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Limit models for a general class of branching processes with memory and population dependence in large populations

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Abstract

We consider a general class of multitype branching processes in discrete time with memory and population size dependence, that may be particularly useful in population dynamics. In this general setting the long term behaviour of this class of processes is an open difficult question. So we rather consider the limit models of this process, as the initial population size tends to $\infty$, either when normalized by the current size of the whole population, or without any normalization, considering then the only rare types of the process. In the first setting, we show that the normalized process, as long as it is not extinct, has the same asymptotic time behaviour as the corresponding deterministic dynamical system on individual probabilities. In the second setting, we show that the limit process concerning the rare types, may be reduced to a memory-dependent Bienaymé-Galton-Watson process (extension of the classical singletype BGW process). We study the asymptotic time behaviour of this class of processes. Moreover, in the subcritical case, we give the distribution of the extinction time and of the size of the tree until extinction. In both settings (nonrare types or rare types), we give a upper bound of the error between the original process (or its transitions) and the limit.