and Finar,[6] using methyl nitrate[7] rather than ethyl nitrate as the nitrating agent. After hydrolysis[6] of the 2-nitro-4-fluoroacetanilide with 8 *N* hydrochloric acid, the reaction mixture was steam distilled. From the distillate, 2-nitro-4-fluoroaniline melting at 93° was isolated by filtration in 81.3% yield.

To a solution of 10 g. (0.064 mole) of 2-nitro-4-fluoroaniline in 20 ml. of ethyl alcohol and 15 ml. of 30% sodium hydroxide solution was added in portions and with shaking 15 g. (0.23 gram atom) of zinc dust. The mixture was heated on the steam-bath for 30 minutes, filtered and extracted with two 100-ml. and five 50-ml. portions of benzene. The extracts were concentrated to about 50 ml., diluted with an equal volume of Skellysolve H, cooled and filtered to give 5 g. of 4-fluorophenylenediamine, m.p. 89–91°. An additional 0.8 g. was isolated by concentration of the mother liquor, bringing the total yield to 72%. The product was not further purified but was used immediately in condensations to produce benzimidazoles.

By reduction of 2-nitro-4-fluoroaniline with sodium hydrosulfite a product melting at 92° was obtained in 37% yield.

Benzimidazoles.—The benzimidazoles were prepared by heating a mixture of the appropriate diamine or its hydrochloride with an excess of the desired acid, with or without dilute hydrochloric acid or water. If the reaction mixture was sufficiently liquid, it was refluxed; if it formed a cake, it was warmed on the steam-bath. Most of the crude products were isolated by filtration from the cooled reaction mixture after it was made just basic to litmus with 10% sodium hydroxide solution or 6 *N* ammonium hydroxide. They were purified by recrystallization from aqueous alcohol and sublimation. If the sublimate was colored or not pure, it was recrystallized.

Exceptions to the above procedure were as follows: 5(or 6)-fluorobenzimidazole was best recrystallized from benzene and Skellysolve H; 5(or 6)-fluoro-2-(trifluoromethyl)-benzimidazole was isolated by benzene extraction from the reaction mixture after it was made just slightly acid to litmus and the product was recrystallized from benzene and Skellysolve H and sublimed; the reaction mixture of 5(or 6)-fluoro-2-(pentafluoroethyl)-benzimidazole was recrystallized directly from benzene and Skellysolve H; the crude product was extracted with 6 *N* ammonium hydroxide and the material obtained by acidification of the extract was sublimed; 2-(fluoromethyl)-benzimidazole was recrystallized from benzene and Skellysolve H and could not be sublimed.

Alternate Preparation of 4,7-Dimethylbenzimidazole.—The mixture of 2,3-dinitro-*p*-xylene and 2,6-dinitro-*p*-xylene obtained by the dinitration of *p*-xylene with fuming nitric acid[8] was reduced with iron powder and hydrochloric acid according to the procedure for the reduction of dinitrotoluene,[9] the product, consisting of mixed diamino-*p*-xylenes, was isolated as the sulfate salts in 55% yield. The condensation of this product with two moles of dilute formic acid, according to the general procedure for the preparation of benzimidazoles, resulted in a 32.8% yield of 4,7-dimethylbenzimidazole, identified by melting point and mixed melting point with a sample prepared from 3,6-dimethyl-*o*-phenylenediamine.

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[CONTRIBUTION FROM THE CHEMISTRY DEPARTMENT, UNIVERSITY COLLEGE, CORK, IRELAND]

Studies in the Pyrazole Series. II. The 1-Nitroguanyl Type

BY F. L. SCOTT, M. T. KENNEDY AND J. REILLY

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The reaction between acetylacetone and nitroaminoguanidine results in both hydrazone and pyrazole formation, the latter being the main process involved. The major product, *viz.*, 3,5-dimethyl-1-nitroguanylpyrazole, is the prototype of a new class of pyrazoles—the 1-nitroguanyl type. With iodine, denitroguanylation and substitution are observed; with chlorine and bromine substitution alone. When these latter halogenations are performed in alkaline media, denitroguanylation again accompanies the substitution. Nitration, depending upon the reagents used, may afford either the 4-nitro-1-nitroguanyl- or the 4-nitro-1-unsubstituted-3,5-dimethylpyrazoles. Reduction caused either disarrangement or denitroguanylation, no pyrazoline formation being observed. Finally, hydrazinolysis and ammonolysis take place, to extents depending on the basicity of the amine used and result in the symmetrical fission of the material, the nitroguanyl side-chain being incorporated in the amino and hydrazino residues.

Reaction of an acylhydrazide ($RN''HN'H_2$) with β-diketones results in (i) hydrazone formation, in which the N′-atom alone of the hydrazide molecule is concerned (primary condensation), or (ii) pyrazole formation, in which both the N′- and N″-atoms of the hydrazide are involved (secondary condensation). The relative extents to which primary and secondary condensations occur depend upon the hydrazide concerned and may be employed for characterization purposes. A condensibility coefficient or the "condensive aptitude" (C_A) of a hydrazide may then be defined as the numerical ratio between the weights (in molar proportions) of primary condensation products and secondary condensation products, formed under specified conditions.

The secondary condensation process occurs *via* $(N \rightarrow \overset{+}{C})$ chelation, followed by dehydration, and hence the extent of pyrazole formation is in reciprocal ratio to the electrophilic activity of the acyl group. The greater the electrophilic power of the acyl group, the greater should be the C_A value of the corresponding hydrazide.

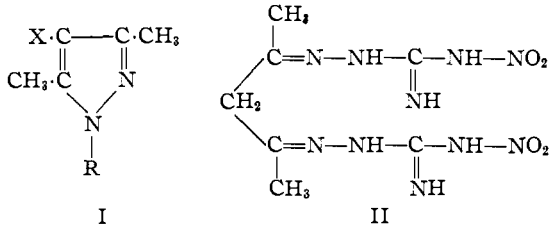
In the acyl hydrazides considered in the present series, namely, where R varies from $-C(=O)-NH_2$ (A), to $-C(=S)-NH_2$ (B), to $-C(=\overset{+}{N}H_2)-NH_2$ (C), to $-C(=NH)-NHNO_2$ (D), the electrophilic activities of the groups may be arranged as follows C > A ≃ D > B. The estimation of the relative electrophilic powers of A and D from theoretical considerations alone is difficult, because the weaker $-I$ effect of the imino grouping in D is counteracted to a certain extent by the weaker $+E$ effect of its nitroamino group.

Use of the C_A concept, with its electronic implications, clarifies the uncertainty of the relative electrophilicities of A and D. The present experimental results indicate the order of electrophilicity to be C > D > A > B. (i) The C_A value for semicarbazide is definitely < 0.3 (we found its

value to be approximately 0.05). (ii) Nitroaminoguanidine forms a pyrazole in 67% yields (20% osazone formation being detected) and therefore to this hydrazide a C_A value of approximately 0.3 can be assigned.

The use of nitroaminoguanidine in heterocyclic synthesis has been limited. Besides the reaction discussed below, the only use, and that indirect, of the hydrazide in heterocyclic synthesis has been the preparation from it of iminotriazoles.[1] The substance, however, has found considerable utility as a reagent for the characterization of the carbonyl group,[2] and its azide has proved to be a useful reagent for the limited introduction of the nitroguanyl group.[3]

We have found[4] (*cf.* above) that it reacts with acetylacetone to give two materials[5]—3,5-dimethyl-1-nitroguanylpyrazole (I, X = H, R = C(=NH)—$NHNO_2$), the prototype of a new class of pyrazoles (the nitroguanyl type), and acetylacetonenitroguanylosazone (II)).



I II

Analogously to 3,5-dimethyl-1-guanylpyrazole nitrate[6] the 3,5-dimethyl-1-nitroguanylpyrazole affords ring substitution alone with chlorine or bromine, 4-chloro- or 4-bromo-3,5-dimethyl-1-nitroguanylpyrazoles (I, X = Cl/Br, R = —C(=NH)—$NHNO_2$) being formed. Halogenations in strongly alkaline solution afford a mixture of the 4-halo-3,5-dimethyl-1-nitroguanylpyrazole and the corresponding 4-halo-3,5-dimethylpyrazole (I, X = Cl/Br, R = H). Iodine monochloride in acetic acid solution gives 4-iodo-3,5-dimethyl-1-nitroguanylpyrazole, while with iodine and sodium acetate the deguanylated iodocompound results. The hydrazinolysis of both amidines[7] and guanidines[8] results in the incorporation of the hydrazine in the parent molecule. When a 1-nitroguanyl- or guanylpyrazole however, is subjected to ammonolysis, or hydrazinolysis[4,9] after the formation of an unstable addition compound,[10] this adduct splits into a 1-unsubstituted pyrazole, and the amine or hydrazine is incorporated into the guanyl fragment.

With alkaline reducing agents, denitroguanylation occurs. With acid reducing agents disarrangement to the 1-guanylpyrazole[11] appears to occur.

Experimental[12]

Nitroaminoguanidine was prepared by the method of Henry, Makosky and Smith.[13]

Reaction of Acetylacetone and Nitroaminoguanidine.—To a solution of 2 g. (0.017 mole) of pure nitroaminoguanidine (its purity being 99.9% as estimated by the Jamieson iodate technique)[14] in 20 ml. of water was added acetylacetone (2 ml.) and a few drops of glacial acetic acid as catalyst. On standing overnight, a white crystalline deposit separated. This was filtered and using boiling, anhydrous chloroform was separated into two materials. One, the insoluble residue (after recrystallization from water) was obtained as fine, white needles of m.p. 157°; these were acetylacetonenitroguanylosazone. *Anal.* Calcd. for $C_7H_{14}N_{10}O_4 \cdot H_2O$: C, 26.3; H, 5.0; N, 43.8. Found: C, 26.6; H, 4.9; N, 43.6. The second solid, which was soluble in chloroform, after recrystallization from aqueous ethanol, melted at 125°. It was found to be 3,5-dimethyl-1-nitroguanylpyrazole. *Anal.* Calcd. for $C_6H_9N_5O_2$: C, 39.3; H, 4.9; N, 38.2. Found: C, 39.55; H, 4.9; N, 38.2. Total yield of the substituted pyrazole was 2.09 g. (67%), and of the osazone 0.53 g. (20%).

Efforts to synthesize this nitroguanylpyrazole from 3,5-dimethyl-1-guanylpyrazole nitrate were as follows.[15] (i) 3.13 g. of 3,5-dimethyl-1-guanylpyrazole nitrate was added carefully to 10 ml. of concentrated sulfuric acid (sp. gr. 1.84), cooled by a freezing mixture. The temperature throughout the addition was maintained below 0°. The solution was then allowed to stand for 10 minutes at 0° and poured onto crushed ice (*ca.* 100 g.). No precipitate separated, therefore no appreciable quantities of 3,5-dimethyl-1-nitroguanylpyrazole (which is water-insoluble) had formed. The solution was then allowed to stand at room temperature overnight and extracted with a total of 250 ml. of ether. The ethereal extracts after drying and evaporating contained no solid. The aqueous mother liquor was then neutralized with 10% sodium hydroxide solution (a volume of alkali, equivalent to 14.7 g. of sodium hydroxide was required). During the neutralization the temperature rose to 30° and when the solution had cooled it was extracted again with a further total of 250 ml. of ether. The ethereal extracts again contained no material. The aqueous mother liquor (400 ml.) was then diluted to 1600 ml. The diluted solution was then heated to 35°—dilution and heating were necessary to avoid precipitation of sodium picrate in the subsequent treatment—and excess saturated aqueous picric acid solution was added; 3.8 g. (70%) of 3,5-dimethyl-1-guanylpyrazole picrate, m.p. 207–209°, separated. A similar result was obtained when the time of contact with sulfuric acid of the guanylpyrazole nitrate was extended. Cognate experiments on aminoguanidine and diaminoguanidine nitrate and on benzylideneguanylhydrazone nitrate revealed that no appreciable N-nitration took place with these compounds either.

On heating from 60–70° for 2 hours with fuming nitric acid in 1 molar quantities, 3,5-dimethyl-1-guanylpyrazole nitrate was recovered 96% unchanged. Increase in the

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(5) Simultaneously with our report (see ref. 4) R. A. Henry and G. B. L. Smith (ref. 2) describe the reaction between acetylacetone and nitroaminoguanidine as giving 1-nitroguanyl-3,4-dimethylpyrazole alone. The structural formula ascribed by them to this product is obviously a misprint for the 3,5-dimethyl derivative. They obtained no other product in the reaction.

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(10) This formulation is in accord with the mechanism proposed for the ammonolysis of acylic nitroguanidines, and of nitraminoimidazolines by A. F. McKay, G. F. Wright, *et al.*, (see A. F. McKay, *Chem. in Canada*, **3**, [3], 21 (1951)).

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(12) All m.ps. are uncorrected. All analyses are by Drs. Weiler and Strauss, Oxford, England.

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TABLE I

REACTIONS OF SOME NITROGUANYL DERIVATIVES

Reaction	Product	M.p., °C.	Yield, %	Mol. formula	Analyses, % Calculated C	H	N	Found C	H	N
3,5-Dimethyl-1-nitroguanylpyrazole (A) + Cl_2[a]	4-Chloro-3,5-dimethyl-1-nitroguanylpyrazole	158–161	96[b]	$C_6H_8ClN_5O_2$	33.1	3.6	32.1[c]	33.6	3.7	32.2[d]
(A) + Br_2[e]	4-Bromo-3,5-dimethyl-1-nitroguanylpyrazole	152–154	96–98[b]	$C_6H_8BrN_5O_2$	27.4	3.1	26.7[f]	28.0	3.1	27.1[g]
(A) + ICl[h]	4-Iodo-3,5-dimethyl-1-nitroguanylpyrazole[i]	153–155	40–50[b]	$C_6H_8IN_5O_2$	23.4	2.6	22.7[j]	23.5	2.7	22.7[k]
(A) + HNO_3[l]	4-Nitro-3,5-dimethyl-1-nitroguanylpyrazole	126–129	53[b]	$C_6H_8N_6O_4$	31.5	3.5	36.8	31.5	3.6	35.9
(A) + HNO_3 + H_2SO_4[m]	4-Nitro-3,5-dimethylpyrazole	124–125	35–40[b]	$C_5H_7N_3O_2$	42.5	4.9	29.7	42.9	5.1	29.2
Benzoylacetone + nitroaminoguanidine	Benzoylacetonenitroguanylhydrazone	160	96–98[b]	$C_{11}H_{13}N_5O_2$	50.2	4.9	26.6	49.7	4.7	26.2
Isonitrosoacetylacetone + nitroaminoguanidine	Isonitrosoacetylacetonenitroguanylhydrazone[n]	191	40[b]	$C_6H_8N_6O_3 \cdot H_2O$	29.0	5.1	33.8	29.8	5.1	33.8

[a] Chloroform solution. [b] Crude material. [c] Cl (calcd.) 16.2. [d] Cl (found) 16.2. [e] Ethereal solution. [f] Br (calcd.) 30.5. [g] Br (found) 30.1. [h] In concd. HCl solution, with slight warming. [i] 3,5-Dimethyl-4-iodopyrazole is obtained in 20–30% yields, also, as well as the tabulated main reaction product. [j] I (calcd.) 40.9. [k] I (found) 41.2. [l] Described in text. [m] At *ca.* 50°. [n] A green oil was also formed in addition to the two solids already described (see text).

TABLE II

SOLVOLYTIC REACTIONS OF 3,5-DIMETHYL-1-NITROGUANYLPYRAZOLE

Reagent	Reaction product[a]	Mol. formula	M.p., °C.	Yield, %[b]	Analyses, % Calculated C	H	N	Found C	H	N
Aniline	1-Phenyl-3-nitroguanidine	$C_7H_8N_4O_2$	152	50	46.6	4.4	31.1	46.7	4.4	31.0
4,4-Diphenylsemicarbazide	1-(N,N-Diphenylureido)-3-nitroguanidine	$C_{14}H_{14}N_6O_3$	207	63	53.5	4.5	26.7	53.6	4.4	26.3
Octylamine	1-Octyl-3-nitroguanidine	$C_9H_{20}N_4O_2$	106	90	50.0	9.25	25.9	50.6	9.2	25.8
2-Phenylethylamine	1-(2'-Phenylethyl)-3-nitroguanidine	$C_9H_{12}N_4O_2$	162	70	51.9	5.8	27.0	51.8	5.8	27.8
Phenylhydrazine	1-Phenylamino-3-nitroguanidine[c]	$C_7H_9N_5O_2$	164	70	43.1	4.62	35.9	43.3	4.66	36.2
Piperidine	1-N,N-Cyclopentenyl-3-nitroguanidine	$C_6H_{12}N_4O_2$	144–146	53	41.9	7.0	32.4	42.3	6.8	33.0
2-Quinolylhydrazine	1-(2'-Quinolylamino)-3-nitroguanidine	$C_{10}H_{10}N_6O_2$	172	86	48.8	4.1	34.1	48.9	4.15	33.6
Semicarbazide hydrochloride	1-Ureido-3-nitroguanidine	$C_2H_6N_5O_3$	220	10[d]	14.8	3.7	51.9	15.3	3.5	52.7
Thiosemicarbazide	1-Thioureido-2-nitroguanidine	$C_2H_6N_6SO_2$	180	70	13.5	3.4	47.2[e]	13.7	3.6	47.0[f]

[a] This column describes only the main reaction products. 3,5-Dimethylpyrazole is formed in all the experiments. Only with phenylhydrazine is a solid of unknown constitution obtained, in addition to the other reaction products. [b] All yields, except where stated are corrected for any unchanged material recovered. This correction applies to the aniline and thiosemicarbazide experiments. [c] Unknown solid has the following data. Calcd. for $C_{19}H_{19}N_7O$: C, 63.2; H, 5.3; N, 27.2. Found: C, 63.5; H, 5.2; N, 26.8. [d] Uncorrected for unchanged starting material (80%) recovered. [e] S (calcd.) 18.8. [f] S (found) 17.9.

molar proportion of acid (to 8 moles) and temperature (to 100°) resulted in reaction—C-nitration taking place, however, together with deguanylation, the product being 3,5-dimethyl-4-nitropyrazole (in 50% yield). This same reaction resulted with mixed acid (at *ca.* 30–40°) to give a 76% yield of the deguanylated nitro compound. Similarly a cognate experiment with 3,5-dimethyl-1-(N-benzoyl)-guanylpyrazole resulted in the formation of benzoylurea and 3,5-dimethyl-4-nitropyrazole.

Nitration of 3,5-Dimethyl-1-nitroguanylpyrazole.—Two grams of 3,5-dimethyl-1-nitroguanylpyrazole was added to 6.5 ml. of fuming nitric acid (sp. gr. 1.53) and the solution after attachment to a reflux condenser, was heated on a water-bath to 60° for 1.5 hours. The solution was then poured into ice and a white precipitate (yield 0.6 g.) separated after a few minutes standing. On recrystallization from aqueous ethanol 3,5-dimethyl-4-nitro-1-nitroguanylpyrazole[16] was obtained in fine, white needles of m.p. 126–129°. Further quantities of the material were obtained by extracting the aqueous diluted solution with ether; average total yield 50–60%.

Reaction between Benzoylacetone and Nitroaminoguanidine.—To 5.71 g. of nitroaminoguanidine, dissolved in 120 ml. of water, was added benzoylacetone (7.77 g.) in 100 ml. of ethanol and the whole was refluxed for 3 hours. The dark yellow solution, on standing at room temperature for 36 hours, deposited 11.2 g. of benzoylacetone nitroguanylhydrazone,[16] m.p. 152–156°, m.p. after recrystallization from ethanol 160°. This was washed with absolute ether to remove any possible substituted pyrazole present, but only hydrazone was found in the washings. Ethereal extractions of the aqueous alcoholic filtrate, together with evaporation of the aqueous mother liquor after extractions, yielded a further 2.37 g. of crude nitroguanylhydrazone together with a little unchanged benzoylacetone. Refluxing 1 g. of pure benzoylacetonenitroguanylhydrazone with 25 ml. of 1 *N* HCl for 5 minutes afforded 0.84 g. of a solid which after recrystallization from 95% ethanol was obtained as long, white needles of m.p. 121–122°. This depressed the m.p. of 3-methyl-5-phenylpyrazole and is 3-methyl-5-phenyl-1-nitroguanylpyrazole. *Anal.* Calcd. for $C_{11}H_{11}N_5O_2$: C, 53.9; H, 4.5. Found: C, 54.0; H, 4.5.

Reaction of Isonitrosoacetylacetone and Nitroaminoguanidine.—To 2.13 g. of nitroaminoguanidine in 70 ml. of water was added isonitrosoacetylacetone (2.29 g.) in 30 ml. of ethanol. The colorless solution was then refluxed for 2 hours by which time it had developed an intense green color. On standing for 36 hours at room temperature, 0.64 g. of crude isonitrosoacetylacetonenitroguanylhydrazone,[16] as a light brown solid of m.p. 186° separated. This was extracted with absolute ether to remove any possible pyrazole material present—only the same substance was found in the ethereal extracts. After recrystallization from aqueous ethanol, it was obtained as white, fibrous needles of m.p. 192°. From the filtrate on working up (ether extraction, etc.) a further 0.72 g. of crude monohydrazone was obtained and 0.47 g. of a solid of m.p. 242°. (This value for the m.p. depended on the rate of heating.) This latter substance was most probably the corresponding osazone. No pyrazolyl material was detected.

Halogenations of 3,5-Dimethyl-1-nitroguanylpyrazole.—The results discussed above are summarized in Table I.

Action of Reducing Agents on 3,5-Dimethyl-1-nitroguanylpyrazole.—When 3,5-dimethyl-1-nitroguanylpyrazole was heated with sodium alcohol, complete and rapid denitroguanylation occurred, ammonia evolution being brisk.

(16) Analytical results for these substances are collected in Table I.

Over temperature ranges of 0° to reflux conditions the results were the same. With sodium hydrosulfite again denitroguanylation was the main effect observed. However, with the acid reducing agents, a different reaction appeared to take place. Thus, 16 g. of stannous chloride was dissolved in 14 ml. of concentrated hydrochloric acid and 3.66 g. of 3,5-dimethyl-1-nitroguanylpyrazole was added. On heating, the pyrazole went into solution and a yellow color developed. After standing for 3 days without the deposition of any material the solution was adjusted to the correct *p*H, and the tin present removed as sulfide. The filtrate, after evaporation deposited a white solid, which after separation from some further inorganic contaminant by solution in absolute ethanol, formed a picrate of m.p. 202–204°. The yield was small (*ca.* 20%). After recrystallization from water, the picrate was obtained as fine yellow needles of m.p. 209°. It was found to be 3,5-dimethyl-1-guanylpyrazole picrate. *Anal.* Calcd. for $C_{12}H_{13}N_7O_7$: C, 39.2; H, 3.7; N, 26.7. Found: C, 39.6; H, 3.7; N, 26.2.

The reaction product between crotonaldehyde and nitroaminoguanidine was shown to be a hydrazone by acid (dil. HCl) hydrolysis. Cyclization attempts using the Nisbet,[17,18] technique, of acetic acid–water mixtures effected a characteristic color development (deep brown) with the crotonylnitroguanylhydrazone, which did not take place with crotonaldehyde, nitroaminoguanidine, acetonenitroguanylhydrazone, benzylidenenitroaminoguanidine, cinnamylidine or crotonylaminoguanidine nitrates, but no pyrazoline was isolated from the colored solution.

Hydrazinolyses and Ammonolyses of 3,5-Dimethyl-1-nitroguanylpyrazole.—Ammonia or hydrazine hydrate afford 90% yields of nitro- or nitroaminoguanidines, respectively, when heated in ethanolic solution in 1-molar quantities with 1-molar quantities of the nitroguanylpyrazole. The remaining experiments are summarized in Table II. The following two examples illustrate the general methods employed.

(a) **Reaction with Phenylhydrazine.**—To a solution of 3 g. of 3,5-dimethyl-1-nitroguanylpyrazole in 90 ml. of absolute ethanol was added 1.7 ml. of phenylhydrazine. The solution was then refluxed for 1.5 hours, during which time it became orange colored. During the heating, a white solid gradually separated out, which after recrystallization from aqueous ethanol melted at 164° and proved to be 1-phenylamino-3-nitroguanidine[16] (yield 1.73 g.). On dilution of the filtrate with water, an orange-colored solid separated which on recrystallization from aqueous ethanol melted at 143°[16] (yield was *ca.* 0.15 g.). The nature of this substance is unknown. 3,5-Dimethylpyrazole was identified when the aqueous diluted filtrate was extracted with ether and the ethereal extracts evaporated. It was characterized by its picrate and silver salt.

When 2,4-dinitrophenylhydrazine in acetic acid solution was refluxed with an equimolar quantity of 3,5-dimethyl-1-nitroguanylpyrazole for 90 minutes and the solution then diluted, 2,4-dinitrophenylhydrazine acetate of m.p. 193° separated. *Anal.* Calcd. for $C_8H_{10}N_4O_6$: C, 37.2; H, 3.8; N, 21.6. Found: C, 37.3; H, 3.5; N, 21.6. No hydrazinolysis was observed in this case.

(b) **Reaction with Thiosemicarbazide.**—To 2 g. of 3,5-dimethyl-1-nitroguanylpyrazole dissolved in 30 ml. of absolute ethanol was added 1.0 g. of thiosemicarbazide dissolved in 25 ml. of water. The solution was refluxed for 90 minutes and on allowing to cool overnight some unchanged pyrazole (0.70 g.) was deposited. From the filtrate, after evaporation in a current of air, 1.30 g. of solid of m.p.'s *ca.* 120° and (major portion) *ca.* 166° separated. On extraction with absolute ether 0.30 g. of 3,5-dimethylpyrazole was obtained in the extracts. The residual 0.90 g. of solid was recrystallized repeatedly from water and obtained as a fine, white powder of m.p. 182–183° (with violent explosion). It proved to be 1-thioureido-3-nitroguanidine[16]; yield 70%.

3,5-Dimethyl-1-nitroguanylpyrazole was recovered unchanged from 1 hour refluxing with either 5-aminotetrazole or *p*-toluenesulfonhydrazide. With benzalaminoguanidine an anomalous reaction resulted.

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CORK, IRELAND

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(18) H. J. Nisbet and C. G. Gray, *ibid.*, 839 (1933).

[CONTRIBUTION FROM THE LABORATORY OF ORGANIC CHEMISTRY OF THE UNIVERSITY OF WISCONSIN]

The Structure of Camphenamine[1]

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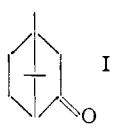
On the basis of previously known as well as newly acquired evidence, the structure 7-aminocamphene (VIII) is proposed for the liquid base camphenamine; the latter is ordinarily obtained by dehydrohalogenating chlorocamphanamine (IV), the reaction product of phosphorus pentachloride and α-aminoborneol (III) (hydrochloride). The stereochemical relationships of α-aminoborneol, the diastereoisomeric β-aminoborneol, and camphenamine have been deduced by means of: (i) acyl migration studies on the aminoalcohols; (ii) the transformation of β-aminoborneol to camphenamine; and (iii) the inertness of N-*p*-nitrobenzoyl-β-aminobornyl tosylate toward strong base. N-*p*-Nitrobenzoyl-α-aminoborneol has been shown to afford N-*p*-nitrobenzoylcamphenamine on treatment with thionyl chloride; the corresponding derivative of β-aminoborneol interacts with this same reagent to yield the cyclic imide derived from N-*p*-nitrobenzoyl-β-bornylsulfurous acid.

In an effort to elaborate a synthetic route to epicamphor (I), Duden and his collaborators[2] carried out, at the turn of the present century, a reaction sequence starting with the reduction of α-aminocamphor (II). The action of sodium and ethanol led to an aminoalcohol, which was designated as "α-aminoborneol" (III) to distinguish it from a diastereoisomer, "β-amino borneol" (IIIa), formed when the reduction was carried out by means of sodium and wet ether. Oxidation of each aminoborneol regenerated α-aminocamphor, thereby confirming the assigned structure III. Phosphorus pentachloride converted the hydrochloride of α-aminoborneol to "chlorocamphanamine" (IV), which was regarded as the 2,3-chloroamine (IVa). Finally, this chloroamine, on treatment with an equivalent of aqueous sodium hydroxide or simply on heating in aqueous solution, was transformed into a halogen-free base (b.p. 205–207° at 748 mm.)



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(1) Abstracted in part from research reports submitted by W. F. Tousignant and P. E. Peckham in partial fulfillment of the requirements for the Master of Science degree, University of Wisconsin.

(2) P. Duden and A. E. Macintyre, *Ann.*, **313**, 59 (1900).