

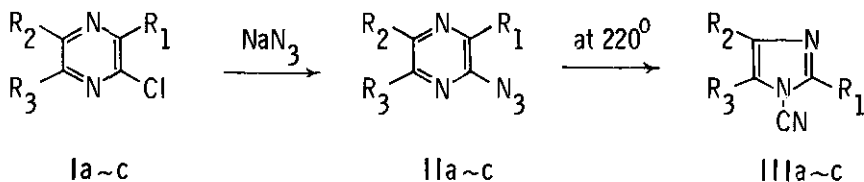
PYROLYSIS of AZIDO-DIPHENYLPYRAZINES

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Abstract ---- The pyrolysis of 2-azido-3,5- (IIa), 2-azido-3,6- (IIb), and 2-azido-5,6-diphenylpyrazines (IIc), prepared from the corresponding 2-chloro-diphenylpyrazines and sodium azide, led respectively to 1-cyano-diphenylimidazoles (IIIa, IIIb, and IIIc) in good yields. The structure elucidation of the products is described.

Ring contraction of N-heteroaromatics is reviewed in detail.¹ In the pyrazine field, it has already been reported that the treatment of monochloropyrazines with liquid ammonia gave imidazoles,² and that 2-azido-5,6-diphenylpyrazine is transformed to 4,5-diphenylimidazole (IVc)³ by photolysis in acetic acid.⁴ The present communication deals with the pyrolytic transformation of 2-azido-diphenylpyrazines to 1-cyano-diphenylimidazoles in good yields (Scheme 1).



a: $R_1 = R_2 = \text{Ph}$, $R_3 = \text{H}$ b: $R_1 = R_3 = \text{Ph}$, $R_2 = \text{H}$ c: $R_1 = \text{H}$, $R_2 = R_3 = \text{Ph}$

Scheme 1

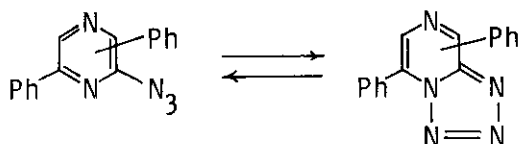
The preparation of 2-azido-3,5- (IIa), 2-azido-3,6- (IIb), and 2-azido-5,6-diphenylpyrazines (IIc) was achieved by heating of the corresponding 2-chloro-diphenylpyrazines (Ia-c) with sodium azide in N,N-dimethylformamide (DMF). The results are given in Table I. Although Sasaki et al. also prepared IIc from

2-chloro-5,6-diphenylpyrazine (Ic) via 2-hydrazino-5,6-diphenylpyrazine,⁴ the present method is thought to be more convenient in total yield.

Table I. 2-Azidopyrazines from 2-Chloropyrazines

Substrate	Product	Reaction Temp. (°C)	Reaction Time (hr)	mp (°C)	Yield (%)
Ia ⁵	IIa	130	5	159-160	81
Ib ⁵	IIb	120	24	170-172	62
Ic ⁶	IIc ⁴	150	5	156-157	80

These prepared azidopyrazines behaved diversely in the IR spectra. Namely, all these azidopyrazines showed no band according to an azido group in a solid state (KBr). On the other hand, IIb and IIc carrying a phenyl group at C-6 indicated a strong band at 2145-2150 cm^{-1} in a chloroform solution. In the spectra of IIa, taken in chloroform, such a band was not detected. Sasaki et al. also described the same phenomena with IIc.⁴ These results suggest that in a solid state, azido-diphenylpyrazines exist exclusively as the corresponding tetrazolo-[1,5-a]-pyrazines (Scheme 2) and in a solution, only the azidopyrazines carrying an electron withdrawing group at C-6 are existent as an azido form.



Scheme 2

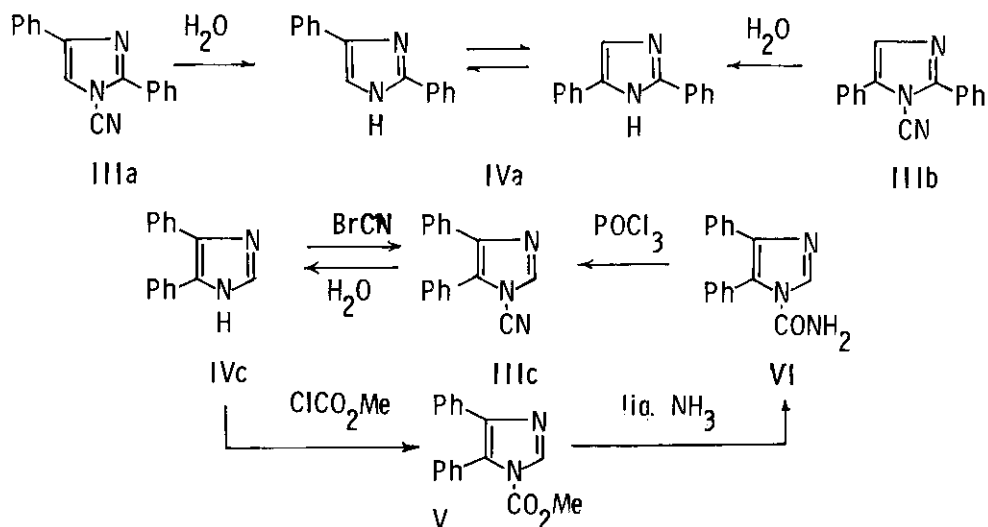
The azido-diphenylpyrazines, IIa, IIb, and IIc, were heated at 220° on a metal bath. The reaction finished in a moment with an explosive generation of nitrogen gas, giving cyano-imidazoles. The products were purified by recrystallization from cyclohexane and the results are shown in Table II.

The IR spectra of the products indicated a strong and sharp band at 2260-2275 cm^{-1} according to a cyano group. Although the position of the cyano group was not always exactly determined, some reactions suggested that the products may be 1-cyano-imidazoles, as will be described next.

Table II. 1-Cyano-diphenylimidazoles

1-Cyano-diphenylimidazole	mp (°C)	Yield (%)	IR (KBr, cm^{-1})
IIIa	118-119	quant.	2262
IIIb	135-136	quant.	2273
IIIc	144-145	quant.	2268

All the products were heated in an aqueous potassium hydroxide solution to afford the diphenylimidazoles, and, moreover, by this hydrolysis, IIIa and IIIb gave the same product, 2,4-diphenylimidazole (IVa).⁷ Reduction of the cyano compounds with lithium aluminum hydride, catalytic hydrogenation in the presence of Raney-Ni, and treatment with hydrogen chloride gas in absolute methanol met with the same results as that of the hydrolysis. If the products obtained by pyrolysis of IIa and IIb were C-cyano compounds, the products should be the same and give amines or esters by the reactions described above. On the other hand, the treatment of IVc with cyanogen bromide led to IIIc. This transformation was also achieved another way, namely, via the methoxycarbonyl derivative (V) and amide (VI). Because it would be predicted that cyanation with cyanogen bromide and acylation take place exclusively on a nitrogen atom, IIIc is thought to be an N-cyanoimidazole.



Scheme 3

Although Crow and Wentrup reported the formation of cyano-imidazoles by the pyrolysis of 4-azido-2,6-dimethoxypyrimidine and 4-azido-6-methyl-2-methylthio-pyrimidine, and proposed a mechanism of the ring contraction, no description of the structure determination of the products was made.^{8,9} The present authors postulate that the pyrolysis of the azido-pyrazines might proceed by the reaction mechanism as reported and is suitable for the preparation of phenyl-imidazoles. The investigation on pyrolysis of other azido-pyrazines is now in progress and will be reported elsewhere.

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