

BeeT - Saving Our Dying HoneyBee

After more than 3 decades of struggle to combat a mite which drove our European honeybee to near extinction, we now give our bees a new chance to fight back. Last week, the European government decided to open up their legislation and allow the use of BeeT, a synthetic biology aided tool to eradicate the mite. BeeT leaves bee, honey, and beekeeper unharmed. It is confined to the hive and only activated once the mite is present.

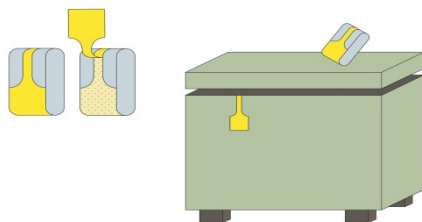
But why should you care? Rising prices for a variety of nuts, vegetables, and even cotton is affecting all of us. Yes, also cotton. The clothes you wear are somehow connected to bees! This is, however, only the immediate impact we feel as the honeybee slowly vanishes. Albert Einstein once predicted: "If the bee disappears from the surface of the earth, man would have no more than four years to live".

"I still remember when I used to buy my honey in the supermarket, completely disconnected from the actual work all those bees have to put into it and all those flowers, trees and crops which are pollinated until you can buy this one honey jar."

Ben, the Beekeeper

Ben is a dedicated beekeeper since 2005 and has experienced the development first hand. He explains that the overall phenomenon of the dying honeybee is also known as Colony Collapse Disorder (CCD). It is mainly caused by the invasive mite *Varroa destructor*, which was introduced to Europe and the Americas during the 1980s. These mites infest the brood of the bees and live from the bees hemolymph, which is the bee's "blood". This causes the new brood to be weakened, and especially winter will put the bees through a difficult time. On top of that, the mite teamed up with several other illnesses amongst which the deformed wing virus is a notable adversary of the bees. Ben further explains that the early ways of tackling *V. destructor*, for example with thymol, were difficult to dose in the right amounts, in addition to being harmful for both bees and beekeepers.

This is why in 2016 twelve young scientists from Wageningen University teamed up to tackle this problem. They talked to beekeepers about their actual day-to-day life, their routine, schedules, and habits to create an integrated product: BeeT!

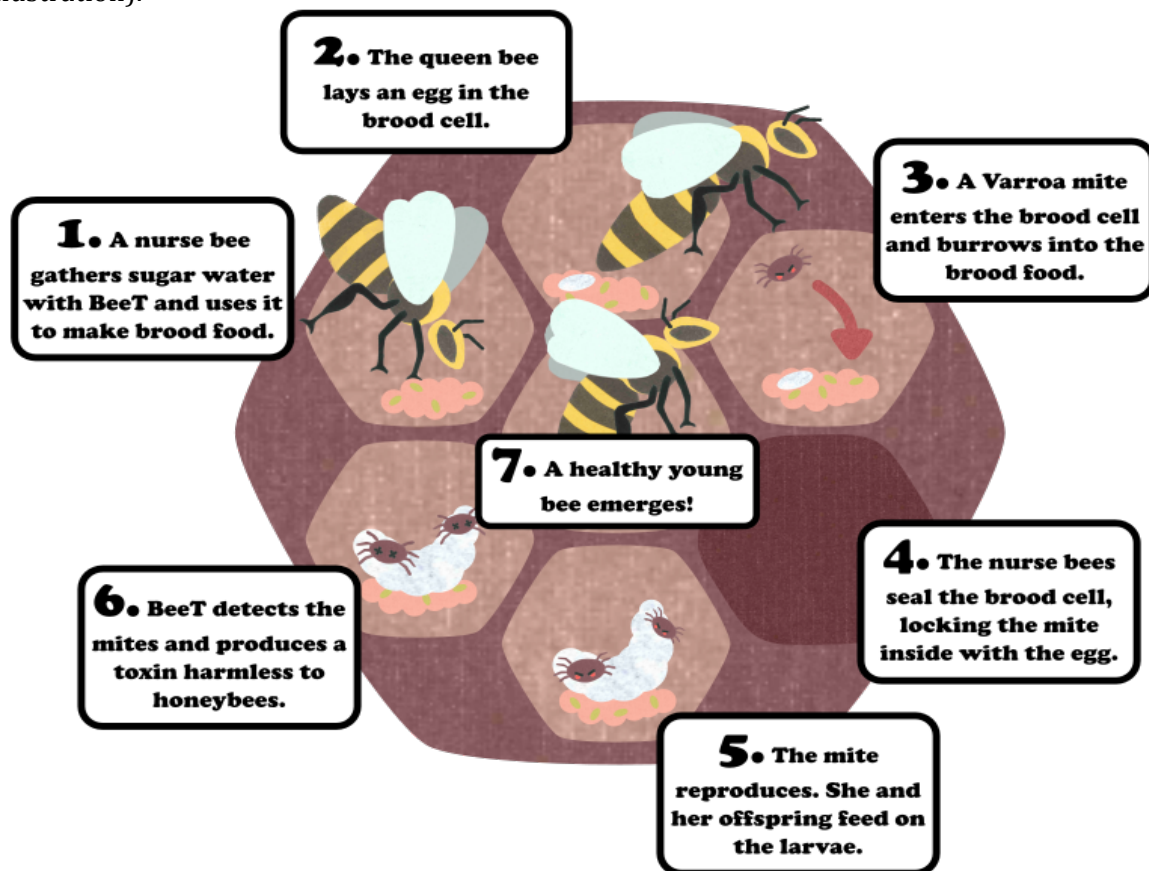


"BeeT is ingenious! Using the BeeTeaBag is as simple as brewing yourself a cup of tea. Even simpler! You don't have to heat up the water."

Ben, the Beekeeper

Figure 1: On the left you can see the BeeTeaBag in its initial stage and its first pull out phase before applying it into the sugar water in the beehive.

But how exactly does BeeT work? In the illustration below, the bee-mite-BeeT life-cycle shows the interactions of all species involved. First, a nursing bee collects sugar water from the supplied storage container (common practice in beekeeping), including BeeT, and uses it to feed and to regurgitate the brood food into the honey combs for the larvae (1). Once the queen laid a new egg (2), and just before the capping of the comb (4), the mite enters the capsule leaving its phoretic stage¹ (3). When the mite enters the comb, it comes in contact with the brood food and ingests some of it. This provides an entry point for BeeT into the mite gut system (4). The mite then attaches to the bee larvae, feeding on its hemolymph (5). Once BeeT senses the mite, BeeT changes its stage and starts producing toxins within the mite (5). After reaching a certain threshold, BeeT again changes its state and starts producing Cry toxins, or other toxins (5). This causes an increase to the mite mortality (6) and leads to healthy hatching bees (7). BeeT also holds two biocontainment mechanisms to prevent BeeT from escaping the hive (not shown in illustration).



bee-mite-BeeT life-cycle: Interactions between bees, mites and BeeT integrated in the bee-mite-BeeT-life-cycle.

"Ideally, I apply BeeT in late Autumn before the last brood is capped (4). This way nothing can enter the honey. With BeeT implemented into a friendly bacterium², I could also safely apply it before any other brood capping."

Ben, the Beekeeper

To assure the livelihood and effectivity of BeeT, a beekeeper has to do only one thing: re-supply a new BeeTeaBag before every capping of a new brood. This way it is assured that BeeT has enough synthetic amino acids which it needs to survive, and that the right amount of BeeT reaches the honeycombs in time to effectively kill the mites.

¹ The phoretic stage is the part of the mite life cycle where the mite is attached to adult bees.

² BeeT is implemented in *Lactobacillus rhamnosus* which is safe for consumption (e.g. in yoghurt).

Around 50 years ago, this application would have been more likely to come from a screen writer than a start-up. As with all start-ups, the beginning is stony and uncertain. However, given the recent changes to European law, BeeT can now be widely applied.

The case of BeeT and multiple other synthetic inventions went through all stages of European legislation and put the topic of synthetic biology and its large scale application high on the agenda. Once the dying bee was officially acknowledged as a serious threat to the wellbeing of society, the world frantically started looking for possible solutions. Outside the comfort zone of European legislation, BeeT was re-discovered in 2024. Only after more than a decade of research and testing in the lab, it was acknowledged to be safe to use in the outside environment.

Ultimately, we have to ask the following questions: Could this disaster of pushing the honey bee close to extinction have been avoided? Should the government have changed its policies earlier? How much responsibility does the government have in this? On the other hand, the government had to weigh the different factors: do we really want to release genetically modified organisms into the environment? Are the legislations, safety, and biocontainment protocols solid enough to prevent other man-made disasters?

"BeeT is specific to mites and does not harm the bee or beekeeper. It is regulated to activate its killing mode only once mites are present. On top of that, it has three biocontainment methods built into it. I am just happy that BeeT is on the market. I use it every year. It works."

Ben, the Beekeeper