Abstract

The objective of this thesis is to construct some mathematical models for formation of coral patterns and study these models analytically and numerically. In this thesis three mathematical models for growth of corals in a tank are proposed. Two of them are for the growth of corals taken place in a well stirred tank. These are Reaction Systems (system of ODEs) and describe the overall time evolution of the nutrient (food of polyps) concentration and coral (calcium carbonate) concentration. The other model is for the growth of corals taken place in an unstirred tank. This model is a Reaction-Diffusion System (RDS) and it describes the spatial time evolution of nutrient and coral concentrations. Also a Reaction-Diffusion-Advection (RDA) type mathematical model is presented based on the model appeared in [5].

The derived Reaction Systems and Reaction Diffusion System (RDS) are analyzed separately. Stability and forms of the solutions of the considered system of ODEs are investigated. Different types of growth forms of the coral (depend on the parameter values and initial states) are observed based on the solution behavior of the considered Reaction System (RS).

It is well known fact that if a Reaction Diffusion System satisfy Turing instability conditions then spatial temporal patterns may occurred. It is observed that the constructed RDS model satisfy Turing instability conditions for some parameter values (called Turing space) of the model. The corresponding system of RDS is solved numerically in one dimensional and two dimensional spaces when parameters lie in Turing space. It is observed that these numerical solutions form some branching patterns which are somewhat similar to the branching patterns of stony corals. Following are the new results presented in this thesis:

- Reaction type and Reaction-Diffusion type mathematical models derived in (4).
- Local and Global stability results of the considered Reaction type model and different types of growth forms of corals based on these stability results presented in chapter (5).
- Turing instability regions of the considered Reaction-Diffusion type model are identified in chapter (6).
- Branching coral like structures formed in (7) based on numerical solutions of the considered Reaction-Diffusion type model.
- The existence and non-existence results of stationary solutions of the considered model are obtained in chapter (8).