The Remarkable Honey Bee

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BEEKEEPING BY THE NUMBERS

One advantage beekeepers have over those who raise or manage mammals and birds is the tremendous reproductive power of the bee hive. While there are huge losses reported in survey results indicating that many beekeepers lose many bee colonies every winter (or their local equivalent, such as a nectar dearth), one unique aspect of bee husbandry is this insect's amazing ability to make a lot of new bees in a short time period. How else can beekeepers who have lost over fifty percent of their colonies take a deep breath and calmly state that they will rebuild their losses, often in one spring buildup season? How else can beekeepers who have 40 colonies predict that they will fill 200 hives with bees within two seasons? Without this numerical reproductive advantage, the bee industry could be in a much more desperate state in light of all the dramatic colony losses that have been reported.

Through evolution honey bees have refined high reproductive rates by combining their egg-laying rate and repeated swarming behavior. These two behaviors are closely linked with each other (a colony with a low egg-laying rate is not very likely to swarm) and the combination of the two produces remarkable results.

In the revision of *Honey Bee Biology and Beekeeping* (Caron and Connor, 2013, Wicwas Press) the authors remind the reader that the primary goal of every beekeeper is to maximize the number of bees in a colony at the same time that the colony has the potential to produce the maximum amount of honey. Or, put the maximum number of pollen collectors into the orchard or target crop for pollination services. There is a powerful numerical effect of keeping large colonies over small. For example, research has shown that four small colonies do not produce as much honey as the same number of bees kept in one hive. This reflects the tremendous efficiency of a large social group. Consider the benefits of a large ant nest or a well-run human community. There are advantages in labor specialization, community protection, food gathering, nest-site creation and maintenance, disease and pest control and even specialized individuals that serve as undertakers for those that die.

At the Mother Earth News Fair in Lawrence, Kansas in October I spoke with many beekeepers who have followed the traditional "Langstroth" method of keeping hives and managing them. But there is a strong mood shift, often observed in young, idealistic non-beekeepers who vocally express that they will soon own bee colonies that will keep themselves—no human help is required for the bees to thrive. Unfortunately, some of these people do not want to have a discussion about the facts-of-life of bee management, or the results of scientific research. Instead, they want to put bees into a container and let the bees keep themselves. These bees cannot be fed, as feeding bees is an act against Nature. These people will not use smoke on the bees, ever. I wonder if they will treat their other animals and small children in the same manner and clinch my jaw tightly for fear of saying something inappropriate. I admit I was not always successful.

Beekeepers help bees by the simple acts of feeding starving colonies, of adding frames of honey or brood when the bees need food or of providing young larvae to create a new queen, especially after the replacement supersedure queen was eaten by a dragonfly on her mating flight. We know that swarms in Nature have a low survival rate, that only 16% of all swarms reach their first birthday. Even with the losses we have seen over the past few years, the post-CCD era beekeeper losses are not as low as Mother Nature's huge loss rate. Population geneticists will tell you that a certain level of mortality is necessary to keep any animal or plant populations healthy. Prior to the appearance of mites, North American beekeepers kept winter mortality at 10% in most years, apparently having found a balance between successful management and minimizing disease and colony loss.

Egg-laying rate

You can calculate an estimate of the number of eggs a queen has produced by using a simple calculation based on of the amount of sealed brood in a hive. I have used a Plexiglas sheet with one-inch grid drawn on it to quickly count the number of cells of sealed worker brood. Or you can use a ruler, kept in your back pocket or tool bucket, to roughly calculate the width and depth of each side of each frame of brood. Add this up and you have an approximate number of square inches of sealed worker brood.

Use your ruler and you will probably come up with the following observation—there are about five worker cells to one inch, so a square inch of sealed worker brood contains about 25 developing bees. If you multiply 25 times the square inches of brood, you can estimate the number of bees in the sealed stage.

European honey bee races spend twelve days in the sealed brood stage (3 as egg, 6 as larvae and 12 as sealed, for a total of 21 days for development). This gives us a simple method to complete the eggs-per-day calculation: simply divide the number of sealed brood cells by 12 and you have an estimate of the number of eggs a queen has produced in a 12-day period ending 9 days prior to the measurement, the time for

Using a ruler to measure the width and depth of each side of each frame with sealed brood, a beekeeper can measure the square inches of brood in a hive. This provides the calculation of the egg-laying rate of the queen bee.

egg and open larvae. Of course, this is a low estimate, but a useful one nonetheless.

While this system is not 100% perfect, it does allow you to compare hives and see which colonies are producing the greatest amount of brood in the same time period. The Dadant-Genetic Systems Starline and Midnite Hybrid bees were based on these back-breaking, intensive observations, as it was a powerful method of comparison to show how bee numbers and honey production (and also pollen collection) were highly correlated statistics. The key is to make the brood measurements about six weeks prior to the start of the nectar flow. Why? Because the bees you measure as sealed brood are the bees that will actually gather the nectar that will become the honey crop. These data suggested that there is an ideal egg-laying rate for a specific area; you may find brood counts that are too little and others that are too high. Colonies that failed to produce the eggs were poorer honey producers, but colonies that produced the maximum brood did not produce the greatest amount of honey, probably because it took more honey to feed these hard-working, but overly abundant and hungry bees!

Based on a few home-apiary observations I have recently made at the farm, I am willing to state that a colony changes its egg-laying rate frequently during the season, and perhaps even during the height of the season. Obviously, colonies have much reduced egg-laying rates in the winter and early spring—until the abundance of pollen and nectar stimulate the colony to collect more food and produce more brood. Certain races, like the Carniolan bees, and queen families like the USDA Russian bees, hold back on buildup during the late winter and early spring but then explode. In a queen rearing course I taught in the Lansing, Michigan area we measured second-year Minnesota hygienic colonies that appeared to be producing 2,200 eggs per day, using the method discussed above. I say 'appeared' because there is always the chance that there is a second queen in a hive working in a mother-daughter supersedure behavior that has been described by several groups of queen breeders.

This big push reaches the objective of maximizing the number of field bees for the nectar flow as described by Caron and Connor. While Italian-American stocks are known for early brood rearing that is sustained as long as there is food coming into the hive (even in December in temperate areas) other strains and queen families are more conservative, but then explode to generate huge bee populations for the flower-blooming period.

The challenge is to find the bee stock that provides the proper 'fit' for the plant community and the climatic conditions that are found in each colony's specific ecosystem. I argue that there can be as much variation between colonies within my home county of Kalamazoo County, MI as found among colonies in different parts of the state of Michigan. Local variations are often huge! Successful, locally adapted queens and bees undoubtedly are the ones that have the right buildup rate for specific areas. Add to this the variations from season to season and no wonder beekeepers are *bee-wildered* about what stock to keep in each area.

Bees per frame

Using the 25 bees per square inch statistic, it is possible to determine the number of bees found in the developing frames of brood of a colony, and to predict the number of bees that will emerge from such a frame over the next few weeks. In a standard deep Langstroth frame, about 19 inches wide and nearly 8.5 inches deep, there are enough cells to produce 3500 or more bees per side of comb, or 7000 adult bees per frame. At 3500 bees to the pound, a full, corner-to-corner frame of brood will produce two pounds of bees, and combs with reduced brood areas will often produce 1.5 pounds of bees once all the worker brood emerges. This provides the beekeeper with a fundamental tool to move frames of sealed brood to weaker brood to boost bee populations (and often reducing the swarming pressure in the donor hive). If a queen lays an average of 1500 eggs per day, the production of 1.5 to 2 pounds of bees in brood represents a queen's efforts for 3.5 to 5 days. This equalization of bee populations between colonies in an apiary is a standard method of boosting production of all colonies in an apiary. The use of these same bees to make increase nucleus colonies, *aka* splits and nucs, is a fundamental method beekeepers use to make up colony losses, as well as methods of producing bees for sale to local beekeepers, bypassing the need to purchase package bees. This is the key to a sustainable approach to beekeeping—maintaining and increasing colony numbers within the apiary.

Colony reproduction through swarming

The second part of this colony number story is the profound swarming behavior of bee colonies. This past summer and fall I've been working with Pittsburgh beekeeper and EAS Master Beekeeper Steve Repasky on a new book titled *Swarm Essentials: Ecology, Management and Sustainability*. Steve has been looking at the entire swarming event. Steve is a swarm catcher. He does cut-outs and promotes swarm capture among new beekeepers.

In Nature swarms issue from most colonies starting their second year. Following the early spring buildup, a combination of factors combine to stimulate swarming in healthy bee colonies. When bees swarm, between 40 and 60% of the adult bees leave with the swarm in a dramatic rush to the entrance that is quite fascinating to observe. Colonies produce multiple queen cells prior to this, and drone brood prior to swarming, in a complicated serial progression ending up with daughter colonies living in nearby nest sites.

What has come out of this book project for me has been the realization that colonies are tremendous risk takers. They put enormous resources into the bees and honey that leave with the prime swarm, along with the mother queen, and then multiple secondary swarms containing one or more virgin daughter queens. The risks are great for the parent hive—will there be enough bees left in adult bees and emerging brood to produce a crop of honey so it can survive the winter? Also, will a daughter virgin queen be successful — to mate and return to the hive without being eaten by birds, dragonflies and other predators? Or will the colony be weakened too much that it will fall prey to robbing by other bee colonies and wasps?

For each of the new hives the risks are also profound—as the 16% feral success rate clearly indicates. These bees must find a suitable home (see Tom Seeley's *Honeybee Democracy*), construct comb or retrofit 'found' comb in an old bee tree, collect adequate amounts of pollen and nectar for winter survival. And, if the old queen left with the prime swarm, will her replacement daughter be successful in her production and mating?

Bee colonies are tremendous risk takers. Humans help bee colonies by providing food, space, comb, and intensive management (such as by making increase nucleus hives to reduce bee population pressures). All beekeepers should keep a minimum of two colonies throughout the season as a means of pulling bees, brood, honey, and pollen—whatever is needed—from one hive to place it into another to keep the second colony alive. All beekeepers should keep one or more nucleus colonies year-round as a means to increasing survival percentages and providing the bees the ecosystem needs for pollination, while at the same time ensuring the beekeeper with honey and other hive products for personal use and for the marketplace. Active beekeeper participation is good for the bee colonies as well as the beekeeper. It is a wonderful synergistic relationship that has worked for centuries.

If you missed the not-so-obvious plugs for Wicwas Press titles, plus one for Harvard University Press, check out the newly revised and continuously revised website www.wicwas.com. In January Wicwas Press will be at both trade shows of the American Beekeeping Federation Conference, as well as the American Honey Producers Association Convention. The same week. Clearly bees communicate better than beekeepers do—it's called a calendar!