Supplementary Information: Modelling genetic regulation of growth and form in a branching sponge

Jaap A. Kaandorp, Joke G. Blom, Jozef Verhoef, Max Filatov, Marten Postma and Werner E.G. Müller

Parameters regulatory network model

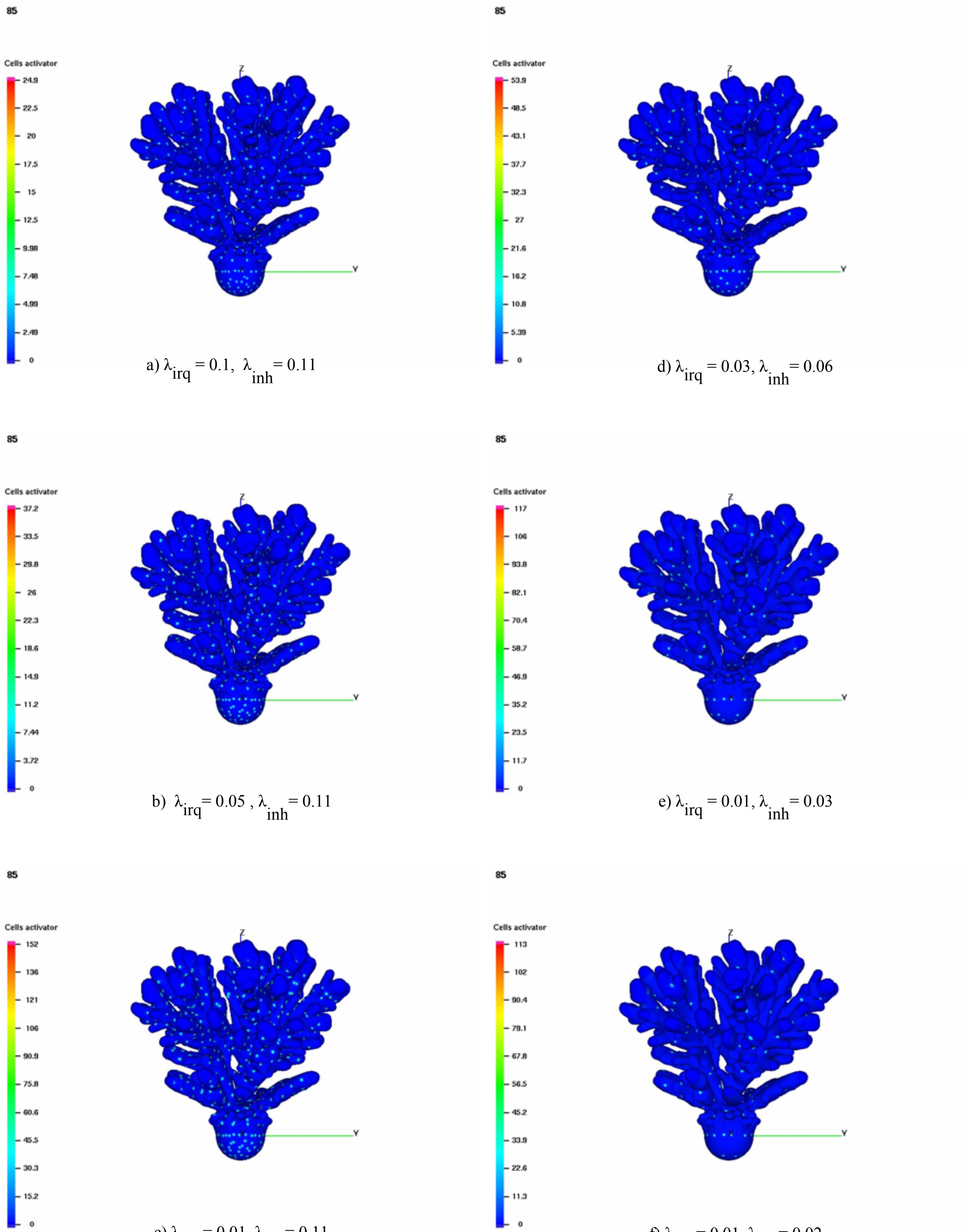
The parameters of the regulatory system described by equations 2.3-2.5 are presented in Table 1. This set of parameters ensures the stability of the reaction-diffusion computation on the sponge surface. Stable patterns are formed when the inhibitor diffuses faster than the activator ($D_{inh} >> D_{irq}$) and when the inhibitor has a greater decay rate ($\lambda_{inh} > \lambda_{irq}$) (Koch & Meinhardt 1994).

Table 1. Parameters of the regulatory network model described in equations.2.3-2.5.

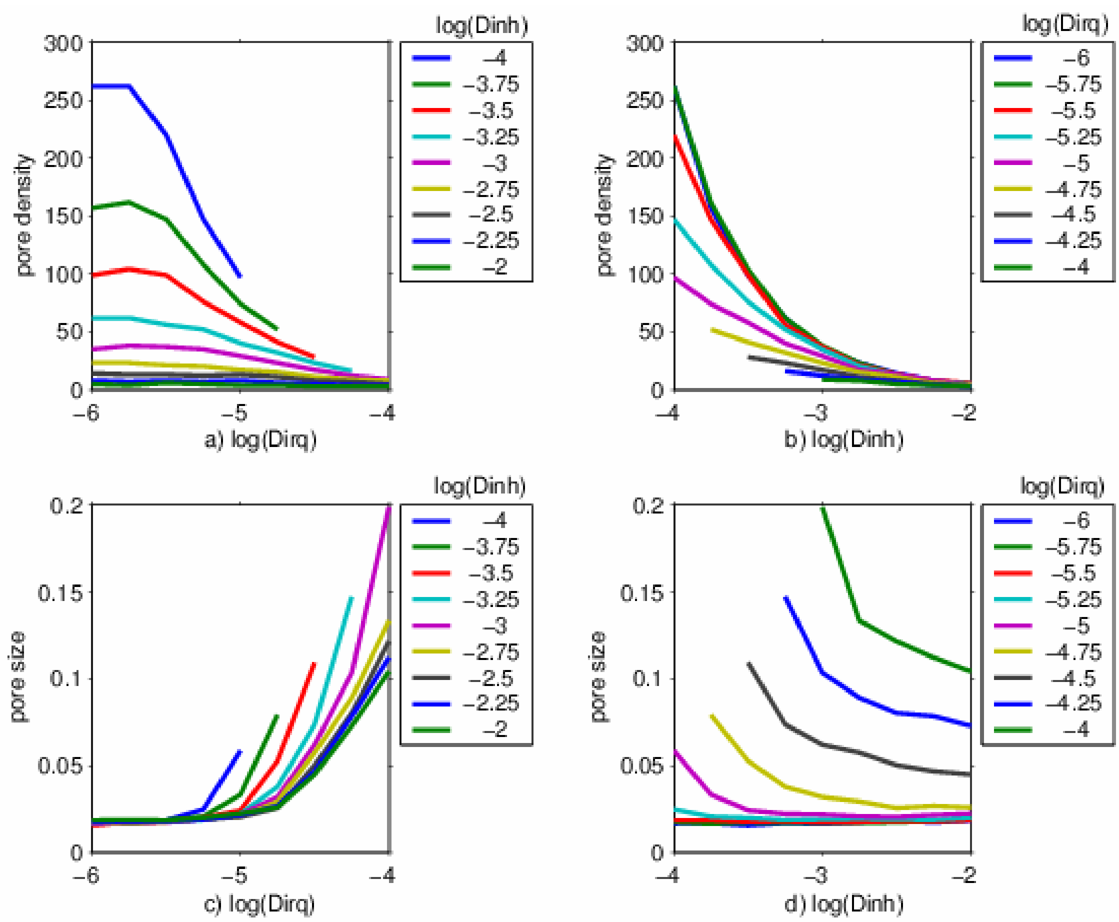
Parameter	Value	Description
δ_{sil}	0.025	*Silicatein-Iroquois* suppression threshold value
D_{irq}	$2\cdot10^{-6}$	Diffusion constant for *Iroquois*
D_{inh}	$2\cdot10^{-3}$	Diffusion constant for the inhibitor of *Iroquois*
λ_{irq}	0.1	Decay parameter for *Iroquois*
λ_{inh}	0.11	Decay parameter for the inhibitor of *Iroquois*
k_1	0.1	Gierer-Meinhardt model parameter
k_3	0.01	Gierer-Meinhardt model parameter
k_4	0.1	Gierer-Meinhardt model parameter
k_5	0.001	Gierer-Meinhardt model parameter

Variation in the parameters affects pore-pattern formation on the surface. The important parameters of the system are diffusion (*D*) and decay (λ) of activator (*irq*) and inhibitor (*inh*). The combination of these two parameters determines how far each substance is spread over the surface of a sponge and its concentration. For instance, if decay of the activator decreases while diffusion remains constant its range will expand. Consequently the pores density will increase as shown in S-figure 2a,b,c. When both parameters λ_{inh} and λ_{irq} are reduced the ranges of activator and inhibitor are mostly determined by diffusion. Since the inhibitor diffuses much faster than activator it suppresses the pore formation. Therefore, pore density decreases as shown in S-figure 2d. Further decrease of decay will result in fewer pores in the simulated object of S-figure 2e,f. By tuning these two parameters the desired density of the pores can be achieved.

S-figure 3 shows the pore density and the pore size for a range of D_{irq} and D_{inh} in a two-dimensional simulation (similar boundary conditions as used by Koch & Meinhardt (1994) while all other parameters of the model remain unchanged. In S-figure 3a and c it is shown that for an increasing D_{irq} the pore density decreases while the pore size increases. S-figure 3b and d demonstrates that the pore density decreases for an increasing D_{inh} while the pore size decreases.



S-figure 2. Pore density dependent on decay of activator and inhibitor. The other parameters of the model remain unchanged. The morphologies are shown after 85 iterations. Concentration of Iroquois is shown on the coloured bar on the left.



S-figure 3. Pore densities (pore densities are measured as the number of pores in a unit square) for respectively a range of D_{irq} (a) and D_{inh} (b) . Pore size (measured on a unit square) for respectively a range of D_{irq} (c) and D_{inh} (d) . The other parameters of the model remain unchanged.