

## **Sodwanones A-F, New Triterpenoids from the Marine Sponge *Axinella weltneri***

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SODWANONES A-F, NEW TRITERPENOIDS FROM  
THE MARINE SPONGE *AXINELLA WELTNERI*

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ABSTRACT.—Six triterpenoids, sodwanones A-F (1-3, 7-9), having three different skeletons, have been isolated from the Indo-Pacific sponge *Axinella weltneri*. The complete spectral data of the previously reported sodwanones A-C [1-3], together with the structure determination of the new sodwanones D-F [7-9], based mainly on 1D and 2D nmr spectroscopy, are the subject of this report.

The structures of three new triterpenoids, sodwanones A-C [1-3], from the Indo-Pacific fan sponge *Axinella weltneri* (Axinellidae), were recently reported (1). Compounds 1-3 are closely related to the previously reported sipholenols (e.g., 4, sipholenol B) (2), siphonellinol [5] (3) and neviotine A (4) isolated from the Red Sea sponge *Siphonochalina siphonella*, as well as the recently reported raspacionins (e.g., 6, raspacionin A) isolated from the Mediterranean red sponge *Raspaciona aculeata* (5-7). Interestingly, the latter sponge, like *A. weltneri*, is an Axinellidae sponge, whereas *S. siphonella* belongs to the order Haplosclerida.

All of the above triterpenoids comprise two separate cyclic systems assumed to be obtained from di- or trioxidosqualenes in two separate acid-catalyzed cyclizations (2-4). Each cyclization is suggested to be initiated by a carbonium ion obtained from protonation of either an epoxide or one of the squalene double bonds. Compounds 1-9 possess at least one perhydrobenzoxepine system derived from one half of the squalene precursor and a variety of other systems obtained from the second half of the squalene. In the previously reported sodwanones A-C [1-3], the second cyclic system is a substituted decalin.

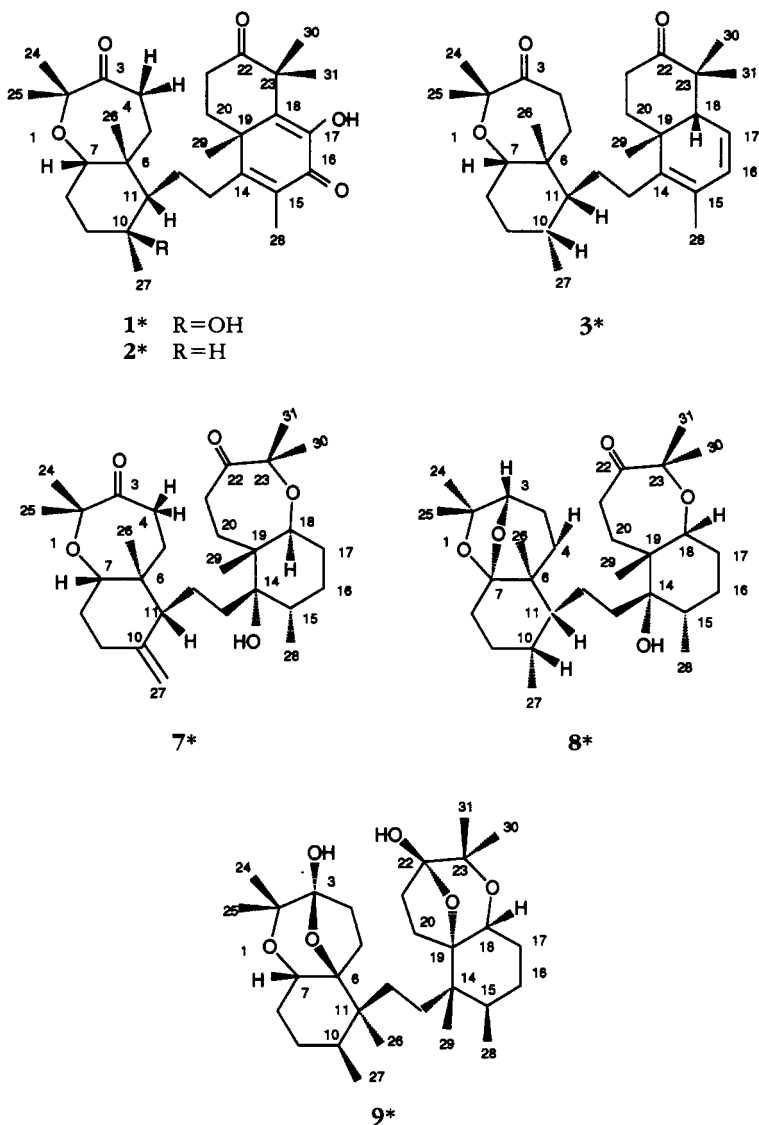
In this paper, the structure determination of three new compounds [7-9], designated sodwanones D, E, and F from *A. weltneri*, together with the complete spectral data and stereochemistry of both these new compounds and sodwanones A-C [1-3] are presented.

## RESULTS AND DISCUSSION

The EtOAc extract of *A. weltneri* was found to contain six triterpenoids having three different carbon skeletons. Of the six, only sodwanone A [1] appears in a somewhat higher concentration (0.1% dry wt) relative to the others, which exist in the sponge in minute amounts (0.01%-0.005%).

The structure of sodwanone A [1], C<sub>30</sub>H<sub>44</sub>O<sub>6</sub>, suggested by analysis of the nmr and other spectral data, was secured by single crystal X-ray diffraction analysis (1).

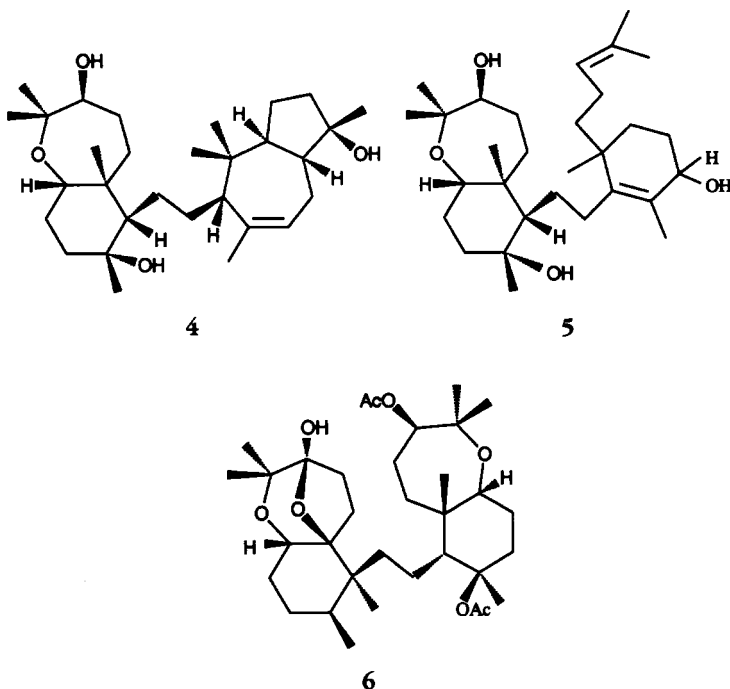
Half of the sodwanone A molecule [1] has the same *trans*-perhydrobenzoxepine system as compounds 4-6 but they have different substituents. The rest of the molecule of 1, however, differs. Mono-, bi-, and tricarbo-cyclic systems have already been found in the second half of the molecule of the *S. siphonella* metabolites (2-4). Sodwanone A [1]



\*relative stereochemistry

contains a different bicyclic system from that of the sipholanols, namely, a substituted decalin moiety which embodies a rare  $\alpha$ -hydroxy cross-conjugated dienone system.

The second compound, sodwanone B [**2**],  $C_{30}H_{44}O_5$ ,  $m/z$  484, has the same decalin moiety as **1** and a very similar perhydrobenzoxepine system. The major difference in the  $^1H$ -nmr spectrum of **2**, when compared to that of **1**, was that the Me-27,  $\alpha$ - to the 10-OH group in **1**, is replaced by a doublet methyl resonating at  $\delta_H$  1.06. At the same time the tertiary C-10 OH singlet resonance ( $\delta_C$  73.5) was replaced by a new methine doublet resonance at  $\delta$  28.2, suggesting that sodwanone B [**2**] is the 10-deoxy derivative of **1**. As for the relative stereochemistry of C-6, C-7, C-10, and C-11, the  $^1H$ - $^1H$  coupling pattern of H-7 ( $\delta$  2.90 dd,  $J=10.7$  and 5.1 Hz) and the chemical shifts of the oxepane C-atoms suggest that the C-6 methyl group (Me-26) and H-7 in **2** are trans diaxial as in **1**. Furthermore, nOe cross-peaks between the axial H-4 ( $\delta_H$  3.16) and methyls 25 and



26 on one side of the ring system (the  $\alpha$ -side), and between H-7 and methyl 24 and H-11 ( $\delta_{\text{H}}$  1.25 m) on the other ( $\beta$ ) side of the system, are in good agreement with a C-6, -7 trans configuration. This also determines the  $\alpha$ -equatorial configuration of the C-12, -13 ethylene bridge. Additionally, an nOe cross-peak between H-11 ( $\beta$  axial) and H-10 ( $\delta_{\text{H}}$  1.93 m) requires H-10 also to be  $\beta$  (equatorial), thus determining the configuration of Me-27 to be  $\alpha$ , and on the same side as methyls 25 and 26.

The nmr line assignments of **2** (Table 1) were based on homo-COSY, HMQC, and HMBC experiments. The structure and stereochemistry of the perhydrobenzoxepine system of **2** was further supported by comparing its nmr data with those of sipholenol B [**4**] (**2**). Based on biogenetic considerations it is tentatively suggested that the relative stereochemistry of the two halves of **2**, as well as those of **3**, are the same as in **1** (having the same C-6 and C-19 configurations) where it was assured by X-ray diffraction analysis. No nOes could be measured between the two separate (by the C-12, C-13 bridge), conformationally labile, bicyclic halves of molecules **1–3**.

Sodwanone C [**3**],  $\text{C}_{30}\text{H}_{46}\text{O}_3$ ,  $m/z$  454, has the same substituted perhydrobenzoxepine system as compound **2** (according to the  $\delta_{\text{C}}$  values, Table 1), but differs in the decalin moiety. The latter moiety still has the same cyclohexanone ring, with its characteristic  $\alpha$ -gem-dimethyl ketone, but instead of the conjugated dienone it has a 1,3-diene group ( $>\text{CH}(18)\text{CH}(17)=\text{CH}(16)-\text{C}(15)\text{Me}=\text{C}(14)\text{CH}_2(13)-$ ;  $\delta_{\text{H}}$  5.90 dd ( $J=9.3$  and  $3.2$  Hz) and 5.62 dd ( $J=9.3$  and  $2.7$  Hz);  $\delta_{\text{C}}$  142.5 s, 131.0 d, 125.2 s, and 124.2 d). Based on the CH-correlations (HMBC) from  $\text{CH}_3$ s -29, -30, -31 to C-18 ( $\delta_{\text{C}}$  53.4 d);  $\text{CH}_3$ s-28, -29 to C-14 ( $\delta_{\text{C}}$  142.5 s); also from  $\text{CH}_3$ -28 to C-15, C-16, and C-17, and, as in all the series, from  $\text{CH}_3$ s -30, -31 to CO-22, the  $\Delta^{14,16}$  (rather than  $\Delta^{15,17}$ ) position was proposed. A trans geometry was determined for the decalin system of **3** based on nOe correlations between the axial 21-proton ( $\delta_{\text{H}}$  2.82) and methyls -29 and -30 ( $\delta_{\text{C}}$  22.8,  $\delta_{\text{H}}$  1.19) on the  $\alpha$ -side of the decalin (the latter effect distinguishes between methyls 30 and 31), and between H-18 ( $\delta_{\text{H}}$  2.48) and Me-31 ( $\delta_{\text{H}}$  1.12) on the  $\beta$ -side of the ring system.

The structure of sodwanone D [**7**],  $\text{C}_{30}\text{H}_{48}\text{O}_5$ ,  $m/z$  488, is proposed to comprise two

TABLE 1. Nmr Data (125 and 500 MHz) Including CH-Correlations of Sodwanones A-C [1-3].<sup>a-c</sup>

Position	Compound						
	1			2	3		
	$\delta_c^b$	$\delta_H^b$		HMBC (C to H)	$\delta_c$	$\delta_c$	HMBC (C to H)
2	82.0 s			H-4a, -7, Me-24, Me-25	82.4 s	82.3 s	Me-24, -25
3	218.0 s			H-4a, -5a, Me-24, Me-25	218.0 s	218.1 s	H-4a, Me-24, -25
4a	35.0 t	3.25 ddd	13.5, 11.1, 2.6	H-5a, -5b	35.1 t	35.2 t	
4b		2.19 m					
5a	40.6 t	1.95 ddd	11.0, 6.3, 2.2	H-7, Me-26	40.5 t	40.4 t	
5b		1.38 m					
6	42.0 s			H-5a, -5b, Me-26	41.5 s	41.3 s	H-7, Me-26
7	80.9 d	2.97 dd	10.7, 5.1	H-5a, -9a, Me-26	81.9 d	82.2 d	Me-24, -25, -26
8a	24.8 t	1.62 m		H-5b	25.5 t	26.3 t	
8b		1.58 m					
9a	41.5 t	1.76 ddd	13.5, 6.5, 3.5	H-8a, -8b, -11, Me-27	29.9 t	31.2 t	
9b		1.48 m					
10	73.5 s			H-8a, -9a, -11, Me-27	28.2 d	28.3 d	
11	57.5 d	1.13 dd	5.5, 3.4	H-9a, -9b, Me-26, Me-27	51.3 d	51.3 d	Me-26, -27
12a	28.7 t	1.55 m		H-7	28.4 t	27.1 t	
12b		1.45 m					
13a	33.9 t	2.64 dd	13.0, 3.5	H-12a, -12b	31.1 t	34.3 t	
13b		2.38 dt	13.0, 5.4				
14	164.7 s			H-13a, -13b, -20a, Me-28	164.5 s	142.5 s	H-16, Me-28, -29
15	128.8 s			H-13a, -13b, Me-28	129.1 s	125.2 s	H-16, -17, Me-28
16	181.5 s			OH (17), Me-28	181.5 s	124.2 d	Me-28
17	141.8 s			OH (17), -20a	141.9 s	131.0 d	Me-28
18	137.6 s			OH (17), -20a, Me-29, Me-30, -31	137.2 s	53.4 d	H-16, -17, Me-29, Me-30, -31
19	42.9 s			H-20a, -20b, -21a, -21b, Me-29	42.7 s	40.6 s	Me-29
20a	27.6 t	2.48 dd	13.4, 6.6	H-21a, -21b, Me-29	25.8 t	26.4 t	
20b		1.75 m					
21a	32.6 t	2.74 dd	18.5, 8.9	H-20a	32.5 t	34.5 t	
21b		2.60 dd	18.5, 2.5				
22	216.0 s			H-21a, -21b, Me-30, -31	215.0 s	215.8 s	H-21a, Me-30, -31
23	49.0 s			H-20b, -21a, -21b, Me-30, Me-31	48.0 s	47.2 s	Me-30, -31
24	20.4 q	1.31 s			20.5 q	20.5 q	
25	26.3 q	1.25 s		Me-24	26.4 q	26.4 q	
26	12.1 q	0.95 s		H-5b, -7	13.4 q	13.4 q	
27	23.6 q	1.21 s			14.7 q	14.5 q	
28	12.0 q	2.02 s			11.9 q	17.7 q	
29	21.6 q	1.09 s			21.6 q	15.0 q	
30	20.8 q	1.56 s			20.8 q	22.8 q	
31	24.3 q	1.46 s		Me-30	24.4 q	24.8 q	

<sup>a</sup>CDCl<sub>3</sub>; Bruker ARX 500 instrument, chemical shifts refer to TMS ( $\delta_H=0$ ) and CDCl<sub>3</sub> ( $\delta_C=77.0$ ).<sup>b</sup>Assignments aided by HMQC, HMBC, homo-COSY, TOCSY, and NOESY experiments.<sup>c</sup>Ha the lower field proton in a geminal pair, and Hb the higher field proton in a geminal pair.

perhydrobenzoxepine systems based on its 1D and 2D nmr data. The 3-oxo-2,2,6- and 22-oxo-19,23,23-trimethylated oxepanes are characteristic of these two systems. These were in full agreement with the proton and carbon chemical shifts of **1-6** (Tables 1 and 2), and exhibited the expected 2D nmr COSY, HMQC, and HMBC correlations. HMQC and HMBC correlations between the various methyl protons and their neighboring C atoms (Table 2) were of special importance. Two other functionalities in **7** were an exocyclic methylene ( $\delta_C$  145.3 s, 103.3 t) and a tertiary hydroxyl group ( $\delta_C$  78.0 s). The existence of an exo methylene group explained the presence of only seven rather than the expected eight methyl groups in **7**, and accounts, with the other functionalities, for the seven degrees of unsaturation within the molecule. The locations of the  $\Delta^{10(27)}$  double bond in one half of **7** and the C-14 position of the hydroxyl group in the second half were proposed in part on the basis of a COSY experiment which showed correlations between H-4a, H-4b and H-5a, H-5b and between H-7, H-8a, H-8b, H-9a and H-9b for one half

TABLE 2. Nmr Data (125 and 500 MHz) Including CH-Correlations of Sodwanones D-F [7-9].<sup>a,b</sup>

Position	Compound								
	7			8			9		
	$\delta_C$	$\delta_H$	HMBC (C to H)	$\delta_C$	$\delta_H$	HMBC (C to H)	$\delta_C$	$\delta_H$	HMBC (C to H)
2	81.8 s		H-7, Me-24, -25	78.9 s		Me-24, -25	76.7 s		Me-24, -25
3	218.0 s		H-4a, -5a, -5b, Me-24, -25	80.6 d	3.97 d	Me-24, -25	105.7 s		H-5b, Me-24, -25
4	35.8 t	3.18 dt 2.14 m		29.9 t	1.95 m 1.58 m		24.2 t	1.85 m 1.85 m	
5	39.3 t	1.95 m 1.30 m	Me-26	32.1 t	1.55 m 1.40 m	H-3, Me-26	32.3 t	2.30 m 1.12 m	
6	42.5 s		Me-26	41.3 s		H-5a, -5b, Me-26	89.3 s		H-5a, H-7, Me-26
7	80.3 d	3.05 dd		110.1 s		H-3, H-5a, -5b, Me-26	70.6 d	4.20 dd	
8	32.5 t	1.70 m 1.50 m		22.7 t	2.02 m 1.62 m		26.7 t	1.78 m 1.38 m	
9	35.3 t	2.28 dd 1.88 m	H-27a, -27b	28.0 t	2.05 m 1.35 m		28.5 t	1.32 m 1.32 m	Me-27
10	145.3 s			29.7 d	1.92 m	Me-26	39.2 d	1.13 m	Me-26, -27
11	54.2 d	1.45 m		48.1 d	1.46 m	H-5a, -5b, Me-26, Me-27	40.9 s		Me-26, -27
12	20.1 t	1.42 m 1.42 m		20.5 t	1.22 m 1.22 m		29.7 t	1.88 m 1.18 m	H-13a
13	36.0 t	1.88 m 1.08 m		35.1 t	1.75 m 1.26 m		29.9 t	2.60 m 1.88 m	Me-29
14	78.0 s		Me-28, -29	77.6 s		Me-28, -29	42.0 s		H-13a, Me-28, -29
15	33.6 d	1.82 m		33.3 d	1.89 m	Me-28	33.5 d	1.75 m	Me-28, -29
16	28.2 t	1.35 m 1.35 m	Me-28	28.7 t	1.40 m 1.40 m	Me-28	26.5 t	1.35 m 1.12 m	H-18, Me-28
17	30.0 t	1.53 m 1.53 m		30.5 t	1.58 m 1.58 m	H-18	27.9 t	1.65 m 1.55 m	
18	76.1 d	3.52 dd	Me-29	76.1 d	3.52 dd	H-17a, -17b, Me-29	71.2 d	4.36 dd	
19	45.3 s		Me-29	45.4 s		H-21a, -22b, Me-29	88.4 s		H-18, H-20a, Me-29
20	32.7 t	2.00 m 1.52 m	H-18, Me-29	32.9 t	2.08 m 1.65 m		33.5 t	2.30 m 1.12 m	
21	35.2 t	3.12 m 2.15 m		35.4 t	3.20 dt 2.25 dd		24.4 t	1.88 m 1.60 m	
22	217.6 s		Me-30, -31	215.8 s		Me-30, -31	104.4 s		H-20b, Me-30, -31
23	82.2 s		H-18, Me-30, -31	81.6 s		H-21a, Me-30, -31	77.1 s		H-20a, Me-30, -31
24	20.3 q	1.28 s		20.7 q	1.39 s		19.2 q	1.65 s	
25	26.9 q	1.22 s	Me-24	28.2 q	1.29 s		24.6 q	1.38 s	Me-24
26	11.2 q	0.83 s		18.6 q	1.04 s		18.9 q	1.15 s	
27	108.3 t	4.94 s 4.57 s		14.7 q	0.97 d		15.4 q	0.80 d	
28	15.3 q	0.80 d		15.5 q	0.86 d		15.8 q	0.86 d	
29	14.0 q	1.04 s	H-18	14.4 q	1.15 s	H-18	17.2 q	1.18 s	
30	20.4 q	1.31 s	Me-31	20.4 q	1.34 s		18.9 q	1.57 s	
31	26.6 q	1.23 s		26.7 q	1.27 s		24.6 q	1.37 s	Me-30

<sup>a</sup>CDCl<sub>3</sub> for 7 and 8 and C<sub>6</sub>D<sub>6</sub> for 9; Bruker ARX 500 instrument, chemical shifts refer to TMS ( $\delta_H=0$ ) and CDCl<sub>3</sub> ( $\delta_C=77.0$ ).

<sup>b</sup>Assignments aided by HMQC, HMBC, homo-COSY, TOCSY, and NOESY experiments.

<sup>c</sup>May be interchangeable.

of 7 and between H-20a, H-20b, H-21a, and H-21b, and between Me-28, H-15, H-16a, H-16b, H-17a, H-17b, and H-18 for the second half of 7. In addition, HMBC correlations ( $CH_3$ -26 to C-7 and C-11; H-27a, H-27b to C-9 and C-11;  $CH_3$ s -28 and -29 to C-14 ( $\delta_C$  78.0); and  $CH_3$ -29 to C-18) supported this assignment. An nOe cross-peak between the axial H-7 and H-11 showed that H-11 is also axial and is on the same side as H-7; H-7 also showed an nOe correlation with  $CH_3$ -24. Hence, C-11 in 7 has the same relative stereochemistry as in sodwanones A-C [1-3]. Further support for the trans C-6, -7 ring junction, as in 1-3, came from the multiplicity of H-7 (Experimental) and nOe correlations between the axial H-4 ( $\delta_H$  3.18 dt,  $J=3.0$  and 11.3 Hz) and methyls -25 and -26, and between H-11 and H-5 on the other side of the ring system. The pattern

of H-18, the C-atom resonances of C-14–C-23 (Table 2) as well as an nOe between H-18 and Me-30 ( $\delta_C$  20.4,  $\delta_H$  1.31), established the C-18, -19 trans configuration for the second ring system of **7**. The latter trans ring junction was further supported by nOe correlations between the axial H-21 ( $\delta_H$  3.12) and methyls -29 ( $\delta_C$  14.0,  $\delta_H$  1.04) and -31 ( $\delta_C$  26.6, 1.23). Two other nOe correlations between Me-29 and H-15 ( $\delta_H$  1.82) and between Me-29 and H<sub>2</sub>-12 ( $\delta_H$  1.42) determined the H-15  $\beta$ -configuration as well as the  $\beta$ -orientation (towards C-14) of the ethylene bridge (i.e., 14 $\alpha$ -OH).

Another compound that was obtained in small amounts (2.5 mg, 0.005% dry wt) was sodwanone E [**8**], C<sub>30</sub>H<sub>50</sub>O<sub>5</sub>, *m/z* 490. Comparison of the nmr data of **8** with those of the above compounds suggested that one half of the molecule (C-14–C-23) had the same 14-hydroxy-22-oxo-perhydrobenzoxepine as sodwanone D [**7**] (Table 2). The absence of sp<sup>2</sup> carbon resonances for the second half of **8** indicated it to be tricyclic. A single carbon resonating at  $\delta_C$  110.1 s, which most likely bears two oxygen atoms, together with two additional C-atoms bearing a single oxygen each ( $\delta_C$  78.9 s and 80.6 d), could be best explained by the presence of an internal ketal group.

The observation of CH-correlations (HMBC experiment) between the protons of methyls -24 and -25 ( $\delta_H$  1.39 and 1.29,  $\alpha$  to an oxygen atom) and C-2 and C-3; between H-3 and C-7, and between CH<sub>3</sub>-26 and C-7, established the position of the proposed ketal as being between the single oxygen-bearing C-2 and C-3 to the doubly oxygenated C-7. NOe cross-peaks between Me-26 and Me-27, H-8 (axial) ( $\delta_H$  2.02) and H-5 (axial) ( $\delta_H$  1.55), and between Me-24 and H-5, suggested the relative stereochemistry shown for **8**. Furthermore, the appearance of H-3 as a doublet at  $\delta_H$  3.97 ppm suggested either a twisted conformation of the oxepane ring, or a strong influence of the oxygen atoms on one of the H-3 coupling constants which becomes close to zero.

Both sodwanones D and E [**7** and **8**] have the same carbon skeleton as the siphonellinols (e.g., siphonellinol, **5**) (3) and raspacionin A [**6**] (5–7).

Sodwanone F [**9**], C<sub>30</sub>H<sub>50</sub>O<sub>6</sub>, *m/z* 506 (six degrees of unsaturation), contains only sp<sup>3</sup> hybridized carbon atoms and hence must be hexacyclic. In **9**, as in the other sodwanones, two geminal pairs of methyls were observable. According to CH-correlations (Table 2) both pairs were positioned between an oxygen and a proposed hemiketal group. For better resolution, the nmr data of **9** were taken in C<sub>6</sub>D<sub>6</sub> and for comparison with raspacionin A [**6**] (5–7) in CDCl<sub>3</sub> (see below). HMBC correlations between C-6 and H-7 and CH<sub>3</sub>-26, and between CH<sub>3</sub>-26, and C-10 and C-11 suggested that one perhydrooxepine-hemiketal system of sodwanone F [**9**] was identical to that in raspacionin A [**6**] (6,7). Indeed, comparison of the nmr data of **9** with those of **6** (6,7) [ $\delta$  4.05 (dd, *J* = 11.2 and 5.2 Hz, H-7), 1.32 (s, Me-24) and 1.25 (s, Me-25) for **9** against  $\delta$  4.05 (dd, *J* = 10.8 and 5.2 Hz), 1.31 s and 1.25 s, respectively, for **6**, and very similar <sup>13</sup>C-nmr chemical shifts, even in C<sub>6</sub>D<sub>6</sub>] clearly pointed to the identification of half of **9** (C-2–C-11) as the same as that of the corresponding half in raspacionin A [**6**] (6). The second half of **9** (C-14–C-23) is proposed to consist of a very similar tricyclic system to that of **6** based on similar  $\delta_C$  values, except for the resonance of C-15, which is shifted about 7 ppm upfield in comparison to C-10. We conclude that the two halves differ in the stereochemistry at C-14 and/or C-15. Extensive overlap in the <sup>1</sup>H-nmr spectra made nOe measurements very difficult.

The multiplicity of H-18 and the carbon resonances of C-18–23 and C-30 and C-31 unequivocally confirmed the dioxabicyclo[3.2.1]octane system. Furthermore, an nOe correlation between Me-29 and one of the C-20 methylene protons determined the methyl group to be in the  $\beta$ -configuration (opposite to the oxygen bridge and H-18), and in the same equatorial configuration as Me-26. These differences in the chemical shifts of the two halves of **9** (Table 2) would require the inversion of C-15 (in comparison to C-10, i.e., Me-28 must be axial). Indeed, a 1D-TOCSY nmr experiment confirmed the

equatorial configuration of H-15 (all  $J$  values around 5 Hz). A Dreiding model of this molecule suggests that the cyclohexane ring, C-14–19, is in a twisted chair conformation.

## EXPERIMENTAL

**GENERAL EXPERIMENTAL PROCEDURES.**—Ir spectra were recorded on a Nicolet 205 Ft-ir spectrophotometer. Low-resolution mass spectra were recorded on a Finnigan-4021 mass spectrometer and high-resolution mass spectra (hrms) were obtained on a VG70 VSEQ instrument.  $^1\text{H}$ - and  $^{13}\text{C}$ -nmr spectra were recorded on Bruker AMX-360 and ARX-500 spectrometers. All chemical shifts are reported with respect to TMS ( $\delta_{\text{H}}=0$ ). Optical rotations were measured on a Perkin-Elmer Model 141 polarimeter using a 1-cm microcell.

**COLLECTION AND ISOLATION PROCEDURES.**—*Axinella weltneri* (Von Lendenfeld) (class Demospongiae, order Halichondria, family Axinellidae) (No. TASA-92) was collected in Sodwana Bay, South Africa by scuba during the summer of 1992. A voucher sample is deposited in the Zoological Department at Tel Aviv University. The freshly collected sponge was immediately frozen at  $-25^\circ$ . The freeze-dried sponge (50 g) was then extracted with EtOAc to give a brown gum (2 g). The latter gum was chromatographed first on a Sephadex LH-20 column, eluted with MeOH- $\text{CHCl}_3$ -hexane (1:1:2) and then several times on Si gel columns eluted with hexane/EtOAc mixtures to afford: **1** (50 mg, 0.1%), **2** (0.01%), **3** (0.01%), **7** (0.01%), **8** (0.005%), and **9** (0.005%).  $R_f$  values (EtOAc-hexane, 1:1) are **1** 0.25, **9** 0.80 and all others approximately 1.0; (EtOAc-hexane, 2:8), **2** 0.18, **3** 0.22, **7** 0.25, **8** 0.35, **9** 0.05.

**Sodwanone A [1].**—Mp  $253^\circ$  (Me<sub>2</sub>CO);  $[\alpha]_{\text{D}} -9^\circ$  ( $c=0.1$ ,  $\text{CHCl}_3$ ); ir  $\nu$  max (neat) 3520, 3400, 2975, 1715, 1613  $\text{cm}^{-1}$ ;  $^1\text{H}$  and  $^{13}\text{C}$  nmr, see Table 1; COSY, H-4a/-4b, -5a, -5b; H-4b/-5a, -5b, Me-24; H-7/-8a, -9a, Me-24; H-8a/-9a, -9b; H-9a/-9b; H-11/-12a, -12b, Me-27; H-12a/-13a, -13b; H-13a/Me-28, -29; H-20a/-20b, -21a, -21b, Me-29; H-20b/21a, -21b, Me-29; Me-24/-25; Me-30/-31; eims  $m/z$  500 ( $\text{M}^+$ , 40), 482 ( $\text{M}-\text{H}_2\text{O}$ , 15), 260 ( $\text{C}_{16}\text{H}_{20}\text{O}_3$ , decalin part, 15), 246 ( $\text{C}_{15}\text{H}_{18}\text{O}_3$ , decalin moiety, 100), 234 ( $m/z$  246- $\text{H}_2\text{O}$ , 62).

**Sodwanone B [2].**—Glass;  $[\alpha]_{\text{D}} -6^\circ$  ( $c=0.1$ ,  $\text{CHCl}_3$ ); ir  $\nu$  max (neat) 3400, 2950, 1713, 1625  $\text{cm}^{-1}$ ;  $^{13}\text{C}$  nmr, see Table 1;  $^1\text{H}$  nmr  $\delta_{\text{H}}$  3.16 ddd ( $J=13.5$ , 11.1, and 2.6 Hz, H-4a), 2.90 dd ( $J=10.7$  and 5.1 Hz, H-7), 2.77 dd ( $J=18.5$  and 8.9 Hz, H-21a), 2.62 dt ( $J=18.5$  and 9.4 Hz, H-21b), 2.01 (Me-28), 1.93 m (H-10), 1.55 s (Me-30), 1.52 s (Me-31), 1.35 s (Me-24), 1.30 s (Me-25), 1.25 m (H-11), 1.15 s (Me-29), 1.06 d ( $J=7.5$  Hz, Me-27), 1.04 s (Me-26); COSY, same correlations as for **1**; eims  $m/z$  484 ( $\text{M}^+$ , 91), 248 ( $\text{C}_{15}\text{H}_{20}\text{O}_3$ , decalin moiety, 50), 234 ( $\text{C}_{14}\text{H}_{18}\text{O}_3$ , decalin part,  $m/z$  248- $\text{CH}_2$ , 100), 188 (80); hreims  $m/z$  484.3188 (calcd  $m/z$  484.3177 for  $\text{C}_{30}\text{H}_{44}\text{O}_3$ ).

**Sodwanone C [3].**—Amorphous powder;  $[\alpha]_{\text{D}} -35^\circ$  ( $c=0.15$ ,  $\text{CHCl}_3$ ); ir  $\nu$  max (neat) 2950, 1715  $\text{cm}^{-1}$ ;  $^{13}\text{C}$  nmr, see Table 1;  $^1\text{H}$  nmr  $\delta_{\text{H}}$  5.90 dd ( $J=9.3$  and 3.2 Hz, H-16), 5.62 dd ( $J=9.3$  and 2.7 Hz, H-17), 3.17 dt ( $J=3.0$  and 11.3 Hz, H-4a), 2.97 dd ( $J=4.3$  and 11.6 Hz, H-7), 2.82 dt ( $J=5.7$  and 14.2 Hz), 1.78 s (Me-28), 1.30 s (Me-24), 1.25 s (Me-25), 1.19 s (Me-30), 1.12 s (Me-31), 1.03 s (Me-29), 0.99 s (Me-26), 0.96 d ( $J=7.5$  Hz, Me-27); COSY, in addition to the correlations of the perhydrobenzoxepine and oxepane moieties, as in **1**, the following correlations were observed: H-16/Me-28; H-17/Me-30, -31; eims  $m/z$  454 ( $\text{M}^+$ , 32), 306 (32), 217 ( $\text{C}_{15}\text{H}_{21}\text{O}$ , decalin moiety, 24), 203 ( $\text{C}_{14}\text{H}_{19}\text{O}$ , decalin part,  $m/z$  217- $\text{CH}_2$ , 100), 147 ( $m/z$  217-70, 10), 133 ( $m/z$  203-70, 26); hreims  $m/z$  454.3425 (calcd 454.3435).

**Sodwanone D [7].**—Oil;  $[\alpha]_{\text{D}} +19^\circ$  ( $c=0.30$ ,  $\text{CHCl}_3$ ); ir  $\nu$  max (neat) 2960, 1715, 980  $\text{cm}^{-1}$ ;  $^{13}\text{C}$  nmr, see Table 2;  $^1\text{H}$  nmr  $\delta_{\text{H}}$  4.94 s (H-27a), 4.57 s (H-27b), 3.25 dd ( $J=10.5$  and 5.1 Hz, H-18), 3.18 dt ( $J=3.0$  and 11.3 Hz, H-4a), 3.12 m (H-21a), 3.05 dd ( $J=11.2$  and 4.7 Hz, H-7a), 2.28 dd ( $J=12.7$  and 2.2 Hz, H-9a), 1.31 s (Me-30), 1.28 s (Me-24), 1.23 s (Me-31), 1.22 s (Me-25), 1.04 s (Me-29), 0.83 s (Me-26), 0.80 d ( $J=6.6$  Hz, Me-28); eims  $m/z$  488 ( $\text{M}^+$ , 8), 306 ( $\text{C}_{20}\text{H}_{24}\text{O}_2$ ,  $\text{C}_{15}\text{H}_{23}\text{O}_2$  left part or right part after water elimination, + $\text{C}_5\text{H}_9$ , 100); hreims  $m/z$  488.3497 (calcd 488.3489).

**Sodwanone E [8].**—Oil;  $[\alpha]_{\text{D}} +3^\circ$  ( $c=0.1$ ,  $\text{CHCl}_3$ );  $^{13}\text{C}$  nmr, see Table 2;  $^1\text{H}$  nmr,  $\delta_{\text{H}}$  3.97 d ( $J=3.2$  Hz, H-3), 3.52 dd ( $J=10.5$  and 5.1 Hz, H-18), 3.20 dt ( $J=11.3$  and 3.0 Hz, H-21a), 2.25 dd ( $J=11.3$  and 2.2 Hz, H-21b), 1.95 m (H-4a), 1.92 m (H-10), 1.89 m (H-15), 1.39 s (Me-24), 1.34 s (Me-30), 1.29 s (Me-25), 1.27 s (Me-31), 1.15 s (Me-29), 1.04 s (Me-26), 0.97 d ( $J=7.5$ , Me-27), 0.86 d ( $J=7.5$  Hz, Me-28); COSY, H-3/-4a, -4b, Me-24; H-21a/-21b, -20a, -20b; cims ( $\text{CH}_4$ )  $m/z$  491 ( $\text{MH}^+$ , 100), 473 ( $\text{M}-\text{OH}$ , 55), 455 ( $\text{M}-\text{OH}-\text{H}_2\text{O}$ , 20); eims  $m/z$  490 (5), 404 ( $\text{M}-86$ , 60), 308 (100); hreims  $m/z$  490.3632 (calcd 490.3645).

**Sodwanone F [9].**—Oil;  $[\alpha]_{\text{D}} -4^\circ$  ( $c=0.1$ ,  $\text{CHCl}_3$ );  $^{13}\text{C}$  nmr, see Table 2;  $^1\text{H}$  nmr ( $\text{C}_6\text{D}_6$ )  $\delta_{\text{H}}$  4.16 dd ( $J=12.0$  and 4.9 Hz, H-18), 4.06 dd ( $J=11.2$  and 5.2 Hz, H-7), 1.75 m (H-15), 1.65 s (Me-24), 1.57 s (Me-30), 1.38 s (Me-25), 1.37 s (Me-31), 1.18 s (Me-29), 1.15 s (Me-26), 0.86 d ( $J=7.5$  Hz, Me-28), 0.80



d ( $J=7.5$  Hz, Me-27); cims ( $\text{CH}_4$ )  $m/z$  507 ( $\text{MH}^+$ , 10), 489 (M-OH, 90), 471 (M-OH-H<sub>2</sub>O, 100); hreims  $m/z$  506.3585 (calcd 506.3594).

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