Tetrahedron Letters,Vol.30,No.25,pp 3331-3332,1989 0040-4039/89 $3.00 + .00
Printed in Great Britain Maxwell Pergamon Macmillan plc

A NEW EUNICELLIN-BASED DITERPENE FROM AN OKINAWAN SOFT CORAL, *CLADIELLA* SP.

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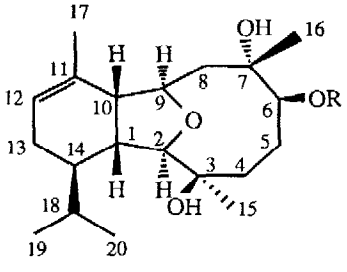
Summary: A new eunicellin-based diterpene has been isolated from a *Cladiella* sp. (Octocorallia, Alcyonacea). The structure and relative stereochemistry of the metabolite (**1**) was determined on the basis of spectroscopic and chemical evidence, and confirmed by a single-crystal X-ray structure determination.

Among the many metabolites produced by soft corals, diterpenoids possessing the eunicellan skeleton are relatively uncommon.[1] In the course of our continuing study[2] of Japanese soft corals, we isolated a new eunicellin-type diterpenoid (**1**) from a *Cladiella* sp.[3] collected at Ishigaki Island, Okinawa, and here report the structure determination of the metabolite.

The dichloromethane extract of the freeze dried soft coral was chromatographed using a combination of medium-pressure LC and preparative TLC on Si gel to give the pure metabolite **1** (0.014% dry weight). The metabolite **1** crystallized as colorless prisms from CH_2Cl_2-hexane, mp 205.5-206.0 °C, $[\alpha]_D$ -16.1° (c 0.75, $CHCl_3$). Microanalysis indicated a molecular formula of $C_{20}H_{34}O_4$ (Found: C, 70.88; H, 10.38. Calcd: C, 70.97; H, 10.13%), ie four degrees of unsaturation. The IR spectrum ($CHCl_3$) showed the presence of hydroxyl (ν 3400 cm^{-1}) and ether (ν 1080 cm^{-1}) absorptions. The ^{13}C NMR spectrum[4] showed signals for a trisubstituted double bond (132.2(s), 121.9(d) ppm) and five oxygen-bearing carbons (74.3(s), 74.6(d), 75.7(s), 76.5(d), 86.8(d) ppm). There were no carbonyl resonances; therefore compound **1** was tricyclic. The ^1H NMR spectrum (400 MHz, $CDCl_3$) showed signals for five methyl groups: an isopropyl group (δ 0.87, 3H, d, J=6.6 Hz and δ 0.97, 3H, d, J=6.6 Hz), two methyl groups attached to quarternary oxygen-bearing carbons (δ 1.19, 3H, s and δ 1.36, 3H, s) and an olefinic methyl group (δ 1.67, 3H, br s) on the trisubstituted double bond (δ 5.44, 1H, m). The presence of a cyclic secondary ether and a secondary hydroxyl group was suggested by three methine signals at δ 3.73 (1H, d, J=7.0 Hz), 4.32 (1H, ddd, J=11.0, 3.0, 1.5 Hz) and δ 4.56 (1H, dd, J=7.0, 3.0 Hz), accounting for two of the four oxygens in **1**. The remaining two oxygens were attributed to two tertiary hydroxyl groups, since only one methine proton (δ 4.56) was shifted downfield to δ 5.70 when **1** was acetylated to give the monoacetate **2**, $C_{22}H_{36}O_5$ ($M^{+\cdot}$ 380), $[\alpha]_D$ +16.8° (c 1.13, $CHCl_3$). Decoupling experiments of **1** showed that the two methine protons of the ether moiety (δ 3.73, H-2 and δ 4.32, H-9) were each coupled to one of the methine protons at δ 2.60 (ddd, J=7.0, 6.0, 4.5 Hz, H-1) and 2.29 (br d, J=6 Hz, H-10), respectively. These data suggest that **1** could be assigned a diterpenoid structure with the eunicellin skeleton. However, the relative locations of the functional groups and the stereochemistries of the substituents in **1** could not be defined from the available spectral data. A single

crystal of **1** was therefore subjected to X-ray diffraction analysis.

Crystals of **1** were orthorhombic, space group $P2_12_12_1$ with a=8.256(3), b=33.80(9), c=6.955(2), D_c=1.16 gcm^{-3} and Z=4. The structure was solved using the MULTAN-78 and refined by the block -diagonal least-squares calculations to the final R-value of 7.46%[5] on 2088 reflections. Figure 1 is a perspective drawing of the final X-ray model of **1**, establishing the structure and relative stereochemistry of the molecule shown in **1**. Of interest is the axial isopropyl group in **1**, whereas in eunicellin[6a] and cladiellin[6b] the isopropyl group is equatorial.



1: R=H

2: R=Ac

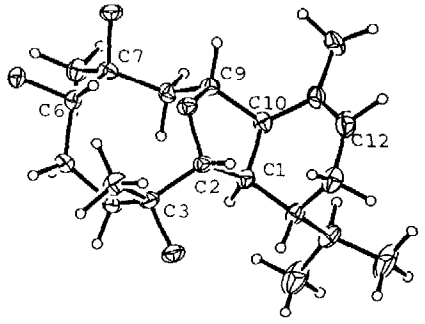


Figure 1. X-ray crystal structure of **1**. Hydogens of hydroxyl groups are not shown.

Although eunicellin-type diterpenes[7] are assumed to be uncommon among soft corals,[8] this novel carbon skeleton has been proposed as a logical biosynthetic intermediate from a cembrane carbon skeleton to the asbestinin diterpenes[9] found in some *Briareum* species of gorgonian corals.

Acknowledgment: We thank Dr. J. C. Coll (James Cook University of North Queensland, Australia) for discussions about this metabolite and for reading this paper ahead of publication.

References and Notes

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3. Tentative classification. Sample number # HS85701.
4. ^{13}C NMR (100 MHz, $CDCl_3$): δ 20.4q, 21.2q, 21.6q, 22.3q, 22.8t, 28.1q, 29.2d, 29.9t, 35.5t, 39.2d, 39.7d, 46.2t, 47.7d, 74.3s, 74.6d, 75.7s, 76.5d, 86.8d, 121.9d, 132.2s.
5. The crystallographic calculations were done using the UNICS III programs: T. Sakurai and K. Kobayashi, Rep. Inst. Phys. & Chem. Res., **55**, 69 (1979). Final crystallographic coordinates have been deposited with the Cambridge Crystallographic Data Center.
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7. So far eunicellan or cladiellan diterpenoids have been isolated from Octocorals of the Orders Alcyonacea,[6a,b,c] and Gorgonacea.[6d,e] Recently Ochi et al and Kusumi et al reported new cladiellan compounds from a *Litophyton* sp. (Family *Nephtheidae*) and *Sinularia flexibilis* (Family *Alcyonaceae*): M. Ochi, K. Futatsugi, H. Kotsuki, M. Ishii and K. Shibata, Chemistry Letters, 2207 (1987); T. Kusumi, H. Uchida, M. Ishituka, H. Yamamoto and H. Kakisawa, ibid., 1077 (1988).
8. No cembranoid diterpenes have been isolated from this coral.
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(Received in Japan 29 March 1989)