## Simulating the Geometric Growth of the Marine Sponge Crella Incrustans (supplementary material)

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## 1 SUPPLEMENTARY

Below we present additional results (all at 50 growth iterations) by showing how changing simulation parameters can produce a large variation in the geometric shape of the sponge. All evaluations used the default simulation parameter values (Table 1) with 50 growth iterations, except for the parameters being changed. See the results in Figures 1, 2, 3, 4, 5, 6, 7. We also show additional photo comparisons in Figure 8 and reference photos in Figure 9.

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Name	Description	Default Value
diffusion limited	If set to true, the velocity vector	True
	is set to 0 in the advection-diffusion equation.	
concentration offset distance	How far along the normal concentration values	0.1
	should be interpolated.	
box resolution	Determines how many times to subdivide the	2
	FEM box mesh, with 1 being no subdivision.	
	More subdivisions means more points of the	
	mesh where the nutrient concentration is solved for.	
sponge resolution	The subdivision level of the initial sponge	4
	icosphere mesh. More subdivisions means	(642 triangles)
	a more accurate growth pattern.	
growth rate	A float which scales the distance a sponge vertex	5
	grows in the direction of the normal.	
growth threshold	The growth length needed for the vertex	0
	to actually grow.	
vertex insertion threshold	If the distance between two vertices is	0.6
	larger than this number, a vertex is inserted between them.	
vertex fusion threshold	If the distance between two vertices is	0.5
	lower than this number, the two vertices are fused into one.	
triangle area deletion threshold	If the area of a triangle is	0.1
	smaller than this value, the triangle is deleted by fusing	
	together the two vertices of the shortest side.	
Chindapol kinetic order	The kinetic order of the growth rate with respect to $C_i$	1.4
	in the Chindapol growth equation.	
Chindapol characteristic growth constant	A constant which influences the characteristic growth curve	1
	in the Chindapol growth equation.	
skeletal growth type	Either Radiate accretive	Radiate
	(which is present in the sponge Haliclona occulata), or	accretive
	Halichondrid (which is present in the sponge Crella incrustans).	
normal offset radius	The length of the random displacement	0.02
	vector applied to the normal.	
max nvs iterations	The maximum number of Navier Stokes non-linear solver iterations	100
	where more iterations means more	
	accuracy in the fluid simulation results.	

Table 1: The main simulation parameters and their default values.



Figure 1: Changing the *concentration offset distance* simulation parameter. This parameter determines how far along the normal concentration values are interpolated.

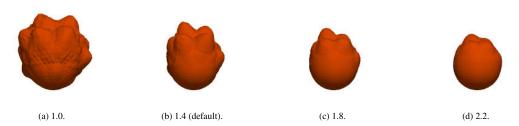


Figure 2: Changing the Chindapol kinetic order simulation parameter. This parameter determines how much the sponge spreads out.

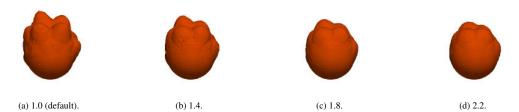


Figure 3: Changing the Chindapol characteristic growth constant simulation parameter. This parameter controls the asymptotic growth curve.

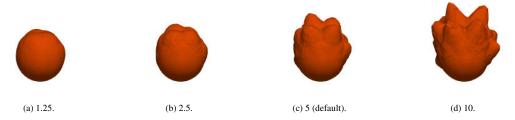


Figure 4: Changing the growth rate simulation parameter. The growth rate determines how much the sponge grows for each iteration.



Figure 5: Changing the *sponge resolution* simulation parameter. The sponge resolution is the subdivision level of the initial icosphere sponge mesh.

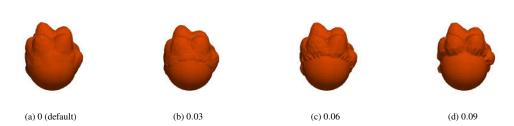


Figure 6: Changing the *nutrient growth threshold* simulation parameter. The sponge will only grow if the growth distance of the vertex is larger than the nutrient growth threshold value.

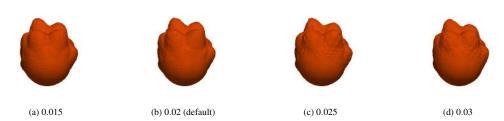


Figure 7: Changing the *normal offset* simulation parameter. This controls the maximum offset value when randomly offsetting the vertex normals.

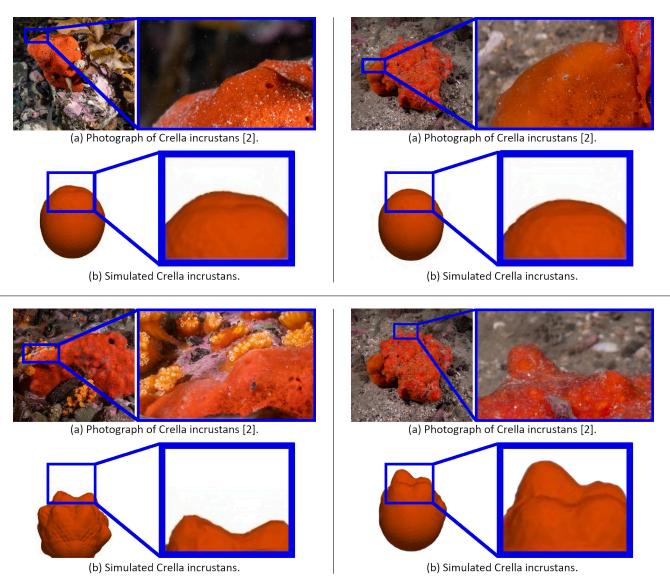


Figure 8: Four examples comparing (a) a real-life photo with (b) the simulated Crella incrustans sponge.



Figure 9: Photographs of the marine sponge Crella incrustans.