Simple functional forms to describe density dependence during aquatic mosquito development

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Density changes the rate at which larvae pupate. In turn these changes in pupation may affect the spread of mosquitoes. Hancock et al. [1] collected data on 56 different larval cohorts, which vary in hatch time. They fit a different gamma curve for each cohort. We aim to find a single function to model all of these cohorts with inputs of time after pupation and density history. We consider seven different functional forms, and fit the data from [1]. We work from a discrete model with the time step of a day with an assumed gamma distribution for the underlying time since pupation, and this is decreased with larger density history. In order to find a good fit, we use Latin hypercube sampling of the parameter space and find a least squares minimum. We then consider the minimum values found for each of the seven functions to determine which functional form is best at describing density dependence of pupation. We find that, although our obtained fits are not as close as precise as Hancock et al. [1], some of the functional forms do a relatively good job, and may be useful inclusions in deterministic models of mosquito dynamics.

References

[1] P. Hancock, V. White, A. Callahan, C Godfray, A. Hoffmann, and S. Ritchie, *Density-dependent population dynamics in Aedes aegypti slow the spread of wMel Wolbachia*. Journal of Applied Ecology, 53(3):785–793, 2016.

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