3-(2-Oxobuty1)-2-benzoxazolones (If, g, h). The method was similar to the foregoing, but on cooling compounds Ig and g were obtained from 2-(3H)-benzoxazolone and 1-bromobutane-2-one. They were recrystallized from ethanol.

Oximes of  $3-(2-\infty ozlkyl)-2-benzoxazolones (IVa-h)$ . A mixture of 0.01 mole ketones I, 0.68 g (0.012 mole) hydroxylamine hydrochloride, 20 ml pyridine and 20 ml ethanol was heated at bp for 4 h, cooled, diluted with water and the precipitate filtered off and washed with water.

<u>1-Methyl-1-(2-benzoxazolone-3-yl)-2-propanone Azine (IIIa)</u>. A mixture of 2.05 g (0.01 mole) ketone Ia, 1 ml hydrazine hydrate, and 20 ml ethanol was heated at bp for 2 h, cooled, and the precipitate filtered off and washed with water.

2,3,4,5-Tetrahydro-1,2,4-triazine-3-ones (IIa-g). A mixture of 0.01 mole ketone I, 3 ml hydrazine hydrate, and 20 ml alcohol was heated 6 h at bp, cooled, neutralized with concentrated hydrochloric acid, and the precipitate filtered off and washed with water.

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4- AND 5-HYDROXYLAMINOTHIAZOLIDINE-2-THIONES.

ACYLATION, SYNTHESIS, AND STRUCTURAL INVESTIGATION OF NEW 6-THIOXO(OXO) DERIVATIVES OF 4,5-DIHYDRO-6H-1,2,5-THIADIAZINE

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The treatment of 4- and 5-hydroxylaminothiazolidine-2-thiones as well as 5-hydroxylaminothiazolidin-2-one with acetic anhydride or benzoyl chloride is accompanied, as a rule, by the formation of 0-acyl derivatives. The 4-(0-acyl) derivatives are thereby either stable to thermal or alkaline treatment, or are converted to 4-iminothiazolidine-2-thione; the 5-(0-acetyl)-hydroxylamines rearrange to 6-thioxo(oxo) derivatives of 4,5-dihydro-6H-1,2,5-thiadiazine.

All-Union Scientific Research Institute of Chemical Agents of Plant Protection, Moscow 109088. L. Ya. Karpov Physicochemical Research Institute, Moscow 107120. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 9, pp. 1280-1284, September, 1987. Original article submitted April 9, 1986. The synthesis and some chemical properties of 4- and 5-hydroxylaminothiazolidine-2thiones were previously communicated [1]. The present work investigates the acylation of these hydroxylamines, as well as the conversion of their O-acyl derivatives on thermal and alkaline treatments. The interest in the given direction was also determined by the fact that a series of unusual rearrangements with the significant restructuring of the molecular skeleton is known for the O-acylhydroxylamines [2]. It was established that the acylation of 4-hydroxylaminothiazolidine-2-thiones (I) with benzoyl chloride or acetic anhydride leads to the corresponding O-acyl derivatives (IIa-c). The compounds (IIb) and (IIc) ( $R^1 = CH_3$ ) are stable to thermal treatment and the action of alkali. Under these conditions, the O-benzoyl derivative (IIa) undergoes the cleavage of a molecule of the organic acid, and the 4iminothiazolidine-2-thione (III) is formed; the hydrolysis of the last gives the known 2thioxo-3,5,5-trimethylthiazolidin-4-one [3].



I a  $R^{1}=H$ , b  $R^{1}=CH_{3}$ ; II a  $R^{1}=H$ ,  $R^{2}=C_{6}H_{5}$ ; b  $R^{1}=CH_{3}$ ,  $R^{2}=C_{6}H_{5}$ ; c  $R^{1}=R^{2}=CH_{3}$ ; IV-VI, VIII a  $R^{1}=H$ ,  $R^{2}=C_{6}H_{5}$ , X=S; b  $R^{1}=CH_{3}$ ,  $R^{2}=C_{6}H_{5}$  or  $CH_{3}$ , X=S; c  $R^{1}=H$ ,  $R^{2}=C_{6}H_{5}$ , X=O

The acylation of 5-hydroxylamino-3,4,4-trimethylthiazolidine-2-thione (IVa) or -2-one (IVc) gave the O- and N-acyl derivatives (Va), (Vc) and (VIa), (VIc) correspondingly, in contrast to the acylation of the compounds (I). However, the benzoylation of 5-hydroxylamino-3,4,4,5-tetramethylthiazolidine-2-thione (IVb) does not lead to the expected O- or N-benzo derivatives. In this case, the compound (VIIIb) (the main reaction product) and the benzamide (IX) were isolated. Moreover, benzoic anhydride is present in the reaction mass according to the TLC data. The absorption bands characteristic of the C==O, NH, and OH groups are absent from the IR spectrum of the compound (VIIIb); its PMR spectrum is described by three singlets at 1.63. 2.21, and 3.56 ppm with the 2:1:1 ratio of the integral intensities. According to the data of the elemental analysis and the mass spectrometry (M.188), the compound (VIIIb) corresponds to the product of the dehydration of the initial hydroxylamine (IVb). The structure of the compound (VIIIb) was established by the method of x-ray structural analysis, and corresponds to 3,4,4,5-tetramethyl-4,5-dihydro-6H-1,2,5-thiadiazine-6-thione. The characteristics thereby obtained are presented in Fig. 1. It should be noted that information on the synthesis and x-ray structural analysis of similar 1,2,5-thiadiazines could not be observed in the literature. There are only single communications on the isolation of . 4-methylimino-5-methyl-6-imino-4,5-dihydro-6H-1,2,5-thiadiazine [4] and perhydro-1,2,5-thiadiazine-6-thiones [5].

The six-membered heterocyclic system in the molecule of compound (VIIIb) has the boat configuration, in which the S(1) and C(3) atoms deviate from the plane of the N(1), C(2), N(4), C(5) fragment by 0.229 and 0.490 Å (with limits of ±0.05 Å). The deviation of the C(3) atom from the plane of the C(7), N(4), and C(2) atoms has such a significance (0.487 Å), whereas, in the case of the C(5), C(2), and N(4) atoms, the deviations of the three atoms, bound to them, from the plane comprise 0.018, 0.044, and 0.125 Å correspondingly. The angles between the planes of the three atoms S(1), N(1), C(5) and C(3), C(2), N(4) and the central four-atom fragment are equal to 13.3° and 34.6°. The angle between the planes specified by C(3), N(4), C(5), S(1) and C(3), C(2), N(1), S(1) is 31.1°; this is significantly less than that in related thic heterocycles [6, 7]. The presence of the C(2)=N(1) and C(5)=S(2) double bonds in the molecule of compound (VIIIb) causes the shortening of the ordinary N(1)-S(1), C(2)-C(6), N(4)-C(5), and C(5)-S(1) bonds by comparison with the standard values [8]. The bond lengths



Fig. 1. The bond lengths and bond angles at the  $C_{(3)}$  atom are as follows:

$C_{(2)} - C_{(3)} - C_{(7)}$	110.8°;
$C_{(2)} - C_{(3)} - C_{(8)}$	107.2°;
$N_{(4)} - C_{(3)} - C_{(8)}$	108.5°;
$C_{(8)} - C_{(3)} - C_{(7)}$	110.3°;
$N_{(4)} - C_{(3)} - C_{(7)}$	109.4°.

and bond angles at the other sp<sup>3</sup>-hybridized carbon atoms correspond with the standard values [9]. Analogous significant deviations of the sulfur atoms from the plane of the heterocycles are observed in similar systems [10]. No specific intermolecular interactions were noted in the structure of (VIIIb).

The mixture of the O-acetylhydroxylamine (Vb) and its rearrangement product -1,2,5-thiadiazine-6-thione (VIIIb) - is formed in the ratio of 3:7 (PMR data) by the acylation of the 5-hydroxylamine (IVb) with acetic anhydride. The heating of this mixture, and of the O-benzoyl derivatives (Va), (Vc), above 100°C, as well as the prolonged keeping of the compound (Va) (~30 days) at 20°C, is accompanied by the rearrangement to the corresponding 1,2,5-thiadiazines (VIIIa-c).

Although the scheme for the formation of the 1,2,5-thiadiazines (VIII) is also not at all clear, it can be assumed that the breaking of the C-S bond and the formation of the N-S bond proceed synchronously with the heterolysis of the N-O bond. However, it is difficult to explain the formation of the benzamide (IX) from the 5-hydroxylamine (IVb) by such a scheme.

In this case, the realization of the process with the intermediate generation of a nitrene is also probable. The last gives the compound (VIII) as a result of the intramolecular introduction at the S-C<sub>(5)</sub> bond. After the breaking away of hydrogen from the solvent, it is converted to the 5-aminothiazolidine, which is also benzoylated to the amide (IX).

The absence of the rearrangement in the case of the compound (II) is evidently associated with the lower nucleophilicity of the nitrogen atom compared to the sulfur atom of the isomeric compounds (V).

## EXPERIMENTAL

The IR spectra were recorded on a Perkin-Elmer-457 instrument using KBr tablets and the solutions in CCl<sub>4</sub>. The PMR spectra were taken on Varian FT-80A and Brucker HX-90E instruments with TMS as the internal standard. The course of the reaction was monitored on Silufol UV-254 plates in the 3:1 and 10:1 benzene-acetone systems. The physicochemical data and spectral characteristics are presented in Table 1. The x-ray structural analysis of compound (VIIIb) was accomplished on the Sinteks R1 automatic diffractometer ( $\lambda_{MO}$ , graphite monochromator) by the method of  $\theta/2\theta$ -scanning. The crystals  $C_7H_{12}N_2S_2$  were monoclinic, a = 9.734(3), b = 8.224(3), c = 11.933(4) Å,  $\gamma$  = 99.75(2)°, V = 941(5) Å<sup>3</sup>; Z = 4, space group P2<sub>1</sub>/n, d<sub>calc</sub> = 1.33 g/cm<sup>3</sup>. The structure was interpreted by the direct method, and was specified by the full-matrix anisotropically by the (S,C,N,H)-isotropic (H) MHK to R = 0.030, R<sub>W</sub> = 0.035. We utilized 1398 independent reflections with I  $\geq 3\sigma/I$  in the calculations. All the calculations were carried out on the Nova-3 computer by the programs of the SHELXTL complex, realized in the Nikolet-R3 system.

<u>3,4,4-Trimethyl-5-hydroxylaminothiazolidin-2-one (IVc)</u>. This is obtained by the reaction of 2-methyl-2-methylaminopropionaldoxime with carbonyl sulfide in acetonitrile according to the method of [1].

<u>4- or 5-(O-Benzoyl- or Acetylhydroxylamino)- and 5-(N-Benzoylhydroxylamino)-thiazoli-</u> <u>dine-2-thiones (or -2-ones) (II, V, VI)</u>. To the solution of 3 mmole of compound (Ia) or (IVa, c) in 50 ml of acetone or in 80 ml of benzene are added, with stirring of the solution, 3 mmole of benzoyl chloride in 10 ml of the solvent and 3 mmole of triethylamine in 10 ml of

	Y ield, %	5 79	0 3 74 71	01 0	86	0 20 20	0 12 53 1 53 53	+ 00 00 1	 	
Calculated, %	z	5 <sup>6</sup>	6.13	15,		<u>0</u> 6	0.61	- 2	n <sup>*</sup>	•
	=	5,4	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6.9	5,4	5,8	بری مرتب 	0°4	6,2	
	ບ	2 52.7	2 54,2 41,4	40,9	2 52,7	55.7 52.7	55.7 41.4	45,6	27.1	Ľ
Empirical formula		C <sub>13</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub> S	C.411,8N2O2S2 C.411,8N2O2S2 C.41,5N2O2S2	CoH 2 N202S	C <sub>13</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub> S	C <sub>13</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub> S C <sub>13</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub> S	CiaHieN203S	Cellinvas Cellinvas	CIALISN2052	•
Found, %	z	9,3	8,8 11,1 15,7	16,2	9,4	10,2 9,7	9,8	17,4	9,4	
	=	5,4	200 200 200 200 200 200 200 200 200 200	2,0	5,5	5,7		0,0 0,0	6,2	,
	U	53,1	54,5 43,4 41,5	40,7	52,6	55,4 52,8	41,7	44,5 45,8	27,I	
al shifts, ô, ppm (SSCC, J, Hz)	NH or OH (broad sig- nal)	9,04 d (3)	8,56 8,21 0.96	6.08 broad, d	(NII) 7,69 (OH) 8,7 d (4,5)		. 16'2	11	⊨ 	
	Cell, or C(0)CH,	7,35-8,18	7,28-8,10	Ι	7,408,25	7,31-8,06	7,28-7,65	11	7,30-7,95	
	NCH,	3,34	3,15	1 2,63	d 3,30	2,79 3,22	3,48	2,93	3,22	
	100 100 100	5 5, Id	4 1,56	8 4,656	3 5,14 (9)	6 4,88 5 6,22	4 6.04 7.67	2,04	1.91	•
Chemic	C(CH <sub>3</sub> ) <sub>7</sub>	1,61; 1,6	1,54; 1,6 1,46; 1,5	1,24, 1,2	1,46; 1,7	1,38; 1,5	1,31; 1,4	1,46	1.57; 1,(	
im, cm <sup>-1</sup>	CCI4. or <sup>n</sup> NH or <sup>n</sup> (OH)	3230	3230 3230 1990		3240	3230 (3600)	(3600)		3430	,
IR spectn	KBr. <sup>v</sup> C=O <sup>or</sup> <sup>v</sup> (C=N)	1720	1720 1735	1630	1710	1660, 1725 1654	1635, 1675		1625, 1530 (NH)	1
	, dm	26-96	82-83 96-97 86 88	001-66	74-76	50-52 200-201	47-48	4750	99	
	Com- pound	11.2		Nc Nc	Va	Vc	VIIIa	VIIIC	XI	

TABLE 1. Characteristics of the Synthesized Compounds

pounds were obtained in  $(CD_3)_2CO$ . +In the region of the  $C_6H_5$  protons. #The yield by the method B is presented in brackets.

the solvent. At the end of the reaction (monitored by TLC), the solvent is evaporated; the remaining oil is treated with ether, and the compounds (IIa) or (Va) are obtained. In the case of compound (IVa), when the acylation is performed in acetone, the mixture of the O- and N-benzoyl derivatives (Va) and (VIa) are additionally filtered off from the ethereal mother liquor; the mother liquor is then evaporated. The residue is dissolved in 10 ml of benzene, from which the N-derivative (VIa) is filtered off after 2 days. The yield of compound (Va) is 44%; the yield of (VIa) is 8%. The yield of the mixture of (Va) and (VIa) is 18%. In the case of compound (IVc), an oil is obtained after the evaporation of the solvent; the oil is a 3:1 mixture of the compounds (Vc) and (VIc) according to the PMR data. The yield of the mixture is 60%. The oil is treated with 20 ml of ether; the residue is crystallized on trituration, and compound (Vc) is obtained. Compound (VIc) is then isolated from the mother liquor.

B. To a solution of 3 mmole of compound (Ib) in 3 ml of pyridine are slowly added 4.5 mmole of benzoyl chloride, and the mixture is maintained at 20°C for 12 h. The reaction mass is diluted with water (30 ml) prior to the extraction with ether (2 portions of 50 ml). The ether extract is dried with MgSO<sub>4</sub> and concentrated. The residue of compound (IIb) is crystallized from hexane.

C. To a solution of 5 mmole of compound (Ib) in 30 ml of acetone are added 10 mmole of  $K_2CO_3$  and a solution of 10 mmole of acetic anhydride in 20 ml of acetone. The mixture is stirred for ~1 h at 20-25°C. The residue is filtered off, and the acetone is evaporated. The residue of compound (IIc) is treated with ether.

<u>3-(H or Methyl)-4,4,5-trimethyl-4,5-dihydro-6H-1,2,5-thiadiazine-6-thiones (or 6-one)</u> (VIIIa-c). A. To a solution of 3 mmole of compound (IVb) in 50 ml of acetone are simultaneously added, dropwise, the solutions of 6 mmole of benzoyl chloride in 15 ml of acetone, and 6 mmole of triethylamine in 15 ml of acetone. At the completion of the reaction (monitored by TLC), the residue is filtered off, and the acetone is evaporated. The residue is treated with ether; compound (VIIIb) is recrystallized from pentane. The ethereal mother liquor is concentrated; the residue is treated with hexane. The residue is filtered off; according to the TLC data, it contains the compounds (VIIIb) and (IX), and benzoic anhydride. A portion of the mixture of the compounds (VIIIb) and (IX) is separated by the method of TLC on Silufol (eluent benzene-acetone, 3:1).

B. To the solution of 1.2 mmole of compound (IVb) in 60 ml of acetone are added 2.4 mmole of  $K_2CO_3$  and 2.4 mmole of acetic anhydride; the mixture is stirred for 12 h at 20°C. The residue is filtered off. The acetone is evaporated, and the residue is crystallized from hexane. The mixture of the compounds (Vb) ( $R^2 = CH_3$ ) and (VIIIb) is obtained in the yield of 1.6 g (70%). The IR spectrum of the mixture (KBr) is characterized at 1740 cm<sup>-1</sup> (CO). The mixture obtained is kept for 1-2 min at 110°C, cooled, and treated with water. The residue of the compound (VIIIb) is filtered off prior to drying it in air.

C. Compound (Va) or (Vc) (2 mmole) is maintained for 1-2 min at 110°C. The oil obtained is dissolved in 60 ml of ether. It is washed with a 10% aqueous solution of ammonia until the complete removal of the benzoic acid is effected (TLC); it is then washed with water (2 portions of 10 ml). The ether layer is dried with MgSO<sub>4</sub> and concentrated. The residue of the compounds (VIIIa) and (VIIIc) is crystallized from hexane.

<u>3,5,5-Trimethyl-4-iminothiazolidine-2-thione (III)</u>. To the solution of 2 mmole of compound (IIa) in 6 ml of dioxane are added 2 ml of a 4 N solution of NaOH; the mixture is kept at 25°C for 4 h. The dioxane is evaporated prior to the extraction of the solution with ether (3 portions of 50 ml). The ether extract is dried with MgSO<sub>4</sub> and evaporated. The residue is treated with boiling pentane; the mixture is decanted. The residue of (III), which comes down on cooling the mixture, is filtered off.

<u>Hydrolysis fo the Imine (III)</u>. To 0.5 mmole of compound (III) are added 3 ml of 10% HCl; the mixture is maintained for 10 min at 50°C. The residue of 2-thioxo-3,5,5-trimethylthiazolidin-4-one, which came down on cooling, is filtered off, washed with water, and dried in air. It has the mp 90-92°C; the yield is 50%. The IR spectrum (KBr) is characterized at 1730 cm<sup>-1</sup> (CO). (According to the data of [3], the mp is 96°C).

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