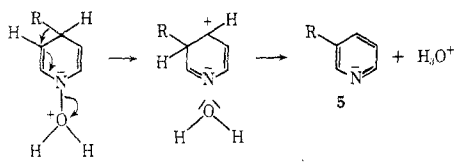
mide 7789-60-8; 1,3-dithiane, 505-23-7; (+)-(S)-2-methylbutanoic acid, 1730-91-2.

References and Notes

(1) W. von E. Doering and V. Z. Pasternak, *J. Am. Chem. Soc.*, **72**, 143 (1950).
(2) L. Lardicci, C. Botteghi, and P. Salvadori, *Gazz. Chim. Ital.*, **98**, 760 (1968); C. Botteghi, E. Guetti, G. Ceccarelli, and L. Lardicci, *ibid.*, **102**, 945 (1972).
(3) H. G. Foley and D. R. Dalton, *J. Chem. Soc., Chem. Commun.*, 628 (1973).
(4) H. Bönemann, R. Brinkmann, and H. Schenkluhn, *Synthesis*, 575 (1974).
(5) R. B. King, P. M. Treichel, and F. G. A. Stone, *J. Am. Chem. Soc.*, **83**, 3593 (1961).
(6) L. Lardicci, F. Navari, and R. Rossi, *Tetrahedron*, **22**, 1991 (1966).
(7) J. Colonge and G. Descotes in J. Hamer, "1,4-Cycloaddition Reactions", Academic Press, New York, N.Y., 1967, p 238.
(8) F. Brody and P. R. Ruby in E. Klingsberg, "Pyridine and Its Derivatives", Part 1, Interscience, New York, N.Y., 1960, p 172.
(9) Yu. I. Chumakov and V. P. Sherstyuk, *Tetrahedron Lett.*, 129 (1965).
(10) In our hands, attempts to prepare β,γ-unsaturated acetals by reaction between allylic Grignard reagents and ethyl orthoformate by a general procedure[11] gave only poor yields and impure products.
(11) J. W. Conforth and M. E. Firth, *J. Chem. Soc.*, 1091 (1958).
(12) C. Botteghi, L. Lardicci, and R. Menicagli, *J. Org. Chem.*, **38**, 2361 (1973).
(13) D. Seebach, *Synthesis*, 17 (1969).
(14) C. Botteghi, G. Ceccarelli, and G. Consiglio, *J. Prakt. Chem.*, **314**, 840 (1972).
(15) E. Vedejs and P. L. Fuchs, *J. Org. Chem.*, **36**, 366 (1971).
(16) An attempt to obtain **12** by direct cyclization of **9** afforded a very low yield of the expected alkylpyridine and other unidentified products.
(17) A sample containing ~80% of **5** was obtained by preparative GLC. The rotatory power of this sample ($[\alpha]^{25}D$ ~+30°) showed that **5** is also optically active. On this basis, and taking into account the reaction intermediates suggested for the cyclization of 1,4-dioxo compounds with hydroxylamine,[18] a possible pathway for the formation of **5** from **10** can be formulated as follows.



(18) See ref 8, p 279.
(19) The optical purity was determined in case of chiral 2-*sec*-butylpyridine (**2**) by NMR analysis in the presence of tris[3-(trifluoromethylhydroxymethylene)-*d*-camphorato]europium(III).[20] From the NMR results obtained on a solution containing 35.3 mg of (−)-(*R*)-**2**, $[\alpha]^{25}D$ −12.8° (ethanol), prepared by resolution of racemic compound with dibenzoyl-(+)-tartaric acid,[1] and 59.9 mg of the europium complex, $[\alpha]D$ +196° (carbon tetrachloride), in 0.7 ml of carbon tetrachloride, looking at the signals of the H-2 ring proton and of the methyl group protons nearer to the asymmetric center, a value of 29 (ethanol) for the maximum rotatory power of **2** was extrapolated. This value is in satisfactory agreement with that obtained through the cleavage method, $[\alpha]^{25}D$ +32.2° (ethanol) (Scheme IV), considering that the precision of the NMR method is about ±10%.
(20) H. L. Goering, J. N. Eikenberry, and G. S. Koerner, *J. Am. Chem. Soc.*, **93**, 5913 (1971).
(21) L. Lardicci, R. Rossi, C. Botteghi, and P. Pino, *Ric. Sci.*, 86 (1967); *Chem. Abstr.*, **72**, 21247 (1970).
(22) J. Kenyon and W. A. Ross, *J. Chem. Soc.*, 3407 (1951); D. D. Davis and F. R. Jensen, *J. Org. Chem.*, **35**, 3410 (1970).
(23) P. Pino, S. Pucci, F. Piacenti, and G. Dell'Amico, *J. Chem. Soc. C*, 1640 (1971).
(24) M. Pailer, *Monatsh. Chem.*, **79**, 331 (1948).
(25) W. M. Stalick and H. Pines, *J. Org. Chem.*, **35**, 422 (1970).

Reaction of Azomethine Ylides with Sulfur Ylides. A Novel Azetidine Synthesis

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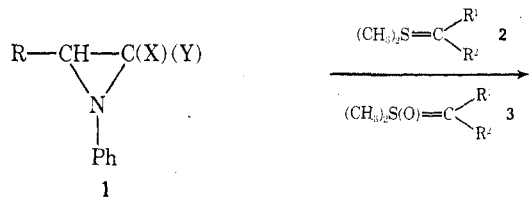
Aziridines represent versatile substrates which can serve as azomethine ylide precursors. We have shown an unusual feature of these ylides: they are able to react with both electrophilic and nucleophilic reagents.[1-4] Not the least interesting of these last are sulfur ylides which lead to azetidines in a novel way.[5] As a result of a continuing study of this last reaction we wish to report some new information and experimental details which were not given in the preliminary note.[5]

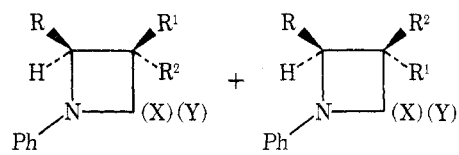
The various azetidines which were prepared are shown in Scheme I.

Scheme I[6]



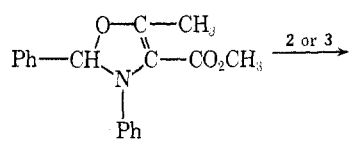
1a, R = Ph; X = Y = CO_2CH_3
1b, R = X = Y = CO_2CH_3
1c, R = Ph; X = H; Y = $CO_2C_2H_5$

2a or **3a**, $R^1 = R^2 = H$
2b, $R^1 = H$; $R^2 = CO_2CH_3$
2c, $R^1 = H$; $R^2 = CO_2C_2H_5$
2d or **3d**, $R^1 = H$; $R^2 = COPh$
2e, $R^1, R^2 = C_{13}H_{18}$[a]
2f, $R^1 = Cl$; $R^2 = CO_2C_2H_5$
2g, $R^1 = Br$; $R^2 = CO_2C_2H_5$

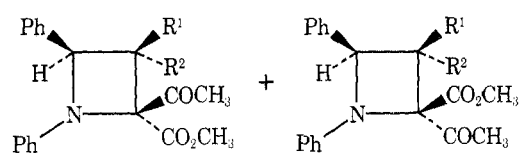


4 a-g
4′ R = Ph; X = Y = CO_2CH_3

4d and **4′d**, R = X = Y = CO_2CH_3



5



6b or **6′b**; **6d** or **6′d**; **6e** or **6′e**; **6f** or **6′f**

[a] Fluorenylidene.

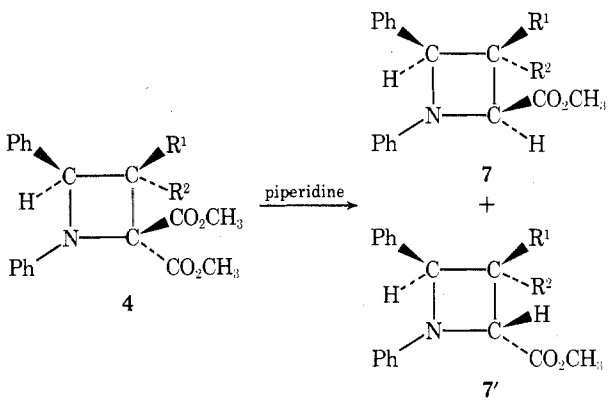
In the reactions of ethyl chloro- (or bromo-) (dimethylsulfuranylidene)acetate (**2f** or **2g**) with aziridine **1a** and 4-oxazoline **5**, we expected competition between dimethyl sulfide (DMS) and bromide or chloride elimination. However, in each case, DMS is a better leaving group than the halide and we observe only formation of the epimeric halogenated azetidines **4f, 4′f; 4g, 4′g;** and **6f, 6′f.** In an attempt to prepare the C_2 monosubstituted azetidines, the sulfonium ylides were heated with aziridine **1c** in boiling benzene (under these conditions, **1c** is in equilibrium with the corresponding azomethine ylide[2,3,7]) but no reaction occurs, except the isomerization of **1c** and the partial decomposition of the sulfur ylide. We have no explanation for this failure; it is not due to instability of the sulfonium ylide, which is still present after 8 hr of reaction. Nevertheless it is possible to get the C_2 monosubstituted azetidines in good yield by demethoxycarbonylation of compounds **4** with piperi-

Table I
Ir and NMR Data of 7 and 7′

Compd	R^1	R^2	Ir, cm^{-1} $\nu_{C=O}$	NMR, δ(Me_4Si) H_2	H_3	H_4	J_{23}, Hz	J_{34}, Hz	CO_2CH_3 ($CO_2CH_2CH_3$)	Rel %
7a	H	H	1744	4.45	2.42[a]	4.82	8.8	8.4	3.83	90
					2.97		7.4	7.6		
7′a	H	H		4.14	2.58	5.36	*b*	*b*	3.69	10
					2.30					
7b	H	CO_2CH_3	1744	4.68 d	3.50 t	4.93 d	7.0	7.0	3.84	≥90[c]
									3.74	
7c	H	$CO_2C_2H_5$	1740	4.76 d	3.50 t	5.03 d	7.0	7.0	3.92	≥90[c]
									(1.27)	
7d	H	COPh	1678	4.91 d	4.42 t	5.00 d	7.0	7.0	3.86	≥90[c]
			1740							
7e	*d*		1754	5.01 s		5.51 s			3.24	91
7′e	*d*			4.85 s		5.39 s			3.20	9

[a] J_{gem} = 11.0 Hz. [b] The mixture **7a** + **7′a** has a satisfactory elementary analysis. It is not possible to measure the coupling constants of **7′a** on the spectra of this mixture. The given δ is the position of the multiplet's center. [c] Near 7 it is possible to detect (NMR) the presence of some impurities bearing ester groups. The integration of the methoxycarbonyl methyl protons allows us to give the ratio of 7. These impurities are not identified. [d] Azetidine resulting from the demethoxycarbonylation of **4e**.

dine in boiling toluene or xylene. Here this reaction, which gives fairly good results for five-membered heterocycles,[8] successfully applied to four-membered rings.



In the resulting mixtures, compounds **7** are always the major products (≥90%); they are isolated and purified by recrystallization. Compounds **7′a** and **7′e** are identified by NMR (Table I); **7′b**, **7′c**, and **7′d**, which are formed in small quantities (≤10%), are not identified with certainty.

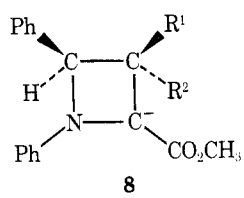
The values of J_{23} and J_{34} in compounds **7** (≤7, 6 Hz) indicate that H_2 and $R^1 = H_3$ are trans and the same for H_4 and $R^1 = H_3$.

The assignment of formula **7e** to the major product arising from **4e** is realized by assuming that this compound behaves as the other azetidines **4**.

Compounds **7a–c** and **7e** are recovered unchanged after boiling with piperidine in toluene. When treated with *N*-deuteriopiperidine, **7b** and **7c** are unchanged; there is no isomerization or deuterium exchange with H_2 or H_3. Furthermore, the *N*-deuteriopiperidine converts **4b** to **7b** with a deuterium on C_2 only, providing a simple method to deuterate the azetidines on C_2. These results indicate that the demethoxycarbonylation of **4a–c** and **4e** is under kinetic control and takes place without changing the configuration at carbon 3.

4d (R = Ph) is a special case since H_3 is acidic enough to be replaced by deuterium, owing to the presence of a benzoyl group. Thus the reaction of **4d** with *N*-deuteriopiperidine in boiling toluene leads to a deuterated compound on C_3 and not on C_2. Furthermore, demethoxycarbonylation of pure **4′d** gives the same mixture as **4d**. Demethoxycarbonylation of **4d** is slower than the isomerization of **4′d** to **4d**.

These results may be rationalized as follows: the demethoxycarbonylation proceeds through the intermediate carbanion **8**, which undergoes a kinetic protonation. These carbanions with an α nitrogen atom are likely to be pyramidal.[9] There are two carbanions epimeric on C_2 which are easily interconverted and which are protonated to give **7** and **7′** in a ratio which depends on the relative stabilities of the epimeric carbanions.



8

Experimental Section[10]

The sulfur ylides were prepared by known procedures: **2a** and **3a**,[11] **2b** and **2c**,[12] **2d**,[13] **2e**,[14] **2f** and **2g**,[15] **3d**.[16]

The aziridines **1a** and **1b** and 4-oxazoline **5** were obtained by thermolysis of the corresponding triazolines under nitrogen.[3,17] The neat triazoline was thermolyzed under nitrogen (**1a**, 180° for 15 min; **1b**, 145° for 20 min; **5**, 155° for 20 min). When the evolution of N_2 had ceased, the resulting aziridines or 4-oxazoline were dissolved in anhydrous benzene or THF.

The addition of the sulfur ylides to aziridines **1** or 4-oxazolines **5** was always realized under nitrogen and anhydrous solvents were used.

Azetidine Synthesis. As an example, we will describe the reaction between aziridine **1a** and dimethylphenacylidene sulfurane (**2d**). All other reactions were done following a similar procedure and we will indicate only the modifications of experimental conditions in each case. Furthermore, we will report the experimental and spectroscopic data related to the compounds which were not already published,[5] i.e., reactions with halogenated sulfuranes and also reactions with the trimethoxycarbonyl aziridine **1b**.

3-Benzoyl-2,2-dimethoxycarbonyl-1,4-diphenylazetidines 4d and 4′d (R = Ph; X = Y = CO_2CH_3). Aziridine **1a**, resulting from the thermolysis of 2.1 g (6 mmol) of the corresponding triazoline, was dissolved in 40 ml of benzene. Then 1.08 g (6 mmol) of the sulfurane **2d** in 20 ml of benzene was added dropwise. When the addition was complete, the reaction mixture was allowed to stand for 2 hr at room temperature before removing the solvent in vacuo. The reaction led to a quantitative yield (NMR) of the mixture **4d** + **4′d**. Recrystallization from methanol gave 85% (2.3 g) of **4d** + **4′d** (79:21). Fractional crystallization from benzene–petroleum ether afforded 0.6 g of **4d**, mp 152°, and 0.2 g of **4′d**, mp 200°.

Compounds **4b**, **4′b**, **4c**, and **4′c** were obtained by this procedure. For compounds **4a** and **4e** the reaction was carried out in the mixture THF–Me_2SO (4:1) at room temperature. All these products

were recrystallized in boiling methanol except for compound **4e** (benzene–petroleum ether).

3-Chloro-2-2-dimethoxycarbonyl-1,4-diphenyl-3-ethoxycarbonylazetidines 4f and 4'f. Using the same procedure, the reaction led to a quantitative yield (NMR) of the mixture **4f** + **4'f** (87:13).

Recrystallization from methanol afforded **4f** in a 72% yield: mp 154°; ir 1736, 1756 cm^{-1} (ester C=O); NMR ($CDCl_3$) δ 5.94 (1 H, s), 3.97 (3 H, s), 3.54 (3 H, s), 1.30 (3 H, t), 4.30 (2 H, q), 6.40–7.60 (10 H, m). **4'f** (isomer only identified by NMR): δ 5.68 (1 H, s), 3.81 (3 H, s), 3.64 (3 H, s), 0.82 (3 H, t), 3.70 (2 H, q), 6.40–7.60 (10 H, m).

The chemical shift of the methyl of the ethoxycarbonyl group on carbon 3 indicates that **4f** has the trans configuration (phenyl and ester group on C_3 and C_4). It is the same for azetidine **4g** (see ref 5).

3-Bromo-2,2-dimethoxycarbonyl-1,4-diphenyl-3-ethoxycarbonylazetidine 4g. A solution containing 1.36 g (6 mmol) of ethyl bromo(dimethylsulfuranylidene)acetate (**2g**) in 25 ml of chloroform was added at 0–5° to a solution of 6 mmol of **1a** in 10 ml of chloroform. After standing for 4 hr at room temperature, the solution was washed with water and dried (Na_2SO_4). Removal of $CHCl_3$ in vacuo led to 2.5 g of an oily residue which contained (NMR) only the isomer **4g** (85%), benzaldehyde, and methyl anilinomalonate (these two last products result from the hydrolysis of unreacted **1a**, 15%). Recrystallization from methanol led to azetidine **4g**: 1.5 g (52%); mp 150°; ir 1738, 1760 cm^{-1} (C=O); NMR ($CDCl_3$) δ 5.88 (1 H, s), 4.04 (3 H, s), 3.61 (3 H, s), 1.33 (3 H, t), 4.36 (2 H, q), 6.60–7.70 (10 H, m).

3-Benzoyl-1-phenyl-2,2,4-trimethoxycarbonylazetidines 4d and 4'd (R = X = Y = CO_2CH_3). The equilibrium between aziridine **1b** and the corresponding azomethine ylide is established only at the reflux of toluene. So the reaction between **1b** and sulfurane **2d** was run in boiling toluene for 3 hr. The reaction led to a quantitative yield (NMR) of the mixture **4d** + **4'd** (48:52). Recrystallization from methanol gave pure **4'd** (38%): mp 164°; ir 1670 (C=O ketone), 1724, 1734, 1760 cm^{-1} (C=O esters); NMR ($CDCl_3$) δ 5.00 (1 H, d, J = 8.9 Hz), 5.27 (1 H, d, J = 8.9 Hz), 3.60 (3 H, s) 3.64 (3 H, s), 3.70 (3 H, s), 6.60–7.90 (10 H, m); **4d** (isomer only identified by NMR) δ 5.15 (1 H, d, J = 7.0 Hz), 5.39 (1 H, d, J = 7.0 Hz), 3.71 (3 H, s), 3.79 (3 H, s), 4.03 (3 H, s).

The stereochemical assignment is based on J_{34} values:[5] **4'd** is the cis compound (J_{34} = 8.9 Hz) and **4d** the trans compound (J_{34} = 7.0 Hz).

2-Acetyl-3-chloro-1,4-diphenyl-3-ethoxycarbonyl-2-methoxycarbonylazetidines 6f and 6'f. The sulfonium ylide **2f** (1.1 g, 6 mmol) was added to a 30-ml benzene solution of 6 mmol of 4-oxazoline **5** (obtained from 2 g of the corresponding triazoline). After standing for 18 hr at room temperature the benzene was removed in vacuo. The reaction led (NMR) to a mixture **6f** + **6'f** (75:25). Recrystallization from methanol gave 0.3 g of **6f** + **6'f** (83:17). Fractional crystallization in benzene–petroleum ether led to **6f** (or **6'f**), mp 126°. A second crop of 0.4 g, containing **6f** + **6'f** (35:65), was obtained from methanol, overall yield 28%: **6f** (or **6'f**) ir 1702, 1740, 1756 cm^{-1} (C=O); NMR ($CDCl_3$) δ 5.94 (1 H, s), 4.03 (3 H, s), 2.33 (3 H, s), 1.33 (3 H, t), 4.27 (2 H, q), 6.40–7.70 (10 H, m); **6'f** (or **6f**), NMR ($CDCl_3$) δ 5.90 (1 H, s), 3.59 (3 H, s), 2.57 (3 H, s), 1.36 (3 H, t), 4.42 (2 H, q), 6.40–7.70 (10 H, m).

6d and **6'd** were obtained by the same procedure. For compounds **6e** and **6'e** the reaction was carried out in the mixture THF–Me_2SO (4:1) at room temperature. For **6b** or **6'b** the reaction was run in boiling benzene (2 hr). All these compounds were recrystallized in methanol except for **6e** or **6'e** (acetone).

Demethoxycarbonylation of Azetidines 4. Piperidine (1 ml) was added to 1 g of azetidine **4** in 20 ml of anhydrous toluene or xylene and the mixture was usually refluxed for 24 hr (the reaction was followed by NMR). When 4 had completely disappeared, the solvent and excess of piperidine were distilled under reduced pressure (3 mm).

I. Demethoxycarbonylation of 4a. **4a** gave a quantitative yield of **7a** + **7'a** (90:10) after 140 hr of reaction in boiling xylene. The mixture **7a** + **7'a** was purified by distillation under vacuum, bp 150–155° (0.015 mm). Addition of ethanol yielded **7a** (30%), mp 74°.

II. Demethoxycarbonylation of 4b–e. The crude reaction mixtures were analyzed by NMR. Compounds **7** were isolated and purified: **7b**, mp 102° (ether), 74% yield; **7c**, mp 60° (ether–petroleum ether), 58% yield; **7d**, mp 118° (éthanol), 74% yield; **7e**, mp 192° (ether–petroleum ether), 68% yield.

III. Demethoxycarbonylation of 4'd. Piperidine (0.2 ml) was added to the solution of 0.1 g of **4'd** in 10 ml of anhydrous toluene. After 8 hr of reflux, the NMR indicated that 52% of **7d** was formed and that the remaining 48% was **4d** (and not the starting **4'd**). This shows that **4'd** is isomerized to **4d** in the reaction. After 24 hr the reaction was complete and gave the same mixture as **4d**.

IV. Evidence for Kinetic Control of the Reaction. A. Reaction of 7a–c and 7e with Piperidine. Piperidine (0.1 g) was added to the solution of 0.1 g of azetidine in 10 ml of anhydrous toluene. After distillation of toluene in vacuo, the starting azetidine was recovered without any change.

B. Preparation of *N*-Deuteriopiperidine. Piperidine (10 ml) distilled over KOH was mixed with 10 ml of D_2O (98%). After standing for 0.5 hr under nitrogen the piperidine was extracted with ether (saturated with D_2O). The ether layer was dried over anhydrous K_2CO_3 and then distilled at atmospheric pressure, giving 8 ml of piperidine deuterated to the extent of 65% (NMR).

Piperidine N-deuterated to 95% was obtained in the following way. In a two-neck flask fitted with a dropping funnel and a Dean-Stark trap, 50 ml of anhydrous toluene, 1 g of *N*-deuteriopiperidine (65%), and 1 g of D_2O (99.5%) were introduced under nitrogen. The mixture was heated to reflux and water was eliminated by azeotropic distillation with toluene and then the compound to be demethoxycarbonylated was added in toluene solution.

C. Reaction of 4b with *N*-Deuteriopiperidine. **4b** (1 g) in toluene solution (10 ml) was added under nitrogen to 1 g of piperidine-*1-d* in toluene (10 ml). After 24 hr of reflux, distillation under reduced pressure gave an oily residue which crystallized by addition of hot methanol. **7b** deuterated on C_2 to the extent of 95% (mp 102°, 70% yield) was obtained.

D. Reaction of 7d with *N*-Deuteriopiperidine. **7d** (1 g) was treated with 1 g of piperidine-*1-d* (65%) in boiling toluene for 24 hr. Distillation of toluene and excess of piperidine in vacuo gave **7d** deuterated on C_3. **7d** was recrystallized from boiling methanol. The NMR showed that it was a mixture of deuterated and nondeuterated compounds in equivalent amount.

Registry No.—**1a**, 34671-09-5; **1b**, 51597-29-6; **1c**, 49790-76-3; **2a**, 6814-64-8; **2b**, 18915-90-7; **2c**, 7380-81-6; **2d**, 5633-34-1; **2e**, 55800-52-7; **2f**, 16980-47-5; **2g**, 55800-53-8; **3a**, 5367-24-8; **3d**, 20718-17-6; **4a**, 43113-13-9; **4b**, 43113-14-0; **4c**, 43113-16-2; **4d**, 55800-57-2; **4e**, 5580-54-9; **4f**, 55800-55-0; **4g**, 55800-56-1; **4'b**, 43113-15-1; **4'c**, 43113-17-3; **4'd**, 55800-58-3; **4'f**, 55800-59-4; **4'g**, 55800-60-7; **5**, 4311-18-4; **6b**, 55869-69-7; **6d**, 55869-70-0; **6e**, 55800-61-8; **6f**, 55800-62-9; **6'b**, 55869-71-1; **6'd**, 55869-72-2; **6'e**, 55800-63-0; **6'f**, 55869-73-3; **7a**, 55800-64-1; **7b**, 55800-65-2; **7b** deuterated on C_2, 55869-74-4; **7c**, 55800-66-3; **7d**, 55800-67-4; **7d** deuterated on C_3, 55869-75-5; **7e**, 55800-68-5; **7'a**, 55800-69-6; **7'e**, 55800-70-9; piperidine, 110-89-4; *N*-deuteriopiperidine, 694-58-6.

References and Notes

(1) F. Texier and R. Carrié, *Tetrahedron Lett.*, 4163 (1971).
(2) M. Vaultier, R. Danion-Bougot, D. Danion, J. Hamelin, and R. Carrié, *Tetrahedron Lett.*, 2883 (1973).
(3) M. Vaultier, R. Danion-Bougot, D. Danion, J. Hamelin, and R. Carrié, *C. R. Acad. Sci.*, **277**, 1041 (1973).
(4) M. Vaultier, R. Danion-Bougot, D. Danion, J. Hamelin, and R. Carrié, *C. R. Acad. Sci.*, **280**, 213 (1975).
(5) M. Vaultier, R. Danion-Bougot, D. Danion, J. Hamelin, and R. Carrié, *Tetrahedron Lett.*, 1923 (1973).
(6) The sulfur ylide **3d** does not react with aziridine **1a**. Furthermore, the dimethylsulfonium methylide **2a** does not lead to the azetidine **4a**. **4a** is obtained with the dimethylsulfoxonium methylide **3a** and we showed that **4a** is unstable in the presence of **2a**.
(7) J. Deyrup, *J. Org. Chem.*, **34**, 2724 (1969).
(8) F. Texier, E. Marchand, and R. Carrié, *Tetrahedron*, **30**, 3185 (1974).
(9) A. Rauk, J. D. Andose, W. G. Frick, R. Tang, and K. Mislow, *J. Am. Chem. Soc.*, **93**, 6507 (1971).
(10) The NMR (δ, $CDCl_3$, Me_4Si as internal standard) and ir (Nujol, ν) spectra were recorded on a Jeol MH-100 spectrometer and a Perkin-Elmer 225 spectrometer, respectively. The melting points were determined on the Kofler apparatus. All new compounds presented satisfactory analytical data (±0.3%) for C, H, N except for compound **6e** or **6'e**.
(11) E. J. Corey and M. Chaykovsky, *J. Am. Chem. Soc.*, **87**, 1353 (1965).
(12) G. B. Payne, *J. Org. Chem.*, **32**, 3351 (1967).
(13) B. M. Trost, *J. Am. Chem. Soc.*, **89**, 138 (1967).
(14) Ylide **2e** was prepared in situ: under nitrogen, 30 ml of anhydrous THF was added to 6 mmol of the Me_2SO carbanion[11] in 10 ml of Me_2SO. The mixture was cooled to −10°, and 2.25 g (6 mmol) of the corresponding sulfonium bromide was added under magnetic stirring. The solution became yellow and then turned brown. When the addition of the bromide was finished, stirring was continued for 10 min and the solution was used without further treatment.
(15) G. B. Payne, *J. Org. Chem.*, **33**, 1285, 3517 (1968).
(16) E. J. Corey and M. Chaykovsky, *J. Am. Chem. Soc.*, **82**, 1640 (1960).
(17) (a) F. Texier and R. Carrié, *Bull. Soc. Chim. Fr.*, **11**, 4119 (1971); (b) *C. R. Acad. Sci.*, **269**, 646 (1969).