

Bisembranes from the Soft Coral *Sarcophyton glaucum*

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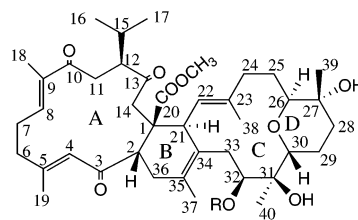
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Four novel bisembranes have been isolated from the soft coral *Sarcophyton glaucum*, collected at Amami Oshima, two of which showed weak activity against proliferation of human promyelocytic leukemia cells (HL-60). Their absolute structures were determined on the basis of the CD spectra.

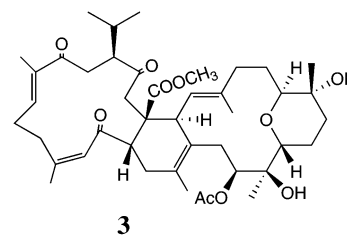
Soft corals belonging to the genus *Sarcophyton* (Alcyoniidae) have proven to be a rich source of common 14-membered carbocyclic cembranes that exhibit a range of biological activities such as antimicrobial, ichthyotoxic, and cytotoxic activity.¹ We have examined the dichloromethane-soluble portion of the methanolic extract of *S. glaucum*, collected at Amami Oshima, Japan, which has yielded four new bisembranes, bisglaucumlide A–D (**1–4**). Two of these compounds possess cytotoxicity against proliferation of human promyelocytic leukemia cells (HL-60). In this paper we describe the isolation and structure elucidation of these compounds. A MeOH extract of the animal (5.0 kg wet wt) was dissolved in H₂O and then extracted with CH₂Cl₂ to give a crude organic extract (59.2 g), which showed cytotoxic activity against HL-60 cells (IC₅₀ 20.6 μg/mL). A portion of the dichloromethane extract (10 g) was subjected to vacuum chromatography on Kieselgel 60 eluting with CH₂Cl₂–MeOH. Final purification was performed by HPLC on a μBondapak C₁₈ column eluting with MeOH–H₂O and/or CH₃–CN–H₂O to give bisglaucumlides A (**1**), B (**2**), C (**3**), and D (**4**).

Results and Discussion

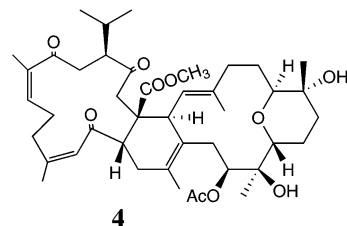
Bisglaucumlide A (**1**) was isolated as an amorphous powder and exhibited the [M + H]⁺ ion at *m/z* 697.4297, corresponding to the molecular formula C₄₁H₆₁O₉. The IR spectrum indicated absorptions indicative of a hydroxyl group (3513 cm⁻¹), an ester carbonyl (1732 cm⁻¹), a carbonyl (1712 cm⁻¹), and a conjugated carbonyl (1667 cm⁻¹). In the ¹H NMR spectrum, resonances due to nine methyls, including two methyls of an isopropyl group (δ 0.82, 0.97, 3H each, d, *J* = 6.8 Hz, δ 2.14, 1H, m), four olefinic methyls (δ 1.71, 1.73, 1.75, 2.09, 3H each, br s), two methyls attached to a hydroxyl-bearing carbon (δ 1.11, 1.33, 3H each, s), and a carbomethoxyl (δ 3.57, 3H, s), were observed as well as those of three carbonyl carbons (δ 210.6, 203.4, 203.6) in the ¹³C NMR spectrum (Table 1). These data implied that bisglaucumlide A was a bisembranoid, such as methyl isosartortuoate,² methyl sarcophytate, methyl chlorosarcophytoate,³ nyalolide,⁴ and tortuoates A and B,⁵ which have been isolated from this same genus, *Sarcophyton*. The gross structure was deduced to be as shown in Figure 1 by interpretation of the NMR spectra, including ¹H–¹H COSY, HMQC, and HMBC spectra (Table 1). The resonances in the NMR spectra due to the A and B rings were similar to those of methyl sarcophytate and nyalolide, respectively. The *E*-geometries of C-4, C-8, and C-22



1 R=H
2 R=Ac



3



4

were evident from the ¹³C chemical shifts of the olefinic methyl carbons at C-19 (δ 18.6), C-18 (δ 11.6), and C-38 (δ 19.7), respectively.⁶ The *E*-geometry of C-22 was also confirmed from the observation of a NOE correlation from H-38 to H-21 in the NOESY spectrum (Figure 2). The relative stereochemistry was elucidated by interpretation of the NOESY spectrum. Thus, H-2 showed correlations to H-4 and to the carbomethoxy methyl protons, the latter of which, in turn, was correlated to one of the methyl protons (δ 0.97) of the isopropyl group and H-22. This suggested that H-2, the carbomethoxy group, and the isopropyl group were situated on the same face (β). H-33 (δ 2.29, 1H, overlapped) showed NOE correlations with H-30 and H-22, suggesting the β-orientation of H-30 and H-33 (δ 2.29). NOE correlations between H-38 and H-21, H-26, and H-32 were observed, while H-21 did not indicate NOE correlation to H-2 and the carbomethoxy methyl. Furthermore, H-26 exhibited NOE correlation with H-40. Therefore, H-21, H-26, H-32, and H-40 were positioned on the α-face. The above findings suggested the major conformation of the A ring as depicted in Figure 2. The conformation of the A and B–D rings was also

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Table 1. NMR Spectral Data of 1–4

no.	1				2				3				4			
	¹ H	¹³ C	HMBC (¹³ C)	NOESY (¹ H)	¹ H	¹³ C	HMBC (¹³ C)	NOESY (¹ H)	¹ H	¹³ C	HMBC (¹³ C)	NOESY (¹ H)	¹ H	¹³ C	HMBC (¹³ C)	NOESY (¹ H)
1		47.1				47.7				48.5				49.5		
2	3.97 d (7.5)	46.6	1, 3, 4, 20,	4, COOMe	3.84 d (7.8)	46.8	1, 3, 4, 20,	4	3.75 dd (3.6, 8.7)	46.7	1, 3, 4, 20,	4, 22, COOMe	3.42 ^b	45.9	1, 3, 14, 20,	4, 22, 36 β
3		203.6	21, 35, 36			202.1	21, 35, 36			201.0	21, 35, 36			201.0	21, 35, 36	
4	6.04 s	126.8	3, 5, 6, 19	2, 6 β , 8	5.98 s	126.6	2, 3, 5, 6, 19	2, 6 β , 8	6.27 br s	126.7	3, 5, 6, 19	2, 19	6.20 s	124.6	3, 5, 6, 19	2, 19
5		159.4				158.0				156.7				160.5		
6 α	2.42 ^b	39.5	4, 5, 7, 8, 19	19	2.26 m	39.6	4, 5, 7, 8, 19	4, 8	2.05 ^b	30.0	4, 5, 7, 8, 9, 19	19	2.72 ^b	35.0	4, 5, 7, 8, 19	
6 β	2.29 ^b		4, 5, 7, 8, 19	4, 8	2.37 ^b		4, 5, 7, 19	19	3.79 dt (2.9, 12.1)		4, 5, 7, 8, 19	8	2.08 ^b		4, 5, 7, 8, 19	8, 19
7 α	2.54 ^b		6, 8, 9	18, 19	2.51 ^b		5, 6, 8, 9	18	2.60 m		5, 6, 9	18	2.14 ^b			11 α
7 β	2.42 ^b	25.2	6, 8, 9	18	2.40 ^b	25.2	5, 6, 8, 9	18, 19	2.29 m	26.1	5, 6, 8, 9	19	2.38 ^b	27.7	6, 8, 9	
8	6.24 m	141.4	6, 10, 18	4, 6 β , 11 α ,	6.22 dd	141.1	6, 7, 10, 18	4, 6 β , 11 α , 11 β	6.38 dd (5.7, 8.9)	142.2	6, 7, 10, 18	6 β , 11 α , 12, 19	5.50 t (7.7)	132.3	10, 18	6 β , 18
9		138.1		11 β	(4.7, 6.8)	137.6				138.0				138.3		
10		203.4				203.2				203.2				206.1		
11 α	3.42 dd (5.3, 13.9)		10, 12, 13, 15		3.44 dd (5.3, 13.9)		10, 12, 13, 15	8	3.15 dd (7.6, 14.1)		10, 12, 13, 15	8	3.13 dd (8.6, 18.6)		10, 12, 13	7 α , 15
11 β	2.04 dd (4.9, 13.9)	33.1	9, 10, 12, 13, 15	8, 16, 17	2.02 dd (5.3, 13.9)	33.1	9, 10, 12, 13, 15	8, 16, 17	2.03 ^b	34.3	10, 12, 13, 15	16, 17	2.24 dd (2.2, 18.6)	40.6	10, 12, 13	15, 16, 17, 18
12	2.58 dd (5.3, 9.7)	56.0	11, 13, 15, 16, 17	8, 14 α , 14 β	2.51 m	56.0	10, 11, 13, 15, 16, 17	14 α	2.70 ^b	55.6	10, 12, 13, 15, 16, 17	8, 14 α	3.24 m	51.0	10, 11, 13, 15, 16, 17	14 α , 14 β
13		210.6				210.1				211.8				210.5		
14 α	3.25 d (18.9)		1, 13, 20, 21	12, 15, 38	3.23 d (19.0)		1, 2, 13, 20, 21	12, 15, 38	3.01 d (19.3)		1, 2, 13, 20, 21	12, 15, 21, 16, 38	2.88 d (18.4)		1, 2, 13, 20, 21	12, 21, 36 α
14 β	1.98 d (18.9)	48.1	2, 13, 20, 21	12, 21	2.12 d (19.0)	47.7	1, 2, 13, 20, 21	21	2.61 d (19.3)	48.0	1, 2, 13, 20, 21	21	2.95 d (18.4)	48.2	1, 2, 13, 20, 21	12
15	2.14 m	30.1	11, 12, 16, 17	14 α	2.16 ^b	30.4	11, 12, 16, 17	14 α	2.03 ^b	29.7	11, 12, 16, 17	14 α	1.89 ^b	29.9	11, 12, 13, 16, 17	11 α , 11 β
16	0.82 d (6.8)	17.3	12, 15, 17	11 α , COOMe	0.80 d (6.9)	17.4	12, 15, 17	11 β , COOMe	0.87 d (6.8)	18.7	12, 15, 17	11 β , 14 α , COOMe	0.83 d (6.8)	19.4	12, 15, 17	11 β
17	0.97 d (6.8)	20.5	12, 15, 16	11 α , COOMe	0.95 d (6.8)	20.6	12, 15, 17	11 β , COOMe	0.93 d (6.8)	20.5	12, 15, 16	11 β , COOMe	0.93 d (6.8)	20.6	12, 15, 16	11 β
18	1.73 s	11.6	8, 9, 10	7 α	1.73 s	11.8	8, 9, 10	7 α , 7 β	1.81 s	11.1	8, 9, 10	7 α	1.88 s	20.6	8, 9, 10	8, 11 β
19	2.09 s	18.6	3, 4, 5, 6	6 α , 7 α	2.09 s	18.6	3, 4, 5, 6	6 α , 7 α	1.91 s	24.5	4, 5, 6	4, 6 α , 7 β , 8	1.86 br s	27.6	3, 4, 5, 6	4, 6 β
20		173.2				173.4				174.2				174.3		
21	3.29 d (11.6)	40.2	20, 21, 34	14, 32, 38	3.27 br d (11.7)	40.3	1, 22, 23, 34, 35	14 β , 32, 38	3.51 d (11.1)	42.0	1, 23, 34, 35	14 α , 14 β , 32, 38	3.41 ^b	44.1	34	14 α , 32, 38
22	4.77 d (11.6)	124.7	24, 34, 38	24 β , 33 α , COOMe	4.78 d (11.7)	124.7	1, 21, 23, 24, 34, 38	24 β , 33 α , COOMe	4.80 d (11.4)	124.6	1, 21, 24, 34, 38	2, 24 β , 33 α	4.85 d (11.1)	124.8	21, 24, 34, 38	2, 24 β , 33 α
23		140.0				140.1	34, 38			140.8				141.0		
24 α	1.85 ^b	38.8	23, 25, 26	26	1.85 t (3.6, 13.0)	38.4	22, 23, 25, 26, 38	26	1.86 m	38.4	22, 23, 25, 38	26	1.86 ^b	38.8	23, 25	
24 β	2.43 ^b		23, 25, 26	22	2.44 m		22, 23, 25, 26, 38	22	2.43 dd (2.6, 10.2)		22, 23, 25, 26, 38	22	2.41 m		22, 23, 25, 26, 38	22
25 α	1.57 m	26.9	23, 24		1.55 ^b	26.6	23, 24, 27	39	1.57 ^b	26.6	23, 24		1.58 ^b	27.0	23, 24, 27	
25 β	1.92 m		24	30	1.95 ^b		23, 24, 26	30	1.90 ^b		26	30	1.85 ^b		23, 26	30
26	3.64 br d (8.9)	85.1	24, 25, 28	24 α , 38, 39	3.68 d (10.2)	85.2	24, 25, 27, 28, 39	24 α , 38, 39	3.68 d (9.6)	85.1	24, 25, 27, 28, 39	24 α , 38, 39	3.69 m	85.1	24, 25, 27, 28	38, 39
27		69.9				69.8				69.8	28, 39			69.9		
28 α	1.69 ^b		26, 29, 30	39	1.68 ^b		26, 27, 29, 30, 39	39	1.68 m		26, 29		1.70 ^b		29	
28 β	1.49 m	31.8	29, 30	30	1.49 m	31.7	26, 29, 30, 39	30	1.49 dt (5.1, 14.0)	31.5	29, 30	30	1.48 dt (14.1, 4.9)	31.8	29	30
29 α	1.59 m	19.9	27, 28	32, 40	1.61 ^b	20.1	28, 30	40	1.59 ^b	19.9	27, 28	40	1.60 ^b	20.2		40
29 β	1.81 m		28	40	1.70 ^b		40	40	1.69 ^b		28, 31	40	1.70 ^(o)		30	40
30	3.68 br d (9.4)	69.3	31, 32, 40	25 β , 28 β , 33 α	3.65 ^b	69.2	31, 40	25 β , 28 β , 33 α	3.63 dd (2.1, 11.4)	69.3	31, 40	25 β , 28 β , 32, 33 α	3.63 br d (11.0)	69.5	31	25 β , 28 β , 33 α
31		75.4				76.0				75.8				75.8		
32	3.56 ^b	70.8	34	21, 29 β , 38, 40	5.07 m	74.0	21, 38, 40		5.01 d (11.1)	75.3	33, 34, 43	21, 30, 38, 40	5.04 d (10.9)	75.5	33, 34, 43	21, 38, 40
33 α	2.29 ^b	31.4	34, 35	22, 30	2.15 ^b	28.6	34, 35	22, 30	2.19 d (14.5)	28.6	34, 35	22, 30	2.24 ^b	29.1	22, 30	22, 30
33 β	2.48 ^b		21, 32,	37	2.74 m			37	2.70 ^b		21, 32, 34, 35	37	2.75 ^b		21, 32, 34, 35	37
34		125.2	34, 35			123.8				125.1				125.3		
35		129.3				127.6				127.0				127.7		
36 α	1.87 d (18.1)	32.5	2, 3, 35, 37		1.80 d (18.3)	32.8	2, 3, 21, 34, 35, 37		2.02 ^b	32.2	1, 2, 3, 34, 35		2.17 ^b	33.0	3, 34, 35	14 β , 37
36 β	2.93 br dd (7.2, 18.1)		3, 34, 35		2.83 br dd (7.7, 18.3)		2, 34, 35		2.70 ^b		2, 3, 34, 35		2.33 ^b		20, 34, 35	2, 37
37	1.71 s	19.9	34, 35, 36	33 β	1.67 br s	19.9	34, 35, 36	33 β , Ac	1.65 s	19.6	21, 34, 35, 36	33 β , Ac	1.66 s	19.6	34, 35, 36	33 β , 36 α , 36 β , Ac
38	1.75 s	19.7	22, 23, 24	14 α , 21, 26, 32	1.88 s	20.0	22, 23, 24	14 α , 21, 26, 32	1.93 br s	19.7	21, 22, 23, 24	14 α , 21, 26, 32	1.95 br s	19.8	21, 22, 23, 24	21, 26, 32, COOMe
39	1.11 s	25.4	26, 27, 28	25 α 26, 28 α ,	1.11 s	25.5	26, 27, 28	25 α , 26	1.11 s	25.4	26, 27, 28	26	1.11 s	25.6	26, 27, 28	26
40	1.33 s	18.8	30, 31, 32	29 α , 29 α , 32	1.14 s	18.8	30, 31, 33	29 α , 29 β , 32, Ac	1.13 s	18.6	30, 31	29 α , 29 β , 32	1.15 s	18.9	30, 32	29 α , 29 β , 32
COOMe	3.57 s	51.3	1, 20	2, 16, 17, 22	3.55 s	51.2	1, 20	16, 17, 22	3.54 s	51.1	20	2, 16, 17	3.54 s	51.0	20	38
Ac					2.09 s	21.5,	COOMe	37, 40	1.95 s	20.6,	COOMe	37	2.04 s	21.0,	32, 43	37
						170.6				170.6				170.5		

^a Chemical shift values of ¹H NMR data and ¹³C NMR data are in ppm from TMS and CDCl₃ (δ 77.0), respectively, and *J* values are in Hz. ^b Overlapping signals.

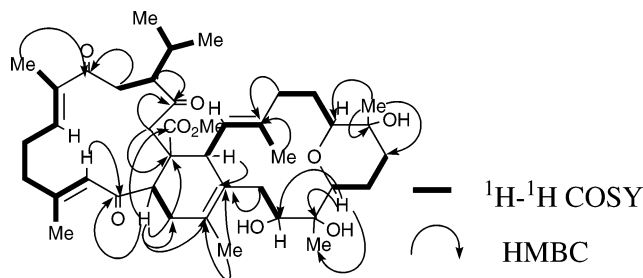


Figure 1. Selected ^1H - ^1H COSY and HMBC correlations of **1**.

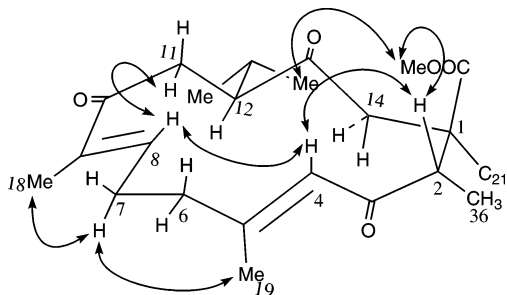


Figure 2. Selected NOE correlations of **1**.

supported by the similar chemical shifts and couplings in the ^1H NMR spectrum to those of methyl sarcophytoate and nyalolide, respectively. A positive Cotton effect in the CD spectrum [λ (MeOH) 249 nm ($\Delta\epsilon$ +2.5), 227 nm ($\Delta\epsilon$ -5.1)] suggested a clockwise relationship between the dipoles of the enone chromophores. Thus, the absolute structure should be as depicted in Figure 1.⁷

Bisglaucumlide B (**2**) was obtained as an amorphous powder, and the molecular formula was assigned as $\text{C}_{43}\text{H}_{62}\text{O}_{10}$ on the basis of the HRFABMS. The ^1H NMR spectrum was similar to that of **1**, except for an additional acetyl group (δ 2.09, 3H, s). The acetyl group was determined to be positioned at C-32, since the chemical shift of H-32 (δ 5.07, 1H, m) was shifted downfield by 1.51 ppm, when compared to that of **1**. It was concluded to have the same stereochemistry as **1** on the basis of similar NOE correlations and coupling constants and signal patterns in the ^1H NMR spectrum to those of **1** and **2**. The absolute configuration of **2** was confirmed by the positive Cotton effect [λ (MeOH) 244 nm ($\Delta\epsilon$ +2.1), 228 nm ($\Delta\epsilon$ -4.4)] in the CD spectrum. Therefore, bisglaucumlide B was 32-acetylbisglaucumlide A.

Bisglaucumlide C (**3**) had the molecular formula $\text{C}_{43}\text{H}_{62}\text{O}_{10}$ on the basis of HRFABMS data and was isomeric with **2**. Compound **3** had the same number of functional groups and double bonds as **2**, but several different structural features were evident in the ^1H NMR spectrum in comparison with that of **2**. Thus, the chemical shifts of H-4 (δ 6.27, 1H, br s) and H-19 (δ 1.91, 3H, s) were shifted downfield and upfield by 0.29 and 0.18 ppm, respectively. Comparing the ^{13}C NMR spectrum with that of **2**, the chemical shifts of C-6 and C-19 in **3** were drastically shifted upfield by 9.6 ppm and downfield by 5.9 ppm, respectively. This suggested that bisglaucumlide C was a geometrical isomer of **2** with regard to the geometry of the C-4 olefin. The relative stereochemistry of the A ring was deduced from the NOESY spectrum: H-4/H-2, H-19; H-7 β (δ 2.29, 1H)/H-8, H-19, H-7 α (δ 2.60, 1H, m)/H-18; H-8/H-6 (δ 3.79, 1H), H-11 (δ 3.15, 1H), H-12; COOMe/H-16, H-17; H-21/H-14 (δ 2.61, 3.01, 1H each). The major conformation of the A ring was thus as depicted in Figure 3, which would promote an anticlockwise rotation of the dipoles of the enone chromophores. This assumption was supported by analysis of the CD spectrum of **3** [λ (MeOH) 250 nm ($\Delta\epsilon$ -13.7)]. As for rings B-D, NOE data similar to those of **1** and **2** were observed. Therefore, the absolute configuration was determined to be as shown for **3**.

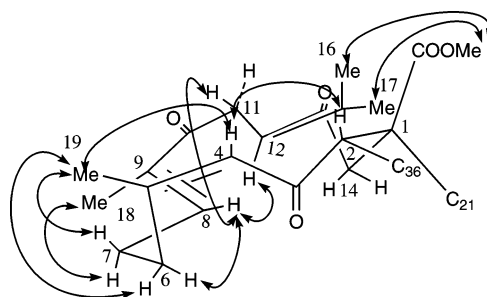


Figure 3. Selected NOE correlations of **3**.

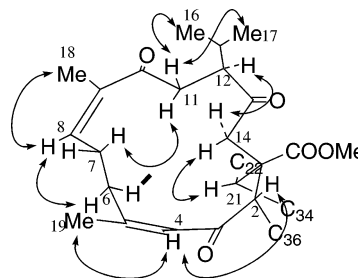


Figure 4. Selected NOE correlations of **4**.

Bisglaucumlide D (**4**), $\text{C}_{43}\text{H}_{62}\text{O}_{10}$, was also an isomer of **2** and **3**. The chemical shift of H-8 (δ 5.50, 1H, t, J = 7.7 Hz) in the ^1H NMR spectrum was shifted upfield by 0.88 ppm, when compared with that of **3**. In addition, the high-field shift of C-8 (δ 132.3) and low-field shift of C-18 (δ 20.6) in the ^{13}C NMR spectrum were observed, suggesting that bisglaucumlide D was a *Z*-isomer of **3**. The major conformation of the A ring was elucidated by interpretation of the NOE spectrum as depicted in Figure 4: H-4/H-2, H-19, H-7/H-11 (δ 3.13), H-8/H-6 (δ 2.08), H-18, H-11 (δ 2.24)/H-16, H-17, H-12/H-14 (δ 2.95), H-14 (δ 2.88)/H-21, H-2, COOMe/H-16, H-17. Conformations of the remaining rings were almost the same as those of **1**-**3** on the basis of the similar NOE correlations to those of **1**-**3**. The CD spectrum showed a negative Cotton effect [λ (MeOH) 250 nm ($\Delta\epsilon$ -9.8)], indicating an anticlockwise relationship between the enone chromophores. The absolute stereochemistry was thus found to be as shown in structure **4**.

The biscembranoid series **1**-**4** is formed through a Diels-Alder reaction of the geometric isomers of methyl sarcophytoate (left part of molecule) with the unknown $\Delta^{1,3,15}$ -cembratriene (right part of molecule). Bisglaucumlides C and D exhibited cytotoxicity against the growth of HL-60 cells with an IC_{50} of 33.7 and 42.3 μM , respectively. However, bisglaucumlides A and B showed no inhibitory activity within 100 μM .

Experimental Section

General Experimental Procedures. Optical rotations were measured at 28 $^\circ\text{C}$ on a JASCO DIP-370S polarimeter. IR spectra were recorded on a MASCO FT/IR 5300. NMR spectra were recorded with either a 400 MHz JEOL or a Varian UNITY-500 NMR instrument using TMS as an internal standard and CDCl_3 as a solvent. MS spectra were obtained with a JEOL JMS XD-303 instrument.

Animal Material. Specimens of *Sarcophyton glaucum* were collected at Amami Oshima, Kagoshima Prefecture. The reference sample (collection no. 272) was deposited in the Department of Chemistry and Bioscience.

Extraction and Isolation. The organisms (wet weight: 5 kg) were chopped into small pieces and extracted with MeOH three times. The dried MeOH extract was resuspended in H_2O and extracted with CH_2Cl_2 . A portion (10 g) of the CH_2Cl_2 extract (59.2 g) was adsorbed on silica gel and subjected to chromatography on silica gel (200 g) packed in hexane. Fractions of 200 mL were collected as follows: 1-3 (CH_2Cl_2 -*n*-hexane, 4:1), 4-6 (CH_2Cl_2), 7-11 (MeOH- CH_2Cl_2 , 1:49), 12 and 13 (MeOH- CH_2Cl_2 , 1:19), 17-21 (MeOH- CH_2Cl_2 , 1:9), 22-24

(MeOH-CH₂Cl₂, 1:1), 25–28 (MeOH). Fractions 12 and 13 (6.8 g) were chromatographed on silica gel eluted with a gradient of MeOH and CH₂Cl₂. Elution with MeOH-CH₂Cl₂ (1:49) gave a crude fraction (184 mg), which was finally purified by HPLC (ODS) with MeOH-H₂O (1:1) and CH₃CN-H₂O (11:9), yielding **2** (12.6 mg) and **3** (3.8 mg) and **4** (1.5 mg), respectively. After the fractions (694 mg) eluted with MeOH-CH₂Cl₂ (1:19), the material was repeatedly subjected to silica gel chromatography and then HPLC [CH₃CN-H₂O (2:3)] to yield compound **1** (5.6 mg).

Bisglaucumlide A (1): amorphous powder, [α]_D +110 (*c* 0.28, MeOH); UV (MeOH) λ_{\max} (log ϵ) 231 nm (4.04); IR (film) ν_{\max} 3513, 1732, 1712, 1667, 1607 cm⁻¹; CD $\Delta\epsilon_{227}$ -5.1, $\Delta\epsilon_{249}$ +2.5; ¹H and ¹³C NMR (see Table 1); HRFABMS *m/z* 697.4297 [M + H]⁺ (calcd for C₄₁H₆₁O₉, 697.4315).

Bisglaucumlide B (2): amorphous powder, [α]_D +126 (*c* 0.22, MeOH); UV (MeOH) λ_{\max} (log ϵ) 231 nm (4.27); IR (film) ν_{\max} 3493, 1732, 1713, 1661, 1611 cm⁻¹; CD $\Delta\epsilon_{228}$ -4.4, $\Delta\epsilon_{244}$ +2.1; ¹H and ¹³C NMR (see Table 1); HRFABMS *m/z* 739.4420 [M + H]⁺ (calcd for C₄₃H₆₃O₁₀, 739.4421).

Bisglaucumlide C (3): amorphous powder, [α]_D +32 (*c* 0.23, MeOH); UV (MeOH) λ_{\max} (log ϵ) 230 nm (4.27); IR (film) ν_{\max} 3495, 1732, 1715, 1659, 1618 cm⁻¹; CD $\Delta\epsilon_{250}$ -13.7; ¹H and ¹³C NMR (see Table 1); HRFABMS *m/z* 739.4412 [M + H]⁺ (calcd for C₄₃H₆₃O₁₀, 739.4421).

Bisglaucumlide D (4): amorphous powder, [α]_D +4 (*c* 0.14, MeOH); UV (MeOH) λ_{\max} (log ϵ) 233 nm (4.04); IR (film) ν_{\max} 3493, 1732, 1711, 1692, 1605 cm⁻¹; CD $\Delta\epsilon_{250}$ -9.8; ¹H and ¹³C NMR (see Table 1); HRFABMS *m/z* 739.4419 [M + H]⁺ (calcd for C₄₃H₆₃O₁₀, 739.4421).

References and Notes

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