A Stereospecific Sulphonium Ylide–Salt Coupling Reaction

By J. E. BALDWIN* and J. A. WALKER

(*Chemistry Department, Massachusetts Institute of Technology, Cambridge, Massachusetts* 02139)

and A. J. H. LABUSCHAGNE and D. F. SCHNEIDER

(*Chemistry Department, University of Stellenbosch, Republic of South Africa*)

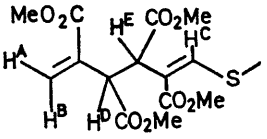
Summary The compound previously described as the ylide (**2**) is now shown to be the vinyl sulphide (**6**); the mechanism of its formation is shown to involve a stereospecific ylide–salt coupling process.

THE product of reaction of (2,3-methoxycarbonylprop-2-enyl)dimethylsulphonium bromide (**1**; R = $\overset{+}{S}Me_2$ Br^- with mild base ($NaHCO_3$) was recently described as the stable ylide (**2**).[1] However, the occurrence of the general process, (**3**) → (**4**),[2] and the demonstration[3] that stabilizing substituents at the anionic centre of such ylides (**3**) do not impede this conversion seemed to contradict the former claim.[1] We have re-examined the earlier work and discovered a highly stereospecific coupling reaction.

That the compound, obtained as previously described,[1] did not possess ylide character was demonstrated by its lack of reaction with strong acids. The n.m.r. spectrum ($CDCl_3$) showed four CO_2Me groups in two environments (δ 3·60 and 3·76 p.p.m.), *S*-Me (δ 2·38), three C=CH singlets (δ 5·85, 6·39, and 7·19) and an AB quartet (δ 4·22, *J* 11 Hz).† The thioether nature of this substance was demonstrated by oxidation (*m*-chloroperoxybenzoic acid) to a mixture of

† The n.m.r. data are assigned as follows [see structure (A)]: δ 5·85 (H^A), 6·39 (H^B, J_{AB} *ca.* 0 Hz), 7·19 (H^C) and 4·22 (AB quartet, *J* 11 Hz, H^D and H^E).

two diastereomeric sulphoxides, m.p. 112—113°, and further to a sulphone, m.p. 98—100°.‡ The n.m.r. spectrum of the sulphone showed a downfield shift of the *S*-Me signal to δ 3·10 p.p.m. and an upfield shift of the C=CH signal at δ 7·19 to 6·81 p.p.m., indicative of the presence of the fragment (**5**). The u.v. spectrum (95% EtOH) of the supposed ylide was a summation of two chromophores, an α-alkylacrylic ester, λ_{max} 205 nm (log ε 3·97), and an α-alkyl-β-thioalkyl acrylate, λ_{max} 295 nm (log ε 4·10). These data are best accommodated by structure (**6**)§ *i.e.*, tetramethyl-1-(methylthio)hexa-1,5-diene-2,3,4,5-tetracarboxylate.



(A)

Chemical proof of this formulation was obtained by ozonolysis (0°; CH_2Cl_2) followed by treatment with sodium periodate–acetic acid and diazomethane to the hemiacetal (**7**), m.p. 133—134°; δ ($CDCl_3$) 4·37 (s, 2H, CH), 3·82 (s, 6H), and 3·92 (s, 6H), which was also obtained by a double condensation of dimethyl oxalate with dimethyl succinate. (Its relative configuration is not known.) Further structural evidence was obtained by mild desulphurisation (Raney Ni W-7) of (**6**) to tetraester (**8**). As expected of the 1,5-diene fragment implicit in formulation (**6**) thermolysis (200°; 14 h) gave, *via* a double Cope rearrangement, a small amount of the isomer (**9**), m.p. 78°, whose n.m.r. spectrum ($CDCl_3$) showed a shift to lower field of the C-6 hydrogen (δ 7·71 p.p.m.). This difference may be explained by a change in the geometry of the vinyl sulphide during the double Cope process. It is not possible at present to assign the C-3 and C-4 configuration although it was shown that these centres are kinetically determined, since isomerisation of (**6**) under more strongly basic conditions (Na_2CO_3) gave the C-3, C-4 isomeric ester (**6**), m.p. 100—102°, λ_{max} (95% EtOH) 204 (log ε 4·11) and 296 nm (log ε 4·18); δ ($CDCl_3$) 7·01 (s, 1H), 6·26 (s, 1H), 5·72 (s, 1H), 4·03 (s, 2H), 3·71 (s, 6H), 3·69 (s, 6H), and 2·35 (s, 3H). This observation demonstrates the stereospecificity of the formation mechanism.

With regard to the mode of formation of (**6**) we have shown that the salt (**10**) is not an intermediate since this material (counterion BF_4^-) did not provide (**6**) on treatment under the original conditions of solvent, basicity, and bromide concentration. Furthermore in the absence of bromide ion the salt (**1**; R = SMe_2, BF_4^-) under the original conditions of formation of (**6**) yielded the triene (**11**), λ_{max} (95% EtOH) 206 (log ε 4·01) and shoulder *ca.* 246 nm (log ε 3·78); δ ($CDCl_3$), 6·45 (s, 2H), 5·85 (s, 2H), 3·78 (s, 6H), and 3·76 (s, 6H) p.p.m. This triene was also obtained by exposure of (**12**; X = BF_4) to the same conditions, whereas addition of sodium bromide to this salt caused smooth demethylation to (**6**). These experiments implicate cation (**12**; X = Br) as an intermediate in the pathway to coupling product (**6**).

The formation of this intermediate (**12**; X = Br) is most simply rationalized as the result of a stereospecific Michael addition of ylide (**13**), arising from deprotonation of salt (**1**; R = $\overset{+}{S}Me_2$, Br^-, to cation (**1**; R = $\overset{+}{S}Me_2$). This reaction provides (**14**), which after elimination of dimethyl sulphide and demethylation as above is transformed into (**6**). In keeping with this explanation is the observation that ylide

‡ New compounds gave satisfactory analytical and spectral data.

§ Assignment of the configuration at C-6 is based on the comparison of the n.m.r. data for this compound and its geometrical isomer (**9**).

(**15**), lacking the second ester function necessary for the Michael addition, does not give dimeric coupling products of the type described here

We thank the National Science Foundation, the Petroleum Research Fund Administered by the American Chemical Society, Eli Lilly and Company, Hoffmann La Roche, and the A P Sloan Foundation for support

(*Received, August 19th,* 1971, *Com* 1461)

[1] C F Garbers, A. J H Labuschagne, and D F Schneider, *Chem Comm*, 1969, 499
[2] J E Baldwin, R E Hackler, and D P Kelly, *Chem Comm*, 1968, 538
[3] J E Baldwin and W E Erickson, *Chem Comm*, 1971, 359
[4] I Scott, 'Interpretation of the Ultraviolet Spectra of Natural Products,' McMillan, New York, 1964, p 242
[5] The relative configuration of this compound is unknown.