

## A New Simple Synthesis of Variously Substituted Furans and Butenolides

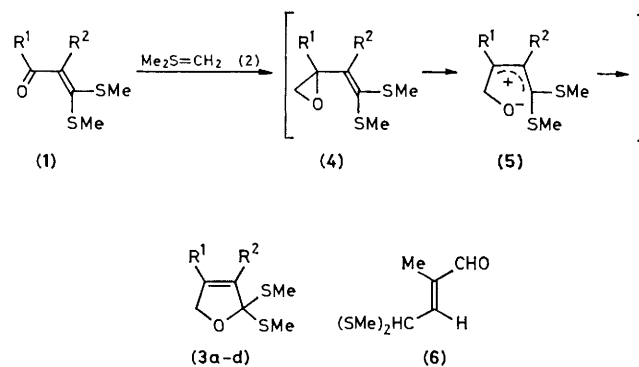
Renji Okazaki,\* Yoshio Negishi, and Naoki Inamoto

Department of Chemistry, Faculty of Science, The University of Tokyo, Hongo, Tokyo 113, Japan

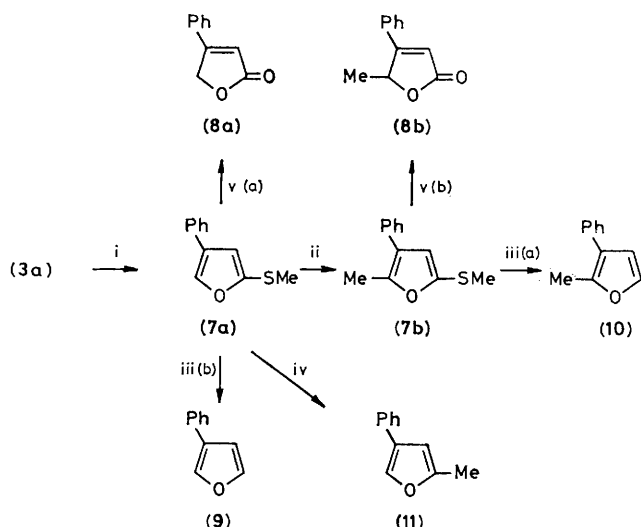
The reaction of 1,2-disubstituted 3,3-bis(methylthio)prop-2-en-1-ones with dimethylsulphonium methylide gave 2,2-bis(methylthio)-2,5-dihydrofurans, useful synthons for a variety of furans and butenolides.

During the course of our study on conjugated keten dithioacetals,<sup>1</sup> we have found that the reaction of 3,3-bis(methylthio)prop-2-en-1-ones (1) with dimethylsulphonium methylide (2) gives 2,2-bis(methylthio)-2,5-dihydrofurans (3), very useful synthons for a variety of furans and butenolides. A recent communication by Garver and van Tamelen,<sup>2</sup> which uses a similar reaction as a key step in the total synthesis of triptonide and triptolide, has prompted us to report our preliminary results in this area.

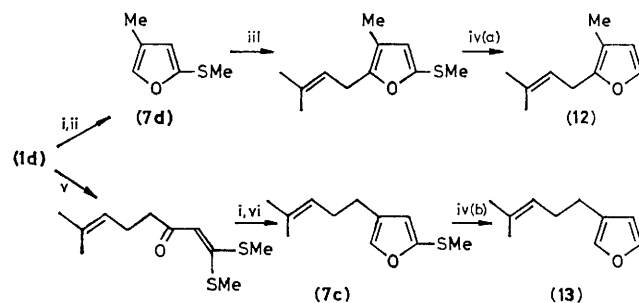
To the ylide (2) (6.0 mmol) in tetrahydrofuran (THF) was added (1)<sup>3</sup> (5.0 mmol) in THF at  $-70^{\circ}\text{C}$  with stirring and the mixture was kept at  $-70^{\circ}\text{C}$  for 1 h and then at room temperature for 1 h. The usual work-up gave the dihydrofurans [(3a) 92%; (3b) 97%; (3c) 83% yield]. For (1d), the reaction mixture containing (3d) was directly subjected to Florisil column chromatography and gave the methyl(methylthio)furan (7d) (19%) and the aldehyde (6) (12%).



a;  $\text{R}^1 = \text{Ph}$ ,  $\text{R}^2 = \text{H}$   
 b;  $\text{R}^1, \text{R}^2 = [\text{CH}_2]_4$   
 c;  $\text{R}^1 = \text{Me}_2\text{C}=\text{CH}[\text{CH}_2]_2$ ,  $\text{R}^2 = \text{H}$   
 d;  $\text{R}^1 = \text{Me}$ ,  $\text{R}^2 = \text{H}$



**Scheme 1.** i, 0.4 equiv. HCl-aq. MeOH, room temp., 1 h, 91%; ii, BuLi,  $-10^{\circ}\text{C}$ , THF, then MeI,  $-10^{\circ}\text{C}$ , 93%; iii, Raney Ni, EtOH, room temp., 0.5 h, (a) 54%, (b) 42%; iv, MeMgI,  $\text{Et}_2\text{O}$ , reflux 8 h, cat.  $\text{NiCl}_2(\text{Ph}_2\text{P}[\text{CH}_2]_3\text{PPh}_2)$ , (ref. 4), 61%; v, dil.  $\text{H}_2\text{SO}_4$ -aq. EtOH, reflux, (a) 1.5 h, 49%, (b) 5 h, 15%.



**Scheme 2.** i,  $\text{Me}_2\text{S}=\text{CH}_2$ , THF,  $-70^{\circ}\text{C}$ , 1 h, room temp., 1 h; ii, Florisil chromatography, 19% (i + ii); iii, BuLi, THF,  $-10^{\circ}\text{C}$ , then  $\text{Me}_2\text{C}=\text{CHCH}_2\text{Br}$ ,  $-10^{\circ}\text{C}$ , 87%; iv, Raney Ni, EtOH, 0.5 h, (a) 68%, (b) 80%; v, lithium di-isopropylamide, THF,  $-70^{\circ}\text{C}$ , then  $\text{Me}_2\text{C}=\text{CHCH}_2\text{Br}$ ,  $-70^{\circ}\text{C}$ , 85%; vi 0.4 equiv. HCl-aq. MeOH, room temp., 1 h, 51% (i + vi).

The dihydrofurans (3) can be converted into a variety of furans and butenolides. This is illustrated in Scheme 1 with (3a) as an example, showing the great utility of (3) in the synthesis of these types of compounds.

The advantages of this methodology lie in the presence of the two methylthio-groups<sup>5</sup> which permit (i) ready rearrangement of a probable intermediate, (4), into (3) by the stabilization of zwitterion (5), (ii) the synthesis of both furans and butenolides from a single intermediate, and (iii) regioselective introduction of an  $\alpha$ -substituent as shown in conversions (7a)  $\rightarrow$  (11) and (7a)  $\rightarrow$  (7b)  $\rightarrow$  (10).

The usefulness of this method has been further exemplified in the synthesis of two isomeric, naturally occurring furans, i.e., rosefuran (12)<sup>6</sup> and perillene (13)<sup>7</sup> as shown in Scheme 2.

Received, 7th June 1982; Com. 647

## References

- 1 M. O-oka, A. Kitamura, R. Okazaki, and N. Inamoto, *Bull. Chem. Soc. Jpn.*, 1978, **51**, 301; R. Okazaki, F. Ishii, and N. Inamoto, *ibid.*, p. 309; R. Okazaki, K. Sunagawa, K.-T. Kang, and N. Inamoto, *ibid.*, 1979, **52**, 496; R. Okazaki, K. Sunagawa, M. Kotera, K.-T. Kang, and N. Inamoto, *ibid.*, 1982, **55**, 243.
- 2 L. C. Garver and E. E. van Tamelen, *J. Am. Chem. Soc.*, 1982, **104**, 867.
- 3 A. Thullier and J. Vialle, *Bull. Soc. Chim. Fr.*, 1962, 2194 and papers of this series; E. J. Corey and R. H. K. Chen, *Tetrahedron Lett.*, 1973, 3817.
- 4 H. Takei, M. Miura, H. Sugimura, and H. Okamura, *Chem. Lett.*, 1979, 1447.
- 5 Cf. M. E. Garst and T. A. Spencer, *J. Am. Chem. Soc.*, 1973, **95**, 250.
- 6 G. Büchi, E. sz. Kovats, P. Enggist, and G. Uhde, *J. Org. Chem.*, 1968, **33**, 1227; A. Takeda, K. Shinjima, and S. Tsuboi, *Bull. Chem. Soc. Jpn.*, 1977, **50**, 1903; N. D. Ly and M. Schlosser, *Helv. Chim. Acta*, 1977, **60**, 2085.
- 7 S. Takahashi, *Synth. Commun.*, 1976, **6**, 331; C. D. Poulter, P. L. Wiggins, and T. L. Plummer, *J. Org. Chem.*, 1981, **46**, 1532.