School of Mathematical and Statistical Sciences
Arizona State University

M E M O R A N D U M

DATE: 03/07/2025

TO: Faculty and Students

FROM: Professor(s) Yang Kuang
Chair/Co-Chairs of Samantha Brozak
Defense for the PhD in Applied Mathematics
Committee Members
John Fricks
John Nagy
Sharon Crook
Steven Baer

DEFENSE ANNOUNCEMENT

Candidate: Samantha Brozak

Defense Date: Friday, April 4, 2025

Defense Time: 12:00 PM

Virtual Meeting Link: https://asu.zoom.us/j/2820424346

Room: WXLR A111 (Tempe Campus)

Title: Beetle Mania Continued: Mathematical Studies of Tribolium Confusum

Please share this information with colleagues and other students, especially those studying in similar fields. Faculty and students are encouraged to attend. The defending candidate will give a 40-minute talk, after which the committee members will ask questions. There may be time for questions from those in attendance. However, guests are primarily invited to attend as observers and will be excused when the committee begins its deliberations or if the committee wishes to question the candidate privately.

ABSTRACT
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ABSTRACT

The humble flour beetle (genus: *Tribolium*) has been living alongside humans for thousands of years and driving biological insights for hundreds. The larvae-pupae-adult (LPA) model was used on *T. castaneum* in the first-ever experiments inducing chaos in a laboratory population. Driven by new experimental data using *T. confusum*, two models (one discrete and one continuous) are presented as extensions of the LPA model. The first, dubbed the LPAA model, is a discrete map which stratifies adults by reproductive capability. This model outperforms the LPA model on experimental data and, while having an additional compartment, remains fully tractable to stability analysis. In addition, while the LPA model may predict chaos under certain experimental parameter regimes, the LPAA model does not. A larvae-adult (LA) continuous-time model is also presented where the pupal stage is represented using a discrete time delay. It is shown that the time delay is critical for oscillations to take place and the model performs well on experimental data. Nonlinearities introduced by cannibalism make traditional analysis of the positive equilibrium untractable, and other approaches are used to characterize its stability. These two models highlight the importance of model choice and their impact on asymptotic dynamics, particularly so given that chaos is not uncommon in discrete maps. We discuss differences in experimental protocols and how these may affect the results, and call for further investigation on the impact of media changes as a driver of chaos.