Kelley Beekeeping

SERVING THE BEEKEEPER SINCE 1924

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oil painting by Delilah Smith

IN THIS ISSUE

From the Queen's Court

by Melanie Kirby

Freedom most times means liberation of burdens and the right to do what one wants to do. As people, we readily know what we don't want…but sometimes have trouble figuring out just what we do want. I have to wonder, do our bees ponder the same things? Are they wanting to be left alone or to be handled? Are they happy with their surroundings, or wanting to move to new pastures? And yet- despite their wings, which give them the freedom to fly as far as their honey reserves can take them, they chose to stay with their families and to allow us to interact with them.

I have to think that perhaps that is what freedom really is—the ability to be with family and friends and work collectively, yet have the independence to do what we each individually feel is appropriate and necessary. It is this independence word that trips me up though… because how can we be independent of each other? Just like bees- they each have their own individual lives and jobs. But, they also are very dependent on each other. It would seem that if we wanted to anthropomorphize, which apparently I'm doing right now…then if we reflect upon that duality as a projection of ourselves, then what is it that we humans need from each other in order to be independent?

I cannot offer an exact answer to that question, but I am, for some reason, thinking that what we need from each other is consideration, which rests on respect. As I drive around in my bee truck listening to the news, I can't help but wonder, why is it so hard for everyone to respect each other. The senseless threats from those who think differently than us Americans is something that I just cannot understand. And yet, as a citizen of this beautiful and bold country, it is these very threats that seem to undermine what we define as freedom and liberty.

Do the bees care what and whom you believe in? Despite different cultures, traditions, religions, customs and cuisines, bees keep doing what they choose to do, to work as individuals for the greater good

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Editor
Melanie Kirby
Editor@KelleyBees.com

Design & Layout
Jon Weaver, Johnny4Eyes.com

Website & Ecommerce
KelleyBees.com

Address
807 W. Main St.
P.O. Box 240
Clarkson, KY 42726

Phone
270-242-2012
800-233-2899

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Want to see your bee-related photo on the cover of this newsletter? Send photos to ***editor@kelleybees.com***

Queen's Court *cont'd*

Sunset in the Southern Rockies.

of their colony. And yet, why can't we humans do the same thing? I have no answers to these queries. These questions give birth to more questions and the majority of them have no finite answers; or more likely, have more than one answer, as it depends on what each and every one of us thinks and chooses to do, as a right of our own volition. In the southern Rocky Mountains, there are a variety of cultures present. It is what we call, the "tri-cultural tapestry" of natives and pilgrims. This includes Native Americans, Iberian-Moors and Spanish settlers, and EuroAsian immigrants. Initially there was strife, just like bees from different hives trying to come to terms with their "community."

And as we flash forward to the present, it is these same cultures that for the most part, seem to get along. It is a sense of ownership that seems to divide. This land for that land, this money for that item, this for that, etc…And while money and prosperity does help the world to go round- at least financially, it is ownership that also unites.

If we claim to be a part of an area, of a piece of land, of a country, then we are the threads of that fabric. And by being woven together- we strengthen the fabric. Just like the cells of the honeycomb; it is when they are all connected and attached to each other that they become the strongest and most resilient shapes in the natural world.

And oh, how so many seamstresses work together to sweat and build that comb. This same comb serves as the memory and circuit board, houses the family and community, feeds the young and old, and cements the resolve of morale.

May we as individual beekeepers, working together to build comb and strengthen our American beekeeping industry, continue to learn from our precious bees. And may the rest of society learn from our resolve to revitalize our livelihoods and hobbies and to work alongside and together with us to create and sustain food production and security.

Bee all you can Bee in the Land of the Free!
Melanie Kirby

Cover Photo is an oil painting by Delilah Smith titled, "Biker Bees Fourth of July Parade." See more artwork at www.artbydelilah.com

Melanie has been keeping bees professionally for 20 years; learning from bees and their keepers in a few different countries and states. She will be travelling to Morocco at the end of this month to share the wonders and intricacies of queen breeding. She is humbled to serve as an international consultant and author on sustainable beekeeping practices. Reach her at Editor@KelleyBees.com

IN HER MAJESTY'S CHAMBERS-
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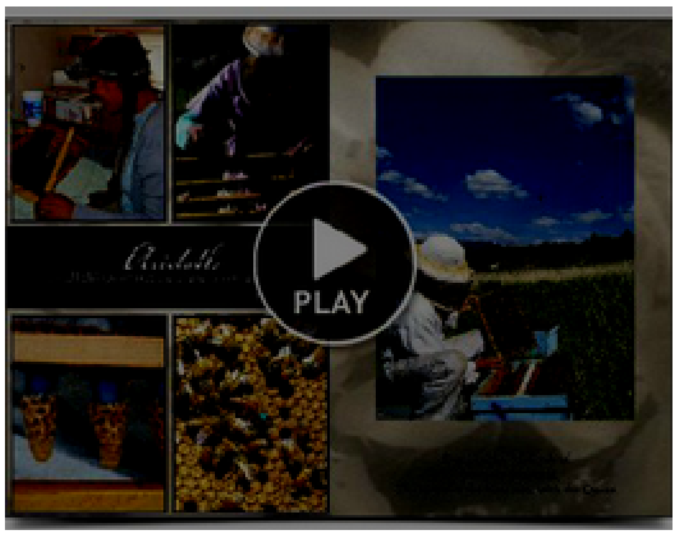

IN HER MAJESTY'S CHAMBERS- INTRO TO QUEEN BREEDING & REARING SHORT COURSE JULY 16-17, 2016 AT ZIA QUEENBEES FARM & FIELD INSTITUTE IN THE MAJESTIC SOUTHERN ROCKY MOUNTAINS.

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Sturdy Non Shrink

If you have a question you would like to share, email it to Editor@KelleyBees.com

A•Bee•Cs

Beginning Beekeeping

by Dennis Brown

Hi Dennis,
I got my two nucs in April and transferred them into a brood box. One nuc was substantially stronger than the other in the beginning and now it's up to two full brood boxes and I'm anticipating putting a honey supper on it this weekend. The other is still in the first brood box and seems to be stagnant. I've confirmed that I have a queen and I have lots of uncapped larvae but it's just not growing. I've checked for mites and see no signs of disease, I'm thinking I should re-queen the hive but I wanted to get your opinion. Paula B.

Hello Paula,
Since having these two nucs, have you been feeding them two parts sugar to one part water? On the strong hive, are all of the frames drawn out in both brood boxes? How much sealed brood do you see in the weak hive compared to just eggs and unsealed larvae? Do you see any empty queen cells on any of the brood frames in the weaker hive? (The queen cells will look like a peanut.) Is the queen you have in the weak hive the marked queen you started with?

Response: I have been feeding them a one to one ratio. The strong hive has drawn-out five frames in the second brood box. In the weak hive, there are eggs and some larva but no sealed brood. It looks like there have been a few queen cells present.

Paula,
The reason the hive is weaker than the other hive you have is because the weaker hive appears to have re-queened itself. You probably lost a good month of productivity in the weaker hive. There is still enough time for that hive to rebound providing the new queen is a good one. You should check the brood pattern of the new queen after the first month or so. And by the way, it's not the water in the mix that provides energy for your bees, it's the sugar content. The bees will be able to produce more wax by providing them a higher sugar mix and it will provide them with more energy. So, whenever you feed, you should use the two to one ratio despite what you read elsewhere. Give it a try.

I hope this helps. Enjoy your bees!
Dennis Brown

Dennis Brown is the author of "Beekeeping: A Personal Journey" and "Beekeeping: Questions and Answers." Contact Dennis at www.lonestarfarms.net.

Just the FAQs & X•Y•Zs

Advanced Beekeeping

by Melanie Kirby & Mark Spitzig

This month's FAQ's and XYZzz's segments will focus on longevity-based selection for queen selection and rearing. This is an article that editor Melanie Kirby wrote 5 years ago! And it still holds true to this day. It is being shared not to promote any single approach or entity, but rather to share the process of how every beekeeper and queen producer can share quality stock to create sustainable and resilient honeybees that can transcend boundaries.

The Reconciliation:
Aspiring Breeders' Practical Approach
To Establishing Survivor Stock for Changing Times & Environments

The "Reconciliation" is a plausible attempt to discern and dissolve the modern day circumstances that envelop our bees and us as their stewards, with the realities of today's changing environments, agroecosystems, and landscapes. The "playing field" is changing—physically, regionally, and philosophically. The modern advancements of the industrial age have changed the landscapes of America and across the globe. And being as such, it has determined the need for flexibility and diversity for those of us working with dynamic organisms in our earthly "laboratories" that are ultimately controlled by the dynamic forces of Nature and human inputs.

The origins of our efforts to establishing Survivor Stock actually began 16 years ago in the Upper Peninsula of Michigan around the community of Marquette along the shores of Lake Superior. Mark began his journey as a beekeeper as a "recreational hobbyist", with a couple of interested friends, a couple of bought packages and several beginning beekeeping books. Of course the initial literature and Mark's interest didn't really touch upon breeding, but on the beginning concepts of the lifecycle and biological cycles of the bees throughout the seasons. These beginning concepts, which for seasonal manifestations of the honeybees, ultimately relies upon their environment and specific location. *Our perspectives start as such, as it does for all beekeepers in every place of the globe: Where one keeps bees will ultimately determine how one can keep their bees and how to evolve one's learnings through the seasons and the gained experience of bee handling into flexible plans of management and decisive protocol.*

Keeping bees, like other livestock, can vary greatly as the numbers increase. Having one hive, one can learn the basics but will be limited in their ability to compare and discern the differences among colonies- both characteristic by strains and races and also of hive "personalities" in varying conditions. Yet, as the numbers increase in any particular apiary, or even as the number of apiaries increases that are under one particular beekeeper's management, the learned lessons from multiple hives exponentially increases. This can make the more experienced realize readily, that indeed- they are still students to the bees, Mother Nature and Father Time.

There is a distinction that is noticeable between Pre-Varroa beekeepers and Post-Varroa beekeepers. For those who were keeping bees prior to Varroa's arrival the experience always is posed against the past. Beekeepers who first felt and had to fight the impact of Varroa destructor while managing healthy hives were devastated. The arena had changed.

Then there are those of us who have known nothing but and have had to deal with their coexistence with our bees as a constant. Varroa resistance is the main target for selection for many across the globe. It is through their permanent affliction of honeybee hives that beekeepers have had to continue to evaluate various forms of management of their bees- with or without chemicals.

The perspective of a Post-Varroa beekeeper is one of acceptance and tolerance. This acceptance can manifest into protocol that incorporates “conventional” or standard forms of management with the use of chemicals, or it can manifest into “alternative” or progressive management. The decision to use or not use chemicals will affect to what degree a selection paradigm for breeding as well as the status of production of rearing for bees will be. This is indicative in the following ways: The varroa presence and the beekeeper’s chosen method of control in any location combined with the locational factors such as weather, climate, topography, and the surrounding agroecosystem and urban/industrial inputs combine to form the “apisphere” or the living conditions in which a colony or apiary resides. These combined factors influence what nutrition is available. And the nutrition available, along with genetic factors of the hives, will nurture colonies into what they end up being: either flourisher-survivors or failures.

This “apisphere” sets the stage for the display of a hive’s longevity. And the longevity of a hive is what will truly indicate its ability to survive through a multitude of seasonal changes and manifestations. In the beginning, Mark relied upon the expertise of others; of the authors and the catalogues which promoted various products and common philosophies for use with managing the bees. He purchased a medication kit from an area beekeeping supply chain and was comprised of antibiotic and chemical applications for the control of varied ailments and conditions that could befall the bees. The warnings on the packaging convinced him never to open them. His initial reaction was fear of these added inputs conflicting with natural reactions and synergizing while leaving residues that would permeate comb, honey and equipment. Mark eventually realized that apart from the locational differences and similarities that manipulate hive performance, the other added inputs- whether through supplemental feeding or applied “therapies” would also add to the complexity of overall hive performance and their establishment of their Overall Lifetime Merit (OLM).

He chose , from the beginning—to seek “alternative” or non-chemically based methods for managing his bees. In the year 2001, he enrolled in The University of Minnesota’s Dr. Marla Spivak’s “Overwintering in Northern Climates” workshop. The techniques he learned there have helped to shape the seasonal management which he continues to apply today. Dr. Spivak shared that colonies are susceptible to death by varroa within 18 months. It became quite apparent to Mark that this indicated the need to find bees that could exceed the 18 month time threshold while continuing to perform well both in production, demeanor and health.

This defined the beginnings of the two-year “thrive and survive” regiment which he, along with partner Melanie Kirby, they continue to apply to all their hives. This two-year regiment is nothing more than Mother Nature tested and Father Time approved. It is what defines longevity as a selection tool for not only varroa resistance, but also for a hive’s Overall Lifetime Merit, which encompasses many more traits including hygienic behavior, pest/disease resistance, gentleness over time and in varied conditions as well as productivity over time and through diverse circumstances.

The bees initially came from all over- from various strains and through various production methods from producers nationwide. All were given time as their critical foe with diverse floral forage/nutrition as their ally. The particular environment of northern Michigan, with lake effect snow and extreme cold temperatures through particularly long winters and short yet intense nectar flows in the summers, became unintended testing grounds for the varied bee stock. Mark pursued keeping bees in this environment for 5 years. Additional unintended testing grounds were re-established in the extreme landscape and topography and microclimates of the southern Rocky Mountains in New Mexico. Though the re-establishment did not recreate identical conditions, the varying altitudes and microclimates from desert to alpine portrays an apisphere with diverse weather extremes, topography, diverse nutrition and varied genetics which formed advanced testing grounds.

There is a need for varied pressures on living organisms for them to demonstrate their varied genetics. This need is translatable and is not dictated alone by location, but also by circumstance including natural and man-inflicted phenomenon. This symbiotic relationship between the environment creating the bees and the bees relying on the environment for their continued longevity is known as nature nurturing. It has been considered a debate yet recent research has presented interesting findings that Nature does indeed nurture by the effects of diet on DNA and genetic performance (Maleszka, 2010)[1]. This is then compounded by the acts of production and reproduction and the diverse inputs for those; the combination of which will ultimately dictate the Overall Lifetime Merit that any colony can possess or attain. The liaisons are as follows:

> *Location creates the apisphere environment which dictates nutrition and bee health portraying genetic ability plus the nature/nurture factor which in turn promotes and equates longevity and leads to the establishment of production/reproduction and rearing propagation protocol and management.*

The practically of this approach is quite simple: either hives make it or they don't. Those that do are worthy of recording and of propagating. This entails the installation of a paradigm of protocol for selection and propagation and also includes the basis for defining and promoting a solid format and methodology for pedigree establishment and its continued replication. Of course with bees, there are multiple generations and thus it is crucial that time be allowed to test and assist in establishing the OLT. The more positive the OLT, the better able we as bee farmers can discern selection points and also co-create the rearing protocol.

Hives that overwintered successfully two winters in Marquette, Michigan were initially selected as breeders. In September of 2005, 50 out of a 100 of these hives were moved to New Mexico. Fifteen hives were lost that first winter in southern NM. Thus 35 Michigan survivor hives were introduced and successfully transitioned to becoming NM survivor hives. Zia Queenbee Co. was established in March of 2006 and began to cross stock grafted daughters from these MI/NM survivors with area NM stock in southern, central and northern NM locations. Numbers have gradually risen over the past 6 seasons and now summit over 300 survivor support hives and between 600-900 mating nuclei. Additional stock in the form of mated queenbees was purchased and integrated into the system from varying locations such as California, Florida, Vermont, Georgia, Louisiana and Michigan including strains of New World Carniolan, SMR/VSH Italian, Cordovan, Russian and various crosses. All purchased queens were monitored throughout two winters and those that survived that maintained quality in their records were inducted as NM survivor-stock breeders.

This introduction program is still the basis for the Zia Queenbee Co. breeding protocol. Any and all queens- whether purchased or traded from out of the area or reared in state are monitored for two years to establish their OLT. Once established, they are then inducted as Breeding Contenders and are promoted to supplying daughter larvae for grafting of queenbees. After their first season as Breeding Contenders, they are then continued to be used as such and also serve as drone supports. All Breeding Contenders are given several frames of drone combs which can then be transferred to out yards to add to area survivor drone saturation. Each season presents new inductees and also allows for out-crossing of various strains to better "dilute" the potential of inbreeding and to add to the regional genetic pool of tested stock. Incorporating other survivor stock from neighboring beekeepers helps to enhance this regionally fortified genetic pool while continuing to add to the diversity of the pool.

Survivor queens from Zia Queenbee Co. now include even more varied genetic inputs from stock that beekeepers have shared from various states, including virgin exchanges Leonard and Linda Pankrantz of CanAm Queens and Pat & Russell Heitkam of Orland, California; crosses from Dr. Vincent Aloyo of EAS; Purdue Ankle Biter virgins from EAS Master Beekeeper and ABF Serious Sideliner organizer—Stephen Repasky, to name a few. ZQB encourages feedback and thus, all queens are shipped marked for follow up comments. Queens have been shipped everywhere in the U.S. - except to Hawaii, as per government ruling (no bees are to be imported into the Hawaiian Islands). No miticides have been implemented in the form of applied "commercial pharmaceuticals" and also no antibiotics of commercial origin have been utilized. On occasion, ZQB will combine essential oils with cane sugar based supplemental feed and protein patties in the fall and spring. Supplying hives with adequate nutrition during times of dearth and seasonal transitions has not been considered "treatments" but rather occasional "therapies" whereby colonies can have an added input of necessary vitamins and nutrients to better serve their transition into the changing seasons and to abate any bacterial, protozoan or fungal afflictions within the bees themselves and their abodes.

Reports from multi-perspective beekeepers in diverse U.S. locations who have introduced ZQB survivor stock into their apiaries are favorable. Whether it is because the daughter queens from survivor breeders that are mated out with diverse survivor drone stock is the base, or whether it is the process of rearing which includes allowing queens to be nurtured in mating nucs for minimum 3 weeks post emergence as virgins, still has yet to be decided. However, it is complementary that these two paradigms of protocol- one for establishing survivor stock and two, for how to promote and propagate survivor stock, correlate into an enhanced format and methodology for rearing quality queens. For these queens to have the ability to transcend their original locations and to flourish is still being tested and proving positive in many varied locations around the nation.

The foundation of survivor stock as being based on a certain location need not be disputed, ignored nor overlooked. It is essential that the implementation of survivor stock be based on a particular locale. There has to be some point from which to start. Promoting regional fortification is the first step. However, it is also essential that over time, new "blood" be incorporated in and tested as there are no "super bees" out there with a "one-size fits all" label. It would be ludicrous and also arrogant to demand and promote such. However, the protocol of establishing regionally fortified stock complemented by conscientious rearing and propagation methods has developed quality queenbees that can not only endure and flourish in their own locals, but are indeed proving to transcend their regional boundaries by flourishing in other diverse locations. The more beekeepers who begin to try this methodology and to incorporate Time-tested and Mother Nature approved stocks into their apiaries, the more efficient The Reconciliation.

The Reconciliation is an acknowledgement that Mother Nature and Father Time compounded with today's changing landscape and human interactions must find a sustainable balance. Beekeepers will not be able to continuously import bees from out of the area to replace their losses. And as mentioned, it is ludicrous and arrogant to demand a "super bee" that works superbly in all circumstances. It is up to those keeping bees, whether professionally or recreationally, to organize their own methodologies and to promote positive stewardship. This positive stewardship is itself The Reconciliation and includes learning how to adapt to the dynamic interface of Mother Nature over Time by their bees the same, and how to incorporate their experiences into building and maintaining healthy hives, whether in the desert, in the alpine mountains, on the tropical islands or cold peninsulas, or the woodsy and prairie flat lands.

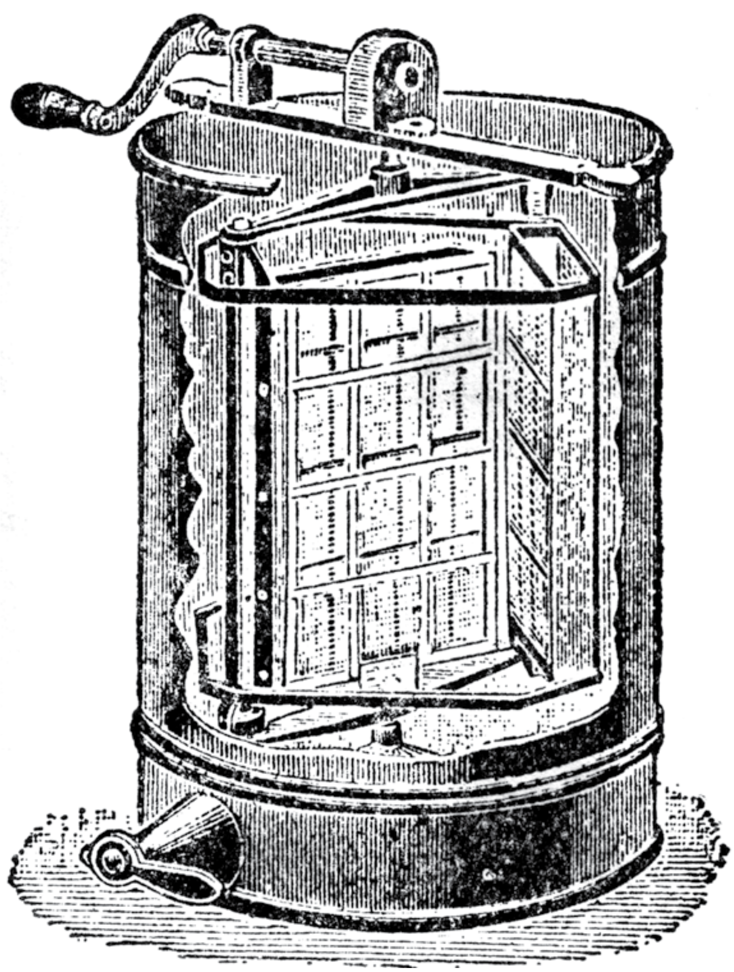
When we first started intentionally rearing survivor stock- we had neither idea nor theory as to how it would develop. We had a whim and a prayer and as Post-Varroa beekeepers, we had but no choice to give it a shot. We were told by numerous persons, near and far, that the standards we began to set up were impossible. But how can Mother Nature and the unavoidable passage of Father Time be considered impossible?! They are but flip sides of the same coin- and both temporally and physiologically necessary as the basis of any development of creation.

Mother Nature and Father Time cannot be denied. Nor can they be bypassed. The current large-scale practice of rearing queens cannot bypass them either. Mother Nature can be thwarted partly by human intervention and applications. And Father Time can be "rushed" by harvesting early. However, they can both only be thwarted and rushed to a certain extent. It is clear that the attempts of man to control them arrogantly have resulted in poor quality queens and bees. So instead of trying to displace them- perhaps it is time more bee stewards began to accept the challenge and truly learn to acknowledge, respect and cooperate alongside them, using both Mother Nature and Father Time as their and their bees' allies.

We encourage those interested to begin to develop their regionally fortified stocks. It does indeed take time and patience and multiple seasons to develop. However, in the "grand-scheme" of things, it is this very necessary process that will promote the bees through the thick and thin of time and which will ultimately determine the sustainability and the clarity of The Reconciliation. We must all learn to reconcile as there will never be the most perfect bee, always the best season or the easiest of endeavors to keep bees. We are truly humbled by our bees and the process in which they manifest and maintain. We can only hope to follow in their footsteps and to increase our knowledge and understanding of them, though we will always continue to be students of the bees, Mother Nature and Father Time.

[1]Bees Reveal Nature-Nurture Secrets: Extensive Molecular Differences in Brains of Workers and Queen http://www.sciencedaily.com/releases/2010/11/101102171606.htm
Frank Lyko, Sylvain Foret, Robert Kucharski, Stephan Wolf, Cassandra Falckenhayn, Ryszard Maleszka. The Honey Bee Epigenomes: Differential Methylation of Brain DNA in Queens and Workers. PLoS Biology, 2010; 8 (11): e1000506 DOI: 10.1371/journal.pbio.1000506

Melanie Kirby has been keeping bees professionally for 20 years with the blessed opportunities of learning from bees and their keepers from South and Central America to the Caribbean, Pacific Islands, North America, the Mediterranean and Europe. Mark Spitzig has been keeping bees for 16 years. Their team efforts are to better serve the bees and their beekeeping communities.



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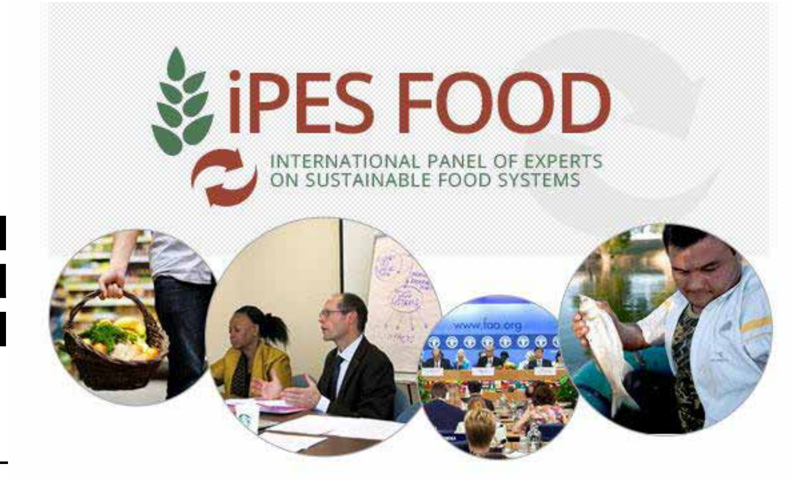

How to leave industrial agriculture behind - food systems experts urge global shift towards agroecology

Input-intensive crop monocultures and industrial-scale feedlots must be consigned to the past in order to put global food systems onto sustainable footing, according to the world's foremost experts on food security, agro-ecosystems and nutrition.

The solution is to diversify agriculture and reorient it around ecological practices, whether the starting point is highly-industrialized agriculture or subsistence farming in the world's poorest countries.

These were the key messages from IPES-Food's first major report, released today (2nd June): 'From Uniformity to Diversity: A paradigm shift from industrial agriculture to diversified agroecological systems'.

Olivier De Schutter, co-chair of IPES-Food, stated: "Many of the problems in food systems are linked specifically to the uniformity at the heart of industrial agriculture, and its reliance on chemical fertilizers and pesticides."

He added: "It is not a lack of evidence holding back the agroecological alternative. It is the mismatch between its huge potential to improve outcomes across food systems, and its much smaller potential to generate profits for agribusiness firms."

The report was presented today at the 8th Trondheim Biodiversity Conference (Norway) by lead author Emile Frison, former Director General of Bioversity International.

The report asks three key questions:
1. What are the outcomes of industrial agriculture / diversified agroecological systems?
2. What is keeping industrial agriculture in place?
3. How can the balance be shifted?

The International Panel of Experts on Sustainable Food Systems (IPES-Food) is an independent panel working to inform the debate on how to reform food systems. Launched in 2015, the Panel comprises environmental scientists, development economists, nutritionists, agronomists and sociologists, as well as experienced practitioners from civil society and social movements.

Frison explained that some of the key obstacles to change are about who has the power to set the agenda. "The way we define food security and the way we measure success in food systems tend to reflect what industrial agriculture is designed to deliver - not what really matters in terms of building sustainable food systems," Frison stated.

Full Report: http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf
Executive Summary: http://www.ipes-food.org/images/Reports/UniformityToDiversity_ExecSummary.pdf
Key Messages (1 page): http://www.ipes-food.org/images/Reports/UniformityToDiversity_KeyMessagesEN.pdf
Press release: http://www.ipes-food.org/how-to-leave-industrial-agriculture-behind-food-systems-experts-urge-global-shift-towards-agroecology

Here is an op ed by Emile Frison/Olivier De Schuttter on the report published on Food Tank:
http://foodtank.com/news/2016/06/how-to-leave-industrial-agriculture-behind

And here is coverage of the report in the Guardian:
http://www.theguardian.com/environment/2016/jun/02/a-switch-to-ecological-farming-will-benefit-health-and-environment-report

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Selection for resistance to Varroa destructor under commercial beekeeping conditions

John Kefuss, Jacques Vanpoucke, Maria Bolt & Cyril Kefuss

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ORIGINAL RESEARCH ARTICLE

Selection for resistance to *Varroa destructor* under commercial beekeeping conditions*

John Kefuss[a,b]*, Jacques Vanpoucke[c], Maria Bolt[d] and Cyril Kefuss[a]

[a]*Le Rucher D'Oc, Toulouse, France;* [b]*Pacific Queens, Limache, Chile;* [c]*ufr M.I.G., Université Paul Sabatier Toulouse, Toulouse, France;* [d]*Le Rucher Bolt, Le Pushin, France*

(*Received 8 June 2015; accepted 24 February 2016*)

A survival field test was initiated in 1999 to observe the effects of no treatment against *Varroa destructor* on European honey bee colony survival. After losses of over two-thirds of the 268 original colonies, new colonies were made from the survivors. In 2002, genetic material from these survivors was bred into an independent group of 60 colonies. In 2013, 519 non-treated colonies from both groups were being used for commercial beekeeping, and mite populations were very low. This indicates that under commercial beekeeping conditions, simple methods can be used to select for reduced mite populations.

Selección para la resistencia a *Varroa destructor* bajo condiciones comerciales de apicultura.

En 1999 se inició una prueba de supervivencia en campo para observar los efectos de la ausencia de tratamiento contra *Varroa destructor* en la supervivencia de colonias de abejas europeas. Tras la pérdida de más de dos tercios de las 268 colonias originales, se hicieron nuevas colonias a partir de las supervivientes. En 2002 el material genético de estas supervivientes fue utilizado para crear en un nuevo grupo independiente de 60 colonias. En 2013, 519 colonias no tratadas de ambos grupos estaban siendo utilizadas para la apicultura comercial, y las poblaciones de ácaros eran muy bajas. Esto indica que en condiciones comerciales de apicultura se pueden utilizar métodos simples para la selección de poblaciones reducidas del ácaro.

Keywords: survival tests; resistance; tolerance; hygienic behavior; *Varroa destructor*

Introduction

A major goal of bee breeders is to develop a honey bee resistant to the parasitic mite varroa (*Varroa destructor*). This mite was observed in the USSR on European honey bee (*Apis mellifera* L.) in 1952. From there, it took only 35 years to spread throughout Europe, Asia, South and North America, where it was found in 1987. At the present time, only a few countries such as Australia are free from the mite (Rosenkranz, Aumeier, & Ziegelmann, 2010). In France, the mite caused extensive damage to the beekeeping industry after its arrival in 1982. Measures to limit its progression by restricting hive movements were not effective, and in some cases may have helped spread the mites as beekeepers tried to move their hives from infested to mite free zones. Varroa has been considered as one of the major causes of bee mortality in France (Faucon & Chauzat, 2008) and other parts of the world (Ritter & Dejong, 1984).

While global efforts to develop acaricidal treatments to control varroa were underway, the possibilities of using honey bees resistant to varroa were being considered. Africanized bees in Brazil were discovered to survive infestations without treatment (Moretto, Gonçalves, De Jong, & Bichuette, 1991). Resistance to varroa by European honey bees in Uruguay was reported by Ruttner, Marx, and Marx (1984). When Uruguay bees were tested in Europe in comparisons with *A. mellifera carnica* and a strain of *A. mellifera ligustica* (Starline honey bees developed by Dadant and Sons in the USA), all stocks were equally susceptible to the European mite ecotype (Koeniger, Schmidt, Wilde, Kefuss, & Ducos de Lahitte, 1995). Later it was found that the population dynamics of the bees in Uruguay were different compared to those found in Europe (Rosenkranz, 1999). Additional reports of local resistance to mites in non-Africanized *A. mellifera* subspecies were reported in Europe, the Middle East and tropical South America (Ritter & Dejong, 1984).

In Sedjenane Tunisia, untreated colonies of *A. mellifera intermissa* were able to resist mite infestation and produce honey without chemical treatments for five years (Ritter, 1990). In 1993, queens from these *A. m. intermissa* ecotypes were compared with *A. m. carnica* ecotypes from Germany in Toulouse, France, and it was found that they had fewer mites than colonies of *A. m. carnica*. It is important to note, however, that both ecotypes had colonies that were mite resistant (Kefuss, Vanpoucke, Ducos de Lahitte, & Ritter, 2004). Naturally mated daughters from these queens were the final survivors in a test of 13 European honey bee strains for

*Corresponding author. Email: jkefussbees@wanadoo.fr
*This paper is dedicated to the memory of Steve Taber III.

survival to mites (Büchler et al., 2002). This implies that mite resistance is under genetic control.

Survival of isolated untreated bees to mites has been also observed on Gotland Island in Sweden (Fries, Imdorf, & Rosenkranz, 2006) and in the semi-isolated Arnot Forest in the USA (Seeley, 2007). In those studies, the investigators' main goal was to see if untreated colonies could survive mite infestations, and for that reason, colonies were manipulated as little as possible. Since no attempt was made to select for production, their suitability for commercial use was not determined.

At Le Mans and Avignon France, untreated colonies showing normal development for two or more years were compared with treated colonies for mortality and honey production. No differences were found in mortality but the treated control colonies produced 1.7 times more honey than the untreated (Le Conte et al., 2007).

In the USA, three commercial stocks have been developed with selective breeding that demonstrate different levels of mite resistance. These include: Russian hybrid bees (RHB); Varroa Sensitive Hygiene bees (VSH); and the Minnesota Hygienic line (MNHYG). Each stock has its own specific mechanism(s) of resistance.

Rinderer, Harris, Hunt, and de Guzman (2010) classified resistance mechanisms as either behavioral or physiological. Behavioral mechanisms included hygienic behavior, grooming behavior, and removal of mites from the hive. Physiological mechanisms involved phoresy and brood characteristics such as attractiveness to mites. RHBs exhibit strong grooming traits (Rinderer et al., 2001), high hygienic behavior, reduced brood attractiveness, and decreased reproductive success in combs built by RHB (de Guzman, Rinderer, & Frake, 2008). Hygienic bees quickly remove dead brood from the colonies (Rothenbuhler, 1964). VSH bees hygienically remove mite infested bees (Harbo & Harris, 2005; Ibrahim & Spivak, 2006).

Rothenbuhler (1964) demonstrated that hygienic behavior is controlled by recessive genes and proposed a two-locus model to explain it. Moritz (1988) re-examined Rothenbuhler's, 1964 paper, and concluded that a three-locus model better fits his data. After testing 500 + hives for hygienic behavior, Kefuss, Taber, Vanpoucke, and Rey (1996) postulated that at least 20 to 30 genetic characters are involved. Seven suggestive QTLs (quantitative trait loci) were found by Lapidge, Oldroyd, and Spivak (2002) each controlling only 9–15% of the observed phenotypic variation in hygienic behavior. They concluded that the genetics of this behavior is complex and probably controlled by many genes. Oxley, Spivak, and Oldroyd (2010) identified six QTLs influencing task thresholds for hygienic behavior. They agreed with Rothenbuhler's (1964) conclusion that independent genetic loci regulate each component of hygienic behavior. Tsuruda, Harris, Bourgeois, Danka, and Hunt (2012) located candidate genes associated with the removal of mite-infested pupae observed in the resistance trait varroa sensitive hygiene (VSH). Studies on the heritability of VSH concluded that selective breeding can probably intensify its expression (Boecking, Bienefeld, & Drescher, 2000). Boutin et al. (2015) were able to correlate hygienic behavior with differential gene expression in 96 genes. Galbraith et al. (2016) found that gene expression in honey bees may have parent-of-origin effects that can change with the individual's physiological state. The possibility of intragenomic conflict between matrigenes and patrigenes should be taken into consideration when studying the genetics of mite resistance. Especially if marker-assisted selection will be used to screen hives for disease resistance.

The above results clearly indicate that there is a genetic basis for mite resistance. The first goal of this field test was to develop simple methods to select colonies for reduced mite populations that could survive without mite treatments under commercial beekeeping conditions. The second goal was to obtain a gene pool expressing low mite phenotypes that could be selected for commercial honey production.

Materials and methods

In this field test, we used only the survival test to select for mite resistance. Exposures to mite-vectored viruses are reduced as non-productive and diseased hives are quickly eliminated from the breeding population. However, most beekeepers and queen breeders will not use this survival test due to the risk of losing large numbers of hives. For them, other tests have been developed for resistance selection where colony losses are reduced (Kefuss, Taber, Vanpoucke, & Rey, 2003; Kefuss, Vanpoucke, Bolt, & Kefuss, 2009 Kefuss et al., 2004).

Genetic material

A collection of commercial colonies ($N = 268$) in standard deep Langstroth hives used for queen rearing and honey production was established in 1999 as test population 1. These colonies were headed by naturally mated queens derived from commercial *A. m. ligustica, A. m. carnica, A. m.caucasica, and A. m. mellifera* breeder queens obtained in 1999 or earlier.

Before 1999, these colonies were systematically treated every year with chemicals to control mites. All chemical treatments were stopped in 1999 and a survival test was initiated (Kefuss et al., 2004). As colonies died out, they were replaced by new colonies with daughter queens made from the best survivors by either splitting survivor hives or requeening non-selected mite infested bees from other beekeepers with open-mated daughters from selected survivor queens.

Test population 2 ($N = 60$) was established in 2002 in Dadant hives 40 km from the location of test population 1. At the origin of this group were six hives purchased from a local beekeeper in 1999 that were split and multiplied to obtain the 60 hives for this test population. These colonies were requeened using virgin queens from test population 1 naturally mated at location 2. Then, colonies were managed as in group 1 for queen rearing and honey production using the best population 2 virgin queens to naturally mate with population 2 drones. Since 2001, this group has never been treated against mites and colony increase was made only by splitting survivor hives.

Genetic material was exchanged back and forth between these two independent test populations on an irregular basis by requeening with queen cells and virgin queens from the best 1–5 colonies in each group throughout the field test. Low mite levels and general colony performance such as the ability to rear high-quality queens and honey production determined selection of the breeding material. Colonies continued to be used for all aspects of commercial queen rearing and honey production using the same techniques as before 1999.

Usually 20–25 colonies were maintained in 20 + apiaries of the two test populations depending upon the year. Both groups were in contact with non-selected hives of other commercial beekeepers with apiaries of similar or larger sizes sometimes located less than 1 km away from the test groups. Due to this proximity, the non-selected colonies were potential mite sources for mite re-infestation and probably helped to maintain high mite re-infestation pressure on the test hives.

No attempt was made to obtain parallel data from the non-selected chemically treated hives of other beekeepers as an external control. However, this survival test does have a built-in internal control because selection progress of the two test groups are tracked through time in an environment where they are continuously exposed to mite re-infestations from local beekeepers who chemically treat their hives against mites.

Hygienic test (frozen brood insert method)

We tested for hygienic behavior because it has been associated with brood disease resistance (Gilliam, Taber III, & Richardson, 1983) and reduced mite populations (Spivak, 1996). A comb of capped pupae with purple eyes and tan body color was cut into 5 cm squares and frozen for less than 24 h before the start of the test. This brood was furnished by a colony not in the hygienic test headed by a young queen to get maximum brood surface at the correct pupae stage (purple eyes and tan body color). Each square of frozen brood was placed on a comb with brood of the same age. A knife was used to trace the shape of this square on the brood comb and a corresponding brood square was cut out from the comb. The square of frozen brood was then inserted into the hole made where the brood was removed (Figure 1). Dates of brood sampling and measures of hygienic behavior by estimation are given in Table 1.

To estimate hygienic behavior at 24 and 48 h, the inserted piece of frozen brood was examined on both sides and a surface estimation of brood removed was made after taking into account the actual number of empty brood cells in the frozen brood square before insertion. The same person estimated hygienic behavior for all colonies. Colonies that removed 100% of the dead brood at 48 h were considered hygienic. Varroa Sensitive Hygiene was not tested.

The frozen brood insert method was chosen because it is more conservative than the "pin test" method, i.e. fewer colonies with 100% removal (Gramacho, Goncalves, Rosenkranz, & De Jong, 1999; Panasiuk, Skowronek, & Bienkowska, 2008; Spivak & Downey, 1998). Also the advantage of this third method over both the pin and the liquid nitrogen methods is that each hive furnishes a brood sample for later mite analysis. Insertion takes less than 2.5 min and thus is less disruptive to the colony (Rey, Kefuss, & Vanpoucke, 2009). Since it makes no difference if brood comes from the same or a different colony (Spivak & Downey, 1998), brood for insertion in our tests was collected and frozen in advance. This reduces time spent in the bee yard.

A trained specialist estimated hygienic behavior in this test. During estimations, the comb is tilted from side to side to observe all relics of brood. Brood photographs may or may not record all these relics and thus may over estimate cell cleaning. Because estimations are fast, they are less disruptive than counting individual cells yet accurate enough to select for hygienic behavior under commercial beekeeping conditions (Table 2; Kefuss et al., 1996; Rey et al., 2009).

Capped brood mite samples

To study the population dynamics of mite reproduction in the brood, all pieces of brood that were removed to make the hole to insert the 5 cm square of frozen brood for the hygienic test were recovered, frozen, and later examined for the presence of varroa mites. The pupal stage of the recovered capped brood sample (purple eyes and tan body color) permitted mother and daughter mites to be easily distinguished from each other. One hundred cells were opened (under a 300 watt halogen lamp to increase visual acuity) and adult female, daughter, and immature mites were counted. Males were not counted, as we were only interested in the production of potentially reproductive daughters that may or may not have been mated.

Sampling for phoretic mites on bees

At the same time, the brood square was inserted for the hygienic test a bee sample was taken from each hive and frozen for evaluation of phoretic mite infestations on adult bees. Bees (usually between 250–300) in each sample were counted and then washed in a one-liter jar containing about 500 ml of water and one drop of liquid detergent. After shaking 30 times, the jar's content was poured into a double screen honey filter and washed.

Figure 1. Frozen brood insert method used in hygienic test. The frozen brood square is used as a template to trace the hole where it will be inserted.

Table 1. Dates of brood sampling and hygienic behavior testing.

Brood samples	Hygienic test
Population 1	
April 23, 2001	July 9, 1999
August 15, 2002	August 15, 2002
May 21, 2008	May 21, 2008
Population 2	
August 15, 2002	August 15, 2002
May 21, 2008	May 21, 2008

Bees remain on the top screen while mites filtered through to the bottom screen. The bottom screen was then sponged from below to remove water lodged in the screen so that mites could be more easily counted.

Statistical analysis and profile graph

Comparisons are made within each test population and between test populations. To compare mite infestations for different years, Student's two-sample t-tests for comparing two means with unequal variances were used (Kendall & Stuart, 1961; Velleman, 1997). Variance ratios between years indicate whether variability is increasing or decreasing and give additional information on changes in the direction of selection.

We used parallel boxplots analysis to compare hygienic test results within years at 24 and 48 h (Velleman, 1997). These plots show boxplots with 95% confidence intervals around the medians. Significant differences are characterized by non-overlapping confidence intervals.

The profile graph used in the hygienic test is designed to represent ascending scores for a given positive characteristic with a fixed maximum value *M* (a true non-gaussian variable) of a finite group of individuals. The characteristic spreads from zero to *M* (in our case, *M* = maximum hygienic value or 100%) along the *y*-axis (vertical). Individual hives are located along the *x*-axis (horizontal) according to their increasing scores at 48 h. This results in a visual ascending effect with platforms for identical scores at 48 h. Each vertical bar represents the scores of one hive for hygienic behavior at both 24 and 48 h.

Results

Mite population growth

In test population 1, mite populations increased in the brood and on the bees between April 2001 and August 2002. There were significantly more daughter mites in the brood for 2002 ($p < .015$) and except for immatures, both means and medians globally increased (Figure 2, Table 3). After 2002, over two-thirds of the colonies were dead in test population 1. At the beginning of 2003, only 164 colonies were alive. When mites were counted again in May 2008 and compared with April 2001 and August 2002, respectively, there were significant reductions for mite infestations in the brood for adults ($p < .0001$, $p < .0001$), daughters ($p < .03$, $p < .004$), immatures ($p < .0001$, $p < .0008$) and on the bees ($p < .0002$, $p < .0048$) (Figures 2, 3,Table 3).

In test population 2 between August 2009 and September 2010, there was a significant mite increase in the brood for adults ($p < .007$) and daughters ($p < .0001$) but not for immatures (NS) nor for mites (NS) on bees (Figures 2, 3 and Table 3). Between test

Table 2. Comparisons of hygienic behavior estimations in France, Chile, and China by two independent observers at different locations and dates in France, Chile, and China; no significant differences between estimations of hygienic behavior by independent observers A and B were found. Significant at $p \leq .05$. NS = not significant. Estimations efficiently discriminate between different levels of hygienic behavior and are less labor intensive than photographic techniques. They are adapted to commercial beekeeping conditions where large numbers of hives need to be screened in a short period of time.

		Hygienic estimations					
		April 1999 France			May 2008 France		
		24 h	48 h		24 h	48 h	
	Mean	29.0	47.1		51.9	71.7	
	Median	24	37		40.5	79	
A	*n*	27	27		54	54	
	Variance	**605.4**	**955.8**		**956.3**	**784.3**	
	StdDev	24.6	30.91		30.92	28	
	Mean	29.6	47.4		53.9	64.8	
	Median	25	42		43.5	60	
B	*n*	27	27		54	33	
	Variance	**457.5**	**730.0**		**867.3**	**911.6**	
	StdDev	21.4	27.0		29.5	30.2	
	t-test	**.10**	**.03**		**.49**	**1.06**	
	df	**51**	**51**		**96**	**63**	
	p≤	**.92**	**.98**		**.62**	**.29**	
		NS	**NS**		**NS**	**NS**	
	August 2010 China			February 2013 Chile			
		24 h	24 h	24 h	24 h	48 h	48 h
	Mean	81.0	81.0	81.0	56.8	92.3	92.3
	Median	84	84	84	58.5	99.5	99.5
A	*n*	21	21	21	106	106	106
	Variance	**391.6**	**391.6**	**391.6**	**799.94**	**294.9**	**294.9**
	StdDev	19.78	19.78	19.78	28.28	17.17	17.17
	Mean	78.5	77.6	76.6	55.2	93.3	93.2
	Median	75.5	79.5	75	55	100	100
B	*n*	21	21	21	106	106	89
	Variance	**337.0**	**358.2**	**399.0**	**746.2**	**226.5**	**179.2**
	StdDev	18.4	18.9	19.9	27.3	15.1	13.4
	t-test	**.43**	**.59**	**.72**	**.42**	**.45**	**.41**
	df	**39**	**39**	**39**	**209**	**206**	**191**
	p≤	**.67**	**.56**	**.47**	**.67**	**.65**	**.68**
		NS	**NS**	**NS**	**NS**	**NS**	**NS**

population 1 in August 2002 and population 2 in August 2009, mites were significantly lower in 2009 for adults ($p < .0001$), daughters ($p < .002$), immatures ($p < .01$), and on bees ($p < .002$). Also between test population 1 in August 2002 and test population 2 in September 2010, mites were significantly lower in 2010 (excepting daughters) for adults ($p < .0006$), daughters (NS), immatures ($p < .002$), and on bees ($p < .029$) (Figures 2, 3 and Table 4)

There were no significant differences for adults and daughters in the brood and mites on bees between test populations 1 (May 2008) and 2 (August 2009) excepting for an increase in immatures ($p < .018$) in population 2. There was a significant increase in adults ($p < .022$) and daughters ($p < .0001$) when September 2010 is compared to May 2008 but not for immatures or mites on bees. At the start of the test, there were 268 colonies in group 1 and 60 in group 2 (328 colonies). In December 2013, there were 334 colonies in group 1 and 185 colonies in group 2 or a total of 519 colonies not being treated against mites.

Sample variances

From a qualitative point of view in table 3, it is interesting to note that after a global increase of sample variances in test population 1 (excepting for immatures) between April 2001 and August 2002 (adults 1 to 1.4, daughters 1 to 11.7, immatures 1.3 to 1, mites on bees 1 to 1.7), sample variances globally decreased between April 2001 and May 2008 (adults 7.4 to 1, daughters 4.2 to 1, immatures 46.7 to 1, and mites on bees 1.9 to 1). Variances also decreased between August 2002 and May 2008 (adults 10.7 to 1, daughters 48.8 to 1, immatures 36 to 1 and mites on bees 3.1 to 1).

In contrast under very low mite conditions, the variances increased within test population 2 from 2009 to 2010 for adults (1 to 3.8), daughters (1 to 30), mites on

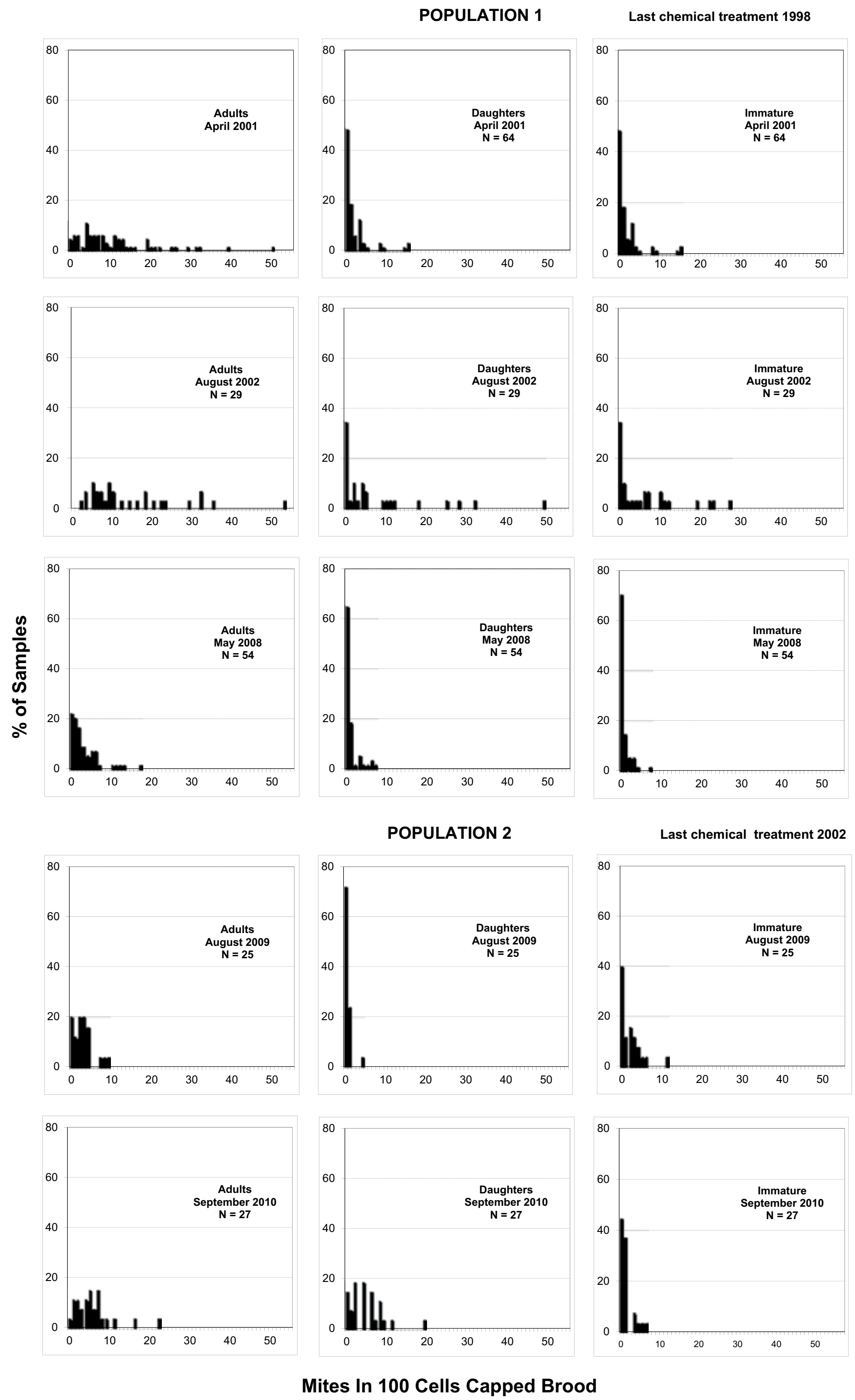

Figure 2. Frequency histograms of adult, daughter, and immature mites in 100 capped brood cells for test populations 1 and 2. The *y*-axis represents % of samples. The *x*-axis represents the amount of mites found in 100 cells. Brood samples were recovered during the hygienic test.

Table 4. Comparisons between populations for mites in brood and on bees. A = adult mite, D = daughter mite, I = immature mite, V.B. = mites on bees, Trend +/− ↘ equals decreasing number of mites. Trend +/− ↗ equals increasing number of mites. Variance ratio is the variance comparison of the first to the second year. Positive ratios indicate decreasing variance and negative ratios indicate increasing variance between years. Significant at $p \leq .05$. NS = not significant.

Comparisons between populations									
		2001 vs 2009				2001 vs 2010			
		April		August		April		September	
Year		A	D	I	V.B.	A	D	I	V.B.
1	Mean	10.8	2	6.8	4.9	10.8	2	6.8	4.9
	Median	8	1	3.5	3.89	8	1	3.5	3.89
	n	64	64	64	65	64	64	64	65
	Variance	**99.9**	**12.1**	**79.4**	**12.3**	**99.9**	**12.1**	**79.4**	**12.3**
	StdDev	10	3.48	8.9	3.5	10	3.48	8.9	3.5
2	Mean	2.7	.4	2	2.5	**5.7**	**4.7**	**1.2**	**3.3**
	Median	2	0	1	2.1	**5**	**4**	**1**	**3.02**
	n	25	25	25	25	**27**	**27**	**27**	**26**
	Variance	**5.9**	**.6**	**6.7**	**2.5**	**22.6**	**17.8**	**2.7**	**7.3**
	StdDev	2.41	.79	2.58	1.57	4.8	4.2	1.63	2.7
	t-test	**6.02**	**3.42**	**3.89**	**4.55**	**3.31**	**2.93**	**4.87**	**2.44**
	df	**78**	**77**	**82**	**85**	**87**	**41**	**72**	**59**
	$p\leq$	**.0001**	**.001**	**.0002**	**.0001**	**.0013**	**.0055**	**.0001**	**.018**
	Trend +/−	↘	↘	↘	↘	↘	↗	↘	↘
	Variance Ratio (Year 1:2)	**16.93**	**20.21**	**11.85**	**4.94**	**4.42**	**.68**	**29.41**	**1.69**
		August		August		August		September	
		2002 vs 2009				2002 vs 2010			
Year		A	D	I	V.B.	A	D	I	V.B.
1	Mean	14.7	7.8	6.1	5.5	14.7	7.8	6.1	5.5
	Median	10	3	3	4.49	10	3	3	4.49
	n	29	29	29	29	29	29	29	29
	Variance	**144.2**	**141.6**	**61.2**	**20.3**	**144.2**	**141.6**	**61.2**	**20.3**
	StdDev	12	11.9	7.8	4.5	12	11.9	7.8	4.5
2	Mean	2.7	.4	**2**	2.5	5.7	4.7	**1.1**	3.3
	Median	2	0	1	2.1	5	4	1	3.02
	n	25	25	25	25	27	27	27	26
	Variance	**5.9**	**.6**	**6.7**	**2.5**	**22.6**	**17.8**	**2.7**	**7.3**
	StdDev	2.41	.79	2.58	1.57	4.8	4.2	1.63	2.7
	t-test	**5.27**	**3.34**	**2.66**	**3.37**	**3.77**	**1.32**	**3.33**	**2.26**
	df	**30**	**28**	**34**	**35**	**37**	**35**	**30**	**46**
	$p\leq$	**.0001**	**.002**	**.01**	**.002**	**.0006**	**NS**	**.0023**	**.029**
	Trend +/−	↘	↘	↘	↘	↘	↘	↘	↘
	Variance ratio (Year 1:2)	**24.6**	**225.2**	**9.2**	**8.2**	**6.4**	**8**	**22.9**	**2.8**
		2008 vs 2009				2008 vs 2010			
		May		August		May		September	
Year		A	D	I	V.B.	A	D	I	V.B.
1	Mean	3.2	.9	.6	2.8	3.2	.9	.6	2.8
	Median	2	0	0	1.98	2	0	0	1.98
	n	54	54	54	54	54	54	54	54
	Variance	**13.5**	**2.9**	**1.7**	**6.5**	**13.5**	**2.9**	**1.7**	**6.5**
	StdDev	3.6	1.71	1.3	2.6	3.6	1.71	1.3	2.6
2	Mean	2.7	.4	**2**	2.5	5.7	4.7	**1.1**	3.3
	Median	2	0	1	2.1	5	4	1	3.02
	n	25	25	25	25	27	27	27	26
	Variance	**5.9**	**.6**	**6.7**	**2.5**	**22.6**	**17.8**	**2.7**	**7.3**
	StdDev	2.41	.79	2.58	1.57	4.8	4.2	1.63	2.7
	t-test	**.65**	**1.84**	**2.51**	**.63**	**2.382**	**4.46**	**1.44**	**.75**
	df	**67**	**76**	**29**	**70**	**41**	**30**	**43**	**47**
	$p \leq$	**NS**	**NS**	**.018**	**NS**	**.022**	**.0001**	**NS**	**NS**
	Trend +/−	↘	↘	↗	↘	↗	↗	↗	↗
	Variance ratio (Year 1:2)	**2.3**	**4.65**	**.26**	**2.63**	**.6**	**.16**	**.63**	**.89**

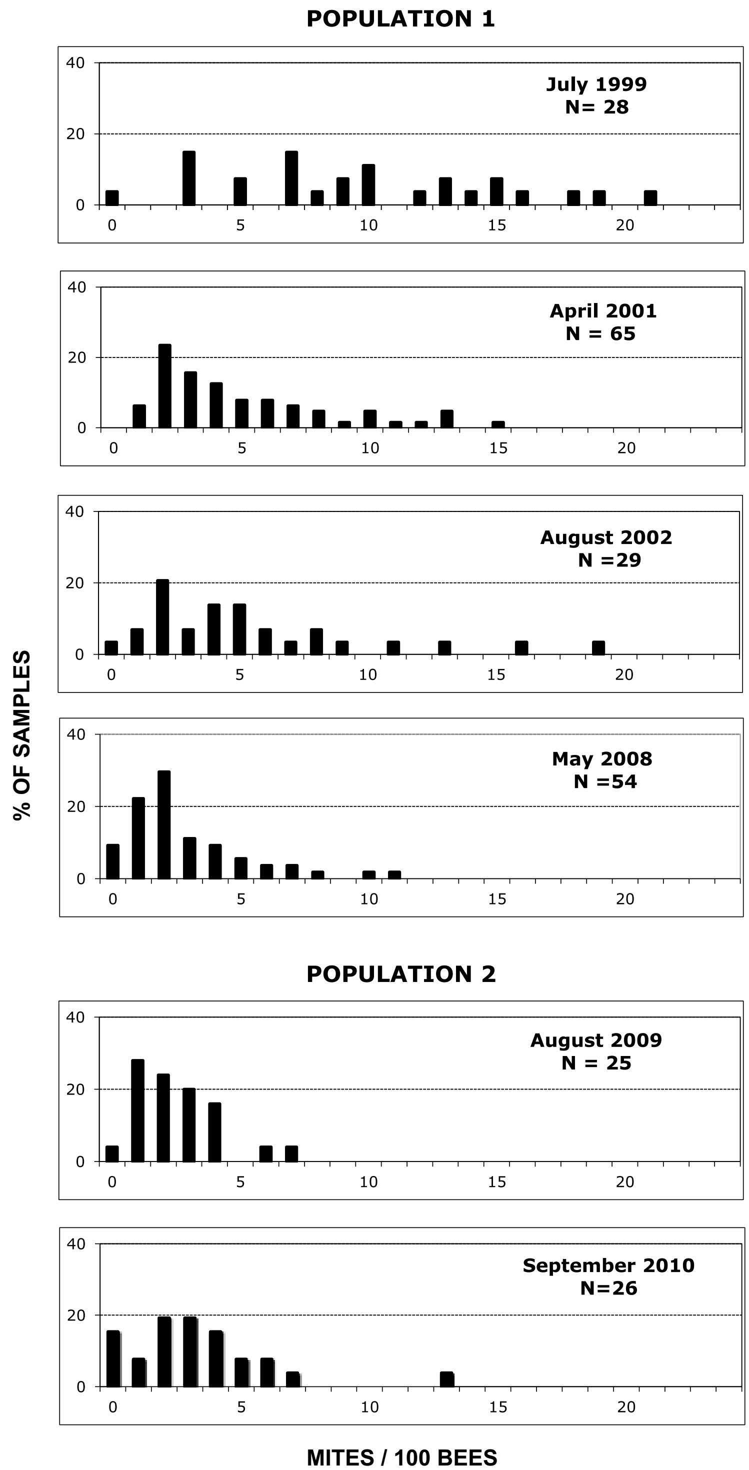

Figure 3. Mites on 100 bees for test populations 1 and 2. The *y*-axis represents % of samples. The *x*-axis represents mites on 100 bees. Bee samples were recovered during the hygienic test.

difference occurred due to the high hygienic behavior already present at 24 h (Figure 4). In group 1, colonies had high hygienic behavior in 1999 at the start of the survival test (Figure 4). No significant differences were found for hygienic behavior at 24 h between the years l999, 2002, and 2008. However, a significant decrease in hygienic behavior at 48 h occurred between the years 1999 and 2008 ($p < .0003$) and 2002 and 2008 ($p < .0068$).

In group 2, there were no significant differences between 2009 and 2010 for hygienic behavior at 24 and 48 h. Between groups, no significant differences for hygienic behavior at 24 h and 48 h were found when the years 1999 and 2002 (Population 1) were compared to 2009 and 2010 (population 2). A significant difference did exist when 2008 (less hygienic) was compared to 2009 at 24 h ($p < .0049$) and to 2009 ($p < .005$) and 2010 ($p < .0005$) at 48 h.

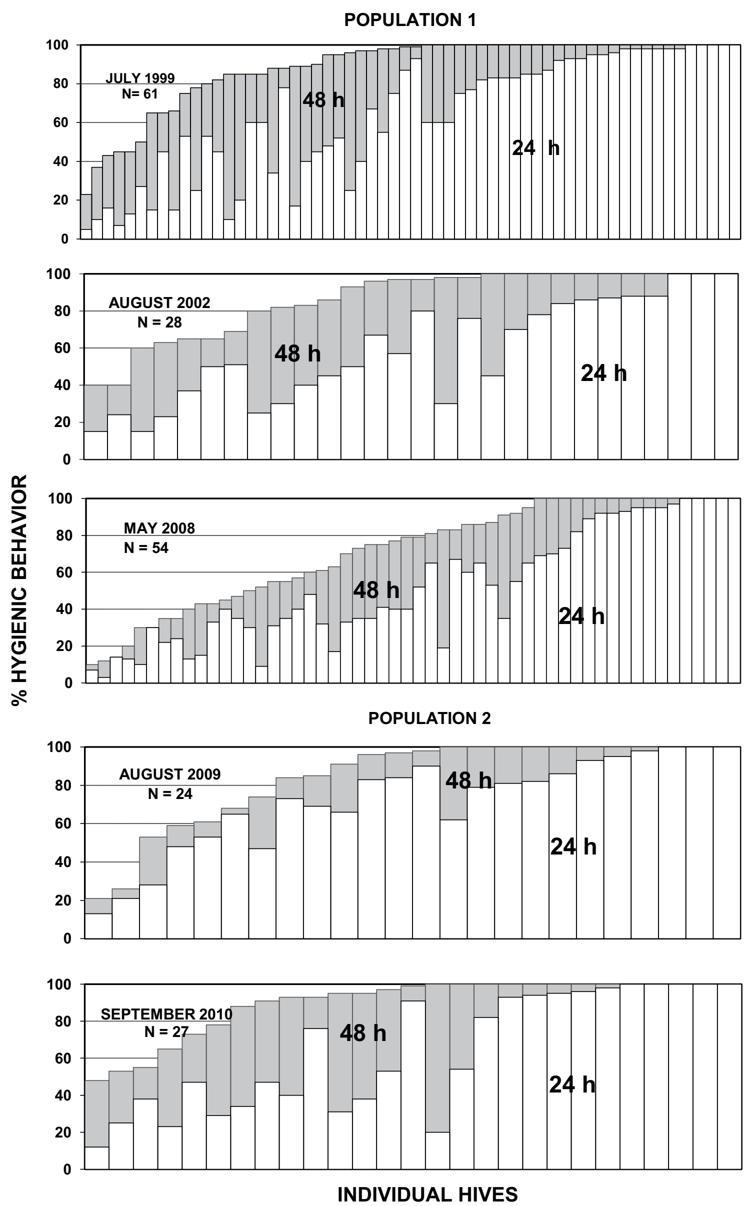

Figure 4. Hygienic behavior in test populations 1 and 2. Global group and detailed individual performances are shown. The *y*-axis represents % hygienic behavior. Columns on the *x*-axis are results for individual colonies. This graph includes a black bar profile graph of ascending removal scores at 48 h. The removal score of each individual colony at 24 h is shown in white over its score at 48 h. For each 48 h plateau, ascending scores at 24 h make a local white sub-profile for these colonies.

Discussion

Precise definitions make it easier to focus on a problem. At the present time, semantic confusion exists among bee scientists whenever the terms resistance and tolerance are utilized. According to Schneider and Ayres (2008), resistance and tolerance are two separate major pathways for survival to infestations. Raberg, Graham, and Read (2009) define resistance as "the ability of a host to limit parasite burden" and tolerance as the ability of a host "to limit the damage caused by a given parasite burden". They state that the advantage of their definitions is that resistance and tolerance can be considered both independently and in parallel. Accepting their definitions for resistance and tolerance, mite populations should decrease as bees become more resistant and would be expected to remain at the same level or even increase if tolerant. Hence, according to these definitions what many bee researchers are describing as tolerance should actually be considered as resistance.

Techniques developed to study resistance and tolerance in other animals may have direct applications to the honey bee and *vice versa* (Bishop, Doeschl-Wilson, & Woolliams, 2012). Doeschl-Wilson et al. (2012a, 2012b) pointed out the problems of making accurate phenotype measures for tolerance and indicated the type of measurements that would have to be made when selecting for tolerance. Tolerance mechanisms that prevent or repair damage may offer individuals wider generic (group) protection when they are exposed to a variety of diseases and may be good candidates for genetic improvement in the immune system (Doeschl-Wilson & Kyriazakis, 2012).

In honey bees, Danka, Rinderer, Spivak, and Kefuss (2013) defined resistance as the ability of a hive to "keep *V. destructor* at a relatively low level". Efforts to document resistance to varroa focus on the maintenance of colony fitness being associated with reduced numbers of infesting mites. Fitness in honey bees can be measured in a number of ways such as amount of brood, colony size, survival, queen, and honey production.

Although tolerance to the haplotype of varroa found in Europe has not been demonstrated (according to the above definitions), efforts to do so would have to focus on the maintenance of colony fitness with elevated numbers of infesting mites.

Hygienic behavior is associated with reduced mite populations (Harbo & Harris, 2005; Ibrahim & Spivak, 2004, 2006; Spivak,1996; Spivak & Reuter, 1998). At present, two types of hygienic behaviors are known. General hygienic behavior that is associated with removal of diseased larvae, pupae, and mites can easily be selected for using the frozen brood technique. The second, Varroa Sensitive Hygiene is characterized by a higher removal rate of mites and manipulation of cell contents but is more difficult to select.

Comparisons between four different lines of honey bees in the USA indicated that lines selected only for general hygienic behavior and those selected for varroa sensitive hygiene removed freeze killed brood at about the same percent in 48 h. However, mites were removed to a lesser degree in the lines selected for general hygienic behavior (14%) than in the group selected for Varroa Sensitive Hygiene (66%)(Danka, Harris, Villa, & Dodds, 2013). This suggests that beekeepers should select for both behaviors to get maximum disease and varroa resistance.

Hygienic tests were performed to see if this trait would be influenced during the survival test. That we globally (excepting for comparisons with 2008) did not find significant changes in hygienic behavior between years is not surprising. Population I colonies had high hygienic behavior in 1999 at the start of the test. This might partially explain the high colony survival after 2002 when almost one-third of the colonies survived. After 2002, no more selection for hygienic behavior was made until 2008 when a significant reduction in hygienic behavior at 48 h was observed (Figure 4).

This indicates that when colonies within a breeding population have been selected for high general hygienic behavior that is controlled by recessive genes (Rothenbuhler, 1964) and selection is stopped, the attained level of hygienic behavior can remain stable over a long period of time.

This might explain the results of Locke and Fries (2011) and our field test where no correlations between general hygienic behavior and mite infestations were found. Groups containing colonies with both high and low general hygienic behaviors such as those in Danka et al. (2013) would have to be tested to see if they differ in mite infestations.

It is clear that mechanisms of resistance and tolerance (whatever they are) may require years to be expressed before they can be utilized for selection. Chemical mite control masks and destroys natural selection for these mechanisms. Short-term experiments lasting only a few months can lead to erroneous conclusions. This is well illustrated in the 1993–2004 *A. m. intermissa* survival experiment where clear differences were observed only after 12 months of testing (Kefuss et al., 2004). Similar results were found by Fries and Bommarco (2007) and Locke and Fries (2011).

That over 33% of the population I colonies would survive after two years was not expected at the start of the tests. At present, parasite burden is low in both test populations indicating that colonies are resistant but probably not tolerant to mite infestations. This is clear when we consider the low number of mites found for the test populations in 2008, 2009, 2010 (Tables 3, 4, Figures 2, 3). We wish to stress that within test population I from April 2001 to May 2008, mite populations on the bees and in the brood significantly decreased indicating a clear progression toward higher resistance

(Figures 2, 3, Table 3). Extreme values of variation diminished between 2001 and 2008 suggesting again that a selection toward resistance had occurred (Table 3). Some of the significant differences observed in the 2002–2008 comparison might have been due to a seasonal effect as mite populations are usually but not always lower in the spring when compared to those of late summer (see Kefuss et al., 2004 for an example of high Spring and low Fall mite populations). In an open mating population, fluctuations in mite numbers and variation are to be expected. This might explain the significant increase of adult and daughter mites between 2009 and 2010 in test population 2. However, mite populations for both years in population 2 were still significantly lower than that of population 1 in 2002 (Table 4).

The population of adult mites on bees and in the brood of the two test populations was significantly limited after 2002. This might have been due to reproductive failure of either female or male mites as many adults were found without daughters (Figure 2 and Table 3). Varroa Sensitive Hygienic behavior (VSH) where bees selectively remove mites might also have played a role (Harbo & Harris, 2005) but was not tested for in this survival test. We are in agreement with Locke and Fries (2011) and Locke, Le Conte, Crauser, and Fries (2012) who concluded that factors such as reduced mite reproduction opportunities (delayed mite egg laying) and suppression of mite reproduction success (high mite infertility) probably play a major role in limiting mite populations. This does not however exclude other unknown factors that might be less, equally, or even more important for colony survival.

Since genetic material was exchanged between the two test populations over time, the populations, though independent, are probably very closely related to each other genetically despite differences in location and mite sources. This situation corresponds to that of a beekeeper who buys queens from a queen breeder to change the genetic composition of his colonies. It also implies that beekeepers should be able to incorporate selected mite resistance material from outside sources into their own populations with little difficulty using queen cells for example. Harbo and Harris (2001) found similar results when they exchanged resistant and non-resistant queens between hives. Resistant colonies became non-resistant and non-resistant became resistant.

If a new lethal mite-vectored virus occurs in a mite tolerant bee, high colony mortality might result until resistance or tolerance to that virus is found. Given the problems of virus transmission by mites (Chen, Pettis, & Feldlaufer, 2005; Locke et al., 2012; Mirinda, Gauthier, Ribierre, & Chen, 2012) we suggest that beekeepers should first select their colonies for mite resistance to reduce colony mite populations. Then, select for tolerance to the damage caused by the mites and the diseases they vector. For example, recent studies indicate that tolerance to the deformed wing virus may be under genetic control (Khongphinitbunjongaet et al., 2015; Locke, Forsgren, & de Miranda, 2014). Al Toufailia Amiri, Scandian, Kryger, and Ratnieks (2014) found that worker bees from colonies that were more than 95% hygienic had significantly fewer mites and lower levels of RNA copies of DWV. The ideal situation for beekeepers would be a mite-resistant bee that is both tolerant to the damage caused by the mites and the diseases they vector.

There are clear reasons why beekeepers should select for mite resistance and why chemicals should not be used in mite control. Chemicals used to treat against mites have been clearly found to impact colony health, immunity, and potentiate the effects of insecticides; Haarmann, Spivak, Weaver, Weaver, and Glenn (2002), Collins, Pettis, Wilbanks, and Feldlaufer (2004), Mullin et al. (2010), Locke et al. (2012) and Johnson, Dahlgren, Siegfried, and Ellis (2013).

Breeding projects in different parts of the world have demonstrated that it is possible to select bees with increased levels of resistance to *V. destructor* (see reviews of Büchler, Berg, & Le Conte, 2010; Rinderer et al., 2010) and that this is a commercially viable situation (Danka et al., 2012). Our results demonstrate that it is possible to select bees that lower mite populations using simple methods adapted to commercial beekeeping conditions and to breed this genetic material into other honey bee gene pools even when the underlying resistance mechanism is not understood (blind selection). We believe that it is the responsibility of everyone who breeds bees to try to select for mite resistance to reduce chemicals in hives. We owe this effort to the general public and to future generations of beekeepers.

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Meet the Beekeeper
Dr. Vanessa Corby-Harris

1. Name: Vanessa Corby-Harris

2. Occupation: Research Physiologist with the USDA-ARS

3. Location- institution: USDA-ARS in Tucson, Arizona

4. How did you get your start in beekeeping and what inspired you to seek to study them?
It happened quite accidentally and I can't say that I've been working with bees that long. After doing a postdoc on mosquitoes, hormones, immunity, and nutrition I became very interested in the underlying biology of nutrition in insects. I am fortunate to know Kirk Anderson, who was starting his work at the USDA in Tucson and he needed a postdoc and I guess that's the start of my beekeeping career.

5. What is some past research or programs that you worked with?
I got my Ph.D. from the University of Georgia (working on the genetics of fruit flies). I then came to the University of Arizona where I worked with mosquitoes. I guess you could say that I'm fascinated by insects, their genes and how their bodies find unique ways of using their genes to respond to their environments.

6. What are you currently working on?
Multiple things… many of you are probably familiar with the "P. apium Project", a citizen science project where we will distribute P. apium, a bacterium that is beneficial in our hands, to beekeepers to test for themselves. This is a relatively minor part of my research program that continues work that I did with Kirk Anderson as his postdoc. The bulk of my current work has to do with nutrition and how nutrition impacts the health and nursing capabilities of young worker bees.

7. Where do you see the next few years of research or beekeeping management leading?
I am really passionate about research that leads to improved products or processes for beekeepers. I hope my current research will help to get prospective products in the world of bee nutrition into the hands of beekeepers.

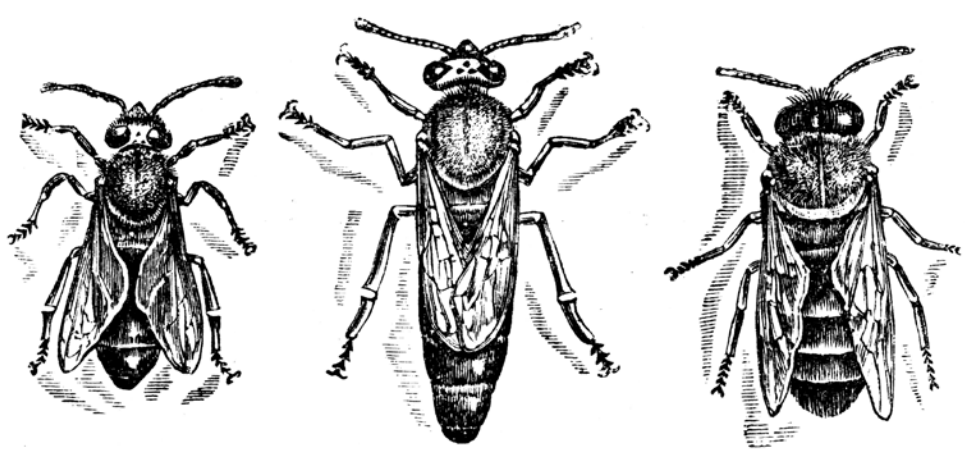
8. What message about bee health and management would you like to share with readers?
In a perfect world, bees would never acquire pathogens and every plant would be free of

pesticides. I would love for that be true, but it's simply not the case and it may never be despite the efforts of the ARS and the entire research community. But positive strides in the area of bee nutrition are realizable goals. We can start out by developing better supplements and making natural forage more available and accessible to bees. And maybe if bees are fed better, they might be able to resist things like pesticides and disease. I think it's a really exciting time for bee nutrition and I'm excited to be working with folks that feel the same way. We need more people working on this - especially folks that want to come up with solutions!

9. Where can we find information about your research/organization?
The USDA-ARS Carl Hayden Bee Research Center in Tucson lists my official USDA-ARS webpage. My unofficial lab website is www.corbyharrislab.com. I should say that this latter website is not a USDA website but that one tends to be more current.

10. Anything on or off topic that you find interesting about yourself/organization to share with readers?
I really love talking to the beekeepers. I learn so much valuable information from all of you and it's my favorite part of my job.

11. How can readers contact you and get more info on your organization?
Look at my website http://www.corbyharrislab.com/, contact me at vanessa.corby@ars.usda.gov, or call me at 520-647-9269.



Worker. Queen. Drone.

Sweet As Honey

The Good Food Awards

There are over 300 unique types of honey in the U.S. The Good Food Awards will showcase honeys most distinctive in clarity and depth of flavor, produced by beekeepers practicing good animal husbandry and social responsibility. From rooftop urban hives to busy bees pollinating organic orchards and meadows filled with wildflowers, awards will be given out in Liquid & Naturally Crystallized, Creamed, Comb and Infused Honey subcategories. To view the full entry criteria, visit: http://www.goodfoodawards.org/honey/honey-criteria/

COMMITTEE CHAIR

Amina Harris is the Director of the Honey and Pollination Center at the Robert Mondavi Institute of Wine and Food Science, UC Davis, working to make the school a leading authority on honey bee health, pollination and honey quality. The Center has been involved in the development of many innovative programs from making mead, to bee health and, most recently, the Honey Sensory Experience. Under her direction, the Center published the UC Davis Honey Flavor Wheel, widely acclaimed to help tasters describe honey flavors. In addition, Amina owns Z Specialty Food, LLC with her husband and son. Moon Shine Trading Company, a division of Z Specialty, has been offering unique American varietal honeys for over thirty years and has won awards from the Specialty Food Association and the National Honey Board. Amina served on the Board of Directors of the Specialty Food Association (then NASFT) for six years and was the Winter and Spring Show Committee Chair for many years. During her time both on the Board and exhibiting at the Fancy Food Shows since the early 1980's, Amina has been an active participant of the ever changing and growing food industry.

M.E.A. McNeil is a journalist writing for Bee Culture Magazine and The American Bee Journal as well as the new edition of the seminal reference book The Hive and the Honey Bee. She is a Master Beekeeper and a member of the UC Davis Mondavi Center Honey and Pollination Board. She lives with her husband on a small organic farm in San Anselmo, California.

Sweet As Honey
The Good Food Awards

COMMITTEE
Emily Brown, Owner, AZ Queen Bee
Mary Canning, Founder & CEO, Follow the Honey
Mark Carlson, Beekeeping Instructor/Entomologist, Round Rock Honey Beekeeping School
Kim Flottum, Editor, Bee Culture Magazine
Terry Oxford, Owner, UrbanBee San Francisco

JUDGES FOR LAST YEAR'S AWARDS
Lynne Devereux, Founder, Butter Communications
Robb Duncan, Founder, Dolcezza
Ann M. Evans, Cookbook Author, Columnist & Local Food Systems Consultant
Deborah Koons Garcia, Filmmaker, Symphony of the Soil & The Future of Food
Orietta Gianjoro, Owner, Orietta LLC
Maia Hirschbein, Oleologist, California Olive Ranch
Thalia Hoehenthal, Senior Scientist, Guittard Chocolate Company
Margaret Lombard, CEO, National Honey Board
Kitty Morgan, Assistant Managing Editor, San Francisco Chronicle
Stacie Pierce, Proprietor, Co-Curator & Baking Instructor, Little Bee Baking
Ina Pinkney, Author & Columnist, Chicago Tribune
Deborah Rogers, Olive Oil Producer & Owner, Marquesa EVOO
Amaryll Schwertner, Executive Chef, Boulettes Larder
Donna Suh, Buyer, Heath Ceramics
Jessica Theroux, Founder, Cooking with Grandmothers & Author, Cooking with Italian Grandmothers
Danielle Vogel, Owner, Glen's Garden Market

Good Food Awards contact info:
Tel: 415.447.3268 | info@goodfoodawards.org

Photography by Aya Brackett & Marc Fiorito

Bee Thinking About

Eastern Apiculture Association 2016 Conference

The Best Bees Company**'s Noah Wilson-Rich, and "**Bee Girl**" Sarah Red-Laird welcome you the** Eastern Apiculture Association**'s 2016 Conference! We will be hosting a "Next Gen" breakout session for fellow young beekeepers!**

What's a "Next Generation Beekeeper"? “Next Gen” is defined as, “The step forward that perpetually propels us into our impending destiny.” We are the next generation in our family of beekeepers, we are the drivers of the next stage of development in the products, services, expertise, and knowledge our industry provides. This beekeeper is a commercial or small scale beekeeper, or works as an educator or researcher. They are passionate about bees, and want to be involved in future beekeeping innovation, research, policy, technology, advocacy, or community leadership.

This breakout session will feature free beer, music, great networking opportunities, free beer, and an organized, interactive group session. The session is designed to develop a few ideas for addressing the issues new beekeepers face, as we join this industry. You tell us what that needs to be done, we’ll listen and help to develop a positive action plan to propel our industry forward.

RSVP here: https://easnextgen.eventbrite.com

We are still on the lookout for a great location! If you are familiar with the Galloway, NJ, area, we would love your help in finding a community center, a home with a big back yard, a park shelter, or a Daddy Warbucks mansion (heh heh). Reply to this email if you've got any ideas to share with us!

Sarah and Noah will also be team teaching a "train the trainer" workshop at the Eastern Apicultural Society Conference, on Monday, July 25th, at 2:30pm, in Galloway, NJ, at Stockton University. Join this session for an outline of how to organize a “Next Gen” breakout session in your region.
Check out Noah's awesome TED Talk on urban beekeeping here:

Noah Wilson-Rich, Ph.D. is a Research Affiliate with the MIT Media Lab / biologist / professor / NYTimes contributor / two-time TEDx speaker / beekeeper / uncle. His book, The Bee: A Natural History was released in 2014 through Princeton University Press. Noah’s research focuses on bee immunology, and extends to include all ways to improve bee health. Noah is a Founding Partner of The Best Bees Company, a beekeeping service that delivers, installs, and manages beehives for residential and commercial properties, nationwide. Proceeds from The Best Bees Company go toward research conducted at the Urban Beekeeping Laboratory and Bee Sanctuary, a 501(c)3 nonprofit organization, based in Boston’s South End.

Sarah Red-Laird is the founder and Executive Director of the Bee Girl organization, a nonprofit with a mission to inspire and empower communities to conserve bees and their habitat. She is a graduate of the University of Montana's College of Forestry and Conservation with a degree in Resource Conservation, focused on community collaboration and environmental policy. Aside from running the Bee Girl organization’s six programs, Sarah is the US Ambassador of the International Bee Research Association's (IBRA) BEEWORLD project, the Kids and Bees Director for the American Beekeeping Federation, a New York Bee Sanctuary Advisory Board member, is an active member of the Northwest Farmers Union, the Western Apicultural Society’s Oregon Director, and the Regional Representative for the Southern Oregon Beekeepers Association. When she is not tirelessly working with bees, beekeepers, kids, farmers, land managers, and policy makers, Sarah heads for the hills with a camera, large backpack, fishing rod, bike or snowboard, and her best friend, Sophie the Yellow Lab.

Bee Thinking About

Back issues of *The Natural Farmer* archived and available for FREE!!!

The Natural Farmer is the journal of the Northeast Organic Farming Association (NOFA) in the northeastern United States. It is published quarterly in a tabloid format of 48 pages. The journal covers news of the organic movement nationally and internationally, as well as featuring recent book reviews and stories about farmers, gardeners and homesteaders from New England, New York and New Jersey. Each issue contains a 24 to 32 page supplement on a particular focused topic. NOFA members receive it as a benefit of membership, others may subscribe directly.

Articles from the supplement are posted individually on a website archive at www.TheNaturalFarmer.org three months after the print version appears. All articles published in the last two years are now available individually, and previously published issues are available temporarily as pdfs while we convert them to the website format.

www.TheNaturalFarmer.org

HONEYBEES

a Biodynamic Apiculture

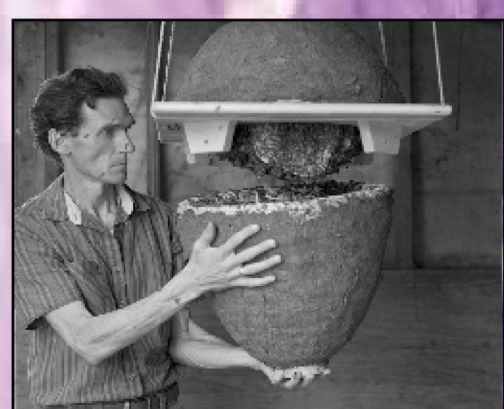
Workshop

August 6 & 7, 2016

Join us at Dancing Sophia Honeybee Sanctuary in Cleveland, NM for a journey into the deeper nature of Apis Mellifera in this two day exploration of the biodynamics of apiculture. We will step into the world of honeybees and enter their multidimensional landscape that constitutes an unusual and unique matrix of life and reveals the deep inter-dependencies and wholeness of the entire biosphere. **Michael Thiele** will present multiple dimensions of the nature of honeybees and a new paradigm of living with bees. We will venture into "hive-mind"; explore the inter-relationships within and outside the hive; and look at the ethical, ecological and spiritual dimensions of our relationship with honeybees.

How can the Earth be healed through healing the life of bees?

FOR MORE INFORMATION and Registration Go To:
www.dancingsophiabees.com or call: (575) 387-5907



Michael Joshin Thiele is leading an innovative approach within the biodynamic apiculture movement and teaches in the United States and abroad. He is Founder and President of Gaia Bees (www.gaiabees.com) and is researching wild honeybees and new dimensions of apiculture in a socio-cultural, agricultural and spirital context. In the last decade, Michael has been involved with the creation of honeybee sanctuaries and refuges as a means of protection and education. His work is documented in various national and international magazines, books and film documentaries ("Queen of the Sun").

BEe Healing Guild
a non-profit

2 Events before the GATHERING

Apiary Class, Wed. **Sept 7**, will be taught by Lady Spirit Moon

Apitherapy Class, Thurs. & Fri., **Sept 8 & 9**, will be taught by Lady Spirit Moon. Class is limited to 20 students due to the many practicums and a full afternoon one-on-one Bee Venom Therapy.

GATHERING - September 10 & 11, 2016

Come join us for a beekeeping experience in Spring Creek, NC – a place that will:

"Provide a sacred space for sharing, learning, expressing, teaching, guiding, experiencing, healing, and understanding the components of body, mind, and spirit for the sake of and for honeybees, humans, and Mother Earth."

Meet internationally renowned speakers on every aspect of beekeeping. Learn no-treatment beekeeping practices, how to communicate with honeybees, keep them in optimum health, grow plants for the well-being of honeybees and humans, and how to use those plants in herbal formulas. Dance bee dances, listen to storytelling, and drumming. Also enjoy, for a nominal fee, Honey Facial Massages and Reiki Sessions. Tour Lady's apiary and honey house that includes her healing room, mini-lab, and honey workshop.

Children participating in classes taught by Sally Adams, certified to teach children in NC and SC school for science credits. They will learn about honeybee anatomy, roll and decorate beeswax candles, and more.

Go to www.BEeHealing.buzz for more information and registration

MAKE IT A FAMILY WEEKEND IN THE MOUNTAINS.

~

Presenter/Lecturers/Performers

Advisor/Main Speaker: Dr. Don Huber, Emeritus Professor, Purdue University, Plant Pathology

Advisor/Presenter: Andrew Goodheart Brown, International Consultant for small scale sustainable agriculture projects; Permaculture Practitioner and Teacher (nationally and internationally)

Advisor/Presenter: Corwin Bell - holistic focus on “behavioral immune system” through attentive observation, intercommunication through right timing and sustainable methods.

Presenter: BEe Healing Guild Founder: Lady Spirit Moon – Certified Apitherapist

Advisor/Presenter: Les Crowder – Topbar Hives. Author Top-Bar Beekeeping: Organic Practices for Honeybee Health.

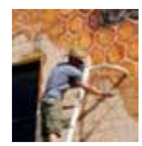
Advisor/Presenter: Laura Bee Ferguson – Founder/Director of College of the Melissae

Advisor/Presenter: Benjamin Pixie – beekeeping, mead maker, a conjurer of spirits, herbalist, a tanner, leather worker, & warrior poet

Advisor/Presenter: Jacqueline Freeman – Author of *Song of Increase*: *Listening to Beekeeping and a the Wisdom of Honeybees for Kinder and a Better World*.

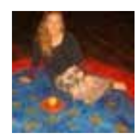
Advisor/Presenter: Sally Adams, Master Beekeeper, owner of MamaBeehive™ Instructs Children’s Programs

Artist Matt Willey is the founder of *The Good of the Hive* Initiative - and has committed to hand-paint 50,000 honeybees in murals around the world to raise awareness about their current struggles.



Advisor/Debra Roberts – Beekeeper, international honeybee educator, speaker, mentor, advocate, artist, and writer.

Bee Dancer: Tarleton Brooks



Storyteller/Musician: Doug Elliott

Musician/singer: Sister 'Je' Spiritvoice

Gathering Extras

Master Reiki – Joyce Rawlings-Davies (Nominal fee)

Mona Hoban – Massage Therapist:

Honey Facial Massage (Nominal fee)

Greta Lee Camp – Yoga Instructor/Therapist (Free)

Randy Bell – Director of Spring Creek Spirituality (Free)

Bee Culture

The Magazine Of American Beekeeping

Get Ready For Bee Culture's Next Event

A CASE FOR HONEY

Our case of honey is filling nicely this winter. Speakers committed so far include Dan Conlon, Warm Colors Apiaries, Massachusetts; Bob Binnie, Blue Ridge Honey Company, Georgia; Dave Shenefield, Clover Blossom Honey, Indiana; Steve Conlon, ThistleDew Honey, West Virginia; Roger Stark, Howalt-McDowell Insurance, South Dakota, Joann Dunlevey RS, Food Safety Specialist, Ohio Dept. of Ag; and a Representative of The FDA. Other speakers are firming up travel plans and will be announced as they become known.

This well rounded group has all aspects of this topic well covered. U.S. Producers, Packers, Producer/Packers, Insurance and Risk Brokers, Marketing, and all the new Food Safety rules and regulations from both Federal and State level perspectives

Unfortunately, missing from this discussion will be the National Honey Board, the marketing arm of the honey industry, and those large packers and importers who have chosen to have their annual meeting on the same weekend. The coincidence has not gone unnoticed. The focus of this event will remain on promoting and informing ambitious US Honey Producers and Packers of U.S. Honey.

New this year will be a Friday Night Social held in Bee Culture's Conference Center, the location of the Two day Conference on Saturday and Sunday. It's a low-key, meet and greet with the speakers and attendees from 5pm to 7pm on Friday where you can pick up your folders with speaker profiles, conference agenda, and lots of information on Medina's dining and shopping opportunities. Supper afterwards is on your own but you'll have plenty of places to choose from, and lots of people to join with.

Tuition is $150.00 per person which includes the Friday night social and classes and an exceptional lunch on Saturday and Sunday. On line Registration opens April 1, 2016.

Friday Night Social, October 21, and classes and lunch Saturday and Sunday October 22 & 23, *Bee Culture's* Conference Center, 640 W. Liberty St., Medina, Ohio. Register early.

Mark Your Calendars Now!

October 22 and 23, 2016 at
Bee Culture's Conference Center
640 West Liberty Street
Medina, Ohio

Watch BeeCulture.com and these pages for program and registration information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UPCOMING EVENTS

July 2016

Washington: Instrumental Insemination Courses with Sue Cobey at WSU
May-July 2016
For more info, visit https://honeybeeinsemination.com/
Email: suecobey@mac.com

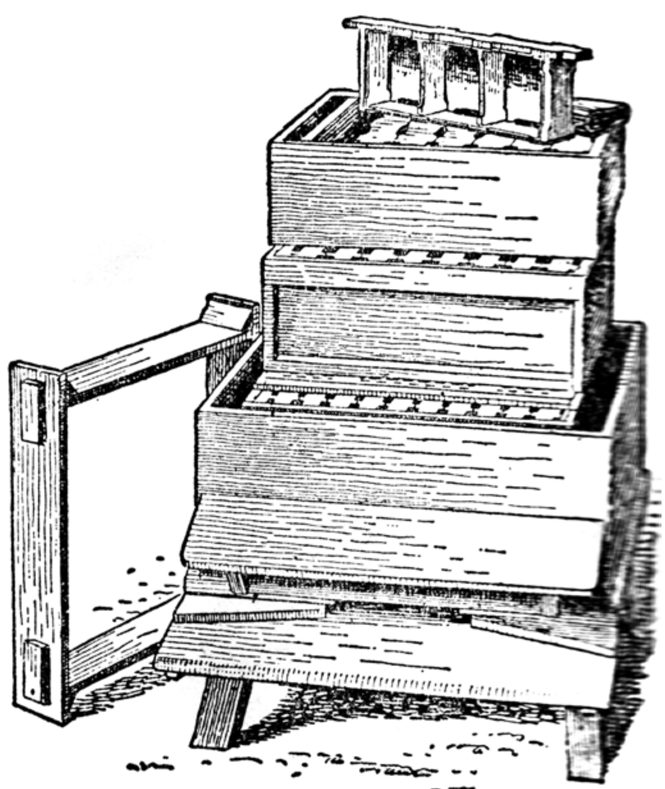
North Carolina: NC Beekeepers Summer Meeting
July 7, 8, & 9, 2016
Hickory Metro Convention Center
1960 13th Avenue
Hickory, NC
Info: www.ncbeekeepers.org

Kentucky: Heartland Apicultural Society- Bowling Green Conference
July 14-16, 2016
Info: www.heartlandbees.org

New Mexico: In Her Majesty's Chambers: Intro to Queen Breeding & Rearing Short Course with Mark Spitzig & Melanie Kirby, Longevity based queen breeders.
July 16-17, 2016
Zia Queenbees Farm & Field Institute
Truchas, New Mexico 87578
Info: www.ziaqueenbees.com/zia

Pennsylvania: 2016 International Conference on Pollinator Biology, Health and Policy
July 18-20, 2016
Penn State Campus
University Park, PA
Info: http://ento.psu.edu/pollinators/events/2016-international-conference-on-pollinator-biology-health-and-policy

New Jersey: Eastern Apicultural Society of North America Conference
July 27-29, 2016
Richard Stockton University
Galloway, NJ
Info: www.easternapiculture.org



We'd love to share news of your upcoming events. Please send the event name, date, website and/or contact information by the 10th of each month for inclusion in the following month's issue. Editor@KelleyBees.com