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Activated Lactams. VI.[1] The Cycloaddition Reaction of Cyclic Ketene-*S,N*-acetals with Dimethyl Acetylenedicarboxylate[2]

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Reaction of ketene-*S,N*-acetals (**1a**—**c**) derived from lactams with dimethyl acetylenedicarboxylate (DMAD) gave the ring-expanded products (**3a**—**c**, respectively). On the other hand, similar treatment of *N*-acetyl ketene-*S,N*-acetals (**5b**, **c**) afforded the [2+2] adducts (**6b**, **c**, respectively). Next, the reaction of benzoketene-*S,N*-acetals (**8a**—**c**) with DMAD furnished the ringopened products (**13a**—**c**, respectively).

Keywords——activated lactams; ketene-*S,N*-acetals; enamine; azepine; azocine; azonine; dimethyl acetylenedicarboxylate; ring-expansion; [2+2] addition

We have been interested in developing a new synthesis of heterocycles using ketene-*S,N*-acetals as activated lactams,[3,4] in which the reactivity arises from their enamine character. In general, the cycloaddition reaction of enamine derived from ketones with dimethyl acetylenedicarboxylate (DMAD) leads to cyclobutene intermediates followed by ring-opening to yield the enaminodienes.[5] The present paper deals with the results of the ring-expanding reaction of ketene-*S,N*-acetals as cyclic enamines with DMAD.

Ketene-*S,N*-acetals (**1a**—**c**) were prepared from *N*-methyl lactams by Gompper's method.[6] Reaction of **1a** with DMAD in acetonitrile yielded the azepine (**3a**) as a ring-opened product in 52% yield together with an indole derivative (**4**) in 5% yield. However, the cyclobutene compound (**2a**) was not isolated. In a similar manner, the treatment of **1b**, **c** with DMAD afforded the azocine and azonine derivatives (**3b** and **3c**) in 75 and 89% yields, respectively. The structures of **3a**—**c** were characterized by proton nuclear magnetic resonance (PMR) spectroscopy, which showed 1H signals at δ 6.40, 6.67, and 7.00 as triplets, respectively, due to the vinyl protons at the 5-positions. The replacement of acetonitrile by ether as a solvent decreased the yields of products, and **3a** could not be obtained. The effects of the reaction conditions on the yields are summarized in Table I.

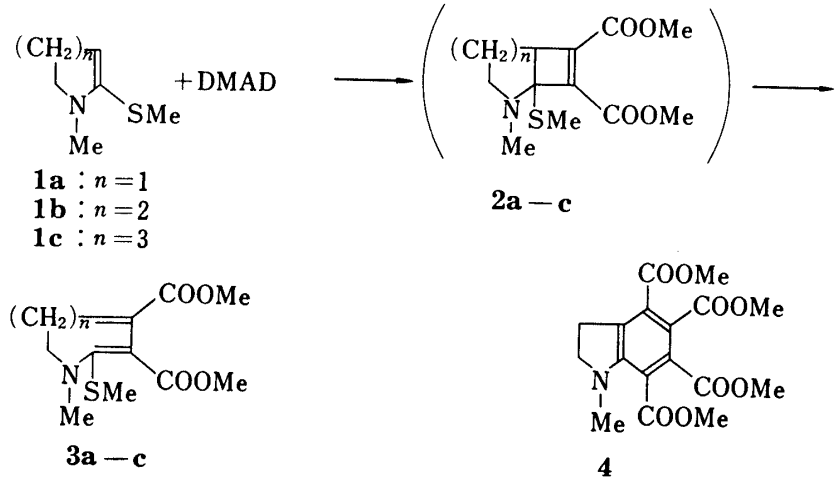
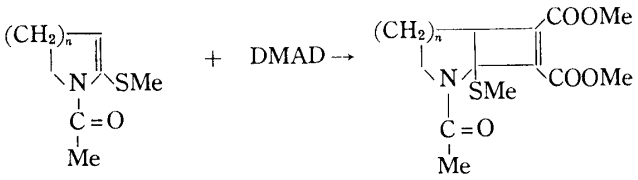


Chart 1

Table I. Reactions of **1a**—**c** with DMAD

Entry	Product	Yield (%)	Reaction conditions	
			Solvent	Temp./Time
1	**3a**	52	CH_3CN	−50°C/1 h→reflux/2 h
2	**3a**	72	CH_3CN	−50°C/1 h→reflux/3 h
3	**3a**	0	Et_2O	r.t./overnight
4	**3a**	0	CH_3CN	r.t./overnight
5	**3b**	75	CH_3CN	r.t./1 h→reflux/3 h
6	**3b**	22	CH_3CN	r.t /overnight
7	**3b**	31	Et_2O	r.t./overnight
8	**3c**	89	CH_3CN	r.t./1 h→reflux/3 h
9	**3c**	39	CH_3CN	r.t./overnight
10	**3c**	60	Et_2O	r.t./overnight

Next, when *N*-acetyl ketene-*S*,*N*-acetals (**5b**, **c**) prepared by the acetylation of lactim thioethers[7] were reacted with DMAD the ring-expanded products could not be obtained in spite of a prolonged reaction time (3—7 d), but cyclobutene products (**6b** and **6c**) were obtained in 40 and 7% yields with 25 and 57% recovery of the starting materials (**5b** and **5c**), respectively), because of the decrease in the enamine character of **5b** and **5c**. The PMR spectra of **6b** and **6c** showed double doublet signals at δ 3.02 and 3.11, respectively, assigned to the fused methine protons. The reactivity in the present reaction can be explained in terms of differences in enamine character deduced from the chemical shifts of vinyl protons at the 3-positions of the ketene-*S*,*N*-acetals (**1a**—**c** and **5b**, **c**); the smaller the value of the chemical shift, the greater the enamine character. It is significant that the nucleophilicity at the 3-position decreases with increasing ring size.[8] Hence, DMAD was added dropwise at room temperature in the case of **1b**, **c**, while in the reaction of **1a**, DMAD was added dropwise at −50°C to furnish the product (**3a**). The difference of yield in the reaction of **5b**, **c** is presumably attributable to the difference in their enamine character.



5b: $n=2$
5c: $n=3$

6b, **c**

Chart 2

Table II. Chemical Shifts of Vinyl Protons at the 3-Position of Ketene-*S*,*N*-acetals (**3a**—**c** and **5b**, **c**)

3a	3b	3c	5b	5c
4.43 ppm	4.83 ppm	4.93 ppm	5.50 ppm	5.73 ppm

Next, desulfurization of these cyclic dienamines (**3a**—**c**) with Raney Ni in acetone–ethanol (2: 1) yielded the corresponding products (**7a**—**c**) in 73, 89, and 68% yields; the PMR spectra of **7a**—**c** showed signals at δ 7.63, 7.50, and 7.67, respectively, due to new vinyl protons at the 2-positions. The *N*-heterocyclic dienes thus prepared are expected to be Diels–Alder type 1,3-dienes.[9]

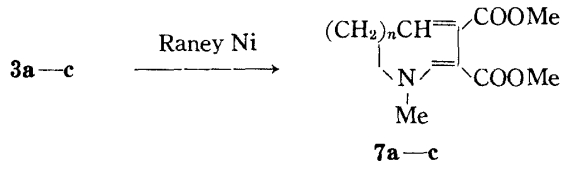


Chart 3

Next, the cycloaddition reaction of ketene-*S*,*N*-acetals (**8a—c**) derived from benzolactams (**9a—c**) with DMAD was attempted. 1-Methyl-2-methylthioindole (**8a**) was prepared by the known procedure.[10] The synthesis of **8b, c** is depicted in Chart 4. Although various attempts at *N*-methylation in the presence of bases [NaH/dimethylformamide (DMF), Na_2CO_3/DMF, and Na/toluene] have hitherto been made, the reaction gave a mixture of the starting material, the *N*-methyl compound, and the *O*-methyl compound.[11] However, *N*-methylation of **9b, c** was carried out by our procedure[12] using phase transfer catalyst (PTC) (n-$Bu_4N^+Br^-$ as PTC, pulv. potassium hydroxide as a base, and tetrahydrofuran as a solvent) to give *N*-methyl benzolactams (**10b, c**) in good yield without any *O*-alkylation. Subsequent sulfurization of **10b, c** with phosphorus pentasulfide afforded *N*-methyl benzothiolactams (**11b, c**). Next, *S*-methylation of **11b, c** with methyl iodide followed by dehydroiodination with a base gave the ketene-*S*,*N*-acetals (**8b, c**). The combination of anhydrous *tert*-butyl alcohol as a solvent and 1,5-diazabicyclo[5.4.0]undecene-5 (DBU) as a base seems to be the most satisfactory. When potassium *tert*-butoxide was used as a dehydrohalogenation reagent, the yields were poorer. The results are summarized in Table III. The structures of **8a—c** were characterized

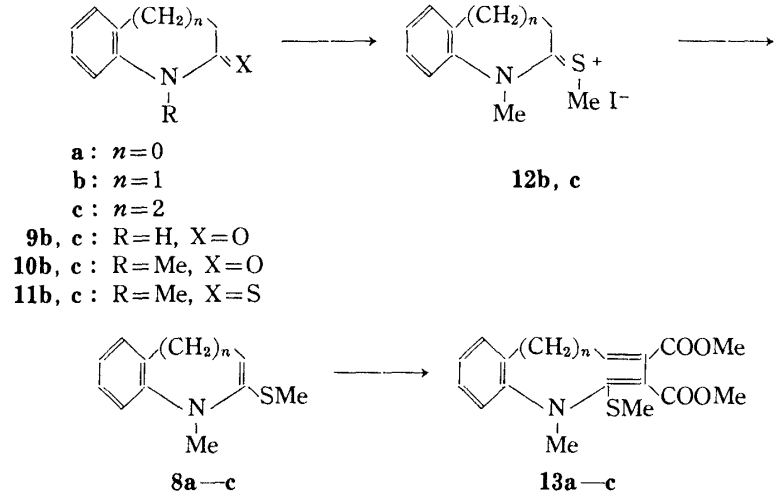


Chart 4

TABLE III. Preparation for **8b, c** from **11b, c**

Entry	Lactams	Reaction conditions[a,b]	Product	Yield (%)
1	**11b**	r.t./6 h; r.t./3 h; A	**8b**	23
2	**11b**	r.t./6 h; 50°C/3 h; A	**8b**	54
3	**11b**	r.t./6 h; 75°C/3 h; A	**8b**	38
4	**11b**	r.t./15 h; r.t./5 h; B	**8b**	18
5	**11b**	r.t./15 h; 50°C/5 h; B	**8b**	22
6	**11c**	r.t./6 h; r.t./3 h; A	**8c**	31
7	**11c**	r.t./6 h; 50°C/3h; A	**8c**	58
8	**11c**	r.t./15 h; 50°C/3 h; B	**8c**	30

a) The reaction conditions are shown in the following order: *S*-methylation (temp./h); dehydroiodination (temp./h).
b) A=Reactions in *tert*-BuOH using DBU as a base.
B=Reactions in Et_2O using KO-*tert*-Bu as a base.

by PMR spectroscopy; signals at δ 7.00, 4.87, and 5.08 were assignable to vinyl protons at the 3-positions, respectively. Reaction of **8a—c** with DMAD under the reaction conditions shown in Table IV gave the ring expansion products: benzazepine, benzazocine, and benzazonine derivatives (**13a—c**), respectively (see Table IV). Acetonitrile is a better choice than ether or dioxane as a solvent. In the PMR spectra, the signals of the vinyl protons at the 5-positions of **13a—c** appeared at δ 7.74 as a singlet, at δ 6.58 as a triplet, and at δ 6.50 as a doublet, respectively.

Table IV. Reactions of **8a—c** with DMAD

Entry	Product	Yield (%)	Reaction conditions	
			Solvent	Temp./Time
1	**13a**	52	CH_3CN	Reflux/3 d
2	**13a**	40	CH_3CN	Reflux/2 d
3	**13a**	10	Et_2O	Reflux/2 d
4	**13a**	6	Neat	120°C/overnight
5	**13b**	45	CH_3CN	−20°C/1 h→reflux/3 h
6	**13b**	8	Et_2O	Reflux/5 h
7	**13c**	57	CH_3CN	−20°C/1 h→reflux/3 h
8	**13c**	40	CH_3CN	−20°C/1 h→reflux/45 min
9	**13c**	25	Neat	r.t./10 min
10	**13c**	0	Dioxane	90°C/5 h
11	**13c**	0	Et_2O	Reflux/2 d

Thus, it was found that cyclic ketene-*S*,*N*-acetals readily reacted as cyclic enamines with DMAD to yield 7—9 membered cyclic dienamines which are useful synthetic intermediates for *N*-heterocycles. Studies to extend the scope of the ring-expansion reaction using ketene-aminals are in progress.

Experimental

Unless otherwise stated, the following procedure were adopted. Melting points were taken on a Yanagimoto micro hot-stage mp apparatus, and are uncorrected. Infrared (IR) spectra were taken with a Jasco IRA 1 spectrophotometer and are given in cm^{-1}. ^1H-Nuclear magnetic resonance (PMR) spectra were taken in $CDCl_3$ solution with tetramethylsilane (TMS) as an internal standard on a JEOL C-60H or Varian-200 spectrometer. Low or High resolution mass spectra were taken with a JEOL JMS-D-200 spectrometer.

Reaction of 1a with DMAD——DMAD (1.42 g) was added dropwise to a solution of **1a** (1.29 g) in acetonitrile (50 ml) at −50°C under argon, and the reaction mixture was stirred for 1 h at the same temperature, then refluxed with stirring for 2 h. The solvent was evaporated off under reduced pressure. The residue was separated by column chromatography on alumina with ether–*n*-hexane (10: 1) as an eluent to give dimethyl 6,7-dihydro-1-methyl-2-methylthio-1*H*-azepine-3,4-dicarboxylate (**3a**) (1.41 g, 52%) and 2,3-dihydro-1-methyl-4,5,6,7-tetramethoxycarbonylindole (**4**) (181 mg, 5%). **3a**: a pale yellow oil, IR ν_{max}^{neat}: 1720, 1680. PMR δ: 2.45 (3H, s, SMe), 3.25 (3H, s, NMe), 3.67 (3H, s, OMe), 3.70 (3H, s, OMe), 6.40 (1H, t, J=4 Hz, C_5–H). MS *m/e*: 271 (M^+). *Anal.* Calcd for $C_{12}H_{17}NO_4S$: C, 53.12; H, 6.32; N, 5.16. Found: C, 53.44; H, 6.15; N, 4.98. **4**: mp 184—186°C (Lit.,[13] mp 168—171°C). The other reaction conditions are described in Table I.

Reaction of 1b with DMAD——DMAD (1.42 g) was added dropwise to a solution of **1b** (1.43 g) in acetonitrile (50 ml) at room temperature and the reaction mixture was stirred for 1 h at ambient temperature, then refluxed with stirring for 3 h. The solvent was evaporated off under reduced pressure. The residue was purified by column chromatography on alumina with ether–*n*-hexane (10: 1) as an eluent to give dimethyl-2-methylthio-1,6,7,8-tetrahydroazocine-3,4-dicarboxylate (**3b**) (2.14 g, 75%) as a pale yellow oil. IR ν_{max}^{neat}: 1720. PMR δ: 2.25 (3H, s, SMe), 2.53 (3H, s, NMe), 3.63 (3H, s, OMe), 3.70 (3H, s, OMe), 6.67 (1H, t, J= 8Hz, C_5–H). MS *m/e*: 285 (M^+). *Anal.* Calcd for $C_{13}H_{19}NO_4S$: C, 54.72; H, 6.71; N, 4.91. Found: C, 54.28; H, 7.00; N, 5.08. The other reaction conditions are described in Table I.

Reaction of 1c with DMAD——Treatment of **1c** (1.57 g) with DMAD (1.42 g) in acetonitrile (50 ml) according to the method described for **3b** gave dimethyl 1-methyl-2-methylthio-6,7,8,9-tetra-1*H*-azonine-3,4-dicarboxylate (**3c**) (2.65 g, 89%) as a pale yellow oil. IR ν_{max}^{neat}: 1720, 1690. PMR δ: 2.33 (3H, s, SMe), 2.76

(3H, s, NMe), 3.63 (3H, s, OMe), 3.70 (3H, s, OMe), 7.00 (1H, t, J=9 Hz, C_5–H). MS m/e: 299 (M^+). *Anal.* Calcd for $C_{14}H_{21}NO_4S$: C, 56.16; H, 7.07; N, 4.68. Found: C, 53.68; H, 6.98; N, 4.33. The other reaction conditions are described in Table I.

Reaction of 5b with DMAD——A solution of **5b** (1.71 g) and DMAD (1.42 g) in acetonitrile (50 ml) was refluxed with stirring for 3 d. The solvent was evaporated off under reduced pressure to afford an oil, which was separated by column chromatography on alumina. Elution with benzene gave (680 mg), and elution with CH_2Cl_2 gave dimethyl 1-acetyl-1,2,3,4,4a,6a-hexahydro-6a-methylthiocyclobuta[*b*]pyridine-5,6-dicarboxylate (**6b**) (1.26 g, 40%) as an oil. IR ν_{max}^{neat}: 1720, 1640. PMR δ: 2.14 (3H, s, SMe), 2.24 (3H, s, COMe), 3.02 (1H, dd, J_1=8.8 Hz, J_2=7 Hz, C_{4a}-H), 3.80 (3H, s, OMe), 3.94 (3H, s, OMe). MS: Calcd for $C_{14}H_{19}NO_5S$: 313.0983. Found: m/e 313.0978 (M^+).

Reaction of 5c with DMAD——A mixture of **5c** (1.85 g), DMAD (1.42 g), and acetonitrile (50 ml) was refluxed with stirring for 7 d to give **5c** (1.06 g) and dimethyl 1-acetyl-2,3,4,5,5a,7a-hexahydro-7a-methylthio-1*H*-cyclobuta[*b*]azepine-6,7-dicarboxylate (**6c**) (227 mg, 7%) as an oil in the same manner as described for **6b**. IR ν_{max}^{neat}: 1730, 1705, 1635. PMR δ: 2.12 (3H, s, SMe), 2.27 (3H, s, COMe), 3.11 (1H, t, J=7 Hz, C_{5a}–H), 3.77 (3H, s, OMe), 3.93 (3H, s, OMe). MS: Calcd for $C_{15}H_{21}NO_5S$: 327.1139. Found: m/e 327.1131 (M^+).

General Procedure for Demethylthiolation of 3 with Raney Ni——A mixture of **3** (0.001 mol) and Raney Ni (W-2) (3.3 g) in ethanol–acetone (1: 2) (30 ml) was heated with stirring at 70°C for 1.5 h. The precipitate was removed by filtration and washed with acetone. The filtrate and the washing solution were concentrated to leave an oil, which was purified by chromatography on alumina using ether–*n*-hexane (10: 1) as an eluent to give **7** as an oil. Dimethyl 7,8-dihydro-1-methyl-1*H*-azepine-3,4-dicarboxylate (**7a**) (165 mg, 73%). IR ν_{max}^{neat}: 1720, 1680. PMR δ: 3.10 (3H, s, NMe), 3.66 (3H, s, OMe), 3.73 (3H, s, OMe), 6.43 (1H, t, J=7 Hz, C_5–H), 7.63 (1H, s, C_2–H). *Anal.* Calcd for $C_{11}H_{15}NO_4$: C, 58.65; H, 6.71; N, 6.22. Found: C, 59.08; H, 6.55; N, 6.62. Dimethyl 1-methyl-1,6,7,8-tetrahydroazocine-3,4-dicarboxylate (**7b**) (212 mg, 89%) as an oil. IR ν_{max}^{neat}: 1720, 1680. PMR δ: 3.00 (3H, s, NCH_3), 3.63 (3H, s, OMe), 3.73 (3H, s, OMe), 6.33 (1H, t, J=8 Hz, C_5–H), 7.57 (1H, s, C_2–H). *Anal.* Calcd for $C_{12}H_{17}NO_4$: C, 60.23; H, 7.16; N, 5.85. Found: C, 60.46; H, 6.99; N, 6.23. Dimethyl 1-methyl-6,7,8,9-tetrahydro-1*H*-azonine-3,4-dicarboxylate (**7c**) (173 mg, 68%) as an oil. IR ν_{max}^{neat}: 1720, 1680. PMR δ: 3.10, (3H, s NMe), 3.66 (3H, s, OMe), 3.77 (3H, s, OMe), 6.90 (1H, t, J=7 Hz, C_5–H), 7.67 (1H, s, C_2–H). *Anal.* Calcd for $C_{13}H_{19}NO_4$: C, 61.64; H, 7.56; N, 5.53. Found: C, 61.28; H, 7.63; N, 5.97.

3,4-Dihydro-1-methylquinolin-2-one (10b)——A solution of 1,2,3,4-tetrahydroquinoline (**9b**) (10.9 g)[14] and MeI (10.6 g) in THF (100 ml) was added to a suspension of pulverized KOH (4.98 g) and tetra-*n*-butylammonium bromide (TBAB) (4.77 g) in THF (75 ml) over 2 h at room temperature. After completion the addition, the reaction mixture was stirred overnight at ambient temperature. The precipitate was filtered off and the filtrate was concentrated to leave an oil, to which CH_2Cl_2 (200 ml) and water (100 ml) were added. The organic phase was washed with brine and dried over anhyd. $MgSO_4$. Removal of the solvent under reduced pressure afforded an oil. Vacuum distillation of this oil gave **10b** (8.6 g, 72%), bp 85°C/0.08 mmHg. IR ν_{max}^{neat}: 1670. PMR δ: 3.27 (3H, s, NMe). MS m/e: 161 (M^+). *Anal.* Calcd for $C_{10}H_{11}NO \cdot 1/10H_2O$: C, 73.68; H, 6.93; N, 8.59. Found: 73.51; H, 6.97; N, 8.84.

1-Methyl-2,3,4,5-tetrahydro-1*H*-benzazepin-2-one (10c)——According to the procedure described above, a solution of 2,3,4,5-tetrahydro-1*H*-benzazepin-2-one (**9c**) (8.05 g) and MeI (7.8 g) in THF (100 ml) was treated with a suspension of pulverized KOH (3.36 g) and TBAB (3.22 g) in THF (100 ml) to yield an oil. Vacuum distillation of this oil afforded **10c** (6.8 g, 78%). bp 120—130°C/5 mmHg. IR ν_{max}^{neat}: 1665. PMR δ: 3.40 (3H, s, NMe). MS: Calcd for $C_{11}H_{13}NO$: 175.0996. Found: m/e 175.0989 (M^+).

3,4-Dihydro-1-methylquinoline-2-thione (11b)——A mixture of P_2S_5 (4.48 g), **10b** (8.05 g), and sea sand (5 g) in xylene (200 ml) was heated with stirring at 100°C for 1.5 h. The precipitate was filtered off and washed with $CHCl_3$. The filtrate and the washing solution were concentrated *in vacuo* to give **11b** (7.7 g, 87%) as pale yellow crystals. mp 54°C (isopropyl ether). IR $\nu_{max}^{CHCl_3}$: 1470, 1380, 1285. PMR δ: 3.70 (3H, s, NMe). *Anal.* Calcd for $C_{10}H_{11}NS$: C, 67.76; H, 6.25; N, 7.90. Found: C, 67.66; H, 6.18; N, 7.62.

1-Methyl-2,3,4,5-tetrahydro-1*H*-benzazepine-2-thione (11c)——Treatment of **10c** (8.75 g) with P_2S_5 (4.48 g) according to the method described for **11b** gave **11c** (8.0 g, 84%) as pale yellow crystals. mp 60—61°C (isopropyl ether). IR $\nu_{max}^{CHCl_3}$: 1470, 1380, 1290. PMR δ: 3.80 (3H, s, NMe). *Anal.* Calcd for $C_{11}H_{13}NS$: C, 69.06; H, 6.85; N, 7.32. Found: C, 68.80; H, 6.75; N, 7.19.

General Procedure for the Preparation of Ketene-*S*,*N*-acetals (8b, c). A. Reactions in *tert*-BuOH using DBU as a Base——Methyl iodide (0.34 g) was added to a solution of **11b** (0.002 mol) in anhydrous *tert*-BuOH (50 ml), and the mixture was stirred under an argon atmosphere at the indicated temperature for the period of time indicated in Table III, then DBU (0.0022 mol) was added *via* a syringe. After reaction at the indicated temperature for the period of time indicated, the reaction mixture was concentrated *in vacuo*. The residue was extracted with ether three times. The extracts were concentrated to leave an oil, which was distilled in a Kugelrohr apparatus to afford **8b** or **8c**. **8b**:[15] bp 97—99°C/0.04 mmHg. IR ν_{max}^{neat}: 1620. PMR δ: 2.17 (3H, s, SMe), 3.37 (3H, s, NMe), 4.87 (1H, t, J=4.5 Hz, C_3–H). MS m/e: 191 (M^+). **8c**:[15] bp 130°C/1 mmHg. IR ν_{max}^{neat}: 1610. PMR δ: 2.15 (3H, s, SMe), 3.27 (3H, s, NMe), 5.08 (1H, t, J=4 Hz, C_3–H). MS m/e: 205 (M^+).

B. Reactions in Ether using KO-*tert*-Bu as a Base——Methyl iodide (0.0024 mol) was added to a solution of **11b** or **c** (0.002 mol) in anhydrous ether (50 ml) and the mixture was stirred at room temperature for 15 h. The precipitate was filtered off and dried over P_2O_5 in a desiccator. KO-*tert*-Bu (0.0024 mol) was added to a suspension of the salt (**12b** or **c**) and the mixture was stirred at the indicated temperature for the period of time shown in Table III. The precipitate was filtered off. The filtrate was concentrated *in vacuo* to leave an oil, which was distilled *in vacuo* to give the desired product **8b** or **c** as an oil.

Dimethyl 1-Methyl-methylthio-1*H*-1-benzazepine-3,4-dicarboxylate (13a)——Entry 1. A solution of **8a** (319 mg) and DMAD (142 mg) in CH_3CN (15 ml) was refluxed with stirring for 3 d. The mixture was concentrated *in vacuo* to leave an oil, which was purified by column chromatography on alumina using ether–*n*-hexane (5: 1) as an eluent to afford **13a** (240 mg, 52%) as pale yellow crystals. Entries 2, 3, 4. The same scale and work-up as described above were used. **13a** mp 99—100°C (isopropyl ether). IR ν_{max}^{Nujol}: 1720, 1710. PMR δ: 2.36 (3H, s, SMe), 3.35 (3H, s, NMe), 3.70 (3H, s, OMe), 3.80 (3H, s, OMe), 7.74 (1H, s, C_5–H). *Anal.* Calcd for $C_{16}H_{17}NO_4S$: C, 60.18; H, 5.37; N, 4.39. Found: C, 60.33; H, 5.31; N, 4.37.

Dimethyl 1,6-Dihydro-1-methyl-2-methylthio-1-benzazocine-3,4-dicarboxylate (13b)——DMAD (142 mg) was added to a solution of **8b** (333 mg) in CH_3CN (15 ml) *via* a syringe through a septum cap at −20°C and the solution was stirred under an argon atmosphere at −20°C for 1 h then refluxed for 3 h. The mixture was concentrated *in vacuo* to leave an oil, which was purified by column chromatography on alumina using ether–*n*-hexane (5: 1) as an eluent to afford **13b** (213 mg, 45%) as pale yellow crystals. Entry 6. A mixture of **8b** (333 mg) and DMAD (142 mg) in ether (15 ml) was refluxed with stirring for 5 h. After work-up as described above, **13b** (38 mg, 8%) was obtained. **13b**: mp 129—131°C (isopropyl ether). IR ν_{max}^{Nujol}: 1720, 1680. PMR δ: 2.26 (3H, s, SMe), 2.99 (3H, s, NMe), 3.40 (3H, s, OMe), 3.77 (3H, s, OMe), 6.58 (1H, t, J= 8 Hz, C_5–H). *Anal.* Calcd for $C_{17}H_{19}NO_4S$: C, 61.25; H, 5.94; N, 4.20. Found: C, 61.30; H, 5.75; N, 4.31.

Dimethyl 6,7-Dihydro-1-methyl-2-methylthio-1*H*-1-benzazonine-3,4-dicarboxylate (13c)——DMAD (142 mg) was added to a solution of **8c** (347 mg) in CH_3CN (15 ml) *via* a syringe through a septum cap at −20°C and the solution was stirred under an argon atmosphere at −20°C for 1 h then refluxed for 3 h (entry 7) or for 45 min (entry 8). The mixture was concentrated *in vacuo* to leave an oil, which was purified by column chromatography on alumina using ether–*n*-hexane (5: 1) as an eluent to afford **13c** (280 mg, 57%) (entry 7) or (195 mg, 40%) (entry 8) as pale yellow crystals. Entry 9. A mixture of **8c** (347 mg) and DMAD (142 mg) was kept for 10 min. The mixture was purified by column chromatography to give **13c** (121 mg, 25%). **13c**: mp 144—145°C (isopropyl ether). IR ν_{max}^{Nujol}: 1710, 1690. PMR δ: 2.37 (3H, s, SMe), 3.30 (3H, s, NMe), 3.53 (3H, s, OMe), 3.63 (3H, s, OMe), 6.50 (1H, dd, J_1=6 Hz, J_2=5 Hz, C_5–H). *Anal.* Calcd for $C_{18}H_{21}NO_4S$: C, 62.23; H, 6.17; N, 4.03. Found: C, 62.52; H, 6.12; N, 3.77.

References and Notes

1) From the present paper, the title of this series of studies (formerly "Chemistry of Lactim Ethers") is changed to "Activated Lactams." Part V: H. Takahata, A. Tomiguchi, and T. Yamazaki, *Chem. Pharm. Bull.*, **29**, 2526 (1981).
2) A part of this work was published as a preliminary report. H. Takahata, A. Tomiguchi, and T. Yamazaki, *Heterocycles*, **16**, 1569 (1981). Presented at the 14th Congress of Heterocyclic Chemistry, Tokyo, Japan, September, 1981, Abstract Papers p. 125.
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7) Similar treatment of butyrothiolactim with acetyl chloride in the presence of triethylamine did not afford *N*-acetyl ketene-*S*,*N*-acetal (**5a**).
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15) Satisfactory analytical data could not be obtained because of the instability of the product.