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METABOLITES OF THE MARINE SPONGE *PLAKORTIS ZYGOMPHA*

D. John Faulkner and B. N. Ravi

Scripps Institution of Oceanography (A-012-F)
La Jolla, California 92093, U.S.A.

Abstract: The major constituent of *Plakortis zygompha* was (Z)-7-methyl-4-octen-3-one **1**, a highly volatile, sweet-smelling oil. The sponge also contained several derivatives of 3-hydroxy-4-hydroxymethyl-4-pentenoic acid.

Marine sponges are generally regarded as among the more malodorous of marine organisms, even when freshly collected. In pleasant contrast to this observation, the marine sponge *Plakortis zygompha* was found to have a sweet, fragrant odor which allowed this sponge to be distinguished from all others in the field. The fragrant constituent of *Plakortis zygompha* was shown to be (Z)-7-methyl-4-octen-3-one (**1**). Several derivatives of 3-hydroxy-4-hydroxymethyl-4-pentenoic acid were also extracted from the sponge.

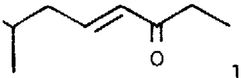
Plakortis zygompha (Laubenfels) was collected by hand, using SCUBA (-10 to -20 m), at Glover and Lighthouse Reefs, Belize, and was immediately frozen. The frozen sponge was allowed to thaw under vacuum, and the volatile constituents were collected in a trap which was cooled by liquid nitrogen. The contents of the trap were thawed and refrozen at -10°C to obtain a clear mobile oil (2.8% dry weight) which separated from the ice layer. The oil was essentially pure, containing >95% of the ketone **1**.

The ketone **1**, bp_{30} 92-94°C, had the molecular formula $C_9H_{16}O$. The infrared spectrum (1680, 1635 cm^{-1}) suggested the presence of an α,β-unsaturated ketone.

The ^{1}H NMR spectrum contained signals at δ 1.00 (t, 3H, J = 7 Hz) and 2.49 (q, 2H, J = 7 Hz) which indicated the presence of an ethyl ketone. The signals at 5.99 (d, 1H, J = 16 Hz) and 6.71 (dt, 1H, J = 16,7,7 Hz) were assigned to the α and β protons on a *trans*-disubstituted conjugated olefin. A two-proton signal at 2.09 (t, 2H, J = 7 Hz) was coupled to the signal at 6.71 and to a multiplet at 1.77 (m, 1H), which was, in turn, coupled to a six-proton doublet at 0.90 (d, 6H, J = 7 Hz). The ketone **1** was therefore (Z)-7-methyl-4-octen-3-one. The ^{13}C NMR spectrum [δ 8.15 (q), 22.5 (2q), 28.3 (d), 33.1 (t), 42.0 (t), 131.8 (d), 144.9 (d), 191.6 (s)] served to confirm the structure.

Silica gel chromatography of the ethyl acetate soluble material from an ethanol extract of the dried sponge gave four fractions having interesting spectral properties. The least polar fraction (0.2% dry weight) contained the alcohol **2**,[1] which could be dehydrated to ketone **1** by treatment with p-toluenesulfonic acid in benzene. A second fraction (0.5% dry weight) contained an alcohol **3** (IR 3350, 1735 cm^{-1}) having the molecular formula $C_9H_{16}O_4$. The ^{1}H NMR spectrum (Table 1) contained signals at δ 1.20 (t, 3H, J = 6.5 Hz) and 3.49 (q, 2H, J = 6.5 Hz) due to an ethyl ether, 3.69 (s, 3H) due to a methyl ester, 5.25 (bs, 1H) and 5.15 (bs) due to an olefinic methylene, 4.05 (s, 2H) due to an isolated methylene bearing oxygen, 4.63 (t, 1H, J = 7 Hz) for a proton on an oxygen-bearing carbon and 2.67 (d, 1H, J = 7 Hz) for a methylene adjacent to carbonyl. In the ^{1}H NMR spectrum of the mono-acetate **4** (IR 1745, 1735 cm^{-1}) the α-acetoxy proton was at δ 5.64 (t, 1H, J = 7 Hz) while other signals were at comparable chemical shifts. The ^{13}C NMR spectrum of alcohol **3** (Table 2) was assigned as indicated. The NMR data indicated that the alcohol **3** was methyl 4-ethoxymethyl-3-hydroxy-4-pentenoate.

A more polar fraction (0.6% dry weight) contained a diol ester **5** (IR 3600, 1735 cm^{-1}) having the molecular formula $C_8H_{14}O_4$. The diol ester **5** formed a diacetate **6** having ^{1}H NMR signals at δ 2.04 (s, 3H) and 2.08 (s, 3H). Both the ^{1}H NMR spectral data [δ 1.26 (t, 3H, J = 7 Hz); 4.09 (q, 2H, J = 7 Hz)] and ^{13}C NMR spectral data [δ 14.1 (q); 60.8 (q)] for alcohol **5** indicated the presence of an ethyl ester while the remaining signals in both spectra (see Tables) could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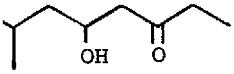
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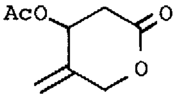
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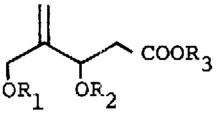


3. R_1 = Et R_2 = H R_3 = Me
4. R_1 = Et R_2 = Ac R_3 = Me
5. R_1 = H R_2 = H R_3 = Et
6. R_1 = Ac R_2 = Ac R_3 = Et
8. R_1 = Ac R_2 = Ac R_3 = Me

Table 1. ^{1}H NMR Spectra of Compounds 3-8

H at C#	3	4	5	6	7	8
2	2.67	2.75	2.66	2.70 2.75	2.83 2.92	2.71 2.77
3	4.63	5.64	4.68	5.68	5.68	5.68
5	4.05	3.88 4.02	4.09 4.17	4.62	4.80 4.93	4.62
6	5.15 5.23	5.21 5.23	5.15	5.29 5.32	5.35 5.48	5.30 5.33
OCH_2CH_3	3.49	3.47	4.09	4.15	--	--
OCH_2CH_3	1.20	1.20	1.26	1.25	--	--
$OCOCH_3$	--	2.03	--	2.04 2.08	2.07	2.05 2.09
OCH_3	3.69	3.66	--	--	--	3.69

Table 2. ^{13}C NMR Spectra of Compounds 3 and 5-8

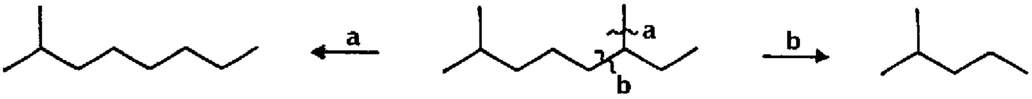
	3	5	6	7	8
C-1 (s)	172.4	172.3	169.7*	169.3*	169.8*
C-2 (t)	41.1	41.3	39.1	36.6	38.9
C-3 (d)	69.6	69.8	70.7	67.9	70.6
C-4 (s)	147.6	150.1	142.5	137.8	142.5
C-5 (t)	71.3	63.3	63.8	69.2	63.8
C-6 (t)	112.6	111.6	115.8	115.9	115.9
OCH_3	51.3	--	--	--	51.3
$O\underline{C}H_2CH_3$	65.8	60.8	60.5	--	--
$OCH_2\underline{C}H_3$	15.1	14.1	14.1	--	--
$OCOCH_3$	--	--	169.0* 169.4*	167.7*	169.0* 169.6*
$OCOCH_3$	--	--	20.3	20.3	20.3

*Signals may be interchanged

only be assigned to a 3-hydroxy-4-hydroxymethyl-4-pentenoic acid skeleton.

The most polar fraction (0.45% dry weight) contained two compounds that could only be separated after acetylation. The major acetate 7 (50% of mixture) had the molecular formula $C_8H_{10}O_4$. The infrared spectrum (1745, 1735 cm^{-1}) indicated the presence of two ester groups, one of which was an acetate (δ 2.07) and the other a δ-lactone. Both the ^{1}H NMR and ^{13}C NMR spectra indicated that acetate 7 was 3-acetoxy-4-hydroxymethyl-4-pentenoic acid lactone. The minor diacetate 8 (30% of mixture) had the molecular formula $C_{11}H_{16}O_6$. The ^{1}H NMR spectrum contained a methyl ester signal at δ 3.69 and two acetate signals at 2.05 and 2.09. The ^{1}H NMR and ^{13}C NMR spectra indicated that diacetate 8 was methyl 3-acetoxy-4-acetoxymethyl-4-pentenoate.

Since ethyl ether, ethyl ester and δ-lactone formation could all occur during ethanol extraction, we propose that the isolation of compounds 3, 5, 7 and 8 be considered evidence for the natural occurrence of an unspecified derivative, possibly the methyl ester, of 3-hydroxy-4-hydroxymethyl-4-pentenoic acid. The isolation of both six-carbon and nine-carbon metabolites in this sponge leads to the speculation that both may be derived from a monoterpene precursor. Although sesquiterpenes and diterpenes have been isolated from sponges, neither monoterpenes nor any metabolites closely related to compounds 1-8 have been found in sponges.[2]



Acknowledgments

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References and Notes

1. IR (film) 3550, 1705 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 0.91 (d, 6H, J = 7Hz), 1.07 (t, 3H, J = 7Hz), 1.3-1.5 (m, 2H), 1.80 (m, 1H), 2.48 (q, 2H, J = 7Hz), 2.56 (m, 2H), 4.14 (m, 1H); ^{13}C NMR (C_6D_6) 191.7 (s), 66.0 (d), 49.7 (t), 46.4 (t), 36.6 (t), 24.7 (t), 23.6 (d), 22.2 (q), 7.6 (q).

2. L. Minale, G. Cimino, S. de Stefano and G. Sodano, Fort. Chem. Org. Nat., **33**, 1 (1976); D. J. Faulkner, Tetrahedron, **33**, 1421 (1977).

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