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ISOLATION AND STRUCTURE OF TWO NEW AMINO ACIDS, PALYTHINOL AND PALYTHENE, FROM THE ZOANTHID PALYTHOA TUBERCULOSA

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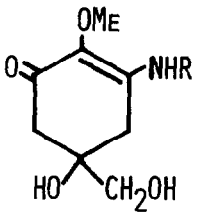
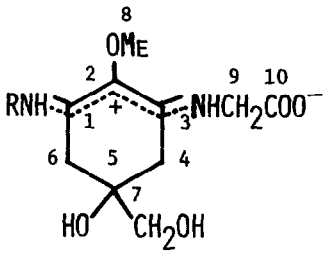
In the course of our studies on the constituents of the zoanthid Palythoa tuberculosa, we have isolated some water soluble compounds with a strong absorption maximum at 310-360 nm, and have already reported the structure of two of these compounds, mycosporine-Gly[1] (λ_{max} 310 nm; structure 1) and palythine[2] (λ_{max} 320 nm; structure 2). On the other hand, it is well known that the compounds with an absorption maximum at 310-340 nm are present in many marine plants and animals[3], however there are few reports on the structure and the role in vivo. Recently, Tsujino et al. have isolated a compound with a absorption maximum at 320 nm from red alga Chondrus yendoi[4]. Interestingly, it has the same structure as palythine (2) from Palythoa tuberculosa. By the further investigations on the UV absorbing compounds from Palythoa tuberculosa, two new compounds with an absorption maximum at 332 and 360 nm have now been assigned structure 3 and 4, and named palythinol and palythene, respectively.

An oily material containing palythinol was obtained by repeated chromatography of aq. EtOH extracts of Palythoa tuberculosa on TSK G-3000S (polystyrene gel; eluent: H_2O) and Dowex 50W (H^+ form; eluent: 0.5N HCl). Then, purification of this material by preparative TLC on silica gel gave compound 3 as yellow crystals[5]; m.p. 154-156 C (dec.); $[\alpha]_D$ -51.9° (c 1.3 in H_2O); $C_{13}H_{22}N_2O_6 \cdot \frac{1}{2}C_2H_5OH$[6]; UV ($H_2O$) λ_{max} 332 nm (ε 4.35X10^4); PMR (D_2O) 1.26 (3H, d, J=5Hz), 2.82 (2H, ABq, J=17Hz), 2.94 (2H, ABq, J=17Hz), 3.46-3.52 (2H, m), 3.62 (2H, s), 3.66 (3H, s), 4.06 (1H, m); CMR (Table-1); IR (KBr) 3340, 3270, 1622, 1540, 1385, 1250, 1130, 1080, 1045 cm^{-1}. It was easily deduced from the above spectral data that palythinol had the same carbon skeleton as palythine (2)[2], and was also supported by the following reaction. On treatment of palythinol



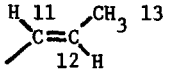
1. R=CH_2COOH

6. R=$CH(CH_3)CH_2OH$ (11 13 12)

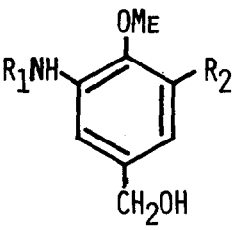


2. R=H

3. R=$CH(CH_3)CH_2OH$ (11 13 12)

4. R=  (H 11 CH_3 13; 12 H)

8. R=$CH_2CH_2CH_3$ (11 12 13)



5. R_1=$CH(CH_3)CH_2OH$, R_2=$NHCH_2COOCH_3$

7. R_1=$CH(CH_3)CH_2OH$, R_2=$NHCH_2COOH$

with diazomethane in ether-MeOH, it was easily aromatized by dehydration, like palythine[2], to give a methyl ester (5)[5]; PMR ($CDCl_3$) 1.27 (3H, d, J=6Hz), 3.02 (1H, dd, J=8, 13Hz), 3.24 (1H, dd, J=4, 13Hz), 3.74, 3.77 (3H each, s), 3.94 (2H, d, J=6Hz; became singlet by the addition of D_2O), 4.01 (1H, m), 4.51 (2H, s), 6.00, 6.17 (1H each, d, J=2Hz); IR ($CHCl_3$) 1741, 1601 cm^{-1}; MS m/e 298 (M^+, $C_{14}H_{22}N_2O_5$). Further, by the nmr spectra of compound 3 and 5, the presence of a group, $=NCH(CH_3)CH_2OH$, in palythinol was indicated. Thus, these results led to structure 3 for palythinol. Further evidence was obtained by the following reactions.

When palythinol was treated with conc. NH_4OH at room temperature overnight, it afforded compound 1, 6[7], 7[8], 2-aminopropanol[9] and glycine. Formation of these compounds indicates that palythinol is a vinylog of amidine and has a 2-aminopropanol moiety. From these results, the structure of palythinol was established as shown in 3.

On the other hand, palythene was eluted from TSK G-3000S with 10% aq. EtOH after the elution of mycosporine-Gly, palythine and palythinol with water. Then, purification of the resulting oily material by preparative TLC on silica gel provided compound 4 as yellow crystals[5]; m.p. 145-146 (dec.); $[\alpha]_D$ -30.1° (c 0.8 in H_2O); $C_{13}H_{20}N_2O_5.H_2O$; UV (H_2O) λ_{max} 360 nm (ε 5.00X10^4); PMR (D_2O) 1.88 (3H, dd, J=2, 6Hz), 2.88 (2H, ABq, J=17Hz), 2.96 (2H, ABq, J=17Hz), 3.66 (2H, s), 3.71 (3H, s), 4.11 (2H, s), 5.75 (1H, dq, J=6, 13Hz), 6.58 (1H, br. d, J=13Hz); CMR (Table-1); IR (KBr) 3400, 3200, 1620, 1550, 1370, 1305, 1275, 1115, 1070, 1045, 965 cm^{-1}.

TABLE-1 ^{13}C Chemical Shifts[a] (δ in ppm; D_2O) of Compound 1[1], 2[2], 3, 4 and 8

Carbon Number	1	2	3	4	5	6	7	8	9	10
1	187.2	130.4	159.7	33.8	72.9	45.4	68.4	60.2	43.7	174.5
2	162.5[b]	125.4	160.9[b]	34.2	72.0	36.6	68.2	59.7	47.5	177.5
3	160.9[b]	126.1	160.4[b]	33.6	71.9	33.9	68.2	59.9	47.4	175.9
		C-11	50.7 (t)[c]	C-12	67.4 (d)[c]	C-13	20.2 (q)[c]			
4	161.5[b]	126.4	154.2[b]	33.8	71.8	33.8	68.4	60.3	47.6	175.4
		C-11	124.5 (d)[c]	C-12	117.9 (d)[c]	C-13	15.2 (q)[c]			
8	160.8[b]	125.8	159.4[b]	33.6	71.8	33.6	68.3	59.7	47.3	176.0
		C-11	45.9 (t)[c]	C-12	23.6 (t)[c]	C-13	11.2 (q)[c]			
Multiplicity[c]	s	s	s	t	s	t	t	q	t	s

[a]Internal standard; dioxane (67.4 ppm)

[b]Each assignment may be exchanged.

[c]Multiplicity in the off-resonance decoupled spectra of compound 1, 2, 3, 4 and 8.

Comparison of spectral data of palythene with those of palythine[2] and palythinol suggested that palythene also had the same carbon skeleton as palythine and palythinol. When palythene was treated with 2N HCl at refluxing temperature for 3 hrs., it afforded palythine and propanal[9], which well supported the estimation mentioned above. Moreover, in the pmr spectrum of palythene, the signals of olefinic protons were observed at 5.75 and 6.58 ppm and coupled with methyl protons at 1.88 ppm, which obviously indicated the presence of a group, $=NCH=CHCH_3$, in palythene.

On the other hand, hydrogenation of palythene with Pd-C as a catalyst in H_2O for 1 hr. afforded dihydro-palythene (8), whose absorption maximum was at 331 nm. The structure of this compound was easily established to be 8 by comparison of the cmr (Table-1) and pmr[10] spectra with those of palythinol (3). These results led to structure 4 for palythene.

The stereochemistry of the amino propene moiety of palythene was readily determined by pmr measurements, that is, the coupling constant of two olefinic protons (13 Hz) clearly indicated trans-relationship[11]. Based on these results, the structure of palythene was established to be 4. In addition, from ir spectra of palythinol and palythene, these are considered to be inner salt as shown in structure 3 and 4, as well as palythine[2].

Thus, four UV absorbing amino acids, mycosporine-Gly, palythine, palythinol and palythene,

have been isolated from Palythoa tuberculosa and the planar structure of these compounds has been determined. These compounds are characterized by the presence of a cyclohexene ring and a glycine moiety. As a series of these compounds is widely present in many marine plants and animals[3], the role and the biogenesis of these compounds in vivo are very interesting.

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5. These compounds gave satisfactory elemental analyses.
6. Ethanol was determined by gas chromatography and pmr spectrometry.
7. UV (H_2O) λ_{max} 310 nm; PMR (D_2O) 1.26 (3H, d, J=5Hz), 2.44 and 2.72 (2H, ABq, J=17Hz), 2.87 (2H, ABq, J=17Hz), 3.46-3.52 (2H, m), 3.58 (2H, s), 3.61 (3H, s), 4.00 (1H, m)
8. PMR (D_2O) 1.27 (3H, d, J=6Hz), 3.13 (1H, dd, J=7, 13Hz), 3.29 (1H, dd, J=5, 13Hz), 3.78 (3H, s), 3.90 (2H, s), 4.05 (1H, m), 6.10, 6.35 (1H each, d, J=2Hz). This compound gave the same methyl ester as compound 5 by the treatment with HCl-MeOH at refluxing temperature.
9. These compounds were identified by gas chromatography-mass spectrometry compared with authentic 2-aminopropanol and propanal, respectively.
10. PMR (D_2O) 0.95 (3H, t, J=7.5Hz), 1.66 (2H, sextet, J=7.5Hz), 2.78 (2H, ABq, J=17Hz), 2.90 (2H, ABq, J=17Hz), 3.46 (2H, t, J=7.5Hz), 3.63 (2H, s), 3.66 (3H, s), 4.02 (2H, s).
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