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Analysis of a Differential System to Get Insights on the Potential Establishment of Microsporidia MB in the Mosquito Population for Malaria Control

Authors : Charlene N. T. Mfangnia, Henri E. Z. Tonnang, Berge Tsanou, Jeremy Herren

Abstract : Microsporidia MB is a recently discovered symbiont capable of blocking the transmission of Plasmodium from mosquitoes to humans. The symbiont can spread both horizontally and vertically among the mosquito population. This dual transmission gives the symbiont the ability to invade the mosquito population. The replacement of the mosquito population by the population of symbiont-infected mosquitoes then appears as a promising strategy for malaria control. In this context, the present study uses differential equations to model the transmission dynamics of Microsporidia MB in the population of female Anopheles mosquitoes. Long-term propagation scenarios of the symbiont, such as extinction, persistence or total infection, are obtained through the determination of the target and basic reproduction numbers, the equilibria, and the study of their stability. The stability is illustrated numerically, and the contribution of vertical and horizontal transmission in the spread of the symbiont is assessed. Data obtained from laboratory experiments are then used to explain the low prevalence observed in nature. The study also shows that the male death rate, the mating rate and the attractiveness of MB-positive mosquitoes are the factors that most influence the transmission of the symbiont. In addition, the introduction of temperature and the study of bifurcations show the significant influence of the environmental condition in the propagation of Microsporidia MB. This finding proves the necessity of taking into account environmental variables for the potential establishment of the symbiont in a new area.

Keywords : differential equations, stability analysis, malaria, microsporidia MB, horizontal transmission, vertical transmission, numerical illustration
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