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Marine Natural Products. XII.[1] On the Chemical Constituents of the Okinawan Marine Sponge *Hymeniacidon aldis*

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Three peptide-like yellow compounds (**1**, **2**, **3**) containing a guanidine moiety, one of which (named hymenialdisine, **2**) is a monobrominated derivative, and six 3β-hydroxymethyl-*A*-nor-sterane derivatives [purified as the acetates: **4a**, **5a**, **6a**, **7a** (a mixture of two compounds), and **8a**] were isolated from the Okinawan marine sponge *Hymeniacidon aldis* and their structures were elucidated on the basis of physicochemical evidence including the X-ray crystallographic analysis of **2**.

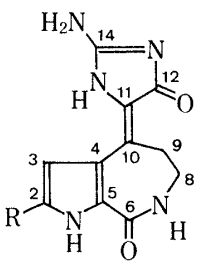
Keywords——marine sponge; *Hymeniacidon aldis*; ^{1}H NMR; ^{13}C NMR; X-ray analysis; peptide-like compound containing a guanidine moiety; hymenialdisine; 3β-hydroxymethyl-*A*-nor-sterane

As part of a continuing search for bioactive substances from marine life,[2] we have investigated the chemical constituents of the Okinawan marine sponge *Hymeniacidon aldis* DE LAUBENFELS (class: Desmospongia) and isolated three yellow peptide-like compounds having a guanidine partial structure from the water-soluble fraction and six 3β-hydroxymethyl-*A*-nor-sterane derivatives (purified as their acetates) from the lipid-soluble portion. This paper deals with the structure elucidation of these compounds on the basis of their physicochemical properties, including an X-ray crystallographic analysis.[3]

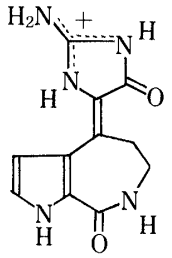
The fresh sponge, collected in July at Ishigakijima, Okinawa Prefecture, was extracted with 10% aq. methanol and methanol successively. The aq. methanol extract was treated with 90% aq. methanol and the soluble portion was subjected to column chromatography to furnish three yellow compounds Y-1 (**1**), Y-2 (**2**), and Y-3 (**3**) in 2, 0.3, and 0.1% yields, respectively, from the 90% aq. methanol-soluble portion. The physicochemical properties of Y-1 and Y-3, including their ultraviolet (UV) and ^{13}C nuclear magnetic resonance (NMR) spectra, indicated that Y-3 is identical with a yellow compound **3** which was previously isolated from the Australian marine sponge *Phakellia flabellata*,[4] and that Y-1 corresponds to the free base **1**, which was shown to be released by treatment of **3** with sodium carbonate.[4]

Y-2, named hymenialdisine (**2**), is a monobromo crystalline compound. The UV spectrum showed absorption maxima similar to those of Y-1 (**1**) and the ^{13}C NMR spectrum suggested that hymenialdisine is a 2-bromo derivative of Y-1 (**1**): *e.g.*, the C-2 signal of **1** was observed at δ_c 122.4 (d) while that of **2** was seen at δ_c 104.5 (s).

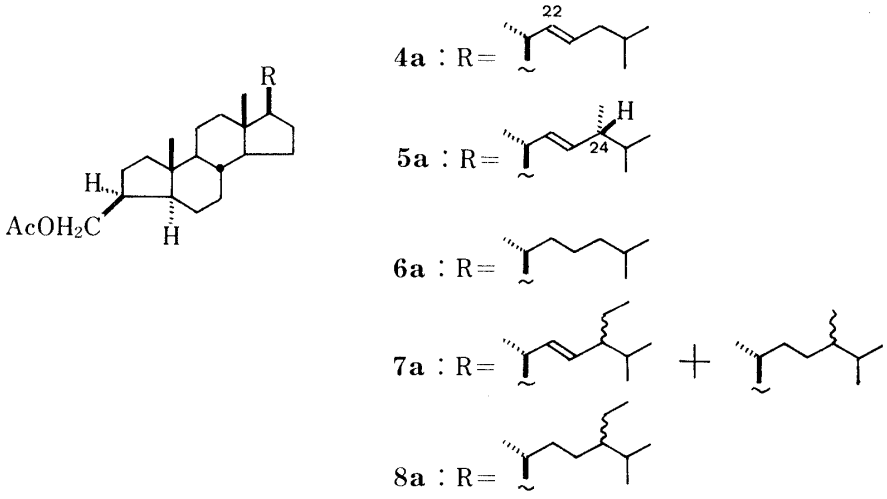
Since the geometry of Δ^{10} in **1**[4] has not yet been fully defined, we carried out an X-ray crystallographic analysis of hymenialdisine to establish the structure. As illustrated in Fig. 1, the structure of hymenialdisine has been clarified to be **2**, in which the dihedral angle between the pyrrole plane (plane 1) and the other 5-membered ring plane containing a guanidine moiety (plane 2) is 43.80° (*cf.* Table IV). The final atomic parameters are listed in Table I and



1 : R=H (Y-1)
2 : R=Br (Y-2 : hymenialdisine)



3 (Y-3)



4a : R=
5a : R=
6a : R=
7a : R= +
8a : R=

Chart 1

the bond distances and angles are given in Table II. Tables III and IV show the hydrogen bond system and the deviation of atoms from the least-squares planes, respectively.

Consequently, the structures of the three yellow substances Y-1 (**1**), hymenialdisine (**2**), and Y-3 (**3**) have been established. In regard to the biogenetic pathway of these guanidino compounds, it may be assumed that they are biosynthesized from proline (**i**) and a new amino acid (**ii**), an α-guanidino isomer of arginine, *via* a peptide (**iii**) which has been proposed as a possible biogenetic intermediate for monobromophakellin (**9**) and dibromophakellin (**10**), metabolites of the marine sponge *Phakellia flabellata*.[5] After the completion of our work, we became aware of a recent communication by Cimino *et al.*[6] who reported the isolation of **2** from the Mediterranean marine sponge *Axinella verrucosa* and the Red Sea marine sponge *Acanthella aurantiaca*; their structure elucidation by X-ray analysis coincides with our present results.

A 3β-hydroxymethyl-*A*-nor-sterane mixture was obtained from the methanol extract of the sponge. After acetylation, the sterane mixture was subjected to high-performance liquid chromatography (HPLC) to furnish five components (**4a**, **5a**, **6a**, **7a**, and **8a**). Among these, **7a** was found to be a mixture of two components, and separation has not yet been accomplished. The physicochemical properties (see "Experimental") of these compounds, especially the ^{1}H NMR signals assignable to a 3β-acetoxymethyl moiety attached to the *A*-nor ring, led us to presume that these compounds are identical with 3β-acetoxymethyl-*A*-nor-sterane derivatives which were previously isolated from the Mediterranean marine sponge *Axinella verrucosa*.[7] However, since the Δ^{22} geometry and the C-20 and C-24 configurations of these 3β-

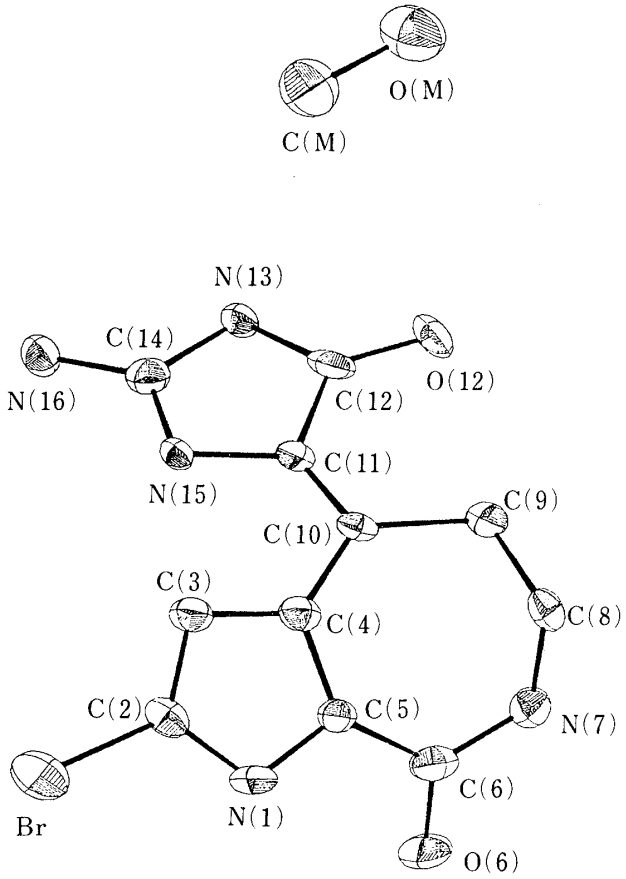


Fig. 1. The Molecular Structure of Hymenialdisine (**2**) with the Atomic Numbering

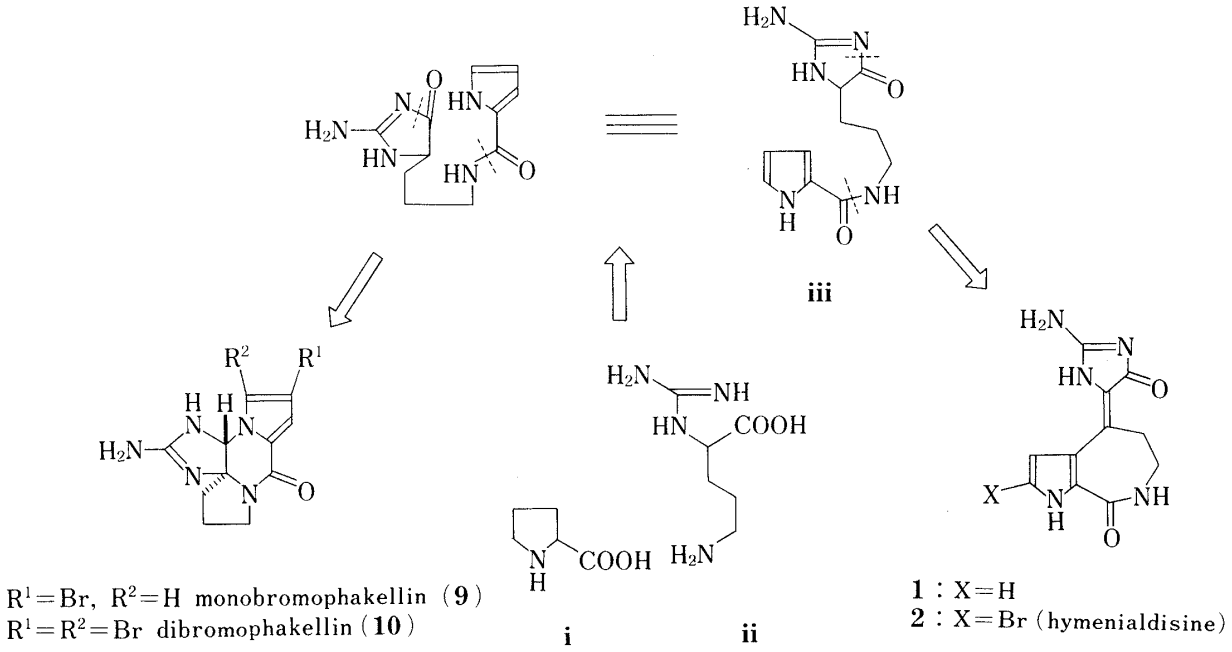


Chart 2. Hypothetical Biogenetic Pathway

TABLE I. Atomic Coordinates ($\times 10^5$ for Br, $\times 10^4$ for the Other Non-hydrogen Atoms and $\times 10^3$ for the Hydrogen Atoms) and Thermal Parameters with e.s.d.'s in Parentheses

	x	y	z	B_{eq}/B (Å^2)
Br	39787 (11)	34946 (4)	46935 (6)	4.2
O(6)	3600 (6)	2723 (2)	9158 (3)	3.5
O(12)	−798 (6)	−712 (2)	7317 (3)	2.9
N(1)	3963 (6)	2790 (3)	6841 (4)	2.4
N(7)	3911 (7)	1346 (3)	9113 (4)	2.8
N(3)	−2708 (6)	−74 (3)	5968 (4)	2.1
N(15)	−835 (6)	992 (2)	5574 (3)	1.9
N(16)	−3706 (6)	897 (3)	4587 (4)	2.5
C(2)	3489 (8)	2677 (3)	5735 (4)	2.4
C(3)	2704 (8)	1914 (3)	5562 (4)	2.0
C(4)	2704 (7)	1533 (3)	6627 (4)	1.9
C(5)	3502 (7)	2081 (3)	7403 (4)	1.9
C(6)	3683 (8)	2073 (3)	8616 (5)	2.4
C(8)	4294 (8)	591 (3)	8485 (5)	2.8
C(9)	2608 (8)	236 (3)	7875 (5)	2.6
C(10)	1775 (8)	762 (3)	6932 (4)	1.8
C(11)	151 (8)	555 (3)	6416 (4)	1.9
C(12)	−1138 (8)	−154 (3)	6617 (4)	2.3
C(14)	−2467 (8)	613 (3)	5346 (4)	2.1
O(M)	1325 (6)	−3727 (3)	3439 (4)	4.5
C(M)	1019 (10)	−2971 (4)	2895 (6)	4.6
H(1)	450 (7)	319 (3)	724 (4)	5 (1)
H(3)	239 (7)	164 (3)	485 (4)	3 (1)
H(7)	371 (7)	140 (3)	984 (4)	2 (1)
H(8)-1	472 (7)	29 (3)	894 (4)	4 (1)
H(8)-2	533 (7)	69 (3)	787 (4)	5 (1)
H(9)-1	290 (7)	−25 (3)	745 (4)	3 (1)
H(9)-2	181 (6)	10 (3)	827 (4)	4 (1)
H(15)	−61 (6)	142 (3)	521 (4)	7 (1)
H(16)-1	−494 (7)	68 (3)	446 (3)	4 (1)
H(16)-2	−340 (6)	131 (3)	426 (4)	4 (1)
H(M)-1	209 (6)	−266 (3)	312 (3)	6 (1)
H(M)-2	10 (6)	−265 (3)	307 (3)	7 (1)
H(M)-3	84 (6)	−313 (3)	204 (4)	9 (1)

acetoxymethyl-*A*-nor-steranes have not yet been defined,[7] **4a**, **5a**, **6a**, and **8a** were examined by means of ^{1}H NMR spectroscopy at 200 MHz and the results were compared with the ^{1}H NMR data reported for various related steroids.[8]

Signals assignable to methyl residues at C-13 and in the side-chains of **4a** and **6a** were observed at the same positions as in the cases of cholesta-5,22*E*-dien-3β-ol (**11**)[8] and cholesteryl acetate (**12**).[8] Thus, the side-chain structures of **4a** and **6a** have been shown to be identical with those of **11** and **12**,[9] respectively. In the ^{1}H NMR spectra of **5a** (taken in $CDCl_3$ and d_6-benzene), signals due to the methyl residues, except for that at C-10,[9] were observed at positions identical with those of the methyl signals of brassicasterol [(24*R*)-24-methylcholesta-5,22*E*-dien-3β-ol] (**13**),[8] but were clearly distinguished from those of the methyl signals of (24*S*)-24-methylcholesta-7,22*E*-dien-3β-yl acetate (**14**).[8] Therefore, the 22*E*-ene-24*R*-methyl structure of **5a** has been clarified. The 24-ethyl side-chain structure of **8a** has been assigned on a similar basis: the C-13 and the side-chain methyl signals (taken in $CDCl_3$ and d_6-benzene) of

TABLE II. Bond Distances (Å) and Angles (°) with Their e.s.d.'s in Parentheses

a) Bond Distance

Br –C (2)	1.876 (5)	O (6) –C (6)	1.247 (7)
O (12) –C (12)	1.253 (6)	N (1) –C (2)	1.364 (7)
N (1) –C (5)	1.389 (7)	N (7) –C (6)	1.331 (7)
N (7) –C (8)	1.478 (7)	N (13) –C (12)	1.351 (7)
N (13) –C (14)	1.362 (7)	N (15) –C (11)	1.397 (7)
N (15) –C (14)	1.353 (7)	N (16) –C (14)	1.327 (7)
C (2) –C (3)	1.379 (7)	C (3) –C (4)	1.422 (7)
C (4) –C (5)	1.392 (7)	C (4) –C (10)	1.482 (7)
C (5) –C (6)	1.454 (7)	C (8) –C (9)	1.507 (8)
C (9) –C (10)	1.516 (7)	C (11) –C (12)	1.517 (7)
O (M) –C (M)	1.405 (8)	C (10) –C (11)	1.344 (8)
H (1) –N (1)	0.88 (5)	H (7) –N (7)	0.90 (5)
H (15) –N (15)	0.84 (5)	H (16)-1–N (16)	0.97 (5)
H (16)-2–N (16)	0.82 (4)	H (3) –C (3)	0.99 (5)
H (8)-1–C (8)	0.78 (5)	H (8)-2–C (8)	1.10 (5)
H (9)-1–C (9)	0.97 (5)	H (9)-2–C (9)	0.80 (5)
H (M)-1–C (M)	0.95 (3)	H (M)-2–C (M)	0.88 (5)
H (M)-3–C (M)	1.06 (4)		

b) Bond Angles

C (2) –N (1)–C (5)	107.8 (4)	C (6) –N (7)–C (8)	122.2 (5)
C (12) –N (13)–C (14)	105.2 (4)	C (11) –N (15)–C (14)	108.7 (4)
Br –C (2)–N (1)	120.4 (4)	Br –C (2)–C (3)	129.3 (4)
N (1) –C (2)–C (3)	110.3 (5)	C (2) –C (3)–C (4)	106.3 (5)
C (3) –C (4)–C (5)	107.4 (5)	C (3) –C (4)–C (10)	128.1 (5)
C (5) –C (4)–C (10)	123.9 (5)	N (1) –C (5)–C (4)	108.3 (4)
N (1) –C (5)–C (6)	119.0 (5)	C (4) –C (5)–C (6)	132.2 (5)
O (6) –C (6)–N (7)	122.0 (5)	O (6) –C (6)–C (5)	120.7 (5)
N (7) –C (6)–C (5)	117.3 (5)	N (7) –C (8)–C (9)	113.2 (5)
C (8) –C (9)–C (10)	115.0 (5)	C (4) –C (10)–C (9)	120.0 (4)
C (4) –C (10)–C (11)	120.0 (5)	C (9) –C (10)–C (11)	120.2 (5)
N (15) –C (11)–C (10)	127.2 (5)	N (15) –C (11)–C (12)	101.9 (4)
C (10) –C (11)–C (12)	130.7 (5)	O (12) –C (12)–N (13)	125.7 (5)
O (12) –C (12)–C (11)	124.1 (5)	N (13) –C (12)–C (11)	110.2 (4)
N (13) –C (14)–N (15)	113.9 (5)	N (13) –C (14)–N (16)	124.0 (5)
N (15) –C (14)–N (16)	122.2 (5)		
H (1) –N (1)–C (2)	134 (3)	H (1) –N (1)–C (5)	118 (3)
H (7) –N (7)–C (6)	109 (3)	H (7) –N (7)–C (8)	128 (3)
H (15) –N (15)–C (11)	134 (3)	H (15) –N (15)–C (14)	118 (3)
H (16)-1–N (16)–C (14)	125 (3)	H (16)-1–N (16)–H (16)-2	120 (4)
H (16)-2–N (16)–C (14)	115 (3)	H (3) –C (3)–C (2)	128 (3)
H (3) –C (3)–C (4)	125 (3)	H (8)-1–C (8)–N (7)	104 (3)
H (8)-1–C (8)–C (9)	113 (3)	H (8)-1–C (8)–H (8)-2	107 (4)
H (8)-2–C (8)–N (7)	112 (2)	H (8)-2–C (8)–C (9)	108 (2)
H (9)-1–C (9)–C (8)	111 (3)	H (9)-1–C (9)–C (10)	100 (3)
H (9)-1–C (9)–H (9)-2	106 (4)	H (9)-2–C (9)–C (8)	115 (3)
H (9)-2–C (9)–C (10)	109 (3)	H (M)-1–C (M)–O (M)	103 (3)
H (M)-1–C (M)–H (M)-2	104 (4)	H (M)-1–C (M)–H (M)-3	117 (4)
H (M)-2–C (M)–O (M)	120 (3)	H (M)-2–C (M)–H (M)-3	109 (4)
H (M)-3–C (M)–O (M)	104 (2)		

TABLE III. Hydrogen Bond System

Donor	Acceptor	Distance (Å)	Symmetry code
N(1)–H	O(12)	2.931 (6)	(0.5−x, 0.5+y, 1.5−z)
N(7)–H	O(M)	2.956 (6)	(0.5−x, 0.5+y, 1.5−z)
N(15)–H	O(6)	2.713 (5)	(−0.5+x, 0.5−y, −0.5+z)
N(16)–H	O(6)	2.871 (6)	(−0.5+x, 0.5−y, −0.5+z)
N(16)–H	N(13)	2.976 (6)	(−1.0−x, −y, 1.0−z)
O(M)–H	O(12)	2.718 (6)	(0.5+x, −0.5−y, −0.5+z)

TABLE IV. Deviations (Å) of Atoms from the Least-squares Planes

Plane 1		Plane 2	
N(1)[a]	−0.005	C(11)[a]	−0.012
C(2)[a]	0.003	C(12)[a]	0.014
C(3)[a]	0.000	N(13)[a]	−0.010
C(4)[a]	−0.003	C(14)[a]	0.005
C(5)[a]	0.005	N(15)[a]	0.004
C(6)	−0.145	C(10)	−0.108
C(10)	−0.206	N(16)	0.001

a) Included in the calculation of the least-squares planes.
Plane 1: $0.9127x-0.3857y-0.1347z=-0.6723$
Plane 2: $0.4561x-0.5467y-0.7022z=-6.0424$
The dihedral angle between planes 1 and 2 is 43.80°.

8a were in good accord with those of 5α-stigmasterol [(24*R*)-24-ethylcholestanol] (**15**),[8] and clionasteryl acetate [(24*S*)-24-ethylcholest-5-en-3β-yl acetate] (**16**).[8] However, in these cases, differences of the C-24 configurations in **15** and **16** would not affect the chemical shifts of the side-chain methyl signals, so the C-24 configuration in **8a** has not yet been defined.

As judged from the isolation procedure, the above-mentioned *A*-nor-steranes are considered to be contained as the 3β-hydroxymethyl derivatives in the marine sponge.

Experimental

The following instruments were used to obtain physical data: melting points, Yanagimoto micro-melting point apparatus (values are uncorrected); specific rotations, JASCO DIP-181 digital polarimeter (1 = 0.5 dm); IR spectra, Hitachi 260-30 infrared spectrometer; UV spectra, Hitachi 330 spectrophotometer; ^{1}H NMR (200 MHz) and ^{13}C NMR (50 MHz) spectra, JEOL JNM-FX 200 FT-NMR spectrometer (with TMS as an internal standard; pulse width, 10 μs; data points, 8192; temp., 25 °C); high resolution MS and MS, JEOL JMS-new D-300 mass spectrometer. The following experimental conditions were used for chromatography: HPLC, Waters system 500A; column chromatography, silica gel 60 (Merck 60—230 mesh); TLC, Silica gel 60 F_{254} (Merck pre-coated TLC plates) (detection by spraying with 1% $Ce(SO_4)_2$–10% aq. H_2SO_4 followed by heating).

Isolation of Y-1 (1), Hymenialdisine (2), and Y-3 (3)——The fresh marine sponge *Hymeniacidon aldis* (1.5 kg, finely cut), which was collected in July at Ishigakijima, Okinawa Prefecture, was extracted with refluxing 10% aq. MeOH (2 l each) three times. Removal of the solvent under reduced pressure gave the 10% aq. MeOH extract (130 g). The sponge was further extracted with refluxing MeOH (2 l each) three more times and the solvent was removed as above to furnish the MeOH extract (2.8 g). The 10% aq. MeOH extract (130 g) was treated with 90% aq. MeOH (400 ml) at room temperature three times, and removal of the solvent from the soluble portion under reduced pressure furnished the residue (35 g). Purification of the residue (10 g) by repeated column chromatography [i) Toyopearl HW-40 Fine and ii) Toyopearl HW-40 Super Fine; elution with 90% aq. MeOH in both cases] furnished Y-1 (**1**, 200 mg), hymenialdisine (**2**, 30 mg), and a fraction containing Y-3 (**3**), which was further purified with a Toyopearl HW-40 Super Fine column (elution with MeOH–$CHCl_3$–H_2O = 10 : 2 : 1) to afford Y-3 (**3**, 10 mg). **1**,

yellow needles, mp 171—180 °C (dec.) (from 90% aq. MeOH). UV λ_{max}^{MeOH} nm (ε): 228 (11600), 265 (10400), 344 (19200). IR ν_{max}^{KBr} cm^{-1}: 3420, 3200 (br), 1691, 1654, 1620, 1283. ^{13}C NMR (d_6-DMSO, δ_c): 173.2 (s, C-12), 163.6 (s, C-6), 160.8 (s, C-14), 127.8 (s), 125.5 (s), 124.5 (s), 123. 2(s) (C-4, 5, 10, 11), 122.4 (d, C-2), 110.8 (d, C-3), 40.5 (t, C-8), 29.8 (t, C-9). MS *m/z* (%): 245 (78, M^+), 228 (18), 216 (32), 202 (86), 174 (56), 146 (100). High resolution MS: Found 245.090. Calcd for $C_{11}H_{11}N_5O_2$ (M^+) = 245.090. Hymenialdisine (**2**), yellow needles, mp 160—164 °C (dec.) (90% aq. MeOH). UV λ_{max}^{MeOH} nm (ε): 227 (sh, 11100), 270 (11700), 346 (15900). IR ν_{max}^{KBr} cm^{-1}: 3310 (br), 3200 (br), 1682, 1655, 1623, 1268. ^{13}C NMR (d_6-DMSO, δ_c): 170.3 (s, C-12), 162.7 (s, C-6), 158.3 (s, C-14), 128.6 (s), 127.4 (s), 124.5 (s), 124.3 (s) (C-4, 5, 10, 11), 112.8 (d, C-3), 104.5 (s, C-2), 39.8 (t, C-8), 30.4 (t, C-9), 48.6 (q, CH_3OH). MS *m/z* (%): 325 (M^+, 72), 323 (M^+, 80), 308 (9), 306 (8), 296 (49), 294 (46), 282 (62), 280 (67), 254 (52), 252 (53), 226 (99), 224 (100). High resolution MS: Found 325.001, 323.001. Calcd for $C_{11}H_{10}{}^{81}BrN_5O_2$ = 325.002, $C_{11}H_{10}{}^{79}BrN_5O_2$ = 323.001. *Anal.* Calcd for $C_{11}H_{10}BrN_5O_2 \cdot CH_3OH$: C, 40.43; H, 3.94. Found: C, 40.10; H, 3.54. **3**, yellow amorphous. UV λ_{max}^{MeOH} nm (ε): 224 (8600), 252 (6300), 338 (15900). IR ν_{max}^{KBr} cm^{-1}: 3274 (br), 1748, 1711, 1622, 1483, 1397, 1280. ^{13}C NMR (d_6-DMSO, δ_c): 165.6 (s, C-12), 163.3 (s, C-6), 154.6 (s, C-14), 125.6 (s), 122.9 (s), 122.7 (s), 121.6 (s) (C-4, 5, 10, 11), 122.2 (d, C-2), 109.9 (d, C-3), 40.3 (t, C-8), 30.7 (t, C-9).

X-Ray Crystallographic Analysis of 2——Crystal data: $C_{11}H_{10}BrN_5O_2 \cdot CH_3OH$, monoclinic, space group $P2_1/n$, a = 7.284 (3), b = 16.288 (8), c = 12.003 (5) Å, β = 93.49 (3)°, Dx = 1.66 g/cm^3, Z = 4 and μ (Mo$K\alpha$) = 30.8 cm^{-1}. All data were collected on a Syntex R3 diffractometer system by the ω-scanning technique within 2θ less than 45° using a variable-scan speed and graphite-monochromated Mo$K\alpha$ radiation. A total of 1527 independent reflections were used for the structure analysis. Lorentz and polarization corrections were applied, but no absorption corrections were made. The structure was solved by the heavy atom method. All the hydrogen atoms except one, bonded to oxygen of methanol, were found on a difference Fourier map. The refinement of atomic parameters was carried out by the block-diagonal least-squares method. The final R-value was 0.045.

Isolation of 3β-Acetoxymethyl-*A*-nor-steranes (4a, 5a, 6a, 7a, 8a)——Purification of the above-mentioned MeOH extract (2.8 g) by column chromatography (SiO_2 30 g; elution with hexane–AcOEt = 7 : 1) furnished a mixture of 3β-hydroxymethyl-*A*-nor-steranes (500 mg). A solution of this mixture (130 mg) in pyridine (5 ml) was treated with Ac_2O (2 ml) and the whole mixture was left standing at 20 °C for 12 h. After work-up of the reaction mixture in the usual manner, the acetate mixture was purified by HPLC (μBondapak C_{18}; elution with $CHCl_3$–MeOH–CH_3CN–H_2O = 25 : 71 : 10 : 6) to furnish **4a** (9 mg), **5a** (16 mg), **6a** (62 mg), **7a** (37 mg), and **8a** (15 mg). **4a**, colorless needles, mp 65—66 °C (MeOH), $[\alpha]_D^{17}$ +21° (c = 0.2, $CHCl_3$). ^{1}H NMR ($CDCl_3$, δ): 0.66 (3H, s, 13-CH_3), 0.76 (3H, s, 10-CH_3), 0.86 (6H, d, J = 6.8, 25-$(CH_3)_2$), 0.99 (3H, d, J = 6.4, 20-CH_3), 2.03 (3H, s, OAc), 2.31 (1H, m, 3α-H), 3.94 (A in ABX, J_{AB} = 10.5, J_{AX} = 9.0, 3-C$\underline{H}_2$OAc), 4.10 (B in ABX, J_{AB} = 10.5, J_{BX} = 6.5, 3-C$\underline{H}_2$OAc), 5.20 (2H, m, 22,23-H). MS *m/z* (%): 428 (32, M^+), 344 (51, C_{20}–C_{22} fission),[10] 257 (91, C_{17}–C_{20} fission–AcOH). High resolution MS: Found 428.363. Calcd for $C_{29}H_{48}O_2$ (M^+) = 428.362. **5a**, colorless needles, mp 101—103 °C (MeOH), $[\alpha]_D^{17}$ +33° (c = 0.1, $CHCl_3$). ^{1}H NMR ($CDCl_3$ δ): 0.66 (3H, s, 13-CH_3), 0.75 (3H, s, 10-CH_3), 0.81, 0.83 (both 3H, d, J = 6.8, 6.4, 25-$(CH_3)_2$), 0.91 (3H, d, J = 6.8, 24-CH_3), 0.99 (3H, d, J = 6.4, 20-CH_3), 2.03 (3H, s, OAc), 2.31 (1H, m, 3α-H), 3.94 (A in ABX, J_{AB} = 10.5, J_{AX} = 9.0, 3-C$\underline{H}_2$OAc), 4.10 (B in ABX, J_{AB} = 10.5, J_{BX} = 6.5, 3-C$\underline{H}_2$OAc), 5.15 (2H, m, 22,23-H). ^{1}H NMR (d_6-benzene, δ): 0.66, 0.67 (both 3H, s, 10,13-CH_3), 0.93 (6H, d, J = 6.3, 25-$(CH_3)_2$), 1.01 (3H, d, J = 6.8, 24-CH_3), 1.12 (3H, d, J = 6.3, 20-CH_3). MS *m/z* (%): 442 (32, M^+), 344 (30, C_{20}–C_{22} fission), 257 (70, C_{17}–C_{20} fission–AcOH). High resolution MS: Found 442.380. Calcd for $C_{30}H_{50}O_2$ (M^+) = 442.380. **6a**, colorless needles, mp 52—54 °C (MeOH), $[\alpha]_D^{17}$ +23° (c = 0.2, $CHCl_3$). ^{1}H NMR ($CDCl_3$, δ): 0.65 (3H, s, 13-CH_3), 0.75 (3H, s, 10-CH_3), 0.86 (6H, d, J = 6.4, 25-$(CH_3)_2$), 0.90 (3H, d, J = 7.8, 20-CH_3), 2.03 (3H, s, OAc), 2.31 (1H, m, 3α-H), 3.94 (A in ABX, J_{AB} = 10.5, J_{AX} = 9.0, 3-C$\underline{H}_2$OAc), 4.10 (B in ABX, J_{AB} = 10.5, J_{BX} = 6.5, 3-C$\underline{H}_2$OAc). MS *m/z* (%): 430 (11, M^+), 370 (95, M^+ – AcOH), 257 (10, C_{17}–C_{20} fission–AcOH). High resolution MS: Found 430.379. Calcd for $C_{29}H_{50}O_2$ (M^+) = 430.378. **7a**, amorphous, MS *m/z* (%): 456 (18, M^+), 444 (6, M^+), 344 (13, C_{20}–C_{22} fission), 257 (49, C_{17}–C_{20} fission–AcOH). High resolution MS: Found 456.394, 444.395. Calcd for $C_{31}H_{52}O_2$ (M^+) = 456.392, $C_{30}H_{52}O_2$ (M^+) = 444.394. ^{1}H NMR ($CDCl_3$, δ): 0.65, 0.67 (total 3H, both s, 13-CH_3), 0.75 (3H, s, 10-CH_3), 2.03 (3H, s, OAc), 2.33 (1H, m, 3α-H), 3.94 (A in ABX, J_{AB} = 10.5, J_{AX} = 9.0, 3-C$\underline{H}_2$OAc), 4.10 (B in ABX, J_{AB} = 10.5, J_{AX} = 6.5, 3-C$\underline{H}_2$OAc). **8a**, colorless needles, mp 90—91 °C (MeOH), $[\alpha]_D^{17}$ +28° (c = 0.1, MeOH). ^{1}H NMR ($CDCl_3$, δ): 0.65 (3H, s, 13-CH_3), 0.75 (3H, s, 10-CH_3), 0.81, 0.83 (both 3H, d, J = 6.8, 25-$(CH_3)_2$), 0.85 (3H, t, J = *ca.* 7, 28-CH_3), 0.91 (3H, d, J = 6.4, 20-CH_3), 2.03 (3H, s, OAc), 2.31 (1H, m, 3α-H), 3.94 (A in ABX, J_{AB} = 10.5, J_{AX} = 9.0, 3-C$\underline{H}_2$OAc), 4.10 (B in ABX, J_{AB} = 10.5, J_{BX} = 6.5, 3-C$\underline{H}_2$OAc). ^{1}H NMR (d_6-benzene, δ): 0.66, 0.67 (both 3H, s, 10,13-CH_3), 0.90, 0.92 (both 3H, d, J = 6.8, 25-$(CH_3)_2$), 0.93 (3H, t, J = 7.5, 28-CH_3), 1.04 (3H, d, J = 6.8, 20-CH_3). MS *m/z* (%): 458 (13, M^+), 398 (100, M^+ – AcOH), 257 (21, C_{17}–C_{20} fission–AcOH). High resolution MS: Found 458.415. Calcd for $C_{31}H_{54}O_2$ (M^+) = 458.416.

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