An Example of a Tin-Pummerer Rearrangement

Roy L. Beddoes, Donald MacLeod, David Moorcroft, Peter Quayle* and Yeukun Zhao

Department of Chemistry Victoria University of Manchester Manchester M13 9PL

and Gareth M. Davies

ICI Pharmaceuticals Alderley Park Macclesfield SK10 4TG.

Abstract: A highly stereoselective tin - Pummerer reaction, leading to the facile preparation of ketene O,S -acetals is described.

The sila-Pummerer rearrangement (<u>Scheme 1</u>) has proven to be a useful synthetic operation¹, yet examples of the analogous tin-Pummerer rearrangement are rare².



During the course of our studies of heterofunctionalised organostannanes of type (1) an example of this little studied process was observed. Reaction of the readily available sulphoxide³ (2) with acetyl chloride (1 eq.) in refluxing dichloromethane (5 hours) afforded a white crystalline solid (3) (71 % yield; mpt. 106-108°C) of molecular formula C11H11NO3S, as a single diastereoisomer. The ¹H nmr spectrum of this product indicated the presence of a phenyl thioether moiety (δ 7.3-7.65 ppm; 5H, m), a single olefinic proton (δ 5.65 ppm) and a high field methyl absorption (δ 1.6 ppm, 3H, s). In addition, the infra-red spectrum indicated that the product contained two carbonyl groups and a primary amide moiety (ν_{max} . 1696, 1655, 3394 and 3195 cm⁻¹). This data is consistent with structure (3), <u>Scheme 2</u>.



A single crystal X-ray structure analysis confirmed the Z-double bond geometry⁴ and showed that the methyl group of the acetyl moiety lies over the shielding zone of the aromatic ring,

(Figure 1), which could account for its anomolously high field absorption in the 1H nmr spectrum.

In order to test the generality of this rearrangement preparation of the sulphoxides (6) and (7) was undertaken. Oxidation of the sulphides⁵ (4) and (5) with MCPBA (1 eq., 1 hr., 20°C) afforded the sulphoxides (6) and (7) in 71% and 58% isolated yield respectively. Reaction of the sulphoxide (6) with acetyl chloride afforded the rearranged acetate (8) in 57% isolated yield, as a single geometric isomer⁶ (stereochemistry by analogy).

Reaction of the sulphoxide (7) with a variety of acyl halides, in refluxing dichloromethane, resulted in a smooth rearrangement to the ketene O,S-acetals (9) - (13), (Table). As expected, reaction of benzyl chloroformate with the sulphoxide (7) was extremely sluggish (64 hrs. reflux), although the isolated yield of the rearranged product (11) was still acceptable (62%). In all cases, the rearranged products (9) - (13) were isolated as a single geometric isomer (300 MHz ¹H nmr; 75 MHz ¹³C nmr).

	RCOC	I; CH ₂ Cl ₂ ; 40°C
	PhS(O) SnBu ₃	Nu
$X = CONH_2$	(2)	Nu=OAc (3); 71%
X = COCCl3	(6)	Nu=OAc (8); 57%
$X = CO_2Me$	(7)	Nu=OAc (9); 90%
	(7)	Nu=OCOPh (10); 88%
	(7)	Nu=O(CO)OCH2Ph (11); 62%
	(7)	Nu=OCOEt (12); 86%
	(7)	Nu=OCO(3-Thienyl) (13); 74%
X = H	(14)	Nu=AcO (15); 50%
	(14)	Nu=OCOPh (17); 93%







Figure 1

(10)

In order to gain an insight into the stereochemical course of these reactions, a single crystal X-ray structure determination of the benzoate (10) was undertaken. (Figure 1). The results of this study again clearly established the Z-configuration about the C2-C3 double bond. As in the case of the acetate (3), the *CH*₃CO- and *CH*₃*CH*₂CO- protons of the esters (9) and (12) experienced an upfield shift ($\Delta\delta$ c.a. 0.5 ppm) in the ¹H nmr spectrum, presumably due to the anisotropy of the neighbouring aromatic ring. In both compounds it was possible to assign the Z-configuration about the C2-C3 bond on the basis of n.O.e studies. Irradiation of the acetate (9) induced a 9.6% enhancement of the vinyl proton, Ha (δ 5.75 ppm). Similarly, irradiation of the methylene protons H₈ (δ 1.8 ppm, (2H, q, J = 8 Hz)) of the propionate (12) induced a 9.5% enhancement of the proton Ha (δ 5.75 ppm), Figure 2.



Finally, reaction of the sulphoxide (14) with acetyl chloride afforded the labile acetate (15) in moderate yield (50%) together with thioester (16) (14%). Reaction of the sulphoxide (14) with benzoyl chloride afforded the stable benzoate (17) in excellent yield (93%), after column chromatography.



Although a detailed mechanistic study for this process has yet to be undertaken, it is tempting to suggest that the reaction proceeds *via* an "additive" Pummerer rearrangement⁷, leading to the formation of the chelated thionium intermediate⁸ (18). Subsequent nucleophilic attack⁹ (by RCO₂⁻) followed by *anti*-elimination¹⁰ of Bu₃SnCl affords the observed product, (<u>Scheme 3</u>). Alternatively, rearrangement could proceed *via* addition of a carboxylate anion to the thionium intermediate (19).



Scheme 3

In summary we have shown that α -stannyl vinylsulphoxides undergo Pummerer-type rearrangements upon reaction with acyl halides. In appropriate cases the rearrangement proceeds with a high degree of stereoselectivity affording a facile route to functionalised ketene O,S-acetals¹¹. We are currently exploring the use of this reaction for the stereoselective construction of tri-substituted double bonds.

Acknowledgements

We thank the SERC for the provision of a CASE award to D. MacL and ICI Pharmaceuticals for generous support of our work.

REFERENCES AND NOTES.

- (1)E. Block and M. Aslam, Tetrahedron, 1988, 44, 284 and refs. therein.
- For the only reported example see M. Pohmakotr and S. Sithikanchanakul, Tetrahedron Letters, 1989, 30, (2)6773
- (3) H. Imanieh, D. MacLeod, P. Quayle and G. M. Davies, Tetrahedron Letters, 1989, 30, 2689
- The full crystallographic data will be published elsewhere. (4)
- (5) C. Booth, H. Imanieĥ, P. Quayle, and L. Shui-Yu, Tetrahedron Letters, 1991, 32, 0000.
- All compounds were fully characterised by 300 MHz ¹H nmr, 75 MHz ¹³C, ir, mass spectroscopy and/or (6) combustion microanalysis.
- (7)e.g. J. P. Marino and A. D. Perez, J. Am. Chem. Soc., 1984, 106, 7643; H. Kosuji, K. Tagami, A. Takahashi, H. Kanna, and H. Uda, J. Chem. Soc., Perkin Trans. 1, 1989, 935; D. Craig and K. Daniels, <u>Tetrahedron Letters</u>, 1990, 37, 6441. see also H.- C. Cheng and T.- H. Yan, <u>Tetrahedron</u> Letters, 1990, 31, 673.
- c.f. B. Jousseaume and P. Villeneuve. J. Chem. Soc., Chem. Commun., **1987**, 513; B. Jousseaume, P. Villeneuve, M. Drager, S. Roller, and J. M. Chezeau, J. Organomet. chem., **1988**, 349, C1. For recent synthetic applications see I. Mori, P. A. Bartlett, and C. H. Heathcock, J. Org. Chem., **1990**, (8)
- (9) 55, 5966.
- (10) c.f. T. Kauffmann, R. Kriegesmann, and A. Hamsen, Chem. Ber., 1982, 115, 1818
- (11) For alternative approaches to this unusual functional group see S. Hackett and T. Livinghouse, Tetrahedron Letters, 1984, 25, 3539.

(Received in UK 19 November 1991)