Norditerpenes and Norsesterterpenes from *Salvia yosgadensis*

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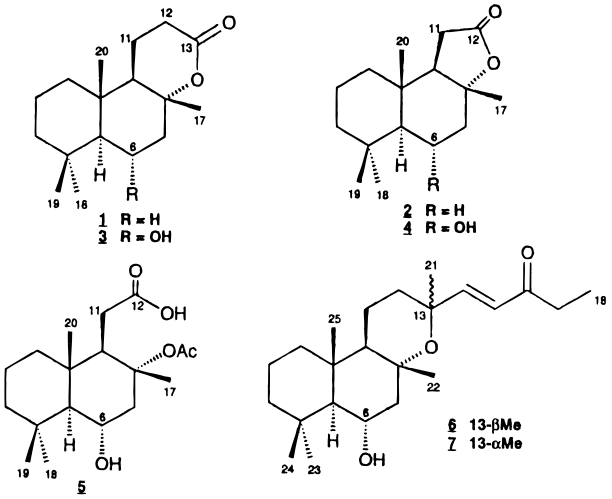
The aerial parts of *Salvia yosgadensis* afforded five new terpenes with unusual skeletons, together with two known norditerpenes, ambreinolide and norambreinolide. The new compounds were elucidated as 6α-hydroxyambreinolide, 6α-hydroxynorambreinolide, 6α-hydroxy-8α-acetoxy-13,14,15,16-tetranorlabdan-12-oic acid, and two 19,20-dinorsesterterpenes, named as yosgadensonol and 13-*epi*-yosgadensonol. Their structures were determined by spectroscopic means, particularly by extensive 1D and 2D NMR studies.

Salvia species are pharmacologically active and used in folk medicine all around the world. Several plants of this genus have been associated with antibacterial, estrogenic, antioxidant, and antitumor activities[1−4] and are used in the treatment of eczema, psoriasis, and tuberculosis.[5,6] There are about 90 species of *Salvia* growing in Turkey, 44 of which are endemic. As part of our continuing chemical investigation of Turkish *Salvia* species, we have now studied an endemic species, *S. yosgadensis* Freyn. et Bornm. (Lamiaceae) for its terpenic constituents. A literature survey showed that this species has not hitherto been studied chemically or biologically. In this report, we describe the isolation and characterization of five new terpene structures, as well as two previously known compounds, ambreinolide (**1**)[7,8] and norambreinolide (**2**).[9] The new compounds were established as 6α-hydroxyambreinolide (**3**), 6α-hydroxynorambreinolide (**4**), 6α-hydroxy-8α-acetoxy-13,-14,15,16-tetranorlabdan-12-oic acid (**5**), and two 19,20-dinorsesterterpenes, yosgadensonol (**6**) and 13-*epi*-yosgadensonol (**7**).



Norditerpenes and norsesterterpenes are not common in *Salvia* species; however, two tetranorlabdanes have been isolated previously from the aerial parts of *Salvia aethiopis*.[10]

Results and Discussion

Ambreinolide (**1**) and norambreinolide (**2**) were identified by analysis of the spectral data and by comparison with literature.[7−10] ^{1}H- and ^{13}C-NMR spectral data unambiguously, assigned by a combination of 1D and 2D techniques, served as reference values for the structure elucidation of new compounds **3**−**7**.

The ^{13}C NMR spectrum (APT and DEPT experiments) of compound **3** (Table 1) displayed four methyl, six methylene, three methine, and four quaternary carbons. The HREIMS gave a molecular ion peak at *m/z* 280.2031. The CIMS gave a $[M + 1]^+$ ion peak at *m/z* 281, indicating the molecular formula $C_{17}H_{28}O_3$, which is consistent with a hydroxyl derivative of ambreinolide. An intense signal appeared at *m/z* 263 for $[M + 1 - H_2O]^+$. The IR spectrum of compound **3** showed absorption signals at 1716 cm^{-1} (six-membered lactone) and 3454 cm^{-1} (hydroxyl). The ^{1}H-NMR spectrum exhibited four methyl singlets at δ 0.89, 1.02, 1.19, and 1.45, a methine proton at δ 3.90 (J = 4, 11, 12 Hz). The multiplicity and J values of the last signal indicate that a secondary hydroxyl group is located between a methine and a methylene group, possibly on either C-6 or C-11 of ambreinolide. The placement of the hydroxyl on C-6 was deduced by the following reasons. First, the chemical shift of C-7 was observed at δ 51.87 with a downfield shift of *ca.* 17 ppm relative to that of **1**. Second, a concomitant downfield shift of C-5 at δ 61.14 is also indicative of a hydroxyl group located at C-6. Spin decoupling and phase-sensitive COSY experiments confirmed the relationship between H-6 (δ 3.90) and H-7β (δ 2.33, dd, J = 4, 13 Hz) and H-7α (δ 1.78, dd, J = 11, 13 Hz), as well as between H-6 and H-5 (δ 1.10, d, J = 12 Hz). The stereochemistry of the hydroxyl group at C-6 was determined as α on the basis of the coupling constants of H-6 and the NOESY results (Figure 1). Thus, H-6 was found to show NOE with H-17, H-19, and H-20, all oriented at β positions. Due to the α orientation of the hydroxyl group at C-6, H-18 and C-18 were shifted more downfield than expected (δ_H 1.19, δ_C 36.47). All carbons could be assigned by HMQC (Table

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Table 1. ^{1}H- and ^{13}C-NMR Data of Compounds **3**, **4**, and **5**[a] (in $CDCl_3$, 400 MHz)

	3		**4**		**5**	
position	^{1}H	^{13}C	^{1}H	^{13}C	^{1}H	^{13}C
1	1.59 br dd, 0.98 m	39.28	1.42 ddd, 1.09 m	39.46	1.5 m, 1.1 m	40.44
2	1.61 m, 1.48 m	18.18	1.68 ddd, 1.47 m	17.89	1.62 m, 1.45 m	19.15
3	1.22 m, 1.39 dt	43.42	1.32 m, 1.43 m	43.65	1.22 m, 1.32 m	44.81
4		33.67		33.82		34.66
5	1.10 d	61.14	1.24 d	62.10	1.17 d	61.38
6	3.90 ddd	68.45	3.99 ddd	69.82	3.80 ddd	69.53
7	2.33 dd, 1.78 dd	51.87	2.42 dd, 1.82 dd	49.90	2.93 dd, 1.94 dd	50.40
8		82.53		84.25		8.65
9	1.53 dd	53.09	2.02 dd	58.81	2.26 dd	55.82
10		37.71		35.51		39.76
11	1.76 ddd, 1.67 dt	15.93	2.25 dd, 2.44 dd	28.80	2.34 dd, 2.42 dd	31.55
12	2.68 ddd, 2.54 dd	28.71		176.39		171.94
13		171.40				
17	1.45 s	24.01	1.37	22.90	1.56 s	21.80
18	1.19 s	36.47	1.18	36.20	1.19 s	37.00
19	1.02 s	21.96	1.02	21.54	0.99 s	22.40
20	0.89 s	16.22	0.95	16.39	0.88 s	17.30
*C*H$_3$C=O					1.92 s	22.68
CH$_3$*C*=*O*						170.00

[a] The spectrum of **5** was taken in ($CDCl_3$ + CD_3OD); assignments were confirmed by ^{1}H−^{13}C correlations. J (Hz): $J_{1\alpha,2\alpha} = 4.5$; $J_{1\alpha,2\beta} = 11$; $J_{1\beta,2\alpha} = 8$; $J_{1\beta,2\beta} = 4.5$; $J_{1\alpha,1\beta} = 13$; $J_{2\alpha,2\beta} = 13.5$; $J_{5,6} = 12$; $J_{6,7\alpha} = 11$; $J_{6,7\beta} = 4$; $J_{7\alpha,7\beta} = 13$. Only for **3**: $J_{9,11\beta} = 11.5$; $J_{9,11\alpha} = 6$; $J_{11\alpha,11\beta} = 14$; $J_{11\alpha,12\alpha} = 2.5$; $J_{11\beta,12\beta} = 4$; $J_{11\alpha,12\beta} = 8.5$; $J_{12\alpha,12\beta} = 17.5$. For **4** and **5**: $J_{9,11\alpha} = 6.5$; $J_{9,11\beta} = 14$; $J_{11\alpha,11\beta} = 16$.

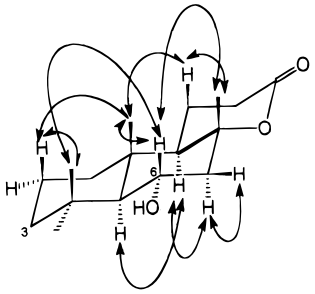

Figure 1.

1) and HMBC (Table 2) experiments. Compound **3** was therefore established as a trinorlabdane, 6α-hydroxyambreinolide.

The HREIMS of compound **4** exhibited a molecular ion peak at *m*/*z* 266.1869, indicating $C_{16}H_{26}O_3$, consistent with a hydroxyl derivative of norambreinolide. The ^{13}C NMR (APT and DEPT) displayed four methyl, five methylene, three methine, and four quaternary carbons. The ^{1}H NMR spectrum (Table 1) of **4** displayed four tertiary methyl singlets at δ 0.95, 1.02, 1.18, and 1.37 and a methine proton at δ 3.99 (ddd, J = 4, 11, 12 Hz), indicating a secondary hydroxyl group between methyl and methylene groups as in compound **3**. Spin decoupling and COSY experiments showed the relationships between H-6 (3.99) and H-7β (δ 2.42, dd, J = 4, 13 Hz) and H-7α (1.82, dd, J = 11, 13 Hz) as well as between H-6 and H-5 (δ 1.24, d, J = 12 Hz), as in compound **3**. After acetylation, H-6 was shifted to δ 5.19 (ddd, J = 4.0, 11.5, 13 Hz) and an acetyl signal appeared at δ 2.07 (3H, s). Compounds **3** and **4** had quite similar ^{1}H-NMR spectra, whereas differences could be found in the IR spectra with the observation of a five-membered lactone ring (1785 cm^{-1}) in **4** instead of a six-membered ring (1716 cm^{-1}) in **3**. Unambiguous assignment of ^{1}H- and ^{13}C-NMR data was made possible by a combination of HMQC (Table 1) and HMBC (Table 2) experiments. By comparing the spectral data with those of **3** and similar tetranorlabdanes,[10] compound **4** was established as a tetranorlabdane, 6α-hydroxynorambreinolide.

The molecular ion peak of compound **5** at *m*/*z* 326.2088 (HREIMS) was analyzed for a molecular formula of $C_{18}H_{30}O_5$. The ^{13}C-NMR spectrum clearly displayed signals for five methyl, five methylene, three methine, and five quaternary carbons. The IR spectrum showed a large hydroxyl band at 3240−3400 cm^{-1} and two carbonyl absorptions at 1685 cm^{-1} (carboxylic acid) and at 1725 cm^{-1} (acetyl). These carbonyl functional groups were substantiated by two carbonyl signals present at δ 171.94 and δ 170.0, as well as an acetyl methyl signal at δ 22.68 in its ^{13}C-NMR spectrum. The ^{1}H-NMR spectrum (Table 1) gave five methyl singlets at δ 0.88, 0.99, 1.19, 1.56, and 1.92, the last assigned to an acetyl methyl. A methine proton was observed at δ 3.80 (ddd, J = 4, 11, 12 Hz) consistent with H-6 as in compounds **3** and **4**. Connectivity of H-9 and H-11, as well as H-5, H-6, and H-7, was confirmed by the COSY experiment, and the 6α-hydroxyl group was deduced from the NOESY results. Thus, H-6 showed NOE with all β-oriented methyl groups [δ 1.56 (C-17), 0.99 (C-19), and 0.88 (C-20)] in the molecule. Following above-mentioned NOESY results, the acetoxyl group must be located at C-8 with an α orientation, thus retaining the same stereochemistry at this asymmetric center as in compounds **1**−**4**. The HMQC (Table 1) and HMBC (Table 2) experiments allowed the assignments of all carbons and protons, and the structure of **5** was deduced as 6α-hydroxy-8α-acetoxy-13,14,15,16-tetranorlabdan-12-oic acid.

Table 2. HMBC Data of Compounds **3**, **4**, and **5**

	long-range correlated carbons		
H	**3**	**4**	**5**
1		C-20	
2			C-1, C-10
3			C-19
5		C-19	
7	C-6, C-8, C-17	C-5, C-6, C-8, C-9, C-17	
9	C-8, C-10, C-11, C-17, C-20	C-8, C-10, C-11, C-17, C-20	C-1, C-11
11	C-8, C-9, C-12,	C-8, C-9, C-12	C-8, C-9, C-10
17	C-7, C-8, C-9	C-7, C-8, C-9	C-7, C-8, C-9
18	C-3, C-4, C-5, C-19	C-3, C-4, C-5, C-19	C-3, C-4, C-5, C-19
19	C-3, C-4, C-5, C-18	C-3, C-4, C-5, C-18	C-3, C-4, C-5, C-18
20	C-1, C-5, C-9, C-10	C-1, C-5, C-9, C-10	C-5, C-9, C-10

The HREIMS spectrum of compound **6** gave a molecular ion peak at *m*/*z* 362.2815 corresponding to a

Table 3. ^{1}H- and ^{13}C-NMR Data of Compounds **6**, **6a**, and **7** (in $CDCl_3$, 400 MHz)[a]

	6		**6a**		**7**	
position	^{1}H	^{13}C	^{1}H	^{13}C	^{1}H	^{13}C
1	1.60 m, 1.34 m	39.91	1.58 m, 1.28 m	38.80	1.60 m, 0.91 m	39.23
2	1.52 m	18.20	1.40 m	18.11	1.47 m	18.33
3	1.42 m, 1.27 m	43.54	1.38 m, 1.21 m	43.30	1.39 m, 1.16 m	43.60
4		33.70		33.28		31.68
5	1.00 d	61.69	1.12 d	58.85	1.02 d	61.69
6	3.87 ddd	69.15	5.12 ddd	70.72	3.84 ddd	69.13
7	2.20 dd, 1.58 dd	54.29	2.12 dd, 1.60 dd	49.69	2.13 dd, 1.48 dd	53.97
8		74.75		74.47		75.64
9	1.19 dd,	54.86	1.14 dd	54.88	1.25 brd	57.65
10		37.70		37.80		32.92
11	1.62 dd, 1.36 dd	15.39	1.62 m, 1.34 m	15.38	1.60 dd, 1.38 dd	16.05
12	2.08 m, 1.56 m	34.86	2.02 m, 1.58 m	34.85	2.20 dd, 1.57 dd	36.44
13		73.03		73.07		72.84
14	6.77 d	154.17	6.97 d	154.17	6.98 d	154.62
15	6.25 d	125.31	6.22 d	125.38	5.99 d	125.18
16		195.31		201.68		201.51
17	2.58 dq	33.96	2.58 dq	33.90	2.61 dq	35.13
18	1.10 t	8.11	1.08 t	8.20	1.11 t	8.08
21	1.29 s	28.81	1.29 s	28.78	1.22 s	25.26
22	1.35 s	26.87	1.40 s	26.68	1.18 s	33.78
23	1.16 s	36.44	1.00 s	36.00	1.15 s	37.55
24	0.99 s	21.84	0.84 s	21.98	0.97 s	21.80
25	0.80 s	16.58	0.86 s	16.50	0.74 s	17.23
*C*H$_3$C=O			2.04 s	21.89		
CH$_3$*C*=*O*				170.13		

[a] J (Hz): $J_{5,6} = 12$, $J_{6,7\alpha} = 11$, $J_{6,7\beta} = 4$; $J_{7\alpha,7\beta} = 12.5$; $J_{9,11\alpha} = 2.5$; $J_{9,11\beta} = 11$; $J_{11\alpha,11\beta} = 13$; $J_{11\alpha,12\beta} = 3$; $J_{11\beta,12\beta} = 4.5$; $J_{12\beta,12\beta} = 14$; $J_{14,15} = 16$; $J_{17,18} = 7.5$.

molecular formula $C_{23}H_{38}O_3$. Although the molecular ion peak was at low intensity, $[M - Me]^+$ and $[M - Me - H_2O]^+$ fragment signals at *m/z* 347 and 329 were significant with high intensities. Its ^{13}C-NMR spectrum indicated the presence of six methyl, seven methylene, five methine, and five quaternary carbons. The presence of a secondary hydroxyl group was shown by a methine signal in the ^{1}H NMR (δ_H 3.87, ddd, $J = 4$, 11, 12 Hz), which was also supported by an IR band at 3460 cm^{-1}. The location of the hydroxyl at C-6 and the connectivity between H-5, H-6, and H-7 were deduced from the COSY spectrum as in compounds **3**−**5**. Acetylation of compound **6** afforded a monoacetate (**6a**) (Table 3), in which the H-6, was shifted downfield to δ 5.12. The presence of an ether ring in **6** was suggested by two quaternary carbon signals at δ 73.03 and 74.75. Two methyl groups which appeared in the ^{1}H-NMR spectrum as two singlets at δ 1.29 and 1.35 must be attached to carbon atoms bearing the oxygen atom of the ether bridge. When the ^{13}C-NMR spectrum of **6** was compared with those of manoyloxide and its derivatives,[10,11] it was deduced that compound **6** possesses the same A, B, and C rings as in manoyloxide. The rest of the molecule forms a side chain containing five carbons, in which a conjugated ketone could be assigned in accordance with the following considerations: An IR band at 1625 cm^{-1} (C=C) and *trans*-coupled two vinylic protons at δ 6.25 and 6.77 (J = 16 Hz) indicated a (CH=CH) group. This was confirmed by two olefinic CH carbons at 125.31 and 154.17 ppm. The downfield shift of one of the olefinic carbons further suggested a conjugated system with a ketone carbonyl group (δ_C 195.31; IR_{max} 1695 cm^{-1}). The HMQC (Table 3) and HMBC (Table 4) experiments allowed assignments of all protons and carbons in **6**. The HMBC technique was particularly useful in determining the partial structure of the side chain. Thus, H-14 showed long-range couplings with C-16 carbonyl and C-21 methyl carbons; on the other hand, H-15 could be related via long-range correlation to C-13 and C-17. Compound **6** was therefore deduced as 19,20-dinorsesterterpene consisting of a partial structure of manoyl oxide, and it was named yosgadensonol.

Table 4. HMBC Data of Compounds **6** and **7**

	long-range correlated carbons	
H	**6**	**7**
5	C-4, C-7	
6		C-5
7	C-5, C-6, C-8, C-9, C-22	C-6, C-8
14	C-16, C-21	C-16, C-21
15	C-13, C-17	C-16, C-17
17	C-18	C-16, C-18
18	C-16, C-17	
21	C-12, C-13	
22	C-7, C-8, C-9	C-7, C-8
23	C-3, C-4, C-5, C-24	C-24
24	C-3, C-4, C-5, C-23	C-6, C-23
25	C-1, C-9, C-10	C-1, C-5, C-10

A compound (**7**) exhibiting similar spectral data to that of **6** was also obtained. The ^{1}H- and ^{13}C-NMR data of both compounds (Table 3 and 4) were quite similar, including the 1D NOE difference spectra obtained by irradiation of H-6β, the signals for H-22, H-24, H-25, and H-7*eq* were clearly enhanced, suggesting β orientation of these groups in both compounds. However, a difference has been detected by NOE irradiation of H-22, which is the most downfield methyl signal in both compounds, observing enhancements on H-21 and H-25 in compound **6** indicating the β orientation of these methyl groups. When H-22 of compound **7** was irradiated in the same manner, only H-25 was enhanced. The lack of NOE between H-22 and H-21 in the latter suggested α position of H-21 at C-13. As a result, 1D NOE experiments of both compounds indicated that the only difference is the stereochemistry at C-13. Compound **7** is therefore an 13-epimer of **6** and was named 13-*epi*-yosgadensonol.

Experimental Section

General Procedures. IR: Perkin-Elmer 983 in $CHCl_3$; ^1H- and ^{13}C-NMR spectra were recorded on 200 MHz Bruker AC 200L at TUBİTAK, (Gebze-Turkey), and 400 MHz JEOL JNM EX-400 at Hong Kong University of Science & Technology, Hong Kong, with TMS as internal standard. LRMS and HRMS data were obtained on a VG Zab Spec at TUBİTAK.

Plant Material. The aerial parts of *Salvia yosgadensis* Freyn. et Bornm. were collected from Central Turkey (near Sultanhani, Konya) and identified by Dr. E. Tuzlaci. Voucher specimen is deposited in the Herbarium of Faculty of Pharmacy, University of Istanbul (ISTE 50876).

Extraction and Isolation of the Compounds. Powdered plant (680 g) was extracted with Me_2CO in a Soxhlet, and the extract was evaporated *in vacuo* to give 40 g of a residue. The latter was fractionated on a Si gel column (5.5 × 70 cm) and eluted with petroleum, first 1 L of petroleum, then followed by a gradient of $CHCl_3$ up to 100%, and then EtOH. After TLC application, similar fractions were combined and further separated on smaller Si gel or Sephadex LH-20 columns. In the latter case, elution was carried out using petrol−$CHCl_3$−MeOH (7:4:1) continuously as solvent. Compounds **4**, **6**, and **7** were obtained during elution of 100% $CHCl_3$, while compounds **3** and **5** were obtained with 2−3% EtOH as gradient to $CHCl_3$. More purification of some compounds was carried out by prep. TLC plates using different solvent systems, petrol−$CHCl_3$ (6:4) for compounds **1** and **2**, C_6D_6−Me_2CO (9:1) for **4**, $CHCl_3$−Me_2CO (9:1) for **5**, and $CHCl_3$−Me_2CO (85:15) for **3**. The following compounds were obtained successively: norambreinolide (**2**) (9 mg), ambreinolide (**1**) (7 mg), yosgadensonol (**6**) (18 mg), 13-*epi*-yosgadensonol (**7**) (15 mg), 6α-hydroxynorambreinolide (**4**) (35 mg), 6α-hydroxyambreinolide (**3**) (18 mg), 6α-hydroxy-8α-acetoxy-13,14,15,16-tetranorlabdan-12-oic acid (**5**) (9 mg).

6α-Hydroxyambreinolide (3): $[\alpha]_D$ +40.8° (*c* 0.1, $CHCl_3$); IR νmax ($CHCl_3$) 3454, 2927, 2875, 1716, 1466, 1394, 1275, 1065, 973 cm^{-1}; ^1H and ^{13}C NMR (400 MHz, in $CDCl_3$, see Table 1); HREIMS *m/z* 280.2031 (calcd for $C_{17}H_{28}O_3$, 280.2038); CIMS *m/z* (rel int) 281 $[M + 1]^+$ (0.5), 263 $[M + 1 - H_2O]^+$ (8.3), 247 (10.2), 219 (3.9), 190 (11.4), 156 (100), 124 (55.2), 109 (77.9), 95 (16.6), 69 (22.2), 43 (32.2).

6α-Hydroxynorambreinolide (4): $[\alpha]_D$ +61.0° (*c* 0.35, $CHCl_3$); IR νmax ($CHCl_3$) 3533, 3289, 2921, 2848, 2368, 1789, 1644, 1457, 1400, 1223, 1190, 1052, 940 cm^{-1}; ^1H and ^{13}C NMR (400 MHz, in $CDCl_3$, see Table 1); HREIMS *m/z* 266.1869 (calcd for $C_{16}H_{26}O_3$, 266.1881); CIMS *m/z* (rel int) 267 $[M + 1]^+$ (3.2), 249 $[M + 1 - CH_3]^+$ (100), 193 (11.6), 189 (37.3), 165 (24.3), 109 (6.9), 41 (65.6).

Acetylation of 4. Compound **4** (8 mg) in pyridine (1 mL) was treated with Ac_2O (1 mL) and left at room temperature for 24 h to afford a monoacetate (**4a**): $[\alpha]_D$ +79.1 (*c* 0.7, $CHCl_3$); ^1H NMR ($CDCl_3$, in 200 MHz) δ 0.90 (3H, s, Me-20), 1.00 (6H, s, Me-18 and Me-19), 1.42 (3H, s, Me-17), 2.07 (3H, s, OAc), 5.19 (1H, ddd, J = 4, 11.5, 13 Hz H-6).

6α-Hydroxy-8α-acetoxy-13,14,15,16-tetranorlabdan-12-oic acid (5): IR νmax ($CHCl_3$) 3240−3400, 2920, 2550, 1725, 1685, 1460, 1380, 1360, 1260, 1170, 1138, 1067, 1052, 755 cm^{-1}; ^1H and ^{13}C NMR (400 MHz, in $CDCl_3$ + CD_3OD, see Table 1); HREIMS *m/z* 326.2088 (calcd for $C_{18}H_{30}O_5$, 326.2093); EIMS *m/z* (rel int) 326 $[M]^+$ (3.4), 267 $[M - OAc]^+$ (22.5), 248 $[M - HOAc - H_2O]^+$ (100), 239 (20.1), 223 (19.7), 203 (76.2), 189 (34.6), 175 (26.6), 163 (29.3), 145 (35.0), 133 (56.9), 125 (59.8), 109 (53.7).

Yosgadensonol (6): IR νmax ($CHCl_3$) 3460, 2920, 2860, 1695, 1625, 1459, 1380, 1362, 1257, 1200, 1155, 1120, 1060, 975, 860, 760 cm^{-1}; ^1H and ^{13}C NMR (400 MHz, in $CDCl_3$, see Table 3); HREIMS *m/z* 362.2815 (calcd for $C_{23}H_{38}O_3$, 362.2093); EIMS *m/z* (rel int) 362 $[M]^+$ (3.3), 347 $[M - Me]^+$ (63.2), 329 $[347 - H_2O]^+$ (50.2), 311 (57.3), 277 (37.6), 261 (32.2), 237 (34.1), 219 (21.3), 201 (47.0), 190 (83.4), 163 (32.0), 138 (32.7), 127 (43.2), 109 (100), 95 (58.6), 81 (52.3), 69 (61.8).

Acetylation of 6. Compound **6** (5 mg) in pyridine (1 mL) was treated with Ac_2O (1 mL) and left at room temperature overnight to yield a monoacetate (**6a**): $[\alpha]_D$ +75° (*c* 0.3, $CHCl_3$); IR νmax ($CHCl_3$) 2934, 2875, 1743, 1677, 1466, 1387, 1250, 1078, 1025, 959 cm^{-1}; ^1H and ^{13}C NMR (400 MHz, in $CDCl_3$, see Table 3); CIMS 405.4 $[M + 1]^+$ (0.5), 390 $[M + 1 - Me]$ (6.2), 344 $[M - HOAc]^+$ (12.8), 329 $[344 - Me]^+$ (78.1), 311 $[329 - H_2O]^+$ (32.9), 259 (30.3), 201 (46.9), 190 (93.8), 149 (75.4), 119 (55.2), 95 (39.3), 69 (45.9), 57 (47.0), 43 (100).

13-epi-Yosgadensonol (7): $[\alpha]_D$ +57° (*c* 0.2, $CHCl_3$); IR νmax ($CHCl_3$) 3447, 2927, 2875, 1710, 1677, 1624, 1460, 1387, 1269, 1203, 1078, 979, 762 cm^{-1}; ^1H and ^{13}C NMR (400 MHz, in $CDCl_3$, see Table 3); EIMS *m/z* 362 $[M]^+$ (0.3), 347 $[M - Me]^+$ (39.7), 329 $[347 - H_2O]^+$ (34.7), 311 (33.1), 261 (12.0), 245 (19.3), 203 (23.2), 201 (37.6), 190 (100), 176 (31.5), 149 (36.0), 137 (42.1), 119 (51.3), 109 (57.4), 95 (46.7), 69 (58.9), 42 (78.8).

References and Notes

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