Bereich: Biologie

Kanton: Thurgau

Samuel Stark, Student,
Kantonsschule Frauenfeld

Statement: *Die Zusammenarbeit mit Helmut Brandl war zweifelsohne eine grosse Bereicherung für meine Maturaarbeit; insbesondere seine methodischen Ratschläge schätze ich sehr.*

Dr. Johannes Kottonau, Lehrer
Kantonsschule Frauenfeld

Statement: *Ich staune immer wieder darüber, wie aufrichtig und verantwortungsbewusst die Betreuung der Maturandinnen und Maturanden im Rahmen einer Patenschaft wahrgenommen wird. Die reine Freude an der Förderung brillanter Köpfe scheint mir Hauptantrieb genug zu sein.*

PD. Dr. Helmut Brandl, Expert
Institute of Evolutionary Biology and Environmental Studies, Universität Zürich

Statement: *Die Betreuung von Maturarbeiten bietet die einmalige Chance, einen aktiven Beitrag zur „Förderung des wissenschaftlichen Nachwuchs“ zu leisten.*

On The Population Dynamics of Bacteria

Summary: The present thesis focuses on the growth dynamics of bacteria. Bacterial growth is a continuous, nonlinear process, and its appropriate mathematical description involves nonlinear differential equations. Population dynamics provides several models for temporal single-species dynamics, the most widespread of which are the Gompertz and the logistic model. All these models were derived from their corresponding differential equations, reparameterized (i.e., the parameters were given biological meaning), and their mathematical properties were discussed before application. The experimental organism was Pseudomonas entomophila, a bacterium that is known to be pathogenic to Drosophila, and the growth dynamics of which have not yet been modelled. The strain ‘Zurich’ was grown on 24 well microtiter plates containing lysogeny broth medium at 35_C, its growth was monitored by means of optical density at 660 nm. Nonlinear regression analysis (Marquardt’s compromise) was used to fit the Gompertz and the logistic model to the data, and to compare them statistically.

As it was found in preliminary studies, the Gompertz model outreached the logistic model. This is not only due to the mathematical nature of the models (the logistic model is, unlike the Gompertz model, radial-symmetric), but it is also due to nature of bacterial growth, i.e. the occurrence of multiple exponential phases. This phenomenon might be caused by the exhaustion of an essential nutritional factor, and is naturally one that both the Gompertz and the logistic model failed to describe. Since models encompassing multiple exponential phases could not be retrieved from the literature, a piecewise-defined function was transformed by means of the Heaviside function into a single function. However, due to the mathematical properties of the Heaviside function (e.g. discontinuity), a suitable, differentiable approximation (a sigmoid function) was used instead. Indeed, the derived model proved to be superior to the Gompertz model, albeit it requires a nearly twofold number of parameters, to which, however, easily a biological meaning can be given. Of course, any piecewise-defined function, regardless of its purpose, can be rewritten in terms of the Heaviside function and its approximation, the approach made has interdisciplinary implications and deserves further scrutiny.

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