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Figure 2. The photograph shows a close-up view of the hands of a person working with a plant. The person is wearing a dark long-sleeved shirt and is using their hands to carefully handle the plant. The background is dark and out of focus, emphasizing the hands and the plant.

The photograph shows a close-up view of the hands of a person working with a plant. The person is wearing a dark long-sleeved shirt and is using their hands to carefully handle the plant. The background is dark and out of focus, emphasizing the hands and the plant.

Question Introduction

The manual shows a method of question introduction that is very similar to the one used in the past. However, this manual method is not idealistic. It is based on the fact that the person who is asked the question will try to answer it in a way that is most likely to be correct.

Figure 3. A close-up photograph of a person's hands working with a plant. The person is wearing a dark long-sleeved shirt and is using their hands to carefully handle the plant. The background is dark and out of focus, emphasizing the hands and the plant.

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Queen Introduction: A Review of the Basics and a Description of Hostile Worker Behavior Towards the New Queen Bee

Abeille

by WYATT A. MANGUM, Ph. D.
Entomology Dept.
Box 7626
North Carolina State University
Raleigh, N. C. 27695-7626
e-mail: wyatt-mangum@ncsu.edu

Maintaining young queen bees in a beekeeping operation is an essential component of proper honey bee management. Some of the benefits expected from having colonies with young queens are as follows: an increase in honey production; a reduction in swarming; and some control over the colony's stinging temperament. Because the egg production of a queen diminishes as she ages, it is generally recommended that colonies be requeened when the queen is two years old. This beekeeper-assisted queen replacement is known as requeening.

Introduction

Requeening a colony begins with the removal of the old queen followed by the introduction of a new queen. Initially, the worker bees of the recipient colony may try to kill the new queen because they regard her as a foreign bee. If the requeening is successful, the bees accept the new queen and eventually she becomes the mother queen of the colony. However, sometimes the queen introduction fails because the bees succeed in killing the new queen. This premature queen death is not only disappointing to the beekeeper, but given the price of queens, it is also expensive. A better understanding of the queen introduction process may prevent some of this premature queen death. To that end, let's take an in-depth look at the queen introduction process.

We will begin our study of queen introduction by reviewing some general guidelines for increasing queen acceptance followed by a discussion on when to requeen. Next, we will review the basic requeening technique using the standard three-hole queen shipping cage. Also included in this review of the basic requeening technique are some additional technical details that should make requeening easier. Once we have reviewed the basics of queen introduction, then we will take a closer look at some of the fascinating bee behavior that can be

observed during the time of queen introduction. This behavior includes the hostile worker bee behavior displayed towards the new queen, and to a minor extent, the new queen's behavior. Observing and understanding the behavior of the new queen and particularly the worker bees are excellent indicators of whether the colony is ready to accept the new queen.

Knowing how to interpret the worker and queen behavior during the introduction process is important when the beekeeper needs to decide whether the queen can be safely released into the colony. When using the three-hole cage, the worker bees usually release the new queen by removing the candy from the cage; but occasionally, this delayed release mechanism fails and the beekeeper may need to manually release the new queen into the colony. In addition, some queen introduction techniques require the beekeeper to manually release the new queen. Hopefully, beekeepers with a better understanding of the behavior between the new queen and the worker bees during the introduction process will know when the queen can be safely released into the colony.

General Guidelines for Increasing Queen Acceptance

Queen acceptance partly depends on the conditions present during the time of queen introduction. To increase queen

acceptance, remember these general guidelines.

1. Younger bees tend to accept new queens more readily than older bees.
2. Smaller groups of bees tend to accept new queens more readily than larger groups of bees.
3. Bees are more likely to accept a new queen that is similar to their old queen, i.e., replace a laying queen with a laying queen.
4. Bees are less likely to accept new queens when colonies are trying to rob each other. (When the bees of a colony remove the honey from another colony, beekeepers refer to that process as robbing.)
5. Bees accept new queens more readily during a nectar flow. (Beekeepers refer to the time when bees are collecting nectar as a nectar flow or a honey flow.)

Most beekeepers time their requeening to coincide with the nectar flows of the spring or fall. Spring vs. fall requeening can be a subject of debate among beekeepers. Other factors can influence the decision of whether requeening should be accomplished in the spring or fall: the number of colonies to be requeened, other demands on the beekeeper's time, and possibly the geographic location of the beekeeping operation. In the next section I

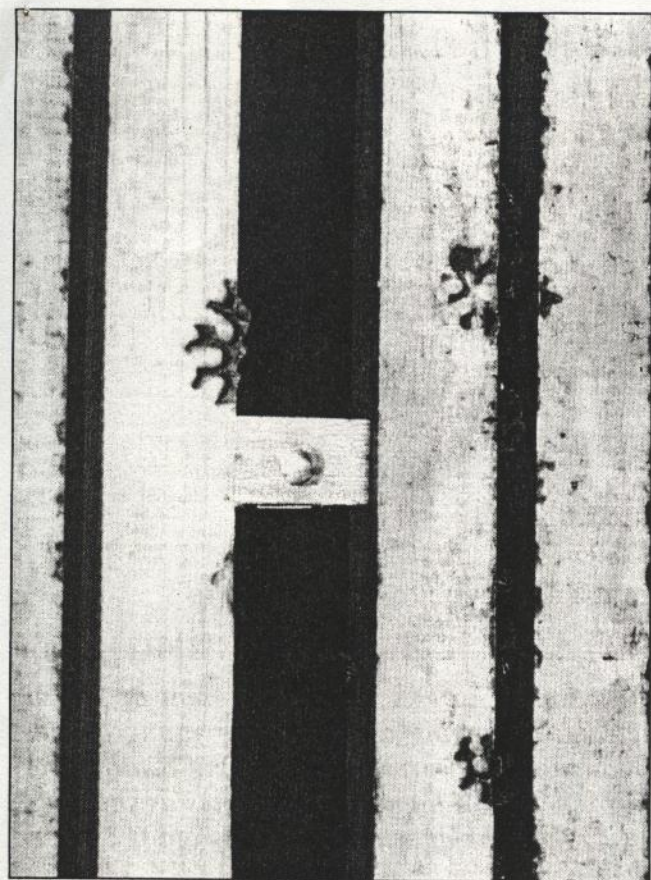


Figure 1: The queen cage positioned between the top bars in the brood chamber. The bees must have access to the queen through the cage's screen. The cage seen here is oriented so that the screen is perpendicular to the top bars. This cage orientation allows the bees plenty of access to the screen, but makes a large gap between the frames and usually requires the removal of one frame. Orienting the cage with the screen parallel to the top bars makes a smaller gap between the frames. However, because the brood comb is usually flush with the side of the top bar, the bees probably will not have access to the queen. If it is not too messy, I sometimes make a depression in the brood comb next to the screen. This depression gives the bees access to the queen by letting them move between the smashed comb and the screen.

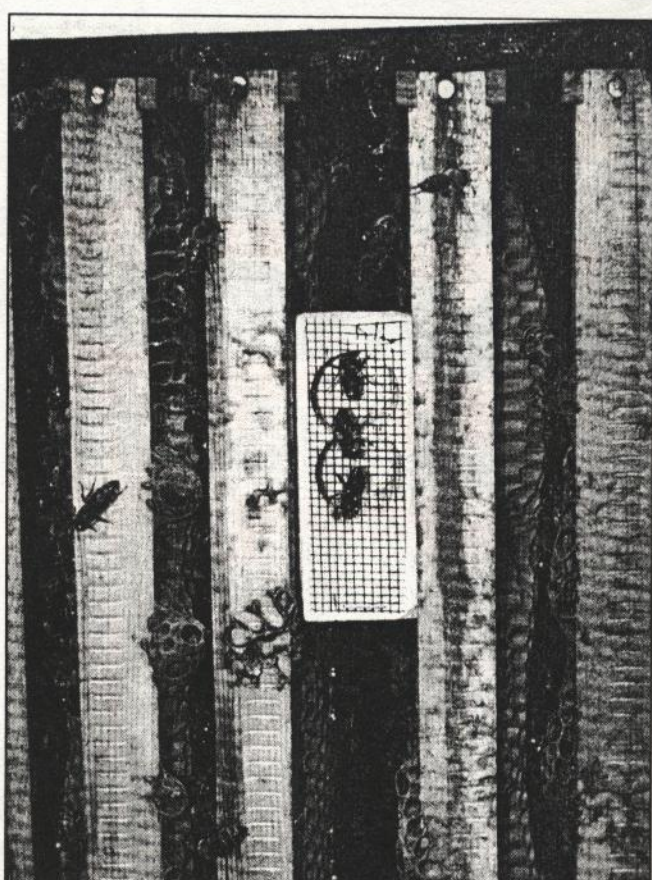


Figure 2: The queen cage positioned between the bottom bars of the super. When propolis has accumulated on the brood frames, the cage may not fit between the top bars. However, the cage can also be positioned horizontally between the bottom bars of the super. To inspect the cage, stand at the rear of the hive and lift the rear of the super. With the front of the super resting on the brood chamber, tilt the super towards the front of the hive. The cage is easily seen by looking beneath the super. With this arrangement, the beekeeper can quickly check a colony for the queen's release.

give some reasons for requeening in the fall.

When to Requeen

Although some beekeepers requeen in the spring and this timing works quite well for them, I prefer requeening in late-summer to early fall. With fall requeening, there should be enough time remaining in the active season for the new queen's worker bees to populate the colony. For example in my geographic area (Eastern North Carolina), I use a rough guide of having the queens accepted in their colonies five or six weeks before the first killing frost. I requeen in the fall for a number of reasons. First with

fall requeening, a queen that is finishing two seasons of egg laying is replaced that fall with a young queen. Therefore, the colony spends the winter with the young queen instead of the older queen that would have been scheduled for replacement in the following spring. Compared to older queens, younger queens should have a lower mortality during the winter and result in fewer hopelessly queenless colonies found during the following spring. When the spring arrives, the colony already has a young queen helping to build up its worker bee population. In contrast, spring requeening causes a break in the brood cycle just as the colony

should be rapidly building its worker bee population for honey production. In addition, fall queens are usually cheaper than queens purchased in the spring. Now that we understand that the timing of requeening is important, let's review the basic requeening technique.

The Basic Requeening Technique: Instructions and Advice

Although there are many requeening techniques, the basic requeening technique described here is a fairly reliable method that uses the standard three-hole queen shipping cage. Before introducing a new queen into a colony, that colony

MUST be queenless. The worker bees will not accept a new queen while their mother queen or a virgin queen resides in the colony. Therefore, the colony's residing queen must be removed. She can be removed several hours before introducing the new queen, or if necessary, at the same time the queen cage is installed. If the colony has been queenless for more than a couple of days, remove any queen cells as they could hinder the success of the queen introduction. Also if these queen cells have been sealed, inspect them carefully because they can indicate the presence of a newly emerged virgin queen. For more details on queen cells as indicators of virgin queens, see the September issue of the *American Bee Journal* (pp. 627-630). An undetected virgin queen is one typical cause of a failed queen introduction. Finding a virgin queen is often difficult because she is smaller and moves faster than a laying queen. After we are sure the colony is queenless, we turn our attention to the queen cage.

It seems safer to introduce the queen without the attendant bees as they may provoke a more aggressive response from the worker bees of the recipient colony. Therefore, remove the cork from the end of the cage without the candy and carefully release the attendant bees without releasing the queen. I hold the cage vertically with the candy end down and my finger over the open hole (which is pointing up). As I watch the bees run around in the cage, I remove my finger, thereby opening the hole, whenever the queen is at the bottom of the cage. As the attendant bees run around in the upper portion of the cage, they will, one by one, find the open hole and escape. When the queen runs towards the upper part of the cage, I close the hole with my finger until she passes by. If the bees are not moving around in the cage during the releasing process, a few gentle puffs of breath on the screen of the cage will get them moving. The attendant bees should be released in an enclosed room or a car, so that if the queen is accidentally released, she cannot escape. Preventing accidental queen escape is important, and a lesson I learned the hard way.

Once, as a 12 year old inexperienced beekeeper, I ordered a queen through the mail. With daily inquiries at the local post office, I had anticipated her arrival for a week before she was actually delivered. Finally, the queen arrived. Although the interruption in egg laying had made her small and nimble, I imagined that soon she would be one of my best queens, heavy with eggs as she slowly walked across the brood combs. I took the cage to the apiary and began releasing the attendant bees, but the queen slipped by my finger and in an instant she had escaped! Her light weight made her a quick and agile flyer. After circling me twice, she



Figure 3: A worker bee biting the screen of the queen cage (as indicated by the arrow). Bees trying to ball a queen in a cage bite the cage's screen. The cage, part of which is seen here, is a home-made cage that I have used for years. As compared to the standard queen shipping cage, this home-made cage also makes photographing bee behavior on the queen cage much easier.

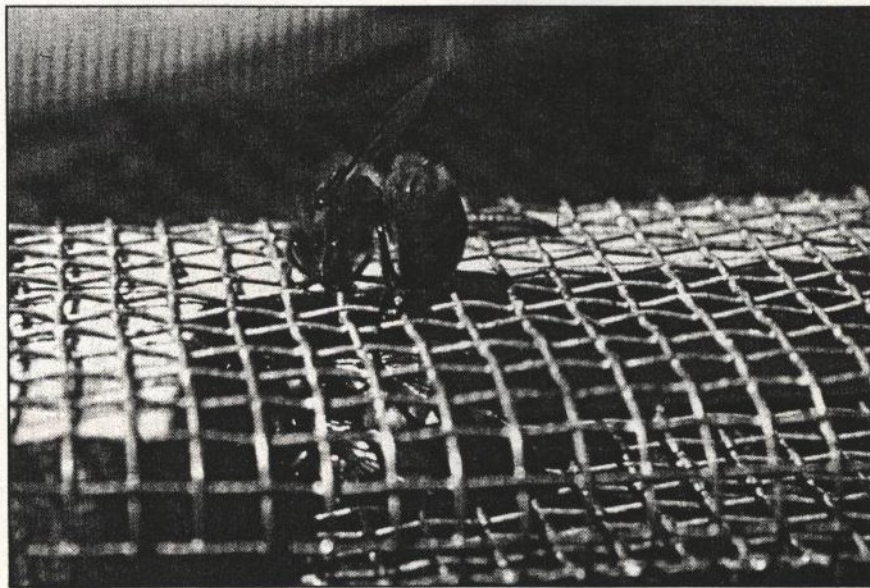


Figure 4: A worker bee apparently attempting to sting through the screen. Bees trying to ball a queen in a cage often curve their abdomen as if they are stinging through the meshes of the screen. Many bees typically display this behavior simultaneously; however to see this behavior more clearly, I removed them all, except for the one seen here.

flew off—never to be seen again. I stood there in the apiary, looking up at the sky, shocked, stunned—and heartbroken.

So carefully release the attendant bees in an enclosed area. If the queen should escape, she will probably be quite excited and run around on the outside of the cage or fly towards a lighted window. When

she settles down, carefully pick her up by grasping both pairs of her wings between your thumb and index finger. (A bee actually has four wings organized as a pair of wings on each side of her body.) Do not be concerned about being stung because queens very rarely sting while being handled. Next, put the queen's head into the

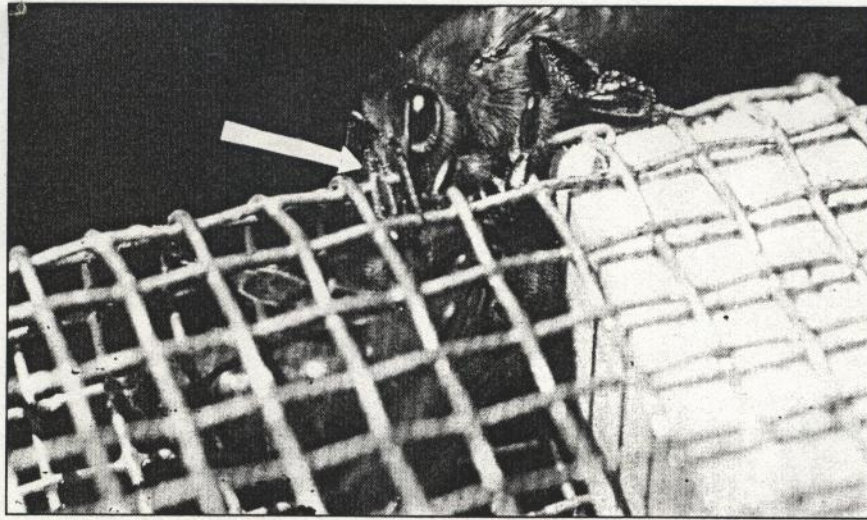


Figure 5: A queen's leg protruding through a mesh of the screen (as indicated by the arrow). A worker bites the screen with the queen in the cage directly below. When the queen's leg protrudes through the mesh, it can be damaged by hostile bees. Cages with larger meshes make it easier for the bees to damage the queen. Conversely, if the meshes are too small, the bees do not have proper access to the queen.

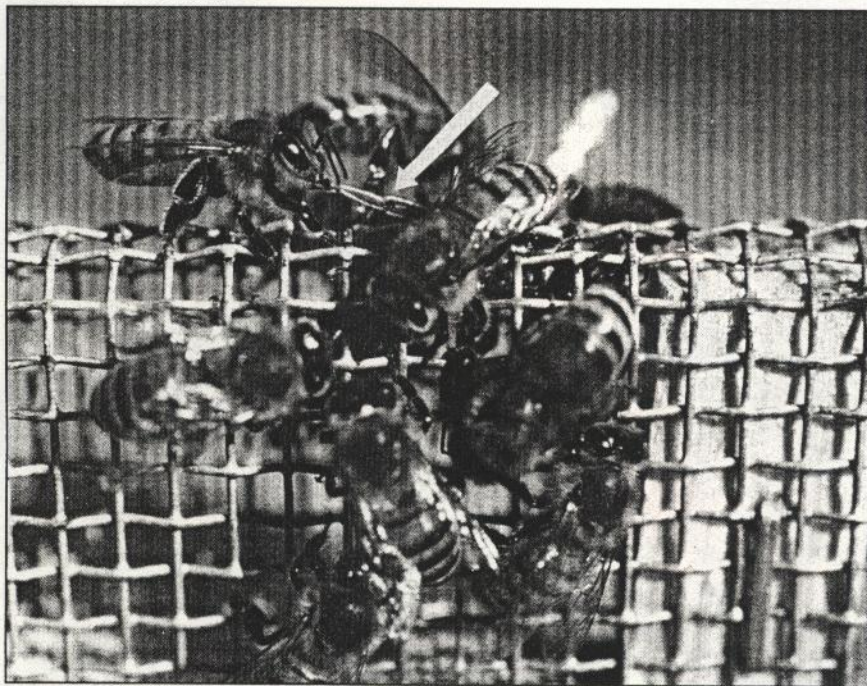


Figure 6: A queen's leg being pulled through a mesh of the screen by a hostile worker (as indicated by the arrow). The queen within the cage cannot be seen because of the bees on the outside of the cage. One of these bees has managed to pull the queen's leg out of the cage. A queen's feet or legs can be damaged by this rough treatment and can subject her to premature supercedure.

cage's hole and release her wings. In most cases, she will walk back into the cage. I realize that some beekeepers may not feel confident in picking up a queen bee. In fact, the new beekeeping students at North Carolina State University often giggle

when I tell them that beekeepers should know how to pick up a bee with their fingers. Although picking up bees with your fingers may sound a little strange, this skill is actually quite valuable, especially when handling queens. Beekeepers can

learn to pick up bees by practicing on their drones because they do not sting and are more expendable if accidentally damaged. Pluck the drone off the comb by grasping both pairs of his wings between your thumb and index finger. Try to grasp his wings close enough to his body so that he cannot turn around and touch you with his feet. Preventing the drone from turning around lessens the chance that he could be damaged in the handling process. After picking up a few dozen drones, one knows when the bee's wings are being held properly. This technique can also be used to pick up workers. Obviously if the worker bee's wings are not held close enough to her body, she can turn around and sting your fingers. A beekeeper who can confidently pick up a queen regards an accidental queen release as only a minor problem. The queen is quickly returned to the cage and the beekeeper can proceed to the next step in the queen introduction process.

After releasing the attendant bees, replace the previously removed cork. Next, remove the cork from the hole at the other end of the cage (the end with the candy). Some beekeepers make a small dent or begin a small hole in the candy that blocks this exit hole. I usually skip this step because removing some of the candy may allow the bees to release the queen too quickly. With the candy-end up, wedge the cage vertically between the top bars of the frames in the brood nest (see Figure 1). Always make sure the bees have access to the queen by ensuring there is enough room for the bees to walk on the screen. Sometimes it is difficult to position the cage properly between the top bars and provide the bees access to the screen, however provided the hive has a super, there is a second option. The cage can be wedged horizontally between the bottom bars of the super frames with the screen facing down towards the brood nest (see Figure 2). A queen cage installed in this horizontal orientation can also be easily inspected. Tilt the super up on its end while it still rests on the brood chamber below. Then look at the cage from the bottom side of the super.

The bees will eat the candy and typically release the queen in about 2-3 days. Hopefully by the time of the queen's release, the bees are ready to accept her. After about a week, briefly inspect the colony using a minimum of smoke. First, examine the cage and determine whether the queen has been released. If the queen is not in the cage, examine the brood combs for the presence of eggs or young larvae. Finding young brood indicates a successful introduction; the queen does not need to be found, and the hive should be closed as further disturbances may incite the bees to kill their new queen. The absence of young brood along with presence of queen cells indicates the queen introduction has probably failed. If the

queen is still in the cage, try to determine why her release has been delayed. Various problems can delay the queen's release: a dead bee could obstruct the cage hole; the candy may be a little too hard for easy removal; or possibly the bees are just slow at candy removal. Before continuing, examine the brood nest and remove any queen cells. These queen cells have had time to mature and later could produce competing queens. After removing the queen cells, one must decide whether the new queen can be manually released into the colony or whether it would be safer to let the bees finish removing the candy, thereby releasing her later. One way to make this decision is by observing the worker bees' behavior on the cage, and that is the subject of the next section.

Hostile Worker Behavior Displayed Towards the New Queen

As we can imagine, a great deal goes on in a honey bee colony that the beekeeper rarely sees, and the queen introduction process is no exception. How do the worker bees behave towards the new queen after the queen cage is installed in the hive? Initially, the worker bees regard the new queen as foreign because her odor differs from their old mother queen. Worker bees kill foreign queens in a process referred to as "queen balling." In queen balling, the worker bees form a tight "ball" around the queen. This ball of bees can vary in size, but is roughly the size of a pecan nut. The bees in the ball may actually sting the queen or just arch their abdomens in a stinging posture. Also, balling bees bite and restrain the queen by pulling at her antennae, legs and wings. Sometimes the bees will stop balling the queen and let her live, although she may have been damaged by the rough treatment. At other times, the bees may ball the queen without damaging her. If this balling behavior sounds a little confusing, that is because the biology of queen balling is complicated and not completely understood. However, for the purposes of queen introduction, any worker behavior associated with queen balling should be regarded as a hostile treatment of the new queen, and greatly lowers her chances of being accepted by the colony.

During the beginning of the queen introduction process, the foreign odor of the new queen emanates from the screen of the cage, and the bees react to the cage as they would react to a foreign queen by balling the screen of the cage. Bees ball the queen cage by biting the screen and by arching their abdomens in an apparent attempt to sting through the screen (see Figures 3 and 4). Initially, not only will many bees typically ball the queen cage, they can bite the screen very diligently, which makes their removal from the screen somewhat difficult. Over time, the number of bees participating in balling the cage diminishes. The bees that continue



Figure 7: Observing the workers' reaction to the new queen. Once the bees have stopped balling the cage, the queen is released into the colony. As a final check on the attitude of the workers towards the new queen, I watch her walk among the workers for a few minutes. In this situation, I am releasing a virgin queen (as indicated by the arrow) among bees that display no hostility toward her.

balling the cage usually do so with less intensity and become easier to remove from the screen.

Supposedly, the cage protects the queen as the bees are trying to ball her. However, a closer inspection reveals that although the cage may save the queen's life, the cage does not always completely protect the queen from damage during the introduction period. As the queen walks on the screen from within the cage, her feet and legs are exposed to the hostile bees that are biting the screen from the outside (see Figure 5). The bees that bite the screen will also bite, and sometimes damage, the queen's feet and legs. On some occasions, hostile bees can pull the queen's leg through a mesh in the screen (see Figure 6). This hostile treatment can result in queens with missing feet and partially paralyzed legs. Depending on the extent of the damage to her feet or legs, the queen may have some difficulty in walking across the brood comb and may be more susceptible to premature queen supersedure (Queen supersedure is where the bees replace their queen without the assistance of the beekeeper.). Whenever I find one of my queens, I check to see if she can walk across the comb normally. Although her feet are small and hard to see, I can see if she can grasp the comb by looking at the movement of her legs. If the queen is constantly groping at the comb with one of her legs, she is probably

missing the hooks on that foot. (These little hooks on her feet are used to grasp the comb.)

Eventually, the balling behavior vanishes; the bees walk calmly over the screen without showing any hostile behavior. Now the colony should be ready to accept the new queen. When using the basic queen introduction technique described above, hopefully the balling behavior has vanished before the bees release the queen. If the queen is released while the bees are still displaying hostile behavior, most likely, she will be killed. To avoid this premature queen release, I manually release my new queens when the bees have stopped balling the cage. This queen introduction technique does require additional trips to the apiary to examine the behavior of the worker bees on the queen cage. After installing the queen cage, I return two or three days later and inspect the cages for balling bees. After this time some bees may continue balling the cage less intensely and even stop temporarily because of disturbances from opening the hive. Therefore, to get a more accurate reading of the bees' behavior towards the new queen, I try not to vibrate the hive when inspecting cages for the balling behavior. After two or three days, most of the balling has ceased. If the balling persists for more than four days, I suspect the colony still has a queen. As a final check on the attitude of

the bees toward their new queen, I watch her walk among the bees for a few minutes after releasing her (see Figure 7). The worker bees should not attempt to bite the new queen or act as if they are going to sting her (see Figure 8). Sometimes the new queen will stop walking and raise one of her legs (typically a middle leg), presumably because she feels threatened by the bees. If this queen behavior or any hostile worker behavior is observed, I return the queen to the cage and try releasing her again in another day or two. I like this method of queen introduction because the bees are effectively "telling me" when they are ready to accept the new queen, instead of having the queen's release determined by how fast they can remove the candy from the queen cage.

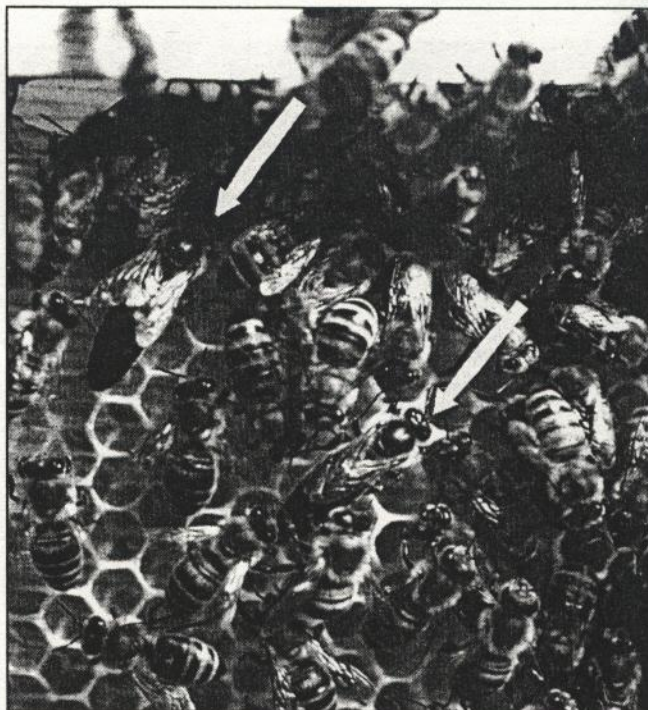
Some Strange Occurrences in Queen Introduction

This manual release method of queen introduction has worked very well for me over the years. However, this manual release method, like any queen introduction method, is not infallible. Sometimes on rare occasions and for unknown reasons, the bees still kill the new queen even when it seems they should accept her.



Figure 8: A hostile worker attempting to sting the new queen. For photographic purposes, I prematurely released this queen into the colony while the bees were still balling the cage. The bees immediately attempted to kill this queen, and I quickly plucked her from the comb along with an adhering hostile bee. Remember, being able to confidently (and quickly) pick up a queen is a very handy skill. If this queen had remained on the comb for just another moment, these bees would have probably killed her.

Figure 9: The colony's mother queen and a foreign queen together on the comb (as indicated by the two arrows). While not recommended for requeening, sometimes during a heavy nectar flow, a foreign queen can be placed directly on the comb without the bees balling her. Although these workers do not try to kill the foreign queen, the queens will try to kill each other.



Once I was introducing a queen into an observation hive. After the bees stopped balling the cage, I released the queen, and still the bees seemed ready to accept her. Then, for some unknown reason, the bees began aggressively balling the queen for about 24 hours before she finally died. Even though it seems that all precautions were taken to insure the queen's acceptance, strangely enough, the bees still killed her.

To make matters even more strange and fascinating, sometimes the bees will accept a queen when it seems that none of the typical precautions were taken. While I definitely do not recommend the following procedure for requeening, sometimes when bees are working in a heavy nectar flow, a foreign laying queen can be placed directly on the comb without the bees balling her (see Figure 9). In this situation, the bees seem to accept the foreign queen without any introduction process at all! Many beekeepers would find this lack of worker hostility strange, and rightly so, because the bees would usually kill such a foreign queen. In fact, when I was taking the pictures for Figure 9, I originally wanted one mother queen and two foreign queens together on the comb because three queens would make a more dramatic picture than just two queens. The worker bees showed no hostility towards any of the three queens; however, the queens would fight when they happened to encounter each other. Everytime a queen fight would begin, I would have to put the camera down, separate the combatants, and start over. I could not take the pictures while simultaneously keeping the three queens close enough to be seen in the picture frame, yet separated sufficiently to prevent

fighting. Finally, I gave up on using three queens and settled for having just two queens together as seen in Figure 9. Ironically, my photographic troubles do not include hostile worker bees—just hostile queen bees! When I was finished taking the picture, I did not try returning the queens to their original colonies. I just arbitrarily put one queen into each of the three original colonies. (It is unlikely, although possible, that by chance the queens were all returned to their original colonies.) To make sure none of the queens were killed later on, I inspected the three colonies five days later and found eggs in all of them. Finding eggs in all three colonies meant that under these local conditions, the queens survived the arbitrary replacement in the colonies.

Deciding whether the new queen can be safely released into the colony by using the behavior of the workers and the new queen is an excellent example of how an understanding of honey bee biology can help beekeepers make the correct bee management decision. In addition, by watching the queen introduction process unfold in an observation hive, beekeepers can acquire a deeper appreciation and understanding of the intricate interaction between the workers and the new queen. Understanding bee behavior deepens our appreciation of honey bees, and it helps us to become more highly skilled beekeepers.

Acknowledgments

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