

A NOVEL, C<sub>8</sub> DICHLORODIENOL METABOLITE OF THE RED ALGA PLOCAMIUM CRUCIFERUM

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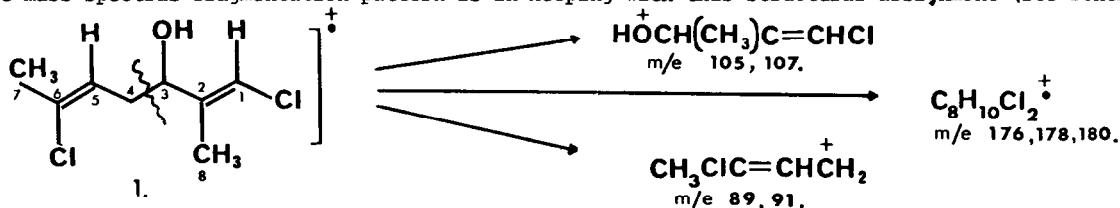
A rich assortment of cyclic and acyclic polyhalogenated monoterpenes have been isolated from several species of the family Plocamiaceae.<sup>1</sup> In complete contrast to these previous observations we now report the isolation and characterisation of an eight carbon halogenated alcohol as the major metabolite from Plocamium cruciferum.

P. cruciferum (Hook and Harv.) was collected subtidally near Kaikoura, N.Z.<sup>2</sup> Chromatography of the methanol extract on "Florisil" gave the unsaturated alcohol (1) (2% of dry weight). The dienol (1) was isolated as a mobile oil ( $[\alpha]_D^{20} = -9.8^\circ$ ,  $c = 0.01$ , CHCl<sub>3</sub>; ir 3400, 1670, 800 cm<sup>-1</sup>; uv (ethanol) end absorption only). Chemical-ionization mass spectrometry (CI/MS)<sup>3a</sup> gave a quasi-molecular ion triplet (9:6:1) as the base peak at 195/197/199 and the molecular formula of C<sub>8</sub>H<sub>12</sub>OCl<sub>2</sub><sup>35</sup> was found by high resolution EI/MS<sup>3b</sup> and confirmed by micro-analysis. The <sup>13</sup>C-NMR spectrum<sup>3c</sup> indicated the presence of two trisubstituted double bonds, which taken in conjunction with the molecular formula required an acyclic skeleton.

Carbon No.	<sup>13</sup> Cδ, ppm	multiplicity <sup>a</sup>	<sup>1</sup> J <sub>CH</sub> (Hz) <sup>b</sup>	<sup>3</sup> J <sub>CH</sub> (Hz) <sup>b</sup>	<sup>13</sup> Cδ, ppm	multiplicity	J (Hz) <sup>b</sup>
1	115.2	d	195.4		6.02	d	1.8
2	139.9	s					
3	73.8	d	147.9	2.8 (C <sub>3</sub> , CH <sub>3</sub> ) 3.1 (C <sub>3</sub> , H <sub>1</sub> )	4.08	d	6.0
4	34.4	t	128.8		2.04	t (overlapping d's)	6.0, 7.0
5	120.8	d	156.3		5.04	dt	7.0, 1.5
6	132.3	s					
7	26.1	q	129.0	4.1 (C <sub>7</sub> , H <sub>5</sub> )	2.13	d	1.5
8	12.3	q	128.4	6.2 (C <sub>8</sub> , H <sub>1</sub> )	1.78	d	1.8
hydroxyl proton					2.52	s	exchanges with D <sub>2</sub> O

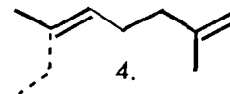
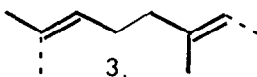
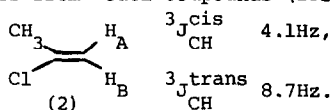
<sup>a</sup>Multiplicity values as determined by SPORD; <sup>b</sup>J's are based on first order analysis, error ±0.2 Hz.

The connectivity of (1) was established by consideration of both the <sup>1</sup>H- and <sup>13</sup>C-NMR data (Table). In addition to the four olefinic carbons there were two methyl, one methylene and one carbinol carbons present. One of the chlorine atoms was connected to a methine vinyl carbon (<sup>1</sup>J<sub>CH</sub> = 195Hz) while the other chlorine atom could only be bonded to a fully substituted vinyl carbon as the remaining <sup>1</sup>J<sub>CH</sub> values were too small for carbons bearing a chloro substituent.<sup>4,5</sup> Specific proton decoupling the <sup>13</sup>C-NMR spectrum allowed a full assignment of proton and carbon relationships. Double irradiation <sup>1</sup>H-NMR experiments established the isolated partial sequences -CH=C(CH<sub>3</sub>)- and -(CH<sub>3</sub>)C=CH-CH<sub>2</sub>-CH(OH)- allowing assignment of the structure of the dienol as (1). The mass spectral fragmentation pattern is in keeping with this structural assignment (see Scheme)



The stereochemistry of each of the trisubstituted olefins was deduced from an analysis of the vicinal  $^{13}\text{C}$ -H coupling constants. In the fully coupled  $^{13}\text{C}$ -NMR spectrum of the dienol the  $\text{C}_8$  methyl quartet was further split into a doublet of doublets by vicinal  $^{13}\text{C}$ -H couplings (6.2Hz, 2.8Hz) between  $\text{C}_8$  and the protons at  $\text{C}_1$  and  $\text{C}_3$ , while the  $\text{C}_3$  carbinol doublet peaks were broad ( $W_{33} 15\text{Hz}$ ). Specific proton decoupling at the  $\text{C}_1$  olefinic proton frequency ( $\delta$  6.02) removed the 6.2Hz  $^3\text{J}_{\text{C}_8\text{H}}$  coupling to  $\text{C}_8$  and only slightly sharpened the  $\text{C}_3$  doublet peaks implying a vicinal coupling to  $\text{C}_3$  of  $<3\text{Hz}$ . As  $^3\text{J}_{\text{C}_8\text{H}}$  is greater than  $^3\text{J}_{\text{C}_3\text{H}}$ , the  $\text{C}_8$  carbon is therefore trans to the olefinic proton while  $\text{C}_3$  is cis, allowing assignment of the 1,2-double bond stereochemistry as (1E).<sup>6,7</sup>

Specific irradiation at the other olefinic proton frequency ( $\delta$  5.40) was unnecessary as  $\text{C}_7$  exhibited long-range coupling to only one proton. ( $^3\text{J}_{\text{C}_7\text{H}} = 4.1\text{Hz}$ ). As it was not possible in this case to extract both cis and trans vicinal coupling constants, this coupling was compared with values from model compounds (for example (2))<sup>6</sup> and assigned as cis.



Substitution of an alkyl substituent for  $\text{H}_B$  would tend to increase the magnitude of  $^3\text{J}_{\text{CH}}^{\text{cis}}$ , while decreasing  $^3\text{J}_{\text{CH}}^{\text{trans}}$ , but with the ratio  $\text{J}_{\text{CH}}^{\text{trans}}/\text{J}_{\text{CH}}^{\text{cis}}$  remaining greater than one.<sup>6</sup> This therefore establishes the observed 4.1Hz coupling as cis and the 5,6-double bond stereochemistry as being (Z).

These configurations (1E, 5Z) were substantiated by  $^1\text{H}$ - and  $^{13}\text{C}$ -NMR chemical shift calculations,<sup>8</sup> and on comparison of the various  $^1\text{J}_{\text{CH}}$  values with model compounds.<sup>5</sup>

There are at least two schemes that could account for the skeleton of the dienol (1) being of monoterpenoid origin - either by loss of two  $\text{C}_1$  units from (3), or by loss of a  $\text{C}_2$  unit from (4). An isoprenoid origin for (1) is also favoured by the co-occurrence with the dienol, as shown by gc/ms, of a variety of halogenated  $\text{C}_{10}$  compounds in the algal extract.

The dichlorodienol was not an effective antibiotic against Bacillus subtilis.

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#### Notes and References

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