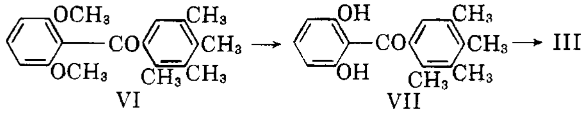
This ketone, when heated with polyphosphoric acid, formed the corresponding fluorenone V.

Confirmatory evidence for the postulated sequence of changes was obtained by subjecting the dimethyl ether of 2-prehnitoylresorcinol (VI) to the action of aluminum chloride. Demethylation occurred first to give the phenol VII which could be isolated and underwent ring closure to form the fluorenone III.



Experimental[4]

Cleavage of the Dimethyl Ether of 2-Duroylresorcinol.—A solution of 12 g. of ether I,[5] 150 ml. of glacial acetic acid, and 45.6 ml. of 48% hydrobromic acid was heated under reflux, with stirring, for 20 hr. and poured into ice water. Recrystallization of the colorless precipitate from benzene gave 5.6 g. (78.9%) of duroic acid, m.p. 177–178°, which was identified by a mixed melting point and comparison of infrared spectra. From the filtrate was obtained 4.6 g. of crude resorcinol.

2-Duroylresorcinol.—In a procedure similar to that of Mauthner[6] a mixture of 4.6 g. of ether I, 46 ml. of dry chlorobenzene, and 4.6 g. of aluminum chloride was heated under reflux for 0.5 hr. with stirring, cooled to room temperature, and poured into a cold solution of 46 ml. of concd. hydrochloric acid in 460 ml. of water. Chlorobenzene was removed by steam distillation. The red-brown, solid product was recrystallized from 95% ethanol to give 3.22 g. (77.2%) of 2-duroylresorcinol, m p. 157–158°.

Anal. Calcd. for $C_{17}H_{18}O_3$: C, 75.53; H, 6.71. Found: C, 75.35; H, 6.74.

2-Prehnitoylresorcinol.—A mixture of 2.12 g. of ether VI, 2.2 g. of aluminum chloride, and 15 ml. of chlorobenzene was heated under reflux and with stirring for 0.5 hr. The product was a yellow oil, which eventually solidified; recrystallized from benzene it formed yellow crystals, yield 1.19 g. (59.7%), m.p. 98–99°. The infrared spectrum has a sharp, strong band at 3440 cm.$^{-1}$ (nonchelated hydroxyl group), a broad, weak band between 3300 and 3100 cm.$^{-1}$ (chelated hydroxyl group), and a broad, strong band between 1630 and 1580 cm.$^{-1}$ (chelated carbonyl group).

Anal. Calcd. for $C_{17}H_{18}O_3$: C, 75.53; H, 6.71. Found: C, 75.21; H, 6.51.

1,2,3,4-Tetramethyl-8-hydroxyfluorenone.—A mixture of 2 g. of phenol II, 20 ml. of chlorobenzene, and 4.5 g. aluminum chloride was heated under reflux for 2.5 hr., stirred at room temperature overnight, and poured with stirring into a solution of 20 ml. of concd. hydrochloric acid in 200 ml. of water. The resulting slurry was steam distilled to remove chlorobenzene, and the crude fluorenone was recrystallized from benzene, yield 0.56 g. (30.3%), m.p. 170–171°.

Anal. Calcd. for $C_{17}H_{16}O_2$: C, 80.92; H, 6.39. Found: C, 80.73; H, 6.69.

The infrared spectrum shows bands assignable to a chelated, phenolic hydroxyl group (3300 cm.$^{-1}$) and to a conjugated, chelated carbonyl group in a five-membered ring (1660 cm.$^{-1}$).

Fluorenone III was produced also when a mixture of 2.6 g. of ketone VI, 20 ml of chlorobenzene, and 3 g. of aluminum chloride was heated with stirring for 3 5 hr. under reflux and then stirred overnight at room temperature. The product was recrystallized from benzene, m.p. 171–172°, yield 42.3%. A mixture melting point determination and comparison of infrared spectra showed this compound to be identical to that prepared from 2-duroylresorcinol. The fluorenone was formed also when a mixture of 0.52 g. of phenol VII, 1.2 g. of anhydrous aluminum chloride, and 15 ml. of chlorobenzene was heated under reflux, with stirring, for 3.5 hr., m.p. 170–171°, yield 23.4%.

1,2,3,4-Tetramethyl-8-methoxyfluorenone.—Methylation of phenol III by a procedure modeled after that of Lander[7] gave ketone V as yellow crystals, m.p. 169–170°, yield 93.8%.

Anal. Calcd. for $C_{18}H_{18}O_2$: C, 81.17; H, 6.81. Found: C, 80.90; H, 7.07.

The infrared spectrum shows bands attributed to a conjugated carbonyl group in a five-membered ring (1690 cm.$^{-1}$) and an ether linkage (1275 cm.$^{-1}$).

2-Duroyl-3-prehnitylanisole.—A solution of 13.2 g. of ethylene bromide in 25 ml. of anhydrous ether was added under nitrogen to a suspension of 3.0 g. of bromoprehnitene, 2.06 g. of magnesium turnings, and 25 ml. of anhydrous ether. The reaction mixture was heated under reflux for 3 hr. and added slowly at reflux temperature, over a period of 30 min., to a solution of 4.2 g. of ether I in 50 ml. of dry benzene. The mixture was heated under reflux for 17.5 hr., with stirring, cooled to room temperature, and stirred for 20 min. with 50 ml. of concd. ammonium chloride solution. The orange-brown, oily product crystallized when stirred with absolute ethanol. Recrystallization from 95% ethanol gave 1.12 g. (19.8%) of ketone IV, m.p. 157–158°.

Anal. Calcd. for $C_{28}H_{32}O_2$: C, 83.96; H, 8.05. Found: C, 84.08; H, 7.78.

A mixture of 0.5 g. of the ketone and 25 ml. of polyphosphoric acid was heated at 60–70°, with stirring, for 4 hr. The yellow product was submitted to chromatographic separation; ketone V, 0.15 g. (45.1%), was eluted at 20:1 benzene–ether and identified by a mixed melting point and comparison of infrared spectra.

Dimethyl Ether of 2-Prehnitoylresorcinol.—A solution of 8.8 g. of prehnitoyl chloride in 20 ml. of ether was added dropwise to a solution of 2,6-dimethoxyphenyllithium made from 9.66 g. of 1,3-dimethoxybenzene.[8] The reaction mixture was heated for 3 hr. under reflux, cooled, and poured into a slurry of ice and hydrochloric acid. The product, isolated by conventional procedures, was a purple solid, yield 12.7 g.; it was placed on a column of 250 g. of acid-washed alumina and eluted with cyclohexane–ether. With pure cyclohexane 2.9 g. of 1,3-dimethoxybenzene was isolated. Ketone VI (7.3 g.) was obtained with cyclohexane containing 8% of ether, m.p. 124–125°, yield 54.5%.

Anal. Calcd. for $C_{19}H_{22}O_3$: C, 76.5; H, 7.43. Found: C, 76.7; H, 7.26

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[4] All melting points are uncorrected.

[5] R. C. Fuson, G. W. Parshall, and E. H. Hess, *J. Am. Chem. Soc.*, **77**, 3776 (1955).

[6] F. Mauthner, *J. prakt. Chem.*, **139**, 290 (1934).

[7] G. D. Lander, *J. Chem. Soc.*, 729 (1900).

[8] G. Wittig and U. Pockels, *Ber.*, **72B**, 89 (1939).

Reaction of 2-Hydroxy-3-nitro-5,6-diphenylpyrazine with Pyridine

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The action of either thionyl chloride or phosphorus oxychloride upon 2-hydroxy-3-nitro-5,6-diphenylpyrazine (I)[1] has previously been shown

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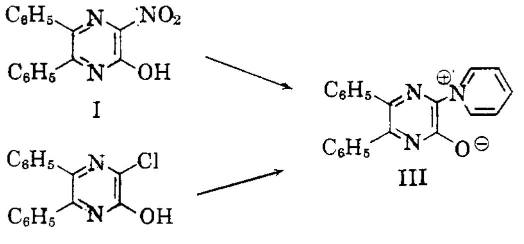
[1] G. Karmas and P. Spoerri, *J. Am. Chem. Soc.*, **75**, 5517 (1953)

to result in loss of the nitro group and formation of only 2-chloro-3-hydroxy-5,6-diphenylpyrazine (II) in the case of thionyl chloride, or both II and 2,3-dichloro-5,6-diphenylpyrazine in the case of phosphorus oxychloride.[2] The normal product from reactions of this type, 2-chloro-3-nitro-5,6-diphenylpyrazine, has never been obtained.

In an attempt to obtain normal replacement of the hydroxy group without loss of the nitro function, 2-hydroxy-3-nitro-5,6-diphenylpyrazine (I)[1] was treated with thionyl chloride in the presence of dry pyridine. The product isolated from this reaction appeared to have lost the nitro group, based on spectral and polarographic evidence, but contained neither halogen nor sulfur, and showed no carbonyl absorption in the infrared. It was insoluble in aqueous alkali, dissolved readily in dilute aqueous acid, but formed a sparingly soluble hydrochloride salt in strong hydrochloric acid. When subjected to acid hydrolysis, the compound gave 2,3-dihydroxy-5,6-diphenylpyrazine[1] and pyridine as the only products. On the basis of these results, together with analytical data which supported a molecular formula of $C_{21}H_{15}N_3O$, the zwitterionic structure (III) has been assigned to the product.



I

III

II

Structure III has been verified by independent synthesis from II with refluxing pyridine in the presence of pyridine hydrochloride. Treatment of II with pyridine alone at 100° for two hours gave only recovered starting material. However, it was found that I could be readily converted to III under the same conditions. Thus, the nitro group is a better leaving group in this system than the chloro group.

It seems unlikely that the chloro compound (II) is an intermediate in the production of III by the treatment of I with thionyl chloride and pyridine, since attempts to convert II to III with pyridine and pyridine hydrochloride at temperatures close to the original reaction conditions (50–60°) gave only starting material.

Experimental[3]

Reaction of 2-Hydroxy-3-nitro-5,6-diphenylpyrazine (I) with Thionyl Chloride and Pyridine.—A solution of 2-hydroxy-3-nitro-5,6-diphenylpyrazine[1] (15.0 g., 0.05 mole) in dry pyridine (150 ml.) was treated dropwise with thionyl chloride (6.0 g., 0.05 mole). The reaction was slightly exothermic and darkened to a reddish brown solution. After standing for about 18 hr., the reaction mixture was poured into ice water (500 ml.) containing concentrated hydrochloric acid (165 ml.), filtered, and the resulting filtrate rendered basic with 45% potassium hydroxide solution. The orange precipitate was collected, washed with water, and dried to obtain 13.2 g. of compound III. This material was apparently very strongly hydrated, since it could not be obtained anhydrous even by drying at 100° *in vacuo*. Anhydrous samples could be obtained only by recrystallization from organic solvents, such as *n*-propyl alcohol, from which III was obtained as orange crystals, decomposed slowly above 260° (cap.).

The infrared spectrum of compound III as well as of its hydrochloride salt showed no carbonyl peaks below 6.4 μ. Polarographic measurements indicated the absence of a nitro group.

Anal. Calcd. for $C_{21}H_{15}N_3O$: C, 77.51; H, 4.65; N, 12.92; O, 4.92. Found: C, 77.60; H, 4.94; N, 12.96; O, 5.18.

Acid Hydrolysis of Compound III.—A mixture of compound III (2.0 g.) and 20% sulfuric acid (25 ml.) was refluxed for 4 hr. and cooled. Filtration removed 1.6 g. of **2,3-dihydroxy-5,6-diphenylpyrazine,**[1] as a yellow crystalline solid. After recrystallization from glacial acetic acid–water and drying *in vacuo* at 100°, it possessed a m.p. 340–342° (cap.); lit., m.p. 335–340°.[1] The infrared spectrum of this compound was identical to that of an authentic sample.[1]

Anal. Calcd. for $C_{16}H_{12}N_2O_2$: C, 72.71; H, 4.58; N, 10.60; O, 12.11. Found: C, 72.65; H, 4.81; N, 10.79; O, 12.40.

The filtrate from the hydrolysis mixture was rendered basic with 50% sodium hydroxide solution, filtered, and extracted with three 10 ml. portions of chloroform. After drying over anhydrous sodium carbonate, the extracts were concentrated to a small volume (2–3 ml.). The infrared spectrum of this solution identified the solute as *pyridine*.

Synthesis of Compound III. A. From 2-Chloro-3-hydroxy-5,6-diphenylpyrazine (II).[2a]—A mixture of 2-chloro-3-hydroxy-5,6-diphenylpyrazine (II) (1.2 g., 0.004 mole), dry pyridine (15 ml.), and pyridine hydrochloride (0.50 g.) was refluxed for 2 hr., cooled, and poured into 2 *N* hydrochloric acid (100 ml.) and ice. After clarification with Norit, the clear yellow filtrate was basified with 45% potassium hydroxide to give 0.25 g. of a gold-brown solid. Recrystallization from *n*-propyl alcohol gave a product with an infrared spectrum identical to that of compound III.

B. From 2-Hydroxy-3-nitro-5,6-diphenylpyrazine (I).[1]—2-Hydroxy-3-nitro-5,6-diphenylpyrazine (I) (3.0 g.) was treated with dry pyridine (20 ml.) at 100° for 1.5 hr. and poured into cold, dilute hydrochloric acid. Filtration and basification gave 2.1 g. of product. Following recrystallization from *n*-propyl alcohol, the product was again identified by its infrared spectrum as being identical to compound III.

Attempts to prepare III by the treatment of 2-chloro-3-hydroxy-5,6-diphenylpyrazine (II) with pyridine at 100° for 2 hr. or with pyridine and pyridine hydrochloride at 50–60° for 2 hr. gave only recovered starting material.

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(2) (a) G. Karmas and P. Spoerri, *J. Am. Chem. Soc.*, **78**, 4071 (1956); (b) R. H. Martin and Z. Tarasiejska, *Bull. soc. chim. Belges*, **66**, 136 (1957).

(3) Melting points are uncorrected. All infrared spectra were Nujol mulls unless otherwise stated.