72. *Mechanism of the Reaction between Arylamines and Benzoins.*

By R. M. Cowper and T. S. Stevens.

The nature of the products from a pair of unsymmetrically substituted benzoins has been determined; it is concluded that the initial point of attack by the amine is the carbonyl group, and that the benzoinanil (as I) so formed passes spontaneously into the anilinodeoxybenzoin (as III).

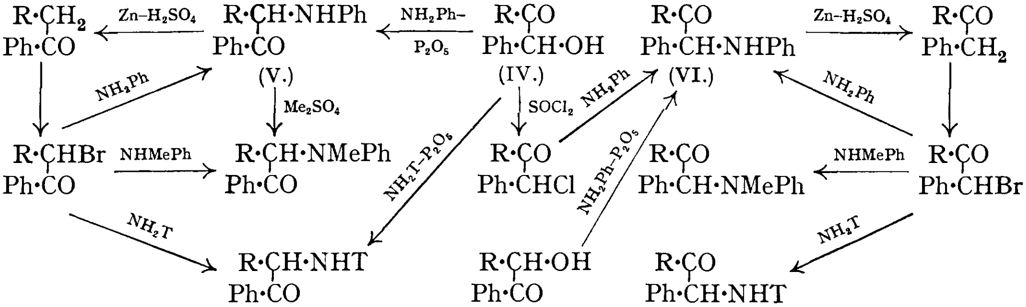
The product of interaction of benzoin and aniline, which can also be obtained from bromodeoxybenzoin and aniline, has been regarded as benzoinanil (I), but its properties have led most workers to formulate it as anilinodeoxybenzoin (III) (Japp and Murray, J., 1894, **65**, 889; Cameron, *Trans. Roy. Soc. Canada*, 1929, **23**, III, 53); Strain envisages tautomerism between the structures (I) and (III) with (II) as an intermediate stage (*J. Amer. Chem. Soc.*, 1929, **51**, 270).

$$\begin{array}{c}\mathrm{Ph{\cdot}C{:}NPh}\\ \mathrm{Ph{\cdot}CH{\cdot}OH}\end{array} \rightleftharpoons \begin{array}{c}\mathrm{Ph{\cdot}C{\cdot}NHPh}\\ \mathrm{Ph{\cdot}C{\cdot}OH}\end{array} \rightleftharpoons \begin{array}{c}\mathrm{Ph{\cdot}CH{\cdot}NHPh}\\ \mathrm{Ph{\cdot}CO}\end{array}$$

(I.) (II.) (III.)

It is not clear whether aniline initially attacks the ketonic or the alcoholic group in benzoin, and this point has now been elucidated by examining the behaviour of an unsymmetrical (" mixed ") benzoin. When " benzanisoin " (IV), of well-established constitution, is treated with aniline, the *product* is (V), in which the arylamine residue is attached to the carbon atom of the original carbonyl group. The constitution of (V) has been established by its synthesis from the appropriate bromodeoxybenzoin and by its reductive fission to the related deoxybenzoin; the last observation incidentally affords a new ground for attributing structures of the type (III) rather than (I) to these bases. It may be inferred that the initial product from aniline and benzanisoin is the anil (as I), which isomerises to (III) according to Strain's scheme. This view is confirmed by the failure of methylaniline to react with benzanisoin, even at a much higher temperature than the primary amine demands.

The isomeric *anilino-ketone* (VI) was obtained by the successive action of thionyl chloride and aniline on benzanisoin, and also by reactions analogous to those already described. The following summary includes other related materials and their transformations :



(R = p-C$_6$H$_4$·OMe; T = p-C$_6$H$_4$Me.)

EXPERIMENTAL.

When a compound was prepared by more than one method, the identity of the products was confirmed by mixed m. p.

Phenyl p-*Methoxybenzyl Ketone*.—This was best prepared by the circuitous method of Tiffeneau and Orékhov (*Bull. Soc. chim.*, 1925, **37**, 437), Buck and Ide's procedure (*J. Amer. Chem. Soc.*, 1931, **53**, 1536) being less efficient in our hands. An attempt to prepare *p*-methoxyphenylacetonitrile as an initial material, from the chloride and potassium cyanide in alcohol, gave a product, b. p. 125—127°/30 mm., evidently the ethyl ether, b. p. 111—113°/11 mm. (Späth, *Monatsh.*, 1914, **35**, 330).

Bromination (compare Cowper and Davidson, *Org. Synth.*, 1939, **19**, 24). To phenyl methoxybenzyl ketone (13 g.) in ether (120 c.c.) containing a trace of aluminium chloride, bromine (3 c.c.) was added gradually with cooling. After ½ hr. the mixture was washed with water and dried over sodium sulphate, the solvent evaporated, and the residue crystallised from ligroin; yield 16—17 g., m. p. 93°, as found by Jenkins (*J. Amer. Chem. Soc.*, 1934, **56**, 683). *p*-Methoxyphenyl α-bromobenzyl ketone (Jenkins, *loc. cit.*) was prepared in the same way from methoxyphenyl benzyl ketone (Buck and Ide, *J. Amer. Chem. Soc.*, 1932, **54**, 3013).

Phenyl α-*Anilino*-p-*methoxybenzyl Ketone* (*V*).—Phenyl α-bromo-*p*-methoxybenzyl ketone (1 mol.) and aniline (2 mols.) were heated on the water-bath for a few minutes. The product was dissolved in benzene and filtered from aniline hydrobromide; the residue from evaporation of the benzene at room temperature crystallised from alcohol in pale yellow laminæ, m. p. 135—

136° (Found : N, 4·5. $C_{21}H_{19}O_2N$ requires N, 4·4%). The hydrochloride formed soft, white needles insoluble in water. In the same way, the appropriate materials yielded the following bases : *phenyl α-*p*-toluidino-*p*-methoxybenzyl ketone*, greenish-yellow prisms, m. p. 119—120° (Found : N, 4·4. $C_{22}H_{21}O_2N$ requires N, 4·2%) ; *phenyl α-methylanilino-*p*-methoxybenzyl ketone*, white needles, m. p. 118—119° (Found : N, 4·3. $C_{22}H_{21}O_2N$ requires N, 4·2%) ; p-*methoxyphenyl α-anilinobenzyl ketone*, white needles, m. p. 144—145° (Found : N, 4·6. $C_{21}H_{19}O_2N$ requires N, 4·4%) ; p-*methoxyphenyl α-*p*-toluidinobenzyl ketone*, white prismatic needles, m. p. 142—143° (Found : N, 4·3. $C_{22}H_{21}O_2N$ requires N, 4·2%) ; p-*methoxyphenyl α-methylanilinobenzyl ketone*, white prisms, m. p. 160—161° (Found : N, 4·5. $C_{22}H_{21}O_2N$ requires N, 4·2%).

*Preparation of Phenyl α-Anilino-*p*-methoxybenzyl Ketone* (V) *from Benzanisoin* (IV).—Benzanisoin (12 g.), aniline (5 g.), and phosphoric oxide (0·5 g.) were heated on the water-bath for 1·5 hours. The brown syrup gradually solidified to a yellow mass, which was taken up in alcohol and filtered hot. Yellow nodules separated on cooling, and after treatment with sodium hydroxide solution these were recrystallised from alcohol, yielding yellow laminæ identical with those already described. This, the most convenient method, was also applied to the preparation of the corresponding *p*-toluidino-ketone, but when methylaniline was used in place of aniline no reaction took place below 170°. By the same method, anisbenzoin, $MeO{\cdot}C_6H_4{\cdot}CH(OH){\cdot}COPh$ (Asahina and Terasaka, *Chem. Zentr.*, **1923**, III, 434), yielded *p*-methoxyphenyl α-anilinobenzyl ketone (VI).

Action of Thionyl Chloride and Aniline on Benzanisoin.—Benzanisoin (10 g., finely powdered) was added gradually with cooling to thionyl chloride (8 g.). The mixture was poured into water, and the product isolated by means of ether as a syrup which could not be purified. Treated with aniline (2 mols.), this yielded 50% of *p*-methoxyphenyl α-anilinobenzyl ketone (VI).

*Methylation of Phenyl α-Anilino-*p*-methoxybenzyl Ketone.*—The amino-ketone (6 g.) in benzene (10 c.c.) containing methyl sulphate (3 c.c.) was treated on the water-bath with successive portions of sodium carbonate until effervescence ceased (2 hours), and the residue from evaporation of the filtered solution was crystallised from alcohol. This is the most convenient source of this ketone.

*Reductive Fission of Phenyl α-Anilino-*p*-methoxybenzyl Ketone.*—The ketone was heated for 2—3 hours on the water-bath with excess of zinc dust and 20% sulphuric acid, and the phenyl methoxybenzyl ketone extracted with ether and crystallised from alcohol; yield, 50%. *p*-Methoxyphenyl α-anilinobenzyl ketone similarly afforded *p*-methoxyphenyl benzyl ketone.

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UNIVERSITY OF GLASGOW.

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