

TABLE I

N.M.R. MAXIMA OF METHYL GROUPS IN REACTION PRODUCTS AND MODEL COMPOUNDS

Compound	N.m.r. maxima ^a
Product of benzamidine-mesityl oxide reaction	8.23-8.25, ^b 8.83 ^c
Isopropylamine	8.92-9.02 ^b
Mesityl oxide	7.89-7.91-7.92, ^b 8.14-8.17 ^{b,d}
Product of benzamidine-dypnone reaction	8.35
α -Methylbenzylamine	8.60 to 8.75 ^e
N-Benzylidene- α -methylbenzylamine	8.42-8.53 ^b
Dypnone	7.45-7.48 ^b

^a τ -Values, relative to internal tetramethylsilane. ^b Hyphenated numbers indicate multiplets. ^c Area ratio of doublet to singlet: 1:2. ^d Area ratio of triplet to doublet: 2:1. ^e Amino hydrogens absorb in the same region, and methyl bands can not be assigned with certainty.

for IVb), but considerably higher than those of dypnone (a model for VIb).

At present we are unable to decide between structures IV and V for the condensation products. One is tempted to favor V which has conjugated endocyclic double bonds. However, structures similar to both IV^{2,5} and V^{5a,5b,6} have appeared in the literature.

Experimental

2-Phenyl-4,4,6-trimethyl-1,4(or 3,4)-dihydropyrimidine (IVa or Va).—A mixture of 15.66 g. (0.10 mole) of benzamidine hydrochloride, 9.8 g. (0.10 mole) of freshly distilled mesityl oxide, 6.60 g. (0.10 mole) of potassium hydroxide, and 300 ml. of absolute ethanol was heated at reflux for 3 hr. The mixture was cooled, filtered to remove potassium chloride, and concentrated *in vacuo*, leaving a brown oil which was boiled with 300 ml. of hexane. The mixture was filtered while hot, the filtrate was cooled to room temperature and poured onto an alumina chromatographic column. Elution with hexane yielded 12.6 g. (63%) of yellow solid, m.p. 85-97°. The product was purified by boiling with 700 ml. of petroleum ether (b.p. 30-60°), filtering while hot, and cooling the filtrate in Dry Ice, giving 9.1 g. (45%) of pale yellow crystals, m.p. 97.0-98.5°.

Anal. Calcd. for C₁₈H₁₈N₂: C, 78.0; H, 8.1; N, 14.0. Found: C, 78.2, 78.2; H, 8.1, 8.2; N, 14.1, 14.2.

The hydrogen chloride-mercuric chloride double salt, m.p. 183-185° (lit., m.p. 179°), was prepared as previously described.¹

The reaction of benzamidine with mesityl oxide in the absence of solvent¹ gave a crude product, m.p. 68-82°, which was too soluble in ether¹ to make recrystallization from this solvent practical. Recrystallization from petroleum ether as described above resulted in a 63% yield of yellow solid, m.p. 89.0-94.5°, which had an infrared spectrum identical to that of the product obtained in ethanol. A second recrystallization raised the m.p. to 93.0-95.5°.

4-Methyl-2,4,6-triphenyl-1,4(or 3,4)-dihydropyrimidine (IVb or Vb).—The above procedure was repeated on a 0.05-mole scale, using dypnone instead of mesityl oxide. The brown oil remaining after solvent removal was boiled with 100 ml. of benzene. The mixture was filtered while hot,

treated with 300 ml. of hexane, and boiled till the volume was 150 ml. Cooling gave two crops of yellow crystals: 1.15 g., m.p. 117-119°, and 3.54 g., m.p. 109-117°, a total yield of 29%. Recrystallization from hexane raised the m.p. of the first fraction to 121.0-122.5°.

Anal. Calcd. for C₂₃H₂₀N₂: C, 85.2; H, 6.2; N, 8.6; mol. wt., 324. Found: C, 85.6, 85.4; H, 6.3, 6.2; N, 8.7, 8.5; mol. wt. (ebullioscopic in benzene), 322, 330.

N-Benzylidene- α -methylbenzylamine.—This compound was prepared by the method of Nerdel, Becker, and Kresze.⁷ Infrared spectra were run in carbon tetrachloride solution on a Perkin-Elmer Infracord, Model 137B.

N.m.r. spectra were determined on a Varian A60 spectrometer, using 0.6 M solutions in 5:1 carbon tetrachloride-tetramethylsilane.

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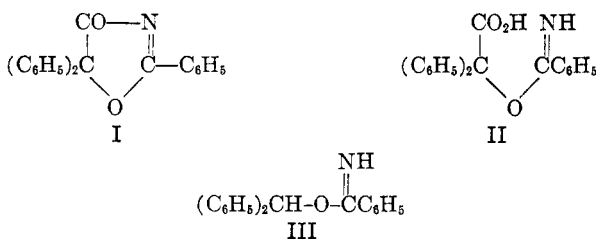
The Reaction of Benzilic Acid with Benzonitrile

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Only one example of a 4-oxazolone is reported in the literature.¹ From the treatment of benzilic acid and benzonitrile with concentrated sulfuric acid there was obtained a compound A, C₂₁H₁₅NO₂, readily hydrolyzed to a compound B, C₂₁H₁₇NO₃. By analogy with prior work² on the formation of oxazoles from benzoin and nitriles under the same conditions, compounds A and B were assigned the structures I and II, respectively. These formula-



tions apparently were confirmed by subsequent transformations. Thus compound B was converted back into compound A by refluxing with acetic anhydride. Both compounds A and B, on reduction with hydriodic acid, gave benzamide and diphenylacetic acid. Further, compound A, on heating either alone or with strong alkali, was decarboxylated to a neutral compound C, C₂₀H₁₇NO₃. This was identical to the product obtained by treating benzonitrile and benzhydrol with hydrogen chloride gas and thus thought to be III.

The marked stability of compounds B and C to

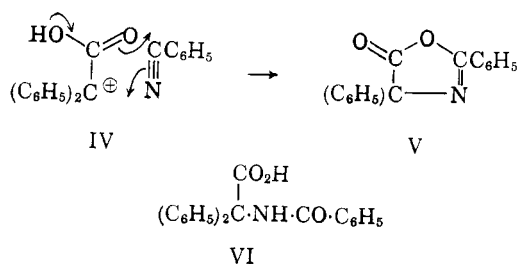
(5) (a) W. H. Hill, U. S. Patent 2,628,716 (1953); (b) Wellcome Foundation Ltd., British Patent 734,842 (1955); (c) G. E. McCasland, E. Blanz, Jr., and A. Furst, *J. Org. Chem.*, **24**, 999 (1959).

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(2) F. R. Japp and T. S. Murray, *ibid.*, **63**, 469 (1893).

hydrolysis, as commented upon by the original authors, appeared remarkable for compounds having imino-ether structures as in II and III. Reinvestigation fully confirmed the reported transformations. It also was found that B was decarboxylated almost quantitatively to C by heating in quinoline. Consideration of the mode of formation of A suggested that the reaction was that of benzonitrile with the $(C_6H_5)_2^+CCO_2H$ carbonium ion, which is known³ to be the main species present, as in IV leading to formulation of compound A as the azlactone V. Compound B then would be VI and



compound C should be N-diphenylmethylbenzamide. This latter conclusion was confirmed by comparison of compound C with an authentic sample.⁴ The formation of C from benzonitrile and benzhydrol must result from a reaction of the Ritter type.⁵

These revised structures obviously are equally compatible with the previously reported transformations, and also are supported by the infrared spectra in Nujol. Thus, in keeping with structure V, compound A shows a high frequency carbonyl band at 1820 cm^{-1} and a strong band at 1650 cm^{-1} characteristic of the $-\text{O}-\text{C}=\text{N}-$ grouping. Compound B, apart from bands at 3350 (N—H), *ca.* 2450 and *ca.* 2600 cm^{-1} (carboxyl O—H), has two bands at 1705 cm^{-1} and 1625 cm^{-1} attributable to carbonyl groups.

Experimental

Compound A, namely 2,4,4-triphenyl-5-oxazolone, and compound B, α -benzamidodiphenylacetic acid, were obtained as previously described¹ and had the reported melting points.

Decarboxylation of α -Benzamidodiphenylacetic Acid.—The acid (0.9 g.) was heated under reflux in quinoline (5 ml.) for 1 hr. The cooled solution was poured into excess water and acidified. The solid product (0.7 g.) was isolated by chloroform extraction and crystallized from ethyl acetate m.p. $172\text{--}173^\circ$. This compound was shown by mixed melting point and infrared spectra to be identical to an authentic specimen of N-diphenylmethylbenzamide.

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(4) G. W. H. Cheeseman and R. C. Poller, *Analyst*, **87**, 366 (1962).

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Biosynthesis of Bacterial Pigments.

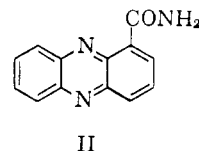
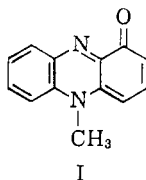
II.¹ Chlororaphin

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A review² of the chemistry of phenazines gives negligible information on biosynthetic pathways of the bacterial phenazine pigments. However, several reports on the biosynthesis of two bacterial pigments, pyrocyanine³ (I) and chlororaphin (a 3:1 molecular compound of phenazine-1-carboxamide (II) and its 5,10-dihydro derivative)⁴ have been helpful in speculating on possible biosynthetic intermediates.



Recent observations that anthranilic acid, an intermediate in the biosynthesis of tryptophan in microorganisms,⁵ has been incorporated into chlororaphin in trace amounts (0.002% incorporation) prompted us to study simulated biosyntheses of phenazine pigments through the dimerization of substituted anilines by symmetrical carbon-nitrogen pairing.

Biogenetic implications of phenol oxidation and the biosynthesis of dimeric and polymeric phenols are available in excellent laboratory analogies—*e.g.*, usnic acid,⁶ gossypol,⁷ griseofulvin,⁸ and picrolichenic acid.⁹ The oxidative dimerization examples can be regarded as either the pairing of radicals ($\text{C}\cdot \rightarrow \cdot\text{O}$ and/or $\text{C}\cdot \rightarrow \cdot\text{C}$) or the substitution of one radical into a neutral phenol molecule followed by further oxidation. Coupling of radicals derived from amino phenols ($\text{C}\cdot \rightarrow \cdot\text{C}$ and/or

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