  Bull. Chem. Soc. Jpn., 61, 3225—3229 (1988)

Skimmiarepin A and B, Two New Insect Growth Inhibitory Triterpenoids from *Skimmia japonica* Thunb. var. *intermedia* Komatsu f. *repens* (Nakai) Hara

Masamitsu Ochi,* Akira Tatsukawa, Naoki Seki, Hiyoshizo Kotsuki, and Kozo Shibata*,†

Faculty of Science, Kochi University, Akebono-cho, Kochi 780

†Faculty of Science, Osaka City University, Sumiyoshi-ku, Osaka 558

(Received March 7, 1988)

Two new triterpenoids, skimmiarepin A and B, which both exhibit an insect growth inhibitory activity against the silkworm, *Bombyx mori* L., have been isolated from the leaves and the fruit of *Skimmia japonica* Thunb. var. *intermedia* Komatsu f. *repens* (Nakai) Hara. Their structures have been determined by extensive 2D NMR studies and chemical methods.

The shrub *Skimmia japonica* Thunb. var. *intermedia* Komatsu f. *repens* (Nakai) Hara (Rutaceae)[1] is widely distributed in Japan and its leaves are relatively free from insect attack. In our preliminary screening for the biological activities of plant materials, the methanol extracts of the leaves and fruit of this plant exhibited an insect growth inhibitory activity against the silkworm, *Bombyx mori* L. Monitoring the fractionations of the methanol extracts by artificial diet feeding bioassay against silkworm larvae[2] led to the isolation of two new triterpenoids responsible to the observed activity.[3] This paper deals with the structures of these new compounds, named skimmiarepin A and B.

Skimmiarepin A (**1**), $C_{35}H_{56}O_6$, mp 164.5—165.5 °C, $[\alpha]_D^{20}$ −22.7° (*c* 0.20, EtOH), was isolated from the methanol extract of the leaves in 0.013% yield as colorless needles by conventional silica-gel column chromatography and preparative high-performance liquid chromatography. It had IR absorptions indicative of hydroxyl (3580 and 3320 cm^{-1}) and ester (1725 cm^{-1}) groups, and formed a couple of diacetates **3**, $C_{39}H_{60}O_8$, mp 79.0—80.0 °C, and **4**, $C_{39}H_{60}O_8$, mp 191.5—192.5 °C, on acetylation with 4-dimethylaminopyridine–acetic anhydride. The oxidation of **1** with pyridinium chlorochromate gave a keto lactone **5**, $C_{35}H_{52}O_6$, mp 135.0—136.0 °C, the IR spectrum of which showed the presence of the newly introduced γ-lactone (1780 cm^{-1}). These facts and the appearance of a pair of ^{13}C NMR signals due to a hemiacetal carbon atom in **1** (δ_C 98.12 and 102.00) suggested that **1** is an epimeric mixture with respect to the hemiacetal carbon atom which constitutes a five-membered cyclic ether. At first our attention was directed to the simplest compound **5**.

The 400 MHz ^1H NMR spectrum of **5** showed signals due to a cyclopropyl methylene group at δ 0.45 and 0.58 (1H each, d, J=5.6 Hz), six tertiary methyl groups at δ 0.84, 0.93, 1.09, 1.32, 1.34, and 1.37 (3H each, s), a trisubstituted epoxide at δ 2.80 (1H, d, J=7.3 Hz), and two oxygen-bearing methine groups at δ 4.17 (1H, ddd, J=10.5, 7.3, and 6.1 Hz) and 4.70 (1H, t, J=2.9 Hz). The presence of an isovaleric ester was also evident from the ^1H NMR signals at δ 0.96 (6H, d,

Table 1. ^1H NMR Spectrum of **5**[a]

Proton	δ	J/Hz	Proton	δ	J/Hz
1α-H	1.54 m#[b]		18a-H	0.45 d	5.6
1β-H	1.12 m#		18b-H	0.58 d	5.6
2α-H	1.93 m#		19- H_3	1.09 s	
2β-H	1.65 m#		20- H	2.89 ddd	12.7, 8.3, 4.4
3- H	4.70 t	2.9	22a-H	1.90 m#	
5- H	1.63 dd	14.0, 2.4	22b-H	2.22 m#	
6α-H	2.16 dd	14.0, 2.4	23- H	4.17 ddd	10.5, 7.3, 6.1
6β-H	2.56 t	14.0	24- H	2.80 d	7.3
9- H	1.15 m#		26- H_3	1.37 s	
11- H_2	1.40 m#		27- H_3	1.34 s	
12a-H	1.65 m#		28- H_3	0.84 s	
12b-H	1.92 m#		29- H_3	0.93 s	
15a-H	1.90 m#		30- H_3	1.32 s	
15b-H	2.00 m#		2′- H_2	2.17 d	6.6
16a-H	0.96 m#		3′- H	2.09 m#	
16b-H	1.57 m#		4′- H_3	0.96 d	6.6
17- H	2.47 ddd	11.5, 7.1, 4.4	5′- H_3		

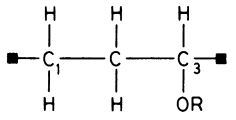
a) The spectrum was determined at 25 °C in $CDCl_3$ solution, with TMS as the internal standard. Assignments were based on the ^1H–^1H and ^1H–^{13}C COSY, and NOESY experiments. b) m#: Overlapped multiplets.

J=6.6 Hz), 2.09 (1H, m), and 2.17 (2H, d, J=6.6 Hz), and the MS fragment at m/z 466 ($M^+-C_5H_{10}O_2$). In addition, an ^1H-^1H COSY analysis and simple homo-decoupling experiments, as summarized in Table 1, revealed the presence of four partial structures, **A**, **B**, **C**, and **D**, all suggesting a carbon framework analogous to those of glabretal (**6**)[4] and ailanthol (**7**)[5] for **5**. The ^1H-^{13}C COSY spectrum of **5** led to straightforward assignments of the ^{13}C NMR signals, except for those of the quaternary carbon atoms at δ_C 28.88, 34.02, 37.12, 37.23, and 50.53 (Table 2). Complete assignments of these quaternary carbon signals as well as ^1H NMR signals of tertiary methyl groups could be accomplished by NOE measurements and ^1H-^{13}C long-range COSY experiments. Namely, observations of NOEs between $H_{3\beta}$ and two methyl groups (δ_H 0.84 and 0.93; $C_{4\alpha}$- and $C_{4\beta}$-Me), between $H_{5\alpha}$ and one of the above methyl groups (δ_H 0.84), between the other one (δ_H 0.93) and $H_{6\beta}$ as well as the third methyl group at δ_H 1.09 (C_{10}-Me), and between the third (δ_H 1.09) and the fourth one at δ_H 1.32 (C_8-Me) defined the positions of all the tertiary methyl groups. The ^{13}C NMR signal at δ_C 37.23 (C_4) showed long-range correlations with methyl proton signals at δ_H 0.84 and 0.93, while the signal at δ_C 37.12 (C_{10}) showed a correlation with that at δ_H 1.09. Further, the methyl proton signal at δ_H 1.32 was long-range-coupled with the carbon signals at δ_C 50.53 (C_8) and

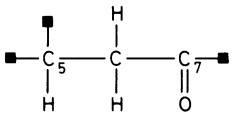
Table 2. ^{13}C Chemical Shifts of **1**—**5**[a]

Carbon	**1**	**2**	**3**	**4**	**5**
1	34.08	34.17	34.42	34.29	34.60
2	26.58	26.63	26.58	26.80	27.09
3	77.77	77.22	77.83	77.76	77.23
4	37.45 (37.18)	37.53 (37.18)	37.44	37.45	37.23
5	41.47 (41.53)	41.66 (41.74)	42.61	42.66	50.35
6	24.50	24.52	23.39	23.36	35.62
7	74.32 (74.20)	74.36 (74.24)	76.23	76.17	214.74
8	39.21 (39.28)	39.23 (39.28)	38.43	38.53	50.53
9	44.24 (44.02)	44.28 (44.18)	45.47	45.03	51.84
10	36.37	36.53	36.99	37.31	37.12
11	16.47 (16.34)	16.48 (16.35)	16.99	16.89	16.84
12	23.15	23.11	23.14	23.09	22.74
13	29.27 (28.92)	29.31 (28.85)	28.80	29.38	28.88
14	37.18	37.18	36.48	36.42	34.02
15	25.85 (26.17)	25.85 (26.23)	26.51	26.01	28.38
16	27.76 (26.48)	27.78 (26.43)	26.90	27.93	21.67
17	44.96 (48.50)	44.97 (48.41)	48.49	45.32	45.04
18	14.08 (13.90)	14.08 (13.93)	15.59	14.85	15.26
19	15.99 (15.87)	16.03 (15.92)	16.16	16.05	15.96
20	49.55 (51.00)	49.54 (50.87)	49.14	48.37	40.91
21	98.12 (102.00)	98.13 (102.01)	101.33	97.53	177.83
22	31.05 (33.28)	31.06 (33.13)	32.29	30.87	26.72
23	78.43 (77.77)	78.45 (77.70)	79.32	79.86	78.42
24	67.68 (65.36)	67.69 (65.39)	65.08	66.84	64.43
25	58.18 (57.36)	58.20 (58.53)	57.10	57.23	57.28
26	25.27 (25.18)	25.25 (25.17)	25.18	25.20	24.82
27	19.72 (19.83)	19.71 (19.81)	19.81	19.81	19.50
28	28.03	28.00	28.07	28.06	27.42
29	22.15	22.19	21.86	21.85	21.15
30	19.48 (19.83)	19.48 (19.71)	19.92	19.64	18.81
1′	172.44	166.02	171.93	172.00	172.40
2′	44.02	117.04	44.31	44.28	43.87
3′	26.03	144.09	26.04	26.04	25.80
4′	22.73	126.66	22.96	22.95	22.50
5′	22.73	139.65	22.86	22.86	22.46
6′		130.37			
7′		141.62			
8′		35.28			
9′		22.55			
10′		14.00			
$COCH_3$			21.66	21.65	
			21.85	21.85	
$COCH_3$			169.51	169.54	
			169.91	169.61	

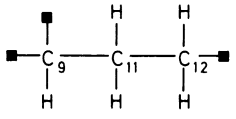
a) The spectra were measured at 100 MHz in $CDCl_3$ solutions and the shifts are given in δ(ppm) relative to the internal TMS. Assignments were made by means of INEPT, ^1H-^{13}C COSY, and ^1H-^{13}C long-range COSY experiments. Values in parentheses are attributable to the $C_{21}\alpha$-OH epimer.



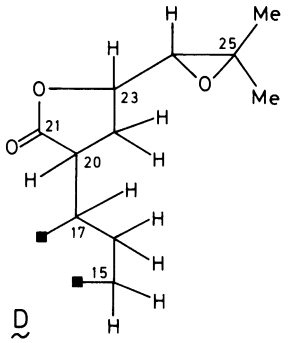
A



B



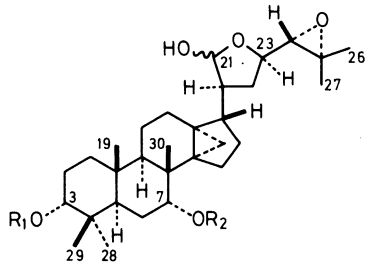
C



D

34.02 (C_{14}). The remaining quaternary carbon signal at δ_C 28.88 could, therefore, be assigned to C_{13}.

These facts inevitably led to an understanding of the gross structure of **5** for the keto lactone and, hence, structure **1** for skimmiarepin A. The locations of the isovaleric ester and the secondary hydroxyl group in **1** were apparently at $C_{3\alpha}$ and $C_{7\alpha}$, respectively, according to the chemical shifts and the coupling pattern of ^{1}H NMR signals due to their carbinyl protons [$H_{3\beta}$: δ 4.66 (t, J=2.8 Hz); $H_{7\beta}$: δ 3.76 (br s)].[4,6] The final confirmation of the assigned structure was achieved by a chemical correlation of **1** with **6**. Thus, a partial methanolysis of the diacetate **3** with triethylamine–methanol yielded an amorphous hemiacetal **8**, $C_{37}H_{58}O_7$. A treatment of **8** with ethyl vinyl ether–pyridinium *p*-toluenesulfonate and a selective methanolysis of the product with sodium methoxide–methanol, followed by a treatment with pyridinium *p*-toluenesulfonate, afforded a diol, the spectral data of which are identical with those of **6**. The stereochemistry at C_{21} of **3** and **4** was deduced from scrutinizing the ^{13}C NMR data for the carbon atoms on the side chains of both compounds.[6]

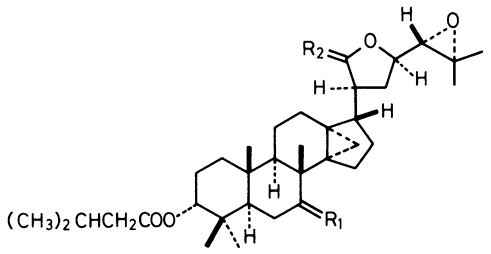


1 R_1 = $COCH_2CH(CH_3)_2$, R_2 = H

2 R_1 = $COCH\overset{Z}{=}CHCH\overset{E}{=}CHCH\overset{E}{=}CHCH_2CH_2CH_3$, R_2 = H

6 R_1 = H, R_2 = Ac

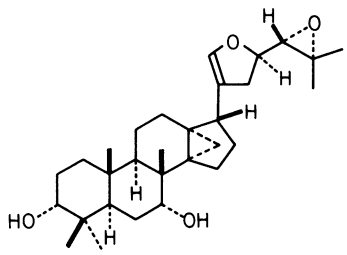
8 R_1 = $COCH_2CH(CH_3)_2$, R_2 = Ac



3 R_1 = α-OAc, β-H, R_2 = α-OAc, β-H

4 R_1 = α-OAc, β-H, R_2 = α-H, β-OAc

5 R_1 = R_2 = O



7

Skimmiarepin B (**2**) was obtained from a methanol extract of the fruit in 0.001% yield as fine needles, $C_{40}H_{60}O_6$, mp 168.0—169.0 °C, $[\alpha]_D^{18}$ −39.8° (*c* 0.11, $CHCl_3$), and exhibited spectral data quite similar to those of **1**, except for following observations. The IR and UV spectra of **2** showed the presence of an unsaturated carboxylic ester [ν_{max} 1705 and 1615 cm^{-1}; λ_{max} 303 nm (ε 21000)]. The ^{1}H NMR spectrum did not show any signal due to the isovaleric ester present in **1** but, instead, showed the presence of a 2,4,6-decatrienoic ester [δ 7.43 (1H, dd, J=14.6 and 11.4 Hz), 6.57 (1H, t, J=11.4 Hz), 6.46 (1H, dd, J=14.6 and 10.6 Hz), 6.27 (1H, dd, J=14.8 and 10.6 Hz), 5.91 (1H, dt, J=14.8 and 7.2 Hz), 5.69 (1H, d, J=11.4 Hz), 2.12 (2H, q, J=7.2 Hz), 1.46 (2H, sext, J=7.2 Hz), and 0.91 (3H, t, J=7.2 Hz)]. The relatively small coupling constant (11.4 Hz) between H_2' and H_3' and the appearance of the H_4' signal at a lower field (δ 7.43)[7] revealed the *Z*-geometry of the C_2' double bond. On the other hand, the *E*-configuration of the C_4' and C_6' double bonds was deduced from the trans ethylenic coupling constants between H_4' and H_5' (14.6 Hz) and between H_6' and H_7' (14.8 Hz), respectively. From this evidence and the pertinent ^{13}C NMR data (Table 2), the structure **2** was proposed for skimmiarepin B.

Experimental

All mps were determined on a Mitamura micro melting-point apparatus and are uncorrected. The IR and UV spectra were recorded on a JASCO model A-302 spectro-

photometer and a JASCO UVIDEC-670 spectrophotometer, respectively. The ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were taken on a JEOL JNM-GX400 instrument in $CDCl_3$ solutions, with TMS as the internal standard. Mass spectra as well as high-resolution mass spectra were measured with a JEOL JMS-D300 spectrometer at 70 eV of ionization energy. A Union Gikken apparatus, model PM-101, was used for measuring the rotations. High-performance liquid chromatographic separation was performed on a Waters Associates HPLC model 6000A, with a TSK-GEL LS-410KG (ODS) column.

Isolation. The leaves and the fruit of *Skimmia* japonica Thunb. var. *intermedia* Komatsu f. *repens* (Nakai) Hara were collected from Mt. Kuishi, Kochi Prefecture, in December 1985. Fresh leaves (1.82 kg) were chopped up and extracted with methanol (6 l) at room temperature for one week. The methanol solution was concentrated up to about 0.5 l, water (0.5 l) was added, and the resulting aqueous suspension was extracted with dichloromethane (3×0.3 l). The dichloromethane layer was washed with water, dried over sodium sulfate, and evaporated to dryness. The residue (65.1 g) was subjected to chromatography over silicic acid (800 g); upon eluting with hexane–ethyl acetate mixtures, ethyl acetate increased from 20 to 80%. Elution with 50% ethyl acetate in hexane gave a fraction (12.0 g) which was rechromatographed over neutral alumina (250 g), using 50% ether in hexane as the eluent, to yield skimmiarepin A (**1**) (347 mg). The fresh fruit (1.44 kg) was extracted in the same manner as described above and the dichloromethane extract (8.3 g) was subjected to chromatography over silicic acid (300 g); upon eluting with hexane–ethyl acetate mixtures, ethyl acetate increased from 20 to 80%. Elution with 50% ethyl acetate in hexane afforded a fraction (155 mg) which was further purified by high-performance liquid chromatography (TSK-GEL LS-410KG, 10% water in methanol) to give skimmiarepin B (**2**) (23 mg).

Skimmiarepin A (1). The crude material was recrystallized from ethanol to give colorless prisms (234 mg); mp 164.5—165.5 °C; $[\alpha]_D^{20}$ −22.7° (*c* 0.20, EtOH); IR (Nujol) 3580, 3320, 1725, 1270, and 1025 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ=0.48 and 0.72 (1H each, d, *J*=4.7 Hz, 18-H_2), 0.96 and 0.97 (3H each, d, *J*=6.6 Hz, 4′- and 5′-H_3), 0.85, 0.88, 0.89, 1.05, 1.31, and 1.32 (3H each, s, 28-, 19-, 29-, 30-, 27-, and 26-H_3), 2.11 (1H, m, 3′-H), 2.23 (2H, d, *J*=6.6 Hz, 2′-H_2), 2.84 (1H, d, *J*=7.3 Hz, 24-H), 3.76 (1H, br s, 7-H), 3.88 (1H, ddd, *J*=9.5, 7.3, and 7.3 Hz, 23-H), 4.66 (1H, t, *J*=2.8 Hz, 3-H), and 5.44 (1H, t, *J*=3.2 Hz, 21-H); ^{13}C NMR (see Table 2); MS (70 eV) *m/z* (rel intensity) 572 (M^+, 3), 554 (M^+-H_2O, 22), 536 (M^+-2H_2O, 7), 470 ($M^+-C_5H_{10}O_2$, 11), 452 ($M^+-H_2O-C_5H_{10}O_2$, 32), 398 (45), 312 (78), 202 (87), and 187 (100). Found: *m/z* 572.4086. Calcd for $C_{35}H_{56}O_6$: M, 572.4077.

Skimmiarepin B (2). The crude substance was recrystallized from acetone to yield white needles (16 mg); mp 168.0—169.0 °C; $[\alpha]_D^{18}$ −39.8° (*c* 0.11, $CHCl_3$); IR (CCl_4) 3600, 3400, 1705, 1615, and 1170 cm^{-1}; UV (EtOH) 303 nm (ε 21000); ^{1}H NMR ($CDCl_3$) δ=0.45 and 0.71 (1H each, d, *J*=5.2 Hz, 18-H_2), 0.87, 1.05, 1.30, and 1.32 (3H each, s, 28-, 30-, 27-, and 26-H_3), 0.90 (6H, s, 19- and 29-H_3), 0.91 (3H, t, *J*=7.2 Hz, 10′-H_3), 1.46 (2H, sext, *J*=7.2 Hz, 9′-H_2), 2.12 (2H, q, *J*=7.2 Hz, 8′-H_2), 2.85 (1H, d, *J*=7.6 Hz, 24-H), 3.77 (1H, br t, *J*=3.2 Hz, 7-H), 3.88 (1H, ddd, *J*=9.5, 7.2, and 7.2 Hz, 23-H), 4.73 (1H, t, *J*=2.7 Hz, 3-H), 5.43 (1H, t, *J*=3.4 Hz, 21-H), 5.69 (1H, d, *J*=11.4 Hz, 2′-H), 5.91 (1H, dt, *J*=14.8 and 7.2 Hz, 7′-H), 6.27 (1H, dd, *J*=14.8 and 10.6 Hz, 6′-H), 6.46 (1H, dd, *J*=14.6 and 10.6 Hz, 5′-H), 6.57 (1H, t, *J*=11.4 Hz, 3′-H), and 7.43 (1H, dd, *J*=14.6 and 11.4 Hz, 4′-H); ^{13}C NMR (see Table 2). Found: C, 74.99; H, 9.51%. Calcd for $C_{40}H_{60}O_6 \cdot 1/4H_2O$: C, 74.90; H, 9.51%.

Acetylation of 1. To a solution of **1** (160 mg) in acetic anhydride (0.3 ml) and pyridine (0.6 ml) was added a catalytic amount of 4-dimethylaminopyridine. The mixture was stirred overnight at room temperature and then worked up in the usual way. The product was chromatographed over silicic acid (20 g), with 75% ether in hexane as the eluent, to give diacetates, **3** (72 mg) and **4** (105 mg).

Diacetate 3. The former fraction was recrystallized from hexane–ethyl acetate to yield colorless prisms (66 mg); mp 79.0—80.0 °C; IR (CCl_4) 1730 and 1250 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ=0.37 and 0.74 (1H each, d, *J*=5.6 Hz, 18-H_2), 0.76, 0.87, 0.91, 1.10, 1.30, and 1.33 (3H each, s, 28-, 19-, 29-, 30-, 27-, and 26-H_3), 1.00 and 1.01 (3H each, d, *J*=6.4 Hz, 4′- and 5′-H_3), 2.04 and 2.06 (3H each, s, 2Ac), 2.12 (1H, m, 3′-H), 2.22 (2H, d, *J*=6.4 Hz, 2′-H_2), 2.75 (1H, d, *J*=7.6 Hz, 24-H), 3.90 (1H, ddd, *J*=10.2, 7.2, and 6.0 Hz, 23-H), 4.67 (1H, t, *J*=2.8 Hz, 3-H), 5.00 (1H, t, *J*=2.8 Hz, 7-H), and 6.29 (1H, d, *J*=3.4 Hz, 21-H); ^{13}C NMR (see Table 2); MS (70 eV) *m/z* (rel intensity) 596 (M^+−AcOH, 52), 536 (M^+−2AcOH, 29), 434 ($M^+-2AcOH-C_5H_{10}O_2$, 27), and 135 (100). Found: *m/z* 596.4049. Calcd for $C_{39}H_{60}O_8$−AcOH: M, 596.4076.

Diacetate 4. The latter fraction was recrystallized from aqueous methanol to afford white needles (89 mg); mp 191.5—192.5 °C; IR (CCl_4) 1730, 1250, and 1230 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ=0.32 and 0.72 (1H each, d, *J*=5.7 Hz, 18-H_2), 0.76, 0.87, 0.91, 1.09, 1.27, and 1.32 (3H each, s, 28-, 19-, 29-, 30-, 27-, and 26-H_3), 1.00 (6H, d, *J*=6.4 Hz, 4′- and 5′-H_3), 2.04 and 2.08 (3H each, s, 2Ac), 2.12 (1H, m, 3′-H), 2.22 (2H, d, *J*=6.4 Hz, 2′-H_2), 2.67 (1H, d, *J*=7.6 Hz, 24-H), 3.88 (1H, ddd, *J*=10.0, 7.6, and 7.0 Hz, 23-H), 4.67 (1H, t, *J*=2.7 Hz, 3-H), 4.98 (1H, t, *J*=2.8 Hz, 7-H), and 6.27 (1H, d, *J*=3.4 Hz, 21-H); ^{13}C NMR (see Table 2); MS (70 eV) *m/z* (rel intensity) 596 (M^+−AcOH, 38), 536 (M^+−2AcOH, 21), 434 ($M^+-2AcOH-C_5H_{10}O_2$, 22), and 135 (100). Found: *m/z* 596.4095. Calcd for $C_{39}H_{60}O_8$−AcOH: M, 596.4076.

Oxidation of 1. To a suspension of pyridinium chlorochromate (50 mg) in dichloromethane (0.5 ml) was added a solution of **1** (30 mg) in dichloromethane (0.5 ml). The mixture was stirred for 6 h at room temperature and then worked up in the usual manner. The product was subjected to chromatography over silicic acid (3 g). Elution with 30% ethyl acetate in hexane gave a keto lactone **5** (22 mg) which was recrystallized from ether–hexane to yield white needles (15 mg); mp 135.0—136.0 °C; IR (CCl_4) 1780, 1738, and 1710 cm^{-1}; ^{1}H NMR (see Table 1); ^{13}C NMR (see Table 2); MS (70 eV) *m/z* (rel intensity) 568 (M^+, 8) and 413 (100). Found: *m/z* 568.3765. Calcd for $C_{35}H_{52}O_6$: M, 568.3764.

Partial Methanolysis of 3. A mixture of **3** (60 mg) and triethylamine (30 mg) in methanol (1.2 ml) was stirred under a nitrogen atmosphere at room temperature for 10 days and then evaporated to dryness. The residue was subjected to chromatography over silicic acid (5 g), with 30% ethyl acetate in hexane, to give a hemiacetal (**8**) as an amorphous solid (34 mg); IR (CCl_4) 3600, 3440, 1730, and 1255 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ=0.35 and 0.65 (1H each, d, *J*=5.4 Hz, 18-H_2), 0.76, 0.87, 0.91, 1.10, 1.30, and 1.31 (3H each, s, 28-, 19-, 29-, 30-, 27-, and 26-H_3), 1.00 (6H d, *J*=6.6 Hz, 4′- and

5′-H_3), 2.04 (3H s, Ac), 2.12 (1H, m, 3′-H), 2.23 (2H, d, J=6.6 Hz, 2′-H_2), 2.83 (1H, d, J=7.6 Hz, 24-H), 3.87 (1H, ddd, J=9.5, 7.6, and 7.3 Hz, 23-H), 4.66 (1H, t, J=2.8 Hz, 3-H), 5.01 (1H, t, J=3.2 Hz, 7-H), and 5.41 (1H, t, J=3.4 Hz, 21-H); MS (70 eV) m/z (rel intensity) 596 (M^+-H_2O, 31), 536 ($M^+-H_2O-AcOH$, 17), 434($M^+-H_2O-AcOH-C_5H_{10}O_2$, 24), and 135 (100). Found: m/z 596.4093. Calcd for $C_{37}H_{58}O_7-H_2O$: M, 596.4077.

Conversion of 8 into Glabretal (6). A mixture of **8** (32 mg), ethyl vinyl ether (0.2 ml), and a catalytic amount of pyridinium *p*-toluenesulfonate was stirred overnight under a nitrogen atmosphere at room temperature. After dilution with dichloromethane (10 ml), the solution was washed with a saturated sodium hydrogencarbonate solution and saturated brine, successively, dried over magnesium sulfate, and evaporated to dryness. The residue, which no longer showed a hydroxylic band in the IR spectrum, was dissolved in methanol (0.5 ml); then, a 0.57 M sodium methoxide solution in methanol (1.0 ml) was added under a nitrogen atmosphere with ice cooling. The mixture was stirred at room temperature for 10 days and then worked up in the usual way. The resulting product was chromatographed over silicic acid (3 g), with 50% ethyl acetate in hexane, to afford a deisovaleryl compound (21 mg). A mixture of the product and a catalytic amount of pyridinium *p*-toluenesulfonate in methanol (0.5 ml) was stirred for 6 h at room temperature under a nitrogen atmosphere and then worked up in the usual manner. The product was chromatographed using a Lobar Column (Merck, LiChroprep Si 60, size B) and 50% ethyl acetate in benzene as the solvent to yield a diol (12 mg) which was identified by comparison of spectral data with those of **6** [IR ($CHCl_3$) 3500, 1715, and 1260 cm^{-1}; ^1H NMR ($CDCl_3$) δ=0.35 and 0.63 (1H each, d, J=5.6 Hz, 18-H_2), 2.04 (3H, s, Ac), 2.83 (1H, d, J=7.3 Hz, 24-H), 3.42 (1H, br s, 3-H), 3.84 (1H, ddd, J=9.5, 7.6, and 7.3 Hz, 23-H), 5.01 (1H, t, J=3.2 Hz, 7-H), and 5.42 (1H, d, J=3.2 Hz, 21-H)].

References

1) S. Kitamura and G. Murata, "Colored Illustrations of Woody Plants of Japan," Revised Ed, Hoikusha Publishing Co., Ltd., Osaka (1984), Vol. 1, p. 315. "Tsurushimi" in Japanese.

2) The second instar larvae of the silkworm were used as the test insects. The procedures for the diet preparation and bioassay were the same as those reported by Asano et al.: S. Asano, E. Kuwano, and M. Eto, *Appl. Entomol. Zool.*, **19**, 212 (1984).

3) The ED_{50}-values, the effective doses for 50% growth inhibition, of skimmiarepin A and B against *Bombyx mori* L. were 0.14 ppm and 0.10 ppm, respectively.

4) G. Ferguson, P. A. Gunn, W. C. Marsh, R. McCrindle, R. Restivo, J. D. Connolly, J. W. B. Fulke, and M. S. Henderson, *J. Chem. Soc., Perkin Trans. 1*, **1975**, 491.

5) B. S. Joshi, V. N. Kamat, S. W. Pelletier, K. Go, and K. Bhandary, *Tetrahedron Lett.*, **26**, 1273 (1985).

6) T. Nakanishi, A. Inada, M. Nishi, T. Miki, R. Hino, and T. Fujita, *Chem. Lett.*, **1986**, 69.

7) K. Ohkuma, F. T. Addicott, O. E. Smith, and W. E. Thiessen, *Tetrahedron Lett.*, **1965**, 2529.