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Tetrahedron 61 (2005) 7632–7653
Tetrahedron

Synthesis of polypropionate subunits from cyclopropanes

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Received 29 March 2005; revised 26 May 2005; accepted 31 May 2005

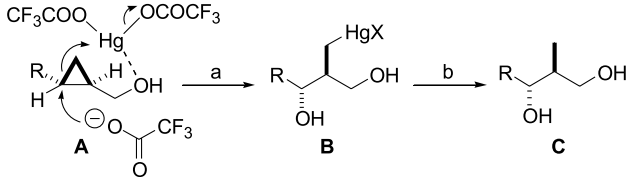
Available online 22 June 2005

Abstract—The oxymercuration–reductive demercuration of several cyclopropanealkanol or their derivatives bearing adjacent stereocenters has been investigated in order to synthesize polypropionate subunits. The crucial importance of the ester protecting group for the remote oxygenated moieties on the mechanism and the stereochemical outcome of these reactions has been rationalized.

1. Introduction

Polypropionate subunits are present in a great number of biological active natural products such as antibiotics, antitumors, antifungals, antiparasitics or immunomodulators.[1] The importance of these natural products together with their structural and stereochemical complexity has led to the development of several ingenious methodologies to provide access to these structures.[2] A widespread strategy involves the disconnection of polypropionate chains into shorter subunits bearing an alternance of methyl and hydroxyl groups and to combine these fragments by using coupling reactions.[3] In conjunction with our interest concerning the development of methods for polypropionate synthesis,[4] the generation of such subunits from cyclopropanealkanols bearing adjacent stereocenters has been investigated. Indeed, several cyclopropanealkanols of type **A** were reported to undergo highly regio- and stereoselective oxymercurations when treated with mercuric trifluoroacetate.[5–9] This reaction involves an electrophilic ring-opening of the cyclopropanealkanols of type **A** at the most electron-rich carbon–carbon bond with concomittant *anti* nucleophilic attack of the trifluoroacetate counter-anion (or any other added more powerful nucleophile). After hydrolysis in the presence of halide ions and subsequent reductive demercuration of the intermediate organomercuric halides of type **B**, 1,3-diols of type **C** were elaborated (Scheme 1).[5–7]

It is noteworthy that, a complex mixture of products was obtained when oxymercurations were applied to some



Scheme 1. Reagents and conditions: (a) $Hg(OCOCF_3)_2$, CH_2Cl_2 then NaCl (X=Cl) or KBr (X=Br); (b) reductive demercuration.

cyclopropanemethanols of type **A** bearing a remote oxygenated moiety ($R=CH_2CH_2OR'$ with $R'=H$ or Si*t*-BuPh_2). However, the reaction proceeded in modest yield if an ester protecting group ($R=CH_2CH_2OAc$) was chosen for the remote hydroxyl group, presumably due to an internal participation of the ester moiety, although, this had only been suggested and not further investigated.[5]

Since, the cyclopropane could be regarded as an equivalent of a methyl-hydroxyl array, whose relative configuration is controlled by the initial stereogenic centers of the three-membered ring, the oxymercuration of cyclopropanemethanol derivatives of types **D**, **E** and **F** bearing one to three adjacent stereocenters and remote hydroxyl groups protected as esters (P=Ac or Piv) was envisaged with the aim of obtaining stereotriads, stereotetrads and stereopentads, respectively.[9,10] On the other hand, the oxymercuration–reductive demercuration of the secondary cyclopropanealkanols derivatives of type **G** and **H** bearing adjacent stereocenters on both sides of the three-membered ring could also provide an access to stereotetrads and stereopentads by a similar process (Scheme 2).

The preparation of racemic cyclopropanealkanols of type **D**–**H** was first considered in order to probe their conversion to polypropionate subunits by an oxymercuration–reductive demercuration sequence.

Keywords: Cyclopropanes; Diastereoselectivity; Ring opening; Electrophilic additions; Mercury.
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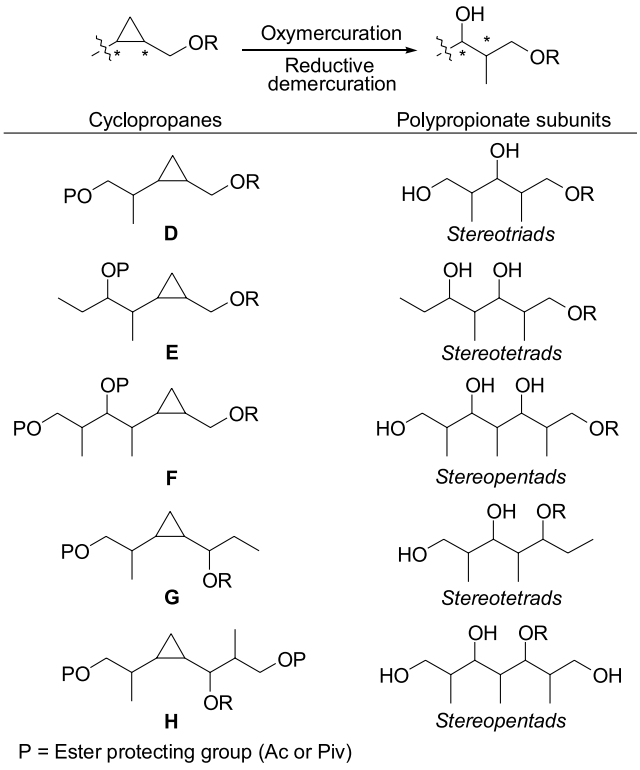
doi:10.1016/j.tet.2005.05.099



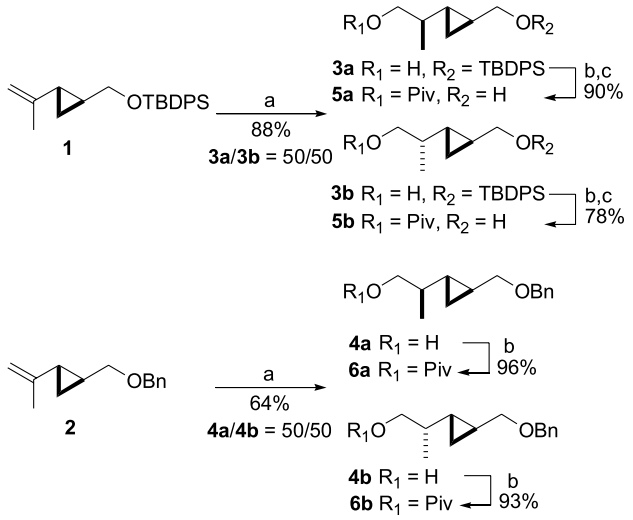
Scheme 2.

2. Preparation of cyclopropanealkanols of type D–H

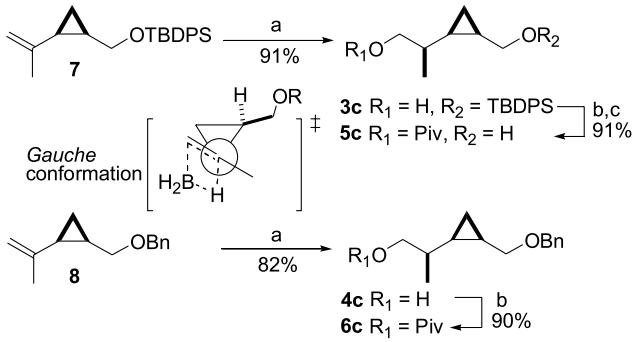
Previous investigations from our laboratory were devoted to the development of efficient synthetic routes to cyclopropanemethanols bearing adjacent stereocenters. In this context, *cis*-1,2-disubstituted alkenylcyclopropanes were reported to undergo highly diastereoselective electrophilic additions, whereas the corresponding *trans* isomers reacted in an almost stereorandom fashion.[11,12] Thus, when isopropenylcyclopropanes **1** and **2** were hydroborated with $BH_3\cdot THF$ followed by a standard alkaline oxidative work-up ($NaOH/H_2O_2$), a 50/50 diastereomeric mixture of the corresponding primary alcohols **3a**,**b** (88%) and **4a**,**b** (64%), respectively, was obtained.[11] The diastereomers were easily separated by flash chromatography and, by standard protecting group manipulations, compounds **3a** and **3b** were converted into cyclopropanemethanols **5a** (90%) and **5b** (78%), respectively, whereas compounds **4a** and **4b** were converted into the corresponding benzyl ethers **6a** (96%) and **6b** (93%) (Scheme 3).

By contrast, the *cis*-isopropenylcyclopropanes **7** and **8**, were hydroborated with high diastereoselectivity (dr > 96/4) to afford, respectively, the primary alcohols **3c** (91%) and **4c** (82%), having the methyl group *syn* to the adjacent cyclopropane.[11] This result was explained by the attack of the organoborane on the less hindered face of the double bond in the more stable and possibly reactive *gauche* conformation.[12,13] Compounds **3c** and **4c** were then converted to the cyclopropanemethanol **5c** (91%) or to the benzyl ether **6c** (90%) (Scheme 4).

In order to have access to a *cis*-disubstituted cyclopropanemethanol derivative with the methyl group on the



Scheme 3. Reagents and conditions: (a) $BH_3\cdot THF$, THF, −30 °C to rt, then NaOH, H_2O_2; (b) PivCl, Et_3N and/or DMAP, Et_2O or CH_2Cl_2; (c) *n*-Bu_4NF, THF.

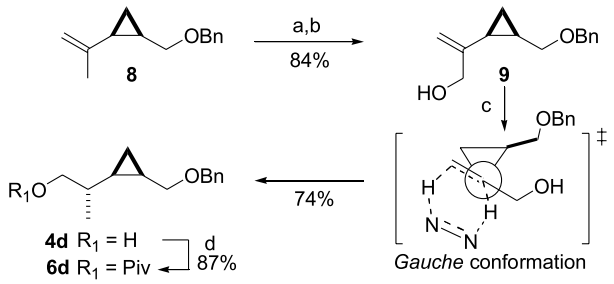


Scheme 4. Reagents and conditions: (a) $BH_3\cdot THF$, THF, −30 °C to rt, then NaOH, H_2O_2; (b) PivCl, DMAP, CH_2Cl_2; (c) *n*-Bu_4NF, THF.

adjacent stereocenter *anti* to the cyclopropane, the isopropenylcyclopropane **8** was first subjected to an allylic oxidation with SeO_2 in the presence of *tert*-butylhydroperoxide (TBHP).[14] Reduction of the crude reaction mixture with sodium borohydride in the presence of cerium(III) chloride afforded the allylic alcohol **9** (84%).[15] By analogy with the hydroboration of **8**, the hydrogenation of the *cis*-disubstituted isopropenylcyclopropane **9** was anticipated to involve an addition to the less hindered face of the carbon–carbon double bond in the *gauche* conformation,[12,13] which would then stereoselectively lead to compound **4d** having the methyl group *anti* to the cyclopropane. Indeed, the reduction of **9** with diimide turned out to proceed with high diastereoselectivity (dr = **4c**/**4d** = 8/92) and the resulting primary alcohol **4d** (74%) was subsequently converted to the pivalate ester **6d** (87%) (Scheme 5).

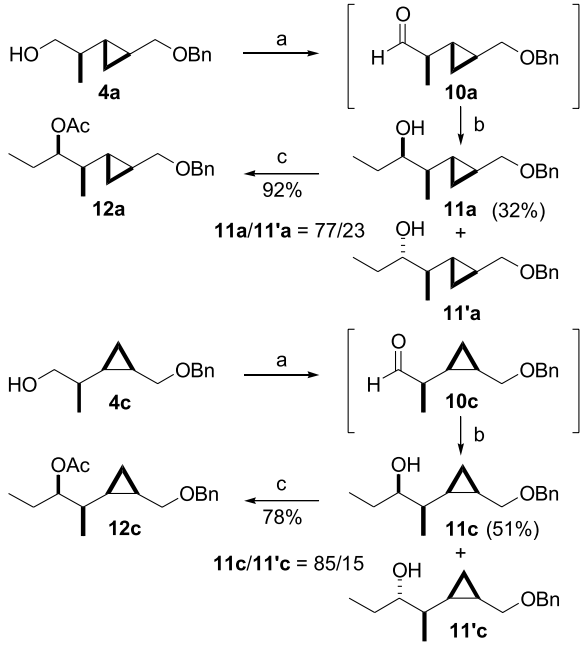
Having synthesized all the possible diastereomeric cyclopropanemethanols of type **D 5a**–**5d** and their corresponding benzyl ethers **6a**–**6d**, the preparation of cyclopropanes of type **E** and **F**, bearing two or three stereocenters adjacent to the three-membered ring, was achieved.

The primary alcohols **4a** and **4c** were oxidized



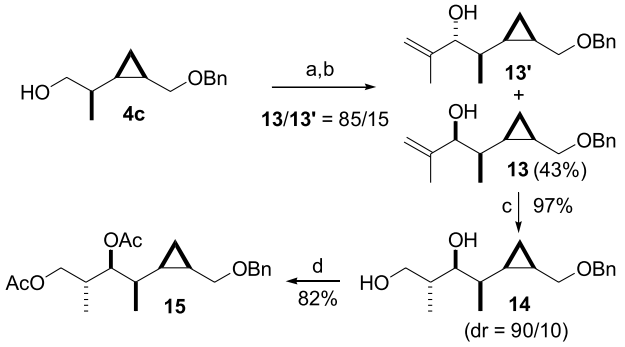
Scheme 5. Reagents and conditions: (a) SeO_2, *t*-BuOOH, CH_2Cl_2; (b) $NaBH_4$, $CeCl_3 \cdot 7H_2O$, MeOH, 0 °C; (c) $KO_2C–N{=}N–CO_2K$, AcOH, EtOH, 45 °C; (d) PivCl, Et_3N, cat. DMAP, Et_2O.

(cat. *n*-$PrNRuO_4$ (TPAP), NMO, CH_2Cl_2/MeCN)[16] to the corresponding sensitive aldehydes **10a** and **10c**, which were not purified but directly treated with ethylmagnesium bromide in THF, to afford diastereomeric mixtures of the corresponding secondary alcohols **11a/11′a** (dr=77/23) and **11c/11′c** (dr=85/15). The major diastereomers **11a** (32%) and **11c** (51%) could be separated after purification by flash chromatography and their relative configurations were initially attributed on the basis of the Felkin–Anh model for nucleophilic additions to carbonyl compounds.[17] This assignment was later confirmed after the oxymercuration to polypropionate subunits. The secondary alcohols **11a** and **11c** were transformed into the acetates **12a** (92%) and **12c** (91%), respectively. They constitute two examples of cyclopropanes of type **E** (Scheme 6).



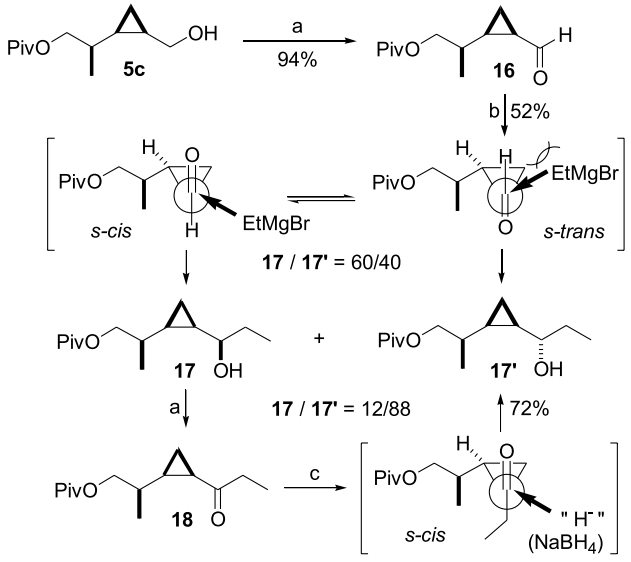
Scheme 6. Reagents and conditions: (a) cat. TPAP, NMO, CH_2Cl_2/MeCN, 0 °C to rt; (b) EtMgBr, THF, −30 °C and separation by flash chromatography; (c) Ac_2O, cat. DMAP, Et_2O.

One single cyclopropane of type **F** bearing three adjacent stereocenters was synthesized from compound **4c**, which was oxidized to aldehyde **10c** and addition of isopropenylmagnesium bromide gave a diastereomeric mixture of alcohols **13** and **13′** (dr=85/15). The major diastereomer **13** (43%) was separated and hydroborated with high diastereoselectivity by using 9-BBN-H followed by a standard oxidative work-up to afford diol **14** (dr=90/10, 97%),[18] which was finally, converted to the diacetate **15** (82%), a substrate of type **F** (Scheme 7).

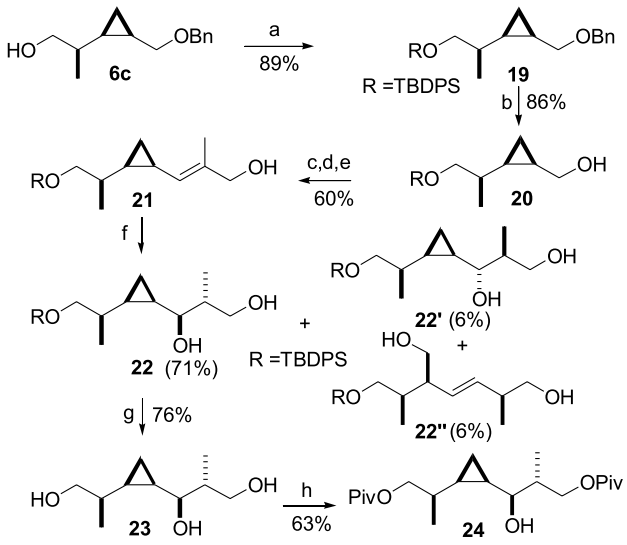


Scheme 7. Reagents and conditions: (a) cat. TPAP, NMO, CH_2Cl_2/MeCN, 0 °C to rt; (b) isopropenylMgBr, THF, −30 °C; (c) 9-BBN-H, THF, −30 °C to rt; (d) Ac_2O, cat. DMAP, Et_2O.

Next, the synthesis of the secondary cyclopropanealkanols of type **G** and **H** was realized. The cyclopropanemethanol **5c** was oxidized with PCC[19] to the corresponding cyclopropanecarboxaldehyde **16** (94%). This aldehyde **16** was treated with ethylmagnesium bromide to afford a diastereomeric mixture of the secondary cyclopropanepropanols **17** and **17′** (60/40 ratio, 52%), which were readily separated by flash chromatography. It is known that the bisected conformers of cyclopropylcarbonyl derivatives are more stable than other conformers and that they are also envisaged to be the reactive conformers in models for nucleophilic additions to this class of compounds.[20] For cyclopropanecarboxaldehydes, the *s-trans* conformation is only slightly preferred, whereas for cyclopropylketones the *s-cis* conformation is markedly more stable.[20] Moreover, nucleophilic addition to the *s-trans* confomer follows the *anti*-Felkin–Anh addition mode with respect to the carbonyl adjacent stereocenter, whereas addition to the *s-cis* conformer implies a Felkin–Anh mode.[17] In agreement



Scheme 8. Reagents and conditions: (a) PCC, 4 Å molecular sieves, CH_2Cl_2; (b) EtMgBr, THF, −30 °C; (c) $NaBH_4$, MeOH, 0 °C.



Scheme 9. Reagents and conditions: (a) TBSCl, imidazole, DMF; (b) H_2, cat. Pd/C, EtOH; (c) PCC, 4 Å molecular sieves, CH_2Cl_2; (d) $Ph_3P{=}CHCO_2Me$, toluene, reflux; (e) DIBAL-H, CH_2Cl_2, −78 °C; (f) *T*-hexBH_2, THF, −30 °C to rt then NaOH, H_2O_2; (g) *n*-Bu_4NF, THF; (h) PivCl, Et_3N, cat. DMAP, CH_2Cl_2.

with these results, the addition of ethylmagnesium bromide to cyclopropanecarboxaldehyde **16** occurred with a low degree of diastereoselectivity and provided a 60/40 mixture of the secondary cyclopropanealkanols **17** and **17′** (52%), which were separated by flash chromatography. Alternatively, ketone **18** resulting from the oxidation of **17** was reduced with $NaBH_4$ in MeOH into the secondary cyclopropylpropanol **17′** with a higher diastereoselectivity of 88/12 (Scheme 8).[17,20]

Finally, one example of secondary cyclopropanealkanol of type **H** was derived from substrate **4c**. This compound was protected as a *tert*-butyldiphenylsilylether **19** (89%) and subsequent debenzylation afforded the cyclopropanemethanol **20** (86%). The latter compound was subjected to a three step sequence involving an oxidation with PCC, a Wittig olefination and subsequent reduction of the α,β-unsaturated ester with DIBAL-H, leading to the allylic alcohol **21** (60% overall yield). Based on previous investigations, hydroboration of *cis*-1,2-disubstituted alkenylcyclopropane **21** (bearing a trisubstituted double bond) with thexylborane proceeded with high diastereoselectivity (dr=12/1) giving a mixture of diols **22** and **22′**, which were separated by flash chromatography and isolated in 71 and 6% yields, respectively.[11b] A third minor ring-opened by-product, whose structure was assigned as **22″**, was also isolated in 6% yield.[11b] The major diastereomer **22** was then desilylated to generate the triol **23** (76%) and the primary alcohol moieties were protected as pivalates to afford the secondary cyclopropanealkanol **24** (63%) of type **H** (Scheme 9).

Thirteen racemic cyclopropanealkanol derivatives of type **D–H** were synthesized during the first part of this study and are reported in Table 1. Their oxymercuration–reductive demercuration was then investigated with the aim of obtaining stereotriads, stereotetrads and stereopentads.

3. Oxymercuration of cyclopropanes of type D–F

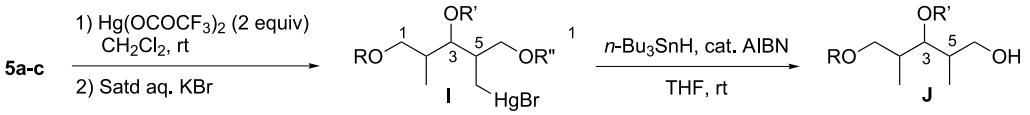
3.1. Oxymercuration of cyclopropanemethanols 5a–c

When the cyclopropanemethanols **5a–c** were subjected to an oxymercuration with mercuric trifluoroacetate (2 equiv) in CH_2Cl_2, a rapid reaction occurred and after treatment

Table 1. Structure of cyclopropanealkanols of type **D–H**

Type of structure	Cyclopropanes	
D	PivO, OR **5a** R=H **6a** R=Bn	PivO, OR **5c** R=H **6c** R=Bn
	PivO, OR **5b** R=H **6b** R=Bn	PivO, OR **6d** R=Bn
E	OAc, OBn **12a**	OAc, OBn **12c**
F	AcO, OAc, OBn **15**	
G	PivO, OH **17**	PivO, OH **17′**
H	PivO, OPiv, OH **24**	

Table 2. Oxymercuration of cyclopropanemethanols **5a–c**

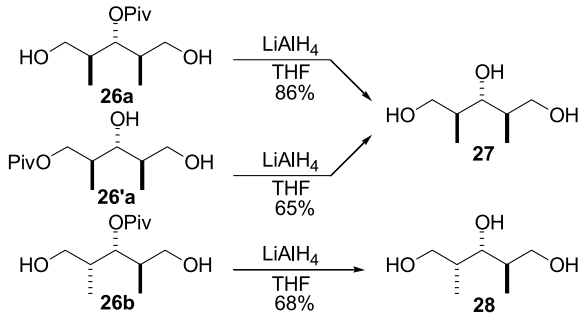


5a	**25a** (60%) **25'a** / **25"a** = 80/20 (20%)	**26a** (96%) **26'a** (92%)
5b	**25b** / **25'b** **25''b**	**26b** / **26'b** = 95/5 (80%) **26''b** not detected
5c	**25c** (60%) **25'c** / **25"c** = 75/25 (17%)	**26b** (88%) **26"b** / **26'b** = 75/25 (70%)

with an aqueous solution of KBr, the organomercuric bromides of type **I** were formed. These compounds have been characterized in the case of substrates **5a** and **5c**, otherwise they were directly subjected to a reductive demercuration by using *n*-Bu_3SnH and a catalytic amount of AIBN in THF,[21] to generate the stereotriads of type **J**. The results are shown in Table 2.

The oxymercuration of **5a** led to two major organomercuric bromides **25a** and **25′a** and a third minor one **25″a**, which was barely detected by analysis of the ^1H NMR spectrum of the crude reaction mixture. After careful purification by flash chromatography, **25a** was isolated in 60% yield together with an inseparable mixture of **25′a** and **25″a** (ratio 80/20, 20% yield). The reductive demercuration of **25a** afforded the symmetrical stereotriad **26′a**, whereas both compounds **25′a** and **25″a** (80/20 mixture) were converted in a similar fashion into the same stereotriad **26′a** (92%) (racemic series).[22]

The fact that compounds **26a** and **26′a** were reduced by $LiAlH_4$ to the same known *anti*,*anti*-triol **27**,[23] indicated that they only differ by the positioning of the pivaloyl ester group and that the

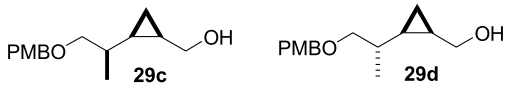


Scheme 10. Configurational assignment of compounds **26a**, **26a′** and **26b**.

organomercuric bromides **25a**, **25′a** and **25″a** all share the same relative *anti*,*anti* relative configuration (Scheme 10).

In the case of cyclopropanemethanol **5b**, the oxymercuration led to a regioisomeric mixture of organomercuric bromides, which was directly subjected to reductive demercuration. A regioisomeric mixture of two stereotriads **26b** and **26′b** (95/5 ratio) was obtained in 80% overall yield and in this case the third regioisomeric product **26″b** was not detected. The relative configuration of **26b** was assigned unambiguously after reduction with $LiAlH_4$ to the known *syn*,*anti*-triol **28**[23] (Scheme 10), whereas the relative configuration of **26′b** was later confirmed by a chemical correlation.[22] Finally, in the case of cyclopropanemethanol **5c**, the oxymercuration led to three organomercuric bromides **25c**, **25′c** and **25″c**. The major one was isolated in 60% yield, whereas an inseparable mixture of **25′c** and **25″c** (75/25 ratio) was isolated in 17% yield. The reductive demercuration of **25c** afforded the previously characterized stereotriad **26b** (88%), whereas the mixture of **25′c** and **25″c** (75/25 ratio) was converted to the stereotriads **26″b** and **26′b** (75/25 ratio), respectively, (70% combined yield).

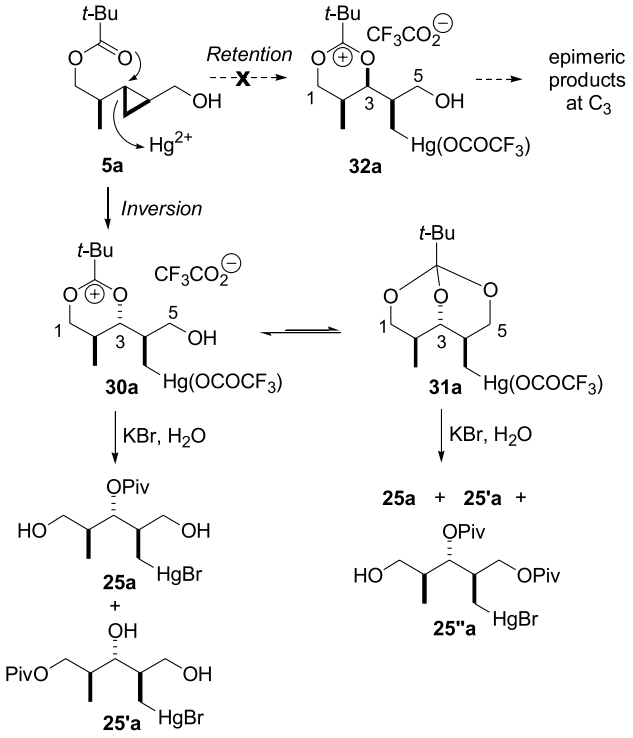
From the results of this study, it appeared that the cyclopropanes **5a–c** of type **D**, with remote oxygenated functional groups protected as pivalates can undergo highly diastereoselective oxymercuration, which proceed with inversion of configuration at the stereocenter bearing the newly introduced oxygenated moiety (at C3). In sharp contrast, cyclopropanemethanols **29c** and **29d** having a remote oxygenated moiety protected as a 4-methoxy-benzyl ether, failed to be oxymercurated under the same conditions despite extended reaction times (Fig. 1).



PMB = 4-methoxybenzyl

Figure 1. Structure of cyclopropanemethanols **29c** and **29d**.

All these observations clearly demonstrate the fundamental role exerted by the remote ester functionality during the mercuration of cyclopropanemethanols **5a–c**. As illustrated in the case of the cyclopropanemethanol **5a**, a reasonable scenario would involve an anchimerically assisted oxymercuration by the carbonyl group of the ester moiety,[10] proceeding with inversion of configuration and leading to a dioxycarbenium ion intermediate of the type **30a**. Hydrolysis of this intermediate is expected to generate the corresponding regioisomeric organomercuric bromides **25a** and **25′a**. In order to explain the formation of the minor organomeruric bromide **25″a**, the intermediacy of a bicyclic orthoester **31a** could also be envisaged,[24] and its subsequent hydrolysis would generate a mixture of the three regioisomeric organomercuric bromides **25a**, **25′a** and **25″a**. Apparently, products that would have resulted from an oxymercuration proceeding with retention of configuration (hydrolysis products of intermediate **32a**) were not observed (Scheme 11).



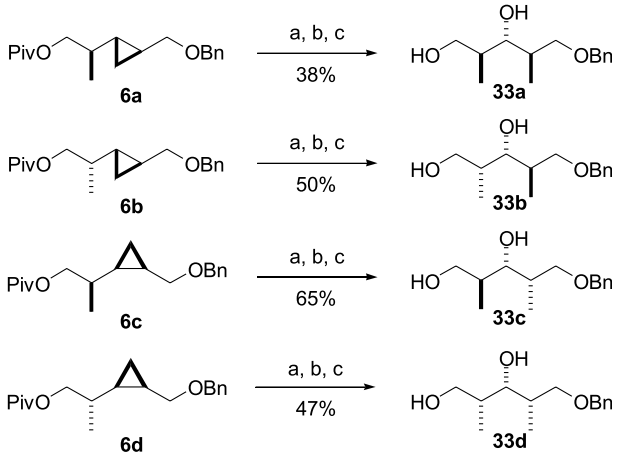
Scheme 11. Oxymercuration of cyclopropanemethanol **5a**.

Although, the possibility of synthesizing stereotriads from cyclopropanemethanols of type **D** was demonstrated, regioisomeric products were obtained from compounds **5a–c**. In order to generate stereotriads having the two primary alcohol functions differentiated, the oxymercuration–reductive demercuration of cyclopropanemethanol derivatives **6a–d** having one hydroxyl group protected as a benzyl ether and the remote hydroxyl group protected as an ester (pivalate) was investigated. Indeed, previous literature results as well as the absence of reactivity of the cyclopropanemethanols **29c** and **29d** (Fig. 1) suggested that benzyl ethers, as protecting groups, should be compatible with the oxymercuration conditions.[6,8a]

3.2. Oxymercuration of the cyclopropane derivatives 6a–d protected as benzyl ethers

Thus, the benzyl-protected cyclopropanemethanols **6a–d** were subjected to a three-step sequence involving oxymercuration with mercuric trifluoroacetate and subsequent work-up with a saturated aqueous solution of KBr, reductive

demercuration with n-Bu_3SnH and deprotection of the regioisomeric mixtures of pivalates with $LiAlH_4$ in THF. Although, $LiAlH_4$ itself could have initiated the reductive demercuration,[21] cleaner reactions were observed by using this two-step reduction procedure. Under these conditions, the known four diastereomeric stereotriads **33a–d** were, respectively, obtained from **6a–d** in 38–68% overall yields and with high diastereoselectivity (dr $\geq$ 95/5). Their relative configurations were confirmed unambiguously by comparison with literature data,[25] confirming that these anchimerically assisted oxymercurations proceed, as anticipated, with inversion of configuration (Scheme 12).

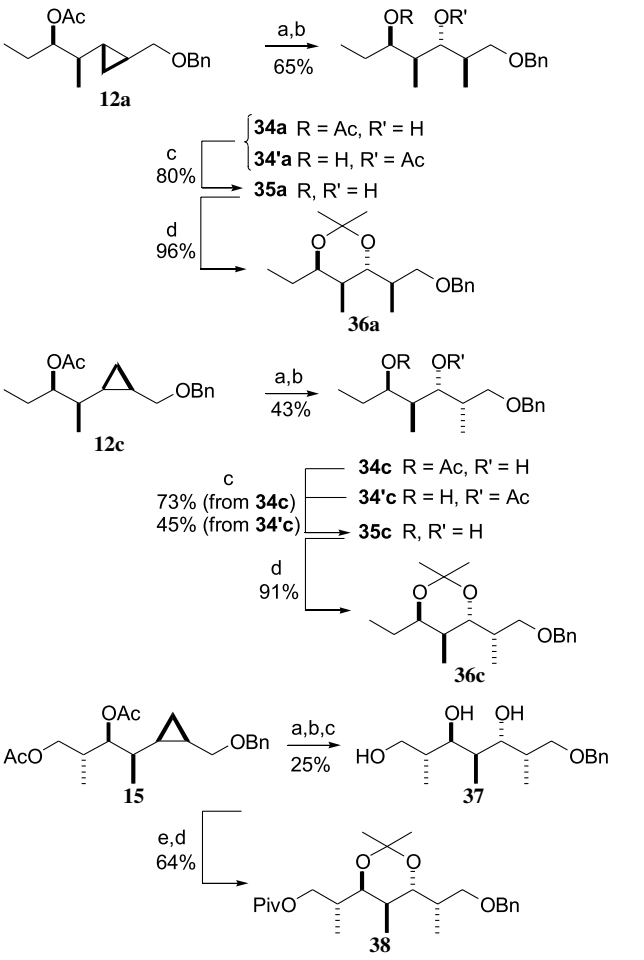


Scheme 12. Reagents and conditions: (a) $Hg(OCOCF_3)_2$, CH_2Cl_2 then satd aq. KBr; (b) n-Bu_3SnH, cat. AIBN, THF; (c) $LiAlH_4$, THF, 0 °C to rt.

The synthesis of stereotetrads and stereopentads from the structurally related cyclopropanemethanols of type **E** and **F** having primary alcohols protected as benzyl ethers and the remote oxygenated moieties protected as acetates was also investigated. The corresponding substrates **12a**, **12c** and **15** were subjected to the same three-step sequence (oxymercuration, reductive demercuration, reduction) and the results are listed in Table 3.

In the case of **12a**, the regioisomeric mixture of acetates **34a** and **34′a** (65%) was not fully characterized but reduced to produce the diol **35a** as a single diastereomer (80%). The relative configuration of this diol was determined after conversion to the acetonide **36a** by ^{13}C NMR.[26] In the case of **12c**, the regioisomeric acetates resulting from the oxymercuration–reductive demercuration sequence, **34c** and **34′c** (75/25 ratio, 43% combined yield) could be separated by flash chromatography. Both compounds were reduced to the same diol **35c**, whose relative configuration was determined after conversion to the acetonide **36c** (91%).[26] Similarly, cyclopropane **15** afforded the triol **37** (25%) after oxymercuration–reductive demercuration and subsequent reduction with $LiAlH_4$. The triol **37**[27] was converted to **38** (64%) by esterification of the primary alcohol as a pivalate and formation of an acetonide, which served to confirm the configurational assignment.[26] In all these anchimerically assisted oxymercurations leading to stereotriads and stereopentads, an inversion of configuration was always observed at the newly introduced oxygenated moiety. Therefore, a pathway similar to the one described in Scheme 11 is likely to operate and the presence of the benzyl group enables the differentiation of the two primary alcohol functionalities.

Table 3. Synthesis of stereotetrads and stereopentads



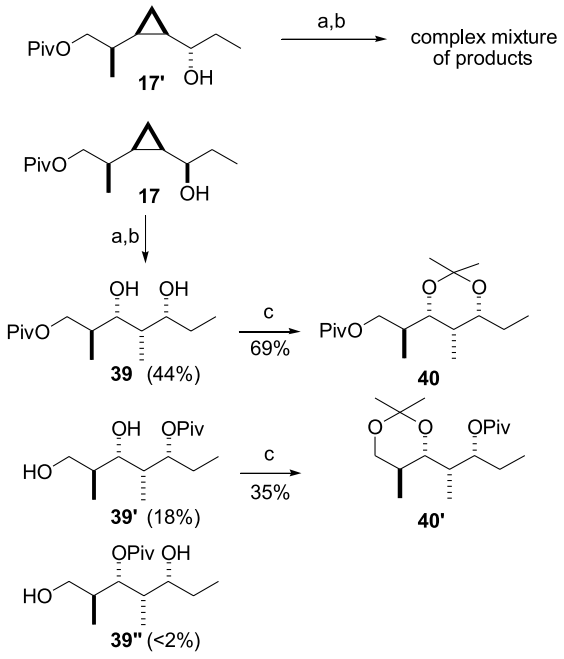
Reagents and conditions: (a) $Hg(OCOCF_3)_2$, CH_2Cl_2 then satd aq. KBr; (b) n-Bu_3SnH, cat. AIBN, THF/toluene, rt then 60 °C; (c) $LiAlH_4$, THF; (d) 2,2-dimethoxypropane, cat. CSA, acetone; (e) PivCl, cat. DMAP, Et_3N, CH_2Cl_2.

The formation of stereotetrads and stereopentads from the cyclopropanealkanols **G** and **H** was next studied.

4. Oxymercuration of the secondary cyclopropanealkanols of type G–H

The oxymercuration–reductive demercuration of the two epimeric cyclopropanealkanols **17** and **17′**; was first investigated in order to study the influence of the relative configuration of the secondary alcohol on the outcome of the reaction. When **17′** was subjected to the oxymercuration–reductive demercuration sequence, a complex mixture of products was formed. In sharp contrast, **17** underwent a faster and cleaner oxymercuration and after reductive demercuration two major regioisomeric diols **39** and **39′** were formed (73/27 ratio) and, respectively, isolated in 44% and 18% yields. A third minor component (<2%) whose structure was tentatively assigned to **39″** was also isolated.

The structure of **39** and **39′** was determined by NMR and the presence of a 1,3-diol moiety was supported by the fact that both compounds could be converted to the acetonides **40** and **40′**. Furthermore, examination of the ^{13}C NMR spectrum of **40** enabled the assignment of its relative configuration[26] and confirmed that the oxymercuration had occurred with inversion of configuration at the stereocenter bearing the newly introduced oxygenated moiety (Scheme 13).

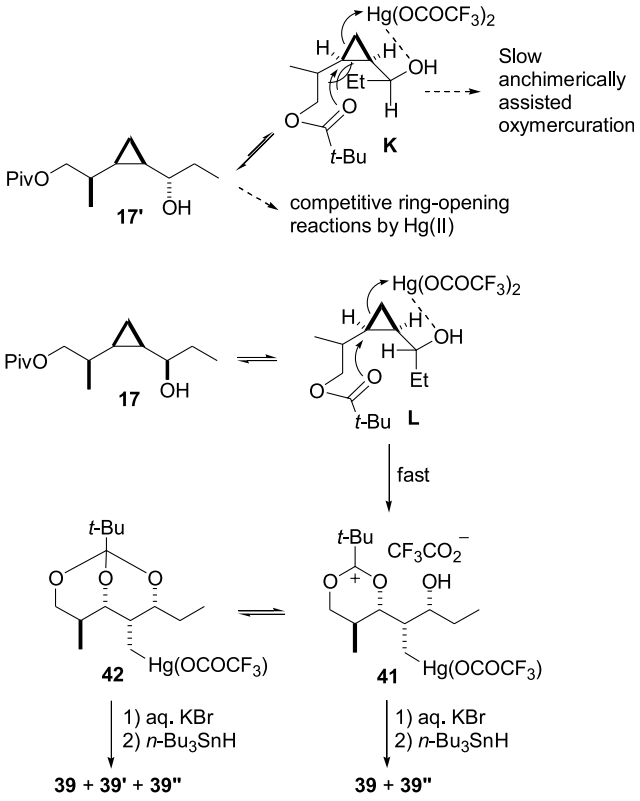


Scheme 13. Reagents and conditions: (a) $Hg(OCOCF_3)_2$, CH_2Cl_2 then satd aq. KBr; (b) n-Bu_3SnH, cat. AIBN, THF/toluene, rt then 60 °C; (c) 2,2-dimethoxypropane, cat. CSA, acetone.

Although, the precise reason for the difference of reactivity between the diastereomeric cyclopropanealkanols **17** and **17′** has not been fully elucidated, it might be due to the fact that the reactive conformer **K** in the oxymercuration of **17′** is destabilized by a severe 1,3-interaction (cyclopropylic strain, similar to $A^{1,3}$ strain),[28,29] thereby slowing down the intramolecularly assisted oxymercuration. This would alter the usual regioselectivity of electrophilic ring-opening of cyclopropanealkanols with mercury salts[5–7] and lead to competing side reactions causing the formation of a complex mixture of products.

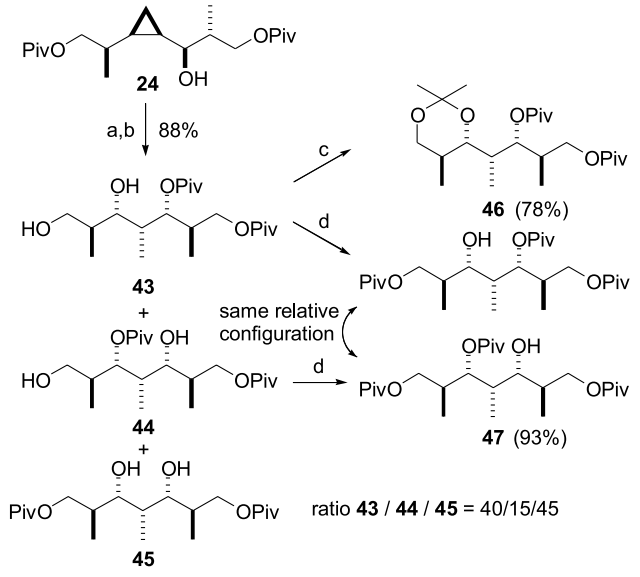
By contrast, such a 1,3-interaction is absent in conformer **L** arising from **17** and an anchimerically assisted oxymercuration by the carbonyl group of the ester would lead to a dioxycarbenium ion intermediate of the type **41**. As previously mentioned, this species could be in equilibrium with a bicyclic orthoester[24] **42**. Upon hydrolysis of the reaction mixture and subsequent reductive demercuration, a regioisomeric mixture of diols **39**, **39′** and **39″** is expected to be produced (Scheme 14).

Therefore, it appeared that the formation of polypropionate subunits from secondary cyclopropanealkanols was only possible for substrates having a hydroxyl group *syn* to the adjacent cyclopropane. Since, the secondary



Scheme 14. Oxymercuration of secondary cyclopropanealkanols **17** and **17′**.

cyclopropanealkanol **24** of type **H** met this stereochemical requirement, this compound was subjected to the oxymercuration–reductive demercuration under the standard conditions. In this case, a regioisomeric mixture of three diols **43**, **44** and **45** (45/15/40 ratio) was obtained in an excellent combined yield (88%). Due to its symmetrical character, the structure of **45** was readily assigned. Among **43** and **44**, only the latter could be converted to the acetonide **46**, thereby establishing the presence of a 1,3-diol moiety in this



Scheme 15. Reagents and conditions: (a) $Hg(OCOCF_3)_2$, CH_2Cl_2, rt then satd aq. KBr; (b) n-Bu_3SnH, cat. AIBN, THF/toluene, rt then 60 °C; (c) 2,2-dimethoxypropane, cat. CSA, acetone; (d) PivCl, cat. DMAP, Et_3N, Et_2O.

compound. Moreover, monoesterification of a mixture of **43** and **44** by treatment with PivCl led to a single compound **47** (93%) due to the formation of a diastereomer of similar relative configuration (racemic series). These results demonstrated once again that **43**, **44** and **45** only differ by the positioning of one pivalate group and that the oxymercuration has involved, like in all cases investigated, an inversion of configuration. Moreover, the further remote second pivalate moiety in cyclopropylcarbinol **24** has not interfered in the oxymercuration reaction (Scheme 15).

5. Conclusion

We have reported a full account of our studies concerning the synthesis of polypropionate-type subunits from cyclopropanes bearing adjacents stereocenters using an oxymercuration–reductive demercuration sequence. The presence of a suitably located ester protecting group for the hydroxyl group at the β-position was found to be crucial due to a favorable anchimeric assistance in the oxymercuration process. Although, the use of mercury salts restricts the interest of these reactions to academic research activities, the results presented in this account should encourage the search for alternative mediators to effect these transformations, as the cyclopropane could be regarded as a useful synthetic equivalent of a methyl-hydroxyl array. Moreover, the stereoelectronic properties of the three-membered ring can be used to control the configurations of adjacent stereocenters as illustrated by stereoselective electrophilic additions to alkenylcyclopropanes or nucleophilic additions to cyclopropylcarbonyl derivatives.

6. Experimental

6.1. General procedures

Infrared (IR) spectra were recorded on a Perkin–Elmer 298, wavenumbers are indicated in cm^{-1}. ^1H NMR spectra were recorded on a Bruker AC 300 at 300 MHz in $CDCl_3$ (unless otherwise specified) and data are reported as follows: chemical shift in ppm from tetramethylsilane as an internal standard, multiplicity (s=singlet, d=doublet, t=triplet, q=quartet, m=multiplet or overlap of non-equivalent resonances), integration. ^{13}C NMR spectra were recorded on a Bruker AC 300 at 75 MHz in $CDCl_3$ and data are reported as follows: chemical shift in ppm from tetramethylsilane with the solvent as an internal indicator ($CDCl_3$ δ 77.0 ppm), multiplicity with respect to proton (deduced from DEPT experiments, s=quaternary C, d=CH, t=CH_2, q=CH_3). Mass spectra with electronic impact (MS-EI) were recorded from a Hewlett-Packard tandem 5890A GC (12 m capillary column)-5971 MS (70 eV). Mass spectra with chemical ionization (MS-CI^+) or FAB and high resolution mass spectra (HRMS) were performed by the Centre de Spectrochimie Organique de l'Ecole Normale Supérieure Ulm (Paris). Elemental analyses were performed by the Centre Régional de Microanalyses (Université Pierre et Marie Curie, Paris VI). THF and diethyl ether were distilled from sodium/benzophenone. CH_2Cl_2, CH_3CN, toluene, Et_3N, DMF were distilled from CaH_2. Other reagents were obtained from commercial suppliers and used as received. TLC was performed on Merck $60F_{254}$ silica gel plates visualized either with a UV lamp (254 nm), or by using solutions of *p*-anisaldehyde/H_2SO_4/AcOH in EtOH or $KMnO_4/K_2CO_3$ in water followed by heating. Flash chromatography was performed with SDS 60 silica gel (230–400 mesh).

6.2. Preparation of cyclopropanes of type D

6.2.1. (2*R)-2-[(1*S**,2*S**)-2-(Hydroxymethyl)cyclopropyl]propyl 2,2-dimethylpropanoate 5a.** To a solution of **3a**[10,11] (500 mg, 1.36 mmol) in Et_2O (10 mL) at rt, were successively added Et_3N (265 μL, 1.90 mmol, 1.4 equiv), DMAP (33 mg, 0.27 mol, 0.2 equiv) and PivCl (236 μL, 1.90 mmol, 1.4 equiv). After 12 h, the reaction was quenched by addition of a saturated aqueous $NaHCO_3$ solution and the resulting mixture was extracted with Et_2O. The combined extracts were washed with a 1 M aqueous HCl solution, brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residual oil was dissolved in THF (5 mL) and to the resulting solution at 0 °C, was added *n*-Bu_4NF (2.0 mL, 1 M in THF, 2.0 mmol). After 3 h at rt, the reaction mixture was hydrolyzed with a saturated aqueous NH_4Cl solution and extracted with Et_2O. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (cyclohexane–EtOAc: 90/10–75/25) to afford 261 mg (90%) of **5a** as a colorless oil; IR 3450, 1725, 1285, 1165, 1035 cm^{-1}; ^1H NMR δ 4.09 (dd, J=10.7, 5.9 Hz, 1H), 3.91 (dd, J=10.7, 6.7 Hz, 1H), 3.49 (dd, J=11.2, 6.9 Hz, 1H), 3.42 (dd, J=11.2, 7.1 Hz, 1H), 2.31 (br s, 1H, OH), 1.20 (m, 1H), 1.20 (s, 9H), 1.02 (d, J=6.8 Hz, 3H), 0.91 (m, 1H), 0.53–0.41 (m, 3H); ^{13}C NMR δ 178.7 (s), 68.8 (t), 66.6 (t), 38.7 (s), 37.6 (d), 27.0 (q, 3C), 21.0 (d), 20.4 (d), 16.4 (q), 8.3 (t); MS-EI *m*/*z* (relative intensity) 197 (M−OH^+, 2), 183 (M−CH_2OH^+, 2), 112 (M−*t*-$BuCO_2H^+$, 13), 97 (14), 95 (15), 85 (19), 81 (16), 79 (18), 69 (18), 68 (18), 57 (100), 55 (17).

6.2.2. (2*S)-2-[(1*S**,2*S**)-2-(Hydroxymethyl)cyclopropyl]propyl 2,2-dimethylpropanoate 5b.** This compound was synthesized from **3b**[10,11] (500 mg, 1.36 mmol), following the procedure described for the preparation of **5a** from **3a**. Purification by flash chromatography (cyclohexane–EtOAc: 90/10–75/25) afforded 227 mg (78%) of **5b** as a colorless oil; IR 3400, 1720, 1290, 1165, 1030 cm^{-1}; ^1H NMR δ 4.10 (dd, J=10.7, 5.9 Hz, 1H), 3.90 (dd, J=10.7, 6.7 Hz, 1H), 3.48 (dd, J=11.2, 6.9 Hz, 1H), 3.42 (dd, J=11.2, 7.1 Hz, 1H), 2.30 (br s, 1H, OH), 1.28–1.14 (m, 2H), 1.21 (s, 9H), 1.02 (d, J=6.8 Hz, 3H), 0.53–0.41 (m, 3H); ^{13}C NMR δ 178.6 (s), 69.0 (t), 66.8 (t), 38.8 (s), 37.0 (d), 27.2 (q, 3C), 20.8 (d), 19.5 (d), 16.6 (q), 9.3 (t); MS-EI *m*/*z* (relative intensity) 197 (M−OH^+, 7), 183 (M−CH_2OH^+, 4), 112 (M−*t*-$BuCO_2H^+$, 14), 97 (19), 95 (19), 85 (20), 81 (15), 79 (20), 69 (16), 68 (18), 57 (100), 55 (18).

6.2.3. (2*R)-2-[(1*S**,2*R**)-2-(Hydroxymethyl)cyclopropyl]propyl 2,2-dimethylpropanoate 5c.** This compound was prepared from **3c**[10,11] (1.28 g, 3.47 mmol) following the procedure described for the preparation of **5a** from **3a**. Purification by flash chromatography (pentane–Et_2O: 60/40–50/50) afforded 676 mg (91%) of **5c** as a

colorless oil; IR 3420, 1725, 1290, 1160, 1035 cm^{-1}; ^1H NMR δ 4.28 (dd, $J=10.8$, 4.0 Hz, 1H), 3.78 (dd, $J=10.8$, 8.3 Hz, 1H), 3.76 (m, 1H), 3.46 (m, 1H), 2.81 (br s, 1H, OH), 1.36 (m, 1H), 1.18 (m, 1H), 1.16 (s, 9H), 1.04 (d, $J=$ 6.7 Hz, 3H), 0.72–0.58 (m, 2H), −0.06 (m, 1H); ^{13}C NMR δ 179.1 (s), 69.7 (t), 62.7 (t), 38.8 (s), 32.6 (d), 27.1 (q, 3C), 19.7 (d), 18.8 (d), 17.9 (q), 7.6 (t); MS-EI *m/z* (relative intensity) 197 ($M-OH^+$, 3), 183 ($M-CH_2OH^+$, 3), 112 ($M-t$-$BuCO_2H^+$, 14), 97 (17), 95 (17), 85 (21), 81 (16), 79 (20), 69 (18), 68 (16), 57 (100), 55 (16).

6.2.4. (2*R)-2-{(1*R**,2*S**)-2-[(Benzyloxy)methyl]cyclopropyl}propan-1-ol 4a and (2*S**)-2-{(1*R**,2*S**)-2-[(benzyloxy)methyl]cyclopropyl}propan-1-ol 4b.**[10,11] To a solution of **2** (340 mg, 1.68 mmol) in THF (5 mL) at −30 °C, was added $BH_3\cdot THF$ (1.7 mL, 1 M in THF, 1.7 mmol, 1.0 equiv) and the reaction mixture was allowed to warm to rt for 1 h. After 1 h, a 6 M aqueous solution of NaOH (5 mL) and a 30% aqueous H_2O_2 solution (5 mL) were successively added dropwise at 0 °C. After 3 h at rt, the resulting mixture was extracted with Et_2O and the combined extracts were washed with brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (cyclohexane–EtOAc: 80/20) to afford 144 mg (39%) of **4a** and 92 mg (25%) of **4b** as colorless oils.

Compound (**4a**). R_f 0.42 (cyclohexane–EtOAc: 50/50); IR 3430, 1095, 1070, 1030 cm^{-1}; ^1H NMR δ 7.38–7.23 (m, 5H), 4.55 (d, $J=12.2$ Hz, 1H), 4.47 (d, $J=12.2$ Hz, 1H), 3.73 (dd, $J=9.5$, 5.3 Hz, 1H), 3.62–3.46 (m, 2H), 3.25 (br s, 1H, OH), 2.86 (dd apparent t, $J=9.5$ Hz, 1H), 1.14–0.94 (m, 3H), 0.90 (d, $J=6.4$ Hz, 3H), 0.40–0.28 (m, 2H); ^{13}C NMR δ 138.1 (s), 128.3 (d, 2C), 127.5 (d), 127.4 (d, 2C), 74.3 (t), 72.7 (t), 69.1 (t), 40.0 (d), 21.7 (d), 18.1 (d), 16.4 (q), 7.1 (t); MS-EI *m/z* (relative intensity) 161 ($M-CH_3CHCH_2OH^+$, 4), 108 (11), 107 (13), 92 (15), 91 (100), 82 (10).

Compound (**4b**). R_f 0.22 (cyclohexane–EtOAc: 50/50); IR 3400, 3080, 1090, 1070, 1030 cm^{-1}; ^1H NMR δ 7.40–7.24 (m, 5H), 4.55 (d, $J=12.1$ Hz, 1H), 4.50 (d, $J=12.1$ Hz, 1H), 3.54 (d, $J=5.9$ Hz, 2H), 3.40 (dd, $J=10.0$, 6.6 Hz, 1H), 3.24 (dd, $J=10.0$, 7.4 Hz, 1H), 2.16 (br s, 1H, OH), 1.24 (m, 1H), 0.93 (m, 1H), 0.92 (d, $J=6.8$ Hz, 3H), 0.55–0.49 (m, 2H), 0.42 (m, 1H); ^{13}C NMR δ 138.4 (s), 128.3 (d, 2C), 127.5 (d, 2C), 127.4 (d), 74.2 (t), 72.4 (t), 68.3 (t), 38.6 (d), 20.3 (d), 15.4 (q), 15.3 (d), 9.0 (t); MS-EI *m/z* (relative intensity) 161 ($M-CH_3CHCH_2OH^+$, 3), 108 (12), 92 (15), 91 (100), 82 (10).

6.2.5. (2*R)-2-{(1*S**,2*S**)-2-[(Benzyloxy)methyl]cyclopropyl}propyl 2,2-dimethylpropanoate 6a.** To a solution of **4a** (460 mg, 2.09 mmol) and DMAP (383 mg, 3.13 mmol, 1.5 equiv) in CH_2Cl_2 (10 mL) at rt, was added PivCl (310 μL, 2.50 mmol, 1.2 equiv). After 2 h, the reaction was quenched with MeOH (1 mL). After 20 min, a saturated aqueous $NaHCO_3$ solution was added and the resulting mixture was extracted with Et_2O. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (cyclohexane–EtOAc: 95/5) to afford 614 mg (96%) of **6a** as a colorless oil; IR 3060, 1725, 1480, 1290, 1160, 1095 cm^{-1}; ^1H NMR δ 7.36–7.23 (m, 5H), 4.50 (s, 2H), 4.07 (dd, $J=10.8$, 5.5 Hz, 1H), 3.95 (dd, $J=10.8$, 6.8 Hz, 1H), 3.45 (dd, $J=10.1$, 6.1 Hz, 1H), 3.16 (dd, $J=10.1$, 7.5 Hz, 1H), 1.19 (m, 1H), 1.19 (s, 9H), 0.98 (d, $J=6.6$ Hz, 3H), 0.98 (m, 1H), 0.54–0.36 (m, 3H); ^{13}C NMR δ 178.4 (s), 138.5 (s), 128.3 (d, 2C), 127.5 (d, 2C), 127.4 (d), 73.7 (t), 72.4 (t), 69.1 (t), 38.7 (s), 37.2 (d), 27.2 (q, 3C), 20.5 (d), 17.5 (d), 16.5 (q), 8.9 (t); MS-EI *m/z* (relative intensity) 213 ($M-CH_2Ph^+$, 1), 96 (22), 95 (17), 92 (12), 91 (100), 81 (16), 57 (37). Anal. Calcd for $C_{19}H_{28}O_3$: C, 74.96; H, 9.27. Found: C, 74.81; H, 9.37.

6.2.6. (2*S)-2-{(1*S**,2*S**)-2-[(Benzyloxy)methyl]cyclopropyl}propyl 2,2-dimethylpropanoate 6b.** This compound was synthesized from **4b** (100 mg, 0.44 mmol) following the procedure described for the preparation of **6a** from **4a**. Purification by flash chromatography (cyclohexane–EtOAc: 95/5) afforded 129 mg (93%) of **6b** as a colorless oil; IR 3060, 1730, 1285, 1165, 1100 cm^{-1}; ^1H NMR δ 7.35–7.25 (m, 5H), 4.56 (d, $J=12.0$ Hz, 1H), 4.49 (d, $J=12.0$ Hz, 1H), 4.07 (dd, $J=10.8$, 5.5 Hz, 1H), 3.90 (dd, $J=10.8$, 6.8 Hz, 1H), 3.38 (dd, $J=10.3$, 6.6 Hz, 1H), 3.27 (dd, $J=10.3$, 7.0 Hz, 1H), 1.21 (m, 1H), 1.20 (s, 9H), 1.04 (d, $J=6.6$ Hz, 3H), 0.93 (m, 1H), 0.52–0.39 (m, 3H); ^{13}C NMR δ 178.5 (s), 138.6 (s), 128.3 (d, 2C), 127.5 (d, 2C), 127.4 (d), 74.0 (t), 72.4 (t), 69.0 (t), 38.8 (s), 37.3 (d), 27.2 (q, 3C), 20.8 (d), 16.8 (q), 16.7 (d), 9.8 (t); MS-EI *m/z* (relative intensity) 304 (M^+, 1), 247 ($M-t$-Bu^+, 1), 197 (15), 96 (11), 95 (21), 92 (13), 91 (100), 57 (37). Anal. Calcd for $C_{19}H_{28}O_3$: C, 74.96; H, 9.27. Found: C, 74.82; H, 9.42.

6.2.7. (2*R)-2-{(1*R**,2*R**)-2-[(Benzyloxy)methyl]cyclopropyl}propan-1-ol 4c.** To a solution of **8** (5.68 g, 28.1 mmol) in THF (300 mL) at −30 °C, was added $BH_3\cdot THF$ complex (32 mL, 1 M in THF, 32 mmol, 1.1 equiv) and the reaction mixture was allowed to warm to rt for 1 h. After 2 h, a 3 M aqueous NaOH solution (70 mL) and a 30% aqueous H_2O_2 solution (70 mL) were successively added dropwise at 0 °C. After 3 h at rt, the aqueous phase was extracted with Et_2O, the combined extracts were washed with brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc gradient: 90/10–70/30) to afford 5.04 g (82%) of **4c** as a colorless oil; IR 3420, 3060, 1090, 1070 cm^{-1}; ^1H NMR δ 7.40–7.24 (m, 5H), 4.51 (s, 2H), 3.80 (br s, 1H, OH), 3.80 (dd, $J=10.4$, 5.1 Hz, 1H), 3.57 (dd, $J=10.4$, 4.5 Hz, 1H), 3.43 (dd apparent t, $J=10.0$ Hz, 1H), 3.11 (dd apparent t, $J=10.0$ Hz, 1H), 1.34–1.18 (m, 2H), 0.96 (d, $J=6.8$ Hz, 3H), 0.73–0.59 (m, 2H), −0.11 (m, 1H); ^{13}C NMR δ 137.4 (s), 128.3 (d, 2C), 127.8 (d, 2C), 127.7 (d), 72.9 (t), 70.4 (t), 68.8 (t), 35.1 (d), 21.1 (d), 17.7 (q), 16.2 (d), 6.3 (t); MS-EI *m/z* (relative intensity) 143 ($M-Ph^+$, 2), 108 (9), 107 (11), 92 (15), 91 (100), 82 (9), 81 (10), 67 (10), 55 (9). Anal. Calcd for $C_{14}H_{20}O_2$: C, 76.33; H, 9.15. Found: C, 76.14; H, 9.37.

6.2.8. (2*R)-2-{(1*S**,2*R**)-2-[(Benzyloxy)methyl]cyclopropyl}propyl 2,2-dimethylpropanoate 6c.** This compound was synthesized from **4c** (140 mg, 0.636 mmol) following the procedure described for the preparation of **6a** from **4a**. Purification by flash chromatography (cyclohexane–EtOAc: 95/5) afforded 172 mg (90%) of **6c** as a colorless oil; IR 3060, 1725, 1285, 1165 cm^{-1}; ^1H NMR δ

7.26–7.15 (m, 5H), 4.47 (d, J=11.8 Hz, 1H), 4.42 (d, J=11.8 Hz, 1H), 4.17 (dd, J=10.6, 4.1 Hz, 1H), 3.82 (dd, J=10.6, 8.1 Hz, 1H), 3.45 (dd, J=10.1, 6.9 Hz, 1H), 3.39 (dd, J=10.1, 7.9 Hz, 1H), 1.31 (m, 1H), 1.17 (s, 9H), 1.13 (m, 1H), 0.97 (d, J=6.7 Hz, 3H), 0.77–0.64 (m, 2H), −0.04 (m, 1H); ^{13}C NMR δ 178.4 (s), 138.4 (s), 128.3 (d, 2C), 127.8 (d, 2C), 127.5 (d), 72.8 (t), 70.5 (t), 69.1 (t), 38.8 (s), 32.8 (d), 27.2 (q, 3C), 19.7 (d), 17.6 (q), 16.1 (d), 8.3 (t); MS-EI m/z (relative intensity) 219 ($M-t$-BuCO$^+$, 1), 213 ($M-CH_2Ph^+$, 1), 96 (25), 95 (16), 92 (12), 91 (100), 81 (19), 57 (40). Anal. Calcd for $C_{19}H_{28}O_3$: C, 74.96; H, 9.27. Found: C, 74.81; H, 9.39.

6.2.9. 2-{(1*S,2*R**)-2-[(Benzyloxy)methyl]cyclopropyl)} prop-2-en-1-ol 9.** To a solution of SeO_2 (28 mg, 0.25 mmol, 0.5 equiv) in CH_2Cl_2 (10 mL) at 0 °C, was added t-BuOOH (370 μL, ca. 5.5 M in decane, 2.04 mmol, 4.0 equiv). After 30 min, a solution of **8** (103 mg, 0.509 mmol) in CH_2Cl_2 (5 mL) was added dropwise and the reaction mixture was allowed to warm to rt. After 7 h, the reaction mixture was hydrolyzed with a 1 M aqueous NaOH solution and extracted with CH_2Cl_2. The combined extracts were washed with brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was dissolved in MeOH (5 mL) and to the resulting solution at 0 °C, were successively added $CeCl_3\cdot 7H_2O$ (190 mg, 0.509 mmol, 1.0 equiv) and $NaBH_4$ (38 mg, 1.0 mmol, 2.0 equiv). After 20 min, the reaction mixture was poured into a saturated aqueous NH_4Cl solution and extracted with Et_2O. The combined extracts were washed with brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc: 80/20–70/30) to afford 93 mg (84%) of **9** as a colorless oil; IR 3400, 3060, 1645, 1060, 1030, 905, 740, 700 cm^{-1}; ^{1}H NMR δ 7.30–7.16 (m, 5H), 4.93 (br s, 1H), 4.56 (br s, 1H), 4.41 (d, J=11.9 Hz, 1H), 4.34 (d, J=11.9 Hz, 1H), 4.10 (br s, 2H), 3.60 (dd, J=10.0, 4.5 Hz, 1H), 3.50 (br s, 1H, OH), 2.89 (dd, apparent t, J=10.0 Hz, 1H), 1.54 (m, 1H), 1.40 (m, 1H), 0.71 (m, 1H), 0.45 (m, 1H); ^{13}C NMR δ 145.6 (s), 137.3 (s), 128.3 (d, 2C), 127.9 (d, 2C), 127.7 (d), 110.7 (t), 72.9 (t), 68.6 (t), 67.5 (t), 18.9 (d), 17.4 (d), 5.1 (t); MS (CI$^+$, CH_4) m/z (relative intensity) 219 ($M+H^+$, 50), 201 (15), 183 (45), 171 (16), 129 (17), 111 (40), 93 (82), 91 (100); HRMS (CI$^+$, CH_4) Calcd for $C_{14}H_{19}O_2$ ($M+H^+$): 219.1385. Found: 219.1381.

6.2.10. (2*S)-2-{(1*R**,2*R**)-2-[(Benzyloxy)methyl]cyclopropyl}propan-1-ol 4d.** A solution of AcOH (7.5 g, 0.12 mol) in EtOH (20 mL) was added over 8 h, via a syringe pump, to a solution of **9** (86 mg, 0.39 mmol) and potassium azodicarboxylate (2×24 g added at 4 h intervall, 0.24 mol) in EtOH (60 mL) at 45 °C. After a further 1 h at 40 °C, the reaction mixture was cooled to rt and filtered through Celite. The filtrate was evaporated under reduced pressure and the solid residue was triturated in Et_2O (300 mL). The resulting mixture was stirred overnight at rt, filtered through Celite and the insoluble material was thoroughly washed with Et_2O. The filtrate was evaporated under reduced pressure and the crude material was analyzed by ^{1}H NMR and GC–MS, which indicated the formation of a diastereomeric mixture of **4c** and **4d** (8/92 ratio). Purification by flash chromatography (cyclohexane–EtOAc: 75/25) afforded 64 mg (74%) of **4d** as a colorless oil; IR 3380, 3060, 1090, 1070, 1020, 750, 740, 700 cm^{-1}; ^{1}H NMR δ 7.37–7.27 (m, 5H), 4.57 (d, J=11.9 Hz, 1H), 4.51 (d, J=11.9 Hz, 1H), 3.64 (dd, J=10.7, 5.7 Hz, 1H), 3.53 (dd, J=10.3, 6.6 Hz, 1H), 3.52 (dd, J=10.7, 6.2 Hz, 1H), 3.44 (dd, J=10.3, 8.0 Hz, 1H), 1.77 (br s, 1H, OH), 1.27–1.14 (m, 2H), 1.08 (d, J=6.3 Hz, 3H), 0.81–0.62 (m, 2H), 0.13 (m, 1H); ^{13}C NMR δ 138.4 (s), 128.3 (d, 2C), 127.7 (d, 2C), 127.5 (d), 72.8 (t), 70.3 (t), 68.9 (t), 35.9 (d), 19.7 (d), 17.3 (q), 14.0 (d), 8.5 (t); MS (CI$^+$, CH_4) m/z (relative intensity) 221 ($M+H^+$, 17), 123 (37), 113 (51), 95 (100), 91 (100). Anal. Calcd for $C_{14}H_{20}O_2$: C, 76.33; H, 9.15. Found: C, 76.03; H, 9.46.

6.2.11. (2*S)-2-{(1*S**,2*R**)-2-[(Benzyloxy)methyl]cyclopropyl}propyl 2,2-dimethylpropanoate 6d.** This compound was synthesized from **4d** (50 mg, 0.23 mmol) following the procedure described for the preparation of **6c** from **4c**. Purification by flash chromatography (petroleum ether–EtOAc: 95/5) gave 59 mg (87%) of **6d** as a colorless oil; IR 3070, 1730, 1290, 1165, 1090 cm^{-1}; ^{1}H NMR δ 7.35–7.25 (m, 5H), 4.56 (d, J=12.0 Hz, 1H), 4.49 (d, J=12.0 Hz, 1H), 4.09 (dd, J=10.7, 5.5 Hz, 1H), 3.91 (dd, J=10.7, 7.0 Hz, 1H), 3.54 (dd, J=10.3, 6.3 Hz, 1H), 3.40 (dd, J=10.3, 8.1 Hz, 1H), 1.42–1.14 (m, 2H), 1.20 (s, 9H), 1.09 (d, J=6.6 Hz, 3H), 0.78–0.64 (m, 2H), 0.10 (m, 1H); ^{13}C NMR δ 178.5 (s), 138.4 (s), 128.3 (d, 2C), 127.6 (d, 2C), 127.5 (d), 72.8 (t), 70.2 (t), 69.6 (t), 38.7 (s), 33.1 (d), 27.2 (q, 3C), 19.8 (d), 17.6 (q), 14.6 (d), 8.7 (t); MS-EI m/z (relative intensity) 304 (M^+, 1), 247 ($M-t$-Bu$^+$, 1), 197 (20), 95 (23), 92 (13), 91 (100), 57 (38). Anal. Calcd for $C_{19}H_{28}O_3$: C, 74.96; H, 9.27. Found: C, 74.79; H, 9.39.

6.3. Preparation of cyclopropanemethanols of type E

6.3.1. (2*R,3*S**)-2-{(1*S**,2*S**)-2-[(Benzyloxy)methyl]-cyclopropyl}pentan-3-ol 11a and (2*R**,3*R**)-2-{(1*S**,2*S**)-2-[(benzyloxy)methyl]cyclopropyl}pentan-3-ol 11′a.** To a solution of **4a** (1.00 g, 4.55 mmol) in CH_2Cl_2–MeCN (9/1, 10 mL) at 0 °C, were successively added NMO (799 mg, 6.82 mmol, 1.5 equiv), 4 Å powdered molecular sieves (2.3 g) and TPAP (102 mg, 0.290 mmol, 0.06 equiv). After 3 h at rt the reaction mixture was concentrated under reduced pressure and the residue was filtered through silica gel (CH_2Cl_2–EtOAc: 50/50). The filtrate was evaporated under reduced pressure and the crude aldehyde **10a** was dissolved in Et_2O (1 mL). The resulting solution was added to a solution of EtMgBr (3.0 mL, 3 M in Et_2O, 9.0 mmol, 2.0 equiv) in Et_2O (10 mL) at −50 °C. After 1 h at −50 °C, the reaction mixture was warmed to rt, poured into a saturated aqueous NH_4Cl solution and extracted with Et_2O. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude material was analyzed by ^{1}H NMR and GC–MS, which indicated a 77/23 ratio of the two diastereomers **11a** and **11′a**. After purification by flash chromatography (petroleum ether–EtOAc gradient: 95/5–80/20), 92 mg (8%) of **11′a** (minor diastereomer) and 358 mg (32%) of **11a** (major diastereomer) were obtained as colorless oils.

Compound (**11′a**). IR 3430, 1065, 1025, 965, 735, 700 cm^{-1}; ^{1}H NMR δ 7.42–7.27 (m, 5H), 4.60 (d, J=12.5 Hz, 1H), 4.53 (d, J=12.5 Hz, 1H), 3.78 (dd, J=9.4, 5.1 Hz, 1H),

3.53 (br s, 1H, OH), 3.46 (td, J=8.1, 2.9 Hz, 1H), 2.83 (dd, apparent t, J=9.4 Hz, 1H), 1.71 (m, 1H), 1.42 (m, 1H), 1.17 (m, 1H), 1.01 (t, J=7.4 Hz, 3H), 0.96 (d, J=6.6 Hz, 3H), 0.80 (m, 1H), 0.49–0.28 (m, 3H); ^{13}C NMR δ 138.2 (s), 128.3 (d, 2C), 127.5 (d, 3C), 78.5 (d), 74.2 (t), 72.7 (t), 43.4 (d), 26.7 (t), 22.1 (d), 19.4 (d), 16.7 (q), 9.8 (q), 7.2 (t); MS-EI *m/z* (relative intensity) 189 ($M-EtCHOH^+$, 0.5), 108 (19), 92 (12), 91 (100), 82 (25), 67 (18).

Compound (**11a**). IR 3420, 3060, 1090, 1060, 1025, 970, 950, 735, 700 cm^{-1}; ^{1}H NMR δ 7.34–7.22 (m, 5H), 4.53 (d, J=12.1 Hz, 1H), 4.46 (d, J=12.1 Hz, 1H), 3.55 (dd, J=9.9, 5.9 Hz, 1H), 3.45 (m, 1H), 3.03 (dd, J=9.9, 8.5 Hz, 1H), 2.63 (br s, 1H, OH), 1.59–1.37 (m, 2H), 1.06–0.81 (m, 2H), 0.94 (t, J=7.4 Hz, 3H), 0.93 (d, J=5.5 Hz, 3H), 0.56 (m, 1H), 0.44–0.31 (m, 2H); ^{13}C NMR δ 138.2 (s), 128.2 (d, 2C), 127.4 (d), 127.3 (d, 2C), 76.7 (d), 74.2 (t), 72.5 (t), 42.4 (d), 26.3 (t), 20.7 (d), 17.8 (d), 14.2 (q), 10.6 (q), 8.9 (t); MS (CI^+, CH_4) *m/z* (relative intensity) 249 ($M+H^+$, 40), 141 (57), 123 (100), 107 (22), 91 (100), 83 (33); HRMS (CI^+, CH_4) Calcd for $C_{16}H_{25}O_2$ ($M+H^+$): 249.1855. Found: 249.1854.

6.3.2. (1*R,2*R**)-2-{(1*S**,2*S**)-2-[(Benzyloxy)methyl]-cyclopropyl}-1-ethylpropyl acetate 12a.** To a solution of **11a** (224 mg, 0.902 mmol) and DMAP (57 mg, 0.47 mmol, 0.5 equiv) in Et_2O (5 mL) at rt, was added Ac_2O (200 μL, 2.13 mmol, 2.4 equiv). After 12 h at rt, the reaction was quenched by addition of MeOH (2 mL) at 0 °C and the reaction mixture was hydrolyzed with a saturated aqueous $NaHCO_3$ solution. The aqueous layer was extracted with Et_2O and the combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc: 90/10) to afford 240 mg (92%) of **12a** as a colorless oil; IR 3060, 1730, 1240, 1095, 1070, 1020, 955, 735, 700 cm^{-1}; ^{1}H NMR δ 7.40–7.21 (m, 5H), 4.86 (ddd apparent dt, J=8.5, 4.8 Hz, 1H), 4.50 (s, 2H), 3.46 (dd, J=10.0, 6.0 Hz, 1H), 3.16 (dd, J=10.0, 7.4 Hz, 1H), 2.02 (s, 3H), 1.81–1.54 (m, 2H), 1.13–0.92 (m, 2H), 0.93 (d, J=6.6 Hz, 3H), 0.86 (t, J=7.4 Hz, 3H), 0.52–0.39 (m, 2H), 0.35 (m, 1H); ^{13}C NMR δ 170.6 (s), 138.5 (s), 128.1 (d, 2C), 127.3 (d, 2C), 127.2 (d), 78.9 (d), 73.7 (t), 72.3 (t), 40.5 (d), 24.3 (t), 20.8 (q), 20.3 (d), 18.2 (d), 14.7 (q), 9.9 (q), 8.9 (t); MS (CI^+, CH_4) *m/z* (relative intensity) 291 ($M+H^+$, 27), 183 (100), 123 (82), 91 (41); HRMS (CI^+, CH_4) Calcd for $C_{18}H_{27}O_3$ ($M+H^+$): 291.1960. Found: 291.1959.

6.3.3. (2*R,3*R**)-2-{(1*S**,2*R**)-2-[(Benzyloxy)methyl] cyclopropyl}pentan-3-ol 11c.** Following the procedure described for the preparation of **11a** from **6a**, compound **6c** (489 mg, 2.2 mmol) was converted to a 85/15 diastereomeric mixture of alcohols **11c** and **11′c**. Purification by flash chromatography (petroleum ether–EtOAc gradient: 90/10–80/20) afforded 279 mg (51%) of **11c** as a colorless oil; IR 3420, 1090, 1070, 1025, 975, 950, 750, 735, 700 cm^{-1}; ^{1}H NMR δ 7.38–7.27 (m, 5H), 4.56 (d, J=12.1 Hz, 1H), 4.50 (d, J=12.1 Hz, 1H), 3.72 (dd, J=10.0, 5.3 Hz, 1H), 3.50 (m, 1H), 3.22 (dd, apparent t, J=10.0 Hz, 1H), 3.07 (br d, J=6.6 Hz, 1H, OH), 1.56–1.38 (m, 2H), 1.37–1.18 (m, 2H), 1.00 (t, J=7.4 Hz, 3H), 0.99 (d, J=7.0 Hz, 3H), 0.86 (m, 1H), 0.73 (m, 1H), −0.11 (m, 1H); ^{13}C NMR δ 137.8 (s), 128.4 (d, 2C), 127.9 (d, 2C), 127.7 (d), 76.9 (d), 72.9 (t), 70.5 (t), 38.1 (d), 26.0 (t), 18.6 (d), 16.6 (d), 16.4 (q), 11.1 (q), 7.2 (t); MS-EI *m/z* (relative intensity) 219 ($M-C_2H_5^+$, 0.3), 108 (19), 92 (13), 91 (100), 82 (26), 81 (11), 67 (19).

6.3.4. (1*R,2*R**)-2-{(1*S**,2*R**)-[(Benzyloxy)methyl]-cyclopropyl}-1-ethylpropyl acetate 12c.** This compound was synthesized from **11c** (116 mg, 0.468 mmol) following the procedure described for the preparation of **12a** from **11a**. Purification by flash chromatography (petroleum ether–EtOAc: 90/10) afforded 121 mg (89%) of **12c** as a colorless oil; IR 3050, 1735, 1240, 1090, 1075, 1025, 1015, 955, 740, 700 cm^{-1}; ^{1}H NMR δ 7.40–7.27 (m, 5H), 4.91 (ddd, apparent td, J=6.9, 3.8 Hz, 1H), 4.57 (d, J=12.0 Hz, 1H), 4.52 (d, J=12.0 Hz, 1H), 3.65 (dd, J=10.1, 6.6 Hz, 1H), 3.33 (dd, J=10.1, 8.1 Hz, 1H), 2.05 (s, 3H), 1.62–1.52 (m, 2H), 1.28–1.16 (m, 2H), 1.01 (d, J=6.6 Hz, 3H), 0.83 (t, J=7.5 Hz, 3H), 0.85–0.74 (m, 2H), 0.05 (m, 1H); ^{13}C NMR δ 170.9 (s), 138.5 (s), 128.3 (d, 2C), 127.7 (d, 2C), 127.5 (d), 78.9 (d), 72.7 (t), 70.7 (t), 35.8 (d), 24.8 (t), 21.1 (q), 20.1 (d), 16.5 (d), 15.1 (q), 10.3 (q), 8.9 (t); MS-EI *m/z* (relative intensity) 261 ($M-C_2H_5^+$, 0.1), 230 ($M-CH_3CO_2H^+$, 0.5), 124 (11), 95 (13), 92 (11), 91 (100), 81 (12).

6.3.5. (3*S,4*R**)-4-{(1*S**,2*R**)-2-[(Benzyloxy)methyl]-cyclopropyl}-2-methylpent-1-en-3-ol 13.** To a solution of **4c** (970 mg, 4.41 mmol) in CH_2Cl_2/MeCN (9/1, 10 mL) at 0 °C, were successively added NMO (825 mg, 7.04 mmol, 1.5 equiv), 4 Å powdered molecular sieves (2.3 g) and TPAP (93 mg, 0.26 mmol, 0.06 equiv). After 3 h at rt the reaction mixture was concentrated under reduced pressure and the residue was filtered through silica gel (CH_2Cl_2–EtOAc: 50/50). The filtrate was evaporated under reduced pressure and the crude aldehyde **10c** was dissolved in THF (2 mL). The resulting solution was added to a solution of isopropenylmagnesium bromide (18 mL, 0.5 M in THF, 9.0 mmol, 2.0 equiv) in THF (10 mL) at −30 °C. After 1 h at −30 °C, the reaction mixture was poured into a saturated aqueous NH_4Cl solution and extracted with Et_2O. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude material was analyzed by ^{1}H NMR which indicated a 85/15 ratio of the two diastereomers **13** and **13′**. Purification by flash chromatography (petroleum ether–EtOAc: 90/10–80/20) afforded 490 mg (43%) of **13** as a pale yellow oil; IR 3420, 3060, 1645, 1115, 1085, 1070, 1025, 900, 750, 735, 700 cm^{-1}; ^{1}H NMR δ 7.36–7.27 (m, 5H), 4.95 (br s, 1H), 4.90 (q, J=1.5 Hz, 1H), 4.57 (d, J=11.9 Hz, 1H), 4.51 (d, J=11.9 Hz, 1H), 4.21 (m, 1H), 3.71 (dd, J=9.9, 5.5 Hz, 1H), 3.32 (dd, apparent t, J=9.9 Hz, 1H), 2.79 (d, J=6.3 Hz, 1H, OH), 1.69 (br s, 3H), 1.42–1.20 (m, 2H), 0.95 (m, 1H), 0.95 (d, J=7.0 Hz, 3H), 0.78 (m, 1H), −0.04 (m, 1H); ^{13}C NMR δ 146.4 (s), 138.0 (s), 128.4 (d, 2C), 127.8 (d, 2C), 127.7 (d), 110.2 (t), 77.9 (d), 72.9 (t), 70.6 (t), 36.8 (d), 19.9 (q), 19.8 (d), 16.6 (d), 14.8 (q), 8.1 (t); MS (CI^+, CH_4) *m/z* (relative intensity) 261 ($M+H^+$, 60), 243 (30), 161 (61), 153 (70), 135 (65), 107 (42), 91 (100), 71 (42); HRMS (CI^+, CH_4) Calcd for $C_{17}H_{25}O_2$ ($M+H^+$): 261.1855. Found: 261.1853.

6.3.6. (2*R,3*S**,4*R**)-4-{(1*S**,2*R**)-2-[(Benzyloxy)-methyl]cyclopropyl}-2-methylpentane-1,3-diol 14.** To a solution of 9-BBN-H (5 mL, 0.5 M in THF, 2.5 mmol,

2.7 equiv) at −30 °C, was added a solution of **13** (242 mg, 0.929 mmol) in THF (2 mL). The reaction mixture was warmed to rt and after 2 h, a 3 M aqueous NaOH solution (2.2 mL) and a 30% aqueous H_2O_2 solution (2.2 mL) were successively added at 0 °C. After 2 h at rt, the resulting mixture was diluted with water and extracted with EtOAc. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc gradient: 70/30–40/60) to afford 251 mg (97%) of **14** as a colorless oil and a 9/1 mixture of diastereomers; IR 3370, 3060, 1370, 1110, 1085, 1070, 1025, 1010, 980, 750, 740, 700 cm^{-1}; Only the major diastereomer could be accurately described; ^1H NMR δ 7.36–7.27 (m, 5H), 4.53 (d, J=11.8 Hz, 1H), 4.48 (d, J=11.8 Hz, 1H), 3.72–3.48 (m, 5H), 3.29 (dd, apparent t, J=9.4 Hz, 1H), 1.87–1.15 (m, 4H), 1.00 (d, J=7.0 Hz, 3H), 1.06–0.95 (m, 1H), 0.80 (m, 1H), 0.70 (d, J=6.8 Hz, 3H), −0.02 (m, 1H); ^{13}C NMR δ 138.0 (s), 128.4 (d, 2C), 127.8 (d, 2C), 127.7 (d), 79.8 (d), 72.9 (t), 70.6 (t), 68.7 (t), 37.3 (d), 35.6 (d), 20.0 (d), 16.3 (d), 13.6 (q), 13.0 (q), 8.4 (t); MS-EI m/z (relative intensity) 219 ($M-HOCH_2CH(CH_3)^+$, 2), 108 (23), 107 (11), 92 (12), 91 (100), 82 (26), 81 (11), 67 (19).

6.3.7. (2*R,3*S**,4*R**)-3-Acetoxy-4-{(1*S**,2*R**)-2-[(benzyloxy)methyl]cyclopropyl}-2-methylpentyl acetate 15.** To a solution of **14** (240 mg, 0.863 mmol) in Et_2O (10 mL) at 0 °C, were successively added DMAP (101 mg, 0.827 mmol, 1.0 equiv) and Ac_2O (400 μL, 4.26 mmol, 5.0 equiv). After 2 h at rt, the reaction was quenched by dropwise addition of MeOH (4 mL) at 0 °C and the resulting mixture was hydrolyzed with a saturated aqueous $NaHCO_3$ solution. The aqueous layer was extracted with EtOAc and the combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc: 80/20) to afford 255 mg (82%) of **15** as a colorless oil; IR 1740, 1235, 1070, 1020, 735, 700 cm^{-1}; ^1H NMR δ 7.43–7.25 (m, 5H), 5.09 (dd, J=9.6, 2.6 Hz, 1H), 4.61 (d, J=12.0 Hz, 1H), 4.55 (d, J=12.0 Hz, 1H), 3.97 (dd, J=11.0, 4.0 Hz, 1H), 3.91 (dd, J=11.0, 6.3 Hz, 1H), 3.64 (dd, J=10.3, 7.4 Hz, 1H), 3.50 (dd, J=10.3, 7.0 Hz, 1H), 2.09 (s, 3H), 2.05 (m, 1H), 2.00 (s, 3H), 1.39 (m, 1H), 1.24 (m, 1H), 1.03 (d, J=6.6 Hz, 3H), 0.89 (d, J=7.0 Hz, 3H), 0.84–0.68 (m, 2H), 0.10 (m, 1H); ^{13}C NMR δ 170.8 (s), 170.2 (s), 138.4 (s), 128.1 (d, 2C), 127.4 (d, 2C), 127.2 (d), 77.0 (d), 72.3 (t), 70.2 (t), 66.0 (t), 34.4 (d), 34.1 (d), 20.7 (q), 20.6 (q), 20.3 (d), 16.1 (d), 13.9 (q), 13.3 (q), 9.0 (t); MS (CI^+, CH_4) m/z (relative intensity) 363 ($M+H^+$, 10), 255 (100), 195 (50), 153 (28), 135 (70), 107 (14), 91 (24); HRMS (CI^+, CH_4) Calcd for $C_{21}H_{31}O_6$ ($M+H^+$): 363.2171. Found: 363.2167.

6.4. Preparation of cyclopropanealkanols of type G and H

6.4.1. (2*R)-2-[(1*R**,2*R**)-2-((1*R**)-1-Hydroxypropyl)-cyclopropyl]propyl 2,2-dimethylpropanoate 17 and (2*R**)-2-[(1*R**,2*R**)-2-((1*S**)-1-hydroxypropyl)cyclopropyl]propyl 2,2-dimethylpropanoate 17′.** To a solution of **5c** (670 mg, 3.12 mmol) in CH_2Cl_2 (30 mL) at rt, were successively added powdered 4 Å molecular sieves (2.7 g) and PCC (1.35 g, 6.25 mmol, 2 equiv). After 1 h, the reaction mixture was diluted with Et_2O (200 mL) and filtered through silica gel (Et_2O). The filtrate was evaporated under reduced pressure to give 630 mg (94%) of the crude aldehyde **16** as a pale yellow oil, which was dissolved in THF (10 mL). To the resulting solution at 0 °C, was added EtMgBr (1.5 mL, 3 M in Et_2O, 4.5 mmol, 1.5 equiv), and after 30 min, the reaction mixture was poured into a saturated aqueous NH_4Cl solution and extracted with Et_2O. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude material was analyzed by ^1H NMR which indicated a 60/40 ratio of the two diastereomers **17** and **17′**. Purification by flash chromatography (pentane–Et_2O gradient: 80/20–50/50) afforded 130 mg (18%) of **17′** and 240 mg (34%) of **17** as colorless oils.

Compound (**17′**). R_f 0.32 (pentane–Et_2O: 70/30); IR 3480, 3060, 1730, 1290, 1165, 1035, 990, 970, 775 cm^{-1}; ^1H NMR δ 4.45 (dd, J=11.0, 4.0 Hz, 1H), 3.90 (dd, J=11.0, 8.3 Hz, 1H), 3.22 (br s, 1H, OH), 3.12 (m, 1H), 1.71–1.60 (m, 2H), 1.45 (m, 1H), 1.28–1.19 (m, 1H), 1.21 (s, 9H), 1.08 (d, J=6.6 Hz, 3H), 1.00 (t, J=7.4 Hz, 3H), 0.73 (m, 1H), 0.58 (m, 1H), −0.06 (m, 1H); ^{13}C NMR δ 179.1 (s), 73.6 (d), 70.0 (t), 38.8 (s), 32.6 (d), 30.7 (t), 27.1 (q, 3C), 23.4 (d), 19.2 (d), 18.1 (q), 10.2 (q), 7.9 (t); MS-EI m/z (relative intensity) 225 ($M-OH^+$, 1), 213 ($M-C_2H_5^+$, 5), 140 ($M-t$-$BuCO_2H^+$, 8), 111 (43), 103 (11), 93 (28), 85 (30), 82 (14), 81 (18), 69 (29), 67 (15), 57 (100), 55 (18).

Compound (**17**). R_f 0.18 (pentane–Et_2O: 70/30); IR 3450, 3070, 1730, 1290, 1165, 1035, 990, 965, 855, 775 cm^{-1}; ^1H NMR δ 4.18 (dd, J=10.7, 3.7 Hz, 1H), 3.79 (dd, J=10.7, 8.5 Hz, 1H), 3.35 (ddd apparent td, J=7.8, 3.7 Hz, 1H), 2.00 (br s, 1H, OH), 1.73 (m, 1H), 1.67–1.46 (m, 2H), 1.21 (s, 9H), 1.01–0.93 (m, 1H), 1.07 (d, J=6.6 Hz, 3H), 1.03 (t, J=7.4 Hz, 3H), 0.76–0.67 (m, 2H), 0.21 (m, 1H); ^{13}C NMR δ 178.6 (s), 72.3 (d), 69.0 (t), 38.8 (s), 32.8 (d), 31.3 (t), 27.2 (q, 3C), 23.4 (d), 20.4 (d), 18.0 (q), 10.0 (q), 7.1 (t); MS-EI m/z (relative intensity) 225 ($M-OH^+$, 1), 213 ($M-C_2H_5^+$, 5), 140 ($M-t$-$BuCO_2H^+$, 7), (111 (41), 103 (12), 93 (28), 85 (29), 81 (18), 69 (29), 67 (15), 57 (100), 55 (18).

6.4.2. Epimerization of 17 to 17′ by an oxidation-stereoselective reduction sequence. To a solution of **17** (50 mg, 0.21 mmol) in CH_2Cl_2 (5 mL) at rt, were added powdered 4 Å molecular sieves (200 mg) and PCC (90 mg, 0.42 mmol, 2 equiv). After 2 h, the reaction mixture was diluted with Et_2O (50 mL) and filtered through silica gel (Et_2O). The filtrate was evaporated and the crude cyclopropylketone **18** was dissolved in MeOH (4 mL). To the resulting solution at 0 °C, was added portionwise $NaBH_4$ (40 mg, 1.0 mmol, 5 equiv). After 1 h at rt, the reaction mixture was hydrolyzed with a saturated aqueous NH_4Cl solution and extracted with Et_2O. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude material was analyzed by ^1H NMR and GC–MS which indicated a 12/88 ratio of the two diastereomers **17** and **17′**. Purification by flash chromatography (petroleum ether–EtOAc: 90/10, 80/20) afforded 36 mg (72%) of **17′** as a colorless oil.

6.4.3. ((2*R)-2-{(1*S**,2*R**)-2-[(Benzyloxy)methyl]cyclopropyl})propoxy-*tert*-butyldiphenylsilane 19.** To a solution of **4c** (1.87 g, 8.50 mmol) and imidazole (1.41 g,

20.7 mmol, 2.4 equiv) in DMF (8 mL) was added TBDPSCl (2.70 mL, 10.4 mmol, 1.2 equiv). After 1 h at rt, the reaction mixture was hydrolyzed with a saturated aqueous NH_4Cl solution and extracted with a petroleum ether–CH_2Cl_2 (90/10) mixture. The combined extracts were washed with brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc: 95/5) to afford 3.47 g (89%) of **19** as a colorless oil; IR 3060, 1590, 1110, 1080, 820, 740, 710, 700, 690, 610 cm^{-1}; ^1H NMR δ 7.75–7.69 (m, 4H), 7.48–7.35 (m, 6H), 7.34–7.25 (m, 5H), 4.43 (d, $J=12.1$ Hz, 1H), 4.38 (d, $J=12.1$ Hz, 1H), 3.79 (dd, $J=9.7$, 4.2 Hz, 1H), 3.57 (dd, $J=9.7$, 7.2 Hz, 1H), 3.43 (dd, $J=10.3$, 7.0 Hz, 1H), 3.31 (dd, $J=10.3$, 7.5 Hz, 1H), 1.28 (m, 1H), 1.17 (d, $J=6.3$ Hz, 3H), 1.11 (m, 1H), 1.10 (s, 9H), 0.82–0.69 (m, 2H), 0.05 (m, 1H); ^{13}C NMR δ 138.6 (s), 135.6 (d, 4C), 134.2 (s), 134.0 (s), 129.5 (d, 2C), 128.3 (d, 2C), 127.6 (d, 2C), 127.5 (d, 4C), 127.3 (d), 72.6 (t), 70.7 (t), 68.8 (t), 36.1 (d), 26.9 (q, 3C), 19.7 (d), 19.3 (s), 17.8 (q), 16.1 (d), 8.6 (t); MS-EI *m/z* (relative intensity) 401 (M−*t*-Bu^+, 2), 319 (20), 290 (14), 289 (52), 259 (31), 233 (40), 211 (28), 205 (29), 199 (32), 183 (35), 167 (23), 139 (23), 135 (20), 95 (27), 91 (100); HRMS (CI^+, CH_4) Calcd for $C_{30}H_{39}O_2Si$ ($M+H^+$): 459.2719. Found: 459.2721.

6.4.4. {(1*R,2*S**)-2-[(1*R**)-2-(*tert*-Butyldiphenylsilyl)-oxy-1-methylethyl]cyclopropyl}methanol 20.** To a solution of **19** (1.80 g, 3.91 mmol) in EtOH (60 mL) was added Pd/C (250 mg, 5% Pd, 0.117 mmol, 0.03 equiv) and the resulting mixture was stirred under an atmosphere of H_2. After 24 h, the reaction mixture was diluted with CH_2Cl_2 and filtered through Celite. The filtrate was concentrated under reduced pressure and the residue was purified by flash chromatography (petroleum ether–EtOAc: 85/15) to afford 2.21 g (86%) of **20** as a white solid; mp = 74 °C; IR 3580, 3410, 3060, 3020, 1590, 1110, 1040, 825, 740, 705, 690 cm^{-1}; ^1H NMR δ 7.74–7.70 (m, 4H), 7.49–7.38 (m, 6H), 3.83 (m, 1H), 3.60 (dd, $J=10.0$, 5.1 Hz, 1H), 3.43 (dd, $J=10.0$, 8.3 Hz, 1H), 3.31–3.21 (m, 2H), 1.46 (m, 1H), 1.30 (m, 1H), 1.09 (s, 9H), 0.93 (d, $J=7.0$ Hz, 3H), 0.72–0.59 (m, 2H), −0.06 (m, 1H); ^{13}C NMR δ 135.7 (d, 2C), 135.6 (d, 2C), 133.1 (s), 133.0 (s), 129.7 (d, 2C), 127.7 (d, 4C), 70.7 (t), 63.1 (t), 34.5 (d), 26.8 (q, 3C), 20.8 (d), 19.4 (d), 19.1 (s), 17.8 (q), 7.0 (t); MS-EI *m/z* (relative intensity) 311 (M−*t*-Bu^+, 1), 229 (21), 200 (20), 199 (100), 181 (10), 139 (8), 95 (28); HRMS (CI^+, CH_4) Calcd for $C_{23}H_{33}O_2Si$ ($M+H^+$): 369.2250. Found: 369.2248.

6.4.5. 3-{(1*R,2*S**)-2-[(1*R**)-2-(*tert*-Butyldiphenylsilyl)-oxy-1-methylethyl]cyclopropyl}-2-methylprop-2-en-1-ol 21.** To a solution of **20** (2.03 g, 5.51 mmol) in CH_2Cl_2 (100 mL) at rt, were successively added powdered 4 Å molecular sieves (4.8 g) and PCC (2.55 g, 11.8 mmol, 2.1 equiv). After 4 h, the reaction mixture was diluted with Et_2O and filtered through silica gel (Et_2O). The filtrate was evaporated under reduced pressure, and the crude aldehyde was dissolved in toluene (50 mL). To the resulting solution was added (carboethoxyethylidene)triphenylphosphorane (3.12 g, 8.59 mmol, 1.5 equiv) and the reaction mixture was heated at reflux. After 12 h, an additional quantity of (carboethoxyethylidene)triphenylphosphorane (2.14 g, 5.90 mmol, 1.1 equiv) was added and the reaction mixture was heated at reflux. After 2 h, the reaction mixture was cooled to rt, evaporated under reduced pressure and the residue was triturated in pentane. The insoluble triphenylphosphine oxide was removed by filtration through Celite (pentane) and the filtrate was evaporated under reduced pressure. The crude resulting α,β-unsaturated ester (2.38 g, 5.28 mmol) was dissolved in CH_2Cl_2 (70 mL), and to the resulting solution at −70 °C, was added DIBAL-H (15.0 mL, 1 M in hexanes, 15.0 mmol, 2.8 equiv). After 3 h, the reaction mixture was poured into a saturated aqueous solution of Rochelle salt (200 mL). After 3 h stirring, the resulting mixture was extracted with Et_2O and the combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc: 83/17) to afford 1.35 g (60% from **20**, 3 steps) of **21** as a colorless oil; R_f 0.30 (petroleum ether–EtOAc: 80/20); IR 3340, 3060, 1110, 1075, 820, 765, 740, 710, 700, 690 cm^{-1}; ^1H NMR δ 7.69–7.64 (m, 4H), 7.48–7.33 (m, 6H), 4.99 (dq, $J=9.4$, 1.5 Hz, 1H), 3.83 (d, $J=5.9$ Hz, 2H), 3.62 (dd, $J=9.6$, 4.1 Hz, 1H), 3.42 (dd, $J=9.6$, 7.7 Hz, 1H), 1.64 (d, $J=1.5$ Hz, 3H), 1.48 (m, 1H), 1.29 (m, 1H), 1.18 (d, $J=6.3$ Hz, 3H), 1.04 (s, 9H), 0.98–0.87 (m, 2H), 0.81 (m, 1H), 0.17 (m, 1H); ^{13}C NMR δ 135.6 (d, 2C), 135.5 (d, 2C), 135.4 (s), 134.2 (s), 134.0 (s), 129.5 (d, 2C), 127.5 (d, 4C), 126.2 (d), 69.0 (t), 68.2 (t), 36.6 (d), 26.8 (q, 3C), 21.9 (d), 19.3 (s), 17.6 (q), 14.9 (d), 13.9 (q), 12.6 (t); MS-EI *m/z* (relative intensity) 351 (M−*t*-Bu^+, 1), 229 (10), 200 (19), 199 (100), 197 (14), 181 (12), 135 (40), 107 (12), 93 (17); HRMS (CI^+, NH_3) Calcd for $C_{26}H_{40}NO_2Si$ ($M+NH_4^+$): 426.2828. Found: 426.2814.

6.4.6. Hydroboration of 21. To a solution of *T*-hexylborane [prepared from $BH_3\cdot THF$ (2.2 mL, 1 M in THF, 2.2 mmol, 2.6 equiv) and 2,3-dimethylbut-2-ene (2.2 mL, 1 M in THF, 2.2 mmol, 2.6 equiv), 2 h stirring at 0 °C] at −40 °C, was added a solution of **21** (350 mg, 0.856 mmol) in THF (3 mL). The reaction mixture was gradually warmed to rt over 3 h. After 18 h, the reaction mixture was cooled to 0 °C and a 3 M aqueous NaOH solution (2 mL) and a 30% aqueous H_2O_2 solution (2 mL) were successively added. After 3 h at rt, the resulting mixture was extracted with Et_2O and the combined extracts were washed with brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc gradient: 75/25–40/60) to afford 21 mg (6%) of **22′**, 258 mg (71%) of **22** and 20 mg (6%) of **22″** as colorless oils.

6.4.7. (1*R,2*S**)-1-{(1*R**,2*R**)-2-[(1*R**)-2-(*tert*-Butyldiphenyl-silyl)oxy-1-methylethyl]cyclopropyl}-2-methylpropan-1,3-diol 22′.** R_f 0.54 (petroleum ether–EtOAc: 50/50); IR 3380, 3060, 1115, 1035, 820, 805, 740, 705 cm^{-1}; ^1H NMR δ 7.73–7.68 (m, 4H), 7.49–7.37 (m, 6H), 5.18 (br s, 1H, OH), 3.95 (br s, 1H, OH), 3.68–3.61 (m, 2H), 3.66 (dd, $J=9.9$, 4.0 Hz, 1H), 3.33 (dd, apparent t, $J=9.9$ Hz, 1H), 3.09 (dd, $J=9.9$, 7.9 Hz, 1H), 1.97 (m, 1H), 1.58 (m, 1H), 1.22 (m, 1H), 1.08 (s, 9H), 0.95 (d, $J=7.0$ Hz, 3H), 0.83 (d, $J=7.0$ Hz, 3H), 0.79 (m, 1H), 0.58 (m, 1H), 0.04 (m, 1H); ^{13}C NMR δ 135.7 (d, 2C), 135.6 (d, 2C), 132.5 (s), 132.4 (s), 129.9 (d, 2C), 127.8 (d, 2C), 127.7 (d, 2C), 79.1 (d), 71.3 (t), 68.9 (t), 41.4 (d), 34.2 (d), 26.8 (q, 3C), 23.8 (d), 20.3 (d), 19.0 (s), 17.8 (q), 14.0 (q), 8.4 (t); MS (CI^+, CH_4) *m/z* (relative intensity) 427 ($M+H^+$, 94), 409 (39), 391 (30),

331 (100), 269 (25), 133 (30); HRMS (CI^+, CH_4) Calcd for $C_{26}H_{39}O_3Si$ ($M+H^+$): 427.2668. Found: 427.2667.

6.4.8. (1*S,2*R**)-1-{(1*R**,2*R**)-2-[(1*R**)-2-(*tert*-Butyldiphenyl-silyl)oxy-1-methylethyl]cyclopropyl}-2-methylpropan-1,3-diol 22.** R_f 0.37 (petroleum ether–/EtOAc: 50/50); IR 3350, 3070, 1590, 1110, 1075, 1030, 970, 825, 770, 740, 705, 690 cm^{-1}; ^1H NMR δ 7.72–7.67 (m, 4H), 7.50–7.37 (m, 6H), 3.78 (dd, $J=10.8$, 3.1 Hz, 1H), 3.63 (dd, $J=9.9$, 5.5 Hz, 1H), 3.51 (dd, $J=9.9$, 6.4 Hz, 1H), 3.50 (dd, $J=11.9$, 6.4 Hz, 1H), 3.38 (dd, apparent t, $J=6.4$ Hz, 1H), 3.20 (br s, 1H, OH), 2.84 (br s, 1H, OH), 1.68 (m, 1H), 1.54 (m, 1H), 1.10–1.00 (m, 1H), 1.12 (d, $J=6.6$ Hz, 3H), 1.09 (s, 9H), 0.86 (d, $J=7.0$ Hz, 3H), 0.83–0.67 (m, 2H), 0.22 (m, 1H); ^{13}C NMR δ 135.6 (d, 2C), 135.5 (d, 2C), 133.6 (s), 133.5 (s), 129.6 (d, 2C), 127.6 (d, 4C), 75.9 (d), 69.0 (t), 66.7 (t), 40.8 (d), 35.3 (d), 26.8 (q, 3C), 22.7 (d), 21.5 (d), 19.2 (s), 18.2 (q), 14.3 (q), 6.2 (t); MS (CI^+, CH_4) *m/z* (relative intensity) 427 ($M+H^+$, 62), 409 (100), 391 (17), 331 (48), 160 (14), 139 (14); HRMS (CI^+, CH_4) Calcd for $C_{26}H_{39}O_3Si$ ($M+H^+$): 427.2668. Found: 427.2667.

6.4.9. (*E*)-(2*S,5*R**)-2-[(1*R**)-2-(*tert*-Butyldiphenylsilyl) oxy-1-methylethyl]-5-methylhex-3-en-1,6-diol 22″.** R_f 0.24 (petroleum ether–EtOAc: 50/50); IR 3350, 3060, 1110, 1085, 1030, 820, 740, 705 cm^{-1}; ^1H NMR δ 7.70–7.65 (m, 4H), 7.48–7.37 (m, 6H), 5.42 (dd, $J=15.4$, 6.8 Hz, 1H), 5.33 (dd, $J=15.4$, 7.9 Hz, 1H), 3.71 (dd, $J=10.7$, 5.2 Hz, 1H), 3.61 (dd, $J=10.3$, 5.9 Hz, 1H), 3.53–3.46 (m, 2H), 3.44 (dd, $J=10.3$, 5.5 Hz, 1H), 3.35 (dd, $J=10.7$, 7.2 Hz, 1H), 2.36–2.23 (m, 2H), 1.79 (m, 1H), 1.71–1.49 (2H, OH), 1.07 (s, 9H), 0.98 (d, $J=6.6$ Hz, 3H), 0.93 (d, $J=6.6$ Hz, 3H); ^{13}C NMR δ 136.2 (d), 135.6 (d, 2C), 135.5 (d, 2C), 133.5 (s, 2C), 130.4 (d), 129.7 (d, 2C), 127.7 (d, 4C), 67.2 (t), 66.9 (t), 64.0 (t), 48.6 (d), 39.5 (d), 37.1 (d), 26.9 (q, 3C), 19.2 (s), 16.4 (q), 15.1 (q); MS (CI^+, CH_4) *m/z* (relative intensity) 427 ($M+H^+$, 100), 409 (40), 369 (12), 349 (28), 331 (23); HRMS (CI^+, CH_4) Calcd for $C_{26}H_{39}O_3Si$ ($M+H^+$): 427.2669. Found 427.2670.

6.4.10. (1*R,2*S**)-1-[(1*R**,2*R**)-2-((1*R**)-2-Hydroxy-1-methylethyl)cyclopropyl]-2-methylpropan-1,3-diol 23.** To a solution of **22** (560 mg, 1.31 mmol) in THF (10 mL) at 0 °C, was added dropwise a solution of *n*-Bu_4NF (4.0 mL, 1 M in THF, 4.0 mmol, 3.1 equiv). After 3 h at rt, the reaction mixture was concentrated under reduced pressure and the residue was purified by flash chromatography (Petroleum ether–EtOAc: 50/50 then EtOAc–MeOH: 90/10) to afford 188 mg (76%) of **23** as a colorless oil; IR 3300, 1450, 1025, 965 cm^{-1}; ^1H NMR δ 3.83 (dd, $J=10.9$, 3.5 Hz, 1H), 3.70–3.20 (3H, OH), 3.63 (dd, $J=10.9$, 6.8 Hz, 1H), 3.62 (dd, apparent t, $J=6.2$ Hz, 1H), 3.55 (dd, $J=10.7$, 6.6 Hz, 1H), 3.48 (dd, $J=10.7$, 6.1 Hz, 1H), 1.85 (m, 1H), 1.52 (m, 1H), 1.04 (m, 1H), 1.02 (d, $J=6.3$ Hz, 3H), 0.99 (d, $J=7.0$ Hz, 3H), 0.72–0.59 (m, 2H), 0.22 (m, 1H); ^{13}C NMR δ 75.0 (d), 68.2 (t), 66.7 (t), 40.8 (d), 35.1 (d), 21.9 (d), 21.8 (d), 18.1 (q), 14.1 (q), 5.8 (t).

6.4.11. (2*S,3*R**)-3-{(1*R**,2*R**)-2-[(1*R**)-2-(2,2-Dimethylpropanoyloxy)-1-methylethyl]cyclopropyl}-3-hydroxy-2-methylpropyl 2,2-dimethylpropanoate 24.** To a solution of **23** (60 mg, 0.32 mmol) and DMAP (87 mg, 0.71 mmol, 2.2 equiv) in CH_2Cl_2 (5 mL) at 0 °C, was added PivCl (84 μL, 0.68 mmol, 2.1 equiv). After 2.5 h at 0 °C, the reaction mixture was hydrolyzed with a saturated aqueous $NaHCO_3$ solution and extracted with CH_2Cl_2. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc gradient: 90/10–80/20) to afford 72 mg (63%) of **24** as a colorless oil; IR 3500, 1730, 1285, 1160, 1030, 985, 770 cm^{-1}; ^1H NMR δ 4.26 (dd, $J=10.9$, 5.2 Hz, 1H), 4.26–4.16 (m, 1H), 4.19 (dd, $J=10.9$, 6.4 Hz, 1H), 3.76 (dd, $J=10.7$, 8.5 Hz, 1H), 3.52 (dd, apparent t, $J=5.5$ Hz, 1H), 2.22 (br s, 1H, OH), 2.00 (m, 1H), 1.61 (m, 1H), 1.21 (s, 9H), 1.20 (s, 9H), 1.10 (d, $J=7.0$ Hz, 3H), 1.07 (d, $J=7.0$ Hz, 3H), 1.12–0.90 (m, 1H), 0.77–0.64 (m, 2H), 0.33 (m, 1H); ^{13}C NMR δ 178.7 (s, 2C), 71.4 (d), 69.0 (t), 66.0 (t), 40.1 (d), 38.8 (s, 2C), 32.3 (d), 27.2 (q, 6C), 21.3 (d), 20.3 (d), 18.1 (q), 14.5 (q), 6.3 (t); MS (CI^+, CH_4) *m/z* (relative intensity) 357 ($M+H^+$, 5), 340 (33), 339 ($M+H^+-H_2O$, 100), 255 (11), 237 (14), 153 (10), 135 (16); HRMS (CI^+, CH_4) Calcd for $C_{20}H_{37}O_5$ ($M+H^+$): 357.2641. Found: 357.2646.

6.5. Oxymercuration–reductive demercuration of cyclopropanemethanols of type D

6.5.1. Oxymercuration of 5a: representative procedure. To a degassed solution of **5a** (400 mg, 1.87 mmol) in CH_2Cl_2 (15 mL) [argon bubbling, 15 min] at rt, was added $Hg(OCOCF_3)_2$ (1.59 g, 3.74 mmol, 2 equiv). After 1 h with exclusion of light [reaction flask wrapped with an aluminum foil], the reaction mixture was hydrolyzed with a saturated aqueous KBr solution and extracted with CH_2Cl_2. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude material was purified by flash chromatography (cyclohexane–EtOAc gradient: 40/60–60/40) to afford 191 mg (20%) of a mixture of **25′a** and **25″a** (80/20 ratio) and 562 mg (60%) of **25a**, as colorless foams.

6.5.1.1. Organomercuric 25a. IR 3440, 1710, 1280, 1170, 1025 cm^{-1}; ^1H NMR δ 4.71 (dd, $J=6.9$, 5.7 Hz, 1H), 3.61 (dd, $J=11.2$, 4.6 Hz, 2H), 3.45 (dd, $J=11.2$, 5.5 Hz, 1H), 3.38 (dd, $J=11.2$, 6.2 Hz, 1H), 2.40 (m, 1H), 1.98 (m, 1H), 1.83 (dd, $J=11.9$, 4.4 Hz, 1H), 1.73 (dd, $J=11.9$, 7.8 Hz, 1H), 1.17 (s, 9H), 0.95 (d, $J=6.9$ Hz, 3H); ^{13}C NMR δ 179.6 (s), 77.8 (d), 63.2 (t), 62.4 (t), 41.3 (d), 39.1 (s), 36.5 (d), 32.5 (t), 27.2 (q, 3C), 14.6 (q).

6.5.1.2. Organomercuric 25′a. IR 3440, 1710, 1290, 1165, 1030 cm^{-1}; ^1H NMR δ 4.29 (dd, $J=11.1$, 5.3 Hz, 1H), 4.15 (dd, $J=11.1$, 4.0 Hz, 1H), 3.96 (dd, $J=11.0$. 4.4 Hz, 1H), 3.67 (dd, $J=11.0$, 3.4 Hz, 1H), 3.31 (dd, $J=8.4$, 3.7 Hz, 1H), 2.38 (m, 1H), 2.01 (m, 1H), 2.01 (dd, $J=11.9$, 4.5 Hz, 1H), 1.88 (dd, $J=11.9$, 5.7 Hz, 1H), 1.22 (s, 9H), 1.00 (d, $J=6.8$ Hz, 3H); ^{13}C NMR δ 179.6 (s), 77.3 (d), 66.5 (t), 63.6 (t), 40.1 (d), 38.9 (s), 36.8 (d), 33.7 (t), 27.2 (q, 3C), 14.3 (q).

6.5.1.3. Organomercuric 25″a. These spectroscopic data have been tentatively deduced from the spectra of a mixture of **25′a** and **25″a** (80/20 ratio); ^1H NMR δ 4.28 (m, 1H), 3.96 (m, 1H), 3.86 (dd, $J=10.6$, 3.7 Hz, 1H), 3.62 (m, 1H), 3.50 (m, 1H), 2.65 (m, 1H), 2.15–1.85 (m, 3H), 1.23 (s, 9H), 0.91 (d, $J=6.9$ Hz, 3H); ^{13}C NMR δ 178.9 (s), 79.1 (d),

68.4 (t), 65.8 (t), 39.5 (d), 38.8 (s), 37.3 (d), 34.3 (t), 27.0 (q, 3C), 13.4 (q).

6.5.2. Reductive demercuration of 25a: representative procedure. To a degassed solution of **25a** (560 mg, 1.10 mmol) in THF (12 mL) [argon bubbling, 15 min] at rt, were added a catalytic amount of AIBN (2 mg) and *n*-Bu_3SnH (590 μL, 2.19 mmol). Mercury began to precipitate almost instantaneously, and after 1 h at rt the reaction mixture was hydrolyzed with a 20% aqueous KF solution (3 mL). After 30 min, the reaction mixture was diluted with EtOAc, filtered through Celite, and the filtrate was extracted with EtOAc. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude material was purified by flash chromatography (cyclohexane–EtOAc: 60/40–40/60) to afford 244 mg (96%) of **26a** as a colorless oil.

6.5.2.1. (1*S,2*R**)-3-Hydroxy-1-((1*S**)-2-hydroxy-1-methylethyl)-2-methylpropyl 2,2-dimethylpropanoate 26a.** IR 3380, 1710, 1285, 1170, 1030 cm^{-1}; ^1H NMR δ 4.80 (t, $J=6.4$ Hz, 1H), 3.62 (dd, $J=11.2$, 3.8 Hz, 2H), 3.44 (dd, $J=11.2$, 5.8 Hz, 2H), 3.03 (br s, 2H, OH), 2.00 (m, 2H), 1.23 (s, 9H), 1.02 (d, $J=6.9$ Hz, 6H); ^{13}C NMR δ 179.4 (s), 77.4 (d), 63.2 (t, 2C), 39.0 (s), 36.5 (d, 2C), 27.1 (q, 3C), 14.4 (q, 2C); MS-EI *m/z* (relative intensity) 173 ($M-CH_3CHCH_2OH^+$, 4), 147 (5), 133 ($M-t$-$BuCO^+$, 9), 103 (61), 95 (16), 89 (20), 85 (37), 82 (12), 71 (14), 69 (18), 57 (100), 55 (11).

6.5.2.2. (2*S,3*R**,4*R**)-3,5-Dihydroxy-2,4-dimethylpentyl 2,2-dimethylpropanoate 26′a.** Reductive demercuration of a mixture of **25′a** and **25″a** (80/20 ratio, 150 mg, 0.294 mmol) with *n*-Bu_3SnH (150 μL, 0.557 mmol) in the presence of a catalytic amount of AIBN in THF (4 mL) at rt, and purification by flash chromatography (cyclohexane–EtOAc: 60/40–40/60) afforded 66 mg (98%) of **26′a** as a colorless oil; IR 3400, 1710, 1285, 1165, 1030 cm^{-1}; ^1H NMR δ 4.22 (dd, $J=11.0$, 4.8 Hz, 1H), 4.13 (dd, $J=11.0$, 6.2 Hz, 1H), 3.84 (dd, $J=10.8$, 3.4 Hz, 1H), 3.61 (dd, $J=10.8$, 6.3 Hz, 1H), 3.50 (br m, 1H, OH), 3.41 (dd apparent t, $J=6.1$ Hz, 1H), 3.10 (br m, 1H, OH), 2.07 (m, 1H), 1.88 (m, 1H), 1.21 (s, 9H), 1.02 (d, $J=7.0$ Hz, 3H), 1.00 (d, $J=7.0$ Hz, 3H); ^{13}C NMR δ 179.0 (s), 79.4 (d), 66.8 (t), 66.0 (t), 38.9 (s), 36.5 (d), 36.0 (d), 27.2 (q, 3C), 14.7 (q), 14.5 (q); MS-EI *m/z* (relative intensity) 173 ($M-CH_3CHCH_2OH^+$,16), 103 (100), 89 (42), 85 (57), 82 (10), 71 (22), 57 (84).

6.5.3. Oxymercuration–reductive demercuration of 5b. Compound **5b** (530 mg, 2.47 mmol) was subjected to the oxymercuration–reductive demercuration representative procedures. Purification by flash chromatography (cyclohexane–EtOAc: 70/30–50/50) afforded 451 mg (80%) of a regioisomeric mixture of **26b** and **26′b** (95/5 ratio).

6.5.3.1. (2*R)-3-Hydroxy-1-((1*R**)-2-hydroxy-1-methyl-ethyl)-2-methylpropyl 2,2-dimethylpropanoate 26b.** IR 3400, 1710, 1285, 1180, 1030 cm^{-1}; ^1H NMR δ 4.99 (dd, $J=9.9$, 2.2 Hz, 1H), 3.54 (dd, $J=11.2$, 3.5 Hz, 1H), 3.45 (dd, $J=11.2$, 5.5 Hz, 1H), 3.44 (dd, $J=11.1$, 4.8 Hz, 1H), 3.22 (dd, $J=11.1$, 9.4 Hz, 1H), 3.09 (br s, 1H, OH), 2.65 (br s, 1H, OH), 2.10–1.89 (m, 2H), 1.24 (s, 9H), 1.00 (d, $J=7.0$ Hz, 3H), 0.85 (d, $J=7.0$ Hz, 3H); ^{13}C NMR δ 179.9 (s), 73.4 (d), 64.4 (t), 64.0 (t), 39.2 (s), 36.7 (d), 36.5 (d), 27.2 (q, 3C), 13.6 (q), 9.5 (q).

6.5.3.2. (2*R,3*S**,4*R**)-3,5-Dihydroxy-2,4-dimethylpentyl 2,2-dimethylpropanoate 26′b.** IR 3400, 1730, 1710, 1290, 1170, 1030 cm^{-1}; ^1H NMR δ 4.25 (dd, $J=11.0$, 8.5 Hz, 1H), 3.91 (dd, $J=11.0$, 5.5 Hz, 1H), 3.78–3.60 (m, 2H), 3.47 (d, $J=9.2$, 2.2 Hz, 1H), 2.03–1.73 (m, 2H), 1.22 (s, 9H), 0.91 (d, $J=7.0$ Hz, 3H), 0.79 (d, $J=7.0$ Hz, 3H); ^{13}C NMR δ 179.3 (s), 76.4 (d), 68.6 (t), 66.7 (t), 38.8 (s), 36.9 (d), 35.2 (d), 27.2 (q, 3C), 13.4 (q), 8.9 (q).

6.5.4. Oxymercuration–reductive demercuration of cyclopropylcarbinol 5c. According to the representative procedure, oxymercuration of **5c** (400 mg, 1.87 mmol) and subsequent purification by flash chromatography (cyclohexane–EtOAc: 80/20) afforded 165 mg (17%) of an inseparable mixture of **25′c** and **25″c** (75/25 ratio) and 574 mg (60%) of **25c**.

6.5.4.1. Organomercuric 25c. ^1H NMR δ 4.96 (dd, $J=8.8$, 3.7 Hz, 1H), 3.63 (dd, $J=9.9$, 5.1 Hz, 1H), 3.57–3.40 (m, 3H+OH), 2.73 (br s, 1H, OH), 2.46 (m, 1H), 2.00 (m, 1H), 1.97 (dd, $J=11.9$, 4.0 Hz, 1H), 1.76 (dd, $J=11.9$, 9.0 Hz, 1H), 1.25 (s, 9H), 1.03 (d, $J=7.0$ Hz, 3H); ^{13}C NMR δ 179.5 (s), 75.4 (d), 65.1 (t), 63.6 (t), 41.3 (d), 39.2 (s), 36.8 (d), 28.7 (t), 27.4 (q, 3C), 14.1 (q).

6.5.4.2. Organomercuric 25′c. ^1H NMR δ 4.34 (dd, $J=11.0$, 4.8 Hz, 1H), 4.07 (dd, $J=11.0$, 4.0 Hz, 1H), 3.87–3.62 (m, 3H), 2.39 (m, 1H), 2.01–1.89 (m, 1H), 1.79–1.58 (m, 2H), 1.22 (s, 9H), 0.95 (d, $J=7.0$ Hz, 3H); ^{13}C NMR δ 179.6 (s), 73.2 (d), 67.4 (t), 66.9 (t), 40.2 (d), 38.9 (s), 36.4 (d), 27.2 (q, 3C), 25.5 (t), 13.8 (q).

6.5.4.3. Organomercuric 25″c. ^1H NMR δ 4.16 (dd, $J=11.0$, 7.3 Hz, 1H), 3.97 (dd, $J=11.0$, 6.1 Hz, 1H), 3.87–3.62 (m, 3H), 2.66 (m, 1H), 2.01–1.89 (m, 1H), 1.79–1.58 (m, 2H), 1.22 (s, 9H), 0.83 (d, $J=7.0$ Hz, 3H); ^{13}C NMR δ 179.1 (s), 75.0 (d), 68.4 (t), 67.4 (t), 39.4 (d), 38.8 (s), 36.7 (d), 27.2 (q, 3C), 26.1 (t), 13.2 (q).

According to the representative procedure, reductive demercuration of **25c** (570 mg, 1.12 mmol) and purification by flash chromatography (cyclohexane–EtOAc: 60/40–40/60) gave 227 mg (88%) of **26b** as a colorless oil. Similarly, reductive demercuration of **25′c** and **25″c** (75/25 mixture, 165 mg, 0.324 mmol) afforded, after purification by flash chromatography (cyclohexane–EtOAc: 60/40–40/60), 52 mg (70%) of a mixture of **26″b** and **26′b** (75/25 ratio).

6.5.4.4. (2*S,3*R**,4*S**)-3,5-Dihydroxy-2,4-dimethylpentyl 2,2-dimethylpropanoate 26″b.** IR 3400, 1730, 1710, 1290, 1170, 1030 cm^{-1}; ^1H NMR δ 4.35 (dd, $J=11.0$, 5.2 Hz, 1H), 4.09 (dd, $J=11.0$, 3.7 Hz, 1H), 3.78–3.60 (m, 2H+OH), 3.56 (dd, $J=9.7$, 2.0 Hz, 1H), 3.39 (br s, 1H, OH), 2.03–1.73 (m, 2H), 1.22 (s, 9H), 0.95 (d, $J=7.0$ Hz, 3H), 0.91 (d, $J=7.0$ Hz, 3H); ^{13}C NMR δ 179.4 (s), 74.5 (d), 67.5 (t), 67.0 (t), 38.9 (s), 36.7 (d), 35.7 (d), 27.2 (q, 3C), 13.7 (q), 8.5 (q).

6.5.5. Chemical correlation for the attribution of the relative configuration of compounds 26a, 26′a and 26b.

6.5.5.1. (2*S,3*S**,4*R**)-2,4-Dimethylpentane-1,3,5-triol 27.**[23] To a solution of **26a** (147 mg, 0.63 mmol) in THF (5 mL) at 0 °C, was added $LiAlH_4$ (72 mg, 1.9 mmol, 3.0 equiv). After 40 min at rt, the reaction was quenched by successive addition of H_2O (0.1 mL), a 15% aqueous NaOH solution (0.1 mL) and H_2O (0.3 mL). After 3 h stirring at rt, the reaction mixture was filtered through Celite and the insoluble salts were thoroughly washed with boiling THF. The filtrate was concentrated under reduced pressure and the crude material was purified by flash chromatography (CH_2Cl_2–MeOH: 90/10) to afford 81 mg (86%) of **27** as a waxy white solid. Similarly, compound **26′a** (54 mg, 0.23 mmol) was reduced with $LiAlH_4$ (26 mg, 0.68 mmol, 3 equiv) to give 22 mg (65%) of **27**. Based on literature results,[23] the ^{13}C NMR data readily enabled the stereochemical assignment; ^{13}C NMR (D_2O) δ 79.4 (d), 66.4 (t, 2C), 39.8 (d, 2C), 16.6 (q, 2C).

6.5.5.2. (2*S,4*S**)-2,4-Dimethylpentane-1,3,5-triol 28.**[23] Reduction of **26b** (68 mg, 0.29 mmol) with $LiAlH_4$ (22 mg, 0.58 mmol, 2.0 equiv) in THF (5 mL) at 0 °C and purification by flash chromatography (CH_2Cl_2–MeOH: 90/10) afforded 27 mg (68%) of **28** as waxy white solid; ^{13}C NMR (D_2O) δ 75.6 (d), 67.6 (t), 67.2 (t), 40.4 (d), 39.1 (d), 15.7 (q), 11.3 (q).

6.5.6. Synthesis of stereotriads 33a–d from the benzyl ethers 6a–d.

6.5.6.1. (1*S,2*S**)-1-[(1*S**)-2-(Benzyloxy)-1-methylethyl]-2-methylpropane-1,3-diol 33a**[25] **(representative procedure)** Compound **6a** (200 mg, 0.657 mmol) was oxymercurated with $Hg(OCOCF_3)_2$ (560 mg, 1.31 mmol, 2.0 equiv) in CH_2Cl_2 (7 mL) at rt for 1 h. The crude mixture of organomercuric bromides was subjected to reductive demercuration with *n*-Bu_3SnH (210 μL, 0.781 mmol) and a catalytic amount of AIBN (2 mg) in THF (10 mL) for 30 min at rt. The resulting crude material was dissolved in THF (5 mL) and $LiAlH_4$ (30 mg, 0.78 mmol) was added at 0 °C. After 2 h at rt, the reaction was quenched by successive addition of H_2O (0.1 mL), a 15% aqueous NaOH solution (0.1 mL) and H_2O (0.3 mL) and after 2 h at rt, the resulting mixture was filtered trough Celite. The insoluble salts were thoroughly washed with boiling THF and the filtrate was evaporated under reduced pressure. The crude material was purified by flash chromatography (cyclohexane–EtOAc: 50/50) to afford 59 mg (38%) of **33a** as a colorless oil; R_f 0.25 (cyclohexane–EtOAc: 50/50); IR 3370, 1455, 1095, 1070, 1030, 990, 745, 705 cm^{-1}; ^1H NMR (C_6D_6) δ 7.31–7.05 (m, 5H), 4.20 (s, 2H), 4.07 (d, J=4.6 Hz, 1H), 3.78 (m, 1H), 3.63–3.57 (m, 2H), 3.38 (dd, J=9.1, 4.8 Hz, 1H), 3.36 (m, 1H), 3.30 (dd, J=9.1, 5.7 Hz, 1H), 1.84 (m, 1H), 1.72 (m, 1H), 0.88 (d, J=7.0 Hz, 6H); ^{13}C NMR (C_6D_6) δ 139.1 (s), 129.3 (d), 128.5 (d, 2C), 128.4 (d, 2C) (overlap with solvent), 82.0 (d), 74.4 (t), 74.1 (t), 67.4 (t), 38.1 (d), 36.8 (d), 15.6 (q), 15.3 (q).

6.5.6.2. (1*S,2*R**)-1-[(1*S**)-2-(Benzyloxy)-1-methylethyl]-2-methylpropane-1,3-diol 33b.**[25] This compound was synthesized from **6b** (50 mg, 0.16 mmol) according to the representative procedure. Purification by flash chromatography (cyclohexane–EtOAc: 50/50) afforded 19 mg (50%) of **33b** as a colorless oil; R_f 0.17 (cyclohexane–EtOAc: 50/50); IR 3330, 1430, 1110, 1070, 745, 705 cm^{-1}; ^1H NMR (C_6D_6) δ 7.23–7.05 (m, 5H), 4.17 (s, 2H), 3.83 (br s, 1H, OH), 3.73–3.63 (m, 3H), 3.28 (dd, J=9.0, 4.5 Hz, 1H), 3.21 (dd apparent t, J=9.0, 8.5 Hz, 1H), 2.30 (br s, 1H, OH), 1.84 (m, 1H), 1.51 (m, 1H), 1.00 (d, J=7.0 Hz, 3H), 0.52 (d, J=6.9 Hz, 3H); ^{13}C NMR (C_6D_6) δ 138.9 (s), 129.3 (d), 128.7 (d, 2C) (overlap with solvent), 128.4 (d, 2C), 79.4 (d), 76.9 (t), 74.1 (t), 68.4 (t), 37.6 (d), 37.0 (d), 13.8 (q), 9.7 (q).

6.5.6.3. (1*S,2*S**)-1-[(1*R**)-2-(Benzyloxy)-1-methylethyl]-2-methylpropane-1,3-diol 33c.**[25] This compound was synthesized from **6c** (80 mg, 0.26 mmol) according to the representative procedure. Purification by flash chromatography (cyclohexane–EtOAc: 60/40) afforded 40 mg (65%) of **33c** as a colorless oil; IR 3330, 1430, 1110, 1070, 745, 705 cm^{-1}; ^1H NMR (C_6D_6) δ 7.25–7.06 (m, 5H), 4.26 (s, 2H), 3.83 (br s, 1H, OH), 3.70–3.58 (m, 3H+OH), 3.38 (dd, J=8.9, 5.8 Hz, 1H), 3.29 (dd, J=8.9, 4.8 Hz, 1H), 1.84–1.69 (m, 2H), 0.96 (d, J=7.0 Hz, 3H), 0.58 (d, J=6.9 Hz, 3H); ^{13}C NMR (C_6D_6) δ 139.4 (s), 129.2 (d), 128.4–128.0 (d, 2C+2C, overlap with solvent), 79.2 (d), 75.8 (t), 74.1 (t), 69.2 (t), 38.3 (d), 36.4 (d), 14.1 (q), 10.3 (q).

6.5.6.4. (1*S,2*R**)-1-[(1*R**)-2-(Benzyloxy)-1-methylethyl]-2-methylpropane-1,3-diol 33d.**[25] This compound was synthesized from **6d** (18 mg, 0.059 mmol) according to the representative procedure. Purification by flash chromatography (pentane–Et_2O gradient: 60/40–40/60) afforded 7 mg (47%) of **33d** as a colorless oil; R_f 0.13 (cyclohexane–EtOAc: 50/50); IR 3380, 1470, 1090, 1030, 980, 745, 705 cm^{-1}; ^1H NMR (C_6D_6) δ 7.25–7.06 (m, 5H), 4.22 (s, 2H), 3.70 (dd apparent t, J=5.1 Hz, 1H), 3.38 (d, J=5.1 Hz, 2H), 3.23 (dd, J=9.1, 5.4 Hz, 1H), 3.18 (dd, J=9.1, 4.8 Hz, 1H), 2.35 (br s, 1H, OH), 1.84 (m, 1H), 1.65 (m, 1H), 1.30 (br s, 1H, OH), 1.07 (d, J=7.0 Hz, 3H), 0.99 (d, J=7.0 Hz, 3H); ^{13}C NMR (C_6D_6) δ 139.6 (s), 129.2 (d), 128.9 (d, 2C), 128.3 (d, 2C) (overlap with solvent), 76.5 (d), 75.1 (t), 73.9 (t), 67.7 (t), 38.7 (d), 37.4 (d), 13.4 (q), 12.2 (q).

6.6. Oxymercuration of cyclopropanes of type E

6.6.1. (2*R,3*R**,4*S**,5*R**)-1-Benzyloxy-2,4-dimethylheptane-3,5-diol 35a.** Compound **12a** (114 mg, 0.393 mmol) was oxymercurated with $Hg(OCOCF_3)_2$ (352 mg, 0.825 mmol, 2.1 equiv) in CH_2Cl_2 (4 mL) for 1 h at rt. The crude mixture of organomercuric bromides was dissolved in a mixture of THF and toluene (1/1, 6 mL) and to the resulting degassed solution [argon bubbling, 20 min] was added AIBN (2.3 mg) and *n*-Bu_3SnH (0.26 mL, 0.97 mmol, 2.5 equiv). After 1 h at rt and 1 h at 55 °C, CCl_4 (1 mL) was added in order to destroy the excess tin hydride. The reaction mixture was diluted with a mixture of petroleum ether–CH_2Cl_2 (75/25, 20 mL) and the resulting solution was washed with a 5% aqueous solution of KF (4×10 mL). The organic extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude material was suspended in CH_2Cl_2 and the insoluble material was removed by filtration. The filtrate was evaporated and the residual oil was purified by flash chromatography (petroleum ether–EtOAc gradient: 95/5–80/20) to afford 79 mg (65%) of a regioisomeric mixture of **34a** and **34′a** (70 mg, 0.023 mmol), which was dissolved in THF (3 mL). To the resulting solution at 0 °C, was added

$LiAlH_4$ (28 mg, 0.74 mmol, 3.3 equiv) and after 3 h at rt, the reaction was quenched by successive addition of H_2O (30 μL), a 15% aqueous NaOH solution (30 μL) and H_2O (120 μL). After 3 h, the resulting mixture was diluted with Et_2O and filtered through Celite. The insoluble salts were thoroughly washed with boiling THF and the filtrate was evaporated under reduced pressure. The crude material was purified by flash chromatography (petroleum ether–Et_2O gradient: 60/40–50/50) to afford 48 mg (80%) of **35a** as a colorless oil; IR 3350, 1085, 965, 735, 700 cm^{-1}; ^1H NMR δ 7.39–7.26 (m, 5H), 4.53 (s, 2H), 4.42 (br s, 1H, OH), 3.87 (m, 1H), 3.81 (br s, 1H, OH), 3.66 (dd, J=9.1, 4.0 Hz, 1H), 3.58 (dd, J=8.3, 3.5 Hz, 1H), 3.49 (dd, J=9.1, 8.3 Hz, 1H), 2.17 (m, 1H), 1.72 (m, 1H), 1.57 (m, 1H), 1.39 (m, 1H), 1.02 (d, J=7.0 Hz, 3H), 0.93 (t, J=7.4 Hz, 3H), 0.83 (d, J=7.0 Hz, 3H); ^{13}C NMR δ 137.4 (s), 128.5 (d, 2C), 127.9 (d), 127.7 (d, 2C), 82.4 (d), 76.1 (t), 73.6 (t), 72.7 (d), 37.1 (d), 35.7 (d), 27.2 (t), 13.7 (q), 10.9 (q), 10.6 (q); MS (CI^+, CH_4) m/z (relative intensity) 267 ($M+H^+$, 100), 249 (15), 231 (13), 157 (12), 141 (28); HRMS (CI^+, CH_4) Calcd for $C_{16}H_{27}O_3$ ($M+H^+$): 267.1960. Found: 267.1955.

6.6.2. (1*R,2*S**,3*R**,4*S**)-5-Benzyloxy-1-ethyl-3-hydroxy-2,4-dimethylpentyl acetate 34c and (1*R**,2*S**,3*R**)-1-[(1*S**)-2-benzyloxy-1-methylethyl]-3-hydroxy-2,4-dimethylpentyl acetate 34′c.** Compound **12c** (107 mg, 0.368 mmol) was subjected to the oxymercuration–reductive demercuration procedure. ^1H NMR analysis of the crude material indicated the formation of regioisomeric mixture of **34c** and **34′c** (75/25 ratio). Purification by flash chromatography (CH_2Cl_2–Et_2O: 97/3–96/4) afforded 33 mg (29%) of **34c** and 16 mg (14%) of **34′c** as colorless oils.

Major regioisomer (**34c**). IR 3510, 1710, 1250, 1100, 1020, 1015, 955, 885, 740, 700 cm^{-1}; ^1H NMR δ 7.38–7.25 (m, 5H), 5.21 (ddd, J=9.2, 4.8, 1.7 Hz, 1H), 4.53 (d, J=12.1 Hz, 1H), 4.49 (d, J=12.1 Hz, 1H), 3.56 (dd, J=9.0, 6.8 Hz, 1H), 3.46 (dd, J=9.0, 5.7 Hz, 1H), 3.41–3.27 (m, 2H, 1H+OH), 2.09 (s, 3H), 1.96 (m, 1H), 1.79–1.65 (m, 2H), 1.49 (m, 1H), 0.91 (t, J=7.4 Hz, 3H), 0.89 (d, J=7.0 Hz, 3H), 0.81 (d, J=7.0 Hz, 3H); ^{13}C NMR δ 172.4 (s), 138.6 (s), 128.3 (d, 2C), 127.5 (d, 3C), 75.7 (d), 74.5 (t), 73.2 (t), 71.5 (d), 39.6 (d), 34.7 (d), 25.4 (t), 21.0 (q), 10.5 (q), 9.2 (q), 8.2 (q); MS-EI m/z (relative intensity) 248 ($M-AcOH^+$, 1), 202 (4), 160 (9), 159 (9), 108 (15), 107 (31), 99 (13), 92 (11), 91 (100), 70 (10), 69 (12).

Minor regioisomer (**34′c**). IR 3520, 1715, 1250, 1095, 1020, 965, 955, 740, 700 cm^{-1}; ^1H NMR δ 7.38–7.25 (m, 5H), 5.08 (dd, J=10.3, 2.6 Hz, 1H), 4.50 (d, J=11.8 Hz, 1H), 4.44 (d, J=11.8 Hz, 1H), 3.34 (m, 1H), 3.27 (d, J=7.0 Hz, 2H), 2.79 (br d, J=3.3 Hz, 1H, OH), 2.19 (m, 1H), 2.03 (s, 3H), 1.73–1.53 (m, 2H), 1.32 (m, 1H), 0.93 (t, J=7.5 Hz, 3H), 0.91 (d, J=7.0 Hz, 3H), 0.85 (d, J=7.0 Hz, 3H); ^{13}C NMR δ 172.4 (s), 138.2 (s), 128.4 (d, 2C), 127.8 (d, 2C), 127.6 (d), 75.5 (d), 73.3 (t), 72.8 (t), 71.0 (d), 38.6 (d), 34.2 (d), 26.9 (t), 20.8 (q), 11.1 (q), 10.0 (q), 8.4 (q); MS-EI m/z (relative intensity) 248 ($M-AcOH^+$, 1), 202 (3), 160 (9), 159 (9), 108 (14), 107 (30), 99 (12), 92 (11), 91 (100), 69 (12).

6.6.3. (2*S,3*R**,4*S**,5*R**)-1-Benzyloxy-2,4-dimethyl-heptane-3,5-diol 35c.** To a solution of **34c** (30 mg, 0.097 mmol) in THF (2 mL) at 0 °C, was added $LiAlH_4$ (8 mg, 0.2 mmol, 2.1 equiv). After 1 h at rt, and usual work-up, purification of the crude material by flash chromatography (petroleum ether–Et_2O gradient: 70/30–50/50) afforded 19 mg (73%) of **35c** as a colorless oil. Similarly, reduction of **34′c** (13 mg, 0.042 mmol) with $LiAlH_4$ and purification by flash chromatography (petroleum ether–Et_2O gradient: 70/30–50/50) afforded 5 mg (45%) of **35c**; IR 3400, 1095, 1070, 970, 735, 700 cm^{-1}; ^1H NMR δ 7.39–7.27 (m, 5H), 4.54 (d, J=12.1 Hz, 1H), 4.49 (d, J=12.1 Hz, 1H), 3.83 (dd, J=9.2, 2.6 Hz, 1H), 3.71 (m, 1H), 3.60 (dd, J=9.0, 4.0 Hz, 1H), 3.55 (dd, J=9.0, 4.8 Hz, 1H), 3.33 (br s, 1H, OH), 2.82 (br s, 1H, OH), 1.93–1.77 (m, 2H), 1.61–1.38 (m, 2H), 1.01 (d, J=7.0 Hz, 3H), 0.99 (t, J=7.4 Hz, 3H), 0.79 (d, J=7.4 Hz, 3H); ^{13}C NMR δ 138.0 (s), 128.4 (d, 2C), 127.7 (d), 127.6 (d, 2C), 76.6 (d), 75.7 (t), 75.6 (d), 73.5 (t), 39.4 (d), 35.3 (d), 25.8 (t), 11.8 (q), 11.1 (q), 9.9 (q); MS (CI^+, CH_4) m/z (relative intensity) 267 ($M+H^+$, 56), 249 (22), 231 (22), 157 (31), 141 (100), 125 (25), 123 (31), 119 (27); HRMS (CI^+, CH_4) Calcd for $C_{16}H_{27}O_3$ ($M+H^+$): 267.1960. Found: 267.1965.

6.6.4. (4*R,5*S**,6*R**)-4-[(1*R**)-2-(Benzyloxy)-1-methylethyl]-6-ethyl-2,2,5-trimethyl-1,3-dioxane 36a.** To a solution of **35a** (20 mg, 0.075 mmol) in a mixture of acetone (1 mL) and 2,2-dimethoxypropane (1 mL) was added a catalytic amount of CSA (3 mg). After 6 h at rt, the reaction mixture was hydrolyzed with a saturated aqueous $NaHCO_3$ solution and extracted with Et_2O. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure to afford 22 mg (96%) of **36a** as a colorless oil; IR 1220, 1180, 1150, 1095, 1020, 990, 880, 735, 700 cm^{-1}; ^1H NMR δ 7.36–7.26 (m, 5H), 4.54 (d, J=12.0 Hz, 1H), 4.49 (d, J=12.0 Hz, 1H), 3.66 (m, 1H), 3.61 (dd, J=9.2, 4.8 Hz, 1H), 3.37 (dd, J=9.2, 7.0 Hz, 1H), 3.26 (dd, J=7.0, 5.3 Hz, 1H), 1.96 (m, 1H), 1.84 (m, 1H), 1.70–1.33 (m, 2H), 1.32 (s, 3H), 1.31 (s, 3H), 1.04 (d, J=7.0 Hz, 3H), 0.92 (t, J=7.4 Hz, 3H), 0.85 (d, J=7.0 Hz, 3H); ^{13}C NMR δ 138.8 (s), 128.3 (d, 2C), 127.5 (d, 2C), 127.4 (d), 100.2 (s), 76.6 (d), 73.1 (t), 72.4 (t), 71.0 (d), 37.8 (d), 36.5 (d), 25.4 (q), 23.6 (t and q, 2C), 14.3 (q), 12.4 (q), 10.5 (q); MS (CI^+, CH_4) m/z (relative intensity) 307 ($M+H^+$, 62), 291 (22), 249 (100), 231 (35), 157 (21), 141 (46); HRMS (CI^+, CH_4) Calcd for $C_{19}H_{31}O_3$ ($M+H^+$): 307.2273. Found: 307.2272.

6.6.5. (4*R,5*S**,6*R**)-4-[(1*S**)-2-Benzyloxy-1-methylethyl]-6-ethyl-2,2,5-trimethyl-1,3-dioxane 36c.** Acetonide formation from **35c** (19 mg, 0.071 mmol) provided 20 mg (91%) of **36c** as a colorless oil; IR 1225, 1180, 1150, 1095, 1020, 980, 880, 730, 700 cm^{-1}; ^1H NMR δ 7.36–7.26 (m, 5H), 4.52 (s, 2H), 3.65 (dt, J=8.5, 4.8 Hz, 1H), 3.50–3.43 (m, 2H), 3.36 (dd, J=9.0, 6.1 Hz, 1H), 1.93–1.77 (m, 2H), 1.51–1.22 (m, 2H), 1.31 (s, 6H), 0.95 (d, J=7.0 Hz, 3H), 0.93 (t, J=7.4 Hz, 3H), 0.83 (d, J=6.6 Hz, 3H); ^{13}C NMR δ 138.7 (s), 128.3 (d, 2C), 127.6 (d, 2C), 127.4 (d), 100.2 (s), 74.1 (d), 73.1 (t, 2C), 71.2 (d), 36.4 (d), 36.3 (d), 25.0 (q), 23.7 (q), 23.6 (t), 11.8 (q), 11.2 (q), 10.6 (q); MS EI m/z (relative intensity) 291 ($M-Me^+$, 6), 248 ($M-Me_2C{=}O^+$, 6), 190 (9), 179 (12), 107 (18), 92 (10), 91 (100), 69 (19), 59 (24).

6.6.6. (2*R,3*R**,4*S**,5*R**,6*S**)-7-Benzyloxy-2,4,6-trimethylheptane-1,3,5-triol 37.**[27] Compound **15** (125 mg, 0.345 mmol) was subjected to oxymercuration–reductive

demercuration sequence. The intermediate regioisomeric mixture of acetates (ratio not determined) was reduced with $LiAlH_4$ (45 mg, 1.2 mmol, 8 equiv) in THF (2 mL) for 2 h at rt and purification by flash chromatography (petroleum ether–EtOAc: 20/80) gave 25 mg (25% from **15**) of **37** as a colorless oil; IR 3360, 1080, 1025, 970, 735, 700 cm^{-1}; ^1H NMR δ 7.39–7.25 (m, 5H), 4.51 (s, 2H), 3.94 (dd, J=9.7, 2.0 Hz, 1H), 3.74 (dd, J=7.5 and 3.5 Hz, 1H), 3.66 (d, J=5.9 Hz, 2H), 3.57 (dd, J=8.8, 4.0 Hz, 1H), 3.53 (dd, J=8.8, 4.4 Hz, 1H), 3.60–3.49 (m, 2H, 2OH), 3.29 (br s, 1H, OH), 1.99–1.84 (m, 2H), 1.74 (m, 1H), 1.04 (d, J=7.0 Hz, 3H), 0.89 (d, J=7.0 Hz, 3H), 0.71 (d, J=7.0 Hz, 3H); ^{13}C NMR δ 137.9 (s), 128.4 (d, 2C), 127.8 (d), 127.7 (d, 2C), 77.2 (d), 76.8 (d), 75.4 (t), 73.5 (t), 69.5 (t), 37.1 (d), 37.0 (d), 35.6 (d), 13.2 (q), 11.0 (q), 10.2 (q).

6.6.7. (2*R,3*R**,4*R**,5*R**,6*S**)-7-Benzyloxy-3,5-dihydroxy-2,4,6-trimethyl 2,2-dimethylpropanoate 38.** To a solution of the triol **37** (10 mg, 0.034 mmol) in CH_2Cl_2 (1 mL) were successively added at 0 °C, Et_3N (60 μL, 0.43 mmol, 13 equiv) and PivCl (50 μL, 0.40 mmol, 12 equiv). After 12 h at 0 °C, additional quantities of Et_3N (30 mL, 0.21 mmol, 6 equiv) and PivCl (20 μL, 0.16 mmol, 4.8 equiv) were added. After a further 12 h at 0 °C, the reaction mixture was evaporated under reduced pressure and the residual oil was dissolved in a mixture of acetone (1 mL) and 2,2-dimethoxypropane (1 mL). A catalytic amount of CSA (2 mg) was added and after 1 h at rt, the reaction mixture was hydrolyzed with a saturated aqueous $NaHCO_3$ solution and extracted with ether. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc: 95/5) to afford 9 mg (64%) of **38** as a colorless oil; IR 1730, 1480, 1280, 1225, 1160, 730, 700 cm^{-1}; ^1H NMR δ 7.35–7.26 (m, 5H), 4.53 (d, J=12.1 Hz, 1H), 4.48 (d, J=12.1 Hz, 1H), 4.19 (dd, J=10.7, 3.3 Hz, 1H), 4.02 (dd, J=10.7, 5.9 Hz, 1H), 3.55 (dd, J=10.9, 4.2 Hz, 1H), 3.48–3.41 (m, 2H), 3.35 (dd, J=8.8, 5.9 Hz, 1H), 1.97–1.83 (m, 3H), 1.27 (s, 3H), 1.25 (s, 3H), 1.21 (s, 9H), 0.95 (d, J=7.0 Hz, 3H), 0.90 (d, J=7.0 Hz, 3H), 0.87 (d, J=6.6 Hz, 3H); ^{13}C NMR δ 178.6 (s), 138.7 (s), 128.3 (d, 2C), 127.6 (d, 2C), 127.5 (d), 100.5 (s), 74.4 (d), 73.1 (t), 72.9 (t), 70.0 (d), 66.3 (t), 38.9 (s), 366.8 (d), 34.8 (d), 33.0 (d), 27.3 (q, 3C), 25.0 (q), 23.4 (q), 12.9 (q), 11.8 (q), 11.3 (q); MS (CI^+, CH_4) *m/z* (relative intensity) 421 ($M+H^+$, 52), 363 (100), 345 (39), 261 (76), 255 (97), 173 (61), 171 (22); HRMS (CI^+, CH_4) Calcd for $C_{25}H_{41}O_5$ ($M+H^+$): 421.2954. Found: 421.2959.

6.7. Oxymercuration of cyclopropanes of type G and H

6.7.1. Oxymercuration of cyclopropane 17. Compound **17** (125 mg, 0.516 mmol) was subjected to the oxymercuration–reductive demercuration sequence and, after purification by flash chromatography (petroleum ether–EtOAc gradient: 80/20–0/100), 42 mg (32%) of **39**, and 38 mg (29%) of **39′** were obtained as colorless oils.

6.7.1.1. (2*S,3*S**,4*S**,5*R**)-3,5-Dihydroxy-2,4-dimethylheptyl 2,2-dimethylpropanoate 39.** R_f 0.42 (petroleum ether–EtOAc: 60/40); IR 3440, 1720, 1290, 1170, 970 cm^{-1}; ^1H NMR δ 4.43 (dd, J=11.2, 4.5 Hz, 1H), 4.02 (dd, 11.2, 3.7 Hz, 1H), 3.90 (br s, 1H, OH), 3.72 (m, 1H), 3.47 (dd, J=9.9, 1.7 Hz, 1H), 3.45 (br s, 1H, OH), 1.91 (m, 1H), 1.67–1.39 (m, 3H), 1.22 (s, 9H), 0.95 (t, J=7.4 Hz, 3H), 0.91 (d, J=7.0 Hz, 3H), 0.90 (d, J=7.1 Hz, 3H); ^{13}C NMR δ 179.6 (s), 78.8 (d), 78.0 (d), 66.8 (t), 39.0 (s), 36.8 (d), 36.7 (d), 28.0 (t), 27.2 (q, 3C), 13.7 (q), 10.5 (q), 3.9 (q); MS (CI^+, CH_4) *m/z* (relative intensity) 261 ($M+H^+$, 100), 243 (18), 225 (14), 173 (15), 159 (11), 141 (68), 123 (38); HRMS (CI^+, CH_4) Calcd for $C_{14}H_{29}O_4$ ($M+H^+$): 261.2066. Found: 261.2065.

6.7.1.2. (1*R,2*R**,3*S**,4*S**)-1-Ethyl-3,5-dihydroxy-2,4-dimethylpentyl 2,2-dimethylpropanoate 39′.** R_f 0.17 (petroleum ether–EtOAc: 60/40); IR 3440, 1730, 1290, 1170 cm^{-1}; ^1H NMR δ 4.84 (ddd, J=7.3, 5.5, 4.8 Hz, 1H), 3.71 (dd, J=11.0, 4.0 Hz, 1H), 3.67 (dd, J=11.0, 3.7 Hz, 1H), 3.61 (dd, J=8.6, 2.8 Hz, 1H), 3.30–3.00 (br m, 2H, 2OH), 1.92–1.75 (m, 2H), 1.73–1.61 (m, 2H), 1.22 (s, 9H), 0.91 (d, J=7.0 Hz, 3H), 0.88 (t, J=7.7 Hz, 3H), 0.82 (d, J=7.0 Hz, 3H); ^{13}C NMR δ 179.0 (s), 79.2 (d), 78.1 (d), 68.4 (t), 39.1 (s), 38.7 (d), 37.3 (d), 27.2 (q, 3C), 25.7 (t), 13.9 (q), 9.8 (q), 7.3 (q); MS (CI^+, CH_4) *m/z* (relative intensity) 261 ($M+H^+$, 100), 243 (23), 159 (31), 141 (35), 124 (14), 123 (26); HRMS (CI^+, CH_4) Calcd for $C_{14}H_{29}O_4$ ($M+H^+$): 261.2066. Found: 261.2065.

6.7.1.3. (2*S)-2-((4*S**,5*S**,6*R**)-6-Ethyl-2,2,5-trimethyl-1,3-dioxan-4-yl)propyl 2,2-dimethylpropanoate 40.** Acetonide formation from diol **39** (25 mg, 0.096 mmol) provided, after purification by flash chromatography (petroleum ether–EtOAc: 95/5), 20 mg (69%) of **40** as a colorless oil; IR 1730, 1285, 1200, 1160, 1020, 975, 865 cm^{-1}; ^1H NMR δ 4.13 (dd, J=10.7, 3.3 Hz, 1H), 4.07 (dd, J=10.7, 5.5 Hz, 1H), 3.74 (m, 1H), 3.65 (dd, J=10.1, 2.0 Hz, 1H), 1.92 (m, 1H), 1.62–1.33 (m, 3H), 1.37 (s, 6H), 1.21 (s, 9H), 0.90 (t, J=7.4 Hz, 3H), 0.89 (d, J=7.4 Hz, 3H), 0.83 (d, J=7.0 Hz, 3H); ^{13}C NMR δ 178.6 (s), 98.8 (s), 75.1 (d), 73.8 (d), 66.2 (t), 38.9 (s), 34.3 (d), 31.9 (d), 29.9 (q), 27.3 (q, 3C), 25.7 (t), 19.5 (q), 12.2 (q), 9.8 (q), 4.2 (q); MS-EI *m/z* (relative intensity) 285 ($M-Me^+$, 53), 242 ($M-Me_2C{=}O^+$, 1), 173 (28), 141 (20), 123 (100), 85 (38), 82 (85), 70 (19), 59 (51), 57 (79), 55 (15); HRMS (CI^+, CH_4) Calcd for $C_{17}H_{33}O_4$ ($M+H^+$): 301.2379. Found: 301.2385.

6.7.1.4. (1*R,2*S**)-1-Ethyl-2-((4*S**,5*S**)-2,2,5-trimethyl-1,3-dioxan-4-yl)propyl 2,2-dimethylpropanoate 40′.** Acetonide formation from diol **39′** (10 mg, 0.038 mmol) provided, after purification by flash chromatography (petroleum ether–EtOAc: 94/6), 4 mg (35%) of **40′**; IR 1730, 1285, 1200, 1170 cm^{-1}; ^1H NMR δ 4.85 (m, 1H), 3.70 (dd, J=11.4, 5.0 Hz, 1H), 3.61 (dd, J=10.3, 1.8 Hz, 1H), 3.51 (dd, apparent t, J=11.4 Hz, 1H), 1.92–1.79 (m, 2H), 1.73–1.50 (m, 2H), 1.42 (s, 3H), 1.34 (s, 3H), 1.22 (s, 9H), 0.91 (d, J=7.0 Hz, 3H), 0.86 (t, J=7.5 Hz, 3H), 0.70 (d, J=6.6 Hz, 3H); ^{13}C NMR δ 177.9 (s), 97.9 (s), 77.2 (d), 74.7 (d), 66.3 (t), 38.9 (s), 36.4 (d), 30.6 (d), 29.7 (q), 27.3 (q, 3C), 24.1 (t), 18.8 (q), 12.4 (q), 9.5 (q), 8.8 (q); MS-EI *m/z* (relative intensity) 285 ($M-Me^+$, 46), 242 ($M-Me_2C{=}O^+$, 4), 201 (35), 183 (11), 141 (26), 140 (11), 129 (44), 123 (84), 103 (46), 99 (34), 97 (10), 85 (53), 81 (12), 71 (22), 70 (14), 69 (16), 59 (82), 57 (100), 55 (13); HRMS (CI^+, CH_4) Calcd for $C_{17}H_{33}O_4$ ($M+H^+$): 301.2379. Found: 301.2379.

6.7.2. Oxymercuration of cyclopropane 24. Compound **24** (55 mg, 0.15 mmol) was subjected to the oxymercuration–reductive demercuration procedures. After purification by flash chromatography (petroleum ether–EtOAc gradient: 80/20–0/100), 21 mg (36%) of **45**, 7 mg (12%) of **44** and 23 mg (40%) of **43** were obtained as colorless oils (88% combined yield from **24**).

6.7.2.1. (2*R,3*R**,5*S**,6*S**)-7-(2,2-Dimethylpropanoyloxy)-3,5-dihydroxy-2,4,6-trimethylheptyl 2,2-dimethylpropanoate 45.** R_f 0.45 (petroleum ether–EtOAc: 70/30); IR 3420, 1725, 1700, 1285, 1175, 1065, 970 cm^{-1}; ^1H NMR δ 4.33 (dd, $J=11.1$, 5.0 Hz, 2H), 4.03 (dd, $J=11.1$, 3.7 Hz, 2H), 3.98 (br s, 2H, 2OH), 3.41 (m, 2H), 1.91 (m, 2H), 1.74 (m, 1H), 1.17 (s, 18H), 0.86 (d, $J=7.0$ Hz, 9H); ^{13}C NMR δ 179.3 (s, 2C), 78.3 (d, 2C), 66.8 (t, 2C), 39.0 (s, 2C), 36.8 (d, 2C), 34.1 (d), 27.2 (q, 6C), 13.7 (q, 2C), 3.8 (q); MS (CI^+, CH_4) *m/z* (relative intensity) 375 ($M+H^+$, 81), 357 (52), 339 (12), 273 (28), 255 (22), 173 (55), 153 (100), 135 (41), 103 (53); HRMS (CI^+, CH_4) Calcd for $C_{20}H_{39}O_6$ ($M+H^+$): 375.2747. Found: 375.2744.

6.7.2.2. (2*R,3*R**,4*S**,5*S**,6*S**)-5-(2,2-Dimethyl-propanoyloxy)-3,7-dihydroxy-2,4,6-trimethylheptyl 2,2-dimethylpropanoate 44.** R_f 0.35 (petroleum ether–EtOAc: 70/30); IR 3420, 1725, 1700, 1285, 1175, 970 cm^{-1}; ^1H NMR δ 4.96 (dd, $J=8.1$, 4.0 Hz, 1H), 4.27 (dd, $J=11.1$, 5.2 Hz, 1H), 4.11 (dd, $J=11.1$, 3.9 Hz, 1H), 3.52 (m, 2H), 3.41 (dd, $J=8.1$, 3.7 Hz, 1H), 2.41 (br s, 1H, OH), 2.07–1.86 (m, 3H), 1.63 (br s, 1H, OH), 1.24 (s, 9H), 1.22 (s, 9H), 1.03 (d, $J=7.0$ Hz, 3H), 0.96 (d, $J=6.6$ Hz, 6H); ^{13}C NMR δ 179.3 (s), 178.9 (s), 77.4 (d), 75.3 (d), 66.4 (t), 63.8 (t), 39.2 (s), 38.9 (s), 37.5 (d), 36.3 (d), 36.2 (d), 27.3 (q, 3C), 27.2 (q, 3C), 14.3 (q), 14.2 (q), 7.5 (q).

6.7.2.3. (2*R,3*R**,4*R**,5*S**,6*S**)-3-(2,2-Dimethyl-propanoyloxy)-5,7-dihydroxy-2,4,6-trimethylheptyl 2,2-dimethylpropanoate 43.** R_f 0.18 (petroleum ether–EtOAc: 70/30); IR 3420, 1725, 1700, 1290, 1175, 1030, 1070, 970 cm^{-1}; ^1H NMR δ 4.85 (dd, $J=7.0$, 4.0 Hz, 1H), 4.15 (dd, $J=11.0$, 4.0 Hz, 1H), 3.91 (dd, $J=11.0$, 7.0 Hz, 1H), 3.68 (m, 2H), 3.60 (dd, $J=8.8$, 2.6 Hz, 1H), 3.38–3.15 (m, 2H, OH), 2.20 (m, 1H), 2.03 (m, 1H), 1.88 (m, 1H), 1.22 (s, 9H), 1.20 (s, 9H), 1.02 (d, $J=6.6$ Hz, 3H), 0.89 (d, $J=7.0$ Hz, 3H), 0.84 (d, $J=6.6$ Hz, 3H); ^{13}C NMR δ 179.2 (s), 178.4 (s), 80.0 (d), 77.3 (d), 68.4 (t), 65.0 (t), 39.3 (s), 38.9 (s), 37.4 (d), 37.2 (d), 36.0 (d), 27.2 (q, 6C), 14.6 (q), 13.9 (q), 7.2 (q).

6.7.2.4. (1*S,2*R**)-[(1*R**)-1-((4*S**,5*S**)-2,2,5-Trimethyl-[1,3]dioxan-4-yl)ethyl]-3-(2,2-dimethylpropanoyloxy)-2-methylpropyl 2,2-dimethylpropanoate 46.** Acetonide formation from diol **43** (7 mg, 0.02 mmol) provided, after purification by flash chromatography (petroleum ether–EtOAc: 90/10), 6 mg (78%) of **46** as a colorless oil; IR 1725, 1280, 1200, 1150 cm^{-1}; ^1H NMR δ 5.01 (dd, $J=6.8$, 4.6 Hz, 1H), 4.33 (dd, $J=11.0$, 3.9 Hz, 1H), 3.79–3.67 (m, 2H), 3.70 (dd, $J=11.8$, 5.2 Hz, 1H), 3.56 (dd, apparent t, $J=11.2$ Hz, 1H), 2.17 (m, 1H), 1.99 (td, $J=6.8$, 2.2 Hz, 1H), 1.86 (m, 1H), 1.40 (s, 3H), 1.34 (s, 3H), 1.23 (s, 9H), 1.22 (s, 9H), 0.97 (d, $J=7.0$ Hz, 3H), 0.90 (d, $J=6.6$ Hz, 3H), 0.75 (d, $J=6.6$ Hz, 3H); ^{13}C NMR δ 178.5 (s), 177.4 (s), 98.1 (s), 77.2 (d), 75.7 (d), 66.2 (t), 65.2 (t), 39.1 (s), 38.8 (s), 35.3 (d), 34.3 (d), 30.7 (d), 29.7 (q), 27.4 (q, 3C), 27.2 (q, 3C), 18.7 (q), 15.2 (q), 12.2 (q), 8.7 (q); MS (CI^+, CH_4) *m/z* (relative intensity) 415 ($M+H^+$, 10), 357 (100), 313 (17), 255 (21), 153 (14); HRMS (CI^+, CH_4) Calcd for $C_{23}H_{43}O_6$ ($M+H^+$): 415.3060. Found: 415.3063.

6.7.2.5. (2*R,3*R**,4*S**,5*S**,6*S**)-5,7-Bis(2,2-dimethylpropanoyloxy)-3-hydroxy-2,4,6-trimethylheptyl 2,2-dimethylpropanoate 47.** To a mixture of **43** (13 mg, 0.035 mmol) and **44** (6 mg, 0.02 mmol) and DMAP (107 mg, 0.876 mmol, 17 equiv) in CH_2Cl_2 (2 mL) at rt, was added PivCl (80 μL, 0.65 mmol, 13 equiv). After 15 h at rt, the reaction mixture was hydrolyzed with a saturated aqueous NH_4Cl solution and extracted with CH_2Cl_2. The combined extracts were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether–EtOAc: 75/25) to afford 21 mg (93%) of **47** as a colorless oil; IR 3500, 1725, 1280, 1155 cm^{-1}; ^1H NMR δ 4.97 (dd, $J=6.1$, 5.3 Hz, 1H), 4.29 (dd, $J=11.0$, 5.2 Hz, 1H), 4.18–4.09 (m, 2H), 3.88 (dd, $J=11.0$, 7.7 Hz, 1H), 3.44 (ddd, $J=8.8$, 4.8, 3.0 Hz, 1H), 2.64 (d, $J=4.8$ Hz, 1H, OH), 2.20 (m, 1H), 2.04–1.89 (m, 2H), 1.22 (s, 9H), 1.21 (s, 9H), 1.20 (s, 9H), 1.00 (d, $J=6.6$ Hz, 3H), 0.95 (d, $J=7.0$ Hz, 3H), 0.88 (d, $J=6.6$ Hz, 3H); ^{13}C NMR δ 179.0 (s), 178.5 (s), 178.4 (s), 77.2 (d), 74.3 (d), 66.7 (t), 65.0 (t), 39.2 (s), 38.9 (s), 38.8 (s), 36.4 (d, 2C), 35.1 (d), 27.3 (q, 6C), 27.2 (q, 3C), 14.8 (q), 14.1 (q), 7.4 (q); MS (CI^+, CH_4) *m/z* (relative intensity) 459 ($M+H^+$, 24), 441 (27), 357 (100), 339 (21), 255 (22), 213 (13), 173 (29), 153 (72), 135 (30), 103 (51); HRMS (CI^+, CH_4) Calcd for $C_{25}H_{47}O_7$ ($M+H^+$): 459.3322. Found: 459.3324.

Acknowledgements

M. D. and N. B. thank the MRES for a grant.

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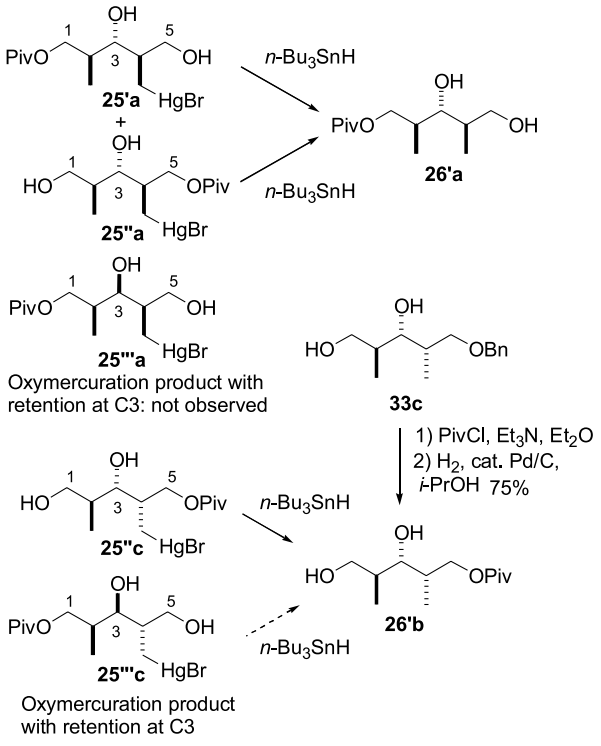

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