CCCXIV.—*Some Derivatives of* 2 : 3 : 5 : 6-*Dibenzo*-1 : 8-*naphthyridine.*

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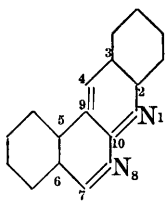
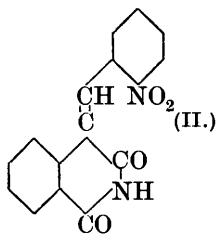
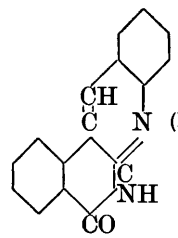
DERIVATIVES of 2 : 3 : 5 : 6-dibenzo-1 : 8-naphthyridine (I) have not been previously described, and a method for their preparation from homophthalimide is now communicated. Dieckmann (*Ber.*, 1914, **47**, 1428) showed that the diethyl ester of homophthalic acid condensed with aldehydes, and homophthalimide is now shown to condense in a similar manner with *o*-nitrobenzaldehyde, giving excellent yields of o-*nitrobenzylidenehomophthalimide* (II) in pyridine solution in the presence of a trace of piperidine.

(I.)





(II.)

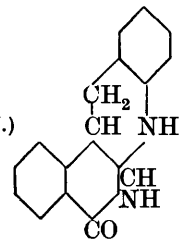


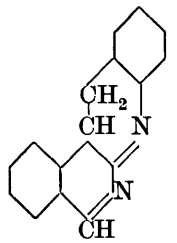
(III.)

This sparingly soluble substance was reduced with stannous chloride in alcoholic solution to 7-*keto*-2 : 3 : 5 : 6-*dibenzo*-7 : 8-*dihydro*-1 : 8-*naphthyridine* (III), which is a pale yellow, very weak base, dissolving in concentrated mineral acids and being precipitated on dilution with water; it possesses marked acidic properties, however, owing to the presence of the *iso*carbostyril

grouping, and on treatment with dilute potassium or sodium hydroxide, bright yellow, sparingly soluble salts were obtained, the *sodium* salt being somewhat more soluble than the *potassium* salt. Owing to the sparing solubility of this ketodibenzodihydronaphthyridine, further reduction was difficult, but zinc dust in glacial acetic acid, saturated with hydrogen chloride, effected reduction to 7-*keto*-2 : 3 : 5 : 6-*dibenzo*-1 : 4 : 7 : 8 : 9 : 10-*hexahydro*-1 : 8-*naphthyridine* (IV), which is devoid of acidic properties, but readily yields a *monohydrochloride* and an amorphous *nitrosoamine*.

(IV.)





(V.)

A similar series of compounds was obtained from the *N*-alkylated homophthalimides, the 8-β-*phenylethyl* and 8-β-*piperonylethyl* derivatives [as (II), (III), and (IV)] being described.

In attempting to reduce the carbonyl group of the ketodibenzodihydronaphthyridine (III), a small yield of a yellow *base*, $C_{16}H_{12}N_2$, was obtained by electrolytic reduction in alcoholic sulphuric acid solution. The same base was, however, more conveniently prepared (in 20% yield) by heating the keto-compound (III) with phosphorus oxychloride and pentachloride at 180° and reducing the unstable chloro-compound with phosphorus and hydriodic acid at 160—170°, the compound (IV) also being formed. The yellow base, $C_{16}H_{12}N_2$, was sparingly soluble in organic solvents and its dilute solutions exhibited an intense violet fluorescence. The two nitrogen atoms are both tertiary in character, since no nitrosoamine or acetyl derivative can be obtained. It is probably 2 : 3 : 5 : 6-*dibenzo*-4 : 9-*dihydro*-1 : 8-*naphthyridine* (V), for it dissolved in hot dilute hydrochloric acid to give a sparingly soluble *monohydrochloride*, and this monoacidic character is in agreement with the amidine structure suggested.

Experimental.

o-*Nitrobenzylidenehomophthalimide* (II).—Homophthalimide (20 g.), *o*-nitrobenzaldehyde (20 g.), pyridine (100 c.c.), and piperidine (0·5 c.c.) were boiled until homogeneous, and the heating was continued on the water-bath for 2 hours; the solution became

dark red and the product gradually separated on cooling in pale yellow needles, which recrystallised from pyridine in pale sulphur-yellow needles (35 g.), m. p. 236° (Found: N, 9·6. $C_{16}H_{10}O_4N_2$ requires N, 9·5%). o-*Nitrobenzylidenehomophthalimide* is sparingly soluble in the usual organic solvents, and gives a yellow solution in dilute aqueous sodium hydroxide.

o-*Nitrobenzylidene*-N-β-*phenylethylhomophthalimide* was prepared similarly from *o*-nitrobenzaldehyde and *N*-β-phenylethylhomophthalimide; it crystallised from pyridine in yellow needles, m. p. 146° (Found: N, 7·2. $C_{24}H_{18}O_4N_2$ requires N, 7·0%). o-*Nitrobenzylidene*-N-β-*piperonylethylhomophthalimide*, prepared from *o*-nitrobenzaldehyde and *N*-β-piperonylethylhomophthalimide, crystallised from pyridine in yellow needles, m. p. 176° (Found: N, 6·7. $C_{25}H_{18}O_6N_2$ requires N, 6·2%).

7-*Keto*-2 : 3 : 5 : 6-*dibenzo*-7 : 8-*dihydro*-1 : 8-*naphthyridine* (III).—A mixture of *o*-nitrobenzylidenehomophthalimide (II) (15 g.), stannous chloride (40 g.), and ethyl alcohol (200 c.c.) was saturated with hydrogen chloride and heated on the water-bath for 12 hours. After cooling, the tin double compound was collected, digested with excess of potassium hydroxide solution for ½ hour, cooled, and the bright yellow *potassium* salt decomposed by trituration with dilute hydrochloric acid; the resulting *ketodibenzodihydronaphthyridine* was recrystallised from glacial acetic acid, forming very pale yellow needles (12 g.), m. p. 246—247° (Found: C, 77·9; H, 4·1; N, 11·1. $C_{16}H_{10}ON_2$ requires C, 78·0; H, 4·1; N, 11·4%). It is almost insoluble in water, ether, alcohol, acetone, or benzene, slightly soluble in hot chloroform, and soluble in hot glacial acetic acid or pyridine. It dissolves in concentrated hydrochloric acid, but is reprecipitated on dilution. The potassium salt is almost insoluble in water. The *sodium* salt is slightly soluble in hot water, from which it separates in glistening, bright yellow plates (Found: Na, 8·7. $C_{16}H_9ON_2Na$ requires Na, 8·6%); it is also obtained by boiling the ketodibenzodihydronaphthyridine (III) with methyl-alcoholic sodium hydroxide, no further hydrolysis taking place.

7-*Keto*-8-β-*phenylethyl*-2 : 3 : 5 : 6-*dibenzo*-7 : 8-*dihydro*-1 : 8-*naphthyridine* was obtained from *o*-nitrobenzylidene-*N*-β-phenylethylhomophthalimide by reduction with stannous chloride, as described above. It crystallises from acetic acid in almost colourless needles, m. p. 220° (Found: C, 82·1; H, 5·2. $C_{24}H_{18}ON_2$ requires C, 82·3; H, 5·1%). It is a very weak base, and shows no acidic properties. 7-*Keto*-8-β-*piperonylethyl*-2 : 3 : 5 : 6-*dibenzo*-7 : 8-*dihydro*-1 : 8-*naphthyridine* crystallises from glacial acetic acid in pale yellow needles, m. p. 217° (Found: C, 76·0; H, 4·9. $C_{25}H_{18}O_3N_2$ requires C, 76·1; H, 4·6%).

7-*Keto*-2 : 3 : 5 : 6-*dibenzo*-1 : 4 : 7 : 8 : 9 : 10-*hexahydro*-1 : 8-*naphthyridine* (IV).—*o*-Nitrobenzylidenehomophthalimide (6 g.) or ketodibenzodihydronaphthyridine (III) (6 g.) was dissolved in glacial acetic acid (100 c.c.), saturated with hydrogen chloride, and heated with a large excess of zinc dust for 3 hours on the water-bath. The mixture was diluted with water, made strongly alkaline with ammonia, extracted with chloroform, the solvent removed, and the residue crystallised first from boiling ethyl alcohol and then from methyl ethyl ketone, colourless needles (0·5 g.), m. p. 250°, being obtained (Found: C, 77·4; H, 5·7. $C_{16}H_{14}ON_2$ requires C, 76·8; H, 5·6%). This substance (IV) is more soluble in organic solvents than the dihydro-compound (III). It is insoluble in sodium hydroxide solution, but dissolves in dilute hydrochloric acid; on concentration the *monohydrochloride* separates in colourless needles, which darken at about 225° and decompose at 270° (Found: Cl, 12·3. $C_{16}H_{15}ON_2Cl$ requires Cl, 12·5%). When its solution in dilute hydrochloric acid was treated with sodium nitrite an amorphous *nitrosoamine* gradually separated. This was extracted with chloroform, the extract washed thoroughly with sodium bicarbonate solution, and the solvent removed; the residue gave Liebermann's test for nitrosoamines. The *picrate*, prepared in alcoholic solution, crystallised from glacial acetic acid in small, yellow needles, m. p. 270° (Found: N, 14·6. $C_{22}H_{17}O_8N_5$ requires N, 14·6%).

7-*Keto*-8-β-*phenylethyl*-2 : 3 : 5 : 6-*dibenzo*-1 : 4 : 7 : 8 : 9 : 10-*hexahydro*-1 : 8-*naphthyridine*, obtained by reducing the corresponding dihydro-compound or *o*-nitrobenzylidene-*N*-β-piperonylethylhomophthalimide with zinc dust, as described above, crystallises from ethyl alcohol in colourless needles, m. p. 217° (Found: C, 81·1; H, 6·4. $C_{24}H_{22}ON_2$ requires C, 81·3; H, 6·2%). 7-*Keto*-8-β-*piperonylethyl*-2 : 3 : 5 : 6-*dibenzo*-1 : 4 : 7 : 8 : 9 : 10-*hexahydro*-1 : 8-*naphthyridine* separates from ethyl alcohol in colourless needles, m. p. 211° (Found: C, 75·4; H, 5·7. $C_{25}H_{22}O_3N_2$ requires C, 75·4; H, 5·5%).

2 : 3 : 5 : 6-*Dibenzo*-4 : 9-*dihydro*-1 : 8-*naphthyridine* (V).—The corresponding 1 : 8-dihydroketo-compound (III; 5 g.), phosphorus pentachloride (6 g.), and phosphorus oxychloride (10 c.c.) were heated for 5 hours in a sealed tube at 180°. The oxychloride was removed under diminished pressure, and the solid residue * (7 g.) heated with red phosphorus (1·5 g.) and hydriodic acid (*d* 1·7; 30 c.c.) for 9 hours at 160—170°; the pale greenish-yellow solution, containing long, pale yellow prisms, was diluted with water, boiled, and the sparingly soluble *hydriodide* decomposed by the addition

* The chloro-derivative could not be isolated from this solid residue, as it was rapidly hydrolysed to the keto-compound (III) by water.

of a large excess of ammonia. The base was extracted with chloroform, the extract dried, the solvent removed, the residual solid dissolved in hot dilute hydrochloric acid, filtered, and cooled; the hydrochloride separated in pale orange needles, which were collected, dissolved in water, and decomposed with sodium hydroxide; the resulting yellow base crystallised from ethyl alcohol in pale yellow needles (0·9 g.), m. p. 232° (Found: C, 82·4, 82·8; H, 5·4, 5·5. $C_{16}H_{12}N_2$ requires C, 82·8; H, 5·2%). It is sparingly soluble in ether, light petroleum, or benzene, fairly soluble in hot alcohol, and readily soluble in chloroform, glacial acetic acid, or hot dilute mineral acids. Its alcoholic solutions are almost colourless, with an intense violet fluorescence. The *monohydrochloride* crystallises from water in pale yellow needles which darken at about 240° and gradually decompose at higher temperatures (Found: Cl, 12·9. $C_{16}H_{13}N_2Cl$ requires Cl, 13·3%). The base does not yield a nitrosoamine or acetyl derivative, and could not be further reduced by zinc dust and acids.

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