reactions and for checking the preparation of the ethyl ester of N-phenylglycine.

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A Novel Rearrangement of *o*-Nitrophenylacetic Acids

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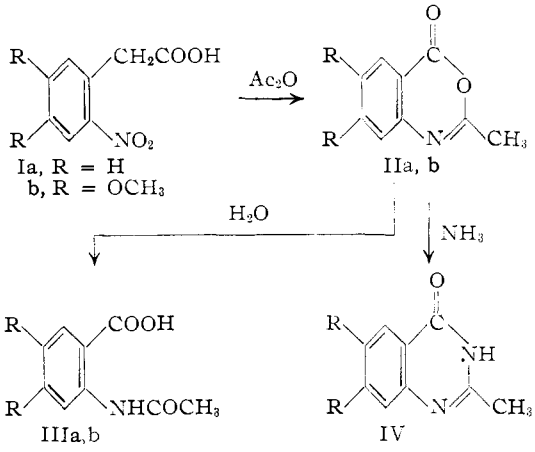
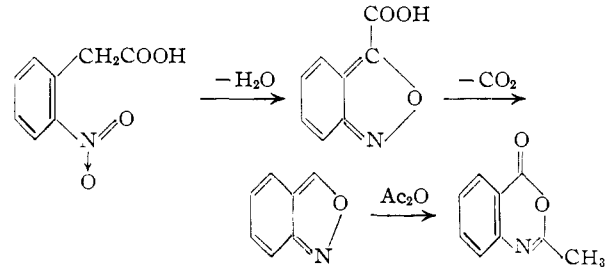
When 2-nitrophenylacetic acid was heated in acetic anhydride an exothermic reaction occurred and carbon dioxide was evolved. A colorless, crystalline substance, m.p. 80–81°, with empirical formula $C_9H_7O_2N$ was formed. This compound reacted readily with a mole of water, giving an acid, $C_9H_9O_3N$, m.p. 182–184°. These characteristics made it apparent that the "acetylation" product was acetylanthranil (IIa) which is hydrolyzed easily[1] to N-acetylanthranilic acid (IIIa). Proof of this assumption was obtained by comparison of the compounds with authentic specimens of IIa and IIIa, respectively, prepared by acetylation of anthranilic acid[1,2] and subsequent treatment with water. The respective materials were identical, as shown by undepressed mixed melting points and two pairs of identical infrared spectra.



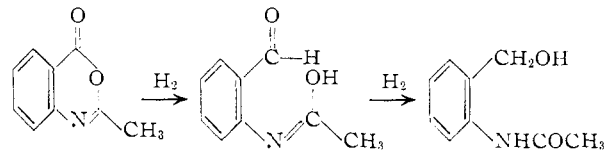
Reaction of 2-nitro-4,5-dimethoxyphenylacetic acid (Ib)[3,4] with acetic anhydride was found to take the same course as with Ia, leading to the corresponding dimethoxyacetylanthranil IIb. This compound was characterized by hydrolysis to amido-acid IIIb, and by reaction with ammonia to form the quinazolone IVb.

Information about the exact course of the rather remarkable change I → II is not available at present. The reaction in any event obviously involves transfer of oxygen from nitrogen to the methylene carbon atom at the adjacent position on the benzene ring. It seems plausible to assume that cyclic intermediates are involved in the change, and evidence in favor of this assumption is the fact that 4-nitrophenylacetic acid does not rearrange in the presence of boiling acetic anhydride, but merely is converted into 4-nitrophenylacetic anhydride. Species such as anthroxanic acid and anthranil might be formed during the rearrangement



This idea is lent support by the following facts: anthroxamic acid is decarboxylated readily,[5] and anthranil is converted into acetylanthranil by acetic anhydride. However, it was found that other compounds, such as ethyl 2-nitrophenylacetate, 2-nitrophenylacetonitriles and 2-nitrotoluene, having a nitro-group and a methylene group in adjacent positions on the benzene nucleus, do not react with acetic anhydride. The reaction appears to be limited to the special case in which a carboxylic acid group is present. The effective driving force in formation of the final product from a complex intermediate may be related to the loss of carbon dioxide. It may be pointed out that the reaction is reminiscent of oxidation–reduction changes with other aromatic nitro-compounds, as for example the formation of anthranils from 2-nitrotoluenes in the presence of alkali,[6] and of the rearrangement of pyridine-N-oxides in the presence of acetic anhydride, which has received attention recently.[7,8] The rearrangement of 2-nitrophenylacetic acid also is in strong contrast with the acetylation of phenylacetic acid, which requires basic catalysis and leads to formation of benzyl ketones.[9]

An interesting hydrogenolytic ring opening was observed during the course of experiments with acetylanthranils. Hydrogenation of IIa in the presence of 10% palladium–charcoal in ethyl acetate resulted in quantitative formation of 2-acetylaminobenzyl alcohol. Thus hydrogen is capable of opening anhydride-like compounds of type II at the same point in the molecule which is sensitive to attack by water, amines and other reagents.



Experimental[10,11]

Acetylanthranil (IIa).—A mixture of 43.8 g. (0.242 mole) of *o*-nitrophenylacetic acid and 300 ml. of acetic anhydride

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(10) Melting points are corrected.
(11) I am indebted to Dr. William C. Alford and his staff for microanalytical data and to Mrs. H. F. Byers of the Instrument Laboratory for spectra.

was warmed gradually to the boiling point. Reaction began immediately, and the solution boiled for 10–15 minutes without application of heat externally. During this time the solution became deep red, and carbon dioxide was evolved. When spontaneous reaction subsided, the solution was refluxed for 2.5 hours longer. Most of the excess reagent was distilled at atmospheric pressure (1 hour), and the residue was distilled *in vacuo*. There was obtained 19.2 g. (49%) of viscous, yellow oil, b.p. 119–127° (3.5 mm.), which crystallized immediately. Recrystallization from dry ether afforded 16.1 g. (41%) of pale yellow crystals, m.p. 76–78°. Further recrystallization raised the m.p. to 80–81°.

Anal. Calcd. for $C_9H_7O_2N$: C, 67.07; H, 4.38; N, 8.69. Found: C, 67.36; H, 4.56; N, 8.92.

The mixed m.p. with a sample of acetylanthranil prepared from anthranilic acid[2] (reported[1] m.p. 80–81°), was 80–81°. The infrared spectra (chf.) of the two samples were identical, having characteristic peaks at 5.69–5.72, 6.08 and 6.23 μ. The odor of the pure compound was as described previously.[1]

2-Acetylaminobenzoic Acid (IIIa).—Material obtained in the preceding experiment was treated with water, and the product was recrystallized from ethyl acetate. There was obtained colorless crystals, m.p. 182–184° (reported[2] m.p. 185°), which were soluble in sodium bicarbonate solution and which did not depress the m.p. of an authentic specimen of acetylanthranilic acid when admixed with it. The infrared spectra of the two samples in chloroform and Nujol were identical in each case; bands at 3.1–3.2, 5.92, 6.04–6.10, 6.23 and 6.32 μ (Nujol) were observed.

6,7-Dimethoxy-2-methyl-3,1,4-benzoxazine (R. I. 947) **(IIb).**—A mixture of 30.2 g. (0.125 mole) of 2-nitro-4,5-dimethoxyphenylacetic acid and 200 ml. of acetic anhydride was refluxed for 2 hours. An exothermic reaction resulting in a deep red color was observed during the first 10 minutes of this period. The excess reagent was evaporated at 100°. The residue crystallized, and was triturated with ethyl acetate. There was obtained 14.4 g. (52%) of orange crystals, m.p. 183–185°. Recrystallization from ethyl acetate (Norit) gave yellow crystals, m.p. 185–186.5°. The infrared spectrum (chf.) had intense peaks at 5.74, 6.07 and 6.19 μ.

Anal. Calcd. for $C_{11}H_{11}O_4N$: C, 59.72; H, 5.01; N, 6.33. Found: C, 59.64; H, 4.97; N, 6.32.

2-Acetylamino-4,5-dimethoxybenzoic Acid (IIIb).—A sample of IIb was warmed with water on a steam-cone for 1.5 hours. Recrystallization from methanol–ethyl acetate (Norit) afforded colorless crystals, m.p. 223.5–224.5° dec. (reported[12] m.p. 228°). The infrared spectrum (Nujol) had a band at 3.1–3.2 μ and intense peaks at 5.94, 6.09, 6.20 and 6.27 μ. The compound was soluble in sodium bicarbonate solution.

Anal. Calcd. for $C_{11}H_{13}O_5N$: C, 55.22; H, 5.48; N, 5.86. Found: C, 55.37; H, 5.55; N, 5.73.

2-Methyl-6,7-dimethoxy-4-quinazolone (IVb).—A sample (0.2 g.) of IIb was warmed with 20 ml. of concd. ammonium hydroxide solution on a steam-cone for a half-hour. Evaporation of the excess reagent and recrystallization of the residue from ethyl acetate gave slightly yellow crystals, m.p. 297–300° dec. The infrared spectrum (Nujol) had peaks at 3.17 and 6.05–6.08 μ.

Anal. Calcd. for $C_{11}H_{12}O_3N_2$: C, 59.99; H, 5.49; N, 12.7. Found: C, 60.05; H, 5.64; N, 12.5.

2-Acetylaminobenzyl Alcohol.—A solution of 2.8 g. of IIa in 150 ml. of ethyl acetate containing 2 g. of 10% palladium-charcoal catalyst was shaken under hydrogen (40 lb.) at 80° for an hour. Filtration of the catalyst and evaporation of the solvent gave 2.8 g. of colorless crystals, m.p. 111–113°. Recrystallization from methanol raised the m.p. to 114–115° (reported[13] m.p. 115–116°). The compound was very soluble in dilute mineral acids and moderately soluble in water. The infrared spectrum (chf.) had peaks at 2.77, 2.97 and 5.95–5.98 μ.

Anal. Calcd. for $C_9H_{11}O_2N$: C, 65.44; H, 6.71; N, 8.48. Found: C, 65.41; H, 6.53; N, 8.37.

Acetylation with acetic anhydride at 100° for 15 minutes gave the **O,N-diacetate** of *o*-aminobenzyl alcohol, m.p. 91–93°, after recrystallization from ether (lit.[14] m.p. 91°). The infrared spectrum of this compound (chf.) had peaks at 3.02, 5.80 and 5.93–5.96 μ.

4-Nitrophenylacetic Anhydride.—A mixture of 5 g. of 4-nitrophenylacetic acid and 50 ml. of acetic anhydride was refluxed for 2 hours. Evaporation of the excess reagent and trituration of the residue with ether gave 3.5 g. of crystals, m.p. 131–137°. Recrystallization from ethyl acetate (Norit) gave pale yellow crystals, m.p. 141–143°, the infrared spectrum of which (chf.) had a characteristic twin peak, 5.48 and 5.70 μ.

Anal. Calcd. for $C_{16}H_{12}O_7N_2$: C, 55.81; H, 3.51; N, 8.14. Found: C, 55.93; H, 3.76; N, 7.92.

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Hydrogenation of Purpurogallin and Its Derivatives

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Since the structure of purpurogallin (I) was established by Haworth and his collaborators,[1-4] few reports of further work with this interesting and easily-prepared benztropolone have appeared. A three-step reduction of tetramethylpurpurogallin to 2,3,4-trimethoxybenzsuber-6-one has been reported.[5] This method requires that purpurogallin be methylated completely at the outset, which process is unattractive from a practical point of view, since methylation of purpurogallin beyond the trimethyl ether stage is not achieved easily.[1a] Catalytic hydrogenation of purpurogallin and its methyl ethers also has appeared unattractive because mixtures of products were obtained from such reactions in earlier work[1a] when platinum catalysts were used.

The use of 10% palladium–charcoal catalyst now has been found to give better results than were obtained previously in hydrogenation of compounds in this series. Purpurogallin is reduced to tetrahydropurpurogallin (II) in 75% yield in the presence of this catalyst. That hydrogen enters the tropolone ring rather than the benzene ring in this reaction follows from the fact that II is converted by diazomethane in two stages to the trimethyl derivative III, indicating that three phenolic groups are present in II. Conclusive evidence for structures II and III was obtained from further experiments. Compound III is an acyloin and as such is susceptible to oxidation under mild conditions. Thus with bismuth oxide in acetic acid,[6] III was converted to diketone IV,[2,3] identified as the 2,4-dinitrophenylhydrazone,[3] m.p. 179–181°. The carbonyl group of III can be reduced, and this was accomplished in two stages. Hydrogenation in ethyl acetate at 80° in the presence of 10% pal-

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