

TWO NEW BICYCLIC DITERPENOIDS FROM THE BROWN ALGA *GLOSSOPHORA KUNTII*

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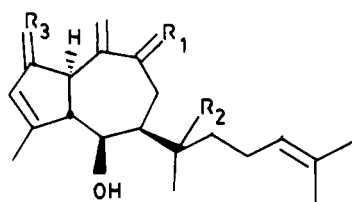
Bicyclic diterpenoids, principally with a perhydroazulene skeleton, are frequently isolated from brown algae (Dictyotaceae) (1). Since Fenical's structure determination of the monohydroxylated diterpenoid pachydictyol A [**1**] (1,2), other related compounds, like dictyol B [**2**], dictyol D [**3**], and dictyol E [**4**] (3-5) have been isolated. We wish to report the isolation and identification of two new diterpenoids from the brown alga *Glossophora kuntii* (C. Agardh) J. Agardh (Dictyotaceae). Along with dictyotriol [**5**] (6) and dictyotriol A diacetate [**6**] (7), our compounds are the only examples of trihydroxylated perhydroazulene derivatives.

RESULTS AND DISCUSSION

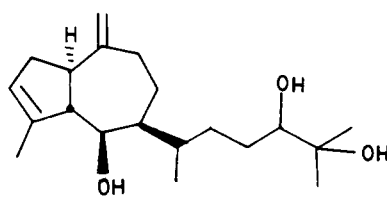
Purification of an extract of *G. kuntii*

as described in the Experimental section yielded two pure substances.

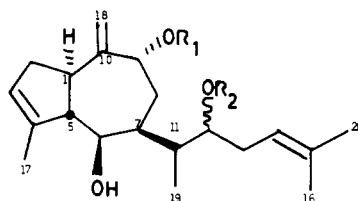
The less polar compound [**7**] was obtained as an optically active oil [$[\alpha]^{25}_D = +7.8^\circ$ (c 0.017, CHCl_3). Its ms was consistent with a molecular formula of $\text{C}_{22}\text{H}_{34}\text{O}_4$. Its ir spectrum showed the presence of both hydroxyl (3600 and 3470 cm^{-1}) and acetate groups (1730 cm^{-1}). The ^{13}C -nmr spectrum contained resonances at δ 110.23 (t), 119.87 (d), 123.64 (d), 134.28 (s), 144.88 (s), 154.34 (s), and 172.17 (s), values corresponding to a carbonyl group and three double bonds. Because the molecular formula of **7** requires six unsaturations, we could conclude that it must be bicyclic. The ^1H -nmr spectrum of **7** showed a methyl resonance a δ 2.02 ppm, attributed to an acetyl group and



- 1** $R_1 = \begin{matrix} \text{H} \\ \diagdown \\ \text{C} \\ \diagup \\ \text{H} \end{matrix}$, $R_2 = \text{H}$, $R_3 = \begin{matrix} \text{H} \\ \diagdown \\ \text{C} \\ \diagup \\ \text{H} \end{matrix}$
2 $R_1 = \begin{matrix} \text{OH} \\ \diagdown \\ \text{C} \\ \diagup \\ \text{H} \end{matrix}$, $R_2 = \text{H}$, $R_3 = \begin{matrix} \text{H} \\ \diagdown \\ \text{C} \\ \diagup \\ \text{H} \end{matrix}$
3 $R_1 = \begin{matrix} \text{H} \\ \diagdown \\ \text{C} \\ \diagup \\ \text{H} \end{matrix}$, $R_2 = \text{H}$, $R_3 = \begin{matrix} \text{OH} \\ \diagdown \\ \text{C} \\ \diagup \\ \text{H} \end{matrix}$
4 $R_1 = R_3 = \begin{matrix} \text{H} \\ \diagdown \\ \text{C} \\ \diagup \\ \text{H} \end{matrix}$, $R_2 = \text{OH}$



5



- 6** $R_1 = R_2 = \text{Ac}$
7 $R_1 = \text{H}$, $R_2 = \text{Ac}$
8 $R_1 = R_2 = \text{H}$

methyl resonances at δ 1.58, 1.65, and 1.78 ppm (5) and at 0.99 ppm (d, $J=6.7$ Hz). The rest of the ^1H -nmr spectrum suggested that the monoacetate **7** had the same carbon skeleton as pachydictyol A since the $\Delta^{3,4}$, $\Delta^{10,18}$, $\Delta^{14,15}$, and C-6 hydroxy functionalities were intact (2).

The more polar compound **8** was isolated as an optically active non-crystalline solid [α] $^{25}_{\text{D}}=+24.9$ (c 0.47, CHCl_3). Its ir spectrum showed only the presence of hydroxyl groups (3600 and 3500 cm^{-1}). The ^1H -nmr spectrum showed the same signals present in **7**, except H-12, which was shifted from δ 4.85 ppm to δ 3.43 ppm in **8**. These data, together with the molecular ion at m/z 362, indicated that **7** is the C-12 monoacetate of **8**. Indeed, alkaline hydrolysis of **7** with $\text{K}_2\text{CO}_3/\text{MeOH}$ yielded a compound identical with **8**.

Recently Andersen reported a dictyotriol A diacetate [**6**] isolated from the brown alga *Dictyota binghamiae* (7). This compound differed from the pachydictyol-related compounds in its α configuration at C-9. A comparison of the ^1H -nmr spectrum of dictyotriol A diacetate with that of our compounds (Table 1) shows that ours are dictyotriol A C-12 monoacetate and dictyotriol A. In fact,

when dictyotriol A [**8**] was treated with $\text{Ac}_2\text{O}/\text{pyridine}$ at room temperature, we obtained a compound identical with dictyotriol diacetate [**6**].

EXPERIMENTAL

Optical rotations were determined for solutions in CHCl_3 with a Perkin-Elmer Model 237 and Model 681 spectrophotometer. ^1H -nmr spectra were recorded on Varian T-60 and Bruker WP-200 SY instruments; chemical shifts are reported relative to TMS ($\delta=0$), and coupling constants are given in Hertz. ^{13}C -nmr spectra were obtained on a Bruker Model WP-200 SY and chemical shifts are reported relative to TMS ($\delta=0$). Mass spectra were obtained on a VG micromass ZAB 2F. Column, dry-column, and low pressure column chromatography were performed on Si gel, all Merck products. The tlc plates were developed by spraying with 6 N H_2SO_4 and heating. All solvents were purified by standard techniques.

The alga *G. kuntii* was collected in November 1983, at Horcones Bay (V Región, Chile). A voucher specimen is deposited in the Chilean Natural History Museum under the number SGO-100180 Leg. M.E. Ramírez. The air-dried seaweed (wet wt. 5 kg) was extracted with Me_2CO and the condensed extract (wet wt. 300 g) chromatographed over Si gel (open column) using solvents of increasing polarity from *n*-hexane to EtOAc.

Dictyotriol A monoacetate was isolated from the *n*-hexane (70:30) fraction. The final purification was accomplished by preparative tlc to yield 125 mg of compound. The more polar fractions were treated with $\text{MeOH-H}_2\text{O}$ (8:2) to precipitate

TABLE 1. ^1H -nmr Data for **6**, **7**, and **8** (200 MHz, CDCl_3)

Carbon	Compounds		
	Dictyotriol A diacetate [6]	Dictyotriol A monoacetate [7]	Dictyotriol A [8]
1	2.79 (q, $J=10$ Hz)	2.85 (q, $J=9.7$ Hz)	2.94 (q, $J=10$ Hz)
3	5.34 (br, s)	5.29 (br, s)	5.29 (br, s)
5	2.33 (m)	2.30 (m)	2.30 (m)
6	3.87 (dd, $J=3$ & 8 Hz)	3.82 (dd, $J=2$ & 7.7 Hz)	3.81 (dd, $J=2$ & 7.7 Hz)
9	5.59 (dd, $J=6$ & 2 Hz)	4.43 (dd, $J=5$ & 2 Hz)	4.43 (dd, $J=5$ & 2 Hz)
12	4.92 (m)	4.85 (m)	3.43 (m)
14	5.10 (t, $J=7$ Hz)	5.06 (t, $J=6.5$ Hz)	5.16 (t, $J=6.5$ Hz)
16	1.64 (s)	1.58 (s)	1.59 (s)
17	1.82 (d, $J=1$ Hz)	1.78 (d, $J=1$ Hz)	1.74 (d, $J=1$ Hz)
18	5.10 (s)	4.89 (s)	4.88 (s)
	5.03 (s)	4.94 (s)	4.93 (s)
19	0.94 (d, $J=7$ Hz)	0.99 (d, $J=7$ Hz)	0.97 (d, $J=7$ Hz)
20	1.70 (s)	1.65 (s)	1.69 (s)
OAc	2.06 (s, 6H)	2.02 (s)	—

tate the chlorophylls. Dictyotriol A was purified through an open Si gel column using *n*-hexane-EtOAc (40:60) to yield 60 mg of compound.

DICTYOTRIOL A MONOACETATE [7].—A viscous and colorless oil $[\alpha]^{25}_D = +7.8^\circ$ (*c*, 0.017, CHCl₃); ir CHCl₃ ν max 3600, 3470, 3000, 2920, 1730, 1640, 1220, 920 cm⁻¹; ¹H nmr see Table 1; ¹³C nmr (CDCl₃) five methyl groups (12.44, 15.79, 17.92, 21.29, 25.78), four methylene groups (27.66, 29.93, 33.76, 110.23), nine methine groups (35.87, 37.15, 41.40, 59.62, 74.27, 74.32, 76.57, 119.87, 123.64), and four quaternary carbon atoms (134.28, 141.88, 154.34, 172.17); ms (15 ev) *m/z* 362 (M⁺), 302 (M⁺-HOAc) 31, 284 (M⁺-HOAc-H₂O) 39, 215 (M⁺-HOAc-H₂O-C₅H₉) 51, 157 (M⁺-2H₂O-C₈H₁₅OAc) 100%.

DICTYOTRIOL A [8].—Amorphous solid, $[\alpha]^{25}_D = +24.9$ (*c*, 0.47, CHCl₃); ¹H nmr see Table 1; ¹³C nmr (CDCl₃) δ 14.9 (q), 15.8 (q), 18.2 (q), 26.1 (q), 29.1 (t), 33.6 (t), 34.2 (t), 34.9 (d), 41.0 (d), 42.0 (d), 61.2 (d), 75.5 (d), 76.9 (d), 77.4 (d), 11.3 (t), 120.7 (d), 124.1 (d), 135.7 (s), 141.4 (s), 154.4 (s), ms (70 ev) *m/z* M⁺ undetected, 302 (M⁺-H₂O) 17, 284 (M⁺-2H₂O) 1.5, 233 (M⁺-H₂O-C₅H₉) 23, 215 (M⁺-2H₂O-C₅H₉) 32, 197 (M⁺-3H₂O-C₅H₉) 14, 175 (M⁺-H₂O-side chain) 18, 157 (M⁺-2H₂O-side chain) 100%.

ALKALINE HYDROLYSIS OF DICTYOTRIOL A MONOACETATE [7].—Dictyotriol A monoacetate [7] (100 mg, 0.27 mmol) as dissolved in 20 ml of Me₂CO. The solution was then cooled to 0°, 500 mg of K₂CO₃ as added, and the mixture was stirred for 5 h. The mixture was filtered, and the solvent was evaporated. The product was purified with a short Si gel column (hexane-EtOAc, 10:90) to yield 77.7 mg (0.24 mmol) of dictyotriol A [8].

ACETYLATION OF THE DICTYOTRIOL A [8].—A solution of 50 mg (0.156 mmol) of dic-

tyotriol A in Ac₂O (0.5 ml) and pyridine (0.5 ml) was allowed to stand at room temperature overnight. The solvents were evaporated under high vacuum, and the residue was dissolved in Et₂O and chromatographed over Si gel using a short column (hexane-EtOAc, 80:20), to obtain dictyotriol A diacetate [6] 56.7 mg (0.14 mmol).

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LITERATURE CITED

1. D.R. Hirschfeld, W. Fenical, G.H.Y. Lin, R.M. Wing, P. Radlick, and J.J. Sims, *J. Am. Chem. Soc.*, **95**, 4049 (1973).
2. H.H. Sun and W. Fenical, *Phytochemistry*, **18**, 340 (1979).
3. E. Fattorusso, S. Magno, L. Mayol, C. Santacroce, D. Sica, V. Amico, G. Oriente, M. Piatelli, and C. Tringalli, *Chem. Commun.*, 575 (1976).
4. B. Danise, L. Minale, R. Riccio, V. Amico, G. Oriente, M. Piatelli, C. Tringalli, E. Fattorusso, S. Magno, and L. Mayol, *Experientia*, **33**, 413 (1977).
5. V. Amico, G. Oriente, M. Piatelli, and C. Tringalli, *Phytochemistry*, **18**, 1895 (1979).
6. N. Enoki, R. Ishida, S. Urano, M. Ochi, T. Tokoroyama, and T. Matsumoto, *Chem. Lett.*, 1837 (1982).
7. C. Pathirana and R. Andersen, *Can. J. Chem.*, **62**, 1666 (1984).

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