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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 Ag_2O, Ag_2CO_3, and CH_3COOAg, 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 acids[4] 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 reagent[5] 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.

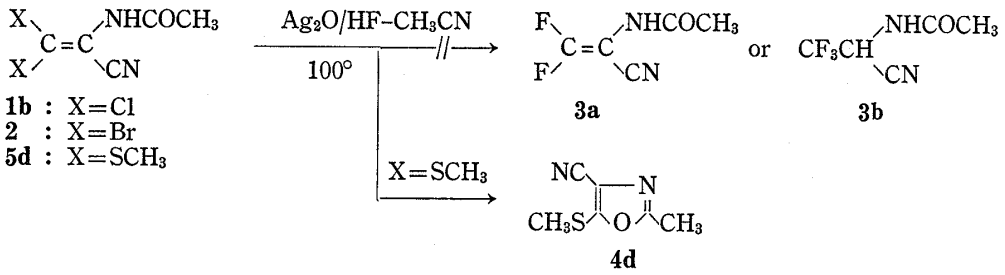


Chart 1

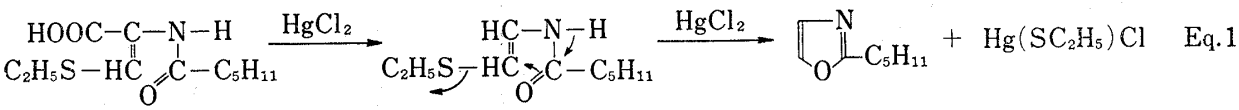
1) Part IX: K. Matsumura, H. Shimadzu, O. Miyashita, and N. Hashimoto, *Chem. Pharm. Bull.* (Tokyo), **24**, 941 (1976).
2) Location: *Jusohonmachi, Yodogawa-ku, Osaka, 532, Japan.*
3) *a*) Part VII: K. Matsumura, T. Saraie, and N. Hashimoto, *Chem. Pharm. Bull.* (Tokyo), **24**, 912 (1976). *b*) Part 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."

To the best of our knowledge, 5-(substituted mercapto)oxazoles (although some are in a 1969 patent[6]) are scarcely known compounds and especially those having functional groups such as –CN, –COOR on the oxazole ring[7] have not been reported. This presents a marked contrast to the corresponding O-analogues, the synthesis of which from acylated α-amino acids and their derivatives is well known in literature.[7] We report on the scope and limitations of this new synthetic method of 5-(substituted mercapto)oxazole derivatives together with the preparation of the starting materials, 2-acylamino-3,3-bis(substituted mercapto)-acrylonitriles (**5**) and their derivatives (**12—18, 22**).

Results and Discussion

The reaction of 2-acetylamino-3,3-dihalogenoacrylonitriles (**1b**, **2**) with silver oxide in anhydrous HF at between 30° and 100° failed and only unreacted starting materials or the decomposition products were recovered. In the case of **5d**, however, an oil was obtained as the only isolable product under similar conditions. The infrared (IR) spectrum shows bands at 2240 (CN), 1590, 1550sh, and 1532 cm^{-1}, lacking those of the $NHCOCH_3$ group, and the nuclear magnetic resonance (NMR) spectrum ($CDCl_3$) shows two sharp singlets of equal intensity at δ 2.46 and 2.56 ppm assignable to a mercapto methyl group and a methyl group attached to an aromatic ring. Based on the mass spectrum, *m/e* 154 (M^+, 14%), and 79 (M^+–SCH_3–CO, 100%), ultraviolet (UV) spectrum ($CDCl_3$), 274 nm (ε=7250), and elemental analysis besides IR and NMR spectra, the structure was determined to be 2-methyl-5-methylthiooxazole-4-carbonitrile (**4d**, 24%), a new cyclization product from **5d** by loss of methyl mercaptan.

Of numerous methods[7] for synthesizing oxazoles known to date, only one reported by Cornforth[8] involves formation of the oxazole ring by the loss of mercaptan, *i.e.*, the action of mercuric chloride in neutral aqueous solution on α-hexanoylamino-β-ethylthioacrylic acid gives 2-amyloxazole in a low yield (Eq. 1).



Eq. 1

We examined the conditions of the present reaction more closely in order to improve the yield of oxazole (**4d**) from **5d**. Based on the results of the experiments mentioned above, various silver, copper, and mercury compounds were investigated as reagents.

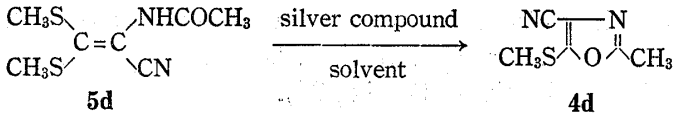
The methanolic solution of **5d** was heated with metal salt in a sealed glass tube overnight at 80°, the formation of oxazole (**4d**) being followed by thin-layer chromatography (TLC). This experiment proved that silver compounds, especially silver fluoride, silver nitrate, silver acetate, silver oxide, and silver carbonate, are suitable reagents. Accordingly, the following experiments for optimizing the other reaction conditions from **5d** to **4d**, were carried out using these reagents under the conditions presented in Table I.

In a protic solvent such as methanol or ethanol (Ent. 1—4), both conversion and yield were rather low even with excess of reagent such as silver oxide, silver carbonate or silver acetate. In acetonitrile, an aprotic solvent, and with the same reagents as above, however, **4d** was obtained in almost quantitative yield together with complete consumption of **5d** (Ent. 5—8). The lower activity of silver fluoride (Ent. 8) was probably due to inferior purity of the reagent used.

6) T. Naito, K. Ueno, and T. Miki, Japan Patent 23088 (1969) [*C. A.*, **71**, 124405 (1969)].
7) For reviews see *a*) R.H. Wiley, *Chem. Rev.*, **37**, 401 (1945); *b*) J.W. Cornforth, "The Chemistry of Penicillin," ed. by H.T. Clarke, J.R. Johnson, and R. Robinson, Princeton Univ. Press, Princeton, New Jersey, 1948, Chapter XXI; *c*) J.W. Cornforth, "Heterocyclic Compounds," Vol. 5, ed. by R.C. Elderfield, Wiley, New York, 1957, Chapter 5; *d*) R. Lakhan and B. Ternai, "Advances in Heterocyclic Chemistry," Vol. 17, ed. by A.R. Katritzky and A.J. Boulton, Academic Press, New York, 1974, pp. 99—211.
8) J.W. Cornforth and H.T. Huang, *J. Chem. Soc.*, **1948**, 1964.

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

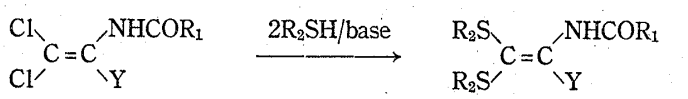


5d **4d**

Ent.	**5d**, mmole	Reagent (mmole)	Solv.[a] (ml)	Reflux time (hr)	Reaction product[b] **4d**, g (Yield, %)[c]	**5d**, g (Recovered)
1	10	Ag_2CO_3 (12)	M(60)	3	0.60(66)	0.83
2	10	Ag_2O (30)	E (60)	2	0.69(50)	0.21
3	10	Ag_2CO_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_2CO_3 (30)	A (200)	3	1.51(98)	0
6	10	AgOAc (30)	A (200)	10	1.51(99)	0.03
7	10	Ag_2O (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.

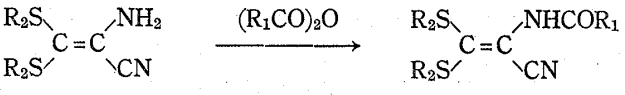
Method A



1: Y=CN
7: Y=$COOCH_3$
8: Y=$CONH_2$
9: Y=$CONHC(CH_3)_3$
10: Y=$CONHCOR_1$(R)
11: Y=COOH

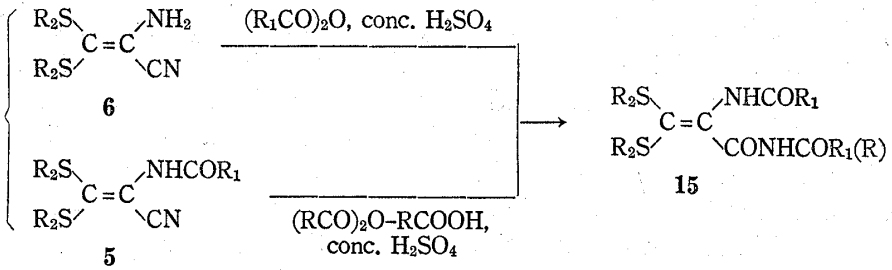
5: Y=CN
12: Y=$COOCH_3$
13: Y=$CONH_2$
14: Y=$CONHC(CH_3)_3$
15: Y=$CONHCOR_1$(R)
16: Y=COOH

Method B



6 **5**

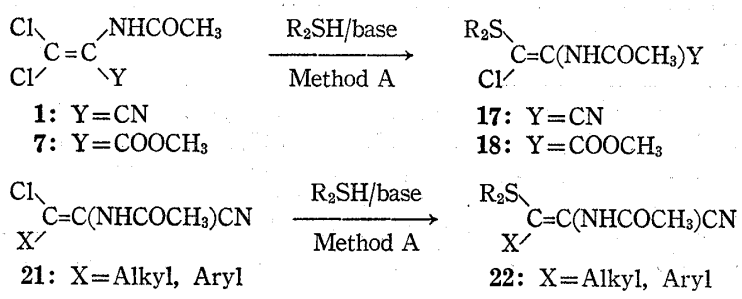
Method C



6

5

15



1: Y=CN
7: Y=$COOCH_3$

17: Y=CN
18: Y=$COOCH_3$

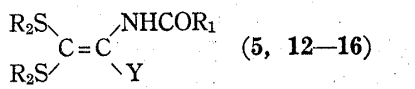
21: X=Alkyl, Aryl

22: X=Alkyl, Aryl

Chart 2

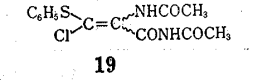
In order to investigate the scope and limitations of this new cyclization to oxazoles, the various 3-mercaptoacrylic acid derivatives listed in Table II were prepared by the routes depicted in Chart 2.

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



Compd. No.	5, 12—18, 22 Y	R1(X)	R2	Method[a]	Solv.[b]	Time (hr)	Temp. (°C)	Yield (%)	mp (°C)	Recryst. solvent[b]
5a	CN	R1=H	CH_3	A	W[c]	2	0	76	100—101	B
5b	CN	H	CH_2CH_3	A	W[c]	3	0	79	56— 57	B-H
5c	CN	H	C_6H_5	A	W[c]	3	0	52	97— 98	B-H
				B[d]	—	10	r.t.	69		
5d[e]	CN	CH_3	CH_3	B	—	10	r.t.	88	122—123.5	B
5e[e]	CN	CH_3	CH_2CH_3	A	W[c]	10	r.t.	89	86— 87	B-H
				B	—	10	r.t.	93		
5f	CN	CH_3	n-C_4H_9	A	W[c]	10	r.t.	75	oil	—
5g	CN	CH_3	C_6H_5	B	—	10	r.t.	94	111—112	B-H
5h	CN	CH_3	CH_2-C_6H_4-Cl (p)	A	M[f]	10	r.t.	90	173—175	B
5i	CN	CH_2CH_3	CH_3	A	W[c]	10	r.t.	74	119—121	B
5j	CN	CH_2CH_3	C_6H_5	B	—	10	r.t.	98	99—101	B-H
5k	CN	$CH_2CH_2CH_3$	CH_3	A	W[c]	10	r.t.	93	87— 89	B-H
5l	CN	$CH_2CH_2CH_3$	C_6H_5	B	—	10	r.t.	89	120—121	B-H
5m	CN	CF_3	C_6H_5	B	E	10	r.t.	96	78— 80	H
12	$COOCH_3$	CH_3	C_6H_5	A	M[f]	10	r.t.	87	129—132	B-H
13a	$CONH_2$	CH_3	CH_3	A	M-W[c]	10	r.t.	60	166—168	A
13b	$CONH_2$	CH_3	C_6H_5	A	M[f]	10	r.t. —40	70	159—160	B-EA
14	$CONHC(CH_3)_3$	CH_3	C_6H_5	A	M[f]	10	r.t. —40	86[g]	211—212	A
15a	$CONHCOCH_3$	CH_3	CH_3	C_1	—	0.1	80	75	183—185	A
				C_2	—	0.5	80	47		
15b	$CONHCOCH_3$	CH_3	CH_2CH_3	C_1	—	0.1	80	43	173—174	B
15c	$CONHCOCH_3$	CH_3	C_6H_5	A	A[h]	72	r.t.	58[i]	153—155	B
				C_1	—	0.1	80	83		
				C_2	—	0.5	80	64		
15d	$CONHCO-CH_2CH_3$	CH_3	CH_3	C_2	—	0.5	80	35	165—168	B
15e	$CONHCO-CH_2CH_3$	CH_3	C_6H_5	C_2	—	0.5	80	65	138—140	B
15f	$CONHCO-CH_2CH_3$	CH_2CH_3	CH_3	C_2	—	0.5	80	42	173—174	B
16	COOH	CH_3	C_6H_5	A	M[f]	10	66	42	173—175 (decomp.)	B
17a	CN	X=Cl	CH_3	A	W[c]	10	0—r.t.	63	145—147	B
17b	CN	Cl	C_6H_5	A	W[c]	10	0—r.t.	80	137—138	B
18	$COOCH_3$	Cl	C_6H_5	A	W[c]	10	0—r.t.	89	107—113	B-H
22a	CN	C_6H_5	CH_3	A	M-W[c]	5	66	84	142—144	B-H
22b	CN	C_6H_5	C_6H_5	A	M[f]	5	66	60	161—163	B
22c	CN	n-C_4H_9	C_6H_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 3*b*)
f) KOH was used as the base.
g) 2-Acetylamino-3-chloro-3-phenylthio-N-*t*-butylacrylamide (**19**, 5% yield) was also isolated. mp 190—199° (from CH_3CN)
h) Et_3N was used as the base.
i) 2-Acetylamino-3-chloro-3-phenylthio-N-acetylacrylamide (**20**, 34% yield) was also isolated. mp 185—190° (decomp.) (from CH_3CN)



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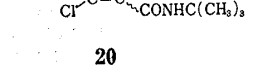


20

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.

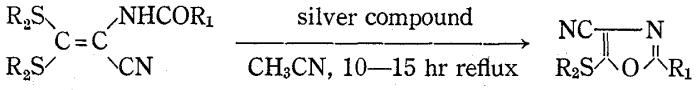
For the preparation of the N-acylacrylamide derivatives (**15**), two methods are available: (A) nucleophilic substitution of the chlorine atoms of **10**, (C) direct one-step conversion of the cyano group of **5** and **6** into the $CONHCOR_1(R)$ group with the acylating agent in the presence of a 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 $NHCOCH_3$ 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**)



5a–m **4a–m**

Ent.	4		Compd. No.	Yield (%)	mp (°C)	Reagent	(molar eq.)
	R_1	R_2					
1	H	CH_3	**4a**	72	oil	Ag_2CO_3	(3)
2	H	CH_2CH_3	**4b**	75	oil	$Ag_2CO_3+Ag_2O$	(3)+(3)
3	H	C_6H_5	**4c**	72	oil	Ag_2CO_3	(4)
4	CH_3	CH_2CH_3	**4e**	86[a]	oil	Ag_2CO_3	(3)
5	CH_3	n-C_4H_9	**4f**	77[b]	oil	Ag_2CO_3	(3)
6	CH_3	C_6H_5	**4g**	99	oil	Ag_2CO_3	(4)
7	CH_3	CH_2-$C_6H_4Cl(p)$	**4h**	92[c]	63—65[d]	Ag_2CO_3	(4)
8	CH_2CH_3	CH_3	**4i**	95	oil	Ag_2CO_3	(3)
9	CH_2CH_3	C_6H_5	**4j**	99	oil	Ag_2O	(4)
10	$CH_2CH_2CH_3$	CH_3	**4k**	97	oil	Ag_2CO_3	(3)
11	$CH_2CH_2CH_3$	C_6H_5	**4l**	95	oil	Ag_2CO_3	(4)
12	CF_3	C_6H_5	**4m**	—[e]	—	Ag_2CO_3 or Ag_2O	(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

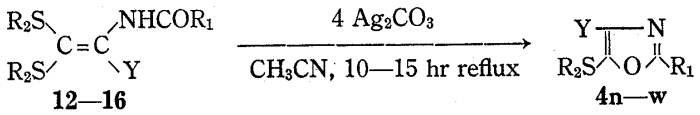
tion using a silica gel column, in almost quantitative yields, except Ent. 1—3, the yields of which were somewhat lower (72—75%) because of the reduced stabilities of both starting materials and oxazoles under the reaction conditions (Table III).

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*-$ClC_6H_4CH_2$ (Ent. 7).

Similar treatment of **12—15**, which have a $COOCH_3$, $CONH_2$, $CONHC(CH_3)_3$, or $CONHCOR_1$(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**)



12—16 **4n—w**

Ent.	4 Y	4 R_1	4 R_2	Compd. No.	Yield (%)	mp (°C)	Recryst. solvent[a]
1	$COOCH_3$	CH_3	C_6H_5	**4n**	96	oil	—
2	$CONH_2$	CH_3	CH_3	**4o**	89	238—239 (decomp.)	A
3	$CONH_2$	CH_3	C_6H_5	**4p**	90	160—161	B
4	$CONHC(CH_3)_3$	CH_3	C_6H_5	**4q**	92	72— 73	H
5	$CONHCOCH_3$	CH_3	CH_3	**4r**	86	105—106	B
6	$CONHCOCH_3$	CH_3	CH_2CH_3	**4s**	44	50— 51	H
7	$CONHCOCH_3$	CH_3	C_6H_5	**4t**	87[c]	105—107	B-H
8	$CONHCOCH_2CH_3$	CH_3	CH_3	**4u**	75	57— 59	H
9	$CONHCOCH_2CH_3$	CH_3	C_6H_5	**4v**	87	63— 64	B-H
10	$CONHCOCH_2CH_3$	CH_2CH_3	CH_3	**4w**	77	57— 59	H
11	COOH	CH_3	C_6H_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) C_6H_5S, H, C=C, C_6H_5S, $NHCOCH_3$ (**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 $CONH_2$.

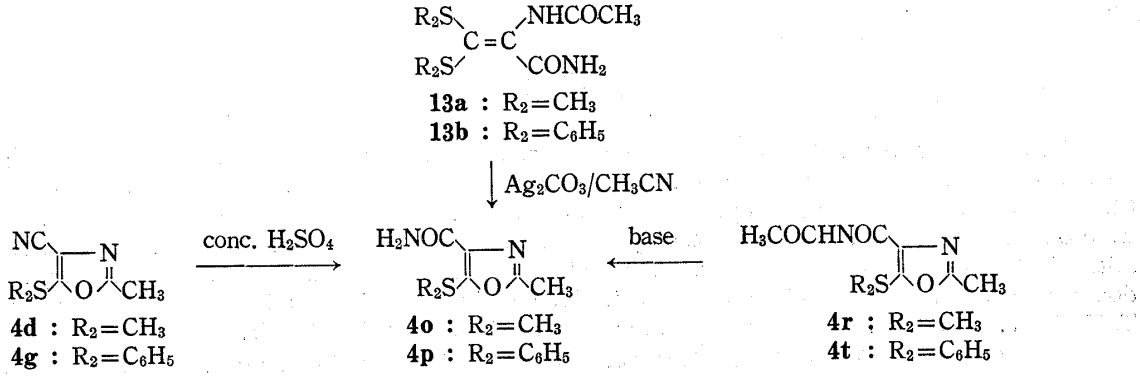


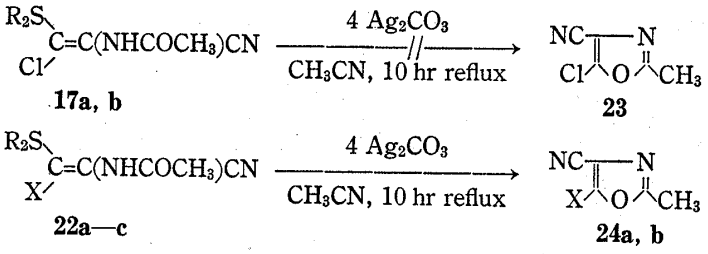
Chart 3

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**)



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		
4	C_6H_5		**22b**	99	48—50	H
5	n-C_4H_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-Acylamino-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 anhydride[10] 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 C_1: 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 C_2: 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 ν_{max}^{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)	$C_6H_8ON_2S_2$	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)	$C_8H_{12}ON_2S_2$	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)	$C_{16}H_{12}ON_2S_2$	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)	$C_{13}H_{22}ON_2S_2$	—	—	—[b]
5g	3250, 2220, 1675sh, 1665, 1558	($CDCl_3$) 2.02 (3H, s), 7.16 (10H, s), 7.72 (1H, br)	$C_{17}H_{14}ON_2S_2$	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)	$C_{19}H_{16}ON_2S_2Cl_2$	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)	$C_8H_{12}ON_2S_2$	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)	$C_{18}H_{16}ON_2S_2$	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)	$C_9H_{14}ON_2S_2$	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)	$C_{19}H_{18}ON_2S_2$	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)	$C_{17}H_{11}ON_2S_2F_3$	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)	$C_{18}H_{17}O_3NS_2$	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)	$C_7H_{12}O_2N_2S_2$	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)	$C_{17}H_{16}O_2N_2S_2$	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)	$C_{21}H_{24}O_2N_2S_2$	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)	$C_9H_{14}O_3N_2S_2$	41.08 (41.20)	5.28 (5.38)	10.93 (10.68)

Compd. No.	IR ν_{max}^{Nujol} 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)	$C_{11}H_{18}O_3N_2S_2$	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)	$C_{19}H_{18}O_3N_2S_2$	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)	$C_{10}H_{16}O_3N_2S_2$	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)	$C_{20}H_{20}O_3N_2S_2$	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)	$C_{11}H_{18}O_3N_2S_2$	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)	$C_{17}H_{15}O_3NS_2$	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)	$C_6H_7ON_2SCl$	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)	$C_{11}H_9O_3SNCl$	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)	$C_{12}H_{12}O_3NSCl$	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)	$C_{15}H_{19}O_2N_2S_2Cl$	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)	$C_{13}H_{13}O_3N_2SCl$	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)	$C_{12}H_{12}ON_2S$	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)	$C_{17}H_{14}ON_2S$	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)	$C_{15}H_{18}ON_2S$	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 (M^+–CH_2=C=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 (M^+–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 ν_{max}^{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)	$C_5H_4ON_2S$	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)	$C_6H_6ON_2S$	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)	$C_{10}H_6ON_2S$	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)	$C_6H_6ON_2S$	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)	$C_7H_8ON_2S$	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)	$C_9H_{12}ON_2S$	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)	$C_{11}H_8ON_2S$	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)	$C_{12}H_9ON_2SCl$	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)	$C_7H_8ON_2S$	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)	$C_{12}H_{10}ON_2S$	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)	$C_8H_{10}ON_2S$	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)	$C_{13}H_{12}ON_2S$	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)	$C_{12}H_{11}O_3NS$	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)	$C_6H_8O_2N_2S$	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]	$C_{11}H_{10}O_2N_2S$	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)	$C_{15}H_{18}O_2N_2S$	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)	$C_8H_{10}O_3N_2S$	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)	$C_9H_{12}O_3N_2S$	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)	$C_{13}H_{12}O_3N_2S$	56.69 (56.51)	4.23 (4.38)	10.22 (10.14)

Compd. No.	IR ν_{max}^{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)	$C_9H_{12}O_3N_2S$	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)	$C_{14}H_{14}O_3N_2S$	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)	$C_{10}H_{14}O_3N_2S$	49.37 (49.57)	5.87 (5.82)	11.40 (11.56)
24a[b]	2210, 1595, 1586, 1568	2.53 (3H, s), 7.30—7.63 (3H, m), 7.63—8.03 (2H, m)	$C_{11}H_8ON_2$	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)	$C_9H_{12}ON_2$	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 (M^+-SCH_3 55%), 79 (100%), 43 (35%); UV $\lambda_{max}^{CHCl_3}$ nm (ε): 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 $\lambda_{max}^{CHCl_3}$ nm (ε): 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 $\lambda_{max}^{CHCl_3}$ nm (ε): 282 (6540)
g) UV $\lambda_{max}^{CHCl_3}$ nm (ε): 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 $\lambda_{max}^{CHCl_3}$ nm (ε): 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 Rf 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 ν_{max}^{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 (M^+-1, 12%), 259 ($M^+-CH_2=C=O$, 10%), 241 (9%), 192 ($M^+-C_6H_5S$, 100%), 151 ($M^+-CH_2=C=O-C_6H_5S$, 38%), 121 ($CSC_6H_5^+$, 28%). *Anal.* Calcd. for $C_{16}H_{15}ONS_2$: C, 63.75; H, 5.02; N, 4.65. Found: C, 63.98; H, 5.18; N, 4.64.

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