

Growth estimates of Caribbean reef sponges on a shipwreck using 3D photogrammetry

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Supplementary Information

Supplementary Table 1 Approximated ages (d_t), measured volumes (V), and specific growth rates (SGR) of the largest individual of each sponge species from the Tibbetts and Spiegel Grove shipwrecks. Chemically defended species in bold

Shipwreck	Order	Species	d_t (y)	V (ml)	SGR
Tibbetts	Astrophorida	<i>Geodia neptuni</i>	8.74	53,296	1.061
	Dictyoceratida	<i>Ircinia felix</i>	8.74	21,047	0.955
		<i>Smenospongia aurea</i>	8.74	16,663	0.928
		<i>Smenospongia conulosa</i>	8.74	13,387	0.903
	Verongida	<i>Aiolochoxia crassa</i>	8.74	23,878	0.969
		<i>Aplysina fistularis</i>	8.74	30,546	0.997
		<i>Verongula gigantea</i>	8.74	76,641	1.103
Spiegel Grove (Pawlik et al. 2008)	Haplosclerida	<i>Callyspongia fallax</i>	4.44	3,840	1.529
		<i>Callyspongia vaginalis</i>	4.43	2,720	1.450
		<i>Niphates digitalis</i>	4.33	420	1.022
		<i>Niphates erecta</i>	4.33	310	0.952
	Poecilosclerida	<i>Iotrochota birotulata</i>	4.33	550	1.084
		<i>Strongylacidon sp.</i>	4.33	270	0.920
		<i>Desmapsamma anchorata</i>	4.33	760	1.159
		<i>Mycale laxissima</i>	4.35	1,010	1.222

Appendix S1 – Age estimations of Tibbetts sponges using the generalized von Bertalanffy growth function (gVBGF; McMurray et al. 2008)

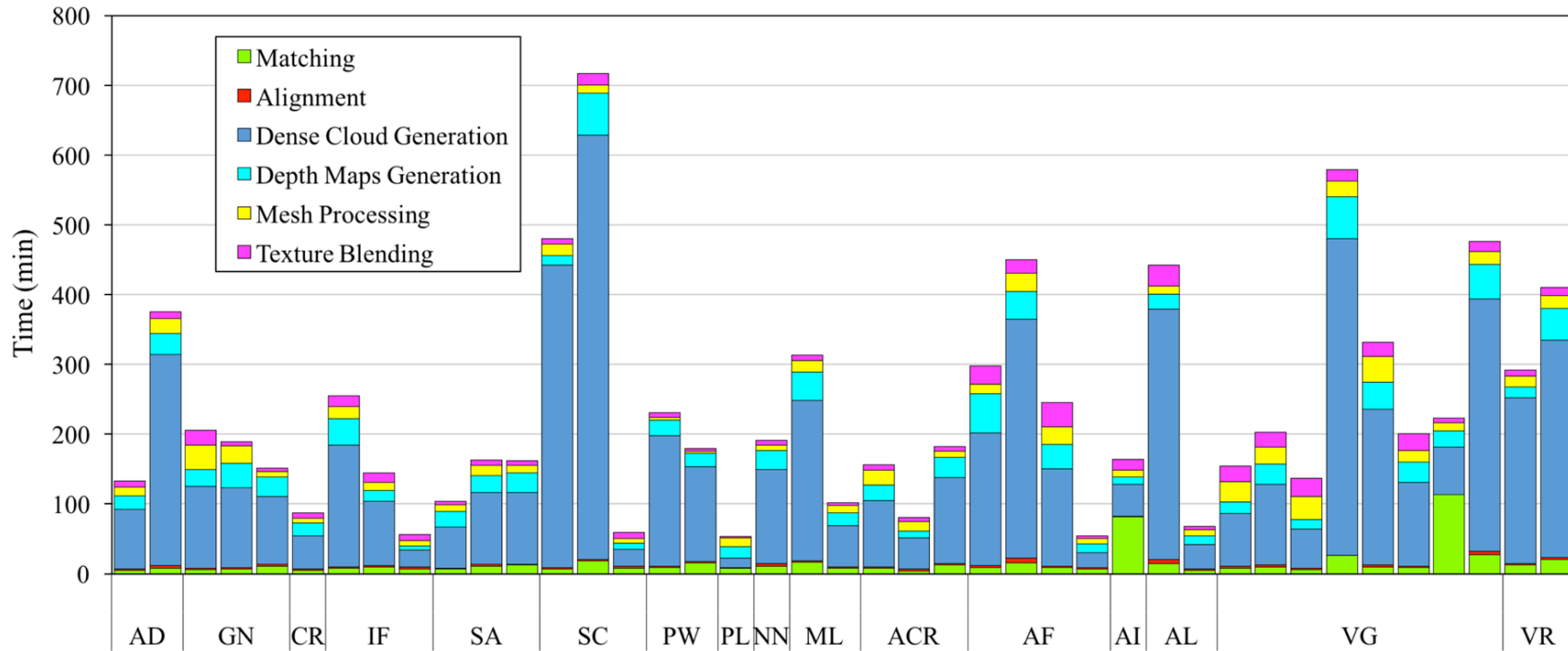
The ages of all individuals were estimated using a generalized von Bertalanffy growth formula (gVBGF) and previously published parameter estimates for *X. muta* (McMurray et al., 2008). The equation for the gVBGF is

$$S_2 = (S_\infty^{1/D} (1 - e^{-K*dt}) + S_1^{1/D} (e^{-K*dt}))^D$$

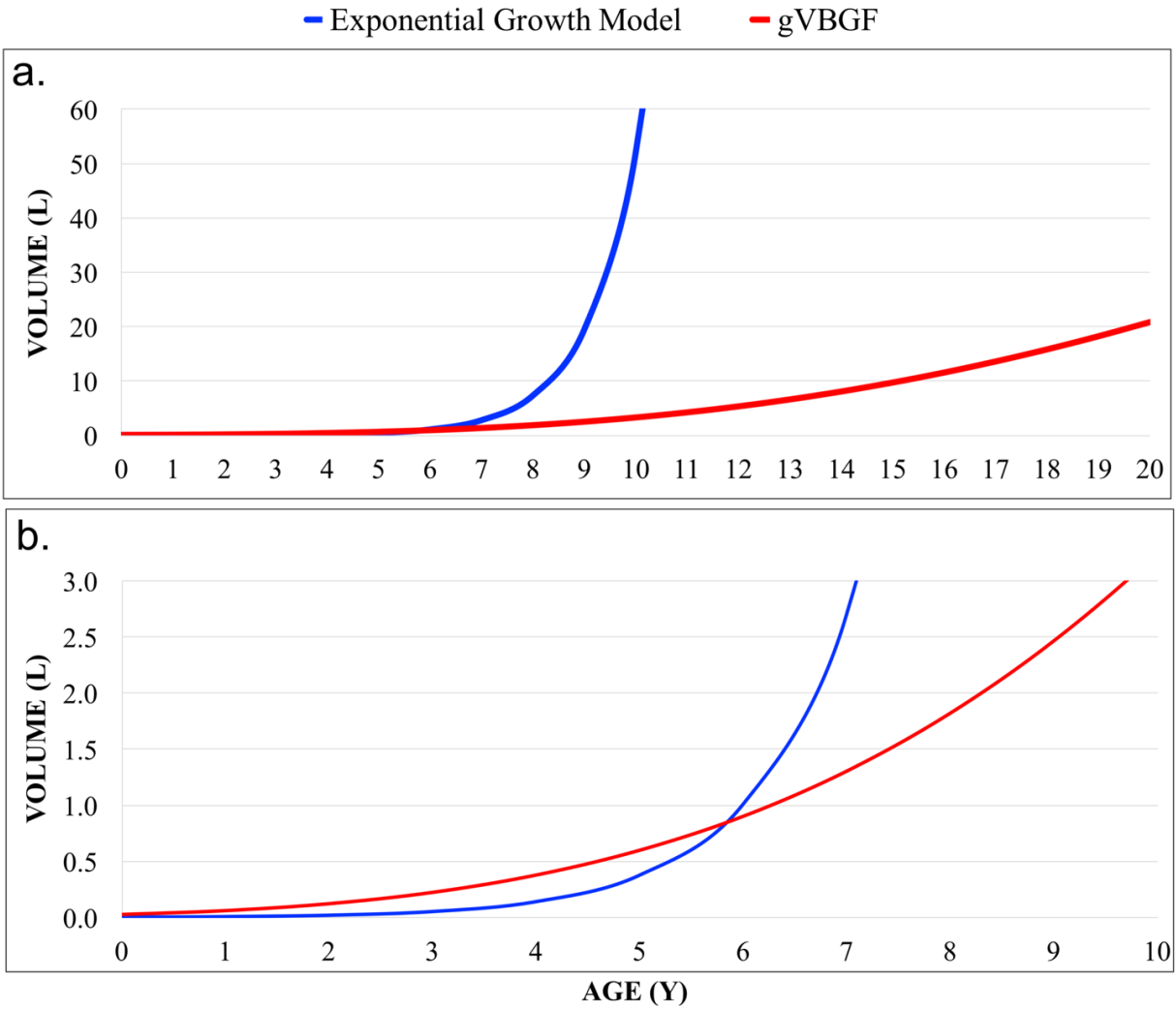
where S_∞ is the cube root of the volume reached at infinite period of growth, K is the relative growth rate, and D determines the shape of the curve. Equation 4 was solved for dt in order to calculate the age of each individual. The cube root of the volume of each individual was assigned to S_2 , and the remaining variables were assigned their original values reflecting the growth of *X. muta* ($S_\infty = 66.1211$, $K = 0.0388$, $D = 1.8972$, $S_1 = 2.89$) (McMurray et al., 2008).

Supplementary Table 2 Volumes and surface areas for each individual, and estimated ages for the largest individuals from each species from the exponential growth model (Wilkinson and Cheshire 1988) and gVBGF (McMurray et al. 2008). Chemically defended species in bold

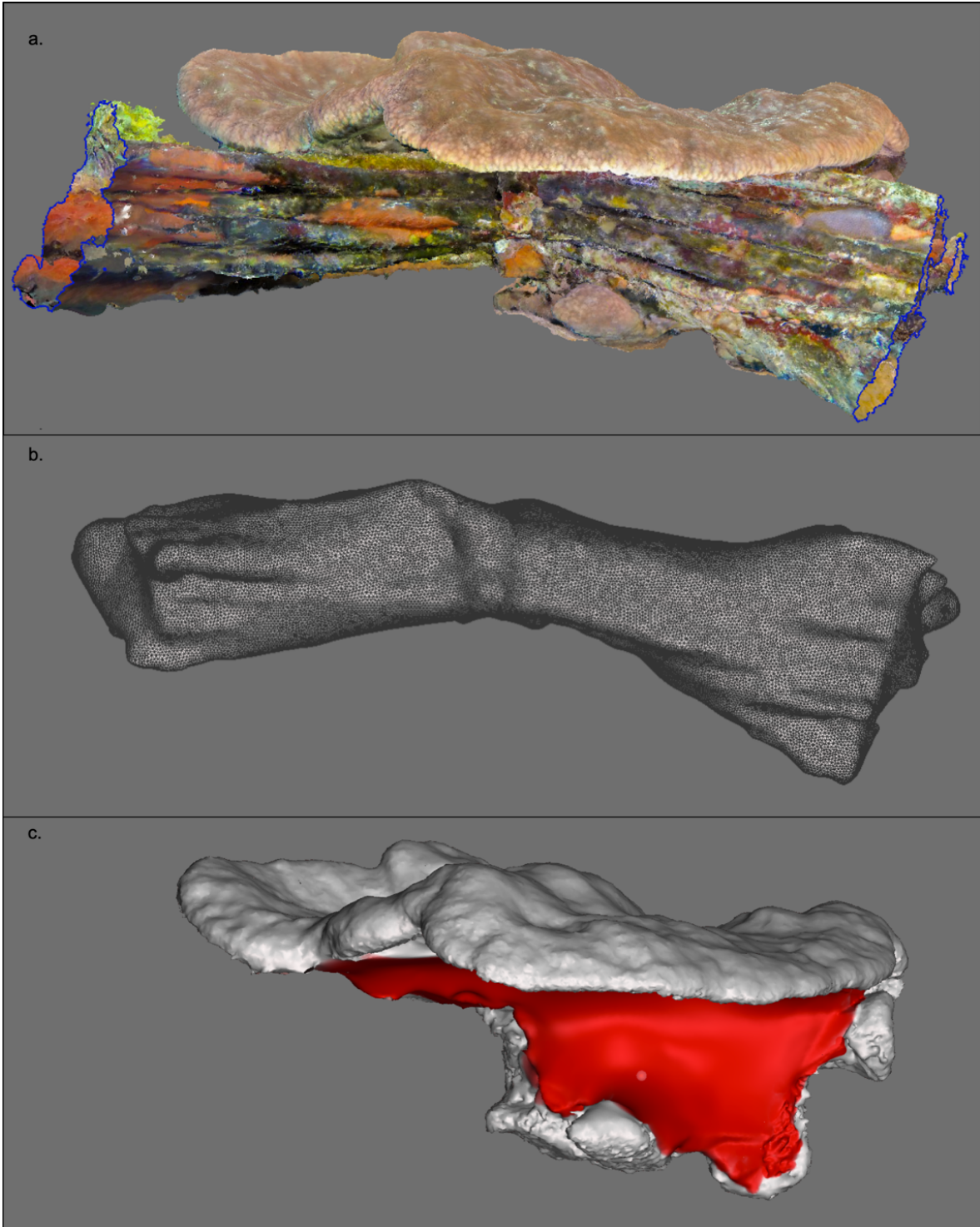
Order	Species	#	V (mL)	SA (cm ²)	Estimated age (exponential growth model)	Estimated age (gVBGF)
Agelasida	<i>Agelas dilitata</i>	1	5,954	3,647	7.8	12.53
		2	4,984	3,298	-	-
Astrophorida	<i>Geodia neptuni</i>	1	53,296	10,470	10.0	29.38
		2	15,863	3,990	-	-
		3	14,257	3,115	-	-
Chondrosida	<i>Chondrosia reniformis</i>	1	5,919	2,357	7.8	12.50
Dictyoceratida	<i>Ircinia felix</i>	1	21,047	4,918	9.1	20.07
		2	18,525	5,214	-	-
		3	7,436	2,197	-	-
	<i>Smenospongia aurea</i>	1	16,663	6,667	8.8	18.36
		2	13,001	7,774	-	-
		3	2,516	2,508	-	-
	<i>Smenospongia conulosa</i>	1	13,387	5,086	8.6	16.91
		2	9,729	3,000	-	-
		3	8,436	3,553	-	-
Halichondrida	<i>Ptilocaulis walpersi</i>	1	479	1,270	5.2	4.50
		2	196	383	-	-
Homosclerophorida	<i>Plakortis sp.</i>	1	6,569	2,391	7.9	12.99
Poecilosclerida	<i>Neofibularia nolitangere</i>	1	3,245	1,732	7.2	13.57
		1	1,645	1,364	8.0	9.99
	<i>Mycale laxissima</i>	2	7,390	2,930	-	-
Verongida	<i>Aiolochoiria crassa</i>	1	23,878	9,224	9.2	21.08
		2	13,788	4,651	-	-
		3	2,221	1,340	-	-
	<i>Aplysina fistularis</i>	1	30,546	11,801	9.5	23.24
		2	24,347	17,444	-	-
		3	20,318	14,235	-	-
		4	6,705	6,514	-	-
	<i>Aplysina insularis</i>	1	17,772	13,600	8.9	18.81
	<i>Aplysina lacunosa</i>	1	11,491	4,346	8.5	15.97
		2	9,080	3,689	-	-
	<i>Verongula gigantea</i>	1	76,641	9,792	10.4	34.83
		2	55,630	15,020	-	-
		3	53,736	18,884	-	-
		4	22,366	11,478	-	-
		5*	35,422	18,136	-	-
		5*	35,276	18,137	-	-
		5*	34,744	18,036	-	-
		5*	33,901	17,767	-	-
		<i>Verongula rigida</i>	1	8,855	19,262	8.2
2			2,302	4,145	-	-



Supplementary Figure 1 Time required to process each mesh, separated by reconstruction step. Individuals sorted into species. AD = *Ag. dilitata*, GN = *G. neptuni*, CR = *C. reniformis*, IF = *I. felix*, SA = *S. aurea*, SC = *S. conulosa*, PW = *P. walpersi*, PL = *Plakortis* sp., NN = *N. nolitangere*, ML = *M. laxissima*, ACR = *Ai. crassa*, AF = *Ap. fistularis*, AI = *Ap. insularis*, AL = *Ap. lacunosa*, VG = *V. gigantea*, VR = *V. rigida*.



Supplementary Figure 2 Size at age estimates from the exponential growth model for *A. crassa* (Wilkinson and Cheshire 1988), and gVBGF with parameters for *X. muta* (McMurray et al. 2008). a) estimates for sponges up to 20 yo; b) estimates for sponges up to 10 yo.



Supplementary Figure 3 3D model of *Agelas dilitata* a. Textured mesh showing sponge wrapped around bundle of cables; b. 3D object representing bundle of cables; c. Water-tight mesh showing isolated *A. dilitata* after Boolean difference operation to subtract volume representing cables. Surface created by Boolean operation highlighted in red. The textured mesh can be viewed at <https://skfb.ly/6wRRP>

References

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