MESOIONIC COMPOUNDS WITH A BRIDGED NITROGEN ATOM.

3.* REACTIONS OF 2-[(1-METHYL-2-PYRIDINIATHIO)ACETYL]-THIAZOLO[3,2-a]PYRIDINIUM 3-OXIDE METHYLSULFATE

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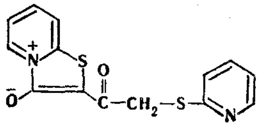
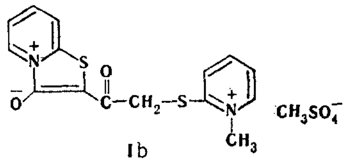
The reactions of the product of cyclodehydration of (2-pyridylthio)acetic acid, viz., 2-[(1-methyl-2-pyridylthio)acetyl]thiazolo[3,2-a]pyridinium 3-oxide, were investigated. It is shown that its quaternary salt at the pyridine nitrogen atom in the presence of triethylamine acts as a nucleophile (by reactions at the methylene group with benzothiazolium and quinolinium sulfonatobetaines) and as an electrophile (by reaction with N-phenylrhodanine) with cleavage of both sulfide sulfur bonds with the simultaneous formation of a disulfide.

The product of dehydration of (2-pyridylthio)acetic acid, viz., [(2-pyridylthio)-acetyl]thiazolo[3,2-a]pyridinium 3-oxide, which is obtained by heating the acid in acetic anhydride at 140°C, has dimeric structure Ia [1-4] and is a polyfunctional compound.

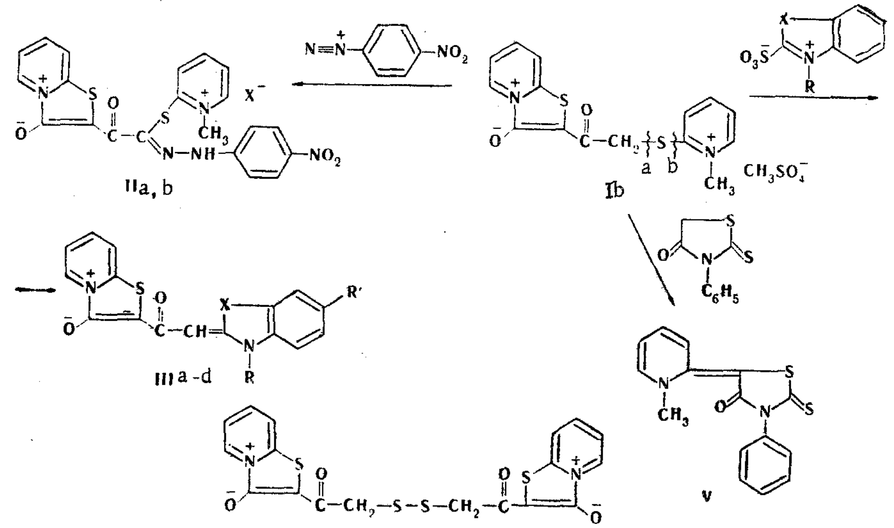


Ia



Ib

Its reaction at the keto group (its conversion to a thiocarbonyl group and the production of a hydrazone) and at the nitrogen atom (quaternization) have been examined [4]. Further study showed that in the conversion of Ia to its quaternary salt (Ib) the latter acquires activity with respect to electrophilic and nucleophilic agents. Reactions of the first type are manifested in reactions involving the methylene group, which is under the influence of the nearby carbonyl group and the pyridinium ring. Reactions of this type were



Scheme 1

II a $X=BF_4$; b $X=CH_3SO_4$; III a $X=S$, $R=C_2H_5$, $R'=H$; b $X=S$, $R=CH_3$, $R'=H$; c $X=CH=CH$, $R=C_2H_5$, $R'=OCH_3$; d $X=CH=CH$, $R=C_2H_5$, $R'=CH_3$

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*See [1] for communication 2.

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TABLE 1. Dyes III

Compound	mp, °C	λ_{max}, nm	lg ε	Found, %				Empirical formula	Calc., %			
				C	H	N	S		C	H	N	S
IIIa	270	476	4.52	60.8	4.2	7.7	18.1	$C_{18}H_{14}N_2O_2S_2$	61.0	4.0	7.9	18.1
IIIb	287	474	4.46	60.0	3.7	8.0	—	$C_{17}H_{12}N_2O_2S_2$	60.0	3.5	8.2	—
IIIc	257	500 530	4.62 4.70	66.1	4.8	7.1	8.4	$C_{21}H_{18}N_2O_3S$	66.6	4.8	7.1	8.4
IIId	267	490 520	4.65 4.73	69.0	5.1	7.7	8.8	$C_{21}H_{18}N_2O_2S$	69.6	5.0	7.7	8.8

investigated by reaction of Ib with p-nitrobenzenediazonium and 2-sulfonato-N-alkylbenzothiazolium and quinolinium salts. The reaction with the p-nitrobenzenediazonium salt was carried out in neutral media and led to the formatiom of II. The reaction with benzothiazolium and quinolinium derivatives in the presence of triethylamine was accompanied by cleavage of the *a* bond (Scheme 1) and splitting out of the 2-pyridylthio residue to give III.

The activity of Ib with respect to nucleophilic agents was manifested in its reaction with N-phenylrhodanine, which entails cleavage of the b bond. The cleavage of the bond between sulfur and the C_2 atom in quaternary salts of heterocyclic bases is well known and constitutes the basis for the synthesis of nullomethylidynemerocyanines of the V type. Using the analogy in the structure of Ib and these salts we obtained merocyanine V. The reaction was carried out in an alcohol medium in the presence of triethylamine. It should be noted that the formation of disulfide IV was always observed in both this and other reactions carried out under the same conditions. This even occurred when the principal reaction took place with cleavage of the *a* bond (with the formation of dye III), which indicated the weakness of both sulfide sulfur bonds in Ib and their competitive cleavage; the ratios of the reaction products differed when the conditions were changed only slightly. Thus, the reaction with benzothiazolium and quinolinium 2-sulfonates in absolute alcohol at a molar reagent ratio proceeds primarily to favor the formation of the disulfide, whereas in 75% alcohol it proceeds primarily to favor the formation of dyes. The reagent ratio also is of great significance with respect to the reaction pathway. If the other reagents are used in excess amounts with respect to Ib, the amount of disulfide formed decreases markedly. Its formation was also noted when Ib was heated in alcohol with triethylamine in the absence of other reagents, but the amount formed was very small.

It is apparent from the information stated above that Ib has the interesting feature that it can behave simultaneously as a nucleophile and as an electrophile.

EXPERIMENTAL

The electronic spectra of alcohol solutions of the compounds were recorded with an SF-10 spectrophotometer. The IR spectra of KBr pellets of the compounds were recorded with a UR-20 spectrometer. The PMR spectra were recorded with a Tesla BS-487B spectrometer (80 MHz) with hexamethyldisiloxane as the external standard.

2-[(1-Methyl-2-pyridiniathio)(p-nitrophenylhydrazono)acetyl]thiazolo[3,2-a]pyridinium 3-Oxide Tetrafluoroborate (IIa). A 0.32-g (0.75 mmole) sample of Ib was diazotized in 15 ml of alcohol with 0.15 g (0.75 mmole) of p-nitrobenzenediazonium tetrafluoroborate in the presence of sodium acetate at 0°C. After standing at room temperature for 90 min, the mixture was poured into a mixture of water and ice, and the red-brown precipitate was removed by filtration, washed with water until the soluble yellow impurity was removed completely, and purified by chromatography of a chloroform solution on aluminum oxide with subsequent precipitation from a solution in acetic anhydride by the addition of aqueous alcohol. The product had mp 158°C. UV spectrum, λ_{max} (log ε): 420 (4.27) and 480 nm (4.20). Found: C 45.7; H 3.0; N 12.1%. $C_{21}H_{16}BN_5F_4O_4S_2$. Calculated: C 45.6; H 2.9; N 12.3%. Methylsulfate IIb. Found: C 46.0; H 2.9; N 12.5%. $C_{22}H_{19}N_5O_8S_3$. Calculated: C 46.0; H 3.2; N 12.2%.

2-[(3-Ethylbenzothiazolin-2-ylidene)acetyl]thiazolo[3,2-a]pyridinium 3-Oxide (IIIa). A 0.2-g (0.5 mmole) sample of Ib and 0.24 g (0.5 mmole) of 3-ethylbenzothiazolium 2-sulfonate were dissolved by heating in 35 ml of absolute alcohol, 0.2 g of triethylamine was added to the solution, and the mixture was refluxed for a few minutes. After 2 h, brown powdery disulfide IV was removed by filtration, and the filtrate was evaporated to a small volume and diluted with water by treatment with small portions until a red precipitate began to form. The precipitate was removed by filtration, washed thoroughly with water, and purified by precipitation from acetone solution by the addition of an alcohol–ether mixture or by chromatography of a chloroform solution with a column filled with aluminum oxide. The yield was 60 mg (34%). The yield could be raised by increasing the amount of 3-ethylbenzothiazolium 2-sulfonate in the starting mixture of products.

2-[(3-Methylbenzothiazolin-2-ylidene)acetyl]thiazolo[3,2-a]pyridinium 3-Oxide (IIIb). This compound was similarly obtained from Ib and 3-methylbenzothiazolium 2-sulfonate.

2-[(1-Ethyl-6-methoxy-1,2-dihydroquinolin-2-ylidene)acetyl]thiazolo[3,2-a]pyridinium 3-Oxide (IIIc). This compound was similarly obtained from 1-ethyl-6-methoxyquinolinium 2-sulfonate.

2-[(1-Ethyl-6-methyl-1,2-dihydroquinolin-2-ylidene)acetyl]thiazolo[3,2-a]pyridinium 3-Oxide (IIId). This compound was similarly obtained from Ib and 1-ethyl-6-methylquinolinium 2-sulfonate. The melting points, spectral characteristics, and results of elementary analysis are presented in Table 1.

The PMR spectrum of dye IIIb (in CF_3COOH) was determined: 4.05 (s, $N-CH_3$), 7.25-8.87 (m, aromatic protons), and 5.16 ppm (s, CH_2).

Bis{[2-(3-Oxidothiazolo[3,2-a]pyridinia)carbonylmethyl]} Disulfide (IV). A 0.28-g sample of Ib and 0.12 g of 3-ethylbenzothiazolium 2-sulfonate were dissolved in 30 ml of absolute alcohol, and the solution was heated to the boiling point and treated with 0.1 g of triethylamine. The resulting solution was refluxed for 30 min and allowed to stand overnight. The yellow-brown precipitate was removed by filtration and washed thoroughly with water, alcohol, and ether to give 0.08 g (45%) of product. The preparation usually did not require additional purification. It was obtained in the form of a powder or fine crystals containing crystallization solvent, from which it could be freed by recrystallization from acetic anhydride. The disulfide was insoluble in water, ether, and benzene, almost insoluble in chloroform, only slightly soluble in alcohol, but soluble in nitromethane, trifluoroacetic acid, and DMSO. UV spectrum (in alcohol), λ_{max}: 422 nm. The IR spectrum contained an absorption band at 1650 cm^{-1} corresponding to a C=O group. PMR spectrum (in CF_3COOH): 4.68 (4H, s, CH_2) and 7.84-9.54 ppm (8H, m, aromatic protons). The ratio of the intensities of the aromatic and aliphatic protons was 2:1. The product had mp 188°C. Found: C 48.1; H 2.75; N 5.95%. $C_{18}H_{12}N_2O_4S_4$. Calculated: C 48.2; H 2.7; N 6.0%.

3-Phenyl-5-(1-methyl-1,2-dihydropyridin-2-ylidene)thiazolidine-2-thione-4-one (V). A 0.21-g (0.5 mmole) sample of Ib and 0.3 g (1.5 mmole) of N-phenylrhodanine were dissolved by heating in 50 ml of absolute alcohol, and 0.2 g of triethylamine was added to the hot solution. The mixture was heated periodically for 30 min, and the solution was allowed to stand overnight. The precipitated disulfide IV (40 mg) was removed by filtration, the filtrate was evaporated to a small volume, and the residue was dissolved in chloroform and chromatographed on aluminum oxide to give 25 mg of the dye. The dye was readily soluble in alcohol, quite soluble in water, and moderately soluble in ether and had mp 231°C (from aqueous alcohol). UV spectrum, λ_{max}: 457 nm (log ε 4.37). Found: C 59.9; H 4.3; N 8.9%. $C_{15}H_{12}N_2OS_2$. Calculated: C 60.0; H 4.0; N 9.3%.

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