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A Non-Aldol Preparation of Enantiopure Propionate-Derived Motifs with the Assistance of Chiral Sulfoxides: Application to a Convergent Synthesis of the Lactone Core of Octalactins

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Keywords: Natural products / Asymmetric synthesis / Synthesis design / Chiral auxiliaries / Macrocycles

Propionate-derived fragments were prepared by a non-aldol method using chiral sulfoxide chemistry. A methacrylate ester, assisted by a chiral sulfoxide as an auxiliary agent, was easily transformed into an optically pure allylic alcohol, which was then subjected to diastereoselective hydroboration with the bulky dialkylborane 9-BBN. The diastereofacial selectivity was governed by a preferred spatial arrangement of a staggered conformation model, as suggested by Houk, taking into account of the various A(1,2) allylic strains. Thus, the the two adjacent stereocentres in the enantiopure allylic alcohol were installed with an *anti* configuration. As an application of this work, we have described an enantioselective synthesis of the unusual eight-membered lactone ring of the octalactins. Two propionate-derived fragments were coupled to give precursor **18**, which was subjected to Yamaguchi's macrolactonisation to give the required lactone ring.

Introduction

Octalactins A and B (Figure 1) are marine metabolites isolated from a *Streptomyces sp.*,[1a] and both compounds contain an unusual eight-membered lactone ring. Octalactin A showed significant cytotoxicity in tests towards B-16-F10 murine melanoma and HCT-116 human colon tumor cell lines, whereas octalactin B showed no activity in the same bioassays.[1a–1c] The complex structure of octalactin A, as well as its therapeutic potential, makes it an attractive target for organic synthesis. The relative configuration of octalactones A and B were determined by X-ray analysis by Fenical and Clardy.[1a] Thereafter, their absolute configuration was determined by a first total synthesis[2a] by Buszek et al.; Clardy et al.[2b] confirmed the absolute configuration through a total synthesis of the enantiomers of the natural octalactins A and B. Since then, six other total syntheses of octalactin A and/or B have been reported, using different approaches,[3] and many other formal syntheses of the octalactins have been described, mainly focussing on the lactone ring.[4] The fascinating synthesis of medium-ring lactones, which are found in many natural products, has proved to be a challenge.[5]

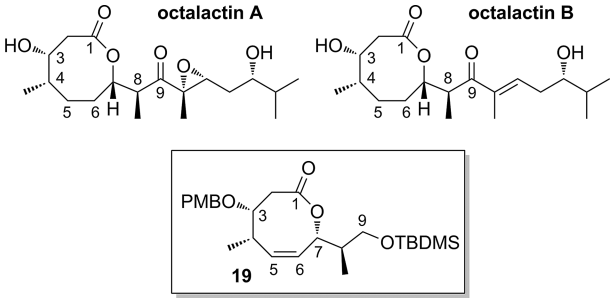

Figure 1. Targeted enantiopure lactone **19** of octalactins; TBDMS = *tert*-butyldimethylsilyl; PMB = *para*-methoxybenzyl.

The highly functionalised framework of the octalactins prompted us to explore a new approach for the synthesis of this peculiar structure through sulfoxide chemistry. As a part of our studies on the development of sulfoxide chemistry, we report in this paper a straightforward synthesis of enantiopure diol **4** (as well as its enantiomer) in a two-step reduction reaction from unsaturated β-keto sulfoxide **2** (Figure 2). These two successive reductions allowed control of the newly formed stereocentres, leading to an *anti* configuration between the alcohol functionality and the adjacent methyl group.

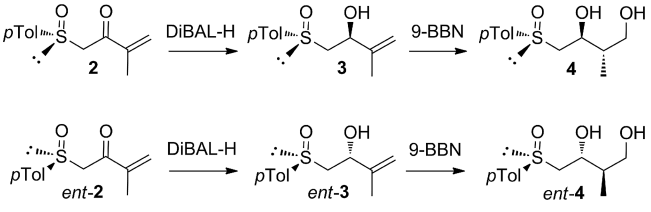

Figure 2. Synthesis of the two enantiomers **4** and *ent*-**4**; DiBAL-H = diisobutylaluminium hydride; 9-BBN = 9-borabicyclo[3.3.1]-nonane.

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These diols (**4** and *ent*-**4**) could be regarded as a propionate derivatives after desulfination, and consequently can be viewed as building blocks for the synthesis of natural products. We have applied this process in the synthesis of the lactone moiety (i.e., **19**) of octalactin (Figure 1).

Results and Discussion

From a synthetic point of view, the lactone unit of the octalactins could come from the connection of two propionate-derived structures followed by a ring closure. Thus, as shown in Figure 3, we envisaged a Yamaguchi macrolactonisation[6] from *seco*-acid **18**. Thus, we planned the synthesis of propionate-derived precursors **14** and *ent*-**7** that would be coupled by a Wittig reaction to give (*Z*)-olefin **18**.

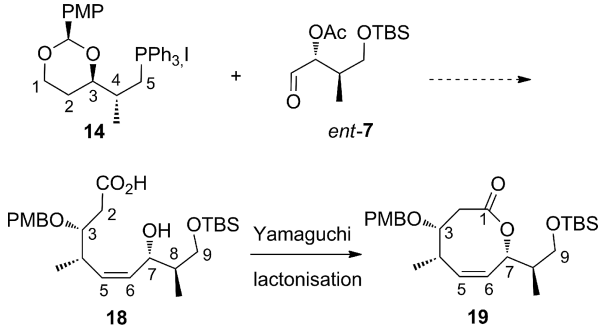
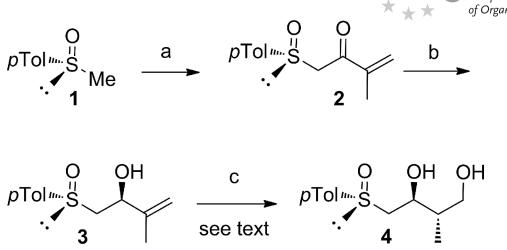


Figure 3. Route for the synthesis of lactone **19** via *seco*-acid **18**; PMP = *para*-methoxyphenyl.

For the stereoselective synthesis of propionate-derived units **14** and *ent*-**7**, we aimed to use a chiral auxiliary[7] approach based on sulfoxide chemistry, which has been extensively developed in our laboratory. By using such a nonaldol approach, enolate species would be avoided. It is known that the diastereoselective hydroboration[8] of optically active allylic alcohols gives convenient access to enantiomerically pure propionic derivatives. To this end, we prepared nonracemic β-keto sulfoxide **2** from the lithium anion of methyl sulfoxide **1**[9] and ethyl methacrylate.[10] Compound **2** was then subjected to stereoselective reduction[11] with DiBAL-H to cleanly give pure alcohol **3** in 68% yield as a single diastereomer (Scheme 1). This result was confirmed by ^{1}H NMR spectroscopic analysis. Compound **3** was then subjected to hydroboration with 9-BBN (9-borabicyclo[3.3.1]nonane) in THF, followed by oxidation with H_2O_2/NaOH to give predominantly diol **4**, among other isomers (86.5%, *dr* = 90:10), with an *anti* configuration for the propionate-derived moiety. The *anti* relationship was determined by full NMR spectroscopic analysis (more specifically an nOe experiment) of the corresponding purified acetonide (i.e., **4a**). Moreover, the absolute configuration of compounds **3** and **4** was confirmed by single-crystal X-ray analysis of the recrystallised products (see Supporting Information).



Scheme 1. Reagents and conditions: (a) LDA (lithium diisopropylamide), THF, ethyl methacrylate, –75 °C, **2** (91%); (b) DiBAL-H, THF, –78 °C, **3** (67.7%); (c) 9-BBN, THF, 0 °C to room temp., 4 h, then H_2O_2/NaOH, 0 °C to room temp., 3 h, **4** and other isomers (86%), see text and experimental section for the purification of **4**.

The hydroboration of substituted olefins with the bulky dialkylborane 9-BBN has the advantage of being regioselective, with the boron atom being installed on the less substituted carbon of the olefin. Furthermore, considering Houk's model for a preferred staggered conformation in acyclic allylic alcohol systems,[12] the selective diastereofacial approach of boranes is controlled both by steric effects [A(1,2) and (A1,3) allylic strain][13] and by the allylic stereocentre. For chiral olefin **3**, we have two possible repulsive A(1,2) allylic strains, depending on the orientation of the substituents on the allylic stereocentre. Consequently, two favourable conformational transition states TS1 and TS2 can be proposed to minimise repulsive interactions (Figure 4), with the OH group adopting an outside or inside position, respectively.

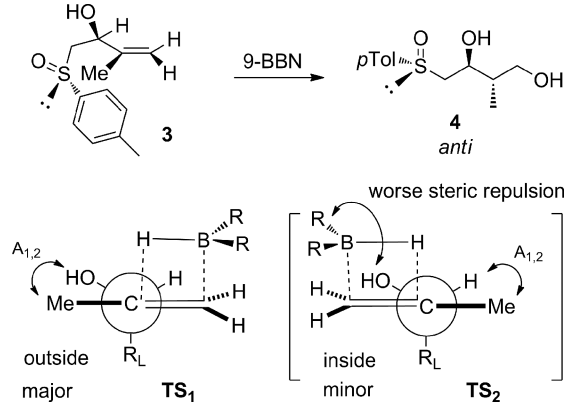


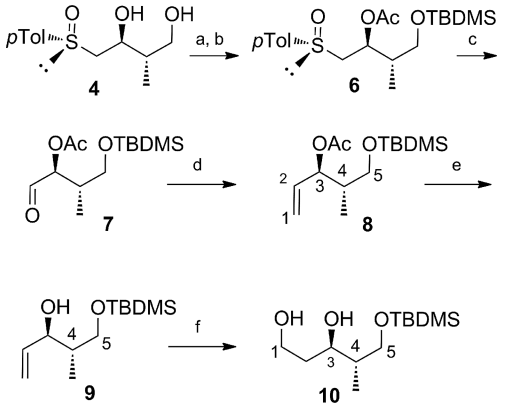
Figure 4. Illustration of the staggered transition states TS1 and TS2 in hydroboration with 9-BBN of enantiopure allylic alcohol **3**.

As has been previously proposed,[8c,8d,12] the antiperiplanar hydroboration will then occur on the face opposite to the largest group on the adjacent chiral centre. It follows that TS1 is more favourable than TS2, as the latter transition state is strongly destabilised by a nonbonding interaction between the large substituents of the alkylborane 9-BBN and the OH group. This implies that the hydroboration of **3** should lead to **4** with good stereoselectivity for an *anti* configuration, bearing in mind the already fixed stereochemistry of the alcohol group.

Unfortunately, at this stage, diol **4** could not easily be separated from the other possible isomeric products by chromatography, due to their close R_f values. To avoid this

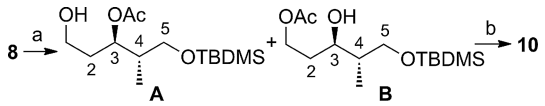
problematic purification, it was necessary to subject the crude diol to acetonide-formation conditions [DMP (2,2-dimethoxypropane), Me_2CO, *p*TsOH]. The major product (i.e., **4a**; the acetonide derivative of **4**) could then be readily separated from the other possible isomers. The required pure diol (i.e., **4**) was then obtained smoothly upon deprotection of **4a** with Amberlyst 15 in MeOH (69% over three steps starting from allylic alcohol **3**). When the hydroboration of allylic alcohol **3** was carried out on a large (grams) scale, a simple crystallisation (from EtOAc) of the crude **4** could be carried out to avoid the formation of acetonide **4a**. But this resulted in a lower yield of the final product.

Thereafter, diol **4** was sequentially subjected to a regioselective silylation and acetylation to give protected sulfoxide **6** (Scheme 2). Compound **6** in turn was transformed into aldehyde **7** by a mild one-pot Pummerer reaction, using TFAA (trifluoroacetic acid ahydride) as activating agent, followed by treatment with aqueous $NaHCO_3$.[14] Subsequently, aldehyde **7** was subjected to a Wittig reaction with triphenylphosphonium bromide to give olefin **8** in good yield (91%). Saponification gave allylic alcohol **9**, and a subsequent classical hydroboration with 9-BBN followed by treatment with sodium hydroxide and H_2O_2 gave diol **10** in a nearly quantitative yield.



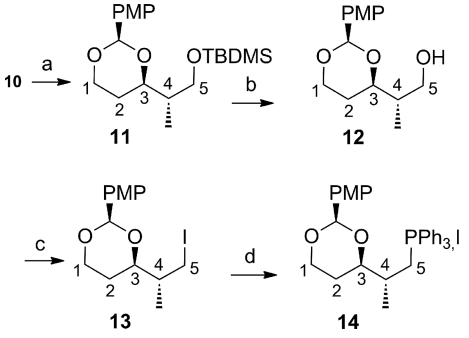
Scheme 2. Reagents and conditions: (a) TBDMSCl, Imd (imidazole), Na_2SO_4, DMF, room temp., **5** (99%); (b) Ac_2O, Et_3N, cat. DMAP (4-dimethylaminopyridine), CH_2Cl_2, room temp., **6** (92%); (c) Et_3N, TFAA, CH_2Cl_2, 0 °C for 25 min, then $NaHCO_3$ aq., room temp., 2 h, **7** (99%); (d) KHMDS (potassium hexamethyldisilazide), Ph_3PMe-Br, THF, 0 °C for 20 min, then aldehyde, room temp., 2 h, **8** (91%); (e) K_2CO_3, MeOH, room temp., 50 min, **9** (88%); (f) 9-BBN, THF, 0 °C to room temp., 6 h, then H_2O_2/NaOH, 0 °C to room temp., 2 h, **10** (99%).

Initially, we also attempted to directly convert allylic acetate **8** into diol **10** by hydroboration under different conditions, using NaOAc[15] as a less drastic base than NaOH. But each attempt gave a low yield (38–41%) of a mixture of regioisomers (A and B), resulting from partial migration of the acetyl group, and also from incomplete conversion of the starting material (Scheme 3). This mixture was also deacylated (K_2CO_3 in MeOH) in low yield (47.5%). Because of these difficulties, the saponification of **8** was carried out before the hydroboration as described above for a better overall yield.



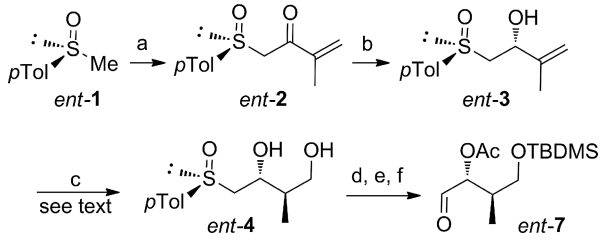
Scheme 3. Reagents and conditions: (a) 9-BBN, THF, NaOAc, H_2O_2, **A** and **B** (41%, when treatment with NaOAc for 4 h), or only **A** (38%, when treatment with NaOAc for 1.5 h); (b) MeOH, K_2CO_3, **10** (47.5%).

The next reactions to accomplish the synthesis of the desired phosphonium salt (i.e., **14**) are shown in Scheme 4. Diol **10** was converted in good yield (91%) into the benzylidene acetal **11**, whose absolute configuration was fully determined on the basis of nOe experiments. Alcohol **12**[16] was synthesised by TBAF (tetrabutylammonium fluoride)-mediated desilylation of **11** in THF at 0 °C. Compound **12** was halogenated by standard methods to give the corresponding iodide (i.e., **13**), which, under standard conditions, was then converted into triphenylphosphonium salt **14** as a white solid.



Scheme 4. Reagents and conditions: (a) $MeOC_6H_4CH(OMe)_2$, CH_2Cl_2, CSA (camphorsulfonic acid), room temp., 3 h, **11** (91%); (b) TBAF, THF, 0 °C to room temp., 3 h, **12** (92%); (c) I_2, THF, PPh_3, Imd, 0 °C to room temp., 1 h 45, **13** (91%); (d) MeCN, PPh_3, 80 °C for 20 h, **14** (85%).

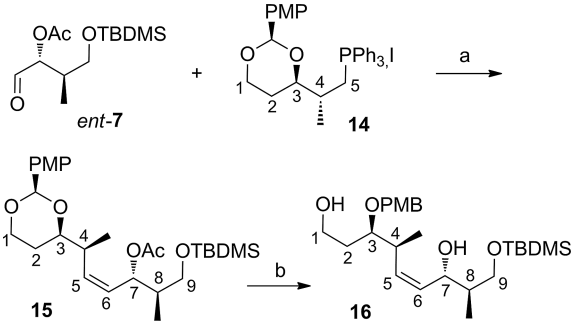
Next, we had to synthesise enantiopure aldehyde *ent*-**7**, which was isolated after several reaction steps. As shown in Scheme 5, the synthesis of *ent*-**7** began with methyl *p*-tolyl sulfoxide *ent*-**1**, following reaction conditions similar to those described for the synthesis of compound **4** in Scheme 1.



Scheme 5. Reagents and conditions: (a) LDA, THF, ethyl methacrylate, –70 °C, *ent*-**2** (99%); (b) DiBAL-H, THF, –78 °C, *ent*-**3** (76%); (c) 9-BBN, THF, 0 °C to room temp., 3 h, then H_2O_2/NaOH, 0 °C to room temp., 4 h, *ent*-**4** and other isomers (71.7%); (d) TBDMSCl, Imd, Na_2SO_4, DMF, room temp., *ent*-**5** (92%); (e) Ac_2O, Et_3N, cat. DMAP, CH_2Cl_2, room temp., *ent*-**6** (90%); (f) Et_3N, TFAA, CH_2Cl_2, 0 °C for 25 min, then $NaHCO_3$ aq., room temp., 2 h, *ent*-**7** (80%).

Thus, compound *ent*-**1** was converted into sulfinyl ester *ent*-**2**, which was then transformed into allylic alcohol *ent*-**3** by stereoselective reduction (DiBAL-H; *de* > 98% according ^{1}H NMR spectroscopy). Compound *ent*-**3** was transformed into pure diol *ent*-**4** (*dr* = 90:10 according ^{1}H NMR spectroscopy) by a diastereofacially selective reduction (9-BBN). Successive protections of diol *ent*-**4**, including an initial regioselective silylation (TBDMSCl) of the primary alcohol and then an acylation, gave *ent*-**6**. The target aldehyde (i.e., *ent*-**7**) was formed in 80% yield from *ent*-**6** by a mild one-pot Pummerer reaction at 0 °C in dichloromethane in the presence of TFAA, followed by treatment with aqueous $NaHCO_3$.[14]

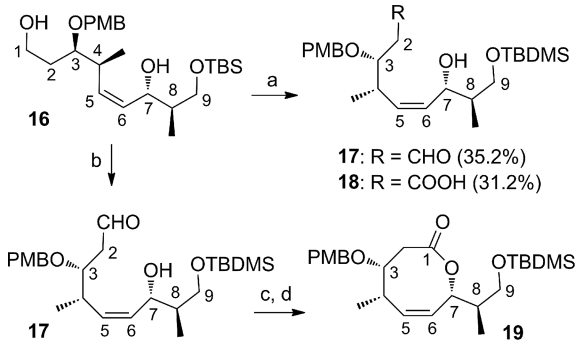
Having achieved, using a convenient sulfur chemistry approach, the synthesis of the two enantiopure propionate-derived precursors, phosphonium **14** and aldehyde *ent*-**7**, we next planned to use these two precursors in an olefination coupling reaction with a view to synthesising the lactone moiety of the octalactins. A Wittig reaction between ylide derivative **14** and aldehyde *ent*-**7** (Scheme 6) gave, in moderate yield (38%), the desired (*Z*)-olefin (i.e., **15**) after purification by silica gel column chromatography. The *Z* configuration should facilitate the subsequent intramolecular cyclisation. Although the (*E*)-olefin was not observed in the crude product, the side-products could not be identified by NMR spectroscopic analysis. Despite this, this reaction was not further optimised.



Scheme 6. Reagents and conditions: (a) KHMDS, THF, phosphonium **14**, 0 °C to room temp., then aldehyde *ent*-**7**, –65 °C to room temp., **15** (38%); (b) DiBAL-H, CH_2Cl_2, 0 °C for 2 h, **16** (58%).

Olefin **15** was subjected to a regioselective cleavage with a large excess of DiBAL-H in CH_2Cl_2, following a slight modification of Takano's procedure,[17] to give polyol **16**. An excess of the reducing agent was used in order to reduce the acetate functionality, but also to cleave the benzylidene acetal regioselectively at the less hindered site, and in this way free the primary alcohol while at the same time installing PMB protection onto the secondary alcohol.

As a key intermediate in our synthetic strategy, compound **16** had to be transformed into *seco*-acid **18** before the final macrolactonisation (Scheme 7). We attempted to regioselectively oxidise the terminal alcohol group of **16** to give a carboxylic group with TEMPO (2,2,6,6-tetramethylpiperidinyloxy)/BAIB [(diacetoxyiodo)benzene] in the presence of water;[18] this led to the isolation of aldehyde **17** and the required acid (i.e., **18**) in 35 and 31% yields, respectively, even after 44 h at ambient temperature. The secondary alcohol was not affected during this oxidation. It seems that under these oxidation conditions, the over-oxidation to the carboxylic acid is more complicated in our case.



Scheme 7. Reagents and conditions: (a) CH_2Cl_2, BAIB, TEMPO, H_2O, room temp. for 44 h, **17** (35%) and **18** (31%); (b) CH_2Cl_2, BAIB, TEMPO, room temp. for 48 h, **17** (43.8%); (c) $NaClO_2$, NaH_2PO_4, H_2O, *t*BuOH, amylene, then aldehyde **17**, room temp. for 1 h, **18** (49%); (d) 2,4,6-Cl_3PhCOCl, Et_3N, PhMe, room temp. for 5 h, then DMAP cat., PhMe, room temp. for 17 h, **19** (52%).

Based on previous investigations, we also attempted a direct lactonisation of **16** under anhydrous conditions in the presence of TEMPO/BAIB.[19] It was described that the initial oxidation of the primary hydroxy group to an aldehyde would lead to the corresponding hemiacetal. This, in turn, would lead to the formation of the lactone after prolonged oxidation. Unfortunately, in our case, we observed only the formation of aldehyde **17** instead of the expected lactone.

To avoid the formation of a mixture of aldehyde and acid, it was more successful to adopt a two-step oxidation sequence followed by Yamaguchi macrolactonisation under high-dilution conditions (Scheme 7). Consequently, diol **16** was first oxidised under anhydrous TEMPO-mediated conditions to give the corresponding aldehyde (i.e., **17**), which was then oxidised into carboxylic acid **18** under Pinnick's conditions.[20] Thereafter, the desired eight-membered ring (i.e., **19**) was obtained in 53% yield from *seco*-acid **18** by means of the macrolactonisation procedure described by Yamaguchi[6,22] using 2,4,6-trichlorobenzoyl chloride and DMAP. The reduction of the olefin bond of **19** can be envisaged according to protocols previously described in the literature[3a,3b,21] to give the saturated medium ring of natural octalatins A and B.

Conclusions

In summary, we have successfully demonstrated a convenient non-aldol approach for the synthesis of enantiopure propionate-derived building blocks using a non-racemic sulfoxide as a chiral auxiliary, and using two successive diastereoselective reductions. The stereocontrolled reduction of the prochiral carbonyl group of a methacrylate ester, coupled to a chiral sulfoxide, gave rise to the key intermediate, an enantiopure allylic alcohol (**3** or *ent*-**3**). This intermedi-

ate was further converted into the corresponding propionate-derived unit by stereoselective hydroboration with 9-BBN. The efficiency of this approach was well demonstrated: all of the stereocentres could be easily controlled, using the chiral sulfoxide as the source of chirality. We aimed to support our results by the application to the synthesis of a natural product. In this context, we were able to synthesise polyfunctionalised precursors that could be used for a convergent synthesis of the medium-ring lactone core of the octalactins. After connection of the appropriate fragments, a final macrolactonisation of *seco*-acid **24** was accomplished using Yamaguchi's convenient method. The approach described in this paper could be useful for the synthesis of many other natural products.

Experimental Section

General Information: All starting materials and reagents were obtained from commercial suppliers and used as received. All solvents were purified according to standard methods: THF and diethyl ether were distilled from Na/benzophenone; toluene was distilled from Na; CH_2Cl_2, Et_3N, and DMSO were distilled from calcium hydride. Anhydrous MeCN and DMF were used as obtained from commercial suppliers. Air- and moisture-sensitive reactions were carried out in heatgun-dried glassware under argon. Reactions were monitored by thin-layer chromatography (TLC) with 0.25 mm Merck precoated silica gel plates (60F-254). Spots were detected under UV irradiation (254 nm) and/or by staining with acidic ceric ammonium molybdate, unless otherwise noted. Flash column chromatography was carried out using silica gel 60 (particle size 0.040–0.063 mm), supplied by Merck, Geduran, packed into a glass column, yields refer to chromatographically and spectroscopically pure compounds, unless otherwise stated. All the NMR spectra (^1H, ^{13}C, COSY, NOESY, HMQC, and HSQC) were recorded with Bruker AV300, AV400, or AV500 spectrometers using an internal deuterium lock at ambient temperature. Unless otherwise noted, $CDCl_3$ was used as solvent for all NMR experiments. Multiplicities are described using the following abbreviations: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br. = broad, and ABX = ABX system. Chemical shifts are given in ppm, and coupling constants are presented in Hz. ^{13}C NMR spectra were calibrated using the central triplet peak of $CDCl_3$ (δ = 77.0 ppm); ^1H NMR spectra were calibrated using the residual $CHCl_3$ peak (δ = 7.26 ppm). For NMR assignments, please refer to the atom numbering in the schemes. Optical rotations ($[\alpha]_D$) were recorded with a Polarimeter Model 341 (Perkin–Elmer) at a wavelength of 589 nm in a 10 cm quartz cuvette, and are reported as follows: $[\alpha]_D^{20}$, concentration (c in g/100 mL), and solvent. Mass spectra (ESI) were obtained with a microTOF instrument (Bruker Daltonics, Bremen, Germany). Elemental analyses were measured at the Service de Microanalyse of the Université de Strasbourg (France).

(+)-(*R*)-Methyl *p*-Tolyl Sulfoxide 1 and (–)-(*S*)-Methyl *p*-Tolyl Sulfoxide (*ent*-1):[9b,9d] A solution of methylmagnesium iodide in diethyl ether [prepared from methyl iodide (19.7 mL, 0.315 mol) and magnesium (7.72 g, 0.317 mol) in anhydrous diethyl ether (120 mL)] was slowly added over 2 h to a chilled (0 °C) solution of (–)-menthyl *p*-toluenesulfinate[9c] (70.3 g, 0.238 mol) in benzene (or toluene; 200 mL). The resulting homogeneous orange solution was stirred for 2 h at 0 °C, and then for 1 h at room temperature. The reaction was then quenched very carefully with saturated aqueous ammonium chloride solution (200 mL). The aqueous layer was extracted with diethyl ether (2× 150 mL), and the combined organic layers were washed with brine (50 mL), dried ($MgSO_4$), filtered, and evaporated under reduced pressure to give a yellow liquid. While the liquid was still hot, hexane (150 to 200 mL) was added until a white precipitate formed. Crystallisation was carried out at –20 °C. The solid (containing both menthol and methyl sulfoxide) was collected by filtration, and then it was dissolved in hot diethyl ether (200 mL) and hexane (ca. 150 mL). After a few hours at ambient temperature (20 h), two crops of crystals (17.9 g and 7.3 g) were collected by filtration. This material was washed with hexane, and dried under vacuum to give (+)-(*R*)-methyl *p*-tolyl sulfoxide (**1**; 25.2 g, 68.5%) as white crystals, m.p. 75 °C. $[\alpha]_D^{20}$ = +192 (c = 1.02, $CHCl_3$); $[\alpha]_D^{20}$ = +149 (c = 0.11, acetone). Pure (+)-(*R*)-methyl *p*-tolyl sulfoxide could also be obtained by chromatographic purification of the crude yellow oil on silica gel (diethyl ether was used as eluent to remove the menthol, and then EtOAc to isolate the desired product as a white solid). ^1H NMR (300 MHz, $CDCl_3$): δ = 7.54 and 7.33 (AA′BB′, J = 8.1 Hz, $\Delta\nu$ = 62.2 Hz, 4 H, *p*Tol), 2.70 (s, 3 H, Me), 2.41 (s, 3 H, Me of *p*Ts) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 142.4 (Cq arom), 141.5 (Cq arom), 130.0 (CH arom), 123.5 (CH arom), 43.9 (Me), 21.4 (Me of *p*Ts) ppm.

The preparation of *ent*-**1** followed the same procedure, starting from (+)-(*R*)-menthyl *p*-toluenesulfinate, m.p. 75 °C. $[\alpha]_D^{20}$ = –187 (c = 1, $CHCl_3$).

(*R*)-3-Methyl-1-(*p*-tolylsulfinyl)but-3-en-2-one (2): A solution of (+)-(*R*)-methyl *p*-tolyl sulfoxide (**1**; 2.90 g, 0.0188 mol) in dry THF (25 mL) was added by cannula to a stirred solution of LDA (1.15 equiv.) [freshly prepared from diisopropylamine (3.5 mL, 1.32 equiv.) and *n*BuLi (in THF; 50 mL, 1.15 equiv.)] at –75 °C. The mixture was stirred for 45 min at the same temperature, then a solution of ethyl methacrylate (1.2 mL, 0.51 equiv.) in dry THF (5 mL) was added to the yellow solution of methyl *p*-tolyl sulfoxide anion. The reaction mixture was stirred for 1 h, during which time the temperature was allowed to reach –40 °C. Then it was carefully quenched with saturated aqueous NH_4Cl solution (20 mL), and diluted with water (10 mL) and EtOAc (30 mL). HCl (20% aq.; 20 mL) was added at room temperature until the mixture reached pH 4, and then the mixture was vigorously stirred for 1 h. The aqueous layer was extracted with EtOAc (15 mL), and the combined organic extracts were washed with water (3× 40 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure. The crude yellow oil was purified by silica gel column chromatography (EtOAc/cyclohexane, 7:3) to remove the excess methyl *p*-tolyl sulfoxide, and give keto sulfoxide **2** (1.93 g, 91%) as a viscous lemon-yellow oil. $[\alpha]_D^{20}$ = +182.8 (c = 1.4, $CHCl_3$). $C_{12}H_{14}O_2Si$ (222.303): calcd. C 64.83, H 6.35; found C 64.96, H 6.22. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.49 and 7.26 (AA′BB′, J = 8.3 Hz, $\Delta\nu$ = 69.7 Hz, 4 H, *p*Tol), 5.90 (q, $J_{4c,Me}$ = 0.9 Hz, 1 H, 4c-H), 5.88 (q, $J_{4t,Me}$ = 1.5 Hz, 1 H, 4t-H), 4.24 and 3.95 (AB system, J_{AB} = 13.8 Hz, $\Delta\nu$ = 83.5 Hz, 2 H, 1-H), 2.35 (s, 3 H, Me of *p*Tol), 1.76 (br. s, 3 H, Me) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 192.5 (CO), 144.3 (Cq-3), 141.9 (Cq arom), 139.8 (Cq arom), 129.8 (CH arom), 128.5 (CH_2-4), 124.0 (CH arom), 64.9 (CH_2-1), 21.2 (Me of *p*Tol), 17.0 (Me) ppm.

(*S*)-3-Methyl-1-[(*R*)-*p*-tolylsulfinyl]but-3-en-2-ol (3): Keto sulfoxide **2** (2.41 g, 0.0108 mol) was dissolved in dry THF (55 mL), and the solution was cooled to –78 °C. DiBAL-H (1 M in hexane; 13 mL, 1.2 equiv.) was added dropwise. The reaction mixture was stirred for 1 h 20 min, and the progress of the reaction was monitored by TLC analysis (diethyl ether/CH_2Cl_2, 1:1). After this time, the reaction was quenched slowly at –40 °C with MeOH (4 mL) and an aqueous disodium tartaric acid salt solution (1 M; 10 mL), then the

mixture was diluted with EtOAc (50 mL) and water (20 mL). After 0.5 h at ambient temperature, the aqueous phase became cloudy, and HCl (20% aq.; 15 mL) was added until the mixture reached pH 2. The mixture was stirred vigorously for 1 h, and then the two clear layers were separated. The aqueous layer was extracted with EtOAc (2 × 15 mL), and the combined organic layers were washed with water (3 × 40 mL) and brine (10 mL), dried with Na_2SO_4, and filtered. The solvents were evaporated in vacuo to leave a yellow oil. This crude product was purified by silica gel column chromatography (diethyl ether) to give alcohol **3** (1.64 g, 67.7%), which crystallised on standing as a white solid, m.p. 90 °C. $[\alpha]_D^{20}$ = +292 (c = 1.0, $CHCl_3$). $C_{12}H_{14}O_2Si$ (222.303): calcd. C 64.25, H 7.19; found C 64.28, H 7.51. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.52 and 7.32 (AA′BB′, J = 8.3 Hz, $\Delta\nu$ = 60.3 Hz, 4 H, *p*Tol), 5.06 (br. s, 1 H, 4t-H), 4.88 (br. s, 1 H, 4c-H), 4.60 (m, X part of ABX system, 1 H, 2-H), 4.22 (d, $J_{OH,2}$ = 3.8 Hz, 1 H, OH), 2.88 (AB part of an ABX system, $J_{1a,1b}$ = 13.5, $J_{1a,2}$ = 10.5, $J_{1b,2}$ = 2.2 Hz, $\Delta\nu$ = 48 Hz, 2 H, 1-H), 2.41 (s, 3 H, Me of *p*Tol), 1.68 (br. s, 3 H, Me) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 144.9 (Cq-3), 141.6 (Cq arom), 139.7 (Cq arom), 130.0 (CH arom), 124.0 (CH arom), 112.1 (CH_2-4), 69.8 (CH-2), 61.1 (CH_2-1), 21.4 (Me of *p*Tol), 18.1 (Me) ppm.

(2*S*,3*S*)-2-Methyl-4-[(*R*)-*p*-tolylsulfinyl]butane-1,3-diol (4): 9-BBN (0.5 M solution in THF; 23 mL, 2.55 equiv.) was added dropwise to a cold (0 °C) solution of sulfoxide **3** (1.0112 g, 4.50 mmol) in anhydrous THF (28 mL). The ice bath was removed after 10 min, and the mixture was stirred at ambient temperature for 4 h. The mixture was then cooled to 0 °C, and NaOH (3 M aq.; 10 mL) and H_2O_2 (30% aq.; 10 mL), and a saturated aqueous solution of NaCl (5 mL) were added slowly in sequence. The reaction mixture was stirred at room temperature for 3 h, and then it was diluted with EtOAc (20 mL). An aqueous solution of $Na_2S_2O_3{\cdot}5H_2O$ (1 M; 2 mL) was carefully added. The organic layer was washed with brine (5 mL), dried with $MgSO_4$, filtered, and concentrated under reduced pressure. The resulting viscous oil was purified by silica gel column chromatography (diethyl ether, then EtOAc, and then EtOAc/acetone, 3:1) to give a translucent oil that solidified as a white solid. This material (941 mg, 86%) contained **4** and other isomers. At this stage, due to the close R_f values, we failed to isolate diastereomerically pure **4**. However, it was separated from the other isomers by conversion into dioxane derivative **4a** (see below).

The mixture of sulfoxides (840 mg, 3.46 mmol) was dissolved in acetone (5 mL) and 2,2-dimethoxypropane (DMP; 10 mL), and a catalytic amount of of *p*-toluenesulfonic acid (*p*TsOH; 22 mg, 10 mol-%) was added. The mixture was stirred at room temperature for 5 h. The solvents were evaporated in vacuo, and the residue was diluted with EtOAc (30 mL). The organic extract was washed with water (3 × 15 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (diethyl ether) to give pure acetonide **4a** (825 mg, 84%) as a colourless oil. $[\alpha]_D^{20}$ = +247 (c = 0.84, $CHCl_3$). HRMS (ESI): calcd. for $C_{15}H_{22}O_3SNa$ $[^m + Na]^+$ 305.1182; found 305.1171. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.53 and 7.30 (AA′BB′, J = 8.1 Hz, $\Delta\nu$ = 67.3 Hz, 4 H, *p*Tol), 4.11 (ddd, J = 10.4, J = 10.4, J = 2.1 Hz, 1 H, 2-H), 3.64 (AB part of an ABX system, $J_{4a,4b}$ = 11.9, $J_{4a,3}$ = 11.4, $J_{4b,3}$ = 5.2 Hz, $\Delta\nu$ = 46 Hz, 2 H, 4-H), 2.78 (AB part of an ABX system, $J_{1a,1b}$ = 12.9, $J_{1a,2}$ = 10.6, $J_{1b,2}$ = 2.0 Hz, $\Delta\nu$ = 67.2 Hz, 2 H, 1-H), 2.39 (s, 3 H, Me of *p*Tol), 1.77–1.61 (m, 1 H, 3-H), 1.52 (s, 3 H, Me ax of acetonide), 1.43 (s, 3 H, Me eq of acetonide), 0.75 (d, J = 6.6 Hz, 3 H, Me-3) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 141.7 (Cq arom), 141.2 (Cq arom), 129.9 (CH arom), 123.7 (CH arom), 98.8 (Cq, acetonide), 69.4 (CH-2), 65.8 (CH_2-4), 63.0 (CH_2-1), 33.9 (CH-3), 29.5 (Me eq of acetonnide), 21.3 (Me of *p*Tol), 19.1 (Me ax of acetonnide), 12.2 (Me-3) ppm.

Deprotection of Acetonide 4a: Amberlyst 15 (350 mg) was added to a solution of acetonide **4a** (313 mg, 1.10 mmol) in MeOH (8 mL). The mixture was stirred at room temperature for 6 h, and then it was filtered through a short pad of Celite, which was rinsed with EtOAc (3 × 10 mL). The filtrate was concentrated in vacuo. The crude product which was purified by silica gel column chromatography (EtOAc) to give free diol **4** (252 mg, 95%) as a white solid, m.p. 126 °C. $[\alpha]_D^{20}$ = +303.5 (c = 1.06, $CHCl_3$). $C_{12}H_{15}O_3S$ (242.334): calcd. C 59.47, H 7.49; found C 59.56, H 7.55. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.52 and 7.35 (AA′BB′, J = 11 Hz, $\Delta\nu$ = 70 Hz, 4 H, *p*Tol), 4.16 (m, X part of ABX system, 1 H, 2-H), 3.83 (br. s, 2 H, 2 OH), 3.68 (AB part of an ABX system, $J_{4a,4b}$ = 14.8, $J_{4a,3}$ = 8.8, $J_{4b,3}$ = 4.6 Hz, $\Delta\nu$ = 56.5 Hz, 2 H, 4-H), 2.95 (AB part of an ABX system, $J_{1a,1b}$ = 17.6, $J_{1a,2}$ = 13.6, $J_{1b,2}$ = 2.6 Hz, $\Delta\nu$ = 71.6 Hz, 2 H, 1-H), 2.42 (s, 3 H, Me of *p*Tol), 1.79 (m, X part of ABX system, 1 H, 3-H), 0.82 (d, J = 7.0 Hz, 3 H, Me-3) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.8 (Cq arom), 139.1 (Cq arom), 130.1 (CH arom), 124.0 (CH arom), 70.6 (CH-2), 66.1 (CH_2-4), 60.7 (CH_2-1), 40.4 (CH-3), 21.4 (Me of *p*Tol), 13.4 (Me-3) ppm.

(2*S*,3*S*)-4-(*tert*-Butyldimethylsilyloxy)-3-methyl-1-[(*R*)-*p*-tolylsulfinyl]butan-2-ol (5): *tert*-Butyldimethylsilyl chloride (142 mg, 1.18 equiv.) was added to a solution of sulfoxide **4** (192 mg, 0.792 mmol), anhydrous Na_2SO_4 (ca. 183 mg, ca. 1.6 equiv.), and imidazole (174 mg, 2.70 equiv.) in dry DMF (3.5 mL). The mixture was stirred for 1 h at ambient temperature until TLC indicated that all of the starting material had been monosilylated. Diethyl ether (15 mL) and water (15 mL) were added, and the mixture was stirred for 1 h at room temperature. The aqueous phase was extracted with diethyl ether (10 mL). The combined organic extracts were washed with water (2 × 10 mL) and brine (5 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel (EtOAc) to give monosilyl ether **5** (280 mg, 99%) as a colourless oil. $[\alpha]_D^{20}$ = +197.4 (c = 3.7, $CHCl_3$). $C_{18}H_{32}O_3SSi$ (356.595): calcd. C 60.63, H 9.05; found C 62.98, H 9.44. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.53 and 7.32 (AA′BB′, J = 8.1 Hz, $\Delta\nu$ = 62.7 Hz, 4 H, *p*Tol), 4.45 (d, J = 1.8 Hz, 1 H, OH), 4.16 (m, 1 H, 2-H), 3.64 (AB part of an ABX system, $J_{4a,4b}$ = 10.2, $J_{4a,3}$ = 7.5, $J_{4b,3}$ = 4.0 Hz, $\Delta\nu$ = 27.3 Hz, 2 H, 4-H), 2.87 (AB part of an ABX system, $J_{1a,1b}$ = 13.0, $J_{1a,2}$ = 10.0, $J_{1b,2}$ = 2.2 Hz, $\Delta\nu$ = 24.1 Hz, 2 H, 1-H), 2.41 (s, 3 H, Me of *p*Tol), 1.78 (m, 1 H, 3-H), 0.86 (s, 9 H, *t*Bu-Si), 0.82 (d, J = 6.9 Hz, 3 H, Me-3), 0.05 (s, 3 H, Me-Si), 0.04 (s, 3 H, Me-Si) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 141.3 (Cq arom), 140.7 (Cq arom), 130.0 (CH arom), 123.9 (CH arom), 70.5 (CH-2), 67.1 (CH_2-4), 62.4 (CH_2-1), 40.1 (CH-3), 25.8 [C(CH_3)$_3$Si], 21.4 (Me of *p*Tol), 18.1 [C(Me)$_3$Si], 13.0 (Me-3), –5.6 (2 MeSi) ppm.

(2*S*,3*S*)-4-(*tert*-Butyldimethylsilyloxy)-3-methyl-1-[(*R*)-*p*-tolylsulfinyl]butan-2-yl Acetate (6): Sulfoxide **5** (308.0 mg, 0.863 mmol) was dissolved in dry CH_2Cl_2 (10 mL), and a catalytic amount of DMAP (27 mg, 0.25 equiv.), anhydride acetic (225 μL, 2.7 equiv.), and triethylamine (0.38 mL, 3.1 equiv.) were added in sequence. The reaction mixture was stirred for 3 h at ambient temperature, and then CH_2Cl_2 (5 mL) and water (10 mL) were added. The organic layer was washed with water (2 × 5 mL), dried with Na_2SO_4, filtered and concentrated under reduced pressure. The oily residue was purified by silica gel column chromatography (EtOAc/cyclohexane, 1:1) to give **6** (318 mg, 92%) as a colourless viscous oil, which crystallised on standing to give a white solid, m.p. 56 °C. $[\alpha]_D^{20}$ = +133.1 (c = 1.42, $CHCl_3$). $C_{20}H_{34}O_4SSi$ (398.632): calcd. C 60.26, H 8.60; found C 60.02, H 8.57. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.52 and

7.31 (AA′BB′, J = 8.1 Hz, $\Delta\nu$ = 63.0 Hz, 4 H, *p*Tol), 5.39 (m, 1 H, 2-H), 3.53 (m, 2 H, 4-H), 3.02 (AB part of an ABX system, $J_{1a,1b}$ = 13.8, $J_{1a,2}$ = 9.9, $J_{1b,2}$ = 2.8 Hz, $\Delta\nu$ = 33.4 Hz, 2 H, 1-H), 2.40 (s, 3 H, Me of *p*Tol), 2.09 (m, 1 H, 3-H), 2.05 (s, 3 H, AcO), 0.88 (d, J = 6.9 Hz, 3 H, Me-3), 0.81 (s, 9 H, *t*Bu-Si), –0.003 (s, 6 H, 2 Me-Si) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 169.9 (CO), 141.5 (Cq arom), 141.2 (Cq arom), 129.9 (CH arom), 124.0 (CH arom), 70.0 (CH-2), 64.2 (CH_2-4), 60.8 (CH_2-1), 38.9 (CH-3), 25.8 [C(CH_3)$_3$Si], 21.4 (Me of *p*Tol), 20.9 (MeCO), 18.0 [*C*(Me)$_3$Si], 12.3 (Me-3), –5.5 (MeSi), –5.6 (MeSi) ppm.

(2*S*,3*S*)-4-(*tert*-Butyldimethylsilyloxy)-3-methyl-1-oxobutan-2-yl Acetate (7): Triethylamine (450 μL, 3.36 equiv.) and trifluoroacetic anhydride (420 μL, 3.1 equiv.) were successively added to a solution of sulfoxide **6** (383.2 mg, 0.961 mmol) in CH_2Cl_2 (8.5 mL) at 0 °C. The mixture was stirred at the same temperature for 25 min, then an aqueous solution of $NaHCO_3$ (0.5 M; 11 mL, 5.72 equiv.) was added. The mixture was left at ambient temperature for 2 h, and then it was diluted with water (10 mL) and CH_2Cl_2 (10 mL). The organic layer was washed with water (3 × 15 mL), and brine (5 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. The crude yellow oil was purified by column chromatography on silica gel (CH_2Cl_2) to give aldehyde **7** (263 mg, 99%) as a colourless oil. $[\alpha]_D^{20}$ = +7.8 (c = 0.81, $CHCl_3$). HRMS (ESI): calcd. for $C_{13}H_{26}O_4SiNa$ [M + Na]$^+$ 297.1493; found 297.1482. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.49 (s, 1 H, CHO), 4.97 (d, J = 2.9 Hz, 1 H, 2-H), 3.56 (AB of a degenerated ABX system, 2 H, 4-H), 2.49 (m, 1 H, 3-H), 2.19 (s, 3 H, AcO), 0.97 (d, J = 7.0 Hz, 3 H, Me-3), 0.87 (s, 9 H, *t*Bu-Si), 0.03 (s, 6 H, 2 Me-Si) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 197.7 (CHO), 170.7 (COOMe), 79.9 (CH-2), 63.6 (CH_2-4), 38.2 (CH-3), 25.8 [C(CH_3)$_3$Si], 20.6 (MeCO), 18.3 [*C*(Me)$_3$Si], 13.2 (Me-3), –5.7 (2 MeSi) ppm.

(3*R*,4*S*)-5-(*tert*-Butyldimethylsilyloxy)-4-methylpent-1-en-3-yl Acetate (8): KHMDS (0.5 M solution in toluene; 1.8 mL, 1.44 equiv.) was added dropwise to a stirred suspension of dry methyltriphenylphosphonium bromide (340.5 mg, 1.52 equiv.) in dry THF (5 mL) at 0 °C. The resulting yellow mixture was stirred for 20 min at 0 °C, then a solution of aldehyde **7** (171.9 mg, 0.626 mmol) in dry THF (3 mL) was added. The mixture was stirred for 2 h at ambient temperature, then the reaction was quenched with saturated aqueous NH_4Cl solution (4 mL), water (5 mL), and HCl (10% aq.; 0.6 mL) until the pH reached 1. The mixture was diluted with EtOAc (10 mL), and the aqueous layer was washed with water (2 × 10 mL), and brine (5 mL). The organic extract was dried ($MgSO_4$), filtered, and evaporated under reduced pressure. The crude product was purified by column chromatography on silica gel (CH_2Cl_2) to give pure olefin **8** (154 mg, 91%) as a slightly yellow liquid. $[\alpha]_D^{20}$ = +2.8 (c = 1.07, $CHCl_3$). HRMS (ESI): calcd. for $C_{14}H_{28}O_3SiNa^+$ [M + Na]$^+$ 295.1700; found 295.1719. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 5.76 (m, 1 H, 2-H), 5.26 (m, 1 H, 3-H), 5.21 (m, 2 H, 1-H), 3.51 (AB part of an ABX system, $J_{5a,5b}$ = 10.0, $J_{5a,4}$ = 6.5, $J_{5b,4}$ = 5.5 Hz, $\Delta\nu$ = 20.8 Hz, 2 H, 5-H), 2.05 (s, 3 H, AcO), 1.93 (m, 1 H, 4-H), 0.90 (d, J = 7.2 Hz, 3 H, Me), 0.89 (s, 9 H, *t*Bu-Si), 0.03 (s, 6 H, 2 Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.0 (CO), 134.4 (CH-2), 117.7 (=CH_2-1), 76.0 (CH-3), 64.3 (CH_2-5), 39.4 (CH-4), 25.9 [C(CH_3)$_3$Si], 21.2 (Ac), 18.2 [*C*(Me)$_3$Si], 12.5 (Me), –5.5 (MeSi) ppm.

(3*R*,4*S*)-5-(*tert*-Butyldimethylsilyloxy)-4-methylpent-1-en-3-ol (9): K_2CO_3 (200 mg, 5.1 equiv.) was added to a solution of acetate **8** (76.3 mg, 0.28 mmol) in MeOH (5 mL). The mixture was stirred at room temperature for 50 min. After this time, TLC indicated that all of the starting material had been consumed. The mixture was filtered through Celite, which was then rinsed with EtOAc. The solvents were evaporated, and the crude product was purified by silica gel column chromatography (CH_2Cl_2) to give alcohol **9** (57 mg, 88%) as a colourless liquid. $[\alpha]_D^{20}$ = +22.9 (c = 0.70, $CHCl_3$). HRMS (ESI): calcd. for $C_{12}H_{28}O_2SiNa$ [M + Na]$^+$ 253.1594; found 253.1620. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 5.85 (m, 1 H, 2-H), 5.27 (dd, $J_{1,2}$ = 17.1, $J_{1t,1c}$ = 1.9 Hz, 1 H, 1-H *trans*), 5.15 (dd, $J_{1,2}$ = 10.4, $J_{1c,1t}$ = 1.9 Hz, 1 H, 1-H *cis*), 4.02 (m, 1 H, 3-H), 3.73 (d, J = 2.7 Hz, 1 H, OH), 3.69 (AB part of an ABX system, $J_{5a,5b}$ = 10.0, $J_{5a,4}$ = 7.5, $J_{5b,4}$ = 3.7 Hz, $\Delta\nu$ = 85.6 Hz, 2 H, 5-H), 1.75 (m, 1 H, 4-H), 0.90 (s, 9 H, *t*Bu-Si), 0.88 (d, J = 7.0 Hz, 3 H, Me), 0.08 (s, 3 H, Me-Si), 0.07 (s, 3 H, Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 139.7 (CH-2), 115.5 (CH_2-1), 78.2 (CH-3), 67.9 (CH_2-5), 39.6 (CH-4), 25.8 [C(CH_3)$_3$Si], 18.1 [*C*(Me)$_3$Si], 13.5 (Me), –5.6 (MeSi), –5.7 (MeSi) ppm.

(3*R*,4*S*)-5-(*tert*-Butyldimethylsilyloxy)-4-methylpentane-1,3-diol (10) from 8: 9-BBN (0.5 M solution in THF; 0.85 mL, 2.4 equiv.) was added dropwise at 0 °C to a solution of olefin **8** (47.7 mg, 0.175 mmol) in anhydrous THF (1 mL). The mixture was stirred for 20 h at ambient temperature, and for 6.5 h at 50 °C, then it was cooled to 0 °C, and hydrolysed by the sequential addition of EtOH (0.3 mL), a saturated aqueous solution of NaOAc (1.4 mL), and H_2O_2 (30% aq.; 0.4 mL). The mixture was stirred for 1.5 h at room temperature, then the organic layer was washed with water (5 mL). An aqueous solution of $Na_2S_2O_3{\cdot}5H_2O$ (1 M; 2 mL) was carefully added, followed by brine (4 mL). The organic layer was dried ($MgSO_4$), filtered, and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (EtOAc/cyclohexane, 2:8) to give product **A** (19 mg, 38%), as well as starting material (11 mg).

Following a similar procedure, but carrying out the hydroboration at room temperature for 19 h, and then treating with NaOAc for 4 h, we obtained, after purification, two inseparable regioisomers **A** and **B** (41%) as well as starting material (33%).

NMR spectroscopic data for **A**: ^{1}H NMR (500 MHz, $CDCl_3$): δ = 5.05 (m, 1 H, 3-H), 3.68–3.62 (m, 1 H, 1a-H), 3.53–3.47 (m, 1 H, 1b-H), 3.53 (AB part of an ABX system, J_{5a-5b} = 9.7, J_{5a-4} = 6.0, J_{5b-4} = 5.0 Hz, $\Delta\nu$ = 25.3 Hz, 2 H, 5-H), 2.49 (br. s, 1 H, OH), 2.08 (s, 3 H, AcO), 1.94–1.87 (m, 2 H, 4-H and 2a-H), 1.67–1.61 (m, 1 H, 2b-H), 0.94 (d, J = 7.0 Hz, 3 H, Me), 0.88 (s, 9 H, *t*Bu-Si), 0.034 (s, 3 H, Me-Si), 0.030 (s, 3 H, Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 171.9 (CO), 72.6 (CH-3), 64.4 (CH_2-5), 58.6 (CH_2-1), 39.5 (CH-4), 34.3 (CH_2-2), 25.8 [C(CH_3)$_3$Si], 21.0 (AcO), 18.2 [*C*(Me)$_3$Si], 13.2 (Me), –5.5 (2 MeSi) ppm.

The mixture of the alcohol regioisomers **A** and **B** (25 mg, 0.087 mmol) was stirred with anhydrous K_2CO_3 (50.5 mg, 4.2 equiv.) in dry MeOH/THF (1 mL/0.5 mL). After 2 h at room temperature, the solution was filtered, the filter residue was rinsed with EtOAc, and the combined filtrates were concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (EtOAc/cyclohexane, 1:1) to give diol **10** (10 mg, 47%). Analysis of this compound is given in the next section.

(3*R*,4*S*)-5-(*tert*-Butyldimethylsilyloxy)-4-methylpentane-1,3-diol (10) from 9: 9-BBN (0.5 M solution in THF; 4.6 mL, 3.49 equiv.) was added dropwise to a solution of allylic alcohol **9** (133.0 mg, 0.577 mmol) in anhydrous THF (5.5 mL) at 0 °C. The mixture was stirred for 6 h at ambient temperature, then it was hydrolysed at 0 °C with NaOH (3 M aq.; 2.4 mL) and H_2O_2 (30% aq.; 2.4 mL). The mixture was stirred at room temperature until complete consumption of starting material occurred (2 h, as monitored by TLC). Brine (3 mL) was added. The organic layer was diluted with EtOAc (10 mL), and washed with water (5 mL), and an aqueous solution

of $Na_2S_2O_3·5H_2O$ (1 M; 1 mL). The organic phase was washed with brine (5 mL), dried ($MgSO_4$), and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (EtOAc/cyclohexane, 2:8, then 1:1) to give diol **10** (142 mg, 99%) as a colourless oil. $[\alpha]_D^{20}$ = +20.15 (*c* = 1.29, $CHCl_3$). HRMS (ESI): calcd. for $C_{12}H_{28}O_3SiNa$ $[M + Na]^+$ 271.1700; found 271.1724. ^1H NMR (500 MHz, $CDCl_3$): δ = 3.85 (m, 2 H, 1-H), 3.79 (m, 1 H, 3-H), 3.69 (AB part of an ABX system, $J_{5a,5b}$ = 10.0, $J_{5a,4}$ = 8.5, $J_{5b,4}$ = 4.0 Hz, $\Delta\nu$ = 86.3 Hz, 2 H, 5-H), 1.78 (m, 1 H, 4-H), 1.72 (m, 2 H, 2-H), 0.90 (s, 9 H, *t*Bu-Si), 0.82 (d, *J* = 7.0 Hz, 3 H, Me), 0.08 (s, 6 H, Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 78.0 (CH-3), 68.9 (CH_2-5), 61.7 (CH_2-1), 39.7 (CH-4), 36.2 (CH_2-2), 25.8 [C(CH_3)$_3$Si], 18.1 [*C*(Me)$_3$Si], 13.3 (Me), –5.6 (MeSi), –5.7 (MeSi) ppm.

***tert*-Butyl{(2*S*)-2-[(4*R*)-2-(4-methoxyphenyl)-1,3-dioxan-4-yl]propoxy}dimethylsilane (11):** Camphorsulfonic acid (6.3 mg, 0.06 equiv.) and *p*-methoxybenzaldehyde dimethyl acetal (90 μL, 1.17 equiv.) were added to a solution of diol **10** (104.9 mg, 0.422 mmol) in CH_2Cl_2 (5 mL) containing anhydrous Na_2SO_4 (175 mg). The mixture was stirred for 3 h at room temperature, then it was diluted with CH_2Cl_2 (5 mL), and quenched with saturated aqueous $NaHCO_3$ (1 mL) and water (5 mL). The organic layer was washed with water (2× 5 mL), brine (4 mL), dried ($MgSO_4$), filtered, and concentrated in vacuo. The residue was purified by silica gel column chromatography (EtOAc/cyclohexane, 2:8) to give **11** (130 mg, 91%) as a colourless oil. $[\alpha]_D^{20}$ = –31.4 (*c* = 1.05, $CHCl_3$). HRMS (ESI): calcd. for $C_{20}H_{34}O_4SiNa$ $[M + Na]^+$ 389.2119; found 389.2092. ^1H NMR (400 MHz, $CDCl_3$): δ = 7.41 and 6.88 (AA′BB′, *J* = 8.8 Hz, $\Delta\nu$ = 210.3 Hz, 4 H, PMP), 5.44 (s, 1 H, H acetal), 4.27 (ddd, $J_{1eq,1ax}$ = 11.4, $J_{1eq,2ax}$ = 5.0, $J_{1eq,2eq}$ = 1.4 Hz, 1 H, 1eq-H), 3.92 (ddd, $J_{1ax,2ax}$ = 12.4, $J_{1ax,1eq}$ = 11.5, $J_{1ax,2eq}$ = 2.6 Hz, 1 H, 1ax-H), 3.80 (s, 3 H, OMe), 3.79 (m, 1 H, 3-H), 3.66 (AB part of an ABX system, $J_{5a,5b}$ = 9.8, $J_{5a,4}$ = 5.4, $J_{5b,4}$ = 4.6 Hz, $\Delta\nu$ = 19.4 Hz, 2 H, 5-H), 1.85 (m, 1 H, 4-H), 1.80 (m, 1 H, 2ax-H), 1.52 (m, 1 H, 2eq-H), 0.95 (d, *J* = 6.9 Hz, 3 H, Me-4), 0.90 (s, 9 H, *t*Bu-Si), 0.03 (s, 6 H, Me-Si) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 159.7 (Cq arom), 131.6 (Cq arom), 127.3 (CH arom), 113.5 (CH arom), 101.0 (CH acetal), 77.8 (CH-3), 67.1 (CH_2-1), 63.9 (CH_2-5), 55.3 (OMe), 40.5 (CH-4), 28.2 (CH_2-2), 25.9 [C(CH_3)$_3$Si], 18.3 [*C*(Me)$_3$Si], 12.3 (Me-4), –5.4 (2 MeSi) ppm.

(2*S*)-2-[(4*R*)-2-(4-Methoxyphenyl)-1,3-dioxan-4-yl]propan-1-ol (12):[16] A solution of TBAF (tetrabutylammonium fluoride; 1 M THF solution; 0.31 mL, 1.13 equiv.) was added dropwise to a stirred solution of silylated alcohol **11** (100.1 mg, 0.273 mmol) in dry THF (4 mL) at 0 °C. The mixture was stirred at room temp. for 3 h, then it was quenched by the successive addition of water (5 mL) and saturated aqueous $NaHCO_3$ (1 mL), and diluted with EtOAc (5 mL). The phases were separated, the aqueous layer was extracted with EtOAc (5 mL), and the combined organic extracts were washed with water (2× 10 mL), and brine (4 mL), dried ($MgSO_4$), filtered, and concentrated in vacuo. The residue was purified by silica gel column chromatography (EtOAc) to give alcohol **12** (63 mg, 92%) as a colourless oil. ^1H NMR (500 MHz, $CDCl_3$): δ = 7.38 and 6.89 (AA′BB′, *J* = 8.7 Hz, $\Delta\nu$ = 253.5 Hz, 4 H, PMP), 5.47 (s, 1 H, acetal), 4.28 (ddd, *J* = 11.5, *J* = 5.0, *J* = 1.4 Hz, 1 H, 1eq-H), 3.95 (ddd, *J* = 12.4, *J* = 11.5, *J* = 2.6 Hz, 1 H, 1ax-H), 3.80 (s, 3 H, OMe), 3.79 (m, 1 H, 3-H), 3.68 (dd, *J* = 5.8, *J* = 5.0 Hz, 2 H, 5-H), 2.53 (dd, *J* = 6.2, *J* = 5.4 Hz, 1 H, OH), 1.92 (m, 1 H, 4-H), 1.88 (m, 1 H, 2eq-H), 1.59 (m, 1 H, 2ax-H), 0.93 (d, *J* = 7.0 Hz, 3 H, Me-4) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 160.0 (Cq arom), 130.9 (Cq arom), 127.3 (CH arom), 113.7 (CH arom), 101.2 (CH acetal), 82.0 (CH-3), 67.0 (CH_2-5), 66.8 (CH_2-1), 55.3 (OMe), 40.4 (CH-4), 29.4 (CH_2-2), 12.8 (Me-4) ppm.

(*S*)-3-Methyl-1-(*p*-tolylsulfinyl)but-3-en-2-one (*ent*-2): A solution of (–)-methyl *p*-tolyl sulfoxide (*ent*-**1**; 4.1777 g, 0.0270 mol) in dry THF (15 mL) was added by cannula to a stirred solution of LDA (1.2 equiv.) [freshly prepared from diisopropylamine (5 mL, 1.32 equiv.) and *n*BuLi (in THF; 38 mL, 1.24 equiv.)] at –70 °C. The mixture was stirred for 55 min at the same temperature, then neat ethyl methacrylate (1.8 mL, 0.53 equiv.) was added dropwise to the resulting lithium anion of methyl *p*-tolyl sulfoxide. The mixture was stirred for 1.5 h, during which time the temperature was allowed to rise to –25 °C. The resulting milky solution was then quenched with saturated aqueous NH_4Cl solution (10 mL), and the aqueous phase was acidified at room temperature with HCl (20% aq.; 30 mL) to pH 2. The organic layer was diluted with EtOAc (20 mL), washed with water (3× 50 mL) and brine (20 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure to leave a pale yellow oil. The crude product was purified by silica gel column chromatography (EtOAc/cyclohexane, 7:3) to give keto sulfoxide *ent*-**2** (3.14 g, 99%) as a pale yellow oil. $[\alpha]_D^{20}$ = –213 (*c* = 3.3, $CHCl_3$). $C_{12}H_{14}O_2Si$ (222.303): calcd. C 64.83, H 6.35; found C 64.96, H 6.31. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.52 and 7.29 (AA′BB′, *J* = 7.9 Hz, $\Delta\nu$ = 69.4 Hz, 4 H, *p*Tol), 5.93 (q, $J_{4c,Me}$ = 0.5 Hz, 1 H, 4c-H), 5.91 (q, $J_{4t,Me}$ = 1.5 Hz, 1 H, 4t-H), 4.26 and 3.97 (AB system, J_{AB} = 13.9 Hz, $\Delta\nu$ = 86.1 Hz, 2 H, 1-H), 2.38 (s, 3 H, Me of *p*Tol), 1.80 (br. s, 3 H, Me) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 192.6 (CO), 144.5 (Cq-3), 142.0 (Cq arom), 139.9 (Cq arom), 129.9 (CH arom), 128.6 (CH_2-4), 124.1 (CH arom), 65.0 (CH_2-1), 21.3 (Me of *p*Tol), 17.1 (Me) ppm.

(*R*)-3-Methyl-1-[(*S*)-*p*-tolylsulfinyl]but-3-en-2-ol (*ent*-3): DiBAL-H (1 M solution in PhMe; 9.3 mL, 1.23 equiv.) was added dropwise to a solution of keto sulfoxide *ent*-**2** (1.685 g, 0.00757 mol) in THF (35 mL) at –78 °C. The reaction mixture was stirred for 1 h, during which time the temperature was allowed to reach –45 °C, then it was quenched carefully with MeOH (2 mL), and diluted with EtOAc (25 mL). The gelatinous mixture was acidified at ambient temperature with HCl (20% aq.; 10 mL) to pH 2–3. The aqueous layer was extracted with EtOAc (15 mL). The combined organic extracts were washed with water (3× 40 mL), and brine (5 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure to give a lemon-yellow viscous oil. The crude product was purified by silica gel column chromatography (diethyl ether/CH_2Cl_2, 1:1) to give alcohol *ent*-**3** (1.30 g, 76%), which crystallised on standing as a white solid, m.p. 80–81 °C. $[\alpha]_D^{20}$ = –278.7 (*c* = 1.08, $CHCl_3$). $C_{12}H_{14}O_2Si$ (222.303): calcd. C 64.25, H 7.19; found C 64.02, H 7.13. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.53 and 7.33 (AA′BB′, *J* = 8.1 Hz, $\Delta\nu$ = 59.7 Hz, 4 H, *p*Tol), 5.06 (br. s, 1 H, 4t-H), 4.87 (br. s, 1 H, 4c-H), 4.60 (m, X part of ABX system, 1 H, 2-H), 4.17 (d, $J_{OH,2}$ = 1.5 Hz, 1 H, OH), 2.89 (AB part of an ABX system, $J_{1a,1b}$ = 13.2, $J_{1a,2}$ = 10.2, $J_{1b,2}$ = 2.1 Hz, $\Delta\nu$ = 49.1 Hz, 2 H, 1-H), 2.40 (s, 3 H, Me of *p*Tol), 1.68 (br. s, 3 H, Me) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 144.9 (Cq-3), 141.6 (Cq arom), 139.7 (Cq arom), 130.0 (CH arom), 123.9 (CH arom), 112.0 (CH_2-4), 69.7 (CH-2), 61.4 (CH_2-1), 21.3 (Me of *p*Tol), 18.1 (Me) ppm.

(2*R*,3*R*)-2-Methyl-4-[(*S*)-*p*-tolylsulfinyl]butane-1,3-diol (*ent*-4): 9-BBN (0.5 M solution in THF; 3.3 mL, 2.45 equiv.) was added dropwise to a cold (0 °C) solution of sulfoxide *ent*-**3** (151 mg, 0.673 mmol) in anhydrous THF (4 mL). The ice bath was removed after 10 min, and the mixture was stirred at ambient temperature for 3 h. The reaction mixture was then treated sequentially at 0 °C with the dropwise addition of NaOH (3 M aq.; 2 mL), H_2O_2 (30% aq.; 2 mL), and saturated aqueous NaCl (2 mL). The mixture was stirred at room temperature for 4 h, and then it was diluted with EtOAc (10 mL). An aqueous solution of $Na_2S_2O_3·5H_2O$ (2 M;

1 mL) was carefully added, and the organic layer was washed with brine (4 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure. The resulting viscous oil was purified by silica gel column chromatography (diethyl ether, then EtOAc, and then EtOAc/acetone, 3:1) to give *ent*-**4** and other isomers (117 mg, 71.7%) as a translucent oil that solidified as a white solid. At this stage, due to the close R_f values, we failed to isolate the pure diastereomer *ent*-**4**. However, it was separated from the other isomers as its dioxane derivative *ent*-**4a** (see below).

The mixture of sulfoxides (605 mg, 0.00249 mmol) was dissolved in acetone (3 mL) and 2,2-dimethoxypropane (DMP; 7 mL), and a catalytic amount of of *p*-toluenesulfonic acid (10.6 mg; *p*TsOH) was added. The mixture was stirred at room temperature for 3 h. The solvents were evaporated in vacuo, and the residue was diluted with EtOAc (20 mL). The organic extract was washed with water (3× 5 mL), dried with Na_2SO_4, filtered and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (diethyl ether) to give pure acetonide *ent*-**4a** (613 mg, 87%) as a colourless oil. $[\alpha]_D^{20}$ = –192.2 (*c* = 1.5, $CHCl_3$). HRMS (ESI): calcd. for $C_{15}H_{22}O_3SNa$ $[M + Na]^+$ 305.1182; found 305.1172. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.54 and 7.31 (AA′BB′, *J* = 8.1 Hz, $\Delta\nu$ = 67.0 Hz, 4 H, *p*Tol), 4.11 (ddd, *J* = 10.4, *J* = 10.4, *J* = 2.1 Hz, 1 H, 2-H), 3.65 (AB part of an ABX system, $J_{4a,4b}$ = 11.7, $J_{4a,3}$ = 11.1, $J_{4b,3}$ = 5.1 Hz, $\Delta\nu$ = 35.8 Hz, 2 H, 4-H), 2.79 (AB part of an ABX system, $J_{1a,1b}$ = 12.9, $J_{1a,2}$ = 10.6, $J_{1b,2}$ = 2.1 Hz, $\Delta\nu$ = 67.3 Hz, 2 H, 1-H), 2.40 (s, 3 H, Me of *p*Tol), 1.77–1.62 (m, 1 H, 3-H), 1.53 (s, 3 H, Me ax of acetonide), 1.44 (s, 3 H, Me eq of acetonide), 0.75 (d, *J* = 6.9 Hz, 3 H, Me-3) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 141.7 (Cq arom), 141.2 (Cq arom), 129.9 (CH arom), 123.8 (CH arom), 98.9 (Cq, acetonide), 69.4 (CH-2), 65.8 (CH_2-4), 63.0 (CH_2-1), 34.0 (CH-3), 29.5 (Me eq of acetonide), 21.3 (Me of *p*Tol), 19.1 (Me ax of acetonide), 12.2 (Me-3) ppm.

Deprotection of Acetonide *ent*-4a: Amberlyst 15 (718 mg) was added to a solution of acetonide *ent*-**4a** (598.9 mg, 2.12 mmol) in MeOH (15 mL). The mixture was stirred at room temperature for 14 h. It was filtered through a short pad of Celite, which was then rinsed with EtOAc (3× 10 mL). The filtrate was concentrated in vacuo. The crude product was purified by silica gel column chromatography (EtOAc) to give free diol *ent*-**4** (421 mg, 82%) as a white solid, m.p. 124 °C. $[\alpha]_D^{20}$ = –307.1 (*c* = 1.04, $CHCl_3$). $C_{12}H_{15}O_3S$ (242.334): calcd. C 59.47, H 7.49; found C 58.23, H 7.43. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.52 and 7.35 (AA′BB′, *J* = 8.2 Hz, $\Delta\nu$ = 50.3 Hz, 4 H, *p*Tol), 4.85 (d, *J* = 3.4 Hz, 1 H, 2-OH), 4.14 (m, X part of ABX system, 1 H, 2-H), 3.76 (m, 1 H, 4a-H), 3.59 (m, 1 H, 4b-H), 3.22 (m, 1 H, 4-OH), 2.94 (AB part of an ABX system, $J_{1a,1b}$ = 13.3, $J_{1a,2}$ = 10.2, $J_{1b,2}$ = 2.0 Hz, $\Delta\nu$ = 62.0 Hz, 2 H, 1-H), 2.43 (s, 3 H, Me of *p*Tol), 1.79 (m, 1 H, 3-H), 0.81 (d, *J* = 7.0 Hz, 3 H, Me-3) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 141.7 (Cq arom), 139.2 (Cq arom), 130.1 (CH arom), 124.0 (CH arom), 70.8 (CH-2), 66.2 (CH_2-4), 60.4 (CH_2-1), 40.4 (CH-3), 21.4 (Me of *p*Tol), 13.4 (Me-3) ppm.

(2*R*,3*R*)-4-(*tert*-Butyldimethylsilyloxy)-3-methyl-1-[(*S*)-*p*-tolylsulfinyl]butan-2-ol (*ent*-5): Imidazole (107 mg, 2.78 equiv.) and *tert*-butyldimethylsilyl chloride (104 mg, 1.22 equiv.) were added successively to a solution of diol *ent*-**4** (137 mg, 0.565 mmol) and anhydrous sodium sulfate (ca. 132 mg) in dry DMF (2.5 mL). The reaction mixture was stirred for 1 h, after which time TLC indicated that no starting material was remaining. The mixture was diluted with diethyl ether (10 mL) and water (10 mL). The mixture was stirred at ambient temperature for 1 h, then the two layers were separated. The aqueous phase was extracted with diethyl ether (10 mL), and the combined organic layers were washed with water (2× 10 mL), and brine (5 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (EtOAc) to give *ent*-**5** (186 mg, 92%) as a colourless liquid. $[\alpha]_D^{20}$ = –199.8 (*c* = 1.93, $CHCl_3$). $C_{18}H_{32}O_3SSi$ (356.595): calcd. C 60.63, H 9.05; found C 60.58, H 9.01. ^1H NMR (400 MHz, $CDCl_3$): δ = 7.54 and 7.32 (AA′BB′, *J* = 8.1 Hz, $\Delta\nu$ = 62.8 Hz, 4 H, *p*Tol), 4.44 (d, *J* = 2.6 Hz, 1 H, OH), 4.16 (m, 1 H, 2-H), 3.64 (AB part of an ABX system, $J_{4a,4b}$ = 10.3, $J_{4a,3}$ = 7.3, $J_{4b,3}$ = 4.2 Hz, $\Delta\nu$ = 25.1 Hz, 2 H, 4-H), 2.87 (AB part of an ABX system, $J_{1a,1b}$ = 13.2, $J_{1a,2}$ = 10.0, $J_{1b,2}$ = 2.2 Hz, $\Delta\nu$ = 25.2 Hz, 2 H, 1-H), 2.40 (s, 3 H, Me of *p*Tol), 1.78 (m, 1 H, 3-H), 0.86 (s, 9 H, *t*Bu-Si), 0.82 (d, *J* = 7.0 Hz, 3 H, Me-3), 0.04 (s, 3 H, Me-Si), 0.03 (s, 3 H, Me-Si) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.3 (Cq arom), 140.7 (Cq arom), 129.9 (CH arom), 123.9 (CH arom), 70.5 (CH-2), 67.1 (CH_2-4), 62.4 (CH_2-1), 40.1 (CH-3), 25.8 [C(CH_3)$_3$Si], 21.4 (Me of *p*Tol), 18.1 [*C*(Me)$_3$Si], 13.0 (Me-3), –5.6 (2 MeSi) ppm.

(2*R*,3*R*)-4-(*tert*-Butyldimethylsilyloxy)-3-methyl-1-[(*S*)-*p*-tolylsulfinyl]butan-2-yl Acetate (*ent*-6): A catalytic amount of DMAP (8 mg) and then acetic anhydride (130 μL, 2.78 equiv.) and triethylamine (250 μL, 3.64 equiv.) were added successively to a solution of sulfoxide *ent*-**5** (176 mg, 0.493 mmol) in CH_2Cl_2 (6.5 mL). The reaction mixture was stirred at room temp. for 15 h, then it was diluted with CH_2Cl_2 (10 mL) and water (10 mL), and the mixture was stirred for 15 min at room temperature. The organic layer was washed with water (2× 10 mL), dried with Na_2SO_4, filtered, and concentrated under reduced pressure. The oily residue was purified by silica gel column chromatography (EtOAc/cyclohexane, 1:1) to give *ent*-**6** (178 mg, 90%) as a white solid, m.p. 58 °C. $[\alpha]_D^{20}$ = –133.3 (*c* = 1.55, $CHCl_3$). $C_{20}H_{34}O_4SSi$ (398.632): calcd. C 60.26, H 8.60; found C 60.13, H 8.47. ^1H NMR (400 MHz, $CDCl_3$): δ = 7.51 and 7.30 (AA′BB′, *J* = 8.2 Hz, $\Delta\nu$ = 63.4 Hz, 4 H, *p*Tol), 5.39 (m, 1 H, 2-H), 3.53 (m, 2 H, 4-H), 3.02 (AB part of an ABX system, $J_{1a,1b}$ = 13.8, $J_{1a,2}$ = 9.6, $J_{1b,2}$ = 2.7 Hz, $\Delta\nu$ = 32.8 Hz, 2 H, 1-H), 2.40 (s, 3 H, Me of *p*Tol), 2.08 (m, 1 H, 3-H), 2.04 (s, 3 H, AcO), 0.88 (d, *J* = 7.0 Hz, 3 H, Me-3), 0.81 (s, 9 H, *t*Bu-Si), –0.002 (s, 6 H, 2 Me-Si) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 169.9 (CO), 141.5 (Cq arom), 141.2 (Cq arom), 129.9 (CH arom), 124.0 (CH arom), 70.0 (CH-2), 64.2 (CH_2-4), 60.8 (CH_2-1), 39.0 (CH-3), 25.8 [C(CH_3)$_3$Si], 21.4 (Me of *p*Tol), 20.9 (Me, AcO), 18.1 [*C*(Me)$_3$Si], 12.3 (Me-3), –5.5 (MeSi), –5.6 (MeSi) ppm.

(2*R*,3*R*)-4-(*tert*-Butyldimethylsilyloxy)-3-methyl-1-oxobutan-2-yl Acetate (*ent*-7): Triethylamine (140 μL, 3.2 equiv.) and trifluoroacetic anhydride (140 μL, 3.1 equiv.) were successively added to a solution of sulfoxide *ent*-**6** (125.8 mg, 0.315 mmol) in CH_2Cl_2 (3.2 mL) at 0 °C. The mixture was stirred at the same temperature for 25 min, then it was treated with $NaHCO_3$ (0.5 M aq.; 3.2 mL, 5 equiv.). The mixture was left at ambient temperature for 2 h, and then it was diluted with water (10 mL) and CH_2Cl_2 (5 mL). The organic layer was washed with water (3× 15 mL), and brine (4 mL), dried ($MgSO_4$), filtered, and concentrated under reduced pressure. The crude yellow oil was purified by column chromatography on silica gel (CH_2Cl_2) to give aldehyde *ent*-**7** (69 mg, 80%) as a colourless oil. $[\alpha]_D^{20}$ = –8.8 (*c* = 1.17, $CHCl_3$). HRMS (ESI): calcd. for $C_{13}H_{26}O_4SiNa$ $[M + Na]^+$ 297.1493; found 297.1528. ^1H NMR (500 MHz, $CDCl_3$): δ = 9.49 (s, 1 H, CHO), 4.97 (d, *J* = 3.2 Hz, 1 H, 2-H), 3.56 (AB of a degenerated ABX system, 2 H, 4-H), 2.48 (m, 1 H, 3-H), 2.19 (s, 3 H, AcO), 0.97 (d, *J* = 7.0 Hz, 3 H, Me-3), 0.87 (s, 9 H, *t*Bu-Si), 0.03 (s, 6 H, 2 Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 197.7 (CHO), 170.6 (AcO), 79.9 (CH-2), 63.6 (CH_2-4), 38.2 (CH-3), 25.7 [C(CH_3)$_3$Si], 20.5 (MeCO), 18.3 [*C*(Me)$_3$Si], 13.2 (Me-3), –5.6 (MeSi), –5.7 (MeSi) ppm.

(4*R*)-4-[(*R*)-1-Iodopropan-2-yl]-2-(4-methoxyphenyl)-1,3-dioxane (13): A solution of iodine (113.3 mg, 1.33 equiv.) in THF (1.5 mL) was added dropwise to a chilled (0 °C) solution of alcohol **12** (84.3 mg, 0.335 mmol), containing imidazole (68.2 mg, 2.98 equiv.) and triphenylphosphine (120.6 mg, 1.37 equiv.) in dry THF (5 mL). After 10 min, the slightly yellow mixture removed from the cooling bath. The mixture was stirred for 1 h 45 min at ambient temperature, during which time a white precipitate formed. The reaction was quenched by the addition of $Na_2S_2O_3{\cdot}5H_2O$ (1 M aq.; 1 mL), followed saturated aqueous $NaHCO_3$ (2 mL). The mixture was diluted with water (5 mL) and EtOAc (10 mL). The aqueous layer was extracted with EtOAc (5 mL), and the combined organic layers were washed with water (2× 5 mL), and brine (5 mL), dried ($MgSO_4$), filtered, and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (EtOAc/cyclohexane, 1:1) to give **13** (111 mg, 91%) as a viscous colourless oil. $[\alpha]_D^{20}$ = –67.01 (*c* = 1.54, $CHCl_3$). HRMS (ESI): calcd. for $C_{14}H_{19}IO_3Na$ $[M + Na]^+$ 385.0271; found 385.0263. ^1H NMR (500 MHz, $CDCl_3$): δ = 7.41 and 6.89 (AA′BB′, *J* = 9.0 Hz, $\Delta\nu$ = 260 Hz, 4 H, PMP), 5.47 (s, 1 H, acetal), 4.29 (ddd, *J* = 11.5, *J* = 5.0, *J* = 1.4 Hz, 1 H, 1a-H), 3.96 (ddd, *J* = 12.3, *J* = 11.5, *J* = 2.7 Hz, 1 H, 1b-H), 3.80 (s, 3 H, OMe), 3.63 (ddd, *J* = 11.2, *J* = 8.4, *J* = 2.4 Hz, 1 H, 3-H), 3.44 (AB part of an ABX system, $J_{5a,5b}$ = 9.5, $J_{5a,4}$ = 5.5, $J_{5b,4}$ = 3.0 Hz, $\Delta\nu$ = 68.2 Hz, 2 H, 5-H), 1.81 (m, 1 H, 2a-H), 1.61 (m, 1 H, 2b-H), 1.51 (m, 1 H, 4-H), 0.99 (d, *J* = 6.7 Hz, 3 H, Me-4) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 159.8 (Cq arom), 131.1 (Cq arom), 127.2 (CH arom), 113.5 (CH arom), 100.9 (CH acetal), 79.6 (CH-3), 66.8 (CH_2-1), 55.3 (OMe), 38.7 (CH-4), 28.5 (CH_2-2), 16.4 (Me-4), 14.7 (CH_2-5) ppm.

{(*R*)-2-[(2*R*,4*R*)-2-(4-Methoxyphenyl)-1,3-dioxan-4-yl]propyl}-triphenylphosphonium Iodide (14): Iodide **13** (51.1 mg, 0.141 mmol), triphenylphosphine (251.2 mg, 6.8 equiv.), and solid $NaHCO_3$ (34.7 mg, 2.9 equiv.) were dissolved in dry MeCN (3 mL). The mixture was heated at 80 °C for 20 h, after which time the solvent was evaporated. CH_2Cl_2 (2 mL) was added, and the inorganics were removed by filtration through cotton wool. The solvent was evaporated again, and the residue was triturated with diethyl ether, the solvent was decanted (3× 4 mL), and the solid was collected by filtration. The resulting solid was purified by silica gel column chromatography (CH_2Cl_2 to CH_2Cl_2/MeOH, 20:1) to give phosphonium salt **14** (74 mg, 85%) as a white solid, m.p. 114 °C. $[\alpha]_D^{20}$ = +25.0 (*c* = 1.02, $CHCl_3$). HRMS (ESI): calcd. for $C_{32}H_{34}IO_3$ $[M + Na]^+$ 497.2240; found 497.2194. ^{31}P NMR (121 MHz, $CDCl_3$): δ = 23.1 ppm. ^1H NMR (500 MHz, $CDCl_3$): δ = 7.83 (m, 6 H, Ph), 7.74 (m, 3 H, Ph), 7.58 (m, 6 H, Ph), 7.45 and 6.90 (AA′BB′, *J* = 8.7 Hz, $\Delta\nu$ = 271 Hz, 4 H, PMP), 5.60 (s, 1 H, acetal), 4.22 (m, 1 H, 1a-H), 4.19 (m, 1 H, m, 1 H, 3-H), 3.98 (m, 1 H, 5a-H), 3.96 (m, 1 H, 1b-H), 3.84 (m, 1 H, 5b-H), 3.80 (s, 3 H, OMe), 2.06 (m, 1 H, 4-H), 1.72 (m, 1 H, 2a-H), 1.57 (m, 1 H, 2b-H), 0.72 (d, *J* = 6.9 Hz, 3 H, Me-4) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 159.9 (Cq arom), 134.9 (d, $J_{C,P}$ = 2.5 Hz, CH arom, P-Ph), 133.7 (d, $J_{C,P}$ = 10.0 Hz, CH arom, P-Ph), 131.1 (Cq arom, P-Ph), 130.3 (d, $J_{C,P}$ = 12.5 Hz, CH arom, P-Ph), 127.8 (Cq arom, PMP), 118.6 (d, $J_{C,P}$ = 85.8 Hz, Cq arom, P-Ph), 113.5 (Cq arom, PMP), 101.3 (CH acetal), 79.8 (d, $J_{C,P}$ = 12.4 Hz, CH-3), 66.5 (CH_2-1), 55.3 (OMe), 34.2 (d, $J_{C,P}$ = 2.9 Hz, CH-4), 28.9 (CH_2-2), 24.9 (d, $J_{C,P}$ = 51.0 Hz, CH_2-5), 16.0 (Me-4) ppm.

(2*R*,3*S*,6*S*,*Z*)-1-(*tert*-Butyldimethylsilyloxy)-6-[(2*R*,4*R*)-2-(4-methoxyphenyl)-1,3-dioxan-4-yl]-2-methylhept-4-en-3-yl Acetate (15): KHMDS (0.5 M solution in PhMe; 0.46 mL, 1.01 equiv.) was added dropwise to a solution of phosphonium salt **14** (141.6 mg, 0.226 mmol, 1.03 equiv.) in THF (4 mL) at 0 °C. The resulting homogeneous yellow solution was stirred at 0 °C for 0.5 h, and then at room temperature for 20 min. The reaction mixture was cooled to –65 °C, and a solution of aldehyde *ent*-**7** (60.2 mg, 1 equiv.) in THF (2 mL) was added slowly. The mixture was stirred 45 min at this temperature, and then for 5 h at ambient temperature, during which time a white precipitate was formed. The reaction was then quenched with a saturated solution of NH_4Cl (4 mL), and the mixture was diluted with water (8 mL) and EtOAc (15 mL), and acidified with HCl (10% aq.; 0.2 mL) to pH 5. The organic layer was washed with water (3× 8 mL), and brine (5 mL), dried ($MgSO_4$), filtered, and evaporated under reduced pressure. The crude orange oil was purified by silica gel column chromatography (diethyl ether/cyclohexane, 1:5) to give exclusively (*Z*)-olefin **15** (41 mg, 38%) as a colourless oil. $[\alpha]_D^{20}$ = +12.02 (*c* = 2.03, $CHCl_3$). HRMS (ESI): calcd. for $C_{27}H_{44}O_6SiNa$ $[M + Na]^+$ 515.2799; found 515.2740. ^1H NMR (400 MHz, $CDCl_3$): δ = 7.41 and 6.87 (AA′BB′, *J* = 8.6 Hz, $\Delta\nu$ = 213 Hz, 4 H, PMP), 5.68 (t app, 1 H, *J* = 10.8 Hz, 5-H vinyl), 5.55 (dd, *J* = 9.7, *J* = 7.4 Hz, 1 H, 7-H), 5.44 (s, 1 H, acetal), 5.35 (t app, *J* = 10.4 Hz, 1 H, 6-H vinyl), 4.21 (m, 1 H, 1a-H), 3.90 (m, 1 H, 1b-H), 3.80 (m, 4 H, 3-H, MeO), 3.49 (AB part of an ABX system, $J_{9a,9b}$ = 10.0, $J_{9a,8}$ = 6.0, $J_{9b,8}$ = 5.2 Hz, $\Delta\nu$ = 19.7 Hz, 2 H, 9-H), 2.91 (m, 1 H, 4-H), 2.00 (s, 3 H, AcO), 1.89 (m, 1 H, 8-H), 1.81 (m, 1 H, 2a-H), 1.39 (m, 1 H, 2b-H), 1.09 (d, *J* = 7.0 Hz, 3 H, Me-4), 0.89 (br. s, 12 H, *t*Bu-Si, Me-8), 0.03 (s, 6 H, Me-Si) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 169.8 (CO), 159.7 (Cq arom, PMP), 135.9 (CH-5 vinyl), 131.7 (Cq arom, PMP), 127.3 (CH arom, PMP), 126.5 (CH-6 vinyl), 113.4 (CH arom, PMP), 101.0 (CH acetal), 79.9 (CH-3), 71.2 (CH-7), 67.0 (CH_2-2), 64.2 (CH_2-9), 55.3 (OMe), 39.8 (CH-8), 36.8 (CH-4), 28.4 (CH_2-2), 25.8 [C(CH_3)$_3$Si], 21.2 (OAc), 18.2 [*C*(Me)$_3$Si], 17.1 (Me-4), 12.7 (Me-8), –5.4 (MeSi), –5.5 (MeSi) ppm.

(2*R*,3*S*,6*S*,7*R*,*Z*)-1-(*tert*-Butyldimethylsilyloxy)-9-hydroxy-7-(4-methoxybenzyloxy)-2,6-dimethylnon-4-en-3-yl Acetate (16): DiBAL-H (1 M in cyclohexane; 0.9 mL, 11.0 equiv.) was added dropwise to a chilled (0 °C) solution of compound **15** (40.5 mg, 0.0821 mmol) in dry CH_2Cl_2 (3 mL). The reaction mixture was stirred at 0 °C for 2 h, and after this time it was carefully quenched with MeOH (0.2 mL) and saturated aqueous K,Na tartrate (Rochelle salt; 3 mL). The mixture was stirred for 1 h at ambient temperature, and then it was diluted with water (10 mL), CH_2Cl_2 (8 mL), and HCl (10% aq.; 0.6 mL) to reach pH 5–6. The organic phase was separated, and concentrated to remove the MeOH. The residue was diluted with diethyl ether (10 mL), and this solution was washed with water (3× 5 mL), and brine (4 mL), dried ($MgSO_4$), filtered and evaporated under reduced pressure. The crude oil was purified by silica gel column chromatography (EtOAc/cyclohexane, 1:1) to give diol **16** (21 mg, 58%) as a colourless oil. $[\alpha]_D^{20}$ = +13.86 (*c* = 2.14, $CHCl_3$). HRMS (ESI): calcd. for $C_{25}H_{44}O_5SiNa$ $[M + Na]^+$ 475.2850; found 475.2799. ^1H NMR (400 MHz, $CDCl_3$): δ = 7.28 and 6.87 (AA′BB′, *J* = 8.8 Hz, $\Delta\nu$ = 162 Hz, 4 H, PMB), 5.44 (m, 2 H, 5-H and 6-H vinyl), 4.56 and 4.47 (AB system, *J* = 11.2 Hz, $\Delta\nu$ = 29.6 Hz, 2 H, CH_2-PMB), 4.29 (t app, *J* = 7.9 Hz, 1 H, 7-H), 3.80 (s, 3 H, MeO), 3.74 (m, 1 H, 9a-H), 3.71 (m, 2 H, 1-H), 3.62 (m, 1 H, 9b-H), 3.53 (m, 1 H, 3-H), 2.94 (m, 1 H, 4-H), 1.76 (m, 3 H, 2-H and 8-H), 1.00 (d, *J* = 6.7 Hz, 3 H, Me-4), 0.89 (s, 9 H, *t*Bu-Si), 0.80 (d, *J* = 7.0 Hz, 3 H, Me-8), 0.08 (s, 6 H, Me-Si) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 159.3 (Cq arom, PMB), 134.8 (CH-5 vinyl), 131.8 (CH-6 vinyl), 130.4 (Cq arom, PMB), 129.6 (CH arom, PMB), 113.8 (CH arom, PMB), 81.6 (CH-3), 71.8 (CH-7), 71.7 (CH_2-PMP), 67.7 (CH_2-9), 60.8 (CH_2-1), 55.2 (OMe), 40.3 (CH-8), 35.2 (CH-4), 33.0 (CH_2-2), 25.8 [C(CH_3)$_3$Si], 18.1 [*C*(Me)$_3$Si], 16.0 (Me-4), 13.1 (Me-8), –5.5 (MeSi), –5.6 (MeSi) ppm.

(3*R*,4*S*,7*S*,8*R*,*Z*)-9-(*tert*-Butyldimethylsilyloxy)-7-hydroxy-3-(4-methoxybenzyloxy)-4,8-dimethylnon-5-enal (17) and (3*R*,4*S*,7*S*,

8*R*,*Z*)-9-(*tert*-Butyldimethylsilyloxy)-7-hydroxy-3-(4-methoxybenzyloxy)-4,8-dimethylnon-5-enoic Acid (18): BAIB (42.1 mg, 7.4 equiv.), TEMPO (5.4 mg, 1.9 equiv.), and water (0.5 mL) were added successively to a solution of diol **16** (8 mg, 0.0176 mmol) in CH_2Cl_2 (1 mL). The mixture was stirred vigorously for 44 h at room temperature. The reaction was then quenched with aqueous $Na_2S_2O_3{\cdot}5H_2O$ (1 M; 0.3 mL), and the mixture was diluted with water (2 mL) and diethyl ether (5 mL). The organic layer was washed with a mixture of saturated aqueous $NaHCO_3$ (0.3 mL) and water (3 mL), then with water (2× 3 mL), and brine (4 mL). It was dried with $MgSO_4$, filtered, and concentrated under reduced pressure. The resulting orange liquid was purified by preparative thin-layer chromatography (EtOAc/cyclohexane, 1:3) to give aldehyde **17** (2.8 mg, 35%), and acid **18** (2.6 mg, 31%). Compound **18** is described in the next section. Data for aldehyde **17**: $[\alpha]_D^{20}$ = +15.67 (*c* = 0.37, $CHCl_3$). HRMS (ESI): calcd. for $C_{25}H_{42}O_5SiNa$ [M + Na]$^+$ 473.2694; found 473.2651. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 9.75 (t, *J* = 1.9 Hz, 1 H, CHO), 7.25 and 6.86 (AA′BB′, *J* = 8.8 Hz, $\Delta\nu$ = 192 Hz, 4 H, PMB), 5.49 (dd, *J* = 11.1, *J* = 6.9 Hz, 1 H, 6-H vinyl), 5.40 (dd, *J* = 10.7, *J* = 10.3 Hz, 1 H, 5-H vinyl), 4.50 (s, 2 H, CH_2-PMB), 4.21 (t app, *J* = 8.5 Hz, 1 H, 7-H), 3.89 (m, 1 H, 3-H), 3.80 (s, 3 H, MeO), 3.67 (AB part of an ABX system, $J_{9a,9b}$ = 10.2, $J_{9a,8}$ = 8.0, $J_{9b,8}$ = 4.7 Hz, $\Delta\nu$ = 58.7 Hz, 2 H, 9-H), 2.84 (m, 1 H, 4-H), 2.63 (m, 2 H, 2-H), 1.74 (m, 1 H, 8-H), 1.01 (d, *J* = 6.7 Hz, 3 H, Me-4), 0.90 (s, 9 H, *t*Bu-Si), 0.77 (d, *J* = 6.9 Hz, 3 H, Me-8), 0.08 (s, 6 H, Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 201.9 (CHO), 159.2 (Cq arom, PMB), 133.3 (CH-5 vinyl), 132.6 (CH-6 vinyl), 130.2 (Cq arom, PMB), 129.5 (CH arom, PMB), 113.7 (CH arom, PMB), 77.1 (CH-3), 71.9 (CH_2-PMB), 71.8 (CH-7), 67.8 (CH_2-9), 55.2 (OMe), 45.9 (CH_2-2), 40.1 (CH-8), 35.7 (CH-4), 25.8 [C(CH_3)$_3$Si], 18.1 [*C*(Me)$_3$Si], 16.5 (Me-4), 13.1 (Me-8), –5.5 (MeSi), –5.6 (MeSi) ppm.

(3*R*,4*S*,7*S*,8*R*,*Z*)-9-(*tert*-Butyldimethylsilyloxy)-7-hydroxy-3-(4-methoxybenzyloxy)-4,8-dimethylnon-5-enoic Acid (18): A premixed solution of $NaClO_2$ (41.2 mg, 29 equiv.) and $NaH_2PO_4{\cdot}H_2O$ (28.5 mg, 13 equiv.) in distilled water (0.9 mL) was added to a vigorously stirred solution of *t*BuOH (3.2 mL) and amylene (1.3 mL). The mixture was stirred for 15 min at ambient temperature, and then it was added to neat aldehyde **17** (7.1 mg, 0.0157 mmol). The reaction was run for 1 h at room temperature, after which time TLC indicated the disappearance of the aldehyde. Water (2 mL) and EtOAc (5 mL) were added, and the aqueous layer was extracted with EtOAc (5 mL). The combined organic layers were evaporated to remove the *t*BuOH. The residue was diluted with EtOAc (6 mL), and the organic phase was washed with water (4 mL), and brine (4 mL), dried with $MgSO_4$, filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (EtOAc/cyclohexane, 1:1) to give acid **18** (3.6 mg, 49%). ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.27 and 6.87 (AA′BB′, *J* = 8.7 Hz, $\Delta\nu$ = 200 Hz, 4 H, PMB), 5.51 (m, 2 H, 2 H, 5-H and 6-H vinyl), 4.58 and 4.46 (AB system, *J* = 11.0 Hz, $\Delta\nu$ = 54.9 Hz, 2 H, CH_2-PMB), 4.24 (t app, *J* = 8.2 Hz, 1 H, 7-H), 3.80 (s, 3 H, MeO), 3.79 (m, 1 H, 3-H), 3.69 (AB part of an ABX system, $J_{9a,9b}$ = 10.2, $J_{9a,8}$ = 8.2, $J_{9b,8}$ = 4.2 Hz, $\Delta\nu$ = 58.9 Hz, 2 H, 9-H), 2.76 (m, 1 H, 4-H), 2.60 (AB part of an ABX system, $J_{2a,2b}$ = 14.2, $J_{2a,3}$ = 7.5, $J_{2b,3}$ = 5.5 Hz, $\Delta\nu$ = 28.7 Hz, 2 H, 2-H), 1.81 (m, 1 H, 8-H), 1.03 (d, *J* = 6.7 Hz, 3 H, Me-4), 0.89 (s, 9 H, *t*Bu-Si), 0.76 (d, *J* = 7.0 Hz, 3 H, Me-8), 0.09 (s, 6 H, Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 173.5 (COOH), 159.2 (Cq arom, PMB), 134.2 (CH-5 or CH-6 vinyl), 131.7 (CH-5 or CH-6 vinyl), 130.0 (Cq arom, PMB), 129.5 (CH arom, PMB), 113.7 (CH arom, PMB), 79.6 (CH-3), 72.4 (CH-7), 71.9 (CH_2-PMB), 68.4 (CH_2-9), 55.2 (OMe), 39.6 (CH-8), 37.8 (CH_2-2), 36.1 (CH-4), 29.7 (grease), 25.8 [C(CH_3)$_3$Si], 18.0 [*C*(Me)$_3$Si], 17.3 (Me-4), 12.9 (Me-8), –5.6 (MeSi) ppm.

(4*R*,5*S*,8*S*,*Z*)-8-[(*R*)-1-(*tert*-Butyldimethylsilyloxy)propan-2-yl]-4-(4-methoxybenzyloxy)-5-methyl-3,4,5,8-tetrahydro-2*H*-oxocin-2-one (19): Et_3N (8 μL, 10.4 equiv.) and 2,4,6-trichlorobenzoyl chloride (9 μL, 10.4 equiv.) were added to a stirred solution of acid **18** (2.6 mg, 0.0055 mmol) in dry toluene (0.5 mL). The mixture was stirred at ambient temperature for 5 h, during which time the solution became cloudy. Dry toluene (2 mL) was added, followed by a solution of DMAP (8.7 mg, 12.9 equiv.) in dry toluene (1 mL). The mixture was stirred for 17 h at room temperature. EtOAc (10 mL), saturated aqueous $NaHCO_3$ (2 mL), and water (5 mL) were sequentially added to the resulting milky reaction mixture. The organic layer was washed with water (2× 5 mL), and brine (4 mL), dried with $MgSO_4$, filtered, and concentrated under reduced pressure to leave a yellow solid. The residue was purified by thin-layer chromatography (EtOAc/cyclohexane, 1:3) to give lactone **19** (1.3 mg, 52%). $[\alpha]_D^{20}$ = –31.9 (*c* = 0.13, $CHCl_3$). HRMS (ESI): calcd. for $C_{25}H_{40}O_5SiNa$ [M + Na]$^+$ 471.2537; found 471.2532. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.29 and 6.87 (AA′BB′, *J* = 8.5 Hz, $\Delta\nu$ = 210 Hz, 4 H, PMB), 4.95 (t app, *J* = 10.5 Hz, 1 H, 6-H), 5.54 (dd, *J* = 10.6, *J* = 6.4 Hz, 1 H, 5-H), 4.95 (t app, *J* = 9.2 Hz, 1 H, 7-H), 4.83 and 4.41 (AB system, *J* = 11.5 Hz, $\Delta\nu$ = 207 Hz, 2 H, CH_2-PMB), 3.81–3.78 (m, 1 H, 9a-H), 3.80 (s, 3 H, MeO), 3.64 (d, *J* = 7.3 Hz, 1 H, 3-H), 3.47 (dd, *J* = 9.8, *J* = 3.8 Hz, 1 H, 9b-H), 3.26 (dd, *J* = 13.4, *J* = 7.4 Hz, 1 H, 2a-H), 2.75 (d, *J* = 13.4 Hz, 1 H, 2b-H), 269 (m, 1 H, 4-H), 2.07 (m, 1 H, 8-H), 1.17 (d, *J* = 7.0 Hz, 3 H, Me-4), 0.93 (d, *J* = 7.0 Hz, 3 H, Me-8), 0.88 (s, 9 H, *t*Bu-Si), 0.03 (s, 3 H, Me-Si), 0.02 (s, 3 H, Me-Si) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 172.0 (CO ester), 159.2 (Cq arom, PMB), 138.7 (CH-5 vinyl), 129.9 (CH arom, PMB), 129.6 (CH-6 vinyl), 113.6 (CH arom, PMB), 75.9 (CH-3), 74.7 (CH-7), 70.3 (CH_2-PMB), 63.3 (CH_2-9), 55.2 (OMe), 38.7 (CH-8), 38.1 (CH-4), 37.7 (CH_2-2), 25.9 [C(CH_3)$_3$Si], 19.9 (Me-4), 18.2 [*C*(Me)$_3$Si], 12.6 (Me-8), –5.5 (MeSi), –5.6 (MeSi) ppm.

CCDC-1039716 (for **3**) and -1039717 (for **4**) contain the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

Supporting Information (see footnote on the first page of this article): Full NMR spectroscopic data and crystallographic data.

Acknowledgments

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