(isomer 1), 94978-11-7; **4** (R = H, 5-[(benzyloxy)methyl]-2,2-dimethyl-1,3-dioxolan-4-yl) (isomer 2), 95043-21-3; (*R**)-**4** (R = H, (1α,5α,6α,7α)-6-(benzyloxy)-3,3-dimethyl-2,4,8-trioxabicyclo[3.3.0]octan-7-yl), 94978-03-7; **4** (R = H, 3,3-dimethyl-8-methoxy-2,4,7-trioxabicyclo[3.3.0]octan-6-yl) (isomer 1), 94978-04-8; **4** (R = H, 3,3-dimethyl-8-methoxy-2,4,7-trioxabicyclo[3.3.0]octan-6-yl) (isomer 2), 95042-59-4; *cis*-**4** (R = $CH_2CH_2CH(t\text{-}Bu)CH_2CH_2$), 94956-85-1; **4** (R = Me, $(CH_2)_8C(O)OEt$), 94956-86-2; **5** (R = H, Ph), 80997-79-1; (*S**,*S**,*S**)-**5** (R = H, 5-[(benzyloxy)methyl]-2,2-dimethyl-1,3-dioxolan-4-yl), 94956-87-3; (*R**)-**5** (R = H, (1α,5α,6α,7α)-6-(benzyloxy)-3,3-dimethyl-2,4,8-trioxabicyclo[3.3.0]octan-1-yl), 94978-05-9; (*S**)-**5** (R = H, (1α,5α,6α,7α)-6-(benzyloxy)-3,3-dimethyl-2,4,8-trioxabicyclo[3.3.0]octan-7-yl), 95042-61-8; (*R**)-**5** (R = H, (1α,5α,6α,8α)-3,3-dimethyl-8-methoxy-2,4,7-trioxabicyclo[3.3.0]octan-6-yl), 94978-06-0; *cis*-**5** (R = $CH_2CH_2CH(t\text{-}Bu)CH_2CH_2$), 94956-88-4; **5** (R = Me, $(CH_2)_8C(O)OEt$), 94956-89-5; **6** (R = R′ = Ph), 94956-90-8; **6** (R = Pr, R′ = Ph), 94956-91-9; **6** (R = Pr, R′ = *i*-Pr), 94956-92-0; **6** (R = Me, R′ = 3-pyridinyl), 94956-93-1; **7** (R = R′ = Ph), 94956-94-2; **7** (R = Pr, R′ = Ph), 94956-95-3; **7** (R = Pr, R′ = *i*-Pr), 94956-96-4; **7** (R = Me, R′ = 3-pyridinyl), 94956-97-5; PhCHO, 100-52-7; $CH_3C(O)(CH_2)_8C(O)OEt$, 36651-38-4; PhCH=NPh, 538-51-2; PhCH=NPr, 6852-55-7; $(CH_3)_2CHCH{=}NPr$, 2875-39-0; $CH_2{=}C(CH_3)CH_2OH$, 513-42-8; Bu_3SnCl, 1421-22-9; $BF_3{\cdot}Et_2O$, 109-63-7; $TiCl_4$, 7550-45-0; $ZnCl_2$, 7646-85-7; Ph_3P, 603-35-0; $Pd(OAc)_2$, 3375-31-3; *trans*-2,2-dimethyl-5-[(benzyloxy)methyl]-1,3-dioxolane-4-carboxaldehyde, 95042-60-7; (1α,5α,6α,7α)-3,3-dimethyl-6-(benzyloxy)-2,4,8-trioxabicyclo-[3.3.0]octane-7-carboxaldehyde, 87938-29-2; (1α,5α,6α,8α)-3,3-dimethyl-8-methoxy-2,4,7-trioxabicyclo[3.3.0]octan-6-carboxaldehyde, 58056-24-9; 4-*tert*-butylcyclohexanone, 98-53-3; 3-[(methylimino)-methyl]pyridine, 16273-54-4.

Cyclization via Isomerization: A Palladium(2+)-Catalyzed Carbocyclization of 1,6-Enynes to 1,3- and 1,4-Dienes

Barry M. Trost* and Mark Lautens

McElvain Laboratories of Organic Chemistry
Department of Chemistry, University of Wisconsin
Madison, Wisconsin 53706

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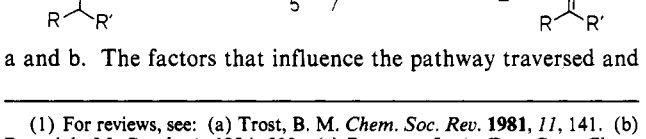
The development of routes for the synthesis of five-membered rings continues to attract attention due largely to the wide variety of natural products containing this structural unit.[1,2] As part of our continuing effort to expand the utility of transition-metal-catalyzed alkylations,[3] we turned our attention to the synthesis of 1,6-enynes. Synthetic routes to such species would offer an efficient entry into highly substituted cyclopentane derivatives via thermal ene reactions.[4] During the course of these studies, we made the unanticipated observation that palladium(2+) salts catalyze cyclizations via an isomerization to lead to related products under very mild conditions as summarized in eq 1, paths



(1)

a and b. The factors that influence the pathway traversed and the generality of this new cyclization are the subject of this communication.

The starting enynes[5] are readily prepared by using the palladium(0)-catalyzed coupling of allylic carboxylates with dimethyl propargylmalonate anion [3–5 mol % $(Ph_3P)_4Pd$, NaH, THF, 1–16 h at reflux]. As seen in Table I the yields are consistantly good (55–90%) with high chemo-, regio-, and stereoselectivity associated with the alkylation process. As previously noted, palladium-catalyzed allylic alkylations[3] tend to favor formation of the isomer that results from attack at the less substituted terminus of the π-allylmetal intermediate.

Carbocyclizations were conveniently carried out by heating a mixture of the enyne with a catalytic amount (3–10 mol %) of a palladium salt in a variety of organic solvents at 60–70 °C for 1–4 h.

A Pd(0) species such as $(Ph_3P)_4Pd$ does *not* catalyze reaction after 12 h at reflux in THF. The effectiveness of the Pd(2+) species appears related to the Lewis acidity of the catalyst. For example, bis(acetonitrile)palladium chloride[6] catalyzes cyclization of **3** to **4** very slowly (16% after 6.5 h in refluxing THF). On the other hand, $L_2Pd(OAc)_2$ effects complete reaction in THF at room temperature to reflux depending on L. Palladium acetate (5 mol %) cyclizes enyne **3** to give diene **4** in 50% yield in THF at room temperature. Best yields and cleanest reactions derive from use of preformed $(Ph_3P)_2Pd(OAc)_2$[7] or $[(o\text{-}CH_3C_6H_4)_3P]_2Pd(OAc)_2$ although heating is required. Changing solvent polarity (PhH, THF, $CHCl_3$, or CH_3CN) does not appreciably affect the *rate* of the reaction. Again, yields appear maximized by use of nonpolar solvents like benzene. A phosphine to Pd ratio as high as 5–6:1 slows the reaction further but does not inhibit reaction.

Substrates containing methyl or methylene groups in allylic positions (Table I, entries 1–4) undergo the isomerization yielding 1,4-dienes. The reaction exhibits a high degree of stereoselectivity (entry 1) yielding the trans olefin. Furthermore, no isomerization to the α,β-unsaturated ester is observed in the preparation of **4**. Examination of a case producing vicinal substituents shows the reaction is diastereoselective—producing a 3:1 trans/cis mixture of cyclopentanes (entry 3). Attempts to further improve the selectivity involving manipulation of phosphine ligands are in progress.

The cyclization of enyne **7** is somewhat puzzling. It is the only case examined to date where one of the double bonds (in this case the cyclohexenyl one) suffers further isomerization. Among several phosphines examined to minimize isomerization of the $\Delta^{6,7}$ isomer to the $\Delta^{7,8}$ one, 5 mol % of dppb with 5 mol % $Pd(OAc)_2$ in PhH produces the best ratio (5.7:1). In the absence of ligands or by using phosphites as ligands, extensive (25%) isomerization of the exocyclic double bond to an endocyclic position occurred.

The discovery of the cyclization process offers several advantages over simple thermal ene methodology. For example, all attempts to thermalize **3** result in the recovery of starting material (<650 °C) or decomposition (>675 °C) in contrast to normal reactivity in the palladium-catalyzed reaction. It is also possible to carry out a "one-pot" alkylation–carbocyclization by simply adding a catalytic amount (~5 mol %) of palladium acetate to the original Pd(0)-catalyzed alkylation reaction mixture. In this way, diene **4** arises directly from the allylic acetate in 68% overall yield.

Entries 5–7 reveal that an alternative pathway is possible when the allylic carbon (C-8 in eq 1) is disubstituted. NMR analysis of the crude reaction mixtures reveal that only 1,3-dienes are produced with no trace of the 1,4-diene. Again a wide variety of functional groups are tolerated and the utility of such products

(1) For reviews, see: (a) Trost, B. M. *Chem. Soc. Rev.* **1981**, *11*, 141. (b) Ramaiah, M. *Synthesis* **1984**, 529. (c) Paquette, L. A. *Top. Curr. Chem.* **1984**, *119*, 1.

(2) For leading references, see: Trost, B. M.; Chan, D. M. T. *J. Am. Chem. Soc.* **1983**, *105*, 2315.

(3) For alkylations catalyzed by palladium(0), see: Trost, B. M. *Acc. Chem. Res.* **1980**, *13*, 385; *Aldrichimica Acta* **1981**, *14*, 43. Trost, B. M.; Verhoeven, T. R. *Compr. Organomet. Chem.* **1982**, *8*, 799–938. Tsuji, J. "Organic Synthesis with Palladium Compounds"; Springer-Verlag: Berlin, 1980. For a review on palladium-assisted reactions of monoolefins, see: Hegedus, L. *Tetrahedron* **1984**, *40*, 2415.

(4) For reviews on the intramolecular ene reaction, see: Taber, D. F. "Intramolecular Diels–Alder and Alder Ene Reactions"; Springer-Verlag: Berlin, 1984. Oppolzer, W.; Snieckus, V. *Angew. Chem., Int. Ed. Engl.* **1978**, *17*, 476. Hoffman, H. M. R. *Angew. Chem., Int. Ed. Engl.* **1969**, *8*, 556.

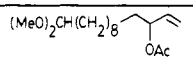
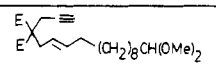
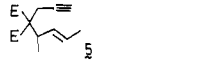
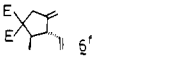
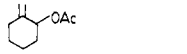
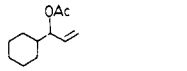
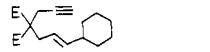
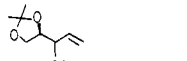
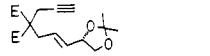
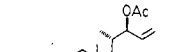
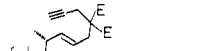
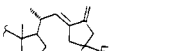
(5) All new compounds have been fully characterized by spectral means including combustion analysis and/or high-resolution mass spectroscopy.

(6) For examples of this catalyst in Cope rearrangements, see: Overman, L. E.; Jacobsen, E. J. *J. Am. Chem. Soc.* **1982**, *104*, 7225 and references therein. Cyclizations of such systems to cyclohexenes are also reported: Overman, L. E.; Renaldo, A. F. *Tetrahedron Lett.* **1983**, *24*, 2235.

(7) Preparation of phosphine complexes of palladium, see: Stephenson, T. A.; Morehouse, S. M.; Powell, A. R.; Heffer, J. P.; Wilkinson, G. *J. Chem. Soc.* **1965**, 3632.

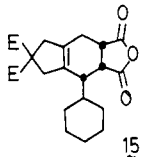
0002-7863/85/1507-1781$01.50/0

Table I. Pd-Catalyzed Synthesis and Isomerization of 1,6-Enynes

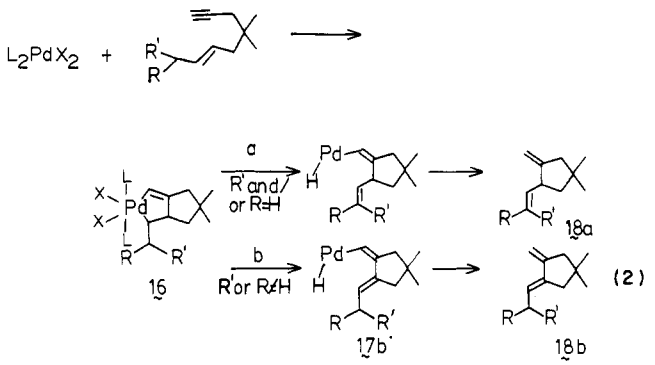
entry	allyl acetate	enyne[a,b]	yield[c]	cyclization conditions: solvent	temp	time, h[d]	product[b]	yield[c]
1		 1		C_6D_6	60 °C	1 h	 2	71%
2		 3	85%	THF	room temp[e]		 4	50%
				THF	reflux	1.5 h		70%
				C_6D_6	60 °C	1.5 h		85%
3		 5		C_6D_6	60 °C		 6[f]	68%
4		 7	87%	see text			 8	see text
5		 9	71%	C_6D_6	66 °C		 10	64%
6		 11	55%	C_6D_6	66 °C	1.75 h	 12	71%
7		 13	62%	C_6D_6	66 °C		 14	80%

[a] For reaction conditions of alkylation see text. [b] E = CO_2CH_3. [c] Isolated yields. [d] All reactions employed 5 mol % $(Ph_3P)_2Pd(OAc)_2$ and 5 mol % Ph_3P unless otherwise noted. [e] Catalyst employed was $Pd(OAc)_2$ in absence of phosphines. [f] In this case, a small amount of the 1,3-diene is also formed.

stems from their ability to participate as Diels–Alder dienes as shown in the successful reaction of **10** with maleic anhydride providing tetracycle **15** (80 °C, toluene, 4 h, 55%).


15

The mechanism of this isomerization must differ dramatically from the intermolecular co-oligomerizations of an acetylene and olefin using $Pd(OAc)_2$ and LiCl in HOAc which appears to be initiated by a halopalladation of the acetylene to give modest yields of 1-chloro-1,3- or 1-chloro-1,4-dienes.[8,9] In analogy to cobalt chemistry we suggest a palladacyclopentene[10] such as **16** as a reasonable intermediate. In contrast to cobalt chemistry where such a species is further trapped by an unsaturated functional group such as carbon monoxide[11] or an unsaturated carbon–carbon bond,[12] palladium initiates a hydrogen migration via a β-hydrogen elimination.[13,14] Because of the geometric constraints imposed by the palladacycles, elimination occurs exocyclic to the ring (eq 2, path a) unless sufficient substitution shifts the reaction toward


(2)

elimination of the more activated allylic ring hydrogen (path b). While **16** represents a Pd(IV) species, other catalytic reactions may also involve such intermediates.[15]

This new type of palladium-catalyzed reaction suggests several exciting directions in which the proposed intermediate may be

(8) Full details are reported in: Kaneda, K.; Uchiyama, T.; Fujiwara, Y.; Imanaka, T.; Teranishi, S. *J. Org. Chem.* **1979**, *44*, 55 and references therein. See also: Kaneda, H.; Kawamok, F.; Fujiwara, Y.; Imanaka, T.; Teranishi, S. *Tetrahedron Lett.* **1974**, 1067. Kaneda, H.; Kobayashi, H.; Fujiwara, Y.; Imanaka, T.; Teranishi, S. *Tetrahedron Lett.* **1975**, 2833.

(9) For the intramolecular cyclization of 1,6-dienes with Pd and Rh catalysts, see: Grigg, R.; Mitchell, T. R. B.; Ramasubbu, A. *J. Chem. Soc., Chem. Commun.* **1979**, 669; **1980**, 27. It should be noted that under the reaction condition described, migration of the olefin occurs to an endocyclic position. These reactions are quite different from our process and appear to involve hydridometalation as a key step. An attempt to cyclize a 1,6-diene under our conditions led to recovered starting material.

(10) For the preparation of cobaltocycles, see: Wakatsubi, Y.; Aoki, K.; Yamazaki, H. *J. Am. Chem. Soc.* **1979**, *101*, 1123 and references therein.

(11) For the stoichiometric cyclization of acetylenes, olefin, and carbon monoxide in the presence of cobalt, see: Khand, I. U.; Knox, G. R.; Pauson, P. C.; Watts, W. E. *J. Chem. Soc., Perkin Trans. 1* **1973**, 977. Newton, R. F.; Pauson, P. L.; Taylor, R. G. *J. Chem. Res., Synop.* **1980**, 277; *J. Chem. Res., Miniprint* **1980**, 3501. For recent exciting applications, see: Billington, D. C.; Pauson, P. L. *Organometallics* **1982**, *1*, 1560. Exon, C.; Magnus, P. *J. Am. Chem. Soc.* **1983**, *105*, 2477.

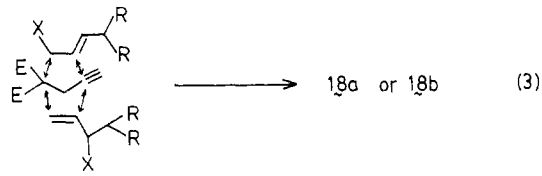
(12) See ref 10 and for leading references to reactions with acetylenes, see: Vollhardt, K. P. C. *Pure. Appl. Chem.* **1980**, *52*, 1645; *Acc. Chem. Res.* **1977**, *10*, 1.

(13) See: Collman, J. P.; Hegedus, L. S. "Principles and Applications of Organotransition Metal Chemistry"; University Science Books: Mill Valley CA, 1982; pp 73, 519.

(14) For β-hydrogen elimination in palladocyclopentanes, see: Deversi, P.; Ingrasso, G.; Lucherini, A.; Murtas S. *J. Chem. Soc., Dalton, Trans.* **1980**, 1633. In nickel metallocyclopentanes, see: Grubbs, R. H.; Miyashita, A. *J. Am. Chem. Soc.* **1978**, *100*, 7416, 7418. In platinum metallocycles, see: Whitesides, G.; White, J.; McDermott, J. *J. Am. Chem. Soc.* **1976**, *98*, 6521.

(15) See: Grille, A.; Stille, J. K. *J. Am. Chem. Soc.* **1980**, *102*, 4933. Loar, M. K.; Stille, J. K. *J. Am. Chem. Soc.* **1981**, *103*, 4174. Morovskiy, A.; Stille, J. K. *J. Am. Chem. Soc.* **1981**, *103*, 4182. Kurosawa, H.; Emoto, M.; Urabe, A. *J. Chem. Soc., Chem. Commun.* **1984**, 968.

diverted to other products. These possibilities in addition to mechanistic studies form the basis of current studies. Overall, the current reaction allows a novel cyclopentannulation of an allylic derivative (eq 3).



(3)

Acknowledgment. We thank the NSF for support of our programs. Mark Lautens thanks NSERC (Canada) for a predoctoral fellowship.

Registry No. 1, 95123-89-0; **2**, 95123-90-3; **3**, 95123-91-4; **4**, 95123-92-5; **5**, 95123-93-6; *cis*-**6**, 95123-94-7; *trans*-**6**, 95123-95-8; **7**, 95123-96-9; $\Delta^{6,7}$-**8**, 95123-97-0; $\Delta^{7,8}$-**8**, 95123-98-1; **9**, 95123-99-2; **10**, 95124-00-8; **11**, 95124-01-9; **12**, 95124-02-0; **13**, 95124-03-1; **14**, 95124-04-2; **15**, 95124-05-3; $(MeO)_2CH(CH_2)_9CH(OAc)CH{=}CH_2$, 88399-89-7; (*E*)-$CH_3CH{=}CHCH(OAc)CH_3$, 31001-80-6; $CH{\equiv}CCH_2CH(CO_2CH_3)_2$, 95124-07-5; $[(o\text{-}CH_3C_6H_4)_3P]_2Pd(OAc)_2$, 69073-98-9; $(CH_3CN)_2PdCl_2$, 14592-56-4; $(Ph_3P)_2Pd(OAc)_2$, 14588-08-0; methyl *cis*-5-acetoxycyclohex-3-enecarboxylate, 60729-55-7; 1-acetoxy-2-methylenecyclohexane, 53723-50-5; (1-acetoxyprop-2-en-1-yl)cyclohexane, 95124-06-4; 4-(1-acetoxyprop-2-en-1-yl)-2,2-dimethyl-1,3-dioxolane, 18524-20-4; 22(*S*)-(acetyloxy)chola-4,23-dien-3-one, 85994-21-4; maleic anhydride, 108-31-6.

2-Thiabicyclo[2.2.1]hept-5-ene *endo*-2-Oxide Derivatives: Stereospecific Formation, Rearrangement to Bicyclic Sultenes, and Conversion to (*E*)-5-Alkylidene-2-cyclopentenones[1]

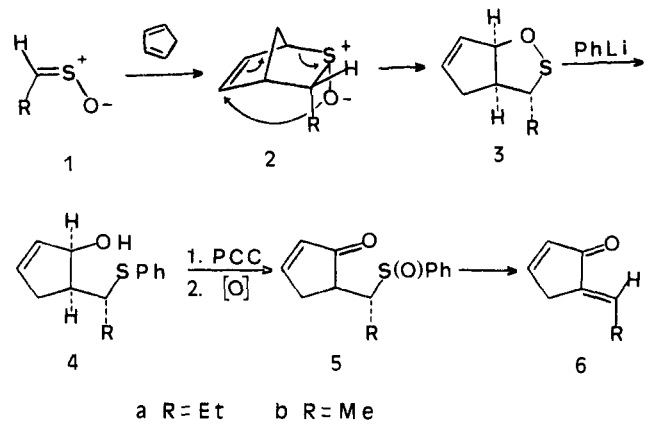
Eric Block,*† Alan Wall, and Jon Zubieta

Department of Chemistry, State University of New York at Albany, Albany, New York 12222

Received September 10, 1984

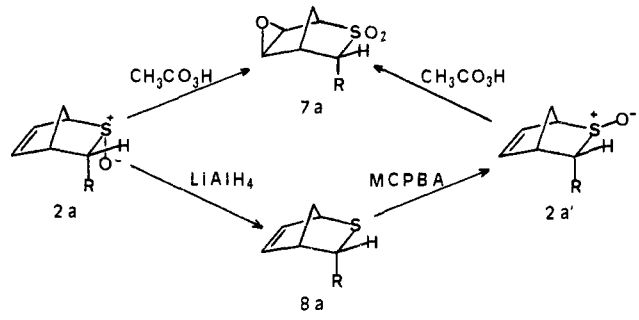
Diels–Alder adducts of cyclopentadiene and thiocarbonyl compounds[2] are attractive intermediates for the controlled synthesis of polyfunctional cyclopentanoids through sulfur-mediated transformations followed by desulfurization. We find that *endo*-sulfoxides **2**, prepared stereospecifically from cyclopentadiene and alkanethial *S*-oxides **1**, readily rearrange to bicyclic sultenes **3**, representatives of a rare class of sulfur heterocycles, which in turn may be easily converted to various cyclopentenoids including (*E*)-5-alkylidene-2-cyclopentenones (**6**) (eq 1).

Addition of cyclopentadiene to a Freon 11 solution of (*Z*)-propanethial *S*-oxide (**1a**),[3] obtained by dehydrochlorination of propanesulfinyl chloride with triethylamine, gave a single product characterized[4] as *endo*-3-ethyl-2-thiabicyclo[2.2.1]hept-5-ene *endo*-2-oxide (**2a**) (eq 1). Thus, on the basis of an X-ray crystal structure of epoxy sulfone **7a** (R = Et),[4] prepared by peracetic acid oxidation of **2a**, we conclude that **2a** has an *endo*-ethyl group. Reduction of **2a** to sulfide **8a** and reoxidation with MCPBA gave a different sulfoxide, **2a′**, also converted to epoxy sulfone **7a** by



(1)

oxidation (eq 2). The presence of an *exo*-sulfoxide oxygen in



(2)

2a′, anticipated on the basis of the stereochemistry of oxidation of 2-thiabicyclo[2.2.1]heptane[5] (**9**; *exo*-sulfoxide favored with MCPBA), was unequivocally established by $Eu(fod)_3$ and aromatic solvent induced shift studies giving results in good agreement with similar studies on the two *S*-oxides of **9**.[6] The endo,endo ethyl group–sulfoxide oxygen relationship in **2a** is consistent with a stereospecific Diels–Alder reaction of (*Z*)-**1a**[7] following the Alder endo rule.

Also consistent with an *endo*-sulfoxide oxygen in **2a** is the striking difference in reactivity of sulfoxides **2a** and **2a′**. While isomer **2a′** was unchanged after refluxing in toluene for 20 h, sulfoxide **2a** rearranges at room temperature, presumably via a [2,3]-sigmatropic shift,[8] to 4-ethyl-2-oxa-3-thiabicyclo[3.3.0]-oct-7-ene (**3a**) (eq 1), a rare example of an isolable sultene.[9] Compound **3a**, obtained in 51% yield (based on propanesulfinyl chloride) after refluxing a methylene chloride solution of **2a** for 1.5 h followed by vacuum distillation (bp 75 °C (0.05 mm)), is a pale yellow oil homogeneous by capillary GC and showing the absence of an S=O group or other functionality other than C=C in the IR.[10] Similarly, 4-methyl-2-oxa-3-thiabicyclo[3.3.0]oct-

† Fellow of the John Simon Guggenheim Memorial Foundation, 1984–1985.

(1) The Chemistry of Sulfines. 10. Part 9: Block, E.; Bazzi, A. A. *Tetrahedron Lett.* **1982**, *23*, 4569–4572. This work was presented at the 187th ACS National Meeting, St. Louis, MO, 1984.

(2) (a) Block, E.; Aslam, M. *Tetrahedron Lett.* **1982**, *23*, 4203–4206. (b) Middleton, W. J. *J. Org. Chem.* **1965**, *30*, 1390–1394. (c) Yamada, K.; Yoshioka, M.; Sugiyama, N. *Ibid.* **1968**, *33*, 1240–1243. (d) Johnson, C. R.; Keiser, J. E.; Sharp, J. C. *Ibid.* **1969**, *34*, 860–864. (e) Raasch, M. *Ibid.* **1975**, *40*, 161–172. Larsen, C.; Harpp, D. N. *Ibid.* **1980**, *45*, 3713–3716.

(3) Block, E.; Penn, R. E.; Revelle, L. K. *J. Am. Chem. Soc.* **1979**, *101*, 2200–2201. Block, E.; Revelle, L. K.; Bazzi, A. A. *Tetrahedron Lett.* **1980**, 1277–1280.

(4) All new compounds have been fully characterized by spectroscopic methods and, in the case of **7a**, by X-ray crystallography; details are provided in the supplementary material.

(5) Johnson, C. R.; Diefenbach, H.; Keiser, J. E.; Sharp; J. C. *Tetrahedron* **1969**, *25*, 5649–5653.

(6) Fraser, R. R.; Wigfield, Y. Y. *J. Chem. Soc. D* **1970**, 1471–1472.

(7) For earlier work on Diels–Alder reactions of sulfines, see: Zwanenburg, B.; Thijs, L.; Broens, J. B.; Strating, J. *Recl. Trav. Chim. Pays-Bas* **1972**, *91* 443–451. Also see: Porskamp, P. A. T. W.; Haltiwanger, R. C.; Zwanenburg, B. *Tetrahedron Lett.* **1983**, *24*, 2035–2038.

(8) Block, E. "Reactions of Organosulfur Compounds"; Academic Press: New York, 1978; pp 263–266.

(9) For examples of isolable sultenes, see: Nakano, J.; Nishimura, H. *Chem. Pharm. Bull.* **1971**, *19*, 705–713. Astrologes, G. W.; Martin, J. C. *J. Am. Chem. Soc.* **1977**, *99*, 4390–4400. Schultz, A. G.; Schlessinger, R. H. *J. Chem. Soc. D* **1970**, 1294–1295. Schultz, A. G.; Schlessinger, R. H. *Tetrahedron Lett.* **1973**, 3605–3608. Schaumann, E.; Ehlers, J.; Behrens, U. *Angew. Chem., Int. Ed. Engl.* **1978**, *17*, 455–456; Davis, A. P.; Whitham, G. H. *J. Chem. Soc., Chem. Commun.* **1981**, 741–742. Carlsen, L.; Egsgaard, H.; Whitham, G. H.; Harpp, D. N. *Ibid.* **1981**, 742–743. Carlsen, L.; Egsgaard, H.; Harpp, D. N. *J. Chem. Soc., Perkin Trans. 2* **1981**, 1166–1170. Walter, W.; Krische, B.; Adiwidjaja, G. *Justus Liebigs Ann. Chem.* **1980**, 14–20. Lown, J. W.; Koganty, R. R. *J. Am. Chem. Soc.* **1983**, *105*, 126–127. Jorgensen, F. S.; Carlsen, L. *Chem. Ber.* **1983**, *116*, 2374–2377. Also see: Yanagisawa, H.; Ando, A. *Tetrahedron Lett.* **1982**, *23*, 3379–3382.

0002-7863/85/1507-1783$01.50/0