Clemens Driessen

Bumblebees and the Remaking of Tomato Worlds

Bumblebees have been made to radically reshape indoor tomato production over the past few decades. Successfully packaged to pollinate for year-round production, their incorporation into the contemporary greenhouse has arguably led to an increase in scale of horticulture as well as promoting a move away from chemical pest control. Meanwhile researchers are still learning about their abilities and experiences.

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Even though tomato plants can self-pollinate, they produce more and better tomatoes when their flowers are actively pollinated. Especially in (indoor) conditions with little wind and high humidity, a juicy tomato requires a flower to be individually visited by a pollinator.

Until the 1980s, pollination inside greenhouses was done by hand. The middle-aged people I talk with in the Westland horticulture region of the Netherlands remember their days of earning some pocket money as school kids, walking through the greenhouse with electric buzzing sticks, going from flower to flower: "Of all the odd jobs I had in these greenhouses, this was by far the most soul crushing one."

Visiting all of the flowers every three days is labour intensive, requiring a full-time employee for each hectare of tomatoes. But employees willing to do this were hard to find. And being a good pollinator is difficult. Then this all changed. In the mid-1980s, some people in Belgium and the Netherlands started to investigate an alternative to teenagers with sticks. Bumblebees.

Drawing on the work of bumblebee enthusiasts, who for the previous century had been documenting the mating behavior and survival strategies of *Bombus terrestris*, researchers and companies started experimenting. Efforts at bumblebee domestication, propagation and commercialization suddenly took off, leading to what has been labeled a veritable "gold rush."[1] Catching queens in the wild is one thing, but getting them to mate, to produce offspring, and to do so year round, was far from easy.

1. Velthuis, H. H., "The historical background of the domestication of the bumble-bee, Bombus terrestris, and its introduction in agriculture" (2002), *Pollinating Bees – the Conservation Link Between Agriculture and Nature*, Ministry of Environment, Sao Paulo, Brasil, 177-184

Why bumblebees? With their thick buzzing bodies they are great pollinators. Some people I talk to argue they're not too clever, especially as they don't seek to escape the greenhouse if they find themselves living there. But they're also just very efficient, visiting more flowers a minute than other types of bees and leaving a scent mark to prevent going back to the same flower too soon.

The greenhouse or "controlled-environment agriculture" production of plants such as tomatoes comes with its own commercial logic. It creates conditions under which it becomes lucrative to start selling "nature" back to these spaces of control and optimization. Considering the labor costs, together with the suboptimal timing and substandard quality of human pollinators, reliable bumblebees become highly desirable: there is no way to beat a bumblebee, which knows exactly how and when to visit these flowers.

Bumblebees have been found to experience pain, emotion, and consciousness. They can develop fear and anxiety after being confronted by predators, even seeing ghosts. And operating as a collective from a hive, they can learn to adapt to new conditions.[2] But it's not so easy to package and ship nature in working condition. A search commenced in Greece and Sardinia for sourcing the best queens that could be used in propagation.[3] Already at the start of the twentieth century it had been established that social interactions between solitary queens and worker bees of incipient colonies are a crucial part of rearing them. Furthermore, timing and temperature were sensitive for mating successfully in dedicated "mating cages." Especially when it was found that the obligatory hibernation for queens to start propagating could be replaced by CO_2 narcosis, bumblebee breeding could be done year round.[4] A further challenge was to come up with designs of appropriate boxes to ship and release the bumblebees inside greenhouses, offering the right conditions and enough food–mostly sugar-water replacing nectar–for keeping them alive for at least long enough to make for an economically viable product.

Once established, this new mode of pollinating set in motion a radical shift in greenhouse production, changing tomatoes as well as sweet peppers, and the scale of production and regional—and eventually global—economies. The diligent labor of the bumblebees willing to work out of their boxes arguably enabled the emergence of larger scale greenhouse operations. While in Westland, it is common to find five hectares of glass greenhouses behind the home of a family, production is now moving to less urbanized zones with space for 20, 30, or 40 hectares.[5] Tomatoes are no longer bulk products sold at cooperative auction, they are now produced at a scale that makes it possible for larger companies to have direct contracts with supermarket chains—and to sell branded and packaged specialty tomatoes.[6] The ongoing consolidation of indoor horticultural

2. Chittka, L., *The Mind of a Bee* (Princeton University Press, 2023)

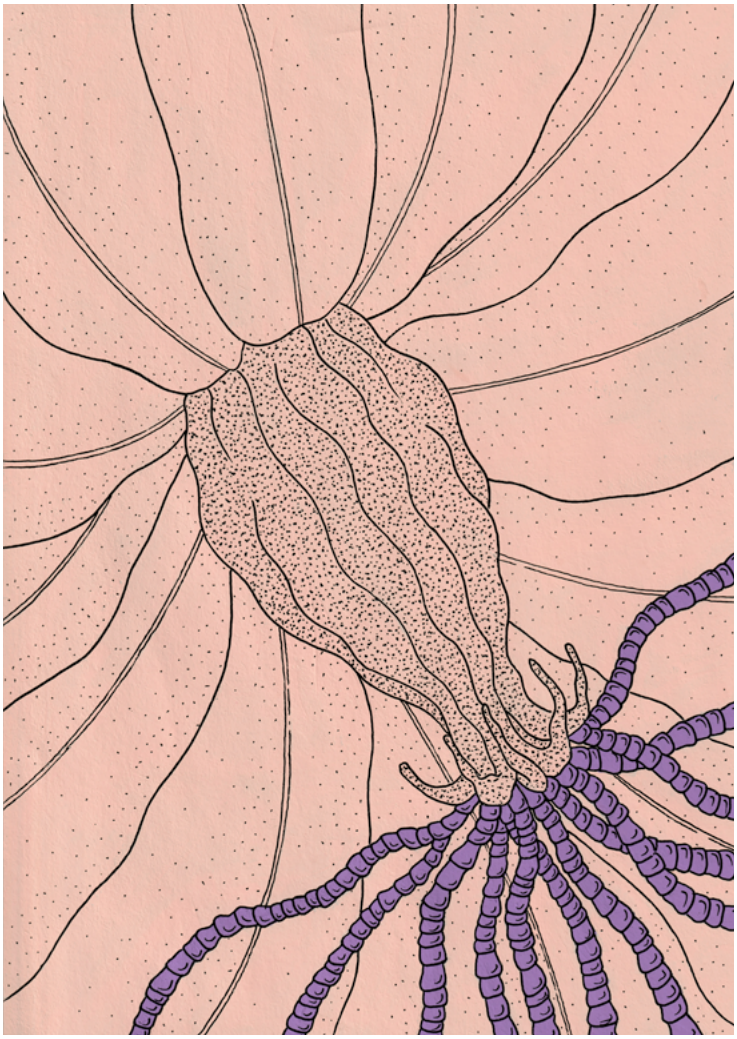
3. Sies, R., H, van Hintum, *Partners with Nature* (Sies van Hintum Beeld/ Verhalen, 2017)

4. Velthuis, "The historical background of the domestication of the bumble-bee, Bombus terrestris, and its introduction in agriculture"

5. Where migrant labourers are housed in remote compounds. Eggers, Anastasia & Driessen, Clemens, "From Polder Colony to Greenhouse Plantation: Dwelling in the Noordoostpolder Plantationocene," *Fieldsights*, January 2023, https://culanth.org/fieldsights/from-polder-colony-to-greenhouse-plantation-dwelling-in-the-noordoostpolder-plantationocene

production means the bumblebee is part of a jump in scale of production and vertical integration, which eventually could lead to only a few major tomato producers surviving.

With the commercial appeal of deploying bumblebees in the greenhouse, a biological agent has been inserted into mainstream intensive horticultural production. Bumblebees are now ubiquitous in the modern tomato greenhouse, and they are not just used by organic growers. They are sensitive creatures, which arguably promotes a more ecological understanding of the process of growing fruits and vegetables. With this non-human pollinator present, chemical insecticides are less appealing to apply while a crucial part of tomato production requires these sensitive workers to do their jobs.



How horticultural growers balance their reliance on bumblebees (and a range of biological controls offered by the same companies that sell the bees), with the chemical means of managing disease and pest pressure, remains somewhat opaque. The trademarked bumblebee boxes come with an option of a one-way gate that allows for gathering the colony into the box, potentially offering a window for the use of a chemical treatment of the plants—although in the Netherlands, tomato growers indicate they rely less and less on such treatments. Meanwhile other developments make life challenging for our bumblebees.

6. Ibáñez Martín, Rebeca, "The New Plantation," *Fieldsights*, January 2023, https://culanth.org/fieldsights/the-new-plantation

Efforts to reduce the energy use of artificial lighting in greenhouses have found that pink light is the most utilized part of the spectrum. With the arrival of LED, artificial light could be reduced to only those wavelengths necessary for plant life. However, the bumblebees utilized as pollinators turned out to have trouble orienting themselves under pink light conditions. Closer study revealed it was the final "hovering" phase of landing, the 0.2 seconds between leg extension and touchdown, that was primarily affected by the new light regime.[7] By adding visual cues to the bumblebee boxes, adjusted to their species-specific eyesight, they can be led to find their way to the hive entry after all. The effects on the bumblebees' abilities to find and land on flowers are still being investigated.

7. De Vries, L. J., Van Langevelde, F., Van Dooremalen, C., Kornegoor, I. G., Lankheet, M. J., Van Leeuwen, Naguib, M., J. L., Muijres, F. T, "Bumblebees land remarkably well in red–blue greenhouse LED light conditions", *Biology Open*, 15 June 2020, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7295593/

A challenge for the bumblebee producers is to adapt to local circumstances. American and Asian markets have regulations that require domesticated bumblebee species that are not considered invasive. Instead of *Bombus terrestris*, they need to breed *Bombus impatiens* to bring to market in North America, thereby hopefully reducing the chance of displacing local wild bumblebees by escapees and bringing diseases.

Sometimes people question the instrumentalization of the hardworking bumblebees, whose trademarked boxes come equipped with a reservoir of sugar water which gets the colony going for a six week lifespan. Wondrous creatures shipped in boxes that last briefly are then discarded, to be replaced by a fresh shipment. At the same time they are productivity enhancing, reducing the amount of fossil fuel used per tomato. And the bumblebees, sold by the companies that also offer biological pest control, are part of an alternative approach to horticulture countering the one offered by the chemical behemoths. Nevertheless, the bumblebee saga/development can also feature as an example of how "nature based solutions" are not per se ecologically benign or morally pure—announcing a world in which more and more of our key ecological interdependencies are managed, packaged and branded.

Bumblebee production is expected to further grow, in view of a seemingly insatiable demand for pollinators in controlled-environment agriculture. Meanwhile the wild kin of these domesticated animals are considered to be in a continuous decline that started in the twentieth century. The gold rush mentioned earlier is suspected to have contributed to this decline, via the initial need for the wild sourcing of queens, leading to restrictions in Turkey and on Sardinia. Today, in ever larger greenhouses, the boxed bumblebees buzz on, throughout the seasons and the pink LED lights, producing hectares of perfect indoor tomatoes.

BIO

Clemens Driessen is a more-than-human geographer and field-philosopher who works at the Cultural Geography group at Wageningen University in the Netherlands. Before losing himself in greenhouses and other Cartesian places, he studied human relations with pigs, cows, robots, ravens and most recently beavers. His book co-edited with Henriëtte Waal, *Water Works: Case Studies in Eco-social Design*, is forthcoming with Valiz Publishers.

Wild Papers editor: Ingo Niermann
Copy-editing: Rosanna McLaughlin
Illustration: Eva Fàbregas
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