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An Integral Equation Model for a Binary Fission Process

Graham K. Winley

Department of Information Technology, Faculty of Science and Technology, Assumption University, Bangkok, 10240, Thailand.

E-mail: gkwinley@scitech.au.edu

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Abstract

A new probabilistic modeling approach is used to describe the transient and stable stages of growth of a population consisting of viable cells and vegetative cells. Viable cells are capable of division at the end of a random life-time (generation time) and when a cell divides it produces exactly two newborn cells. On average, at time t, α(t) of these two newborn cells are viable cells and 2 - α(t) are vegetative cells, which do not divide at any time. The model is developed by modifying the integral equation used by demographers to study the growth of human populations. The solution of the model is studied using various biologically plausible assumptions concerned with the inputs α(t) and the probability distribution of the generation time and comparisons made with other modeling approaches indicate that the new model is easier to formulate and analyze, provides a more complete analysis, and enables the incorporation of assumptions concerning environmental and internal cell factors that influence the production rate of viable cells.

Keywords: age structured generation time distribution, integral (renewal) equation, transient and stable stages of growth, vegetative parameter, viable and vegetative cells.