Tetrahedron 64 (2008) 8815–8829

Contents lists available at ScienceDirect

Tetrahedron

journal homepage: www.elsevier.com/locate/tet

Synthetic studies to highly functionalised B ring labdanes

I.S. Marcos *, L. Castañeda, P. Basabe, D. Díez, J.G. Urones

Departamento de Química Orgánica, Facultad de Ciencias Químicas, Universidad de Salamanca, Plaza de los Caidos 1-5, 37008 Salamanca, Spain

ARTICLE INFO

Article history:
Received 28 May 2008
Received in revised form 20 June 2008
Accepted 23 June 2008
Available online 26 June 2008

Keywords:
Labdanes
Diterpenes
Sclareol

ABSTRACT

Several 6,7-dioxygenated (cis or trans) labdanes have been synthesised starting from sclareol. A new strategy that allows the obtention of diols α-cis as well as β-cis or trans is described. In particular, the syntheses of three natural highly functionalised labdanes in the B rings of **2**, **3** and **4** with different side chains are reported. The syntheses have permitted to correct the proposed structure for one of them.

1. Introduction

Highly functionalised B ring labdane diterpenes are a very interesting class of natural products due to the important biological activities that some of them show.[1] Being perhaps forskolin **1**[2] the most interesting example of all of them, as it presents cardioactive, adenylate cyclase stimulant and hypotensive properties. As well as forskolin, there are other functionalised labdanes in C-6 and C-7 as **2**–**5**,[3] isolated from plants, that have been used in folk medicine for the treatment of cardiovascular diseases or as sedative, uterotonic or repellents (Fig. 1).

In C-6 and C-7 positions can appear several oxygenated functions with different stereochemistry. The side chains are differently functionalised with *Z* and *E* double bonds, lactone rings or with monosubstituted double bonds (Fig. 1).

Our group has been interested in the synthesis of several of these compounds as **2**[3a] with unknown C-13 configuration and **4**[3c] that has in the side chain a less common *Z* double bond in this kind of derivatives. The structures of these compounds have been established only by spectroscopic methods and now we want to corroborate their structures and establish their absolute configuration. Compound **3**[3b] is a highly toxic metabolite isolated from the mucus of *Trimusculus reticulatus*, and it is a likely candidate to be active in defence mechanism against depredators. Recently Morin et al. have described the synthesis of **3** from larixol[4] and established the absolute configuration of the natural compound. Now, a new synthesis of **3** is described by us.

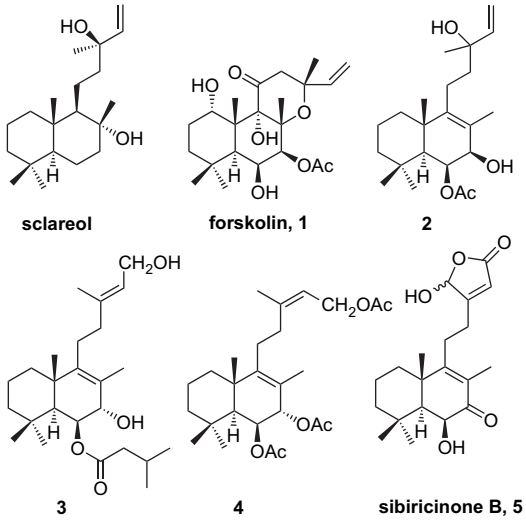


Figure 1.

Sclareol is a commercial compound that has been chosen as the starting material. We have previously used for the synthesis of several natural products as luffolide,[5] subersic acid,[6] hyrtiosal,[7] chrisolic acid[8] and nimbiol.[9]

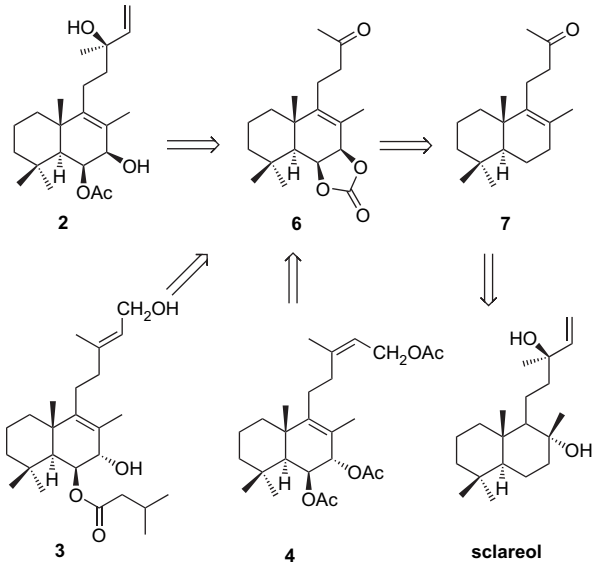
2. Results and discussion

The synthesis of **2**, **3** and **4** from sclareol was planned according to the following retrosynthetic scheme, Scheme 1. The key

* Corresponding author. Tel.: +34 923 294474; fax: +34 923 294574.
E-mail address: ismarcos@usal.es (I.S. Marcos).

0040-4020/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tet.2008.06.083

intermediate for the elaboration of the target compounds **2**, **3** and **4** is ketone **6** from which can be elaborated the different side chains of **2**, **3** and **4** and installed the adequate functionalisation of the B ring. Ketone **6** can be accessible from methylketone **7** obtained from sclareol and previously used by our group.[9] First of all we describe the synthesis of intermediate **6**, followed by the synthesis of **2** and finally the syntheses of **3** and **4**.

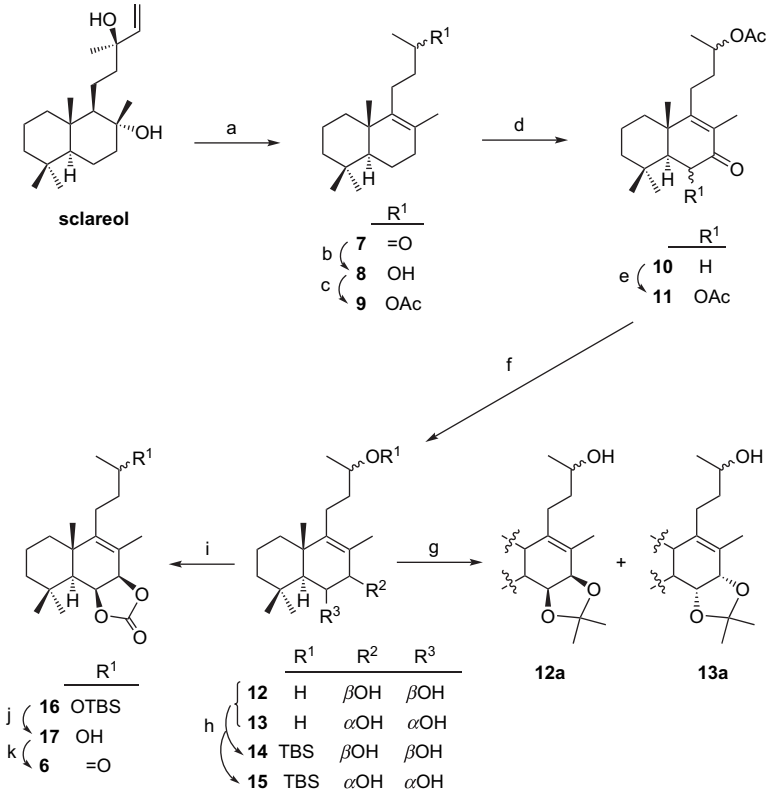


Scheme 1.

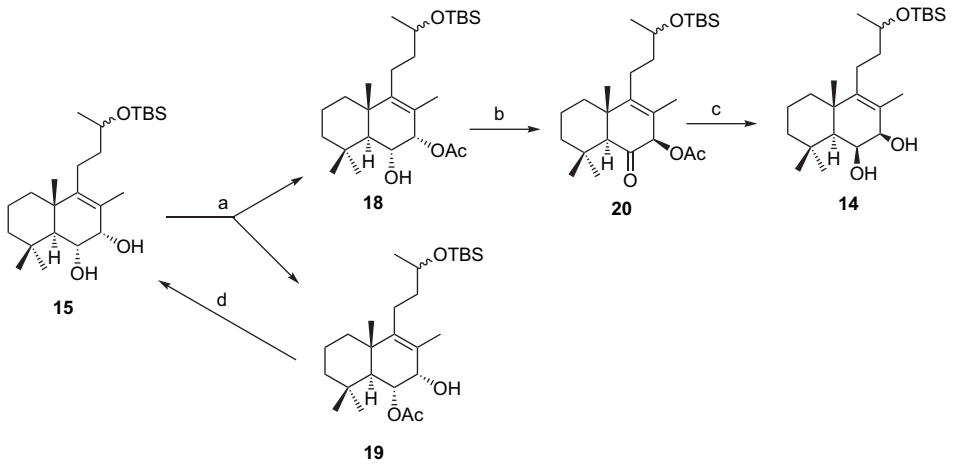
2.1. Synthesis of intermediate 6

The synthesis of **6** was done according to Scheme 2. Methylketone **7** was obtained from sclareol in an excellent yield,[9] and was transfomed into the acetylderivative **9** by reduction and ulterior acetylation of the hydroxyderivative **8**. The allylic oxidation[10] of **9** with Na_2CrO_4 gave enone **10** from which the mixture of epimer diacetylderivatives **11** was obtained by $Pb(OAc)_4$[11] oxidation in a 66% yield in two steps. The LAH reduction of **11** gave the mixture of triols **12** and **13** (1:2.5), hardly separable by CC. Each triol is an epimeric mixture in the side chain and can be distinguished as the hydroxyl groups of the B ring in **12** have β-cis configuration while in **13** appear as well as cis but with α configuration, as can be deduced from the acetonide derivatives **12a** and **13a**, ^{1}H NMR spectra. These derivatives are obtained by reaction of the corresponding diols **12** and **13** with 2,2-DMP using *p*-TsOH acid as catalyst. The cis orientation of the hydroxyl groups is required in both cases for the protection to take place in the above conditions. This in agreement with the coupling constants found for the geminal hydrogens H-6 in **12a** (4.59 ppm, dd, *J*=6.4 and 1.7 Hz), H-6 in **13a** (4.38 ppm, dd, *J*=12.8 and 2.0 Hz) and for H-7 in **12a** (4.30 ppm, d, *J*=6.4 Hz), H-7 in **13a** (3.79 ppm, d, *J*=2.0 Hz).

The quimioselective protection of the side chain hydroxyl group of **12** and **13** with TBDMSCl[12] gave **14** and **15**, respectively. The required isomer at this stage for the synthesis of **6** is **14**, although as will be commented later on, the isomer **15** can be transformed into **14** by inversion of the two stereogenic centres C-6 and C-7 in a high yield. Reaction of **14** with triphosgene[13] led quantitatively to the dioxolanone **16**. The TBAF[14] deprotection of **16** followed by TPAP[15] oxidation of the obtained hydroxyderivative **17** gave the required ketone **6**.



Scheme 2. Reagents and conditions: (a) Ref. 9; (b) LAH, Et_2O, rt, 1 h (99%); (c) Ac_2O, Py, rt, 6 h (98%); (d) Na_2CrO_4, Ac_2O, AcOH, AcONa, C_6H_6, 60 °C, 5 h (71%); (e) $Pb(OAc)_4$, C_6H_6, 80 °C, 72 h (93%); (f) LAH, Et_2O, rt, 1 h (100%); (g) 2,2-DMP, *p*-TsOH, rt, 1 h (**12a**, 31%; **13a**, 67%); (h) TBDMSCl, imidazole, DMF, rt, 15 h (**14**, 35%; **15**, 55%); (i) $(Cl_3CO)_2CO$, DCM, Py, −78 °C, 1 h (100% from **14**); (j) TBAF, THF, rt, 2 h (95%); (k) TPAP, NMO, sieves, DCM, rt, 1 h (96%).

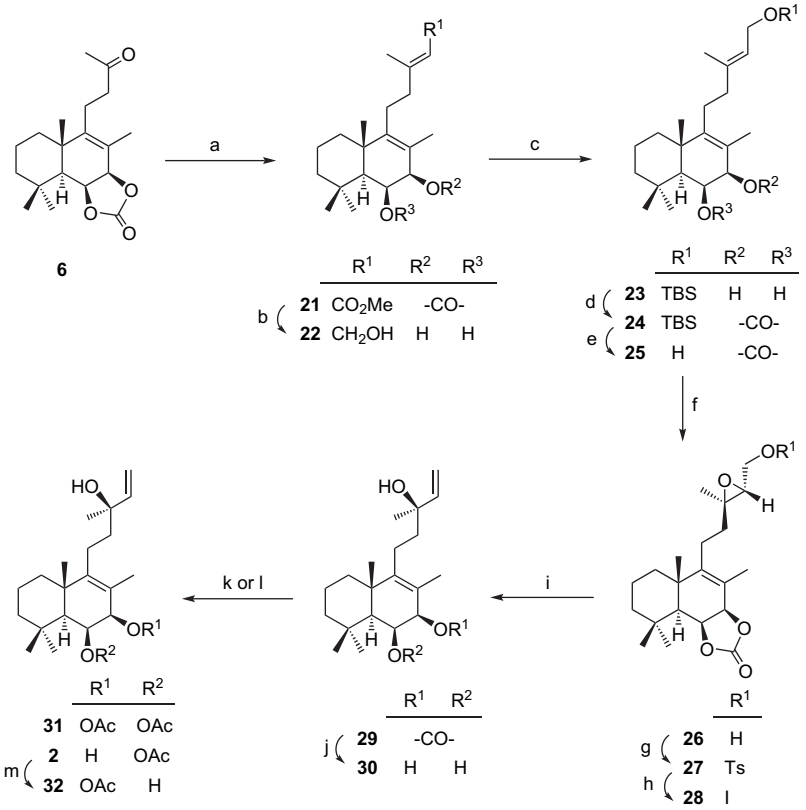


Scheme 3. Reagents and conditions: (a) Ac_2O, Py, rt, 2 h (**18**, 81%; **19**, 15%); (b) TPAP, NMO, sieves, DCM, rt, 1 h (99%); (c) LAH, Et_2O, rt, 45 min (99%); (d) LAH, Et_2O, rt, 1 h (96%).

The transformation of **15** into **14** can be achieved as indicated in Scheme 3. Controlled acetylation with Ac_2O in pyridine of **15** permitted to obtain as major compound the monoacetylderivative **18** (81%) together with the monoacetylderivative **19** (15%) that can be transformed back into **15**. The ^1H NMR spectrum for **18** shows signal at 5.22 ppm (1H, d, J=7.4 Hz) of H-7 geminal to the acetoxy group in allylic position, for its multiplicity and shield. The H-7 hydrogen signal, in the ^1H NMR spectrum for **19**, appears as doublet as well but more shielded at 3.95 ppm. By contrary, H-6 the geminal hydrogen to the acetoxy group appears in **19** at 5.22 ppm (1H, dd, J=12.2 and 6.6 Hz). The TPAP oxidation of **18** (Scheme 3) gave quantitatively ketone **20**. In the ^1H NMR spectrum of **20** by irradiation of the signal (singlet) corresponding to the geminal hydrogen to the acetoxy group at 5.61 ppm an NOE was observed with the signal at 2.52 ppm corresponding to H-5, which allowed us to verify the expected inversion of C-7, with the acetoxyl group in the more stable equatorial position. The LAH reduction of **20** gave the required isomer **14**.

2.2. Synthesis of 2

The synthesis of **2** was achieved as shown in Scheme 4. The side chain of **2** was completed in two different ways. In the first one the C-13 configuration was controlled using the Sharpless asymmetric



Scheme 4. Reagents and conditions: (a) $(EtO)_2P(O)CH_2CO_2Me$, NaH, monoglyme, 60 °C, 90 min (76%); (b) DIBAL-H, DCM, −78 °C, 30 min (100%); (c) TBDMSCl, imidazole, DMF, rt, 17 h (92%); (d) $(Cl_3CO)_2CO$, DCM, Py, −78 °C, 1 h (100%); (e) TBAF, THF, rt, 2 h (99%); (f) D(−)-DET, Ti(*i*-PrO)$_4$, *t*-BuOOH, DCM, −23 °C, 24 h (65%); (g) TsCl, Py, rt, 3 h (87%); (h) NaI, Me_2CO, 70 °C, 3 h (86%); (i) Zn, AcOH, rt, 2 h (98%); (j) LAH, Et_2O, rt, 1 h (100%); (k) Ac_2O, Py, rt, 6 days (**31**, 96%); (l) Ac_2O, Py, rt, 14 h (**2**, 97%); (m) AcOH, $CHCl_3$, rt, 48 h (**2**, 41%; **32**, 46%).

epoxidation and in the second one by the addition of an organometallic in presence of TADDOL.

The Horner–Wadsworth–Emmons (HWE)[16] reaction of **6** led to **21** that by DIBAL[17] reduction gave triol **22**. The glycol protection of C-6 and C-7 was done as dioxolanone and not as dimethyldioxolane. The deprotection of the acetonides requires relatively strong acid conditions, and the side chain functionalities were observed not to be stable under these conditions.

In order to protect again the hydroxyl groups of the B ring, the hydroxyl group of the side chain was protected as its silyl ether. Reaction of **22** with TBDMSCl and imidazol in DMF gave **23** that by reaction with trifosgene led to the carbonate derivative **24**. TBAF deprotection of **24** gave the hydroxyderivative **25**. The Sharpless[18] asymmetric epoxidation of **25** using D(−)-DET produced epoxyde **26**. The tosylation of the last compound with TsCl conduced to the tosylderivative **27** that by substitution with iodide provided **28**, which by reduction with Zn in AcOH[19] furnished carbonate **29** that has the allylic functionality in the side chain. The diacetate **31** was obtained by acetylation with acetic anhydride in pyridine at room temperature for 6 days of triol **30**, previously obtained by LAH reduction of **29**. The acetylation of **30** in the same conditions but keeping it only for 14 h provided unexpectedly the monoacetylderivative **2** in quantitative yield. When the compound **2** was left in chloroform with AcOH at room temperature for 48 h a mixture of **2** (41%) and **32** (46%) was obtained that was separated by column chromatography.

The monoacetylderivative **2** formation, that shows the more hindered axial hydroxyl group at C-6 esterified, can be explained by the hydrogen bond formation between the hydroxyl group of C-6 and the oxygen of the hydroxyl at C-7 (Fig. 2). In this manner the more nucleophilic oxygen of C-6 reacts with the acetic anhydride.

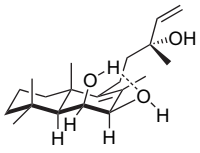


Figure 2.

The formation of **32** from **2** in mild acidic medium can be explained by an interchange of the acetoxy group. The acetoxy is transferred from the axial hydroxyl group at C-6 to the more stable equatorial hydroxyl group at C-7. The spectroscopic properties of **2** were not coincident with the corresponding ones of the natural compound isolated from *Haplopappus parvifolius*.[3a] Neither the properties of **32** were coincident with the ones of that natural compound. The differences in the spectroscopic properties led us to propose for the natural compound the structure of **37** (Scheme 5) that corresponds to the epimer at C-7, which was synthesised from **6**, as shown in Scheme 5.

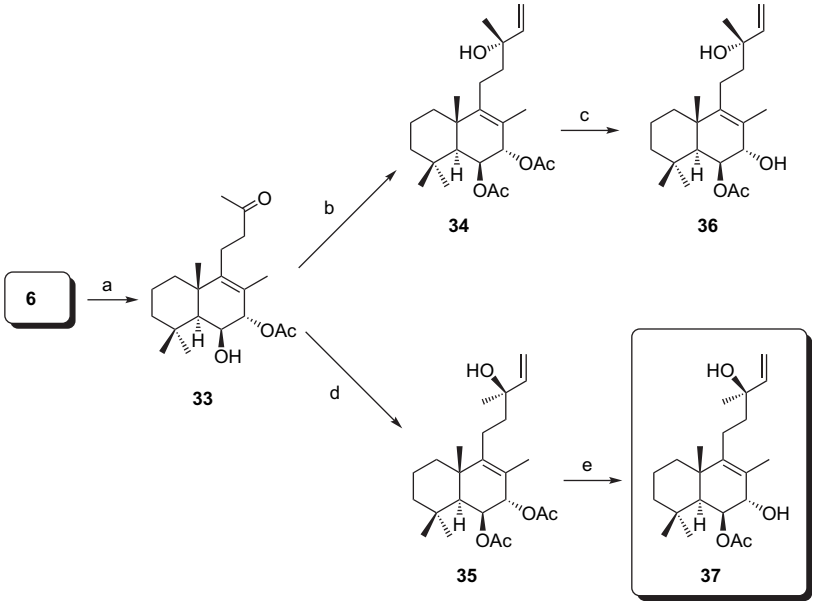
Reaction of **6** with Bu_4NOAc[20] in hot toluene (100 °C) for 20 h provided the monoacetylderivative **33**, with inversion of the configuration at C-7. The asymmetric addition of vinylbromide in presence of (+)- or (−)-TADDOL[21] led after acetylation to **34** and **35**, respectively, in good yield and excellent diastereoselection (de >99% in each case). The configuration for C-13 in **34** and **35** was established in agreement with the chiral auxiliary stereochemistry used in each case, corresponding to **34** the 13*S* configuration and to **35** the 13*R* configuration.

The monoacetylderivatives **36** and **37** were accessible by controlled hydrolysis of the diacetylderivatives **34** and **35**, respectively. The NMR signals were assigned using bidimensional $^1H/^{13}C$ HMBC and HMQC NMR experiments. The physical properties of the natural compound, isolated from *Haplopappus parvifolius*,[3a] $[\alpha]_D^{24}$ +30 (*c* 4.40, $CHCl_3$), were coincident with the ones of **37**, 6β-acetoxylabda-8,14-dien-7α,13*R*-diol, $[\alpha]_D^{22}$ +27 (*c* 0.50, $CHCl_3$), so in this manner the structure and absolute configuration for the natural compound were established.

2.3. Synthesis of 3 and 4

The structures of **3** and **4** differ in the stereochemistry of the side chain double bond *E* and *Z*, respectively, and in the acid that esterifies the hydroxyl group at C-6, isovaleric acid for **3** or acetic for **4**.

The reaction of **6** (Scheme 6) with $Ph_3PCHCOOEt$[22] heated in toluene, provided a mixture of isomeric esters *Z*/*E* **38** and **39** in a ratio 1:2 with excellent yield. The *E* isomer **21** was obtained in an excellent yield and major diastereoselection (10:1 *E*:*Z*) when compound **6** was submitted to the HWE reaction with methyl-



Scheme 5. Reagents and conditions: (a) Bu_4NOAc, Ph–Me, 100 °C, 20 h (94%); (b) (i) CH_2=CHMgBr, (+)-TADDOL, THF, −85 °C/−50 °C/rt/−90 °C, 24 h; (ii) Ac_2O, Py, rt, 6 days (86%); (c) K_2CO_3, MeOH, rt, 1 h (98%); (d) (i) CH_2=CHMgBr, (−)-TADDOL, THF, −85 °C/−50 °C/ rt/−90 °C, 24 h; (ii) Ac_2O, Py, rt, 6 days (85%); (e) K_2CO_3, MeOH, rt, 1 h (100%).

diethyl-phosphonoacetate in monoglyme, as previously described. The treatment of **39** with Bu_4NOAc in hot toluene provided the monoacetylderivative **40**, in which the required inversion at C-7 has taken place. The DIBAL reduction of **40** gave triol **41**. The selective esterification of **41** with isovaleric acid in order to obtain **3** was not possible as the esterified position C-6 is the more hindered, making necessary a process of esterification and hydrolysis.

The esterification of triol **41** was carried out by Yamaguchi[23] procedure, achieving in this way the complete esterification, obtaining **42**, that by selective hydrolysis controlled by TLC led to **3**, $[\alpha]_D^{22}$ +40.0 (*c* 1.01, $CHCl_3$), whose physical properties are identical to the ones described[3c] for the natural compound $[\alpha]_D^{22}$ +38.7 (*c* 0.83, $CHCl_3$).

For the synthesis of the natural compound **4** was used **38** as intermediate. In this case, it was not possible to follow the same strategy as for **3**, that is, to invert first C-7 and then to proceed with the esterification of C-6, as a cis–trans interconversion in the side chain took place during the C-7 inversion process of **38** by Bu_4NOAc treatment. For this reason it was necessary to proceed by reduction of the side chain ester and later on to do the inversion at C-7.

The DIBAL reduction of **38** gave triol **43**, which by treatment with TBDMSCl provided the silyl derivative **44**. Reaction of **44** with triphosgene gave the carbonate **45**. The next step was the inversion at C-7 that was achieved by treatment of **45** with Bu_4NOAc in hot toluene obtaining a mixture of **46** and **47**. The acetylation of **47** gave a triacetoxyderivative **4**, $[\alpha]_D^{22}$ +32.1 (*c* 0.51, $CHCl_3$), whose physical properties are identical to the ones of the natural product[3b] of unknown rotation value. In order to compare the physical properties of **4** with the ones of its isomer on the side chain, compound **48** was synthesised (Scheme 6).

3. Conclusions

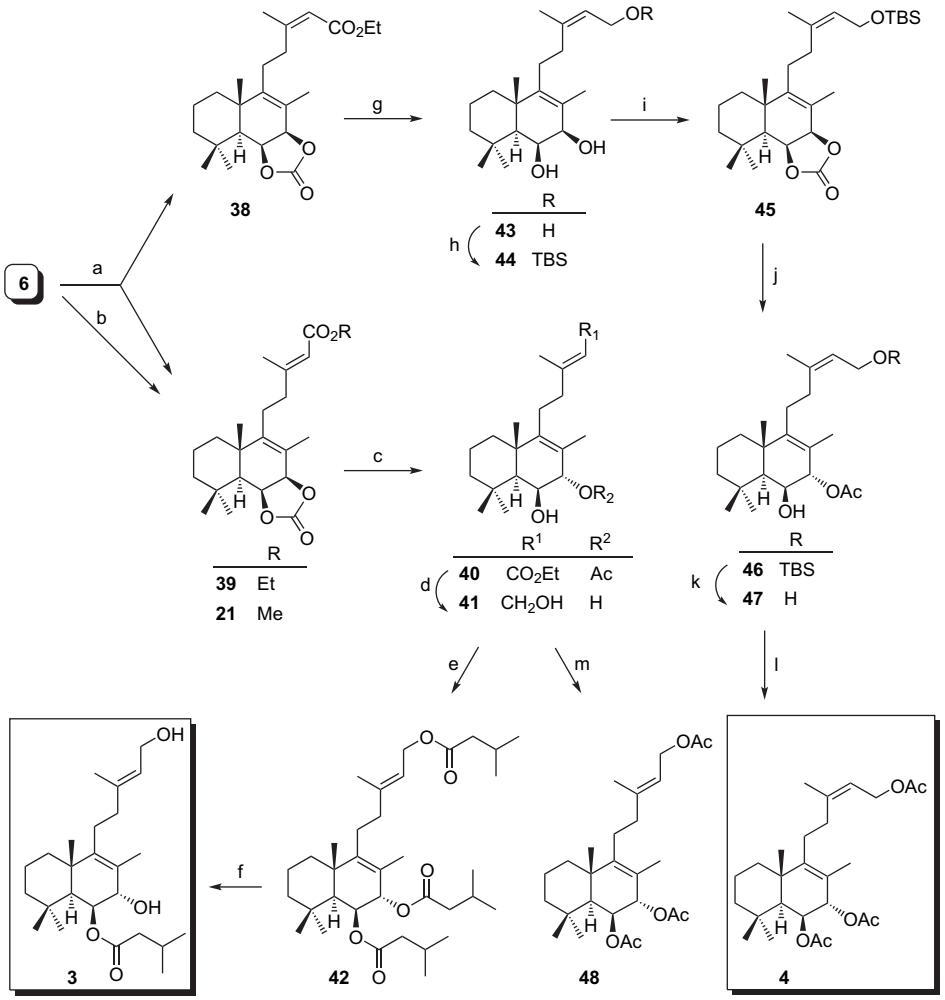
Starting with sclareol **1**, a new route of synthesis for highly functionalised B ring labdanes is described. In particular three labdanes with oxygenated functions at C-6 and C-7 cis and trans have been synthesised. A new strategy that permits the inversion of the two centres in the B ring from diols α-cis to diols β-cis, is shown.

The synthesis of compound **37** has permitted to correct the originally proposed structure for the natural product isolated from *Haplopappus parvifolius*. The synthesis of **4** has allowed us to corroborate the structure of the natural compound. A new synthesis of **3** is described.

4. Experimental

4.1. General

Unless otherwise stated, all chemicals were purchased as the highest purity commercially available and were used without



Scheme 6. Reagents and conditions: (a) Ph_3PCHCO_2Et, Ph–Me, 120 °C, 48 h (**38**, 19%; **39**, 28%, **6**, 31%); (b) $(EtO)_2P(O)CH_2CO_2Me$, NaH, monoglyme, 60 °C, 90 min (**21**, 76%); (c) Bu_4NOAc, Ph–Me, 80 °C, 46 h (98%); (d) DIBAL-H, DCM, −78 °C, 1 h (98%); (e) isovaleric acid, 2,4,6-trichlorobenzoyl chloride, Et_3N, Ph–Me, 28 h, 80 °C (100%); (f) K_2CO_3, MeOH, rt, 20 h (85%); (g) DIBAL-H, DCM, −78 °C, 1 h (100%); (h) TBDMSCl, imidazole, DMF, 40 h (96%); (i) $(Cl_3CO)_2CO$, DCM, Py, −78 °C, 1 h (100%); (j) Bu_4NOAc, Ph–Me, 80 °C, 46 h (**46**, 27%; **47**, 56%); (k) TBAF, THF, rt, 90 min (90%); (l) CH_3COCl, *N*,*N*-dimethylaniline, DCM, rt, 5 days (96%); (m) CH_3COCl, *N*,*N*-dimethylaniline, DCM, rt, 5 days (98%).

further purification. IR spectra were recorded on a BOMEM 100 FT-IR or an AVATAR 370 FT-IR Thermo Nicolet spectrophotometer. ^{1}H and ^{13}C NMR spectra were performed in $CDCl_3$ and referenced to the residual peak of $CHCl_3$ at δ 7.26 ppm and δ 77.0 ppm, for ^{1}H and ^{13}C, respectively, using Varian 200 VX and Bruker DRX 400 instruments. Chemical shifts are reported in δ ppm and coupling constants (*J*) are given in hertz. MS were performed at a VG-TS 250 spectrometer at 70 eV ionising voltage. Mass spectra are presented as *m*/*z* (% rel int.). HRMS were recorded on a VG Platform (Fisons) spectrometer using chemical ionisation (ammonia as gas) or Fast Atom Bombardment (FAB) technique. For some of the samples, QSTAR XL spectrometer was employed for electrospray ionisation (ESI). Optical rotations were determined on a Perkin–Elmer 241 polarimeter in 1 dm cells. Diethyl ether and THF were distilled from sodium, and dichloromethane was distilled from calcium hydride under argon atmosphere.

4.2. Reduction of 7 with $LiAlH_4$ to yield 8

An ice cooled solution of ketone **7** (4.37 g, 16.7 mmol) in dry Et_2O (145 mL) was treated with $LiAlH_4$ (0.94 g, 24.9 mmol) and stirred at room temperature for 1 h. Then, the solution was cooled to 0 °C, wet EtOAc was added and the mixture filtered. The resulting organic phase was dried over Na_2SO_4, filtered and evaporated affording **8** (4.36 g, 99%).

*4.2.1. 14,15-Dinor-labd-8-en-13-R/S-ol (**8**)*

R_f (Hex/EtOAc 9/1)=0.15; $[\alpha]_D^{22}$ +61.8 (*c* 1.17, $CHCl_3$); IR (film): 3346, 1460, 1387, 1374, 1118; ^{1}H NMR δ: 3.70 (1H, m, H-13), 2.20–0.80 (15H, m), 1.48 (3H, s, Me-17), 1.12 (3H, d, *J*=6.2 Hz, Me-16), 0.85 (3H, s, Me-20), 0.79 (3H, s, Me-18), 0.74 (3H, s, Me-19); ^{13}C NMR δ: 140.4 (C-9), 126.0 (C-8), 69.0 (C-13), 52.1 (C-5), 42.0 (C-3), 40.2 (C-12), 39.2 (C-10), 37.3 (C-1), 33.8 (C-7), 33.4 (C-4), 33.4 (C-18), 24.3 (C-11), 23.6 (C-16), 21.9 (C-19), 20.3 (C-17), 19.7 (C-20), 19.3 (C-6), 19.2 (C-2); EIHRMS: calcd for $C_{18}H_{32}ONa$: 287.2345, found 287.2361.

4.3. Acetylation of 8 to yield 9

To a solution of **8** (8.80 g, 33.3 mmol) in dry pyridine (13 mL), acetic anhydride (18 mL) was added and the mixture was stirred at room temperature for 6 h. The reaction mixture was poured into ice-water and extracted with EtOAc. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and water. The resulting solution was then dried over Na_2SO_4 and evaporated to yield **9** (9.92 g, 98%).

*4.3.1. Acetate of 14,15-dinor-labd-8-en-13-R/S-ilo (**9**)*

R_f (Hex/EtOAc 9/1)=0.51; $[\alpha]_D^{22}$ +54.9 (*c* 1.41, $CHCl_3$); IR (film): 1739, 1458, 1372, 1241; ^{1}H NMR δ: 4.87–4.81 (1H, m, H-13), 2.10–0.70 (15H, m), 2.03 (3H, s, *Me*COO), 1.55 (3H, s, Me-17), 1.21 (3H, d, *J*=6.2 Hz, Me-16), 0.92 (3H, s, Me-20), 0.87 (3H, s, Me-18), 0.82 (3H, s, Me-19); ^{13}C NMR δ: 170.9 (Me*C*OO), 140.1 (C-9), 126.2 (C-8), 71.7 (C-13), 52.1 (C-5), 42.0 (C-3), 39.2 (C-10), 37.2 (C-1), 36.8 (C-12), 33.8 (C-7), 33.5 (C-18), 33.5 (C-4), 23.7 (C-11), 21.9 (C-19), 21.6 (*Me*COO), 20.3 (C-17), 19.9 (C-16), 19.6 (C-20), 19.3 (C-2), 19.3 (C-6); EIHRMS: calcd for $C_{20}H_{34}O_2Na$: 329.2451, found 329.2439.

4.4. Oxidation of 9 with Na_2CrO_4 to yield 10

To a solution of **9** (5.34 g, 17.5 mmol) in benzene (110 mL), Na_2CrO_4 (12.4 g, 76.8 mmol), acetic anhydride (50 mL), acetic acid (50 mL) and NaOAc (7.54 g) were added and the mixture stirred at 60 °C for 5 h. Then it was cooled down to room temperature and ice was added. The mixture was extracted with EtOAc and washed with aqueous 6% $NaHCO_3$, water and brine. The organic layer was dried over Na_2SO_4 and evaporated to give a crude oil, which was chromatographed on silica gel to afford the expected compound **10** (3.91 g, 71%).

*4.4.1. 13-R/S-Acetoxy-14,15-dinor-labd-8-en-7-one (**10**)*

R_f (Hex/EtOAc 8/2)=0.37; UV 249 nm; $[\alpha]_D^{22}$ +48.2 (*c* 1.03, $CHCl_3$); IR (film): 1737, 1663, 1374, 1242; ^{1}H NMR δ:4.95–4.87 (1H, m, H-13), 2.60–0.80 (13H, m), 2.06 (3H, s, *Me*COO), 1.75 (3H, s, Me-17), 1.26 (3H, d, *J*=6.2 Hz, Me-16), 1.08 (3H, s, Me-20), 0.92 (3H, s, Me-18), 0.88 (3H, s, Me-19); ^{13}C NMR δ: 199.7 (C-7), 170.5 (Me*C*OO), 166.9 (C-9), 130.3 (C-8), 70.9 (C-13), 50.4 (C-5), 41.4 (C-10), 41.0 (C-3), 36.2 (C-1), 35.3 (C-12), 35.0 (C-6), 33.0 (C-18), 32.5 (C-4), 25.1 (C-11), 21.3 (*Me*COO), 19.7 (C-16), 19.6 (C-19), 18.3 (C-20), 18.7 (C-2), 11.7 (C-17); EIMS: (70 eV) m/z (%): 321 ($M+H^+$, 72), 260 (100), 205 (30), 135 (50).

4.5. α-Acetoxylation of 10 with LTA to yield 11

To a solution of **10** (1.40 g, 4.37 mmol) in benzene (125 mL), $Pb(OAc)_4$ (18.4 g, 41.5 mmol) was added and the mixture was stirred at 80 °C for 72 h. The solution was filtered washing with AcOEt and the resulting organic layer was washed several times with water, dried over Na_2SO_4 and evaporated to give a crude oil, which was chromatographed on silica gel to afford **11** (1.53 g, 93%).

*4.5.1. 6,13-Diacetoxy-14,15-dinor-labd-8-en-7-one (**11**)*

R_f (Hex/EtOAc 7/3)=0.53; IR (film): 1739, 1672, 1373, 1239, 1033; ^{1}H NMR δ: 5.80–5.60 (1H, m, H-6), 4.95–4.87 (1H, m, H-13), 2.40–1.20 (11H, m), 2.19 (3H, s, *Me*COO), 2.06 (3H, s, *Me*COO), 1.76 (3H, s, Me-17), 1.28 (3H, s, Me-20), 1.26 (3H, d, *J*=6.2 Hz, Me-16), 1.04 (3H, s, Me-18), 1.00 (3H, s, Me-19); EIHRMS: calcd for $C_{22}H_{34}O_5Na$: 401.2298, found 401.2267.

4.6. Reduction of 11 with $LiAlH_4$ to yield 12 and 13

An ice cooled solution of **11** (98 mg, 0.26 mmol) in dry Et_2O (145 mL) was treated with $LiAlH_4$ (33 mg, 0.85 mmol) and was stirred at room temperature for 1 h. Then, the solution was cooled to 0 °C, wet EtOAc was added and the mixture filtered. The resulting organic phase was dried over Na_2SO_4, filtered and evaporated to give a crude oil, which was chromatographed on silica gel to afford **12** (15 mg, 19%) and **13** (42 mg, 54%).

*4.6.1. 14,15-Dinor-labd-8-en-6β,7β,13-R/S-triol (**12**)*

R_f (Hex/EtOAc 1/1)=0.34; $[\alpha]_D^{22}$ +63.0 (*c* 0.40, DMSO); IR (film): 3358, 1459, 1375, 1265, 1125, 1021; ^{1}H NMR (DMSO) δ: 4.43 (1H, d, *J*=7.8 Hz, OH), 4.36–4.32 (1H, m, OH), 4.10–4.00 (1H, m, H-7), 3.84 (1H, d, *J*=2.8 Hz, OH), 3.87–3.65 (1H, m, H-6), 3.60–3.45 (1H, m, H-13), 2.20–0.80 (11H, m), 1.57 (3H, s, Me-17), 1.26 (3H, s, Me-20), 1.15 (3H, s, Me-19), 1.22 (3H, d, *J*=7.0 Hz, Me-16), 0.89 (3H, s, Me-18); ^{13}C NMR (DMSO) δ: 139.3 (C-9), 123.1 (C-8), 69.4 (C-7), 63.8 (C-13), 63.8 (C-6), 49.8 (C-5), 40.0 (C-3), 36.9 (C-1), 36.8 (C-12), 30.8 (C-10), 30.8 (C-18), 30.7 (C-4), 21.2 (C-11), 21.0 (C-19), 20.8 (C-16), 18.4 (C-20), 16.1 (C-2), 12.1 (C-17); EIHRMS: calcd for $C_{18}H_{32}O_3Na$: 319.2244, found 319.2249.

*4.6.2. 14,15-Dinor-labd-8-en-6α,7α,13-R/S-triol (**13**)*

R_f (Hex/EtOAc 1/1)=0.14; $[\alpha]_D^{22}$ +59.1 (*c* 0.64, DMSO); IR (film): 3358, 1459, 1375, 1265, 1125, 1021; ^{1}H NMR δ: 3.87 (1H, d, *J*=7.6 Hz, H-7), 3.85–3.70 (2H, m, H-6 and H-13), 2.60–0.80 (11H, m), 1.69 (3H, s, Me-17), 1.21 (3H, d, *J*=6.5 Hz, Me-16), 1.18 (3H, s, Me-20), 1.07 (3H, s, Me-19), 1.07 (3H, s, Me-18); ^{13}C NMR δ: 144.1 (C-9), 126.6 (C-8), 80.2 (C-7), 74.7 (C-6), 68.8 (C-13), 54.0 (C-5), 43.8 (C-3), 42.3 (C-10), 39.3 (C-1), 37.5 (C-12), 36.6 (C-18), 33.5 (C-4), 24.6 (C-11), 23.4 (C-16), 22.4 (C-19), 21.6 (C-20), 18.9 (C-2), 14.4 (C-17); EIHRMS: calcd for $C_{18}H_{32}O_3Na$: 319.2244, found 319.2223.

4.7. Reaction of 12 and 13 with 2,2-DMP to yield 12a and 13a

To a solution of **12**/**13** (85 mg, 0.29 mmol) in Me_2CO (1.20 mL) was added 2,2-DMP (0.12 mL) and *p*-TsOH acid (10 mg, 0.05 mmol). The mixture was stirred at room temperature for 1 h, then Et_2O was added and the mixture was washed with aqueous 6% $NaHCO_3$ and H_2O. The resulting organic phase was dried over Na_2SO_4, filtered and evaporated to give a crude oil, which was chromatographed on silica gel to afford **12a** (30 mg, 31%) and **13a** (65 mg, 67%).

*4.7.1. 6β,7β-(2,2-Propilendioxy)-14,15-dinor-labd-8-en-13-ol (**12a**)*

R_f (Hex/EtOAc 1/1)=0.69; IR (film): 3400, 1458, 1377, 1366, 1236, 1216, 1126, 1022; ^{1}H NMR δ: 4.59 (1H, dd, J=6.4 and 1.7 Hz, H-6), 4.30 (1H, d, J=6.4 Hz, H-7), 3.85–3.75 (1H, m, H-13), 2.30–0.80 (11H, m), 1.70 (3H, s, Me-17), 1.35 (3H, s, Me_2CO), 1.34 (3H, s, Me_2CO), 1.29 (3H, s, Me-20), 1.22 (3H, d, J=6.2 Hz, Me-16), 1.18 (3H, s, Me-19), 1.01 (3H, s, Me-18). EIHRMS: calcd for $C_{21}H_{36}O_3Na$: 336.4234, found 336.4245.

*4.7.2. 6α,7α-(2,2-Propilendioxy)-14,15-dinor-labd-8-en-13-ol (**13a**)*

R_f (Hex/EtOAc 8/2)=0.13; IR (film): 3448, 1655, 1459, 1378, 1122, 1077, 1039; ^{1}H NMR δ: 4.38 (1H, dd, J=12.8 and 2.0 Hz, H-6), 3.86–3.79 (1H, m, H-13), 3.79 (1H, d, J=2.0 Hz, H-7), 2.28–0.90 (11H, m), 1.83 (3H, s, Me-17), 1.25 (3H, s, Me_2CO), 1.25 (3H, s, Me_2CO), 1.22 (3H, d, J=6.2 Hz, Me-16), 1.17 (3H, s, Me-20), 1.16 (3H, s, Me-19), 1.15 (3H, s, Me-18). EIHRMS: calcd for $C_{21}H_{36}O_3Na$: 336.4234, found 336.4245.

4.8. Reaction of 12 and 13 with TBDMSCl to yield 14 and 15

To an ice cooled solution of **12**/**13** (259 mg, 0.87 mmol) in DMF (8.7 mL), TBDMSCl (132 mg, 0.87 mmol) and imidazole (119 mg, 1.75 mmol) were added, and the mixture was stirred at room temperature for 15 h under argon. Then, the solution was cooled to 0 °C, diluted with water and extracted with Et_2O. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated under reduced pressure to give a crude oil, which was chromatographed on silica gel to afford **14** (125 mg, 35%) and **15** (196 mg, 55%).

*4.8.1. 13-R/S-tert-Butyldimethylsilyloxy-14,15-dinor-labd-8-ene-6β,7β-diol (**14**)*

R_f (Hex/EtOAc 1/1)=0.74; $[\alpha]_D^{22}$ +43.5 (c 1.14, $CHCl_3$); IR (film): 3411, 1472, 1255, 1033, 836; ^{1}H NMR δ: 4.30 (1H, br s, H-7), 3.98 (1H, br s, H-6), 3.80–3.72 (1H, m, H-13), 2.40–0.80 (11H, m), 1.71 (3H, s, Me-17), 1.35 (3H, s, Me-20), 1.22 (3H, s, Me-19), 1.14 (3H, d, J=6.2 Hz, Me-16), 0.96 (3H, s, Me-18), 0.89 (9H, s, Me_2SiCMe_3), 0.05 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 144.4 (C-9), 124.9 (C-8), 73.6 (C-7), 69.2 (C-13), 68.0 (C-6), 53.2 (C-5), 43.0 (C-3), 40.1 (C-10), 40.1 (C-12), 39.6 (C-1), 34.0 (C-4), 33.8 (C-18), 26.1 (Me_2SiCMe_3), 24.2 (C-11), 24.2 (C-19), 23.8 (C-16), 22.1 (C-20), 19.2 (C-2), 18.3 (Me_2SiCMe_3), 15.0 (C-17), −4.3 (Me_2SiCMe_3), −4.5 (Me_2SiCMe_3); EIHRMS: calcd for $C_{24}H_{46}O_3SiNa$: 433.3108, found 433.3136.

*4.8.2. 13-R/S-tert-Butyldimethylsilyloxy-14,15-dinor-labd-8-ene-6α,7α-diol (**15**)*

R_f (Hex/EtOAc 1/1)=0.61; $[\alpha]_D^{22}$ +33.2 (c 1.12, $CHCl_3$); IR (film): 3365, 1472, 1255, 1038, 835; ^{1}H NMR δ: 3.95–3.80 (2H, m, H-6 and H-7), 3.80–3.72 (1H, m, H-13), 2.30–0.80 (11H, m), 1.68 (3H, s, Me-17), 1.16 (3H, s, Me-20), 1.12 (3H, d, J=6.2 Hz, Me-16), 1.07 (3H, s, Me-19), 1.05 (3H, s, Me-18), 0.89 (9H, s, Me_2SiCMe_3), 0.05 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 144.4 (C-9), 126.2 (C-8), 80.4 (C-7), 74.9 (C-6), 69.2 (C-13), 54.0 (C-5), 43.9 (C-3), 42.4 (C-10), 39.7 (C-12), 39.4 (C-1), 33.6 (C-4), 33.6 (C-18), 26.1 (Me_2SiCMe_3), 24.5 (C-11), 23.8 (C-16), 22.4 (C-19), 21.6 (C-20), 18.9 (C-2), 18.3 (Me_2SiCMe_3), 14.8 (C-17), −4.2 (Me_2SiCMe_3), −4.5 (Me_2SiCMe_3); EIHRMS: calcd for $C_{24}H_{46}O_3SiNa$: 433.3108, found 433.3139.

4.9. Reaction of 14 with triphosgene to yield 16

To a solution of triphosgene (26 mg, 0.09 mmol) in pyridine (0.04 mL) and CH_2Cl_2 (0.60 mL) cooled at −78 °C was added another solution of **14** (36 mg, 0.09 mmol) in CH_2Cl_2 (0.20 mL). The reaction mixture was stirred until it warmed up to room temperature and then saturated NH_4Cl solution was added. The mixture was extracted with Et_2O and washed with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and brine. The organic layer was dried over Na_2SO_4, filtered and evaporated to afford **16** (39 mg, 100%).

*4.9.1. 6β,7β-Carbonyldioxy-13-R/S-tert-butyldimethylsilyloxy-14,15-dinor-labd-8-eno (**16**)*

R_f (Hex/EtOAc 8/2)=0.52; $[\alpha]_D^{22}$ +49.7 (c 1.08, $CHCl_3$); IR (film): 1802, 1374, 1168, 1137, 1038, 1017, 836, 775; ^{1}H NMR δ: 5.15 (1H, dd, J=8.0 and 1.4 Hz, H-6), 4.90 (1H, d, J=8.0 Hz, H-7), 3.72–3.83 (1H, m, H-13), 2.30–0.75 (11H, m), 1.73 (3H, s, Me-17), 1.27 (3H, s, Me-20), 1.19 (3H, s, Me-19), 1.13 (3H, d, J=6.1 Hz, Me-16), 1.02 (3H, s, Me-18), 0.89 (9H, s, Me_2SiCMe_3), 0.05 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 155.3 (OCOO), 149.7 (C-9), 120.4 (C-8), 79.0 (C-7), 75.0 (C-6), 68.7 (C-13), 51.6 (C-5), 42.5 (C-3), 39.3 (C-12), 38.9 (C-10), 38.5 (C-1), 34.0 (C-4), 32.8 (C-18), 25.8 (Me_2SiCMe_3), 24.1 (C-11), 23.6 (C-16), 23.5 (C-19), 22.3 (C-20), 18.5 (C-2), 18.0 (Me_2SiCMe_3), 16.1 (C-17), −4.5 (Me_2SiCMe_3), −4.8 (Me_2SiCMe_3); EIHRMS: calcd for $C_{25}H_{44}O_4SiNa$: 459.29011, found 459.2917.

4.10. Reaction of 16 with TBAF to yield 17

A solution of **16** (35 mg, 0.08 mmol) in THF (1.6 mL) was treated with TBAF (0.33 mL solution 1.0 M in THF, 0.33 mmol). After being stirred for 2 h under argon, the reaction mixture was diluted with water and extracted with EtOAc. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated under reduced pressure to give a crude oil, which was chromatographed on silica gel to afford **17** (25 mg, 95%).

*4.10.1. 6β,7β-Carbonyldioxy-14,15-dinor-labd-8-en-13-R/S-ol (**17**)*

R_f (Hex/EtOAc 1/1)=0.35; IR (film): 3400, 1800, 1717, 1460, 1374, 1171, 1120, 1079, 1021; ^{1}H NMR δ: 5.17 (1H, dd, J=8.0 and 1.8 Hz, H-6), 4.91 (1H, d, J=8.0 Hz, H-7), 3.86–3.77 (1H, m, H-13), 2.40–0.80 (11H, m), 1.74 (3H, s, Me-17), 1.22 (3H, s, Me-20), 1.20 (3H, d, J=6.2 Hz, Me-16), 1.19 (3H, s, Me-19), 1.03 (3H, s, Me-18); ^{13}C NMR δ: 155.6 (OCOO), 149.7 (C-9), 120.9 (C-8), 79.1 (C-7), 75.3 (C-6), 68.5 (C-13), 51.8 (C-5), 42.6 (C-3), 39.9 (C-12), 39.0 (C-10), 38.6 (C-1), 34.2 (C-4), 33.0 (C-18), 24.4 (C-11), 23.7 (C-19), 23.6 (C-16), 22.6 (C-20), 18.8 (C-2), 16.4 (C-17); EIHRMS: calcd for $C_{19}H_{30}O_4Na$: 345.2036, found 345.2037.

4.11. Oxidation of 17 with TPAP to yield 6

To a mixture of **17** (35 mg, 0.11 mmol), *N*-methylmorpholine *N*-oxide (NMO) (58 mg, 0.43 mmol) and molecular sieves (120 mg) in dry CH_2Cl_2 (2.5 mL) at room temperature was added TPAP (3 mg, 0.01 mmol). The reaction mixture was stirred for 1 h under argon and then it was filtered through silica gel and Celite eluting with AcOEt. The solvent was evaporated to give a crude oil, which was chromatographed on silica gel to afford **6** (34 mg, 96%).

*4.11.1. 6β,7β-Carbonyldioxy-14,15-dinor-labd-8-en-13-one (**6**)*

R_f (Hex/OAcEt 1/1)=0.64; $[\alpha]_D^{22}$ +27.1 (c 0.73, $CHCl_3$); IR (film): 1801, 1717, 1461, 1373, 1166, 1137, 1119, 1076, 1017; ^{1}H NMR δ: 5.17 (1H, dd, J=8.2 and 1.0 Hz, H-6), 4.90 (1H, d, J=8.2 Hz, H-7), 2.60–0.80 (11H, m), 2.15 (3H, s, Me-16), 1.71 (3H, s, Me-17), 1.23 (3H, s,

Me-20), 1.18 (3H, s, Me-19), 1.03 (3H, s, Me-18); ^{13}C NMR δ: 207.6 (C-13), 155.3 (OCOO), 148.8 (C-9), 121.7 (C-8), 78.9 (C-7), 75.1 (C-6), 51.8 (C-5), 43.5 (C-12), 42.6 (C-3), 39.1 (C-10), 38.6 (C-1), 34.1 (C-4), 33.0 (C-18), 30.0 (C-16), 23.7 (C-19), 22.5 (C-20), 21.5 (C-11), 18.8 (C-2), 16.4 (C-17); EIHRMS: calcd for $C_{19}H_{28}O_4Na$: 343.1880, found 343.1896.

4.12. Acetylation of 15 to yield 18 and 19

To a solution of **15** (2.44 g, 5.94 mmol) in dry pyridine (10 mL), acetic anhydride (8 mL) was added and the mixture was stirred at room temperature for 2 h. The reaction mixture was poured into ice-water and extracted with EtOAc. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and water. The resulting solution was then dried over Na_2SO_4 and evaporated to give a crude oil, which was chromatographed on silica gel to afford **18** (2.18 g, 81%) and **19** (0.40 g, 15%).

*4.12.1. 7α-Acetoxy-13-R/S-tert-butyldimethylsilyloxy-14,15-dinor-labd-8-en-6α-ol (**18**)*

R_f (Hex/EtOAc 8/2)=0.45; $[\alpha]_D^{22}$ +7.7 (*c* 1.12, $CHCl_3$); IR (film): 3498, 1719, 1472, 1463, 1374, 1254, 1135, 1087, 1039, 1021, 976, 835, 774; ^{1}H NMR δ: 5.22 (1H, d, *J*=7.4 Hz, H-7), 4.12–3.95 (1H, m, H-6), 3.85–3.70 (1H, m, H-13), 2.40–0.80 (11H, m), 2.14 (3H, s, *Me*COO), 1.53 (3H, s, Me-17), 1.15 (3H, s, Me-20), 1.12 (3H, d, *J*=5.8 Hz, Me-16), 1.11 (3H, s, Me-19), 1.05 (3H, s, Me-18), 0.88 (9H, s, Me_2SiCMe_3), 0.04 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 173.5 (Me*C*OO), 148.3 (C-9), 122.8 (C-8), 84.2 (C-7), 73.6 (C-6), 69.1 (C-13), 54.8 (C-5), 43.8 (C-3), 41.6 (C-10), 39.7 (C-12), 39.4 (C-1), 36.5 (C-18), 33.8 (C-4), 26.1 (Me_2SiCMe_3), 24.5 (C-11), 23.7 (C-16), 22.2 (C-19), 21.7 (C-20), 21.5 (*Me*COO), 18.8 (C-2), 18.3 (Me_2SiCMe_3), 15.2 (C-17), −4.2 (Me_2SiCMe_3), −4.5 (Me_2SiCMe_3); EIHRMS: calcd for $C_{26}H_{48}O_4SiNa$: 475.3214, found 475.3217.

*4.12.2. 6α-Acetoxy-13-R/S-tert-butyldimethylsilyloxy-14,15-dinor-labd-8-en-7α-ol (**19**)*

R_f (Hex/EtOAc 8/2)=0.29; $[\alpha]_D^{22}$ +54.5 (*c* 1.03, $CHCl_3$); IR (film): 3451, 1737, 1719, 1471, 1463, 1375, 1254, 1136, 1085, 1037, 835, 774; ^{1}H NMR δ: 5.22 (1H, dd, *J*=12.2 and 6.6 Hz, H-6), 3.95 (1H, d, *J*=6.6 Hz, H-7), 3.82–3.70 (1H, m, H-13), 2.20–0.80 (11H, m), 2.13 (3H, s, *Me*COO), 1.68 (3H, s, Me-17), 1.12 (3H, d, *J*=5.0 Hz, Me-16), 1.11 (3H, s, Me-20), 1.04 (3H, s, Me-19), 0.90 (3H, s, Me-18), 0.88 (9H, s, Me_2SiCMe_3), 0.04 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 172.8 (Me*C*OO), 145.0 (C-9), 126.6 (C-8), 78.7 (C-7), 78.6 (C-6), 69.1 (C-13), 53.0 (C-5), 43.6 (C-3), 41.9 (C-10), 39.8 (C-12), 39.6 (C-1), 36.2 (C-18), 33.3 (C-4), 26.1 (Me_2SiCMe_3), 24.5 (C-11), 23.8 (C-16), 22.3 (C-19), 22.1 (C-20), 22.0 (*Me*COO), 18.7 (C-2), 18.3 (Me_2SiCMe_3), 15.3 (C-17), −4.2 (Me_2SiCMe_3), −4.5 (Me_2SiCMe_3). EIHRMS: calcd for $C_{26}H_{48}O_4SiNa$: 475.3214, found 475.3200.

4.13. Oxidation of 18 with TPAP to yield 20

To a mixture of **18** (2.18 g, 4.82 mmol), *N*-methylmorpholine *N*-oxide (NMO) (1.75 g, 13.0 mmol) and molecular sieves (2.00 g) in dry CH_2Cl_2 (40 mL) was added TPAP (49 mg, 0.14 mmol). The reaction mixture was stirred at room temperature for 1 h under argon and then was filtered through silica gel and Celite eluting with AcOEt. The solvent was evaporated to afford **20** (2.15 g, 99%).

*4.13.1. 7β-Acetoxy-13-R/S-tert-butyldimethylsilyloxy-14,15-dinor-labd-8-en-6-one (**20**)*

R_f (Hex/EtOAc 8/2)=0.61; $[\alpha]_D^{22}$ +100.0 (*c* 0.42, $CHCl_3$); IR (film): 1751, 1734, 1472, 1463, 1370, 1229, 1135, 1089, 1035, 835, 774; ^{1}H NMR δ: 5.61 (1H, s, H-7), 3.85–3.70 (1H, m, H-13), 2.52 (1H, s, H-5), 2.20–0.80 (11H, m), 2.18 (3H, s, *Me*COO), 1.62 (3H, s, Me-17), 1.29 (3H, s, Me-20), 1.13 (3H, d, *J*=4.8 Hz, Me-16), 0.97 (3H, s, Me-19), 0.93 (3H, s, Me-18), 0.88 (9H, s, Me_2SiCMe_3), 0.05 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 203.6 (C-6), 171.0 (Me*C*OO), 147.8 (C-9), 124.1 (C-8), 77.9 (C-7), 69.0 (C-13), 62.7 (C-5), 46.7 (C-10), 42.4 (C-3), 39.8 (C-12), 39.5 (C-1), 32.5 (C-18), 32.5 (C-4), 26.1 (Me_2SiCMe_3), 24.6 (C-11), 23.8 (C-16), 22.3 (C-19), 21.7 (*Me*COO), 20.9 (C-20), 18.7 (C-2), 18.3 (Me_2SiCMe_3), 15.3 (C-17), −4.2 (Me_2SiCMe_3), −4.5 (Me_2SiCMe_3); EIHRMS: calcd for $C_{26}H_{46}O_4SiNa$: 473.3058, found 473.3051.

4.14. Reduction of 20 with $LiAlH_4$ to yield 14

An ice cooled solution of **20** (2.15 g, 4.77 mmol) in dry Et_2O (80 mL) was treated with $LiAlH_4$ (500 mg, 13.1 mmol) and stirred at room temperature for 45 min. Then, the solution was cooled back to 0 °C, wet EtOAc was added and the mixture filtered. The resulting organic phase was dried over Na_2SO_4, filtered and evaporated affording **14** (1.94 g, 99%).

4.15. Reaction of Horner–Wadsworth–Emmons of 6 to yield 21

To a mixture of NaH (1.25 g 60 % in mineral oil, 31.2 mmol) and monoglyme (4.75 mL), methyl-diethyl-phosphonoacetate (5.70 mL) was added under argon atmosphere and the resulting solution was stirred at room temperature 40 min. Then a solution of **6** (0.33 g, 1.03 mmol) in monoglyme (3 mL) was added via canula and the mixture was stirred 90 min at 60 °C. After that the solution was cooled to 0 °C, poured into water, extracted with Et_2O and dried over Na_2SO_4. The solvent was evaporated to give a crude oil, which was chromatographed on silica gel to afford **21** (0.28 g, 76%).

*4.15.1. Methyl 6β,7β-carbonildioxi-labda-8,13E-dien-15-oate (**21**)*

R_f (Hex/EtOAc 7/3)=0.47; $[\alpha]_D^{22}$ +69.7 (*c* 0.75, $CHCl_3$); IR (film): 1794, 1718, 1648, 1437, 1373, 1324, 1225, 1149, 1118, 1017, 916, 733; ^{1}H NMR δ: 5.68 (1H, s, H-14), 5.17 (1H, dd, *J*=8.2 and 1.2 Hz, H-6), 4.91 (1H, d, *J*=8.2 Hz, H-7), 3.69 (3H, s, COO*Me*), 2.40–0.80 (11H, m), 2.19 (3H, s, Me-16), 1.75 (3H, s, Me-17), 1.24 (3H, s, Me-20), 1.19 (3H, s, Me-19), 1.03 (3H, s, Me-18); ^{13}C NMR δ: 167.3 (C-15), 159.4 (C-13), 155.3 (OCOO), 148.5 (C-9), 121.9 (C-8), 115.4 (C-14), 78.8 (C-7), 75.1 (C-6), 51.8 (C-5), 51.1 (COO*Me*), 42.7 (C-3), 40.6 (C-12), 39.1 (C-10), 38.6 (C-1), 34.2 (C-4), 32.9 (C-18), 26.5 (C-11), 23.7 (C-19), 22.6 (C-20), 19.0 (C-16), 18.8 (C-2), 16.4 (C-17); EIHRMS: calcd for $C_{22}H_{32}O_5Na$: 399.2142, found 399.2151.

4.16. Reaction of 21 with DIBAL-H to yield 22

To a solution of **21** (56 mg, 0.15 mmol) in CH_2Cl_2 (2.5 mL) at −78 °C, DIBAL-H (0.60 mL of solution 1.5 M in toluene, 0.90 mmol) was added under argon. After 30 min the mixture was warmed up to 0 °C, quenched with wet Et_2O and at room temperature, Et_2O, Na_2SO_4 (1 g) and $NaHCO_3$ (800 mg) were added and the solution was stirred for 1 h, filtered eluting with Et_2O and EtOAc and concentrated to afford **22** (49 mg, 100%).

*4.16.1. Labda-8,13E-dien-6β,7β,15-triol (**22**)*

R_f (Hex/EtOAc 1/1)=0.35; $[\alpha]_D^{22}$ +29.8 (*c* 0.84, $CHCl_3$); IR (film): 3373, 1465, 1378, 1217, 1122, 1067, 1021, 926, 734; ^{1}H NMR δ: 5.40 (1H, t, *J*=7.0 Hz, H-14), 4.33 (1H, d, *J*=4.4 Hz, H-7), 4.15 (2H, d, *J*=7.0 Hz, H-15), 4.01 (1H, br s, H-6), 2.20–0.80 (11H, m), 1.70 (6H, s, Me-16 and Me-17), 1.33 (3H, s, Me-20), 1.21 (3H, s, Me-19), 0.95 (3H, s, Me-18); ^{13}C NMR δ: 143.8 (C-9), 140.4 (C-13), 125.5 (C-8), 123.2 (C-14), 73.5 (C-7), 68.0 (C-6), 59.6 (C-15), 53.2 (C-5), 43.0 (C-3), 40.1 (C-10), 40.0 (C-12), 39.6 (C-1), 34.0 (C-4), 33.8 (C-18), 26.9 (C-11), 24.2 (C-19), 22.1 (C-20), 19.2 (C-2), 16.6 (C-16), 15.1 (C-17); EIHRMS: calcd for $C_{20}H_{34}O_3Na$: 345.2400, found 345.2407.

4.17. Reaction of 22 with TBDMSCl to yield 23

To an ice cooled solution of **22** (56 mg, 0.17 mmol) in DMF (2 mL) TBDMSCl (26 mg, 0.17 mmol) and imidazole (24 mg, 0.36 mmol) were added, and the mixture was stirred at room temperature for 17 h under argon. Then, the solution was cooled to 0 °C, diluted with water and extracted with Et_2O. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated under reduced pressure to afford **23** (68 mg, 92%).

*4.17.1. 15-tert-Butyldimethylsilyloxy-labda-8,13E-dien-6β,7β-diol (**23**)*

R_f (Hex/EtOAc 1/1)=0.74; $[\alpha]_D^{22}$ +31.1 (*c* 0.84, $CHCl_3$); IR (film): 3390, 1471, 1386, 1253, 1110, 1072, 836, 776; ^{1}H NMR δ: 5.29 (1H, t, *J*=6.2 Hz, H-14), 4.27 (1H, d, *J*=4.4 Hz, H-7), 4.17 (2H, d, *J*=6.2 Hz, H-15), 3.94 (1H, dd, *J*=4.4 and 1.2 Hz, H-6), 2.20–0.80 (11H, m), 1.68 (3H, s, Me-17), 1.63 (3H, s, Me-16), 1.32 (3H, s, Me-20), 1.19 (3H, s, Me-19), 0.93 (3H, s, Me-18), 0.89 (9H, s, Me_2SiCMe_3), 0.05 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 144.0 (C-9), 137.7 (C-13), 125.4 (C-8), 124.2 (C-14), 73.4 (C-7), 67.9 (C-6), 60.6 (C-15), 53.1 (C-5), 43.0 (C-3), 40.1 (C-10), 39.9 (C-12), 39.6 (C-1), 33.9 (C-4), 33.8 (C-18), 26.3 (Me_2SiCMe_3), 26.9 (C-11), 24.1 (C-19), 22.0 (C-20), 19.2 (C-2), 18.7 (Me_2SiCMe_3), 16.6 (C-16), 15.1 (C-17), −4.8 (Me_2SiCMe_3); EIHRMS: calcd for $C_{26}H_{48}O_3SiNa$: 459.3265, found 459.3278.

4.18. Reaction of 23 with triphosgene to yield 24

To a solution of triphosgene (44 mg, 0.15 mmol) in pyridine (0.08 mL) and CH_2Cl_2 (0.80 mL) cooled at −78 °C was added another solution of **23** (65 mg, 0.15 mmol) in CH_2Cl_2 (0.70 mL). The reaction mixture was stirred until it warmed up to room temperature and then saturated NH_4Cl solution was added. The mixture was extracted with Et_2O and washed with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and brine. The organic layer was dried over Na_2SO_4, filtered and evaporated to afford **24** (69 mg, 100%).

*4.18.1. 6β,7β-Carbonyldioxy-15-tert-butyldimethylsilyloxy-labda-8,13E-diene (**24**)*

R_f (Hex/EtOAc 7/3)=0.65; $[\alpha]_D^{22}$ +59.0 (*c* 1.15, $CHCl_3$); IR (film): 1803, 1471, 1373, 1332, 1254, 1166, 1114, 1075, 1038, 1017, 836, 776; ^{1}H NMR δ: 5.30 (1H, t, *J*=6.2 Hz, H-14), 5.16 (1H, dd, *J*=7.8 and 1.2 Hz, H-6), 4.91 (1H, d, *J*=7.8 Hz, H-7), 4.19 (2H, d, *J*=6.2 Hz, H-15), 2.20–0.80 (11H, m), 1.72 (3H, s, Me-17), 1.63 (3H, s, Me-16), 1.20 (3H, s, Me-20), 1.16 (3H, s, Me-19), 1.00 (3H, s, Me-18), 0.87 (9H, s, Me_2SiCMe_3), 0.04 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 154.8 (OCOO), 148.8 (C-9), 136.1 (C-13), 124.1 (C-14), 120.5 (C-8), 78.4 (C-7), 74.5 (C-6), 59.8 (C-15), 51.1 (C-5), 42.0 (C-3), 38.6 (C-1), 38.4 (C-12), 38.3 (C-10), 33.5 (C-4), 32.3 (C-18), 26.3 (C-11), 25.5 (Me_2SiCMe_3), 23.0 (C-19), 21.9 (C-20), 18.1 (C-2), 17.9 (Me_2SiCMe_3), 15.9 (C-16), 15.7 (C-17), −5.5 (Me_2SiCMe_3); EIHRMS: calcd for $C_{27}H_{46}O_4SiNa$: 485.3058, found 485.3067.

4.19. Reaction of 24 with TBAF to yield 25

A solution of **24** (68 mg, 0.15 mmol) in THF (3 mL) was treated with TBAF (1 mL solution 1.0 M in THF, 1.00 mmol). After being stirred for 2 h under argon, the reaction mixture was diluted with water and extracted with EtOAc. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated under reduced pressure to afford **25** (51 mg, 99%).

*4.19.1. 6β,7β-Carbonyldioxy-labda-8,13E-dien-15-ol (**25**)*

R_f (Hex/EtOAc 1/1)=0.52; $[\alpha]_D^{22}$ +66.3 (*c* 1.38, $CHCl_3$); IR (film): 3421, 1793, 1668, 1464, 1374, 1324, 1266, 1172, 1138, 1117, 1081, 1017, 781, 739, 714; ^{1}H NMR δ: 5.43 (1H, t, *J*=6.6 Hz, H-14), 5.17 (1H, dd, *J*=7.8 and 1.2 Hz, H-6), 4.91 (1H, d, *J*=7.8 Hz, H-7), 4.16 (2H, d, *J*=6.6 Hz, H-15), 2.30–0.80 (11H, m), 1.75 (3H, s, Me-17), 1.70 (3H, s, Me-16), 1.23 (3H, s, Me-20), 1.19 (3H, s, Me-19), 1.03 (3H, s, Me-18); ^{13}C NMR δ: 155.2 (OCOO), 149.1 (C-9), 139.2 (C-13), 123.4 (C-14), 121.0 (C-8), 78.7 (C-7), 74.9 (C-6), 59.3 (C-15), 51.6 (C-5), 42.5 (C-3), 39.0 (C-1), 38.8 (C-10), 38.4 (C-12), 34.0 (C-4), 32.8 (C-18), 26.7 (C-11), 23.5 (C-19), 22.3 (C-20), 18.6 (C-2), 16.3 (C-16), 16.2 (C-17); EIHRMS: calcd for $C_{21}H_{32}O_4Na$: 371.2193, found 371.2179.

4.20. Epoxidation of Sharpless of 25 with D(−)-DET to yield 26

To D(−)-DET (85 mg, 0.41 mmol) at −23 °C were added DCM (2.8 mL) and $Ti(iPrO)_4$ (0.12 mL, 0.41 mmol) under argon and the mixture was stirred for 30 min. Then a solution of **25** (102 mg, 0.29 mmol) in CH_2Cl_2 (2 mL) and *t*-BuOOH (0.12 mL of solution 5.5 M in decane, 0.67 mmol) were added and the resulting mixture was stirred for 24 h at this temperature. Afterwards tartaric acid (2 mL, 10% solution) was added and it was warmed up to room temperature and stirred until it turned to be a clear solution. It was filtered through Celite and eluted with CH_2Cl_2, the solvent was removed and the resulting residue was dissolved in Et_2O (55 mL), washed with brine, dried over Na_2SO_4, filtered and concentrated to give a crude oil, which was chromatographed on silica gel to afford **26** (69 mg, 65%).

*4.20.1. 13R,14R-Epoxy-6β,7β-carbonyldioxy-labd-8-en-15-ol (**26**)*

R_f (Hex/EtOAc 1/1)=0.23; $[\alpha]_D^{22}$ +65.5 (*c* 0.89, $CHCl_3$); IR (film): 3422, 1793, 1459, 1374, 1324, 1175, 1138, 1117, 1081, 1018; ^{1}H NMR δ: 5.16 (1H, dd, *J*=8.2 and 1.2 Hz, H-6), 4.89 (1H, d, *J*=8.2 Hz, H-7), 3.83 (1H, dd, *J*=12.0 and 4.4 Hz, H_A-15), 3.69 (1H, dd, *J*=12.0 and 6.6 Hz, H_B-15), 2.98 (1H, dd, *J*=6.2 and 4.4 Hz, H-14), 2.30–0.80 (11H, m), 1.72 (3H, s, Me-17), 1.32 (3H, s, Me-16), 1.22 (3H, s, Me-20), 1.17 (3H, s, Me-19), 1.01 (3H, s, Me-18); ^{13}C NMR δ: 155.5 (OCOO), 148.7 (C-9), 121.6 (C-8), 79.0 (C-7), 75.2 (C-6), 63.0 (C-14), 61.6 (C-15), 61.3 (C-13), 51.8 (C-5), 42.7 (C-3), 39.1 (C-10), 38.6 (C-1), 38.3 (C-12), 34.3 (C-4), 33.0 (C-18), 23.7 (C-19), 23.3 (C-11), 22.6 (C-20), 18.8 (C-2), 16.9 (C-16), 16.3 (C-17); EIHRMS: calcd for $C_{21}H_{32}O_5Na$: 387.2142, found 387.2132.

4.21. Reaction of 26 with TsCl to yield 27

To an ice cooled solution of **26** (53 mg, 0.15 mmol) in pyridine (2 mL) was added TsCl (110 mg, 0.58 mmol) and the mixture was stirred at room temperature for 3 h. The reaction mixture was poured into ice-water and extracted with Et_2O. The combined organic layers were washed successively with aqueous 20% $CuSO_4$ solution, aqueous 6% $NaHCO_3$ solution and brine, dried over Na_2SO_4 and concentrated under reduced pressure to afford the tosylate **27** (65 mg, 87%).

*4.21.1. Tosylate of 13R,14R-epoxy-6β,7β-carbonyldioxy-labd-8-en-15-ilo (**27**)*

R_f (Hex/EtOAc 1/1)=0.59; $[\alpha]_D^{22}$ +60.4 (*c* 1.10, $CHCl_3$); IR (film): 1794, 1459, 1373, 1324, 1177, 1118, 1097, 1018, 964, 824, 777; ^{1}H NMR δ: 7.80 (2H, d, *J*=8.6 Hz, H-2′ and H-6′), 7.35 (2H, d, *J*=8.6 Hz, H-3′ and H-5′), 5.15 (1H, dd, *J*=8.2 and 1.2 Hz, H-6), 4.88 (1H, d, *J*=8.2 Hz, H-7), 4.14 (1H, dd, *J*=11.8 and 5.6 Hz, H_A-15), 4.09 (1H, dd, *J*=11.8 and 5.2 Hz, H_B-15), 3.00 (1H, dd, *J*=5.6 and 5.2 Hz, H-14), 2.44 (3H, s, Ph-*Me*), 2.30–0.80 (11H, m), 1.69 (3H, s, Me-17), 1.23 (3H, s, Me-16), 1.21 (3H, s, Me-20), 1.17 (3H, s, Me-19), 1.01 (3H, s, Me-18); ^{13}C NMR δ: 155.4 (OCOO), 148.5 (C-9), 145.5 (C-4′), 132.8 (C-1′), 130.2 (C-3′), 130.2 (C-5′), 128.2 (C-2′), 128.2 (C-6′), 121.7 (C-8), 78.9 (C-7), 75.1 (C-6), 68.5 (C-15), 61.1 (C-13), 58.9 (C-14), 51.9 (C-5), 42.7 (C-3), 39.1 (C-1), 38.7 (C-10), 38.3 (C-12), 34.2 (C-4), 33.0 (C-18), 23.7 (C-19), 23.1 (C-11), 22.6 (C-20), 21.9 (Ph*Me*), 18.8 (C-2), 16.7 (C-16), 16.3 (C-17). EIHRMS: calcd for $C_{28}H_{38}O_7SNa$: 541.2230, found 541.2221.

4.22. Reaction of 27 with NaI to yield 28

To a solution of tosylate **27** (20 mg, 0.04 mmol) in acetone (2.5 mL) at room temperature, NaI (27 mg, 0.18 mmol) was added. The mixture was heated at 70 °C for 3 h. The solvent was removed, water was added and extracted with Et_2O. The combined organic layers were washed successively with 10% aqueous $Na_2S_2O_3$ solution, 6% aqueous $NaHCO_3$ solution and brine, dried over Na_2SO_4 and concentrated under reduced pressure to afford **28** (16 mg, 86%).

*4.22.1. 15-Iodo-13R,14S-epoxy-6β,7β-carbonyldioxy-labd-8-ene (**28**)*

R_f (Hex/EtOAc 7/3)=0.47; $[\alpha]_D^{22}$ +43.5 (*c* 0.98, $CHCl_3$); IR (film): 1794, 1463, 1374, 1324, 1176, 1138, 1118, 1081, 1018; ^{1}H NMR δ: 5.16 (1H, dd, *J*=8.0 and 1.2 Hz, H-6), 4.89 (1H, d, *J*=8.0 Hz, H-7), 3.38 (1H, dd, *J*=8.6 and 5.2 Hz, H_A-15), 3.08 (1H, dd, *J*=8.6 and 5.2 Hz, H-14), 2.99 (1H, dd, *J*=8.6 and 8.6 Hz, H_B-15), 2.40–0.80 (11H, m), 1.73 (3H, s, Me-17), 1.31 (3H, s, Me-16), 1.24 (3H, s, Me-20), 1.18 (3H, s, Me-19), 1.02 (3H, s, Me-18); ^{13}C NMR δ: 155.4 (*O*COO), 148.7 (C-9), 121.6 (C-8), 78.9 (C-7), 75.1 (C-6), 64.0 (C-13), 62.7 (C-14), 51.9 (C-5), 42.7 (C-3), 39.1 (C-10), 38.7 (C-1), 38.2 (C-12), 34.2 (C-4), 33.0 (C-18), 23.7 (C-19), 23.6 (C-11), 22.6 (C-20), 18.8 (C-2), 16.4 (C-17), 15.8 (C-16), 2.4 (C-15); EIHRMS: calcd for $C_{21}H_{31}O_4INa$: 497.1159, found 497.1147.

4.23. Reduction of 28 with Zn/AcOH to yield 29

To a solution of **28** (29 mg, 0.06 mmol) in AcOH glacial (1.5 mL) at 0 °C was added activated Zn[†] (48 mg, 0.73 mmol) and it was stirred for 2 h. Then the mixture was filtered washing with Et_2O and the resulting organic phase was washed with aqueous 10% $Na_2S_2O_3$, aqueous 6% $NaHCO_3$ and water. The organic layer was dried over Na_2SO_4, filtered and evaporated to afford **29** (21 mg, 98%).

*4.23.1. 6β,7β-Carbonyldioxy-labda-8,14-dien-13R-ol (**29**)*

R_f (Hex/EtOAc 1/1)=0.63; $[\alpha]_D^{22}$ +23.8 (*c* 0.85, $CHCl_3$); IR (film): 3470, 1793, 1463, 1374, 1323, 1265, 1175, 1138, 1117, 1036, 1018, 738, 704; ^{1}H NMR δ: 5.91 (1H, dd, *J*=17.6 and 10.8 Hz, H-14), 5.23 (1H, dd, *J*=17.6 and 1.2 Hz, H-15), 5.16 (1H, dd, *J*=8.4 and 1.2 Hz, H-6), 5.11 (1H, dd, *J*=10.8 and 1.2 Hz, H-15), 4.89 (1H, d, *J*=8.4 Hz, H-7), 2.40–0.80 (11H, m), 1.73 (3H, s, Me-17), 1.30 (3H, s, Me-16), 1.23 (3H, s, Me-20), 1.18 (3H, s, Me-19), 1.02 (3H, s, Me-18); ^{13}C NMR δ: 155.6 (*O*COO), 149.7 (C-9), 144.5 (C-14), 121.0 (C-8), 112.7 (C-15), 79.1 (C-7), 75.2 (C-6), 73.6 (C-13), 51.9 (C-5), 42.8 (C-3), 41.5 (C-12), 39.2 (C-10), 38.7 (C-1), 34.3 (C-18), 33.1 (C-4), 28.2 (C-16), 23.7 (C-19), 22.6 (C-20), 22.5 (C-11), 18.9 (C-2), 16.4 (C-17); EIHRMS: calcd for $C_{21}H_{32}O_4Na$: 371.2193, found 371.2184.

4.24. Reduction of 29 with $LiAlH_4$ to yield 30

An ice cooled solution of **29** (30 mg, 0.09 mmol) in dry Et_2O (2 mL) was treated with $LiAlH_4$ (8 mg, 0.21 mmol) and stirred at room temperature for 1 h. Then, the solution was cooled back to 0 °C, wet EtOAc was added and the mixture filtered. The resulting organic phase was dried over Na_2SO_4, filtered and evaporated affording **30** (28 mg, 100%).

*4.24.1. Labda-8,14-dien-6β,7β,13R-triol (**30**)*

R_f (Hex/EtOAc 1/1)=0.38; $[\alpha]_D^{22}$ +27.3 (*c* 1.04, $CHCl_3$); IR (film): 3389, 1717, 1647, 1464, 1375, 1341, 1264, 1216, 1124, 1068, 1023, 925, 902, 875, 787, 739; ^{1}H NMR δ: 5.93 (1H, dd, *J*=17.2 and 10.6 Hz, H-14), 5.22 (1H, dd, *J*=17.2 and 1.0 Hz, H-15), 5.08 (1H, dd, *J*=10.6 and 1.0 Hz, H-15), 4.30 (1H, d, *J*=4.4 Hz, H-7), 3.95 (1H, br s, H-6), 2.40–0.80 (11H, m), 1.67 (3H, s, Me-17), 1.33 (3H, s, Me-16), 1.29 (3H, s, Me-20), 1.20 (3H, s, Me-19), 0.95 (3H, s, Me-18); ^{13}C NMR δ: 144.9 (C-14), 143.9 (C-9), 125.4 (C-8), 112.3 (C-15), 73.8 (C-13), 73.5 (C-7), 68.0 (C-6), 53.1 (C-5), 43.0 (C-3), 41.9 (C-12), 40.2 (C-10), 40.1 (C-1), 33.9 (C-18), 33.8 (C-4), 28.0 (C-16), 24.2 (C-19), 22.3 (C-11), 22.2 (C-20), 19.2 (C-2), 15.0 (C-17). EIHRMS: calcd for $C_{20}H_{34}O_3Na$: 345.2400, found 345.2394.

4.25. Acetylation of 30 to yield 31 and 2

To a solution of **30** (10 mg, 0.03 mmol) in dry pyridine (1 mL), acetic anhydride (1 mL) was added and the mixture was stirred at room temperature for 70 h. The reaction mixture was poured into ice-water and extracted with EtOAc. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and water. The resulting solution was then dried over Na_2SO_4 and evaporated to give a crude oil, which was chromatographed on silica gel to afford **31** (5 mg, 40%) and **2** (5 mg, 45%).

*4.25.1. 6β,7β-Diacetoxy-labda-8,14-dien-13R-ol (**31**)*

R_f (C_6H_6/EtOAc 7/3)=0.53; $[\alpha]_D^{22}$ +22.3 (*c* 0.13, $CHCl_3$); IR (film): 3504, 1742, 1459, 1369, 1251, 1117, 1025, 946; ^{1}H NMR δ: 5.94 (1H, dd, *J*=17.4 and 10.7 Hz, H-14), 5.68 (1H, d, *J*=5.2 Hz, H-7), 5.42 (1H, dd, *J*=5.2 and 0.9 Hz, H-6), 5.24 (1H, dd, *J*=17.4 and 1.2 Hz, H-15), 5.10 (1H, dd, *J*=10.7 and 1.2 Hz, H-15), 2.20–0.80 (11H, m), 2.07 (3H, s, *Me*COO), 2.01 (3H, s, *Me*COO), 1.56 (3H, s, Me-17), 1.36 (3H, s, Me-16), 1.31 (3H, s, Me-20), 0.97 (3H, s, Me-19), 0.96 (3H, s, Me-18); ^{13}C NMR δ: 170.9 (Me*C*OO), 170.9 (Me*C*OO), 145.2 (C-9), 144.8 (C-14), 122.1 (C-8), 112.4 (C-15), 73.7 (C-13), 72.9 (C-7), 66.6 (C-6), 51.5 (C-5), 43.0 (C-3), 41.9 (C-12), 40.5 (C-1), 39.9 (C-10), 33.9 (C-18), 33.6 (C-4), 28.2 (C-16), 23.3 (C-19), 22.4 (C-11), 21.6 (*Me*COO), 21.6 (*Me*COO), 21.1 (C-20), 19.1 (C-2), 14.5 (C-17); EIHRMS: calcd for $C_{24}H_{38}O_5Na$: 429.2611, found 429.2599.

*4.25.2. 6β-Acetoxy-labda-8,14-dien-7β,13R-diol (**2**)*

R_f (C_6H_6/EtOAc 7/3)=0.42; $[\alpha]_D^{22}$ +10.0 (*c* 0.13, $CHCl_3$); IR (film): 3467, 1763, 1461, 1371, 1248, 1117, 1025, 920; ^{1}H NMR δ: 5.91 (1H, dd, *J*=17.4 and 10.6 Hz, H-14), 5.33 (1H, d, *J*=4.6 Hz, H-6), 5.20 (1H, dd, *J*=17.4 and 0.9 Hz, H-15), 5.07 (1H, dd, *J*=10.6 and 0.9 Hz, H-15), 4.36 (1H, d, *J*=4.6 Hz, H-7), 2.13 (3H, s, *Me*COO), 2.12–0.80 (11H, m), 1.51 (3H, s, Me-17), 1.36 (3H, s, Me-16), 1.28 (3H, s, Me-20), 1.18 (3H, s, Me-19), 0.93 (3H, s, Me-18); ^{13}C NMR δ: 170.8 (Me*C*OO), 146.0 (C-9), 144.9 (C-14), 121.4 (C-8), 112.2 (C-15), 76.6 (C-7), 73.7 (C-13), 66.1 (C-6), 53.0 (C-5), 43.3 (C-3), 41.8 (C-12), 40.4 (C-10), 40.0 (C-1), 34.0 (C-18), 33.8 (C-4), 28.0 (C-16), 23.9 (C-19), 22.3 (C-11), 21.8 (C-20), 21.6 (*Me*COO), 19.1 (C-2), 14.7 (C-17); EIHRMS: calcd for $C_{22}H_{36}O_4Na$: 387.2506, found 387.2501.

4.26. Acetylation of 30 to yield 31

To a solution of **30** (10 mg, 0.03 mmol) in dry pyridine (1 mL), acetic anhydride (1 mL) was added and the mixture was stirred at room temperature for 6 days. The reaction mixture was poured into ice-water and extracted with EtOAc. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and water. The resulting solution was then dried over Na_2SO_4 and concentrated to afford **31** (12 mg, 96%).

4.27. Acetylation of 30 to yield 2

To a solution of **30** (10 mg, 0.03 mmol) in dry pyridine (1 mL), acetic anhydride (1 mL) was added and the mixture was stirred at room temperature for 14 h. The reaction mixture was poured into

[†] *Activation of Zn:* Powder of Zn was washed four times with aqueous 5% HCl, five times with water, five times with MeOH, six times with Et_2O and then was dried carefully under reduced pressure.

ice-water and extracted with EtOAc. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and water. The resulting solution was then dried over Na_2SO_4 and concentrated to afford **2** (11 mg, 97%).

4.28. Transacetylation of 2 to yield 32

To a solution of **2** (11 mg, 0.03 mmol) in $CHCl_3$ (1.00 mL), AcOH (1 drop) was added. After 48 h the solvent was removed and the resulting crude was chromatographed on silica gel to afford **2** (4.5 mg, 41%) and **32** (5.1 mg, 46%).

*4.28.1. 7β-Acetoxy-labda-8,14-dien-6β,13R-diol (**32**)*

R_f (Bz/EtOAc 7/3)=0.13; $[\alpha]_D^{22}$+18.4 (*c* 0.63, $CHCl_3$); IR (film): 3466, 1737, 1459, 1371, 1250, 1161, 1117, 1076, 1032, 945, 922; ^{1}H NMR δ: 5.92 (1H, dd, *J*=17.4 and 10.8 Hz, H-14), 5.64 (1H, d, *J*=4.6 Hz, H-7), 5.21 (1H, dd, *J*=17.4 and 1.2 Hz, H-15), 5.07 (1H, dd, *J*=10.8 and 1.2 Hz, H-15), 4.12 (1H, br s, H-6), 2.15–0.80 (11H, m), 2.07 (3H, s, *Me*COO), 1.65 (3H, s, Me-17), 1.30 (3H, s, Me-16), 1.28 (3H, s, Me-20), 0.96 (3H, s, Me-19), 0.96 (3H, s, Me-18); ^{13}C NMR δ: 172.4 (Me*C*OO), 144.9 (C-9), 143.5 (C-14), 125.3 (C-8), 112.2 (C-15), 73.7 (C-13), 72.5 (C-7), 69.6 (C-6), 51.7 (C-5), 43.2 (C-3), 41.8 (C-12), 40.1 (C-1), 39.9 (C-10), 33.8 (C-18), 33.5 (C-4), 28.0 (C-16), 23.3 (C-19), 22.3 (C-11), 21.8 (C-20), 21.6 (*Me*COO), 19.1 (C-2), 14.7 (C-17); EIHRMS: calcd for $C_{22}H_{36}O_4Na$: 387.2506, found 387.2499.

4.29. Reaction of 6 with Bu_4NOAc to yield 33

A solution of **6** (42 mg, 0.13 mmol) in dry toluene (3 mL) was added over Bu_4NOAc (60 mg, 1.99 mmol) and the mixture was stirred for 20 h at 100 °C under argon. Then the solution was cooled down to room temperature and AcOEt was added. The resulting organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$, brine, dried over Na_2SO_4 and concentrated to afford **33** (42 mg, 94%).

*4.29.1. 7α-Acetoxy-6β-hidroxy-14,15-dinor-labd-8-en-13-one (**33**)*

R_f (Hex/EtOAc 6/4)=0.56; $[\alpha]_D^{22}$+24.3 (*c* 0.96, $CHCl_3$); IR (film): 3467, 1716, 1650, 1464, 1367, 1238, 1163, 1119, 1017; ^{1}H NMR δ: 4.83 (1H, br s, H-7), 4.14 (1H, br s, H-6), 2.60–0.80 (11H, m), 2.17 (3H, s, Me-16), 2.06 (3H, s, *Me*COO), 1.60 (3H, s, Me-17), 1.29 (3H, s, Me-20), 1.18 (3H, s, Me-19), 0.91 (3H, s, Me-18); ^{13}C NMR δ: 208.6 (C-13), 171.4 (Me*C*OO), 148.0 (C-9), 121.5 (C-8), 78.2 (C-7), 68.9 (C-6), 50.4 (C-5), 44.3 (C-12), 43.1 (C-3), 39.5 (C-10), 39.2 (C-1), 33.8 (C-4), 33.5 (C-18), 29.9 (C-16), 24.1 (C-19), 21.5 (C-20), 21.3 (*Me*COO), 20.4 (C-11), 19.2 (C-2), 17.5 (C-17); EIHRMS: calcd for $C_{20}H_{32}O_4Na$: 359.2193, found 359.2175.

4.30. Reaction of 33 with vinyl magnesium bromide/(−)-TADDOL and acetylation to yield 34

(−)-TADDOL (0.18 g, 0.38 mmol) was dissolved in THF (1.2 mL) and cooled to −85 °C and under argon atmosphere vinyl magnesium bromide (0.76 mL of solution 1.0 M in THF, 0.76 mmol) was added. The mixture was heated to −50 °C and then vinyl magnesium bromide (0.38 mL of solution 1.0 M in THF, 0.38 mmol) was added, and the resulting solution was warmed up to room temperature. The mixture was cooled to −90 °C, a solution of **33** (18 mg, 0.05 mmol) in THF (1 mL) was added and the mixture was stirred at this temperature for 24 h. Afterwards the reaction was quenched by adding saturated NH_4Cl solution (10 mL) and Et_2O and the resulting organic phase was washed with brine and dried over Na_2SO_4. The solvent was removed to give a crude oil that was dissolved in dry pyridine (3 mL), acetic anhydride (2 mL) was added and the mixture was stirred at room temperature for 6 days. The reaction mixture was poured into ice-water and extracted with EtOAc. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and water. The resulting solution was then dried over Na_2SO_4 and evaporated to give a crude oil, which was chromatographed on silica gel to afford **34** (18 mg, 85%).

*4.30.1. 6β,7α-Diacetoxy-labda-8,14-dien-13S-ol (**34**)*

R_f (Hex/EtOAc 6/4)=0.52; $[\alpha]_D^{22}$ +34.3 (*c* 0.14, $CHCl_3$); IR (film): 3464, 1742, 1461, 1369, 1242, 1115, 1019, 737; ^{1}H NMR δ: 5.93 (1H, dd, *J*=17.4 and 10.6 Hz, H-14), 5.30 (1H, br s, H-6), 5.24 (1H, dd, *J*=17.4 and 1.0 Hz, H-15), 5.10 (1H, dd, *J*=10.6 and 1.0 Hz, H-15), 4.95 (1H, s br, H-7), 2.20–0.80 (11H, m), 2.08 (3H, s, *Me*COO), 2.04 (3H, s, *Me*COO), 1.58 (3H, s, Me-17), 1.32 (3H, s, Me-16), 1.28 (3H, s, Me-20), 0.96 (3H, s, Me-18), 0.95 (3H, s, Me-19); ^{13}C NMR δ: 169.7 (Me*C*OO), 168.6 (Me*C*OO), 147.7 (C-9), 144.6 (C-14), 121.3 (C-8), 112.0 (C-15), 73.4 (C-13), 73.4 (C-7), 69.5 (C-6), 49.2 (C-5), 43.0 (C-3), 41.5 (C-12), 39.5 (C-10), 38.9 (C-1), 33.4 (C-4), 33.0 (C-18), 27.6 (C-16), 23.0 (C-19), 22.4 (C-11), 21.3 (*Me*COO), 21.2 (*Me*COO), 20.9 (C-20), 18.9 (C-2), 16.9 (C-17). EIHRMS: calcd for $C_{24}H_{38}O_5Na$: 429.2611, found 429.2624.

4.31. Reaction of 33 with vinyl magnesium bromide/(+)-TADDOL and acetylation to yield 35

(+)-TADDOL (0.19 g, 0.40 mmol) was dissolved in THF (1.1 mL) and cooled to −85 °C and under argon atmosphere vinyl magnesium bromide (0.79 mL of solution 1.0 M in THF, 0.79 mmol) was added. The mixture was heated to −50 °C and then vinyl magnesium bromide (0.39 mL of solution 1.0 M in THF, 0.39 mmol) was added, and the resulting solution was warmed up to room temperature. The mixture was cooled to −90 °C, a solution of **31** (17 mg, 0.05 mmol) in THF (1 mL) was added and the mixture was stirred at this temperature for 24 h. Afterwards the reaction was quenched by adding saturated NH_4Cl solution (10 mL) and Et_2O and the resulting organic phase was washed with brine and dried over Na_2SO_4. The solvent was removed to give a crude oil that was dissolved in dry pyridine (3 mL), acetic anhydride (2 mL) was added and the mixture was stirred at room temperature for 6 days. The reaction mixture was poured into ice-water and extracted with EtOAc. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and water. The resulting solution was then dried over Na_2SO_4 and evaporated to give a crude oil, which was chromatographed on silica gel to afford **35** (17 mg, 84%).

*4.31.1. 6β,7α-Diacetoxy-labda-8,14-dien-13R-ol (**35**)*

R_f (Hex/EtOAc 6/4)=0.52; $[\alpha]_D^{22}$ +52.0 (*c* 0.24, $CHCl_3$); IR (film): 3457, 1742, 1461, 1448, 1369, 1242, 1122, 1076, 1020, 948; ^{1}H NMR δ: 5.93 (1H, dd, *J*=17.4 and 10.6 Hz, H-14), 5.30 (1H, br s, H-6), 5.24 (1H, dd, *J*=17.4 and 1.0 Hz, H-15), 5.10 (1H, dd, *J*=10.6 and 1.0 Hz, H-15), 4.95 (1H, br s, H-7), 2.20–0.80 (11H, m), 2.08 (3H, s, *Me*COO), 2.04 (3H, s, *Me*COO), 1.58 (3H, s, Me-17), 1.32 (3H, s, Me-16), 1.28 (3H, s, Me-20), 0.97 (3H, s, Me-18), 0.95 (3H, s, Me-19); ^{13}C NMR δ: 169.9 (Me*C*OO), 169.7 (Me*C*OO), 147.8 (C-9), 144.5 (C-14), 121.3 (C-8), 112.1 (C-15), 73.5 (C-13), 73.4 (C-7), 69.5 (C-6), 49.2 (C-5), 43.0 (C-3), 41.4 (C-12), 39.5 (C-10), 38.9 (C-1), 33.4 (C-4), 33.0 (C-18), 27.6 (C-16), 23.0 (C-19), 22.7 (C-11), 21.5 (*Me*COO), 21.2 (*Me*COO), 20.9 (C-20), 18.9 (C-2), 16.9 (C-17); EIHRMS: calcd for $C_{24}H_{38}O_5Na$: 429.2611, found 429.2614.

4.32. Reaction of 34 with K_2CO_3/MeOH to yield 36

Compound **34** (3.4 mg, 0.01 mmol) was treated with K_2CO_3 in MeOH (2%, 0.80 mL) and the mixture was stirred at room temperature for 75 min. After that time, the reaction mixture was diluted with H_2O and extracted with EtOAc. The organic phase was washed with aqueous 2 M HCl and water, dried over Na_2SO_4, filtered and the solvent evaporated to afford **36** (3.0 mg, 98%).

*4.32.1. 6β-Acetoxy-labda-8,14-diene-7α,13S-diol (**36**)*

R_f (Hex/EtOAc 6/4)=0.23; $[\alpha]_D^{22}$ +14.3 (*c* 0.29, $CHCl_3$); IR (film): 3435, 1738, 1460, 1375, 1241, 1103, 1020, 736; ^{1}H NMR δ: 5.94 (1H, dd, *J*=17.6 and 10.6 Hz, H-14), 5.26 (1H, br s, H-6), 5.24 (1H, dd, *J*=17.6 and 1.0 Hz, H-15), 5.10 (1H, dd, *J*=10.6 and 1.0 Hz, H-15), 3.66 (1H, br s, H-7), 2.20–0.70 (11H, m), 2.04 (3H, s, *Me*COO), 1.72 (3H, s, Me-17), 1.31 (3H, s, Me-16), 1.25 (3H, s, Me-20), 0.99 (3H, s, Me-19), 0.99 (3H, s, Me-18); ^{13}C NMR δ: 170.7 (Me*C*OO), 145.1 (C-9), 144.7 (C-14), 124.4 (C-8), 111.9 (C-15), 73.4 (C-13), 73.4 (C-6), 72.6 (C-7), 47.9 (C-5), 42.9 (C-3), 41.9 (C-12), 39.5 (C-10), 39.0 (C-1), 33.1 (C-18), 33.0 (C-4), 27.5 (C-16), 23.4 (C-19), 22.4 (C-11), 21.4 (*Me*COO), 21.0 (C-20), 19.0 (C-2), 17.5 (C-17). EIHRMS: calcd for $C_{22}H_{36}O_4Na$: 387.2506, found 387.2513.

4.33. Reaction of 35 with K_2CO_3/MeOH to yield 37

Compound **35** (9 mg, 0.02 mmol) was treated with K_2CO_3 in MeOH (2%, 1.4 mL) and the mixture was stirred at room temperature for 75 min. After that time, the reaction mixture was diluted with H_2O and extracted with EtOAc. The organic phase was washed with aqueous 2 M HCl and water, dried over Na_2SO_4, filtered and the solvent evaporated to afford **37** (8 mg, 100%).

*4.33.1. 6β-Acetoxy-labda-8,14-diene-7α,13R-diol (**37**)*

R_f (Hex/EtOAc 6/4)=0.23; $[\alpha]_D^{22}$ +27.0 (*c* 0.50, $CHCl_3$); IR (film): 3437, 1736, 1462, 1375, 1243, 1101, 1022, 738; ^{1}H NMR δ: 5.94 (1H, dd, *J*=17.6 and 10.6 Hz, H-14), 5.26 (1H, br s, H-6), 5.24 (1H, dd, *J*=17.6 and 1.2 Hz, H-15), 5.10 (1H, dd, *J*=10.6 and 1.2 Hz, H-15), 3.66 (1H, br s, H-7), 2.20–0.70 (11H, m), 2.04 (3H, s, *Me*COO), 1.72 (3H, s, Me-17), 1.31 (3H, s, Me-16), 1.25 (3H, s, Me-20), 0.99 (3H, s, Me-19), 0.99 (3H, s, Me-18); ^{13}C NMR δ: 170.8 (Me*C*OO), 145.2 (C-9), 144.6 (C-14), 124.4 (C-8), 112.0 (C-15), 73.5 (C-13), 73.4 (C-6), 72.6 (C-7), 47.9 (C-5), 42.9 (C-3), 41.8 (C-12), 39.6 (C-10), 39.0 (C-1), 33.1 (C-18), 33.0 (C-4), 27.5 (C-16), 23.4 (C-19), 22.6 (C-11), 21.6 (*Me*COO), 21.0 (C-20), 19.0 (C-2), 17.5 (C-17). EIHRMS: calcd for $C_{22}H_{36}O_4Na$: 387.2506, found 387.2518.

4.34. Wittig reaction of 6 to yield 38 and 39

To a solution of **6** (200 mg, 0.62 mmol) in dry toluene (42 mL), Ph_3PCHCO_2Et (11 mg, 31.4 mmol) was added and the mixture was stirred for 48 h to 120 °C under argon atmosphere. Then AcOEt was added and the resulting organic phase was washed with water and brine and dried over Na_2SO_4. The solvent was evaporated to give a crude oil, which was chromatographed on silica gel to afford **6** (62 mg, 31%), **38** (46 mg, 19%) and **39** (68 mg, 28%).

*4.34.1. Ethyl 6β,7β-carbonyldioxy-labda-8,13Z-dien-15-oate (**38**)*

R_f (Hex/EtOAc 6/4)=0.70; $[\alpha]_D^{22}$ +54.8 (*c* 0.82, $CHCl_3$); IR (film): 1801, 1713, 1649, 1463, 1442, 1373, 1323, 1227, 1176, 1159, 1038, 1017; ^{1}H NMR δ: 5.64 (1H, s, H-14), 5.16 (1H, dd, *J*=8.0 and 1.0 Hz, H-6), 4.91 (1H, d, *J*=8.0 Hz, H-7), 4.13 (2H, q, $COOCH_2CH_3$), 2.90–2.50 (2H, m, H-12), 2.30–0.80 (9H, m), 1.91 (3H, s, Me-16), 1.82 (3H, s, Me-17), 1.24 (3H, t, $COOCH_2CH_3$), 1.24 (3H, s, Me-20), 1.18 (3H, s, Me-19), 1.02 (3H, s, Me-18); ^{13}C NMR δ: 166.3 (C-15), 158.7 (C-13), 155.5 (*O*COO), 149.1 (C-9), 121.9 (C-8), 116.8 (C-14), 79.2 (C-7), 75.2 (C-6), 59.8 ($CO_2CH_2CH_3$), 51.9 (C-5), 42.7 (C-3), 39.2 (C-10), 38.6 (C-1), 38.5 (C-12), 34.3 (C-4), 33.1 (C-18), 26.4 (C-11), 25.1 (C-19), 23.7 (C-20), 22.7 (C-16), 18.9 (C-2), 16.4 (C-17), 14.5 ($CO_2CH_2CH_3$); EIHRMS: calcd for $C_{23}H_{34}O_5Na$: 413.2298, found: 413.2310.

*4.34.2. Ethyl 6β,7β-carbonyldioxy-labda-8,13E-dien-15-oate (**39**)*

R_f (Hex/EtOAc 6/4)=0.70; $[\alpha]_D^{22}$ +69.9 (*c* 1.13, $CHCl_3$); IR (film): 1801, 1713, 1649, 1464, 1384, 1373, 1323, 1146, 1118, 1038, 1017; ^{1}H NMR δ: 5.67 (1H, s, H-14), 5.17 (1H, dd, *J*=8.0 and 1.0 Hz, H-6), 4.90 (1H, d, *J*=8.0 Hz, H-7), 4.14 (2H, q, $COOCH_2CH_3$), 2.30–0.80 (11H, m), 2.17 (3H, s, Me-16), 1.75 (3H, s, Me-17), 1.27 (3H, t, $COOCH_2CH_3$), 1.23 (3H, s, Me-20), 1.18 (3H, s, Me-19), 1.02 (3H, s, Me-18); ^{13}C NMR δ: 165.9 (C-15), 158.1 (C-13), 154.4 (*O*COO), 147.7 (C-9), 120.9 (C-8), 114.8 (C-14), 77.9 (C-7), 74.1 (C-6), 58.9 ($CO_2CH_2CH_3$), 50.9 (C-5), 41.7 (C-3), 39.6 (C-12), 38.1 (C-10), 37.7 (C-1), 33.3 (C-4), 32.1 (C-18), 25.5 (C-11), 22.7 (C-19), 21.6 (C-20), 18.1 (C-16), 17.8 (C-2), 15.5 (C-17), 13.6 ($CO_2CH_2CH_3$); EIHRMS: calcd for $C_{23}H_{34}O_5Na$: 413.2298, found: 413.2279.

4.35. Reaction of 39 with Bu_4NOAc to yield 40

A solution of **39** (42 mg, 0.11 mmol) in dry toluene (4 mL) was added over Bu_4NOAc (1.03 g, 3.43 mmol) and the mixture was stirred for 18 h at 100 °C under argon. Then the solution was cooled down to room temperature and AcOEt was added. The resulting organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$, brine, dried over Na_2SO_4, filtered and concentrated to **40** (42 mg, 98%).

*4.35.1. Ethyl 7α-acetoxy-6β-hidroxy-labda-8,13E-dien-15-oate (**40**)*

R_f (Hex/EtOAc 6/4)=0.74; $[\alpha]_D^{22}$ +64.3 (*c* 1.02, $CHCl_3$); IR (film): 3467, 1797, 1713, 1649, 1464, 1384, 1238, 1146, 1118, 1038, 1017; ^{1}H NMR δ: 5.68 (1H, s, H-14), 4.82 (1H, br s, H-7), 4.15 (2H, q, $COOCH_2CH_3$), 4.13 (1H, br s, H-6), 2.30–0.80 (11H, m), 2.17 (3H, s, Me-16), 2.06 (3H, s, *Me*COO), 1.61 (3H, s, Me-17), 1.27 (3H, t, $COOCH_2CH_3$), 1.29 (3H, s, Me-20), 1.18 (3H, s, Me-19), 0.91 (3H, s, Me-18); ^{13}C NMR δ: 169.6 (Me*C*OO), 165.8 (C-15), 158.3 (C-13), 147.9 (C-9), 121.4 (C-8), 114.9 (C-14), 78.3 (C-7), 68.8 (C-6), 58.8 ($CO_2CH_2CH_3$), 50.5 (C-5), 43.1 (C-3), 39.6 (C-12), 39.3 (C-10), 38.7 (C-1), 33.7 (C-4), 33.4 (C-18), 24.9 (C-11), 23.9 (C-19), 21.6 (C-20), 21.3 (*Me*COO), 18.7 (C-2), 18.1 (C-16), 16.9 (C-17), 13.6 ($CO_2CH_2CH_3$); EIHRMS: calcd for $C_{24}H_{37}O_5Na$: 428.2599, found: 428.2419.

4.36. Reaction of 40 with DIBAL-H to yield 41

To a solution of **40** (39 mg, 0.10 mmol) in CH_2Cl_2 (1.7 mL) at −78 °C, DIBAL-H (0.40 mL of solution 1.5 M in toluene, 0.60 mmol) was added under argon. After 30 min the mixture was warmed up to 0 °C, quenched with wet Et_2O and at room temperature, Et_2O, Na_2SO_4 (800 mg) and $NaHCO_3$ (650 mg) were added and the solution was stirred for 1 h, filtered eluting with Et_2O and EtOAc and concentrated to afford **41** (30 mg, 98%).

*4.36.1. Labda-8,13E-dien-6β,7α,15-triol (**41**)*

R_f (Hex/EtOAc 1/1)=0.15; $[\alpha]_D^{22}$ +27.2 (*c* 0.93, $CHCl_3$); IR (film): 3376, 1719, 1460, 1371, 1222, 1128, 1063, 1029, 921, 730; ^{1}H NMR δ: 5.44 (1H, t, *J*=6.8 Hz, H-14), 4.25 (1H, br s, H-6), 4.17 (2H, d, *J*=6.8 Hz, H-15), 3.71 (1H, br s, H-7), 2.25–0.80 (11H, m), 1.80 (3H, s, Me-17), 1.72 (3H, s, Me-16), 1.31 (3H, s, Me-20), 1.21 (3H, s, Me-19), 1.01 (3H, s, Me-18); ^{13}C NMR δ: 169.7 (Me*C*OO), 146.2 (C-9), 140.0 (C-13), 124.2 (C-8), 123.0 (C-14), 76.2 (C-7), 71.7 (C-6), 59.4 (C-15), 49.3 (C-5), 42.8 (C-3), 39.4 (C-10), 39.3 (C-1), 39.3 (C-12), 33.6 (C-4), 33.4 (C-18), 26.9 (C-11), 24.1 (C-19), 21.6 (C-20), 21.2 (*Me*COO), 19.0 (C-2), 17.8 (C-17), 16.4 (C-16); EIHRMS: calcd for $C_{20}H_{34}O_3Na$: 345.2400, found: 345.2411.

4.37. Reaction of 41 with isovaleric acid to yield 42

To a solution of isovaleric acid (0.16 mL, 1.50 mmol) in toluene (0.50 mL), 2,4,6-trichlorobenzoyl chloride (0.23 mL, 1.50 mmol) and Et_3N (0.21 mL, 1.50 mmol) were added and the mixture was stirred for 2 h at room temperature. Then **41** (24 mg, 0.07 mmol) dissolved in toluene (0.50 mL) was added and the resulting solution heated at 80 °C for 2 h. After that, the mixture was filtered washing with AcOEt and the organic layer obtained was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and brine, dried over

Na_2SO_4, filtered and concentrated to give a crude oil, which was chromatographed on silica gel to afford **42** (42 mg, 100%).

*4.37.1. 6β,7α,15-Triisovaleryloxy-labda-8,13E-diene (**42**)*

R_f (Hex/EtOAc 9/1)=0.43; $[\alpha]_D^{22}$ +52.2 (*c* 0.89, $CHCl_3$); IR (film): 1742, 1581, 1548, 1371, 1291, 1122, 987, 844; ^{1}H NMR δ: 5.35 (1H, t, *J*=6.9 Hz, H-14), 5.33 (1H, br s, H-6), 4.98 (1H, br s, H-7), 4.61 (2H, d, *J*=6.9 Hz, H-15), 2.36–2.00 (10H, m), 1.90–0.90 (10H, m), 1.75 (3H, s, Me-16), 1.61 (3H, s, Me-17), 1.28 (3H, s, Me-20), 1.00 (3H, d, *J*=6.5 Hz), 0.98 (12H, d, *J*=6.5 Hz), 0.97 (3H, s, Me-19), 0.96 (3H, s, Me-18), 0.95 (3H, d, *J*=6.5 Hz); ^{13}C NMR δ: 172.5 ($OCOCH_2$), 170.1 ($OCOCH_2$), 169.8 ($OCOCH_2$), 147.5 (C-9), 142.3 (C-13), 121.5 (C-8), 118.1 (C-14), 73.5 (C-7), 69.6 (C-6), 61.4 (C-15), 49.1 (C-5), 44.1 ($OCOCH_2$), 44.0 ($OCOCH_2$), 44.0 ($OCOCH_2$), 43.0 (C-3), 39.5 (C-10), 39.1 (C-1), 38.3 (C-12), 33.4 (C-4), 33.0 (C-18), 26.8 (C-11), 25.5 ($CHMe_2$), 25.4 ($CHMe_2$), 25.4 ($CHMe_2$), 22.9 (C-19), 22.5 ($CHMe_2$), 22.5 ($CHMe_2$), 22.4 ($CHMe_2$), 22.4 ($CHMe_2$), 22.3 ($CHMe_2$), 22.3 ($CHMe_2$), 21.5 (C-20), 18.9 (C-2), 17.0 (C-17), 16.6 (C-16); EIHRMS: calcd for $C_{35}H_{58}O_6Na$: 597.4173, found: 597.4198.

4.38. Reaction of 42 with K_2CO_3/MeOH to yield 3

Compound **42** (24 mg, 0.04 mmol) was treated with K_2CO_3 in MeOH (4%, 1.5 mL) and the mixture was stirred at room temperature for 20 h. After that time, the reaction mixture was diluted with H_2O and extracted with EtOAc. The organic phase was washed with aqueous 2 M HCl and water, dried over Na_2SO_4, filtered and the solvent evaporated to afford **3** (14 mg, 85%).

*4.38.1. 6β-Isovaleryloxy-labda-8,13E-diene-7α,15-diol (**3**)*

R_f (Hex/EtOAc 6/4)=0.23; $[\alpha]_D^{22}$ +40.0 (*c* 1.01, $CHCl_3$); IR (film): 3400, 1732, 1466, 1377, 1294, 1260, 1192, 1169, 1101, 1008; ^{1}H NMR δ: 5.44 (1H, t, *J*=6.8 Hz, H-14), 5.27 (1H, d, *J*=1.4 Hz, H-6), 4.12 (2H, d, *J*=6.8 Hz, H-15), 3.67 (1H, d, *J*=1.4 Hz, H-7), 2.25–0.80 (14H, m), 1.74 (3H, s, Me-17), 1.71 (3H, s, Me-16), 1.26 (3H, s, Me-20), 1.00 (3H, s, Me-19), 1.00 (3H, s, Me-18), 0.93 (6H, d, *J*=6.5 Hz, Me-24 and Me-25); ^{13}C NMR δ: 172.9 ($OCOCH_2$), 145.7 (C-9), 140.1 (C-13), 124.1 (C-8), 123.0 (C-14), 73.2 (C-6), 72.6 (C-7), 59.4 (C-15), 48.0 (C-5), 44.0 ($OCOCH_2$), 42.9 (C-3), 39.5 (C-10), 39.3 (C-1), 38.9 (C-12), 33.5 (C-4), 33.2 (C-18), 26.8 (C-11), 25.5 ($CHMe_2$), 23.5 (C-19), 22.5 ($CHMe_2$), 22.4 ($CHMe_2$), 21.1 (C-20), 19.0 (C-2), 17.5 (C-17), 16.4 (C-16); EIHRMS: calcd for $C_{25}H_{42}O_4Na$: 429.2975, found: 429.2995.

4.39. Reaction of 38 with DIBAL-H to yield 43

To a solution of **38** (26 mg, 0.07 mmol) in CH_2Cl_2 (2.5 mL) at −78 °C, DIBAL-H (0.30 mL of solution 1.5 M in toluene, 0.45 mmol) was added under argon. After 1 h the mixture was warmed up to 0 °C, quenched with wet Et_2O and at room temperature, Et_2O, Na_2SO_4 (1.00 g) and $NaHCO_3$ (0.80 g) were added and the solution was stirred for 1 h, filtered eluting with Et_2O and EtOAc and concentrated to afford **43** (22 mg, 100%).

*4.39.1. Labda-8,13Z-dien-6β,7β,15-triol (**43**)*

R_f (Hex/EtOAc 1/1)=0.23; $[\alpha]_D^{22}$ +21.4 (*c* 1.26, $CHCl_3$); IR (film): 3366, 1463, 1377, 1261, 1095, 1020, 799; ^{1}H NMR δ: 5.39 (1H, t, *J*=7.0 Hz, H-14), 4.32 (1H, d, *J*=4.4 Hz, H-7), 4.13 (2H, d, *J*=7.0 Hz, H-15), 4.05–3.95 (1H, br s, H-6), 2.20–0.70 (11H, m), 1.78 (3H, s, Me-17), 1.75 (3H, s, Me-16), 1.33 (3H, s, Me-20), 1.21 (3H, s, Me-19), 0.96 (3H, s, Me-18); ^{13}C NMR δ: 143.9 (C-9), 140.6 (C-13), 125.8 (C-8), 124.1 (C-14), 73.5 (C-7), 67.9 (C-6), 59.4 (C-15), 53.1 (C-5), 42.9 (C-3), 40.1 (C-10), 40.1 (C-1), 33.9 (C-4), 33.8 (C-18), 32.3 (C-12), 26.9 (C-11), 24.2 (C-19), 23.6 (C-16), 22.0 (C-20), 19.2 (C-2), 15.4 (C-17); EIHRMS: calcd for $C_{20}H_{34}O_3Na$: 345.2400, found: 345.2416.

4.40. Reaction of 43 with TBDMSCl to yield 44

To an ice cooled solution of **43** (19 mg, 0.06 mmol) in DMF (1 mL) TBDMSCl (9 mg, 0.06 mmol) and imidazole (8 mg, 0.12 mmol) were added, and the mixture was stirred at room temperature for 40 h under argon. Then, the solution was cooled to 0 °C, diluted with water and extracted with AcOEt. The combined organic layers were washed with brine, dried over Na_2SO_4, filtered and concentrated under reduced pressure to afford **44** (24 mg, 96%).

*4.40.1. 15-tert-Butyldimethylsilyloxy-labda-8,13Z-diene-6β,7β-diol (**44**)*

R_f (Hex/EtOAc 7/3)=0.56; $[\alpha]_D^{22}$ +15.8 (*c* 0.92, $CHCl_3$); IR (film): 3399, 1463, 1379, 1259, 1104, 1071, 1044, 836, 805, 777; ^{1}H NMR δ: 5.30 (1H, t, *J*=6.4 Hz, H-14), 4.33 (1H, d, *J*=5.0 Hz, H-7), 4.18 (2H, d, *J*=6.4 Hz, H-15), 3.99 (1H, dd, *J*=5.0 and 1.0 Hz, H-6), 2.20–0.80 (11H, m), 1.76 (3H, s, Me-17), 1.76 (3H, s, Me-16), 1.35 (3H, s, Me-20), 1.22 (3H, s, Me-19), 0.94 (3H, s, Me-18), 0.90 (9H, s, Me_2SiCMe_3), 0.06 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 143.9 (C-9), 138.2 (C-13), 125.6 (C-8), 125.1 (C-14), 73.4 (C-7), 67.9 (C-6), 60.3 (C-15), 53.1 (C-5), 43.0 (C-3), 40.1 (C-10), 40.1 (C-1), 33.9 (C-4), 33.8 (C-18), 32.2 (C-12), 27.0 (C-11), 26.3 (Me_2SiCMe_3), 24.2 (C-19), 23.6 (C-16), 22.1 (C-20), 19.2 (C-2), 18.7 (Me_2SiCMe_3), 15.1 (C-17), 1.3 (Me_2SiCMe_3), −4.8 (Me_2SiCMe_3); EIHRMS: calcd for $C_{26}H_{48}O_3SiNa$: 459.3265, found: 459.3259.

4.41. Reaction of 44 with triphosgene to yield 45

To a solution of triphosgene (7 mg, 0.02 mmol) in pyridine (0.01 mL) and CH_2Cl_2 (0.40 mL) cooled at −78 °C was added another solution of **44** (11 mg, 0.02 mmol) in CH_2Cl_2 (0.40 mL). The reaction mixture was stirred until it warmed up to room temperature and then saturated NH_4Cl solution was added. The mixture was extracted with Et_2O and washed with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and brine. The organic layer was dried over Na_2SO_4, filtered and evaporated to afford **45** (11 mg, 100%).

*4.41.1. 15-tert-Butyldimethylsilyloxy-6β,7β-Carbonyldioxy-labda-8,13Z-diene (**45**)*

R_f (Hex/EtOAc 7/3)=0.72; $[\alpha]_D^{22}$ +20.5 (*c* 1.00, $CHCl_3$); IR (film): 1805, 1735, 1463, 1376, 1259, 1163, 1101, 1074, 1041, 1024, 804, 776; ^{1}H NMR δ: 5.30 (1H, t, *J*=6.2 Hz, H-14), 5.17 (1H, dd, *J*=7.8 and 1.2 Hz, H-6), 4.93 (1H, d, *J*=7.8 Hz, H-7), 4.16 (2H, d, *J*=6.2 Hz, H-15), 2.20–0.80 (11H, m), 1.78 (3H, s, Me-16), 1.76 (3H, s, Me-17), 1.29 (3H, s, Me-20), 1.20 (3H, s, Me-19), 1.04 (3H, s, Me-18), 0.90 (9H, s, Me_2SiCMe_3), 0.06 (6H, s, Me_2SiCMe_3); ^{13}C NMR δ: 154.9 (OCOO), 148.8 (C-9), 138.2 (C-13), 125.1 (C-14), 120.5 (C-8), 78.4 (C-7), 74.5 (C-6), 60.3 (C-15), 51.1 (C-5), 42.0 (C-3), 38.6 (C-1), 38.3 (C-10), 33.6 (C-18), 32.3 (C-4), 32.3 (C-12), 27.0 (C-11), 25.6 (Me_2SiCMe_3), 23.6 (C-16), 23.4 (C-19), 21.9 (C-20), 18.1 (C-2), 18.0 (Me_2SiCMe_3), 15.6 (C-17), 1.2 (Me_2SiCMe_3), −5.0 (Me_2SiCMe_3); EIHRMS: calcd for $C_{27}H_{46}O_4SiNa$: 485.3058, found: 485.3060.

4.42. Reaction of 45 with Bu_4NOAc to yield 46 and 47

A solution of **45** (51 mg, 0.11 mmol) in dry toluene (4 mL) was added over Bu_4NOAc (1.03 g, 3.43 mmol) and the mixture was stirred for 46 h at 80 °C under argon. Then the solution was cooled down to room temperature and AcOEt was added. The resulting organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$, brine, dried over Na_2SO_4, filtered and concentrated to give a crude oil, which was chromatographed on silica gel to afford **46** (14 mg, 27%) and **47** (22 mg, 56%).

*4.42.1. 7α-Acetoxy-15-tert-butyldimethylsilyloxy-labda-8,13Z-dien-6β-ol (**46**)*

R_f (Hex/EtOAc 1/1)=0.80; $[\alpha]_D^{22}$ +43.5 (*c* 0.20, $CHCl_3$); IR (film): 3451, 1805, 1731, 1647, 1463, 1374, 1252, 1103, 1073, 1017, 941, 836, 776; ^{1}H NMR δ: 5.31 (1H, t, *J*=6.0 Hz, H-14), 4.85 (1H, br s, H-7), 4.19 (2H, d, *J*=6.0 Hz, H-15), 4.18 (1H, br s, H-6), 2.30–0.70 (11H, m), 2.08 (3H, s, *Me*COO), 1.77 (3H, s, Me-16), 1.69 (3H, s, Me-17), 1.31 (3H, s, Me-20), 1.20 (3H, s, Me-19), 0.93 (3H, s, Me-18), 0.90 (9H, s, Me_2SiCMe_3), 0.07 (6H, s, Me_2SiCMe_3); EIHRMS: calcd for $C_{28}H_{50}O_4SiNa$: 501.3371, found: 501.3375.

*4.42.2. 7α-Acetoxy-labda-8,13Z-dien-6β,15-diol (**47**)*

R_f (Hex/EtOAc 7/3)=0.45; $[\alpha]_D^{22}$ +46.7 (*c* 0.09, $CHCl_3$); IR (film): 3407, 1728, 1460, 1443, 1375, 1237, 1160, 1118, 1095, 1039, 1018; ^{1}H NMR δ: 5.40 (1H, t, *J*=7.4 Hz, H-14), 4.84 (1H, br s, H-7), 4.16 (1H, s ancho, H-6), 4.14 (2H, d, *J*=7.4 Hz, H-15), 2.20–0.70 (11H, m), 2.07 (3H, s, *Me*COO), 1.79 (3H, s, Me-16), 1.68 (3H, s, Me-17), 1.30 (3H, s, Me-20), 1.18 (3H, s, Me-19), 0.92 (3H, s, Me-18); ^{13}C NMR δ: 169.8 (Me*C*OO), 146.2 (C-9), 140.6 (C-13), 124.3 (C-8), 124.0 (C-14), 76.1 (C-7), 71.7 (C-6), 59.4 (C-15), 49.2 (C-5), 42.9 (C-3), 39.5 (C-1), 39.5 (C-10), 33.7 (C-4), 33.5 (C-18), 32.2 (C-12), 26.9 (C-11), 24.0 (C-19), 23.6 (C-16), 21.5 (C-20), 21.3 (*Me*COO), 19.0 (C-2), 17.7 (C-17); EIHRMS: calcd for $C_{22}H_{36}O_4Na$: 387.2506, found: 387.2488.

4.43. Reaction of 46 with TBAF to yield 47

A solution of **46** (8 mg, 0.02 mmol) in THF (0.40 mL) was treated with TBAF (0.40 mL solution 1.0 M in THF, 0.40 mmol). After being stirred for 90 min under argon the reaction mixture was diluted with water, and extracted with EtOAc. The combined organic layers were washed with brine, dried over Na_2SO_4, filtered and concentrated under reduced pressure to afford **47** (5 mg, 90%).

4.44. Acetylation of 47 to yield 4

To a solution of **47** (6 mg, 0.02 mmol) in CH_2Cl_2 (0.50 mL), CH_3COCl (0.12 mL, 1.50 mmol) and *N*,*N*-dimetilaniline (0.12 mL, 1.20 mmol) were added under argon atmosphere and the mixture was stirred at room temperature for 5 days. The reaction mixture was poured into ice-water and extracted with Et_2O. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and brine. The resulting solution was then dried over Na_2SO_4, filtered and concentrated to give a crude oil, which was chromatographed on silica gel to afford **4** (7 mg, 96%).

*4.44.1. 6β,7α,15-Triacetoxy-labda-8,13Z-diene (**4**)*

R_f (Hex/EtOAc 7/3)=0.60; $[\alpha]_D^{22}$ +32.1 (*c* 0.51, $CHCl_3$); IR (film): 1740, 1471, 1440, 1371, 1240, 1017; ^{1}H NMR δ: 5.36 (1H, t, *J*=7.0 Hz, H-14), 5.32 (1H, br s, H-6), 4.97 (1H, br s, H-7), 4.57 (2H, d, *J*=7.0 Hz, H-15), 2.30–0.80 (11H, m), 2.09 (3H, s, *Me*COO), 2.05 (3H, s, *Me*COO), 2.04 (3H, s, *Me*COO), 1.82 (3H, s, Me-16), 1.65 (3H, s, Me-17), 1.30 (3H, s, Me-20), 0.97 (3H, s, Me-19), 0.95 (3H, s, Me-18); ^{13}C NMR δ: 171.1 (Me*C*OO), 169.9 (Me*C*OO), 169.8 (Me*C*OO), 147.6 (C-9), 144.1 (C-13), 121.6 (C-8), 118.7 (C-14), 73.5 (C-7), 69.5 (C-6), 61.7 (C-15), 49.2 (C-5), 43.0 (C-3), 39.4 (C-10), 39.3 (C-1), 33.5 (C-4), 33.4 (C-18), 31.4 (C-12), 26.9 (C-11), 23.6 (C-16), 23.1 (C-19), 21.5 (*Me*COO), 21.4 (C-20), 21.0 (*Me*COO), 20.9 (*Me*COO), 18.9 (C-2), 17.1 (C-17); EIHRMS: calcd for $C_{26}H_{40}O_6Na$: 471.2717, found: 471.2722.

4.45. Acetylation of 41 to yield 48

To a solution of **41** (11 mg, 0.03 mmol) in CH_2Cl_2 (1 mL), CH_3COCl (0.24 mL, 3.00 mmol) and *N*,*N*-dimetilaniline (0.24 mL, 2.40 mmol) were added under argon atmosphere and the mixture was stirred at room temperature for 5 days. The reaction mixture was poured into ice-water and extracted with Et_2O. The organic layer was washed successively with aqueous 2 M HCl, aqueous 6% $NaHCO_3$ and brine. The resulting solution was then dried over Na_2SO_4, filtered and concentrated to give a crude oil, which was chromatographed on silica gel to afford **48** (15 mg, 98%).

*4.45.1. 6β,7α,15-Triacetoxy-labda-8,13E-diene (**48**)*

R_f (Hex/EtOAc 7/3)=0.45; $[\alpha]_D^{22}$ +44.8 (*c* 0.33, $CHCl_3$); IR (film): 1742, 1474, 1442, 1368, 1239, 1019; ^{1}H NMR δ: 5.35 (1H, t, *J*=7.0 Hz, H-14), 5.32 (1H, br s, H-6), 4.97 (1H, br s, H-7), 4.60 (2H, d, *J*=7.0 Hz, H-15), 2.20–0.80 (11H, m), 2.10 (3H, s, *Me*COO), 2.07 (3H, s, *Me*COO), 2.04 (3H, s, *Me*COO), 1.74 (3H, s, Me-16), 1.62 (3H, s, Me-17), 1.28 (3H, s, Me-20), 0.97 (3H, s, Me-18), 0.96 (3H, s, Me-19); ^{13}C NMR δ: 171.1 (Me*C*OO), 169.9 (Me*C*OO), 169.7 (Me*C*OO), 147.6 (C-9), 142.3 (C-13), 121.6 (C-8), 118.0 (C-14), 73.4 (C-7), 69.5 (C-6), 61.3 (C-15), 49.2 (C-5), 43.0 (C-3), 39.4 (C-10), 39.2 (C-1), 38.8 (C-12), 33.4 (C-4), 33.0 (C-18), 26.8 (C-11), 23.0 (C-19), 21.5 (C-20), 21.5 (*Me*COO), 21.0 (*Me*COO), 20.9 (*Me*COO), 18.9 (C-2), 17.0 (C-17), 16.6 (C-16); EIHRMS: calcd for $C_{26}H_{40}O_6Na$: 471.2717, found: 471.2720.

Acknowledgements

The authors are gratefully acknowledged to Dr. A. Lithgow and Dr. C. Raposo, from the NMR and Mass Spectrometry Services, respectively, of Universidad de Salamanca and to the ClCYT (CTQ2005-04406) for financial support. L.C. is grateful to Junta de Castilla y León for a fellowship.

References and notes

1. Hanson, J. R. *Nat. Prod. Rep.* **2007**, *24*, 1332.
2. (a) Bhat, S. V.; Bajwa, B. S.; Dornauer, H.; De Souza, N. J.; Fehlhaber, H. W. *Tetrahedron Lett.* **1977**, *19*, 1669; (b) Hashimoto, S.; Sakata, S.; Sonegawa, M.; Ikegami, S. *J. Am. Chem. Soc.* **1988**, *110*, 3670; (c) Corey, E. J.; Da Silva Jardine, P.; Rohloff, J. C. *J. Am. Chem. Soc.* **1988**, *110*, 3672; (d) Hagiwara, H.; Takeuchi, F.; Kudou, M.; Hoshi, T.; Suzuki, T.; Hashimoto, T.; Asakawa, A. *J. Org. Chem.* **2006**, *71*, 4619; (e) Shan, Y.; Wang, X.; Zhou, X.; Kong, L.; Niwa, M. *Chem. Pharm. Bull.* **2007**, *55*, 376; (f) Hagiwara, H.; Tsukagoshi, M.; Hoshi, T.; Suzuki, T.; Hashimoto, T.; Asakawa, Y. *Synlett* **2008**, 929.
3. (a) Zdero, C.; Bohlmann, F.; Niemeyer, M. *Phytochemistry* **1991**, *30*, 3683; (b) Manker, D. C.; Faulkner, J. *Tetrahedron* **1987**, *43*, 3677; (c) Rovirosa, J.; Quezada, E.; San Martín, A. *Bol. Soc. Chil. Quim.* **1992**, *37*, 143; (d) Boalino, M. D.; McLean, S.; Reynolds, W. F.; Tinto, W. F. *J. Nat. Prod.* **2004**, *67*, 714.
4. Patha, K. A.; Aslaoui, J.; Morin, C. *J. Org. Chem.* **2005**, *70*, 4184.
5. Basabe, P.; Delgado, S.; Marcos, I. S.; Díez, D.; Diego, A.; De Román, M.; Urones, J. G. *J. Org. Chem.* **2005**, *70*, 9480.
6. Basabe, P.; Diego, A.; Delgado, S.; Díez, D.; Marcos, I. S.; Urones, J. G. *Tetrahedron* **2003**, *59*, 9173.
7. (a) Basabe, P.; Diego, A.; Díez, D.; Marcos, I. S.; Urones, J. G. *Synlett* **2000**, 1807; (b) Basabe, P.; Diego, A.; Díez, D.; Marcos, I. S.; Urones, J. G.; Mollinedo, F. *Synthesis* **2002**, 1523.
8. Marcos, I. S.; Laderas, M.; Díez, D.; Basabe, P.; Moro, R. F.; Garrido, N. M.; Urones, J. G. *Tetrahedron Lett.* **2003**, *44*, 5419.
9. Marcos, I. S.; Beneitez, A.; Castañeda, L.; Moro, R. F.; Basabe, P.; Díez, D.; Urones, J. G. *Synlett* **2007**, 1589.
10. (a) House, H. O. *Mod. Synth. React.* **1972**, 280; (b) Mechoulam, R.; Luchter, K.; Goldblum, A. *Synthesis* **1974**, 363; (c) Salmond, W. D.; Barta, M. A.; Havens, J. L. *J. Org. Chem.* **1978**, *43*, 2057; (d) Schlessinger, R. H.; Parson, W. H. *J. Org. Chem.* **1983**, *48*, 1146.
11. Oppolzer, W.; Sarkar, T.; Mahalanabio, K. K. *Helv. Chim. Acta* **1976**, *59*, 2012.
12. (a) Greene, T.; Wuts, P. G. M. *Protective Groups in Organic Síntesis*, 3rd ed.; Wiley: 1999; p 127; (b) Ermoleuke, L.; Sasaki, N. A.; Potier, P. *J. Chem. Soc., Perkin Trans* **2000**, 2465; (c) Nakagawa, Y.; Irie, K.; Masuda, A.; Ohigashi, H. *Tetrahedron* **2002**, *58*, 2101.
13. (a) Buró, R. M.; Roof, M. B. *Tetrahedron Lett.* **1993**, *34*, 395; (b) Kang, S.-K.; Jeon, J.-H.; Nam, K.-S.; Park, C.-H.; Lee, H.-W. *Synth. Commun.* **1994**, *24*, 305; (c) Greene, T.; Wuts, P. G. M. *Protective Groups in Organic Síntesis*, 3rd ed.; Wiley: 1999; p 241.
14. (a) Yokohama, K.; Sakata, J.; Kuwajima, I.; Shimizu, M.; Nakamura, E.; Noyori, R. *J. Org. Chem.* **1983**, *43*, 932; (b) Greene, T.; Wuts, P. G. M. *Protective Groups in Organic Síntesis*, 3rd ed.; Wiley: 1999; p 133; (c) Nicolaou, K. C.; Xu, J. Y.; Kim, S.; Pfefferkorn, J.; Ohshima, T.; Vourloumis, D.; Hosokawa, S. *J. Am. Chem. Soc.* **1998**, *120*, 866; (d) Marcos, I. S.; Escola, M. A.; Moro, R. F.; Basabe, P.; Díez, D.; Mollinedo, F.; Urones, J. G. *Synlett* **2007**, 2017.
15. (a) Ley, S. V.; Norman, J.; Griffith, W. P.; Marsden, S. P. *Synthesis* **1994**, 639; (b) Díez Martín, D.; Kotecha, N. R.; Ley, S. V.; Mantegani, S.; Menéndez, J. C.; Organ, H. H.; White, A. D. *Tetrahedron* **1992**, *48*, 7899.
16. (a) van Wyk, A. W. W.; Davies-Coleman, M. T. *Tetrahedron* **2007**, *63*, 12179; (b) Kelly, S. E. Alkene Synthesis. Phosphorus-Stabilized Alkenation. In *Comprehensive*

Organic Synthesis; Trost, B. M., Fleming, I., Eds.; Pergamon: Oxford, 1991; Vol. 1, pp 755–782.
17. (a) Keinan, E. Partial Reduction of Enones, Styrenes and Related Systems. In *Comprehensive Organic Synthesis*; Trost, B. M., Fleming, I., Eds.; Pergamon: Oxford, 1991; Vol. 8, pp 523–578; (b) Paquette, L. A. *Reagents for Organic Synthesis*; Wiley: New York, NY, 1995; Vol. 3; p 1908; (c) Sydorenko, S.; Hsung, R. P.; Darwish, O. S.; Hahn, J. M.; Liu, J. *J. Org. Chem.* **2004**, *69*, 6732; (d) Xie, Y.-P.; Li, B.-G.; Luo, Y.-G.; Chen, X.-Z.; Zhang, G.-L. *Helv. Chim. Acta* **2008**, *91*, 734.
18. (a) Katsuki, T.; Sharpless, K. B. *J. Am. Chem. Soc.* **1980**, *102*, 5974; (b) Pfenninger, A. *Synthesis* **1986**, 89.
19. (a) Tsuda, K.; Ohki, G.; Suzuki, J.; Shimizu, H. *Chem. Pharm. Bull.* **1961**, *9*, 131; (b) Carda, M.; Murga, J.; González, F.; Marco, J. A. *Tetrahedron* **1995**, *51*, 2755; (c) Balmer, E.; Germanin, A.; Jackson, W. P.; Luggo, B. *J. Chem. Soc., Perkin Trans. 1* **1983**, 399.
20. Hanessian, S.; Tremblay, M.; Petersen, J. F. W. *J. Am. Chem. Soc.* **2004**, *126*, 6064.
21. (a) Weber, B.; Seebach, D. *Tetrahedron* **1994**, *50*, 6117; (b) Weber, B.; Seebach, D. *Angew. Chem., Int. Ed. Engl.* **1992**, *31*, 84; (c) Corey, E. J.; Guzman-Perez, A. *Angew. Chem., Int. Ed.* **1998**, *37*, 388; (d) Seebach, D.; Beck, A. K.; Heckel, A. *Angew. Chem. , Int. Ed.* **2001**, *40*, 92.
22. (a) Maryanoff, B. E.; Reitz, A. B. *Chem. Rev.* **1989**, *89*, 863; (b) Still, W. C.; Gennari, C. *Tetrahedron Lett.* **1983**, *24*, 4405; (c) Fraser-Reid, B.; Molino, B. F.; Magdzinski, L.; Mootoo, D. R. *J. Org. Chem.* **1987**, *52*, 4505.
23. (a) Hartmann, B.; Kanazawa, A. M.; Deprés, J.-P.; Greene, A. E. *Tetrahedron Lett.* **1991**, *32*, 5077; (b) Ball, M.; Andrews, S. P.; Wierschem, F.; Cleator, E.; Smith, M. D.; Ley, S. V. *Org. Lett.* **2007**, *9*, 663.