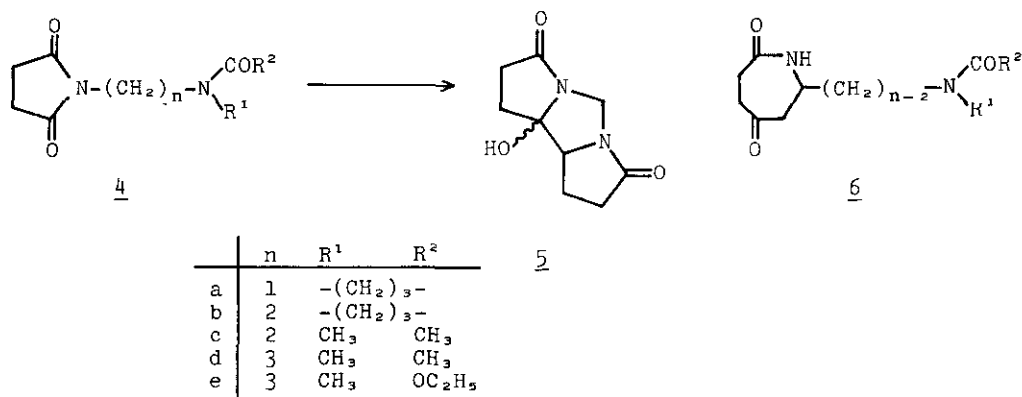
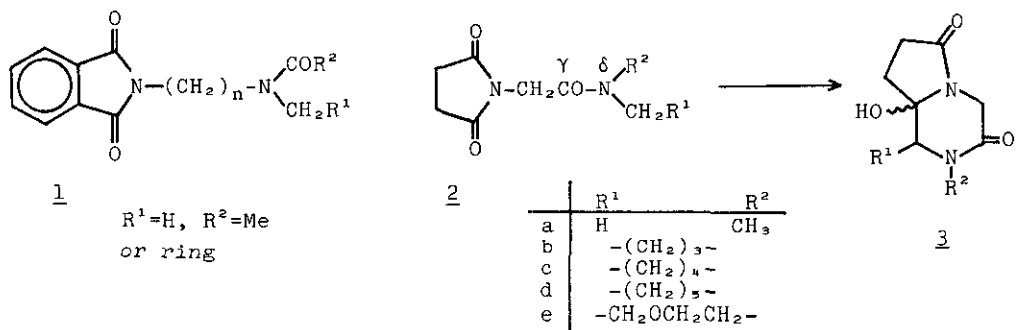
Interestingly, such γ -hydrogen abstraction was not observed with the phthalimide derivatives (1).^{1b} In contrast with the photoreactions of the aromatic imides (phthalimides) 1 which are believed to proceed mainly by an electron transfer mechanism,^{1b-4} it is worth noting that the reactions of their aliphatic counterparts (succinimides) 4 are initiated predominantly by typical γ -hydrogen abstraction, being parallel to the behavior of the common carbonyl.⁶ Although further work is required for the determination of stereochemistry of the photoproducts, this method provides a simple route to the tricyclic nitrogen heterocycles, which will serve as a convenient source of synthetic intermediates for such alicyclic amine systems.

Table 1 Photoproducts from 2 and 4.

Substrate	mp °C	Time (h)	Product	mp °C	Yield(%)
<u>2a</u>	95.5 - 98	1.5	<u>3a</u>	110.5-112	60
<u>2b</u>	141 - 142	1.5	<u>3b-i</u>	135 - 138	11
			<u>3b-ii</u>	81 (dec.)	43
<u>2c*</u>	120 - 122.5	5	<u>3c-i</u>	143 (dec.)	13
			<u>3c-ii</u>	102.5-104.5	9
<u>2d*</u>	88.5 - 91	2	<u>3d-i</u>	160 - 163	29
			<u>3d-ii</u>	142 - 144	21
<u>2e*</u>	185.5-186.5	4	<u>3e</u>	200 (dec.)	26
<u>4a**</u>	138.5-140	1.5	<u>5</u>	131 - 133	51
<u>4b</u>	100 - 101.5	1.5	<u>6b</u>	154 - 156	41
<u>4c</u>	87 - 87.5	1.5	<u>6c</u>	115.5-117.5	21
			succinimide		16
<u>4d*</u>	oil	3.5	<u>6d</u>	115.5-117	23
			succinimide		18
<u>4e</u>	bp _{0.6} 165	2	<u>6e</u>	78 - 81	25

* A 120 W low-pressure mercury lamp was used.

** in methanol



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