Synthesis of Di- and Tetra-substituted 1,4,5,8-Tetra-azaphenanthrenes (Pyrazino[2,3-*f*]quinoxalines)

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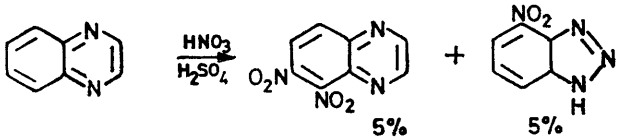
6-Nitroquinoxalines (I) are aminated by hydroxylamine to 5-amino-6-nitroquinoxalines (II). These are reduced to 5,6-diaminoquinoxalines (III) which condense with appropriate α-dicarbonyl compounds to yield substituted 1,4,5,8-tetra-azaphenanthrenes (IV).

ONLY a few di- and tetra-substituted [1] 1,4,5,8-tetra-azaphenanthrenes are known, despite their potential interest as analogues of 1,10-phenanthroline. We report here a convenient synthesis of such derivatives.

5,6-Dinitroquinoxaline [2] was an attractive precursor for the preparation of 2,3-disubstituted tetra-azaphenanthrenes. However, attempts to nitrate quinoxaline gave poor yields of 5,6-dinitroquinoxaline and 5% of an unexpected compound, 4-nitrobenzotriazole (Scheme 1). The method described by Case and Brennan [2] is, however, impossible to apply to the synthesis of 2,3,6,7-tetra-aryltetra-azaphenanthrenes, since the nitration which is involved will probably occur also on the aromatic substituents.

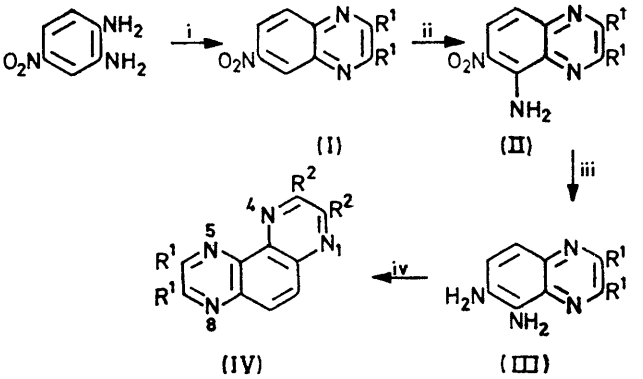
The direct amination of nitroaromatic compounds,[3-5] which has been relatively little studied and never applied systematically, offers an alternative route to the synthesis of precursors such as (II).

Exploratory experiments finally led us to adopt the following sequence. 4-Nitro-*o*-phenylenediamine is condensed with the appropriate α-dicarbonyl compound in boiling ethanol [6] or acetic acid, leading to the known 2,3-disubstituted 6-nitroquinoxalines (I), which react readily with hydroxylamine in alkaline medium to give



SCHEME 1

the corresponding 5-amino-6-nitroquinoxalines (II); these are reduced almost quantitatively to 5,6-diaminoquinoxalines, and further condensation with α-diketones affords the desired 2,3-disubstituted or 2,3,6,7-tetra-substituted 1,4,5,8-tetra-azaphenanthrenes (IV), in overall yield ranging from 20 to 55% based on starting nitrophenylenediamine. Tetra-azaphenanthrenes (IV) with



SCHEME 2 Reagents: i, $R^1CO{\cdot}COR^1$ in EtOH or AcOH; ii, NH_2OH + KOH in EtOH or EtOH–dioxan; iii, N_2H_4 with 10% Pd–C; iv, $R^2CO{\cdot}COR^2$ in EtOH or AcOH

the following substituents have been synthesised: $R^1 = R^2 = H$; $R^1 = H$, R^2 = Me †, Ph †, or *p*-MeO·C_6H_4 †; $R^1 = R^2$ = Me †, Ph, or *p*-MeO·C_6H_4 † (Scheme 2).

EXPERIMENTAL

The Experimental section is available as Supplementary Publication No. SUP 21349 (9 pp.).‡

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† New compound.

‡ For details of Supplementary Publications see Notice to Authors No. 7 in *J.C.S. Perkin I*, 1974, Index issue.

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