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Numerical solutions of a mathematical model of pattern formation in coral reefs

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Reaction-diffusion type mathematical model for formation of coral patterns under no-flux boundary conditions has been considered. Turing type instability analysis is done in order to determine the Turing space (or the parameter space that corresponds to the spatial pattern formation) of the considered Reaction Diffusion system (RDS). The model is solved numerically in one dimensional and two dimensional spaces when the parameters satisfy the Turing instability criteria.

In particular, it has been observed that, when λ (a dimensionless parameter corresponding to several parameters such as depth, diffusivity etc) is fixed, the heterogeneity of the patterns increase as another dimensionless parameter α (which is also related to the rate of a reaction as well to the other parameters mentioned in the above) increases from its critical value. According to the density plots of the numerical solutions on two dimensional space, spots replication patterns were observed for particular parameter values. In particular, in 3D (2D-space and time) visualizations generated with MATLAB, we could obtain spatial branching structures in the above spots replication process. These branching structures whose behavior vary with parameter values as well as the domain sizes, resemble the branching structures of stony corals.

Keywords: Reaction-Diffusion Systems, Turing Instability , Coral pattern formation