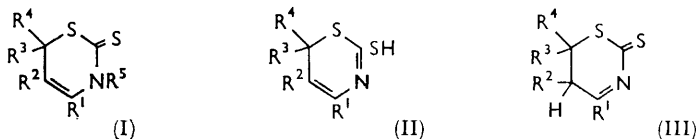


## 760. Cyclic Derivatives of Dithiocarbamic Acids.

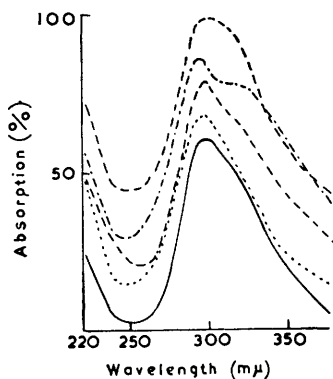
By J. L. GARRAWAY.

The preparation of some 2,3-dihydro-2-thio-1,3-thiazines and their 3-methyl analogues is described. The ultraviolet spectra and stability of these compounds are discussed.

DURING investigations on fungicidal activity, the formation of 2,3-dihydro-2-thio-1,3-thiazines (I) from  $\beta$ -(thiocarbamoylthio)-substituted aldehydes and ketones<sup>1</sup> was studied.



Cyclic compounds (I;  $R^1 = \text{Me}$ ,  $R^5 = \text{H}$ ) derived from  $\beta$ -(thiocarbamoylthio)-ketones have been reported, but the preparation of cyclic derivatives of  $\beta$ -(thiocarbamoylthio)-aldehydes (I;  $R^1 = \text{H}$ ,  $R^5 = \text{H}$ )<sup>2</sup> has proved difficult. Such compounds were obtained by treating  $\beta$ -(thiocarbamoylthio)-aldehydes with 20% acetic acid in acetic anhydride at 120—150°. New derivatives (I;  $R^5 = \text{Me}$ ) of *N*-methylthiocarbamic acid were also obtained by the elimination of water from the corresponding  $\beta$ -(*N*-methylthiocarbamylthio)-aldehydes and -ketones by means of acetic anhydride.



Spectra of 2,3-dihydro-2-thio-1,3-thiazine (1) (—) and its 3-methyl (6) (·····), 4-methyl (5) (---), 5-methyl (2) (— · — · —) and 6-methyl (3) (— — —) analogues in water. Each spectrum, except the first, is displaced 10% relative to that below it for clarity.

Ultraviolet (u.v.) absorption spectra ( $\log \epsilon \geq 3$ , 220—400  $m\mu$ ; Tables 1 and 2) were determined for each compound in alcohol and water. The effects of acid and alkali on the spectra and stabilities of these compounds were also assessed.

*Derivatives of Dithiocarbamic Acid* (I;  $R^5 = \text{H}$ ; Table 1).—Compounds having alkyl substituents only (1—8) exhibited one band in alcohol at approximately 310—320  $m\mu$ , whilst in water two bands were observable at 320 and 290  $m\mu$ . A third band, of lower intensity, was observed in the region 360—380  $m\mu$  with some compounds. The spectra remained unchanged in the presence of acid, but alkaline conditions in alcohol resulted in a band at 270—290  $m\mu$ . Since the spectra of the 3-methyl analogues (16—20) are unaffected by alkali, the modification is probably due to thione–thiol tautomeric change, and so the thiol form (II) is unlikely to exist in neutral solution. The effects of the presence and position of a methyl substituent on the absorption spectrum are summarised in the Figure, where it can be seen that the maximum effect is exerted at the 5-position.

<sup>1</sup> Garraway, preceding Paper.

<sup>2</sup> Jansen and Mathes, *J. Amer. Chem. Soc.*, 1955, **77**, 2866.

Compounds of this group were stable in neutral and alkaline solutions, but certain members (1, 3, 5, 6, and 7) decomposed in the presence of acid to form products having spectra corresponding to the parent  $\beta$ -(thiocarbamoylthio)-aldehydes and -ketones. Methyl substitution at the 4-position appeared to promote instability; whilst substitution at the 6-position improved stability, 5-methyl-substituted compounds were the most stable.

TABLE I.

Derivatives of dithiocarbamic acid (I; R <sup>5</sup> = H).														
No.	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	Method of prepn.	Yield (%)	M. p.	Formula	Nitrogen (%)		$\lambda_{\max.}$ (m $\mu$ ) and log $\epsilon$			
									Found	Reqd.	in water		in alcohol	
1	H	H	H	H	A, C	3, 10	106—107°	C <sub>4</sub> H <sub>5</sub> NS <sub>2</sub>	10.22	10.07	300	4.08	315	4.04
											S325	?		
2	H	Me	H	H	A	10	145—146	C <sub>5</sub> H <sub>7</sub> NS <sub>2</sub>	9.62	9.65	295	4.01	322	3.93
											318	3.92		
											~360	?		
3	H	H	Me	H	A, C	5, 21	94—95	C <sub>5</sub> H <sub>7</sub> NS <sub>2</sub>	9.76	9.65	302	4.07	320	4.09
											S320	?		
4	H	Me	Me	H	A	10	115—116	C <sub>6</sub> H <sub>9</sub> NS <sub>2</sub>	8.57	8.79	294	3.96	323	4.06
											317	3.99		
											~360	?		
5	Me	H	H	H	A	12	88—89	C <sub>5</sub> H <sub>7</sub> NS <sub>2</sub>	9.59	9.65	298	4.04	310	3.97
											S320	?		
											~360	?		
6	Me	H	Me	H	A	17	103—104	C <sub>6</sub> H <sub>9</sub> NS <sub>2</sub>	8.53	8.79	297	4.01	318	4.04
											S317	?		
7	Me	Me	Me	H	B	10	130—131	C <sub>7</sub> H <sub>11</sub> NS <sub>2</sub>	8.02	8.08	290	3.92	320	4.02
											318	3.93	380	?
											~360	?		
8	Me	H	Me	Me	B	18	94—96 *	C <sub>7</sub> H <sub>11</sub> NS <sub>2</sub>	8.29	8.08	298	4.01	318	4.09
											S311	?		
9	H	H	Ph	H	A, C	9, 6	134—135	C <sub>10</sub> H <sub>9</sub> NS <sub>2</sub>	6.83	6.76	307	4.08	323	4.10
10	Me	H	Ph	H	A	11	147—148 *	C <sub>11</sub> H <sub>11</sub> NS <sub>2</sub>	6.27	6.33	305	4.06	323	4.08
											S325	?		
11	Me	Me	Ph	H	A	27	183—184 †	C <sub>12</sub> H <sub>13</sub> NS <sub>2</sub>	6.14	5.96	299	— †	325	4.03
											321	—		
											~360	—		
12	Ph	H	Ph	H	A	16	126—127 *	C <sub>16</sub> H <sub>13</sub> NS <sub>2</sub>	5.07	4.94	251	4.22	248	4.29
											~310	~4.00		
											~325	~3.97	328	4.05
13	Me	H	CCl <sub>3</sub>	H	B	10	173—174 †	C <sub>6</sub> H <sub>6</sub> Cl <sub>3</sub> NS <sub>2</sub>	5.19	5.33	S291	3.76	S290	?
											320	4.03	327	4.04
													S360	?
14	Me	Me	CCl <sub>3</sub>	H	A	50	95—96	C <sub>7</sub> H <sub>8</sub> Cl <sub>3</sub> NS <sub>2</sub>	5.24	5.06	S290	~3.74	S290	?
											320	4.03	326	4.07
													S360	?
15	Ph	H	CCl <sub>3</sub>	H	B	16	120—121	C <sub>11</sub> H <sub>8</sub> Cl <sub>3</sub> NS <sub>2</sub>	4.15	4.31	250	— †	247	4.16
											293	—		
											325	—	328	4.01

\* Jansen and Mathes (*loc. cit.*) give the following m. p.s: compound 8, 96—97°; 10, 145°; 12, 125—126°. † Solubility in water too low. ‡ Melting with decomposition.

The spectra and stabilities of compounds having a 6-phenyl group (9—11) followed a similar pattern. A phenyl grouping at the 4-position (12 and 15) resulted in an absorption band at 247 m $\mu$ .

Small differences were observed in the spectra of trichloromethyl-substituted compounds (13 and 14). In neutral alcohol a band, which did not undergo the expected hypsochromic shift on passing to aqueous solution, was present at 290 m $\mu$ . Extra bands were also observed at 250 and 360 m $\mu$  in the presence of alkali.

*Derivatives of N-Methyldithiocarbamic Acid* (I; R<sup>5</sup> = Me; Table 2).—The spectra of alkyl- and aryl-substituted compounds (16—23) of this group closely resembled those of their dithiocarbamic-acid analogues discussed above. An additional band was observed at 265—270 m $\mu$  in alcohol with compounds possessing a 5-methyl group. The close

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similarity between the spectra of derivatives of dithiocarbamic and *N*-methyldithiocarbamic acids would seem to discount alternative structures (II and III) for the former group of compounds. As expected, alkali had no effect on the absorption spectra, but the presence of acid produced an intense band at 240—260  $m\mu$  with certain compounds (17—19).

TABLE 2.

Derivatives of *N*-methyldithiocarbamic acid (I; R<sup>5</sup> = Me).

No.	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	Method of prepn.	Yield (%)	M. p.	Formula	Nitrogen (%) Found	Nitrogen (%) Req'd.	$\lambda_{\max.}$ ( $m\mu$ ) and log $\epsilon$			
											in water		in alcohol	
16	H	H	H	H	A	11	41—42.5°	C <sub>5</sub> H <sub>7</sub> NS <sub>2</sub>	9.81	9.65	298	4.04	308	4.01
17	H	Me	H	H	A, B	11, 6	60—61.5	C <sub>6</sub> H <sub>9</sub> NS <sub>2</sub>	8.71	8.80	S~320 293	3.98	S270	3.34
											S312	3.88	312	3.70
18	H	H	Me	H	A	8	41—42.5	C <sub>6</sub> H <sub>9</sub> NS <sub>2</sub>	8.63	8.80	298	4.01	310	4.03
19	H	Me	Me	H	A	28	104—105	C <sub>7</sub> H <sub>11</sub> NS <sub>2</sub>	8.18	8.09	S~320 294	?	270	3.45
											S312	3.93	315	3.78
20	Me	H	Me	Me	A	26	58—59	C <sub>8</sub> H <sub>13</sub> NS <sub>2</sub>	7.63	7.48	297	4.02	S273	3.59
													310	3.97
21	H	H	Ph	H	A	22	101—102	C <sub>11</sub> H <sub>11</sub> NS <sub>2</sub>	6.35	6.33	305	4.11	314	4.12
22	Me	H	Ph	H	A	43	80.5—81.5	C <sub>12</sub> H <sub>13</sub> NS <sub>2</sub>	6.14	5.96	303	4.06	310	4.02
23	Me	Me	Ph	H	A	54	162—163	C <sub>13</sub> H <sub>15</sub> NS <sub>2</sub>	5.47	5.62	S~320 300	?	265	3.65
											S~315	?	314	4.02
24	Me	H	CCl <sub>3</sub>	H	A	39	101—102	C <sub>7</sub> H <sub>5</sub> Cl <sub>3</sub> NS <sub>2</sub>	5.22	5.06	S267	3.61	268	3.64
											315	3.90	318	3.96
25	Me	Me	CCl <sub>3</sub>	H	A	15	64—66	C <sub>8</sub> H <sub>10</sub> Cl <sub>3</sub> NS <sub>2</sub>	4.89	4.82	S270	3.62	270	3.63
											314	3.89	316	3.99
26	Ph	H	CCl <sub>3</sub>	H	A	40	166—168 †	C <sub>12</sub> H <sub>10</sub> Cl <sub>3</sub> NS <sub>2</sub>	4.32	4.13	—	—*	240	4.12
													?	?
													321	4.04

\* Solubility in water too low. † Melting with decomposition.

Compounds with alkyl substituents only (16—20) appeared to be unstable in neutral and acid solutions, whilst aryl-substituted derivatives (21—23) were also unstable in the presence of alkali. The nature of these reactions could not be established but did not appear to involve the formation of the parent  $\beta$ -(*N*-methylthiocarbamoylthio)-aldehydes and -ketones.

Trichloromethyl-substituted derivatives (24 and 25) differed slightly from the other members of this group by the presence of a band at 267—270  $m\mu$ , which became more intense in the presence of alkali. These compounds also underwent unidentified spectral changes in neutral, acid, and alkaline alcoholic solution.

Detailed results of fungitoxicity tests will be published elsewhere.

## EXPERIMENTAL

The following preparations are examples of the methods used:

*2,3-Dihydro-3,4-dimethyl-6-phenyl-2-thio-1,3-thiazine* (22) (*Method A*).—4-(*N*-Methylthiocarbamoylthio)-4-phenylbutan-2-one<sup>1</sup> (5.0 g.) was shaken for 18 hr. with acetic anhydride (50 ml.) and concentrated sulphuric acid (5 drops). The solution was poured into water and after decomposition of excess of acetic anhydride the yellow solid was filtered off and dried. The *product* (4.4 g.) was recrystallised as pale yellow plates from rectified spirit.

*2,3-Dihydro-4-methyl-6-trichloromethyl-2-thio-1,3-thiazine* (13) (*Method B*).—5,5,5-Trichloropent-3-en-2-one (9.0 g.) was dissolved in rectified spirit (150 ml.) and concentrated hydrochloric acid (5.0 ml.). Ammonium dithiocarbamate (6.0 g.) dissolved in a minimum volume of water was then added at 10°. After 4 hours' stirring the mixture was poured into excess of water, and the yellow solid filtered off and dried. The *product* (9.8 g.) was recrystallised from benzene as pale yellow crystals.

*2,3-Dihydro-2-thio-1,3-thiazine* (1) (*Method C*).— $\beta$ -(Thiocarbamoylthio)propionaldehyde<sup>1</sup>

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(5.5 g.) was heated with 20% acetic acid in acetic anhydride (50 ml.) at 130—140° for  $\frac{1}{2}$  hr. The mixture was poured into water (400 ml.), left 2 hr., filtered, saturated with salt, and cooled to -5°. The precipitate was dried and the *product* (1.4 g.) crystallised from 25% petroleum-benzene, forming yellow needles.

The u.v. absorption spectra and stabilities were studied as described in the preceding Paper. <sup>1</sup>

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