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A NOVEL DITERPENOLIDE FROM THE SOFT CORAL
SARCOPHYTON SOLIDUN

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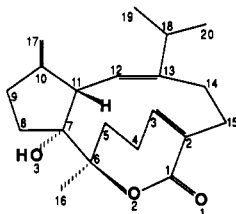
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ABSTRACT.—A novel diterpenolide, sarsolilide A (**1**), has been isolated from the South China Sea soft coral *Sarcophyton solidun*. The structure of sarsolilide A was suggested on the basis of comprehensive spectral analysis and confirmed by X-ray crystallography.

The EtOH extract obtained from *Sarcophyton solidun* Tixier-Durivault (Alcyoniidae) was chromatographed to give a new diterpenolide **1**, named sarsolilide A. Sarsolilide A was isolated as colorless crystals, $[\alpha]^{25}_D + 142.2^\circ$ (EtOH, $c=0.03$), mp 240.2–242.0°. It was assigned the molecular formula $C_{20}H_{28}O_3$ on the basis of accurate mass measurements of a weak molecular ion at m/z 316.2034 (calcd 316.2038).

The ^{13}C -nmr (90 MHz, in $CDCl_3$) spectrum of compound **1** contained signals for seven sp^2 carbon atoms between 107 and 170 ppm. The 1H -nmr spectrum at 400 MHz in $CDCl_3$ also indicated the signals for one terminal double bond at δ 4.64 (1H, d, $J=1.94$ Hz, H_a -17) and 4.89 (1H, d, $J=1.94$ Hz, H_b -17), two trisubstituted double bonds at δ 5.18 (1H, d, $J=10.26$ Hz, H-12) and 6.29 (1H, dd, $J=9.0, 6.0$ Hz, H-3) (Table 1) (1).

**1**

The uv spectrum absorptions at λ max 221 (log ϵ 3.81) and 209 (log ϵ 3.86) nm revealed the presence of an α,β -unsaturated carbonyl group (2). The ir spectrum (KBr) also showed α,β -unsaturated carbonyl absorptions at ν max 1669, 1039 cm^{-1} (3). The molecule was thus tricyclic. In addition, the broad band decoupled ^{13}C -nmr spectrum and DEPT experiment indicated the presence of two non-protonated carbon atoms both bonded to oxygens, two methine, six methylene, and three methyl groups.

The elucidation of the carbon skeleton of sarsolilide A was greatly facilitated by 2D nmr techniques. The 2D homonuclear shift correlation spectrum of **1** showed three different sets of mutually coupled spins.

In the 2D homonuclear spectrum, the doublet at δ 3.01 (1H, d, $J=10.26$ Hz) showed cross peaks with the doublet at δ 5.18 (1H, d, $J=10.26$ Hz), as well as with the doublets at δ 4.64 and 4.89. The doublet of double doublets at δ 2.40 (2H, ddd, $J=10.10$ Hz) showed cross peaks with the doublet of double doublets at δ 1.78 (2H, ddd, $J=10.10$ Hz) (A_2B_2 system) (4) and the doublets at δ 4.64 and 4.89. So, the coupling interactions and chemical shifts of protons at δ 1.78, 2.40, 4.64, 4.89, 3.01, and 5.18

TABLE 1. ^{13}C -nmr, H/H COSY and ^1H -nmr Spectra of Sarsolilide A (**1**).^a

Position	^{13}C chemical shift (BB)	Multiplicities (DEPT)	2D COSY	Multiplicities ^1H - ^1H , (J in Hz)
1	169.48			
2	133.67			
3	143.42	CH	6.29	dd, 3,4, (9.0, 6.0)
4	21.85	CH ₂	2.35 (H _a -4)	m
			2.91 (H _b -4)	dd, 4b, 4a, 5
5	38.16	CH ₂	1.97	m
6	86.48			
7	86.81			
8	33.07	CH ₂	1.78	ddd, 8, 9, (10.10)
9	31.22	CH ₂	2.40	ddd, 9, 8, (10.10)
10	151.80			
11	48.72	CH	3.01	d, 11, 12, (10.26)
12	120.99	CH	5.18	d, 12, 11, (10.26)
13	144.61			
14	26.78	CH ₂	2.43-2.60	m
15	26.46	CH ₂	2.07	m
16	26.17	Me	1.40	s
17	107.20	CH ₂	4.64 (H _a -17)	d, 17a, 17b, (1.94)
			4.89 (H _b -17)	d, 17b, 17a, (1.94)
18	31.40	CH	2.20	ddd, 18, 19, 20, (6.8)
19	20.82	Me	1.04	d, 19, 18, (6.8)
20	22.66	Me	1.04	d, 20, 18, (6.8)
-OH			1.60	br s

^aSpectra were run in CDCl₃ using TMS as internal reference.

readily led to their assignment at H-8, H-9, H_a-17, H_b-17, H-11, and H-12, respectively, of sarsolilide A. In addition, the double doublet of δ 6.29 showed cross peaks with the multiplet at δ 2.35 (1H, m) and 2.07 (2H, m), which was coupled to another multiplet at δ 2.43-2.60 (2H, m), and there are three other cross peaks among the multiplet at δ 2.35 (1H, m), the multiplet at δ 1.97 (2H, m) and the double doublet at δ 2.91 (1H, dd, $J=5.44, 12.32$ Hz). Because it is more shielded by the carbonyl group, the H_b-4 is shifted to lower field as compared to the H_a-4. The protons at δ 6.29, 2.35, 2.91, 1.97, 2.43, and 2.07 were thus assigned as H-3, H_a-4, H_b-4, H-5, H-14, and H-15 of sarsolilide A, respectively.

The ^1H -nmr spectrum showed the signals for isopropyl methyls at δ 1.04 (3H, d, $J=6.8$ Hz, Me-19), 1.06 (3H, d, $J=6.8$ Hz, Me-20), and methine at 2.20 (1H, ddd, $J=6.8$ Hz, H-18). The ir spectrum also indicated the presence of the

isopropyl methyls at 1376, 1386 cm^{-1} . The isopropyl group was attached to a double bond.

The ^1H -nmr spectrum showed a signal for -OH at δ 1.60; the ir spectrum strong absorption at 3435 cm^{-1} and the eims peak at m/z 298 [$\text{M}-\text{H}_2\text{O}$]⁺ all also indicated the presence of a hydroxyl. The signal at δ_{H} 1.40 (3H, s, H-16) indicated a methyl attached to a tertiary carbon (C-6) linked to oxygen. So the other oxygen-bearing carbon (C-7) must be at the bridgehead of sarsolilide A.

In order to confirm the stereochemistry of **1**, an X-ray analysis was carried out. Figure 1 is a stereoview of the structure (less hydrogen atoms). In the crystal structure, the molecules are linked by intermolecular O—H...O hydrogen bonds to form zigzag chains running parallel to the *b* axis.

EXPERIMENTAL

INSTRUMENTATION.— ^1H nmr and 2D-COSY were recorded on Bruker MSL-400 MHz and ^{13}C

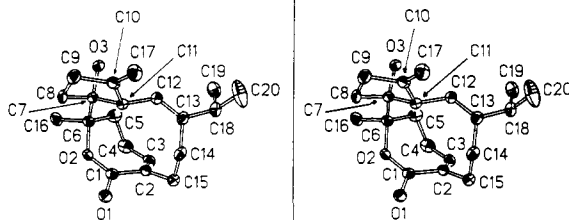


FIGURE 1. Stereoview of the structure of sarsolilide A [1]. The thermal ellipsoids are drawn at the 30% probability level.

nmr on Jeol Fx-90Q instruments. A Vg analytical ZAB mass spectrometer, a Nicolet 5Dx-FTIR spectrometer, and a Shimadzu UV-240 spectrometer were used. Optical rotation was measured with a Perkin-Elmer 241 polarimeter.

ANIMAL MATERIAL.—The fresh soft coral *S. solidun* was collected by hand from the South China Sea near the Xisha Islands in July 1987. The animals were dried under the sun and brought back to our laboratory. A voucher specimen is deposited in the Research Center of Organic Natural Products, Zhongshan University, Guangzhou, China.

EXTRACTION AND ISOLATION.—The specimens (1 kg) were extracted thrice with EtOH. The extracts were combined and chromatographed over a column of Si gel, eluting stepwise with petroleum ether containing increasing concentrations of EtOAc. The fractions eluted with 10% EtOAc gave sarsolilide A.

Sarsolilide A [1].—White needles, mp 240.2–242.0°, $[\alpha]_D^{25} +142.2^\circ$ (EtOH, $c=0.026$); ir (KBr) 3435, 2950, 1669, 1640, 1386, 1376, 1272, 1250, 1178, 1084, 1031 cm^{-1} ; uv (EtOH) λ max 209 nm ($\log \epsilon=3.68$) and 221 nm ($\log \epsilon=3.81$); hreims m/z (rel. int.) $[M]^+$ 316.2034 (calcd 316.2038), 298.1926(11), 232.1451(23), 187.1480(26), 152.0837(53), 134.1084(92), 121.1013(87), 107.0862(60), 91.0544(100).

X-ray structural analysis.—A colorless transparent single crystal with dimensions $0.48 \times 0.40 \times 0.32$ mm of the title compound obtained by recrystallization from an EtOAc solution was selected. Diffraction measurements were made at 20° on a Nicolet R3m/V diffractometer using monochromatized $\text{MoK}\alpha$ radiation, $\lambda=0.71069$ Å. Determination of the crystal class, orientation matrix, and accurate unit-cell parameters was performed according to established procedures (5).

Crystal data¹.— $\text{C}_{20}\text{H}_{28}\text{O}_3$, MW=316.44, orthorhombic, space group $P2_12_12_1$, $a=10.945(3)$, $b=1.533(2)$, $c=14.051(3)$ Å, $V=1773.6(8)$ Å³, D_m (floatation in $\text{CCl}_4/\text{cyclohexane}$)= $1/189$ $\text{g}\cdot\text{cm}^{-3}$, $D_c=1.85$ $\text{g}\cdot\text{cm}^{-3}$, $Z=4$, $F(000)=688$, $\mu=0.72$ cm^{-1} .

The crystal remained stable throughout the diffraction experiment, as two standard reflections monitored every 125 data measurements showed only random fluctuations within $\pm 0.5\%$ of their mean values. Data were recorded to 2θ max= 45° , yielding 1458 unique reflections. The raw intensities were processed with the learnt-profile procedure (6), and absorption corrections were applied by fitting a pseudo ellipsoid to the φ -scan data of ten selected strong reflections over a range of 2θ values (7,8).

The structure was solved by direct phase determination, and all nonhydrogen atoms were subjected to anisotropic refinement. All H atoms, except that of the hydroxy group, were generated geometrically (C–H bond length fixed at 0.96 Å) and assigned isotropic thermal parameters. The hydroxy H atom was located from a difference Fourier map and included in structure-factor calculations with assigned isotropic temperature factors.

Computations were performed on a DEC Micro VAX-II computer with the SHELXTL-PLUS program package (9). Analytic expressions of atomic scattering factors were employed, and anomalous dispersion corrections were incorporated (10). Blocked cascade least-squares refinement (11) converged to $R=0.046$ and wR (on $|F_o|^2$)= 0.065 with $w=[\sigma^2(F_o)+0.001|F_o|^2]^{-1}$, and $S=1.637$ for 208 variables and 1230 observed $[|F_o|>6\sigma(F_o)]$ reflections.

The final atomic coordinates are listed in Table 2. Hydrogen coordinates, anisotropic thermal parameters and structure factors are available as supplementary material upon request from the authors. The absolute configuration of **1** was not determined.

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¹ Atomic coordinates for this structure have been deposited at the Cambridge Crystallographic Data Centre and can be obtained on request from Dr. Olga Kennard, University Chemical Laboratory, 12 Union Road, Cambridge CB2 1EZ, UK.

TABLE 2. Atomic Coordinates ($\times 10^4$) and Equivalent Isotropic Temperature Factors* ($\text{\AA}^2 \times 10^3$) for Sarsolilide A [1].

Atom	x	y	z	U(eq)
O-1	429(3)	1288(3)	5984(2)	47(1)
O-2	174(3)	3099(3)	6366(2)	38(1)
O-3	1528(3)	4964(3)	8226(2)	47(1)
C-1	854(5)	2271(4)	5988(3)	38(2)
C-2	2066(4)	2525(4)	5538(3)	39(2)
C-3	2281(5)	3517(4)	5105(3)	45(2)
C-4	1535(6)	4563(4)	5183(3)	56(2)
C-5	1498(5)	4926(4)	6236(3)	51(2)
C-6	538(5)	4202(4)	6824(3)	41(2)
C-7	1003(4)	3917(4)	7839(3)	36(1)
C-8	18(4)	3454(4)	8509(3)	46(2)
C-9	691(5)	2993(5)	9363(4)	53(2)
C-10	1955(5)	2635(4)	8980(3)	44(2)
C-11	2004(4)	2964(4)	7930(3)	37(2)
C-12	3251(4)	3221(4)	7591(3)	41(2)
C-13	3955(5)	2562(5)	7023(3)	45(2)
C-14	3487(5)	1414(4)	6610(3)	48(2)
C-15	2972(5)	1567(5)	5588(3)	50(2)
C-16	-655(5)	4850(5)	6842(4)	55(2)
C-17	2776(5)	2096(5)	9451(4)	62(2)
C-18	5215(5)	2868(5)	6742(4)	60(2)
C-19	5434(6)	4155(6)	6572(5)	77(2)
C-20	6168(7)	2367(9)	7411(7)	126(4)

*Equivalent isotropic temperature factor $U(\text{eq})$ defined as $1/3$ of the trace of the orthogonalized U tensor.

LITERATURE CITED

1. D. Chen, "Applications of ^{13}C -NMR Spectra in Chinese Herbal Medical Chemistry," Renmin Health Publishing House Press, Beijing, 1991, pp. 60-72.
2. S. Hong, "Applications of Spectroscopic Methods in Organic Chemistry," Science Press, Beijing, 1981, p. 383.
3. S. Hong, "Applications of Spectroscopic Methods in Organic Chemistry," Science Press, Beijing, 1981, p. 33.
4. X. Liang, "The Interpretation and Application of High-Resolution NMR," Science Press, Beijing, 1982, p. 88.
5. R.A. Sparks, in: "Crystallographic Computing Techniques." Ed. by F.R. Ahmed, Munksgaard, Copenhagen, 1976, p. 452.
6. R. Diamond, *Acta Crystallogr.* **A25**, 43 (1969).
7. G. Kopfmann and R. Huber, *Acta Crystallogr.* **A24**, 348 (1968).
8. A.C.T. North, D.C. Phillips, and F.S. Mathews, *Acta Crystallogr.* **A24**, 351 (1968).
9. G.M. Sheldrick, in "Crystallographic Computing 3: Data Collection, Structure Determination, Proteins and Databases." Ed. by G.M. Sheldrick, C. Kruger, and R. Goddard, Oxford University Press, New York, 1985, p. 175.
10. "International Tables for X-ray Crystallography, Vol. IV," Kynoch Press, Birmingham, 1974, pp. 55, 99, 149.
11. J.M. Schilling, in: "Crystallographic Computing." Ed. by F.R. Ahmed, Munksgaard, Copenhagen, 1970, p. 201.

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