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Studies Toward the Total Synthesis of Diterpenes in the Labdane Series. III. Synthesis of Two Epimeric 6, 7, 8-Trihydroxylabdadienes

Denyse Herlem and Françoise Khuong-Huu*

CNRS, Institut de Chimie des Substances Naturelles, 91190 Gif-sur-Yvette,France.

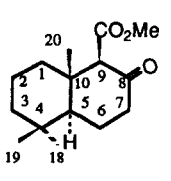
and

Andrew S. Kende

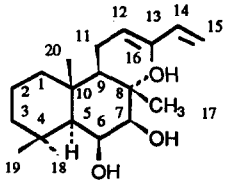
Department of Chemistry, University of Rochester, Rochester, N.Y.14627, USA

Summary- The syntheses of 6β,7β, 8α, and 6β, 7β, 8β-trihydroxy labdadienes, **2a** and **2b** respectively, were performed starting from the decalin **3**, in order to determine the exact structure of compounds, isolated from plant sources, for which configuration at C-8 was not clearly demonstrated. As a result, the structure **2a** was established with certainty for crotomachlin, a diterpene from *Croton macrostachys*.

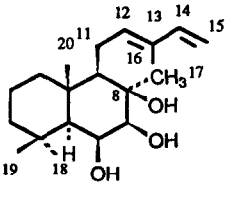
Recent work reported from our laboratories has described early model studies, heading from the decalin β-ketoester **1**, toward the stereocontrolled synthesis of two epimeric trihydroxylabdane derivatives, namely the 6β, 7β, 8β-triol **2b** and its 6β, 7β, 8α–triol epimer **2a**.[1] Our interest in the latter pair derives from unpublished studies by I. Kubo reporting the isolation, from the East African plant *Croton machrostachys*, of a trihydroxylabdadiene, named crotomachlin, tentatively assigned structure **2b**.[2] Subsequently, an independent investigation by F. Bohlmann of the leaves of *Koanophyllon conglobatum* led to report of a trihydroxylabdadiene constituent having physicochemical properties closely similar to crotomachlin, but assigned structure **2a**.[3] In order to resolve this structural ambiguity, we now report the total syntheses of both **2b** and its epimer **2a**, by stereocontrolled processes which unambiguously establish the stereochemistry of each substance.



1



2a

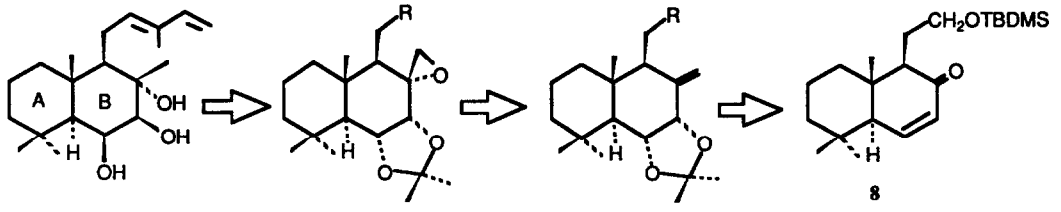


2b

Preparation and Use of the C(8)-Enone 8.

Although our previous paper[1] demonstrated some success in the introduction of 6β, 7β, 8β–trihydroxy functionality in the B-ring, and separately showed the elaboration of a diene chain, we were unable to achieve concomitant elaboration of both sets of functional groups starting directly from any 8-keto derivative. In an early strategy toward the 8α-hydroxy epimer **2a**, the retrosynthetic Scheme 1 was explored. Here, the 8α-oxygen would be introduced in masked form as the epoxide by peracid oxidation of an exo-methylene derivative following hydroxylation of the 6, 7 double bond.

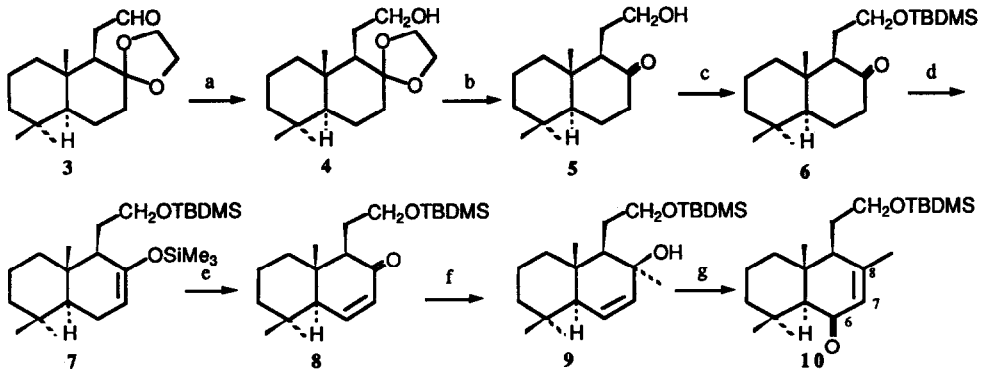
Scheme 1



To minimize neighbouring reactions between the functional groups as those we had observed in preliminary experiments,[1] we chose to investigate the functionalization of the decalin system starting from the unsaturated ketones **8** or **10**, each of which could be prepared from the previously described aldehyde-dioxolane **3**.[1]

From the bicyclic dioxolane aldehyde **3**, readily available from **1** as described earlier,[1] a high yield reaction sequence was developed to produce the enone **8** in five steps (Scheme 2). Thus the aldehyde function of **3** was reduced with $NaBH_4$. After dioxolane hydrolysis, the primary hydroxyl of **5** was protected as the t-butyldimethylsilyl ether **6** before dehydrogenation of enolsilane **7** with $Pd(OAc)_2$[4] to give the requisite enone, **8**.

Scheme 2

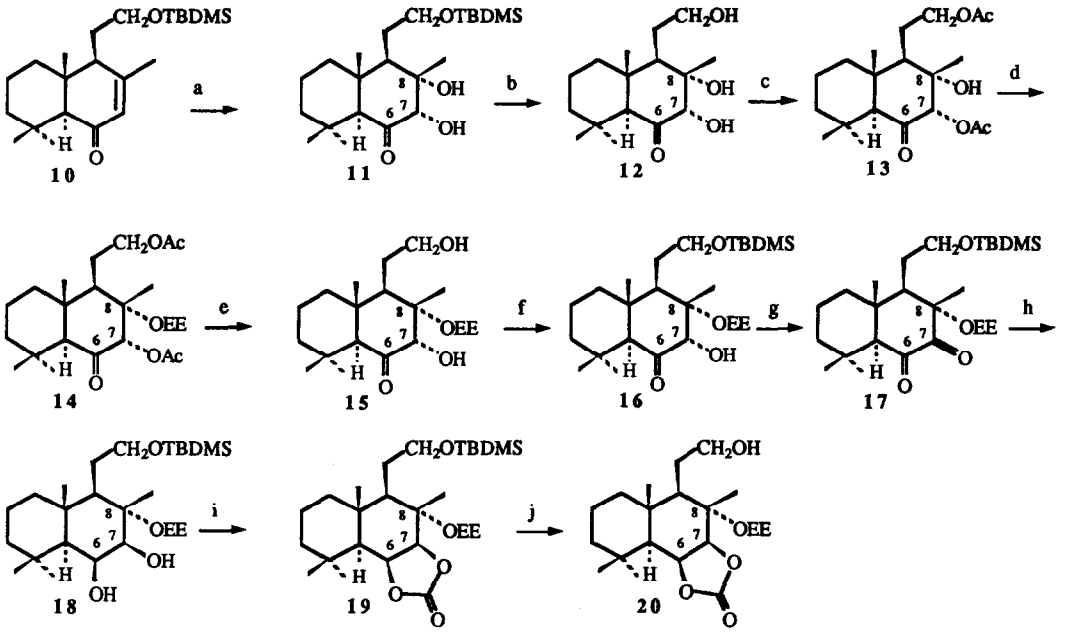


a) $NaBH_4$, 2 eq, EtOH, rt, 98%; b) 1N HCl, THF/H_2O, rt, 82%; c) TBDMSCl, 1.2 eq., imidazole 2 eq, THF, rt, overnight, 95%; d) LDA, 5 eq, THF, -78°C, 1h, then $ClSiMe_3$, 2 eq, -78°C to 0°C, 72%; e) $Pd(OAc_2)$, 1.2eq, AcCN, rt, overnight, 85%; f) MeLi, 2 eq,.ether, 0°C, 1 h, 98%; g) PCC, 4.5eq., NaOAc, CH_2Cl_2, 0°C,15 min, then, rt, 2 h, 91%.

Synthesis of 6β, 7β, 8α–trihydroxylabdadiene 2a.

While conversion of enone **8** to the 6α, 7α-diol as envisioned in Scheme 1 was in fact achieved, subsequent C(8) methylenations were unsuccessful (Wittig, Tebbe[5]) or proceeded in low yield (Peterson[6]). For this and the previously noted reasons, we refocused our strategy to proceed from the C(6)-enone **10**, readily available from C(8)-enone **8** by MeLi addition[1] and oxidative rearrangement with PCC[7] as shown in Scheme 2. Our purpose was to introduce all three B-ring hydroxyls in protected form before elaboration of the diene chain at C(9), as summarized in Scheme 3.

Scheme 3

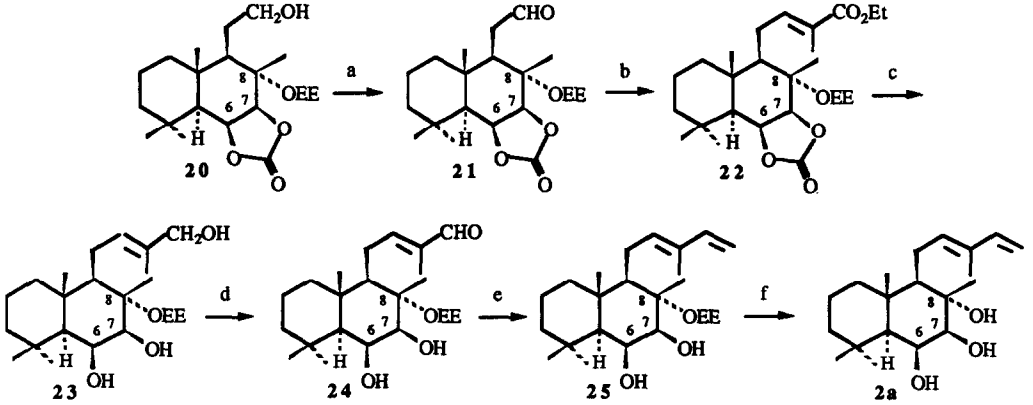


a) Catalytic OsO_4, NMO, 3 eq., t-BuOH, acetone, H_2O, rt, 48 h, 55%; b) TBAF, 1 eq., THF, rt, 3 h, 90%; c) Ac_2O, excess, py, rt, overnight, 86%; d) ethylvinyl ether, 5 eq., catalytic CSA, CH_2Cl_2, overnight, 70%; e) 2% KCN, MeOH, overnight, 91%; f) TBDMSCl, 1.2 eq., imidazole, 3 eq., THF, rt, overnight, 96%; g) Dess-Martin periodinane, 1 eq., CH_2Cl_2, rt, 1 h; h) $NaBH_4$, 5 eq., EtOH, rt, overnight, 64%; i) $COCl_2$, 1.2 eq., toluene, py, rt, overnight, 97% j) TBAF, 1 eq., THF, rt, 3 h., 91%.

By catalytic osmylation using OsO_4 and NMO,[8] the 7, 8 double bond was hydroxylated to give the 7α, 8α-diol **11**. To confirm the stereochemistry of diol **11**, series of 2D nuclear Overhauser experiments were conducted on the desilylated triol **12**, in which the proton NMR signals for all methyl groups were well separated from each other. Here, nOe effects were observed between the two axial B-ring methyl groups, C(17) and C(20), as well as between the C(20)-Me and the C(19)-Me, showing that the dihydroxylation reaction took place, as expected, on the less hindered α-side of the molecule.

Acetylation of triol **12** with acetic anhydride in pyridine afforded the 7, 12-diacetate **13**, and the critical protection of the C(8)α-hydroxyl was carried out with ethyl vinyl ether to yield the ethoxyethyl (EE) ethers **14**, obtained as epimers in the EE group. The epimers **14** were gently deacetylated with 2% methanolic KCN[9] to give hydroxyketols **15**. The primary hydroxyl was reprotected as the *t*-butyldimethylsilyl ethers **16**, and the latter oxidized by Dess-Martin periodinane[10] to produce the 6,7-diones **17**. An apparently more direct sequence, in which a TBDMS group is placed at C(12) of triol **12**, proved unsuccessful since ethoxyethyl protection of the hindered C(8)α-hydroxyl failed with a preformed TBDMSO substituent at C(12). Reduction of diones **17** with excess $NaBH_4$ in ethanol provided the 6β,7β-diols **18**, which were protected as the cyclic carbonates **19**, using phosgene and pyridine. Desilylation of the primary hydroxyl with tetra-*n*-butylammonium fluoride now gave **20**. At this stage, the diene side chain could be introduced by adaptation of the four-step sequence we reported in the previous paper[1] (Scheme 4).

Scheme 4



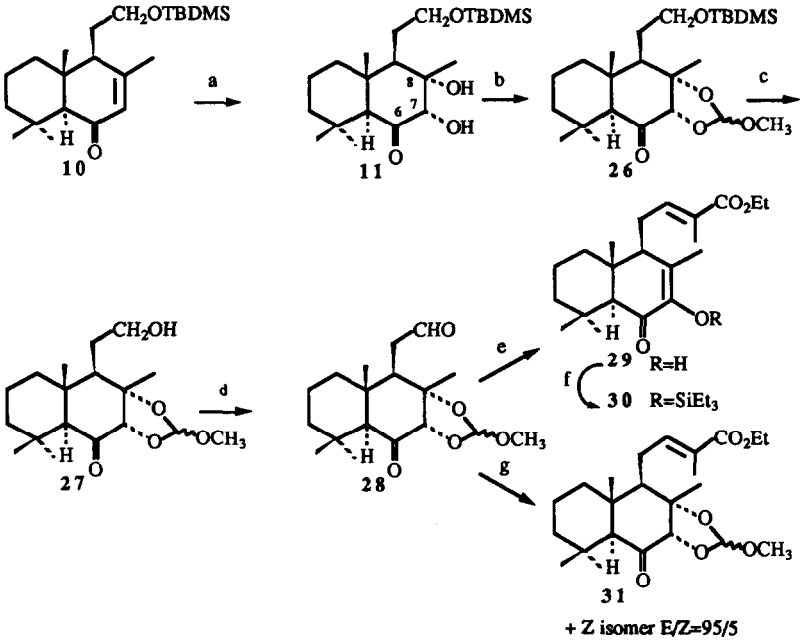
a) Dess-Martin periodinane, 1 eq., CH_2Cl_2, rt, 1 h, 87%; b) $NaCH(CH_3)(Et_2OP{=}O)CO_2Et$, 3 eq., toluene, 80°C, 1 h, 82%; b) $LiAlH_4$, 2 eq., ether, rt, 3 h, 57%; d) Dess-Martin periodinane, 1 eq., CH_2Cl_2, rt, 1 h, 37%; e) $H_2C{=}PPh_3$, 5 eq., THF, 0°C, 3 h, 62%; f) AcOH, MeOH, rt, 30 min., quantitative.

The primary hydroxyl of **20** was oxidized with Dess-Martin periodinane to **21**. A Horner-Emmons condensation with the sodio derivative of ethyl diethyl-2-phosphonopropionate in toluene transformed **21** to the *E*-olefins **22** as major products (*E*/*Z*>10/1), where the *E* isomers could be separated by chromatography. Reduction of *E*-**22**with lithium aluminium hydride provided triols **23** by concomitant reductive scission of the carbonate protecting group.The allylic hydroxyl in **23** was selectively oxidized to carbaldehyde **24** with one equivalent of Dess-Martin periodinane. Methylenation of **24** was achieved by excess methylenetriphenylphosphorane to give **25**. Mild hydrolysis of the EE protecting group then produced pure (±)-6β, 7β, 8α-triol **2a**.

Synthesis of 6β, 7β, 8β–trihydroxylabdadiene 2b.

Starting from the conjugated ketone **10**, the synthesis of the (±)-6β, 7β, 8β-triol **2b** was also carried out. As depicted in Scheme 5, the previously described 7α, 8α-diol **11** was protected as the orthoester **26**. Desilylation with tetra-*n*-butylammonium fluoride gave **27**, which was oxidized to aldehyde **28** with Dess-Martin periodinane.[10] At this point, the introduction of the side chain was begun as previously outlined in Scheme 4. In this instance, condensation with the sodio derivative of ethyl diethyl-2-phosphonopropionate in toluene at 80°C for 30 min converted **28** to the enol **29** in 62% yield, with more than 20:1 *E/Z* stereoselectivity. In contrast, the use of DBU and LiCl in acetonitrile[11] for the Horner-Emmons condensation, carried out at 20°C, gave the (E)-orthoester **31**.

Scheme 5



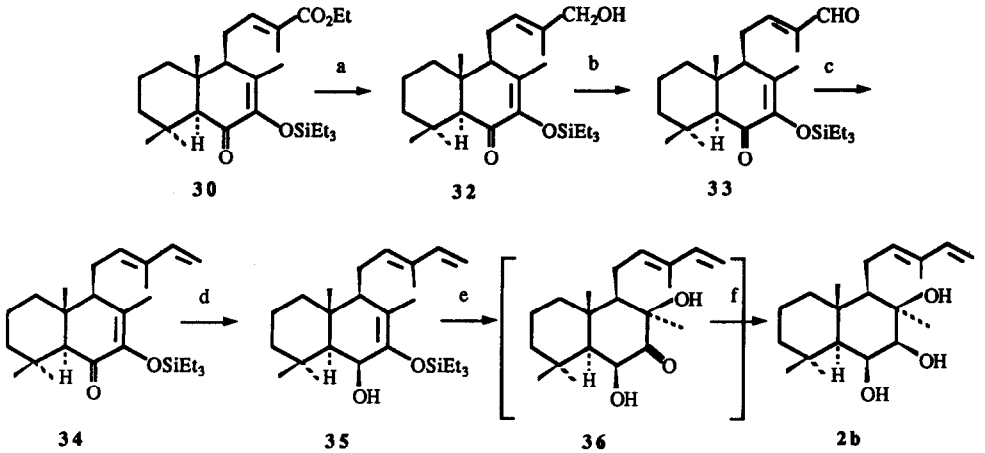
+ Z isomer E/Z=95/5

a) NMO, 4.2 eq, OsO_4 in *t*-BuOH, 0.03 eq, acetone, H_2O, rt, 48 h, 55%; b) $HC(OMe)_3$, 4 eq, benzene, cat. CSA, reflux, 15 min, 78%; c) TBAF.$3H_2O$, 1 eq, THF, rt, overnight, 96%; d) Dess-Martin periodinane, 1.2 eq, CH_2Cl_2, 0°C then rt, 98%; e) ethyl diethyl-2-phosphonopropionate, 3 eq, NaH, 3 eq, toluene, 80°C, 30 min, 61%; f) $ClSiEt_3$, 2.6 eq, Et_3N, 2.6 eq, cat DMAP, 76% (f+g 46%); g) ethyl diethyl-2-phosphonopropionate, 5 eq, DBU, 5 eq, LiCl, 5 eq, MeCN, rt, 4 h, 51% for **31**.

Starting from enol silane **30**, prepared by *in situ* silylation of **29**, the synthesis of triol **2b** was achieved (Scheme 6). The lithium aluminium hydride reduction of **30** gave alcohol **32**, smoothly oxidized to aldehyde **33** by Dess-Martin periodinane. Wittig methylenation transformed **33** into the diene **34**. We found the 7,8 double bond of **34** inert toward selective MCPBA oxidation. Therefore, careful reduction of the enone carbonyl was carried out at -78°C with diisobutylaluminium hydride to give the unstable 6β-alcohol **35**. Careful oxidation of

35 with MCPBA,[12] in the presence of sodium carbonate, gave the crude intermediate ketol **36**, directly reduced with sodium borohydride, to give the 6β, 7β, 8β-triol **2b** (22% yield from **34**).

Scheme 6



a) $LiAlH_4$, 2 eq, ether, rt, 1 h, 85%; b) Dess-Martin periodinane, 1.2 eq, CH_2Cl_2, pyridine, rt, 92%; c) $H_2C{=}PPh_3$, 3 eq, THF, rt, 1 h, 63%; d) DIBAH, 4.4 eq, toluene, -78°C, 77%; e) MCPBA, 0.8 eq, Na_2CO_3, CH_2Cl_2, 0°C, 1.5 h; f) $NaBH_4$, 5.5 eq, EtOH, rt, 22% (d+e+f).

Spectrometric Comparison of Synthetic 2a and 2b with the Kubo and Bohlmann Natural Materials.

Table 1. ^1H NMR Spectra in $CDCl_3$

	C(5)-H	C(6)-H	C(7)-H	C(9)-H	C(11)-H_2	C(12)-H	C(14)-H
2a	0.98 *d*	4.40 *br. dd*	3.41 *d*	1.28 *dd*	2.29, 2.49	5.59 *br.t*	6.34 *dd*
ref.2	0.95 *d*	4.38 *br. dd*	3.40 *d*		2.27, 2.40	5.56 *br.t*	6.34 *dd*
ref.3		4.42 *br. dd*	3.42 *d*			5.59 *br.t*	6.34 *dd*
2b	1.33 *d*	4.26 br. t	3.59 *d*	1.33 *dd*	2.18, 2.43	5.45 *br.t*	6.34 *dd*

	C(15)-H c	C(15)-H t	C(16)-H_3	C(17)-H_3	C(18)-H_3	C(19)-H_3	C(20)-H_3
2a	4.92 *d*	5.07*d*	1.81 *s*	1.36 *s*	1.01 *s*	1.21 *s*	1.22 *s*
ref.2	4.89 *d*	5.05*d*	1.80 *s*	1.35 *s*	0.97 *s*	1.19 *s*	1.19 *s*
ref.3	4.93 *d*	5.07*d*	1.82 *s*	1.39 *s*	1.03 *s*	1.24 *s*	1.25 *s*
2b	4.90 *d*	5.06*d*	1.77 *s*	1.26 *s*	0.98* *s*	1.22 *s*	1.15* *s*

^1H NMR data, chemical shifts δ ppm, $CDCl_3$; **ref.2**: Kubo's crotomachlin; **ref.3**: Bohlmann' s dihydroxy-(*E*)-abienol; *tentative assignments which could be inverted.

Table 2. Carbon-13 NMR Spectra

	C(14)	C(12)	C(13)	C(15)	C(7)	C(8)	C(6)	C(9)	C(5)	CH_2
2a*	143.02	138.24	132.45	109.67	81.63	77.57	72.22	62.01	56.89	44.81
2a**	141.54	135.59	132.8	110.73	80.65	77.28	70.93	60.57	55.77	43.74
ref.2*	143.20	138.28	132.5	109.8	81.85	77.77	72.29	62.14	57.12	45.01
ref.2**	141.49	135.6	132.74	110.54	80.56	77.0	70.87	60.49	55.70	43.67
2b*	143.02	138.11	133.20	110.09	77.55	78.09	73.95	55.44	50.71	44.83
2b**	141.75	136.71	132.41	110.15	77.09	76.57	73.52	54.27	50.10	43.73

	CH_2	C	C	C(18)	C(20)	CH_2	CH_2	C19	C17	C16
2a*	43.46	40.42	34.85	33.55	24.08	24.08	19.48	18.70	17.22	11.81
2a**	42.25	39.57	34.25	33.45	24.02	23.42	18.78	19.51	16.82	11.96
ref.2*	43.69	40.63	35.03	33.74	24.36	24.26	19.67	18.95	17.23	11.86
ref.2**	42.17	39.47	34.19	33.35	23.91	23.32	18.67	19.38	16.70	11.86
2b*	43.61	39.61	34.70	33.75	27.02	24.71	19.54	24.45	18.30	12.30
2b**	42.40	38.46	33.85	33.36	27.11	23.69	18.47	24.35	17.99	12.03

^{13}C NMR data, chemical shifts δ ppm; *CD_3OD as solvent, **$CDCl_3$ as solvent; **ref.2**: Kubo's crotomachlin.

We conclude from the ^1H NMR data of table 1 and the ^{13}C NMR data of table 2 that the natural substances isolated by Kubo[2] and Bohlmann[3] are identical and correspond to our synthetic **2a**. A series of 2D NMR experiments led to these proton and carbon assignments. We note the shielding of C(5)-H in the 8α-hydroxy-series, in the ^1H NMR spectra..

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Experimental

Melting points (mp) were determined in capillary tubes and are uncorrected. IR spectra were determined with a NICOLET FT-IR 205 spectrometer, UV spectra with a PERKIN-ELMER Lambda 205 spectrometer. ^1H NMR spectra were performed in $CDCl_3$, unless otherwise stated, chemical shifts δ were expressed in ppm, coupling constants in Hz. They were recorded on BRUKER WP-200, BRUKER AC-250, WP-300 or BRUKER WM-400 instruments. ^{13}C NMR spectra were performed in $CDCl_3$ or CD_3OD recorded on Bruker WP-200 or Bruker AC-250. Mass spectra (MS) were run on AEI MS-50 or AEI MS-9 spectrometers. Diethyl ether and tetrahydrofuran were distilled from sodium-benzophenone ketyl, dichloromethane from phosphorus pentoxide, toluene from sodium, acetonitrile from calcium hydride. Other solvents and reagents were purified by standard procedures as necessary. Column chromatography was performed on Merck Kieselgel 60 or Florisil 60-100

mesh., flash column chromatography on Merck Kieselgel 60H. Analytical thin layer chromatography was performed using Kieselgel pre-coated foils. Usual work-up means that water was added to the reaction mixture which was then extracted three times with CH_2Cl_2; the combined organic layers were washed with brine, dried over Na_2SO_4 or $MgSO_4$ and evaporated.The natural product numbering system was adopted for ^1H and ^{13}C assignments for the decahydronaphthalene derivatives. The described products are racemates, however, to point out the relative configurations of their substituents they are represented as labdane derivatives in the 4α, 4β, 10β-trimethyl- (5α-H)- decahydronaphthalene series.

8-Ethylenedioxy-9β-hydroxyethyl-4α,4β,10β-trimethyl-(trans)-decahydro-naphthalene, 4.
Solid sodium borohydride (0.54 g, 14 mmol) was added portionwise to a solution of **3** (8g, 28 mmol), in EtOH (250 mL). After completion of the reaction monitored by TLC, water was added and the solution was extracted three times with CH_2Cl_2. The organic phase was washed with brine, dried on $MgSO_4$ and evaporated to give **4** (7.9 g, 98%), as an oil, $C_{17}H_{30}O_3$, EIMS: M^+ 282, m/z 267; 221, 205, 99; ^1H NMR, 200 MHz, δ ppm: 0.80 (3H, s, CH_3), 0.9 (6H, s, CH_3), 0.8-2.0 (14 H, m, CH, CH_2), 3.45 and 3.65 (2H, 2m, C-12H_2), 3.80-4.15 (4 H, m, OCH_2CH_2O).

9β-Hydroxyethyl-4α,4β,10β-trimethyl-(*trans*)-decahydro-naphthalen-8-one, 5.
A solution of **4** (7.9 g, 28 mmol) in THF/aqueous HCl 0.1N 1/1 (320 mL) was kept at room temperature. After completion of the reaction monitored by TLC, the reaction was made alkaline by addition of aqueous $NaHCO_3$ and the solution was extracted three times with ether. The organic phase was washed with brine, dried on $MgSO_4$ and evaporated to give **5** (5.5 g, 82%), as an oil, after flash chromatography, $C_{15}H_{26}O_2$, Calc %: C 75.58, H 10.99 found: C 75.50 H 11.03, EIMS: M^+ 238, m/z 220, 205, 194, 180, 179; IR cm^{-1}: 3400 (OH),1709 ($\nu_{C=O}$), 1050 (C-O); ^1H NMR, 200 MHz, δ ppm: 0.73 (3H, s, CH_3), 0.86 (3H, s, CH_3), 1.0 (3H, s, CH_3), 0.8-2.6 (14 H, m, CH, CH_2), 3.55 (2H, m, C-12H_2); ^{13}C NMR, δ ppm: 14.87 (CH_3), 19.03 (CH_2), 21.70 (CH_3), 23.85 (CH_2), 25.02 (CH_2), 33.52 (CH_3), 33.74 (C), 39.25 (CH_2), 41.95 (CH_2), 42.37 (C, CH_2), 54.14 (CH), 61.26 (CH), 62.54 (C-12), 211.54 (C=O).

9β-t-Butyldimethylsilyloxyethyl-4α,4β,10β-trimethyl-(*trans*)-decahydro-naphthalen-8-one, 6.
TBDMSCl (4.06 g, 27 mmol) was added to a solution of **5** (5.5 g, 23 mmol) and imidazole (3.8 g, 56 mmol) in anhydrous THF (150 mL). The mixture was stirred overnight at room temperature. The reaction was made alkaline by addition of aqueous $NaHCO_3$ and the solution was extracted three times with ether. The organic phases were washed with brine, dried on $MgSO_4$ and evaporated to give **6** (7.7 g, 95%), as an oil, after flash chromatography, $C_{21}H_{40}O_2Si$, EIMS: M^+ 352, m/z 337, 295, 205;^1H NMR, 200 MHz, δ ppm: -0 (3H, s, $SiCH_3$), 0.03 (3H, s, $SiCH_3$), 0.70 (3H, s, CH_3), 0.84 (3H, s, CH_3), 0.87 (9H, s, tBu), 0.96 (3H, s, CH_3), 0.8-2.6 (14 H, m, CH, CH_2), 3.31 and 3.62 (2H, 2m, C-12H_2); ^{13}C NMR, δ ppm: -5.29 ($SiCH_3$), -5.17 ($SiCH_3$), 14.83 (CH_3), 18.34 (C), 19.02 (CH_2), 21.70 (CH_3), 23.96 (CH_2), 25.18 (CH_2), 25.98 (tBu), 33.52 (CH_3), 33.70 (C), 39.25 (CH_2), 42.02 (CH_2), 42.27 (C), 42.54 (CH_2), 54.40 (CH), 59.72 (CH), 62.21 (C-12), 211.20 (C=O).

9β-t-Butyldimethylsilyloxyethyl-4α,4β,10β-trimethyl-(*trans*)-1,2,3,4,5,8,9,10-octahydro-naphthalen-8-one, 8.
LDA (109 mL of 1M solution in THF, 109 mmol) was added at -78°C to a solution of **6** (7.7 g, 21.8 mmol) in THF (100 mL), under Argon atmosphere. The mixture was stirred at -78°C for 3 h, then freshly distillated $ClSiMe_3$ (4.7 mL, 37 mmol) was added with a syringe. The reaction was warmed to 0°C. Aqueous ammonium chloride was added and extraction was performed three times with ether. The organic phases were washed with brine and evaporated to give crude **7** roughly purified by filtration on Florisil column using heptane as solvent (6.7 g, 72%), as an oil; ^1H NMR, 200 MHz, δ ppm: 0.01 (6H, s, $SiCH_3$), 0.2 (9H, s, $SiCH_3$), 0.76 (3H, s, CH_3); 0.88 (3H, s, CH_3), 0.89 (9H, s, t-Bu), 0.90 (3H, s, CH_3), 0.5-2 (12H, m, CH, CH_2), 3.53 and 3.84 (2H, 2m, C-12H_2), 4.72 (1H, t, J=1, C-7H). Palladium acetate (4.2 g, 18.7 mmol) was added to a solution of **7** (6.7 g, 15.8 mmol) in acetonitrile (150 mL). The mixture was stirred overnight at room temperature. Standard work-up gave **8**, mp 50°C, (4.73 g, 85%, overall yield from 6, 62%), as an oil, after flash chromatography, $C_{21}H_{38}O_2Si$, Calc %: C 71.95, H 10.93, found: C 72.10, H 10.99; EIMS: M^+ 350, m/z 335, 293; IR cm^{-1}: 1675 ($\nu_{C=O}$), 1615 (C=C), 1090 (C-O); UV $\lambda_{max\ EtOH}$: 231.9 nm, ε 7444; ^1H NMR, 250 MHz, δ ppm: 0.05 (3H, s, $SiCH_3$), 0.06 (3H, s, $SiCH_3$), 0.81 (3H, s, CH_3), 0.91 (9H, s, tBu), 0.93 (3H, s, CH_3), 1.05 (3H, s, CH_3), 0.8-2.3 (10 H, m, CH, CH_2), 3.57 and 3.83 (2H, 2m, CH_2-12), 6.05 (1H, dd, J=10, J'=3, C-7H), 6.93

(1H, dd, J=10, J'=2, C-6H); ^{13}C NMR, δ ppm: -5.23 ($SiCH_3$), -5.12 ($SiCH_3$), 13.95 (CH_3), 18.39 (C), 18.53 (CH_2), 22.35 (CH_3), 26.08 (CH_2), 26.09 (tBu), 32.58 (CH_3), 32.88 (C), 37.75 (CH_2), 41.10 (CH_2), 43.83 (C), 56.71 (CH), 58.99 (CH), 62.93 (C-12), 130.25 (C-6), 149.03 (C-7), 201.61 (C=O).

8β-Hydroxy-9β-t-butyldimethylsilyloxyethyl-4α,4β,8α,10β-tetramethyl-(*trans*)-1,2,3,4,5,8,9,10-octahydro-naphthalene, 9.

MeLi (16.8 mL of 1.6 M solution in ether, 27 mmol) was added at 0°C to a solution of **8** (4.7 g, 13.5 mmol), in anhydrous ether, under Argon atmosphere. The mixture was stirred for 1 h at room temperature. Aqueous ammonium chloride was added and the organic products were extracted three times with ether. The ethereal solutions were washed with brine, dried on $MgSO_4$ and evaporated to give **9** (4.84 g, 98%), as an oil, after flash chromatography, $C_{22}H_{42}O_2Si$, Calc. %: C 72.07, H 11.55, found C 72.22, H 11.54; CIMS: MH^+ 367, m/z 349, 217, 191; ^1H NMR, 250 MHz, δ ppm: 0.06 (3H, s, $SiCH_3$), 0.07 (3H, s, $SiCH_3$), 0.85 (3H, s, CH_3), 0.89 (3H, s, CH_3), 0.91 (9H, s, tBu), 0.92 (3H, s, CH_3), 1.20 (3H, s, CH_3), 0.8-2.3 (10 H, m, CH, CH_2), 3.60 and 3.72 (2H, 2m, C-12H_2), 5.68 (2H, s, C-6H, C-7H); ^{13}C NMR, δ ppm: -5.18 (2$SiCH_3$), 14.38 (CH_3), 18.29 (C, CH_2), 21.89 (CH_3), 26.08 (tBu), 27.57 (CH_2), 29.81 (CH_3), 32.69 (C, CH_3), 37.23 (CH_2), 37.52 (C), 41.34 (CH_2), 54.60 (CH), 54.90 (CH), 64.79 (CH_2), 70.45 (C-8), 126.89 (sp^2 CH), 134.88 (sp^2 CH).

9β-t-Butyldimethylsilyloxyethyl-4α,4β,8,10β-tetramethyl-(*trans*)-1,2,3,4,5,6,9,10-octahydro-naphthalen-6-one, 10.

PCC (12.8 g, 59.6 mmol), was added, at 0°C, to a solution of **9** (4.8 g, 13.2 mmol) in anhydrous CH_2Cl_2 (100 mL), in the presence of solid sodium acetate. After 15 min. at 0°C, the mixture was stirred at room temperature for 2 h. Ether (50 mL) and CH_2Cl_2 (50 mL) were added and the mixture was poured on a silicagel column. Elution with toluene and then CH_2Cl_2 gave **10** (4.42 g, 91%), as an oil, $C_{22}H_{40}O_2Si$, Calc. %: C 72.47, H 11.06, found C 72.27, H 10.83; CIMS: MH^+ 365, m/z 361, 313, 257; IR cm^{-1}: 1682 ($\nu_{C=O}$), 1635 (C=C), 1100 (C-O); UV $\lambda_{max\ EtOH}$: 231.9 nm, ε 7 444; ^1H NMR, 250 MHz, δ ppm: 0.06 (6H, s, 2 $SiCH_3$), 0.83 (3H, s, CH_3), 0.90 (9H, s, tBu), 1.11 (3H, s, CH_3), 1.16 (3H, s, CH_3), 1.90 (3H, s, C-17H_3), 1.0-2.2 (10 H, m, CH, CH_2), 3.66 and 3.73 (2H, 2m, C-12H_2), 5.73 (1H, q, J=1, C-7H); ^{13}C NMR, δ ppm: -5.18 (2$SiCH_3$), 14.48 (CH_3), 18.02 (C, CH_2), 21.41 (CH_3), 21.93 (CH_3), 26.09 (CH_2), 27.16 (tBu), 32.18 (C), 33.32 (CH_3), 38.80 (CH_2), 42.72 (C), 43.05 (CH_2), 52.36 (CH), 63.38 (CH), 64.84 (C-12), 128.83 (C-7), 157.16 (C-8), 199.44 (C=O).

9β-t-Butyldimethylsilyloxyethyl-7α,8α-dihydroxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydronaphthalen-6-one, 11.

A solution of NMO (5 g, 42.3 mmol) in water (10 mL) was mixed with a solution of **10** (4.4 g, 12 mmol) in acetone (20 mL) and then catalytic OsO_4 (6.5 mL of a 0.065 M in t-BuOH, 0.4 mmol), was added. The mixture was kept for 48 h, at room temperature. Standard work-up and flash chromatography furnished **11** (2.65 g, 55%), $C_{22}H_{42}O_4Si$, Calc. %: C 66.28 H 10.62, found C 66.42, H 10.56; EIMS: M^+ 398, m/z 380, 365, 341, 323, 266; IR cm^{-1}: 3400 (OH), 1722 ($\nu_{C=O}$), 1100 (C-O); ^1H NMR, 200 MHz, δ ppm: 0.01 (3H, s, $SiCH_3$), 0.10 (3H, s, $SiCH_3$), 0.70 (3H, s, CH_3), 0.83 (3H, s, CH_3), 0.86 (9H, s, tBu), 1.0 (3H, s, CH_3), 1.15 (3H, s, C-17H_3), 0.9-2.2 (10 H, m, CH, CH_2), 2.90 (1H, s, C-5H), 3.56 (1H, s, C-7H), 3.56 and 3.78 (2H, 2m, C-12H_2).

9β-Hydroxyethyl-7α,8α-dihydroxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydronaphthalen-6-one, 12.

A solution in THF (50 mL) of tetrabutylammonium fluoride trihydrate (1.73 g, 5.48 mmol) and **11** (1.68 g, 4.2 mmol) was kept overnight at room temperature. After addition of water, ether extraction provided **12** (1.1 g, 92%), purified by flash chromatography, white crystals, mp 144-145°C (acetone) $C_{16}H_{28}O_4$, Calc. %: C 67.57, H 9.92, found C 67.45, H 9.74; EIMS: M^+ 284, m/z 266, 251, 236, 233; IR cm^{-1}: 3400 (OH), 1712 ($\nu_{C=O}$), 1100 (C-O); ^1H NMR, 400 MHz, δ ppm: 0.74 (3H, s, C-20H_3), 0.90 (3H, s, C-18H_3), 1.09 (3H, s, C-19H_3), 1.12 (2H, m, CH), 1.18 (3H, s, C-17H_3), 1.33 (1H, m, CH), 1.49 (1H, m, CH), 1.65 (4H, m, CH), 1.97 (1H, m, C-9H), 2.92 ((1H, s, C-5H), 3.52 and 3.84 (2H, 2m, C-12H_2), 3.60 (1H, s, C-7H); ^{13}C NMR, δ ppm: 15.97 (C-20H_3), 18.24 (CH_2), 21.98 (C-19H_3), 22.12 (C-17H_3), 27.34 (CH_2), 31.92 (C), 32.09 (C-

18H3), 39.6 (CH_2), 40.51 (C), 42.25 (CH_2), 52.71 (C-9), 58.73 (C-5), 63.60 (C-12), 76.27 (C-8), 83.21 (C-7), 211.91 (C=O).

9β-Acetoxyethyl-7α-acetoxy-8α-hydroxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6-one, 13.
A solution of **12** (2 g, 5 mmol) in Ac_2O (10 mL) and pyridine (10 mL) was kept overnight at room temperature. The solvents were removed under vacuum. Aqueous $NaHCO_3$ and CH_2Cl_2 were added to the residue. Usual work-up provided **13** (1.9 g, 86%) after purification by flash chromatography, crystals, mp 134-135°C (acetone), $C_{20}H_{32}O_6$, calc. %: C 65.19, H 8.75, found C 65.21, H 8.99; EIMS: M^+ 368, m/z 326, 308, 266, 248; IR cm^{-1}: 3550 (OH), 1748, 1735, 1715 ($\nu_{C=O}$), 1250 (C-O, ester), 1050 (C-O); ^1H NMR, 200 MHz, δ ppm: 0.73 (3H, s, CH_3), 0.80 (3H, s, CH_3), 1.10 (3H, s, CH_3), 1.20 (3H, s, C-17H3), 0.7-1.8 (9 H, m, CH, CH_2), 2.03 (3H, s, $COCH_3$), 2.16 (3H, s, $COCH_3$), 2.50 (1H, s, C-5H), 4.15 (2H, 2m, C-12H2), 4.48 (1H, s, C-7H); ^{13}C NMR, δ ppm: 15.54 (CH_3), 18.11 (CH_2), 20.82 (CH_3), 20.94 (CH_3), 21.03 (CH_3), 21.79 (CH_3), 24.28 (CH_2), 31.91 (C), 32.25 (CH_3), 39.89 (CH_2), 40.32 (C), 42.14 (CH_2), 52.50 (CH), 60.30 (CH), 65.92 (C-12), 76.07 (C-8), 85.04 (C-7), 169.45 (C=O, ester), 171.16 (C=O, ester), 205.96 (C=O, ketone).

9β-Acetoxyethyl-7α-acetoxy-8α-ethoxyethyloxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6-one, 14.
A solution of **13** (1.6 g, 4.3 mmol) in anhydrous CH_2Cl_2 (20 mL) was treated with freshly distillated ethylvinyl ether (720 mg, 100 mmol) and PPTS (100 mg, 0.4 mmol), overnight, at room temperature. Aqueous $NaHCO_3$ was added and standard work-up gave a mixture providing **14** (2/1 mixture of 2 epimers, 1.338 g, 70%) and starting material **13** (300 mg, 18%) after flash chromatography with heptane/AcOEt 9/1 and 8/2 ; **14**- $C_{24}H_{40}O_7$, calc. %: C 65.43, H 9.15, O 25.42; found: C 65.52, H 8.96, O 25.5; CIMS: no MH^+, peaks at 369, 309, 293, 291, 249; IR cm^{-1}: 1748, 1735, 1720 ($\nu_{C=O}$), 1230 (C-O, ester), 1050 (C-O); less polar isomer, ^1H NMR, 300 MHz, δ ppm: 0.74 (3H, s, CH_3), 0.79 (3H, s, CH_3), 1.08 (3H, t , J=7, $CH_2\underline{CH_3}$), 1.10 (3H, d, J=5, $CH\underline{CH_3}$), 1.14 (3H, s, CH_3), 1.16 (3H, s, C-17H3), 1-1.82 (9 H, m, CH, CH_2), 2.0 (3H, s, $COCH_3$), 2.10 (3H, s, $COCH_3$), 2.55 (1H, s, C-5H), 3.4 (2H, m, $\underline{CH_2}CH_3$), 4.06 and 4.18 (2H, 2m, C-12H2), 4.71 (1H, q, J=5, C-1'H), 4.80 (1H, s, C-7H); ^{13}C NMR, δ ppm: 15.36 (CH_3), 15.95 (CH_3), 17.82 (CH_3), 17.96 (CH_2), 20.24 (CH_3), 20.81 (CH_3), 20.93 (CH_3), 21.64 (CH_3), 24.78 (CH_2), 31.80 (C), 32.05 (CH_3), 39.88 (CH_2), 40.07 (C), 42.11 (CH_2), 51.66 (CH), 57.45 (CH_2), 60.26 (CH), 66.10 (C-12), 80.89 (C-7), 81.22 (C-8), 92.75 (C-1'H), 169.17 (C=O, ester), 170.66 (C=O, ester), 205.96 (C=O, ketone); more polar isomer, ^1H NMR, 300 MHz, δ ppm: 0.80 (3H, s, CH_3), 0.81 (3H, s, CH_3), 1.08 (3H, t , J=7, $CH_2\underline{CH_3}$), 1.17 (3H, s, CH_3), 1.20 (3H, s, C-17H3), 1.26 (3H, d, J=5, $CH\underline{CH_3}$), 1.4-1.90 (9 H, m, CH, CH_2), 2.04 (3H, s, $COCH_3$), 2.16 (3H, s, $COCH_3$), 2.57 (1H, s, C-5H), 3.37 (2H, q, J=7, $\underline{CH_2}CH_3$), 4.02 and 4.22 (2H, 2m, C-12H2), 4.70 (1H, s, C-7H), 4.87 (1H, q, J=5, C-1'H); ^{13}C NMR, δ ppm: 14.66 (CH_3), 15.34 (CH_3), 15.46 (CH_3), 17.49 (CH_2), 19.94 (CH_3), 20.28 (CH_3), 20.42 (CH_3), 21.16 (CH_3), 24.51 (CH_2), 31.19 (C), 31.68 (CH_3), 39.51 (CH_2), 39.58 (C), 41.59 (CH_2), 50.89 (CH), 58.55 (CH_2), 58.87 (CH), 65.41 (C-12), 79.96 (C-8), 83.16 (C-7), 93.14 (C-1'H), 168.92 (C=O, ester), 170.33 (C=O, ester), 206.48 (C=O, ketone).

9β-Hydroxyethyl-7α-hydroxy-8α-ethoxyethyloxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6-one, 15.
Asolution of **14** (1.7 g, 3.8 mmol) in MeOH (25 mL) containing 2% KCN was kept overnight at room temperature. Standard work-up gave **15** (1.25 g, 91%), as an oil, $C_{20}H_{36}O_5$; IR cm^{-1}: 3400 (OH), 1715 ($\nu_{C=O}$), 1050 (C-O); ^1H NMR, 300 MHz, one isomer, δ ppm: 0.86 (3H, s, CH_3), 1.0 (3H, s, CH_3), 1.16 (3H, s, CH_3), 1.30 (3H, s, C-17H3), 1.30 (3H, t , J=7, $CH_2\underline{CH_3}$), 1.36 (3H, d, J=5, $CHCH_3$), 1-1.90 (9 H, m, CH, CH_2), 3.06 (1H, s, C-5H), 3.53 (2H, m, $\underline{CH_2}CH_3$), 3.54 and 3.76 (2H, 2m, C-12H2), 3.80 (1H, s, C-7H), 4.90 (1H, q, J=5, C-1'H).

9β-t-Butyldimethylsilyloxyethyl-7α-hydroxy-8α-ethoxyethyloxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6-one, 16.
A solution of **15** (1.1 g, 3.08 mmol), imidazole (420 mg, 6.17 mmol) and TBDMSCl (513 mg, 3.4 mmol) in anhydrous THF (20 mL) was kept overnight at room temperature. After addition of aqueous $NaHCO_3$, extraction with ether and usual work-up provided **16** (1.4 g, 96%), mixture of epimers, as an oil; $C_{26}H_{50}O_5Si$, calc.% C

66.34, H 10.71, found C 66.60 H 10.45; CIMS: MH^+ 471, peaks at 425, 399, 381; ^1H NMR, 300 MHz, one isomer, δ ppm: 0.08 (6H, s, $SiMe_3$), 0.80 (3H, s, CH_3), 0.93 (9H, s, tBu), 0.95 (3H, s, CH_3), 1.10 (3H, s, CH_3), 1.27 (3H, s, C-17H_3), 1.27 (3H, t , J=7, $CH_2\underline{CH_3}$), 1.30 (3H, d, J=5, $CH\underline{CH_3}$), 1-1.90 (9 H, m, CH, CH_2), 3.0 (1H, s, C-5H), 3.50 (2H, m, $\underline{CH_2}CH_3$), 3.56 and 3.76 (2H, 2m, C-12H_2), 3.73 (1H, s, C-7H), 4.83 (1H, q, J=5, C-1'H).

9β-t-Butyldimethylsilyloxyethyl-8α-ethoxyethyloxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6-7-dione, 17.
Dess-Martin periodinane (1.5 g, 3.5 mmol) was added to a solution of **16** (1.5 g, 3.19 mmol) in CH_2Cl_2 (30 mL). The mixture was stirred for 1 h. Ether (50 mL) was added and then aqueous $S_2O_7Na_2$ and aqueous $NaHCO_3$ were added. The mixture was stirred again until it becomes clear. Extraction with ether and treatment as usual gave **17**, which was reduced without further purification.

9β-t-Butyldimethylsilyloxyethyl-8α-ethoxyethyloxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6β-7β-diol, 18.
$NaBH_4$ (38 mg, 1 mmol) was added to a solution of crude **17** (343 mg, 0.73 mmol) in EtOH (5 mL). Standard work-up provided **18** (223 mg, 64%), purified by flash chromatography, as an oil, $C_{26}H_{25}O_5Si$, calc.% C 66.05, H 11.05, found C 65.88 H 11.01; CIMS: MH^+ 473, peaks at 427, 401, 383; ^1H NMR, 300 MHz, one isomer, δ ppm: 0.05 (3H, s, $SiMe_3$), 0.06 (3H, s, $SiMe_3$), 0.90 (9H, s, tBu), 0.98 (3H, s, CH_3), 1.18 (6H, s, CH_3), 1.18 (3H, t, J=7, $CH_2\underline{CH_3}$), 1.32 (3H, d, J=5, $CH\underline{CH_3}$), 1.50 (3H, s, C-17H_3), 1-1.90 (10 H, m, CH, CH_2), 3.54 (2H, m, CH_2CH_3), 3.56 and 3.68 (2H, 2m, C-12H_2), 3.63 (1H, d, J=4, C-7H), 4.39 (1H, t, J=4, C-6H), 5.02 (1H, q, J=5, C-1'H).

9β-t-Butyldimethylsilyloxyethyl-8α-ethoxyethyloxy-6β-7β-carbodioxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalene 19.
Phosgene (0.25 mL of a 20% toluene solution) was added to a solution of **18** (223 mg, 0.47 mmol) in pyridine (3 mL) at 0°C. The mixture was kept overnight at room temperature. After careful addition of aqueous $NaHCO_3$, standard work-up gave **19** (230 mg, 97%), purified by flash chromatography, as an oil, $C_{27}H_{50}O_6Si$, calc.% C 65.02, H 10.11, found C 65.10 H 10.17; CIMS: MH^+ 499, peaks at 427, 409, 385; IR cm^{-1}: 1770 ($\nu_{C=O}$); ^1H NMR, 300 MHz, one isomer, δ ppm: 0.05 (6H, s, $SiMe_3$), 0.89 (9H, s, tBu), 1.03 (3H, s, CH_3), 1.08 (3H, s, CH_3), 1.13 (3H, s, CH_3), 1.16 (3H, t , J=7, CH_2CH_3), 1.28 (3H, d, J=5, $CHCH_3$), 1.39 (3H, s, C-17H_3), 1-1.90 (10 H, m, CH, CH_2), 3.51 (2H, m, $\underline{CH_2}CH_3$), 3.51 and 3.57 (2H, 2m, C-12H_2), 4.63 (1H, d, J=7, C-7H), 5.01 (1H, dd, J=4, J'=7, C-6H), 5.12 (1H, q, J=5, C-1'H).

9β-Hydroxyethyl-8α-ethoxyethyloxy-6β-7β-carbodioxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalene 20.
TBAF.3 H_2O (105 mg, 0.40 mmol) was added to a solution of **19** (200 mg, 0.40 mmol) in THF (5 mL). Standard work-up gave **20** (140 mg, 91%) after purification by flash chromatography, as an oil, mixture of epimers; CIMS: MH^+ 385, peaks at 367, 339, 295, 277, 251, 233; IR cm^{-1}: 3250 (OH), 1780 ($\nu_{C=O}$)1015, 1035, 1080 (C-O); ^1H NMR, 250 MHz, one epimer, δ ppm: 1.05 (3H, s, CH_3), 1.10 (3H, s, CH_3), 1.14 (3H, s, CH_3), 1.19 (3H, t , J=7, $CH_2\underline{CH_3}$), 1.33 (3H, d, J=5, $CH\underline{CH_3}$), 1.43 (3H, s, C-17H_3), 0.9-1.90 (10 H, m, CH, CH_2), 3.47 (2H, m, $\underline{CH_2}CH_3$), 3.47 and 3.75 (2H, 2m, C-12H_2), 4.58 (1H, d, J=7, C-7H), 5.05 (1H, dd, J=4, J'=7, C-6H), 5.17 (1H, q, J=5, C-1'H).

9β-Carbaldehydemethyl-8α-ethoxyethyloxy-6β-7β-carbodioxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalene 21.
Dess-Martin periodinane (165 mg, 0.39 mmol) was added to a solution of **20** (150 mg, 0.39 mmol) in CH_2Cl_2 (5 mL). The mixture was stirred at room temperature for 1 h. Aqueous $S_2O_7Na_2$ and aqueous $NaHCO_3$ were then poured. Stirring was continued until the solution became clear. Standard work-up provided **21** (130 mg, 87%) purified by flash chromatography, as an oil, mixture of epimers, $C_{21}H_{34}O_6$ calc.% C 65.93, H 8.94, found C 65.72 H 8.77; CIMS: MH^+ 383; IR cm^{-1}: 1770, 1718 ($\nu_{C=O}$), 1015, 1040 (C-O); ^1H NMR, 250 MHz, one epimer, δ ppm: 1.04 (3H, s, CH_3), 1.06 (3H, s, CH_3), 1.14 (3H, s, CH_3), 1.16 (3H, t , J=7, $CH_2\underline{CH_3}$), 1.24 (3H, d, J=5, $CH\underline{CH_3}$), 1.34 (3H, s, C-17H_3), 0.9-1.90 (7 H, m, CH, CH_2), 2.18 (1H, m, CH), 2.49 and

2.70 (2H, ABXY, J=18, J'= 4, J''=2, J'''=0.5, C-11H_2), 3.46 (2H, q, J=7, $\underline{CH_2}CH_3$), 4.80 (1H, d, J=7, C-7H), 5.09 (1H, dd, J=4, J'=7, C-6H), 5.10 (1H, q, J=5, C-1'H), 9.72 (1H, s, CHO).

9β-[(E)-3'-Carbethoxy-3'-methyl-prop-2'-enyl]-8α-ethoxyethyloxy-6β-7β-carbodioxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalene, 22.

Ethyl 2-diethylphosphonopropionate (242 mg, 1.02 mmol) was added to a stirred suspension of NaH (39 mg of a 63% suspension in oil, 1.02 mmol), in anhydrous toluene (3 mL), at 0°C, under Argon atmosphere. After 15 min. at rt, **21** (202 mg, 0.53 mmol) in toluene (3 mL) was introduced. The yellow solution was stirred at room temperature for 30 min. After cooling, aqueous ammonium chloride was added and ether extraction provided pure E-ester **22** (202 mg, 82%) after chromatography on silicagel column (the Z isomer which was present in ca.5% was not isolated), $C_{26}H_{42}O_7$, calc. %: C 66.93, H 9.07, O 24, found: C 67.03, H 8.97, O 23.82; CIMS: MH^+ 467, peaks at 395, 377, 351, 333, 315; UV $\lambda_{max\ EtOH}$: 220.8 nm (ε 13 212); IR cm^{-1}: 1802 ($\nu_{C=O}$ carbonate), 1711 ($\nu_{C=O}$ ester), 1653 (C=C), 1036, 1078, 1126, 1151 (C-O); ^1H NMR, 200 MHz, one of the epimers δ ppm: 0.8-1.8 (8H, m, CH, CH_2), 1.01 (3H, s, CH_3), 1.10 (6H, s, CH_3), 1.14 (3H, t, J=6, $CH_2\underline{CH_3}$), 1.24 (3H, d, J=5, $CH\underline{CH_3}$), 1.25 (3H, t, J=7, $CH_2\underline{CH_3}$), 1.34 (3H, s, C-17H_3), 1.80 (3H, s, C-16H_3), 2.20 and 2.45 (2H, m, C-11H_2), 3.47 (2H, q, J=6, $\underline{CH_2}CH_3$), 4.14 (2H, q, J=7, $\underline{CH_2}CH_3$), 4.72 (1H, d, J=6, C-7H), 5.04 (1H, dd, J=6, J'=3, C-6H), 5.08 (1H, d, J=5, $\underline{CH}CH_3$), 6.74 (1H, m, C-12H).

9β-[(E)-3'-Hydroxymethyl-3'-methyl-propen-2'-enyl]-8α-ethoxyethyloxy-6β-7β-carbodioxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6-one, 23.

$LiAlH_4$ (15 mg, 0.4 mmol), was added to a stirred solution of **22** (40 mg, 0.086 mmol) in anhydrous ether (3 mL), under Argon atmosphere. The suspension was stirred for 1 h at room temperature. Dropwise addition of saturated aqueous Na_2SO_4 was followed by filtration through paper filter . Evaporation of the solution gave **24** (18 mg, 57%), CIMS: MNH_4^+ 416, peaks at 398 , 370, 344, 326, 308; ^1H NMR, 250 MHz, one of the epimers, δ ppm: 0.5-1.87 (8H, m, CH, CH_2), 0.97 ((3H, s, CH_3), 1.21 (3H, s, CH_3), 1.23 (3H, s, CH_3), 1.24 (3H, d, J=7, $CH_2\underline{CH_3}$), 1.25 (3H, d, J=6, $CH\underline{CH_3}$), 1.37 (3H, s, C-17H_3), 1.65 (3H, s, C-16H_3), 2.10 (2H, m, C-11H_2), 3.35 (1H, d, J=4, C-7H), 3.48 (2H, q, J=7, $\underline{CH_2}CH_3$), 3.95 (2H, d, J=4, C-14H_2), 4.36 (1H, broad dd, C-6H), 4.79 (1H, q, J=6, $\underline{CH}CH_3$), 5.42 (1H, m, C-12H).

9β-[(E)-3'-Carbaldehylde-3'-methyl-prop-2'-enyl]-8α-ethoxyethyloxy-6β-7β-carbodioxy-4α,4β,8β,10β-tetramethyl-(*trans*)-1,3,5,9-octahydro-naphthalen-6-one, 24.

Dess-Martin periodinane (81mg, 0.20 mmol) was added portionwise to a solution of **23** (80 mg, 0.20 mmol), in anhydrous CH_2Cl_2 (5 mL) and pyridine (0.1 mL) at 0°C. The mixture was stirred at room temperature until completion of the reaction, monitored by TLC, ether (10 mL) and then, aqueous $Na_2S_2O_7$ and aqueous $NaHCO_3$ were added. Stirring was gone on for 1 h. Extraction with ether gave **24** (24 mg, 37%), after flash chromatography, $C_{23}H_{40}O_5$, CIMS: MNH_4^+ 414, peaks at 368, 342, 324, 306; IR cm^{-1}: 1675 ($\nu_{C=O}$), 1642 (C=C), 1068, 1100, 1111, 1151 (C-O); UV $\lambda_{max\ EtOH}$: 232.8 nm (ε 21 266); ^1H NMR, 250 MHz, one of the epimers δ ppm: 0.8-2.2 (8H, m, CH, CH_2), 1.1 ((3H, s, CH_3), 1.21 (3H, s, CH_3), 1.22 (3H, d, J=7, $CH_2\underline{CH_3}$), 1.26 (3H, s, CH_3), 1.26 ((3H, d, J=5, $CH\underline{CH_3}$), 1.38 ((3H, s, C-17H_3), 1.75 (3H, s, C-16H_3), 2.47 and 2.65 (2H, m, C-11H_2), 3.51 (1H, d, J=4, C-7H), 3.50 (2H, q, J=7, $\underline{CH_2}CH_3$), 4.51 (1H, broad dd, C-6H), 4.90 (1H, q, J=5, $\underline{CH}CH_3$), 6.41 (1H, m, C-12H), 9.36 (1H, s, C-14H).

9β-[3'-Methylpenta-2',4'-dienyl]-6β-7β-8α-trihydroxy-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydro-naphthalene 2a.

Methylenetriphenylphosphorane (1 mL of 0.5 M THF solution, 0.5mmol) was added to **24** (18 mg, 0.045 mmol) in THF, at 0°C, under Argon atmosphere. The solution was stirred at room temperature for 1 h. After quenching with aqueous ammonium chloride, standard work-up gave **25** (10 mg, 62%) after purification by flash chromatography, as an oil, which was dissolved in MeOH (2 mL). PPTS (2mg; 0.008 mmol) was added. After 1 h at room temperature, aqueous $NaHCO_3$ was added and extraction with CH_2Cl_2 gave **2a** (14 mg, 95%) after flash chromatography, $C_{20}H_{34}O_3$, HR CIMS (CH_4 + NH_3): MNH_4^+ calc.341.2929 found 341.2890, MH^+ calc. 323.2586 found 323.2572, UV $\lambda_{max\ EtOH}$: 231.8 nm (ε 18.000); ^1H NMR, 400 MHz, δ ppm: 0.8-1.8 (7H, m, CH, CH_2), 0.98 (1H, d, J=2, C-5H), 1.01 (3H, s, CH_3), 1.21 (3H, s, CH_3), 1.22 (3H, s, CH_3), 1.36 (3H, s , C-17H_3), 1.81 (3H, s, C-16H_3), 2.29 and 2.49 (2H, ABXY, C-11H_2), 3.41 (1H, d, J=4, C-7H), 4.40

(1H, broad dd, C-6H), 4.92 (1H, d, J=9, C-15H), 5.07 ((1H, d, J=18, C-15H), 5.59 (1H, broad t, J=6, C-12H), 6.34 (1H, dd, J=18, J'=9, C-14H).^{13}C NMR, δ ppm: 11.96 (CH_3), 16.80 (CH_3), 18.77 (CH_2), 19.52 (CH_3), 23.41 (CH_2), 24.02 (CH_3), 33.45 (CH_3), 34.25 (C), 39.57 (C), 42.25 (CH_2), 43.74 (CH_2), 55.77 (CH), 60.58 (CH), 70.93 (CH), 77.28 (C), 80.67 (CH), 110.73 (C-15), 133.0 (C), 135.60 (CH), 141.54 (CH); CD_3OD, δ ppm: 11.81 (CH_3), 17.22 (CH_3), 18.70 (CH_3), 19.48 (CH_2), 24.08 (CH_2), 24.08 (CH_3), 33.55 (CH_3), 34.85 (C), 40.42 (C), 43.46 (CH_2), 44.81 (CH_2), 56.89 (CH), 62.01 (CH), 72.22 (CH), 77.57 (C), 81.63 (CH), 109.6 (CH_2), 132.45 (C), 138.24 (CH), 143.02 (CH).

9β-t-Butyldimethylsilyloxyethyl-7α,8α-[1'-methoxy-1'-dioxymethyl]-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydronaphthalen-6-one, 26.
A solution of **11** (1.2 g, 3 mmol) and trimethyl orthoformate (1mL, 12 mmol) in benzene (50 mL) was refluxed for 15 min. in the presence of CSA (catalytic). After cooling, ether was added and the solution was washed with aqueous $NaHCO_3$. The organic phase dried on $MgSO_4$ was evaporated to give **26** purified by flash chromatography (0.94 g, 78%) as mixture of epimers, $C_{24}H_{44}O_5Si$, Calc. %: C 65.41, H 10.06, found C 65.77, H 9.81; EIMS: M^+ 440, m/z 411, 383, 323; IR cm^{-1}: 1721 ($\nu_{C=O}$), 1100 (C-O); ^{1}H NMR, 250 MHz, δ ppm: (mixture of epimers 1/4), -0.25 (major) and -011 (minor) (6H, s, 2 $SiCH_3$), 0.66 (3H, s, CH_3), 0.81 (9H, s, tBu), 0.86 (3H, s, CH_3), 1.13 (3H, s, CH_3), 1.27 (minor) (3H, s, C-17H_3), 0.80-1.80 (9H, m, CH, CH_2), 2.56 (major) and 2.70 (minor) (1H, s, C-5H), 3.23 (major) and 3.32 (minor) (3H, s, OCH_3), 3.65 and 3.80 (2H, 2m, C-12H_2), 3.73 (1H, s, C-7H), 5.60 (minor) and 5.78 (major) (1H, s, C-1'H).

9β-Hydroxyethyl-7α,8α-[1'-methoxy-1'-dioxymethyl]-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydronaphthalen-6-one, 27.
A solution of **26** (2 g, 4.5 mmol) and TBAF.3H_2O (1.43 g, 4.5 mmol) in THF (30 mL) was kept overnight at room temperature. After addition of water, ether extraction gave **27** (1.35 g, 96%). After purification by flash chromatography, the major epimer could be separated for spectral analysis, $C_{18}H_{30}O_5$; EIMS: M^+ 326, m/z 294, 266; IR cm^{-1}: 3400 (OH), 1718 ($\nu_{C=O}$), 1070, 1110 (C-O); ^{1}H NMR, 250 MHz, δ ppm: (major epimer) 0.75 (3H, s, CH_3), 0.8-2.0 (9H, m, CH, CH_2), 0.98 (3H, s, CH_3), 1.23 (3H, s, CH_3), 1.31 ((3H, s, C-17H_3), 2.80 (1H, s, C-5H), 3.48 (3H, s, OCH_3), 3.73 (2H, m, C-12H_2), 3.73 (1H, s, C-7H), 5.75 (1H, s, H-1'); ^{13}C NMR, δ ppm: 16.37 (CH_3), 18.26 (CH_2), 20.26 (CH_3), 21.87 (CH_3), 27.78 (C, C-11), 32.16 (CH_3), 39.61 (CH_2), 41.25 (C), 42.26 (CH_2), 51.29 (CH), 52.44 (CH), 60.60 (OCH_3), 62.38 (C-12), 85.77 (C-7), 89.01 (C-8), 115.80 (C-1'), 206.56 (C=O).

9β-Carbaldehydemethyl-7α,8α-[1'-methoxy-1'-dioxymethyl]-4α,4β,8β,10β-tetramethyl-(*trans*)-decahydronaphthalen-6-one, 28.
Dess-Martin periodinane (1.98 g, 4.6 mmol) was added, at 0°C, to a stirred solution of **27** (1.27 g, 3.9 mmol) in CH_2Cl_2 (30 mL), then, the reaction was carried on at room temperature. After completion of the reaction, monitored by TLC, ether (30 mL) was introduced and then, aqueous $Na_2S_2O_7$ followed by aqueous $NaHCO_3$ were added. The mixture was stirred for 1 h. After addition of water, the organic products were extracted with ether. Ethereal solutions were washed with brine, dried on $MgSO_4$ and evaporated to give **28** (1.24 g, 98%). The major epimer could be separated by chromatography for spectral analysis, $C_{18}H_{28}O_5$; EIMS: M^+ 324, m/z 292, 264, 235; IR cm^{-1}: 1722 ($\nu_{C=O}$), 1070, 1110 (C-O); ^{1}H NMR, 250 MHz, δ ppm, (major epimer): 0.76 (3H, s, CH_3), 0.80-1.66 (7H, m, CH, CH_2), 0.96 (3H, s, CH_3), 1.20 (3H, s, CH_3), 1.35 ((3H, s, C-17H_3), 2.53 (2H, m, C-11H_2), 2.70 (1H, s, C-5H), 3.33 (3H, s, OCH_3), 3.86 (1H, s, C-7H), 5.90 (1H, s, C-1'H), 9.75 (1H, s, C-12H_2); ^{13}C NMR, δ ppm: 16.38 (CH_3), 17.81 (CH_2), 20.26 (CH_3), 21.53 (CH_3), 23.8 (C), 31.82 (CH_3), 39.20 (CH_2), 39.98 (CH_2), 40.77 (C), 42.53 (CH_2), 50.65 (CH), 53.57 (CH), 59.93 (OCH_3), 85.68 (C-8), 87.83 (C-7), 118.29 (C-1'), 201.55 (CH=O), 205.74 (C=O).

9β-[(E)-3'-Carbethoxy-3'-methyl-prop-2'-enyl]-7-hydroxy-4α,4β,8β,10β-tetramethyl-(*trans*)-1,3,5(6),9(10)-octahydro-naphthalen-6-one, 29.
Ethyl 2-diethylphosphonopropionate (715 mg, 3 mmol) was added to a stirred suspension of NaH (123 mg of a 63% suspension in oil, 3 mmol), in anhydrous toluene (3 mL), at 0°C, under Argon atmosphere. After 15 min. at rt, **28** (336 mg, 1.03 mmol) in toluene (3 mL) was introduced. The yellow solution was warmed at 80°C for 30 min. After cooling, aqueous ammonium chloride was added and ether extraction provided pure E-ester **29** (215 mg, 61%) after chromatography on Florisil column (the Z isomer was not isolated), $C_{21}H_{32}O_4$, EIMS: M^+ 348;

^{1}H NMR, 250 MHz, δ ppm: 0.87 (3H, s, CH_3), 1.13 (3H, s, CH_3), 1.15 (3H, s, CH_3), 1.1-1.9 (6H, m, CH_2), 1.30 (3H, t, J=7, $CH_2\underline{CH_3}$), 1.80 (3H, s, C-17H_3), 1.86 (3H, s, C-16H_3), 2.15 (1H, s, C-5H), 2.35 and 2.49 (2H, m, C-11H_2), 2.35 (1H, m, C-9H), 4.20 (2H, q, J=7, $\underline{CH_2}CH_3$), 6.20 (1H, s, OH), 6.80 (1H, m, C-12H).

9β-[(E)-3'-Carbethoxy-3'-methyl-prop-2'-enyl]]-7-triethylsilyloxy-4α,4β,8,10β-tetramethyl-(*trans*)-1,3,5(6),9(10)-octahydro-naphthalen-6-one, 30.

Ethyl diethylphosphono-2-propionate (1.07g, 4.5 mmol) was added to a stirred suspension of NaH (171 mg of a 63% suspension in oil, 4.5 mmol), in anhydrous toluene (5 mL), at 0°C, under Argon atmosphere. After 15 min. at 0°C, **28** (490 mg, 1.5 mmol) in toluene (5 mL) was introduced. The yellow solution was warmed at 80°C for 30 min. After cooling, Et_3N (364 mg, 4 mmol), chorotriethylsilane (603 mg, 4 mmol) and DMAP (12 mg, 0.1 mmol) were successively added. The mixture was kept overnight at room temperature. After dilution with water, ether extraction provided E-ester **30** (323 mg, 46%), purified by chromatography on Florisil column, $C_{27}H_{46}O_4Si$; EIMS: M^+ 462, m/z 433, 418; IR cm^{-1}: 3400 (OH), 1712 ($\nu_{C=O}$, ester), 1683 ($\nu_{C=O}$, ketone), 1640 and 1626 (C=C), 1278 (C-O ester), 1100 (C-O); UV $\lambda_{max\ EtOH}$: 217.8 (ε 8000), 268.9 (ε 8805); ^{1}H NMR, 200 MHz, δ ppm: 0.69 (2H, q, J=8, $SiCH_2$) 0.70 (4H, q , J=8, $SiCH_2$), 0.88 (3H, s, CH_3), 0.96 (9H, t, J=8, $SiCH_2\underline{CH_3}$), 1.12 (3H, s, CH_3), 1.19 (3H, s, CH_3), 1.2-1.9 (6H, m,, CH_2), 1.29 (3H, t, J=7, $CH_2\underline{CH_3}$), 1.76 (3H, d, J= 1, C-17H_3), 1.86 (3H, s, C-16H_3), 2.08 (1H, s, C-5H), 2.34 and 2.47 (2H, m, C-11H_2), 2.34 (1H, m, C-9H), 4.19 (2H, q, J=7, $\underline{CH_2}CH_3$), 6.81 (1H, m, C-12H); ^{13}C NMR, δ ppm: 6.0 ($SiCH_2$), 6.98 (CH_3), 12.66 (CH_3), 14.32 (CH_3), 14.60 (CH_3), 15.08 (CH_3), 18.21 (CH_2), 21.60 (CH_3), 27.49 (CH_2), 32.48 (C), 33.39 (CH_3), 39.38 (CH_2), 42.56 (C), 43.12 (CH_2), 54.99 (CH), 60.52 (CH_2), 62.83 (CH), 127.19 (C), 132.58 (C), 143.26 (C-12) 145.32 (C-7), 167.88 (C=O, ester), 194.889 (C=O, ketone).

9β-[(E)-3'-Carbethoxy-3'-methyl-prop-2'-enyl]-7α,8α-[1'-methoxy-1'-dioxymethyl]-4α,4β,8,10β-tetramethyl-(*trans*)-decahydro-naphthalen-6-one, 31.

Flame dried LiCl (593 mg, 14 mmol) was dissolved in anhydrous acetonitrile (10 mL) under Argon. DBU (2.12 g, 14 mmol) and ethyl diethyl-2-phosphonopropionate (3.33 g, 14 mmol) were successively added. After stirring at room temperature, for 15 min, **28** (0.907g, 2.8 mmol) in MeCN was introduced. The reaction mixture was stirred for 4 h. After quenching with aqueous ammonium chloride, standard work-up gave a residue which, by chromatography on silicagel column, provided a small amount of (Z)-ester (60mg, 5%) and **31** (560 mg, 51%), as an oil, mixture of epimers, $C_{23}H_{36}O_6$, EIMS: M^+ 408, m/z 376, 348; IR ν cm^{-1}: 1710 ($\nu_{C=O}$, ester, ketone), 1640 (C=C), 1250 (C-O, ester, 1085, 1110 (C-O); ^{1}H NMR, 200 MHz, major epimer, δ ppm: 0.79 (3H, s, CH_3), 0.95 (3H, s, CH_3), 1.20 (3H, s, CH_3), 1.2-1.9 (7H, m, CH, CH_2), 1.25 (3H, s, C-17H_3), 1.26 (3H, t, J=7, $CH_2\underline{CH_3}$), 1.86 (3H, s, C-16H_3), 2.32 and 2.65 (2H, 2m, C-11H_2), 2.80 (1H, s, C-5H), 3.42 (3H, s, OCH_3), 3.72 (1H, s, C-7H), 4.18 (2H, q, J=7, $\underline{CH_2}CH_3$), 5.72 (1H, s, C-1'H), 6.96 (1H, tq, J=7, J'=1, C-12H).

Z-isomer, ^{1}H NMR, 200 MHz, major epimer, δ ppm: 0.79 (3H, s, CH_3), 0.95 (3H, s, CH_3), 1.20 (3H, s, CH_3), 1.2-1.9 (7H, m, CH, CH_2), 1.25 (3H, s, C-17H_3), 1.26 (3H, t, J=7, $CH_2\underline{CH_3}$), 1.90 (3H, s, C-16H_3), 2.58 and 2.79 (2H, 2m, C-11H_2), 2.79 (1H, s, C-5H), 3.45 (3H, s, OCH_3), 3.74 (1H, s, C-7H), 4.22 (2H, q, J=7, $\underline{CH_2}CH_3$), 5.72 (1H, s, C-1'H), 6.19 (1H, tq, J=6, J'=1, C-12H).

9β-[(E)-3'-Hydroxymethyl-3'-methyl-propen-2'-enyl]-7-triethylsilyloxy-4α,4β,8,10β-tetramethyl-(*trans*)-1,3,5,9-octahydro-naphthalen-6-one, 32.

$LiAlH_4$ (40 mg, 1.05 mmol), was added to a stirred solution of **31** (320 mg, 0.69 mmol) in anhydrous ether (5 mL), under Argon atmosphere. The suspension was stirred for 1 h at room temperature. Dropwise addition of saturated aqueous Na_2SO_4 was followed by filtration through paper filter. Evaporation of the solution gave **32** (248 mg, 85%) used without further purification, $C_{25}H_{44}O_3Si$, EIMS: M^+ 420, m/z 391, 305; IR cm^{-1}: 3500 (OH), 1686 ($\nu_{C=O}$, ketone), 1616 (C=C), 1000 (C-O); ^{1}H NMR, 200 MHz, δ ppm: 0.72 (6H, q, J=8, $SiCH_2$), 0.86 (3H, s, CH_3), 0.96 (9H, t, J=8, $SiCH_2\underline{CH_3}$), 1.11 (3H, s, CH_3), 1.18 (3H, s, CH_3), 0.8-1.9 (6H, m, CH_2), 1.68 (3H, s, C-16H_3), 1.79 (3H, s, C-17H_3), 2.05 (1H, s, C-5H), 2.23 (2H, m, C-11H_2), 2.31 (1H, m, C-9H), 4.0 (2H, broad s, C-14H_2), 5.43 (1H, m, C-12H); ^{13}C NMR, δ ppm: 5.99 ($SiCH_2$), 7.0 (CH_3), 14.05 (CH_3), 14.61 (CH_3), 15.07 (CH_3), 18.26 (CH_2), 21.63 (CH_3), 26.33 (CH_2), 32.48 (C), 33.03 (CH_3),

39.32 (CH_2), 42.65 (C), 43.22 (CH_2), 55.47 (CH), 62.97 (CH), 68.79 (C-14), 127.68 (C-12), 133.87 (C), 134.07 (C), 145.08 (C-7), 195.15 (C=O, ketone).

9β-[(E)-3'-Carbaldehylde-3'-methyl-prop-2'-enyl]-7-triethylsilyloxy-4α,4β,8,10β-tetramethyl-(trans)-1,3,5,9–octahydro-naphthalen-6-one, 33.

Dess-Martin periodinane (300 mg, 0.71 mmol) was added portionwise to a solution of **32** (248 mg, 0.59 mmol), in anhydrous CH_2Cl_2 (5 mL) and pyridine (0.2 mL) at 0°C. The mixture was stirred at room temperature until completion of the reaction, monitored by TLC, ether (10 mL) and then, aqueous $Na_2S_2O_7$ and aqueous $NaHCO_3$ were added. Stirring was gone on for 1 h. Extraction with ether gave **33** (240 mg, 92%), used without further purification, $C_{25}H_{42}O_3Si$, EIMS: M-1$^+$ 417, m/z 389, 361, 307; ^{1}H NMR, 200 MHz, δ ppm: 0.70 (6H, q, J=8, $SiCH_2$), 0.89 (3H, s, CH_3), 0.96 (9H, t, J=8, $SiCH_2\underline{CH_3}$), 1.12 (3H, s, CH_3), 1.18 (3H, s, CH_3), 0.8-1.9 (6H, m, CH_2), 1.76 (3H, s, C-16H_3), 1.77 (3H, s, C-17H_3), 2.09 (1H, s, C-5H), 2.53 (3H, m, C-9H, C-11H_2), 6.5 (1H, m, C-12H), 9.39 (C-14H).

9β-[(E,E)-3'-Methyl-penta-2',3'-dienyl]-7-triethylsilyloxy-4α,4β,8,10β-tetramethyl-(*trans*)-1,3,5,9–octahydro-naphthalen-6-one, 34.

Methylenetriphenylphosphorane (3.4 mL of 0.5 M THF solution, 1.7 mmol) was added to **33** (240 mg, 0.57 mmol) in THF, at 0°C, under Argon atmosphere. The solution was stirred at room temperature for 1 h. After quenching with aqueous ammonium chloride, standard work-up gave **34** (150 mg, 63%) after purification by flash chromatography, as an oil, $C_{26}H_{44}O_2Si$; EIMS: M$^+$ 416, m/z 401, 387, 335, 306; ^{1}H NMR, 200 MHz, δ ppm: 0.65 (6H, q, J=8, $SiCH_2$), 0.82 (3H, s, CH_3), 0.8-1.9 (6H, m, CH_2), 0.91 (9H, t, J=8, $SiCH_2\underline{CH_3}$), 1.07 (3H, s, CH_3), 1.13 (3H, s, CH_3), 1.70 (3H, s , C-16H_3), 1.73 (3H, d, J=1, C-17H_3), 2.01 (1H, s, C-5H), 2.28 (3H, m, C-11H_2, C-9H), 4.95 (1H, d, J=10, C-15Ha), 5.30 (1H, d, J=18, C-15Hb), 5.50 (1H, broad t, J=5, C-12H), 6.36 (1H, dd, J=10, J'=18, H-14).

9β-[(E,E)-3'-Methyl-penta-2',3'-dienyl]-7-triethylsilyloxy-4α,4β,8,10β-tetramethyl-(*trans*)-1,3,5,9–octahydro-naphthalen-6β-ol, 35.

DIBAH (0.73 mL of 1.5 M toluene solution, 1.1 mmol) was added to a stirred solution of **34** (104 mg, 0.25 mmol) in toluene (3 mL), at -78°C, under Argon atmosphere and the resulting solution was stirred for 2 h. at -78°C. MeOH (0.05 mL) was added for quenching the reaction and the mixture was poured on a Florisil column. Elution with ether gave **35** (80 mg, 77%), used without further purification, $C_{26}H_{46}O_2Si$; EIMS: M$^+$ 418; ^{1}H NMR, 300 MHz, δ ppm: 0.66, 0.67 and 0.75 (6H, 3q , J=8, $SiCH_2$), 0.8-1.9 (7H, m, CH, CH_2), 0.97 (3H, s, CH_3), 1.01 (9H, t, J=8, $SiCH_2\underline{CH_3}$), 1.04 (3H, s, CH_3), 1.32 (3H, s, CH_3), 1.5 (1H, d, J=5, OH), 1.58 (3H, d, J=1, C-17H_3), 1.74 (3H, s, C-16H_3), 2.25 (3H, m, C-11H_2, C-9H), 4.27 (1H, dd, J=4, J'=5, C-6H), 4.90 (1H, d, J=10, C-15aH), 5.05 (1H, d, J=18, C-15bH), 5.50 (1H, broad t, J=6, C-12H), 6.34 (1H, dd, J=10, J'=18, C-14H).

9β-[(E,E)-3'-Methyl-penta-2',3'-dienyl]-6β,7β,8β-trihydroxy-4α,4β,8α,10β-tetramethyl-(*trans*)-decahydro-naphthalene, 2b.

Commercial MCPBA (70%, 50 mg, 0.17 mmol) was dried overnight in a dessicator and added to a solution of **22** (80 mg, 0.19 mmol) in anhydrous CH_2Cl_2 (3 mL) in the presence of solid Na_2CO_3, at 0°C. The suspension was stirred for 1.5 h at 0°C and then, aqueous $Na_2S_2O_7$ was added. The organic phase was separated, washed with brine and evaporated to give a residue which was dissolved in absolute EtOH (2 mL) and directly reduced with $NaBH_4$ (40 mg, 1.05 mmol). The solution was stirred overnight at room temperature. Standard work-up provided a mixture of products which were separated by chromatography on silicagel column. Elution with CH_2Cl_2/MeOH 95/5 provided **2b** (14 mg, 22%), $C_{20}H_{34}O_3$, HR CIMS (CH_4+NH_3): MH$^+$ calc. 323.2586 found 323.2590, UV $\lambda_{max\ EtOH}$: 231.8 nm (ε 17.000); ^{1}H NMR, 250 MHz, δ ppm: 0.98 (3H, s, C-18H_3), 1.15 (3H, s, C-20H_3), 1.22 (3H, s, C-19H_3), 1.26 (3H, s, C-17H_3), 1.3 (6H, m, CH, CH_2), 1.7 (2H, m, CH_2), 1.77 (3H, s, C-16H_3), 2.18 and 2.43 (2H, ABXY, C-11H_2), 3.59 (1H, d, J=3, C-7H), 4.26 (1H, broad t, C-6H), 4.90 (1H, d, J=10, C-15H), 5.06 ((1H, d, J=18, C-15H), 5.45 (1H, broad t, J=6, C-12H),6.34 (1H, dd, J=18, J'=10, C-14H); ^{13}C NMR, $CDCl_3$, δ ppm: 12.04 (C-16), 17.99 (C-17), 18.47 (CH_2), 23.66 (C-19), 24.33 (C-11), 27.11 (C-20), 33.36 (C-18), 33.85 (C), 38.46 (C), 42.40 (CH_2), 43.74 (CH_2), 50.10 (CH), 54.27 (CH), 73.52 (C-6), 76.57 (C-8), 77.09 (C-7), 110.15 (C-15), 133.41 (C-13), 136.71 (C-12), 141.75 (C-14); CD_3OD, δ ppm: 12.30 (C-16), 18.30 (C-17), 19.54 (CH_2), 24.45 (C-19), 24.71 (C-11), 27.02 (C-18),

33.75 (C-20), 34.70(C), 39.61 (CH_2), 44.83 (CH_2), 50.71 (CH), 55.44 (CH), 73.97 (C-6), 77.55 (C-7), 78.09 (C-8), 110.09 (C-15), 133.20 (C-13), 138.11 (C-12), 143.02 (C-14).

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