# Producing Swarm Queens for Fun, Profit, and Really Big Queens

## Part 1: What we don't know about swarms

### by Shelley Stuart

The growth and reproduction of a honey bee colony relies on a complex mélange of pheromonal cues and environmental signals. These cues include information that tells worker bees to create new queens under duress (emergency supersedure) or in advance of healthy colony-level reproduction (a swarm).

In both a swarm and supersedure, the workers make a new queen. This happens in the former situation through an egg laid in a queen-sized cell, and in the latter by an egg laid in a worker-sized cell. Beekeepers have masterfully harnessed the supersedure impulse to create an entire industry around commercial queen rearing, providing a vital resource to the livestock-sales aspect of honey bee husbandry.

But yet, we know that "swarm queens make the best queens."

A growing body of research supports this often-heard phrase. In a nutshell, eggs laid directly into queen-sized cups are larger, and result in more robust queens with better laying potential.[1] Additionally, the offspring from these queens are likely to themselves be more robust, with greater pollen- and nectar-foraging capacity.[2] The potential end result for the diligent beekeeper? Healthier bees and more honey.

So why don't we have our breeder queens lay directly into queen cups and create bigger, better queens for our customers and our industry?

It turns out that raising queens based on the swarm impulse (where the queen lays an egg in a queen cup) for commercial or breeding purposes has not been seriously (or perhaps successfully) pursued. In the fall of 2023 I received a two-year, $8,468 grant from the Northeast Sustainable Agriculture Research and Education (SARE) program to research ways to coax out the swarm impulse on demand. My goal was to deliberately raise "swarm queens" on a commercial, or at least a semi-commercial, level. I conducted these experiments during the summers of 2024 and 2025. Before reporting on these initial efforts, I share some background biology and research for those unfamiliar with limitations and relevant science.

#### Underlying biology

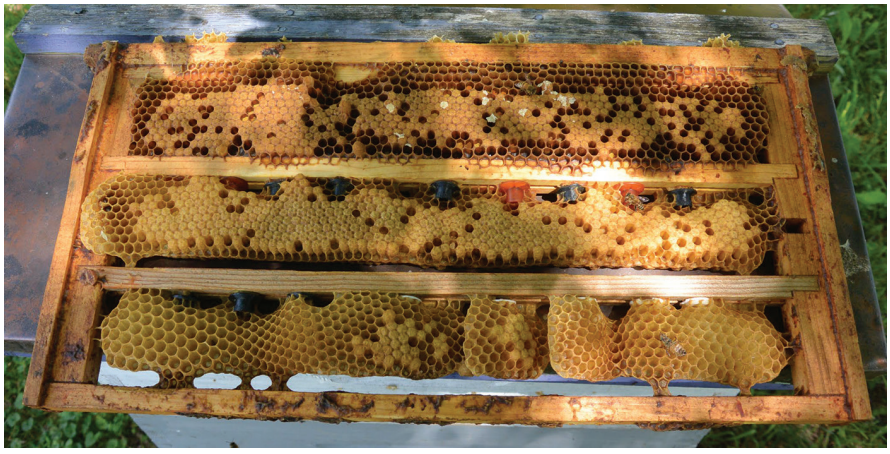
Swarm-impulse queen rearing is not straightforward. When I placed a queen frame with 30 empty queen cups into a colony during a good flow, I pulled out a queen frame full of perfectly drawn worker and drone comb, with all of my queen cups waxed over and stuck for the season (Figure 1).

Over the past century, beekeepers have done a commendable job of identifying ways to prevent swarming which, for beekeepers wanting a robust worker population and bountiful honey crop, was desirable. However, "overcrowding" and "a good nectar flow" paint the swarm event with a deceptively broad brush.

"Swarming" is best viewed as a series of distinct steps which lead from a pleasantly buzzing colony to a ball of bees bivouacking 40 feet up a nearby tree. This perspective also helps identify some swarm triggers that remain murky in the literature — but are critical to understand in order to intentionally breed swarm queens. For this reason, I break down the swarming process as follows:

1. Environmental cues start to build in the colony, signaling to the workforce that swarming will soon have a good chance to realize colony-level reproductive success.[3]
2. Workers build queen cups.
3. Bees continue experiencing environmental cues.
4. Eggs appear in queen cups.
5. Bees continue experiencing environmental cues.
6. Nurse bees provision newly hatched queen larvae.
7. Bees continue experiencing environmental cues.
8. Nurse bees continue to provision developing queen larvae.[4]
9. Bees continue experiencing environmental cues.
10. Workers cap queen cells.
11. Bees continue experiencing environmental cues.
12. Colony swarms.
13. (Bees continue experiencing environmental cues.)
14. (Colony issues afterswarms.)
15. Once bees lose the environmental cues, swarming ceases.

Every odd-numbered step highlights the dynamic responsiveness of bees to their environment; at any point the colony may step back from swarm preparation, which I witnessed several times during this experiment. You may have seen it in your own colonies, or heard the tales told. Empty queen cups appear and disappear. Cups with eggs — and



Shelley Stuart

**Fig. 1** *Well, maybe not perfectly drawn ...*

larvae or even pupae — may vanish.[5] Workers will prevent virgin queens from hatching. And afterswarms can make a beekeeper wonder if the bees really do know what's best, when an anticipated honey-maker now has only two frames of bees left!

In order to figure out how to create a partnership with my bees to raise swarm queens, I researched each of the above steps. This process exposed some of the murkier aspects of swarming, which I then evaluated to see how they might affect a prototype swarm-queen system.[6]

### 1. Bees experience environmental cues

Environmental cues are probably the best-understood aspect of swarming, with crowding and ample nutrition at the top of the list. While much of the swarm process is probably worker-driven, drones play known (and almost certainly unknown) roles. A virgin queen must fly to a local drone congregation area to mate. Therefore, colonies are unlikely to swarm unless they expect to find drones in the environment; they likely use their own drone population for this environmental cue. Speaking of the queen, different levels of her various pheromones may also be contributing factors. Finally, queens that have reached their second summer are more likely to swarm than first-year queens, in part because of decreasing levels of those pheromones.[7,8]

Given its theoretical importance as a systematic checkpoint toward ultimate swarming, a successful swarm-queen system needs to maintain this initial readiness level. Working with a second-year queen may also increase success.

### 2. Workers build queen cups

To create a swarm queen the colony needs queen cups. There's an interesting rabbit hole to explore here about queen cups — the average natural size, the effect of size on the developing queen, preference for a certain size, inclination for wax or plastic bases, and partiality for cup positioning on the face or bottom of the frame.

All of these aspects must be considered with regard to the orientation, composition, placement, and construction of any artificial queen cups used in a swarm-queen system. Here lies a balance between the preferences of the colony and the practical needs of the beekeeper. Pulling charged swarm cells (cells with eggs or larvae) off the face of a frame presents different challenges than simply prying cups from a queen-bar frame. Ideally, a swarm-queen breeder would be able to take advantage of existing queen-cup hardware and supporting tools and equipment.

### 4. Eggs appear in queen cups

I will pose some questions here that, as far as I have found, remain unanswered. All of these are important to the ultimate goal of deliberately breeding swarm queens. Do workers move eggs into queen cups?[9] Does the queen lay in any cell she happens upon, with the workers removing those eggs if swarming's not on the to-do list? Do workers in swarm-ready mode corral the queen toward queen cups and force her to lay in them? Do queens sense a prime swarm condition and start laying in queen cups on their own? Some combination thereof? Or something else entirely?

How should a swarm-queen production process address this? Cage the queen with a queen bar? For how long? With or without workers? With or without brood comb? Will she refuse to lay in queen cells if the colony's not primed enough? The longer she's confined, the more larvae hatch out, making more space and reducing one of the known swarming pressures. And by confining her, queen pheromone distribution in the hive, and any swarming influence it may have, may be affected.

### 6 & 8. Nurse bees provision queen larvae

Unlike a cell starter or finisher,[10] swarm-queen colonies are queen-right, and not driven by the desperate need to make a queen. Therefore, they can choose to stop growing any swarm-queen larvae. I witnessed this twice where JZBZ cups had beautiful, charged queen cells, and three days later those same cells had been torn down to the base.

A lack of ample pollen might be a reason for a colony to "uncharge" swarm cells as they start to sense that available food in the local area is dwindling. This could mean that a swarm colony needs pollen supplements. Other reasons may also exist. Without knowing exactly why this teardown impulse occurs, a successful swarm-queen methodology should include a cell-finisher colony in the apiary.

Determining how to transfer queen cells from a swarm-queen colony to a cell finisher carries its own considerations. Removing an entire frame from the colony may affect swarm readiness by opening up laying space for the colony. Swapping out individual queen cells would maintain a crowded space, but will the bees make additional queens? Will the colony back away from swarming, or will they swarm "on the clock" despite the missing swarm cells?

### 10 & 12. Workers cap queen cells/colony swarms

Once workers cap queen cells, it becomes much more certain that the colony will swarm in the near future.

### What SARE supported

Based on this initial research, I knew I would pursue different methods of swarm-queen rearing. I planned to conduct multiple trials involving isolating the queen, different queen-cup and queen-frame designs, then a second year of education and partnership with volunteer beekeepers in the area. I decided to forego nuc production in 2024 and 2025 in order to run my trials. To accomplish this, I estimated an $8,468 budget that covered the following:

- Materials and equipment, year 1 (hardware, queen isolation cages, queen-cup materials, nutritional support, queen-bar frames, wax foundation, nuc boxes, calipers): $1,530 based on commercial beekeeping/retail prices.
- Materials and equipment for five additional participants, year 2 (isolation cages, nutritional support, queen-bar frames, wax foundation, $75 stipend), mileage for apiary visits: $2,138
- Research stipend (based on associate research average rates), estimated 150 hours total: $4,800.

Over the two years of research, I was able to economize in some areas, and only found two of five local participants. I anticipate that final costs will total approximately $6,750, with savings realized across all three areas of the budget.

When propagating particular traits and genetics, the swarm-queen producer doesn't want to reach this point.

At this point, I have described the many factors leading toward a swarm. In the next installment I will move from theory to practice and share my field experiments with swarm-queen production.

*This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast Sustainable Agriculture Research and Education program under subaward number FNE24-102.* ***https://projects.sare.org/sare_project/fne24-102/***

## References

1. **Wei, H., He, X. J., & Liao, C. H. (2019, July 8).** A maternal effect on queen production in honeybees. Current Biology. Retrieved October 1, 2023, from **https://www.cell.com/current-biology/pdf/S0960-9822(19)30673-6.pdf**
2. **Yu, L., He, X., & Shi, X. (2023, April 25).** Honey bee maternal effects improve worker performance and reproductive ability in offspring. PubMed. Retrieved October 1, 2023, from **https://pubmed.ncbi.nlm.nih.gov/37181751/**
3. In more generic terms: Two colonies will successfully exist instead of one.
4. Could this be combined with 6? Perhaps; but fat larvae have been chewed down by colonies prior to capping, suggesting to me that it's an ongoing choice to finish making queens.
5. For some quantified observations see Simpson, J. 1957. Observations on colonies of honey-bees subjected to treatments designed to induce swarming. Proceedings of the Royal Entomological Society London. Series A. General entomology. 32 (10-12), pp. 185-192. **https://doi.org/10.1111/j.1365-3032.1957.tb00369.x**
6. The swarm-queen system differs from the Nicot and Jentner systems which use worker-sized, horizontally-oriented cups in queen-confinement cages.
7. **Simpson, J. (1957).** The incidence of swarming among colonies of honey-bees in England. The Journal of Agricultural Science, 49(4), 387-393.
8. **Smith, M. L., Ostwald, M. M., Loftus, J. C., & Seeley, T. D. (2014, August 21).** A critical number of workers in a honeybee colony triggers investment in reproduction. Naturwissenschaften, 101, 783–790. **https://doi.org/10.1007/s00114-014-1215-x**
9. Which would defeat the entire goal of having larger eggs laid in our queen cups. But in the thousands of hours of videos, and probably millions of pictures of bees in colonies, such behavior has yet to be observed. I believe it to be a nonexistent to insignificant factor.
10. Briefly, cell starters and cell finishers are queenless colonies packed with nurse bees. When correctly established, these colonies are desperate to make queens for a beekeeper due to their queenless status.



**Shelley Stuart** has kept bees in the Finger Lakes, NY, region since 2009. Under the HoneyApple Hill label, she markets honey into DIY kits for budding mead makers and beer brewers. Her experiences range from screenwriting to medieval reenacting, with an occasional volleyball league thrown in for good measure.

She earned her Master Beekeeper certificate from Cornell University in 2015, and now facilitates the Master Beekeeping program and Beekeeping Essentials course offered by eCornell. You can contact her via **HoneyAppleHill.com**.