The Reactions of 2-Arylacetylene-1-sulfonamides with Heterocumulenes

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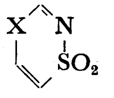
The syntheses of new heterocyclic compounds by the reaction of 2-arylacetylene-1-sulfonamides **1**, (*Z*)-*β*-bromo- **12** or (*Z*)-*α*-chloro-*β*-styrenesulfonamides **13** with heterocumulenes are described. Weak base treatment of ureas $R^1C_6H_4C{\equiv}CSO_2NHC(=O)NHR^2$ prepared from **1** and isocyanates gave 2-amino-6-aryl-1,4,3-oxathiazine 4,4-dioxides, whereas strong base treatment of the ureas afforded 3-oxo-4,5-diphenyl-2,3-dihydro-1,2,4-thiadiazine 1,1-dioxides where R^2 is a phenyl group. The thiadiazines were also prepared by the strong base treatment of *N*-((*Z*)-*α*-bromo- or (*Z*)-*β*-chlorostyrylsulfonyl)-*N′*-phenylureas. The reaction of **1**, **12**, or **13** with isothiocyanates in the presence of weak base gave 3-amino-5-aryl-1,4,2-dithiazine 1,1-dioxides, but the major products produced were 3-amino-5-benzylidene-1,4,2-dithiazole 1,1-dioxides when **12a** was treated with isothiocyanates in the presence of strong base. The reaction of **1** with carbon disulfide and dimethyl sulfate in the presence of 5 M NaOH afforded 3-methylthio-5-benzylidene-1,4,2-dithiazole 1,1-dioxide with a small amount of 3-methylthio-5-aryl-1,4,2-dithiazine 1,1-dioxide. A mixture of both isomers was also prepared from **12a**. Possible mechanisms for the formation of the heterocycles from **1**, **12**, or **13** are suggested.

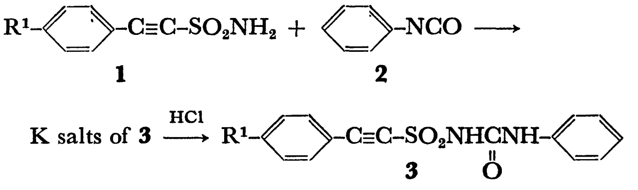
The syntheses of 5,6-dihydro-1,4,2-dithiazine 1,1-dioxide and 5,6-dihydro-1,2,4-thiadiazine 1,1-dioxide rings from *β*-styrenesulfonamides have been reported.[1–3] The synthesis of hitherto unknown 5,6-unsaturated heterocyclic systems is reported here. Since triple bonds are more susceptible to nucleophilic attack than double bonds,[4] reactions of 2-arylacetylene-1-sulfonamides **1**[5] with heterocumulenes such as isocyanate, isothiocyanate and carbon disulfide were investigated. This paper describes the syntheses of new 1,4,3-oxathiazine 4,4-dioxide, 2,3-dihydro-1,2,4-thiadiazine 1,1-dioxide, 1,4,2-dithiazine 1,1-dioxide and 1,4,2-dithiazole 1,1-dioxide derivatives. These heterocycles were also prepared from (*Z*)-*β*-bromo- **12**[5] and (*Z*)-*α*-chloro-*β*-styrenesulfonamides **13**.[5]



X=O, S

Results and Discussion

Reaction of the Sulfonamides with Isocyanates. A mixture of **1**, phenyl isocyanate **2** and K_2CO_3 in acetone was stirred for 30 min at 0—5 °C. Analytically pure potassium salts of *N*-(arylethynylsulfonyl)-*N′*-phenylureas **3** subsequently separated out. As the salts were immediately cyclized to 2-phenylamino-6-aryl-1,4,3-oxathiazine 4,4-dioxides **6** when dissolved in water,



1 **2**

3

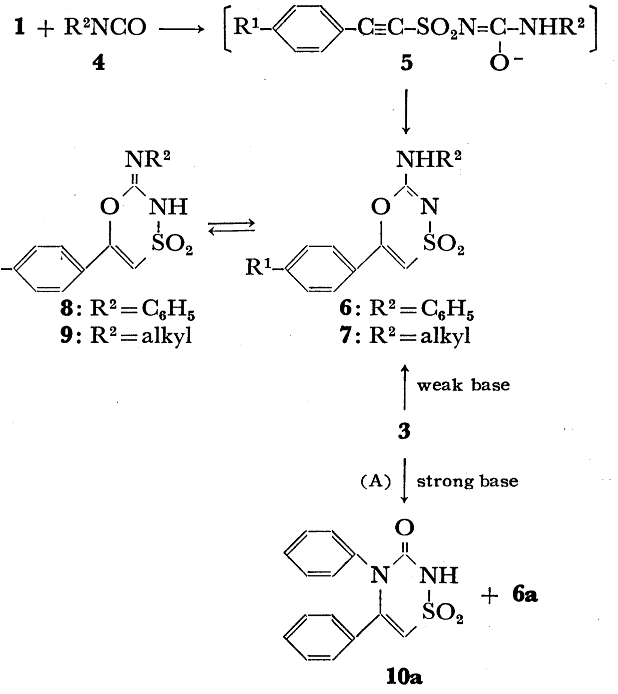
the sulfonylureas **3** were prepared by suspending the salts in aqueous 9 M HCl. All of the ureas **3** thus

TABLE 1. LIST OF THE UREAS **3**, **11**, **14**, AND **15**, AND THE THIOUREA **19**

Compd	R^1	R^2	Yield path(%)	Mp (°C)	Found % C	Found % H	Found % N	Found % S	Calcd % C	Calcd % H	Calcd % N	Calcd % S
3a	H		71	260—262	60.07	4.01	9.13		60.00	4.03	9.33	
3b	Cl		64	274—276	53.58	3.48	8.10	9.59	53.82	3.31	8.37	9.58
3c	Br		56	275—276	45.42	2.91	7.15	8.64	45.71	2.92	7.39	8.46
3d	CH_3		75	274—276	60.94	4.63	8.76		61.14	4.49	8.91	
11a	H	CH_3	D(85), E(84), F(80)	163—164	47.17	4.64	10.86	12.50	46.88	4.72	10.93	12.51
11b	H	C_2H_5	D(74), E(89)	154—156	49.13	5.26	10.16	11.61	48.89	5.22	10.37	11.86
11c	H	C_6H_{13}	E(51), F(80)	185—186	55.78	6.39	8.61		55.55	6.22	8.64	
11d	H	C_6H_5	D(43)	152—154	56.33	4.20	8.55		56.59	4.43	8.80	
14a	H	CH_3	87	206—207	37.86	3.55	8.75	10.12	37.63	3.45	8.78	10.05
14b	H	C_2H_5	90	216—217	39.90	3.71	8.26		39.65	3.93	8.41	
14c	H	C_6H_{13}	87	178—180	46.45	5.14	7.47	8.30	46.52	4.95	7.23	8.28
14d	H	C_6H_5	93	158—160	47.17	3.42	7.19	8.42	47.25	3.44	7.35	8.41
14e	Cl	C_6H_5	77	163—165	43.58	3.15	6.91		43.33	2.91	6.74	
15a	H	CH_3	86	208—209	43.76	4.00	10.14	11.65	43.72	4.04	10.20	11.67
15b	H	C_2H_5	59	176—178	45.60	4.69	9.56	11.18	45.75	4.54	9.70	11.10
15c	H	C_6H_{13}	89	189—190	52.81	5.30	8.11	9.07	52.55	5.59	8.17	9.35
15d	H	C_6H_5	94	166—168	53.76	3.98	8.28	9.51	53.49	3.89	8.32	9.52
19			72	108—113	41.58	4.05	9.90	21.93	41.30	3.82	9.64	22.05

obtained was analytically pure. Recrystallization was not attempted because of ready cyclization to **6**. The results are summarized in Table 1. The IR spectra of **3a**—**d** displayed absorption bands at 1670—1680 (C=O) and 2185—2195 (C≡C) cm^{-1}. The NMR and mass spectra were identical with those of **6a**—**d**.

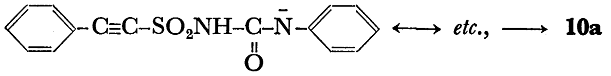
1 reacted with alkyl isocyanates **4** to give only 2-alkylamino-6-aryl-1,4,3-oxathiazine 4,4-dioxides **7** as shown in Scheme 1.



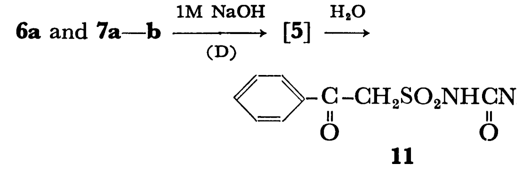
Scheme 1.

Treatment of **3a**—**d** with weak base (0.01—0.1 M K_2CO_3) gave a mixture of **6a**—**d** and their "imino" isomers **8a**—**c** (Table 2). Although "imino" isomers **9** were not isolated, the equilibrium between **7** and **9** (about 3: 1) in DMSO-d_6 was established by estimating the peak areas of the doublet due to NH**CH$_3$** protons (δ=2.77, J=4.0 Hz) and the singlet due to NCH_3 protons (δ=2.76) in the NMR spectra of **7a**, **7d**, and **7e**.

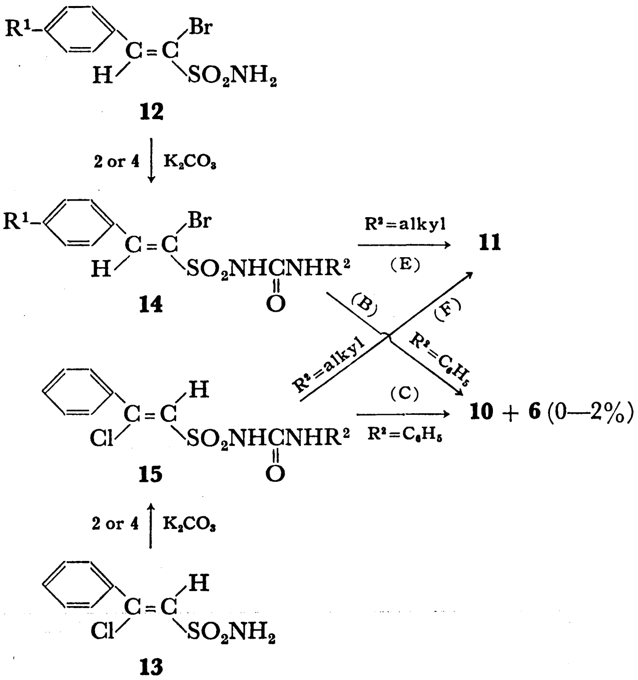
Treatment of **3a** with strong base (1 M NaOH) at 45—50 °C for 4 h afforded a 96: 4 mixture of 3-oxo-4,5-diphenyl-2,3-dihydro-1,2,4-thiadiazine 1,1-dioxide **10a** and **6a**. **10a** was purified by fractional recrystallization (path A in Table 2). Aqueous 1 M NaOH has sufficient basicity to abstract a N'-proton from **3** and the resulting amide ion stabilized by a phenyl group seems to be responsible for the thiadiazine formation. The structures of **6**—**8** and **10a** were assigned on the basis of analytical and spectral data. The IR spectra of **6** and **7** showed C=N absorption bands adjacent to a SO_2 group at a lower frequency (1640 cm^{-1}) than those of **8** (1680 cm^{-1}). The IR spectrum of **10a** displayed absorption bands at 1680 (C=O) and 3080 (NH) cm^{-1}. These values are similar to the frequencies reported for 3-oxo-4-alkyl-5-aryl-2,3,5,6-tetrahydro-1,2,4-thiadiazine 1,1-dioxides.[3] The mass spectra of the oxathiazines **6**, **7** and **8** and **10a** showed fragment peaks assigned to $R^1C_6H_4CO^+$ and $C_6H_5CN^+C_6H_5$, respectively. The NMR spectra of **6**—**8** and **10a** displayed singlet CH signals in the region described in Table 2.



Strong base treatment of **6a** and **7a**—**b** gave N'-substituted N-(benzoylmethylsulfonyl)ureas **11** (path D in Table 1). A possible driving force for C–O fission is the abstraction of a vinyl proton on C_5 activated by an adjacent sulfonyl group.



The thiadiazines **10** were also prepared from **14** (path B) or **15** (path C) under reaction conditions similar to those described in path A. **11** was prepared when R^2 groups in **14** and **15** are alkyls. The paths are illustrated in Scheme 2 and the results summarized in Tables 1 and 2. Two mechanisms for the formation of **10** are conceivable: (a) dehydrohalogenation followed by addition, or (b) addition followed by dehydrohalogenation. The mechanisms are similar to those suggested in the cyclization of N-(α-bromostyrylsulfonyl)amidines.[6] The reaction of **7a**, **14**, or **15** with 1 M NaOH proceeds slowly even at 10—20 °C, but attempts to detect and isolate the intermediates by IR and high-speed liquid chromatography were unsuccessful. At present it has not been established whether the reactions in paths B, C, E, and F involve the mechanism (a) or (b). N-(Styrylsulfonyl)-N'-alkyl(or phenyl)ureas[7] gave no cycloadducts as compared with ready cyclization of **3**, **14**, and **15**.



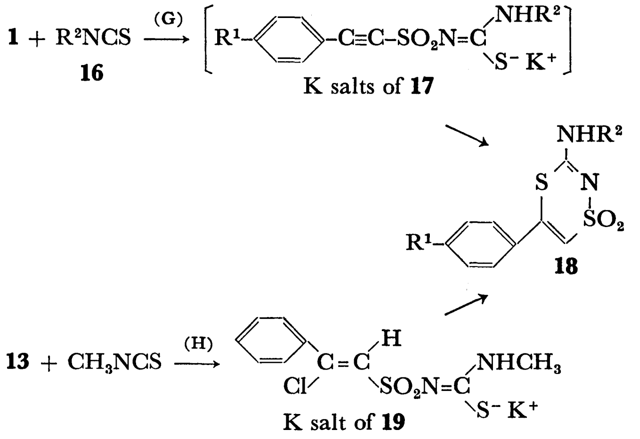
Scheme 2.

TABLE 2. LIST OF HETEROCYCLES

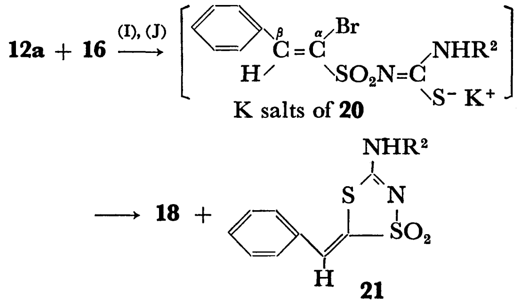
Compd	R^1	R^2	Yield path (%)	Mp (°C)	δ_{CH} (ppm)	$\lambda_{\max}^{C_2H_5OH}$ ($\varepsilon_{\max}$)	Found % (Calcd %)			
							C	H	N	S
6a	H	C_6H_5	77	274—275	7.70	257 (18900)	60.14 (60.00	4.29 4.03	9.56 9.33	10.69 10.66)
6b	Cl	C_6H_5	73	279—280	a)	263 (17700)	53.57 (53.81	3.52 3.31	8.09 8.37	9.60 9.76)
6c	Br	C_6H_5	71	276—277	a)	258 (23800)	47.39 (47.50	2.90 2.92	7.26 7.39	8.68 8.46)
6d	CH_3	C_6H_5	90	277—278	7.62	262 (19700)	61.18 (61.14	4.60 4.49	8.66 8.91	10.17 10.18)
7a	H	CH_3	45$^{b)}$	230—231	7.56	260 (14800)	50.59 (50.42	4.07 4.23	11.61 11.76	13.28 13.46)
7b	H	C_2H_5	59$^{b)}$	203—204	7.60	260 (14000)	52.47 (52.38	4.52 4.80	11.19 11.11	12.68 12.71)
7c	H	C_6H_{13}	69$^{b)}$	211—213	7.60	266 (12600)	58.64 (58.81	6.05 5.92	8.88 9.15	9.65 10.47)
7d	Cl	CH_3	49$^{b)}$	238—239	7.64	266 (14800)	43.93 (44.13	3.36 3.33	10.14 10.30	11.32 11.76)
7e	Br	CH_3	55$^{b)}$	242—243	7.60	270 (16100)	38.03 (37.87	2.57 2.86	8.88 8.83	10.11 10.11)
8a	H	C_6H_5	9	169—170	c)	257 (19600)	59.80 (60.00	4.03 4.03	9.56 9.33)	
8b	Cl	C_6H_5	18	156—158	c)	262 (21500)	53.94 (53.81	3.37 3.31	8.17 8.37)	
8c	Br	C_6H_5	19	186—187	8.12	263 (22600)	47.33 (47.50	2.67 2.92	7.20 7.39)	
10a	H		A(40),$^{b)}$ B(58)$^{b)}$ C(55)$^{b)}$	188—190	6.85	247 (10900)	59.76 (60.00	4.19 4.03	9.14 9.33	10.67 10.66)
10b	Cl		B(56)$^{b)}$	198—200	6.82	247 (11700)	54.05 (53.81	3.28 3.31	8.15 8.36)	
10c	CH_3		B(53)$^{b)}$	202—204	c)	252 (11500)	61.18 (61.13	4.59 4.59	8.90 8.90)	
18a	H	CH_3	G(35)$^{b)}$, H(34)$^{b)}$, I(41)$^{b)}$, M(66)$^{b)}$	188—190	7.55	244 (17500)	47.12 (47.25	3.71 3.97	11.18 11.02	25.08 25.20)
18b	H	C_2H_5	G(25)$^{b)}$, I(40)$^{b)}$, M(58)$^{b)}$	184—186	7.60	244 (18200)	49.51 (49.25	4.50 4.51	10.43 10.54	23.65 23.87)
18c	H	C_6H_5	G(35)$^{b)}$, I(42)$^{b)}$	247—248	d)	274 (22300)	56.65 (56.94	3.74 3.82	8.64 8.86	20.03 20.23)
18d	Cl	CH_3	G(26)$^{b)}$	256—258	7.70	248 (18800)	41.81 (41.59	3.10 3.14	9.64 9.70	21.73 22.20)
18e	Br	CH_3	G(33)$^{b)}$	268—270	7.84	251 (18700)	36.19 (36.04	2.86 2.72	8.28 8.41	19.03 19.24)
18f	CH_3	CH_3	G(36)$^{b)}$	185—186	7.55	249 (16000)	49.38 (49.25	4.35 4.51	10.21 10.45	23.82 23.86)
21a	H	CH_3	J(58)$^{b)}$	210—212	7.62	296 (20900)	47.14 (47.25	4.15 3.97	10.82 11.02)	
21b	H	C_2H_5	J(63)$^{b)}$	174—175	7.63	296 (23200)	49.32 (49.25	4.52 4.51	10.15 10.54	23.58 23.87)
21c	H	C_6H_5	J(60)$^{b)}$	234—235	7.68	304 (32400)	56.73 (56.94	3.88 3.82	9.12 8.86	20.28 20.23)
24a$^{e)}$	H		42$^{b)}$	217—221	7.17		34.14 (34.27	3.22 3.20	4.20 4.44)	
25a	H		K(7^{b}, 9$^{f)}$)	175—176	7.87	296 (22800)	44.04 (44.29	3.18 3.35	5.46 5.17	35.51 35.40)
25b	Cl		K(25$^{b)}$, 31$^{f)}$)	187—189	7.90	320 (21900)	39.00 (39.27	2.3_8 2.64	4.74 4.58	31.74 31.45)
25c	CH_3		K(13$^{b)}$, 16$^{f)}$)	149—151	7.80	322 (14800)	46.33 (46.29	3.91 3.89	4.94 4.91)	
26a	H		L(34)	162—163	7.83	252 (19000)	44.04 (44.29	3.18 3.35	5.46 5.17	35.51 35.40)
27	H		53	121—122	7.90	245 (9800)	41.74 (41.62	2.42 2.33	5.55 5.39)	

a) The NMR spectra could not be measured on account of the low solubility in usual solvent. b) Yield after recrystallization. c) The NMR spectra could not be measured on account of insufficient material. d) The CH proton is ambiguous because of overlapping with multiplet of phenyl protons. e) Dihydrate. f) Yield of a mixture of **25** and **26**, respectively.

Reaction of the Sulfonamides with Isothiocyanates. The reaction of **1**, isothiocyanates **16** and K_2CO_3 in acetone at 50—55 °C gave 3-alkylamino(or anilino)-5-aryl-1,4,2-dithiazine 1,1-dioxides **18**, which are the Michael cycloadducts of intermediate potassium salts of *N*′-substituted *N*-(arylethynylsulfonyl)thioureas **17** (path G). In contrast to the reaction of *β*-styrenesulfonamides with **16**,1) the potassium salts of **17** could not be isolated since they were soluble in warm acetone and their triple bonds were more susceptible to nucleophilic attack than their double bonds. Aqueous 5 M NaOH may be used in place of K_2CO_3.

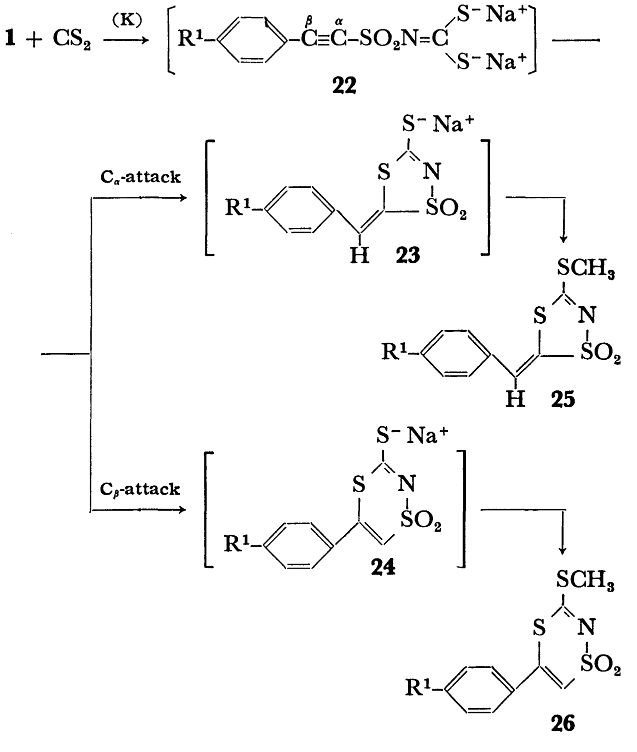


The dithiazine **18a** ($R^2{=}CH_3$) was also prepared by the reaction of **13** with methyl isothiocyanate (path H) under conditions similar to those described for path G. The results are summarized in Table 2. The intermediate potassium salt of *N*-((*Z*)-*β*-chlorostyrylsulfonyl)-*N*′-methylthiourea **19** was isolated under ambient conditions (Table 1). The IR spectra of **18** showed typical C=N bands attached to a SO_2 group at 1570—1590 cm^{-1}. In the NMR spectra of **18**, a methine proton peak appeared as a singlet (Table 2). The mass spectra of **18** displayed fragment peaks assigned to $R^1C_6H_4CS^+$ and $R^1C_6H_4C(S){=}CH^+$. The reaction of **12a** ($R^1{=}H$) with **16** in acetone in the presence of K_2CO_3 gave **18** along with small amounts of 3-alkylamino-5-benzylidene-1,4,2-dithiazole 1,1-dioxide **21** (path I in Table 2). The content ratios(%) of **18** were as follows: $R^2{=}CH_3$(96), C_2H_5(97), and C_6H_5(82).



Potassium carbonate is not sufficiently basic to eliminate HX from **12**—**15**, thus the formation of **18** from **19** and **20** may proceed by the Michael addition followed by dehydrohalogenation. A similar reaction carried out in DMF in the presence of 10 M NaOH gave **21** along with small amount of **18** (path J). The content ratios(%) of **21** were as follows: $R^2{=}CH_3$(96), C_2H_5(97), and C_6H_5(96). The formation of **21** by path J may be explained in terms of S_N attack of a thiolate anion on the C_α atom, and this is favored under strongly basic conditions. **18** and **21** were purified by fractional recrystallization of the crude products of paths I and J, respectively. The structure of **21** was determined by means of the IR (1620 cm^{-1} for C=N), NMR (*δ*: *ca.* 7.65 for CH), UV and mass spectra, and also by elemental analysis (Table 2). All mass spectra of **21** displayed peaks due to $C_6H_5CH{=}CS^+$ but no peaks due to $C_6H_5CS^+$.

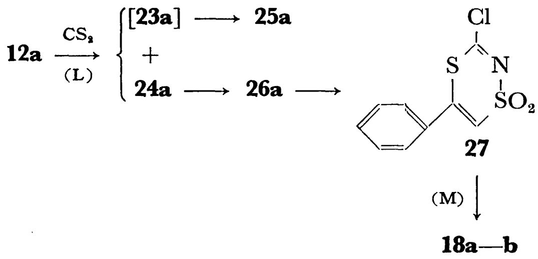
Reaction of the Sulfonamides with Carbon Disulfide. The reaction of **1** with CS_2 in the presence of 5 M NaOH at 0—3 °C and subsequent methylation yielded 3-methylthio-5-benzylidene-1,4,2-dithiazole 1,1-dioxide **25** in low yield together with a small amount of 3-methylthio-5-aryl-1,4,2-dithiazine 1,1-dioxide **26** (path K). Possible mechanisms for the formation of **25** and **26** are shown in Scheme 3. The content ratios of **25** and **26** in the crude products were determined by evaluating the peak areas of the methyl protons and the results are as follows: R^1, yield % (ratio % of **25**)=H, 9(94), Cl, 31(92), and CH_3, 16(70). **25** was purified by fractional recrystallization of the crude products (Table 2), but **26** could not be purified.



Scheme 3.

The sulfonamide **12a** was reacted with CS_2 and dimethyl sulfate by a procedure similar to path K to give a 44: 56 mixture of **25a** and **26a** (91% yield). The mixture could not be separated into **25a** and **26a**, so intermediate **24a** was isolated and converted into **26a** by methylation (path L).

Chlorination of **26a** gave the 3-chloro derivative **27**



which was treated with amines to afford **18a** and **18b** (path M). The structure of **26a** was determined by the presence of $C_6H_5CS^+$ in the mass spectrum and also by the synthetic pathway **26a**→**18a**—**b**. The spectral data of **25a** differed from those of **26a** and **25a** displayed no peak due to $C_6H_5CS^+$.

3-Substituted 1,4,2-dithiazole 1,1-dioxide rings were previously prepared by the reaction of α-chloromethanesulfonamide with isothiocyanate or carbon disulfide.[9]

p-Substituent effect on the formation of **25** in path K was examined, but the results were not satisfactory as illustrated above ($H \simeq Cl > CH_3$). This may be due to low yield and formation of an unknown oily by-product. Further studies are required to clarify the mechanisms for paths K and L.

Experimental

The melting points were determined on a Yanagimoto micro melting-point measuring apparatus, MP-S2, and are uncorrected. The IR and UV spectra were recorded on a JASCO IRA-1 and Hitachi EPS-3T spectrometer, respectively. The NMR spectra were determined with a JEOL JNM-MH-100 spectrometer, with TMS as the internal standard and the mass spectra, with JEOL JNM-O1SG spectrometer. The high-speed liquid chromatographic (HLC) analysis was carried out using a JASCO FLC-150 apparatus equipped with a UV detector (254 nm) and a 0.5m×2.1 mm column packed with JASCO-DAC SV-02 (Solvent: methanol (2C—50%)-water). Distribution of the isomers was determined by the results of NMR and HLC analyses. Spectral data are given only for a representative of each class.

N-*(Arylethynylsulfonyl)*-N′-*phenylurea (3a).* To a solution of **1a** (0.199 g, 0.0011 mol) in dry actone (3 ml) was added **2** (0.143 g, 0.0012 mol) and anhydrous K_2CO_3 (0.235 g, 0.0017 mol), and the mixture stirred for 30 min at 0—5° C. The resulting potassium salt of **3a** was filtered and suspended in aqueous 9 M HCl (5 ml). After standing for a night, the suspension was filtered to give 0.213 g (71%) of **3a** as analytically pure crystals: IR(KBr) 3340 (NH), 2180 (C≡C), 1620 (C=N), 1270 and 1140 (SO_2) cm^{-1}. *N,N′*-Diphenylurea (0.050 g) was obtained from the acetone filtrate, mp 238—239 °C (lit,[8] 235 °C).

2-Phenylamino-6-phenyl-1,4,3-oxathiazine 4,4-Dioxide (6a). When potassium salt of **3a** (0.102 g, 0.00030 mol) was dissolved in warm water (40—50 °C, 10 ml) or when **3a** (0.090 g, 0.00030 mol) was dissolved in warm aqueous 0.01—0.1 M K_2CO_3 (10 ml), **6a** began to separate out. After about 5 min, the reaction mixture was filtered to give 0.054 g (60%) of **6a**. The filtrate was acidified with conc HCl to afford 0.008 g (9%) of **8a**. Compound **6a** was recrystallized from CH_3OH and **8a** from CH_3OH-H_2O. When the reaction mixture was filtered after 12 h, 0.069 g (77%) of **6a** was obtained as shown in Table 2. **6a**: IR(KBr) 3260 (NH), 1640 (C=N), 1290 and 1160 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 7.20—7.70 (m, 10, $2C_6H_5$), 7.70 (s, 1, CH) and 7.96 ppm (broad, 1, NH); MS *m/e* 105 ($C_6H_5CO^+$), 118 (base peak, $C_6H_5C(O){=}CH^+$), 236 (M^+-SO_2) and 300 (M^+). **8a**: IR (KBr) 3320 (NH), 1680 (C=N), 1330 and 1160 (SO_2) cm^{-1}. MS *m/e* 105 (base peak), 118, 236 and 300 (M^+). **8c** NMR (DMSO-d_6) δ 7.20—7.65 (m, 5, C_6H_5), 7.85—8.06 (dd, 4, C_6H_4), 8.10 (s, 1, CH) and 11.50 ppm (broad, 1, NH).

2-Methylamino-6-aryl-1,4,3-oxathiazine 4,4-Dioxides (7). To a solution of **1** (0.0010 mol) in acetone (4 ml) was added **4** (0.0011 mol) and anhydrous K_2CO_3 (0.0015 mol), and the solution stirred for 1 h at 20—25 °C. Oxathiazines **7a**—**c** were obtained by evaporation of the acetone filtrates, and **7d** and **7e**, which were almost insoluble in acetone, by filtration. **7e**: IR (KBr) 3300 (NH), 1650 (C=N), 1290 and 1130 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 2.76 (s, 0.7 H, =NCH_3), 2.77 (d, $J_{NH-CH_3}=4.0$ Hz, 2.3H, CH_3), 7.60 (s, 1, CH), 7.72—7.78 (m, 4, C_6H_4), 8.40 (broad, 0.3H, SO_2NH) and 8.80 ppm (broad, 0.7H, NH); MS *m/e* 184±1 ($BrC_6H_4CO^+$), 197±1 (base peak, $BrC_6H_4C(O){=}CH^+$), 253±1 (M^+-SO_2) and 317±1 (M^+).

3-Oxo-4,5-diphenyl-2,3-dihydro-1,2,4-thiadiazine 1,1-Dioxide (10a). *Path A*: A suspension of **3a** (0.060 g, 0.00020 mol) in aqueous 1M NaOH (2.0 ml, 0.0020 mol) was stirred at 45—50 °C for 4 h. The resulting clear solution was acidified with conc HCl to give 0.040 g of a 96: 4 mixture of **10a** and **6a**. Recrystallization of the crude mixture from benzene gave 0.024 g (40%) of ***10a*** and ***6a*** remained insoluble in warm benzene. **10a**: IR (KBr) 3080 (NH), 1680 (C=N), 1330 and 1160 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 6.85 (s, 1, CH), 7.12—7.30 (m, 10, $2C_6H_5$) and 8.60 ppm (broad, 1, NH), MS *m/e* 116, 145, 180 ($C_6H_5CN^+C_6H_5$), 193 (base peak, $C_6H_5C(NC_6H_5){=}CH^+$), 236 (M^+-SO_2), 257 and 300 (M^+).

Path B: By using the way described in path A, 0.035 g (58%) of **10a** was obtained from **14d** (0.076 g, 0.00020 mol).

Path C: By using the way described in path A, 0.148 g (55%) of **10a** was obtained from **15d** (0.30 g, 0.00090 mol).

N-*(Benzoylmethylsulfonyl)*-N′-*methylurea (11a).* *Path D*: A solution of **7a** (0.238 g, 0.0010 mol) in aqueous 1M NaOH (10 ml, 0.0100 mol) was stirred at 50 °C for 4 h and acidified with conc HCl to give 0.217 g (85%) of **11a**. It was recrystallized from CH_3OH: IR (KBr) 3380 (NH), 1680 and 1660 (C=O), 1350 and 1160 (SO_2) cm^{-1}; NMR (DMSO-d_6)[10] δ 2.64 (d, $J_{NH-CH_3}=4.0$ Hz, 3, CH_3), 5.20 (s, 2, CH_2), 6.35 (broad, 1, NH), 7.50—7.80 and 8.04—8.20 ppm (m, 5, C_6H_5), MS *m/e* 105 (base peak), 120, 131, 143, 174, 199, 225, and 238 (M^+-H_2O). The urea **11d** was obtained under the more drastic reaction conditions (20 equiv of 1M NaOH, 60—70 °C, 4h) because **6a** was almost insoluble in 10 equiv of 1M NaOH at 50 °C.

Path E: By using the way described in path D, 0.103 g (84%) of **11a** was obtained from **14a** (0.153 g, 0.00048 mol).

Path F: By using the way described in path D, 0.103 g (80%) of **11a** was obtained from **15a** (0.136 g, 0.00050 mol).

The ureas **11a** and **11d** were also prepared by stirring the acetone solution (3 ml) of benzoylmethanesulfonamide (0.0005 mol) with K_2CO_3 (0.00075 mol) and methyl and phenyl isocynate (0.00055 mol) for 2 h at 20—25 °C in 70 and 50% yields, respectively.

N-*((Z)-α-Bromostyrylsulfonyl)*-N′-*methylurea (14a).* To a solution of **12a** (0.40 g, 0.0015 mol) in dry acetone (4 ml) was added methyl isocyanate (0.094 g, 0.00165 mol) and anhydrous K_2CO_3 (0.311 g, 0.00225 mol), and the mixture stirred for 2h at 55—60 °C. The resulting potassium salt was filtered and dissolved in water (20 ml). The solution was acidified with conc HCl to give 0.36 g (75%) of **14a**. An additional crop of **14a** (0.058 g, 12%) was obtained from the acetone filtrate and recrystallized from CH_3OH: IR(KBr) 3360 (NH), 1660 (C=O), 1350 and 1160 (SO_2) cm^{-1}; NMR (DMSO-d_6)[10] δ 2.60 (d, J_{NH-CH3}=4.0Hz, 3, CH_3), 6.40 (broad, 1, NH), 7.48—7.60 and 7.80—7.96 (m, 5, C_6H_5) and 8.18 ppm (s, 1, CH); MS *m/e* 319±1 (M^+).

N-*((Z)-β-Chlorostyrylsulfonyl)*-N′-*methylurea (15a).* By using the way described in the synthesis of **14a**, 0.236 g (86%) of **15a** was obtained from the acetone filtrate of the reaction mixture of **13** (0.218 g, 0.0010 mol), methyl isocyanate (0.063 g, 0.0011 mol) and anhydrous K_2CO_3 (0.207 g, 0.0015 mol), and was recrystallized from CH_3OH–H_2O: IR (KBr) 3340 (NH), 1650 (C=O), 1340, 1175 and 1150 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 2.65 (d, J_{NH-CH3}=4.0 Hz, 3, CH_3), 3.90 (broad, 1, NH), 6.35 (broad, 1, SO_2NH), 7.30 (s, 1. CH) and 7.45—7.60 ppm (m, 5, C_6H_5); MS *m/e* 274±1 (M^+).

3-Methylamino-5-phenyl-1,4,2-dithiazine 1,1-Dioxide (18a). *path G*: To a solution of **1a** (3.0 g, 0.0165 mol) in acetone (23 ml) was added methyl isothiocyanate (1.33 g, 0.0182 mol) and anhydrous K_2CO_3 (3.42 g, 0.025 mol), and the mixture stirred for 3 h at 50—55 °C. The solution was filtered and the filtrate concentrated to dryness *in vacuo* to leave viscous oil. It was recrystallized three times from CH_3OH to give 1.47 g (35%) of **18a**: IR (KBr) 3240 (NH), 1590 and 1570 (C=N), 1280 and 1120 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 2.90 (s, 3, CH_3), 7.55 (s, 1, CH), 7.60 (s, 5, C_6H_5) and 9.50 ppm (broad, 1, NH): MS *m/e* 102, 121 ($C_6H_5CS^+$), 134 (base peak, $C_6H_5C(S)=CH^+$), 162, 190 (M^+–SO_2), and 254 (M^+).

Path H: By using the way described in path G, 0.085 g (34%) of **18a** was obtained from **13** (0.218 g, 0.0010 mol), methyl isothiocyanate (0.080 g, 0.0011 mol) and anhydrous K_2CO_3 (0.207 g, 0.0015 mol).

Path I: By using the way described in path G, 0.104 g (41%) of **18a** was obtained from **12a** (0.262 g, 0.0010 mol), methyl isothiocyanate (0.080 g, 0.0011 mol) and anhydrous K_2CO_3 (0.207 g, 0.0015 mol).

Path M: To a suspension of **27** (0.052 g, 0.00020 mol) in methanol (5 ml) was added 30% aqueous methylamine (0.21 g, 0.0020 mol), and the mixture stirred for 1 h at 50—55 °C. The clear solution was concentrated to dryness *in vacuo* to leave viscous oil. Water (2 ml) was added and the cooled precipitate was filtered to give 0.034 g (66%) of **18a**.

3-Methylamino-5-benzylidene-1,4,2-dithiazole 1,1-Dioxide (21a). *Path J*: To a solution of **12a** (0.262 g, 0.0010 mol) in DMF (2 ml) was added methyl isothiocyanate (0.080 g, 0.0011 mol) and aqueous 10 M NaOH (0.20 ml, 0.0020 mol), and the mixture stirred for 4h at 55—60 °C. Water (7 ml) was added to the solution and cooled precipitate filtered to afford 0.185 g of a 96: 4 mixture of **21a** and **18a**. It was recrystallized from CH_3OH to give 0.147 g (58%) of **21a**: IR (KBr) 3200 (NH), 1620 (C=N), 1290 and 1160 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 3.00 (s, 3, CH_3), 7.50 (s, 5, C_6H_5), 7.62 (s, 1, CH) and 9.50 ppm (broad, 1, NH); MS *m/e* 102, 108, 134 (base peak, $C_6H_5CH=CS^+$), 190 (M^+–SO_2) and 254 (M^+).

3-Methylthio-5-benzylidene-1,4,2-dithiazole 1,1-Dioxide (25a). *Path K*: To a solution of **1a** (0.72 g, 0.0040 mol) in DMF (4 ml) was added aqueous 5 M NaOH (1.60 ml, 0.0080 mol) and CS_2 (0.61 g, 0.0080 mol), and the mixture was stirred for 2 h at 0—3 °C. Dimethyl sulfate (0.55 g, 0.0044 mol) was then added to the red solution and the mixture stirred for 2 h at 0—3 °C. The resulting precipitate was filtered and washed with methanol to give 0.097 g (9%) of a 94: 6 mixture of **25a** and **26a**. It was recrystallized from CH_3OH to afford 0.078 g (7%) of **25a** as colorless columns: IR(KBr) 1510 (C=N), 1330 and 1160 (SO_2) 995, 960, 825 and 750 cm^{-1}; NMR (DMSO-d_6) δ 2.81 (s, 3, CH_3), 7.50—7.60 (m, 5, C_6H_5) and 7.87 ppm (s, 1, CH); MS *m/e* 102, 108, 134 (base peak, $C_6H_5CH=CS^+$), 207 (M^+–SO_2) and 271 (M^+).

3-Methylthio-5-phenyl-1,4,2-dithiazine 1,1-Dioxide (26a). *Path L*: To a solution of **12a** (1.00 g, 0.0038 mol) in DMF (8 ml) was added aqueous 10 M NaOH (0.76 ml, 0.0076 mol) and CS_2 (0.58 g, 0.0076 mol), and the mixture stirred for 2h at 15—20 °C. Evaporation of DMF *in vacuo* left a residue, which was recrystallized twice from aqueous 1M NaOH to give 0.50 g (42%) of **24a** as dihydrate: IR (KBr) 3550—3400 ($2H_2O$), 1350 and 1130 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 3.26 ($2H_2O$), 7.17 (s, 1, CH) and 7.54—7.58 ppm (m, 5, C_6H_5).

To a solution of **24a** (0.63 g, 0.0020 mol) in 2: 1 (v/v) CH_3OH–H_2O (10 ml) was added dimethyl sulfate (0.28 g, 0.0022 mol), and the mixture was stirred for 2h at 15—20 °C. The precipitate was filtered to give 0.43 g (80%) of **26a**. It was recrystallized from CH_3OH to give colorless needles: IR (KBr) 1510 (C=N), 1330 and 1150 (SO_2), 940 and 750 cm^{-1}; NMR (DMSO-d_6) δ 2.71 (s, 3, CH_3), 7.55-7.60 (m, 5, C_6H_5) and 7.83 (s, 1, CH); MS *m/e* 102 ,108, 121 ($C_6H_5CS^+$), 134 (base peak, $C_6H_5C(S)=CH^+$), 174, 198, 207 (M^+–SO_2) and 271 (M^+).

3-Chloro-5-phenyl-1,4,2-dithiazine 1,1-Dioxide (27). Excess chlorine was bubbled through a solution of **26a** (0.65 g, 0.0024 mol) in chloroform (10 ml) at 20—30 °C. The orange solution was concentrated to dryness *in vacuo* and the residue suspended in CCl_4 (5 ml). The mixture was filtered to give 0.33 g (53%) of **27** and recrystallized from CCl_4: IR (KBr) 1570 (C=N), 1330 and 1160 (SO_2) cm^{-1}; NMR (DMSO-d_6) δ 7.45—7.65 (m, 5, C_6H_5) and 7.90 ppm (s, 1, CH); MS *m/e* 102, 108, 121 ($C_6H_5CS^+$), 134 (base peak, $C_6H_5C(S)=CH^+$), 195 (M^+–SO_2) and 258 (M^+).

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