Total Synthesis of 6-Epi-Erythronolide Derivatives

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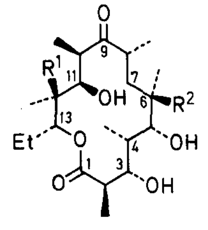
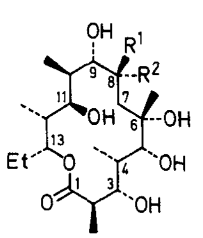
A concise convergent synthesis of 6-epi-erythronolide B 3,5-acetonide and of (9*R*)-dihydro-6-epi-erythronolide B from (*R*)-2,3-*O*-isopropylideneglyceraldehyde is described. The key step in the synthesis involves the coupling of two aldehydes, comprising the C1–C6 and the C9–C13 portions of the target molecule, across a formal acetylide dianion (≙ C7–C8 (Scheme 1).

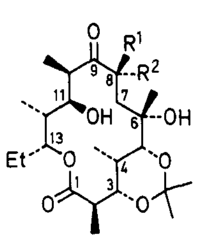
The total synthesis of the erythromycin antibiotics[1] and in particular of their aglycons **1a–c**,[2,3] has been one of the largest projects in organic chemistry over the past decade. More than fifteen research groups have been involved in this project, and a number of elegant syntheses of **1a–c** and precursors thereof have been recorded.[3] Surprisingly, almost all of these efforts have been concentrated on the preparation of the natural products, which are available in multigram quantities via fermentation,[1] and have neglected the total synthesis of metabolically more stable structural analogues. Recent research has re-emphasized the fact that the 6*R*-OH function together with the carbonyl group at C9 is responsible for the rapid decomposition of the macrolide under physiological conditions, due to ketal formation and subsequent dehydration.[4]



1a R¹ = R² = H 6-Deoxyerythronolide B
b R¹ = H, R² = OH Erythronolide B
c R¹ = R² = OH Erythronolide A

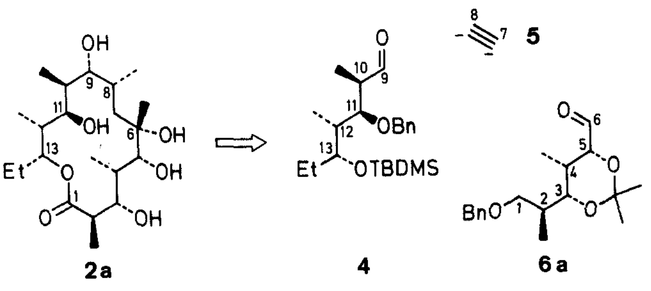


2a R¹ = H, R² = Me
b R¹ = Me, R² = H



3a R¹ = H, R² = Me
b R¹ = Me, R² = H

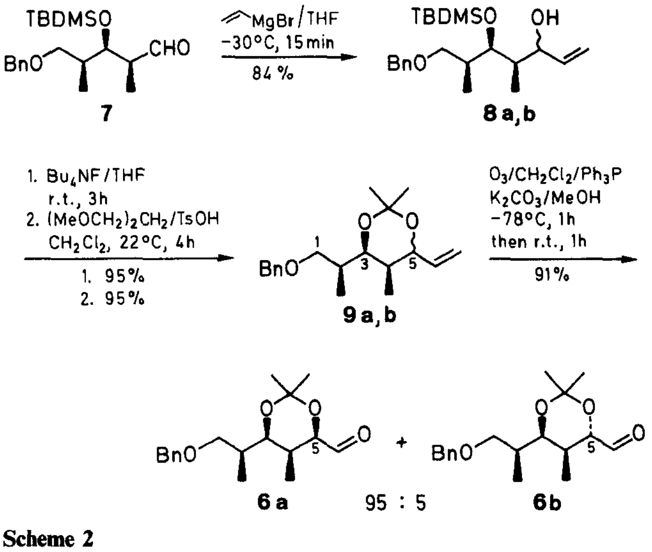
Having completed a total synthesis of **1b**[3s] and thus demonstrated that we are capable of handling the stereochemical and functional complexity of the naturally occurring substance, we decided to develop a synthesis of suitably modified erythronolides, e.g., the 9-dihydro and 6-epi derivatives **2** and **3** of **1b**. Our retrosynthetic analysis for compound **2** is shown in Scheme 1. The target molecules **2** and, similarly, **3**, are dissected into two aldehyde fragments **4** (C9–C13) and **6a** (C1–C6) respectively, which are coupled across a two carbon (C7–C8) acetylide dianion synthon **5**.



Scheme 1

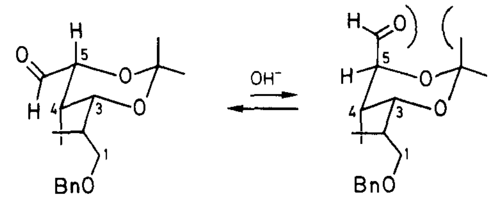
Such anionic couplings of two major fragments have been the limiting step in most erythronolide syntheses, as satisfactory solutions to this central problem have been found in only very few cases. We were thus delighted to notice that the extreme nucleophilicity of the acetylide anion made our coupling process an extremely efficient one, proceeding in 95% isolated yield on a multigram scale. The missing methyl group at C8 was introduced at a later stage of the synthesis, via a cuprate addition.

Both fragments **4** and **6a** are readily available from (*R*)-2,3-*O*-isopropylideneglyceraldehyde in multigram quantities. The synthesis of **4** has already been described in detail.[3s] For the preparation of **6a** (Scheme 2) the known aldehyde **7**[3s] was treated with vinylmagnesium bromide to give allyl alcohol **8** as a 3.5:1-mixture of the epimers **8a, b**, which was converted into the acetonide **9** without separation.



Scheme 2

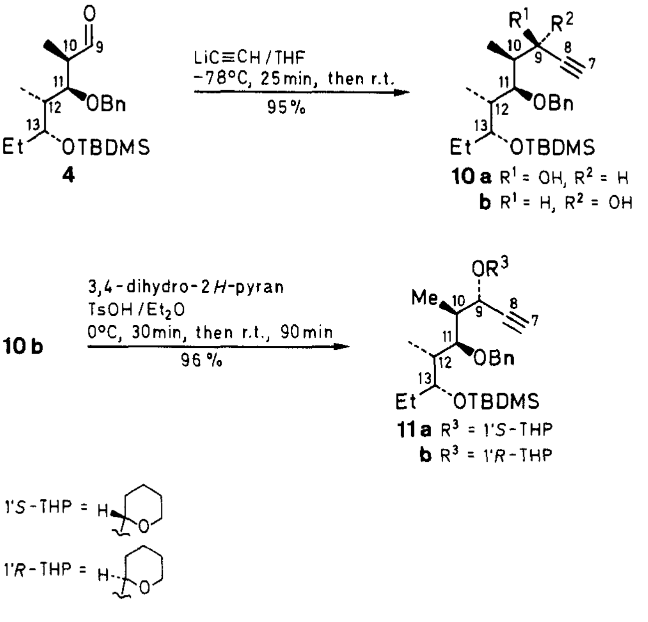
After ozonolysis the resulting aldehydes **6a,b** were submitted to a base-catalyzed epimerization at C5, resulting in an equilibrium mixture of **6a**/**6b** = 95:5 (HPLC analysis), presumably due to the large preference of the aldehyde group for the equatorial position (Scheme 3).[3f,s]



6a 95 : 5 **6b**

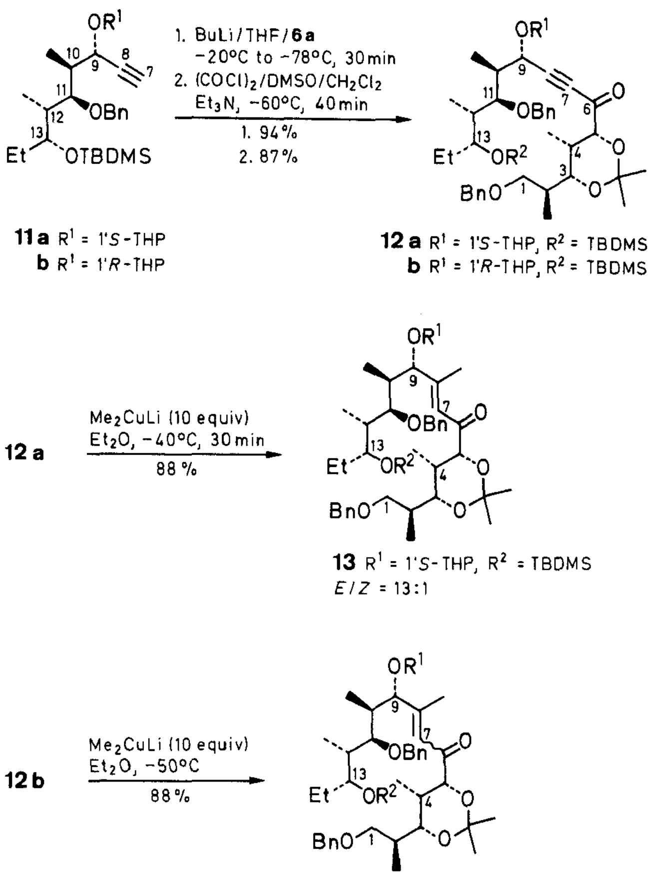
Scheme 3

The acetylide fragment **5** was first attached via the monoanion to aldehyde **4** to give the propargylic alcohol **10** as an easily separable mixture of the epimers **10a** and **10b**, respectively (Scheme 4).



Scheme 4

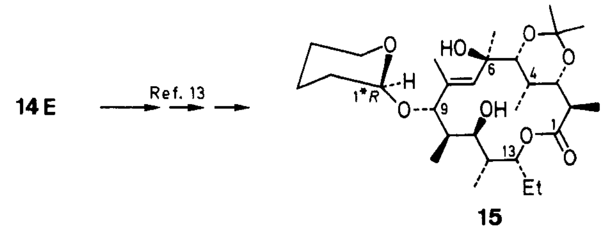
To avoid separation, this mixture could be oxidized to the 9-ketone under Swern conditions[5] and then stereoselectively be reduced with Midland's reagent (Alpine-Borane, *B*-isopinocampheyl-9-borabicyclo[3.3.1]nonane) to give either **10a** or **10b**; depending on which α-pinene enantiomer was used.[6] However, the chromatographic separation of **10a,b** proved to be too straightforward to justify such an oxidation–reduction sequence. As the 9*S*-configuration can be achieved from sodium tetrahydroborate reduction of natural **1b**,[3a] we continued our synthesis with the "unnatural" 9*R*-diastereomer **10b**. The configuration of **10a,b** at C9 was established by means of X-ray analysis[12] of more advanced synthetic intermediates, i.e. **15**[13] and **20a** (Figures 1 and 2) later on. Compound **10b** was transformed into the 9-THP ether as a 1 : 1 anomeric mixture of **11a,b**, which was converted into the lithium acetylides with butyllithium and added to aldehyde **6a** to give the alkynones **12a** and **12b** in > 80% yield after Swern oxidation (Scheme 5).



Scheme 5

Compounds **12a,b** were readily separable by column chromatography. Such a separation of THP anomers may be considered an additional chance for exerting stereocontrol, and thus we carried on with both anomers separately. Again, the assignment of 1'*S* and 1'*R* configurations to **12a** and **12b**, respectively, was possible via the above mentioned X-ray analyses, as will be specified later. In the next step the 8-methyl group had to be introduced via treatment of **12** with dimethyl cuprate. Surprisingly, the *E*/*Z*-ratio of the enones **13** and **14** thus obtained drastically varied with the 1'*S* and *R*-configurations of the THP ether. Thus, the 1'*S*-anomer **12a** furnished enone **13** with an *E*/*Z*-ratio of 13 : 1 (HPLC analysis), whereas the 1'*R*-derivative **12b** afforded enone **14** with an *E*/*Z*-ratio of 1 : 1. The reason for this novel and totally unexpected stereodirecting effect of a THP group on a cuprate addition is unclear so far and deserves a detailed investigation in its own right. Due to the high selectivity of its formation we used **13E** for the main branch of our synthesis. A parallel sequence was also performed with isomer **14E**, which presented us a crystalline macrolide **15** several steps later.

The X-ray analysis of **15**[13] (Figure 1) permitted the unequivocal assignment of the stereocenters at C9 and 1' as well as of the 7,8-double bond, as detailed in the genealogy of Scheme 10: at each branching point of this pedigree only one additional element of stereochemistry has been introduced so that the relative and absolute configurations of all the intermediates can be safely assigned. The *E*/*Z*-configuration of the enones **13** and **14** has an interesting consequence on the ^{1}H NMR signal of H9, which appears downfield in the *Z*-isomers (δ = 5.66 in **13Z** and δ = 5.68 in **14Z**) and upfield in the corre-



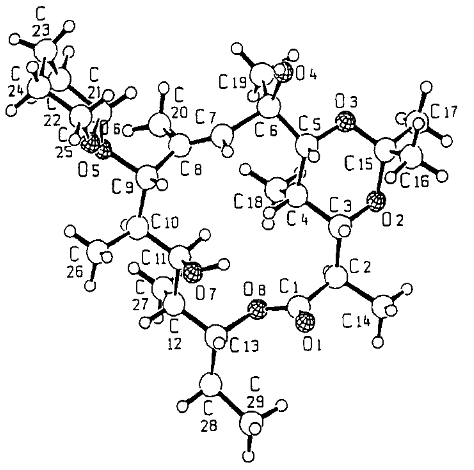
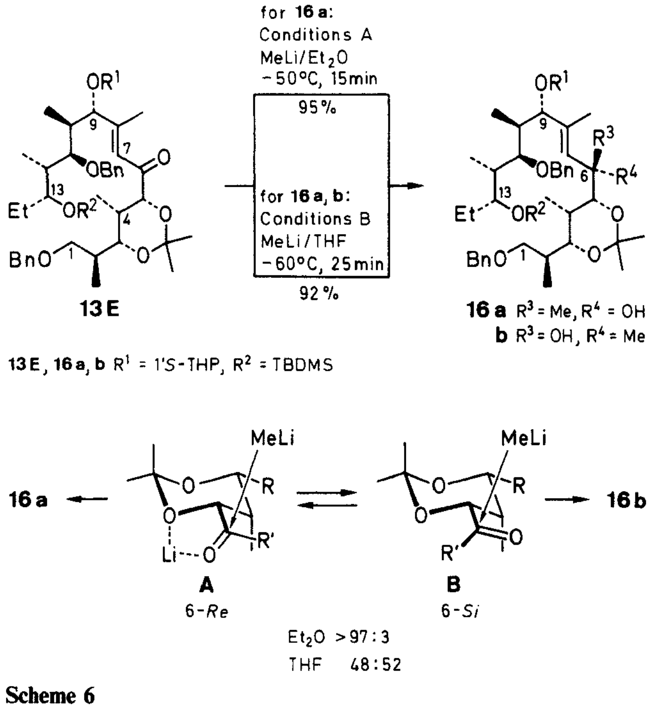


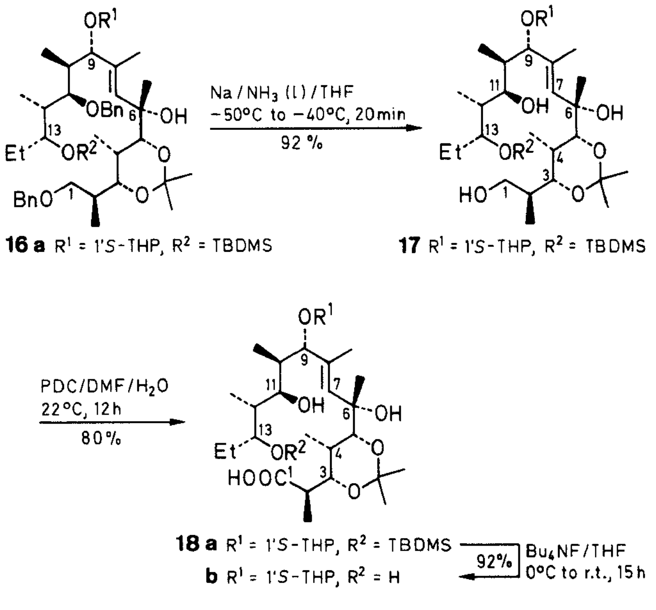
Figure 1. Crystal Structure of Macrolide **15**.

sponding *E*-isomers ($\delta = 4.06$ in **13E** and $\delta = 4.18$ in **14E**). Apparently H9 lies in the deshielding region of the 6-C=O function only if the double bond is *Z*-configurated. Interestingly, the *E*/*Z*-enone configuration has almost no influence on the chemical shifts of H7 and 8-Me.



Scheme 6

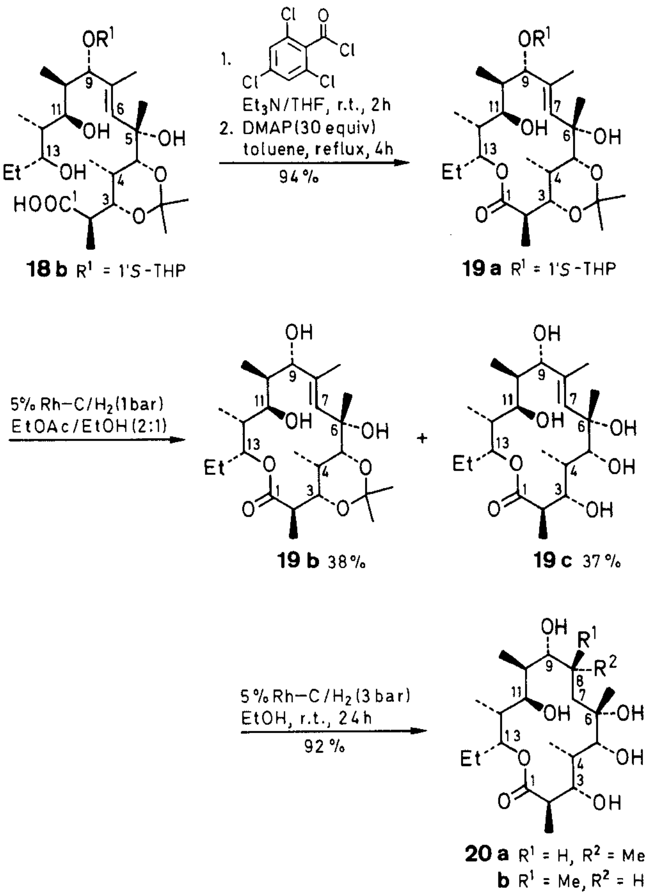
The next problem was the introduction of the 6-methyl group via an organometallic addition to the 6-oxo function (Scheme 6). In view of the ether group at C-5 the choice was between a chelate or a non-chelate controlled mechanism.[7] In the first case **16a** and in the latter case **16b** would have been the preferred stereoisomer. Literature precedence for organometallic additions to the 6-oxo position of erythronolide seco acid fragments only exists for saturated systems[3r,t] and indicates high selectivities in favor of the non-chelated process. In our hands, enone **13E** reacted with methyllithium to give a quantitative yield of **16a** and **16b** in a stereomer ratio of > 97 : 3, if the addition was performed in diethyl ether. In tetrahydrofuran, by contrast, the ratio of **16a**/**16b** was 48 : 52 (Scheme 6). Methylmagnesium bromide was totally inert towards **13E** in either solvent. The stereochemical outcome of the addition can be interpreted in terms of a competition between chelated and non-chelated conformers **A** and **B**, respectively. **A** leads to **16a** and **B** to **16b**. In both conformers the bottom face of the molecule is shielded by the axial methyl group at C4, so that the methyllithium attacks from the top face. Obviously **A** is the preferred species in diethyl ether, whereas the much higher donicity of tetrahydrofuran loosens the chelate. **16a** and **b** are easily separable by column chromatography.



Scheme 7

In keeping with our original objective we continued with the unnatural 6*S*-epimer **16a** (Scheme 7) which was debenzylated at both 1- and 11-hydroxy functions to give diol **17**, which was oxidized with pyridinium dichromate (PDC) selectively at the primary position to furnish the desired seco acid derivative **18a**. No oxidation occurred at the 11-OH function under these conditions. Desilylation of **18a** led to **18b** (Scheme 7) which was smoothly lactonized to **19a** under Yamaguchi's conditions (Scheme 8).[8] No lactone formation was observed to the 11-OH position, which may be interpreted in terms of ring strain effects (14-membered ring better than 12-membered ring) or of steric shielding of the 11-position by the two adjacent methyl groups at C10 and 12, respectively. Systematic studies are underway to clarifying the factors responsible for such chemoselective lactonizations in medium ring systems.

The removal of the acetonide and THP protective groups proved to be extremely difficult. Standard treatment of **19a** with acetic or trifluoroacetic acid in various solvents led to extensive decomposition of the material. Eventually hydrogen in the presence of rhodium catalysts turned out to be the reagent of choice.



Scheme 8

As shown in Scheme 8, it was even possible by an appropriate adjustment of the conditions to remove the THP and acetonide groups in succession before the double bond was hydrogenated. On changing the solvent and increasing the hydrogen pressure both deacetalization and hydrogenation of the double bond took place to form the (9*R*)-dihydro-6-epi-erythronolides **20** as an epimeric mixture at C-8, easily separable by HPLC. **20a** is crystalline and was submitted to an X-ray analysis (Figure 2).

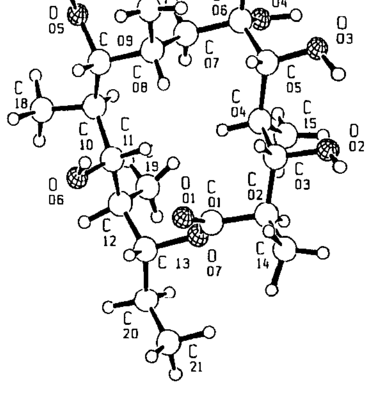
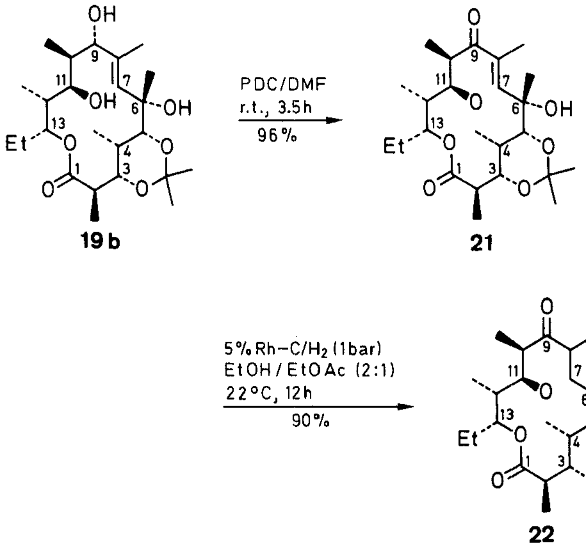


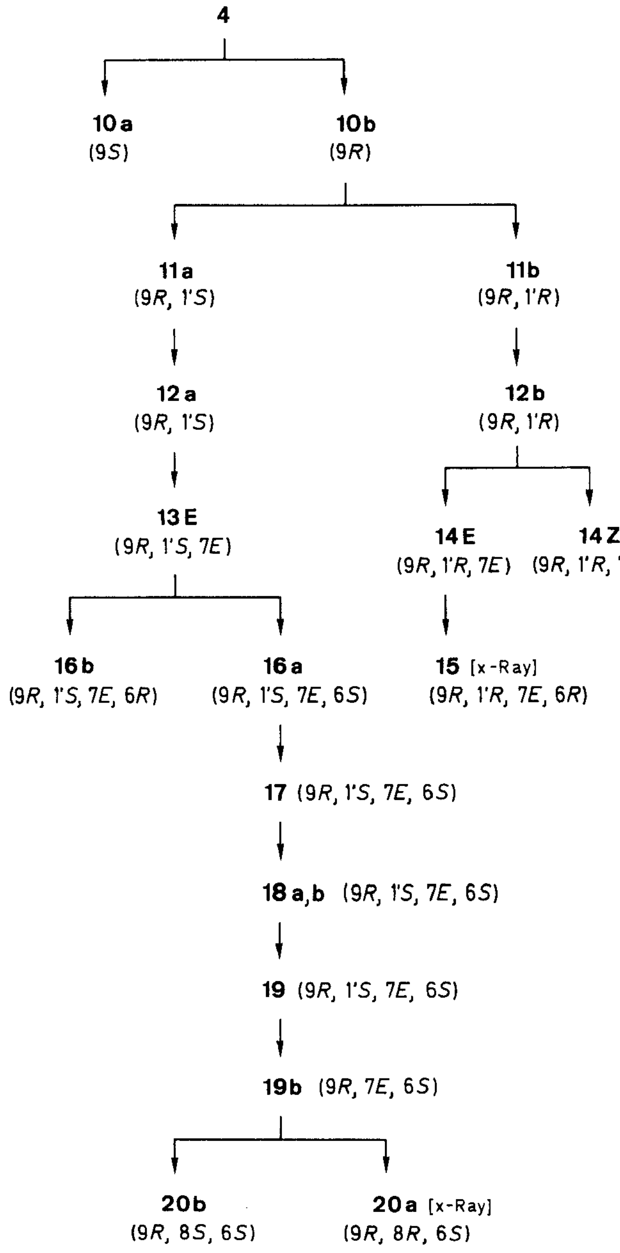
Figure 2. Crystal Structure of Macrolide **20a**.

Again it follows from the genealogy in Scheme 10, that a safe assigment of the configurations of all newly created chirality centers is possible on the basis of this crystal structure. The sequential removal of the protective groups also allows a selective oxidation of the 9-OH function in **19b** to ketone **21** with PDC (Scheme 9). Catalytic hydrogenation of **21** proceeded with high stereocontrol to form one of the two epimers **22a** or **b**. However, it is impossible at the moment to decide which epimer has been generated.



Scheme 9

As only one crystal structure of an unnatural erythronolide derivative has been reported[3s] it is worthwhile to discuss some of the important features of the structures of **15**[13] and **20a**, respectively. Both macrolides are very similar in their overall conformation. The dominating effect in both compounds is the formation of two relatively rigid parallel zig-zag carbon–carbon chains, one reaching from C9 to the methyl group of the 13-ethyl moiety, and the second from C6 to the methyl group at C2 (macrolide numbering). These carbon chains are in both macrolides crosslinked by C7–8 at the top and C1–O8 (in **15**) or C1–O7 (in **20a**) at the bottom. For the overall conformation, it does not matter whether the carbons C7–8 are sp^2 (in **15**) or sp^3 (in **20a**) hybridized. From this standpoint the conformation of 14-membered macrolides may better be expressed in terms of parallel crosslinked polypropionate chains than of a diamond lattice sub-structure.[9] A further comment should be made on the geometry around the double bond region (C5–C10) of **15**. One might expect that the perpendicular arrangement of C5–C6 and the C9–C10 single bonds on the plane of the C7–C8 olefin is induced by an allylic 1,3-strain effect.[10] Such an effect will surely be of some importance, however, the comparison of **15** with the saturated compound **20a** shows a similar geometry in the C5–C10 region. On the other hand, the 7,8-double bond may enforce a bent structure like in **15** also on the corresponding seco acids (e. g. **18b**) and thus facilitate the lactonization (cf. the discussion in Ref. 3s). A comparison of the structures **15** and **20a** may also teach us something about the hydrogenation step **19b** → **20a,b**. The low stereocontrol of this step may be due to the comparable accessibility of the double bond from the "inner" and the "outer" sphere; hydroboration,[3s] in contrast, has a much higher preference for the "outer" sphere. Furthermore, the geometry of C8 in **15** and **20a** is different and indicates that in course of the hydrogenation the C8-"edge" of the C7-C8-C9-triangle is twisted by a dihedral angle of approximately 180° (Table 4). A similar effect has already been recognized in the hydroboration reaction reported previously.[3s]



Scheme 10

Table 1. Crystal Data and Experimental Details for Structure Determinations of **15** and **20a**[12a–c, 13]

	15	**20a**
formula	$C_{29}H_{50}O_8$ (526.71)	$C_{21}H_{40}O_7$ (404.5)
crystal system	monoclinic	orthorhombic
a (Å), b (Å), c (Å)	13.269 (2), 9.654 (2), 12.106 (2)	13.023 (1), 13.912 (2), 25.616 (7)
α (deg), β (deg), γ (deg)	90, 104.64 (1), 90	90, 90, 90
V (Å³)	1500.42	4641.004
F (000)	576	1776
space group	$P2_1$	$P2_12_12_1$
Z	2	8
d_{calc}, g/cm³	1.166	1.158
crystal size, mm	0.67 × 0.37 × 0.075	0.62 × 0.21 × 0.38
radiation	Mo–K_α	Cu–K_α
λ (Å)	0.71068	1.5418
μ (cm^{-1})	0.90	7.05
temp. (°C)	18	18
data collection instrument	Siemens four circle	STOE four circle
orientation reflections, no., range (2Θ, deg)	29, 17.0–22.4	31, 36.7–51.3
scan method	ω-2Θ	2Θ-ω
scan width	$\Delta\omega = 1.58°$ $+ 0.26° \tan\omega$	$\Delta\omega = 1.02°$ $+ 0.23° \tan\omega$
scan rate (ω, deg/min)	0.6–2.4	0.67–4.0
data collection range (2Θ, deg)	4.0–40.0	6.0–120
no. of reflections collected	1608	3938
no. of unique reflections	1363	3868
no. of unique reflections	1023 with $F_0 > 3\sigma(F_0)$	3733 with $F_o > 2\sigma(F_o)$
no. of parameters refined	334	825
largest Δ/σ, final cycle	1.89	0.48
largest residual peak (e/Å³)	0.593	0.20
R_{int} for merging reflections	/	0.016 (for 84 measurements)
final R[a]	0.081	0.029
R_w[b]	0.086	0.027
goodness of fit indicator S[c]	/	2.89 (4)

[a] $R = \Sigma||F_0| - |F_c||/\Sigma|F_0|$.

[b] $R_w = [\Sigma w(|F_0| - |F_c|)^2/\Sigma w|F_0|^2]^{1/2}$; $w = 1/\sigma^2 (|F_0/)$.

[c] $S = [\Sigma w(|F_o| - |F_c/)^2/(N_{obs} - N_{parameters})]^{1/2}$ (or the F^2 equivalents).

Table 2. Selected Bond Lengths[a] (Å) of **15** and **20a**

Atom 1	Atom 2	**15**	**20a**
C1	O1	1.16 (4)	1.199 (4)
C2	C14	1.61 (6)	1.533 (7)
C2	C3	1.49 (6)	1.531 (5)
C3	O2	1.40 (4)	1.436 (4)
C5	O3	1.45 (4)	1.430 (3)
C6	O4	1.44 (4)	1.446 (3)
C6	C7	1.61 (5)	1.532 (4)
C7	C8	1.32 (4)	1.532 (4)
C9	O5	1.50 (4)	1.447 (3)

[a] Numbers in parentheses are estimated standard deviations in the least significant digits.

Table 3. Selected Valence Angles[a] (deg) of **15** and **20a**

Atom 1	Atom 2	Atom 3	**15**	**20a**
C1	O1	C2	124(3)	123.3(3)
C1	C2	C14	104(4)	107.7(3)
C2	C3	O2	106(2)	109.3(3)
C3	O2	C4	109(4)	108.0(4)
C5	O3	C6	105(6)	106.3(2)
C5	O3	C4	108(2)	110.5(2)
C5	C6	O4	108(2)	109.8(2)
C6	C7	C8	136(7)	120.7(2)
O4	C6	C7	107(2)	103.5(2)
C7	C8	C9	122(4)	110.5(2)
C8	C9	C10	116(3)	116.2(2)
C8	C9	O5	109(4)	110.5(2)
O5	C9	C10	111(3)	106.9(2)

[a] Numbers in parentheses are estimated standard deviations in the least significant digits.

Table 4. Selected Dihedral Angles[a] (deg) of **15** and **20a**

Atom 1	Atom 2	Atom 3	Atom 4	**15**	**20a**
O1	C1	C2	C14	47(4)	53.4(4)
O1	C1	C2	C3	−72(4)	−68.3(4)
C14	C2	C3	O2	62(4)	56.3(4)
O2	C3	C4	C5	−61(3)	−65.7(3)
O3	C5	C6	O4	−76(3)	59.8(3)
C4	C5	C6	O4	163(3)	−64.7(3)
O4	C6	C7	C8	127(5)	168.2(2)
C5	C6	C7	C8	−118(5)	49.4(3)
O3	C5	C6	C7	171(2)	174.8(2)
C6	C7	C8	C9	177(4)	−178.4(3)
C7	C8	C9	C10	−107(4)	58.2(3)
C7	C8	C9	O5	128(4)	−63.4(3)
O5	C9	C10	C11	−178(4)	−174.2(2)

[a] Numbers in parentheses are estimated standard deviations in the least significant digits.

Efficient convergent syntheses have been presented for the erythronolide B derivatives **20a,b (2a,b)** and **22 (3a,b)**, procuring these compounds in quantities of several hundred milligrams. To test potential bioactivities the severe task remains of attaching the monosaccharide components to O-3 and 5, respectively. This task appears to be no less demanding than the synthesis of the erythronolides themselves.[11]

IR spectra were obtained with a Perkin-Elmer IR 580B Spectrophotometer. NMR spectra were recorded with a Bruker WH 270 or 250 spectrometer in $CDCl_3$ with TMS as internal standard. Optical rotations were determined in $CHCl_3$ (unless stated otherwise) with a Perkin-Elmer 121 polarimeter at a wavelength of 589 nm at 20 °C. Mass spectra (MS) were recorded with a Varian MAT 711 spectrometer. HPLC separations were performed on 7-μm (preparative separations) and 5-μm (analytical separations) Nucleosil 50. All reactions were performed in purified solvents and monitored by TLC plates (Merck 5554). Preparative column chromatography was performed on silica gel Merck 60. 230–400 mesh. The preparation of aldehydes **4** and **7** is described in ref.[3s]

1) Synthesis of 6a:

(2*S*,3*R*,4*R*,5*R*)- and (2*S*,3*R*,4*R*,5*S*)-1-*O*-Benzyl-3-*O*-(*tert*-butyldimethylsilyl)-2,4-dimethyl-6-heptene-1,3,5-triol (8a,b):

Aldehyde **7** (35.0 g, 100.4 mmol) in THF (250 mL) was treated dropwise at − 45 °C with vinylmagnesium bromide (1 M in THF, 321 mL, 321 mmol). The mixture was stirred for 15 min at − 30 °C and quenched with 1 N H_2SO_4 (50 mL) until a clear solution was formed. The inorganic salts were removed by filtration, washed thoroughly with Et_2O and the combined organic phases were dried ($MgSO_4$). Flash column chromatography (hexane/EtOAc, 10:1) afforded **8a,b** (31.93 g, 84 %) as a 3.5:1 mixture of diastereomers in form of a colorless oil.

The mixture was partly separated by column chromatography (hexane/EtOAc, 10:1) to provide pure **8a**. Compound **8a** (major diastereomer): R_f = 0.63 (silica gel, hexane/EtOAc, 1:1).

$C_{22}H_{38}O_3Si$	calc.	C 69.79	H 10.11
(378.6)	found	69.69	9.82

^{1}H NMR: δ = 0.04 (s, 3 H, $SiCH_3$), 0.08 (s, 3 H, $SiCH_3$), 0.88 (d, *J* = 7.2 Hz, 3 H, 2-CH_3), 0.94 (d, *J* = 7.0 Hz, 3 H, 4-CH_3), 0.94 [s, 9 H,$SiC(CH_3)_3$], 1.75 (mc, 1 H, 4-H), 2.02 (d, *J* = 3.8 Hz, 1 H, –OH), 2.14 (mc, 1 H, 4-H), 3.28 (dd, *J* = 8.5, 6.5 Hz, 1 H, 1-H), 3.52 (dd, *J* = 8.5, 6.5 Hz, 1 H, 1-H), 3.86 (dd, *J* = 5.0, 4.0 Hz, 1 H, 3-H), 4.22 (mc, 1 H, 5-H), 4.51 (s, 2 H, $OC\underline{H}_2Ph$), 5.16 (d, *J* = 10.5 Hz, 1 H, 7-H), 5.26 (d, *J* = 17.5 Hz, 1 H, 7-H), 7.22–7.38 (m, 5 H_{arom}).

MS (EI, 80 eV, 60 °C): *m/z* 378 $(M)^+$, 360 $(M-H_2O)^+$, 321 $(M-C_4H_9)^+$, 303 $(M-H_2O-C_4H_9)^+$, 293 $[M-SiC(CH_3)_3]^+$, 253 $(M-H_2O-OCH_2Ph)^+$, 229, 213 $(M-H_2O-OCH_2Ph-2CH_3)^+$, 187, 173, 147, 145.

(2*S*,3*R*,4*S*,5*R*)- and (2*S*,3*R*,4*S*,5*S*)-1-*O*-Benzyl-3,5-*O*-isopropylidene-2,4-dimethyl-6-heptene-1,3,5-triol (9):

To a mixture of **8a, 8b** (28.0 g, 105.90 mmol) in THF (100 mL) at 0 °C was added 1 M Bu_4NF solution in THF (150 mL, 150 mmol). The ice bath was removed and the pale brown solution was stirred for 3 h at r. t. The solvent was then removed under reduced pressure and the residue was applied directly to a column of flash silica gel. Elution was effected with EtOAc/hexane (1:2) to afford the desired diol. To a stirred solution of the diol (23.0 g, 0.87 mmol) in CH_2Cl_2 (100 mL) was added TsOH until pH 3; then 2,2-dimethoxypropane (10 g, 100 mmol) was added dropwise and the mixture was stirred for 4 h at 22 °C. The reaction was quenched with sat. aq $NaHCO_3$ and the resulting aqueous phase was thoroughly extracted with Et_2O. The combined organic layers were washed with H_2O and brine, dried ($MgSO_4$) and concentrated in vacuo to give, after flash chromatography, (hexane/EtOAc, 10:1) **9** (25.2 g, 95 %) as clear oil. A small amount of the main, (5*R*) diastereomer was purified by flash chromatography (hexane/EtOAc, 15:1). R_f = 0.54 (silica gel, hexane/EtOAc, 3:1); $[\alpha]_D^{20}$ + 3.55 (*c* = 4.05).

^{1}H NMR: δ = 0.86 (d, *J* = 7.5 Hz, 3 H, 2-CH_3), 1.08 (d, *J* = 7.0 Hz, 3 H, 4-CH_3), 1.44 (s, 6 H, $C(CH_3)_2$), 1.48 (mc, 1 H, 2-H), 1.86 (mc, 1 H, 4-H), 3.34 (dd, *J* = 7.5, 3.5 Hz, 1 H, 1-H), 3.38 (dd, *J* = 7.5, 3.5 Hz, 1 H, 1-H), 3.72 (dd, *J* = 10.0, 2.2 Hz, 1 H, 3-H), AB system (δ_A = 4.46, δ_B = 4.52, J_{AB} = J_{BA} = 10.8 Hz, 2 H, $OC\underline{H}_2Ph$), 5.14 (d, J_{cis} = 10.5 Hz, 1 H, 7-H), 5.22 (d, J_{trans} = 17.5 Hz, 1 H, 7-H), 5.76 (ddd, J_{trans} = 17.5 Hz, J_{cis} = 10.5 Hz, $J_{6,5}$ = 7.2 Hz, 1 H, 6-H), 7.28–7.40 (m, 5 H_{arom}).

^{13}C NMR: δ = 5.59, 14,62, 19.63, 29.96, 34,28, 35.08, 71.42, 73.12, 74.28, 75.43, 99.01, 114.85, 127.49, 128.28, 137.64, 138.52.

IR (film): ν = 3100 m, 3070 m, 3040 m, 2990 vs, 2940 s, 2920 s, 2880 s, 1650 m, 1495 m, 1480 m, 1455 s, 1410 s, 1385 vs, 1370 s, 1360 s, 1330 m, 1310 m, 1295 m, 1260 vs, 1200 vs, 1185 s, 1165 s, 1105 s, 1090 s, 1065 s, 1020 s, 990 s, 925 s, 875 s, 830 w, 805 w, 740 s, 700 vs cm^{-1}.

MS (EI, 80 eV, 40 °C): *m/z* = 289 $(M-CH_3)^+$, 246 $(M-(CH_3)_2CO)^+$, 229 $[M-(CH_3)_2CO-OH]^+$, 190 $[M-(CH_3)_2CO-H_2CCHCHO]^+$.

MS (CI, isobutane, 120 °C): *m/z* = 305 $(M+H)^+$, 247 $[M+H-(CH_3)_2CO]^+$, 229 $[M+H-(CH_3)_2CO-H_2O]^+$, 179 $(M+H-HOCH_2Ph-H_2O)^+$, 139 $[M+H-(CH_2)_2CO-H_2O]^+$, 179 $(M+H-HOCH_2Ph-H_2O)^+$, 139 $[M+H-(CH_3)_2CO-HOCH_2Ph]^+$.

(2*R*,3*S*,4*R*,5*R*)- and (2*S*,3*S*,4*R*,5*S*)-6-Benzyloxy-2,4-isopropylidenedioxy-3,5-dimethyl-1-hexanal (6a,b):

A stream of O_3 was bubbled through a solution of alkene **9** (25.0 g, 82.12 mmol) in CH_2Cl_2 (1500 mL) at − 78 °C until the blue color persisted. Ph_3P (22.3 g, 85 mmol) was added and the mixture was stirred at − 78 °C for 1 h. After warming to r.t. and stirring for an additional hour, the solvent was evaporated in vacuo and the resulting residue was diluted with ice cold Et_2O (300 mL). Removal of the Ph_3PO by filtration, followed by flash chromatography (hexane/EtOAc, 10 : 1) provided a mixture of aldehydes **6a,b** (22.9 g, 91 %) as clear oil. The mixture of aldehydes **6a,b** (19.5 g, 63.6 mmol) was dissolved in MeOH (30 mL) and sat. aq Na_2CO_3 in MeOH (10 mL) was added dropwise at 0 °C. The mixture was stirred at 22 °C for 2 h; Et_2O (50 mL) and H_2O were added and the aqueous layer was thoroughly extracted with Et_2O. The combined organic phases were washed with sat. aq NH_4Cl, dried ($MgSO_4$), filtered and the solvent was evaporated in vacuo to provide, after flash chromatography (hexane/EtOAc, 10: 1), pure aldehyde **6a** (19.0 g, 98 %) as a colorless oil. The product ratio of **6a,b** after the epimerization step was determinated as > 95 : 5 (by ^1H NMR integration and analytical HPLC).

Compound **6a**: R_f = 0.31 (silica gel, hexane/EtOAc, 3 : 1); $[\alpha]_D^{20}$ + 15.0 (c = 3.50).

$C_{18}H_{26}O_4$ calc. C 70.56 H 8.55
(306.4) found 70.43 8.61

^1H NMR: δ = 0.88 (d, J = 7.2 Hz, 3 H, 5-CH_3), 1.06 (d, J = 7.0 Hz, 3 H, 4-CH_3), 1.44 (s, 3 H, $C(CH_3)_2$), 1.50 (s, 3 H, $C(CH_3)_2$), 1.86 (mc, 1 H, 5-H), 2.02 (mc, 1 H, 3-H), 3.36 (d, J = 4.8 Hz, 2 H, 6-H), 3.72 (dd, J = 8.2, 2.5 Hz, 1 H, 4-H), 4.28 (d, J = 2.5 Hz, 1 H, 2-H), 4.48 (s, 2 H, $OC\underline{H}_2Ph$), 7.28–7.32 (m, 5 H_{arom}), 9.56 (s, 1 H, 1-H).

^{13}C NMR: δ = 6.63, 14.39, 19.16, 29.58, 31.70, 34.76, 71.20, 73.08, 73.19, 78.76, 99.65,127.56, 127.50, 128.35, 138.29, 202.63.

IR (film): ν = 3450 m, 3090 m, 3070 m, 3030 m, 2990 vs, 2940 s, 2880 s, 2860 s, 2720 w, 1735 vs, 1605 w, 1590 w, 1495 s, 1455 s, 1380 vs, 1365 vs, 1260 s, 1255 s, 1200 vs, 1180 vs, 1180 s, 1160 s, 1105 vs, 1065 s, 1015 vs, 985 s, 935 m, 900 m, 870 s, 740 s, 700 vs cm^{-1}.

MS (CI, isobutane, 160 eV, 100 °C): m/z: 307 $(M + H)^+$, 305 $(M–H)^+$, 291 $(M–CH_3)^+$, 277 $(M + H–2CH_3)^+$, 249 $[M + H–(CH_3)_2CO]^+$, 231 $(M + H– C_6H_4)^+$, 157 $[M–(CH_3)_2CO – CH_2Ph]^+$ 141 $[M–H –(CH_3)_2CO – CH_2Ph–CH_3]^+$.

MS (EI, 80 eV, 40 °C): m/z = 291 $(M–CH_3)^+$, 277 $(M + H–2CH_3)^+$, 230 $(M–C_6H_4)^+$, 219 $[M + H – (CH_3)_2CO – 2CH_3]^+$, 201 $(M + H – CH_3–OCH_2Ph)^+$.

Compound **6b**: R_f = 0.30 (silica gel, hexane/EtOAc, 3 : 1); $[\alpha]_D^{20}$ − 23.25 (c = 6.50).

$C_{18}H_{26}O_4$ calc. C 70.56 H 8.55
(306.4) found 69.98 8.56

^1H NMR: δ = 1.04 (d, J = 7.0 Hz, 3 H, 5-CH_3), 1.10 (d, J = 7.0 Hz, 3 H, 3-CH_3), 1.38 (s, 3 H, $C(CH_3)_2$), 1.42 (s,3 H, $C(CH_3)_2$), 1.90 (mc, 1 H, 5-H), 2.16 (mc, 1 H, 3-H), 3.28 (dd, J = 9.5, 5.4 Hz, 1 H, 6-H), 3.38 (dd, J = 8.6, 5.1 Hz, 1 H, 6-H), 3.60 (dd, J = 9.5, 3.5 Hz, 1 H, 4-H), 3.80 (d, J = 6.0 Hz, 1 H, 2-H), AB system δ_A = 4.44, δ_B = 4.54, J_{AB} = J_{BA} = 10.2 Hz, 2 H, $OC\underline{H}_2Ph$), 7.32 (mc, 5 H_{arom}), 9.78 (s, 1 H, 1-H).

^{13}C NMR: δ = 12.51, 14.39, 23.83, 25.89, 32.28, 34.16, 70.80, 71.75, 73.21, 81.13, 100.97, 127.50, 128.29, 138.35, 201.07.

2) Synthesis of 11a,b:

(3*R*,4*R*,5*S*,6*S*,7*R*)- and (3*S*,4*R*,5*S*,6*S*,7*R*)-5-*O*-Benzyl-7-*O*-(*tert*-butyldimethylsilyl)-4,6-dimethyl-1-nonyne-3,5,7-triol (10a,b):

To a stirred solution of lithium acetylide (50.0 mmol) in THF (150 mL) at − 78 °C was added a THF solution of the aldehyde **4** (11.0 g, 29.05 mmol, 30 mL THF) over a 10 min period. Additional THF (5 mL) was used to wash the rest of the aldehyde into the reaction flask. The solution was stirred for 25 min at − 78 °C and then warmed to r.t. H_2O (25 mL) was added followed by anhydr. K_2CO_3 until the aqueous phase became pasty. The organic phase was decanted and the aqueous layer was washed with Et_2O (4 × 30 mL). The combined organic phase was dried ($MgSO_4$), filtered and concentrated. Purification by flash chromatography (hexane/EtOAc, 4 : 1) provided 11.3 g (95 %) of **10a,b** as mixture of diastereomers, which were separated by column chromatography (hexane/EtOAc, 10 : 1) to furnish **10a** (7.2 g, 64 %)and **10b** (4.0 g, 36 %) in diastereomerically pure form.

Compound **10a**: R_f = 0.36 (silica gel, hexane/EtOAc, 3 : 1; $[\alpha]_D^{20}$ + 3.34 (c = 2.30).

$C_{24}H_{40}O_3Si$ calc. C 71.23 H 9.96
(404.6) found 70.89 9.91

^1H NMR: δ = 0.08 (s, 6 H, $SiCH_3$), 0.82 (t, 3 H, J = 7.5 Hz, 9-H), 0.88 (d, J = 7.0 Hz, 3 H, 4-CH_3), 0.92 [s, 9 H, $SiC(CH_3)_3$], 1.08 (d, J = 6.8 Hz, 3 H, 6-CH_3), 1.58 (mc, 2 H, 8-H), 1.80 (mc, 1 H, 6-H), 1.94 (mc, 1 H, 4-H), 2.36 (d, J = 4.0 Hz, 1 H, OH), 3.52 (d, J = 2.2 Hz, 1 H, 1-H), 3.92 (dd, J = 8.5, 2.3 Hz, 1 H, 5-H), 3.96 (mc 1 H, 7-H), 4.39 (dd, J = 7.5, 2.2 Hz, 1 H, 3-H), AB system (δ_A = 4.62, δ_B = 4.68, J_{AB} = J_{BA} = 10.5 Hz, 2 H, OCH_2Ph), 7.32 (mc, 5 H_{arom}).

^{13}C NMR: δ = − 4.25, − 2.98, 8.68, 9.19, 10.06, 18.33, 25.92, 26.09, 28.20, 39.06, 42.61, 66.33, 73.15, 74.07, 74.09, 81.38, 84.76, 127.07, 127.34, 128.30, 138.97.

IR (film): ν = 3700–3340 s, 3340–3140 s, 3090 s, 3065 s, 3035 s, 2960 s, 2890 s, 2860 s, 2725 m, 2710 m, 1710 w, 1610 w, 1585 w, 1495 s, 1470 s, 1460 s, 1455 s, 1435 s, 1400 s, 1380 s, 1360 m, 1345 s, 1330 s, 1310 s,1250 s, 1215 m, 1145 s, 1120 s, 1080 s, 1045 s, 1025 s, 1015 s, 985 s, 960 s, 940 s, 905 w, 875 s, 835 s, 820 s, 775 s, 735 s, 700 s, 680 s, 665 s, 635 s cm^{-1}.

MS (EI, 80 eV, 100 °C): m/z = 347 $(M – C_4H_9)^+$, 298 $(M – PhCHO)^+$, 239 $(M – C_4H_9 – PhCH_2OH)^+$, 223 $(M – H_2O – PhCHO)^+$, 173, 133, 115 $(Si\ Me_2C_4H_9)^+$, 91, 73.

MS (CI, isobutane, 160 eV, 200 °C): m/z = 405 $(M + H)^+$, 404 $(M)^+$, 387 $(M–OH)^+$, 297 $(M–PhCHOH)^+$, 273 $(M–OSiMe_2C_4H_9)^+$, 255 $(M–H_2O – OSiMe_2C_4H_9)^+$, 173, 165, 113, 111, 91, 73.

HRMS (EI, 80 eV, 100 °C): m/z, $C_{20}H_{31}O_3Si$ $[M–C(CH_3)_3]^+$ calc.: 347.204247; found: 347.204152.

HRMS (EI, 80 eV, 100 °C): m/z, $C_{13}H_{23}O_2Si$ $[M–PhCH_2OH – C(CH_3)_3]^+$ calc.: 239.146732, found: 239.146599.

Compound **10b**: R_f = 0.44 (silica gel, hexane/EtOAc, 3 : 1); $[\alpha]_D^{20}$ + 16.90 (c = 3.30).

$C_{24}H_{40}O_3Si$ calc. C 71.23 H 9.96
(404.6) found 71.21 9.46

^1H NMR: δ = 0.06 (s, 3 H, $SiCH_3$), 0.08 (s, 3 H, $SiCH_3$), 0.80 (d, J = 6.75 Hz, 3 H, 4-CH_3), 0.86 (t, J = 7.5 Hz, 3 H, 9-H), 0.94 [s, 9 H, $SiC(CH_3)_3$], 1.08 (d, J = 6.8 Hz, 3 H, 6-CH_3), 1.60 (mc, 2 H, 8-H), 1.90 (mc, 2 H, 6-H, 4-H), 2.48 (d, J = 2.3 Hz, 1 H, 1-H), 2.76 (d, J = 6.5 Hz, 1 H, OH), 3.96 (ddd, J = 7.5, 5.0, 2.3 Hz, 1 H, 7-H), 4.12 (dd, J = 7.5, 2.0 Hz, 1 H, 5-H), 4.32 (dt, J = 6.5, 2.3 Hz, 1 H, 3-H), 4.76 (s, 2 H, OCH_2Ph), 7.32 (mc, 5 H_{arom}).

^{13}C NMR: δ = − 4.21, − 3.01, 9.26, 10.02, 10.39, 18.35, 26.06, 2814, 38.82, 40.9)8, 65.79, 73.24, 73.54. 73.74, 79.02, 85.25, 127.21, 127.34, 128.93, 157.49, 159.09.

(3*S*,4*S*,5*S*,7*R*)-5-*O*-Benzyl-7-*O*-[(*tert*-butyldimethylsilyl)-4,6-dimethyl-3-*O*-[(1′*R*,*S*)-tetrahydro-2*H*-pyran-2-yl]-1-nonyne-3,5,7-triol (11a,b):

To a solution of **10b** (10.0 g, 24.71 mmol) in dry Et_2O (50 mL) and freshly distilled dihydropyran (2.22 g, 2.40 mL, 26.5 mmol) at 0 °C was added TsOH · H_2O (170 mg, 1.0 mmol). After stirring for 30 min at 0 °C and 90 min at r.t., the mixture was quenched with sat. aq $NaHCO_3$ (40 mL); the organic phase was separated and the aqueous layer was extracted with Et_2O (2 × 50 mL). The combined organic solution was washed with brine (20 mL), dried ($MgSO_4$), filtered and concentrated in vacuo. Flash column chromatography (hexane/EtOAc, 10 : 1) gave the tetrahydropyranyl ether **11a,b** as a mixture of THP anomers (11.59 g, 96 %) as a clear and viscous oil.

$C_{29}H_{48}O_4Si$ calc. C 71.26 H 9.89
(488.8) found 71.07 9.89

Compound **11a** [(1′*S*)-anomer]: R_f = 0.53 (silica gel, hexane/EtOAc, 3 : 1).

^1H NMR: δ = 0.06 (s, 3 H, $SiCH_3$), 0.08 (s, 3 H, $SiCH_3$), 0.80 (d, J = 7.0 Hz, 3 H, 4-CH_3), 0.84 (t, J = 7.5 Hz, 3 H, 9-H), 0.92 [s, 9 H, $SiC(CH_3)_3$], 1.04 (d, J = 6.75 Hz, 3 H, 6-CH_3), 1.44–1.68 (m, 6 H), 1.72–1.88 (m, 3 H), 2.02 (mc, 1 H), 2.42 (d, J = 2.2 Hz, 1 H, 1-H), 3.48 (mc, 1 H, 5'-H), 3.98 (mc, 2 H, 7-H, 5'-H), 4.42 (mc, 1 H, 1'-H), 4.56 (dd, $J = 8.0$, 2.2 Hz, 1 H, 3-H), AB system ($\delta_A = 4.66$, $\delta_B = 4.86$, $J_{AB} = J_{BA} = 10.0$ Hz, 2 H, OC$\underline{H}_2$Ph), 7.32 (mc, 5 H_{arom}).

Compound **11b** [(1'*R*)-anomer]: $R_f = 0.51$ (silica gel, hexane/EtOAc, 3:1)

^{1}H NMR: $\delta = 0.72$ (s, 6 H, SiCH$_3$), 0.80 (d, $J = 7.0$ Hz, 3 H, 4-CH$_3$), 0.88 (t, $J = 7.5$ Hz, 3 H, 9-H), 0.92 [s, 9 H, SiC(CH$_3$)$_3$], 1.10 (d, $J = 6.75$ Hz, 3 H, 6-CH$_3$), 1.48–1.68 (m, 6 H), 1.70–1.86 (m, 3 H), 2.08 (mc, 1 H), 2.44 (d, $J = 2.1$ Hz, 1 H, 1-H), 3.52 (mc, 1 H, 5'-H), 3.80 (mc, 2 H, 5'-H, 7-H), 3.93 (dd, $J = 9.0$, 2.1 Hz, 1 H, 3-H), 4.00 (mc, 1 H, 1'-H), AB-system ($\delta_A = 4.66$, $\delta_B = 4.74$, $J_{AB} = J_{BA} = 11.0$ Hz, 2 H, OC$\underline{H}$Ph), 7.28 (mc, 5 H_{arom}).

MS (EI, 80 eV, 50 °C, 1:1 mixture of THP anomers): $m/z = 431$ (M–C$_4$H$_9$)$^+$, 403 (M–THP)$^+$, 389 (M–DHP – CH$_3$)$^+$, 373 (M–SiMe$_2$C$_4$H$_9$)$^+$, 347 [M–THP – CH$_2$C(CH$_3$)$_2$]$^+$, 329 [M–THP – CH$_2$C(CH$_3$)$_2$ – H$_2$O]$^+$.

3) Coupling of the Fragments 11a,b and 6a; (2*S*,3*R*,4*S*,5*R*,9*R*,10*S*,11*R*,12*R*,13*R*)-1,11-Dibenzyloxy-13-(*tert*-butyldimethylsiloxy)-3,5-isopropylidenedioxy-2,4,10,12-tetramethyl-9-(1'*S*)-tetrahydro-2*H*-pyran-2-yloxy]-7-pentadecyn-6-one (12a,b):

To a stirred solution of **11a,b** (10.0 g, 20.46 mmol; as 1:1 mixture of diastereomers) in THF (40 mL) at – 18 °C was added BuLi (13 mL, 20.8 mmol, 1.6 M in hexane). After stirring for 15 min at 0 °C, a solution of aldehyde **6a** (6.13 g, 20.0 mmol) in THF (15 mL) was added dropwise at – 78 °C. The mixture was stirred at – 78 °C for 30 min, after which time TLC analysis indicated complete consumption of **6a**. The mixture was treated with a sat. aq NH$_4$Cl (20 mL) and diluted with Et$_2$O (300 mL). The organic layer was washed with H$_2$O and worked up as usual, affording after flash chromatography (hexane/EtOac, 10:1) the desired coupling product (15.3 g, 94%, based on **6a**) as a clear and viscous oil. HPLC analysis (10% EtOAc in hexane; UV detection; $t_R = 4.5$, 5.3, 6.0, 7.5 min; flow rate 2.0 mL/min) showed four compounds (THP anomers and diastereomers at C6) in the ratio 25:25:16:34 (in the order of elution). This mixture of alkynols was used directly for formation of the alkynones **12a,b** without further separation. Neat DMSO (11.2 g, 10.24 mL, 144 mmol) was added to a solution of oxalyl chloride (11.4 g, 8.0 mL, 91.4 mmol) in CH$_2$Cl$_2$ (60 mL) at – 78 °C. The solution was stirred for 5 min at – 78 °C and a solution of the alkynols (15.0 g, 18.86 mmol) in CH$_2$Cl$_2$ (40 mL) was added dropwise. The mixture was stirred at – 60 °C for 20 min and Et$_3$N (39.4 mL, 28.5 g, 282.8 mmol) was added. After stirring for 20 min at – 60 °C, the mixture was warmed to r.t., diluted with Et$_2$O (350 mL) and the organic phase was washed with sat. aq NaHSO$_4$ (2 x 50 mL), H$_2$O (3 x 70 mL), sat. aq NaHCO$_3$ (70 mL) and brine (70 mL). The organic layer was dried (MgSO$_4$), filtered, concentrated in vacuo and chromatographed (silica gel, hexane/EtOAc, 10:1) to afford **12a,b** (13.4 g, 89%) as a mixture of THP anomers in the ratio 52:48 (HPLC analysis). The mixture was partly separated by column chromatography with a solvent gradient ranging from 10 to 20% EtOAc in hexane, to provide diastereomerically pure **12a** (5.24 g, 35%) and a 83:17 (by NMR integration) mixture of **12b,a** (7.78 g, 52%). No attempts were made to isolate alkynone **12b** in pure form.

Compound **12a** [(1'*S*)-anomer]: $R_f = 0.46$ (silica gel, hexane/EtOAc, 3:1); $[\alpha]_D^{20}$ – 37.93 ($c = 2.80$).

^{1}H NMR: $\delta = 0.04$ (s, 3 H, SiCH$_3$), 0.06 (s, 3 H, SiCH$_3$), 0.80 (d, $J = 7.5$ Hz, 3 H, CH$_3$), 0.82 (t, $J = 7.5$ Hz, 3 H, 15-H), 0.85 (d, $J = 7.2$ Hz, 3 H, CH$_3$), 0.92 [s, 9 H, SiC(CH$_3$)$_3$], 1.04 (d, $J = 6.5$ Hz, 3 H, CH$_3$), 1.10 (d, $J = 6.5$ Hz, 3 H, CH$_3$), 1.34 (s, 3 H, C(CH$_3$)$_2$), 1.46 (s, 3 H, C(CH$_3$)$_2$), 1.42–1.70 (m, 6 H), 1.72–1.90 (m, 4 H), 2.04–2.22 (m, 2 H), 3.30 (mc, 2 H, 1-H), 3.52 (mc, 1 H, 5'-H), 3.66 (dd, $J = 10.0$, 2.2 Hz, 1 H, 11-H), 3.75 (mc, 1 H, 5'-H), 3.88 (dd, $J = 9.5$, 2.0 Hz, 1 H, 3-H), 3.92 (mc, 1 H, 13-H), 4.22 (d, $J = 3.0$ Hz, 1 H, 5-H), AB system ($\delta_A = 4.44$, $\delta_B = 4.52$, $J_{AB} = J_{BA} = 12.5$ Hz, 2 H, OC$\underline{H}_2$Ph), 4.60 (d, $J = 8.75$ Hz, 1 H, 9-H), AB system ($\delta_A = 4.64$, $\delta_B = 4.74$, $J_{AB} = J_{BA} = 11.25$ Hz, 2 H, OC$\underline{H}_2$Ph), 5.08 (mc, 1 H, 1'-H), 7.28 (mc, 10 H_{arom}).

^{13}C NMR: $\delta = -4.24$, – 3.22, 6.32, 9.53, 9.88, 10.08, 14.42, 18.24, 18.90, 19.23, 25.30, 25.99, 28.12, 29.66, 30.25, 32.54, 34.93, 39.21, 40.25, 61.87, 67.76, 71.18, 72.99, 73.15, 73.69, 74.89, 79.08, 79.58, 84.39, 94.07, 95.14, 99.64, 126.87, 126.99, 127.35, 127.49, 128.09, 128.29, 138.30, 139.26, 185.61.

IR (film): ν 3090 s, 3070s, 3030 s, 2980 vs, 2965 vs, 2920 s, 2880 s, 2850 s, 2800 s, 2740 m, 2710 m, 2210 s, 1950 w, 1875 w, 1810 w, 1690 s, 1675 s, 1605 m, 1585 m, 1495 s, 1470 s, 1455 s, 1385 s, 1355 s, 1325 s, 1310 s, 1285 s, 1255 s, 1205 s, 1185 s, 1160 s, 1125 s, 1090 s, 1075 s, 1045 s, 1015 s, 1000 s, 965 s, 940 s, 910 s, 870 s, 835 s, 815 s, 790 s, 775 s, 735 s, 695 s, 670 s, 645 s, 620 s, 610 s, 590 s, 530 s, 510 s, 475 s, 465 s, 430 m cm^{-1}.

MS (EI, 80 eV, 90 °C): m/z: 792 (M)$^+$, 777 (M–CH$_3$)$^+$, 734 [M–(CH$_3$)$_2$CO]$^+$, 693 (M–CH$_3$ - DHP)$^+$, 690 (M–H$_2$O - DHP)$^+$, 677 (M–2CH$_3$ – THP)$^+$, 650 [M–(CH$_3$)$_2$CO–DHP]$^+$, 633 [M–OH – (CH$_3$)$_2$CO – DHP]$^+$, 593 (M–SiMe$_2$C$_4$H$_9$ – DHP)$^+$, 575 (M–SiMe$_2$C$_4$H$_9$ - DHP - H$_2$O)$^+$, 517, 501, 485, 467, 459, 431, 427, 404, 403, 402, 369, 345, 315, 313, 173, 91.

HRMS (EI, 80 eV, 100 °C), m/z, C$_{46}$H$_{69}$O$_8$Si (M–CH$_3$)$^+$ calc.: 777.6172; found: 777.476350.

Compound **12b** (83:17 mixture of 1'*R*/1'*S* anomers): $R_f = 0.41$ (silica gel, hexane/EtOAc, 3:1.

C$_{17}$H$_{72}$O$_8$Si	calc.	C 71.17	H 9.15
(793.2)	found	70.25	8.95

^{1}H NMR: $\delta = 0.10$ (s, 3 H, SiCH$_3$), 0.12 (s, 3 H, SiCH$_3$), 0.88 (t, $J = 7.0$ Hz, 3 H, 15-H), 0.92 [s, 9 H, SiC(CH$_3$)$_3$], 0.98 (d, $J = 7.5$ Hz, 3 H, CH$_3$), 1.02 (d, $J = 7.2$ Hz, 3 H, CH$_3$), 1.04 (d, $J = 7.0$ Hz, 3 H, CH$_3$), 1.06 (d, $J = 6.8$ Hz, 3 H, CH$_3$), 1.40 (s, 3 H, C(CH$_3$)$_2$), 1.45–1.58 (m, 4 H), 1.49 (s, 3 H, C(CH$_3$)$_2$), 1.72 (mc, 2 H), 1.90 (mc, 2 H), 2.02–2.20 (m, 3 H), 2.24 (mc, 1 H), 3.32 (mc, 2 H, 1-H), 3.88 (mc, 1 H, 11-H), 3.46 (mc, 1 H, 5'-H), 3.76 (dd, $J = 9.5$, 8.1 Hz, 1 H, 3-H), 3.80 (mc, 1 H, 13-H), 3.98 (mc, 1 H, 5'-H), 4.42 (d, $J = 5.5$ Hz, 1 H, 5-H), 4.48 (mc, 4 H, 2 x OC$\underline{H}_2$Ph), 4.50 (mc, 1 H, 1'-H), 4.66 (d, $J = 10.2$ Hz, 1 H, 9-H), 7.28 (mc, 10 H_{arom}).

4) Cuprate Addition; (2*S*,3*R*,4*S*,5*R*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)-1,11-Dibenzyloxy-13-(*tert*-butyldimethylsiloxy)-3,5-isopropylidenedioxy-2,4,8,10,12-pentamethyl-9-[(1*S)-tetrahydro-2*H*-pyran-2-yloxy]-7-pentadecen-6-one (13E):

A slurry of CuI (18.2 g, 95.5 mmol) in Et$_2$O (50 mL) at – 30 °C under Ar was treated with an ethereal solution of MeLi (120 mL, 191 mmol, 1.6 M) and the resulting yellow solution was stirred for 30 min at – 30 °C. The cuprate solution was cooled to – 60 °C and a solution of alkynone **12a** (5.10 g, 643 mmol) in Et$_2$O (30 mL) at – 60 °C was added via cannula to the cuprate solution. The mixture was allowed to warm to – 40 °C and was stirred at this temperature for 30 min, at which time TLC analysis (silica gel, hexane/EtOAc, 3:1) showed that no starting material was left. The reaction was quenched by the careful addition of 40 mL of 1:10 concentrated NH$_4$OH/sat. NH$_4$Cl. The mixture was diluted with Et$_2$O (350 mL), the layers were separated and the aqueous layer was thoroughly extracted with Et$_2$O. The combined organic layers were washed with H$_2$O (50 mL) and brine (50 mL). After drying (MgSO$_4$), the organic layer was concentrated in vacuo to afford the conjugate addition product, which was purified by flash chromatography (hexane/EtOAc, 8:1) yielding 4.61 g (88%) of isomers **13E,Z** (*E*/*Z* = 13:1 by HPLC analysis; UV-detection; t_R (**13E**) = 4.5 min, t_R (**13Z**) = 6.26 min; 2 mL/min flow rate). These were separated by HPLC (5% EtOAc in hexane) to give **13E** (4.2 g, 80%) and **13Z** (331 mg, 6%) as very viscous oils. For the continuation of the synthesis he cuprate addition was carried out with a mixture of **12a,b** (7.78 g, 9.8 mmol, ratio 17:83) as described for **12a**, affording 7.20 g (91%) of **13E,Z** and **14E,Z** as a mixture of diastereomers (THP anomers, *E*/*Z* isomers) in the *E*/*Z* ratios **13E,Z** 13:1 and **14E,Z** 1:1 (HPLC analysis; 5% EtOAc in hexane; UV-detection; t_R (**13E**) = 4.5 min, t_R (**13 Z**) = 5.51 min, t_R (**14 Z**) = 6.26 min, t_R (**14E**) = 8.37 min; 2 mL/min flow rate). Separation of this mixture by preparative HPLC (6% EtOAc in hexane) provided **13E** (1.13 g, 14%), **13 Z** (40 mg, 0.5%), **14E** (2.83 g, 36%) and **14Z** (2.79 g, 35%).

Compound **13E**: $R_f = 0.51$ (silica gel, hexane/EtOAc, 3:1; $[\alpha]_D^{20}$ – 10.33 ($c = 2.72$).

^{1}H NMR: $\delta = 0.02$ (s, 3 H, SiCH$_3$), 0.04 (s, 3 H, SiCH$_3$), 0.76 (d, $J = 7.5$ Hz, 3 H, CH$_3$), 0.84 (t, $J = 8.0$ Hz, 3 H, 15-H), 0.87 [s, 9 H,

$SiC(CH_3)_3]$, 0.88 (d, $J = 6.5$ Hz, 3 H, CH_3), 1.02 (d, $J = 7.0$ Hz, 3 H, CH_3), 1.14 (d, $J = 6.75$ Hz, 3 H, CH_3), 1.24 (s, 3 H, $C(CH_3)_3$), 1.32 (s, 3 H, $C(CH_3)_2$), 1.36–1.62 (m, 7 H), 1.70–1.88 (m, 4 H), 2.04 (s, 3 H, 8-CH_3), 2.06 (mc, 1 H), 3.29–3.36 (m, 3 H, 1-H, 13-H), 3.49 (mc, 1 H, 5′-H), 3.70 (dd, $J = 8.6, 2.2$ Hz, 1 H, 3-H), 3.92 (mc, 1 H, 5′-H), 4.18 (d, $J = 9.5$ Hz, 1 H, 9-H), 4.24 (d, $J = 2.5$ Hz, 1 H, 5-H), 4.42 (s, 2 H, $OC\underline{H}_2Ph$), 4.49 (mc, 1 H, 1′-H), AB system ($\delta_A = 4.51$, $\delta_B = 4.70$, $J_{AB} = J_{BA} = 10.8$ Hz, 2 H, $OC\underline{H}_2Ph$), 6.68 (s, 1 H, 7-H), 7.18–7.38 (mc, 10 H_{arom}).

^{13}C NMR: $\delta = -4.24, -3.19$, 6.53, 9.52, 9.97, 10.02, 14.42, 14.45, 18.21, 19.24, 25.47, 25.95, 26.10, 28.30, 29.69, 29.80, 30.81, 32.79, 35.02, 38.01, 39.37, 62.29, 71.30, 73.09, 73.17, 73.62, 75.22, 79.41, 79.83, 83.34, 94.80, 99.25, 124.51, 126.93, 127.12, 127.29, 127.44, 127.66, 128.16, 128.29, 138.44, 139.54, 156.68, 199.83.

IR (film) ν = 3090 s, 3070 s, 3030 s, 2980 vs, 2940 vs, 2880 vs, 2740 m, 2710 m, 1950 w, 1875 w, 1810 w, 1740 m, 1720 s, 1690 s, 1615 vs, 1495 s, 1470 s, 1455 s, 1385 s, 1355 s, 1325 s, 1310 s, 1285 s, 1255 s, 1185 s, 1160 s, 1115 s, 1075 s, 1015 s, 1000 s, 975 s, 940 s, 915 s, 870 s, 835 s, 815 s, 790 s, 775 s, 735 s, 695 s, 670 s, 610 s 590 m,550 m, 525 m cm^{-1}.

MS (EI, 80 eV, 90 °C): *m*/*z* 793 $(M{-}CH_3)^+$, 724 $(M{-}DHP)^+$, 794 $(M{-}2CH_3 - DHP)^+$, 693, 665 $[M{-}(CH_3)_2CO{-}\ THP]^+$, 649 $(M{-}SiMe_2C_4H_9 - C_2H_4)^+$, 609 $(M{-}SiMe_2C_4H_9 - DHP)^+$, 591 $(M{-}DHP - SiMe_2C_4H_9 - H_2O)^+$, 534 $[M{-}THP - (CH_3)_2CO - OSiMe_2C_4H_9]$, 517 $[M{-}DHP - OSiMe_2C_4H_9 - (CH_3)_2CO - H_2O]^+$, 501 $[M{-}THP - OSiMe_2C_4H_9 - (CH_3)_2CO - H_2O - CH_3]^+$, 493, 484 $[M{-}DHP - OSiMe_2C_4H_9 - (CH_3)_2CO - 2H_2O - CH_3]^+$, 443, 427, 409, 375, 277, 223, 219, 173, 91, 85, 73.

HRMS (EI, 80 eV, 150 °C): *m*/*z*, $C_{47}H_{73}O_8Si$ $(M{-}CH_3)^+$ calc.: 793.507472; found: 793.507286.

HRMS (EI, 80 eV, 150 °C): *m*/*z*, for $C_{43}H_{68}O_7Si$ (M–DHP) calc.: 724.473432; found: 724.473512.

HRMS (EI, 80 eV, 150 °C): *m*/*z*, $C_{40}H_{61}O_6Si$ $(M{-}2CH_3 - THP)^+$ calc.: 665.423742; found: 665.423768.

Compound **13Z**: $R_f = 0.49$ (silica gel, hexane/EtOAc, 3:1); $[\alpha]_D^{20}$ + 34.05 (c = 1.85).

^1H NMR: $\delta = 0.02$ (s, 3 H, $SiCH_3$), 0.06 (s, 3 H, $SiCH_3$), 0.78 (d, $J = 7.0$ Hz, 3 H, CH_3), 0.82 (d, $J = 7.2$ Hz, 3 H, CH_3), 0.84 (t, $J = 7.5$ Hz, 3 H, 15-H), 0.92 [s, 9 H, $SiC(CH_3)_3$], 1.06 (d, $J = 7.5$ Hz, 3 H, CH_3), 1.10 (d, $J = 7.0$ Hz, 3 H, CH_3), 1.38 (s, 3 H, $C(CH_3)_2$), 1,42–1.60 (m, 7 H), 1.50 (s, 3 H, $C(CH_3)_2$), 1.70–1.90 (m, 4 H), 2.02 (d, $J = 1.2$ Hz, 3 H, 8-CH_3), 2.08 (mc, 1 H), 3.36 (mc, 3 H, 1-H, 11-H), 3.72 (mc, 2 H, 5′-H, 13-H), 4.02 (mc, 2 H, 5′-H, 3-H), 4.26 (d, $J = 3.7$ Hz, 1 H, 5-H), AB system ($\delta_A = 4.34$, $\delta = 4.46$, $J_{AB} = J_{BA} = 11.2$ Hz, 2 H, $OC\underline{H}_2Ph$), AB system ($\delta_A = 4.49$, $\delta_B = 4.56$, $J_{AB} = J_{BA} = 10.8$ Hz, 2 H, $OC\underline{H}Ph$), 4.66 (mc, 1 H, 1′-H), 5.66 (d, $J = 10.0$ Hz, 1 H, 9-H), 6.52 (d, $J = 1.2$ Hz, 1 H, 7-H), 7.20–7.40 (mc, 10 H_{arom}).

^{13}C NMR: $\delta = -4.42, -3.28$, 6.43, 9.78, 10.17, 14.48, 14.58, 18.22, 19.22, 20.64, 25.37, 25.63, 28.38, 28.48, 30.96, 32.54, 35.05, 38.36, 39.54, 63.66, 71.43. 72.95, 73.04, 73.22, 75.40, 78.85, 79.14, 79.33, 99.30, 101.81, 122.61, 127.13, 127.24, 127.36, 127.97, 128.18, 128.24, 128.31, 138.48, 139.86, 159.78, 198.39.

MS (EI, 80 eV, 150 °C): *m*/*z* = 809 $(M + H)^+$, 808 $(M)^+$, 793 $(M{-}CH_3)^+$, 751 $(M{-}C_4H_9)^+$, 724 $(M{-}DHP)^+$, 385, 277, 223, 219, 173, 127, 115, 111, 109, 99, 91, 85, 73.

HRMS (EI, 80 eV, 90 °C): *m*/*z*, $C_{47}H_{73}O_8Si$ $(M{-}CH_3)^+$ calc.: 793.507472; found: 793.507444.

HRMS (EI, 80 eV, 150 °C) *m*/*z*, $C_{43}H_{68}O_7Si$ $(M{-}DHP)^+$ calc.: 724.473432; found: 724.473440.

Compound **14E**: $R_f = 0.46$ (silica gel, hexane/EtOAc, 3:1, $[\alpha]_D^{20}$ + 17.60 (c = 2.30).

^1H NMR: $\delta = 0.10$ (s, 3 H, $SiCH_3$), 0.14 (s, 3 H, $SiCH_3$), 0.80 (d, $J = 7.5$ Hz, 3 H, CH_3), 0.88 (t, $J = 7.0$ Hz, 3 H, 15-H), 0.90 [s, 9 H, $SiC(CH_3)_3$], 0.92 (d, $J = 7.0$ Hz, 3 H, CH_3), 0.98 (d, $J = 7.5$ Hz, 3 H, CH_3), 1.04 (d, $J = 7.3$ Hz, 3 H, CH_3), 1.26 (mc, 1 H), 1.34–1.56 (m, 6 H), 1.40 (s, 3 H, $C(CH_3)_2$), 1.48 (s, 3 H, $C(CH_3)_2$, 1.58–1.92 (m, 4 H), 2.00 (mc, 1 H), 2.10 (d, $J = 1.0$ Hz, 3 H, 8-CH_3), 3.22–3.32 (m, 3 H, 1-H, 13-H), 3.38 (dd, $J = 9.5, 5.0$ Hz, 1 H, 11-H), 3.66 (mc, 1 H, 5′-H), 3.72 (dd, $J = 9.5, 7.5$ Hz, 1 H, 3-H), 3.82 (mc, 1 H, 5′-H), 4.06 (d, $J = 8.0$ Hz, 1 H, 9-H), 4.24 (mc, 1 H, 1′-H),4.30 (d, $J = 2.5$ Hz, 1 H, 5-H), AB system ($\delta_A = 4.40$, $\delta_B = 4.52$, $J_{AB} = 11.2$ Hz, $J_{BA} = 12.0$ Hz, 2 H, $OC\underline{H}_2Ph$), AB system ($\delta_A = 4.42$, $\delta_B = 4.70$, $J_{AB} = J_{BA} = 11.3$ Hz, 2 H, $OC\underline{H}_2Ph$), 6.58 (d, $J = 1.0$ Hz, 1 H, 7-H), 7.24–7.38 (mc, 10 H_{arom}).

^{13}C NMR: $\delta = -4.24, -3.19$, 6.53, 9.52, 9.97, 10.02, 14.42, 14.45, 18.21, 19.24, 25.47, 25.95, 26.10, 28.30, 29.69, 29.80, 30.81, 32.79, 35.02, 38.01, 39.37, 62.29, 71.30, 73.09, 73.17, 73.62, 75.22, 79.41, 79.83, 83.34, 94.80, 99.25, 124.51, 126.93, 127.12, 127.29, 127.44, 127.66, 128.16, 128.29, 138.44, 139.54, 156.68, 199.83.

Compound **14Z**: $R_f = 0.50$ (silica gel, hexane/EtOAc, 3:1); $[\alpha]_D^{20}$ − 23.23 (c = 1.73).

$C_{48}H_{76}O_8Si$	C 71.24	H 9.47
(809.2)	71.18	9.28

^1H NMR: $\delta = 0.02$ (s, 3 H, $SiCH_3$), 0.04 (s, 3 H, $SiCH_3$), 0.76 (d, $J = 6.8$ Hz, 3 H, CH_3), 0.80 (d, $J = 7.0$ Hz, 3 H, CH_3), 0.86 (t, $J = 7.3$ Hz, 3 H, 15-H), 0.90 [s, 9 H, $SiC(CH_3)_3$], 1.02 (d, $J = 7.0$ Hz, 3 H, CH_3), 1.08 (d, $J = 7.0$ Hz, 3 H, CH_3), 1.40 (s, 3 H, $C(CH_3)_2$), 1.42–1.58 (m, 7 H), 1.50 (s, 3 H, $C(CH_3)_2$), 1.66–1.88 (m, 4 H), 2.00 (s, 3 H, 8-CH_3), 2.06 (mc, 1 H), 3.26–3.38 (m, 4 H, 1-H, 11-H, 13-H), 3.72 (mc, 2 H, 5′-H, 3-H), 4.00 (mc, 1 H, 5′-H), 4.24 (d, $J = 3.5$ Hz, 1 H, 5-H), AB system ($\delta_A = 4.36$, $\delta_B = 4.72$, $J_{AB} = 10.5$ Hz, $J_{BA} = 10.8$ Hz, 2 H, $OC\underline{H}_2Ph$), AB system ($\delta_A = 4.46$, δ_B 4.58, $J_{AB} = J_{BA} = 11.0$ Hz, 2 H, $OC\underline{H}_2Ph$), 4.48 (mc,1 H, 1′-H), 5.68 (d, $J = 5.9$ Hz, 1 H, 9-H), 6.54 (s, 1 H, 7-H), 7.28–7.38 (mc, 10 H_{arom}).

^{13}C NMR: $\delta = -4.55, -4.20$, 6.40, 11.03, 11.69, 14.39, 15.81, 15.86, 17.99, 19.22, 20.06, 24.85, 25.43, 25.86, 29.60, 29.79, 30.95, 32.69, 35.11, 35.21, 39.32, 62.88, 71.36, 71.86, 73.18, 74.13, 75.13, 79.36, 81.93, 83.56, 96.15, 99.14, 122.15, 127.03, 127.27, 127.41, 127.64, 127.87, 128.16, 128.27, 138.42, 138.83, 158.90, 199.71.

5) MeLi Addition to Oxo Compound (2*S*,3*R*,4*S*,5*R*,6*S*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)- and (2*S*,3*R*,4*S*,5*R*,6*R*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)-1,11-Di-*O*-benzyl-13-*O*-(*tert*-butyldimethylsilyl)-3,5-*O*-isopropylidene-2,4,6,8,10,12-hexamethyl-9-*O*-[(1′*S*)-tetrahydro-2*H*-pyran-2-yl]-7-pentadecene-1,3,5,6,9,11,13-heptol (16a, b):

Compound **16a** (Conditions A): Enone **13E** (4.0 g, 4.94 mmol) was dissolved in Et_2O (20 mL), cooled to − 50 °C and treated dropwise with an ethereal solution of MeLi (9.4 mL, 15 mmol, 1.6 M) at this temperature. After stirring for 15 min at − 50 °C the reaction was quenched with sat. aq NH_4Cl (10 mL) and the mixture was diluted with Et_2O (200 mL). The layers were separated and the organic layer was washed with H_2O and brine and dried ($MgSO_4$). Filtration and removal of the solvent under reduced pressure afforded after flash chromatography (hexane/EtOAc, 10:1) pure 6*S*-alcohol **16a** (3.87 g, 95 %) as a clear viscous oil. No traces of the diastereomeric 6*R*-alcohol could be detected by HPLC analysis (5 % EtOAc in hexane; UV detection; t_R **(16a)** = 8.77 min; 2 mL/min flow rate) of the crude product.

Compounds **16a, b** (Conditions B): To a stirred solution of **13E** 1.5 g, 1.85 mmol) dissolved in THF (15 mL) at − 78 °C was added dropwise an ethereal solution of MeLi (3.75 mL, 6.0 mmol), 1.6 M). After stirring for 25 min at − 60 °C the reaction was quenched with sat. aq NH_4Cl (5 mL) and worked-up as described in A. Separation of the diastereomers by flash chromatography (hexane/EtOAc, 10:1) furnished **16a** (0.68 g, 48 %) and **b** (0.74 g, 52 %) as viscous oils with the following properties.

Compound **16a**: $R_f = 0.48$ (silica gel, hexane/EtOAc, 3:1); $[\alpha]_D^{20}$ − 22.55 (c = 1.45).

^1H NMR: $\delta = 0.04$ (s, 6 H, $SiCH_3$), 0.74 (d, $J = 7.0$ Hz, 3 H, CH_3), 0.76 (t, $J = 7.5$ Hz, 3 H, 15-H), 0.84 [s, 9 H, $SiC(CH_3)_3$], 0.95 (d, $J = 6.7$ Hz, 3 H, CH_3), 1.02 (d, $J = 7.0$ Hz), 3 H, CH_3), 1.12 (d, $J = 7.2$ Hz, 3 H, CH_3), 1.26 (s, 3 H, 6-CH_3),1.36 (s, 3 H, $C(CH_3)_2$), 1.38 (s, 3 H, $C(CH_3)_2$), 1.42–1.72 (m, 8 H), 1.70 (s, 3 H, 8-CH_3), 1.72–1.88 (m, 3 H), 2.04 (mc, 1 H), 2.64 (s, 1 H, OH), 3.16–3.36 (m, 3 H, 1-H, 3-H), 3.48 (mc, 1 H, 5′-H), 3.60 (dd, $J = 9.5, 2.0$ Hz, 1 H, 11-H), 3.76 (d, $J = 2.5$ Hz, 1 H, 5-H), 3.92 (mc, 2 H, 5′-H, 13-H), 4.12 (d, $J = 9.5$ Hz, 1 H, 9-H), AB system ($\delta_A = 4.32$, $\delta = 4.36$, $J_{AB} = J_{BA} = 10.8$ Hz, 2 H, $OC\underline{H}_2Ph$), AB system ($\delta_A = 4.51$, $\delta_B = 4.70$, J_{AB}

= J_{BA} = 11.0 Hz, 2 H, OC$\underline{H}_2$Ph), 4.58 (mc, 1 H, 1'-H), 5.80 (s, 1 H, 7-H), 7.16–7.36 (mc, 10 H_{arom}).

^{13}C NMR: δ = – 3.89, – 3.23, 7.19, 9.92, 10.04, 10.16, 12.84, 14.55, 18.27, 19.71, 2559, 26.12, 26.46, 28.54, 29.82, 31.10, 31.80, 34.67, 37.95, 39.37, 62.11, 71.25, 73.02, 73.13, 73.88, 74.28, 75.93, 79.41, 80.05, 83.72, 93.65, 99.36, 127.09, 127.34, 127.46, 128.15, 128.29, 134.58, 136.11, 138.54, 139.61.

IR (film): ν = 3640–3520, 3090 s, 3070 s, 3030 s, 2970 vs, 2930 vs, 2880 vs, 2860 vs, 2740 m, 2710 m, 1950 w, 1875 w, 1810 w, 1720 w, 1660 w, 1605 m, 1590 m, 1495 s, 1455 vs, 1380 s, 1360 s, 1345 s, 1315 s, 1285 s, 1255 s, 1200 s, 1185 s, 1160 s, 1115 s, 1075 vs, 1030 s, 1015 s, 985 s, 965 s, 935 s, 915 s, 870 s, 835 s, 815 s, 790 m, 775 s, 735 s, 695 vs, 670 s, 605 w, 590 m, 555 m, 525 m cm^{-1}.

MS (EI, 80 eV, 200 °C): m/z = 807 (M–OH)$^+$, 806 (M–H$_2$O)$^+$, 740 (M–DHP)$^+$, 739 (M – THP)$^+$, 724 (M–THP – CH$_3$)$^+$, 722 (M–OH – THP)$^+$, 665 (M - OH –C$_4$H$_9$– THP)$^+$, 647 (M–THP – OH – H$_2$O – C$_4$H$_9$)$^+$, 607 (M–THP – SiMe$_2$C$_4$H$_9$ – OH)$^+$, 589 (M– SiMe$_2$C$_4$H$_9$ – THP – H$_2$O –OH)$^+$, 547, 502 [M–SiMe$_2$C$_4$H$_9$– DHP – OH – H$_2$O– 2CH$_3$ – (CH$_3$)$_2$CO]$^+$, 499 [M–H – SiMe$_2$C$_4$H$_9$ – THP – 2H$_2$O – 2CH$_3$ – (CH$_3$)$_2$CO]$^+$, 463, 391, 315, 277, 222, 219, 173, 127, 91, 85, 73.

HRMS (EI, 80 eV, 200 °C): m/z, C$_{49}$H$_{78}$O$_7$Si (M–H$_2$O)$^+$ calc.: 806.551682; found: 806.552407.

HRMS (EI, 80 eV, 200 °C): m/z, C$_{44}$H$_{70}$O$_6$Si (M–OH – THP)$^+$ calc.: 722.494167; found: 722.493993.

Compound **16b**: R$_f$ = 0.37 (silica gel, hexane/EtOAc, 3 : 1); $[\alpha]_D^{20}$ + 32.94 (c = 1.70).

C$_{49}$H$_{80}$O$_8$Si	calc.	C 71.31	H 9.77
(825.3)	found	71.21	10.13

^{1}H NMR: δ = 0.05 (s, 3 H, SiCH$_3$), 0.07 (s, 3 H, SiCH$_3$), 0.80 (d, J = 6.8 Hz, 3 H, CH$_3$), 0.84 (t, J = 8.0 Hz, 3 H, 15-H), 0.90 [s, 9 H, SiC(CH$_3$)$_3$], 0.98 (d, J = 6.7 Hz, 3 H, CH$_3$), 1.00 (d, J = 7.0 Hz, 3 H, CH$_3$), 1.02 (d, J = 7.0 Hz, 3 H, CH$_3$), 1.28 (s, 3 H, C(CH$_3$)$_2$), 1.30 (s, 3 H, C(CH$_3$)$_2$, 1.32 (s, 3 H, 6-CH$_3$), 1.44–1.72 (m, 8 H), 1.82 (mc, 3 H), 1.90 (s, 3 H, 8-CH$_3$), 2.01 (mc, 1 H), 2.32 (s, 1 H, OH), 3.26–3.42 (m, 5 H, 1-H, 3-H, 5-H, 5'-H), 3.54 (dd, J = 9.5, 2.3 Hz, 1 H, 11-H), 3.72 (d, J = 10.0 Hz, 1 H, 9-H), 3.80 (mc, 1 H, 5'-H), 3.96 (mc, 1 H, 13-H), AB system (δ_A = 4.54, J_{AB} = J_{BA} = 12.0 Hz, 2 H, OC$\underline{H}_2$Ph), AB system (δ_A = 4.55, δ_B = 4.66, J_{AB} = J_{BA} = 11.8 Hz, 2 H, OC$\underline{H}_2$Ph), 4.58 (mc, 1 H, 1'-H), 5.44 (s, 1 H, 7-H), 7.20–7.34 (mc, 10 H_{arom}).

^{13}C NMR: δ = – 3.91, – 3.02, 6.78, 9.77, 9.98, 10.04, 12.17, 14.74, 18.29, 19.53, 19.75, 23.64, 25.53, 26.13, 28.32, 29.82, 30.52, 31.16, 34.61, 38.49, 39.04, 62.65, 71.58, 73.19, 73.76, 74.00, 76.50, 80.04, 80.33, 89.44, 99.16, 99.36, 126.95, 127.48, 128.18, 128.29, 136.58, 137.80, 138.54, 139.88.

MS (EI, 80 eV, 80 °C): m/z = 807 (M – OH)$^+$, 806 (M – H$_2$O)$^+$, 739 (M – THP)$^+$, 724 (M–THP – CH$_3$)$^+$, 722 (M–OH – THP)$^+$, 721 (M–THP – H$_2$O)$^+$, 665 (M – OH – C$_4$H$_9$– THP)$^+$, 663 [M–H$_2$O – THP – HC(CH$_3$)$_3$]$^+$, 647 (M–THP – OH – H$_2$O – C$_4$H$_9$)$^+$, 607 (M–THP – SiMe$_2$C$_4$H$_9$ – OH)$^+$, 590 (M–SiMe$_2$C$_4$H$_9$) – DHP – H$_2$O – OH)$^+$, 589 (M– SiMe$_2$C$_4$H$_9$ – THP – H$_2$O –OH)$^+$, 547, 505, 502 [M–SiMe$_2$C$_4$H$_9$) – DHP – OH – H$_2$O– 2CH$_3$ – (CH$_3$)$_2$CO]$^+$, 499 [M–H – SiMe$_2$C$_4$H$_9$ – THP – 2H$_2$O – 2CH$_3$ – (CH$_3$)$_2$CO]$^+$, 487, 475, 463, 391, 315, 277, 222, 219, 173, 127, 91, 85, 73.

6) Preparation of Seco Acid 18b:

(2*S*,3*R*,4*S*,5*R*,6*S*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)-13-*O*-(*tert*-Butyldimethylsilyl)-3,5-*O*-isopropylidene-2,4,6,8,10,12-hexamethyl-9-*O*-[(1'*S*)-tetrahydro-2*H*-pyran-2-yl]-7-pentadecene-1,3,5,6,9,11,13-heptol (17):

To a stirred solution of liquid NH$_3$ (80 mL) and THF (50 mL) at – 50 °C was added dropwise a solution of **16a** (4.5 g, 5.45 mmol) in THF (30 mL). Na (92 mg, 40 mmol) was added in one portion at – 50 °C under vigorous stirring. After the mixture turned blue, stirring was continued for additional 20 min at – 40 °C and the mixture was quenched by slow addition of 2.7 g (50 mmol) of granular NH$_4$Cl. The reaction vessel was placed in a water bath, and the NH$_3$ was distilled off while Et$_2$O (100 mL) was added gradually. After the larger part of the NH$_3$ had been removed the ether phase was separated by filtration. Evaporation of the solvent in vacuo followed by flash chromatography (hexane/EtOAc, 3 : 1) yielded **17** (3.24 g, 92 %) as a colorless and very viscous oil with the following properties:

R$_f$ = 0.50 (silica gel, hexane/EtOAc, 1 : 1; $[\alpha]_D^{20}$ – 6.77 (c = 1.30).

^{1}H NMR: δ = 0.08 (s, 3 H, SiCH$_3$), 0.12 (s, 3 H, SiCH$_3$), 0.72 (d, J = 7.0 Hz, 3 H, CH$_3$), 0.90 [s, 9 H, SiC(CH$_3$)$_3$], 0.92 (t, J = 7.5 Hz, 3 H, 15-H), 0.99 (d, J = 6.7 Hz, 3 H, CH$_3$), 1.02 (d, J = 6.5 Hz, 3 H, CH$_3$), 1.04 (d, J = 7.0 Hz, 3 H, CH$_3$), 1.36 (s, 3 H, C(CH$_3$)$_2$), 1.42 (s, 3 H, C(CH$_3$)$_2$), 1.45 (s, 3 H, 6-CH$_3$), 1.48–1.62 (m, 5 H), 1.64–1.92 (m, 7 H), 1.76 (d, J = 1.0 Hz, 3 H, 8-CH$_3$), 2.54 (s, 1 H, OH), 3.38–3.52 (m, 4 H, 1-H,. 5'-H), 3.62 (dd, J = 10.0, 2.0 Hz, 1 H, 11-H), 3.72 (d, J = 2.2 Hz, 1 H, 5-H), 3.76 (mc, 1 H, 5'-H), 3.88 (mc, 1 H, 13-H), 4.02 (d, J = 9.0 Hz, 2 H, 9-H, OH), 4.58 (mc, 1 H, 1'-H), 5.52 (d, J = 1.0 Hz, 7-H).

^{13}C NMR: δ = – 4.64, – 4.57, 7.07, 7.86, 11.11, 12.46, 12.65, 13.90, 17.93, 19.58, 19.69, 24.73, 25.45, 25.78, 27.93, 29.77, 30.91, 31.67, 36.18, 36.90, 39.52, 62.33, 63.31, 73.56, 74.90, 75.99, 78.49, 84.14, 94.40, 99.31, 131.99, 133.04.

IR (film): ν = 3700–3100 s, 2980 vs, 2960 vs, 2930 vs, 2880 s, 2860 s, 2750 s, 1745 s, 1675 w, 1465 s, 1445 s, 1390 s, 1380 s, 1360 s, 1330 s, 1255 s, 1240 s, 1200 s, 1185 s, 1185 s, 1160 s, 1135 s, 1115 s, 1095 s, 1075 s, 1050 s, 1015 s, 1000 s, 965 s, 935 s, 915 s, 980 s, 835 s, 815 s, 775 s, 755 s, 725 m, 670 s, 610 w, 585 w, 560 m, 545 m, 515 m cm^{-1}.

MS (EI, 80 eV, 150 °C): m/z = 627 (M + H)$^+$, 541 (M–H$_2$O – THP)$^+$, 427 (M–OH – SiMe$_2$C$_4$H$_9$) – THP)$^+$, 409 (M–H$_2$O – OH– THP – SiMe$_2$C$_4$H$_9$)$^+$, 356 [M–DHP – SiMe$_2$C$_4$H$_9$ – CH$_3$– (CH$_3$)$_2$CO]$^+$, 355 [M–SiMe$_2$C$_4$H$_9$ – THP – (CH$_3$)$_2$CO]$^+$, 337 [M–Si Me$_2$C$_4$H$_9$ – THP – H$_2$O– CH$_3$ – (CH$_3$)$_2$CO]$^+$, 299, 297, 271, 231, 187, 173, 133, 129, 111, 109, 85.

HRMS (EI, 80 eV, 150 °C): m/z, C$_{30}$H$_{57}$O$_6$Si (M–H$_2$O–THP)$^+$ calc.: 541.392442; found: 541.392563.

(2*R*,3*S*,4*S*,5*R*,6*S*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)-13-(*tert*-butyldimethylsilyloxy)-6,11-dihydroxy-3,5-isopropylidenedioxy-2,4,6,8,10,12-hexamethyl-9-[(1'*S*)-tetrahydro-2*H*-pyran-2-yloxy]-7-pentadecenoic Acid (18a):

Alcohol **17** (3.15 g, 4.9 mmol) in DMF (20 mL) was treated with a solution of PDC (9 equiv, 16.5 g, 44.7 mmol) in DMF (25 mL) and H$_2$O (1 mL) for 12 h at 22 °C. H$_2$O (50 mL) was added and the mixture was extracted with Et$_2$O (3 × 10 mL), followed by extraction with EtOAc (3 × 100 mL). The combined organic phases were washed with H$_2$O and brine, dried (MgSO$_4$) and concentrated in vacuo. Flash chromatography (hexane/EtOAc, 2 : 1) afforded the desired acid **18a** (2.6 g, 80 %) as a pale yellow and very viscous oil. R$_f$ = 0.32–0.25 (silica gel, hexane/EtOAc, 1 : 1); $[\alpha]_D^{20}$ – 19.48 (c = 0.39).

C$_{35}$H$_{66}$O$_9$Si	calc.	C 63.97	H 10.09
(865.9)	found	62.98	9.85

^{1}H NMR: δ = 0.06 (s, 3 H, SiCH$_3$), 0.12 (s, 3 H, SiCH$_3$), 0.72 (d, J = 7.3 Hz, 3 H, CH$_3$), 0.92 (t, J = 7.5 Hz, 3 H, 15-H), 0.94 [s, 9 H, Si(CH$_3$)$_3$], 1.00 (d, J = 7.0 Hz, 3 H, CH$_3$), 1.10 (d, J = 7.2 Hz, CH$_3$), 1.26 (d, J = 7.5 Hz, 3 H, CH$_3$), 1.38 (s, 3 H, 6-CH$_3$), 1.42 (s, 3 H, C(CH$_3$)$_2$), 1.48 (s, 3 H, C(CH$_3$)$_2$), 1.40–1.58 (m, 7 H), 1.60–1.90 (m, 3 H), 1.76 (d, J = 1.0 Hz, 3 H, 8-CH$_3$), 2.64 (m, 1 H, 2-H), 3.50 (mc, 1 H, 5'-H), 3.58 (mc, 2 H, 5'-H, 11-H), 3.70 (d, J = 2.0 Hz, 1 H, 5-H), 3.78 (mc, 1 H, 13-H), 3.92 (dd, J = 9.5, 2.5 Hz, 1 H, 3-H), 4.04 (d, J = 8.1 Hz, 1 H, 9-H), 4.52 (mc, 1 H, 1'-H), 5.54 (d, J = 1.0 Hz, 7-H).

^{13}C NMR: δ = – 4.52, – 4.41, 7.00, 7.52, 11.13, 11.97, 13.49, 14.45, 19.62, 19.95, 25.47, 25.82, 25.88, 27.50, 2969, 30.96, 32.10, 37.02, 39.53, 4115, 62.73, 73.90, 74.66, 75.47, 76.53, 77.47, 78.45, 84.27, 95.22, 99.82, 131.02, 134.07, 176.51.

IR (film): ν = 3650–3100 s, 2960 vs, 2940 vs, 2880 s, 2860 s, 1735 s, 1710 s, 1465 s, 1385 s, 1360 s, 1330 m, 1255 s, 1205 s, 1185 s, 1160 s, 1135 s, 1115 s, 1095 s, 1075 s, 1045 s, 1015 s, 1000 s, 940 s, 910 s, 870 s, 835 s, 815 s, 775 s, 760 m, 665 m, 545 m, 520 m cm^{-1}.

MS (EI, 80 eV, 150 °C): m/z = 640 (M–2H$_2$O)$^+$, 556 (M–H$_2$O – DHP)$^+$, 555 (M–H$_2$O – THP)$^+$, 538 (M–DHP – 2H$_2$O)$^+$, 499 (M–SiMe$_2$C$_4$H$_9$) – CO$_2$)$^+$, 481 (M– SiMe$_2$C$_4$H$_9$ – CO$_2$ –

$H_2O)^+$, 441 (M– THP – $HOSiMe_2C_4H_9)^+$,423 (M–THP – $HOSiMe_2C_4H_9$) – $H_2O)^+$, 355, 251, 231, 223, 201, 173, 125, 85, 59.

HRMS (EI, 80 eV, 160 °C): *m/z*, $C_{30}H_{55}O_7Si$ $(M-H_2O-THP)^+$ calc.: 555.371707; found: 555.371631.

(2*R*,3*S*,4*S*,5*R*,6*S*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)-6,11,13-Trihydroxy-3,5-isopropylidenedioxy-2,4,6,8,10,12-hexamethyl-9-[(1′*S*)-tetrahydro-2*H*-pyran-2-yloxy]-7-pentadecenoic Acid (18b):

For desilylation a solution of Bu_4NF in THF (1.0 M, 10.0 mL, 10.0 mmol) was added to **18a** (2.50 g, 3.8 mmol) at 0 °C and the mixture was allowed to warm to r. t. while stirring for 15 h at 22 °C, at which time TLC analysis showed complete consumption of the starting material and formation of a polar product (silica gel, CH_2Cl_2/MeOH, 10:1). The solvent was evaporated in vacuo and the residue was purified by flash chromatography (hexane/EtOAc/MeOH, 4:4:1) to give seco acid **18b** (1.9 g, 92 %) as a colorless and viscous oil: $R_f = 0.26-0.22$ (silica gel, hexane/EtOAc, 1:1); $[\alpha]_D^{20}$ – 25.65 (c = 0.81).

^1H NMR: δ = 0.82 (d, J = 7.0 Hz, 3 H, CH_3), 0.94 (t, J = 8.5 Hz, 3 H, 15-H), 1.00 (d, J = 7.5 Hz, 3 H, CH_3), 1.04 (d, J = 7.0 Hz, 3 H, CH_3), 1.18 (d, J = 7.0 Hz, 3 H, 2-CH_3), 1.32 (s, 3 H, 6-CH_3), 1.40 (s, 3 H, $C(CH_3)_2$), 1.42 (s, 3 H, $C(CH_3)_2$), 1.46–1.62 (m, 5 H), 1.64–1.76 (m, 3 H), 1.80 (s, 3 H, (8-CH_3), 1.82–1.92 (m, 3 H), 2.40–2.60 (m, 2 H, 2-H, OH), 3.02 (mc, 2 H, OH, 5′-H), 3.42 (mc, 1 H, 5′-H), 3.58 (d, J = 8.7 Hz, 1 H, 11-H), 3.64 (d, J = 1.5 Hz, 1 H, -H), 3.74 (d, J = 9.2 Hz, 1 H, 9-H), 3.82 (mc, 2 H, OH, 13-H), 3.94 (d, J = 9. Hz, 1 H, 3-H), 4.56 (mc, 1 H, 1′-H), 5.28 (d, J = 1.0 Hz, 7-H).

^{13}C NMR: δ = 6.96, 8.89, 11.02, 13.55, 15.00, 19.69, 19.78, 20.12, 25.33, 25.58, 28.78, 29.76, 30.90, 32.68, 3785, 39.52, 42.62, 52.45, 62.36, 74.44, 75.44, 77.51, 77.89, 84.09, 94.21, 99.88, 132.27, 132.52, 179.36.

IR (film): ν = 3700–3150 s, 2980 vs, 2920 vs, 2880 s, 1715 vs, 1560 s, 1465 s, 1440 s, 1415 s, 1385 s, 1360 s, 1325 s, 1255 s, 1235 s, 1200 s, 1160 s, 1115 s, 1095 s, 1075 s, 1015 s, 975 s, 940 s, 915 s, 885 m, 870 s, 845 w, 815 m, 795 m, 760 vs, 700 w, 665 s, 645 w, 630 w, 560 s, 520 m, 465 w, 430 w cm^{-1}.

MS (EI, 80 eV, 150 °C): *m/z* = 526 $(M-H_2O)^+$, 441 (M– H_2O – $THP)^+$, 427 (M–H_2O – DHP – $CH_3)^+$, 409 (M–2 H_2O – DHP – $CH_3)^+$, 367 [M–DHP – OH – H_2O – $(CH_3)_2CO]^+$, 315, 311, 297, 281, 267, 201, 142, 125, 85, 69, 59.

HRMS (EI, 80 eV, 150 °C): *m/z*, $C_{24}H_{41}O_7$ $(M-H_2O-THP)^+$ calc.: 441.285230; found: 441.285204.

7) Macrolactonization; (2*R*,3*S*,4*S*,5*R*,6*S*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)-13-Ethyl-6,11-dihydroxy-3,5-isopropylidenedioxy-2,4,6,8,10,12-hexamethyl-9-[(1′*S*)-tetrahydro-2*H*-pyran-2-yloxy-7-tridecen-13-olide (19a):

To a solution of seco acid **18b** (1.7 g, 3.12 mmol) in THF (20 mL) was added at 22 °C Et_3N (324 mg, 0.45 mL, 3.20 mmol). The mixture was treated with 2,4,6-trichlorobenzoyl chloride (771 mg, 3.15 mmol) and stirred for 2 h at r.t. The mixture was diluted with anhydr. toluene (315 mL) and added dropwise over a period of 3 h to a refluxing solution of DMAP (11.6 g, 95 mmol) in dry toluene (500 mL). To achieve high dilution conditions, the dropping funnel was placed on top of a 30-cm vigreux column, half of which was rinsed by the refluxing toluene. After complete addition, the mixture was refluxed for an additional hour and then concentrated in vacuo, providing, after flash chromatography (hexane/EtOAc, 10:1), lactone **19a** (1.52 g, 94 %) as colorless crystals of mp 136 °C, R_f = 0.54 (silica gel, hexane/EtOAc, 1:1); R_f = 0.20 (silica gel, hexane/EtOAc, 3:1); $[\alpha]_D^{20}$ – 16.09 (c = 1.10).

^1H NMR: δ = 0.84 (t, J = 7.3 Hz, 3 H, 15-H), 0.90 (d, J = 7.2 Hz, 3 H, CH_3), 1.04 (d, J = 6.5 Hz, 3 H, CH_3), 1.08 (d, J = 6.8 Hz, 3 H, CH_3), 1.20 (d, J = 6.8 Hz, 3 H, 2-CH_3), 1.30 (s, 3 H, 6-CH_3), 1.42 (s, 3 H, $C(CH_3)_2$), 1.48 (s, 3 H, $C(CH_3)_2$), 1.50–1.82 (m, 10 H), 1.84 (d, J = 1.3 Hz, 3 H, 8-CH_3), 2.02 (mc, 1 H), 2.28 (d, J = 4.0 Hz, 1 H, OH), 2.40 (d, J = 2.5 Hz, 1 H, OH), (mc, 1 H, 2-H), 3.12 (dd, J = 9.5, 3.5 Hz, 1 H), 11-H), 3.46 (mc, 1 H, 5′-H), 3.52 (d, J = 2.0 Hz, 1 H, 5-H), 3.70 (dd, J = 10.2, 2.0 Hz, 1 H, 3-H), 3.88 (mc, 1 H, 5′-H), 4.04 (d, J = 10.0 Hz, 1 H, 9-H), 4.66 (mc, 1 H, 1′-H), 5.06 (d, J = 1.3 Hz, 7-H), 5.36 (ddd, J = 6.8, 5.0 Hz, J = 2.5 Hz, 1 H, 13-H).

^{13}C NMR: δ = 6.30, 8.63, 9.33, 10.39, 10.46, 13.85, 19.20, 19.96, 25.65, 25.69, 29.22, 29.66, 30.83, 33.63, 36.33,38.95, 42.37, 61.60, 70.81, 75.13, 76.80, 83.34, 93.52, 100.94, 131.31, 133.41, 142.84, 176.65.

IR (film): ν = 3640–3330 s, 2970 vs, 2940 vs, 2880 s, 1705 vs, 1585 w, 1550 w, 1455 s, 1385 s, 1370 s, 1340 s, 1320 s, 1275 s, 1235 s, 1200 s, 1185 s, 1160 s, 1135 s, 1115 s, 1095 s, 1075 s, 1055 s, 1015 s, 975 s, 940 s, 925 s, 915 s, 885 s, 870 s, 815 m, 795 m, 760 s, 715 w, 705 w, 665 m, 645 w, 570 w, 555 m, 520 m, 475 w, 445 w, 430 m cm^{-1}.

MS (EI, 80 eV, 150 °C): *m/z* 526 $(M)^+$, 511 $(M-CH_3)^+$, 508 (M–$H_2O)^+$, 490 (M–2 $H_2O)^+$, 468 [M– $(CH_3)CO]^+$, 450 [M– H_2O – $(CH_3)_2CO]^+$, 442 $(M-DHP)^+$, 441 $(M-THP)^+$, 424 (M–DHP – $H_2O)^+$, 409 (M–DHP – H_2O – $CH_3)^+$, 406 (M–2 H_2O – $DHP)^+$, 366 [M–DHP – H_2O – $(CH_3)CO]^+$, 349, 296, 241, 223, 201, 143, 125, 123, 99, 85, 69.

HRMS (EI, 80 eV, 150 °C): *m/z*, $C_{29}H_{46}O_6$ $(M-2H_2O)^+$ calc.: 490.329440; found: 490.329365.

8) Deprotection and Hydrogenation: (2*R*,3*S*,4*S*,5*R*,6*S*,9*R*,10*S*,11*R*,12*R*,13*R*,7*E*)-13-Ethyl-6,9,11-trihydroxy-3,5-isopropylidenedioxy-2,4,6,8,10,12-hexamethyl-7-tridecen-13-olide (19b), (2*R*,3*S*,4*S*,5*R*,6*S*,9*R*,10*R*,11*R*,12*R*,13*R*,7*E*)-13-Ethyl-3,5,6,9,11-pentahydroxy-2,4,6,8,10,12-hexamethyl-7-7-tridecen-13-olide (19c), (2*R*,3*S*,4*S*,5*R*,6*S*,8*R*,9*R*,10*S*,11*R*,12*R*,13*R*)- and (2*R*,3*S*,4*S*,5*R*,6*S*,8*S*,9*R*,10*S*,11*R*,12*R*,13*R*)-13-Ethyl-3,5,6,9,11-pentahydroxy-2,4,6,8,10,12-hexamethyl-13-tridecanolide (20a, b):

A solution of the protected lactone **19a** (1.30 mol, 2.50 mmol) in EtOAc/hexane (2:1, 25 mL) was shaken with Rh–C (5 %, 250 mg) under H_2 atmosphere (1.0 atm) at 22 °C for 15 h. The solution was purged with Ar, filtered through celite with EtOAc/hexane (3:1) and concentrated under reduced pressure. Flash chromatography on silica gel with an elution gradient ranging from 10 to 50 % EtOAc/hexane initially afforded **19b** (420 mg, 38 %) as colorless crystals. Further elution provided the unprotected, unsaturated lactone **19c** (370 mg, 36.8 %) as colorless needles and the hydrogenated lactones **20a, b** (193.9 mg, 19.2 %) as a mixture of diastereomers in the ratio **20a, b** (1.5:1; determinated by HPLC analysis, 20 % *i*-PrOH in hexane, RI-detection) as colorless crystals.

Compound **19b**: mp 207–209 °C; R_f = 0.27 (silica gel, hexane/EtOAc, 1:1); $[\alpha]_D^{20}$ + 11.98 (c = 2.16).

^1H NMR: δ = 0.84 (t, J = 6.7 Hz, 3 H, 15-H), 0.88 (d, J = 7.0 Hz), 3 H, CH_3), 1.00 (d, J = 6.8 Hz, 3 H, CH_3), 1.08 (d, J = 7.3 Hz, 3 H, CH_3), 1.20 (d, J = 7.5 Hz, 3 H, 2-CH_3), 1.28 (s, 3 H, 6-CH_3), 1.44 (s, 3 H, $C(CH_3)_2$), 1.50 (s, 3 H, $C(CH_3)_2$), 1.54 (mc, 1 H), 1.68–1.80 (m, 2 H), 1.90 (mc, 1 H), 1.98 (d, J = 1.3 Hz, 3 H, 8-CH_3), 2.34 (d, J = 2.0 Hz, 1 H, OH), 2.40 (d, J = 4.0 Hz, 1 H, OH), 2.40 (d, J = 2.5 Hz, 1 H, OH), 2.68 (mc, 1 H, 2-H), 3.06 (mc, 1 H), 3.52 (d, J = 2.7 Hz, 1 H, 5-H), 3.72 (dd, J = 10.2, 1.3 Hz, 1 H, 9-H), 4.04 (dd, J = 10.8, 1.2 Hz, 1 H, 11-H), 5.00 (d, J = 1.3 Hz, 7-H), 5.36 (ddd, J = 9.5, 4.5, 1.0 Hz, 1 H, 13-H).

^{13}C NMR (CD_3OD): δ = 7.18, 8.40, 9.79, 10.66, 13.93, 20.11, 26.66, 29.14, 30.06, 30.65, 34.95, 38.59, 39.41, 43.03, 72.11, 76.20, 77.58, 7797, 78.82, 83.11, 101.78, 130.26, 137.83, 176.57.

IR (film): ν = 3700–3200 s, 3070 s, 2925 vs, 2850 s, 2740 m, 2620 m, 1745 s, 1705 s, 1670 m, 1640 m, 1605, 1585 m, 1515 s, 1465 s, 1385 s, 1375 s, 1335 s, 1320 s, 1270 s, 1230 s, 1160 s, 1075 s, 1055 s, 1015 s, 985 s, 955 s, 940 s, 910 s, 885 s, 865 s, 815 m, 795 m, 770 w, 740 m, 720 m, 695 m, 645 w, 610 m, 560 s, 515 s, 485 s, 435 s cm^{-1}.

MS (EI, 80 eV, 150 °C): *m/z* = 443 $(M+H)^+$, 442 $(M)^+$, 427 $(M-CH_3)^+$, 424 (M– $H_2O)^+$, 409 (M–H_2O– $CH_3)^+$, 406 (M–2 $H_2O)^+$, 367 [M– OH– $(CH_3)CO]^+$, 366 [M– H_2O – $(CH_3)_2CO]^+$, 349 [M–OH – H_2O – $(CH_3)CO]^+$, 337, 321, 315, 296, 241, 223, 201, 143, 125, 123, 114, 109, 99, 85, 69.

HRMS (EI, 80 eV, 150 °C): *m/z*, $C_{21}H_{34}O_5$ [M–H_2O – $(CH_3)CO]^+$ calc.: 366.240625; found: 366.240627.

HRMS (EI, 80 eV, 150 °C): *m/z*, $C_{21}H_{33}O_4$ [M–H_2O – OH – $(CH_3)CO]^+$ calc.: 349.237885; found 349.237951.

Compound **19c**: mp 245 °C; $R_f = 0.28$ (silica gel, hexane/EtOAc, 1:2); $[\alpha]_D^{20}$ + 19.70 (c = 1.97, MeOH)).

$C_{21}H_{38}O_7$	calc.	C 62.66	H 9.51
(402.5)	found	62.61	9.43

^1H NMR (CD_3OD): δ = 0.79 (d, J = 6.8 Hz, 3 H, CH_3), 0.86 (d, J = 7.0 Hz, 3 H, CH_3), 0.89 (t, J = 6.6 Hz, 3 H, 15-H), 1.08 (d, J = 7.0 Hz, 3 H, CH_3), 1.18 (d, J = 6.8 Hz, 3 H, 2-CH_3), 1.29 (s, 3 H, 6-CH_3), 1.52 (mc, 1 H), 1.65–1.84 (m, 2 H), 1.87 (d, J = 0.5 Hz, 3 H, 8-CH_3), 2.64 (mc, 1 H, 2-H), 3.01 (dd, J = 10.2, 0.8 Hz, 1 H), 3.59 (s, 1 H, 5-H), 3.75 (d, J = 10.0 Hz, 1 H, 9-H), 3.86 (dd, J = 10.2, 0.8 Hz, 1 H), 5.14 (d, J = 0.5 Hz, 7-H), 5.30 (ddd, J = 10.0, 4.2, 1.0 Hz, 1 H, 13-H).

^1H NMR (acetone-d_6): δ = 0.68 (d, J = 7.3 Hz, 3 H, CH_3), 0.76 (t, J = 7.0 Hz, 3 H, 15-H), 0.82 (d, J = 6.7 Hz, 3 H, CH_3), 0.96 (d, J = 6.5 Hz, 3 H, CH_3), 1.12 (d, J = 6.7 Hz, 3 H, 2-CH_3), 1.16 (s, 3 H, 6-CH_3), 1.38 (mc, 1 H), 1.51–1.68 (m, 4 H), 1.74 (s, 3 H, 8-CH_3), 2.50 (mc, 1 H, 2-H), 2.72 (s, 1 H, OH), 2.88 (dd, J = 10.3, 5.0 Hz, 1 H), 3.24 (d, J = 5.0 Hz, 1 H), 3.24 (d, J = 5.2 Hz, 1 H, OH), 3.46 (d, J = 4.0 Hz, OH), 3.60 (d, J = 10.5 Hz, 1 H), 3.80 (dd, J = 9.5, 4.0 Hz, 1 H), 4.24 (mc, 2 H, 9-H, OH), 4.94 (s, 1 H, 7-H), 5.14 (ddd, J = 10.2, 4.5, 1.0 Hz, 1 H, 13-H).

^{13}C NMR (CD_3OD, ^{13}C-signals determinated by DEPT90/DEPT135): δ = 5.97, 8.43, 9.63, 10.78 (4,10,12,14 -CH_3), 15.36 (2-CH_3), 26.75 (14-C), 29.37 (8-CH_3), 30.60 (6-CH_3), 38.49, 39.40, 40.93 (4,10,12 -C), 45.29 (2-C), 72.23, 76.62, 80.72, 82.58, 8.73 (3,5,9,11,13 -C), 78.38 (6-C), 131.37 (7-C), 137.89 (8-C), 178.88 (1-C).

IR (film): ν = 3650–3150 s, 2980 vs, 2920 vs, 2880 s, 2850 s, 1705 s, 1605 s, 1605 s, 1455 s, 1385 s, 1335 s, 1260 s, 1185 s, 1145 s, 1115 s, 1085 s, 1040 s, 975 s, 910 s, 885 s, 845 w, 815 m, 755 m, 720 m, 685 m, 665 m, 625 w, 595 w, 500 m, 460 w cm^{-1}.

MS (EI, 80 eV, 150 °C): m/z 385 $(M-OH)^+$, 384 $(M-H_2O)^+$, 370 $(M-CH_3 - OH)^+$, 366 $(M-2H_2O)^+$, 352 $(M-H_2O- CH_3 - OH)^+$, 334 $(M-2H_2O -OH-CH_3)^+$, 327 $[M-OH - (CH_3)CO]^+$, 315, 308 $[M-2H_2O - (CH_3)_2CO]^+$, 297, 279, 272 $[M-4H_2O - -(CH_3)_2CO]^+$, 271, 259, 223, 143, 125, 114, 99, 85, 71, 69.

HRMS (EI, 80 eV, 150 °C): m/z, $C_{21}H_{36}O_6$ $(M-H_2O)^+$ calc.: 384.251190; found: 384.251326.

HRMS (EI, 80 eV, 150 °C): m/z $C_{18}H_{31}O_5$ $[M- OH - (CH_3)CO]^+$ calc.: 327.217150; found: 327.215948.

The properties of compounds **20 a, b** are described after the following step.

(2*R*,3*S*,4*S*,5*R*,6*S*,8*R*,9*R*,10*S*,11*R*,12*R*,13*R*)- and (2*R*,3*S*,4*S*,5*R*,6*S*,8*S*,9*R*,10*S*,11*R*,12*R*,13*R*)- and (2*R*,3*S*,4*S*,5*R*,6*S*,8*S*,9*R*,10*S*,11*R*,12*R*,13*R*)-13-Ethyl-3,5,6,9,11-pentahydroxy-2,4,6,8,10,12-hexamethyl-13-tridecanolide (20 a, b):

To a solution of **19b** (100 mg, 0.225 mmol) and **19c** (100 mg, 0.248 mmol) in dry EtOH (10 mL) was added 5 % Rh–C (200 mg). The mixture was shaken for 24 h under H_2 pressure (3.0 atm). The H_2 was purged with Ar and the solution was filtered through a pad of Celite. Evaporation and purification by flash column chromatography (hexane/EtOAc, 1:1) afforded a diastereomeric mixture of hydrdogenated lactones **20a,b** in a ratio of 1.5:1 (by HPLC-analysis, 20 % *i*-PrOH in hexane, RI detection, t_R (**20a**) = 5.00 min, t_R (**20b**) = 5.60 min; 2 mL min flow rate). The mixture was separated by preparative HPLC (20 %) *i*-PrOH in hexane, RI detection) to give **20a** (105.6 mg, 55 %) and **20b** (70.4 mg, 37 %) as colorless crystals with the following properties:

Compound **20a**: mp 208–209 °C; $R_f = 0.21$ (silica gel, hexane/EtOAc, 1:2); $[\alpha]_D^{20}$ + 7.72 (c = 1.62, MeOH).

^1H NMR (CD_2OD): δ = 0.84 (d, J = 6.5 Hz, 3 H, CH_3), 0.92 (t, J = 8.0 Hz, 3 H, 15-H), 0.95 (d, J = 7.0 Hz, 3 H, CH_3), 1.10 (d, J = 7.0 Hz, 3 H, CH_3), 1.13 (d, J = 6.6 Hz, 3 H, CH_3), 1.22 (d, J = 6.4 Hz, 3 H, CH_3), 1.30 (s,3 H, 6-CH_3), 1.44–1.57 (m, 3 H), 1.62–1.84 (m, 5 H), 2.74 (mc, 1 H, 2-H), 3.18 (dd, J = 10.0, 1.0 Hz, 1 H), 3.35 (dd, J = 10.0, 1.0 Hz, 1 H), 3.58 (d, J = 2.0 Hz, 1 H, 5-H), 3.72 (d, J = 10.0 Hz, 1 H), 5.29 (ddd, J = 9.8, 4.4, 1.0 Hz, 1 H, 13-H).

^{13}C NMR (CD_3OD): δ = 6.69, 9.32, 9.38, 10.90, 15.25, 20.10, 26.68, 30.11, 3076, 37.95, 38.34, 42.28, 45.04, 71.26, 76.99, 77.26, 80.72, 81.15, 81.43, 178.61.

IR: ν = 3700–3050 s, 2950 vs, 2910 vs, 2840 s, 1720 s, 1700 s, 1640 w, 1575 w, 1540 w, 1455 s, 1375 s, 1335 s, 1310 s, 1285 s, 1260 s, 1185 s, 1150 s, 1115 s, 1085 s, 1065 s, 1040 s, 965 s, 905 m, 885 m, 825 w, 755 w, 720 m, 685 m, 560 m cm^{-1}.

MS (EI, 80 eV, 160 °C): m/z = 386 $(M-H_2O)^+$, 371 $(M-CH_3 - H_2O)^+$, 368 $(M-2H_2O)^+$, 353 $(M-2H_2O - CH_3)^+$, 335 $(M-3H_2O - 2CH_3)^+$, 329, 299, 281, 241, 225, 223, 197, 167, 157, 155, 139, 127, 115, 109, 99, 69, 55.

HRMS (EI, 80 eV, 160 °C): m/z, $C_{21}H_{38}O_6$ $(M-H_2O)^+$ calc.: 386.266840; found: 386.267070.

HRMS (EI, 80 eV, 160 °C): m/z, $C_{21}H_{36}O_5$ $(M-2H_2O)^+$ calc.: 368.256275; found: 368.255986.

HRMS (EI, 80 eV, 160 °C): m/z, $C_{20}H_{33}O_5$ $(M-2H_2O - CH_3)^+$ calc.: 353.232800; found: 353.232630.

Compound **20b**: mp 170–171 °C; $R_f = 0.20$ (silica gel, hexane/EtOAc, 1:2); $[\alpha]_D^{20}$ – 9.45 (c = 2.18, MeOH).

^1H NMR (CD_3OD): δ = 0.85 (d, J = 7.0 Hz, 3 H, CH_3), 0.93 (t, J = 7.0 Hz, 3 H, 15-H), 0.96 (d, J = 7.2 Hz, 3 H, CH_3), 1.10 (d, J = 7.0 Hz, 3 H, CH_3), 1.16 (d, J = 6.5 Hz, 3 H, CH_3), 1.23 (d, J = 7.2 Hz, 3 H, CH_3), 1.24 (s, 3 H, 6-CH_3), 1.30 (mc, 1 H), 1.52 (mc, 1 H), 1.64–1.83 (m, 4 H), 1.85–2.00 (m, 2 H), 2.72 (mc, 1 H, 2-H), 3.23 (dd, J = 10.0, 1.0 Hz, 1 H), 3.48 (dd, J = 10.0, 1.2 Hz, 1 H), 3.64 (s, 1 H, 5-H), 3.70 (d, J = 10.2 Hz, 1 H), 5.29 (ddd, J = 9.8, 4.0, 1.0 Hz, 1 H, 13-H).

^{13}C NMR (CD_3OD): δ = 3.66, 6.69, 6.92, 8.33, 12.86, 14.49, 22.65, 24.23, 34.13, 35.86, 35.93, 37.18, 39.59, 42.77, 68.65, 73.74, 74.70, 76.99, 77.76, 79.70, 176.04.

IR (film): ν = 3700–3100 s, 2950 vs, 2920 vs, 2880 vs, 2840 s, 1715 s, 1700 s, 1665 s, 1640 s, 1595 s, 1575 s, 1455 s, 1400 m, 1375 s, 1325 s, 1310 s, 1285 s, 1260 s, 1210 m, 1185 s, 1150 s, 1115 s, 1085 s, 1065 s, 1040 s, 990 s, 965 s, 925 m, 905 m, 885 s, 850 w, 835 w, 825 w, 810 w, 790 m, 750 s, 695 s, 660 m, 645 w, 610 m, 575 m, 545 m cm^{-1}.

MS (EI, 80 eV, 160 °C): m/z = 386 $(M-H_2O)^+$, 371 $(M-CH_3 - H_2O)^+$, 368 $(M- 2H_2O)^+$, 353 $(M-2H_2O - CH_3)^+$, 338 $(M-2H_2O - 2CH_3)^+$, 335 $(M-3H_2O - 2CH_3)^+$, 329, 327, 317, 311, 299, 281, 241, 225, 223, 197, 167, 157, 155, 139, 127, 115, 109, 99, 69, 55.

HRMS (EI, 80 eV, 160 °C): m/z, $C_{21}H_{38}O_6$ $(M-H_2O)^+$ calc.: 386.266840; found: 386.266690.

HRMS (EI, 80 eV, 160 °C): m/z, $C_{21}H_{36}O_5$ $(M-2H_2O)^+$ calc.: 368.256275; found: 368.256353.

9) Formation and Hydrogenation of the 9-Oxo Compound 22:

(2*R*,3*S*,4*S*,5*R*,6*S*,10*S*,11*R*,12*R*,13*R*,7*E*)-13-Ethyl-6,11-dihydroxy-3,5-isopropyliodenedioxy-2,4,6,8,10,12-hexamethyl-9-oxo-7-tridecen-13-olide (21):

A solution of **19b** (150 mg, 0.337 mmol) in anhydr. DMF (5 mL) was treated with PDC (15 equiv, 1.86 g, 5.0 mmol) at 22 °C. The mixture was stirred for 3.5 h at r.t., diluted with Et_2O (100 mL) and the organic phase was washed with H_2O (10 mL). The organic layer was dried ($MgSO_4$), filtered and the solvent was evaporated in vacuo to provide after flash chromatography (hexane/EtOAc, 10:1) **21** (142 mg, 96 %) as colorless needles with mp 134–135 °C; $R_f = 0.57$ (silica gel, hexane/EtOAc, 1:1); $[\alpha]_D^{20}$ + 23.07 (c = 0.65).

^1H NMR (CD_3OD): δ = 0.80 (d, J = 7.0 Hz, 3 H, CH_3), 0.86 (t, J = 8.0 Hz, 3 H, 15-H), 1.06 (d, J = 7.0 Hz, 3 H, CH_3), 1.08 (d, J = 6.8 Hz, 3 H, CH_3), 1.11 (d, J = 7.0 Hz, 3 H, CH_3), 1.31 (s, 3 H, 6-CH_3), 1.34 (mc, 1 H), 1.42 (s, 6 H, 2 × $C(CH_3)_2$), 1.44 (mc, 1 H), 1.60–1.74 (m, 3 H), 1.89 (d, J = 1.0 Hz, 3 H, 8-CH_3), 1.90 (mc, 1 H, 10-H), 2.66 (dq, J = 10.0, 6.0 Hz, 1 H, 2-H), 3.53 (dd, J = 10.2, 2.0 Hz, 1 H), 3.60 (d, J = 2.5 Hz, 1 H), 3.62 (dd, J = 10.0, 1.8 Hz, 1 H), 5.30 (d, J = 1.0 Hz, 1 H, 7-H), 5.41 (ddd, J = 8.2, 6.0, 2.0 Hz, 1 H, 13-H).

^1H NMR ($CDCl_3$): δ = 0.76 (d, J = 6.8 Hz, 3 H, CH_3), 0.88 (t, J = 7.5 Hz, 3 H, 15-H), 1.06 (d, J = 6.8 Hz, 3 H, CH_3), 1.16 (d,

$J = 7.0$ Hz, 3 H, CH_3), 1.20 (d, $J = 6.8$ Hz, 3 H, CH_3), 1.26 (s, 3 H, 6-CH_3), 1.44 (s, 3 H, $C(CH_3)_2$), 1.48 (s, 3 H, $C(CH_3)_2$), 1.52 (mc, 2 H), 1.64–1.80 (m, 2 H), 1.92 (s, 3 H, 8-CH_3), 2.00 (dq, $J = 8.2$, 2.5 Hz, 1 H, 10– H), 2.34 (s, 1 H, OH), 2.70 (dq, $J = 10.5$, 6.5 Hz, 1 H, 2-H), 3.56 (dd, $J = 10.2$, 2.0 Hz, 1 H), 3.71 (d, $J = 6.2$ Hz, 1 H, 5-H), 3.74 (dd, $J = 10.8$, 2.0 Hz, 1 H), 3.99 (d, $J = 5.2$ Hz, 1 H, OH), 5.28 (s, 1 H, 7-H),5.34 (ddd, $J = 8.5$, 5.5, 2.3 Hz, 1 H, 13-H).

^{13}C NMR: $\delta = 6.37$, 9.03, 10.36, 13.92, 15.18, 20.05, 25.73, 28.90, 29.72, 31.95, 33.69, 34.35, 39.34, 42.56, 71.47, 74.66, 77.85, 82.51, 101.00, 124.31, 136.48, 176.68.

IR (film): $\nu = 3700-3100$ s, 2980 vs, 2930 vs, 288 vs, 2860 vs, 2740 w, 2450 w, 1720 vs, 1580 w, 1460 vs, 1365 s, 1335 s, 1320 s, 1280 s, 1270 s, 1220 s, 1200 s, 1160 s, 1135 s, 1095 s, 1055 s, 1020 vs, 975 vs, 940 s, 895 s, 880 s, 820 m, 800 m, 760 vs, 700 m, 665 vs, 640 w, 545 w, 505 m, 450 m cm^{-1}.

MS (EI, 80 eV, 120 °C): $m/z = 441$ $(M+H)^+$, 440 $(M)^+$, 425 $(M-CH_3)^+$, 424 $(M-H-CH_3)^+$, 407 $(M-CH_3-H_2O)^+$, 406 $(M-H-H_2O-CH_3)^+$, 388 $(M-H-2H_2O-CH_3)^+$, 382 $[M-(CH_3)_2CO]^+$, 383 $(M-H_2CCOCH_3)^+$, 366 $(M-H_2CCOCH_3-OH)^+$, 349 $[M-H_2O-CH_3-(CH_3)_2CO]^+$, 339 $(M-H_2CCOCH_3-CO_2)^+$, 331 $[M-(CH_3)_2CO-2H_2O-CH_3)^+$, 314 $[M-2H_2O-OH-(CH_3)_2CO-CH_3]^+$, 296 $[M-3H_2O-OH-(CH_3)_2CO-CH_3]^+$, 281, 241, 223, 201, 183, 143, 125, 123, 109, 99, 97, 69, 59.

HRMS (EI, 80 eV, 160 °C): m/z $C_{23}H_{37}O_7$ $(M-CH_3)^+$ calc.: 425.253930; found: 425.253708.

(2*R*,3*S*,4*S*,5*R*,6*S*,8*S*/*R*,10*S*,11*R*,12*R*,13*R*)-13-Ethyl-6,11-dihydroxy-3,5-isopropylidenedioxy-2,4,6,8,10,12-hexamethyl-9-oxo-13-tridecanolide (22):

A mixture of **21** (100 mg, 0.227 mmol) and 5% Rh–C (100 mg) in EtOAc/EtOH (1:2, 15 mL) was shaken under H_2 atmosphere (1.0 atm) at 22 °C for 12 h. The mixture was filtered through Celite with hexane/EtOAc (1:1) and concentrated. Purification by flash chromatography (15% EtOAc in hexane) afforded pure **22** (90.4 mg, 90%) as colorless crystals. No traces of any other diastereomeric lactone could be detected by HPLC analysis (2% *i*-PrOH in hexane, RI detection, t_R **(22)** = 6.20 min, 2 mL/min flow rte) and ^1H NMR spectroscopy of the crude reaction product.

Compound **22**: mp 126–128 °C; $R_f = 0.42$ (silica gel, hexane/EtOAc, 1:1); $[\alpha]_D^{20}$ + 15.0 ($c = 0.30$).

^1H NMR: $\delta = 0.80$ (d, $J = 7.5$ Hz, 3 H, CH_3), 0.86 (t, $J = 5.7$ Hz, 3 H, 15-H), 0.90 (d, $J = 7.5$ Hz, 3 H, CH_3), 0.96 (d, $J = 7.0$ Hz, 3 H, CH_3), 1.02 (d, $J = 7.0$ Hz, 3 H, CH_3), 1.20 (d, $J = 7.0$, 7.0 Hz, 3 H, CH_3), 1.24 (s, 3 H, 6-CH_3),1.26 (s, 3 H, $C(CH_3)_3$), 1.28 (s, 3 H, $C(CH_3)_2$), 1.48 (mc, 1 H), 1.92 (mc, 1 H), 1.98 (mc, 1 H), 2.18–2.42 (m, 3 H), 2.62 (mc, 1 H, 2-H), 3.04 (d, $J = 4.5$ Hz, 1 H, OH), 3.28 (mc, 1 H, 10-H), 3.38 (mc, 1 H), 3.50 (s, 1 H, OH), 3.58 (dd, $J = 6.8$, 5.0 Hz, 1 H), 3.88 (dd, $J = 10.5$, 7.0 Hz, 1 H), 5.24 (ddd, $J = 8.5$, 5.0, 1.5 Hz, 1 H, 13-H).

^{13}C NMR: $\delta = 6.35$, 6.79, 9.98, 10.58, 13.36, 14.35, 15.38, 23.20,25.47, 29.68, 35.23, 37.89, 38.34, 41.55, 45.57, 47.98. 69.19, 76.18, 79.05, 82.41, 82.68, 109.82, 178.25, 216.58.

MS (EI, 80 eV, 120 °C): $m/z = 442$ $(M)^+$, 441 $(M-2H+OH-CH_4)^+$, 424 $(M-H_2O)^+$, 423 $(M-H-H_2O)^+$, 413 $(M-C_2H_5)^+$, 411 $(M-H-CH_3)^+$, 395 $(M-H_2O-C_2H_5)^+$, 393 $(M-H-H_2O-2CH_3)^+$, 385 $(M-H_2CCOCH_3)^+$, 384 $[M-(CH_3)_2CO]^+$, 372, 367 $(M-H_2CCOCH_3-H_2O)^+$, 366 $[M-H_2O-(CH_3)_2CO]^+$, 353, 337, 327, 325, 303, 285, 279, 267, 259, 239, 221, 211, 172, 171, 149, 143, 125, 99, 69,57.

HRMS (EI, 80 eV, 120 °C): m/z $C_{23}H_{37}O_8$ $(M-CH_4+OH-2H)^+$ calc.: 441.248845; found: 441.247279.

HRMS (EI, 80 eV, 120 °C): m/z, $C_{22}H_{35}O_7$ $(M-CH_3-H)^+$ calc.: 411.238280; found: 411.238220.

HRMS (EI, 80 eV, 120 °C): m/z, $C_{21}H_{37}O_6$ $(M-H_2CCOCH_3).^+$ calc.: 385.259015; found: 385.259008.

HRMS (EI, 80 eV, 120 °C): m/z, $C_{21}H_{36}O_6$ $[M-(CH_3)CO]^+$ calc.: 384.251160; found: 384.251160.

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