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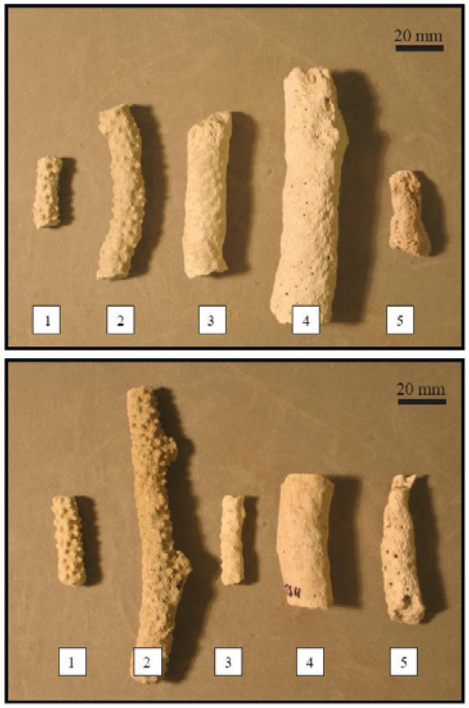
Taphonomy Methods:
Samples were collected for taphonomic analysis by excavating 48 20 cm horizontal x 10 cm vertical sections of outcrop for available *A. cervicornis* at 3 different locations within the Las Clavallinas outcrop. The 3 sites were chosen to represent the base of the section (oldest deposits), contemporaneous but shallower water deposits across the gully, and the top of the section (youngest deposits). Elevations for all samples are reported relative to a -14.64 m below present (year 2000) benchmark (Greer, 2001). Taphonomy values were assigned based on an adapted taphonomy grade scale of 1 to 5 which factored corallite and fine scale skeletal preservation, dissolution and porosity, angularity or roundness of broken edges or skeletal protrusions, and friability of specimens (Supplemental Fig. DR1). Grade 1 (Pristine) corresponds to corallites clearly preserved, corallite tips intact, small ridges clearly defined on coral surface, and angular, not rounded edges of coral specimens (Supplemental Fig. DR2). Grade 5 (highly degraded) corresponds to high dissolution, void space where corallites should be located, friable or 'crumby' nature of specimen, very well rounded edges and corners of broken specimens.



Supplemental Fig. DR1: Numbered taphonomy grades listed below each sample include 1) pristine, 2) slightly weathered, 3) moderately weathered, 4) weathered, and 5) degraded. For a more detailed description of taphonomic grading criteria, see Supplemental Fig. 2).

Taphonomy Grades

The taphonomic scale is a measure of how well a particular coral fossil has been preserved. This scale (Fig. 4) is for use with *Acropora cervicornis* staghorn coral and has been divided into five grades, based on criteria for each taphonomic level: character of corallites, nature of tiny ridges, and roundness of coral edges.

Grade 1 – Pristine condition

- corallites clearly preserved, tips of corallites intact
- tiny ridges clearly defined on surface
- corners of coral are not rounded, breaks are sharp

Grade 2 – Slightly weathered

- tips of corallites have been weathered away
- tiny ridges are not sharply defined
- corners of coral are not rounded, breaks are fairly sharp

Grade 3 – Moderately weathered

- corallites are present as bumps rather than protrusions
- tiny ridges are no longer present on surface
- corners of coral begin to become rounded

Grade 4 – Weathered

- corallites are not present
- surface of coral is very smooth
- corners of coral are rounded

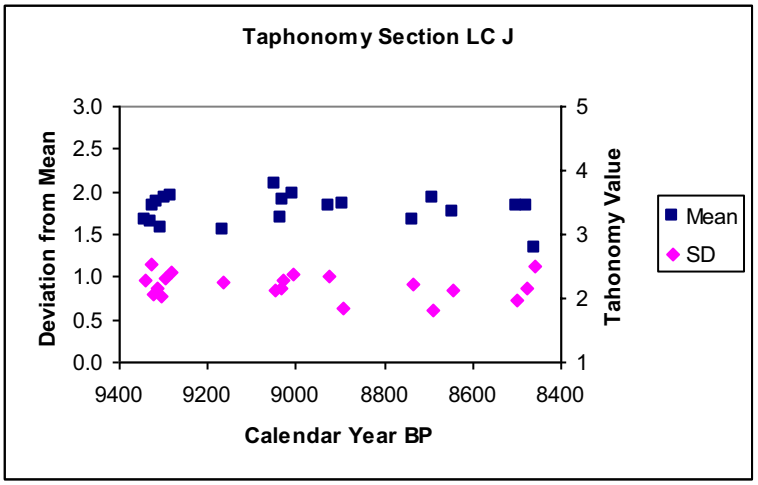
Grade 5 – Degraded

- pockets exist where corallites once were
- surface is degraded, has holes, or is crumbly
- corners are very rounded

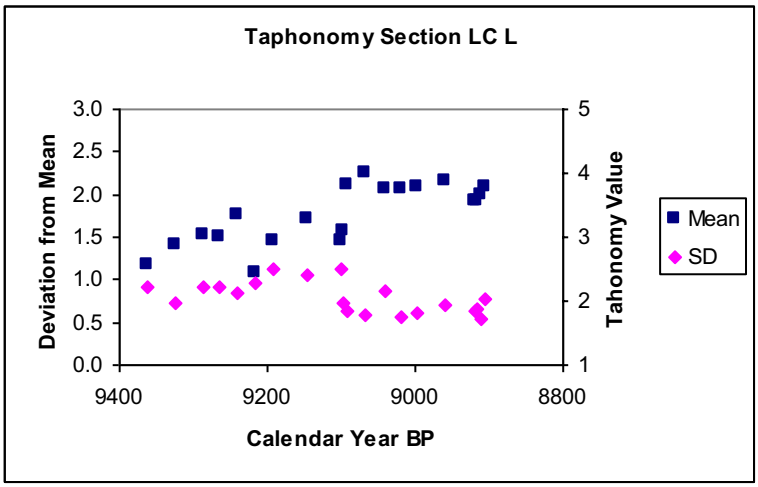
Supplemental Figure DR2. Taphonomic grading criteria used in the field.

Taphonomy Results:

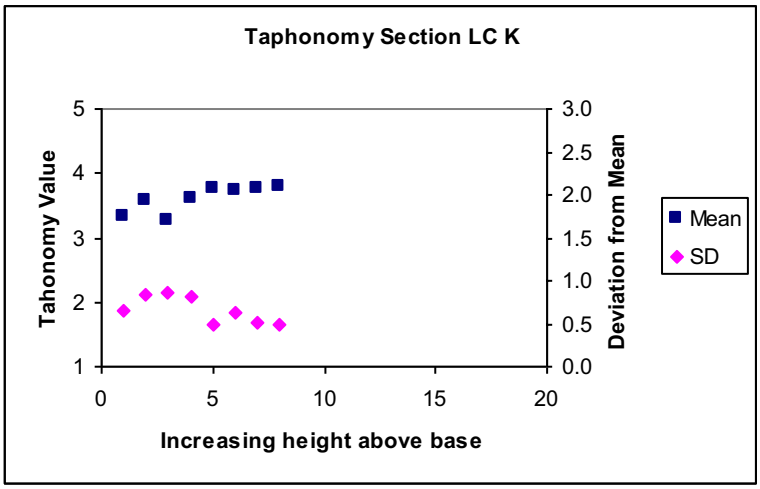
Supplemental Figure DR3 shows mean and standard deviation taphonomy values for all samples analyzed. LC J refers to the 2 meter section at the base, and deepest water section of the fossil reef. LC J is the location for all data presented in Figure 2 of the manuscript. LC L refers to an adjacent LC site, a contemporaneous but shallower section of reef. LC K refers to the youngest, post-HTM coral section at the top of the LC outcrop. In order to plot all taphonomy data on a time line (for illustrative purposes), some ages were interpolated from available radiocarbon data (interpolated dates are indicated in Supplemental Table 1). As we only obtained one radiocarbon date from LC K, we cannot interpolate relative ages and have plotted taphonomy data on a linear scale for illustrative purposes.



A



B



C

Supplemental Figure DR3: Taphonomy data for each LC site. LC J (A) represents the basal deepest (paleo)water LC site. LC L (B) represents contemporaneous shallow water reef accretion, and LC K (C) represents the shallowest and youngest *A. cervicornis* accumulation. The irregular spacing of data points is a function of age interpolation rather than uneven sampling strategies.

Section LC J

Height	Age	Mean	SD	N
10	9305.5	3.09	0.78	35
20	9323.5	3.45	0.80	38
30	9341.5	3.23	0.95	56
40	9328.5	3.18	1.15	82
50	9313.2	3.49	0.87	80
60	9297.8	3.57	0.98	76
70	9282.5	3.60	1.05	55
80	9166.5	3.05	0.94	42
90	8926.0	3.45	1.01	53
100	9007.5	3.61	1.03	57
110	9028.3	3.52	0.95	56
120	9049.0	3.79	0.84	53
130	8892.8	3.48	0.62	46
140	8736.5	3.23	0.91	53
150	8691.3	3.56	0.61	36
160	8646.0	3.35	0.84	52
170	9033.0	3.26	0.87	54
180	8457.0	2.78	1.13	55
190	8478.5	3.44	0.87	25
200	8500.0	3.43	0.72	68

radiocarbon ages are in orange
Interpolated ages are in yellow

Height indicates cm above base of each outcrop
Age is Calendar years BP
Mean and **standard deviation** (sd) are calculated from raw data
N is number of individual corals measured for each sample

Values for Mean correspond to 1 (pristine) through 5 (degraded) as outlined in supplemental data methods

Section LC J

Mean	**3.4**
SD	**0.90**

Bottom m Section LC L

Mean	**2.9**
SD	**0.93**

Top m Section LC L

Mean	**3.8**
SD	**0.66**

Section LC L

Height	Age	Mean	SD	N
10	9362.0	2.57	0.91	49
20	9324.8	2.87	0.73	83
30	9287.6	3.04	0.90	78
40	9264.0	2.99	0.92	73
50	9240.4	3.35	0.83	83
60	9215.6	2.44	0.96	54
70	9190.8	2.95	1.12	41
80	9145.9	3.27	1.04	37
90	9101.0	2.92	1.11	66
100	9096.2	3.09	0.73	58
110	9091.4	3.80	0.63	35
120	9066.6	4.01	0.59	143
130	9041.7	3.76	0.87	84
140	9019.4	3.76	0.57	85
150	8997.0	3.79	0.60	72
160	8958.5	3.87	0.70	55
170	8920.0	3.56	0.64	39
180	8915.5	3.56	0.66	55
190	8911.0	3.66	0.54	64
200	8906.5	3.78	0.77	77

Section LC K

Mean	**3.6**
SD	**0.66**

Section LC K 5854+/-78

Height	Age	Mean	SD	N
10	1	3.33	0.65	12
20	2	3.57	0.84	23
30	3	3.25	0.87	12
40	4	3.59	0.80	56
50	5	3.77	0.50	60
60	6	3.73	0.63	92
70	7	3.75	0.51	64
80	8	3.80	0.48	56

The above age model was used to plot taphonomic data. Some ages are radiocarbon dates and some are interpolated. Please see additional file for complete radiocarbon data for the ~2000 year LC section.

Table DR1. High Resolution Age Data

Sample Name	Sample Type	Location	$d^{13}C$	fraction Modern	±	$D^{14}C$	±	^{14}C age	±	1 Sigma Range		Age Calendar Yrs
DR900 B	A. cervicornis	LC	-4.5	0.3385	0.0014	-661.5	1.4	8700	35	9308	9446	9377
DR903	A. cervicornis	LC	-4.5	0.3402	0.0012	-659.8	1.2	8660	30	9270	9413	9341.5
DR904D	A. cervicornis	LC	-4.5	0.3409	0.0012	-659.1	1.2	8645	30	9253	9404	9328.5
DR901B	A. cervicornis	LC	-4.5	0.3419	0.0012	-658.1	1.2	8620	30	9221	9390	9305.5
907 B	A. cervicornis	LC	-4.0	0.3425	0.0016	-657.5	1.6	8605	40	9186	9379	9282.5
908 B	A. cervicornis	LC	-4.0	0.3459	0.0012	-654.1	1.2	8530	30	9077	9256	9166.5
912	A. cervicornis	LC	-4.0	0.3500	0.0014	-650.0	1.4	8435	35	8968	9130	9049
917	A. cervicornis	LC	-3.0	0.3508	0.0014	-649.2	1.4	8415	35	8949	9117	9033
910	A. cervicornis	LC	-4.0	0.3516	0.0014	-648.4	1.4	8395	35	8916	9099	9007.5
909 B	A. cervicornis	LC	-4.0	0.3536	0.0014	-646.4	1.4	8350	35	8838	9014	8926
DR933	A. cervicornis	LC	-3.5	0.3590	0.0012	-641.0	1.2	8230	30	8636	8857	8746.5
914	A. cervicornis	LC	-3.5	0.3594	0.0014	-640.6	1.4	8220	35	8625	8848	8736.5
DR930B	A. cervicornis	LC	-3.5	0.3597	0.0014	-640.3	1.4	8215	35	8619	8842	8730.5
DR924	A. cervicornis	LC	-3	0.3616	0.0016	-638.4	1.6	8170	35	8561	8759	8660
916	A. cervicornis	LC	-3.5	0.3621	0.0014	-637.9	1.4	8160	35	8549	8743	8646
DR926	A. cervicornis	LC	-3	0.3625	0.0013	-637.5	1.3	8150	30	8540	8721	8630.5
DR932	A. cervicornis	LC	-3.5	0.3629	0.0013	-637.1	1.3	8145	30	8536	8715	8625.5
DR921B	A. cervicornis	LC	-3	0.3658	0.0012	-634.2	1.2	8075	30	8448	8595	8521.5
DR928	A. cervicornis	LC	-3	0.3667	0.0013	-633.3	1.3	8060	30	8442	8580	8511
DR918	A. cervicornis	LC	-4	0.3694	0.0013	-630.6	1.3	8000	30	8396	8518	8457
DR935	A. cervicornis	LC	-3.5	0.3712	0.0013	-628.8	1.3	7960	30	8361	8482	8421.5
DR940	A. cervicornis	LC	-2.5	0.3713	0.0013	-628.7	1.3	7960	30	8361	8482	8421.5
DR937	A. cervicornis	LC	-3.5	0.3719	0.0013	-628.1	1.3	7945	30	8346	8466	8406
DR947C	A. cervicornis	LC	-2.5	0.3794	0.0017	-620.6	1.7	7785	40	8185	8320	8252.5
DR943	A. cervicornis	LC	-2.5	0.3799	0.0013	-620.1	1.3	7775	30	8182	8308	8245
DR949B	A. cervicornis	LC	-2.5	0.3832	0.0013	-616.8	1.3	7705	30	8106	8267	8186.5
DR945	A. cervicornis	LC	-2.5	0.3834	0.0013	-616.6	1.3	7700	30	8097	8260	8178.5
DR954	A. cervicornis	LC	-2.5	0.3862	0.0013	-613.8	1.3	7640	30	8025	8160	8092.5
DR951	A. cervicornis	LC	-2.5	0.3864	0.0017	-613.6	1.7	7640	40	8019	8164	8091.5
DR955	A. cervicornis	LC	-2.5	0.3877	0.0013	-612.3	1.3	7610	30	8005	8138	8071.5
DR960B	A. cervicornis	LC	-2.5	0.4010	0.0014	-599.0	1.4	7340	30	7730	7871	7800.5
DR958	A. cervicornis	LC	-2.5	0.4028	0.0015	-597.2	1.5	7305	30	7695	7830	7762.5
DR964	A. cervicornis	LC	-2.5	0.4049	0.0015	-595.1	1.5	7265	35	7660	7793	7726.5
DR966	A. cervicornis	LC	-2.5	0.4063	0.0014	-593.7	1.4	7235	30	7636	7765	7700.5
DR968B	A. cervicornis	LC	-2.5	0.4074	0.0014	-592.6	1.4	7215	30	7612	7738	7675
DR962	A. cervicornis	LC	-2.5	0.4082	0.0018	-591.8	1.8	7200	40	7594	7726	7660
DR970	A. cervicornis	LC	-1.5	0.4093	0.0014	-590.7	1.4	7175	30	7577	7689	7633
DR974	A. cervicornis	LC	-1.5	0.4099	0.0014	-590.1	1.4	7165	30	7571	7679	7625
DR972	A. cervicornis	LC	-1.5	0.4112	0.0016	-588.8	1.6	7140	35	7558	7666	7612
DR976B	A. cervicornis	LC	-1.5	0.4152	0.0014	-584.8	1.4	7060	30	7485	7593	7539
DR981B	A. cervicornis	LC	-1.5	0.4191	0.0015	-580.9	1.5	6985	30	7430	7533	7481.5
DR979	A. cervicornis	LC	-1.5	0.4200	0.0016	-580.0	1.6	6970	35	7418	7524	7471
DR983	A. cervicornis	LC	-1.5	0.4223	0.0015	-577.7	1.5	6925	30	7385	7496	7440.5
DR992	A. cervicornis	LC	-1.5	0.4226	0.0015	-577.4	1.5	6920	30	7379	7491	7435
DR991	A. cervicornis	LC	-1.5	0.4249	0.0015	-575.1	1.5	6875	30	7323	7439	7381
DR989B	A. cervicornis	LC	-1.5	0.4279	0.0016	-572.1	1.6	6820	30	7293	7404	7348.5
DR987	A. cervicornis	LC	-1.5	0.4296	0.0017	-570.4	1.7	6785	35	7255	7377	7316

Table DR2. Additional Age and Isotope Data

Sample ID	Speciman	Location	Lat	Long	Radiocarbon Age	mean d18O	N
DR A1-3	*A. cervicorni*	LC	18 30.077 N	71 32.800 W	9362 +/- 73		
DR E1-6	*A. cervicorni*	LC	18 30.077 N	71 32.800 W	9088.5 +/- 84		
DR J2-6	*A. cervicorni*	LC	18 30.077 N	71 32.800 W	8861 +/- 15.5		
DR 21-7J	*A. cervicorni*	LC	18 30.077 N	71 32.800 W	8292.5 +/-64.5		
DR 21-5J	*A. cervicorni*	LC	18 30.077 N	71 32.800 W	7711.5+/-64.5		
DR 21-3Jb	*A. cervicorni*	LC	18 30.077 N	71 32.800 W	7328.5+/-57.5		
DR KD D3	*A. cervicorni*	LC	18 30.077 N	71 32.800 W	5854+/-78	-2.61	150
DR CG B1-5	*A. cervicorni*	CG	18 32.576	71 47.968	5699+/-80	-2.94	92
DR CH1.5	*A. cervicorni*	CH	18 32.020 N	71 37.202 W	5800+/-71		
DR CH1.7 1	*A. cervicorni*	CH	18 32.020 N	71 37.202 W	5382+/-71		
*DR LD**	*Tellina goulc*	*LC*	18 30.077 N	71 32.800 W	*8577*		
*DR LP**	*Codakia orb*	*LC*	18 30.077 N	71 32.800 W	*8382*		
*DR KG**	*Arcopsis ad*	*LC*	18 30.077 N	71 32.800 W	*5608*		

Age is reported in Calyr with 1 sigma value.

**Additional dates obtained from non A. cervicornis material courtesy of A. Martini*

d18O values are reported relative to PDB
N = number of powdered carbonate samples analysed from each individual coral sample

all d18O values were analyzed by were roasted in vacuo at 200°C and analyzed by reaction with phosphoric acid at 70°C using a Kiel-III carbonate preparation device directly coupled to a Thermo-Finnigan MAT 252 in the Saskatchewan Isotope Laboratory.