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HYDRAZINE DERIVATIVES. II. FORMATION OF URAZOLES BY TRANSCARBAMYLATION AND THE TRUE NATURE OF PINNER'S p-URAZINE.

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It is known that biuret (1,2) and ethyl allophanate (3,4,5) react with phenylhydrazine to give 1-phenylurazole (I). However, when urea is used, the emerging picture is more complicated. The senior author* has observed three possibilities upon several runs of the reaction between urea and phenylhydrazine. In one set of experiments, 1-phenylurazole (I) is formed; in another set, 4-anilino-1-phenylurazole (II) is obtained and thirdly, mixtures of the two urazoles are obtained. It appears that if the rate of heat increase is slow, 1-phenylurazole (I) is formed with urea and phenylhydrazine; with very fast rate, the main product is 4-anilino-1-phenylurazole (II). In the case of phenylhydrazine and urea in the ratio 1:1, with heating periods of several hours, 4-anilino-1-phenylurazole (II) is the main product (the expected 1-phenylsemicarbazide (III), formed with shorter heating periods, was not found). It is now well established that 1-phenylsemicarbazide (III) is converted to 4-anilino-1-phenylurazole (II) when heated at 150-160°C. just as is ethyl phenylcarbazate (IV) (6) when it is heated around 200°C. The structure is not the s-tetrazine type (V) as proposed by Pinner (2) and others (7) but is rather a 1,2,4-triazole type (9,10). In our opinion, when the temperature is slowly raised to 150-160°C. urea is converted to biuret which then reacts as a transcarbamylation reagent with phenylhydrazine to produce the proposed intermediate 1-anilinobiuret (VI). Subsequently, the latter undergoes cyclisation (8) via a second transcarbamylation reaction to give 1-phenylurazole. If the temperature of the reaction mixture reaches 150-160°C. very quickly, the urea reacts by transcarbamylation with the phenylhydrazine to form 1-phenylsemicarbazide (III) which, at the temperature mentioned, goes to 4-anilino-1-phenylurazole (II) (i.e., at slow rates of temperature increases the urea, reacting instead by transcarbamylation with itself, produces biuret). The main product, 4-anilino-1-phenylurazole (II) may be formed by the condensation of two molecules of 1-phenylsemicarbazide (III) or the 1-phenylsemicarbazide may undergo a transcarbamylation to give 1-carbamyl-1-phenylsemicarbazide (VII), followed by a reaction with phenylhydrazine and a cyclisation by transcarbamylation into (II)

with evolution of ammonia or the 1-phenylsemicarbazide may undergo a bimolecular rearrangement (with diphenylcarbohydrazide (VIII) and its N-1 carbamyl derivative (IX) as acceptable intermediates) followed by cyclisation to the urazole (II). The mechanisms of these reactions are presently under study.

When mono- and dichlorophenylhydrazines as well as mono- and dinitrophenylhydrazines react with urea, very low yields of 1-substituted urazoles are obtained. In some cases, (p-nitrophenylhydrazines) no urazoles were isolated, instead decomposition products of the substituted phenylhydrazines and some cyanuric acid are formed. It is apparent that the nature of the hydrazines (besides the rate of temperature increases) must be taken into account in transcarbamylations with urea as reagent. Since the corresponding phenylsemicarbazides are normally formed by the reaction of phenylhydrazines with potassium cyanate, it is almost certain that the transcarbamylation with urea in the phenylhydrazine series does not involve the formation of isocyanic acid from urea. Instead, an addition transition complex stabilised by ammonia evolution occurs as proposed (9) and as shown from the low yields reported below.

In a previous publication (9), the C^{13} NMR spectrum established the presence of a five-membered ring for Pinner's compounds. Subsequent work showed the product formed with phenylhydrazine and urea (1:4) under carefully controlled rate of heating, maximum temperature control and time factor to be definitely 1-phenylurazole (I) and, the product formed by heating 1-phenylsemicarbazide (III) at 150-160°C., definitely 4-anilino-1-phenylurazole (II). The IR and proton NMR spectra, mixed melting point depression, and quantitative elemental analysis accrues the conclusion drawn from previous C^{13} NMR analysis. A complete C^{13} NMR analysis and other considerations will appear soon (10). Some urazoles were prepared and studied. The two key compounds have the following m. pt. values: 4-anilino-1-phenylurazole (II) (m.pt. 266-267°C.) and 1-phenylurazole (I) (m.pt. 268°C.); mixed melting point: 256-262°C. The UV (molar conc. 0.01/1 cm/EtOH) values are:

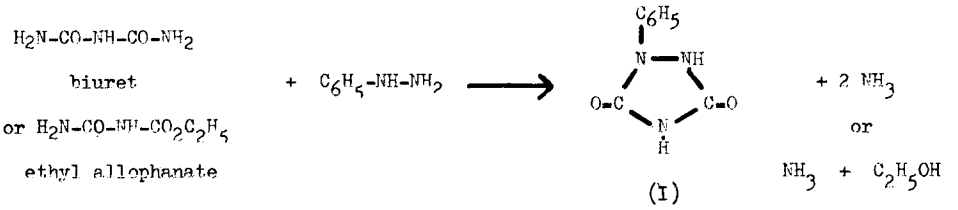
1-methylurazole (m. pt. 232-233°C.); λ = 2075 Å, $\epsilon = 4.0 \times 10^3$

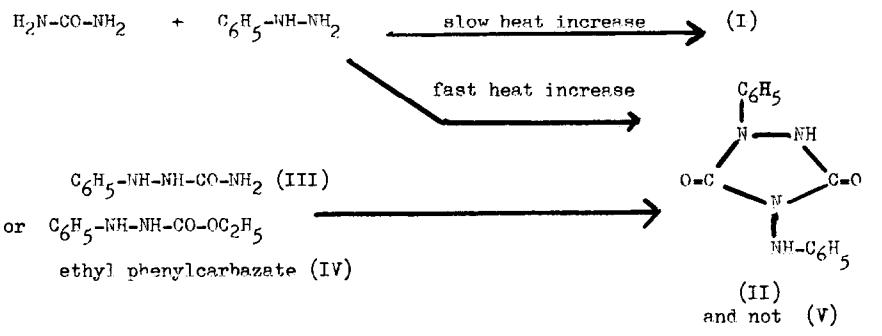
1-(2,5-dichlorophenyl)-urazole (m.pt. 225-227°C.)(20% yield) λ = 2915 Å, $\epsilon = 2.2 \times 10^3$

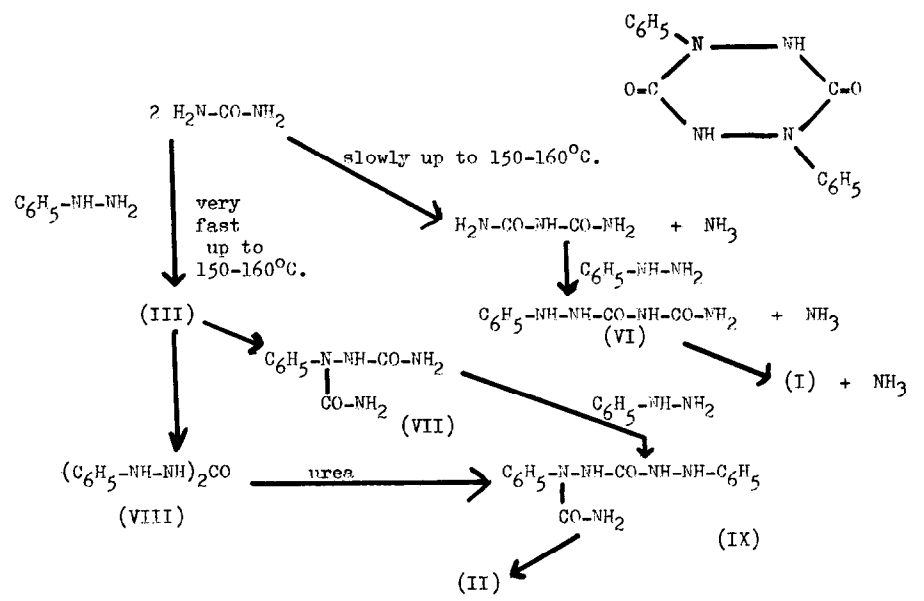
1-(3,4-dichlorophenyl)-urazole (m.pt. 158-160°C.)(20% yield) λ = 2970 Å, $\epsilon = 1.8 \times 10^3$

1-(4-methyl-2-nitrophenyl)-urazole (m.pt. 192-194°C.)(6% yield) λ = 2760 Å, $\epsilon = 5.2 \times 10^3$.

All the products listed above gave one spot by TLC with various eluents. The reaction failed to produce 1-(4-nitrophenyl)-urazole.


H2N-CO-NH-CO-NH2
biuret
or H2N-CO-NH-CO2C2H5
ethyl allophanate
+ C6H5-NH-NH2
+ 2 NH3
or
NH3 + C2H5OH
(I)


H2N-CO-NH2 + C6H5-NH-NH2
slow heat increase
(I)
fast heat increase
C6H5-NH-NH-CO-NH2 (III)
or C6H5-NH-NH-CO-OC2H5
ethyl phenylcarbazate (IV)
(II)
and not (V)


2 H2N-CO-NH2
slowly up to 150-160°C.
C6H5-NH-NH2
very fast up to 150-160°C.
H2N-CO-NH-CO-NH2 + NH3
C6H5-NH-NH2
C6H5-NH-NH-CO-NH-CO-NH2 + NH3
(VI)
(III)
C6H5-N-NH-CO-NH2
CO-NH2
(VII)
(I) + NH3
C6H5-NH-NH2
(C6H5-NH-NH)2CO
(VIII)
urea
C6H5-N-NH-CO-NH-NH-C6H5
CO-NH2
(IX)
(II)

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