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Studies of Nitriles. X.¹⁾ Synthesis and Reactions of 2-Acylamino-3,3-bis-(substituted mercapto)acrylonitriles and Their Derivatives. A New Synthesis of 2-Substituted-5-(substituted mercapto)oxazole-4-carbonitriles and Their Derivatives

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The reaction of 2-acylamino-3,3-dichloroacrylonitriles (1) with various mercaptans in the presence of base gives 2-acylamino-3,3-bis(substituted mercapto)acrylonitriles (5) or 2-acylamino-3-chloro-3-(substituted mercapto)acrylonitriles (17), each in good yield, depending upon the amount of mercaptans used. Similar nucleophilic substitutions are possible with the corresponding amides (8,9), N-acylamides (10), esters (7), and acid (11). Treating the 3-mercapto acrylic acid derivatives thus obtained with silver compounds, such as Ag₂O, Ag₂CO₃, and CH₃COOAg, gives an excellent new method for synthesizing 5-(substituted mercapto)oxazoles (4). The scope and limitations of this new cyclization are also described.

In the course of investigating the reactivity of ADAN,³⁾ 2-amino-3,3-dichloroacrylonitrile, the fact that some fluorinated amino acids⁴⁾ act as antagonists or antimetabolites of essential amino acids prompted us to investigate the possibility of synthesizing fluorinated amino acids from ADAN. We took 2-acetylamino-3,3-dihalogeno- or 3,3-bismethylthioacrylonitriles (1b, 2, or 5d)³⁾ as possible starting materials and tried first of all to replace the halogen atoms or methylmercapto groups with fluorine atoms.

However, the reaction of 1b, 2, 5d with silver oxide in anhydrous HF, a reagent⁵⁾ for the addition of HF to the C-C and C-N triple bonds or C-C double bond of some unsaturated nitriles, failed to give the expected products (3a or 3b). Instead, an oil was obtained only in the case of 5d (Chart 1); the structure of the oil proved to be 2-methyl-5-methylthiooxazole-4-carbonitrile (4d) on the basis of spectral data and elemental analysis.

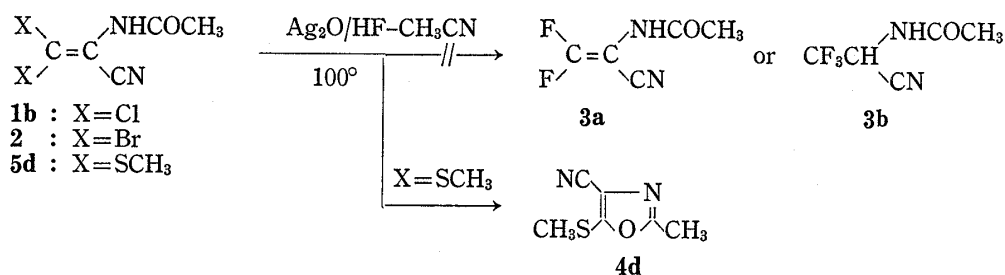


Chart 1

- 1) Part IX: K. Matsumura, H. Shimadzu, O. Miyashita, and N. Hashimoto, *Chem. Pharm. Bull.* (Tokyo), **24**, 941 (1976).
- 2) Location: Jusohonmachi, Yodogawa-ku, Osaka, 532, Japan.
- 3) a) Part VII: K. Matsumura, T. Saraie, and N. Hashimoto, *Chem. Pharm. Bull.* (Tokyo), **24**, 912 (1976).
b) Part VIII: *Idem, ibid.*, **24**, 924 (1976).
- 4) a) J. Kollonitsch, L. Barash, F.M. Kahan, and H. Kropp, *Nature*, **243**, 346 (1973); b) D.F. Loncrini and R. Filler, "Advances in Fluorine Chemistry," Vol. 6, ed. by J.C. Tatlow, R.D. Peacock and H.H. Hyman, Butterworth, London, 1970, pp. 43-67, and references cited therein.
- 5) Part XIII: K. Matsumura and N. Hashimoto, *Bull. Chem. Soc. Japan.*, "in preparation."

In contrast to the reported results,⁸⁾ however, mercuric chloride was not effective under similar conditions. Thus, with mercuric chloride, were recovered only unidentified compounds containing mercury.

TABLE I. Formation of Oxazole (4d) Reaction Conditions and Results

		$\begin{array}{c} \text{CH}_3\text{S} \diagdown \\ \text{C}=\text{C} \diagup \text{NHCOCH}_3 \\ \text{CH}_3\text{S} \diagup \quad \text{CN} \end{array}$		$\xrightarrow[\text{solvent}]{\text{silver compound}}$		$\begin{array}{c} \text{NC} \diagdown \quad \text{N} \diagup \\ \text{CH}_3\text{S} \diagdown \quad \text{O} \diagup \text{CH}_3 \end{array}$	
		5d				4d	
Ent.	5d, mmole	Reagent (mmole)	Solv. ^{a)} (ml)	Reflux time (hr)	Reaction product ^{b)}		
					4d, g (Yield, %) ^{c)}	5d, g (Recovered)	
1	10	Ag ₂ CO ₃ (12)	M (60)	3	0.60(66)	0.83	
2	10	Ag ₂ O (30)	E (60)	2	0.69(50)	0.21	
3	10	Ag ₂ CO ₃ (30)	E (200)	3	0.78(54)	0.11	
4	10	AgOAc (40)	E (100)	5	0.99(93)	0.63	
5	10	Ag ₂ CO ₃ (30)	A (200)	3	1.51(98)	0	
6	10	AgOAc (30)	A (200)	10	1.51(99)	0.03	
7	10	Ag ₂ O (30)	A (200)	10	1.44(94)	0	
8	10	AgF (60)	A (200)	10	0.91(60)	0	

a) A=acetonitrile, E=ethanol, M=methanol

b) after chromatography on silica gel column

c) Yields were based on 5d consumed.

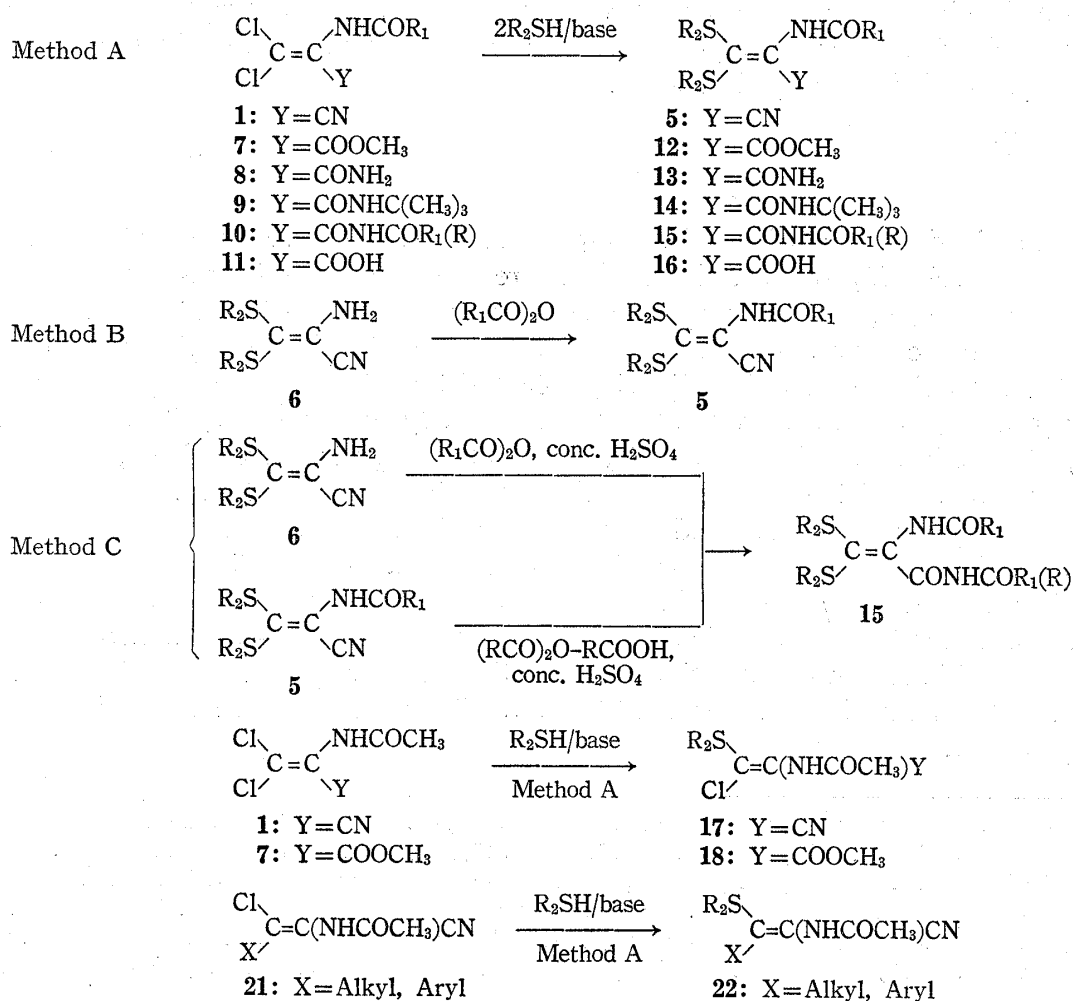


Chart 2

In order to investigate the scope and limitations of this new cyclization to oxazoles, the various 3-mercaptoacrylic acid derivatives listed in Table II were prepared by the routes depicted in Chart 2.

TABLE II. 2-Acylamino-3,3-bis-(substituted mercapto)acrylonitriles and Their Derivatives

Compd. No.	5, 12-18, 22			Reaction conditions				Yield (%)	mp (°C)	Recryst. solvent ^{b)}
	Y	R ₁ (X)	R ₂	Method ^{a)}	Solv. ^{b)}	Time (hr)	Temp. (°C)			
5a	CN	R ₁ =H	CH ₃	A	W ^{e)}	2	0	76	100—101	B
5b	CN	H	CH ₂ CH ₃	A	W ^{e)}	3	0	79	56—57	B-H
5c	CN	H	C ₆ H ₅	{A B ^{d)}	{W ^{e)} —	{3 10	{0 r.t.	{52 69	{97—98	{B-H
5d ^{e)}	CN	CH ₃	CH ₃	B	—	10	r.t.	88	122—123.5	B
5e ^{e)}	CN	CH ₃	CH ₂ CH ₃	{A B	{W ^{e)} —	{10 10	{r.t. r.t.	{89 93	{86—87	{B-H
5f	CN	CH ₃	<i>n</i> -C ₄ H ₉	A	W ^{e)}	10	r.t.	75	oil	—
5g	CN	CH ₃	C ₆ H ₅	B	—	10	r.t.	94	111—112	B-H
5h	CN	CH ₃	CH ₂ -C ₆ H ₄ -Cl (<i>p</i>)	A	M ^{f)}	10	r.t.	90	173—175	B
5i	CN	CH ₂ CH ₃	CH ₃	A	W ^{e)}	10	r.t.	74	119—121	B
5j	CN	CH ₂ CH ₃	C ₆ H ₅	B	—	10	r.t.	98	99—101	B-H
5k	CN	CH ₂ CH ₂ CH ₃	CH ₃	A	W ^{e)}	10	r.t.	93	87—89	B-H
5l	CN	CH ₂ CH ₂ CH ₃	C ₆ H ₅	B	—	10	r.t.	89	120—121	B-H
5m	CN	CF ₃	C ₆ H ₅	B	E	10	r.t.	96	78—80	H
12	COOCH ₃	CH ₃	C ₆ H ₅	A	M ^{f)}	10	r.t.	87	129—132	B-H
13a	CONH ₂	CH ₃	CH ₃	A	M-W ^{e)}	10	r.t.	60	166—168	A
13b	CONH ₂	CH ₃	C ₆ H ₅	A	M ^{f)}	10	r.t. —40	70	159—160	B-EA
14	CONHC(CH ₃) ₃	CH ₃	C ₆ H ₅	A	M ^{f)}	10	r.t. —40	86 ^{g)}	211—212	A
15a	CONHCOCH ₃	CH ₃	CH ₃	{C ₁ C ₂	{— —	{0.1 0.5	{80 80	{75 47	{183—185	{A
15b	CONHCOCH ₃	CH ₃	CH ₂ CH ₃	C ₁	—	0.1	80	43	173—174	B
15c	CONHCOCH ₃	CH ₃	C ₆ H ₅	{A C ₁ C ₂	{A ^{h)} — —	{72 0.1 0.5	{r.t. 80 80	{58 ⁱ⁾ 83 64	{153—155	{B
15d	CONHCO-CH ₂ CH ₃	CH ₃	CH ₃	C ₂	—	0.5	80	35	165—168	B
15e	CONHCO-CH ₂ CH ₃	CH ₃	C ₆ H ₅	C ₂	—	0.5	80	65	138—140	B
15f	CONHCO-CH ₂ CH ₃	CH ₂ CH ₃	CH ₃	C ₂	—	0.5	80	42	173—174	B
16	COOH	CH ₃	C ₆ H ₅	A	M ^{f)}	10	66	42	173—175 (decomp.)	B
17a	CN	X=Cl	CH ₃	A	W ^{e)}	10	0—r.t.	63	145—147	B
17b	CN	Cl	C ₆ H ₅	A	W ^{e)}	10	0—r.t.	80	137—138	B
18	COOCH ₃	Cl	C ₆ H ₅	A	W ^{e)}	10	0—r.t.	89	107—113	B-H
22a	CN	C ₆ H ₅	CH ₃	A	M-W ^{e)}	5	66	84	142—144	B-H
22b	CN	C ₆ H ₅	C ₆ H ₅	A	M ^{f)}	5	66	60	161—163	B
22c	CN	<i>n</i> -C ₄ H ₉	C ₆ H ₅	A	M ^{f)}	5	66	71	118—119	B-H

a) See the experimental section.

b) A=acetonitrile, B=benzene, E=ether, EA=ethyl acetate, H=*n*-hexane, M=methanol, W=water

c) NaOH was used as the base.

d) Acetic-formic anhydride (cf. reference 10) was used.

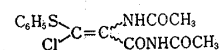
e) cf. reference 3b)

f) KOH was used as the base.

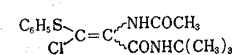
g) 2-Acetyl-amino-3-chloro-3-phenylthio-N-*t*-butylacrylamide (19, 5% yield) was also isolated. mp 190—199° (from CH₃CN)

h) Et₃N was used as the base.

i) 2-Acetyl-amino-3-chloro-3-phenylthio-N-acetylacrylamide (20, 34% yield) was also isolated. mp 185—190° (decomp.) (from CH₃CN)



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2-Acylamino-3,3-bis(substituted mercapto)acrylonitriles (**5**) were prepared easily either (A) by nucleophilic substitution of the halogen atoms of **1** with the corresponding mercaptides or (B) by acylation of 2-amino-3,3-bis(substituted mercapto)acrylonitriles^{3a)} (**6**) at between 0° and 30°. Preparation of N-formyl analogues (**5a—c**) by route A had to be carried out in a short period at low temperatures (0—5°), since the NHCHO group would have been easily hydrolyzed under the reaction conditions (see preceding paper^{3a)}). The acrylic acid derivatives (**12—14**, **16**) were prepared in good yields (except **16**) similarly by the reaction of **7—9**, **11** with mercaptides (method A), although slightly higher reaction temperatures (between 30—80°) were needed.

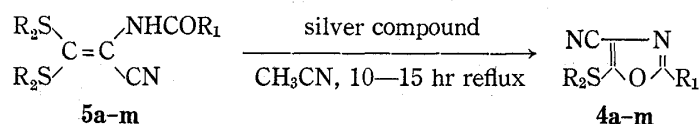
For the preparation of the N-acylacrylamide derivatives (**15**), two methods are available: (A) nucleophilic substitution of the chlorine atoms of **10**, (C) direct one-step conversion of the cyano group of **5** and **6** into the CONHCOR₁(R) group with the acylating agent in the presence of a catalytic amount of conc. sulfuric acid^{3b)} (and direct conversion of the cyano group of amino nitrile (**6**) into the CONHCOR group), accompanied by acylation of the amino group in the latter case. Mono-(substituted mercapto)-mono-chloro compounds (**17**, **18**) were obtained in excellent yields by the reaction of **1**, and **7**, respectively with 1 molar eq. of mercaptides.

Similarly, the reaction of monochloro compounds^{3b)} (**21**) with mercaptides gave **22** in good yields, although brief heating was required to complete the reaction.

Each of the compounds (**17**, **18**, **22**) isolated shows only one spot on TLC and a sharp singlet due to the methyl protons of the NHCOCH₃ group in the NMR spectrum, which indicates that only one isomer was obtained almost selectively in each case, although the configuration has not been determined yet. All the compounds listed in Table II are previously unreported ones, and their structures were supported by spectral data and elemental analyses (Table VI).

When heated with 3—4 molar eq. of a silver compound, such as silver oxide, silver carbonate, or silver acetate, in anhydrous acetonitrile at reflux temperature for 5—15 hr, these compounds underwent smooth cyclization. Oxazoles (**4a—m**) were obtained, after purifica-

TABLE III. Preparation of 2-Substituted-5-(substituted mercapto)-oxazole-4-carbonitriles (**4a—m**)



Ent.	4 R ₁ R ₂		Compd. No.	Yield (%)	mp (°C)	Reagent	(molar eq.)
1	H	CH ₃	4a	72	oil	Ag ₂ CO ₃	(3)
2	H	CH ₂ CH ₃	4b	75	oil	Ag ₂ CO ₃ + Ag ₂ O	(3) + (3)
3	H	C ₆ H ₅	4c	72	oil	Ag ₂ CO ₃	(4)
4	CH ₃	CH ₂ CH ₃	4e	86 ^{a)}	oil	Ag ₂ CO ₃	(3)
5	CH ₃	<i>n</i> -C ₄ H ₉	4f	77 ^{b)}	oil	Ag ₂ CO ₃	(3)
6	CH ₃	C ₆ H ₅	4g	99	oil	Ag ₂ CO ₃	(4)
7	CH ₃	CH ₂ -C ₆ H ₄ Cl(<i>p</i>)	4h	92 ^{c)}	63—65 ^{d)}	Ag ₂ CO ₃	(4)
8	CH ₂ CH ₃	CH ₃	4i	95	oil	Ag ₂ CO ₃	(3)
9	CH ₂ CH ₃	C ₆ H ₅	4j	99	oil	Ag ₂ O	(4)
10	CH ₂ CH ₂ CH ₃	CH ₃	4k	97	oil	Ag ₂ CO ₃	(3)
11	CH ₂ CH ₂ CH ₃	C ₆ H ₅	4l	95	oil	Ag ₂ CO ₃	(4)
12	CF ₃	C ₆ H ₅	4m	— ^{e)}	—	Ag ₂ CO ₃ or Ag ₂ O	(4)

a) **5e** (6%) was recovered.

b) **5f** (6%) was recovered.

c) based on consumed **5h** (**5h** was recovered (34%) after 20 hr of refluxing.)

d) recrystallized from *n*-hexane

e) decomposition

tion using a silica gel column, in almost quantitative yields, except Ent. 1—3, the yields of which were somewhat lower (72—75%) because of the reduced stabilities of both starting materials and oxazoles under the reaction conditions (Table III).

No oxazole was isolated from the reaction mixture of **5m** with silver carbonate or silver oxide, although consumption of the starting material was almost complete.

No distinct difference in reactivity due to changes in R_2 of the R_2S -substituent of **5** was observed. The bulkier the R_2S group, however, the slower the reaction is, *i.e.*, a considerable amount (34%) of starting material **5h** was recovered after refluxing for 20 hr when $R_2 = p\text{-ClC}_6\text{H}_4\text{CH}_2$ (Ent. 7).

Similar treatment of **12—15**, which have a COOCH_3 , CONH_2 , $\text{CONHC}(\text{CH}_3)_3$, or $\text{CONH-COR}_1(\text{R})$ group instead of a nitrile group, gave the expected oxazoles (**4n—w**) in excellent yields (Table IV).

TABLE IV. Preparation of 2-Substituted-5-(substituted mercapto)-oxazole Derivatives (**4n—w**)

$$\begin{array}{c}
 \begin{array}{c} R_2S \\ \diagup \\ C=C \\ \diagdown \\ R_2S \end{array} \begin{array}{c} \diagup \\ \text{NHCOR}_1 \\ \diagdown \\ Y \end{array} \xrightarrow[\text{CH}_3\text{CN, 10—15 hr reflux}]{4 \text{ Ag}_2\text{CO}_3} \begin{array}{c} Y \quad N \\ \diagdown \quad \diagup \\ C=O \\ \diagup \\ R_2S \end{array} \\
 \text{12—16} \qquad \qquad \qquad \text{4n—w}
 \end{array}$$

Ent.	Y	R ₁	R ₂	Compd. No.	Yield (%)	mp (°C)	Recryst. solvent ^{a)}
1	COOCH ₃	CH ₃	C ₆ H ₅	4n	96	oil	—
2	CONH ₂	CH ₃	CH ₃	4o	89	238—239 (decomp.)	A
3	CONH ₂	CH ₃	C ₆ H ₅	4p	90	160—161	B
4	CONHC(CH ₃) ₃	CH ₃	C ₆ H ₅	4q	92	72—73	H
5	CONHCOCH ₃	CH ₃	CH ₃	4r	86	105—106	B
6	CONHCOCH ₃	CH ₃	CH ₂ CH ₃	4s	44	50—51	H
7	CONHCOCH ₃	CH ₃	C ₆ H ₅	4t	87 ^{c)}	105—107	B—H
8	CONHCOCH ₂ CH ₃	CH ₃	CH ₃	4u	75	57—59	H
9	CONHCOCH ₂ CH ₃	CH ₃	C ₆ H ₅	4v	87	63—64	B—H
10	CONHCOCH ₂ CH ₃	CH ₂ CH ₃	CH ₃	4w	77	57—59	H
11	COOH	CH ₃	C ₆ H ₅	— ^{d)}	—	—	—

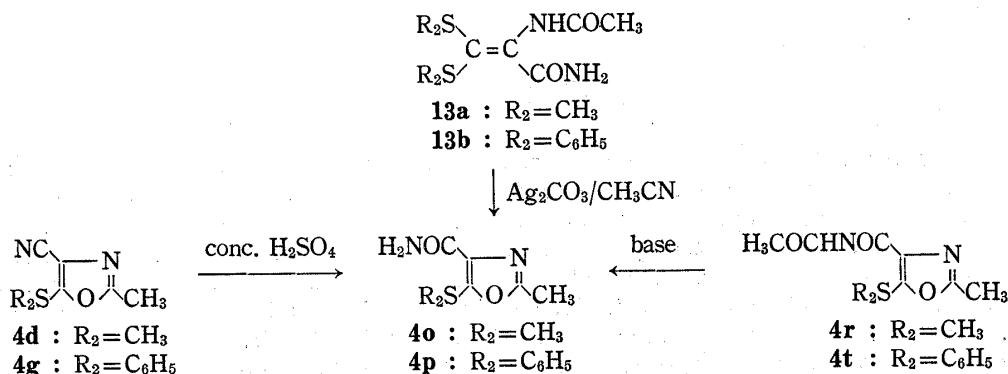
a) A=acetonitrile, B=benzene, H=*n*-hexane

b) Compound **4o** was also isolated (4% yield).

c) Compound **4p** was also isolated (8% yield).

d) $\begin{array}{c} C_6H_5S \\ \diagup \\ C=C \\ \diagdown \\ C_6H_5S \end{array} \begin{array}{c} \diagup \\ H \\ \diagdown \\ \text{NHCCH}_3 \end{array}$ (25, 67% yield) was isolated after 30 min of refluxing.

From 2-acylamino-3,3-bis(substituted mercapto)-N-acylacrylamides (**15**) as starting material a small amount of 2-alkyl-5-(substituted mercapto)oxazole-4-carboxamides (**4o, p**) were also obtained as a result of hydrolysis of the CONHCOR group into CONH_2 .



Oxazole-4-carboxamides (**4o**, **p**), prepared by the reaction of **13a**, **b** with silver carbonate, can be produced also either by hydrolysis of the CONHCOCH_3 group of oxazole-4-N-acetylcarboxamides (**4r**, **t**) or the cyano group of oxazole-4-carbonitriles (**4d**, **g**) with conc. sulfuric acid (Chart 3).

Compound **16**, when treated with Ag_2CO_3 in refluxing acetonitrile, did not give the expected oxazole-4-carboxylic acid (**4z**) and only a simple decarboxylation product **25** was isolated, the structure of which was ascertained by spectral data and elemental analysis.

Those 3-mercapto acrylic acid derivatives (**17**, **22**), where the other 3-substituent is either a chlorine atom or an alkyl or aryl group, were subjected to the cyclization and the results are given in Table V.

TABLE V. Preparation of 2-Methyl-5-alkyl(or aryl)oxazole-4-carbonitriles (**24**)

	R_2S	$\text{C}=\text{C}(\text{NHCOCH}_3)\text{CN}$	$\xrightarrow[\text{CH}_3\text{CN, 10 hr reflux}]{4 \text{ Ag}_2\text{CO}_3}$	$\text{NC}-\text{N}$ $\text{Cl}-\text{O}-\text{CH}_3$	23
	Cl				
	17a, b				
	R_2S	$\text{C}=\text{C}(\text{NHCOCH}_3)\text{CN}$	$\xrightarrow[\text{CH}_3\text{CN, 10 hr reflux}]{4 \text{ Ag}_2\text{CO}_3}$	$\text{NC}-\text{N}$ $\text{X}-\text{O}-\text{CH}_3$	24a, b
	X				
	22a-c				

Ent.	Oxazole X	No.	Starting material	Yield (%)	mp (°C)	Recryst. solvent ^a
1	—	23	17a	— ^b	—	—
2	—		17b	— ^c	—	—
3	C_6H_5	24a	22a	97	48—50	H
4	C_6H_5		22b	99		
5	$n\text{-C}_4\text{H}_9$	24b	22c	99	oil	—

a) H=*n*-hexane

b) **17a** (88%) was recovered.

c) **17b** (92%) was recovered.

In cases of 3-chloro-3-(substituted mercapto)acrylonitriles (**17a**, **b**; Ent. 1, 2), the expected oxazole (**23**) could not be obtained and around 90% of the starting materials (**17a**, **b**) was recovered. The reason why cyclization failed with these compounds is not clear at present. On the other hand, 3-alkyl- or 3-aryl-3-(substituted mercapto) compounds (Ent. 3, 4) gave 5-alkyl or -aryloxazole-4-carbonitriles (**24a**, **b**) in almost quantitative yields.

All oxazoles obtained (**4**, **24**) are new and the structures were confirmed by IR, NMR, UV and mass spectra, and elemental analysis (Table VII).

From these results, we conclude that this new cyclization using silver compounds is fairly general and a good route to 5-(substituted mercapto)oxazoles with a functional group in the 4-position.

Experimental

Melting points were determined in open capillary tubes and are uncorrected. IR spectra were recorded on a Hitachi EPI-S2 spectrophotometer. NMR spectra were recorded on a Varian A-60 or T-60 spectrometer. Chemical shifts are given in parts per million (δ) down field from TMS as an internal standard. UV spectra were obtained with a Parkin-Elmer 450 spectrophotometer. Mass spectra were obtained at 70 eV with a Hitachi RMU-6D mass spectrometer. The following abbreviations are used; sh=shoulder, s=singlet, d=doublet, t=triplet, m=multiplet, and br=broad. Yields, melting points, and reaction conditions are shown in Table I—V. Analytical and spectral data are summarized in Table VI, VII.

General Procedure for the Synthesis of 2-Acyamino-3,3-bis-(substituted mercapto)acrylic Acid Derivatives (5, 12—16)—Method A: To an ice-cooled, stirred solution of 0.22—0.26 mole of appropriate mercaptan

(in case of methylmercaptan, 20% aqueous solution of CH_3SNa ⁹) was used) and the same mole of a base (only in case of 2-acetylamino-3,3-dichloroacrylic acid (11) as the starting material, 0.36 mole of base (KOH) was used) in about 50—500 ml of the solvent listed in Table II, 0.1 mole of 2-acylamino-3,3-dihalogenoacrylic acid derivative (1, 7—11) was added in portions, and the mixture was allowed to react under the conditions listed in Table II. The isolation of the product was carried out as follows. When water was used as solvent, the mixture was cooled to 0° and the insoluble product was collected by filtration followed by washing with a small amount of chilled water, or the mixture was extracted with 200—1000 ml of ethyl acetate and the extract was washed with water and dried (MgSO_4), then the solvent was evaporated *in vacuo* to yield the crude product. When MeOH or CH_3CN was used as solvent, the solvent was evaporated *in vacuo* to dryness, and the residue was extracted with ethyl acetate (in case of 2-acetylamino-3,3-bisphenylthioacrylic acid (16), the residue was acidified with 2N sulfuric acid prior to extraction). An analytically pure sample was obtained by silica gel column chromatography and/or by recrystallization from the solvent listed in Table II.

Method B: A mixture of 0.15—0.30 mole of an acid anhydride (acetic-formic anhydride¹⁰) was used in formylation) and 0.1 mole of 2-amino-3,3-bis(substituted mercapto)acrylonitrile^{3a}) (6) was allowed to stand overnight at room temperature. Water was added and the resulting solution was extracted with 200—1000 ml of ethyl acetate. The extract was washed with water and dried (MgSO_4). The solvent was evaporated *in vacuo*, and the residue was chromatographed on silica gel to yield almost pure 5.

Method C₁: To a solution of 0.01 mole of 2-amino-3,3-bis(substituted mercapto)acrylonitrile^{3a}) (6) in 0.03—0.04 mole of an acid anhydride, 2—10 drops of conc. sulfuric acid was added at room temperature. After a mild exothermic reaction had taken place, the mixture was heated at 80° for 5 min, then allowed to stand overnight at room temperature. Ice water was added the mixture was extracted with ethyl acetate. The extract was washed with water and dried (MgSO_4). The solvent was removed and the residual semi-solid was washed with a little cold ether to give almost pure 15.

Method C₂: To a suspension of 0.01 mole of 2-acylamino-3,3-bis(substituted mercapto)acrylonitrile (5) in 0.02—0.03 mole of an acid anhydride and 0.01 mole of the same acid heated to around 80°, 2—10 drops of conc. sulfuric acid was added and the mixture was heated at the same temperature for an additional 30 min. Similar work up as above gave almost pure 15.

2-Acetylamino-3-chloro-3-(substituted mercapto)acrylonitriles (17a, b) and Methyl 2-Acetylamino-3-chloro-3-phenylthioacrylate (18)—**Method A:** As a typical procedure, the preparation of 2-acetylamino-3-chloro-3-methylthioacrylonitrile (17a) is described. To an ice-cooled suspension of 17.9 g (0.1 mole) of 1b in 500 ml of water, 24 g (0.1 mole) of 20% aqueous CH_3SNa solution (Tokyo Chemical Ind.) was added dropwise during 1 hr with vigorous stirring. The mixture was stirred further at the same temperature for 5 hr and the insoluble product was collected by filtration to give 9.0 g of crude 17a. The filtrate was extracted with ethyl acetate. The extract was washed with water and dried (MgSO_4). The solvent was removed *in vacuo* to give 5.9 g of crude 17a. The total yield was 14.9 g. The crude solid was purified by being passed through a silica gel column to yield 12.07 g (63.4%) of pure 17a.

2-Acetylamino-3-alkyl- or -aryl-3-(substituted mercapto)acrylonitriles (22a—c)—As a typical procedure, the preparation of 2-acetylamino-3-*n*-butyl-3-phenylthioacrylonitrile (22c) is described. To a solution of 2.86 g (26 mmoles) of thiophenol and 1.35 g (24 mmoles) of KOH in 200 ml of MeOH, 4.01 g (20 mmoles) of 2-acetylamino-3-*n*-butyl-3-chloroacrylonitrile^{3b}) (21a) was added and the mixture was stirred at room temperature for 1 hr then refluxed for 1 hr. The volatiles were removed *in vacuo*, and the residue was partitioned with water and ethyl acetate. The organic layer was washed with water, and dried (MgSO_4). The solvent was evaporated *in vacuo*, and the residue was chromatographed on silica gel to yield 3.88 g (70.8%) of 22c.

Reaction of 2-Acetylamino-3,3-bismethylthioacrylonitrile (5d) with Silver Oxide in Anhydrous HF—To an ice-cooled solution of 3 ml anhydrous HF in a 50 ml steel bomb, 4.64 g (20 mmoles) of silver oxide was added first in portions followed by a solution of 2.02 g (10 mmoles) of 5d in 20 ml of anhydrous CH_3CN . The vessel was closed, then the mixture was stirred magnetically at room temperature for 1 hr and then at 100° for 10 hr. The vessel was cooled to 0° and opened. To the reaction mixture, about 3 g of H_3BO_3 was added to decompose excess HF, followed by 1 g of NaF to eliminate the trace amount of remaining HF. The insoluble inorganics were filtered off, then washed with a little CH_3CN . The filtrate and washings were combined, and evaporated to give a yellow oil, which was purified by chromatography through a silica gel column with CHCl_3 to give 376 mg (24%) of 2-methyl-5-methylthiooxazole-4-carbonitrile (4d) as a pale yellow oil.

General Procedure for the Synthesis of 2-Substituted-5-(substituted mercapto)oxazole-4-carbonitriles and Their Derivatives (4, 24)—A suspension of 10 mmoles of 3-mercapto acrylic acid derivative (5, 12—15, or 22) and 30—40 mmoles of silver carbonate (or silver oxide, silver acetate) in 150—300 ml of anhydrous CH_3CN was refluxed for 5—15 hr with stirring. The mixture was cooled to room temperature and the insoluble material was filtered off, then washed with CH_3CN . The combined filtrate and washings were evaporated *in vacuo* and the residue was separated on a silica gel column eluted with CHCl_3 (or CHCl_3 —5% acetone) yielding the oxazole (4a—w, or 24a, b) as an oil or a solid.

9) Tokyo Chemical Industry Co., Ltd.

10) V.C. Mehlenbacher, *Org. Analysis*, 1, 37 (1953).

TABLE VI. 2-Acylamino-3,3-bis(substituted mercapto)acrylonitriles and Their Derivatives (5, 12—20, and 22)

Compd. No.	IR $\nu_{\text{max}}^{\text{Nujol}}$ cm^{-1}	NMR (Solv.) δ	Formula	Analysis (%) Found (Calcd.)		
				C	H	N
5a	3240, 2220, 1660, 1563	(CDCl_3) 2.43 (6H, s), 8.02 (1H, br), 8.70 (1H, br)	$\text{C}_6\text{H}_8\text{ON}_2\text{S}_2$	38.34 (38.28)	4.26 (4.28)	14.88 (14.88)
5b	3290, 2225, 1668, 1556	(CDCl_3) 1.28 (3H, t, $J=6.0$ Hz), 1.32 (3H, t, $J=6.0$ Hz), 2.91 (2H, q, $J=6.0$ Hz), 2.92 (2H, q, $J=6.0$ Hz), 8.20 (1H, br), 8.88 (1H, br)	$\text{C}_8\text{H}_{12}\text{ON}_2\text{S}_2$	44.46 (44.42)	5.56 (5.59)	12.69 (12.95)
5c	3200, 3080, 2220, 1668, 1578, 1556	(CDCl_3) 6.98—7.70 (10H, m), 8.15 (1H, br), 8.80 (1H, br)	$\text{C}_{16}\text{H}_{12}\text{ON}_2\text{S}_2$	61.62 (61.51)	3.57 (3.87)	8.96 (8.97)
5f	3240, 2210, 1690, 1670, 1550 ^a	(CDCl_3) 0.75—1.30 (6H, br), 1.30—2.02 (3H, s), 2.75—3.22 (4H, br), 7.94 (1H, br)	$\text{C}_{13}\text{H}_{22}\text{ON}_2\text{S}_2$	—	—	— ^b
5g	3250, 2220, 1675sh, 1665, 1558	(CDCl_3) 2.02 (3H, s), 7.16 (10H, s), 7.72 (1H, br)	$\text{C}_{17}\text{H}_{14}\text{ON}_2\text{S}_2$	62.42 (62.55)	4.14 (4.32)	8.62 (8.58)
5h	3200, 2200, 1660, 1640sh, 1593, 1555	(d_6 -DMSO) 2.02 (3H, s), 4.08 (4H, s), 7.24 (8H, s), 9.60 (1H, br)	$\text{C}_{19}\text{H}_{16}\text{ON}_2\text{S}_2\text{Cl}_2$	54.02 (53.90)	3.83 (3.81)	6.53 (6.62)
5i	3250, 2215, 1665, 1554	(CDCl_3) 1.20 (3H, t, $J=8.0$ Hz), 2.17—2.64 (2H, q, $J=8.0$ Hz), 2.41 (6H, s), 7.37 (1H, br)	$\text{C}_8\text{H}_{12}\text{ON}_2\text{S}_2$	44.27 (44.42)	5.59 (5.59)	12.96 (12.95)
5j	3260, 2210, 1670, 1555	(CDCl_3) 1.13 (3H, t, $J=8.0$ Hz), 2.27 (2H, q, $J=8.0$ Hz), 6.90—7.55 (11H, m)	$\text{C}_{18}\text{H}_{16}\text{ON}_2\text{S}_2$	63.58 (63.50)	4.64 (4.74)	8.16 (8.23)
5k	3250, 2230, 1668, 1558	(CDCl_3) 1.01 (3H, t, $J=7.0$ Hz), 1.42—2.10 (2H, m), 2.20—2.62 (2H, q, $J=7.0$ Hz), 2.45 (6H, s), 7.57 (1H, br)	$\text{C}_9\text{H}_{14}\text{ON}_2\text{S}_2$	46.69 (46.81)	5.90 (6.37)	12.18 (12.13)
5l	3170, 2210, 1653, 1580, 1572	(CDCl_3) 0.92 (3H, t, $J=7.5$ Hz), 1.20—1.95 (2H, m), 2.17 (2H, q, $J=7.5$ Hz), 7.10 (10H, s), 7.57 (1H, br)	$\text{C}_{19}\text{H}_{18}\text{ON}_2\text{S}_2$	64.70 (64.38)	5.21 (5.11)	8.10 (7.90)
5m	3250, 2210, 1722sh, 1708, 1580, 1555	(CDCl_3) 6.95—7.50 (10H, m), 7.93 (1H, br)	$\text{C}_{17}\text{H}_{11}\text{ON}_2\text{S}_2\text{F}_3$	53.40 (53.67)	2.84 (2.92)	7.45 (7.36)
12	3320, 1740, 1710, 1582	(CDCl_3) 1.97 (3H, s), 3.84 (3H, s), 6.98—7.60 (10H, m), 8.02 (1H, br)	$\text{C}_{13}\text{H}_{17}\text{O}_3\text{NS}_2$	60.35 (60.14)	4.81 (4.77)	3.79 (3.90)
13a	3330, 3250, 3150, 1689, 1650, 1620sh, 1550	(d_6 -DMSO) 1.94 (3H, s), 2.24 (6H, s), 7.20 (2H, br), 9.13 (1H, br)	$\text{C}_7\text{H}_{12}\text{O}_2\text{N}_2\text{S}_2$	37.88 (38.16)	5.41 (5.49)	— —
13b	3450, 3370, 3270, 3210, 3150, 3050, 1675, 1650, 1603, 1578, 1545	(d_6 -DMSO) 1.93 (3H, s), 7.18 (10H, s), 7.38 (2H, br), 9.38 (1H, br)	$\text{C}_{17}\text{H}_{16}\text{O}_2\text{N}_2\text{S}_2$	59.20 (59.28)	4.63 (4.68)	7.84 (8.13)
14	3300, 3250, 3060, 1668, 1650sh, 1585, 1540	(d_6 -DMSO) 1.22 (9H, s), 1.94 (3H, s), 7.22 (10H, s), 7.62 (1H, br), 9.33 (1H, br)	$\text{C}_{21}\text{H}_{24}\text{O}_2\text{N}_2\text{S}_2$	62.89 (62.97)	5.89 (6.04)	7.07 (6.99)
15a	3290, 3140, 1730, 1692, 1680, 1630sh, 1590	(d_6 -DMSO) 1.95 (3H, s), 2.07 (3H, s), 2.18 (3H, s), 2.25 (3H, s), 9.33 (1H, br), 10.82 (1H, br)	$\text{C}_9\text{H}_{14}\text{O}_3\text{N}_2\text{S}_2$	41.08 (41.20)	5.28 (5.38)	10.93 (10.68)

Compd. No.	IR $\nu_{\text{max}}^{\text{NaJol}}$ cm^{-1}	NMR (Solv.) δ	Formula	Analysis (%) Found (Calcd.)		
				C	H	N
15b	3300, 3150, 1732, 1695sh, 1680, 1590	(d_6 -DMSO) 1.12 (3H, t, $J=8.0$ Hz), 1.22 (3H, t, $J=8.0$ Hz), 2.01 (3H, s), 2.09 (3H, s), 2.45—3.10 (4H, m), 9.20 (1H, br), 10.80 (1H, br)	$\text{C}_{11}\text{H}_{18}\text{O}_3\text{N}_2\text{S}_2$	45.49 (45.50)	6.16 (6.25)	9.81 (9.65)
15c	3260, 3150, 1730, 1698sh, 1680, 1583	(CDCl_3) 2.03 (3H, s), 2.22 (3H, s), 7.26 (10H, s), 8.05 (1H, br), 8.97 (1H, br)	$\text{C}_{19}\text{H}_{18}\text{O}_3\text{N}_2\text{S}_2$	59.15 (59.05)	4.72 (4.69)	7.22 (7.25)
15d	3250, 3180sh, 1730, 1692, 1680, 1665sh, 1590	(d_6 -DMSO) 1.00 (3H, t, $J=7.6$ Hz), 1.96 (3H, s), 2.15 (3H, s), 2.24 (3H, s), 2.40 (2H, q, $J=7.6$ Hz), 9.32 (1H, br), 10.75 (1H, br)	$\text{C}_{10}\text{H}_{16}\text{O}_3\text{N}_2\text{S}_2$	43.82 (43.46)	5.85 (5.84)	10.25 (10.14)
15e	3300, 3050, 1730, 1715, 1693sh, 1680, 1592	(d_6 -DMSO) 0.98 (3H, t, $J=8.0$ Hz), 2.00 (3H, s), 2.31 (2H, q, $J=8.0$ Hz), 6.85—7.40 (10H, br), 9.80 (1H, br), 11.12 (1H, br)	$\text{C}_{20}\text{H}_{20}\text{O}_3\text{N}_2\text{S}_2$	60.09 (59.98)	4.90 (5.03)	6.99 (6.99)
15f	3260, 3175, 1740, 1700, 1670, 1585, 1530	(d_6 -DMSO) 1.00 (6H, t, $J=8.0$ Hz), 2.18 (3H, s), 2.27 (3H, s), 2.20—2.65 (4H, m), 9.23 (1H, br), 10.78 (1H, br)	$\text{C}_{11}\text{H}_{18}\text{O}_3\text{N}_2\text{S}_2$	45.80 (45.50)	6.21 (6.25)	9.39 (9.65)
16 ^c	3270, 3170, 3050, 1720, 1660, 1580	(d_6 -DMSO) 2.05 (3H, s), 7.20 (1H, br), 7.36 (10H, s), 13.03 (1H, br)	$\text{C}_{17}\text{H}_{15}\text{O}_3\text{NS}_2$	58.99 (59.11)	4.30 (4.38)	3.85 (4.05)
17a	3260, 3050, 2225, 1665, 1640sh, 1575	(d_6 -DMSO) 2.02 (3H, s), 2.50 (3H, s), 9.57 (1H, br)	$\text{C}_6\text{H}_7\text{ON}_2\text{SCl}$	37.45 (37.80)	3.99 (3.70)	15.03 (14.69)
17b	3230, 3160sh, 3050, 2205, 1680sh, 1665, 1574	(d_6 -DMSO) 2.02 (3H, s), 7.40 (5H, s), 9.77 (1H, br)	$\text{C}_{11}\text{H}_9\text{O}_3\text{SNCl}$	52.32 (52.28)	3.46 (3.59)	10.97 (11.08)
18	3260, 3050, 1710, 1690sh, 1672, 1580,	(d_6 -DMSO) 2.00 (3H, s), 3.69 (3H, s), 7.38 (5H, s), 9.91 (1H, br)	$\text{C}_{12}\text{H}_{12}\text{O}_3\text{NSCl}$	50.71 (50.61)	4.23 (4.22)	5.04 (4.88)
19 ^d	3290, 3080, 1676, 1656, 1605, 1550	(d_6 -DMSO) 1.23 (9H, s), 2.00 (3H, s), 7.34 (5H, s), 7.80 (1H, br), 9.33 (1H, br)	$\text{C}_{15}\text{H}_{19}\text{O}_2\text{N}_2\text{S}_2\text{Cl}$	55.22 (55.12)	5.70 (5.86)	8.70 (8.57)
20	3280, 3140, 1730, 1705sh, 1690, 1675, 1656sh, 1640sh, 1610, 1585sh	(d_6 -DMSO) 2.03 (3H, s), 2.05 (3H, s), 7.31 (5H, s), 9.77 (1H, br), 11.17 (1H, br)	$\text{C}_{13}\text{H}_{13}\text{O}_3\text{N}_2\text{SCl}$	50.13 (49.92)	3.96 (4.19)	9.04 (8.96)
22a	3200, 3050, 2200, 1660, 1570	(CDCl_3) 2.06 (3H, s), 2.36 (3H, s), 7.05—7.62 (5H, br)	$\text{C}_{12}\text{H}_{12}\text{ON}_2\text{S}$	62.10 (62.04)	4.99 (5.21)	12.17 (12.06)
22b	3160, 2220, 1653, 1590	(CDCl_3) 2.17 (3H, s), 7.05—7.55 (10H, m), 7.60 (1H, br)	$\text{C}_{17}\text{H}_{14}\text{ON}_2\text{S}$	68.92 (69.36)	4.76 (4.79)	9.23 (9.52)
22c	3160, 2200, 1660, 1642sh, 1592	(CDCl_3) 0.55—0.95 (3H, br. t), 0.95—1.70 (4H, br), 2.03 (3H, s), 2.16—2.60 (2H, m), 7.23 (1H, br), 7.32 (5H, s)	$\text{C}_{15}\text{H}_{18}\text{ON}_2\text{S}$	65.80 (65.61)	6.38 (6.61)	10.21 (10.21)

a) as liquid film

b) mass spectrum m/e (rel. intensity): 286 (M^+ , 41%), 245 (15%), 244 ($\text{M}^+ - \text{CH}_2 = \text{C}=\text{O}$, 100%), 197 (19%)c) mass spectrum m/e (rel. intensity): 345 (M^+ , 2%), 329 (14%), 328 (22%), 327 (100%), 303 (11%), 302 (17%), 301 (80%), 259 (22%), 258 (16%), 257 (74%), 236 (35%), 218 (64%), 192 (89%), 121 (59%), 117 (28%), 110 (21%), 109 (26%), 104 (31%), 77 (45%), 51 (21%), 43 (56%)d) mass spectrum m/e (rel. intensity): 314, 312 (1:3, M^+ , 1%), 277 ($\text{M}^+ - \text{Cl}$, 26%), 235 (13%), 218 (22%), 205, 203 (1:3, 100%), 193 (9%), 167 (19%), 163, 161 (1:3, 79%), 125 (14%), 121 (33%), 104 (22%), 77 (13%), 43 (77%)

Hydrolysis of 2-Methyl-5-(substituted mercapto)oxazole-4-N-acetylcarboxamides (4r, t)—As a typical procedure, the preparation of 2-methyl-5-methylthiooxazole-4-carboxamide (**4o**) is described. To a solution of sodium ethoxide (4.13 mmoles) in 100 ml of EtOH, 800 mg (3.74 mmoles) of 2-methyl-5-methylthiooxazole-4-N-acetylcarboxamide (**4r**) was added, and the mixture was allowed to stand at room temperature for 1 hr. The mixture was concentrated *in vacuo* to a volume of about 20 ml and allowed to stand in a refrigerator (-10°) overnight. Crystals were collected by filtration, then washed with a little ether to give 550 mg (85.5 %) of **4o** as colorless needles.

Hydrolysis of 2-Methyl-5-(substituted mercapto)oxazole-4-carbonitriles (4d, g)—As a typical procedure, the preparation of **4o** is described. To an ice-cooled 2 ml of conc. sulfuric acid, 1.54 g (10 mmoles) of **4d** was added slowly and the mixture was allowed to stand overnight at room temperature. Ice water was added, and the resulting solid was filtered and washed with water, then ether to give 1.65 g (96 %) of **4o**.

TABLE VII. 2-Substituted-5-(substituted mercapto)oxazole-4-carbonitriles and Their Derivatives (**4** and **24**)

Compd. No.	IR $\nu_{\max}^{\text{Nujol}}$ cm^{-1}	NMR (CDCl_3) δ	Formula	Analysis (%)		
				Found (Calcd.)		
				C	H	N
4a	3120, 2250, 1530, 1510 ^a	2.65 (3H, s), 7.90 (1H, s)	$\text{C}_3\text{H}_4\text{ON}_2\text{S}$	42.76 (42.85)	2.94 (2.88)	19.84 (19.99)
4b	3130, 2250, 1530, 1508 ^a	1.36 (3H, t, $J=7.0$ Hz), 3.07 (2H, q, $J=7.0$ Hz), 7.93 (1H, s)	$\text{C}_6\text{H}_6\text{ON}_2\text{S}$	46.93 (46.74)	4.01 (3.92)	18.09 (18.17)
4c	3120, 3060, 1575 ^a	7.16—7.60 (5H, m), 7.90 (1H, s)	$\text{C}_{10}\text{H}_6\text{ON}_2\text{S}$	59.52 (59.39)	3.08 (2.99)	13.90 (13.85)
4d^b	2240, 1590, 1550sh, 1532 ^a	2.46 (3H, s), 2.58 (3H, s)	$\text{C}_6\text{H}_6\text{ON}_2\text{S}$	46.71 (46.74)	3.91 (3.92)	17.98 (18.17)
4e	2250, 1582, 1532 ^a	1.34 (3H, t, $J=7.4$ Hz), 2.46 (3H, s), 3.02 (2H, q, $J=7.4$ Hz)	$\text{C}_7\text{H}_8\text{ON}_2\text{S}$	50.03 (49.98)	4.74 (4.79)	17.01 (16.65)
4f	2245, 1580, 1530 ^a	0.60—1.10 (3H, br), 1.10—2.05 (4H, m), 2.50 (3H, s), 3.02 (2H, t, $J=7.2$ Hz)	$\text{C}_9\text{H}_{12}\text{ON}_2\text{S}$	55.24 (55.08)	6.29 (6.16)	14.35 (14.27)
4g^c	3050, 2240, 1580, 1542 ^a	2.43 (3H, s), 7.16—7.64 (5H, br)	$\text{C}_{11}\text{H}_8\text{ON}_2\text{S}$	61.35 (61.09)	3.55 (3.73)	12.53 (12.95)
4h	2245, 1575	2.43 (3H, s), 4.12 (2H, s), 7.21 (4H, s)	$\text{C}_{12}\text{H}_9\text{ON}_2\text{S}$	54.60 (54.44)	3.45 (3.43)	10.69 (10.58)
4i	2250, 1582, 1534 ^a	1.33 (3H, t, $J=7.5$ Hz), 2.57 (3H, s), 2.90 (2H, q, $J=7.5$ Hz)	$\text{C}_7\text{H}_8\text{ON}_2\text{S}$	49.84 (49.98)	4.93 (4.79)	16.71 (16.65)
4j	3060, 2250, 1572, 1540 ^a	1.27 (3H, t, $J=8.0$ Hz), 2.75 (2H, q, $J=8.0$ Hz), 7.15—7.60 (5H, s)	$\text{C}_{12}\text{H}_{10}\text{ON}_2\text{S}$	62.77 (62.59)	4.21 (4.38)	12.28 (12.16)
4k	2250, 1582, 1533 ^a	1.04 (3H, t, $J=7.0$ Hz), 1.50—2.20 (2H, m), 2.61 (3H, s), 2.72 (2H, q, $J=7.0$ Hz)	$\text{C}_8\text{H}_{10}\text{ON}_2\text{S}$	52.60 (52.72)	5.46 (5.53)	15.34 (15.37)
4l	3060, 2250, 1580 ^a	0.98 (3H, t, $J=7.0$ Hz), 1.45—2.15 (2H, m), 2.75 (2H, t, $J=7.0$ Hz), 7.25—7.70 (5H, s)	$\text{C}_{13}\text{H}_{12}\text{ON}_2\text{S}$	64.25 (63.91)	4.85 (4.95)	11.18 (11.47)
4n	3060, 1730, 1715sh, 1600sh, 1586, 1550 ^a	2.37 (3H, s), 3.96 (3H, s), 7.16—7.66 (5H, m)	$\text{C}_{12}\text{H}_{11}\text{O}_3\text{NS}$	57.90 (57.82)	4.49 (4.45)	5.58 (5.62)
4o^d	3340, 3250sh, 3190, 1670, 1658, 1605, 1550	2.40 (3H, s), 2.50 (3H, s), 7.25 (2H, br)	$\text{C}_6\text{H}_8\text{O}_2\text{N}_2\text{S}$	41.85 (41.85)	4.57 (4.68)	16.42 (16.27)
4p^f	3330, 3220, 3180sh, 3050, 1690, 1675sh, 1665, 1620, 1588, 1574	2.36 (3H, s), 7.30 (5H, s), 7.20—7.55 (2H, br) ^e	$\text{C}_{11}\text{H}_{10}\text{O}_2\text{N}_2\text{S}$	56.40 (56.39)	4.30 (4.30)	11.92 (11.96)
4q	3390, 3050, 1670, 1592, 1570	1.43 (9H, s), 2.33 (3H, s), 6.80 (1H, br), 7.16—7.70 (5H, m)	$\text{C}_{15}\text{H}_{18}\text{O}_2\text{N}_2\text{S}$	61.97 (62.04)	6.36 (6.25)	9.63 (9.65)
4r^g	3230, 3140sh, 1726, 1670, 1605, 1540	2.44 (3H, s), 2.53 (3H, s), 2.58 (3H, s), 9.05 (1H, br)	$\text{C}_8\text{H}_{10}\text{O}_3\text{N}_2\text{S}$	44.99 (44.85)	4.60 (4.71)	12.97 (13.08)
4s	3350, 1720, 1705, 1690, 1672sh, 1652, 1608, 1545	1.38 (3H, t, $J=7.0$ Hz), 2.46 (3H, s), 2.55 (3H, s), 3.14 (2H, q, $J=7.0$ Hz), 9.13 (1H, br)	$\text{C}_9\text{H}_{12}\text{O}_3\text{N}_2\text{S}$	47.48 (47.36)	5.27 (5.30)	12.29 (12.27)
4t^h	3360, 1750, 1692, 1598, 1550	2.36 (3H, s), 2.56 (3H, s), 7.20—7.70 (5H, m), 9.37 (1H, br)	$\text{C}_{13}\text{H}_{12}\text{O}_3\text{N}_2\text{S}$	56.69 (56.51)	4.23 (4.38)	10.22 (10.14)

Compd. No.	IR $\nu_{\text{max}}^{\text{Nujol}}$ cm^{-1}	NMR (CDCl_3) δ	Formula	Analysis (%) Found (Calcd.)		
				C	H	N
4u	3350, 1712, 1604, 1550	1.17 (3H, t, $J=8.0$ Hz), 2.43 (3H, s), 2.57 (3H, s), 2.93 (2H, q, $J=8.0$ Hz), 9.03 (1H, br)	$\text{C}_9\text{H}_{12}\text{O}_3\text{N}_2\text{S}$	47.27 (47.36)	5.05 (5.30)	12.31 (12.27)
4v	3350, 1710, 1692, 1680, 1602, 1550, 1540	1.16 (3H, t, $J=8.0$ Hz), 2.35 (3H, s), 2.94 (2H, q, $J=8.0$ Hz), 7.16—7.70 (5H, m), 9.18 (1H, br)	$\text{C}_{14}\text{H}_{14}\text{O}_3\text{N}_2\text{S}$	58.01 (57.92)	4.60 (4.86)	9.61 (9.65)
4w	3300, 1705, 1690, 1598, 1550, 1535sh	1.18 (3H, t, $J=7.5$ Hz), 1.30 (3H, t, $J=8.0$ Hz), 2.57 (3H, s), 2.6—3.2 (4H, m), 9.17 (1H, br)	$\text{C}_{10}\text{H}_{14}\text{O}_3\text{N}_2\text{S}$	49.37 (49.57)	5.87 (5.82)	11.40 (11.56)
24a ^d	2210, 1595, 1586, 1568	2.53 (3H, s), 7.30—7.63 (3H, m), 7.63—8.03 (2H, m)	$\text{C}_{11}\text{H}_8\text{ON}_2$	71.82 (71.73)	4.33 (4.38)	15.12 (15.21)
24b	2250, 1610, 1592 ^a	0.70—1.2 (3H, br), 1.2—2.10 (4H, m), 2.45 (3H, s), 2.84 (2H, t, $J=7.5$ Hz)	$\text{C}_9\text{H}_{12}\text{ON}_2$	65.83 (65.83)	7.62 (7.37)	17.19 (17.06)

a) as liquid film

b) mass spectrum m/e (rel. intensity): 154 (M^+ , 14%), 107 ($\text{M}^+ - \text{SCH}_3$, 55%), 79 (100%), 43 (35%); UV $\lambda_{\text{max}}^{\text{CHCl}_3}$ nm (e): 274 (7250)

c) mass spectrum m/e (rel. intensity): 216 (M^+ , 60%), 188 (6%), 187 (9%), 173 (3%), 147 (33%), 121 (5%), 109 (10%), 107 (100%), 79 (44%), 77 (10%); UV $\lambda_{\text{max}}^{\text{CHCl}_3}$ nm (e): 271 (5750)

d) mass spectrum m/e (rel. intensity): 172 (M^+ , 44%), 155 (36%), 125 (100%), 97 (4%), 69 (47%), 43 (26%)

e) in d_6 -DMSO

f) mass spectrum m/e (rel. intensity): 234 (M^+ , 47%), 125 (100%), 109 (8%), 97 (3%), 77 (7%), 69 (37%); UV $\lambda_{\text{max}}^{\text{CHCl}_3}$ nm (e): 282 (6540)

g) UV $\lambda_{\text{max}}^{\text{CHCl}_3}$ nm (e): 298 (12200)

h) mass spectrum m/e (rel. intensity): 276 (M^+ , 64%), 234 (7%), 167 (48%), 126 (57%), 125 (100%), 109 (15%), 69 (17%), 43 (13%); UV $\lambda_{\text{max}}^{\text{CHCl}_3}$ nm (e): 300 (10600)

i) mass spectrum m/e (rel. intensity): 184 (M^+ , 100%), 156 (14%), 155 (17%), 115 (33%), 105 (52%), 77 (42%), 51 (15%)

1-Acetylamino-2,2-bisphenylthioethylene (25)—A suspension of 1035 mg (3 mmoles) of **16** and 3.41 g (12 mmoles) of Ag_2CO_3 in 200 ml of anhydrous CH_3CN was refluxed. After 1 hr, the reaction mixture became brown. TLC of the reaction mixture showed that the starting material had been consumed completely to yield a new substance with a larger R_f value than that of **16**. The insoluble material was filtered off, then washed with CH_3CN . The combined filtrate and washings were evaporated *in vacuo* and the residue was chromatographed on silica gel to yield 607 mg (67%) of **25**, as fine colorless needles, mp 110° (from *n*-hexane). IR $\nu_{\text{max}}^{\text{Nujol}}$ cm^{-1} : 3250 sh, 3210, 3040, 1670, 1610, 1600 sh, and 1580. NMR (CDCl_3) δ : 2.08 (3H, s), 6.95—7.55 (11H, br), and 7.90 (1H, br). Mass Spectrum m/e (rel. intensity): 303 (M^+ , 58%), 302 ($\text{M}^+ - 1$, 12%), 259 ($\text{M}^+ - \text{CH}_2 = \text{C} = \text{O}$, 10%), 241 (9%), 192 ($\text{M}^+ - \text{C}_6\text{H}_5\text{S}$, 100%), 151 ($\text{M}^+ - \text{CH}_2 = \text{C} = \text{O} - \text{C}_6\text{H}_5\text{S}$, 38%), 121 (CSC_6H_5^+ , 28%). Anal. Calcd. for $\text{C}_{18}\text{H}_{15}\text{ONS}_2$: C, 63.75; H, 5.02; N, 4.65. Found: C, 63.98; H, 5.18; N, 4.64.

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