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Models for population growth in a randomly varying environment and the stochastic calculus used

Autonomous stochastic differential equations (SDE) are commonly used to model the growth of populations in randomly varying environments. However, depending on the stochastic calculus used, different results are obtained both quantitatively and qualitatively. This fact compromises the application of such models. In previous papers we have considered Itô and Stratonovich calculi and have shown that the apparent difference between their results was due to the fact that the deterministic part of the SDE, interpreted as the average growth rate, was indeed representing different types of averages under the two calculi. If one takes into account the difference between the two averages, the results obtained under the two calculi are completely coincidental. In reality, besides these two calculi, there is a whole continuum of stochastic calculi which can be parameterized by a continuous parameter α varying between 0 (Itô calculus) and 1, where $\alpha=1/2$ corresponds to the Stratonovich calculus. Here we study this much more general situation. We also show that, in a certain sense, the Stratonovich calculus is more "natural".