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The effect of thermoregulation on honey bee colony health and survival

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In recent years honey bee colonies have been experiencing increased loss of hives. One cause of hive loss is colony collapse disorder (CCD). Colony collapse disorder is characterised by a previously healthy hive having few or no adult bees but with food and brood still present. This occurs over several weeks. It is not known if there is an exact cause of CCD but rather it is thought to be the accumulation of multiple stressors placed on a hive. One of these stressors is the breakdown of thermoregulation inside the hive.

The bee life cycle begins with eggs that hatch into larvae that in turn pupate. The eggs, larvae and pupae together are known as brood. The hive contains combs which are made up of multiple cells; these cells house the brood. Pupal cells are capped off by adult bees (and so are known as capped brood) and they undergo changes to develop into an adult bee. In order for this capped brood to develop correctly, the temperature within the hive must be regulated by the hive bees to ensure optimal development of the capped brood. Variations in the temperature, caused by the breakdown of thermoregulation, lead to suboptimal development in adults that emerge from capped brood. In particular, their brains and flight muscles are compromised. This later leads to these bees becoming inefficient foragers which also have shorter life spans.

We model the effect of thermoregulation on hive health using a system of DDEs which gives insights into how varying hive temperatures have an effect on the survival of the colony. We show that thermoregulatory stress has the capacity to drive colony collapse disorder via a saddle-node bifurcation.

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