

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

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**Index Terms:** Computing methodologies—Computer graphics—Shape modeling; Computing methodologies—Modeling and simulation; Human-centered computing—Visualization—Scientific visualization

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

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

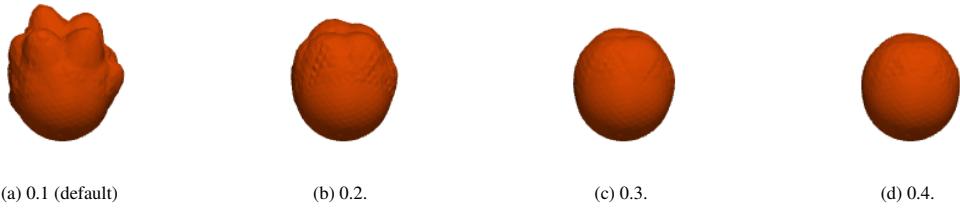


Figure 1: Changing the *concentration offset distance* simulation parameter. This parameter determines how far along the normal concentration values are interpolated.

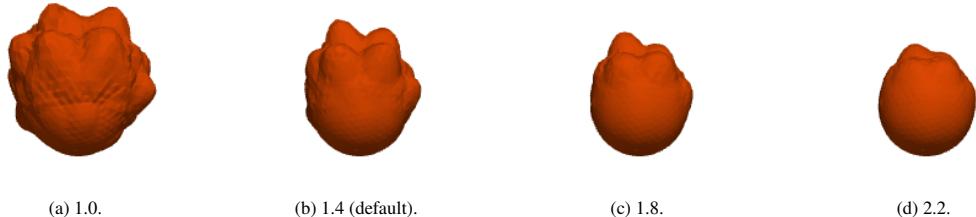


Figure 2: Changing the *Chindapol kinetic order* simulation parameter. This parameter determines how much the sponge spreads out.

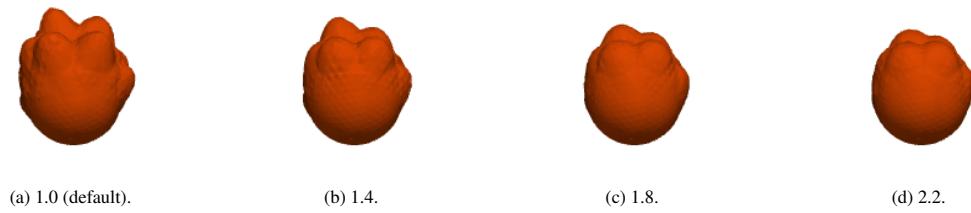


Figure 3: Changing the *Chindapol characteristic growth constant* simulation parameter. This parameter controls the asymptotic growth curve.

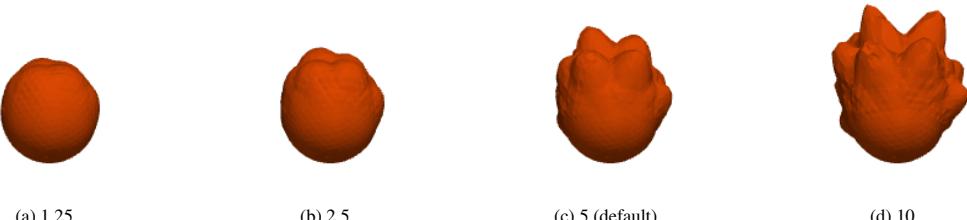


Figure 4: Changing the *growth rate* simulation parameter. The growth rate determines how much the sponge grows for each iteration.

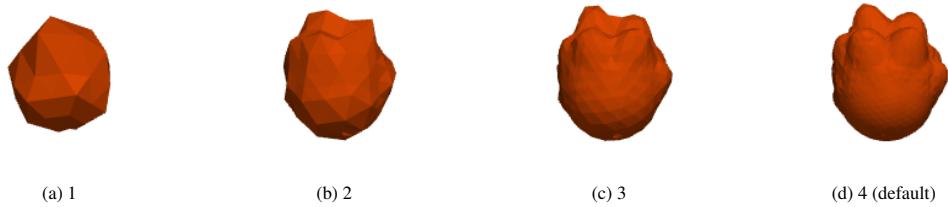


Figure 5: Changing the *sponge resolution* simulation parameter. The sponge resolution is the subdivision level of the initial icosphere sponge mesh.

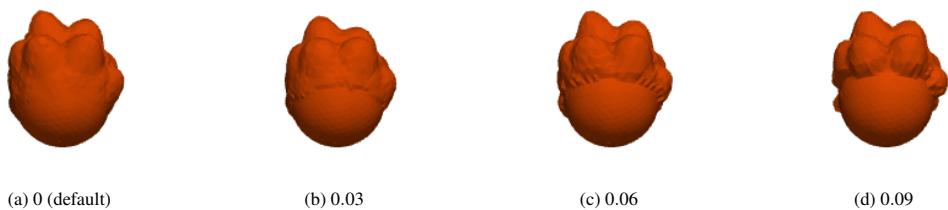


Figure 6: Changing the *nutrient growth threshold* simulation parameter. The sponge will only grow if the growth distance of the vertex is larger than the nutrient growth threshold value.

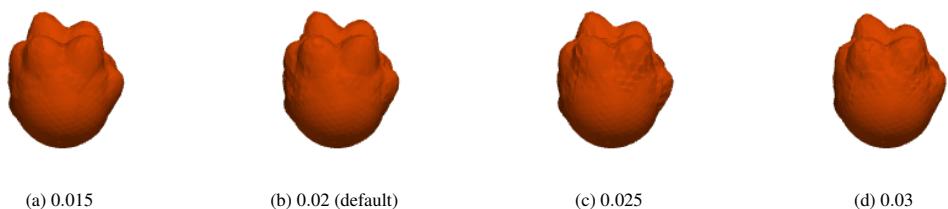
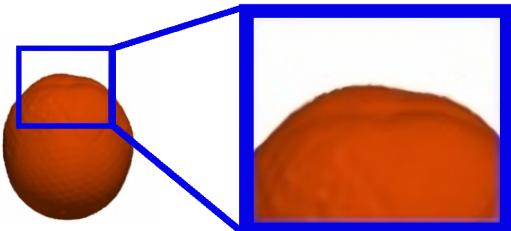


Figure 7: Changing the *normal offset* simulation parameter. This controls the maximum offset value when randomly offsetting the vertex normals.



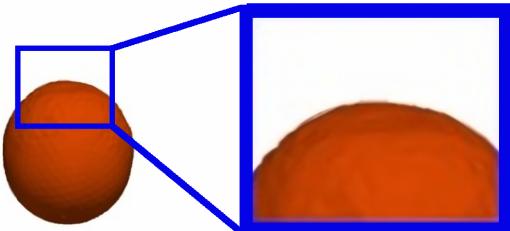
(a) Photograph of *Crella incrustans* [2].



(b) Simulated *Crella incrustans*.



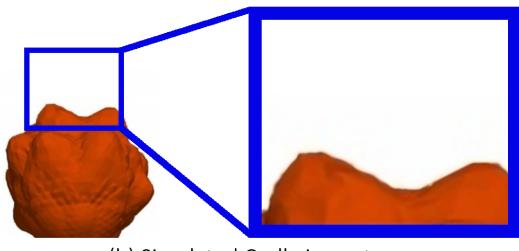
(a) Photograph of *Crella incrustans* [2].



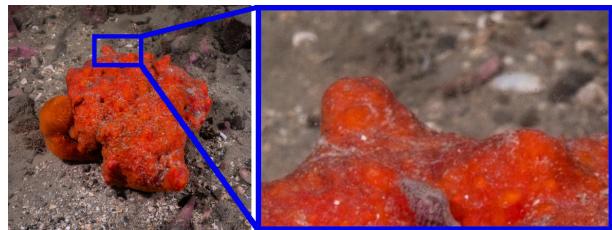
(b) Simulated *Crella incrustans*.



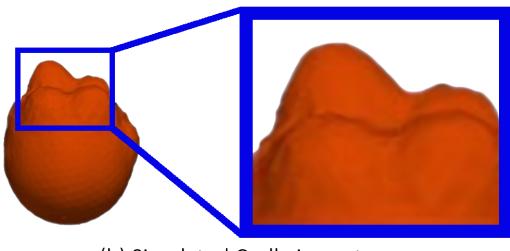
(a) Photograph of *Crella incrustans* [2].



(b) Simulated *Crella incrustans*.



(a) Photograph of *Crella incrustans* [2].



(b) Simulated *Crella incrustans*.

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*.