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TWO NEW DITERPENES RELATED TO EUNICELLIN FROM A *CLADIELLA* SPECIES (SOFT CORAL)

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Coelenterates of the orders Gorgonaceae and Alcyonaceae have been investigated extensively and have yielded many novel secondary metabolites[1]. The most frequently encountered compounds in both orders are derived from the 14-membered cembrane nucleus and many examples have been reported[1]. Eunicellin (1), isolated from the gorgonian *Eunicella stricta*[2] is the only previously reported example of this unusual ring system. We now report the isolation and structural elucidation of two new members of this group from an Alcyonarian, identified as a *Cladiella* species[3], collected on the Great Barrier Reef near Townsville.

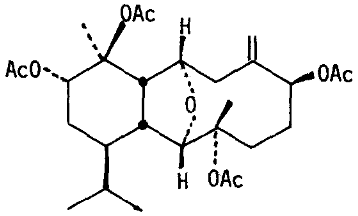
Extraction of the freeze dried soft coral with dichloromethane followed by extensive chromatography on silica gel afforded two new compounds acetoxycladiellin (2) and cladiellin (3). Cladiellin (3), the least polar compound (0.09% dry weight) analysed for $C_{22}H_{34}O_3$. The presence of an ester carbonyl group was indicated by the i.r. spectrum (ν_{max} 1740cm^{-1}). The ^{1}H n.m.r. spectrum showed a broad triplet at δ5.58 (1H) and a methyl singlet at δ1.82 attributable to a $-CH_2-CH=C-CH_3$ group. An exocyclic methylene group was indicated by resonances at δ4.72 (bs) and δ4.76 (bs). The presence of two double bonds was confirmed by ^{13}C n.m.r. which showed resonances at 124.9 (s), 131.5 (d), 146.6 (s) and 110.1 (t) ppm. The ^{1}H n.m.r. spectrum also indicated the presence of an isopropyl group (δ0.96, 3H, d J = 7Hz and δ0.76, 3H, d J = 7Hz), a tertiary methyl group (δ1.50, 3H, s) attached to a carbon bearing an oxygen function and an acetoxyl group (δ2.02, 3H, s). The absence of hydroxyl or a second carbonyl function (i.r. and ^{13}C n.m.r.) suggested that the third oxygen was part of a cyclic ether and the molecule was therefore tricyclic. This was supported by two signals at δ4.05 (1H, dd J = 6Hz, 10Hz) and δ3.80 (1H, bs) in the ^{1}H n.m.r. spectrum. Three signals at 87.1 (s), 91.9 (d) and 80.5 (d) in the ^{13}C n.m.r. spectrum were attributable to a tertiary acetoxyl group and two secondary ether carbons respectively. The resonance at δ4.05 was coupled to signals at δ2.82 (1H, dd J = 8Hz, 10Hz) and δ2.46 (1H, dd J = 6Hz, 14Hz). Both of these were allylic and the size of the coupling in the latter suggested geminal coupling to a proton under the methylene envelope. A partial structure $=C-CH-\overset{O}{C}H-CH_2-C=$ was therefore implied. Combining all these structural features it was probable that cladiellin (3) was related to eunicellin (1) and two structures (3) and (5) were postulated.

Acetoxycladiellin (2), the more polar compound (0.15% dry weight), was very closely related to (3). The formula $C_{24}H_{38}O_5$ was established by high resolution m.s. and ^1H and ^{13}C n.m.r. spectroscopy suggested that the exocyclic methylene group of (3) or (5) was replaced by a $CH_3-\overset{|}{\underset{|}{C}}-OAc$ group. Thus structures (2) or (4) seemed most plausible. The two tertiary methyl groups in (2) appeared as singlets in the ^1H n.m.r. spectrum at $\delta 1.58$ and $\delta 1.42$. The latter was a very broad signal at 25° but at 80° became sharp and appeared at $\delta 1.40$. As the sample was cooled the signal broadened and then sharpened at $\delta 1.32$. Other signals also sharpened slightly with change of temperature. A one proton broad multiplet at $\delta 3.16$ was most affected. This signal corresponded to that occurring at $\delta 2.82$ in cladiellin (3) and was assigned to C5-H in both structures. In (2) the acetoxy group must deshield this proton and thereby affect it during conformational changes in the six membered ring. Structure (2) for acetoxycladiellin was established by a single crystal X-ray analysis which gave relative but not the absolute stereochemistry.

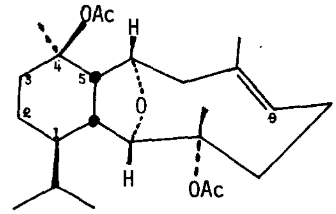
Acetoxycladiellin separated slowly from pentane at -10° as orthorhombic prisms of space group $P2_12_12_1$ with $a = 11.986(3)$ $b = 10.037(3)$ and $c = 20.035(6)$, $\alpha=\beta=\gamma= 90^\circ$ with four molecules per unit cell. The number of measured reflections was 3286 of which 2150 were taken to be observed. The phase problem was solved with a MULTAN[4] programme and the parameters of the heavier atoms were refined anisotropically to an R-value of 9.4% after 13 block-diagonal least squares cycles. The stereo-drawing shown in Figure 1 was obtained by the OR-TEP programme[5].

The X-ray structure for (2) did not distinguish unambiguously between structures (3) and (5) for cladiellin. Treatment of cladiellin (3) with excess *m*-chloroperbenzoic acid gave an epoxy-hydroxy-*m*-chlorobenzoate (6) which on reduction with lithium aluminium hydride gave a tetrol (7) identical with that prepared by treatment of (2) with *m*-chloroperbenzoic acid followed by reduction with lithium aluminium hydride. This confirmed (3) as the structure for cladiellin.

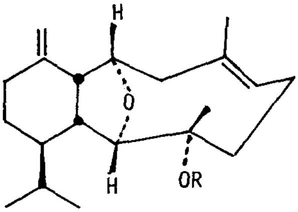
Treatment of (3) with one mole of *m*-chloroperbenzoic acid gave the hydroxy-*m*-chlorobenzoate (8) which on reduction with lithium aluminium hydride gave the triol (9) identical to the product obtained by treatment of (10) (from LAH reduction of (3)) with osmium tetroxide. The ether bridge oxygen would be expected to give anchiameric assistance in the epoxide opening stabilising a carbonium ion at C9 to give a *cis*-diol. This would also imply attack from the least hindered side giving the stereochemistry shown in (9).



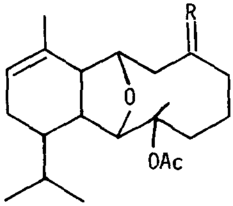
(1)



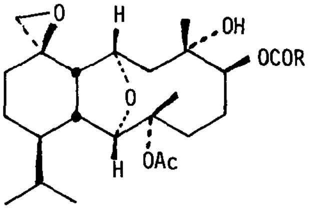
(2)



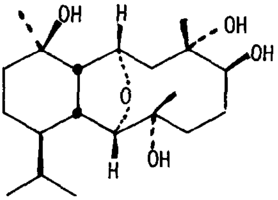
(3) R = Ac (10) R = H



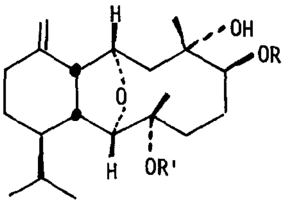
(4) R =Me, OAc (5) R = CH_2

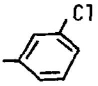


(6) R = m-chlorophenyl



(7)



(8) R = CO–  , R' = Ac

(9) R = R' = H

ACKNOWLEDGEMENTS

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