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## **Death of the Bees: A Mathematical Model of Colony Collapse Disorder in *Apis mellifera***

A mysterious problem has developed within honey bee populations; in a worst case scenario, bee hives will spontaneously collapse as the entire population disappears from the hive. This phenomenon has been named Colony Collapse Disorder (CCD). The problem is recent and has no known cause, though it is surmised to stem from one or multiple infections. In order to gain insight into its dynamics and possible causes, we have attempted to create a mathematical model. First, we establish a baseline model for the population dynamics of a single healthy hive, using a system of ordinary differential equations. To this model we then add equations which account for the disease affecting the population. Here we must take some liberties regarding assumptions of the disease source given how little is known about CCD, but our model accommodates both direct (bee-to-bee) and indirect (via contaminated plants as vectors) transmission. An analysis of the model's six equilibria including disease-free, endemic, and extinction states develops criteria for distinguishing among several scenarios, including both survival and extinction due to CCD. These criteria identify several key parameters which could offer insight into the nature of the cause of this colony collapse. All theoretical results are supported by a set of numerical simulations and are consistent with raw data regarding the dynamics of the disorder.

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