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# A NEW MESOIONIC SYSTEM WITH A SIX-MEMBERED RING; REACTIONS OF 1,4-DISUBSTITUTED 2,6-DIOXOPIPERAZINES WITH BENZENESULFONYL AND BENZENESULFENYL CHLORIDE IN PYRIDINE

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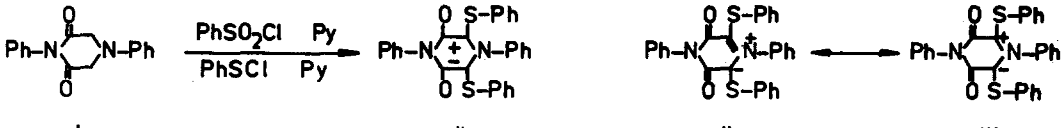
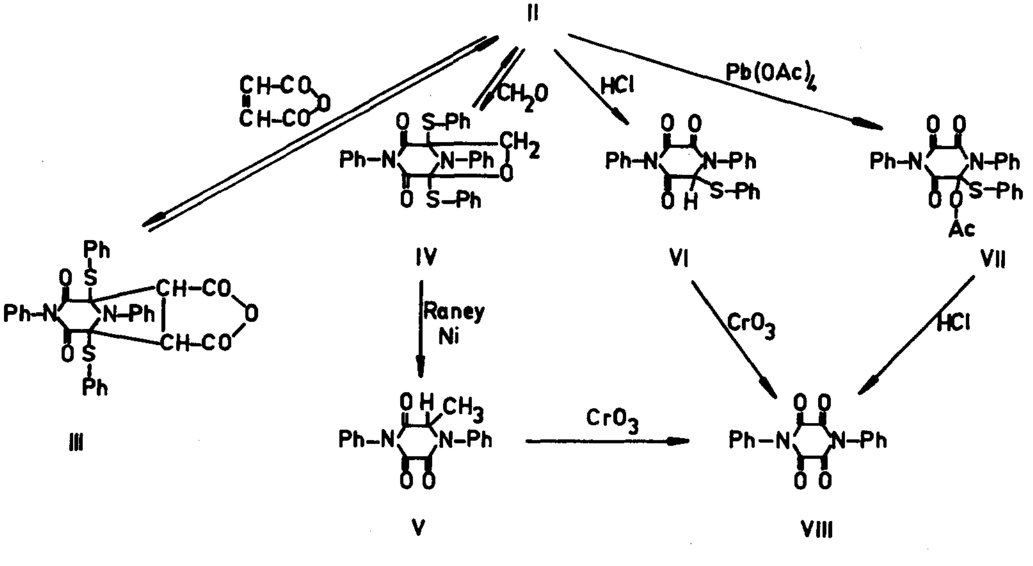
In connection with the investigation of the reactions of 1,4-disubstituted dioxopiperazines with electrophilic agents (1), the reactions of 1,4-disubstituted-2,6-dioxopiperazines with benzenesulfonyl chloride have been studied.

In the reaction of 1,4-diphenyl-2,6-dioxopiperazine I with benzenesulfonyl chloride carried out in boiling pyridine, diphenyl disulfide and a compound with the molecular formula $C_{28}H_{20}N_2O_2S_2$ (b.p. 251-253°) were formed; for the latter, the mesoionic structure II was proved. The compound II is yellow ( $\lambda$max 438); on comparing the IR spectra of I and II, a considerable decrease of the bands corresponding to the diacylamine grouping can be observed, from 1705 cm$^{-1}$ and 1750 cm$^{-1}$ to 1640 cm$^{-1}$ and 1690 cm$^{-1}$, respectively.



I II IIa IIb

Recently, it has been confirmed several times (2) that mesoionic compounds can add dipolarophilic substances. Thus II in which the limit structures of the azomethinylide type IIa and IIb can also be expected to exist undergoes a 1,3-dipolar cycloaddition in positions 3 and 5. Reactions with formaldehyde and maleic anhydride yield the adducts IV and III. In the IR spectra of these compounds we observed bands corresponding to the diacylamine grouping with wave numbers very near to that of the dioxopiperazine I. The NMR spectrum of III contains, besides the bands corresponding to the hydrogen atoms of the aromatic nuclei, only a singlet ( $\tau$ 5.4), and the NMR spectrum of IV has only a quartet with the centre at $\tau$ 5.91. This is in agreement with the suggested structures. The structure of IV was moreover confirmed by its degradation to V with the aid of the Raney-Ni. The NMR spectrum of this compound contains a doublet at $\tau$ 8.4 and a quartet at $\tau$ 5.25 with a splitting 7 c/s, which corresponds to the $CH_3$-CH< group. V yields upon oxidation the known tetraoxo-derivative VIII. By these reactions, the mesoionic structure II was proved.

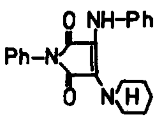


Reactions of II which take place in a neutral or acid medium lead to products which keep their piperazine ring. The reduction with activated aluminium in aqueous THF gives dioxopiperazine I in a high yield, along with a small quantity of 1,4-diphenyl-2,6-dioxo-3(S-phenylthio)piperazine. Acid hydrolysis (HCl, diluted AcOH) gives rise to the trioxo derivative VI, and oxidation with lead tetraacetate in acetic acid yields VII. The structure of both VI and VII was proved by transforming them into the known tetraoxo derivative VIII.

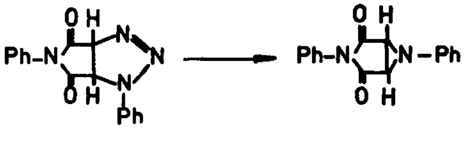
Reactions of II occurring in an alkaline medium can also give rise to derivatives with a five-membered ring. By desulfurization with the Raney-Ni, anilino-N-phenylmaleimide was formed in a small yield along with dioxopiperazine I. A compound with a similar ring, IX, was obtained in the reaction of II with piperidine.

1,4-dimethyl-2,6-dioxopiperazine, 1-methyl-4-phenyl-2,6-dioxopiperazine and 1-phenyl-4-methyl-2,6-dioxopiperazine react with benzenesulfonyl chloride and pyridine, yielding mesoionic compounds of type II.

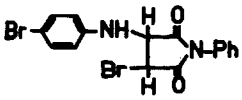
Only preliminary hypotheses can be made on the reaction mechanism of the reaction of I with benzenesulfonyl chloride and pyridine. It has been found, with the help of the EPR spectroscopy, that in this reaction at least two types of free radicals were formed. It seems probable therefore that the reaction occurs by a chain mechanism similar to that observed by Oae and Ikura (3) in the reaction of benzenesulfinyl chloride with pyridine N-oxide. This suggestion is in agreement with the fact that II can be prepared by a reaction involving benzene sulphenylchloride, I, and pyridine. The reaction mechanism must include the dehydrogenation of the dioxopiperazine ring to the mesoionic system; it is not possible, however, to decide whether this dehydrogenation occurs before the substitution of the dioxopiperazine ring, or vice versa.



IX



X XI



XII

The nearest analogous compound to the mesoionic system II is compound XI, prepared by a decomposition of triazole X (4). Reactions of this compound, however, can be explained by the classical formula (5). Ohta and Kato have found that in this compound the reactivity of both the succinimine and aziridine ring (5) is preserved. In the reaction with hydrogen chloride, they obtained 2-anilino-3-chlorosuccine anil; the reaction with basic agents (NaOH,$N_2H_4$) yielded derivatives of aziridine dicarboxylic acid. With bromine, an addition dibromo derivative was obtained, for which the above authors gave several possible alternative structures.

We have found in our experiments that XI does not enter into an addition reaction with formaldehyde and maleic anhydride, and that it can be transformed by reduction in anilinosuccine anil. As to the product of the reaction of XI with bromine, we have shown it to be XII (by an alternative synthesis), instead of the structures suggested by Ohta and Kato. Thus, the reaction with bromine leads to bromination of the benzene ring and opening of the aziridine ring by the hydrogen bromide formed, in agreement with the classical structure XI. Also the IR spectrum of XI is in good agreement with the supposed structure; it contains a band at 1200cm$^{-1}$ which can be assigned to the aziridine ring fused in positions 2 and 3 to another ring (4b), and bands of the diacylamine grouping with wave numbers 1725 cm$^{-1}$ and 1785 cm$^{-1}$.

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