

USE OF 2-PHENYLSULPHONYL CYCLIC ETHERS IN THE PREPARATION OF TETRAHYDROPYRAN AND TETRAHYDROFURAN ACETALS AND IN SOME GLYCOSIDATION REACTIONS.

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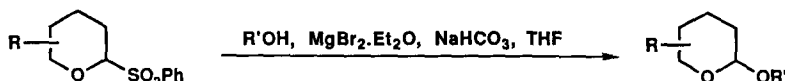
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Abstract: 2-Phenylsulphonyl cyclic ethers undergo facile displacement of the sulphonyl group by alcohols, in the presence of magnesium bromide etherate and sodium bicarbonate in tetrahydrofuran, to give good yields of the corresponding acetals.

The preparation of tetrahydro-pyran and -furan ethers typically involves relatively acidic conditions¹. Since many functional groups may not be compatible with such acidity, we have examined the magnesium bromide induced displacement of the phenylsulphonyl moiety by alcohols under mildly basic conditions^{2,3} (scheme). These mild conditions tolerate a wide variety of functional groups including furans, ketones, esters, silyl ethers, acetals, alkenes and alkynes.



Scheme

The starting 2-phenylsulphonyl cyclic ethers 1-5, were prepared in excellent yield, as previously reported, from lactols, lactol ethers, dihydro-pyrans, or -furans.⁴ Sulphone 6 was synthesised by oxidation of the corresponding sulphide with *meta*-chloroperbenzoic acid (*m*CPBA). In a typical experiment, these sulphones were converted into the corresponding acetals by stirring in tetrahydrofuran (THF) with the required alcohol, magnesium bromide etherate and sodium bicarbonate, at room temperature overnight. (Tables 1-4).

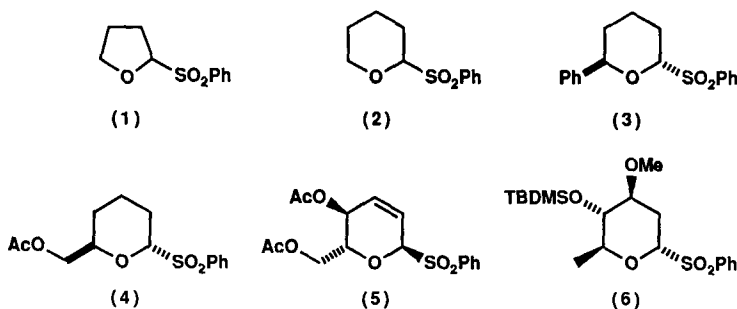
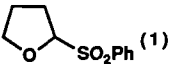
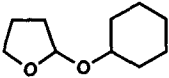
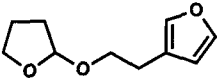
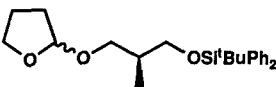
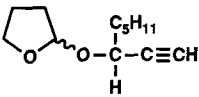
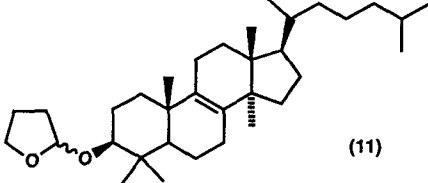


TABLE 1

PRODUCTS OF REACTIONS OF ALCOHOLS WITH 				
ENTRY	PRODUCT		YIELD	CONDITIONS
1		(7)	98 %	Method A
2		(8)	84 %	Method B
3		(9)	Quant.	Method A
4		(10)	99 %	Method A
5		(11)	89 %	Method A

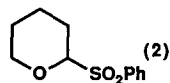
CONDITIONS for Tables 1-3

Method A: 1 eq. sulphone, 2 eq. alcohol, 2 eq. $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$, 1 eq. NaHCO_3 , stirred overnight at room temperature.

Method B: 1 eq. sulphone, 1 eq. alcohol, 2 eq. $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$, 1 eq. NaHCO_3 , stirred overnight at room temperature.

From the tables it can be seen that relatively hindered tertiary alcohols may be used (Table 2, entry 2 and Table 3, entry 2).⁵ Phenols will also react, although the yields have been less than 50% in the few examples investigated (Table 2, entry 13 and Table 3, entry 6). In all situations where the pyran ring additionally carries a substituent in the C-6 position (Table 3), one observes preferential *trans*-stereoselectivity in the formation of the acetal product, although the ratio of products depends on the steric bulk of the incoming group. This is in contrast to our work on the substitution of the phenylsulfonyl group by carbon nucleophiles, where the 2,6-*trans*-isomer is usually the only product, suggesting preferred axial attack by the incoming nucleophile at the anomeric centre⁴. Our reasoning is that, with the oxygen nucleophiles, equilibration to the thermodynamic mixture of products is possible, and thus a stereochemical mixture is obtained. In some cases, as shown in Table 4, glycosidations can be achieved, using carbohydrate derivatives as either the sulphone or alcohol component, with varying degrees of success.^{6,7} In examples where the reaction was slow, considerable rate enhancement could be achieved by the use of ultrasonication in a small cleaning bath⁸, or even warming to gentle reflux.

TABLE 2
PRODUCTS OF REACTIONS OF ALCOHOLS WITH



ENTRY	PRODUCT		YIELD	CONDITIONS
1		(12)	92 %	Method A
2		(13)	80 %	Method A
3		(14)	78 %	Method A
4		(15)	90 %	Method B
5		(16)	96 %	Method A
6		(17)	Quant.	Method A
7		(18)	97 %	Method A
8		(19)	67 %	Method B
9		(20)	67 %	Method B
10		(21)	95 %	Method B
11		(22)	84 %	Method A
12		(23)	67 %	Method A
13		(24)	47 %	Method B

TABLE 3**PRODUCTS OF REACTION OF ALCOHOLS WITH
6-SUBSTITUTED TETRAHYDROPYRANYLSULPHONES**

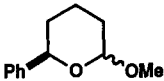
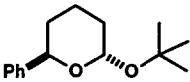
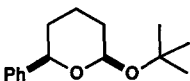
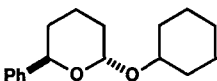
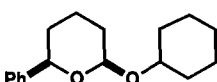
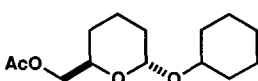
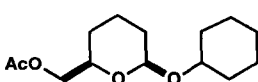
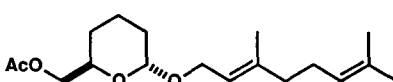
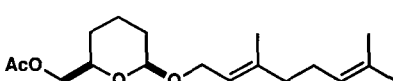
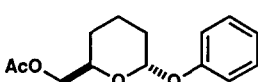
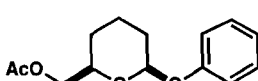
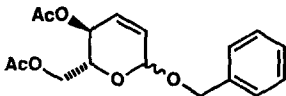
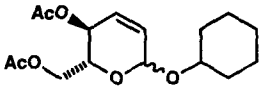
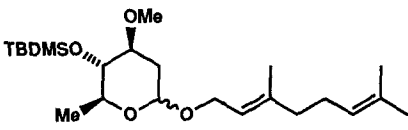
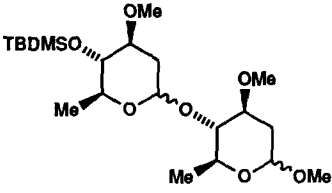
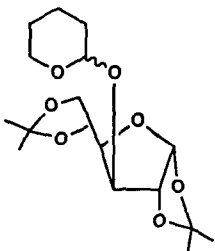
ENTRY	PRODUCT		YIELD	CONDITIONS
1		(25)	70 % trans:cis 80:20	Method A with sonication
2		(26)	40 %	Method B
		(27)	38 %	
3		(28)	62 %	Method B with sonication
		(29)	11 %	
4		(30)	58 %	Method B Four days room temp
		(31)	18 %	
5		(32)	59 %	Method B Four days room temp
		(33)	26 %	
6		(34)	39 %	Method B
		(35)	11 %	

TABLE 4
GLYCOSIDATION REACTIONS

ENTRY	PRODUCT	YIELD	CONDITIONS
1	 (36)	70 % eq:ax 22:78	Method A with sonication
2	 (37)	76 % eq:ax 13:87	Method B with sonication
3	 (38)	58 % eq:ax 33:67	Method A at reflux
4	 (39)	65 % major product is αα	Method A with sonication
5	 (40)	53 %	Method B with sonication

CONDITIONS

Method A: 1 eq. sulphone, 5 eq. alcohol, 2 eq. $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$, 1 eq NaHCO_3 .

Method B: 1 eq. sulphone, 1 eq. alcohol, 2 eq. $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$, 1 eq NaHCO_3 , stirred overnight at room temperature.

In summary, the above method constitutes a new, mild, room temperature procedure for the formation of tetrahydropyran and tetrahydrofuran acetals, with the considerable advantage of being weakly basic rather, than acidic. The commercial availability of the tetrahydropyranyl sulphone (2), also increases its appeal as a protecting group reagent for alcohols.

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Experimental:

Solutions were dried over anhydrous sodium sulphate or anhydrous magnesium sulphate, and solvents by standard methods.⁹ The products were purified by column chromatography on Merck silica gel 60 (Art. 9385 230-400 mesh) under pressure using diethyl ether / petrol as the solvent unless otherwise stated. "Petrol" refers to the fraction boiling at 40-60°C. Melting points were measured on a Kofler hot-stage apparatus and are uncorrected. IR spectra were recorded on a Perkin-Elmer 983G spectrophotometer as liquid films or chloroform solutions. ¹H NMR spectra were recorded in CDCl₃ on Bruker WM-250, Jeol GSX-270 or Bruker AM-500 spectrometers. Mass spectra were recorded on a VG Micromass 7070B instrument, except for the accurate mass measurements, for which we thank the S.E.R.C. Mass Spectrometry Service at the University of Swansea. Microanalyses were performed by the analytical department of Imperial College.

The Sulphones (1)-(5) were prepared as previously published⁴.

4-*O*-(*tert*-Butyldimethylsilyl)-1-deoxy-1-(phenylsulphonyl)- α -L-oleandrose (6). Phenyl 4-*O*-(*tert*-butyldimethylsilyl)-1-deoxy-1-thio- α -L-oleandroside¹⁰ (333mg, 0.90 mmol) was dissolved in dichloromethane (20 ml) at 0°C and treated with *meta*-chloroperbenzoic acid (0.51g, 85%, 2.51 mmol, 2.8 equiv.) in the presence of saturated aqueous sodium hydrogen carbonate solution (20 ml). The reaction was stirred overnight at room temperature. Work-up and purification by silica gel chromatography (gradient elution, Et₂O:petrol, 1:3-2:3) gave the sulphone 6 as a white solid (285 mg, 0.71 mmol, 79%), m.p. 54-58°C; [α]_D²⁰ -116.8° (c 1.02 in CHCl₃); $\nu_{\max}$ (film) 3063, 2930, 2890, 2855, 1460, 1446, 1387, 1308, 1289, 1249, 1206, 1141, 1124, 1081, 1059, 888, 837, 777, 730, 687 and 665 cm⁻¹; δ_{H} (500 MHz) 0.06 (3H, s, SiCH₃), 0.09 (3H, s, SiCH₃), 0.88 (9H, s, SiC(CH₃)₃), 1.15 (3H, d, *J* 6.5 Hz, 6-CH₃), 1.92 (1H, ddd, *J* 14.5 9.5 7.0 Hz, 2-Hax), 2.93 (1H, ddd, *J* 14.5 5.0 3.0 Hz, 2-Heq), 3.18 (1H, dd, *J* 9.0 7.5 Hz, 4-H), 3.40 (3H, s, 3-OCH₃), 3.72 (1H, ddd, *J* 9.5 7.0 5.0 Hz, 3-H), 4.24 (1H, dq, *J* 9.0 6.5 Hz, 5-H), 4.75 (1H, dd, *J* 7.0 3.0 Hz, 1-H), 7.56-7.59 (2H, m) 7.65-7.69 (1H, m) and 7.89-7.91 (2H, m) (PhH); *m/z* 343 (M-^tBu)⁺, 311 (M-^tBu-CH₃O)⁺, 259 (M-PhSO₂)⁺, 243 (M-PhSO₂H-CH₃)⁺, 227 (M-PhSO₂-CH₃O)⁺, 201 (M-PhSO₂H-^tBu)⁺, 115 (^tBuMe₂Si)⁺, 89 (C₄H₉O)⁺, 73 (C₃H₅O)⁺, and 59 (C₃H₇O)⁺; (Observed (M-^tBu)⁺, 343.1035, calc. for C₁₅H₂₃O₅SSi (M-^tBu), 343.103); (Found: C, 57.01; H, 8.10, C₁₉H₃₂O₅SSi requires C, 56.97; H, 8.05%).

General Method for 2-Substitution of Cyclic Ethers by Alcohols. A mixture of the sulphone (1 equiv.), alcohol (1-2 equiv.), magnesium bromide etherate (2 equiv.) and sodium hydrogen carbonate (1 equiv.) in dry, freshly distilled THF (5 ml/mmol) was stirred at room temperature for 15-24 hours under argon. The reaction mixture was quenched with 1N NaOH and extracted with ether. The combined extracts were dried (MgSO₄) and concentrated *in vacuo*. Products were purified by silica gel chromatography (eluted with Et₂O:petrol, 1:15 unless stated otherwise).

2-(Cyclohexyloxy)tetrahydrofuran (7)^{1g}. Reaction of tetrahydro-2-(phenylsulphonyl)furan (1) (208 mg, 0.98 mmol) with cyclohexanol (0.210 ml, 200 mg, 2.0 mmol, 2.0 equiv.), MgBr₂·Et₂O (521 mg, 2.0 mmol, 2.1 equiv.) and NaHCO₃ (86 mg, 1.0 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 7 (164 mg, 0.96 mmol, 98%) as a colourless oil; $\nu_{\max}$ (film) 2922, 2850, 1726, 1459, 1259, 1068 and 1023 cm⁻¹; δ_{H} (250 MHz) 1.00-2.10 (14H, m, 3-H₂ 4-H₂ 2'-H₂ 3'-H₂ 4'-H₂ 5'-H₂ 6'-H₂), 3.50 (1H, tt, *J* 9.5 4.5 Hz, 1'-H), 3.77-3.95 (2H, m, 5-H₂), 5.27 (1H, dd, *J* 4.5 1.5 Hz, 2-H); *m/z* 170 (M)⁺, 141 (M-C₂H₅)⁺, 125 (M-C₂H₅O)⁺, 96 (C₆H₈O)⁺, 84 (C₆H₁₄)⁺ and 71 (C₄H₇O)⁺; (Observed (M+NH₄)⁺, 188.1650, calc. for C₁₀H₂₂NO₂ (M+NH₄), 188.1650).

2-[2-(3-Furyl)ethoxy]tetrahydrofuran (8). Reaction of tetrahydro-2-(phenylsulphonyl)furan (1) (232 mg, 1.1 mmol) with 2-(3-furyl)ethanol (110 mg, 0.98 mmol, 1.0 equiv.), MgBr₂·Et₂O (525 mg, 2.0 mmol, 2.0 equiv.) and NaHCO₃ (95 mg, 1.1 mmol, 1.0 equiv.), followed by standard work-up and chromatography (Et₂O:petrol, 1:10), gave the acetal product 8 (167 mg, 0.92

mmol, 84%) as a colourless oil; $\nu_{\max}$ (film) 3131, 2947, 2914, 2879, 1456, 1348, 1324, 1184, 1160, 1122, 1094, 1067, 1039, 979, 920, 873, 781 and 727 cm^{-1} ; δ_{H} (250 MHz) 1.75-2.07 (4H, m, 3-H₂ 4-H₂), 2.68 (2H, t, J 6.5 Hz, 2'-H₂), 3.55 (1H, dt, J 9.5 7.0 Hz, 5-H), 3.72-3.89 (3H, m, 5-H, 1'-H₂), 5.13 (1H, dd, J 3.5 2.0 Hz, 2-H), 6.30 (1H, br s, 4''-H), 7.27 (1H, s, 2''-H), 7.34 (1H, br s, 5''-H); m/z 182 (M)⁺, 123 (M-C₃H₇O)⁺, 112 (M-C₄H₆O)⁺, and 71 (C₄H₇O)⁺; (Observed M⁺, 182.0943, C₁₀H₁₄O₃ M requires 182.0943).

[2*RS*(S)]-2-[3-(*tert*-Butyldiphenylsilyloxy)-2-methylpropyloxy]tetrahydrofuran (9).- Reaction of tetrahydro-2-(phenylsulphonyl)furan (1) (215 mg, 1.0 mmol) with (2*S*)-(3-*tert*-butyldiphenylsilyloxy)-2-methylpropanol (660 mg, 2.0 mmol, 2.0 equiv.), MgBr₂.Et₂O (516 mg, 2.0 mmol, 2.0 equiv.) and NaHCO₃ (92 mg, 1.1 mmol, 1.1 equiv.), followed by standard work-up and chromatography (Et₂O:petrol, 1:9), gave the acetal product 9 (398 mg, 1.0 mmol, Quant.) as a colourless oil and an inseparable mixture of diastereoisomers at C-2 (*ca.* 1:1); $\nu_{\max}$ (film) 3068, 3047, 2955, 2929, 1740, 1470, 1426, 1388, 1359, 1233, 1186, 1111, 1040, 998, 971, 931, 920, 823, 740, 703 and 614 cm^{-1} ; δ_{H} (250 MHz) 0.97 (3H, d, J 6.5 Hz, 2'-CH₃), 1.05 (9H, s, (CH₃)₃), 1.75-2.05 (5H, m, 3-H₂ 4-H₂ 2'-H₂), 3.33 (0.5H, dd, J 10.5 6.0 Hz, 3'-H one isomer), 3.44 (0.5H, dd, J 9.5 7.0 Hz, 3'-H one isomer), 3.51-3.66 (2.5H, m, 1'-H, 1'-H one isomer, 3'-H), 3.68 (0.5H, dd, J 9.5 6.5 Hz, 1'-H one isomer), 3.79-3.87 (2-H, m, 5-H₂), 5.08 (1H, t, J 2.0 Hz, 2-H), 7.35-7.47 (6H, m) and 7.62-7.71 (4H, m) (PhH); m/z 341 (M-^tBu)⁺, 327 (M-C₄H₇O)⁺, 211 (M+H-^tBu-C₄H₇O)⁺, and 71 (C₄H₇O)⁺; (Observed (M+H)⁺, 399.2355, calc. for C₂₄H₃₅O₃Si (M+H), 399.2355).

2-(1-Ethynylhexyloxy)tetrahydrofuran (10).- Reaction of tetrahydro-2-(phenylsulphonyl)furan (1) (202 mg, 0.95 mmol) with oct-1-yn-3-ol (0.30 ml, 258 mg, 2.0 mmol, 2.1 equiv.), MgBr₂.Et₂O (522 mg, 2.0 mmol, 2.1 equiv.) and NaHCO₃ (93 mg, 1.1 mmol, 1.2 equiv.), followed by standard work-up and chromatography, gave the acetal product 10 as a separable mixture of diastereoisomers (*ca.* 1:1) (total yield, 185 mg, 0.94 mmol, 99%) both colourless oils. Diastereoisomer of higher Rf: $\nu_{\max}$ (film) 3309, 2921, 2850, 1707, 1459, 1377, 1260 and 1017 cm^{-1} ; δ_{H} (250 MHz) 0.88 (3H, t, J 7.0 Hz, 6'-H₃), 1.25-1.50 (6H, m, 3'-H₂ 4'-H₂ 5'-H₂), 1.60-1.75 (2H, m, 4-H₂), 1.78-2.05 (4H, m, 3-H₂ 2'-H₂), 2.38 (1H, d, J 2.0 Hz, C≡CH), 3.81-3.89 (2H, m, 5-H₂), 4.33 (1H, td, J 6.5 2.0 Hz, 1'-H), 5.46 (1H, dd, J 3.5 1.5 Hz, 2-H); m/z 196 (M), 195 (M-H)⁺, 167 (M-C₂H₅)⁺, 153 (M-C₃H₇)⁺, 125 (C₈H₁₃O)⁺, 109 (C₈H₁₃)⁺, and 71 (C₄H₇O)⁺ or (C₅H₁₁)⁺; (Observed (M+NH₄)⁺, 214.1815, calc. for C₁₂H₂₄NO₂ (M+NH₄), 214.1807). Diastereoisomer of lower Rf: $\nu_{\max}$ (film) 3306, 2930, 2859, 1459, 1378, 1326, 1185, 1115, 1086, 1030 and 920 cm^{-1} ; δ_{H} (250 MHz) 0.89 (3H, t, J 7.0 Hz, 6'-H₃), 1.20-1.50 (6H, m, 3'-H₂ 4'-H₂ 5'-H₂), 1.62-1.78 (2H, m, 4-H₂), 1.78-1.98 (3H, m, 3-H 2'-H₂), 1.98-2.10 (1H, m, 3-H), 2.42 (1H, d, J 2.0 Hz, C≡CH), 3.89 (1H, td, J 8.0 6.0 Hz, 5-H), 4.01 (1H, td, J 8.0 6.0 Hz, 5-H), 4.22 (1H, td, J 6.5 2.0 Hz, 1'-H), 5.28 (1H, t, J 2.5 Hz, 2-H); m/z 195 (M-H)⁺, 153 (M-C₃H₇)⁺, 125 (C₈H₁₃O)⁺, and 71 (C₄H₇O)⁺ or (C₅H₁₁)⁺; (Observed (M+NH₄)⁺, 214.1807, calc. for C₁₂H₂₄NO₂ (M+NH₄), 214.1807).

Tetrahydro-2-(lanost-8-en-3-yloxy)furan (11).- Reaction of tetrahydro-2-(phenylsulphonyl)furan (1) (156 mg, 0.74 mmol, 1.5 equiv.) with lanost-8-en-3-ol (215 mg, 0.50 mmol, 1.0 equiv.), MgBr₂.Et₂O (260 mg, 1.0 mmol, 2.0 equiv.) and NaHCO₃ (43 mg, 0.50 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 11 (222 mg, 0.45 mmol, 89%) as a white solid, (m.p. 96-98°C) and an inseparable mixture of diastereoisomers at C-2 (*ca.* 2:3); $\nu_{\max}$ (film) 2944, 2014, 1463, 1369 and 1031 cm^{-1} ; δ_{H} (250 MHz) 0.50-2.10 (54H, m, 3-H₂ 4-H₂ and all protons of steroid except 3'-H), 3.06 (0.4H, dd, J 14.0 5.0 Hz, 3'-H one isomer), 3.22 (0.6H, dd, J 13.5 5.0 Hz, 3'-H one isomer), 3.76-3.97 (2H, m, 5-H₂), 5.17 (0.4H, t, J 3.5 Hz, 2-H one isomer), 5.27 (0.6H, dd, J 4.5 2.0 Hz, 2-H one isomer); m/z 498 (M)⁺, 483 (M-CH₃)⁺, 428 (M-C₄H₆O)⁺, 413 (M-C₅H₉O)⁺, 395 (M-C₅H₉O₂)⁺ and 71 (C₄H₇O)⁺; (Observed M⁺, 498.4437, calc. for C₃₄H₅₈O₂ M, 498.4437); (Found: C, 81.99, H, 11.85, C₃₄H₅₈O₂ requires C, 81.87, H, 11.72%).

2-(Cyclohexyloxy)tetrahydro-2*H*-pyran (12)^{1a}.- Reaction of tetrahydro-2-(phenylsulphonyl)-2*H*-pyran (2) (230 mg, 1.0 mmol) with cyclohexanol (0.22 ml, 222 mg, 2.2 mmol, 2.2 equiv.), MgBr₂.Et₂O (513 mg, 2.0 mmol, 1.9 equiv.) and NaHCO₃ (87 mg, 1.0 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 12 (173 mg, 0.94 mmol, 92%) as a colourless oil; $\nu_{\max}$ (film) 2932, 2855, 1449, 1356, 1201, 1169, 1117, 1063, 1022, and 998 cm^{-1} ; δ_{H} (250 MHz) 1.10-2.00 (16H, m, 3-H₂ 4-H₂ 5-H₂ 2'-H₂ 3'-H₂ 4'-H₂ 5'-H₂ 6'-H₂), 3.43-3.52 (1H, m, 6-H), 3.59 (1H, t, J 9.5 4.0 Hz, 1'-H), 3.87-3.95 (1H, m, 6-H), 4.70 (1H, dd, J 4.5 3.0 Hz, 2-H); m/z 102 (C₅H₁₀O₂)⁺, and 85 (C₅H₉O)⁺; (Found: C, 71.79, H, 11.14, calc. for C₁₁H₂₀O₂, C, 71.70, H, 10.94%).

2-(Tricyclo[3.3.1.1^{3,7}]dec-1-yloxy)tetrahydro-2H-pyran (13)^{1e}. Reaction of tetrahydro-2-(phenylsulphonyl)-2H-pyran (2) (230 mg, 1.0 mmol) with adamantanol (302 mg, 2.0 mmol, 2.0 equiv.), MgBr₂.Et₂O (515 mg, 2.0 mmol, 2.0 equiv.) and NaHCO₃ (95 mg, 1.1 mmol, 1.1 equiv.), followed by standard work-up and chromatography, gave the acetal product 13 (193 mg, 0.82 mmol 80%) as a colourless oil; $\nu_{\max}$ (film) 2906, 2849, 1446, 1353, 1305, 1200, 1185, 1132, 1118, 1102, 1075, 1041, 1023, 998 and 982 cm⁻¹; δ_{H} (250 MHz) 1.43-1.58 (4H, m, 4-H₂ 5-H₂), 1.63 (6H, t, *J* 3.5 Hz, 3 $\times$ γ -H₂), 1.65-1.93 (8H, m, 3-H₂ 3 $\times$ α -H₂), 2.12 (3H, br s, 3 $\times$ β -H), 3.44 (1H, ddd, *J* 11.5 6.0 4.5 Hz, 6-H_{ax}), 3.95 (1H, dt, *J* 11.0 4.0 Hz, 6-Heq), 4.83 (1H, dd, *J* 6.0 4.0 Hz, 2-H); *m/z* 236 (M)⁺, 218 (M-H₂O)⁺, 190 (M-H₂O-C₂H₄)⁺, 152 (C₁₀H₁₆O)⁺, 135 (C₁₀H₁₅)⁺ and 85 (C₅H₉O)⁺; (Observed M⁺, 236.1776, calc. for C₁₅H₂₄O₂ M, 236.1776).

[4S(RS)]-4-[2-(Tetrahydro-2H-pyran-2-yloxy)ethyl]-2,2-dimethyl-1,3-dioxolane (14). Reaction of tetrahydro-2-(phenylsulphonyl)-2H-pyran (2) (226 mg, 1.0 mmol) with (*S*)-2,2-dimethyl-1,3-dioxolane-4-ethanol (310 mg, 2.1 mmol, 2.1 equiv.), MgBr₂.Et₂O (526 mg, 2.0 mmol, 2.0 equiv.) and NaHCO₃ (88 mg, 1.1 mmol, 1.1 equiv.), followed by standard work-up and chromatography, gave the acetal product 14 (179 mg, 0.78 mmol 78%) as a colourless oil and an inseparable mixture of diastereoisomers at C-2' (*ca.* 1:1); $\nu_{\max}$ (film) 2982, 2939, 2870, 1451, 1440, 1377, 1366, 1352, 1322, 1250, 1201, 1161, 1138, 1123, 1076, 1036, 1023, 989, 908, 866 and 814 cm⁻¹; δ_{H} (250 MHz) 1.35 and 1.39 (2 $\times$ 3H, 2 $\times$ s, CH(CH₃)₂), 1.40-2.00 (8H, m, 3"-H₂ 4"-H₂ 5"-H₂ 1'-H₂), 3.39-3.61 (3H, m, 6"-H 2'-H 5-H), 3.75-3.98 (2H, m, 6"-H 5-H), 4.06 (1H dt, *J* 8.0 6.0 Hz, 2'-H), 4.12-4.25 (1H, m, 4-H), 4.55 and 4.57 (2 $\times$ 0.5H, 2 $\times$ t, *J* 3.0 Hz, 2"-H); *m/z* 229 (M-H)⁺, 215 (M-CH₃)⁺, 172 (M-C₃H₆O)⁺, 159 (M-C₄H₇O)⁺, 145 (M-C₅H₉O)⁺, 129 (M-C₅H₉O)⁺ or (C₅H₉O₂CH₂CH₂)⁺, 115 (C₅H₉O₂CH₂)⁺, 101 (C₅H₉O₂)⁺, and 85 (C₅H₉O)⁺; (Observed (M+NH₄)⁺, 248.1862, calc. for C₁₂H₂₆NO₄ (M+NH₄), 248.1862).

(*E*)-2-(3,7-Dimethyl-2,6-octadienyloxy)tetrahydro-2H-pyran (15)^{1c}. Reaction of tetrahydro-2-(phenylsulphonyl)-2H-pyran (2) (228 mg, 1.0 mmol) with geraniol (0.175 ml, 156 mg, 1.0 mmol, 1.0 equiv.), MgBr₂.Et₂O (521 mg, 2.0 mmol, 2.0 equiv.) and NaHCO₃ (88 mg, 1.1 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 15 (217 mg, 0.91 mmol, 90%) as a colourless oil; $\nu_{\max}$ (film) 2939, 1440, 1376, 1200, 1117, 1077, and 1023 cm⁻¹; δ_{H} (250 MHz) 1.42-2.15 (10H, m, 3-H₂ 4-H₂ 5-H₂ 4'-H₂ 5'-H₂), 1.59 (3H, s, 3'-Me), 1.65 (6H, s, 7'-Me), 3.45-3.54 (1H, m, 6-H), 3.84-3.93 (1H, m, 6-H), 4.02 (1H, dd, *J* 11.5 7.5 Hz, 1'-H), 4.23 (1H, ddd, *J* 12.0 6.5 0.5 Hz, 1'-H), 4.62 (1H, t, *J* 3.5 Hz, 2-H), 5.08 (1H, t, *J* 4.0 1.5 Hz, 6'-H), 5.35 (1H, t, *J* 6.5 1.0 Hz, 2'-H); *m/z* 238 (M)⁺, 195 (M-C₂H₃O)⁺, 85 (C₅H₉O)⁺ and 69 (C₅H₉)⁺; (Observed M⁺, 238.1933, calc. for C₁₅H₂₄O₂ M, 238.1933); (Found: C, 75.47, H, 11.17, calc. for C₁₅H₂₆O₂, C, 75.58; H, 10.99%).

2-(1-Ethynylhexyloxy)tetrahydro-2H-pyran (16). Reaction of tetrahydro-2-(phenylsulphonyl)-2H-pyran (2) (229 mg, 1.0 mmol) with oct-1-yn-3-ol (0.30 ml, 259 mg, 2.1 mmol, 2.0 equiv.), MgBr₂.Et₂O (518 mg, 2.0 mmol, 2.0 equiv.) and NaHCO₃ (84 mg, 1.0 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 16 as a separable mixture of diastereoisomers (*ca.* 1:1) (total yield, 205 mg, 0.97 mmol, 96%), both colourless oils. Diastereoisomer of higher Rf: $\nu_{\max}$ (film) 3306, 2939, 2867, 1465, 1440, 1377, 1353, 1259, 1201, 1183, 1158, 1126, 1115, 1077, 1037, 1022, 980, 907, 870, 815, 656 and 624 cm⁻¹; δ_{H} (250 MHz) 0.90 (3H, t, *J* 7.0 Hz, 8'-H₃), 1.20-1.40 (4H, m) 1.40-1.67 (6H, m) 1.67-1.88 (4H, m) (3-H₂ 4-H₂ 5-H₂ 2'-H₂ 3'-H₂ 4'-H₂ 5'-H₂), 2.37 (1H, d, *J* 2.5 Hz, C $\equiv$ CH), 3.52 (1H, ddd, *J* 11.0 6.0, 5.0 Hz, 6-H), 3.80 (1H, ddd, *J* 11.5 8.0 3.5 Hz, 6-H), 4.40 (1H, td, *J* 6.5 2.0 Hz, 1'-H), 4.67 (1H, t, *J* 3.0 Hz, 2-H); *m/z* 209 (M-H)⁺, 181 (M-C₂H₅)⁺, 139 (M-C₅H₁₁)⁺, 109 (C₈H₁₃)⁺, 101 (C₅H₉O₂)⁺, 85 (C₅H₉O)⁺ and 67 (C₅H₇)⁺; (Observed (M+NH₄)⁺, 228.1964, calc. for C₁₃H₂₆NO₂ (M+NH₄), 228.1963). Diastereoisomer of lower Rf: $\nu_{\max}$ (film) 3306, 2941, 2859, 1465, 1452, 1440, 1379, 1351, 1334, 1320, 1260, 1201, 1184, 1117, 1078, 1051, 1023, 981, 910, 870, 816, 652 and 623 cm⁻¹; δ_{H} (500 MHz) 0.89 (3H, t, *J* 7.5 Hz, 6'-H₃), 1.27-1.47 (4H, m) 1.40-1.50 (2H, m) 1.50-1.65 (4H, m) 1.65-1.78 (3H, m) 1.80-1.90 (1H, m) (3-H₂ 4-H₂ 5-H₂ 2'-H₂ 3'-H₂ 4'-H₂ 5'-H₂), 2.43 (1H, d, *J* 1.5 Hz, C $\equiv$ CH), 3.53 (1H, ddd, *J* 11.5 4.5 1.0 Hz, 6-Heq), 4.01 (1H, ddd, *J* 11.5 9.0, 3.0 Hz, 6-H_{ax}), 4.27 (1H, td, *J* 6.5 2.0 Hz, 1'-H), 4.74 (1H, t, *J* 3.5 Hz, 2-H); *m/z* 209 (M-H)⁺, 181 (M-C₂H₅)⁺, 167 (M-C₂H₃O)⁺, 139 (M-C₅H₁₁)⁺, 109 (C₈H₁₃)⁺, 101 (C₅H₉O₂)⁺, 85 (C₅H₉O)⁺ and 67 (C₅H₇)⁺; (Observed M⁺, 210.1620, calc. for C₁₃H₂₂O₂ M, 210.1620).

[2*RS*(*S*)]-2-[3-(*tert*-Butyldiphenylsilyloxy)-2-methylpropyloxy]tetrahydro-2*H*-pyran (17).— Reaction of tetrahydro-2-(phenylsulphonyl)-2*H*-pyran (2) (225 mg, 0.99 mmol) with (2*S*)-3-(*tert*-butyldiphenylsilyloxy)-2-methylpropanol (660 mg, 2.0 mmol, 2.0 equiv.), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (514 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (96 mg, 1.2 mmol, 1.2 equiv.), followed by standard work-up and chromatography, gave the acetal product 17 (410 mg, 0.99 mmol, Quant.) as a colourless oil and an inseparable mixture of diastereoisomers (ca. 1:1); ν_{max} (film) 3068, 3047, 2931, 2807, 1740, 1588, 1468, 1426, 1387, 1359, 1260, 1200, 1184, 1169, 1112, 1078, 1060, 1033, 976, 903, 869, 823, 740, 703 and 614 cm^{-1} ; δ_{H} (500 MHz) 0.98 and 1.00 (3H, 2 x d, J 7.5 Hz, 2'- CH_3), 1.05 (9H, s, $(\text{CH}_3)_3$), 1.46-1.62 (4H, m, 4- H_2 5- H_2), 1.64-1.71, (1H, m, 3-Hax), 1.75-1.85, (1H, m, 3-Heq), 1.95-2.05, (1H, m, 2'-H), 3.35 (0.5H, dd, J 9.5 5.5 Hz, 3'-H one isomer), 3.45 (0.5H, dd, J 9.5 7.0 Hz, 3' one isomer), 3.46-3.60 (1H, m, 6-Heq), 3.60-3.68 (2.5H, m, 3'-H 1'-H one isomer 1'-H), 3.77 (0.5H, dd, J 9.5 6.5 Hz, 1'-H one isomer), 3.83 (0.5H, ddd, J 11.5 8.5 3.0 Hz, 6-Hax one isomer), 3.86 (0.5H, ddd, J 11.5 8.5 3.0 Hz, 6-Hax one isomer), 4.57 (1H, dd, J 8.5 2.0 Hz, 2-H), 7.33-7.45 (6H, m) and 7.54-7.6 (4H, m) (PhH); m/z 313 ($\text{M}-\text{C}_5\text{H}_9\text{OCH}_2$)⁺, 271 ($\text{M}+\text{H}-^1\text{Bu}-\text{C}_5\text{H}_9\text{O}$)⁺, 241 ($\text{M}+\text{H}-^1\text{Bu}-\text{C}_5\text{H}_9\text{O}_2\text{CH}_2$)⁺, 227 ($\text{CH}_3\text{CH}_2\text{OSiPh}_2$)⁺, 199 (Ph_2SiOH)⁺, 85 ($\text{C}_5\text{H}_9\text{O}$)⁺ and 69 (C_5H_9)⁺; (Observed ($\text{M}+\text{NH}_4$)⁺, 430.2777, calc. for $\text{C}_{25}\text{H}_{40}\text{NO}_3\text{Si}$ ($\text{M}+\text{NH}_4$), 430.2777).

2-(4-Chlorobutyloxy)tetrahydro-2*H*-pyran (18).— Reaction of tetrahydro-2-(phenylsulphonyl)-2*H*-pyran (2) (231 mg, 1.0 mmol) with 4-chloro-1-butanol (0.17 ml, 185 mg, 1.70 mmol, 1.7 equiv.), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (516 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (85 mg, 0.99 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 18 (191 mg, 0.99 mmol, 97%) as a colourless oil; ν_{max} (film) 2940, 2868, 1441, 1351, 1276, 1260, 1200, 1136, 1120, 1076, 1034, 1022, 986, 906, 869, 814 and 651 cm^{-1} ; δ_{H} (250 MHz) 1.48-1.95 (10H, m, 3- H_2 4- H_2 5- H_2 2'- H_2 3'- H_2), 3.42 (1H, dt, J 9.5 6.0 Hz, 1'-H), 3.46-3.56 (1H, m, 6-Heq), 3.58 (2H, t, J 6.5 Hz, 4'- H_2), 3.77 (1H, dt, J 9.5 6.5 Hz, 1'-H), 3.85 (1H, ddd, J 11.5 7.5 4.0 Hz, 6-Hax), 4.58 (1H, t, J 3.5 Hz, 2-H); m/z 191 ($\text{M}-\text{H}$)⁺, 157 ($\text{M}-\text{Cl}$)⁺, 149 ($\text{M}-\text{C}_2\text{H}_3\text{O}$)⁺, 134 and 136 ($\text{M}-\text{C}_3\text{H}_5\text{O}$)⁺, 115 ($\text{M}-\text{C}_3\text{H}_6\text{Cl}$)⁺, 101 ($\text{M}-\text{C}_4\text{H}_8\text{Cl}$)⁺, 91 and 93 ($\text{C}_4\text{H}_8\text{Cl}$)⁺, 85 ($\text{C}_5\text{H}_9\text{O}$)⁺ and 69 (C_5H_9)⁺; (Observed ($\text{M}-\text{H}$)⁺, 191.0840, calc. for $\text{C}_9\text{H}_{16}\text{ClO}_2$ ($\text{M}-\text{H}$), 191.0839);.

***trans*-1,2-Bis-(tetrahydro-2*H*-pyran-2-yloxy)cyclohexane (19).**— Reaction of tetrahydro-2-(phenylsulphonyl)-2*H*-pyran (2) (486 mg, 2.2 mmol, 2.2 equiv.) with *trans*-1,2-cyclohexanol (113 mg, 0.97 mmol), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (769 mg, 3.0 mmol, 3.1 equiv.) and NaHCO_3 (171 mg, 2.0 mmol, 2.1 equiv.), followed by standard work-up and chromatography, gave the diacetal product 19 (171 mg, 0.65 mmol, 67%) as a colourless oil and an inseparable mixture of diastereoisomers; ν_{max} (film) 2936, 2869, 1448, 1362, 1200, 1117, 1066, 1033, 1020, 989, 903, 868 and 814 cm^{-1} ; δ_{H} (250 MHz) 1.10-1.40 (4H, m) 1.43-1.95 (14H, m) 1.98-2.10 (2H, m) (3- H_2 4- H_2 5- H_2 6- H_2 2 x 3'- H_2 2 x 4'- H_2 2 x 5'- H_2), 3.39-3.78 (4H, m, 1-H 2-H 2 x 6'-H), 3.80-4.19 (2H, m, 2 x 6'-H), 4.79 (0.67H, dd, J 4.5 3.0 Hz) 4.86 (0.67H, br s) 4.95 (0.67H, dd, J 5.0 3.0 Hz) (2 x 2H); m/z 284 (M)⁺, 226 ($\text{M}-\text{C}_3\text{H}_6\text{O}$)⁺, 199 ($\text{M}-\text{C}_5\text{H}_9\text{O}$)⁺, 101 ($\text{C}_5\text{H}_9\text{O}_2$)⁺, 96 ($\text{C}_6\text{H}_8\text{O}$)⁺, 94 ($\text{C}_6\text{H}_6\text{O}$)⁺, 85 ($\text{C}_5\text{H}_9\text{O}$)⁺ and 71 (C_5H_{11})⁺ or ($\text{C}_4\text{H}_7\text{O}$)⁺; (Observed M^+ , 284.1988, calc. for $\text{C}_{16}\text{H}_{28}\text{O}_4$ M, 284.1987).

2-[2-(3-Furyl)ethoxy]tetrahydro-2*H*-pyran (20).— Reaction of tetrahydro-2-(phenylsulphonyl)-2*H*-pyran (2) (228 mg, 1.0 mmol, 1.0 equiv.) with 2-(3-furyl)ethanol (110 mg, 0.98 mmol), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (513 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (86 mg, 1.0 mmol, 1.0 equiv.), followed by standard work-up and chromatography (Et_2O :petrol, 1:12), gave the acetal product 20 (129 mg, 0.66 mmol, 67%) as a colourless oil; ν_{max} (film) 3131, 2941, 2868, 1498, 1439, 1382, 1351, 1260, 1200, 1182, 1160, 1136, 1120, 1078, 982, 965, 907, 873, 816, 781 and 729 cm^{-1} ; δ_{H} (250 MHz) 1.46-1.90 (6H, m, 3- H_2 4- H_2 5- H_2), 2.73 (2H, t, J 7.0 Hz, 2'- H_2), 3.44-3.55 (1H, m, 6-Heq), 3.56 (1H, dt, J 9.5 7.0 Hz, 1'-H), 3.83 (1H, ddd, J 11.0 7.0 4.0, 6-Hax), 3.90 (1H, dt, J 9.5 7.0 Hz, 1'-H), 4.62 (1H, t, J 3.5 Hz, 2-H), 6.32 (1H, s, 4"-H), 7.28 (1H, s, 2"-H), 7.35 (1H, s, 5"-H); m/z 196 (M)⁺, 166 ($\text{M}-\text{CH}_2\text{O}$)⁺, 149 ($\text{M}-\text{CH}_3\text{O}_2$)⁺, 137 ($\text{M}-\text{C}_3\text{H}_7\text{O}$)⁺, 135 ($\text{M}-\text{C}_2\text{H}_5\text{O}_2$)⁺, 112 ($\text{C}_6\text{H}_8\text{O}_2$)⁺, 101 ($\text{C}_5\text{H}_9\text{O}_2$)⁺, 95 ($\text{C}_6\text{H}_7\text{O}$)⁺, 85 ($\text{C}_5\text{H}_9\text{O}$)⁺, 81 ($\text{C}_5\text{H}_5\text{O}$)⁺ and 67 ($\text{C}_4\text{H}_3\text{O}$)⁺; (Observed M^+ , 196.1099, calc. for $\text{C}_{11}\text{H}_{16}\text{O}_3$ M, 196.1099).

2-(Benzyloxy)tetrahydro-2*H*-pyran (21)^{1c}.— Reaction of tetrahydro-2-(phenylsulphonyl)-2*H*-pyran (2) (231 mg, 1.0 mmol, 1.1 equiv.) with benzyl alcohol (0.10 ml, 105 mg, 0.97 mmol), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (511 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (89 mg, 1.1 mmol, 1.1 equiv.), followed by standard work-up and chromatography (Et_2O :petrol, 1:12), gave the acetal product 21 (178 mg, 0.93 mmol 95%) as a colourless oil; ν_{max} (film) 3062, 3029, 2940, 2868, 1450, 1439, 1383, 1350, 1262, 1201, 1183,

1155, 1120, 1078, 1057, 1026, 976, 906, 870, 810, 736 and 699 cm^{-1} ; δ_{H} (250 MHz) 1.40-2.00 (6H, m, 3-H₂ 4-H₂ 5-H₂), 3.51-3.62 (1H, m, 6-H), 3.88-4.02 (1H, m, 6-H), 4.51 (1H, d, *J* 11.0 Hz, PhCH), 4.73 (1H, t, *J* 4.0 Hz, 2-H), 4.81 (1H, d, *J* 11.0 Hz, PhCH), 7.22-7.40 (5H, m, PhH); *m/z* 192 (M^+), 146 ($\text{M}-\text{C}_2\text{H}_6\text{O}^+$), 101 ($\text{C}_5\text{H}_9\text{O}_2^+$), 91 (C_7H_7^+) and 85 ($\text{C}_5\text{H}_9\text{O}^+$); (Observed M^+ , 192.1150, calc. for $\text{C}_{12}\text{H}_{16}\text{O}_2$ M, 192.1150).

5-(Tetrahydro-2H-pyran-2-yloxy)pentan-2-one (22).— Reaction of tetrahydro-2-(phenylsulphonyl)-2H-pyran (2) (226 mg, 1.0 mmol) with 5-hydroxy-pentane-1-one (201 mg, 2.0 mmol, 2.0 equiv.), $\text{MgBr}_2\cdot\text{Et}_2\text{O}$ (508 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (89 mg, 1.1 mmol, 1.1 equiv.), followed by standard work-up and chromatography (gradient elution, Et_2O :petrol, 1:10-1:5), gave the acetal product 22 (156 mg, 0.84 mmol, 84%) as a colourless oil; ν_{max} (film) 3512, 2942, 2869, 1709, 1439, 1354, 1200, 1164, 1136, 1120, 1076, 1034, 974, 906, 870 and 814 cm^{-1} ; δ_{H} (250 MHz) 1.45-1.91 (8H, m, 4-H₂ 3'-H₂ 4'-H₂ 5'-H₂), 2.13 (3H, s, 1-H₃), 2.52 (2H, t, *J* 7.5 Hz, 3-H₂), 3.38 (1H, dt, *J* 9.5 6.0 Hz, 5-H), 3.42-3.52 (1H, m, 6'-H), 3.71 (1H, dt, *J* 9.5 6.5 Hz, 3.77-3.86 (1H, m, 6'-H), 4.53 (1H, t, *J* 3.5 Hz, 2'-H); *m/z* 101 ($\text{C}_5\text{H}_9\text{O}_2^+$), and 85 ($\text{C}_5\text{H}_9\text{O}^+$); (Observed ($\text{M}+\text{NH}_4$)⁺, 204.1596, calc. for $\text{C}_{10}\text{H}_{22}\text{NO}_3$ ($\text{M}+\text{NH}_4$), 204.1600); (Found: C, 64.78; H, 9.97, calc. for $\text{C}_{10}\text{H}_{18}\text{O}_3$, C, 64.49; H, 9.74%).

2-(Diphenylmethyloxy)tetrahydro-2H-pyran (23)^{1d}.— Reaction of tetrahydro-2-(phenylsulphonyl)-2H-pyran (2) (227 mg, 1.0 mmol) with 1,1-diphenylmethanol (186 mg, 1.0 mmol, 1.0 equiv.), $\text{MgBr}_2\cdot\text{Et}_2\text{O}$ (521 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (91 mg, 1.1 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 23 (179 mg, 0.67 mmol, 67%) as a colourless solid, m.p. 55-57°C; ν_{max} (film) 3058, 3026, 2939, 2869, 1490, 1448, 1200, 1183, 1118, 1077, 1020, 976, 908, 762, 742 and 700 cm^{-1} ; δ_{H} (250 MHz) 1.40-2.00 (6H, m, 3-H₂ 4-H₂ 5-H₂), 3.42-3.54 (1H, m, 6-H), 3.82-3.92 (1H, m, 6-H), 4.66 (1H, t, *J* 6.5 Hz, 2-H), 5.80 (1H, s, Ph₂CH), 7.14-7.40 (10H, m, PhH); *m/z* 268 (M^+), 222 ($\text{M}-\text{C}_2\text{H}_6\text{O}^+$), 184 (Ph_2CHOH^+), 167 (Ph_2CH^+), 105 (PhCO^+), 85 ($\text{C}_5\text{H}_9\text{O}^+$) and 77 (Ph^+); (Observed M^+ , 268.1463, calc. for $\text{C}_{18}\text{H}_{20}\text{O}_2$ M, 268.1463); (Found: C, 80.67; H, 7.69, calc. for $\text{C}_{18}\text{H}_{20}\text{O}_2$, C, 80.56; H, 7.51%).

Tetrahydro-2-(phenoxy)-2H-pyran (24)^{1f}.— Reaction of tetrahydro-2-(phenylsulphonyl)-2H-pyran (2) (230 mg, 1.0 mmol, 1.0 equiv.) with phenol (94 mg, 1.0 mmol), $\text{MgBr}_2\cdot\text{Et}_2\text{O}$ (527 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (87 mg, 1.0 mmol, 1.0 equiv.), followed by standard work-up and chromatography, gave the acetal product 24 (84 mg, 0.47 mmol, 47%) as a colourless oil; ν_{max} (film) 3063, 3037, 2942, 2872, 2850, 1587, 1491, 1450, 1439, 1387, 1355, 1288, 1232, 1202, 1182, 1172, 1123, 1111, 1077, 1038, 1021, 1000, 964, 921, 872, 810 and 690 cm^{-1} ; δ_{H} (250 MHz) 1.58-1.73 (3H, m) 1.83-1.90 (2H, m) (3-Hax 4-H₂ 5-H₂), 1.96-2.06 (1H, m, 3-Heq), 3.61 (1H, ddd, *J* 11.5 5.5 4.0 Hz, 6-Heq), 3.93 (1H, m, *J* 11.5 9.0 3.0 Hz, 6-Hax), 5.43 (1H, t, *J* 3.0 Hz, 2-H), 6.95-7.09 (3H, m) and 7.24-7.32 (2H, m) (PhH); *m/z* 178 (M^+), 184 (PhOH^+) and 85 ($\text{C}_5\text{H}_9\text{O}^+$); (Observed M^+ , 178.0994, calc. for $\text{C}_{11}\text{H}_{14}\text{O}_2$ M, 178.0994).

Tetrahydro-2-methoxy-6-phenyl-2H-pyran (25).— Reaction of *trans*-tetrahydro-2-phenyl-6-(phenylsulphonyl)-2H-pyran (3) (302 mg, 1.0 mmol) with methanol (81 μl , 64 mg, 2.0 mmol, 2.0 equiv.), $\text{MgBr}_2\cdot\text{Et}_2\text{O}$ (517 mg, 2.0 mmol, 2.0 equiv.) and NaHCO_3 (84 mg, 1.00 mmol, 1.0 equiv.) at room temperature overnight gave no reaction as detected by t.l.c. However, sonication of the reaction mixture for six hours, followed by standard work-up and chromatography gave the acetal product (25) (135 mg, 0.70 mmol, 70%) (*cis:trans* 20:80) as a colourless oil; ν_{max} (film) 2941, 1125, 1061, 1028, 951, 754, and 699 cm^{-1} ; δ_{H} (250 MHz) 1.40-2.10 (6H, m, 3-H₂ 4-H₂ 5-H₂), 3.42 (2.4H, s, *trans* isomer OCH₃), 3.53 (0.6H, s, *cis* isomer OMe), 4.46 (0.2H, dd, *J* 10.0 2.0 Hz, *cis* isomer 6-H), 4.49 (0.2H, dd, *J* 9.5 2.0 Hz, *cis* isomer 2-H), 4.76 (0.8H, dd, *J* 11.0 2.5 Hz, *trans* isomer 6-H), 4.88 (0.8H, dd, *J* 2.5 2.0 Hz, *trans* isomer 2-H), and 7.25-7.40 (5H, m, PhH); *m/z* 192 (M^+), 162 ($\text{M}-\text{CH}_2\text{O}^+$), 161 ($\text{M}-\text{CH}_3\text{O}^+$), 105 ($\text{M}-\text{C}_5\text{H}_9\text{O}^+$), 104 ($\text{M}-\text{C}_5\text{H}_{10}\text{O}^+$) and 58 ($\text{C}_3\text{H}_6\text{O}^+$); (Found: C, 74.96; H, 8.41. $\text{C}_{12}\text{H}_{16}\text{O}_2$ requires C, 74.97; H, 8.39%).

***trans*- and *cis*-2-(*tert*-Butyloxy)tetrahydro-6-phenyl-2H-pyran (26) and (27).**— Reaction of *trans*-tetrahydro-6-phenyl-2-(phenylsulphonyl)-2H-pyran (3) (151 mg, 0.50 mmol) with *tert*-butanol (52 μl , 41 mg, 0.55 mmol, 1.1 equiv.), $\text{MgBr}_2\cdot\text{Et}_2\text{O}$ (262 mg, 1.01 mmol, 2.0 equiv.) and NaHCO_3 (44 mg, 0.52 mmol, 1.0 equiv.), followed by standard work-up and chromatography (Et_2O :petrol, 1:50) gave the 2,6-*trans*-acetal product 26 (47 mg, 0.20 mmol, 40%) as a white solid, m.p. 50-55°C; ν_{max} (film) 2971, 2939, 1367, 1195, 1163, 1118, 1110, 1029, 993, 753 and 678 cm^{-1} ; δ_{H} (250 MHz) 1.26 (9H, s, $\text{C}(\text{CH}_3)_3$), 1.51-1.88 (5H, m, 3-Hax 4-H₂ 5-H₂), 1.97-2.14 (1H, m, 3-Heq), 4.97 (1H, dd, *J* 11.5 2.5 Hz, 6-Hax), 5.29 (1H, d, *J* 3.0 Hz, 2-

Heq) 7.21-7.39 (5H, m, PhH); m/z 234 (M)⁺, 219 ($M-CH_3$)⁺, 206 ($M-C_2H_4$)⁺, 178 ($M+H-^iBu$)⁺, 161 ($M-^iBuO$)⁺, 107 (C_7H_7O)⁺, 104 (C_8H_8)⁺, 91 (C_7H_7)⁺, 77 (C_6H_5), and 57 (iBu); (Observed ($M+NH_4$)⁺, 252.1963, calc. for $C_{15}H_{26}NO_2$ ($M+NH_4$), 252.1964); (Found: C, 76.87; H, 9.60, $C_{15}H_{22}O_2$ requires C, 76.88; H, 9.46%). Further elution gave the 2,6-*cis*-acetal product 27 (44 mg, 0.19 mmol, 38%) as a white waxy solid; ν_{max} (film) 2935, 2854, 1450, 1138, 1073, 1024, 963, 755 and 698 cm^{-1} ; δ_H (250 MHz) 1.29 (9H, s, CMe_3), 1.40-1.98 (6H, m, 3-H₂ 4-H₂ 5-H₂), 4.46 (1H, dd, J 11.0 2.0 Hz, 6-Hax), 4.78 (1H, dd, J 9.0 2.0 Hz, 2-Hax) 7.21-7.41 (5H, m, PhH); m/z 234 (M)⁺, 206 ($M-C_2H_4$)⁺, 188 ($M-C_2H_6O$)⁺, 177 ($M-^iBu$)⁺, 161 ($M-^iBuO$)⁺, 107 (C_7H_7O)⁺, 104 (C_8H_8)⁺, 91 (C_7H_7)⁺, 77 (C_6H_5)⁺ and 57 (iBu); (Observed M^+ , 234.1620, calc. for $C_{15}H_{22}O_2$ M , 234.1620).

***trans*- and *cis*-2-Cyclohexyloxy-6-phenyltetrahydro-2H-pyran (28) and (29).**- Reaction of *trans*-tetrahydro-6-phenyl-2-(phenylsulphonyl)-2H-pyran (3) (155 mg, 0.51 mmol) with cyclohexanol (58 μ l, 56 mg, 0.56 mmol, 1.1 equiv.), $MgBr_2 \cdot Et_2O$ (259 mg, 1.00 mmol, 2.0 equiv.) and $NaHCO_3$ (60 mg, 0.71 mmol, 1.4 equiv.) under ultrasound conditions overnight, followed by standard work-up and chromatography (petrol) gave the 2,6-*trans*-acetal product 28 (82 mg, 0.31 mmol, 62%) as a colourless solid, m.p. 38-40°C; ν_{max} (film) 3059, 3027, 2930, 2854, 1602, 1491, 1448, 1357, 1260, 1210, 1171, 1121, 1062, 1032, 998, 950, 894, 754 and 698 cm^{-1} ; δ_H (250 MHz) 1.42 (1H, ddd, J 22.5 11.5 3.5 Hz, 4-Hax), 1.52 (1H, dd, J 9.0 4.5 Hz, 3-Hax), 1.17-1.32 (5H, m) and 1.59-1.81 (6H, m) (4-Heq 2'-H₂ 3'-H₂ 4'-H₂ 5'-H₂ 6'-H₂), 1.84-1.92 (2H, m) and 2.00-2.09 (1H, m) (3-H 5-H₂), 3.63 (1H, tt, J 9.5 4.0 Hz, 1'-H), 4.86 (1H, dd, J 11.5 2.0 Hz, 6-Hax), 5.14 (1H, d, J 3.0 Hz, 2-Heq) 7.24-7.37 (5H, m, PhH); m/z 260 (M)⁺, 232 ($M-C_2H_4$)⁺, 177 ($M-C_6H_{11}$)⁺, 161 ($M-C_6H_{11}O$)⁺, 154 ($M-C_7H_6O$), 132 (C_9H_8O), 126 ($C_8H_{14}O$)⁺, 117 (C_9H_9)⁺, 107 (C_7H_6O)⁺, 104 (C_8H_8)⁺, 91 (C_7H_7)⁺, 82 (C_6H_{10})⁺ and (C_5H_6O), and 55 (C_4H_7); (Observed M^+ , 260.1776, calc. for $C_{17}H_{24}O_2$ M , 260.1776); (Found: C, 78.47; H, 9.58, $C_{17}H_{24}O_2$ requires C, 78.42; H, 9.29%). Further elution gave the 2,6-*cis*-acetal product 29 (15 mg, 0.058 mmol, 11%) as a colourless solid, m.p. 82-84°C; ν_{max} (film) 2929, 2853, 1448, 1361, 1138, 1064 and 1012 cm^{-1} ; δ_H (250 MHz) 1.17-1.58 (8H, m, 4-H₂ 3'-H₂ 4'-H₂ 5'-H₂), 1.65-1.83 (5H, m, 3-Heq 2'-H₂ 6'-H₂), 1.91-2.01 (3H, m, 3-Hax, 5-H₂), 3.72 (1H, tt, J 9.5 4.0 Hz, 1'-H), 4.46 (1H, dd, J 11.5 2.0 Hz, 6-Hax), 4.71 (1H, dd, J 9.6 2.0 Hz, 2-Hax) 7.24-7.41 (5H, m, PhH); m/z 260 (M)⁺, 232 ($M-C_2H_4$)⁺, 177 ($M-C_6H_{11}$)⁺, 161 ($M-C_6H_{11}O$)⁺, 154 ($M-C_7H_6O$), 132 (C_9H_8O), 126 ($C_8H_{14}O$)⁺, 117 (C_9H_9), 107 (C_6H_6O)⁺, 104 (C_8H_8)⁺, 91 (C_7H_7)⁺, 82 (C_6H_{10})⁺ and (C_5H_6O), and 55 (C_4H_7); (Observed M^+ , 260.1776, calc. for $C_{17}H_{24}O_2$ M , 260.1776); (Found: C, 78.67; H, 9.58, $C_{17}H_{24}O_2$ requires C, 78.42; H, 9.29%).

***trans*- and *cis*-6-(Cyclohexyloxy)tetrahydro-2H-pyran-2-methanol acetate (30) and (31).**- Reaction of *trans*-6-(phenylsulphonyl)-tetrahydro-2H-pyran-2-methanol acetate (4) (151 mg, 0.51 mmol) with cyclohexanol (58 μ l, 56 mg, 0.56 mmol, 1.1 equiv.), $MgBr_2 \cdot Et_2O$ (257 mg, 1.00 mmol, 2.0 equiv.) and $NaHCO_3$ (43 mg, 0.51 mmol, 1.0 equiv.) for four days at room temperature, followed by standard work-up and chromatography (gradient elution, Et_2O :petrol, 1:20-1:10) gave the 2,6-*cis*-acetal product 30 (76 mg, 0.30 mmol, 58%) as a colourless oil; ν_{max} (film) 2933, 2854, 1743, 1448, 1366, 1234, 1205, 1120, 1062, 1039, 1024, 1004, 953, and 867 cm^{-1} ; δ_H (250 MHz) 1.16-1.41 (6H, m) and 1.53-1.68 (5H, m) (3-H₂ 4-H₂ 5-Hax 3'-H₂ 4'-H₂ 5'-H₂), 1.72-1.77 (2H, m, 2'-Hax 6'-Hax), 1.88-1.92 (3H, m, 5-Heq 2'-Heq 6'-Heq), 2.07 (3H, s, CH_3CO), 3.57 (1H, tt, J 9.5 4.0 Hz, 1'-H), 3.98-4.09 (3H, m, 1-H₂ 2-H), 5.02 (1H, s, 6-Heq); m/z 256 (M)⁺, 213 ($M-CH_3CO$)⁺, 196 ($M-CH_3CO_2H$)⁺, 183 ($M-CH_3CO_2CH_2$)⁺, 173 ($M-C_6H_{11}$)⁺, 157 ($M-C_6H_{11}O$)⁺, 128 ($C_7H_{12}O_2$)⁺, 114 ($C_6H_{10}O_2$)⁺, 101 ($C_6H_{13}O$)⁺ and ($C_5H_9O_2$)⁺, 83 (C_6H_{11})⁺ and 43 (C_2H_3O); (Observed M^+ , 256.1675, calc. for $C_{14}H_{24}O_4$ M , 256.1674); (Found: C, 65.48; H, 9.69, $C_{14}H_{24}O_4$ requires C, 65.60; H, 9.44%). Further elution gave the 2,6-*trans*-acetal product 31 (23 mg, 0.090 mmol, 18%) as a colourless oil; ν_{max} (film) 2931, 2855, 1741, 1448, 1364, 1233, 1200, 1164, 1074, 1032, 964, 900 and 845 cm^{-1} ; δ_H (250 MHz) 1.15-1.55 (10H, m, 3-H₂ 4-H₂ 3'-H₂ 4'-H₂ 5'-H₂), 1.71-1.76 (3H, m, 5-Hax 2'-Hax 6'-Hax), 1.81-1.90 (2H, m, 2'-Heq 6'-Heq), 1.97 (1H, br d, J 9.5 Hz, 5-Heq), 2.06 (3H, s, CH_3CO), 3.60-3.66 (2H, m, 2-H 1'-H), 4.06 (1H, dd, J 11.5 4.5 Hz, 1-H), 4.15 (1H, dd, J 11.5 6.5 Hz, 1-H), 4.52 (1H, dd, J 9.5 2.0 Hz, 6-Hax); m/z 255 ($M-H$)⁺, 237 ($M-H_2O$)⁺, 213 ($M-CH_3CO$)⁺, 196 ($M-CH_3CO_2H$)⁺, 183 ($M-CH_3CO_2CH_2$)⁺, 173 ($M-C_6H_{11}$)⁺, 157 ($M-C_6H_{11}O$)⁺, 101 ($C_6H_{13}O$)⁺ and ($C_5H_9O_2$)⁺ and 43 (C_2H_3O); (Observed ($M-H$)⁺, 255.1596, calc. for $C_{14}H_{23}O_4$ ($M-H$), 255.1596); (Found: C, 65.42; H, 9.61, $C_{14}H_{24}O_4$ requires C, 65.60; H, 9.44%).

[2 α ,6 β (*E*)]- and [2 α ,6 α (*E*)]-6-(3,7-Dimethyl-2,6-octadienyloxy)tetrahydro-2*H*-pyran-2-methanol acetate (32) and (33). Reaction of *trans*-6-(phenylsulphonyl)-tetrahydro-2*H*-pyran-2-methanol acetate (4) (149 mg, 0.50 mmol) with geraniol (95 μ l, 84 mg, 0.54 mmol, 1.1 equiv.), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (256 mg, 0.99 mmol, 2.0 equiv.) and NaHCO_3 (48 mg, 0.57 mmol, 1.1 equiv.) for four days at room temperature, followed by standard work-up and chromatography (gradient elution, Et_2O :petrol, 1:20-1:10) gave the 2,6-*trans*-acetal product 32 (91 mg, 0.29 mmol, 59%) as a colourless oil; ν_{max} (film) 2938, 1743, 1668, 1439, 1367, 1234, 1205, 1119, 1050, 1017, 963 and 866 cm^{-1} ; δ_{H} (500 MHz) 1.38 (1H, ddd, *J* 24.5 13.0 4.0 Hz, 4-Hax), 1.60 (3H, s, 3'-Me), 1.68 and 1.68 (2 x 3H, 2 x s, 7'-Me₂), 1.55-1.92 (5H, m, 3-H₂ 4-Heq 5-H₂), 2.02-2.20 (4H, m, 4'-H₂ 5'-H₂), 2.08 (3H, s, CH₃CO), 3.97-4.05 (1H, m, 2-H), 4.00 (1H, dd, *J* 11.5 7.5 Hz, 1'-H), 4.06 (2H, d, *J* 5.0 Hz, 1-H₂), 4.19 (1H, ddd, *J* 12.0 6.5 0.5 Hz, 1'-H), 4.90 (1H, s, 6-Heq), 5.09 (1H, tt, *J* 7.0 1.5 Hz, 6'-H), 5.36 (1H, tt, *J* 6.5 1.0 Hz, 2'-H); *m/z* 310 (M^+), 292 ($\text{M}-\text{H}_2\text{O}$)⁺, 173 ($\text{M}-\text{C}_{10}\text{H}_{17}$)⁺, 157 ($\text{M}-\text{C}_{10}\text{H}_{17}\text{O}$)⁺, 136 ($\text{C}_{10}\text{H}_{16}$)⁺, 97 (C_7H_{13})⁺, 69 (C_5H_9)⁺ and 43 ($\text{C}_2\text{H}_3\text{O}$); (Observed M^+ , 310.2144, calc. for $\text{C}_{18}\text{H}_{30}\text{O}_4$ M, 310.2144). Further elution gave the 2,6-*cis*-acetal product 33 (40 mg, 0.13 mmol, 26%) as a colourless oil; ν_{max} (film) 2941, 2857, 1742, 1664, 1441, 1367, 1234, 1199, 1153, 1139, 1074, 1037, 998, 954, 898 and 827 cm^{-1} ; δ_{H} (500 MHz) 1.27 (1H, ddd, *J* 25.0 13.5 4.0 Hz, 4-Hax), 1.38-1.46 (1H, m) and 1.49-1.57 (2H, m) (3-Hax 4-Heq 5-Hax), 1.60 (3H, s, 3'-Me), 1.68 (6H, s, 7'-Me₂), 1.74-1.77 (1H, m) and 1.85-1.93 (1H, m) (3-Heq 5-Heq), 1.95-2.11 (4H, m, 4'-H₂ 5'-H₂), 2.07 (3H, s, CH₃CO), 3.60-3.66 (1H, m, 2-H), 4.09 (1H, dd, *J* 11.5 4.5 Hz, 1-H), 4.14 (1H, dd, *J* 11.5 6.5 Hz, 1-H), 4.20 (1H, dd, *J* 12.0 8.0 Hz, 1'-H), 4.29 (1H, dd, *J* 12.0 6.0 Hz, 1'-H), 4.43 (1H, dd, *J* 9.5 2.0 Hz, 6-Hax), 5.08 (1H, tq, *J* 7.0 1.5 Hz, 6'-H), 5.34 (1H, tt, *J* 6.5 1.0 Hz, 2'-H); *m/z* 310 (M^+), 292 ($\text{M}-\text{H}_2\text{O}$)⁺, 173 ($\text{M}-\text{C}_{10}\text{H}_{17}$)⁺, 157 ($\text{M}-\text{C}_{10}\text{H}_{17}\text{O}$)⁺, 136 ($\text{C}_{10}\text{H}_{16}$)⁺; (Observed M^+ , 310.2144, calc. for $\text{C}_{18}\text{H}_{30}\text{O}_4$ M, 310.2144); (Found: C, 69.89; H, 9.96, $\text{C}_{18}\text{H}_{30}\text{O}_4$ requires C, 69.64; H, 9.74%).

***trans*- and *cis*-Tetrahydro-6-phenoxy-2*H*-pyran-2-methanol acetate (34) and (35).** Reaction of *trans*-6-(phenylsulphonyl)-tetrahydro-2*H*-pyran-2-methanol acetate (4) (283 mg, 0.95 mmol) with phenol (94 mg, 1.00 mmol, 1.1 equiv.), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (514 mg, 1.99 mmol, 2.1 equiv.) and NaHCO_3 (87 mg, 1.04 mmol, 1.1 equiv.), followed by non-basic work-up and chromatography on alumina (Et_2O :petrol, 1:9) gave the 2,6-*trans*-acetal product 34 (92 mg, 0.37 mmol, 39%) as a colourless oil; ν_{max} (film) 2945, 2873, 1740, 1597, 1587, 1492, 1453, 1439, 1366, 1232, 1206, 1173, 1114, 1045, 1000, 963, 870, 757 and 693 cm^{-1} ; δ_{H} (250 MHz) 1.48-2.11 (6H, m, 3-H₂ 4-H₂ 5-H₂), 1.96 (3H, s, CH₃CO), 3.98-4.08 (1H, m, 2-H), 4.04 (2H, dd, *J* 3.0 2.0 Hz, 1-H₂), 5.61 (1H, br s, 6-Heq), 6.98 (1H, tt, *J* 7.5 1.0 Hz, *p*-PhH), 7.09 (2H, dd, *J* 9.0 1.0 Hz, 2 x *o*-PhH), 7.23-7.31 (2H, m *m*-PhH); *m/z* 250 (M^+), 177 ($\text{M}-\text{CH}_3\text{CO}_2\text{CH}_2$)⁺, 157 ($\text{M}-\text{PhO}$)⁺, 97 ($\text{C}_6\text{H}_9\text{O}$)⁺ and 43 ($\text{C}_2\text{H}_3\text{O}$); (Observed M^+ , 250.1205, calc. for $\text{C}_{14}\text{H}_{18}\text{O}_4$ M, 250.1205); (Found: C, 67.34; H, 7.40, $\text{C}_{14}\text{H}_{18}\text{O}_4$ requires C, 67.18; H, 7.25%). Further elution gave the 2,6-*cis*-acetal product 35 (26 mg, 0.10 mmol, 11%) as a colourless oil; ν_{max} (film) 2922, 2851, 1739, 1587, 1490, 1459, 1367, 1236, 1195, 1070, 1037, 753 and 690 cm^{-1} ; δ_{H} (250 MHz) 1.25-1.46 (1H, m, 4-Hax), 1.55-1.81 (3H, m, 3-H₂ 4-Heq), 1.94-2.05 (2H, m, 5-H₂), 2.05 (3H, s, CH₃CO), 3.85 (1H, dddd, *J* 11.0 6.5 4.5 2.5 Hz, 2-H), 4.13 (1H, d, *J* 2.0 Hz, 1-H), 4.16 (1H, d, *J* 4.5 Hz, 1-H), 5.09 (1H, dd, *J* 8.5 2.0 Hz, 6-Hax), 6.96-7.05 (3H, m) 7.22-7.30 (2H, m) (PhH); *m/z* 250 (M^+), 177 ($\text{M}-\text{CH}_3\text{CO}_2\text{CH}_2$)⁺, 157 ($\text{M}-\text{PhO}$)⁺, 97 ($\text{C}_6\text{H}_9\text{O}$)⁺ and 43 ($\text{C}_2\text{H}_3\text{O}$); (Observed M^+ , 250.1205, calc. for $\text{C}_{14}\text{H}_{18}\text{O}_4$ M, 250.1205).

(2*R*,3*S*,6*RS*)-3-Acetoxy-6-benzyloxy-3,6-dihydro-2*H*-pyran-2-methanol acetate (36). Reaction of (2*R*,3*S*,6*R*)-3-acetoxy-3,6-dihydro-6-(phenylsulphonyl)-2*H*-pyran-2-methanol acetate (5) (27 mg, 0.076 mmol) with benzyl alcohol (40 μ l, 42 mg, 0.39 mmol, 5.1 equiv.), $\text{MgBr}_2 \cdot \text{Et}_2\text{O}$ (39 mg, 0.15 mmol, 2.0 equiv.) and NaHCO_3 (14 mg, 0.17 mmol, 2.2 equiv.) in dry distilled THF (2.0 ml) at room temperature overnight gave no reaction as detected by t.l.c. However, sonication of the reaction mixture for three days, followed by standard work-up and chromatography (Et_2O :petrol, 1:9), gave the glycoside product 36 (17 mg, 0.053 mmol, 70%) as a colourless oil and an inseparable mixture of diastereoisomers (1*S*:1*R*, 22:78); ν_{max} (film) 2926, 2855, 1742, 1451, 1369, 1235, 1039, 733 and 699 cm^{-1} ; δ_{H} (500 MHz) 2.08 (3H, s, *minor*/*major* CH₃CO), 2.08 (0.66H, s, *minor* CH₃CO), 2.10 (2.34H, s, *major* CH₃CO), 4.06-4.33 (3H, m, *minor*/*major* 1-H₂ 2-H), 4.60 (0.78H, d, *J* 11.5 Hz, *major* PhCH), 4.62 (0.22H, d, *J* 12.0 Hz, *minor* PhCH), 4.81 (0.78H, d, *J* 11.5 Hz, *major* PhCH), 4.88 (0.22H, d, *J* 12.0 Hz, *minor* PhCH), 5.14 (0.78H, t, *J* 1.0 Hz, *major* 6-Heq), 5.19-5.21 (0.44H, m, *minor* 3-H *minor* 6-Hax), 5.34 (0.78H, dq, *J* 9.5 1.5 Hz, *major* 3-H), 5.85 (0.78H, ddd, *J* 10.5 2.5 2.0 Hz, *major* 4-H), 5.90 (0.78H, dd, *J* 10.0 0.5 Hz, *major* 5-H), 5.97 (0.22H, dd, *J* 10.5 1.0 Hz, *minor* 4-H), 6.01 (0.22H, ddd, *J* 10.0 3.5 1.5 Hz, *minor* 5-H), 7.28-7.71 (5H, m, PhH); *m/z* 302 ($\text{M}-\text{H}_2\text{O}$)⁺, 279 ($\text{M}+\text{H}_2-\text{CH}_3\text{CO}$)⁺, 261 ($\text{M}-\text{CH}_3\text{CO}_2$)⁺, 242 ($\text{M}-\text{PhH}$)⁺, 229 ($\text{M}-\text{PhCH}_2$)⁺, 218 ($\text{M}-\text{CH}_3\text{CO}_2-\text{CH}_3\text{CO}$)⁺, 213 ($\text{M}-\text{PhCH}_2\text{O}$)⁺,

200 ($C_{13}H_{12}O_2$)⁺, 187 ($C_8H_{11}O_5$)⁺, 176 ($C_{11}H_{12}O_2$)⁺, 153 ($C_8H_9O_3$)⁺, 111 ($C_6H_7O_2$)⁺, 94 (C_6H_6O)⁺, 91 (C_7H_7)⁺ and 43 (C_2H_3O); (Observed (M+NH₄)⁺, 338.1604, calc. for $C_{17}H_{24}NO_6$ (M+NH₄), 338.1603).

(2*R*,3*S*,6*RS*)-3-Acetoxy-6-cyclohexyloxy-3,6-dihydro-2*H*-pyran-2-methanol acetate (37).— Reaction of (2*R*,3*S*,6*R*)-3-acetoxy-3,6-dihydro-6-(phenylsulphonyl)-2*H*-pyran-2-methanol acetate (5) (88 mg, 0.25 mmol) with cyclohexanol (50 μ l, 48 mg, 0.48 mmol, 1.9 equiv.), MgBr₂·Et₂O (128 mg, 0.50 mmol, 2.0 equiv.) and NaHCO₃ (22 mg, 0.26 mmol, 1.1 equiv.) in dry distilled THF (1.0 ml) under ultrasound conditions overnight, followed by standard work-up and chromatography (Et₂O:petrol, 1:4), gave the glycoside product 37 (59 mg, 0.19 mmol, 76%) as a colourless oil and an inseparable mixture of diastereoisomers (6*R*:6*S*, 13:87); $\nu_{\max}$ (film) 2931, 2855, 1742, 1448, 1389, 1232, 1185, 1102, 1035, 982 and 742 cm⁻¹; δ_H (500 MHz, 6*S* isomer only seen clearly) 1.15–1.45 (6H, m, 3'-H₂ 4'-H₂ 5'-H₂), 1.73–1.77 (2H, m, 2'-Hax 6'-Hax), 1.88–2.00 (2H, m, 2'-Heq 6'-Heq), 2.07 (3H, s, CH₃CO), 2.09 (3H, s, CH₃CO), 3.64 (1H, ddd, *J* 13.5 9.5 4.0 Hz, 1'-H), 4.13–4.20 (2H, m, 1-H 2-H), 4.23 (1H, dd, *J* 12.0 6.0 Hz, 1-H), 5.17 (1H, d, *J* 2.5 Hz, 6-Heq), 5.29 (1H, ddd, *J* 9.5 3.0 1.5 Hz, 3-H), 5.81 (1H, ddd, *J* 10.0 2.5 2.0 Hz, 4-H), 5.86 (1H, br d, *J* 10.5 Hz, 5-H); *m/z* 312 (M)⁺, 270 (M+H-CH₃O)⁺, 252 (M-CH₃CO₂H)⁺, 239 (M-CH₃CO₂CH₂)⁺, 213 (M-C₆H₁₁O)⁺, 211 (M+H-CH₃CO₂-CH₃CO)⁺, 168 ($C_8H_8O_4$)⁺, 153 ($C_8H_9O_3$)⁺, and 128 ($C_6H_{11}OCHO$)⁺; (Observed (M+NH₄)⁺, 330.1917, calc. for $C_{16}H_{28}NO_6$ (M+NH₄), 330.1916); (Found: C, 61.47, H, 7.88, $C_{16}H_{24}O_6$ requires C, 61.52, H, 7.74%).

(*E*)-(3,7-Dimethyl-2,6-octadienyl)-4-*O*-(*tert*-butyldimethylsilyl)-L-oleandroside (38).— Reaction of 4-*O*-(*tert*-butyldimethylsilyl)-1-deoxy-1-(phenylsulphonyl)- α -L-oleandrose (6) (41 mg, 0.10 mmol) with geraniol (85 μ l, 76 mg, 0.49 mmol, 4.9 equiv.), MgBr₂·Et₂O (127 mg, 0.49 mmol, 4.9 equiv.) and NaHCO₃ (47 mg, 0.56 mmol, 5.6 equiv.) in dry distilled THF (2.0 ml) at room temperature overnight gave no reaction as detected by t.l.c. However, heating of the reaction mixture at 50°C overnight, followed by standard work-up and chromatography (gradient elution, Et₂O:petrol, 1:15–1:6), gave the glycoside product 38 (24 mg, 0.058 mmol, 58%) as a colourless oil and an inseparable mixture of diastereoisomers (1*S*:1*R*, 33:67); $\nu_{\max}$ (film) 2929, 2355, 1666, 1456, 1384, 1358, 1248, 1201, 1145, 1104, 1075, 1016, 989, 893, 873, 836, 777 and 666 cm⁻¹; δ_H (500 MHz) 0.07 (1H, s, *minor* SiMe), 0.08 (2H, s, *major* SiMe), 0.08 (1H, s, *minor* SiMe), 0.09 (2H, s, *major* SiMe), 0.89 (3H, s, *minor* Si^tBu), 0.90 (6H, s, *major* Si^tBu), 1.25 (2H, d, *J* 6.5 Hz, *major* 5-Me), 1.30 (1H, d, *J* 6.5 Hz, *minor* 5-Me), 1.57 (2H, s, *major* 3'-Me), 1.61 (1H, s, *minor* 3'-Me), 1.68 (4H, s, *major* 7'-Me₂), 1.69 (2H, s, *minor* 7'-Me₂), 1.41–1.72 (1H, m, *minor/major* 2-Hax), 2.04 and 2.10 (2 $\times$ 2H, 2 $\times$ t, *J* 7.5 Hz, *minor/major* 4'-H₂ 5'-H₂), 2.27 (0.67H, dd, *J* 13.0 5.0 Hz, *major* 2-Heq), 2.32 (0.33H, ddd, *J* 12.5 4.5 2.0 Hz, *minor* 2-Heq), 3.13 (1H, t, *J* 8.5 Hz, *minor/major* 4-H), 3.05–3.25 (0.67H, m, *minor* 3-H 5-H), 3.30 (3H, s, *minor/major* 3-OMe), 3.40 (0.67H, ddd, *J* 11.5 8.5 5.0 Hz, *major* 3-H), 3.65 (0.67H, dq, *J* 9.0 6.5 Hz, *major* 5-H), 3.97 (0.67H, dd, *J* 12.0 7.5 Hz, *major* 1'-H), 4.10 (0.67H, dd, *J* 12.0 6.0 Hz, *major* 1'-H), 4.16 (0.33H, dd, *J* 12.0 8.0 Hz, *minor* 1'-H), 4.28 (0.33H, dd, *J* 12.0 6.0 Hz, *minor* 1'-H), 4.46 (0.33H, dd, *J* 10.0 2.0 Hz, *minor* 1-Hax), 4.88 (0.67H, d, *J* 3.5 Hz, *major* 1-Heq), 5.07–5.10 (1H, m, *minor/major* 6'-H), 5.31–5.34 (1H, m, *minor/major* 2'-H); *m/z* 412 (M)⁺, 394 (M-H₂O)⁺, 380 (M-CH₃OH)⁺, 355 (M-^tBu)⁺, 259 (M-C₁₀H₁₇O)⁺, 227 (M-CH₃OH-C₁₀H₁₇O)⁺, 187 (M-CH₃OH-^tBu-C₁₀H₁₇O)⁺, 137 (C₁₀H₁₇)⁺, and 126 (C₇H₁₀O₂)⁺; (Observed (M+NH₄)⁺, 430.3353, calc. for $C_{23}H_{48}NO_4Si$ (M+NH₄), 430.3352).

Methyl 4-*O*-[4-*O*-(*tert*-butyldimethylsilyl)-L-oleandrosyl]-L-oleandroside (39).— Reaction of 4-*O*-(*tert*-butyldimethylsilyl)-1-deoxy-1-(phenylsulphonyl)- α -L-oleandrose (6) (41 mg, 0.10 mmol) with methyl L-oleandroside (40 mg, 0.23 mmol, 2.2 equiv.), MgBr₂·Et₂O (56 mg, 0.22 mmol, 2.1 equiv.) and NaHCO₃ (18 mg, 0.21 mmol, 2.1 equiv.) in dry distilled THF (2.0 ml) under ultrasound conditions overnight, followed by standard work-up and chromatography (Et₂O:petrol, 1:9), gave the glycoside product 39 (29 mg, 0.067 mmol, 65%) as a colourless oil and an inseparable mixture of diastereoisomers at the two anomeric positions; $\nu_{\max}$ (film) 2930, 2898, 2856, 1456, 1384, 1361, 1300, 1251, 1206, 1103, 1054, 985, 931, 895, 837, 778, 745 and 667 cm⁻¹; δ_H (500 MHz, *major* α,α isomer only) 0.07 (3H, s, SiMe), 0.09 (3H, s, SiMe), 0.89 (9H, s, Si^tBu), 1.21 (3H, d, *J* 6.5 Hz) and 1.29 (3H, d, *J* 6.0 Hz) (5-Me 5'-Me), 1.48 (1H, ddd, *J* 13.0 11.5 4.0 Hz) and 1.52 (1H, ddd, *J* 13.0 11.5 4.0 Hz) (2-Hax 2'-Hax), 2.24 (1H, ddd, *J* 13.0 5.0 1.0 Hz) and 2.28 (1H, ddd, *J* 13.0 5.0 1.0 Hz) (2-Heq 2'-Heq), 3.13 (1H, t, *J* 9.0 Hz) and 3.20 (1H, t, *J* 9.0 Hz) (4-H 4'-H), 3.31 (6H, s) and 3.35 (3H, s) β -OMe 1'-OMe 3'-OMe), 3.27–3.41 (1H, m) and 3.56 (1H, ddd, *J* 11.5 8.5 5.0 Hz) (3-H 3'-H), 3.64 (1H, dq, *J* 9.5 6.0 Hz) and 3.69 (1H, dq, *J* 9.0 6.5 Hz) (5-H 5'-H), 4.74 (1H, d, *J* 2.5 Hz, 1'-Heq), 5.30 (1H, d, *J* 3.0 Hz, 1-Heq); *m/z* 433 (M-H)⁺, 403 (M-CH₃O)⁺, 377 (M-^tBu)⁺, 333 (M-C₅H₉O₂)⁺, 301 (M-H₂-^tBuMe₂SiO)⁺, 293 (M-C₈H₁₃O₂)⁺, 259 (C₁₃H₂₇O₃Si)⁺, 227 (C₁₂H₂₃O₂Si)⁺, 173 (C₈H₁₃O₄)⁺, 159 (C₈H₁₅O₃)⁺, 127

(C₇H₁₁O₂)⁺, 115 (C₆H₁₁O₂)⁺, 101 (C₅H₉O₂)⁺, and 89 (C₄H₉O₂)⁺; (Observed (M-H)⁺, 433.2622, calc. for C₂₁H₄₁O₇Si (M-H), 433.2621); (Found: C, 57.62; H, 9.23, C₂₃H₄₄O₄Si requires C, 58.03; H, 9.74%).

(3*RS*)-1,2:5,6-Di-*O*-isopropylidene-3-*O*-(tetrahydro-2-*H*-pyran-2-yl)-α-*D*-glucofuranose (40).— Reaction of tetrahydro-2-(phenylsulphonyl)-2*H*-pyran (2) (110 mg, 0.49 mmol) with 1,2:5,6-diisopropylidene-α-*D*-glucofuranose (128 mg, 0.49 mmol, 1.0 equiv.), MgBr₂.Et₂O (256 mg, 0.99 mmol, 2.0 equiv.) and NaHCO₃ (55 mg, 0.65 mmol, 1.3 equiv.) in dry distilled THF (2.0 ml) under ultrasound conditions overnight, followed by standard work-up and chromatography (gradient elution, Et₂O:petrol, 1:8 - 1:6), gave the acetal product **40** (88 mg, 0.26 mmol, 53%) as a colourless oil and a separable mixture of diastereoisomers (*ca.* 1:1). Diastereoisomer of higher R_f: ν_{max} (film) 2936, 1371, 1215, 1165, 1072 and 1022 cm⁻¹; δ_H (500 MHz) 1.31, 1.33, 1.41, and 1.50 (4 x 3H, 4 x s, 2 x CMe₂), 1.42-1.61 (4H, m, 4'-H₂ 5'-H₂), 1.70-1.75 (1H, m, 3'-H_{ax}), 1.78-1.82 (1H, m, 3'-H_{eq}), 3.53-3.58 (1H, m, 6'-H), 3.87-3.92 (1H, m, 6'-H), 3.98 (1H, dd, *J* 8.5 6.0 Hz, 6-H), 4.09 (1H, dd, *J* 8.5 6.0 Hz, 6-H), 4.11 (1H, dd, *J* 8.0 3.0 Hz, 4-H), 4.21 (1H, d, *J* 2.5 Hz, 3-H), 4.23 (1H, dt, *J* 8.0 6.0 Hz, 5-H), 4.71 (1H, d, *J* 3.5 Hz, 2-H), 4.76 (1H, dd, *J* 5.0 2.5 Hz, 2'-H), 5.90 (1H, d, *J* 3.5 Hz, 1-H); m/z 344 (M)⁺, 329 (M-CH₃)⁺, 286 (M-(CH₃)₂CO)⁺, 259 (M-C₅H₉O)⁺, 243 (M-C₅H₉O₂)⁺, 201 (C₉H₁₃O₅)⁺, 186 (C₉H₁₄O₄)⁺, 143 (C₇H₁₁O₃)⁺, 129 (C₆H₉O₃)⁺, 113 (C₆H₉O₂)⁺, 101 (C₅H₉O₂)⁺, and 85 (C₅H₉O)⁺; (Found: C, 59.12, H, 8.33, C₁₇H₂₈O₇ requires C, 59.29, H, 8.19%). Diastereoisomer of lower R_f: ν_{max} (film) 2983, 2937, 1371, 1218, 1165, 1123, 1076, 1031, 972, 868, 850 and 815 cm⁻¹; δ_H (500 MHz) 1.30, 1.35, 1.43, and 1.50 (4 x 3H, 4 x s, 2 x CMe₂), 1.47-1.66 (4H, m, 4'-H₂ 5'-H₂), 1.67-1.86 (2H, m, 3'-H₂), 3.48-3.53 (1H, m, 6'-H_{eq}), 3.84 (1H, dd, *J* 11.0 6.5 Hz, 6'-H_{ax}), 4.00 (1H, dd, *J* 8.5 6.5 Hz, 6-H), 4.13 (1H, dd, *J* 8.5 6.5 Hz, 6-H), 4.25 (1H, dd, *J* 7.0 3.0 Hz, 4-H), 4.35 (1H, d, *J* 3.5 Hz, 3-H), 4.43 (1H, q, *J* 6.5 Hz, 5-H), 4.49 (1H, d, *J* 3.5 Hz, 2-H), 4.71 (1H, t, *J* 2.5 Hz, 2'-H), 5.89 (1H, d, *J* 4.0 Hz, 1-H); m/z 344 (M)⁺, 329 (M-CH₃)⁺, 286 (M-(CH₃)₂CO)⁺, 243 (M-C₅H₉O₂)⁺, 229 (M-C₆H₁₁O₂)⁺, 142 (C₇H₁₀O₃)⁺, 129 (C₆H₉O₃)⁺, 113 (C₆H₉O₂)⁺, 101 (C₅H₉O₂)⁺, and 85 (C₅H₉O)⁺; (Found: C, 59.23; H, 8.23, C₁₇H₂₈O₇ requires C, 59.29; H, 8.19%).

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