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HYDROXYDICTYODIAL, A NEW ANTIFEEDANT DITERPENE FROM THE BROWN ALGA *DICTYOTA SPINULOSA*

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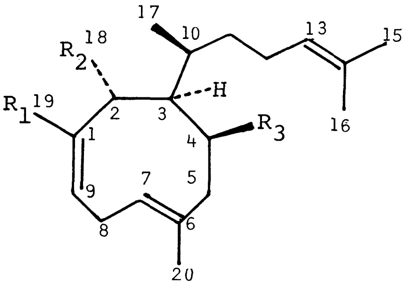
Hydroxydictyodial, an antifeedant diterpene and a key intermediate in the biogenesis of several related diterpenes, has been isolated from the brown alga *Dictyota spinulosa*, and its structure was determined by spectroscopic analysis and chemical transformation.

As a part of chemoecological study of coral reef communities, we have examined antifeedant constituents of *Dictyota spinulosa* and found a new diterpene, hydroxydictyodial (**1**), which occluded in feed induced an avoidance response to the omnivorous fish *Tilapia mossambica*. The alga collected from Kin, Okinawa in April, 1982 was air-dried in the laboratory and extracted by steeping in 95% ethanol. The ethyl acetate-soluble portion of the extract was separated on a silica gel column by eluting with a hexane-ethyl acetate system. Major fractions were repeatedly run on flush chromatography columns to yield a major active compound, hydroxydictyodial (**1**), mp 79-81 °C, $[\alpha]_D$-256° (c 2.41, $CHCl_3$), in a yield of 0.17% of the dry alga. High resolution mass spectrometry established the molecular formula $C_{20}H_{30}O_3$ (obsd 318.2187, calcd 318.2192). Other spectral data were as follows: IR (CCl_4) 3490, 2970, 2920, 2725, 1712, 1690, and 1608 cm^{-1}; λ_{max}(MeOH) 228 nm (ε 5000); ^1H NMR (90 MHz, $CDCl_3$) δ9.70 (1H, s, 18-H), 9.37 (1H, s, 19-H), 7.03 (1H, dd, J=8, 3 Hz, 9-H), 5.31 (1H, brd, J=10.5 Hz, 7-H), 5.00 (1H, brt, J=7 Hz, 13-H), 4.33 (1H, brt, J=3 Hz, 4-H), 1.96 (3H, s, 20-H), 1.65 (3H, s, 15-H), 1.54 (3H, s, 16-H), and 1.11 (3H, d, J=7 Hz, 17-H); ^{13}C NMR ($CDCl_3$) δ203.9 (d, C-18), 194.4 (d, C-19), 157.9 (d, C-9), 148.3 (s, C-1), 138.3 (s, C-6), 131.3 (s, C-14), 124.8 (d, C-7), 124.4 (d, C-13), 73.7 (d, C-4), 52.1 (d, C-2), 50.6 (d, C-3), 48.0 (t, C-5), 39.6 (t, C-11), 33.3 (d, C-10), 29.6 (t, C-8), 25.8 (t, C-12), 25.6 (q, C-15), 20.2 (q, C-20), and 17.7 (2q, C-16, 17).

Comparison of these data with those of dictyodial (**2**)1) and hydroxy acetyldictyolal2) or fukurinolal (**3**)3) indicated the compound to be 4-hydroxydictyodial (**1**). In particular, the ^{13}C NMR signals, except for those of the C-2 and C-18, were in good agreement with those of **3**. As advanced by Matsumoto et al.2) a low-field shift of the C-20 signal relative to that (δ17.1) of **2** can be taken as an evidence for the β-orientation of the C-4 hydroxyl group which, in a preferred conformation of the nine-membered ring, exerts deshielding effect on the C-20. The structure of **1** was confirmed by its transformation to known dictyotriol (**4**) and hydroxydictyolactone (**5**). Thus, treatment of **1** with $LiAlH_4$ in THF afforded **4**, mp 150-152.5 °C (lit.3) mp 151-154 °C), $[\alpha]_D$ -73° (c 0.195, $CHCl_3$). After

Ochi et al., the triol 4 was then treated with Fétizon's reagent[4] to give two lactonic products[5] in 49 and 15% yields. The major product, $[\alpha]_D$ -153° (c 2.01, $CHCl_3$); λ_{max} (MeOH) 206 (ε 10000) and 225 (sh) nm (ε 6500), showed identical ^1H and ^{13}C NMR signals with those reported for the lactone 5.[3]

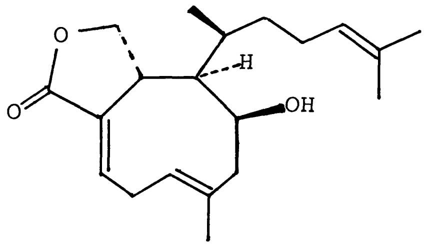


1, $R_1=R_2=CHO$, $R_3=OH$

2, $R_1=R_2=CHO$, $R_3=H$

3, $R_1=CHO$, $R_2=CH_2OAc$, $R_3=OH$

4, $R_1=R_2=CH_2OH$, $R_3=OH$



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Compound 1 was proposed by Ochi et al.[3] as a precursor in the biogenesis of fukurinal, a related bicyclic diterpene. Another related diterpene, dictyodiacetal isolated by Matsumoto et al.[2] from *D. dichotoma* was suggested to be an artifact derived from the acetate of 1 which has not yet been isolated. Furthermore, 1 is perhaps involved as an intermediate in the biogenesis of acetoxycrenulatin,[6] a diterpene of the same family.

In the feeding tests with *T. mossambica*, feed containing 1% of 1 was avoided, while that containing the same level of 2 was consumed, suggesting that 1 is more effective than 2 in deterring herbivolous animals in the sea. Compound 1 also showed antibiotic activity against *S. aureus* and *B. subtilis*.

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References

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3) M. Ochi, N. Masui, H. Kotsuki, I. Miura, and T. Tokoroyama, Chem. Lett., 1982, 1927.

4) V. Balogh, M. Fétizon, and M. Golfier, J. Org. Chem., 36, 1339 (1971).

5) The Minor compound, $[\alpha]_D$ -150° (c 0.45, $CHCl_3$), is believed to be an isomer of 5 with the lactonic carbonyl at the C-18 as it showed only an end absorption in the UV spectrum.

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