SUPPORTING INFORMATION

Diastereoselective Cyclopropanation of Chiral Allylic Alcohols with *gem*-Dizinc Carbenoids

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General: All non-aqueous reactions were run under argon atmosphere with rigid exclusion of moisture from reagents and glassware using standard techniques for manipulating air-sensitive compounds.¹ All glassware was stored in the oven and/or was flame-dried prior to use under argon. Anhydrous, oxygen-free solvents were obtained by filtration through drying columns. Flash column chromatography was performed using 230-400 mesh silica (Silicycle or Merck) of the indicated solvent system according to standard technique.² Infrared spectra were taken on a Perkin Elmer Spectrum One FTIR spectrometer and are reported in reciprocal centimeters (cm⁻¹). Nuclear magnetic resonance spectra (¹H, ¹³C, DEPT 135, COSY, NOESY) were recorded either on a Bruker AV300, AMX300, AV400, ARX400 or DMX600 spectrometer. Chemical shifts for ¹H NMR spectra are recorded in parts per million from tetramethylsilane with the solvent resonance as the internal standard (chloroform, δ 7.27 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, qn = quintet, sex = sextuplet, hept = heptuplet, oct = octuplet, m = multiplet and br = broad), coupling constant in Hz, integration and assignment. Chemical shifts for ¹³C NMR spectra are recorded in parts per million from tetramethylsilane using the central peak of deuteriochloroform (77.00 ppm) as the internal standard. All spectra were obtained with complete proton decoupling. When ambiguous, proton, carbon and stereochemistry assignments were established using COSY, NOESY and DEPT experiments. High resolution mass spectra were performed by the Centre régional de spectroscopie de masse de l'Université de Montréal. Combustion analyses were performed by the Laboratoire d'analyse élémentaire de l'Université de Montréal.

Semi-preparative High Performance Liquid Chromatography was performed on a Gilson Liquid Handler 215/Gilson 322 Pump equipped with a electrospray mass detector with simultaneous diode array UV detection. Data are reported as follows: (column type, column dimension, eluent, flow rate: retention time (t_r)).

Analytical gas chromatography was carried out on a Hewlett Packard 5880A gas chromatograph equipped with a splitless mode capillary injector and a flame ionization detector or with a Agilent 6890 Series GC system equipped with an Agilent 5973 EI mass detector. Unless otherwise noted, the injector and detector temperature were set to 250 °C and hydrogen was used as the carrier gas (63 psi). Data are reported as follows: (column type, column length, initial temperature, initial time, rate, final temperature, final time: retention time (t_r)).

Preparation of starting alkenes: Alkenes **5**, **8**, **17** and **23** were prepared by the addition of the corresponding Grignard reagents in the presence of cerium chloride to (*Z*)- or (*E*)-4-benzyloxy-but-2-enal or according to a protocol described in the literature.³

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(Z)-4-Benzyloxy-but-2-enal. To (Z)-4-benzyloxy-but-2-en-1-ol⁴ (1.06 g, 5.92 mmol, 1.0 equiv) in DMSO (20 mL), IBX⁵ (1.99 g, 7.10 mmol, 1.2 equiv) was added. The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material, after which it was simply poured on a silica gel column and eluted with EtOAc/hexanes (15%) to afford the aldehyde (5.37 g, 91%) as a clear colorless oil: R_f 0.68 (50% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 10.06 (d, $J = 7$ Hz, 1H, C(=O)H), 7.43-7.26 (m, 5H, Ph), 6.65 (dt, $J = 11, 6$ Hz, 1H, $\text{CH}_2\text{CH}=\text{CH}$), 6.07 (ddt, $J = 11, 7, 2$ Hz, 1H, $\text{COCH}=\text{CH}$), 4.60 (s, 2H, PhCH_2O), 4.54 (dd, $J = 6, 2$ Hz, 2H, BnOCH_2); ^{13}C NMR (75 MHz, CDCl_3) δ 191.9 CH, 148.0 CH, 137.7 C, 130.1 CH, 129.0 2xCH, 128.4 CH, 128.2 2xCH, 73.5 CH_2 , 67.3 CH_2 .

(E)-4-Benzyloxy-but-2-enal.⁶ To (Z)-4-benzyloxy-but-2-enal (3.29 g, 40.4 mmol, 1.0 equiv) in CH_2Cl_2 (125 mL) add catalytic *p*-TsOH (~50 mg). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. The organic phase was then washed with saturated aqueous NaHCO_3 (40 mL), then brine (40 mL), dried over MgSO_4 and concentrated under reduced pressure. The resulting clear colorless oil was pure *E*-aldehyde (6.99 g, 98%) and was used as is: R_f 0.61 (50% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 9.60 (d, $J = 8$ Hz, 1H, C(=O)H), 7.40-7.30 (m, 5H, Ph), 6.87 (dt, $J = 16, 6$ Hz, 1H, $\text{CH}_2\text{CH}=\text{CH}$), 6.42 (ddt, $J = 16, 8, 2$ Hz, 1H, $\text{COCH}=\text{CH}$), 4.61 (s, 2H, PhCH_2O), 4.31 (dd, $J = 6, 2$ Hz, 2H, BnOCH_2); ^{13}C NMR (100 MHz, CDCl_3) δ 193.7 CH, 153.4 CH, 137.8 C, 132.2 CH, 128.9 2xCH, 128.4 CH, 128.1 2xCH, 73.4 CH_2 , 68.9 CH_2 .

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(Z)-5-Benzyloxy-pent-3-en-2-ol (5). Colorless oil (5.22 g, 96%) from (Z)-4-benzyloxy-but-2-enal: R_f 0.27 (65% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.37-7.28 (m, 5H, Ph), 5.71-5.61 (m, 2H, $\text{CH}=\text{CH}$), 4.61-4.57 (m, 1H, CHMe), 4.54 (s, 2H, PhCH_2O), 4.16 (dd, $J = 12, 5$ Hz, 1H, BnOCH_2), 4.07 (dd, $J = 12, 5$ Hz, 1H, BnOCH_2), 1.92 (s(br), 1H, OH), 1.25 (d, $J = 6$ Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ 137.7 C, 137.5 CH, 128.3 2xCH, 127.7 2xCH, 127.6 CH, 126.7 CH, 72.3 CH_2 , 65.5 CH_2 , 63.8 CH, 23.1 CH_3 ; IR (neat) 3348 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{12}\text{H}_{14}\text{O}$ (M- H_2O) 174.1045, found 174.1046.

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(Z)-5-Benzyloxy-hex-3-en-2-ol (8). Colorless oil (999 mg, 85%) from (Z)-4-benzyloxy-but-2-enal: R_f 0.48 (50% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.39-7.28 (m, 5H, Ph), 5.78-5.69 (m, 1H, $\text{CH}_2\text{CH}=\text{CH}$), 5.61 (ddt, $J = 12, 8, 1$ Hz, 1H, $\text{CH}=\text{CHCH}_2\text{Et}$), 4.54 (d, $J = 1$ Hz, 2H, PhCH_2O), 4.34-4.26 (m, 1H, CH_2Et), 4.17 (ddd, $J = 12, 6, 1$ Hz, 1H, BnOCH_2), 4.06 (ddd, $J = 12, 6, 1$ Hz, 1H, BnOCH_2), 1.88 (s(br), 1H, OH), 1.66-1.41 (m, 2H, $\text{CH}_3\text{CH}_2\text{CH}$), 0.90 (t, $J = 7$ Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ 138.3 C, 136.5 CH, 128.8 2xCH, 128.4 CH, 128.2 CH, 128.1 2xCH, 72.9 CH_2 , 69.6 CH, 66.2 CH_2 , 30.5 CH_2 , 10.0 CH_3 ; IR (neat) 3369 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{13}\text{H}_{17}\text{O}_2$ (M-H) 205.1229, found 205.1220.

4 Prepared according to the protocol described in Charette, A. B.; Gagnon, A.; Fournier, J.-F. *J. Am. Chem. Soc.* **2002**, *124*, 386-387.

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(Z)-4-Benzyloxy-1-phenyl-but-2-en-1-ol (17). Colorless oil (1.31 g, 91%) from (Z)-4-benzyloxy-but-2-enal: R_f 0.54 (50% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.39-7.28 (m, 10H, Ph), 5.89-5.76 (m, 2H, $\text{CH}=\text{CH}$), 5.51 (d, $J = 8$ Hz, 1H, CHPh), 4.56 (s, 2H, PhCH_2O), 4.29 (ddd, $J = 13, 7, 1$ Hz, 1H, BnOCH_2), 4.17 (ddd, $J = 13, 6, 1$ Hz, 1H, BnOCH_2), 2.31 (s(br), 1H, OH), ^{13}C NMR (75 MHz, CDCl_3) δ 143.4 C, 138.2 C, 135.9 CH, 128.9 2xCH, 128.8 2xCH, 128.2 3xCH, 128.1 CH, 128.0 CH, 126.3 2xCH, 72.9 CH_2 , 70.4 CH, 66.2 CH_2 ; IR (neat) 3360 (br) cm^{-1} .

23

(E)-5-Benzyloxy-pent-3-en-2-ol (23). Colorless oil (4.56 g, 87%) from (E)-4-benzyloxy-but-2-enal: R_f 0.36 (50% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.38-7.27 (m, 5H, Ph), 5.85-5.75 (m, 2H, $\text{CH}=\text{CH}$), 4.53 (s, 2H, PhCH_2O), 4.35-4.30 (m, 1H, CHMe), 4.03 (dd, $J = 4, 1$ Hz, 2H, BnOCH_2), 1.97 (s(br), 1H, OH), 1.28 (d, $J = 6$ Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ 138.6 C, 137.6 CH, 128.8 2xCH, 128.1 2xCH, 128.0 CH, 126.5 CH, 72.6 CH_2 , 70.5 CH_2 , 68.5 CH, 23.6 CH_3 ; IR (neat) 3370 (br) cm^{-1} .

6-Benzyloxy-2-methyl-hex-4-yn-3-ol.⁷ To benzyl propargyl ether⁸ (5.0 g, 34.2 mmol, 1.0 equiv) in THF (110 mL) at -78°C was added *n*-BuLi (22 mL, 2.05 M, 44.5 mmol, 1.3 equiv) followed by isobutyraldehyde (3.70 g, 51.3 mmol, 1.5 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. It was then quenched by the addition of saturated aqueous NH_4Cl . The aqueous layer was extracted with Et_2O (4 x 40 mL) and the combined organic layers were washed with brine (50 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography (25% EtOAc/hexanes) to afford the desired alcohol (6.23 g, 84% yield) as a clear colorless oil.

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(Z)-6-Benzyloxy-2-methyl-hex-4-en-3-ol (11). To 6-benzyloxy-2-methyl-hex-4-yn-3-ol (2.00 g, 9.16 mmol, 1.0 equiv) in THF (23 mL) at 0°C was added dicyclohexylborane⁹ (4.08 g, 22.9 mmol, 2.5 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. Acetic acid (7 mL) was then added and the mixture stirred at 60°C until TLC analysis showed the complete consumption of intermediate product (baseline). The solvent was removed under reduced pressure and a solution of KOH 4M: CH_2Cl_2 (1:1, 30 mL) was added to the residue. The heterogeneous solution was stirred for 12 h and the aqueous layer was extracted with CH_2Cl_2 (3 x 30 mL). The combined organic layers were washed with saturated aqueous NH_4Cl (3x20 mL) then brine (40 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography (25% EtOAc/hexanes) to afford the allylic alcohol **11** (1.46 g, 72% yield) as a clear colorless oil: R_f 0.44 (65% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.39-7.28 (m, 5H, Ph), 5.81-5.73 (m, 1H, $\text{CH}_2\text{CH}=\text{CH}$), 5.63 (ddt, $J = 11, 9, 1$ Hz, 1H, $\text{CH}=\text{CHCH}$), 4.56 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.51 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.18 (ddd, $J = 12, 7, 1$ Hz,

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1H, BnOCH₂), 4.10-4.02 (m, 2H, BnOCH₂, CH(*i*-Pr)), 1.82 (s(br), 1H, OH), 1.70 (oct, *J* = 7 Hz, 1H, CH(CH₃)₂), 0.94 (d, *J* = 7 Hz, 3H, CH₃), 0.87 (d, *J* = 7 Hz, 3H, CH₃); ¹³C NMR (75 MHz, CDCl₃) δ 138.3 C, 134.9 CH, 129.0 CH, 128.8 2xCH, 128.2 2xCH, 128.1 CH, 73.1 CH, 72.9 CH₂, 66.3 CH₂, 34.3 CH, 18.4 2xCH₃; IR (neat) 3402 (br) cm⁻¹; HRMS (MAB) calcd for C₁₄H₁₈O₂ (M-H₂O) 202.1358, found 202.1373.

(-)-(3S)-Benzyloxy-2,2-dimethyl-hex-4-yn-3-ol.⁷ Prepared from benzyl propargyl ether⁸ (88 mg, 0.60 mmol, 1.2 equiv) and trimethylacetaldehyde (43 mg, 0.50 mmol, 1.0 equiv) according to the protocol described by Carreira¹⁰ and the enantiomeric excess (96% *ee*) was determined by GC analysis on chiral stationary phase of its trifluoroacetate derivative (Cyclodex B, 30 m, 120 °C, *t*_r (minor) 83.1 min, *t*_r (major) 85.0 min). Propargyl alcohol **14** was obtained (86 mg, 74% yield) as a clear colorless oil: *R*_f 0.33 (20% EtOAc/hexanes); [α]_D²⁰ -14.2 (*c* 1.18, MeOH); ¹H NMR (300 MHz, CDCl₃) δ 7.37-7.30 (m, 5H, Ph), 4.61 (s, 2H, PhCH₂O), 4.24 (d, *J* = 2 Hz, 2H, BnOCH₂), 4.08 (dt, *J* = 6, 2 Hz, 1H, CH(*t*-Bu)), 1.79 (d, *J* = 6 Hz, 1H, OH), 1.02 (s, 9H, C(CH₃)₃); ¹³C NMR (75 MHz, CDCl₃) δ 137.8 C, 128.8 2xCH, 128.5 2xCH, 128.3 CH, 86.7 C, 82.0 C, 71.9 CH₂, 71.8 CH, 57.8 CH₂, 36.2 C, 25.7 3xCH₃; IR (neat) 3401 (br) cm⁻¹. Anal. Calcd for C₁₅H₂₀O₂: C, 77.55; H, 8.68. Found: C, 77.34; H, 9.10.

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(+)-(3R)-(Z)-6-Benzyloxy-2,2-dimethyl-hex-4-en-3-ol (14). Prepared from the alkyne (2.00 g, 8.61 mmol, 1.0 equiv) according to the same protocol as for **11**. The allylic alcohol **14** was obtained as a clear colorless oil (1.74 g, 86% yield): *R*_f 0.27 (25% EtOAc/hexanes); [α]_D²⁰ +23.0 (*c* 0.90, MeOH); ¹H NMR (300 MHz, CDCl₃) δ 7.39-7.28 (m, 5H, Ph), 5.83-5.75 (m, 1H, CH₂CH=CH), 5.66 (ddt, *J* = 11, 9, 1 Hz, 1H, CH=CHCH), 4.56 (d, *J* = 12 Hz, 1H, PhCH₂O), 4.51 (d, *J* = 12 Hz, 1H, PhCH₂O), 4.20 (ddd, *J* = 12, 7, 1 Hz, 1H, BnOCH₂), 4.05 (ddd, *J* = 12, 6, 1, 1H, BnOCH₂), 4.02 (dd, *J* = 8, 1 Hz, 1H, CH(*t*-Bu)), 1.70 (s(br), 1H, OH), 0.90 (s, 9H, C(CH₃)₃); ¹³C NMR (75 MHz, CDCl₃) δ 138.4 C, 133.2 CH, 129.6 CH, 128.8 2xCH, 128.2 2xCH, 128.1 CH, 75.5 CH, 72.9 CH₂, 66.4 CH₂, 35.4 C, 25.8 3xCH₃; IR (neat) 3435 (br) cm⁻¹.

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(E)-6-Benzyloxy-2,2-dimethyl-hex-4-en-3-ol (24). Prepared from 6-benzyloxy-2,2-dimethyl-hex-4-yn-3-ol (1.02 g, 4.39 mmol, 1.0 equiv) according to the protocol described by Ley¹¹. The allylic alcohol **24** was isolated as a clear colorless oil (907 mg, 88% yield): *R*_f 0.33 (25% EtOAc/hexanes); ¹H NMR (300 MHz, CDCl₃) δ 7.39-7.27 (m, 5H, Ph), 5.83-5.80 (m, 2H, CH₂CH=CH), 4.53 (s, 2H, PhCH₂O), 4.05 (d, *J* = 4 Hz, 2H, PhCH₂O), 3.79 (d, *J* = 5 Hz, 1H, CH(*t*-Bu)), 1.51 (s(br), 1H, OH), 0.92 (s, 9H, C(CH₃)₃); IR (neat) 3440 (br) cm⁻¹; ¹³C NMR (75 MHz, CDCl₃) δ 138.6 C, 133.4 CH, 129.3 CH, 128.8 2xCH, 128.1 2xCH, 128.0 CH, 80.7 CH, 72.5 CH₂, 70.6 CH₂, 35.2 C, 26.0 3xCH₃; HRMS (MAB) calcd for C₁₅H₂₂O₂ 234.1620, found 234.1618.

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(Z)-1,4-Dibenzyloxy-pent-2-ene (20). To a suspension of NaH (253 mg, 60% in oil, 6.33 mmol, 1.2 equiv) in dry DMF (10 mL) was added **5** (1.01 g, 5.27 mmol, 1.0 equiv). The reaction mixture was stirred for 40 min before adding BnBr (1.17 g, 6.86 mmol, 1.3 equiv). The foamy mixture was stirred for 14 h before it was quenched by the addition of saturated aqueous NH_4Cl . The aqueous layer was extracted with Et_2O (4 x 15 mL) and the combined organic layers were washed with H_2O (3 x 10 mL) then brine (10 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography (10% EtOAc /hexanes) to afford the dibenzyl ether **20** as a clear colorless oil (1.44 g, 97% yield): R_f 0.46 (10% EtOAc /hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.38-7.27 (m, 10H, Ph), 5.83-5.75 (m, 1H, $\text{CH}_2\text{CH}=\text{CH}$), 5.59 (dd, $J = 10, 9$ Hz, 1H, $\text{CH}=\text{CHCHMe}$), 4.56 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.50 (s, 2H, PhCH_2O), 4.34 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.25 (qn, $J = 6$ Hz, 1H, CHMe), 4.11-4.01 (m, 2H, BnOCH_2), 1.26 (d, $J = 6$ Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ 139.0 C, 138.4 C, 135.6 CH, 128.9 CH, 128.8 2xCH, 128.7 2xCH, 128.1 5xCH, 127.9 CH, 72.8 CH_2 , 70.5 CH, 70.3 CH_2 , 66.1 CH_2 , 21.9 CH_3 ; HRMS (MAB) calcd for $\text{C}_{19}\text{H}_{23}\text{O}_2$ ($\text{M}+\text{H}^+$) 283.1698, found 283.1686.

(E)-3-Benzyloxy-1-iodo-1-trimethylsilyl-propene. To *O*-benzyl propargyl ether⁸ (2.00 g, 13.7 mmol, 1.0 equiv) in THF (45 mL) at -78°C was added *n*-BuLi (10.3 mL, 1.59 M, 16.4 mmol, 1.2 equiv) followed by trimethylsilyl chloride (1.93 g, 17.8 mmol, 1.3 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. It was then quenched by the addition of saturated aqueous NaHCO_3 (10 mL). The aqueous layer was extracted with Et_2O (3 x 15 mL) and the combined organic layers were washed with brine (15 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was distilled under vacuum to afford the (3-benzyloxy-prop-1-ynyl)-trimethylsilanebenzyl ether (2.92 g, 98% yield) as a clear colorless oil: Bp 101°C (~ 0.1 mm Hg). This product (1.42 g, 6.49 mmol, 1.0 equiv) was used to prepare the title compound according to the protocol described by Zweifel.¹² **(E)-(3-benzyloxy-1-iodo-propenyl)-trimethylsilane** (1.54 g, 69% yield) as a clear yellow oil: R_f 0.63 (5% EtOAc /hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.37-7.26 (m, 6H, Ph, $\text{C}=\text{CHCH}_2$), 4.51 (s, 2H, PhCH_2O), 3.95 (d, $J = 7$ Hz, 2H, BnOCH_2), 0.23 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C NMR (75 MHz, CDCl_3) δ 152.6 CH, 138.0 C, 128.9 2xCH, 128.3 2xCH, 128.2 CH, 112.0 C, 72.7 CH_2 , 70.4 CH_2 , 1.2 3x CH_3 ; HRMS (MAB) calcd for $\text{C}_{13}\text{H}_{19}\text{IOSi}$ 346.0250, found 346.0256.

(Z)-1-Benzyloxy-3-trimethylsilyl-pent-2-en-4-ol (26). To $\text{MgBr}_2 \cdot \text{OEt}_2$ (3.73 g, 14.4 mmol, 2.0 equiv) and **(E)-3-benzyloxy-1-iodo-1-trimethylsilyl-propene** (2.50 g, 7.22 mmol, 1.0 equiv) in ether (25 mL) at -78°C was added *n*-BuLi (5.48 mL, 1.58 M, 8.66 mmol, 1.2 equiv) followed by acetaldehyde (636 mg, 14.4 mmol, 2.0 equiv). The reaction mixture was stirred for 30 min before it was quenched by adding into saturated aqueous NH_4Cl (10 mL). The aqueous layer was extracted with Et_2O (3 x 15 mL) and the combined organic layers were washed with saturated aqueous Na_2SO_3 (15 mL) then brine (15 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography (5-25 % EtOAc /hexanes) to afford the recovered starting material (859 mg, 34 %) and the allylic alcohol **7c** (862 mg,

¹² Zweifel, G.; Lewis, W. J. *Org. Chem.* **1978**, *43*, 2739-2744.

45 % yield) as a clear colorless oil: R_f 0.30 (25 % EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.36-7.26 (m, 5H, Ph), 6.44 (td, $J = 7$, 1 Hz, 1H, $\text{C}=\text{CH}$), 4.54 (s, 2H, PhCH_2O), 4.42 (q, $J = 6$ Hz, 2H, MeCHOH), 4.14 (d, $J = 7$ Hz, 2H, BnOCH_2), 1.51 (s(br), 1H, OH), 1.27 (d, $J = 6$ Hz, 3H, CH_3), 0.16 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C NMR (75 MHz, CDCl_3) δ 148.5 C, 138.5 C, 136.3 CH, 128.8 2xCH, 128.3 2xCH, 128.1 CH, 73.1 CH_2 , 71.9 CH, 69.5 CH_2 , 24.3 CH_3 , 0.8 3x CH_3 ; IR (neat) 3392 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{15}\text{H}_{24}\text{O}_2\text{Si}$ 264.1546, found 264.1517; Anal. Calcd for $\text{C}_{15}\text{H}_{24}\text{O}_2\text{Si}$: C, 68.13; H, 9.15. Found: C, 68.23; H, 9.44.

(Z)-1-Benzyloxy-5,5-dimethyl-3-trimethylsilyl-hex-2-en-4-ol (27). To $\text{MgBr}_2 \cdot \text{OEt}_2$ (1.42 g, 5.50 mmol, 2.0 equiv) and (*E*)-3-benzyloxy-1-iodo-1-trimethylsilyl-propene (953 mg, 2.75 mmol, 1.0 equiv) in THF (9 mL) at -78°C was added *n*-BuLi (2.1 mL, 1.59 M, 3.3 mmol, 1.2 equiv) followed by trimethylacetaldehyde (474 mg, 5.50 mmol, 2.0 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. It was then quenched by adding into saturated aqueous NH_4Cl (5 mL). The aqueous layer was extracted with Et_2O (3 x 5 mL) and the combined organic layers were washed with saturated aqueous Na_2SO_3 (5 mL) then brine (5 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography (15 % EtOAc/hexanes) to afford the allylic alcohol **7f** (373 mg, 44 % yield) as a clear slightly yellow oil that turned to a white solid with time: mp $39\text{--}42^\circ\text{C}$; R_f 0.42 (25 % EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.37-7.26 (m, 5H, Ph), 6.53 (t, $J = 7$ Hz, 1H, $\text{C}=\text{CH}$), 4.57 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.52 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.18 (d, $J = 7$ Hz, 2H, BnOCH_2), 4.08 (s, 1H, $\text{CH}(t\text{-Bu})\text{OH}$), 1.45 (s(br), 1H, OH), 0.92 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.16 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C NMR (100 MHz, CDCl_3) δ 145.5 C, 140.9 CH, 137.9 C, 128.2 2xCH, 127.7 2xCH, 127.5 CH, 80.0 CH, 72.4 CH_2 , 69.1 CH_2 , 36.0 C, 26.1 3x CH_3 , 0.9 3x CH_3 ; IR (neat) 3470 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{18}\text{H}_{30}\text{O}_2\text{Si}$ 306.2015, found 306.2025.

(Z)-1-Benzyloxy-5,5-dimethyl-2-iodo-4-trimethylsilyloxy-hex-2-ene. To ($\pm$)-benzyloxy-2,2-dimethyl-hex-4-yn-3-ol (1.00 g, 4.30 mmol, 1.0 equiv) in THF (25 mL) was added Red-Al (2.5 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. It was then cooled to -78°C and a solution of iodine (2.0 equiv) in THF (25 mL) was added by cannula. The black mixture was stirred until TLC analysis showed the complete consumption of vinyl alane. It was then quenched by adding it into saturated aqueous Na_2SO_3 (100 mL) and HCl (or Rochelle's solution) was added until the aluminum salts were completely dissolved. The aqueous layer was extracted with Et_2O (3 x 20 mL) and the combined organic layers were washed with saturated aqueous Na_2SO_3 (20 mL), saturated aqueous NaHCO_3 (20 mL) then brine (20 mL), dried over MgSO_4 and concentrated under reduced pressure. The crude oil was dissolved in CH_2Cl_2 (80 mL), cooled to 0°C and DMAP (20 mg, catalytic), NEt_3 (1.2 equiv) then TMS-Cl (1.2 equiv) were added and the ice bath was removed. The reaction mixture was stirred until TLC analysis showed the complete consumption of the alcohol. The reaction was then quenched by adding it into ice cold saturated aqueous NaHCO_3 . The aqueous layer was extracted with CH_2Cl_2 (2 x 10 mL) and the combined organic layers were washed with brine (10 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography (3% EtOAc/hexanes) to afford the TMS ether (1.46 g, 79 % yield) as a clear colorless oil: R_f 0.36 (4% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.38-7.28 (m, 5H, Ph), 5.93 (dt, $J = 9$, 1 Hz, 1H, $\text{C}=\text{CH}$), 4.52 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.49 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.19 (s, 2H, BnOCH_2), 4.04 (d, $J = 9$ Hz, 1H, $\text{CH}(t\text{-Bu})$), 0.92 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.13 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C NMR (100 MHz, CDCl_3) δ 137.7 CH, 137.4 C, 128.3 2xCH, 127.7 2xCH, 127.6 CH,

105.4 C, 83.0 CH, 77.7 CH₂, 71.1 CH₂, 36.3 C, 25.6 3xCH₃, 0.3 3xCH₃; Anal. Calcd for C₁₈H₂₉IO₂Si: C, 50.00; H, 6.76. Found: C, 50.19; H, 6.91.

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(Z)-1-Benzyloxy-5,5-dimethyl-2-trimethylsilyl-hex-2-en-4-ol (28). To (Z)-(1-benzyloxy-5,5-dimethyl-2-iodo-4-trimethylsilyloxy-hex-2-ene (2.25 g, 5.20 mmol, 1.0 equiv) in THF (17 mL) at -78°C was added *n*-BuLi (3.90 mL, 1.59 M, 6.24 mmol, 1.2 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. It was then quenched by adding it into saturated aqueous NH₄Cl. The aqueous layer was extracted with Et₂O (3 x 10 mL) and the combined organic layers were washed with saturated aqueous Na₂SO₃ (10 mL) then brine (10 mL), dried over MgSO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography (15% EtOAc/hexanes) to afford the alcohol **28** (594 mg, 37%) as a clear colorless oil: *R*_f 0.58 (25% EtOAc/hexanes); ¹H NMR (400 MHz, CDCl₃) δ 7.35-7.26 (m, 5H, Ph), 6.31 (d, *J* = 10 Hz, 1H, C=CH), 4.50 (d, *J* = 12 Hz, 1H, PhCH₂O), 4.45 (d, *J* = 12 Hz, 1H, PhCH₂O), 4.14 (d, *J* = 12 Hz, 1H, CH(*t*-Bu)), 4.02 (d, *J* = 12 Hz, 1H, BnOCH₂), 4.01 (d, *J* = 10 Hz, 1H, BnOCH₂), 1.51 (s (br), 1H, OH), 0.95 (s, 9H, C(CH₃)₃), 0.22 (s, 9H, Si(CH₃)₃); ¹³C NMR (75 MHz, CDCl₃) δ 143.3 CH, 142.0 C, 138.8 C, 128.7 2xCH, 128.0 2xCH, 127.8 CH, 77.8 CH, 76.8 CH₂, 72.1 CH₂, 34.9 C, 26.2 3xCH₃, 0.9 3xCH₃; IR (neat) 3461 (br) cm⁻¹; Anal. Calcd for C₁₈H₃₀O₂Si: C, 70.53; H, 9.87. Found: C, 70.44; H, 10.29.

General procedure for the synthesis of cyclopropanes: Compounds **6**, **8**, **9**, **10** and **11** were prepared according to the following general procedure. To a solution of iodine (645 mg, 2.5 mmol, 4.0 equiv) and diethyl ether (462 μL , 4.45 mmol, 7.0 equiv) in dry CH₂Cl₂ (2.4 mL) at 0°C was slowly added Et₂Zn (228 μL , 2.22 mmol, 3.5 equiv). The ice bath was removed and the solution stirred for 10 min, before recooling to 0°C . A solution of CHI₃ (375 mg, 0.953 mmol, 1.5 equiv) in CH₂Cl₂ (6 mL) was then added via cannula to this clear colorless solution followed by the iodozinc alkoxide (*vide infra*) and by 100 μL of dry air. The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. The solution was then either quenched with DCl/D₂O, saturated aqueous NH₄Cl, or cooled to -78°C prior to the addition of a solution of iodine (484 mg, 1.91 mmol, 3.0 equiv) in THF (3 mL) for 5 min before adding in 5 mL of saturated aqueous Na₂SO₃. The aqueous layer was extracted with ether or CH₂Cl₂ (3 x 4 mL), the combined organic layers were washed with saturated aqueous Na₂SO₃ (4 mL), saturated aqueous NaHCO₃ (4 mL), then brine (4 mL), dried over MgSO₄ and concentrated under reduced pressure. The residue was purified by flash chromatography to afford the desired cyclopropane.

The iodozinc alkoxide was prepared in the following manner: to a solution of iodine (194 mg, 0.763 mmol, 1.2 equiv) and diethyl ether (158 μL , 1.525 mmol, 2.4 equiv) in dry CH₂Cl₂ (0.6 mL) at 0°C was slowly added Et₂Zn (78 μL , 0.763 mmol, 1.2 equiv). The ice bath was removed and the solution stirred for 15 min, before it was added over a solution the allylic alcohol (0.636 mmol, 1.0 equiv) in dry CH₂Cl₂ (1.0 mL). This solution was stirred at rt for 10 min before being used.

(1S*,2R*,3S*,1'S*)-1-(1-Hydroxyethyl)-3-deutero-2-benzyloxymethyl-cyclopropane (6) (Table 1, entry 1). The general procedure was followed on a 0.624 mmol scale starting from **5**. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (50% EtOAc/hexanes) to afford the desired deuterocyclopropane **6** as a clear slightly yellow oil (106 mg, 82% yield): *R*_f 0.28 (50 % EtOAc/hexanes); ¹H NMR (300 MHz, CDCl₃) δ 7.38-7.27 (m, 5H, Ph), 4.54 (d, *J* = 12 Hz, 1H, PhCH₂O), 4.48 (d, *J* = 12 Hz, 1H, PhCH₂O), 3.62 (dd, *J* = 10, 6 Hz, 1H, BnOCH₂), 3.45 (dq, *J* = 9, 6 Hz, 1H, CHMe), 3.35 (dd, *J* = 10, 8 Hz, 1H, BnOCH₂), 1.66 (s (br), 1H, OH),

1.35 (d, $J = 9$ Hz, 3H, CH_3), 1.35-1.26 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.04 (q, $J = 9$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.80 (t, $J = 8$ Hz, 1H, $\text{CHD}_{\text{cyclopro.}}$); ^{13}C NMR (75 MHz, CDCl_3) δ 138.5 C, 128.8 2xCH, 128.2 2xCH, 128.0 CH, 73.2 CH_2 , 70.7 CH_2 , 68.9 CH, 24.5 CH, 24.0 CH_3 , 16.2 CH, 8.3 (t) CHD; IR (neat) 3375 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{13}\text{H}_{17}\text{DO}_2$ 207.1370, found 207.1376.

(1S*,2S*,3R*,1'S*)-2-(1-Hydroxyethyl)-1-iodo-3-benzyloxymethyl-cyclopropane (7) (Table 1, entry 1). The general procedure was followed on a 0.624 mmol scale starting from **5**. The crude material was purified on silica gel (35% EtOAc/hexanes) to afford the desired iodocyclopropane **7** as a clear colorless oil that crystallized to colorless cubes (156 mg, 75% yield): mp 37-40 °C; R_f 0.35 (35% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.37-7.26 (m, 5H, Ph), 4.58 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.52 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.71-3.50 (m, 3H, BnOCH_2 , CHMe), 2.89 (t, $J = 7$ Hz, 1H, $\text{CHI}_{\text{cyclopro.}}$), 2.03 (s (br), 1H, OH), 1.36 (d, $J = 6$ Hz, 3H, CH_3), 1.32-1.21 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.04-0.95 (m, 1H, $\text{CHCH}_{\text{cyclopro.}}$); ^{13}C NMR (75 MHz, CDCl_3) δ 138.3 C, 128.8 2xCH, 128.2 3xCH, 73.7 CH_2 , 71.5 CH_2 , 69.6 CH, 26.8 CH, 22.5 CH_3 , 19.4 CH, -1.3 CH; IR (neat) 3394 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{13}\text{H}_{17}\text{IO}_2$ 332.0273, found 332.0273; Anal. Calcd for $\text{C}_{13}\text{H}_{17}\text{IO}_2$: C, 47.00; H, 5.16. Found: C, 47.01; H, 5.05.

(1S*,2R*,3S*,1'S*)-1-(1-Hydroxypropyl)-3-deutero-2-benzyloxymethyl-cyclopropane (9) (Table 1, entry 2). The general procedure was followed on a 0.630 mmol scale starting from **8**. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (35% EtOAc/hexanes) to afford the desired deuterocyclopropane **9** as a clear colorless oil (118 mg, 85% yield): R_f 0.46 (50% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.38-7.27 (m, 5H, Ph), 4.56 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.48 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.58 (dd, $J = 10$, 7 Hz, 1H, BnOCH_2), 3.41 (dd, $J = 10$, 8 Hz, 1H, BnOCH_2), 3.22 (td, $J = 8$, 4 Hz, 1H, CHEt), 1.79-1.53 (m, 3H, CH_2CH_3 , OH), 1.30 (qn, $J = 8$ Hz, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.05 (q, $J = 9$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.99 (t, $J = 7$ Hz, 3H, CH_3), 0.81 (t, $J = 8$ Hz, 1H, $\text{CHD}_{\text{cyclopro.}}$); ^{13}C NMR (100 MHz, CDCl_3) δ 138.6 C, 128.8 2xCH, 128.1 2xCH, 128.0 CH, 73.5 CH, 73.2 CH_2 , 70.8 CH_2 , 30.9 CH_2 , 23.0 CH, 16.4 CH, 10.4 CH_3 , 7.9 (t) CHD; IR (neat) 3397 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{14}\text{H}_{19}\text{DO}_2$ 221.1525, found 221.1530.

(1S*,2S*,3R*,1'S*)-2-(1-Hydroxypropyl)-1-iodo-3-benzyloxymethyl-cyclopropane (10) (Table 1, entry 2). The general procedure was followed on a 0.630 mmol scale starting from **8**. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (25% EtOAc/hexanes) to afford the desired iodocyclopropane **10** as a clear colorless oil (184 mg, 84% yield): R_f 0.63 (50% EtOAc/hexanes); ^1H NMR (400 MHz, C_6D_6) δ 7.39 (d, $J = 7$ Hz, 2H, H_{Ar}), 7.29-7.26 (m, 2H, H_{Ar}), 7.19 (t, $J = 7$ Hz, 1H, H_{Ar}), 4.41 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.32 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.50-3.41 (m, 3H, BnOCH_2 , CHEt), 2.40 (t, $J = 8$ Hz, 1H, $\text{CHI}_{\text{cyclopro.}}$), 1.85 (s (br), 1H,

OH), 1.77-1.65 (m, 2H, CH_2CH_3), 1.09 (t, $J = 7$ Hz, 3H, CH_3), 0.93-0.85 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 0.64 (td, $J = 10, 7$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$); ^{13}C NMR (100 MHz, C_6D_6) δ 139.0 C, 128.7 2xCH, 128.4 CH, 127.9 2xCH, 73.8 CH, 73.4 CH_2 , 71.7 CH_2 , 29.8 CH_2 , 25.6 CH, 19.6 CH, 10.4 CH_3 , -0.9 CH; IR (neat) 3431 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{14}\text{H}_{19}\text{IO}_2$ 346.0430, found 346.0429.

(1S*,2R*,3S*,1'S*)-1-(1-Hydroxy-2-methylpropyl)-3-deutero-2-benzyloxymethyl-cyclopropane (12) (Table 1, entry 3). The general procedure was followed on a 0.636 mmol scale starting from **11**. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (35% EtOAc/hexanes) to afford the desired deuterocyclopropane **12** as a clear colorless oil (129 mg, 86% yield): R_f 0.36 (35% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.39-7.28 (m, 5H, Ph), 4.57 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.51 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.51 (d, $J = 7$ Hz, 2H, BnOCH_2), 3.10 (dd, $J = 8, 5$ Hz, 1H, $\text{CH}(i\text{-Pr})$), 1.84 (hept, $J = 7$ Hz, 1H, $\text{CH}(\text{CH}_3)_2$), 1.46 (s (br), 1H, OH), 1.31 (qn, $J = 8$ Hz, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.10 (q, $J = 8$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.99 (d, $J = 7$ Hz, 3H, CH_3), 0.98 (d, $J = 7$ Hz, 3H, CH_3), 0.83 (t, $J = 8$ Hz, 1H, $\text{CHD}_{\text{cyclopro.}}$); ^{13}C NMR (100 MHz, CDCl_3) δ 138.6 C, 128.8 2xCH, 128.2 2xCH, 128.0 CH, 76.2 CH, 73.2 CH_2 , 70.8 CH_2 , 34.6 CH, 21.2 CH, 19.6 CH_3 , 17.3 CH_3 , 16.9 CH, 7.6 (tr) CHD; IR (neat) 3436 (br) cm.

(1S*,2S*,3R*,1'S*)-2-(1-Hydroxy-2-methylpropyl)-1-iodo-3-benzyloxymethyl-cyclopropane (13) (Table 1, entry 3). The general procedure was followed on a 0.636 mmol scale starting from **11**. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (20% EtOAc/hexanes) to afford the desired iodocyclopropane **13** as a clear yellow oil (198 mg, 87% yield): R_f 0.51 (35% EtOAc/hexanes); ^1H NMR (600 MHz, CDCl_3) δ 7.43-7.31 (m, 5H, Ph), 4.63 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.57 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.71 (dd, $J = 10, 6$ Hz, 1H, BnOCH_2), 3.51 (dd, $J = 10, 8$ Hz, 1H, BnOCH_2), 3.29 (dd, $J = 10, 6$ Hz, 1H, $\text{CH}(i\text{-Pr})$), 2.96 (t, $J = 8$ Hz, 1H, $\text{CHI}_{\text{cyclopro.}}$), 2.05 (s (br), 1H, OH), 1.89-1.83 (m, 1H, $\text{CH}(\text{CH}_3)_2$), 1.35-1.30 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.12 (td, $J = 10, 8$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 1.06 (d, $J = 7$ Hz, 3H, CH_3), 1.03 (d, $J = 7$ Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ 137.8 C, 128.3 2xCH, 127.7 2xCH, 127.6 CH, 76.5 CH, 73.3 CH_2 , 71.1 CH_2 , 33.1 CH, 23.4 CH, 19.8 CH, 19.2 CH_3 , 17.0 CH_3 , -1.2 CH; IR (neat) 3468 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{15}\text{H}_{21}\text{IO}_2$ 360.0586, found 360.0581.

(1S*,2R*,3S*,1'R*)-1-(1-Hydroxy-2,2-dimethylpropyl)-3-deutero-2-benzyloxymethyl-cyclopropane (15) (Table 1, entry 4). The general procedure was followed on a 0.640 mmol scale starting from **14** except that 2.0 equiv of *gem*-dizinc carbenoid was used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (35% EtOAc/hexanes) to afford the desired deuterocyclopropane **15** as a clear colorless oil (145 mg, 91% yield): R_f 0.40 (33 % EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.38-7.28 (m, 5H, Ph), 4.56 (d, $J = 12$ Hz, 1H,

PhCH₂O), 4.52 (d, $J = 12$ Hz, 1H, PhCH₂O), 3.64 (dd, $J = 10, 7$ Hz, 1H, BnOCH₂), 3.43 (dd, $J = 10, 8$ Hz, 1H, BnOCH₂), 3.00 (d, $J = 8$ Hz, 1H, CH(*t*-Bu)), 1.42 (s (br), 1H, OH), 1.30 (qn, $J = 7$ Hz, 1H, CH₂CH_{cyclopro.}), 1.12 (q, $J = 8$ Hz, 1H, CHCH_{cyclopro.}), 0.96 (s, 9H, C(CH₃)₃), 0.80 (t, $J = 8$ Hz, 1H, CHD_{cyclopro.}); ¹³C NMR (100 MHz, CDCl₃) δ 138.7 C, 128.8 2xCH, 128.1 2xCH, 128.0 CH, 78.0 CH, 73.2 CH₂, 70.8 CH₂, 35.7 C, 26.2 3xCH₃, 19.2 CH, 17.6 CH, 7.1 (t) CHD; IR (neat) 3418 (br) cm⁻¹; HRMS (MAB) calcd for C₁₆H₂₃DO₂ 249.1839, found 249.1828.

(+)-(1*S*,2*S*,3*R*,1'*R*)-2-(1-Hydroxy-2,2-dimethylpropyl)-1-iodo-3-benzyloxymethyl-cyclopropane (16) (Table 1, entry 4). The general procedure was followed on a 0.640 mmol scale starting from **14** except that 2.0 equiv of *gem*-dizinc carbenoid was used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (20% EtOAc/hexanes) to afford the desired iodocyclopropane **16** as a white solid (218 mg, 91% yield): mp 82-84 °C; R_f 0.68 (35% EtOAc/hexanes); $[\alpha]_D^{20} +20.9$ (c 1.00, CH₃OH); ¹H NMR (400 MHz, CDCl₃) δ 7.42-7.27 (m, 5H, Ph), 4.60 (d, $J = 12$ Hz, 1H, PhCH₂O), 4.55 (d, $J = 12$ Hz, 1H, PhCH₂O), 3.79 (dd, $J = 10, 5$ Hz, 1H, BnOCH₂), 3.44 (t, $J = 10$ Hz, 1H, BnOCH₂), 3.11 (d, $J = 10$ Hz, 1H, CH(*t*-Bu)), 2.91 (t, $J = 8$ Hz, 1H, CH_{cyclopro.}), 2.23 (s (br), 1H, OH), 1.34-1.26 (m, 1H, CH₂CH_{cyclopro.}), 1.11 (td, $J = 10, 8$ Hz, 1H, CHCH_{cyclopro.}), 0.97 (s, 9H, C(CH₃)₃); ¹³C NMR (100 MHz, CDCl₃) δ 138.4 C, 128.8 2xCH, 128.3 2xCH, 128.1 CH, 79.2 CH, 73.9 CH₂, 71.8 CH₂, 35.3 C, 26.5 3xCH₃, 22.3 CH, 21.6 CH, -0.6 CH; IR (neat) 3475 (br) cm⁻¹; HRMS (MAB) calcd for C₁₆H₂₃IO₂ 374.0743, found 374.0754; Anal. Calcd for C₁₆H₂₃IO₂: C, 51.35; H, 6.19. Found: C, 51.21; H, 6.48.

(1*S,2*R**,3*S**,1'*R**)-1-(Hydroxy-phenyl-methyl)-3-deutero-2-benzyloxymethyl-cyclopropane (18)** (Table 1, entry 5). The general procedure was followed on a 0.629 mmol scale starting from **17** except that 2.0 equiv of *gem*-dizinc carbenoid was used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (15% EtOAc/hexanes) to afford the desired deuterocyclopropane **18** as a beige oil (105 mg, 62% yield): R_f 0.17 (25% EtOAc/hexanes); ¹H NMR (400 MHz, CDCl₃) δ 7.45 (d, $J = 7$ Hz, 2 H, H_{Ar}), 7.36-7.26 (m, 8H, H_{Ar}), 4.54-4.47 (m, 3H, PhCH₂O, CHPh), 3.64 (dd, $J = 10, 7$ Hz, 1H, BnOCH₂), 3.48 (dd, $J = 10, 7$ Hz, 1H, BnOCH₂), 2.26 (s (br), 1H, OH), 1.43 (q, $J = 8$ Hz, 1H, CHCH_{cyclopro.}), 1.35 (qn, $J = 8$ Hz, 1H, CH₂CH_{cyclopro.}), 0.96 (t, $J = 8$ Hz, 1H, CHD_{cyclopro.}); ¹³C NMR (100 MHz, CDCl₃) δ 144.6 C, 138.5 C, 128.8 2xCH, 128.7 2xCH, 128.2 2xCH, 128.0 CH, 127.8 CH, 126.5 2xCH, 73.7 CH, 73.1 CH₂, 70.4 CH₂, 24.2 CH, 16.9 CH, 8.5 (t) CHD; IR (neat) 3370 (br) cm⁻¹; HRMS (MAB) calcd for C₁₈H₁₉DO₂ 269.1526, found 269.1527.

(1*S,2*S**,3*R**,1'*R**)-2-(Hydroxy-phenyl-methyl)-1-iodo-3-benzyloxymethyl-cyclopropane (19)** (Table 1, entry 5). The general procedure was followed on a 0.543 mmol scale starting from **17** except that 2.0 equiv of *gem*-dizinc carbenoid was used. The relative configuration was determined by chemical derivatization (see

section below) and nOe experiments. The crude material was purified on silica gel (25% EtOAc/hexanes) to afford the desired iodocyclopropane **19** as a clear colorless oil (123 mg, 58% yield): R_f 0.25 (25% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.55-7.27 (m, 10H, H_{Ar}), 4.55-4.43 (m, 3H, PhCH_2O , CHPh), 3.64 (dd, $J = 10, 5$ Hz, 1H, BnOCH_2), 3.55 (dd, $J = 10, 8$ Hz, 1H, BnOCH_2), 3.05 (t, $J = 8$ Hz, 1H, $\text{CH}_{\text{cyclopro.}}$), 2.28 (s (br), 1H, OH), 1.42 (td, $J = 10, 7$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 1.37-1.27 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$); ^{13}C NMR (75 MHz, CDCl_3) δ 142.4 C, 138.2 C, 129.0 2xCH, 128.7 2xCH, 128.4 CH, 128.3 2xCH, 128.1 CH, 126.9 2xCH, 73.7 CH, 71.2 CH_2 , 66.5 CH_2 , 26.6 CH, 20.1 CH, -0.6 CH; IR (neat) 3406 (br), 1717 cm^{-1} .

(1S*,2R*,3S*,1'S*)-1-(1-Benzyloxyethyl)-3-deutero-2-benzyloxymethyl-cyclopropane (21) (Table 1, entry 6). The general procedure was followed on a 0.620 mmol scale starting from **20** except that zinc alkoxide preformation was not necessary and the benzyl ether was directly added over the *gem*-dizinc carbenoid. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (15% EtOAc/hexanes) to afford the desired deuterocyclopropane **21** as a clear colorless oil (159 mg, 86% yield): R_f 0.29 (10% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.38-7.25 (m, 10H, 2xPh), 4.61 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.56 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.54 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.46 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.50 (dd, $J = 10, 7$ Hz, 1H, BnOCH_2), 3.34 (dd, $J = 10, 8$ Hz, 1H, BnOCH_2), 3.15 (dq, $J = 9, 6$ Hz, 1H, CHMe), 1.38 (d, $J = 6$ Hz, 3H, CH_3), 1.26-1.18 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.04 (q, $J = 9$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.92 (t, $J = 8$ Hz, 1H, $\text{CHD}_{\text{cyclopro.}}$); ^{13}C NMR (100 MHz, CDCl_3) δ 139.4 C, 138.7 C, 128.8 2xCH, 128.7 2xCH, 128.1 2xCH, 128.0 3xCH, 127.7 CH, 75.7 CH, 73.2 CH_2 , 70.7 CH_2 , 70.5 CH_2 , 22.0 CH, 21.7 CH_3 , 14.5 CH, 9.8 (t) CHD; HRMS (MAB) calcd for $\text{C}_{20}\text{H}_{23}\text{DO}_2$ 298.1917, found 298.1913.

(1S*,2R*,3S*,1'S*)-2-(1-Benzyloxyethyl)-1-iodo-3-benzyloxymethyl-cyclopropane (22). The general procedure was followed on a 0.620 mmol scale of **20** except that zinc alkoxide preformation was not necessary and the benzyl ether in CH_2Cl_2 was directly added over the *gem*-dizinc carbenoid. The relative configuration was determined by chemical derivatisation (see section below) and nOe experiments. The crude material was purified on silica gel (8% EtOAc/hexanes) to afford the desired iodocyclopropane **22** as a clear colorless oil (202 mg, 77% yield): R_f 0.27 (10 % EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.48-7.29 (m, 10H, 2xPh), 4.67 (d, $J = 10.9$ Hz, 1H, PhCH_2O), 4.63 (d, $J = 10.9$ Hz, 1H, PhCH_2O), 4.62 (d, $J = 11.7$ Hz, 1H, PhCH_2O), 4.57 (d, $J = 11.7$ Hz, 1H, PhCH_2O), 3.57 (dddd, $J = 10.7, 10.7, 10.7, 7.1$ Hz, 2H, BnOCH_2), 3.48 (dq, $J = 9.5, 6.2$ Hz, 1H, CHMe), 3.02 (t, $J = 7.7$ Hz, 1H, $\text{CH}_{\text{cyclopro.}}$), 1.43 (d, $J = 6.1$ Hz, 3H, CH_3), 1.32-1.24 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.13 (ddd, $J = 9.6, 7.5, 7.5$ Hz, 1H, $\text{CHCH}_{\text{cyclopro.}}$); ^{13}C NMR (100 MHz, CDCl_3) δ 138.8 C, 138.2 C, 128.6 2xCH, 128.5 2xCH, 128.3 2xCH, 128.0 2xCH, 127.9 CH, 127.7 CH, 76.1 CH, 73.5 CH_2 , 71.7 CH_2 , 71.3 CH_2 , 25.7 CH, 19.8 CH_3 , 18.8 CH, -0.9 CH; HRMS (ES) calcd for $\text{C}_{20}\text{H}_{24}\text{IO}_2$ (M+H) $^+$: 423.0816, found 423.0810.

1-(1-Hydroxyethyl)-2-benzyloxymethyl-cyclopropane (29) (Table 2, entry 1). The general procedure was followed on a 0.624 mmol scale starting from **23**. The relative configurations were determined by chemical derivatization (see section below) and nOe experiments. The crude material that consisted of a 60:40 mixture of **29a** and **29b** was purified on silica gel (50% EtOAc/hexanes) to afford a mixture of the two diastereomeric cyclopropanes **29a** (E = H) and **29c** (E = H) (109 mg, 85% yield) as a clear colorless oil. Cyclopropanes **29a** and **29c** were separated by semi-preparative HPLC Prevail Altech C18 5 μ , 22x250 mm, 50% B/A (B, 1% TFA/CH₃CN; A, 1% TFA/H₂O), 15 mL/min: t_r (**29a**) 11.9 min, t_r (**29c**) 13.4 min).

(1S*,2S*,1'S*)-1-(1-Hydroxyethyl)-2-benzyloxymethyl-cyclopropane (29a). Clear colorless oil (61% yield): R_f 0.19 (35% EtOAc/hexanes); ¹H NMR (300 MHz, CDCl₃) δ 7.38-7.26 (m, 5H, Ph), 4.53 (s, 2H, PhCH₂O), 3.39-3.33 (m, 2H, BnOCH₂), 3.32-3.21 (m, 1H, CHMe), 1.68 (s (br), 1H, OH), 1.29 (d, J = 6 Hz, 3H, CH₃), 1.06-0.99 (m, 1H, CH₂CH_{cyclopro.}), 0.89-0.81 (m, 1H, CHCH_{cyclopro.}), 0.63-0.56 (m, 1H, CH_{2cyclopro.}), 0.56-0.45 (m, 1H, CH_{2cyclopro.}); ¹³C NMR (75 MHz, CDCl₃) δ 138.8 C, 128.7 2xCH, 128.0 2xCH, 127.9 CH, 73.7 CH₂, 72.9 CH₂, 71.7 CH, 25.5 CH, 22.9 CH₃, 16.3 CH, 8.9 CH₂; IR (CHCl₃) 3413 (br) cm⁻¹; HRMS (MAB) calcd for C₁₃H₁₈O₂ 206.1307, found 206.1302.

(1S*,2S*,1'R*)-1-(1-Hydroxyethyl)-2-benzyloxymethyl-cyclopropane (29c). Clear colorless oil (24% yield): R_f 0.19 (35% EtOAc/hexanes); ¹H NMR (400 MHz, CDCl₃) δ 7.35-7.27 (m, 5H, Ph), 4.54 (s, 2H, PhCH₂O), 3.41 (dd, J = 10, 8 Hz, 1H, BnOCH₂), 3.26 (dd, J = 10, 7 Hz, 1H, BnOCH₂), 3.18 (qn, J = 6 Hz, 1H, CHMe), 1.97 (s (br), 1H, OH), 1.26 (d, J = 6 Hz, 3H, CH₃), 1.12-1.06 (m, 1H, CH₂CH_{cyclopro.}), 0.88-0.82 (m, 1H, CHCH_{cyclopro.}), 0.48 (t, J = 7 Hz, 2H, CH_{2cyclopro.}); ¹³C NMR (100 MHz, CDCl₃) δ 138.8 C, 128.7 2xCH, 128.0 2xCH, 127.9 CH, 73.9 CH₂, 73.0 CH₂, 72.1 CH, 25.9 CH, 22.6 CH₃, 17.3 CH, 8.1 CH₂; IR (CHCl₃) 3403 (br) cm⁻¹.

2-(1-Hydroxy-2,2-dimethylpropyl)-1-iodo-3-benzyloxymethyl-cyclopropane (Table 2, entry 2). The general procedure was followed on a 0.640 mmol scale starting from **24** except that 2.0 equiv of *gem*-dizinc carbenoid and 1.5 equiv of EtZnI were used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (20% EtOAc/hexanes) to afford the desired iodocyclopropanes **30a** (E = I) (52 mg, 22% yield) and **30b** (145 mg, 61% yield) as a clear yellow oil and a white solid respectively.

(1S*,2S*,3S*,1'R*)-2-(1-Hydroxy-2,2-dimethylpropyl)-1-iodo-3-benzyloxymethyl-cyclopropane (30a). Clear yellow oil (52 mg, 22% yield): R_f 0.21 (10 % EtOAc/hexanes); ¹H NMR (300 MHz, CDCl₃) δ 7.38-7.28 (m, 5H, Ph), 4.54 (d, J = 12 Hz, 1H, PhCH₂O), 4.49 (d, J = 12 Hz, 1H, PhCH₂O), 3.61 (dd, J = 10, 5 Hz, 1H, BnOCH₂), 3.34 (dd, J = 10, 6 Hz, 1H, BnOCH₂), 2.98 (d, J = 10 Hz, 1H, CH(*t*-Bu)), 2.52 (dd, J = 8, 5 Hz, 1H, CH_{cyclopro.}), 2.10 (s (br), 1H, OH), 1.42 (qn, J = 5 Hz, 1H, CH₂CH_{cyclopro.}), 1.00 (s, 9H, C(CH₃)₃), 0.72 (ddd, J = 10, 8, 6 Hz, 1H, CHCH_{cyclopro.}); ¹³C NMR (75 MHz, CDCl₃) δ 138.4 C, 128.8 2xCH, 128.1 CH, 127.8 2xCH, 84.5 CH, 73.1 CH₂, 70.7 CH₂, 35.8 C, 29.9 CH, 26.6 3xCH₃, 23.1 CH, -6.6 CH; IR (neat) 3476

(br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{16}\text{H}_{23}\text{IO}_2$ 374.0743, found 374.0736; Anal. Calcd for $\text{C}_{16}\text{H}_{23}\text{IO}_2$: C, 51.35; H, 6.19. Found: C, 51.46; H, 6.21.

(1*R,2*S**,3*S**,1'*R*')-2-(1-Hydroxy-2,2-dimethylpropyl)-1-iodo-3-benzyloxymethyl-cyclopropane (30b).** White solid (145 mg, 61% yield): mp 103-105°C; R_f 0.40 (20 % EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.40-7.27 (m, 5H, Ph), 4.59 (d, J = 12 Hz, 1H, PhCH_2O), 4.56 (d, J = 12 Hz, 1H, PhCH_2O), 3.66 (dd, J = 10, 5 Hz, 1H, BnOCH_2), 3.48 (dd, J = 10, 8 Hz, 1H, BnOCH_2), 2.99 (d, J = 6 Hz, 1H, $\text{CH}(t\text{-Bu})$), 2.71 (dd, J = 8, 5 Hz, 1H, $\text{CHI}_{\text{cyclopro.}}$), 1.45 (s (br), 1H, OH), 1.15 (td, J = 6, 5 Hz, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.00-0.95 (m, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.96 (s, 9H, $\text{C}(\text{CH}_3)_3$); ^{13}C NMR (100 MHz, CDCl_3) δ 138.0 C, 128.2 2xCH, 127.6 2xCH, 127.4 CH, 80.2 CH, 74.1 CH_2 , 72.9 CH_2 , 35.9 C, 29.6 CH, 25.6 3x CH_3 , 20.4 CH, -7.1 CH; IR (neat) 3452 cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{16}\text{H}_{23}\text{IO}_2$ 374.0743, found 374.0745; Anal. Calcd for $\text{C}_{16}\text{H}_{23}\text{IO}_2$: C, 51.35; H, 6.19. Found: C, 51.77; H, 6.29.

(1*S,2*S**,3*S**,1'*R*')-3-Deutero-1-(1-hydroxy-2,2-dimethylpropyl)-2-triisopropylsilyloxymethylcyclopropane (31a) and (1*S**,2*S**,3*R**,1'*R*')-3-deutero-1-(1-hydroxy-2,2-dimethylpropyl)-2-triisopropylsilyloxymethylcyclopropane (31b) (Table 2, entry 3).** The general procedure was followed on a 0.599 mmol scale starting from **24** except that 2.0 equiv of *gem*-dizinc carbenoid and 1.2 equiv of EtZnI were used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (15% EtOAc/hexanes) to afford the desired iodocyclopropanes **31a** and **31b** (120 mg, 64% yield) as a clear colorless oil: ^1H NMR (300 MHz, C_6D_6) δ 3.76 (dd, J = 10, 5 Hz, 1H, CH_2O), 3.50 (dd, J = 10, 6 Hz, 1H, CH_2O), 2.50 (d, J = 8 Hz, 1H, $\text{CH}(t\text{-Bu})$), 1.22-1.03 (m, 30H, $\text{C}(\text{CH}_3)_3$, $\text{Si}(\text{CH}(\text{CH}_3)_2)_3$), 1.01-0.92 (m, 2H, 2x $\text{CH}_{\text{cyclopro.}}$), 0.36 (dd, J = 8, 5 Hz, 0.75 H_{31a} , $\text{CDH}_{\text{cyclopro.}}$), 0.31 (dd, J = 8, 5 Hz, 0.25 H_{31b} , $\text{CDH}_{\text{cyclopro.}}$); ^{13}C NMR (100 MHz, C_6D_6) δ 80.1 CH, 63.1 CH_2 , 33.1 C, 23.5 3x CH_3 , 18.1 CH, 17.1 CH, 15.4 6x CH_3 , 9.4 3xCH; IR (neat) 3368 (br), 2945, 2867, 1464, 1090, 1068, 1000 cm^{-1} ; HRMS (MAB) Calc. for $\text{C}_{15}\text{H}_{30}\text{DO}_2\text{Si}$ (M- C_3H_7): 272.2172, found: 272.2163.

(1*R,2*R**,3*S**,1'*R*')-1-(1-Hydroxyethyl)-2-benzyloxymethyl-3-deutero-1-trimethylsilanyl-cyclopropane (32c) (Table 2, entry 4).** The general procedure was followed on a 0.378 mmol scale starting from **26** except that 2.0 equiv of *gem*-dizinc carbenoid and 1.5 equiv of EtZnI were used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material¹³ was purified on silica gel (25% EtOAc/hexanes) to afford the desired deuterocyclopropane **32c** (46 mg, 68% based on recovered starting material) as a clear colorless oil. Residual starting material **26** (37 mg, 37% yield) could also be recovered when ozonolysis was not carried out on the crude product to facilitate

13 To facilitate purification, ozonolysis was carried out on the crude product to remove remaining starting material using a protocol described in the literature: Veysoglu, T.; Mitscher, L. A.; Swayze, J. K. *Synthesis* **1980**, 807-810.

purification. Characterization data for **32c**: R_f 0.45 (35% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.36-7.26 (m, 5H, Ph), 4.54 (s, 2H, PhCH_2O), 3.60-3.51 (m, 2H, BnOCH_2 , CHMe), 3.43 (dd, $J = 10, 8$ Hz, 1H, BnOCH_2), 1.48 (s (br), 1H, OH), 1.29-1.22 (m, 1H, $\text{CH}_{\text{cyclopro.}}$), 1.23 (d, $J = 6$ Hz, 3H, CH_3), 0.43 (d, $J = 5$ Hz, 1H, $\text{CHD}_{\text{cyclopro.}}$), 0.06 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C NMR (75 MHz, CDCl_3) δ 138.7 C, 128.7 2xCH, 128.2 2xCH, 127.9 CH, 73.0 CH_2 , 72.5 CH, 71.7 CH_2 , 23.1 CH_3 , 21.5 CH, 18.5 C, 12.3 (t) CHD, 0.9 3x CH_3 ; IR (CHCl_3) 3429 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{15}\text{H}_{22}\text{DO}_2\text{Si}$ (M- CH_3): 264.1529, found 264.1535.

33c

(1R*,2R*,3S*,1'R*)-1-(1-Hydroxy-2,2-dimethylpropyl)-2-benzyloxymethyl-3-deutero-1-trimethylsilanyl-cyclopropane (33c) (Table 2, entry 5). The general procedure was followed on a 0.392 mmol scale starting from **27** except that 2.0 equiv of *gem*-dizinc carbenoid and 2.5 equiv of EtZnI were used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (10% EtOAc/hexanes) to afford the desired deuterocyclopropane **33c** (92 mg, 73% yield) as a clear colorless oil: R_f 0.53 (25% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.35-7.27 (m, 5H, Ph), 4.56 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.51 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.56 (dd, $J = 10, 7$ Hz, 1H, BnOCH_2), 3.44 (dd, $J = 10, 8$ Hz, 1H, BnOCH_2), 3.40 (s, 1H, $\text{CH}(t\text{-Bu})$), 1.70 (q, $J = 7$ Hz, 1H, $\text{CH}_{\text{cyclopro.}}$), 1.45 (s (br), 1H, OH), 0.98 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.44 (d, $J = 6$ Hz, 1H, $\text{CHD}_{\text{cyclopro.}}$), 0.07 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C NMR (75 MHz, CDCl_3) δ 138.8 C, 128.7 2xCH, 128.0 2xCH, 127.9 CH, 80.1 CH, 72.9 CH_2 , 71.5 CH_2 , 37.2 C, 27.8 3x CH_3 , 23.1 CH, 16.6 C, 12.6 (t) CHD, 1.5 3x CH_3 ; IR (neat) 3468 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{15}\text{H}_{22}\text{DO}_2\text{Si}$ (M- C_4H_9) 264.1524, found 264.1496; Anal. Calcd for $\text{C}_{19}\text{H}_{31}\text{DO}_2\text{Si}$: C, 70.97; H, 10.34. Found: C, 71.04; H, 10.38.

34b

(1R*,2R*,3S*,1'R*)-1-Benzyloxymethyl-3-deutero-2-(1-hydroxy-2,2-dimethylpropyl)-1-trimethylsilanyl-cyclopropane (34b) (Table 2, entry 6). The general procedure was followed on a 0.392 mmol scale starting from **28**. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified by chromatography on silica gel (10% EtOAc/hexanes) to afford cyclopropane **34b** as a colorless oil: R_f 0.20 (10% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.36-7.24 (m, 5H, Ph), 4.47 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.42 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.58 (d, $J = 9$ Hz, 1H, BnOCH_2), 3.16 (d, $J = 8$ Hz, 1H, $\text{CH}(t\text{-Bu})$), 2.88 (d, $J = 9$ Hz, 1H, BnOCH_2), 1.24 (s (br), 1H, OH), 1.21-1.10 (m, 1H, $\text{CH}_{\text{cyclopro.}}$), 1.01 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.54-0.47 (m, 1H, $\text{CHD}_{\text{cyclopro.}}$), 0.10 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C RMN (75 MHz, CDCl_3) δ 139.2 C, 128.6 2xCH, 127.6 3xCH, 79.2 CH_2 , 78.4 CH, 73.1 CH_2 , 36.1 C, 29.0 CH, 26.3 3x CH_3 , 15.1 C, 10.6 CH_2 (23%), 10.3 (t) CHD, 0.0 3x CH_3 ; IR (neat) 3472 (br), 2953, 2868, 1455, 1363, 1248, 1095, 837 cm^{-1} ; HRMS (MAB) calc. for $\text{C}_{18}\text{H}_{28}\text{DO}_2\text{Si}$ (M- CH_3) 306.2015, found: 306.1998.

35b

(1*S,2*R**,3*R**,1'*R**)-3-(1-Hydroxy-2,2-dimethylpropyl)-1-iodo-2-benzyloxymethyl-2-trimethylsilanyl-cyclopropane (35b)** (Table 2, entry 7). The general procedure was followed on a 0.392 mmol scale starting from **28** except that 2.0 equiv of *gem*-dizinc carbenoid and 2.0 equiv of EtZnI were used. The relative configuration was determined by chemical derivatization (see section below) and nOe experiments. The crude material was purified on silica gel (5% EtOAc/hexanes) to afford the desired iodocyclopropane **35b** (142 mg, 81% yield) as a clear colorless oil: R_f 0.64 (25% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.39-7.27 (m, 5H, Ph), 4.50 (s, 2H, PhCH_2O), 3.66 (d, $J = 9$ Hz, 1H, BnOCH_2), 3.34 (d, $J = 6$ Hz, 1H, $\text{CHI}_{\text{cyclopro.}}$), 3.22 (d, $J = 9$ Hz, 1H, BnOCH_2), 2.86 (d, $J = 5$ Hz, 1H, $\text{CH}(t\text{-Bu})$), 1.42 (t, $J = 5$ Hz, 1H, $\text{CH}_{\text{cyclopro.}}$), 1.30 (s (br), 1H, OH), 0.99 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.13 (s, 9H, $\text{Si}(\text{CH}_3)_3$); ^{13}C NMR (100 MHz, CDCl_3) δ 138.9 C, 128.6 2xCH, 127.7 3xCH, 82.8 CH_2 , 78.1 CH, 73.3 CH_2 , 38.5 CH, 36.4 C, 26.2 3x CH_3 , 18.5 C, 0.0 3x CH_3 , -0.4 CH; IR (neat) 3475 (br) cm^{-1} .

36

(-)-(1*S*,2*S*,3*R*)-2-(2,2-Dimethyl-propionyl)-1-iodo-3-benzyloxymethyl-cyclopropane (36). To alcohol **16** (733 mg, 1.96 mmol, 1.0 equiv) in CH_2Cl_2 (7 mL) was added pyridine (232 mg, 2.94 mmol, 1.5 equiv) followed by Dess-Martin periodinane¹⁴ (1.25 g, 2.94 mmol, 1.5 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. Water (3 mL) and CH_2Cl_2 (5 mL) were added and the heterogeneous solution was filtered on a thick celite pad. The volatiles were removed under reduced pressure and the residue was purified by flash chromatography (10% EtOAc/hexanes) to afford the ketone **36** (698 mg, 1.88 mmol, 96% yield) as a sticky white oil: R_f 0.30 (10% EtOAc/hexanes); $[\alpha]_D^{20}$ -20.8 (c 0.68, CH_3OH); ^1H NMR (400 MHz, CDCl_3) δ 7.35-7.27 (m, 5H, Ph), 4.54 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.50 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.85 (dd, $J = 10, 7$ Hz, 1H, BnOCH_2), 3.78 (dd, $J = 10, 6$ Hz, 1H, BnOCH_2), 3.29 (t, $J = 8$ Hz, 1H, $\text{CHI}_{\text{cyclopro.}}$), 2.54 (dd, $J = 9, 8$ Hz, 1H, $\text{C}(=\text{O})\text{CH}_{\text{cyclopro.}}$), 1.71-1.63 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.19 (s, 9H, $\text{C}(\text{CH}_3)_3$); ^{13}C NMR (100 MHz, CDCl_3) δ 210.3 C, 138.7 C, 128.7 2xCH, 128.2 2xCH, 128.0 CH, 73.6 CH_2 , 69.6 CH_2 , 45.4 C, 26.5 3x CH_3 , 25.5 CH, 22.2 CH, -2.4 CH; IR (neat) 1697 (s) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{16}\text{H}_{21}\text{O}_2$ (M-I) 245.1542, found 245.1541.

37

(-)-(1*S*,2*S*,3*R*)-3-Benzyloxymethyl-2-iodo-cyclopropanecarboxylic acid tert-butyl ester (37). To ketone **36** (52.5 mg, 0.141 mmol, 1.0 equiv) in CH_2Cl_2 (2 mL) was added *m*-CPBA (122 mg, 0.705 mmol, 5.0 equiv). The reaction was stirred in the dark for 2 h, it was then stopped by the addition of ether (2 mL) and saturated aqueous Na_2SO_3 (2 mL). The organic phase was washed with saturated aqueous Na_2SO_3 (3x2 mL), saturated aqueous NaHCO_3 (3x2 mL), then brine (2 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was submitted to *m*-CPBA under the same reaction conditions and the reaction was worked up in the same manner after 2 h. The crude product was purified by flash chromatography (25%

EtOAc/hexanes) to afford the ester **37** (42.4 mg, 78% yield) as a white solid: R_f 0.38 (15% EtOAc/hexanes); $[\alpha]_D^{20}$ -31.3 (c 1.42, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.39-7.27 (m, 5H, Ph), 4.57 (d, J = 12 Hz, 2H, PhCH_2O), 3.89 (dd, J = 10, 6 Hz, 1H, BnOCH_2), 3.80 (dd, J = 10, 7 Hz, 1H, BnOCH_2), 3.11 (t, J = 8 Hz, 1H, $\text{CH}_{\text{cyclopro.}}$), 1.95 (dd, J = 9, 8 Hz, 1H, $\text{C(=O)CH}_{\text{cyclopro.}}$), 1.53-1.44 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 1.48 (s, 9H, $\text{C(CH}_3)_3$); ^{13}C NMR (75 MHz, CDCl_3) δ 168.3 C, 138.6 C, 128.7 2xCH, 128.3 2xCH, 128.0 CH, 82.0 C, 73.7 CH_2 , 70.3 CH_2 , 28.6 3x CH_3 , 23.0 CH, 22.6 CH, -5.1 CH; IR (neat) 1715 (s) cm^{-1} ; Anal. Calcd for $\text{C}_{16}\text{H}_{21}\text{IO}_3$: C, 49.50; H, 5.45. Found: C, 49.99; H, 5.72.

(1S*,2R*,3S*,1'S*)-1-(1-Hydroxy-2-methylpropyl)-3-allyl-2-benzyloxymethylcyclopropane. The general procedure was followed on a 0.636 mmol scale starting from **11**. The resulting solution was cooled to -78 °C and freshly prepared $\text{CuCN}\cdot 2\text{LiCl}$ (CuCN : 142 mg, 1.59 mmol; LiCl : 135 mg, 3.18 mmol) in THF (10 mL) at -78 °C was added by cannula. Allyl iodide (320 mg, 1.907 mmol) was then added at -78 °C. The resulting mixture was allowed to warm up to 0 °C and stirred for 3 h. The reaction was then warm up at rt for 1 h before quenching by adding NH_4OH 28% and saturated aqueous NH_4Cl . The copper salts were filtered away, the aqueous layer was extracted with ether (3 x 10 mL), the combined organic layers were washed with brine (8 mL), dried over MgSO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography (25 % EtOAc/hexanes) to afford the allyl-cyclopropane (68 mg, 39 %) as a white solid¹⁵: R_f 0.36 (35 % EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.41-7.26 (m, 5H, Ph), 6.14-6.01 (m, 1H, $\text{CH}_2\text{CH}=\text{CH}_2$), 5.21 (ddd, J = 17, 1, 1 Hz, 1H, $\text{CH}_2\text{CH}=\text{CH}_2$), 5.09 (dd, J = 10, 1 Hz, 1H, $\text{CH}_2\text{CH}=\text{CH}_2$), 4.51 (s, 2H, PhCH_2O), 3.62 (dd, J = 10, 6 Hz, 1H, BnOCH_2), 3.46 (dd, J = 10, 9 Hz, 1H, BnOCH_2), 3.29-3.22 (m, 1H, $\text{CH}(i\text{-Pr})$), 2.50-2.43 (m, 1H, $\text{CH}_{\text{cyclopro.}}\text{CH}_2\text{CH}$), 2.20-2.09 (m, 1H, $\text{CH}_{\text{cyclopro.}}\text{CH}_2\text{CH}$), 1.80-1.69 (m, 1H, $\text{CH}(\text{CH}_3)_2$), 1.51 (s (br), 1H, OH), 1.44-1.33 (m, 1H, $\text{OCH}_2\text{CH}_{\text{cyclopro.}}$), 1.26-1.12 (m, 2H, $\text{CCH}_2\text{CH}_{\text{cyclopro.}}$, $\text{CHCH}_{\text{cyclopro.}}$), 0.97 (d, J = 7 Hz, 3H, CH_3), 0.96 (d, J = 7 Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ 139.1 CH, 138.1 C, 128.2 2xCH, 127.6 2xCH, 127.5 CH, 73.0 CH_2 , 72.8 CH_2 , 66.8 CH_2 , 33.8 CH, 27.7 CH_2 , 23.6 CH, 19.4 CH_3 , 19.0 CH, 17.1 CH, 16.7 CH_3 ; IR (neat) 3420 (br), 2959, 2872, 1639, 1455, 1057, 1033, 1009, 699, 633 cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{18}\text{H}_{26}\text{O}_2$ 274.1933, found 274.1932.

Stereochemistry assignment: Chemical correlations

In order to fully assign stereochemistry of all compounds, X-ray (**7**) or nOe experiments (**6**, **9**, **10**, **12**, **13**, **15**, **16**, **18**, **19**, **29**,) were taken for the *cis/trans* assignment while x-ray, nOe experiments and chemical correlations were used to assign *syn/anti* relationship (Scheme 1).

¹⁵ The remaining of the material (42%) is the compound obtained by protonation of the cyclopropyl zinc.

Scheme 1. Chemical correlations

(1S*,4S*,5R*,6R*)-6-Benzyloxymethyl-4-methyl-3-oxa-bicyclo[3.1.0]hexan-2-one (S1). To iodocyclopropane **7** (26.0 mg, 78.3 μ mol, 1.0 equiv) in ether (0.5 mL) at -78°C was added *n*-BuLi (149 μ L, 1.58 M, 235 μ mol, 3.0 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. Ethyl chloroformate (42.5 mg, 391 μ mol, 5.0 equiv) was then added and the solution was allowed to warm up to 0°C . Methanol (2 drops) was added to quench the reaction and the solution was filtered on a small silica pad. The volatiles were removed under reduced pressure and the residue was purified by flash chromatography (35% EtOAc/hexanes) to afford **S1** (7.2 mg, 40% yield) as a clear colorless oil: R_f 0.29 (35% EtOAc/hexanes); ^1H NMR (300 MHz, C_6D_6) δ 7.28-7.18 (m, 5H, Ph), 4.23 (s, 2H, PhCH_2O), 3.86 (q, $J = 6$ Hz, 1H, CHMe), 3.02 (dd, $J = 10, 5$ Hz, 1H, BnOCH_2), 2.81 (dd, $J = 10, 6$ Hz, 1H, BnOCH_2), 1.77 (dd, $J = 5, 2$ Hz, 1H, $\text{C(=O)CH}_{\text{cyclopro.}}$), 1.30-1.26 (m, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 1.05 (s (br), 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 0.90 (d, $J = 6$ Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ 175.3 C, 138.0 C, 128.9 2xCH, 128.3 CH, 128.1 2xCH, 77.8 CH, 73.4 CH_2 , 69.1 CH_2 , 28.6 CH, 25.7 CH, 22.7 CH, 22.3 CH_3 ; IR (neat) 1764 (s) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{14}\text{H}_{16}\text{O}_3$ 232.1099, found 232.1098. The stereochemistry was assigned by nOe experiments.

(1S*,4R*,5R*,6R*)-4-tert-Butyl-6-benzyloxymethyl-3-oxa-bicyclo[3.1.0]hexan-2-one (S2). Prepared from **16** (18.0 mg, 48.1 μ mol, 1.0 equiv) according to the same protocol as for **S1**: (5.3 mg, 40% yield) as a clear colorless oil: R_f 0.32 (25% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.39-7.29 (m, 5H, Ph), 4.52 (s, 2H, PhCH_2O), 4.01 (s, 1H, $\text{CH}(t\text{Bu})$), 3.58 (dd, $J = 10, 5$ Hz, 1H, BnOCH_2), 3.40 (dd, $J = 10, 6$ Hz, 1H, BnOCH_2), 2.08-2.03 (m, 2H, $\text{C(=O)CH}_{\text{cyclopro.}}$, $\text{CHCH}_{\text{cyclopro.}}$), 1.49-1.44 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 0.98 (s, 9H, $\text{C}(\text{CH}_3)_3$); ^{13}C NMR (100 MHz, CDCl_3) δ 175.8 C, 138.1 C, 128.9 2xCH, 128.3 CH, 128.1 2xCH, 88.8 CH, 73.3 CH_2 , 69.2 CH_2 , 35.5 C, 25.3 CH, 25.0 3x CH_3 , 23.9 CH, 23.0 CH; IR (neat) 1767 (s) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{17}\text{H}_{22}\text{O}_3$ 274.1569, found 274.1582. The stereochemistry was assigned by nOe experiments.

Dehalogenation of 7 and 16. To the corresponding iodocyclopropane (107 μ mol, 1.0 equiv) in ether (0.7 mL)) at -78°C was added *n*-BuLi (204 μ L, 1.58 M, 322 μ mol, 3.0 equiv). The reaction mixture was stirred until TLC analysis showed the complete consumption of starting material. Methanol (2 drops) was added to quench the reaction and the solution was filtered on a small silica pad. The volatiles were removed under reduced pressure and the residue was purified by flash chromatography (EtOAc/hexanes) to afford the dehalogenated cyclopropanes (20.0 mg, 91% yield) which was compared to an authentic sample by ^1H NMR.

S3: Colorless oil. R_f 0.19 (35% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.38-7.26 (m, 5H, Ph), 4.53 (s, 2H, PhCH_2O), 3.39-3.33 (m, 2H, BnOCH_2), 3.32-3.21 (m, 1H, CHMe), 1.68 (s (br), 1H, OH), 1.29 (d, $J =$

6 Hz, 3H, CH_3), 1.06-0.99 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 0.89-0.81 (m, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.63-0.56 (m, 1H, $\text{CH}_{2\text{cyclopro.}}$), 0.56-0.45 (m, 1H, $\text{CH}_{2\text{cyclopro.}}$); ^{13}C NMR (75 MHz, CDCl_3) δ 138.8 C, 128.7 2xCH, 128.0 2xCH, 127.9 CH, 73.7 CH_2 , 72.9 CH_2 , 71.7 CH, 25.5 CH, 22.9 CH_3 , 16.3 CH, 8.9 CH_2 ; IR (CHCl_3) 3413 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{13}\text{H}_{18}\text{O}_2$ 206.1307, found 206.1302.

S4: Colorless oil. R_f 0.28 (25% EtOAc/hexanes); ^1H NMR (300 MHz, CDCl_3) δ 7.38-7.25 (m, 5H, Ph), 4.55 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.50 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.47 (dd, $J = 10$, 6 Hz, 1H, BnOCH_2), 3.25 (dd, $J = 10$, 7 Hz, 1H, BnOCH_2), 2.63 (d, $J = 9$ Hz, 1H, $\text{CH}(t\text{-Bu})$), 1.53 (s (br), 1H, OH), 1.17-1.05 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 0.99 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.93-0.81 (m, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.59-0.53 (m, 1H, $\text{CH}_{2\text{cyclopro.}}$), 0.51-0.45 (m, 1H, $\text{CH}_{2\text{cyclopro.}}$); ^{13}C NMR (75 MHz, CDCl_3) δ 138.8 C, 128.7 2xCH, 127.9 3xCH, 83.6 CH, 73.7 CH_2 , 73.0 CH_2 , 36.1 C, 26.4 3x CH_3 , 20.0 CH, 18.8 CH, 8.1 CH_2 ; IR (neat) 3432 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{16}\text{H}_{24}\text{O}_2$ 248.1776, found 248.1768.

Protodesilylation. Protonolysis of the cyclopropyltrimethylsilane were performed according to a protocol described in the literature¹⁶. The crude products were compared to authentic compounds by ^1H NMR.

S5: Colorless oil. R_f 0.19 (35% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.35-7.27 (m, 5H, Ph), 4.54 (s, 2H, PhCH_2O), 3.41 (dd, $J = 10$, 8 Hz, 1H, BnOCH_2), 3.26 (dd, $J = 10$, 7 Hz, 1H, BnOCH_2), 3.18 (qn, $J = 6$ Hz, 1H, CHMe), 1.97 (s (br), 1H, OH), 1.26 (d, $J = 6$ Hz, 3H, CH_3), 1.12-1.06 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 0.88-0.82 (m, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.48 (t, $J = 7$ Hz, 2H, $\text{CH}_{2\text{cyclopro.}}$); ^{13}C NMR (100 MHz, CDCl_3) δ 138.8 C, 128.7 2xCH, 128.0 2xCH, 127.9 CH, 73.9 CH_2 , 73.0 CH_2 , 72.1 CH, 25.9 CH, 22.6 CH_3 , 17.3 CH, 8.1 CH_2 ; IR (CHCl_3) 3403 (br) cm^{-1} .

S6: Colorless oil. R_f 0.38 (25% EtOAc/hexanes); ^1H NMR (400 MHz, CDCl_3) δ 7.39-7.28 (m, 5H, Ph), 4.58 (d, $J = 12$ Hz, 1H, PhCH_2O), 4.54 (d, $J = 12$ Hz, 1H, PhCH_2O), 3.44 (dd, $J = 10$, 6 Hz, 1H, BnOCH_2), 3.27 (dd, $J = 10$, 7 Hz, 1H, BnOCH_2), 2.60 (d, $J = 9$ Hz, 1H, $\text{CH}(t\text{-Bu})$), 1.59 (s (br), 1H, OH), 1.11-1.01 (m, 1H, $\text{CH}_2\text{CH}_{\text{cyclopro.}}$), 0.98 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.88-0.81 (m, 1H, $\text{CHCH}_{\text{cyclopro.}}$), 0.64-0.58 (m, 2H, $\text{CH}_{2\text{cyclopro.}}$); ^{13}C NMR (75 MHz, CDCl_3) δ 138.8 C, 128.7 2xCH, 128.0 2xCH, 127.9 CH, 83.7 CH, 73.9 CH_2 , 72.9 CH_2 , 36.1 C, 26.4 3x CH_3 , 20.7 CH, 16.1 CH, 11.0 CH_2 ; IR (neat) 3436 (br) cm^{-1} ; HRMS (MAB) calcd for $\text{C}_{12}\text{H}_{15}\text{O}_2$ (M- C_4H_9) 191.1072, found 191.1073.

^1H NMR (400 MHz, CDCl_3)

^{13}C NMR (75 MHz, CDCl_3)

^1H NMR (400 MHz, CDCl_3)

¹H NMR (300 MHz, CDCl₃)

^{13}C NMR (75 MHz, CDCl_3)

¹H NMR (300 MHz, CDCl₃)

^{13}C NMR (75 MHz, CDCl_3)

¹H NMR (400 MHz, CDCl₃)

^{13}C NMR (75 MHz, CDCl_3)

¹H NMR (400 MHz, CDCl₃)

^{13}C NMR (100 MHz, CDCl_3)

^1H NMR (300 MHz, CDCl_3)

^{13}C NMR (75 MHz, CDCl_3)

^1H NMR (300 MHz, CDCl_3)

^{13}C NMR (75 MHz, CDCl_3)

^1H NMR (300 MHz, CDCl_3)

^1H NMR (300 MHz, CDCl_3)

¹H NMR (300 MHz, CDCl₃)

¹H NMR (300 MHz, CDCl₃)

¹³C NMR (75 MHz, CDCl₃)

¹H NMR (300 MHz, CDCl₃)

^{13}C NMR (75 MHz, CDCl_3)

^1H NMR (400 MHz, CDCl_3)

^1H NMR (400 MHz, CDCl_3)

¹³C NMR (100 MHz, CDCl₃)

^1H NMR (400 MHz, CDCl_3)

^1H NMR (300 MHz, CDCl_3)

^{13}C NMR (75 MHz, CDCl_3)

^{13}C NMR (75 MHz, CDCl_3)

^1H NMR (400 MHz, CDCl_3)

^1H NMR (300 MHz, CDCl_3)

¹H NMR (300 MHz, C₆D₆)