IOCMA 2026 Conference

The 2nd International Online Conference on Mathematics and Applications

10–12 June 2026 | Online

MDPI

Modelling Microsporidia MB Invasion in Mosquitoes

Wanjala HM[1], Okongo MO[1], Ochwach J[2]

[1]Chuka University, Kenya

[2]Mama Ngina University College, Kenya

INTRODUCTION & AIM

INTRODUCTION

- Microsporidia MB are mosquito symbionts
- Transmitted vertically and through mating
- May influence mosquito population dynamics
- Potential relevance in malaria vector control

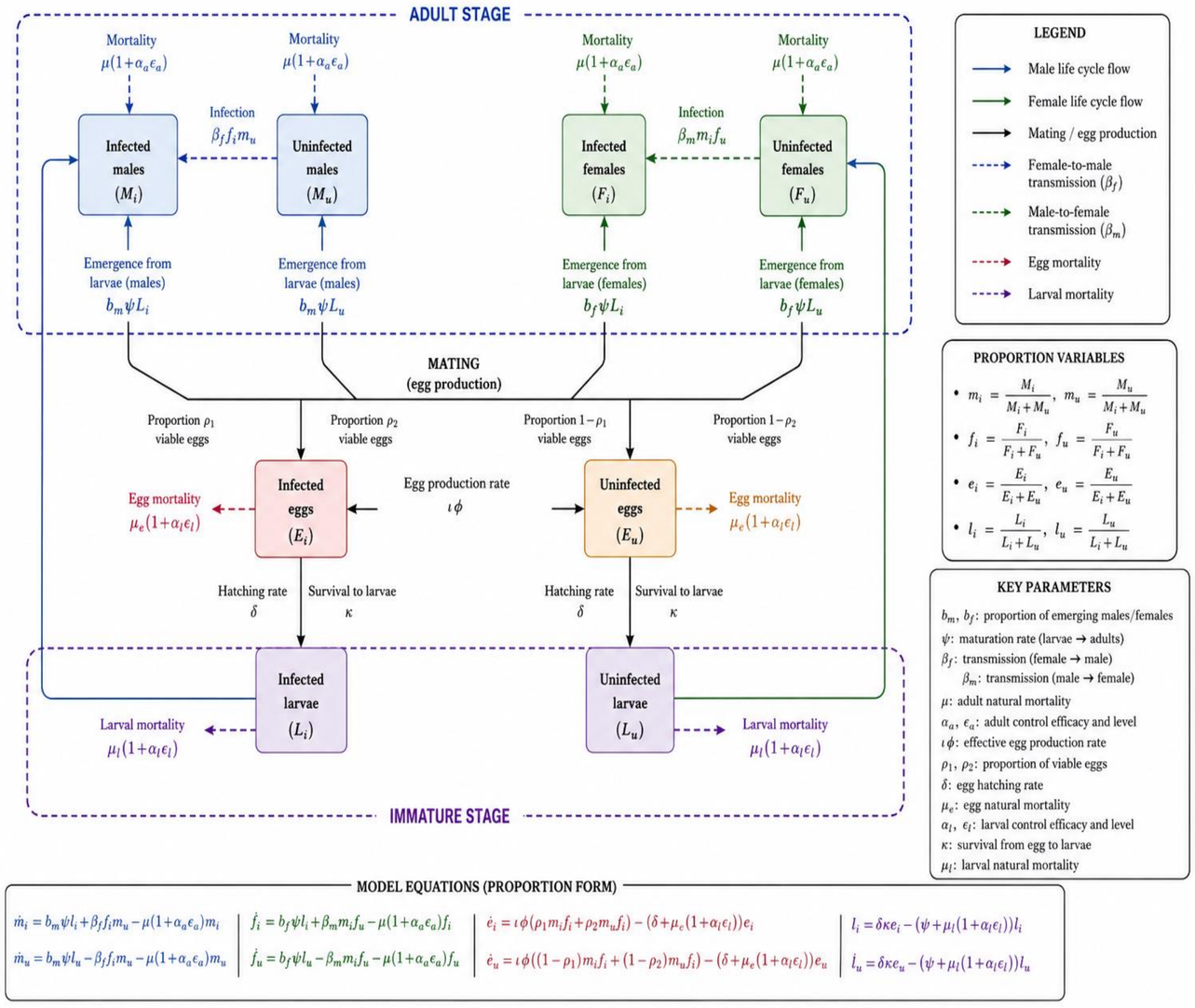
AIM

To develop and analyze a sex- and stage-structured model for:

✓ Microsporidia invasion
✓ Persistence dynamics
✓ Chemical control interactions
✓ Integrated vector management implications

METHOD

1. Data from literature review
2. A variant of SEIR model incorporating adulticides and larvicides.
3. Reproduction Number by the Next Generation Matrix
4. Equilibrium Analysis
5. Stability Analysis by Eigen-value Method and the Quadratic Lyapunov Method
6. Bifurcation Analysis by the Centre Manifold Theory



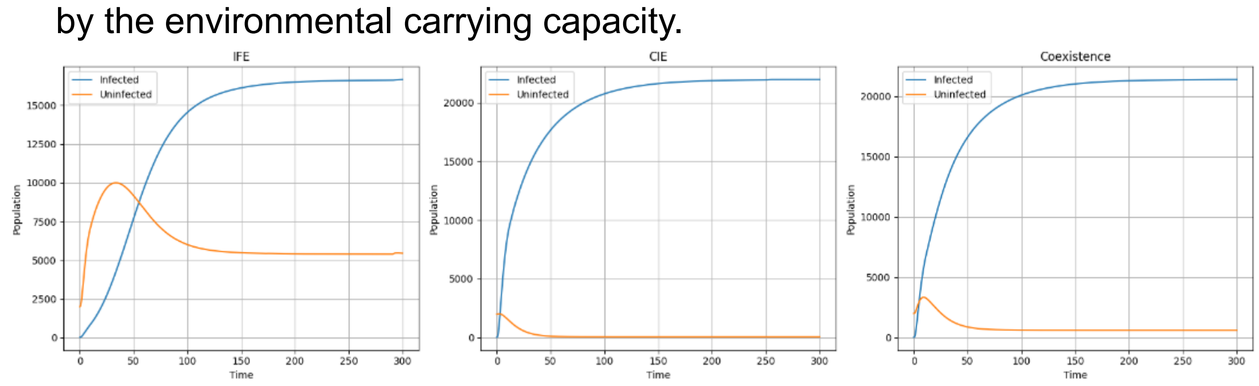
MODEL EQUATIONS (PROPORTION FORM)

$$\dot{m}_i = b_m\psi l_i + \beta_f f_i m_u - \mu(1+\alpha_a\epsilon_a)m_i \qquad \dot{f}_i = b_f\psi l_i + \beta_m m_i f_u - \mu(1+\alpha_a\epsilon_a)f_i \qquad \dot{e}_i = \iota\phi(\rho_1 m_i f_i + \rho_2 m_u f_i) - (\delta+\mu_e(1+\alpha_l\epsilon_l))e_i \qquad \dot{l}_i = \delta\kappa e_i - (\psi+\mu_l(1+\alpha_l\epsilon_l))l_i$$

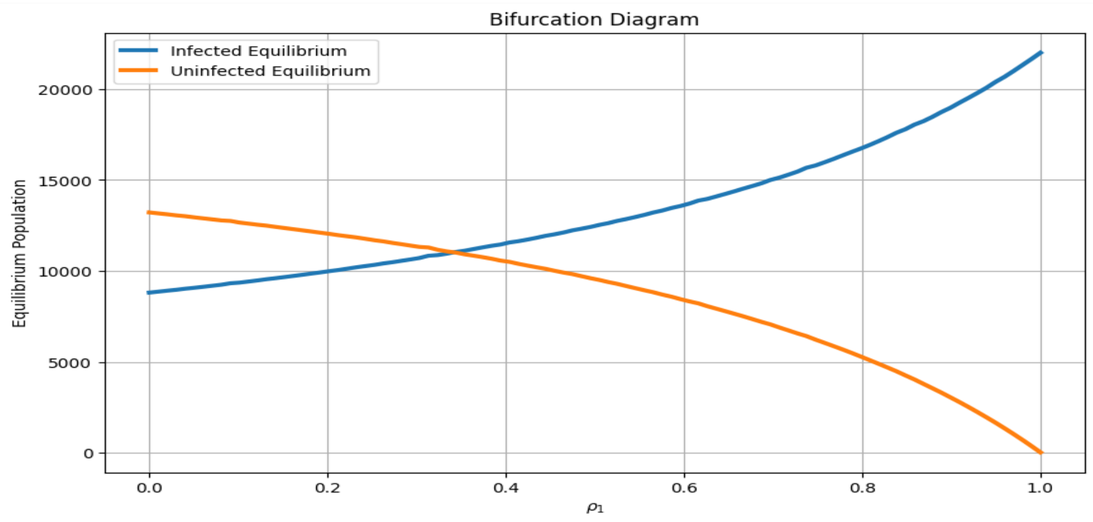
$$\dot{m}_u = b_m\psi l_u - \beta_f f_i m_u - \mu(1+\alpha_a\epsilon_a)m_u \qquad \dot{f}_u = b_f\psi l_u - \beta_m m_i f_u - \mu(1+\alpha_a\epsilon_a)f_u \qquad \dot{e}_u = \iota\phi((1-\rho_1)m_i f_i + (1-\rho_2)m_u f_i) - (\delta+\mu_e(1+\alpha_l\epsilon_l))e_u \qquad \dot{l}_u = \delta\kappa e_u - (\psi+\mu_l(1+\alpha_l\epsilon_l))l_u$$

RESULTS & DISCUSSION

1. The simulations demonstrate three biologically relevant equilibrium states of the Microsporidia MB mosquito population system: the Infection-Free Equilibrium (IFE), where the infection fails to establish; the Complete-Infected Equilibrium (CIE), where infected mosquitoes dominate the population; and the Coexistence Equilibrium, where both infected and uninfected mosquitoes persist simultaneously. The sigmoidal trajectories arise from density-dependent regulation induced by the environmental carrying capacity.



2. The model exhibits a forward bifurcation in which the infection-free state is stable when the control parameter is below a critical threshold, leading to the elimination of Microsporidia MB. Once this threshold is exceeded, the system shifts to a Complete-Infected state where infection persists, with the threshold playing a role analogous to R = 1 in classical epidemiological models.



CONCLUSION

1. Developed a Microsporidia MB invasion in mosquito model.
2. The IFE, CIE and the coexistence equilibrium are all locally and globally asymptotically stable.
3. The model exhibits a forward bifurcation, implying that the invasion shall persist if above the reproduction number only

FUTURE WORK / REFERENCES

1. Temfack, D., Tsanou, B., Lubuma, J., & Diaby, M. (2025). A Sex-Structured Mmathematical Model of Mosquito Infection with Microsporidia MB: Model Reduction and Release Strategies. *International Journal of Applied and Computational Mathematics*, *11*(6), 225.