

A Matrix-Based Framework for Structured Inheritance in Population Dynamics: Bilinear Forms for One- and Two-Sex Models

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Abstract

Anticipating the outcomes of genetic interventions requires combining population dynamics, genetics, and control theory. In this talk, we discuss a unified formulation that uses bilinear forms for inheritance matrices to model mating combinations in offspring, explicitly capturing complex mating systems such as polygyny and polyandry. We illustrate this approach through three models. First, we use a single-sex Mendelian inheritance model to analyse insecticide resistance. Next, we present a unified model of Mendelian and maternal inheritance simulating simultaneous resistance evolution and Wolbachia introgression in a mosquito population. Finally, a two-sex model incorporates sex-specific inheritance matrices to evaluate seasonal Wolbachia suppression and replacement strategies. The stability analysis and simulations demonstrate how this matrix-based approach rigorously supports the synthesis of effective vector control. We acknowledge the support by ARASY ESTR01-23 [1–3].

References

- [1] Pastor E Pérez Estigarribia, Pierre-Alexandre Bliman, and Christian E Schaerer. Modelling and control of mendelian and maternal inheritance for biological control of dengue vectors. In *2021 European Control Conference (ECC)*, pages 333–340. IEEE, 2021.
- [2] Pastor E Pérez-Estigarribia, Pierre-Alexandre Bliman, and Christian E Schaerer. A class of fast–slow models for adaptive resistance evolution. *Theoretical Population Biology*, 135:32–48, 2020.
- [3] César Vian, Pastor Perez, Diego P Pinto-Roa, Francisco Benitez, and Christian Schaerer. Multi-objective optimization with genetic algorithms for the release of wolbachia mosquitoes models. *Proceeding Series of the Brazilian Society of Computational and Applied Mathematics*, 12(1):1–2, 2026.

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