Georgia's Bee Lab

Rich in tradition, research, and accomplishments.

Jennifer **Berry**

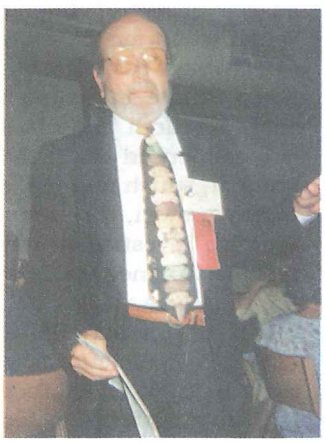
In our 21st century, fast-pace lifestyles, we tend to be unmindful about how it is our jobs came to be. Whose hard work, sweat and tears occurred previously in order to pave the way for our job to exist today? Until just recently, I, too, knew little about the history of the bee lab in which I work. So, let's take a look back over the past 38 years of the University of Georgia's Honey Bee lab.

In 1969, Dr. Alfred Dietz was hired as the state's only beekeeping research and education professor at the University of Georgia. He was fresh out of the University of Maryland were he successfully coordinated the 1967 Apimondia world congress, which, by the way, was the last time it was in the United States. Dr. Dietz quickly came to realize that just because you work for a large, land grant institution doesn't necessarily mean your lab will be financed. In fact he learned it was the opposite. He had very little financial support, so in order to survive in the land of research, he quickly become an expert at writing grants to fund his projects. While learning the ropes in grant writing he began working with electron microscopy and took the first pictures of the honey bee sensory organs and the bee louse (*Braula coeca*). Shortly afterward he returned to his roots and began delving into honey bee nutrition. While studying at the University of Minnesota he worked for Dr. M. Haydak, the famed honey bee nutritionist. His work with pollen lead to the determination that purple brood came from pollen collected from summer titi (*Cyrilla racemiflora*). He also expanded his research concerning queen storage and found that using emerged queens in mating nuclei was better than using queen cells.

Dr. Dietz, having an instructional appointment as well as a research one, began teaching a beekeeping course at UGA. His classes were not well attended at first, with only six students, so he decided to try the theatrics in order to lure more students to class. He would dress up in traditional German costume and pose as the infamous Dr. Karl von Frisch. He would then present lectures on bees around the campus. He also mentored students as well as post docs during his years of service at UGA. Two of his students became well known in the honey bee world; Dr. Jeff Pettis, researcher at Beltsville Bee Lab and Dr. Malcolm Sanford, retired entomologist at the University of Florida. His post doctorate, Dr. Frank Eischen, forged on and is now a research entomologist at the Weslaco Honey Bee Research Facility. In 1980, Dr. Dietz expanded his program by building the original bee lab at the horticulture farm in Watkinsville. That lab was the only semblance of a honey bee research facility in the state until 2000 when Dr. Delaplane received money from the state to build an additional lab. By 1983, Dr. Dietz's program was the top recipient of grant money for the entire department of Entomology at UGA, earning a total of $2 million. In 1977, Dr. Dietz became an exchange professor at Ehrlangen and in 1995 a guest professor at the University of Tubungen. But probably his greatest legacy was his work in Latin America on Africanized honey bees in the 1980s.

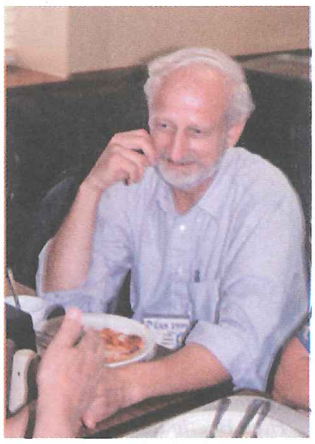
In January of 1990, Dr. Keith Delaplane took a position as assistant professor in the Department of Entomology at UGA. He was a recent graduate of Louisiana State University, mentored by Dr. John Harbo. His position replaced Rodney Coleman who retired as the extension apiculturalist before him. In the good ole days when money was available in the College of Agriculture, there were actually two Georgia state apiculturalists; one for extension and one for research. Rodney Coleman was Dr. Dietz's extension partner at UGA until he retired. Dr. Delaplane then filled the position as entomologist with the appointment being 100% extension. During this

Al Dietz



Malcolm Sanford

Jeff Pettis



Frank Eischen

Keith Delaplane in the Georgia Bee Lab.

The Georgia Bee Lab.

time, Dr. Dietz was a consultant on Africanized Honey Bees in Washington DC. It wasn't until 1994 that Dr. Dietz retired from UGA and gained Emeritus status from the department of Entomology. No plans were made to hire a replacement for Dr. Dietz so the lab became Dr. Deleplane's responsibility. One year later Dr. Delaplane was offered associate tenured professor, becoming a full professor in 2000.

During Dr. Delaplane's first years at UGA, he created his much watched public TV series "A Year in the Life of an Apiary". Dr. Delaplane's initial idea was for a short 30 minute beekeeping overview to be used at beekeeping and extension meetings. The idea expanded and grew until it became an eight part television show. The series follows the start up, management and maintenance of productive honey bee colonies through an entire year. He also wrote a book which accompanies the series which has recently been revised. Dr. Delaplane's name became well known almost over night due to the public TV series. To this day he believes the video project, his first inspiration at UGA, may be his best work.

Early in his career, Dr. Delaplane decided to coordinate an annual beekeeping event with Young Harris College. The Young Harris Beekeeping Institute has been an annual occurrence for 15 years and has been a huge success. It has hosted numerous speakers from all across the country and the world with attendance growing to over 100 participants over the years. The institute is held every year in May at Young Harris College in the beautiful mountainous region of north Georgia.

Jamie Ellis' Small Hive Beetle incubation chamber.

In between the extension responsibilities, writing monthly articles and extension publications and lecturing, Dr. Delaplane also found time for research. In the early 90s, he looked at controlling tracheal mites with vegetable oil and menthol. Then shortly afterwards, he and Dr. Mike Hood from Clemson University took on a three year project to determine the economic threshold for *Varroa* mites in the southeastern US. In the 1990s, very little attention had been paid to IPM in the beekeeping world.. Determining the economic threshold was the first step in laying the foundation work and has become instrumental in future IPM research projects (which I'll discuss later). Dr. Delaplane felt that the beekeeping industry needed to break free of its dependence on chemicals. That is why this lab has worked for over a decade on IPM for *Varroa* mite and small hive beetle control.

Along with his research accomplishments, Dr. Delaplane is the author of numerous research and extension publications. He is author of *Honey Bees and Beekeeping: A Year in the Life of an Apiary* and Dadant's revised edition on *First Lessons in Beekeeping*, plus he co-authored with Dan Mayer on *Crop Pollination by Bees*. Along with Tom Webster, he edited *Mites of the Honey Bee* as well as several chapters in books. He is currently the senior editor for the *Journal of Apicultural Research.*

Over the past eight years, Dr. Delaplane has mentored five graduate students and one post doc and with them came research projects, lots of research projects. Here is a condensed list of those projects. His first graduate student, which was me, explored how old comb effected colony growth, brood survivorship and adult mortality. We also investigated whether top or bottom supering increased honey yields and found no differences. During that time, Selim Dedej came to UGA in 1999 as a Fulbright Scholar. His research project explored what effects hygienic queens, comb age, and colony microclimate have on chalkbrood disease. He then returned in 2000 to pursue his doctorate which focused on blueberry pollination. His work proved that when honey bees are

introduced to blueberries they increase productivity of that crop. He also investigated the interaction between honey bees and carpenter bees on blueberry pollination efficacy and the effectiveness of honey bees in delivering the biological control agent *Bacillus subtilis* to blueberry flowers in order to suppress mummy berry disease. Next on the scene was master student Nabor Hector Mendizabal Chavez from Bolivia. Nabor worked on selecting queens with reduced colony *Varroa* levels, high brood production, hygienic behavior, high honey production, and gentleness. Then the Ellis team showed up with Dr. Jamie Ellis as the bee lab's post doctorate and Amanda Ellis as a PhD student. Dr. Ellis continued his work on small hive beetles since they had become such a pest here in the south east. It was also the main topic for his doctorate work in South Africa.

He took on several ambitious projects during his two years here at UGA. One project was to determine the economic threshold of SHB's in honey bee colonies and the other one to determine if IPM methods for *Varroa* mite control are cost effective for the beekeeper. He also explored certain nematodes as biological control agents for the larval stages of SHB's.

In 2006, Amanda Ellis finished her second year of research and will join the lab once again this spring to finish her final season. Her research will attempt to quantify the secondary effects of parasites on pollination efficacy and foraging energetics of honey bees. *Varroa* mites and small hive beetles served as the model parasites, and blueberry as the study plant. She also evaluated the pheromone-based attractant Fruit-Boost™ to determine if it enhanced pollination by honey bees in seedless watermelon systems.

Finally, to round out the students we have master student Eleanor Spicer from North Carolina. Eleanor is investigating the pollinator's role in sustainable agriculture. In a nutshell, when there is a shortage of pollinators, plants begin to compete with one another. Therefore how does one reconcile for this when fewer pollinators force floral competition. Her project focused on watermelon and sunflower. From her work this summer, she showed that when plants compete for pollination, the least attractive suffers. In this case watermelon was pollinated less than the sunflowers.

Jennifer Berry.

Well there it is, 38 years at the University of Georgia bee lab. Since I have run out of room, later I'll bring the lab into the present and discuss in more detail our decade long IPM studies and queen breeding project. Till then, see ya! BC

Jennifer Berry is a Research Associate at the University Of Georgia and is past president of EAS.

Get Ready To POLLINATE This Spring

Jennifer Berry

If you're going to pollinate for money this Spring and Summer, you better be getting your bees in shape now.

While the cold January winds continue to keep colonies tucked in up north, our southern girls are beginning to stir. By the end of this month, if current trends continue, most of South Georgia will be seeing the New Year's first bloom, red maple. Even further south, beekeepers are gearing up their colonies for blueberry and citrus pollination. But January in the south can be a rollercoaster ride, weather wise. We can experience all four seasons in a 24 hour period. One day we are outside working hives in t-shirts while the bees are buzzing about checking out their new landscape. Then the next day icicles dangle down from lids and hive entrances.

It is just a few days past Thanksgiving (when I'm writing this), and finally Winter and rain have arrived. It is forty degrees outside with a steady downpour. If it wasn't so cold we would all be outside dancing about and enjoying the rain. As most of you have probably heard by now, the southeast has been gripped by a severe drought. The Piedmont region of Georgia (hardest hit by the drought so far) is still 17 inches below normal, but at least it's raining today. Hopefully, by January the drought will only be a bad memory. I bring this up because the drought has not only affected Atlanta's water supply but may have also influenced your colonies as well. Late Fall and early Winter inspections revealed little to no pollen in many of our colonies. Pollen patties were fed last month to most colonies; a procedure I plan to repeat again. If your area experienced dry conditions I would highly recommend feeding pollen or pollen substitute patties. There is also a question about the quality of the pollen that was collected last year. With the extremely hot and dry conditions experienced over most of the Summer and Fall months, plants were severely stressed. What pollen was being produced and collected may not have been as nutritional as it should. But that is just speculation. Feeding is cheap insurance.

Like I mentioned earlier, beekeepers in Northern Florida are already gearing up for blueberry and citrus pollination with melons and squash not far behind. Beekeepers provide pollination because most commercial farmers don't keep bees. Having bees in the field year round can eventually interfere with normal farming operations. Therefore, they rent bees from beekeepers to pollinate their crops. In the old days when natural pollinators were more abundant and farming practices didn't include thousand acre monocultural plots, there wasn't such a need for pollination services. But that is not the case today. Just look at the California Almond industry. Every year they must produce more almonds, therefore more trees have been planted which in turn need to be pollinated hence more bees are required. Seems like a vicious cycle to me. But almond production is a profitable business and so is pollinating them.

If you are willing to work long hours, travel for days and move heavy equipment, pollinating crops can be a lucrative business but there are a few things you should be aware of. To begin, it is not as easy as it seems. What's the big deal right? Throw a few hives in a field and collect a check. Not so fast. Beekeepers are farmers, but most farmers are not beekeepers. This is important to note. The farmer, like the beekeeper, will hopefully be able to profit from all his hard work. However, there is a lot that needs to be accomplished before this can happen. On the farmers' side, fields need to be prepared and seed sown, fertilizers applied, weeds and pests controlled, and crops harvested. Several of these procedures can be harmful to colonies so precautions must be taken. But let's start at the beginning.

First, you need strong colonies. Colonies used for pollination services can quickly go down hill during crop bloom. That is why it's important for them to be as strong as possible to start. Many crops requiring pollination aren't good sources of pollen and nectar. Weak colonies not only are poor pollinators in terms of the field force but also, with the added stress of moving and poor forage, can crash fast.

Strong colonies in late Winter are a result of properly managed colonies in the fall so hopefully you planned ahead. Now, when the lid is removed bees should boil over six to eight frames. The colony should also have at least five frames of brood. Bees are more motivated to forage when there is lots of open brood. If colonies are not quite up to par, feeding sugar syrup and adding pollen or pollen substitute patties can help build up populations.

After you locate a grower in need of your services, it is important that the two of you sign a pollination contract before any bees are moved into the field. Unfortunately the days

when agreements were sealed by a "gentleman's handshake" are long gone. After a quick search on the internet I found an excellent example of a contract from the Mid-Atlantic Apicultural Research & Extension Consortium. The MAAREC contract is pretty self explanatory. But take great care when it comes to the responsibility of the grower. You must make it very clear that no pesticides or herbicides can be applied to crops while your bees are in the fields unless you have agreed to it. Losing all your colonies to pesticide poisoning is not worth any pollination fee. There are other pollination contracts online if you want to compare. These contracts will prevent any miscommunications between you and the person you are providing pollination services for.

Growers want to push the system in order for their product to be first to market. Demand is high and supply is low, therefore wholesalers and consumers are willing to pay more money for the early produce. Makes sense. Think about how much you pay for those first season blueberries. If you had only waited a few weeks the price would have been much lower, but it's been almost a year since you tasted that last berry. As the grower pushes for earlier yields he has to push for earlier blooms. This in turn means an earlier presence of bees in the field which can pose several problems. One, the bees may not be strong enough early enough. Late in the Winter months the queen begins laying eggs in anticipation of the first Spring nectar flow and colonies begin to rapidly build up. However, if early blooming cultivars are awaiting pollination, the bees may not be ready to handle the work. Therefore many commercial beekeepers needing colonies early will over-Winter them in southern Texas or Florida.

The other problem is the grower demanding to see bees in the field before the first bloom ever appears. This can be a serious mistake. Bees are opportunists. They will always go to the bloom that offers the biggest "bang for the buck." Let's say several hives of bees are placed on two acres of blueberries. The berries are a few days from blooming. However, there are dandelions, clover and other scrumptious wildflowers blooming down the road. In just a few days the bees are trained to fly *over* the blueberry patch and *into* the fields beyond. Once the blueberries begin to bloom, they will be mostly ignored. Then, the grower visits his field, discovers that there are blossoms but no bees and he's not too happy. He paid for a service which the blooms are not receiving.

The optimum plan is to bring the bees into the field just after the crop begins to bloom. You want the bees to be inexperienced foragers in the area. You don't want them trained to other floral sources before the crop bloom begins. Foraging behavior is not a fixed behavior but an adaptable one. It is controlled by the attractiveness of the nectar and pollen, and not necessarily the total number of blooms. So an acre full of open blueberry blossoms may be less attractive than sporadic wildflowers in the next field. Remember, the farmer is not a beekeeper and will not understand until you explain. But back yourself up by adding the arrival dates in the pollination contract. It will benefit both his yield and your future in the pollination business.

Weather can also play an important role in pollination. Rainy Spring days are great for the drought stricken areas here in the south, however, bees don't forage when it rains. Yields from early Spring blooming crops can be extremely hampered by cool, wet days. However, there is nothing you or the grower can do about the weather. The rain in the night is a farmer's delight, with bright sunshine beaming right at first light. It goes something like that.

Another thing to consider is the placement of the hives. It is best if you can spread the hives throughout the field at 500 ft intervals. Bees prefer foraging within a short distance (300 feet) of their colony. However, bees will fly several miles if necessary. Placing colonies so their 300 ft radii overlap is the best situation. If the inner fields are inaccessible, group a large number of hives in the center of the edge with a few isolated ones on the ends. Bees from hives placed along the edges may not penetrate to the center of the field resulting in poor pollination of those particular plants. Again, they will only fly as far as they have to.

Ok, you found a grower, the contract is signed, your bees are healthy and strong, and now it is time for the hard part; deliver the bees to the field. Moving hives is a chore and should be well planned out in advance. Seriously, it can be disastrous. Take your time, have plenty of help, don't be in a hurry, have more equipment than you will need, slow down, and most important be careful. Unless the temperatures are below 50°F it is recommended to move bees in the evening hours. They are less active and the temperatures are cooler which in the Summer months can mean the difference between arriving with dead bees or live ones. For smaller operations, screen each entrance and use a top screen. Use hive staples or those inexpensive hive straps bee suppliers sell. They're almost disposable, work well, are easy to use and keep everything together. Hive lifters work

Feeding protein is good insurance against having slow, weak colonies down the road.

well if you have two people, but better yet use a couple of hand trucks. Just scoop those hives up and away you go. Hand trucks will save on countless trips to the chiropractor. Make sure hives are well secured in the back of the truck or trailer and to the deck – no sliding, and no jack rabbit starts. Check to make sure brake lights are working. Not fun running into a trailer full of bees.

One last thing, make sure the grower knows you are coming and has made any arrangements necessary so you can enter the fields. It would be most unpleasant (fake British accent) to be standing at a locked gate at three in the morning with a truck load of unhappy bees. Some beekeepers always carry a large, heavy duty bolt cutter under the front seat. "My universal key," said one.

The commercial folks who move thousands of hives use pallets and load them unscreened onto trucks with forklifts. They then cover the entire truck with nets to prevent bees from escaping. A tractor trailer loaded down with hives is a sight to see. Bees are then moved from Florida to Maine, Pennsylvania to California and North Dakota to Mississippi to name a few. From time to time one hears about the semi that lost its load of bees. Then the next day, the front page of some local paper has the picture to prove it.

With gas prices and other hits to the economy it seems everything is going up in price. That includes the price per hive for pollination. Don't sell yourself short, this is hard work. The day of the $35/hive is gone. Beekeepers have to charge more for their colonies plain and simple. Not only with increased transportation costs, but with the trickle down effect there are increased costs in packages, queens, beekeeping equipment, medication, sugar, etc. It is passed on to us, we pass it on to the grower, he passes it (if he can) on to his supplier, and eventually we pay for it again at the check out line.

With the increase of human activity on this planet natural bee habitats are rapidly being destroyed. The days of "free" pollination are also quickly disappearing. This opens up new business opportunities for beekeepers. Know your skills, your limitations and your costs – both real costs and opportunity costs, and charge accordingly.

See ya! BC

Jennifer Berry conducts honey bee research at the University of Georgia bee lab in Athens, Georgia. She is a frequent contributor to these pages.

Pesticides, Bees And Wax

An unhealthy, untidy mix

Jennifer Berry

This past Spring our lab, along with Clemson University, received a critical issues grant from the USDA to study the sub-lethal effects of miticides on honey bee colony health and performance, (bee population, brood production, honey production, and colony foraging rates), brood survivorship and adult longevity, and finally worker learning and responsiveness to queen pheromone. It is a two year study with our first season's data collection almost completed.

The study consists of six treatments with eight colonies per treatment for a total of 48 colonies. The treatments are Apistan™, CheckMite+™, Mavrik®, Taktic®, copper napthenate and a control (no chemicals). Treatments were inserted in the spring and fall. The chemicals used for the miticides are as follows: fluvalinate (Apistan™ and Mavrik®), coumaphos (CheckMite+™), and amitraz (Taktic®). All three chemicals control mites; however Mavrik® and Taktic® are not labeled for use in honey bee colonies but are used by beekeepers.

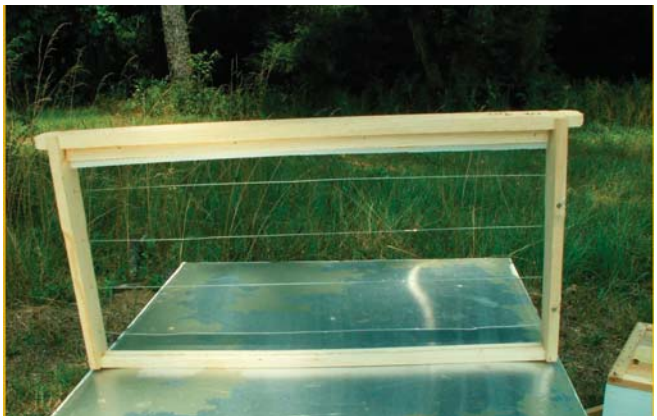
There were two main issues we had to address before the study could begin. First, we needed a source of "clean" (miticide free) wax foundation. We are examining the sub-lethal effects of different chemicals; therefore we needed to start with a clean slate, everything equal. If there are differing concentrations of chemicals unaccounted for, then what are we really measuring?

The first step was to analyze commercial foundation in order to find a source free of miticides. I quickly discovered this task had already been completed and the results were not good. Commercial foundation from the top five bee supply companies in the U.S. had been analyzed and residues of coumaphos, fluvalinate and the metabolites of amitraz were detected.

The next step in the venture was to ask several "chemical free" beekeeper friends for wax. Both were and had always been chemical free (including their wooden ware). Their samples were analyzed and again the news wasn't good. Both samples came back with detectable levels of coumaphos (512 & 870 PPB), a breakdown compound of coumaphos, coumaphos oxon (32 & 31 PPB) and fluvalinate (1820 & 2500 PPB). These compounds were detected at levels measured in parts per billion, which are miniscule amounts, but unfortunately still present. So, where did the chemicals come from? Here are a few ideas. Maybe bees from nearby apiaries, which have been treated with miticides, deposit chemicals onto the flowers they visit. When the "chemical" free bee visits these flowers she comes into contact with the chemical(s), bringing it back to the colony. Another idea, the miticides came in with the foundation that was purchased and placed into the hives. Both beekeepers used commercially bought foundation.

We kept searching and finally headed south, all the way to Brazil. Beekeepers in Brazil don't treat with miticides because of the Africanized bee population. They emerge in 19 days which is too early for the foundress mite's progeny to complete development before the adult bee emerges. Anyway, wax was collected and sent to our lab. It was analyzed and, unfortunately, there were so many other chemicals detected it wasn't suitable for our study.

Finally we gave up trying to find a source of untainted wax and settled on using a ½ inch strip of un-waxed, plastic foundation. Four wires were added to each frame to increase the strength and durability of the wax comb. The bees did a great job building the wax combs, however it was during a nectar flow. The only problem; if the colony was slightly tilted from left to right they would



Frame with strip of unwaxed plastic foundation and four wires.

A comb drawn out from the plastic strip.

build from say, the top bar of frame three to the bottom bar of frame four. Then it was quite difficult to remove and examine frames.

The second issue that needed to be addressed was *Varroa* mites. Miticides were being applied to four out of the six treatment groups so we assumed the mite population levels would be contained. But what about the control or the copper napthenate colonies in which no miticides were to be applied? Varroa could definitely take their toll on these colonies and affect the results. We needed a non-chemical treatment, so we turned to powder sugar.

Each time we applied powder sugar we inserted sticky screens to measure mite populations. The colonies which received miticides were given one treatment in the Spring and one in the Fall according to the label instructions. By November the coumaphos, fluvalinate and copper napthenate colonies had an overwhelming number of mites, well beyond the economic threshold level determined for the southeast. Interesting?

Let me give a quick background for each chemical we choose to examine. Fluvalinate, a synthetic pyrethroid, is the effective ingredient used in Apistan™ strips. It targets the axons or nerve fibers used for the transmission of nerve impulses. At one time it was the only chemical registered in the US for the control of *Varroa* in honey bee colonies. Since its introduction, the formulation has changed. The original or "racemic" form of fluvalinate has now been changed to tau-fluvalinate. The difference: it went from having multiple forms (racemic) to a single form (tau). By doing so, the toxicity levels have increased two-fold. The original median lethal dose (LD_{50} - the lethal dose it takes to kill 50% of a population) was 65.86 µg/bee but with the new formulation the LD_{50} is now 8.78 µg/bee. This new level is considered to be moderately toxic to honey bees. But the EPA reported back in the mid 1990s that the LD_{50} for fluvalinate is now 0.2µg/bee which makes it highly toxic to honey bees. Most of this information was reported by Maryann Frazier in the 2008 June issue of *American Bee Journal*.

Mavrik®, also a tau-fluvalinate product, is a broad spectrum insecticide/miticide used to control a whole array of insects including mosquitoes, ants, spiders, mites, ticks, springtails, cockroaches, fire ants, and aphids to name a few. It is used widely in residential and commercial settings plus nurseries and greenhouses. Since the active ingredient is fluvalinate, same as Apistan™, beekeepers use this product primarily because it is cheaper.

Coumaphos, an organic phosphate, is an insecticide used for the control of a wide variety of insects found on livestock. It is a cholinesterase inhibitor, which attacks the nervous system. It is used against insects that live outside the host animals, (ectoparasites) such as ticks, and mites. It was registered in this country for use in honey bee colonies under a Section 18 or emergency use registration because of the mounting resistance to fluvalinate being reported by beekeepers back in the 1990s.

Amitraz, a formamide acaracide-insecticide, is used to control red spider mites (deciduous fruit crops, citrus, cotton and certain other crops), and leaf miners, scale insects, whiteflies, and aphids in other agricultural settings. On cotton it is used to control bollworms, white fly, and leaf worms. On cattle, sheep, goats and pigs it is used as a topical spray or dip to control ticks, mites, lice and keds (wingless fly). Since it is an acaracide (pesticide that targets mites) and again cheaper, some beekeepers chose to use it to for controlling *Varroa* in their colonies. However, it is not registered for use in honey bee colonies and is therefore illegal.

Fluvalinate, coumaphos and amitraz are all contact poisons. It is transferred throughout the colony by bee to bee contact. The mite either comes into contact directly or from the bee. They are also lipophilic molecules which are more likely to be absorbed and detected in wax than in honey. Amitraz degrades rapidly because of exposure to sunlight (UV), low pH, metabolism by bacteria and solution properties. Degradation usually occurs within two to three weeks, and is not very stable in honey, which is good news. The bad news is the break down products or metabolites which form are 2, 4-dimethylaniline (2, 4-DMA) and 2, 4- dimethyl phenyl formamide (2, 4-DMPF). These products are apparently more environmentally stable, plus the 2, 4-DMA has mutagenic (causes changes to DNA), oncogenic (malignant transformation – tumors) and genotoxic properties (genetic mutations) (Osano *et al.*, 2002). Of course this is dependent on the levels present.

Because of mounting complaints from beekeepers about problems with queens (increasing supersedure rates, and colonies unable to re-queen themselves) researchers began investigating the sub-lethal effects of coumaphos and fluvalinate on queens and drones.

In 1999, Rinderer's group investigated the effect of Apistan™ on drones. Their findings showed a 9.4% reduction of drone survival in colonies treated with Apistan™. Other negative effects were observed as well: lower weights, mucus gland and seminal vesicle weights and the number of spermatozoa (Rinderer *et al.* 1999).

In 2002 a group of researches from across the U.S. examined the effects of queens reared in wax exposed to varying concentrations of fluvalinate and coumaphos. Queens weighed significantly less when exposed to high doses of fluvalinate than those reared in lower concentrations or controls. Even though these concentrations were higher than doses beekeepers would apply, the misuse or accumulation of fluvalinate in wax could lead to these higher concentrations within colonies. They also examined other effects of coumaphos and found that during queen development, body and ovary weight were both lower. Also, when one coumaphos strip was placed into colonies with developing queens, they suffered high mortality along with physical abnormalities and atypical behavior. Both of these findings conclude that when

fluvalinate or coumaphos are applied during queen development there is a significant negative impact on the queen's health (Haarmann *et al.* 2002).

Two years later the effects of coumaphos on queen rearing was again examined. Known concentrations of coumaphos were applied to queen cups in which queen larvae were being reared. Queens exposed to 100 mg/kg of coumaphos (which, by the way, is the U.S. tolerance level allowed in beeswax) were rejected by colonies 50% of the time. If that exposure was increased 10 fold to 1000 mg/kg there was complete rejection (Pettis *et al.* 2004). There are two trains of thought here as to how the coumaphos may affect the queens. One the miticides are being passed around the colony from bee to bee and from bee to the nurse bees which are attending the developing larvae. The toxin is making direct contact with the developing queen. The bees detect this and therefore reject the cell or emerging virgin. The second thought is that coumaphos is being directly incorporated into the wax as the queen cell is being constructed, which the bees detect and reject (Haarmann *et al.* 2002).

Dr. Collins took the above study one step further. Beeswax cups in which queens were to be reared were exposed to known concentrations of coumaphos (0 to 1000 mg/kg). Young bee larvae were then transferred into those cups and allowed to mature. The cells were placed into mating nucs for 21 days and then into production colonies for six months, or they were dissected to determine mating success. Queens reared in coumaphos laden wax weighed less. All but one of the queens failed to develop after being exposed to 1000mg/kg. Greater than 50% of the queen cells were rejected in the group exposed to 100mg/kg. The number of queens still functioning in colonies after six months was reduced by 75% if they were reared in cells with the presence of coumaphos (Collins *et al.* 2004).

Queens aren't the only ones affected, drones are as well. A student from Virginia Tech recently investigated sperm viability of drones when exposed to miticides. Drones exposed to coumaphos (recommended dose on the label) during development and sexual maturation had significantly reduced sperm viability which continued to decrease over a six week sampling period (Burley *et al.* 2008).

At a point in our beekeeping history, fluvalinate and coumaphos may have served a purpose. You may remember the initial years of *Varroa* and how our colonies would not have survived without the use of these chemicals. However, over time, researchers, beekeepers and the bees themselves have found methods to reduce mite populations without the use of these harsh chemicals. Now with mounting evidence showing the negative impact these miticides are having on our bees, what more do we need to convince us? Sick, little, skinny queens mating with inept drones, which will soon be superseded by bees born in unhealthy, chemically laced wax; not something I want in my colonies.

We'll have more from this study when it has been completed and the results analyzed. Stay tuned. BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

AN AMERICAN BEEKEEPER IN LONDON

To be a judge at THIS honey show you have to have won 75 prizes and entered in 10 categories, be a good beekeeper, get a certificate, keep good records, help set up shows, know the rules, know about honey, mead, wax, bakery goods, and have been a judge in at least five shows. Good Luck.

Jennifer Berry

The National Honey Show, which is held in England each October, is by far the world's most prestigious honey show. To have one of your entries even place is a major accomplishment, and an honor. Established in 1922, the first "National Show of Bees and Honey" was held in the original Crystal Palace in London the following year. Since then it has been held annually (except during WWII) to award those who pay the upmost attention to detail and quality when it comes to honey bee products.

There are 96 classes that you can enter. There are the traditional classes like extracted light, medium, and dark honey (unlike U.S. color classes, here there are only three colors). There are classes for candles and wax blocks, mead, melomel and honey beer. Artistic classes include encaustic art, photos, videos, needlecrafts, essays or honey labels. For chefs, there are classes for honey cakes, biscuits, cookies, fruit loafs and sweets. They have a junior class for those under 16 who wish to start competing early. There's even a class for new inventions. But the most distinguished class of them all is Class Number One – 24 jars of honey. That's right, 24 jars of honey all displayed as a single display. You can have one, two, three or four kinds of honey but they must all be in the same sized and shaped jars and filled exactly alike. The prize for this class is the Hamlin Cup, a "Silver Medal" and 50 Sterling Pounds. Rather than ribbons to adorn your first class honey the English award these lavish silver engraved cups and plaques.

The judging and display room.

This past October I was honored by being asked to speak at the National Honey Show. The 2009 show was held at St. George's College in Weybridge, a small town in the district of Surrey, which is a commuter suburb of London. I had not been to England before, so from my arrival at Heathrow airport every step was a new adventure. The only problem was getting there. Unfortunately, I had to fly.

Flying ranks up there with other fun and exciting experiences like root canals (*Is it safe?*), being buried alive or hunted down and then slowly devoured by a pack of wild dogs. That's of course when there's no turbulence. Add moderate to severe turbulence for seven hours, 56 minutes and 12 seconds in a torture tube and pretty much all the above "experiences" would be welcomed.

To top things off the flight left Atlanta at 11:00 p.m. arriving in Heathrow the next day at noon, hence an overnight flight. Since there was no way I was ever going to sleep a wink you could say I was a bit groggy when the death tank FINALLY pulled up to the gate. After exiting the plane I followed the masses, turning down this hall and that corridor until finally we came to immigration. I kept imagining long lines of anxious travelers waiting for the next security guard to sternly call them over to the interrogation table. You know the scene; baggage being tossed about and riffled through, questions asked about this item or that, pointing fingers, pieces of clothing tossed into the air, accusing stares, large intimidating dogs running to and fro. Then all of a sudden just behind you there's a skirmish as the un-expectant traveler is pushed to the ground by several dogs, guards rush in from all directions, nightsticks are pulled, a pile of blue polyester and then finally a roughed up, wide-eyed, handcuffed person is hauled away. Everyone in line looks down, not wanting to make eye contact with this poor soul as he's dragged into a nearby room. For a few minutes you hear him plead with the officers that he didn't know bringing *Bee Culture* into the UK was against the law, and then, silence.

But instead I walked right up to a booth where the immigration officer smiled, took my passport, asked in that oh so brilliant English accent the purpose of my visit, and then bang, bang, bang with the stamp, my

A sample of the jars to be judged.

document is returned and off I went to experience the antiquity of England.

As mentioned, the National Honey Show is by far the show of all honey shows. Beekeepers from all over the UK and the world bring their honey bee products to be judged by the best and to compete against the best. While attending the show I realized becoming a British Beekeepers Association (BBKA) honey judge is no small feat. It takes years of hard work and dedication to accomplish this task.

Just to be considered entry into the BBKA Show Judge Assessment Program the candidate must hold a BBKA basic certificate, have been awarded at least 30 prizes (1st, 2nd, or 3rd) from honey shows at a county or national level or where there's been at least 100 entries, and have participated as Steward for a minimum of six BBKA Senior Show Judges. The basic certificate has an oral and practical portion to the exam. Reading over the syllabus you have to have in depth knowledge about how to manipulate a colony, the names and functions of different pieces of equipment, a broad knowledge of natural history and general beekeeping, and be able to describe symptoms of disease, poisoning and pests. Remember this is just to be considered a candidate of entry. Now comes the difficult part.

After you have met the above criteria you have five years to complete the following requirements. First, candidates applying for judge assessment must pass a) the honey bee management, and b) products and foraging examinations, **or,** the general husbandry certificate. To achieve the Honey Bee Management Certificate candidates must give detailed accounts on 32 different aspects of honey bee management. Here are a few examples taken directly from the BBKA website . . .

These are made of beeswax.

Candidates must give detailed accounts of:	
1.2	the principles which govern the design of hives and frames, including the concept of bee space, and the main features of their construction
1.12	the year's work in the apiary and how this is dependent upon the annual colony cycle and the timing of local bee forage;
1.18	methods of swarm control used in small-scale beekeeping enterprises;
1.23	robbing by honey bees and wasps and the associated dangers, including prevention and curtailment;
1.31	laying workers and drone laying queens and the conditions leading to their development;

For the section on products and foraging, here are a few examples from the 28 different requirements needed to achieve the certificate . . .

Candidates must give detailed accounts of:	
2.1	the main requirements of the current United Kingdom statutory regulations affecting the handling, preparation for sale, hygiene, composition, labeling and weight of packs of honey;
2.26	an account of the factors affecting nectar secretion and the variations in the composition of nectar in different plant species and differing weather conditions;
2.28	an account of how the worker honey bees process nectar to change it into honey, including the enzymes and chemistry involved (to include a chemical equation).;

If you think that's difficult, looking over the requirements for the General Husbandry Certificate is even more imposing. First, the candidate must have been keeping bees for a minimum of three years and still have an active apiary with the following: three honey production colonies with bees and one nucleus colony with bees, plus sufficient spare equipment for feeding, queen introduction and swarm collection, to name a few. In addition they must have honey and wax processing equipment, plus samples of their honey (6 jars minimum) and wax (25g minimum), which are suitable for sale. They are also observed working colonies to assess their beekeeping skills.

Records of beekeeping activities must be maintained. An apiary layout, plans for work in the apiary and records of the season (i.e., quantity of honey collected during the season) must all be kept. There is also a separate record book which contains information about the condition of each colony every time there was an inspection (i.e., existence of a queen, temperament, brood size, disease, feeding details, swarming, etc). After the above requirements are met there are seven separate sections that they must be able to demonstrate an understanding about:general information about keeping bees, practical beekeeping, natural History and behavior, foraging, disease, pests and poisoning, honey and honey processing and stings.

In addition to the certifications, there are **99** other criteria that need to be satisfied. I can't review them all, but here are some you'll need to consider.

If you want to be a BBKA honey judge you must have been awarded at least 75 prizes of third place or higher in a variety of different classes at a county, or national honey show, **or,** a honey show where there are at least 100 entries. That's 75 1st, 2nd, or 3rd place ribbons. Plus, you must have entered in *at least* 10 different categories.

Next you must be a steward for at least four different BBKA show judges at four different locations. And the honey show must have had at least 100 entries.

If you want to be a BBKA honey judge you also need to have other relevant experience such as helping set up shows or accepting entries. You must also have an understanding of honey show procedures, record keeping, schedules, rules, and legal requirements.

If you want to be a BBKA honey judge you need to know everything there is to know about the different types of honey (liquid, granulated, soft set, Heather, and composite classes), comb, cut comb and section honey. You need to know about the different meads and what is and is not suitable.

You need to know about wax, candles and artistic displays. You need to know about observation hives and nucleus colonies. And don't forget about honey cakes and sweetmeats (a sweet delicacy). You must know about slides, photographs and how to judge them properly.

Then, finally, the candidate must have judged a minimum of at least five separate shows, where five categories were judged per show. After all this hard work and dedication you have finally become a BBKA honey judge. Congratulations!

Back on this side of the pond our honey judges don't go through such a rigorous program but times are changing. In 2001, Michael Young from Ireland was the guest lecturer for our Young Harris/UGA Bee Institute. Michael is a National Honey Judge, a culinary master and professor at Belfast Metropolitan College, artist and executive chef for the Malone Golf Club in Hillsboro, Ireland. From the moment he stepped onto our shores, Michael raised the standard for honey judging and honey shows in the U.S. Because of his influence there has been a new found interest in honey judging and shows, so the Young Harris/UGA Bee Institute has a honey judging certificate program which is modeled after the Welsh Beekeeper's Association honey judging certificate. This certificate is the only partnership of its kind between the U.S. and the U.K. If you get the chance, check out the rules and guidelines used in the U.K. You will most likely learn something about bees, beekeeping, and honey. Cindy Hodges from Atlanta, Georgia entered this year, for the very first time mind you, and placed second in Photography, and third in the International Honey Class. Congratulations Cindy!

But now, let me turn your attention to the south and the problems beekeepers may be facing. Due to the wet, cool, rainy Spring and the wet, warm Summer, oh, and the wet, cool Fall, it seems many colonies did not find enough food to make it through the Winter. You MUST inspect your colonies this month. When the temperature allows (upper 50s, lower 60s and that's not uncommon) get into your colonies and check food levels. It's January and if you don't have 30 pounds of honey next to or above the bees then you MUST feed. This time of year still use a 2:1 sugar:water solution, especially if you are trying to get some weight on your girls. That's two parts sugar to one part water. It takes boiling water to achieve this mixture. If the weather is too cold to open the colony lift the back of the colony off the ground. If it feels light to you then feed. Remember during colder temperatures it is difficult for the bees to leave the cluster, hence entrance feeders and division board feeders won't work. Buckets, or jars above the cluster are best. A few dollars investment in sugar now is far better than to lose the colony. And if you give them that little extra they need your bees can produce award winning honey this Spring. See ya at the honey shows!

The next National Honey Show will be October 28-30, 2010 in the same location. For more information check **www.honeyshow.co.uk**. BC

---

*Jennifer Berry is the Research Coordinator at the University of GA Bee Lab. Contact her at **Jennifer@BeeCulture.com**.*

What's Worse — The Pest, Or The Cure?

When It Comes To Small Hive Beetles, There Are No Easy Choices

Jennifer **Berry**

The average consumer is pretty naïve about where food comes from. Generally, we have no clue about how it's planted, grown, harvested, processed, packaged, transported and finally displayed in the grocery store. (Not that there's anything wrong with that.) It's understandable that most people just have more pressing issues in their lives than to occupy themselves with the process of how food gets to the table. But if consumers did know more, we might see some serious changes in how we produce food in this country such as more humane, organic, and free range options, to name a few.

When you talk to the experts they say it is unrealistic to think we could possibly feed the world with organic meats and produce, unless the population was dramatically lowered; which is not a good solution. However, demand for changes in the whole food chain are occurring and growing in popularity. Organic food is the fastest growing sector in the American food marketplace and is becoming more commonplace in grocery stores. Biodynamic agriculture, farmers' markets, food co-ops, organic farms, and sustainable farming are all on the rise. Localvore (one who consumes locally grown food), CSA (community supported agriculture), and CNG (certified naturally grown) are the newest buzzwords. These are all efforts to protect soil, water and wildlife while recycling resources, promoting ecological balance, and conserving biodiversity. And as a result, these measures help ensure that our food and our world are a bit less toxic.

Let's narrow the focus just a bit. Before you became a beekeeper (or interested in bees) did you know what went into making a pound of honey? Well, I didn't know squat, except that those cute little smiling bees on retail packaging were responsible for filling honey bears and sweetening my life. That's about what the average honey consumer knows as well. Oh yes, we also know that bees sting, and that kids look absolutely adorable when dressed up in a fuzzy honey bee costume with that little stinger projecting out the back. "Isn't that just too cute, honey? Take a picture."

What was it about beekeeping that lured you in? Was it your love of honey that brought you into the fold, or do you just like wearing white? If it was the honey, do you remember tasting "real" honey for the first time? Not the junk they sell in stores that's been imported from wherever, filled with whatever, and processed however. I'm talking about the stuff you eat right off your finger, directly out of the comb while working bees, or right out of a jar from the local beekeeper at the farmers market?

Once exposed to the rich, full flavor of pure honey, your "palate," as they say, changes forever. I've seen it time and time again. Whether it's a friend, family member, next door neighbor or stranger, once someone tastes the real stuff . . . they're hooked! And they keep coming back for more.

Some returnees do so because they have certain health issues, allergies for instance. They've heard that eating local honey can help lessen the symptoms. And, here in the southeast many people are miserable with allergies, especially during the spring months. Folks also seek out pollen since it's been promoted as the "perfect food;" it's consumed by the tons for nutritional or health reasons. Finally, beeswax is used for candles and skin products. People searching out these products usually are more health conscious, for whatever reason, than the normal consumer. So how would their perception change if they realized there are numerous chemicals in these bee products?

The use of chemicals in honey bee colonies has been a source of concern for some time, not only for beekeepers, but for researchers as well. In recent years, due to adoption of IPM, chemical use by backyard beekeepers has dropped dramatically. But most of us realize that there is a time and a place for chemical use. Look at our own bodies, for instance. We don't think twice about taking a pill if we become ill. Off to the doctor we go to get a prescription, then to the drug store to fill it, and finally home to take it. But aren't these very medications we're slipping into our own bodies chemicals as well? What would bees infested with mites choose if they were able: a strip of coumaphos, a dose of apistan, a dollop of amitraz, a dribble of acid, a wafer of thymol, a spoonful of sugar, or nothing at all?

Beekeeping today is not like the good ole days when our grandfathers kept bees. Prior to the 80's few chemicals, if any, were needed to keep colonies alive. Unfortunately, with the weight of current stresses on bees, including mites, diseases, and more recently small hive beetles, this is not the case anymore.

"Can we reduce the use of these pest control chemicals in our beehives?"

With yet another exotic pest being introduced to the U.S., beekeepers have been desperate for a control against small hive beetles (SHBs), especially in southern regions. SHBs can pose a problem to bee colonies just about anywhere, but nothing as compared to the Deep South. In my neck of the woods, beetles usually make their devastating march only after a colony has been compromised by other issues, such as mites, disease, queenlessness, etc. However, further to the south, beetles don't need an invitation to take over, they just do. Hence, controlling populations has become a priority in some operations. With coumaphos (Checkmite+□) having been approved for use in hives to control mites, it was quickly approved for dual use to control SHBs. However, numerous other techniques and concoctions have been tried and are used today . . . some illicitly.

One popular product used by beekeepers, which kills SHBs, is Maxforce Roach Killer Bait Gels or Maxforce FC Magnum. The bait was developed to kill ants and roaches in and around areas inhabited by people, but without causing them harm. The active ingredient is fipronil, a broad-spectrum insecticide. If you have cats or dogs, then you may recognize the trade name Frontline, which is used to control fleas. Fipronil is also widely used in other applications from inside to out. Inside, it is used in commercial and residential food processing areas. The benefit with this particular insecticide is that there's no need to cover food prep stations during treatment. Outside, it is commonly used for managing termites and pests in turf grass. However, fipronil is **very toxic** to honey bees and has NOT been approved for the use in honey bee colonies.

Here's some interesting information that comes directly from a website which sells Maxforce: "The active ingredient in Maxforce FC Magnum, Fipronil, provides a unique mode of action that works through both ingestion and contact, knocking down roaches and ants that eat or simply touch the bait. Either way, one contaminated roach or ant kills many others where they live and breed. The Domino Effect® still achieves population control, but with faster visible results. Maxforce FC Magnum roach bait gel is the newest bait from Maxforce by Bayer. It has the same great active ingredient (Fipronil) as the other Maxforce products. Only this time, you get five times the active ingredient, plus a new technology called ContactX(TM) that kills roaches even when they just touch the bait. Other roaches touch or eat the dead roach and spread the bait again, controlling the entire colony, even the roaches you can't see." Controlling the entire colony . . . Hmmm?!?

Maxforce is applied to colonies in several different ways. One way is to inject the gel into corrugated plastic signage material. You know the ones. They pop up like mushrooms along roadsides and front lawns during campaigns suggesting that you elect this candidate or that one. Another way of introducing this product is to squirt it into the center of a CD or DVD case and the beetles will enter through the small holes on the side. The idea behind these semi-closed systems is to draw the beetles in to partake of the bait where they hopefully will croak immediately, that is to say without exiting and re-entering the hive contaminated. If the beetle does die inside the trap, the chemical would be contained, never exposing the bees, wax, pollen or honey to the toxin: at least this is the assumption made by those applying the product. They rely on the idea that the fipronil is "quarantined" inside the trap and not spread around the colony. However, it seems this may not be the case.

Fipronil is a slow acting poison. When it's used in a beehive, an exposed pest is able to amble around before dying, either returning to its hiding place or continuing to feed on pollen or brood and the residues are spread everywhere they go. In addition, once the insect does die, if it is eaten by other beetles or their larvae, there are sufficient residuals left to kill those beetles as well. And the contamination process goes on and on.

Recent analysis of hundreds of wax and pollen samples has revealed unprecedented levels of miticides and agricultural pesticides. While fipronil was not in the top 10 most detected pesticides, it was detected in both wax and pollen. Those consistently detected as the top three were fluvalinate (Apistan□), coumaphos (Checkmite+□), and chlorpyrifos (Mullin et. al. 2010). The first two are beekeeper applied miticides used for controlling *varroa*. Chlorpyrifos (an organophosphate) was at one time one of the most common and widely-used household pesticides. Trade names you probably recognize are Lorsban and Dursban. But because of undesirable children's health issues, it was banned from homeowner use and severely restricted for use on crops; however it is still very prominent in the environment.

But what's worse, the pest or the cure? Our world is so inundated with man-made chemicals we would be hard pressed to find any food item free of toxins, including honey. They're in the air, the water, the soil, inside our homes, and our bodies. They're passed through the food chain from one organism to the next. But as we become more educated about the food we eat, I imagine we'll become even more selective. By being more selective we can at least limit some of what goes into our system, can't we? And maybe by restricting or reducing the use of chemicals in our bee colonies we can ultimately reduce the amount released into the environment, chemicals that would otherwise eventually find their way back to us. Listen to what some of your fellow beekeepers are saying. "It's been years since I've treated with anything, and the bees are still alive." At least for now!

See Ya! BC

Jennifer Berry is the Research Coordinator at the University of GA Bee Lab. Contact her at Jennifer@BeeCulture.com.

Reference:

Mullin, C.A., M. Frazier, J.L. Frazier, S. Ashcraft, R. Simonds, D. vanEngelsdorp, J.S. Pettis 2010. *High levels of miticides and agrochemicals in North American apiaries: implications for honey bee health.* PLoS ONE 5(3): e9754. Doi:10.1371/journal.pone.0009754.

Revisiting Powdered Sugar For Varroa Control On Honey Bees (*Apis mellifera* L)

Jennifer **Berry**

Prior to our study, when an experiment required *Varroa* free colonies, we would dust bees with powder sugar as a means of removing mites. Dusting with powder sugar was also gaining popularity in the beekeeping arena as a method of controlling *Varroa*. In 2009, researchers in Florida conducted a study which examined the efficacy of powder sugar and found it did not help in controlling *Varroa*. However, even though the study was sound, powder sugar only dislodges phoretic mites and not ones inside the cell. Therefore, for powder sugar to be effective it would have to be applied during broodless periods, which Florida rarely experiences due to its warmer climate. So we decided to design an experiment that would test the efficacy of powdered sugar when applied during broodless times verses when brood was present.

Unfortunately, as the study revealed, relying solely on powdered sugar as a means of controlling *Varroa* mites does not keep mite populations from reaching devastating levels. This was bad news for us here at the lab. We were hoping that powdered sugar would be the cure-all, a silver bullet, that one control method that worked which didn't include chemicals in the mix, but it's not. Yes, it does work at dislodging mites but is not "powerful" enough to remove enough mites in order to keep them from eventually causing damage to colonies. If you are or are planning to use powder sugar, be aware that it needs to be "part of" your *Varroa* management scheme and not your only choice.

Below then is the paper we published showing the results of our study. It was originally published in the Journal Of Apicultural Research, an IBRA publication www.IBRA.org. We thank them for permission to reprint this important study on these pages.

Dusting bees with powdered sugar has been examined as a remedial control for *Varroa destructor* Anderson and Trueman. Two modes of action have been proposed: one being that fine dust impedes locomotion of phoretic mites and induces them to fall off bees (Ramirez, 1994), and another being that dust induces a grooming response in bees that similarly dislodges mites (Macedo *et al.*, 2002). When measured as a percentage of phoretic mites dislodged, powdered sugar dusting has achieved experimental knock-down rates ranging from 77% (Aliano and Ellis, 2005) to more than 90% (Fakhimzadeh 2001, Macedo *et al.*, 2002), but a persistent problem has been translating these kinds of results into practical field applications. The most comprehensive examination of powdered sugar as a field-level *Varroa* control was the work of Ellis *et al.* (2009) in Florida. These authors dusted the top bars of brood combs with powdered sugar every two weeks from April until the following February (11 months), compared numerous parameters of colony strength and *Varroa* populations against a control group, and found no treatment effects on any parameter of interest. In spite of these negative – and convincing – results, we wanted to do a field study that (1) exploited a brood-free period of the season when all mites are phoretic on adults and vulnerable to dust treatment (bee colonies in sub-tropical Florida are rarely brood-free), (2) compared more than one dust delivery method, and (3) compared more than one treatment timing interval. We felt that these outstanding questions should be resolved before we abandon powdered sugar as a bee-safe (Fakhimzadeh, 2001) and chemical-free *Varroa* control option.

We set up 64 equalized, queen-right colonies (single-body Langstroth hives with screen floors) and divided them equally between two apiary sites in Oconee County, Georgia, USA (33°50' N; 84°34' E). Once in their respective apiaries, each colony was randomly assigned one of eight (2^3) treatment combinations: (1) initiation of powdered sugar treatment (a) in January (broodless period) or (b) in March (brood area rapidly expanding), (2) treatment applied at an interval of (a) every other month for a duration of nine days (four treatments three days apart) or (b) treatment applied one day at an interval of every two weeks, and (3) powdered sugar applied as (a) a dusting of 120 g (250 ml) powdered sugar with a sifter over the top bars of brood combs then brushing the sugar down between frames using a bee brush or (b) powdered sugar (same quantity) blown into the hive entrance with forced air from a shop vacuum custom-fitted with a chamber made of polyvinyl chloride (PVC) plumbing components holding the powdered sugar. There were eight colonies (replicates) per treatment combination. The treatment interval ran from Jan-Oct, inclusive.

As an appendage to this balanced design, we set up and managed an additional eight colonies as negative,

Dusting bees with powder sugar to dislodge mites.

Dusting bees with powder sugar using a flour sifter.

non-treated controls (never treated with powdered sugar or any remedial action), raising the experiment to *n*=72 colonies. These colonies provided an additional treatment group for comparison in one-way ANOVAs against the simple effect of powdered sugar.

After colonies were established, they were managed optimally for swarm control and honey production while administering the prescribed treatments. In January prior to administering the first treatments and again in May and October, we collected the following measures of colony strength and mite numbers using published methods (Ellis *et al.*, 2009): bee population, brood area (cm^2) (only in May and Oct), brood viability (72-hr survivorship of open larvae), and number of phoretic mites per 100 bees (derived from strained alcohol samples of ~300 bees). Additionally, the number of mites retrieved on three-day bottom board sticky sheets (adjusted for mite catch per 24 h) was collected for each surviving colony on 19 Jan, 8 Mar, 16 Apr, 1 Jun, 25 Jun, 30 Jul, 17 Aug, 25 Sep, and 11 Oct. All statistical analyses were done with SAS JMP (version 8.0.2).

Our first question was simply whether *Varroa* mite levels were affected by powdered sugar treatment. To test this, we pooled all 64 colonies in the balanced experiment into one "treated" group (irrespective of the 2^3=8 sugar combinations described above), assigned each a random number, and sorted them by random number, thus creating eight randomly-assigned groups of eight treated colonies. Each of these treated groups thus presented a comparison group to the eight untreated control colonies, essentially letting us perform eight separate ANOVAs on the dependent variables. In two of eight ANOVAs (25%), powdered sugar significantly reduced colony mite levels. In one analysis, the number of phoretic mites per 100 bees averaged across Jan-Oct was significantly (F=4.4; df=1,14; P=0.0537) lower in the treated group (3.0 ± 0.98 (mean ± SE), n=8) than the control group (6.0 ± 0.98, n=8). In another analysis, the number of mites caught on sticky sheets per 24 h averaged across Jan-Oct was significantly (F=4.7; df=1,14; P=0.0475) lower in the treated group (24.4 ± 7.3, n=8) than the control group (46.9 ± 7.3, n=8). No other parameters of interest responded to powdered sugar in these tests.

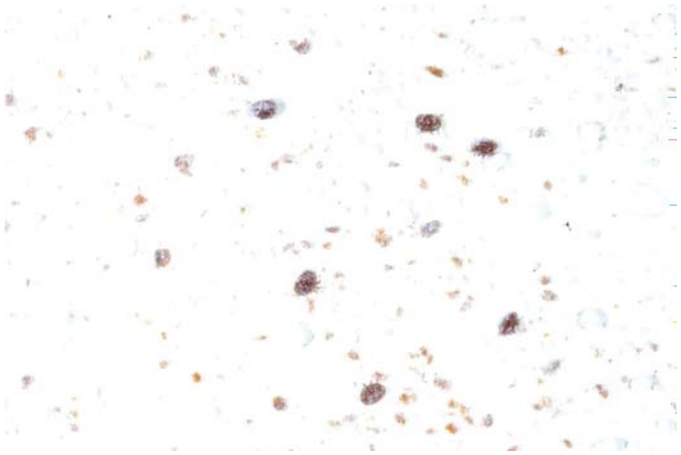
After dusting colonies with powder sugar, inserting sticky screens in order to count mite drop.

We next turned our attention to the balanced experiment in order to tease out effects of month of treatment initiation, mode of dust application, treatment interval, and any interactions thereof. The only significant effect in a whole-model analysis was an interaction between mode of application and treatment interval for cm^2 brood in May. Deeming this uninteresting, we simplified the analyses by treating month of initiation, mode, and interval as simple effects in one-way ANOVAs. The number of phoretic mites per 100 bees in October was significantly (F=4.8; df=1,22; P=0.0401) lower in colonies in which powdered sugar treatment began the previous January (3.4 ± 0.9 mites (mean ± SE), n=11) compared to colonies in which treatment was delayed until March (6.1 ± 0.8, n=13). This suggests that powdered sugar dusting is more efficacious when it can be applied early and exploit a winter brood-free period. Colony bee population in May was significantly (F=3.9; df=1,61; P=0.0524) higher in colonies in which powdered sugar had been blown into hive entrances (8496 ± 710 bees, n=32) compared to colonies which had received powdered sugar by sifting onto exposed brood comb top bars (6493 ± 721, n=32). This suggests that applying powdered sugar with forced air at the hive entrance was less disruptive to bee populations than exposing and dusting comb top bars. No other parameters of interest responded to independent variables in these one-way ANOVAs.

A final observation of interest is the number of colonies surviving at the end of the experiment. Of the eight non-treated control colonies, three (3/8=38%, n=1) were alive in October. Average survival among the eight sets of randomly-derived treated colonies was 39 ± 6.4% (mean ± SE), n=8).

In conclusion, powdered sugar treatment resulted in lower colony *Varroa* levels in two of eight (25%) separate analyses. We have evidence that powdered sugar is most efficacious when it can be applied early in the season and exploit a winter brood-free period. A labor-saving technique of applying powdered sugar dust at hive entrances with forced air appears to be less disruptive to colony bee populations than a more invasive practice of sifting sugar onto exposed brood comb top bars. In spite of these highlights, we cannot pretend that these results are a strong affirmation of powdered sugar in the fight against *Varroa*. The method was ineffective at reducing

Charlie Gwyn and Graduate student, Brett Nolan testing out the dustructor.



Mites that were dislodged by powder sugar dusting.

Varroa in 75% of our analyses. Moreover, 10-month colony survival between treated and non-treated colonies was virtually identical, and poor, at 38-39%. Powdered sugar is, at best, another "weak" IPM component that may contribute toward *Varroa* management when used in conjunction with other components. BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

References

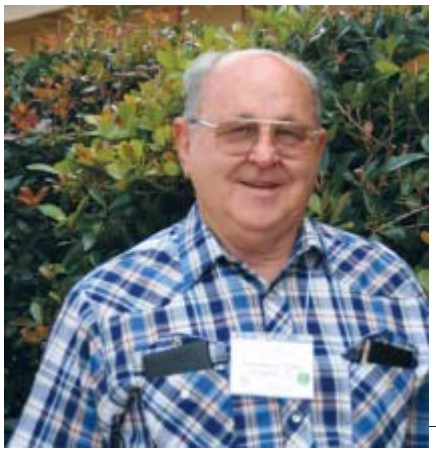
Aliano, N.P., Ellis, M.D. (2005) *A strategy for using powdered sugar to reduce* Varroa *populations in honey bee colonies.* Journal of Apicultural Research 44(2): 54-7

Ellis, A.M.; Hayes, G.W.; Ellis, J.D. (2009) *The efficacy of dusting honey bee colonies with powdered sugar to reduce* Varroa *mite populations.* Journal of Apicultural Research and Bee World 48(1): 72-76 DOI: 10.3896/IBRA.1.48.1.14

Fakhimzadeh, K. (2001) *The effects of powdered sugar* Varroa *control on* Apis mellifera *colony development.* Journal of Apicultural Research 40(3-4): 105-109

Macedo, P.A.; Wu, J.; Ellis, M.D. (2002) *Using inert dusts to detect and assess* Varroa *infestations in honey bee colonies.* Journal of Apicultural Research 41: 3-7

Ramirez, B.W. (1994) *Conformation of the ambulacrum of* Varroa jacobsoni *Oud and mite control with dusts.* American Bee Journal 134: 835



Laurence Cutts

Jennifer Berry

He's been in the middle of everything honey bees have.

If you ever meet Laurence Cutts, from Florida, you would never forget him. He is one of a kind who is always willing to share his knowledge and experiences about bees, beekeeping, and life in general. I sat with Laurence during lunch recently, and in between bites, I asked him to share his life as an apiary inspector and beekeeper. Here is his story.

Laurence is a third generation beekeeper with his legacy dating back to 1889 when his grandfather started keeping bees. Over time, the business grew and he became a prominent queen and package producer in Montgomery County, Alabama. Eventually Laurence's father took over the business and had many successful years himself until the need for lumber almost put him out of business. It was 1943, WWII was in full swing and the demand for timber was great. Numerous (tulip) poplar trees were being cut in and around his apiaries for the war effort. Since these trees were a major nectar source for the bees he was forced to purchase and feed sugar, which greatly cut into his profits – and profits were scarce during the war. Earlier, he had expanded his operation by moving colonies to Florida. Thinking he would have to feed them also, he headed south only to find the colonies were "plugged up" with honey. A decision was made on the spot and he relocated the business and his family to Chipley, Florida.

Laurence worked for his father but started taking on more responsibilities during the 1970s, eventually taking over the business. He, too, was involved in the queen and package industry but expanded the business into honey production. Laurence had colonies all throughout North and Central Florida, and North Carolina but moved them to the Everglades when soybeans in his area were treated with regular applications of Sevin® dust.

However, shortly after his travels south Laurence found himself out of the queen and package business due to the discovery of tracheal mites. Packages and queens were quarantined in Florida in an effort to contain the pest. Unfortunately, most of the packages Laurence sold were sent to Nova Scotia and Prince Edward Island. Laurence decided to shift gears and convert the business over to honey production, but with a poor spring flow, profits were lost. Laurence said he "saw the hand writing on the wall." Right about this time, the State Apiary Inspector in Florida, Leroy Putnam, died of a heart attack. After Mr. Putnam's death the agriculture commissioner asked Laurence to help in the search for a new state inspector. The search ended when Laurence was convinced to take the position in 1985. As Laurence puts it "I got my first job one day before my 50th birthday." He worked 18 years as chief apiary inspector for the state of Florida. This was a rough time for the beekeeping industry: introduction of tracheal mites, *Varroa* mites, small hive beetles, and rampant resistance to AFB. As a honey bee inspector, Laurence was exposed to the good, the bad and the ugly, but he loved every minute. Laurence's retirement came during another dark time for Florida's beekeepers: the arrival of Africanized honey bees. Not only is this a problem for the beekeeper who may be exposed to an Africanized colony but the backlash from media sensationalism that may erupt after the first stinging episode could be devastating to the industry. Public hysteria could lead to a ban on beekeeping in certain counties and urban areas throughout Florida and the Southeast. Laurence feels the hobby and backyard beekeepers will be a great asset in the fight against AHB's. He explained how managed colonies saturating an area will be the first defense against AHB's becoming established.

Sideliners are also some of the most knowledgeable and politically influential people in the industry. Laurence said "they're the real promoters and educators in the business because they're usually the ones speaking to schools and various groups on the importance of bees and beekeeping."

Hopefully, as the public becomes aware that bees will not invade their home through windows and chimneys, knock over furniture and chew through doors to sting them, the misconception about Hollywood's "killer bees" will subside. But until then, education will be the beekeeper's best defense.

Even though Laurence has been involved in the beekeeping industry for decades now, he is also well-known for his story telling. Beekeepers always have a tale to tell, but just imagine the situations state inspectors are exposed to when dealing with the public. For instance . . . One day a lady phoned and was hysterically screaming about killer bees surrounding her home. She explained how no one in the entire trailer park could open their doors due to the fear of being stung to death. She wanted somebody to come now and "git rid of these varmints before they kill us all." Laurence tried to talk some sense into her by explaining that Florida didn't have killer bees at this time, but she wouldn't listen. Laurence told her he would send an inspector right away to check out these "killer bees" and take a sample. The lady and her husband were retired

and lived in a small trailer park with about six other trailers. When the inspector arrived he immediately knew the "varmints" were not killer bees but in fact your run of the mill hornet. During his visit that day the entire story was revealed. The hornets had built their nest inside an old magnolia tree in front of the lady's trailer. The husband loved that old tree, and knowing this, his wife threatened to cut down the tree if her husband didn't take care of the "bee problem." So he grabbed an old cane fishing pole, tiptoed toward the nest and beat it to a pulp. Unfortunately for him, he only destroyed the nest and not the inhabitants inside. They took to the air. With no home to return to, the hornets were flying haphazardly around the park. The husband had taken several stings, so the people in the trailer park were afraid to venture outside with all these mad hornets flying around. The inspector calmly informed the residents that the hornets would soon disperse and life would return to normal. Lawrence never received another call from that trailer park again.

Soon after that there was another killer bee incident to deal with. A lady called from Miami complaining about a killer bee that was trying to attack her through the window. Laurence asked her to describe "the bee" which she quickly informed him was two inches long and fire red. It was beating itself against the window screen she explained and trying to get in the house to kill her. Laurence knew that it wasn't a killer bee and again tried to explain this to the women. She wasn't convinced and as hysteria grew in her voice Laurence assured her someone was on the way. When the inspector arrived at the apartment, he knocked several times on the door but there was no answer. Eventually somebody came out from next door explaining that the lady who lived there was taken back to the mental facility.

I asked Laurence to describe one of the scariest situations he remembers as a beekeeper and he immediately began to tell me about the time when he and his son were moving a load of bees out of the Everglades. It was late and they were just about to arrive at the beeyard located several miles off a paved road. The two trucks were loaded down with colonies which were packed with honey. Add to that, it had been a particularly wet Spring and the dirt road they were traversing had numerous mud holes and ruts. His son, while driving the two-ton truck, tried to avoid one of these mud holes by going around it. Unbeknownst to him, there in the dark lay an even bigger hole and the back-end of the truck slowly sank into a sea of mud and muck. The truck was leaning over to such a degree they just knew it was going to lay over on its side at any moment releasing all 120 colonies. After inspection they realized a wrecker would offer no assistance so they opted for plan B; jack up the truck and hopefully drive it out themselves. They drove home, picked up their 12-ton jack, stirred the parts-man out of bed in order to purchase another 12-ton jack, and collected all the timbers they could find. When they returned, Laurence began shoveling mud from around the tires until he could get the jack under the rim. The process was taking hours and all the while Laurence worried that the truck would tumble over and bury him in a sea of mud and angry bees. To prevent this from happening, he cut a scrub oak tree and propped it against the truck in hopes of stabilizing it. However, he knew the tree was no match against the two-ton truck if it began to lay over. "It would have been as useful as a toothpick in ice cream if that truck began to roll." After hours of hard work, the truck was freed, the bees unloaded and they were finally home, safe in bed.

Laurence told me many stories that day I visited with him in Florida. I've only been able to share a few with you, however I did save the best for last.

Laurence and his oldest son were moving bees down to the Everglades when they decided to pull off the road and "check the load." They were somewhere north of Brooksville on a dark, lonely stretch of highway with not a car in sight. Now when a beekeeper says he's going to "check the load" while standing on a lonely stretch of road, he's probably not thinking about checking the bees. Anyway, it hadn't been two minutes since they pulled over when they heard the sound of a car engine crank up about a quarter of a mile down the road. Then all of a sudden this raggedy, old car flew up behind them and slammed on the brakes. A crazy looking character jumped out of the car screaming, "Did you see them, did you see them?" Laurence of course replied with a touch of apprehension in his voice, "Did I see what?" "The UFOs!" the excited man exclaimed, "they're everywhere, everywhere, I see them all the time." He began explaining to Laurence and his son that there were these small UFOs flying overhead every night and when a plane flew by to investigate, they would quickly fly back to the mother ship and disappear. He also rambled on about how they could read your mind and that he'd been waiting for years for them to come and take him for a ride. He repeatedly stated how he wanted to "ride really bad." Laurence and his son wished him luck and quickly returned to the truck. Safely inside and several miles down the road, Laurence looked over at his son and said "Were you thinking the same thing I was?" His son replied without hesitation, "Don't come get him now! Don't come get him now! Don't come get him now!" Fortunately for the both of them, the aliens were able to read their minds instead.

Laurence retired two years ago and is now back in the bee business. He keeps around 300 colonies for the production of honey and hopes to build a honey house next year. I asked him what was the best part of his job, and he told me it was working with beekeepers and the wonderful educational opportunities he enjoyed during his 18 years of service. Lawrence is still making the rounds at local, state and national meetings. If you see him at a meeting ask him for a story, and he'll certainly oblige since he has hundreds.

See y'all soon. BC

Jennifer Berry does research on Varroa *resistant queens at the University of Georgia in Athens. She is also the President for EAS 2006 which will be at Young Harris College in Georgia in August this year.*

Brushy Mountain Bee Farm

Jennifer Berry

In The Brushy Mountains of North Carolina Sits This Innovative Bee Supply Company

Being an Air Force brat I spent the majority of my younger years bouncing from school to school, neighborhood to neighborhood, and state to state. Moving about was trying at times, but also exciting. By the time I was 13 we had lived in nine different states and 11 different homes. Leaving those homes meant leaving my friends behind which was always difficult. It seemed the minute I was finally asked to join the group at lunchtime or finally **not** the last to be picked for a team it was time to pack up and move to the next location. I was sometimes envious of my classmates who had resided in the same place most of their lives. They had shared memories with others since kindergarten or before. The trend continued into my adulthood. Even after college, work moved me about from state to state. It gave me the opportunity to meet some extraordinary people, some of whom I'll never forget. But there have been some of those I've met that I've felt truly lucky to call friends. Steve and Sandy Forrest are two of those folks.

Inside the old log cabin which is now the retail store.

If you have ever been to an Eastern Apicultural Society meeting or a North Carolina meeting, or others too numerous to mention, and found yourself wandering through the vendor area, then you must have met Steve or Sandy Forrest. They are the body and soul of Brushy Mountain Bee Farm. Each year they will attend anywhere from eight to 10 different beekeeping meetings. They tirelessly stand from sun up to sun down explaining anything from how to become a beekeeper to why this bottom board is the best you can buy, or try this hat on or what do you think about this new item? Steve is definitely the salesman in the family but he won't ever sell you anything he doesn't believe in or wouldn't use himself. That is why when I was a beginner I enjoyed hanging out at their booth listening to each of them explain the wonders of beekeeping.

Brushy Mountain Bee Farm, like most businesses, wasn't created overnight. It took years to evolve. So let's take a look at the road leading to the conception and creation of Brushy Mountain Bee Farm.

Steve and Sandy met in college while Steve was attending graduate school. Of course they immediately fell in love, were married and began to pursue their calling, teaching. Sandy taught Kindergarten for five years and Steve taught business classes in high school for six years in Statesville, North Carolina. Even though it was a grand time, they both wanted a business of their own, especially one in agriculture. They decided to move to the country and pursue their dream. On Steve's birthday, November 7, 1977, they received their first business license. Their initial thoughts for a business was to either dry apples or produce honey. Thankfully, the latter made more sense. Steve will be the first to admit, "it hasn't been easy, but we sure have had fun along the way."

The property they purchased is located in the Brushy Mountains of Eastern North Carolina. In the beginning their property consisted of 60 acres with a house, a small

Crew busy at work assembling equipment.

barn, and a separate two room house just down the hill. The first night in the house they slept in the attic because they felt safer on higher ground. "The bathroom didn't have a sink; no septic system, just a big barrel out back; no closets; over 30 window panes knocked out and it was in the middle of nowhere. I was scared that first night" Sandy said. The house they purchased is what you call a "fixer-upper". They completed some of the work themselves but eventually had to hire help to do the remaining repairs.

During construction they stored all their belongings in a tractor trailer parked in the front yard. Sandy laughs about how their stove and refrigerator stayed on the front porch for several months while they refurbished the kitchen. "The house had so many holes in it you could stand in the kitchen and see the basement" she said. After a year's worth of construction they finally settled into their dream home. Soon the basement became Steve's wood shop where he began designing and building bee equipment and the extra bedroom became the office. The barn later became the working warehouse and the two room house was used for storage. Next they decided to add onto the old two room house just down the hill. They wanted to turn it into a retail store with office space. Just above their house rested a 200 year old log cabin. It would be the perfect addition if they could only get it down the hill. Steve had the perfect relocation plan all worked out. They asked the gentleman who owned the property if they could have the cabin. He said it was theirs as long as they kept his field bush-hogged. Not a bad proposition they thought. The neighbors hearing of the plan told them, "you'll never be able to move that there log cabin, never, never, never". This only made Steve want to achieve his goal that much more. "We'll show them" he thought.

The plan was first to remove the extra rooms built around the cabin that had fallen in. This would expose the actual log cabin. Next Steve and Sandy cut down three big poplar trees, drug them with their tractor and placed them next to the cabin. A neighbor came over and helped them jack up the corners so they could roll the logs under the cabin. Then it would be so simple, they'd just "drag" the cabin down the hill while resting on the logs. The day arrived for the move. All the neighbors were convinced the cabin wasn't going anywhere. To them Steve and Sandy were city folks and didn't have a clue what to do. They lashed the logs with chains, got a bulldozer and drug the cabin down the hill and right next to the ole' house. Success they thought. Not only did they move the cabin but it still remained intact. They were proud and the neighbors amazed. Moments after the celebration began reality hit. They couldn't get the cabin to line up next to the house; therefore the adjoining buildings would never be level. After all the planning and hard work (and effort to prove they weren't just city folks) here they had to tear the cabin down after all. Each log was numbered and set aside for reassembly. After Steve told the story he said in his most serious voice, "Which brings forth the axiom in which we live by, ain't nothing easy at the bee farm."

But exactly how they got into manufacturing and designing bee equipment is another story. After moving to the country they acquired 100 hives and were on their way to producing sourwood honey. Weekly Steve and Sandy would ride to the apiaries and check on their mounting amounts of honey. Sandy explained how exciting it was to see their very own colonies producing the prettiest sourwood honey they had ever seen. The last time they laid eyes on their colonies, each one had two supers completely filled with honey. The very next week they went to extract their bounty and found 80 of the 100 hives gone. They had vanished into thin air. They were just here a week ago, they pondered, what could have happened? After a few moments the harsh truth sunk in and they realized, the hives had been stolen! "They even took the railroad ties the hives were resting on," Steve added. It's a sad day when someone steals from you, no matter what it is. Yet, this story does have a silver lining. Steve and Sandy have both expressed that there is very little they would have changed in their lives. "In retrospect," Steve said, "it was a blessing in disguise, because after that incident we decided to shift gears and focus on building woodenware products instead. Hallelujah for small miracles." Steve admits that wood working is his true passion.

During the late 70s, early 80s, flyers advertised their business and were placed in stores around the area and handed out at bee meetings. Each morning Steve and Sandy would walk hand in hand down the long drive to the mailbox. Sandy would prepare the orders and take care of billing while Steve built and shipped the equipment. Word of mouth also helped boost sales in the early years. It wasn't until 1982 that the first Brushy Mountain Bee Farm catalog hit the stands. "One of the major successes of a business is where to put the advertising dollars" Steve said. The catalog they publish each year is the hardest thing they do. It is extremely time consuming because it has to be perfect.

As with most businesses, the early years can be the leanest and with beekeeping demands occurring in spurts it was tough keeping the doors open. One minute the phone was ringing off the hook and then the next, silence. In order to sustain a business year round Steve and Sandy decided to try their hand at selling non-beekeeping items. For several years they sent out a 20 page catalog called the "Mountain Mercantile" in which they sold porch swings, pottery, fat lamps, honey pots, and other mountain crafts. After that endeavor they decided to try food items and sold under the name of "A Taste of Carolina" with a colored paged catalog which focused on foods of the south: country hams, peanuts, pickles, artichokes, smoked duck, turkey and trout. Meanwhile, they still worked hard at expanding the bee supply busi-

ness and eventually were able to let go of these other ventures.

As the business grew they moved the wood shop out of the basement and into the barn. After a few more years it was time to build a large warehouse which they did in 1986. Unfortunately it didn't stand long. A strong wind storm took the entire building to the ground. One morning, a few days later, twenty-six men showed up and tore the whole mess apart. Two women also appeared and fixed food while the men worked. A true southern cuisine was served; two meats, seven vegetables, and two desserts. It only took two days to clean up the mess and stack the usable wood under plastic sheets. Next they even brought in the local fire truck and blew off the pad. When they were completed a neighbor patted Steve on the back and said, "try it again son, we're with ya." Sandy laughed, "instead of a barn raising it was a barn cleaning." "It was amazing to see all these people band together and help us out; we were flabbergasted," Steve said. They figured the neighbors would never really accept them living in their neck of the woods. It may have been because they were city folks or the fact that they showed up in the country with Afghan hounds. In the early days they didn't have the typical farm dogs; no, they had what the neighbors swore were overgrown goats.

Steve and Sandy don't look back much but when I asked them if there was something they could change what would it have been? They both said, almost together, that they wished they had purchased a large warehouse in the small town down the road and moved the business there instead of running it out of their own house. They love the business but they can never get away from it. Their house sits less than 100 yards from the store and numerous warehouses.

Even though they both left the classroom, they never left behind the love of teaching. Their mission has always been to not only provide the best equipment available but also to help people succeed in beekeeping. "Our philosophy is to bring innovative products to beekeepers, to make the job of keeping bees easier, and to keep introducing beekeeping to folks all across the United States. Helping them to succeed in beekeeping is our dream" Steve said. They intentionally concentrated their efforts towards the hobbyist. They also wanted to offer quality equipment that the commercial folks were able to purchase. Today they are one of the largest suppliers to backyard beekeepers in the country.

Walking around the shops and warehouses Steve is like a kid, excitedly showing me the latest new piece of equipment or the quality of the craftsmanship, or where they render the wax or how they take orders. However, anytime an employee walked by he stopped and introduced me to them and chatted awhile. Then off to the side he said, "the strength of our business is our employees and we really have the best." It was a realization they learned early on when starting their own business. "The whole success is hiring good people and trust me we have great people" he said.

Larry Baily in the rendering area holding a block of newly formed wax.

Thirty years later the office and basement wood shop have now turned into 20,000 square feet of working space. It consists of a wood shop, metal shop, sewing room, wax room, warehouse space plus offices and the retail store. If you ever find yourself in the Brushy Mountains of North Carolina and you're in need of some beekeeping supplies, you should stop by and check out the store. The log cabin and old house are still standing and now the base of the business. No more Afghan hounds, now you'll be greeted by Jake, the friendliest chocolate lab this side of the Mississippi. You may have to throw a stick a bit but he'll love you for it. Steve and Sandy have no plans on retiring anytime soon. They are having too much fun. They love their business, they love their employees, they love their land, they love each other, and of course, they love their dog Jake.

See ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

Climate Change, Nectar Flows, NASA, And You

Jennifer Berry

You can play an important role in measuring Climate Change and Nectar Flows – Here's How.

Just a few years ago the Southeast was experiencing the worst drought in more than a century. Lakes, which supplied water to nearby towns and cities were losing water so rapidly that fears about available drinking water in the near future began to surface. Strict rations and bans on outdoor watering became mandate around the state. Homeowners watched as their newly planted lawns, gardens and shrubbery turned brown and withered. Nurseries hit with restricted water use, and the inability to move vegetative stock (since nobody was planting), closed their doors forever. Car washes, swimming pools, and water parks were forced to turn the water off. Farmers watched as their crops wilted and died and the ground dried and cracked and blew away. Local and state governments started panicking when it became obvious that the taps would soon run dry. Even lawsuits erupted over which states had access to water usage from two river basins – the Alabama-Coosa-Tallapoosa and the Apalachicola-Chattahoochee-Flint.

Now let's fast-forward two years into the future. What do we see – the southeast experiencing record rainfall. Below are rainfall totals for 1999-2009. These amounts were recorded in Peachtree City, Georgia, south of Atlanta. The 2009 totals, which don't include a total for December, are double that which fell in 2007. Yet, so far this December we have already surpassed our monthly average of 3.71 inches of rain. Hopefully, 2010 will be a Goldilocks' year and be just right.

Year	Rainfall Totals (inches) (Peachtree City, Ga)
1999	38.86
2000	35.56
2001	38.40
2002	47.82
2003	52.90
2004	53.60
2005	56.43
2006	48.46
2007	**31.85**
2008	41.43
2009	**62.33**

With all this torrential rain, come swollen creeks, over-flowing rivers and streams. What used to be a dry creek bed one day can become a raging torrent of water the next. If you are at all concerned, check your hives. Several beekeepers were taken by surprise this year when a non-threatening stream quickly turned into what resembled the Mississippi river and in a matter of seconds years of hard work were swept down stream. One in particular, Bob Brachman, a Russian queen producer, lost a significant number of breeder colonies when an unusual August thunderstorm dumped inches of rain in a few short hours.

So is all this due to normal climatic changes or global warming? A recent study from Columbia University examined the 2005-2007 drought that brought the south to its knees and concluded that it was not global warming but instead population growth that ran the lakes dry. Between 1990 and 2007 Georgia's population increased by 3.06 million people but the water supply or storage capacity had not kept up with the growth. Therefore, the severe water shortages were a result of over population more than changing rainfall patterns.

Now, regardless of your stance on global warming (whether you're a card carrying environmentalist, global warming supporter or a Limbaugh-Hannity following, global warming basher), the earth is experiencing worldwide climate changes. For example, the 20th century was the hottest century for the past 400 years. And at this point the Arctic is experiencing some of the most dramatic affects. But these pages are not

P. Lefebvre photo


T. Wilson photo

intended to discuss the facts or fictions of global warming, but instead to visit how climate change may be altering our beekeeping calendar. Currently, Dr. Wayne Esaias, a NASA scientist, is heading a research project exploring this issue.

Since 1979 Dr. Esaias has worked for NASA as a biological oceanographer at the Goddard Space Flight Center in Maryland. His earlier work examined the abundance and occurrence of phytoplankton in the oceans and how this related to climatic systems. In 1992, Dr. Esaias became a beekeeper when his son's Boy Scout leader had to find a new home for several hives (and a scale). At first Dr. Esaias was a bit wary of any kind of bee since he had once been hospitalized due to an allergic reaction after being stung multiple times by ground hornets. But once the bees arrived they quickly settled in and became part of the family routine. The colonies produced surplus honey, which was sold, plus they were perfect candidates for upcoming 4-H projects. For Dr. Esaias, the bees became a welcomed relief from his day-to-day schedule.

But soon the beekeeping successes departed and the colonies started to wane. Numerous swarms produced weakened colonies, which eventually perished. Blaming himself for being a bad beekeeper, Dr. Esaias couldn't get a handle on what he was doing wrong. Had he not read every book he could get his hands on about bees and beekeeping? Hence he began to think outside the box and started exploring other causes. That particular season in Maryland had been much warmer and wetter than normal which was typical of an El Nino year (unusually warm ocean temperatures in the Equatorial Pacific). The bees, which were not behaving in their usual manner, were reacting to the climatic changes brought on by this El Nino. Warm, wet Springs (precursors to earlier nectar flows) can trigger colonies to swarm sooner and more often.

Then an idea came to his mind. How can honey bees be utilized as climate data collectors? Bees are already excellent environmental samplers so one just needs to tap in on this tremendous resource. They're already doing the work for us. But how??? Then it dawned on him: scale hives! By weighing colonies each day (which are continually sitting on an industrial scale) these individual data points over time can quantify the amount and pinpoint the exact timing and duration of nectar flows. Scale hive data. But the bigger picture here is this: how does this tie into climate change? Because of his question, two years ago Dr. Esaias made the transition from sea to land in order to investigate a possible correlation between nectar flows and climate change. He wrote a grant, was funded by NASA and has since been trying to put the pieces together.

One of NASA's primary functions/objectives for earth sciences is to understand how climate change impacts our home planet. There's the physical climate, such as temperature and rainfall, which is simply measured over time. So far the data shows that significant changes are occurring. Yet, how do these physical changes impact the earth or more specifically ecosystems? And going one-step further how do these changes affect plant/pollinator interaction? Then the bottom line of course: how does this affect humans on the planet?

Being a NASA employee Dr. Esaias has resources available to him. Because his question is sought to unravel something so complex, he felt that large-scale satellite data would be needed to help. There are just too many plants, too many pollinators, too many different ecosystems all interacting and not enough hours available in someone's lifetime to explore each one.

So how is all this data collected, correlated, crunched, analyzed and then understood? Let's start by looking to the skies. Sensors, such as MODIS (Moderate Resolution Imaging Spectro Radiometer) located on NASA's Aqua and Terra satellites, are continually snapping detailed images of the planet. Because of the rotation of the earth, within eight days (some areas may be under cloud cover) an entire image of the earth's surface is available. Overtime these recorded images show the earth "greening up" (when the earth wakes up from its long winter slumber and vegetation begins to sprout new leaves) and then "browning down" (when vegetation looses its leaves). Dr. Esaias takes these space satellite images of the earth's greening and compares them with the nectar flow data collected from the scale hives. They corresponded nearly perfectly. But recently something unusual was detected; it seems the Northern US is "greening up" a half a day earlier each year. "In total, since the 1970s, the nectar flow also has moved forward by about one month in Maryland" says Esaias.

Unable to be everywhere each day, Dr. Esaias has conscripted a network of citizen-scientist-beekeepers across the country who volunteer their time to collect hive weights. At this point, there are 87 data collection sites, mainly concentrated in the state of Maryland, though there are also sites scattered across 20 other states. The south and west, however, is especially void of these experimental sites. The data is sent to Dr Esaias through a web site set up specifically for this project: HoneyBeeNet (honeybeenet.gsfc.nasa.gov). As the data flows in scientists are able to better understand how climate is affecting the dynamics of incoming nectar overtime. And beekeepers get a better picture of what is happening in their apiary.

So how does this information help me, the beekeeper?

By placing colonies on a scale and weighing them each day, data records the ebbs and flows of the season. A rapid increase in hive weight indicates nectar intake, a steady decrease in weight indicates a nectar dearth, hence a colony loses weight as food stores are being depleted. So far the most weight Dr. Esaias has seen a colony gain in one day is 25 pounds in Maryland. As a

colony gains weight brood is being reared, comb drawn out, and honey stored. But something else may be happening as well. Colonies may be preparing to swarm. If all of a sudden a colony loses over three pounds in a day something has obviously happened: a swarm perhaps? Most beekeepers aren't aware that their colony has swarmed, but with this sort of data it would help reduce the amount of time the colony is queenless. This kind of data is a great help in hive management.

Such data could also help us forecast when or if Africanized honey bees (AHBs) will be encroaching upon an area. At this point, theoretical models, which are too unstable and unpredictable, project AHBs advancing all the way to Canada. But based on climate and vegetation patterns are these northern areas suitable for AHBs? There are two factors largely responsible for keeping AHBs contained to the western part of the U.S. and Florida: temperature and food availability. For instance, when AHBs crossed the border into Texas they headed north then tracked west ending up in California. They did make a small presense in the Western portion of Louisiana, but didn't venture any farther east. The most likely reason: no fall nectar flow. From east Texas to Georgia plants and nectar flows are dramatically different. However, Florida and Arizona both have Fall nectar flows, which resemble nectar flows in Africa. Scale hive data in the gulf states would give us a better knowledge of nectar flows which might tell us whether AHBs could survive there.

This data will also be beneficial to commercial beekeepers. A certain percentage of commercial beekeepers move colonies to follow nectar flows. They may be moving south for the Winter to take advantage of early blooming crops or north to the Dakotas for clover. With climate change comes a whole host of issues, which impacts blooming dates, which in turn affects nectar flows. They may come earlier or later. They may be more or less productive. With this information at hand, areas predicted to be less productive could be avoided while more productive areas can be accessed. It could also help beekeepers know when they should be feeding to avert colony starvation. Overtime such data would provide a more reliable idea of when to expect a nectar flow in a given area. It could help us predict good years, or bad years and on a larger scale, agriculturally speaking, it could predict possible times of crop failure leading to famines.

But????? Wouldn't it be beneficial for the bees if Winters were warmer and nectar flows earlier? Perhaps, but lets explore the downside to this. If plants are blooming earlier each year, will the pollinators be able to keep up with this forward motion or will they fall out of sync with the plants? Overtime pollinators and plants have become in sync with one another since they both rely on the other for survival. Most plants need pollination in order to produce seeds and they accomplish this by luring the pollinator in with nectar. Both benefit and both survive. But, if plants bloom too early when the pollinators aren't there, the plants lose the benefit of pollination and when the pollinators finally do arrive the flowers are no longer in bloom and they lose the nectar. Hence, system failure. Another thought, earlier flows could mean longer times an area experiences a summer dearth (areas that see summer dearths). The bees eat more than usual because the temperatures are still warm, but nothing is coming in the front door. By the end of Summer, early Fall, when colonies should still have plenty of stores, colonies are starving when they should be beginning to raise Winter bees. Not good for overwinter survival.

As climate changes, how are our bees/pollinators coping with these shifts? Scale hive data is focusing in on the timing of this pollinator/plant interaction, which to a degree has never been explored before. This data gives us a picture so that we may be better prepared in the future. Climate prediction models don't include blooming dates and how they relate to nectar yields as a function of climate. As climate change continues ranges will shift. First the most obvious is when the nectar flow begins and ends. With this information scientists can extrapolate when the nectar flows are occurring across the nation in accordance with the wall-to-wall coverage of the satellite imagery.

L. Kish photo

Another long term goal of this project is to come up with a map of the US with nectar flow dates and variability. Right now the resolution of this information is very course but as more data is collected and analyzed the clearer the picture will become.

How do I become a volunteer?

First you go to the **http://honeybeenet.gsfc.nasa.gov/** web site and nose around. Get your GPS (latitude and longitude) coordinates. Then you will answer a short questionnaire. Citizen-scientist-beekeepers will need to purchase an industrial sized scale to weigh their colony each day. Data is then entered and sent directly to Dr. Esaias through the HoneyBeeNet site. The best possible scenario is if the colony could be weighed each and every day. But we all have lives and sometimes are not around to take such measurements. So every few days will work also. Since these scales cost around $300 new, (sometimes used for $20-60) I think it would be an appropriate use of local or state beekeeper's association funds. If a local/state club set up a scale hive members could rotate responsibilities weighing the colony so no one is carrying the entire burden.

As proven climate change is occurring. Now whether or not we are contributing to that change doesn't really matter, does it? What does matter is we could be and should be better stewards of this planet and to our bees.

Whether the weather be cold,
Or whether the weather be hot.
We'll weather the weather,
Whatever the weather,
We'll weather it, like it or not!
See Ya! BC

---

*Jennifer Berry is the Research Coordinator at the University of GA Bee Lab. Contact her at **Jennifer@BeeCulture.com**.*

African Honey Bees In Georgia

Jennifer **Berry**

A Tragic Event Is The First Chapter In this Evolving Story

On October 11, 2010, Mr. Curtis Davis, 73, was clearing a portion of his property in Dougherty County, Georgia, when he disturbed a colony of Africanized Honey Bees (AHBs). According to an eyewitness, the blade of the bulldozer Mr. Davis was operating scraped against an abandoned house column, splitting it open. Within seconds a cloud of bees swarmed out of the column surrounding both the bulldozer and Mr. Davis. He was able to exit the dozer and run, however the bees stayed in pursuit. He collapsed about 100 yards from where the hive existed. The coroner believed Mr. Davis probably died of cardiac arrest brought on, of course, by the stinging incident.

At first, emergency responders were unable to approach Mr. Davis due to the number of bees in the vicinity stinging everything that moved. Hence, the fireman quickly donned protective gear in order to retrieve Mr. Davis. Shortly afterwards, a local Georgia Certified Master Beekeeper, Dale Richter, arrived at the scene and even at a distance of over 200 yards, he too was being stung. He attributed the extraordinarily aggressive behavior to the facts that there were numerous piles of burning debris set by Mr. Davis, the bulldozer was still running next to the colony, plus fire trucks and other emergency response vehicles were in the area. Bees, of any background, are easily agitated by large, loud, vibrating machinery. It was determined that the bulldozer needed to be shut off before any investigation of the scene could occur.

Dale approached the bulldozer without a veil, (his and extras passed out to the emergency crew) and with the help of an EMT, finally turned it off. While doing so, he noticed a two-pound ball of bees clustered in the corner of the cab just a few feet from his exposed head and face. The bees paid no attention to what he was doing. Next he found the exposed colony at the edge of the bulldozer blade with only a few bees remaining. After samples were collected the bees were exterminated.

Samples of the bees were sent to the USDA lab in Gainesville, Florida for examination and identification. The bees tested positive for Africanization. This was the first case of AHBs being officially identified in Georgia. Along the east coast, AHBs are established in South Florida with occasional incidences flaring up North of Tampa Bay, however before this incident, not this far north. Barry Smith, Georgia State Inspector, immediately began to set up trap hives within a two-mile radius from where the accident occurred. He also started collecting samples from nearby colonies within the perimeter to be analyzed.

It is still unclear as to where these bees came from. However, once the initial shock of the tragic scenario began to lessen some interesting facts surfaced raising a few questions. According to Curtis Simmons, who was with Mr. Davis on the day of the attack, Mr. Davis and a neighbor had cut a portion of the column full of bees from his house back in April and had transported it to the dump site several miles away – the same location where the incident occurred. They wore no protective gear and never received a first sting. So, was this the same colony that attacked Mr. Davis, or was it later usurped by an Africanized colony, or was it just the time of year?

Once the results of the second set of samples were back the Georgia Department of Agriculture released the following statement commenting on the additional AHB

The bulldozer and the trash.

Comb in the remains of the column.

discovery from the colonies sampled several miles from the initial site.

Since this tragic event, The Georgia Department of Agriculture has been monitoring bee swarms, trapping and testing suspect bees. Testing of more than 90 samples identified two more colonies in the southern half of the state near the first confirmed colony. "The bees could have come from almost anywhere" said Agriculture Commissioner Tommy Irvin. "It is unclear how Africanized honey bees arrived in Dougherty County."

Africanized bee swarms are occasionally found on cargo ships coming from South or Central America. A container from one of these ships could have been transported via rail or truck from almost any seaport. Some beekeepers from other states Winter their bees in Georgia. Some commercial beekeepers that produce honey or pollinate crops move their bees to California, Florida, Texas and other states where Africanized honey bees are established. Finally, a beekeeper in the area could have purchased bees or queens that had African genes from a commercial beekeeper in another state.

"The important thing to keep in mind, says Irvin, is that other states and countries have learned to live with Africanized honey bees. We need to move beyond the hype of 'killer bees.' Just as we have learned to live with fire ants and rattlesnakes, we will learn to take certain precautions when in areas where Africanized bees may be established."

Both the Georgia Department of Agriculture and the University of Georgia stress that beekeepers are the best defense Georgians have against Africanized honey bees. Without responsible beekeepers managing hives in the area, the density of docile European bees will decrease, leaving that area open to infestation by Africanized bees. Removing managed bee colonies is equivalent to "abandoning territory to the enemy." Only beekeepers have the knowledge and resources to maintain high densities of European bees that can genetically dilute Africanized populations.

"Because of the fear that accompanies the arrival of Africanized bees, some groups and even lawmakers may want to ban beekeeping in their city or county. These actions have taken place in other states and the result has been the same – it benefits Africanized honey bees rather than protecting a community," says Dr. Keith Delaplane, Professor and Program Director of the University of Georgia Honey Bee Program.

Although budget cuts have affected the department's ability to offer services, Georgia agriculture officials are evaluating how to best monitor for Africanized honey bees in 2011 but plan to resume trapping in middle to late February when bees become more active.

Georgia is a major queen and package bee producer. In 2007, agriculture officials in Alabama, Florida, Georgia, and Mississippi worked together to develop Best Management Practices (or BMPs) for commercial beekeepers in effort to preserve European genetics. The Georgia Department of Agriculture recommends that commercial queen and package beekeepers consider adopting these BMPs. Georgia Agriculture officials recommend that hobbyists purchase bees and queens from licensed beekeepers that have taken steps to preserve the European honey bee traits.

Africanized honey bees are a sub-species of the more gentle and well-known European honey bee which is responsible for pollinating crops and producing honey. To the untrained eye, AHBs are similar in size to European bees, however there are subtle physical differences. These bees are capable of inter-breeding with European bees, thus passing on the more aggressive AHB gene. Behaviorally, they are extremely defensive and respond to provocation by pouring out of their hive in large numbers and stinging anything in their path. They are also more difficult to manage because of the frequency in which they swarm and their flighty, nervous behavior. Most fatalities in the U.S. have been the result of colonies being disturbed by heavy equipment such as tractors.

In 1990, AHBs' first introduction into the U.S. was complete when they crossed the border from Mexico into Texas. Once in the U.S., AHBs headed west towards California, initially sparing states east of Louisiana. Their movement was closely monitored and beekeepers in Georgia felt somewhat safe from an eastward invasion. However, we weren't looking to our South. In 2005 established populations of AHBs were confirmed in Florida. Since that time the Georgia Department of Agriculture and the UGA Bee Lab have been planning for their arrival, putting together best management practices along with training sessions for emergency personnel across the state. We knew it was only a matter of time before a confirmed case of AHBs would be discovered in Georgia.

At this point educating the public has become a priority. following is a list of the most important things to be aware of:

1. Be cautious around places where Africanized bees are likely to nest, such as abandoned sheds, bee hive equipment, discarded tires and subterranean cavities.

2. If you are attacked, ***run away***. You may think this sounds silly, but experience has taught us that people do NOT run away. Instead, they stand and swat, which simply escalates the defensive frenzy until it reaches lethal proportions.

3. Get inside a closed vehicle or building as fast as possible, and STAY there. Do not worry if a few bees follow you inside. Here's another hard lesson we've learned: People do NOT stay inside a closed vehicle if a few bees follow them inside. Instead, they panic and flee back

outside where tens of thousands of angry bees attack them. Maybe it's a bizarre form of claustrophobia, but this pattern has repeated itself over and over in the stinging incidents we've monitored in Latin America and the Southwest U.S. Get inside. Stay inside.

4. European bees and local beekeepers are our best defense against AHBs. In response to Africanized honey bees, some communities may consider zoning restrictions against all forms of beekeeping. This essentially cedes territory to the enemy. Only gentle European bees can genetically dilute the defensive Africanized variety, compete with them, and minimize their local impact.

This last statement is of the utmost importance for beekeepers and needs to reach as many non-beekeepers as possible. Prior to the stinging incident back in October, Fayetteville's City Council voted to restrict beekeeping in the county. From now on, beekeepers must have five consecutive acres of land in order to maintain hives. Hence, your typical backyard beekeeper is banned.

But here's yet another problem: disagreements that flare up between people. Unfortunately, when neighbors and beekeepers clash its usually the beekeeper that suffers. The most common complaints voiced by non-beekeepers are bees in pools, birdbaths, hot tubs, dog bowls, and birdfeeders, or the ever popular "bee swarm," which is of course going to kill the children. If the neighbor doing the complaining doesn't see results, or even worse, has it out for the beekeeper to begin with, the bees become the tool the neighbor uses to "win." Classic example: Neighbor one, who lives two sub-divisions away, is upset with neighbor two, the beekeeper. Neighbor one can't settle with neighbor two, so he decides to complain about the bees, (even though he lives two sub-divisions away). He takes his complaint to the city council and just like that the city of Suwanee banned beekeeping in the city limits. Neighbor one wins and neighbor two has to move the bees.

So what protection is available for the beekeeper? Not much, according to Mike Evans, Division Director for the Georgia Department of Agriculture. "There is a statute in place in the state of Georgia, §2-14-41.1, which is somewhat confusing. There are two sentences in this section. The first bars counties, cities, and other political subdivisions in Georgia from prohibiting beekeeping. However, the second sentence of this section seems to contradict the first in that it states 'This Code section shall not be construed to restrict the zoning authority of county or municipal governments.' These statements seem to contradict each other. While this statute seems like a good idea, the Department does not have statutory authority to enforce any zoning restrictions or regulations. Although §2-14-41.1 is included with statutes the Department does enforce, it is my understanding that we are not empowered to enforce this particular section."

There was yet another concern that surfaced once we heard about Mr. Davis: the media. Phones started ringing across the state to any person associated with bees, experienced or not, as soon as the press got wind of what happened. If you have ever dealt with the media first hand, it can be a very frustrating experience, especially when they misquote you, or interpolate, or just get the facts wrong. Not only do you sound like an idiot, but worse, the wrong information is being passed along and can be circulated from paper to paper for years, decades even. The printed word can last forever.

When I first started my job a local newspaper called and wanted to interview me for a story about, what else, honey bees. A reporter and photographer showed up the next day and began the interview. At first I was a bit nervous, but as the clock ticked on, I began to relax. By the end of the day I felt like this reporter was my new best friend. She told me the story would appear in the Sunday issue. I was very excited. That Sunday the paper arrived and there I was, front page. But my excitement soon turned to horror as I made my way through the article. It was all so wrong.

She wrote about how drones collected the pollen and water and the queens collected the honey. And the queens needed to mate with the drones at least once a week in order to continue laying eggs and honey is created by the plants. She quoted me saying "Nosema mites attach themselves to the drones and get passed from hive to hive" and American Foul Brood is a very serious "beekeeper" disease and one has to take antibiotics if you're exposed. Really? She didn't seem drunk when we did the interview, so what happened? I just prayed my boss would never, ever get a copy.

As far as the first round with the media dealing with the discovery of AHBs in Georgia, it wasn't too bad. Once the samples came back positive, we had only a few hours to get our ducks in a row before the information was released to the press. Calls were made to give everyone and anyone associated with bees in Georgia the correct information and a heads up. The worst possible scenario was to be caught off guard when you hear on the other end of the phone, "Hello, this is Ted Franklin with channel 5 action news. Can we come out to your house and film Africanized Bees for the six o'clock news?"

Everyone did a great job, especially Dale Richter, our bee representative in Dougherty County. We kept the "killer bee" scenario to a minimum and stressed and will continue to stress the importance of bees and beekeeping in our state. And with any luck, AHBs will find our winters too cold and will head back south.

See Ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab. contact her at ***Jennifer@Beeculture.com****.*

Rossman Apiaries

Jennifer **Berry**

You've probably met Fred and Ann at a beekeeper meeting. There's a lot of history, and great people standing behind that table.

The U.S. beekeeping community is relatively small when you look at the numbers. Roughly there are 1200 full-time commercial operations, 5000 part-time sideliners and between 120,000 and 150,000 backyard beekeepers. If you read the journals, magazines, newsletters or attend meetings you are bound to become familiar with certain names, especially those that have been in the business for sometime now. One of those names is Rossman Apiaries located in Moultrie, Georgia. Fred Rossman, owner and operator of Rossman Apiaries, is well known and respected by beekeepers from coast-to-coast for his ability to provide quality bees and beekeeping equipment, but there's a lot more to him than that. Fred is one of those rare souls whom, when you meet him, you instantly feel at ease because he tells it like it is, and, when he says he's going to do something, you can bank on it.

But, Fred's also known for reinvesting in both his community and the beekeeping industry through public speaking, education, and his various leadership roles. He's been Director of the American Bee Breeders Association, a Board Member for several terms for the American Beekeeping Federation. Locally, he has served as President for the Civic Club, and Board of Deacons and Elders for the First Presbyterian Church. He has also served several terms as President and Board Member for the Georgia Beekeepers Association who, by the way, recently recognized Fred with their highest award: Georgia "Beekeeper of the Year" for 2011. Recently, I was fortunate enough to have a private audience with Fred and queried him about his life and business. Fred is a quiet fellow and is somewhat reluctant to talk about

Fred Rossman and his good friend.

Ann Rossman.

himself. But, he was generous with his time and energy, and eventually shared a good bit of history about Rossman Apiaries, his family and his philosophy that I believe beekeepers would enjoy hearing (reading) as much as I did! Let's start from the beginning.

Fred's Father, Joseph "Joe" Grey Rossman, oldest of nine children, grew up on a dairy farm. Each day he milked the cows, fed the cows, cleaned up after the cows, and delivered milk from the cows. So, by the time he was a young man, he was pretty much done with the cows. Across the street, there lived a beekeeper that roused Joe's interest. From time to time, Joe would wonder over to learn the nuts and bolts of his trade. Over the years, this routine slowly carved a path, which led him to a new career. One day in 1934, Joe left the dairy farm to work for the Puetts in Hahira, Georgia, who were the largest queen and package producers in the state. The small town of Hahira was eventually known as the "Queen Bee Capital of the World." Joe worked there for several years until he met a beekeeper from St. Paris, Ohio, E. W. Long (short for Emerson W.).

Like most large, Northern operations, E.W. would transport his colonies down South, specifically Georgia, during the Winter months. Then, in the Spring, he would make splits and haul them back North to sell. Joe and E. W. joined forces in 1936 and started a partnership called Rossman & Long. E.W. concentrated on the northern end of things while Joe worked the southern. They sold bees, queens, and nucs. They remained business partners for 14 years and parted as friends when Joe formed Rossman Apiaries in 1952. Joe continued producing queens, packages and nucs, and occasionally delved into honey production, albeit only as an afterthought when there were surplus quantities.

During our conversation about the history of Rossman's Apiaries, Fred reminisced for a moment about a trip that he and his father took to North Georgia to deliver honey, which was a particularly long journey from South Georgia in the 1950s. Once they arrived at the Tallulah Gorge, a two mile long and 1,000 foot deep Southern Appalachian canyon, Fred and his father parked the truck, and walked to the center of the bridge spanning the gorge. Joe took out one of those big-headed, wooden match sticks, told his son to watch this, and dropped it over the side. Fred said, "No joke; just before that match hit the bottom of the canyon, it lit."

Queen Cell Production.

Fred and his siblings worked for the family business as they grew up. Hence, when Fred graduated from high school, he already knew exactly what he wanted to do for the rest of his life. Actually, he had always known. Though, there was an opportunity to go to college and, through the persuasion of his parents, he begrudgingly pursued it. By the time his junior year at Auburn University came around, he had had enough of college. He drove home to tell his folks. His mother looked at him and said, "You need to finish." His Father, a man of few words, said, "Do what you want to, but I'd like to see you finish." On the way back to school, Fred made a decision, to not quit. In 1966, he graduated from college with a degree in business. Finally, he was ready to do what he knew was in his heart. Oh, he had several business opportunities, and inquiries from petroleum and manufacturing companies, but he didn't even take the first interview. He packed his bags because he knew where he belonged: Rossman Apiaries in Moultrie Georgia. And he has never regretted his decision, not for even one second.

When Fred arrived home from college he was ready to go to work. He quickly established himself as the field man. Fred liked having his hands full, of bees, that is. He tended the colonies, ran the crews, shook packages, drove the trucks, caged queens, fed bees and anything else that needed doing. His younger brother, Philip, also came to work for the family business after completing a degree in Agricultural Administration. Philip worked almost 20 years until Multiple Sclerosis finally forced him to take medical disability in 1987. Fred still raves about how Philip was great at queen rearing and

Rossman nuc yard.

Rossman packages ready to be shipped.

the business end of things, especially public relations.

When Fred joined his father, the bee business was booming. While keeping bees has never been without effort, it was certainly a heck of a lot easier then than it is today. Borders were open and package bee exportations were off the chart. There were no varroa mites (and their associated viruses), no tracheal mites, no small hive beetles, no Africanized bees, no chalkbrood, and no European Foulbrood.

From 1960 through the mid-1980s, Rossman's sold 15,000 to 16,000 packages per year, mostly to Canada. Semi-trucks would drive down from Canada, pick up 2,300 packages at a time and haul them back north. The most notable difference between then and now was that two-pound packages were the staple, not the three-pound ones that we're familiar with today. Northern customers preferred the two-pounders because, at less cost, they could build up just as fast as a three-pounder as long as they were installed by the first part of April. Fred reminded me that during those "golden years," the bees had more forage, less disease, and no mites to contend with. During that time over 90% of Rossman's package orders went to Canada; this, however, was all about to change.

Feeding cans.

March 12th, 1986 was a bad day for the queen and package producers in the southeast, especially for the Rossman's. Fred said that he will never forget when he heard the news that the Canadian government closed the eastern border to southern U.S. bee imports in a desperate, yet unsuccessful, effort to stop the onslaught of tracheal mite infestation. "There had been reports but I never expected the shut down to occur at the beginning of the season" he said. One day the boarders were open, the next day closed. A regular Canadian customer of Rossman's had a truck en route to Moultrie at the time, expecting to pick up a load of packages, but, as soon as the news hit, they were diverted to California, which had not yet been included in the ban.

Within a short spell of the border shutdown, Rossman Apiaries' was on the verge of bankruptcy! Fred was trying desperately to keep the business running. He auctioned off land, cows, and anything he could to keep the doors open. He had to cut the work force down to a bare minimum because there wasn't any orders, hence any business. And, to make matters worse, other bee producers, who were in the same boat, were now all competing for the U.S. market. There were too many producers with too many bees and too few customers. Unfortunately, several businesses didn't survive. Others turned to honey production and got out of the package business completely. Just a handful of the producers who experienced those hard times are left in Georgia.

Fortunately for Fred and his family, it didn't take too long for the clouds to part and the sun to shine. Fred was offered an opportunity to buy Forbes and Johnston, a cypress bee supply company in Homerville, Georgia. He figured that, while the bee package business recovered, Rossman Apiaries could diversify into selling beekeeping supplies. While it didn't solve everything overnight, it definitely helped to turn the corner during a difficult time. They also began accepting pollination contracts, but eventually ceased doing so for two reasons: one, Fred hates to move bees, and, two, you can't do everything!

Fred told me that nothing makes him more tense than hauling around a truckload of bees (which I agree!). When everything works out, it's no big deal: you leave at 3 or 4 a.m., arrive at the location before sunup, unload the bees, and, presto, you have instant pollinators! But, unfortunately, it doesn't always work that way. Here in the south, and elsewhere where temperatures are too warm to keep colonies closed up during a move, a decision has to be made either to cover the colonies with large nets or not; Fred always opted for the latter. Only problem being, a truck breaks down in the middle of the night, and there's nobody willing or able to help you until late the next morning. Meanwhile, the truck is in the sun, and by first light little bee bodies start appearing at the entrances and taking flight. Then by the time the repair guy shows up and sees this enormous, black cloud of bees flying around, he quickly makes an about face, gets back in his truck, and speeds away . . . , which is not a good start to your day.

The second reason they stopped moving bees around was Fred realized that something had to go. "Too many irons in the fire!" he said. "We were running night and day: shaking bees, making deliveries, moving bees, taking orders, shipping out orders, caging queens, working in the shop, building equipment, and taking more orders." So, one day, he realized pollination would have to be someone else's job.

While talking with Fred, I asked, what are the biggest challenges you face running your business? After thinking about it for a minute or two, he said, "Well, Jennifer, I really can't think of anything. I may have to get back to you on that one." Then he told me about how much he enjoys what he does. "So, sure there are stumbling blocks, but one can al-

ways find a way around them when you're happy with what you do," he said. We were chatting about other things when he stopped and added, "I wouldn't necessarily say this is a challenge, but what concerns me from year to year is promising something and then making sure I can fulfill that promise."

Every year even before the first package is shaken, Rossman Apiaries is sold out of packages. This is a good thing for business, but it makes Fred nervous every season. "You are walking on faith because you don't have a clue what is going to take place from now to then," Fred explained. One thing is for sure; Fred is very conscientious about trying not to overbook. He knows how many productive colonies are going into the winter and runs the percentages. Fortunately, in the past, there have been no major disasters. However, Fred does interject that their schedule is so tight that, once spring arrives, it only takes one day of rain, cold weather, the crew being sick, or the trucks breaking down for the entire year to be out of kilter. It's like a domino effect. Then, you realize that most of your packages were ordered five months ago. "The customers are relying on you to fulfill that promise," he continued, "If you can't satisfy the order, then, more than likely, the customers won't be able to find bees anywhere else because everyone has been sold out for months." Ouch!

Another concern of Fred's is making sure his customers are satisfied. "To be honest, it bothers me if I have sold someone something, and they aren't happy with it. But, sometimes customers won't or don't say anything. So, how are you supposed to know? I guess that, as long as you're honest with your customers, your goal is met," he said.

As stated, Fred definitely tries not to overload his plate. To avoid this, he relies heavily on his wife, Ann Rossman. "Scheduling the queen and package pickups are the most important aspect of this company," he noted, "So, I let someone more qualified than I handle it." Ann is not only in charge of the office, but she also attends most of the bee meetings and manages payroll. This is quite a lot to handle, but handle it she does! "She's the backbone of this company," Fred clarified. What is that saying . . . behind every great man, there's an even greater women? Well**,** Ann is that**;** you'll never meet a finer Southern lady.

The other kind of packages that get shipped from Rossman Apiaries.

When I visited Rossman Apiaries this Fall, Fred took me around and introduced me to his crew. They were in the wood shop sawing, cutting out equipment, and putting together orders in boxes of all sizes to be shipped. They were also coming in from the beeyards and in the office taking orders. It is quite the operation, and they have a great crew. "You're only as good as the people you hire," Fred continued, "A lot of people over the decades have worked very hard making this business successful."

If you've ever met Fred, probably while manning his booth at a bee meeting, then you know what a solid man he is. Things could be going crazy all around him and he would just smile, shrug his shoulders and get to work. He told me once that worrying about something doesn't do a bit of good. He said, "Yes, you need to be concerned when it matters, but sitting around worrying about something is a waste of time." He then quoted one of his favorite life mottos, "Worrying is like a rocking chair; it gives you plenty of work to do, but it will never get you anywhere." Amen!

Today, Rossman Apiaries sell from 9,000 to 10,000 honey bee packages, as well as 10,000 queens, per year. The wooden ware they build is made out of cypress. Since the acquisition of Forbes & Johnston, Fred has continued to work with cypress because it's a better wood for bee hives. It's insect resistant, hardy, and easy to work with.

Ann and Fred have three children: Amanda, Scott and David. Amanda's husband Clint works for Fred. Their two boys are entrenched in jobs outside of beekeeping: banking and construction. Fred doubts they'll ever come home to Moultrie to carry on the business, which is fine. He also jokes from time to time about selling his business. I hope this never happens, at least while I'm still a beekeeper. BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

Jennifer **Berry**

HONEYBEENET

NASA, Honeybeenet and Bee Informed measuring change, saving bees.

The weather in 2012 had a considerable impact on much of the U.S., which seems to be the trend lately. For instance, it was either too wet, too dry, too hot, too cold, (too windy even), and when you mix too hot, dry and windy, disastrous events can occur. For instance, these exact ingredients came together causing massive wildfires across the western states. The Colorado wildfires, specifically the Waldo Canyon fire that threatened Colorado Springs, was the one most folks witnessed. Remember last summer when hundreds of homes burned to the ground and thousands of acres were scorched? Even though wildfires are common in Colorado and the west, this particular fire was the state's costliest because of the number of homes destroyed.

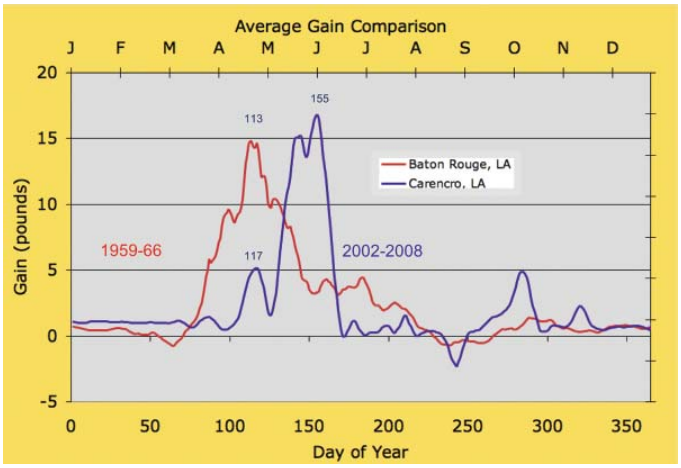
As the western skies glowed red, the Midwest experienced the warmest and driest summer on record (1895-2012). Excessive heat and lack of rain in the Midwest caused extensive crop failures in those areas. Plus, all time record highs were recorded in the southeast. Here in Georgia we experienced a week long stretch of scorching temperatures. One day while in the field working bees, the mercury rose to 112°. The bees, along with ourselves, were miserable, but as long as there was access to water, we survived.

When it came to the "too wet category" let's turn our attention to Florida. Prior to Memorial Day, 2012, about 84% of the state of Florida was in a moderate to extreme drought. Just a month later, the "Sunshine State" was rain soaked with some areas receiving up to 28 inches of rain in a couple days. It only took two tropical storms, Beryl and Debby, to eliminate the rain-starved area. But, with all that instant rain, streets, homes and businesses were flooded. So, how is all this crazy weather affecting our bees? Well, there are scientists trying to figure that out right now.

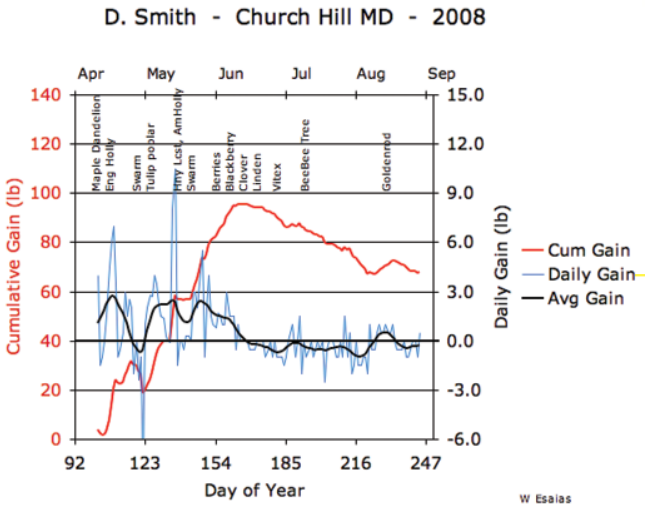
Back in 2009, I wrote an article about Dr. Wayne Esaias and his scale hive project. I felt his project was worth exploring and believe so even more today. At that time, Dr. Esaias was employed at NASA as a biological oceanographer at the Goddard Space Flight Center in Maryland. His earlier work examined the abundance and occurrence of phytoplankton in the oceans and how this related to climatic systems. But all of that was about to change. In 1992, Dr. Esaias became a beekeeper when his son's Boy Scout leader had to find a new home for several hives. Life with the bees was easy at first. Then numerous swarms weakened the colonies, which eventually perished. Blaming himself for being a bad beekeeper, Dr. Esaias couldn't get a handle on what he was doing wrong. Had he not read every book he could get his hands on about bees and beekeeping? Hence, he began to apply his scientific reasoning to come up with possible causes. That particular season in Maryland had been much warmer and wetter than normal-typical of an El Nino year (unusually warm ocean temperatures in the Equatorial Pacific). Were the bees simply reacting to the unusual climatic changes? Warm, wet spring seasons (precursors to earlier nectar flows) can trigger colonies to swarm sooner and more often.

Then, an idea came to him. Could honey bees be utilized as climate-impact data collectors? Bees are already excellent environmental samplers; they're already doing the work for us. So, one just needs to tap in on this tremendous resource. But how??? Then, it dawned on him: **SCALE HIVES**! By weighing colonies each day (positioned continuously on industrial scales) scale hive data, over time, can illustrate the relative abundance, timing and duration of seasonal nectar flows. But, one might ask, how does this tie into climate change? Dr. Esaias made the transition from sea to land in order to investigate the very possibility of a correlation between nectar flows and climate change. Funded by a grant from NASA, he has been trying to put these pieces together through his current work as an adjunct professor at the University of Maryland in the Entomology department. He has been coordinating with Dennis vanEngelsdorp, who is in charge

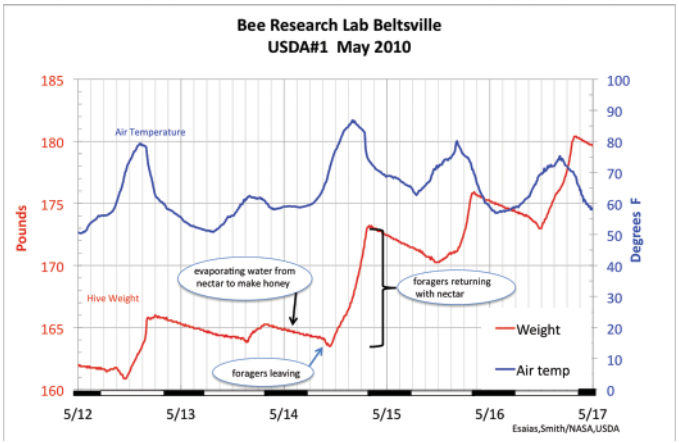
C. Vorisek uses a fairly new manual platform scale. Manual scales, some dating to the early 1900s, are the major type used by volunteers. (C. Vorisek photo on Honeybeenet)



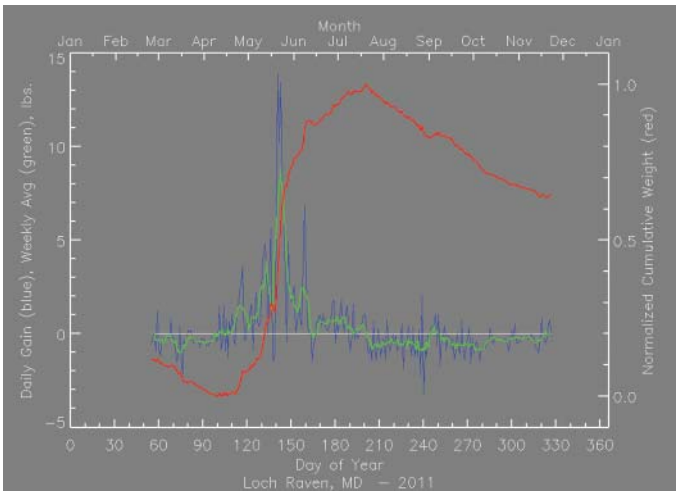
Data taken by E. Oertel in 1950s in Baton Rouge and by C. Harper in the 2005 era show a major difference in nectar flow, most likely due to the invasion of Chinese Tallow during the intervening 50 years. it would be interesting to have modern data from Baton Rouge for a comparison.



Plot of data provided by D. smith in Church Hill, MD gives blooming information for some sources to accompany his manual scale observations.



Electronic scales recording data every 10 minutes at the Bee Research Lab in Beltsville, MD reveal changes in colony behavior and nectar collected on sunny (higher temperatures) and overcast (lower temperature) days. Other interesting examples compiled by Paul Vonk can be found at ***hivetool.org*** *under Hive Management.*



Sample plot provided on Honeybeenet site for Loch Raven, MD, shows the Daily Gain in pounds/day on the left axis and green line, the weekly averaged Daily Gain (black line), and the relative increase during the active season (red line). The total gain was 149 lbs, not counting Spring and Fall syrup, supers added, and honey harvest. This overall shape is typical of Eastern tree dominated nectar seasons. Plots and digital data are available for all sites and years. The peak date has advanced by roughly a month since 1970 in central Maryland.

of the Bee Informed Project (http://beeinformed.org/).

NASA, the National Aeronautics and Space Administration, is a US agency that's responsible for the nation's space program, aeronautics and aerospace research, including earth remote sensing. These are pretty broad topics, but one of NASA's objectives is to understand how climate change impacts the earth. The physical climate, such as temperature and rainfall, is simply measured over time. So far, data shows that significant change has been occurring. How do these physical changes impact the earth or more specifically earth's ecosystems? Further, how do these changes affect plant and pollinator interactions? And finally, how does this affect humans on the planet?

As a former NASA employee, Dr. Esaias had wonderful resources available to him. Because his question is sought to unravel something so complex, he felt that large-scale satellite data would be needed to help. There are just too many plants, too many pollinators, too many different ecosystems all interacting and not enough hours available in someone's lifetime to explore each one.

So how is all this data collected, correlated, analyzed and then understood? Let's start by looking to the skies. Sensors, such as MODIS (Moderate Resolution Imaging Spectroradiometer) located on NASA's Aqua and Terra satellites, are continually snapping detailed images of the planet. Along with these there's NPOESS Preparatory Project (NPP), NASA's newest polar-orbiting environmental satellite. Because of the orbits of these satellites, within days (some areas may be under cloud cover) an entire image of the earth is available. Overtime these recorded images show the earth "greening up" (when the earth wakes up from its long winter slumber and vegetation begins to sprout new leaves) and then "browning down" (when vegetation looses its leaves). Terrestrial scientists have discovered that spring green-up was arriving earlier on average, due to warmer winters. Dr. Esaias takes these space satellite images of the earth's greening and compares them with the nectar flow data collected from

the scale hives. They corresponded nearly perfectly. But recently something unusual was detected; it seems the Northern US is "greening up" a half a day earlier each year, and the dates of the nectar flows in the north east US are staying right in sync. "In total, since the 1970s, it has moved forward by about one month in Maryland" says Esaias.

At this point, Honeybeenet has 147 data collection sites, scattered across 34 states, including DC and 2 provinces and over 400 individual annual records. The south, however, is especially void of these experimental sites. Unable to be at all 147 sites each day, Dr. Esaias and Honeybeenet depends on a network of citizen-scientist-beekeepers across the country, who volunteer their time to collect hive weights. The data is sent to Dr Esaias via email and winds up on a web site set up specifically for this project: HoneyBeeNet (*honeybeenet.gsfc.nasa.gov*). As the data flows in, scientists are able to better understand how climate is affecting the dynamics of incoming nectars. So how does this information help me, the beekeeper?

By placing colonies on a scale and weighing them each day, data records the ebbs and flows of the season. A rapid increase in hive weight indicates nectar intake, a steady decrease in weight indicates a nectar dearth since a colony loses weight as food stores are being depleted. So far the most weight Dr. Esaias has seen a colony gain in one day is 25 pounds. As a colony gains weight brood is being reared, comb drawn out, and honey stored. But something else may be happening as well. Colonies may be preparing to swarm. If all of a sudden a colony looses 3-8lbs in a day something has obviously happened: a swarm perhaps? Many beekeepers aren't aware that their colony has swarmed, but with this sort of data it would help reduce the amount of time the colony is queenless which would be a great help in hive management.

Such data could also help us forecast when or if Africanized honey bees (AHBs) will be encroaching upon an area. At this point, theoretical models, which are too unstable and unpredictable, project AHBs advancing all the way to Canada. But based on climate and vegetation patterns are these northern areas suitable for AHBs? There are two factors largely responsible for keeping AHBs contained to the western part of the US and Florida: temperature and food availability. For instance, when AHBs crossed the border into Texas they headed north then tracked west, barely making it in to the state of Louisiana. The most likely reason: no fall nectar flow. From east Texas to Georgia plants and nectar flows are dramatically different. However, Florida and Arizona both have fall nectar flows, which resemble nectar flows in Africa. Scale hive data in those regions may be able to determine if AHBs can survive.

This data will also be beneficial to commercial beekeepers. A certain percentage of commercial beekeepers move colonies to follow nectar flows. They may be moving south for the winter to take advantage of early blooming crops or north to the Dakotas for clover. With climate change comes a whole host of issues, which impacts blooming dates, which in turn affects nectar flows. They may come earlier or later. They may be more or less productive. With this information at hand, areas predicted to be less productive could be avoided while more productive areas can be accessed. It could also help beekeepers know

Example of an electronic scale in use. This scale at Loch Raven, MD has withstood three Winters and three hurricanes. Data must be retrieved manually every three to six months.

when they should be feeding to avert colony starvation. Overtime such data would provide a more reliable idea of when to expect a nectar flow in a given area. It could help us predict good years, or bad years and on a larger scale, agriculturally speaking, it could predict possible times of crop failure leading to famines.

Yet the question most beekeepers ask; wouldn't it be beneficial for the bees if winters were warmer and nectar flows earlier? Perhaps, but lets explore the downside to this. If plants are blooming earlier each year, will the pollinators be able to keep up with this forward motion or will they fall out of sync with the plants? Overtime pollinators and plants have become in sync with one another since they both rely on the other for survival. Most plants need pollination in order to produce seeds and they accomplish this by luring the pollinator in with nectar. Both benefit and both survive. But, if plants bloom too early when the pollinators aren't there, the plants loose the benefit of pollination and when the pollinators finally do arrive the flowers are no longer in bloom and they get less nectar and pollen. Hence, system failure.

Other issues that we've observed here at the horticulture farm are required chilling hours and late frosts killing early blooming fruit trees. Particular plants, especially fruit bearing trees, need a certain amount of hours of cold in order to bloom or properly bloom; without which, they exhibit a loss of yield. Also, fruit trees fooled into early blooms by warm Winters and/or early Springs are often caught off guard by late frosts; again, the results are significant crop losses.

As climate changes, how are our bees/pollinators coping with these phenomena? Scale hive data is focusing in on this pollinator/plant interaction, which to a degree has never been explored before. By having this data it gives us a picture so that we may be better prepared in the future. Climate prediction models know very little about blooming dates and how they relate to nectar yields as a function of climate. As climate change continues ranges will shift. First the most obvious is when the nectar flow begins and ends. With this information scientists can

extrapolate when the nectar flows are occurring across the nation in accordance with the wall to wall ubiquitous coverage of satellite imagery. Secondly, as the climate shifts, the plants and trees present in an area may find themselves in poor conditions in the southern portion of their range, and may not produce as much nectar. The same species growing in the northern extents may become much more productive. This may be a reason why tulip poplar honey, once the mainstay of many Mid-Atlantic beekeepers, has now become relatively rare compared to black locust. Scale hives may be able to give us a piece of the puzzle into what is going on.

How do I become a volunteer?

First you go to the HoneyBeeNet web site and download the "How To Do It Protocol" under the Site Data. Then you will answer a short questionnaire and put in your GPS coordinates and email that back. Citizen-scientist-beekeepers will need to purchase an industrial-sized scale on which to keep a strong healthy colony, and weigh their colony each day. Data is then entered on data forms and sent directly to Dr. Esaias through the HoneyBeeNet site. The best possible scenario is if the colony could be weighed each and every day. But we all have lives and sometimes are not around to take such measurements, and some gaps are OK. Since these scales cost around $400 new (used from $25 up at farm auctions), I think it would be an appropriate use of local or state beekeeper's association funds. If a local/state club set up a scale hive the members could rotate responsibilities weighing the colony so no one person is carrying the entire burden. Beekeeping clubs would greatly benefit by having the local nectar flow data, so it may be something that should be encouraged throughout the region. Several regional networks have even developed in Europe.

Electronic scales for use as hive scales are now coming on the market. They tend to be much more expensive but may make a big difference. They have the advantage of recording and storing the weight daily, hourly and even every 10 minutes. Some send the data thru the internet, or directly to a home computer. Some examples can be seen at http://*hivesensors.com*, http://*hivetool.org*, Swienty.com and at some of the sites pictured on the HoneyBeeNet site. Beekeepers with good computer and electronic skills can put together their own data collection systems, as Paul Volk and colleagues have done with the Rabun Gap Nagoochee School and other sites in north Georgia and North Carolina. The NASA crew is also working with BIP (Bee Informed Project) and other groups to transition the Honeybeenet activity to a more permanent home in the bee research community.

With milder Winters, the eastern U.S. is experiencing earlier spring nectar flows and longer summer dearths. However, yields from the spring nectar flow are not greater (since no increase in bee forage) and are often less (colonies are not yet at maximum strength). And, the fall nectar flows are now unreliable and weak. This is a problem. Since bees use much more energy (honey) when the weather is warm, the honey they make during the spring nectar flow has to last them up to two months longer now than it did back in 1970s. Colonies often run out in late August-September, just when they are trying to make lots of winter bees, and this can lead to increased winter losses if beekeepers are not paying attention. In the Mid Atlantic and the southern states, beekeepers are now told to start feeding syrup in August. Other regions, like the Mid West, can have very different nectar flow seasons and the bees may respond to climate change differently than what's been experienced in the east. That is why more scale hive sites are needed in order to establish the relationship between nectar flow timing and intensity, with satellite vegetation and climate images. Since honey bees are managed pollinators, we can adjust our management techniques in response to these slow changes if they can be identified. Another goal of this project is to come up with a map of the northern US with nectar flow dates and variability. Right now the resolution of this information is very course but as more data is collected and analyzed the clearer the picture will become.

If you can contribute past scale hive records, from any year, for North America, please contact Dr. Esaias and make arrangements to get the information to him. It would be a shame to have that data lost forever. BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

A Spring Primer

All the management tricks you need to get from Winter, to honey flow.

Jennifer Berry

Standing outside the other day (back in February) I could smell Spring in the air. It was still cold and grey but a wind was blowing from the south and the air was filled with an aroma of greenery. Beekeepers can identify with the scent of Spring. During these past icy, Winter months (OK, not that icy in Georgia) I've been leafing through numerous seed, plant and beekeeping catalogs in anticipation of working with nature once again. And now it is just a few weeks away! Red maple is blooming, the bees are getting anxious, and so am I. Soon we will see clover, tupelo, blackberry, tulip poplar, and gallberry in full bloom, summoning our bees. But with my joyous anticipation also comes a sense of urgency. I didn't quite complete all my Winter projects and now Spring is almost here. I still have boxes and frames to construct and wax to melt and honey to sell and, and, and. But Mother Nature waits for no one and neither will the bees. They are ready to hit the sky in search of nectar, pollen and new home sites. So ready or not, get your veils on and let's get to work!

Successful overwintering is a result of proper Fall and Winter management. But that's neither here or there now. What we need to do is concentrate on problems at hand. Due to the above-average temperatures experienced by most of the United States in early Winter, food reserves may be below average. Not only were the bees more active over the Winter months but brood production is on the rise in anticipation of the upcoming nectar flow and swarming season. This is a critical time of year for your colonies so it is important not to make the mistake of assuming they're OK.

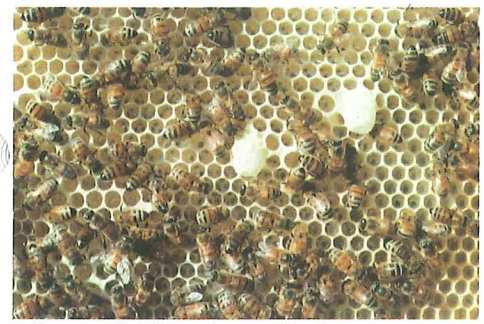
In the late Winter months, brood rearing has begun, but not without a price. Large quantities of the food reserves are consumed during this time. The colony has to keep the brood area at 35° C ± 1° (95°F). This takes energy, and energy ain't cheap. Thus, the proper placement and amount of food is critical if the colony is going to survive. It is crucial that you check your colonies this month for honey and pollen supplies and location. If it is still too cold to enter the colonies, lift them from the rear to determine the weight. If the colony feels light (that is, you can tip it forward easily with one hand) feed a 2:1 sugar syrup solution directly on top of the cluster with either an inverted bucket feeder or gallon baggy. Don't count on Boardman entrance feeders or hive top feeders in cold weather since the bees are unable to leave the cluster to feed. And don't be skimpy on syrup. Think in terms of gallons per colony, not quarts. (Actually, think in terms of pounds of sugar. Eight pounds is about the equivalent of one deep frame of honey, and you'll need *at least* that in the north.) During this time of year our lab gets numerous calls about colony death. Upon inspection we usually find that it was simply starvation. The worst case scenario is to find that a colony starved even with 30-40 pounds of honey still in the super just out of their reach. Sharp drops in temperatures or prolonged cold weather can separate the cluster from the honey supplies and they die. That is why it is necessary to put food right next to the cluster. Not only is honey being consumed, but pollen as well. If pollen loads were light last year (and they were in a lot of places), don't forget pollen patties. With brood rearing in full gear, pollen supplies are in high demand. It's probably safer to feed a pollen supplement patty and have the bees ignore it because they have plenty than to seriously curtail brood rearing due to a lack of protein.

Tulip Poplar is an early source of flavorful honey.

Now for the next hurdle and probably the most frustrating: swarm management. Here in the Piedmont region of Georgia we can experience swarms as early as February, but they usually begin at the commencement of the Spring nectar flow. I've seen too many of my bees hit the trees over the years, so I take this pretty seriously. Plus, with a queen breeding operation, you really don't want your breeder queens flying away with all the goods.

Once the temperatures allow, go through each of your colonies and assess their condition; food quantities, queen quality and overall strength of the colony. Keep records of each colony's condition.

If the colony is weak and the queen poorly performing, it is best to combine that colony with another, unless you have a queen in the mail, so to speak. If the queen is poor, replace her as soon as possible. Requeening is one method of swarm control even if the old queen is still doing well. A fresh new queen with her new aroma will sometimes confuse the bees into thinking they have swarmed. But remember, swarming



You can let the colony raise its own queen.

is the colony's way of reproducing. To swarm means to survive and all creatures big or small are inherently programmed for survival.

Another way to discourage swarming is to equalize colonies or produce splits. After your inspection, you'll know your colonies' conditions, especially since you kept records. Strong colonies are the first to hit the trees. Swarming cues like a large population, congestion, reduced laying space for the queen and a nectar flow are all they need. Take three to five frames of bees and brood (make sure you have enough bees covering the brood, and you don't take the queen) and add it to a weaker colony. Or, if you're ready to expand, put the frames into a nuc box or a single deep and move the bees to a new site; otherwise the forager-aged bees will fly right back to their original colony leaving only house bees to cover brood and do the work.

If queens are unavailable, let the colony re-queen itself. Sometimes a beekeeper finds himself with too many bees, so selling frames of bees and brood is a great way to reduce numbers. Since bees move up in the Winter months, hive body reversal or adding empty supers may alleviate some of the congestion. This is only a temporary solution and will not stop the urge to swarm.

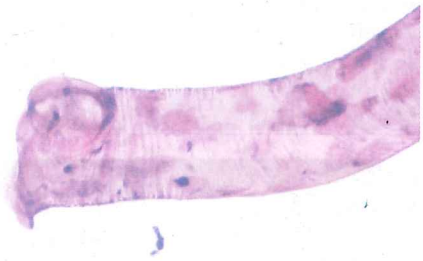
OK, if you don't have extra boxes, don't want to expand, and don't know anyone else in the bee business, there is still hope. Cutting queen cells on a regular basis is probably your best strategy against swarming. Actually, here at the lab we cut queen cells in all of our breeder colonies once a week. However, we still lose bees to the trees.

One quick note, while making your assessments, this is a great time to cull out old combs and replace with new foundation. Put a date on your new frames so you can keep track of their age.

Let's see, you've tackled your colonies' needs and desires so now it is time to deal with diseases and pests. They come in all shapes and sizes, from all parts of the world, and depending on where you live, some or all need to be taken seriously. They can be a major obstacle, but with patience and good management you can win the battle.

With all the concern about *Varroa* mites we sometimes lose sight of other issues; one being the tracheal mite. We haven't seen the colony losses like in years past, but tracheal mites can still pose a threat to your colonies. If you haven't already done so, now is the time to treat with oil extender patties: two parts sugar to one part vegetable shortening or oil. If you have only a few colonies to treat, make up small patties about four inches in diameter and one inch thick. Place these on a piece of wax paper and put in the middle of a two-story colony, just to one side, or the top of a single story colony.

If there are large numbers of colonies to treat, it may be easier to fill a bucket with the mixture and purchase an ice cream scoop for just this purpose. Take wax paper and

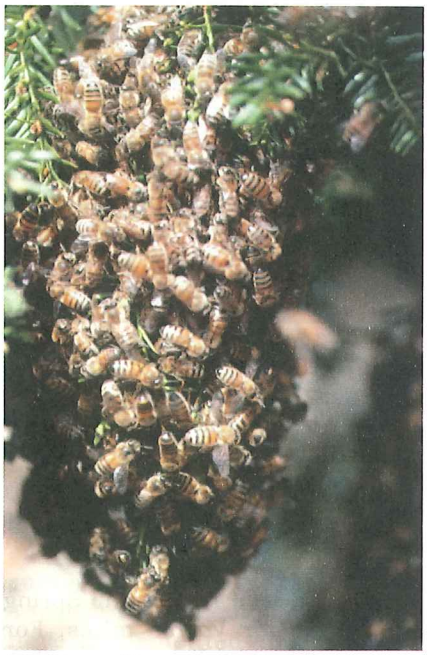


Tracheal mites invade the breathing tubes and cause all manner of problems. Grease patties help.

pre-cut them into six-inch squares. Place one square on top of the frames in the brood chamber. Scoop out one large serving and place it onto the pre-cut wax paper.

While the bees consume the sugar, oil from the patty will adhere to their bodies. The oil acts like a shield, and the tracheal mites are unable to recognize suitable young hosts. Oil patties are acceptable for prolonged treatment since the oil will not contaminate honey supplies, but remove them during the warmest part of the Summer as they can get messy. Resistant stock has also helped ease the pressure of tracheal mites but don't rely on that solely.

Some recommend that you treat

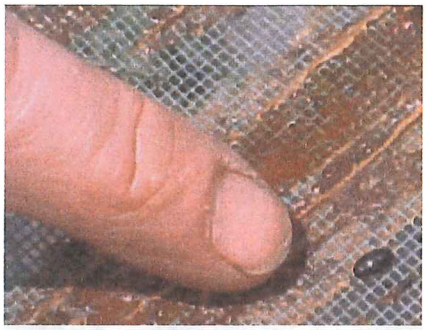


A swarm with an expensive breeder queen leading the way is an expensive lesson.

with Terramycin (for AFB and EFB) and Fumagilin-B (for Nosema) this time of year. This is a practice that we avoid at the lab. We occasionally see European foulbrood (EFB) but usually refrain from treating with chemicals. We start by removing and destroying the infected frames and adding some healthy brood. If the queen is failing, out the door she goes and in with a new. As far as Nosema, I've never seen it here in Georgia. Not that it doesn't occur, it's just very rare to see outbreaks here in the south, but watch for it in the north.

However, rumors of that new strain of Nosema that was first identified in Europe, and now here, have us reexamining our attitude toward Fumigillin treatments. We'll have to see how it shakes out, but treatment is still not on our must-do list. Yet.

One thing we do have is small hive beetles. Our southern cohorts have a more difficult time with these pests than we do in the northern and central regions of Georgia. (Not to say we don't have the little vermin scurrying around in every colony.) At this point, we don't employ any kind of small hive beetle control, other than keeping our colonies healthy and queenright. There are several traps on the market which work well in reducing beetle numbers but will not completely eliminate them. This is OK. Colonies can withstand a certain number of beetles. At this time, there is only one chemical approved for use



Small hive beetles are a nuisance. Traps work pretty well, with the right bait.

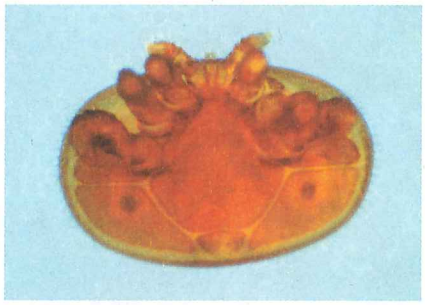
in honey bee colonies for the control of small hive beetles. But remember, chemical controls are expensive, eliminate the problem only momentarily and can leave contamination behind for years.

Finally, let's review our Spring procedures for *Varroa* mites. For years, just like in disease control, it was recommended to treat your colonies in the Spring and Fall for mites. Understandably, you don't want to allow the overwintered mites to gain a foothold now that brood rearing has commenced. However, why waste time and money if the mite population hasn't reached the economic threshold (ET). Simply, the ET is a number which represents the population of mites that should trigger action from the beekeeper. The ET is the cornerstone for all Integrated Pest Management (IPM) practices. Sticky boards are placed into each colony for 24 hours to derive this number.

In the Southeast we consider the ET a 24-hour mite drop of 60-180 mites depending on the size of the colony – small to buster; this is the mite level that warrants a treatment. For now, no matter where you are, if you use that ET and treat if above it, you'll probably be OK. *Varroa* are tricky, watch those numbers. It's always advisable to use an ET derived as closely as possible for your particular region, if available.

There are chemical and non chemical methods for reducing mite populations. The most common non-chemical ones are bottom screens, drone trapping, powdered sugar, and resistant queens. These all help in reducing mite populations inside your colonies; however, resistant queens are likely the key. With the constant pressure of *Varroa*, honey bees have had to adapt in order to survive. This natural adaptation has been amplified with the help of queen breeders who select stock that's resistant to *Varroa*. This is a subject we could go into greater depth about, but let's leave it for now.

By April you should be experiencing either a top-notch nectar flow or be gearing up with your bees. To me, Spring is the best time to be a bee-



Varroa *mites fall off bees, and are captured below and can be counted on a sticky board, under a screened bottom*

keeper. Working outside, anticipation of the honey crop, challenges to face, warm breezes, flowers peeking out, exercising off our winter stores, gardens eager and ready, bees in a tizzy, landscapes coming to life, glorious sunshine. OK, I know, how many more clichés can I think of? It's been a long Winter, so let's get out and enjoy this 2007 Spring season. See ya! BC

Jennifer Berry is a Research Associate at the University of Georgia and is past president of EAS.

Deformed wing virus.

Evaluating Your Colony & Your Queen

Jennifer Berry

Check Now For Problems So They Don't Come Up And Bite You Later

When the calendar page is turned and the 1st week of March appears, we southerners realize that crunch time is upon us. There are only a few short weeks to get our colonies set and ready to go. Otherwise nectar will be left untouched and therefore unprocessed into honey. Hopefully we didn't spend the winter months goofing off but instead got plenty of work accomplished. Old equipment was repaired, ratty, black comb replaced, honey supers primed and ready for action and new, pristine apiary sites selected. If expanding operations then plenty of hammering, wiring, gluing, and painting were part of your Winter activities. If starting those first colonies then queens, packages or nucs have been ordered already. Whatever your plan of attack is I hope you are ready because the bees surely are.

Now that the equipment is in order let's see how the bees survived the winter. The first thing you will want to undertake this month is to inspect your colonies. Don't procrastinate! It is easy to put this off with other Springtime chores breathing down your neck, but your bees may need you sooner than later. During the month of March there should be numerous opportunities to inspect your colonies. The earlier you finish this task the better. Assuming your colonies are ok by just observing bees flying in and out of the hive means nothing. On your first hive inspection of the year you really must open the hive and check each individual frame when the temperatures allow. Later in the year hive inspections don't need to be so thorough but you need a good idea how each colony is faring before the season begins.

So what are you looking for? Here are the basics. Is there a queen? How does the brood pattern look? Are there any signs of disease? How much honey and pollen is available and where is it located? How do the bees look? Are there signs of mites? And don't forget your notebook and pencil! Records on each individual hive are important information you will want to have, especially if something goes wrong down the road.

Let's begin the inspection with the most important issue; is there a queen and if so is she performing? If the colony is queenless then you may want to combine it with another colony, especially a weaker one. If you didn't order queens last year, getting one this Spring maybe almost impossible, especially this early. Now inspect the brood area. Brood patterns should be tight, with little to no skipped cells. The larvae should be pearly white. Discolored larvae could be a sign of disease or chilled brood. If you suspect a brood disease like AFB or EFB and are unsure how to diagnosis it, contact an experienced beekeeper or your county agent. The sooner a positive diagnosis can be reached the better. Chilled brood occurs when the brood nest expands too quickly for the bees to keep warm. The brood is exposed to cold temperatures and dies.

There should be an equal arrangement of eggs, larvae and capped brood. If the brood pattern is spotty, and the population low, at this point the best recommendation is to combine these colonies with others. There is no need allowing a colony to limp along if they aren't going to survive. These colonies are susceptible to disease, wax months, and robbing. By combining colonies you not only save the bees but the equipment as well. Just don't forget to kill the poor performing queen first before you combine. However, there are exceptions (doesn't there always seem to be exceptions when it comes to the world of beekeeping?). Some strains of bees will build up slower or faster depending on their genetics. Russians for instance are slower coming out the gate but will rapidly build up, catching or even surpassing your best colonies. You need to know the nature of your colony. In the past I've contemplated whether or not to combine certain weaker colonies. I didn't because the brood pattern was solid even though it was small. In a few cases the decision was a good one. They built up nicely and ended up making a substantial amount of honey. That is why good notes are

Solid frame of brood.

an important asset. It helps you remember exactly what is happening in each colony.

Ok, the queen and brood appear to be in good shape, so how about the honey stores? Spring weather in the south can be very unpredictable. Last year we had one of the warmest Springs on record however that late two day Easter freeze in April wiped out not only the newly formed tender vegetation but colonies as well. Dramatic shifts in temperatures can separate the cluster from the food. Warm days the bees become active, then with sharp temperature drops the cluster can find itself separated from the honey stores. The bees may be only an inch away from the food but unable to retrieve it when temperatures plummet. The colony then starves before warmer temperatures arrive.

Even though the nectar flow is just around the corner don't count on it solely if honey stores are depleted. Colonies at this time are rapidly consuming food. Feeding each of those individual larvae takes a considerable amount of honey and pollen. They are nothing but little eating machines, made up primarily of a midgut and hindgut. And to think there are thousands of them per frame! So how much food is enough? This can be difficult to determine. However, the rule of thumb at our lab is too much is better than none. If our full size colonies are down to less than a half a super with no honey frames

Strong cluster of bees.

in the brood chamber, we feed. If we have surplus honey frames we add those, if not we use gallon baggies with syrup. Even though nectar flows may be only weeks away, inclement weather may keep the bees from flying and hence gathering nectar. Another thing to examine is the placement of the honey. As the cluster moves up into the honey supers during the Winter, honey is depleted in those areas. Move full frames of honey around the cluster. Frames of honey at the end of a super are worthless if the bees can't access them during cold spells.

And don't forget to check pollen stores. Here in the south the continued drought wreaked havoc on plant and animal life (as well as Atlanta's water supply). Little to no pollen was produced or collected. Mid Winter inspections of our colonies revealed absolutely no pollen. Not a single cell's worth. Therefore, add pollen patties now if your inspection reveals the same situation. There are numerous pollen substitute products available. Some are even pre-packaged into ready made patties which eliminate the hassle of having to mix it yourself. Pollen is the protein source needed for larval development. If there is little to no pollen, then brood production is reduced.

Even though the mite populations have decreased over the Winter months due to the decline in brood rearing, mites are still present. Examine the newly emerged bees to see if there are signs of deformed wings. If you see a considerable amount of deformed wings then treating should be on the horizon. However, we are nearing a nectar flow so chemicals are out of the question. A non chemical approach to knock back mites is to dust adult bees with powdered sugar. The powdered sugar dislodges the mite from the adult bee. Used in conjunction with bottom screens or a sticky sheet, the mite is then removed from the hive. You will have to repeat this method several times in order to eliminate the mites emerging with workers and drones. The powdered sugar will not penetrate the wax cappings and therefore will not affect the reproductive or immature stage of the mite.

After your inspection make sure you put the frames back in the order you removed them. You don't want to leave brood frames at the end of the hive because they'll be susceptible to colder temperatures.

Since we are only a few weeks away from the start of our nectar flow there is another issue we must consider. Overcrowded colonies are just itching to hit the trees once pollen and nectar start coming through the front door. If you want to make a substantial honey crop you need to discourage this natural, swarming tendency. One larger colony of 60,000 individuals has been shown to produce more honey that the honey combination of two smaller colonies with 30,000 individuals. Swarm prevention and control is important. There are many ways to accomplish this task but none are foolproof. Plus, once a colony has it in their mind to swarm, they will. The methods we choose is splitting, equalizing and cutting queen cells.

Colonies that are "boiling over" with bees, (eight to 10 frames bees and brood) we split. We take four frames bees and brood (with eggs) and place them into a four to five frame nuc. If we have no queens available we allow the nuc to rear their own (which will take several weeks before the virgin queen will emerge). First of March in our area is a little early for queens to mate but by the end of March there should be ample drones and warm weather for mating. If there are weaker colonies in need of a frame

or two of brood we take them from our stronger colonies and give it to them. Basically we rob Peter to feed Paul. Since we can't allow our breeder colonies to swarm we regularly cut queen cells. It's a painstakingly long process but until we have made our final selections we can't afford to lose a single queen.

Retiring old, tired queens also helps to discourage swarming. Since my preference is to re-queen in the Fall the queen is only six months old when the swarm season hits. Another positive for Fall re-queening, there is no disruption to the colony just before the one and only nectar flow we experience. Our flow is short and sweet so we don't have time to mess around. There are Summer nectar flows to our north and south but this involves transporting hives. And finally, I already have a pretty good idea which queens are superior and which aren't so hot (because records are kept for each colony).

One more recommendation for swarm prevention, make sure the colony has plenty of room to expand. If you have empty, drawn deep frames drop those into the brood box. It gives the queen more cells to deposit eggs. Place these empty frames on the edge of the brood area. It's not a good idea to divide the cluster too early unless the colony is extremely strong. Removing old brood comb and replacing it with new wax foundation keeps the bees busy. Adding supers upstairs will also help ease congestion.

The last thing to discuss is site selection. This can be a difficult and time consuming chore but well worth the reward. If you have a few colonies and want those in your backyard, great. Just make sure they are facing southeast and aren't sitting in a low spot. Hive entrances facing the morning sun will warm up quicker thereby stimulating the colony to forage earlier (the early bird really does get the worm). Numerous nectar bearing plants only have nectar in the morning hours so you want your bees in the sky at first light. Other issues to be aware of when finding a site for your bees; Is there heavy agricultural activity in the area and if so what pesticides are being applied and when? Is there a clean source of water? Is it easily accessible, especially after it rains? How far is it? Are there wind breaks? Is it in a flood plain or water way? I have had to move my bees several times out of what seemed to be the perfect apiary site, but unfortunately no honey filled the supers. Then other sites which didn't look promising at all produced like mad. But don't get discouraged if you don't make honey the first year. You need to take into account weather conditions that year or the previous year. Give it a few seasons before abandoning a site.

Next month I'll discuss package installation since most packages are being produced and shipped at the end of March here in Georgia. But there is one final touch you can add to your empty hive bodies if packages are on your calendar for delivery soon. Here in the south we are constantly battling small hive beetles. One thing we try to do with our newly constructed equipment is to caulk cracks, crevices and seams in the interior of the hive. They make perfect breeding grounds and hiding places for beetles. By sealing these areas the beetles are forced out in the open more often which in turn keeps the bees on their tails. Get those girls ready cause the flow is a coming.

See ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

WhatKindOfQueen?

Italian, Carniolan, Caucasian, or Russian?

Jennifer Berry

A Little Background

Honey bees were first introduced into this country in the early 1600s by settlers from Europe. The race of bees that traveled by boat to the Americas was *Apis mellifera mellifera,* commonly known as the Dark, German, or Black bee. The German bee was predominant for decades but later lost ground to the imported Italian honey bee because of certain, undesirable characteristics. Beekeepers were annoyed with the temperament of the German bee. It was defensive, nervous on the comb and would boil out of the colony when disturbed. It was also very susceptible to European Foul Brood, which swept the country in the early 1900s. Colony losses were severe enough to spark a move towards the Italian honey bee. Today in the U.S., *Apis m. mellifera* is very uncommon and probably doesn't even exist in its pure form.

The Italian honey bee, *Apis mellifera ligustica*, is still the dominant player in the bee industry today. When you order package bees and queens from commercial sources the bee you more than likely will receive is the Italian honey bee: aka the "three banded Italian." These bees became popular for numerous reasons. First, they tend to be a semi gentle bee, not overly defensive or nervous on the comb. Second, Italians can handle most of the climatic variety that the Americas offer. Third, they don't use a tremendous amount of propolis and finally, swarming is not on the top of their list. The main complaint surrounding the Italian honey bee is their propensity to produce a ton of bees. This is fantastic while plants are bearing nectar and pollen but not so much when the blooms have disappeared. Unfortunately, the trend to produce wall to wall progeny continues into the Summer and Fall. This equates to more mouths to feed which in turn means dwindling honey stores which translates to either less honey removed by the beekeeper or more trips to the apiary to feed sugar syrup. In the past the Italians were the reigning monarch in the U.S. but in recent decades they've been challenged. The Carniolans along with the Russians are gaining in popularity.

Carniolans, *Apis mellifera carnica,* are a dark, grey bee that originated in Slovenia. The Carniolan gained popularity because of its gentle disposition and resistance to brood diseases. The other advantage they have over the Italian is their ability to "flow with the flow." In other words they build up quickly in the late Winter in time for the Spring flow then shut down brood production when nectar and pollen become scarce. The Carniolans overwinter in smaller clusters and hence honey stores are conserved. The only disadvantage is their tendency to swarm more readily when the brood nest becomes overcrowded.

Sue Cobey's breeding program developed the "New World Carniolan." Over decades queens in her program have been evaluated and selected for their ability to resist pests and diseases while still exhibiting important traits like overwintering ability, gentleness, increased brood and honey production.

Another western honey bee, the Caucasian, *Apis mellifera caucasica*, originates from the high valleys of the Central Caucasus. This is a geopolitical region located between Europe, Asia and the Middle East. The Caucasian is a race of gentle, dark bees that aren't bothered when beekeepers open their hive. They are slow to expand in the Spring but eventually can reach fairly large populations by mid Summer. They do have a few negative attributes which is probably what has kept them from gaining too much ground. Probably the most annoying to beekeepers is their tendency to collect and use propolis. Over the years beekeepers have selected against this trait due to the difficulty it added while working colonies; sticky hive tools, fingers, or gloves in warm weather while in cooler temperatures frames, lids, and inner covers cemented together. Caucasians are also inclined to drift, and robbing behavior can be bothersome. You won't find them very often anymore for these reasons.

The newest arrivals on the scene are the Russian bees which have been growing in popularity over the years. They are a mixed hybrid of *Apis mellifera* and come from Primorsky region of far-eastern Russia. In the mid-1800s settlers brought European bees, perhaps several races in all, to this area which were already inhabited by the native Indian honey bee, *Apis cerana,* the original host of *Varroa destructor*. It is believed that these initial populations of European honey bees became infested with *Varroa* and over time developed resistance in order to survive. Hence Russian bees have been exposed to *Varroa* mites longer than other races of *A. mellifera*. In 1997 Dr. Thomas Rinderer, USDA Bee Lab Researcher, imported these bees into North America. In 2007 the Russian Honey bee Breeders Association was formed. The purpose of the association "is to maintain and

Battery Box.

Individual Queen Cages

improve the various lines of Russian honey bees through propagation and selective breeding."

The Russian bee is a dark bee that overwinters in small clusters and can withstand harsh Winter conditions. They are good honey producers but shut down brood production earlier than Italians which is good for conserving honey stores. Russians are inclined to build numerous queen cells during the brood season and can swarm more readily than some other bees.

Finally, I'd like to mention the Minnesota Hygienic, which isn't a race of bees but rather a line of queens selected for a particular trait. Developed by Dr. Marla Spivak at the University of Minnesota, hygienic bees will detect, uncap, and remove infected or infested brood from the combs. Bees with this behavior reduce the incidence of diseases like American foulbrood and limit reproduction and therefore population growth of mites and small hive beetles. These queens are commercially available.

While thumbing through the bee journals you will notice numerous ads selling queens. To a new beekeeper this can be a bit overwhelming. How do you know which queen is best for you, or your location? This is when a local mentor comes in handy. Talk with them or other members in your club to see which queens they've been purchasing over the years. You will quickly find out that beekeepers can be opinionated, especially when it comes to a race or line of bees they've been keeping. Actually, if you stay in beekeeping long enough, so will you. Now, you may receive conflicting stories about which queens to purchase and hence your path becomes even more unclear. So experiment. Purchase several different queens from different breeders and make your own decision. Another way to narrow the selection process is to find a queen breeder that fits your particular beekeeping philosophy.

After you muffle through and figure out which queen you want to purchase you need to order her sooner than later. By now it's March. Most early queens are already sold but they should be available later in the year. If you prefer to re-queen in the Fall you still have plenty of time.

If you have never received queens in the mail let me give you a few pointers. Depending on who you purchase your queen from will determine how she arrives. If you are ordering a few queens they usually arrive in a sturdy, cardboard, postal envelope or box. Holes are cut for ventilation and the queens will be in individual cages (wooden or plastic) inside. If you are purchasing a large number of queens they're usually shipped in a battery box; a cardboard box with wired mesh windows. Inside the queens are securely housed in individual cages. The main difference between the two methods is the location of the attendants. In the envelope, the attendants are placed inside the cage with the queen. In the battery box, they're shook directly into the box and then sealed. Hence there are live, free flying bees inside the box but outside the queen cages. It's usually not a good idea to open the box inside unless you like buzzing bees at windows and lights. The battery box is supplied with queen candy which the attendants consume and then feed to the queens. Cages with attendants have the queen candy inside at one end.

If you are unable to install your queen when she arrives, take the cage out of the envelope and place a few drops of water directly on the screen towards the end where the candy is located. Not too much water, you don't want to drown them. This will help the nurse bees consume the candy and feed it to the queen. Then place the queen back in the envelope and keep it out of direct sunlight and away from any heat source. If your queens arrive in a battery box, lightly squirt water through the wired opening to hydrate the bees; again not too much. It is also a good idea to place your queen(s) someplace where the cat, dog, ferret, gerbil, rabbit, or snake will not have access. I've heard numerous stories about the horrible demise of queens due to a quick swipe of the paw or snap of a jaw.

Before installing a queen it is a good idea to remove the attendants. Several years ago Wyatt Magnum conducted research which showed acceptance rates increased when queens were introduced without attendants. Removing these attendants can be tricky if you're not used to handling bees/queens. If your queen is in a wooden cage, both ends will have a cork plug securely in place. Remove the plug on the end without the queen candy and let the attendants out. Preferably you want to have the cage in some sort of clear bag, queen muff, or veil covering because the queen may shoot out of the hole and take off flying. This can be disturbing when you watch your newly purchased queen fly off into the wild blue yonder. If she escapes the cage just carefully grab her by the thorax and gently place her head into the hole of the cage. She will be grateful to return to the cage if it means being released from the Giant Fingers. Plastic cages have a cap but usually the candy is in that part of the cage. There is a second plastic cap that is attached to the cage. Gently remove it and allow the bees to exit. If you are

Description	1876 price	Adjusted 2007 price
10 frame colony with imported Italian queen	$18.00	$346.55
10 frame colony with a home raised tested queen	$14.00	$269.54
One queen tested specially	$5.00	$96.26
One queen tested specially with bees	$15.00	$288.79
Tested queen from imported mother	$4.00	$77.01
4-full size nuc with warranted queen	$6.00	$115.52

brand spanking new at beekeeping you may want to just leave the attendants in the cage and install her. Once you feel confident picking up queens then you can attempt this. If the queens are in a battery box you don't have to worry about removing attendants. Just open the box next to the hive and insert the queen.

Here is how I introduce a queen. Open the colony, find the old queen and remove her. Open one end of the queen cage and remove the attendants then replace the cork or plastic cap. I take a small amount of honey with my hive tool and touch the corner of the screen. The queen will usually immediately start to feed on the honey. When inserting the queen cage, I prefer to put the queen-candy side down. This way there is no chance of the queen-candy melting and seeping down, entombing the queen. Since there aren't any attendants, no dead bodies could possibly block the candy. After several days I personally release the queen from her cage. I want to see the queen emerge from her cage, walk out onto the comb and be greeted, lovingly, by her new court. If bees are balling the cage (layers of worker bees curled up around the cage, biting and trying to sting the new queen) I leave her for another day or two. Take care with this newest member. Remember without her there's no colony.

I'm going to change the subject for just a minute, but I promise there is a point. Recently it seems our souring economy has been on everyone's mind. Turn on the radio, TV or computer and you're bombarded with doom and gloom: stock market down again, raising unemployment, foreclosures, failed bailouts, company closures, corporate thieves and increasing crime rates. Driving around Athens, Georgia I see the direct results of our failing economy. Folks standing on the road side with large orange signs that read, "Going out of business, 60-80% off, everything must go." It's the topic of conversation at dinner parties and lunch socials. Friends in the restaurant business are wondering how they can hold on for another month. Houses still on the market for over a year have new "for sale" signs reading "Price Lowered."

With all this concern about the economy one would think that the interest in beekeeping would also take a downturn. It doesn't seem to be the trend, so far. Maybe it's due to all the headlines about CCD or the desire to save money by making one's own honey. Who knows? But we, as consumers, are still wary of carelessly letting go of our hard earned money. Purchasing beekeeping equipment, bees and queens may still be on our list but we want more reassurance that the product is good.

Where am I going you ask? Last year I was invited to speak at the Western Reserve Beekeepers Association, in Medina Ohio. One of the highlights of my trip was a tour of the A.I. Root Company; you know the place they make all of those fabulous candles. I saw first hand how votives, pillars, and tapers were made, colored and scented. It was a fascinating tour. But more interesting was the building that A.I. Root built back in 1869. It is still standing and houses this amazing company. While on the tour Kim Flottum, tour master and editor of this magazine, handed me the fourth issue of *Gleanings* magazine dated 1876. I sat down and gently began to thumb through it. One thing that caught my eye was the advertisements for queens and bees. A few of those are in that yellow chart. Just for fun, I converted the 1876 price to today's (actually 2007) to see if the industry has kept up with inflation, which is where those numbers come from on the chart. Now granted I'm over simplifying a bit, but it seems to me that we're getting queens and bees today at a steal. Maybe our beekeeping dollar isn't hurting so bad.

See ya! BC

Jennifer Berry is the Research Coordinator at the University of GA Bee Lab.

MOVIN' BEES

Everybody that's moved bees has a story.

Jennifer **Berry**

There are only a few things I dislike about beekeeping and foremost among them are: shipping queens and moving bees. Regarding the former, my article a few months ago mentioned that I was about to try UPS and would let you know how they compared to the USPS. Well, the first batch went out, and several died in shipment. What a disappointment! But, it could be worse, for example if several million bees were tipped out onto the highway at 65 mph, which brings to mind one of many fears beekeepers have associated with the latter.

But if everything goes ok, what's the big deal, right? Boxes of bees are loaded onto a trailer, the back of a truck or bottom of a trunk, either before sunrise, after sunset, or during the day when temperatures are cool, hauled a few or thousands of miles from home, unloaded, set up and they're good to go. Yet, when things go wrong, it can get really bad, really quickly, even to the point of downright dangerous.

If you've moved bees, then you know what I'm talking about. It's kind of a secret society. We recognize each other, (our fellow movers) as we pass in the hall at meetings. It's that understanding head nod, which translates into "Yeap, been there, done that, and why did I do that?" And, if you've moved bees with any regularity then you more than likely have a story to tell; one that hopefully includes a good bit of laughing.

Even though moving bees is hard work, and can be extremely nerve-racking, I find myself doing it quite often for the lab and the business. For example, every year, starting at around 80 miles north of Athens, the opportunity to make a potentially massive amount of sourwood honey presents itself at the end of June. At least that's in theory. Reality, sometimes, is not so generous. The sourwood nectar flow can be very fickle and will fluctuate drastically from year to year. If you have ever moved colonies to the mountains only to find a single cell of sourwood honey after weeks of work, then you would understand. It can be a very frustrating ordeal. It can also be deadly as well. Folks figure the bees will have plenty to eat, only to come back a month later to 1000s of starved bees.

But the promise of world-class honey can drive one "to drive" up there and back with a load of bees. You can't resist. Each year I get caught up in the frenzy despite not having made an ounce in previous years. Location, location, location!!! Then my friend Bob Binnie came to the rescue and offered to give up one of his great spots just outside of Tiger, Georgia. Finally, I thought, I'll get a taste of the "sourwood experience."

The spot was perfect, off the beaten path, down several winding dirt roads, and finally up the side of a mountain with beautiful scenic views and hundreds of sourwood trees. But, getting a truck and a trailer up there, loaded down with hives, was not going to be easy. The move was not only not easy, but downright miserable. I guess complacency had set in over the years because I found myself unprepared and unprotected. Plus, I had hired Bob Luckey, who was a brand new beekeeper, squeaky clean, right out of the box, had only worked bees a few times, and had never been stung before; he had no clue what he was about to get into.

Strong, robust colonies were needed for the job and had already been selected in advance. However, they were scattered across four different locations, which meant a lot of driving. It was a hot, humid night as we pulled into the first yard. The first thing on the list was to close en-

Putting foam in the front door.

Putting straps on.

Straps over screened top.

Two-wheelers make life easier . . .

. . . especially up ramps.

trances, for which we used window screen to allow extra ventilation into the colony along with bottom screens. The screen used is a heavier gage window screen that holds its shape once bent and stuck into place. It is much easier than having to nail on entrance moving screens for each of the 30 colonies (and cheaper). But, remember, you get what you pay for.

Once the entrances were all closed, it was time to strap the colonies. I prefer using moving straps as opposed to hive staples. I've had issues in the past with hive staples coming loose over time, allowing hive bodies to slip apart, and releasing bees. But, you know the saying, "If you have 10 beekeepers in the room you're going to get 12 different opinions." Everyone has a method they prefer. For me strapping colonies is easy and not too expensive. The main issue here is to make sure the straps are cinched down tightly and the loose pieces are tied securely so that they're not flapping around or getting tangled up. As we began the task of strapping, it was starting to get dark; so I was off to the truck to grab my trusty Coleman lantern, but it wouldn't turn on. After several minutes of fooling around with it, I went back for the Maglite flashlight, yet it wouldn't work either. "Really? Really?" Both sources of light wouldn't work . . . "Really!!!!" Then I turned on the truck lights because at least I knew those worked!

Now, if you're a direct descendent of Superman, Wonder Woman, Batman, Cosmic Boy, Spiderman or Mighty Mouse, then lifting a colony onto the back of a truck or bed of a trailer would be a piece of cake for you. I imagine you could load 30 colonies in a flash, the blink of an eye, a split second, but, for us mortals, picking up 100-200 plus pounds is not such an easy task. And over time, things begin to wear out a bit and since we can't regenerate broken down or worn out body parts, protecting what we have, especially our backs, becomes important. Two person hive lifters work nice for lighter colonies, or adjusting colonies once loaded, but, for the larger double-deeped, triple-supered ones, a hand truck comes in "handy". Though here's a word of caution: if your bottom boards are screened, you need to make sure the tongue of the hand truck is long enough to clear them. Otherwise, you may puncture your screen.

In the glow of the truck's lights, we were able to load the hives one by one without incident. Once loaded, the

Three on, more to go.

colonies were strapped to the trailer. Insert motto here: "Better to be safe than sorry!" A sharp swerve to miss a critter that just ran across the road or a sudden stop to avoid the stupid driver that cut you off while texting, scrolling through their iPod, and yelling at their child (all at the same time) instead of paying attention to the road. Sudden changes in direction or speed can result in hives bouncing down the road, which is not a good thing!

As we drove to the next yard, I figured we had experienced our requisite glitch for the evening (lights not working). So, we should be good to go. Hmmmm, have you ever seen Apollo 13? Remember, right after take off, they had a minor problem with the #5 engine, and, once it was bypassed, and the alarms went silent, Jim Lovell says to the crew . . . "looks like we just had our glitch for this mission." Little did he know, because just a few hours later – well, you know the rest of the story. A minor hiccup, followed by a sense of calm, then, Boom, even more issues materialize to deal with. And, it all started as we entered the fourth and final yard.

This is one of those yards you love and hate. You love it because it has great nectar potential, and you hate it because driving through it is enough to dislodge the fillings in your teeth. Yard 4 had been logged some years past and what remained were large stumps, holes, divots, terraces, ruts, and a steep incline to where the bees were. By now it was late and the grass was wet with dew. The

Ford with its trailer refused to go up the hill. No way sista! So, Bob and I grabbed what we would need and walked up the hill to retrieve the colonies.

Once we got there, we encountered yet another problem. Apparently, I can't count properly. This last yard had seven colonies needing to be screened and strapped, but only four screens and straps remained. Leaving the three colonies behind was not an option as I had promised the owners that I would remove all colonies that night so they could clear more land the next day. So, we stuffed grass into entrances and began hauling 200 lbs colonies down the hill using a two-person hive lifter. There was lots of huffing and puffing, but we managed just fine until the last hive.

It was an extremely heavy one, and, as we were about to clear the last stump, we both stumbled into a hole and dropped the hive. Fortunately, it only came apart between the top two supers but bees still went everywhere. We quickly put the colony back together, then dashed back to the truck to put on our veils. Both of us choreographed the sting dance as we removed bees from all parts of our body.

Once the dancing stopped we maneuvered the unstrapped hives into the center of the trailer, duct-taped the supers and lids, braced colonies, then bounced out of the yard and finally headed north towards sourwood country. It was midnight by the time we hit pavement, which meant we would arrive on site at 2:00 a.m. Bob Binnie had agreed to meet us at the bottom of the mountain and show us the way, which was a good thing. We never would have found it by ourselves. What a great friend Bob is to get out of bed at 2:00 a.m. and help us out.

The roads getting in while a bit bumpy, were at least maneuverable except for the last 100 yards. There was a steep bank with more of that dew covered grass. Bob Binnie recommended that I "gun it" in order to get the truck and the trailer up the hill, around a big oak tree, and to make the 90° turn needed to keep us from falling off the other side of the mountain. I did just that. I know for a fact that the truck and trailer went airborne at one point or another. By the time we came to a stop, the original positions of the hives had shifted quite a bit, especially those colonies that weren't screened or strapped. When we started unloading, bees covered the bed of the trailer, as well as the sides and tops of the hives. One thing you should know is that bees rarely fly at night; instead they crawl! And, insects always want to crawl up. Hence, as we're standing there trying to move hives, bees were crawling up our legs, underneath our britches, and under our shirts. With no bee suits to wear, long sleeve shirts to put on or gloves to show off, our veils, blue jeans and short-sleeved t-shirts became our only protection against the onslaught. Normally bees are particular adept at finding exposed skin to sting, but after the rough treatment these girls had just experienced; they were on a mission! By the end of the night, we both were showing off our new "cankles."

All bee movers belong to a Secret Society, you know. There's a handshake and everything. Dues are paid in stings.

Because of this experience we now have a box that is brought along anytime colonies are moved. The box contains suits, leather gloves, (which we affectionately have termed "our big boy gloves,") a flashlight, extra screen and straps, duct tape, hive tools, a lighter, a first aid kit, box cutters, a 4 x 7 smoker, a small wad of pine straw, and a tin of Altoids (those "Curiously strong mints").

Another tidbit of information that I've learned since that night is to use foam pieces to block entrances and screened moving tops. The foam works great. It's cheap, and, if one piece is too long, you just pinch it off, or, if too short, just add another piece. You can get an old cushion from Goodwill and slice the foam into long, narrow pieces about the width of an entrance. Now, it is ready for stuffing. Screened moving tops are a must when moving colonies during the warm months. With screened tops and bottoms you don't have to worry about colonies overheating with entrances stuffed with foam. Just be ready to cover them if it begins to rain.

There is still time, even in the south, to get your colonies moved to that ideal location before the temperatures get too warm. The best part about this time of year, you don't have to move hives in the dark. Chilly mornings provide perfect opportunities because the bees are still clustered and not foraging. But please remember, be prepared, be careful and take your time. Never get in a hurry, especially when moving bees. It could end disastrously.

And as far as catching the "sourwood" fever this Summer; I'm prepared. I left the bees up in the mountains which both Bobs, the bees and myself are very happy about!

See Ya! BC

Jennifer Berry is the Research Coordinator at the University of GA Bee Lab. Contact her at ***Jennifer@Beeculture.com****.*

SPIDERS

Not to be afraid of, but to be aware of.

Jennifer **Berry**

Ever since I was a little kid, bugs have always fascinated me. This, of course, drove my mother nuts because I wanted to bring a variety of these six and eight-legged creatures into the house for closer observation. Mostly, she didn't approve of my extra curricular activity because she was terrified of both insects and spiders. Over the years, I have slowly and with much effort, tried to extinguish her fears. She can now, at least look at a beetle, praying mantis or spider without immediately going into what I call the "spider dance." You know the one; I'm sure you've seen it or perhaps even done it yourself. After seeing something you think is exceptionally creepy, your body begins to wiggle uncontrollably. Your arms start flailing. You are running around erratically, bouncing off walls and furniture, all the while making a strange, high-pitched screeching noise! After the fact, I think some people take pride in their own version of this dance, while others are simply embarrassed.

For a kid with such enthusiasm for bugs, a farm was the place to be. Each day it seemed there were numerous critters to seek out and investigate. As for spiders, we could always find them. Barns, sheds, root cellars, silos, fences and garden rows were perfect places. There were big ones, small ones, brown ones and green ones. You could find them in webs or on the ground. They were always plentiful. But the home run, so to say, was finding that giant, black and yellow garden spider, a.k.a. the writing spider, usually in between the rows of corn. As kids, we would dare one another to run down these long rows without stopping or swerving to miss the large webs. After one row, we were usually done. There is something about having an entire sticky web clinging to your face, hair and body, or, even worse, when it included the unlucky spider struggling to stay in her web, that can send shivers up your spine. Garden spiders do bite; while they're not poisonous, they can make you wince in pain. I'd probably want to inflict a little pain on the one who destroyed my home, too!

Speaking of spider bites, an urban (or suburban) myth about spiders is that they bite people at night while they're sleeping. Folks who find a two-pronged (or single) bite mark on their body in the morning immediately jump to the conclusion that it is a spider bite. Actually, most spiders inhabiting our homes are of the smaller variety whose fangs are too short or too weak to puncture human skin. To have such a wound, one would have to have been bitten by one of the larger varieties of spiders, like tarantulas, garden spiders, giant night spiders or wolf/timber spiders. Simply, this is very unlikely. What is much more likely is that other insects are to blame, such as flies, mosquitoes, fleas, mites, ticks or bed bugs.

Think about it. For a bite to be visible, you're talking about a pretty large spider. Are these really crawling around in your bed??? Are there gangs of spiders convening in bedrooms at night just waiting for their human prey to start snoring before pouncing on them and feeding until sunrise? Spiders have no motivation to bite humans because, first of all, we are too big for them to consume, and, second, they don't want to waste venom on us. Each time a spider discharges venom, it can take up to two weeks for the venom to be regenerated, which means the spider goes hungry until then.

My enthusiasm for spiders has not waned over the years even after hearing a pretty creepy story about one particular species. Several years ago, we had an extension agent from Tennessee deliver a seminar talk for our Entomology Department. It was one of those talks that I'll never forget, but some of the details may be a bit fuzzy. It was 1998 when he spoke to our department.

Built back in 1929, the Georgian-styled, governor's mansion in Tennessee had slowly deteriorated over the years and was in need of major repairs. However, the governors were a bit wary about making those repairs since it would have required the use of state tax dollars, which may have displeased certain voters. With widening cracks and crevices, it provided the perfect home to many unwanted pests.

One night, during a dinner party, a guest of the governor noticed a spider swimming in the punch bowl. The spider was quickly scooped up and saved for later investigation. The next day, the spider was taken to an extension specialist and identified as a brown recluse, which are found in every county in Tennessee.

A Brown Recluse spider.

The brown recluse, or violin spider, is a small (7-12 mm) brown spider with a dark patch, which may resemble a violin (hence the name), on the cephalothorax (the head and thorax are fused together in certain subphyla of arthropods). The eight legs are lighter brown, and the abdomen is darker brown or even green. Nocturnal feeders, brown recluse spiders prefer the darkness of undisturbed places, like under furniture. Since staying out of sight during the day is their habit, they love to nest in that old pair of boots stored in the shed or that Winter coat hanging in the back of the closet. They are not aggressive and rarely bite unless provoked, for instance, when pinched between a body part and another surface. A toe pushed into a shoe, or an arm pressed against a garment or mattress, is a typical example.

The governor was advised to have the entire mansion fumigated in order to do away with these pests and the possibility of being bitten. However, the governor's wife was heavily involved in environmental issues and wouldn't allow the mansion to be fumigated with any kind of pesticide. As an alternative, as well as in an effort to quantify the infestation level and locate breeding areas, hundreds of sticky traps were placed throughout the mansion. These sticky traps were 12" x 12" cardboard squares with glue on the upper surface. Anything walking across one was sure to get stuck.

From the attic to the basement, traps were placed under chairs, couches, tables, beds, dressers, and sideboards. They were put behind furniture and pictures, plus in corners, bookshelves, and cabinets. Twenty-four hours later, as the traps were being collected, the extension agent became terribly disturbed. Each trap was completely covered with brown recluse spiders. And, these were not just the traps in the more remote locations, but also the ones under the bed where the governor and his wife slept, the couch where their children played and the kitchen table where they all ate together. This was not good. This was not good at all! Yet, the most surprising thing was that no one had ever been bitten even with all these spiders roaming around.

The bite of brown recluse may go unnoticed for several hours or even days. Depending on the amount of poison injected and the sensitivity of the person bitten, there can be a wide range of symptoms. The poison from the spider causes necrosis (death) of the tissue adjacent to the bite area. Other symptoms include fever, itching, nausea, vomiting and shock. Long-term effects are scaring at the bite site, kidney insufficiency and even death (less than 3%). But, the brown recluse, along with their other eight-legged cousins, may be getting a bad rap according to our departmental spider expert, Dr. Nancy Hinkle.

A Black Widow with her obvious red spots.

When a patient presents an unexplained, dermatological wound to their doctor, spiders, especially the brown recluse, seem to get the blame, even when the spider doesn't exist in the area. For example, according to Rick Vetter, Urban Entomologist for UC Riverside, in 41 months, 216 brown recluse spider bite diagnoses were made in California, Oregon, Washington and Colorado**.** Yet, these are all states in which the brown recluse doesn't reside! Medical personnel are even quicker to misdiagnose any type of necrotic wound as the result of a brown recluse. In fact, such wounds or infections have likely been caused by a bacteria, virus, fungus, or vascular disorder than by spider bite. Though, I concede that, "You've been bitten by a spider,**"** sounds a whole lot better than, "Sorry, Miss. You've been infected with a flesh eating bacteria."

The brown recluse**'**s native range is from Central Texas, east to Western Georgia, north to Kentucky and west to southern Nebraska. Here, in the Piedmont region of Georgia, brown recluse spiders are rare to none. However, we have another spider that is very common, especially under beehives.

The black widow spider has been so named because, after she mates, she usually kills and consumes her male suitor. So, throughout history, the black widow spider has gained an ugly reputation as a bloodthirsty maniac, wandering the streets in search of her next victim. This is not quite the case. The reason that female spiders, along with other insects in the wild kingdom, post-coitally devour their mates is for the survival of the young. By eating the male, the female acquires nutrients important for the development of the eggs she will soon deposit and protect with her life.

The black widow is a shinny, black orbed spider with long skinny legs and a distinguishable, red hourglass-shaped marking usually on the underneath of her abdomen. However, not all black widows have this red hourglass. Some may have yellow, orange, or red spots, dotting areas on the top or bottom of their abdomen, as well. Black widows, like the brown recluse, prefer areas that are dark and undisturbed. Outside, they are commonly found under rocks, in woodpiles, hollow stumps, and abandoned rodent burrows. They are also fond of those dark corners, cracks and crevices found in sheds, garages, basements and crawl spaces. But, in the beeyard, especially here in Georgia, black widows love the cozy underbellies of a beehive. With available food, warmth, and protection from the elements, what better place to call home? However, we never apply any kind of insecticide in or around our hives to kill spiders.

Here at the UGA lab apiary, most of our colonies sit atop cinder

blocks or horizontal, 4" x 4" fence posts. During the Spring and summer months each hive, including the stored equipment as well, will have at least one black widow as a resident. It's crazy. Even the horticultural farm crew (with whom we share the farm) complains about constantly finding black widows in their storage sheds, pump houses, empty pots, and soil bins. A few years back, we were moving some nucs (nucleus hives – four or five-frame starter hives) off-site. I was carrying them to the truck and handing them over, when one of our grad students said, "Um Jen, I think you have a black widow crawling up your shirt!" Sure enough, there she was.

The black widow spins a very unorganized, erratic web, unlike the orb spiders with their classic, spiral, wheel-shaped home. The web is very sticky and will snare most unaware insects that come too close. Once snagged in the web, the black widow will quickly spin a silken cocoon around her victim. When feeding, she punctures the insect with her fangs and administers digestive enzymes which liquefy the prey's internal structures, so the contents or body juices can be easily sucked out. Yummy!

Black widows are common and widespread across the U.S. Yet, there are very few reports of actual bites from black widows, and no one has died in over 10 years from these most-feared spiders. But, if you are bitten and venom is injected, you will probably need to be admitted into a hospital. At first, the bite area will resemble a target with a pale area in the center surrounded by a red ring. Within a few hours severe muscle cramps will develop along with headache, nausea, vomiting, breathing difficulty, weakness, itching and increased blood pressure. The very young, elderly and infirm are at the highest risk of developing life-threatening complications.

With that said, I know of someone who was bitten on the toe by a black widow as he put on a pair of boots, which he had left outside over night in downtown Athens, GA. He spent several days in the hospital receiving morphine to ease the pain. So, while being bitten may be a rare likelihood, I keep my eye out when handling equipment (either in storage or in the field), gardening, moving rocks (which I do a lot), and hauling firewood because I don't ever want to have the type of pain that necessitates that much morphine administration.

As the picture shows, we also occasionally find black widows in the handholds of our supers. A certain amount of caution should always be taken while working bees. From not letting a hot smoker burn down the apiary or honey house to not becoming overheated or dehydrated. It is just as important to keep an eye out for the occasional poisonous spider, snake or charging hippo (which are always dangerous this time of year)!

Spiders are probably some of the most misunderstood of all the animal groups, which is a shame since they are extremely beneficial to us and the environment. In a way, it's much like how the general public reacts to the buzzing sound of bees; they tend to run screaming while swatting wildly at the air (a variation of the spider dance)! But, at least people are becoming aware of the importance of bees, due to all the media attention during the CCD scare. Spiders, unfortunately, are still left in the wings with no hope of better favor in sight. I just can't imagine there being much of an outcry if, all of a sudden, spiders began dying off in droves. However, it wouldn't take long for us to notice the increase in insects, especially the ones that invade our homes and food supply. So, the next time you see a little spider scurrying across the floor, and before you drench it with insecticidal spray or make it a permanent fixture on the bottom of your shoe, you may want to recognize it as an amazing creature with its own important role to play. Try picking it up with a sheet of paper, releasing it outside and letting life happen. Just a thought. BC

A black Widow, resting on the brand on this hive.

Thanks again to Philip Quinn for repairing grammatical issues within this article.

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

Protecting Pollinators & Beneficials

Jennifer **Berry**

UGA Is Reaching Out This Year

Last October, staff from the UGA bee lab traveled south to Moultrie, Georgia to participate in the Sunbelt Ag Expo Show, which, for 35 years, has showcased the newest innovations in agriculture. The annual Expo is housed on a 100-acre site and features over 1,200 exhibitors. One of those exhibitors was Rossman Apiaries. Fred and Ann Rossman have been attending the Sunbelt Expo for over a decade now. Fred explained that they had decided to exhibit because it was an excellent opportunity to educate the public about honey bees; plus, they only had to travel a few miles from their business location. Every year, they display beekeeping equipment and observation hives for the public to see. They also offer educational materials about the importance of honey bees and the role they play in agriculture – not only in Georgia, but world-wide.

While walking around Expo, it was amazing to see every kind of agricultural equipment imaginable: big tractors, small tractors, red tractors, blue tractors, bush hogs, sprayers, diggers, and harvesters. Everything you could possibly need in the agriculture business was on demonstration. Alongside all this machinery were research specialists from the College of Agriculture and Environmental Sciences (CAES) offering helpful, educational information to the public. The college's theme this year was "Pollinators and Peanuts," which provided the perfect opportunity to launch our "Protecting Pollinators and Beneficials" program.

Here at the UGA Bee Lab, one of our most important goals is to disseminate information about all aspects of beekeeping to the public. We accomplish this through direct consultations, our website (*http://www.ent.uga.edu/bees*), the Young Harris Beekeeping Institute (May 9-11), exhibits, publications, classes, workshops and lectures to local, state, national and international audiences. It is also our goal to educate the general public on the importance of honey bees, other pollinators (bumble bees, mason bees, sweat bees, digger bees, butterflies, moths, flies, bats, hummingbirds, and flying squirrels) and beneficials, along with how to protect and encourage their presence. By "the general public," I'm referring to non-beekeepers, since most beekeepers already have an understanding of the importance of honey bees. For instance, the average American usually doesn't realize that honey bees are responsible for the pollination of about 1/3 of the food that we consume. Most folks, and I was one of them years ago, have no clue where their food comes from or how it even becomes food to begin with. So, it is important that the public be informed not only about pollinators, but beneficial species as well.

We all know the definition of pollinators. When we speak of beneficials, we are talking about any organism that feeds upon or parasitizes unwanted pests in the farm, orchard, garden, landscape setting or turf grass. They benefit the growing process by reducing the extent of botanical injury by pests. These "good" insects, such as praying mantises, ladybugs, green & brown lacewings, dragonflies, tiger beetles and spiders (e.g., garden, jumping and wolf spiders), are some of the most common beneficials around. They eat agriculturally destructive insects such as whiteflies, aphids, plant bugs, and potato beetles, but, since they're not particularly discriminate eaters, they also sometimes eat each other. Notably, most parasitoid wasps are species-specific, only attacking one species of insect. For instance, the braconid wasp, *Aphidius ervi*, parasitizes exclusively the pea aphid. While parasitoids can act externally or internally, the ones most important to agriculture parasitize internally (endoparasitoid). Another parasitoid wasp, *Encarsia formosa* is used commercially for the control of the greenhouse whitefly, *Trialeurodes vaporariorum*, on greenhouse-grown vegetable crops and to a lesser extent ornamental crops. Some parasitoid wasps are tiny, measuring less than 0.6mm. Endoparasitoids pierce the integument of the host-insect of choice with their ovipositors and deposit their eggs. These eggs hatch into larvae and begin to feed on internal tissues; this eventually kills the host, which is a good thing, since now the destructive pest is no longer dining in your garden or yard.

Rossman Apiaries set up at the Sunbelt Ag Expo.

Praying mantis eating grasshopper.

Parasitized caterpillar. (photo by David Cappaert)

Unfortunately, homeowners are some of the worst abusers of pesticides. Panic-stricken after having seen a **bug** ("Oh, my!"), too many rush off to the nearest big box store and grab the bottle that promises instant, devastating and the longest-lasting results**.** Then they race home, haphazardly toss a "feels good" amount of the concentrate into a pump sprayer without reference to written instructions, and proceed to douse the garden or yard indiscriminately until saturated. Unfortunately, the "menacing intruder" that initially gave rise to this environmental tragedy was quite possibly not even a true pest. It may have just been an inconsequential passerby or, even worse, a pollinator or beneficial! The problem with using broad-spectrum pesticides is they eliminate all bugs in the system, the good along with the bad. This is why it is important to first know the beneficials from the pests. I'm not suggesting that everyone becomes an entomologist, but at least have some appreciation of the environment as a whole and be open to strategies to target specific pests. This year, our lab will be focusing on this very objective: to raise the public's awareness of the good verses the bad bugs.

The orders which include most of the bad bugs are Orthoptera (grasshoppers, crickets and katydids), Hemiptera (true bugs, which include, aphids, lacebugs, scales, spider mites, and spittlebugs), Coleoptera (beetles, Japanese beetles, and flea beetles), and Lepidoptera (butterflies and moths, with the caterpillars doing the damage).

Once identified as a pest, the next step is to determine if a bug is actually causing enough damage to be harmful to the plant as a whole. Direct injury is physically eating the leaves, sucking sap or burrowing into stems, fruit, or roots. This is usually apparent upon inspection of the plant; some examples are holes in leaves, necrotic spots on fruit or stippling on leaves and stems. Indirect injury is the secondary bacterial, viral, or fungal infection transmitted to a plant by a pest via direct injury. A few examples of this are chlorosis (change in leaf color), growth malformations, loss of vigor, and leaf wilt.

Now, most plants can tolerate some infestation and infection. Problems arise when that infection or infestation goes beyond the threshold of what the plant can handle. A few aphids or whiteflies on your tomatoes are usually not going to cause the plant to die or reduce yield. However, a few thousand is another story; this is when we may need to take incursive action if we want any tomatoes.

But, before reaching for that can with the skull and

crossbones, first try one of several less-toxic approaches such as physical controls. For example, soft-bodied insects, such as aphids, are no match against a strong, steady blast from a water hose. Or, better yet, a pair of fingers can work wonders, squashing, picking and flicking off these guys while inspecting stems and leaves. This is a regular practice of mine in my veggie and flower garden. "Hasta la vista, Baby!!!"

When there are no other physical control options and pesticides are necessary, there are still several simple "tricks" to reduce undesired side effects. Try the softer chemicals first. For instance, insecticidal soaps or oils are excellent alternatives to use in place of the harsher chemicals, and are sometimes much cheaper. Again, they work great against the smaller, soft-bodied arthropods such as aphids, mealybugs, psyllids and spider mites. Bt, *Bacillus thuringiensis*, another great alternative, is a soil dwelling bacterium used to control susceptible Lepidopteron larvae. Another biological pesticide is *Paenibacillus popilliae*, the bacterium responsible for causing a disease called milky spore, which helps to control Japanese beetle larvae in the ground.

When applying pesticides, two of the best usage suggestions are to apply at night and to avoid blooms. The first of these strategies helps since most pollinators are back home or out of the area after the sun has set. The second is important, obviously, because pollinators carry out their work by visiting the flowers, whereas most pests suck from stems or chew leaves. Another quick suggestion is to not apply any pesticide during windy conditions.

UGA Lab technicians Nicholas Weaver and Ben Rouse.

Pesticide contaminants can drift onto areas you want to avoid such as flowers, nesting sites, hives, waterways, and your body!

When choosing pesticides, you will have more control over environmental impact with those that break down (lose their effectiveness) rapidly. Also, avoid dusts, such as Sevin™ Dust, since the particulate size is similar to pollen and can be collected by bees and then fed to brood. Incorporating just these few measures will dramatically reduce the effects chemicals will have on the beneficials you want to keep around your yard and garden plus the impact on the environment as a whole.

Several years ago I took an IPM biological control class and just loved it. At one point during a lecture, the professor stated that it was unrealistic to assume that we could feed the population on this planet without the use of common, harsher pesticides. Our monocultured approach to agriculture was one of his reasons for this belief. He lamented that organic and sustainable agriculture were wonderful ideals, but they could only feed a small portion of the world. To this day, I question that statement. BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

Southern Spring

Jennifer Berry

Privet

It's Already Time To Go!

By now most of the U.S. should be experiencing some sort of nectar flow. Bees should be scurrying about rewarding us with the riches of nature. Our lazy days inside, sipping on hot toddies in front of the fire, are long gone. Now is the time we shed that extra weight and feel our superman strength return as we begin lifting those 100 pound supers. Backs beware, spring time is here!

Before we jump into what's blooming, let me reiterate once more about starvation. Last month I talked about lifting colonies from the rear in order to check honey stores if cold temperatures restricted opening them. However, I recently remembered something from my beginning beekeeping years that I want to pass along. It was early Spring and I was out on a cold morning lifting colonies to determine if they were in need of food. All the colonies felt heavy plus the nectar flow was just around the corner; I was confident they would be fine. A week later I noticed numerous dead bees scattered out in front of one colony. I opened the colony only to find a box full of dead bees, and I do mean packed to the top. Plus, every frame had a single bee tucked head first into each cell but not a drop of honey to be found. The weight I was feeling was not the honey stores but the weight of the bees themselves. The colony started rearing brood earlier than usual, hence the colony population exploded, consuming all stores before the nectar flow arrived. Just be aware of this so you don't make the same mistake. With all the other problems facing us, starvation should be the last thing to kill our colonies. If you are concerned your colony doesn't have enough stores, just feed them.

So far this year, the season seems to be three to four weeks ahead of schedule. Hopefully during the wintery months you built and repaired your equipment and are now ready for the flow. Here in the piedmont region of Georgia the red maple, blueberry, henbit and redbud blossoms are on the decline. These blooms provide more pollen than nectar, which kick start colonies into heavy brood rearing. Any day now we are

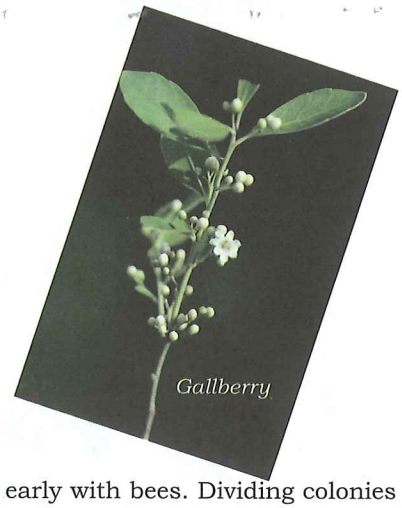
anticipating a strong nectar flow with blackberry (bramble), tulip poplar, privet, and clover. Years past, our Spring nectar flows easily produced two to three supers per colony. The only problem being, it's our only nectar flow. We may see a trickle of goldenrod in early Autumn but we can never rely on it. Therefore, our bees must collect all the honey needed for our table as well as theirs in roughly four to six weeks. This honey is usually light amber with a fruity flavor. It does tend to crystallize quickly due to its high glucose content but is still a crowd pleaser.

So, when should I super, you ask? The time is now. How should I super, you say? That's a good question and still under considerable debate. There are several ways, depending on which beekeeper you talk to. You have bottom- versus top-, all at once versus "as needed" basis. To keep confusion to a minimum let me state how we do things here at the lab. We try to super colonies as they need it. When a super is about half full, we add another. However, apiaries too far away to check on a weekly basis are supered two to three at a time per colony. I'd rather give them too much space than not enough. Crowded conditions during a nectar flow will force bees to fill up the brood nest with honey restricting the queen, triggering swarming. However, with the addition of our latest pest, the small hive beetle, one must be careful. Additional room allows space for the beetles to hide. They can't rear young in empty supers if there's no food available, but they can congregate there. If you are in an area prone to beetle troubles, you may want to be careful about giving your bees too much space. And don't put old nasty supers with dark comb on your colonies. Get rid of that old junk! If you don't know how old a frame is, then it is probably too old and needs to be removed. A steady Spring nectar flow is the best time for bees to construct new comb. Here at the lab we have disposed of hundreds of old frames: too many to count. We also decided not to melt the wax from these old combs. Who knows what contaminants may be lingering in the wax? A good yearly practice is to replace two frames each year in the brood chamber, marking them with the year. Therefore, none of your frames is ever over five years old.

By April our southern cohorts have already begun supering for the Tupelo flow. The Tupelo Gum tree produces large amounts of nectar in a few short weeks. The nectar output is so strong the bees go "honey crazy." Honey produced from Tupelo is considered a delicacy because of its light, amber color and exquisite flavor. Due to its low glucose concentration it doesn't crystallize as quickly as other light colored honeys, thereby making it a desirable honey, especially for northern markets. However, production of Tupelo on a commercial scale is not easy. It takes experienced beekeeping skills and a keen knowledge of regional nectar flows. There are numerous challenges facing Tupelo producers. Here are just a few: First, Tupelo locations are difficult to find and traverse since most are situated in swampy, river areas. Some beekeepers keep their colonies on barges and float them up and down the river in search of the Tupelo trees. Just prior to the nectar flow, all honey stores must be removed to insure only pure Tupelo nectar is being placed in the cells. And finally, supers must be removed before other floral sources bloom in order for the Tupelo honey not to be contaminated. Because of the difficulty producing Tupelo and its desirability, it can bring top dollar at the market. However, don't plan on heading south any time soon in search of your very own, private patch of Tupelo. These prized locations are fiercely guarded and passed down from generation to generation.

The coastal regions of Georgia will soon be gearing up for the Gallberry flow, one of the largest flows in the country. Gallberry is another light, amber honey which tends not to granulate. It is produced from an evergreen shrub in the sandy soil along the coast. It is a major honey crop for beekeepers from coastal Texas to Virginia.

Each year, swarm management and prevention seems to come earlier due to our mild, and warmer Winters. Normally strong colonies in the Piedmont regions of Georgia are swarming the first of April with the peak of the season hitting in May. This year swarms are a full month early. Our stronger colonies were producing drones as early as January. If there ever was a time to expand your operation, this is it. Colonies are loaded



early with bees. Dividing colonies or making splits is best done just prior to a strong nectar flow, which is now. Hopefully, you anticipated how many splits you would be making last year and ordered the proper number of queens. If there are no queens available, and your hives are busting at the seams, why not raise your own queens? However, realize, you will not have emerging brood from this new colony for at least 44 days. The queen has to complete her development (16 days), orientate (three to five days), make her mating flights (two to four days), commence egg laying (two to three days) and then it's still 21 days before the first round of brood will emerge. But at least you have a new colony with your very own queen. We will explore the actual rearing process in the next issue.

An additional thought. As a beekeeper and a researcher I live with a notebook strapped to my side. Every yard is named, every colony is numbered and even sides of frames may be labeled. Taking notes has become a habit and one I recommend to all beekeepers. It helps you keep track of your colonies' needs, problems or successes. After working several colonies, one tends to forget which colony needed the new queen and which one was out of food. All those white boxes begin to look the same. But if you have your trusted notebook by your side, you can quickly jot down any problems you encounter. Another reason to take notes is you'll be amazed at how much you learn about your bees. For instance, as your colonies are coming out of the Winter and your assessing their condition, why are some weaker or stronger than others? Why did one die and not the next one? If you took notes during your Fall preparation, the answers may be there.

Have a grand Spring! See ya'll! BC

Package time

Jennifer Berry

It'salwaysgoodtoreviewthebasics,andtomakesureyougetitrightthefirsttime.

Commercial queen and package producers in Georgia have been gearing up since last Fall in anticipation of "package" time. Colonies that have been properly managed had populations at their peak by the end of March. This month bees are being shook by the millions into packages (weather dependent of course) and shipped all across the country. It is an intense time for queen and package producers. They're working from sunup to sundown and still wishing for that one extra hour of daylight.

Hopefully you have been busy as well and completed your "things I need to do this Winter" list. Chores appearing on that list included ordering queens and packages, assembling new hives or repairing old ones, painting, painting, painting, and finding the best location for your new arrivals. If you ordered your packages last Winter then you should be first in line for your bees. If you haven't placed an order you may have a hard time finding packages before the nectar flow ends. Maybe purchasing nucs would be a better choice this late in the game, however finding nucs maybe just as difficult. Spring beekeeping, with either established colonies or new ones actually starts in the Fall/Winter. If you remember that you'll always be ahead of the game.

Now let's get those bees in their new home.

Bees are shook into a wooden framed, metal screened box. Usually packages contain three pounds of bees but some operations will sell higher or lower poundage. Each package is given a canister of sugar syrup and a caged queen (if ordered). However, some producers will sell queenless packages. After the packages are complete they are shipped off to their final destination, your home. Here at the lab when we order packages the post office calls requesting us to please come collect our bees as quickly as possible. We've been receiving packages for years now so the postal service isn't as stunned to see thousands of stinging insects, buzzing and humming, in their back room. But that wasn't always the case. In the early, inexperienced package receiving days, the phone would ring here at the lab and the postal worker on the other end would inform me that the bees had arrived and would I please come pick them up at my earliest convenience, of course. However, the tone in her voice was actually conveying, "come and get these *$!#*& bees before they kill us all!!! And yes, have a nice day."

Your bees have traveled a good distance so take great care with them once they arrive. If you are unable to install the package the day they're delivered, place them in a cool, dark environment away from children and pets. It's a good idea to place paper or cardboard under the package since debris can scatter out from the box leaving behind a mess. If you are installing more than one package it is a good idea to install them later in the day. This will help to discourage drift since bees are anxious to bed down before dark. This gives them 12 hours to adjust to their new digs.

There are several different ways to install a package. Let's review the two most common methods. The first, more traditional way to install packages is to physically shake the bees into the hive. To do this, you first want to remove a few frames from the hive in order to leave a space for the bees to fall into. Using a hive tool, pry the plywood lid off the package exposing the top of the feeder can. To keep the bees from flying once you remove the can, lightly spray the bees with a thin mixture of sugar and water. Don't soak the bees, just lightly spritz them. Next locate the queen cage. There should be a wire or tab stick-

ing out from the side of the feeder can. Take hold of the tab while removing the feeder can. The can may be snug so use your hive tool to pry it out. Take the queen cage out, remove the cork plug next to the queen candy and staple, wedge or wire the queen cage, candy side down, to the frame side exposed to the opening you created by removing the frames. Don't place her on an end frame or off to the side. You want her to be in the center of cluster. She still needs to be fed until she is released. Now comes the scary part, shaking 10,000 bees from their temporary home to their permanent one. Actually it's not scary, but definitely strange the first time you do it.

Lightly shake the bees from the package into the hive. Not all the bees will be removed on this first pass so knock the package on the side to collect a mass of bees then tilt the package back and forth to allow the bees to sprinkle out from the hole. There may be a few bees remaining inside the package. That's fine; just rest the package with the hole facing the entrance of the hive. The remaining bees will be attracted to the scent of their sisters and the queen, leaving the package behind. Next slowly return the frames, and then place the inner cover and lid and you're finished. Well almost finished. You still have one more thing to do.

Another package installation technique is actually less stressful to the bees. Follow the same procedure as mentioned before except remove half the frames, and don't shake the bees from the package. After you remove the lid, feeder can and secure the queen, place the now "opened" package inside the hive. The bees will exit the package on their own which is less stressful than the first method. Shaking bees into or out of packages can result in some mortality so the second method cuts down on the number of dead bees. After a few hours go back to retrieve the empty package and return the removed frames.

Even though there may be a nectar flow occurring at the time your bees arrive, it will still take some time for your bees to orientate themselves to their new surroundings and find any food. It is always a good idea to feed your newly installed package. Actually it is imperative that you do so or they will die. Gallon baggies placed on top of the brood chamber are quick and simple however do require an additional empty super to account for the space taken up by the baggie. Entrance feeders work well only if the temperatures are in the 50s and above. Cold temperatures keep bees tightly clustered and unable to move great distances. That's why it is a good idea to feed directly on top of the cluster during these unpredictable Spring months. Plus, entrance feeders can encourage robbing if there are numerous colonies in the area. Gallon buckets, top feeders or division board feeders will work as well. Plan to feed your new colony a 1:1 syrup for six to eight weeks to help them get established.

It is also a good idea to feed pollen patties or a pollen substitute to your newly installed package. The queen will begin to lay eggs shortly after she is released and pollen will be needed to feed the young larvae. However, unless you have supplied your new colony with pollen frames or patties there will be none to be found. Again the bees will take a few days to orientate themselves to their new environment so why not give them a head start. There's a variety of pollen and pollen substitutes available on the market. If you want the real thing, natural pollen is available from several commercial sources. You can usually

buy it powdered or granulated. Mix it with honey or sugar syrup until it forms a solid patty that holds its form. Place it on wax paper and center it over the bees.

Now for the issue of treating for diseases and mites. There is considerable controversy over when, how, what, and where to treat or even if one should treat at all. To simplify life I'll tell you what we commonly do (unless the design of the experiment calls for otherwise). In addition to feeding our new colonies, we feed, feed, feed then feed some more. That's it.

One more point. If you are installing several "queenless" packages at once you may want to reconsider. The bees can be a bit disoriented and may drift about from colony to colony causing a population shift to occur. Here is an example of what we experienced one year after installing packages. During the swarm season we split our colonies or shake packages for use in research projects. One important lesson learned (the hard way) was it's better to introduce a queen sooner than later. Here is what happened. We were setting up an experiment which required 40 colonies. We ordered queens from a local producer however decided to shake bees from our own colonies to reduce population levels and save money. After the packages were complete we installed them into their individual hives (in an apiary a good distance away from the original). Next we added the caged queen. When we returned the following day we had a mess on our hands. Some colonies were busting with bees while others only had a small cluster surrounding the queen cage. The problem was drift. Bees for whatever reason decided they preferred the colony next door as opposed to their own. Some of the colonies were starting out with six pounds of bees while others had less than one. This was unacceptable so back to the drawing board we went. When we shook the bees the second time we introduced the queen into the package immediately, left them overnight and installed them the next day. There was minimal drift the second time. The point: if you purchase a queen from a source other than your package it has been queenless for several days. You will want to introduce a queen sooner than later in order for the bees to adjust to the scent of her. Obviously, you don't want to open the package until you are ready to install it so place the queen cage, mesh side toward the screen on the side of the package. This is especially important if you plan on installing more than one package in a single apiary.

If you purchase a queen with your package, drift can still occur but maybe not to the extent that we experienced. For one, the bees have been with each other and the queen for days and have, hopefully, united.

Now comes the hard part, keeping those bees alive and productive. Beekeeping is an art that will teach you many different skills. There's a certain amount of knowledge needed but more importantly, a whole lot of work. But unlike inherent talent at least it can be learned and understood. Just be attentive, be patient, be gentle and be happy with your new bees.

See ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

Rabbits, Turtles and Bees, Oh My!

Turtles and healing honey at the Georgia Sea Turtle Center

Jennifer Berry

Last Summer I rescued a tiny baby rabbit. His nest had been invaded and his two siblings killed by a coyote, raccoon or some other predator. In a panic to save this little guy I turned to the internet for help. I typed in "what to do with a baby rabbit" and immediately the information appeared. It said that baby rabbits are extremely delicate and will most likely die unless handled by a person trained in wildlife rehabilitation. Not being certified in that area I contacted a trained professional and she agreed to take the precious little guy off my hands but I would have to drive the 120 miles to meet her. No problem.

I packed him into a box with the remains of his nest and took off like a bullet. Of course during the ride I continually stuck my hand into the box to see if the noise of the truck or the sound of that ambulance racing by or the drama of being removed from his nest hadn't just sent him into shock. So far, so good. About half way there, speeding down a windy country road, I ran over a medium size turtle, literally. He was in the middle of the lane and I missed him completely. A sigh of relief was quickly replaced with, "Oh my, he'll be surely hit if I don't pick him up". It was just after 5:00 p.m. and the traffic on the road was horrible. But as I drove away, I looked in my rear-view mirror and saw the little guy still hunkering down as the car behind me barely missed him. About a mile down the road, there was a place to turn around. Cars were racing by as I waited, for what seemed like hours, to get back on the road. I dreaded the fact that he had probably been hit by now. I got a break, pulled out and raced back. There he was, still in one piece and not moving. I pulled over on the side of the road. Again it seemed like hours before I could even open my door to get out due to all the cars whizzing by; but the turtle was still alive and I wasn't about to sit and watch him die. Finally there was a break in the traffic. I jumped out, ran across the road, scooped him up and made it to the other side just as the pickup truck sped by blasting his horn. Guess he wasn't too happy to see someone in the middle of the road as he came around the corner. But the turtle was safe and unharmed, however now the task of getting back to my truck. Hmmm? Just to let you know, the little rabbit made it and was successfully released and so was the turtle.

Ok, rabbits, turtles, what does this have to do with bees? Well, actually you'll be surprised. Last December I spoke at the annual Georgia Farm Bureau Commodities meeting at Jekyll Island. Right after I spoke Dr. Terry M. Norton, DVM, from the Jekyll Island Sea Turtle Center gave such as interesting talk I just had to find out more. Now be patient, much like the tortoise, and not the hare, to find out how sea turtles and bees are connected.

Dr. Terry M. Norton is the director and creator of the Georgia Sea Turtle Center. He received his BS degree at Mexico State University and his Doctorate in Veterinary Medicine from Tufts University in Massachusetts. He then interned in small animal medicine and surgery in Washington, DC. Next he completed his two year residency at the University of Florida College of Veterinary Medicine in Zoo and Wildlife Medicine and became board certified in the same field. Afterwards he worked for the White Oak Conservation Center in NE Florida, the Riverbank Zoo in South Carolina, and the North Carolina Zoo, focusing his attention on what he loved most, zoo and wildlife medicine. During this period he would also travel to St Catherines Island every two weeks to provide medical, surgical and preventative health care for a variety of endangered, captive mammals, birds and reptiles. St. Catherines Island is a 10 mile long island owned and managed by the St. Catherines Island Foundation. The island is located off the coast of Georgia and a center for endangered species breeding and research.

Working in wildlife medicine Dr. Norton realized that a native wildlife health program was desperately needed for coastal Georgia. Thus, he ambitiously went to work. From 2001 to 2006 the Georgia Sea Turtle Center slowly began to materialize. In February 2006, renovations began and in June 2007, the Georgia Sea Turtle Center, a marine turtle rehabilitation, research, and education facility, opened on Jekyll Island. After six long years the vision was now reality.

Prior to the center opening, injured turtles were shipped to facilities in Florida, South Carolina, and North Carolina. Now Georgia has a facility

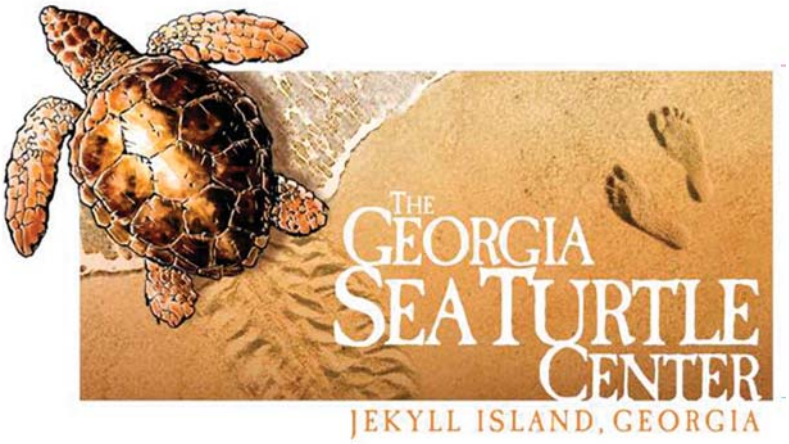
that has the ability to "not only provide state of the art emergency care to sick and injured turtles but also opportunities in research and long-term treatment."

Another goal of the center is to engage the public and offer educational programs by increasing the "awareness of habitat and wildlife conservation challenges, promote responsibility for ecosystem health and empower individuals to act locally, regionally, and globally to protect the environment." Not an easy task but well worth the effort. Education is a powerful tool and the center strives to educate anyone willing to listen. Once you create awareness about the plight of our environment, folks understand the urgency and become involved. If people can make the connection with nature, they take this home and become more active in conservation.

With the continual development of coastal areas, turtles and other marine life are losing their nesting and breeding sites. Plus with increased human population along the coast comes the desire and need to be entertained and fed. Hence the number of boats and jet skis increase to meet these demands. One of the major problems marine life faces is fishing gear entanglements. Birds, turtles, manatees, etc may become entangled in the gear which may eventually lead to severe injuries and even death. They may also ingest hooks, lines, and lures. Dredging and trawling activities also take their toll. Propellers are another danger which causes about 20% of the injuries observed in turtles.

Approximately 300 terrapins on the Jekyll Island causeway alone are hit by cars during their nesting season from May to July. The terrapins are attracted to higher ground for their nesting and the causeway forms the perfect habitat for this. Unfortunately it is a death trap for the terrapins if they try to cross.

Various pollutants such as runoff from golf courses, lawns, sewer systems, roads, the fuel from boats, and sediment from dredging compromise the health of sea turtles and other marine wildlife. The ecosystem created is now out of balance (similar to what we are seeing with CCD). Not only are sea turtles affected and declining in numbers, but 1000's of other species, all interconnected, are affected as well. The center was established to address these issues that disrupt coastal areas and coastal wildlife.



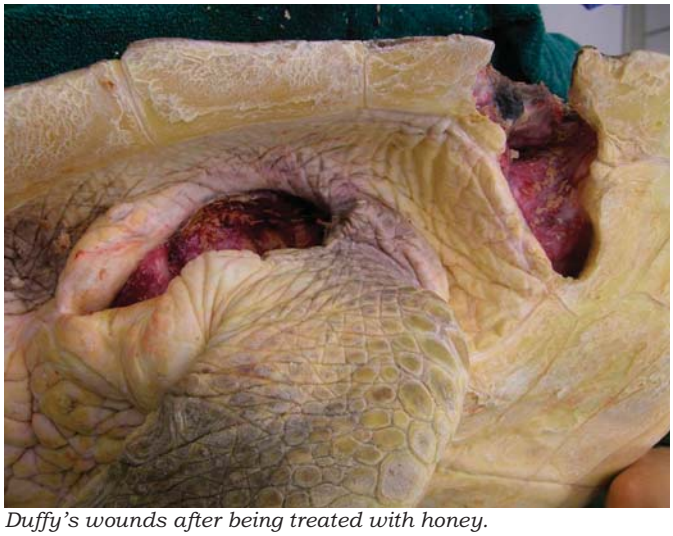
In June of 2008 a large loggerhead turtle was found with a severe propeller injury. The propeller had sliced through the leg and shell of the turtle. Early prognosis wasn't good. He was named Duffy. Now imagine a gapping wound from a propeller that has sliced through the shell of a turtle. How would you possibly mend that? There is a machine called a VAC that is used to help heal non-healing wounds in humans and animals. It rests directly onto the wound where the suction created promotes and improves blood supply to the area while pulling out debris and infection. It permits healthy tissue to form allowing the wound to heal faster. However, this can only be used on land, not in water. So when applied to aquatic turtles they need to be removed from the water. It is stressful for an aquatic animal to be out of the water.

In the past, Dr. Norton had used honey for wound care in other animals, so he applied honey to Duffy. Unfortunately, the honey kept washing out because the turtle was returned to a water tank. A student worker at the center, Katie Haman, suggested packing the wound using honeycomb to hold the honey in place. Sure enough it worked and the wound began to heal. Duffy will be released back into the ocean this May.

The newest patient at the center receiving honey treatments is Varun, a green turtle. He was brought to the center with a horrible injury; a deep gash caused by a boat propeller that exposed his lung and body organs. Again, the early prognosis wasn't good. The process for healing Varun's wound is using sterile gauze with honey. They are used as bandages to aid in healing burn victims or diabetic wounds. These MediHoney gauze bandages don't come cheap. They run $10 a strip and can only be used for one day. While interviewing Dr. Norton he told me that the day before his visit was the first day the Varun's injuries were beginning to improve.

Honey, especially in other countries, is routinely used to treat all

Dr. Norton examining an injured turtle.



Duffy's wounds after being treated with honey.

Rehabilitated turtle being released back into the ocean.

sorts of maladies in humans, including healing wounds. Honey inhibits the growth of most bacteria because it produces hydrogen peroxide when exposed to tissue. Here is a simplistic overview of the process. Honey by itself has a low pH of around four, so it's acidic. Depending on the floral type, honey averages about 30% glucose. While bees are ripening honey they add an enzyme, glucose oxidase, to the honey. This enzyme oxidizes glucose and forms gluconic acid. The acid formed aids in the stability of honey against fermentation. Also, for every molecule of glucose oxidized one molecule of hydrogen peroxide is formed. This too helps keep the honey from spoiling. When skin and body fluids are treated with honey the environment is just right for the glucose to break down and release hydrogen peroxide. These antibacterial properties from the creation of hydrogen peroxide help wounds heal faster. Remember that nasty cut your mother poured liquid into while you writhed in pain? More than likely it was hydrogen peroxide and it was killing all sorts of bacteria, which was a good thing even though it didn't seem like it at the time.

Injured sea turtle at the center.

Since the center has opened 18 sea turtles have been successfully rehabilitated and released. Currently there are 12 sea turtle patients. Most of these will be released in late spring. As of May 31, 2008, Dr. Norton and his staff treated 256 diamondback terrapins with 69 releases. They have hatched 131 terrapins from eggs recovered from dead or injured terrapins. Roughly 52 turtles (freshwater, gopher tortoises and box turtles) have been treated at the center.

Along with Dr. Norton, the sea turtle center is staffed with a hospital coordinator, three rehabilitation technicians, a husbandry intern, an educational coordinator, an education and outreach coordinator, a education and volunteer coordinator, a marine field program coordinator, several interns, a gift shop manager, hourly employees and hundreds of volunteers. Rescuing wildlife takes people with passion and knowledge.

This year Dr. Norton was selected to join the Institute for Georgia Environmental Leadership. The Institute was started in 2001 to create a diverse group of state environmental leaders to work together and address environmental challenges in the state of Georgia. And it doesn't stop there. He has been awarded 12 research grants, collaborated on numerous research projects and has served on many national committees. He is an Adjunct Professor at the University of Florida, North Carolina State University and the University of Georgia Colleges of Veterinary Medicine. He has published 35 articles and is the associate editor for the Journal of Zoo and Wildlife Medicine. In 1992 Dr. Norton was honored by being awarded the distinction of Diplomate in the American College of Zoological Medicine. Dr. Norton also organizes, teaches and lectures to groups ranging from the general public, to local veterinary associations, to zoos, to universities, scientific meetings and even beekeepers.

If you ever find yourself visiting our lovely state take a day or two and go see the center.

It is open to the public Tuesdays through Sundays. Admissions collected help with operational costs along with the expense for rehabilitating the injured or sick patients. Check out their website for more information. www.georgiaseaturtlecenter.org

Quoted lines in this article were taken directly from the Georgia Sea Turtle Center's website.

See Ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab. To comment on this article: Jennifer@BeeCulture.com.

Splits For Different Reasons

Jennifer **Berry**

What do you want from your splits?

Since moving to Georgia, April has become my favorite month by far. The temperatures aren't too cold and definitely not too hot. It's the perfect weather for playing in your yard, hiking about, planting your garden, camping and, of course, working bees (that is if the rains hold off). The dull browns and grays of the Winter have been replaced with lime greens, pinks, whites, reds, yellows, and blues. The cold Winter smells have melted away, and the sweet warm aroma of Springtime has returned. Yes, I love April in Georgia. I imagine that, in the northern tiers of the country, your thaw is almost complete, and you too are shaking off the Winter chill and soaking up the Spring sun with a smile.

Yet, for the beekeeper here in the south, the month of April, along with its picture perfect days, can also bring about some serious headaches. The degree of which depends partly on us, partly on the nectar flow and mostly on the weather. Here in central Georgia and to our north, April is the peak swarming month, but there are no absolutes when it comes to bees. Swarms can occur as early as February or as late as September. Granted, those are the outliers of the season and they typically don't have a chance in . . . (you know where) for survival, but, why would we ever just sit back and let them hit the trees?

To maximize our honey, we should always take advantage of each bee's potential. We must harness her energy, and guide it in the right direction. (Do I sound like an infomercial?). As long as the colony has been managed properly in the Fall and overwintered with plenty of healthy Winter bees, it should now be strong and ready for the challenge.

As proper Fall management and overwintering yield strong and ready bees, proper funding yields strong and ready University Bee Labs. Unfortunately, like I've said before and probably will say again, this lab runs hand to mouth. We receive a pittance from the State, which only covers a minimal percentage of our monthly needs. The rest (supplies, repairs, gas, wages, bees, sugar, etc.) is funneled from grant money. And, for those out there who still believe that our lab receives money from large chemical companies . . . well, guess what? You're wrong! Anyway, I digress. Back to the point, our budget, just like the rest of the nation, is tight; tighter than tight, and looks like it's going to get even tighter. Hence, we need to watch every penny, and every bee lost to the trees, whether here at the Lab or in my private operation, is critical money down the drain. In the Georgia Spring-time, we need every bee we can keep our hands on. So, what do we do? We make splits or "artificial swarms." It's so easy; all you need is an additional hive (nuc box or standard eight or 10 frame), frames, sugar syrup, and about 15 minutes!

Now, before going into the apiary, you need to decide what purpose you have in mind for these new splits. Are they for swarm prevention? Will they go into honey or queen production? Are they to be sold off? Or, are they just more pets to look after? There are slight differences when making up the splits for each of the above cases. Also, the strength of the original colony will play a role as well. They may not be strong enough to make splits yet, or so strong as to be able to make more than one.

Let's start off with the basic split for swarm control. For you in the far North, the first of April may be a bit too early temperature wise, to make a split; however, you can at least begin to plan your attack so that you'll be ready when the time comes. To begin a split for swarm control, open the colony, locate the queen and set her aside. What we prefer to do here at the Lab is to take frames covered in bees, including most of the capped brood frames, a frame of pollen, and a frame of honey, as well as last year's queen and transfer them into a five-frame nuc box. This equates to a total of four frames with bees and brood from the parent colony (given that it has the resources to do so) and an

When you've made the split move one to a new location.

empty frame. Arrange the frames in the nuc box (and the parent colony) as follows:

Honey (H)– Empty frame (preferably drawn) (E)– Brood (B)– Brood (B)– Pollen (P)

If you are using a standard eight or 10 frame box, just add empty frames to the outside positions. As the temperatures warm, you can move those empty frames next to the brood frames to provide extra room for the queen to lay eggs. However, just be careful not to separate the brood from the pollen or honey too early, as April can still be very unpredictable, with drastic changes from high to low temperatures being common, even here in the South. This arrangement can be dangerous if cold temperatures are still in the forecast because the bees will not leave the brood. They can be a mere inch from the honey and starve. Think of the amount of energy it takes to fuel their bodies in order to create enough heat to keep not only the brood but themselves warm. As their internal energy supply dwindles, they lose their ability to generate heat, and the cluster becomes colder and colder. Once the bees are chilled, they're too cold to traverse the frames to reach the honey and will stand in place and starve. Hence, you may want to either put a few frames of honey in a super directly above the brood nest or bring the lateral honey frames closer if temperatures are predicted to drop.

Now, let's go back to the parent colony. Make sure to leave behind plenty of nurse bees, a frame of eggs or very young larvae, honey and pollen; this colony is now queenless and will need to raise its own queen. If there are swarm cells, leave those behind. Or better yet, if you've thought ahead, and ordered a queen she can be introduced immediately by placing the cage into the parent colony, thus saving precious brood-rearing time.

Finding the queen in a big colony can be a challenge.

After the swarm control split is made, screen the entrance, load it in the truck and take it to a different location. This will reduce the tendency of adult foragers to return to the original hive. It's a good idea to feed these girls to reduce stress since they've been moved to a different location and don't know their way around the new neighborhood just yet. Also, keep in mind that this new split will soon bust out of that five-frame nuc box, so you will need to anticipate transferring it into a bigger box shortly. Now, not only have you kept your colony from swarming (hopefully), you have another colony that you can keep, give away or sell.

If your goal is to make more honey, especially cut comb, a slightly different arrangement is warranted, and timing is of the essence. In this scenario, the split needs to be done just prior to the nectar flow. Take the queen, all the open brood, most of the honey and pollen and transfer them into a nuc or standard hive box. Again, take this new colony to a different location so that the remaining foragers don't fly back into the nuc where the queen is located. Leave behind most of the foraging force, the capped brood, a frame of eggs, and some honey for the bees to survive on. With little to no open brood for the bees to attend to, it frees them up to forage mostly for honey. For cut comb, you need these boxes full of bees, basically on the verge of swarming during the entirety of the nectar flow. But, don't forget to check for a laying queen in about four weeks. Plus, you will want to arrange the split and parent colony exactly like before with honey and pollen frames on the outer edges with brood in the center.

If you want to expand your operation, there is yet another route you can take, especially if you were on the ball last year and ordered early queens. This works great for sourwood honey production or any other mid Summer nectar flow. Making splits now gives your new, robust queens time to populate the hives with plenty of foragers eager to bring in that nectar this Summer. Basically, you are just splitting the colony in half. Take half the brood, bees, honey and pollen and put them into a new box leaving the remaining half in the parent hive. Place the honey and pollen frames on opposite ends of the box with empty frames next to the brood.

E-H-E-E-B-B-B-E-E-P-E

Again, keep an eye on those future temperatures and, as the threat of chilly weather subsides, move those empty frames even closer to the brood so the queen has more cells available to her.

Splits not only help keep your colonies from swarming or provide you with additional colonies and honey, but they are also a natural method of *Varroa* control. Each time the queen's egg laying is interrupted, there are breaks in the honey bee brood cycle; hence, there are corresponding breaks in the foundress mites' reproduction cycle. The resulting delay in mite population growth reduces the stress on the colony. The splits that you've made without the original queen will take days (if introducing a mated queen immediately) to weeks (if they must rear their own) before egg laying will resume. There's even more time before the larvae are old enough for the mite's migration into the cell for her egg laying to commence. So if you time this right (when there is little to no capped brood), and dust the colony with powder sugar, you may be able to remove a good majority of mites from that colony since the mites are outside the cells feeding on the adult bees or hunting for a suitable larvae, and not under the protective wax capping.

If I've learned anything from my years in beekeeping, it's this: When I think that I still have time to do something in the beeyard, it's usually already too late. Beekeepers always need to think weeks in advance, to keep one step ahead of the bees, especially this time of year! And one other thing I've learned; if I goofed off this Winter and didn't do my rainy day chores (building frames and hive bodies), then I'm out of time come April. So, don't waste time. Get that equipment ready today for what you will need tomorrow to harness the energy of your bees and guide them in the direction of high productivity and long-term survival. Have fun and enjoy the season.

See Ya! BC

BACKYARD QUEENS

Jennifer Berry

Marked queens are soooo much easier to find. (photo by Jennifer Berry)

Grafting, splits, swarms or supersedure cells – Making a few queens can be easy!

Raising your own queens can be a rewarding adventure. First, you know the history of your queen – her roots, her mother's background, her age. Second, she's your baby. You were responsible for bringing her into this world. Too sappy? Maybe, but there're not too many people who aren't fascinated and overjoyed at the sight of their first queen. But the best part about raising queens is you can have one emerged (16 days), mated (21-25 days) and laying eggs in 23- 28 days and it didn't cost you a dime.

Still, why raise your own when there are so many good queen producers out there? One answer is the local queen producer has no queens until next year and the following has occurred: your colonies are busting at the seams, the queen just died, disappeared, left the building, you mashed (southern for smash) her, you didn't order enough, your relatives, friends, and neighbors decided they really like your honey and want more, more, more so you have to expand. Or maybe you have decided to join the "Brethren of Better Beekeepers" and rear queens that you've selected from colonies that can thrive in this rough world we have created for them. What ever the reason is, you can do it.

There are many ways to rear a queen, the most popular being the Doolittle or grafting method. Simply put, grafting is the transference of young larvae into artificial queen cells. Mastering this technique takes time plus a variety of equipment and supplies: grafting tools, queen cell cups, grafting frames, queenless starter colonies, queenright finisher colonies, and mating nucs to name a few. This can be overwhelming for the beginner especially one who just wants to raise a few queens. So let's simplify queen rearing the best we can.

First, you will need to order, build or set aside the number of hives/nucleus colonies needed to raise the queens. One complete hive or nuc per queen desired. Four or five frame nucs work the best since it takes fewer frames and bees to set them up.

Next, you need to select the colony from which to rear a queen. This is a very important step because the queen is the HEART of your colony. Starting off with excellent breeding stock is the key to producing an excellent queen. When you have an exceptional queen you have the right ingredients for an exceptional colony. 50% of her genetic makeup comes from the mother queen. Her genetics, like brood production, gentleness and disease and mite resistance, is what she confers onto her progeny, which in turn makes the type of colony you desire.

Here at the bee lab each colony goes through a series of tests before a queen is selected to become a breeder queen. This may be a bit extreme for your operation however you may want to incorporate a few of these techniques. For disease and mite resistance we want queens which display hygienic behavior (something Marla Spivak has been talking about for decades). We test for hygienic behavior by freezing a circular section of capped brood with liquid nitrogen. The frame is returned to the colony for 24 hours, and then the number of cells removed are counted. Knowing the number of cells within the circumference, then counting the number of cells removed results in a percentage of hygienic behavior. The higher the percentage the better. In conjunction with mite resistance each colony's *Varroa* mite population is measured with 24 hour sticky sheets. Next, we determine how well the queen is laying by measuring brood production. We take a plastic, frame sized grid which is marked off in centimeter squares, place it on a frame with brood and then count the total. Again the higher the number the better. Another trait we measure is colony temperament. Every time we manipulate a breeder colony we evaluate their temperament on a scale of one to five with one being extremely gentle and five being extremely hot. Finally, we measure honey production and brood spottiness to determine the rate of inbreeding. Granted, this is probably more than you want to tackle for raising a few queens, however, you can definitely evaluate mite population, brood production, honey production and colony temperament.

Now we need to locate the queen in the colony you have selected. The best advice I can give for finding queens is spend the extra dollar and have your queens marked. This makes life so much easier when trying to find queens. But you still need to find her, mark or not. Let's say you have several hive bodies and supers with no queen excluders. Where do you begin? Remove the honey supers and place them on the inner cover. Next place the second hive body (if you have one) on the lid, leaving the main

hive body intact and start your search there. More than likely you will find the queen on frames with a mixture of empty cells, eggs and milk brood. Queens are usually, not always, but usually **not** on frames with honey/pollen, sealed brood or frames void of bees much like the empty ones you find on the ends. Scan for the queen from left to right, flipping the frame over and scanning again from left to right. Don't forget the bottom or end bars. If she is not on that frame, place it outside the colony, leaning it up against the box you are working. Don't lean it against the other boxes since she may be on that frame and travel into those boxes. If you can't find her on the frames check the sides of the box. If no queen is found move to the next hive body, or supers and resume your search like before.

Still can't find the queen? You're not alone. Even the most experienced of beekeepers can't find queens every time. You can either continue on with another pass or put the colony back together with queen excluders between each box and return in four days. Look for eggs and your search is at least narrowed to that box. When you find the queen, temporarily cage her or set aside the frame with her on it until you are finished with the next step.

You are now going to transfer frames from the parent colony into the new hive. Whichever colony not housing the old queen must have eggs or at least very young larvae, (preferably less than 24 hours old), in order to produce a viable queen. The queenless colony will also need young nurse bees in order to raise a queen. One way to ensure nurse bees are in the box is to do the split while the foragers are out in the field. If using a four or five frame nuc, remove one frame of eggs, milk brood, and bees, one to two frames, depending, of emerging brood with bees, and two frames of pollen/honey. Transfer these frames into your new box. Put the brood frames in the center, with honey/pollen frames on either side. Shake several frames of bees into the box. If using a 10 frame hive, fill in the spaces with foundation or drawn comb. To the remaining colony add foundation or drawn frames to fill the hive. You will need to move the new colony to a different location until the new queen has emerged, otherwise all the field bees will return to the original colony. Take care in transporting the hive. Frames tend to sway back and forth, thus mashing bees, including queens.

Another easy way to rear a few queens with the least amount of work is to take advantage of the swarming season. If you come across a colony that is preparing to swarm (visual swarm cells), make a split from this colony. Make sure you have a queen cell and not a queen cup. Queen cells have the egg/larva in place while the cup is empty. Take the old queen along with half the bees, brood and honey/pollen and place them into a new hive. Make sure to cut any queen cells from this colony if you want to keep that queen. Move this colony to a different location. In the remaining colony, leave the swarm cells intact, moving them to the center of the brood box. Make sure this colony has plenty of honey/pollen and young bees. Not only does this give the illusion to the workers from both colonies that they have swarmed, but now you get a free queen.

A new item just introduced by Brushy Mountain Bee Farm is worth mentioning. It is called the queen castle and simplifies queen rearing even more. Basically, it consists of a hive body that has been separated into four compartments with alternating entrance holes into each section. Each compartment holds two frames, so you now have four-2 frame nucs in one box. You can also remove the dividers to make two-4 frame nucs. Take one frame with eggs/milk brood or one with swarm cells along with one frame of honey/pollen and place it into one section. Don't forget to add plenty of bees, enough to cover each frame and the walls. Continue until all four sections are filled. Carefully move the box away from the parent colony. If you transferred capped queen cells be extra careful. This is a delicate time for the queen pupa so try not to bounce the box too much.

You can use an emergency cell to raise your queen.

You can use a swarm cell to raise a queen.

Just a few quick reminders. Maturing queen larvae need an abundance of royal jelly to develop into healthy, vigorous queens. Royal jelly is produced by young worker bees which need plenty of honey and pollen to do so. Make sure the colonies rearing your queens have plenty of both. Also, try not to bother the colonies too much once they have started rearing the queens or during the queen mating flights. Remember it takes 16 days for a queen to emerge from the egg, three to five days before she takes her first mating flight, two to four days to mate and then two to three days to start laying eggs. The earliest you will begin to see eggs are 23 days if your queen started from an egg. Don't be alarmed if you see a few eggs per cell in the beginning. Sometimes young laying queens will put a few eggs in a cell. However, if this condition continues you either have laying workers or a bad queen.

After your queen is laying and you are pleased with her performance, don't forget to mark her. Now sit back and enjoy your newest title, Queen Breeder Extraordinaire. See ya! BC

For The Love Of Honey

Jennifer Berry

Savannah Bee Company

Remember the first time you were about to explore the interior of a beehive? The range of feelings coming at you all at once: excitement, fear, joy, anxiety, curiosity, nervousness, delight, and terror. Putting a veil on for the very first time. Wondering if you got all the strings tied right, or what about this gap between your neck and the netting or was your collar high enough in the back or was that hole in your jeans going to be a beacon for these flying creatures with sharp stinging instruments?

Walking out to the apiary with this metal tool in your hand, not having a clue what to do with the darn thing. Watching as the beekeeper lights the smoker and fills the air with smoke, creating this mystical, foggy environment. Moving ever so slowly towards the hive and hearing a faint buzzing sound as you cautiously come in for a closer look. Then a bee buzzes by your head and begins this kamikaze attack mode in your face. You panic, blood pressure rises, sweat beads up on your forehead, images of killer bees covering your body (much like they did in that movie you saw back in the 70s). You start to run but just then the beekeeper touches your arm and in a very calm voice says, "Would you like to see the queen?"

After several hours and numerous colonies the beekeeper is exhausted from all my questions and really wants to go home. But I keep pressing him for more information. I don't want to leave, not yet. Wait, let's open just one more hive, and can you explain again that round dance thing they do or watch bees emerging. And how many drones does the queen mate with? Can we see her again? How long does she live? Just one more hive, please!

A few months ago at the Georgia Beekeepers Association Spring meeting, I had the opportunity to sit down and talk with Ted Dennard, owner of Savannah Bee Company. We started off the conversation talking about how he became a beekeeper. As he paused to think for a second, he smiled and then started telling me about his first experience in a beehive, the excitement and horror he experienced at the same time.

Ted was 13, living in Brunswick, Georgia, when a friend of the family, Roy Hightower, "Old Roy" as he lovingly expressed, asked if he could put bees on their property. When the bees arrived Ted was immediately interested but also terrified. Hesitant about going into a colony, he put on several layers of clothes to cover every inch of his body. He was not going to get stung. He explained, "When Old Roy first opened the hive, it was almost like watching a scary movie. You want to cover your eyes and look away but you just can't because you don't want to miss a thing." Well, he kept looking. He said as he stood there he was drawn in, totally fascinated by what he was seeing, hearing, and smelling. His fear quickly melted away and fascination took over. Then what he remembers most from that first voyage into a bee's world was the honey frames. He explained as a frame was pulled out of the super, it

Beeyard at Savannah Bee Companies new warehouse.

Savannah Bee Companies trade mark.

was backlit by the sun. The image was breathtakingly beautiful. He was overwhelmed by the colors of the honey shinning through. Then he began to notice the various hues, some amber, some golden, some red. The assortment of different honeys glowing in that beeyard that day opened a door, which would eventually carve a path to the conception of the Savannah Bee Company.

Well Ted's beeyard days didn't end there. His interest continued. Several years after his introduction to bees, Mr. Hightower passed away, leaving the bees for Ted to manage. He was still a novice but did the best he could to keep the bees alive. But then it was time for college and off he went to study Theology at the University of the South in Sewanee, Tennessee. Back home Ted's father tried to take charge of the bees, but a nasty allergic reaction pulled him out of the beeyard, forever. Then mites arrived and the bees perished, but not Ted's fascination.

While in college Ted rented a log cabin from a retired minister/beekeeper, Archie Stapleton, who became Ted's teacher and mentor. "He was extremely smart and knew all the really cool facts about bees. He was also this happy, jolly sort of fellow who loved making wine". Years later when Archie died an incredible story followed. Archie passed while reading a book in his favorite chair. EMS arrived and as they were loading his body into the ambulance, bees filled the entire truck. The EMS workers had to quickly evacuate and wait for the bees to leave. People who witnessed this event were truly amazed at what they saw; the bees just wanted to say goodbye.

After college, Ted volunteered for the Peace Corps and was assigned to work with beekeepers in Jamaica for two years. He worked primarily in the field addressing issues and helping where he could. While there, the Jamaican beekeepers formed an association, which attracted over 130 beekeepers, and Ted worked with them all. Being in Jamaica was glorious but while there he had an epiphany. Years ago "Old Roy" introduced him to the glorious world of the honey bee and now here he was, working in Jamaica, helping beekeepers. The ripple effect made him pause. He realized then it's the small acts that make a difference, one by one that have an impact.

After his return to the states he moved to Flagstaff and Durango. For five years Ted ran a wilderness business called Onshore & Offshore Adventures. It was an awesome concept. He would take school age kids backpacking for a week, exposing them to the wilds of the earth. Next they would stay a week on a Hopi or Navajo reservation giving them a real, cultural experience. Then to end the adventure, they would spend one week on a river trip.

Recently Savannah Bee Co. took home the grand prize for products entered at the 2010 Flavor of Georgia Food Product Contest.

It was a grand time, but Ted was anxious for something more in his life. So he traveled to Asia for six months exploring ideas for his future. He loved the multi-cultural, diverse nature of Asia and knew he needed to live somewhere that offered this type of environment. When he arrived back into the U.S. he landed in Savannah. It didn't take him long to realize that Savannah was going to be his home. He quickly started back to beekeeping with five hives. It was a dream of his to turn beekeeping into a full time career but he hesitated. Beekeeping was a hobby that he loved and was extremely passionate about; he didn't want to spoil it. He understood that too often this is the case when you're trying to make a buck. Your passion runs dry with the day-to-day pressures of running a business. It can become more about the profit and less about the product. And making a profit sometimes requires cutting corners.

But he loved producing honey and his few hives were doing such a great job of it. He and his roommate decided to buy an extractor and sell the surplus to surrounding stores. "Bee Buster Honey" was sold in squat, little jars

Ted inspecting tupelo honey.

Ted explaining the honey process to the crew of Food Network.

with hand painted logos. But it wasn't paying the bills (yet) so Ted worked numerous full time jobs. He was teaching an experiential youth program for the Savannah Board of Education until they lost funding. Next he taught environmental science classes to 1st and 2cd graders.

But he loved producing honey and slowly but steadily his honey began to sell. Stores started asking for more and then other stores became interested and started asking. The line kept growing. However, for the business to expand, this meant more equipment, more bees, and more time in order to meet demand, so off to the bank Ted traveled. His initial business loan was $13,000. This enabled him to buy 50 hives, a truck and a trailer. The following year he made his first crop of tupelo, and gallberry honey; the Savannah Bee Company was born. As more stores kept asking for more honey, the business moved from the kitchen, to the garage to an 800 square foot space at the Oatland Island Wildlife Preserve. Yet, he still had to work numerous other jobs to pay off the note from the bank. He resurfaced bathtubs, flipped houses, removed bees, was a Mr. Fix-It man, and beekeeper.

It was a crazy time and the requests for his product kept growing. Swankier stores started calling and demand was rapidly growing, but his "time" was the limiting factor. So he decided to take the plunge in December of 2001 and make the Savannah Bee Company his one and only job. Just three years after he bought his first round of production hives, Ted walked down the road called "Dream Job Lane". Ok, that was corny.

He headed west for a short course in business, mortgaged the house and decided to give the Savannah Bee Company everything he had for 12 months. In 2002 Ted started displaying at gift shows. In 2003 Williams-Sonoma approached him and asked for his product. Shortly later Dean & DeLuca, Nieman-Marcus, and Bloomingdale's followed. He moved into a warehouse and in four short years outgrew it, so had to buy an even bigger warehouse. Demand continued to outpace supply and by 2004 he started packing honey because he just couldn't do all the honey production and extraction himself.

In 2007 the Savannah Bee Company was honored with the Georgia Small Business of the Year Award given by the U.S. Small Business Administration. This year they won the grand prize at the Flavor of Georgia Food Product Contest. And the accolades keep mounting.

Having that charitable soul of his, the Savannah Bee Company has partnered with the Heifer International, "helping people to help themselves." They're selling Honduran honey which is part of the Heifer Beekeeping projects. It is labeled "Peace Honey" and $3 from each bottle sold is donated to Heifer.

In nine years, after risking everything, Ted has cre-

One of many production lines at the Savannah Bee Co.

Ted's honey filling operation.

ated a multi million-dollar company. If you haven't seen the products Savannah Bee Co. offers, check them out and you will understand why the company has become so successful. Ted's marketing savvy took honey to a different dimension. He removed honey from the pick-up truck tailgate, and placed it into the halls of culinary sophistication. For decades honey has languished in quart jars on the shelves of roadside stands and farmer's markets. Savannah Bee Co. discarded that image and raised honey into the ranks of that of a fine wine or cheese. From the logo to the elegance of the French style wine bottle, the presentation of Savannah Bee Company's honey sets it apart from the rest.

While in the peace corp Ted worked with 100's of beekeepers in Jamaica.

But is it the only reason this company is flourishing? Partly, but more importantly, Ted loves what he does. His passion for bees and their products, his hunger to learn more, to do better, to give back, and to create something new, all play into his success. And maybe a tad bit of luck: being at the right place at the right time? But remember, it takes a lot of sweat equity to get to that right place at the right time.

And too, he keeps looking.

See Ya! BC

Jennifer Berry is the Research Coordinator at the University of GA Bee Lab. Contact her at ***Jennifer@BeeCulture.com****.*

The DANGEROUS Side OF BEEKEEPING

Jennifer **Berry**

While in grad school, and still a very inexperienced beekeeper, our lab was investigating the effects of certain IPM strategies (hygienic queens, bottom screens and isolated apiaries) on *Varroa* mite levels. The colonies used in the study were located in the Georgia Mountains, about two hours north of the bee lab. It was July and time to test the colonies for hygienic behavior. Once the truck was packed with all the essential items, I began the trek northward. Usually, several lab folks were available to help in the data collection but, that particular day, I was flying solo.

The colonies scheduled for testing were situated on the side of a mountain, smack-dab in the middle of a cow field. I was truly heading into the backwoods of North Georgia and what a chore it was to get there. After turning off the major highway, I traveled onto one dirt road after another, traversing around a mountain, over a creek, across a cattle guard, through a field, and finally, up a hill. Plus this was in the day when cell phones were still a rarity and not the norm. I know crazy!

After several hours of negotiating the back-roads, I finally arrived at the locale. However, my sense of relief quickly faded when I saw the condition of the access road leading to the colonies. The two inches of rain which fell the night before, made the road practically impassable. Plus, the intervening yard was home to some 30 or so cows, which were all standing behind the gate looking at me. No way was this truck going up that mountain. This is a fine time to realize that I should've packed lighter!

While reorganizing for the long haul up the mountain, I kept hearing the strangest noises. One sounded like something scratching on metal while another was a weird swooshing sound. As I scanned the area around me, I could not detect the source of the sound. The cows were still to my left, staring at me (kinda creepy), and, on the other side of the road there was a field with a herd of goats. These were not your average, run of the mill, plain white goats either, but an array of all sorts. There were big ones, small ones, and even smaller ones. Some had straight horns, while others had curly horns. There were solid colored, multi-colored, short haired and long haired goats. They seemed just as curious of my presence as the cows since they too were lined along their fence just staring at me (kinda creepy). Other than the cows and goats, there was an old barn, some trees scattered about, the deserted dirt road, and the UGA state truck; I saw nothing moving. "Hello," I called out several times, but there was no response, only those noises.

Getting nervous, I hastily lit the ➪

smoker, finished stuffing my backpack, grabbed the canister of liquid nitrogen (part of the experiment) and headed for the gate. As I came around the truck, a sudden eruption of sound and movement shook me! Hundreds of turkey vultures (Ok. "Hundreds" might be a slight exaggeration.) took flight from their perch atop the old barn and tree. The bedlam made me stop dead in my tracks. A horde of turkey vultures is not what you want to see while standing on an isolated dirt road, in the middle of nowhere, all by yourself, without a cell phone. Plus these birds are huge with bright red heads and six-foot wingspans. To see that many, all together, flying by my head and looking at me was more than just creepy, it was frightening. The noises that I had heard earlier were their sharp claws scraping the tin roof of the old barn and their wings flapping to maintain balance.

I slowly turned my back on the scene of pending doom and headed for the gate. Carefully I pushed aside the cows and entered the field. The cows immediately encircled me, nudged me with their noses, and gazed relentlessly. I tried shooing them away and even yelled, "What do you want? I am not a bale of hay. Go away!!!!" But they stayed with me like white on rice.

Farther along my way to the colonies, I didn't notice the huge mud pit until I began to sink. Both feet quickly became stuck. Putting down all of my equipment and bending to wrench myself loose was not an option given my apprehension with all the annoying livestock surrounding me. Finally, I was able to pull free, but lost a shoe in the process.

By the time I had lugged my semi-shoeless self and my equipment to the apiary, I began to feel the heat and humidity of that July day. Fortunately, the colonies were behind an electric fence so at least I could escape wet bovine noses, but, unfortunately, they were in the full sun. Once behind the skinny metal wires, data needed to be collected on 24 colonies and the day was wasting away, so to beekeeping I went. The bees were not particularly happy since the nectar flow had ceased leaving the older field bees with nothing to do, except defend their hard-earned stores from intruders like myself. As the day wore on, the heat was becoming unbearable. I became more frustrated working with just one shoe. Plus, I had only brought one bottle of water, which had been quickly consumed before 10 AM. I was unwilling to entertain the idea of trekking back to the truck, through the cows, the mud, and vultures to drive the 20 miles back into town for a drink since it would cause an additional trip the next day.

Despite my best intentions, I soon noticed that I was having difficulty seeing eggs, and my eyes weren't focusing. Shortly thereafter, I could feel my heart beat starting to race and pounding in my temples. My hands were also noticeably shaking. Thinking it had to do with being hungry, I kept going. Then, it hit me. Little stars started from the periphery of my vision and moved slowly towards the center of my line of site. The next thing I knew I was on the ground and the sun was blazing down on me. Moments later when I collected my thoughts, I realized that shade had to be found. Looking around, I saw that the only shade available was a small patch at the top corner of the field. The cows, which also needed shade, had already inhabited the entire space. I didn't care. I crawled under the electric fence and across the field to join the cud-chewers lounging in a shade-covered mud pit. Luckily, they didn't care either.

Here I was, in the throes of heat exhaustion, all alone, with a bunch of cows and ominous turkey vultures, without water, cell phone or a complete set of shoes. How did it all come to this? I could just see the headlines now, "Mud-Covered Body of UGA Grad Student Found Splayed in North Georgia Cow Field . . . Full story found on page 11."

After resting for some time, I knew water was next on the list of "had to haves." So, down the hill I went, through the mud, out the gate, by the vultures, past the goats, across the field, down this dirt road, then another,

around the mountain, then another, until I found a convenience store.

Footware-challenged, covered in mud and smelling like cows, I proudly limped into the store and bought a dozen or so bottles of ice-cold water and Gatorade. Standing before the store clerk with disheveled clothes and "Don King" hair, she wouldn't even look me in the eye; she was probably afraid that I was about to freak out at any moment. After drinking several bottles, I began to rejoin the living. The lesson of the day was the next time I was to go into the field I would be better prepared, and so should you.

What may be best for the bees may not be best for us. There has been limited research on the effects of apiary location on *Varroa* mites and small hive beetles. In 2004, Dr. Rinderer compared colonies with commercial Russian stock to those colonies with Italian stock, as well as the effects of direct sun exposure and shade, on the growth of *Varroa destructor* populations, worker bee populations and honey production. He concluded that colonies in the sun had significantly fewer mites than colonies in the shade. Research conducted on Small Hive Beetles (SHBs) has shown that soil moisture plays a significant role in the success rate of beetle pupation; beetle populations are unable to reach damaging levels in more arid (i.e., sunny) locations.

However, if you have worked colonies in the full sun, during the summer months, then you understand how brutal it can be. In the perfect world, we would all have apiaries with morning sun and late afternoon shade, cool breezes, and a refreshing minty mist from the nearby crystal-clear waterfall, which keeps temperatures in the mid-seventies. Actually, several of my spots are perfect, minus the waterfall and minty-fresh breeze. The sun hits the entrances at first light, which gets the bees warmed up and raring for action. As they say, "the early bird gets the worm," or, in our case, "The early bees get the nectar." But, I have a few apiaries that are the reverse: morning shade and afternoon sun.

Working bees is hard enough, plus your health is in potential danger. Not only are you exerting yourself (i.e., back issues, muscle strain), but you are exposing yourself to two very serious conditions when working outside: heat exhaustion and heat stroke. Both occur when your body experiences hyperthermia, where the body heat rises dramatically.

Heat exhaustion is the lesser form of the two heat-related illnesses. It occurs when the temperature of the body gets too high and can't cool down properly. It can range in severity from mild to severe, can show up days after exposure or lead to the more serious, life-threatening, heat-related syndrome: heat stroke. There are numerous warning signs that heat exhaustion has a grip on you. They don't come in any particular order and may appear in different ways. You may experience heavy sweating, muscle cramps, weakness, headache, muscle spasms, nausea, and vomiting. If these symptoms are left untreated because you continue working and ignore what your body is trying to communicate, it may progress to heat stroke which is a medical emergency and is often fatal if not treated promptly and properly. So always pay attention to what your body is telling you, especially while working in high heat and humidity.

Heat stroke, also referred to as sun-stroke, occurs when the body experiences extreme hyperthermia which occurs when your temperature rises to 106°F or higher. Symptoms include those of heat exhaustion plus feeling faint, clammy, tired, dizzy, lethargic, and confused. Having a seizure may also occur.

Our bodies create heat and will dissipate it through the skin. As we sweat, air circulates over our body and, as the moisture on our skin begins to evaporate, it actually cools us down through a process called evaporative cooling. Bees even take advantage of this principle as well. During hot weather, bees regurgitate droplets of water, hold them in their mouths, position themselves throughout the hive, and fan their wings. The air passing over the water cools the interior of the hive.

Another cause of either heat stroke or exhaustion is being dehydrated. When the body runs out of water, and sweating doesn't occur, the effective dissipation of heat fails and, hence, internal temperatures rise.

There are steps that can be taken to minimize becoming ill, embarrassing yourself or worse! First, always wear loose fitting, lightweight, light colored clothes. Not only does dark clothing absorb heat, but it may also cause your bees to sting. If you wear a beesuit, then have minimal, lightweight clothing on underneath (shorts, t-shirt or bikini works well). Make sure that both the suit and your clothes are not too tight and preferably made out of a breathable fabic (ie..cotton). Sweating is actually a good thing, but, if your clothes are too tight, evaporative cooling can't occur. Drink lots and lots of water. Think in terms of gallons. It is recommended to drink a cup of water every 15 minutes while working in the heat. I'm lucky if I drink a cup every hour, which is something I need to improve. It seems as though I am always on a tight schedule, and taking a minute to drink some water or rest just doesn't occur to me.

Working in the morning hours when temperatures are cooler helps as well. If you begin to feel the slightest problem, stop what you are doing, seek out a shady spot, sit down, and drink water. Over the years I've learned to bring a cooler with plenty of ice water. When I start feeling lightheaded, I take a bandana, soak it in ice cold water and lay the cloth on the back of my neck or forehead. I feel better almost instantly.

Beekeeping is a wonderful hobby or job, but there are risks involved. As researchers and beekeepers, we focus so much energy on taking care of the bees. We put the bees in the best locations possible. We check on the bees. We feed the bees. We treat the bees for infections, infestations and disorders when necessary. But, while working the bees, we need to be concerned with taking care of ourselves as well. It's easy to get caught up in the work and forget how important that is. So, be careful out there. Dress appropriately. Drink plenty of fluids. Take breaks, take your time, and stay healthy.

See Ya! BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

PROTECT YOUR HIVES

Jennifer Berry

Over the years, I have encountered all types of beekeepers. And like people everywhere, beekeepers (for the most part) also fall into three categories. First you have the type "A" beekeeper. These are the ones who visit their colonies everyday and take temperature and humidity readings. They mix up the exact proportion of vitamins, minerals, sugars and amino acids into their pollen patties and syrup. Body measurements are taken each week to ensure the bees are getting a proper diet. There are landing lights laid out in their backyard to help guide the incoming foragers to their particular hive. Each queen, worker and drone is given a name. There are infrared sensory devices posted through out the yard to alert of any unwanted pests or people. Cameras are mounted inside the hive, outside the entrance and by the feeder to monitor all types of activities, 24 hours a day, seven days a week. They have pictures of their queen on their computer screen. Their website has images of every queen they have ever had with little gold crowns photoshopped onto each. The front door mat states, "Wipe your feet, all six of them." The back door mat that used to say "Hi I'm Mat" has since been replaced with "Got Bees." Every item of clothing has shapes representing a head, thorax, abdomen, six legs and wings either embroidered or stamped. Bumper stickers that read: "Bee Happy," "Too Bee or Not Too Bee," "Let it Bee," "Bee Kind to Your Bees," "Bees Happen," "Give Bees a Chance" (I actually have this one), "I Love my Bees," "Bees Aboard," and "I Am, Therefore Let Me Bee" litter every square inch on their bumpers. They attend beekeeping meetings and workshops every weekend. They log into chat rooms and discuss the latest about their bees. Every book ever written about *Apis mellifera* has been read and re-read. A portrait of their first colony hangs over the mantle and portraits of every colony since lines the hallway. Anytime guests arrive they are offered a large array of foods prepared with honey, and pollen.

The other type of beekeeper, the type "C," is a bit more laid back; maybe a bit too laid back when it comes to beekeeping. They figure bees have been around for millions of years so they don't have to intervene too much. And hey, they read a book, so what's the big deal, right? Dump some bees in a box and let them do all the work. So, they buy their package and plunk the bees into the hive and walk away. Then the following year they wonder out in the backyard to look for the hive they thought was over there by the Sycamore. "Hmmmmm? Well, maybe it's over here behind the shed. Nope." So after several hours of searching for the hive it is finally revealed. It is uncovered when a years worth of overgrown brush is cut away. It takes an extreme amount of effort just to open the lid. Once inside the hive all that is visible is wax moth webbing. It is so thick the frames won't budge without a fight. Frustrated, dirty and sweating, the type "C" beekeeper returns to the confines of his home turns on the computer, and googles "how to get started in pottery."

The Survivor.

Then there is the type "B" beekeeper, which most of us are. We love our bees but they don't consume our lives (except from February to July). We are saddened when we loose a colony but don't have a lengthy burial service where each bee's name is called while Amazing Grace is played live, on the bagpipes. We attend meetings, try to keep up on the latest information regarding the fate of our bees, and are so pleased when our bees make it through yet another year. Some days we may even find ourselves taking a moment while going through a colony and just watching, in wonder, the activities of the hive. We do procrastinate sometimes and know we should check our colonies sooner than later, but our personal life seems to interfere more often than not. But when the day comes and we extract that first super of honey and our bees are thriving we're so proud to be a beekeeper.

Being a beekeeper in the 21st century has its challenges and it seems new ones are popping up on the horizon each week. With all the issues facing beekeepers today (mites, viruses, CCD, viruses, mites, CCD, and all things that come with mites (viruses) and CCD) protecting your hives from thieves or vandals is not that frequently thought about. I mean, who would want to steal or bother honey bee colonies? But it may be something you want to think about, especially since bees are gaining more and more attention. Honestly, I never thought about it myself until last Fall.

We have numerous experimental apiaries scattered over three counties. Several of our sites are located on University property but others are on private property. One of our sites is located at the Full Moon organic farm. It is a great place for bees and I never once thought twice about hav-

A Casualty.

ing them there. This particular farm is located on the outskirts of Athens. The surrounding area is a hodge-podge of small farms, larger home tracks and smaller neighborhoods. Our bees were located at the back of the farm along an edge of a small forest. During the day the bees were in full view of the farm crew, but once the crew left for the evening the bees were on their own. The farm house was a good half mile away from where the bees were located.

Last year I received a call from the farm's owner explaining that there had been a fire at our apiary site and we may want to come by and have a look. When we arrived, three of the four colonies were gone. Incinerated. Burned to the ground. Nothing left but a pile of ash, wood chips, a few nails and bits of wire from the foundation. It was heart breaking to see. However, there was a sole survivor and it was amazing that it survived. The bottom board had been completely burned away. The interior sides of the brood box and honey supers were scorched. The bottom bars of the brood frames were burned away and the wax from the bottom half of the frames had melted. Flames had actually seared the interior of the hive, but the bees and queen were still alive. Actually, the hive was thriving. But they were pissed off. As a matter of fact it was one of the few times I have had to walk away from a colony. They were not happy and getting madder by the second.

The fire had not only engulfed three of our hives but also about half an acre of the surrounding forest. It was amazing though that the entire east side of Athens Clarke County didn't burn up and blow away that day. We hadn't had rain in weeks and were facing the worst drought in decades. The forest floor was like kindling. But the forest remained along with that single colony.

After the bees had finally settled down we examined the surrounding area and found a lighter, a crumpled pack of Camels and a honey super about 30 yards from where the colonies were located. The super had been slightly burned and obviously tossed aside. All ten frames were scattered about but the honey was still capped and intact. So, Dan Harris and I concocted the sequence of events that occurred the day they burned ole Dixie down.

A couple of punks with nothing better to do were walking through the woods late one day and came upon some white boxes. One kid recognized the boxes and said they were honey bee colonies. "Honey bees, man we better get out of here" said one kid. "Nah, I say we get us some honey" said the other. The third didn't offer any opinion as he took another drag off his cigarette and tossed his empty pack on the ground. So they walked over to the colonies and slowly took off the lid. Immediately several bees came out and greeted these unwanted guests. As they retreated, ball caps and arms were being flung about swatting away the bees that bombard their heads and torsos. Several hundred feet from the colony they finally stopped. No major damage, just a few stings but some severely wounded egos due to the fact that they all screamed like girls as they high-tailed it from the colony. After the embarrassment wore off and they caught their breath the anger set in and they wanted revenge. Finally the silent kid spoke. He said he had heard that smoke would cause bees to abandon their hive. "Let's light a fire and smoke the little &*$$#@ out" he said. They talked about walking back and retrieving a can of gasoline but decided that was too far and they didn't really feel like walking the distance. Then the silent one spoke again. "We will come from behind, through the forest. We will silently, but quickly make a pile of dry leaves and set it on fire. There is plenty of dry stuff around, so it should light up pretty quick. Once the bees have left we will take what we want." So they did just that. They lit the pile and within minutes the fire had engulfed the forest floor, hives and nearby trees. A wave of uneasiness ran through each kid but it quickly turned into excitement as they watched the fire growing in intensity. When all four hives were completely engulfed they rushed in. They kicked over one of the colonies to break free the honey super. Instantly the bees attacked. The silent one grabbed the super and they all took off running, his yellow Bic lighter falling out of his pocket. Hot on their tails were a few thousand very upset bees. About 30 yards from the colonies the one kid finally dropped the super to swat at the numerous bees stinging his face, neck, arms, back and legs. The others, also covered with bees, were frantically running in circles bumping into one another. After a few minutes they all bee lined it for home and once again the high pitched sounds of girl-screams were heard for miles around.

Stolen and abandoned booty.

Protecting colonies from this kind of senseless destruction is hard. Unless we are watching our colonies 24-7 they can't be 100% protected. But there are a few measures we can do. First it's a good idea to have colonies in sight of your house but out of sight from your neighbors or at least the street. Of course high tech sensory devices can be used, but most of us aren't into the James Bond gadgets and gizmos. If you have colonies off site and in remote areas a solar powered electrical fence may not only ward off the bears but may also deter criminal activity. Stealing colonies is also an issue. There's a GPS hive locator now on the market that will alert you by calling your cell phone if your colonies are moved or disturbed. This is a great idea, especially if you have a lot invested in your colonies. You should also brand your equipment and hive bodies. It's not a full proof measure but someone, somewhere may recognize your brand and call the police. I've always thought one of the best ways to deter

anyone from messing with my bees is to put up signs that read, in big red letters, “Africanized Honey Bee Quarantined Area. DO NOT ENTER” and then under that, in smaller black print, “Venom is extremely potent and deadly. Unfortunately, the sting kit is temporarily unavailable. If stung begin praying immediately”.

To end, it’s June and in central Georgia our nectar flow has ceased. Yet there’s still plenty of nectar available to our north and south. If sourwood is your thing you better be moving colonies to your north Georgia Mountain sites sooner than later. We’re keeping our fingers crossed hoping that this year will be a good one even though the soils are still pitifully dry. There’s also nectar to be found to our south from a variety of cultivated crops. Wherever you or your bees may be, hopefully it’s been a good year.

See Ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

Swarms!

Jennifer Berry

Keeping colonies from swarming is like forcing a dog to not like bacon, a cat to ignore tuna or a fish to breath out of water.

It's April in Georgia (even though you're reading this in June) and it's definitely one for the record books. If you experienced it, then you know what I am talking about. It was a magnificent time to be a southerner (that is, of course, if you're allergy free). The dogwoods, Bradford pears, azaleas, redbuds, yellowbells, peaches and a host of other blooming plants have never been more spectacular.

While those of you in the Northeast experienced warmer than average temperatures this past Winter, the south experienced a cooler, wetter one. The sun did not shine for weeks. Complaints started mounting and phrases like "all this rain" and "will it ever warm up" were part of most conversations. We Georgians quickly forgot about the years of drought this state had recently suffered.

Due to the cold, early blooming plants were delayed several weeks. Then temperatures shifted overnight from Winter to Summer averages. The first two weeks of April saw June like temperatures in the 80s and 90s (10 to 20 degrees above average). And it stopped raining.

Because of the sunny, hot days, early bloomers were bursting alongside the later varieties; hence everything bloomed at once. Usually we experience cycles of bloom that are spread out over months. But not this year. One day the landscape was brown and drizzly, then the next, color was leaping out everywhere. The bees were just as frantic as the plants and their populations exploded overnight. They had spent too many days crammed inside. So when the sun broke out so did the bees.

With all the bloom came daily, record breaking amounts of pollen and an early nectar flow that most beekeepers are still talking about. However, our world quickly took on a yellowish hue. Pollen found its way onto every surface, inside and out. Each morning before going to work folks had to run their wipers in order to dislodge all the pollen. Tops of hives, cars, driveways, sidewalks, roofs, birdbaths, decks, porches, leaves, grass, dressers, carpets, tables, cats, blankets, and computers were all yellow in color. In the morning pulling out of the driveway the tires would leave tracks. Plus, as one walked through the fields, explosions of pollen bombs would cover your boats and legs.

I felt for those with allergies. People walking around in a daze because they were so tanked up on anti-histamines: eyes red and puffy, swollen nose, looking absolutely miserable. Balls of crumpled Kleenex in their hand, sticking out of their pockets or scattered about on the floor. The nasally voice that keeps apologizing for sneezing for the 100th time.

With the tremendous onslaught of bloom something else kicked in as well. Swarms, swarms and more swarms. By the last week of March, first week of April, swarms were hitting the trees faster than we could count. One day while making splits, five out of the 32 colonies swarmed. The first coated a three-foot section of a branch, which was impossible to harvest. They quickly figured it was time to find a new place to hang out and away they went. The next three flew straight up from the hive into the trees lining the apiary. A bucket truck may have worked well toward retrieving them, maybe. But the final swarm was perfect. They landed at the end of a low hanging branch. The weight of the swarm brought them even closer to snatching height. They were shook into a nuc box and taken to a new site a few miles away.

Keeping colonies from swarming is like forcing a dog

to not like bacon, a cat to ignore tuna or a fish to breathe out of water. It's an integral part of the colony's nature: reproduction. And once they're in "swarm mode," I don't think there is anything you can do to prevent it. Over the years I have tried all sorts of different methods and have found one that works to some degree: creating an artificial swarm by splitting the colony. In the early Spring months, just prior to swarming (construction of queen cups), the old queen and several frames of bees and brood are placed into a nuc box and then transported to a different apiary. The remaining parent colony is given a queen cell, frames of foundation and a super if needed. The colony in the nuc box is still susceptible to swarming so they are given plenty of space by placing them into a 10-frame box and adding a super. Depending on the quality of the old queen, she may be replaced as well.

But, if you tried this or some other method and your colony still swarmed, not all is lost (that is of course if you can locate the swarm and it's within reach). In any case, I always keep a few five-frame nuc boxes in the back of the truck with four frames of foundation and one frame drawn comb. If a swarm comes available and it is accessible, take out three of the frames, bring the nuc box (entrance screened) as close to the swarm as feasibly possible, spritz the bees lightly with sugar water, and then shake, bounce, dump, brush, or jiggle the bees into the box closing the lid. If some of the bees don't make it into the box and they begin to re-form another cluster, more than likely you did not get the queen. Wait a few minutes for the cluster to form, then again bounce the bees into the same box. Close the lid and transport them to a different location. Once there, replace the two frames and feed them sugar syrup and a pollen patty. It will take the foragers a few days to locate nectar and pollen in the new area so it is a good idea to feed them.

If the bees are hanging on a smaller branch, cutting the branch just above the cluster and laying the swarm into the box works nicely as well. But swarms come in all different shapes and sizes and land in all different sorts of locations, positions and areas.

Now, what do we do with the old queen in the newly caught swarm? I like to keep queens longer than a year or two but my motivation may be different than yours. You may want to re-queen the new swarm.

So how do you know your colony has swarmed? Evidence that your colony has swarmed is a dramatic decrease in bees, no queen, numerous capped or nearly capped queen cells, little to no eggs, lots of capped brood, a disproportionate amount of drones to workers and cells in the brood area (which recently housed brood) are now being filled with nectar/pollen (if a flow is on).

But probably the best indication that your colony has swarmed is actually seeing the colony swarm. Suddenly thousands of bees erupt out of the entrance, pouring into the air, haphazardly taking flight. A cloud of bees encircles the area around the hive and a loud buzzing sound fills the air. Once the queen lands and she is located, the cloud migrates towards her and begins to form a cluster. Within minutes the cluster grows until all the bees have landed. It is an amazing thing to watch. If they are within reach grab a box quickly and retrieve them. It is not uncommon for a swarm to fly away to a different location.

While writing this article two colonies in our breeder yard swarmed. However, just two weeks prior they had already swarmed. These secondary swarms are called afterswarms and they are not uncommon. Depending on population, a single colony can issue four, maybe more afterswarms and each time they do, there goes another huge portion of your bee population (and honey production). Supposedly, the number of afterswarms is directly correlated to the amount of sealed brood. Just to let you know we were able to hive both of the afterswarms and one original swarm with our modified UGA bee lab bucket truck. The picture best describes how we save tax dollars around here.

Now what to do with the colony that was left behind? If you want, let the colony raise a queen. However, there is no guarantee you will have a laying queen at the end of the day. Plus, you are looking at weeks before she will begin to lay eggs and you run the risk of numerous afterswarms if cells are left behind.

Colonies **usually** swarm the day of or the day after the first queen cell is capped. Therefore, you have on average eight or nine days before the first virgin queen emerges. Then it takes her five to six days to become sexually mature. Next there are orientation flights, mating flights, a "resting period" and then finally she begins to lay eggs.

Before I could finish this article we had two more swarms. Maybe I should follow some of my own advice and get to beekeeping.

So the earliest your queen could be producing eggs is in 10 days, but it usually closer to 14 days. So 22-23 days after you colony has swarmed you now (maybe) have a laying queen. That is, of course, if she was able to find ample drones to mate with, navigate her way home, recognize her hive, not get eaten by a bird or a giant praying mantis, or hit by a plane, train or automobile.

Then you have another 21 days before the first worker bees emerge, and then another 25 days (mean age) before they take their first foraging trip. Adding the numbers, that's 69 days (on average) from the time your colony swarmed until you have a new flush of workers foraging. Now granted, there were numerous frames of capped and uncapped brood left behind but there is still a gap in brood production.

Here are some suggestions for the colony left behind. After the colony has swarmed, immediately cut out all the queen cells. Once virgin queens have hatched it is very difficult to a) find them and b) know for sure how many are running around in the colony. If there are numerous open queen cells I'd let nature take over because you really don't know how many virgin queens may have emerged and survived. Inserting a caged, mated queen into this scenario is a sure death sentence (for the mated queen). But if you catch them in time, cut out all the cells and insert a mated queen the next day or so. Then you're ahead of the game by several weeks. But a word of caution. Before you cut all the cells, make sure you can receive a mated queen within a reasonable amount of time.

Next remove a few frames of capped brood if the colony is well populated. Give the brood to a colony in need, such as a newly purchased nuc, a captured swarm or make a split. Reducing the amount of brood may help deter them from future afterswarms as well.

But if you do decide to let them raise their own queen this may help reduce the occurrence and number of afterswarms. Find two mature, nicely formed capped cells and leave them alone. Cut out all remaining queen cells capped or uncapped. These are the next generation of queens that could take part in afterswarms.

Before I could finish this article we had two more swarms. Maybe I should follow some of my own advice and get to beekeeping. Enjoy the Summer.

See ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab. Contact her at ***Jennifer@BeeCulture.com****.*

The Dog Days Of Summer

Jennifer Berry

The dog days of Summer are here. Hot temperatures not only drive us to our porches, but the bees to theirs as well.

This time of year usually calls for mint juleps and blackberry pie, cane pole fishing and lemonade, naps in the hammock and BBQ, but for the beekeeper, chores are still mounting. Here in the piedmont region of Georgia our honey flow ceased at the end of May. Now, we can only hope for a trickle of goldenrod and aster this Fall, unless we moved our bees north for the sourwood flow (June-July), or south for Gallberry (May-June), cotton and a variety of other agricultural crops. Usually we can count on these plants for providing decent flows, but with the horrible drought we are experiencing, only time will tell.

Hot Summer days along with dry weather are not only tough on the vegetation, they can also be especially hard on our colonies. One thing you can do to help reduce stress is provide your colonies with water, especially if the colony is not near a natural water source. Bees collect water to dilute honey. They also use water to cool the interior of the hive. One way they do this is by depositing water directly inside of the cells toward the top of the frames or cells with developing larvae. If humidity levels fall too low, developing larvae will dry out and die. They also cool the inside by fanning in different areas of the hive. This activity keeps the air circulated and temperatures lowered. While fanning, they'll extend their proboscis with a droplet of water. The surrounding air is then cooled due to the evaporation of the water. On a Summer afternoon, check out the entrances of your colonies and you will see several bees positioned there fanning their wings as hard as they can.

If there are no natural water sources located within a mile of your apiary keep birdbaths, pans or buckets full of water at all times. Make sure to add some sort of floating device so the bees won't drown. Another idea is to use a Boardman entrance feeder filled with water. This way the bees don't have to travel far for the water. It will also help keep your bees at home as opposed to visiting your neighbor's pool, dog bowl, pond, etc. We receive several calls each Summer complaining about bees swarming around water sources and scaring the children. After a little investigation we usually locate a beekeeper in the area and explain the crisis. Once water is provided, the problem's solved and everyone – bees and children alike – are happy.

Water may not be the only thing your colonies require this Summer. You will need to evaluate honey supplies and *Varroa* population levels plus prevent robbing. Let's start with food stores. I realize I may push this issue a bit; however starvation is something we can control. During the sweltering Summer months we sometimes forget about our colonies as other projects draw us away, but don't let this be the case. If Spring/Summer honey flows were light to medium and you don't expect another substantial flow this year or you were a wee bit greedy during honey extraction, your colonies may be in danger of starving well before the Winter winds ever blow. But no matter what

Bearding colonies during hot Summer days.

A Boardman feeder used for water.

Our baggie feeder works like a charm.

your situation is, periodically checking food supplies should always be on your list. If colonies are short on supplies, feed a 1:1 sugar solution. An average colony in our region needs at least 35-40 lbs to survive the Winter but you must also consider those long Summer dearths. In certain parts of the country you may only experience one nectar flow, like here in Athens, yet colonies are still growing and therefore consuming stores. Feeding bees can be a chore and an expense you may not have considered. Here at the lab we use gallon zip-lock baggies filled about ½ way. We then lay the baggie on top of the upper super, slice a four-inch slit on the top, add a super, and ring the dinner bell. The air leaks out of the slit leaving the sugar syrup for the taking. The bees will crawl to the slit and collect the syrup. Over the years I have had numerous problems with division board feeders, hive top feeders and buckets, so we've opted for this method.

Another problem beekeepers overlook this time of year is robbing. Strong colonies will rob honey supplies from weaker colonies even if they have plenty of food. If you have ever experienced robbing before, you know it is not a pretty sight. Colonies are wiped out within a day or two. They just can't hold back the tens of thousands of bees forcing their way inside. But the major problem is, once robbing starts in an apiary it is almost impossible to stop. Therefore, precautionary measures should be taken earlier rather than later. Colonies should be equalized throughout an apiary. Weaker colonies are vulnerable to robbing and hence should be removed or equalized. Entrances should be reduced and all gaps, cracks, and holes taped to discourage foreign bees from entering a colony. Too many colonies at a particular site may also increase the robbing urge. 25-30 colonies are usually the maximum for a single apiary. Another important tip, if you find yourself feeding, be extremely careful not to drip sugar syrup anywhere outside a hive. Bees will quickly find it, and then mob the colony near the spill. Also, Boardman entrance feeders are not a good idea during a nectar dearth. They attract unwanted neighbors to the entrance due to the smell of sugar syrup. Feed internally with buckets, jars, division board feeders or baggies. After extraction, don't put wet supers out to be robbed in or near the apiary. Place them as far away as possible. Once the robbing frenzy is started it is impossible to stop. The bees become fixated on finding food and will strike any colony in their path. In years past we experienced robbing to such a degree we had to work each colony under large netted cages. Without the cage the colony would have been overwhelmed in minutes. Even strong colonies are at risk if you leave them open too long. The best advice to discourage robbing is: don't pack in the colonies, keep entrances reduced, don't leave honey/sugar syrup around, use inner hive feeders, and don't leave hives open too long.

Only one more Summer chore left for now; evaluating *Varroa* mite levels. Female mites over Winter inside the cluster and survive by feeding on adult bees. However, once brood rearing commences in late Winter, early Spring, the female mite kicks into gear. It is her time to reproduce. She makes her move by entering a cell just prior to being capped and starts laying eggs; she is called the foundress mite. The first egg laid is a male which will mate with those from subsequent eggs laid, which are female. These offspring mites develop and emerge from the cell along side the worker bee. These newly emerged female mites seek out other cells in order to lay eggs of their own. Warmer temperatures, and nectar flows not only trigger swarming but drone production as well. There is nothing more appealing to a female mite than drone brood. Think of all the extra time her progeny has to complete development before the drone emerges: three extra days. That translates into a lot of extrababy mites. If the drone or worker bee emerges before the newly hatched mites reach adulthood, the mite will die. Here are some numbers you may find interesting. In worker brood, the foundress mite's first female egg (first egg is a male) has a 92% chance of reaching adulthood before the worker bee emerges. Her second female egg only has only a 38% chance of survival and her third only 13% chance. However, in drone brood, her first female egg has a 98% chance of survival, second egg a 94%, third egg an 84%, fourth egg a 76% and fifth egg a 63% chance of survival. Oh, what a difference three days can make. Hence, the foundress mite can more than likely replicate herself *by five* inside drone brood and *only once* in worker brood. Therefore, by late Spring mite populations are quickly escalating. By mid Summer, mite populations can be well into the damaging levels or above the economic threshold. That is why it is essential for beekeepers to appraise their colonies mite populations several times a year. We sometimes evaluate mite numbers once a month. Especially those colonies close to the economic threshold level.

There are several methods for sampling mites: ether roll, powdered sugar roll, alcohol samples or sticky

sheets. We choose sticky sheets because it's the easiest. Insert sticky sheets (you can make these or purchase them) for 72 hours, count the number of mites and then divide that number by three.

Leaving the sheets in for 72 hours as opposed to 24 is a preferable method because it allows for weather fluctuations which may occur and alter mite drop. Do not put any miticides on while you are sampling. This number needs to represent a natural mite drop. If you find populations above the economic threshold (60-180 mites for 24 hours in August and 1-12 mites in February) you will need to treat. This particular economic threshold was determined for the southeastern US. The economic threshold in your area may be lower or higher due to regional climate/geographical variations. James Strange and Steve Sheppard determined a western economic threshold of 12 mites in February and 23 mites in August. You can also go to the National Bee Unit's internet site and enter your mite numbers in their *Varroa* calculator http://beebase.csl.gov.uk/public/BeeDiseases/varroaCalculator.cfm. Due to time of year and the number of mites the program will determine if you need to treat. Be aware, their threshold levels are much more conservative than ours.

Then the question remains; what to use in order to reduce mite populations? There are more options today than there used to be (which may be a good thing). The newest being essential oils which are proving well for reducing mite loads. Remember, all creatures big and small can tolerate a certain amount of infection or infestation, including honey bees. It's when that amount reaches a critical level that we need to intervene. One more thing, never put any kind of miticide in your colony during a nectar flow. Don't want to contaminate the honey now do we.

See ya! BC

Evaluating mite populations several times a season, using sticky boards, is critical for colony survival.

Jennifer Berry is a Research Associate at the University of Georgia at Athens.

Just Starting Out?

GET TO A MEETING!

The Best Way There Is To Learn About Bees And Beekeeping!

With the recent flood of media attention focusing on honey bees and the problems they face, people from all ages, backgrounds and locations are becoming interested in beekeeping. This is fantastic and I hope the momentum continues. Just think, every person becoming a new beekeeper is one less person who knows nothing about bees and one more person hopefully informing others about the importance of bees and other pollinators.

This past year I have had more requests for the Georgia Bee Letter than ever before. Daily phone calls and e-mails requesting information about how to become a beekeeper keep coming in at a steady pace. Bee supply companies have been bombarded with new customers and have literally run out of items and are scrambling to fill orders. Steve Forrest (Brushy Mountain), Fred Rossman (Rossman Apiaries) and Jerry Latner (Dadant) have all informed me that business is the best they have ever seen. They are extremely excited so many new people are becoming fascinated with beekeeping and they too hope the trend continues. However, I can hear it in their voices; they're exhausted. They have been working from sunup to sundown, seven days a week and see no end in sight. No one could have anticipated the swarm of new people wanting to start up colonies. And hence, no one could have anticipated the amount of equipment needed to do just that.

Since there are so many new beekeepers in our ranks I would like to offer some advice; join a beekeeping association, attend regular meetings, acquire a mentor, subscribe to a beekeeping journal, get hands on experience by working with an experienced beekeeper, do your homework, find out as much information as you can and keep informed. Not too much to ask.

Attending local, state or national meetings may be one of the best things you can do as a beekeeper, especially if you are a beginner. Only reading a book (even though there are some exceptional books out there) isn't going to cut it. Trust me. I hate the cliché but here it is; "Bees don't read books." Even experienced beekeepers are perplexed from time to time because their bees aren't doing what they should be. "Doggone it! They never did that before." Well that's Mother Nature and she has a way of changing "our" rules from time to time.

Plopping a colony in your backyard and walking away is a thing of the past. Much has changed even in the past few years. Beekeeping in the 21st century is challenging. You need all the tools at hand in order to keep your bees healthy and alive. Remember these are your pets and they need your attention, especially now. Books and articles will help with the fundamentals, the big picture or the outline so to say. They will also help to familiarize yourself with beekeeping terminology: supers, uncapping tanks, EFB, hive bodies, queenline jars, excluders, hair rollers, shallows, *Varroa* mites, Duragilt, mediums, AFB, queen cells, inner cover, tracheal mites, crimp wire, Sacbrood, uncapping scratcher, queen cups, deeps, hive tool, small hive beetles, brood, telescoping cover, entrance feeder, nucs, foundation, grafting tool, grafting cups, extractors (radial verses tangential), settling tanks, and honey gates. However, it is the experience working a colony that will help you fill in the details. It will bring the picture to life. Unfortunately, it may take years to fully understand the world inside a colony but it sure will be fun getting there.

So why attend meetings? Bottom line, to learn from other beekeepers more experienced than you, to find a mentor, to keep up on the newest information and to hang with people interested in something you like, bees. Experienced beekeepers can be better than any book. They have the hands on knowledge, so listen, watch and learn. Plus they can tell you about the mistakes they've made in the past in order for you to avoid them in the future.

A book explains how to do a particular task but it can't prepare you for the actual event of doing it. However, working with a mentor in the field will help you build the confidence you need to work a colony. Opening a hive full of bees can be intimidating the first time so it is important to work with someone who knows what they are doing. They can also show you the finessé required when working a colony. How to pull frames, look for the queen, examine brood, mash hive beetles with your hive tool, pull supers, and so on. Whenever, wherever, ask questions because believe me you will have thousands of them. Meetings are also a great source of information

about the latest problems plaguing our industry, and the best ways to solve them. They may not pertain to you personally but it is information you should be aware of.

Another reason to attend meetings is networking. Meeting and then knowing beekeepers in your area can be a life saver at times. You may need something that the queen, package or equipment suppliers can't get to you in time. You also share the same environmental conditions along with the same pollen and nectar flows. It gives you someone to bounce ideas off of, someone to borrow a super from or a frame of brood. It also helps to know that other beekeepers may be experiencing the same problems you are. Hence, you are not alone. "Your colony is queenless too? So is mine!"

But probably the best thing? You're hanging out with a bunch of people who understand what the heck you are talking about. Ever try to explain a simple beekeeping chore to someone who is not a beekeeper: "Yesterday, I went through a potentially queenless colony and took a frame out of the brood chamber to see if there where any eggs. It had been several weeks since I saw an open queen cell so I assumed a virgin had emerged. And sure enough there was milk-brood from wall to wall. She's of Italian decent but she sure has some Russian blood in her." Deer in the headlights: Blink. Blink.

When I first began my job at the bee lab, Dr. Delaplane insisted that I speak at local and state meetings. I agreed, thinking there were maybe two in the state. Come to find out (and to my amazement) there were 15 county groups in the state of Georgia plus one state organization. If you go to the Georgia Beekeepers Association website (www.gabeekeeping.com) there is information about each club, meeting time and place – along with contact information.

Not only are local, state and national meetings important but beekeeping institutes, classes and workshops as well. In May we concluded our 17th annual Young Harris beekeeping institute. It was one of the largest institutes to date with over 150 people in attendance. National speakers like Jerry Hayes (Chief of Apiary Inspections with the Florida Department of Agriculture), Ross Conrad (Author of *Natural Beekeeping: Organic Approaches for Modern Beekeeping*) and Kim Flottum (editor of *Bee Culture* magazine and author of *The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden*) helped bring in the crowds. Regional speakers included Cindy Bee, Bill Owens, Jim Quick, Shane Gebaeur, Bob Binnie, Will Montgomery, Lonnie Funderburg, Dr. Paul Arnold, Robert Brewer, Dr. Keith Delaplane, and myself.

Jerry's topics ranged from CCD to Africanized bees to advances in disease and pest control. Ross enlightened us about the natural approaches for disease and pest control. Kim presented information on how to get started, who's who in beekeeping, and using nucs. The other speakers rounded out the program to make it one of our best yet. Now if you are new to beekeeping, you may not know all these names yet, but give it time and you will recognize most of them – especially if you live in the south.

Another thing that makes beekeeping meetings special is you can ask the speakers questions. I have met very few people in this business that can not be approached. Most are eager to answer your questions.

The UGA Beekeeping Institute like others across the states is a two day event. Participants are engaged in morning lectures and hands on workshops in the afternoons. The goal of our institute is to provide basic information for the beginner and more current topics or concerns for the experienced beekeeper. The institute also has a master beekeeping program and Welsh honey judging certificate program. If you have either of these in your state, I would recommend you participate if for nothing more than for your own personal satisfaction.

Our institute also offers a master beekeeper program which starts off with the certified level, and then moves to journeyman, master and finally master craftsman. By the time you get to master craftsman you are required to not only pass an oral exam, but to participate in a university research project, complete 15 units of public service, present a program at a state meeting and the bee institute, demonstrate practical

Here is a list of beekeeping associations in the southeast and some upcoming meetings.

State	Web address	Upcoming meetings
Georgia	gabeekeepers.com	Sept. 26th & 27th
Alabama	alabamabeekeepers.com	Oct 10th & 11th
SC	cstatebeekeepers.org	July 17th -19th
NC	ncbeekeepers.org	July 10th - 12th
Tennessee	tnbeekeepers.org	Oct 17th &18th
Florida	floridabeekeepers.org	
Heartland Apicultural Society (HAS)	heartlandbees.com	July 10th – 12th West Virginia
Eastern Apicultural Society (EAS)	easternapiculture.org	August 4th – 8th Kentucky

experience in seven specialties and either publish an article or be interviewed on radio or TV concerning honey bees. It is quite the accomplishment. Actually they all are.

So far our institute has graduated over 100 certified, 16 journeymen, 12 masters and one master craftsman. Bill Owens still solely holds the title of Master Craftsman for the state of Georgia. Several states also have bee schools that offer a master beekeeping program along with classes and workshops for beginners and experienced alike. Check out your state association website for information about upcoming classes and meetings.

Over the years I have attended meetings all over the U.S. and I have to say there hasn't been a bad group yet. Not even the association that forgot to pick me up at the airport. The people you meet are from all walks of life, down to earth, friendly and eager to help new beekeepers. Get involved sooner than later. You'll be glad you did.

It's July in Georgia which means only one thing, its hot! The sourwood flow should be reaching its peak so I hope your colonies are already in place. Since I am writing this article in May, I can't comment about how good or bad the sourwood flow is at this point. However, future projections are for an outstanding sourwood flow.

So far in Georgia our Spring flow has been exceptional in most places from North to South, East to West. But I have heard from a few beekeepers that they barely made a super of honey. Location, location, location! Here at the lab we made a good bit of honey. If only we could have kept our honey producers from hitting the trees we would have made a bumper crop. It was an unusual year for excessive swarms. Not only did 90% of my colonies swarm but they did so by the end of March first week of April. I am hearing other reports of swarming being higher than usual.

Now if you have missed the sourwood flow, there is still nectar to be had down south. Cotton should be blooming soon and the good thing about cotton is that it's usually irrigated. So drought or no drought it will be supplying the nectar and pollen for your colonies.

Hope your bees didn't hit the trees like mine.

See Ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

Is Natural Really Natural?

Jennifer **Berry**

When the most recent and well-publicized phenomenon of honey bee disappearance, termed Colony Collapse Disorder (CCD), began, it gave rise to serious concerns not only among those in the commercial beekeeping industry, but also among environmentalists, academics, and even the mainstream media and general public, as well.

Bees were dying at alarming rates. Large commercial beekeeping operations, having sustained crippling losses, were on the brink of bankruptcy. And, thousands of acres of pollinator-dependant crops were in jeopardy. Theories and rumors quickly arose as to why colonies were dying. In response, researchers raced across affected areas to collect samples and begin their investigations. The initial, knee jerk blame claims, ranging from cellular emissions and high-voltage power lines to UFOs and the wrath of God, began to fill the airwaves. However, cooler heads prevailed and the Coordinated Agricultural Project (CAP) was started to actually examine the facts; just the facts ma'am. The project attracted 17 institutions from across the U.S. to study why bees were dying, and, hopefully, to find a cure. For four years, nutrition, disease, mites, environmental toxins, miticides, habitat loss, along with other potential culprits have been investigated. The conclusion; there is no single "smoking gun," but that the causation of the syndrome seems to be a combination of stresses on the bees, chiefly from varroa mites and chemicals (in the hive and environment). Many of us sensed this all along. But, because of the project, we now have a much better understanding of honey bees and the effects of these stresses than we did back in 2007. This is a good thing!

However, this article is not about the outcome of the CAP research, but, instead, it is about a silver lining, or positive twist, so to say, that has spun off from the CCD disaster.

As bees were dying, the media jumped and jumped hard. News vans rolled into apiaries. Reporters and camera folk scrambled in search of beekeepers to interview. Jackets and ties were donned, shirts tucked in, lipstick and makeup applied, sound checked, cameras rolled, lenses focused, and mics turned on: "In, 3, 2, 1..."

> "Hello this is Melinda Jo Johnson standing in a field that used to have 100s of healthy, honey bee colonies. But, that's not the case today. Instead, the boxes you see behind me [camera pans] – are empty. Why are they empty, you ask? Well, for some unknown reason, all the bees have left or died. What does this mean for us? Could the bees be the proverbial 'canaries in the coal mine'? Is this a sign – some manifestation of global warming? And, without bees to pollinate the fruits and vegetables that we eat, will mankind starve? These, along with many other questions, may never be fully answered, but beekeepers and researchers alike are struggling to find out what is happening to the bees. Let's just hope it's not too late. Back to you, John, in the studio." And . . ., fade to black.

News reporters from the big guys (Fox, CNN, ABC, NBC, CBS) to the neighborhood stations were all racing to do a story. The newspaper and magazine giants were involved as well. Movies and shorts were filmed, and books were written. Even the local journalism majors in high schools and colleges were writing about CCD. And, with this blitz of media attention, the plight of honey bees reached a huge audience of non-beekeepers. This is the positive twist mentioned earlier; the CCD frenzy facilitated mass public awareness of the importance of bees and pollination. YES!!!

Then a second wave crashed in as individuals from all backgrounds wanted to become beekeepers. Interested folks started reading books on honey bees, joining beekeeping clubs and associations, buying equipment, and taking bee classes across the country. A few wanted to help to save the bees. Others sought a hobby for their kids. Some wanted to ensure the pollination of their farm, orchard or garden while others just wanted bees for the fun of seeing them flying to and from their porch, deck, rooftop or backyard. And, the trend still continues today.

Now, let's turn back to CCD. When symptoms first appeared, it resembled classic, in-field pesticide poisoning. Remember, there were no adult "forager" bees present. There were only brood, a queen and young bees. Plus, secondary scavengers or robbers were not present. As mentioned, pesticides were certainly a part of the problem, but it is much more complicated than that. Yet, at least early on, pesticides received the brunt of the blame. In response, a purist, "all natural" movement arose. Beekeepers, especially new ones, began to stay completely away from any chemical use. This new level of public awareness led to an upsurge of new beekeepers, who in turn, fueled the natural beekeeping movement. Maybe a stretch but seems like a logical stream of events to me.

However, the concept of "natural" beekeeping is not new. Many beekeepers have been claiming their naturalness for decades now. Yet, it has, irrefutably, gained much more attention recently. This is a good thing. Beekeeping should be more natural because beekeeping is so natural to begin with . . . Or, is it?

Whether it's triangular, rectan-

Whether triangular, rectangular, circular or hexagonal, we keep bees in a box. Is that natural?

If anyone tells you NOT to feed your bees, walk away.

gular, circular, or hexagonal, we keep bees in a box. Is that natural? Then, we put that bee box or boxes where we want them, next to our garden, gazebo or lining an open field. On average, feral hives tend to be a good distance apart, yet we (beekeepers) line them up, sometimes even side-by-side, for convenience. Natural? Next, during the Spring months, we take swarm prevention measures (cutting queen cells, rotating hive boxes, and adding more space) because we don't want to loose our foraging force. How natural is that? What about the idea of harvesting honey, pollen or propolis? Taking something away from the bees for which they have worked so very hard doesn't seem very natural. Then we re-queen to address issues of defensiveness, poor colony strength, hygiene against pests, low honey production, or simply because she's a year old or the wrong color. Does this sound natural? What about even lifting the lid and inspecting the colony? How natural would it be for the wall of a tree cavity to pop off and magic forest hands to reach in and rearrange "the furniture" in a feral hive?

In the end, keeping bees isn't very natural, is it? So, where do we draw the line between using bees as factors of production and treating them as fellow creatures of this planet? What really defines natural beekeeping? How about we do the best we can to keep our bees healthy and alive for their own sake as well as for the benefits to humans from their amazing abilities. Ok, the definition probably needs a little more work, but, it's a start.

Drawing haphazardly from numerous sources, let's consider these general parameters for a natural beekeeping objective: minimal intervention, no toxic chemicals applied to the bees, their hives or apiary, and, finally, taking only what the bees can afford to give without directly putting their quality of life and survival at risk. I'm sure there are hundreds of other additional ideas we could also consider, but let's begin with these.

Not only has there been an explosion of new, natural beekeepers, but there is also more natural beekeeping information available. A good bit, though not all, has been accumulating on the Internet. While doing some background research for this article (and other searches), I came across some seriously **BAD** information on the net. Some of it was just down right **WRONG** from beginning to end! That provoked me to do a quick survey among beekeepers (hobbyist and commercial), honey bee academics and beekeeping supply purveyors. I asked them to answer a simple question: what books or beekeeping information would you recommend to 1) a beginner and 2) a more experienced beekeeper.

Here is the list of titles (in order of most nominations to least):

Beginner information

The Beekeepers Handbook
First Lessons in Beekeeping
The ABC & XYZ of Bee Culture
Honey Bee Biology and Beekeeping
The Hive and the Honey Bee
Backyard Beekeeping
Bee-sentials
A Book of Bees: And How to Keep Them
Beekeeping: A Practical Guide
Hive Management

More Advanced

The Wisdom of the Hive
Honeybee Democracy
The Biology of the Honey Bee
Honeybee Ecology
The Buzz About Bees
Bee Culture Magazine
American Bee Journal

Of course you know this, but not everything you read or see on the Internet is correct!

Anyone can post a blog or YouTube video on his/her practices, thoughts, opinions, conclusions, personal views, belief, ideas, etc. And, because we've been somewhat trained to trust what's in print and other media, subconsciously we expect that it MUST be right! Please be careful while searching information in cyberspace. Especially, if you're a new (newer) beekeeper, start with credible information. Build your foundation of beekeeping knowledge from reliable, sound, and peer reviewed material. Don't buy into some fly-by-night, who's only credible experience is website building, and has had only one bee hive (now a dead-out) in his/her life. Yet, people of this ilk have convinced novice beekeepers to follow their nonsensical beekeeping theories, which invariably leads these new beekeepers to lose their colony, become discouraged, and likely give up beekeeping entirely. Thus, our cause loses a potentially great beekeeper.

Now, I didn't mention feeding above when exploring what is natural beekeeping. Is feeding your colonies natural? There are two obvious camps on this. If you were to call the UGA bee lab with the question of to feed or not to feed, this is what we would recommend: if your colonies are light in stores, feed them! If anyone tells you it is unnatural to feed your bees, walk away. If they write about how they don't feed because they want to stop perpetuating weak genetics and allow only the strong to survive, turn the page. If they blog about the fact they let their bees starve because the bees aren't smart or strong enough to find their own food source, hit the back button.

A rectangular box on a roof top. Natural? (photo by Cindy Hodges

It's early April as I'm writing this. It has been a challenging spring for the bees. Georgia and the southeast experienced a very warm December and January. So, the queens never shut down; in other words, they continued laying eggs through the Winter. These eggs hatched into brood, which were fed copious amounts of honey and pollen before pupating. Then, they emerged into hordes of active, hungry bees with little-to-no food sources in the environment. Then, to compound the crisis, a cold, wet winter returned for several months, which resulted in starving bees across the state. These circumstances also perpetuated the growth of mites, which will be discussed in Part II of this article next time.

For the past three months, we've fed about 800-1000 pounds of sugar per week to keep over 400 colonies alive. If we hadn't, at least 75% of our colonies would have starved, if not more. Their own stores were depleted by February. So, I have to strongly disagree with the naturalist camp who would write off this situation to bad genes, weak genes, or say that the world is better off without these bees. Nope. Sorry. As everyone who relies on agriculture for a living knows, you can't control the weather. And trust me, the lab staff would prefer not to feed; it's time consuming and messy. There are much better things we could be doing with our time and money than mixing up syrup, cleaning and filling jars, and enduring the wrath of hungry bees while swapping out jars in the field. However, I refuse to let bees die when it's within my control to take care of them – even if it calls for "unnatural" practices.

There are a whole host of reasons why a colony may not have enough food to survive the dearth: bad weather, inappropriate hive location, ill-timed swarming, queen injury, poisoning, infections, infestations and other disorders such as a bear attack. Of such circumstances too numerous to list, few have anything to do with the bees having inferior genetics.

A diverse selection of food sources. Natural?

As extension personnel for the University of Georgia, we apply our knowledge and expertise to sift through information and disseminate the most important and applicable to the public. Beekeepers pose questions to our office by phone and email all the time. One common question in the late Winter and early Spring, unfortunately, is, "Why did my bees die?" After a few minutes of discussion we can usually figure out what happened. And, nine times out of 10, it's either starvation or mites. This is probably why I tend to go a bit overboard when talking about feeding and mite control. But, I will say this: If your bees are healthy and surviving without your intervention then, by all means, keep doing what you are or aren't doing. I only know what works here, in the Piedmont region of Georgia, under conditions similar to the lab or my own apiaries. So, our course of action may not be the same as that for beekeepers in other areas of the country or with different situations.

In any case, remember that the bees we have today aren't indigenous to the Americas. Settlers brought them here. Then, we imposed our human management techniques on them, laced our environment with a myriad of toxic chemicals, proceeded to convert vast amounts of natural landscape to golf courses, shopping malls and parking lots, and imported exotic honey bee pathogens and parasites. How can we expect honey bees to thrive on their own under these conditions? How can we stack the odds against them, and then demand that they survive without our help? If our environment was more "natural," then perhaps we could expect honey bees to proliferate more naturally and independently.

Take care of you & your bees! BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

The Not-So-Lazy Drones

There's much to be said about the male of the species.

Jennifer **Berry**

The drone, a.k.a. the "idler" or "lazy worker," with his large eyes (all the better to see her with), robust thorax (all the better to fly to her with) and stout abdomen (all the better to mate with) is nothing more than flying gametes (sperm cells). Developed from an unfertilized egg, the drone has only 16 chromosomes, half of what the queen mother and each of the workers have. The drone's only mission in life is to mate with a queen and pass on those alleles. But, back at the hive, the drone is basically a lazy, no good for nuthin', ne'er-do-well. He doesn't forage, clean, help in the nursery, build comb, polish cells, make honey or defend the hive. Hence, many beekeepers don't want them around and even take actions to keep their numbers down. Yet drones are an integral piece of the equation for the queen producer, specifically, as well as the health and perpetuation of the species, on the grand scale. Before we explore the wonderful world of the drone, let me first tell you about a funny thing that happened on the way to the apiary . . .

This Spring our lab set up a research project consisting of 200 full-sized colonies. The lab's existing bees were already involved in other projects. So, thanks to Bob Binnie and Ron Kirkland, we purchased 200 additional top-notch nucs. To pick them up, we had to drive about 2.5 hours south of the Bee Lab to the small town of Unadilla, GA. It's no big deal, (insert sarcastic tone here), really! I love to move bees, especially at night. Here you are with trucks and trailers, loaded down with thousands of pounds of bees and equipment driving down a windy, dark, two-lane country road, void of cell phone signals yet littered with deer, raccoons, ground hogs, foxes, bobcat, squirrels, unidentifiable critters, and possums, just waiting to jump out into the road at every turn. Did I mention deer? By 2:00 a.m., you start jerking the wheel ever so slightly as you approach a tan-colored mailbox or clump of grass illuminated by the headlights, which, in your exhausted state, you see as a 400-pound buck about to leap out in front of your overloaded truck.

But before this wonderful journey began, and the trucks loaded, the crew needed sustenance. After much debate, and several calls back and forth between the two trucks, it was decided that Chic-fil-A was the place to go. Oh, joy! I have nothing against the cows holding up the "Eat More Chicken" signs, but I was hoping for something not in the fast food category. So, we pull in, get out, and begin to trek across the parking lot when someone sees a dead drone on the ground. "Isn't it strange to see a drone out here in the middle of this over grown, crowded, noisy, polluted, no-tree-in-sight interstate exit." You know the kind, peppered with fast food joints, gas stations, over-priced hotels and the proverbial Cracker Barrel.

As we took additional steps, more drones were discovered. "Oh look. There's one. And here's another one right here. They're all over the parking lot!" We look at each other wanting to say, "what the????" When all together, we looked up, scanning the skies, and noticed the black, buzzing mass just to the right of the Chic-fil-A sign. And this is no normal side of the road sign either, but one of those, really tall, huge signs that you can see for a mile away while driving down the interstate. It's our first drone congregation area, a.k.a. DCA. Since we were ill equipped (in other words no high powered telephoto lens just our iPhone cameras), there were no pictures to document our claim of the first DCA next to a Chic-fil-A sign, but there were five witnesses. And "How did we determine it was not a swarm without the aid of binoculars," you ask? We determined this by the fact that there were only dead drones on the ground, (no workers), and some of the drones had expelled their endophallus, (evidence they had mated).

Mating in the honey bee world is not a simple task and is even down right deadly. At about a week old, virgin queens fly from the protection of their hive into the air in search of DCAs. That's right. It's the drones that congregate together in large numbers and not the queens. The queens seek out the drones. This makes sense, proportionally speaking, since there are more drones present in a hive than queens. Hence "he" is not as "precious."

One way to make sure you have enough drones is to use drone comb. This green plastic drone comb frame makes it easy to see drone production.

A colony will put drones wherever they please, making it difficult to measure drone production.

A normal colony will produce 5,000 to 20,000 drones as compared to around 10 queens, which roughly works out to be about 1,000 drones per queen. And, out of those thousands of drones, only a dozen or so will actually have the privilege of passing on their inheritance. So the drones are, shall we say, more expendable than the queen and drones flying in DCAs are extremely vulnerable to a number of predators. Just imagine being a bird and stumbling into a DCA. It would be like hitting the jackpot; all those tasty little morsels buzzing about just beggin' to be dinner.

DCAs are aerial zones, which remain geographically constant day to day and year to year. Why these areas are chosen and how they orientate to them year after year, no one completely understands. However, there are theories. One idea is physical characteristics such as an open field lined with trees, which provide a contrasting horizon next to a bright sky. It has been suggested that flowing water above or below ground may be an attractant as well. It is also believed that pheromones play an important role in assembling drones in an area and keeping them cohesive.

Drones take off from their hive in the afternoon, locate a DCA, fly around, and wait for the illustrious virgin queen to arrive. But, all that flying wears them out. So, occasionally they will take breaks and have been observed resting on vegetation in the vicinity of a DCA. However, once their energy stores have been completely depleted, they must return home in order to refuel. Depending on the weather, drones will make several trips a day, back and forth to the DCA. Anywhere from a few hundred to thousands of drones from different colonies will gather together. The boundaries of a DCA range from around 30-200 m in diameter and 10-40 m above the ground. Now for those rebellious queens, who won't soar inside these DCA parameters will be ignored by the drones. Similar behavior is witnessed inside the colony as virgin queens and drones rub elbows, but mating never takes place. Only in flight will mating occur, which again in the grand Darwinian scheme of things, makes sense.

Virgin queens and drones from the same colony are closely related, so mating in the hive would quickly amplify inbreeding. By leaving the hive and traveling a distance away the chance of encountering different drones from different lineages is increased. Hence, increasing the fitness and survival probability of the species. Plus physically, it would be impossible for the drone to mate while on a solid surface.

As the virgin flies into a DCA she releases pheromones that attract the drones to her. And as she flies through the air with the greatest of ease, drones form a "drone comet" consisting of a multitude of eager males flying at top speed closely behind. One by one drones will catch the queen from behind, mount her and copulate while they streak through a DCA. Queens do this over several days or even weeks. When mating occurs, the drone everts his endophallus into the queen's sting chamber and then flips backward forcing the semen into this chamber ending up in her oviduct. The drone's abdomen literally explodes during this five-second mating process resulting in his sacrificial death.

Virgin queens will continue to mate until their spermatheca has reached the maximum capacity, which is roughly 5.3-5.7 million sperm. Given that each drone ejaculate contains anywhere from 87 to 200 million sperm, only a small percentage of the sperm from each drone actually makes it to the spermatheca. Most is passed back out into the sting chamber and lost. Yet, due to sperm migration and mixing, each drone mating with the queen (17-24 on average) has a fairly equal representation of its genetic contribution in the spermatheca.

The term "polyandry" comes to mind at this point. Polyandry, in the bee world, means multiple matings. Polyandry in the human world is defined as a woman with many husbands. But that's another topic for a different time and magazine (wink!). So why is polyandry important to bees?

Due to the fact that sperm from a variety of drones is readily mixed, there are different patrilines simultaneously represented in a single colony. Recent studies have found these multiple patrilines within colonies do indeed vary in their response to certain pests and pathogens, each of which may catastrophically affect the colony. Much like throwing out a wide net as opposed to a single line and hook, the more drones with whom a queen has mated, the greater chances are that she may capture

Continued on Page 26

those rare alleles that may just provide resistance to pests or diseases.

By mating with numerous drones the collective sperm is genetically more diverse, which offers variation among the female progeny, which in turn may increase the overall fitness of the hive or ability to survive. With genetic variation, organisms are better adapted to changes in their environment. The ability to tolerate certain infections or infestations for instance reduces the potential, for catastrophic threats posed by pests or pathogens to the colony's survival and reproduction.

Good queen producers (and feral colonies) need a vast number along with genetically different drones during the mating season to ensure queens are not only properly mated but are carrying as many of those different patrilines as possible.

So the next time you look upon that drone lazing about with disdain, try not to be too judgmental of the little guy. He plays an important role, and will lay down his life for that rare possibility that his legacy will carry on, from generation to generation, into the future.

Side note. As I sit here writing this article I'm closing on the sale of my house tomorrow, and have just started building a barn/apartment (it's been a four-year process). So I want to thank Philip Quinn, our lab technician, for his superb editing of my grammatically incorrect article. Something he has helped me with numerous times in the past.

See ya! BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

What's The Buzz About?

There's many differences between wasps and bees. Here's good ways to help others understand.

Jennifer **Berry**

Humans often associate the "buzzing" of insects with that of a bee: Why not a wasp, or a June bug, or a robber fly . . . Nope, only a bee! More often than not when any airborne insect is out buzzing about, people identify it as a bee. Why is this? Perhaps our early teachings that cows go moo, pigs go oink, and bees go buzzzzzzz are to blame. If so, then maybe these early teachings should also include that a flying cockroach or a long horned beetle goes buzzzzzzz as well. Ok, maybe that's going a bit too far (though they do buzzzzzzz). Alternatively, perhaps this auto-assumption initiates deep within our subconscious, a likely result from the years of the media's relentless pairing of words like "bee" and "buzz"? As a child one of my favorite breakfast foods was Honey Nut Cheerios. I'll never forget the image found in every commercial and on every box of this tasty breakfast treat – a friendly fun-loving bee named "buzz." I wonder if this insulted Mr. Aldrin?

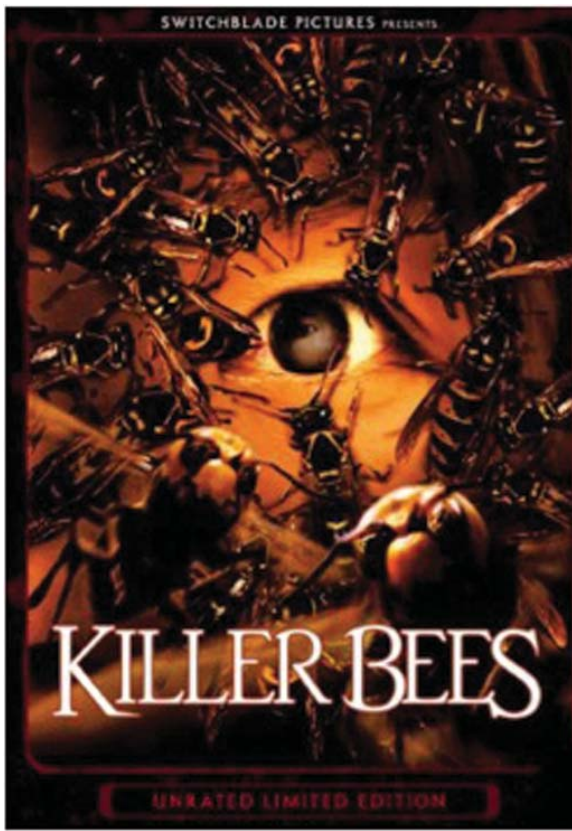
The general public commonly associates 'buzzing' with 'bees,' 'bees' with 'stinging,' and 'stinging' with 'pain.' Therefore, it seems only logical that they might also associate bees with pain. This explains why, when you're relaxing on a blanket in the park with friends or family, all of a sudden, buzzzzzzz, that noise rings in your ears and simultaneously a neuron fires in your brain communicating that a **bee** is in the vicinity. The potential for physical harm causes fear to ooze from your brain, overtaking your ability for rational thought, so naturally you stand-up and take off running, swatting the air wildly until you reach the safety of your car or until your energy gives out. Apiophobia, the *irrational* fear of bees, doesn't seem *so irrational*, huh?

Bees in general, though honey bees especially, have been given a bad rap. I guess it's the lack of knowledge about all the other stinging "bugs" scampering about this planet. But during the Summer month's, the reputation of bees is especially susceptible to slander. Hot, dry spells, like we usually experience from June to October here in Georgia, lend to very few blooming plants and shrinking water holes. Therefore, foragers of all kinds are attracted to just about anything sweet and watery. There tends to be large amounts of sugary beverages consumed in the Summer, and the remains are tossed in trash cans scattered about in parks and other public areas. The syrupy substance found in these partially consumed beverages attracts not only ants but also wasps, yellow jackets, and occasionally honey bees.

Calls usually start around July 1st. People upset that their hummingbird feeders are covered in bees, or that they can't enjoy the picnic areas because of all the bees flying around the trashcans – *all* of which are scaring the children. My initial response is to calm the distressed caller, and convince them to put down the can of Raid, and then try to get an idea of what is actually happening. Usually, the "killer bees" that are causing such havoc, aren't bees at all but instead, those annoying little creatures we call yellow jackets. Not to be confused with the other pesky critters associated with Georgia Tech, (sorry, state rival). And yes, admittedly, bees resemble wasps, which the general public apparently doesn't care enough to find out that there is a difference.

While doing some research for an Africanized bee presentation, I came across the cover art for a movie titled "Killer Bees". There were three different images, with the same insect, all of which were not bees, but wasps. You would think the artist would have at least researched this a little better, considering it was the cover art for a movie.

Another example, Dr. Delaplane was being interviewed by Bill O'Reilly several years ago. Apparently there was a stinging incident at a park, where a group of school children were "attacked" by yellow jackets. Why this made national news, I don't know. Anyway, they contacted ➪



Red wasp.

Wasp.

Dr. Delaplane and he was rushed to Atlanta to be interviewed about bees. During the show, while reference was being made to bees, not wasps, they continued to run stock footage of wasps. ARGHHHHHHHH!!!!! So there you have it; to most folks, wasps are bees, hornets are bees, all stinging things are bees.

Differences between bees and wasps: Part I

Living things are classified into groups depending on their similarities or relatedness. The animal kingdom is divided into a number of phyla (singular *phylum*) with each phyla divided into classes, classes into orders, orders into families, families into genera (singular *genus*), and genera into species. Bees, wasps, sawflies and ants belong to the **Phylum**, *Arthropoda*; **Class**, *Hexapoda* (Insecta); and order **Hymenoptera**, which is one of the largest orders of insects consisting of over 130,000 species. Other than *Isoptera*, the order to which termites belong, *Hymenoptera* is the only other order to have evolved complex social systems with a division of labor. This order is by far the most beneficial to mankind because it contains not only the pollinators of plants (bees) but parasites and predators of insect pests. But what put them together in the same order to begin with?

Bees, wasps and alates (winged reproductive ants) have two pairs of wings, as opposed to flies which have only a single pair of wings. These wings contain hamuli, tiny hooks in a row that connect the forewing to the hindwing during flight. All members have chewing mouthparts, mandibles, and antennae with usually 10 or more segments. The stinger is a modified ovipositor, hence only the females can sting, and is used for defense and offense. Metamorphosis is complete with the larvae being grublike and pupae formed in a cocoon. Fertilized eggs develop into females, whereas unfertilized eggs usually develop into males. Behaviorally they are categorized into parasitoid, social and solitary.

Even though bees and wasps belong to the same order and share many morphological/behavioral characteristics, there are equally as many (if not more) key differences which separate them. Some of the more obvious physical differences – bees are usually hairy, with robust bodies, while wasps tend to be more slender with shiny, smooth, exteriors. Additionally, wasps have a narrow "waist" connecting the thorax to the abdomen whereas bees look as if the two are fused. The legs of each insect differ as well. Wasp legs are more long and cylindrical (better to catch its prey with) where a bee's legs are stouter and flattened, especially the back legs. Why the difference in body types? Well it's all about what they eat.

Bees are technically vegans since they consume absolutely no animal products. No cheese, no milk, no eggs, not even yogurt infused with honey. Pollen and nectar are their sole food sources. Pollen supplies the protein, minerals, amino acids, vitamins and everything else except the carbohydrates, which come from the nectar. Stepping back a moment, actually more like 96 million years, angiosperms, or the flowering plants, co-evolved with bees. Flowers, with their brightly colored petals and enticing nectar depend on bees and other pollinators to distribute their pollen to other like-minded flowers, while bees depend on the pollen and nectar for food. I guess it is fair to say that both would not survive without the other. So which came first, the pollen or the pollinator? Ok, that's a whole different story and a long standing debate; back to why bees are fuzzy.

Bees must visit numerous flowers in order to collect enough pollen to feed their baby sisters back at the hive. As a result they have evolved stout, hairy bodies to which the tiny pollen grains adhere to. Pollen covered bees begin to "wipe" themselves clean of the pollen that has collected on their head, body and forelegs. The pollen is moistened with nectar during this process and moved to a specialized structure called the pollen basket or for you master beekeepers, the corbicula. Located on the hind legs, it's a slightly concaved section surrounded by spiky hairs which helps to hold the pollen in place. Over time, the collected pollen forms a sphere. There are other bees with such structures – bumble bees, stingless bees, sweat bees and orchid bees to name a few. It's always an exciting moment to witness a season's first load of pollen being brought in because you know that spring is just around the corner.

Wasps on the other hand are omnivores, meaning they eat both plant and animal food – first like us. But they are predominately carnivorous, and they eat mostly insects. Depending on how they collect their food and whether or not they share it, determines how wasps are categorized. There are three arenas – parasitoid, solitary hunter, or social – to which wasps may belong. Bees on the other hand are categorized as either social or solitary. We will explore the complicated "social" world of both bees and wasps in Part II. For now lets begin with the first two arenas in which wasps are grouped.

Parasitoid wasps, which range in size and color, can be a gardener's best friend. However, unless you are looking for them, they probably go completely unnoticed, as most of them are quite tiny. These particular wasps lay an egg or eggs inside or on the surface of their prey. These eggs hatch into larvae and consume the parasitized insect from the inside out or outside in. Not the most lovely mental image but, if you have numerous, fat, hornworms devouring the leaves on your tomato plant, or aphids sucking out precious nutrients, then I imagine you would

welcome these wasps to your garden to wreak havoc upon these pests, no matter how cruel. Having these wasps in the vicinity also keeps one from having to expose yourself and your garden to toxic and expensive insecticides.

Parasitoid wasps are usually host-species specific. For instance, the small braconid wasp, *Cotesia congregata*, only preys on tomato hornworms, and the tiny *Encarsia formosa* only whiteflies. This superfamily of wasps are viewed as beneficial since they control a whole array of agricultural pests – aphids, whiteflies, beetles, flies, scales, caterpillars and true bugs. For instance, when an aphid has been parasitized it becomes motionless, stops eating and eventually turns brown and appears swollen. These are called aphid mummies. If you look closely you may eventually see a hole appear in the abdomen where the adult wasp has chewed its way out.

Another type of wasp are the solitary hunters. These wasps hunt for a particular prey, sting it in order to paralyze it, then transports it home and stuffs it into a nest. The nest may be a hole in the ground, or a tube made out of mud, or a hollowed out plant. Once the nest is constructed and the nest provisioned with enough food, the wasp will lay an egg and seal the nest. The larva eventually emerges and consumes the food its mother has provided. These solitary hunters include many of the more common wasp species. Mud daubers, which love to construct tubes of mud along side your home, under eaves, inside your garage or bee equipment, are one example of this large group. If you've ever broken open a nest, then you may have seen either a half consumed spider or perhaps a very lethargic, motionless spider.

This particular category also contains one of the scariest looking wasps out there, the Cigar Wasp, often called the Cicada Killer. This wasp is roughly two inches long with a thick yellow and black body. Not only are they big, but when one flies by you it sounds like a helicopter. However, they are gentle giants, maybe not to cicadas. You practically have to force them to sting. They are not aggressive and fun to watch. They dig a hole in the ground, fly off in search of their prey and return and stuff the paralyzed cicada into the hole.

Carpenter bee.

Years ago we got a call here at the lab from a "terrified" women telling me how her yard had been invaded with these large, pterodactyl looking "bees" that would not allow her or her children to exit their home. "Please come save them", she whimpered. When I arrived on the scene there were 20 or so cicada killers flying around in their backyard. They had found the perfect nesting ground: sandy, loam soil, on a slight incline. As I approached the nesting location, it was a bit intimidating to have these large wasps flying around my head, but I quickly realized they were apathetic to my presence in their territory. Actually, one landed on my arm, just taking a breather I guess. The lady and her children's faces were pressed up against the window, with mouths agape as they watched me put one of the wasps in my hand. They couldn't believe I was actually in the midst of these killer "bees" and not writhing in pain from all the stings I was receiving. After much persuasion, I was able to lure the children out into the yard to see these fascinating wasps, but mom continued to refuse. Once the initial fear had dissipated, the kids loved observing these creatures up close and personal. They even saw one wasp fly in with a cicada and spend about 10 minutes trying to stuff it, pull it, drag it down the hole that had been excavated earlier.

Another very common solitary wasp is the velvet ant, aka, cow killer. These furry, brightly colored, mostly red to orange, wingless, female wasps resemble large ants. You will notice them running along in search of the immature stages of ground nesting bees. The female will enter the nest and lay an egg. The immature wasp larvae are external parasites on the developing bees. But don't be fooled by their "ant" like appearance. These wasps can deliver a painful sting if threatened.

As mentioned before, bees are grouped into two camps, social and solitary. Solitary bees, as the name implies, work on their own to raise their young and are valuable pollinators. They make a nest either by taking over one that already exists, digging burrows in the ground, or excavating nests in wood or plants. Digger bees, sweat bees, orchard mason bees, and carpenter bees are some examples of solitary bees. In this group, all females are fertile and provision their nest with food for the developing brood. These bees are rarely aggressive and if provoked their sting is very mild. Folks that usually do get stung are popped while working in the yard by a very common but tiny (4-10 mm) bee, the sweat bee. Sweat bees, as the name implies, are attracted to salt from human perspiration. They usually sting when trapped between folds of skin or aggressively handled. These beautifully marked or colored bees (metallic gold, blue, or green) can be observed wherever flowers are blooming.

Carpenter bees are probably the most annoying of all the bee species. First off, females excavate holes in the wood-boards around our homes, barns, garages, and sheds. These 'galleries' are the nesting sites for future generations. Even though they are considered to be pests, they do pollinate open-faced flowers, though they struggle with flowers with narrow,

Cicada Killer.

deep corollas, like, blueberry flowers. So, they've figured out a creative way they get around this by biting the side of the flower at the base, exposing the nectaries, and then extract the sweet substance they secrete. If you have carpenter bees in your area, check the base of your flowers and you may see these slits.

The males, which have yellow dots on their foreheads, are also a bit intimidating. During the early spring months, they become very territorial and will hover in the air just waiting for anything to come close. If something does enter the zone, they swoop down and make several passes around the intruder, sometimes even making physical contact. They will also fight tooth and nail with other males to protect their nesting site. But don't be afraid, these males, like all males in the Hymenopteran order, have no stinger and therefore can not inject a painful sting. But they can be somewhat annoying.

Speaking of stings, honey bees and wasps are different in this arena as well. When a wasp stings its victim it doesn't die, and can sting multiple times, which makes for a bad day when one stumbles into a yellow jacket or bald face hornet's nest. When a honey bee stings she will die and it all has to do with the stinger. Honey bees are unique since they are the only member of Hymenoptera that carries a barbed stinger. Once the stinger embeds into the skin and the bee flies away she leaves behind the sting, the venom sac and the muscles that pump venom and push the sting further into the skin. Because of this physical insult she will die, but she seldom dies in vain.

I've yet to mention one of the biggest differences between bees and wasps; wasps don't make the honey that goes on my biscuits or in my tea. We'll continue next time with more morphological differences and the complex world of sociality in Part II.

See Ya! BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

Getting Ready Southern Style

Jennifer Berry

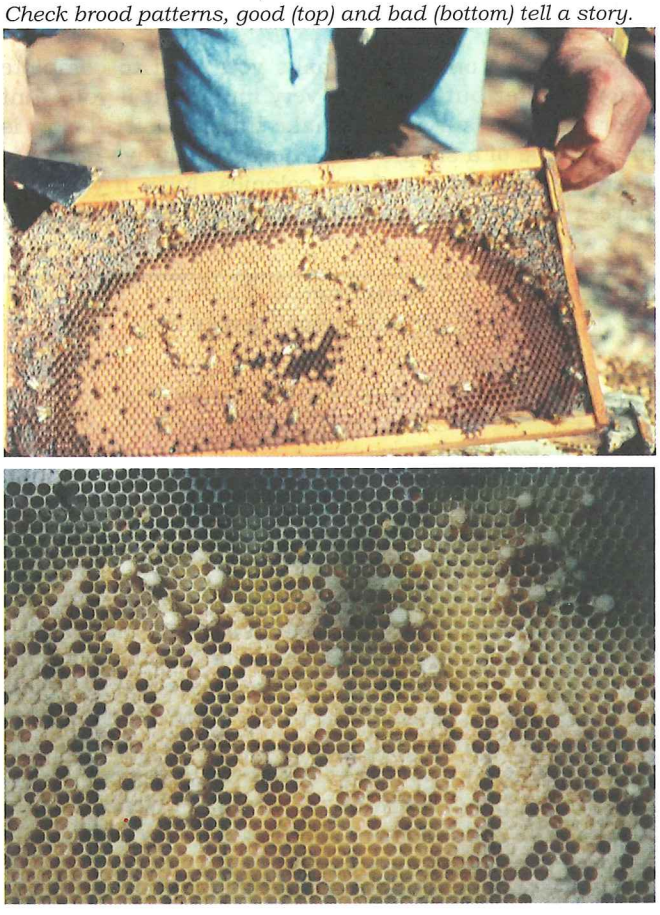
It's been a tough Spring and Summer here in the southeast. Take special care getting ready for Winter.

Growing up, I spent most of my Summer months at my grandparent's farm in Missouri. It was a kid's paradise. Open fields, farm animals, fishing ponds and barns to explore. After my few morning chores were complete, the rest of the day was mine to discover. Unbeknownst to me, this was a working farm and not just a personal playground. Being a working farm meant my grandparents struggled from year to year to make ends meet. Dry or wet springs could delay planting in the fields. Prices for seed, fertilizer, pesticides, herbicides, gas, and repairs could be manageable one year and then the next they could go sky high. Then to top things off, market prices plummet on crops before they're even out of the field. This would usually take the final bite out of the bottom line. However, some years all the ingredients fell into place and steak made its way to our table, but this was rare (ha!). Living off the land can be rough, especially when your mortgage depends on it. Beekeeping for a living is also no easy meal ticket. Milking each of those bees for that single drop of honey can be tough.

This year in particular has been hard for Georgia farmers, beekeepers included. The exceptionally dry spring not only postponed crops from being planted, but also severely impacted our major early nectar sources: gallberry, blackberry, Tupelo, and tulip poplar. Fields across the state turned into dust bowls as southern winds continually blew, sucking out all the remaining moisture. Dust devils were the only things visible in these parched fields. Then a late freeze with temperatures in the upper 20s for three nights wiped out peaches, blueberries, apples, and all newly formed vegetation. The freeze also affected the northern half of the Tupelo region. If that wasn't bad enough, drought-induced fires began raging in the southern part of our state. Hundreds of thousands of acres were consumed. Pine tree farmers watched from a distance as decades of work disappeared in minutes. Firefighters from across America descended to battle the fires that continued for months. Lack of rain and high winds fueled the flames which with each passing day became more and more out of control. Colonies sent south for the gallberry flow turned to ashes instantly as the fires whipped through apiaries. However, the flames weren't the only issue. Smoke produced from the fires created clouds so thick that interstates and roads were closed. Beekeepers were unable to retrieve threatened colonies so up in smoke they went. Week after week smoke from the fires blanketed the region. What little nectar was available was unattainable due to the clouds of smoke so some colonies not consumed by the fires simply starved. Like I said earlier, this has been a hard year for all farmers in the south. However, there is a silver lining. Even though cotton was planted late this year, nectar yields were very good, especially on irrigated fields.

In our northern counties, sourwood finally bloomed with a vengeance. Early in July, the scale colony located at Brushy Mountain Bee Farm was making five pounds of this wonderful mountain nectar each day. Also, it has finally started to rain, if only a little. The south is still well below average on the rainfall scale but at least the clouds open up occasionally and this wet stuff falls from

Check brood patterns, good (top) and bad (bottom) tell a story.



Feeding may be necessary this Fall.

the sky.

Enough talk about things out of our control. Let's examine what chores we need to tackle at this point. Even though Summer temperatures are still lingering, it's time to begin preparing your colonies for their long Winter nap. Remember this – a good honey producer for an early Spring flow starts from a strong colony going into the Winter. Here in the south, red maple is blooming as early as January. Weak colonies limping along don't have the time to build up in time for such an early flow. Plus, weak colonies barely survive the Winter months, especially in the north. Therefore, I prepare my honey producing colonies in the late Summer and early Fall. I assess mite populations, inspect for disease, re-queen, feed, repair equipment and move colonies into good locations (for honey and wind breaks). Windbreaks are especially critical for you northern birds since your winds are truly "cold."

There are only a few tasks you need to complete before Winter but these are very important if you want your colony to survive. To make things easier, below is an example of a simple data sheet. We always use data sheets to keep track of our colonies. Even if you only have a few colonies, take the time and create a system that works for you.

Colony #	Queen Condition	Honey/Pollen Stores & Position	Condition of Brood & Bees	Condition of Equipment
1				
2				
3				
4				
5				

First and foremost you should check the viability of your queen. How does her brood pattern look? Are there skipped/open cells?

If so, you may also want to look for other problems such as disease or mite infestation instead of automatically assuming it's queen issues. Late Summer through early Fall is the time we usually re-queen our colonies. This way I don't disrupt the colony in the early Spring just as they are kicking into gear. If you find a queen that is failing and can't acquire another, your best bet is to combine that colony with a strong one. Weak colonies rarely survive the winter and if they do, they are usually not very good honey producers.

The next task is to assess the amount of honey stores. Due to the lack of nectar in the southeast, feeding has become a priority. The commercial beekeepers to our south began pouring syrup into their colonies early in the Summer.

They rely heavily on the gallberry flow but with only about one-third of the total actually materializing, reliance on outside sources has become a must. Our central and northern counties were able to store enough cotton honey (and other crops) along with sourwood to hopefully make the leap through Winter. Also, with the goldenrod flow just around the corner, colonies will hopefully be able to pick up a few more pounds. Here in the piedmont region our goldenrod flow can be minimal, so we don't rely on it at all. Plus this honey tastes horrible (my opinion of course). When you open the colonies the smell reminds me of damp, stale laundry that you forgot to remove from your dryer several months ago. If food stores are low, (< 1 full medium super for the south: < 1 full deep super for the north) you need to start feeding sooner rather than later. Remember to think in terms of gallons not pints. Feed a heavy 2:1 sugar solution (two parts sugar to one part water) in whatever feeding contraption you may have.

A practice we have started here at the lab is to leave two full medium or shallow supers of honey on each colony. I've heard the argument before; "you make more off honey so it offsets the cost of feeding." Sorry, I just don't buy into it. The time and labor involved in feeding colonies, not to mention the cost of sugar, is just not worth the extra extracted pounds of honey. Call me crazy, but feeding hundreds of colonies is not my idea of fun. Now granted, I'm not a commercial honey producer in which every drop counts, so I am coming from this at a completely different angle.

Feeding this time of year can be tricky, so be careful not to trigger robbing. A single drop of sugar syrup clinging to the side of a colony will attract attention. Once they have their mind set on robbing it is impossible to change it. In July we talked about the importance of determining mite population levels. This is very important. Mite popu-

Fix or replace old equipment, below left, to keep out pests, and the weather.

lations have reached their highest peak by now. Don't wait till your colonies are crashing. Once the downward slide begins it is almost impossible for them to recover. Check those mite populations today!

Now it is time to examine the brood area for disease. Look for symptoms of AFB, EFB, chalkbrood and sacbrood. EFB, chalkbrood and sacbrood are more prominent in the Spring but can occur in the Fall. You want to see healthy, white larva in the cells. Also look for depressed cappings or ones with holes. Open these and inspect the pupae. Anything slightly off colored may be a sign of trouble (unless the pupa is in its later stage of development). If you see symptoms of EFB treating with Terramycin is an option. If you see symptoms of AFB you need to remove the infected frames and burn them or in bad cases, destroy the entire colony. There are no treatments available for chalkbrood or sacbrood. Chalkbrood problems can be reduced by providing better ventilation in and around a colony. Poor air circulation creates the perfect damp conditions necessary for fungal growth. If your colonies are in a low spot, move them. Low lying spots in fields accumulate moisture which in turn collects in your colonies. Also, clear any brush or debris from around the entrance of the colony. This reduces air flow into and out of the colony which in turn causes moisture to build up. Also, the direction colonies face is important. You need to protect them from prevailing winds. Tree lines and fences work great as wind breaks.

Nosema has been a hot topic as of late. Here in the south we just don't see it all that often since our bees are not confined for months on end. However, if you are concerned feed your colonies Fumagilin®-B.

Finally, you need to inspect your equipment.

Replace old, decrepit frames, supers, lids, and bottom boards with newer equipment. Beehives don't have to be pristine, little palaces; however, they do need to be in good condition. Gaping holes not only allow access for critters to come and go but also the rain and wind. Mice have an easy enough time getting into colonies. They just love to make their homes in the corners after tearing apart several frames. A continual food supply plus a warm cozy environment make it a suitable dwelling. Use mouse guards to discourage these unwanted guests.

I don't know about you but I am ready for a break. Cooler temperatures and shorter days will be a welcomed change, just don't let it catch you off guard.

See ya! BC

Jennifer Berry is a Research Associate at the University of Georgia at Athens.

Bob & Suzette Binnie

Jennifer Berry

A well run commercial operation in Georgia.

Since being elected president of the Georgia Beekeeping Association last year, Bob Binnie has worked exceptionally hard to organize meetings that are not only educational but also entertaining. If you attended the Spring GBA meeting in Covington this past February then you experienced just that: a well assembled, informative, fun meeting. Well, he is doing it again for this year's GBA fall meeting. It will take place September 26th and 27th at the Rabun County Civic Center in Clayton, Georgia. Bob has brought together top-notch speakers from across the U.S. to address issues that are important to beekeepers. He has also arranged for a laid back evening in which we will be entertained by an auctioneer while consuming fresh shrimp, sausage, corn and potatoes. Not only is the program exceptional but the location of the meeting is picture perfect. The mountainous region of North Eastern Georgia is breathtaking. Since the meeting is in close proximity to North and South Carolina, we Georgians would like to extend an invitation across the border for you to attend. For those who aren't Carolinians, please don't misunderstand, we extend the invitation to you as well. Anyone, anywhere is welcomed. It would be our pleasure to host our neighbors and kin alike. Here's a sample of what to expect at the GBA Fall meeting.

Dr. Tom Rinderer will be joining us to share his experiences in research and queen rearing. Dr. Rinderer is the Research Leader for the USDA lab in Baton Rouge which focuses on bee breeding, genetics, and physiology research. Dr. Rinderer has been heavily involved with developing genetically resistant lines of queens.

One of Bob's many beeyards in north Georgia. Notice the bear fence. No fence, no bees in the mountains.

Removing honey.

Unloading supers. Note the gate, storage boxes and tie downs.

Bob checking for moisture.

Cowen 60 frame air ram parallel radial extractor.

The line he is most passionate about originated in Russia and are called, easy enough, "Russians." He will talk about his experiences with the Russian line, their traits and the Russian Bee Breeder Program.

Another heavy hitter in the Russian world of queen rearing is Carl Webb. He will be giving us more information about Russian stock and how he keeps bees without using chemicals.

Dann Purvis, owner and creator of Purvis Brothers' Apiaries, will be sharing his experiences with queen breeding and how he developed his own resistance stock by selecting for survivability.

A Californian will be joining us also. If you have in recent years picked up an issue of the *American Bee Journal* then you have come across the name Randy Oliver. Randy is a monthly contributor to the magazine focusing on issues that effect beekeepers today. He is a teacher and researcher in all things to do with honey bees.

Steve Forrest, always a crowd pleaser, will be talking about the evolution of beekeeping equipment. Steve is owner of Brushy Mountain Bee Farm and has been in the business of honey bees for over thirty years.

300 qallon honey tanks.

Berry Wright from the Wrights Honey will be teaching about Fall management while working colonies in the beeyard. He has been a beekeeper for decades with his operation located in the mountains of North Georgia.

And of course Robert Brewer will be helping us to prepare honey for show. For more information about the meeting you can go to the GBA website at gabeekeeping.com. Hope to see you there. It will be worth it!

Before you arrive to the meeting there is some history I found out about the man who made it all happen, Bob Binnie. This past spring I sat down with Bob and Suzette Binnie and got a brief glimpse of their past and how beekeeping became their future.

Years ago, Bob was living in California when he married his wife Suzette. Shortly after their wedding they decided to move to Alaska. They packed up their belongings, threw them into a 20-year-old pick up truck and headed north with only $700 in their pockets. They weren't too concerned about what they would do when they arrived because at the time the pipeline was being built, so jobs were plentiful. Bob and Suzette settled in the back country of the Wrangell Mountains of Alaska. After many different side jobs, Bob landed

Part of Bob's bottling process.

Bob's honey.

employment as a Winter watchman for a hunting camp and then later guided big game hunters through the rough terrain. They lived in a rustic, 16 X 16 foot cabin, but for two adventurous spirits, it was just ideal.

Living in Alaska definitely has it fine points: majestic mountains, untamed wilderness, wide open spaces, unimaginable night skies, minimal people, and crystal clear streams. However, the winters can be harsh. It's not just the extreme cold, blowing snow and howling wind that can take its toll while living off the beaten path but also the isolation. So during these days of confinement Bob read, and read, and then read some more. One day he came across information about beekeeping in a Mother Earth catalog and it caught his attention. He didn't realize it then but beekeeping was about to become his life's ambition. Immediately he ordered Walter T. Kelly's book, *How to Keep Bees and Sell Honey*. After reading the book from cover to cover Bob was hooked and began to order every beekeeping book he could get his hands on. He said he knew instantly that commercial beekeeping was for him. However, he had never laid his hands in or even near a colony of bees.

When the weather allowed, Bob ventured out and met with local beekeepers. One in particular, a retired beekeeper, gave him some excellent advice. He told Bob that before he started his own business he recommended that he work for a commercial beekeeper. He explained about the numerous pitfalls involved with beekeeping. He told Bob it was essential for him to work with a professional. It will help you avoid potentially hazardous career moves which inevitably come with a lack of experience. So after six years of living in the wilderness of Alaska, Bob and Suzette packed up and headed to Oregon where Bob took the advice and worked for a commercial beekeeper. Beekeeping came very easy to Bob. During the three years of his employment Bob learned about pollinating almonds in California, pears in Oregon, apples in Washington, and honey production in North Dakota. Bob slowly built up his own outfit on the side (500 colonies) while absorbing every bit of knowledge he could. Once he was confident to step out on his own, Bob began pollinating numerous crops in California and Oregon. This was his life for 10 years.

A job offer brought Bob and Suzette to the Blue Ridge Mountains of North Georgia where he briefly changed careers and no longer kept bees. But it didn't take him long to quickly build up colonies and return to what he loved the most, beekeeping. For the first time Bob decided to delve into honey production. The West coast offered pollination while the North Georgia Mountains offered sourwood honey.

Bob's beekeeping operation over the years has ranged from 400 to 700 colonies, but for a one man operation the optimal number for him is 500. Along with producing his own honey Bob also buys and packs honey from beekeepers he trusts. He sells to grocery stores, produce stands, farmers markets and to other beekeepers. But lately Bob has begun selling nucs. This past year he sold over 600. Presently his honey operation consists of the optimal number of colonies, 500, with half located at permanent locations in North Georgia and Western North Carolina. The other half are situated on four-way pallets and travel back and forth from North to South Georgia.

Since Bob has been in Georgia he has become a member of the Georgia Beekeepers Association, and the Macon County Beekeepers Association in North Carolina. He is also a member of the Mountain and North East Georgia Mountain Beekeepers Association. The latter he served as president for three consecutive terms. Currently he is the president of the Georgia Beekeepers Association and in 2003 received the Beekeeper of the Year Award. He has also served as a board member for the GBA several times. Not only does he take on these extra activities but he is often a guest speaker for many clubs and associations and teaches numerous classes at Beekeeping Schools. Honestly, I don't know where he finds the time but he always does.

The first opportunity I had to work with Bob in the field was one Spring about six years ago. The UGA bee lab was starting a queen breeding program and Bob generously donated over 100 frames of bees, brood and 50 queens. I gained a lot of experience working with Bob. He was very calm and methodical in his techniques. It was obvious while working with him that his beekeeping experience spanned decades. That's not the only time Bob has helped out our lab and hence other beekeepers. Several years ago he was very instrumental in providing bees, equipment and time for a three year IPM research project.

Bob is a conscientious beekeeper who is not only concerned with his own bees but the future of beekeeping in general. He is always researching and fine tuning ways to become a better beekeeper. For instance he doesn't fall into the philosophy that newer, stronger or a combination of chemicals are the answer to our beekeeping problems. He believes that healthier bees are born in chemical free environments. One way he avoids using harsh chemical treatments is by choosing superior bee stock. His primary stock comes from queens purchased from Dann Purvis. In addition to Purvis Brother's queens he has Russian and South Georgian blood mixed in as well. "I want bees that won't succumb to every little sniffle that comes around" he says. So he chooses wisely. Bob is also aware of the number of colonies he puts into a yard. Only 32 colonies are allowed. "The more colonies per yard the worse they perform" he said.

Bob also shared his step by step procedure of how he gets his honey from the apiary to the extracting room, a timely piece of advice right now. He starts by making a trip to the beeyard the day before he plans to pull honey and places escape boards on all his colonies. "Most commercial beekeepers would probably think I'm crazy for doing this because it adds an extra trip into the formula. However it removes the bees with minimal disturbance to the colony, you are in and out quickly, there is little to no robbing and they clean up the dripping burr comb by the next day". He can enter a yard, pull the honey supers, toss them onto his truck and be gone. However, Bob explained that you **must** have bee tight equipment or this method will not work. Normally in the field his is a one man operation except for when he is pulling honey. His neighbor joins him for the time it takes to remove all the supers which helps out tremendously. During some months he has a college student who builds equipment and another person to help bottle honey.

Once at home, Bob unloads the supers with a hand truck and places them into a "comb room." This room has a de-humidifier which removes any excess moisture from the honey. He won't extract honey until the moisture content is 18% or lower. Once the honey is ready he moves eight supers at a time into his extracting room. Here he places the supers into a Cowen uncapper in preparation for the conveyer which loads them into a 60 frame, parallel radial extractor. Bob explained if he has all his ducks in a row he can extract 200-240 supers per day by himself.

The honey flows into a two barrel sump tank below the floor. When the tank is full an automatic pump kicks on and sends it into one of four, 300 gallon settling tanks. "Our honey is course filtered not micro filtered or pasteurized so we can advertise it as natural and raw" he says. Once the honey has settled for several days he begins to bottle it directly from the tanks into drums for storage or individual jars and buckets for sale. He wholesales about 85% of his crop by the case, while the rest is sold in buckets or drums.

Bob and Suzette raised three children all of whom have worked at one point in their life for the family business. Suzette runs the bookkeeping, shipping and website for the operation. Their oldest son is returning this year and will be distributing honey in Atlanta. This past spring when I had the opportunity to sit and talk at length with Bob and Suzette I realized that a story about their honey bee operation, the Blue Ridge Honey Company, needed to be written. Their dedication to the well being of honey bees, producing quality honey in America, the beekeeping industry, and the environment is admirable. How lucky Georgia is to have such an outstanding beekeeping operation and beekeeper in her midst. The saying definitely applies here; honesty and hard work pays off (for us!).

See ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

FALL FUNDAMENTALS

You'll do things a bit sooner in the North than we do down here, but it's the same things. Ignore them at your peril.

Jennifer **Berry**

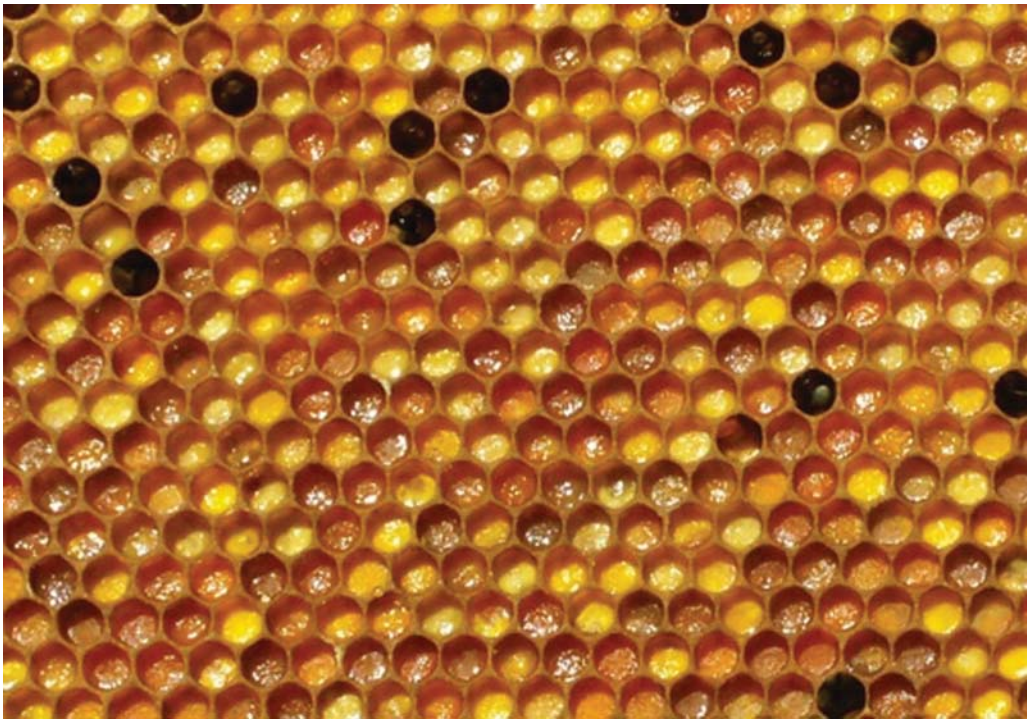
So far, 2010 has been an exceptional year for most of us southern beekeepers. Years of disappointing nectar flows, due in part to water-starved landscapes, finally came to an end. Plus, as opposed to last year, when the Spring rains came this season they stopped just as the bloom began to open letting the sun shine in. Spring and Summer flows in some areas were off the charts. Beekeepers were stacking supers higher and higher as the bees tried to keep up with the flow. "So many blooms, so little time," became our motto. And the pollen . . . did I mention the pollen? Loads and loads of multi colored pellets being stuffed into any available cell. Assuming we are diligent beekeepers now, our bees could be stronger than ever coming out of the Winter and into next Spring nectar flow because for the first time in years our bees are extremely well fed. But Winter preparation in September? Absolutely! This is the time to re-queen if necessary, fatten up those bees, reduce *Varroa* populations, and take care of any other issue that may have occurred during the season. So grab those evaluation sheets and let's get cracking by checking each and every colony from top to bottom.

Start by removing the lid and inner cover and look for small hive beetles (SHBs). Populations have been on the increase during the Summer months, hence some colonies may have more than they can handle. If you see these little black devils scurrying about, placing traps in your colony may be the way to go. There are several on the market and available through the bee supply companies. We've tried them all and have had the best success with the Beetle Jail Jr. (plastic, three-chambered reservoir, which snaps onto the top

bars) and the Beetle Blaster (single chambered reservoir which rests between two frames). Fill them with oil but be careful not to fill them to the top. Only fill the reservoirs about half way, otherwise you may spill oil onto the bees when placing them into the hive and the oil will kill bees instantly. Since temperatures are still warm, beetles mainly keep to the outskirts of the hive, so place the traps where you see the most beetles. As temperatures begin to drop they will begin to migrate towards the cluster. But, for now, the majority of SHBs can be found in the upper supers, hiding in the corners and in-between frame parts. Just a word of caution: SHBs love frame spacers because they provide little pockets into which the beetles can disappear.

The next task is to assess the amount of honey stores. Depending on numerous factors, nectar flows can differ drastically from one apiary to the next. If flows were below par, or too much honey was taken at harvest, feeding must become a priority. Once the temperatures drop the bees won't be able to break cluster in order to collect the food. All the syrup in the world will be useless if the bees can't get to it. And think in terms of gallons when feeding. It has been my experience that five gallons of a 2:1 sugar solution (two parts sugar to one part water) will yield one full medium super (roughly 35 pounds) of stored food. Depending on your neck of the woods, this may not be enough. If you are unsure of how much honey is required to get a colony through Winter in your region, consult an experienced beekeeper in your area. The further north bees are kept, the more honey is required to survive the longer Winter. A word of caution: feeding at this time of year can be tricky, so be careful not to trigger robbing. A single drop of sugar syrup clinging to the side of a colony will attract attention, especially when nothing else is available. Once bees start robbing it becomes a feeding frenzy, with even strong colonies succumbing to the onslaught.

Moving into the brood chamber check the viability of the queen. How does her brood pattern look? Are there skipped/open cells? Do you see any supersedure cells? If the pattern is spotty and the colony population is weaker than most, you may want to look for other problems first, such as disease or mite infestation before automatically assuming that there



are queen issues. However, the queen could be old, poorly mated, or not properly reared. If you determine that the queen is past her prime, late Summer to Fall is a great time to requeen, especially when accompanied by a flow, which is just around the corner.

Goldenrod blooms in North Georgia during September and moves south, with the Piedmont region usually experiencing a pollen flow by early October. So far, there's good ground moisture in place and plenty of sunshine, so goldenrod could mimic the Spring bloom, and be phenomenal. In years past, drought prior to, or excessive rain during the bloom meant minimal amounts of late-season pollen. Since adequate amounts of pollen must be available in order to produce winter bees (which we'll explore in a minute), check the pollen supplies. If pollen stores are lacking you may not want to wait for the fall pollen, just in case it doesn't materialize. Pollen patties are simple and easy to install and can be purchased already mixed together or in powder form. You may want to try several to see which you prefer. Another word of caution: SHBs love pollen patties. If you are seeing SHBs, portion out the pollen patties in stages (a ¼ or ½ patty at a time) otherwise they remain in the hive too long and the beetles will oviposit into them.

If by chance you can't acquire another queen, and the colony is weak, your best bet is to combine the colony with a strong one or one needing a boost. Weak colonies rarely survive the winter, so there's no sense in allowing the colony to limp along when you could have spared the bees and equipment from eventual disaster.

Next, examine the brood area for disease. You want to see healthy, white larva in the cells. Also, look for depressed cappings or ones with holes. Open these and inspect the pupae. Anything slightly off-color may be a sign of trouble (unless the pupa is in its later stage of development). Again, if you are unsure about what may be ailing your colony, consult a professional for diagnosis and treatment options.

Another late Summer chore is to inspect your equipment. Move frames with old comb to the outer edge so that they can be removed in the Spring and replaced with new foundation. Old comb is a reservoir for numerous contaminants, which can be detrimental to the developing brood and should be removed every three years. Replace old, decrepit hive bodies, supers, lids, inner covers and bottom boards with newer equipment. Bee hives don't have to be pristine little palaces; however, they do need to protect the bees from the upcoming frigid Winter weather. Gaping holes and cracks allow access for critters to come and go. Mice especially love to make their Winter homes in a beehive. A continual food supply, plus a warm cozy environment, make hives a suitable rodent dwelling. Structurally tight equipment and mouse guards discourage these unwanted guests.

Queen issues, food supplies, disease, and bad equipment are all things that need to be addressed before the arctic air descends upon us. Yet, there is still one more thing that we must not overlook: *Varroa* mites. By the end of Summer, mite populations may be skyrocketing. Please don't wait until your colonies are crashing. Once the downward spiral begins, it is almost impossible for them to recover. Check those mite populations today. Not only is it important to get their numbers under control for the existing bees, but also for the future bees that will bring the colony into the New Year. I'll get back to the importance of reducing mite populations, but first let's talk about these future bees.

The average lifespan of honey bees varies considerably based on the season when they emerge. These variations have been designated into two groups of bees dubbed Summer bees and Winter bees. Summer bees live approximately one month, while Winter bees can live anywhere from six to eight months. Winter bees emerge during August or September, depending on location, and differ from Summer bees by several physiological characteristics. Scientists have determined that the lifespan of

honey bees can largely be determined by the amount of protein stored in the fat body, hemolymph, and hypopharyngeal glands. The most notable and scientifically relevant type of protein is the high-density glycolipoprotein vitellogenin. It is loosely described as a female-specific, hemolymph storage protein, or more specifically, an egg yolk protein precursor. However, since worker bees rarely lay eggs, this protein is stored in fat bodies for future use. The relevance of this specific protein is largely based on its abundance in honey bee hemolymph as well as its high zinc concentration which regulates many functions within the honey bee. Vitellogenin is also thought to be a powerful antioxidant which significantly slows the effects of aging.

Now, getting back to the importance of reducing mite populations. Higher mite populations at the end of Summer or early Fall coincide with the production of these Winter bees. Research has shown that mite infestation during the pupal stage has a negative impact on the bees because they are unable to accumulate the necessary hemolymph proteins, including vitellogenin, to the same extent as non-infested bees, thus reducing their ability to overwinter. In order for the colony to have a chance of overwintering successfully it is imperative to reduce mite levels *before* the production of these Winter bees. And to step back even further, *the bees rearing the Winter bees* need the proper nutrition and development as well. They must be healthy enough to rear the Winter bees, and the bees rearing those bees need to be healthy, and so on.

Re-queening, appraising honey and pollen stores, checking for mites and disease, inspecting equipment while keeping robbing at bay will only help the colonies do what they do best. By storing honey for energy and pollen for protein, European bees have evolved to survive long Winters. But unfortunately, with introduced exotic parasites, diseases, viruses and a whole host of other non-indigenous problems, "we" have thrown this whole process out of kilter. Now "we" must be better stewards of our bees or face the consequences of finding more and more of our hives devoid of life. BC

Jennifer Berry is the Research Coordinator at the University of GA Bee lab. Contact her at ***Jennifer@BeeCulture.com****.*

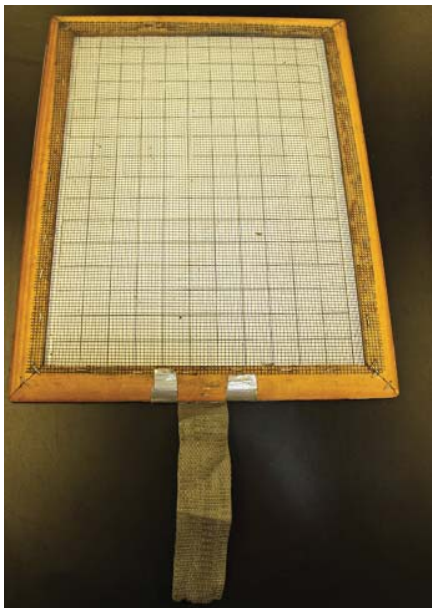
More Natural

Do we treat? Do we walk away? Do we do a little dance?

Jennifer **Berry**

"Why did my colony/ies die?" This seems to be a common question we receive from beekeepers either at meetings, in the field, or over the phone. After a brief inquiry, it usually becomes obvious that the colony/ies either died from starvation or mite infestation. Since we've already covered feeding in an earlier article, I won't bore you again, so let's now turn our attention to the main reason colonies die: *Varroa destructor*. Yet, folks continue to ignore the situation, maybe due to a lack of knowledge, or understanding or reality or awareness, or – while others believe that waving a magic wand will work. Unfortunately, for all the above, it's not the answer.

It has been a challenging year for the bees in Georgia. But, it was in the early part of the year that set the stage for some disastrous events that will occur this Fall and Winter. The southeast experienced a very warm December and January. Hence, queens never shut down, and brood production continued throughout the Winter. In turn, mites continued to lay eggs and reproduce along side the bees since there were plenty of tasty young larvae available. So, once again, mite populations are at much higher levels than normal. By Summer's end, your colonies' population could be crashing. And, by Winter, you may find your wooden boxes void of bees.



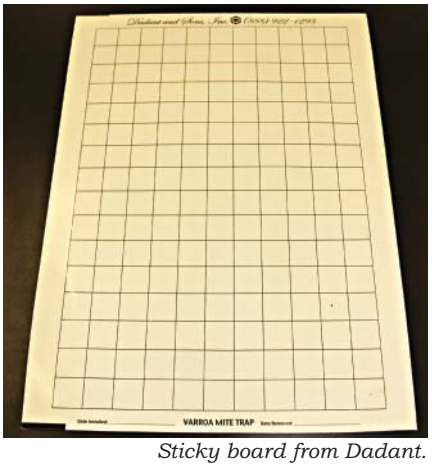
Framed screen Varroa *trap.*

So what do we do? Do we treat? Do we walk away? Do we let nature take its course and allow these weak bees to die? Do we do a little dance? When becoming a beekeeper, it is important to know or understand that those bees, in that hive, in your backyard, need your help to survive. In the July issue, I concluded in, "Is Natural Really Natural?", that our modern honey bees aren't indigenous to the Americas; settlers brought them here. Ever since, we have imposed our human-centric management techniques on them, laced our environment with a myriad of toxic chemicals, converted vast amounts of natural landscape to monocultures, golf courses, shopping malls and parking lots, and, finally, negligently imported exotic honey bee pathogens and parasites. How can we expect honey bees to thrive on their own under these conditions? How can we stack the odds against them, and then demand that they survive without our help? If our environment was more "natural," then perhaps we could expect honey bees to proliferate more naturally and independently.

Like pets, when we bring honey bees into our lives, we take on a certain responsibility for their care and welfare. Here in Georgia, animals can have a fit with fleas and ticks. I refuse to let mine suffer. So, I treat them with medication (chemicals) to eliminate the pests and prevent disease. If they get sick, I take them to the vet and administer any medication (chemicals) as directed. For that matter, if I get sick and rest/home remedies fail, I go to the doctor and take the medicine (chemicals) prescribed – along with a spoonful of sugar, of course! All that being said, if mite population has exceeded the level that the colony can tolerate and all other "non-chemical" strategies have been exhausted, then, yes, I advise that medication (chemicals) needs to be applied in order to save the colony. Some of us may oversimplify that it doesn't make sense to put an insecticide into a box of insects. However, if it will lower the mite population and ensure the colony's survival, then so be it.

I'm telling you what we do, not because I think it's the best way, or the only way, or "it's my way or the highway," but because we've learned over the years through trial and error along with close observations when working with successful beekeepers.

Before one can truly become a "good" beekeeper, one must understand the mite-bee relationship. *Varroa destructor*, an ectoparasite (one that lives on the surface of its host), is a relatively new parasite on *Apis mellifera*. *V. destructor* evolved on its original host, *Apis cerana* or the Asian honey bee. Over the years, the host (Asian bee) and the parasite (*Varroa*) developed a host-parasite equilibrium, so to say. If no equilibrium is



Sticky board from Dadant.

reached, the parasite will continue to kill off the host, which may eventually lead to there being no host. When this occurs, the parasite dies. But, if the virulence (degree or ability to infect or cause disease) of the parasite is mitigated somewhat and the resistance of the host is improved, a possible balance may follow. Since the Asian bee and *Varroa* evolved together, *Varroa* does not devastate the Asian bee. In this case, over time, Asian bees developed behavioral traits, such as hygienic behavior, or grooming in order to reduce mite populations. The mites are there, but they are not able to reproduce to destructive levels.

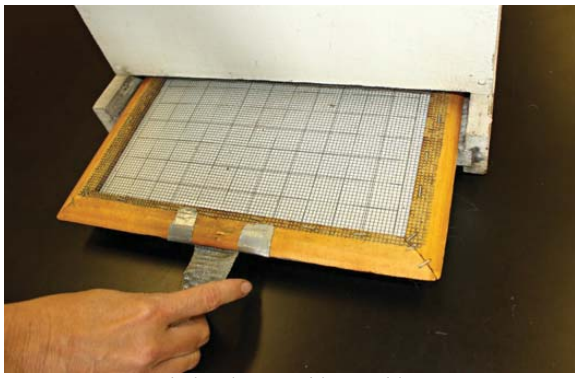
Lamentably, this is not yet the case with our A. *mellifera* bee-mite relationship. They've not reached the host-parasite equilibrium. As a result, the number of bee colonies, as well as beekeepers, have been dramatically reduced here and abroad. There's simply more to keeping bees now than before mites came ashore. This is why it is imperative that beekeepers understand economic thresholds (ETs) – the number of pests that must trigger the administration of control measures to save the host - and know how to apply them to their particular situation, location, time of year, etc.

Here at the lab, we begin to pay attention when mite levels are hovering around 40-60 mites in a 24-hour natural mite drop. Instructions for inserting sticky *Varroa* screens are very simple. You can use a *Varroa* mite trap below a screened bottom board, which can be purchased from several supply companies. Or, you can make a framed, metal screen in order to keep the bees from sticking to the surface of the trap, and insert it into the entrance of the colony. The traps are left in the colony for three days, removed, and the mites are counted. The total number for that colony is then divided by three to give us an average 24-hour count. If the colony is a five-frame nuc, full of bees, then 10-15 mites would be too many. If it is a single deep with a honey super, then 30-40 mites would be over the limit. For a stronger colony, say a double deep with a super, then 60 mites is our limit. The original research was actually conducted here at the UGA bee lab. If you are interested in reading more, go to www.ent.uga.edu/bees, click on "Research Archives," and click on "**Economic threshold for *Varroa jacobsoni* in the southeastern USA. K.S. Delaplane & W.M. Hood 1999.**" Disregard the name *jacobsoni*, rather than *destructor*; it hadn't been correctly identified at that time. And, due to increasing concern over the viruses transmitted by the mites, you'll note that we have lowered our mite margin.

It is also essential to understand the biology and behavior of mites in order to be a better beekeeper. *Varroa* mites must cohabit with honey bees in order to survive and can only reproduce on honey bee brood. Mites are small (1-1.8mm long and 1.5-2mm wide), but compared to their host the honey bee, they are one of the largest ectoparasites known. Their flattened oval shape is perfectly designed to slide between the abdominal segments of bees and their hardened (sclerotized) cuticle protects the mite from bee aggression.

There are two stages during the lifecycle of the female mite. The first is the phoretic stage in which female mites live on adult bees. They puncture the soft tissue between segments and feed off hemolymph (bee blood). They are carried throughout the hive, from bee to bee, or to other colonies through drifting or robbing. When brood is present, this phase can last 4.5-11 days or up to six months when brood is absent. This phoretic stage is when most miticide treatments are effective. Reason; mites are exposed at this stage and not under the protective layer of wax. On average, the life expectancy of the female mite is 27 days when brood is present and multiple months in the absence of brood.

The second stage, or reproductive phase, begins when the female mite, now titled the foundress mite, infests worker cells (15-20 hours prior to being capped) and drone cells (40-50 hours before capping). Once she enters the cell, she submerges herself into the brood food, extends tiny breathing tubes, and remains buried until the larva consumes all the brood food, hence releasing her. Afterward, the mite climbs onto the larva and begins feeding. Seventy hours after being securely sealed within the worker or drone cell, and protected from the bees and the environment, she begins to lay the first egg. This egg develops into a male, which only has one stage; he will never leave the cell and will die once the adult bee emerges. After the male egg is laid, subsequent female eggs are laid at 30-hour intervals. The foundress mite only has 13 days to lay eggs in worker cells and 15 days in drone cells. This allows for those eggs to hatch, molt, become sexually mature, and mate all before the adult bee emerges. The mite operates on the bee's clock. So, the entire mite reproduction cycle must be completed within the time frame of the developing bee. Otherwise, any progeny not completely developed will die.

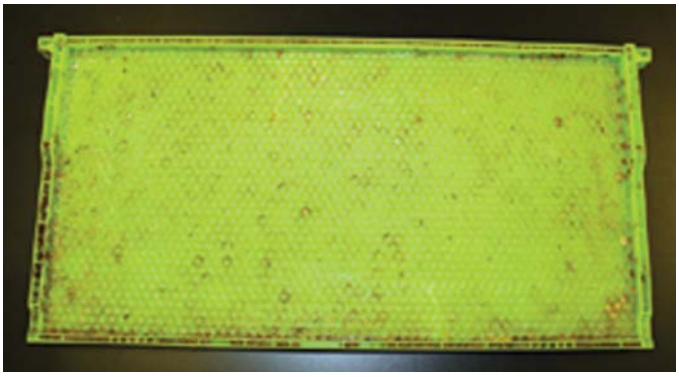


Screen being inserted into a hive.

Once the eggs hatch, they must start feeding. So, the foundress mite creates a hole through the cuticle of the pupa in order for these newly emerged protonymphs to feed. Without the establishment of these feeding zones by the mother mite, the nymphal stages would not survive. The chelicerae (insect fangs) of the protonymphs are too soft to penetrate through the cuticle and the male's chelicerae are only used for sperm transfer. The developing protonymph molts into a duetonymph, next a deutochrysalis, and eventually into the adult mite. The entire developmental process (egg hatch to adult molt) takes about 5.8 days for females and 6.6 days in males.

The reproductive rate of mites is 1.3-1.45 in worker brood and 2.2-2.6 in drone brood. However, five mites along with the foundress mite can successfully develop and emerge along with the adult drone bee. Hence, one female mite can potentially replicate herself five times in drone brood, but only once in worker brood. So, it makes sense that the foundress mite would choose drone brood over worker to complete her reproduction. We will revisit this idea about drone brood later. In the average temperate region, *Varroa destructor* populations can increase 12-fold in colonies having brood during half the year. However, in areas where

Varroa *on the screen.*



Drone frame.

brood is produced year-round, mite populations can increase 800-fold. That's why the *Varroa* "window" is greatly reduced in northern portions of the U.S. Here in Georgia, it's been two years since we've seen a broodless period. Consequently, mites have really taken a toll.

Not only are the mites sapping the strength of the developing brood, but they are also vectors for a variety of honey bee viruses: Kashmir bee virus (KBV), Sacbrood virus (SBV), Acute bee paralysis virus (ABPV), Israeli acute paralysis virus (IAPV), and Deformed wing virus (DWV). Before the introduction of *Varroa*, bee viruses were basically benign. By feeding, the foundress mite inadvertently injects viral particles into the developing pupae, and, along with additional feeding sites by subsequent mites, activates the virus. It is the viral infections that eventually take out the colony slowly over time through population decline, scattered brood patterns, crippled bees unable to forage, and loss of social structure!

The big question now is what can we do to hold back the onslaught of these parasites? First, start off by purchasing queens that have been selected for resistant traits. This is not a cure-all, but it's one part of a whole management scenario. Next, install bottom boards with screens; these have been shown to incrementally help to reduce mite populations.

In early Spring, insert drone brood foundation into the brood chamber next to the outer frame of brood. As mentioned earlier, the foundress mite prefers to reproduce in drone brood because of the extra time for more of her progeny to develop to adults. Insert the frame directly into a colony as soon as drone brood rearing commences. Now, if you are in the northern section of the country, you don't want to do this too early. Here in Georgia, we insert between late February and early March when the bees are flying and able to move around the hive.

Once the drawn drone frame is in place, the queen will lay eggs into the cells. When the cells are capped, remove the frame and place it into the freezer for 24 hours or until solidly frozen. Afterward, let the frame thaw. Use a capping scratcher to remove the dead drones and mites. Then, put it back into the colony and let the bees clean it out. If you want, leave it in for a second round of mite removal. Remember, you will need **drawn** comb in early Spring since the bees will not be drawing comb out just yet. So, get those frames drawn out this year and protect them until next Spring. Wax moths and small hive beetles would love to destroy the entire frame.

Another management option is brood cycle disruption, which will slow down mite population growth. If there are no suitable bee larvae available, then the foundress mite cannot reproduce. And, that's what we want – no reproduction! Here at the lab, as well as in my personal colonies, we do a combination of all the above. Relying on just one strategy may not do the trick.

Monitor your mite loads. Some colonies may take years before reaching the ET. Some may never reach it. And, still, others may reach it in their first year. That's why it's best to start checking levels NOW, and, if they are too high, you must do something.

At this point, late Summer, it is too late for resistant queens, brood cycle disruption, and screen bottom boards to do what needs to be done if levels are too high. You need to get levels down quickly. Colonies are gearing up to produce Winter bees. If these bees are compromised by mites (viruses), then they will not survive the Winter. Plus if you don't have drawn drone frames, then treatment is your only option. We recommend ApiLife Var®, a Brushy Mountain Bee Farm product, or Api Guard®, a Dadant & Sons product. The active ingredient in both miticides is Thymol, an essential oil. There are other products out there, but we've had the best success with the thymol-based ones. Just make sure you read all the accompanying material and follow the instructions completely. Too little won't work, and too much can kill bees. One more thing, powder sugar will not work at this point as a treatment option. The sugar only dislodges mites found on the adult bees and doesn't touch the reproductive stage under the cell. 80% of the mites are under the protective wax cap during brood rearing and hence are not affected. Trust me, I wish this wasn't the case. When we first started testing powdered sugar, we were so hopeful that it would be a successful mite treatment. It was very disappointing when we discovered it did little in reducing mite populations.

As a side note, my fellow researchers and I have never received money from a single chemical company that produces the chemicals (miticides) mentioned above. So, we can extinguish the myth that researches want beekeepers to remain reliant on chemicals because it is making us rich or keeps us in business.

I hate to be so straightforward here, but, if you want to be a beekeeper, then do what it takes to be a good beekeeper. If your bees are hungry, feed them. If they are overrun with mites, treat them. Your bees are your responsibility. If you refuse not to feed or take care of them because it is somewhat un-natural, then don't become a beekeeper. It's not fair to the bees.

Take care! BC

Photos by Ben Rouse.

Fall Feeding

Jennifer Berry

If your bees need feeding, there's lots of right ways to go about it.

During the month of October it's great to be in Georgia. The days are cooling down and the evenings are just splendid. Plus, it's enjoyable working colonies once again. The steamy hot and humid (did I mention hot) days of July, August and sometimes September are gone. The days of wilting attitudes and heat exhaustion are just a bad memory. It's rough working colonies in Georgia during the Summer, especially the latter part (even though as I write this article it has been the coolest and wettest week in years thanks to the left over remnants of tropical storm Fay).

During the Summer the bees, at least in the Athens area, have nothing to do other than collect water to keep their colony cool. Very little is blooming so thousands of bored, frustrated, little foragers are stuck in the hive. And trust me they aren't happy about it and let you know each time you open that lid. Here's a typical August morning in a Georgia beeyard. By 8:30 a.m. you're completely soaked so the bees just stick to you, you can't see because the sweat is pouring in your eyes, the supers weigh a ton, honey is dripping everywhere, bees are popping you left and right, robbing becomes a huge concern, there's not a breath of air, chiggers are eating you alive, ticks on every blade of grass and there's snakes and black widows under every colony. I know some of you are shaking your head saying, "yep, been there, done that"!

But it's no longer August, it's October. Soon the leaves will begin showing off their magnificent colors and the sunsets will match the hues of the horizon. Fall is a spectacular time of year. But with Fall comes the end of many of our Summer pleasures. Gardens are rapidly cranking down and all those over abundant tomatoes, squash, cucumbers, cantaloupe, okra, and peppers you couldn't give away a few months ago, will once again become a precious commodity. Now is the time to plant our Winter gardens. It is also time to prepare our colonies for colder temperatures since they are just around the corner.

You can start by combining weaker colonies with stronger ones. If a colony has been limping along all Summer, what is the point of keeping it around? Pinch the queen, and combine it with another colony, preferably one that needs a slight boost. Re-queening is also an option for queens that are past their prime. Older queens will stop laying too soon. You need a viable, young queen to continue laying into mid-November to insure a proper Winter population for survival. Also, check their pollen supplies. To enhance the queen's egg laying performance you will need fresh pollen coming in. If you don't see pollen coming in the front door add pollen patties. There are numerous pollen substitutes on the market. We tend to use natural pollen mixed with a pollen substitute and honey. The bees consume it quickly probably due to the presence of the honey.

Colony food supplies also need to be assessed this time of year. Here in the south we can experience a modest golden rod flow this time of year, depending on location. But my experience with the golden rod in the Piedmont region has been minimal to none. Don't rely on golden rod to supply your Winter needs (even in the

Plastic hive top feeder.

Continued on Page 53

Pail feeder.

Plastic baggie feeder.

north). Colonies lacking in the amount of food required to survive the Winter need to be fed. If your colonies need a substantial amount of food you must start feeding today! Once the temperatures drop the bees won't be able to break cluster to collect the food. All the syrup in the world will be useless if the bees can't get to it.

Average sized colonies in this part of the country require a full *medium* super for Winter survival. If a colony is in need of this feed them roughly five gallons of 2:1 sugar syrup. I wouldn't recommend feeding the five gallons all at once because sugar syrup tends to go bad, especially in warmer temperatures. But feeding one to two gallons at a time has not been a problem for us.

Over the years I have tried practically every type of feeder available on the market and some not. I definitely have my favorites but every beekeeper or beekeeping situation is different. In the past we got into the habit of pulling most of the honey off our colonies in order to sell it on campus. Then we would have to feed in order for them to build up enough stores for the Winter. Yet, after doing the math it just wasn't adding up. By the time we set up the extracting equipment, pulled supers, uncapped, extracted, bottled, labeled, bought sugar, mixed up the sugar syrup, drove to all the apiaries and fed, plus paid for labor, it just didn't add up. Now, at least two medium (or shallow) supers are left on each of our colonies. Remember our nectar flow is over by June therefore each colony needs to endure nine months with little to nothing coming in the front door before the next flow arrives. To our north and south it is a different situation. Both regions experience a Summer and sometimes even a Fall nectar flow. But now the question at hand is how to deliver the feed necessary for their survival.

There are several different feeding options available to beekeepers: top feeders, buckets, zip-loc baggies, entrance feeders, and division board feeders. We have used them all but definitely prefer some to others. Most of the bee supply companies carry different versions of the same type of feeders but they all pretty much work the same.

Hive top feeders, as the name conveys, fit on top of the hive. To install all you do is remove the lid and inner cover, place the feeder directly on top of the upper super, fill it with the appropriate amount of syrup, put the lid back on and walk away. There is little to no disturbance to the colony because you don't have to dig around inside manipulating frames. The bees will crawl up the hardware cloth from the super below and down to the syrup pool. They are made to fit a standard 10 frame hive body but there are ones available to fit nucs. Most now have a self enclosed, plastic unit holding one to five gallons of sugar syrup depending on the brand. These feeders tend to work the best, because they prevent leaking. You can also make your own top feeders (which we did once) but again, beware of leaking. If you need to put on a large amount of feed in a short amount of time this is a good option for you.

Years ago we made 50 hive top feeders out of plywood and such. The design was similar to the ones sold today with one exception; instead of a plastic insert we painted the interior with polyurethane. This lasted about a season, maybe two depending. Slowly over time they began to leak. And trust me this was a problem in our over crowded apiaries, especially in August. The slightest amount of sugar syrup that leaked outside the colony drew in bees by the thousands. Even the strongest of colonies were overwhelmed once clouds of bees forced their way inside. Another problem we experienced with the hive top feeders was the number of drowned bees (and yellow jackets) floating in the syrup. The bees were able to squeeze their way through the smallest of openings and under the inner cover/lid or they slide in-between the narrow openings in the wire mesh and outer wall. The newer hive top feeders have tried to eliminate this issue by making the feeders flush with the super and leaving no space for the bees to enter the syrup chamber. Finally there is the issue of cost. If you have more than one colony to feed the cost goes up considerably. I eventually got rid of all 50 of our hive top feeders.

Buckets are another way to apply large amounts of syrup at a time. The suppliers usually sell two gallon buckets with a removable plug in the center. You fill the buckets with syrup and turn it upside down with the plug intact. Vacuum suction keeps the liquid from pouring out. But be careful! If the seal has been compromised or

Boardman feeder.

Division board feeder.

the plug isn't inserted properly, the syrup may pour out all at once. Not a good idea to drench your colony with two gallons of sugar syrup. When feeding we bring a five-gallon bucket with us to the yard. Just prior to setting the bucket onto the colony we turn it upside down over the five-gallon bucket and let it drain. It's also best not to let it spill onto the ground around your colonies. It will attract robbers, ants, the beloved yellow jackets and other sugar seeking, hungry critters. Once syrup is no longer dripping we place it onto the colony. By the end of the day, depending on how many hives were fed, we may collect a gallon of syrup.

If your colony is close to starvation, place the opening of the bucket directly on top of the cluster. This allows the bees to use minimal effort to collect the syrup. Besides the syrup pouring out, there are other issues to consider when using buckets. One, the bees will propolize the metal grid attached to the plug which needs to be cleaned periodically. Second, you need an extra empty deep super per colony. Some beekeepers avoid this practice by placing the bucket directly over the opening of the inner cover and then laying the outer cover (lid) on top of the bucket, but I fear this approach. A good wind gust and both the lid and bucket will be tossed aside leaving an opening into your colony. However, I know several commercial beekeepers that use this method and have never had a problem. Plus, if your colonies are in the back yard this may be option worth considering. There is a way to avoid this all together. Cut a hole directly into the lid and add a plug. Then when you're ready to feed just pull the plug, place the bucket and walk away. This eliminates extra equipment needs plus the concern about weather affecting the woodenware.

The above two methods are the best for getting a good bit of syrup on at one time. But say you just need to get a few frames worth of honey into a colony. The past couple of years our method of choice has been to use zip-loc gallon baggies. We take the baggies, fill them with eight cups of syrup, smoke the bees off the top-bars, lay them on top of the frames, cut a four-inch slit (making sure not to slice into the bottom of the baggie), put an empty super on, add the inner cover and lid and move to the next colony. There is minimal cost involved, it's simple and there's little to no hive manipulation.

But as always there a few problems associated with this method too. If you are not extremely careful you can puncture the baggie (like placing it on the ground). You may not securely tighten the "zip-loc" allowing syrup to leak out the sides. Nails poking up through the top bars will puncture the plastic (happens while building frames). To check this run your hand or hive tool across the surface of the top bars where you plan to place the baggie. Trust me they are sharp enough to puncture the plastic. Also make sure the baggie is laying flat otherwise the syrup will leak out quicker than the bees can consume. Finally, environmentally speaking, the baggies can't be re-used again.

My least two favorite feeder options are entrance feeders and division board feeders but they do have their finer points. Entrance feeders are great for convenience. All you do is fill a quart jar, push the holder into the entrance, and plop the jar on. Easy enough and you can see when it is time to re-fill the jar. And again, you don't have to enter the colony. However, you are feeding only one quart at a time (although bigger feeders are available). This method could take months before you have any substantial amount of stores built up. Another problem is robbing (my favorite). The odor of the syrup will draw unwanted neighbors right to the front entrance, but if you only have a few colonies this may not be an issue. Finally, you can not use these during periods of cold weather.

Division board feeders eliminate the problem of robbing since the food is directly in the colony however you have to enter the colony and remove a frame in order for this to work. In addition to hive manipulation bees will drown, sometimes by the hundreds. In the past we added a piece of 8" hardware cloth cut to length and then folded and placed it into the feeder. This reduces the risk of bees drowning plus it helps keep the integrity of the feeder intact and open. Again you can't use it during cold weather because the bees are unable to break their cluster. Finally, during a nectar flow if you are not diligent about keeping syrup in the feeder they will fill it with comb. Best advice is to remove the feeder once a nectar flow is occurring.

Sometimes our bees just need a little assistance but just think what they give back in return.

Have a wonderful Fall.

See ya! BC

SMALL HIVE BEETLE ROUND-UP

Beetles come on strong in the south right now – Be Ready!

Jennifer Berry

For the past few months I've been absent from these pages. There's no excuse other than the fact that I've been in the beeyard more than the office this year. Actually, if you could see the state of my office you would understand why I'd rather not be in here; piles of folders, books, various pieces of beekeeping equipment, data sheets, queen cages, clip boards, envelopes, stacks of un-opened mail (paper and e-mail), grafting tools, stuff I have no idea what it is and of course a wide collection of hive tools and veils.

Even though our research season is still in full swing, I've forced my way into the office. I had to plow through all the clutter and sweep piles into the corners, until finally my desk was revealed. Why? Well, it may have to do a little something with this fine new computer I just took out of the box (which is now blocking the only path to the door). And what is this new computer you ask? It's an iMac. Yeap, I'm back with Mac!

I was never very interested in computers, so most of the late 80s and early 90s technological innovations zoomed right by me. It wasn't until I came back to pursue a graduate degree that I was reintroduced to computers. A friend gave me an older model apple computer. Wow, what a machine!!! I couldn't believe how many different things you could now do on a computer, plus the internet and the world it opened up. Because of school I did everything on the Mac.

Then along came this job and boom, I was forced into the world of Bill Gates. Now I'm not saying that's a bad thing, I just wasn't used to it. I had to be re-trained, re-programmed, re-formed.

Ok, enough jabber – let's move outside. Its Fall in Georgia and what a fine time to be here. October, in the south, is the crème de la crème of months. The heat and humidity, which is long past, has been replaced with crystal blue skies, cool breezes and marvelous days in the beeyard. No more head rushes as the temperature and humidity hits over 100°. The Fall colors are just beginning to make their appearance and the nights are almost chilly. You snowbirds have probably already tucked your bees in for the Winter while down south our bees are still desperately searching for that last droplet of nectar or granule of pollen. Not much remains, but if it's there the bees will surely find it. Goldenrod, which bloomed a month ago, with its brilliant orangey heads and stinky nectar, is our clue to start preparing for Winter.

Even with the wonders of the Fall season there are still issues brewing. One which becomes really apparent this time of year is the small hive beetle (SHB). Earlier in the Spring/Summer we may have seen a few beetles on the inside of the inner cover, or end frames where the bees are absent but throughout the Summer the beetle populations have been on the rise. Actually, by July/August beetles are starting to rapidly multiply in our colonies, much like that other unwanted pest, *Varroa*. By September you can start seeing beetles by the hundreds on the underside of inner covers and bunched up in corners. But October can be even worse. Yet, it all depends on the colony and location. Some colonies will have a few while others a few hundred to even thousands.

In some cases, beetles probably bother us more than they bother the bees, especially during the warmer months when the majority are hanging out in the upper honey supers. However, when I start seeing hundreds of those slimy b!!#&!^!! crawling around the brood area, darting in and out of the brood cells, it's very un-nerving. This is when I begin to question how they're impacting the

The Hood trap sits on the bottom bar of an empty frame. The advantage is that the bees will fill up the empty space with drone comb, so you can get rid of trapped varroa and small hive beetles at the same time with the same frame.

The Freeman trap serves as a screened bottom board when not in use. Fill the tray with oil and beetles fall through the mesh and drown.

colony. Plus, as temperatures begin to cool down the beetles will start making their way to the center of the colony to the cluster for warmth. These sub-tropical species don't react well to cold temperatures. It's not part of their agenda.

Location may determine the seriousness of your beetle problem as well. Here in Georgia you don't just have to live in the southern regions or below the "fall" line to experience beetles. This fall line I refer to is a geological boundary that runs across Georgia northeastward from Columbus to Augusta. It used to be the Mesozoic shoreline of the Atlantic Ocean. Hence, sandy soils predominate south of the fall line, whereas harder clay soils are found to the north. Athens is north of this line. The sandy soils provide an easier home for the larva to excavate their pupae site. Beetles are often a problem in southern Georgia much earlier in the year and persist further into the fall. As far a Florida is concerned, it's a yearlong battle. But again, also depends on where your apiary is located.

Several years ago we moved beehives down to Perry for SHB IPM test. We started the colonies here in Athens, late in the Summer (bad idea) and then transported them south (another bad idea) to take advantage of irrigated crops still providing nectar. The first month the colonies were thriving beautifully. They were drawing out comb, the queens looked healthy, bee populations were strong and they were making honey. We patted ourselves on our collective back, said job well done and drove away with not a care in the world. Four weeks later we returned to a disaster. Over half of the colonies were dead and those remaining were in sad shape. Several colonies had absconded and were still clinging to shrubbery a few yards from their hives. All that remained from those that had perished or absconded was the dripping, disgusting slime and stench of tens of thousands of beetle larvae. The other colonies that still had bees were hanging on, but barely. Adult SHBs were everywhere. The poor bees were spending more time chasing the beetles out of the cells than attending to the brood or other duties necessary for their survival.

We rectified the situation by hauling the colonies back home to Athens. Now here's the irony. The study was to investigate which IPM method or methods best controlled SHBs. So, in essence, we needed beetles, not as many as we encountered down south, but we still needed beetles. Within a few weeks the remaining colonies recovered but unfortunately there were no beetles. For whatever reason this particular location didn't support them.

There are numerous "non chemical" options available to reduce SHB populations. But probably the best defense is maintaining a healthy, strong, queenright colony. However, in some cases beetles can overwhelm even those. Again location, location, location.

Here are some basic cultural practices to consider. Avoid providing extra space that the bees cannot properly protect. For instance, don't stack a bunch of supers (empty or full) onto a colony. Swarming is no longer an issue in late Summer early Fall, so consolidate frames of honey into one or two supers, depending on the strength of the colony. Leaving empty supers with no bees, or worse, empty frames with pollen and no bees is asking for trouble. Also, if a colony is weak for whatever reason, take it from a 10 frame and put it into a four or five frame nuc. I like to keep the bees compact so to say, especially this time of year.

If your apiary is prone to having high beetle numbers, move the hives. Find another location for a season or two in order to break the lifecycle of the beetle. Also, beekeepers have found keeping colonies in the sun as opposed to the shade helps in reducing beetle numbers. Frame spacers are a magnet for beetles. They love to hide under the metal flashing and laugh at you as you try to wedge your hive tool down in there to mash em! The bees are also frustrated because they can't get to them either. Get rid of them if you have a problem. Seal all cracks and crevices inside the hive. Don't leave them any place to hide.

If you find a colony heavily infested with beetles don't combine it with one that's not. Suddenly increasing the SHB population may cause a strong colony to collapse. In our experience here at the lab, when we come across a colony loaded with beetles, we add traps (which I'll get to here in a minute) reduce the amount of space available, take any frames

The Beetle Jail replaces a whole frame in a super or hive body. Beetles hide in the slot on top, fall into the container of oil below and drown. The clear plastic container simply slides out of the surrounding frame to be emptied and refilled. No spilling, and a huge capacity.

infested with larvae and freeze them, manually remove as many adult beetles as we can and then move the colony. In the long run, however, I prefer to re-queen colonies with a more hygienic stock since it's been shown that bees with hygienic behavior will remove cells infested with beetle larvae. But sometimes the option just isn't available.

Making weak splits or mating nucs in mid to late Summer can be disastrous if you're not careful. They are beacons to those homeless beetles flying about in search of prey. And finally, for honey that you plan to extract, get it done sooner than later. Most beekeepers in the south have probably learned this lesson the hard way.

Before the days of the beetle, we could remove honey supers, stack them in our honey house and get to them when we had time. Not true these days. Stacking honey and walking away could mean the loss of your entire crop. Humidity and temperature levels in your honey house helps but it is still recommended to not pull honey supers off until you are ready to extract. I spoke to Bob Binnie who has had a lot more experience extracting honey and he told me some interesting information. If comb has had brood reared in it, you better get the honey extracted within four to five days or beetle larvae will appear. However, virgin comb (never had brood reared in it) won't succumb to beetles that quickly. But beware, if there's any lingering pollen in those cells the beetles will jump on it even faster. Another thing, the experts claim that honey houses with humidity levels below 49% won't allow beetle eggs to hatch. Be careful

The 2 piece BeetleEater trap. Beetles try to hide from the bees by running into the holes on the sides of the top. The Cutts trap has the holes in the center. The value of the this trap is that it is reusable.

about relying on this completely. Once in the past Bob had the opposite occur. Nothing worse than all your hard work ending up in the bellies of those beasts.

During the Summer months I insert beetle traps in colonies that seem to have populations higher than I'm comfortable with. Like most beekeepers here in Georgia and the south, I've been experimenting with all sorts of traps and "non chemical" baits. So far nothing eliminates the beetles completely but I do see a reduction in the numbers.

For top bar traps you put inside the colony there's the reusable AJ's beetle eater and the Laurence Cutts' Better Beetle Blaster. The AJ beetle eater is a two-piece plastic trap you snap together and place in between two frames. The reservoir is filled with oil before placing and the beetles when chased by the bees, look for a place to hide, head into the holes and drown while trying to escape from the bees. It works well because you can place the trap wherever you see the most beetles. However, be careful not to spill any oilwhen placing and especially when removing the trap. If you don't already know, bees and oil don't mix.

The Beetle Blaster works the same way but is a one piece, disposable (and therefore cheaper) plastic trap that has a clear reservoir. It is just now available and is sold by major bee supply companies. According to the inventor, Laurence Cutts, it will hold around five to six hundred beetles and is very easy to install. Just put it between the frames and then use a squirt bottle to fill the trap with oil. Any vegetable oil will do. Once the trap is full of beetles, you just remove it and throw it away. The bees will propolize the top of the trap to the top bars so use care not to spill oil when prying up.

Both of these traps can be used in the brood nest for a continual trapping method even over Winter.

There are other in-hive traps available on the market; the Hood trap and a new comer, the Beetle Jail produced by Millerbees. Both of these traps take the place of a single frame. The Hood trap is a three-chambered plastic trap that sits in a frame. The outer two chambers are filled with oil and the inner chamber with apple cider vinegar. The beetles are attracted to the vinegar and enter the oil chamber and suffocate. The beetle jail uses a slightly different concept; it actually "traps" the beetles. The trap fits snug up against the wall (hence no space to hide) forcing the beetles inside the trap to escape the pursuing bees. The trap comes in three different sizes, deep, medium or shallow and has a small slit along the top of the trap where the beetles enter. Now here's the trick, the opening has a lip protruding outward on the underside. According to the information on the website, the beetles stay in the jail because they won't cross over that lip. There is a plastic reservoir that you place oil into so the beetles eventually drown.

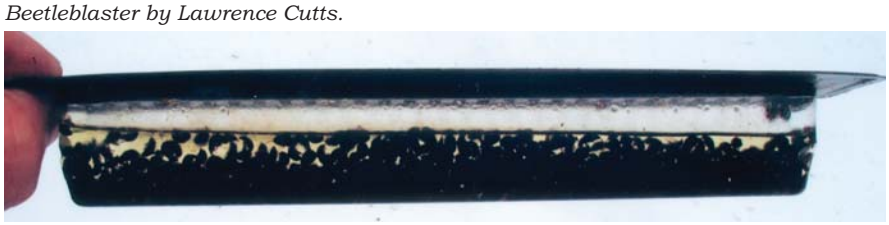
There are also bottom tray traps. The West small hive beetle trap and the Freeman beetle trap. The West trap consists of a plastic tray with a slotted cover that sits on the bottom board. The tray is filled with oil which suffocates the beetles that crawl or fall into the tray.

The Freeman trap takes the place of a screened bottom board. It is a separate unit with a wooden frame to support the colony, a wired mesh screen and a removable plastic tray. The tray is filled with oil and again the beetles either fall or are chased into the tray. The tray can be removed from the back of the hive with little to no disturbance to the colony. Both of these traps will reduce large numbers of beetles from your colony, but need to be perfectly level to operate efficiently.

For you northerners, I am assuming by October the ability to enter colonies is limited due to the weather. If beetles are present they have made their way to the cluster and don't plan to leave until the temperatures outside are much warmer. So trapping beetles now may not work. Unfortunately, in your area it was something that needed to be done in August. However, for our southerners it's not too late. Get out there, enjoy this magnificent weather, check in on your hives and make sure they're ready for whatever the season may bring. See ya! BC

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab. To comment on this article contact her at Jennifer@BeeCulture.com.

Beetleblaster by Lawrence Cutts.



SHIPPING LIVE BEES

Jennifer **Berry**

My queens start out alive and healthy from my beeyards . . .

Back in the day, (prior to computers, cell phones, and texting), communication with someone far away was done primarily through the mail. If you wanted to reconnect with a friend from high school, there was no facebook so you sent a letter. If you wanted to wish someone happy birthday there were no Ecards available, so you mailed a card. If you wanted to see how a relative was doing, you wrote a message by hand, put it into an envelope, sealed, addressed and stamped it, walked it to the mailbox, put it in, raised the flag and waited days, weeks, maybe even months for a response. Oh, the good ole days. Over the years, as technology in telecommunications has advanced, the need for mail service decreased dramatically; information was only a phone call away. But the Internet has probably been even more instrumental in causing the near extinction of the hand written letter. However, for some of us the mailbox used to be a treasure-trove, back in the day.

There was something magical about that ole black box possibly holding, at any given moment, that most desired, ever anticipated package or envelope - the one you'd been waiting for seemly a lifetime. When that day arrived, you opened the mailbox and there it was - the manila package with your, yes, *your* name on it. Finally! Will it be the magic kit that you ordered with the 10 bubble gum wrappers, or the sea monkeys from the cereal box tops you'd been saving?

The mailbox also added a sense of adventure. During a recent visit with my father our conversation turned to the innocence of youth and how during his younger years the mailbox held adventures beyond imagination. My dad grew up listening to the radio with the afternoon shows geared for kids. Following those shows were ads for all sorts of "must have" items that were to protect him from the enemy. It was during the war and the enemy could be anywhere hiding out in that small town of Owensboro, KY. He had the decoder ring to decode important messages only privy to him. He had the rear view mirror ring so he could periodically see if the enemy was sneaking up behind him. If he did see someone/something suspicious he could use his whistling ring to muster up help. But if for some reason the covert operation called for complete silence, he could write a note for help, secure it to a tiny airplane on his ring and then jettison it off to his comrades in arms (hoping of course they were only a few feet away).

Because of the times he rarely traveled out of that small town in Kentucky as a boy so the mail box was his link to the outside world. A quarter and a cereal box top was his ticket to Battle Creek, Michigan, the cereal capital of the world.

But today that ole black box is rarely used except for unwanted bills, and junk mail. Other than Christmas cards, I never write letters anymore. Today I walk to the computer, turn it on, write my note to whomever, and hit the send button. Done! But there's something impersonal about that. Maybe that's why Christmas cards are still so popular. It's the one day a year we take a moment, turn away from the computer screen and by the light and crackle of the fire, while snow flakes gently settle to earth, and dogs snuggle around our feet, we sit down, sip warm cocoa, and actually put pen to paper.

Before starting this article I "googled" information about the post office. The post office has been around much longer than I had realized. Actually, the United States Postal Service (USPS) has been around for over 231 years. Prior to the signing of the Declaration of Independence a postal service did exist but it wasn't until July 26, 1775 when the 2cd Continental Congress agreed to

. . . but too often end up not alive at all.

appoint Benjamin Franklin as Postmaster General. That day the USPS came into existence. The principle then and now is that "every person in the United States – no matter who, no matter where – has the right to equal access to secure, efficient, and affordable mail service." Back in the day, the postal service was the only means of communication available and "efficient" mail service may have existed. But times have changed.

Over the years I've found that shipping through the post office can be a real challenge but when dealing with something live, that's a whole new ballgame. Awhile back I started raising queens, and finally took the plunge last year to begin selling them. However, the thought about shipping queens didn't set well with me. I decided queens would only be available by pick up. Well, that didn't work since it limited my customer base dramatically to an area around Athens. So I looked into the process of how to safely ship queens. I called several queen and package producers to get their feel on the situation. They basically told me this; shipping queens is no picnic. And here's why:

Shipping live animals used to be more common, but now it's becoming more and more difficult. FedEx won't even consider shipping live queens or package bees. Since most of their service is completed by air the company fears packages would leak during the flight releasing thousands of "not so happy" bees. A situation they don't want to experience plus they don't want the liability. So no option there.

Next is UPS. They will ship live animals but won't guarantee live delivery. In other words UPS won't insure their safety. UPS however will guarantee that the package will arrive on time, just not alive. The USPS will insure live delivery, however will not guarantee arrival time. Arrggh! Hence the frustration!

Each time a queen is caged a thought crosses my mind. Will she actually make it to her final destination alive and well? Once I put her into the envelope and hand her over to the postman, I no longer have control over the situation. It is now up to the post office to process the package properly, get it to its final destination on time, and then for the beekeepers to NOT do something stupid like leave the package in their garage for days because it was just too hot to go into the hives, or leave them on the dash of the car while stopping for a bite to eat, or leave them on the kitchen table for their cats to munch on or . . .

Rearing queens is not an easy task. If you have done it yourself then you know the time involved to successfully raise a quality queen. By the time a queen is caged there's not only the minimum 45 days invested into her, but the time and money invested into a whole series of things; the breeder colonies she was grafted from, the starter finisher colonies she was reared in, the mating nucs she was housed in, and finally the drone mother colonies in which the drones she mated with were produced. So when I hear the comment "Relax lady, it's only a bug" after losing queen/s in the mail, I don't take it so lightly. Also it hurts my feelings when someone doesn't treat packages labeled **Live Honey Bee Queens** with just the normal amount of care.

In the past year I have lost a total of 38 queens in the mail due to mis-handling, carelessness, or other inefficiencies. That's almost 10% of the total number of queens I've shipped so far. That to me is insane. Some queens were left in mailboxes ⇨

(black mailboxes in full sun during the Summer months even though it states very clearly all over the package **PLEASE DO NOT LEAVE IN MAILBOX** or **IN THE SUN**), some in the bottom of a bag, some never made it to their destinations, some took weeks to arrive, some were on time but just dead. And here's the kicker, since these queens are insured I have to wait 90 days before a file can be claimed and usually they want the customers to file the claim, not me.

Last year I sent several queens to South Carolina, a destination that would have taken me four hours to drive to from Athens. The queens were mailed two to three day priority, on a Monday and arrived 10 days later, the following Thursday. Fortunately, they were still alive. Queens sent to a customer in Montana mailed priority took 14 days and again the queens were still alive. Queens mailed to Huntsville, Alabama, a three hour drive from Athens, arrived in 12 days after the said delivery time. Those girls were not so lucky. Because of these and other negative experiences with the post office I've decided to switch to UPS even though they don't insure live arrival. Here's a bit of information I found on the web about their history.

UPS got its start in 1907 in Seattle, Washington when a young James E. (Jim) Casey borrowed $100 to establish the American Messenger Company. Out of their basement headquarters messengers ran errands, delivered packages, carried notes, and even delivered trays of food. Jim's brother along with numerous other teenage boys, ran these assignments by foot or bicycle since automobiles were not as common then as they are now. Yet as advances in technology increased so did the abundance of autos and telephones, hence the need for a messenger service quickly faded. So the company focused more on package deliveries primarily for department stores. As time marched on so did the company. By 1919 the company expanded beyond Seattle to Oakland, California. The company also changed its name to United Parcel Service and in a few short years expanded to Los Angeles and then to all major cities on the Pacific coast. By the 1930's the company had reached across the US to include cities on the East coast. Quickly it became a leader in the parcel business, adding air service across the country and today across the world. A near 12 million envelopes, packages, boxes and crates are shipped daily through UPS.

I have not yet dealt with UPS on a professional basis so the jury is still out. Hopefully my experience will be better, if not, maybe "pick-up only" will be back on the table. But it still saddens me to see that ole empty mailbox, with it rust spots and floppy flag not standing at attention.

See ya! BC

Jennifer Berry is the Research Coordinator at the University of GA Bee lab. Contact her at Jennifer@BeeCulture.com.

Bees for Beef

Let me tell you about Certified Naturally Grown Bees, and Beef

Jennifer **Berry**

"Environmentalist, naturalist, tree hugger, preservationist, eagle freak, greenie, anti-pollutionist, ecologist," and "green geek" are some of the terms used to describe those concerned with protecting the environment. Often, they refer to people working in some capacity to solve environmental issues such as population growth and pollution, for example. I find it interesting that, prior to 1962, these terms did not exist. It was only after Rachael Carson's novel, "*Silent Spring,*" was published, that the environmental movement began. Since that time, the movement has sprouted, grown, and took on a life of its own.

Annie and Nolan Kennedy with Certified Naturally Grown beehives.

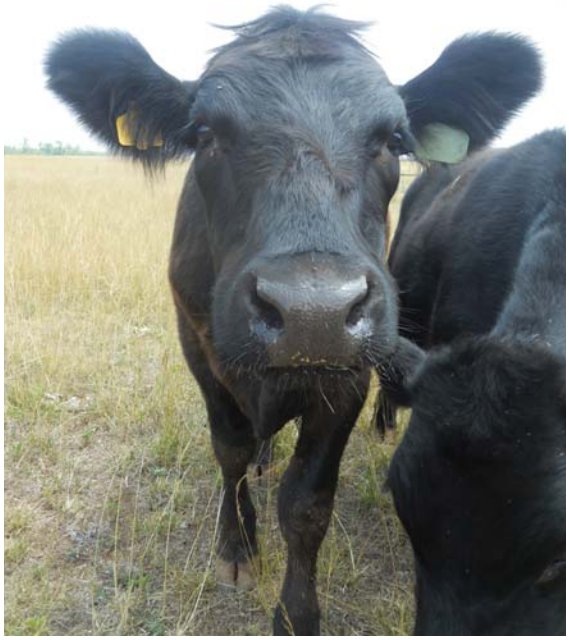
As the human population continues to increase, more and more food must be produced in order to feed the masses. However, with such rapid growth, humans are exhausting the world's land base. As land is consumed for non-agricultural needs or overworked and overgrazed, this resource is in jeopardy. Hence, day after day researchers and farmers are working to find better ways to cultivate the land so that at harvest time, yields are at their peak; it's a constant struggle to improve land-use efficiency. Another struggle is to achieve this while decreasing the cost of production. One thing is for sure, there is only so much land, and we ain't making any more. "Land is the only thing in the world worth workin' for, worth fightin' for, worth dyin' for, because it's the only thing that lasts," goes the saying.

Since the end of World War II, populations have flourished along with technology. This has given rise to industry-standard, monocultural farming. Some examples are the vast acres of corn, soybeans and wheat fields that consume miles of America's heartland. Given such advances, in the past, the small, local farmer all but disappeared, only to survive in the paintings of Norman Rockwell. While large farming systems efficiently produce massive amounts of food, I ask, "But, at what price to humans and the environment?" Desertification, salinization, loss of biodiversity, depletion of ground water and eradication of genetic diversity are just a few of the issues that have surfaced over the years.

Another concern is the pollution of soil and water. With a whole landscape sowed with the same crop, pest and disease populations can rapidly explode infesting and infecting virtually everything overnight. So, pesticide use is a must! Insecticides are used to kill the insects that devour the food. Herbicides are used to kill the weeds that compete for precious resources and fertilizers are used to grow the food-bearing plants big and strong. Granted, the use of these chemicals has enabled great gains in food productivity over the years, but, again, I ask, "At what risk to humans and the environment?"

It is understood that with the growing population on this planet, organic or alternative agricultural operations cannot feed all the inhabitants. However, these farms are growing by leaps and bounds all across the country. Over the years, many people have gained a better understanding of how the food they consume is grown, harvested, processed and packaged. With this knowledge, they're making better-informed decisions about what to buy and from whom, as evidenced by the appearance of more organic and local products in larger supermarkets, led by, of all stores, Wal-Mart.

For a food product to be labeled "organic" it must have been produced, handled and stored without the use of any synthetic chemicals. Plus, the land in which it was grown must have been chemical free for more than three years. There are other rules and regulations that must be adhered to in order to receive the label, which is why it's almost impossible for honey to be labeled organic. This is not because of the beekeepers' practices, but where the bees themselves fly. Bees do not discriminate between organic and non-organic fields. They forage in areas that provide the biggest bang for the buck. So, unless our bees' flight range is completely encompassed by a pristine area,



Happy cow (steer actually).

free of insecticides, fungicides, herbicides, or genetically modified organisms, then, the "Organic" label will always be just outside of our grasp. Yet there's still hope!

The closest to an organic certification, that MOST beekeepers can get, is a grassroots program called Certified Naturally Grown, or CNG, which is modeled after the *Participatory Guarantee Systems* or PGS. PGS is a peer-review certification program of over 10,000 farmers, primarily outside the US, which has been in practice for decades. PGS recognizes organic practices yet draws upon local resources, as opposed to relying on large bureaucratic organizations, to inspect and educate. This avoids frustration, excessive paperwork and high fees.

Certified Naturally Grown started as an alternative to the USDA National Organic Program and, since its inception in 2002, has begun to sprout across the U.S. The program caters to the small-scale farmer, who sells products locally at farmers markets, roadside stands, restaurants, and through community supported agriculture (CSA) farms. It is a brilliant choice for beekeepers since it offers a common sense option to the organic standard. Plus, there are less restrictions and costs involved.

The process for being certified as CNG is quite simple. First, go to **www.naturallygrown.org** and read the requirements for the certification. These are basic, common sense approaches to keeping bees (treatments for pests, apiary location, feeding, comb removal, etc). If your apiary practices meet the requirements, you will want to connect with several beekeepers in your area who are also committed to natural beekeeping methods. Next, you will need to fill out the application on line. After your application has been accepted, you will receive a declaration by mail along with information about the program and the annual contribution. Finally, you will have your apiary inspected by a beekeeper whom you know and, with success, become a member of the CNG community. I became a member a few months back and am proud to be a part of this organization.

Last year, I was asked by a local beekeeping family to certify their apiary as CNG. It was the first apiary certification for the state of Georgia; so, I was excited to be apart of the process. Annie and Nolan Kennedy along with their three children, live on a farm outside of the small town, Colbert, Georgia.

Annie and Nolan met while attending school at Texas A&M. After graduation, Nolan went into USAF pilot training program. He eventually became a F-16 flight instructor. Years later, this training lead him to a career as a Delta pilot, a job he continues today. Annie worked in the Human Health Division of Merck industries as a Pharmaceutical Representative until she retired. They remained in Texas until Delta transferred Nolan from Dallas to Atlanta. They opted for the farm in the country as opposed to the overcrowded, polluted madness of Atlanta.

Annie and Nolan began to explore living a healthier lifestyle when their youngest daughter was diagnosed with food allergies and autoimmune disorder. What they discovered in the grocery stores was not to their liking. Meats, dairy and eggs were full of hormones, antibiotics and other chemicals. Very little-to-no organic vegetables were available, but there were plenty of processed foods loaded with ingredients they no longer wanted to feed their family. So, they decided to take matters into their own hands and make a move back to the basics with not just their food, but their environment as well.

Covenant Valley Farms, the name of their farm, is the place they call home. At first, they had no intention of having more than just a few horses, but this proved not to be enough. As time went on, the population of the farm began to expand. First, a rooster named Michael Angelo needed rescuing. Next, they got, chickens, sheep, cattle, bees, and, finally, turkeys. The farm has become a full time job, but one they love.

The Kennedy's cattle are a mixed-breed of Angus. They have better immunity and resistance to common aliments versus the commercial stock widely-used today. Hence, there's no need for injections of antibiotics. Further, the fields where the cattle graze are not treated with synthetic pesticides, herbicides or fertilizers, which is one reason why their stock is also Certified Naturally Grown.

The Kennedy's cattle are grass fed, which is what nature intended. Most beef operations will "sweeten" cattle for 60-120 days (some, actually, for their entire lives) on grain (predominantly corn) to add additional fat before they are slaughtered. Unfortunately, a cow's stomach is not designed to digest corn. Once on a corn diet, the cow becomes "sick;" this is one reason why antibiotics are continually fed. Grain feeding also promotes the growth of E. coli, which is another reason why such cattle must be fed antibiotics. Finally, cramming 100's to 1000's of potentially diseased animals into small areas (stockyards) can be a recipe for disaster.

Another debate circulating the country is the use of hormones within the meat and dairy industries. In recent years, there have been many questions and concerns about the effects of these hormones on people eating beef and drinking milk. During their life, cows are fed or injected hormones to accelerate their growth and make them more "beefy," so to say. These hormones are the same

muscle-building androgens (testosterone) that nefarious athletes consume. Dairy cows are also fed hormones in order to increase milk production; traces of which are detected in the meat and milk. But, what may be more disturbing is the amount of these hormones finding their way into water sources (rivers, streams, creeks, ponds, lakes). Waste from the cows runs off into waterways and eventually make it into our drinking water. So, how is this affecting our health or the health of the environment?

The industry has modeled this current system of raising cattle to be more cost effective, which is why beef in this country is so cheap compared to other parts of the world. Plus, American consumers have grown accustomed to the fat-marbled meat which has been produced for decades. However, meat from grass fed cattle has about one-half to one-third less fat. It is lower in calories and is much higher in vitamin E, omega-3 fatty acids, and a beneficial fat called linoleic acid (CLA), which supposedly reduces the risk of cancer.

Folks raise cattle unconventionally, and buy the beef as well, to minimize the risk of contracting deadly diseases like Mad Cow and Foot and Mouth. Plus, it greatly reduces the chance of being exposed to E. coli infections, which kill people each year in this country. Some feedlots not only feed grain to cattle, but feed the animal remains of horses, and pigs, as well. Also, in his book, "*Fast Food Nation*," Eric Schlosser reports that about one quarter of minced beef sold in this country is made from worn-out dairy cattle, which are likely to be riddled with disease and antibiotic residues.

Journalist and food researcher Michael Pollan explains that, "…the chronic diseases that now kill most of us can be traced directly to the industrialization of our food: the rise of highly processed foods and refined grains; the use of chemicals to raise plants and animals in huge monocultures; the superabundance of cheap calories of sugar and fat produced by modern agriculture; and the narrowing of the biological diversity of the human diet to a tiny handful of staple crops, notably wheat, corn and soy. This loss of nutrients (and replacement by superabundant yet non-nutritious calories) has contributed to the rise in chronic degenerative diseases in humans over the last 60 years." (Pollan, 2008)

Back at the farm, while sitting down and chatting with the Kennedys, we actually did some bartering. I purchased ½ a steer in exchange for five nucs and five queens. Not bad. It is more expensive than what you find at the grocery store, but, for me, I'm willing to spend more for fresh, local, organic, or CNG food because I BELIEVE it is healthier, better tasting, grown with a respect to animals and the environment. It also makes me feel good. But, something that I find ironic is that natural foods usually contain fewer ingredients; they are just common, everyday, simple fare. The fancy-dancy, premixed, fast cooking, dinner in a bag, box, or plastic tub is cheaper than the real thing because the chemicals and additives are cheap to create and easy to apply. Next time you are at the store, read some of the labels from a few organic products and compare them to their "fast food" counterparts. Interesting read!

Annie and Nolan believe in food quality over quantity. They want to raise the animals humanely and with as little impact to the environment as possible. They want the food that they eat, feed to their children, and sell to their customers to be like yesteryear: full of nutrients, but not artificial, four to 12 syllabled ingredients that nobody can pronounce.

Annie holding a baby chicken which will soon be supplying eggs for the family.

"Thank you," to all the small, local farmers out there like the Kennedys! Glad you're no longer just a memory. BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

Wilbanks Apiaries

Jennifer Berry

Since my introduction to bees, I have attended numerous beekeeping conferences, and during those events I have met many interesting people. This has been a highlight of my job. Everyone has a story to share, an idea, a trick for this or a tool for that. So, why I am telling you this? I've been trying to gather stories focusing on the fundamentals of beekeeping in the Southern U.S. This was a challenge. How does one incorporate information on an area with such a wide variety of honey plants, soil types, and climates? What Maryland beekeepers are doing in October is different from beekeeping activities the same month in Georgia. So, I decided to drop the "Beekeeping in the South" idea in favor of visting with personalities that are uniquely southern. We'll visit commercial operators, hobbyists and researchers during my journey visiting beekeepers in the South. We'll find Southern beekeeping practices, different modes of operation, and tricks of the trade rather than seasonal beekeeping tasks. We'll explore research programs across the area, and may just find some interesting personalities to boot. Hopefully, it'll teach us a thing or two and no doubt, we'll come across that one in a million tall tale to share.

First, let me clarify what I mean by "the South," which includes states east of Texas (including Texas) plus the states south of the Mason Dixon line. That's the "South" where I came from.

Let me introduce to you one of Georgia's own, Mr. Reg Wilbanks. Reg comes from a long line of beekeepers, himself being the fourth generation. Reg is owner and operator of Wilbanks Apiaries, Inc. It is one of the country's largest commercial operations that ships package bees and queens nationally and internationally.

The Wilbanks business started when Reg's great grandfather, Gresham Duckett, gave his grandfather, Guy T. Wilbanks, four hives of bees as a wedding present back in the 1800s. With hard work, dedication and the help of his son, Warren Wilbanks, Reg's grandfather, soon turned those four colonies into three hundred. In the early years the business focused on honey production. At that time their family resided in Banks County in North Georgia located at the foot hills of the Appalachian Mountains. Their honey market ranged from the surrounding area all the way to Atlanta. North Georgia is known for its sourwood honey which blooms during the Summer months. However, honey flows can be un-dependable, being almost non-existent some years. Just ask any of the north Georgia beekeepers today. The past four years have seen little sourwood honey.

Back to the story. In 1946, the family home was destroyed in a fire so Guy and Warren Wilbanks moved to south Georgia, where floral sources offered larger honey crops and had a reputation for being more dependable than their northern counterparts. However, the first year after their arrival, the honey crop was a disaster. No crop, no money. So Guy T. Wilbanks had to take a job in the shipyards in Brunswick, Georgia. Warren Wilbanks, Reg's father, also needed to make ends meet so he went to work for the Georgia Department of Agriculture as a state bee inspector. The job not only offered an income but also an opportunity to travel and learn about different honey bee operations, primarily the queen and package bee industry. The family decided to branch out from solely producing honey to producing package bees and queens. A year later, the family moved to Claxton, Georgia, their present location.

Reg was involved in the family business taking only a short break to attend college. After receiving a BS degree in Industrial Management from Georgia Southern University in 1972, he returned home, eventually

Webbs Win At Apimondia

In August the world convened in Dublin, Ireland for the 39th Apimondia International Apicultural Congress. Along with lectures and exhibitors there was the world honey show in which America stole the stage. Here are the results.

Virginia Webb, from Clarkesville, Georgia, won a Gold medal for her 24-Jar entry. It is hard to overstate the significance of this award. It is considered "Best in the World," crème de la crème, number one. This award is the one that other honey exhibitors covet because it is the hardest to achieve. Virginia took home several other awards: a Silver in Decorative Display of Honey, a Silver for two Jars Light Honey and two Jars Medium Honey, and a Bronze medal in Dark Honey. Virginia was the top medal winner in the honey show. The U.S. National Honey Board sponsored her Display Class while Gamber Containers sponsored her other entries. Other winning Americans included Wayne Morris from Montana with Gold Medals for his Ross Rounds and Section Comb Honey and a Bronze Medal for Chunk Honey. Judy Schmaltz from Clarkston, Minnesota won a Gold for Crystallized Honey, and Ray Nicholson from Wadena, Minnesota won a Bronze for his Ross Rounds. Finally, Carl Webb, husband of Virginia, won a Bronze for the 24-Jar Class and a Bronze for his Beeswax Block.

Let me explain why the 24-Jar entry is so difficult. First, each jar must be in the same and perfect condition: no honey on lids, filled to an exact proportion, no smudges on the glass, no debris in the honey, etc. The 24-jar entry must also conform to European Union label regulations.

So how did Virginia get all that honey to Ireland, you ask? She mailed it to the hotel where she and Carl were staying. After arriving in Dublin, Virginia spent days in her hotel room cleaning jars, removing air bubbles, attaching labels, and ensuring proper levels of honey in each container. Not only does the honey have to be world class, but the container as well. Virginia and Carl Webb started working on their entries a year in advance. That's the kind of dedication it takes to win best in the world. Congratulations to all our stateside winners.

becoming president of Wilbanks Apiaries, Inc. Since that time he has been active in all aspects of the beekeeping industry. He was president for three consecutive terms for the Georgia Beekeepers Association and the American Bee Breeders Association. He's served as Chairman of the Georgia Farm Bureau Honey Bee Advisory Committee and as president of the American Beekeeping Federation in which he is still involved as a member of its Board of Directors. He served as a member of the American Farm Bureau Research Advisory Committee for fire ants and Africanized honey bees. In 1987 he was appointed by the U.S. Secretary of Agriculture to represent the U.S. beekeeping industry on the USDA *Varroa* Mite Negotiating Rulemaking Committee. He is a member of the National Honey Board and represents producer region six which includes Georgia, Florida and Puerto Rico. He is the past chairman of the University of Georgia Agricultural Experiment Station Research Advisory Board, and in 1984 he received the Georgia "Beekeeper of the Year" award. He also has numerous civic, state and local appointments to his credit. Reg is not only dedicated to his business, but also to the community in which he works and lives.

Wilbank's Apiaries operate approximately 6,000 colonies primarily for the production of package bees, which results in 15,000 – 20,000 packages a year. As for the queen rearing side of the operation, they run close to 15,000 mating nuclei which produce over 60,000 queens annually for sale worldwide. The colonies and nuclei are spread out over a six county area which keeps Reg and his employees moving. It is an impressive operation, and when I visited he and his crew of 20 were about to depart on a deep sea fishing adventure. After they returned to shore, Reg was treating them to a weekend of relaxation on the beach at Tybee Island. This business is hard work. He and his crew hustle year round from sun up till sun down. Reg realizes this and rewards his employees each year.

Before we finish, let's look at a typical year for Wilbanks Apiaries. South Georgia in January is still a little on the cool side. Red Maple, which marks the beginning of the season for Georgia, is fixing to bloom and a rigorous feeding program has begun for colonies selected for package production. This, in combination with the pollen collected off the Red Maple stimulates the queen to begin laying and colony populations explode overnight.

By the middle of February the grafting operation begins and newly grafted queen cells are coming off by the first week of March. These cells are placed into baby nucs which have been stocked and are ready for production. If all goes well, including no major weather systems or unforeseen problems, the first round of mated queens are ready for sale by the last week of March.

By the first week of April, an additional crew comes in to start shaking packages. This will last several weeks, usually subsiding by the first week of June. However, they will continue to raise queens through September. After the last of the packages are mailed out, the "shaking" crew shifts gears and begins to requeen every colony. As they enter each colony, they clean bottom boards, scrap off lids, and remove burr

comb between the frames, the top bars, sides, etc. When trying to produce 20,000 packages and 60,000 queens annually, speed is important. Colonies must be clear of burr comb and debris so frames come out easily without rolling bees and damaging queens. Materials that were ordered the first of July are arriving in the fall. By winter, packages are being assembled and repairs being made. Just as the hammer is put down January has arrived and the cycle begins again.

When I asked Reg why he choose beekeeping as a career he told me he enjoys working outside and with nature. He enjoys the constant challenge that beekeeping delivers on a day to day basis. How the nature of the job changes each day, each week, each month. He told me "beekeeping is in my blood" and in the blood of my sons. His two sons, Patrick and Timothy, comprise the fifth generation of Wilbanks beekeepers. When he was talking about why he loves working with bees and the challenges he faces, it sounded like so many other beekeepers I have spoken to over the years. I think there is something inherent in all beekeepers – a desire to work with one of nature's most fascinating insects.

Or else we're all a little crazy? Take your pick.

As we say in the south, see ya'll soon. **BC**

Jennifer Berry is the Honey Bee Research Technician at the University of Georgia Bee Lab.

Honey Bee Research

WHAT WE DO & WHY

Research is complicated and expensive. Here's why.

Jennifer Berry

Over the years we've all heard the rumors and read the comments about the corporate sponsored research conducted at universities here in the states; how research labs are funded by drug companies and therefore corrupt their own research; and how results are tainted to favor the interests of those paying the big bucks. In fact the perception still exists that professors and researchers actually laze around in seaside cabanas, drinking high priced bourbon, smoking Cuban cigars, discussing (in their best Old English Shakespearean accents of course) the latest on just how "the expression of the MRJP1 protein found in royal jelly and caffeic acid phenethyl ester derived from propolis may just possibly inhibit the reduction of pro-inflammatory cytokines by activated macrophages." Meanwhile, beekeepers are losing colonies left and right because the uninterested university types are too busy living the high life off the backs of the taxpayers. It's interesting how this kind of information can eventually become fact to some people.

Let me shed some light on the reality of the situation. Let's begin with the money trail and my experience here at the University of Georgia bee lab.

"Show me the Money!" Each year the bee lab receives a small allowance from the University of Georgia's entomology department, in the neighborhood of a few thousand dollars. This pays phone, electric, and water bills here at the lab. It is also used for some gas and repair expenses for our two state vehicles (1989 GMC, 1995 GMC). This money is divvied out from the College of Agricultural and Environmental Sciences to individual departments. Lean years, like those experienced lately, mean less money. The College of Agricultural and Environmental Sciences receives money each year from the state. This amount is determined by the state legislature. That's where the dean of the college comes in. Deans are political advocates for their particular College and hence the university. They spend a large portion of their time rubbing elbows with politicians in order to keep money flowing into their institution.

From time to time some federal money will trickle directly to certain departments. This is called Hatch money. It is usually earmarked for salaries to pay state employees like myself. However, sometimes there's money left over which buys a new copier for the department or replaces old computers for students and staff. Now, once in a blue moon a lab or department will be awarded a one-time gift from the state. In 2000, Dr. Delaplane was awarded money in order to build the lab I work in now.

Since we are located off-campus, we don't fall under the umbrella of the university building maintenance and janitorial services. All repairs and upkeep to the lab are our responsibility. When the AC goes out, we pay for it. When the walls need painting, we paint them. When the landscaping needs trimming, we trim it. There are also numerous items which we use on a daily basis that the lab supplies – things like computers, printers, books, tables, chairs, trash cans, cleaning products, toilet paper all come out of our budget. Lab supplies such as microscopes, dissecting tools, optic lights, alcohol, liquid nitrogen, CO_2, balance scales, Pyrex ware, sampling jars, freezers all come out of our budget. Hive tools, supers, queen excluders, frames, sugar syrup, bottom boards, lids, wax paper, pollen, foundation, hammers, nails, glue guns, drills, screws, queens, all come out of our budget. Hourly employees and graduate student assistantships come out of our budget as well. Gas and wear and tear on our state vehicles driving to and from experimental apiary sites come out of our budget. Travel to and from local and state meetings come out of our budget. This is just like any business but with one BIG exception – we don't sell anything. Therefore, we don't make any money. Hence we have to beg or borrow every cent we have to spend.

So, if the department isn't paying and the college isn't paying and the university isn't paying for the lab

Equipment purchased and assembled for research.

Equipment ready for bees.

to operate on a day to day basis, then who is? Ha, the money must be coming from big corporate drug companies, right? Well, actually no.

The majority of our money comes from competitive federal grants. In fact, since my tenure here at the lab we have had only one corporate sponsored grant. A company asked us to test a product which would possibly enhance the attractiveness of flowers to honey bees. We received $2000 for the project which didn't even cover the labor expenses needed to test the product in the field. We've also received research money generously awarded to our lab from the Georgia State Beekeepers Association for various projects that their board of directors felt were credible. Plain and simple, we would not be able to function as a research facility without grant money.

Each year the granting agencies publicize research agendas and the amount of money available. Therefore they dictate what research will be conducted for that particular year. Scores of proposals will be submitted for consideration with most of them not making the first cut. This can be extremely disappointing because writing a grant is no picnic. It can take months to properly prepare and submit a proposal.

If you are lucky enough (and good enough) to be awarded a grant it can take months before the check arrives to the university. Then depending on how the grant is worded there may be stipulations stating that the university receives 15-20% (or even more sometimes) off the top for overhead. Oh, and one more thing, when the government needs to make cuts to federal programs, guess where the cuts begin.

Here's a conservative scenario. A three-year research proposal submitted for 2006 with two other institutions with a budget of $100,000 becomes a $90,000 grant for the 2007 fiscal year. After the three-way cut and the univ ersity's take, this leaves $24,000 to fund a project for three years; labor and supplies not included. The next time you hear about all this "easy money" the government gives to research, think again.

Beekeepers often ask why it is that research takes so long. Let's look at the research aspect of the equation. Honey bee research on average takes several years, especially field research. The actual steps vary from project to project but here are the fundamentals. First an experimental design is created to test a hypothesis. Then funding attempts are made. Next equipment, bees and personnel must be conscripted and put into place. Then data needs to be collected and analyzed. If the data is worth reporting, a peer-reviewed paper is written and submitted. Extension personal then disseminate the information at local, state and national meetings. Our experience here at the lab has been on average two to three years from start to finish.

Let's start with designing the experiment. Research is the pursuit of causality: cause and effect. We want to pin down causation hence we design an experiment which will hopefully answer the question we seek. In order to pursue this answer, treatments are assigned. Treatments denote the different procedures whose effects will be measured and compared[1]. Here are a few examples of some pretty straightforward treatments we've used in the past: screened bottom boards-solid bottoms, small cell-conventional cell, old comb-new comb, resistant queens-non resistant-queens, isolated apiaries-non isolated apiaries, and nematodes-no nematodes.

In order for the conclusions of an experiment to be as accurate as possible, replications must be included as part of the initial experimental design. Research only examines a sub-set of an entire population. For example, we could not possibly examine every colony in every county and state. Therefore, an appropriately designed project requires as many replicates as physically and financially possible. By replicating, the experimenter increases the likelihood of detecting differences between the established treatments and at the same time decreasing experimental error. Experimental error includes all types of extraneous or unmanaged variation. Experimental error must be taken into account or the conclusions drawn may be false. Results of an experiment may not only be affected by the action of the treatments but also these outside sources which can alter the effect being examined. Natural sciences, especially field studies, are full of experimental error. Climate difference from year to year is an example of experimental error. That is why one must replicate over both time *and* space.

Another issue to consider when designing an experiment is how uniform are the experimental units being examined. The best way for me to explain is through an example.

For grins let's say we want to test a new concoction which has been flaunted as the next best thing for *Varroa* mite control. We have two colonies in the back yard that seem perfect for the project. We pour the potion into colony one but not into colony two. Two days later (as advertised by the producer of the product) we return and collect data on mite populations. Colony one we examine 100 cells of *worker* brood for mites. We find that colony one is completely void of mites. Excellent! The next day we return and count mites from the colony two. We examine 100 cells of *drone* brood and discover it is loaded with mites. This must mean the product works, because colony one had zero mites and colony two had lots. Well, not exactly. I realize this is an extremely simple example, but it is a good way to explain statistics.

Bee packages acquired from university hives awaiting assignment.

Grafting our own queens for experimental use.

Experimental colonies on their way to the cotton fields.

Varroa *free packages being prepared.*

Examining sticky sheets for Varroa *mites.*

First, we didn't standardize the experimental colonies. Colony one, which received the concoction may have been mite-free from the beginning, but since we didn't measure the mite or bee populations before we treated we don't know if was the action of the concoction that caused our measurements to show no mites or not. Then, we measured mites on different days *and* in dissimilar ways – worker-drone brood. Again, we did not standardize our data collection method. If the experimental units are not the same then what we measure isn't the same, and what we find can't be compared. That is why a fool-proof design is imperative.

Collecting data is a time consuming and laborious job. Trust me – I do it for a living. If data collection isn't done right, the results of the best planned experiment aren't worth the paper they're printed on. Bottom line: research is only as good as the researcher.

Moreover, statistical results can be presented in such a way as to support any theory you desire. Hopefully, the consciousness of the researcher wouldn't allow for unethical representation of the data, but I wouldn't be surprised if it's happened before. A great quote my dad always says "figures don't lie, but liars can figure." And there's another one I heard: "Lies, damn lies, and statistics." That is why we submit our research for peer review before it can be published. It's the scientific community's way of checks and balances. Research builds upon itself, but if the foundation is weak, that is, if bad research is depended upon, it is only a matter of time before it collapses.

See ya! BC

Jennifer Berry conducts honey bee research at the University of Georgia bee lab in Athens, Georgia. She is a frequent contributor to these pages.

---

1. *Cochran, WG & GM Cox (1992) The Contribution of Statistics to Experimentation. In Experimental Designs. John Wiley & Sons, INC.*

GORMANSTON

Meeting Ireland's Best

Jennifer **Berry**

Over the past 15 years, I've attended and presented at numerous beekeeping meetings from Georgia to California, Maine to Texas. I've also had the privilege to attend meetings held internationally in places such as Bolivia, England, and more. There is no doubt that these opportunities have been the highlight of my extension duties while at UGA, however, some of these meetings were better than others, and sadly there were a few that left me feeling unfulfilled to say the least. That said – what is it that separates the great meetings from the not-so-great? I'm of the opinion that good folk, good food, good drink, and good music are always a good start. I understand that most meetings, especially at the local level, are unable to put out the red carpet for just an hour, once a month. In contrast, the larger state meetings, often lasting a few days, have more flexibility.

Planning a meeting is much like planning a party – first and foremost you want your guests to enjoy themselves! In both cases it is often beneficial to employ an overarching theme. Is it a costume party, birthday party, cocktail party, shower, backyard BBQ, formal sit-down dinner, or casual shin-ding celebrating your bosses' retirement. For a beekeeping meeting, your "theme" is pretty much decided for you: it's a beekeeping meeting. However, depending on the length of the meeting, you may be able to play around with the individual evenings to spice it up a bit. For instance, at our 2006 EAS meeting here in Georgia, the Friday night banquet's theme was a "southern ball," where folks dressed up in their finest "Gone with the Wind" attire.

Next, one must decide who to invite to lecture at the meeting. Most topics allow for plenty of qualified candidates to choose from; however schedules do fill up fast so it's often smart to extend invitations at least a year in advance. I'm *already* working on speakers for 2014 for our Young Harris Bee Institute. If the meeting calls for multiple speakers try to select ones with varied backgrounds and expertise. You don't want five lecturers all talking about honey bee biology or mead making.

After your speakers are in the bag, start planning what food and drink will be provided. You may be able to use the theme of the meeting to help determine what and what not to serve. For instance, you wouldn't serve

Gormanston Castle.

kegs of beer and hot wings at a baby shower, but for an outside BBQ, it would be just fine. Another indulgence which should not be neglected, is the presence of *appropriate* music. Music adds background elegance which immediately sets the mood and relaxes folks, unless of course it's Guns and Roses or AC/DC.

Our primary reason for attending these meetings is to learn more about bees, however, it also offers the opportunity to establish new connections, see old friends and make new ones, or discuss the latest new widget or converse about some innovative management practice. Though facilitating information is the predominate priority, one should not do so at the cost of eliminating a chance to enjoy the company of others within a group linked by a common interest. Therefore, make sure to devote attention and planning to help cultivate a social atmosphere at your meetings as well.

As mentioned earlier, I've attended my fair share of meetings over the years, but one in particular truly exceeded my expectations. The Federation of Irish Beekeepers' Association, Gormanston Summer Course, in my opinion, sets the standard for what makes an enjoyable, informative, and well-rounded meeting. Not only is it held in Ireland, (which doesn't hurt) but it's hosted by Gormanston College, which touts a beautiful campus amongst a breathtaking landscape. Additionally, the college is equipped with its very own castle (it is Ireland folks . . .), not to mention the feral colony inhabiting one of the castle turrets. All of that aside, what really separates this meeting from the rest is the people. Both the organizers and attendees all seem to ooze with excitement and passion – you can't help but recognize they are really enjoying themselves.

The Gormanston Summer Course maintains a superior reputation not only among Irish beekeepers but throughout Europe as a whole. The college gets its name, Gormanston, from a tiny village located in the County of Meath, where the Summer course is held. Roughly 20 miles north of the Dublin airport the town consists of no more than a few homes, the college, and two pubs; the Huntsman and the Cock, of which the latter claims to be the oldest pub in Ireland. The college campus makes up the majority of the town and encircles the Gormanston castle located at its center. It's a fairly new castle by Irish terms, built only a *few* years ago back in the 14th century. The castle was constructed by the Preston family, who managed to hold onto their estate and the surrounding lands until the 1950s. The original patriarch of the Preston family was awarded the title of Viscount Gormanston. Viscount or Viscountess (for female) is a title given to European nobility, which according to ranking, is above that of a Baron but just below an Earl. The title is currently held by Jenico Preston, the 17th Viscount Gormanston, whom resides in London. However, the family sold the castle in the 1950s to the Franciscan Order of Friars, who founderd Gormanston College initially to serve as a boarding school for boys. After the Franciscans purchased the Castle they soon built a large addition which is now a public, coeducational, secondary Catholic school under the trusteeship of the Franciscan Province of Ireland. When school is out for the Summer, the college is open for groups and organizations to hold various camps or courses.

Lecture hall at Gormanston.

The first Summer course was organized in 1947 by the Federation of Irish Beekeepers' Association (FIBKA) and was held at the University College Cork (UCC) with Mr. H.J. Wadey, editor of *Bee Craft*, as guest speaker. Between 1947 and 1960 the host-site for this annual course hopped around the country until finally settling at Gormanston in 1961. Since that time, the FIBKA has held their annual Summer course solely at this location,

Judges at the Gormanston Honey Show.

Richard Jones of IBRA and Jennifer Berry.

Cows and castles.

Single women in search of men.

now totaling 52 years!

Every year since its inception, the organizers of the course extend invitations to international guest speakers. This list includes individuals from all over Europe, Canada and the United States. To mention a few, past speakers include: Dr. E.E. Edwards, Mr. A.S.C Deans, Dr. Colin Butler, Mr. C.C. Tonsley, Mr. Robert Couston, Dr. G.F. Townsend, Mr. Ted Hooper, Mr. Adrian Waring, Dr. Francis Ratneiks, Mr. Norman Carreck, Dr. Mark Winston, Sue Cobey, Mr. Clive de Bruyn, Dr. Keith Delaphane, Dr. Dewey Caron, and Prof. Robert Pickard. Their guest speaker for 2013 will be Mr. Fleming Vejsnaes from Denmark and 2014, Dr. Thomas D Seeley, of Cornell University. I had the privilege of serving as their guest speaker for 2012, an honor I will cherish for years to come.

The course spans an entire week, starting on a Sunday evening with closing ceremonies commencing Friday afternoon. Attendance currently ranges from 300-350 participants, and seems to generate an ever increasing audience. The first course had only 60 people. Attendees often take lodging in the dorm rooms on campus (no Holiday or Hampton Inns around here . . .). The campus contains a cafeteria capable of accommodating even the largest of crowds. They provide breakfast, lunch and dinner, each of which is served with a bowl of boiled or fried potatoes. The presence and availability of the cafeteria was a valuable resource as there aren't many other local places to eat, other than the pub. Absolutely no fast food chains, which was a pleasant change. Actually driving through a good portion of Ireland, I only saw one fast food joint, a Burger King. What a pleasure it was to stop in a town, find a local pub, have a warm bowl of soup, yummy brown bread, and cup of tea and not have it taste exactly the same as the previous pub's food. The Irish haven't homogenized their cities and towns yet and I for one believe they are all the better for it!

Jennifer with Gormanston hives and beekeepers.

The weeklong program was structured to benefit the needs of beginners to even the most advanced of beekeepers. Each afternoon was devoted to various workshops including: queen rearing, bee anatomy, morphometrics, wax-working, mead making, etc. The course also offers the Federation of Irish Beekeepers' Association examination, which is quite similar to our Master Beekeepers certificate, with entry levels leading up to 'Lectureship', which equates to our Master level. Last but certainly not least the course includes the Irish National Honey Show, often including participates which also take home top awards at the London Honey Show every October.

To reiterate, I believe the attention devoted to creating evenings filled with lively social banter is what really gives this course its unique charm, and separates it from the pack. Following a full day of listening to speaker after speaker, isn't it refreshing to have an unstructured, though guaranteed, hang out session to 'chew the fat' with a group of likeminded folks? Each night there was always a source of entertainment, from table quizzes to discussions, to competitions and music, song and dance. And let me tell you, the Irish love to sing! My favorite night consisted of the entire college meeting at the pub and having spontaneously generated a table vs. table singing contest; one person stood up and belted out a tune, upon their completion someone from the next table over jumped up and followed suit, and then the

next table and so on. Some songs were funny, some sad, some historic and yes, some even a bit bad, but all in all it was just what everyone needed! When it was my turn to sing, I shamefully resorted to "Home on the Range." Perhaps not the best choice, I admit, but in the heat of the moment I couldn't remember the first stanza of "Georgia on My Mind" and had to improvise. At the conclusion of the course I departed feeling I had learned so much, met some amazing people, and obtained so many wonderful memories.

There was a legend told to me while at Gormanston I feel I must share. Myth holds it that when a family patriarch is in his final hours, the foxes of County Meath, with the exception of nursing vixens, emerge from their earths and make way to the door of the Gormanston Castle to keep vigil until his passing to show thanks for the deliverance and protection from marauding predators provided by the previous Lords.

Following the conclusion of the conference I traveled to visit a few friends. My first stop landed me in Hillsboro, Northern Ireland to visit with Michael Young, MBE and his lovely wife Rae. Next I ventured across to Gallway and Liscannor for a hike along the ocean and then southeast to Tipperary where I initiated the beekeeping side of the trip.

I stayed with Mary and Gerry Ryan, who both hold the equivalent of our Master Beekeeping Certification and are wildly involved in all aspects of beekeeping. They live outside of Dundrum, in the county of Tipperary. And yes, it is a long way to Tipperary with roads no wider than a mid-sized car, squeezed between sheep pastures, rock walls, hedges, and cliffs. I must admit, however, once I was finally able to pry my white knuckled fingers from the steering wheel, I was completely entranced by the scenic landscape. When I arrived at the Ryan's farm, I came to find Michael Gleeson and Jim Ryan there as well. It was a like a mini Gormanston reunion. The duration of my visit featured a whirlwind of touring castles, abbeys, pubs and apiaries.

One fond memory of mine is visiting Micheál Mac Giolla Coda's bee breeding operation. Micheál is the chairman of the Galtee Bee Breeding Group (GBBG), a group dedicated to the study, improvement, conservation and propagation of the native dark European honey bee, *Apis mellifera mellifera*. Impressively, they have been at it now for over 20 years. In the beginning, there were only four members: Micheál Mac Giolla Coda, Redmond Williams, David Lee and Johnny Carrigan. Over time, membership has grown along with the implementation of a few program objectives: a simple system of colony evaluation, record keeping, culling and selection. Any colony showing undesirable traits such as over-aggressiveness and excessive swarming are re-queened at once while colonies with the desired characteristics (gentleness, decreased supersedure, longevity, productivity and purity of strain) are selected.

Each year improvements are made to the local stock via selection methods coupled with morphometric analysis. Additionally they utilize instrumental insemination from selected queens and drones to produce numerous combinations for queen-distribution to members who are then encouraged to keep records. Queens selected to stay in the program are allowed to propagate drones in order to saturate not only the breeding apiary but the whole of

Philip McCabe PRO FIBKA, Gerry Ryan Summer Course Convenor, Seamus Reddy President FIBKA, Jennifer Berry, Eddie O'Sullivan, Past President FIBKA, Mary Ryan Summer Course Convenor, Terry Clare President BIBBA, Alan Jones Executive BIBBA.

Galtee/Vee Valley. Just for reference, the Galtee/Vee Valley is located in southern Tipperary County. The Galtee/Vee valley is positioned between the mountain ranges of the Galtees and the Knockmealdowns and runs about 15 miles long and five miles wide. In the center of the valley, the GBBG has established a breeding apiary, which serves as the headquarters for most of their activities.

Education and training is another endeavor of the GBBG. Workshops devoted to honey bee improvement and queen rearing, winter discussion groups, along with a quarterly newsletter called "The Four Seasons" are all ways they facilitate information to beekeepers.

On a side note, and a cause of concern to the GBBG, up until several years ago, the Emerald Isle was off limits to the importation of exotic (non-endemic) honey bee stock. But recently the Northern Ireland Ministry of Agriculture has reversed their original ruling and now allows the importation of queens from different parts of the world. The members of the GBBG, along with other Irish beekeepers, fear that if this trend continues it may have deleterious effect on the purity of their native bee which they have tried so hard to preserve.

If you are searching for a vacation opportunity that includes a bee meeting, look no further, you must attend the Gormanston Summer Course! I can't imagine you will

Singing contest.

Micheál Mac Giolla Coda and his daughter Aoife examining mites under the scope for bite marks, a sign of grooming behavior.

From left to right, Michael Gleeson, Jennifer Berry, Mary Ryan, Jim Ryan and Gerry Ryan.

leave disappointed. And if you're a president, board member, or on a planning committee that organizes meetings of your own, take notes while you're there. These folks really know how to put on a top-notch meeting.

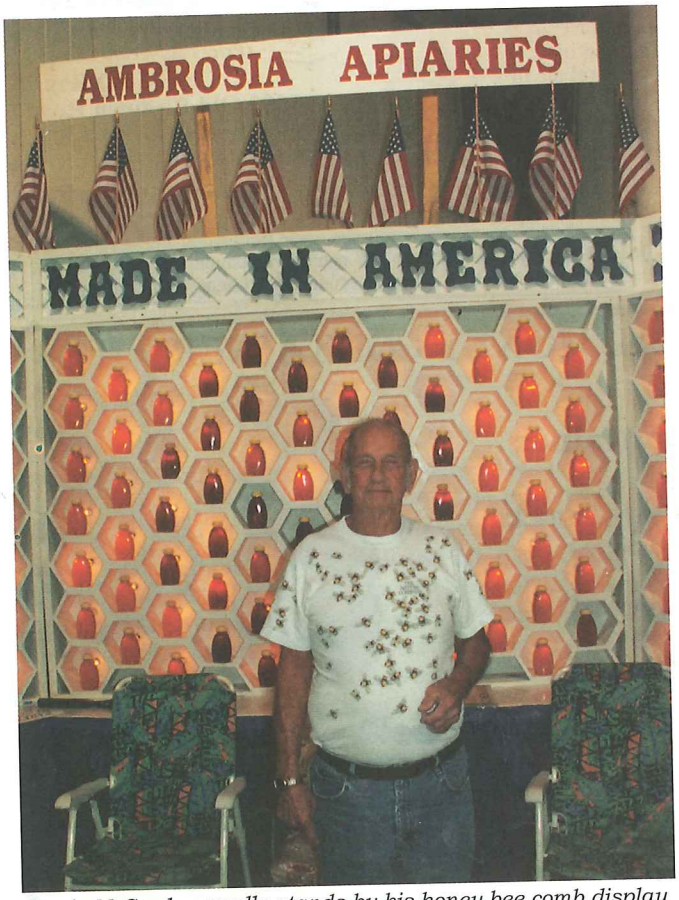
I want to extend thanks to all my friends in Ireland that contributed to this amazing adventure. Michael Gleeson, thank you for inviting me to be a guest lecturer at Gormanston 2012, and for the information you provided for this article. Kevin Lincoln, thank you for permitting use of your beautiful photos. Mary and Gerry Ryan as well as Michael and Rae Young, thanks for your generous hospitality. Jim Ryan, Eddie O'Sullivan, Eamon Magee, Seamus Reddy, Richard Jones, Micheál C. Mac Giolla Coda, Aoife NicGiolla Coda, Ben Harden, Terry Clare, and Dennis Ryan thank you for your gracious help, beekeeping wisdom, guidance and friendship. And to Brother Kennedy, a spry 80-year-old veteran beekeeper and author, whose first words whispered to me were, "When it comes to bees, there is always more to learn . . ."

And learn more I will! BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

Jessie McCurdy – A Georgia Institution

Jennifer Berry



Jessie McCurdy proudly stands by his honey bee comb display at the Georgia National State Fair.

This past Summer Dan Harris (our lab technician) and I traveled to Perry, Georgia to relocate some colonies. We were in search of a Summer nectar flow. We had 40 colonies with newly installed packages on wax foundation. The bees needed a flow in order to draw out the comb and hopefully store enough honey to survive over Winter. Unfortunately, in Athens, the nectar flow usually shuts down by the end of Spring. Except for a few gardens here and several flowers there, the bees can't find a drop of nectar for the remainder of the year. However, just three hours to our south it's a whole different ballgame. Summer time in South Georgia offers a bounty of nectar and pollen from fields planted with a variety of crops. From horizon to horizon, laid out in a patch work of green carpet, you have cotton, cantaloupe, peanuts, watermelon, squash, soybeans and a variety of other crops just begging for bees.

But not any ole' field would do, so we asked our friend Jessie McCurdy for help. His bees have been pollinating crops in the Perry area for decades. He knows the farmers, fields, and when and where to expect a flow. He knows which cotton fields are fixin' to bloom, or which cantaloupe field isn't worth putting bees on (because they didn't irrigate). Within a few hours our bees were sitting on the edge of a cotton field that bees dream about; for as far as you could see, cotton blossoms in all directions.

Since Jessie came to our rescue, it was our turn to return the favor. We drove over to an apiary of his which was located next to a cantaloupe field. He wanted to pull some honey. No problem, we thought until we saw his colonies. Jessie doesn't use mediums or shallows for honey supers. Oh no, he likes to super his colonies with deeps. These were the heaviest supers I've ever encountered. Dan and I were struggling with one super when Jessie sprints past us with his own deep super. He picked up those supers like they weighed no more than a quart of honey and slung them onto the back of the pickup like they were pillows. Did I mention he just turned 76?

Jessie became a beekeeper when he was 10 years old. He didn't come from a long line of beekeepers like some. Neither his grandfather nor uncle showed him the ropes. No brother or father encouraged his interest. Nope, Jessie was the first McCurdy to mess with bees and it came purely by accident. One day Jessie noticed a neighbor's pine tree had bees flying in and out of a small hole. Wanting to harvest the honey, he asked permission to cut it down. It took him two weeks to finally chop down and split open that tree. He couldn't wait for that delicious, first taste of raw honey that he himself removed. However, the great expectation of his sweet reward was not granted. The honey he extracted from the tree tasted like turpentine, but he ate it anyway, all by himself. "I worked too hard to let it go to waste," Jessie explained. He made a box for his new pets which survived for years. Hence his beekeeping days began and he's been playing with them ever since. That was 66 years ago.

Jessie grew up in Albany Georgia, just off of Lonesome Road. For all you Yankees up there, that's southeast of Columbus and about half way between Atlanta and Tallahassee. It's just north of Putney and south of Leesburg. You can't miss it. However, I guarantee if you are not from South Georgia you will mispronounce the name. Trust me Albany, New York is pronounced differently than Albany, Georgia. Just ask anyone who lives there.

Throughout his youth, Jessie kept bees and made a little money here and there selling honey. But it was only a hobby and not a way of life. After high school Jessie joined the Navy. Four years later he decided to join civilian life and went to Americus to attend trade school. That's were he met his wife Hazel.

After they were married they moved to Perry, Georgia

Jessie explaining the wonders of the hive to kids and moms alike.

were they still reside today. He became an electrician by trade and started his own TV and radio repair business. Jessie and his wife Hazel had three boys and one girl, none of whom followed their daddy's passion for bees. In 1974 he went to work for Pap's Brewing Company. "It was a very nerve wracking job, but when I came home, I would go out and work the bees. Their humming would relax and calm me. I would feel closer to nature and God. It also helped me renew my faith in man kind".

Fifteen years later at the age of 58, Jessie found himself out of work due to the company downsizing. Jessie explained that it was difficult for him to find a job. "Companies didn't want to hire someone who was technically so close to retirement" he said. Jessie decided it was time to expand his honey bee hobby into a full time business. He quickly increased the number of hives and eventually maxed out at 800 colonies. He figured with all the agriculture in the area, pollination was a sure thing. He drove from field to field talking to farmers about the benefits of pollination by bees. The first crop his bees pollinated was apples. He charged only $8.00 per hive. After a few years his services were in such high demand he had to conscript the help from other beekeepers.

But making ends meet as a beekeeper wasn't easy. So, Jessie honed in on his wood working skills and began building his own equipment; something he still does today. When ever he spies a dead pine tree in the area, Jessie has it cut down, and sawn into boards. Then with his numerous saws and tools, he sculpts these boards into boxes, frames, lids, bottom boards, and whatever else comes to his mind. But not a shred of wood is ever wasted. Even the saw dust is used as mulch on their flower beds and gardens.

Pollination is still a major part of Jessie's business but more recently he has started selling specialty honeys. In the Perry area his bees collect wildflower, cantaloupe, Paulownia, and cotton. To his south they collect Tupelo, and orange blossom and to his north Sourwood.

He said "he was tired of hearing people saying all honey tastes alike." They've just never tried the different kinds" he explained.

Jessie still sells honey out of his house, but his biggest market is the Georgia National Fair. He and his wife have been a permanent fixture at the national fair for 18 years and plan on being there another 18; "if the good Lord allows", he says.

Jessie, Hazel and their son Chip are at the fair from sunup to sundown, every day for 14 days; not including the two weeks it takes to set up and tear down. They love being a part of the fair but it is hard work. Years ago, Jessie built a display (pictured) to reveal how honey comes in a variety of different colors. It is a huge crowd pleaser. He also sets out samples of wildflower, orange blossom, Tupelo and Sourwood for people to taste. "They are always amazed at the differences between them" Jessie said. Not only do they sell honey, they educate people about the little girls that produce it. There is an observation hive for people to explore, displays and brochures about Africanized bees, and CCD and even information on how to become a beekeeper. He wants the public to be aware of how important honey bees are and to understand how different our food source would be without them.

Jessie says he is nervous about the future of bees. I expressed to him how hard it must have been the year *Varroa* arrived and he explained "that was nothing compared to this year." To start, the drought kept numerous wildflowers from blooming. If crops were not irrigated, they didn't have a chance of surviving. "It was the driest year I've ever experienced" he said. Next he explained how the wildfires which burned out of control for weeks kept a blanket of smoke over much of south and central Georgia. "Some days the smoke was so thick the bees couldn't fly." Days of nectar foraging were lost due to the bee's inability to forage. Farmers started to complain about crooked vegetables and low yields. Then to top it off, he told me how the small hive beetle populations have ex-

Jessie in the field.

Jessie pointing out newly defoliated cotton fields.

ploded. Since the area around Perry has such a high volume of cantaloupe and watermelon fields, small hive beetles thrive. By the end of Summer colonies were dropping like flies all over South Georgia. Some beekeepers reported losses up to 90% from beetles. Jessie explained that this has been by far his worst year. "The mites are hard enough to deal with, but add beetles and boy it's hard to keep bees" he said.

Jessie and Hazel own and operate Ambrosia Apiaries. I've known Jessie and Hazel for almost 10 years now. They have both been extremely helpful whenever the lab or I have asked for help. They have also done a tremendous service for the beekeeping industry here in the state of Georgia. Not only with the exposure beekeeping receives at the fair (The Georgia National Fair committee expected over 450,000 visitors this year), but also their work with local schools, clubs and organizations. That's a right many folk that's been exposed to the wonders of honey bees over the years. Thank you Jessie and Hazel!

A quick note about Winter colony management in the south.

This year our southern bees have really been put through the wringer and it looks as if they're not out of the woods yet. According to meteorologists, if current predictions are correct, the southeast will experience an exceptionally dry Winter. This means bad news for our spring nectar flows. Here in Georgia, the bees are still flying on occasion which means they are consuming honey faster than they should. You will need to check your bees often to make sure they have plenty of food. If it doesn't rain, the red maple flow may be severely hampered. Pollen patties are a great remedy for poor pollen collection. I usually mix fresh pollen, brood builder (half and half) and honey to make a hamburger size patty. We've noticed some of our colonies collected plenty of goldenrod pollen, but other sites have very little. We will definitely be feeding pollen patties by the end of January. Another thing, plenty of creeks and ponds dried up this year meaning water sources are becoming scarce. In the past, we've never had to worry about this. Not any more. Make sure your bees have access to water. Even during the Winter months bees need water. Take care of those little girls, they've had it rough.

Hope your bees are merry and your Christmas white. See ya! BC

Jennifer Berry conducts honey bee research at the University of Georgia bee lab in Athens, Georgia. She is a frequent contributor to these pages.

Replace That Old Comb

Here's why!

Jennifer Berry

Some time ago I completed a project on the effects of old comb versus new comb on honey bee colony growth, brood survivorship and adult mortality. This paper was originally published in the *Journal of Apicultural Research* 40(1): 3-8 (2001). (To read it in its entirety go to our website **www.ent.uga.edu/bees** and click on the research archives icon.) Here is a shortened version of that research.

This topic is still timely because of the more recent findings regarding chemical residues in wax and pollen in colony comb, and, because this is the time of the year it is easiest to remove that old, disease-ridden, chemical laden junk, and replace it.

Honey bees use structures like trees and man-made hives for shelter, but it is the beeswax that provides the basic building material for the interior nest substrate. Adult worker bees secrete oval shaped wax scales from glands located on their abdomen and then modify these scales with mandibular gland secretions in order to construct the comb. Wax secretion usually occurs during peak foraging times because large quantities of honey or nectar must be consumed by the worker bees in order to produce these wax scales (Gary, 1992). The comb, made up of an array of hexagonal cells placed back to back, is the site where immatures are reared and food is stored. The comb also plays an important role in communication by providing the substrate on which dances are performed and chemical messages transferred (Winston, 1987).

When comb is first constructed it is pliable and nearly white in color but changes over time due to constant use and incoming resources. Comb used for food storage takes on a yellowish hue due to the accumulation of pollen (Free & Williams, 1974). As comb used for brood rearing ages, it becomes darker, almost black, and more brittle (Hepburn, 1998) because of accumulated fecal material (Jay, 1963), propolis and pollen (Free & Williams, 1974). The darker color may also be a result of numerous contaminants that are collected and absorbed in the wax over time.

Wax comb consists primarily of hydrocarbons and ester components with a small percentage of free acids and alcohols. These minor components are believed to give wax its plasticity (Tulloch, 1980) and ability to absorb many types of materials. Some of these materials include fungal and bacterial spores, pesticides and heavy metals which may be detrimental to a colony's welfare. Here is a list of some biotic and abiotic contaminants found in wax.

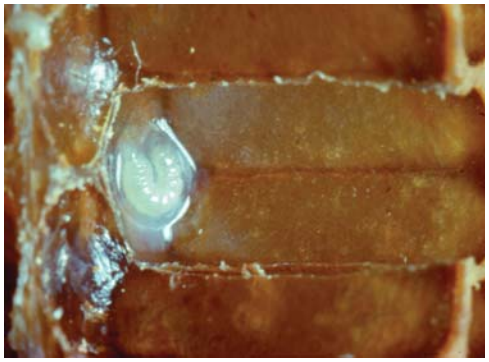
Biotic: American and European foulbrood spores, Chalkbrood spores, Nosema

Abiotic: Amitraz, Arsenic, Azoxystrobin, Boscalid, Bromopropylate, Captan, Carbaryl (Sevin), Chlordimeform, Chlordane, 2-chloroethanol, Chlorpyrifos, Chlorothalonil, Chromated copper arsenate, Copper naphthenate, Coumaphos (CheckMite+®), Diazinon, 4,4'-dibromobenzophenone, 1,4-dichlorobenzene, Dicofol, Endosulfan, Esfenvalerate, Ethion, Ethylene dibromide, Fenthion, Fluvalinate (Apistan™), Malathion, Menthol, Methomyl, Organochlorine (multi-residue), Organophosphorus (multi-residue), Methyl parathion (Penncap-M), P-dichlorobenzene, Pentachlorophenol, Phenkapton, Phenol, Phenothiazine, Polychlorinated biphenyls, 2,4,5-T,Tributyltin oxide (TBTO), Vinclozolin

As materials accumulate in wax comb the diameter of cells becomes smaller (Winston, 1987). Each time a larva pupates, it spins a silken cocoon, parts of which remain in the cell after the adult emerges (Jay, 1963). Over time, the mass ratio of silk to wax increases, and thereby wax comb goes from a single-phase material to a fiber-reinforced two-phase composite product (Hepburn & Kurstjens, 1988). The bees, along with the cell size in old comb, are smaller.

Pheromones also are absorbed and transferred in the wax comb and, depending on their volatility, may remain for a considerable time (Naumann et al. 1991). One pheromone group relevant in the current context is brood pheromones. These contact pheromones are emitted by brood and communicate to nurse bees the immatures' presence, age and nutritional needs (Free, 1987). Nurse bees, responsible for brood care, detect these pheromones more readily in older comb, and feed the brood more often. Therefore, larvae reared in comb with a previous history of brood rearing may receive somewhat better care with resultant higher survivorship (Free & Winder, 1983).

Prior to the presence of *Varroa destructor* (Anderson and Trueman) in the United States, wild, temperate honey bee colonies were known to survive for about six years (Seeley, 1978). Once the colony died, wax moths, mice and other nest scavengers usually removed the wax comb, leaving an empty cavity for the next colony to inhabit (Gilliam & Taber,



New comb cells are lighter in color and larger. (Jaycox photo)

1991). Modern beekeeping practices disrupt this natural recycling process by housing bees on semi-artificial comb that may be years or even decades old. Advances in beekeeping equipment, like the Langstroth hive and wire-reinforced foundation, have added years to the longevity of wax comb.

In the United Kingdom, beekeepers are encouraged to replace old combs as part of good husbandry practices (Brown, 1999). In the United States, Bonney (1990) recommends replacing two of the oldest combs each year to ensure that the hive body will not contain comb over five years old. Nowadays this may even be too old. Even so, many beekeepers believe that it is not economically feasible to regularly remove and replace old comb. Not only is the new foundation expensive and time consuming to replace, there is an energetic cost for the bees who must draw out the foundation into a functional comb using metabolically-derived beeswax. The typical nest contains around 100,000 cells (Seeley & Morse, 1976) which takes about 1,200 g of wax to construct. The amount of sugar required to secrete the wax is energetically equivalent to 7.5kg (16.5 lbs.) of honey, about one-third of the honey stores consumed by a colony over winter (Seeley, 1985). Therefore, beekeepers believe they lose money, time and honey yields by replacing old comb.

However, it is possible that the economic savings of using long-lasting comb may be offset by deleterious effects of old comb acting as a biological sink for toxins and pathogens or as a physical constraint on larval development. This question led me to investigate the effects of comb age on honey bee colony growth, brood survivorship and adult mortality.

In a three-year field study, we compared the quantity of brood produced, brood survivorship, average body weight of adult bees and population of adult bees in colonies housed on brood combs comprised of either old beeswax or newly drawn, first-year beeswax.

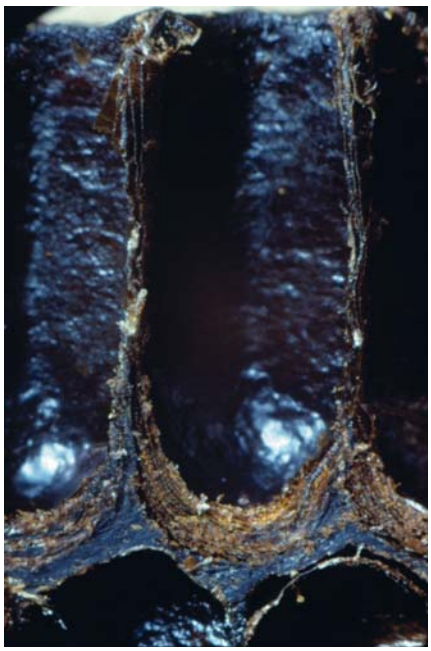
Outcome for this particular study resulted with colonies maintained on new comb having a significantly higher area of total brood, area of sealed brood and higher young bee weight. Comb age produced no statistically significant treatment effects in ending adult bee population or change in adult bee population; however, the trend was for higher ending bee populations in new comb and, correspondingly, a greater loss of bees in old comb. Brood survivorship was either unaffected by treatment or higher in the old comb class.

The increased brood production measured in the new comb may have been the result of several different events taking place inside the colony. It may have been due to the survivorship of the brood, quality of brood care delivered by nurse bees, or the queen's egg production. Let's review the latter. Queens are able to distinguish between worker cells and drone cells by appraising the width of the cell with their forelegs (Koeniger, 1970). The cell diameter in old comb become smaller over time (Abdellatif, 1965); thus, an average reduction of cell diameter in old comb may have a negative effect on a queen's egg-laying productivity.

Older comb is also known to harbor numerous pesticide residues and diseases which may be detrimental to the brood's health. They're spread from colony to colony by tainted wax and materials brought into the hive. The queen may be sensitive to these contaminants and not lay eggs in particular cells. Also, the old comb may harbor brood pheromones (Free & Winder, 1983) that act as egglaying inhibitors to the queen because she perceives the cell to be already occupied.

Another phenomenon relevant to this study is the observation that bees prefer to store honey and pollen in cells that have been previously used for brood rearing. In the wild, as a colony grows and continues to add new comb, brood rearing gradually shifts into this new comb and the honey is stored in the old brood comb (Free & Williams, 1974). In unmanaged colonies this behavior may serve to avoid the negative effects of old comb on brood production. However, modern beekeeping practices inhibit this natural process by forcing bees to reuse old brood comb for brood rearing and to store honey in comb usually only used for honey storage.

Higher weight of emerging young bees in new comb is best explained by differences between the average diameter of cells in the two comb age classes. As mentioned before, while brood comb ages, the diameter of the cells decreases due to accumulated cocoons and fecal material that are deposited by the larval and pupal instars developing within the cell (Jay, 1963). The body weight of a worker bee is mediated by genetics (Ruttner & Mackensen,1952) as well as by environmental effects such as the amount of food fed to larvae (Daly & Morse, 1991; Fyg, 1959) and the size of the natal cell (Jay, 1963; Abdellatif, 1965). Buchner (1955) determined that the mean weight of newly emerged bees from old comb in which



Would you raise your young in this environment? (Jaycox photo)

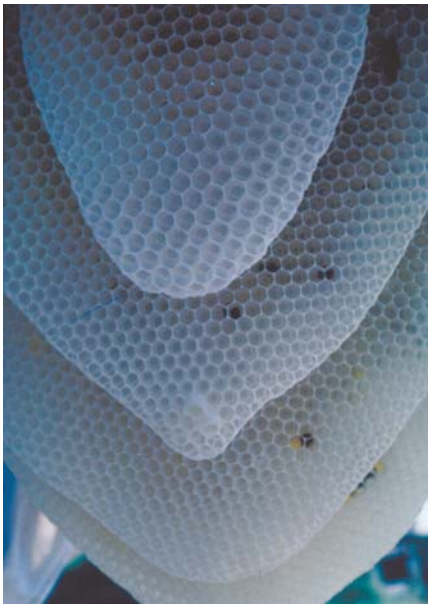
68 generations had emerged was about 19% smaller (96.1 mg) than the controls (118.3 mg). Morphological characteristics of European worker bees reared in smaller Africanized comb were smaller than those of European bees reared in the larger European comb (Rinderer et al., 1986). Daly & Morse (1991) found that larger worker bees could be reared from the large cells of drone comb. Glushkov (1958) discovered that bees reared in enlarged cells were heavier and larger resulting in more honey being produced by the colony and larger cells constructed. Worker larvae reared in enlarged cells received more food (21% more protein and 39.7% more glucose) than worker larvae reared in normal worker cells (Volosevich & Kulzhinskaya, 1953). The bulk of the evidence suggests that the weight of newly emerged bees is proportional to the volume of the cells in which they are reared (Nowakowski, 1969) and the amount of food fed to them by the nurse bees.

In this study bees reared in new comb weighed about 8.3% more than those reared in old comb, which is similar to Abdellitif's (1965) finding that worker bees reared in old comb in which 70 generations had been reared have an 8% reduction in body weight.

Lower bee populations in the old comb may result from an accumulation of foreign contaminants sequestered in the older comb causing higher mortality. Also, contaminants in the wax comb may mask hive signature and nestmate recognition cues, making it difficult for foraging bees to return to their own colony. Some nestmate recognition cues are obtained from the wax comb (Breed & Stiller, 1992), and Breed et al. (1988a) discovered that colony odor acquired from wax comb can mask the genetic differences between bees. Colony odor is transferred to the adult bees by exposure to the comb substrate and can alter the recognition phenotype in as little as five minutes (Breed et al., 1988b).

Brood communicate to the worker bees their presence in the cell, caste, age and hunger levels through mechanical and chemical signals (Free, 1987). The chemical signals are the brood pheromones that may be the causative agent responsible for the increased survivorship found in old comb in this study. Wax comb acts as a reservoir for absorbing and transmitting pheromones which may explain why honey bee swarms are more attracted to older comb (Naumann et al., 1991). The presence of brood pheromones stimulates pollen foraging (Pankiw et al., 1998), enhances brood recognition (Le Conteet al., 1994) and stimulates nurse bees to feed larvae (Le Conte et al., 1995), all of which are important factors in brood survivorship. Free & Winder (1983) determined that brood survival was greater in cells which had been used previously for brood rearing than in comb cells never used before. Taken together these studies demonstrate that pheromones incorporated in wax comb may improve brood survivorship. The differences in brood survivorship noted in this study may be partly explained by more optimal concentrations of brood pheromones in older comb. In this study we found the seemingly paradoxical results of higher brood production in new comb but higher brood survivorship in old comb. We believe that this is best reconciled, internally and with the literature, by positing that the egg-laying rate of queens is highest in new comb, but once placed in a cell the chances of a larva's survival are best in old comb. Nevertheless, overall brood production is highest in new comb. Apparently the benefits of maximized egg production exceed the benefits of maximized brood survival.

Over three years of field study, honey bee colonies housed on new comb had higher area of total brood, area of sealed brood, and weight of newly emerged bees. Brood survivorship was the only variable significantly higher in old comb. And finally, mortality of adult bee as affected by the age of comb in which they were reared or maintained was lower in new comb but not significantly. The bulk of the evidence suggests that new combs optimize overall honey bee colony health and reproduction. These findings suggest that beekeepers should eliminate very old brood combs from their operations. BC



Naturally drawn new comb is white, and generally quite fragile

Jennifer Berry is the Research Coordinator at the University of Georgia Bee Lab.

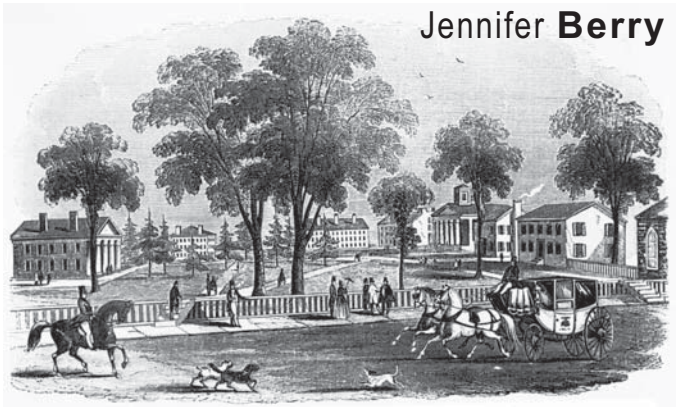
References for this article will appear on Bee Culture's web page.

Morrill In Action

UGA

The University Of Georgia

Jennifer **Berry**



Franklin College.

When choosing a college, most students have an array of different reasons for wanting to attend this one over that one. For instance, a recent graduate who wants to study the fine art of ballet probably would not apply to MIT**,** and one wanting to become an atmospheric scientist would stay away from Juilliard.

When I was exploring graduate programs, I narrowed my search for a particular school pretty fast. First, I had to have a decent Entomology Department. Second, I refused to live in a big city again since I had just left Hollywood, CA. And, third, I didn't want to move to a state where I had already lived. These may have been pretty lame reasons, but I was older and knew a little more about what I wanted to do and where I wanted to live. Whether or not the school had a good football team was the least of my concerns. Once I narrowed the list, only two schools remained; this presented a difficult decision. Then, a professor friend of mine told me where he had received his PhD and how much he loved not only the school but the town and the people, as well. I was sold. So, I packed my bags, cats and dogs, loaded the truck, and headed to Athens, Georgia – home of the University of Georgia (UGA).

UGA is big news here in Georgia, not only because of the Bulldogs, a nationally-ranked football team (yes, even after their recent, horrific loss to South Carolina), but because UGA is, well, the University of "GEORGIA." UGA, with nearly 10,000 faculty and staff across the state, is one of the largest employers in Georgia. UGA owns 39,395 acres of property, consisting of six campuses across 30 counties, as well as numerous farms and research facilities. The annual budget to run the university this year is $1.32 billion, 29% of which is provided by the State of Georgia. The money provided by the state has been a recurring political issue since the economy went south. When the State of Georgia can't pay its bills, and, by corollary, the budget is out of balance, education always seems to be the first item on the chopping block. According to Georgia's constitution, the budget must be balanced. This is a good thing for the state in the long run. However, it is hard on those in education who have lost their jobs or gone without cost of living increases for over five years.

UGA houses numerous colleges offering 79 programs, including the colleges of Agricultural and Environmental Sciences (to which our lab belongs), Arts and Sciences, Business, Ecology, Education, Environment and Design, Family and Consumer Sciences, Forest Resources, Graduate School, Journalism and Mass Communication, Law, Pharmacy, Public Health, Public and International Affairs, Social Work, Veterinary Medicine, the GHSU/UGA Medical Partnership, and Engineering. This abundance is necessary to afford the 26, 571 undergraduate and 8,194 graduate/professional students plenty of choices. That's a grand total of 34,765 students! And, I thought things were big only in Texas.

The students at UGA are also involved in extra curricular activities. UGA recognizes over 600 registered student organizations, which include 32 social fraternities and 26 social sororities.

An overwhelming number of high school students, particularly in Georgia, want to attend UGA – one of the largest schools in the South East. Lamentably, there are only so many openings each year, and acceptance into UGA has become extremely competitive. For example, last year, the average GPA score for the 4,685 entering freshmen was 3.8. That's a pretty high standard for a state school. And, among these new, bright-eyed students, 97 percent of the in-state freshmen have earned the HOPE Scholarship, which is funded entirely from revenue generated from the lottery. It is available to Georgia residents whose academic achievements are above par. The program basically pays for a student's educational costs while attending a HOPE eligible college in Georgia.

UGA also has quite a history. First, it's the country's first chartered public university. It was established on January 27, 1785 by the Georgia General Assembly and it is the oldest public institution of higher education in the United States. The University's first president was Abraham Baldwin. He held the radical position that higher education was "a public good, not a private privilege, and should not be exclusive to those of wealth."

But, it wasn't until 1799 when the university actually began. During a meeting of the Senatus Academicus (a joint assembly of the Board of Visitors and the Board of Trustees, both presided over by the Georgia Senate), 633 acres of land was set aside in order for the university to be built. The land was located along the banks of the Oconee River, in the heart of Athens, Georgia. Two years later the first class was held in a clearing which is now the historic section of UGA's North Campus. The first class graduated on May 31, 1804. It wasn't until 1806 that the first brick building was constructed on campus. It was named Franklin College in honor of Benjamin Franklin. It is still in use today, housing administrative offices and classrooms. The Board of Trustees, which replaced the *Senatus Academicus* in 1859, has been in service ever since. While great hopes were raised when Abraham Lincoln signed the Morrill Act in July, 1862, portending federal support for state institutions of higher learning, there was a slight obstacle that got in the way for Georgia: War!

On January 18, 1861 Georgia seceded from the union and, by February 5th, was the fifth state to join the Confederacy (Confederate States of America). On April 12th, 1861, Civil War hostilities began when the Confederate forces attacked Fort Sumter – a U.S. military installation in South Carolina. It marked the beginning of the "War Between the States" with battles raging for years, primarily in the south, and resulting in the deadliest war ever in American history with over 750,000 soldier and civilian casualties. It finally came to an end on April 16, 1865, which was four months after Sherman's famous "march to the sea" and the capture of Savannah.

Before the long march ended, Sherman had seized and burned most of Atlanta to the ground. Remember that famous scene in *Gone With the Wind* when Rhett so gallantly saves Scarlett, Melanie and Prissy? He whisked them away through the streets while railroad cars exploded and criminals tried to take their horse and buggy. Well, that was the old Atlanta.

Once he was satisfied that Atlanta would not stand again for some time, Sherman stripped his army of all non-essentials and proceeded to march southeast through Georgia. The result was that parts of Georgia lay completely in ruins. Farms were raided and destroyed. Tens of thousands of livestock were slaughtered or seized. Homes were burned. Millions of pounds of corn and fodder were confiscated. Hundreds of miles of railroad, bridges, and telegraph lines were demolished. Cotton gins and mills were burned to the ground. And, the psychological damage as a result of Sherman's destructive swath affected Georgians from the mountains to the southern border for years to come. Thousands of civilians were either killed or arrested as traitors, including women and children.

One of the University of Georgia beeyards.

Georgia was the last of the Confederate States to reenter the Union in June 15, 1870. Its infrastructure and economy were in shambles. As a result, Georgia remained poor and didn't recover until well into the 20th century. However, there was a small glimmer of hope when the State Assembly gave $300 to the injured soldiers who served in the war. And, there was another flicker of light that would soon shine as well.

During the war, Abraham Lincoln signed the Morrill Act of 1862 which granted federal land to the states for the establishment and funding of educational institutions. It also provided for the education of people from all social classes in agriculture, mechanical and other applied fields.

Understandably, the states that had seceded from the Union were not eligible for the benefits of the Morrill Act right away. UGA had to close its doors for a little over two years during the war. Soon afterwards, the enrollment peaked at 78 students. Eventually, the Morrill Act helped with the creation of the UGA College of Agriculture and Mechanical Art, opening May 1, 1872.

Michael Adams, current president of UGA, wrote, "the

Morrill Act, too, sees higher education as a public good, a means not only to educate young people but to be of broader benefit to all the people of the state. We take this charge seriously at the University of Georgia. The spirit and the letter of the Morrill Act are alive and well at UGA, and I am proud of the good work that we are doing."

Like the president wrote, UGA is not here just to educate, but also to help connect UGA's resources and expertise to the needs of the people and communities throughout the state. UGA's Cooperative Extension and Outreach Programs are good examples of UGA's commitment to solving some of Georgia's most daunting challenges. Extension agents and specialists across the state provide vital information to producers and consumers of Georgia's agricultural products. All citizens in Georgia including homeowners, farmers, and business people benefit from these programs. For example, there is expert advice and information available about poultry, horses, beef and dairy cattle, swine, sheep, goats and aquaculture. There are resources and best management practices for field crops such as canola, cotton, grains, peanuts, soybeans, tobacco, as well as for forestry. There are guidelines for growing apples, beans, blackberries, blueberries, citrus, corn, grapes, greens, onions, peaches, pecans, potatoes, squash, strawberries, and tomatoes. There's information available about pests and diseases on all the above. And, finally, there are "how to" programs on organic agriculture, running your own business, sustainable agriculture and urban agriculture.

Please join me in wishing a Happy Birthday to the Morrill Act of 1862 and in offering many thanks to Jonathan Baldwin Turner, Justin Smith Morrill and those who had such a bright vision for the future! BC

Jennifer Berry is the research director at the University of Georgia Honey Bee Research Lab.

Lazy Hazy Days of Summer in the Beeyard

Jennifer Berry

We take an overall look at bee health and testing for disease

DURING THE summer months, at least in my part of the world, the nectar has dried up and pollen is scarce. Thousands of bored, frustrated foragers are stuck in the hive with nothing much to do (other than collect water from time to time to cool the colony).

But just because the girls are lazing around doesn't mean we can follow suit. There is work to be done, especially if these colonies are to survive the winter. This is the time to requeen if necessary, fatten up those bees, reduce varroa populations and take care of 'issues' that may have occurred during the season.

EVALUATION

A good start is evaluating each and every colony from top to bottom. A quick suggestion before we crack open the lid. Whenever I venture into the beeyard, there's always a colony data sheet in hand. Below is an example of one used over the years at the University of Georgia bee laboratory. Having this information helps to keep track of each colony's condition.

Even if you only have a few colonies, take the time and create a data sheet that works for you. By next spring, when you're doing those first colony inspections, you won't have to rely on memory. All the information is already written down on your handy-dandy data sheets.

Checking the queen's brood pattern. Are there missed cells? Are there supersedure cells?

Claire Waring

The first check is that your queen is viable and she is producing a good brood pattern

Yard:			
Date:			
Colony	Queen (Y/N)	Honey/pollen stores	General notes

CHECK THE QUEEN

Back in the beeyard, first and foremost you should check the viability of your queen. How does her brood pattern look? Are there skipped/open cells? Do you see any supersedure cells?

If the pattern is spotty, you may want to look for other problems first, such as disease or mite infestation, before automatically assuming it is a poor queen. However, the queen could be old, poorly mated, or was not properly reared.

If you determine that the queen is past her prime, late summer to fall is a great time to requeen. If by chance you can't acquire another queen, and the colony is weak, your best bet is to combine that colony with a strong one, a nucleus or another needing a boost. Weak colonies

rarely survive the winter, so there's no sense in allowing the colony to limp along when you could have spared the bees and equipment from possible demise.

HONEY STORES

The next task is to assess the amount of honey stores. Depending on numerous factors (rainfall, temperature, etc), nectar flows can be superb one year and horrible the next. If flows were below par, or too much honey was taken for human consumption, feeding must become a priority for the colony.

Once the temperatures drop, the bees won't be able to break cluster in order to collect the food. All the syrup in the world will be useless if the bees can't get to it. And think in terms of gallons when feeding. It has been my experience that 5 gallons of a 2:1 sugar solution (2 parts sugar to 1 part water) will yield one full medium super (roughly 40 pounds).

Depending on your location, this may not be enough. If you are unsure how much honey is required to get a colony through winter in your region, consult an experienced beekeeper in your area.

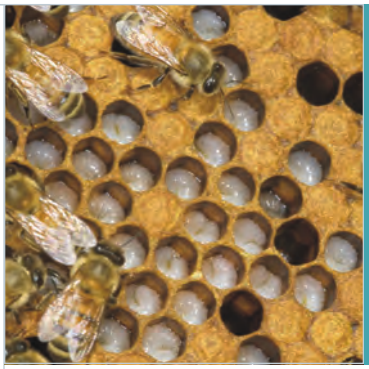
CAUTION

A word of caution: feeding during a time of poor resources can be tricky, so be careful not to trigger robbing. A single drop of sugar syrup clinging to the side of a colony will attract attention, especially when nothing else is available. Once bees start robbing it becomes a feeding frenzy, with even strong colonies succumbing to the onslaught.

BROOD DISEASE

In your colony inspection examine the brood area for disease. You want to see healthy, white larva in the cells. Also look for depressed cappings or ones with holes.

Make sure that your equipment is sound. Robber bees and other unwanted visitors do not need a large gap to enter



Larvae should be a healthy white color, lying curled up in their cells

Open these and inspect the pupae. Anything slightly off-colored may be a sign of trouble (unless the pupa is in its later stage of development).

If you are unsure about what may be ailing your colony, consult a professional for diagnosis and treatment options. (See *Bee Craft America*, May 2010, page 4 for details of how to send a sample to Beltsville, USDA lab for disease determination.)

EQUIPMENT

Another colony inspection chore is to inspect your equipment.

Move frames with old comb to the outer edge so they can be removed in the spring and replaced with new foundation. Replace old, decrepit hive bodies, supers, lids, inner covers and bottom boards with newer equipment.

Bee hives don't have to be pristine little palaces; however, they do need to protect the bees from the upcoming, frigid winter weather. Plus gaping holes and cracks allow access for critters to come and go. Mice especially love to make their winter homes in a bee hive. A continual food supply plus a warm cozy environment make it a suitable dwelling.

Structurally tight equipment, along with mouse guards or reduced entrance, work well to discourage these unwanted guests.

DON'T FORGET VARROA

Queen issues, food supplies, disease, and poor equipment are all things that need to be addressed before winter temperatures descends upon us. Yet there is still one more thing we must not overlook: varroa mites. Yes, the dreaded *Varroa destructor*.

By the end of summer, mite populations are skyrocketing. Don't wait until your colonies are crashing. Once the downward spiral begins it is almost impossible for colonies to recover. August is the best time to check those mite populations! Not only is it important to get their numbers under control for the existing bees, but also for the future bees that will bring the colony into the New Year.

VARYING LIFESPANS

Speaking of the future bees, remember the average lifespan of honey bees varies considerably based on the season when they emerge. These variations have been designated into two groups of bees dubbed summer bees and winter bees. Summer bees live approximately one month, while winter bees can live anywhere from six to eight months. Winter bees emerge during August to October, depending on location. They differ from summer bees by several physiological characteristics.

Scientists have determined that the lifespan of honey bees can largely be determined by the amount of protein stored in the fat body, hemolymph, and hypopharyngeal glands. The most notable and scientifically relevant type of protein is the high-density glycolipoprotein, vitellogenin. It is loosely described as a female-specific, hemolymph storage protein, or more specifically, an egg yolk protein precursor. However, since worker bees rarely lay eggs, this protein is stored in fat bodies, mainly in their abdomens, for future use. This specific protein's relevance is largely based on its abundance in honey bee hemolymph as well as its high zinc concentration, which regulates many functions within the honey bee. Vitellogenin is also thought to be a powerful anti-oxidant, which significantly slows the effects of aging.

REDUCE MITE POPULATIONS

One of the important reasons for reducing mite populations is that higher mite populations at the end of summer or early fall coincide with the production of these winter bees. Results from research have shown that mite infestation during the pupal stage has a negative impact on bees because they're not able to accumulate the necessary hemolymph proteins, including vitellogenin, to the same extent as in non-infested bees; hence reducing their ability to overwinter.

Good pollen stores are vital for production of winter bees

In order for the colony to have a chance of overwintering successfully, it is imperative to reduce mite levels before the production of these winter bees. Bees rearing the winter bees need proper nutrition and development. They must be healthy enough to rear the winter bees and the bees rearing those bees need to be healthy, and so on.

POLLEN LEVELS

And one last thing, since adequate amounts of pollen must be available in order to produce winter bees, check in-coming and stored pollen supplies. If pollen stores are lacking, pollen patties are a definite plus for feeding in late summer to enhance the production of these winter bees, nurse bees, mother bees, etc. Sugar feeding alone may not be adequate.

RESPONSIBLE STEWARDS

By storing honey for energy and pollen for protein, European bees have evolved the ability to survive long winters. But unfortunately, with introduced exotic parasites, diseases, viruses and a whole host of other non-indigenous species, 'we' have thrown this whole process out of kilter. Now 'we' must be better stewards of our bees or face the consequences of finding empty spring hives devoid of life. We can be responsible stewards. ◈

(above) *Varroa destructor* mite levels must be reduced before the colony begins to produce winter bees (right)

Jennifer Berry is Apicultural Research Coordinator and Lab Manager at the University of Georgia. She is a popular speaker to beekeeper groups and also a sideline beekeeper and a queen breeder

Apidologie
© INRA, DIB and Springer-Verlag France, 2014
DOI: 10.1007/s13592-014-0283-4

Original article

Distinguishing feral and managed honeybees (*Apis mellifera*) using stable carbon isotopes

Lucy M. Anderson[1], Travis M. Dynes[1], Jennifer A. Berry[2], Keith S. Delaplane[2], Lydia L. McCormick[1], Berry J. Brosi[1]

[1]Department of Environmental Studies, Emory University, 400 Dowman Drive, Suite E510, Atlanta, GA 30322, USA
[2]Department of Entomology, University of Georgia, Athens, GA 30602, USA

Received 11 October 2013 – Revised 10 February 2014 – Accepted 24 February 2014

Abstract – The ability to distinguish feral and managed honeybees (*Apis mellifera*) has applications in studies of population genetics, parasite transmission, pollination, interspecific interactions, and bee breeding. We evaluated a diagnostic test based on theoretical differences in stable carbon isotope ratios generated by supplemental feeding. We evaluated (1) if carbon isotope ratios can distinguish feral and managed honeybees and (2) the temporal persistence of the signal after discontinuation of supplemental feeding. We compared carbon isotope ratios from four types of experimental colonies: feral, managed with and without supplemental feed, and managed with ^{13}C-labeled glucose added to supplemental feed. There was a significant difference between the isotopic signatures of colonies receiving supplemental feed and unfed feral colonies. This difference, however, only persisted for a few weeks after supplemental feeding was discontinued, suggesting that this method may work best under a narrow range of conditions. This work highlights the potential for exploiting temporal turnover of carbon in bee tissues as a tool for studying nutrient flow in honeybee colonies.

feral honeybees / stable isotopes / carbon / photosynthesis pathways / isotopic fractionation

1. INTRODUCTION

Unlike most agricultural animal species, honeybees (*Apis mellifera* L.) exist in both managed and feral populations. This duality has potentially important implications for gene flow, transmission of parasites and pathogens, pollination of crops and native plants, and interactions with other pollinator species. Developing a consistent and inexpensive method for distinguishing feral and managed honeybees could lead to improvements in resistance breeding programs in managed bees as well as the ability to gather key data for agricultural and ecological studies.

Corresponding author: B. Brosi, bbrosi@emory.edu
Manuscript editor: David Tarpy

Breeding programs, in which bees are bred for desirable characteristics such as disease resistance, have the potential to aid in the mitigation of ongoing honeybee declines. These declines, which include colony collapse disorder (e.g., Oldroyd 2007; Potts et al. 2010), pose a major threat to global agricultural production and food security worldwide and are likely driven by a range of threats. Pesticides, pathogens, and loss of traditional honeybee forage from urbanization are all probable drivers of bee decline, but *Varroa destructor* is thought to be the most significant factor (e.g., Rosenkranz et al. 2010; Martin et al. 2012). Feral bees, unmanaged by people, have potentially experienced intense natural selection for resistance to colony pests and parasites and may provide a source of resistance genes to honeybee breeders and scientists (e.g., Seeley 2007). Selective breeding efforts to improve

Published online: 28 March 2014

honeybee resistance and/or tolerance to *V. destructor* and other disorders have been hindered by the inability to effectively distinguish unmanaged or "feral" honeybees from managed honeybees (Oxley et al. 2010; Spivak et al. 2011).

Differentiating between feral and managed honeybees also has implications for agricultural pollination and ecological studies. It would allow the potential to determine proportions of crops pollinated by managed versus feral bees and to investigate competition and resource partitioning between feral honeybees and native bees (e.g., whether honeybees sampled in the course of diversity or pollination studies are feral or managed). Moreover, little is known about the relative population sizes of feral honeybees and managed honeybees or their respective habitat suitability and preference.

Here, we evaluated a test based on stable isotopes of carbon to differentiate between feral and managed honeybees using isotope ratio mass spectrometry (IRMS) to determine the relative concentrations of stable carbon isotopes between tissues of feral and managed honeybees. Isotopes of an element have the same atomic number but a different number of neutrons which causes isotopes to vary in atomic mass. All atomic isotopes are either radioactive or stable, and each atomic element has both a dominant form (for example, carbon 12 or ^{12}C) and rarer forms (e.g., ^{13}C which is stable or ^{14}C which is radioactive). Rarer isotopes react chemically in similar ways to the most abundant isotope of the specific element, but the mass differences between isotopes can lead to changes in reaction rates, which can then lead to differential concentrations of different isotopes—a process called "fractionation" (Peterson and Fry 1987; Brosi and Harkins 1937). Stable isotopes have been used widely in industrial applications (including quality control and tracing studies) and in ecological studies, including nutrient cycling, food webs, and animal movement and migration patterns (Hobson 1999; Kelly 2000; Kennedy et al. 1997; O'Brien et al. 2000; Ostrom et al. 1997; Phillips 2001).

In particular, stable isotopes of carbon are commonly used to distinguish between plants with different photosynthesis pathways. Photosynthesizing plants have developed three distinct metabolic pathways of carbon fixation: C3, C4, and CAM. The C4 carbon fixation process produces higher ratios of ^{13}C to ^{12}C in the plant relative to C3 fixation, yielding a distinct isotopic $\delta^{13}C$ signature in IRMS (Farquhar et al. 1989). Many monocots, including the grass family (Poaceae)—of which corn, sugarcane, and wheat are members—undergo C4 carbon fixation (Koziet et al. 1993).

In the USA, honeybees typically forage on nectar-producing wildflowers which primarily utilize the C3 photosynthesis pathway. By contrast, the sugar solutions most frequently used by US beekeepers to supplement their colonies are made from corn syrup or sugarcane, both of which are C4 grass species and therefore have much greater concentrations of ^{13}C. Notably, this property of detectable carbon isotope signatures based on photosynthetic pathways led to an early use of stable isotopes: the detection of adulteration of honey with supplemental sugars (cane sugar and/or corn syrup) (Doner & White 1977; Elflein and Raezke 2008). Still, there is the caveat that sugar beets, a C3 species, are also used in sugar production, and some beekeepers may utilize beet sugar in feeding. Beyond signatures in honey, it has been shown that royal jelly, a secretion of protein, sugars, and amino acids fed to honeybee larvae, produced by honeybees with supplemental feed can be distinguished from royal jelly produced by honeybees not receiving this feed (Daniele et al. 2011).

Because carbon isotopes can be used to detect adulteration of honey and royal jelly with supplemental sugars, we hypothesized that carbon isotopes would also allow for distinguishing feral from managed honeybees given that most managed bees are given supplemental sugars from C4 photosynthesis pathway plants (corn and sugar cane). Specifically, in this study, we had two distinct objectives. Our first objective was to determine if honeybee tissues from feral versus managed bees show a difference in isotopic signatures. In order for this test to be completely reliable in all situations, there could be no overlap

between signatures of bees from managed colonies and signatures of bees from feral colonies. Ideally, the heaviest signature from any feral bee will still be lighter (i.e., more negative) than the lightest signature from a managed bee. Our second objective was to determine how long a distinct signal will persist between the two types of bees after supplemental feeding is removed. Understanding the temporal trends in signal persistence is the key because supplemental feeding typically occurs periodically rather than year-round. Though little is known about the temporal turnover of carbon in bee tissues, we hypothesized that distinct ^{13}C signals persist in bees from colonies receiving supplemental feed for several months, assuming that ^{13}C from supplemental feed is incorporated into the chitin in the honeybee exoskeleton.

2. METHODS

2.1. Study site

This study took place from January 2011 to November 2012 in Athens, Georgia, in and around the University of Georgia Bee Lab (located at the UGA Durham Horticulture Farm, Watkinsville, GA). We utilized nine pre-existing honeybee colonies from the UGA bee lab stocks, each composed of a brood box and a shallow honey super. We randomly designated three colonies, each as labeled managed ("LM"), fed managed ("FM"), and unfed managed ("UM").

We also collected 17 feral colonies using swarm traps (Schmidt 1994) in the Oconee block of the Chattahoochee-Oconee National Forest from December 2011 to May 2012. The area surrounding this block of National Forest lacks large honeybee producers to our knowledge, but may have some small-scale beekeepers. After collecting swarms, we moved them to feral bee-specific apiaries at the UGA Bee Lab. Because the swarm-trapping effort was set up for a separate study, we sampled these colonies at various intervals. We designated these as unfed feral ("UF") colonies. Each colony, managed or feral, was given a unique colony ID.

There were two colony types that received supplemental feed (FM and LM) and two colony types that did not (UF and UM). We assumed that unfed feral colonies had not been given supplemental feed as we had captured them from swarms. We did not give unfed managed colonies any supplemental feed after the initiation of the study, and we assumed they only foraged on flowers. This was to simulate the fact that supplemental feeding is often irregular and seasonal, and thus, some managed colonies can go months at a time without supplemental feeding. We gave fed managed and labeled managed colonies supplemental feed once per week for 3 weeks, and we assumed that they foraged on flowers as well as the sugar-water solutions provided. We gave labeled managed colonies a solution that included "labeled" glucose enriched with ^{13}C (detailed below) to allow us to track the turnover of carbon in honeybee workers over time.

We kept the colonies in different apiaries managed by the UGA Bee Lab, separated by type, and apiaries were located at least 2 miles away from each other. We maintained the colonies in separate apiaries to reduce the possibility of robbing and contamination of samples between colony types.

2.2. Supplemental feeding

We prepared supplemental feed for FM colonies by creating 3 L of 50:50 solution (by wt) of deionized water to pure sugarcane sucrose with molarity 2.92144 M. We prepared supplemental feed for LM colonies by mixing 1.0 g 99 % atomic ^{13}C-glucose (Omicron Biochemicals, Inc., South Bend, IN, USA) with pure sugarcane sucrose, creating 3 L of solution with an identical molarity to the solution used for fed managed colonies and nearly a 50:50 water sugar solution by weight. This solution thus had 0.54 mg of 99 % atomic ^{13}C-glucose per gram sucrose. We homogenized mixtures in 3 L Erlenmeyer flasks with a magnetic stirrer bar and a hotplate stirrer and refrigerated until use. We covered the surfaces in aluminum foil, which was changed between preparation of different feeding solutions and thoroughly cleaned the equipment with detergent and then 70 % ethyl alcohol between handling of different sugars to prevent contamination with labeled glucose.

In mid June of 2012, one 3-L batch of supplemental feed was mixed for the FM colonies and one 3-L batch of supplemental feed was mixed for the LM colonies. One liter of the appropriate solution was put into a typical top feeder, i.e., a sterile glass jar with a metal lid perforated with several small (~1 mm diameter) holes, and placed upside down on the top of each of the six colonies. Feed was replaced twice in 1-week intervals following the initial feeding. Three weeks after the initial feeding, all feedings were removed from the six supplementally fed colonies (FM and LM).

2.3. Sampling

We collected honeybee individuals from each of the nine colonies starting at the time of the first supplemental feed (Table I). For the first 3 weeks, we collected individuals from each colony. Individuals from the three LM colonies continued to be collected weekly for 12 more weeks, for a total of 15 weeks, in order to follow comprehensive tracking of the fractionation of the ^{13}C in the honeybee tissues over time. In the other three colony types, UF, UM, and FM, we collected samples biweekly after the first 3 weeks for a total of nine sampling dates over 15 weeks from June to September 2012.

We collected ten individuals from each of the colonies by brushing bees from a frame into a 1-pint (0.473 L) lidded glass jar (Ball brand, Daleville, IN, USA) with ~0.125 L of 70 % ethanol. We collected specimens from each colony into different sample jars to prevent cross-contamination between colonies (Table II). The sampled bees were likely young workers given that they were not foraging. This sampling system allowed for (1) standardization of age between different colony types and (2) the likelihood that a sampled bee had been reared in the presence of the target food type (supplemental sugars, labeled sugars, or absence of labeled food). Once taken back to the lab, we placed bees into small vials filled with 90 % ethanol until they could be pinned and labeled. We pinned bees on separate clean paper towels to prevent cross-contamination.

We dried pinned bees at 50 °C for 3 h. We used a single hind leg from each specimen for isotope analysis because preliminary analyses showed fractionation among different body parts (Brosi et al. 2009) and because hind legs have a mass range close to the target weight for IRMS given their carbon-nitrogen ratio. We chose bees for analysis without wing damage (again, to maintain a consistent age range) and without pollen on their hind leg (which could have affected the isotope values). We removed one hind leg from each specimen with clean forceps, placed it into a tin envelope, and weighed it using a microbalance (accuracy of 0.01 mg). Weights ranged from 0.50 to 1.05 mg. To avoid cross-contamination,

Table I. Quantities of managed bees per colony selected for analysis. Each "sample date" corresponds to a unique date where each sample date is 1 week apart. Sample dates run from 21 June 2012 (sample date 1) to 27 September 2012 (sample date 15).

Colony type		Sample date														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
UM	1	2	2	2		2		2		2		2		2		2
	2	2	2	2		2		2		2		2		2		2
	3	1	1	1		1		1		1		1		1		2
FM	1	2	2	2		2		2		2		2		2		2
	2	2	2	2		2		2		2		2		2		2
	3	1	1	1		1		1		1		1		1		1
LM	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table II. Quantities of feral bees per colony selected for analysis.

Colony	Number of sample dates	Number of individuals per sample date
1.2	1	3
1.3	1	3
1.4	1	3
1.7	1	3
1.8	3	5/4[a]
2.1	2	3
2.2	1	3
2.3	1	3
2.4	2	5
2.5	2	5
2.11	1	3
3.1	1	3
3.3	1	3
3.5	3	5
3.6	1	3
3.9	1	3
3.11	1	3

[a] One of the three sample dates had only four samples due to sample mass restrictions (i.e., sampled hind legs were outside of the instrument bounds for mass); the other two had five samples

we covered work surfaces with aluminum foil and thoroughly cleaned tools and workspace with ethyl alcohol between samples. After weighing, tin sample envelopes were crimped and placed in a labeled microwell plate.

We sent samples to the Boston University Stable Isotope Facility (Department of Biology, Boston, MA) for analysis, where they were processed using an elemental analyzer interfaced to a GV Instruments Isoprime isotope ratio mass spectrometer (GV Instruments Ltd., Manchester, UK). The BU Isotope Facility made mass corrections to ensure that sample mass did not affect isotopic measurements.

2.4. Data analysis

Stable carbon isotopes include ^{13}C and ^{12}C. The relative ratio of ^{13}C to ^{12}C can be detected using IRMS. Carbon isotope ratios are expressed in $\delta^{13}C$ units, signifying parts per thousand (‰) of the heavy isotope relative to an international standard value. In the case of carbon, the standard is Pee Dee Belemnite (PDB), a cretaceous fossil from North Carolina that is thus defined to have a $\delta^{13}C$ value of zero (Craig 1957). As the PDB standard contains a relatively high concentration of ^{13}C, most compounds found in nature have a negative $\delta^{13}C$ signature in comparison. The formula for $\delta^{13}C$ is:

$$\delta^{13}C = \left(\left(R_{\text{sample}}/R_{\text{standard}}\right)-1\right) \times 1,000$$

where R_{sample} is the ratio of $^{13}C/^{12}C$ of the sample and R_{standard} is the ratio of $^{13}C/^{12}C$ of PDB.

To test for statistical differences in $\delta^{13}C$ values between different management (feral vs. managed) and feeding groups, we used linear mixed effects models (LMMs) with colony ID as a random effect, with the "lme4" package (Bates et al. 2011) in the R Statistical Programming Language (R Development Core Team 2012). We took this approach because different bee individuals from the same colony cannot be considered independent samples, and mixed effects models allow for the use of all data points while taking into account the non-independence of colony groups (e.g., Bolker et al. 2009). We used Gaussian errors because the response variable ($\delta^{13}C$) is continuous, and errors were approximately normally distributed. To test for the significance of colony type (UF vs. UM; UF vs. FM; UF vs. UM+UF), for each test, we conducted likelihood ratio tests comparing a model including colony type (as the only fixed effect) plus colony ID (random effect) to a null model that included no fixed effects (random effect only) (e.g., Bolker et al. 2009). We also calculated pairwise, post hoc comparisons between each colony type using the "glht" function from the "multcomp" package for R (Hothorn et al. 2008).

Because our goal was to assess the efficacy of stable isotope markers for assignment of colony type, we used linear discriminant function analysis to classify bee specimens into colony types using the "lda" function from the "MASS" library for R (Venables and Ripley 2002). We characterized the proportion of correct classifications and used χ^2 tests to test the statistical significance of the classification results.

3. RESULTS

We analyzed the carbon isotopic signature of 257 honeybee individuals. Of these, 91 individuals were from UF colonies (N=17 colonies), 45 were from FM colonies (N=3 colonies), 46 were from UM colonies (N=3 colonies), and 75 were from LM colonies (N=3 colonies). Distributions of isotopic signatures within each colony type are shown in Figure 1. The $\delta^{13}C$ values of the samples ranged from −26.76 to −13.80‰. Values on both ends of the spectrum reside within the standard ranges for C3 and C4 plants, but not within the average range of isotopic signatures for pure cane sugar (−11.65 to −10.75‰).

There was overlap in the spread of isotopic signatures between feral and managed bees, including overlap between fed managed bees and unfed feral bees (Figure 1). Although there was overlap in the carbon isotopic signatures of the different colony types, there was a significant difference between the isotopic signatures of the feral and fed managed (UF vs. FM) bees (linear mixed effects model, LMM; χ^2=4.88, P=0.027). That difference did not hold when comparing feral and both categories of managed bees considered together (UF vs. FM+UM; LMM, χ^2=1.86, P=0.172). Similarly, there was no significant difference between feral and unfed managed bees (UF vs. UM), and moreover, the means of those two groups were essentially identical (LMM, $\chi^2\approx0$, P=0.99). Post hoc pairwise comparisons between groups are shown as letters in Figure 1.

After the feeding began, isotopic signatures became heavier over time in both the FM and LM bees, and values continued to increase for

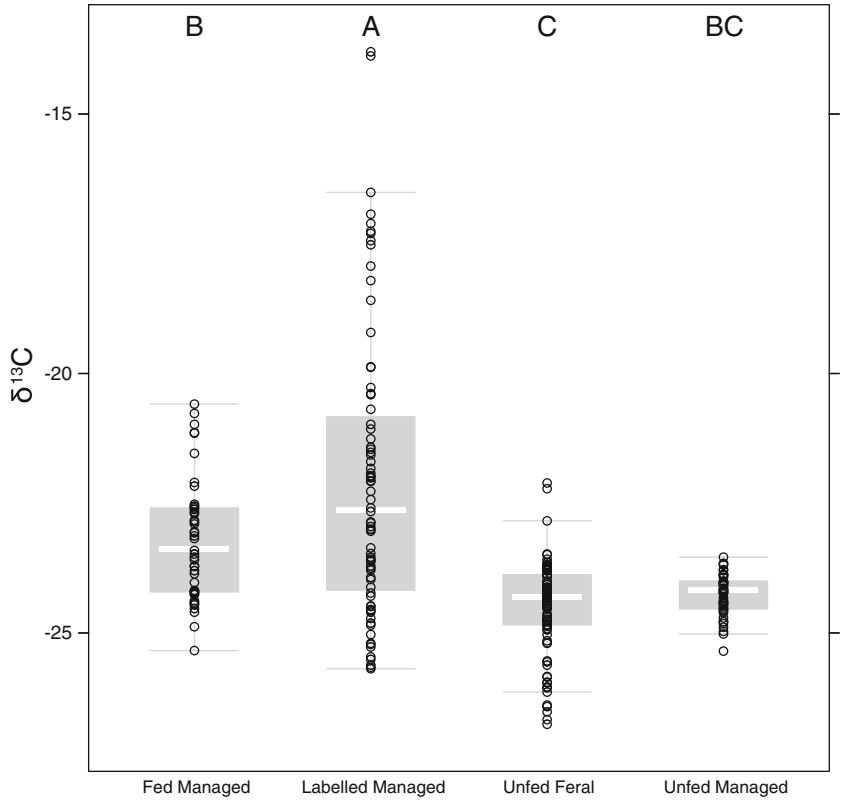


Figure 1. Carbon isotopic signature values by colony type. Different letters depict statistical differences between groups, as determined by post hoc comparisons from a linear mixed effects model.

about 5 weeks after feeding was removed (Figure 2; up to approximately sample date 8). As expected, the isotopic signatures of the fed labeled individuals were significantly heavier on average than those of the fed managed bees (pooled across all time points, LMM, χ^2=6.15, P=0.013). After sample date 8, $\delta^{13}C$ values in both types of fed colonies began to decline and were ultimately indistinguishable from the unfed colonies by the end of the 15-week study.

When comparing feral to managed bees (excluding those fed with labeled glucose), discriminant function analyses correctly classified 58 % of bee specimens. While this resolution is likely not strong enough for most practical applications, it is statistically significantly relative to random assignment (χ^2= 13.10, df=2, P=0.00143). The proportion of correct classifications was higher in feral (62 %) than in managed bees (54 %). When comparing fed managed bees to feral bees, the probability of correct classification improved to 73 % overall (assuming equal numbers of feral and managed bees), a highly significant result (χ^2=38.73, df=1, P=4.86e^{-10}), with correct classification of nearly all (97 %) feral individuals and 49 % of managed bees. Comparing unfed managed bees to feral bees, classification was poor, with correct classification of only 48 % of individuals (NS; χ^2=0.067, df=1, P=0.796). Classification was highly polar, correctly classifying nearly all feral bees (98 %) but no unfed managed bees (0 %).

4. DISCUSSION

4.1. Overview

The aims of this study were to (1) determine if stable isotopes of carbon could reliably

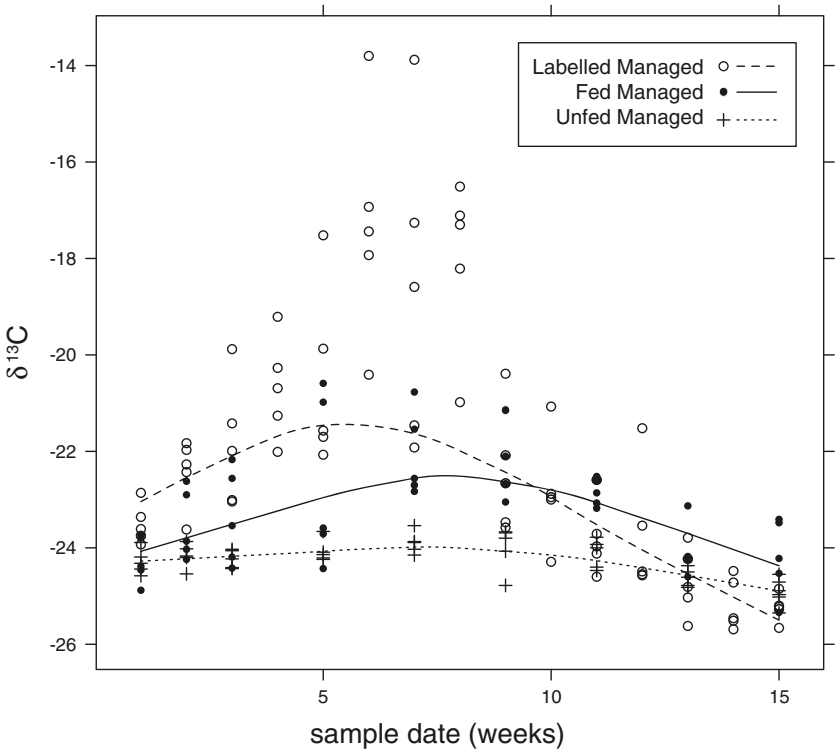


Figure 2. Isotopic signatures of FM, UM, and LM colonies by date over the 15-week sample period. *Trend lines* were generated using the "smooth" command in the lattice graphics package for R.

distinguish feral from managed honeybees and (2) estimate the turnover time of carbon from supplemental feed in honeybee workers. These aims are interrelated in that reliable differentiation of feral from managed bees depends on the length of time the signature of enriched ^{13}C lasts after feeding of C4-enriched supplemental feed ends.

We found a significant difference between the isotopic signatures of fed managed and unfed feral bees, indicating some potential for differentiating managed honeybees receiving supplemental feed from feral honeybees using stable carbon isotopic ratios. While we did find statistically significant differences between fed managed and unfed feral bees, there was still overlap in the ranges of carbon isotope values in the two groups. The temporal signal of feeding was very short-term, however, indicating that managed and feral bees cannot be positively differentiated at any time of year. Classifications based on $\delta^{13}C$ using discriminant function analysis supported these findings, with about 75 % correct classification when comparing fed managed and feral bees, which dropped to below 50 % when comparing unfed managed and feral individuals. Our data suggest that during summer in Georgia, managed bees receiving supplemental feed can be differentiated from feral bees up to 6 weeks after feeding is removed. Due to the time frame in which the study was completed and the setup of the experiment, we did not have a sufficient number of samples to test for statistical significance in the length of time for which there remained a significantly different isotopic signature between the fed and unfed bees.

4.2. Mechanisms for rapid turnover of heavy signatures

The relatively short timescale of the heavier isotopic signals in supplementally fed honeybee tissue can most likely be accounted for by honeybee biology and/or potential limitations of the study design. In terms of bee biology, three aspects are relevant: (1) general patterns of honeybee worker development, (2) the patterns of carbon isotope fractionation that occur during development, and (3) seasonal changes in nectar/supplemental sugar consumption and storage within a colony.

First, the length of development and lifespan of honeybee workers most likely affected the length of time for which a heavier signature persisted in our data. Worker bees have a ~21-day developmental period after the egg is laid before they emerge as adults, and in summer, an average adult lifespan is ~28 days. As worker bees age, their roles in colony maintenance change ("age-based polytheism"; e.g., Graham 1992). The younger bees work inside the hive, cleaning, handling food, and building and maintaining comb and brood cells, and begin foraging when they are ~18 days old (Sakagami 1953; Winston and Fergusson 1985). It is likely that most of the bees collected for this analysis were relatively young, likely pre-foragers. We sampled bees from a frame inside the hive, and we specifically avoided choosing individuals for analysis that had wing damage, a sign of aging. If supplemental feed was transferred into brood cells relatively soon after it was provided to the hive, the 3 weeks of development plus an additional 2 to 3 weeks working inside the hive amounted to an equivalent length of time for which the distinct isotopic signature persisted. This scenario also accounts for the time lag in the spike of carbon isotopic signatures in the bees fed labeled glucose.

Second, there is little information available on the fractionation of the carbon isotopes in the developing individual honeybee. Sources of carbon in growing tissue could originate from pollen, nectar, sugar solution, or most likely, a combination of the three, provisioned to honeybee brood in individual cells via worker bees. Brood cells are capped with wax shortly before the molt to prepupae, and thus, no new nutritive provisions are added after capping. It is likely that chitin in the honeybee exoskeleton—which may have been the dominant form of carbon in our hind leg samples—has different carbon fractionation processes than other tissues or hemolymph. Diet-tissue fractionation in black fly (*Anopheles arabiensis*, Culicidae) larvae varies from 1 to 2‰ (Overmyer et al. 2008),

but the underlying mechanisms remain unknown. Using this as a baseline, future studies should examine the extent of honeybee diet-tissue fractionation in various tissues.

Third, the fastest carbon isotopic turnover in a honeybee colony likely occurs in the summer. This may be due to shorter worker lifespan (two to three times shorter relative to winter; Graham 1992) coupled with an increase in the production of offspring (and thus high resource use). Short lifespans and high resource demands mean that colony carbon turnover may have hit an annual peak during the time of this study. Similarly, because this study took place in the summer, it is likely that little supplemental feed was stored and was instead either transferred directly to brood cells or consumed immediately by the workers. Thus, isotopic turnover between colonies receiving supplemental feed and unfed colonies may be shorter in the summer relative to other times of year.

In addition to biological mechanisms that could be responsible for the short duration of supplemental feeding signals, it is possible that methodological shortcomings have contributed to this result. We stored the bees in 90 % ethyl alcohol from collection until pinned and dried, and there is a possibility that storage in alcohol weakened the carbon isotopic signatures of our honeybee samples. We stored the feral bees in the alcohol for a longer period of time, so if there were an effect, it could have been amplified in the feral bees. In addition, the feral colonies in this study were established from swarm traps. While swarm traps were placed in isolated areas of the Oconee block of the Chattahoochee-Oconee National Forest, some of the feral swarms could have originated from managed colonies. Thus, the isotopic differences between feral and managed bees may have been obscured by the inclusion of colonies with a signal of supplemental feeding in our "unfed feral" category.

4.3. Applications of isotope analysis in honeybees

Although the use of stable carbon isotopes may not be applicable in differentiating feral and managed honeybees in all situations, this technique holds promise for applications in broader ecological studies. If it is known that managed colonies are receiving supplemental feed, relative distributions of habitat and foraging location preferences could be potentially identified with the use of carbon isotopic signatures of bees foraging in a specific area (e.g., Brosi et al. 2009).

In addition, the carbon isotopic signatures of nectar in flowers and plants vary geographically, with climate and rainfall having a major effect on which isotopes of carbon they absorb from the atmosphere. With increased drought stress, plants close their stomates (leaf pores) in order to conserve moisture. This leads to less discrimination against ^{13}C and a subsequent heavier isotopic signature in a drought-stressed plant relative to a plant receiving adequate moisture (Peterson and Fry 1987). Because of this, there may be potential in situations of drought or extreme moisture for the use of isotopic signatures to differentiate feral and managed bees.

An example of conditions where this concept might apply is areas with high rainfall such as tropical rainforests, where it is assumed that the feral honeybee populations are foraging on C3 plants that experience minimal drought stress, producing relatively light carbon isotopic signatures due to the presence of ample moisture (Farquhar et al. 1989; Brosi et al. 2009). In such a context, if it is known that beekeepers are feeding their managed bees with C4-based supplemental feed, it may be possible to determine more definitively whether a honeybee specimen is from a managed or feral colony. Supplemental feeding does occur in some such tropical areas because even in the absence of drought stress, there can still be nectar dearths at different times of year.

Although there was overlap in the isotopic signature values of managed and feral bees in our study, there may be potential for distinguishing feral and managed honeybees if the isotopic signature of a particular specimen falls outside a specific range. For example, in this study, the heaviest isotopic value of a feral bee is −23.48 and the lightest signature of a fed

managed bee is −25.6. Although the ranges of isotopic signals overlap, with further research, it may be possible to establish a range of values on either side of this overlap zone (likely region-specific) that could be used to discriminate feral from managed bees. Our labeling experiment, however, presents a potential counter-argument to this idea: the isotopic signals of the fed managed and fed labeled bees became indistinguishable from unfed managed bees in the same amount of time in our experiment, so a larger gap in isotopic signatures may not impact the timeframe over which there is a distinct signature.

4.4. Future directions

Future research is necessary in several areas, including (1) seasonal isotopic turnover, (2) the relationship between duration of feeding and duration of signal persistence, and (3) stable carbon isotope fractionation in honeybee tissue development. First, the variation in carbon turnover in bee colonies between seasons should be explored in the future to help determine the applicability of using stable isotopes to differentiate feral and managed bees. Second, exploring the relationship between duration of feeding and the duration of heavy isotopic signal persistence could provide further insight on the effect of continued feeding on the turnover rate of carbon in honeybee tissue. This is particularly salient given that most beekeepers in the USA provide supplemental feed for periods longer than 3 weeks (the timescale of our feeding experiment) and, thus, exploring if longer feeding periods are correlated with a longer persistence of distinguishable isotopic signatures could be useful for differentiating feral and managed honeybees for longer periods of time. Finally, given that so little is known about the fractionation of carbon in developing honeybee tissues, further research could be done, for example, via labeling pollen with ^{13}C to determine the extent to which pollen-derived carbon is involved in exoskeleton formation and to develop an understanding of carbon turnover from pollen in different bee tissues.

4.5. Conclusion

In conclusion, we were able to detect a ^{13}C signal from supplemental sugar feeding in bee tissues consistent with isotope studies in a range of systems including bees (Brosi et al. 2009). Although stable carbon isotopic ratios cannot be used to differentiate feral from managed bees in all situations, this study gives insight into the temporal turnover of ^{13}C in honeybee colonies. There is great potential for using isotopes in diet and foraging studies, especially with more work on understanding carbon turnover in honeybees and other insects.

ACKNOWLEDGMENTS

We thank B. Nolan, P. Quinn, and N. Weaver for their contributions to the apiary management and B. Tran, E. Lake, and D. Gruenewald for their assistance in pinning bees in the lab. H. Briggs, E. Dobbs, D. Tarpy, and two anonymous reviewers provided constructive comments on the manuscript. B. Ryan and D. Barr both provided helpful discussion on analytic chemistry and the use of a microbalance. We are grateful to the Chattahoochee-Oconee National Forest for permission to collect feral swarms. This work was funded by the US Department of Agriculture (NIFA 2011-67013-30131 to BJB, KSD, and J. De Roode), the US National Institutes of Health (R01-109501-01, part of the joint NIH-NSF-USDA Ecology and Evolution of Infectious Diseases program, to J. De Roode, BJB, and KSD), Emory University (Scholarly Inquiry and Research at Emory grants and the James G. Lester Environmental Studies Research Grant, both to LMA), and the North American Pollinator Protection Campaign (Honey Bee Health Grant to BJB, KSD, and LLM).

Distinction entre abeilles sauvages et abeilles de ruches (*Apis mellifera*) par l'utilisation d'isotopes stables du carbone

colonie naturelle / fractionnement isotopique / photosynthèse / carbone

Unterscheidung von wildlebenden und imkerlich gehaltenen Honigbienen (*Apis mellifera*) anhand von stabilen Kohlenstoff-Isotopen

Wildlebende Honigbienen / stabile Isotope / Kohlenstoff / Photosyntheseverlauf / isotopische Fraktionierung

REFERENCES

Bates, D. Maechler, M., Bolker, B. (2011). lme4: Linear mixed-effects models using S4 classes. R package version 0.999375-42. http://CRAN.R-project.org/package=lme4. Accessed March 2013

Bolker, B.M., Brooks, M.E., Clark, C.J., Geange, S.W., Poulsen, J.R., Stevens, M.H.H., White, J.S. (2009) Generalized linear mixed models: a practical guide for ecology and evolution. Trends Ecol. Evol. **24**, 127–135

Brosi, A.R., Harkins, W.D. (1937) The abundance ratio of the isotopes in natural or isotopically separated carbon. Phys. Rev. **52**, 472–474

Brosi, B.J., Daily, G.C., Chamberlain, C.P., Mills, M. (2009) Detecting changes in habitat-scale bee foraging in a tropical fragmented landscape using stable isotopes. Forest Ecol. Manag. **258**, 1846–1855

Craig, H. (1957) Isotopic standards for mass spectrometric analysis of carbon dioxide. Geochim. Cosmochim. Acta. **12**, 113–140

Daniele, G., Wytrychowski, M., Batteau, M., Guibert, S., Casabianca, H. (2011) Stable isotope ratio measurements of royal jelly samples for controlling production procedures: impact of sugar feeding. Rapid Commun. Mass Spectrom. **25**, 1929–1932

Doner, L.W., White, J.W. (1977) Carbon-13/Carbon-12 ratio is relatively uniform among honeys. Science **197**, 891–892

Elflein, L., Raezke, K. (2008) Improved detection of honey adulteration by measuring differences between 13C/12C stable carbon isotope ratios of protein and sugar compounds with a combination of elemental analyzer-isotope ratio mass spectrometry and liquid chromatography-isotope ratio mass spectrometry (δ13 C-EA/LC-IRMS). Apidologie **39**, 574–587

Farquhar, G.D., Ehleringer, J.R., Hubick, K.T. (1989) Carbon isotope discrimination and photosynthesis. Annu. Rev. Plant Phys. **40**, 503–537

Graham, J.M. (1992) The Hive and the Honey Bee. Dadant & Sons, Hamilton

Hobson, K.A. (1999) Tracing origins and migration of wildflower using stable isotopes: a review. Oecologia **120**, 314–326

Hothorn, T., Bretz, F., Westfall, P. (2008) Simultaneous Inference in General Parametric Models. Biom. J. **50**(3), 346–363

Kelly, J.F. (2000) Stable isotopes of carbon and nitrogen in the study of avian and mammalian trophic ecology. Can. J. Zool. **78**, 1–27

Kennedy, B.P., Folt, C.L., Blum, J.D., Chamberlain, C.P. (1997) Natural isotopic markers in salmon. Nature **387**, 766–767

Koziet, J., Rossmann, A., Martin, G.J., Ashurst, P.R. (1993) Determination of carbon-13 content of sugars of fruit and vegetable juices: A European inter-laboratory comparison. Anal. Chim. Acta **271**, 31–38

Martin, S.J., Highfield, A.C., Bretell, L., Villalobos, E.M., Buge, G.E., Powell, M., Nikaido, S., Schroeder, D.C. (2012) Global honey bee viral landscape altered by a parasitic mite. Science **336**, 1304–1306

O'Brien, D.M., Schrag, D.P., del-Rio, C.M. (2000) Allocation to reproduction in a hawkmoth: a quantitative analysis using stable carbon isotopes. Ecology **81**, 2822–2831

Oldroyd, B.P. (2007) What's killing American honey Bees? PLoS Biol **5**, 1195–1199

Ostrom, P.H., Colunga-Garcia, M., Gage, S.H. (1997) Establishing pathways of energy flow for insect predators using stable isotope ratios: field and laboratory evidence. Oecologia **109**, 108–113

Overmyer, J.P., MacNeil, M.A., Fisk, A.T. (2008) Fractionation and metabolic turnover of carbon and nitrogen stable isotopes in black fly larvae. Rapid Commun. Mass Spectrom. **22**, 694–700

Oxley, P., Spivak, M., Oldroyd, B. (2010) Six quantitative trait loci influence task thresholds for hygienic behavior in honeybees (*Apis mellifera*). Mol. Ecol. **19**, 1452–1461

Peterson, B.J., Fry, B. (1987) Stable isotopes in ecosystem studies. Annu. Rev. Ecol. Syst. **18**, 293–320

Phillips, D.L. (2001) Mixing models in analyses of diet using multiple stable isotopes: a critique. Oecologia **127**, 166–170

Potts, S.G., Beismeijer, J.C., Kremen, C., Neumann, P., Schweiger, O., Kunin, W.E. (2010) Global pollinator declines: trends, impacts, and drivers. Trends Ecol. Evol. **25**, 345–353

R Development Core Team (2012) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, http://www.R-project.org/. Accessed March 2013

Rosenkranz, P., Aumeier, P., Ziegelmann, B. (2010) Biology and control of *Varroa destructor*. J. Invertebr. Pathol. **103**, S96–S119

Sakagami, S.F. (1953) Untersuchungen ber die Arbeitsteilung in einem Zwergvolk der Honigbiene. Beitr ge zue Biologie des Bienenvolkes, *Apis mellifera* L. I. Jap. J. Zool. **11**, 117–185

Schmidt, J. (1994) Attraction of reproductive honey-bee swarms to artificial nests by Nasonov pheromone. J. Chem. Ecol. **20**, 1053–1056

Seeley, T.D. (2007) Honey bees of the Arnot Forest: a population of feral colonies persisting with Varroa destructor in the northeastern United States. Apidologie **38**, 19–29

Spivak, M., Mader, E., Vaughan, M., Euliss Jr., N.H. (2011) The plight of the bees. Environ. Sci. & Technol. **45**, 1–34

Venables, W.N., Ripley, B.D. (2002) Modern Applied Statistics with S, 4th edn. Springer, New York

Winston, M.L., Fergusson, L.A. (1985) The effect of worker loss on temporal caste structure in colonies of the honey bee (*Apis mellifera L.*). Can. J. Zool. **63**, 777–780

Effects of Top- Versus Bottom- Supering on Honey Yield

by JENNIFER A. BERRY and KEITH S. DELAPLANE

Department of Entomology
University of Georgia
Athens, Georgia 30602 USA

Manuscript received for publication January 24, 2000

SUMMARY

Bottom-supering failed to achieve significantly higher honey yields than the less labor-intensive method of top-supering. The experiment was replicated across three apiaries and two nectar flows.

INTRODUCTION

Beekeepers typically employ one of two supering methods during a nectar flow: top-supering or bottom-supering (Fig. 1). Top-supering, placing empty honey supers on top of those already being filled by the bees, is the easiest of the two. However, there may be disadvantages with this method. By placing supers on top of each other, the distance between the hive entrance and the top super increases with each additional super. This may increase the distance a bee must travel in order to be relieved of her nectar load. Top-supering conceivably also increases traffic across capped honey, thereby darkening the comb (Ambrose, 1992). Bottom supering, placing empty honey supers underneath existing supers, is more labor-intensive for the beekeeper since each filled or partially filled super must first be lifted in order for the next super to be added. Another drawback for bottom-supering is that the queen may enter the new super and lay eggs in it unless a queen excluder is used. Nevertheless, the amount of traveling space is reduced compared to top-supering since the new supers are closer to the entrance.

Working in Alberta, Canada, Szabo and Sporns (1994) failed to detect differences in honey yield between colonies that were top- versus bottom-supered. They hypothesized that poor nectar flow conditions during their study obscured possible treatment effects. Thus, we re-examined whether honey yield differs in colonies that are top- versus bottom-supered. The experiment was replicated across three apiaries and two distinct nectar flows typical of northeast Georgia, USA.

MATERIALS AND METHODS

In a one-year field study, we compared honey yield in colonies that were top- versus bottom-supered. The experiment was replicated across three apiaries and two nectar flows (May wildflower and June sourwood) in Habersham County, Georgia. Each colony was configured in one standard Langstroth hive body plus one food super (Illinois dimension, 65/8-inch, 16.8-cm). There were ten experimental colonies per apiary, resulting in 60 experimental units (3 apiaries x 10 colonies per apiary x 2 nectar flows). At the beginning of each nectar flow, colonies within the apiary were equalized with regard to brood, adult bees, and food stores. Each experimental colony within the apiary was then randomly assigned one of two treatments: (1) top-supering, that is, adding empty honey supers successively on top of honey supers already on the hive, or (2) bottom-supering, placing the empty honey super immediately above the food super and beneath honey supers already on the hive (Fig. 1). In each colony there was a queen excluder between the food super and the experimental honey supers. Experimental honey supers were of Illinois dimension and contained fully- drawn comb; each was weighed (kg) and given an identifying number before it was placed on a hive. Supers were added during each nectar flow as it was deemed necessary, according to the amount of incoming nectar, but whenever supering was required, all colonies in the experiment were given one super on that particular day. Thus, the amount of available empty comb space was equalized in the experiment. Volatiles from empty comb are known to affect honey hoarding behavior (Rinderer 1981, Rinderer et al. 1979). Experimental colonies were managed optimally and weak colonies were removed from the study. At the end of each nectar flow, experimental supers were removed and immediately weighed to determine net weight gain of harvestable honey per colony.

ANALYSES

The design was a 2 x 2 factorial treatment arrangement between supering method and nectar flow, blocked on apiary (Proc GLM; SAS Institute 1992). Terms were tested against residual error. Means were separated with a *t*-test, and lsmeans was used to adjust for non-equal sample sizes. Differences were accepted at the $\alpha \leq 0.05$ level.

RESULTS AND DISSCUSSION

There were no significant differences between supering treatments ($F = 1.9$; df=1, 46; $P = 0.1737$) nor among apiaries ($F = 1.4$; df = 2,46; $P = 0.2510$). Top or bottom-supering did not significantly affect total yield of honey averaged across three apiaries and two nectar flows. Although honey yield was numerically higher when bottom-supering was employed (Table 1), this difference was not statistically significant. There were no treatment interactions with the apiary ($F = 0.6$; df = 2,46; $P = 0.5636$) nor with nec-

Variable	Colony Honey Yield (kg)
Treatment	
Top-Supering	40.0 ± 3.5a (30)
Bottom-Supering	44.5 ± 3.4a (28)
Flow	
Spring	53.7 ± 3.4a (28)
Summer	31.3 ± 2.0b (30)
Apiary	
A	38.0 ± 4.6a (20)
B	44.0 ± 4.1a (19)
C	44.7 ± 4.0a (19)

Table 1. Effects of supering method, nectar flow, and apiary on average colony honey yield. Values are mean ± standard error. Number in parenthesis, *n*. Column means within variable followed by the same letter are not different at the $\alpha \leq 0.05$ level.

tar flow ($F = 0.9$; df = 1, 46; $P = 0.3483$). It is noteworthy that yields were significantly higher in the spring flow ($F = 32.6$; df 1, 46; $P = 0.0001$). Although Szabo and Sporns (1994) speculated that poor flow conditions during their study may have obscured differences between top- or bottom-supering, we found that bottom-supering did not affect yield in either a strong flow or a moderate one.

The results of this experiment and that of Szabo and Sporns (1994) indicate that bottom-supering, a relatively labor-intensive practice, does not significantly increase honey yield. This seems to be the case in either strong nectar flows or moderate ones. However, beekeepers may still choose to employ bottom- supering for other management considerations such as producing comb honey or drawing out foundation (Crane, 1990).

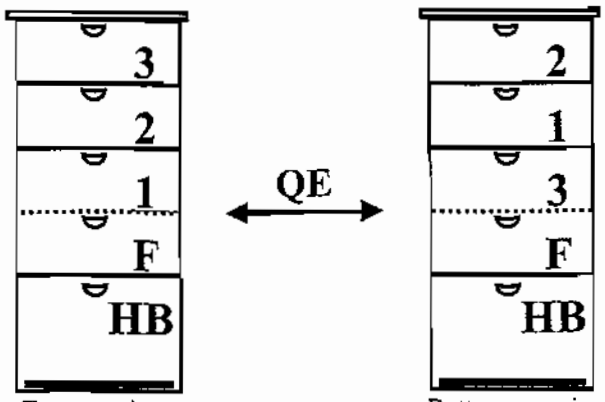


Figure 1. Two methods of progressively supering a colony during a nectar flow. in top-supering (L), the latest empty honey super (3) is simply added on top of those supers already being filled by bees (1 and 2). In bottom-supering (R), the latest super is placed below existing supers. In our study, colonies were configured with one hive body (HB) and a food super (F). QE shows the location of the queen excluder.

ACKNOWLEDGEMENTS

We thank Carl and Virginia Webb for their assistance on this project and for providing the three apiary sites. We also thank Jamie Ellis and David Jenkins for their technical assistance. This research was funded by the Georgia Beekeepers Association and the Agricultural Experiment Station of the University of Georgia.

REFERENCES

Ambrose, J. T. (1992) Management for honey production. *In:* Graham, J.M. (Ed.). The Hive and the Honey Bee. Dadant and Sons, Hamilton, Illinois, U.S.A. pp. 601-655

Crane, E. (1990) Bees and beekeeping. science, practice and world resources. Comstock Publishing Associates, Cornell University Press, Ithaca, New York, U.S.A. 614 pp.

Rinderer, T.E. (1981) Volatiles from empty comb increase hoarding by the honey bee. *Animal Behaviour* 29(4): 1275-1276.

Rinderer, T.E., J.R. Baxter, C.E. Carter, Jr., and L.R. Mornhinveg (1979) Empty comb stimulates honey production. *American Bee Journal* 119(1): 40-43.

SAS Institute (1992) SAS/STAT user's guide, version 6. SAS Institute, Cary. North Carolina, U.S.A. 846 pp.

Szabo, T.I. and P. Sporns (1994) A comparison of top and bottom supering on honey quantity and quality. *American Bee Journal* 134(10): 695-696

Apidologie 41 (2010) 40–44
DOI: 10.1051/apido/2009049

Available online at:
www.apidologie.org

Original article

Small-cell comb foundation does not impede Varroa mite population growth in honey bee colonies*

Jennifer A. BERRY[1], William B. OWENS[2], Keith S. DELAPLANE[1]

[1] Department of Entomology, University of Georgia, Athens, GA 30602, USA
[2] Owens Apiaries, 4510 Springwood Drive, Monroe, GA 30655, USA

Received 1 October 2008 – Revised 23 March 2009 – Accepted 27 April 2009

Abstract – In three independently replicated field studies, we compared biometrics of Varroa mite and honey bee populations in bee colonies housed on one of two brood cell types: small-cell (4.9 ± 0.08 mm cell width, walls inclusive) or conventional-cell (5.3 ± 0.04). In one of the studies, ending colony bee population was significantly higher in small-cell colonies (14994 ± 2494 bees) than conventional-cell (5653 ± 1082). However, small-cell colonies were significantly higher for mite population in brood (359.7 ± 87.4 vs. 134.5 ± 38.7), percentage of mite population in brood (49.4 ± 7.1 vs. 26.8 ± 6.7), and mites per 100 adult bees (5.1 ± 0.9 vs. 3.3 ± 0.5). With the three remaining ending Varroa population metrics, mean trends for small-cell were unfavorable. We conclude that small-cell comb technology does not impede Varroa population growth.

***Apis mellifera* / *Varroa destructor* / IPM / comb / cell size**

1. INTRODUCTION

The mite *Varroa destructor* Anderson and Trueman is a natural ectoparasite of the eastern honey bee *Apis cerana* F, but now parasitizes the western honey bee *Apis mellifera* L. throughout much of its modern range. Mite reproduction is limited to the brood cells of its host bee, and it is clear in free-choice studies that Varroa preferentially enter comparatively large brood cells. When Message and Gonçalves (1995) compared brood reared in small worker cells produced by Africanized bees with brood reared in large cells produced by European bees, they found a 2-fold increase in mite infestation rates in the larger cells. When Piccirillo and De Jong (2003) compared Varroa infestation rates in three types of brood comb with different cell sizes (inner width), 4.84 mm, 5.16 mm, or 5.27 mm, they found that percentage of cells infested was significantly higher in the largest cells compared to the other two groups.

These kinds of observations have led to an interest among beekeepers in downsizing comb foundations as a cultural control against Varroa. In North America, the resulting "small-cell" foundation measures 4.9 mm per cell (Dadant & Sons, Hamilton, IL, USA) compared to that of conventional foundation measuring between 5.2 mm and 5.4 mm. These numbers are derived by measuring the width of 10 cells in a straight line, inclusive of wall widths. In this study we challenged a null hypothesis of no difference in Varroa and bee population metrics between bee colonies housed on combs of small-cell or conventional-cell foundation.

2. MATERIALS AND METHODS

In three independent experimental replicates, we compared biometrics of Varroa mite and honey

Corresponding author: K.S. Delaplane, ksd@uga.edu
* Manuscript editor: Peter Rosenkranz

bee populations in bee colonies housed on one of two brood cell types: small-cell or conventional-cell. In spring 2006, foundation of both types was drawn during natural nectar flows prior to set up of the experiment. Small-cell foundation was drawn out by colonies containing honey bees which had themselves been reared in small-cell combs. Conventional foundation was similarly drawn out by colonies whose bees were derived from conventional combs. Once combs were drawn we determined realized cell width (walls inclusive) by counting the number of cells in 10 cm linear (n = 60 samples each cell type). Cell width from small-cell combs was 4.9 ± 0.08 mm and from conventional-5.3 ± 0.04 mm. In August 2006, bees were collected from a variety of existing colonies (irrespective of rearing history) and combined in large cages to achieve a homogeneous mixture of bees and Varroa mites. Twenty screened packages were made up, each containing ca. 2.0 kg (15966) bees. Packages were transported to a test apiary in Oconee County, Georgia, USA (33°50′N, 83°26′W) where each was used to stock one of 20 single-story deep Langstroth hives. Ten of the hives each contained ten frames of drawn small-cell comb, and the other ten contained drawn conventional-cell comb. One alcohol sample of ca. 300 bees was collected from each package to derive starting mite: adult bee ratios and, by extrapolation, beginning mite populations (colonies were broodless so all mites were phoretic on adults). Queens from a single commercial source were introduced into colonies. All colonies received sugar syrup and pollen patties as needed. Colonies were removed from the experiment if they died or their queens failed.

In March 2007 a second experiment of twenty colonies was established in the same manner as before with the following differences: each package contained ca. 1.45 kg (11612) bees, and colonies were established on foundation instead of drawn comb. A third experiment was set up in April 2008, each colony with 1.36 kg (10886) bees and started on drawn comb of the appropriate experimental type stored from the previous year; honey was removed from combs to remove variation in beginning food stores.

In June 2007 (for colonies started in August 2006 and March 2007) and in August 2008 (for colonies started in April 2008) we collected the following ending parameters: daily mite count on bottom board sticky sheet (72-h exposure), average mites per adult bee recovered from alcohol samples (ca. 100–300 bees), mites per 100 cells of capped brood, and brood area (cm^2). A measure of ending bee population was made by summing the proportions of whole deep frames covered by bees (after Skinner et al., 2001) then converting frames of adult bees to bee populations with the regression model of Burgett and Burikam (1985). Brood area (cm^2) was converted to cells of brood after determining average cell density as 3.93 per cm^2 for conventional-cells and 4.63 for small-cell. From cells of brood we calculated the number of cells sealed by applying the multiplier of 0.53 derived by Delaplane (1999). From mites on adult bees and mites in brood we could derive ending mite populations and percentage of mite population in brood – a positive indicator of the fecundity of a mite population (Harbo and Harris, 1999). Finally, for the August 2006 colonies we sampled adult bees in October 2006 for average body weight.

The duration of time between experiment start date and collection of ending Varroa population metrics was ca. 40 weeks for August 2006 colonies, 12 weeks for March 2007 colonies, and 16 weeks for April 2008 colonies. A field test of no more than 9–10 weeks is adequate to accurately appraise Varroa population change (Harbo, 1996).

An initial analysis was run as a randomized block analysis of variance recognizing the three experiment start dates as blocks and using the interaction of treatment and block as test term (Proc GLM, SAS 2002–2003). There was an interaction between treatment and block for ending colony bee population, so for this variable the analysis was performed separately for each start date and residual error used as test term. Differences were accepted at the $\alpha \leq 0.05$ level and where necessary means separated by Tukey's test.

3. RESULTS

Significant effects of cell size were detected for ending mites in brood (F = 38.3; df = 1,2; P = 0.0252), percentage of mite population in brood cells (F = 57.4; df = 1,2; P = 0.0170) and ending mites per 100 adult bees (F = 23.8; df = 1,2; P = 0.0396). The ending number of mites in brood, percentage of mite population in brood, and mites per 100 adult bees were significantly higher in small-cell colonies (Tab. I). There was a significant interaction between start date and treatment for ending colony bee population (F = 5.14; df = 2,33; P = 0.0114) which is explained by the fact that

Table I. Mean values (± se) for bee and Varroa population metrics in bee colonies housed on conventional-sized brood cells or small cells. Colonies of both cell types were set up in August 2006 (15966 bees), March 2007 (11612 bees), or April 2008 (10886 bees). Ending data were collected in June 2007 (August 2006 and March 2007 colonies) and August 2008 (April 2008 colonies). A one-time measure of adult bee live weight was made October 2006 for August 2006 colonies. Numbers in parentheses = *n*. The occurrence of significant treatment effects ($\alpha \leq 0.05$) is indicated by *.

Variable	Conventional-cell	Small-cell
Beginning colony mite popn.	303.1 ± 61.4 (19)	308.6.2 ± 54.1 (21)
Adult bee weight (mg) in October 2006 (Aug. 2006 colonies only)	141.3 ± 6.7 (4)	129.3 ± 5.7 (3)
Ending cm^2 brood	6320 ± 681 (19)	5627 ± 490 (21)
Ending cells of brood	24838 ± 2675 (19)	26053 ± 2271 (21)
Ending mites per 24 h sticky sheet	17.4 ± 5.0 (19)	28.3 ± 6.0 (21)
Ending mites per 100 brood cells	0.9 ± 0.2 (19)	2.8 ± 0.6 (21)
Ending colony mite popn.	409.7 ± 93.4 (18)	670.5 ± 112.5 (21)
Ending mites in brood	134.5 ± 38.7 (19)	359.7 ± 87.4 (21)*
Ending % mite popn. in brood	26.8 ± 6.7 (16)	49.4 ± 7.1 (20)*
Ending mites per 100 adult bees	3.3 ± 0.5 (18)	5.1 ± 0.9 (21)*

Table II. Mean values (± se) for ending colony bee population in bee colonies housed on conventional-sized brood cells or small cells. Colonies of both cell types were set up in August 2006 (15966 bees), March 2007 (11612 bees), or April 2008 (10886 bees). Ending data were collected in June 2007 (August 2006 and March 2007 colonies) and August 2008 (April 2008 colonies). Means for this variable are reported by experiment start date which interacted significantly with treatment. Numbers in parentheses = *n*. The occurrence of significant treatment effects ($\alpha \leq 0.05$) is indicated by *.

Variable	Conventional-cell	Small-cell
Ending colony bee popn.	August 2006	
	5653 ± 1082 (3)	14994 ± 2494 (3)*
	March 2007	
	10960 ± 2115 (6)	13717 ± 1309 (9)
	April 2008	
	14629 ± 1111 (9)	12461 ± 2177 (9)

populations tended to be higher in small-cell colonies except for the April 2008 start date. The advantage for small-cell colonies was significant for the August 2006 start date (F = 11.8; df = 1,4; P = 0.0264) (Tab. II).

We failed to detect significant effects of cell size on cm^2 brood, cells of brood, mites per 24 h sticky sheet, mites per 100 brood cells, and colony mite populations (Tab. I).

4. DISCUSSION

Although a significant and favorable trend for small-cell colonies was indicated for ending bee populations for the August 2006 start date (Tab. II), the chief interest in small-cell technology resides in its potential as a non-chemical limiter of Varroa population growth. By this criterion, the present results are not encouraging. The ending number of mites in brood, percentage of mite population in brood, and mites per 100 adult bees were significantly higher in small-cell colonies (Tab. I). Moreover, with all remaining ending Varroa population metrics, mean trends were unfavorable for small cell (Tab. I). We conclude that small-cell comb technology does not impede Varroa population growth. This null conclusion is reinforced by the facts that: (1) the experiment was replicated independently three times with start dates varying between spring and fall and test

periods ranging from 12–40 weeks, (2) there were no interactions between start date and treatment for ending Varroa metrics, showing that responses were consistent across experiments, (3) the question of Varroa population growth was examined holistically with six dependent variables, and finally (4) the bar for performance should be high before a candidate technology is recommended for field use. It is worth noting that Varroa densities in this study (3.3–5.1 mites per 100 bees, Tab. I) were not within the action threshold of ca. 13 mites per 100 bees shown for the region by Delaplane and Hood (1999).

Interest in small-cell foundation has been fueled in part by observations of Martin and Kryger (2002) that conditions which constrict the space between the host pupa and male protonymph mite promote male mite mortality. However, as these authors point out, "reducing cell sizes as a mite control method will probably fail to be effective since the bees are likely to respond by rearing correspondingly smaller bees". The present study supports this deduction directly, and its premise indirectly: average bee live weight in October was numerically smaller in small-cell colonies than conventional (Tab. I).

ACKNOWLEDGEMENTS

Technical assistance was provided by Dan Harris, Cody Sorensen, Eleanor Spicer, and Nicholas Weaver.

La petite taille des alvéoles des rayons de cire n'entrave pas le développement des populations de *Varroa destructor* dans les colonies d'abeilles.

***Apis mellifera* / *Varroa destructor* / lutte intégrée / rayon/ taille de la cellule**

Zusammenfassung – Mittelwände mit kleinen Zellen reduzieren nicht das Wachstum der Varroa-Population in Honigbienenvölkern. In Wahlversuchen konnte gezeigt werden, dass Milbenweibchen (*Varroa destructor*) bevorzugt größere Brutzellen von *Apis mellifera* befallen (Message and Gonçalves, 1995; Piccirillo and De Jong, 2003). Diese Beobachtungen stießen bei den Imkern auf großes Interesse und haben dazu geführt, dass eine Verringerung der Zellgröße bei den Mittelwänden als eine mögliche biotechnische Kontrollmaßnahme gegen die Varroose diskutiert wurde. In Nordamerika beträgt der daraus resultierende Durchmesser für "kleine Zellgrößen" bei den Mittelwandgussformen 4,9 mm pro Zelle (Dadant & Sons, Hamilton, IL, USA) im Vergleich zu normalen Zellgrößen mit 5,2 bis 5,4 mm. Diese Werte werden ermittelt, indem 10 Zellen in Reihe einschließlich der Zellwände gemessen werden.
In Feldstudien mit drei unabhängigen Wiederholungen verglichen wir die Entwicklung der Varroa-, Bienen- und Brutpopulation bei Bienenvölkern mit zwei verschiedenen Zelltypen: Kleine Zellen (4,9 ± 0,08 mm Zelldurchmesser einschließlich Zellwände) und konventionelle Zellen (5,3 ± 0,04 mm). Die Versuche begannen im August 2006, März 2007 bzw. April 2008 und die letzten abhängigen Testvariablen wurden im Juni 2007 (für Völker von August 2006 und März 2007) bzw. im August 2008 (für Völker von April 2008) ermittelt. Für die im August 2006 gestarteten Versuchsvölker war die Bienen-Endpopulation in Völkern mit kleinen Zellen signifikant größer als in denen mit konventionellen Zellen (14994 ± 2494 im Vergleich zu 5653 ± 1082 Bienen). Allerdings hatten die Völker mit kleinen Zellen signifikant mehr Milben in der Brut (359,7 ± 87,4 vs. 134,5 ± 38,7), einen höheren prozentualen Brutbefall (49,4 ± 7.1 vs. 26,8 ± 6,7) und mehr Milben pro 100 adulte Bienen (5,1 ± 0.9 vs. 3,3±0,5). In Anbetracht dieser Daten zur Varroa-Populationsdynamik haben kleine Zellen im Durchschnitt sogar einen nachteiligen Effekt. Wir schließen daraus, dass die "Kleine-Zellen-Betriebsweise" das Wachstum der Varroa-Population nicht reduziert. Diese Schlussfolgerung wird durch folgende Details der Versuche untermauert:

1. Das Experiment wurde dreimal wiederholt mit unterschiedlichen Startterminen vom Frühjahr bis zum Herbst und variablen Versuchzeiträumen von 12–40 Wochen.
2. Es gab keine Interaktionen zwischen dem Starttermin und der Variable "Zellgröße" bzgl. der Varroa-Endpopulation; dies zeigt, dass die Ergebnisse der Versuchsserien untereinander konsistent sind.
3. Das Wachstum der Varroa-Population wurde anhand von 6 unabhängigen Variablen beurteilt.
4. Die Vorteile einer neuen Technologie müssen eindeutig nachgewiesen sein, bevor diese in der Praxis empfohlen werden kann.

Abschließend sei noch bemerkt, dass der Varroabefall in diesen Untersuchungen (3,3–5,1 Milben pro 100 Bienen, Tab. I) deutlich unterhalb des Befalls von 13 Milben pro 100 Bienen liegt, der von Delaplane and Hood (1999) für diese Region als Schwellenwert für Sofortmaßnahmen ermittelt wurde.

***Apis mellifera* / *Varroa destructor* / Integrierte Schädlingsbekämpfung / Wabe / Zellgröße**

REFERENCES

Burgett M., Burikam I. (1985) Number of adult honey bees (Hymenoptera: Apidae) occupying a comb: a standard for estimating colony populations, J. Econ. Entomol. 78, 1154–1156.

Delaplane K.S. (1999) Effects of the slatted rack on brood production and its distribution in the brood nest, Am. Bee J. 139, 474–476.

Delaplane K.S., Hood W.M. (1999) Economic threshold for *Varroa jacobsoni* Oud in the southeastern USA, Apidologie 30, 383–395.

Harbo J.R. (1996) Evaluating colonies of honey bees for resistance to *Varroa jacobsoni*, BeeScience 4, 100–105.

Harbo J.R., Harris J.W. (1999) Heritability in honey bees (Hymenoptera: Apidae) of characteristics associated with resistance to *Varroa jacobsoni* (Mesostigmata: Varroidae), J. Econ. Entomol. 92, 261–265.

Martin S.J., Kryger P. (2002) Reproduction of *Varroa destructor* in South African honey bees: does cell space influence *Varroa* male survivorship? Apidologie 33, 51–61.

Message D., Gonçalves L.S. (1995) Effect of the size of worker brood cells of Africanized honey bees on infestation and reproduction of the ectoparasitic mite *Varroa jacobsoni* Oud., Apidologie 26, 381–386.

Piccirillo G.A., De Jong D. (2003) The influence of brood comb cell size on the reproductive behavior of the ectoparasitic mite *Varroa destructor* in Africanized honey bee colonies, Genet. Mol. Res. 2, 36–42.

SAS Institute (2002–2003) SAS/STAT user's guide, version 9.1, SAS Institute, Cary, NC, USA.

Skinner J.A., Parkman J.P., Studer M.D. (2001) Evaluation of honey bee miticides, including temporal and thermal effects on formic acid gel vapours, in the central south-eastern USA, J. Apic. Res. 40, 81–89.

Hygienic Behavior of Cape and European *Apis mellifera* (Hymenoptera: Apidae) toward *Aethina tumida* (Coleoptera: Nitidulidae) Eggs Oviposited in Sealed Bee Brood

JAMES D. ELLIS, JR., KEITH S. DELAPLANE,[1] CAMERON S. RICHARDS, RANDALL HEPBURN, JENNIFER A. BERRY,[1] AND PATTI J. ELZEN[2]

Department of Zoology and Entomology, Rhodes University, Grahamstown, 6140 South Africa

Ann. Entomol. Soc. Am. 97(4): 860–864 (2004)

ABSTRACT In this study, we tested for the presence and efficacy of hygienic behavior by Cape honey bees in South Africa and European honey bees, *Apis mellifera* L. (Hymenoptera: Apidae), of mixed origin in the United States toward *Aethina tumida* Murray (Coleoptera: Nitidulidae) eggs oviposited in sealed bee brood. We looked for colony differences in removal rates of brood in cells with cappings perforated by *A. tumida* within each subspecies to identify colonies within location that display superior hygienic behavior. Finally, we determined the oviposition rate (number of *A. tumida*-perforated cells actually oviposited in by *A. tumida*/total number of *A. tumida*-perforated cells) in *A. tumida*-perforated cells and the number of *A. tumida* eggs oviposited in each cell. There were no colony differences within subspecies for the removal of normal capped brood, artificially perforated brood (capped cells perforated by experimenter with a pin), and *A. tumida*-perforated brood. For both subspecies, the bees removed significantly more *A. tumida*-perforated brood than either normal or artificially perforated brood. *A. tumida* oviposited significantly more eggs per cell in Cape colonies than in European colonies, but the oviposition rate in *A. tumida*-perforated cells did not differ between Cape and European colonies. Both subspecies removed a proportion of *A. tumida*-perforated brood statistically indistinguishable from the proportion of *A. tumida*-perforated brood containing *A. tumida* eggs. Thus, both Cape and European *A. mellifera* preferentially remove the contents of *A. tumida*-perforated cells in which *A. tumida* have actually oviposited.

KEY WORDS *Aethina tumida*, hygienic behavior, oviposition, Cape honey bees, European honey bees

HONEY BEES, *Apis mellifera* L., express hygienic behavior, which is defined as the detection of abnormal brood, removal of the wax covering it, and removal of the affected larva or pupa, a behavior generally understood to be a defensive strategy against a host of parasites and pathogens (Boecking and Spivak 1999, Spivak and Boecking 2001). Rothenbuhler (1964), who advanced the study of hygienic behavior, demonstrated that European *A. mellifera* can detect and remove brood killed by *Paenibacillus larvae* White, and others have subsequently shown detection and removal of brood affected by *Ascosphaera apis* Maassen ex Claussen and *Varroa destructor* Anderson & Trueman (Gilliam et al. 1983, Spivak and Gilliam 1993, Boecking and Spivak 1999, Spivak and Boecking 2001).

Female small hive beetles, *Aethina tumida* Murray, oviposit in bee brood cells capped with wax (Ellis et al. 2003a,b), and the removal of this brood may be one component that contributes to the overall success of natural host colonies (African subspecies of *A. mellifera*) at limiting *A. tumida*-associated depredation (Ellis et al. 2003b). Failure to remove brood in which *A. tumida* have oviposited could easily lead to a population buildup of *A. tumida* larvae (we have found as many as 120 *A. tumida* eggs oviposited in one brood cell), which in turn damage host colonies by consuming honey, pollen, and bee brood (Elzen et al. 1999, Hood 2000, Ellis et al. 2002).

In this study, we tested for the presence and efficacy of hygienic behavior by Cape honey bees, *Apis mellifera capensis* Esch., in South Africa and European *A. mellifera* of mixed origin in the United States toward *A. tumida* eggs oviposited in sealed bee brood. We set forth a practical assay that can be used to test for the presence and degree of hygienic behavior toward *A. tumida* eggs expressed by a single *A. mellifera* colony. We also looked for colony differences within each bee subspecies for the removal rates of brood cells perforated by *A. tumida* to possibly identify colonies within each location that display superior hygienic behavior. Finally, we determined the oviposi-

[1] Department of Entomology, The University of Georgia, Athens, GA 30602.

[2] USDA, Kika de la Garza Subtropical Agricultural Research Center, Weslaco, TX 78596.

0013-8746/04/0860–0864$04.00/0

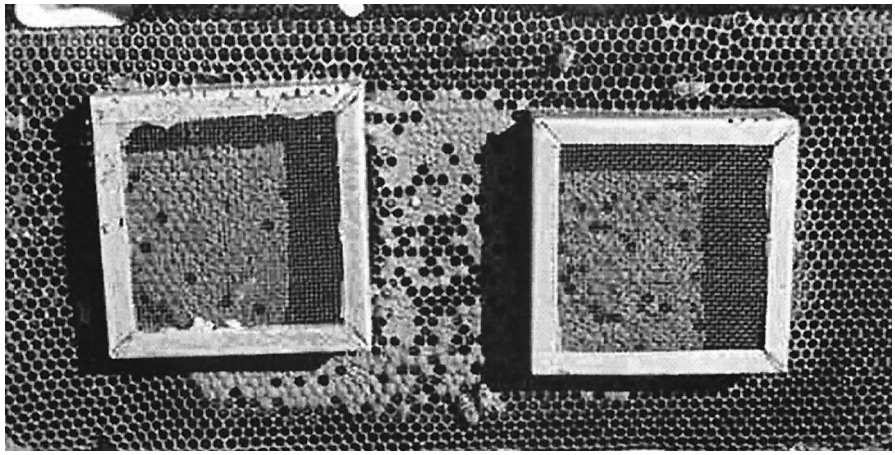


Fig. 1. Metal push-in cages used to confine adult *A. tumida* to sections of brood. The face of the cage was screen mesh (for ventilation). For each experimental replicate, one cage contained *A. tumida* and the other cage remained empty.

tion rate in *A. tumida*-perforated cells (number of *A. tumida*-perforated cells in which *A. tumida* actually oviposited/total number of *A. tumida*-perforated cells) and the number of *A. tumida* eggs oviposited in each cell.

Materials and Methods

Experiments on Cape *A. mellifera* were conducted at a Rhodes University research apiary outside of Grahamstown, South Africa (a geographic area predominantly inhabited by Cape bees) in March through May 2003. The complimentary studies with European *A. mellifera* of mixed origin were conducted at The University of Georgia research apiary, Oconee County, in July and August 2003. Ten colonies of Cape *A. mellifera* and nine colonies of European *A. mellifera* (housed in standard Langstroth-style hives of equal strength and having nearly identical reserves of brood, honey, pollen, and adult bees) were used for the study. All colonies had been previously and naturally exposed to *A. tumida.*

We established three experimental treatments: capped brood that had been 1) perforated by *A. tumida*, 2) artificially perforated by experimenter (positive control), or 3) not perforated (negative control). This was accomplished by trapping *A. tumida*, or excluding them, on a 10 by 10-cm area of sealed brood with a sheet metal push-in cage (10 by 10 by 2.5 cm), the face of which was screened to allow for ventilation but exclude bees and other *A. tumida* (Fig. 1). The combs contained ≈60–90% capped brood. The selected brood was >6 d from eclosing (determined by uncapping and examining brood in the test area) so that no brood from the test area would emerge during the study. For each colony, the frame of capped brood was removed, and 20 adult *A. tumida* (nonsexed, captured from nature or laboratory-reared, cooled in a vial surrounded by ice for 4–5 min) were placed under one cage (the adults mate and the females subsequently oviposit); this prepared the *A. tumida*-perforated treatment. A second cage without *A. tumida* was pushed into the same brood frame as a nonperforated negative control. Both caged sections of brood were then returned to the center of the bee cluster in each colony.

Twenty-four hours later, both cages were removed, and adult *A. tumida* from the treatment cage were collected. Cells containing *A. tumida* perforations (Ellis et al. 2003a) in the *A. tumida*-perforated treatment square were counted and labeled by placing a transparent sheet of acetate over the brood and marking all cells having perforated cappings. Similarly, 20 nonperforated brood cells (no perforations in the cappings) from under the negative control cage were marked. The positive control (artificial perforations) was created by puncturing the cappings of 20 brood cells with a minuten insect pin to simulate *A. tumida* oviposition perforations. The perforations were positioned around the capping perimeter to avoid damaging the pupae (pin-killed pupae are removed by bees; Boecking and Spivak 1999). The documented brood cells of all three treatments were then returned to the center of the bee cluster. After 48 h, they were removed and marked cells from which brood had been removed by the bees were counted. The procedure was replicated three times for each Cape and European colony.

The oviposition rate in *A. tumida*-perforated cells also was determined. For each of six Cape and seven European colonies, 20 adult *A. tumida* were confined to one frame of capped brood as described above, and the frames were returned to the colonies. Twenty-four hours later, cells with perforations in their cappings were opened to determine the presence or absence of *A. tumida* eggs (≈30 cells per colony in Cape colonies were opened, and all perforated cells in European colonies were opened). The oviposition rate was calculated as the percentage of *A. tumida*-perforated cells actually containing *A. tumida* eggs. The number of *A. tumida* eggs was determined for each cell in which oviposition occurred.

Table 1. Colony removal rate (proportion) of *A. mellifera* brood cells that were non-perforated (negative control), artificially-perforated (positive control), or *A. tumida*-perforated

Colony	Cape *A. mellifera*			European *A. mellifera*		
	Non-perforated	Artificially-perforated	*A. tumida*-perforated	Non-perforated	Artificially-perforated	*A. tumida*-perforated
1	0.02 ± 0.02	0.02 ± 0.02	0.41 ± 0.14	0.03 ± 0.03	0.15 ± 0.09	0.59 ± 0.10
2	0.03 ± 0.02	0	0.73 ± 0.13	0.02 ± 0.02	0.08 ± 0.08	0.73 ± 0.03
3	0	0	0.74 ± 0.14	0	0.12 ± 0.04	0.67 ± 0.03
4	0	0.02 ± 0.02	0.71 ± 0.07	0.02 ± 0.02	0.25 ± 0.18	0.51 ± 0.08
5	0.03 ± 0.02	0.02 ± 0.02	0.57 ± 0.15	0.02 ± 0.02	0.23 ± 0.21	0.51 ± 0.12
6	0.08 ± 0.04	0.02 ± 0.02	0.79 ± 0.14	0	0.07 ± 0.07	0.42 ± 0.12
7	0	0.05 ± 0.03	0.67 ± 0.11	0	0.10 ± 0.08	0.58 ± 0.08
8	0.10 ± 0.08	0.02 ± 0.02	0.69 ± 0.07	0	0.03 ± 0.02	0.60 ± 0.10
9	0.07 ± 0.07	0.02 ± 0.02	0.65 ± 0.05	0	0.08 ± 0.04	0.46 ± 0.09
10	0.07 ± 0.04	0.03 ± 0.02	0.71 ± 0.12			

Colonies within each subspecies did not differ with respect to the amount of brood removed within each treatment type. Data are mean ± standard error, $n = 3$ for all data. Data within columns are not different at the $\alpha \leq 0.05$ level.

Statistical Analyses. Differences between colony removal rates of *A. tumida*-perforated, nonperforated (negative control), and artificially perforated (positive control) brood were analyzed within bee subspecies by using one-way analysis of variance (ANOVA). Because colonies within subspecies did not differ with respect to the amount of treatment brood removed (i.e., no colonies within subspecies were "more hygienic" than others), colony replicates were averaged (=proportion of brood removed) for each colony for use in further analyses. The proportion of brood removed was analyzed by ANOVA recognizing treatment and *A. mellifera* subspecies (Cape or European) as main effects. Because there was an interaction between treatment and subspecies, the proportion of brood removed was analyzed further by subspecies by using ANOVA. Differences in the oviposition rate in perforated cells and in the number of *A. tumida* eggs per cell were analyzed by *A. mellifera* subspecies by using independent sample *t*-tests. Furthermore, the oviposition rate in perforated cells was compared with the removal rate of perforated cells for both subspecies by using independent sample *t*-tests. Where analyzed data were proportions (as in the proportion of removed brood and the oviposition rate), data were transformed using arcsine $\sqrt{}$proportion to stabilize the variance before analyses. All differences were accepted at $\alpha \leq 0.05$, and all analyses were conducted using Statistica (2001).

Results

Colony-Level Removal of Perforated Brood. There were no colony differences among Cape *A. mellifera* for the removal of nonperforated ($F = 1.1$; df = 9, 20; $P = 0.4364$), artificially perforated ($F = 0.6$; df = 9, 20; $P = 0.7510$), or *A. tumida*-perforated ($F = 0.8$; df = 9, 20; $P = 0.6602$) brood. Furthermore, there were no colony differences among European *A. mellifera* for the removal of nonperforated ($F = 0.6$; df = 8, 18; $P = 0.7359$), artificially perforated ($F = 0.3$; df = 8, 18; $P = 0.9373$), or *A. tumida*-perforated ($F = 1.2$; df = 8, 18; $P = 0.3647$) brood. Mean removal rates for colonies of both bee subspecies are reported in Table 1.

Hygienic Behavior of Cape and European Bees. There were no subspecies effects for the total proportion of brood removed ($F = 0.1$; df = 1, 51; $P = 0.7716$). Overall, Cape bees removed the same proportion of all tested brood (0.24 ± 0.06, 30; mean ± SE, *n*) as did their European counterparts (0.23 ± 0.05, 27). There were treatment effects ($F = 336.4$; df = 2, 51; $P < 0.0001$) and treatment × subspecies interactions ($F = 16.9$; df = 2, 51; $P < 0.0001$) for the proportion of brood removed. Because of the significant interaction, the removal data were analyzed separately by subspecies. There was a significant difference in the amount of treatment brood removed within both Cape ($F = 202.8$; df = 2, 27; $P < 0.01$) and European ($F = 152.4$; df = 2, 24; $P < 0.0001$) *A. mellifera.* For both subspecies, the bees removed significantly more *A. tumida*-perforated than either nonperforated or artificially perforated brood (Table 2). In Cape colonies, the amount of nonperforated and artificially perforated brood did not differ, whereas it did in European colonies (Table 2). Colonies of both bee subspecies also uncapped some *A. tumida*-perforated pupae (<5%) without removing them.

Oviposition Rate and Number of Eggs per Cell. There was no difference between Cape and European *A. mellifera* for the oviposition rate in cells perforated by *A. tumida* ($t = 1.5$, df = 11, $P = 0.1642$). In Cape colonies, the proportion of *A. tumida*-perforated cells in which *A. tumida* oviposited (0.68 ± 0.04; 6) was

Table 2. Removal rate (proportion) of *A. mellifera* brood cells that were non- perforated (negative control), artificially-perforated (positive control), or *A. tumida*-perforated

Treatment	Cape *A. mellifera*	European *A. mellifera*
Non-perforated	0.04 ± 0.01a	0.01 ± 0.004a
Artificially-perforated	0.02 ± 0.005a	0.12 ± 0.02b
A. tumida-perforated	0.67 ± 0.03b	0.57 ± 0.03c

Data were analyzed by subspecies, because of the significant interaction between treatment and and *A. mellifera* subspecies. Data are mean ± standard error. Ten Cape and nine European colonies were sampled. Columnar data followed by the same letter are not different at the $\alpha \leq 0.05$ level.

similar to that in European colonies (0.56 ± 0.06; 7). *A. tumida* oviposited significantly more eggs per cell in Cape colonies (14.5 ± 1.4; 122) than in European colonies (7.3 ± 0.4; 312) ($t = 7.0$, df = 432, $P < 0.0001$). In Cape colonies, the proportion of *A. tumida*-perforated brood in which *A. tumida* oviposited was not significantly different from the proportion of *A. tumida*-perforated brood that was removed by the bees ($t = 0.2$, df = 14, $P = 0.8367$); the same held true in European colonies ($t = 0.1$, df = 14, $P = 0.9393$).

While rearing *A. tumida* in vitro for use in this study, we observed the process by which *A. tumida* perforate and oviposit in capped brood cells. Female *A. tumida* use their mandibles to bite small holes through the cell capping. They then position the distal terminus of their abdomen flush with the perforation and insert their ovipositor to begin laying eggs. This process usually lasts >5 s per occurrence, probably depending on the number of eggs the females were ovipositing per cell.

Discussion

In colonies of European species of *A. mellifera*, *A. tumida* perforate cell cappings and oviposit even in the presence of bees (Ellis et al. 2003a), but it is not yet known whether they do the same in colonies of African subspecies of *A. mellifera.* This mode of oviposition may be an important reproductive pathway for *A. tumida* (Ellis et al. 2003b), because exposed *A. tumida* eggs are removed quickly from colonies (Neumann and Härtel 2004). Lundie (1940) and Schmolke (1974) suggest that *A. tumida* oviposit in cracks and crevices around the hive. However, this would require hatching larvae to crawl to the combs while evading bees, and studies have shown that free-roaming larvae are removed from African colonies (Neumann and Härtel 2003). Therefore, direct oviposition into brood cells may be a superior survival strategy (Ellis et al. 2003b). As a result, the hygienic removal of brood on which *A. tumida* oviposits may be an important resistance mechanism against this nest invader.

The data indicate that both Cape and European *A. mellifera* remove brood on which *A. tumida* have oviposited. If this behavior were essential to the resistance of Cape bees toward *A. tumida* depredation, then one would expect to find the behavior reduced or absent in European bees. This was not the case. It remains possible that subspecific differences with respect to the removal rate of *A. tumida*-perforated brood will emerge if larger areas of brood are involved.

Interestingly, both subspecies removed the same proportion of *A. tumida*-perforated brood as that in which *A. tumida* actually oviposited, a finding similarly demonstrated for a second mode of *A. tumida* oviposition wherein *A. tumida* enter empty cells and oviposit through the cell wall into an adjacent cell (Ellis et al. 2003b). In the current study, both subspecies removed an amount of *A. tumida*-perforated brood equal to that of the actual oviposition rate, suggesting that they preferentially open and remove brood from those perforated cells actually containing eggs. Furthermore, neither subspecies removed artificially perforated brood at similar or higher rates than *A. tumida*-perforated brood, suggesting that it is not the perforated capping that stimulates the removal of cell contents.

The stimuli that elicit removal of *A. tumida* egg-infested cells remain unclear. Pathogen-killed brood may be recognized and removed by bees (Rothenbuhler 1964, Boecking and Spivak 1999); however, the oviposition tactics of *A. tumida* may not necessarily kill the brood. Despite this, both bee subspecies were able to detect and remove brood on which *A. tumida* had oviposited. One possibility is that the presence of *A. tumida* eggs or an unknown oviposition chemical deposited by female *A. tumida* causes bees to remove the cell contents. Also possible is that because *A. tumida* eggs can hatch within 48 h (Schmolke 1974), the beetle larvae damage the bee pupae or secrete a substance that elicits the bees to remove the cell contents.

If bees cue onto the presence of *A. tumida* eggs, there may exist a minimum number of eggs per cell that elicits the removal of the cell contents. If so, then one would expect that colonies in which *A. tumida* lay fewer eggs per cell would be less likely to detect and remove infested brood. This study does not permit one to determine whether such a putative egg threshold exists, but *A. tumida* clearly laid fewer eggs per cell in European colonies, perhaps increasing the bees' chances of missing infested cells in these colonies. As a result, putting fewer *A. tumida* under each cage may encourage *A. tumida* to oviposit fewer eggs per cell, because competition for oviposition sites could lead to the high number of eggs per cell seen in this study. Using fewer adults may make the test more sensitive to detecting differences in the removal rates between both subspecies if such differences exist.

It is also unclear why *A. tumida* perforate some cells but do not oviposit in them. In Cape colonies, ≈32% of *A. tumida*-perforated cells did not contain *A. tumida* eggs, the corresponding number for European colonies was ≈44%. This may indicate that *A. tumida* cue onto certain developmental stages of the brood or chemicals produced by the brood. Interestingly, the oviposition rate of *A. tumida*-perforated cells in Cape colonies was higher than that in European colonies. This may indicate the absence/reduction of a chemical oviposition-stimulant in non-native hosts.

One objective of this study was to determine whether colonies differed with respect to the degree of hygienic behavior they express; colony variation for hygienic removal of varroa is often high (Boecking and Spivak 1999). However, differences in the level of hygienic removal of *A. tumida*-perforated brood for colonies of either subspecies were not detected. Because other factors (such as genetics, environmental conditions, and colony size) affect hygienic expression (Boecking and Spivak 1999), one may need to control for these when trying to determine whether the level of hygienic expression toward *A. tumida* oviposition varies between colonies.

Regardless, it is interesting that all tested colonies of both bee subspecies removed *A. tumida*-perforated brood, especially because reports indicate that only few colonies (<10%) in nature express hygienic behavior (Boecking and Spivak 1999). This further suggests that the level of removal stimulants in the brood (such as eggs and oviposition chemicals) in our study may have been unnaturally high. This demonstrates a need to examine *A. tumida* stimuli that elicit brood removal so that one may manipulate these factors experimentally. If successful, it may be possible to 1) further determine whether the expression of removal of *A. tumida*-perforated brood differs between African and European subspecies of *A. mellifera* and 2) select for this behavior as a natural defense against *A. tumida* depredation.

Acknowledgments

We thank Nick and Helen James for providing the South African study site and Sarah Radloff and Martin Villet (Rhodes University) for statistical advice. The U.S. Department of Agriculture, Georgia Beekeepers Association, and Rhodes University provided financial support.

References Cited

Boecking, O., and M. Spivak. 1999. Behavioral defenses of honey bees against *Varroa jacobsoni* Oud. Apidologie 30: 141–158.

Ellis, J. D. Jr., P. Neumann, H. R. Hepburn, and P. J. Elzen. 2002. Longevity and reproductive success of *Aethina tumida* (Coleoptera: Nitidulidae) fed different natural diets. J. Econ. Entomol. 95: 902–907.

Ellis, J. D., H. R. Hepburn, K. S. Delaplane, and P. J. Elzen. 2003a. A scientific note on small hive beetle (*Aethina tumida* Murray) oviposition and behavior during European (*Apis mellifera*) honey bee clustering and absconding events. J. Apic. Res. 42:47–48.

Ellis, J. D., C. S. Richards, H. R. Hepburn, and P. J. Elzen. 2003b. Oviposition by small hive beetles elicits hygienic responses from Cape honeybees. Naturwissenschaften 90: 532–535.

Elzen, P. J., J. R. Baxter, D. Westervelt, C. Randall, K. S. Delaplane, L. Cutts, and W. T. Wilson. 1999. Field control and biology studies of a new pest species, *Aethina tumida* Murray (Coleoptera, Nitidulidae), attacking European honey bees in the Western hemisphere. Apidologie 30: 361–366.

Gilliam, M., S. Taber III, and G. V. Richardson. 1983. Hygienic behaviour of honey bees in relation to chalkbrood disease. Apidologie 14: 29–39.

Hood, W. M. 2000. Overview of the small hive beetle, *Aethina tumida*, in North America. Bee World 81: 129–137.

Lundie, A. E. 1940. The small hive beetle, *Aethina tumida.* Sci. Bull. 220, Union of South Africa, Dep. of Agric. Forestry., Pretoria, South Africa.

Neumann, P., and S. Härtel. 2004. Removal of small hive beetle (*Aethina tumida*) eggs and larvae by African honeybee colonies (*Apis mellifera scutellata*). Apidologie 35: 31–36.

Rothenbuhler, W. C. 1964. Behavior genetics of nest cleaning behavior in honeybees. I. Response of four inbred lines to disease killed brood. Anim. Behav. 12: 578–583.

Schmolke, M. D. 1974. A study of *Aethina tumida:* the small hive beetle. University of Rhodesia (Zimbabwe) certificate in field ecology project report, Salisbury (Harare).

Spivak, M., and O. Boecking. 2001. Honey bee resistance to Varroa mites, pp. 205–227. *In* T. C. Webster and K. S. Delaplane [eds.], Mites of the honey bee. Dadant & Sons, Inc., Hamilton, IL.

Spivak, M., and M. Gilliam. 1993. Facultative expression of hygienic behaviour in honey bees in relation to disease resistance. J. Apic. Res. 32: 147–157.

Statistica. 2001. System reference, version 6. StatSoft, Tulsa, OK.

Received 4 February 2004; accepted 3 May 2004.

Journal of Apicultural Research 40(1): 00–00 (2001)

Effects of comb age on honey bee colony growth and brood survivorship

JENNIFER A BERRY; KEITH S DELAPLANE

Department of Entomology, University of Georgia, Athens, Georgia 30602, USA

(Received 10 January 2000, accepted subject to revision 17 July 2000, accepted for publication 28 September 2000)

SUMMARY

This research examined the effects of comb age on honey bee colony growth and brood survivorship. Experimental old combs were of an unknown age, but were dark and heavy as typical of combs one or more years old. New combs were produced just prior to the beginning of the experiment and had never had brood previously reared in them. Either old or new combs were installed into each of 21–24 nucleus colonies each year over a three-year period. On average, colonies with new comb produced a greater area (cm^2) of brood, a greater area (cm^2) of sealed brood, and a higher weight of individual young bees (mg). Brood survivorship was the only variable significantly higher in old comb.

Keywords: honey bees, *Apis mellifera*, beeswax, comb age, old comb, new comb

INTRODUCTION

Honey bees (*Apis mellifera*) use structures like trees, hollows and man-made hives for shelter, but it is beeswax that provides the basic building material for the interior nest substrate. When comb is first constructed it is pliable and near-white in colour. Comb used for food storage takes on a yellowish hue over time due to the accumulation of pollen (Free & Williams, 1974). As comb used for brood rearing ages it becomes darker, almost black, and more brittle (Hepburn, 1998) because of accumulated faecal material (Jay, 1963), propolis and pollen (Free & Williams, 1974). The darker colour may also be a result of numerous undefined contaminants that are collected and absorbed in the wax over time. Wax comb consists primarily of hydrocarbons and ester components (Tulloch, 1980) which easily absorb many types of materials. Unfortunately, some materials including fungal and bacterial spores, pesticides and heavy metals may be detrimental to a colony's welfare. As materials accumulate in wax comb, the diameter of the cells becomes smaller (Hepburn & Kurstjens, 1988) and each time a larva pupates it spins a silken cocoon that remains in the cell after the adult emerges (Jay, 1963). Over time the mass ratio of silk to wax increases, and thereby wax comb goes from a single-phase material to a fibre-reinforced composite product (Hepburn & Kurstjens, 1988). Studies have suggested that smaller cell diameters result in smaller bees in old comb because of the lack of space and a relative shortage of food. Bees reared in old comb may weigh up to 19% less than bees reared in new comb (Buchner, 1955). Diminishing space may force larvae to moult to the non-feeding prepupal phase prematurely, causing nurse bees to cap the cells before larvae have developed maximally (Abdellatif, 1965).

Pheromones also are absorbed and transferred in the wax comb and, depending on their volatility, may remain for a considerable time (Naumann *et al.* 1991). One pheromone group relevant in the current context is brood pheromones. These contact pheromones are emitted by brood and communicate the presence, age and nutritional needs of immatures to nurse bees (Free, 1987).

In the wild, honey bee colonies are known to survive for about six years (Seeley, 1978). Once the colony dies, wax moths, mice and other nest scavengers remove the wax comb, leaving an empty cavity for the next colony to inhabit (Gilliam & Taber, 1991). Modern beekeeping practices disrupt this natural recycling process by housing bees on semi-artificial comb that may be years or even decades old. Advances in beekeeping equipment, like the Langstroth hive and wire-reinforced foundation, have added years to the life of wax comb.

Many beekeepers believe that it is not economically feasible to regularly remove and replace old comb with new foundation. Moreover, there is an energetic cost for the bees that must draw out the foundation into a functional comb using metabolically-derived beeswax. A typical nest contains around 100 000 cells (Seeley & Morse, 1976) which takes about 1200 g of wax to construct. The amount of sugar required to secrete the wax is energetically equivalent to 7.5 kg of honey, about one-third of the honey stores consumed by a colony over winter (Seeley, 1985).

However, it is possible that the economic savings of using long-lasting comb may be offset by deleterious effects of old comb acting as a biological sink for toxins and pathogens or as a physical constraint on larval development. This question led us to hypothesize that comb age affects honey bee colony growth and brood survivorship.

MATERIALS AND METHODS

In a three-year field study, we compared the quantity of brood produced, brood survivorship, average body weight of adult bees and population of adult bees in colonies housed on brood combs comprised of either old beeswax or new, first-year beeswax.

Experimental colonies were set up in standard four-frame Langstroth nucleus hives (21 colonies in 1997, 21 in 1998, and 24 in 1999). Colonies were housed on deep brood combs belonging to one of two age classes: old comb or new comb. Brood combs in the old class were collected from a variety of sources throughout the apiary. Old combs were of an unknown age, but were dark and heavy as typical of combs one or more years old. We placed the old combs into strong colonies to clean them of debris. New brood combs were produced by placing frames of wax foundation into existing colonies during the spring nectar flow. Honey in all combs, old and new, was removed by allowing robber bees access to the combs. Combs were used only if they were completely drawn out. If pollen was present in the cells, the frames were soaked in water overnight and flushed clean. We measured numerous characteristics of all combs used at the start of the experiment (table 1).

We collected bees from existing colonies or from standard mail-order 0.9 kg (2 lb) packages, and combined them into large cages to achieve a homogeneous mixture. Each year we set up 21–24 test colonies each with 0.62–1.03 kg of bees. For each colony, we collected a sample of bees and determined average weight per bee. Using average weight per bee and the starting net weight of each test colony we calculated starting bee populations. Each colony was provided with a caged, open-mated queen. After each colony was stocked with bees, it was placed inside a chilled building to reduce the threat of overheating. Bees were kept inside until after dark, then transported to a test apiary site in Oconee County (Georgia, USA) and released. Entrances to colonies were faced in various directions to discourage drift. Colonies were fed a 1 : 1 sugar : water solution *ad libitum* for the duration of the study. Colonies were treated with Terramycin antibiotic to

TABLE 1. Physical characteristics of combs used at the beginning of the experiment. Values are mean ± s.e. (*n*).

Comb measurements	New comb	Old comb
Inner cell diameter (mm)	4.9 ± 0.02 (100)	4.6 ± 0.02 (100)
Comb weight (g) w/wood frame	368.2 ± 4.2 (96)	591.5 ± 18.4 (96)
Cells per 10 cm	18.3 ± 0.02 (96)	18.5 ± 0.05 (96)
Cells per 4 cm^2	16.3 ± 0.2 (96)	16.0 ± 0.2 (96)
Total available comb space (cm^2) on both sides	6182.0 ± 66.1 (96)	6371.5 ± 39.0 (96)

prevent brood diseases and a 0.1 kg vegetable oil patty to control tracheal mites (*Acarapis woodi*) (Delaplane, 1992). Five to seven days later, we released the queens. This marked day zero of the experiment. Colonies were removed from the experiment if their queens failed or if colony populations dwindled to non-viable levels.

On days 7 (1998, 1999), 14 (1997–1999), and 21 (1997, 1999) we measured for each colony the area (cm^2) of all brood including eggs, larvae and sealed brood, using a measuring grid marked in cm^2. Brood survivorship was measured on day 7 (1997), and 7 and 14 (1998, 1999) by placing a sheet of transparent acetate onto a comb, marking on it the location of 10–40 cells of live, uncapped larvae, excluding eggs and drone brood. Three days later, we placed the same sheet of acetate onto the coordinating frame and counted the surviving capped and uncapped cells in order to determine percentage brood survivorship.

The experiment was dismantled on day 21 (1998, 1999) or day 28 (1997). Before dawn on the day of dismantling we screened the entrances to capture all bees. We determined net weight of bees by weighing each hive with bees, brushing out bees, then reweighing the hive empty. We then calculated bee populations as before. For all years we measured area (cm^2) of sealed brood for each colony. Average weight of newly emerged bees was determined by bagging combs of emerging bees and collecting and weighing bees the next day.

Analyses

A completely randomized design analysis of variance, blocked on year (Proc GLM; SAS Institute, 1992) was used to test the effects of comb age class on area of total brood for days 7, 14 and 21, area of sealed brood, brood survivorship on two sampling dates, ending weight of young bees, ending bee population and change in bee population. There were no interactions of year with treatment; therefore, residual error was used as the error term. Differences were deemed significant at $\alpha \leq 0.05$.

RESULTS

There were no interactions of treatment by year for any of the variables measured. On average, colonies maintained on new comb had a greater area of total brood, area of sealed brood and higher young bee weight (tables 2 and 3). Brood survivorship was either unaffected by treatment or higher in the old comb class.

Total area (cm^2) of brood was significantly higher in the new comb colonies on days 14 and 21. Area of sealed brood was also significantly higher in new comb (table 3). There were year effects for all of the brood area variables (table 2). Survivorship of brood tended to be higher in the old comb than in the new comb, but was significantly so only for week 2 (table 3); there were year effects for both weeks 1 and 2 (table 2). Newly emerged bees weighed significantly more if they were reared in new comb than in old comb (tables 2 and 3). Comb age produced no statistically significant treatment effects in ending adult bee population or change in adult bee population; however, there were year effects. The trend was for higher ending bee populations in new comb and, correspondingly, a greater loss of bees in old comb. It is noteworthy that the analysis of variance showed near-significant treatment effects ($P \leq 0.0858$, table 2).

DISCUSSION

Brood production

Increased brood production in new comb may arise from differences in the survivorship of brood (but see next section), quality of brood care given by nurse bees, and the queen's egg production. The literature does not report explicit studies on the effects of comb age on nurse bee behaviour or queen egg-laying performance. Thus, we believe that differences in a queen's egg-laying behaviour are the best explanation for our observed results.

Queens are able to distinguish between worker cells and drone cells by appraising the width of the cell with their forelegs (Koeniger, 1970). The cell diameters in

TABLE 2. Analysis of variance of the effects of year (yr), comb age (new or old = treatment [tmt]) and interactions (yr × tmt) on nine dependent variables. Treatment and year effects were tested against residual error because treatment and year never interacted significantly. Differences were accepted at the $\alpha \leq 0.05$.

Variable	Source of variation	d.f.	*F*	*P > F*
Area (cm^2) of total brood for day 7 (1998, 1999)	yr	1	6.9	0.0126 *
	tmt	1	1.4	0.2523
	yr × tmt	1	0.1	0.7310
Area (cm^2) of total brood for day 14 (1997-1999)	yr	2	50.2	0.0001 **
	tmt	1	13.5	0.0005 **
	yr × tmt	2	1.1	0.3378
Area (cm^2) of total brood for day 21 (1997, 1999)	yr	1	29.0	0.0001**
	tmt	1	7.3	0.0102 *
	yr × tmt	1	0.06	0.8074
Area (cm^2) of sealed brood (1997-1999)	yr	2	26.8	0.0001 **
	tmt	1	5.3	0.0257 *
	yr × tmt	2	0.04	0.9643
Brood survivorship for week 1 (%)	yr	2	10.8	0.0001 **
	tmt	1	1.4	0.2369
	yr × tmt	2	0.3	0.7832
Brood survivorship for week 2 (%)	yr	1	6.0	0.0194 *
	tmt	1	7.3	0.0104 *
	yr × tmt	1	2.7	0.1060
Weight (mg) of young bee	yr	2	1.8	0.1784
	tmt	1	5.2	0.0262 *
	yr × tmt	2	0.71	0.4980
Ending adult bee population	yr	2	14.7	0.0001 **
	tmt	1	3.1	0.0858
	yr × tmt	2	0.5	0.6003
Change in adult bee population	yr	2	11.1	0.0001 **
	tmt	1	3.7	0.0580

TABLE 3. Effects of comb age on brood production, brood survivorship, weight of young bees, and adult bee populations. Values are means ± s.e. (*n*). A * indicates significant differences within row ($\alpha \leq 0.05$).

Dependent variables	New comb	Old comb
Area (cm^2) of total brood for day 7 (1998, 1999)	1193.6 ± 71.39 (21)	1071.7 ± 87.2 (21)
Area (cm^2) of total brood for day 14 (1997-1999)	2040.2 ± 140.6 (32)	1600.8 ± 138.6 (31) *
Area (cm^2) of total brood for day 21 (1997, 1999)	2356.6 ± 154.6 (22)	1865.7 ± 191.9 (21) *
Area (cm2) of sealed brood (1997-1999)	1115.3 ± 86.2 (32)	907.0 ± 93.0 (31) *
Brood survivorship for week 1 (%) (1997-1999)	79.3 ± 4.2 (31)	86.9 ± 4.7 (31)
Brood survivorship for week 2 (%) (1998, 1999)	88.1 ± 2.4 (21)	94.8 ± 1.1 (21) *
Weight (mg) of young bee (1997-1999)	106.3 ± 1.0 (31)	98.2 ± 3.6 (31) *
Ending adult bee population (1997-1999)	3978.2 ± 241.7 (32)	3398.7 ± 296.3 (31)
Change in adult bee population (1997-1999)	-2986.2 ± 234.7 (32)	–3648.0 ± 287.4 (31)

old comb are comparatively small (table 1 and Abdellatif, 1965); thus, an average reduction of cell diameter in old comb may have a negative effect on a queen's egg-laying productivity.

Older comb is known to harbour numerous contaminants that may be detrimental to the brood's health. Old comb has been associated with increased incidence of chalkbrood (Koenig *et al.*, 1986), and diseases like nosema (Bailey & Ball, 1991) and American foulbrood (Gilliam, 1985) which are spread from colony to colony by infectious wax. The queen may be sensitive to these contaminants and not lay eggs in particular cells. Also, the old comb may harbour brood pheromones (Free & Winder, 1983) that act as egglaying inhibitors to the queen because she perceives the cell to be already occupied.

Another phenomenon relevant to this study is the observation that bees prefer to store honey and pollen in cells that have been previously used for brood rearing. In the wild, as a colony grows and continues to add new comb, brood rearing gradually shifts into this new comb and the honey is stored in the old brood comb (Free & Williams, 1974). In unmanaged colonies this behaviour may serve to avoid the negative effects of old comb on brood production. However, modern beekeeping practices inhibit this natural process by forcing bees to reuse old brood comb for brood rearing and to store honey in comb never used for brood rearing.

Brood survivorship

Brood communicate to the worker bees their presence in the cell, caste, age and hunger levels through mechanical and chemical signals (Free, 1987). The chemical signals are the brood pheromones that may be the causative agent responsible for the increased survivorship found in old comb in this study. Wax comb acts as a reservoir for absorbing and transmitting pheromones which may explain why honey bee swarms are more attracted to older comb (Naumann *et al.*, 1991). The presence of brood pheromones stimulates pollen foraging (Pankiw *et al.*, 1998), enhances brood recognition (Le Conte*et al.*, 1994) and stimulates nurse bees to feed larvae (Le Conte *et al.*, 1995), all of which are important factors in brood survivorship. Free & Winder (1983) determined that brood survival was greater in cells which had been used previously for brood rearing than in comb cells never used before. Taken together these studies demonstrate that pheromones incorporated in wax comb may improve brood survivorship. The differences in brood survivorship noted in our study may be partly explained by more optimal concentrations of brood pheromones in older comb.

In our study we found the seemingly paradoxical results of higher brood production in new comb but higher brood survivorship in old comb. We believe that this is best reconciled, internally and with the literature, by positing that the egg-laying rate of queens is highest in new comb, but once placed in a cell the chances of a larva's survival are best in old comb. Nevertheless, overall brood production is highest in new comb (table 3); apparently the benefits of maximized egg production exceed the benefits of maximized brood survival.

Weight of emerging young bees

Higher weight of emerging young bees in new comb is best explained by differences between the two comb age classes in the average diameter of cells. As brood comb ages, the diameter of the cells decreases due to accumulated cocoons and faecal material that are deposited by the larval and pupal instars developing within the cell (Jay, 1963). The body weight of a worker bee is mediated by genetics (Ruttner & Mackensen, 1952) as well as by environmental effects such as the amount of food fed to larvae (Daly & Morse, 1991; Fyg, 1959) and the size of the natal cell (Jay, 1963; Abdellatif, 1965). Buchner (1955) determined that the mean weight of newly emerged bees from old comb in which 68 generations had emerged was about 19% smaller (96.1 mg) than the controls (118.3 mg). In our study bees reared in new comb weighed about 8.3% more than those reared in old comb, which is similar to Abdellitif's (1965) finding that worker bees reared in old comb in which 70 generations had been reared have an 8% reduction in body weight.

Adult bee population

Lower bee populations in the old comb may result from an accumulation of foreign contaminants sequestered in the older comb causing higher mortality. Smith & Wilcox (1990) documented 35 toxic chemicals found in wax. Also, contaminants in the wax comb may mask hive signature and nestmate recognition cues, making it difficult for foraging bees to return to their own colony. Some nestmate recognition cues are obtained from the wax comb (Breed & Stiller, 1992), and Breed *et al.* (1988a) discovered that colony odour acquired from wax comb can mask the genetic differences between bees. Colony odour is transferred to the adult bees by exposure to the comb substrate and can alter the recognition phenotype in as little as five minutes (Breed *et al.*, 1988b).

Conclusions

Over three years of field study, honey bee colonies housed on new comb had a greater area of total brood, a greater area of sealed brood, and higher weight of individual young bees. Brood survivorship was the only variable significantly higher in old comb. The bulk of the evidence suggests that new combs optimize overall honey bee colony health and reproduction. These findings suggest that beekeepers should eliminate very old brood combs from their operations.

ACKNOWLEDGEMENTS

We thank Jamie Ellis, Peter Norris and Hosafy Eshbah for technical assistance. We also thank Sonny Swords, Fred Rossman, Wade DeBerry for

their generous donation of bees and Wilson White for providing an apiary site. This project was funded by the Georgia Beekeepers Association and the Agricultural Experiment Station of the University of Georgia. This research was completed by the senior author in partial fulfilment of the requirements for the degree of Master of Science.

REFERENCES

ABDELLATIF, M A (1965) Comb cell size and its effect on the body weight of the worker bee, *Apis mellifera* L. *American Bee Journal* 105: 86–87.

BAILEY, L; BALL, B V (1991) *Honey bee pathology*. Harcourt Brace Jovanovich; Sidcup, Kent, UK; 193 pp.

BREED, M D; WILLIAMS, K R; FEWELL, J H (1988a) Comb wax mediates the acquisition of nest-mate recognition cues in honey bees. *Proceedings of the National Academy of Sciences* 85: 8766–8769.

BREED, M D; STILLER, T M; MOOR, M J (1988b) The ontogeny of kin discrimination cues in the honey bee, *Apis mellifera. Behavioral Genetics* 18: 439–448.

BREED, M D; STILLER, T M (1992) Honey bee, *Apis mellifera*, nestmate discrimination: hydrocarbon effects and the evolutionary implications of comb choice. *Animal Behaviour* 43: 875–883.

BUCHNER, R (1955) Effect on the size of workers of restricted space and nutrition during larval development. *Wilhelm Roux Archive für Entwicklungsmechanik der Organismen* 146: 544–579.

DALY, H V; MORSE, R A (1991) Abnormal sizes of worker honey bees (*Apis mellifera* L.) reared from drone comb (Hymenoptera, Apoidea). *Journal of the Kansas Entomological Society* 64: 193–196.

DELAPLANE, K S (1992) Controlling tracheal mites (Acari: Tarsonemidae) in colonies of honey bees (Hymenoptera: Apidae) with vegetable oil and menthol. *Journal of Economic Entomology* 85: 2118–2124.

FREE, J B (1987) *Pheromones of social bees*. Comstock Publishing Associates; Ithaca, NY, USA, 218 pp.

FREE, J B; WILLIAMS, I H (1974) Factors determining food storage and brood rearing in honeybee (*Apis mellifera* L.) comb. *Journal of Entomology, Series A* 49: 47–63.

FREE, J B; WINDER, M E (1983) Brood recognition by honeybee (*Apis mellifera*) workers. *Animal Behaviour* 31: 539–545.

FYG, W (1959) Normal and abnormal development in the honeybee. *Bee World* 40: 57–66.

GILLIAM, M (1985) Microbes from apiarian sources: *Bacillus* spp. in frass of the greater wax moth. *Journal of Invertebrate Pathology* 45: 218–224.

GILLIAM, M; TABER, S (1991) Diseases, pests, and normal microflora of honeybees, *Apis mellifera*, from feral colonies. *Journal of Invertebrate Pathology* 58: 286–289.

HEPBURN, H R (1998) Reciprocal interactions between honeybees and combs in the integration of some colony functions in *Apis mellifera* L. *Apidologie* 29: 47–66.

HEPBURN, H R; KURSTJENS S P (1988) The combs of honeybees as composite materials. *Apidologie* 19: 25–36.

JAY, C S (1963) The development of honeybees in their cells. *Journal of Apicultural Research* 2: 117–134.

KOENIG, J P; BOUSH, G M; ERICKSON, E H (1986) Effect of type of brood comb on chalk brood disease in honeybee colonies. *Journal of Apicultural Research* 25: 58–62.

KOENIGER, N (1970) Factors determining the laying of drone and worker eggs by the queen honeybee. *Bee World* 51: 166–169.

LE CONTE, Y; SRENG, L; TROUILLER, J (1994) The recognition of larvae by worker honeybees. *Naturwissenschaften* 81: 462–465.

LE CONTE, Y; SRENG, L; POITOUT, S H (1995) Brood pheromone can modulate the feeding behavior of *Apis mellifera* workers (Hymenoptera: Apidae). *Journal of Economic Entomology* 88: 798–804.

NAUMANN, K; WINSTON, M L; SLESSOR, K N; PRESTWICH, G D; WEBSTER, F × (1991) Production and transmission of honey bee queen (*Apis mellifera* L.) mandibular gland pheromone. *Behavioral Ecology and Sociobiology* 29: 321–332.

PANKIW, T; PAGE JR., R E; FONDRK, M K (1998) Brood pheromone stimulates pollen foraging in honey bees (*Apis mellifera*). *Behavioral Ecology and Sociobiology* 44: 193–198.

RUTTNER, F; MACKENSEN, O (1952) The genetics of the honeybee. *Bee World* 33: 53–62.

SAS INSTITUTE (1992) *SAS/STAT user's guide, version 6*. SAS Institute; Cary, NC, USA, 846 pp (4th edition).

SEELEY, T D (1978) Life history strategy of the honey bees, *Apis mellifera. Oecologia* 32: 109–118.

SEELEY, T D (1985) *Honeybee ecology*. Princeton University Press; Princeton, NJ, USA, 201 pp.

SEELEY, T D; MORSE, R A (1976) The nest of the honey bee (*Apis mellifera* L.). *Insectes Sociaux* 23: 495–512.

SMITH, R K; WILCOX, M M (1990) Chemical residues in bees, honey and beeswax. *American Bee Journal* 130: 188–192.

TULLOCH, A P (1980) Beeswax – composition and analysis. *Bee World* 61: 47–62.

Journal of Apicultural Research 44(4): 157–162 (2005)

ORIGINAL ARTICLE

Integrated pest management against *Varroa destructor* reduces colony mite levels and delays treatment threshold

KEITH S DELAPLANE,[1]* JENNIFER A BERRY,[1] JOHN A SKINNER,[2] JAMES P PARKMAN[2] AND W MICHAEL HOOD[3]

[1]Department of Entomology, University of Georgia, Athens, GA 30602, USA

[2]Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN 37996, USA

[3]Department of Entomology, Soils, and Plant Sciences, Clemson University, Clemson, SC 29634, USA

Received 24 February 2005, accepted subject to revision 10 May 2005, accepted for publication 22 August 2005

SUMMARY

Two independent, long-term (17 months and 87 weeks) studies were done to appraise the effects of published integrated pest management (IPM) practices on colony varroa mite levels, length of time before onset of treatment threshold, and other measures of colony productivity. Screen hive floors tended to reduce colony mite levels (24-h sticky sheet counts), sometimes significantly. Likewise, mite-resistant queens tended to cause a numeric and sometimes significant reduction in mite levels; number of mites on sticky sheets decreased as the percentage expression of hygienic behaviour in a colony increased, and on the majority of sampling episodes the number of mites retrieved on sticky sheets was numerically lower in colonies with queens expressing suppressed mite reproduction (SMR). In six of eight cases when IPM components were found to interact they did so in a manner favourable to mite control. Time until achieving treatment threshold was significantly delayed in colonies with SMR queens (*c.* 72 weeks) compared to non-selected queens (59). In one experiment, stored honey was significantly reduced in colonies with screens (3.8 frames) compared to solid floors (5.1); likewise, stored pollen was lower in screen colonies (0.9 frames) than on solid floors (1.3). SMR queens tended to have reduced brood production.

Keywords: integrated pest management, IPM, *Apis mellifera*, *Varroa destructor*

INTRODUCTION

One of the explicit goals of investigators in the integrated pest management (IPM) of *Varroa destructor* is to reduce or eliminate beekeepers' reliance on synthetic acaricides. Several non-chemical strategies have shown promise as control agents, either by (1) eliminating mites from a colony, or (2) slowing rate of mite population growth. Examples of the former include grooming behaviour in bees (Peng, 1992), various brood trapping techniques (Dung *et al*., 1995; Schulz *et al*., 1983), and dusts applied in the hive (Fakhimzadeh, 2000). Examples of the latter are weighted toward honey bee stocks that display genetic varroa resistance (Spivak, 1996; Harbo & Harris, 1999; Harbo & Hoopingarner, 1997; Rinderer *et al*., 1997), but also include apiary isolation (Sakofski *et al*., 1990), apiary exposure to sun (Rinderer *et al*., 2004) and screen hive floors that reduce colony mite levels (Pettis & Shimanuki, 1999), apparently by decreasing the rate at which foundress mites invade brood cells (Harbo & Harris, 2004).

In spite of the promising IPM tools suggested by the literature, large-scale adoption of IPM has not been realized in many parts of the world. Few of the practices listed above can singly or indefinitely keep mites at non-damaging levels; computer modelling simulations indicate that non-chemical IPM practices delay damaging mite levels rather than prevent them (Hoopingarner, 2001; Wilkinson *et al*., 2001). Thus at this point it seems most practical to think of IPM as a means to delay, not eliminate, chemical treatment. If a beekeeper can prolong the inter-treatment interval as long as possible this not only reduces net chemical use and its attendant hazards to bees, honey and the environment, but enables mites through genetic recombination and reproduction over time to conserve their chemical susceptible genes (see Metcalf, 1982), thus prolonging the useful life of an acaricide.

If delaying chemical applications is a key objective of IPM then it is paramount that beekeepers have the means to monitor mite population growth and criteria to determine when mites have achieved levels that warrant chemical treatment. Such treatment thresholds have been developed in the USA, specifically for the south-east (Georgia and South Carolina) and north-west (Washington State). On the basis of 24-h mite counts on hive floor sticky sheets, recommended early season treatment thresholds for the two regions are congruent at 12 mites for the north-west (Strange & Sheppard, 2001) and 0.7–12.2 mites for the south-east (Delaplane & Hood, 1997, 1999) for April and February, respectively. For August the recommendations are more divergent at 23 mites for the north-west and 70.8–224.4 for the south-east. Armed with such region-specific thresholds, coupled with known or suspected methods of slowing mite growth, beekeepers are now within reach of a comprehensive IPM paradigm for managing varroa. It remains to experimentally demonstrate whether the diverse and published IPM tactics do indeed delay onset of treatment threshold. Such a project is essentially a confirmation of decades of work by numerous researchers and signals the maturity of IPM research on this important beekeeping pest.

*Corresponding author: ksd@uga.edu

In this study we tested the efficacy of three IPM practices – genetically mite-resistant bees, screened hive floors, and apiary isolation – at slowing growth of colony mite populations, delaying onset of treatment threshold, and improving colony health conditions. Two independent experiments are herein reported: one using hygienic-selected queens as the resistant stock and another, using queens selected for suppressed mite reproduction (SMR (Harbo & Harris, 1999), lately understood to be a specified form of hygienic behaviour (Ibrahim & Spivak, 2004; Harbo & Harris, 2006)).

MATERIALS AND METHODS

Effects of hygienic queens, screens and isolation

In June–July 2001 40 colonies of *Apis mellifera* were set up in north Georgia (USA), each with *c.* 0.9 kg bees, one Langstroth hive body, a queen excluder, and one super of honey for food. Small incipient populations of *V. destructor* were achieved by collecting experimental bees from an apiary in which overnight mite counts on hive floor sticky sheets averaged 0.4 ± 0.5 (mean ± s.d.). Queens were marked and replaced as necessary and colonies managed as for honey production except for experimental constraints explained below.

Twenty of the colonies were randomly assigned to one of three 'isolated' apiaries and 20 to three 'non-isolated' apiaries. There were three apiaries of each class, two with eight colonies each and one with four. Within each apiary, each colony randomly received one of the following experimental treatments: (1) a queen selected for hygienic behaviour, conventional solid hive floor, (2) hygienic queen, screen floor, (3) non-selected queen, solid floor, or (4) non-selected queen, screen floor. Treatments were replicated twice in those apiaries with eight colonies. 'Isolated' apiary sites were selected on the criterion that each was at least 5 km from another known apiary. 'Non-isolated' apiaries were apiaries owned by beekeeper co-operators; experimental colonies were simply placed among non-experimental ones, and co-operators were free to manage their own colonies as they wished. Production-grade hygienic queens (Spivak, 1996) were purchased from a queen supplier, and screen floors were the type described by Pettis & Shimanuki (1999) in which a screen is suspended above a conventional solid hive floor.

Beginning 8 August 2001 and continuing at monthly intervals until November 2002 (inclusive), colonies were sampled for the number of mites collected on overnight (*c.* 24 h) hive floor sticky sheets and the number of months determined at which each colony remained under the minimum treatment threshold of 60 mites (Delaplane & Hood, 1999). Since sticky sheets necessarily rest on the hive floor while they are in place, any benefit from screened floors is presumably suspended during that interval; however in this experiment (and the next) this effect was experimentally void because all colonies were treated identically. A colony was removed from further monthly sampling once it achieved minimum treatment threshold at which time it received a rescue application of acaricide Api-Life VAR (Chemicals LAIF) or formic acid after the gel formulation of Feldlaufer *et al.* (1997) in plastic containers 55 mm deep, 85 mm diameter, 300 ml volume); the miticide applications not only salvaged colonies but minimized mite emigration within apiary, thus maintaining independence of observations. In April, September and November 2002, we collected data on gross colony condition by summing for each surviving colony the amount of adult bees, brood (including eggs), honey and pollen using the proportion of a whole deep frame as units (after Skinner *et al.* 2001). Frames of adult bees were converted to estimates of colony bee populations with the regression model of Burgett & Burikam (1985), and frames of brood converted to cm^2 brood based on the determination that surface of both sides of a deep frame (comb) is 1754 cm^2. On two occasions (June and September 2002) we measured hygienic behaviour of each colony using the liquid nitrogen method of Spivak & Reuter (1998).

The effects of apiary isolation, queen type (hygienic or non-selected), and hive floor type (solid or screen) on mite numbers retrieved on overnight hive floor sticky sheets (as well as colony strength parameters for April, September and November 2002) were tested with analysis of variance recognizing apiary (isolation class), month, and all interactions of main effects with apiary and month (Proc GLM, SAS 1992). When this analysis showed interactions between month and main effects the analyses were run separately by month. Additionally, the degree of hygienic expression by colonies was used as a covariate in an analysis of variance for the June 2002 mite numbers; when this test failed to show effects of hygienic behaviour on mite numbers we ran regression analyses for the June and September 2002 data testing for a linear, quadratic, or cubic relationship between percentage expression of hygienic behaviour and mite numbers on overnight sticky sheets. Only linear relationships were confirmed and presented below.

Effects of SMR queens, screens and isolation

The basic design and execution described above was repeated in 2002–2003 with the following changes. The experiment was set up with 40 overwintered, rather than package, colonies beginning in March 2002. Since the colonies available to us were headed by a mixture of non-selected queens and queens selected for SMR, we attempted to equalize incipient varroa levels by starting each colony with two frames of brood and bees from a non-selected queen and two frames of brood and bees from an SMR queen. Screen hive floors (Brushy Mountain Bee Farm, Moravian Falls, NC) consisted of a floor of screen mesh (3.2 mm) open to the ground below.

Instead of hygienic queens, for our resistant treatment we began with instrumentally-inseminated queens selected for SMR purchased from a commercial breeder. Over the course of the study many of these queens died, to the extent that we decided to continue the study with naturally-mated daughters of these queens. To help control for this variation, in May and July 2003 we measured expression of SMR for each colony (personal communication, Jeff Harris, US Dept Agric) for use as a covariate in subsequent ANOVA. Twenty to 500 cells (depending on availability of brood) of white/purple-eyed to tan-coloured pupae were excised from their cells and the cell contents examined for presence and demographic characterization of mite families. Cells were discarded if they contained evidence of >1 foundress. A foundress was deemed non-reproductive if by the white/purple-eyed bee stage she had produced no living brood at or beyond the protonymph stage, or if by the tan pupa stage she had produced no living brood at or beyond the deutonymph stage. Average expression of suppressed mite reproduction (percentage of mite families non-reproducing) was 12.9 ± 3.3, n = 16 (mean ± s.e.) for SMR queens and 8.8 ± 3.2, n = 10 for non-selected queens. SMR was shown to be a non-significant covariate in ANOVAs.

Beginning 7 May 2002 and continuing every three weeks until 12 November 2002 (inclusive), then again from 25 March 2003 until 2 December 2003 (inclusive), colonies were sampled for the number of mites collected on 3-day hive floor sticky sheets; numbers were converted to a 24-h basis to facilitate comparison with other data sets. The number of weeks was noted at which each colony remained under the minimum treatment threshold of 60 mites (Delaplane & Hood, 1999). Beginning 28 May 2002 and repeating at 6-week intervals until 13 November 2003 (inclusive), and again from 18 March 2003 until 30 July 2003 (inclusive, one time a 7-week interval), we collected data on gross colony condition.

RESULTS

Effects of hygienic queens, screens and isolation

For average number of varroa mites, the full model analysis detected significant effects only for floor type (F = 8.4; df = 1,12;

TABLE 1. Average monthly values (± s.e.) for number of mites retrieved on 24-h mite monitoring sticky sheets for colonies on conventional solid hive floors or screen floors. Numbers in parentheses = *n*. For the months of June and July 2002 (*) mite levels were significantly lower in colonies with screen floors.

Month	Solid floor	Screen floor
Aug 2001	1.0 ± 0.3 (20)	0.7 ± 0.2 (19)
Sep 2001	2.0 ± 0.4 (20)	2.2 ± 0.5 (20)
Oct 2001	6.2 ± 1.7 (19)	5.3 ± 1.1 (20)
Nov 2001	12.1 ± 3.3 (18)	10.1 ± 2.5 (20)
Dec 2001	11.1 ± 3.0 (18)	7.2 ± 1.9 (20)
Jan 2002	6.9 ± 2.8 (19)	2.8 ± 0.8 (20)
Feb 2002	6.2 ± 1.4 (13)	8.9 ± 3.2 (17)
Mar 2002	13.4 ± 4.2 (13)	10.9 ± 3.8 (15)
Apr 2002	23.8 ± 7.3 (13)	22.1 ± 5.7 (16)
May 2002	34.5 ± 16.1 (13)	10.1 ± 3.0 (16)
Jun 2002	42.1 ± 11.2 (11)	15.3 ± 3.7 (14)*
Jul 2002	148.7 ± 30.5 (11)	59.8 ± 8.7 (14)*
Aug 2002	12.5 ± 9.5 (2)	32.6 ± 11.4 (8)
Sep 2002	47.5 ± 44.5 (2)	34.8 ± 11.2 (6)
Oct 2002	0	7.7 ± 2.9 (5)
Nov 2002	0	5.2 ± 2.7 (5)

$P = 0.0134$). Across the 16 sampling months (spanning 17), the average number of varroa mites retrieved on 24-h sticky sheets was lower in colonies with screen floors (12.7 ± 1.3, $n = 235$, mean ± s.e.) than with conventional solid floors (20.4 ± 3.3, $n = 194$). However, because of many interactions we also ran analyses by month. On 11 of 16 months, the average number of varroa mites retrieved on 24-h sticky sheets was numerically lower in colonies with screen floors. On two of those months, June and July 2002, mite numbers were significantly reduced in colonies with screen floors ($F \geq 6.5$; df = 1,6; $P \leq 0.043$) (table 1). Interactions between main effects were detected for apiary isolation and floor type on months 10 and 13 ($F \geq 5.7$; df = 1,6; $P \leq 0.0536$). On the two months we measured hygienic behaviour, the relationship between number of mites retrieved on 24-h sticky sheets and percentage hygienic expression was explained by regression models with negative linear terms (figs 1 and 2).

Time before achieving treatment threshold (months) was not significantly affected by any independent variable. Mean months to threshold was 13.4 ± 0.7 months (mean ± s.e., $n = 16$) for colonies with screen floors, 11.6 ± 0.5 ($n = 14$) for colonies with solid floors, 11.9 ± 0.6 ($n = 16$) for hygienic queens, and 13.4 ± 0.7, ($n = 14$) for non-selected queens.

Concerning the three months for which we measured gross colony condition, the full model ANOVAs failed to detect differences among independent variables for any parameter of interest. The ranges of values for all parameters across the three sampling months were as follows: colony bee populations 1043–23266, cm^2 brood 8.8–9647, frames of honey 0.5–9.6, and frames of pollen 0.05–3.

Effects of SMR queens, screens and isolation

For average number of varroa mites, the full model analysis detected significant effects for queen type and floor type ($F = 5.5$; df = 1,12; $P = 0.037$). Across the 87-week experiment, the average number of varroa mites retrieved on 24-h sticky sheets was lower in colonies headed by resistant (SMR) queens (7.8 ± 1.1, $n = 317$, mean ± s.e.) than non-selected queens (9.5 ± 1.5, $n = 236$), and mite levels were also lower in colonies with screen floors (6.7 ± 1.0, $n = 275$) than with conventional solid floors (10.4 ± 1.5, $n = 278$). However, because of many interactions we ran analyses by sampling week. On 17 of 22 sampling weeks (spanning 87 weeks), the average number of varroa mites retrieved on 24-h sticky sheets was numerically lower in colonies headed by resistant queens. On four of those weeks, mite numbers were significantly reduced in colonies with resistant queens ($F \geq 7.9$; df = 1,7; $P \leq 0.0264$) (table 2). On 18 of 22 sampling weeks, the average number of varroa mites retrieved on 24-h sticky sheets was numerically lower in colonies with screen floors, but differences were never significant within week. For only one sampling week (October 2003) was a significant effect found for apiary isolation; mite counts were significantly ($F = 48.9$; df = 1,2; $P \leq 0.0198$) higher in isolated apiaries (50.2 ± 37.9, $n = 4$) than non-isolated (0.4 ± 0.3, $n = 3$). Interactions between main effects were detected for weeks 8, 11, 32, and 54 ($F \geq 4.9$; df = 1,7; $P \leq 0.0483$).

Time before reaching treatment threshold (weeks) was significantly affected by type of queen ($F = 933$; df = 1,1; $P = 0.02$). Colonies headed by SMR queens took longer to reach threshold (71.7 ± 3.9 weeks, $n = 14$, mean ± s.e.) than colonies headed by non-selected queens (59.2 ± 4.4, $n = 13$).

Concerning measurements of gross colony condition, the full model ANOVAs detected differences among floor type for

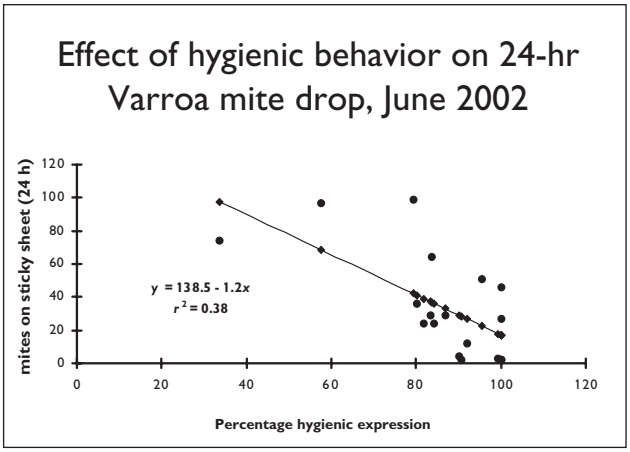


FIG. 1. Linear relationship between number of mites recovered on 24-h sticky sheets and percentage hygienic behaviour expressed by a colony, June 2002.

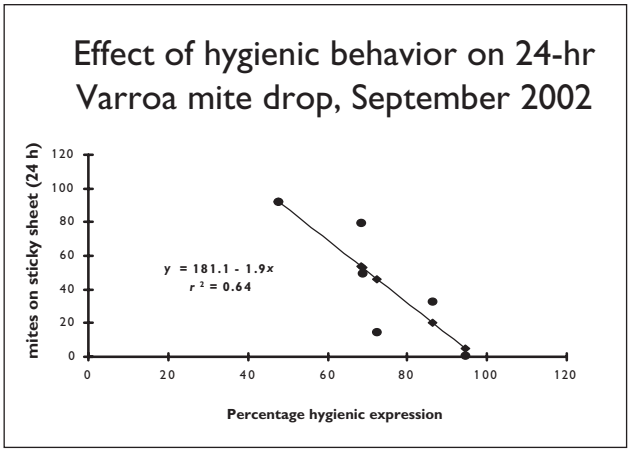


FIG. 2. Linear relationship between number of mites recovered on 24-h sticky sheets and percentage hygienic behavior expressed by a colony, September 2002.

TABLE 2. Average weekly values (± s.e.) for number of mites retrieved on 24-h mite monitoring sticky sheets for colonies headed by non-selected queens and queens selected to express SMR. Numbers in parentheses = *n*. On four sampling weeks in March, April, and May 2003 (*) mite levels were significantly lower in colonies with SMR queens.

Week and date	Non-selected queens	SMR queens
5 (7 May 2002)	0.22 ± 0.1 (20)	0.15 ± 0.1 (20)
8 (28 May 2002)	0.2 ± 0.1 (19)	0.4 ± 0.2 (20)
11 (18 Jun 2002)	0.4 ± 0.1 (19)	0.2 ± 0.1 (20)
14 (9 Jul 2002)	0.5 ± 0.2 (15)	0.1 ± 0.04 (19)
17 (30 Jul 2002)	1.6 ± 0.7 (19)	0.9 ± 0.5 (20)
20 (20 Aug 2002)	3.4 ± 1.5 (19)	0.6 ± 0.2 (19)
23 (10 Sep 2002)	12.6 ± 10.1 (17)	0.4 ± 0.2 (19)
26 (1 Oct 2002)	6.0 ± 1.7 (16)	8.1 ± 3.0 (18)
29 (22 Oct 2002)	3.5 ± 1.0 (15)	5.4 ± 2.5 (19)
32 (12 Nov 2002)	13.5 ± 4.8 (15)	7.4 ± 3.9 (19)
51 (25 Mar 2003)	5.4 ± 1.9 (11)	2.8 ± 0.7 (15)*
54 (15 Apr 2003)	6.5 ± 1.5 (11)	3.3 ± 1.0 (15)*
57 (6 May 2003)	15.7 ± 5.7 (11)	2.3 ± 0.6 (15)*
60 (27 May 2003)	41.2 ± 12.3 (10)	9.8 ± 3.7 (15)*
63 (17 Jun 2003)	41.7 ± 10.9 (7)	25.8 ± 7.9 (13)
66 (8 Jul 2003)	47.7 ± 26.0 (4)	20.4 ± 7.8 (10)
69 (29 Jul 2003)	66.8 ± 35.2 (3)	25.9 ± 11.2 (9)
72 (19 Aug 2003)	11.3 (1)	46.9 ± 18.4 (8)
75 (9 Sep 2003)	1.3 (1)	20.6 ± 10.2 (7)
78 (30 Sep 2003)	34.7 (1)	27.9 ± 26.8 (6)
81 (21 Oct 2003)	47.7 (1)	44.1 ± 16.0 (5)
84 (11 Nov 2003)	73.0 (1)	22.2 ± 13.3 (3)
87 (2 Dec 2003)	NA	9.9 ± 4.7 (3)

frames of honey (F = 6.6; df = 1,12; P = 0.0248) and pollen (F = 4.6; df = 1,12; $P \leq 0.0526$). Across the 87-week experiment, the average number of frames of honey was lower in colonies on screen floors (3.8 ± 0.3, n = 102, mean ± s.e.) than on solid floors (5.1 ± 0.2, n = 117), and likewise frames of pollen was lower in colonies on screen floors (0.9 ± 0.06, n = 118) than on solid floors (1.3 ± 0.06, n = 137). The full model ANOVA detected no effects for queen type on cm^2 brood, but there were significant interactions so analyses were run by week. Of nine sampling weeks, cm^2 brood was significantly higher on two in colonies headed by non-selected queens (table 3).

TABLE 3. Average weekly values (± s.e.) for cm^2 brood for colonies headed by non-selected queens and queens selected to express SMR. Numbers in parentheses = *n*. On two sampling weeks in October 2002 and May 2003 (*) brood production was significantly lower in colonies with SMR queens.

Week and date	Non-selected queens	SMR queens
8 (28 May 2002)	7947 ± 630 (20)	6170 ± 577 (20)
14 (9 Jul 2002)	6213 ± 700 (17)	6103 ± 544 (20)
20 (20 Aug 2002)	4601 ± 203 (17)	4047 ± 354 (20)
26 (1 Oct 2002)	6859 ± 304 (17)	5240 ± 598 (19)*
32 (13 Nov 2002)	741 ± 170 (10)	583 ± 169 (7)
50 (18 Mar 2003)	5370 ± 942 (11)	6183 ± 912 (14)
57 (6 May 2003)	7064 ± 837 (12)	4581 ± 595 (15)*
63 (17 Jun 2003)	8479 ± 907 (11)	8653 ± 609 (15)
69 (30 Jul 2003)	7732 ± 764 (3)	7659 ± 422 (9)

DISCUSSION

The results of the two independent experiments can be summarized as follows: Screen hive floors tend to reduce colony varroa mite levels; on the majority of sampling episodes the number of mites retrieved on sticky sheets was numerically lower, sometimes significantly, in colonies with screen floors (table 1 and text). Likewise, mite-resistant queens tended to cause a numeric and sometimes significant reduction in mite levels; number of mites on sticky sheets decreased as the percentage expression of hygienic behaviour in a colony increased (figs 1 and 2), and on the majority of sampling episodes the number of mites retrieved on sticky sheets was numerically lower in colonies with SMR queens (table 2). Time until achieving treatment threshold is significantly delayed in colonies with SMR queens (*c.* 72 weeks) compared to non-selected queens (59); this benefit was not realized in the first study although time before threshold was delayed numerically in colonies with screen floors (13.4 months) compared to solid floors (11.6). Screen floors may have negative effects on some measures of colony productivity; in the second experiment screens significantly reduced frames of stored honey and pollen. Finally, SMR queens tend to have reduced brood production, sometimes significantly (table 3). Apiary isolation was shown to be virtually insignificant in our study; its direct effects were detectable only one sampling week when mite levels were higher in isolated apiaries. However we deem this a sampling artefact owing to small sample sizes and the observation that mean mite levels were less divergent the sampling weeks before and after.

Our study independently confirms the work of other authors, contributes additional information about hive screen floors, demonstrates interactions between main IPM components, and provides the first evidence that IPM practices delay treatment threshold in varroa mites. To begin, we confirm the efficacy of hygienic and SMR queens at reducing colony varroa mite levels as reported previously (Spivak, 1996; Harbo & Harris, 1999; Harbo & Hoopingarner, 1997; Rinderer *et al*., 1997). We demonstrate a negative linear association between the degree of expression of hygienic behaviour and colony mite levels (figs 1 and 2). We demonstrate a general reduction in brood production in colonies with SMR queens. This effect was also detected by Harbo & Harris (2001) who found reduced brood production in SMR queens inseminated with SMR drones, but in their case this liability was offset when SMR queens were open-mated to non-selected crosses; such compensation was not apparent in our study since a large fraction of our SMR queens were open-mated daughters of instrumentally-inseminated SMR mothers.

Concerning screen hive floors, our study contributes to an evidential base indicating weak effects on bees and mites. In table 4 we attempt to summarize this literature. In most cases the effects of screens are either innocuous or beneficial. The present study is the first to report a significant liability: the finding in the second experiment that screens reduced honey and pollen stores. Nevertheless we believe that the balance of evidence tips in favour of screen hive floors. They exert a modest restraint on mite population growth and a modest stimulus to brood production. Moreover, their cost-benefit profile is considered good, based on an expected useful life of 10 years (Rice *et al*., 2004).

TABLE 4. Summary of some literature (including present study) on average effects of screen hive floors on bees and varroa mites. Non-significant numeric trends are distinguished from statistically significant differences.

Source	Effects on varroa	Effects on bees
Rodionov & Shabarshov (1986)	Mite populations "may be considerably reduced."	
Pettis & Shimanuki (1999)	Numerically reduced sticky sheet mite counts.	Significantly increased brood production.
Ellis *et al.* (2001)[a]	Numerically reduced colony mite populations and sticky sheet mite counts. Numerically reduced percentage mite population in brood.	Numerically increased brood production.
Ellis *et al.* (2003)	Numerically increased number of mites per adult bee.	Numerically increased brood production in 2 apiaries, 1 significantly. Significantly increased bee weight. Significantly increased colony adult bee populations. Did not affect colony weight gain (numerically reduced in 1 of 2 apiaries). Did not affect pollen stores.
Rinderer *et al.* (2003)[a]	Numerically reduced colony mite populations.	Did not affect brood production. Did not affect colony adult bee populations.
Harbo & Harris (2004)	Significantly reduced colony mite populations. Significantly reduced percentage mite population in brood.	Significantly increased cells of capped brood. Numerically increased colony adult bee populations.
Present study	Numerically reduced sticky sheet mite counts on 11 of 16 months, 2 significantly. Numerically reduced sticky sheet mite counts on 18 of 22 sampling weeks. Numerically prolonged months to threshold.	Significantly reduced frames of honey. Significantly reduced frames of pollen.

[a]Comparison limited to 'screen only' treatment vs. control.

Our study joins a relatively small body of papers that tests a multi-component IPM approach against *V. destructor* (Ellis *et al.*, 2001; Rinderer *et al.*, 2003, 2004; Rice *et al.*, 2004; Sammataro *et al.*, 2004). Implicit in this approach are expectations that multiple tactics (1) reduce the likelihood of pests evolving resistance to any one, or (2) interact such that control is enhanced or compensatory control provided if one component fails. With the current study and available literature, assumption (2) is available for scientific consideration.

Of the studies cited above, only the designs of Rinderer *et al.* (2003, 2004) resemble ours in permitting an examination of interacting fixed-effect IPM components. No interactions were detected by Rinderer *et al.* (2003) between bee stock type (Russian or Italian), floor type (screen or solid), and formic acid (applied or not). However, Rinderer *et al.* (2004) found evidence for enhanced mite control in a two-component system employing resistant (Russian) queens and sunny (versus shaded) apiary locations. In the present study, six of eight cases of main effects interaction were favourable in a compensatory manner. In week 54 of the second experiment (15 April 2003) 24-h mite counts were lowest in colonies with SMR queens and screen hive floors; on this particular date screens had failed to reduce average mite numbers, but if the screened colonies also possessed a resistant queen then control was elevated to the highest across the experiment. In the other cases of favourable interaction, mite counts were reduced in colonies in non-isolated apiaries (otherwise with higher average mite levels) if those colonies had screen floors or resistant queens. Although Ellis *et al.* (2001) did not employ a test of interactions, they found evidence for compensatory action by screen floors in colonies with fluvalinate-resistant mites. We believe that the sum of evidence supports the continued use of multi-component tactics against *V. destructor*.

Finally, the present study consummates earlier work on treatment thresholds (Delaplane & Hood, 1997, 1999; Strange & Sheppard, 2001) by demonstrating that IPM practices, most notably mite resistant queens, can be expected to delay onset of treatment threshold and the need to apply chemicals. This objective should underpin varroa IPM projects until fixation of genetic mite resistance in honey bee populations renders acutely toxic acaricides obsolete.

Acknowledgements

We thank the following individuals for providing us research sites: Bob Binney, Henry Hibbs, James Miller, Lee Moody, James Thaxton and Carl Webb. Funding was provided by grants from the Southern Region IPM program (US Dept Agriculture), Eastern Apicultural Society, and Georgia Beekeepers Association. Brushy Mountain Bee Farm (Moravian Falls, NC, USA) provided screen hive floors.

REFERENCES

BURGETT, M; BURIKAM, I (1985) Number of adult honey bees (Hymenoptera: Apidae) occupying a comb: a standard for estimating colony populations. *Journal of Economic Entomology* 78: 1154–1156.

DELAPLANE, K S; HOOD, W M (1997) Effects of delayed acaricide treatment in honey bee colonies parasitized by *Varroa jacobsoni* and a late-season treatment threshold for the southeastern USA. *Journal of Apicultural Research* 36(3/4): 125–132.

DELAPLANE, K S; HOOD, WM (1999) Economic threshold for *Varroa jacobsoni* Oud in the southeastern USA. *Apidologie* 30: 383–395.

DUNG, N VAN; TAN, N Q; HUAN, L V; BEETSMA, W J (1995) Bio-technical manipulations used in Vietnam to control *Varroa jacobsoni* and *Tropilaelaps clareae* in colonies of *Apis mellifera. Bee Science* 4: 11–13.

ELLIS, J D JR; DELAPLANE, K S; HOOD, W M (2001) Efficacy of a bottom screen device, Apistan, and Apilife VAR in controlling *Varroa destructor*. *American Bee Journal* 141(11): 813–816.

ELLIS, J D JR; DELAPLANE, K S; HEPBURN, R; ELZEN, P J (2003) Efficacy of modified hive entrances and a bottom screen device for controlling *Aethina tumida* (Coleoptera: Nitidulidae) infestations in *Apis mellifera* (Hymenoptera: Apidae) colonies. *Journal of Economic Entomology* 96(6): 1647–1652.

FAKHIMZADEH, K (2000) Potential of super-fine ground, plain white sugar dusting as an ecological tool for the control of varroasis in the honey bee (*Apis mellifera*). *American Bee Journal* 140(6): 487–491.

FELDLAUFER, M F; PETTIS, J S; KOCHANSKY, J P; SHIMANUKI, H (1997) A gel formulation of formic acid for the control of parasitic mites of honey bees. *American Bee Journal* 137: 661–663.

HARBO, J R; HARRIS, J W (1999) Selecting honey bees for resistance to *Varroa jacobsoni*. *Apidologie* 30: 183–196.

HARBO, J R; HARRIS, J W (2001) Resistance to *Varroa destructor* (Mesostigmata: Varroidae) when mite-resistant queen honey bees (Hymenoptera: Apidae) were free-mated with unselected drones. *Journal of Economic Entomology* 94: 1319–1323.

HARBO, J R; HARRIS, J W (2004) Effect of screen floors on populations of honey bees and parasitic mites (*Varroa destructor*). *Journal of Apicultural Research* 43(3): 114–117.

HARBO, J R; HARRIS, J W (2006) Suppressed mite reproduction explained by the behaviour of adult bees. *Journal of Apicultural Research* 45 (in press).

HARBO, J R; HOOPINGARNER, R A (1997) Honey bees (Hymenoptera: Apidae) in the United States that express resistance to *Varroa jacobsoni* (Mesostigmata: Varroidae). *Journal of Economic Entomology* 90(4): 893–898.

HOOPINGARNER, R (2001) Biotechnical control of varroa mites. *In* Webster, T C; Delaplane, K S (eds) *Mites of the honey bee*. Dadant; Hamilton, IL, USA; pp. 197–204.

IBRAHIM, A; SPIVAK, M (2004) The relationship between suppression of mite reproduction (SMR) and hygienic behaviour. *American Bee Journal* 144 (5): 406.

METCALF, R L (1982) Insecticides in pest management. *In* Metcalf, R L; Luckmann, W H (eds) *Introduction to insect pest management*. John Wiley; New York, USA; pp. 217–277 (2nd edition).

PENG, C (1992) Honey bee grooming behavior in Varroa mite resistance. *Bee Science* 2(4): 200–201.

PETTIS, J S; SHIMANUKI, H (1999) A hive modification to reduce varroa populations. *American Bee Journal* 139: 471–473.

RICE, N D; WINSTON, M L; HIGO, H A (2004) Integrated pest management for the parasitic mite *Varroa destructor* (Anderson and Trueman) in colonies of honey bees (*Apis mellifera*). *American Bee Journal* 144(10): 791–795.

RINDERER, T E; KUTSNETZOV, V N; DANKA, R G; DELATTE, G T (1997) An importation of potentially varroa-resistant honey bees from far-eastern Russia. *American Bee Journal* 137(11): 787–789.

RINDERER, T E; DE GUZMAN, L I; DELATTE, G T; HARPER, C (2003) An evaluation of ARS Russian honey bees in combination with other methods for the control of varroa mites. *American Bee Journal* 143(5): 410–413.

RINDERER, T E; DE GUZMAN, L I; HARPER, C (2004) The effects of co-mingled Russian and Italian honey bee stocks and sunny or shaded apiaries on varroa mite infestation level, worker bee population and honey production. *American Bee Journal* 144(6): 481–485.

RODIONOV, V V; SHABARSHOV, I A (1986) *The fascinating world of bees*. Mir Publishers; Moscow, Russia.

SAKOFSKI, F; KOENIGER, N; FUCHS, S (1990) Seasonality of honey bee colony invasion by *Varroa jacobsoni* Oud *Apidologie* 21(6): 547–550.

SAMMATARO, D; DEGRANDI-HOFFMAN, G; WARDELL, G; FINLEY, J; OSTIGUY, N (2004) Testing a combination of control tactics to manage *Varroa destructor* (Acari: Varroidae) population levels in honey bee (Hymenoptera: Apidae) colonies. *International Journal of Acarology* 30(1): 71–76.

SAS INSTITUTE (1992) *SAS/STAT user's guide, version 6*. SAS Institute; Cary, NC, USA; 846 pp. (4th edition).

SCHULZ, A; KOENIGER, N; RUTTNER, F (1983) Drohnenbrut als Varroa-Falle. *Imkerfreund* 38: 50–51.

SKINNER, J A; PARKMAN, J P; STUDER, M D (2001) Evaluation of honey bee miticides, including temporal and thermal effects on formic acid gel vapours, in the central south-eastern USA. *Journal of Apicultural Research* 40(3–4): 81–89.

SPIVAK, M (1996) Honey bee hygienic behavior and defense against *Varroa jacobsoni*. *Apidologie* 27: 245–260.

SPIVAK, M; REUTER, G S (1998) Honey bee hygienic behavior. *American Bee Journal* 138(4): 283–286.

STRANGE, J P; SHEPPARD, W S (2001) Treatment thresholds and timing for the control of *Varroa destructor* in honey bee colonies in Washington State. *Journal of Economic Entomology* 94: 1324–1333.

WILKINSON, D; THOMPSON, H M; SMITH, G C (2001) Modeling biological approaches to controlling Varroa populations. *American Bee Journal* 141(7): 511–516.

Journal of Apicultural Research 51(4): 367-368 (2012)
DOI 10.3896/IBRA.1.51.4.14

NOTES AND COMMENTS

Revisiting powdered sugar for varroa control on honey bees (*Apis mellifera* L.)

Jennifer A Berry[1], Ohad Afik[1,2], Maxcy P Nolan IV[1] and Keith S Delaplane[1*]

[1]Department of Entomology, University of Georgia, Athens, GA 30602, USA.
[2]present address: B. Triwaks Bee Research Center, The Hebrew University of Jerusalem, Faculty of Agriculture, Food and the Environment, Rehovot, Israel 76100.

*Corresponding author: Email: ksd@uga.edu

Received 27 September 2011, accepted subject to revision 11 June 2012, accepted for publication 1 September 2012.

Keywords: *Varroa destructor*, IPM, powdered sugar, dusts

Dusting bees with powdered sugar has been examined as a remedial control for *Varroa destructor* Anderson and Trueman (varroa). Two modes of action have been proposed: one being that fine dust impedes the locomotion of phoretic mites and induces them to fall off bees (Ramirez, 1994), and another being that dust induces a grooming response in bees that similarly dislodges mites (Macedo *et al.*, 2002). When measured as a percentage of phoretic mites dislodged, powdered sugar dusting has achieved experimental knock-down rates ranging from 77% (Aliano and Ellis, 2005) to more than 90% (Fakhimzadeh, 2001; Macedo *et al.*, 2002), but a persistent problem has been translating these kinds of results into practical field applications.

The most comprehensive examination of powdered sugar as a field-level varroa control was the work of Ellis *et al.* (2009) in Florida. These authors dusted the top bars of brood combs with powdered sugar every two weeks from April until the following February (11 months), compared numerous parameters of colony strength and varroa populations against a control group, and found no treatment effects on any parameter of interest. In spite of these negative, yet convincing results, we wanted to do a field study that: 1. exploited a brood-free period of the season when all mites are phoretic on adults and vulnerable to dust treatment (bee colonies in sub-tropical Florida are rarely brood-free); 2. compared more than one dust delivery method, and; 3. compared more than one treatment timing interval. We felt that these outstanding questions should be resolved before we abandon powdered sugar as a bee-safe (Fakhimzadeh, 2001) and chemical-free varroa control option.

We set up 64 equalized, queen-right colonies (single-body Langstroth hives with screen floors) and divided them equally between two apiary sites in Oconee County, Georgia, USA (33º 50' N; 84º 34' E). Once in their respective apiaries, each colony was randomly assigned one of 8 (2^3) treatment combinations: 1. initiation of powdered sugar treatment (a) in January (broodless period) or (b) in March (brood area rapidly expanding); 2. treatment applied at an interval of (a) every other month for a duration of 9 days (4 treatments 3 days apart) or (b) treatment applied one day at an interval of every 2 weeks, and; 3. powdered sugar applied as (a) a dusting of 120 g (250 ml) powdered sugar with a sifter over the top bars of brood combs then brushing the sugar down between frames using a bee brush or (b) powdered sugar (same quantity) blown into the hive entrance with forced air from a shop vacuum cleaner custom-fitted with a chamber made of polyvinyl chloride (PVC) plumbing components holding the powdered sugar. There were 8 colonies (replicates) per treatment combination. The treatment interval ran from January to October, inclusive.

As an appendage to this balanced design, we set up and managed an additional 8 colonies as negative, untreated controls (never treated with powdered sugar or any remedial action), raising the experiment to n = 72 colonies. These colonies provided an additional treatment group for comparison in one-way ANOVAs against the simple effect of powdered sugar.

After colonies were established, they were managed optimally for swarm control and honey production while administering the prescribed treatments. In January prior to administering the first treatments and again in May and October, we collected the following measures of colony strength and mite numbers using published methods (Ellis *et al.*, 2009): bee population, brood area (cm^2) (only in May and October), brood viability (72 hr survivorship of open larvae), and number of phoretic mites per 100 bees (derived from strained alcohol samples of ~300 bees). Additionally, the number of mites retrieved on 3-day bottom board sticky sheets (adjusted for mite catch per 24 h) was collected for each surviving colony on 19 January, 8 March, 16 April, 1 June, 25 June, 30 July, 17 August, 25 September, and 11 October. All statistical analyses were done with SAS JMP (version 8.0.2).

Our first question was simply whether varroa mite levels were affected by powdered sugar treatment. To test this, we pooled all 64 colonies in the balanced experiment into one "treated" group

(irrespective of the $2^3 = 8$ sugar combinations described above), assigned each a random number, and sorted them by random number, thus creating 8 randomly-assigned groups of 8 treated colonies. Each of these treated groups thus presented a comparison group to the 8 untreated control colonies, essentially letting us perform 8 separate ANOVAs on the dependent variables. In 2 of 8 ANOVAs (25%), powdered sugar significantly reduced colony mite levels. In one analysis, the number of phoretic mites per 100 bees averaged across January to October was significantly ($F = 4.4$; $df = 1,14$; $P = 0.0537$) lower in the treated group (3.0 ± 0.98 (mean ± SE), n = 8) than the control group (6.0 ± 0.98, n = 8). In another analysis, the number of mites caught on sticky sheets per 24 h averaged across January to October was significantly ($F = 4.7$; $df = 1,14$; $P = 0.0475$) lower in the treated group (24.4 ± 7.3, n = 8) than the control group (46.9 ± 7.3, n = 8). No other parameters of interest responded to powdered sugar in these tests.

We next turned our attention to the balanced experiment in order to tease out the effects of month of treatment initiation, mode of dust application, treatment interval, and any interactions thereof. The only significant effect in a whole-model analysis was an interaction between mode of application and treatment interval for cm^2 brood in May. Deeming this uninteresting, we simplified the analyses by treating month of initiation, mode, and interval as simple effects in one-way ANOVAs. The number of phoretic mites per 100 bees in October was significantly ($F = 4.8$; $df = 1,22$; $P = 0.0401$) lower in colonies in which powdered sugar treatment began the previous January (3.4 ± 0.9 mites (mean ± SE), n = 11) compared to colonies in which treatment was delayed until March (6.1 ± 0.8, n = 13). This suggests that powdered sugar dusting is more efficacious when it can be applied early and exploit a winter brood-free period. Colony bee population in May was significantly ($F = 3.9$; $df = 1,61$; $P = 0.0524$) higher in colonies in which powdered sugar had been blown into hive entrances (8496 ± 710 bees, n = 32) compared to colonies which had received powdered sugar by sifting onto exposed brood comb top bars (6493 ± 721, n = 32). This suggests that applying powdered sugar with forced air at the hive entrance was less disruptive to bee populations than exposing and dusting comb top bars. No other parameters of interest responded to independent variables in these one-way ANOVAs.

A final observation of interest is the number of colonies surviving at the end of the experiment. Of the 8 non-treated control colonies, three (3/8 = 38%, n = 1) were alive in October. Average survival among the 8 sets of randomly-derived treated colonies was 39 ± 6.4% (mean ± SE), n = 8).

In conclusion, powdered sugar treatment resulted in lower colony varroa levels in 2 of 8 (25%) separate analyses. We thus have evidence that powdered sugar is most efficacious when it can be applied early in the season and exploit a winter brood-free period. A labour-saving technique of applying powdered sugar dust at hive entrances with forced air appears to be less disruptive to colony bee populations than the more invasive practice of sifting sugar onto exposed brood comb top bars. In spite of these highlights, we cannot pretend that these results are a strong affirmation of powdered sugar in the fight against varroa. The method was ineffective at reducing varroa in 75% of our analyses. Moreover, 10-month colony survival between treated and non-treated colonies was virtually identical, and poor, at 38-39%. Powdered sugar is thus, at best, another "weak" IPM component that may contribute toward varroa management when used in conjunction with other components.

References

ALIANO, N P; ELLIS, M D (2005) A strategy for using powdered sugar to reduce *Varroa* populations in honey bee colonies. *Journal of Apicultural Research* 44(2): 54-7.

ELLIS, A M; HAYES, G W; ELLIS, J D (2009) The efficacy of dusting honey bee colonies with powdered sugar to reduce *Varroa* mite populations. *Journal of Apicultural Research* 48(1): 72-76. http://dx.doi.org/10.3896/IBRA.1.48.1.14

FAKHIMZADEH, K (2001) The effects of powdered sugar *Varroa* control on *Apis mellifera* colony development. *Journal of Apicultural Research* 40(3-4): 105- 109.

MACEDO, P A; WU, J; ELLIS, M D (2002) Using inert dusts to detect and assess *Varroa* infestations in honey bee colonies. *Journal of Apicultural Research* 41: 3-7.

RAMIREZ, B W (1994) Conformation of the ambulacrum of *Varroa jacobsoni* Oud and mite control with dusts. *American Bee Journal* 134: 835.

OPEN ACCESS Freely available online

PLOS ONE

Field-Level Sublethal Effects of Approved Bee Hive Chemicals on Honey Bees (*Apis mellifera* L)

Jennifer A. Berry[1], W. Michael Hood[2], Stéphane Pietravalle[3], Keith S. Delaplane[1]*

1 Department of Entomology, University of Georgia, Athens, Georgia, United States of America, **2** School of Agricultural, Forest, and Environmental Sciences, Clemson University, Clemson, South Carolina, United States of America, **3** The Food and Environment Research Agency, Sand Hutton, North Yorkshire, United Kingdom

Abstract

In a study replicated across two states and two years, we tested the sublethal effects on honey bees of the miticides Apistan (tau fluvalinate) and Check Mite+ (coumaphos) and the wood preservative copper naphthenate applied at label rates in field conditions. A continuous covariate, a colony Varroa mite index, helped us disambiguate the effects of the chemicals on bees while adjusting for a presumed benefit of controlling mites. Mite levels in colonies treated with Apistan or Check Mite+ were not different from levels in non-treated controls. Experimental chemicals significantly decreased 3-day brood survivorship and increased construction of queen supercedure cells compared to non-treated controls. Bees exposed to Check Mite+ as immatures had higher legacy mortality as adults relative to non-treated controls, whereas bees exposed to Apistan had improved legacy mortality relative to non-treated controls. Relative to non-treated controls, Check Mite+ increased adult emergence weight. Although there was a treatment effect on a test of associative learning, it was not possible to statistically separate the treatment means, but bees treated with Apistan performed comparatively well. And finally, there were no detected effects of bee hive chemical on colony bee population, amount of brood, amount of honey, foraging rate, time required for marked released bees to return to their nest, percentage of released bees that return to the nest, and colony Nosema spore loads. To our knowledge, this is the first study to examine sublethal effects of bee hive chemicals applied at label rates under field conditions while disambiguating the results from mite control benefits realized from the chemicals. Given the poor performance of the miticides at reducing mites and their inconsistent effects on the host, these results defend the use of bee health management practices that minimize use of exotic hive chemicals.

Citation: Berry JA, Hood WM, Pietravalle S, Delaplane KS (2013) Field-Level Sublethal Effects of Approved Bee Hive Chemicals on Honey Bees (*Apis mellifera* L). PLoS ONE 8(10): e76536. doi:10.1371/journal.pone.0076536

Editor: Guy Smagghe, Ghent University, Belgium

Received May 3, 2013; **Accepted** September 1, 2013; **Published** October 18, 2013

Funding: This research was funded by a primary contract (no. 2008-37610-18834) awarded to Clemson University by the United States Department of Agriculture, Cooperative States Research and Education Service, Critical Issues Initiative. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

* E-mail: ksd@uga.edu

Introduction

The parasitic honey bee mite, *Varroa destructor* Anderson and Trueman has been responsible for transitioning beekeeping from one of the world's most chemical-averse agricultural industries to one of its most chemical-dependent. In the United States, the synthetic acaricides tau-fluvalinate (Apistan^{TM}) and coumaphos (Check Mite+^{TM}) are routinely used to control this exotic honey bee pest. It is generally believed that Varroa-related losses would be unacceptably high without these inputs. Although these products have low acute toxicity (high LD_{50}s) to honey bees, there is growing evidence that they are not entirely benign. Rinderer et al. [1] showed that drones exposed to fluvalinate during immature development have increased mortality and reduced body weight and tend toward lower sperm counts, and Burley et al. [2] showed that drones similarly exposed to coumaphos have lower sperm viability. Haarmann et al. [3] showed that queens have reduced body weight if reared in the presence of elevated levels of fluvalinate. At beeswax coumaphos levels equal to the legal tolerance of 100 ppm >50% of queen cells were rejected by nurse bees in a rearing colony, and those queens that survived to adulthood weighed less than control queens [4] and at 6 months expressed only 31% survival compared to control group survival of 48% [5]. Coumaphos has been shown to alter honey bee gene expression for detoxification pathways and may down-regulate gene products associated with cellular or humoral immunity [6]. There is evidence that acaricides alter physiological functions, immune responses, and detoxification functions in the host bees rendering them more susceptible to pathogens and pesticides [7–6]. And finally, the active ingredients fluvalinate and coumaphos have been shown to synergize in the company of each other, elevating the honey bee toxicity of each to potentially injurious levels [8–9].

Honey bee exposure to toxins has been a subject of increasing scrutiny as colony numbers continue to decline in the United States and Europe [10–11]. Survey analyses of bees and hive matrices show a high degree of pesticide exposure, both in diversity of compounds and level of residues [12–13]. But it has not proven easy to assign direct causation to pesticides or to any single factor, and the prevailing thinking is that bee decline is a product of many interacting stressors including but not exclusive to environmental toxins [14–15]. Field pesticide symptoms sometimes lack clear indication, raising interest in sublethal effects on bees – morbidities that escape casual observation but nevertheless add up to colony-killing effects. The fact that beekeeper-applied chemicals top the list of compounds found in hive matrices

[12,13,16] underscores the need to examine these chemicals for their sublethal effects and potential contributions to bee health problems.

In this paper we report a two-year (2008, 2009) study replicated across two states (Georgia, South Carolina) looking for sublethal effects on bees at labeled rates of compounds registered for use by beekeepers in the United States: the synthetic acaricides tau-fluvalinate (Apistan^{TM}) and coumaphos (Check Mite+^{TM}) used to control Varroa mites and, in Georgia only, copper naphthenate (Jasco^{TM}) used to protect wooden hive parts from termites and decay fungi. Key to our purposes was a simultaneous statistical control for the effects (presumably beneficial) of the miticides Apistan and Check Mite+. In other words, we wanted to parse out the benefits of miticides so that we could unambiguously examine them for their sublethal effects on the insects they are designed to protect. We did this by tracking colony mite level with three independent measures and using a combined colony mite index score as a covariate with the fixed effect colony chemical treatment. This implies the non-controversial assumption that mite depredations are lower in colonies in which mites are controlled with miticides.

Materials and Methods

General Set-up and Field Measurements

Experimental bee colonies were placed on lands owned and maintained by the University of Georgia or Clemson University for the explicit purpose of research, so no special permissions were required. No endangered or threatened species were involved in these studies.

Forty eight experimental colonies were set up in Georgia (4 treatments×12 replicates) and 24 in South Carolina (4×6), each colony consisting of a single 10-frame Langstroth hive body, a queen excluder, and enough honey supers to accommodate incoming nectar. We took pains to eliminate incipient pesticide residues as sources of variation. All hives were begun with factory-new equipment, and instead of using beeswax comb foundation (a potential source of exotic residues) we fitted each frame with a 2.5-cm strip of wax-less plastic comb foundation across the top bar. Bees used this plastic strip as a template to construct semi-natural combs inside the wooden frames. Within state, each colony was randomly selected to receive one of the following treatments at labeled rates: (1) two strips of Apistan inserted one between frames 3 and 4 and one between frames 5 and 6 for 42 days, (2) two strips of Check Mite+ inserted one between frames 3 and 4 and one between frames 5 and 6 for 42 days or (3) no treatment, and in Georgia only (4) a 37.5×45.7×0.3-cm sheet of wood laminate board impregnated with 2% copper naphthenate solution and placed on the hive floor for 42 days to simulate bee exposure to treated woodenware. After year 1 we sampled experimental colonies for target chemical residues in beeswax. We took wax from brood frames in position 1 or 10, representing the furthest possible distance from the experimental chemicals. The samples were sent to the USDA AMS National Science Laboratory in Gastonia, NC for chemical residues analysis for the target active ingredients shown in Table 1. In year 2, colonies retained their original treatment designations, and those that died were re-started with combs of the appropriate treatment saved in a freezer from the previous year.

Each year we measured relative colony Varroa mite levels using three methods: (1) mites per 100 bees recovered from strained alcohol samples, (2) natural 24-hr mite drop recovered from hive floor inserts, and (3) mites recovered from hive floor inserts during 24-hr after dusting colony with 250 mL powdered sugar sifted onto top bars of brood frames. Measurements with one or more of these methods were done in Jul, Aug, Sep, Oct, and Nov 2008 and Apr, Jun, Aug, Sep, Oct, Nov, and Dec 2009.

In each state in each year, chemical applications were applied and data collected in each of two seasons: spring (May–Jun) and late-season (Aug–Sep). The following dependent field measurements were taken after a 42-day treatment interval: (1) brood survivorship, (2) number of queen cells in construction, (3) frames of adult bees, (4) frames of brood, (5) frames of honey, (6) foraging rate, (7) time for marked, released bees to return to the nest, (8) percentage of marked, released bees that return to the nest, and (9) incidence of "medium", "medium high", or "high" colony levels of *Nosema* spp. spores.

Frames of brood, bees, or honey were derived by taking the mean of results from two independent observers who visually estimate the surface area of comb surfaces covered by each target [17–18]. Brood survivorship was measured by placing a sheet of transparent acetate onto a brood comb and marking on the acetate the location of 40 cells of live, uncapped brood. Combs were selected that were not in direct contact with pesticide strips. Three days later, the same sheet of acetate was returned to the same frame and surviving brood counted to determine percentage brood survivorship. Bee foraging rates at the colony entrance (number of bees exiting per min) was measured during days of good flight condition. The number of queen cells under construction was noted regularly when colonies were opened and summed for each colony. Time (sec) for released bees to return to the nest and percentage of released bees that return to the nest were derived with a mark-recapture technique. Twenty-five foraging-age bees from each colony were collected at the hive entrance, narcotized in the field with either CO_2 or ice, and marked on the thorax with a colony-specific color. One person moved the marked bees to a site 0.5-km away, and using cell phones communicated release time to observers back at the hives who then observed hive entrances for 15 min and recorded the number and time for each returning marked bee. Colony Nosema levels were determined by sampling 25 adult bees in alcohol and microscopically examining each for Nosema spores in macerated and suspended abdmoninal tissue [19]. Because Nosema spore distribution tends to be heavily clumped – large numbers in a few individuals [20] – we subjectively assigned each bee into one of five classes: (1) no spores, (2) low number of spores, (3) medium, (4) medium high, or (5) high. We analyzed and report our results as the incidence of colony Nosema levels scoring "medium," "medium high," or "high."

Conditioned Learning and Memory

Conditioned learning response and memory retention were tested with the Proboscis Extension Reflex (PER) assay [21]. A test arena was constructed to direct air over a scent and onto the face and antennae of a tethered bee which the operator could observe and reward with a drop of sugar syrup onto antennae or mouth parts. An aquarium pump was used to direct scented air onto the bee and an exhaust fan to vent it away. Individuals were restrained in a plastic drinking straw with only the mouthparts and antennae free. Bees reflexively extend the proboscis when their antennae are touched with a droplet of sucrose solution. If this process is accompanied with an odor stimulus, it sets the stage for a test of associative learning. There were three phases to the assay: the conditioning (learning) phase, a test blank, and the testing (memory) phase [22]. For each bee there were five conditioning trials during which the bee was restrained, a conditioning stimulus of odor (geraniol) blown across its face for 6 sec, a droplet of sucrose applied to the antennae after 3 sec, and the bee thereafter

Table 1. Beeswax chemical residue analysis (ppb) in experimental colonies after first season.

Georgia					
	Experimental treatments				
Active ingredients screened	**Non-treated**	**Apistan™**	**Check Mite+™[c]**		**Cu naphthenate**
			Year 1	**Year 2**	
2,4-dimethylaniline[a]	ND	ND	ND	ND[d]	ND[d]
2,4-dimethylphenyl formamide[a]	ND	ND	ND	ND	ND
Amitraz[a]	ND	ND	ND	ND	ND
Coumaphos[b]	392	429	256,000	514,000	212
Fluvalinate[b]	18	16,600	219	1700	trace
Elemental Cu	NA	NA	NA	NA	58.5
South Carolina					
Active ingredients screened	**Non-treated**	**Apistan™**	**Check Mite+™[c]**		**Cu naphthenate**
2,4-dimethylaniline[a]	ND	ND	ND		NA
2,4-dimethylphenyl formamide[a]	ND	ND	ND		NA
Amitraz[a]	ND	ND	ND		NA
Coumaphos[b]	9310	24.7	271,000		NA
Fluvalinate[b]	ND	3290	ND		NA

[a]detection limit (ppb) 4.0.
[b]detection limit (ppb) 1.0.
[c]Check Mite+™ colonies in Georgia were sampled both years to confirm unexpecedly high residues in year 1.
[d]detection limit (ppb) 50.
doi:10.1371/journal.pone.0076536.t001

rewarded with the same droplet to the proboscis. A bee responding (extending proboscis) to the stimulus at or after the second trial was considered to be expressing a learned conditioned response; individuals were eliminated who extended the proboscis in trial 1 before the reward because there was no reason to expect conditioned learning at this point. The five conditioning trials were followed by a blank test of plain air to eliminate individuals responding to the mechanical stimulus of forced air. Individuals that exhibited conditioned learning in the first experiment were retained for four post-conditioning test intervals to appraise memory: 7-min post conditioning, 14-min [23], 28-min, or 56-min. In both conditioning and trial phases the response variable was percentage of individuals extending the proboscis. Thus, the assay measures expression of both learning and memory.

Adult Bee Emergence Weight and Longevity

Emergence weight and daily cumulative mortality were compared for adult bees reared as immatures in field colonies under the chemical regimes. One frame of teneral adults emerging from their cells was removed from each colony and bagged overnight to collect newly-emerged bees. The next day, newly emerged bees from each colony were weighed and placed into colony-specific cages (target 50 bees per cage, $n = 24$ cages) and housed in an incubator at 35°C. Bees were fed sugar syrup, water, and pollen *ad libitum*. Cumulative daily mortality was counted until the last bee died.

Statistical Analyses

All analyses were performed with the GenStat 15.1 statistics package [24]. In cases such as emergence weight, average numbers of frames of bees, brood, honey or the time taken to return to the apiary, the data were analyzed by analysis of variance recognizing colony mite level as a covariate and chemical hive treatment as fixed effect. The mite covariate was created by combining with a χ transformation into one synthetic mite index the three relative measures of colony mite level: (1) mites per 100 bees recovered from alcohol samples, (2) natural 24-hr mite drop, and (3) mites recovered after dusting with powdered sugar. When response data were counts (proportions), they were analyzed using a Generalized Linear Model (GLM) [25] assuming a Poisson (binomial) distribution and using a logarithm (response logit: $\log(p/(1-p))$) link function. When a significant ($P \leq 0.05$) effect of treatment was detected, the treatments were compared using means separating groupings. The predictions and 95% confidence intervals were produced for each treatment for an average mite level based on the range of mite levels observed in the population.

The effect of treatment on colony mite measures was tested with a simple analysis of variance recognizing treatment as fixed effect after log-transforming the colony mite measures to correct for the skewness of the data.

For the PER learning analysis, the data were first sorted to the level of year, state, season in which test was performed (summer or fall), chemical treatment, and learning trial (time effect) in order to create independent replicates. The conditioning trials were repeated on the same individuals over five trials; therefore it was necessary to account for repeated measures. Because the data also had a binomial structure (X respondents out of Y tested), we used Generalized Estimated Equations (assuming a binomial distribution) [26], with a logit link function. The effects of treatment and trial (and their interaction) were tested using a X^2 test based on the change of deviance between models.

For the PER memory analysis, the data were number of respondents out of the number of individuals tested. Therefore, it was still necessary to account for the binomial distribution of the

data. However, there was only one observation per bee, so it was not necessary to account for repeated measures. As a result, a Generalized Linear Model with a logit link function was used. The effects of treatment, post-conditioning test interval and their interaction were tested through F tests looking at deviance ratios.

When looking at cumulative adult mortality, the data were analyzed using a proportional hazard model for comparing the overall (i.e. whole pattern) mortality of the bees in the different treatment groups. The Cox proportional hazard model [27] relies on the notion of hazard function (in other words, estimated risk of death), defined as the probability of an individual dying at a fixed time point given that the individual has survived up to that point. This hazard function is defined piece-wise and uses each time point when death is recorded for any of the treatments and assumes that the baseline hazard is constant between two consecutive time points. One assumption made by the Cox proportional hazard model is that the bees in the "Control" group have a baseline hazard function and that the bees in the other treated groups have a hazard function proportional to it. Although the original ratios from the Cox proportional hazards model represent the increase (or decrease) in mortality of the insects in the different treatment groups in comparison to the control group, it is possible to compare those ratios to one another and therefore compare individual hazards to one another.

Results and Discussion

In this study we attempted to identify sublethal effects on bees from field label rates of in-hive chemicals commonly used by beekeepers in the United States. The challenge was to do this while controlling for health benefits presumably derived from using these chemicals to control mites. We attempted to control this confounding variable by constructing a continuous covariate – a mite index score – from three independent measures of relative colony mite level. This covariate strengthens our argument that the colony strength measures reported below are relatively unambiguous indicators of the effects of these chemicals on the insects they are designed to protect.

Chemical residue analysis of brood comb wax after the first season confirms that the experimental active ingredients were the predominate exposures in their respective test colonies (Table 1). However, it was not unusual for low levels of non-target active ingredient to occur. For example, whereas fluvalinate was predictably the predominate exposure in Georgia colonies receiving Apistan^{TM} (16,600 ppb), there were also detectable amounts of coumaphos (429 ppb). As no beeswax foundation was used to start these colonies, these exotic residues are likely the work of drifting bees or other unknown environmental exposures. More surprising was the high levels of coumaphos detected in colonies treated with Check Mite+^{TM} at label rates. Comb residues of coumaphos at the end of year one in both Georgia and South Carolina were over five times the EPA tolerance of 45,000 ppb (Table 1). We analyzed Georgia Check Mite+^{TM} colonies again at the end of year two, and residues had more than doubled after a second season's use. These high residues are unexpected given that (1) treatments were applied at label rates, (2) experimental chemicals were not in hives at time of sampling, and (3) samples were taken from brood combs at the edge of the brood super and furthest from the site of treatment. Analytic standards were not available for copper naphthenate, but elemental copper was predictably detected in colonies receiving the wood preservative in Georgia.

Field Measurements: Colony Varroa Levels

Results are shown in Table 2. Chemical hive treatment had significant effects on natural 24-hr colony mite drop and powder sugar-assisted mite drop (Table 2), but no significant effects on mites per 100 bees ($P = 0.36$). The miticidal properties of Apistan and Check Mite+ were weak or not evident, in neither case differing from non-treated controls; this is consistent with evidence for Varroa resistance to both these chemicals in the United States [28–29]. It is worth noting, however, that mite control although never different from non-treated controls was numerically optimized in colonies receiving Apistan^{TM} (Table 2). With both measurements mite levels were significantly lower in colonies treated with the miticide Apistan than in colonies treated with the wood preservative copper naphthenate.

It is important to note here that when the mite covariate was significant in the results reported below, the direction of the effect was always negative such that increasing mite levels were associated with decreasing measures of colony strength, with one exception – time for marked bees to return to the nest. Mite levels were therefore important in these measures, but it seems that mite levels varied independently of the experimental chemicals, two of which were commercial miticides.

Field Measurements: Colony Strength Measures Adjusted for Mite Level

In all these dependent variables the effect of colony mite level was controlled as an independent covariate, and when the effect was significant it is shown in Table 3. There were no significant effects of chemical hive treatment nor mite covariate on frames of honey, foraging rate, and percentage of marked released bees that return to the nest ($P > 0.05$).

Brood survivorship was significantly affected by hive chemical regime, whilst it was not significantly affected by the mite covariate. Brood survivorship was significantly higher in non-treated controls than in colonies receiving bee hive chemicals. These results provide context to the work of Wu et al. [30] who housed bees on brood combs with a known history of high pesticide residues or on combs that were relatively non-contaminated. The "high" combs contained an average of ten different pesticide residues, the three most common being fluvalinate, coumaphos, and coumaphos oxon – a breakdown metabolite. Although brood survivorship was not different between the two comb types, these authors detected delayed larval development in young bees reared on the "high" residue combs. Our present data suggest that negative effects such as these translate into reduced larval survivorship with bee hive chemicals at label rates in field conditions.

The number of queen cells under construction was significantly affected by hive chemical regime, whilst it was not significantly affected by the mite covariate. The number of queen cells under construction was significantly higher in colonies receiving bee hive chemicals than in non-treated controls. We included this variable as a proxy measure of the queen's state, as her supersedure is generally considered an indicator of suboptimal distribution of queen mandibular pheromone within the colony [31]. Without suggesting a mechanism, our results indicate that exotic chemicals in the nest matrix are associated with higher rates of queen replacement.

Adult bee population (frames of bees) was not significantly affected by hive chemical regime after adjusting for the mite covariate. However, the effect of the covariate was significantly negative so that increasing mites were associated with decreasing bee populations, an effect shown before [32]. There was a significant interaction between chemical regime and the mite

Table 2. Effects of field-rate in-hive chemical treatments on colony Varroa mite measures.

analysis[a]	treatment	mean[b]	*n*	min	Q1	median	Q3	max
Mite drop natural[c]								
$F_{tmt} = 3.3$; df = 3,186; $P = 0.023$	Non-treated	8.1 ab	55	0	1.0	7.5	41.6	200.9
	Apistan™	4.8 a	53	0	0.1	4.1	24.2	145.7
	Check Mite+™	7.5 ab	52	0	1.2	8.3	31.1	143.9
	Cu naphthenate	15.9 b	30	0.8	6.3	15.4	45.8	89.2
Mite drop sugar[d]								
$F_{tmt} = 2.8$; df = 3,158; $P = 0.040$	Non-treated	15.1 ab	47	0	1.6	14.0	66.4	523.8
	Apistan™	12.1 a	46	0	2.0	15.0	60.0	336.8
	Check Mite+™	13.2 ab	42	0	3.0	12.5	66.0	411.3
	Cu naphthenate	40.3 b	27	3.6	14.6	44.6	108.5	347.7

[a]$F_{treatment} = F_{tmt}$.
[b]Means separated by Tukey's 95% confidence intervals on the log-transformed data (log(value+1)). However, for convenience we here show mean separations on the back-transformed predicted means.
[c]Mites recovered per 24 hr from hive floor inserts.
[d]Mites recovered from hive floor inserts after dusting colony with powdered sugar.
doi:10.1371/journal.pone.0076536.t002

covariate; however, the direction of the effect was always negative, whether for the three chemicals ($P<0.01$ in each case) or untreated control ($P = 0.025$). Therefore, mite levels were influential in these results, but they varied independently of colony chemical treatment (see section 3.1). Our most important finding here is that bee hive chemicals, in isolation from confounding effects of mites, did not affect colony bee populations.

The amount of brood (frames of brood) was not significantly affected by hive chemical regime after adjusting for the mite covariate. However, the effect of the covariate was significantly negative so that the amount of brood decreased as mite level increased, a phenomenon known from previous authors [32]. There was a significant interaction between chemical regime and the mite covariate; however, the direction of the effect was always negative, whether for the three chemicals ($P<0.01$ in each case) or untreated control ($P = 0.049$).

Time (sec) for marked, released bees to return to the nest was not significantly affected by hive chemical regime after adjusting for the mite covariate. However, the effect of the covariate was significant and negative so that the length of time for a bee to return to the nest decreased as colony mite level increased. These results stand in contrast to earlier experiments dedicated to the hypothesis that phoretic mites affect homing behavior of foraging bees [33]. In that work, foragers were released at different distances, and mite-infested individuals took over twice as long as non-infested individuals to return to their nests. The differences in our designs are considerable and include different release distances (5–400 m *vs.* 500 m in present study) and comparisons of individual mite levels [33] vs. colony mite levels (present study). These are enough to render comparisons difficult, but the collective evidence suggests that Varroa may act differently on individual behaviors vs. mean colony effects. For our present purposes, however, we have no evidence that bee hive chemicals at field rates affected honey bee homing.

The incidence of colony Nosema spore loads scoring "medium," "medium high," or "high" was not significantly affected by hive chemical regime after adjusting for the mite covariate. However, the effect of the covariate was significantly positive so that spore count increased as colony mite level increased. A similar correlative association was shown in Argentina where investigators found that colonies more heavily loaded with Varroa sustained higher Nosema spore loads after the seasonal peak in spore formation occurred [34]. This contributes to a mounting database that managed honey bees are increasingly subject to multiple stressors [35]. But our main conclusion here is that bee hive chemicals at field rates did not significantly affect colony Nosema spore load.

Conditioned Learning and Memory

Results are shown in Table 3. No mite covariate was included in these analyses because we were forced to pool colonies by treatment, state, year, and season to create one replicate due to small numbers of responding bees in some colonies; therefore, we could not associate response data to unique colony mite levels. There were no significant effects of chemical hive treatment nor post-conditioning time interval (7, 14, 28, or 56 min) on the percentage of bees expressing retained memory from the learning conditioning trials ($P = 0.39$). For percentage of bees learning, however, there were significant ($P<0.001$) effects of hive chemical regime on learning trials 2–5 (trial 1 was discarded as described in Methods). But despite the significant effect of treatment as shown by the chi-square value, it is not possible to identify which groups are significantly different from one another. Nevertheless, bees from the Apistan-treated group performed comparatively well. These results provide field-level context to earlier work on the effects of acaricides on honey bee cognition. Although topical applications of fluvalinate at sublethal rates are known to reduce movement of individuals and their social exchanges with nestmates [36], there is no similar evidence for an effect of fluvalinate on bee response to the PER assay [37]. This raises the possibility that the present results are indicating heightened cognitive performance by bees for whom Varroa control has been optimized by fluvalinate. For these PER data we were not able to partition out a mite covariate; however it is worth noting that mite control, although never different from non-treated controls, was nevertheless optimized in colonies receiving Apistan™ (Table 2). This interpretation is consistent with evidence that Varroa parasitism changes the expression of genes responsible for host embryonic development and that bees known to be mite tolerant have measurable differences in the expression of genes controlling neuronal development and sensitivity [38].

Table 3. Effects of field-rate in-hive chemical treatments on honey bee biometrics.

analysis[a]	treatment	*n*	lower CI	predicted mean[b]	upper CI
Brood survivorship[c]					
$F_{tmt} = 4.5$; df = 3,178; $P = 0.004$	Non-treated	54	94.1	96.0 b	97.3
$F_{mite} = 2.5$; df = 1,178; $P = 0.12$	Apistan™	49	90.2	92.7 a	94.6
	Check Mite+™	51	90.6	93.0 a	94.8
	Cu naphthenate	29	86.3	90.1 a	92.9
Queen cells started					
$F_{tmt} = 5.6$; df = 3,121; $P = 0.001$	Non-treated	34	0.15	0.47 a	1.51
$F_{mite} = 0.6$; df = 1,121; $P = 0.43$	Apistan™	32	1.88	3.02 b	4.85
	Check Mite+™	29	2.16	3.44 b	5.49
	Cu naphthenate	31	1.31	2.28 b	3.97
Frames of bees					
$F_{tmt} = 1.1$; df = 3,128; $P = 0.33$	Non-treated	40	4.77	5.71	6.65
$F_{mite} = 36.3$; df = 1,128; $P < 0.001$	Apistan™	37	3.74	4.72	5.70
$F_{tmt*mite} = 3.1$; df = 3,128; $P = 0.030$	Check Mite+™	36	4.78	5.76	6.74
	Cu naphthenate	23	4.52	5.75	6.98
Frames of brood					
$F_{tmt} = 0.9$; df = 3,128; $P = 0.45$	Non-treated	40	1.92	2.32	2.73
$F_{mite} = 42.9$; df = 1,128; $P < 0.001$	Apistan™	37	1.51	1.94	2.36
$F_{tmt*mite} = 4.2$; df = 3,128; $P = 0.008$	Check Mite+™	36	1.97	2.40	2.82
	Cu naphthenate	23	1.55	2.09	2.62
Time (sec) to return to nest[d]					
$F_{tmt} = 2.5$; df = 3,50; $P = 0.07$	Non-treated	20	427.6	481.5	535.5
$F_{mite} = 8.5$; df = 1,50; $P = 0.005$	Apistan™	16	364.9	426.1	487.2
Covariate estimate: -176.1 ± 59.4	Check Mite+™	12	478.0	547.7	617.4
	Cu naphthenate	7	352.4	446.7	541.0
Incidence of Nosema spore load scoring ''medium,'' ''medium high,'' or ''high''[e]					
$F_{tmt} = 2.0$; df = 3,51; $P = 0.13$	Non-treated	15	0.5	1.4	3.8
$F_{mite} = 5.2$; df = 1,51; $P = 0.027$	Apistan™	14	0.4	1.2	3.5
Covariate estimate: 1.9 ± 0.7	Check Mite+™	13	0.5	1.5	4.1
	Cu naphthenate	14	2.2	4.1	7.6
Percentage bees learning[f]					
$X^2_{tmt} = 20.6$; df = 3; $P < 0.001$	Non-treated	28	9.9	12.9	16.8
$X^2_{time} = 15.5$; df = 3; $P = 0.0015$	Apistan™	24	11.1	14.2	17.9
$X^2_{tmt*time} = 8.1$; df = 9; $P = 0.52$	Check Mite+™	28	9.9	12.7	16.2
	Cu naphthenate	8	9.4	12.3	15.9
Adult emergence weight (mg)					
$F_{tmt} = 3.5$; df = 3,67; $P = 0.020$	Non-treated	22	97.5	100.6 a	103.7
$F_{mite} = 10.5$; df = 1,67; $P = 0.002$	Apistan™	16	100.4	104.0 ab	107.7
Covariate estimate: -9.6 ± 3.2	Check Mite+™	20	103.7	106.9 b	110.1
	Cu naphthenate	14	103.3	107.2 b	111.1

[a]Accumulated analysis of deviance, $F_{treatment} = F_{tmt}$. Three independent measures of colony mite level were taken (the two shown in Table 2+ mites per 100 bees recovered from strained alcohol samples) and combined by *Z* transformation into one covariate term F_{mite}.
[b]When presented, mean separation groups are derived on the transformed scale, but for convenience we here show means on the back-transformed scale.
[c]Percentage of open brood cells surviving 3 d.
[d]Time (sec) for bees to return to nest from release site 0.5 km from nest within 30 min.
[e]Proportion of bees from a colony sample of $n = 25$ falling into subjective classes of ''medium,'' ''medium high,'' or ''high'' numbers of *Nosema* spp. spores.
[f]Percentage bees exhibiting conditioned learning response in Proboscis Extension Response assay. Each bee within chemical treatment was tested in 4 successive conditioning (learning) trials with the expectation that this would discriminate earlier versus delayed learning; data for trial 1 were discarded because there was no reason to expect individuals responding at the first trial to be exhibiting a conditioned response.
doi:10.1371/journal.pone.0076536.t003

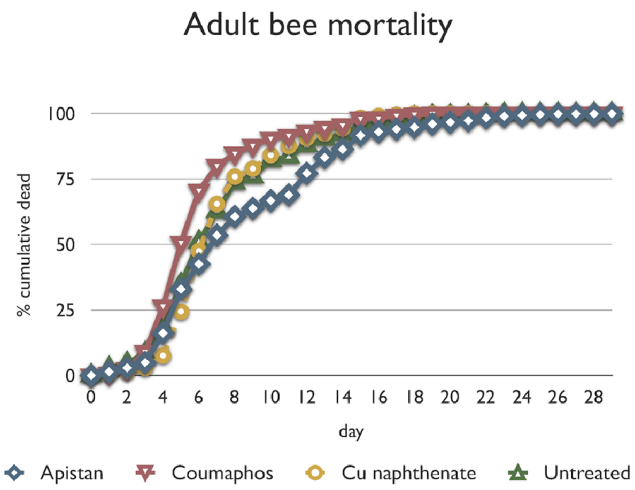


Figure 1. Cumulative daily adult bee mortality. Same-aged cohorts were made in the lab from adult bees reared as brood in field colonies receiving labeled rates of bee hive chemicals. The cohorts were followed for cumulative daily mortality. The figure shows plotted raw data, not the proportional hazard curves fitted in the model.
doi:10.1371/journal.pone.0076536.g001

Adult Bee Emergence Weight and Longevity

Results are shown in Table 3 and Figure 1. Adult bee emergence weight (mg) was significantly affected by hive chemical regime after adjusting for the mite covariate. The effect of the covariate was significantly negative so that increasing mite levels were associated with decreasing bee weight. Bee weight was significantly higher in colonies treated with Check Mite+ or copper naphthenate than in non-treated controls; colonies treated with Apistan were intermediate. Decreased bee weight has long been known to be an artifact of Varroa parasisitm [39], and these data are weak evidence for a measure of mite mitigation with Check Mite+ (but see section 3.1).

Cumulative daily mortality was analyzed by analysis of deviance using a hazard function – the probability of an individual dying at a fixed time point relative to a control group baseline. Hazard function was significantly affected by hive chemical regimen (change of deviance = 202.5; df = 3; $P<0.001$), whilst the mite covariate did not have any significant effect on the hazard function (change of deviance = 0.29; df = 1; $P = 0.59$). Pairwise separation tests of the three test chemicals (Apistan, Check Mite+, and Cu napthenate) showed that hazard function followed the pattern Check Mite+>(Cu naphthenate ≅ non-treated control)>Apistan. This pattern of comparative mortality is graphically apparent in Figure 1 where near the middle of the curve the cumulative daily mortality spread among the three chemicals is most divergent and the control group is mid-point. These data, adjusted for the mite covariate, are unambiguous evidence that bee hive chemicals are associated with legacy survival effects on the bees exposed to them as immatures. Check Mite+ caused higher legacy mortality than non-treated controls, and Apistan improved legacy mortality relative to non-treated controls; however, evidence that these two molecules synergize to cause lethal effects in bees [8]strengthens the argument for honey bee health management approaches that deemphasize synthetic miticides.

Summary and Conclusions

Exotic chemicals are routinely and legally inserted into hive matrices as part of honey bee health management strategies. Key to understanding the effects of these chemicals on the host is disambiguating their sublethal effects from their purported benefits – in our case, killing parasitic Varroa mites. We attempted to do this by adjusting our analyses for a continuous covariate – a colony Varroa level index. We included copper naphthenate wood preservative as an outgroup chemical. Even though it has no known or suspected miticidal properties, we nevertheless subjected it to covariate adjustment so we could unambiguously compare it alongside the miticides for its impact on bees.

After adjusting for the mite covariate, exotic hive chemicals significantly decreased 3-day brood survivorship and increased construction of queen supercedure cells compared to non-treated controls. Bees exposed to Check Mite+ as immatures had higher legacy mortality as adults relative to non-treated controls, whereas bees exposed to Apistan had improved legacy mortality relative to non-treated controls; bees exposed to Cu naphthenate were intermediate and not significantly different from controls. In contrast to these morbidities, Check Mite+ significantly improved adult emergence weight over non-treated controls, and Apistan-treated bees performed comparatively well on tests of associative learning. And finally, there were no effects of bee hive chemical detected for frames of bees, frames of brood, frames of honey, foraging rate, time required for marked released bees to return to their nest, percentage of released bees that return to the nest, and colony Nosema spore loads.

To our knowledge, this is the first study to examine sublethal effects of bee hive chemicals applied at label rates under field conditions while disambiguating the results from any mite control benefits realized from the chemicals. Given the poor performance of the miticides at reducing mite levels and their inconsistent effects on the host, these results emphasize the importance of minimizing use of exotic hive chemicals in honey bee management.

Acknowledgments

Technical assistance was provided by Robert Collum, Charlie Gwyn, Jim Kenaston, Kathryn Miller, Maxcy P. Nolan IV, Barbara J. Tate, and Nicholas Weaver.

Author Contributions

Conceived and designed the experiments: KSD WMH JAB. Performed the experiments: JAB KSD WMH. Analyzed the data: SP KSD. Contributed reagents/materials/analysis tools: JAB WMH SP KSD. Wrote the paper: KSD SP.

References

1. Rinderer TE, DeGuzman L, Lancaster V, Delatte G, Stelzer JA (1999) Varroa in the mating yard: The effects of *Varroa jacobsoni* and Apistan on drone honey bees. Am Bee J 139: 134–139.
2. Burley LM, Fell RD, Saacke RG (2008) Survival of honey bee (Hymenoptera: Apidae) spermatozoa incubated at room temperature from drones exposed to miticides. J Econ Entomol 101: 1081–1087.
3. Haarmann T, Spivak M, Weaver D, Weaver B, Glenn T (2002) Effects of fluvalinate and coumaphos on queen honey bees (Hymenoptera: Apidae) in two commercial queen rearing operations. J Econ Entomol 95: 28–35. DOI: http://dx.doi.org/10.1603/0022-0493-95.1.28.
4. Pettis JS, Collins AM, Wilbanks R, Feldlaufer MF (2004) Effects of coumaphos on queen rearing in the honey bee, *Apis mellifera*. Apidologie 35: 605–610.
5. Collins AM, Pettis JS, Wilbanks R, Feldlaufer MF (2004) Performance of honey bee (*Apis mellifera*) queens reared in beeswax cells impregnated with coumaphos. J Apic Res 43: 128–134.

6. Boncristiani H, Underwood R, Schwarz R, Evans JD, Pettis J, et al. (2011) Direct effect of acaricides on pathogen loads and gene expression levels in honey bees *Apis mellifera*. J Insect Physiol 58: 613–620.
7. Locke B, Forsgren E, Fries I, de Miranda J (2012) Acaricide treatment affects viral dynamics in *Varroa destructor*-infested honey bee colonies via both host physiology and mite control. Appl Environ Microbiol 78(1): 227–235. DOI: 10.1128/AEM.06094-11.
8. Johnson RM, Pollock HS, Berenbaum MR (2009) Synergistic interactions between in-hive miticides in *Apis mellifera*. J Econ Entomol 102: 474–479.
9. Johnson RM, Dahlgren L, Siegfried BD, Ellis MD (2013) Acaricide, fungicide and drug interactions in honey bees (*Apis mellifera*). PLoS ONE 8(1): e54092. doi:10.1371/journal.pone.0054092.
10. vanEngelsdorp D, Hayes J Jr, Underwood RM, Pettis JS (2010) A survey of honey bee colony losses in the United States, fall 2008 to spring 2009. J Apic Res 49: 7–14.
11. Potts SG, Roberts SPM, Dean R, Marris G, Brown MA, et al. (2010) Declines of managed honey bees and beekeepers in Europe. J Apic Res 49: 15–22.
12. Chauzat M-P, Faucon J-P, Martel A-C, Lachaize J, Cougoule N, et al. (2006) A survey of pesticide residues in pollen loads collected by honey bees in France. J Econ Entomol 99: 253–262.
13. Mullin CA, Frazier M, Frazier JL, Ashcraft S, Simonds R, et al. (2010) High levels of miticides and agrochemicals in North American apiaries: Implications for honey bee health. PLoS ONE 5, e9754. doi:10.1371/journal.pone.0009754.
14. vanEngelsdorp D, Evans JD, Saegerman C, Mullin C, Haubruge E, et al. (2009) Colony collapse disorder: A descriptive study. PLoS ONE 4, e6481. DOI:10.1371/journal.pone.0006481.
15. vanEngelsdorp D, Speybroeck N, Evans JD, Nguyen BK, Mullin C, et al. (2010) Weighing risk factors associated with bee colony collapse disorder by classificiation and regression tree analysis. J Econ Entomol 103: 1517–1523.
16. Genersch E, von der Ohe W, Kaatz H, Schroeder A, Otten C, et al. (2010) The German bee monitoring project: a long term study to understand periodically high winter losses of honey bee colonies. Apidologie 41: 332–352.
17. Burgett M, Burikam I (1985) Number of adult honey bees (Hymenoptera: Apidae) occupying a comb: a standard for estimating colony populations. J Econ Entomol 78: 1154–1156.
18. Skinner JJ, Parkman JP, Studer MD (2001) Evaluation of honey bee miticides, including temporal and thermal effects on formic acid gel vapours, in the central south-eastern USA. J Apic Res 40: 81–89.
19. Shimanuki H, Knox DA (2000) Diagnosis of honey bee diseases. US Dept Agric. Handbook AH-690. 61.
20. Doull KM (1965) The effects of time of day and method of sampling on the determination of *Nosema* disease in beehives. J Invertebr Pathol 7: 1–4.
21. Abramson CI, Sokolowski MBC, Wells H (2011) Issues in the study of proboscis conditioning. In: Stewart, EM, editor. Social insects: Structure, function, and behavior. Nova Science Publishers. 25–49.
22. Picard-Nizou AL, Grison R, Olsen L, Pioche C, Arnold G, et al. (1997) Impact of proteins used in plant genetic engineering: toxicity and behavioral study in the honeybee. J Econ Entomol 90(6): 1710–1716.
23. Smith BH (1991) The olfactory memory of the honeybee *Apis mellifera*. I. Odorant modulation of short- and intermediate-term memory after single-trial conditioning. J Exp Biol 161: 367–382.
24. VSN International (2012) GenStat for Windows 15th Edition. VSN International, Hemel Hempstead, UK. Available: http://www.GenStat.co.uk.
25. McCullagh P, Nelder J (1989) Generalized Linear Models, Second Edition. Boca Raton: Chapman and Hall.
26. Hardin J, Hilbe J (2003) Generalized Estimating Equations. London: Chapman and Hall.
27. Cox DR (1972) Regression models and life-tables. Journal of the Royal Statistical Society. Series B (Methodological) 34(2): 187–220.
28. Elzen PJ, Baxter JR, Spivak M, Wilson WT (2000) Control of *Varroa jacobsoni* Oud. resistant to fluvalinate and amitraz using coumaphos. Apidologie 31: 437–441 DOI: http://dx.doi.org/10.1051/apido:2000134.
29. Pettis JS (2004) A scientific note on *Varroa destructor* resistance to coumaphos in the United States. Apidologie 35: 91–92 DOI: http://dx.doi.org/10.1051/apido:2003060.
30. Wu JY, Anelli CM, Sheppard WS (2011) Sub-lethal effects of pesticide residues in brood comb on worker honey bee (*Apis mellifera*) development and longevity. PLoS ONE 6(2): e14720. DOI:10.1371/journal.pone.0014720.
31. Butler CG (1957) The process of queen supersedure in colonies of honeybees (*Apis mellifera* Linn.). Insectes Sociaux 4: 211–223.
32. Murilhas AM (2002) *Varroa destructor* infestation impact on *Apis mellifera carnica* capped worker brood production, bee population and honey storage in a Mediterranean climate. Apidologie 33: 271–281. DOI: 10.1051/apido:2002013.
33. Kralj J, Fuchs S (2006) Parasitic *Varroa destructor* mites influence flight duration and homing ability of infested *Apis mellifera* foragers. Apidologie 37: 577–587. DOI: 10.1051/apido:2006040.
34. Mariana F, Maggi M, Porrini M, Fuselli S, Caraballo G, et al. (2012) Parasitic interactions between *Nosema* spp. and *Varroa destructor* in *Apis mellifera* colonies. Zootecnia Trop 30: 81–90.
35. Cornman RS, Tarpy DR, Chen Y, Jeffreys L, Lopez D, et al. (2012) Pathogen webs in collapsing honey bee colonies. PLoS ONE 7(8): e43562. DOI:10.1371/journal.pone.0043562.
36. Teeters BS, Johnson RM, Ellis MD, Siegfried BD (2012) Using video-tracking to assess sublethal effects of pesticides on honey bees (*Apis mellifera* L.). Environ Toxicol Chem 31: 1349–1354 DOI: 10.1002/etc.1830.
37. Decourtye A, Devillers J, Genecque E, Le Menach K, Budzinski H, et al. (2005) Comparative sublethal toxicity of nine pesticides on olfactory learning performances of the honeybee *Apis mellifera*. Arch Environ Contam Toxicol 48: 242–250.
38. Navajas M, Migeon A, Alaux C, Martin-Magniette ML, Robinson GE, et al. (2008) Differential gene expression of the honey bee *Apis mellifera* associated with *Varroa destructor* infection. BMC Genomics 9: 301 DOI:10.1186/1471-2164-9-301.
39. De Jong D, De Jong PH, Gonçalves LS (1982) Weight loss and other damage to developing worker honey bees from infestation with *Varroa jacobsoni*. J Apic Res 21: 165–167.