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Synthesis of a Tetradehydro-Disorazole C_1

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Dedicated to Professor Gerhard Höfle

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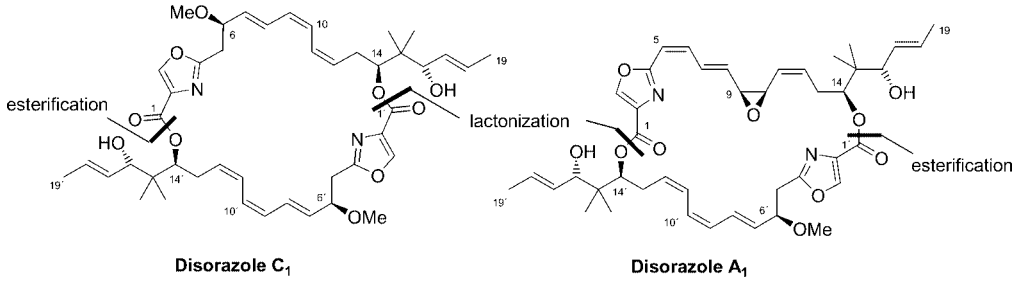
The synthesis of a protected 9,9′,10,10′-tetradehydro-disorazole C_1 is described. A C1–C8 oxazole fragment with an *E*-vinylic iodide terminus is coupled to a suitable C9–C19 enyne. The resulting ω-hydroxycarboxylic acid is cyclodimerized stepwise via intermolecular esterification, followed by lactonization. In addition, simplified masked analogues of disorazole C_1 with truncated side chains are prepared.

1. Introduction

The disorazoles comprise a class of 29 macrodiolides which have been isolated from the fermentation broth of the myxobacterium *Sorangium cellulosum* in 1994 by Höfle and his coworkers.[1] The main compound disorazole A_1 as well as several of the other isolated disorazoles show exceptionally promising biological activity inhibiting the proliferation of human cancer cell lines in subnanomolar concentration. Disorazoles A_1 and E_1 bind to tubulin, induce depolymerization of microtubules and thus arrest the cell cycle in G2/M phase. Disorazole A_1 is up to 100 times more efficacious than epothilon B in its antiproliferative effect in human cancer cell lines such as A-549 (human lung carcinoma) or A-498 (human kidney carcinoma).[2,3] Recently, the biosynthetic gene cluster for the disorazoles was identified and sequenced.[4]

The disorazoles are each built up from two hydroxy acids. Their complex structure is based on a polyolefinic polyketide chain which is terminated by a masked amino acid forming a 2,4-disubstituted oxazole. Disorazoles can also be regarded as a class of naturally occurring cyclophanes in which the benzenoid moieties are replaced by oxazoles.[5] The main compound disorazole A_1 is a non-symmetric macrodiolide being built up from two distinct ω-hydroxycarboxylic acids (Scheme 1). In contrast, the rare disorazole



Disorazole C_1 **Disorazole A_1**

Scheme 1. Cyclization strategy of disorazoles C_1 and A_1.

C_1 is C_2-symmetric corresponding to the dimerized southern half of disorazole A_1. To date no bioactivity data are available for disorazole C_1 due to its low natural abundance.

In this final account on our synthetic efforts towards the disorazoles[6] we report the synthesis of a disorazole C_1 analogue and the preparation of a simplified analogue without the C17–C19, C17′–C19′ side chains.[7]

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2. Results and Discussion

The retrosynthetic analysis is similar to that previously described for disorazole A_1.[6c] Disconnection at the ester linkages leads to a northern and a southern half which in the case of disorazole C_1 are identical. For the latter a direct cyclodimerization was envisaged for constructing the macrocycle.[8] Our strategy included protection of the labile conjugated triene by masking one of the *Z*-double bonds as an alkyne. The choice of the double bond to be protected was thought to be critical. A competing lactonization reaction which would lead to a 15-membered macrolactone was undesirable and had to be suppressed. Additionally, the triple bond likely blocks a facile electrocyclization of the triene to a cyclohexadiene. Therefore, a molecular mechanics calculation was performed providing the relative minimized energies of the two possible 15-membered macrolactones **I** and **II** along with the two possible 30-membered macrodiolides **III** and **IV** (Figure 1).[6c]

Our calculations suggested that the unwanted lactonization to the 15-membered ring should be efficiently suppressed if the *central* C9–C10 *Z*-configured double bond rather than the adjacent *Z*-double bond was masked as an acetylene. The retrosynthesis of the masked segments of disorazole C_1 is depicted in Scheme 2.

In contrast to our first generation approach – disconnection between C10–C11 – we turned to a disconnection strategy of this half between C8 and C9 affording *Z*-enyne **2** and *E*-configured vinyl iodide **3**. This was due to problems arising from construction of the C7–C8 double bond by a Wittig reaction using triphenyl[1-(trimethylsilyl)propargyl]-phosphonium bromide.[6c] During this reaction the double bond could be built up at best in 49% yield and with only low *E*/*Z*-selectivity.

E-configured vinyl iodide **3** was prepared starting from the previously reported alcohol **4**[6c] which is accessible in eight steps from 2-(benzyloxy)acetaldehyde (Scheme 3).

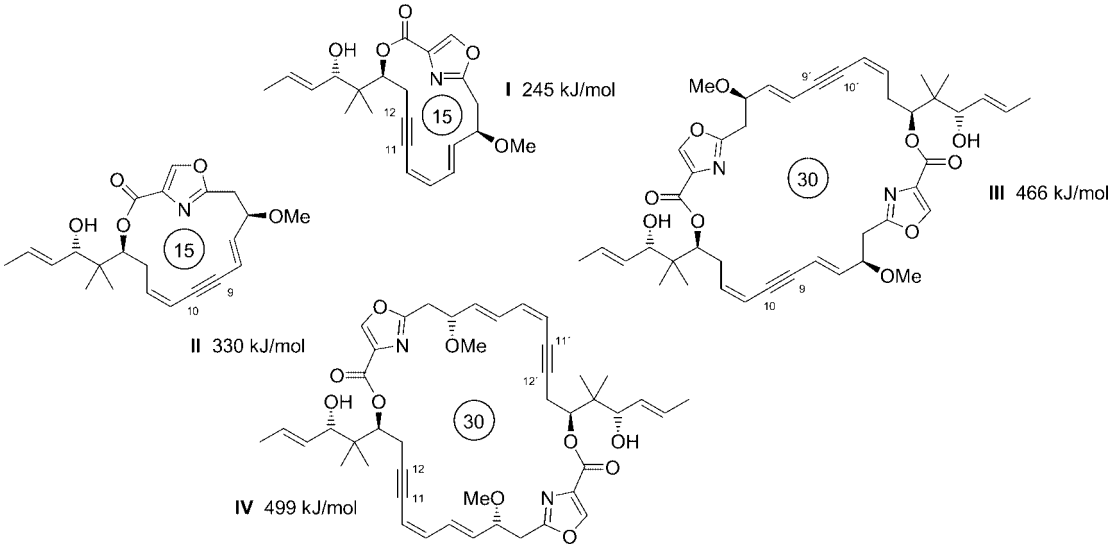
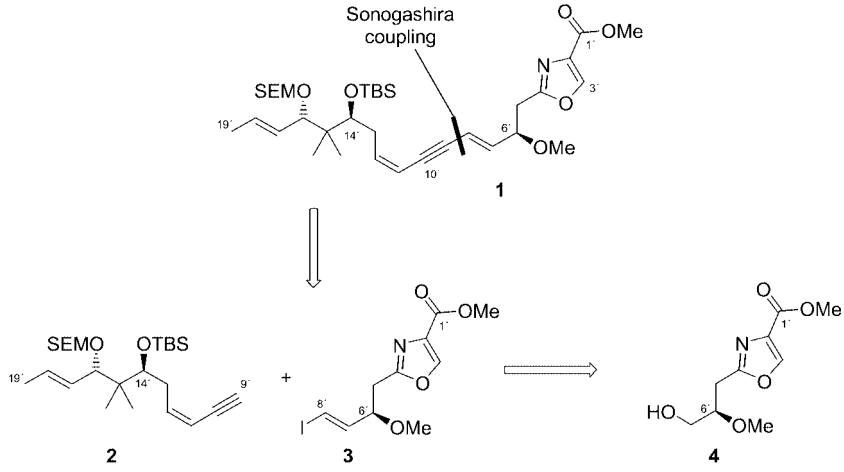
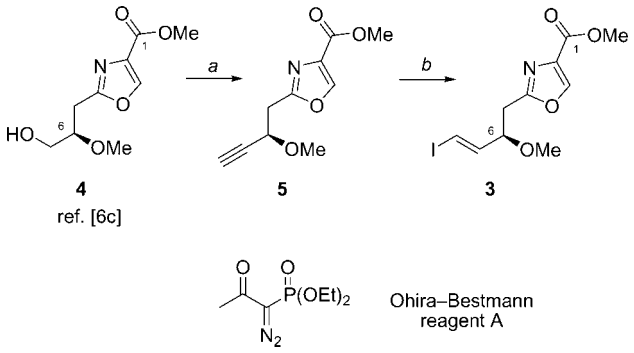


Figure 1. Minimized energies of 15-membered lactones **I** and **II** and 30-membered macrodiolides **III** and **IV**.



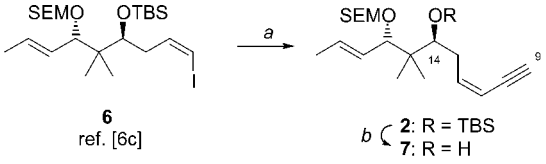
Scheme 2. Retrosynthesis of the southern segment of disorazoles C_1 and A_1.



Scheme 3. C1–C8 precursor. Reaction conditions: *a*) $(ClCO)_2$, Et_3N, DMSO/CH_2Cl_2, –78 °C to –40 °C; then: **A**, K_2CO_3, MeOH, 0 °C to room temp., 75% starting from **4**; *b*) nBu_3SnH, $Pd(PPh_3)_4$, THF, then I_2, 88%, *E*-selective.

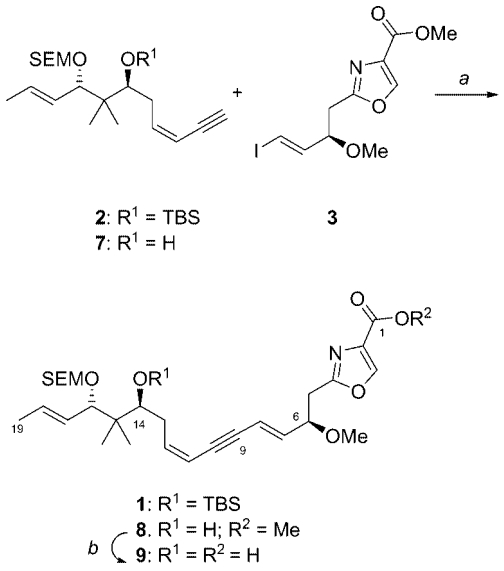
Oxidation of the alcohol **4** gave the corresponding aldehyde which was then transformed into the terminal alkyne **5** applying the Ohira–Bestmann reagent.[9] This two-step transformation was best accomplished without intermediate isolation of the unstable aldehyde.[10] Hence, the reaction mixture of the Swern oxidation was directly added at –40 °C to the Ohira–Bestmann reagent and K_2CO_3. The latter had to be used in large excess to avoid deleterious side reactions. This procedure made the oxazolyl-alkyne **5** accessible in reproducible 75% yield over two steps. Subsequently, the alkyne was converted into the *E*-configured vinyl iodide **3** by hydrostannylation/metal–iodine exchange in very good *E*-selectivity and yield.[11] This procedure proved to be superior compared to e. g. hydrozirconation.

The respective *Z*-enyne **2** was derived from the known *Z*-configured vinyl iodide **6**[6c] by 2C-elongation via Sonogashira cross coupling reaction with (trimethylsilyl)acetylene (Scheme 4).



Scheme 4. C9–C19 fragment. Reaction conditions: *a*) 1. (trimethylsilyl)acetylene, $PdCl_2(PPh_3)_2$, CuI, Et_3N, CH_3CN, room temp., 99%; 2. TBAF (1.1 equiv.), THF, 0 °C to room temp., 81%; *b*) TBAF (10.0 equiv.), THF, room temp., 95%.

Deprotection of the terminal triple bond set the stage for the crucial coupling which was achieved under Sonogashira conditions giving a fully resolved southern fragment **1** in 77% yield (Scheme 5). It turned out that the removal of the C14-TBS group in the dieneyne segment **1** proved to be difficult (see below). For this reason deprotection of the TBS ether had to be achieved before cross coupling so that the simple C14-unprotected C9–C19 hydroxy fragment **7** was entered into the Sonogashira reaction. The yield of the dienyne segment **8** was thus even improved to 89%.



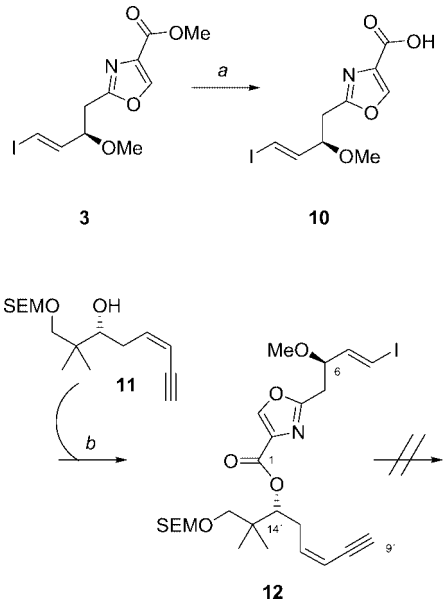
Scheme 5. Fully resolved southern segment. Reaction conditions: *a*) $PdCl_2(PPh_3)_2$, CuI, Et_3N, DMF, room temp., 77% **1**, 89% **8**; *b*) 1.1 N LiOH, THF, room temp., quant.

In order to examine the direct cyclodimerization approach the methyl ester was saponified with aqueous lithium hydroxide yielding the corresponding hydroxy acid **9** quantitatively. Various applied conditions to dimerize **9**, among them dipyridyl-thionocarbonat/DMAP,[12] trichlorobenzoyl chloride/DMAP[13] and 2-chloro-1-methylpyridinium iodide/DMAP,[14] met with no success. It is worthy of note that not in a single case was a 15-membered macrolactone isolated. In one instance the corresponding monomer ethyl ester was isolated, resulting from reaction with trace amounts of ethanol in the reaction mixture. Although this failure in inducing a direct dimerization called for a prolonged stepwise endgame, the absence of any 15-membered macrolactone underscored our assumption that the central triple bond blocks the undesired intramolecular cyclization. Remarkably, under comparable reaction conditions using a didehydro disorazole C_1 hydroxy acid with the alkyne in the C11–C12 position, Meyers et al. reported exclusive formation of the corresponding 15-membered macrolactone.[7a]

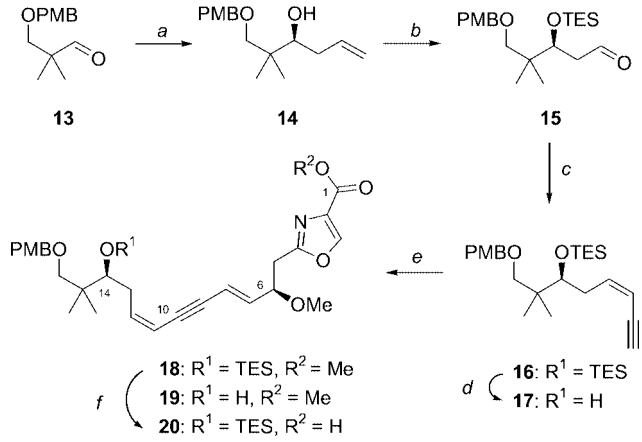
In an additional attempt to induce a direct dimerization we turned our attention briefly to a double Sonogashira endgame (Scheme 6). Firstly, the ester linkage between oxazole fragment **10** and a simplified C9–C16 fragment **11** was constructed, circumventing the macrolactonization step. Unfortunately, cyclodimerization of this ester requiring a macrocyclization by means of two sp-sp^2 couplings was not successful under the conditions applied.[15]

In context with the cyclization studies we prepared another simplified southern half without the C17–C19 side chains. The required enyne fragment was obtained starting from homoallyl alcohol **14** (Scheme 7).

TES protection and subsequent oxidative cleavage of the double bond by ozonolysis afforded aldehyde **15**. This was transformed to the corresponding *Z*-configured vinyl iodide with IPh_3PCH_2I applying the Stork–Zhao olefination.[16]



Scheme 6. Alternative cyclodimerization attempt. Reaction conditions: *a*) LiOH, THF, H_2O, room temp., quant.; *b*) 2-chloro-1-methylpyridinium iodide, Et_3N, DMAP, toluene, 80 °C, 58%.

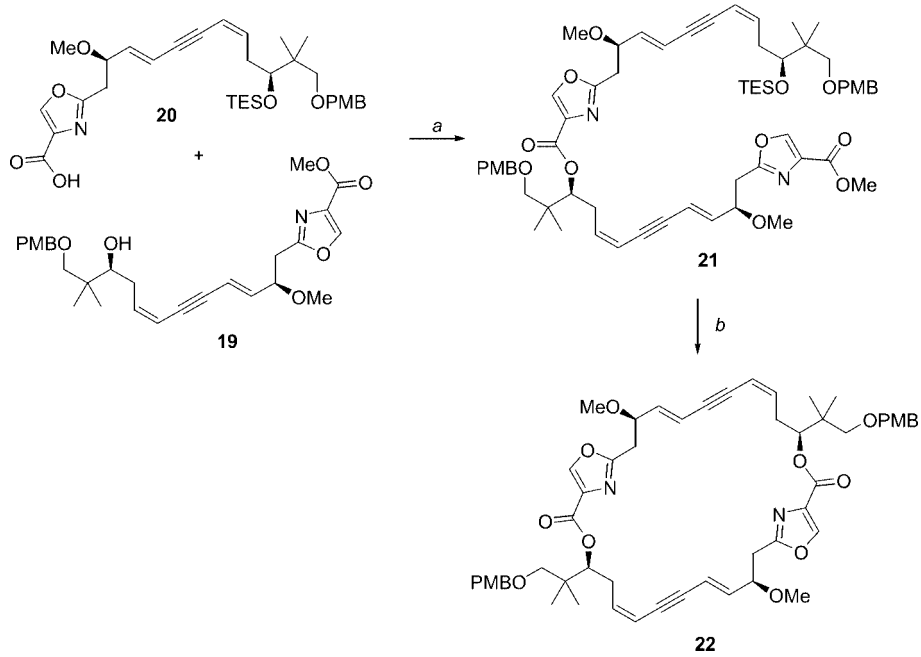


Scheme 7. Simplified C9–C16 fragment. Reaction conditions: *a*) (+)–Ipc_2BOMe, allylmagnesium bromide, Et_2O, –98 °C, 79%, 89% *ee*; *b*) 1. TESOTf, 2,6-lutidine, DCM, 0 °C to room temp., 84%; 2. O_3, PPh_3, CH_2Cl_2, –78 °C to room temp., 85%; *c*) 1. IPh_3PCH_2I, NaHMDS, HMPA, THF, –78 °C to room temp., 72%, *Z*/*E* >10:1; 2. CH≡CMgBr, $Pd(PPh_3)_4$, THF, room temp., 95%; *d*) TBAF, THF, 0 °C to room temp., 79%; *e*) $PdCl_2(PPh_3)_2$, CuI, **3**, Et_3N, DMF, room temp., 67% **18**, 81% **19**; *f*) 1 N LiOH, THF, room temp., quant. Ipc = Isopinocampheyl.

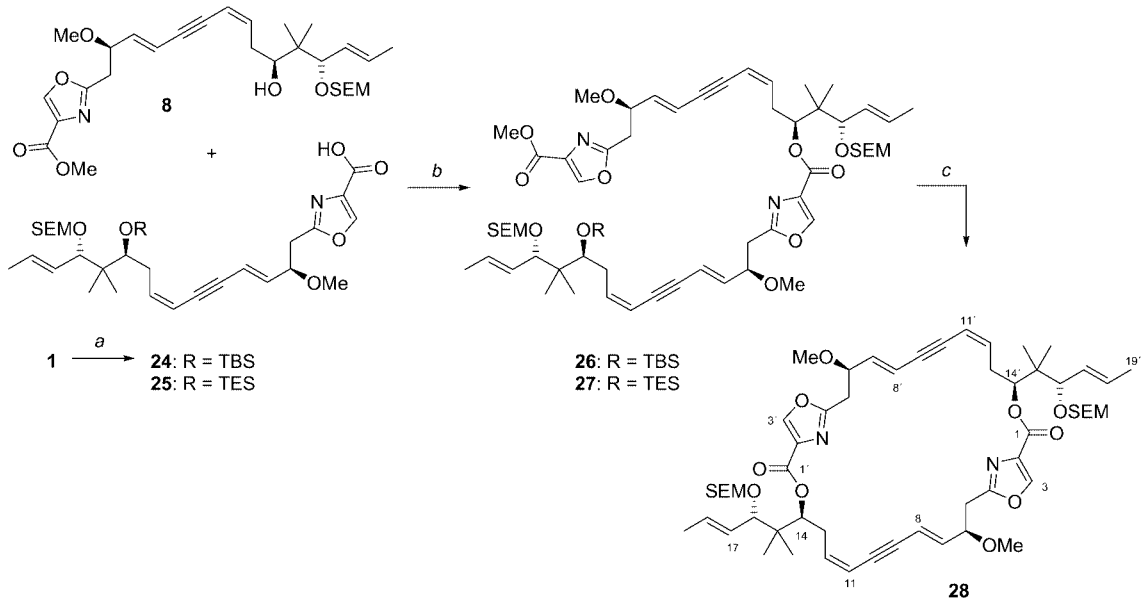
Negishi coupling with ethynylmagnesium bromide proceeded with retention of the double bond geometry yielding the free terminal alkyne **16** directly.[17] Finally, Sonogashira coupling with **3** under our standard conditions afforded the simplified southern segment **18**. Once again, Sonogashira coupling of the C14-unprotected enyne **17** was slightly higher yielding to give hydroxy ester **19**.

Treatment of **18** with aqueous lithium hydroxide in THF provided free oxazolecarboxylic acid **20**. In model studies, these fragments **19** and **20** were submitted to a variety of esterification conditions giving the open dimer **21** in at best 34% yield applying Yamaguchi's conditions (Scheme 8).

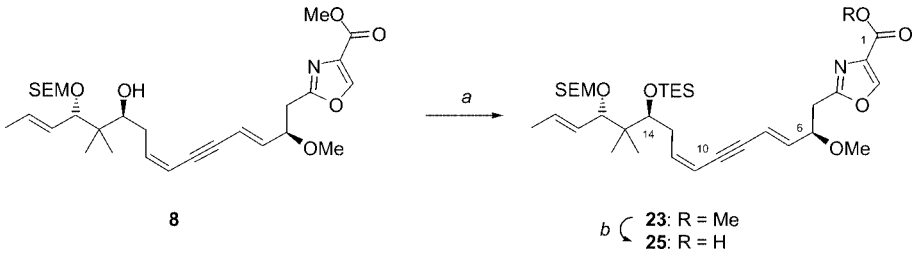
Removal of the triethylsilyl group in **21** with buffered TBAF and chemoselective saponification of the methyl ester with barium hydroxide in the presence of the internal ester linkage[18] led to the dimeric hydroxy acid which under Yamaguchi conditions was macrocyclized to **22** in 35% yield. The macrocycle thus synthesized serves not only as a



Scheme 8. Cyclisation to the simplified analogue. Reaction conditions: *a*) $Cl_3C_6H_2COCl$, Et_3N, DMAP, toluene, room temp., 8 h, 34%; *b*) 1. TBAF, AcOH/ H_2O (1:1), THF, room temp., 86%; 2. $Ba(OH)_2$, H_2O, MeOH, THF, room temp., quant.; 3. $Cl_3C_6H_2COCl$, Et_3N, DMAP, toluene, room temp., 35%.



Scheme 9. Synthesis of a disorazole C_1 analogue. Reaction conditions: *a*) 1 N LiOH, THF, room temp., quant.; *b*) For **24**: DPTC, DMAP, toluene, reflux, 45%; for **25**: **25**, $Cl_3C_6H_2COCl$, Et_3N, toluene, room temp.; **8**, DMAP, toluene, 40 °C, 69%; *c*) 1. **27**, TBAF, AcOH, H_2O, THF, room temp., 87%; no reaction for **26**; 2. $Ba(OH)_2$, H_2O, MeOH, THF, room temp., quant.; 3. $Cl_3C_6H_2COCl$, Et_3N, DMAP, toluene, 40 °C, 31%.



Scheme 10. Protecting group manipulation. Reaction conditions: *a*) TESOTf, 2,6-lutidine, DMAP, CH_2Cl_2, –40 °C to –20 °C, 85%; *b*) 1 N LiOH, THF, room temp., quant.

model for our cyclization studies but also provides an entry into SAR studies.

We next turned our attention to effecting the stepwise dimerization of the full C1–C19 system. A TBS-protected dimer **26** was prepared starting from alcohol **8** and carboxylic acid **24** in 45% yield applying DPTC/DMAP[7a] (Scheme 9).

In the subsequent deprotection step we encountered difficulties removing the TBS group. Either the substrate decomposed or it did not react at all what brought us to change the TBS ether to the more labile TES ether (Scheme 10).

From this methyl ester **23** the oxazole carboxylic acid **25** was liberated with a lithium hydroxide solution in THF (Scheme 10). The crude acid was then submitted to esterification conditions. Simple activation of the acid with trichlorobenzoyl chloride/Et_3N followed by slow addition to the C14 alcohol **8** furnished the ester **27** in only 35% yield. Generally, under various conditions some of the starting alcohol **8** could be reisolated but no acid, implying that the activated acid decomposes significantly before being able to react.

The TES-protected derivative **25** and alcohol **8** were esterified with greatly improved efficiency by portionwise activation of the acid yielding **27** in 69% isolated yield (Scheme 9). The triethylsilyl ether in **27** could then be cleaved with buffered TBAF delivering the corresponding alcohol in respectable 87% yield.

Selective saponification of the terminal methyl ester in the presence of the internal ester linkage was again quantitatively achieved with aqueous barium hydroxide in THF/MeOH. Finally, the dimeric seco acid was submitted to Yamaguchi lactonization giving the macrodiolide **28** in 31% yield. As shown by Wipf and Graham the tetradehydro analogue can be efficiently transformed to disorazole C_1 under Lindlar conditions.[7c]

3. Conclusion

Our flexible and modular strategy allows the synthesis of six different disorazole hydroxy acid precursors[6] and the completion of the synthesis of the disorazole C_1 macrocycle. The threefold role of the C9–C10 triple bond is noteworthy:

Firstly, a rigid structural element is introduced thus suppressing any unproductive intramolecular cyclizations. The appropriate positioning (C9–C10 vs. C11–C12) was guided by molecular mechanics. Secondly, its presence provides us with a retrosynthetic handle allowing for a convergent Sonogashira cross coupling. Finally, it causes an obvious stabilizing effect on the monomeric ω-hydroxy acids by blocking electrocyclizations. Late stage diversification is feasible and our modular retrosynthetic design offers the opportunity for an entry into SAR studies.

The disorazoles – especially the non-C_2-symmetric members – remain a prime target for synthetic organic chemists. Besides posing a significant synthetic challenge, the non-symmetric macrodiolide skeleton of disorazole A_1 reminds us of the rather unexplored biosynthetic origin of such structural features, which add an additional level of complexity to the structural space present in polyketide natural products.

Experimental Section

Infrared spectra were recorded on a Perkin–Elmer 1710 infrared spectrometer. ^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker AVS 400 and Bruker AVM 500 spectrometer in deuterated chloroform or acetone with tetramethylsilane as internal standard when indicated. ^{1}H NMR chemical shifts are reported in parts per million (ppm) downfield from tetramethylsilane (δ = 0 ppm) as internal standard or in relation to $CDCl_3$ (δ = 7.26 ppm). The following abbreviations are used to describe spin multiplicity: s = singlet, br. s = broad singlet, d = doublet, t = triplet, q = quadruplet, m = multiplet, dd = doublet of doublets, etc. Coupling constants (*J*) are reported in Hertz (Hz). ^{13}C NMR spectra were fully decoupled with chemical shifts reported relative to the solvent signal ($CDCl_3$, 77.0 ppm). Signal assignments are based on DEPT and – if necessary – on additional ^{1}H-^{1}H-COSY and HMQC experiments. The numbering of carbon and hydrogen signals refers to the numbering of the natural product. Mass spectra were performed on a Finnigan MAT 312 (70 eV), a VG Autospec (HR-MS) spectrometer or with a Micromass LCT with lock-spray unit (ESI-MS).

Oxazolyl-alkyne 5: Oxalyl chloride (0.30 mL, 3.49 mmol, 1.5 equiv.) and DMSO (0.50 mL, 6.98 mmol, 3.0 equiv.) in CH_2Cl_2 (6 mL) were cooled to –78 °C, stirred for 10 min and afterwards oxazole alcohol **4** (500 mg, 2.33 mmol, 1.0 equiv.) in CH_2Cl_2 (3.0 mL) was added. After 30 min Et_3N (1.29 mL, 9.30 mmol, 4.0 equiv.) was added. The reaction mixture was stirred for 3 h at –78 °C while its progress was monitored by GC. After complete oxidation, Ohira–Bestmann reagent (893 mg, 4.65 mmol, 2.0 equiv.) was dissolved in MeOH (5 mL) in a separate flask and treated at 0 °C with K_2CO_3 (1.93 g, 13.95 mmol, 6.0 equiv.). This suspension was stirred for 10 min and then the chilled reaction mixture (–40 °C) of the Swern oxidation was transferred to this flask using MeOH (3 mL) for rinse. The mixture was allowed to reach room temperature and after 18 h satd. NH_4Cl solution was added and the aqueous layer was extracted with MTBE. The combined organic layers were dried (Na_2SO_4) and the solvent was evaporated. Purification of the crude product by flash chromatography afforded alkyne **5** (364 mg, 75% over two steps) as colorless, viscous oil. $[\alpha]_D^{20}$ = +21.4 (*c* = 0.87, $CHCl_3$). IR (neat): $\tilde{\nu}$ = $\tilde{\nu}$ = 3248, 3117, 2995, 2935, 2112, 1719, 1583, 1453, 1435, 1323, 1272, 1200, 1163, 1097, 1060, 995, 928, 850, 811, 775 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.17 (s, 1 H, H-3), 4.49 (ddd, *J* = 7.8, 6.2, 2.1 Hz, 1 H, H-6), 3.91 (s, 3 H, CO_2CH_3), 3.41 (s, 3 H, OCH_3), 3.28 (dd, *J* = 15.2, 7.8 Hz, 1 H, H_a-5), 3.21 (dd, *J* = 15.2, 6.2 Hz, 1 H, H_b-5), 2.49 (d, *J* = 2.1 Hz, 1 H, H-8). ^{13}C NMR: (100 MHz, $CDCl_3$): δ = 160.87, 160.86 (C_q, C-4, C-1), 143.39 (CH, C-3), 132.74 (C_q, C-2), 79.72 (CH, C-6), 74.45 (C_q, C-7), 67.58 (CH, C-8), 55.90 (CH_3, OCH_3), 51.38 (CH_3, CO_2CH_3), 34.09 (CH_2, C-5). MS (room temp.): *m*/*z* (%) = 209 (3, [M$^+$]), 208 (6, [M$^+$ – 1]), 194 (46), 178 (38), 166 (37), 146 (10), 69 (100). HR-MS: *m*/*z* calcd. for $C_{10}H_{10}NO_4$: 208.0610, found: 208.0613.

(*E*)-Oxazolyl-vinyl Iodide 3: The (1,3-oxazolyl)alkyne **5** (120 mg, 0.574 mmol, 1.0 equiv.) and $Pd(PPh_3)_4$ (3 mg, 0.002 mmol, 0.004 equiv.) were dissolved in THF (5.7 mL) and treated with Bu_3SnH (0.19 mL, 0.69 mmol, 1.2 equiv.) at room temp. After 2 h the reaction mixture was cooled to –20 °C and I_2 (204 mg, 0.804 mmol, 1.4 equiv.) in THF (5 mL) was added dropwise to the reaction mixture keeping the temperature between –20 °C and –15 °C. The resulting mixture was warmed to room temperature. After 1 h the mixture was treated with satd. KF solution. The aqueous phase was extracted with MTBE and the combined organic layers were washed with satd. $Na_2S_2O_3$ solution. This was re-extracted with MTBE and the combined organic layers were dried (Na_2SO_4). The solvent was evaporated and the residue was purified by chromatography furnishing **3** (170 mg, 88%) as colorless wax. $[\alpha]_D^{20}$ = –9.1 (*c* = 1.59, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 2931, 2825, 1734, 1583, 1436, 1343, 1314, 1206, 1136, 1096, 1004, 1004, 936, 806, 769 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.15 (s, 1 H, H-3), 6.48–6.40 (m, 2 H, H-7, H-8), 4.09 (dtd, *J* = 7.7, 6.0, 0.7 Hz, 1 H, H-6), 3.89 (s, 3 H, CO_2CH_3), 3.26 (s, 3 H, OCH_3), 3.07 (dd, *J* = 15.1, 7.7 Hz, 1 H, H_a-5), 2.98 (dd, *J* = 15.1, 5.8 Hz, 1 H, H_b-5). ^{13}C NMR (100 MHz, $CDCl_3$): 162.01, 161.53 (C_q, C-4, C-1), 144.34, 143.97 (CH, C-7, C-3), 133.36 (C_q, C-2), 81.09 (CH, C-8), 80.07 (CH, C-6), 56.84 (CH_3, OCH_3), 52.08 (CH_3, CO_2CH_3), 33.89 (CH_2, C-5). MS (70 °C): *m*/*z* (%) = 337 (5, [M$^+$]), 306 (37), 210 (46), 197 (100), 178 (36), 159 (3), 141 (41), 109 (5), 71 (35). HR-MS: *m*/*z* calcd. for $C_{10}H_{12}NO_4I$: 336.9811, found: 336.9810.

TBS-Protected Enyne 2: $PdCl_2(PPh_3)_2$ (137 mg, 0.195 mmol, 0.1 equiv.) and CuI (74 mg, 0.39 mmol, 0.2 equiv.) were dissolved in CH_3CN (15 mL) and stirred for 20 min at room temp. To this vinyl iodide **6** (1.083 g, 1.95 mmol, 1.0 equiv.) in CH_3CN (5 mL), TMS-acetylene (0.55 mL, 3.90 mmol, 2.0 equiv.) and, after 20 min, Et_3N (5.44 mL, 39.0 mmol, 20.0 equiv.) were added successively. After 5 h at room temp. the reaction mixture was hydrolyzed with satd. NH_4Cl solution. The aqueous phase was extracted with MTBE, the organic phases were dried (Na_2SO_4) and the solvent was evaporated. Flash chromatography afforded TMS-protected alkyne (1011.7 mg, 99%).

This TMS-protected enyne (1.0 g, 1.9 mmol, 1.0 equiv.) in THF (20 mL) was treated with TBAF (2.1 mL, 1 M solution in THF, 2.1 mmol, 1.1 equiv.) at 0 °C and was afterwards allowed to reach room temp. After 4 h at room temp. the reaction mixture was hydrolyzed with H_2O and the aqueous phase was extracted with MTBE. The combined organic layers were dried (Na_2SO_4) and the crude product was purified by flash chromatography to give **2** (14.0 mg, 81%) as colorless oil together with 89 mg of **7** (14%). $[\alpha]_D^{20}$ = +35.0 (*c* = 1.16, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 3313, 2953, 2928, 2884, 2856, 2099, 1668, 1614, 1471, 1379, 1361, 1249, 1189, 1146, 1080, 1029, 973, 936, 858, 831, 772, 693, 668, 636, 604 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS): δ = 6.17 (dtd, *J* = 11.0, 7.0, 0.7 Hz, 1 H, H-12), 5.67 (dq, *J* = 15.3, 6.5 Hz, 1 H, H-18), 5.47 (dq [= ddd], *J* = 10.9, 1.76 Hz, 1 H, H-11), 5.35 (ddq, *J* = 15.3, 9.1, 1.7 Hz, 1 H, H-17), 4.56–4.70 (m, 2 H, OCH_2OSEM), 3.87 (d, *J* = 9.2 Hz, 1 H, H-16), 3.65–3.76 (m, 2 H, H-14, H_a-

OCH_2CH$_2$TMS), 3.48–3.56 (m, 1 H, H$_b$-OCH_2CH$_2$TMS), 3.12 (dd, J = 1.7, 0.7 Hz, 1 H, H-9), 2.56–2.60 (m, 2 H, H-13), 1.75 (dd, J = 6.5, 1.6 Hz, 3 H, H-19), 0.90–0.94 (m, 2 H, OCH$_2$CH_2TMS), 0.94 (s, 3 H, Me), 0.93 [s, 9 H, SiC(CH_3)$_3$] 0.87 (s, 3 H, Me′), 0.07 (s, 3 H, SiCH_3), 0.06 (s, 3 H, SiCH_3′), 0.03 [s, 9 H, Si(CH_3)$_{3,SEM}$]. ^{13}C NMR (100 MHz, CDCl$_3$, TMS): 144.44 (CH, C-12), 130.85 (CH, C-18), 127.89 (CH, C-17), 108.28 (CH, C-11), 91.75 (CH$_2$, OCH_2O$_{SEM}$), 81.69 (Cq, C-10), 81.43 (CH, C-16), 80.79 (CH, C-9), 75.79 (CH, C-14), 65.05 (CH$_2$, OCH_2CH$_2$TMS), 43.26 (Cq, C-15), 34.34 (CH$_2$, C-13), 26.11 [CH$_3$, SiC(CH_3)$_3$], 20.17 (CH$_3$, Me), 19.50 (CH$_3$, Me′), 18.35 [C$_q$, SiC(CH$_3$)$_3$], 18.12 (CH$_2$, OCH$_2$CH_2TMS), 17.86 (CH$_3$, C-19), –1.44 [CH$_3$, Si(CH_3)$_3$], –3.43 (CH$_3$, SiC$H_{3,TBS}$), –4.26 (CH$_3$, SiC$H_{3,TBS}$). MS (110 °C): m/z (%) = 452 (1, [M$^+$]), 395 (2), 394 (1), 388 (2), 387 (3), 367 (3), 365 (2), 357 (3), 337 (4), 319 (18), 318 (29), 317 (42), 289 (11), 271 (28), 270 (20), 269 (33), 251 (29), 242 (19), 241 (33), 233 (28), 209 (99), 201 (41), 147 (56), 143 (99), 73 (100). HR-MS: m/z calcd. for C$_{21}$H$_{39}$O$_3$Si$_2$: 395.2438 (M$^+$ – tBu), found: 395.2438.

PMB-Protected Aldehyde 15: Homoallyl alcohol **14** (690 mg, 2.61 mmol, 1.0 equiv.) in CH$_2$Cl$_2$ (5.3 mL) was cooled to 0 °C, 2,6-lutidine (0.61 mL, 5.23 mmol, 2.0 equiv.) was added, followed by the dropwise addition of TESOTf (0.71 mL, 3.14 mmol, 1.2 equiv.). After 30 min at 0 °C and 4 h at room temp. the reaction mixture was hydrolyzed with satd. NaHCO$_3$ solution. The aqueous layer was extracted with MTBE, the combined organic layers were dried (Na$_2$SO$_4$) and the solvents were removed. The crude product was purified by flash chromatography furnishing the TES-protected alcohol (825 mg, 84%) as a colorless oil. This alcohol (800 mg, 2.12 mmol, 1.0 equiv.) was dissolved in CH$_2$Cl$_2$ (15 mL), cooled to –78 °C and a drop of Sudan red was added. O$_3$ was bubbled through this solution until the indicator turned colorless. For additional few minutes oxygen was passed through the mixture. Finally, PPh$_3$ (998 mg, 3.81 mmol, 1.8 equiv.) was added and the reaction mixture was warmed to room temp. After 2 h the solvent was removed and the residue was purified by flash chromatography affording aldehyde **15** (649 mg, 85%) as colorless oil. $[a]_D^{20}$ = –3.7 (c = 1.14, CHCl$_3$). IR (neat): $\tilde{\nu}$ = 2955, 2875, 1725, 1612, 1513, 1462, 1414, 1361, 1301, 1245, 1172, 1085, 1005, 820, 725 cm^{-1}. ^{1}H NMR (400 MHz, CDCl$_3$, TMS): δ = 9.52 (dd, J = 2.8, 1.9 Hz, 1 H, H-12), 7.98 (d, J = 8.6 Hz, 2 H, PMB), 6.63 (d, J = 8.6 Hz, 2 H, PMB), 4.16 (d, J = 11.7 Hz, 1 H, H$_a$-PMPCH_2), 4.08 (d, J = 11.7 Hz, 1 H, H$_b$-PMPCH_2), 3.99 (dd, J = 6.2, 4.9 Hz, 1 H, H-14) 3.56 (s, 3 H, CH_3OPh), 2.95 (d, J = 8.8 Hz, 1 H, H$_a$-16), 2.87 (d, J = 8.8 Hz, 1 H, H$_b$-16), 2.38 (ddd, J = 16.6, 4.9, 1.8 Hz, 1 H, H$_a$-13), 2.23 (ddd, J = 16.5, 6.1, 2.8, 1 H, H$_b$-13), 0.69 [t, J = 7.8 Hz, 9 H, Si(CH$_2$CH_3)$_3$], 0.66 (s, 3 H, Me), 0.61 (s, 3 H, Me′), 0.34 [q, J = 7.8 Hz, 6 H, Si(CH_2CH$_3$)$_3$]. ^{13}C NMR (100 MHz, CDCl$_3$, TMS): δ = 202.22 (CH, C-12), 159.04 (C$_q$, COCH$_{3,PMB}$), 130.62 (C$_q$, CCH$_{2,PMB}$), 129.05 (CH, PMB), 113.65 (CH, PMB), 76.26 (CH$_2$, C-16), 72.71 (CH$_2$, PMPCH$_2$), 71.69 (CH, C-14), 55.23 (CH$_3$, CH_3OPh), 48.04 (CH$_2$, C-13), 39.76 (C$_q$, C-15), 21.35 (CH$_3$, Me), 21.02 (CH$_3$, Me′), 6.95 [CH$_3$, Si(CH$_2$CH_3)$_3$], 5.18 [CH$_2$, Si(CH$_2$CH$_3$)$_3$]. ESI-MS: m/z calcd. for C$_{21}$H$_{36}$NaO$_4$Si: 403.2281, found: 403.2279.

PMB-Protected Enyne 16: Freshly prepared IPPh$_3$CH$_2$I[16] (1.27 g, 2.4 mmol, 1.6 equiv.) was suspended in THF (5 mL) and NaHMDS (1.2 mL, 2 M solution in THF, 2.4 mmol, 1.6 equiv.) was added dropwise at room temp. until a clear, orange-red solution was formed. After 10 min at room temp. HMPA (45 μL) was added and the reaction mixture was cooled to –78 °C. Afterwards, aldehyde **15** (570 mg, 1.5 mmol, 1.0 equiv.) in THF (4 mL) was added slowly and the mixture was stirred for additional 30 min at –78 °C. After warming to room temp. the reaction mixture was hydrolyzed with satd. NH$_4$Cl solution. The aqueous layer was extracted with MTBE, the combined organic layers were dried (Na$_2$SO$_4$) and the solvent was evaporated. Purification by chromatography yielded the Z-configured vinyl iodide (544 mg, 72%) as colorless oil. This vinyl iodide (507 mg, 1.01 mmol, 1.0 equiv.) in THF (5 mL) was added to Pd(PPh$_3$)$_4$ (58 mg, 0.05 mol, 0.05 equiv.). Ethynylmagnesium bromide (3 mL, 0.5 M solution in THF, 1.51 mmol, 1.5 equiv.) was dropped slowly into this mixture. After 2 h at room temp. the reaction mixture was diluted with MTBE and hydrolyzed with satd. NH$_4$Cl solution. The aqueous layer was extracted with MTBE and the combined organic phases were dried (Na$_2$SO$_4$). After removal of the solvents the residue was purified by flash chromatography and enyne **16** (393 mg, 95%) was obtained as colorless oil. $[a]_D^{20}$ = –6.1 (c = 0.79, CHCl$_3$). IR (neat): $\tilde{\nu}$ = 3292, 2954, 2875, 2097, 1612, 1512, 1463, 1434, 1415, 1359, 1301, 1245, 1172, 1085, 1036, 1007, 821, 739 cm^{-1}. ^{1}H NMR (400 MHz, CDCl$_3$, TMS): δ = 7.24 (d, J = 8.7 Hz, 2 H, PMB), 6.86 (d, J = 8.7 Hz, 2 H, PMB), 6.15 (dt, J = 10.9, 7.2 Hz, 1 H, H-12), 5.46 (dd, J = 10.9, 1.8 Hz, 1 H, H-11), 4.43 (d, J = 11.8 Hz, 1 H, H$_a$-PMPCH_2), 4.37 (d, J = 11.8 Hz, 1 H, H$_b$-PMPCH_2), 3.80 (s, 3 H, CH_3OPh), 3.79 (dd, J = 6.4, 4.6 Hz, 1 H, H-14), 3.24 (d, J = 8.6 Hz, 1 H, H$_a$-16), 3.12 (d, J = 8.6 Hz, 1 H, H$_b$-16), 3.07 (d, J = 1.8 Hz, 1 H, H-9), 2.58 (dddd, J = 15.3, 6.7, 4.7, 1.9 Hz, 1 H, H$_a$-13), 2.47 (dddd, J = 15.3, 7.6, 6.5, 1.2, 1 H, H$_b$-13), 0.94 [t, J = 7.9 Hz, 9 H, Si(CH$_2$CH_3)$_3$], 0.90 (s, 3 H, Me), 0.88 (s, 3 H, Me′), 0.58 [q, J = 7.9 Hz, 6 H, Si(CH_2CH$_3$)$_3$]. ^{13}C NMR (100 MHz, CDCl$_3$, TMS): δ = 158.97 (C$_q$, COCH$_{3,PMB}$), 144.53 (CH, C-12), 131.06 (C$_q$, CCH$_{2,PMB}$), 128.95 (CH, PMB), 113.63 (CH, PMB), 108.45 (CH, C-11), 81.63 (CH, C-9), 80.67 (C$_q$, C-10), 77.03 (CH$_2$, C-16), 75.82 (CH, C-14), 72.80 (CH$_2$, PMPCH$_2$), 55.24 (CH$_3$, CH_3OPh), 40.21 (C$_q$, C-15), 34.32 (CH$_2$, C-13), 21.46 (CH$_3$, Me), 20.99 (CH$_3$, Me′), 7.06 [CH$_3$, Si(CH$_2$CH_3)$_3$], 5.39 [CH$_2$, Si(CH$_2$CH$_3$)$_3$].

PMB-Protected Hydroxy Enyne 17: TES-protected enyne **16** (195 mg, 0.49 mmol, 1.0 equiv.) was dissolved in THF (2 mL) and treated with concd. AcOH (0.1 mL), H$_2$O (0.1 mL) and TBAF·H$_2$O (723 mg, 2.45 mmol, 5.0 equiv.). After 2 d at room temp. the reaction mixture was diluted with MTBE and H$_2$O. The aqueous layer was extracted with MTBE and the combined organic layers were dried (Na$_2$SO$_4$). The solvent was evaporated and the crude residue was purified by flash chromatography furnishing alcohol **17** (111 mg, 79%) as colorless oil. $[a]_D^{20}$ = –42.5 (c = 1.10, CHCl$_3$). IR (neat): $\tilde{\nu}$ = 3469, 3288, 2958, 2860, 2095, 1612, 1512, 1465, 1418, 1360, 1301, 1245, 1173, 1076, 1033, 819, 736 cm^{-1}. ^{1}H NMR (400 MHz, CDCl$_3$, TMS): δ = 7.23 (d, J = 8.5 Hz, 2 H, PMB), 6.87 (d, J = 8.7 Hz, 2 H, PMB), 6.23 (dtd, J = 10.9, 7.5, 0.5 Hz, 1 H, H-12), 5.54 (ddd, J = 10.9, 3.7, 1.6 Hz, 1 H, H-11), 4.44 (s, 2 H, PMPCH_2), 3.80 (s, 3 H, CH_3OPh), 3.53 (dt, J = 10.0, 3.1 Hz, 1 H, H-14), 3.38 (d, J = 8.9 Hz, 1 H, H$_a$-16), 3.36–3.33 (m, 1 H, OH), 3.28 (d, J = 8.6 Hz, 1 H, H$_b$-16), 3.08 (d, J = 1.9 Hz, 1 H, H-9), 2.58 (dddd, J = 14.5, 7.5, 2.5, 1.7 Hz, 1 H, H$_a$-13), 2.33 (dddd, J = 14.5, 10.1, 7.0, 1.4, 1 H, H$_b$-13), 0.94 (s, 6 H, Me, Me′). ^{13}C NMR (100 MHz, CDCl$_3$, TMS): δ = 159.31 (C$_q$, COCH$_{3,PMB}$), 144.05 (CH, C-12), 129.90 (C$_q$, CCH$_{2,PMB}$), 129.21 (CH, PMB), 113.82 (CH, PMB), 109.15 (CH, C-11), 81.53 (C$_q$, C-10), 80.58 (CH, C-9), 79.50 (CH$_2$, C-16), 78.29 (CH, C-14), 73.32 (CH$_2$, PMPCH$_2$), 55.27 (CH$_3$, CH_3OPh), 38.44 (C$_q$, C-15), 33.14 (CH$_2$, C-13), 22.85 (CH$_3$, Me), 19.73 (CH$_3$, Me′). ESI-MS: m/z calcd. for C$_{18}$H$_{24}$NaO$_3$: 311.1623, found: 311.1616.

General Procedure for the Sonogashira Coupling: PdCl$_2$(PPh$_3$)$_2$ and CuI were dissolved in degassed DMF in an atmosphere of Ar and stirred for 10 min. The vinyl iodide in degassed DMF and Et$_3$N were added and the mixture is stirred for additional 10 min at room temp. Finally, the enyne compound in DMF was added and the

reaction mixture was stirred at room temp. until completion was indicated by TLC. The mixture was hydrolyzed with satd. NH_4Cl solution. The aqueous phase was extracted with MTBE and the combined organic layers were dried (Na_2SO_4). After evaporation of the solvent the residue was purified by flash chromatography.

PMB-Protected (7*E*,11*Z*)-Hydroxydienyne 19: Following the general procedure for the Sonogashira coupling vinyl iodide **3** (130 mg, 0.385 mmol, 1.0 equiv.) and enyne **17** (111 mg, 0.385 mmol, 1.0 equiv.) in DMF (1.2 mL each) were allowed to react in the presence of $PdCl_2(PPh)_2$ (14 mg, 0.019 mmol, 0.05 equiv.) and CuI (7 mg, 0.039 mmol, 0.1 equiv.) in DMF (1.2 mL) and Et_3N (1.0 mL). The reaction was complete after 5 h at room temp. After general workup hydroxy-dienyne **19** (156 mg, 81%) was obtained as colorless oil. $[\alpha]_D^{20}$ = –43.3 (*c* = 1.14, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 3469, 2931, 2851, 1743, 1612, 1584, 1513, 1463, 1438, 1344, 1322, 1302, 1246, 1199, 1171, 1139, 1097, 1033, 1004, 956, 807, 762 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS): δ = 8.16 (s, 1 H, H-3), 7.23 (d, *J* = 8.5 Hz, 2 H, PMB), 6.87 (d, *J* = 8.7 Hz, 2 H, PMB), 6.18 (dt, *J* = 10.8, 7.3 Hz, 1 H, H-12), 5.96 (dd, *J* = 15.8, 7.3 Hz, 1 H, H-7), 5.86 (dd, *J* = 15.8, 2.1 Hz, 1 H, H-8), 5.66 (dd, *J* = 10.8, 1.8 Hz, 1 H, H-11), 4.44 (s, 2 H, PMPCH_2), 4.19–4.14 (m, 1 H, H-6), 3.90 (s, 3 H, CO_2CH_3), 3.80 (s, 3 H, CH_3OPh), 3.54 (dd, *J* = 10.0, 2.5 Hz, 1 H, H-14), 3.38 (d, *J* = 8.9 Hz, 1 H, H_a-16), 3.36–3.33 (m, 1 H, OH), 3.31 (d, *J* = 8.9 Hz,1 H, H_b-16), 3.26 (s, 3 H, CHOCH_3), 3.10 (dd, *J* = 15.1, 7.8 Hz, 1 H, H_a-5), 2.99 (dd, *J* = 15.1, 5.6, 1 H, H_b-5), 2.56 (dddd, *J* = 14.5, 7.5, 2.6, 1.6 Hz, 1 H, H_a-13), 2.31 (dddd, *J* = 14.4, 10.1, 7.0, 1.3, 1 H, H_b-13), 0.95 (s, 3 H, Me), 0.94 (s, 3 H, Me′). ^{13}C NMR (100 MHz, $CDCl_3$, TMS): δ = 162.36, 161.57 (C_q, C-1, C-4), 159.24 (C_q, $COCH_{3,PMB}$), 143.92 (CH, C-3), 142.61 (CH, C-12), 140.15 (CH, C-7), 133.31 (C_q, C-2), 129.81 (C_q, $CCH_{2,PMB}$), 129.11 (CH, PMB), 113.80 (CH, PMB), 113.70 (CH, C-8), 109.15 (CH, C-11), 90.99, 88.06 (C_q, C-9, C-10), 79.45 (CH_2, C-16), 79.15 (CH, C-6), 78.29 (CH, C-14), 73.24 (CH_2, PMPCH_2), 56.74 (CH_3, CHOCH_3), 55.20 (CH_3, CH_3OPh), 52.03 (CH_3, CO_2CH_3), 38.43 (C_q, C-15), 34.49 (CH_2, C-5), 33.18 (CH_2, C-13), 22.77 (CH_3, Me), 19.60 (CH_3, Me′). ESI-MS: *m*/*z* calcd. for $C_{28}H_{35}NNaO_7$: 520.2311, found: 520.2306.

PMB,TES-Protected (7*E*,11*Z*)-Dienyne 18: Following the general procedure for the Sonogashira coupling, the oxazolyl-vinyl iodide **3** (152 mg, 0.452 mmol, 1.05 equiv.) and the enyne **16** (173 mg, 0.430 mmol, 1.0 equiv.) in DMF (1.5 mL each) were allowed to react in the presence of $PdCl_2(PPh)_2$ (15 mg, 0.022 mmol, 0.05 equiv.) and CuI (8 mg, 0.043 mmol, 0.1 equiv.) in DMF (1.5 mL) and Et_3N (1.2 mL). The reaction was complete after 3 h at room temp. General workup afforded TES-protected dienyne **18** (176 mg, 67%) as colorless oil. $[\alpha]_D^{20}$ = –31.4 (*c* = 0.70, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 2952, 2875, 1748, 1612, 1584, 1513, 1437, 1322, 1246, 1199, 1170, 1138, 1091, 1034, 1004, 956, 806, 725 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS): δ = 8.15 (s, 1 H, H-3), 7.24 (d, *J* = 8.5 Hz, 2 H, PMB), 6.86 (d, *J* = 8.7 Hz, 2 H, PMB), 6.10 (dt, *J* = 10.8, 7.3 Hz, 1 H, H-12), 5.96 (dd, *J* = 15.9, 7.3 Hz, 1 H, H-7), 5.86 (dd, *J* = 15.9, 2.1 Hz, 1 H, H-8), 5.58 (dq, *J* = 10.8, 1.7 Hz, 1 H, H-11), 4.42 (d, *J* = 11.7 Hz, 1 H, H_a-PMPCH_2), 4.37 (d, *J* = 11.7 Hz, 1 H, H_b-PMPCH_2), 4.19–4.14 (m, 1 H, H-6), 3.90 (s, 3 H, CO_2CH_3), 3.80 (s, 3 H, CH_3OPh), 3.78 (dd, *J* = 6.3, 4.6 Hz, 1 H, H-14), 3.27 (s, 3 H, CHOCH_3), 3.11 (d, *J* = 8.5 Hz, 2 H, H-16), 3.09 (dd, *J* = 15.1, 7.8 Hz, 1 H, H_a-5), 2.98 (dd, *J* = 15.1, 5.6, 1 H, H_b-5), 2.57 (dddd, *J* = 15.3, 6.8, 4.7, 1.9 Hz, 1 H, H_a-13), 2.44 (dddd, *J* = 15.3, 7.3, 6.7, 1.0, 1 H, H_b-13), 0.94 [t, *J* = 7.9 Hz, 9 H, Si(CH_2CH_3)$_3$], 0.90 (s, 3 H, Me), 0.89 (s, 3 H, Me′), 0.58 [q, *J* = 7.9 Hz, 6 H, Si(CH_2CH_3)$_3$]. ^{13}C NMR (100 MHz, $CDCl_3$, TMS): δ = 162.46, 161.66 (C_q, C-1, C-4), 158.99 (C_q, PMB), 143.98 (CH, C-3), 143.17 (CH, C-12), 140.16 (CH, C-7), 133.40 (C_q, C-2), 131.04 (C_q, PMB), 128.94 (CH, PMB), 113.80 (CH, C-8), 113.65 (CH, PMB), 109.25 (CH, C-11), 91.17, 88.30 (C_q, C-9, C-10), 79.25 (CH, C-6), 77.04 (CH_2, C-16), 75.94 (CH, C-14), 72.82 (CH_2, PMPCH_2), 56.80 (CH_3, CHOCH_3), 55.26 (CH_3, CH_3OPh), 52.10 (CH_3, CO_2CH_3), 40.27 (C_q, C-15), 34.58, 34.53 (CH_2, C-5, C-13), 21.62 (CH_3, CH_3), 20.90 (CH_3, CH_3′), 7.10 [CH_3, Si(CH_2CH_3)$_3$], 5.40 [CH_2, Si(CH_2CH_3)$_3$]. ESI-MS: *m*/*z* calcd. for $C_{34}H_{49}NNaO_7Si$: 634.3176, found: 634.3184.

General Procedure for Saponification of the Methyl Ester: The methyl ester was dissolved in THF and slowly treated with a LiOH solution (1 M *in* H_2O) at room temp. The mixture was stirred until completion of the reaction and afterwards adjusted to a pH value of 2–3 with 1 N HCl. After addition of MTBE and separation of phases the aqueous phase was extracted with MTBE (6×). The combined organic layers were dried (Na_2SO_4) and the solvent was evaporated. The crude acid was generally used directly in the next step without further purification.

TES-Protected Dimer 21: Following the general saponification procedure methyl ester **18** (81 mg, 0.133 mmol, 1.0 equiv.) in THF (1.3 mL) was treated with LiOH (0.27 mL, 1 M solution in H_2O, 0.265 mmol, 2.0 equiv.). The mixture was stirred for 4 h at room temp. The crude acid was dissolved in toluene (1 mL) and to this solution was added 2,4,6-trichlorobenzoyl chloride (72 mg, 0.296 mmol) and Et_3N (33 mg, 0.327 mmol) in toluene (1.5 mL). After 45 min at room temp. the activated acid was added at room temp. to a solution of **17** (68 mg, 0.137 mmol, 1.03 equiv.) and DMAP (49 mg, 0.398 mmol, 3.0 equiv.) in toluene (1 mL) over a period of 70 min. After the addition was complete the reaction mixture was stirred for another 5 hours. The mixture was hydrolyzed with satd. $NaHCO_3$ solution and diluted with MTBE. The aqueous phase was extracted with MTBE and the organic phases were dried (Na_2SO_4). The solvent was removed and the crude product was purified by flash chromatography yielding dimer **21** (50 mg, 34%) as colorless oil, together with 25 mg of a mixture consisting of alcohol and dimer. $[\alpha]_D^{20}$ = +13.8 (*c* = 1.49, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 2954, 2875, 1740, 1612, 1584, 1513, 1463, 1440, 1357, 1318, 1246, 1200, 1170, 1137, 1095, 1034, 1005, 956, 821, 760, 736 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS): δ = 8.17, 7.99 (s, 2 H, H-3, H-3′), 7.25–7.22 (m, 4 H, PMB), 6.88–6.83 (m, 4 H, PMB), 6.09 (dt, *J* = 10.6, 7.2 Hz, 1 H, H-12$_{OTES}$), 5.98 (dd, *J* = 15.9, 7.2 Hz, 1 H, H-7/H-7′), 5.97 (dd, *J* = 15.9, 7.3 Hz, 1 H, H-7/H-7′), 5.99–5.96 (m, 1 H, H-12$_{ester}$), 5.88 (dd, *J* = 15.8, 2.1 Hz, 1 H, H-8/H-8′), 5.86 (dd, *J* = 15.9, 1.7 Hz, 1 H, H-8/H-8′), 5.60 (dq, *J* = 10.8, 1.8 Hz, 2 H, H-11, H-11′), 5.31 (dd, *J* = 9.6, 3.6 Hz, 1 H, H-14$_{ester}$), 4.44–4.35 (m, 2 H, PMPCH_2), 4.37 (s, 2 H, PMPCH_2′), 4.19–4.14 (m, 2 H, H-6, H-6′), 3.91 (s, 3 H, CO_2CH_3), 3.80, 3.79 (s, 6 H, CH_3OPh, CH_3OPh′), 3.80–3.77 (m, 1 H, H-14$_{OTES}$), 3.27, 3.26 (s, 6 H, CHOCH_3, CHOCH_3′), 3.28–3.24 (m, 1 H, H_a-16), 3.22–3.20 (m, 2 H, H-16′), 3.13–3.05 (m, 3 H, H_b-16, H_a-5, H_a-5′), 3.00 (dd, *J* = 15.1, 5.8 Hz, 1 H, H_b-5/H_b-5′), 2.96 (dd, *J* = 15.2, 5.3, 1 H, H_b-5/H_b-5′), 2.75–2.63 (m, 2 H, H-13$_{ester}$), 2.61–2.54 (m, 1 H, H_a-13$_{OTES}$), 2.49–2.41 (m, 1 H, H_b-13$_{OTES}$), 0.94 [t, *J* = 8.0 Hz, 9 H, Si(CH_2CH_3)$_3$], 1.02, 1.00, 0.90, 0.89 (s, 12 H, 4 Me), 0.58 [q, *J* = 8.1 Hz, 6 H, Si(CH_2CH_3)$_3$. ^{13}C NMR (100 MHz, $CDCl_3$, TMS): 162.41, 162.39, 161.63, 160.70 (C_q, C-1, C-1′, C-4, C-4′), 159.07, 158.99 (C_q, $COCH_{3,PMB}$, $COCH_{3,PMB'}$), 144.02, 143.54 (CH, C-3, C-3′), 143.13 (CH, C-12$_{OTES}$), 140.51, 140.23 (CH, C-7, C-7′), 133.41 (C_q, C-2, C-2′), 131.04, 130.57 (C_q, $CCH_{2,PMB}$, $CCH_{2,PMB'}$), 129.17, 128.94 (CH, PMB, PMB′), 113.58, 113.87 (CH, C-8, C-8′), 113.88, 113.66 (CH, PMB, PMB′), 111.06, 109.24 (CH, C-11, C-11′), 91.37, 91.24, 88.26, 87.92 (C_q, C-9, C-9, C-10′, C-10′), 79.23, 79.14 (CH, C-6, C-6′), 76.34 (CH_2, C-16, C-16′), 77.24, 75.93 (CH, C-14, C-14′), 72.99, 72.82 (CH_2, PMPCH_2, PMPCH_2′), 56.88,

56.76 (CH_3, CHOCH_3, CHOCH_3'), 55.28, 55.24 (CH_3, CH_3OPh, CH_3OPh′), 52.11 (CH_3, CO_2CH_3), 40.27, 39.08 (C_q, C-15, C-15′), 34.61, 34.58, 34.55, 34.53 (CH_2, C-5, C-5′, C-13, C-13′),], 21.62, 21.40, 21.21, 20.91 (CH_3, 4 Me), 7.10 [CH_3, Si(CH_2CH_3)$_3$], 5.40 [CH_2, Si(CH_2CH_3)$_3$]. ESI-MS: *m/z* calcd. for $C_{61}H_{81}N_2O_{13}Si$: 1077.5508, found: 1077.5525.

PMB-Protected Tetradehydro-Dimer 22: TES-Dimer **21** (50 mg 0.046 mmol, 1.0 equiv.) was dissolved in THF (0.5 mL) and treated with concd. AcOH (13 μL, 0.232 mmol, 5.0 equiv.), 1 drop of H_2O and TBAF (0.46 mL, 1 M solution in THF, 0.464 mmol, 10.0 equiv.). After stirring for 3 d at room temp. the reaction mixture was diluted with H_2O and MTBE. The phases were separated and the aqueous phase was extracted with MTBE. The combined organic layers were dried (Na_2SO_4) and the solvent was evaporated. Purification of the crude residue by flash chromatography gave the hydroxy dimer (38.4 mg, 86%) as slightly yellow oil. $[\alpha]_D^{20}$ = –2.9 [*c* = 0.55, $(CH_3)_2CO$]. IR (neat): $\tilde{\nu}$ = 3480, 2932, 1738, 1612, 1584, 1513, 1464, 1440, 1362, 1316, 1302, 1246, 1200, 1170, 1138, 1098, 1034, 1005, 956, 820, 760, 735 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS): δ = 8.46, 8.40 (s, 2 H, H-3, H-3′), 7.29–7.25 (m, 4 H, PMB), 6.91–6.87 (m, 4 H, PMB), 6.20 (ddd, *J* = 10.5, 7.9, 6.7 Hz, 1 H, H-12$_{OH}$), 6.08 (dd, *J* = 15.9, 7.0 Hz, 1 H, H-7/H-7′), 6.06 (dd, *J* = 15.9, 6.8 Hz, 1 H, H-7/H-7′), 6.00–5.96 (m, 3 H, H-12$_{ester}$, H-8, H8′), 5.66–5.64 (m, 2 H, H-11, H-11′), 5.26 (dd, *J* = 7.2, 6.0 Hz, 1 H, H-14$_{ester}$), 4.43 (s, 2 H, PMBCH_2), 4.40–4.36 (m, 2 H, PMPCH_2'), 4.24–4.19 (m, 2 H, H-6, H-6′), 3.82 (s, 3 H, CO_2CH_3), 3.79, 3.78 (s, 6 H, CH_3OPh, CH_3OPh′), 3.63 (d, *J* = 4.6 Hz, 1 H, OH), 3.57–3.52 (m, 1 H, H-14$_{OH}$), 3.39 (d, *J* = 8.9 Hz, 1 H, H$_a$-16), 3.30–3.29 (m, 2 H, H-16′), 3.29 (d, *J* = 8.9 Hz, 1 H, H$_b$-16), 3.25, 3.24 (s, 6 H, CHOCH_3, CHOCH_3'), 3.10–2.97 (m, 4 H, H-5, H-5′), 2.72–2.69 (m, 2 H, H-13$_{ester}$), 2.63 (dddd, *J* = 14.4, 7.9, 2.5, 1.6 Hz, 1 H, H$_a$-13$_{OH}$), 2.28 (dddd, *J* = 14.4, 10.0, 6.5, 1.4 Hz, 1 H, H$_b$-13$_{OH}$), 1.02, 1.01, 0.94, 0.93 (s, 12 H, 4 Me). ^{13}C NMR (100 MHz, $CDCl_3$, TMS): δ = 162.94, 162.89 (C_q, C-4, C-4′), 161.85, 160.98 (C_q, C-1, C-1′), 159.94, 159.93 (C_q, COCH$_{3,PMB}$), 145.22, 145.10 (CH, C-3, C-3′), 143.97 (CH, C-12$_{OH}$), 142.07, 141.70 (CH, C-7, C-7′), 141.06 (CH, C-12$_{ester}$), 134.00, 133.88 (C_q, C-2, C-2′), 131.49, 131.34 (C_q, CCH$_{2,PMB}$), 129.77, 129.61 (CH, PMB), 114.26, 114.21 (CH, PMB), 113.64, 113.48 (CH, C-8, C-8′), 111.45, 109.89 (CH, C-11, C-11′), 92.40, 91.89, 88.34, 87.88 (C_q, C-9, C-9′, C-10, C-10′), 79.38 (CH, C-6, C-6′), 78.42 (CH_2, C-16/C-16′), 77.34 (CH, C-14/C-14′), 76.87 (CH_2, C-16/C-16′), 76.64 (CH, C-14/C-14′), 73.40, 73.34 (CH_2, PMPCH_2, PMPCH_2'), 56.66, 56.62 (CH_3, CHOCH_3, CHOCH_3'), 55.28, 55.27 (CH_3, CH_3OPh, CH_3OPh′), 51.69 (CH_3, CO_2CH_3), 39.61, 39.56 (C_q, C-15, C-15′), 34.58, 34.52 (CH_2, C-5, C-5′), 33.77, 31.65 (CH_2, C-13, C-13′), 21.93, 21.55, 21.25, 20.55 (CH_3, 4 Me). ESI-MS: *m/z* calcd. for $C_{55}H_{66}N_2NaO_{13}$: 985.4463, found: 985.4487.

The hydroxy dimer (prepared as above) was dissolved in THF (1 mL) and cooled to 0 °C. To this a $Ba(OH)_2$ solution [0.6 mL of a satd. solution of $Ba(OH)_2$ in MeOH/H_2O, 3:2, v/v] was added. The reaction mixture was allowed to reach room temp. and stirred for 3 h. For workup the mixture was acidified with 1 N HCl and diluted with MTBE. The aqueous phase was extracted with MTBE. The combined organic layers were dried (Na_2SO_4) and the solvent was evaporated. The crude residue was used directly in the next step. A stock solution of 2,4,6-trichlorobenzoyl chloride (48 mg, 0.197 mmol) and Et_3N (22 mg, 0.218 mmol) in toluene (1 mL) was prepared. From this 0.6 mL were added to the crude acid in toluene (1.2 mL) at room temp. After 1 h the mixture was diluted with toluene (1.6 mL) and added at room temp. to DMAP (19 mg, 0.158 mmol, 4.0 equiv.) in toluene (8 mL) over a period of 5 h. Stirring was continued for additional 24 h. Afterwards, the mixture was hydrolyzed with satd. $NaHCO_3$ solution. The aqueous phase was extracted with MTBE and the combined organic layers were dried (Na_2SO_4). After evaporation of the solvents the residue was purified by flash chromatography yielding dimer **22** (13 mg, 35%) as colorless foam. $[\alpha]_D^{20}$ = –107.5 (*c* = 0.40, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 2927, 2854, 1737, 1612, 1584, 1513, 1464, 1358, 1303, 1246, 1171, 1138, 1097, 1035, 989, 956, 820, 753 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS): δ = 8.00 (s, 2 H, H-3, H-3′), 7.24 (d, *J* = 8.7 Hz, 4 H, PMB), 6.85 (d, *J* = 8.7 Hz, 4 H, PMB), 5.97 (dd, *J* = 15.9, 7.7 Hz, 2 H, H-12, H-12′), 5.96 (dt, *J* = 10.5, 5.2 Hz, 2 H, H-7, H-7′), 5.65 (ddd, *J* = 16.0, 2.3, 0.8 Hz, 2 H, H-8/H-8′), 5.52 (dm, *J* = 10.5 Hz, 2 H, H-11, H-11′), 5.35 (dd, *J* = 11.04, 2.3 Hz, 2 H, H-14, H-14′), 4.40–4.36 (m, 4 H, PMBCH_2), 4.12 (dddd, *J* = 9.8, 7.7, 3.9, 0.9 Hz, 2 H, H-6, H-6′), 3.79 (s, 6 H, CH_3OPh, CH_3OPh′), 3.35 (s, 6 H, CHOCH_3, CHOCH_3'), 3.30–3.29 (m, 2 H, H$_a$-5, H$_a$-5′), 3.20 (s, 4 H, H-16, H-16′), 3.00 (dd, *J* = 14.2, 9.8 Hz, 2 H, H$_b$-5, H$_b$-5′), 2.93 (dt, *J* = 13.4, 10.8 Hz, 2 H, H$_a$-13), 2.38–2.33 (m, 2 H, H$_b$-13), 1.03, 1.01 (s, 12 H, 4 Me). ^{13}C NMR (100 MHz, $CDCl_3$, TMS): δ = 161.62 (C_q, C-4, C-4′), 161.60 (C_q, C-1, C-1′), 159.07 (C_q, COCH$_{3,PMB}$, COCH$_{3,PMB'}$), 143.34 (CH, C-3, C-3′), 141.10, 140.23 (CH, C-12, C-12′, C-7, C-7′), 133.56 (C_q, C-2, C-2′), 130.50 (C_q, CCH$_{2,PMB}$, CCH$_{2,PMB'}$), 129.13 (CH, PMB), 113.67 (CH, PMB), 113.55 (CH, C-8, C-8′), 111.99 (CH, C-11, C-11′), 90.82, 87.80 (C_q, C-9, C-9′, C-10, C-10′), 79.58 (CH, C-6, C-6′), 77.20 (CH, C-14, C-14′), 76.31 (CH_2, C-16, C-16′), 73.00 (CH_2, PMPCH_2, PMPCH_2'), 56.86 (CH_3, CHOCH_3, CHOCH_3'), 55.23 (CH_3, CH_3OPh, CH_3OPh′), 38.86 (C_q, C-15, C-15′), 34.37 (CH_2, C-5, C-5′), 31.14 (CH_2, C-13, C-13′), 21.26, 21.20 (CH_3, 4 Me). ESI-MS: *m/z* calcd. for $C_{54}H_{62}N_2NaO_{12}$: 953.4200, found: 953.4221.

(11*Z*,18*E*)-Hydroxyenyne 7: TBS ether **2** (200 mg, 0.44 mmol, 1.0 equiv.) in THF (4.5 mL) was cooled to 0 °C and TBAF (4.5 mL, 1 M solution in THF, 10.0 equiv.) was added dropwise. The reaction mixture was warmed to room temp. and stirred for 24 h. MTBE and H_2O were added and after separation of the phases the aqueous layer was extracted with MTBE. After drying (Na_2SO_4) the solvent was evaporated and the residue was purified by flash chromatography. The alcohol **7** was obtained as a colorless oil (143 mg, 95%). $[\alpha]_D^{20}$ = +18.9 (*c* = 0.85, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 3486, 3312, 2953, 2882, 2097, 1668, 1468, 1380, 1249, 1191, 1145, 1095, 1022, 973, 921, 858, 833, 759, 738, 693 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 6.26 (dddd, *J* = 10.8, 8.0, 6.3, 0.9 Hz, 1 H, H-12), 5.66 (dqd, *J* = 15.3, 6.5, 0.7 Hz, 1 H, H-18), 5.53 (ddt, *J* = 10.9, 2.3, 1.5 Hz, 1 H, H-11), 5.39 (ddq, *J* = 15.3, 8.6, 1.6 Hz, 1 H, H-17), 4.64 (d, *J* = 6.8 Hz, 1 H, H$_a$-OCH_2O$_{SEM}$), 4.57 (d, *J* = 6.8 Hz, 1 H, H$_b$-OCH_2O$_{SEM}$), 3.90 (d, *J* = 8.5 Hz, 1 H, H-16), 3.78–3.71 (m, 1 H, H$_a$-TMSCH$_2$CH_2O$_{SEM}$), 3.69–3.64 (m, 2 H, H-14, OH), 3.51–3.44 (m, 1 H, H$_b$-TMSCH$_2$CH_2O$_{SEM}$), 3.09 (dd, *J* = 2.3, 0.8 Hz, 1 H, H-9), 2.61–2.54 (m, 1 H, H$_a$-13), 2.35–2.27 (m, 1 H, H$_b$-13), 1.74 (dd, *J* = 6.4, 1.6 Hz, 3 H, H-19), 0.96–0.91 (m, 2 H, TMSCH_2CH$_2$O$_{SEM}$), 0.89 (s, 3 H, Me), 0.86 (s, 3 H, Me′), 0.01 [s, 9 H, Si(CH_3)$_{3,SEM}$]. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 144.57 (CH, C-12), 131.45 (CH, C-18), 126.93 (CH, C-17), 108.75 (CH, C-11), 92.02 (CH_2, OCH_2O), 84.42 (CH, C-16), 81.45 (C_q, C-10), 80.58 (CH, C-9), 75.67 (CH, C-14), 65.91 (CH_2, TMSCH$_2$CH_2O$_{SEM}$), 40.85 (C_q, C-15), 32.43 (CH_2, C-13), 20.67 (CH_3, Me), 19.30 (CH_3, Me′), 18.10 (CH_2, TMSCH_2CH$_2$O$_{SEM}$), 17.87 (CH_3, C-19), –1.49 [CH_3, Si(CH_3)$_{3,SEM}$]. ESI-MS: *m/z* calcd. for $C_{19}H_{34}NaO_3Si$: 361.2175, found: 361.2187.

(7*E*,11*Z*,18*E*)-Hydroxydienyne 8: Following the general procedure for the Sonogashira coupling $PdCl_2(PPh_3)_2$ (19 mg, 0.027 mmol, 0.05 equiv.) and CuI (10 mg, 0.054 mmol, 0.10 equiv.) were dissolved in DMF (2.0 mL). Oxazol vinyl iodide **3** (183 mg,

0.544 mmol, 1.00 equiv.) in DMF (2.0 mL) and Et_3N (1.2 mL) were added followed by addition of enyne **7** (184 mg, 0.544 mmol, 1.00 equiv.) in DMF (2.0 mL). The reaction was complete after 6 h at room temp. General workup gave **8** (267 mg, 89%) as a colorless oil. $[\alpha]_D^{20}$ = –26.7 (*c* = 1.21, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 3497, 2951, 1748, 1585, 1437, 1323, 1196, 1167, 1139, 1104, 1008, 859, 835, 763 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 8.14 (s, 1 H, H-3), 6.20 (ddd, *J* = 10.8, 8.2, 6.4 Hz, 1 H, H-12), 5.95 (dd, *J* = 15.9, 7.3 Hz, 1 H, H-7), 5.86 (dd, *J* = 15.9, 2.1 Hz, 1 H, H-8), 5.68–5.61 (m, 2 H, H-11, H-18), 5.39 (ddt, *J* = 15.3, 8.6, 1.6, 1 H, H-17), 4.62 (d, *J* = 6.8 Hz, 1 H, H_a-OCH_2O), 4.56 (d, *J* = 6.8 Hz, 1 H, H_b-OCH_2O), 4.18–4.13 (m, 1 H, H-6), 3.89 (d, *J* = 8.4 Hz, 1 H, H-16), 3.89 (s, 3 H, CO_2CH_3), 3.77–3.70 (m, 1 H, H_a-OCH_2CH_2TMS), 3.67–3.64 (m, 1 H, H-14), 3.50–3.44 (m, 1 H, H_b-OCH_2CH_2TMS), 3.26 (s, 3 H, OCH_3), 3.09 (dd, *J* = 14.9, 7.9 Hz, 1 H, H_a-5), 2.98 (dd, *J* = 14.9, 5.6 Hz, 1 H, H_b-5), 2.57–2.52 (m, 1 H, H_a-13), 2.31–2.23 (m, 1 H, H_b-13), 1.73 (dd, *J* = 6.3, 1.5 Hz, 3 H, H-19), 0.95–0.84 (m, 2 H, CH_2TMS), 0.88 (s, 3 H, CH_3), 0.84 (s, 3 H, CH_3'), –0.004 [s, 9 H, $Si(CH_3)_3$]. ^{13}C NMR (100 MHz, $CDCl_3$): 162.41, 161.59 (C_q, C-4, CO_2CH_3), 143.92 (CH, C-3), 143.23 (CH, C-12), 140.09 (CH, C-7), 133.38 (C_q, C-2), 131.34 (CH, C-11/C-18), 127.03 (CH, C17), 113.79 (CH, C-8), 109.50 (CH, C-11/C-18), 92.11 (CH_2, OCH_2O), 90.99, 88.17 (C_q, C-9, C-10), 84.38 (CH, C-16), 79.21 (CH, C-6), 75.77 (CH, C-14), 65.90 (CH_2, OCH_2CH_2TMS), 56.75 (CH_3, OCH_3), 52.02 (CH_3, CO_2CH_3), 40.96 (C_q, C-15), 34.56 (CH_2, C-5), 32.56 (CH_2, C-13), 20.62, 19.25 (CH_3, Me, Me′), 18.11 (CH_2, CH_2CH_2TMS), 17.80 (CH_3, C-19), –1.29 [CH_3, $Si(CH_3)_{3,SEM}$]. ESI-MS: *m*/*z* calcd. for $C_{29}H_{45}NNaO_7Si$: 570.2863, found: 570.2883.

TES-Protected (7*E*,11*Z*,18*E*)-Dienyne 23: Alcohol **8** (145 mg 0.265 mmol, 1.0 equiv.) in CH_2Cl_2 (1.8 mL) was cooled to –40 °C. 2,6-Lutidine (71 μL, 0.609 mmol, 2.3 equiv.) was added followed by the dropwise addition of TESOTf (96 μL, 0.424 mmol, 1.6 equiv.). The reaction mixture was stirred for 1.5 h keeping it between –40 and –15 °C. Finally, the mixture was hydrolyzed at –20 °C with satd. $NaHCO_3$ solution. After warming to room temp. the aqueous phase was extracted with MTBE and the combined organic layers were dried (Na_2SO_4). The solvents were evaporated. Flash chromatography afforded **23** (149 mg, 85%) as slightly yellow oil. $[\alpha]_D^{20}$ = –8.8 (*c* = 1.03, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 2952, 2877, 1752, 1585, 1437, 1323, 1248, 1196, 1166, 1138, 1099, 1029, 1005, 859, 835, 737 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 8.18 (s, 1 H, H-3), 6.05 (dt, *J* = 10.8, 7.4 Hz, 1 H, H-12), 5.98 (dd, *J* = 15.8, 7.3 Hz, 1 H, H-7), 5.88 (dd, *J* = 15.8, 2.1 Hz, 1 H, H-8), 5.61 (dq, *J* = 15.4, 6.5 Hz, 1 H, H-18), 5.58 (dm, *J* = 10.8 Hz, 1 H, H-11), 5.32 (ddq, *J* = 15.4, 9.0, 1.8, 1 H, H-17), 4.65 (d, *J* = 6.7 Hz, 1 H, H_a-OCH_2O), 4.54 (d, *J* = 6.7 Hz, 1 H, H_b-OCH_2O), 4.19–4.14 (m, 1 H, H-6), 3.89 (s, 3 H, CO_2CH_3), 3.82 (d, *J* = 9.0 Hz, 1 H, H-16), 3.74–3.66 (m, 1 H, H_a-OCH_2CH_2TMS), 3.66 (dd, *J* = 7.0, 3.8 Hz, 1 H, H-14), 3.55–3.48 (m, 1 H, H_b-OCH_2CH_2TMS), 3.25 (s, 3 H, OCH_3), 3.12 (dd, *J* = 15.1, 7.9 Hz, 1 H, H_a-5), 3.01 (dd, *J* = 15.1, 5.6 Hz, 1 H, H_b-5), 2.54 (dddd, *J* = 15.1, 7.3, 3.8, 1.8 Hz, 1 H, H_a-13), 2.41 (dtd, *J* = 15.1, 7.4, 1.3 Hz, 1 H, H_b-13), 1.72 (dd, *J* = 6.4, 1.4 Hz, 3 H, H-19), 0.96 [t, *J* = 8.0 Hz, 9 H, $Si(CH_2CH_3)_3$], 0.94–0.90 (m, 2 H, CH_2CH_2TMS), 0.92 (s, 3 H, Me), 0.86 (s, 3 H, Me′), 0.61 [q, *J* = 8.0 Hz, 6 H, $Si(CH_2CH_3)_3$], 0.02 [s, 9 H, $Si(CH_3)_3$]. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 162.45, 161.61 (C_q, C-4, C-1), 143.95 (CH, C-12), 143.03 (CH, C-3), 140.22 (CH, C-7), 133.38 (C_q, C-2), 130.52 (CH, C-11/C-18), 128.08 (CH, C-17), 113.76 (CH, C-8), 109.29 (CH, C-11/C-18), 91.82 (CH_2, OCH_2O), 91.04, 88.30 (C_q, C-9, C-10), 81.45 (CH, C-16), 79.25 (CH, C-6), 76.10 (CH, C-14), 65.06 (CH_2, OCH_2CH_2TMS), 56.76 (CH_3, OCH_3), 52.02 (CH_3, CO_2CH_3), 43.08 (C_q, C-15), 34.58 (CH_2, C-5), 34.39 (CH_2, C-13), 19.71, 19.31 (CH_3, Me, Me′), 18.09 (CH_2, CH_2CH_2TMS), 17.81 (CH_3, C-19), 7.07 [CH_3, $Si(CH_2CH_3)_3$], 5.59 [CH_2, $Si(CH_2CH_3)_3$], –1.21 [CH_3, $Si(CH_3)_{3,SEM}$]. ESI-MS: *m*/*z* calcd. for $C_{35}H_{59}NNaO_7Si_2$: 684.3728, found: 684.3734.

TBS-Protected Dimer 26: Following the general procedure for methyl ester saponification ester **1** (31 mg, 0.046 mmol, 1.0 equiv.) was saponified during 4 h. After workup the crude acid was used directly in the next step. Alcohol **8** (25 mg, 0.046 mmol, 1.0 equiv.) and acid **24** were dissolved in toluene (0.6 mL) and treated with DPTC (17 mg, 0.074 mmol, 1.6 equiv.) and a crystal of DMAP. The reaction mixture was refluxed for 36 h. After cooling to room temp. MTBE was added, followed by silica gel and evaporation to dryness. Flash chromatography furnished **26** (19 mg, 45%) as a colorless oil. $[\alpha]_D^{20}$ = +35.6 (*c* = 0.94, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 2929, 2884, 1742, 1583, 1464, 1437, 1360, 1320, 1249, 1196, 1168, 1137, 1101, 1026, 972, 955, 858, 833, 760, 693 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 8.17, 8.06 (s, 2 H, H-3, H-3′), 6.08 (dt, *J* = 10.8, 7.2 Hz, 1 H, H-12_{OTBS}), 6.01 (dd, *J* = 15.9, 6.7 Hz, 1 H, H-7/H-7′), 5.95 (dd, *J* = 16.0, 6.8 Hz, 1 H, H-7/H-7′), 5.91 (dd, *J* = 15.7, 2.4 Hz, 1 H, H-8/H-8′), 5.94–5.89 (m, 1 H, H-12_{ester}), 5.87 (dd, *J* = 15.8, 2.2 Hz, 1 H, H-8/H-8′), 5.64 (dq, *J* = 15.3, 6.2 Hz, 2 H, H-18, H-18′), 5.59–5.54 (m, 2 H, H-11, H-11′), 5.38 (ddq, *J* = 15.3, 9.1, 1.5, 1 H, H-17/H-17′), 5.33 (ddq, *J* = 15.3, 9.1, 1.5 Hz, 1 H, H-17/H-17′), 5.22 (dd, *J* = 7.3, 5.6 Hz, 1 H, H-14_{ester}), 4.64 (d, *J* = 6.7 Hz, 2 H, H-OCH_2O), 4.54 (d, *J* = 6.9 Hz, 1 H, H_a-OCH_2O'), 4.50 (d, *J* = 6.9 Hz, 1 H, H_b-OCH_2O'), 4.21–4.16 (m, 2 H, H-6, H-6′), 3.90 (s, 3 H, CO_2CH_3), 3.85 (d, *J* = 9.0 Hz, 1 H, H-16_{OTBS}), 3.75 (d, *J* = 8.9 Hz, 1 H, H-16_{ester}), 3.73–3.63 (m, 3 H, H_a-OCH_2CH_2TMS, H_a-OCH_2CH_2TMS', H-14_{OTBS}), 3.53–3.46 (m, 2 H, H_b-OCH_2CH_2TMS, H_b-OCH_2CH_2TMS'), 3.28, 3.27 (s, 6 H, OCH_3, OCH_3'), 3.11 (dd, *J* = 15.1, 7.7 Hz, 1 H, H_a-5), 3.07 (dd, *J* = 15.3, 8.0 Hz, 1 H, H_b-5), 3.00 (dd, *J* = 15.0, 5.7 Hz, 1 H, H_a-5′), 2.97 (dd, *J* = 15.2, 5.2 Hz, 1 H, H_b-5′): 2.69–2.65 (m, 2 H, H-13_{ester}), 2.55–2.51 (m, 2 H, H-13_{OTBS}), 1.73–1.69 (m, 6 H, H-19, H-19′), 1.02, 0.97, 0.91, 0.84, (s, 12 H, 4 Me), 0.94–0.83 (m, 4 H, OCH_2CH_2TMS, OCH_2CH_2TMS'), 0.90 [s, 9 H, $SiC(CH_3)_{3,TBS}$], 0.05 (s, 3 H, $SiCH_{3,TBS}$), 0.04 (s, 3 H, $SiCH_{3'TBS}$), –0.003 [s, 18 H, 2×$Si(CH_3)_{3,SEM}$]. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 162.46, 162.38 (C_q, C-4, C-4′), 161.59 (C_q, C-1_{OTBS}), 160.65 (C_q, C-1_{ester}), 143.97, 143.46 (CH, C-3, C-3′), 142.99 (CH, C-12_{OTBS}), 140.56, 140.38 (CH, C-7, C-7′), 140.18 (CH, C-12_{ester}), 133.57, 133.44 (C_q, C-2, C-2′), 131.39 (CH, C-18_{ester}), 130.57 (CH, C-18_{OTBS}), 128.09, 127.36 (CH, C-17, C-17′), 113.63, 113.53 (CH, C-8, C-8′), 110.98 (CH, C-11_{ester}), 109.05 (CH, C-11_{OTBS}), 91.96, 91.85 (CH_2, OCH_2O, OCH_2O'), 91.31, 91.22 (C_q, C-9, C-9′), 88.32, 87.92 (C_q, C-10, C-10′), 81.66 (CH, C-16_{ester}), 81.52 (CH, C-16_{OTBS}), 79.18 (CH, C-6, C-6′), 77.20 (CH, C-14_{ester}), 75.91 (CH, C-14_{OTBS}), 65.33, 65.05 (CH_2, OCH_2CH_2TMS, OCH_2CH_2TMS'), 56.83, 56.77 (CH_3, OCH_3, OCH_3'), 52.05 (CH_3, CO_2CH_3), 43.28 (C_q, C-15_{OTBS}), 41.81 (C_q, C-15_{ester}), 34.66, 34.56 (CH_2, C-5, C-5′), 34.56 (CH_2, C-13_{OTBS}), 31.30 (CH_2, C-13_{ester}), 26.11 [CH_3, $SiC(CH_3)_3$], 20.16, 19.91, 19.56, 19.37 (CH_3, 4 Me), 18.33 [C_q, $SiC(CH_3)_3$], 18.10, 18.06 (CH_2, CH_2CH_2TMS, CH_2CH_2TMS'), 17.85 (CH_3, C-19, C-19′), –1.43, –1.44 [CH_3, $Si(CH_3)_{3,SEM}$, $Si(CH_3)_{3,SEM'}$], –3.42 (CH_3, $SiCH_{3,TBS}$), –4.29 (CH_3, $SiCH_{3,TBS'}$). ESI-MS: *m*/*z* calcd. for $C_{63}H_{100}N_2NaO_{13}Si_3$: 1199.6431, found: 1199.6454.

TES-Protected Dimer 27: Following the general procedure for methyl ester saponification, the TES-protected ester **23** (50 mg, 75.6 μmol, 1.0 equiv.) in THF (1 mL) was saponified during 3 h using aqueous LiOH solution (0.23 mL, 1 M in H_2O, 226.9 μmol, 3.0 equiv.). After general workup the crude acid was used directly in the next step. For the next step a stock solution of 2,4,6-trichlorobenzoyl chloride (64 mg, 262.5 μmol, 3.5 equiv.) and Et_3N

(30 mg, 288.8 μmol, 3.8 equiv.) in toluene (1.5 mL) was prepared. The crude acid was dissolved in toluene (1 mL). From this solution one portion (0.2 mL) was transferred to a separate flask and treated dropwise with the above prepared stock solution (0.3 mL). After 45 min at room temp. the activated acid was added to a 40 °C warm solution of alcohol **8** (37 mg, 67.5 μmol, 0.9 equiv.) and DMAP (27 mg, 225 μmol, 3.0 equiv.) in toluene (1 mL) over 45 min using a perfusor. This procedure was repeated four times using the carboxylic acid solution (0.2 mL each). After complete addition of the last portion of activated acid the reaction mixture was stirred for an additional 2 h at 40 °C before being diluted with MTBE and hydrolyzed with satd. NH_4Cl solution. The aqueous phase was extracted with MTBE, the combined organic layers were dried (Na_2SO_4) and the solvents were evaporated. Purification by flash chromatography yielded **27** (55 mg, 69%) as a colorless oil. $[\alpha]_D^{20}$ = +35.5 (*c* = 1.45, $CHCl_3$). IR (neat): $\tilde{\nu}$ = 2952, 2878, 1745, 1584, 1438, 1322, 1197, 1167, 1137, 1103, 1028, 973, 859, 835, 761, 738 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 8.17, 8.14 (s, 2 H, H-3, H-3′), 6.05 (dt, *J* = 10.8, 7.4 Hz, 1 H, H-12$_{OTES}$), 6.00 (dd, *J* = 16.0, 7.0 Hz, 1 H, H-7′), 5.98 (dd, *J* = 15.9, 7.1 Hz, 1 H, H-7), 5.95–5.89 (m, 1 H, H-12$_{ester}$), 5.90 (dd, *J* = 15.8, 2.3 Hz, 1 H, H-8), 5.87 (dd, *J* = 15.9, 2.3 Hz, 1 H, H-8′), 5.63 (dq, *J* = 15.2, 6.4 Hz, 1 H, H-18), 5.60–5.53 (m, 3 H, H-11, H-11′, H-18′), 5.38 (ddq, *J* = 15.3, 9.0, 1.6, 1 H, H-17), 5.33 (ddq, *J* = 15.3, 8.8, 1.7 Hz, 1 H, H-17′), 5.22 (dd, *J* = 7.3, 5.6 Hz, 1 H, H-14$_{ester}$), 4.65 (d, *J* = 6.7 Hz, 1 H, H$_a$-OCH_2O), 4.55 (d, *J* = 6.7 Hz, 1 H, H$_b$-OCH_2O), 4.64 (d, *J* = 6.9 Hz, 1 H, H$_a$-OCH_2O′), 4.56 (d, *J* = 6.9 Hz, 1 H, H$_b$-OCH_2O′), 4.21–4.15 (m, 2 H, H-6, H-6′), 3.90 (s, 3 H, CO_2CH_3), 3.83 (d, *J* = 9.0 Hz, 1 H, H-16$_{OTES}$), 3.75 (d, *J* = 8.9 Hz, 1 H, H-16$_{ester}$), 3.73–3.63 (m, 3 H, H$_a$-OCH_2CH$_2$TMS, H$_a$-OCH_2CH$_2$TMS′, H-14$_{OTES}$), 3.53–3.46 (m, 2 H, H$_b$-OCH_2CH$_2$TMS, H$_b$-OCH_2CH$_2$TMS′), 3.27, 3.26 (s, 6 H, OCH_3, OCH_3′), 3.11 (dd, *J* = 15.1, 7.7 Hz, 1 H, H$_a$-5), 3.07 (dd, *J* = 15.8, 7.8 Hz, 1 H, H$_b$-5), 3.00 (dd, *J* = 15.0, 5.7 Hz, 1 H, H$_a$-5′), 2.97 (dd, *J* = 15.2, 5.1 Hz, 1 H, H$_b$-5′): 2.58–2.64 (m, 2 H, H-13$_{ester}$), 2.59–2.52 (m, 1 H, H$_a$-13$_{OTES}$), 2.46–2.38 (m, 1 H, H$_b$-13$_{OTES}$), 1.71–1.69 (m, 6 H, H-19, H-19′), 1.02, 0.96, 0.91, 0.84, (s, 12 H, 4 Me), 0.96–0.84 (m, 4 H, OCH$_2$CH_2TMS, OCH$_2$CH_2TMS′), 0.94 [t, *J* = 7.7 Hz, 9 H, Si(CH$_2$CH_3)$_3$], 0.59 [q, *J* = 7.8 Hz, 6 H, Si(CH_2CH$_3$)$_3$], –0.002 [s, 18 H, Si(CH_3)$_{3,SEM}$, Si(CH_3)$_{3,SEM′}$]. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 162.46, 162.37 (C$_q$, C-4, C-4′), 161.59 (C$_q$, C-1$_{OTES}$), 160.64 (C$_q$, C-1$_{ester}$), 143.98, 143.47 (CH, C-3, C-3′), 142.99 (CH, C-12$_{OTES}$), 140.52, 140.37 (CH, C-7, C-7′), 140.18 (CH, C-12$_{ester}$), 133.53, 133.41 (C$_q$, C-2, C-2′), 131.41 (CH, C-18$_{ester}$), 130.50 (CH, C-18$_{OTES}$), 128.13, 127.31 (CH, C-17, C-17′), 113.63, 113.54 (CH, C-8, C-8′), 110.98 (CH, C-11$_{ester}$), 109.31 (CH, C-11$_{OTES}$), 92.05, 92.01 (CH$_2$, OCH_2O, OCH_2O′), 91.29, 91.13 (C$_q$, C-9, C-9′), 88.27, 87.90 (C$_q$, C-10, C-10′), 81.63, 81.49 (CH, C-16, C-16′), 79.17 (CH, C-6, C-6′), 77.20 (CH, C-14$_{ester}$), 76.12 (CH, C-14$_{OTES}$), 65.32, 65.02 (CH$_2$, OCH_2CH$_2$TMS, OCH_2CH$_2$TMS′), 56.83, 56.77 (CH$_3$, OCH_3, OCH_3′), 52.08 (CH$_3$, CO_2CH_3), 43.10 (C$_q$, C-15$_{OTES}$), 41.79 (Cq, C-15$_{ester}$), 34.63, 34.55 (CH$_2$, C-5, C-5′), 34.42 (CH$_2$, C-13$_{OTES}$), 31.28 (CH$_2$, C-13$_{ester}$), 19.89, 19.73, 19.35, 19.32 (CH$_3$, 4 Me), 18.09, 18.05 (CH$_2$, CH$_2$CH_2TMS, CH$_2$CH_2TMS′), 17.86, 17.82 (CH$_3$, C-19, C-19′), 7.07 [CH$_3$, Si(CH$_2$CH_3)$_3$], 5.55 [CH$_2$, Si(CH_2CH$_3$)$_3$], –1.44, –1.45 [CH$_3$, Si(CH_3)$_{3,SEM}$, Si(CH_3)$_{3,SEM′}$]. ESI-MS: *m*/*z* calcd. for $C_{63}H_{100}N_2NaO_{13}Si_3$: 1199.6431, found: 1199.6429.

Tetradehydro-Dimer 28: The TES-dimer **27** (43 mg, 36.6 μmol, 1.0 equiv.) was dissolved in THF (1 mL) and treated with H_2O and concd. AcOH, two drops each. TBAF (0.55 mL, 1 M in THF, 549 μmol, 15.0 equiv.) was added at room temp. The reaction mixture was stirred 3 d at this temperature being afterwards diluted with H_2O and MTBE. After separation of the phases the aqueous layer was extracted with MTBE. The combined organic layers were dried (Na_2SO_4) and after removal of the solvent purification by flash chromatography gave the hydroxy dimer (34 mg, 87%) as a slightly yellow oil. $[\alpha]_D^{20}$ = +14.8 [*c* = 0.63, $(CH_3)_2CO$]. IR (neat): $\tilde{\nu}$ = 3505, 2951, 1741, 1584, 1437, 1317, 1248, 1196, 1168, 1137, 1102, 1023, 859, 834, 760 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 8.17, 8.05 (s, 2 H, H-3, H-3′), 6.20 (ddd, *J* = 10.8, 8.0. 6.2 Hz, 1 H, H-12$_{OH}$), 5.98 (dd, *J* = 15.9, 7.3 Hz, 1 H, H-7/H-7′), 5.97 (dd, *J* = 15.9, 7.3 Hz, 1 H, H-7/H-7′), 5.88 (dd, *J* = 15.9, 2.0 Hz, 1 H, H-8/H-8′), 5.87 (dd, *J* = 15.9, 2.1 Hz, 1 H, H-8/H-8′), 5.95–5.92 (m, 1 H, H-12$_{ester}$), 5.69–5.49 (m, 4 H, H-11, H-11′, H-18, H-18′), 5.39 (ddq, *J* = 15.2, 7.1, 1.5, 1 H, H-17/H-17′), 5.37 (ddq, *J* = 15.3, 7.9, 1.4, 1 H, H-17/H-17′), 5.21 (dd, *J* = 8.2, 4.8 Hz, 1 H, H-14$_{ester}$), 4.64 (d, *J* = 6.8 Hz, 1 H, H$_a$-OCH_2O), 4.63 (d, *J* = 6.7 Hz, 1 H, H$_a$-OCH_2O′), 4.56 (d, *J* = 6.7 Hz, 1 H, H$_b$-OCH_2O′), 4.48 (d, *J* = 6.8 Hz, 1 H, H$_b$-OCH_2O), 4.20–4.15 (m, 2 H, H-6, H-6′), 3.91–3.88 (m, 1 H, H-16/H-16′), 3.90 (s, 3 H, CO_2CH_3), 3.77–3.64 (m, 5 H, H-16/H-16′, H-14$_{OH}$, O*H*, H$_a$-OCH_2CH$_2$TMS, H$_a$-OCH_2CH$_2$TMS′), 3.52–3.43 (m, 2 H, H$_b$-OCH_2CH$_2$TMS, H$_b$-OCH_2CH$_2$TMS′), 3.27, 3.26 (s, 6 H, OCH_3, OCH_3′), 3.11 (dd, *J* = 15.1, 7.8 Hz, 1 H, H$_a$-5/ H$_a$-5′), 3.07 (dd, *J* = 15.1, 8.2 Hz, 1 H, H$_a$-5/ H$_a$-5′), 3.00 (dd, *J* = 15.1, 5.7 Hz, 1 H, H$_b$-5/H$_b$-5′), 2.97 (dd, *J* = 15.1, 5.3 Hz, 1 H, H$_b$-5/H$_b$-5′), 2.68–2.64 (m, 2 H, H-13$_{ester}$), 2.57–2.52 (m, 1 H, H$_a$-13$_{OH}$), 2.28 (dddd, *J* = 14.57, 9.99, 6.38, 1.52 Hz, 1 H, H$_b$-13$_{OH}$), 1.73 (dd, *J* = 6.5, 1.6 Hz, 3 H, H-19/H-19′), 1.70 (dd, *J* = 6.4, 1.6 Hz, 3 H, H-19/H-19′), 0.94–0.84 (m, 4 H, OCH$_2$CH_2TMS, OCH$_2$CH$_2$TMS′), 1.02, 0.95, 0.88, 0.85 (s, 12 H, 4 Me), 0.002 [s, 18 H, Si(CH_3)$_{3,SEM}$, Si(CH_3)$_{3,SEM′}$]. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 162.41, 162.36 (C$_q$, C-4, C-4′), 161.59 (C$_q$, C-1$_{OH}$), 160.63 (C$_q$, C-1$_{ester}$), 143.99, 143.48 (CH, C-3, C-3′), 143.22 (CH, C-12$_{OH}$), 140.51, 140.24 (CH, C-7, C-7′), 140.17 (CH, C-12$_{ester}$), 133.50, 133.38 (C$_q$, C-2, C-2′), 131.45, 131.41 (CH, C-18, C-18′), 127.26 (CH, C17$_{ester}$), 126.98 (CH, C-17$_{OH}$), 113.72, 113.55 (CH, C-8, C-8′), 111.00 (CH, C-11$_{ester}$), 109.50 (CH, C-11$_{OH}$), 92.07, 91.88 (CH$_2$, OCH_2O, OCH_2O′), 91.27, 91.04 (C$_q$, C-9, C-9′), 88.13, 87.90 (C$_q$, C-10, C-10′), 84.41 (CH, C-16$_{OH}$), 81.59 (CH, C-16$_{ester}$), 79.17 (CH, C-6, C-6′), 77.20 (CH, C-14$_{ester}$), 75.76 (CH, C-14$_{OH}$), 65.90, 65.30 (CH$_2$, OCH_2CH$_2$TMS), 56.84, 56.78 (CH$_3$, OCH_3, OCH_3′), 52.08 (CH$_3$, CO_2CH_3), 401.77 (C$_q$, C-15$_{ester}$), 40.95 (C$_q$, C-15$_{OH}$), 34.61, 34.54 (CH$_2$, C-5, C-5′), 32.55 (CH$_2$, C-13$_{OH}$), 31.25 (CH$_2$, C-13$_{ester}$), 20.68, 19.90, 19.33, 19.27 (CH$_3$, 4 Me), 18.11, 18.04 (CH$_2$, OCH$_2$CH_2TMS, OCH$_2$CH_2TMS′), 17.89, 17.85 (CH$_3$, C-19, C-19′), –1.44, –1.48 [CH$_3$, Si(CH_3)$_{3,SEM}$, Si(CH_3)$_{3,SEM}$]. ESI-MS: *m*/*z* calcd. for $C_{57}H_{86}N_2NaO_{13}Si_2$: 1085.5566, found: 1085.5585.

The hydroxy dimer (23 mg, 22 μmol, 1.0 equiv.) in THF (0.5 mL) was cooled to 0 °C and treated with $Ba(OH)_2$ solution [0.3 mL of a satd. solution of $Ba(OH)_2$ in MeOH/H_2O, 3:2, v/v]. The reaction mixture was warmed to room temp. and was stirred for 3 h. After completion of the reaction, the mixture was acidified with 1 N HCl solution and diluted with MTBE. The phases were separated and the aqueous layer was extracted with MTBE (6×). The combined organic layers were dried (Na_2SO_4) and the solvents evaporated to dryness. The crude hydroxy acid was used in the next step without further purification.

The crude acid was dissolved in toluene (1.2 mL) and a solution (0.3 mL) of 2,4,6-trichlorobenzoyl chloride (48 mg, 0.197 mmol) and Et_3N (22 mg, 0.218 mmol) in toluene (1 mL) was added. After 1 h at room temp. the activated acid was diluted with toluene to 3.0 mL and was dropped during 5 h to DMAP (10 mg, 88 μmol, 4.0 equiv.) in toluene (4 mL) at a temperature of 40 °C. Completion of addition was followed by stirring for 24 h. The reaction mixture

was hydrolyzed with satd. $NaHCO_3$ solution and the aqueous phase was extracted with MTBE. The combined organic layers were dried (Na_2SO_4), the solvents were removed and the crude residue was purified by flash chromatography affording **28** (7 mg, 31%) as a colorless oil. $[a]_D^{20} = +120.9$ ($c = 0.42$, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 8.05 (s, 2 H, H-3, H-3′), 6.07–5.81 (m, 6 H, H-12, H-12′, H-18, H-18′, H-7, H-7′), 5.68–5.61 (m, 2 H, H-8, H-8′), 5.52–5.50 (m, 2 H, H-11, H-11′), 5.44–5.38 (m, 2 H, H-17, H-17′), 5.31–5.27 (m, 2 H, H-14, H-14′), 4.69–4.65 (m, 2 H, H_a-OCH_2O, H_a-OCH_2O′), 4.53–4.50 (m, 2 H, H_b-OCH_2O, H_b-OCH_2O′), 4.18–4.10 (m, 2 H, H-6, H-6′), 3.76–3.65 (m, 4 H, OCH_2CH$_2$TMS, OCH_2CH$_2$TMS′), 3.55–3.48 (m, 2 H, H-16, H-16′), 3.36 (s, 6 H, OCH_3, OCH_3′), 3.34–3.27 (m, 2 H, H_a-5, H_a-5′), 3.05–3.00 (m, 2 H, H_b-5, H_b-5′), 2.98–2.91 (m, 2 H, H_a-13, H_a-13′), 2.40–2.36 (m, 2 H, H_b-13, H_b-13′), 1.74–1.70 (m, 6 H, H-19, H-19′), 1.05 (s, 6 H, Me, Me′), 0.99 (s, 6 H, Me, Me′), 0.94–0.84 (m, 4 H, OCH$_2$CH_2TMS, OCH$_2$CH_2TMS′), 0.01 [s, 18 H, Si(CH_3)$_{3,SEM}$, Si(CH_3)$_{3,SEM'}$]. ^{13}C NMR (100 MHz, $CDCl_3$): 161.74 (C_q, C-4, C-4′), 160.47 (C_q, C-1, C-1′), 143.31 (CH, C-3, C-3′), 141.14, 140.14 (CH, C-12, C-12′, C-7, C-7′), 133.63 (C_q, C-2, C-2′), 131.48 (CH, C-18, C-18′), 127.35 (CH, C17, C-17′), 113.52, 112.10 (CH, C-8, C-8′, C-11, C-11′), 91.95 (CH$_2$, OCH_2O, OCH_2O′), 90.83, 87.75 (C_q, C-9, C-9′, C-10, C-10′), 81.64, 79.58, 77.20 (CH, C-16, C-16′, C-14, C-14′, C-6, C-6′), 65.40 (CH$_2$, OCH_2CH$_2$TMS, OCH_2CH$_2$TMS′), 56.81 (CH$_3$, OCH_3, OCH_3′), 41.58 (C_q, C-15, C-15′), 34.35 (CH$_2$, C-5, C-5′), 31.30 (CH$_2$, C-13, C-13′), 19.80, 19.40, (CH$_3$, 4 Me), 18.03 (CH$_2$, OCH$_2$CH_2TMS, OCH$_2$CH_2TMS′), 17.95 (CH$_3$, C-19, C-19′), –1.43 [CH$_3$, Si(CH_3)$_{3,SEM}$, Si(CH_3)$_{3,SEM'}$]. ESI-MS: *m*/*z* calcd. for $C_{56}H_{83}N_2O_{13}Si_2$: 1031.5485, found: 1031.5499.

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