Neoclerodane Diterpenoids from *Teucrium montbretii* Subsp. *libanoticum* and Their Absolute Configuration

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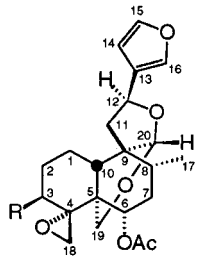
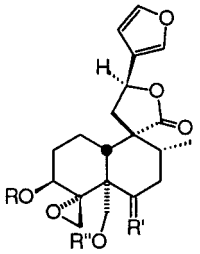
From the aerial parts of *Teucrium montbretii* subsp. *libanoticum* 10 neoclerodane diterpenoids were isolated. Three of them are new [3β-hydroxyteubutilin A (**1**), 12-*epi*-montanin G (**2**), 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**)], whereas the other seven, namely, 6-ketoteuscordin (**4**), teuscordinon (**5**), 6β-hydroxyteuscordin (**6**), montanin D (**7**), 3,20-di-*O*-deacetylteupyreinidin (**8**), montanin G (**9**), and 3-*O*-deacetylteugracilin A (**10**), are previously known structures. The structures of **1**−**3** were determined by spectral and chemical methods.

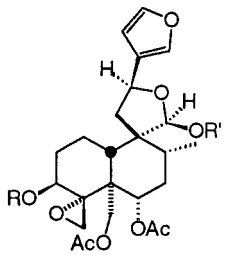
It is known that the plant genus *Teucrium*, belonging to the Labiatae (Lamiaceae), is a rich source of neoclerodane diterpenoids,[1−6] with many showing antifeedant activity against certain insect pests.[7] As part of an ongoing program of research on plants of this genus, we report herein on the investigation of *T. montbretii* subsp. *libanoticum* P. H. Davis, collected in Lebanon. This plant has been never studied previously (biologically or phytochemically).



1 R = OH
11 R = H



2 R = H, R' = α-OAc, β-H, R'' = Ac
10 R = H, R' = α-H, β-OH, R'' = Ac
12 R = Ac, R' = α-OH, β-H, R'' = Ac
17 R = Ac, R' = α-OAc, β-H, R'' = Ac
18 R = H, R' = O, R'' = H



3 R = R' = H
15 R = Ac, R' = Me

Results and Discussion

The acetone-soluble extract of the aerial parts was fractionated by column chromatography. Repeated column and radial chromatography led to three new neoclerodane diterpenes (**1**−**3**) and seven already known compounds, namely, 6-ketoteuscordin (**4**), teuscordinon (**5**), 6β-hydroxyteuscordin (**6**), montanin D (**7**), 3,20-di-*O*-deacetylteupyreinidin (**8**), montanin G (**9**), and 3-*O*-deacetylteugracilin A (**10**).

Compound **1** had the molecular formula $C_{22}H_{28}O_7$, and its ^{1}H and ^{13}C NMR spectra (Table 1) showed characteristic signals for a β-substituted furan ring, a secondary methyl group, a 4α,18-oxirane ring, a 6α-acetoxy group, and an acetal between C-20 and C-12 as well as C-20 and C-19, all identical to those found in teubutilin A (**11**), a neoclerodane diterpenoid isolated from *T. abutiloides*.[8] In addition, the IR and ^{1}H NMR and ^{13}C NMR spectra of **1** revealed the presence of a 3β-hydroxy group (ν_{OH} 3480 cm^{-1}; $\delta_{H-3\alpha}$ 4.04 dd; δ_{C-3} 66.5 d), inducing a clear γ-gauche effect on C-18 (δ 44.9 t). The relative configurations of the C-12 and C-20 asymmetric centers were established by NOE experiments. Thus, irradiation at δ 1.00 (Me-17) caused NOE enhancements in the signals of the furanoid protons H-14 and H-16 (2.9% and 0.9%, respectively) and of the acetalic proton H-20 (9.0%), whereas no effect was observed on H-12.[9,10] From these data it was clear that the C-17 methyl group, the furan ring, and the C-20 proton are on the same side of the plane containing C-11, C-12, and C-20. This information allowed us to assign to this compound the structure and relative configuration depicted in formula **1**, with the compound accorded the trivial name 3β-hydroxyteubutilin A. The full assignments of protons and protonated carbons were made by HETCOR one-bond NMR experiments.

The MS (*m*/*z* 462) and elemental analysis indicated $C_{24}H_{30}O_9$ as the molecular formula of compound **2**. It showed absorptions for hydroxy, furan, γ-lactone, and

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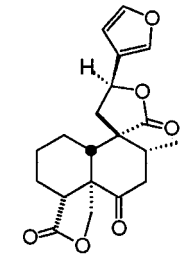

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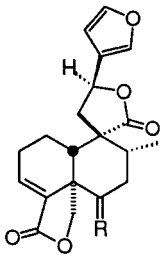
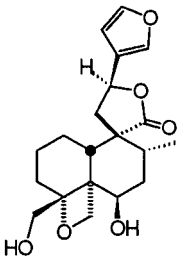


5 R = O
6 R = α-H, β-OH



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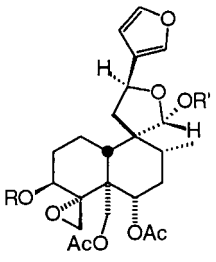
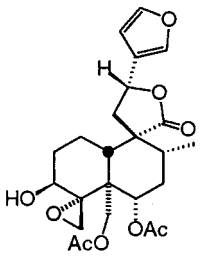


8 R = R' = H
14 R = Ac, R' = Me
16 R = Ac, R' = Ac



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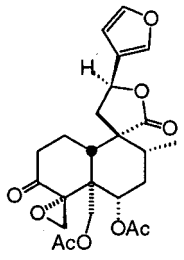

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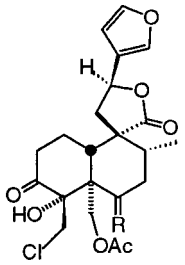

19 R = O
20 R = α-OAc, β-H

acetate groups in its IR spectrum. The ^{1}H and ^{13}C NMR spectra (Tables 2 and 3) were consistent with the presence of a β-substituted furan ring, a C-20/C-12 γ-lactone, a 4α,18-epoxide group, a secondary methyl, two acetyl groups, and a secondary hydroxy group. One of the two acetoxy groups was clearly in the C-19 position, while the two remaining oxygenated functions occurred as 3β and 6α. Teumicropodin (**12**), a neoclerodane diterpenoid isolated from *T. micropodioides*,[11] has 3β-acetoxy and 6α-hydroxy substitution. Since ^{1}H and ^{13}C NMR spectra of our compound differed somewhat from those of teumicropodin, we assumed that 3β-hydroxy and 6α-acetoxy substituents are present in **2**. Our hypothesis was confirmed by pyridinium dichromate oxidation that yielded a compound identical in all respects with 4α,18-epoxytafricanin B (**13**), a synthetic derivative of tafricanin B.[12] The ^{13}C NMR spectral data of 4α,18-epoxytafricanin B, not previously reported, are shown in Table 3. From the same fraction, we isolated a compound (**9**) with the same elemental formula as **2**, but slightly less polar on TLC (petroleum ether−EtOAc, 2:3). The ^{1}H and ^{13}C NMR spectra (in $CDCl_3$) of the two compounds were very similar, but major differences in the latter compound were downfield shifts of the C-17 protons (δ_H 1.11 d) and the C-8 (δ_C 40.8) and C-9 (δ_C 51.2) signals and an upfield shift of the C-10 (δ_C 50.3) signal, relative to analogous data for **2**. Similar observations have been previously reported[9,10,13] for neoclerodane diterpenoid pairs of epimers at carbon C-12. Hence we have assigned to this compound the known structure **9**, corresponding to montanin G, a neoclerodane diterpenoid with a 12*R* configuration, isolated from *T. montanum*[14] and whose ^{13}C NMR spectrum, measured in pyridine-d_5, was not comparable with the spectrum of **2** in $CDCl_3$. Therefore the ^{13}C spectra of compounds **2** and **9** were run in both $CDCl_3$ and pyridine-d_5 (Table 3). Moreover, the 12*S* configuration of compound **2** was confirmed by NOE experiments. Thus, irradiation at δ 1.02 (C-17 protons) caused NOE enhancements in the signals of the H-14 and H-16 furanoid protons (3.8% and 1.3%, respectively), whereas no effect was observed in the H-12 signal.[10] The trivial name for compound **2** is 12-*epi*-montanin G. The co-occurrence of a pair of clerodane diterpene C-12 epimers in the same plant is not a usual feature and has been reported only for *T. kotschyanum*[13] and more recently for *T. maghrebinum*.[15]

Table 1. NMR Data of Compound **1**

proton	δ_H	$J_{H,H}$ (Hz)		carbon	δ_C
1α	2.28 dddd	1α,1β	13.2	1	24.8 t
1β	2.05 dddd	1α,2α	4.0	2	31.2 t
2α	2.18 dddd	1α,2β	13.2	3	66.5 d
2β	1.45 dddd	1α,10β	13.2	4	67.2 s
3α	4.04 dd	1β,2α	4.0	5	40.8 s
6β	4.86 dd	1β,2β	4.0	6	73.9 d
7α	1.60 ddd	1β,10β	5.3	7	35.3 t
7β	1.99 ddd	2α,2β	12.5	8	35.8 d
8β	1.72 ddq	2α,3α	4.0	9	48.7 s
10β	1.48 dd	2β,3α	11.7	10	46.5 d
11A	2.11 dd	6β,7α	10.5	11	38.3 t
11B	2.19 dd	6β,7β	5.8	12	73.7 d
12	5.20 dd	7α,7β	12.7	13	126.2 s
14	6.41 dd	7α,8β	12.7	14	108.5 d
15	7.41 dd	7β,8β	3.0	15	143.5 d
16	7.42 m	8β,17	6.4	16	139.5 d
Me-17	1.00 d	11A,11B	13.0	17	16.2 q
18A	2.86 d	11A,12	9.2	18	44.9 t
18B	2.98 d	11B,12	6.9	19	62.6 t
19A	4.01 d	14,15	1.7	20	102.7 d
19B	4.25 d	14,16	0.9	Ac	170.5 s
20	5.11 s	15,16	1.7		21.3 q
Ac	2.03 s	18A,18B	3.9		
		19A,19B	13.0		

The third compound, apparently homogeneous by TLC, showed the occurrence of two products in a 7:3 ratio in the ^{1}H NMR and ^{13}C NMR spectra (Tables 2 and 3). The spectral data of the main component agreed exactly with those reported in the literature for 3,20-di-*O*-deacetylteupyreinidin (**8**),[16] a neoclerodane diterpene isolated from *Teucrium polium* subsp. *aurasianum*. The minor component showed NMR spectra quite similar to those of **8**, but with some significant differences. In fact, variations were observed for the chemical shifts of the Me-17 protons (δ 1.25 vs 0.97), the H-20 hemiacetalic proton (δ 5.36 vs 5.29), the H-19B proton (δ 4.99 vs 4.76), and the C-9 (δ 49.9 vs 52.8), C-11 (δ 45.9 vs 42.7), and C-13 (δ 125.6 vs 124.9) signals. Such differences led us to hypothesize a structure epimeric to **8** at C-20 and/or C-12 for this product.

The oxidation of this mixture by pyridinium dichromate in diluted CH_2Cl_2 solution gave a single product, identified

Table 2. ^{1}H NMR Spectral Data of Compounds **2**, **3**, **8**, **14**, and **15**

proton	**2**	**3**	**8**	**14**	**15**
3α	4.20 dd	4.13 dd	4.09 dd	5.31 dd	5.38 dd
6*β*	4.90 dd	4.90 dd	4.90 dd	4.85 dd	4.69 dd
11(2H)	2.39 d	*a*	*a*	*a*	*a*
12	5.38 t	*a*	5.17 dd	4.97 dd	4.86[a]
14	6.38 dd	6.47 dd	6.40 dd	6.42 dd	6.47 dd
15	7.44 dd	7.40 dd	7.40 dd	7.40 dd	7.40 dd
16	7.45 m	7.42 dd	7.42 dd	7.42 dd	7.42 dd
Me17	1.02 d	1.25 d	0.97 d	0.98 d	1.25 d
18A	2.82 d	2.83 d	2.80 d	2.62 d	2.66 d
18B	2.91 d	2.94 d	2.93 d	2.88 d	2.91 d
19A	4.36 d	4.50 d	4.62 d	4.49 d	4.53 d
19B	5.24d	4.99 d	4.76 d	4.66 d	4.83 d
20		5.36 d	5.29 d	4.68 s	4.85 s
Ac	2.00 s	1.99 s	1.98 s	1.97 s	1.99 s
	2.09 s	2.13 s	2.11 s	2.01 s	2.01 s
				2.14 s	2.17 s
20-OH		5.42 d	4.54 d		
OCH_3				3.40 s	3.50 s
$J_{H,H}$ (Hz)					
2α,3α	5.0	4.6	4.6	4.4	4.4
2*β*,3α	11.7	11.7	11.7	11.8	11.8
6*β*,7α	12.0	11.4	11.4	11.4	11.4
6*β*,7*β*	4.3	5.0	5.0	5.0	5.0
8*β*,17	6.6	6.9	6.7	6.7	6.9
11A,12	8.2	*b*	10.3	10.5	*b*
11B,12	8.2	*b*	6.8	6.3	*b*
14,15	1.7	1.7	1.7	1.7	1.7
14,16	0.9	0.9	0.9	0.9	0.9
15,16	1.7	1.7	1.7	1.7	1.7
18A,18B	4.1	4.0	4.0	4.0	4.0
19A,19B	13.3	12.9	12.9	12.8	12.8
20,OH		4.2	4.2		

[a] Overlapped signal. [b] Not observed.

as 4α,18-epoxytafricanin B (**13**). This result confirmed the occurrence of epimerization at C-20 and permitted the assignment to the product of the structure 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**).

To isolate the two pure epimers **3** and **8**, an unsuccessful radial chromatography separation was performed ($CHCl_3$−MeOH, 49:1), affording only a complex, unresolvable mixture of many products. The acetylation of this mixture, followed by column chromatography (petroleum ether−Et_2O, 2:3), yielded two pure products, **14** and **15**, and another unresolvable mixture. The ^{1}H NMR and ^{13}C NMR spectra of this last mixture showed the occurrence of two products: the more abundant (80%) was identified as teupyreinidin (**16**) by comparison with literature data.[17] The spectral data of the minor product led us to presume the probable occurrence of the C-20 epimer of teupyreinidin.

The pure compound **14** had a molecular formula of $C_{27}H_{36}O_{10}$ and its IR spectrum was devoid of hydroxyl absorptions. The ^{1}H and ^{13}C NMR spectra (Tables 2 and 3) showed the presence of a 3*β*-acetoxy group ($\delta_{H-3\alpha}$ 5.31 dd, δ_{C-3} 67.0 d), and, surprisingly, a methoxy group (δ_H 3.40 s, δ_C 54.7 q) at C-20 (δ_H 4.68 s, δ_C 106.9 d). The configuration of the C-20 asymmetric center was established by a NOE experiment. Thus irradiation at δ 0.98 (Me-17) caused NOE enhancements in the signals of the furanoid protons H-14 and H-16 (4.6% and 2.6%, respectively) and the acetalic proton H-20 (7.9%), whereas no effect was observed on H-12.[9,10] From these data, it was clear that the C-17 methyl group, the furan ring, and the C-20 proton are on the same side of the plane containing C-11, C-12, and C-20, and therefore, the structure **14** was assigned to this compound. The pure compound **15** was the C-20 epimer of **14**, as clearly shown by its ^{1}H and ^{13}C NMR spectra (Tables 2 and 3) and a NOE experiment. In fact, irradiation at δ 1.25 (Me-17) caused NOE enhancements only on the signals of the furanoid protons H-14 and H-16 (4.4% and 2.1%, respectively), whereas no effect was observed on H-12 and on the acetalic proton H-20. From these data, this compound was assigned the structure **15**.

The generation of two methoxy derivatives (**14** and **15**) confirmed again the occurrence of two C-20 epimers in the original mixture and could be attributed to the methylation of the OH-20 during the unsuccessful radial chromatography with the $CHCl_3$−MeOH eluent.[18]

20-*epi*-3,20-Di-*O*-deacetylteupyreinidin (**3**) could be an artifact formed during the extraction or the chromatogra-

Table 3. ^{13}C NMR Spectral Data of Compounds **2**, **3**, **8**, **9**, **13**, **14**, and **15**

carbon	**2**[a]	**2**[b]	**3**[a]	**8**[a]	**9**[a]	**9**[b]	**13**[a]	**14**[a]	**15**[a]
1	22.1 t	22.2 t	21.7 t	21.8 t	21.3 t	21.7 t	23.1 t	22.0 t	21.9 t
2	32.0 t[c]	32.6 t[c]	33.3 t	33.2 t	32.1 t[c]	32.9 t[c]	39.2 t	31.9 t	31.0 t
3	65.3 d	64.7 d	65.7 d	66.1 d	65.6 d	64.8 d	202.9 s	67.0 d	67.0 d
4	67.4 s	67.7 s	67.1 s	67.4 s	67.4 s	67.7 s	65.2 s	65.0 s	64.8 s
5	45.2 s	45.6 s	45.2 s	45.1 s	45.1 s	45.4 s	46.2 s	45.9 s	45.9 s
6	71.6 d	71.9 d	68.7 d	70.6 d	71.5 d	71.9 d	70.8 d	70.5 d	68.9 d
7	32.2 t[c]	33.7 t[c]	32.3 t	34.6 t	32.6 t[c]	33.6 t[c]	32.6 t	34.8 t	33.6 t
8	38.2 d	37.5 d	40.4 d	40.9 d	40.8 d	40.1 d	38.6 d	40.9 d	40.4 d
9	50.8 s	51.0 s	49.9 s	52.8 s	51.2 s	51.3 s	51.9 s	52.9 s	50.4 s
10	52.5 d	51.9 d	51.6 d	51.4 d	50.3 d	49.7 d	50.8 d	51.2 d	51.6 d
11	43.0 t	42.3 t	45.9 t	42.7 t	43.2 t	42.6 t	43.9 t	42.6 t	45.5 t
12	71.9 d	71.6 d	72.9 d	72.1 d	71.9 d	71.5 d	72.2 d	71.5 d	72.4 d
13	125.0 s	125.7 s	125.6 s	124.9 s	125.3 s	125.9 s	124.9 s	124.9 s	125.9 s
14	107.8 d	108.6 d	108.7 d	108.7 d	107.8 d	108.6 d	107.9 d	108.7 d	108.8 d
15	144.2 d	144.5 d	143.4 d	143.3 d	144.3 d	144.5 d	144.4 d	143.4 d	143.5 d
16	139.5 d	140.4 d	139.5 d	139.3 d	139.1 d	140.0 d	139.5 d	139.4 d	139.5 d
17	16.3 q	16.2 q	17.4 q	17.1 q	16.7 q	16.4 q	16.3 q	17.2 q	17.5 q
18	42.7 t	42.1 t	43.0 t	43.8 t	42.2 t	41.7 t	51.0 t	43.6 t	43.1 t
19	61.7 t	61.6 t	62.0 t	62.2 t	61.6 t	61.9 t	62.8 t	61.7 t	61.4 t
20	175.7 s	176.5 s	99.5 d	99.8 d	175.7 s	176.3 s	176.0 s	106.9 d	107.0 d
Ac	170.1 s	169.9 s	171.1 s	171.0 s	170.2 s	170.0 s	170.3 s	170.2 s	171.1 s
	170.1 s	169.3 s	170.0 s	169.9 s	170.0 s	169.3 s	169.3 s	170.0 s	170.0 s
								169.6 s	169.6 s
	21.2 q	20.9 q	21.1 q	21.1 q	21.2 q	20.9 q	21.2 q	21.1 q	21.2 q
	21.1 q	20.6 q	21.0 q	21.0 q	21.0 q	20.7 q	20.6 q	21.1 q	21.1 q
								21.0 q	20.9 q
OCH_3								54.7 q	57.7 q

[a] $CDCl_3$ solution. [b] Pyridine-d_5 solution. [c] These assignments may be reversed.

phy through a CHO-9α intermediate, even if there are no prior examples in the literature of the isolation of two C-20 epimers from the same plant.[16,19−21]

Oxidation of the mixture of 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**) and 3,20-di-*O*-deacetylteupyreinidin (**8**), repeated in a concentrated solution of CH_2Cl_2 using only 1 equiv of pyridinium dichromate, was more selective; besides a small amount of 4α,18-epoxytafricanin B (**13**), 12-*epi*-montanin G (**2**) was isolated as the main product.

Acetylation of 12-*epi*-montanin G (**2**) yielded 12-*epi*-teupyreinin (**17**), a diterpene previously isolated from *T. nudicaule*[22] and also prepared by semisynthesis from teumicropodin (**12**).[11] The latter has been correlated in turn with teulepicin (**18**) and tafricanin A (**19**),[23] whose neoclerodane absolute configuration is known.[12] Hence, in the present paper, the absolute configurations were determined for 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**), 3,20-di-*O*-deacetylteupyreinidin (**8**), 12-*epi*-montanin G (**2**), and tafricanin B (**20**), the latter being in turn correlated with 4α,18-epoxytafricanin B (**13**).[12] Previously known compounds were identified by conventional methods.

From a taxonomic point of view, the species *T. montbretii* belongs to the section *Isotriodon* Boiss.[24] It can be pointed out that other subspecies of *T. montbretii* show a different qualitative content of neoclerodane diterpenoids: in fact, *T. montbretii* subsp. *montbretii*[25] contains 10 neoclerodanes, of which only 6-ketoteuscordin (**4**), 6β-hydroxyteuscordin (**6**), and montanin D (**7**) occur in the *T. montbretii* subsp. *libanoticum*; *T. montbretii* subsp. *heliotropifolium*[26] contains 6β-hydroxyteuscordin (**6**), montanin D (**7**), and other two neoclerodanes, namely, teugin and teucrin H_2 also occurring in *T. montbretii* subsp. *montbretii*. Finally, *T. montbretii* subsp. *pamphilicum* is devoid of diterpenoids.[4]

Experimental Section

General Experimental Procedures. Optical rotations were measured on a Perkin-Elmer 141 polarimeter. IR spectra were obtained on a Perkin-Elmer 1310 spectrometer. ^{1}H NMR spectra were recorded in $CDCl_3$ solution using a Bruker AC 250E instrument at 250 MHz and Bruker AMX 600 at 600 MHz. ^{13}C NMR spectra were recorded in $CDCl_3$ or pyridine-d_5 solution on the same instruments at 62.7 and 150.9 MHz. EIMS were recorded on a Finnigan TSQ70 instrument (70 eV, direct inlet). Elemental analysis was carried out with a Perkin-Elmer 240 apparatus. Merck Si gel (70−230 mesh), deactivated with 15% H_2O, was used for column chromatography. Radial chromatography was performed on a Harrison Chromatotron 7924 T apparatus using Merck Si gel PF_{254} 60 as plate adsorbent.

Plant Material. The aerial parts of *T. montbretii* subsp. *libanoticum* P. H. Davis were collected at Hamat, near Ras Chakka, Lebanon, in June 1999. A voucher specimen (leg., det. and confirmed by N. Arnold *s.n.*) is deposited in the Herbarium of the Botanischer Garten und Botanisches Museum, Freie Universitat, Berlin.

Extraction and Isolation. Dried and finely powdered aerial parts of *T. montbretii* subsp. *libanoticum* (275 g) were extracted with Me_2CO (3 × 5 L) at room temperature for 1 week. After filtration, the solvent was evaporated at low temperature (35 °C), yielding a gum (21 g) which was chromatographed over a Si gel dry column with a solvent gradient from 100% petroleum ether (bp 50−70 °C) to 100% EtOAc, and finally with EtOAc−MeOH (19:1, 9:1). The fraction that eluted with petroleum ether−EtOAc (3:2) (100 mg) was subjected to radial chromatography, using $CHCl_3$ as eluent, to afford 6-ketoteuscordin (17 mg) (**4**).[27,28] The fraction that eluted with petroleum ether−EtOAc (2:3) (90 mg) was also subjected to radial chromatography, using $CHCl_3$−MeOH, 99:1, as eluent, to afford teuscordinon (23 mg) (**5**).[29] The fraction that eluted with petroleum ether−EtOAc (3:7) (600 mg) was purified by column chromatography (petroleum ether−EtOAc 1:1) to give the following compounds, in order of increasing polarity: 3β-hydroxyteubutilin A (3 mg) (**1**), 6β-hydroxyteuscordin (10 mg) (**6**),[30] montanin D (12 mg) (**7**),[31,32] a mixture (170 mg) of 3,20-di-*O*-deacetylteupyreinidin (**8**)[16] and 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**), montanin G (21 mg) (**9**),[14] and 12-*epi*-montanin G (18 mg) (**2**). The fraction that eluted with EtOAc (150 mg) was subjected to radial chromatography, using $CHCl_3$−MeOH (19:1) as eluent, to afford 3-*O*-deacetylteugracilin A (94 mg) (**10**).[33] The known compounds were identified by comparison of their $[\alpha]_D$, IR, ^{1}H NMR, ^{13}C NMR, and mass spectra data with published values.

3β-Hydroxyteubutilin A (1): amorphous solid; IR (KBr) ν_{max} 3480, 3140, 3075, 2956, 2891, 1730, 1500, 1442, 1375, 1247, 1161, 1033, 980, 872, 802 cm^{-1}; ^{1}H NMR (600 MHz), see Table 1; ^{13}C NMR (150.9 MHz), see Table 1; EIMS *m/z* 404 (1) $[M]^+$, 386 (5) $[M - H_2O]^+$, 344 (10), 315 (12), 289 (24), 173 (23), 94 (100), 91 (27), 81 (32), 79 (20), 43 (66); *anal.* C 65.17%, H 6.91%, calcd for $C_{22}H_{28}O_7$, C 65.33%, H 6.98%.

12-*epi*-Montanin G (2): amorphous solid; $[\alpha]^{20}_D$ +17.0° (*c* 0.33 $CHCl_3$); IR (KBr) ν_{max} 3500, 3130, 3075, 3000, 1760, 1735, 1500, 1460, 1260, 1240, 1065, 915, 875 cm^{-1}; ^{1}H NMR (250 MHz), see Table 2; ^{13}C NMR (62.7 MHz), see Table 3; EIMS *m/z* 462 (1) $[M]^+$, 419 (2) $[M - COCH_3]^+$, 402 (3) $[M - HOAc]^+$, 371 (4), 342 (8) $[M - 2 \times HOAc]^+$, 329 (8), 311 (11), 267 (5), 173 (10), 105 (10), 94 (100), 81 (92); *anal.* C 62.39%, H 6.42%, calcd for $C_{24}H_{30}O_9$, C 62.32%, H 6.54%.

Oxidation of 12-*epi*-Montanin G (2). 12-*epi*-Montanin G (**2**) (5 mg, 0.011 mmol) was dissolved in CH_2Cl_2 (10 mL), and pyridinium dichromate (12 mg, 0.03 mmol) was added. The suspension was stirred for 24 h and then filtered on Florisil (Fluka 46386). Column chromatography on Si gel (petroleum ether−EtOAc, 1:1) yielded 4 mg of 4α,18-epoxytafricanin B (**13**).

Mixture of 20-*epi*-3,20-Di-*O*-deacetylteupyreinidin (3) and 3,20-Di-*O*-deacetylteupyreinidin (8): amorphous solid; IR (KBr) ν_{max} 3480, 3120, 3080, 2960, 2935, 2880, 1730, 1505, 1385, 1320, 1255, 1155, 1117, 875, 800 cm^{-1}; ^{1}H NMR (250 MHz), see Table 2; ^{13}C NMR (62.7 MHz), see Table 3; EIMS *m/z* 464 (1) $[M]^+$, 404 (3) $[M - HOAc]^+$, 344 (5) $[M - 2 \times HOAc]^+$, 326 (12), 107 (10), 94 (30), 81 (25), 43 (100); *anal.* C 61.95%, H 6.81%, calcd for $C_{24}H_{32}O_9$, C 62.05%, H 6.94%.

Oxidation of the Mixture of 20-*epi*-3,20-Di-*O*-deacetylteupyreinidin (3) and 3,20-Di-*O*-deacetylteupyreinidin (8). The unresolved mixture (20 mg, 0.043 mmol) containing 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**) and 3,20-di-*O*-deacetylteupyreinidin (**8**) was dissolved in CH_2Cl_2 (10 mL), and pyridinium dichromate (49 mg, 0.13 mmol) was added. The suspension was stirred for 24 h and then filtered on Florisil. Column chromatography on Si gel (petroleum ether−EtOAc, 1:1) yielded 17 mg of 4α,18-epoxytafricanin B (**13**).

Selective Oxidation of the Mixture of 20-*epi*-3,20-Di-*O*-deacetylteupyreinidin (3) and 3,20-Di-*O*-deacetylteupyreinidin (8). The unresolved mixture (22 mg, 0.047 mmol) containing 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**) and 3,-20-di-*O*-deacetylteupyreinidin (**8**) was dissolved in CH_2Cl_2 (2 mL), and pyridinium dichromate (18 mg, 0.047 mmol) was added. The suspension was stirred for 24 h and then filtered on Florisil. Column chromatography on Si gel (petroleum ether−EtOAc, 1:1) yielded 17 mg of 12-*epi*-montanin G (**2**) and 2 mg of 4,18-epoxytafricanin B (**13**).

Acetylation of the Mixture of 20-*epi*-3,20-Di-*O*-deacetylteupyreinidin (3) and 3,20-Di-*O*-deacetylteupyreinidin (8). The unresolved mixture (100 mg) containing 20-*epi*-3,20-di-*O*-deacetylteupyreinidin (**3**) and 3,20-di-*O*-deacetylteupyreinidin (**8**) was dissolved in 3 mL of Ac_2O−pyridine (2:1) and maintained at room temperature for 24 h. The reaction mixture was diluted with H_2O, extracted with EtOAc, washed with saturated aqueous $NaHCO_3$, and dried with anhydrous Na_2SO_4. Column chromatography on Si gel (petroleum ether−EtOAc, 1:1) yielded in order of increasing polarity 37 mg of 20-*O*-deacetyl-20-methoxyteupyreinidin (**14**), 14 mg of 20-*epi*-20-*O*-deacetyl-20-methoxyteupyreinidin (**15**), and 40 mg of an unresolvable mixture containing mainly teupyreinidin (**16**) and

the presumed 20-*epi*-teupyreinidin. The ^{1}H and ^{13}C NMR data previously[17] reported for **16** matched with the signals observed in the mixture.

20-*O*-Deacetyl-20-methoxyteupyreinidin (14): amorphous solid; $[\alpha]^{20}_D$ +11.0° (*c* 0.20 $CHCl_3$); IR (KBr) ν_{max} 3122, 3055, 2955, 2925, 2867, 2848, 1738, 1733, 1718, 1363, 1254, 1234, 1159, 1103, 1054, 1024, 892, 875, 731 cm^{-1}; ^{1}H NMR (250 MHz), see Table 2; ^{13}C NMR (62.7 MHz), see Table 3; EIMS *m*/*z* $[M]^+$ absent, 460 (5) $[M - HOAc]^+$, 345 (29), 340 (14) $[M - 3 \times HOAc]^+$, 174 (45), 128 (52), 107 (47), 95 (79), 94 (94), 81 (100); *anal*. C 62.14%, H 6.89%, calcd for $C_{27}H_{36}O_{10}$, C 62.29%, H 6.97%.

20-*epi*-20-*O*-Deacetyl-20-methoxyteupyreinidin (15): amorphous solid; $[\alpha]^{20}_D$ −18.1° (*c* 0.32 $CHCl_3$); IR (KBr) ν_{max} 3122, 3055, 2955, 2925, 2867, 2848, 1738, 1733, 1718, 1363, 1254, 1234, 1159, 1103, 1054, 1024, 892, 875, 731 cm^{-1}; ^{1}H NMR (250 MHz), see Table 2; ^{13}C NMR (62.7 MHz), see Table 3; EIMS *m*/*z* $[M]^+$ absent, 460 (5) $[M - HOAc]^+$, 345 (29), 340 (14) $[M - 3 \times HOAc]^+$, 174 (45), 128 (52), 107 (47), 95 (79), 94 (94), 81 (100); *anal*. C 62.11%, H 6.87%, calcd for $C_{27}H_{36}O_{10}$, C 62.29%, H 6.97%.

Acetylation of 12-*epi*-Montanin G (2). 12-*epi*-Montanin G (**2**) (4 mg) was dissolved in 2 mL of Ac_2O−pyridine (2:1) and maintained at room temperature for 24 h. The reaction mixture was diluted with H_2O, extracted with EtOAc, washed with saturated aqueous $NaHCO_3$, and dried with anhydrous Na_2SO_4. Column chromatography on Si gel (petroleum ether−EtOAc, 1:1) yielded 3 mg of 12-*epi*-teupyreinin (**17**).

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