

***p*-Iodobenzoate of Jeunicin**

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(Received 29 September 1975; accepted 16 December 1975)

Abstract. $C_{27}H_{33}O_5I$, monoclinic, space group $P2_1$, $a = 8.088$ (1), $b = 25.670$ (3), $c = 6.237$ (1) Å, $\beta = 96.56$ (1)°, $Z = 2$, $M = 564.46$, $D_c = 1.467$, $D_m = 1.454$ g cm⁻³. The compound is the *p*-iodobenzoate derivative of jeunicin, an oxa-bridged cembranolide from the gorgonian *Eunicea mammosa*. The molecular structure and absolute configuration are determined.

Introduction. A new marine cembranolide, jeunicin ($C_{20}H_{30}O_4$; m.p. 139–141°; $[\alpha]_D^{27} + 12.8^\circ$, $c = 0.75$, $CHCl_3$), has been isolated from the gorgonian *Eunicea mammosa* collected at Lime Cay, Jamaica. Similarity of spectral features (IR: 1740 cm⁻¹, lactone; 3460 cm⁻¹, hydroxyl), particularly in the NMR, suggested a very close structural relationship to eunicin (Weinheimer, Middlebrook, Bledsoe, Marsico & Karns, 1968; Hosain, Nicholas & van der Helm, 1968), except for transposition of the ethereal and hydroxyl functions (secondary and tertiary in eunicin; tertiary and secondary in jeunicin, respectively) at positions 12 and 13.

The oxa-bridged cembranolide eunicin has been isolated from the same species of gorgonian collected at Bimini, The Bahamas. Indeed jeunicin was readily oxidized (Bowers, Halsall, Jones & Lemin, 1953) to the expected ketone (m.p. 137–139°; $[\alpha]_D^{27} - 51.7^\circ$, $c = 1$, $CHCl_3$). Reduction (Na, *n*-BuOH) of the α -methylenic unsaturation of the lactone led to one of the epimeric α -methyl γ -lactones (m.p. 175–177°; IR 1745 cm⁻¹). Esterification with the acid chloride in pyridine led to the *p*-iodobenzoate, m.p. 213–215°, recrystallized from a benzene–hexane mixture.

A crystal of the *p*-iodobenzoate with dimensions of 0.48 × 0.10 × 0.05 mm was used for the data collection and the unit-cell determination. The crystal is monoclinic and the data show extinctions for the $0k0$ reflections, $k = 2n + 1$, indicating space group $P2_1$, which is confirmed by the structure determination. The unit-cell dimensions were determined at 27°C from the $+2\theta$ and -2θ values of 30 reflections, distributed through all quadrants of reciprocal space, using $Cu K\alpha_1$ radiation ($\lambda = 1.54051$ Å). The intensities of all 2343 reflections with $2\theta < 50^\circ$ were measured on a Nonius CAD-4 automatic diffractometer using $Mo K\alpha$ radiation ($\lambda = 0.71069$ Å), $\theta - 2\theta$ scans, variable scan speeds and a maximum scan time of 150 s for each reflection. For

2015 reflections the intensity was larger than $1.4 \sigma(I)$. Absorption corrections ($\mu = 12.94$ cm⁻¹) and Lorentz–polarization corrections were applied to the data.

The structure was solved from a Patterson synthesis and subsequent difference Fourier maps. The structure was refined using block-diagonal least-squares techniques (Ahmed, 1966) with anisotropic temperature factors for the non-hydrogen atoms. All hydrogen atoms, with the exception of those on the methylene and methyl groups, were located from a difference Fourier map and included in the structure factor calculations but their positions were not refined. The absolute configuration of the compound was determined by comparing the calculated and observed differences in the intensities of 15 Friedel pairs (Bijvoet, Peerdeman & van Bommel, 1951), using $Cu K\alpha$ radiation. The intensity differences for all 15 reflections are in agreement with the configuration shown in the figures. The Mo intensity data were corrected for the anomalous dispersion of iodine (Patterson, 1963). The least-squares refinement was terminated when all shifts were less than 0.4 of the corresponding standard deviation. The weights of F were determined from the counting statistics (van der Helm, Ealick & Burks, 1975). The final R value is 0.065 for all 2343 data,* based on the final parameters (Table 1). Scattering factors for I, C and O atoms were taken from *International Tables for X-ray Crystallography* (1962), while scattering factors for H atoms were those of Stewart, Davidson & Simpson (1965).

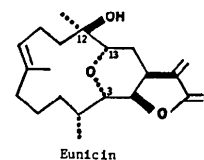
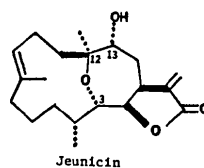
Discussion. An *ORTEP* (Johnson, 1965) drawing of the molecule is shown in Fig. 1. The bond distances and bond angles are shown in Figs. 2 and 3. No unusual values are observed. The C–H distances range from 0.94 to 1.14 Å. There is one short intermolecular distance between the iodine atom and the C(8)=C(9) double bond of a neighboring molecule [$C(8) \cdots I(2-x, y - \frac{1}{2}, 2-z)$: 3.44 and $C(9) \cdots I$: 3.53 Å]. These distances are 0.3–0.4 Å smaller than the sum of the van der Waals radii.

The structure confirms the suspected transposition of the hydroxyl and ether functions in jeunicin relative

* Supported in part by NIH Development Award K4-GM-42572.

* A list of structure factors has been deposited with the British Library Lending Division as Supplementary Publication No. SUP 31588 (13 pp., 1 microfiche). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 13 White Friars, Chester CH1 1NZ, England.

to their location in eunicin. It is significant to note that in jeunicin the absolute configurations at C(1), C(2), C(3) and C(4) are the same, but at C(12) and C(13) opposite to those observed in eunicin (Hossain *et al.*, 1968). The configurations at the latter two sites in eunicin and jeunicin are related in such a way that these compounds could be derived from a common precursor, the 12,13-epoxide, *via* a stereospecific nucleophilic opening of the epoxide ring by the oxygen function at C(3). Attack by the C(3) oxygen at C(12) would generate jeunicin, and at position C(13), eunicin.



Both jeunicin and eunicin are of interest because they are toxic to the ciliate *Tetrahymena pyriformis* (Perkins & Ciereszko, 1970, 1973), and because they display cytotoxicity in the National Cancer Institute's

Table 1. Final positional parameters and anisotropic temperature factors for the iodine, carbon and oxygen atoms. The temperature factors are of the form: $\exp[-(b_{11}h^2 + b_{22}k^2 + b_{33}l^2 + b_{23}kl + b_{13}hl + b_{12}hk)]$. The standard deviations for the last digit are in parentheses.

	$x (\times 10^4)$	$y (\times 10^4)$	$z (\times 10^4)$	$b_{11} (\times 10^3)$	$b_{22} (\times 10^4)$	$b_{33} (\times 10^3)$	$b_{23} (\times 10^3)$	$b_{13} (\times 10^3)$	$b_{12} (\times 10^3)$
I	11358 (1)	0	11150 (1)	20.2 (1)	16.3 (1)	36.3 (2)	-1.8 (2)	-3.9 (2)	-4.0 (1)
C(1)	1203 (10)	-2260 (4)	4954 (14)	10 (1)	14 (2)	20 (3)	0 (1)	6 (3)	1 (1)
C(2)	952 (10)	-2847 (3)	4535 (13)	12 (2)	12 (2)	14 (3)	2 (1)	-5 (3)	-1 (1)
C(3)	2581 (9)	-3130 (3)	4318 (13)	8 (1)	12 (2)	14 (2)	1 (1)	4 (3)	0 (1)
C(4)	2491 (11)	-3682 (4)	3421 (14)	11 (2)	15 (2)	19 (3)	0 (1)	6 (3)	0 (1)
C(5)	1789 (11)	-4078 (4)	4922 (15)	16 (2)	14 (2)	21 (3)	0 (1)	7 (4)	-1 (1)
C(6)	2480 (13)	-4627 (4)	4754 (17)	21 (2)	12 (2)	13 (4)	0 (1)	2 (5)	-2 (1)
C(7)	4161 (12)	-4728 (4)	6182 (18)	20 (2)	10 (2)	44 (4)	-2 (1)	6 (5)	0 (1)
C(8)	5531 (12)	-4363 (4)	5668 (17)	15 (2)	12 (2)	37 (4)	2 (1)	-3 (4)	2 (1)
C(9)	5961 (11)	-3966 (4)	7037 (16)	13 (2)	15 (2)	35 (4)	3 (1)	6 (4)	3 (1)
C(10)	7182 (11)	-3541 (4)	6810 (15)	12 (2)	12 (2)	30 (3)	1 (1)	7 (4)	0 (1)
C(11)	6321 (11)	-3036 (3)	5764 (15)	10 (1)	13 (2)	30 (4)	0 (1)	-1 (4)	-3 (1)
C(12)	4882 (10)	-2809 (3)	6874 (14)	9 (1)	10 (2)	26 (3)	1 (1)	1 (3)	0 (1)
C(13)	4414 (9)	-2262 (3)	5956 (13)	8 (1)	14 (2)	16 (3)	-1 (1)	3 (3)	-2 (1)
C(14)	2720 (10)	-2082 (3)	6455 (14)	12 (2)	12 (2)	22 (3)	0 (1)	3 (3)	0 (1)
C(15)	1054 (10)	-2054 (4)	2686 (15)	11 (2)	14 (2)	26 (3)	1 (1)	5 (4)	3 (1)
C(16)	50 (10)	-2433 (4)	1334 (14)	10 (2)	18 (2)	23 (3)	2 (1)	-1 (4)	1 (1)
C(17)	1692 (13)	-1628 (4)	1878 (17)	20 (2)	15 (2)	33 (4)	2 (1)	8 (5)	3 (1)
C(18)	1686 (14)	-3732 (4)	1086 (15)	29 (3)	16 (2)	16 (3)	-5 (1)	3 (4)	-2 (1)
C(19)	6298 (14)	-4456 (5)	3601 (18)	23 (2)	24 (3)	33 (4)	-3 (2)	13 (5)	4 (1)
C(20)	5264 (11)	-2795 (4)	9354 (13)	14 (2)	20 (2)	10 (3)	1 (1)	-4 (3)	-1 (1)
C(21)	6668 (12)	-1652 (4)	5858 (15)	16 (2)	18 (2)	20 (3)	1 (1)	7 (4)	-2 (1)
C(22)	7717 (10)	-1261 (3)	7184 (15)	13 (2)	5 (1)	30 (3)	1 (1)	8 (4)	-1 (1)
C(23)	9109 (11)	-1048 (4)	6251 (15)	16 (2)	14 (2)	20 (3)	-1 (1)	1 (4)	1 (1)
C(24)	10141 (11)	-692 (4)	7441 (15)	14 (2)	12 (2)	23 (3)	2 (1)	6 (4)	-1 (1)
C(25)	9768 (11)	-533 (3)	9411 (15)	13 (2)	9 (2)	27 (3)	-1 (1)	-5 (4)	0 (1)
C(26)	8398 (11)	-722 (4)	10253 (15)	15 (2)	14 (2)	22 (3)	-1 (1)	3 (4)	-1 (1)
C(27)	7435 (12)	-1090 (4)	9214 (14)	19 (2)	13 (2)	18 (3)	-2 (1)	8 (4)	-2 (1)
O(1)	-169 (7)	-2860 (3)	2527 (10)	10 (1)	17 (1)	27 (2)	2 (1)	-8 (2)	-1 (1)
O(2)	3424 (6)	-3127 (2)	6417 (9)	9 (1)	12 (1)	17 (2)	0 (1)	3 (2)	-1 (1)
O(3)	5605 (7)	-1885 (3)	7039 (9)	13 (1)	17 (1)	21 (2)	0 (1)	8 (2)	-2 (1)
O(4)	-545 (8)	-2389 (3)	-488 (11)	15 (1)	27 (2)	30 (3)	3 (1)	-9 (3)	0 (1)
O(5)	6790 (10)	-1745 (3)	3989 (11)	33 (2)	35 (2)	26 (2)	-4 (1)	18 (4)	-13 (1)

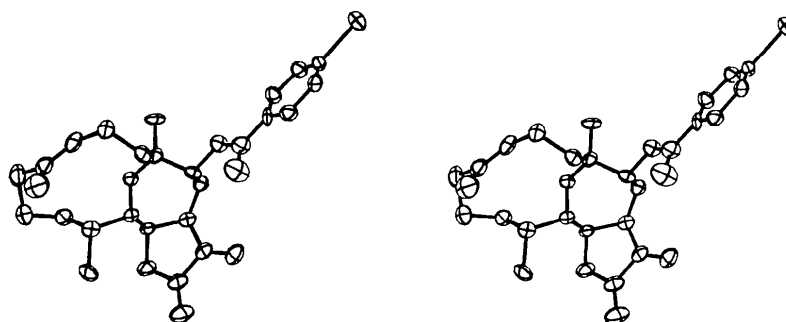


Fig. 1. A stereoscopic ORTEP plot of the iodobenzoate of jeunicin.

