SYNTHESIS AND THERMAL DECOMPOSITION OF HALOALKOXY-sym-TRIAZINES

III.* SYNTHESIS AND THERMAL DECOMPOSITION OF 2-METHYLTHIO-4-(2-CHLOROETHOXY)-6-DIALKYLAMINO-sym-TRIAZINES

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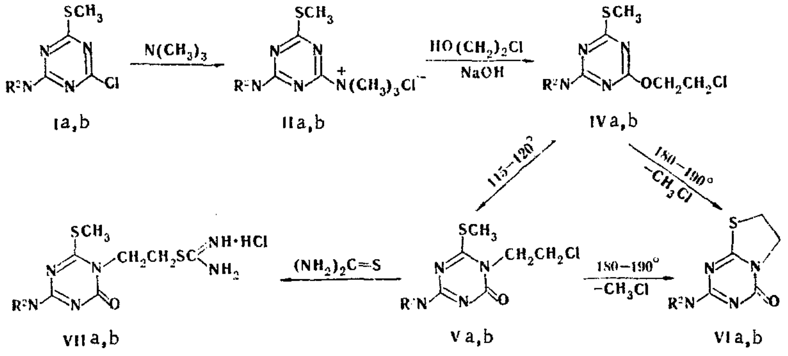
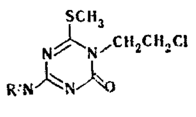
Reaction of [2-methylthio-6-dialkylamino-sym-triazin-4-yl]trimethylammonium chlorides with ethylene chlorohydrin gave 2-methylthio-4-(2-chloroethoxy)-6-dialkylamino-sym-triazines, which are converted to 2-methylthio-3-(2-chloroethyl)-4-oxo-6-dialkylamino-3,4-dihydro-sym-triazines when they are heated to 115-120°C and to the corresponding tetrahydrothiazolo-sym-triazine derivatives when they are heated at 180-190°C.

Continuing our earlier research [1, 2] we have studied the thermal decomposition of 2-methylthio-4-(2-chloroethoxy)-6-dialkylamino-sym-triazines (IVa, b), synthesized by the action of ethylene chlorohydrin on quaternary ammonium salts of the triazine series (IIa, b) in the presence of alkali. Since salts II, obtained by the reaction of chloro-sym-triazines Ia, b with trimethylamine, eliminate methyl chloride at high temperatures to give 2-methylthio-4-dimethylamino-6-dialkylamino-sym-triazines (IIIa, b), the synthesis of IVa, b was carried out at low temperatures.

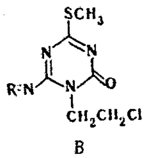


I–VII a R=CH₃; b R=C₂H₅

When IVa, b are heated briefly in refluxing toluene or are allowed to stand for a long time they undergo rearrangement to N-(2-chloroethyl) derivatives V. In this case one might have expected the formation of two isomeric forms (A and B):



A



B

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[*] See [1] for communication II.

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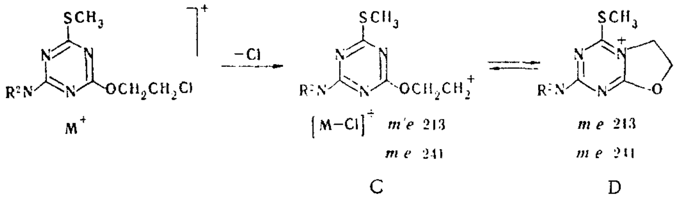
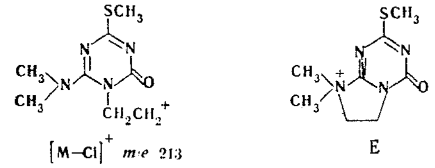
The choice in favor of structure A was made on the basis of subsequent transformations of the products. Thus at 180-190°C they undergo intramolecular cyclization with the elimination of methyl chloride to give thiazolo-sym-triazine derivatives (VIa, b). The latter were also obtained under similar conditions from IV. A study of the mass spectra of IV and V also confirms the structure of V.

The differences in the mass spectra of the above-indicated compounds are primarily associated with the fact that ejection of a chlorine atom from the molecular ion proceeds readily in the case of the O-isomers but is almost absent in the case of the N-isomers.

The intensity of the $[M - Cl]^+$ ion peak in the mass spectrum of IVa is 75% of the intensity of the maximum peak, whereas it does not exceed 3% in the spectrum of Va. This large difference is associated with the possibility of stabilization of the $[M - Cl]^+$ carbonium ion (structure C) in the case of the O-isomers by the formation of a cyclic ammonium cation (structure D).



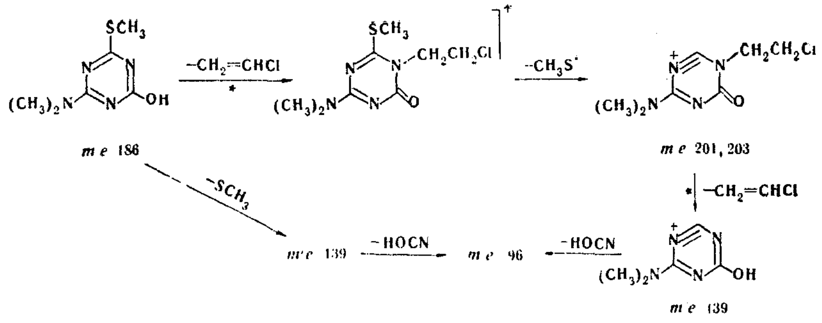
Stabilization of this type is impossible when there is a 2-chloroethyl group attached to the $N_{(3)}$ atom (structure A), and this also explains the very low intensity of the $[M - Cl]^+$ ion peak (m/e 213) in the mass spectrum of Va. However, this sort of stabilization is possible but occurs via the formation of an ammonium cation with structure E when there is a 2-chloroethyl group attached to the $N_{(5)}$ atom:



On the basis of the material set forth above it can be asserted that the products of rearrangement of IV are 2-methylthio-3-(2-chloroethyl)-4-oxo-6-dialkylamino-3,4-dihydro-sym-triazines (V).

The mass spectra of IVa and Va also differ with respect to the intensities of the M^+, $[M - CH_3]^+$, $[M - SCH_3]^+$, and $[M - CH_2{-}CHCl]^+$ ion peaks and the peaks with m/e 139 and 96. A scheme for the formation of some of these fragments is presented below on the basis of the metastable transitions.

The ejection of an SCH_3 group from the M^+ ion of O-isomer IVa is inhibited by competitive ejection of a $CH_2{=}CHCl$ molecele. The $[M - CH_2{=}CHCl]^+$ ion (m/e 186) formed in this case subsequently readily loses a $CH_3S^\bullet$ radical (formation with m/e 139). The latter ion in the case of N-isomer Va is formed from the $[M - SCH_3]^+$ ion (m/e 201, 203). The ease of ejection of a $CH_3S^\bullet$ radical from the M^+ ion of Va is due partially to the ortho effect that is exerted between the methylthio and 2-chloroethyl group.



The IR, UV, and PMR spectral data, which confirm the structures of the compounds obtained in this research, are presented in Table 1.

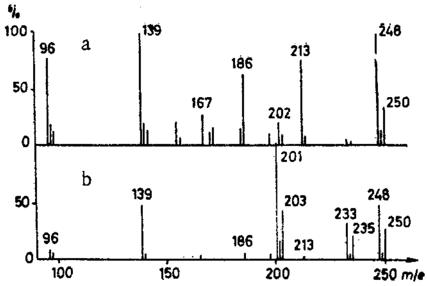


Fig. 1. Mass spectra of IVa (a) and IVb (b).

TABLE 1. Spectral Characteristics of IV-VI

Compound	PMR spectrum,[a] chemical shifts, δ, ppm				IR spectra, cm⁻¹		UV spectra,[b] λ_{max}, nm (log ε)
	$-NR_2$	$-SCH_3$	XCH_2[c]	$-CH_2Y$[d]	ν_{CO}	$\nu_{triazine\ ring}$	
IVa	3,14, 3,11	2,41	4,47	3,69	—	1516, 1564, 1587, 1599	239 (4,69)
IVb	$-CH_2-$ 3,56 3,53 $-CH_3$ 1,17 1,13	2,39	4,47	3,73	—	1512, 1560, 1576	241 (4,73)
Va	3,22 3,17	2,54	4,24	3,77	1680	1537, 1580	255 (4,28), 235 (4,31), 218 (4,32)
Vb	$-CH_2-$ 3,61 $-CH_3$ 1,20	2,52	4,21	3,76	1678	1528, 1549, 1568	258 (4,42), 235 (4,48), 219 (4,48)
VIa	3,13	—	4,35	3,37	1679	1544, 1560, 1588	254 (4,27), 235 (4,35), 221 (4,31)
VIb	$-CH_2-$ 3,60 3,58 $-CH_3$ 1,21 1,17	—	4,35	3,33	1681	1531, 1586	254 (4,29), 237 (4,38), 224 (4,37)

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[a] The PMR spectra of CCl_4 solutions of IV and $CDCl_3$ solutions of V and VI were recorded. [b] The UV spectra of dioxane solutions of IV and C_2H_5OH solutions of V and VI were recorded. [c] In IV, $X = -O-$; in the remaining compounds, $X = -N<$. [d] In IV and V, $Y = -Cl$; in VI, $Y = -S-$.

EXPERIMENTAL

The IR spectra of mineral oil suspensions of the compounds were recorded with a UR-10 spectrometer. The PMR spectra of the compounds were recorded with a Varian T-60 spectrometer with tetramethylsilane as the internal standard. The mass spectra were obtained with an MKh-1303 spectrometer with direct introduction of the samples into the ionization region at an ionizing-electron energy of 30 eV at 20-30°C below the melting points of the investigated compounds. The UV spectra were recorded with a Specord spectrophotometer. The purity of the compounds was monitored by thin-layer chromatography on activity II Al_2O_3 with elution by acetone–hexane (20 : 80) or acetone–hexane–CH_3COOH (80 : 15 : 5 or 60 : 36 : 4) with development of the chromatograms with 2% and 0.4% solutions of Bromphenol Blue.

[2-Methylthio-6-dialkylamino-sym-triazin-4-yl]trimethylammonium Chloride (IIa). A solution of 6.5 g (0.11 mole) of trimethylamine in 30 ml of absolute benzene was added with cooling (to −5°C) and stirring to 20.5 g (0.1 mole) of I in 100 ml of absolute benzene, and the mixture was allowed to stand overnight. The precipitate was removed by filtration, washed with absolute ether, and dried in a vacuum desiccator to give 22.5 g (85%) of a product with mp 133-135°C (dec.). Found: Cl 13.9; N 26.8%. $C_9H_{18}ClN_5S$. Calculated: Cl 13.4; N 26.6%.

A similar procedure was used to obtain IIb in 80% yield with a decomposition point of 102-104°C. Found: Cl 12.6; N 24.3%. $C_{11}H_{22}ClN_5S$. Calculated: Cl 12.2; N 24.0%.

2-Methylthio-4-(2-chloroethoxy)-6-dimethylamino-sym-triazine (IVa). A 4.0-g (0.1 mole) sample of 10% NaOH solution was added dropwise with stirring to a mixture of 26.4 g (0.1 mole) of IIa and 32.2 g (0.4 mole) of ethylene chlorohydrin, and the mixture was allowed to stand for 1-1.5 h. It was then treated with 60 ml of water, and the resulting precipitate was removed by filtration to give 21.6 g (87%) of a product with mp 100-101°C (after dissolving in ether and evaporation of the solution). Found: C 38.4; H 5.0; Cl 14.5; N 22.7%. $C_8H_{13}ClN_4OS$. Calculated: C 38.6; H 5.2; Cl 14.3; N 22.5%. R_f 0.70.

A similar procedure was used to obtain IVb in 77.3% yield as a viscous syrup with n_D^{20} 1.5555. Found: C 43.1; H 5.8; Cl 13.2; N 20.6%. $C_{10}H_{17}ClN_4OS$. Calculated: C 43.3; H 6.1; Cl 12.8; N 20.3%. R_f 0.87.

When the reaction was carried out with the same proportions of reagents at 120°C it gave III. Compound IIIa, with mp 105-107°C, was obtained in 87% yield. Found: N 32.6; S 15.4%. $C_8H_{15}N_5S$. Calculated: N 32.9; S 15.0. Compound IIIb, was obtained as a viscous syrup in 89% yield. Found: N 29.2; S 13.6%. $C_{10}H_{19}N_5S$. Calculated: N 29.0; S 13.3%.

2-Methylthio-3-(2-chloroethyl)-4-oxo-6-dimethylamino-3,4-dihydro-sym-triazine (Va). A suspension of 2.5 g (0.01 mole) of IVa in 6 ml of toluene was heated at 120° for 3 h, after which it was cooled, and the precipitate was removed by filtration to give 2.4 g (96%) of Va with mp 121-122°C (from octane). Found: Cl 14.4; N 22.7; S 12.6%. $C_8H_{13}ClN_4OS$. Calculated: Cl 14.3; N 22.5; S 12.9%. R_f 0.58.

A similar procedure was used to obtain Vb, with mp 86-87°C (from octane), in 90% yield. Found: Cl 13.0; N 20.5; S 11.4%. $C_{10}H_{17}ClN_4OS$. Calculated: Cl 12.8; N 20.3; S 11.7% R_f 0.46.

2-Dimethylamino-4-oxo-4,5,6,7-tetrahydrothiazolo[1,2-a]-sym-triazine (VIa). A 3.0-g (0.013 mole) sample of Va was heated at 180-190°C for 3 h. The melt began to crystallize after heating at this temperature for 30 min. At the end of the reaction, the material was triturated with absolute ether, and the solid was removed by filtration to give 2.2 g (92%) of VIa with mp 219-222°C (from toluene). Found: N 28.1; S 15.7%. $C_7H_{10}N_4OS$. Calculated: N 28.3; S 16.1%. R_f 0.79.

The methyl chloride eliminated during the reaction was identified by the method in [2].

A similar procedure was used to obtain VIb, with mp 129-130°C [from octane–benzene (97 : 3)], in 96% yield. Found: N 25.0; S 14.5%. $C_9H_{14}N_4OS$. Calculated: N 24.8; S 14.2%. R_f 0.85.

Thiuronium Salts VII. A 0.01 mole sample of V was added with stirring to 0.01 mole of thiourea in 20 ml of acetone, and the mixture was heated on a water bath for 2 h. The resulting precipitate was removed by filtration, washed with acetone, and dried. Workup gave VIIa, with mp 226-227°C (from ethanol), in 80% yield. Found: C 33.5; H 5.3; Cl 10.6; N 25.7%. $C_9H_{17}ClN_6OS_2$. Calculated: C 33.2; H 5.2; Cl 10.9; N 25.9%. R_f 0.58. Also obtained was VIIb, with mp 193-194°C, in 71% yield. Found: C 40.3; H 6.1; Cl 10.4; N 24.0%. $C_{11}H_{21}ClN_6OS_2$. Calculated: C 40.0; H 6.4; Cl 10.0; N 23.8%. R_f 0.64.

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2. V. V. Dovlatyan, A. V. Dovlatyan, and K. A. Éliazyan, Khim. Geterotsikl. Soedin., No. 7, 989 (1977).